Attachment 1: Output/Outcome Performance Measures Reporting Highlights

This attachment provides a full reporting of the subset of Delta Plan output/outcome performance measures listed in the table below.

Delta Plan Chapter	Type	Performance Measure
3. Water Supply Reliability		
	Outcome	▪ Urban Per Capita Water Use Reduction
4. Ecosystem Restoration		
	Output	▪ Acres of Habitat Restored
5. Delta as an Evolving Place		
	Outcome	▪ Acres of Farmland Loss
	Output	▪ Acres of Subsidence Reversal Projects
6. Water Quality		
	Outcome	▪ Dissolved Oxygen
	Outcome	▪ Salinity Trends
7. Risk Reduction		
	Output	▪ Multi-Hazard Coordination Task Force

Quantitative and qualitative information is included, organized to answer the following key questions:

- Why is this measure important?
- How is progress tracked?
- What do the results tell us?
- What are the recommended next steps?

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Urban per Capita Water Use Reduction

Delta Plan Performance Measures Highlights
Chapter 3 – A More Reliable Water Supply for California

Improved management of the state's water resources, including water conservation and efficiency, is central to the state's ability to better match its demands to the amount of supply that is available.

Why is this important?

The coequal goals of the Delta Reform Act include providing a more reliable water supply for California. To support the achievement of this goal, the Urban per Capita Water Use Reduction performance measure (PM) will mirror the Water Conservation Act of 2009 (SB X7 7) legislative mandate; specifically:

- Achieve a 20 percent reduction in urban per capita water use by 2020.
- Demonstrate incremental progress by reducing urban per capita water use by at least 10 percent by 2015.

Increasing water use efficiency is a key legislative mandate, as one of the means to reduce reliance on the Delta for water supply. This PM provides valuable, albeit partial information on the success of implementing these core strategies:

- Increase water conservation and expand local and regional supplies
- Improve water management information

Knowledge gained on urban water use will help implement recommendation WR R6 in the Delta Plan: update water efficiency goals, and provide information for a related performance measure to set expanded future goals on water conservation and water use efficiency.
In April 2014, the Governor proclaimed a drought emergency and issued an Executive Order directing the State Water Resources Control Board (SWRCB) to adopt emergency regulation to ensure that urban water suppliers implement conservation measures. In April 2015, the Governor issued an Executive Order that called for a 25 percent average statewide reduction in potable urban use compared to use in 2013.

This PM is chosen for reporting to the Council in August 2015 primarily because of the drought urgency. This report serves to both complement and contrast the SWRCB's reporting on urban water use due to differences in baselines and targets.

How is progress tracked?

Progress in meeting the performance measure target of 20 percent reduction by 2020 (20x2020) will be tracked through gross water use data submitted by urban water suppliers in their 2015 and 2020 Urban Water Management Plans (UWMPs). For each urban water supplier to adopt a historical baseline and 2020 target, the Department of Water Resources (DWR) developed methodologies for calculating urban per capita use.

The baselines, as stated in the 2010 UWMPs, generally reflect average use over a historical 10-year period around the mid-1990s to mid-2000s. The targets vary among the urban water suppliers, depending on the chosen methodology. Figure 4 in the following section shows the population-weighted average baselines and targets statewide and for each hydrologic region. Urban water suppliers are scheduled to file their 2015 UWMPs by July 2016, including their interim achievements in meeting the 20x2020 targets.

In light of the current drought, Council staff decided to develop an interim report on this PM despite the lack of 2015 UWMP data. The SWRCB has been collecting water production data from urban water agencies since June 2014 as part of the 2014 drought emergency declaration. The SWRCB reports monthly on estimated residential per capita water use in 2014-15 compared to use in the same periods in 2013. Making use of this set of "drought data," a comparison is made between the total water production in 2014-15 and 2013 to the UWMP-adopted historical baselines and 20x2020 targets, as shown in Figure 4. The water production data are expressed in the unit of gallons per capita per day (GPCD), and are higher in value than the estimated residential use because total water production includes non-residential uses.

The 20x2020 PM is intended to show progress in urban water use reduction at two snapshots in time: 2015 and 2020. Council staff also accessed annual water production data filed by public water systems under the SWRCB's Drinking Water Program. The 2010-2012 data are also analyzed and arrayed against the UWMP-adopted baselines to show trends in urban water use over time, as shown in Figure 4.

What do the results tell us?

Based on the preliminary drought data[1] collected by the SWRCB for the 12-month period of June 2014 to May 2015, population-weighted average[2] reduction in water production for urban use in each hydrologic region and statewide have exceeded the UWMP-adopted 2020 targets. Figure 1 shows the 2014-15 water production compared to the historical baseline use and to the 2020 use targets for each hydrologic region and statewide.

Reduction in urban water production in 2013 has exceeded the 2020 targets in six of the ten hydrologic regions. Statewide reduction in urban water production met the UWMP-adopted statewide target. However, water use patterns are heavily influenced by precipitation and supply availability. Once drought restrictions are lifted, water use may increase.

Based on preliminary data from the Public Water Systems Statistics, urban water production in 2010 to 2012 show variations across the different hydrologic regions and across the three-year time period. Nevertheless, water production stayed below the historical baseline use despite the economic recovery and growth after the recession. Figure 2 shows the 2010 to 2014-15 water production compared to the historical baseline use and to the 2020 targets for each hydrologic region and statewide. Figure 3 shows the statewide annual average production trend compared to the statewide average historical baseline and statewide average 2020 targets.

Because of differences in data sources and the preliminary nature of the drought data and the public water systems statistics, the results shown in this report should be regarded as preliminary and qualitative in nature.

[1] June 2014 to May 2015 and 2013 data posted 7/1/2015 on SWRCB drought water conservation reporting portal http://www.waterboards.ca.gov/water_issues/programs/conservation_portal/conservation_reporting.shtml

[2] Water production by each urban water agency is weighted by population served relative to the total population in the hydrologic region in calculating population-weighted average production in GPCD. Population-weighted average water production in each hydrologic region is weighted by population within the region relative to the total statewide population in calculating population-weighted statewide average production in GPCD.

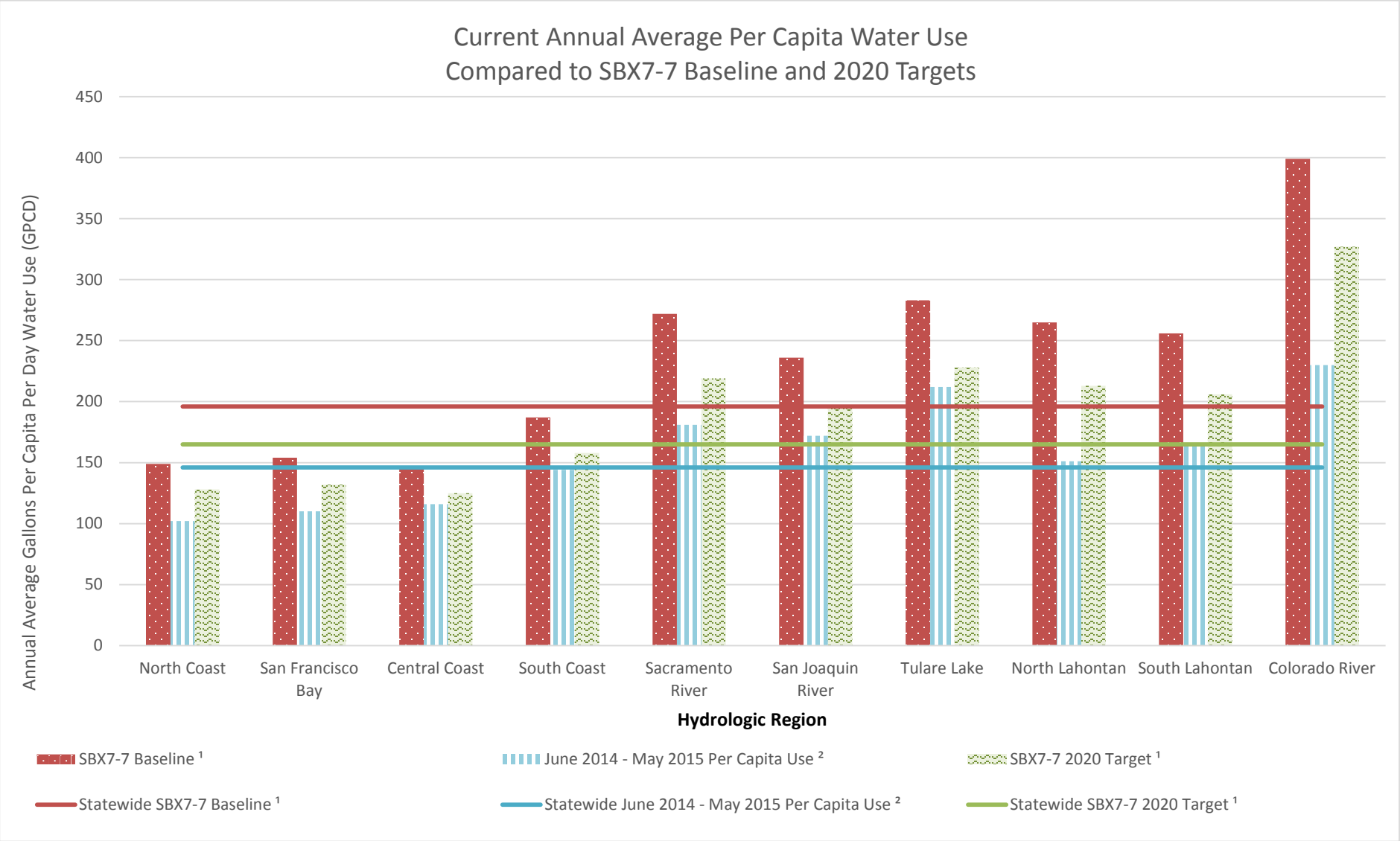


Figure 1.

1. SBX7-7 baseline and targets were aggregated from individual Urban Water Management Plan baselines and targets.
2. The most current annual average per capita water use was compiled from SWRCB's conservation reporting posted 7/1/15 and spans June 2014 through May 2015.

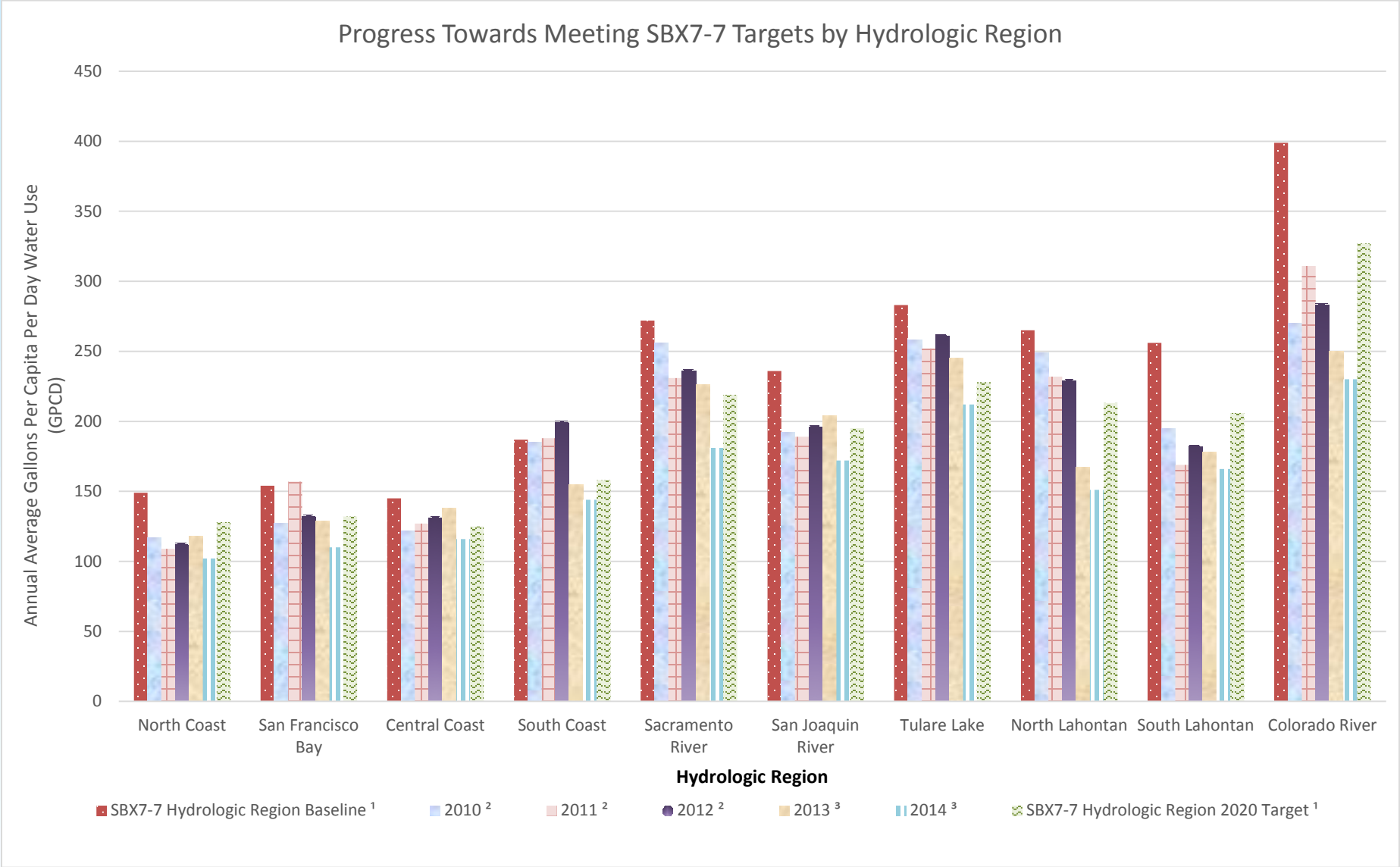


Figure 2.

1. SBX7-7 baseline and targets were aggregated from individual Urban Water Management Plan baselines and targets.
2. Data for 2010 through 2012 was compiled from DWR's preliminary Public Water System Statistics.
3. The data for 2013 and May 2014–June 2015 was compiled from SWRCB's conservation reporting posted 7/1/15.

