Chapter 7: Agriculture

7.1 Overview and Key findings

- Close to 80 percent of all farmland in the Delta is classified as Prime Farmland, the California Farmland Mapping and Monitoring Program's highest designated tier.
- Total cropped acreage in 2010 was 423,727 acres, not including approximately 38,000 acres of grazing land.
- The top five Delta crops in terms of acreage are: 1) Corn, 2) Alfalfa, 3) Processing Tomatoes, 4) Wheat, and 5) Wine Grapes.
- Total crop value in 2009 was approximately $702 million. Truck and vineyard crops account for 59 percent of crop revenues on 18 percent of acreage.
- The top five Delta crops in terms of value are: 1) Processing Tomatoes, 2) Wine Grapes, 3) Corn, 4) Alfalfa, and 5) Asparagus.
- The highest per-acre values in the Delta come from truck crops mainly situated in the southern Delta and deciduous crops principally located in the northern Delta.
- The approximately $702 million in Delta crop production and $93 million in Delta animal and animal product revenue has an economic impact of 9,681 jobs, $683 million in value added and $1.416 billion in output in the five Delta counties. Across all of California, the economic impact of Delta agriculture is 12,934 jobs, $819 million in value added, and $1.643 billion in output.
- When related value-added manufacturing such as wineries, canneries, and dairy products are included with the impact of Delta agriculture, the total economic impact of Delta agriculture is 13,179 jobs, $1.059 billion in value-added, and nearly $2.647 billion in economic output in the five Delta counties. Including value-added manufacturing, the statewide impact of Delta agriculture is 25,125 jobs, $2.135 billion in value-added, and $5.372 billion in economic output.
- The 10-year land allocation forecast in the baseline scenario predicts a future increase in vineyards, deciduous, and truck crops, and decreases in grain and pasture crops. Field crops will continue to account for 50 percent or more Delta agriculture acreage for the foreseeable future. This shift of 5 percent of land to higher value crops could lead to an approximately $111 million gain in crop revenues.
- The potential impact of policy changes on Delta salinity is highly uncertain at this time and depends on decisions on water quality standards and the effect of isolated conveyance. A preliminary estimate of losses from increased salinity is between $20 million and $80 million per year. The loss of farmland to construct the conveyance facility is estimated to generate an additional $10 to $15 million in crop losses per year.
- The agricultural impacts of most of the BDCP conservation measures are difficult to quantify due to the lack of precision in site specification and other details. Broad ranges of potential annual crop losses have been calculated from the land requirements and descriptions of easement costs in the draft BDCP.
    - Tidal habitat restoration losses range from $18 to $77 million annually with lower losses when restoration is targeted to Suisun Marsh.
    - Natural Communities Protection losses are estimated to range from $5 to $25 million annually.

- San Joaquin River Floodplain crop losses are estimated at $5 to $20 million annually, and could be reduced significantly by implementing an alternative proposal to expand an existing bypass at Paradise Cut.
- Yolo Bypass Fishery Enhancements could generate crop losses between $7 and $10 million annually..

7.2 Current Status and Trends

7.2.1 Mapping Delta Agriculture

Delta agriculture is part of a complex and constantly-changing landscape, and it presents many challenges to precise measurement. Over the past few years, studies and data-collection by a range of state and federal agencies have yielded results which provide a detailed overview of the Delta's diverse agricultural backdrop. The use of empirical techniques such as satellite imaging, digitization of farm records, field surveys, and public review have accumulated a wealth of information pertinent to policymaking. None of the data sources described below is complete in itself, but collectively leveraged they create the best available picture of Delta agriculture and its broad role in the Delta economy.

7.2.1.1 Land Use Data

Field Borders
California law requires full reporting of agricultural pesticide use. Each Delta county collects information from farmers on all crop fields in which pesticide applications are conducted. Through the use of geographic information system (GIS) software, four of the Delta counties digitally map that data to form a mosaic of agricultural fields within their borders. This data is extremely useful, as it provides recent data on fields intended for actual use and harvest, and includes specific information on the crops each land manager intends to grow in the coming year. This data enables analysis of Delta agriculture at an extremely granular level, that of the individual crop field. Approximately 90 percent of Delta acreage in this study is represented at this level. One challenge presented by this data is that though the vast majority of crop fields have some form of pesticide application, the small percentage that do not is not included and must be estimated by other means.

National Agricultural Statistics Service
For the two counties which do not digitally map their field borders, satellite remote sensing data captured and made available by the National Agricultural Statistics Service (NASS) provides good information. The data collected by this agency is applied in a wide range of agricultural applications, and the accuracy of the methods used to determine crop type is quantified in detail. Though less accurate than direct field borders reporting, this data shows agriculture not permitted for pesticide use, and provides a means to survey Delta land not covered by field borders.

Farmland Mapping and Monitoring Program
For estimates of total farmland acreage, GIS data collected by the California Farmland Mapping and Monitoring Program (FMMP) was employed. This state program uses a combination of satellite imagery, public review, and field surveys to produce a complete map of the state's agricultural lands. FMMP maps were leveraged by making use of their categorization of grazing land. Though grazing land is not actively farmed, it is sometimes incorrectly captured in the NASS data as active pastureland; close examination of areas marked by FMMP as grazing land eliminated such errors.

National Agriculture Imagery Program
Public aerial photography provided by the National Agriculture Imagery Program is used to resolve major inconsistencies between the previously described data sources. While it is impossible to eliminate the more minute discrepancies, for large acreage areas in which conflicts are noted, NAIP photos allow a direct look at the area in question in order to ascertain into what land use category a parcel should be attributed.

UC Berkeley Resilient and Sustainable Infrastructure Networks (RESIN)
The RESIN project at Berkeley mapped areas of the Delta region expected to undergo urbanization in the future. These were used to determine the extent of urbanization expected to occur on agricultural lands, and those effects are included in the long-term forecasts of agricultural land allocation presented in Section 7.5.

7.2.1.2 Revenues, Profits, and Costs Data

County Crop Reports
In order to determine aggregate revenues from Delta crop production, crop yield and price figures published in each county's 2009 crop report were used. These were the most recent figures available at the time the data was compiled. Though the values used in reporting are collected through a variety of sources and represent average yields for the entire county, they offer the most practical means of determining total revenues from Delta agriculture. Where possible, outside sources were consulted to obtain more accurate values for Delta-specific agriculture.

University of California Cost and Return Studies
The University of California Cooperative Extension prepares extremely detailed studies on the costs and returns associated with establishing and maintaining various crops in different regions of the state. Where available, this analysis drew from the UC Cooperative Extension studies conducted in Delta regions to calculate various costs and profits expected from different agricultural operations in the Delta region.

7.2.2 Crop Categories

In order to facilitate presentation and analysis of Delta agriculture, it is necessary to categorize crops into a limited number of discrete categories. In addition to enabling the use of econometric techniques for forecasting future land use, these categories allow for the broader overview of Delta agriculture presented in the tables and maps throughout this report. Examples of major Delta crops from each category are outlined in Table 5 below, and the full crop category table is included in Appendix G.[98]

[98] In response to a suggestion by the California Department of Food and Agriculture at both a DPC meeting and a comment letter on an earlier draft, alfalfa was moved from the pasture to field crop category in this draft. In addition to the significant change of reclassifying alfalfa, some additional adjustments were also made to low acreage crops so that the groups were more consistent across value, salt tolerance, and crop type.

Table 5 Crop Category Examples

Deciduous	*Almond, Cherry, Pear, Walnut*
Field	*Alfalfa, Corn, Rice*
Grain	*Barley, Oats, Wheat*
Pasture	*Pastureland, Clover*
Truck	*Tomato, Asparagus, Potato, Blueberry*
Vineyard	*Grapes*

7.2.3 Delta Agricultural Acreage

Total Farmland Acreage

All agricultural production in the Delta is dependent on high-quality farmland able to support it. Adequate soil quality, moisture, and temperatures are just a few of the characteristics necessary to support sustainable high yields. FMMP mapping uses a tiered system of farmland categories which provide a comprehensive view of agriculture suitability around the Delta. Since FMMP surveys are updated every two years, they also allow observation of the continuing effects of urban growth and expansion on agricultural farmland. The table and figure below offer a snapshot of Delta farmland in 2008, the most recent year from which FMMP maps are available. The total size of available farmland in the Delta is 500,383 acres, with almost 80 percent of the total acreage designated in the FMMP's top tier of Prime Farmland.

Table 6 Total Farmland Acreage, 2008

County		Class	
San Joaquin	267,741	Prime Farmland	396,554
Sacramento	71,722	Farmland of Statewide Importance	33,360
Yolo	54,644		
Solano	53,509	Unique Farmland	29,525
Contra Costa	49,685	Farmland of Local Importance	40,944
Alameda	3,082		
Total	**500,383**	**Total**	**500,383**

Harvested Acreage and Crop Allocation

This analysis places the total number of Delta acres in agricultural production in 2010 at 461,380 acres. Acreage includes all irrigated crops and pastureland, and grazing land. Table 7 depicts the total acreage of each crop category by county, as well as totals for the entire Delta. Table 8 depicts the largest crops by total acreage.

Table 7 Delta Agricultural Acreage, 2010

Crop Category	San Joaquin	Sacramento	Yolo[1]	Solano[1]	Contra Costa[2]	Alameda[2]	TOTAL
Deciduous	7,127	6,902	816	486	1,426	82	**16,839**
Field	127,912	33,178	13,082	16,097	22,591	789	**213,649**
Grain	21,222	7,589	9,141	14,295	14,196	2,262	**68,705**
Pasture	3,724	3,957	7,465	19,738	6,243	223	**41,350**
Truck	43,158	3,661	3,789	1,755	248	4	**52,615**
Vineyard	10,477	8,295	9,194	1,528	1,074	1	**30,569**
Grazing Land[3]	433	2,846	11,499	18,600	2,284	1,991	**37,653**
TOTAL	**214,053**	**66,428**	**54,986**	**72,499**	**48,062**	**5,352**	**461,380**

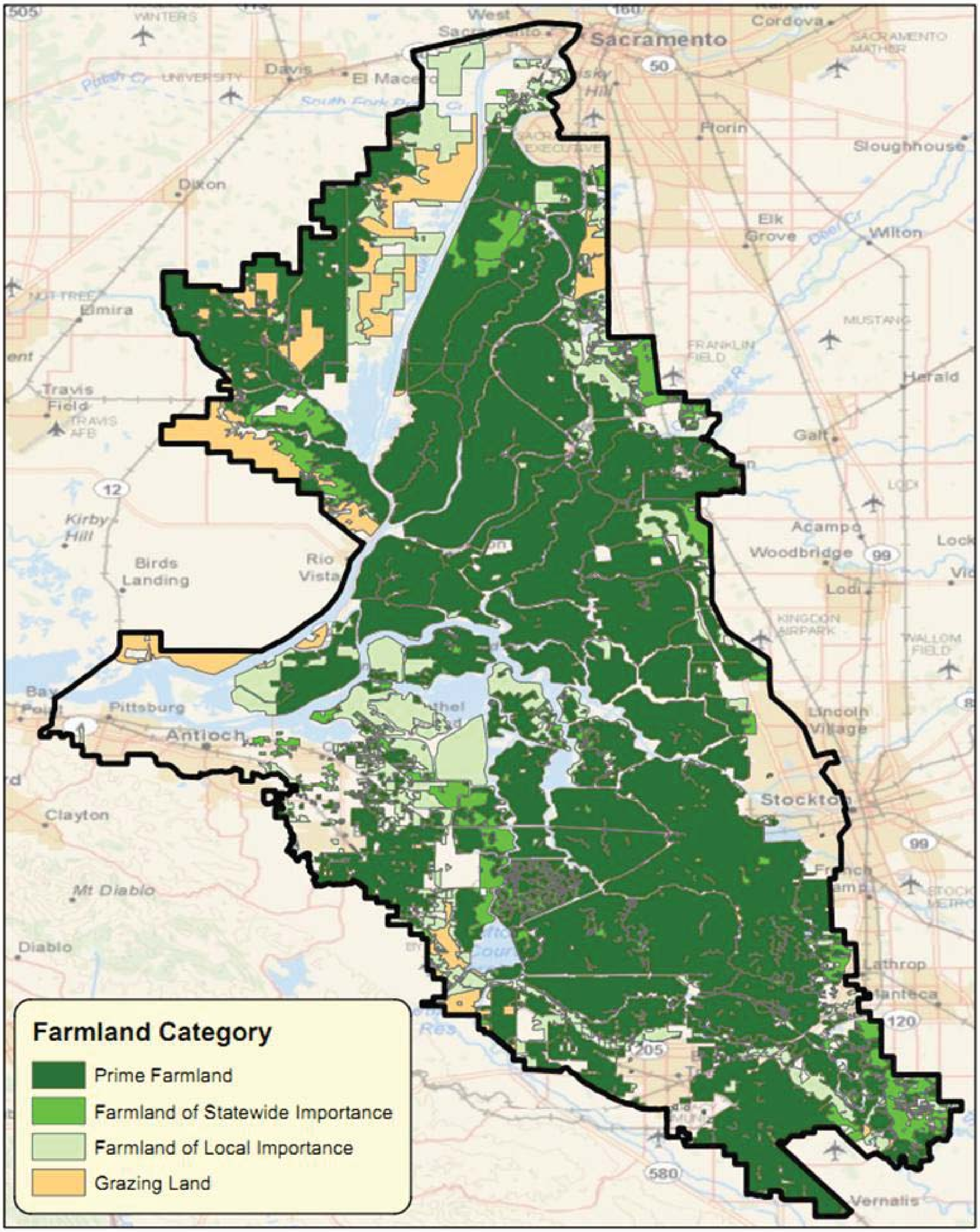
[1] Pasture acreage adjusted using NASS estimates.
[2] NASS data used due to lack of recorded field borders.
[3] Grazing land acreage estimated from FMMP data.

