Appendix J1

Bypass Production Model Technical Appendix

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Appendix J1. Bypass Production Model Technical Appendix

1.0 Introduction

This technical appendix describes the agricultural economic model used in the analysis of alternatives considered for the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project (Project) Environmental Impact Statement/Environmental Impact Report (EIS/EIR). The Bypass Production Model (BPM) is used to evaluate the agricultural economic impact resulting from changes in the frequency, duration, and timing of increased Yolo Bypass flooding under each of the Project alternatives. The BPM was previously applied and reviewed with stakeholders in an analysis of Yolo Bypass flooding commissioned by Yolo County between 2011 and 2013 (Yolo County 2013). The underlying model theory and data are unchanged from the Yolo County analysis. Improvements to the BPM for the economic impact analysis of Project alternatives include the following:

- The BPM was changed from an annual time-step to a daily time-step for consistency with the TUFLOW hydrodynamic model output.
- The pre-processing of hydrodynamic model output was updated to incorporate field-by-field dry day estimates from the TUFLOW model.
- The hydrologic period of record was adjusted for consistency with the post-processed TUFLOW model output (1997 – 2012).
- An Existing Conditions (ExCon) / No Action Alternative (NAA) baseline was defined, consistent with TUFLOW ExCon/NAA output.
- The number of days required for field preparation was updated based on additional stakeholder feedback provided under this current analysis.
- All input and output data were updated for consistency with federal project evaluation guidelines.

As wetted area changes in the Yolo Bypass as a result of Project alternatives there is a corresponding effect on expected crop yields, crop mix, fallowing, and farm income. The BPM is an economic model linked to the hydrodynamic model (TUFLOW) that calibrates to observed conditions in the Yolo Bypass and historical farming decisions in response to changes in wetted area. It is used to quantify incremental changes over baseline (ExCon/NAA) conditions resulting from Project alternatives in terms of economic metrics including irrigated acreage, gross farm revenues, and net farm income. BPM inputs and outputs are consistent with federal National Economic Development (NED) guidelines for evaluating water development projects specified in the Principles and Guidelines (P&Gs).

The economic analysis includes the following alternatives:

- Existing Conditions (same as the No Action Alternative), abbreviated as ExCon/NAA
- Project alternatives including Alternative 1, Alternative 4 (March 15 gate closure), Alternative 4 March (March 7 gate closure), Alternative 5 and Alternative 6 (abbreviated as Alt1, Alt4, Alt4M, Alt5, and Alt6, respectively).

The economic impact to Yolo Bypass agriculture is defined as the incremental change under each Project alternative from ExCon/NAA. Each alternative is defined over the 1997 – 2012 hydrologic period of record. Economic impacts for each Project alternative are expressed as an average annual impact over this 16-year hydrologic period of record.

2.0 BPM Model Overview

The BPM is an agricultural production and economic optimization model that simulates Yolo Bypass agricultural production. It was initially applied in a preliminary analysis of Yolo Bypass flooding commissioned by Yolo County and completed between 2011 and 2013 (Yolo County 2013). The underlying model theory is unchanged from the 2013 Yolo County analysis. Modifications to the BPM that were summarized in the previous section are described in more detail in the following sections.

The BPM model is a calibrated economic optimization model of agricultural production. This type of economic model is designed to estimate economic impacts that require linkage with biophysical models (in this case, the TUFLOW model). The framework is also consistent with basic principles of economic impact analyses, and inputs and outputs are adjusted for consistency with NED guidelines. It was selected for the analysis for these reasons.

Calibrated optimization models have been widely applied in agricultural economic impact analyses concerning California agriculture for the last 30 years. The BPM has similar data requirements and shares the same underlying methods and theory as the Statewide Agricultural Production (SWAP) model. The SWAP model is widely used by the Bureau of Reclamation (Reclamation), California Department of Water Resources, United States Department of Agriculture (USDA), and various other state and local agencies for analysis of agricultural impacts in response to changes in resource conditions. In 2009, the SWAP model replaced the Central Valley Production Model (CVPM), which was developed in the 1980s and was initially applied for the economic impact analysis of the 1992 Central Valley Project Improvement Act.

The economic methods underlying the BPM (or calibrated optimization models in general) are well-established, widely applied, and have been peer reviewed. The calibration approach underlying the BPM (and SWAP and CVPM) known as Positive Mathematical Programming (PMP) was developed in the late 1970s and formalized in the peer-reviewed publication by Howitt (1995). This seminal paper has been cited over 990 times and the PMP method continues to be applied in a range of economic analyses concerning agricultural production and water use around the world. The specific application of these models in California and the peer-reviewed publication of California’s SWAP model can be found in Howitt et al. (2012).

The following subsections provide an overview of the BPM mechanics, calibration by PMP, and application of the model for the economic impact analysis of Project alternatives.

2.1 BPM Model Mechanics

The BPM assumes that farmers maximize profit subject to resource, technical, and market constraints. Farmers sell and buy in competitive markets, and no one farmer can affect or control the price of any commodity. The model selects those crops, water supplies, and other inputs that maximize profit subject to constraints on available resources, and subject to economic conditions regarding prices, yields, and costs. The competitive market is simulated by maximizing producer surplus subject to the following characteristics of production, market conditions, and available resources:

- Leontief production technology. This is a rigid production technology specification that does not allow for intensive margin adjustments (e.g., input substitution) by farmers. This specification was chosen because it does not allow for input substitution and economic impacts estimated using the BPM are conservative (more significant). Parameters are calculated using a combination of prior information and the PMP method.
- Cost-of-production information for each crop is based on standard University of California Cooperative Extension (UCCE) budgets.
- Resource use and availability is based on UCCE budgets and the Yolo County (2013) study geospatial cropping data.
- Expected crop yield is a function of the planting date, as estimated from the DAYCENT model (Yolo County 2013).
- Wetted area output by field is from the TUFLOW model for the 1997 – 2012 hydrologic period of record.
- Field preparation and miscellaneous drydown time are from Yolo County (2013) and ERA (2015).

The BPM incorporates the wetted area output from the TUFLOW model and other conditions listed above. As conditions change within each BPM region (e.g., the number of dry acres and expected crop yield changes), the model simulates planting decisions, inputs, and corresponding farm revenues. It also fallows land when that appears to be the most cost-effective response to resource conditions.

The TUFLOW model output for each alternative over the 1997 – 2012 period of record includes the last day wet for each field in the Yolo Bypass. A field can be planted no sooner than 34 days after the last day the field was wet. This includes 28 days for field preparation plus an additional 6 days for miscellaneous drydown time determined in coordination with Yolo County representatives and Yolo Bypass growers (Yolo County 2013, ERA 2015).

2.2 BPM Model Theory

The BPM is calibrated using the standard PMP method (Howitt 1995). The underlying assumption in any economic model, including calibrated optimization models such as the BPM, is that farmers behave as profit-maximizing agents. In a traditional optimization model, or spreadsheet accounting analysis, profit-maximizing farmers would simply allocate all land, up until resource constraints become binding, to the most valuable crop(s). This is inconsistent with the mix of high and low value crops observed empirically and thus is not a defensible basis for establishing the economic impacts of any project. The PMP method incorporates information on the marginal production conditions that farmers face and historical observed responsiveness to changes in prices and resource conditions, allowing the model to exactly replicate the base conditions of observed input use and outputs. Marginal conditions may include factors known to affect bypass planting decisions such as inter-temporal effects of crop rotation, microclimate, management skills, farm-level effects such as risk management and input smoothing, and heterogeneity in soil and other physical capital. These factors along with crop profitability jointly determine what is produced in any given area, as revealed in the geospatial Yolo Bypass cropping data.

Production costs are incorporated into the BPM through an exponential PMP cost function that reflects average and marginal production costs. The PMP cost function is both region and crop specific, reflecting differences in production across crops and heterogeneity across different regions in the bypass. For example, the southern end of the Yolo Bypass is characterized by a cooler microclimate, winds, and birds that limit its production potential for rice. The BPM is calibrated using information from acreage response elasticities and shadow values of calibration and resource constraints. The information is incorporated in such a way that the average cost data reflected in standard crop budgets (known data) are unaffected and consistent with NED guidelines.

The PMP calibration procedure can be briefly summarized in three steps. In the first step a linear profit-maximization program is solved. In addition to basic resource availability and non-negativity constraints, a set of calibration constraints is added to restrict land use to observed values in the base year of calibration data. In the second step, the dual (shadow) values from the calibration and resource constraints are used to derive the parameters for the exponential PMP cost function and production functions. In the third step, the calibrated production function and PMP cost function are combined into a full profit maximization program. At each stage, there is a corresponding model validation check to ensure the model is calibrating properly. These diagnostic tests are discussed in Howitt et al. (2012).

2.3 BPM Specification

Crop production in the BPM is represented by a Leontief production function (fixed input proportions) for each region and crop. In general, a production function is a mathematical specification of the relationship between inputs and output. The calibration routine in the BPM ensures that both input use and output replicate the base year of observed data. A Leontief production relationship was selected because it does not allow for input substitution which would tend to understate potential economic impacts. In addition, the fixed proportion production function ensures the BPM emphasizes the essential factor in this analysis, the effect of planting date on expected crop yields.

The BPM can be succinctly specified as follows:

$$\max_{X_{gid}} \sum_{g}\sum_{d}\sum_{i} EY_{gid} P_i X_{gid} - \sum_{g}\sum_{i} \alpha_{gi} \exp\left\{\beta_{gi} XT_{gi}\right\}$$

Subject to:

$$EY_{gi} = f_{gid}(\cdot)$$

$$XT_{gi} = \sum_{d} X_{gid}$$

$$\sum_{d} X_{gid} \le \sum_{d} DA_{gd}$$

$$DA_{gd} = \sum_{f}\sum_{d<\bar{d}} LDW_{fd+34}$$

$$X_{gid} \ge 0$$

The sets include crops $i \in$ {corn, dry pasture, irrigated pasture, processing tomatoes, rice, wild rice, safflower, sunflower, alfalfa, grain}, fields $f \in \{1,2,\ldots,454\}$, regions $g \in \{1,2,\ldots,6\}$, and Julian days $d \in \{60, 61, \ldots,180\}$. The set *f* maps uniquely into the set *g*. The variable X_{gid} defines acreage allocated to crop *i*, in region *g*, on day *d* and XT_{gi} defines total acreage. Parameters include the price P_i, expected yield EY_{gid}, total dry acreage DA_{gd}, last day wet from TUFLOW model output LDW_{fd}, and calibrated cost function parameters α_{gi} and β_{gi}. The expected yield is defined by the crop yield function $f_{gid}(\cdot)$, which is defined as a function of the dry date output from the TUFLOW model and illustrated in subsequent sections of this technical appendix. The cost function parameters include the average variable production costs, embedded in the α_{gi} term, and the PMP calibrated average plus marginal cost, embedded in the β_{gi} term.

The BPM objective function is to maximize farm net revenue defined as gross revenues less production costs. The convex constraint set is defined as follows. Expected yield is a function of the plant date, which in turn is a function of the cumulative dry fields at a given day. The total acreage planted cannot exceed the cumulative dry acreage, where the total planted acreage is defined as the sum of the planted acreage up to the current date. The total dry acreage at any given day (subscript $\bar{d}$) is the sum over the corresponding fields in the TUFLOW last day wet output field data, shifted by 34 days to allow for field preparation (28 days) and miscellaneous drydown adjustment time (6 days). Finally, a non-negativity constraint is redundant, but included for completeness.

The model is solved dynamically for each alternative on an annual timestep over the set of Julian days $d \in \{60, 61, \ldots,180\}$. Acreage may be planted incrementally as fields become dry, consistent with revealed farmer actions in the calibration data in the Yolo Bypass. Each alternative is run individually and looped over the 1997 – 2012 period of record. Economic impacts are calculated as the difference between ExCon/NAA and the respective Project alternative for each year. This correctly isolates the incremental impact of the Project.

The BPM does not allow for fields that are typically fallow to be planted under either the ExCon/NAA or Project alternatives. That is, the average annual fallow footprint (fields) in the Yolo Bypass are excluded from the incremental dry acreage (TUFLOW output) in the BPM. This is a conservative assumption that ensures standard rotational fallowing is not incorrectly netted out of the Project impacts – only the typically irrigated footprint (summarized in subsequent sections) is included in the economic impact analysis.

2.4 BPM Calibration

The BPM calibrates to 2005 – 2009 average Yolo Bypass geospatial cropping data, consistent with the Yolo County (2013) study. There are a series of calibration tests in the BPM that ensure various economic first order conditions are satisfied, ultimately cumulating in the final calibration check that the model calibrates in inputs and outputs. Table 1 summarizes the percentage difference between the calibrated BPM and the base land use data by crop and model region. As shown, the BPM calibrates within one percent of the base data, verifying that the model is correctly calibrated. Since the model includes Leontief production technology, the other inputs and outputs are calibrated at the same accuracy by definition.

Table 1. BPM Calibration: Model Acreage by Crop and BPM Region, Percent Difference

	1	2	3	4	5	6
Sunflower	0.00%					0.16%
Alfalfa						0.13%
Corn	0.16%	0.17%	0.29%	0.62%		
Dry pasture					-0.02%	0.01%
Grain	0.01%	0.02%			0.06%	0.14%
Irrigated Pasture					0.03%	-0.03%
Processing Tomatoes	-0.01%	-0.01%	0.00%			0.01%
Rice	-0.01%	-0.01%	-0.01%	-0.02%	0.00%	0.03%
Safflower	-0.01%	-0.02%	-0.02%	0.02%	0.06%	0.21%
Vine Seed		-0.01%	0.00%	0.02%		
Wild Rice		-0.01%	-0.01%	-0.01%	0.01%	0.04%

2.5 Linkage to Hydrodynamic Analysis

The BPM has important interactions with the hydrodynamic analysis. In particular, the TUFLOW model provides last day wet information for each field to the BPM. These data are provided for each field, alternative, and year. Each field has a timestamp for the last day the field was wet as determined by TUFLOW. The BPM model adds an additional 28 days for field preparation and an additional 6 day for miscellaneous drydown time to the TUFLOW model output. This date (dry day plus 34 days) represents the earliest day a field could be planted. It is noteworthy in some years farmers are able to prep and plant fields in a shorter timeframe.

3.0 BPM Model Data

The BPM model requires a wide range of data to simulate Yolo Bypass agricultural production. The data are compiled from various public sources, stakeholder input under the Yolo County (2013) study, and stakeholder input under this current analysis (ERA 2015).

3.1 BPM Regions and Crop Definitions

The Yolo Bypass is divided into seven production regions which reflect differences in soil, microclimate, and cropping patterns determined in consultation with stakeholders (Yolo County 2013). Each region includes a number of fields which are identified and uniquely mapped to the corresponding region. Regions 1-6 are included in the BPM model. Region 7 is excluded because that area is not affected by the Project, has different cropping patterns than the rest of the Yolo Bypass, and is missing data observations that were not gathered under the Yolo County (2013) study. Figure 1 illustrates the BPM regions.

Crops are aggregated into 11 crop groups which are the same across all BPM regions[1]. Each crop group represents a number of individual crops, but many are dominated by a single crop. Irrigated acres represent acreage of all crops within the group; production costs and returns are represented by a single proxy crop for each group. Production costs and returns are from the UCCE crop budgets. Crop group definitions and the corresponding proxy crop are shown in Table 2.

Table 2. BPM Crop Groups

BPM Crop Group	Proxy Crop	Crop Budget
Corn	Field Corn (Grain)	UCCE 2012 Sacramento Valley Corn (field)
Dry Pasture	Dry Pasture	UCCE 2012 Intermountain Pasture
Irrigated Pasture	Pasture Irrigated	UCCE 2012 Intermountain Pasture
Processing Tomatoes	Processing Tomatoes	UCCE 2012 Sacramento Valley Proc. Tomatoes
Rice	Rice	UCCE 2012 Sacramento Valley Rice
Safflower	Safflower	UCCE 2011 Sacramento Valley Safflower
Sunflower	Sunflower	UCCE 2011 Sacramento Valley Sunflower
Vine Seed	Vine Seed	UCCE Squash (2005) and Yolo County (2013)
Wild Rice	Wild Rice	UCCE 2005 Intermountain Wild Rice
Alfalfa	Alfalfa	UCCE 2012 Sacramento Valley Alfalfa
Grain	Wheat	UCCE 2009 Sacramento Valley Wheat (grain)

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[1] A potential 12th group of “orchards” is not included because no orchards are grown in Yolo Bypass regions 1-6.

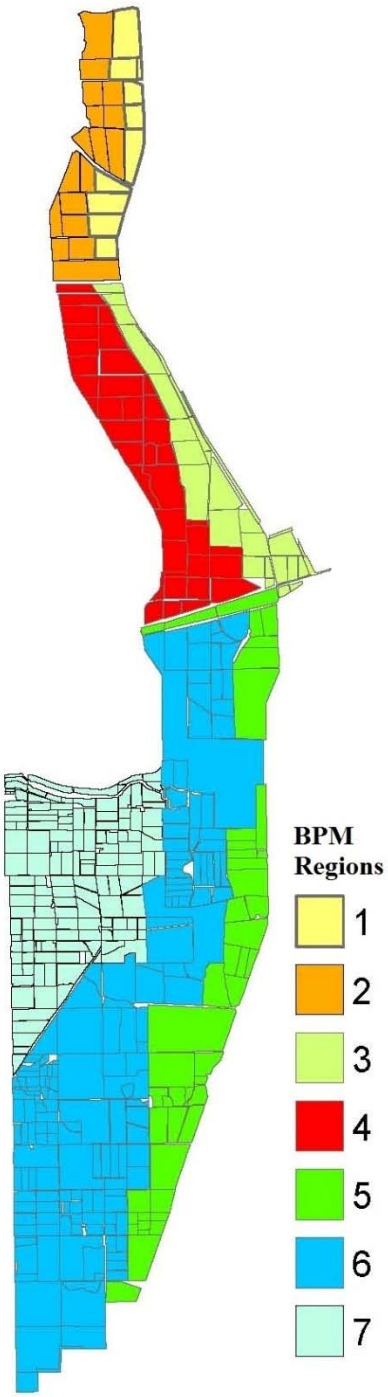


Figure 1.
BPM Production Regions

Land use in the BPM is from the Yolo County (2013) field footprints developed for the Yolo Bypass. These include the years 2005 through 2009. These years represent a series of wet and dry years and are described in more detail in Yolo County (2013). Table 3 summarizes the average of 2005 through 2009 crop acreage used to calibrate the BPM.

Table 3. Yolo Bypass 2005 - 2009 Average Crop Acreage

Region	1	2	3	4	5	6	Total
Corn	59	110	62	78	0	0	**309**
Dry Pasture	0	0	0	0	2,406	6,625	**9,031**
Irrigated Pasture	0	0	0	0	560	7,012	**7,572**
Processing Tomatoes	304	673	194	0	0	1,403	**2,574**
Rice	342	533	390	2,922	570	922	**5,679**
Safflower	205	406	632	497	173	81	**1,993**
Sunflower	28	0	0	0	0	48	**76**
Vine Seed	0	114	48	17	0	0	**178**
Wild Rice	0	70	368	883	140	520	**1,982**
Alfalfa	0	0	0	0	0	78	**78**
Grain	28	30	0	0	171	547	**776**

Source: Yolo County (2013)

In most years the Yolo Bypass includes a significant amount of fallow land. As discussed previously, including the fallow land footprint as potential irrigable acreage could incorrectly understate the economic impacts of the Project by allowing irrigated acreage to switch these areas. This BPM does not allow for this crop switching to occur by excluding these fallow fields from the potential irrigated footprint.

3.2 Crop Prices and Yields

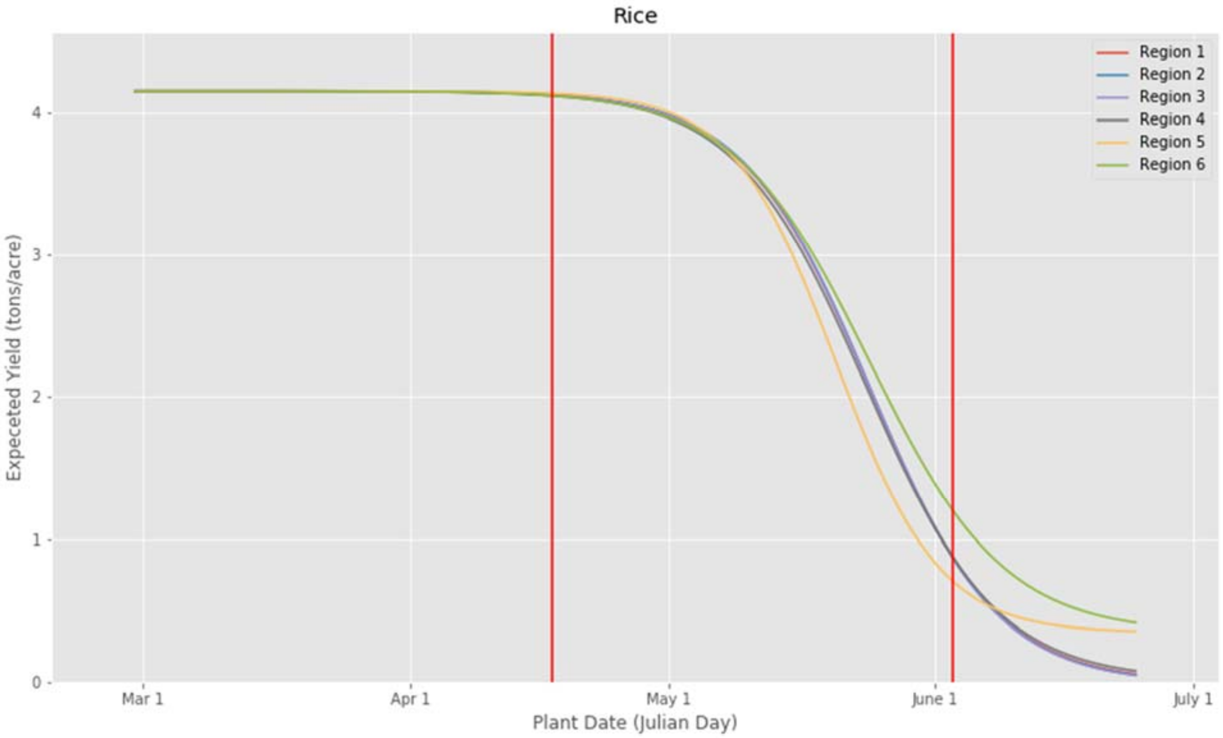
The BPM calibrates to average 2005 – 2009 cropping patterns in the Yolo Bypass. Growers make current planting decisions based on expectations of crop prices. The BPM does not attempt to model how growers form their price expectations; as an approximation, the BPM uses an average of county-level crop prices. Data for county-level crop prices are obtained from the respective County Agricultural Commissioners’ annual crop reports for years 2007 through 2009, corresponding to the base average years of calibration data used in the BPM (Yolo County 2005 – 2009).

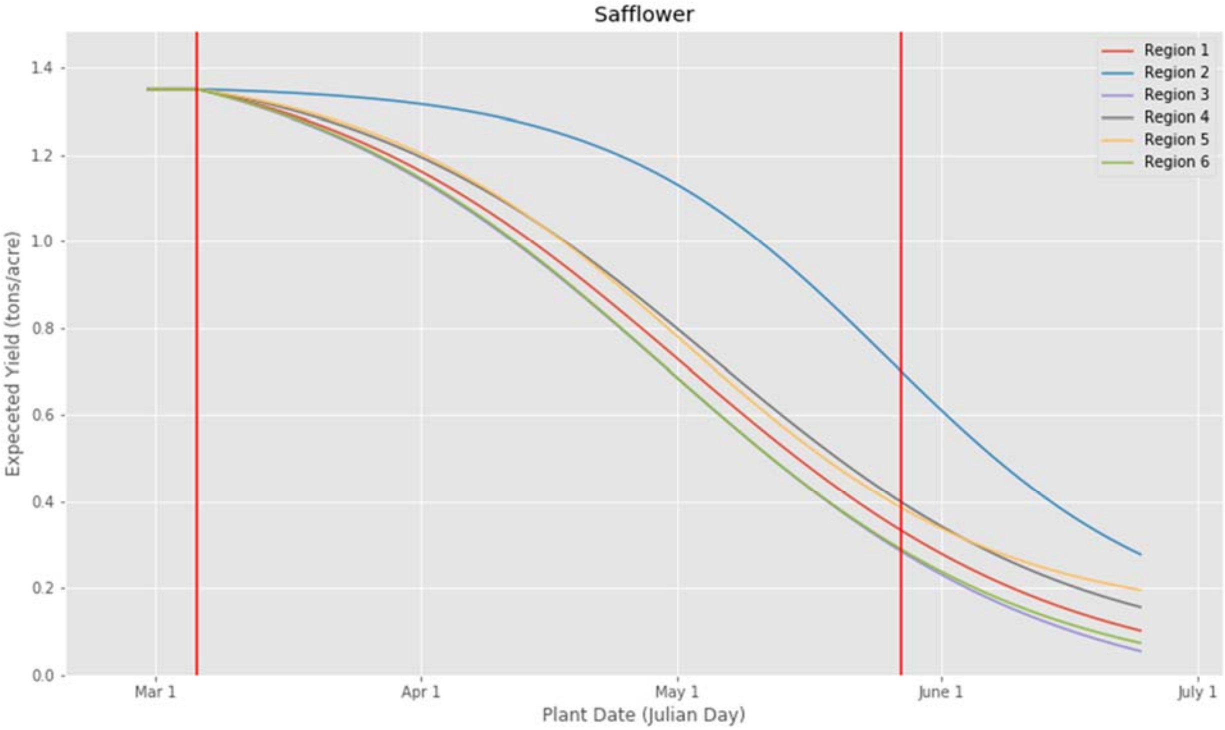
Crop yields for each crop group in the BPM correspond to the proxy crops listed in Table 2. The corresponding costs of production, discussed in a subsequent section, are from the same UCCE production cost budgets. These represent the maximum yield for each crop group. Prices and yield are summarized in Table 4. It is important to note that prices and yields vary over time and by crop. The economic impacts are defined as the incremental change from the baseline (ExCon/NAA) and these underlying prices yields are, by definition, the same across all alternatives.

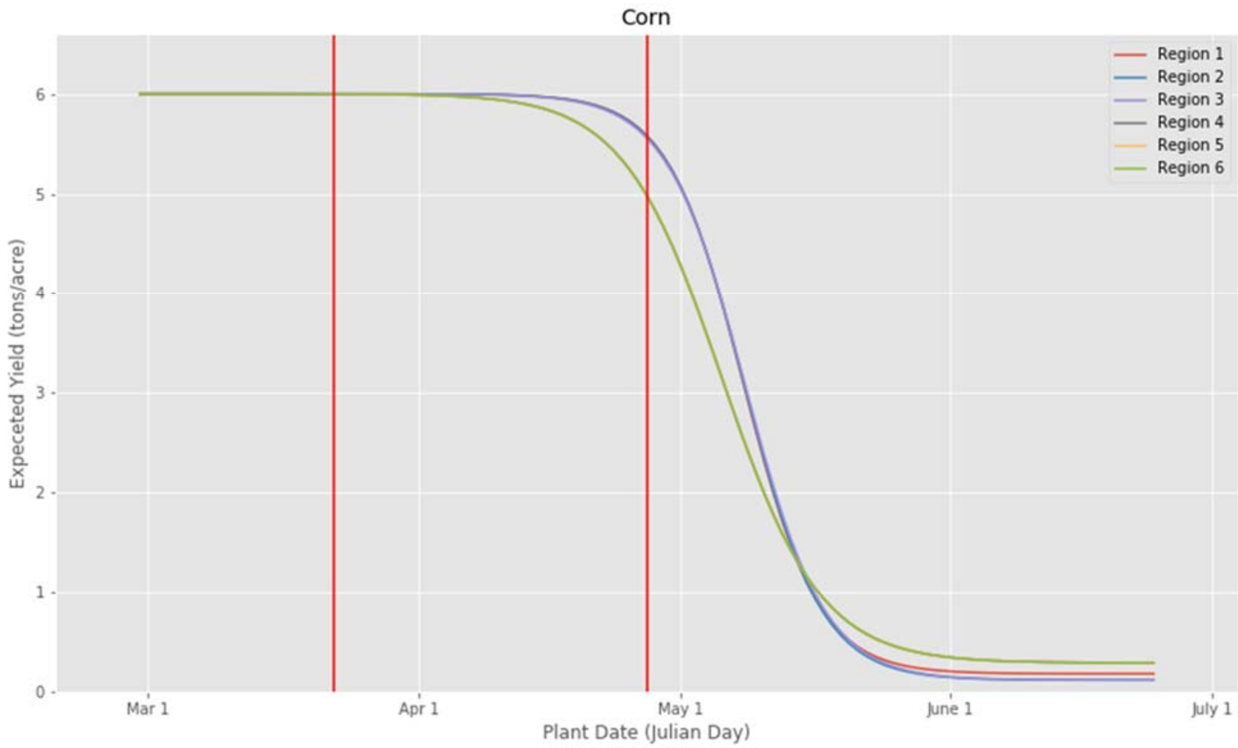
Table 4. BPM crop price (2009 dollars) and yield

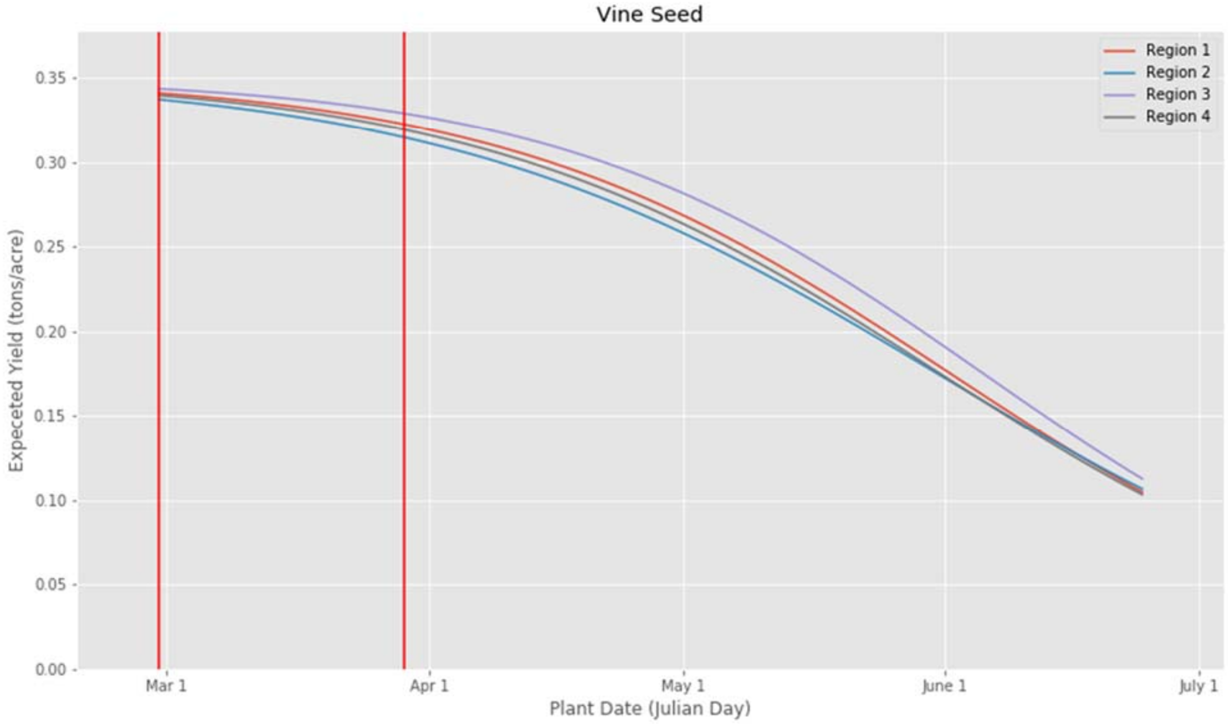
Crop	Price ($/ton)	Yield (ton/acre)
Corn	152	6.00
Dry Pasture	223	0.50
Irrigated Pasture	223	2.50
Processing Tomatoes	71	35.00
Rice	397	4.15
Safflower	376	1.35
Sunflower	1,436	0.68
Vine Seed	4,844	0.35
Wild Rice	1,442	1
Alfalfa	144	8
Grain	176	3

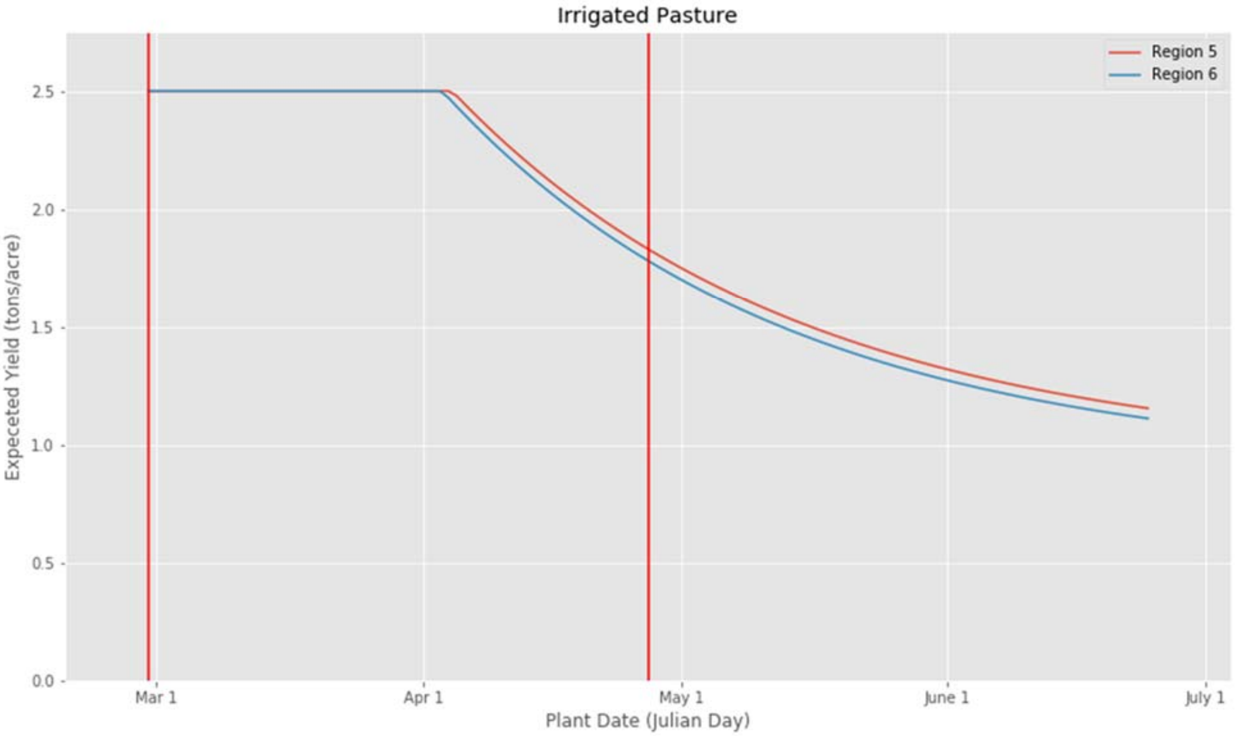
Increased wetted area in the bypass delays planting date which reduces expected crop yield. The BPM uses the same expected yield relationship as the Yolo County (2013) study, which leverages DAYCENT model output. The yield functions are scaled so that the maximum yield is equal to the reported yield in the UCCE budgets listed in Table 1. This ensures that the fitted functions are consistent with the UCCE budgets and the subsequent NED impact analysis. The dry and irrigated pasture yield functions are the same (scaled to reflect dry yield 0.5 tons/acre and irrigated yield 2.5 tons/acre, respectively). The grain yield uses the same relationship as the corn yield, following the Yolo County (2013) study, where the yield function is scaled to match the grain yield (3 tons/acre). The wild rice function is the same as the conventional rice, following the Yolo County (2013) study, where the yield function is scaled to match the wild rice yield (1 tons/acre). Wild rice can typically be planted later than conventional rice, thus this is a conservative assumption. Figure 2 illustrates the crop yield and standard planting window for each of the BPM crops and regions. The standard planting window is from the respective UCCE budgets. As shown, the BPM yield functions decrease at an increasing rate (with the exception of pasture) as the planting date is pushed farther into the standard planting window. Crops such as processing tomatoes are typically grown under contract and planting is purposefully staggered, sometimes very late in the planting window, to manage processor throughput.

