California Department of Water Resources
Climate Change Vulnerability Assessment

Artwork by Qinqin Liu

John Andrew
California Water Commission
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Kerman, California

Climate Action Plan

DWR's Comprehensive Response to Climate Change

Phase I: Greenhouse Gas Emissions Reduction Plan

Phase II: Consistent, high quality climate change analysis across all DWR programs and projects

Phase III: **Vulnerability Assessment** and Adaptation Plan

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Vulnerability Categories

- Wildfire
- Extreme Heat
- Sea Level Rise
- Long-term Persistent Hydrologic Changes
- Short-Term Extreme Hydrologic Changes
- Habitat and Ecosystem Services Impacts

Climate Action Plan, Phase III

The Vulnerability Assessment

- Identified the vulnerabilities to climate change that could affect DWR's staff, facilities and operations by:
  - ✓ Assessing the level of exposure and sensitivity associated with each to determine overall risk (E + S = R)
  - ✓ Considering adaptive capacity for moderately or highly exposed facilities and operations

Vulnerability Assessment Scope

DWR facilities, operations, staff, and managed lands

Mid-century time horizon (2030-2070)

Vulnerability Assessment Scope

Assessed

- Infrastructure (Facilities and Lands)
  - State Water Project
  - Flood facilities
  - Regional/field division offices
  - Managed lands
- Staff Activities
  - O&M of SWP
  - Biological surveys/monitoring
- SWP Operations
  - Hydrologic changes and effects on snowpack, streamflow, and deliveries

Not Assessed

- Delta levees (including seismic risk)
- Subsidence
- Electrical grid (due to wildfire or extreme heat)
- Sedimentation behind dams (due to post-wildfire erosion)

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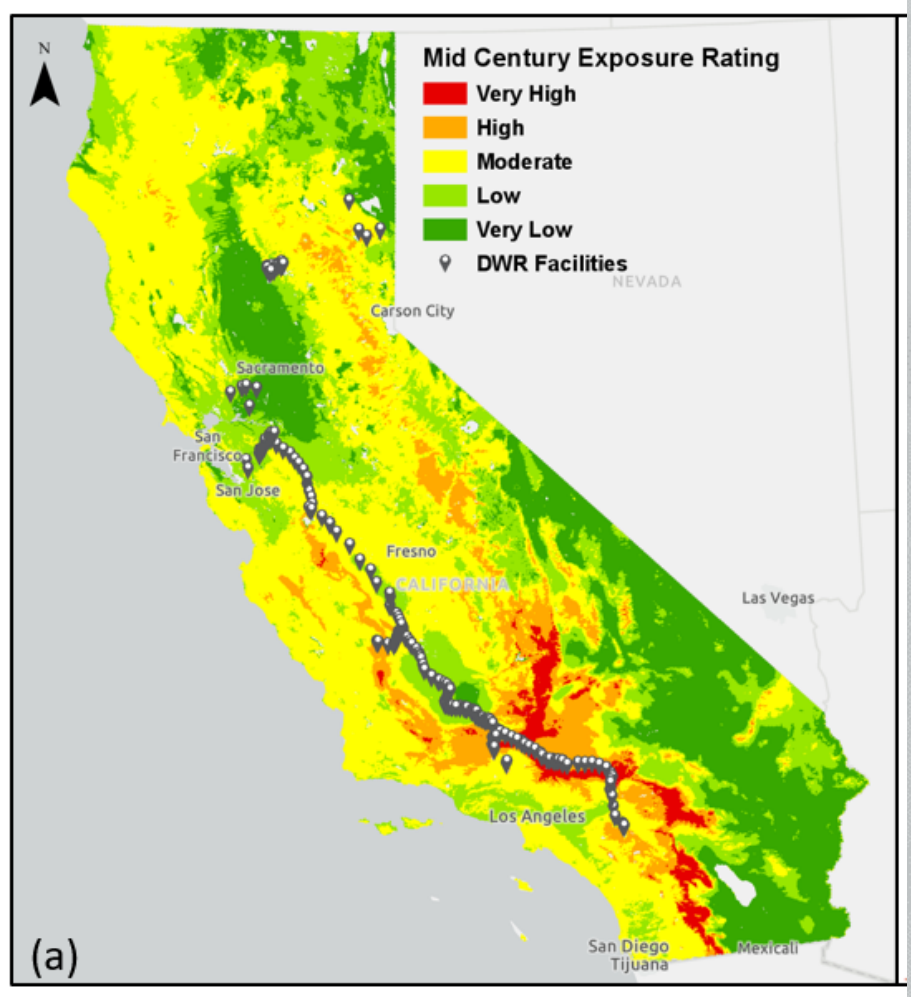
Statewide Projected Change in Wildfire Exposure at Mid-Century

