Evaluations of Policy Alternatives to Benefit Agriculture in the Sacramento-San Joaquin Delta of California

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Issues of the California Delta—the confluence of the Sacramento and San Joaquin rivers at the eastern edge of the San Francisco Bay—have been analyzed and vigorously debated for decades (CDWR 1965, CDFG 1973). Not only is the Delta an important agricultural and economic region in its own right, the region is also central to much broader economic and environmental concerns. Some of the economic and environmental importance of the Delta is related to its role in the delivery of water from Northern California to the San Joaquin Valley and beyond for agricultural, environmental and urban purposes.

After decades of study and many proposals for remediation there is still no policy consensus and the Delta continues to draw policy attention (Weiser 2011). Recent assessments have called current management of the Delta environmentally and economically "unsustainable" (Lund et al. 2007, 2008). Moreover, physical factors on the horizon, such as land subsidence, changing runoff patterns, anticipated rises in sea level with climate change, and potential earthquakes, raise the risk of levee failure and severe economic losses.

In earlier times water flowed north from the San Joaquin and south from the Sacramento meeting in the Delta and then moved west out to the Pacific ocean. For more than a half century, some of that water has been diverted for other uses before reaching the Delta and some has been moved through the Delta from North to South. Much research has examined the various consequences of these changed water flows. Lund et al. (2007, 2008) evaluate the broad statewide consequences for what they consider to be potentially feasible long term scenarios for the Delta

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as alternatives to the status quo. These include;(1) a version of the long contemplated canal to bypass the Delta to convey water south; (2) completely eliminating shipments of water from Northern California to South of the Delta; and (3) rebuilding an effective levy system and other infrastructure to deal with likely threats to the current situation. This last option they find to be extremely expensive and unlikely to solve the long term problems. They also find that eliminating shipments of water from the North to South of the Delta would have serious economic consequences for agriculture and the economy in the San Joaquin Valley.

Against this background, the present brief report is modest in its objectives. We do not attempt to restate or condense previous analysis here; rather we look specifically at agriculture in the Delta itself and ask how its prospects might be improved. The study examines the efficacy for the Delta of some of the kinds of proposals that have been made to stimulate agriculture and rural communities in other regions.

The report first provides an overview of the agricultural economic geography of the Delta and points out that most of the Delta is devoted to field crops. We next turn to a series of potential options that might increase farm and rural revenue in the Delta. These options include rural tourism, specializing in local markets, and production of biofuels. Other options include shifting land out of agriculture and attempting to generate revenue through ecological tourism. Considering the long term success of Delta agriculture requires dealing with infrastructure. We next discuss the ecological drivers of change in Delta agriculture. The main policy option for maintaining agricultural acreage in the face of likely flooding and salinity problems is to build a stronger levee system that will withstand the increased pressures on the horizon.

Geographic and Economic Overview of Delta Agriculture

Most land in the Delta is dedicated to agriculture, but the share of agricultural land out of land area in the Delta fell from about 80 percent in 1984 to about 74 percent in 2008. About three-quarters of farmland in the Delta is highly productive “prime” farmland (DSC 2011). A grower survey in 2007 reported grower's statements that as water salinity increased in the West and Central Delta they shifted from higher revenue per acre field crops to hay and pasture (Trott 2007).

Delta agriculture is spread across a roughly triangular region that is some 65 miles from North to South (from near Sacramento to near Tracy) along its eastern edge and is some 30 miles from East to West as it reaches the mouth of the Suisun Bay near Pittsburg. The northeastern part of the Delta is in Sacramento County and the southeast part is in San Joaquin County. The southwest border is in Contra Costa County and the northern boundaries are in Solano, Yolo and Sacramento Counties. The Delta is comprised of land and a water network with streams and other water bodies separating large and small land masses (Figure 1). Agriculture dominates land use in the Delta, although reversions to native uses and urbanization have both become significant (Figure 1).

Field crops and pasture covers most of the Delta agricultural acreage (Figure 2). Of the about 400,000 acres of irrigated farm land in the Delta, about one fourth has been used for corn, much of which is harvested as silage and used in the dairy industry. Alfalfa is the second most widely planted crop and irrigated pasture used by livestock is also important. These three livestock forage sources account for about half of the irrigated acreage in the Delta. Other important field crops are grains, such as wheat and sorghum, safflower and processing tomatoes, which together account for more than 100 thousand acres.

The important implication of this pattern is that Delta agriculture is a part of the global market for basic feed and food commodities such as corn, wheat and safflower. Hay and silage is also connected to global feed markets. However, because these commodities are expensive to transport long distances, the growth of dairy farming near the Delta has increased the local demand for hay and silage and given the Delta a cost advantage compared to regions more distant from the local dairy farms. With very high grain prices in 2007 and 2008, corn acreage shifted somewhat from silage to corn harvested for grain. Corn for grain decreased in 2009, but very high corn prices projected for 2011 suggests acreage may once again shift up.

Processing tomato acreage in the Delta has been in the range of about 30 thousand acres. Because transport costs for tomatoes are high relative to the value per ton, tomato acreage depends on local processing facilities, just as local processing depends on having a reliable

supply of raw material to process. Processing tomatoes have been a relatively stable feature of Delta agriculture for many years.

The predominance of field crops in the Delta indicate that soil and local climate conditions in most parts of the Delta favor those crops relative to fruits and vegetables, which would be likely to have higher gross returns per acre, if they were well suited to the local growing conditions. Farmers plant grape vines, tree crops and vegetables, including fresh tomatoes on almost 75 thousand acres in the Delta. These crops often have higher input costs than field crops and sometimes require special soils or other conditions.

The broad pattern of crops in the Delta has changed over time with trends in farm prices and other incentives. For example, asparagus acreage has declined substantially while acreage used for tree crops has declined more modestly. Grape acreage has increased to offset the loss in tree crops and other vegetables have replaced some of the loss of asparagus acreage. Overall, the crop with the biggest increase in irrigated crop area over the past three decades has been corn (CDWR 2007).

Of course, the Delta is comprised of a diverse landscape with distinct regions and soil profiles. For example, low-lying islands in the west of the Delta protected by levees may be more subject to flooding or saltwater intrusion than higher ground further east. Many crops are scattered across the Delta while others are more location-specific. For example, corn is grown throughout the Delta, but there is a strong concentration in the Central Delta from Discovery Bay in the South up to Walnut Grove in the North. Alfalfa production occurs mainly in the South, south of Antioch and Stockton, in the East along the I-5, and in the North, stretching northwest from Rio Vista up to Borges Clarksburg Airport. Grain production is scattered through the Delta, although a significant share is located north of Walnut Grove. Other field crop production is also scattered throughout the Delta, but is concentrated just north of Rio Vista. Pasture is located primarily in the West, and in the North, west of CA-84.

Vegetable production occurs mainly south of Stockton and in stretches along the eastern parts of the Central and North Delta. Orchards are located in the West Delta between Oakley and Clifton Court Forebay. Orchards are also located south of Tracy, and are scattered throughout the North

Delta, primarily along CA-160 between Walnut Grove and Hood. Grape production takes place in the North between CA-84 in the east and CA-160 in the west. In the East Delta, grape production stretches from Morgan's Landing to the crossing of CA-12 and I-5. Grape production is also scattered across the South Delta.