Table 8 Top 20 Delta Crops by Acreage, 2009

	Crop	Acreage	Value
1.	Corn	105,362	$92,975,715
2.	Alfalfa	91,978	$66,027,076
3.	Processing Tomatoes	38,123	$117,242,615
4.	Wheat	34,151	$17,549,215
5.	Wine Grapes	30,148	$104,990,142
6.	Oats	15,847	$4,195,540
7.	Safflower	8,874	$3,312,014
8.	Asparagus	7,217	$50,050,037
9.	Pear	5,912	$36,746,649
10.	Bean, Dried	5,493	$3,990,318
11.	Rice	4,874	$6,822,488
12.	Ryegrass	4,398	$1,061,436
13.	Cucumber	3,737	$7,866,553
14.	Turf	3,633	$31,643,344
15.	Potato	3,353	$28,605,465
16.	Almond	3,121	$8,776,101
17.	Sudangrass	3,025	$1,398,634
18.	Walnut	2,512	$9,453,874
19.	Pumpkin	2,103	$7,926,038
20.	Watermelon	1,717	$7,953,590

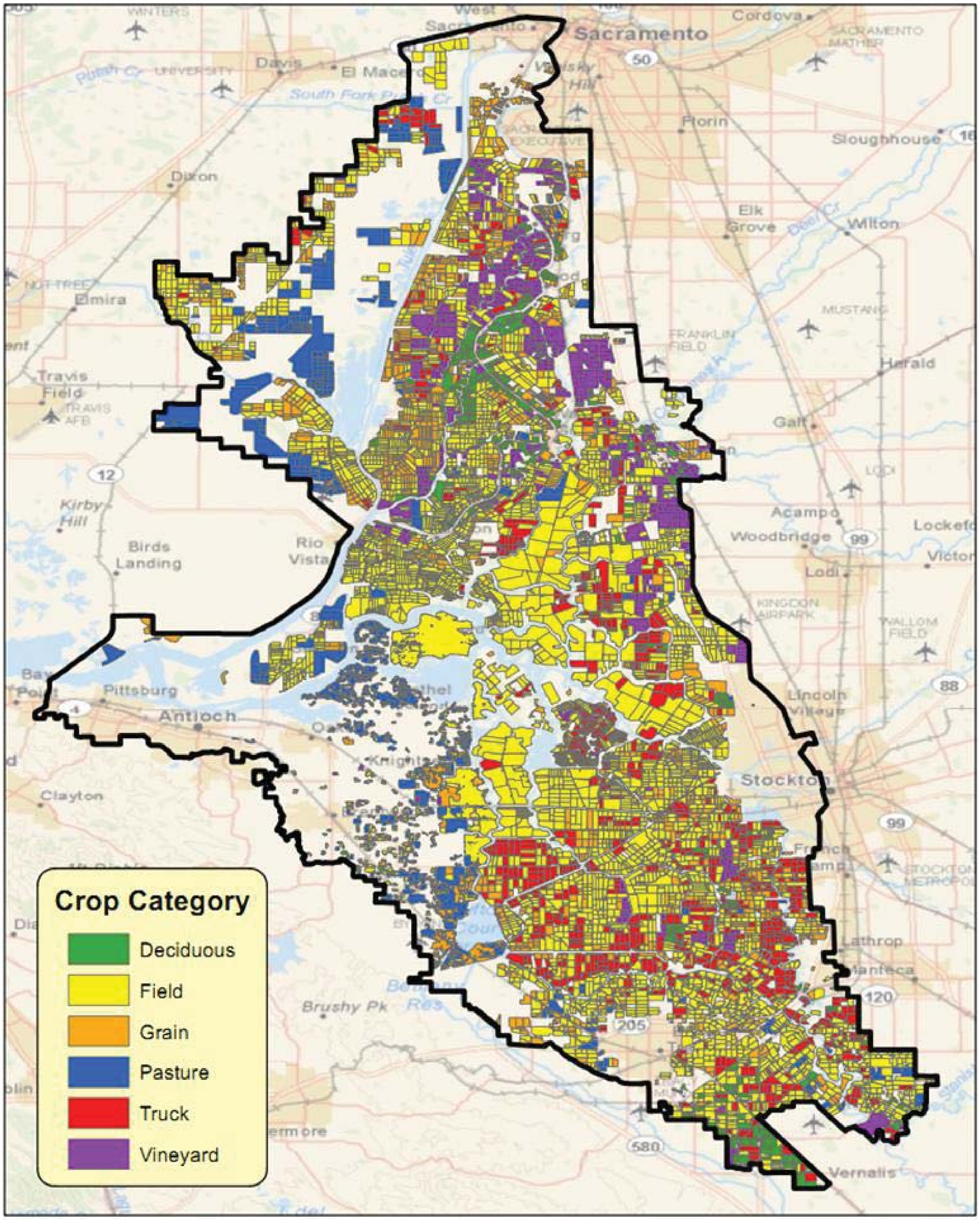
Note: 2009 acreages used in order to provide accompanying value estimates, which were not available for 2010.

Figure 20 FMMP Delta Farmland Coverage[99]



[99] For high resolution image see http://forecast.pacific.edu/desp-figs.html

Figure 21 Agricultural Land Cover, 2010[100]



[100] Note: Grazing Land indicated on previous figure. For high resolution image see http://forecast.pacific.edu/desp-figs.html

7.2.4 Delta Agricultural Revenues

Total Delta agriculture revenues can be calculated using the acreage analysis described above and multiplying the 2009 acreage of each individual crop by the yield and unit price reported in that year's county crop reports. This produces a total of $702 million in revenues from Delta agriculture in 2009. Tables 9 and 10 depict total revenue by crop category in each county and the top revenue-generating Delta crops.

Table 9 Delta Agricultural Revenues, 2009 (in $1000s)

Crop Category	*San Joaquin*	*Sacramento*	*Yolo*	*Solano* [1]	*Contra Costa* [2]	*Alameda* [3]	TOTAL
Deciduous	25,118	41,738	3,345	1,347	8,667	355	**80,570**
Field	107,001	22,071	9,341	12,418	21,398	398	**172,627**
Grain	15,535	3,276	2,587	7,512	288	1,059	**30,257**
Pasture	741	438	411	1,717	1,013	270	**4,590**
Truck	248,982	20,847	15,987	8,949	13,871	17	**308,653**
Vineyard	32,099	28,474	32,718	5,042	6,657	3	**104,993**
Grazing Land[4]	9	57	230	372	46	40	**754**
TOTAL	**429,485**	**116,901**	**64,619**	**37,357**	**51,940**	**2,142**	**702,444**

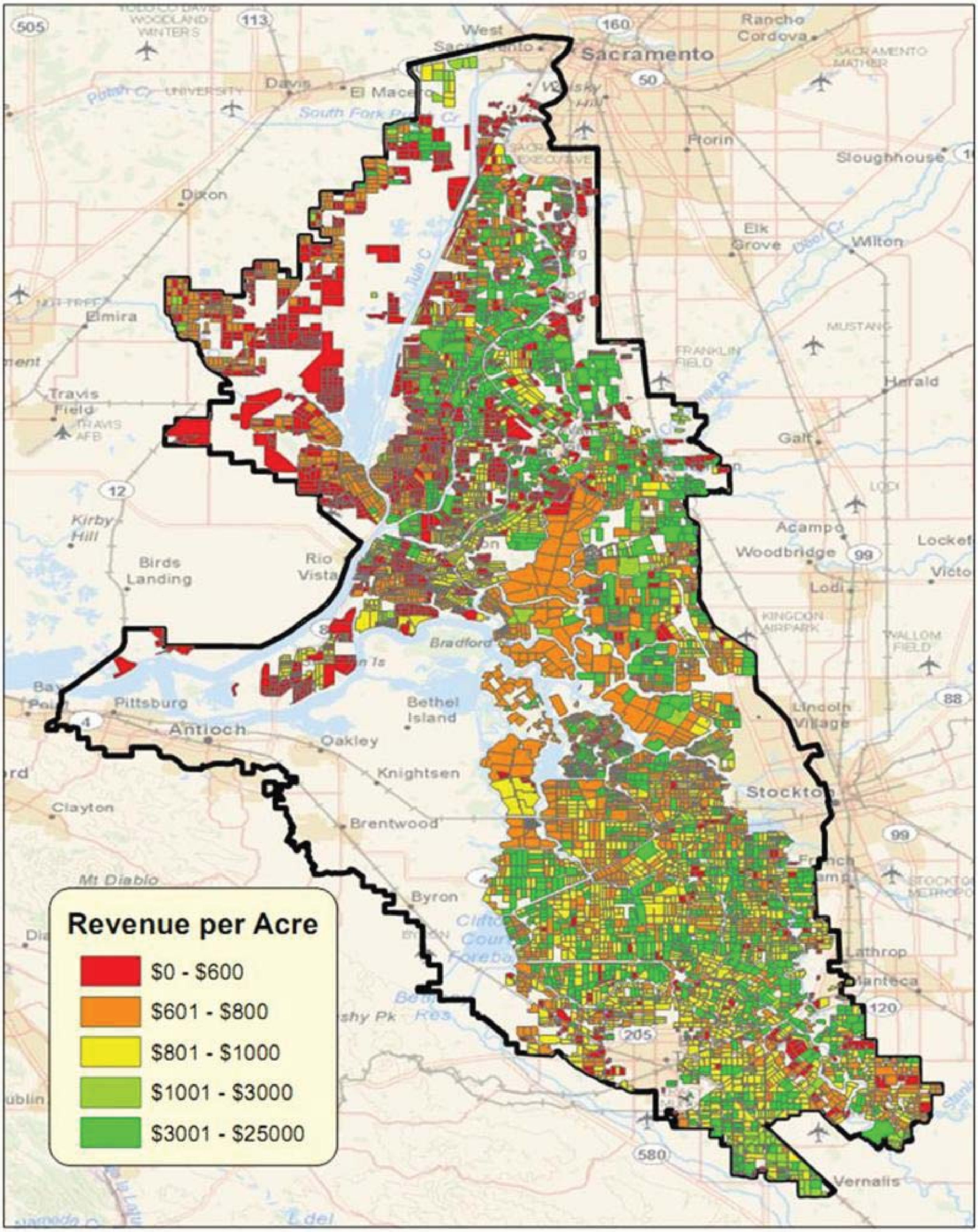
[1] Crop value calculations use 2010 field borders acreage.
[2] Values for non-grazing land include all reported county crop report acreage due to lack of reported field borders.
[3] Values computed using 2010 NASS acreage estimates and average crop category values.
[4] Grazing land acreage estimated from 2008 FMMP data and valued at $20 an acre.

Table 10 Top 20 Delta Crops by Value, 2009

	Crop	Value	Acreage
1.	Processing Tomatoes	$117,242,615	38,123
2.	Wine Grapes	$104,990,142	30,148
3.	Corn	$92,975,715	105,362
4.	Alfalfa	$66,027,076	91,978
5.	Asparagus	$50,050,037	7,217
6.	Pear	$36,746,649	5,912
7.	Turf	$31,643,344	3,633
8.	Potato	$28,605,465	3,353
9.	Blueberry	$25,255,917	1,097
10.	Wheat	$17,549,215	34,151
11.	Cherry	$11,490,843	1,855
12.	Almond	$8,776,101	3,121
13.	Walnut	$9,453,874	2,902
14.	Watermelon	$7,953,590	1,717
15.	Pumpkin	$7,926,038	2,104
16.	Cucumber	$7,866,553	3,529
17.	Rice	$6,822,488	4,874
18.	Pepper	$6,247,592	1,289
19.	Apple	$4,455,826	846
20.	Oat	$4,195,540	15,847

Note: Kern County crop report value used for turf value, as no Delta counties report turf separately from other nursery crops.