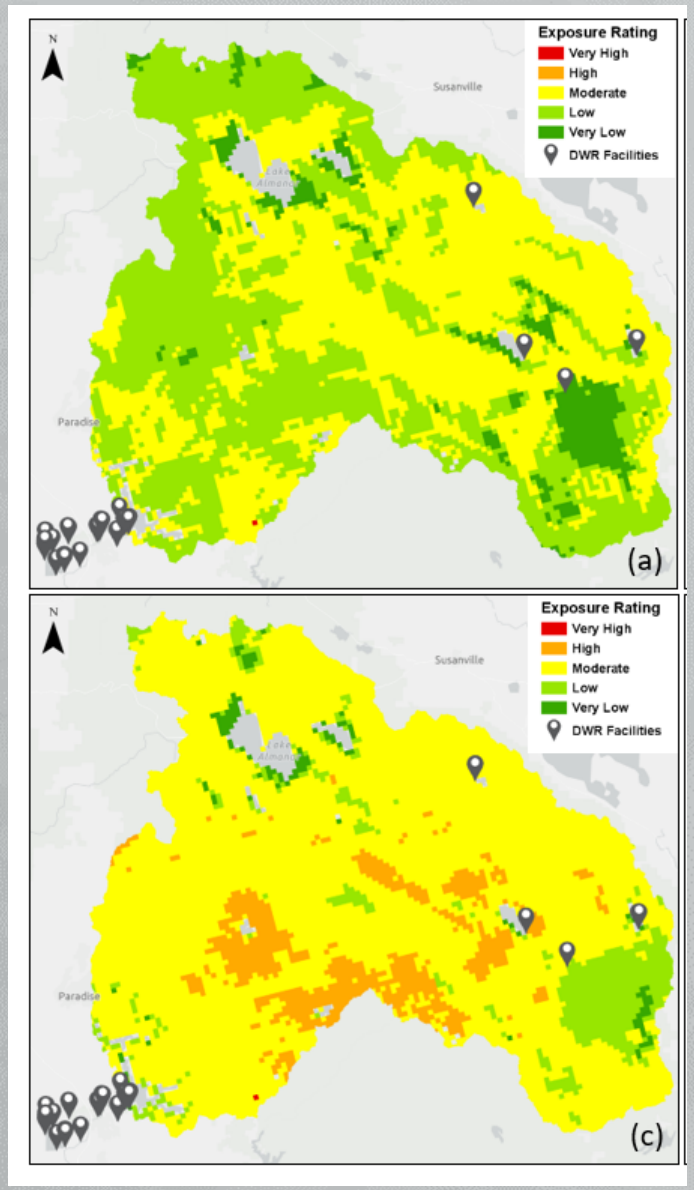


Wildfire Vulnerability Assessment Results

- DWR's facilities are likely not vulnerable to increased wildfire risk because existing management and maintenance practices are adequate to protect infrastructure from current as well as future wildfire exposure levels.

- However, the Upper Feather River headwaters for the State Water Project see significant increases in wildfire by mid-century.

Projected Feather River Watershed Wildfire Exposure Resulting from Climate Change — Early and Mid-Century



Projected Feather River Watershed Wildfire Exposure Resulting from Climate Change — Early and Mid-Century

Wildfire Exposure	Early Century (2010–39)	Mid-Century (2040–69)
Very Low	6.5%	2%
Low	46%	8%
Moderate	48%	80%
High	0%	10%
Very High	0%	0%

Extreme Heat Vulnerability Assessment Results

- Although some areas in California are projected to experience moderate increases in extreme heat levels, utilizing the existing DWR safety plans and programs could keep the vulnerability of staff at current levels.