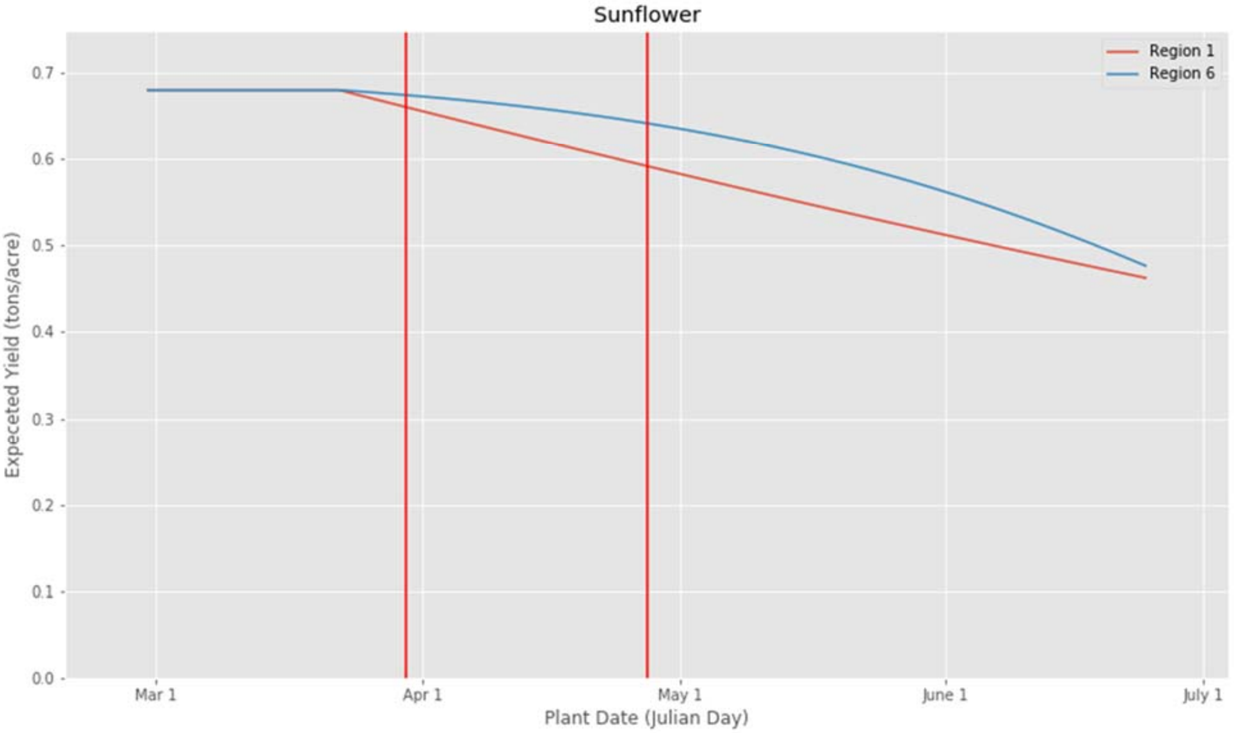

Rice
Expeceted Yield (tons/acre)
0
1
2
3
4
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)
Region 1
Region 2
Region 3
Region 4
Region 5
Region 6


Safflower
Expeceted Yield (tons/acre)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)
Region 1
Region 2
Region 3
Region 4
Region 5
Region 6


Corn
Region 1
Region 2
Region 3
Region 4
Region 5
Region 6
Expeceted Yield (tons/acre)
0
1
2
3
4
5
6
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)


Vine Seed
Region 1
Region 2
Region 3
Region 4
Expeceted Yield (tons/acre)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)


Irrigated Pasture
Region 5
Region 6
Expeceted Yield (tons/acre)
0.0
0.5
1.0
1.5
2.0
2.5
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)


Sunflower
Region 1
Region 6
Expeceted Yield (tons/acre)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)

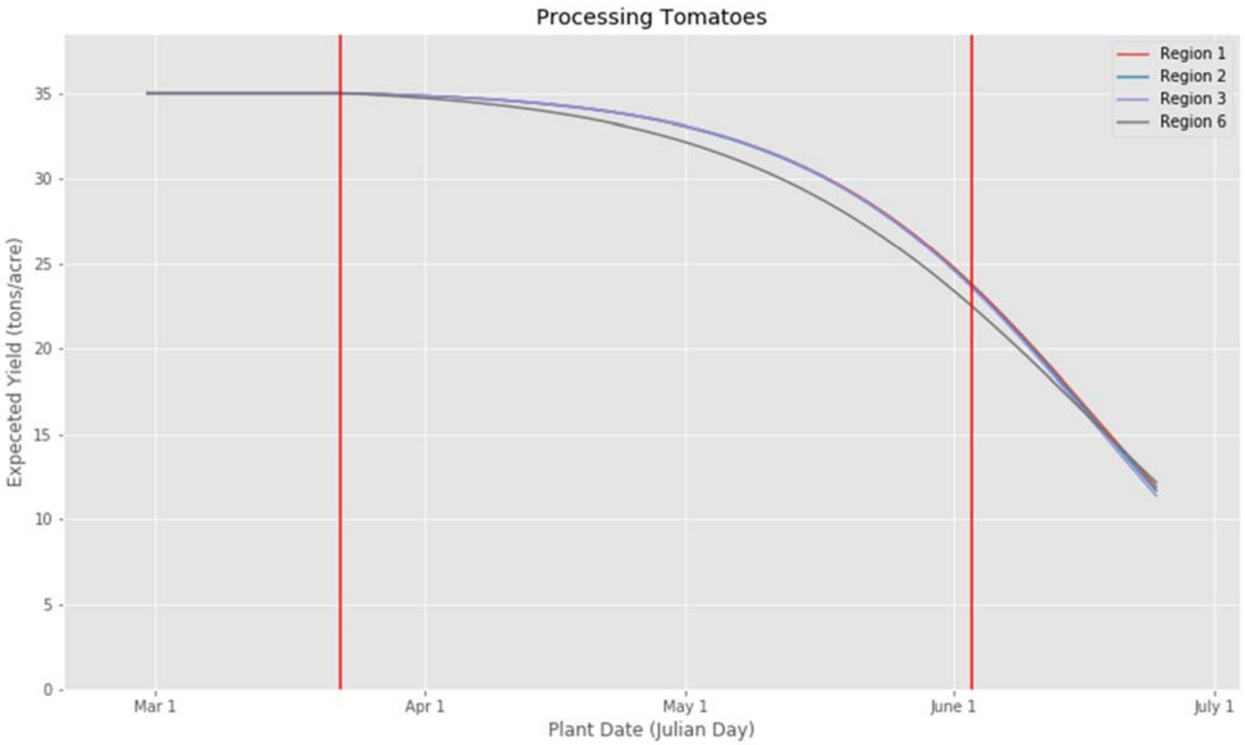


Figure 2.
Expected Crop Yield by Planting Day

3.3 Crop Cost of Production Budgets

Land, labor, and other supply costs of production are obtained from the same UCCE crop budgets listed above. Each UCCE budget uses interest rates for capital recovery and interest on operating capital specific to the year of the study. These range from 4 percent to over 8 percent, and as such, require adjustment to a common base year interest rate. A common rate of 6 percent is used for all data.

Land costs are derived from the respective UCCE crop budget and include land rent or land capital recovery costs, as applicable. Capital recovery interest rates are adjusted to a common base of 6 percent.

The labor cost category in the BPM includes both machine and non-machine labor. Labor wages per hour differ for machine and non-machine labor and are reported separately in the UCCE budgets. Both machine and non-machine labor costs include overhead to the farmer of federal and state payroll taxes, workers’ compensation, and a small percentage for other benefits which varies by budget. Additionally, a percentage premium (typically around 20 percent) is added to machine labor costs to account for equipment set-up, moving, maintenance, breaks, and field repair. The sum of these components, reported on a per acre basis, is used as input data into the BPM.

The supply cost category in the BPM includes all inputs not explicitly included in the other three input categories (land, labor, and water), including fertilizers, herbicides, insecticide, fungicide, rodenticide, seed, fuel, and custom costs. Additionally, machinery, establishment costs, buildings, and irrigation system capital recovery costs are included. Each sub-category of supply cost is broken down in detail in the respective crop budget. For example, safflower in the Sacramento Valley requires pre-plant Nitrogen as aqua ammonia at 100 pounds per acre in fertilizer costs. Application of Roundup in February and Treflan in March account for herbicide costs. The sum of these individual components, on a per acre basis, is used as base supply input cost data in the BPM.

3.4 Crop Water Requirements

Applied water is the amount of water applied by the irrigation system to an acre of a given crop for production in a typical year. Variation in rainfall and other climate effects will alter this requirement. Additionally, farmers may stress irrigate crops or substitute other inputs in order to reduce applied water. The latter effect is not considered in the BPM due to the fixed-proportion production technology. Applied water per acre (base) requirements for crops in the BPM is derived from the respective UCCE budget.

3.4.1 BPM Data Sources Summary

The BPM uses a base price level of 2009 for calibration for consistency with the land use data. These prices and costs are deflated to current (2016) dollars in the post-processing of economic impacts, described in subsequent sections. Table 5 summarizes input data and sources used in the BPM.

Table 5. BPM Model Input Data Summary

Input	Source	Notes
Land Use	Yolo County (2013)	Years 2005 - 2009
Crop Prices	County Agricultural Commissioners’	By proxy crop using 2007—2009 average prices
Max Crop Yields	UCCE Crop Budgets	By proxy crop for various years (most recent available)
Expected Crop Yields	Yolo County (2013)	Expected yield by plant day
Interest Rates	UCCE Crop Budgets	All interest rates normalized to 6%
Land Costs	UCCE Crop Budgets	By proxy crop for various years (most recent available)
Labor Costs	UCCE Crop Budgets	By proxy crop for various years (most recent available)
Other input Costs	UCCE Crop Budgets	By proxy crop for various years (most recent available)
Irrigation Water	UCCE Crop Budgets	Average crop irrigation water requirements

4.0 Implementing the BPM for Analysis of Alternatives

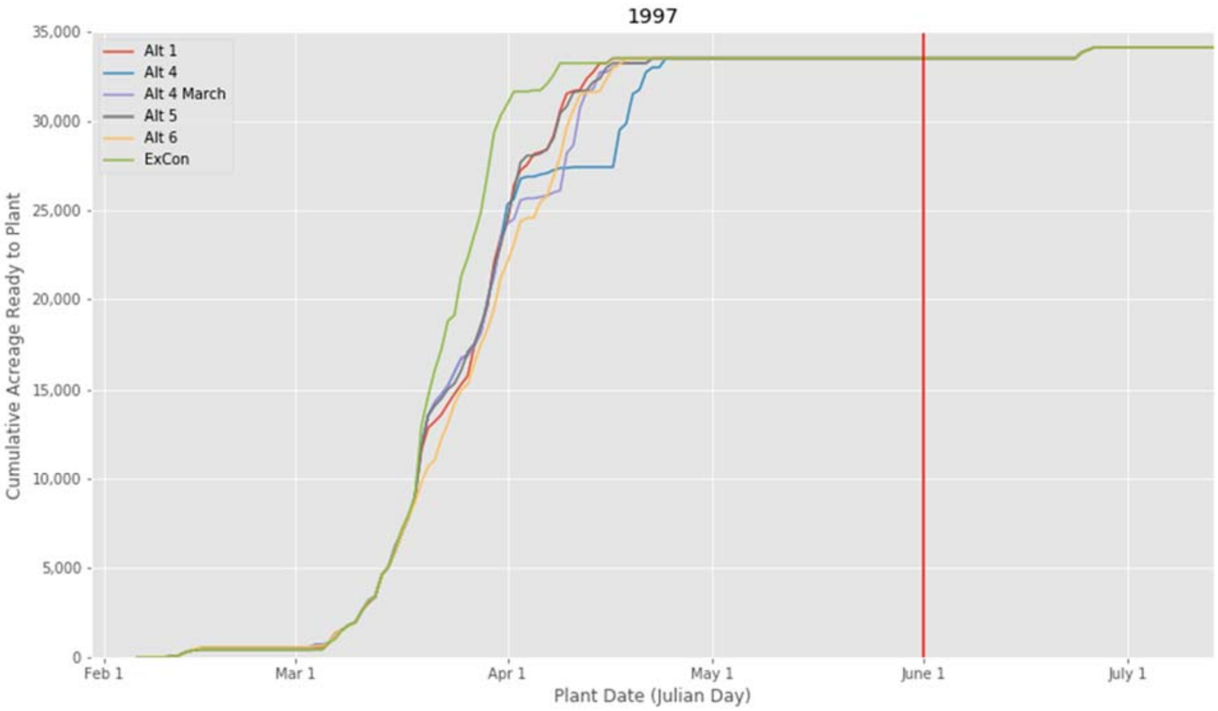
The Project alternatives were evaluated over the 1997 – 2012 hydrologic period of record. The BPM is used to compare Yolo Bypass agriculture response to changes in wetted area under the Project alternatives. Alternatives include ExCon/NAA, and the Project alternatives Alt1, Alt4, Alt4M, Alt5, and Alt6. The economic impact is defined as the incremental difference between the ExCon/NAA and each Project alternative.

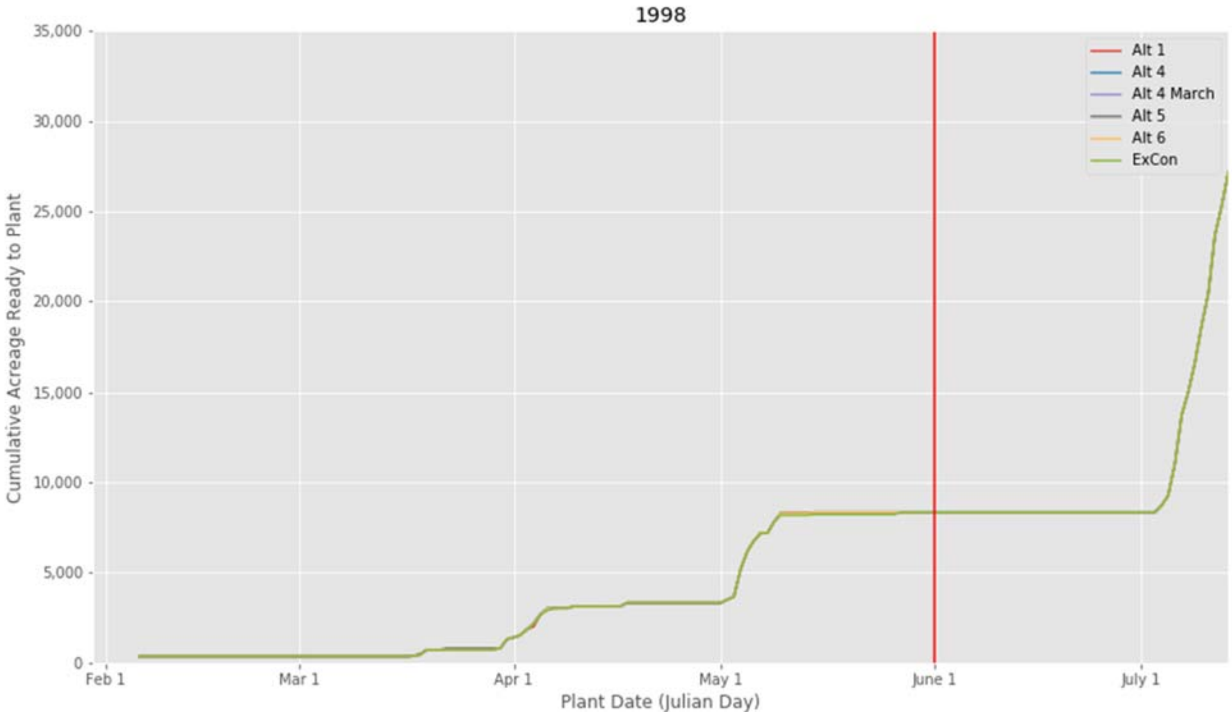
4.1 Wetted Area

The driving variable behind the economic impacts of the Project alternatives is the incremental difference in location, duration, and frequency of additional wetted area in the Yolo Bypass. The economic impact is the difference between ExCon/NAA and each Project alternative. It follows that the Project causes economic impacts when the Project alternative results in additional wetted area during the standard crop planting window for areas that would have otherwise been planted. For example, extending the wetted area in January and February has a negligible effect on economic costs because fields would typically be dry by the beginning of the standard planting window (late March - early April). Conversely, extending wetted area above ExCon/NAA into April and May would have proportionally greater impacts. In short, the economic impacts are driven by the incremental—not total— wetted area simulated by the TUFLOW model.

Figure 3 illustrates the cumulative acreage “ready to plant” for each alternative and year. Ready to plant is defined as the dry date from the TUFLOW model plus 6 days for additional miscellaneous drydown plus an additional 28 days for field preparation. The cumulative acreage is calculated by summing over all acreage up to that date. The vertical difference between each Project alternative (various color lines) and ExCon/NAA (green line) shows the incremental wetted area attributable to the Project. That is, reading off of the vertical axis shows the additional acres affected by the Project over and above the baseline (ExCon/NAA) conditions. The red vertical line at June 1 illustrates the end of the standard planting window for most Yolo Bypass crops.

The years 1997 and 1998 illustrate two important factors underlying the economic impact analysis. The year 1997 shows that the Project would result in additional wetted area in the Yolo Bypass under the 1997 hydrologic conditions. This is shown by the vertical difference between the green line (ExCon/NAA) and the line for each of the Project alternatives. However, the additional wetted area is dry and prepped for planting (dry date plus 34 days) by the end of April. It follows that the *incremental* effect on expected crop yields and economic impacts are expected to be moderate to small as fields are dry within a week of ExCon/NAA and before the planting window. Hydrologic year 1998 illustrates a wet year in the Yolo Bypass. In this case the economic impacts of the Project are small because the difference between ExCon/NAA and each of the Project alternatives is negligible. Since the economic impact is the incremental difference between ExCon/NAA and each Project alternative, the economic impact will typically by (perhaps counter-intuitively) small in wet years. Economic impacts are more significant in years when wetted area is extended into the standard planting window over and above what would have naturally occurred under ExCon/NAA.


1997
Alt 1
Alt 4
Alt 4 March
Alt 5
Alt 6
ExCon
Cumulative Acreage Ready to Plant
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Feb 1
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)


1998
Alt 1
Alt 4
Alt 4 March
Alt 5
Alt 6
ExCon
Cumulative Acreage Ready to Plant
35,000
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25,000
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15,000
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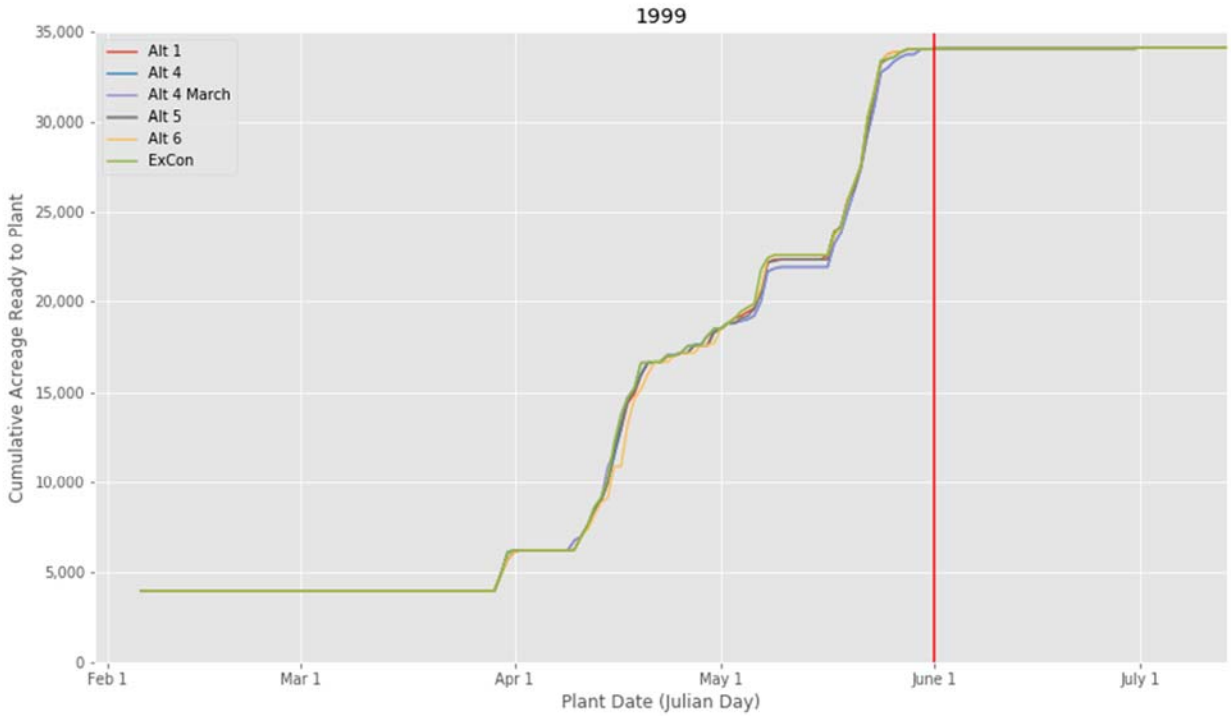
Feb 1
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)


1999
Alt 1
Alt 4
Alt 4 March
Alt 5
Alt 6
ExCon
Cumulative Acreage Ready to Plant
35,000
30,000
25,000
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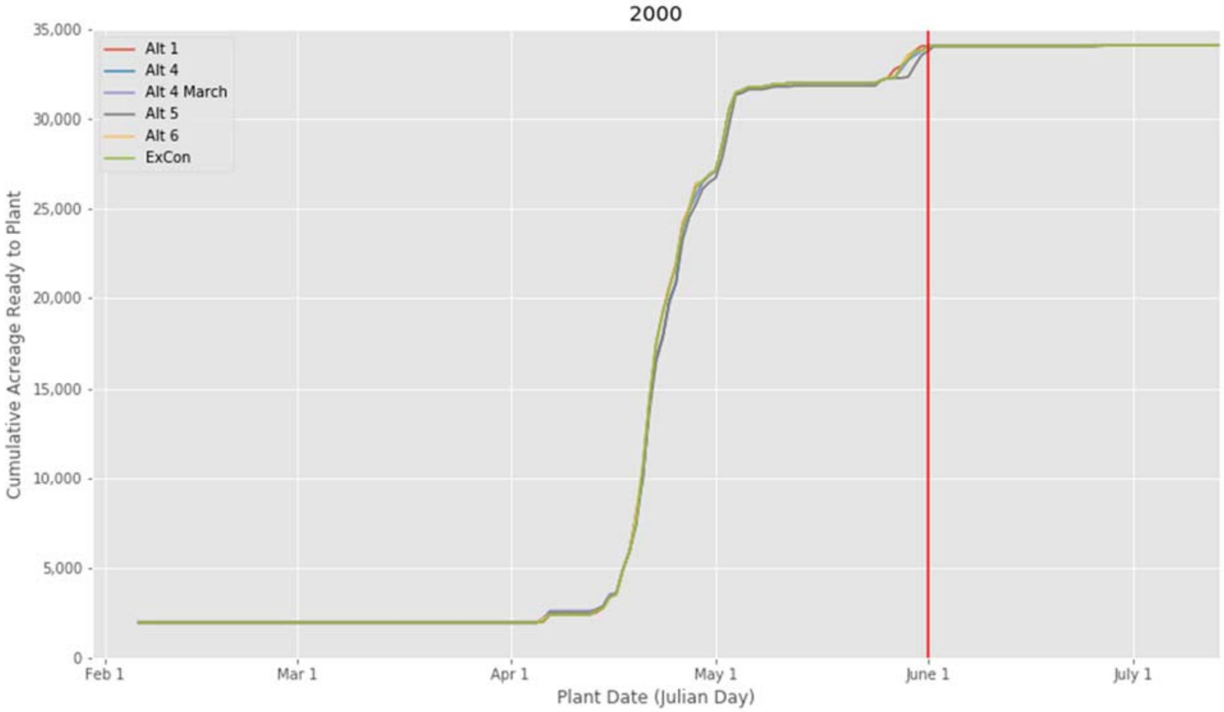
Feb 1
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)


2000
Alt 1
Alt 4
Alt 4 March
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Alt 6
ExCon
Cumulative Acreage Ready to Plant
35,000
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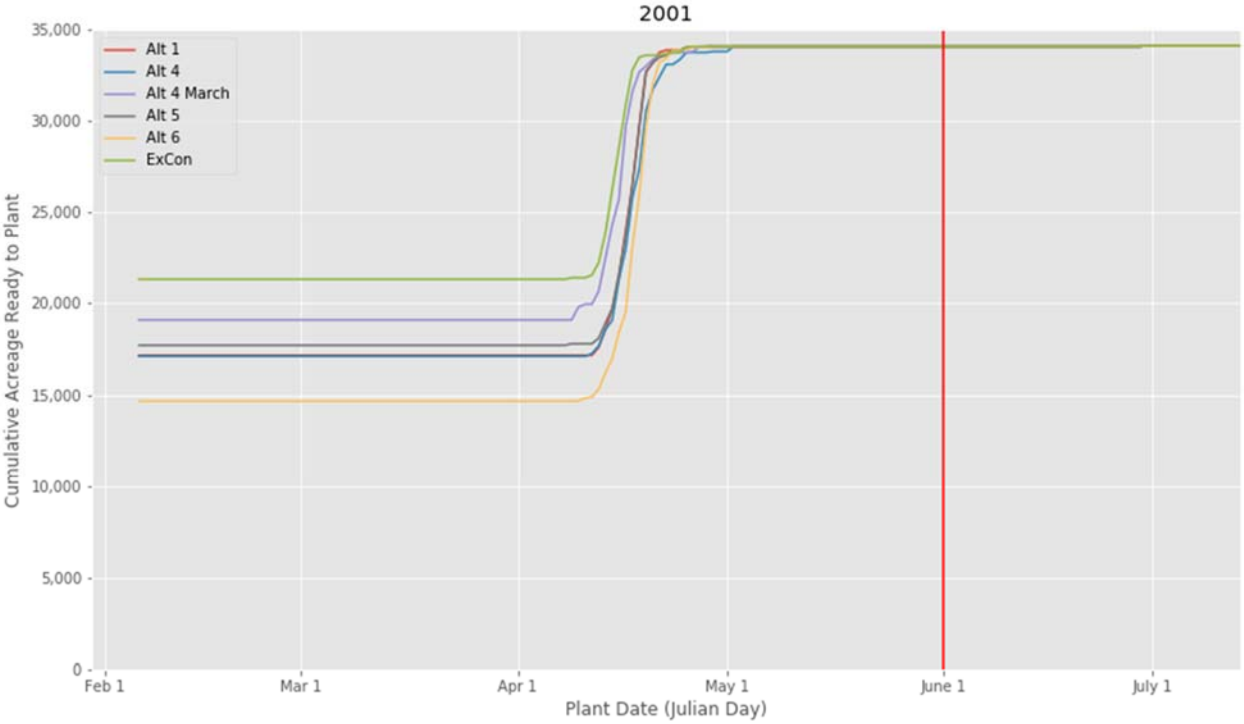
Feb 1
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)


2001
Alt 1
Alt 4
Alt 4 March
Alt 5
Alt 6
ExCon
Cumulative Acreage Ready to Plant
35,000
30,000
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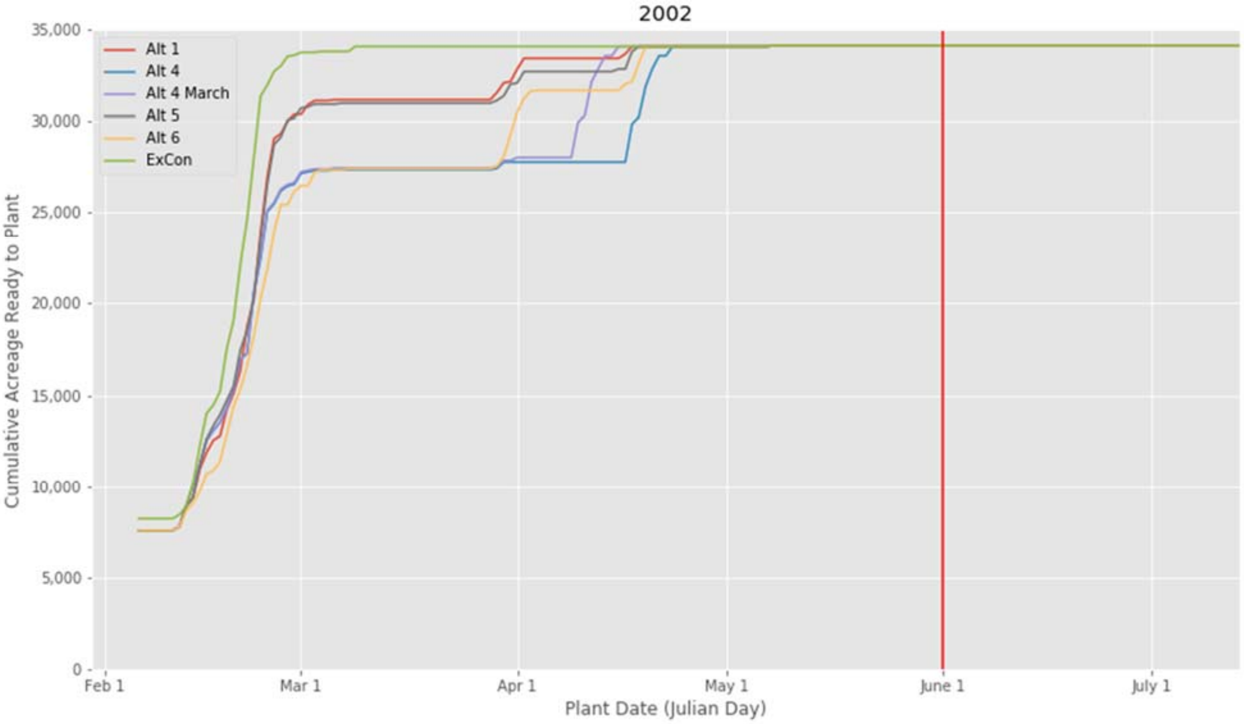
15,000
10,000
5,000
0
Feb 1
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)


2002
Alt 1
Alt 4
Alt 4 March
Alt 5
Alt 6
ExCon
Cumulative Acreage Ready to Plant
35,000
30,000
25,000
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15,000
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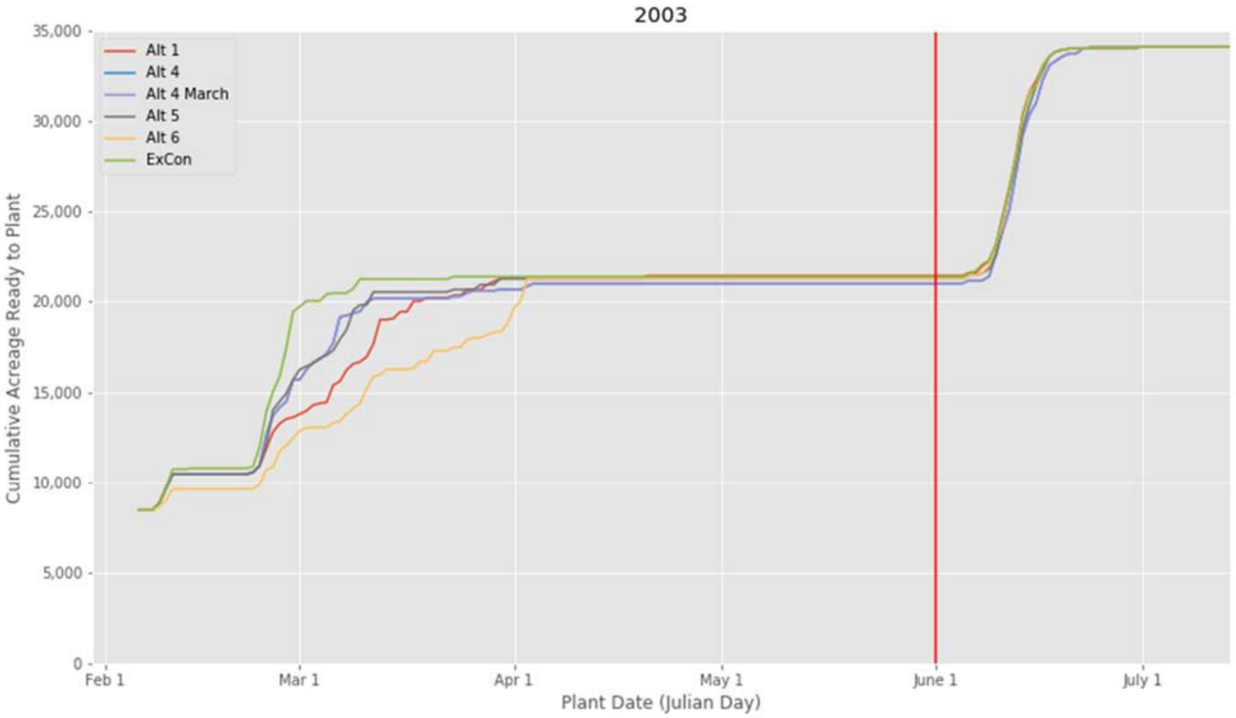
Feb 1
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)