The main policy point to emerge from this economic overview is that it is difficult to envision a wholesale shift in Delta agriculture away from field crops without drastic changes in incentives or growing conditions. Agriculture in the Delta is diverse but the majority of agricultural production is devoted to grains, livestock feed and related field and row crops. These commodities are grown throughout the Delta, with pockets of tree, vine and vegetable crops in certain regions. Another important implication is that the nearby dairy industry is important for the current pattern of crops and pasture in the Delta and therefore regulatory or other threats to the success of the dairy industry would have significant impacts on Delta agriculture. At the same time, processing tomato production relies on local processing facilities for economic viability.

Agricultural Tourism

Some stakeholders view agritourism as a means to stimulate the Delta economy. Along these lines, the Discover the Delta Foundation was established in 2006 with the goal of "teaching people about the importance of the California Delta and stimulating the Delta economy." The foundation has begun construction of an $8m Delta Discovery Center. The center will be an "8,000 square foot, 2 story state-of-the-art educational facility" that includes outdoor learning centers and a Delta Farmers' Market with food grown in the Delta. The Delta Farmers' Market is scheduled to open in March 2011.

Agritourism is a growing source of revenue for many California farmers. A 2009 statewide survey found that there were more than 2.4 million agricultural tourist visits to California farms and ranches in 2008 (George, Rilla and Leff 2009), including people who made purchases at farm stands. The survey identified 332 agritourism operators in the state, of which 84 were located in the Central Valley, 80 in the Foothills and Mountains region, 67 in the North Coast, and 53 in the Central Coast. Some crops lend themselves well to agritourism, such as wine

grapes and some fruits and vegetables. It is more problematic whether the mainly field crop farms in the Delta can attract enough agritourist activities to be a significant source of revenue.

Agritourism may be combined with recreational opportunities offered by the Delta and Suisun Marsh. In addition to providing opportunities for kayaking, fishing, hiking, bird watching, and hunting, the Delta region has many waterways and marinas which are a significant source of revenues for the region. The Sacramento Delta is a major boating and fishing area with about 18 percent of all boating facilities in California (Dangermond Group 2006). Almost a quarter of boaters and anglers in California recreate in the Delta every year (CDPC 2007). However, only 5 percent of California's launch ramps are found in the Delta, potentially limiting external visitors' access to off-water sites.

In 2006, there were 95 marinas in the Delta, 52 percent of which had transient docks. Boaters and anglers use these docks to visit to Delta communities and in 1995 they spent more than $430 million in the Delta region (CDPC 2007). A report prepared for the Delta Protection Commission projects that annual visitor days will increase from 6.4 million in 2000 to 8.1 million by 2020 (Dangermond Group 2006). An increase in visitors will expand demands on marinas for additional boating support services.

With agriculture remaining in the Delta and the area being marketed as an agritourist destination, Delta policies and operations would need to maintain the Delta as a largely fresh water system. Delta management would then continue largely as it has for decades, meaning levees will be maintained at their current state and failed levees will be fixed and flooded islands repaired. Increasing levee failures will eventually lead to either increasing reconstruction and maintenance costs or more abandoned islands. As levees fail, water shipments through the Delta to the South would likely decrease.

Under this scenario, environmental degradation of some areas of the Delta would continue as it has for the past several decades. Lund et al. (2008) estimate that continued through-Delta pumping offers the Delta Smelt and Fall-Run Chinook salmon the lowest chances for long-term survival. The authors report that continued pumping will give the Smelt a 5 percent to 30 percent likelihood of maintaining a viable population and the Chinook salmon a 10 percent to 30

percent likelihood. These fish species are often used as indicators of the overall health of the Sacramento-San Joaquin Estuary and upstream waters, including the more than 55 fish species and more than 750 plant and wildlife species that inhabit the Delta (DSC 2011). Of course, health of the fish populations is an important requirement for success of the boating and angling visits which are one of the unique offers of the Delta for agritourists.

A policy of using public funds to encourage agritourism faces several challenges. Tourism is a potential source of farm and rural revenues for the Delta region. Significant tourist revenue is likely limited to the relatively small farm area bordering key natural habitats and less likely to be successful for large scale grain and other field crop farms that cover most Delta farmland. However, drawing in more visitors will not solve the Delta's water and land subsidence issues that challenge the agricultural production upon which such tourism is based. Recreational activities in general could displace agriculture as a source of revenue for the region, but this would not be agriculturally-based tourism. It is unlikely that such activities alone could generate sufficient revenue to cover the costs of protecting agricultural land.

The main policy challenge is that long term policies consistent with environmental health of the region are unlikely to be consistent with an unchanged agricultural economy. One path would be to encourage, through public funds or other means, reductions in field area with some shift of production into those crops that are also attractive to agritourism and Delta recreation. The problem with such a plan is that it may not be consistent with the most profitable agricultural use of Delta land and so significant additional incentives may be needed.

Emphasis on Satisfying Local Demands for Local Production

Consumers have shown increased interest in local and regional markets, and some believe that agricultural production in the Delta can be stimulated by catering to local markets. Local food is marketed through many channels. These include traditional retailers, farmer's markets (such as the one in the proposed Delta Discovery Center), farm-to-school programs, or community-supported agriculture (CSA) arrangements, in which individuals form a group that pledges to cover in advance the expected costs of a farm and thereby share in the risks and benefits of food production.

In an important sense, Delta agriculture is already largely devoted to local markets. With almost 200 thousand acres producing livestock feed that is mostly consumed in or around the Delta, local demand is crucial for Delta crop farmers. Of course, the direct demand in this case is largely from dairy cows and the dairy production itself is only partly for fluid milk consumed locally. Much of the milk production is used for cheese and other products that are distributed to final consumers nationally and internationally.

Outside observers sometimes suggest that agriculture can be stimulated through alternative cropping practices such as switching production to crops that generate more revenue per acre. Of course, growers themselves have the greatest and most direct incentive to seek the most profitable combination of crops that suit their land and expertise. Crops that generate higher total revenue per acre, such as fruits and nuts, often have specific climatic and soil requirements and be unsuited for some land. Moreover, generating more total revenue usually entails higher costs and to be economically sustainable, producers must make their production decisions based upon net revenues. Therefore, unless the underlying conditions change, it is unlikely that large-scale change of crop mix in the Delta will occur. One kind of change that can affect crop mix is an improvement in relative prices for crops that better service local demand. Several proposals are under active development to encourage increased demand for Delta produce.

The proposed farmers' market at the Delta Discovery Center would market products from Delta and California farmers, employ Delta residents, and promote the "Purchased in the California Delta" label. As shown in Figure 2 and discussed above, most farm acreage in the Delta is devoted to grains, other field crops or pasture. That means that much of current output is not well suited for local food marketing because farmers' market and CSAs tend to focus on fresh fruits and vegetables. The Delta is close enough to market local food to consumers in Sacramento, Stockton and San Francisco. San Francisco is about 60 miles or about a one hour drive away from Rio Vista in the Sacramento River Delta. At 50 miles away, Sacramento is slightly closer to Rio Vista and much closer to the Eastern Delta. Fairfield, Stockton and Vacaville are also near the edges of Delta farm production. Of course, in all these markets, Delta producers would face competition for those consumers who want to buy locally from local producers from other parts of Solano, Yolo, Sacramento, San Joaquin and other nearby counties.