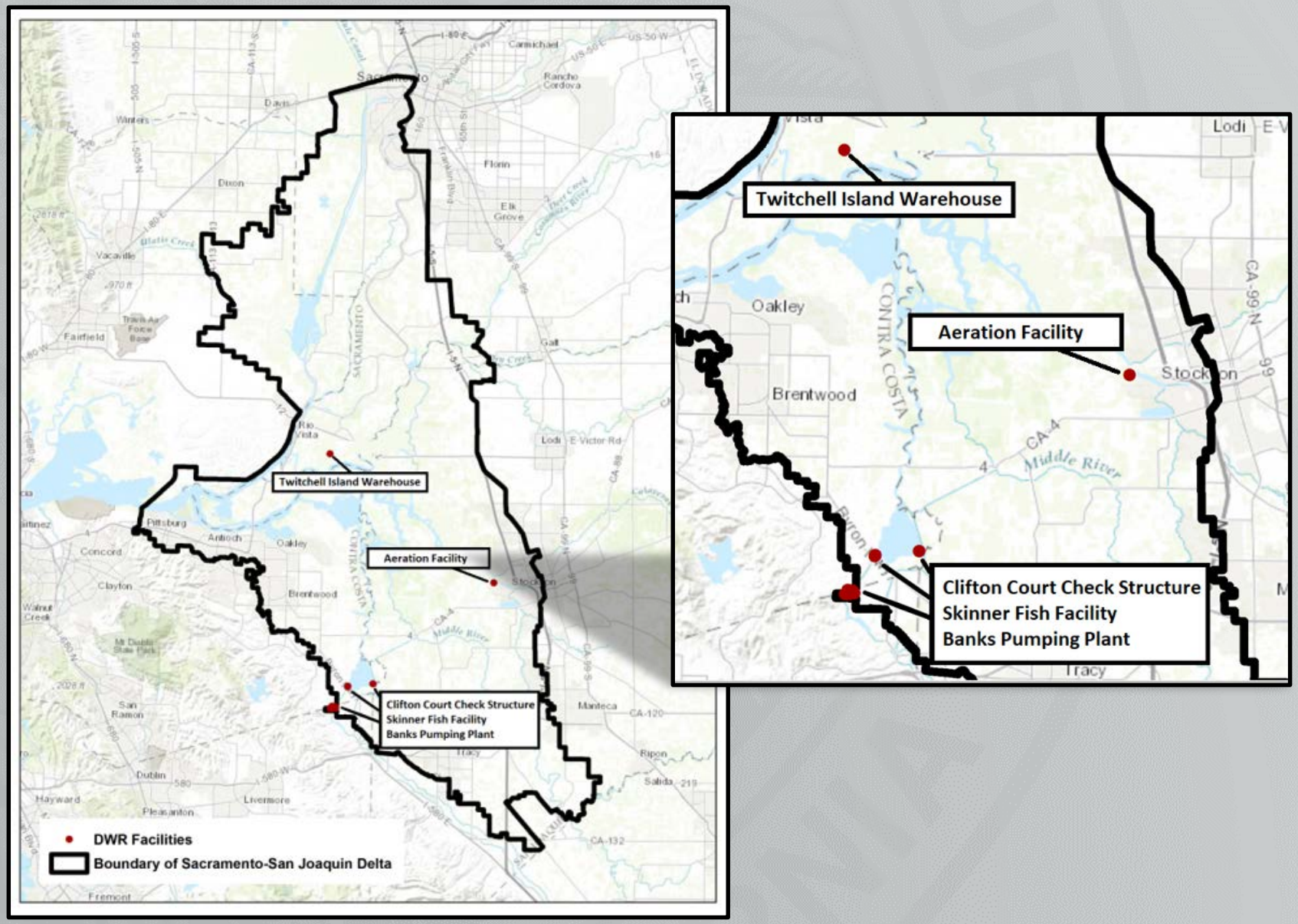
Modeled Number of Days Exceeding Temperature Thresholds

Location Name	Number of days exceeding 80 ºF		Number of days exceeding 95 ºF		Number of days exceeding 105 ºF	
	1990–1999	2040–2049	1990–1999	2040–2049	1990–1999	2040–2049
Oroville Field Division	128–163	**150–174**	33–63	**58–84**	0–8	**2–13**
Delta Field Division	119–168	**151–175**	21–47	**37–64**	0–5	**0–11**
San Luis Field Division	121–165	**146–171**	15–35	**28–61**	0–1	**0–7**
San Joaquin Field Division	156–188	**174–199**	53–93	**87–117**	3–16	**7–32**
Southern Field Division	139–180	**160–194**	48–81	**84–105**	0–6	**3–20**

Sea Level Rise Vulnerability Assessment Results

- State Water Project (SWP) operations and performance are found to be vulnerable to rising sea levels in the Delta.
- Few DWR facilities are sensitive to rising sea levels, and so overall vulnerability is considered low.

DWR Facilities in the Delta with High Exposure to Sea-Level Rise



Sea Level Rise Vulnerability Assessment Results

- The Suisun Marsh will likely be impacted by increasing inundation of mud flats and low-lying areas and greater variation in environmental conditions.
- Rising sea level coupled with storm surge and storm-driven stream flow into the Delta could result in substantial increases in stage elevation in the Delta (technical report in the State's Fourth Assessment)

Long-term Persistent Hydrologic Changes

- Co-production of DWR and the University of Massachusetts, Amherst
- Included in the State's Fourth Assessment
- Improves planning for the uncertain effects of climate change
- Integrates vulnerability-based analysis with traditional risk-based assessment methods

Long-term Persistent Hydrologic Changes

Performance Metric	Probability that Mid-Century (2050) Performance will be Less than Current Performance
Oroville April Storage	76%
Oroville Carryover Storage	95%
Winter Net Delta Outflow	63%
Spring Net Delta Outflow	65%
Summer Net Delta Outflow	21%
Fall Net Delta Outflow	40%
SWP Deliveries	87%
System Shortages	76%