2003
Alt 1
Alt 4
Alt 4 March
Alt 5
Alt 6
ExCon
Cumulative Acreage Ready to Plant
35,000
30,000
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10,000
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0
Feb 1
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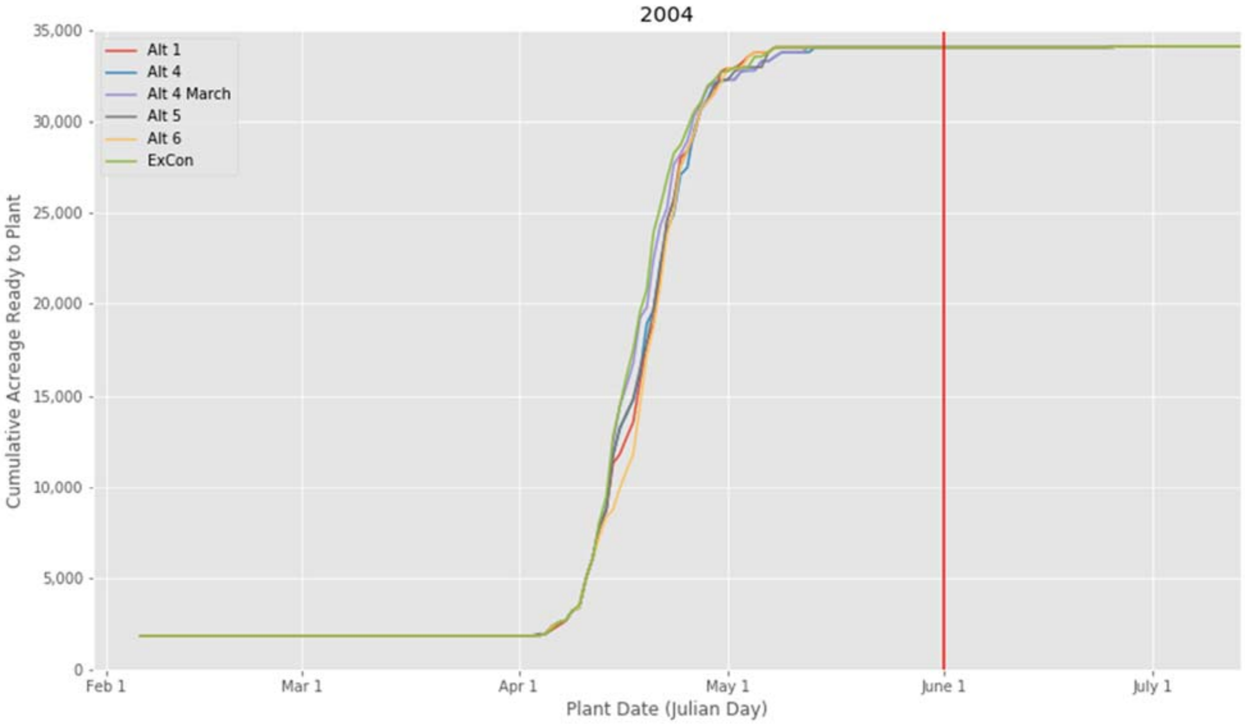
May 1
June 1
July 1
Plant Date (Julian Day)


2004
Alt 1
Alt 4
Alt 4 March
Alt 5
Alt 6
ExCon
Cumulative Acreage Ready to Plant
35,000
30,000
25,000
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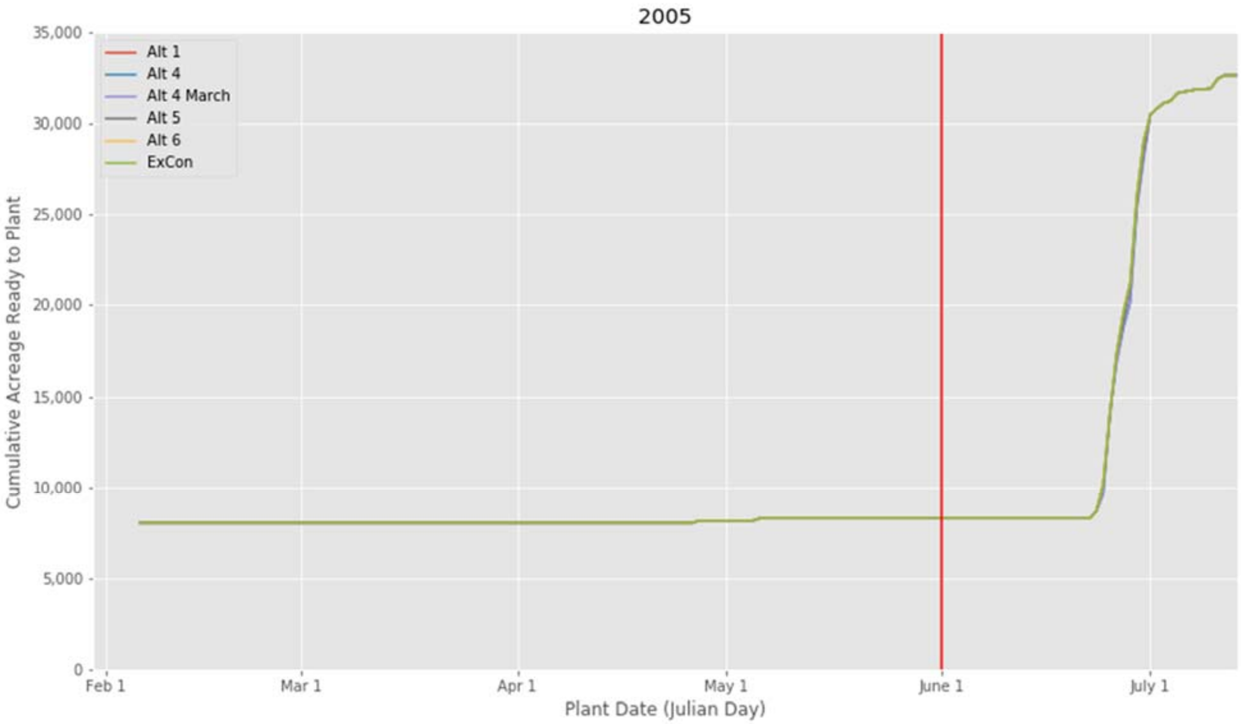
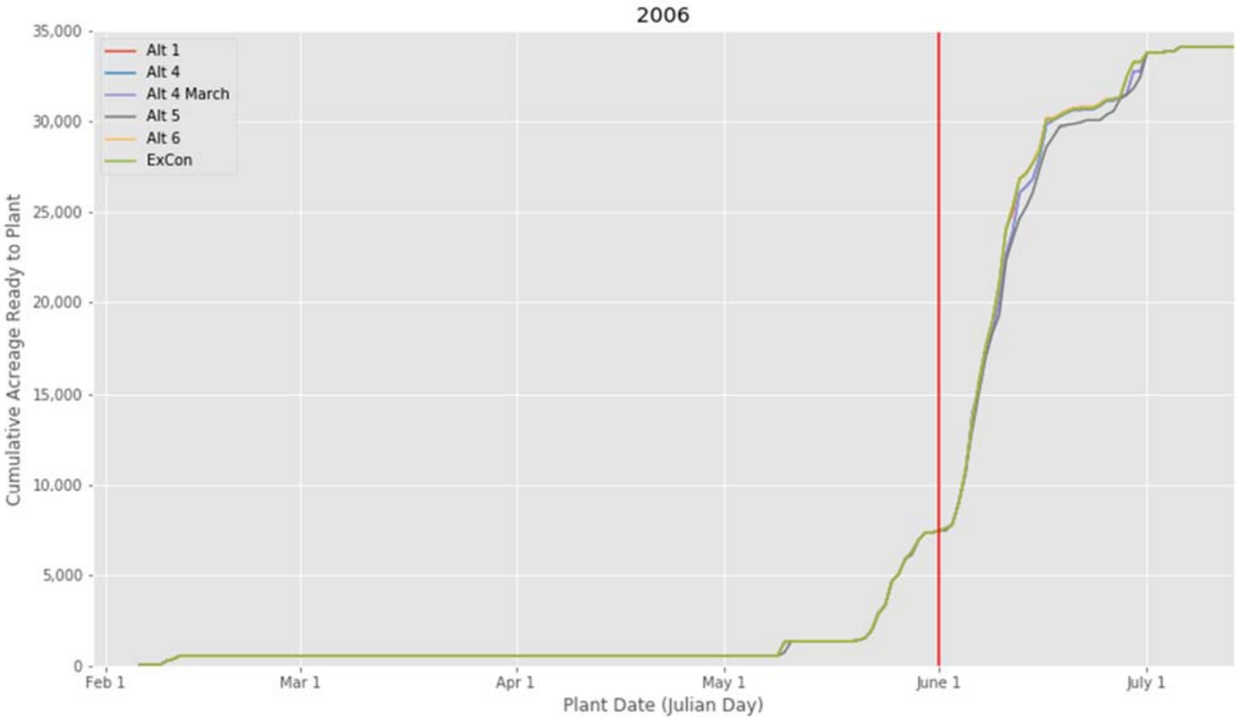
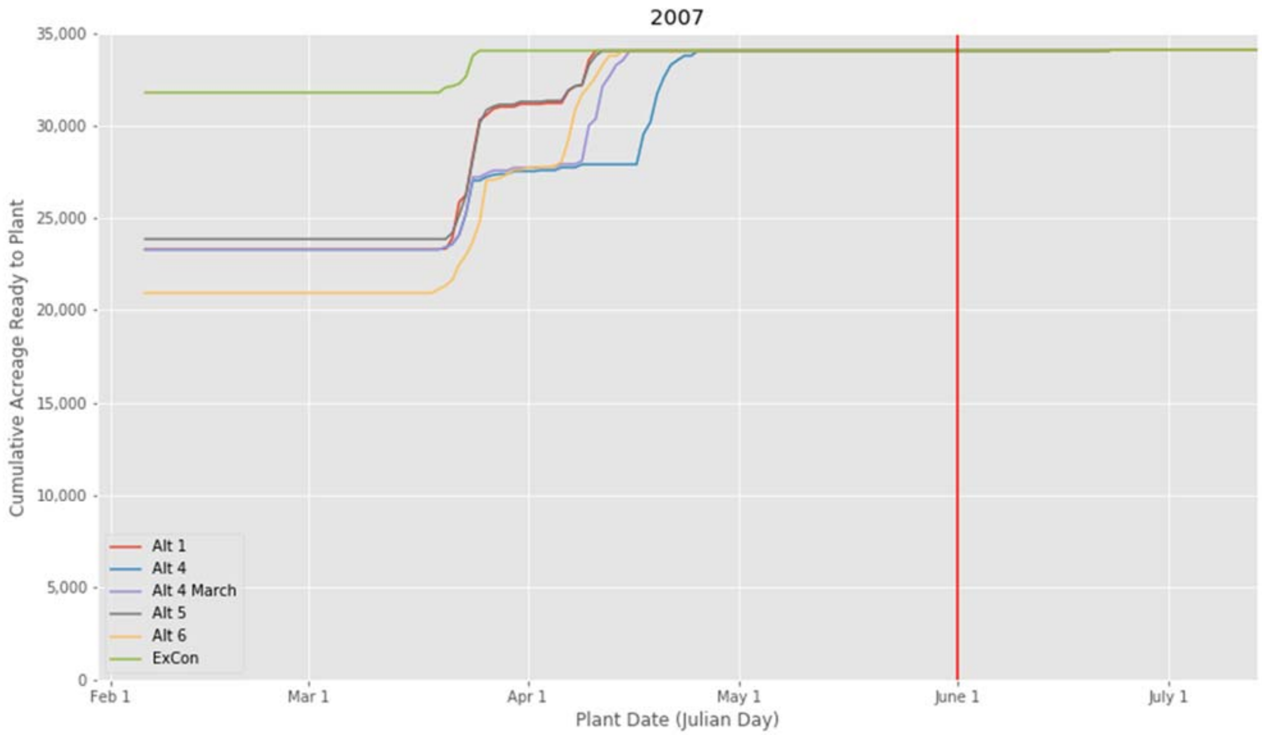
5,000
0
Feb 1
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)


2005
Alt 1
Alt 4
Alt 4 March
Alt 5
Alt 6
ExCon
Cumulative Acreage Ready to Plant
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Feb 1
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)


2006
Alt 1
Alt 4
Alt 4 March
Alt 5
Alt 6
ExCon
Cumulative Acreage Ready to Plant
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Feb 1
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)


2007
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Cumulative Acreage Ready to Plant
Alt 1
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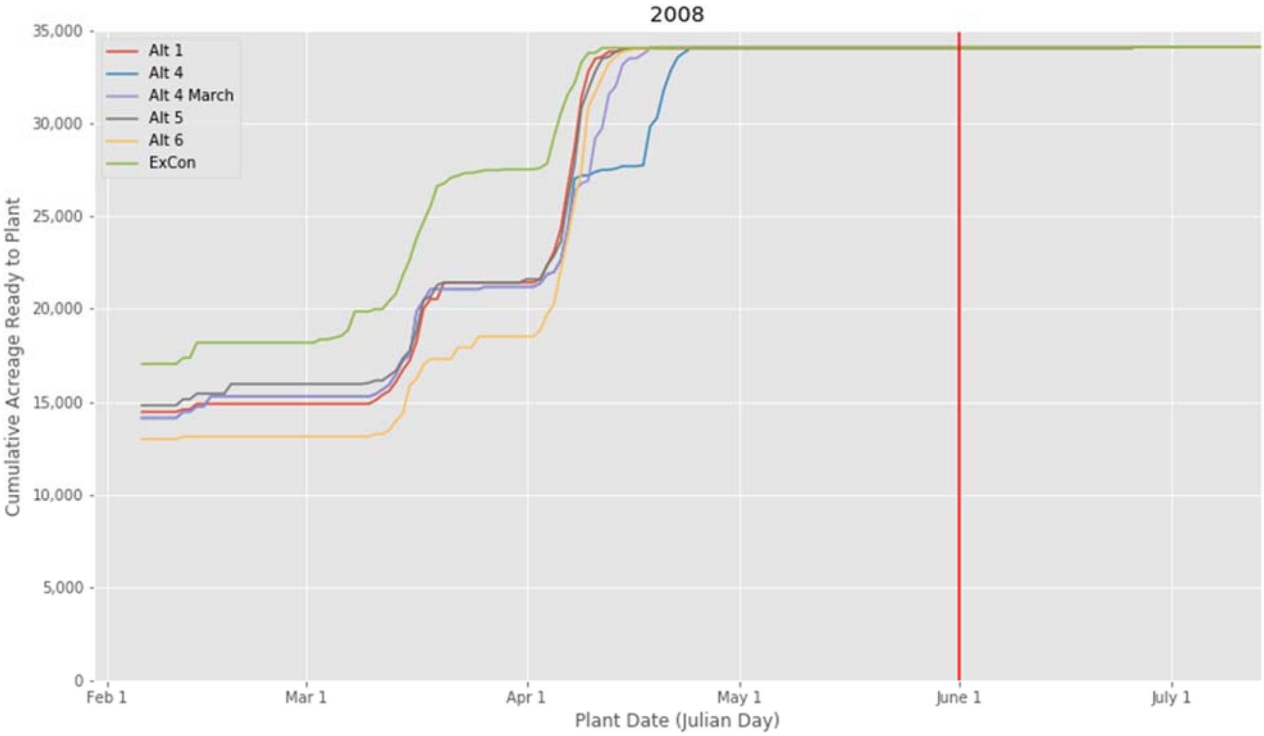
Alt 4 March
Alt 5
Alt 6
ExCon
Feb 1
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)


2008
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Cumulative Acreage Ready to Plant
Alt 1
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Alt 5
Alt 6
ExCon
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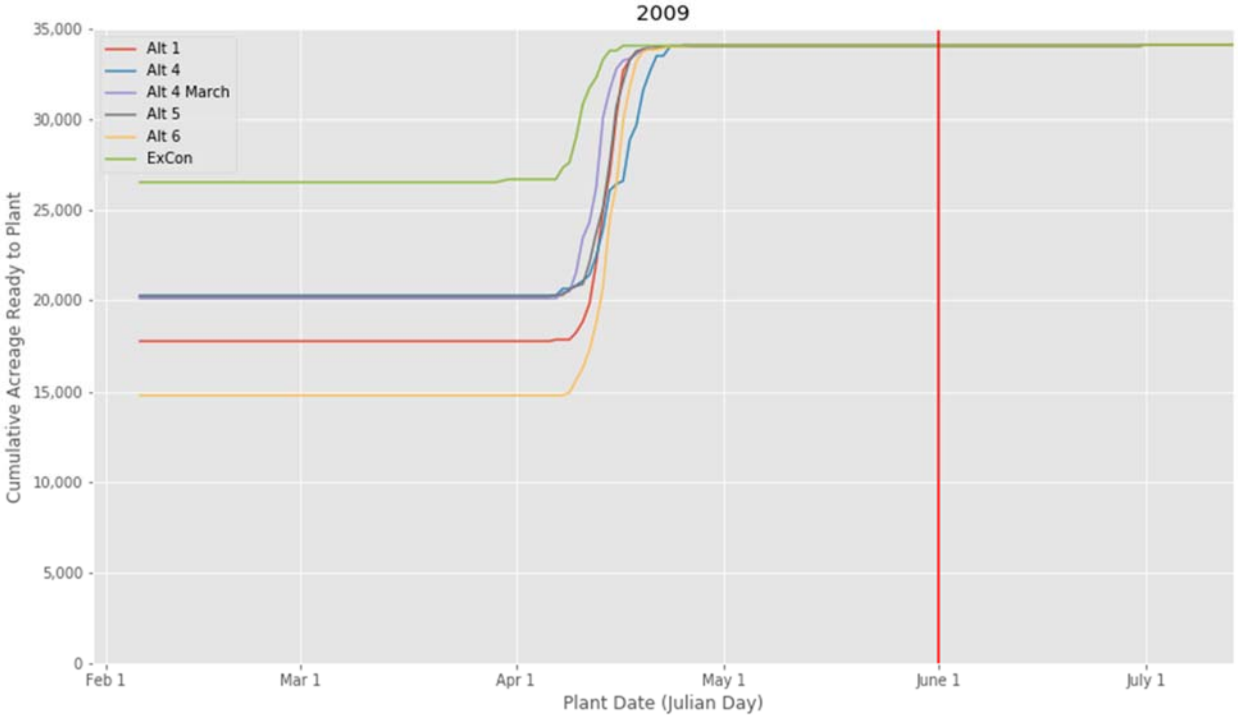
May 1
June 1
July 1
Plant Date (Julian Day)


2009
Alt 1
Alt 4
Alt 4 March
Alt 5
Alt 6
ExCon
Cumulative Acreage Ready to Plant
35,000
30,000
25,000
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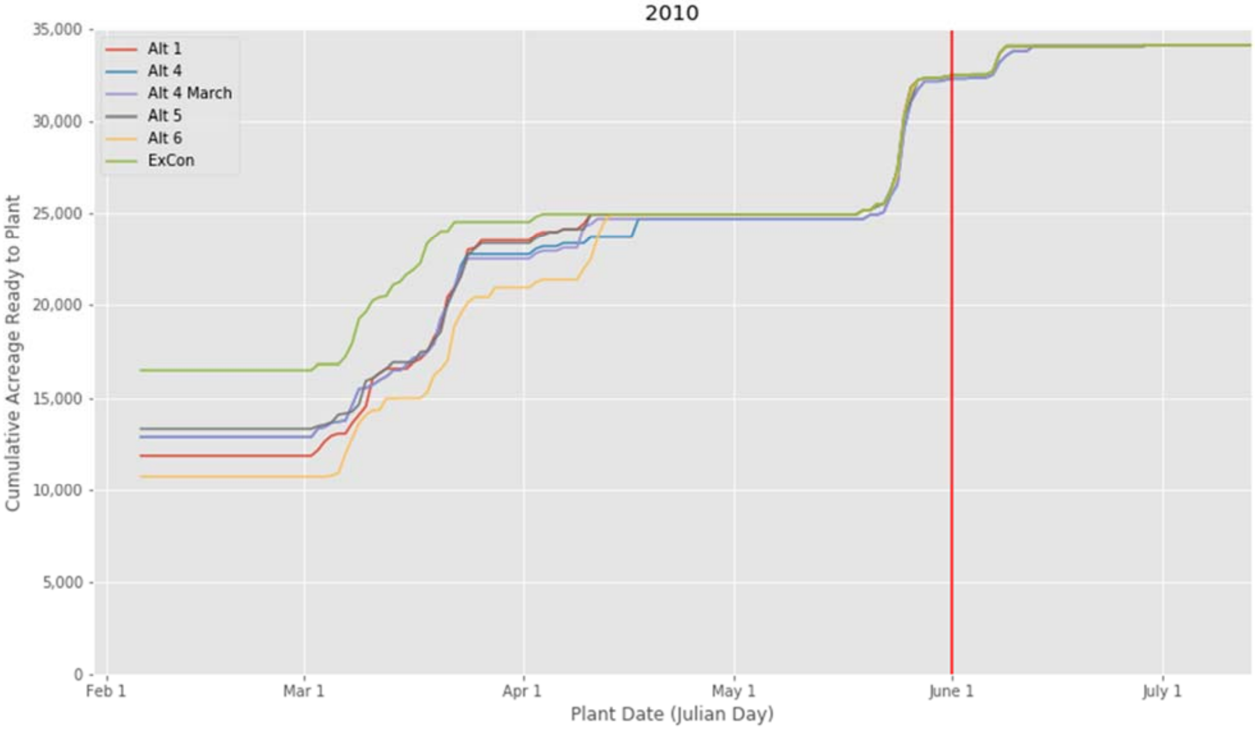
May 1
June 1
July 1
Plant Date (Julian Day)


2010
Alt 1
Alt 4
Alt 4 March
Alt 5
Alt 6
ExCon
Cumulative Acreage Ready to Plant
35,000
30,000
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0
Feb 1
Mar 1
Apr 1
May 1
June 1
July 1
Plant Date (Julian Day)

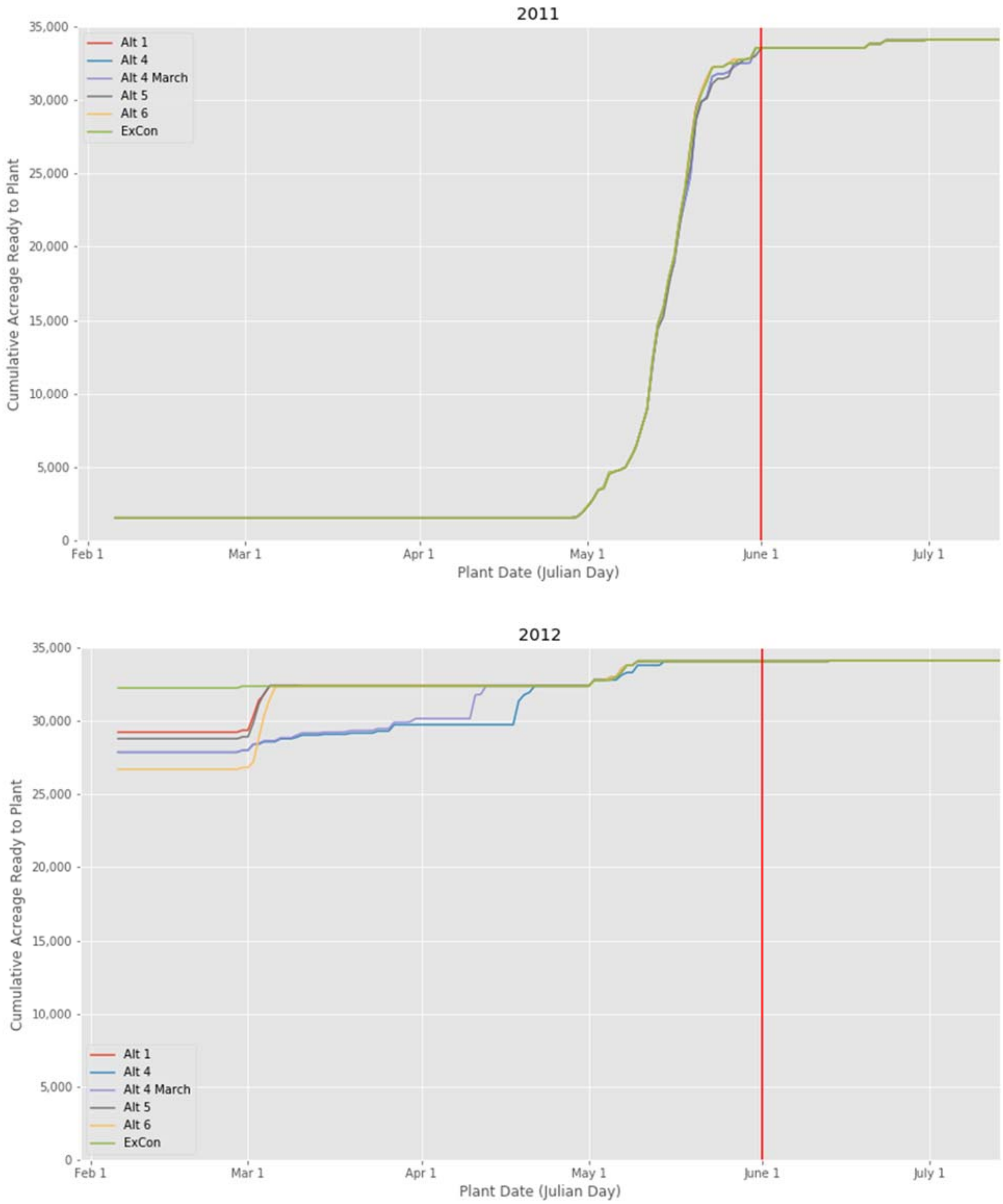

Figure 3.
Cumulative Acreage Ready to Plant by Year and Alternative

4.2 National Economic Development (NED) Calculations

The basic guidelines for evaluating water projects at the federal level are specified in the P&Gs. Under the P&Gs, the federal objective for water contributions is to maximize the contribution to the NED consistent with protection of the environment. In order to adhere to the P&Gs and determine the contribution to NED, a series of adjustments to the BPM outputs are necessary.

Adjustments fall into two categories: pre- and post-processing. Pre-processing adjustments are made prior to optimization with the BPM and include adjustments to input data costs and interest rates. Post-processing adjustments are applied to BPM output and include adjustments to prices and costs. In particular, guidelines require that certain prices be used for valuing changes in physical inputs and outputs. They do not explicitly affect farmers' decisions, so they are applied after the BPM optimization. Post-processing adjustments include interest rates, other supply costs, fallow land costs, normalized crop prices, consumer surplus, water costs, and management charges.

Pre-processing adjustments include changes to the data that occur before BPM optimization, and are made regardless of whether the project is being evaluated under NED guidelines. This includes adjusting interest rates to a consistent 6 percent.

Post-processing adjustments take place after the BPM model optimization. These include:

1. The P&Gs requires that the federal discount rate be used for all interest and capital recovery calculations. The current federal discount rate for is 3.125 percent. A post-processing adjustment is applied to cost data components to adjust the interest rate to 3.125 percent.
2. Machinery capital recovery costs are removed from the NED analysis under all alternatives. Additional land out of production would be quite small and is therefore unlikely to require additional machinery investment. By the same logic, buildings capital recovery costs are removed from the NED analysis under all alternatives.
3. Land rent and cash overhead and land capital recovery costs are removed from the NED analysis under all alternatives. The NED analysis is adjusted to remove land costs that are included within the BPM because land investment in irrigated production is already considered a sunk investment. Sunk investments are irrelevant to determining the economic feasibility/impact of new project investments.
4. Interest on operating capital and capital recovery charges for permanent crop establishment and for irrigation systems are adjusted to consistent interest rate.
5. An annual maintenance cost of $53.89 per acre (in 2016 dollars) is used for the NED analysis to account for fallow land costs, as required by the P&Gs.
6. Reclamation guidelines for preparing NED analysis under the P&Gs recommend including management costs at no less than 6 percent of variable costs. A 6 percent management charge is added to the variable production costs in the BPM.
7. The P&Gs state that USDA Current Normalized Prices (CNP) must be used for calculations when available. These prices have been adjusted by USDA to remove any federal subsidies because such subsidies represent an NED cost that must be accounted for in comparing project benefits and costs. For crop groups covered by USDA's CNP estimates, BPM prices were converted to CNP (USDA 2016). For crop groups without

available CNP, the BPM prices are used. CNP reported in 2016 dollars per ton, are as follows: Corn $211.07, Grains (wheat) $254.67, and Rice $394.00. All other crop prices correspond to the BPM input data described previously and are deflated to 2016 dollars using the Gross Domestic Product implicit price deflator.

8. Pasture is treated separately from the other crops for NED post-processing. Pasture yield and returns are from the 2012 UCCE Intermountain Region Irrigated Pasture study. The UCCE study estimates 2.5 tons of hay per acre and the price of meadow hay is approximately $220/ton in 2009 dollars. The field is additionally grazed and the UCCE study summarizes additional grazing yields in total Animal Unit Months (AUMs), estimated to be 3 AUMs. For air-dried pasture hay, 800 pounds of hay is equivalent to 1 AUM (2.5 AUM = 1 ton of pasture hay). Based on lease market rates, ranchers estimate $27 per AUM for good summer pasture. The BPM uses a yield of 2.5 tons of hay per acre at approximately $220/ton. For comparison, the 2013 USDA California Livestock Review indicates that AUM grazing fees for non-irrigated pasture were $21.50 per AUM in 2011 and $23 per AUM in 2012. In summary, pasture values follow these definitions and are deflated to 2016 dollars.

5.0 Yolo Bypass Economic Impacts

This section provides a summary of the agricultural economic impacts of the Project alternatives to Yolo Bypass agriculture estimated using the BPM. A more detailed discussion of each Project alternative and the corresponding economic and socioeconomic impact of each alternative can be found in sections of the main text of the EIR/S. As discussed previously, economic impacts are expressed as the incremental change between each Project alternative and the ExCon/NAA over the 1997 – 2012 period of record analyzed in the TUFLOW hydrodynamic model. Economic impacts include the change in irrigated acreage, gross farm revenues, fallowing cost, and net farm income (income over expenses). Project alternatives include Alternative 1, Alternative 4 (March 15 gate closure), Alternative 4 March (March 7 gate closure), Alternative 5 and Alternative 6 (abbreviated as Alt1, Alt4, Alt4M, Alt5, and Alt6, respectively).

It is important to note that average annual fallowing reflects temporary cropland idling, and not permanent land retirement. This is because the incremental impact of the Project alternatives only occurs in some years, and the additional wetted acreage is small (in proportion to the larger bypass) in those years. As such, all fallowing is temporary (annual), and the economic costs—and modeling using the BPM—reflects these temporary fallowing costs.

Table 6 summarizes the total economic impacts under each of the Project alternatives. The following subsections describe each alternative and the associated economic impacts in greater detail. As shown, Alt 4 (March 15 gate closure) results in the highest average annual economic impact. An average of 106 acres is fallowed annually as a result of the Project, at an average annual fallow land maintenance cost of $5,708. In addition to fallowing, the Project may cause yield losses in some years as farmers are forced to delay planting until fields are dry. Crop revenue losses resulting from yield losses and fallowing average $173,903 per year under Alternative 4. The combined NED impact of Alternative 4 equals $179,611 per year. Alternative 1 causes the lowest average annual economic impact, with 22 acres fallowed and total NED impact of $65,222 per year.

Table 6. Average Annual Economic Impact of Project Alternatives (2016 dollars)

Metric	Alt 1	Alt 4	Alt4M	Alt5	Alt6
Income over Expenses ($2016)	-$64,026	-$173,903	-$122,602	-$75,855	-$99,645
Acres Fallow	22	106	95	44	26
Variable Fallow Expenses ($2016)	$1,195	$5,708	$5,124	$2,370	$1,394
NED Impact ($2016)	-$65,222	-$179,611	-$127,725	-$78,225	-$101,039

The economic impact analysis also considers the indirect and induced effects in Yolo County resulting from a change in direct farm revenues in the Yolo Bypass. Indirect effects include changes in farm input purchases such as seed, chemicals, and other farm inputs. Induced effects include changes in farm labor and other employee expenditures. Thus the total economic impact includes the direct changes in gross farm revenues and the multiplier effect on all ancillary (backward-linked) industries in Yolo County. The IMPLAN model was constructed with the 2014 R3 data for Yolo County and is used to estimate the indirect and induced impacts. The technical details of the IMPLAN model are described in other sections of the EIR/S. The total economic impact, in terms of jobs, value-added, and total output value, follows from the direct economic impacts estimated using the BPM (gross farm revenues) is summarized in each of the subsequent subsections.

5.1 Alternative 1

Alternative 1 causes the smallest average annual economic impact out of the five Project alternatives considered. Table 5 summarizes the average annual economic impact of Alternative 1 over the 1997 – 2012 hydrologic period of record. Average annual fallowing equals 22 acres and the average annual NED impact equals $65,222, representing a total decrease of 0.97% over the ExCon/NAA simulation. The maximum annual economic impact occurs in year 2009. Net farm income falls by $256,106 in this year, and total fallowing equals 126 acres. Net income losses are the combined impact resulting from fallowing and lost revenues due to decreasing yields. The former is illustrated in the plots in Figure 3 and the latter is illustrated in Figure 2.

Table 7. Alternative 1 BPM Economic Impact Summary

Metric	Average annual change
Income over Expenses ($2016)	($64,026)
Acres Fallow	22
Variable Fallow Expenses ($2016)	1,195
NED Impact ($2016)	($65,222)
Average % Change in NED Farm Income	-0.97%
Maximum Annual Impact: 2009	
Income over Expenses ($2016)	($256,106)
Acres Fallow	126

Figure 4 illustrates the decrease in farm income over expenses for each year in the 1997 – 2012 period of record. Economic impacts are driven by the wetted acreage plots shown in Figure 3. Economic losses increase when additional flooding occurs during the standard planting window. The Alternative 1 economic impact is small in most years because, as shown in Figure 3, the incremental increase in wetted area is small and occurs outside of the standard planting window for most crops. The years 2001, 2002, and 2009 show the largest annual economic impacts because the incremental wetted area is most significant during these years.

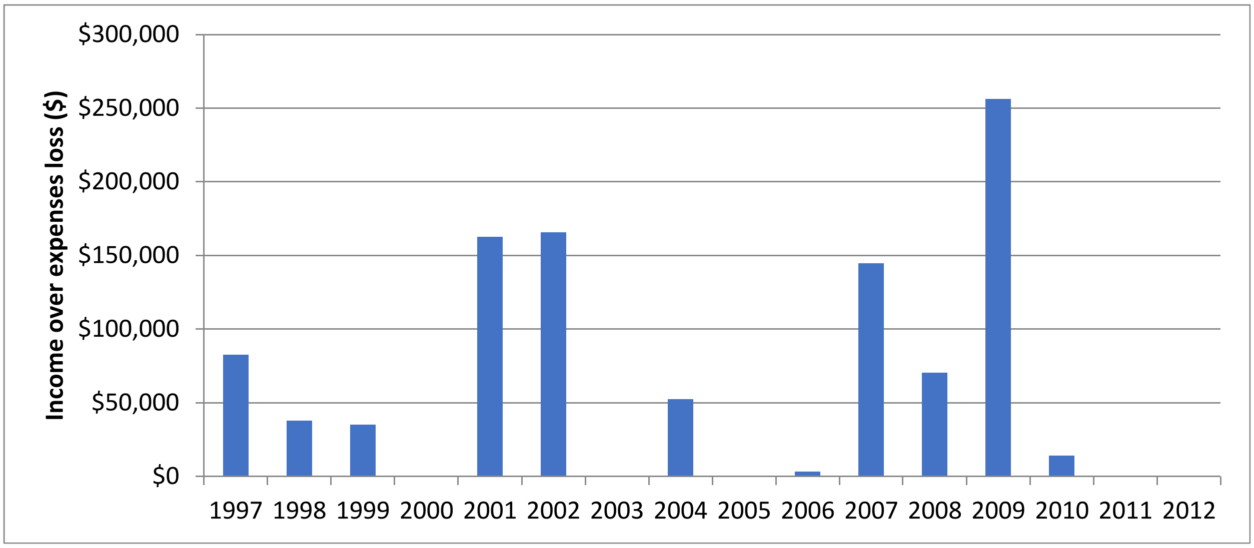

Figure 4.
Alternative 1 Annual Loss of Income Over Expenses, 1997 - 2012, ($ 2016)

Economic impacts are caused by crop yield losses and fallowing. Figure 5 illustrates additional acreage fallowed as a result of Project Alternative 1. As expected, additional fallowing typically occurs in years where the project causes a decrease in income over expenses. In years when the additional wetted acreage caused by the Project is either small or does not occur during the standard planting window, fallowing is generally minor. The most significant fallowing occurs in 2009, when Alternative 1 causes an increase in wetted area during the edge of the standard planting window. It is noteworthy that significant Yolo Bypass fallowing occurs in wet years but this is not an impact of the Project. For example, 2005 and 2006 were particularly wet years with late flooding in the Yolo Bypass, however Project impacts are small because there is no incremental increase in wetted area that is attributable to the Project.