Farm to schools programs may provide another outlet for local Delta agricultural production. Under the 2008 Farm Bill, schools receiving funds through the National School Lunch Act or other child nutrition programs can specify geographic preferences in food procurement, allowing them to increase purchases of unprocessed locally-produced foods. However, it is not clear to what extent this would translate into demand for agricultural output from the Delta, as opposed to output from elsewhere in California. Again, most acreage in the Delta is devoted to field crops or pasture, and some crops in the Delta, such as processing tomatoes, cannot be delivered directly to schools for consumption. Some crops that may be suitable for farm to school programs include asparagus and cucurbits. However, with historically relatively high market prices for these crops, it is unlikely that producers will utilize farm to school programs to any great extent without additional incentives.

As with the agritourism approach, the conversion of the Delta to a source of "local" food will retain agricultural production in the Delta and maintain it as a largely fresh water system. As such, agricultural producers will face the same long-run problems described earlier. Eventually, increasing levee failures will lead to either increasing reconstruction and maintenance costs or more abandoned islands. As levees fail, water exports would likely decrease. Environmental degradation of some areas of the Delta would continue as it has for the past several decades. Such changes will be delayed somewhat by the strengthening of levees, but at very high cost.

Negative environmental effects could be mitigated by a peripheral canal that would remove the issue of pumping activity and allow improved in-Delta flows for ecosystem purposes. Other environmental benefits of local food production are not clear. Differences in transport distance are easily offset by differences in yields, land use practices, and storage costs necessary to supply locally-produced food through all seasons.

The main policy point here is that additional public funds to support local marketing are likely to provide only limited additional revenue for Delta agriculture. Most Delta crops are not suited for local food markets and unless longer term environmental and infrastructure concerns are addressed, investments in permanent tree and vine crops or in local marketing infrastructure are unlikely to be economically feasible. However, sometimes there are regulatory or other

unexpected barriers to production for local markets. It makes sense for local authorities to investigate rules to assure that untoward impediments that restrict growth of these markets are removed (Richter 2010).

Conversion of farmland towards the production of crops for biofuel

Despite the controversy regarding the economic and environmental benefits of biofuels, the use of agricultural output as an energy feedstock continues to be mandated and subsidized by government and promoted by some agricultural producers. Feed corn is grown throughout most of the Delta, and national corn demand has increase as ethanol consumption has increased, as growers anticipated several years ago (Trott 2007). It is worth evaluating whether farm acreage in the Delta should be converted towards the production of crops to be used as biofuels.

Key factors in the production of crops for conversion into biofuel are transport costs and the scale of local production to support efficient size of biofuel production facilities. Economies of scale in the production and transport of either corn or biomass crops requires more than one hundred thousand acres of local field production and a highly integrated road network to move feedstock from farms to the plant. Existing biofuel processing facilities in California tend to utilize grain from the Midwest. If production of these grains were to occur in the Delta, costs would be considerably higher than in the Midwest, and processing facilities would need to be local to the Delta to minimize transport costs (Richter 2010). Commercial production of next-generation biofuels from such feedstock as algae is not yet viable and no reliable objective projections of when such technologies may come on line are available.

Producers in California, including the Delta, do not have a comparative advantage in the production of biofuel feedstocks compared to producers elsewhere in the United States or the world. Recall that biofuel feedstock such as corn or, especially biomass, tends to generate relatively low revenue per acre. The Midwest of the United States has long had a comparative advantage in these crops. Nothing in the policy mandated demand for biofuels feedstock has changed those economic relationships. It is therefore unlikely that increased production of biofuel feedstock would occur in the Delta without significant local subsidies. In addition, the

livestock industry, especially local dairy production, is vulnerable to policies that shift crop resources from animal feed production to energy feedstocks.

Conversion of more Delta farmlands to biofuel feedstock production would retain agricultural production in the Delta and maintain it as a largely fresh water system. Agricultural production will face the same long-run problems of levee failures that will lead to either increasing reconstruction and maintenance costs or more abandoned islands. Environmental degradation of some areas of the Delta would continue as it has for the past several decades.

The main policy point here is that the Delta does not have a comparative advantage in the increasing production of crops for biofuel. The Delta already grows substantial amounts of corn for grain and silage and some of the local corn may be used in local biofuels plants currently operating. But, the local dairy industry uses most of the locally produced corn and the remaining production is not enough to supply plants of efficient scale. Switching additional production in the Delta to biofuel feedstock is unlikely without substantial local subsidy and the result would be encouragement for an expansion of relatively low revenue per acre crops that could be produced more efficiently elsewhere. In addition, water quality and delivery issues, land subsidence, and levee failures would continue to be major issues.

Ecotourism and management of the Delta for environmental purposes

If the Delta cannot be managed as a reliable source of water for agriculture, producers may begin the slow process of shifting to other sources for their irrigation water. A longer term vision for the Delta calls for gradual reduction of crop production as land is flooded or shifts to non-agricultural uses. In one scenario, water shipments through the Delta from pumping plants in the South Delta would also cease and the region would be allowed to revert to the natural conditions that existed there before the large-scale projects that transformed it for use by agricultural and urban users.

Federal court action in 2007 that pointed to the threat posed by pumping activities to the endangered Delta smelt and several other fish species reduced water exports from the Delta. It is likely that litigation centered on endangered species and threats to their wildlife habitat will

continue to disrupt deliveries in the future. Since many species are specifically adapted to the Delta habitat, the loss of such habitat is a serious issue for many environmental advocates. Some species, such as migratory waterfowl, use Delta habitat seasonally. The conversion of more of the Delta to a wildlife habitat would be environmentally beneficial for some species, but would likely reduce water exports through the Delta for users south of the Delta.

California's greenhouse gas (GHG) mitigation bill, AB32, may allow producers in the Delta to receive payments for halting agricultural production on their land. AB 32 imposes a cap and trade system for GHG emissions in California. Agriculture is not scheduled to be capped under this system, but if farms are able to show that they have reduced emissions they may be in a position to sell GHG reduction credits, or "offsets" to firms in other industries. No protocols for such credits trading are yet developed and it is not clear how abandoning agricultural production in favor of wildlife habitat or other environmental purposes would fare under AB 32 rules.

Growers may receive offset payments for the carbon-sequestering potential that their land offers, although they may be able to receive such payments even if they were to continue farming. Current market prices for similar offsets in other regions suggest revenue from offset trading is likely to be small. It is unclear whether producers could receive other compensation for allowing their land to revert to its natural state as a wildlife habitat. Current producers could gain much more revenue from special funding to encourage them to halt production and allow land conversion to wildlife habitat in the Delta, and these costs would largely be borne by taxpayers.

It is difficult to forecast whether ecotourist activities in the Delta would be a significant source of revenue. California already has an extensive state park system, indicating that there is demand for preserved and protected areas of nature. In 2007, the California's 278 state parks received about 79 million visits (Groves and McGreevy 2008). However, the lack of available funding has led to reduced services. Widespread closures in the park system were proposed in 2008. More are likely coming. Using scarce state funds to create new publically supported recreation areas seems unlikely in the near term. It is also difficult to foresee ecotourist activities in the Delta as capable of self-funding. As an ecotourist destination, the Delta would be competing with some of the most notable preserved nature destinations in the world, such as Yosemite National Park

and Redwood National and State Parks. Nonetheless, if ecotourism could generate significant revenues, such activities could provide funds for ecological conservation efforts.

