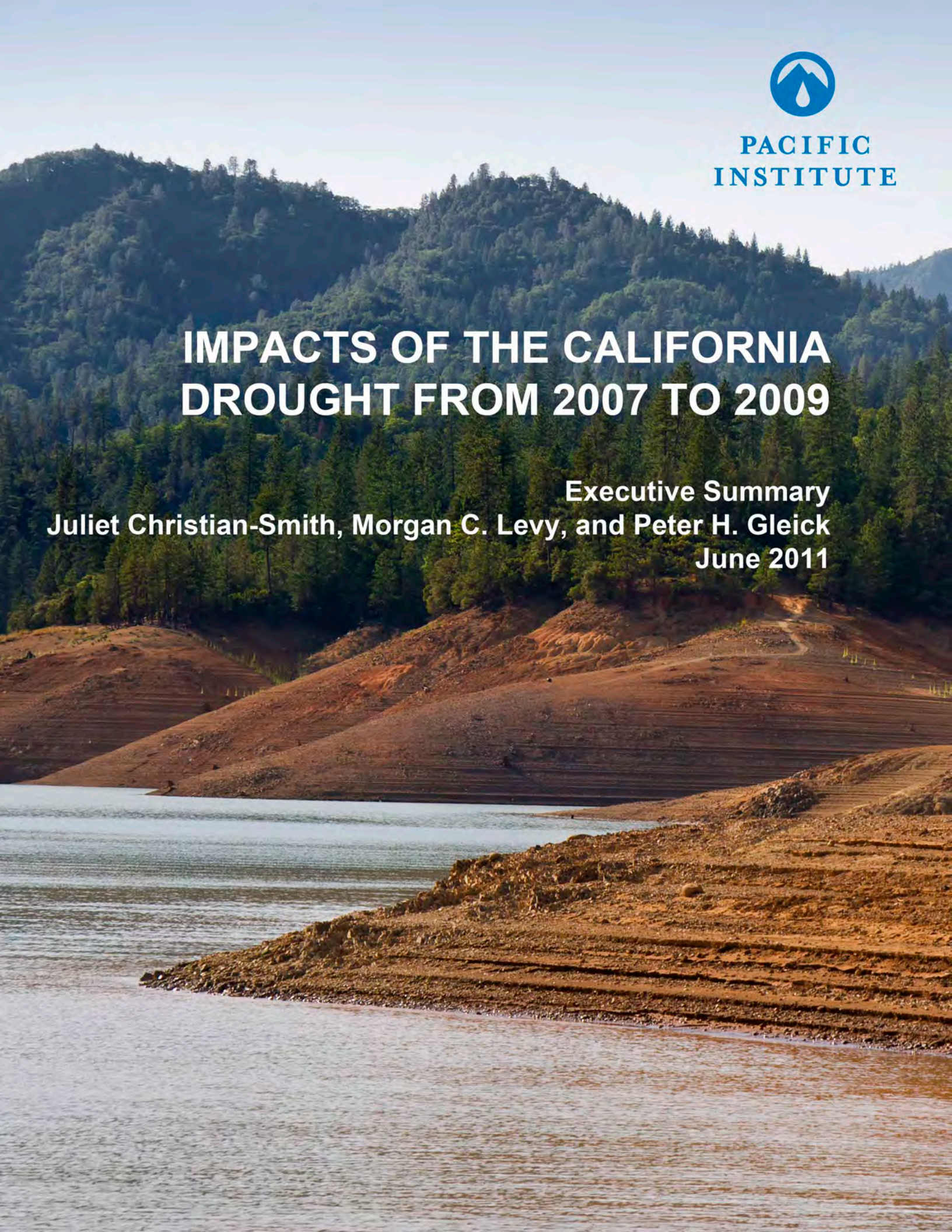

PACIFIC INSTITUTE

IMPACTS OF THE CALIFORNIA DROUGHT FROM 2007 TO 2009

Executive Summary

Juliet Christian-Smith, Morgan C. Levy, and Peter H. Gleick

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Authors:
Juliet Christian-Smith
Morgan Levy
Peter H. Gleick

Editors:
Nancy Ross and Paula Luu, Pacific Institute

Pacific Institute
654 13th Street, Preservation Park
Oakland, California 94612
www.pacinst.org
Phone: 510.251.1600
Facsimile: 510.251.2203

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About the Authors

Juliet Christian-Smith

Dr. Christian-Smith is a Senior Research Associate with the Pacific Institute's Water Program. Her interests include agricultural water uses, comparative analyses of water governance structures, water reuse, and climate change. Dr. Christian-Smith is a recipient of the Environmental Protection Agency's Award for Outstanding Achievement and serves on the Executive Board of the Agricultural Water Management Council. She is also a Frontiers of Science Fellow for the National Academy of Sciences. Dr. Christian-Smith holds a Ph.D. from the University of California, Berkeley and a B.A. from Smith College.