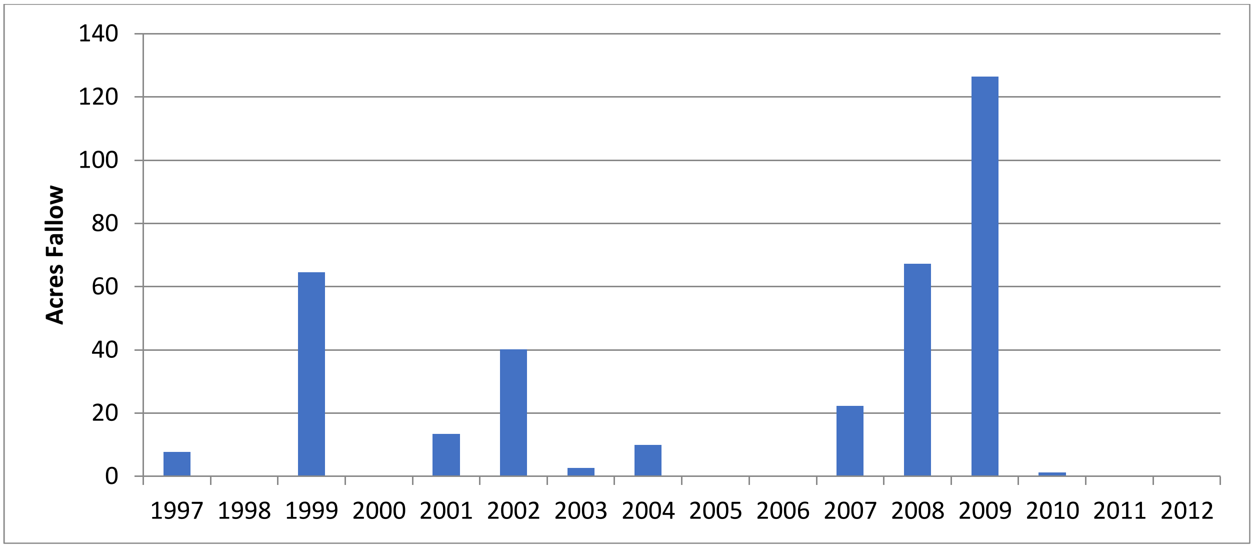

Figure 5.
Alternative 1 Annual Fallow Acreage, 1997 - 2012

The gross farm revenue losses estimated using the BPM are inputs to the IMPLAN model and used to estimate the total economic impact caused by the Project. A change in Yolo Bypass farming activity may have multiplier effects on ancillary industries as growers purchase fewer inputs and there are fewer farm jobs available. Table 6 summarizes the total economic impact of Alternative 1. Average annual gross farm revenue are equivalent to the direct change in output value and average $71,699 per year over the 1997 – 2012 period of record. The total output value loss equals $102,277 annually. Total value added, a measure of economic activity occurring in Yolo County, falls by $62,766 across Yolo Bypass crop production and backward-linked industries. Average annual employment decreases by a total of 0.6 jobs as a result of Alternative 1.

Table 8. Alternative 1 Total Economic Impact Summary

Metric	Employment	Value Added	Output Value
Direct Effect	-0.3	($42,890)	($71,699)
Indirect Effect	-0.2	($12,851)	($19,089)
Induced Effect	-0.1	($7,025)	($11,489)
Total Effect	**-0.6**	**($62,766)**	**($102,277)**

5.2 Alternative 4 (March 15 Gate Closure)

Alternative 4 causes the highest average annual economic impact out of the five Project alternatives considered. Table 9 summarizes the average annual economic impact of Alternative 4 over the 1997 – 2012 hydrologic period of record. Average annual fallowing equals 106 acres and the average annual NED impact equals $179,611, representing a total decrease of 2.68% over the ExCon/NAA simulation. The maximum annual economic impact occurs in year 2002. Net farm income falls by $409,931 in this year, and total fallowing equals 71 acres. Note that fallowing is more significant in other years, but the year 2002 represents the highest loss in net income. Net income losses are the combined impact resulting from fallowing and lost revenues due to decreasing yields. The former is illustrated in the plots in Figure 3 and the latter is illustrated in Figure 2.

Table 9. Alternative 4 BPM Economic Impact Summary

Metric	Average annual change
Income over Expenses ($2016)	($173,903)
Acres Fallow	106
Variable Fallow Expenses ($2016)	5,708
NED Impact ($2016)	($179,611)
Average % Change in NED Farm Income	-2.68%
Maximum Annual Impact: 2002	
Income over Expenses ($2016)	($409,931)
Acres Fallow	71

Figure 6 illustrates the decrease in farm income over expenses for each year in the 1997 – 2012 period of record. Economic impacts are driven by the impacted acreage plots shown in Figure 3. Economic losses increase when additional flooding occurs during the standard planting window. Alternative 4 economic impacts occur in most years because, as shown in Figure 3, the incremental increase in wetted area occurs, in part, during the standard planting window for most crops. The years 1997, 2001, 2002, 2007, and 2009 show the largest annual economic impacts because the incremental wetted area is most significant during these years.

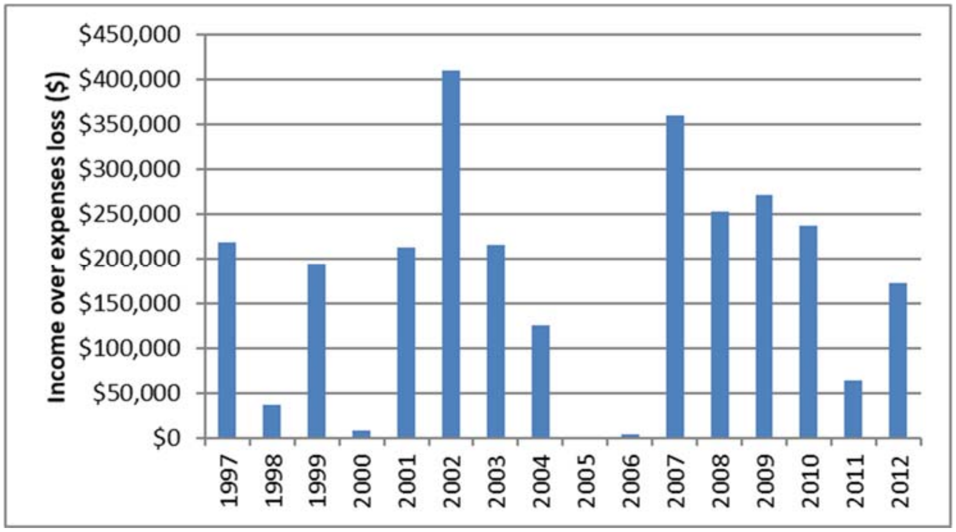

Figure 6.
Alternative 4 Annual Loss of Income Over Expenses, 1997 - 2012, ($ 2016)

Economic impacts are caused by crop yield losses and fallowing. Figure 7 illustrates additional acreage fallowed as a result of Project Alternative 4. As expected, additional fallowing typically occurs in years where the project causes a decrease in income over expenses. In years when the additional wetted acreage caused by the project is either small or does not occur during the standard planting window, fallowing is generally minor. This includes 2005 and 2006. The most significant fallowing occurs in 2010, when Alternative 1 causes an increase in wetted area during the edge of the standard planting window. It is noteworthy that significant Yolo Bypass fallowing occurs in wet years such as 2005 and 2006. However, Project fallowing impacts are small because there is no incremental increase in wetted area that is attributable to the Project in those years.

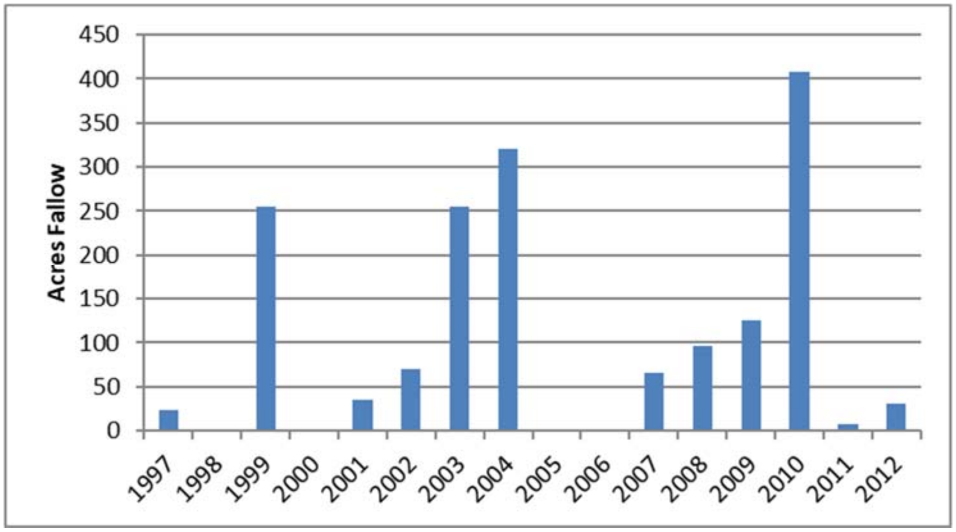

Figure 7.
Alternative 4 Annual Fallow Acreage, 1997 - 2012

The gross farm revenue losses estimated using the BPM are inputs to the IMPLAN model and used to estimate the total economic impact caused by the Project. A change in Yolo Bypass farming activity may have multiplier effects on ancillary industries as growers purchase fewer inputs and there are fewer farm jobs available. Table 10 summarizes the total economic impact of Alternative 4. Average annual gross farm revenue are equivalent to the direct change in output value and average $246,620 per year over the 1997 – 2012 period of record. The total output value loss equals $360,730 annually. Total value added, a measure of economic activity occurring in Yolo County, falls by $189,367 across Yolo Bypass crop production and backward-linked industries. Average annual employment decreases by a total of 1.5 jobs as a result of Alternative 4.

Table 10. Alternative 4 Total Economic Impact Summary

Metric	Employment	Value Added	Output Value
Direct Effect	-0.5	($115,103)	($246,620)
Indirect Effect	-0.8	($55,569)	($83,536)
Induced Effect	-0.2	($18,695)	($30,575)
Total Effect	**-1.5**	**($189,367)**	**($360,730)**

5.3 Alternative 4M (March 7 Gate Closure)

Alternative 4M causes the second highest annual economic impact out of the five Project alternatives considered. Table 11 summarizes the average annual economic impact of Alternative 4M over the 1997 – 2012 hydrologic period of record. Average annual fallowing equals 95 acres and the average annual NED impact equals $127,725, representing a total decrease of 1.90% over the ExCon/NAA simulation. The maximum annual economic impact occurs in year 2002, similar to Alternative 4. Net farm income falls by $282,893 in this year, and total fallowing equals 42 acres. Net income losses are the combined impact resulting from fallowing and lost revenues due to decreasing yields, thus the maximum fallowing impact occurs in other years. The former is illustrated in the plots in Figure 3 and the latter is illustrated in Figure 2.

Table 11. Alternative 4M BPM Economic Impact Summary

Metric	Average annual change
Income over Expenses ($2016)	($122,602)
Acres Fallow	95
Variable Fallow Expenses ($2016)	5,124
NED Impact ($2016)	($127,725)
Average % Change in NED Farm Income	-1.90%
Maximum Annual Impact: 2002	
Income over Expenses ($2016)	($282,893)
Acres Fallow	42

Figure 8 illustrates the decrease in farm income over expenses for each year in the 1997 – 2012 period of record. Economic impacts are driven by the impacted acreage plots shown in Figure 3. Economic losses increase when additional flooding occurs during the standard planting window. Alternative 4M economic impacts are moderate in most years because, as shown in Figure 3, the incremental increase in wetted area is moderate and occurs during the standard planting window for most crops. The years 1999, 2002, 2003, 2007, 2010 and 2009 show the largest annual economic impacts because the incremental wetted area is most significant during these years.

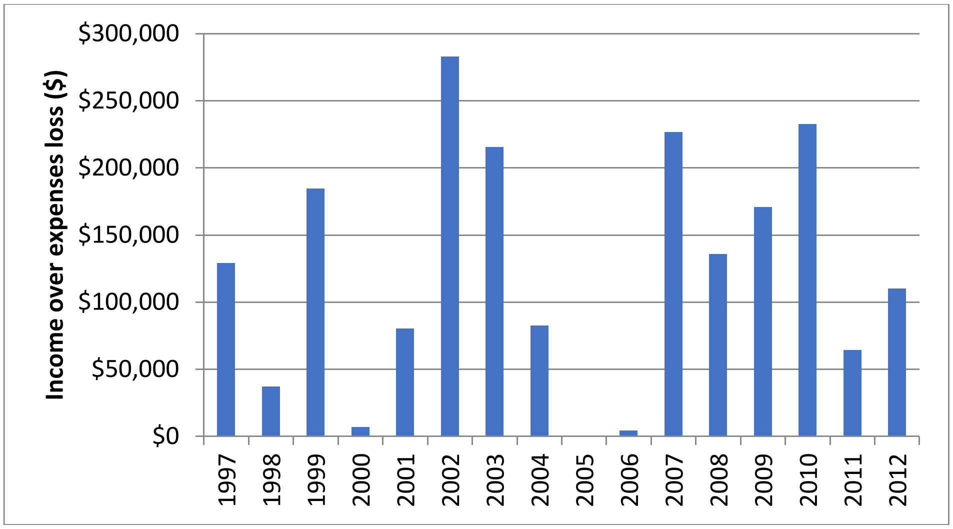

Figure 8.
Alternative 4M Annual Loss of Income Over Expenses, 1997 - 2012, ($ 2016)

Economic impacts are caused by crop yield losses and fallowing. Figure 9 illustrates additional acreage fallowed as a result of Project Alternative 4M. As expected, additional fallowing typically occurs in years where the project causes a decrease in income over expenses. In years when the additional wetted acreage caused by the project is either small or does not occur during the standard planting window, fallowing is generally minor. The most significant fallowing occurs in 2010, when Alternative 4M causes an increase in wetted area during the edge of the standard planting window. It is noteworthy that significant Yolo Bypass fallowing occurs in wet years. For example, 2005 and 2006 were particularly wet years with late flooding in the Yolo Bypass, however Project impacts are small because there is no incremental increase in wetted area that is attributable to the Project.

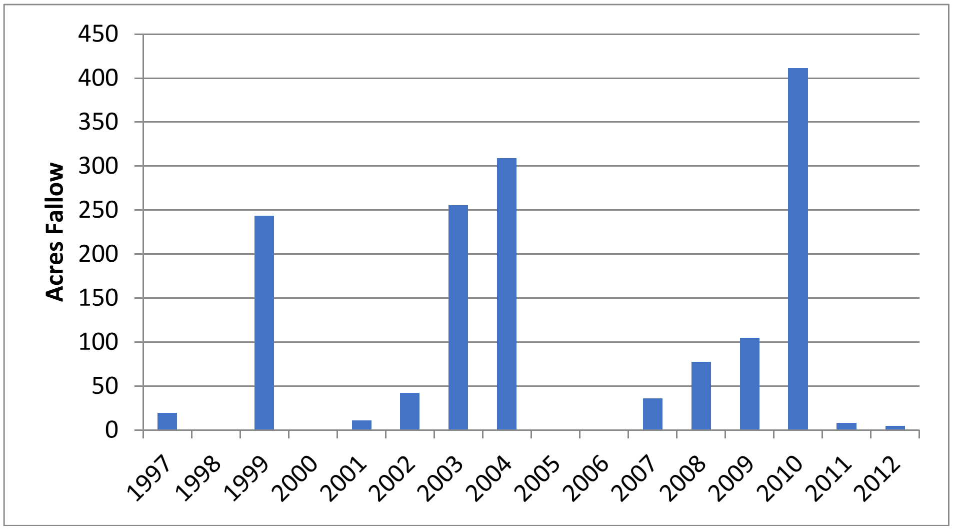

Figure 9.
Alternative 4M Annual Fallow Acreage, 1997 - 2012

The gross farm revenue losses estimated using the BPM are inputs to the IMPLAN model and used to estimate the total economic impact caused by the Project. A change in Yolo Bypass farming activity may have multiplier effects on ancillary industries as growers purchase fewer inputs and there are fewer farm jobs available. Table 12 summarizes the total economic impact of Alternative 4M. Average annual gross farm revenue are equivalent to the direct change in output value and average $191,066 per year over the 1997 – 2012 period of record. The total output value loss equals $284,495 annually. Total value added, a measure of economic activity occurring in Yolo County, falls by $141,526 across Yolo Bypass crop production and backward-linked industries. Average annual employment decreases by a total of 1.2 jobs as a result of Alternative 4M.

Table 12. Alternative 4M Total Economic Impact Summary

Metric	Employment	Value Added	Output Value
Direct Effect	-0.4	($80,659)	($191,066)
Indirect Effect	-0.7	($46,470)	($69,883)
Induced Effect	-0.2	($14,398)	($23,546)
Total Effect	**-1.2**	**($141,526)**	**($284,495)**

5.4 Alternative 5

Alternative 5 causes the second smallest average annual economic impact out of the five Project alternatives considered. Table 13 summarizes the average annual economic impact of Alternative 5 over the 1997 – 2012 hydrologic period of record. Average annual fallowing equals 44 acres and the average annual NED impact equals $78,225, representing a total decrease of 1.17% over the ExCon/NAA simulation. The maximum annual economic impact occurs in year 2002. Net farm income falls by $222,091 in this year, and total fallowing equals 43 acres. Net income losses are the combined impact resulting from fallowing and lost revenues due to decreasing yields. The former is illustrated in the plots in Figure 3 and the latter is illustrated in Figure 2.

Table 13. Alternative 5 BPM Economic Impact Summary

Metric	Average annual change
Income over Expenses ($2016)	($75,855)
Acres Fallow	44
Variable Fallow Expenses ($2016)	2,370
NED Impact ($2016)	($78,225)
Average % Change in NED Farm Income	-1.17%
Maximum Annual Impact: 2002	
Income over Expenses ($2016)	($222,091)
Acres Fallow	43

Figure 10 illustrates the decrease in farm income over expenses for each year in the 1997 – 2012 period of record. Economic impacts are driven by the impacted acreage plots shown in Figure 3. Economic losses increase when additional flooding occurs during the standard planting window. Alternative 5 economic impacts are small in most years because, as shown in Figure 3, the incremental increase in wetted area is small and occurs outside of the standard planting window for most crops. The years 2001, 2002, and 2009 show the largest annual economic impacts because the incremental wetted area is most significant during these years.

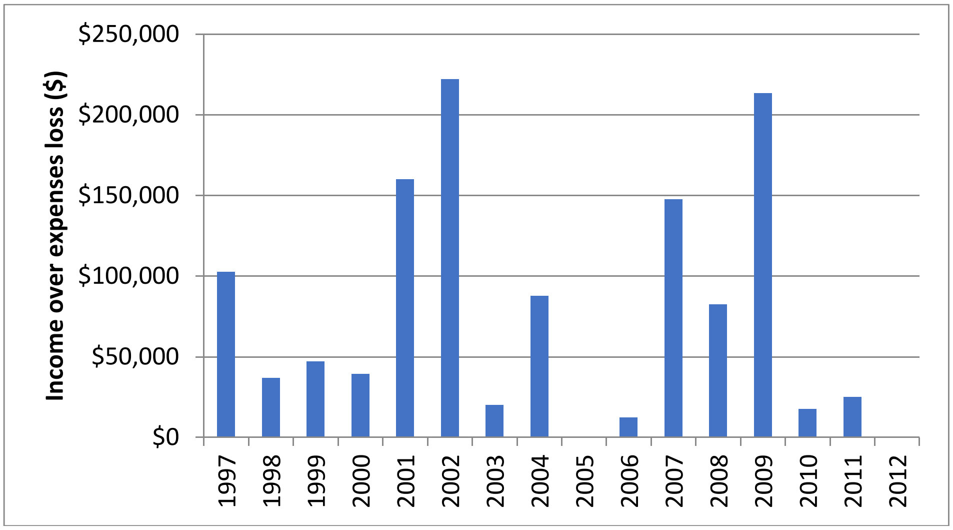

Figure 10.
Alternative 5 Annual Loss of Income Over Expenses, 1997 - 2012, ($ 2016)

Economic impacts are caused by crop yield losses and fallowing. Figure 11 illustrates additional acreage fallowed as a result of Project Alternative 5. As expected, additional fallowing typically occurs in years where the project causes a decrease in income over expenses. In years when the additional wetted acreage caused by the project is either small or does not occur during the standard planting window, fallowing is generally minor. The most significant fallowing occurs in 2004, when Alternative 5 causes an increase in wetted area during the edge of the standard planting window. It is noteworthy that significant Yolo Bypass fallowing occurs in wet years. For example, 2005 and 2006 were particularly wet years with late flooding in the Yolo Bypass, however Project impacts are small because there is no incremental increase in wetted area that is attributable to the Project.

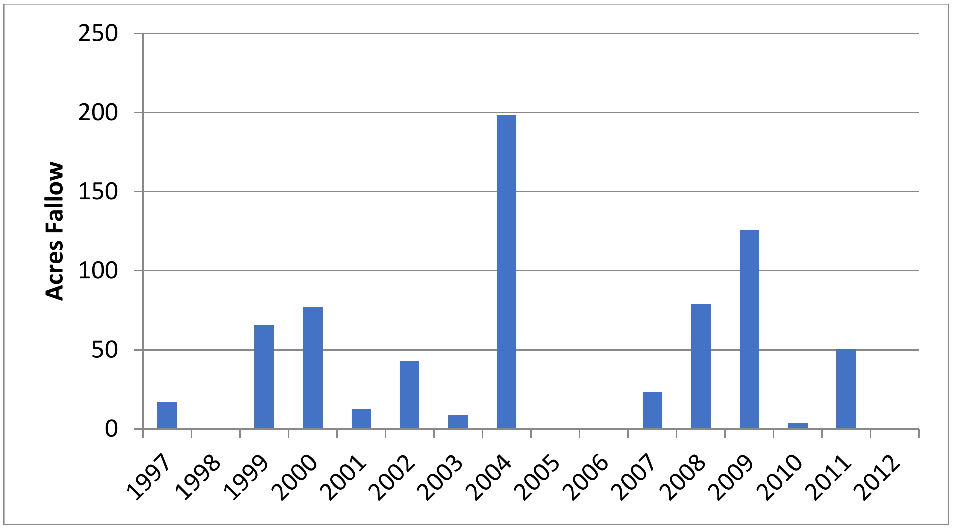

Figure 11.
Alternative 5 Annual Fallow Acreage, 1997 - 2012

The gross farm revenue losses estimated using the BPM are inputs to the IMPLAN model and used to estimate the total economic impact caused by the Project. A change in Yolo Bypass farming activity may have multiplier effects on ancillary industries as growers purchase fewer inputs and there are fewer farm jobs available. Table 14 summarizes the total economic impact of Alternative 5. Average annual gross farm revenue are equivalent to the direct change in output value and average $95,252 per year over the 1997 – 2012 period of record. The total output value loss equals $135,154 annually. Total value added, a measure of economic activity occurring in Yolo County, falls by $81,324 across Yolo Bypass crop production and backward-linked industries. Average annual employment decreases by a total of 0.7 jobs as a result of Alternative 5.

Table 14. Alternative 5 Total Economic Impact Summary

Metric	Employment	Value Added	Output Value
Direct Effect	-0.3	($55,406)	($95,252)
Indirect Effect	-0.3	($17,422)	($26,007)
Induced Effect	-0.1	($8,496)	($13,895)
Total Effect	**-0.7**	**($81,324)**	**($135,154)**

5.5 Alternative 6

Alternative 6 causes moderate annual economic impacts relative to the other Project alternatives considered. Table 15 summarizes the average annual economic impact of Alternative 6 over the 1997 – 2012 hydrologic period of record. Average annual fallowing equals 26 acres and the average annual NED impact equals $101,039, representing a total decrease of 1.51% over the ExCon/NAA simulation. The maximum annual economic impact occurs in year 2009. Net farm income falls by $317,084 in this year, and total fallowing equals 137 acres. Net income losses are the combined impact resulting from fallowing and lost revenues due to decreasing yields. The former is illustrated in the plots in Figure 3 and the latter is illustrated in Figure 2.

Table 15. Alternative 6 BPM Economic Impact Summary

Metric	Average annual change
Income over Expenses ($2016)	($99,645)
Acres Fallow	26
Variable Fallow Expenses ($2016)	1,394
NED Impact ($2016)	($101,039)
Average % Change in NED Farm Income	-1.51%
Maximum Annual Impact: 2009	
Income over Expenses ($2016)	($317,084)
Acres Fallow	137

Figure 12 illustrates the decrease in farm income over expenses for each year in the 1997 – 2012 period of record. Economic impacts are driven by the impacted acreage plots shown in Figure 3. Economic losses increase when additional flooding occurs during the standard planting window. Alternative 6 economic impacts are small in most years because, as shown in Figure 3, the incremental increase in wetted area is small and occurs outside of the standard planting window for most crops. The years 2001, 2002, 2007, and 2009 show the largest annual economic impacts because the incremental wetted area is most significant during these years.

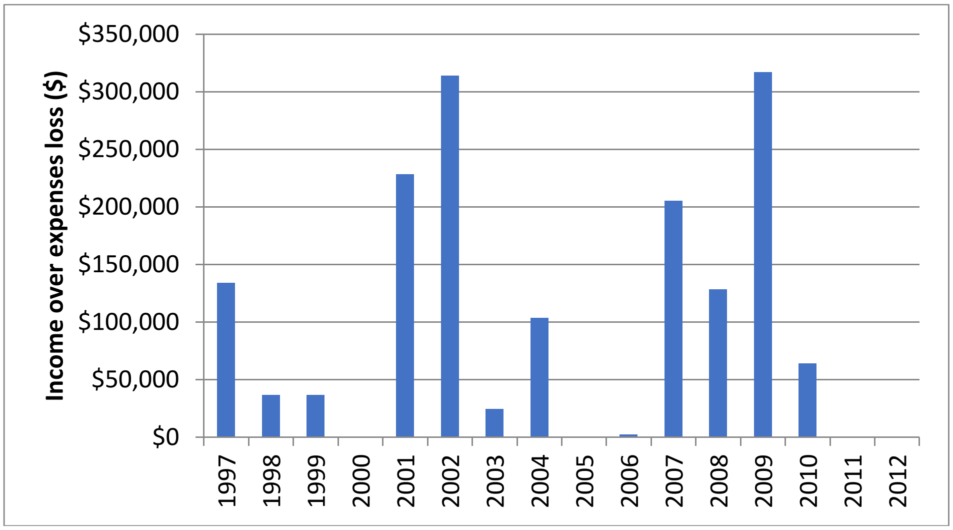

Figure 12.
Alternative 6 Annual Loss of Income Over Expenses, 1997 - 2012, ($ 2016)

Economic impacts are caused by crop yield losses and fallowing. Figure 13 illustrates additional acreage fallowed as a result of Project Alternative 6. As expected, additional fallowing typically occurs in years where the project causes a decrease in income over expenses. In years when the additional wetted acreage caused by the project is either small or does not occur during the standard planting window, fallowing is generally minor. The most significant fallowing occurs in 2009, when Alternative 6 causes an increase in wetted area during the edge of the standard planting window. It is noteworthy that significant Yolo Bypass fallowing occurs in wet years.

For example, 2005 and 2006 were particularly wet years with late flooding in the Yolo Bypass, however Project impacts are small because there is no incremental increase in wetted area that is attributable to the Project.

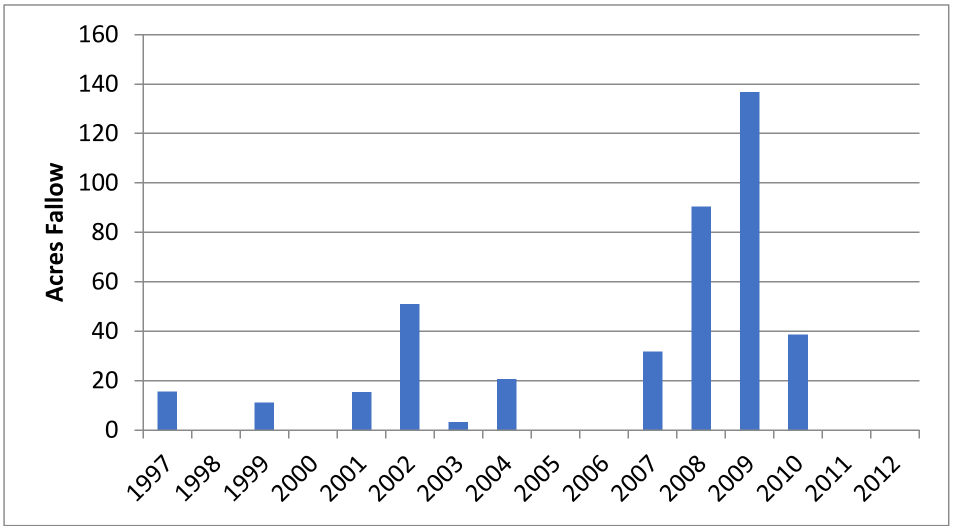

Figure 13.
Alternative 6 Annual Fallow Acreage, 1997 - 2012

The gross farm revenue losses estimated using the BPM are inputs to the IMPLAN model and used to estimate the total economic impact caused by the Project. A change in Yolo Bypass farming activity may have multiplier effects on ancillary industries as growers purchase fewer inputs and there are fewer farm jobs available. Table 16 summarizes the total economic impact of Alternative 6. Average annual gross farm revenue are equivalent to the direct change in output value and average $106,568 per year over the 1997 – 2012 period of record. The total output value loss equals $150,624 annually. Total value added, a measure of economic activity occurring in Yolo County, falls by $95,602 across Yolo Bypass crop production and backward-linked industries. Average annual employment decreases by a total of 0.9 jobs as a result of Alternative 6.

Table 16. Alternative 6 Total Economic Impact Summary

Metric	Employment	Value Added	Output Value
Direct Effect	-0.5	($66,981)	($106,568)
Indirect Effect	-0.3	($17,889)	($26,506)
Induced Effect	-0.1	($10,731)	($17,551)
Total Effect	**-0.9**	**($95,602)**	**($150,624)**

6.0 Economic Impact Summary

The economic impacts of incremental increases in wetted acreage vary across the Yolo Bypass depending on the Project alternative. Figure 14 illustrates the average annual change in irrigated acreage (temporary fallowing) under each of the Project alternatives. As shown, bypass regions 3 and 4 have the highest temporary fallowing under the alternatives. These areas are most frequently inundated. Under alternative 4 and 4M additional water infrastructure is installed to increase standing water, which in turn increases temporary fallowing.

Figure 15 illustrates the average annual change in NED farm income under each of the Project alternatives. As shown, bypass regions 3 and 4 have the highest economic impact under the alternatives. These areas are most frequently inundated, and thus realize higher losses from temporary fallowing, crop switching, or yield losses. Under alternative 4 and 4M additional water infrastructure is installed to increase standing water, which in turn increases economic costs.

7.0 BPM Limitations

The BPM is an optimization model that makes the best (most profitable) adjustments to changes in resource conditions. The BPM calibrates to observed planting decisions by bypass farmers and these cropping decisions reflect responses to changes in bypass wetted area under natural flood events. Nevertheless, an optimization model can tend to over-adjust and minimize costs associated with detrimental changes or, similarly, maximize benefits associated with positive changes.

The BPM is importantly linked to the dry day estimates generated by the TUFLOW hydrodynamic model. The assumptions implicit to the TUFLOW model therefore affect the economic impact analysis. TUFLOW model output enters into the BPM as acreage available for planting under each Project alternative after adjusting for assumed field preparation time (28 days) and miscellaneous drydown (6 days).

The BPM does not explicitly account for the dynamic nature of agricultural production and it does not explicitly incorporate risk or risk preferences (e.g., risk aversion) into its objective function. Risk aversion is incorporated implicitly into the model. The calibration procedure for the BPM reproduces the observed crop mix, so to the extent that the observed crop mix in the Yolo Bypass incorporates risk spreading and risk aversion by bypass farmers, the starting, calibrated BPM base condition will also.

