Marine and Coastal Impacts of Ocean Desalination in California

Prepared by Water in the West, Center for Ocean Solutions, Monterey Bay Aquarium, The Nature Conservancy

May 2016

Stanford Woods Institute for the Environment

Water in the West

Center for Ocean Solutions

Monterey Bay Aquarium

The Nature Conservancy

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Acknowledgments

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About Water in the West

Water in the West is a partnership of the faculty, staff and students of the Stanford Woods Institute for the Environment and the Bill Lane Center for the American West. The mission of Water in the West is to design, articulate and advance sustainable water management for the people and environment of the American West. Linking ideas to action, we accomplish our mission by engaging in cutting-edge research, creative problem solving, active collaboration with decision-makers and opinion leaders, effective public communications and hands-on education of students. To learn more, please visit: waterinthewest.stanford.edu.

About Center for Ocean Solutions

The Center for Ocean Solutions works to solve the major problems facing the ocean and prepares leaders to take on these challenges. We value and steward linkages between the ocean, health and climate resulting in thriving marine ecosystems and vibrant coastal communities. The Center for Ocean Solutions is a partnership of Stanford University (through the Stanford Woods Institute for the Environment and Hopkins Marine Station), the Monterey Bay Aquarium, and the Monterey Bay Aquarium Research Institute. To learn more, please visit centerforoceansolutions.org.

About Monterey Bay Aquarium

The mission of the nonprofit Monterey Bay Aquarium is to inspire conservation of the ocean. Today, more than 30 years after opening, the Aquarium is a showcase for the habitats and sea life of one of the world's richest marine regions. More than 35,000 creatures representing over 550 species fill nearly 200 exhibits in all. The Aquarium is not only a window to the wonders of the ocean for 2 million visitors per year, but it is also a leader in ocean conservation and education. To learn more, please visit montereybayaquarium.org.

About The Nature Conservancy

The Nature Conservancy is a global, non-profit organization dedicated to the conservation of the lands and waters upon which all life depends. Our vision is a world where the diversity of life thrives, and people act to conserve nature for its own sake and it's ability to fulfill our needs and enrich our lives. We achieve our mission and vision by working collaboratively to develop field-leading science, demonstrate solutions at place and advocate for policies that enable conservation at scale. To learn more, please visit nature.org.

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INTRODUCTION

Like many areas of the world, California is facing an increasing challenge to maintain a water supply that meets the needs of its growing population and addresses the uncertainties of a changing climate (Brozovic et al., 2007; Cayan et al., 2010; Viviroli et al., 2011; CDWR, 2013; Grantham and Viers, 2014; Diffenbaugh et al., 2015). Currently in its fourth year of drought, California is investigating a variety of alternative sources for water—each of which has its own environmental, economic and social considerations. Ocean desalination, currently a small piece of California's overall water supply, has received rekindled interest as a potential alternative in large part due to a seemingly "drought-proof" supply of seawater on the state's doorstep. However, many desalination proposals have been controversial, and many community leaders, policymakers and advocates have questioned the relative value of ocean desalination as compared to potentially cheaper and more efficient alternatives, such as water conservation. In addition, as with all developed sources of water, the process of desalination could impact the environment. If poorly sited and designed, ocean desalination can have major undesirable impacts on marine ecosystems, nearshore habitats and coastal communities. Moreover, regardless of how well they are designed, all desalination facilities currently consume a great deal of energy and have the potential to increase greenhouse gas emissions.

In January 2016, the Stanford Woods Institute for the Environment, through its Water in the West Program and the Center for Ocean Solutions, collaborated with the Nature Conservancy and the Monterey Bay Aquarium to organize and facilitate an "uncommon dialogue" on the coastal and marine impacts of ocean desalination among leading experts from nongovernmental organizations, private industry, government agencies and academia. The dialogue had two primary objectives: 1) to promote information exchange and open discussion regarding the best available science, technology and policy related to marine and coastal impacts of desalination projects in California and beyond; and 2) to identify key issues and knowledge gaps for future research and policy development with respect to marine and coastal impacts of ocean desalination in California. To accomplish these objectives, the dialogue was split into four sessions: (1) Scope of Desalination and Current Regulatory Framework in California, (2) Seawater Intakes, (3) Brine Disposal, and (4) Facility Siting and Community Impacts. This report synthesizes and summarizes the proceedings and conclusions of that dialogue.