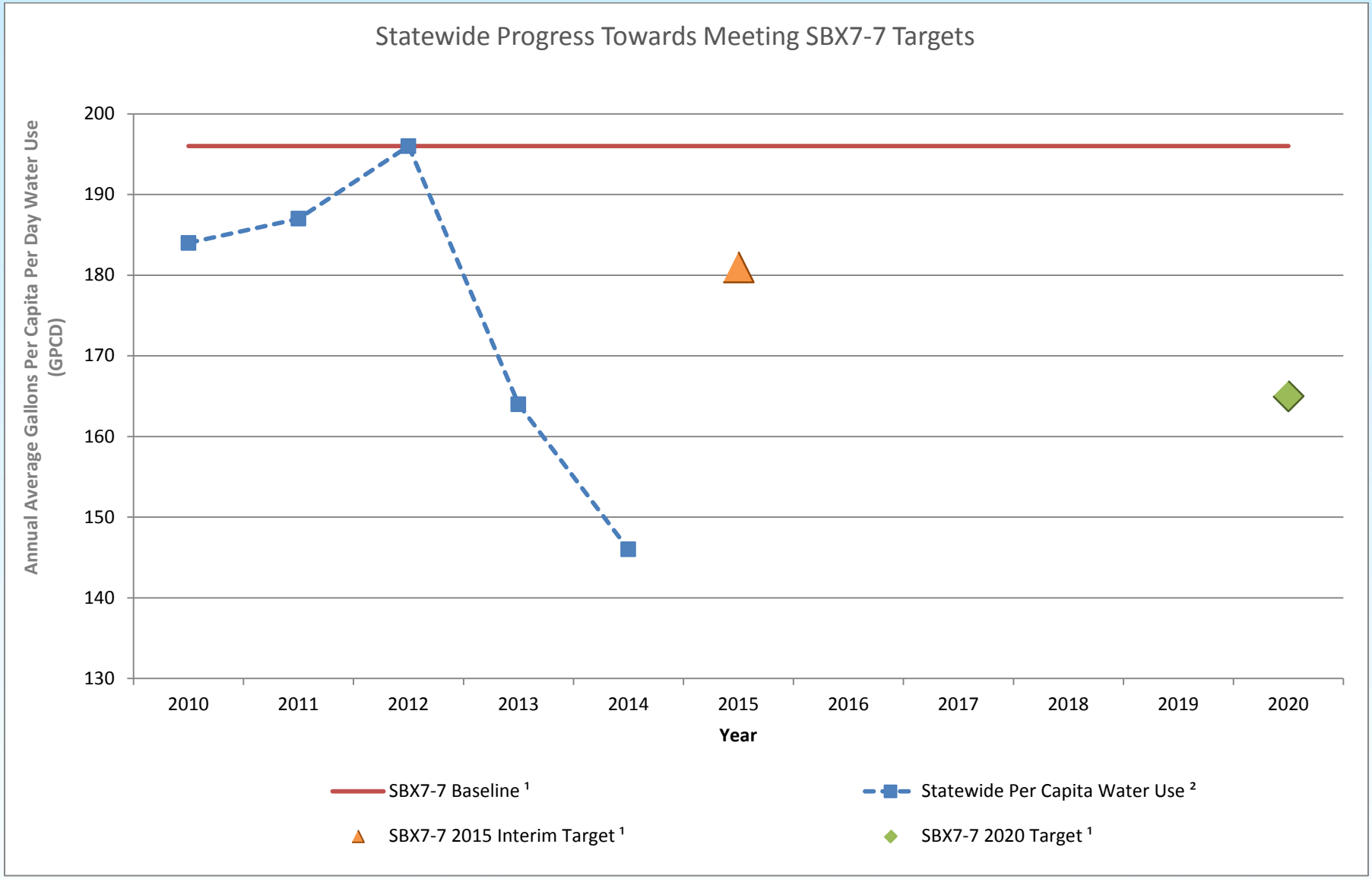


Figure 3.

1. SBX7-7 baseline and targets were aggregated from individual Urban Water Management Plan baselines and targets.
2. The data for 2013 and May 2014–June 2015 was compiled from SWRCB's conservation reporting posted 7/1/15. Data for 2010 through 2012 was compiled from DWR's preliminary Public Water System Statistics.

Data compiled by DWR from 2010 Urban Water Management Plans			Data compiled by SWRCB per 2014 drought declaration				Preliminary data compiled from Public Water Systems Statistics					
Adopted Baselines and Targets by Hydrologic Region (data as of 11/20/14)												
Averaged gross water use data and weighted by population			Urban water production data (posted 7/1/15) June 2014 to May 2015		2013 Urban water production data (posted 7/1/15)		2012		2011		2010	
Hydrologic Region	Average Baseline Use (GPCD) [1]	Average 2020 Use Target (GPCD) [1]	Annual Average Per Capita Use (GPCD) [2]	% Reduction in production from UWMP baseline	Annual Average Per Capita Use (GPCD) [2]	% Reduction in production from UWMP baseline	Annual Average Per Capita Use (GPCD) [3]	% reduction from UWMP baseline	Annual Average Per Capita Use (GPCD) [3]	% reduction from UWMP baseline	Annual Average Per Capita Use (GPCD) [3]	% reduction from UWMP baseline
North Coast	149	128	102	32%	118	21%	113	24%	109	27%	117	21%
San Francisco Bay	154	132	110	29%	129	16%	133	14%	157	2%	127	18%
Central Coast	145	125	116	20%	138	5%	132	9%	127	12%	122	16%
South Coast	187	158	144	23%	155	17%	200	7%	188	1%	185	1%
Sacramento River	272	219	181	33%	226	17%	237	13%	231	15%	256	6%
San Joaquin River	236	195	172	27%	204	14%	197	17%	189	20%	192	19%
Tulare Lake	283	228	212	25%	245	13%	262	7%	252	11%	258	9%
North Lahontan	265	213	151	43%	167	37%	230	13%	232	12%	249	6%
South Lahontan	256	206	166	35%	178	30%	183	29%	169	34%	195	24%
Colorado River	399	327	230	42%	250	37%	284	29%	311	22%	270	32%
Statewide Weighted Average	196	165	146	26%	164	16%	196	0%	187	5%	184	6%

Figure 4. Comparison of SBX7-7 baselines and targets to annual average water use statewide and by hydrologic region.

1. SBX7-7 baseline and targets were aggregated from individual Urban Water Management Plan baselines and targets.
2. The most current annual average per capita water use was compiled from SWRCB's conservation reporting posted 7/1/15 and spans June 2014 through May 2015.
3. Data for 2010 through 2012 was compiled from DWR's preliminary Public Water System Statistics.

Notes on SWRCB drought reporting data:

1. *Deleted 2 suppliers <10% residential: Humboldt Bay and Vernon*
2. *Tahoe City population is averaged over 10-month period in 2014 because of wide fluctuation*
3. *Population weighted means GPCD * population served/total population in the HR*
4. *Statewide population weighted average means GPCD * population within HR/total statewide population*

Next Steps

- Staff will report on this PM when the 2015 UWMP data becomes available in late 2016.
- The Council should consider refining the PM to:
  - Extend the 2020 sunset date.
  - Consider long-term average targets rather than single year targets.
  - Work with the Legislature, DWR and the SWRCB to establish and adopt a more frequent reporting requirement on urban water production and use.
  - Work with the Legislature, DWR and others to establish and adopt reporting requirements on agricultural water use that encompass both surface water and groundwater use.

Acres of Habitat Restored

Delta Plan Performance Measures Highlights
Chapter 4 – Protect, Restore and Enhance the Delta Ecosystem

Past land and water uses have compromised the Delta's ecosystem and water quality. Restoration projects must be implemented and progress measured in strategic areas:

- **Habitat**
- **Delta Flows**
- **Water Quality**
- **Species**
- **Hatcheries**

Why is this important?

Ecosystem protection, restoration, and enhancement is one of the coequal goals of the Delta Plan. To achieve this goal, the Number of Acres of Habitat Restored performance measure (PM) will:

- Measure the progress of pilot scale project implementation in Priority Habitat Restoration Areas (PHRAs).
- Ensure the utilization of adaptive management practices in restoration projects.
- Inform whether strategic investments are being made to restore the Delta.

This PM will provide a valuable opportunity to assess initial restoration efforts and apply lessons learned to future, large-scale ecosystem restoration projects and programs proposed for the Delta. Additional PMs will be implemented in the future and will focus on achieving the greater acreage targeted under the BiOps. These additional PMs will also encompass assessments of broader ecological functions in their metrics, since acreage targets alone are not sufficient to evaluate restoration success.

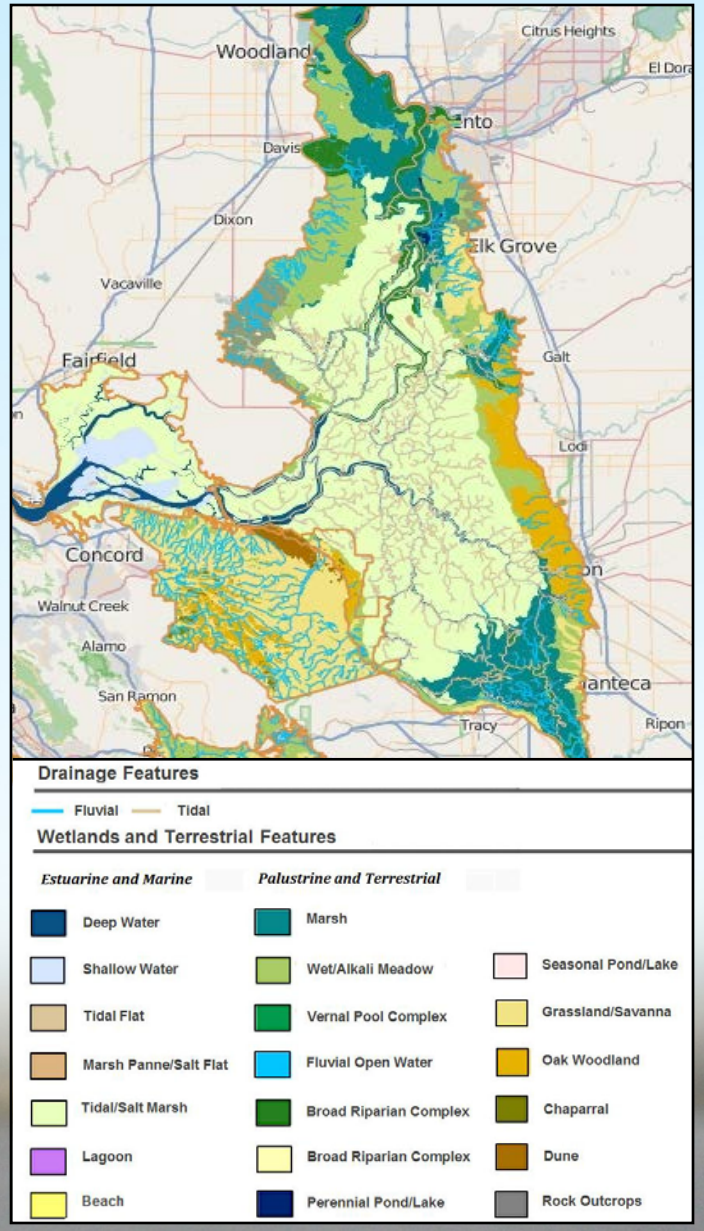


Figure 1. Historical Aquatic and Terrestrial Resources. Since the 1990s, the San Francisco Estuary Institute-Aquatic Science Center and partner organizations have been mapping California's historical aquatic and terrestrial resources. This dataset combines the historical mapping from 12 separate research projects with historical mapping sources spanning from 1777 to 2011.

Data Source: EcoAtlas. Web. June 2015.

The Delta ecosystem has undergone enormous changes over the centuries (see Figure 1). Since the mid-1800s, native species diversity and abundance have plummeted — with a number of fish and wildlife now on the brink of extinction. Invasive species have a firm hold, out-competing their native residents. Large water exports and altered flow patterns have impacted water volumes and quality. Exports, altered flow patterns, and other stressors have also compromised the natural services provided by healthy estuaries, including the ability to mitigate for and adapt to the impacts of drought and climate change. These changes threaten biodiversity and overall water supply, as well as local economies and communities. The Delta Plan has recognized the magnitude of the problem by identifying ecosystem restoration as one of its most important goals.

While many habitat restoration projects have been proposed for the Delta, implementation has been slow to occur. This PM will evaluate initial pilot projects, with the aim of improving and informing future projects and management decisions through on-the-ground experience, monitoring, and data analysis. Assessments of pilot projects will provide real data as well as the potential for prioritizing future restoration choices and investments based on the success of these first efforts. Likewise, pilot projects allow the opportunity for experimentation and adaptive management to assess and compare options in restoration techniques and designs.

Enormous Change

Prior to the rise in farming in the mid/late 1800s and extensive infrastructure development in the 1900s, the Delta existed as a large, complex estuary, dominated by flood basins in the north, tidal islands in the central region, and rivers with multiple branches of many sizes throughout the southern portion. This landscape supported a rich, diverse habitat complex, with streams, rivers, tidal marsh, and uplands working together to support vast populations of native plant and animal species. This estuarine ecosystem also provided a number of important ecological services, including water filtration, flood control, natural control of non-native invasive species, and tremendous habitat for the economically vital fisheries industry.

Beginning in the mid-1800s, clearing of riparian vegetation, dam and levee construction, channelization, and extensive water diversions for agricultural and other uses all irreversibly altered the hydrology and associated habitat and functions of the Delta estuary.

How is progress tracked?

This PM will track progress through the implementation of pilot-scale habitat restoration projects in the six PHRAs identified under the Delta Plan (see Figure 2). It will monitor and review projects as they move from planning to construction and evaluate restoration success in the longer-term. Progress will be tracked by “acres of habitat restored,” with two evaluation phases:

- Acres of habitat constructed (e.g., short-term steps).
- Acres of habitat restored (e.g., long-term assessment of viability and success of restoration project and function, using a set of standardized protocols developed by experts in the field).

Additionally, in order to follow project movement from “planned” to “constructed,” this PM will informally track pilot projects in the PHRAs that are close to construction (e.g., been certified as consistent with the Delta Plan), or in the lead for approval in the near term (see Figure 3). Projects located within the Delta Plan’s six PHRAs have the following initial targets:

- Accomplish a minimum of one project of at least 50 acres in size within each PHRA. Projects counted towards this PM must include an adaptive management plan.
- Utilize metrics to assess total acreage of newly-constructed habitat over all PHRAs (e.g., X/total). Tracking will include habitat type where/when data are available.
- Projects must be constructed within the next five years (by 2020).

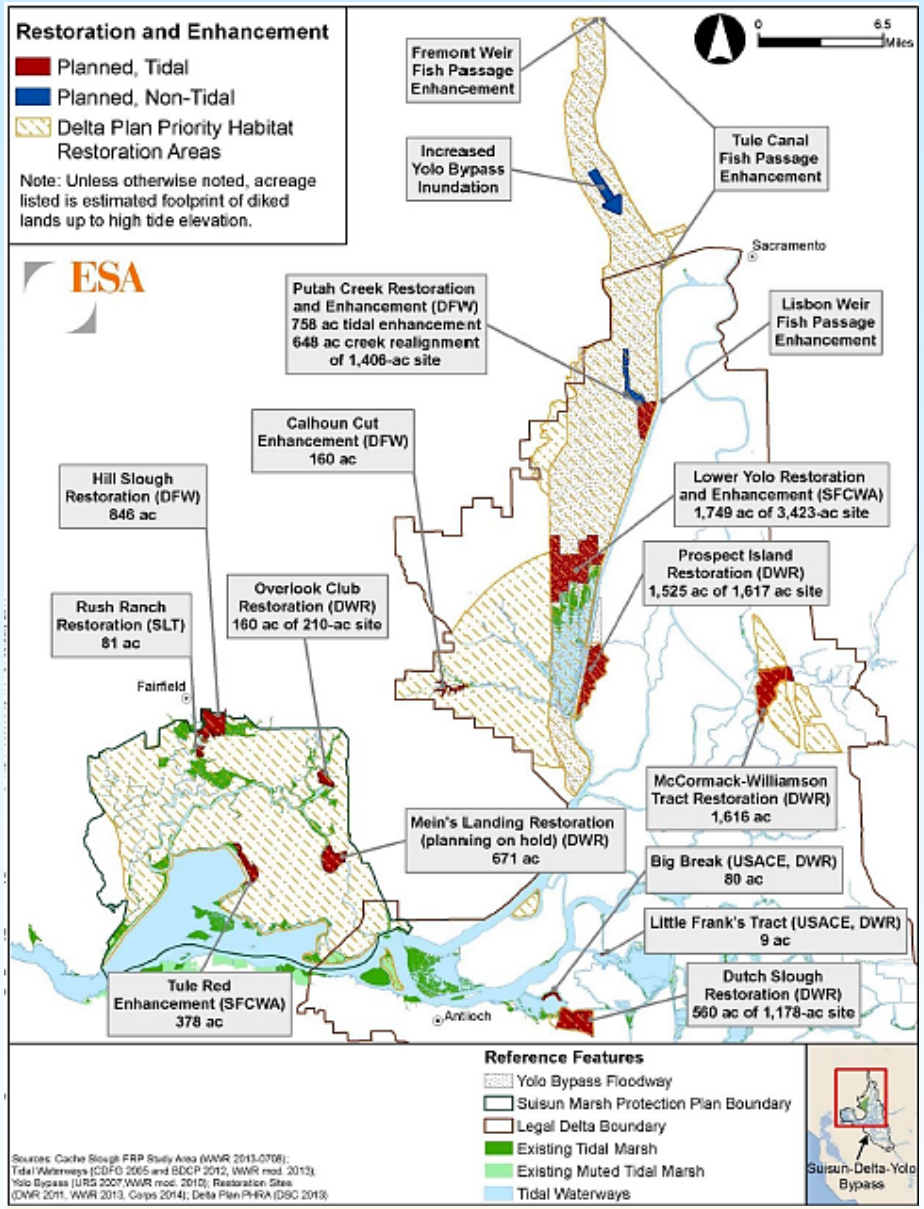


Figure 2. Restoration and Enhancement Sites for Tidal and Non-Tidal Habitat in the Delta. This image is excluding the Lower San Joaquin River floodplain PHRA and Paradise Cut, which is located further south of the Delta, off the map. *Source: Davenport, J. "Restoring Habitat with Science and Society in Mind." Delta Stewardship Council Issue Paper, August 2014.*

What do the results tell us?