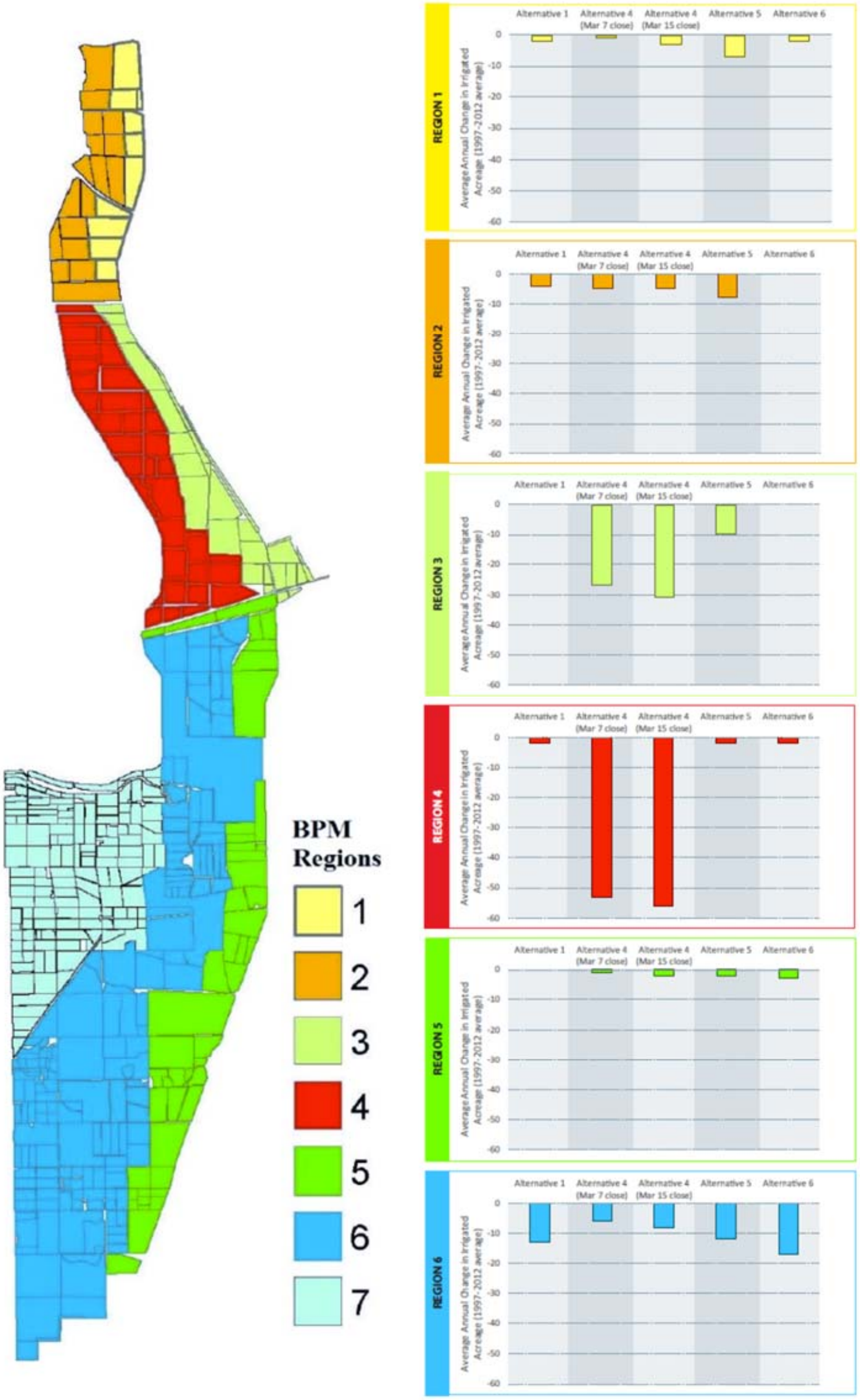

Figure 14.
Average annual temporary land fallowing under each alternative

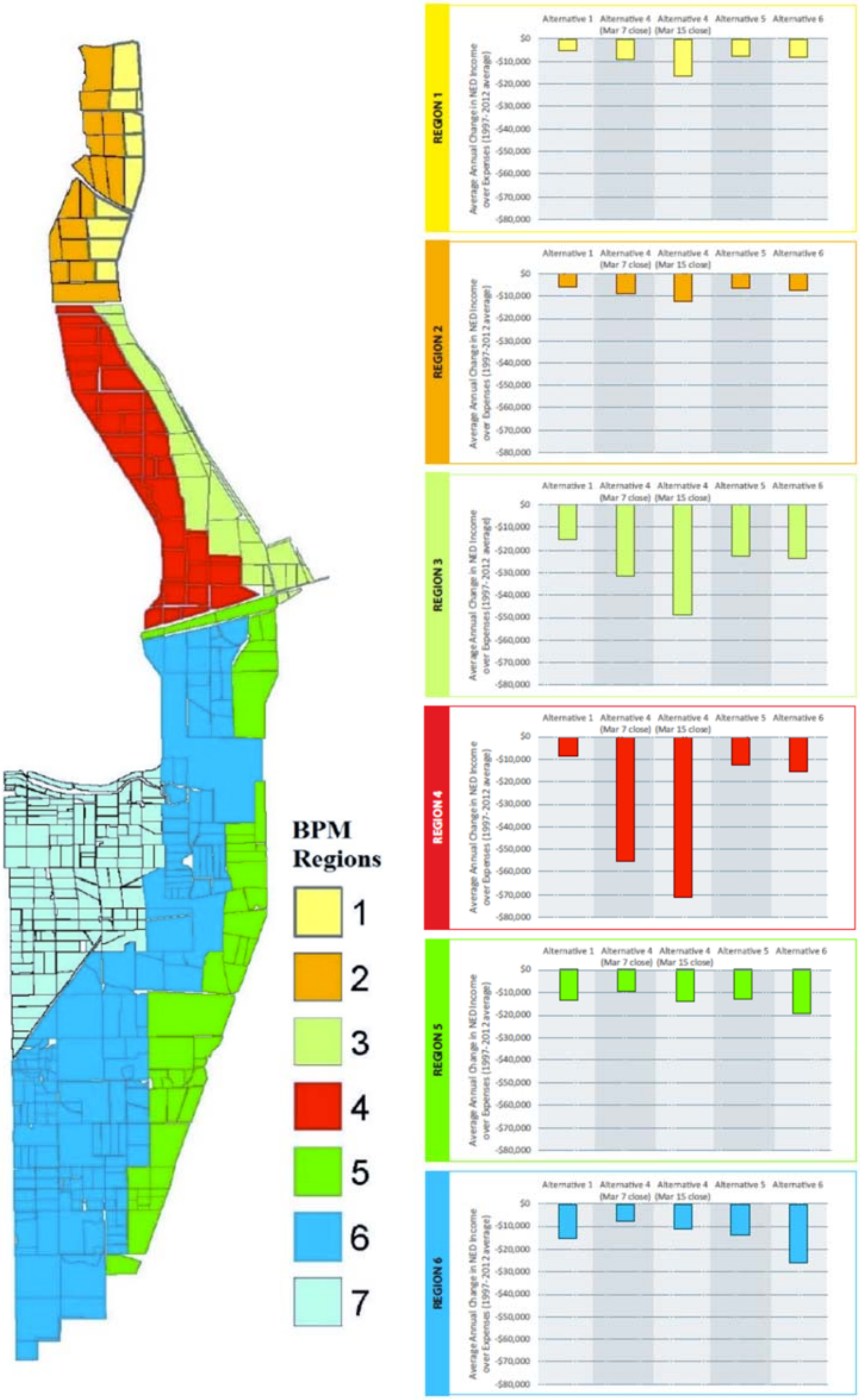

Figure 15.
Average annual change in NED farm income under each alternative

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Appendix J2

Yolo Bypass Rice and Tomato Tipping Points: Milling and Processing, Crop Insurance, and Loan Rates

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RECLAMATION
Managing Water in the West

Yolo Bypass Rice and Tomato Tipping Points: Milling and Processing, Crop Insurance, and Loan Rates

Yolo Bypass Salmonid Habitat Restoration and Fish Passage
Mid-Pacific Region

U.S. Department of the Interior
Bureau of Reclamation

October 2017

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Executive Summary

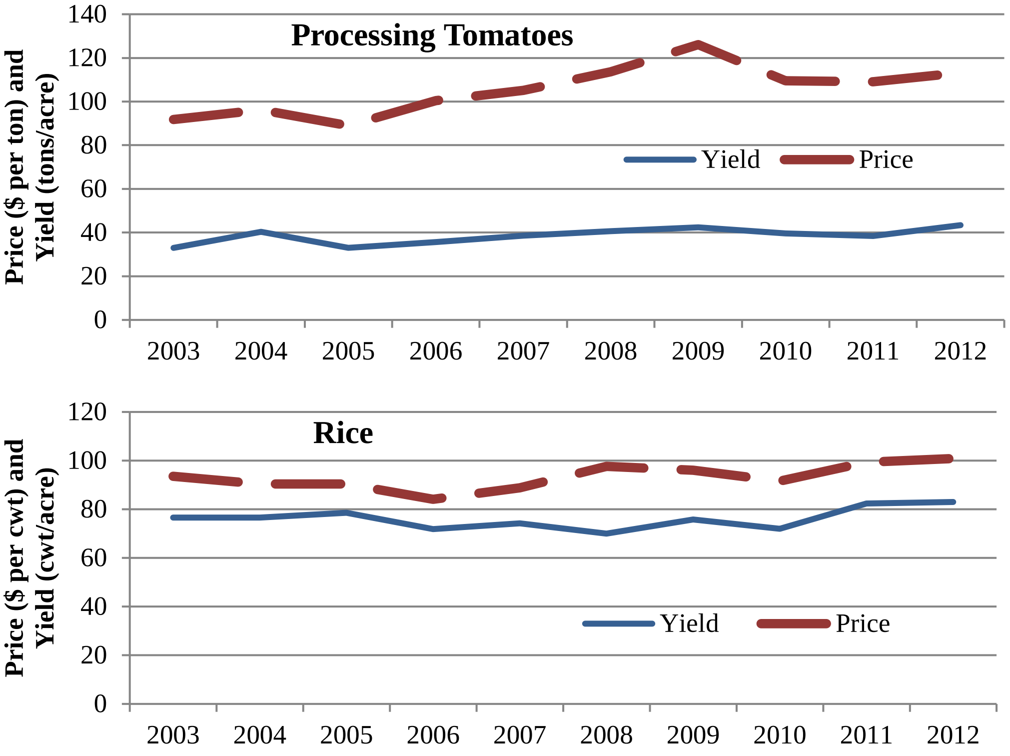
California Department of Water Resources (DWR) and United States Bureau of Reclamation (Reclamation) are jointly working on the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project. DWR and Reclamation are planning the project to comply with the 2009 National Marine Fisheries Service (NMFS) Biological Opinion (BO) and Conference Opinion on the Long-term Operation of the Central Valley Project and State Water Project Reasonable and Prudent Alternative (RPA) actions 1.6.1 and 1.7. The RPA and BO broadly require improvements in seasonal floodplain rearing habitat from December through April in the lower Sacramento River Basin. Reclamation and DWR are preparing a Draft Environmental Impact Report and Environmental Impact Statement (EIR/S) for alternatives to meet RPA requirements. The project alternatives are still being developed, but generally consist of modifying the Fremont Weir to improve the connection between the Yolo Bypass and the Sacramento River to extend the frequency and duration of flooding in the bypass.

The 59,000-acre Yolo Bypass is a working agricultural landscape, protects the city of Sacramento and surrounding communities from Sacramento River flood events, and provides seasonal habitat for fish and terrestrial species. Approximately 16,000 acres of the total bypass area are conserved as permanent wildlife habitat and native vegetation (YBF 2016). Total agricultural harvested acreage in the bypass varies with market conditions but generally averages around 35,000 acres per year, representing approximately 7 percent of the total harvested acreage in Yolo County (USDA NASS various years; Yolo County GIS various years). Primary crops produced include rice, processing tomatoes, miscellaneous vegetables and melons, and a mix of grains and pastureland (YBF 2001; Yolo County 2016; Howitt et al. 2013). The gross farm-gate value of Yolo Bypass agriculture also varies with market conditions, but generally averages $25 million per year, representing approximately 4 percent of the total value in Yolo County (USDA NASS various years).

Farming in the Yolo Bypass is an inherently risky venture with the periodic winter and spring flood events. Bypass growers understand these production risks, and importantly, have the knowledge and expertise to profitably manage their businesses. An increase in the frequency and duration of flood events in the Yolo Bypass may impose financial costs on growers, and in turn, input suppliers, processing industries, insurers, and lenders. The magnitude of the potential economic cost depends on when the additional flooding occurs. In general, when fields are wet during the March – June spring planting season this prevents growers from beginning field preparation and crops will be planted later than what would otherwise be ideal. Shorter growing seasons can lower expected yields, expose growers to risk from early fall rains, and cause a loss in farm-gate production value. Ancillary industries are also affected by this loss in farm-gate revenues. The agricultural economic impact analysis being completed for the EIR/S will quantify these losses for each proposed project alternative. This technical report quantifies the potential impact to key industries supporting major crops produced in the Yolo Bypass that could result from the RPA actions.

Rice and processing tomatoes are the dominant Yolo Bypass crops likely to be affected by RPA actions. Processing tomatoes are grown on approximately 3,300 acres in the Yolo Bypass, accounting for approximately 8 percent of total processing tomato acreage in Yolo County. Rice is grown on approximately 7,500 acres in the Yolo Bypass—ranging from 5,800 to 10,100 acres between 2005 and 2009— and accounts for approximately 25 percent of Yolo County rice production and 1.4 percent of California rice production (USDA NASS various years; Howitt et al. 2013). Like most crops, farm-gate prices and yields vary with market conditions, weather, pest and disease pressure, and other factors outside of the growers’ control. Figure ES-1 illustrates price and yield variability for Yolo County rice and processing tomatoes. Price and yield variability affects gross crop revenues, and in turn, farm profitability.

Table ES-1. Yolo County rice and processing tomato price and yield, 2003 – 2012 (price in 2012 dollars)



Source: USDA NASS various years.

The purpose of this technical report is to quantify the impact of reduced rice and processing tomato production in the Yolo Bypass on rice mills, tomato processors, crop insurance, and bank loan rates. These analyses are collectively referred to as tipping point studies because they quantify the conditions under which changes in Yolo Bypass crop production could “tip” the broader industry and cause other firms to leave the area.

The tipping point studies presented in this technical report quantify the maximum potential economic impact from a decrease in the production of rice and processing tomatoes in the Yolo Bypass. Specifically, the maximum potential impact in this study is defined as complete cessation of rice and processing tomato production in the Yolo Bypass.

The following tipping point studies are presented in this technical report:

1. **Rice mill and tomato processer**. Could rice mills or tomato processors shut down if Yolo Bypass production decreases (ceases)?
2. **Crop insurance**. Could access to rice and processing tomato crop insurance change if the frequency and duration of flooding in the Yolo Bypass increases? What is the associated financial cost to growers who farm in the bypass?
3. **Loan rates**. Could an increase in the frequency and duration of flooding in the Yolo Bypass cause an increase in production risk sufficient to cause lenders to increase interest rates or stop offering loans? What is the associated financial cost to growers who farm in the bypass?

The following sections of the executive summary briefly review the methods, data, and results for each component of the analysis. The main text of the report presents additional background information and a more detailed description of each component of the study.

Mill and Processor Tipping Point

This analysis evaluates whether a representative rice mill or tomato processor is likely to shut down if there is a decrease in Yolo Bypass production of rice or processing tomatoes, respectively. The first step in the methodology is to establish the minimum quantity of product (rice or tomatoes) that must be milled/processed in order for the mill/processor to break even, defined as the “tipping point.” The tipping point is calculated using the widely-accepted microeconomic principles for a profit maximizing firm. The tipping point occurs at a throughput quantity where there are enough units processed so that the sum of the contribution margin per unit is sufficient to cover the plant fixed costs. The contribution margin is defined as the gross revenues minus the variable or operating costs. If the quantity of product processed falls below this threshold, the firm shuts down. In other words, if the firm is not able to generate enough revenue to cover its fixed costs of production, the firm would make more profit (incur lower losses) if the firm shut down. Given this definition and the assumptions outlined below, the shut-down decision for the rice mill and tomato processor is evaluated by comparing the tipping point quantity to the quantity of rice/tomatoes available to the mill/processor if there is no production in the Yolo Bypass. Data for the analysis are compiled from primary interviews, published studies, and industry reports.

The following assumptions apply to the analysis:

1. The analysis assumes there is a 100 percent decrease in the production of rice and processing tomatoes in the Yolo Bypass.
2. The scenario evaluates a “representative” mill or processor. The representative mill or processor is modeled after the existing businesses that process Yolo Bypass production, as described below, but business names are omitted to preserve confidentiality.
3. The analysis assumes 100 percent of Yolo Bypass rice/tomato production goes to the representative mill/processor and that the mill/processor cannot procure additional rice/tomatoes from other regions when Yolo Bypass production decreases. All mill and processor managers interviewed for the analysis indicated they in fact have a diverse supply portfolio to manage against this type of risk.
4. The analysis evaluates a short-run tipping point decision using a long-run economic criterion, and as such, is a conservative analysis. In practice, most businesses are able to manage (potentially large) short-run fluctuation in production (price or quantity) without deciding to leave the industry.

Tomato processor. The analysis finds that the quantity of processing tomatoes available to the tomato processor does not fall below the tipping point quantity under a plausible range of parameter assumptions. Tomatoes grown in the Yolo Bypass represent a small share of total Yolo County acreage, and a smaller share of the quantity processed by the representative processor. Without bypass production, the processor is able to maintain production above the tipping point threshold. A series of sensitivity analyses are performed to establish the robustness of this result. Under all scenarios, the representative processor’s throughput quantity is 2.5 to 3.5 times the tipping point threshold. However, as shown under one scenario where the representative tomato processor does not secure contracts from other regions, net revenues fall by $23 million to $42 million.

Rice mill. The analysis finds that the quantity of rough rice available to the mill does not fall below the tipping point quantity under a plausible range of parameter assumptions. The analysis finds the tipping point quantities for the mill range between 400,000 and 800,000 hundredweight (cwt) annually. The representative rice mill handles rice quantities between 3.3 and 3.6 million cwt annually without any rice from the Yolo Bypass. A series of sensitivity analyses are performed to establish the robustness of this result. Under all scenarios, the representative mill's throughput quantity is above the tipping point threshold.

It is also noteworthy that during the current drought California rice acreage fell by more than 25 percent, from 563,000 acres in 2012 to 416,000 acres in 2015 (USDA ERS 2015). However, even with 25 percent less rice available for California mills to process, no mills have shut down, demonstrating the resilience of the industry to market volatility

Crop Insurance

Crop insurance is an important tool that growers use to hedge against production risk (ISUUE 2014). There are a number of insurance instruments available to growers who farm rice or processing tomatoes in the Yolo Bypass. The most popular insurance policies used in the Yolo Bypass are yield and revenue protection (USDA RMA 2014; USDA FCIC 2010). Yield protection insures against yield variability whereas revenue protection insures against price and yield variability. Within this coverage there are fundamentally two types of crop insurance options available for growers: (i) catastrophic risk protection that is subsidized by the federal government, and (ii) buy-up insurance policies that enable growers to select a higher coverage level and pay a corresponding premium. This analysis focuses primarily on buy-up policies, as they are the most commonly used crop insurance policies by Yolo Bypass growers. Common provisions in buy-up policies include late planting, prevented planting, replanting, and replanting to a different crop (USDA RMA 2014; FCIC 2010).

Much like home or auto insurance, crop insurance premiums are based on coverage level and production risk. Higher risk production areas naturally require growers to pay higher premiums for the same level of coverage. Risk ratings for any production area are developed by the United States Department of Agriculture (USDA) Risk Management Agency (RMA) (USDA RMA 2012; USDA RMA 2012a). They are crop-specific measures which are periodically updated and used to quantify the level of risk for farming a given crop in a given area. The production risk can be classified as 001 (lowest risk), AAA, or BBB (highest risk). Processing tomato production anywhere in Yolo County is classified as risk rating AAA (USDA RMA 2014a). Rice production on land outside of the Yolo Bypass is classified as 001. Rice production on land in the Yolo Bypass is either AAA (areas to the north) or BBB (areas to the south affected by colder Delta winds) (USDA RM, 2014a; USDA RMA 2013). It is important to note that not all policies are available for all crops (NCIS 2014). For example, there is no prevented planting coverage (insurance for missed or late plantings) offered for processing tomatoes in Yolo County (Sanchez 2014; Otto 2014).

The increase in production risk resulting from project alternatives should be quantified by evaluating the increase in variability of farm-gate revenues (price and yield variability) under each of the proposed alternatives relative to historical average conditions. Since the project alternatives have not been specified, this analysis assumes that the project alternatives increase the production risks for rice and processing tomato farming in the Yolo Bypass in all years. That is, it is assumed that there is late-season flooding in the bypass that is likely to affect the planting window for these crops in every year, representing a 100 percent increase in production risk.

The USDA RMA sets policy provisions and rates for crop insurance, and contracts with private insurance companies to facilitate and administer the policies (Sanchez 2014; Otto 2014). Insurer risk is partially offset through reinsurance policies. If production risk increases, USDA RMA may increase the risk classification. Representatives from the USDA RMA who are responsible for setting Yolo County risk classifications were interviewed to determine if the risk classification would change in response to additional flooding in all years in the Yolo Bypass. The USDA RMA representatives confirmed that the risk classification already takes into account flood risks, and as such, the risk classification for rice and processing tomatoes in the Yolo Bypass would stay at the current classification under the hypothesized increase in flooding in all years.

Insurance companies may increase insurance premiums to compensate for higher expected indemnity payouts even if USDA RMA does not increase the risk classification for rice or processing tomatoes. Data from local private insurance companies, growers, USDA RMA, and USDA RMA representative interviews were used to estimate the potential increase in rice and tomato crop insurance premiums in response to increased flood risk. The analysis finds, and interviews confirmed, that crop insurance, including prevented planting buy-up policies, would still be offered if the frequency of flooding in the bypass increases in all years. For processing tomatoes the only insurance offered is Actual Production History (APH), which is a yield-based insurance policy (USDA RMA 2014). The analysis estimates that tomato crop insurance premiums could increase by $1.36 to $2.73 per acre under a scenario with additional bypass flooding in all years. Rice growers have more options for insurance, including prevented planting. The analysis estimates that rice insurance premiums could increase by $6.48 to $12.96 per acre if flooding increases in all years.

The final part of the analysis evaluates the impact of an increase in insurance premiums on farm income to determine whether growers are likely to continue farming in the bypass. It is important to note that agriculture is one of the most heavily regulated and highly variable industries in California. Any increase in costs due to policy action or regulation places significant financial strain on growers. The analysis uses the University of California Cooperative Extension (UCCE) farm cost of production budgets for rice and processing tomatoes to evaluate the impact of higher insurance premiums (UCCE 2008; UCCE 2012). Net returns to land and management per acre decrease by 1.4 to 3.0 percent for rice growers and 0.3 to 0.6 percent for tomato growers, if insurance premiums increase in response to the scenario of additional flooding in all years. Both rice and tomato growers are likely to realize a decrease in net income, but likely to be able to maintain a positive margin over variable costs under the scenarios considered. However, it is important to note that growers are not able to maintain a positive margin over variable costs (on a cash accounting basis) on some fields in years where rice prices are low, yields are poor, or there is late season flooding.

Table ES-2 summarizes the effect of an increase in insurance premiums on rice and processing tomato net returns. As shown,

Table ES-2. Rice and tomato production costs and returns with increased insurance premiums (in 2012 dollars)

Rice Cost and Returns per Acre	AAA	0.25 Increase	0.35 Increase	0.50 Increase
Gross Returns	1,598	1,598	1,598	1,598
Operating Costs	-1,148	-1,148	-1,148	-1,148
Crop Insurance Premium	-31	-38	-41	-45
Net Returns Above Operating Costs	419	412	410	406
Tomato Cost and Returns per Acre	AAA	0.003 Increase	0.004 Increase	0.006 Increase
Gross Returns	2,839	2,839	2,839	2,839
Operating Costs	-2,337	-2,337	-2,337	-2,337
Crop Insurance Premium	-13	-14	-15	-16
Net Returns Above Operating Costs	489	487	487	486

Source: UCCE 2008, UCCE 2012

Bank Loans

Operating loans are an important financial tool that many growers use to smooth seasonal cash flow (Blank 2012). Most crops require a significant capital outlay at planting and additional expenditures for management costs during the growing season, but do not generate revenue until sometime after harvest. Short-term seasonal loans can be used to smooth this financial cycle. Short-term financing is usually acquired through budgeted loans or revolving lines of credit with maturities of one to four years. Current lending rates on these loans are on the order of 5.5 percent (AAC 2016; Elliessy 2014). Other medium and long-term loans are discussed, but the analysis is primarily concerned with short-term lending as this would be most likely to be affected by an increase in bypass farming risk.

The ability of an agricultural business to obtain financing is primarily based on the creditworthiness of the borrower and the intended use of the funds (Elliessy 2014; Monaco 2014). Standard quantitative measures used to evaluate the creditworthiness of agricultural borrowers include farm financial information (balance sheets, and importantly, total crop/business portfolio), collateral support (farm property), current and historical cash flow, and structuring (longer term maturity increase the probability of repayment). Agricultural lenders also consider qualitative factors such as management ability, character, reputation, intangible risk factors, farm appearance, farm record keeping, asset quality, and general business knowledge. There is no standard method used to evaluate the creditworthiness of an individual loan. A combination of financial ratios and qualitative factors are used in the loan decision.

General loan requirements, loan criteria, and loan processes are examined to identify key factors affecting lenders and borrowers, and how these factors could change under an increase in production risk. The same increase in production risk used in the crop insurance analysis is applied to the bank loan analysis. Namely, there is an increase in Yolo Bypass flooding in all years. The analysis quantifies the effect of increased production risk on access to credit and interest rates using data from the USDA, a local representative at a large lending institution in Yolo County, data from USDA NASS, and a farm loan manager from the Farm Services Agency (FSA). These data and interviews with local lenders were combined to quantify the potential change in loan access and interest rates in response to an increase in bypass farming risk.

The primary finding of the analysis is that interest rates may increase if the increase in risk was perceived (by lenders) to be significant, but loans are likely to continue to be offered to bypass growers. However, all of the experts that were interviewed emphasized the importance of personal relationships between lenders and growers and stressed that is was highly unlikely interest rates offered to current growers would increase if they continue to farm in the bypass. In other words, increased production risks are more likely to affect growers with limited farming experience or with limited additional assets (collateral). In addition to personal relationships, another important consideration is the total business portfolio of the grower. If the significant proportion, typically defined as 25 percent or more, of the total land farmed by a grower is located in the bypass, this can limit the ability to get a production loan. However, if the grower has a diversified business then farming exclusively in the bypass is not a limit to securing short-term production loan. That is, both the crop portfolio and business portfolio are important for determining access to credit. Bypass growers have a diversified crop and business portfolio, making it unlikely that an increase in risk would lead to an increase in production loan rates.

The FSA representative and private lender were interviewed to estimate the potential increase in production loan rates if there is a large increase in flooding risk. They were able to generate a series of hypothetical scenarios to show how their business would increase rates if risk increased (generically). They estimated that a 2 to 3 percentage point interest rate increase would cover the additional risk exposure of the lender under the scenarios of increased flooding in all years. This estimate is supported by an analysis by Walraven and Barry (2003) of the Federal Reserve Bank that examined agricultural lending risk between 1997 and 2002 and found that, on average, a loan with the least risky rating carried an interest rate 1.3 percentage points lower than a loan with the highest risk rating. This analysis finds that an upper bound for the increase in interest rates charged to growers for short-term production loans is between 1.3 and 3 percentage points.

To quantify the additional financing costs incurred by growers due to increased flooding risk, 1.3 and 3 percentage point increases in the interest on operating capital are evaluated. The UCCE crop production budgets are used to estimate grower revenues and costs (UCCE 2008; UCCE 2012). The baseline data and assumptions in the UCCE budgets were confirmed with the representatives from the lending agencies, industry experts, and growers. These estimates are used as a baseline for determining changes in net returns to land and management due to increased interest rates. The line-item expense “interest on operating capital” in a standard UCCE budget captures the interest cost on short-term loans. The baseline interest rate is 5.75 percent, and this is increased by 1.3 to 3 percentage points to evaluate the cost to the grower. Processing tomato interest on operating capital could increase by $12 to $29 per acre with an increase of 1.3 to 3 percentage points, respectively, translating to a 2.9 to 7 percent reduction in net return to land and management. Rice interest on operating capital could increase by $6 to $11 per acre with an increase of 1.3 to 3 percentage points, respectively, translating to a 1.4 to 2.6 percent reduction in net return to land and management. In all cases, farm profitability is reduced but growers are maintain a positive margin over variable production costs in the scenarios considered in this analysis. Table ES-2 summarizes the results of the analysis. Average annual net return above operating cost falls as interest rates on seasonal loans increase.

Table ES-3. Net Returns per Acre with Increased Interest Rates on Short-term Seasonal Loan (Net Revenues in 2012 dollars)

	Net Returns Above Operating Costs 5.75% base interest	with 1.3% Increase	with 3% Increase
Processing Tomatoes	$409	$397	$380
Rice	$416	$411	$405

Source: UCCE Cost and Return Studies

The analysis additionally considers access to federal support programs. The 2014 Farm Bill authorizes the USDA Commodity Credit Corporation (CCC) to issue nonrecourse marketing assistance loans (MALs) to agricultural producers who grow certain crops including medium grain rice (USDA FSA 2014a – 2014e). The loan rate for medium grain rice is $6.50 per cwt for 2014 – 2018. If the price of rice falls below $6.50 a loan deficiency payment is issued. Since marketing assistance loans and loan deficiency payments are used to help protect against price fluctuations in the rice market, the loans and payments are not used during the production timeframe. The USDA Commodity Credit Corporation (CCC) only issues the marketing loan against a physical crop after a crop is harvested. As a result, any increase in risk to farming in the Yolo Bypass does not impact the ability of a grower to acquire federal loan assistance.

Summary

The tipping point studies include an evaluation of rice mill and tomato processor shut-down decision, an analysis of insurance availability and premiums, and an analysis of changes in short-term production loans and interest rates. The analyses are based on the best available data, interviews with industry experts and growers, and well-established economic methods. Since the project alternatives are still being developed all of the tipping point studies are based on a “worst case” scenario where flooding increases in all years and the risks to farming unambiguously increase. The study finds: (i) it is unlikely that rice mills or processors would shut down if Yolo Bypass crop production decreases, (ii) the risk classification for rice and tomatoes grown in the Yolo Bypass is likely to remain unchanged, insurance is likely to continue to be offered, but premiums could increase thereby decreasing net farm income, and (iii) banks are likely to continue to offer loans, but interest rates could increase slightly thereby decreasing net farm income as the cost of servicing this short-term debt increases.

1 Introduction

California Department of Water Resources (DWR) and United States Bureau of Reclamation (Reclamation) are jointly working on the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project. DWR and Reclamation are planning the project to comply with the 2009 National Marine Fisheries Service (NMFS) Biological Opinion (BO) and Conference Opinion on the Long-term Operation of the Central Valley Project and State Water Project Reasonable and Prudent Alternative (RPA) actions 1.6.1 and 1.7. These broadly require improvements in seasonal floodplain rearing habitat from December through April in the lower Sacramento River Basin. Reclamation and DWR are preparing a Draft Environmental Impact Report and Environmental Impact Statement (EIR/S) to evaluate alternatives to meet RPA requirements. The project alternatives are still being developed, but generally consist of modifying the Fremont Weir to improve the connection between the Yolo Bypass and the Sacramento River thereby extending the frequency and duration of flooding.

The 59,000-acre Yolo Bypass is a working agricultural landscape, protects the city of Sacramento and surrounding communities from Sacramento River flood events, and provides seasonal bird and fish habitat. Approximately 16,000 acres of the total bypass area are conserved as permanent wildlife habitat and native vegetation (Yolo County 2016; YBF 2016). Total agricultural harvested acreage in the bypass varies with market conditions but generally averages around 35,000 acres per year, representing approximately 7 percent of the total harvested acreage in Yolo County. Primary crops produced include rice, processing tomatoes, miscellaneous vegetables and melons, and a mix of grains and pastureland. The gross farm-gate value of Yolo Bypass agriculture also varies with market conditions, but generally averages $25 million per year, representing approximately 4 percent of the total value in Yolo County (USDA NASS various years).

Extending the frequency and duration of flood events in the Yolo Bypass may impose financial costs on agricultural producers, and in turn, input suppliers, processing industries, insurers, and lenders. The magnitude of the potential economic cost depends on when the additional flooding occurs. In general, if the Yolo Bypass has standing water that extends into the March – June spring planting season it prevents growers from beginning field preparation and crops are planted after the standard planting window. Shorter growing seasons can lower expected yields and expose growers to risk from early fall rains, translating into a decrease in farm-gate production value. Ancillary industries, including processors, insurers, lenders, and input suppliers, are also affected by any loss in farm-gate revenues. The agricultural economic impact analysis being completed for the EIR/S will quantify the loss in farm revenue for each proposed project alternative. The purpose of this technical report is to estimate the potential impact of the RPA actions to key industries that support the major crops produced in the Yolo Bypass. The following studies are presented in this technical report:

1. **Rice milling and tomato processing**. Given that rice and tomatoes are the dominant crops in the bypass is it possible that rice mills or tomato processors shut down if Yolo Bypass production decreases (ceases)?
2. **Crop insurance**. Could access to rice and processing tomato crop insurance change if the frequency and duration of flooding in the Yolo Bypass increases? What is the associated financial cost to growers who farm in the bypass?
3. **Loan rates.** Could an increase in the frequency and duration of flooding in the Yolo Bypass cause an increase in production risk sufficient to cause lenders to increase interest rates or stop offering loans? What is the associated financial cost to growers who farm in the bypass?

Organization of the Report

The first section of the report provides an overview of agriculture in Yolo County and the Yolo Bypass. This section includes a description of current and historical trends in acreage and the value of production for major crops produced in the county. Yolo County and the Yolo Bypass are summarized separately so that the reader can understand the proportional contribution of bypass agriculture to the agricultural economy of the county. The following two sections describe the tomato processing and rice milling tipping points, respectively. The following two sections describe the loan rate and crop insurance tipping point analyses. Each of these sections provides a narrative and describes the problem, data, methods, results, and sensitivity analysis.

2 Yolo County and Yolo Bypass Agriculture

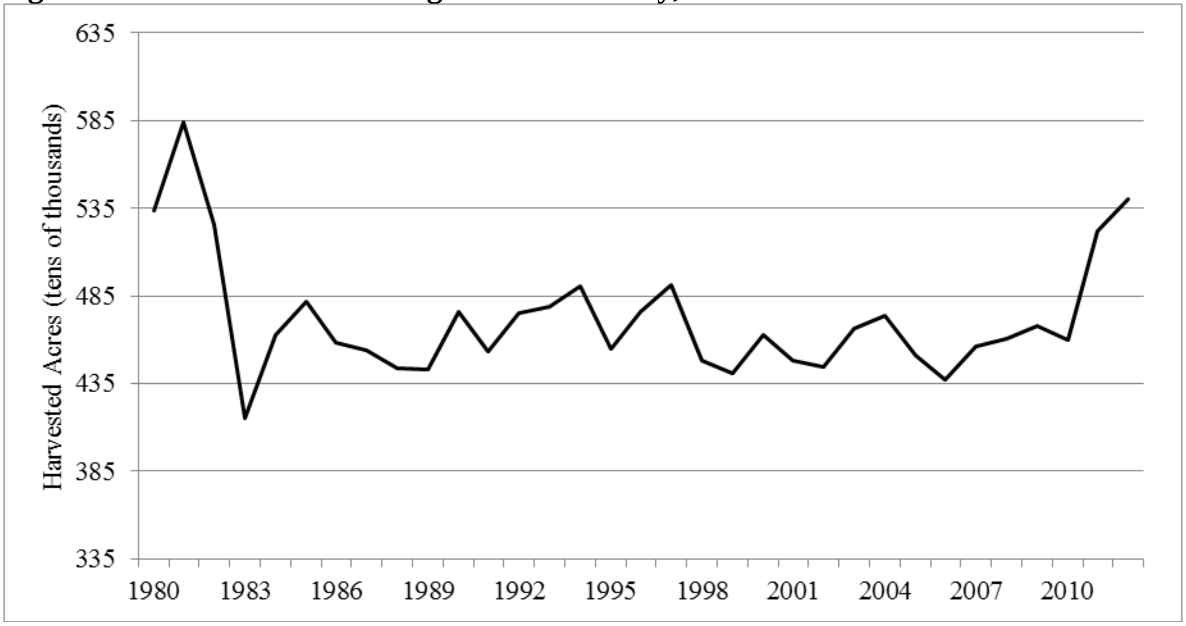
Yolo County boasts a robust and growing agricultural industry. Agricultural production currently accounts for more than 80 percent of total developed land use in the county. The gross farm-gate value of crop production in the county currently exceeds $600 million annually. Primary crops produced include fruits, nuts, rice, and a mix of field crops (USDA NASS various years). The Yolo Bypass is generally a small proportion of total county production (USDA NASS various years). However, although it is small, it is an important and unique area in the county with fertile farmland producing a mix of high-value crops (Young 2014). This section presents an overview of Yolo County and Yolo Bypass agriculture so that the reader can put the tipping point studies presented in the following sections into context.