The conversion of farmland in the Delta to wildlife habitat or a low-impact ecotourist destination does not necessarily mean the end of water exports through the Delta. However, such conversion would likely lead to an increase in environmental outflows and at least a partial reduction in exports. Lund et al. (2007) estimate that the end of exports would permit annual Delta outflows of about 18.7 million acre-feet (MAF) in 2050. Let us consider a conversion that would entail an end to all exports and that the Delta would be allowed to revert to something nearer to its natural state. In that scenario, levees would be abandoned and flooded islands would not be repaired. With an end to through-Delta water pumping, agricultural water users in the Delta would actually see an increase in water availability of about three percent (Lund et al. 2008) and there may actually be a small gain in farm acreage in the Delta. However, the abandonment of levees and islands would likely lead to the eventual conversion of the western Delta to open water with fluctuating salinity. An end to water exports would eliminate pumping costs, but overall statewide operating costs for irrigation would increase due to increased need for water desalinization and wastewater reuse. Lund et al. (2008) estimate annual statewide system operating costs of about $1.5 to $2.5 billion with an end to conveying water from Northern California through the Delta to the South. This compares to the status quo of $0.5 billion to $1.9 billion per year.

The end of pumping activity for exports would eliminate some environmental threats to the Delta Smelt and other aquatic species. The end of exports is the management option with the highest chance of restoring viable populations for the Delta Smelt and the Fall-Run Chinook Salmon. Lund et al. (2008) estimate that the ending of exports gives the Delta Smelt a 30-60 percent and the Fall-Run Chinook Salmon a 40-80 percent chance of reestablishing viable populations. The Sacramento and Trinity Rivers may see environmental benefits, but overall statewide environmental conditions may deteriorate because the use of water for environmental activities south of the Delta will become significantly more expensive or may no longer be possible without water exports.

Ecotourism or wildlife habitat designation throughout the Delta would likely mean an eventual phasing out of most of the Delta's farm economy. The curtailment of exports of irrigation water would also be costly for agriculture south of the Delta, especially in the San Joaquin Valley and the Tulare Basin. These areas would likely see significant loss of acreage and revenues as reduced water availability will raise water costs. Lund et al. (2008) estimate that the San Joaquin Valley alone would lose almost one million acres of irrigated crops and about $3.3 billion in farm revenues. Statewide, irrigated crop acreage could fall as much as 15 percent or by about 1.2 million acres with an end to water exports from the Delta.

A policy to encourage or allow the conversion of the Delta into wildlife habitat or into a low-impact ecotourist destination would reduce agricultural acreage and revenue in the Delta. Such a policy may be a low-cost option for public funds for infrastructure, but is not consistent with saving agriculture in the Delta. Eventually, much of the land that is now in agriculture would likely revert to open water. If such a process is delayed or occurs unexpectedly, costs would be even higher and many species will have already died out. However, if the process is planned and managed slowly, costs can be reduced.

Changes in Delta Salinity and the Effects of Salinity on Crops

Any plans to encourage additional sources of revenue for Delta agriculture are predicated on successful response to threats from increased salinity and flooding. We now turn to those issues and the key infrastructure needs to deal with them.

Lund et al. (2008) use hydrologic models to examine the effects that sea level rise, island flooding and water management have on salinity. Ending through-Delta pumping would substantially increase salinity in the South Delta due to saline drainage water from the San Joaquin Valley. Smaller diversions or no diversions would lead to an overall fresher Delta with more seasonal variability. A peripheral canal or dual conveyance would increase salinity in some areas and decrease it in other areas. However, eventually the rise in sea level (with expected climate change) would cause increased salinity even with a canal. Regardless of water management choice, physical forces will eventually limit Delta fresh water for urban or agricultural uses.

Currently, the highest salinity is in the west edge of the Delta. Rising sea levels that are expected to accompany climate change would cause saline waters to push further into the Delta, even with higher levees. Releasing more fresh water into the Delta would delay this intrusion, but not stop it. The flooding of islands in the Western Delta would lead to greater salinity of water pumped to the South Delta. The loss of islands in the East or South Delta seems to have little impact on salinity (Lund et al. 2008).

Ending conveying water through the Delta for shipments south would lower salinity in the North and West Delta, but would increase salinity in the South Delta because the higher salinity San Joaquin River water would no longer be diluted with fresher Sacramento River water. Seasonal variation in salinity would increase in the West Delta. The peripheral canal would lead to higher salinity in the South Delta for similar reasons; curtailing the pumping of fresh water from the Sacramento River into more saline San Joaquin flows would lead to higher salinity.

According to Lund et al. (2007), orchard acreage will fall significantly with increased salinity (by 10 fold), especially in the West and South Delta. Acreage of tomatoes, alfalfa and truck crops will fall throughout the Delta, but especially in the South Delta. Pasture acreage will fall in the North and West Delta, but rise significantly in the Central Delta. Field crop acreage will fall modestly, with the largest decrease occurring in the North Delta. Grain acreage will increase somewhat in the North, Central and West Delta, and will increase strongly in the South Delta. Acreage of wine grapes will fall in the North and South Delta. All these results follow from individual choices based on land that becomes less suited for current uses as salinity increases.

Flooding and Reduced Agricultural Acreage in the Delta

Lund et al. (2007, 2008) provide information on specific regions in the delta are subject to high long run pressures on levees and which are likely to be flooded. Counting acreage for islands and tracts that face moderate or high long-term levee pressure allows us to estimate agricultural acreage prone to significant long term threat of flooding. About 100 thousand acres or about one fourth of irrigated crop acreage in the Delta fits this category. Most of this acreage is in field crops, including grains and hay, about 10 thousand acres is pasture and about 15 thousand acres is in fruits and vegetables.

If all at-risk islands and tracts are flooded (as Lund et al. (2008) predict will happen over the next decades), more than half of all Delta agricultural acreage would be removed from production with a distribution similar to that shown above. Many of the effects of salinity will occur in the same regions where flooding is likely. However, salinity increases are also predicted for the South Delta, which faces less risk of flooding.

Infrastructure Investment to Avoid Flooding and Salinity Losses

Maintaining Delta agricultural acreage would require substantial investment in levees and related infrastructure. Lund et. al. (2008) estimate that through-Delta exports in 2050 would average about 6 MAF per year and Delta outflows would average about 13.3 MAF per year if current management policies continue. For the current flows and for agriculture in the Delta to be maintained in the short run would require limited new investments. However, it is very likely

that levee failures would occur and the likelihood of levee failure will increase with time. Indeed, few of the levees in the 1100 mile Delta system meet modern engineering standards. To keep the levee system functioning would require an initial investment of about $1 billion for infrastructure to meet minimum standards to protect essential islands (Lund et al. 2007). More would be needed to address challenges of new flooding and salinity threats. For example, to allow the levee system to protect essential islands for a longer period would cost about $4 billion and even this would not protect all agricultural land in the Delta. This would involve upgrading levees around urban areas to meet 200-year level protection and levees around islands that are deemed essential for a freshwater Delta to the Dutch-model, offering protection at the 1,250 to 10,000-year level. However, eventually, weaker levees will fail and some islands will be abandoned, given the cost to repair them relative to the value of the land and the value of economic activity that the levees protect (Logan 1989, Lund et al. 2007 and 2008).