As of July 2015, one pilot project meeting the goals and parameters of this PM has been constructed (see Figure 3). This project is the Calhoun Cut Enhancement Project at the Calhoun Cut Ecological Reserve in Solano County, which is in the process of restoring tidal inundation to 160 acres of habitat.

Habitat Restoration Pilot Project Progress in Delta Plan Priority Habitat Restoration Areas (PHRAs)

Name	Year	Project Description	Acreage
Constructed Projects:			
Calhoun Cut Enhancement	2014	Cache Slough Complex PHRA: Restore tidal channel connectivity & habitat	160
		Subtotal – July 2015 (acres):	*160*
Planned Projects: (DSC certified, and/or in the lead for breaking ground)			
Dutch Slough, Phase 1 (Emerson & Gilbert parcels)	t.b.d.	Western Delta/Eastern Contra Costa County PHRA: Restore freshwater tidal marsh & uplands habitat for native species	~ 554
Prospect Island	t.b.d.	Yolo Bypass PHRA: Restore native fish habitat & enhance aquatic foodweb	1,617
McCormack-Williamson Tract	t.b.d.	Cosumnes River-Mokelumne River confluence PHRA: Flood control in conjunction with ecosystem restoration	~ 1,595
Paradise Cut	t.b.d.	Lower San Joaquin River floodplain PHRA: Restore native species habitat	~ 138
Hill Slough	t.b.d.	Suisun Marsh PHRA: Restore brackish tidal marsh & uplands	940
		Projected on-deck project construction (by 2020):	*~ 4,844*
		Projected Total by 2020 (acres):	***~5,004***

Notes: Projects listed show acreage based on project descriptions, proposals, and other assessments. Acreage (constructed or on-deck) includes only new habitat restoration construction – not protected/preserved existing habitat.
Data sources: pers. comm. Jessica Davenport, DSC, spring 2015; Davenport, J. 2014, "Restoring Habitat with Science and Society in Mind," DSC Issue paper August 2014.

Figure 3. Constructed/On Deck Habitat Restoration Pilot Projects, as of July 2015.

Construction of this project serves as an encouraging step in the progress of this PM. Current proposals for additional planned projects (Figure 3, above) include at least one project (Dutch Slough, Phase 1) which has already been certified as consistent with the Delta Plan, and others that appear to be close to certification and approval. This suggests that with continued pressure from the Council to initiate pilot projects and begin on-the-ground monitoring and data analysis, this PM could achieve — or even exceed — its initial target of at least six restoration projects with adaptive management plans of at least 50 acres in size by 2020.

Next Steps

Reporting by the Council will continue to incorporate quantitative assessments of the progress of pilot project acreage constructed, as well as qualitative analysis of the success of projects implemented by habitat restoration specialists within the Delta science and management community.

Specific areas of focus need to include:

- Continual re-assessment of the habitat restoration acreage target figures. It is likely that these initial targets will be revised substantially upward as new projects are proposed and new programs are implemented (e.g., EcoRestore) which meet the parameters of this PM.
- Collaboration in data collection and aggregation/synthesis needs further coordination and fine-tuning for accuracy. Several key potential data sources for tracking the status and progress of Delta habitat restoration projects are being finalized (e.g., EcoAtlas), while new methods for integrating this data are coming online. The Council will need to monitor these developments closely to ensure that data are timely, accurate, and robust.
- Future tracking of this PM should specifically incorporate habitat types (e.g., “tidal marsh complex”) in project acreage as data become available.
- The metrics used in this PM and related PMs under the Delta Plan should be refined to encompass a broader set of critical ecological functions and objectives (e.g., patch size of habitat type, connectivity). New PMs should be developed for future Delta Plan updates to incorporate this broader “landscape vision” approach to the evaluation of habitat restoration success, and focus on measurements of ecological functions rather than simple acreage. Development of these metrics and new PMs should occur in collaboration with agencies such as the California Department of Fish and Wildlife (CDFW) and DWR to align with programs and plans already being proposed, including CDFW’s Draft State Wildlife Action Plan, DWR’s Central Valley Flood System Conservation Strategy, and San Francisco Estuary Institute’s (SFEI) Delta Landscapes proposed reporting framework.

Farmland Acreage

Delta Plan Performance Measures Highlights

Chapter 5 – Protect and Enhance the Unique Cultural, Recreational, Natural Resource, and Agricultural Values of the California Delta as an Evolving Place

The coequal goals shall be achieved while protecting the Delta as an evolving place and recognizing its distinctive values, including:

- **Unique geography**
- **Rural and cultural heritage**
- **Agricultural economy**
- **Local economy coexisting with native ecosystems**

Why is this important?

The Delta Reform Act requires that its coequal goals be achieved "in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place." To achieve this goal, the Farmland Acreage Lost to Urban Development performance measure (PM) will:

- Focus on preventing further Delta rural farmland loss to urban development in areas designated for agricultural use in the Delta Plan regulations.
- Zero acres of farmland loss to urban uses within areas designated for agricultural use in the Delta Plan regulations.

As the largest and most vital industry in the Delta, agriculture is among the key qualities that define the Delta as a place. It strongly contributes to California's important agricultural economy. The Delta's uniquely productive peat soils and moderating marine influence result in Delta per acre agricultural yields almost 50 percent higher than the state's average (Trott 2007[i]). Farmland dominates the Delta landscape and provides several key beneficial uses, including:

- Cultivation of a strong Delta economy: Farming, food processing, and related industries serve as the Delta's primary economic engine, and contribute significantly to the economy, particularly in the Delta's Primary Zone. With an estimated $790 million in Delta crop production and animal product revenue in 2012, Delta agriculture has resulted in 9,681 jobs, $683 million in "value-added" activities (e.g., grape production facilitating wine industry jobs, etc.), and $1.4 billion in output in the five Delta counties (ESP 2012[ii]).
- Protection of Delta species and ecosystems: Farmland protection can help protect endangered species, particularly when wildlife-friendly farming is practiced. "Wildlife-friendly agriculture" employs techniques that integrate management of agriculture and wildlife habitat, including: conservation tillage, winter flooding of farm fields to provide waterfowl habitat, crop rotations of soil building crops or fallowing, integrated pest management, cover crops, the strategic use of permanent crops, and other efforts to conserve biodiversity.
- Preservation of the Delta's rural character and heritage: Preserving Delta farmland fosters community and small family farms, which retains the Delta's rural heritage. Characteristic local crops, such as pears, asparagus, and dried beans are celebrated in annual festivals and county fairs.

Preserving these important benefits requires protecting Delta farmland resources. The total area of agricultural lands (including fallow lands) in the combined Delta and Suisun Marsh area has declined from 549,420 acres in 1984 (Delta Plan, 2013[iii]) to 530,501 acres in 2012 (DOC, 2015[iv]). (Figure 1) provides a comparison of 1992 and 2012 farmland mapping data, and shows notable losses in farmland acreage in the areas around Brentwood, Stockton, Tracy, and West Sacramento. Models used to generate probabilities of urbanization in the Delta predict a loss of over 26,600 acres of agricultural crop acreage to urbanized land by 2050 (ESP, 2012).

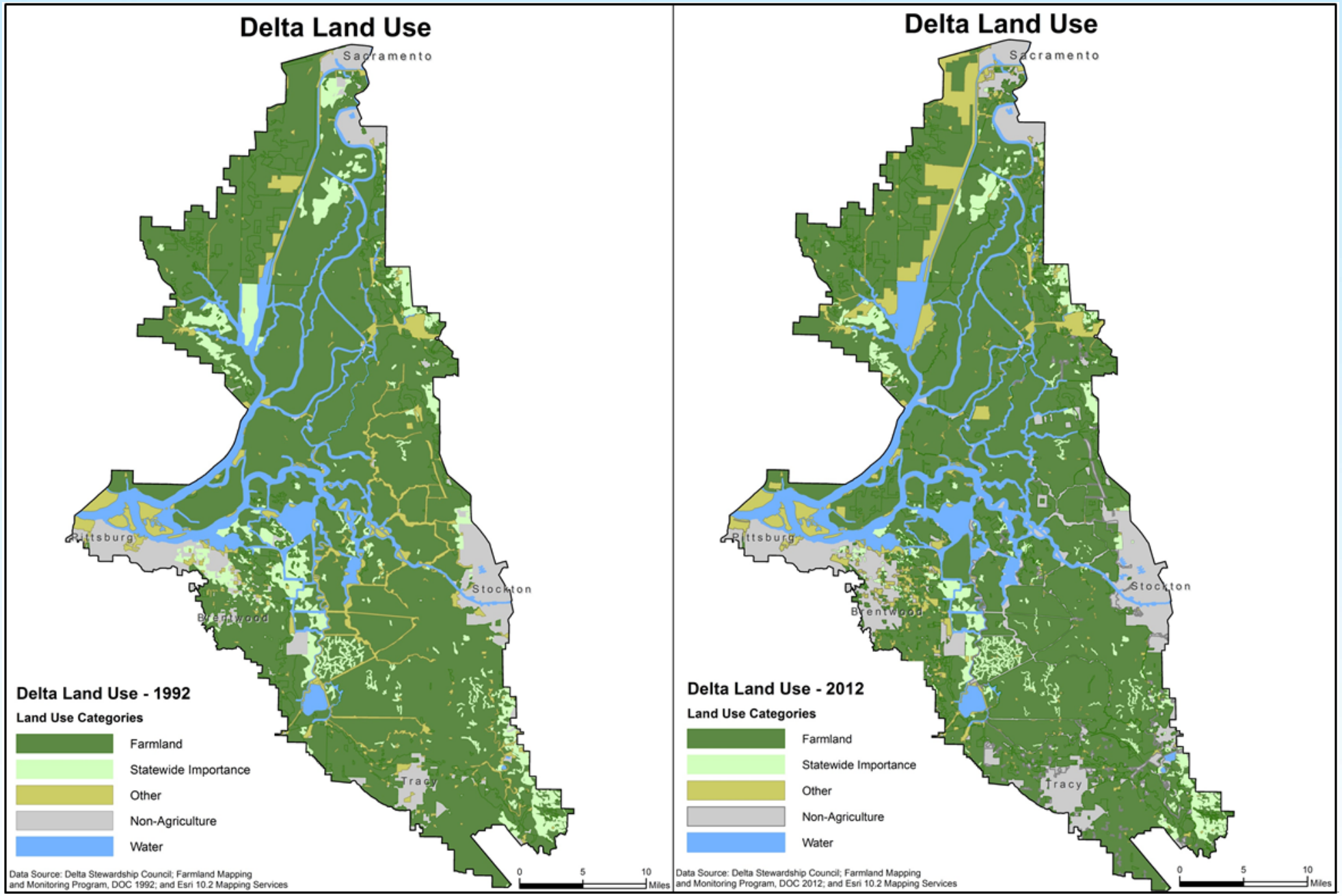


Figure 1: Comparison of Delta Land Use, 1992 to 2012. Using the Department of Conservation's (DOC) Farmland Mapping and Monitoring Program (FMMP) online data, maps identifying Delta farmland acreage were created, providing a comparison of Delta farmland resources in 1992 and 2012. The total area of agricultural lands (including fallow lands) in the combined Delta and Suisun Marsh area has declined from 549,420 acres in 1984 to 530,501 acres in 2012. *Data source: DOC, 1992 and 2012 FMMP online data; Delta Stewardship Council.*

Any further loss of Delta farms to urban development will impact the local economy, species, habitat, and the Delta way of life. The continued viability of agriculture in the Delta requires the protection of sufficient farmland and fresh water to support commercially viable operations and provide ways for agriculture to coexist with habitat restoration. The Delta Protection Commission (DPC) and local governments play key roles in the protection of these lands. The Economic Sustainability Plan (ESP) concludes that the loss of some farmland to urbanization, habitat, and flooding is inevitable. However, continued shifts to higher-valued crops and value-added activities, as well as planning restoration in appropriate locations may help compensate if land loss is not too great.

By implementing this PM, the prevention of excessive farmland loss can be attained while meeting the Delta Plan's coequal goals of providing more reliable water supply, and protecting, enhancing, and restoring the Delta ecosystem.

How is progress tracked?

This performance measure is summarized in the Delta Plan as "No further rural farmland in the Delta is lost to urban development." For purposes of consistency with the Delta Plan Policy DP P1, Council staff proposes a change to the original PM language to *"No further Delta rural farmland loss to urban development in areas designated for agricultural use in Delta Plan regulations."* DP P1 allows for additional farmland loss in areas designated for development according to city or county general plans as of May 16, 2013.

Utilizing the Department of Conservation's (DOC) Farmland Mapping and Monitoring Program (FMMP) data, the Council will generate a map identifying any changes in Delta primary and secondary zone farmland acreage to urban uses since the Delta Plan's implementation. Once the FMMP 2014 data are released (expected early 2016), a map similar to the comparison of 1992 and 2012 farmland acreage (Figure 1) can be generated, and land use changes identified and highlighted. These land use changes will then be overlaid with Delta Plan regulations maps (see Figure 2: derived from the Delta Plan regulations, Appendix 7), which

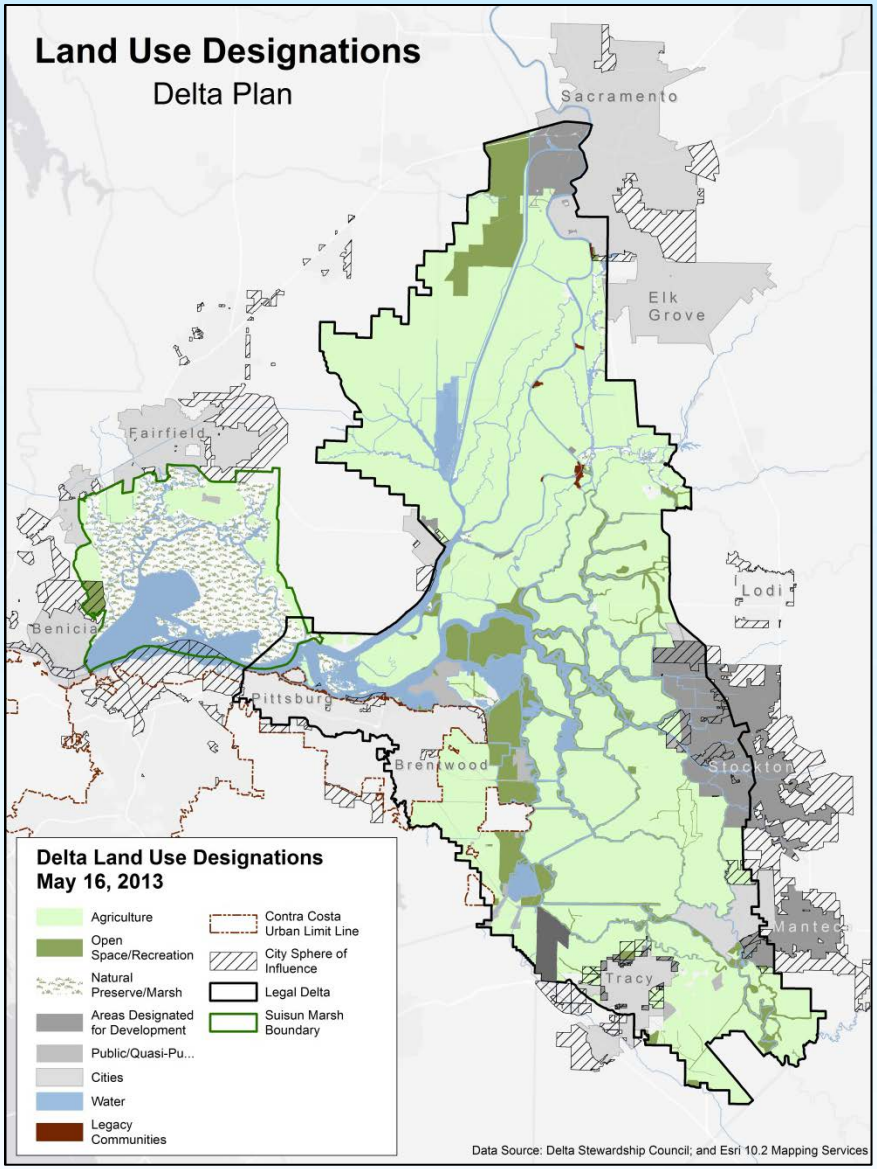


Figure 2: Map of Delta Land Use Designations, 2013. This map is derived from the Council's Delta Plan regulations, and shows all Delta land uses designated in city and county general plans as of the adoption of the Delta Plan. The performance measure related to Delta Plan policy DP P1 states *"(n)o further Delta rural farmland loss to urban development in areas designated agricultural use in Delta Plan regulations"* and this map will be used to identify any conversions inconsistent with general plans as of the Delta Plan's adoption via an overlay of actual land use activities with designated land uses. *Data source: The Delta Stewardship Council and Esri 10.2 Mapping Services.*

identifies general plan land use designations as of May 16, 2013. This will allow for the identification of any land use changes not authorized by the Delta Plan. Council staff will additionally track and identify any proposed general plan changes in the Delta region associated with acreage designated as agricultural land as of the Delta Plan's adoption.