2.1 Yolo County Agriculture

The total land footprint of agriculture in Yolo County has contracted over the last decade. Development pressure, regulations, and drought are some of the commonly cited factors driving this general trend. The California Department of Conservation Farmland Mapping and Monitoring Program (FMMP) survey data confirm a long run, county-wide contraction in the agricultural footprint. Over the last decade, 19,000 net acres, 3.5 percent of total harvested acres, of agricultural land were converted to other uses. Some of the farmland conversion in Yolo County has been for habitat conservation (FMMP various years; USDA NASS various years; Jeutong 2013). In 2001, 8,656 acres in Tule Ranch were converted into conservation land and became part of the Yolo Bypass Wildlife Area (YBWA) (Young 2014). The total area of the YBWA now includes approximately 16,000 acres and represents the largest (by area) conservation project within Yolo County (YBF 2016). There has been a concurrent increase in conservation areas including farmland, creeks, watershed areas, riparian corridors, and various plant and animal habitats, which exist to conserve natural open space and agricultural landscapes that provide a habitat for special and at-risk species (YBF 2016).

While the total footprint of agriculture has decreased, trends in total harvest acreage over the last 30 years can be described as stable. A decreasing total footprint and stable, or increasing, harvested acreage means that the intensity of farming has increased. Figure 1 illustrates total harvest acreage in Yolo County between 1980 and 2012. The total change over this time frame was a modest increase of 1.2 percent. Total harvested acreage fluctuated between a low of 415,000 acres in 1983 and a high of 584,000 acres in 1981, primarily driven by changes in market conditions for crops produced in the county. The recent increase in acreage since 2010/2011 has been driven by strong demand for fresh fruit, vegetables, and nuts. With a comparatively stable water supply, Yolo County agriculture has benefited from strong prices for specialty crops and the harvested acreage has expanded significantly. It is likely this trend will level off as the current downturn in the nut market plays out over the next few years.

Figure 1. Total harvested acreage in Yolo County, 1980 – 2012



Source: USDA NASS, California Agricultural Statistics, 1980-2012

Underlying the trends in total harvested acreage is a significant shift in the crop mix. Table 1 summarizes harvested acreage by crop group over the decade ending in 2012. Between 2003 and 2012 total harvested acreage increased from 448,000 acres to 540,000 acres, driven by a more than 50 percent increase in fruit and nut acreage in the county. Walnuts, almonds, citrus, and olives have more than doubled in acreage driven by strong market conditions and conversion of grazing land into orchards and vineyards. Processing tomatoes and rice, the primary focus of this technical report, have been relatively stable with patterns following the variability in market conditions and weather. Yolo County produces around 7 percent of total California rice production and 13 percent of total California processing tomato production (USDA NASS various years). Yolo County rice predominantly consists of medium grain Calrose and some wild rice varieties that are grown in the Yolo Bypass. Tomato acreage has expanded post-2012 during the current drought as tomato contracts have shifted from the San Joaquin Valley to areas with better access to water supplies like Yolo County.

Table 1. Yolo County harvested acreage by crop, 2003 – 2012 (in thousands of acres)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Field Crops[1]	349.3	340.9	333.4	320.4	333.2	339.2	342.6	334.6	387.7	408.7
Fruit and Nuts[2]	29.7	29.2	30.2	33.1	32.9	36.0	38.3	38.2	41.8	45.2
Rice[3]	37.3	45.7	34.7	32.6	36.6	34.4	37.4	41.4	42.5	40.5
Processing Tomatoes	38.3	45.1	42.2	37.0	42.1	37.6	37.9	33.0	40.1	36.8
Vegetable Crops[4]	12.1	12.6	10.5	13.6	11.4	12.9	11.5	12.1	9.2	9.4
Nursery[5]	0.0	0.0	0.0	0.6	0.0	0.5	0.5	0.4	0.3	0.0
Total	466.6	473.5	451.0	437.3	456.2	460.6	468.1	459.7	521.7	540.5

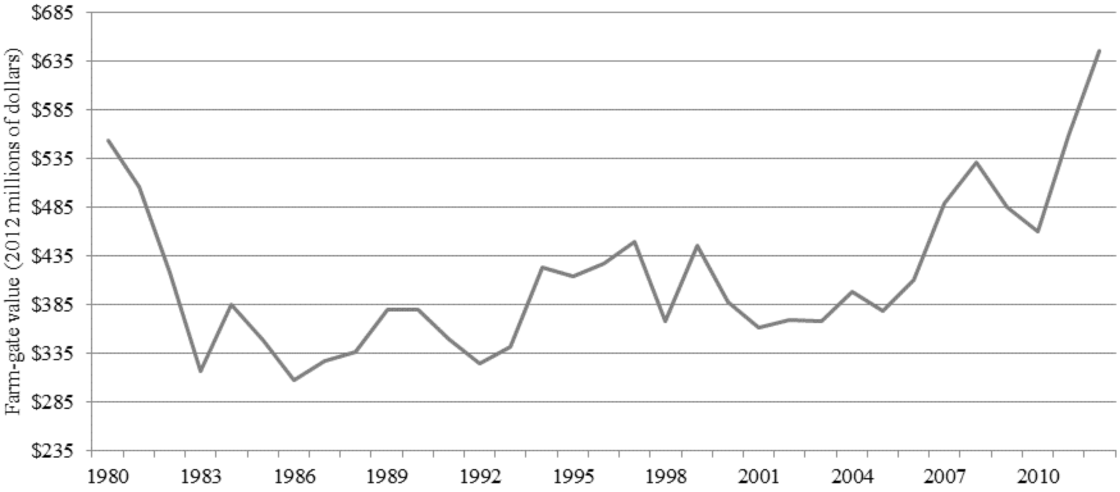
Source: USDA NASS, California Agricultural Statistics 2003-2012

Notes:

1. Field Crops are comprised of corn grain, cotton, miscellaneous field crops, alfalfa, grain, pasture, sudan grass, safflower, safflower seed, unspecified seed grass, other seed, sunflower seed, and wheat.
2. Fruit and nuts are comprised of almond, unspecified fruit and nuts, wine grapes, olives, dried plums, and English walnuts.
3. Rice includes wild rice.
4. Vegetable Crops are comprised of Honeydew, vine and vegetable seed, unspecified lettuce, and unspecified vegetables.
5. Nursery is comprised of bearing and non-bearing fruit and vine products, and other miscellaneous nursery products.

Total harvested acreage in the county has been relatively stable, but the value of the crops produced on that land has been steadily increasing since the early 1990s. Figure 2 illustrates the total value of crop production in Yolo County between 1980 and 2012. Over this time period the total farm-gate value of Yolo County agriculture grew approximately 16.5 percent, from $554 million to $646 million, in constant 2012 dollars. Most of this increase is driven by the shift to higher-value fresh fruit, vegetables, and nuts in response to strong consumer demand for these products.

Figure 2. The total farm-gate value of Yolo County agriculture, 1980 – 2012 (in 2012 millions of dollars)



Source: USDA NASS, California Agricultural Statistics, 1980-2012

Increasing farm-gate value of production is driven by increasing yields per acre (improved technology), increasing crop prices, or both. Table 2 summarizes prices for significant crops produced in Yolo County over the decade ending in 2012. The price received for most crops increased between 2003 and 2012. Nut price increases were driven by increased demand for almond and walnut exports from Asian and Middle Eastern countries (AMRC 2016; ABC 2014). Field crop prices increased as a result of drought, increased demand for grains from developing countries, increased demand for ethanol, and low inventory stocks (USDA ERS, 2011). The average price received for processing tomatoes increased by 18 percent, from $59 to $70 per ton. Rice prices increased approximately 14 percent, from $312 to $357 per ton ($15.60 – $17.85 per cwt) (CalAgTrader 2014; USDA ERS 2012; USDA NASS various years). In short, there has been robust growth in the market for crops produced in Yolo County. However, balanced against the strong general market trends, some crop prices have fallen from recent all-time highs. In particular, the 2016 spot-market for rice is closer to $230 per ton, in line with prices before the recent increases.

Table 2. Yolo County crop prices received, 2003 – 2012 (in 2012 dollars per ton)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Fruit and Nuts[1]	1,455	1,971	2,442	1,972	1,908	1,530	1,532	1,341	1,573	1,739
Rice[2]	339	275	237	246	293	552	405	392	338	357
Field Crops[3]	144	139	144	147	191	246	179	177	246	259
Processing Tomatoes	59	56	56	65	66	73	84	70	71	70
Apiary, Livestock, and Poultry[4]	15	16	15	15	19	20	11	N/A	N/A	N/A
Vegetable Crops[5]	289	309	278	329	318	313	N/A	N/A	N/A	N/A

Source: USDA NASS, California Agricultural Statistics 2003-2012

Notes:

1. Fruit and nuts are comprised of almond, unspecified fruit and nuts, wine grapes, olives, dried plums, and English walnuts.

2 Rice includes wild rice.

3. Field Crops are comprised of corn grain, cotton, miscellaneous field crops, alfalfa, grain, sudan grass, pasture (dry and irrigated), safflower, safflower seed, unspecified seed grass, other seed, sunflower seed, and wheat.

4. Apiary, Livestock and Poultry comprised of unspecified apiary bee products, cattle and calves, hogs and pigs, unspecified livestock, milk, poultry, sheep ewes, and lambs.

5. Vegetable Crops are comprised of honeydew melons, vine and vegetable seed, unspecified lettuce, and unspecified vegetables.

Trends in the total farm-gate value of crops produced in Yolo County generally follow the price trends, but also take into account variation in yields. Table 3 summarizes crop values between 2003 and 2012. The total annual farm-gate value of the crops produced in Yolo County increased by just over 75 percent, from approximately $368.5 million to $645 million. Processing tomatoes and rice are two of the highest value crops annually. Between 2003 and 2012 processing tomatoes increased in value by 50 percent, from $74.1 million to $112 million. As of 2012, tomato production contributed 17 percent of total agricultural value in Yolo County. Over the same time period, the total value of rice increased modestly, from $48.3 million to $60 million. As of 2012, rice contributed 9 percent of total agricultural value in Yolo County (USDA NASS various years).

Table 3. Yolo County farm-gate crop value, 2003 – 2012 (in 2012 millions of dollars)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Field Crops[1]	99.2	97.6	86.5	127.1	146.4	173.9	102.0	117.1	183.4	222.3
Fruit and Nuts[2]	87.6	85.5	117.6	105.0	113.5	101.6	118.3	105.3	123.9	176.4
Processing Tomatoes	74.1	101.5	77.9	85.4	107.9	111.2	134.2	91.2	108.7	111.6
Rice[3]	48.3	48.0	32.2	28.4	41.6	64.1	56.9	58.4	59.2	60.0
Vegetable Crops[4]	27.7	35.0	30.1	29.6	36.6	38.7	36.9	49.8	40.8	31.7
Apiary, Livestock and Poultry[5]	24.5	25.2	28.0	25.4	35.4	32.2	26.6	28.6	28.6	30.9
Nursery[6]	7.1	5.6	6.9	9.0	7.9	9.8	10.4	9.8	14.2	12.8
Total	368.5	398.4	379.2	410.0	489.3	531.5	485.3	460.2	558.9	645.8

Source: USDA NASS, California Agricultural Statistics 2003-2012

Notes:

1. Field Crops are comprised of corn grain, cotton, miscellaneous field crops, alfalfa, grain, sudan grass, pasture (dry and irrigated), safflower, safflower seed, unspecified seed grass, other seed, sunflower seed, and wheat.

2. Fruit and nuts are comprised of almond, unspecified fruit and nuts, wine grapes, olives, dried plums, and English walnuts.

3 Rice includes wild rice.

4. Vegetable Crops are comprised of Honeydew, vine and vegetable seed, unspecified lettuce, and unspecified vegetables.

5. Nursery is comprised of bearing and non-bearing fruit and vine products, and other miscellaneous nursery products.

Agriculture employs approximately 6 percent of the total county workforce. According to the California Employment Development (EDD), in 2012 Yolo County employed 96,900 people, with 5,300 employed on farms (directly). Between 2003 and 2012, direct farm employment increased by 1,100 employees, a 26 percent increase, whereas employment in all industries increased by about 1 percent. Direct farm employment includes laborers and others employed on the farm. It does not include employment in related industries such as processing, distribution, and input suppliers (EDD various years).

2.2 Yolo Bypass Agriculture

The 59,000 acre Yolo Bypass represents a small but unique area in the county with fertile farmland able to produce a mix of high-value crops. The purpose of this technical report is to evaluate the effect of changes in bypass crop production on mills, processors, insurance, and bank loans. As such, it is important to understand the proportion of crop production that occurs in the bypass relative to the rest of the county. This section summarizes crop production in the bypass from 2005 – 2009. These years are selected because they represent the most recent available data available from geo-referenced data, validated through grower interviews, and prepared in coordination with Yolo County representatives (Howitt et al. 2013). The years 2005 – 2009 are a representative sample for conditions in the Yolo Bypass. Crop prices were low in 2005 and steadily increased through 2009. The years 2005 and 2006 were wet, with late season flooding in the Yolo Bypass, whereas the years 2007 – 2009 were relatively dry years with no flooding in the bypass.

Approximately 16,000 acres in the Yolo Bypass are conserved as permanent wildlife habitat and native vegetation (YBF 2016). Crops include a mix of grazing land (pasture) and various crops. Grazing lands (pasture) have been the primary historical use of land in the bypass, and continue to be the largest share of land use (Yolo County 2016; USDA NASS various years, FMMP various years). The periodic floods limit the types of crops that can be grown to annual crops that can tolerate a shorter growing season (Miyao 2014). In addition, variation in soil and weather limit the economic viability of some crops. Delta winds are more prevalent at the southern end of the bypass (south of I-80) which limits the ability to grow some crops (Miyao 2014; Espino 2014). As such, pastureland is primarily seen on land south of I-80, north of Cache Slough. Rice and processing tomatoes are generally grown on land in the northern part of the bypass. Rice and processing tomatoes are the primary crops in 2009, representing 45 percent and 15 percent of cultivated land in the bypass, respectively (Yolo County GIS various years). Table 4 summarizes acreage in the Yolo Bypass between 2005 and 2009[1].

Table 4. Yolo Bypass acreage of major crops, 2005 – 2009 (acres)

	2005	2006	2007	2008	2009
Pasture	19,052	18,040	18,452	18,385	19,442
Rice	5,837	5,655	8,951	7,677	10,181
Wetlands	9,428	9,428	9,428	9,428	9,428
Field Crops[1]	6,172	8,004	8,339	8,823	7,245
Native Vegetation	11,659	10,707	5,905	6,621	4,525
Processing Tomatoes	2,564	2,944	3,699	3,668	3,653
Fruit and Nuts[2]	48	155	373	373	373
Vegetable Crops[3]	402	229	14	186	314
Total Bypass Acres	55,161	55,161	55,161	55,161	55,161

Source: Compiled into a GIS using data from: University of California Davis, Yolo County, Yolo Bypass Farmers, Pesticide Use Reports, and various local agencies.

Notes:

1. Field Crops are comprised of alfalfa, barley, beans (dried), corn, oats, safflower, rye grass, sorghum, sorghum seed, sudan grass, sunflower, sunflower seed, and wheat.
2. Fruit and Nuts are comprised of apples, pears, and walnuts.
3. Vegetable Crops are comprised of melons, melon seed, peppers, squash seed, and tomato seed.

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[1] Yolo Bypass crop data compiled into a GIS using data from University of California Davis, Yolo County, Yolo Bypass Farmers, Pesticide Use Reports, and various local agencies, are referred to as “Yolo County GIS” data in the rest of the report. See Howitt et al. (2013) for a description of how these data were merged.

In total, the Yolo Bypass comprises around 7 percent of the average annual crop acreage in Yolo County (USDA NASS various years). Table 5 summarizes rice, tomato, and other crop acreage, including all pastureland, in the bypass and in Yolo County. Between 2005 and 2009, bypass crop acreage ranged between 34,000 and 41,000 acres. Over the same time period, total county acreage ranged between 437,000 and 468,000 acres. Rice was planted to between 5,800 and 10,100 acres, representing 17 to 28 percent of total county rice production. The share of rice production in the Yolo Bypass usually increases in drought years because Yolo Bypass growers have senior water rights. Tomatoes were planted to between 2,500 and 3,600 acres, representing 6 to 10 percent of total county tomato production. Processing tomato acreage has expanded in the bypass and Yolo County in response to drought condition in the San Joaquin Valley.

Table 5. Yolo Bypass and Yolo County Agricultural Acreage, 2005 – 2009

	2005	**2006**	**2007**	**2008**	**2009**
Yolo Bypass (Acres)					
Rice	5,837	5,655	8,951	7,677	10,181
Tomatoes	2,564	2,944	3,699	3,668	3,653
Other Crops	25,674	26,427	27,178	27,767	27,374
Total	**34,075**	**35,026**	**39,828**	**39,112**	**41,209**
Yolo County (Acres)					
Rice	34,700	30,000	32,700	30,100	36,600
Tomatoes	42,200	37,000	42,100	37,600	37,900
Other Crops	374,100	370,300	381,400	392,900	393,600
Total	**451,000**	**437,300**	**456,200**	**460,600**	**468,100**
Share of land in the Yolo Bypass (%)					
Rice	17	19	27	26	28
Tomatoes	6	8	9	10	10
Other Crops	7	7	7	7	7
Total	**8**	**8**	**9**	**8**	**9**

Source: State of California GIS Maps and USDA NASS, California Agricultural Statistics, 2005 - 2009

2.3 Summary

The 59,000 acre Yolo Bypass represents a small but unique area in the county with fertile farmland. On average, the bypass contributes around 7 percent of total harvested acreage in Yolo County. Primary crops produced in the bypass include rice and tomatoes, which constitute 17-28 and 6-8 percent of total county acreage, respectively. The following sections analyze the effect of a decrease in bypass production on rice milling, tomato processing, crop insurance, and bank loans.

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3 Tomato Processor Tipping Point Analysis

Proposed changes in Yolo Bypass flooding frequency and duration may reduce the growing season for processing tomatoes. If fields remain wet too long due to flooding, growers may miss the planting window (late March through June), with direct consequences for both growers and processors (Miyao 2014; Espino 2014). Growers may either fallow the field or plant a crop with a shorter growing season. Processing facilities may fall short of anticipated supply, or have to secure contracts in other areas, potentially jeopardizing the facility’s ability to stay in business, or causing the firm to relocate. This analysis presented in this section provides a basis for understanding the cost incurred by a representative tomato processing facility if tomato production decreases.

3.1 An Overview of Tomato Processing in Yolo County

Processing tomatoes are typically grown under contract with a tomato processor. The processor pays the grower the market value for raw tomatoes, picks up the raw product directly from the field, and transports it to the processing facility (Durham et al. 1995). California produces around 90 percent of the United States processing tomatoes and approximately 35 percent of world production (Hartz et al. 2008). Table 6 summarizes processing tomato acreage and production quantities by county in 2012. Processing tomatoes are produced across the state, from Kern County in the south to Colusa County in the north. In 2012, Yolo County ranked second in total area with 36,800 acres and third in total production with 1.6 million tons, accounting for 11 percent of the California’s total processing tomato production (USDA NASS various years).

Table 6. 2012 Processing tomato acreage and production, by county

County	**Harvested Acres**	**Tons of Production**
Fresno	97,600	5,504,000
Yolo	**36,800**	**1,597,000**
Kings	36,000	1,858,000
Stanislaus	28,300	1,473,000
San Joaquin	26,300	1,105,000
Merced	15,000	773,000
Colusa	13,500	593,000
Kern	12,000	671,000
Solano	10,000	419,000
Sutter	7,830	296,000
Madera	3,000	202,000
Sacramento	2,640	98,400
Contra Costa	2,120	106,000
San Benito	1,730	106,000
Santa Clara	980	61,900
Total	**293,800**	**14,863,300**

Source: USDA NASS California Agricultural Statistics 2012

Tomato processing facilities turn raw tomatoes into consumable products, destined for domestic consumption or international export. Table 7 summarizes the 21 tomato processing companies operating in California as of 2015, excluding sun driers and dehydrator facilities (PTAB 2014). Pacific Coast Producers (PCP) is located in Woodland and is the only tomato processing plant in Yolo County. PCP is a canning facility that produces diversified products. There are additional processing facilities in the surrounding areas including Morning Star and Olam Tomato Processors in Williams, and Campbell Soup in Dixon. Morning Star and Olam Tomato Processors primarily produce paste and Campbell Soup produces a range of products (Miyao 2014).

Table 7. California tomato processing facilities

Processor Name	City
Campbell Soup Supply Co. LLC	Sacramento
Cascade Specialties, Inc	Merced
Cebro Frozen Foods	Newman
Con-Agra Foods, Inc	Oakdale
Del Monte Corporation	Lathrop
Escalon Premier Brands, Inc	Escalon
Ingomar Packing Company	Los Banos
J.G. Boswell Tomato Company - Kern, LLC	Buttonwillow
Los Gatos Tomato Products	Huron
Olam Tomato Processors	Lemoore
Olam Tomato Processors	Williams
Pacific Coast Producers	Lodi
Pacific Coast Producers	Woodland
Pictsweet Frozen Foods, Inc	Santa Maria
San Benito Foods	Hollister
Stanislaus Food Products Co	Modesto
The Morning Star Packing CO	Liberty
The Morning Star Packing CO	Los Banos
The Morning Star Packing CO	Williams
Toma Tek	Firebaugh
Unilever Foods N.A.	Stockton

Source: PTAB, 2014

The representative processing facility in this analysis is a diversified tomato processing plant located in Yolo County. The viability of the plant is evaluated if there is a significant and permanent decrease in the quantity of tomatoes produced in the Yolo Bypass. Rather than predicting the extent of flooding and modeling variation in flooding, this analysis considers a worst-case scenario where all Yolo Bypass tomato production ceases. This is not a proposed policy, but rather an upper bound on the potential impacts from changes in Yolo Bypass flooding.

3.2 Methodology

This analysis evaluates whether the representative tomato processor would be likely to shut down if there is a decrease in Yolo Bypass tomato production. The first step in the methodology is to establish the minimum quantity of tomatoes that must be processed in order for the processor to break even. The break-even point is calculated using well-established microeconomic principles for a profit maximizing firm (Nicholson 2004). The break-even point occurs at a throughput quantity where there are enough units processed so that the sum of the contribution margin per unit is sufficient to cover the plant fixed costs. If the quantity of product processed falls below this threshold, the processor would shut down. Given this definition and the assumptions outlined below, the shut-down decision for the processor is evaluated by comparing the break-even quantity to the quantity of tomatoes available to the processor if there is no production in the Yolo Bypass. The following critical assumptions apply to the analysis:

1. The analysis assumes there is a 100 percent decrease in Yolo Bypass crop production.
2. The scenario evaluates a "representative" processor using the best available data to characterize business financial information.
3. The analysis assumes 100 percent of Yolo Bypass tomato production goes to the representative processor and that the processor cannot procure additional tomatoes from other regions when Yolo Bypass production decreases. In practice, processors have a diverse supply portfolio to manage against this type of risk.
4. The analysis evaluates a short-run tipping point decision using a long-run economic criterion, and as such, is a conservative analysis. In practice, most businesses are able to manage (potentially large) short-run fluctuation in production (price or quantity) without deciding to leave the industry.

The analysis requires detailed sensitive financial information for the representative processor. These data are necessary to establish the production volume, product mix, and fixed and variable production costs, which are then combined to estimate the break-even point described above. Data come from three primary sources: (i) consultation with local experts (Farm Advisors and growers), (ii) tax data available from the IMPLAN model[2], and (iii) a review of published studies and industry reports for tomato processing costs. The processing tomato cost of production data are largely based on a report published by the Giannini Foundation examining transportation and marketing efficiency in California tomato processors (Durham, et al. 1995) and a previous study of the processing tomato industry by Logan (1984). All of the cost data were validated with industry experts and all values in the analysis are deflated to 2012 dollars for consistent comparison (Miyao 2014; Hartz et al. 2008; Morning Star 2013; UCCE 2008;). Processing costs assume a large diversified processing plant with a 300,000 to 400,000-ton raw tomato capacity, consistent with a plant based in Yolo County (Morning Star 2013; PCP 2014).

The analysis evaluates the tipping point for each year, 2005 – 2009, individually. These years are used because the data are available and they are a representative sample of years with variation in crop prices and bypass flooding. Sensitivity analysis is performed to examine how adjustments in parameters, data, and assumptions affect the tipping point threshold.

3.3 Tomato Processor Costs and Revenues

Yolo County's processing tomato production ranged from 1.3 million tons to 1.6 million tons between 2005 and 2009 (USDA NASS various years). The analysis assumes that all of the raw tomatoes that go to the processor are sourced from Yolo County. As such, approximately 24 percent of total Yolo County processing

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[2] IMPLAN Group LLC. www.implan.com. 2013 V3 Data for California counties.

tomatoes are sent to the representative facility to meet the production capacity of the processor (300,000 – 400,000 tons). It is further assumed that all of the tomato production in the Yolo Bypass goes to the representative processor. The top two rows of table 8 show the total quantity of tomatoes produced in the Yolo Bypass and the total quantity produced in other parts of Yolo County. Taking 2009 as an example, 155,000 tons of tomatoes were produced in the bypass and 1,452,000 tons were produced outside of the bypass in Yolo County.[3] Rows 4 and 5 show the production sent to the processor from the bypass and other parts of Yolo County. Again using 2009 as an example, the processor processes 386,000 tons with bypass production, but only 230,000 tons (155,000 tons less) without bypass production.

Tomato processors establish production contracts to purchase tomatoes from growers well before harvest begins (Miyao 2014; Hartz et al. 2008). Plantings are staged so that harvest can be staged, creating a steady supply of raw tomatoes being delivered to the processor. Generally, tomato processors diversify the geographic source of their tomato supplies to better manage quality and quantity issues that may arise in a particular region (Miyao 2014). The farm-gate price received by growers for processing tomatoes is also the price paid for raw tomatoes (a production input) by the processor. Rows 5 and 6 of Table 8 show the variable cost of raw tomatoes purchased by the processor, calculated by multiplying the farm-gate price by total quantity sent to the processor. Row 7 shows the difference in the cost of raw tomatoes purchased by the processor. Without bypass production the processor purchases fewer inputs, and variable input costs decrease by $4.7 million to $12.9 million.

Table 8. Tomato production, processing, and input cost, 2005 – 2009

	2005	**2006**	**2007**	**2008**	**2009**
Total Tomato Production (thousands of tons)					
Yolo Bypass	85	105	143	150	155
Other Yolo County	1,311	1,214	1,480	1,380	1,452
Tomato Processor Raw Tomato Inputs (thousands of tons)					
Total	335	317	390	367	386
Total without bypass	250	211	247	218	230
Total Raw Tomato Cost to Processor (thousands of dollars, 2012)					
Total	$18,685	$20,472	$25,863	$26,715	$32,210
Total without bypass	$13,955	$13,669	$16,385	$15,833	$19,246
Difference	**-$4,730**	**-$6,804**	**-$9,478**	**-$10,881**	**-$12,964**

Source: USDA NASS California Agricultural Statistics, various years, Yolo Bypass GIS, Durham, et al. 1995, Morning Star 2013, PCP 2014, IMPLAN, 2013.

A processor will generally contract with a single transportation company and pay the transportation cost from the field to the processing facility. This analysis assumes the average distance from the field to the representative processor is 16

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[3] Total tomato production is calculated by multiplying the total acres by the average annual production (yield) expressed in tons per acre.

miles, based on standard practice of contracting tomato production within 16 miles of the facility (PCP 2016). Transportation cost estimates are based on a fixed fee per ton per mile using deflated average fuel costs (BLS 2014a). Processor transportation costs, with and without Yolo Bypass production, are summarized in Table 9. The bottom row in Table 9 shows that by removing Yolo Bypass tomato production, the processor purchases fewer tomatoes and transportation costs decrease by $1.8 million to $3.3 million.

Table 9. Processor transportation costs, 2005 – 2009 (in 2012 thousands of dollars)

	2005	2006	2007	2008	2009
Total	7,284	6,884	8,468	7,983	8,387
Total without bypass	5,440	4,596	5,365	4,731	5,011
Difference	-1,844	-2,288	-3,103	-3,252	-3,376

Source: USDA NASS California Agricultural Statistics, various years, Yolo Bypass GIS, Durham, et al. 1995, Morning Star 2013, PCP 2014, IMPLAN, 2013, BLS 2014a.

Tomato processing facilities generally specialize in either paste production or diversified products (e.g., diced tomatoes, pizza sauce, ketchup, etc.), but may produce both (Morning Star 2013; PCP 2014; Miyao 2014; Logan 1984). The representative processor costs are based on a diversified plant like that found in Yolo County. Tomato processors run 24 hours a day, 7 days a week during the processing season. They carefully plan transitions between products to avoid unnecessary labor and equipment startup and shutdown costs. High solids content tomatoes are used for paste, ketchup, and sauces, and low solids content tomatoes are used for canned diced or whole tomato production. The processor determines the optimal solids mix and ensures this is met through grower contracts. This analysis assumes that 50 percent of the representative plant’s processing activity generates high solids content products and 50 percent of production is low solids content products.

Plant operation variable costs include labor, electricity, materials, and all other inputs required to process high and low solids tomatoes. Table 10 summarizes plant operating costs between 2005 and 2009. Without tomato production from the Yolo Bypass there is a reduction in variable processing costs of $15 million to $29 million. All values are deflated to 2012 dollars using the BLS Fruit & Vegetable Preserving & Specialty Food Manufacturing index (BLS 2014).

Table 10. Processor operating costs, 2005 – 2009 (in 2012 thousands of dollars)

	2005	2006	2007	2008	2009
Total	57,533	56,049	70,774	68,021	72,012
Total without bypass	42,969	37,422	44,838	40,314	43,028
Difference	-14,564	-18,627	-25,936	-27,706	-28,983

Source: USDA NASS California Agricultural Statistics, various years, Yolo Bypass GIS, Durham, et al. 1995, Morning Star 2013, PCP 2014, IMPLAN, 2013, BLS 2014.

Tables 8, 9, and 10 summarized the variable production costs for the representative tomato processor. Fixed costs include those costs that must be paid by the processor whether or not the plant is operating. In general, fixed costs vary based on processor type (paste-only or a diversified product plant), processor size, facility age, and technology, among other factors. The representative tomato processor's fixed cost estimate is based on a report published by Morning Star (2013), validated by Durham et al. (1995) and with industry experts, and estimated to equal $20.9 million annually.

Having established the fixed and variable production costs, the final piece of financial information required for the analysis is processor revenues. Output prices are based on prices identified by Durham et al. (1995) with high solids products (50 percent of production) receiving a price premium. Table 11 summarizes gross sales revenue, with and without bypass production. Since it is assumed that the processor does not purchase tomatoes from other regions, total revenues fall when bypass production decreases.

Table 11. Processor gross sales revenue, 2005 – 2009 (in 2012 thousands of dollars)

	2005	2006	2007	2008	2009
Total	173,560	169,084	213,503	205,198	217,238
Total without Bypass	129,626	112,891	135,261	121,616	129,803
Difference	-43,935	-56,193	-78,241	-83,581	-87,434

Source: USDA NASS California Agricultural Statistics, various years, Yolo Bypass GIS, Durham, et al. 1995, Morning Star 2013, PCP 2014, IMPLAN, 2013.

Table 12 summarizes the variable costs (raw tomato inputs, transportation, and operating cost), gross revenue, and net revenue for the representative tomato processor. Net revenues are calculated by subtracting variable costs from gross sales revenue. The top 5 rows summarize costs and revenues with bypass production, and the bottom 5 rows summarize costs and revenues without bypass production. Without bypass production, all other factors being equal and assuming that the processor does not replace the lost tomatoes with tomatoes from other sources, net revenue decreases by between $23 million and $42 million annually, or 25 to 41 percent.

Table 12. Summary of processor costs and revenues, 2005 – 2009 (in 2012 millions of dollars)

	2005	2006	2007	2008	2009
Total Including Bypass Production					
Raw Tomato Cost	18.7	20.5	25.9	26.7	32.2
Transportation Cost	7.3	6.9	8.5	8.0	8.4
Operating Cost	57.5	56.0	70.8	68.0	72.0
Gross Revenue	173.6	169.1	213.5	205.2	217.2
Contribution Margin	**90.1**	**85.7**	**108.4**	**102.5**	**104.6**
Total Excluding Bypass Production					
Raw Tomato Cost	14.0	13.7	16.4	15.8	19.2
Transportation Cost	5.4	4.6	5.4	4.7	5.0
Operating Cost	43.0	37.4	44.8	40.3	43.0
Gross Revenue	129.6	112.9	135.3	121.6	129.8
Contribution Margin	**67.3**	**57.2**	**68.7**	**60.7**	**62.5**

Source: USDA NASS California Agricultural Statistics, various years, Yolo Bypass GIS, Durham, et al. 1995, Morning Star 2013, PCP 2014, IMPLAN, 2013.

3.4 Tomato Processor Tipping Point Analysis

The data summarized in the previous section are used to estimate the break-even or “tipping point” and determine if the tomato processor would continue to operate if no tomatoes are grown in the Yolo Bypass. As discussed previously, for a given plant, the tipping point occurs at a throughput quantity where there are enough units processed so that the sum of the contribution margin per unit is sufficient to cover the plant fixed costs. Intuitively, if the processor is not able to cover fixed costs it is more profitable to shut down the plant.

The contribution margin per ton is calculated by dividing the total contribution margin (row 5 in Table 12) by the total production quantity (row 3 in Table 8). The break-even quantity is calculated by dividing the total fixed costs of the plant ($20.9 million) by the contribution margin per ton. Row 1 and 2 in Table 13 summarize the contribution margin and break-even (tipping point) quantity, respectively. The tipping point quantity for the representative mill is between 74,900 and 77,700 tons per year.

Row 3 in Table 13 shows the quantity of tomatoes processed by the processor if there are no tomatoes produced in the Yolo Bypass and the processor does not secure tomatoes from another region (from row 4 in Table 8). Comparing this to the break-even quantity demonstrates that in all years the processor is significantly above the tipping point quantity. Row 4 shows that the total quantity is 133,500 to 172,305 tons above the tipping point quantity.

Table 13. Summary of tomato processor tipping point, 2005 – 2009 (2012 dollars)

	2005	2006	2007	2008	2009
Including Bypass Production					
Contribution margin ($/ton)	269	270	278	279	271
Break-even (tons)	77,695	77,407	75,179	74,910	77,120
Production without bypass (tons)	250,000	211,000	247,000	218,000	230,000
Difference (tons)	**+172,305**	**+133,593**	**+171,821**	**+143,090**	**+152,880**

If growers stopped producing tomatoes in the Yolo Bypass, a tomato processor would be likely to seek tomato contracts with growers in other regions to offset the loss of supply. In addition, processors take a long run view of their processing activities since they do not have perfect foresight of important factors that impact their profitability such as input prices, input quantities, and output prices. Because of their long run decision making, processors would likely remain in business even if they cannot cover fixed costs for a single year. In addition, a processor may enter a production season anticipating a profitable season, and if market conditions change after contracts have been signed, it would be too late for the processor to consider shutting down. As such, the findings of the analysis should be interpreted as an upper bound on the maximum tipping point.