Figure 22 Average Revenues per Acre[101]



[101] Using Field Borders Data, Contra Costa County is not included in the figure because data was not available in this format. For high resolution image see http://forecast.pacific.edu/desp-figs.html

7.3 Economic Impact of Delta Agriculture

The previous sections focused on the value and composition of crop production in Delta agriculture. To calculate the economic impact of agriculture in the Delta, two additional areas needed to be considered: 1) the value of animal agriculture in the Delta, and 2) the output of local food and beverage manufacturing firms that are located in the region because of Delta crop output. The section concludes with a brief discussion of impact analysis and policy analysis and how to interpret the results, and a discussion and comparison with related estimates by the Department of Water Resources.

7.3.1 Animal Production in the Delta

Animal and animal product output in the Delta is more difficult to estimate than crop production. It is clear that the Delta is not as oriented towards crop production as many other areas in the Central Valley, although a significant amount of its crop production is alfalfa and field crops that are consumed by animal enterprises outside the Delta. Other reports by the Department of Water Resources and the Delta Stewardship Council White Papers have estimated animal-related output in the Delta at about $90 million per year, significantly less than crop production. Estimates produced for this study are very similar. Enterprise data from Dun and Bradstreet and NETS were used to identify dairy, cattle, and other animal production enterprises located within the legal Delta, and this figure was compared to the total number in the counties. The percentage of animal enterprises in each county located in the Delta was applied to the total animal production in the crop reports for each of the five Delta counties, resulting in an estimate of $93 million in animal output, shown in Table 11.

Table 11 Animal Output in the Delta

Animal Output	Value
Cattle	$24,097,110
Sheep, Poultry, other Livestock	$3,160,977
Milk	$64,322,406
Wool	$94,628
Apiculture	$1,712,879
Total Animal and Animal Products	**$93,388,000**

7.3.2 Value Added Processing: Food and Beverage Manufacturing

The value of farm production is typically measured as the revenue earned by farm operations for selling crops. "Farm gate" values are reported in County Crop Reports and are the measures of agricultural revenues used in this chapter and most other discussions of agricultural values. Some farm products are not transformed significantly, and therefore have little additional value added to them between the farm and when they are shipped out of the region, or received by retailers or food service providers for sale to local consumers. Tree nuts such as almonds and walnuts, cotton, and many fresh fruits and vegetables are examples of high-value agricultural crops that have little additional value added to them before they are exported from the state or region. In contrast, wine grapes, processing tomatoes and milk are examples of farm products that have significant processing and value added by local food and beverage manufacturers.

Food and beverage manufacturing is an important economic sector in California and the five Delta Counties. Some of that manufacturing only exists in the region because of local farm output, whereas many food and beverage manufacturing enterprises such as bakeries are located in a region to serve the local market or for other reasons. Wineries, most fruit and vegetable canneries such as tomato paste, and most dairy product manufacturing such as cheese, butter, and fluid milk in California is closely linked to local farm production.[102] Wine grapes also have a large associated tourist economy. Thus, valuing wine grapes to the California economy at the "farm gate" significantly understates their true value to the economy.

Comparing data for food and beverage manufacturing from the 2007 Economic Census to 2007 farm production in California for the associated farm products illustrates the point.[103] The value of wine grape production at the farm gate in 2007 was $1.855 billion according to the California Department of Food and Agriculture, but the value of shipments from California wineries was $10.764 billion, 5.8 times the agricultural value of the wine grapes harvested on 480,000 acres in California in 2007 (or $22,400 of output per acre). The Delta is about 5 percent of California's wine grape production. Milk was the highest value California farm product in 2007 at $7.33 billion in agricultural production. Virtually all of that milk was used by various segments of California's dairy product manufacturing industry (NAICS 3115, includes fluid milk, cheese, ice cream, etc.) which recorded a value of shipments of $12.467 billion in 2007, 1.7 times the value of raw milk in agricultural reports. Roughly 2 million acres of irrigated crops in California supported the dairy industry, about 10 percent of which is in the Delta, although a significant amount of feed is also imported from other states. Disaggregated data on processing tomatoes is unavailable as it is combined in NAICS code with all fruit and vegetable canning, but data from major tomato processor Morning Star suggests that the value of shipments in the tomato paste production is roughly 2 times the value of processing tomatoes purchased from local farms.[104] Thus, the $849 million in processing tomatoes produced in 2007 would be conservatively supporting about $1.7 billion in canned tomato products production,[105] from about 300,000 acres of production of which a little more than 10 percent is in the Delta.

The point is that all of the four most significant crops in the Delta—alfalfa, corn, processing tomatoes, and wine grapes—are supporting a significant value-added chain in the region and state. In contrast, crops such as nuts, cotton, and even produce such as lettuce, melons, and broccoli may have higher farm gate values and agricultural revenue per acre, but less economic value is added to the crop in the region or state between the farm and consumers. Almonds have slightly higher agricultural receipts than wine grapes in California, but wine grapes generate more than five times the income of almonds. Processing tomatoes and cotton have similar agricultural receipts, but processing tomatoes generate more than double the income for the state. Thus, when measuring and comparing the contribution of various regions to the state's economy, an approach that focuses solely on agricultural receipts is easy to calculate but is too narrow and will significantly undervalue the Delta's contribution relative to areas further south in the Valley that receive water exported from the Delta.

To be conservative in the modeling, only food and beverage manufacturing where a clear link to regional production could be identified and reasonably estimated are used in the economic

[102] It should be noted that relatively "low value" alfalfa and corn silage production in California is an important part of the dairy product value chain as well.
[103] 2007 is the most recent year for which the value of shipments data is available at the 5-digit NAICS level that identifies wineries as a separate manufacturing category, NAICS 31213.
[104] See exhibit 2 and exhibit 8 in this presentation, http://www.morningstarco.com/statdocs/2010%20Exhibits%20Brochure.pdf
[105] Morning Star is known for low cost tomato paste production; other higher valued canned tomato products are likely adding more value than bulk tomato paste production, which absorbs roughly 75 percent of California's processing tomato production, according to Morning Star.

impact analysis, and all analysis is presented with and without the related manufacturing component. Although Delta crops are definitely consumed in large quantities by dairies outside the Delta, these dairies also use grain and alfalfa transported significant distances and could increase the use of these imported feeds if necessary, although at higher cost. Thus, dairy production outside the Legal Delta is not attributed to Delta agriculture in proportion to the Delta's contribution to dairy cattle feed. Some additional value-added processing to cattle production and fruits and vegetables other than tomatoes and cattle are excluded due to measurement difficulties. The complexity of the industry and limited data makes it difficult to precisely estimate the entire value-chain and linkages, but this analysis is important to capture the overall scale and contribution of agricultural production to the region.

As discussed above, our estimate of value-added manufacturing focuses on three industries: wineries, tomato canning, and dairy product manufacturing. Delta wine grapes are roughly 5 percent of California production by both weight and value. The prices are similar to state averages, much higher than other areas of the Central Valley but much lower than premier growing areas such as Napa and Sonoma. Winery capacity in the Delta and the five Delta counties is small relative to local production, but Napa and Modesto winery capacity is very high relative to local production. The data and interviews with local producers support that most Delta wine grape production is contracted to large Napa County wineries or Modesto-based Gallo. Using state and regional shares of wine grape production from the Delta, and county winery output estimates from IMPLAN, we estimate that $181 million of winery output in the five Delta counties is dependent on Delta wine grapes, and $541 million of winery output in adjacent counties (Napa and Stanislaus) is sourced from the Delta. The $117 million in processing tomato output is estimated to support $234 million in cannery output based on the Morning Star input data.

Delta farms produce less than 1 percent of California's milk, but produce roughly 10 percent of the state's alfalfa and forage crops, critical and increasingly scarce and costly inputs to the dairy industry. Although there are few dairies in the Delta, maps of dairy cow concentration in the San Joaquin Valley indicate large nearby clusters between Highway 99 and I-5 between Manteca and Merced, and in southeast San Joaquin County near Escalon.[106] Clearly the Delta is more critical to the state's industry than the milk production data shows, but quantifying its importance is difficult since Dairy producers can import feed and adjust the mix of feeds in cow rations in response to scarce local feed sources. One could argue Delta agriculture supports anywhere from 1 percent ($137 million) to 10 percent ($1.37 billion) of California's dairy product industry. As a rough estimate in this range, we link 5 percent ($687 million) of California dairy product manufacturing to Delta agriculture, a similar contribution as winery production, and attribute half of this total ($344 million) to dairy products produced in the five Delta counties, which is a little less than half of all dairy product manufacturing in the Delta counties.[107]

7.3.3 Economic Impact Estimates

The IMPLAN 3 model calibrated to 2008 regional and statewide economic data was used to estimate the overall economic impact of Delta agriculture. See Appendix F for a description of the IMPLAN model and formal definitions of terms such as direct, indirect, and induced effects. Following a methodology initially proposed by UC-Davis agricultural economists, the default

[106] EPA Dairy Cow Concentration Map. http://www.epa.gov/region9/ag/dairy/images/CED0601309_2.gif
[107] There is one very large cheese manufacturer of note in the legal Delta, Leprino Foods in Tracy.

IMPLAN production functions were adjusted to account for the unusually high use of contract labor in California agriculture.[108]

Table 12 Agriculture Related Output Used for the IMPLAN model

Industry	Output Value (millions $)
1 Oilseed farming	3.3
2 Grain farming	135.9
3 Vegetable and melon farming	250.1
4 Fruit farming	191.7
5 Tree nut farming	20.1
10 All other crop farming	101.5
11 Cattle ranching and farming	27.2
12 Dairy cattle and milk production	64.3
14 Animal production, except cattle and poultry and eggs	1.8
Food/Beverage Manufacturing in expanded analysis	
54 Fruit and vegetable canning, pickling, and drying	234 in Delta counties & statewide
55-58 Dairy Products Manufacturing	344 in Delta counties 687 statewide
72 Wineries	180.5 in Delta counties 722 statewide

For the five-county economic impact model, Delta agricultural production and Delta-dependent food processing and winery production was distributed across IMPLAN production sectors according to Table 12. In the initial model, only the impacts of the $795 million in direct agricultural production were modeled. As shown in Table 13 (A), the approximately $702 million in Delta crop production and $93 million in Delta animal and animal product revenue has an economic impact of 9,681 jobs, $683 million in value added and $1.416 billion in output in the five Delta counties. Table 14 (A) shows that across all of California, the economic impact of Delta agriculture is 12,934 jobs, $819 million in value added, and $1.642 billion in output. This equates to an employment multiplier of 12.2 jobs per million dollars in output in the five Delta Counties and 16.2 jobs per million dollars in output when evaluated statewide. These multipliers are very consistent, if not low, compared to other studies. In a recent essay published by UC-Davis, Howitt et al. (2011) states that agricultural employment multipliers typically range from 16 to 27 jobs per million dollars.[109]

To get a more complete picture of the full economic impact of Delta agriculture, the impact of linked food and beverage manufacturing for wineries, tomato canning and dairy products were included as described in the previous section. These upward linkages must be estimated separately, because the indirect effects of the IMPLAN model only includes backwards linkages from purchased inputs. To avoid double counting impacts from the initial stage, the indirect effects attributed to the purchase of crops as inputs were netted out of the results. For example,

[108] The production functions were adjusted to ensure that virtually all (97 percent) of the output of the agricultural service sector was utilized by the regional agriculture industry, a common sense adjustment and a methodology that recently yielded good predictions of the employment effects of the 2009 drought in the San Joaquin Valley.
[109] Howitt, R.E., D. MacEwan and J Medellin-Azuara, "Drought, Jobs, and Controversy: Revisiting 2009," *ARE Update*, 14 (6) (2011): 1-4.

for wineries, the indirect effects associated with purchasing wine grapes were estimated and removed from the total to avoid double counting the impact of growing wine grapes. The total five-county economic impacts are displayed in Table 13 (C). Delta agriculture supported 13,179 jobs, $1.059 billion in value-added, and $2.647 billion in output in the five Delta counties. For the California economic impact model, the additional $541 million of Delta dependent winery production and $344 million in dairy product production from adjacent counties and was added to the totals. The economic impact rises from this extra production, and also because the indirect and induced effects grow when considered on a statewide rather than five-county basis. Table 14 (C) shows that across the State of California, Delta agriculture supports nearly 25,125 jobs, over $2.135 billion in value added, and over $5.372 billion in output.[110] Even when using this more expansive view of impacts, the employment multipliers are 16 to 32 jobs per million dollars of agricultural production, similar to the range described as typical by Howitt et al. (2011).