To put these numbers in perspective, if all 100,000 acres prone to significant long term threat of flooding were saved, the cost of $1 billion is $10,000 per acre. If the $1 billion investment protected all 250,000 acres at risk in the Delta, the cost would be $4,000 per acre. Irrigated crop land in the Delta is worth about $5,750 per acre and comparable crop land in the nearby counties is valued roughly between $7,000 and $10,000 for field crop land, which is most of the land that is likely to be lost from production (Table 1 from ASFMRA 2010). With a cost of $4 billion to permanently protect the vulnerable 250,000 acres, the cost is about $16,000 per acre – far in excess of the value of the land (Table 1). These costs, as large as they are, do not include normal costs of maintenance and repair.

It is hard to justify spending public money to keep land in farming that is in excess of the value that farmers and landowners themselves place on the land.

The Peripheral Canal

The Delta could also be maintained as a mainly fresh water system if a peripheral canal is constructed that would draw water from the Sacramento River and divert it to the Central Valley Project (CVP) and Statewide Water Project (SWP) canal intakes. Many in-Delta farmers in Northern and Eastern Delta are unlikely to be directly affected by a peripheral canal, but

Western, Central, and Southern Delta farmers could see increases in San Joaquin River salinity. A peripheral canal would significantly reduce salinity of water exported south of the Delta, but exports would be limited by the export capacity of the CVP and SWP aqueducts. If water exports conveyed through the Delta decrease, water availability may increase for agricultural producers in the Delta and the area may see a small gain in crop acreage. A peripheral canal would remove the environmental issue of pumping activity, allowing improved in-Delta flows for ecosystem purposes. Lund et al. (2008) estimate that a peripheral canal provides a 10-40 percent likelihood that the Delta Smelt will maintain a viable population and a 20-50 percent likelihood that the Fall-Run Chinook Salmon will do the same. Only the complete elimination of exports offers a higher likelihood of maintaining viable fish populations.

The idea of a peripheral canal was first put forward in the mid-1960s but the controversial project was voted down by Californians in a 1982 ballot initiative. In 2011, the idea of a peripheral canal or tunnel was revived. Initial reports describe plans for a pair of 43 mile tunnels, possibly as large as 33 feet in diameter that would cost about $12.3 billion to construct (Leavenworth 2011). In 2008, Lund et al. estimated construction costs on the order of $10 billion and annual operating costs for the canal of between $250 and $850 million.

High Commodity Prices, Farm Programs and Delta Agriculture

Since 2007, grain, oilseed and other field crop prices have been high by historical standards and these crops have become profitable alternatives in the Delta as elsewhere (Figure 3). The long term projections released by USDA in February 2011, summarized in Table 2, indicate continued relatively high prices over the next decade for grains and oilseeds and other crop and livestock commodities (USDA, WAOB 2011). The California price of corn, which is now more than double the pre-boom prices, is projected to remain more than 50 percent above the average prices from 2003 to 2006 (Figure 3). Wheat prices are similarly high and that is also true for oilseed crops. As grain and oilseed prices have increased and are projected to remain high, prices of hay and silage have also increased, even though their markets tend to be more local.

Based on high prices, the USDA projects net return per acre for grain and oilseed crops to remain quite high for the next decade. Under those conditions, field crop growers have less incentive to

shift the crop mix or undertake practices that might reduce yields. Of course, deteriorating productivity or a disastrous event related to the vulnerability of the Delta to its environmental situation would imply major changes, including willingness to abandon some acreage or shift land to environmental or conservation uses.

Tree fruits, tree nuts, and vegetable prices have not experienced the recent spike that has affected markets for field crops (Figure 4). That means the relative prices and net revenues per acre for field crops are currently very high compared to their traditional relationships with prices and revenues for horticultural crops. USDA projects that prices for horticultural crops will rise modestly over the next decade, roughly in line with inflation, thereby maintaining their relationship with production costs (Table 2). The impact of these price and revenue patterns across crops is that, using official USDA data and projections, there seems to be little economic incentive to shift field crops to horticultural crops in the Delta. Moreover, with very high farm prices and net revenues generally, growers have strong incentives to maintain or increase production in the short run (Vilsack 2011).

The policy implications of current high farm prices and projections over the next decade are that growers in the Delta are likely to resist changes that reduce their ability to maintain and perhaps expand production of field crops and other commodities. Growers recognize that farm returns are variable and times of favorable economic conditions offset inevitable periods of low returns that are likely to occur. Periods of low grower returns are more suitable for significant reductions in agricultural acres or for significant changes in crop mix or other farming practices.

As with most of California agriculture, the crops grown in the Delta have relatively little federal farm subsidy. The price based federal subsidy programs for grains and oilseeds have not been active in recent years because market prices have been high relative to government set benchmarks. Direct payments that are provided regardless of price or which crops are grown have continued for Delta land that has a historical base in one of the grain or oilseed program crops. However, the payments per acre are low for Delta agriculture relative to payments for land that has a history of producing rice or cotton. These payments place relatively small impediment to shifting the crop mix in the Delta.

Other federal government agricultural programs may affect land use in the Delta for some farms in some specific locations. Environmental support under the Environmental Quality Incentive Program (EQIP) and the Conservation Stewardship Program (CSP) could potentially provide growers with funds to help offset costs of improving environmental security for working lands. However, funding for these programs is small in California. The EQIP provided $57 million in funds for about 1,700 cost share contracts for California growers over the 1999 to 2009 period. Almost 7,000 applications were unfunded and even the funded activities are not suited for large scale projects affecting a full region (NRCS 2010). The CSP is a very small program with only a few million in outlays for all of California.

The Wetlands Research Program (WRP) is designed to remove land from production to restore wetlands and enhance ecosystem services. However, in California fewer than 10,000 acres were enrolled in the WRP in 2009 (NRCS 2010a). This program has no ability to provide funds needed for full Delta restoration even if the objective was to remove agricultural land from production.

Federal agricultural programs aimed at environmental objectives are not suited for protecting agriculture in the Delta.

Summary of Policy Implications for Delta Agriculture

Delta agriculture faces the same economic challenges to agricultural viability and sustainability that occur everywhere. In addition, the Delta must respond to a unique confluence of environmental and legal concerns that mean current practices and policies are unlikely to continue in the long term. As an agricultural issue, dealing with policy in the Delta relates not only to agriculture in the Delta itself, but also, and perhaps more importantly, to agriculture throughout the Central Valley of California.

This section summarizes the main policy points and implications raised above.

- The main policy option for maintaining Delta agricultural acreage in the face of likely flooding and salinity problems is to build a stronger and more reliable levee system that would withstand the increased pressures on the horizon. The main question then is the degree to which the economic and other contributions of Delta agriculture can justify the expenditures.

- Delta agriculture is comprised mainly of crops grown for livestock feed as well as other field and row crops. The main policy implication is that agriculture in the Delta has been tailored to local conditions and demands. Growers have found these crops offer the highest potential profits.

- Using public funds to encourage agritourism faces several challenges. Recreational activities in general could supplement some agricultural output as a source of revenue for the region, but this is unlikely to be agriculturally-based tourism. The crop mix in the Delta is not well suited to typical tourist activities. The main policy challenge is that long term policies consistent with environmental health of the region are unlikely to be consistent with maintaining crop acreage and some of the land subject to flooding or other problems is likely to be land most suited for tourists.