3.4.1 Sensitivity Analysis

The previous section demonstrates that the representative Yolo County tomato processor is likely to be able to maintain production above the tipping point threshold if growers decide to stop producing tomatoes in the Yolo Bypass. The analysis in this section adjusts key parameters to determine how sensitive the tipping point level of tomato production is to the previously defined assumptions. Sensitivity analysis is performed for 7 scenarios described below.

Scenario 1: Increase the share of low solids tomatoes to 100 percent
This scenario increases the share of low solids tomatoes from 50 percent to 100 percent of total processing quantity. Shifting to 100 percent low solids tomato products simulates a tomato processing plant with no tomato paste production. Variable costs decrease in this scenario because low solids tomatoes cost less to process; however, revenues also decline since low solids tomato products sell for a lower price. By changing the share of low solids content, net revenue decreases by approximately $9 per ton. Table 14 shows that the tipping point quantity increases to 79,652, which is below the minimum quantity of tomatoes available without bypass production, 211,000 tons. The processor maintains production above the tipping point threshold.

Scenario 2: Increase the share of high solids tomatoes to 100 percent
This scenario increases the share of high solids tomatoes to represent 100 percent of total processing quantity. Tomatoes with high solids content are more expensive to process because they require greater processing times and inputs. However, tomato paste made from high solids tomatoes receive a price premium compared to other tomato products. By increasing the share of high solids content tomatoes, net revenues increase by approximately $9 per ton. Table 14 shows that

the tipping point quantity decreases to 74,654, which is still below the minimum quantity of tomatoes available without bypass production, 211,000 tons. The processor maintains production above the tipping point threshold.

Scenario 3: Increase transportation distance to 30 miles

In this scenario, tomatoes purchased by the representative processor are sourced from a 30-mile radius, rather than the standard 16-mile radius. Marginal costs for transportation increase in this scenario while other marginal costs and marginal revenue remains the same, resulting in a $4 per ton decrease in net revenue. Table 14 shows that the tipping point quantity increases to 78,405, which is below the minimum quantity of tomatoes available without bypass production, 211,000 tons. The processor maintains production above the tipping point threshold.

Scenario 4: Increase cost of raw tomatoes to $100/ton

Agricultural prices are notoriously volatile. In this scenario, the price paid for raw tomatoes is increased to $100 per ton. This is well above prices in recent years but consistent with the inflation-adjusted historical high price. Net revenues decrease to $255 per ton as marginal costs increase and gross revenue remains the same. Table 14 shows that the tipping point quantity increases to 82,065, which is below the minimum quantity of tomatoes available without bypass production, 211,000 tons. The processor maintains production above the tipping point threshold.

Scenario 5: Decrease gross revenue to $500/ton

Prices received for processed agricultural goods are also variable. Morning Star's report *Tomato Paste and Processed Tomato Statistics* indicates that since 1985, the lowest price for tomato paste was $670 per ton in 2012 dollars (Morning Star 2013). This scenario decreases gross revenue even further, to $500 per ton, to simulate a downturn in the consumer demand for processed tomatoes. Marginal costs remain unchanged resulting in a $63 per ton decrease in net revenue. Table 14 shows that the tipping point quantity increases to 100,458, which is below the minimum quantity of tomatoes available without bypass production, 211,000 tons. The processor maintains production above the tipping point threshold.

Scenario 6: Combination of Scenarios 2-5

Under this scenario, the representative tomato processor processes 100 percent high solids tomatoes, acquired for $100 per ton, sourced from 30 miles away, and sold as tomato paste for $500 per ton. This is an improbable event of high costs and poor market conditions. It is a highly unlikely scenario as weak demand for processed tomatoes would put downward pressure on the farm-gate price. This scenario results in net revenue equal to $183 per ton. Table 14 shows that the tipping point quantity increases to 114,014, which is below the minimum quantity of tomatoes available without bypass production, 211,000 tons. The processor maintains production above the tipping point threshold.

Table 14. Tomato processor tipping point sensitivity analysis

	Net Revenue ($ per ton)	Tipping Point (tons)	Minimum tons available without bypass (2005 – 2009)
Standard assumptions	$271	77,072	211,000
Scenario 1. Increase share of low solids to 100%	$262	79,652	211,000
Scenario 2. Increase share of high solids to 100%	$280	74,654	211,000
Scenario 3. Increase transportation distance to 30 miles	$267	78,405	211,000
Scenario 4. Increase cost of raw tomatoes to $100/ton	$255	82,065	211,000
Scenario 5. Decrease gross revenue to $500/ton	$208	100,458	211,000
Scenario 6. Combination of scenarios 2-5	$183	114,014	211,000

Source: USDA NASS California Agricultural Statistics, various years, Yolo Bypass GIS, Durham, et al. 1995, Morning Star 2013, PCP 2014, IMPLAN, 2013..

3.5 Tomato Processor Tipping Point Summary

The analysis demonstrates that the representative processor processes more than the tipping point tonnage in every scenario without bypass production and no supplemental tomatoes sourced from other regions. The sensitivity analysis suggests that processor could change its mix of low and high solids tomatoes, increase transportation costs, increase raw tomato costs, decrease output prices, or double its fixed costs and maintain production levels above the tipping point threshold. If the processor does not secure additional production from other regions outside of the bypass, production volume and net revenue would decrease, as shown under each of the sensitivity analyses described above.

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4 Rice Mill Tipping Point Analysis

Proposed changes in Yolo Bypass flooding frequency and duration may reduce the growing season for rice. If fields remain wet too long due to flooding, growers may miss the planting window (April through June), with direct consequences for both growers and processors. Growers would either fallow the field or plant a crop with a shorter growing season. Mills may fall short of anticipated supply, potentially jeopardizing the facility's ability to stay in business.

The analysis presented in this section provides a basis for understanding the cost incurred by a representative rice mill in Yolo County if no rice is produced in the bypass. The analysis establishes the economic shut-down decision, which is then used to evaluate whether the mill would be likely to stay in business if bypass rice production decreases.

4.1 An Overview of Rice Milling in Yolo County

California is the second largest rice producing state in the United States, producing more than 2 million tons of rough rice each year (Richardson and Outlaw, 2010; USDA NASS, various years). California rice is used for household consumption, sushi, beer production, rice mixes, and pet food. Approximately 40 percent of California rice production is exported to Japan, Korea, Taiwan, and Turkey. According to the California Rice Commission, around 97 percent of rice produced in California is grown within a 100-mile radius of Sacramento (CRC 2016). Colusa, Sutter, Butte, and Glenn Counties are the dominant producers in the state (USDA NASS various years). Table 15 summarizes rice acreage and production in California. Yolo County ranks fifth in total rice production in California (USDA NASS various years).

Table 15. 2012 California rice acreage and production, by county

County	Harvested Acres	Tons of Production
Colusa	150,000	652,000
Sutter	116,000	467,000
Butte	94,500	412,000
Glenn	84,800	359,000
Yolo	**40,500**	**168,000**
Yuba	37,600	163,000
Placer	15,900	62,200
San Joaquin	6,010	24,600
Sacramento	5,900	24,800
Fresno	3,240	10,100
Merced	2,410	9,110
Stanislaus	2,030	8,530
Sum of Others	261	365
Total	**559,151**	**2,360,705**

Source: USDA NASS California Agricultural Statistics 2012

Rice mills turn roughrice into a consumption good by removing the husk from the rice. After milling and removing excess debris from the rice, the mill packages the final product into bags destined for export or domestic purchase. There are generally two types of rice milling operations: grower-owned cooperatives and independent mills. Cooperatives usually mill, market, and sell the rice as a vertically integrated operation. Members of the cooperative are paid based on production share and the price received for milled rice throughout the season. Independent rice mills may also market and sell the rice on behalf of the grower and take a share of profit from total net revenue. There are other agencies that exclusively market and sell rice, but this analysis examines the cost of milling and selling rice from the perspective of an independent mill.

The California Rice Commission lists 12 rice processing companies throughout the state, with the majority located in the greater Sacramento area. Three processing facilities are located in Yolo County: Bunge Milling (Pacific International Rice Mills), Farmers' Rice Cooperative, and SunFoods, LLC (CRC 2014a). Table 16 summarizes rice mill, exporter, marketer, and foodservice supplier companies in California. The "County Location" indicates company headquarters, which is not necessarily where a production or storage facility is located.

Table 16. California rice milling, drying, and distribution

Company	County Location	Description
Bunge Milling, Inc (Pac. Int'l)	Yolo	Milling & Foodservice Supplier
Farmers' Rice Cooperative	Yolo	Milling & Foodservice Supplier
PGP International	Yolo (Colusa mill)	Processor & Foodservice Supplier
SunFoods, LLC	Yolo	Milling
Rue & Forsman Ranch, Inc.	Sutter	Foodservice Supplier
Valley Commodities, LLC	Sutter	Marketing
Penny Newman Grain	Sacramento	Exporter
Koda Farms	Merced	Milling
Sage V Foods	Los Angeles	Foodservice Supplier
ADM Rice, Inc	Colusa	Exporter
American Commodity Company, LLC	Colusa	Drying, Storing, Foodservice Supplier
California Family Foods, LLC	Colusa	Milling & Foodservice Supplier
California Heritage Mills	Colusa	Exporter
Calrose Co-op	Colusa	Marketing
Polit Farms, Inc.	Colusa	Milling & Foodservice Supplier
Sun Valley Rice Company, LLC	Colusa	Milling & Foodservice Supplier
Tamaki Rice Corporation	Colusa	Milling & Foodservice Supplier
Associated Rice Marketing Coop	Butte	Marketing, Supplier
Butte County Rice Growers Assn.	Butte	Drying & Storage
California Rice Exchange, Inc.	Butte	Trader
California Rice Marketers	Butte	Marketing
Far West Rice, Inc.	Butte	Milling & Foodservice Supplier
Farm and Trade, Inc.	Butte	Marketing
Lundberg Family Farms	Butte	Milling & Foodservice Supplier
SunWest Foods, Inc.	Butte	Milling & Foodservice Supplier

Source: California Rice Commission 2014a.

Rice growers receive revenue in two installments, partial payment upon rice delivery at a mill and a share of revenue once the rice is sold. The price mills pay to growers includes a marketing loan amount issued by the United States Department of Agriculture (USDA). The USDA marketing loan rate is $6.50 per hundredweight[4] (cwt) of rice under the 2014 Farm Bill (USDA FSA 2014e). Mills generally have annual contracts with their buyers and negotiate prices at specified time intervals. An interview with a local independent mill owner, who asked to remain anonymous, indicated that mills generally attempt to return as much money as possible to growers in order to establish ongoing relationships and consistent supply for future harvests. As a result, the rice milling industry is highly competitive. The representative mill in this analysis is an independent mill in Yolo County. The viability of the facility is evaluated if there is a significant and permanent decrease in the quantity of rice produced in the Yolo Bypass. Rather than predicting the extent of flooding and modeling variation in flooding, this analysis considers a worst case scenario where all Yolo Bypass rice production ceases. This is not a proposed policy, but rather an upper bound on the potential impacts to Yolo County mills from changes in Yolo Bypass flooding.

It is important to note that this study focuses on an independent mill as opposed to a cooperative mill. Independent mills, as mentioned above, have annual contracts with growers and some additionally buy product from the cash market during the milling year. As such, independent mills are influenced by market conditions and rough rice prices. This forces independent mills to be more focused on profit maximization. Cooperative mills have a defined membership, allowing them to know their milling pool before planting begins, ensuring supply for the mill from year to year. This provides a competitive advantage when supply is anticipated to be short, since every harvesting acre is crucial. Therefore, performing this analysis on a cooperative mill would yield a more optimistic result.

4.2 Methodology

The rice mill tipping point analysis uses the same general methodology as the tomato processor analysis described in the previous section. Namely, this analysis evaluates whether the representative mill is likely to shut down if there is a decrease in Yolo Bypass rice production. The first step in the methodology is to establish the minimum quantity of rice that must be milled in order for the mill to break even. The break-even point is calculated using well-established microeconomic principles for a profit maximizing firm. The break-even point occurs at a throughput quantity where there are enough units processed so that the sum of the contribution margin per unit is sufficient to cover the plant fixed costs. If the quantity of rice milled falls below this threshold, the mill is likely to shut down. Given this definition and the assumptions outlined below, the shut-down decision for the mill is evaluated by comparing the break-even quantity to the quantity of rice available to the mill if there is no production in the Yolo Bypass. The following critical assumptions apply to the analysis:

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[4] The common unit for measuring rice in California is a hundredweight, which is abbreviated cwt and is equivalent to 100 pounds or 0.04536 metric tons.

1. The analysis assumes there is a 100 percent decrease in Yolo Bypass crop production.
2. The scenario evaluates a “representative” mill using the best available data.
3. The analysis assumes 100 percent of Yolo Bypass rice production goes to the representative mill and that the mill cannot procure additional rice from other regions when Yolo Bypass production decreases.
4. The analysis evaluates a short-run tipping point decision using a long-run economic criterion, and as such, is a conservative analysis. In practice, most businesses are able to manage (potentially large) short-run fluctuation in production (price or quantity) without deciding to leave the industry.

The analysis requires detailed proprietary financial information for the representative mill. These data are necessary to establish the production volume, and fixed and variable production costs, which are then combined to estimate the break-even point described above. Data come from three primary sources: (i) consultation with local experts (Farm Advisors, growers, a rice mill owner, and other local rice mill representatives), (ii) tax data available from the IMPLAN model, and (iii) a review of published studies and industry reports for rice milling costs.

The variable and fixed cost framework is based on various sources including: information from a local rice mill, a 2010 report by Texas A&M University examining the economic benefits of rice to the United States (Richardson and Outlaw, 2010), and a 1993 report by the American Society of Agricultural Engineers (ASAE) examining a how changes in the variable cost affect the economics of wheat milling (Flores, et al. 1993). Wheat milling costs are used because an independent rice mill owner recommended using wheat milling studies as a proxy cost structure since first-hand information on rice milling is not publicly available. Accordingly, wheat milling fixed cost estimates are used as a proxy for the rice mill in Yolo County. Previous studies examining the economics of rice milling have also used wheat milling cost structures as a proxy for rice milling cost structures (Borsen 1987). These costs are verified by reviewing IMPLAN data for rice milling in the Sacramento Region (IMPLAN 2013), and supplemental cost studies for milling costs (Eustace et al. 1976; Eustace et al. 1977).

Annual variable milling costs are based on a mill capacity of approximately 4 million cwt annually. This estimate is extrapolated from the data previously cited, based on local mills, and it is intentionally conservative, local rice mill capacities may exceed this estimate. Additionally, this study assumes that rice growers bear the cost of drying and transporting the rough rice to the milling facility. All of Yolo County rice production is assumed to go to the representative Yolo County rice mill. This is done to test the effects of the most significant impact to a single rice mill, despite information from local rice farmers that suggests less than 50 percent of Yolo Bypass rice production is sent to any one mill. Since Yolo County production does not meet annual mill capacity, rice is also obtained from nearby counties.

The analysis evaluates the tipping point for each year, 2005 – 2009, individually. These years are used because the data are available and they are a representative sample of years with variation in crop prices and bypass flooding. Sensitivity analysis is performed to examine how adjustments in parameters, data, and assumptions influence the tipping point threshold.

4.3 Rice Mill Costs and Revenues

Yolo Bypass rice production ranged from 406,000 to 772,000 cwt between 2005 and 2009 (Yolo County GIS, various years). In the Sacramento Valley, rice is typically harvested in September and October and is dried to a moisture level that helps preserve quality and enables long-term storage (Espino 2014). Following harvest growers transport rice to a drying and storage facility or directly to a mill. This analysis assumes growers receive prices as reported by the USDA NASS, which combines pooled prices (cooperative) and cash prices to create a weighted average for the county (CalAgTrader 2014; USDA NASS various years).

The analysis assumes that the mill sources rough rice from Yolo County first and then makes up any excess capacity from other nearby counties. The Yolo Bypass contributes approximately 12 percent of the 4 million cwt capacity of the mill. The top 4 rows of Table 17 show the total quantity of rough rice produced in the Yolo Bypass, within Yolo County, and from outside of the county that is handled by the representative mill. Taking 2009 as an example, the mill processes 772,000 cwt of rice produced in the bypass, 2,774,000 cwt from elsewhere in Yolo County, and 454,000 cwt from other counties. The total rice milled is 4 million cwt. The bottom row of Table 17 shows the cost of the rough rice purchased by the mill. Rice input costs range between $11.83 and $27.58 per cwt between 2005 and 2009.

Table 17. Rice production quantity and input cost, 2005 – 2009

	2005	**2006**	**2007**	**2008**	**2009**
Rough rice Quantity to Mill (thousands of cwt)					
Yolo Bypass	459	406	664	537	772
Other Yolo County	2,727	2,154	2,426	2,107	2,774
Other counties	814	1,440	909	1,356	454
Percent from Yolo Bypass	11%	10%	17%	13%	19%
Rough rice Cost (dollars per cwt)					
Cost of rough rice	11.83	12.29	14.64	27.58	20.25

Source: USDA NASS California Agricultural Statistics, Yolo County GIS, Flores et al. 1993, SunWest 2014, Richardson and Outlaw 2010, CRC 2014b, IMPLAN 2013.

The variable costs of rice milling include the processes for turning rough rice into a consumable good. The representative rice mill operating costs include energy, labor, and material requirements for receiving and storage, cleaning and conditioning, milling, packaging, storage, and load out. This cost is estimated to equal $3.04 per cwt.

Table 18 summarizes the mill operating costs between 2005 and 2009. Total operating costs averaged $12 million per year between 2005 and 2009. Between $1.4 and $2.3 million — or 11 to 19 percent — of the annual operating cost of the representative mill are from Yolo Bypass rice.

Table 18. Rice mill variable costs, 2005 – 2009

	2005	2006	2007	2008	2009
Mill Operating Cost (thousands of dollars, 2012)					
Yolo Bypass	1,395	1,234	2,019	1,634	2,346
Other Yolo County	8,291	6,548	7,376	6,405	8,434
Other counties	2,474	4,378	2,765	4,121	1,380
Total operating cost	12,160	12,160	12,160	12,160	12,160
Mill Operating Cost (dollars per cwt)					
Operating cost per cwt	3.04	3.04	3.04	3.04	3.04

Source: USDA NASS California Agricultural Statistics, Yolo County GIS, Flores et al. 1993, SunWest 2014, Richardson and Outlaw 2010, CRC 2014b, IMPLAN 2013.

Fixed costs include those costs that must be paid by the mill whether or not the plant is operating. For example, overhead costs such as repairs and maintenance, research, insurance, advertising, interest payments, telecommunications service fees, legal services, tax preparation, and the share of labor costs associated with managerial and administrative salaries. The fixed costs of the mill are estimated using industry interview, industry reports, and IMPLAN data for rice milling in the Sacramento area. Using these data, the fixed costs of the representative mill are estimated to equal $9 million per year.

Milled rice revenues are based on USDA data, interviews with growers and a mill owner, and the study by Richardson and Outlaw (2010). Growers receive a share of revenue after the processed rice is sold. Mills compete to retain growers by maximizing the proportion of revenues returned to the grower. Rice harvested in the fall, dried, stored, and milled, is usually sold the following year. Thus, the price received for the current year harvest is determined by the market in the following year. This lag time is accounted for in the analysis by adjusting revenue years to reflect harvest years. In addition, there is a loss of product during the rice milling process, estimated to equal 25 percent of rough rice input, and milled rice quantities used to calculate gross returns reflect this loss. That is, mills purchase rough rice in the year it is grown at the price per cwt shown in Table 17, and 75 percent of that rough rice is turned into a consumable good (3 million cwt per year) and sold the following year at the prices shown below in row 1 of Table 19. Table 19 shows that the gross revenues of the representative mill (output price multiplied by output quantity) were between $78 million and $159 million per year.

Table 19. Rice mill gross revenues, 2005 – 2008

	2005	2006	2007	2008
Output price ($ per cwt)	26.09	28.13	34.22	53.15
Total gross revenue ($)	78,271	84,403	102,657	159,456

Source: USDA NASS California Agricultural Statistics, Yolo County GIS, Flores et al. 1993, SunWest 2014, Richardson and Outlaw 2010, CRC 2014b, IMPLAN 2013.

Table 20 summarizes rice mill net revenue, which is defined as the gross revenues net of all the variable operating costs. Between 2005 and 2008 the representative rice mill annual net revenues ranged between $18.8 million to $37 million per year.

Table 20. Rice mill net revenue, 2005 – 2008 (in 2012 thousands of dollars)

	2005	2006	2007	2008
Including bypass production				
Rough rice cost	47,329	49,140	58,540	110,322
Operating cost	12,160	12,160	12,160	12,160
Gross revenue	78,271	84,403	102,657	159,456
Contribution Margin	18,783	23,103	31,957	36,974
Excluding bypass production				
Rough rice cost	41,900	44,152	48,820	95,501
Operating cost	10,765	10,926	10,141	10,526
Gross revenue	70,326	70,389	88,865	128,692
Contribution Margin	17,661	15,311	29,904	22,665

Source: USDA NASS California Agricultural Statistics, Yolo County GIS, Flores et al. 1993, SunWest 2014, Richardson and Outlaw 2010, CRC 2014b, IMPLAN 2013.

4.4 Rice Mill Tipping Point Analysis

The data summarized in the previous section are used to estimate the break-even or “tipping point” and determine if the rice mill would continue to operate if no rice is grown in the Yolo Bypass. As discussed previously, for a given plant, the tipping point occurs at a throughput quantity where there are enough units processed so that the sum of the contribution margin per unit is sufficient to cover the plant fixed costs. Intuitively, if the mill cannot cover fixed costs it is more profitable to shut down the mill.

The contribution margin per unit is calculated by subtracting the cost of rough rice per cwt (in Table 17) and the operating cost (Table 18) from the gross revenue per cwt (row 1 in Table 19). The break-even quantity is calculated by dividing the total fixed costs of the plant ($9 million) by the contribution margin per cwt. Row 1 and 2 in Table 13 summarize the contribution margin and break-even (tipping point) quantity, respectively. The tipping point quantity for the representative mill is between 399,000 and 802,000 tons per year. Row 3 shows the rough rice available without bypass production (from Table 17), and row 5 shows the margin over the tipping point. As shown, the mill is able to operate at a level well above the tipping point threshold even if there is no rice produced in the Yolo Bypass.

Table 21. Summary of rice mill tipping point, 2005 – 2008

	2005	2006	2007	2008
Contribution margin ($/cwt)	11.22	12.81	16.54	22.53
Break-even (cwt)	802,258	702,615	544,005	399,441
Production without bypass (cwt)	3,541,000	3,594,000	3,335,000	3,463,000
Difference	**+2,738,742**	**+2,891,385**	**+2,790,995**	**+3,063,559**

4.4.1 Rice Mill Sensitivity Analysis

The previous section demonstrates that the representative Yolo County rice mill is able to maintain production above the tipping point threshold if it is assumed that there is no rice produced in the bypass, the mill does not purchase additional rice from other regions, and the mill operates under standard market conditions and costs. The analysis in this section involves adjusting the parameters to determine how sensitive the tipping point level of rice production is to the previously defined assumptions. The following 4 scenarios demonstrate the sensitivity of the rice mill tipping point. Table 22 summarizes the results of the analysis.

Scenario 1: Increase cost of rough rice

This scenario increases the cost of rough rice to simulate volatility in the farm-gate price of rice. In practice, a rise in the cost of rough rice is likely coupled with an increase in the price of milled rice and a commensurate increase in the mill's revenues. This scenario increases the farm-gate price for rough rice by 50 percent over the highest observed price ($27.58 per cwt), to $41.37 per cwt. Under this scenario, net revenue per hundredweight drops to $8.74 and the tipping point quantity is 1,029,511 cwt. The mill still processes 2.3 million cwt above the tipping point threshold without bypass production. The mill is able to maintain production above the tipping point threshold.

Scenario 2: Increase operating costs

Milling operational costs vary depending on the mill's age, technology, and management practices. The mill operating costs used in this study are based on the best available data and mill owner interview. However, operating costs are highly confidential and thus subject to some uncertainty in the analysis. This scenario triples the operating costs of the representative mill to $9.12 per cwt. Under this scenario, net revenue per hundredweight drops to $5.14 and the tipping point quantity is no greater than 1,751,540 cwt. The mill still processes 1.5 million cwt above the tipping point threshold without bypass production. The mill is able to maintain production above the tipping point threshold.

Scenario 3: Increase fixed costs

Rice mill fixed costs may vary significantly based on the facility's age, technology, staffing efficiencies, and management. The mill fixed costs used in this study are based on the best available data and mill owner interviews. However, fixed costs are highly confidential and thus subject to some uncertainty in the analysis. This scenario triples the fixed costs of the representative mill to $27 million. Under this scenario, net revenue is unchanged but the tipping point quantity is no greater than 2,406,774 cwt. The mill still processes 0.9 million cwt above the tipping point threshold without bypass production. The mill is able to maintain production above the tipping point threshold.

Scenario 4: Decrease milled rice revenues
Prices for processed rice are also volatile. This scenario decreases milled rice revenue by 25 percent to simulate this situation. As in Scenario 1, a decline in the price of milled rice is almost certainly coupled with a decrease in the cost of rough rice and a commensurate decrease in the mill's input costs, meaning this scenario is highly improbable. Under this scenario, net revenue per hundredweight drops to $4.70 and the tipping point quantity is no greater than 1,916,641 cwt. The mill still processes 1.4 million cwt above the tipping point threshold without bypass production. The mill is able to maintain production above the tipping point threshold.

Table 22. Rice mill tipping point and sensitivity analysis ($2012 Dollars)

	Net Revenue ($ per cwt)	Tipping Point (cwt)	Minimum cwt available without bypass (2005 – 2009)
Standard assumptions	$11.22	802,258	3,335,000
Scenario 1. Increase cost of rough rice by 50%	$8.74	1,029,511	3,335,000
Scenario 2. Triple mill operating costs	$5.14	1,751,540	3,335,000
Scenario 3. Triple mill fixed costs	$11.22	2,406,774	3,335,000
Scenario 4. Decrease output price by 25%	$4.70	1,916,641	3,335,000

Source: USDA NASS California Agricultural Statistics, Yolo County GIS, Flores et al. 1993, SunWest 2014, Richardson and Outlaw 2010, CRC 2014b, IMPLAN 2013.

4.5 Rice Mill Tipping Point Summary

This study has provided a quantitative assessment of the impacts to a representative rice mill's economic viability from a reduction in rice acreage in the Yolo Bypass. The baseline scenario indicates that even without Yolo Bypass production, the processor still processes well above the minimum profitable quantity, or tipping point quantity, in any given year.

The sensitivity analysis evaluated a range of scenarios where key parameters that affect the tipping point decision were changed. Under all scenarios the mill is able to maintain production above the tipping point threshold without milling any rice from the bypass. An empirical confirmation of the analysis can be seen in the current ongoing drought. It is noteworthy that during the current drought California rice acreage fell by more than 25 percent, from 563,000 acres in 2012 to 416,000 acres in 2015 (USDA NASS various years; USDA ERS 2015). However, even with 25 percent less rice available for California mills to process, no mills have shut down, demonstrating the resilience of the industry to market volatility.

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5 Rice and Processing Tomato Crop Insurance Analysis

Late season flooding in the Yolo Bypass shortens the growing season for crops, and growers may decide to fallow fields or plant alternative crops. Most crop insurance policies offer coverage for late planting and missed plantings. When yields or revenues fall below a specified threshold an indemnity payout[5] is issued. If there is an anticipated increase in risk, the United States Department of Agriculture (USDA) Risk Management Agency (RMA) and insurance companies may increase insurance premiums to compensate for potentially higher indemnity payouts. Insurance premium rates and coverage are determined by historical risk factors, which in the Yolo Bypass, include some risk of late season flooding. This section summarizes crop insurance, standard policies carried by most bypass growers, and the potential for premiums to increase if farming risks in the Yolo Bypass increase.

5.1 Crop Insurance

Growers face financial risks from a number of factors including: water supply, weather events, pests, disease, and variation in market conditions. Many growers use crop insurance as a risk-management tool to hedge against events that can lead to increased costs, lost crop revenue, and partial or complete crop loss (FDIC 2014; NCIS 2014; Paulson and Coppess 2014). A range of flexible insurance plans are available and coverage rates can be tailored to specific farming operations. Protection and coverage levels are defined before crops are planted, so growers know the risk involved with producing the crop. Most insurance programs provide partial coverage of losses to cover some of the planting, material application, and other production costs incurred.

Most growers carry crop insurance. Between 2000 and 2012, the number of crop insurance contracts in California decreased by 7 percent, but the total crop insurance coverage increased by 25 percent. That is, the level of coverage per contract has increased. In 2012, there were 1,818 rice crop insurance contracts in California with a net indemnity payout of $1.2 million and 1,061 tomato crop insurance contracts with a total payout of $2.5 million (RHIS 2013).

The USDA provides insurance premium subsidies to farmers to reduce the out of pocket expense of purchasing crop insurance. The USDA RMA sets policy provisions and rates for crop insurance, and then contracts with private insurance companies to facilitate and administer the policies (USDA RMA 2014b; USDA

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[5] An indemnity payout is money paid to a grower when an inurance claim is filed.

RMA 2013). USDA also provides support programs to insurance companies (reinsurance) to help offset risky policies and reduce financial exposure.

The insurance policies offered to growers reflect the diversity of agricultural production. There are fundamentally two types of crop insurance options available for growers: (i) catastrophic risk protection that is fully subsidized by the federal government, and (ii) buy-up insurance policies that enable growers to select a higher coverage level and pay a corresponding premium (USDA RMA 2014). This analysis focuses primarily on buy-up policies, as they are the most commonly used crop insurance policies by Yolo Bypass growers (Sanchez, 2014; Otto, 2014).

The standard Catastrophic Risk Protection (CAT) policies pay out based on historical prices (USDA RMA 2012; USDA RMA 2012a). Typical payout is for 55 percent of the crop price on crop losses greater than 50 percent of historical yield. The insurance premium is fully subsidized by the federal government. Each grower must pay a $300 administrative fee for each crop insured in each county. CAT coverage offers a basic level of risk protection, but it is not available to all growers or for all crops (RMA 2014). As such, many growers opt to purchase a buy-up policy. Buy-up policies can be purchased in coverage levels between 50 and 85 percent, typically in 5 percent increments (ISUUE 2014). The coverage level can be based on a number of measures including county historical yields, individual actual yields, projected prices, or harvest price. Basic policy provisions that are included in many buy-up policies include coverage for:

- Late planting
- Prevented planting
- Replanting
- Replanting to a different crop

In all insurance policies, an indemnity payout is issued when yields or revenues fall below the specified threshold. Growers pay a pre-determined amount for insurance coverage based on crop farming risk classification set by the USDA RMA and the level of coverage. The insurance premium is paid at the end of the season or when an indemnity payment is made, whichever comes first, and a portion of the insurance premium is subsidized by the federal government (USDA RMA 2014; Sanchez 2014; Otto 2014).

Each year the USDA sets a reference price for each crop. This price is used as the basis for indemnity payouts. Growers can select coverage of between 55 and 100 percent of the reference price. For example, if a grower chooses a yield/price coverage plan of 70/100, if yield drops below 70 percent the specified yield then the USDA maximum price is covered at 100 percent (USDA RMA 2014; Sanchez 2014; Otto 2014).

The methods used to determine premium rates by the USDA RMA changed in 2012. This was required by Section 508(i) of the Federal Crop Insurance Act (FCIA), which mandates the RMA review its premium rates and rating methodology on a periodic basis. With the revised premium calculation approach in 2012, rice growers in California realized a 14 percent savings on crop insurance premiums (USDA RMA 2012a).

Federal grower premium subsidies consist of two components: (i) premium cost subsidy, and (ii) administration and operation expense payment. In the CAT policy, the federal government subsidizes the full premium cost, but not the administrative costs. With buy-up policies, the subsidy rate varies with the coverage level (USDA RMA 2014; Sanchez 2014; Otto 2014). Table 23 summarizes 2014 California rice and tomato premium subsidy rates in California. The federal government subsidizes the premium at the defined rate regardless of premium. This is important to note when examining increased risk production in the Yolo Bypass because the federal government incurs additional costs as premiums increase, as do growers. In general, federal subsidies make crop insurance more affordable for growers to purchase and for insurance companies to sell.

Table 23. California insurance coverage and subsidy rate for rice and tomatoes in 2014

	Percent Coverage							
Coverage Level	50	55	60	65	70	75	80	85
Rice Premium Subsidy	67	64	64	59	59	55	48	38
Tomato Premium Subsidy	67	64	64	59	59	55	N/A	N/A

Source: USDA RMA 2014

Reinsurance is when an insurance company transfers risk to another company who is willing to bear the risk, but not willing to administer an insurance policy. The purpose of reinsurance is to offset some of the financial risk that the insurance provider undertakes in offering insurance to a risky operation. If the RMA designates a crop and area eligible for crop insurance, by law the private insurance company must provide coverage, meaning that they may take on more risk. In addition, insurance companies may believe that the premium rates set by the USDA in a particular area are not reflective of actual risk associated with production. Reinsurance also helps insurance companies may not have enough capital to cover potential indemnity payments (USDA RMA 2014; Sanchez 2014; Otto 2014).

The current Farm Bill, passed in 2014, is comprehensive legislation that provides funding for nutrition and agriculture programs. As it relates to crop insurance, the 2014 Farm Bill replaced the Direct Payment subsidies with the Price Loss Coverage (PLC) and Agricultural Risk Coverage (ARC) programs, which are aimed at providing income protection against significant losses (USDA FSA 2014f; USDA FSA 2014a – 2014e). Conceptually, the ARC and PLC programs act as supplemental coverage for growers' deductibles, if a claim is filed. The ARC and PLC programs are available to rice growers; however growers must make a one-time decision of selecting either: (i) PLC/County ARC, or (ii) individual ARC program. Selecting between the two programs depends on the type of risk the grower is trying to minimize. The PLC has the greatest benefits if it is more likely that market price for a covered commodity will fall below the reference price, and the ARC has the greatest benefits if is more likely that some combination of future revenues (yields and prices) will drop below historic levels by more than 14 percent (Kelleher 2014).

Under the PLC program, indemnities are paid when the price of a crop drops below the established reference price for that commodity. The indemnity is equal to 85 percent of the base acres covered times the reference price (or effective price difference) times the program payment yield (USDA RMA 2014). Under the county ARC program, indemnities are issued when the county crop revenue of a covered crop is less than the ARC revenue guarantee. The indemnity is equal to 85 percent of the base acres times the difference between the county guarantee and the actual crop revenue (USDA FSA 2014f; USDA RMA 2014). Under the individual ARC program, indemnities are issued when individual crop revenues, across all covered crops, fall below the ARC individual guarantee for those crops. The indemnity is equal to 65 percent of the total base acres covered multiplied by the difference between the individual revenue guarantee and the actual individual revenue.

5.2 Methodology

This section describes the methodology used to quantify the impacts of increased production risk for Yolo Bypass rice and tomato growers. This analysis examines available crop insurance options and commonly used coverage levels by growers in Yolo County and the Yolo Bypass, and assesses the fiscal impact of increased risks to farming in the Yolo Bypass. Since the project alternatives have not been specified it is not possible to quantify the increased "level" of risk. As such, the analysis is based on a "significant" increase in the level of risk from farming in the Yolo Bypass. This means that the probability of late season flooding events increases in all years.