Caution is advised before using the more expansive multipliers to estimate the potential long-range socio-economic impacts of the policy changes described in this chapter. These are current economic impact estimates for Delta agriculture, and do not take into account potential substitution or adjustment strategies that may be employed. For example, wineries or canneries could purchase inputs from different sources if Delta tomatoes or wine grapes became unavailable, so the multipliers from the broader scenario including food processing would be too large for analyzing long-range policy impacts, particularly at the statewide level.

Table 13 Economic Impact of Delta Agriculture on Five Delta Counties

Impact Type	Employment	Labor Income	Value Added	Output
(A) Delta Crop and Animal Production Impacts				
Direct Effect	4,132	$146,710,832	$361,683,700	$815,797,504
Indirect Effect	4,051	$155,957,376	$192,082,400	$380,246,048
Induced Effect	1,499	$69,450,720	$129,108,300	$219,740,912
Total Effect	9,681	$372,118,912	$682,874,400	$1,415,784,448
(B) Delta Agriculture Processing Impacts				
Direct Effect	609	$82,201,128	$109,578,400	$665,876,520
Indirect Effect	2,000	$98,387,163	$190,347,240	$434,962,236
Induced Effect	888	$41,268,532	$76,653,590	$130,501,340
Total Effect	3,498	$221,856,824	$376,579,120	$1,231,340,096
(C) Total Delta Agriculture Impacts				
Direct Effect	4,741	$228,911,960	$471,262,100	$1,481,674,024
Indirect Effect	6,051	$254,344,539	$382,429,640	$815,208,284
Induced Effect	2,387	$110,719,252	$205,761,890	$350,242,252
Total Effect	13,179	$593,975,736	$1,059,453,520	$2,647,124,544

[110] The Department of Water Resources has called these estimates inflated and inflammatory in comments, including to the Delta Stewardship Council. The accusation is strange since DWR's own estimate of Delta agricultural production of $817.6 million is higher than in this study. Interestingly, DWR has not estimated any employment impacts of Delta agriculture, but used employment multipliers of 50-60 jobs per million dollars of agricultural output in the San Joaquin Valley in their highly publicized 2009 drought reports. If DWR were to apply similar multipliers to their estimate of Delta agricultural output, they would estimate that Delta agriculture creates 41,000 to 49,000 jobs, far higher than the estimates in this report.

Table 14 Economic Impact of Delta Agriculture on California

Impact Type	Employment	Labor Income	Value Added	Output
(A) Delta Crop and Animal Production Impacts				
Direct Effect	5,104	$158,528,784	$361,683,600	$815,797,504
Indirect Effect	5,502	$207,782,128	$241,993,300	$447,518,752
Induced Effect	2,328	$119,379,712	$215,517,800	$379,519,392
Total Effect	12,934	$485,690,624	$819,194,800	$1,642,835,712
(B) Delta Agriculture Processing Impacts				
Direct Effect	1,457	$188,053,130	$273,482,330	$1,506,051,552
Indirect Effect	7,066	$389,934,316	$702,163,970	$1,623,701,672
Induced Effect	3,669	$188,538,768	$340,253,880	$599,425,808
Total Effect	12,191	$766,526,200	$1,315,900,600	$3,729,179,040
(C) Total Delta Agriculture Impacts				
Direct Effect	6,561	$346,581,914	$635,165,930	$2,321,849,056
Indirect Effect	12,568	$597,716,444	$944,157,270	$2,071,220,424
Induced Effect	5,997	$307,918,480	$555,771,680	$978,945,200
Total Effect	25,125	$1,252,216,824	$2,135,095,400	$5,372,014,752

7.4 Other Agriculture Issues

There has been significant interest in alternative forms of agriculture in the Delta, as well as new approaches to increase agricultural revenue. Many of the ideas have been proposed in Delta Vision and other Delta related plans and reports. Ideas include increased agritourism, regional branding and marketing of Delta crops, growing crops for biofuels, subsidence-reversal agriculture, and growing crops for carbon sequestration purposes and the marketing of carbon credits. Some of the ideas are promoted for the dual benefits of ecosystem restoration and reducing flood risks, whereas others are primarily seen as a way to enhance local agricultural income.

Most of these options were evaluated in a recent report by the UC Davis Agricultural Issues Center (AIC) developed for the California Department of Food and Agriculture and presented to the Delta Stewardship Council. In virtually all cases, the AIC report determined that the ideas have very limited potential to develop a significant market in the Delta. For example, most Delta crops are commodities such as corn and processing tomatoes for which branding is not effective.

Agritourism, defined as recreational, educational, and other visits to working farms, is a small but fast growing source of income for farms in the region. As discussed in the Appendix of the recreation and tourism chapter,[111] agritourism was estimated by USDA to generate $4 million in income for farms in the five Delta counties in 2007. Assuming agritourism in the Delta is proportional to overall agriculture in the county, a roughly 25 percent share, agritourism generated roughly $1 million in revenue in 2007. An inventory of agritourism enterprises in California maintained by UC cooperative extension (http://www.calagtour.org/) identifies 91 agritourism operations in the five Delta counties, and 12 (13 percent) of these are located in the Delta. Over half of the Delta agritourism enterprises were in Contra Costa County where there is a cluster of U-pick orchards and other farms open to tourists around Brentwood. Only one of the

[111] Appendix H

20 agritourism locations in San Joaquin County was in the Delta, but it was a very large attraction at Dell'Osso Family Farm adjacent to Interstate 5 near Lathrop that is estimated to draw over 100,000 visitors each fall to its corn maze and other attractions. Currently, it appears that agritourism is only significant in the suburban edges of the Delta secondary zone, and it is probably best suited to these areas. Agritourism is discussed in more detail as a potential growth strategy for tourism and Legacy Communities in subsequent chapter.

A January 2011 report prepared for the Nature Conservancy examines the potential of carbon capture wetland farms and low carbon agriculture in the Delta.[112] Although carbon capture wetland farms could generate environmental benefits and potentially reverse subsidence on Delta islands, the report casts doubt on whether carbon capture farming is economically viable, although the authors encourage large-scale demonstration projects to further research the potential. Specifically, the authors state:

> "Our analysis illustrates that Carbon Capture Wetland Farms are unlikely to provide a clear incentive to both landowners and investors without either fairly high carbon prices or some type of grant or payment scheme to subsidize some of the costs of conversion and annual management." (p. 106)

The report also details other problems including increased methylmercury, organic carbon, and mosquitos that could have negative impacts on various aspects of the Delta economy. The report discusses other low carbon changes to agriculture including conversion to rice growing and reduced tillage practices that may be more economically feasible. The authors encourage large-scale demonstration projects to more fully research the potential of carbon capture wetland farms.

7.5 Modeling Crop Choice in the Delta

A multinomial logit model is used to estimate farmers crop choice at the field level in the Delta. Since its development in the early 1970s, the multinomial logit model has been extensively used to statistically model choices between multiple options, and has been applied to myriad settings including occupational choice, health care choices, and crop choices among others.[113] Professor Daniel McFadden of UC Berkeley was a significant contributor to the development of the multinomial logit and related models for which he was awarded the Nobel Prize in Economic Sciences in 2000. In addition to crop choice, the approach has been used to study a variety of problems in agriculture over the past three decades including studies of irrigation technology choices (Caswell and Zilberman, 1985), and crop management practices (Wu, Adams, Kling, and Tanaka, 2004; Wu and Babcock 1998).[114]

[112] A. Merrill, S. Siegel, B. Morris, A. Ferguson, G. Young, C. Ingram, P. Bachand, Holly Shepley, Maia Singer, Noah Hume, "Greenhouse Gas Reduction and Environmental Benefits in the Sacramento-San Joaquin Delta: Advancing Carbon Capture Wetland Farms and Exploring Potential for Low Carbon Agriculture," prepared for The Nature Conservancy, Sacramento, California, 2010. Available at: http://www.stillwatersci.com/

[113] Maddala, G.S., *Limited Dependent and Qualitative Variables in Econometrics.* Cambridge University Press, 1993.

[114] Caswell, M.F. and D. Zilberman, "The choice of irrigation technologies in California," *American Journal of Agricultural Economics* (1985), 67: 224-34.
Wu, J. and B. A. Babcock, "The choice of tillage, rotation, and soil testing practices: Economic and environmental implications," *American Journal of Agricultural Economics* (1998), 80: 494-511.

The multinomial logit model is used to predict agricultural land allocation, conditional on its current land use and other exogenous variables, including soil quality, a multi-year average of irrigation water salinity, temperature, slope, elevation, field size, and dummy variables for year and conservation zone to capture fixed effects. The model generates estimates of the probability of observing a given crop type in each specified field over a long-term time horizon. It was trained on a dataset of over 6,000 individual crop fields for which annual crop data was tabulated for each year from 2002 through 2010, excluding 2005 for which reliable data was not available. All of the explanatory variables were statistically significant and of the expected signs. More details on the model input data and output results are provided in Appendix G. The impact on Delta crop allocations under various scenarios is described in tables on the following pages.

There is significant urbanization pressure in the Secondary Zone of the Delta, so the model was run with and without the inclusion of land that is expected to be developed by 2050. We determined this area using the urbanization probability maps generated by the UC Berkeley RESIN project with some minor adjustments to the high and very high probability categories to conform to the sphere of influence of cities in the Secondary Zone and discussions with city officials and local developers with knowledge of land development plans. Table 15 depicts the agricultural crop acreage expected to convert to urbanized land, while Figure 23 displays the affected fields. All of these fields are excluded in the forecast with urbanization effects.

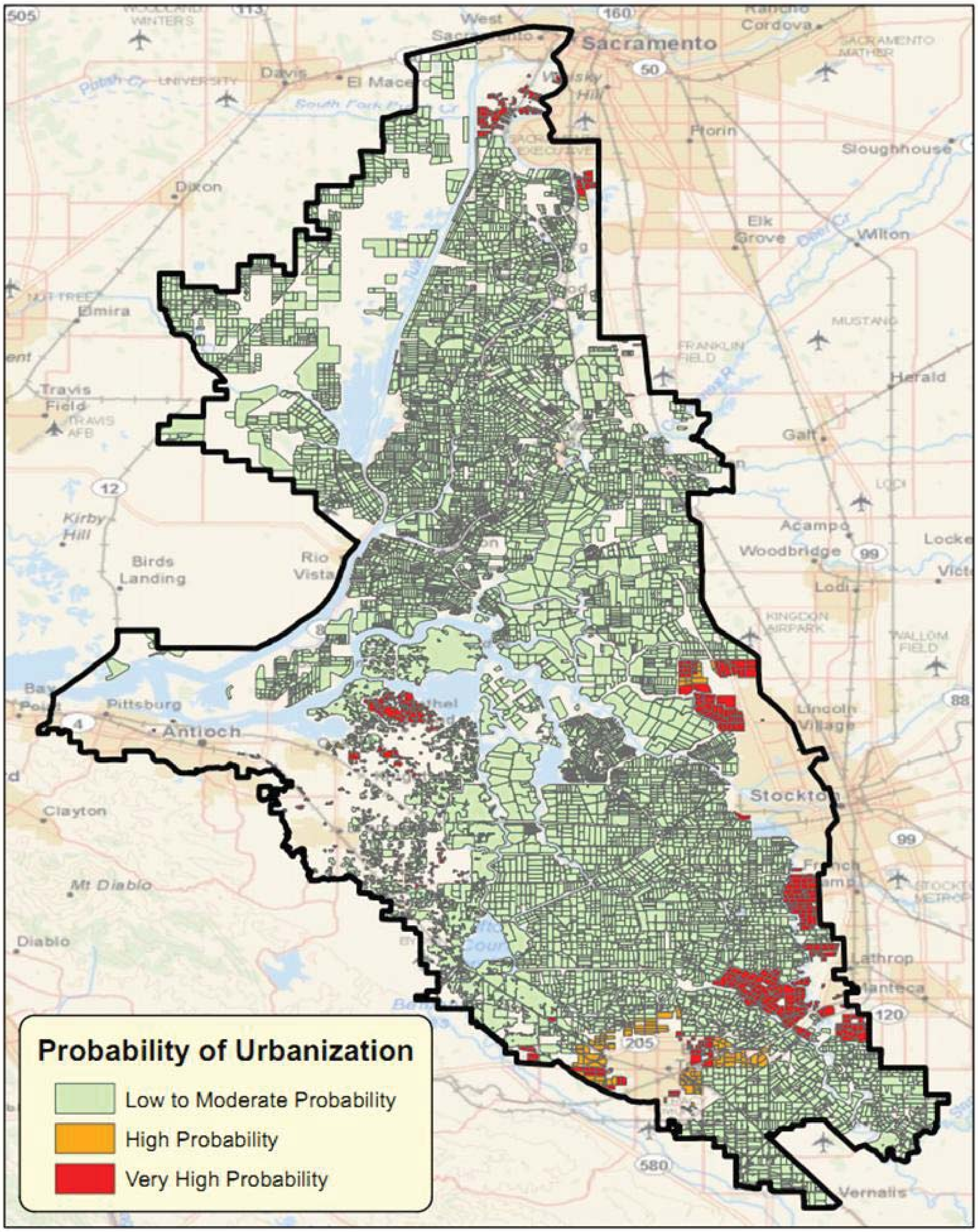
Overall, urbanization will reduce agricultural production in the Delta due to the loss of land. However, it should be noted that the Delta's location in the heart of the growing Northern California megaregion surrounded by growing cities creates opportunity for the majority of farmland that remains in production. Wu, Fisher, and Pasqual (2011) find that the revenue opportunities created by urbanization could outweigh the negative impacts on farm infrastructure and production costs due to growing market opportunities for higher-value crops such as vineyards, fresh vegetables, and nursery products.[115] In a later section of this report, we also discuss the presence and growth of agritourism around the urban fringe.