What do the results tell us?

Delta-wide results for this performance measure will not be available until release and synthesis of the DOC's 2014 farmland data due in early 2016. In the interim, Council staff have established a baseline Delta farmland map using the DOC 2012 data (Figure 1). Staff monitoring of development projects has identified no conversions of rural farmland to urban uses since the Delta Plan's adoption. Council staff will also identify and highlight any proposed general plan changes to agricultural land use designations. See "Case Study: San Joaquin County" for an example of such tracking.

Next Steps

The availability of timely and complete Delta land use data is critical to this performance measure's tracking process. Currently, the DOC FMMP data are assembled on a county-by-county basis. The provision of Delta specific farmland data in the future will serve the PM reporting procedures. The DPC also has an interest in the provision of Delta specific land use data. To this end, Council staff encourages the following:

- Support and/or participate in interagency agreements for future DOC FMMP data to provide Delta-specific farmland acreage summaries.
- Support the allocation of funding to the DOC to provide Delta-specific land use maps and data.

Future refinements considerations for this measure include:

- This PM only addresses DP P1 *Locate New Urban Development Wisely*, which falls under core strategy, "Plan to Protect the Delta's Lands and Communities." However, to reduce farmland loss and promote agriculture preservation, it is highly recommended that this PM (or a more integrated agricultural PM) also address the Delta Plan's core strategy, "Maintain Delta Agriculture," including recommendations DP R8, DP R9, and DP R10.
- This PM currently focuses on farmland loss within areas designated for agriculture in the Delta Plan regulations. It is worth investigating whether farmland loss may be occurring within areas designated for open space and nature preserves, as well.

Case Study: San Joaquin County

In October 2014, San Joaquin County released a Draft General Plan and Draft Environmental Impact Report (EIR) for its 2035 General Plan Update. State law specifically directs the Delta Stewardship Council to provide advice to local and regional planning agencies regarding the consistency of local and regional planning documents with the Delta Plan (Water Code section 85212). In December 2014, Council staff provided comments to San Joaquin County regarding proposed land use changes that involved conversion of agriculturally designated land to urban use designations.

Council staff recommended that the final EIR discuss any inconsistencies with the Delta Plan, and noted concern about the continuing loss of agricultural lands in the Delta caused by conversion to urban development. Staff specifically highlighted proposed land use changes (by change request number and location) and their potential impacts to agricultural resources in the Delta. Council staff and Board members also presented these concerns to the San Joaquin County Board of Supervisors, and explained how this proposal is inconsistent with a Delta Plan policy, DP P1.

The DPC also noted to San Joaquin County inconsistencies with the DPC's Land Use and Resources Management Plan. The Council consults with the DPC on land use issues in the Primary Zone of the Delta where the two agencies have concurrent jurisdiction.

Council Staff continue to track these proposed San Joaquin County General Plan changes to ensure compliance with the Delta Plan's policies and recommendations aimed at protecting important Delta farmland resources.

[i] Trott, Ken. 2007. Context Memorandum: Agriculture in the Delta Iteration 2: August 10, 2007. http://deltavision.ca.gov/Context_Memos/Agriculture/Agriculture_Iteration2.pdf
[ii] Delta Protection Commission. 2012. Economic Sustainability Plan.
[iii] Delta Stewardship Council. 2013. Delta Plan.
[iv] Department of Conservation. 2012. Sacramento-San Joaquin Delta Primary & Secondary Zones 2010-2012 Land Use Conversions.

Subsidence Reversal and Carbon Sequestration

Delta Plan Performance Measures Highlights

Chapter 5 – Protect and Enhance the Unique Cultural, Recreational, Natural Resource, and Agricultural Values of the California Delta as an Evolving Place

The coequal goals shall be achieved while protecting the Delta as an evolving place and recognizing its distinctive values, including:

- **Unique geography**
- **Rural and cultural heritage**
- **Agricultural economy**
- **Local economy coexisting with native ecosystems**

Why is this important?

The coequal goals of the Delta Reform Act include the protection, restoration and enhancement of the Delta ecosystem. To achieve this goal, this performance measure (PM) will track the progress of implementing 5,000 acres of subsidence reversal and carbon sequestration projects.

The Delta is known for its unique and highly productive peat soils — soils that result in per acre agricultural yields 50% higher than the state's average (Trott, 2007[i]). Yet, ironically, diking, draining, and cultivating Delta islands have led to the decline of these peat soils. These activities have initiated a process of "subsidence," or the lowering of the soil surface as a result of compaction, consolidation, and loss of volume. When Delta peat soils are drained and exposed to air, they decrease in volume by about 50 percent as peat layers oxidize and erode, and organic carbon in the soil decomposes and is released as carbon dioxide gas. As a result, Delta islands have subsided, and have essentially become holes in which land surfaces are now up to 25 feet below sea level.

Although subsidence has slowed in some areas, other regions of the Delta islands continue to lose soil to oxidation and wind erosion at a rate of five to fifteen tons/per acre/per year. It is projected that some areas of the Delta could subside an additional two to four feet by 2050.

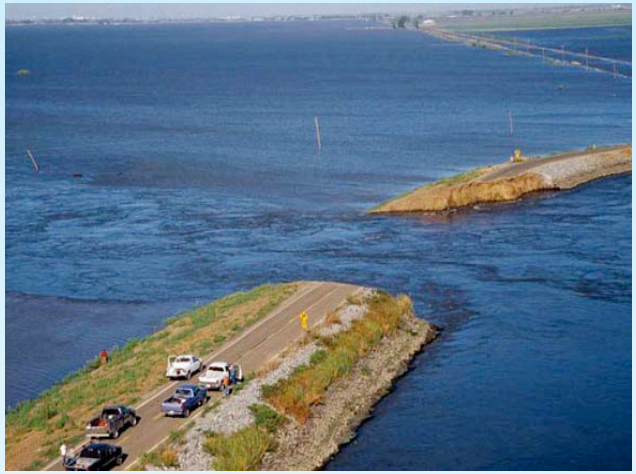


Figure 1: Levee failure on Upper Jones Tract, June 4, 2004. Delta island subsidence has led to less stable levees that are required to hold back substantially more water than when they were originally constructed. The resulting increase in hydraulic pressures on levees constructed on foundations of sand, peat and organic sediments has contributed to more than 35 levee failures since the 1930's. *Source: DWR.*

Subsidence causes several serious problems, including:

- Levee instability and flood risk: As soil elevations decrease, Delta levees become less stable and increase flood risks. This has contributed to about 35 levee failures since the 1930's, with flood damage costs in the hundreds of millions of dollars (see Figure 1).

- Water quality risk: Flooding of Western Delta islands threatens to degrade water quality for Delta communities and to impact water exports by allowing saline water to intrude from the Bay into the Delta.
- Agriculture: Land subsidence impairs Delta agriculture through soil loss and increases the difficulty of maintaining drainage systems and levees.
- Climate Change: Peat soil oxidation liberates vast quantities of carbon dioxide, a greenhouse gas that contribute to climate change.

There is significant pressure to stop and reverse this problem of subsidence and prevent Delta island flooding in order to protect water quality, recreational use, agriculture, wildlife habitat, and property. In 1991, the U.S. Geological Survey and the California Department of Water Resources (DWR) began studying the effect of water management practices on carbon inputs and outputs and island subsidence in the Western Delta. Study results indicate that permanent flooding of peat soils can stop subsidence and increase the land-surface elevation as well as accumulate soil carbon. The potential to retire croplands on deeply subsided islands and manage them to rebuild peat and sequester carbon has been put forth as an alternative to continued farming in those areas. Future opportunities may exist for Delta farmers to earn carbon offset credits for growing plants that promote subsidence reversal and sequester carbon.

How is progress tracked?

As defined in the Delta Plan, progress for this PM will be measured by tracking the number of acres of land converted to address subsidence reversal and carbon sequestration. The Delta Plan has set a target of 5,000 acres by 2017 for this performance measure. Figure 2 displays the acreage associated with already implemented projects ("implemented") as well as projected acreage for planned projects ("projected").

DWR is currently the only landowner to implement subsidence reversal projects in the Delta, and is focusing on DWR-owned lands on Sherman and Twitchell Islands. The data in Figure 2 represent projects implemented by DWR as part of their ongoing West Delta Program. Researchers continue to monitor and track land surface elevation changes and carbon sequestration associated with these projects, which are focused on the accumulation of organic matter from decomposed plants. The trend in implementing these projects will be tracked on an ongoing basis to help ensure the PM goal is achieved. Figure 4 shows the locations of the implemented and planned subsidence projects in the Delta.

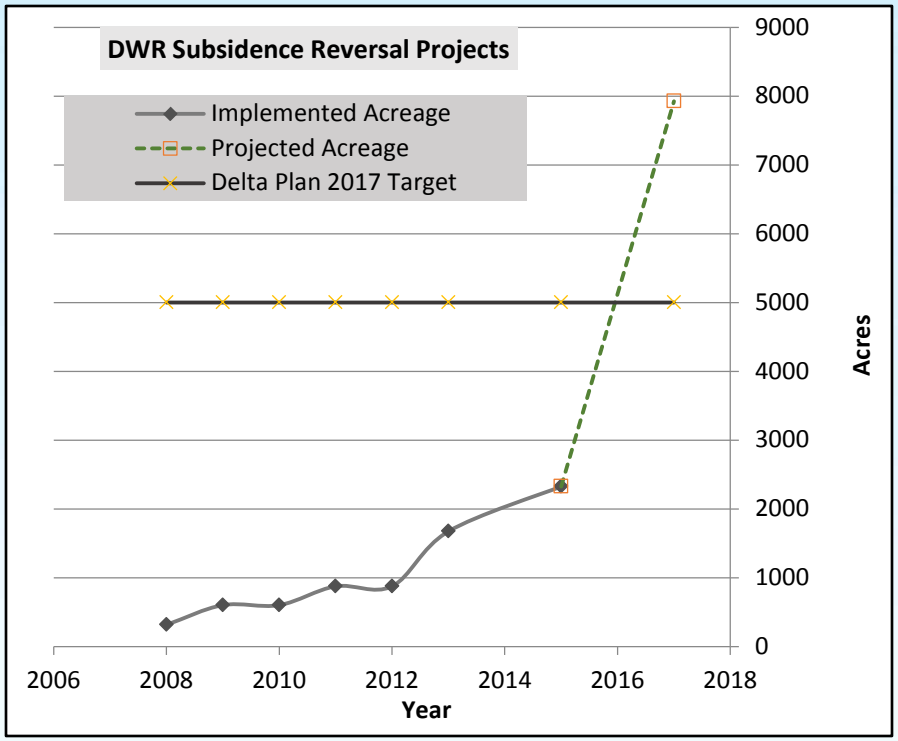


Figure 2: Implemented and Projected Totals for DWR Subsidence Reversal Projects in the Delta.

DWR Subsidence Reversal Projects			
Year	**Island**	**Project Name and Description**	**Acreage**
Implemented projects:			
2008	Twitchell	**Twitchell Island Rice Research Project:** Subsidence Mitigation Through Rice Cultivation (augment to the DWR pilot 15 acre Wetland Research Facility, started in 1997).	315
2010	Sherman	**Mayberry Farms**: Subsidence Reversal and Carbon Sequestration Project	285
2011	Twitchell	**Twitchell Rice Expansion Project**	275
		"Baseline" -- Subtotal 2008-2011:	*875 acres*
2013	Twitchell	**Twitchell Island Wetland Restoration**: East End Habitat Restoration Project	~800
Start 2014	Sherman	**Whale's Mouth:** Wetland Restoration Project	650
		Subtotal 2008-2014:	*~2,325 ac.*
Planned projects:			*(Estimated)*
2016	Sherman	**SH-1** : Belly Wetland (funded, not permitted)	1,500
2017	Sherman	**SH-2:** Mayberry Expansion - Wetland North of Mayberry	1,600
2017	Twitchell	**Chevron Point Tidal Marsh**	80
2017	Sherman	**SH-3:** East End Sherman Island	1,060
2017	Sherman	**SH-4a:** Wetland East of SR 160	620
2017	Sherman	**SH-4b:** Wetland East of SR 160	740
2017	Twitchell	Wetland North of Rice Project and Wetland Expansion	t.b.d.
		Projected Additional by 2017 (acres):	*5,060*
		Projected Total by 2017 (acres):	***~ 7,925***
Notes: The 15-acre pilot subsidence reversal project on Twitchell Island (1997): "DWR Wetland Research Facility" is not included in the acreage total. All planned project acreage values are estimates with final details to be determined based on surveying and other assessments. *(Data source: Bryan Brock, DWR, personal communication, 2015).*			

Figure 3: DWR Subsidence Reversal Projects. A summary of the West Delta Program's implemented and planned projects. *Source: DWR.*

What do the results tell us?