Data for the analysis come from a review of published studies, industry reports, and from interviews with local farmers, private insurers, and RMA representatives. The analysis examines general crop insurance policies and rate determination and then focuses on crop insurance use in the Yolo Bypass. The analysis then quantifies the additional costs growers may incur as well as the point at which insurance companies may stop offering crop insurance due to greater crop production risk.

5.3 Yolo County Crop Insurance

This section of the analysis focuses on crop insurance options for rice and tomato growers in Yolo County and the Yolo Bypass, including how risk differs among production regions within the Yolo Bypass and how increased production risk translates to changes in the premiums paid by growers. Data was collected primarily through conversations with USDA RMA representatives in the California Regional Office and from RMA insurance data.

RMA representatives communicated that indemnity payments are only issued when a natural disaster occurs such as drought, flooding, or earthquake. It is important to clarify that the increased flooding frequency and duration must result from a naturally occurring event, rather than a controlled event, in order for Yolo Bypass growers to receive indemnity payouts. The representatives also stated that Yolo County growers have historically received higher indemnity payouts in comparison to other local counties because of the prevented planting indemnities paid to Yolo Bypass growers (Sanchez 2014; Otto 2014).

The most popular insurance policies used in the Yolo Bypass are yield and revenue protection (USDA RMA 2014; Sanchez 2014; Otto 2014). Yield protection insures against yield variability whereas revenue protection insures against price and yield variability. Crop insurance premiums are based on coverage level and production risk. Higher risk production areas naturally command higher grower premiums for the same level of coverage. Risk ratings are developed by RMA and are based on natural disaster occurrences over a pre-determined historical time frame. The assessment uses a combination of quantitative and qualitative data in determining risk. Risk maps are defined on a county-level basis for all major crops produced. Within a county, each production region has a risk classification used to determine grower premium cost. The RMA defines risk in three categories in Yolo County (USDA RMA 2014):

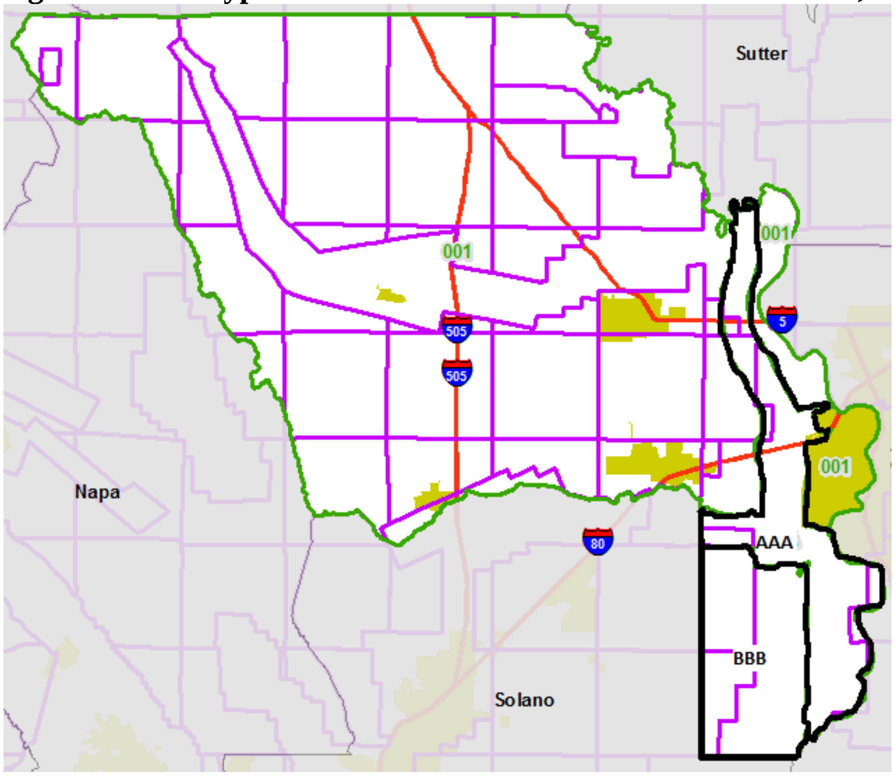
- 001: This classification has the lowest level of production risk,
- AAA: This classification has moderate production risk and is closer to natural disaster areas,
- BBB: This classification has high production risk and usually occurs in areas with marginal agricultural production.

5.3.1 Rice Insurance

Figure 3 illustrates Yolo County RMA risk classification for rice production as of 2014 (USDA RMA 2014a). For the production regions outside of the Yolo Bypass, production risk is defined as 001, which is the lowest risk classification level. The Yolo Bypass, encircled in black, reflects higher risk production with AAA and BBB ratings. The northern half of the bypass is classified as AAA because it is better suited for rice production. According to RMA representatives the occasional flooding is not sufficient enough to be considered incompatible with growing rice. The southern region is classified as BBB, because of poor rice production conditions, caused by frequent Sacramento-San Joaquin Delta winds and cooler temperatures. AAA premium rates are 1.167 times the 001 rate, and BBB premium rates are 2 times the 001 rate.

Indemnity payments are paid to growers when actual yield falls below a defined reference yield. If a grower does not have historical yield data, the grower can use county data provided by the RMA. In 2014, for 001 and AAA risk classifications the reference yield is 79.35 cwt per acre and for BBB classifications the reference yield is 20 cwt per acre. Using these reference yields, a grower with 75 percent coverage is paid when yields drop below 15 cwt per acre in BBB areas and 59.51 cwt per acre in 001 and AAA areas.

Figure 3. Yolo Bypass rice risk classification from USDA RMA, 2014



Source: USDA RMA, 2014a

Grower premium costs are based on the level of coverage selected and the risk classification. Rice insurance plans offered in Yolo County include yield protection, revenue protection, and revenue protection with harvest price exclusion (USDA FCIC 2010; USDA RMA 2014; NCIS 2014). According to the USDA RMA, rice coverage rates range between 50 to 85 percent (Sanchez 2014; Otto 2014). Based on grower feedback, the most commonly used rice insurance program and coverage used in the Yolo Bypass is yield protection with 75 percent coverage (Espino 2014).

Table 24 summarizes 2014 yield crop insurance rates in Yolo County. The estimates are based on a 100-acre irrigated medium grain rice field with 75 percent yield coverage and 100 percent price coverage. The bottom rows of Table 24 show the important information. The cost of rice insurance is $25.06 to $50.12 per acre for the same level of coverage, depending on the risk classification. A rice field outside of the bypass (001 rating) would pay $25.06 per acre and that same field in the bypass (AAA rating) would pay $29.24, an increase of $4.18 per acre (USDA RMA 2014a).

Table 24. Yolo County rice premium rates, 2014 (2012 dollars per acre)

	001 Rating	AAA Rating	BBB Rating
Coverage:	850.03	850.03	850.03
Production Guarantee Amount:	1,133.38	1,133.38	1,133.38
Total Premium Amount (Including admin):	67.09	78.30	134.19
Premium Risk Subsidy:	30.27	35.32	60.54
Administrative and Operating Subsidy:	12.06	14.07	24.11
Producer Premium (No Administrative Fee Included):	24.77	28.90	49.54
Administrative Fee:	0.29	0.29	0.29
Producer Premium (Administrative Fee Included):	25.06	29.24	50.12
Producer Premium Cost Difference per acre	-	4.18	20.87

Source: USDA RMA 2014a

The USDA RMA representatives interviewed anticipate that even with increased flooding frequency and duration, in all years, in the Yolo Bypass risk ratings would not change from AAA to BBB; however, the premium multiplier may increase. The current AAA premium multiplier rate is estimated to increase by 25 to 35 basis points, where a basis point is equal to 0.01 percentage points, depending on how frequently growers receive payouts caused by increased flooding frequency and duration (USDA RMA 2014a; Sanchez 2014; Otto 2014).

Table 25 uses the basic AAA rating risk classification from Table 24 to show the incremental cost of increased production risk in the bypass. The premium multiplier is increased from 1.167 to 1.667, which conservatively increases the multiplier by 50 basis points, 15 basis points over the USDA RMA estimated increase of 35 basis points. Using these multiplier increases, the per-acre premium cost increases from $4.18 per acre to $12.53 per acre. These increases are selected to demonstrate the effects of a more extreme impact than is anticipated by USDA RMA experts, thus establishing a conservative upper bound.

Table 25. Rice insurance premium rates with increased production risk (2012 dollars per acre)

	AAA	0.25 Increase	0.35 Increase	0.50 Increase
Coverage:	850.03	850.03	850.03	850.03
Production Guarantee Amount:	1,133.38	1,133.38	1,133.38	1,133.38

Total Premium Amount (Including admin):	78.30	95.07	101.78	111.84
Premium Risk Subsidy:	35.32	42.89	45.92	50.46
Administrative and Operating Subsidy:	14.07	17.08	18.29	20.10
Producer Premium (No Administrative Fee Incl.):	28.90	35.10	37.57	41.29
Administrative Fee:	0.29	0.41	0.44	0.48
Producer Premium (Administrative Fee Incl.):	29.24	35.51	38.01	41.77
Producer Premium Cost Difference	-	6.26	8.77	12.53

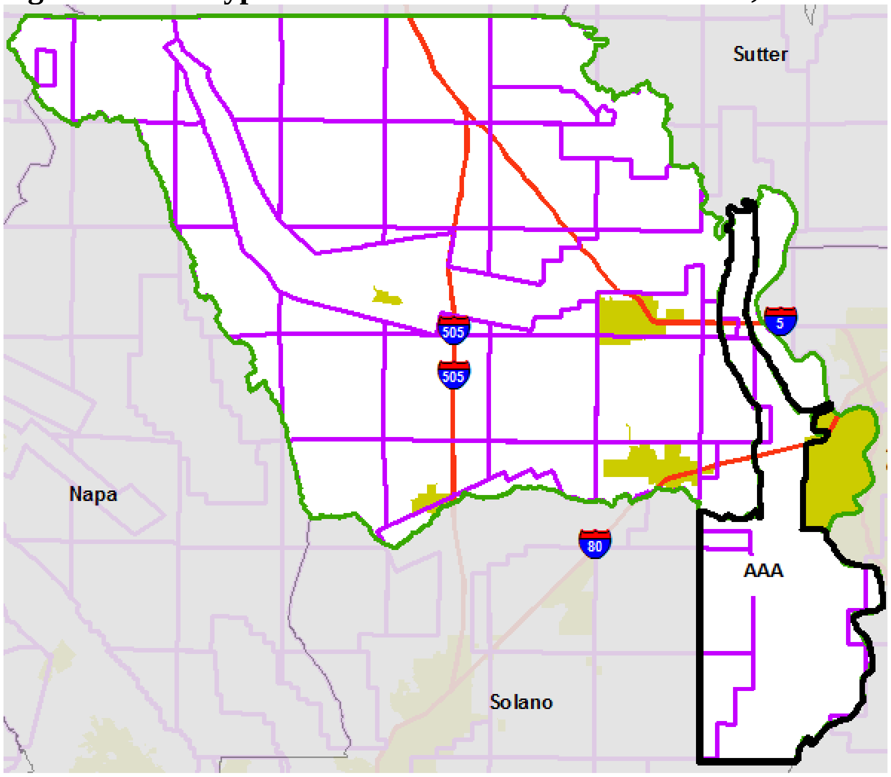
Source: USDA RMA 2014a

Since the federal government subsidizes 55 percent of premium cost, the cost of the increase in premium rates is split with the grower. By increasing the premium rate multiplier from 1.167 to 1.667, the grower’s cost increases by $12.53 per acre. The 2014 Farm Bill introduced the ARC and PLC plans which are available to Yolo Bypass rice growers (USDA FSA 2014f). According to RMA representatives, bypass growers generally do not use these policies (Sanchez 2014; Otto, 2014).

5.3.2 Processing Tomato Insurance

Processing tomato production in Yolo County is classified as risk rating AAA (USDA RMA, 2014a). USDA RMA representatives confirmed that prevented planting coverage insurance is not offered for tomatoes anywhere in Yolo County (Sanchez 2014; Otto 2014). For tomato production, seed and transplant material represents nearly 20 percent of production costs in a season, thus prevented planting coverage is too expensive for insurance companies to offer. Growers typically avoid planting in areas that jeopardize young plants because they cannot secure prevented planting coverage (UCCE 2008; Espino 2014).

Figure 4. Yolo Bypass Risk Classification for Tomatoes, 2014



Source: USDA RMA 2014a

In Yolo County, the Actual Production History (APH) plan is the only crop insurance plan offered to tomato growers and it does not cover prevented planting (USDA RMA 2014a; Sanchez 2014; Otto 2014). The APH plan offers coverage rates between 50 and 75 percent of historical yields. The standard coverage plan used by Yolo Bypass growers is 65 percent coverage.

For Yolo County tomato production the USDA RMA applies a multiplier to the base rates to account for additional production risk. The total premium liability amount is multiplied by the premium rate to determine the premium cost. Areas with AAA risk classification carry a premium rate that is 0.002 points higher than a 001 risk classification (USDA RMA, 2014a). Table 26 shows the difference between 001 and AAA premium costs for tomato growers in Yolo County. The estimates are based on 100 acres of irrigated tomatoes in Yolo County. The price premium cost to the grower increases by $88.11 for 100 acres, or $0.88 per acre, between the 001 and AAA risk classifications. USDA RMA representatives noted that the AAA classification and small additive value are intended to reflect a slightly higher risk for tomato production in Yolo County (Sanchez, 2014; Otto, 2014).

Table 26. Yolo County tomato premium rates, 2014 (Premium per 100 acres, in 2012 dollars)

	001 Rating	AAA Rating
Liability Amount:	$107,346.87	$107,346.87
Total Guarantee Amount (Tons):	$2,030.19	$2,030.19
Total Premium Amount (Including A&O):	$3,009.84	$3,224.41
Subsidy (Including A&O):	$1,997.64	$2,443.14
Producer Premium (No Admin Administrative Included):	$1,012.20	$1,100.31
Administrative Fee:	$29.00	$29.00
Producer Premium (Administrative Fee Included):	$1,041.20	$1,129.31
Producer Premium Cost Difference	-	88.11

Source: USDA RMA 2014a

The increased production risk for tomatoes increases the multiplier. This analysis applies the same approach used to calculate rice premium rate increases to determine tomato premium increases. Table 27 summarizes the results based on an AAA risk classification and a base premium cost of $1,041 per 100 acres from Table 26.

Table 27. Tomato premium rates with increased production risk (Premium per 100 acres in 2012 dollars)

	AAA	0.003 Increase	0.004 Increase	0.006 Increase
Liability Amount:	$107,347	$107,347	$107,347	$107,347
Total Guarantee Amount (Tons):	$2,030	2,030	2,030	2,030
Total Premium Amount (Including A&O):	$3,010	$3,668	$3,801	$4,000
Subsidy (Including A&O):	$1,998	$2,723	$2,802	$2,919
Producer Premium (No Admin Administrative Incl.):	$1,012	$1,232.08	$1,284.79	$1,363.85
Administrative Fee:	$29	$30	$30	$30
Producer Premium (Administrative Fee Incl.):	$1,041	$1,262	$1,315	$1,394
Producer Premium Cost Difference	-	$94	$147	$226

5.4 Insurance Premiums and Net Farm Income

Given current conditions and assumptions about policy coverage, rice premium costs increase by $6.48 to $12.96 per acre and tomato premium costs increase by an average of $1.36 to $2.73 per acre. Table 28 examines variable operating costs and revenues for rice and tomatoes in the Sacramento Valley, based on UCCE Cost and Return Studies (UCCE 2008; UCCE 2012; UCCE various years). Yolo Bypass farmer costs of production are likely to differ from the UCCE budgets, but they provide a useful reference point to illustrate how insurance premiums affect farm profitability.

Table 28 shows that the increased insurance premium costs reduce net returns to land and management by 3.0 percent in rice and 0.6 percent in tomato production. Revenues are still sufficient to cover variable production costs and growers would likely remain in business.

Table 28. Rice and tomato production costs and returns with increased insurance premiums (in 2012 dollars)

Average Price and Yields				
Rice Cost and Returns per Acre	AAA	0.25 Increase	0.35 Increase	0.50 Increase
Gross Returns	1,598	1,598	1,598	1,598
Operating Costs	-1,148	-1,148	-1,148	-1,148
Crop Insurance Premium	-31	-38	-41	-45
Net Returns Above Operating Costs	419	412	410	406
Tomato Cost and Returns per Acre	AAA	0.003 Increase	0.004 Increase	0.006 Increase
Gross Returns	2,839	2,839	2,839	2,839
Operating Costs	-2,337	-2,337	-2,337	-2,337
Crop Insurance Premium	-13	-14	-15	-16
Net Returns Above Operating Costs	489	487	487	486
Low Price and Yields				
Rice Cost and Returns per Acre	AAA	0.003 Increase	0.004 Increase	0.006 Increase
Gross Returns	1,085	1,085	1,085	1,085
Operating Costs	-1,111	-1,111	-1,111	-1,111
Crop Insurance Premium	-30	-37	-39	-43
Net Returns Above Operating Costs	-56	-63	-65	-69
Tomato Cost and Returns per Acre *(Low Price and Yield)*	AAA	0.003 Increase	0.004 Increase	0.006 Increase
Gross Returns	2,123	2,124	2,124	2,124
Operating Costs	-2,134	-2,134	-2,134	-2,134
Crop Insurance Premium	-12	-13	-14	-14
Net Returns Above Operating Costs	-22	-23	-24	-25

Source: UCCE 2008, 2012

5.5 Crop Insurance Summary

By increasing production risk in the Yolo Bypass in all years, premium rates could increase by $6.48 to $12.96 per acre for rice growers and by $1.36 to $2.73 per acre for tomato growers. Under all scenarios, increases in crop insurance costs result in a small (less than 3 percent) decrease in net returns. Private insurance companies would continue to provide crop insurance as required by the USDA RMA, with additional costs subsidized by federal programs.

Increased flooding frequency and duration in the Yolo Bypass would lead to riskier production conditions and greater likelihood of payouts. Crop insurance companies are required to provide insurance policies that follow USDA RMA guidelines. Even with increased production risk in the bypass it is mandatory for crop insurance companies to continue offering coverage, but premiums may increase.

In summary, the tipping point analysis of the cost and availability of crop insurance policies for Yolo Bypass processing tomato and rice growers was completed before the final EIR/S Project alternatives were specified. As such, the insurance tipping point analysis considered a hypothetical “high risk” scenario where there would be an increasing in wetted acreage in the Yolo Bypass in all (or most) years. The Project alternatives have been defined subsequent to the initial analysis and it is clear that the Project causes a marginal incremental increase in wetted acreage in some—but not all—years. As of the publication date of the draft EIR/S there is uncertainty over the incremental effect of the Project on rice and processing tomato crop insurance cost, and availability.

Crop insurance, like all insurance, is a way for the purchaser to offset a portion of risk in exchange for a premium payment to the insurer. Growers purchase insurance from an insurer to cover a portion of losses that could occur under adverse events, thereby transferring some risk to the insurer in exchange for an insurance premium payment. Any increase in risk generally translates to higher premiums. The increase in insurance premiums that could occur under Project alternatives is still uncertain. The initial tipping point analysis hypothesized a clear increase in farming risk in all years. Subsequent hydrodynamic modeling of the Project alternatives now shows that the Project may cause small incremental changes in inundation under specific year types. Since the incremental change in inundated acreage is small, the corresponding effect on Yolo Bypass farming risk is also small—much less than the catastrophic scenario considered in the tipping point studies—and it is likely that the effect of any increase in farming risk caused by the Project on crop insurance premiums will be less than what was estimated in the initial tipping point study.

Indemnity payments for crop insurance policies are only issued when the crop loss is the result of an insurable event. USDA RMA representatives have stated that insurable events for prevented planting coverage (a common policy for Yolo Bypass rice growers) would include natural events but might not include “man made” events. It is not clear at this time if the incremental increase in wetted acreage caused by the operation of the Fremont Weir gates under the proposed Project alternatives would constitute “man made” or “natural” flooding. As such, it is possible that insurers would no longer offer prevented planting coverage to Yolo Bypass rice growers. However, it is important to note this is not a new issue for California crop insurance. The operation of the Central Valley Project and State Water Project is constantly evolving due to “man made” changes in operations, where many districts historically received full water supply but now expect must less than that in many years. These operational changes in the state and federal water supply system could be viewed as uninsurable ("man made") events, but rice growers in these regions still have access to prevented planting coverage. Since crop insurance is federally mandated, and insurers are in the business of selling insurance to growers, there are incentives to continue to offer crop insurance policies so long as it is profitable for both insurers and growers. It is important to establish whether the proposed Project alternatives result in additional wetted acreage due to "man made" events, and if so, whether insurers will continue to offer insurance plans to Yolo Bypass growers. However, a final resolution might not be reached until the USDA, insurers, and the growers are actually facing this situation and have to grapple with the various implications and incentives.

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6 Rice and Processing Tomato Bank Loan Rate Analysis

Operating loans are an important financial tool that many growers use to smooth seasonal cash flow (Blank 2012). Most crops require a significant capital outlay at planting and payment for management costs through the season, but do not receive payment until sometime after harvest. Short-term seasonal loans can be used to smooth this financial cycle. Short-term financing is usually acquired through budgeted loans or revolving lines of credit with maturities of one to four years. Current lending rates on these loans are on the order of 5.5 percent (Elliessy 2014). Other medium and long-term loans are discussed, but the analysis is primarily concerned with short-term lending as this would be most likely to be affected by an increase in bypass farming risk.

6.1 Bank Loan Rate Introduction

Growers use agricultural loans to purchase land, make improvements, and cover production expenses. Short-term loans are used primarily for operating finance and are the most frequently occurring agricultural loans. Short-term financing is usually acquired through budgeted loans or revolving lines of credit with maturities of one to four years, and are typically structured to be paid back from post-harvest revenues. Intermediate loans usually have loan maturities of up to 10 years and are often used for development of permanent plantings, production and processing equipment purchases, building repairs or improvements, construction, debt refinancing, and timber or land purchases. Long term agricultural loans may have fixed or variable interest rates and are generally used for real estate purchase and improvement, vineyard and orchard development, packing and storage facilities, water development and irrigation projects, and debt refinancing (Elliessy 2014).

Production loans are an important component of many banks’ loan portfolios because they diversify risk. Agricultural production is much less responsive to changes in the financial industry, in contrast to the residential and commercial real estate industries. However, agricultural production is subject to commodity price changes and weather conditions that other markets are not subject to. Most traditional banks have less than 30 percent of their portfolios in agricultural products, while banks that specialize in agricultural lending may hold up to 100 percent of their portfolios in agricultural loans (Elliessy 2014; AAC 2016).

6.2 Methodology

This analysis examines production loan underwriting and how lending practices may change with increased production risk due to increased flooding frequency and duration in the Yolo Bypass. The analysis focuses on short-term production loans as they are most responsive to changes in crop production. General loan requirements, loan criteria, and loan processes are examined to identify the factors that influence lenders in lending and growers in borrowing. The analysis then measures the effect of increased production risk in the Yolo Bypass, using data from a representative at a large lending institution in Yolo County, as well as a representative from the United Stated Department of Agriculture and the Farm Bureau. Conversations with lenders gave a local account of agricultural lending and likely reactions to an increase in flooding frequency and duration in the Yolo Bypass. Finally, a literature review examines how bank loan rates change with increased production risk.

The analysis uses UCCE Cost and Return Budgets for crops grown in the Sacramento Valley and Yolo Bypass to determine production costs and revenues (UCCE 2008; UCCE 2012), GIS data to estimate bypass production acreage (Yolo County GIS, various years), and USDA NASS data to examine Yolo County prices and yields (USDA NASS various years). The analysis uses the UCCE budgets as a baseline and then adds increased production loan rates to quantify the cost of additional production risk and the overall impact on farm profitability. The UCCE budgets take into consideration interest paid on production loans, defined as “interest on operating capital.” For this analysis, production interest rates are estimated to equal 5.75 percent, based on the recommendation of an agricultural lending agency (Monaco 2014).

6.3 Loan Criteria and Process

Loan amounts and access to credit are determined based on standard lending criteria and personal relationships. Generally, loan underwriting standards that are used for commercial loans are also applied to agricultural loans. Lenders examine several components of a farm operation to consider the following in developing a loan:

- **Financial and Other Credit Information**. In agricultural production, financial and credit information is the first and most important information to determine if a loan will be granted. The process uses annual financial information including balance sheets, income statements, cash flow projections, loan officer file comments, collateral inspections, verifications, and valuations (FDIC 2014). Considerations in underwriting a loan include profitability, financial leverage, degree of asset liquidity, managerial and financial expertise, amount and type of credit, financial strength and history of the borrower, loan type, and the economic, climatic or other external conditions that may affect repayment (FDIC 2014).

- **Collateral Support**. Collateral is often used as security by the lender in intermediate and long-term agricultural loans. Generally, collateral security is an all-inclusive lien of farm personal property including crops, machinery and equipment, livestock, and harvested grain (FDIC 2014). A real estate lien is commonly used for land purchase or in instances where a lender desires additional security.
- **Cash Flow Analysis**. Cash flow, as opposed to collateral coverage, is the primary repayment method for intermediate and short-term agricultural loans (FDIC 2014). This component considers current conditions, as well as historical performance of the farming operation. For short term loans, cash flow analysis helps the lender determine how much risk exposure is safe, based on historical cash flow data for repayment.
- **Structuring**. A short maturity loan can lead to loan default or impose a burden on the farming operation’s cash flow capacity (FDIC 2014). Timely liquidation of agricultural debt based on a repayment schedule and borrower’s understanding of repayment obligations helps prevent collection problems from occurring (FDIC 2014). Conversely, a loan maturity that is too long can leave the bank vulnerable to changes in the borrower’s financial circumstances.

In practice, each lending institution has a different method to assess risk and loan viability, using a combination of financial ratios, historical information, and qualitative factors.

6.4 Yolo County Agricultural Loans

This section examines production loan availability to growers in Yolo County and determinants used in setting loan rates. Information from FSA and a private industry representative are used as the basic framework to examine how changes in risk affect loan availability in Yolo County and the Yolo Bypass (USDA FSA 2014a – 2014e; Monaco 2014; Elliessy 2014). The representatives were asked how increased production risks in the Yolo Bypass changes a grower’s ability to acquire a production loan.

The FSA representative works as a Farm Loan Manager and has extensive knowledge of Sacramento Valley agricultural production. The FSA representative indicated that nearly all production loans are based on yield averages over the previous three years. If flooding occurs and decreases yields in a particular year, interest rates will increase to reflect the additional risk of production in an area. Knowledge of future events, such as increased frequency and duration of flooding, also increases interest rates as banks factor in the probability that a grower may not be able to plant or harvest a crop in time to determine payback expectations.

The FSA representative estimated that a 2 to 3 percentage point interest rate increase covers the additional risk exposure of the lender under the scenarios of increased flood frequency and duration in the Yolo Bypass in all years. The increased interest rate estimate is reasonable given a 2013 study that examined commercial bank risk rating usage between 1997 and 2002. On average, a loan with the least risky rating carried an interest rate 1.3 percentage points lower than a loan with the highest risk rating (Walraven 2003).

According to the FSA representative, although production loans are based primarily on a three year production history, qualitative considerations are also used in loan underwriting. Qualitative factors include how long a grower has produced in a particular area, what other crops the grower has in her or his portfolio, and the grower's track record in repaying loans. Some lenders may not increase production loan rates with increased flooding in the Yolo Bypass because these qualitative factors are deemed sufficient to mitigate the additional risk. This is likely in an area such as the Yolo Bypass where there a few well-established growers.

The second contact works as a Branch Manager in Woodland for a lending institution that has been servicing California agriculture since 1917. The institution has 11 regional offices in California, located in Southern California, the Central Coast, the San Joaquin Valley, and the Sacramento Valley. The representative has worked with the institution for over 20 years. The representative indicated that the largest threat to a grower is the ability to acquire a loan. Interest rates for production loans may not change substantially, but increased production risk may change the likelihood of a bank loan to growers, particularly for new borrowers. The representative discussed Yolo Bypass flooding that occurred in the 1990s, and how lending practices did not change because of the floods. Despite this past lack of response, the frequency of flooding may alter lending practices in the future.

An important consideration in lending to a Yolo Bypass grower is the grower's crop and acreage portfolio. If a grower's acreage is largely located in the bypass, that is, 25 percent or more, the ability to acquire a production loan becomes extremely limited. However, if less than 10 percent of total acreage is located in the bypass, then bank risk decreases for an individual grower and the grower has a greater likelihood of acquiring a production loan.

Yolo Bypass portfolio diversification data are based on interviews with Yolo Bypass rice growers. Based on interviews with growers and loan officers, many growers have acreage outside the Yolo Bypass. However, for some bypass growers, a large share of production, ranging between 30 and 100 percent, is located inside the bypass. The acreage share varies depending on the water year. In dry years, growers tend to have a larger production share within the bypass because of senior water rights, and the opposite is true in wet years.

There are a few growers that make up the majority of rice production within the Yolo Bypass. All growers reported producing a diverse mix of crops with some land in the bypass and some land outside of the bypass. Despite the concentration of acreage in the Yolo Bypass, according to information from the private industry lender and growers most growers diversify their farming operations through income-generating activities outside the bypass. Growers may have production risk with increased flooding risk, but most are financially diversified and are not expected to have difficulty acquiring a production loan.

6.5 Production Loan Rate Changes

To quantify the additional financing costs incurred by growers due to increased flooding risk, 1.3 and 3 percentage point increases in the interest on operating capital are evaluated. The analysis uses 2009 USDA NASS prices and yields for Yolo County production to reflect local production conditions.

The UCCE Cost and Return budgets are used to estimate grower profitability based on information provided by farmers, farm advisors, and industry experts (UCCE 2008; UCCE 2012; Monaco 2014; Elliessy 2014). These estimates are used as a baseline in determining profitability changes due to increased interest rates. The analysis assumes that all crops have the same production loan rates and are equally impacted by increased production risk from increased flooding frequency and duration. The analysis uses these budgets to determine interest costs incurred during the production season. The budgets account for interest on operating capital based on cash operating costs and are calculated monthly until harvest. The nominal interest rate provided by a representative farm lending agency for a production loan is 5.75 percent (Elliessy 2014), which is confirmed with the UCCE budgets (UCCE various years).

Increased loan costs incurred by growers are estimated by calculating the difference between the baseline loan rate and the increased loan rates. Table 29 summarizes the annual per acre losses from higher interest rates. Tomato growers incur the largest losses, at $12 per acre with a 1.3 percentage point increase and $29 per acre with a 3 percentage point increase. All values are presented in 2012 dollars for equal comparison.

Table 29. Per Acre Interest Rate Effects

	2009 Acres	1.3% Increase	3% Increase
		Lost Revenues, 2012 dollars per acre	*Lost Revenues, 2012 dollars per acre*
Processing Tomatoes	3,661	-12	-29
Rice	7,448	-5	-11

Source: UCCE various Cost and Return Studies, Yolo County GIS, 2012

Increased interest rate costs are evaluated to determine if they are sufficient to force a grower to stop producing in the Yolo Bypass. This happens if the operating costs of production exceed expected revenues. The UCCE Cost and Return studies summarize a grower's net return above operating costs, which is used as the baseline profitability value.

Table 30 summarizes how interest rate changes impact grower profitability. In all instances, cash net returns above operating costs remain positive. Net returns above operating costs vary year-to-year with market conditions, climate, and across different farms. However, this variation is independent from an increase in loan rates due to an increase in farming risk.

Table 30. Grower Net Returns per Acre with Increased Interest Rates (Net Revenues in 2012 dollars)

	Net Returns Above Operating Costs 5.75% base interest	with 1.3% Increase	with 3% Increase
Processing Tomatoes	409	397	380
Rice	416	411	405

Source: Calculations based on UCCE Various Cost and Return Studies

6.6 Marketing Assistance Loans and Loan Deficiency Payments

This section examines marketing assistance loans and loan deficiency payments (LDP) provided by the federal government. The USDA offers loans called Marketing Assistance Loans (MAL) to growers who produce certain crops[6] to help smooth supply and store production until market conditions are more favorable than at harvest time (FSA 2014a). When the price of a crop falls below the MAL the federal government pays a LDP. MALs help smooth supply and serve as a price floor for growers through the LDP.

The 2014 Farm Bill authorizes the USDA Commodity Credit Corporation (CCC) to issue nonrecourse MALs to agricultural producers who grow certain crops including medium grain rice. MALs provide interim financing at harvest to alleviate cash flow issues without having to sell the harvested product when market prices are usually at their lowest (USDA FSA 2014b). These loans are nonrecourse in nature because the harvested crop is pledged as collateral and growers have the option of delivering the collateral as loan repayment upon maturity. A settlement value is determined and applied to the outstanding loan principal and interest (USDA FSA 2014b). By law, the CCC charges one percentage point above the cost of borrowing from the United States Treasury at

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[6] Crops include: wheat, corn, grain sorghum, barley, oats, upland cotton, extra-long staple cotton, long grain rice, medium grain rice, soybeans, other oil seeds, dry peas, lentils, small chickpeas, large chickpeas, graded and non-graded wool, mohair, unshorn pelts, honey and peanuts.

the time the loan is made (USDA FSA 2014a). The loan rate for medium grain rice is $6.50 per cwt for 2014 – 2018.

LDPs are used to support growers when loan amounts are above the price received for certain crops, including medium grain rice. This helps to ensure that growers do not take a loss if market conditions weaken. Loan deficiency payments are based on Posted County Price (PCP), which is an estimate of the crop's local price, developed by the CCC. The loan deficiency payments are generally available when the posted county price is below the loan rate. Growers are paid the difference between the posted price and loan rate (Borton and Betz 2006). Additional support is available when the posted county price is below than the loan rate. When this happens only a portion of the principal and no interest has to be paid. The share of principal that is waived when the posted price is less than the loan rate is called the marketing loan gain.

Since marketing assistance loans and loan deficiency payments are used to help protect against market price fluctuations, the loans and payments are not used during the production timeframe. The CCC only issues the marketing loan against a physical crop after a crop is harvested, eliminating any production risk. As a result, increased flooding frequency and duration in the Yolo Bypass does not impact a grower's ability to acquire federal marketing assistance loans.

6.7 Bank Loan Rate Summary of Findings

This study has provided an independent and quantitative assessment of potentially increased loan rates, caused by increased flooding frequency and duration in the Yolo Bypass. Increased production risk is estimated to increase production loan rates by 1.3 to 3 percentage points above current rates. Using these estimates, total operating costs across the major crops grown in the Yolo Bypass increase by $1 to $29 per acre after accounting for changes in production loan rates. Even with the increased loan rates, growers would still achieve a positive net return above operating costs for all crops reviewed.

Data from local lenders and growers indicate that many Yolo Bypass growers have acreage both inside and outside the bypass and, on average, bypass growers have a majority of their acreage within the bypass. Even with higher concentration of acres within the Yolo Bypass, most growers diversify production risk by having other businesses outside of the bypass. The private lender indicated that rather than increasing interest rates, it is more likely that banks will discontinue lending to Yolo Bypass growers if risk is too high. Overall, with increased flooding frequency and duration, the ability of bypass growers to acquire a production loan would not be significantly jeopardized.

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