Table 15 Crop Acreage with High or Very High Probability of Urbanization

Crop Category	High Probability	Very High Probability	Total
Deciduous	72	588	660
Field	3,598	8,210	11,808
Grain	597	6,095	6,692
Pasture	531	703	1,234
Truck	604	5,111	5,715
Vineyard	1	515	516
All Crops	**5,403**	**21,222**	**26,625**

Wu, J., R.M. Adams, C.L. Kling, and K. Tanaka, "From micro-level decisions to landscape changes: An assessment of agricultural conservation policies," *American Journal of Agricultural Economics* (2004), 86: 26-41.
[115] Wu, J., M. Fisher, and U. Pasqual, "Urbanization and the Viability of Local Agricultural Economies," *Land Economics* (2011), 87: 109-125.

Figure 23 Crop Fields with High or Very High Probability of Urbanization[116]



[116] For high resolution image see http://forecast.pacific.edu/desp-figs.html

Table 16 Long-run Land Allocation Forecast

Scenario	*Deciduous*	*Field*	*Grain*	*Pasture*	*Truck*	*Vineyard*
Current Land Allocation	3.97%	50.42%	16.21%	9.76%	12.42%	7.21%
Baseline Forecast	5.12%	51.11%	11.46%	6.80%	17.74%	7.76%
Forecast with Urbanization Effects	5.26%	51.13%	11.02%	7.08%	17.24%	8.26%
Forecast with Urbanization Effects vs. Current Allocation						
Land Allocation Change	1.29%	0.71%	-5.19%	-2.68%	4.83%	1.04%
Relative Crop Allocation Change	32.34%	1.41%	-32.01%	-27.45%	38.87%	14.46%
Forecast with Urbanization Effects vs. Baseline Forecast						
Land Allocation Change	0.14%	0.02%	-0.44%	0.28%	-0.50%	0.50%
Relative Crop Allocation Change	2.66%	0.05%	-3.81%	4.10%	-2.81%	6.41%

The results of the long-run land allocation forecast are contained in Table 16 above. Significant growth is predicted in truck, deciduous, and vineyard crops, with the largest decline among grain and pasture crops. Forecasted revenue changes are illustrated in Table 17 below. It indicates a trend towards increased planting of high-value crops, which would lead to an estimated $111 million increase in total agriculture revenue assuming current crop acreage and average crop class revenue using 2009 prices. Taking into account the 26,625 acres expected to undergo urbanization, annual revenues are expected to increase by $68 million, a decline of $43 million per year compared to the baseline.

Table 17 Long-run Agricultural Revenue Forecast

Crop Category	Average Revenue per Acre	Forecasted Acreage Change			Forecasted Revenue Change		
		Baseline	*Urbanization*	*Urbanization vs. Baseline*	*Baseline*	*Urbanization*	*Urbanization vs. Baseline*
Deciduous	$4,612	4,869	4,046	-823	$22,455,695	$18,660,853	-$3,794,841
Field	$780	2,921	-10,595	-13,516	$2,278,075	-$8,264,247	-$10,542,321
Grain	$426	-20,138	-24,926	-4,788	-$8,578,785	-$10,618,569	-$2,039,784
Pasture	$116	-12,532	-13,236	-704	-$1,453,712	-$1,535,376	-$81,664
Truck	$3,903	22,566	15,862	-6,704	$88,076,852	$61,909,659	-$26,167,192
Vineyard	$3,566	2,314	2,222	-91	$8,251,441	$7,925,330	-$326,111
				Total Revenue Change	**$111,029,565**	**$68,077,651**	**-$42,951,914**

Many future crop allocations are possible, and these results depict the most likely allocation calculated by the model. It predicts a modest (approximately 5 percent) shift towards higher-value crops over several decades, with field crops holding steady at over 50 percent of Delta cropland over time. Some comments have pointed to a decline in higher-value truck crops in the Delta to cast doubt on the model results. However, that recent decline is due to the rapid loss of tens of thousands of acres in the Delta's signature asparagus crop which has declined to a mere 7,000 acres from reported levels near 70,000 acres in the 1960s. The California Asparagus Board reports acreage was relatively stable during the 1990s, then dropped from 37,000 acres statewide in 2000 to a mere 12,000 acres in 2010, with a little over half of the acreage in the Delta. Asparagus is a labor-intensive crop, and increased competition from the growth of lower-cost producers in Peru and Mexico has impacted California producers.

However, other truck crops including tomatoes, peppers, cucumbers, pumpkins and blueberries have shown modest growth in recent years, and it is hard to see asparagus production in the Delta dropping all the way to zero given its iconic status at local festivals, growing consumption, and the demand for the fresh market. Even in the unlikely prospect that asparagus were to completely disappear from the Delta, the lower bound of zero production would soon stop the downward trend.

Thus, the 16,000 acre increase in truck crops predicted by the model is plausible, certainly over the 2050 planning horizon of this study. In contrast, other comments and recent trends suggest the prediction for 2,000 acres of additional vineyards is too small given current trends. In comments received from Delta farmers, most expected the most rapid growth in vineyards, as much as another 20,000 acres over the next one to two decades. Current trends and the 64,000 acres of available land in the growing Clarksburg American Viticultural Area suggest this is possible, if not probable. Overall, the 5 percent shift from lower-value crops such as grains to higher-value crops is a reasonable, if not conservative, forecast through 2050. Markets will change and projections are, of course, uncertain and could be more or less than predicted. Nevertheless, the trend towards higher-value crops is consistent with broad trends throughout the Central Valley, although the shift to higher-value crops in other areas has been dominated by growth in tree nuts. However, the shift towards permanent crops in the rest of the Valley and growing urbanization around the Delta creates a market opportunity for increased specialization in truck and vineyard crops in the Delta. In spite of this, truck crops and vineyards, with the notable exception of asparagus, are sensitive to salinity.

7.6 Impact of Policy Scenarios

7.6.1 Background on Salinity and Delta Agriculture

The impact of salinity and potential salinity changes on Delta agriculture is a contentious topic.[117] There are two current proposals that could affect salinity in the Delta:

A proposal to increase the salinity levels allowed in the south Delta from 700 ec to 1000 ec during the growing season, and from 1000 ec to 1400 ec at other times, a 40-42 percent increase. This is known as the D-1641 standard, and the proposed change is currently being considered by the State Water Resources Control Board (SWRCB). The Department of Water Resources and State and Federal Water Contractors support the change, whereas the Central and South Delta Water Agencies oppose the change.

A proposal to shift from through-Delta conveyance to "dual conveyance" utilizing an isolated conveyance facility as proposed in the draft BDCP. The operation of dual conveyance is the subject of continued modeling, but the intention would be to use the isolated conveyance as much as possible while still maintaining south Delta water quality standards. Under the current through-Delta conveyance, salinity levels in the south Delta vary substantially from year to year, and are often much lower than the current 700 ec standard while running at or above the standard in dry years. Thus, under dual conveyance that diverts more water around the Delta in wet years, it is expected that south Delta salinity will run close to the D-1641 standard most of the time, making "every year a drought" in the words of a Delta farmer. The effect could be an increase in the average level of salinity of 25-50 percent even if the 700 ec standard is always met, and a potential doubling in average salinity levels if dual conveyance were combined with an increase of the D-1641 standard to 1000 ec.[118]

[117] In the report, for consistency among databases, salinity is measured by electroconductivity (ec) in units of micro Siemens per centimeter.

[118] Modeling by William Fleenor reported in the 2007 PPIC report indicates that ec would rarely if ever exceed 1000 ec with a dual conveyance system.

In addition to the current proposals, concerns have been expressed by Delta agriculture interests that isolated conveyance could lead to future increases in salinity that would exceed the levels discussed above. They point to emergency declarations by the Governor during periods of drought that temporarily suspend water quality standards and current efforts to weaken environmental and water quality protections through legislation and the courts. The pressures on water quality standards could increase if a $12 billion isolated conveyance facility is built as water exporters attempt to maximize the value of the isolated facility they are financing, and the commitment to maintaining Delta levees could decrease.

The 2007 PPIC "Envisioning Futures" report estimated the potential impacts of a peripheral canal on Delta agriculture by modeling a tenfold and twentyfold increase in Delta salinity, far greater than the salinity increases contemplated in this chapter. In contrast, the same PPIC report estimates a similar isolated facility operated in a dual conveyance system would rarely if ever exceed 1000 ec as discussed above.

Perhaps the most contentious issue isn't the level of salinity changes, but whether salinity will have significant impacts on Delta agriculture at proposed levels. In focus groups, Delta farmers have told us that they monitor salinity levels closely in their current operations, and that some already incur significant costs in chemicals and drainage systems to deal with current levels of salinity. In contrast, the Department of Water Resources and water contractors argue that there would be no loss to Delta agriculture, even if the SWRCB adopted a 1000 ec standard in the south Delta. For example, Department of Water Resources' comments to an earlier draft of this report state,

> *"The salinity objective established by the State Water Resources Control Board is determined by the most salt-sensitive crop grown in the Delta—beans. The EC value has been determined to provide full yields for these most salt-sensitive crops when best-management is practiced by farmers. If the SWP with the isolated facility is operated to meet this objective, then water quality conditions in the Delta would be adequate to allow full crops yields for all crops grown in the Delta and no loss of revenue would occur at all."*[119]

The position that there is no impact on Delta agriculture from proposed increases to Delta salinity levels is based on a report by Hoffman (2010).[120] Hoffman uses well-established yield functions for crops typically grown in the south Delta to estimate potential loss to Delta farmers from changes to salinity. The yield functions depend on the leaching fraction of the soil. Yield loss can occur at low levels of salinity when leaching fractions are low, and crops can tolerate higher salinity in irrigation water when leaching fractions are high. The Hoffman (2010) report states (p. 51),

> "The leaching fraction in the South Delta is difficult to estimate because measurements of soil salinity or salt concentration of drainage water are not measured routinely."

[119] See page 42 of comments at http://www.delta.ca.gov/res/docs/ESP%20Comments%20-%20DWR.pdf.
[120] "Salt Tolerance of Crops in the Southern Sacramento-San Joaquin Delta," Final Report, January 5, 2010, by Glenn Hoffman. Prepared for the California EPA and the State Water Resource Control Board. http://www.swrcb.ca.gov/waterrights/water_issues/programs/bay_delta/bay_delta_plan/water_quality_control_planning/docs/final_study_report.pdf

In his calculations, Hoffman generally assumes leaching fractions of 0.15 or above. This is supported by deriving leaching fractions from water samples collected from tile drains in an area in the southwest corner of the south Delta, and a 1976 study of soil salinity in nine locations of the south Delta by Meyer et al.[121] Hoffman's assumed leaching fractions are strongly contested by Delta water agencies.[122] Delta water agencies point out that Hoffman is using tile drains from an area in the southwest corner of the Delta characterized by clay soils and low water tables not typically found in the Delta, and that the sample points used by Meyer are also not broadly representative of the area. They contend that high water tables and soil permeability conditions in most of the south Delta produce low leaching fractions and high sensitivity to irrigation water salinity, and provided a report by Dr. G.T. Orlob that calculated yield loss for soils with a leaching fraction of .05 and estimates this soil type characterizes roughly 40 percent of south Delta cropland.[123] The Orlob report estimates the following percent yield decrements for crops in this soil type where applied water salinity is 1000 ec: beans, -68 percent; corn, -34 percent; alfalfa, -19 percent; tomatoes, -21 percent;, fruit and nuts, -61 percent; and grapes, -29 percent. Similar to Hoffman, Orlob estimates virtually no impact on yields if leaching fractions are 0.18.