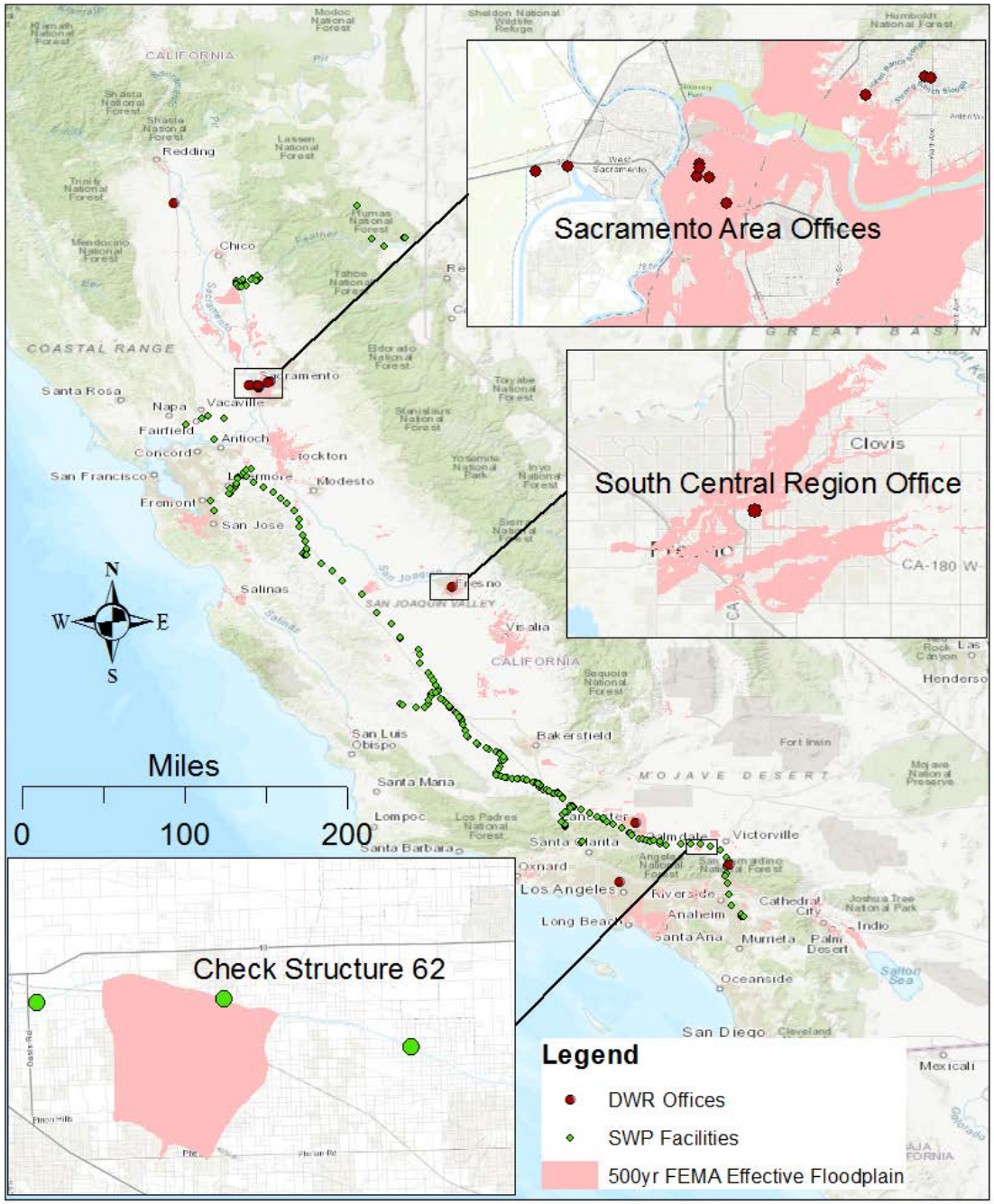
Long-term Persistent Hydrologic Changes Vulnerability Assessment Results

- High likelihood of significant reductions in SWP delivery and storage performance as the climate warms.
- While SWP operations thus are at risk to climate change, SWP facilities and operations can be adapted to ameliorate losses in performance.

Short-Term Extreme Hydrologic Changes Vulnerability Assessment Results

- Maximum annual 1-day and 3-day flows are projected to increase for all watersheds evaluated.
  - Flood operations are considered to have high risks throughout the Central Valley
  - Risks are even higher, particularly for large events, in the San Joaquin Valley compared to Sacramento Valley.

- Analysis draws from the Central Valley Flood Protection Plan (CVFPP) 2017 Update: Climate Change Analysis Technical Memorandum


Sacramento Area Offices
South Central Region Office
Clovis
CA-180 W
Check Structure 62
N
W
E
S
Miles
0
100
200
Legend
DWR Offices
SWP Facilities
500yr FEMA Effective Floodplain
CALIFORNIA
COASTAL RANGE
SAN JOAQUIN VALLEY
MOJAVE DESERT
GREAT BASIN
Redding
Chico
Sacramento
Santa Rosa
Napa
Vacaville
Fairfield
Antioch
Concord
Stockton
San Francisco
Livermore
Modesto
Fremont
San Jose
Fresno
Salinas
Visalia
San Luis Obispo
Bakersfield
Santa Maria
Lompoc
Santa Barbara
Oxnard
Los Angeles
Riverside
Long Beach
Anaheim
Santa Ana
Victorville
Oceanside
San Diego