Morgan Levy

Ms. Levy is a joint Masters/Ph.D. student in the Energy and Resources Group at the University of California, Berkeley, and research intern with the Pacific Institute's Water and Sustainability Program. She was a Fulbright Fellow in 2009 and recently received the Association of California Water Agencies 2010-2011 Water Law & Policy Scholarship. Her research focuses on agricultural water resources in California and the American West.

Peter H. Gleick

Dr. Gleick is co-founder and president of the Pacific Institute. He works on the hydrologic impacts of climate change, sustainable water use, planning and policy, and international conflicts over water resources. Dr. Gleick received a B.S. from Yale University and an M.S. and Ph.D. from the University of California at Berkeley. He is the recipient of the MacArthur Fellowship, an Academician of the International Water Academy, a member of the U.S. National Academy of Sciences, and is the author of many scientific papers and books, including the biennial water report *The World's Water* and the newly released *Bottled and Sold: The Story Behind Our Obsession with Bottled Water.*

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Glossary of Acronyms

AF	Acre-Feet
Bay-Delta	San Francisco Bay Sacramento-San Joaquin River Delta
CDEC	California Data Exchange Center
CDFA	California Department of Food and Agriculture
CEC	California Energy Commission
CFS	Cubic-Feet Per Second
CRS	Congressional Research Service
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
DFG	Department of Fish and Game
DOI	Department of the Interior
DWR	Department of Water Resources
EDD	Employment Development Department
ESA	Endangered Species Act
EWA	Environmental Water Account
FMWT	Fall Midwater Trawl
GHG	Greenhouse Gas
GWhrs	Gigawatt-Hours
GRACE	NASA's Gravity Recovery and Climate Experiment
MAF	Million Acre-Feet
NASS	National Agricultural Statistics Service
NDO	Net Delta Outflow
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OCAP	Operational Criteria and Plan
PFMC	Pacific Fishery Management Council
PUMA	Public Use Microdata Areas
SJV	San Joaquin Valley
SWP	State Water Project
SWRCB	State Water Resources Control Board
WQCP	Water Quality Control Plan
TAF	Thousand Acre-Feet
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WWD	Westlands Water District

Executive Summary

Droughts can produce a wide range of adverse impacts on diverse economic sectors and environmental conditions depending on their intensity, duration, and location and on the actions taken by those affected. Often, the overall consequences of a drought are not fully understood until some time has passed and comprehensive data are collected and analyzed. A good example is the recent multi-year drought in California from 2007 through 2009. During the drought, there was considerable concern and controversy throughout the state about the nature and severity of water shortfalls, and the impacts on individual communities.

Here, we present updated information on impacts of the recent drought on California's economy and environment, and, where possible, its costs. We also assess what this drought tells us about California's vulnerability to future droughts. The state's growing population, the declining health of ecosystems, and climate change all contribute to rising pressure on water resources. It will be increasingly important to have robust and resilient strategies to cope with these pressures. The recent drought provides a unique opportunity to retrospectively examine how the drought affected different sectors and how those sectors responded, in turn. This information can help improve drought planning and management and, ultimately, help minimize negative impacts of future droughts.

According to the California Department of Water Resources, water years 2007-2009 were the 12th driest three-year period in recorded climatic history (DWR 2010). From a purely hydrological perspective, droughts in the late 1920s, 1970s, and 1980s were more severe. The 2007-2009 drought, however, coincided with a period of increased demands for freshwater, changes in operating rules at reservoirs, and environmental protections that reduced pumping of water from the Sacramento-San Joaquin Delta to state and federal water users south of the Delta (DWR 2010). Among the sectors affected by reduced water availability were agriculture, ecosystem health, and hydropower production. We discuss each in this assessment.