SUMMARIES OF SESSIONS

1) Scope of Desalination and Current Regulatory Framework in California

Issue Statement

California's major population centers are located away from areas of high precipitation levels in the Sierra Nevada Mountains and the coastal northwest (Figure 1A). To address this mismatch in supply and demand, the state has an elaborate (and now considerably stressed) combination of federal, state, and local infrastructure to store water and to convey it from Northern California, the Sierra Nevada and the Colorado River to agricultural users in the Central Valley and to the population centers of Central and Southern California, most of which are found near or along the coast (Figure 1B). The current drought, restrictions on historical sources of freshwater and uncertainty stemming from a changing climate are among the factors driving a search for new sources of water for human use—including ocean desalination for coastal populations.

Figure 1A. Average annual precipitation in California (in inches) between 1961 and 1990.

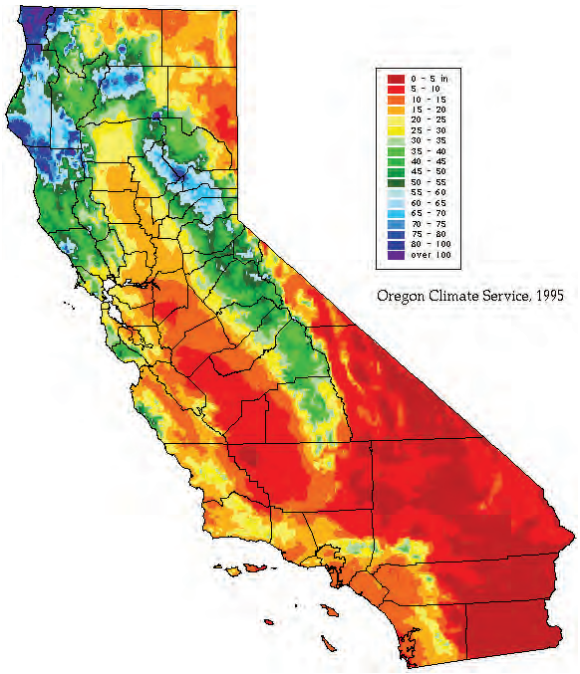
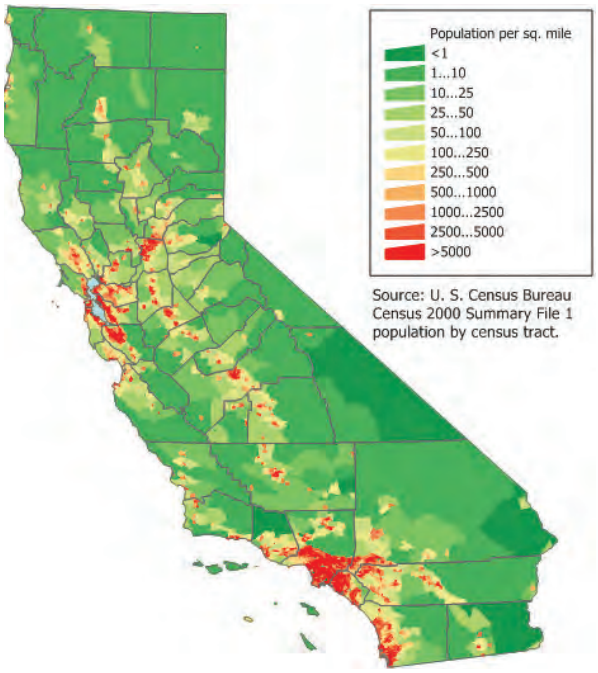


Figure 1B: Population density in California from the 2000 US Census.



As the interest in desalination projects increases, the role of review of the relative costs, benefits and environmental impacts of ocean desalination becomes more important. The State Water Resources Control Board recently developed a new and promising regulatory framework for ocean desalination in the form of an amendment to its Water Quality Control Plan for the Ocean Waters of California (Ocean Plan). The new policy covers siting, design, best technologies for intakes and discharges, and appropriate mitigation measures. However, there are further policy development opportunities. Work can be done on incentivizing the most sustainable categories of desalination (including with respect to facility siting and energy use), further inform permitting with better science and data, and support true demand driven projects.