Habitat and Ecosystem Services

DWR managed land includes: mitigation properties, right-of-way easements, and restoration projects

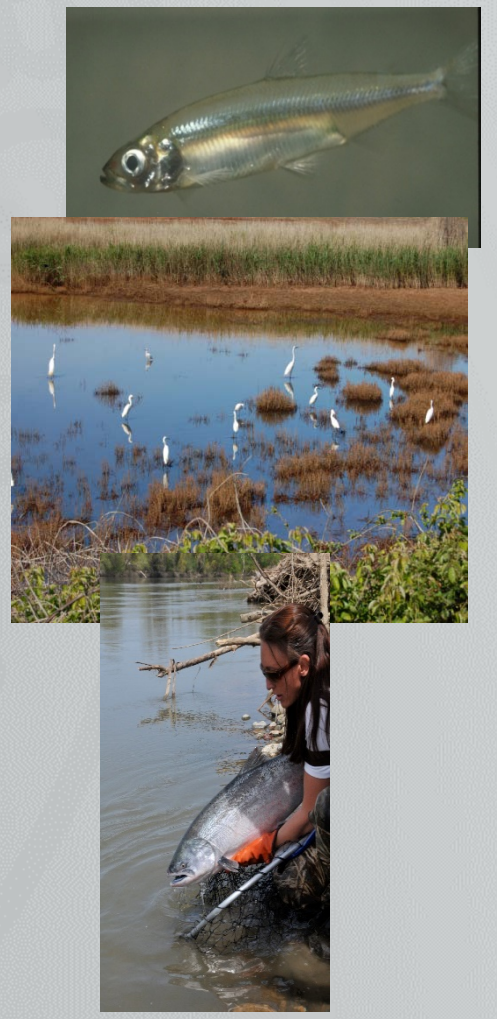
For this report, the following was assessed:

- Habitat and ecosystem services by ecoregion
- Facilities and lands vulnerable to ecosystem services impacts
- Operational vulnerability to ecosystem services impacts

Habitat and Ecosystem Services

Potential Implications for DWR

- Climate change will impact species/habitat in some regions more than others, and in unpredictable ways
  - Sacramento-San Joaquin Delta properties at risk include the Yolo Bypass, Prospect Island, Twitchell/Sherman Island, and multiples sites within the Suisun Marsh
  - California Aqueduct Right-of-Way habitat
- Mitigation and restoration parcels may not be suitable for target species under future conditions
  - A complete managed lands inventory is needed for future site-specific analyses
- Impacts to Operations
  - Salmon species and freshwater fisheries impacts will be exacerbated



Next Steps: Adaptation Planning

- The Vulnerability Assessment serves as a foundation for the development of an Adaptation Plan.
- The Adaptation Plan will help prioritize DWR climate resiliency efforts such as infrastructure improvements, enhanced maintenance and operation procedures, revised health and safety procedures, and improved habitat management.

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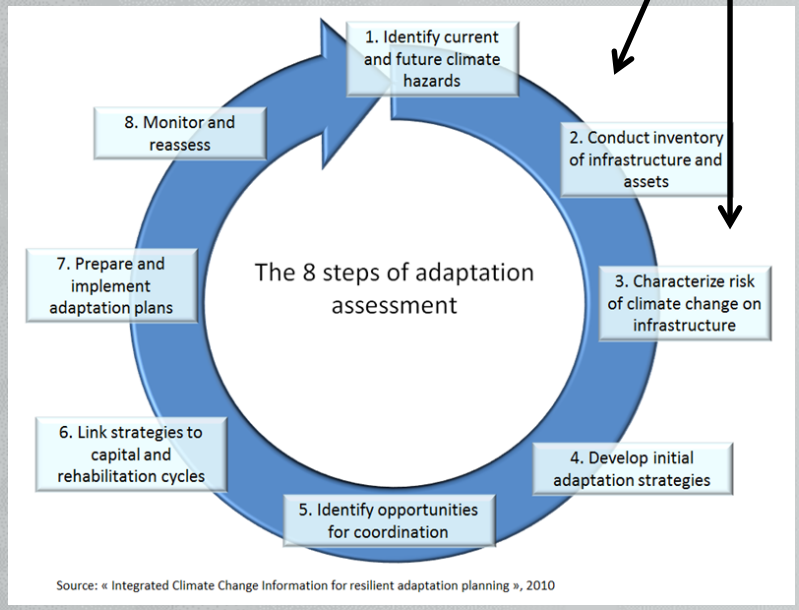
CAP Phase 3

Vulnerability Assessment and Adaptation Plan

The Adaptation Plan will:

- Address vulnerabilities identified in the VA
- Describe climate change adaptation goals and objectives
- Lay out a plan that will help achieve those objectives

The VA process



***Revisit and update** every 5 years

Why should DWR conduct a Climate Change Vulnerability Assessment?