- Additional public funds to support local marketing are likely to provide only limited additional revenue for Delta agriculture. Most Delta crops are not suited for local food markets and unless longer term environmental and infrastructure concerns are addressed, investments in permanent tree and vine crops or in local marketing infrastructure are unlikely to be economically feasible.

  Sometimes, however, there are regulatory or other unexpected barriers to production for local markets. It makes sense for local authorities to investigate rules to assure that untoward impediments that restrict growth of these markets are removed.

- The Delta does not have a comparative advantage in the production of crops for biofuel. The Delta already grows substantial amounts of corn for grain and silage and some of the local corn may be used in local biofuels plants currently operating, but to use policy initiative to encourage relatively low value per acre production of biomass or other agricultural feedstock for bio energy is not likely to be successful without large subsidy.

- A policy to encourage or allow the conversion of the Delta into wildlife habitat or into a low-impact ecotourist destination would reduce agricultural acreage and revenue in the Delta. Such a policy may be a low-cost option for public funds for infrastructure, but is not consistent with saving agriculture in the Delta. Eventually, much of the land that is now in agriculture would likely revert to open water. If such a process is delayed or occurs unexpectedly, costs would be even higher and many species will have already died out. However, if the process is planned and managed slowly, costs can be reduced.

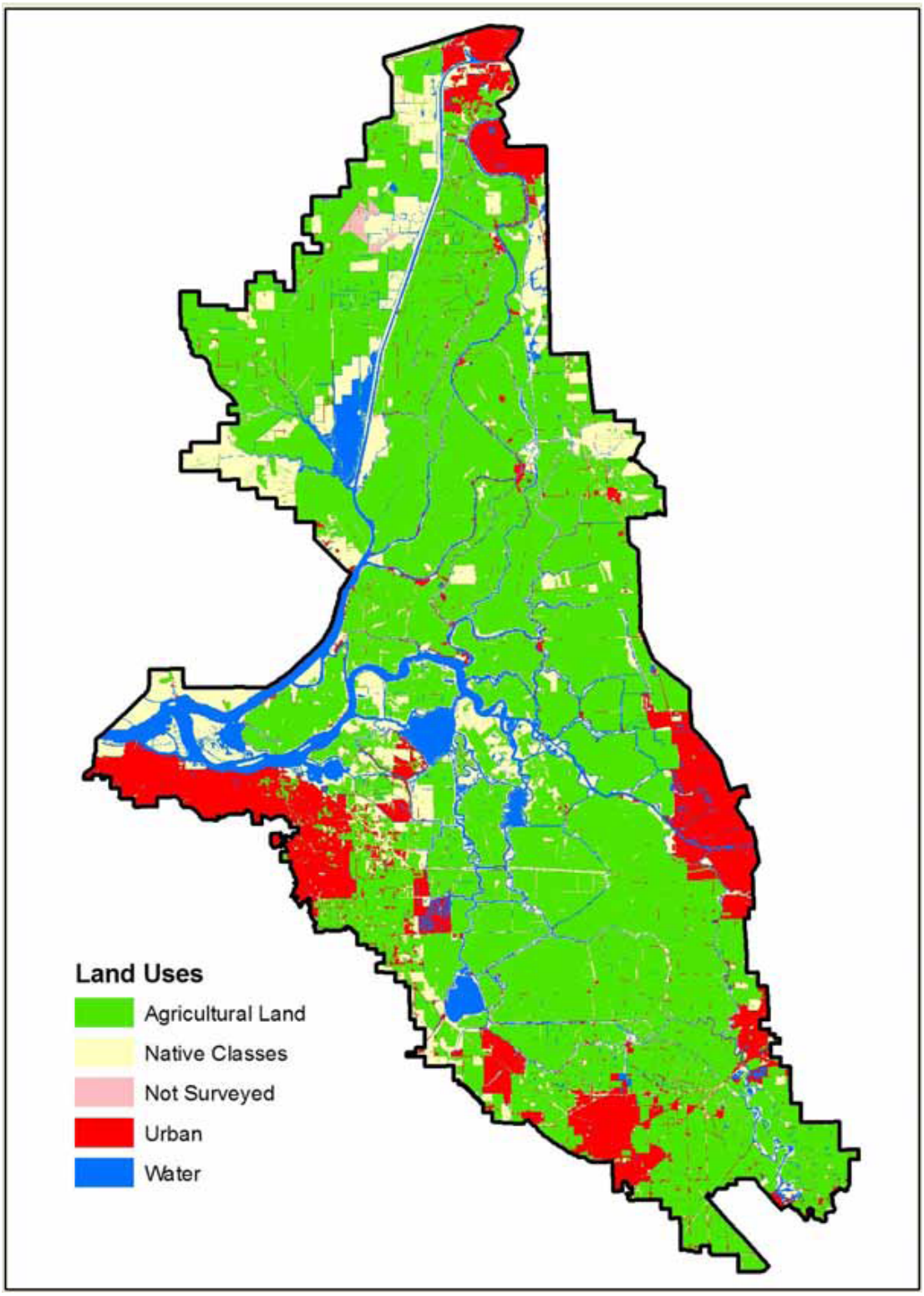
- Substantial investments to rebuild levees are likely to be prerequisites for continued farming on vulnerable lands in the Delta. But relatively straightforward comparisons of land values and infrastructure costs indicate that it would be hard to justify spending public money to keep land in farming when the costs would be in excess of the value that farmers and landowners themselves place on the land.

- High current and projected farm prices indicate that growers in the Delta are likely to resist changes that reduce their ability to maintain and perhaps expand production of field crops and other commodities over the next decade. Farm returns are variable and times of favorable economic conditions offset inevitable periods of low returns that are likely to occur. Periods of low grower returns are more suitable for significant reduction in agricultural acre or for significant changes in crop mix or other farming practices.

- Federal environmental programs for agriculture are unlikely to provide funds or assistance for the kind of infrastructure or related changes needed to sustain Delta agriculture. These programs are oriented to small on-farm projects or to removing land from farming, not for large-scale efforts such as would be needed to maintain the current size and configuration of Delta agriculture.