A simple comparison of south Delta soil maps and the sampling locations utilized by Hoffman confirms that they are not a representative sample of the region. Thus, Hoffman's conclusion regarding the 1000 ec standard is based on an untested hypothesis about soil conditions in the south Delta. The hypothesis could be tested by conducting the appropriate soil tests on a truly representative sample of cropland in the south Delta, but that data is not available. The empirical analysis in this report can be seen as an alternative approach to testing the hypothesis with existing crop production data. If salinity below 1000 ec has no impact on crop yields in the Delta, then an empirical study should show no relationship between salinity and crop choice controlling for the environmental conditions of the field and other factors.

Incorporating measurements of salinity throughout the Delta as an exogenous variable in the multinomial logit model allows for capturing the marginal impacts on crop choice of changes in salinity. These observations can then be used to predict how the agricultural composition of the southern Delta would change if it were subjected to various scenarios of increasing salinity. The average revenues of the different crop classes are then used to estimate total impacts on the Delta's annual agricultural revenue. The model inputs and results are described in more depth in Appendix G.

To our knowledge, the only other economic study to model the impact of salinity on Delta agriculture is the 2007 PPIC report.[124] In contrast to the econometric approach of this report, they build a Delta Agricultural Production Model using the positive mathematical programming approach.[125] The Hoffman yield functions are built into the model, and the report states regarding current salinity levels, "most of the stations have an EC less than 1 mS/cm, which in

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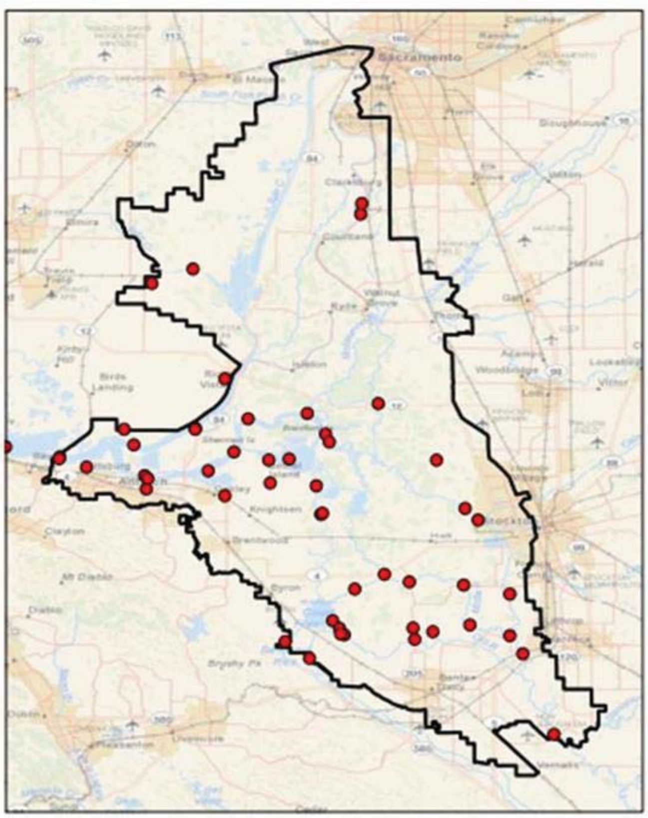
[121] Meyer, J. L., Carlton, A., Kegel, F., Ayers, R. S., "South Delta Salinity Status Report," University of California, Davis, CA, 1976, 16 p.
[122] Personal communication with John Herrick, July 5, 2011. See also a presentation to the State Water Board:
http://www.swrcb.ca.gov/waterrights/water_issues/programs/bay_delta/bay_delta_plan/water_quality_control_planning/docs/060611wrkshp/sdwa.pdf, and comments on the Hoffman report to the State Board, http://www.swrcb.ca.gov/waterrights/water_issues/programs/bay_delta/bay_delta_plan/water_quality_control_planning/cmmnts052311/john_herrick.pdf.
[123] G.T. Orlob, *Impact of San Joaquin River Quality on Crop Yields in the South Delta,* 1987.
[124] Details of the model are in Appendix D, http://www.ppic.org/content/pubs/report/R_207JLR.pdf.
[125] Howitt, R.E. 1995. Positive Mathematical Programming. *American Journal of Agricultural Economics* 77: 329-342.

practice means no effect on agricultural production." Thus, the study is assuming leaching fractions above 0.15 as in the Hoffman report. Nevertheless, the study predicts potentially large impacts of salinity from a peripheral canal and other strategies to increase salinity, ranging from 25-60 percent declines in Delta agricultural revenue, and 8-40 percent declines in irrigated acreage as water quality in some areas could decline to levels unsuitable for any crop. If the same model were applied to dual conveyance that would keep salinity at or below the 1000 ec threshold, it would predict virtually no loss in agricultural output in parallel to the argument of the Department of Water Resources, because the Hoffman threshold functions for crop yield are built in.

7.6.1.1 Salinity Data

For the purposes of baseline salinity modeling, salinity data has been collected for over 50 sites in the Delta region. An analysis of salinity impacts required the creation of a variable representing average salinity on an annual basis. Based on information gained in a working group and further consultation with Delta farmers, a decision was made to use a value for the average salinity observed between May and August, when sensitive crops are most vulnerable to salinity changes in the Delta. Salinity is represented using measures of electroconductivity (ec), in units of micro Siemens per centimeter.

Figure 24 Salinity Observation Stations[126]



The modeling also required the ability to map salinity values to each individual crop field. In order to predict these values, salinity measurements were averaged across all observation sites in a three-mile radius of each crop field. The measurement value of the nearest station was used for fields without multiple monitoring stations within that radius. This generated

[126] For high resolution image see http://forecast.pacific.edu/desp-figs.html

standardized estimations of salinity for fields throughout the Delta using a replicable technique. A map of the salinity observation stations used as inputs is depicted in Figure 24, and the sources of the station data are described below.

Interagency Ecological Program (IEP)
The IEP samples discrete water-quality data at 19 sites throughout the Delta. The sites are chosen in an attempt to represent the major inflows and outflows of the Delta, with new data sampled monthly. All reported observations undergo a detailed quality assurance process prior to being made publicly available. Sampling sites are mapped in GIS using longitudinal and latitudinal coordinates provided by the IEP.

California Data Exchange Center (CDEC)
Additional salinity data is collected from 45 Delta water monitoring stations reported through the CDEC. The sites are maintained by a variety of organizations, including the California Department of Water Resources, the U.S. Bureau of Reclamation, and the U.S. Geological Survey. The sites are sampled daily, and the monthly average is taken based on reported daily values.

Tables in Appendix G provide more detail about how average salinity varies across space and years in the Delta. It is important to emphasize that the data is presented here as a season long average, and thus masks important spikes that often occur during years when the average is considerably lower. The ten-year sample for which detailed information is provided includes six dry years with very high salinity from 2001–2002, 2004, and 2007–2009. Salinity was significantly lower in other years. During 2008, average salinity levels in most of the Delta were 60 percent to 80 percent higher than in 2006. In the north Delta, average salinity is less than 200 ec in most years and there is relatively less variation between years. In contrast, the south Delta averaged 646 ec in 2008 and 408 ec in 2006, with some areas averaging 800 ec or more in 2008 and 2009. Thus, the south Delta experiences significantly higher levels of salinity and more variation than the north Delta. This reflects many factors, including the significant differences in water quality between the Sacramento and San Joaquin Rivers.

7.6.1.2 Salinity Modeling

As discussed earlier and shown in the model results in Appendix G, the multinomial logit model found salinity to have a statistically significant impact on crop choice in the Delta. Since virtually all of the fields in the sample have irrigation water supplies below the 1000 ec, the finding does not support the assumption that there are no agricultural impacts below 1000 ec as argued by the Department of Water Resources and others.

For preliminary calculations of impacts, scenarios were established for percentage increases in salinity for the southern Delta regions, comprising fields within BDCP conservation zones 6 through 9. In reality, salinity would not increase uniformly across the region, and future simulations of the model with more spatially precise estimates of salinity changes could generate more accurate and detailed results. However, the current predictions in Table 18 below are a good initial estimate of the magnitude of agricultural revenue impacts that could be generated by crop shifting from salinity changes.

Table 18 Forecasted Crop Revenue Impacts from Increasing Delta Salinity

		Forecast Acreage					Total Revenue				
Crop Category	Crop Category Avg. Revenue per Acre	Baseline	25% Salinity Increase	50% Salinity Increase	100% Salinity Increase	200% Salinity Increase	Baseline	25% Salinity Increase	50% Salinity Increase	100% Salinity Increase	200% Salinity Increase
	[a]	[b]	[c]	[d]	[e]	[f]	[g]	[h]	[i]	[j]	[k]
Deciduous	$4,612	6,954	5,971	5,051	3,486	1,499	$32,071,848	$27,538,252	$23,295,212	$16,077,432	$6,913,388
Field	$780	80,752	83,621	85,246	85,011	74,848	$62,986,560	$65,224,380	$66,491,880	$66,308,580	$58,381,440
Grain	$426	15,925	19,197	22,734	30,335	45,892	$6,784,050	$8,177,922	$9,684,684	$12,922,710	$19,549,992
Pasture	$116	2,963	3,757	4,667	6,810	12,056	$343,708	$435,812	$541,372	$789,960	$1,398,496
Truck	$3,903	29,804	24,460	19,843	12,741	5,029	$116,325,012	$95,467,380	$77,447,229	$49,728,123	$19,628,187
Vineyard	$3,566	3,519	2,911	2,376	1,534	594	$12,548,754	$10,380,626	$8,472,816	$5,470,244	$2,118,204
				Total Revenue			**$231,059,932**	**$207,224,372**	**$185,933,193**	**$151,297,049**	**$107,989,707**
				Scenario Revenue Losses				**-$23,835,560**	**-$45,126,739**	**-$79,762,883**	**-$123,070,225**

Notes:
Modeled regions include 2010 field borders acreage located w ithin specified BDCP conservation zones.
[a] is the average crop class revenue per acre based on 2009 yield and price data from county crop reports.
[a] is the forecasted acreage of each crop class under the specified baseline salinity conditions.
[c]- [f] are the forecasted acreage of each crop class assuming a 25-200% increase in salinity levels
[g] = [a] * [b]
[h] = [a] * [c]
[i] = [a] * [d]
[j] = [a] * [e]
[k] = [a] * [f]

The model predicts a large shift from high-value truck and vineyard crops to lower-value grain and pasture crops should salinity levels rise in the south Delta. This shift would have significant revenue impacts on Delta agriculture. The forecasted shifts in crop distribution are intuitive, as they reflect the salt sensitivity of the dominant Delta crops in each crop category. Processing tomatoes, the dominant truck crop in the Delta, are salt-sensitive, as are wine grapes. Both are expected to decline, while salt-tolerant grain and low-value pasture crops are expected to increase in acreage. Deciduous crops are largely salt-sensitive and are also expected to face decreasing acreage in the south Delta under forecasted salinity increases.

As shown in Table 18, a 25 to 50 percent increase in south Delta salinity could cause a $24 million to $45 million reduction in crop revenue, and the roughly 40 percent proposed increase in south Delta salinity standards falls in this range. The model projects an $80 million revenue loss from a doubling of south Delta salinity, and the potential for larger losses if salinity were to increase further is illustrated by a $123 million loss.

It is important to note that the estimated revenue losses in Table 18 are solely due to crop shifts, and the model does not estimate any potential impacts from yield declines as salinity increases. Further, it does not move any land out of agricultural production as salinity increases, it merely assigns it to lower value categories, and does not account for accumulation of salinity over time. Thus, the losses could be even higher if accounting for these effects, especially for the higher levels of salinity increase. On the other hand, the losses in Table 18 probably include a few upland areas in the Delta that would be little impacted by increased salinity in Delta channels, and these could be areas with higher concentrations of high-value deciduous crops. As discussed earlier, as more spatially disaggregated data on potential salinity changes become available, the estimated effects could be adjusted to take advantage of that data.

7.6.1.3 Agricultural Revenue Impacts of Isolated Conveyance

As discussed above, the potential revenue impacts of introducing an isolated conveyance facility operated as dual conveyance in combination with continued through-Delta conveyance is closely linked to south Delta salinity standards. If south Delta salinity standards remain at their current levels, the water quality impacts of dual conveyance could be as low as $20 million per year. If an isolated conveyance is introduced and salinity standards are relaxed, the model predicts up to $80 million in lost agricultural revenue per year. There still is significant uncertainty regarding the exact impacts of isolated conveyance, but $20 million to $80 million in annual revenue impacts is a reasonable range based on this modeling. The $20 million to $80 million annual decline is significantly different than the estimates of no loss based on the threshold yield functions and untested assumptions regarding soil leaching fractions.