During the drought, there was considerable controversy around the role that environmental protections, and in particular, the Endangered Species Act (ESA), played in the reduced exports to south-of-Delta water users. Some critics contended that environmental protections forced dramatic reductions in water supply that hurt agricultural sector production and employment in the Central Valley. Yet, data and analyses from the California Department of Water Resources and the Congressional Research Service now estimate that legal environmental protections accounted for less than a quarter of the overall reductions in 2009 (Cody et al. 2009). The remaining reductions were related to precipitation and runoff. In addition, the Commissioner of the Bureau of Reclamation and the Congressional Research Service have found that these reductions were not due to the ESA alone but to a wide range of federal and state policies, including the Clean Water Act, the state Porter-Cologne Act, the state Fish and Game Code, and the Central Valley Project Improvement Act. Finally, local differences in water-supply impacts also resulted from the priority of use: some federal water project users – settlement and exchange contractors – received 100% of their desired supplies throughout the drought, while others received only 10% (USBR 2009). As a result, contract priority was a critical factor in the disparity in water deliveries during the drought.

Several factors buffered California's agricultural sector from suffering even worse impacts. Among the coping strategies employed were increased reliance on local groundwater, temporary water transfers among users, fallowing farmland, and the alteration of cropping patterns and changes to the types of crops cultivated. New research has found that the average groundwater depletion rate doubled during the 2006-2010 time period (Famiglietti et al. 2011). For instance, in the wet year of 2006, Westlands Water District pumped around 25,000 acre-feet of groundwater (2% of the district's water supply), while in 2009 the district pumped 480,000 acre-feet groundwater (more than 50% of water supply) (Westlands Water District 2010). Strong demand for California farm products on national and global markets also kept both crop prices and revenue high throughout the drought.

As a result of these complex factors, the state's 81,500 farms and ranches received $34.8 billion in gross revenue for their production in 2009[1] – the third highest year on record and just below the all-time high of $38.4 billion reached during 2008, the second year of the drought (USDA-NASS Agricultural Statistics 2010). The California Department of Food and Agriculture (CDFA 2010) reported that the state's agricultural sales for 2009 ranked behind only 2008 and 2007 as third highest on record.

Statewide, harvested acreage has been declining over the past decade, even during periods of more abundant water. The rate of decline in acreage actually appears to have slowed between 2007 and 2009. Yield fluctuates from year to year, but yield throughout the drought years dropped below 2006 (wet year) levels only once and in a single crop category – in field and seed crops - during the final year of the drought (2009). The average total combined yield of irrigated crops in California was higher during the drought period (2007-2009) than prior to the drought (2000-2006).

A closer study of data from county crop reports and irrigation districts reveals varied responses to drought between and within individual counties. For instance, while the total gross revenue of Fresno County agriculture increased by 2% during the drought years, gross revenue in neighboring Kern and Kings Counties declined by 9% and 19%, respectively. And while Fresno, Kern, and Kings Counties all fallowed land at higher rates during the drought, nearby Tulare County did not. In fact, Tulare County harvested more acres in both 2008 and 2009 than it did in 2006, considered a wet water year.

The drought period coincided with the foreclosure crisis and a national and global recession. From 2005 to 2009, unemployment almost doubled statewide from 5.4% to 11.3%.[2] Michael et al. (2010) found that over the same time period crop production and agricultural support jobs declined by 1.5% (2,500 jobs) to 2.3 % (3,750 jobs) in the San Joaquin Valley. However, U.S. Census data and California Employment Development Department data indicate that many employment sectors saw more severe declines than farming, fishing, and forestry occupations in the San Joaquin Valley, which either remained stable or increased as a percentage of the total

[1] Our analysis reports changes to the total market value of agricultural products in the state. This is the primary measure that the state and counties use to report the value of agriculture. It should be noted, however, that this measure represents gross, not net, revenue and does not include rising production costs or federal payments, such as crop insurance.

[2] Statewide unemployment rates are calculated by California's Employment Development Department and are available here: http://www.labormarketinfo.edd.ca.gov/?pageid=164

jobs available. Notably, unemployment rates rose from 2009 to 2010 in every San Joaquin Valley County, despite greater water supplies in 2010 (EDD 2005-2010). Recent attention to the human suffering in this region highlights the problem of severe and chronic poverty in the Valley, ironically one of the highest grossing agricultural regions in the world. Communities within the San Joaquin Valley have had the highest levels of unemployment and poverty in the state for decades, in both wet and dry years (CRS 2005).