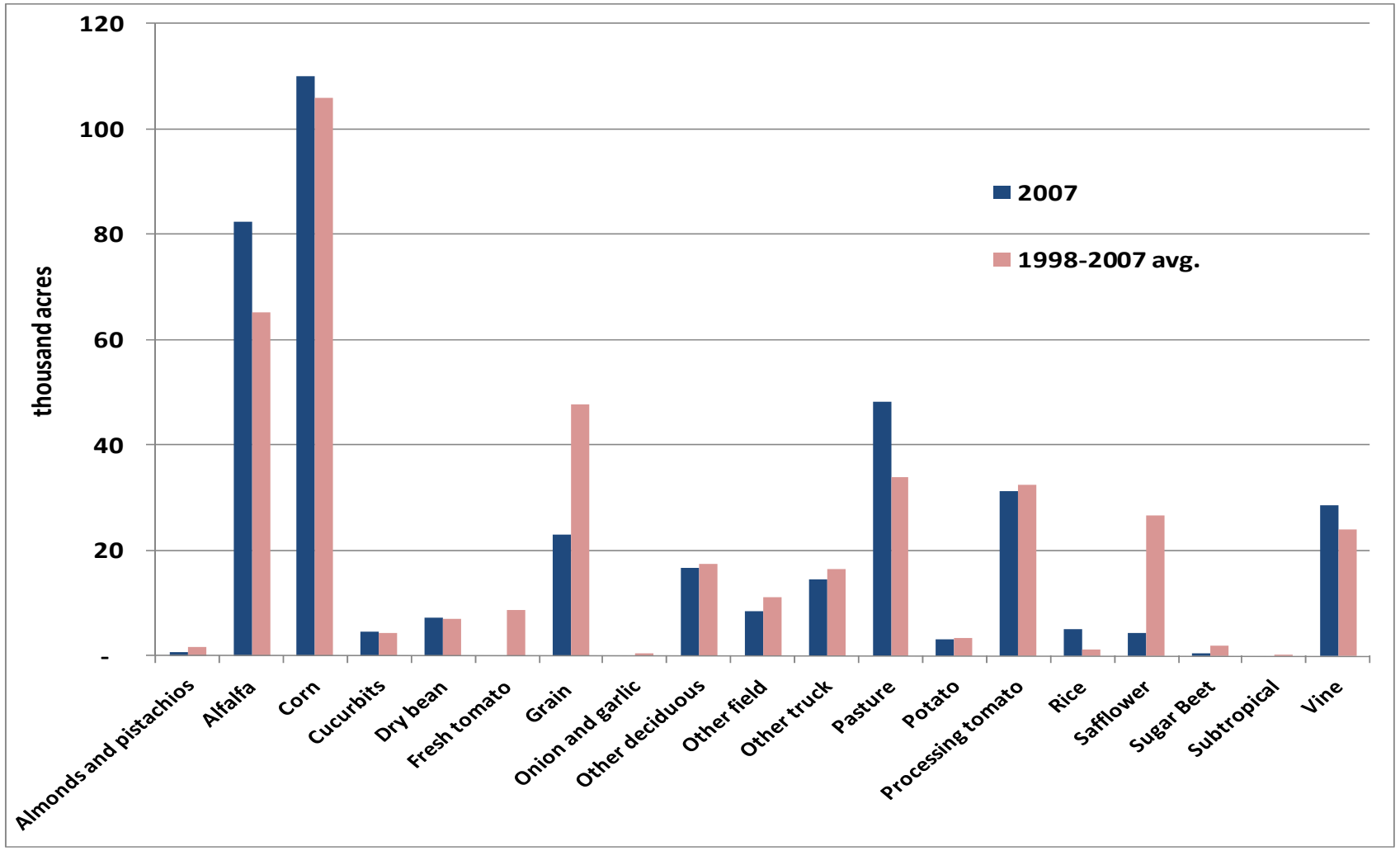
The environmental and agricultural challenges facing the Delta continue unabated. The dilemma of how to move water from Northern California to Southern California demands a long term solution that does not aggravate environmental and agricultural concerns in the Delta itself. Delta agriculture also faces implications of climate change that are as challenging as for any other region. The result is that the acreage devoted to agriculture in the Delta is likely to decline over the long term because costs to rebuild the elaborate levee system are simply too high. The result is likely to be a small but more sustainable Delta agriculture that can be a vibrant contributor to the local and statewide rural and agricultural economy.

Figure 1: Land use in the Delta, 2007



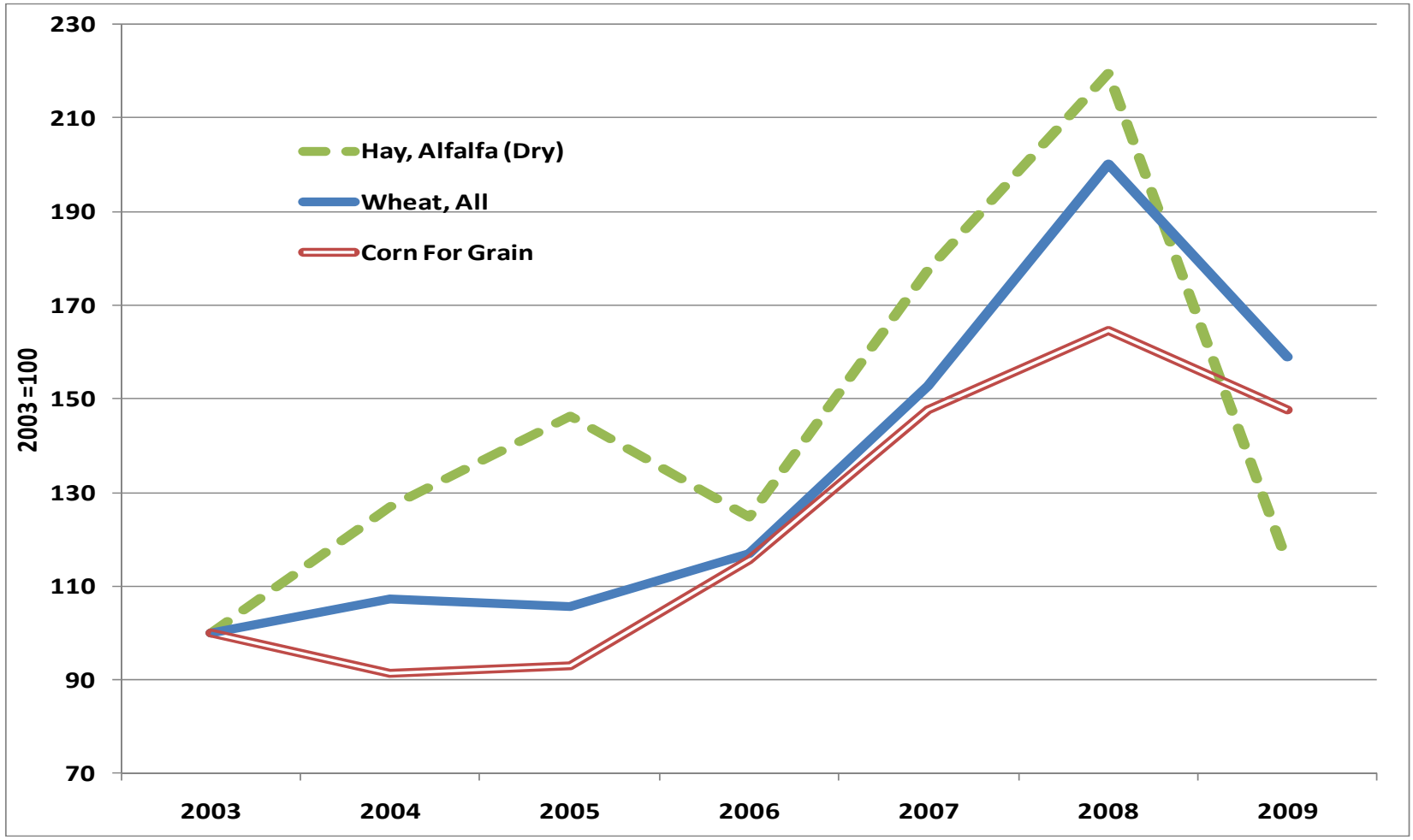
Source: CDWR 2007. "Past and Present Land Uses in the Sacramento-San Joaquin Delta and Suisun Marsh." Water Plan Land and Water Use Work Team.