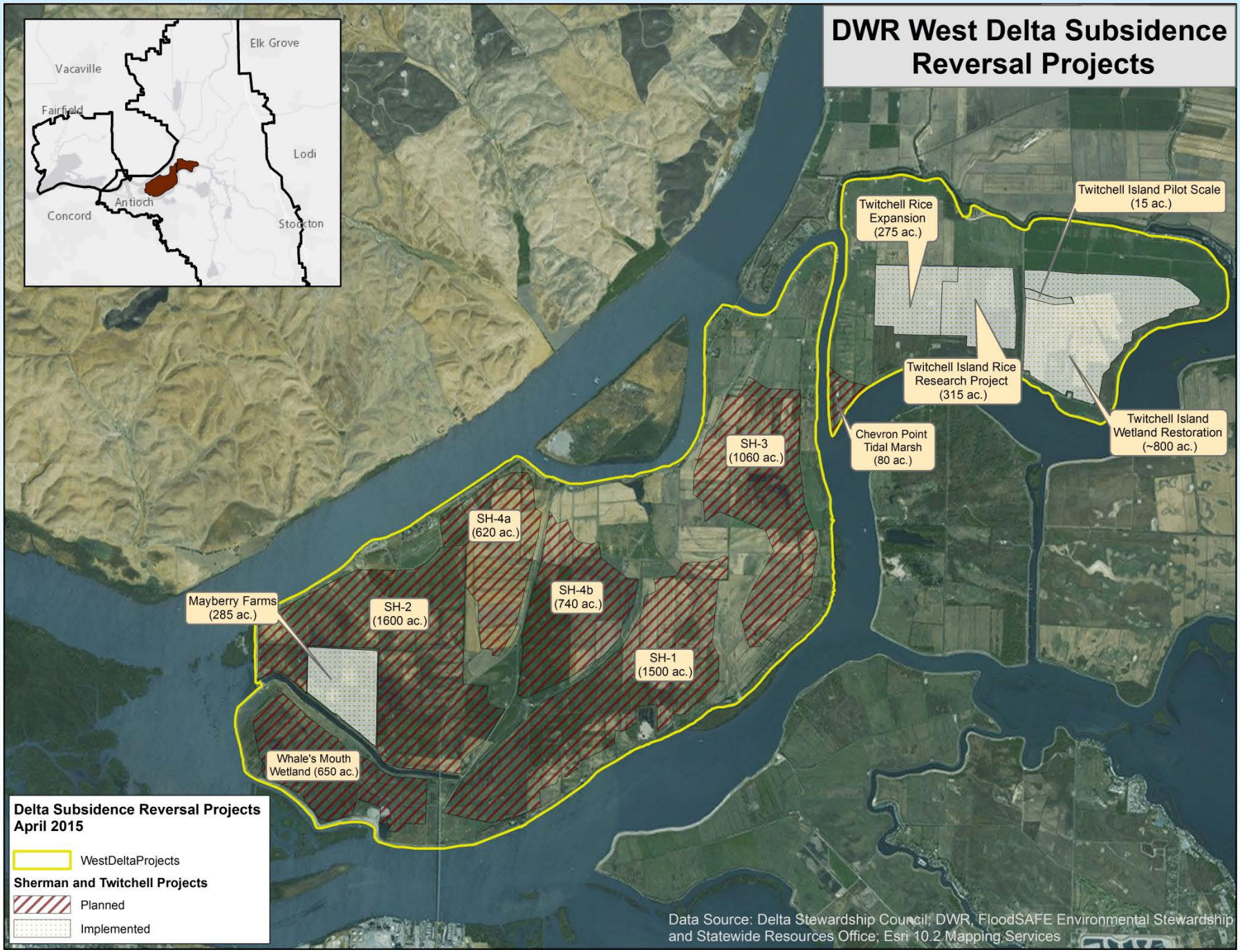
Three observations are evident from this data:

- Past: The rate of subsidence reversal project implementation has increased since 2008.
- Present: As of June 2015, 2,325 acres of subsidence reversal projects have been implemented in the Delta.
- Future: Additional projects are expected to be complete by 2017, with a projected total of 7,925 acres, which exceeds the Delta Plan goal.

The projects on Sherman and Twitchell islands are in various states of planning, funding, and permitting, and account for an estimated addition of 5,600 acres of subsidence reversal and carbon sequestration projects by 2017 (see Figure 3). This Delta Plan PM sets a total acreage target of 5,000 acres by 2017, which has been almost halfway met as of 2015, and is projected to be exceeded by 2017.

With the recent submission of the California wetland protocol for carbon credits to the Air Resources Board, it will become important to track the use of offset credits by Delta farmers for growing plants that promote subsidence reversal and sequester carbon as a "second crop." Cap-and-Trade Auction Proceeds and other funding mechanisms will provide additional incentives and funding for carbon sequestration projects in the Delta.

Figure 4: Location of all Delta Subsidence Reversal Projects, Implemented and Planned.



Next Steps

In collaboration with other Delta Plan partner agencies, the Council will continue to track acreage of carbon sequestration projects in the Delta and will refine methods for better understanding the results of those projects.

There is also emerging opportunity to incorporate the habitat restoration actions identified through the California EcoRestore program, including 3,500 acres designated for subsidence reversal and carbon management. As these projects are implemented, the Council will need to continue its support for the use of Cap-and-Trade funds for managed wetlands associated with carbon sequestration projects. It will also be important for the Council and other agencies to encourage and support:

- The pursuit and implementation of projects by private landowners. One means of support includes creating a template and other streamlined means for accounting and verifying carbon credits.
- Consideration of designating a single agency (or broker) to oversee and evaluate potential private landowner candidate projects, which also might advise applicants on the practicality and procedures for program participation.
- Discussion of what will happen once the 5,000 acre performance measure target is met. This PM focuses on total acreage, yet an assessment or characterization of project success with respect to reducing Delta subsidence merits evaluation in the future. Periodic assessments and analysis of this research will disclose if land subsidence is in fact being reduced by strategic investments in the Delta.

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[i] Trott, Ken. 2007. Context Memorandum: Agriculture in the Delta Iteration 2: August 10, 2007. http://deltavision.ca.gov/Context_Memos/Agriculture/Agriculture_Iteration2.pdf

Salinity Trends

Delta Plan Performance Measures Highlights
Chapter 6 – Improve Water Quality to Protect Human Health and the Environment

Salinity is a natural feature of the Delta, but climate change, drought, and human-induced alterations to flows have created critical challenges. Salinity management is now a "balancing act" to maintain the variability beneficial to ecosystem health, while providing reliable, stable fresh water for human use year-round.

Why is this important?

Ecosystem restoration and *water supply reliability* are the two coequal goals of the Delta Plan. Salinity concentrations directly influence these goals by impacting both ecosystem water quality as well as drinking water quality.

To aid in achieving the coequal goals, the Salinity Trends performance measure (PM) will:

- Highlight recent salinity trends in the Delta, utilizing extensive existing electrical conductivity and X2 measurement data.
- Analyze these salinity trends to help address management challenges in accomplishing Delta Plan goals.
- Utilize salinity trend analysis to educate agencies and the public about the impacts of both environmental and human-induced changes in the Delta.

A Tug of War

Salinity in the Delta reflects the convergence point for the Delta Plan's co-equal goals: overall ecosystem health and status of water quality and supply for human use. Naturally occurring variations in salinity levels are integrally related to freshwater flows in and through the Delta, which link to habitat and species integrity, particularly for several endangered species. But higher and fluctuating salinity levels negatively impact drinking water and public health, reducing agricultural plant growth, and limit water recycling and recharge activities. Allowing for the natural inflow of saltwater from the tides and ocean forces, while supporting a non-fluctuating freshwater supply year-round for human use and adequate flows for fish, has created a "tug of war" in managing salinity.

A Unique Ecosystem

The mixing of salt and freshwater uniquely distinguishes estuary ecosystems from purely freshwater or ocean environments. In the Delta, this mix provides a unique, nutrient-rich habitat which supports a wide array of native species specifically adapted to and dependent on these conditions. Delta estuaries provide spawning, rearing and migratory habitat for endangered delta and longfin smelt, several salmonid species, and many other fish. They provide food and nesting areas for shorebirds and ducks, and they support a diverse collection of plants and algae, which form a stable, enduring base for the food chain. Annual, seasonal, and daily fluctuations in salinity levels act as a natural and essential feature of healthy estuary functions (see Figure 1).

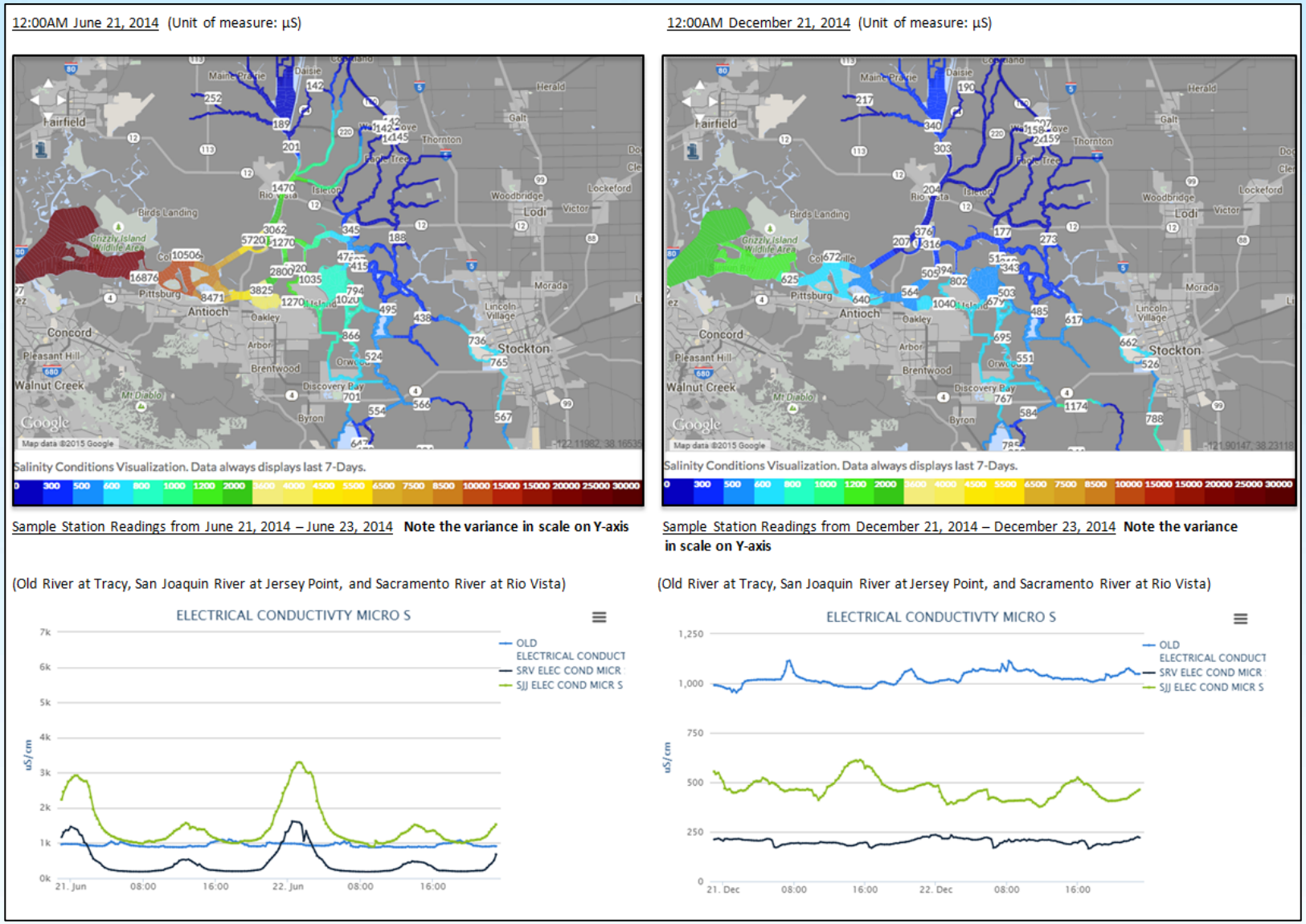

Figure 1. "Seasonal Salinity Levels In Delta."
Source: Bay-Delta Live. Digital image. Salinity Conditions In The Delta. Web. 30 June 2015. [1]

[1] The image displays "natural variations" that compares and contrast seasonal salinity levels in Delta, in June and December of 2014.

During wetter periods and storm events (e.g., winter months in the Delta), substantial freshwater flows ("peak flows") push the salt farther downstream in the estuary, while drier conditions allow the salt field to move further inland. Tidal cycles operate on a daily basis, with ranges of two to four-foot differences in ebbs and flows each day. With large tidal fluxes, significant salinity changes regularly occur across Delta waters.

Agricultural and Municipal Use

Historically, salinity fluctuations in the Delta, operated within broader, natural ecological thresholds, and these salinity changes were accommodated across the extensive, meandering Delta floodplains. However, human impacts on the Delta, from water diversions for rice farming in the early 1800s to intensive channelization, damming, and draining from large infrastructure construction in the 1900s, have led to severely altered hydrological conditions (see Figure 2).

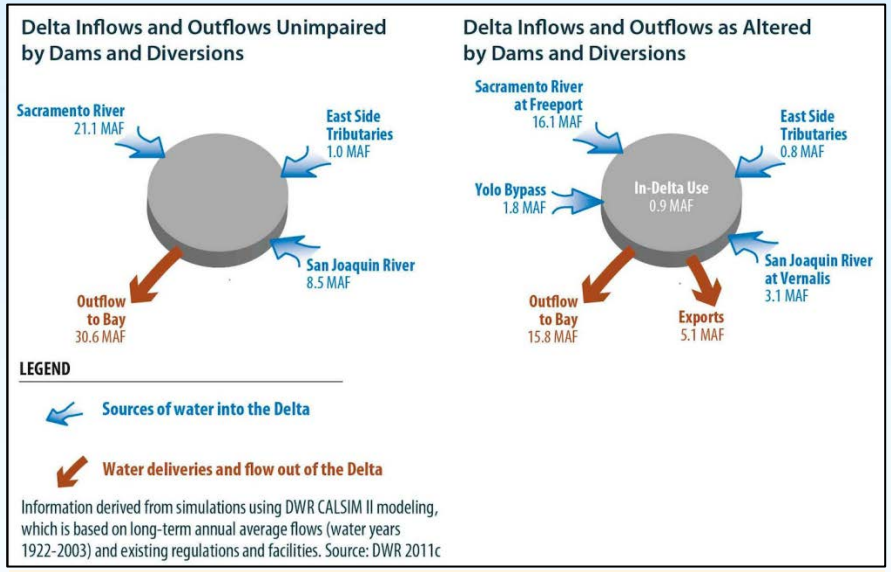

Figure 2. "Effects of Dams and Diversions on Delta Inflows and Outflows."
Source: Delta Stewardship Council. Digital image. The Delta Plan. May 2013. [2]

Diversions for agricultural and municipal use have:

- Reduced freshwater outflows, resulting in a more permanent shift of the saltwater-freshwater interface upstream and inland.
- Prompted fish declines due to lack of cold, freshwater conditions for migration and rearing.
- Created conditions that promote and favor non-native, invasive species.
- Forced changes to basic algal diversity.
- Impacted seasonal cycles of salinity.

Agricultural inputs (e.g., irrigation, chemical additions) and increasing municipal inputs (e.g., wastewater and industrial discharges, urban runoff) are further compounding salinity problems, and are expected to increase with projected growth and development in the Delta (see Figure 3).

[2] Adapted from the Delta Plan, 2013, Figure 4-4.

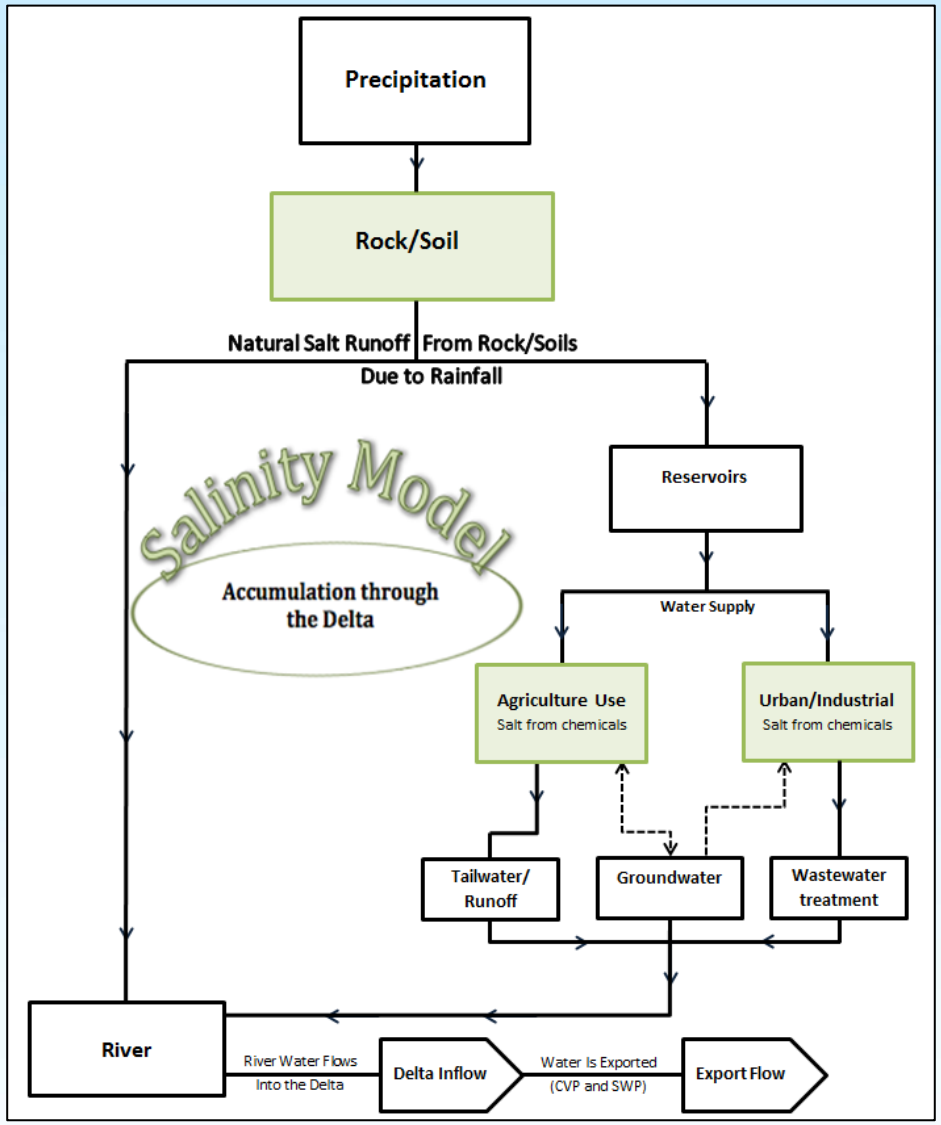

Figure 3. "Conceptual Model For Salinity In The Central Valley And Sacramento-San Joaquin Delta."
Source: Prepared by the CALFED Bay-Delta Program, Lisa Holm, Sam Harader, et al. July 2007. Print. Modified June 2015.