In addition to water quality impacts, the footprint of an isolated conveyance facility will also take a significant amount of land out of agricultural production, especially in the north Delta. The November 2010 draft BDCP estimates that roughly 8,000 acres will still be required for a tunnel conveyance system, even though the land requirements are much lower than a surface canal. Most of the affected acres are in relatively high-value agricultural lands in the north Delta that currently average about $2,000 per acre per year in revenue. Using detailed acreages allocated across crop classes in the draft BDCP, the land consumption of the isolated conveyance project would result in an additional $10 to $15 million annual loss to Delta agricultural revenues. A surface canal would impact roughly four times the amount of agricultural land.

7.6.2 Agricultural Revenue Impacts from Habitat Conservation Scenarios

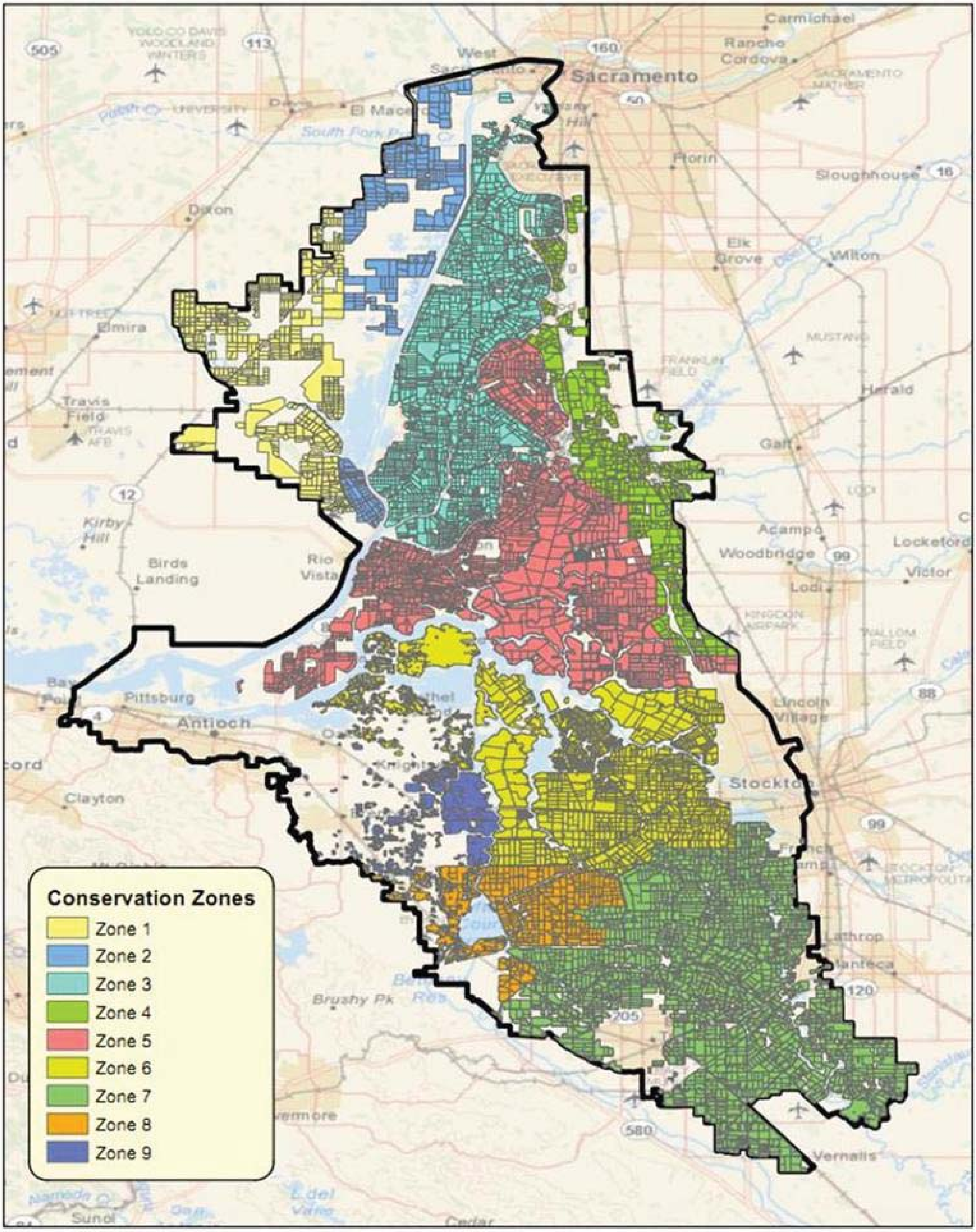
As outlined in Chapter 6, this report seeks to address impacts of four major conservation measures proposed by the BDCP. An extremely precise examination of agriculture impacts is not currently possible due to the lack of specificity provided in the BDCP as to where lands would potentially be conserved or restored. The best spatial approximation of targeted areas is provided by the BDCP's delineation of Conservation Zones and Restoration Opportunity Areas (ROAs) for which conservation investments are proposed. Replicating the spatial extent of these zones and analyzing the agricultural landscape of each gives an estimate of the impacts on agriculture that each conservation measure would entail.

Table 19 below illustrates the total agricultural acreage and average revenue generated by crops fields in each of the BDCP's conservation zones. In addition, a list of the conservation measures with significant impacts in each conservation zone is provided. A map of Delta crop fields and their associated conservation zone is included in Figure 25.

Table 19 Agricultural Composition of BDCP Conservation Zones

Conservation Zone	Agricultural Acreage (2010)	Revenue per Acre (2009)	Relevant Conservation Measures
1	31,030	$463	CM3, CM4
2	14,064	$802	CM2, CM3, CM4
3	59,011	$1,474	CM6
4	26,441	$2,075	CM3, CM4, CM6
5	75,239	$1,838	CM3, CM4, CM6
6	71,219	$1,885	
7	89,716	$1,823	CM3, CM4, CM6
8	27,595	NA	
9	15,809	NA	

Figure 25 BDCP Conservation Zones[127]



[127] For high resolution image see http://forecast.pacific.edu/desp-figs.html

7.6.2.1 Yolo Bypass Fisheries Enhancement

Major impacts on agriculture from Yolo Bypass Fisheries Enhancement will come from the potential acquisition of lands through fee-title or conservation and flood easements. The largest source of revenue in the affected conservation zone comes from rice fields located along the northern region of the Yolo Bypass, and the use of rangeland could also be impacted. Table 20 estimates current Yolo Bypass crop production excluding grazing land, which might add another $500,000 to the total of $27.1 million. Total agricultural revenue in the Legal Delta area is currently estimated at about $11 million. However, the majority of high-value rice fields is located in the area of the Yolo Bypass north of the Legal Delta, and is estimated to generate almost $16 million in annual revenue and could experience the most significant direct impacts. Given that it is impossible to enhance the Yolo Bypass fishery flows in the legal Delta without simultaneously affecting the area outside the legal Delta, we consider impacts beyond the legal Delta for this conservation measure.

The November 2010 draft BDCP estimates that new flowage easements would be required for 21,500 acres on the eastern bypass or as much as 48,000 acres assuming western tributary flows also flooded the central and western portions of the bypass. Current documents from the BDCP working group are focused on the Fremont Weir Gated Channel operations with an impact on 17,000 acres, and most important, would inundate 7,000 to 10,000 acres in most years after March 1, which gets into the time period where flooding interferes with agricultural planting.[128]

Yolo County is working with UC-Davis on an analysis of the agricultural impacts of more frequent flooding of the Yolo Bypass for fish habitat. The study has more detailed crop, yield and price data than is currently available.[129]

The November 2010 draft BDCP estimates new flowage easements would average 25 percent of property value on 21,500 acres in the bypass, using the current agricultural revenue that implies a roughly $7 million annual decline in crop revenue. If, as in the September 2011 discussion document, roughly 10,000 acres were flooded to preclude production in about 60 percent of years, average lost agricultural revenue could be as high as $10 million. Thus, our rough estimate of potential lost agricultural revenue from Yolo Bypass Fishery enhancements is $7 million to $10 million.

Yolo County is working with the BDCP Yolo Bypass Fishery Enhancement Working Group to develop a proposed project that minimizes or avoids impacts to existing land uses, and provides full mitigation for tax revenue and economic impacts. Like other preliminary cost estimates for habitat measures, the estimated impacts could change as plans change over time.

[128] Potential Operation Pattern for Fremont Weir Gated Channel, or “Notch,” September 23, 2011 Draft for Discussion Purposes. Available at www.baydeltaconservationplan.com.
[129] Garnache, C. and R.E. Howitt. 2011 “Analyzing the Tradeoffs Between Agriculture and Native Species: The Case of the Yolo Bypass Floodplain.” Selected Paper prepared for presentation at the AERE 2011 Summer Conference, Seatlle, June 9-10, 2011.

Table 20 Yolo Bypass Crop Acreage and Revenue, 2009[130]

	Inside Legal Delta		*Outside Legal Delta*	
Crop Category	**Acres**	**Value**	**Acres**	**Value**
Deciduous	73	$314,000	0	$0
Field	5,026	$3,961,837	7,760	$11,087,862
Grain	1,179	$394,461	370	$145,050
Pasture	4,415	$241,030	0	$0
Truck	1,875	$6,321,309	1,500	$4,634,129
Vineyard	0	$0	0	$0
Total	**12,568**	**$11,232,637**	**9,630**	**$15,867,041**
YOLO BYPASS TOTAL			**22,198**	**$27,099,678**

7.6.2.2 Natural Communities Protection

The Natural Communities Protection strategy has several elements. The most significant for agricultural production in the Delta would be the conversion of 8,000 acres of grazing land to native grasslands, and the creation of nearly 33,000 acres of agricultural habitat through fee-title purchases or easement acquisition. Since grazing lands crop value is roughly $20 per acre, the loss of 8,000 acres would amount to only $160,000 per year. However, that measure probably understates the total impact on cattle production in the region, as this would represent a roughly 30 percent loss in the current grazing land that supports cattle production estimated at $24 million per year. The increase in irrigated pasture that could be created through the 32,000 acres of “agricultural habitat” protection could offset this loss and thereby minimize any impact on the cattle industry.

The most significant part of this conservation strategy is the acquisition of nearly 33,000 acres in “wildlife friendly” agricultural easements. The draft BDCP does not give specific information about implementation, but offers some general guidelines that can be used to anticipate impacts. Pages 2-130-132 of the November 2010 draft BDCP identify alfalfa, irrigated pasture, and rice as crops that provide high habitat values, and orchards and vineyards as crops that provide little habitat value. Other cultivated annual crops such as corn, tomatoes, grains, and other truck crops are described as providing seasonal habitat value with high variation among crop types. The high habitat value crops generate average revenue of $100 to $1,400 per acre, whereas the low habitat value crop types generate average revenues of $3,500 to $4,500 per acre. The draft BDCP estimates the costs of land and easement acquisition of cultivated habitat at $8,000 per acre ($260 million for 32,600 acres) which suggests that at least some permanent crops will be targeted for acquisition given current land prices.

Roughly 13,000 acres of the “agricultural habitat” is targeted for Conservation Zones 1 and 2 which include most of the Cache Slough area in Solano County and the Yolo Bypass. These areas average less than $1,000 per acre in crop value and are already mostly planted in the preferred crop types for habitat. Thus, the creation of “agricultural habitat” in this area would presumably lock in current cropping patterns, and have little impact on agricultural revenue compared to current levels.

[130] Yolo bypass crop production varies widely from year to year and as explained earlier, our field level data does not include fields that did not have pesticide use filing (e.g. organic). Detailed studies in progress by UC-Davis will likely have more detailed and complete data.

Approximately 10,000 acres of agricultural habitat is targeted for Conservation Zone 4, in the northeast Delta, and Conservation Zone 7, the south Delta. These areas have average revenues of approximately $2,000 per acre, among the highest value croplands in the Delta. Vineyards are a significant part of CZ4, and there is much potential growth for this region. Presumably, the objective of this conservation measure would be to stop or reduce vineyards in this region in favor of pasture, alfalfa, or corn as grown by the Nature Conservancy on Staten Island. In the south Delta, there are some vineyards as well as significant numbers of truck crops that might be viewed as less wildlife friendly. The anticipated easement costs suggests a displacement of $300 to $400 per year in net profit, which might translate to roughly $1000 per year in net production.

Overall, the natural communities and agricultural habitat protection is among the most difficult to value the agricultural revenue impacts. Considering the discussion above, an agricultural revenue loss of $5 million to $25 million per year is a reasonable estimate at full implementation. The use of more limited term easements or a conservation reserve program model instead of fee-simple and permanent easement purchases might be considered. This would reduce the impact on the agricultural economy by allowing Delta agriculture more flexibility to respond to future market changes.