Findings

- The role of ocean desalination will be minor in the context of California's overall water budget, although it may be very important in some local areas.
- Ocean desalination will not, in the foreseeable future, significantly reduce stress on freshwater resources—particularly freshwater ecosystems. Even the highest total projected production of potable water from ocean desalination in California is so low that it will not meaningfully reduce stress on freshwater systems, such as, for example, exports from the Bay Delta system (Water Plan, 2013). In addition, it is not clear the extent to which planned desalination facilities will provide the regions with supplemental supply and therefore work to reduce or replace existing demands on groundwater and surface water sources.
- It is possible for desalination to reduce stress on other water sources. For example, on the Monterey Peninsula, desalination will serve to replace withdrawals from the Carmel River, reducing stress on that ecosystem. Based on the discussion, this situation is ideal, but also unique. It would be worth evaluating whether other similar opportunities exist in California.
- Communities should compare all costs and benefits (social, environmental and economic) of desalination with the true costs and benefits of other water supply sources. Researchers have an important role to play in developing methodologies to allow for the quantification and comparison of all the costs of various potential sources of water supply, from withdrawal to disposal.

- Characteristics of what could be deemed a "sustainable desalination" facility are becoming more apparent, including projects that (1) are based on community demand in coastal areas; (2) use subsurface intakes that do not adversely affect marine life and do not affect inland water sources; (3) draw energy from renewable sources; (4) use brackish water sources, which require less energy to extract salt and can be disposed of at ocean salinities; and (5) are sized and sited to reduce local community impacts and to allow for the use of subsurface intakes. An important area of future work is assessing the success of the new California desalination policy in incentivizing such projects, and whether additional policies are needed.

2) Seawater Intakes

Issue Statement

The new California desalination policy explicitly favors subsurface intakes. These intakes greatly reduce entrainment impacts but have other potential downsides. Depending on context and perspective, such downsides may include initial construction costs, size limitations, potential impacts on freshwater aquifers, and a larger terrestrial footprint for wells and pumping stations. Subsurface intakes will not work everywhere. Not all facilities will have land available for pumping stations and wells. Larger facilities will likely use screened open-water intakes, for which the California policy requires after-the-fact mitigation for any impacts of entrainment mortality. California, other coastal states and the federal government have decades of experience monitoring and regulating ocean intakes for power plants. In recent years, this data has led to stricter rules for power plant intakes, including a prohibition on once through cooling for new plants. Additional monitoring, research and other work may be needed to assess entrainment impacts and develop more effective mitigation strategies for ocean desalination intakes.

Findings

- California has access to many years of expertise and data related to open ocean water intakes related to power plants. Further study of this data, as well as monitoring of new desalination facilities, is needed to assess and mitigate impacts resulting from desalination if technology other than subsurface is used.
- The primary adverse effect of screened open ocean intakes is mortality of larval fish, fish eggs and other types of plankton. This mortality can be assessed, but prediction of the overall impact from such mortality using traditional models is hindered by the paucity of information on typical survivorship to maturity for most species. As a result, the overall impact of intake mortality on the marine ecosystem cannot always be quantified reliably.
- As a result of this difficulty in quantifying the impact of open water intakes, California policy has relied on the Empirical Transport Model (ETM)/Area of Production Foregone (APF) approach. This approach estimates the habitat needed to compensate for entrainment impacts and requires mitigation of that quantity of habitat.
- This mitigation requirement applies only to open water intakes. The effect of the policy is to favor underground (either under the beach or below the seabed) intakes, which are primarily appropriate for smaller facilities (due to increased land requirements and pumping costs for below ground intakes). Despite this approach, some proposed facilities intend to use open ocean intakes to allow for greater volumes of water.
- Focusing on selecting sites where subsurface intakes would be feasible has the potential to reduce the entrainment impacts of open water intakes.