Climate Change

In addition to agricultural and municipal impacts, large-scale climate change and drought conditions have exacerbated fresh water problems and their effects. Projected sea level rise, reduced winter snowpack and peak flows (which provide necessary freshwater pulses through the Delta), and drier summers bring higher levels of salt water intrusion.

A Delicate Balancing Act

The interactions of these various factors directly impact both Endangered Species Act (ESA)-related flow decisions, as well as water quality management actions, including inflow and outflow controls, diversion, storage, and export pumping. DWR and the Bureau of Reclamation are the primary agencies implementing the actions needed to meet a complex set of regulatory standards for fish and wildlife, municipal and industrial uses, and agricultural use, which all vary by month and "year type" (dry versus wet).

Management actions rely on three primary control mechanisms or "knobs":

- Reservoir releases
- Modulation and control of water export volumes, which affect outflows from the Delta
- The Delta Cross Channel Gate, which provides a direct path for freshwater to move to the Central Delta

Management actions have also involved basic water supply operations procedures. In an effort to maintain required stable freshwater profiles and keep the salt field at bay, management decisions have significantly altered more natural salinity trends. Before construction of the first large dams in the mid-1900s, salinity across the Delta was highly variable. With the new reservoir operations and the forced freshwater flows year-round, more recent trends show artificially restricted salinity levels, with water managers intent on protecting the inland Delta from saltwater intrusion.

Ultimately, management action faces a delicate balancing act. The timing and extent of freshwater releases from reservoirs in the Sierras must provide adequate freshwater throughout the year for human use *and* comply with fish regulations under the ESA, which demand specific

minimum flows and water temperatures. Salinity fluctuations operate in conflict with water quality and supply goals, which are artificially managed for stable, “flat-lined” year-round freshwater conditions. State Water Board salinity standards have been designed and implemented to try and balance different interests, including compliance with ESA parameters while maintaining water quality for human use.

Salinity and flow considerations also affect long-term management actions in the Delta. Several proposed ecosystem restoration projects under the Delta Plan include components designed to study impacts of salinity on native vegetation and improve fish habitat through improved flows.

The long term and more recent changes to the Delta ecosystem present substantial challenges. Salinity levels drive water management decisions and actions across a full spectrum of projects and operations in the Delta, with direct and indirect impacts on the ecosystem as a whole.

How is progress tracked?

The primary methods for measuring salinity in the Delta are: electrical conductivity (EC) and X2 measurements. Frequent, extensive, reliable, and associated with regulatory targets, they serve as the primary sources for reporting on this PM. Based on a complex array of State Water Board standards set for fish and wildlife, municipal, industrial and agricultural uses, compliance is measured and determined through 14-day or 30-day averages.

EC can be used as a measure of salinity because it is affected by levels of salts in water. Dissolved salts break into electrically charged ions, and higher levels of these ions increase electrical conductivity, so higher EC measurements correlate with higher salinity levels. EC measurement data are collected every 15 minutes at Delta Monitoring Stations.

X2 is the 2 parts per thousand salinity contour at one meter off the bottom of the estuary (“2”), as measured in kilometers upstream from the Golden Gate Bridge (“X”). The current State Water Board regulatory standard for X2 is 75 km (near Chipps Island) from February through May, and 81 km (near Collinsville) during January, as well as June through August. X2 measurements are collected hourly and daily at several locations across the Delta.

For tracking this PM, there are a variety of data sites and data visualization methods to analyze salinity trends across the Delta. This PM will initially focus on annual and seasonal trends, accessing source monitoring data from USGS and DWR through centralized data sites such as DWR’s California Data Exchange Center (CDEC). Tracking will also utilize advanced data visualization methods and reporting from a number of sites such as Bay-Delta Live and OpenNRM.org (and similar organizations) to highlight the educational and qualitative focus of this PM.

What do the results tell us?

Electrical conductivity measurements over 2014 and 2015 indicate that meeting salinity standards for the Delta is becoming increasingly difficult, with salinity management pushed to the edge by the current drought (see Figure 4). The precariousness of this balance is highlighted by several recent management actions

In early 2015, exceedingly dry conditions and the inability to provide adequate freshwater flows from reservoirs led to water managers anticipating a failure to meet a number of water quality regulatory standards, including salinity. As a result, these agencies petitioned the State Water Board to relax salinity (and other) standards, to avoid non-compliance and allow for more freshwater to be retained in reservoirs upstream, which reduced freshwater flows through the Delta.

The State granted this petition, which means that salinity standards are temporarily more lenient than the existing State Water Board standards described above.

An additional “emergency” management action occurred in May 2015. DWR installed an emergency salinity barrier on the West False River, just northeast of Oakley in the western Delta to repel further saltwater intrusion and prevent contamination of regional water supplies further inland. However, because barriers reduce flows and prevent fish migration, this barrier will require removal in the fall to prevent harm to endangered migratory fish during the critical flood season.

There are several key issues and “lessons learned” from both the changing ecological context of recent salinity trends, as well as the management actions now occurring around salinity:

- The location of X2 (the saltwater-freshwater interface) is tending to move farther inland. Hydrologic alterations in the Delta, compounded by drought, are exacerbating the freshwater flow crisis, with less and less freshwater available to “keep the salt field at bay.”
- The natural variability in salinity is being further tested and suppressed through water supply standards and regulations in order to meet increasing freshwater demands.
- It is becoming increasingly difficult to meet both salinity standards for water supply, as well as complying with ESA parameters for fish and other species.
- Climate change, future drought, or even a continued “new normal” for California water, may mean that consistently meeting current salinity standards is virtually impossible.

Given the issues raised above, the Council may want to consider how these changes impact the commitment to achieve the Delta Plan’s coequal goals, using salinity trends as a benchmark for broader decisions about water quality and ecosystem trade-offs. While current salinity regulatory standards may just meet the demands of the salinity “balancing act,” new environmental conditions, the collapse of several fish species in the Delta, and human pressures all suggest that this balancing act may be too precarious to maintain. The Council and experts in this field need to consider how this will impact future management strategies and decisions, and whether there are more effective ways to address these challenges that go beyond the implementation of temporary, emergency actions.

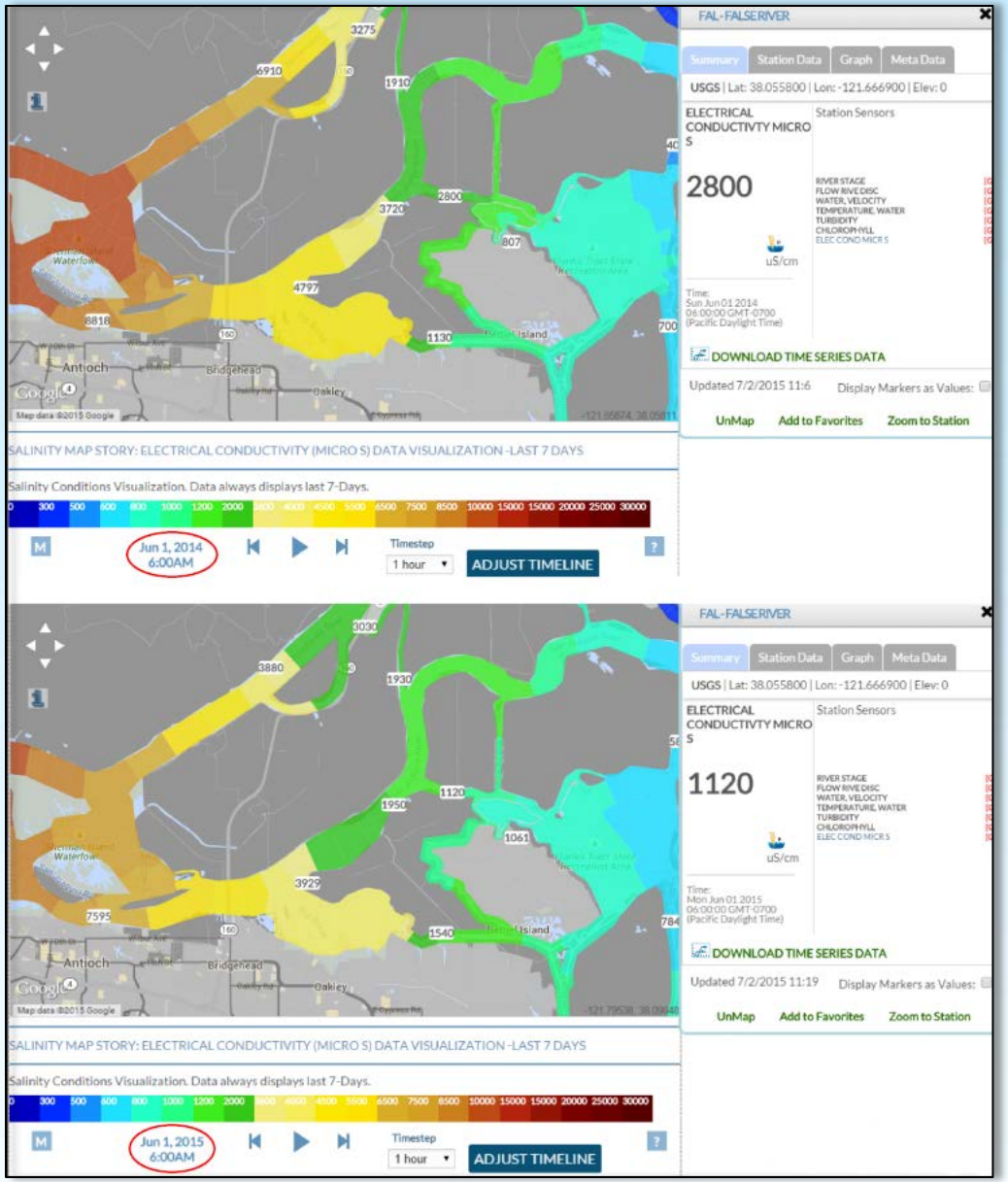

Figure 4. “Sample Salinity Levels In Delta.”
Source: Bay-Delta Live. Digital image. Salinity Conditions In The Delta. Web. 30 June 2015 [3]

[3] The image displayed compares sample conditions for June 2014 and 2015, along with accompanying data figures showing non-compliance and/or close to non-compliance conditions.

Next Steps

- Tracking seasonal variations in reporting on salinity trends.
- Tracking various salinity sources as data become available (e.g., agricultural and municipal inputs). While these inputs are not currently the major drivers of salinity in the Delta, they are likely to have greater influence on salinity levels in the future as development in the Delta continues to increase.
- Tracking the changing salinity management context, in terms of types of decision implemented, the frequency of “emergency” actions required, and similar.

Dissolved Oxygen

Delta Plan Performance Measures Highlights
Chapter 6 – Improve Water Quality to Protect Human Health and the Environment

Dissolved oxygen (DO) is fundamental to the survival of most aquatic organisms. Low DO episodes are a significant problem in the Delta, leading to fish kills and other pollution impacts. Strategies and actions at the site and regional levels can help to achieve progress in this water quality arena.

Why is this important?

Water quality directly impacts the achievement of the coequal goals of the Delta Plan: *ecosystem health and water supply reliability*. To achieve these related goals, the Dissolved Oxygen (DO) performance measure (PM) will:

- Highlight the importance of DO concentrations with respect to fish and environmental health.
- Inform decisions and actions taken to comply with the State Water Resources Control Board's Total Maximum Daily Load (TMDL) standards for DO to prevent the spread and severity of DO depletion problems in the Delta.

Aquatic organisms across the entire food chain — from zooplankton and phytoplankton, to amphibians, and top predators such as birds and fish — need sufficient DO levels to survive. As a fundamental part of the basic functions of all aquatic life, DO is often used as a marker of general aquatic or ecosystem "health." Low DO concentrations can lead to noticeable and severe impacts such as fish kills and noticeable odors, as well as less visible effects, including changes in algal species composition and reduced natural water purification processes in rivers and streams. Low DO also impacts food sources of several endangered and threatened species in the Delta (e.g., various salmonid species), which impacts survivability and causes death.

Factors Controlling Dissolved Oxygen Concentrations

Under natural conditions, DO levels generally fluctuate both daily and seasonally. Throughout the day, aquatic plants produce oxygen through photosynthesis, which raises DO concentrations to peak levels by late afternoon. At night, plants and animals use the DO produced during the day for basic functions, reducing DO concentrations, to a minimum just before dawn.

Water temperature also affects DO concentration. More oxygen can dissolve in cold water than in warm water, so DO concentrations drop in warmer seasons (e.g., summer months), or in locations where water temperatures are artificially increased. In the Delta, the daily and seasonal DO fluctuations have been impacted by a host of factors leading to an overall downward trend in DO concentrations across the estuary and in many cases, beyond natural thresholds.

Factors that influence DO include physical/environmental conditions and specific pollutant and nutrient loading inputs (see Figure 1). Significant pollutant sources and detrimental conditions in the Delta include:

- Increased nutrient loads due to over-fertilization, which lead to eutrophication (rapid algal growth) and subsequent algae die-offs.
- Ammonia discharges from wastewater treatment plants, which lead to increased nitrate levels that promote excessive algal growth.
- Site-specific hydrological modifications that have altered natural flow in ways that promote plant growth (e.g., flooding ponds for waterfowl plant food).
- Overall warming temperatures, which limit the amount of oxygen that can dissolve in water.

TMDL standards for DO in the Delta are being developed to maintain levels that ensure environmental and habitat health. This PM will track these levels at specific sites, not only to monitor compliance and flag problems, but to assess whether management actions are improving DO conditions. These actions could include:

- Requiring improved wastewater treatment processes.
- Implementing National Pollutant Discharge Elimination.
- System (NPDES) permits (standard point sources and stormwater).
- Further developing overall water rights policies.
- Revising the management of Waste Discharge Requirements (WDRs) and waivers.

Tracking the relative success of such actions will contribute to an effective adaptive management framework and future decision-making.