Figure 2: Acreage in the Legal Delta by crop group for 2007 and 1998-2007 average



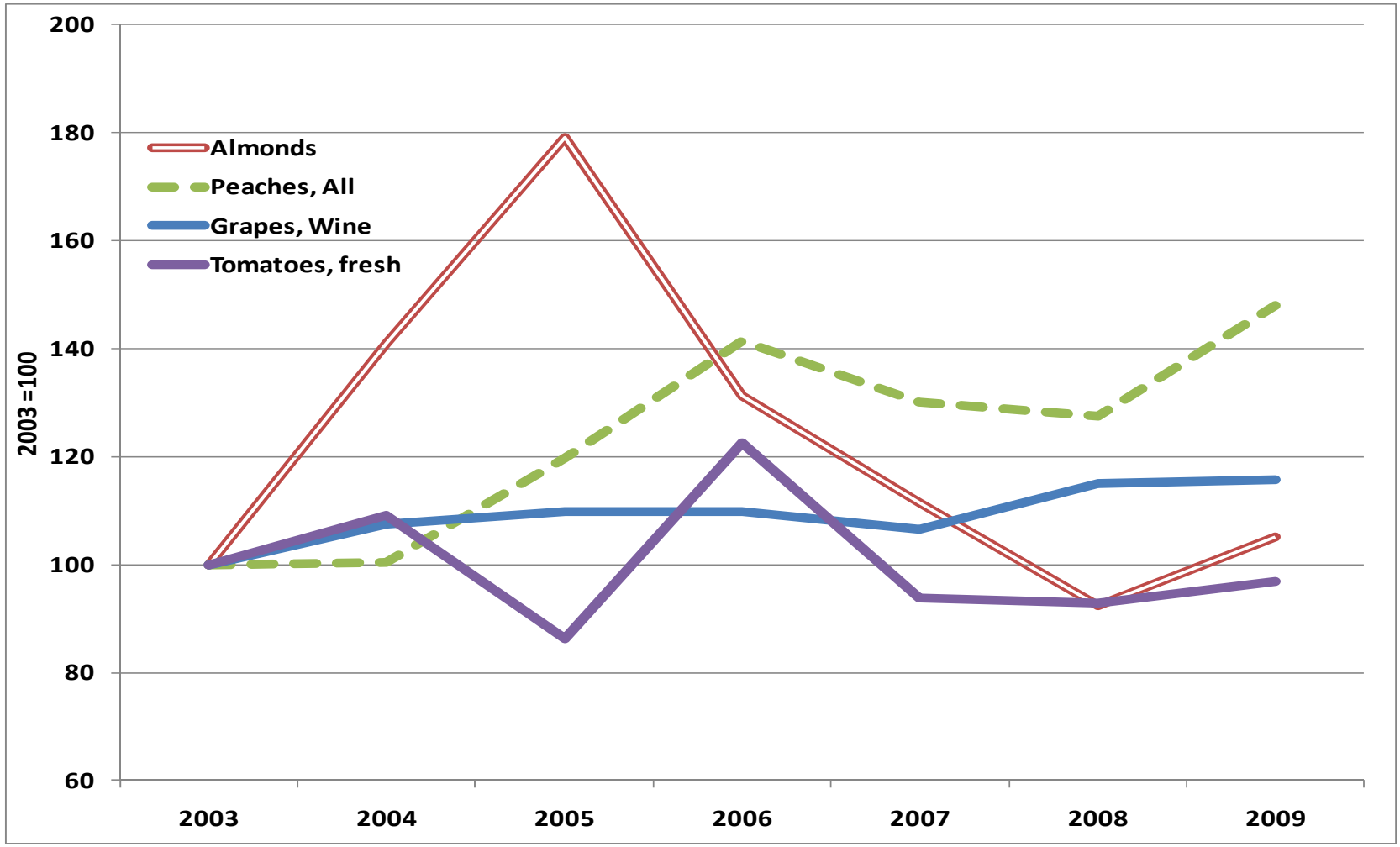
Sources: CDWR. 2009. "Annual Land & Water Use Estimates." California Water Plan Update 2009.
CDWR 2007. "Past and Present Land Uses in the Sacramento-San Joaquin Delta and Suisun Marsh." Water Plan Land and Water Use Work Team.

Figure 3: California prices for all wheat, corn for grain, and alfalfa hay by marketing year



Source: National Agricultural Statistics Service, USDA. 2011. "QuickStats." http://www.nass.usda.gov/Data_and_Statistics/index.asp
Note: Marketing year for wheat is June 1 through May 31; for corn - September 1 to August 31; and for alfalfa hay - April 1 to March 31.

Figure 4: California prices for almonds, all peaches, winegrapes, and fresh tomatoes by marketing year



Source: National Agricultural Statistics Service, USDA. 2011. "QuickStats." http://www.nass.usda.gov/Data_and_Statistics/index.asp
Note: Marketing year for almonds is August 1 through July 31; for peaches - June 1 to September 30; for winegrapes - July 1 to June 31; and for tomatoes - May 1 to November 30.

Table 1: Land values, rent ranges and ratio of rent to land values for Delta and other cropland, 2009

County	Land	Values per acre	Median value per acre	Rent range	Median rent	Ratio of rent to land value
San Joaquin	Delta lands	$3,500-$8,000	$5,750	$150-$175	$162.50	35.38
San Joaquin	Cropland, westside	$8,000-$12,000	$10,000	$150-$200	$175	57.14
Solano and Yolo	Irrig. field crops	$3,000-$10,700	$6,850			

Source: American Society of Farm Managers and Rural Appraisers (ASFMRA). 2010.

Table 2: USDA long-term projections of U.S. commodity prices and net returns

Marketing Year	Corn		Wheat		Calendar Year	Non-citrus fresh fruits	Tree nuts	Vegetables	Fresh Vegetables	Pulses (dried)
	Price	Net returns	Price	Net returns		Producer Prices				
	($/bu.)	($/acre)	($/bu.)	($/acre)		2009=100				
2009	3.55	286	4.87	88	2009	100.0	100.0	100.0	100.0	100.0
2010	5.20	515	5.50	130	2010	114.8	103.4	112.0	115.1	92.6
2011	4.80	474	6.50	152	2011	115.9	104.4	114.0	108.2	101.3
2012	4.30	395	5.90	125	2012	117.1	105.4	115.0	110.3	111.7
2013	4.10	367	5.55	109	2013	118.2	106.4	116.0	112.4	112.6
2014	4.10	370	5.45	104	2014	119.4	107.5	117.0	114.5	113.5
2015	4.10	374	5.45	104	2015	120.5	108.5	117.9	116.6	114.4
2016	4.15	384	5.50	105	2016	121.7	109.6	118.9	118.7	115.3
2017	4.20	396	5.50	104	2017	123.0	110.7	119.9	120.7	116.2
2018	4.25	407	5.55	105	2018	124.2	111.7	120.8	122.7	117.1
2019	4.25	410	5.55	104	2019	125.5	112.8	121.8	124.8	118.0
2020	4.25	412	5.60	105	2020	126.7	113.9	122.8	126.8	119.0

Source: World Agricultural Outlook Board, USDA. 2011. *USDA Agricultural Projections to 2020.* Available at: http://www.usda.gov/oce/commodity/ag_baseline.htm

Note: Marketing year for corn is September 1 to August 31; for wheat - June 1 to May 31. Indexes for calendar year crops reindexed so that 2009=100

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