- **Climate change impacts have been widely documented globally, across the nation, and within the state.**
- **Climate-driven hazards represent a clear threat to Department of Water Resources (DWR) facilities, managed lands, operations, and staff activities.**
- **We need to establish a 'snapshot' of baseline vulnerability**
- **Future updates will build upon this foundation**

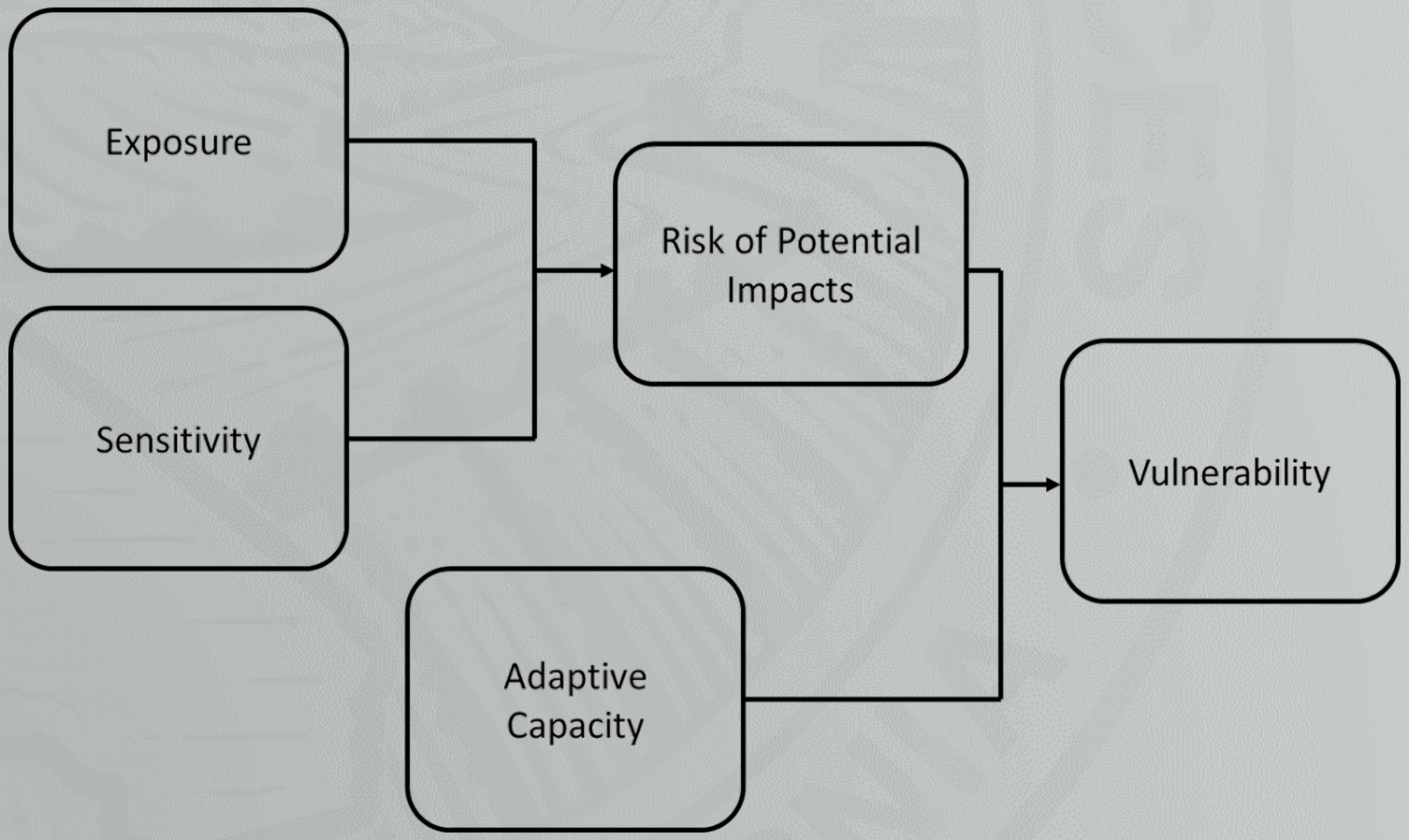
Why should DWR conduct a Climate Change Vulnerability Assessment?

Policy and legislation include:

- **B-30-15**
  - Directs state government to identify how climate change will affect infrastructure. “state agencies shall take climate change into account in their planning and investment decisions”
- **AB 1482**
  - Requires the California Natural Resources Agency to oversee and coordinate state agency actions to adapt to climate change. Safeguarding California.
- **AB 2800**
  - Ensures that the planning and design of state infrastructure projects consider future climate change impacts.
- **Good business practices**
  - DWR is better prepared, decision-making for an uncertain future.