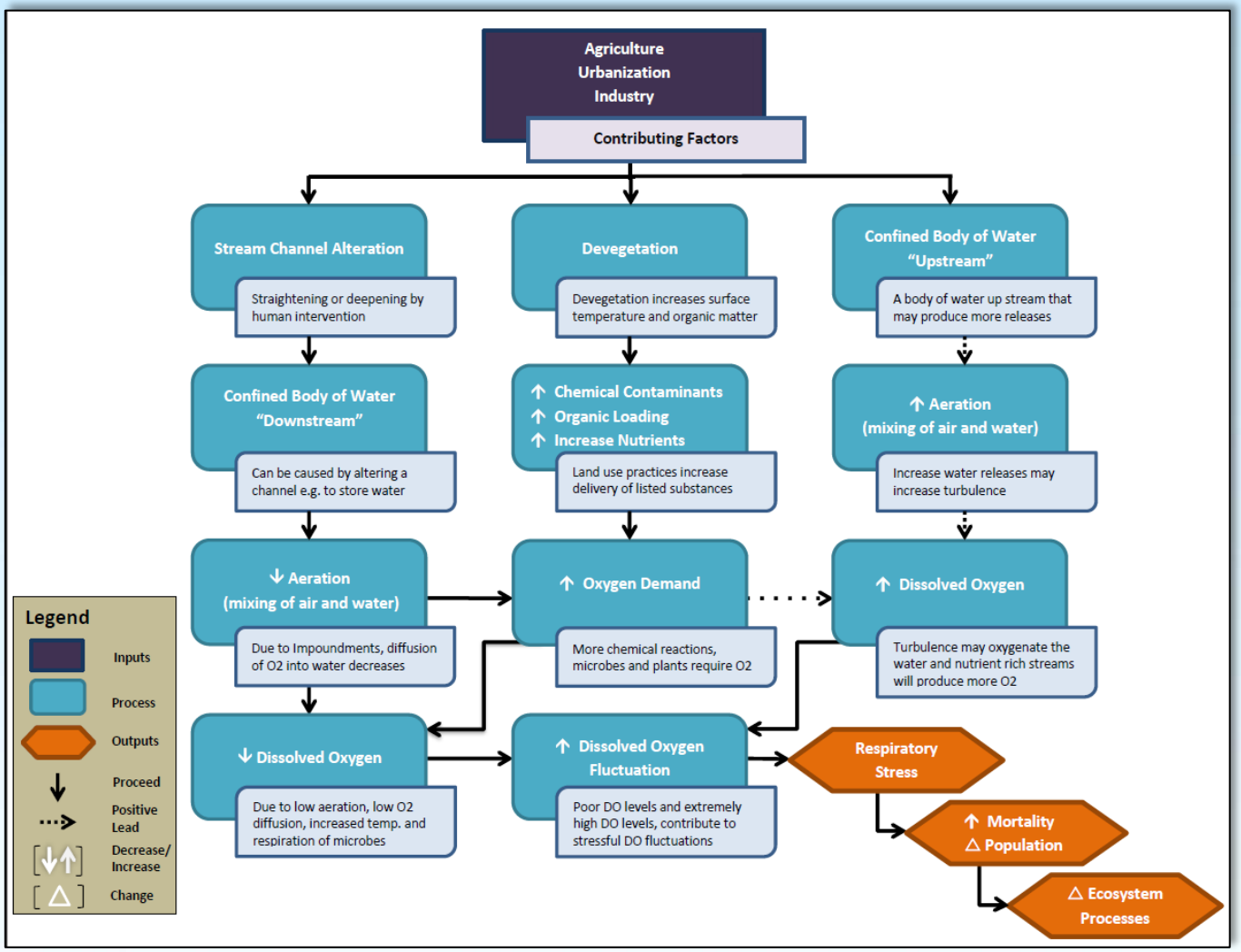

Figure 1. "Conceptual Model of DO Sources and Flows." Diagram Modified by the Council, 2015.
Source: Environmental Protection Agency. Digital image. "Dissolved Oxygen: Simple Conceptual Diagram." July 2007.

How is progress tracked?

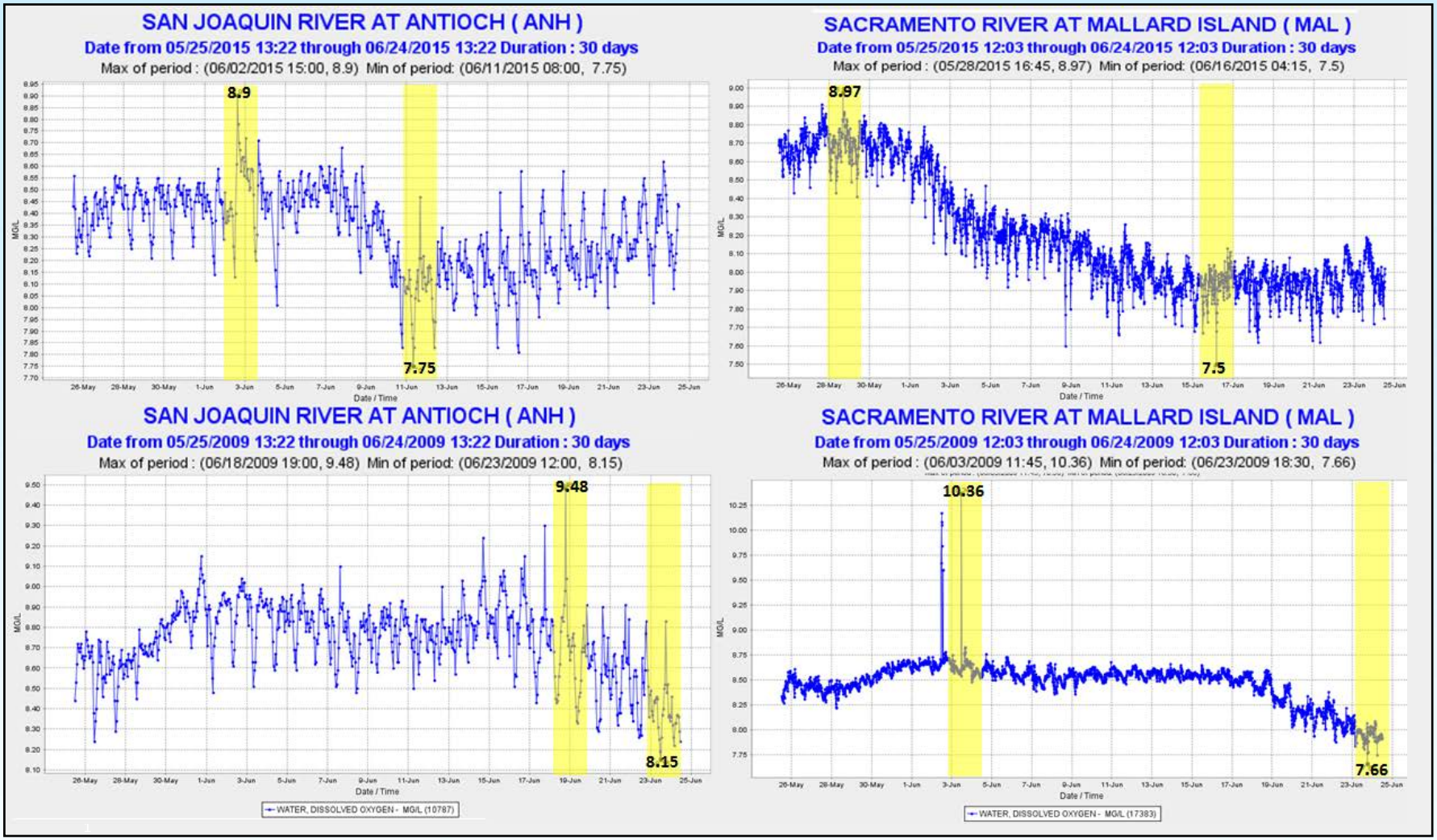

Figure 2. "Historical DO Concentration Trends Across Delta, 2009 – 2015."
Source: California Data Exchange Center, California Department of Water Resources. Web. 02 July 2015.[1]

[1] Charts show decreasing DO levels from several non-SDWSC sites in the Delta, comparing charts from May 2009 through June 2015.

While DO monitoring and trend data are available across the Delta, regulatory objectives and thresholds have not yet been set for many regions and locations. However, monitoring data clearly show that lower DO levels are a pervasive problem in many locations, and are impacting fish, algae, aquatic organisms, and overall estuary health (see Figure 2).

As the only place for which DO TMDLs currently exist, PM reporting will initially focus targets and measurements on the Stockton Deep Water Ship Channel (SDWSC). Charts and graphs showing DO concentration measurements and trends at this site will provide absolute values to compare against regulatory targets, and show general trends for this water quality issue. Additional sites and regions will be added (such as the Suisun Marsh, for which DO regulatory objectives are currently in development) once those TMDLs are adopted.

Stockton Deep Water Ship Channel Tracking

Located in the South Delta, the SDWSC connects the Port of Stockton to the lower San Joaquin River, which flows northward into the Delta, and then to the San Francisco Bay and ocean (see Figure 3). The 78-mile long channel was dredged in the 1930s to provide a cargo ship corridor for the Port of Stockton. However, it also acts a key migration corridor for endangered and threatened native fish, such as salmon and steelhead, which use it to reach upstream spawning sites in the tributaries of the river. As early as the 1960s, studies indicated that DO levels in the SDWSC were critically low due to wastewater discharges as well as reduced flows in the San Joaquin River itself. Various fish-specific studies over the subsequent years confirmed that low DO levels appeared to be impacting fish migration behavior and survival. In 2005, the Central Valley Regional Water Quality Water Control Board (CVRWQCB) finally adopted TMDL water quality objectives for DO in the SDWSC and an accompanying Control Program for addressing the low DO problem.

The Stockton Deep Water Ship Channel

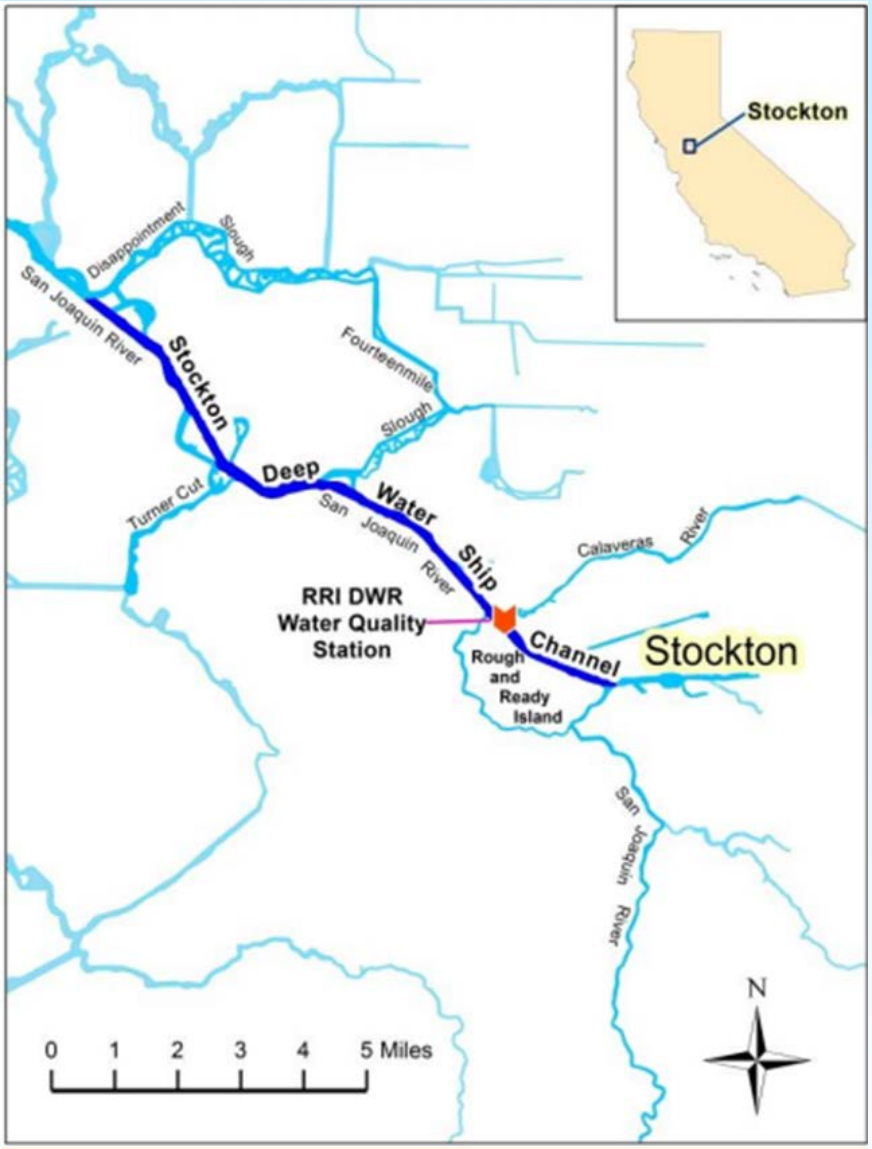

Figure 3. "Map of Stockton Deep Water Ship Channel."
Source: San Joaquin River DO TMDL, Fact Sheet. Central Valley Regional Water Quality Control Board, Nov. 2014. Web. Mar. 2015.

The TMDL DO objectives specified the following regulatory targets:

- 6.0 milligrams per liter (mg/L) for September 1 through November 30
- 5.0 mg/L for the rest of the year

The Control Program implemented several key management actions to achieve these targets, including:

- The identification and reduction of upstream nutrient-loading sources, with an initial primary focus on requirements to reduce ammonia discharges at the Stockton Regional Wastewater Control Facility (SRWCF) through improved wastewater treatment processes.
- The development and implementation of a pilot demonstration project, the Dissolved Oxygen Aeration Facility, which increases DO levels at the SDWSC location.

What do the results tell us?

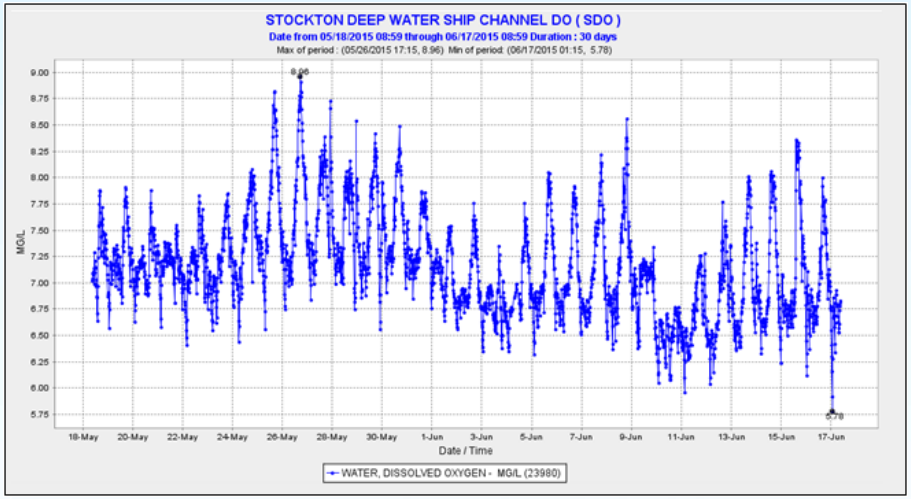

Figure 4. "Stockton Deep Water Ship Channel Trends."
Source: California Data Exchange Center, California Department of Water Resources. [2]

Long term data from the SDWSC location demonstrated a consistent, historical problem with increasingly low DO as far back as the 1960s. The SDWSC is located along a migratory route for endangered fish in the Delta, and the low DO concentrations were cited as impacting fish survival and migration timing. In 2005, the CVRWQCB adopted a DO TMDL for the SDWSC, and a Control Program to implement actions to meet these regulatory targets. Recent data indicate that these management actions have succeeded in significantly improving DO levels at this site, with current measurements showing compliance with TMDL standards (see Figure 5).

[2] Chart shows DO levels from the SDWSC monitoring station in the Delta, over a 30-day time frame from May through June 2015.

The success in meeting the DO regulatory targets since the adoption of the TMDL and Control Program suggests several important "lessons learned":

- The adoption and implementation of rigorous and decisive actions *do* produce results.
- The SDWSC site has the advantage of having several identifiable sources of nutrient loading and specific tangible actions that could be implemented immediately (e.g., improvement of wastewater treatment processes at the SRWCF treatment plant, and the installation of an aeration facility). Where similar conditions exist in the Delta (e.g., around other wastewater treatment plants), the actions applied at SDWSC could be used as a model and replicated with site-specific, adaptive modifications as appropriate.
- There is a current proposal to deepen and dredge a channel at the Port of Stockton. Given the known effects of dredging, including exacerbating conditions that promote lower DO concentrations, if implemented, this project may negatively impact and/or reverse the gains made at the SDWSC site. Such impacts need to be considered carefully as the proposal goes forward.
- The demonstration aeration facility at SDWSC currently operates as a voluntary project with scheduled termination in 2016. Data collected since this project was implemented suggest that it is having a beneficial impact on DO levels — specifically helping to raise DO concentrations to meet TMDL targets. The Council and/or appropriate state and regional agencies should consider the potential negative impacts of removing this aeration facility, and develop a plan to replace this project or implement it as a permanent operation at the SDWSC location. Likewise, the evidence linking the aeration facility to elevated DO levels may suggest that this technique be applied elsewhere in the Delta for appropriate sites.