3) Brine Disposal

Issue Statement

California has much less experience regulating and monitoring coastal impacts from brine disposal than it does for ocean water intakes; however, other areas of the world have been developing and researching technologies relevant to brine disposal for decades. California's new policy focuses on water quality near the discharge point, and the preferred technologies identified in the

new state desalination policy (either combining a desalination discharge with an existing wastewater treatment facility discharge or using multiport diffusers) should be able to meet the standard in the new regulations. The specific standard is that increases in salinity 100 meters from the discharge point can be no more than 2.0 parts per thousand (ppt). The consensus is that this standard is both achievable and adequate to protect marine life in general. However, there is still concern about whether it is adequate at all locations and whether it protects from all potential site-specific adverse effects of brine disposal. The accumulation of higher salinity water in seabed depressions and mortality in the discharge plume were among site-specific concerns raised at the workshop. While the technology for releasing brine effluent into the water column advances, there is a need to better understand the impacts through research and monitoring. Additionally, the impacts from brine disposal could be alleviated significantly through siting facilities in nonsensitive areas of the California coast.

Findings

- The current best practices for mitigating the effects of brine discharge into the ocean are the use of multiport diffusers or combining a brine discharge with another existing discharge when the combined discharge would have fewer overall effects than two separate discharges. The best science indicates that these approaches, deployed appropriately for each site, can meet requirements of California state policy (limit of a 2.0 ppt increase in salinity outside of 100-meter mixing zone).
- More work is needed to understand the long-term impacts of discharges meeting the above standard on ecosystems at specific sites. For example, larval mortality in the 100-meter mixing zone where elevated salinities are permitted and long-term accumulation of higher salinity water in depressions on the ocean floor are areas that both merit focused monitoring and more study.
- There is a great deal of data related to brine impacts from desalination facilities around the world, including those using technologies contemplated for California. California should assess the existing analyses of these data and conduct any additional work that might provide information relevant to how to deploy and monitor these technologies in the state. The state needs to ensure that monitoring at existing and new facilities in California is appropriately designed to capture potential site-specific impacts.