CAP Phase III: Vulnerability Assessment

Methodology for Assessing Vulnerability of DWR Facilities, Lands, Staff Activities, and Operations to Climate Change



Extreme Heat - Analysis

Qualitative Approach

- **Staff Survey – July 2014**
  - Comprehensive list of outdoor activities
  - Identify those activities with most exposure and/or least flexibility

- **Data Analysis**
  - Used Cal-Adapt data (GFDL w/ A2 emission scenario)
  - Based on Heat Illness Prevention Plan (HIPP)
  - Estimated the increase in number of days over the HIPP thresholds (plus additional threshold of 105^{o}F)

Extreme Heat Findings

	Mid-Century Increase in Number of Days above:	
Location Name	95 ^{0}F	105 ^{0}F
San Luis Field Division	74-87%	0-600%
South Central Region Office	35-77%	93-100%
Southern Region Office	150-300%	0-200%
San Joaquin Field Division	26-64%	100-133%
Southern Field Division	30-75%	0-233%

Projected Sea-Level Change

Location	2030	2050
North of Cape Mendocino	-4 to 23 cm	-3 to 48 cm
South of Cape Mendocino	4 to 30 cm	12 to 61 cm

Sea Level Rise Findings

	Suisun Marsh will likely be impacted by increasing inundation of mud flats and low lying areas and greater variation in environmental conditions
	Rising sea level coupled with storm surge, and storm driven stream flow into the Delta could result in substantial increases in stage elevation in the Delta