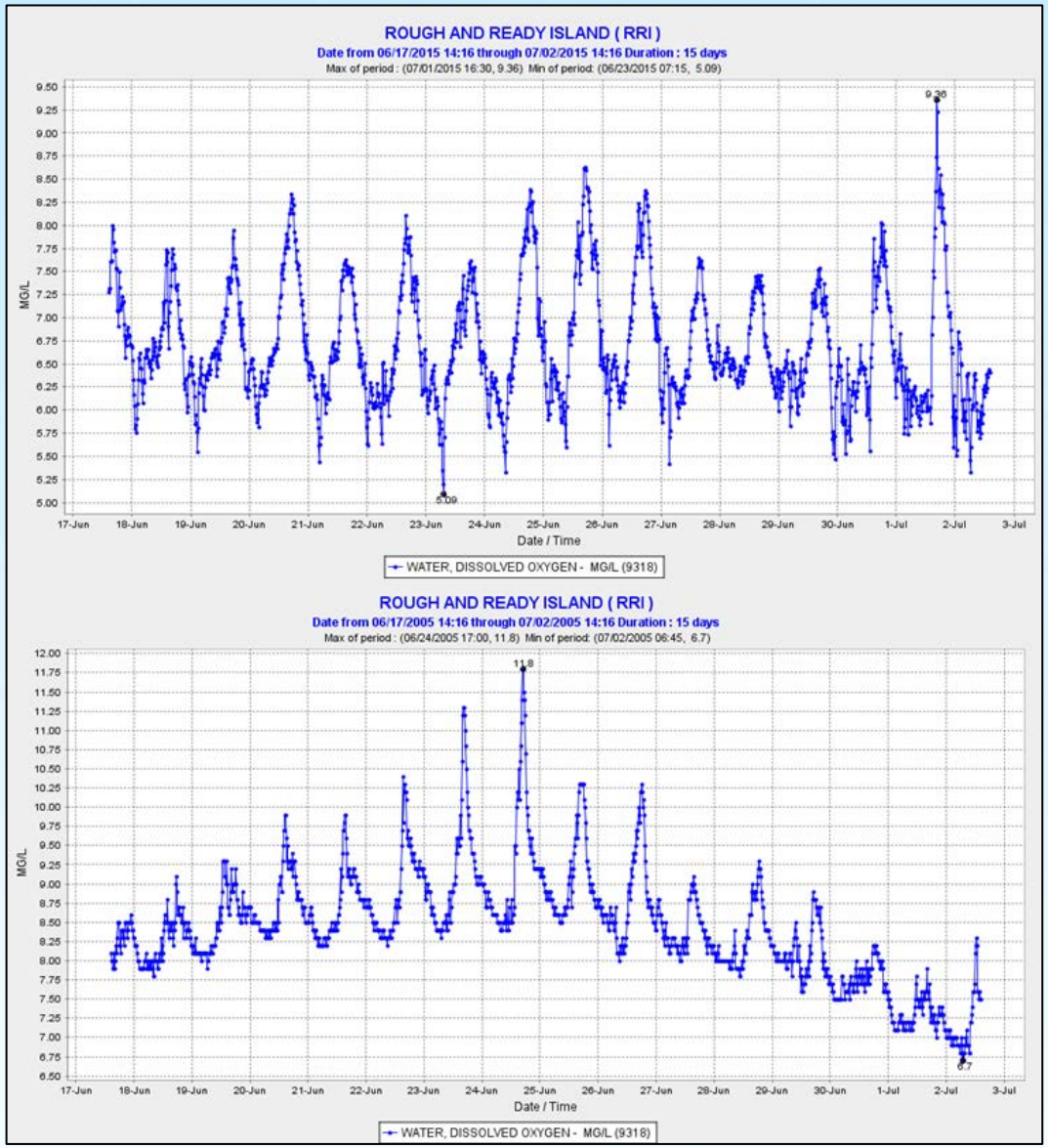

Figure 5. "Rough and Ready Island DO Concentration Trends in the SDWSC," 2005 – 2015.
Source: California Data Exchange Center, California Department of Water Resources. Web. 02 July 2015.[3]

[3] Charts show DO levels from the SDWSC monitoring station in the Delta, over a 15 day time frame from July through June of 2005-2015, comparing pre- and post-action DO levels.

Next Steps

Recommendations for short-term refinements include:

- Expansion of PM tracking to include Suisun Marsh when DO TMDLs are adopted.
- Expand the scope of this PM to include additional sites as DO TMDLs are adopted across the Delta.

Delta Multi-Hazard Coordination Task Force Recommendations

Delta Plan Performance Measures Highlights

Chapter 7 – Reduce Risk to People, Property, and State Interests in the Delta

Reducing flood risks to people, property, and State interests in the Delta must be implemented and progress measured in strategic areas:

- **Emergency preparedness**
- **Flood management activities and investments**
- **Residential flood protection**
- **Floodways, floodplains, and bypasses**
- **Integration of ecosystem function**
- **Limiting state liability**

Why is this important?

The coequal goals of the Delta Reform Act include *the protection, restoration and enhancement of the Delta ecosystem* and providing a more reliable water supply for California. Reducing flood risks to people, property, and State interests is critical to achieving these goals.

Section 85305(a) of the State Water Code requires the Delta Plan reduce flood risks by promoting effective emergency preparedness, appropriate land uses, and strategic levee investments. Under the direction of the Sacramento-San Joaquin Delta Emergency Preparedness Act of 2008 (Senate Bill 27-Simitian), the Sacramento-San Joaquin Delta Multi-Hazard Coordination Task Force (Task Force) has also developed an emergency preparedness and response strategy for the Delta region, including a set of specific recommendations to the Legislature and Governor.

The Implementation of Delta Multi-Hazard Coordination Task Force Recommendations performance measure (PM) tracks the progress of carrying out Task Force recommendations. Task Force goals include:

- Improve the quality and effectiveness of all-hazard emergency response in the Delta region.
- Maintain a level of readiness consistent with identified threats and current capabilities.

Tracking the progress of achieving these goals provides a good indicator of the state of emergency preparedness, as well as areas that may require additional policy and funding support.

How is progress tracked?

Task Force recommendations are tracked by compiling information on the accomplishments by the various State, local, and federal agencies with emergency planning and response responsibilities. These agencies and the Delta Working Group, which is comprised of flood emergency agencies, meet to verify and update this information. “Task Force Recommendations” are a standing agenda item at the Delta Working Group quarterly meetings, and also include coordinating planning activities and discussing roles and responsibilities during catastrophic events in the Delta.

What do the results tell us?

Implementation of the Task Force recommendations is well underway and will continue into the future. All the responsible agencies at the State, local, and federal levels have made significant accomplishments towards the goals of improving the quality and effectiveness of emergency response and maintaining a level of readiness for identified threats within their current capabilities. Accomplishments and challenges in implementing the Task Force recommendations are summarized in the tables below. Key points include:

- An independent Delta all-hazard emergency response fund needs to be developed to provide immediate response as emergencies arise.
- To remove funding uncertainties and disincentives for immediate action, legislative support is needed to change Cal OES' authority to advance funds for emergency response efforts and FEMA's reimbursement policy.
- To help foster accountability and prioritize implementation, awareness and visibility of emergency planning efforts needs to increase for all levels of government and in general.
- Decentralized levee maintenance has advantages and disadvantages. Reclamation Districts/Local Maintaining Agencies have the authority and responsibility to maintain the levees and respond to flood emergencies, but many local agencies lack resources and training to maintain a desired level of preparedness. State agencies have access to more resources but may be burdened by more layers of decision making.
- "You can never be as ready as you'd like to be," as stated by Cal OES staff.

There are also suggestions for funding. They include:

- Develop an emergency funding mechanism to ensure: 1) immediate emergency actions by addressing the lack of ready cash to fund significant engineering response, 2) response by the agency best placed to take action, and 3) eligibility for reimbursement and post-disaster assistance.
  Suggested actions and their status include:

  - Revising the California Disaster Assistance Act to enhance Cal OES' ability to advance funds for response efforts.
    Status: Discussions initiated.
  - A flood response fund maintained and managed by the Department of Water Resources' Flood Operations Center.
    Status: In progress.

    The Disaster Preparedness and Flood Prevention Bond Act of 2006 made $135 million available to the Department of Water Resources (DWR) for essential emergency preparedness supplies and projects. The Delta Flood Emergency Preparedness, Response and Recovery Program (Delta ER Program) is working towards a coordinated and effective multi-agency response during a large scale Delta flood emergency.

- A collaborative effort between Cal OES and FEMA to develop an independent Delta all-hazard emergency response fund.
  Status: No action.

- Fund initial projects to set the Delta preparedness strategy in motion.
  Status: In progress, as described by "accomplishments" under each Task Force recommendation.
- Support joint applications by Delta region stakeholders to potential funding sources, including:

  - Department of Water Resources Flood Emergency Response Projects Direct Grants Program funded by Proposition 84 Bonds, Subventions and Special Projects programs, Grants for Flood Emergency Response Projects through the Flood SAFE Initiative, including Prop. 1E funding. DWR has prepared an Implementation Plan and Five Year Strategic Funding Plan for implementation of the Flood Emergency Response Program which includes the Flood Emergency Response Grants Program.
    Status: On-going.

  - FEMA Catastrophic Incident Preparedness Grant Program
    Status: The Post-Katrina Emergency Management Reform Act and the Homeland Security Act gave FEMA the authority to preposition resources prior to events. FEMA administers three grant programs that provide funding to reduce disaster losses from future disaster damages through various mitigation activities. The 2013 California Enhanced State Multi-Hazard Mitigation Plan (SHMP) was approved by FEMA in 2013. The 2013 SHMP and the state's commitment to revise and resubmit for FEMA approval every three years ensures the state's continued eligibility of Stafford Act funding.

  - CAL FED Levee Stability Program authorized through Section 3015 of the Water Resource Development Act of 2007
    Status: The original Water Supply, Reliability, and Environmental Improvement Act (2004) authorized the appropriation of $90 million. The Water Resource Development Act of 2007

authorized the appropriation of an additional $106 million. Over $18 million has been spent on this program between 2006 and 2014, with about $180 million remaining. Completed projects include: the 2011 Delta Risk Management Strategy studies, a set of map books developed by the Sacramento District of US Army Corps of Engineers as part of the California Delta Emergency Management and Response Plan, and the 2014 Delta Islands and Levees Feasibility Study and draft EIS.

- FEMA Pre-Event Mitigation Grant Program
  Status: FEMA's program allows reimbursement to the legally responsible and eligible applicant, as well as other entities that provided assistance, as long as agreements are in place. However, FEMA's regulation that only reimburses the costs for expenses incurred within an agency's jurisdiction created a disincentive for action by other agencies. This issue may not be as critical for the State, but local agencies do not have enough cash on hand to cope with this reimbursement issue.

- Department of Homeland Security Grant Program
  Status: The Homeland Security Grant Program provides funding to states, territories, urban areas, and other local and tribal governments to prevent, protect against, mitigate, respond to, and recover from potential terrorist attacks and other hazards.

Next Steps

- The Council may want to consider working with Cal OES and others to highlight funding gaps and build momentum for legislative changes to ensure that funding will be available for immediate emergency response actions.
- The Council may want to consider elevating the visibility of emergency planning and preparedness by creating a new, successor task force comprised of decision makers from key stakeholder agencies, or by expanding membership in the Delta Plan Interagency Implementation Committee

Delta region strategy goals – Goals identified by the Task Force and supported by the recommendations in the 2012 report

	Goal	Accomplishments and Challenges	Status
1	Improve the quality and effectiveness of all-hazard emergency response in the Delta region.	**Accomplishments:** • The Governor's Office of Emergency Services (Cal OES) since the 2013 reorganization has clearer authority to act on the Governor's behalf during emergencies and to implement mitigation initiatives. • The Department of Water Resources' (DWR) Delta Flood Emergency Preparedness, Response, and Recovery Program has made major strides in meeting the objectives to: i. Protect the lives, property, and infrastructure critical to the functioning of both the Delta and California ii. Protect water quality and restore water supply for both Delta and export water users iii. Reduce the recovery time of California's water supply to less than six months iv. Minimize impacts on environmental resources • The Delta Working Group has been meeting quarterly to improve coordination and collaboration among State, federal, and local levels. **Challenges:** • Complexities related to coordinating the large number of agencies and personnel involved • Unmet resource needs at local levels • Uncertainties in reimbursement for immediate emergency response actions	Improved, from DWR's and CalOES' perspective. Progress among local agencies is hindered by lack of resources and training.
2	Maintain a level of readiness consistent with identified threats and current capabilities.	**Accomplishments:** • Conducted exercises – operational and table top • Developed/developing flood safety plans and maps at state and local levels • Stockpiled materials for flood fights, contracts in place for mobilizing crews and support • Delta Flood Emergency Response Grants improved local flood emergency preparedness and response **Challenges:** • Can never be as ready as you'd like to be • Identifying and addressing all potential threats and weak areas • Some local (levee) maintaining agencies lack flood safety plans and training. • Need more exercises among multiple agencies to improve readiness • Need more response materials	Ongoing, making progress

Summary on Status of Implementation: Recommendations from the Delta Multi-Hazard Task Force

Recommendations		Status of Implementation
Action Recommendations: Interagency Unified Command System Organizational Framework		
1	Implement a common regional Interagency Unified Command Organizational Framework	In progress. Cal OES is leading the state's efforts while local agencies are developing and implementing local plans to be integrated with state plans into a common Unified Command Organizational framework.
2	Adopt and Implement a Delta Multi-Agency Coordination System (MACS)	Functional. Successfully exercised during the 2011 Golden Guardian full-scale exercise.
Action Recommendations: Emergency Preparedness and Response Strategy		
3	Coordinate the identification of potential threats and consequences	In progress. Standard protocol in place. Decision support tools under development in the Northern California Catastrophic Flood Response Plan will identify trigger points for State involvement, and potential federal assistance, in emergency response.
4	Identify emergency planning and response authorities, capabilities and specific roles	In progress. Ongoing integration of local plans into statewide plan.
5	Adopt and implement a Regional Mass Evacuation Plan	In progress. The Northern California Catastrophic Flood Response Plan is the Delta Region Regional Mass Evacuation Plan.
6	Develop and implement a Delta region specific Interoperability Communications Plan	In progress. The Delta region Interoperable Communications Plan was updated in 2011. DWR awarded $5M Delta Emergency Communications Grants in 2012 to the five Delta counties and a local agency to ensure interoperability within the Delta region. Implementation of communications infrastructure is scheduled to be completed in 2016.
7	Actively participate in federal and state flood and evacuation contingency mapping projects	In progress. Cal OES, DWR, and other state and local stakeholders participated in USACE project to identify and map resources and facilities for emergency response operation.
8	Develop a Sacramento-San Joaquin Delta Catastrophic Flood Incident Plan	The Northern California Catastrophic Flood Response Plan base plan is 80% completed in 2014. Various logistics and resources annexes are being developed in 2015/2016. Delta Flood Emergency Management Plan and DWR-USACE Delta Emergency Operations Integration Plan final documents are planned for September 2015.
Action Recommendations: Exercise and Training		
9	Conduct Golden Guardian 2011	Exercise completed. After-action report completed.
10	Develop and conduct all-hazard emergency response drills and exercises	In progress. This will be complete once the exercise is conducted.
11	Emergency Management Policy Development Training	Ongoing