We also examine the impact of the drought on the environment, which includes fisheries and associated economies. Environmental impacts are difficult to disaggregate from natural fluctuations and other anthropogenic factors (land use, climate change, etc.) that contribute to the degradation of California's aquatic ecosystems. But, there are several environmental indicators that have been consistently tracked over the years that allow us to examine evidence of drought stress within longer-term trends, including the salinity of the Sacramento-San Joaquin Delta, environmental flows for waterfowl and wildlife refuges, and fisheries. Our review of these data indicates that the drought led to significant declines in native fish populations and a collapse in related industries. Fish populations naturally fluctuate over time, yet certain species have experienced significant population declines over the past decade, and record lows can be seen in the 2007-2009 drought years. During the drought, the California Department of Fish and Game (DFG) found that Delta smelt, longfin smelt, American shad, and threadfin shad populations all were at record low levels; in 2010, striped bass and splittail populations plunged to record lows as well (in two of the past three years, zero splittail were collected in annual surveys) (DFG 2010).

The quantities of Chinook salmon caught off the coast of California have been in decline for the past several decades. Between 1960 and 1980, commercial catch averaged 7.7 million pounds per year. Between 1980 and 2000, the catch averaged 5.2 million pounds per year. Catch average during the past decade declined even further to 3.9 million pounds per year. In 1990, during the middle of the last major drought, the salmon harvest was 4.4 million pounds. Harvests during the most recent drought were much less: only 1.5 million pounds were landed during the first year of the drought (2007), and then the fisheries were closed completely during 2008 and 2009. Preliminary numbers document only 228 thousand pounds caught in 2010. The Eberhardt School of Business at the University of the Pacific estimates that salmon fishery closures during the drought resulted in a loss of 1,823 jobs and $118.4 million in income compared to the jobs and income of the salmon fishery in 2004 and 2005 (Michael et al. 2010).

In addition, despite statements that significant quantities of water were diverted during the drought to natural ecosystems (Nunes 2009), many of the state's environmental flows went unmet during the drought period. For example, during the 2008 water year (October 2007 – September 2008), flow objectives along the American River were not met for 8 consecutive months (CDEC and AFRP 2001). In the 2009 water year (October 2008 – September 2009), Stanislaus River flows fell under the minimum required for 4.5 consecutive months beginning in November 2008. Over the drought period, average unmet annual flow quantities along the San Joaquin River were 500 times the level of unmet flows in 2006, and in 2009, flow objectives were not met 67% of the time (CDEC and WQCP 1995). Reduced environmental flows have economic implications, such as impacts on water and riparian land quality. These may be quantified to a degree in terms of "environmental services" provided by natural river flows to

both people and the environment. However, there are currently no widespread, accepted methods for quantifying these impacts in economic terms.

Finally, we assess and quantify the impacts of the drought on California's hydropower production, which declined significantly during the drought years. During the three-year drought period, California hydropower was roughly halved. This lost hydropower was made up with the purchase and combustion of additional natural gas. We calculate that electricity rate payers spent $1.7 billion to purchase natural gas over the three-year drought period, emitting an additional 13 million tons of CO_2 (about a 10% increase in total annual CO_2 emissions from California power plants). The substitution of hydropower with natural gas also released substantial quantities of nitrous oxides, volatile organic compounds, and particulates – pollutants that are known contributors to the formation of smog and triggers for asthma.

There are several main conclusions of this assessment. Although agricultural revenues remained high during the drought, some of the response strategies such as groundwater mining were short-term fixes that would not provide water security in the face of a longer or more severe drought. Aquatic ecosystems have suffered long-term declines and have little resiliency to changing conditions. And our energy sector currently has limited ability to produce or buy renewable energy sources to replace hydropower production during droughts. In order for California to become more resilient to future drought conditions, it will be critical to shift from crisis-driven responses to development and enactment of long-term mitigation measures. All of the sectors that we examine in this report (agriculture, energy, and the environment) are highly vulnerable to future droughts and should develop more comprehensive drought planning and mitigation measures to reduce the potential for human, environmental, and economic harm.

For the full report, go to: http://www.pacinst.org/reports/california_drought_impacts