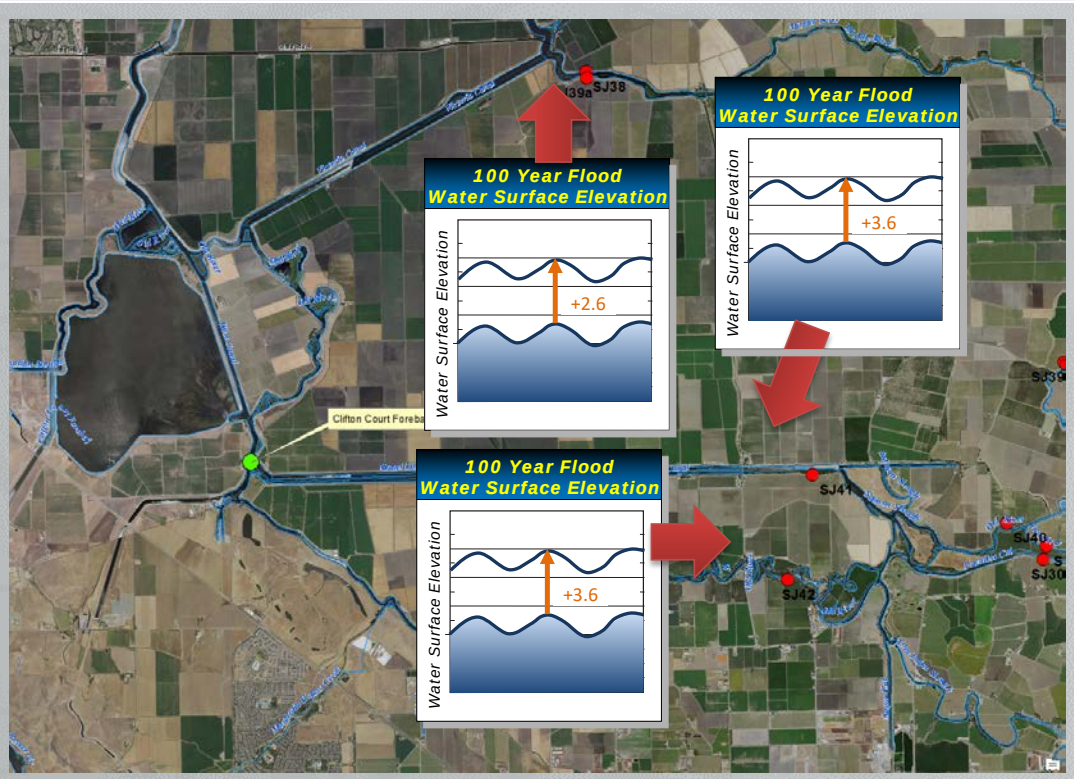


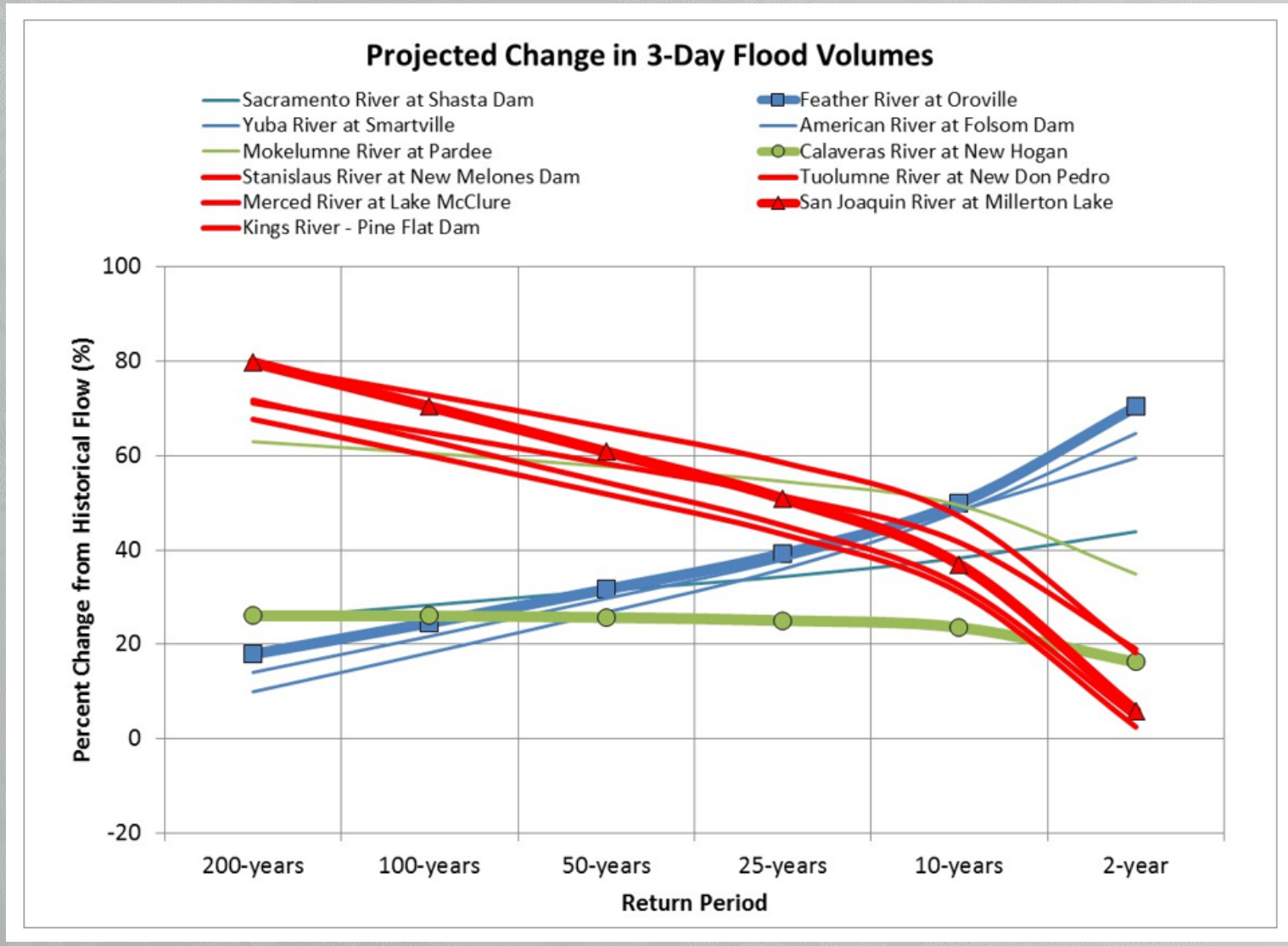
Figure 4-5 Clifton Court Forebay with Water Surface Elevation Change between Current and Future Climate during a 100-year Flood

Performance Metric	Probability that Mid-Century Performance will be Worse than Current Performance	
Oroville September Storage	98%	Less water in storage
Oroville April Storage	87%	Less water in storage
SWP Deliveries	87%	Lower deliveries
System Shortages	63%	More shortages

Short-Term Extreme Hydrologic Changes

- Peak flows are projected to occur significantly earlier in the year, likely because of the reduction in precipitation falling as snow and a greater portion of the watershed contributing to direct runoff.
- Maximum annual 1-day and 3-day flows are projected to increase for all watersheds evaluated. This observation suggests that the increases in flood flows may be robust for durations up to 5–7 days.
- Storm durations are projected to decrease in all major watersheds. The signal of shorter duration, but more intense floods is strongest in the San Joaquin Basin, but is also observed for most Sacramento watersheds.

Short-Term Extreme Hydrologic Changes



Habitat and Ecosystem Services Impacts

- Key ecosystem services such as habitat provision for sensitive species and floodwater attenuation could be disrupted by climate-influenced conditions that change too quickly for ecological adaptation to occur.
- Cold water fisheries, such as those on the Feather River, may be impacted by warmer water in streams, leading to more species listed as endangered and more operational constraints.
- Warming temperatures could cause some species to migrate (i.e., northward in latitude and upward in elevation) in response to changing ecological conditions, making mitigation parcels purchased to protect them unsuitable in the future.

Habitat and Ecosystem Services Impacts

- Climate change will exacerbate stresses on listed species and habitat types. As a result, DWR may need to take additional measures to manage or restore lands for mitigation or other purposes.