7.6.2.3 San Joaquin River Floodplain Restoration

The November 2010 draft BDCP calls for the restoration of 10,000 acres of seasonally-inundated floodplain habitat over a 40-year period, with 1,000 acres restored in the first 15 years. No specific regions are outlined, though the BDCP notes that “the most promising opportunities for large-scale restoration are in the south Delta along the San Joaquin River, Old River, and Middle River channels…” These areas fall almost entirely within conservation zone 7, which is largely occupied by high-value alfalfa and tomato crops and has an average per-acre revenue of $1,823. In addition, the identified areas are almost entirely in agricultural production, and a large proportion of the restored floodplain would almost certainly affect land currently in production. Based on current production, the San Joaquin River Floodplain Restoration could reduce annual agricultural revenue by $15 million to $20 million per year.

An alternative proposal focused on enhancing the flood bypass at Paradise Cut has been developed cooperatively between environmental groups and local Delta landowners. This proposal would generate significant flood control and ecosystem benefits while limiting agricultural impacts to 2,000 acres, thereby reducing agricultural impacts by up to 80 percent. The alternative proposal is recommended in the fourth draft of the Delta Stewardship Council’s Delta Plan. The details of these plans are very uncertain at this time, and BDCP planning does not seem to be as well developed as it is for Yolo Bypass Fishery Enhancements at this point. Given the uncertainty, the estimate of potential lost agricultural revenue ranges between $3 million and $20 million per year depending on what plans are implemented.

7.6.2.4 Tidal Habitat Restoration

Of the major conservation measures addressed in this report, tidal habitat restoration has the most clearly defined geographic areas and restoration targets. Tidal habitat also has by far the largest potential economic impact on agriculture due to the high acreage targets and the fact that it eliminates all agricultural uses rather than limits agricultural activity with measures such as conservation easements. The agricultural fields contained in each Restoration Opportunity Area (ROA) are shown in Figure 26, with their acreage and value in each region depicted in Table 21 below. The BDCP outlines various restoration targets to be achieved over the next 40 years, with a final target of 65,000 restored acres in the Delta and Suisun Marsh. In addition, there are minimum values for acreage in each of the four ROAs which must be restored, as shown in Table 21. A minimum of 7,000 acres is targeted for Suisun Marsh, which lowers the maximum target for tidal habitat in the Delta to 58,000 acres.

Table 21 Agricultural Composition of BDCP Restoration Opportunity Area

Restoration Opportunity Area (ROA)	Total Acreage	Agricultural Acreage (2010)*	Minimum Restoration Target (Acres)	Revenue per Acre (2009)
Cache Slough Complex	49,167	19,854	5,000	$491
Cosumnes/Mokelumne River	7,805	7,840	1,500	$2,175
South Delta	39,969	34,914	5,000	$2,151
West Delta	6,178	2,587	2,100	$1,279
TOTAL	**103,119**	**65,195**	**13,600**	**$2,014**

*Values may be slightly inflated due to large fields centered within the ROA which extend past its borders.

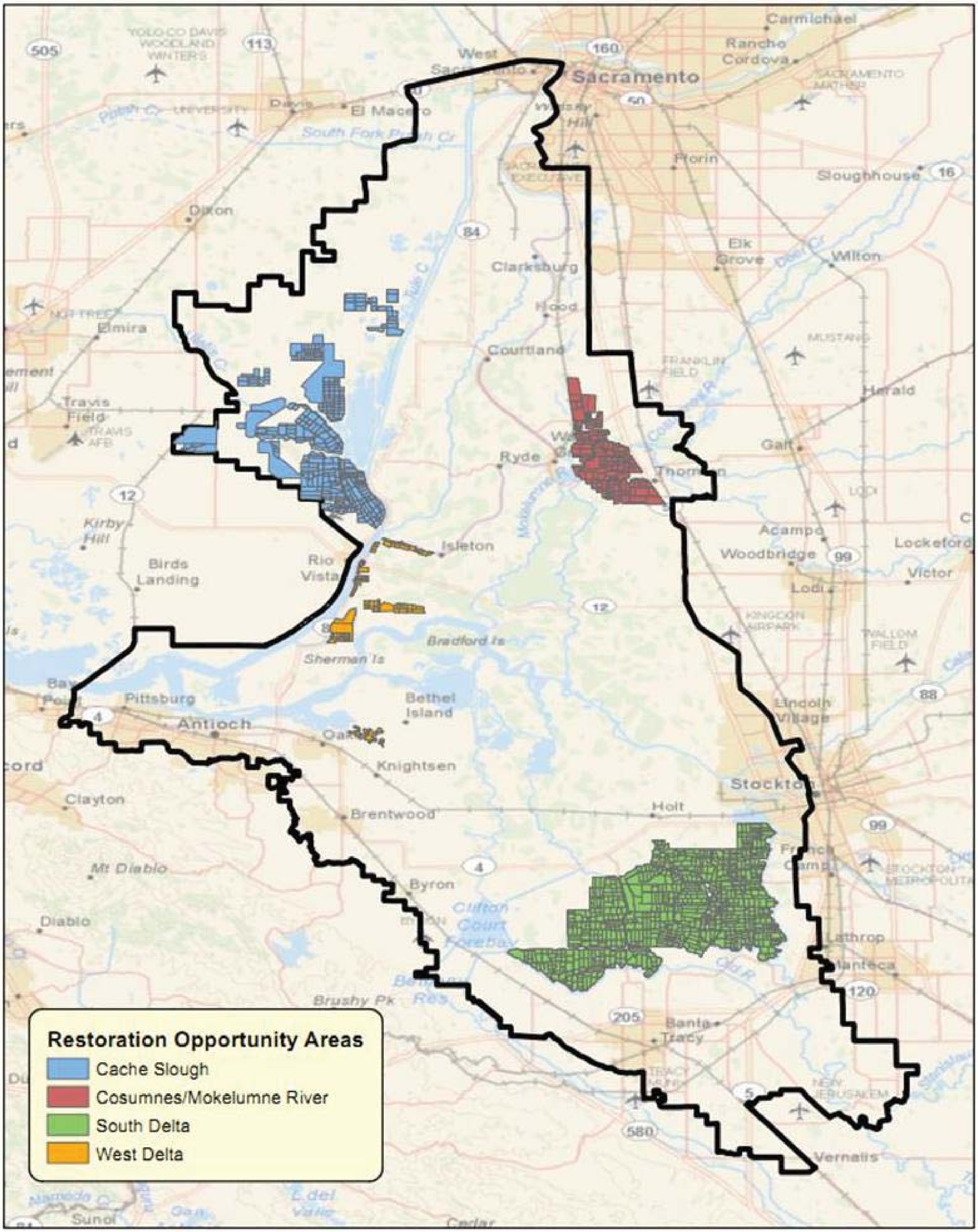
As can be seen in Table 21, in some regions even the minimum restoration targets will require the acquisition of land currently used in crop production. In addition, both the Cosumnes/Mokelumne River ROA and the South Delta ROA are centered in some of the highest revenue agricultural areas of the Delta. Even if over 50,000 acres were restored in Suisun Marsh so that only the minimum restoration targets were reached in the four Delta ROAs, total agricultural revenue loss would be about $18 million per year with nearly $11 million of the total loss occurring in the south Delta. If only the minimum were restored in Suisun Marsh and the remaining 58,000 acres were proportionally distributed across the Delta, the estimated revenue loss would reach $77 million per year with about a $46 million loss in the South Delta.

Tidal marsh restoration in Cache Slough has been discussed for decades because restoration in the area would have little impact on the current through-Delta conveyance of fresh water, and it has desirable environmental and elevation characteristics. Table 21 indicates that its lower revenue per acre might make it a target area for economic reasons, although representatives from Solano County have said that the low revenues per acre can be partially attributed to the regulatory and planning “cloud” that has been over the area for years and discouraged investment in higher-value crops. A March 2008 report by Kurt Richter of the University California Agricultural Issues Center[131] provides a detailed tract by tract analysis of the potential impacts of tidal habitat restoration proposals in Cache Slough and Suisun Marsh that go beyond the direct loss of agricultural production.

The report finds that the least costly way to attain the ecological restoration goals for Cache Slough area would be to convert Hastings Island, Egbert Tract and Little Egbert Tract to tidal habitat. These three areas “would provide over 17,000 acres of habitat and remove $9.6 million from the agricultural economy in Solano County (2006 dollars).” The report also notes that restoration of these three areas “will require that the levees around Ryer Island, North Ryer Island and Hass Slough be moved or redesigned since the new system will increase the threat of underseepage,” and notes other concerns related to waterfowl habitat and water quality.

[131] Richter, K.R., “The Potential Impact of the Delta and Suisun Marsh Habitat Restoration Plans on Agricultural Production in Solano County,” University of California Agricultural Issues Center, March 14, 2008.

Figure 26 BDCP Restoration Opportunity Areas[132]



132 For high resolution image see http://forecast.pacific.edu/desp-figs.html

The wide range of potential agriculture losses ranging from $18 million to $77 million annually illustrate the risk and uncertainty this conservation strategy poses for Delta agriculture. Compared to the other conservation measures, the tidal marsh restoration strategy entails the largest necessary direct impacts on Delta agricultural production, and also has some of the highest direct implementation costs for BDCP. The BDCP currently states that the majority of these targeted lands will be determined "based on land availability, biological value, and practicability considerations." The absence of agricultural impacts from the described methodology is a notable omission considering the potential implications for the Delta economy. Targeting criteria that avoids high-value agriculture lands and reduced target acreages, particularly in the south Delta, should be considered.

7.6.2.5 Summary and Additional Concerns Regarding Habitat and Agriculture

Considered together, the four habitat conservation measures here could reduce agricultural output in the Delta between $33 million and $137 million per year. The wide range shows the importance of considering agricultural impacts when designing conservation measures. The $33 million revenue loss scenario shows that it is possible for significant habitat restoration to be compatible with economic sustainability of Delta agriculture if it is carefully planned to minimize impacts. However, the potential for $137 million in direct losses to agricultural output shows that habitat restoration could also have severe negative impacts on the Delta economy.

There are additional risks to Delta agriculture from habitat restoration measures in addition to the direct losses to agricultural production described in this section. The following list of additional concerns is taken from a letter from Deputy Natural Resources Secretary Jerry Meral inviting participants to a September 13, 2011 meeting on the potential impacts of the BDCP habitat projects on agriculture.

- Increased risk of levee failure due to changes in levee configurations with tidal habitat restoration actions
- Water quality and salinity issues for agricultural irrigation as a potential result of water facilities operations and tidal habitat restoration
- Water elevation changes at agricultural intakes as a result of water facilities operations
- Effects on agricultural land from adjacent restored tidal habitat, such as seepage
- Neighbor effects of increased endangered wildlife species on BDCP preserves next to agricultural lands
- Increased presence of listed fish species at agricultural diversions and potential regulatory effects where aquatic habitat restoration increases listed fish densities
- Weed control on habitat lands
- Mosquito and vector control issues

In addition to these impacts, participants in the meeting raised concerns about the potential for decreased property values even if land is not being restored, and increased crop loss from feeding and predation of wildlife such as birds attracted to nearby restored habitats.

7.6.3 Loss of Agricultural Value from Open Water Scenario

The central Delta open water scenario discussed in Chapter 6 would result in a loss of agricultural production on the flooded islands. The impacts can be quantified simply by looking at the agricultural farmland currently in production on each island. If the six islands were flooded, almost 13,000 acres would be lost, with a corresponding loss of around $11 million dollars in direct revenues per year. The islands are largely composed of low-value field crops, with average revenue per acre significantly below that of the Delta as a whole. A summary of the affected islands is depicted below in Table 22. As discussed in Chapters 4 and 6, it is highly unlikely that Empire Tract would be flooded due to new water supply infrastructure for the City of Stockton.

Table 22 Six Island Agricultural Composition

Island	Agricultural Acreage (2010)	Total Revenue (2009)	Revenue per Acre (2009)
Mandeville	2,345	$2,198,583	$1,117
Medford	365	$279,797	$715
Quimby	629	$487,720	$776
Venice	2,587	$2,008,844	$765
Webb	4,469	$3,467,869	$776
Empire	2,521	$2,539,318	$1,031
TOTAL	**12,916**	**$10,982,131**	**$981**

7.6.4 Impact of Land Use Regulatory Changes on Delta Agriculture

The “covered actions” provisions of 5th Draft of the Delta Plan have raised concerns about increased regulatory costs or constraints on Delta agriculture. For example, on page 54, the Delta Plan attempts to clarify what are “covered actions” regulated by the Delta Plan by saying, “Routine agricultural practices are unlikely to be considered a covered action unless they have a significant impact on the achievement of the coequal goals or flood risk.” The statement has created concerns that increased regulation could affect investment to supporting farm structures such as packing sheds or regulating the planting of permanent or crops that are deemed to be less wildlife friendly. There are also concerns about potential impacts on property values.