4) Facility Siting and Community Impacts

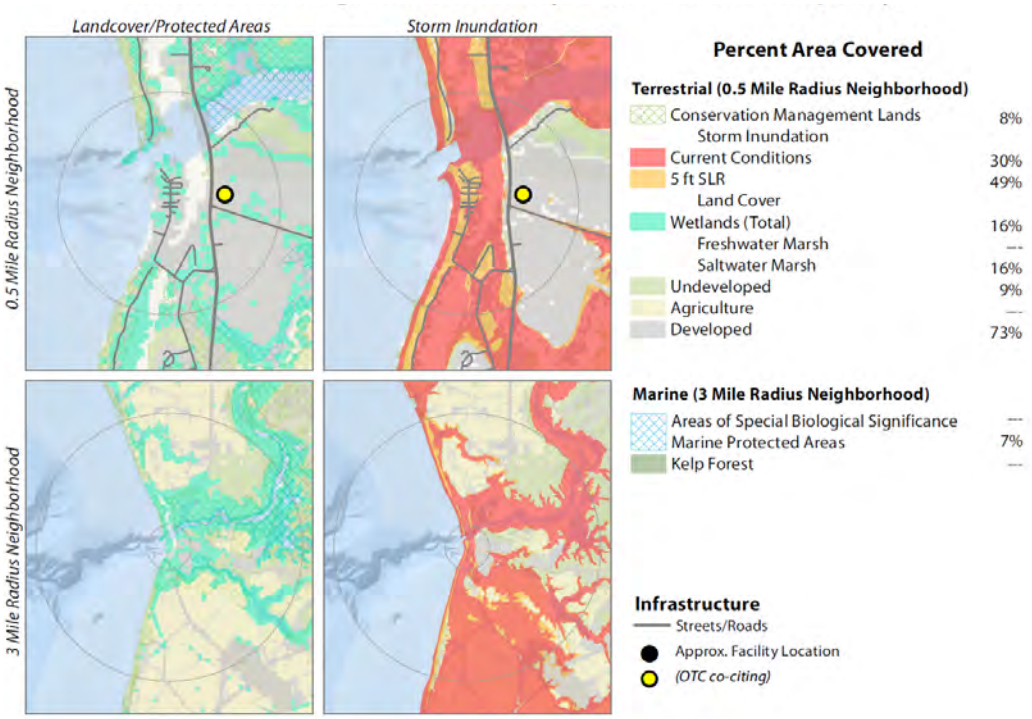
Issue Statement

To date, siting and design specifications for proposed desalination facilities have primarily been based on opportunistic considerations, such as proximity to demand and to existing intake and discharge infrastructure. However, a comprehensive spatial siting framework could help inform decisions that optimize both meeting water demand and reducing environmental impacts. By elucidating high value coastal areas, such as wetland habitats, kelp forests or marine bathymetric features, a geodatabase could identify avoidance areas to prevent ecosystem impacts (Figure 2). A full suite of ecological coastal and marine attributes could be mapped, as well as coastal and marine protection status (for example, Figure 2), to inform an impact avoidance and mitigation strategy that would minimize site-specific concerns related to intakes and discharges. Other key issues, including vulnerability to rising sea levels, demonstrated local need, uncertainty about the reliability of an area's existing water sources, beneficial existing infrastructure and community concerns, could further identify locations more suited to or in need of desalination. For example, a desalination facility may be appropriate where water supply needs cannot be met through other means (for example, efficiency measures or water recycling), particularly if it has been determined that impacts to sensitive ecosystems would be minimal. Ideally, local communities—in collaboration with statewide agencies—can take the lead in identifying their water supply needs and the appropriate means to address them.

Figure 2: Central Coast Regional Water Project (10 – 25 MGD Capacity)

Examples of criteria to be mapped to inform locations where facilities would meet supply needs while minimizing impacts to marine and coastal environments. Zones of influence may vary from local footprint impacts to coastal areas of concern to larger zones of influence when considering marine species entrainment. The full suite of information needed to guide siting decisions is not represented here. Example maps courtesy of the Nature Conservancy and the Center for Integrated Spatial Research.

Desalination co-sited with Moss Landing Power Plant (10-25 MGD Capacity)



Findings

- The Nature Conservancy presented a spatial analysis framework to inform a mitigation hierarchy and potential guide for decision making. The full suite of environmental, political, infrastructure and social attributes to be included in such an analysis framework merits further research and effort. In addition, state agencies and localities need to evaluate potential policy and permitting approaches for integrating such a framework into existing decision making.
- A more thorough spatial analytic approach that integrates evaluation of sensitive ecosystems and human concerns could help minimize impacts to marine and coastal environments. Such an approach could also help reduce the chances of site-specific impacts that are not considered by the generally applicable permitting approach.
- While sometimes cited as a co-benefit, co-location of desalination intakes with existing power plant intakes will likely not be an effective strategy for the long term. Open ocean intakes are no longer allowed for new power plants, and existing power plants with that technology along California's coast will likely be retired or retrofitted in coming years. Co-location opportunities with such facilities are declining, but are also controversial because of perpetuating or compounding existing impacts to the ocean from intakes.
- An integrated spatial analysis of the California coast has the potential to identify locations where desalination facilities would have the lowest impacts to marine and coastal environments; combined with favoring smaller projects that are demand-driven, use subsurface intakes and are powered by renewable power, this integrated approach could potentially guide the siting of sustainable ocean desalination for California.

SUMMARY

Throughout the course of the dialogue, participants raised and clarified a variety of existing scientific and policy-related knowledge gaps. As a collective group, the participants agreed that ocean desalination could potentially contribute to the state's water portfolio; however the extent to which it should and will do so remains uncertain. This uncertainty highlights several clear opportunities to fill knowledge gaps in a way that better informs decision-makers and the general public about the true costs and benefits of desalination in relation to using other sources of water. To highlight these opportunities and begin to chart a course of action, the dialogue concluded with a discussion around potential areas of further focus.

Summary Findings

Through exploration of the session topics and extensive open discussion, a general (but not necessarily unanimous) consensus of the group formed around a few findings:

- While desalination may prove critical for a few coastal communities, it is unlikely to be a major part of California's water supply portfolio due to its high cost of operation, the availability of other sources of water (such as recycled wastewater), its high energy use and the resulting high levels of greenhouse gas emissions, and siting difficulties given the fragility and importance of California's coastal ecosystems.
- Given the relatively small potential footprint of ocean desalination, it is not likely to play a meaningful role in reducing the stress on freshwater ecosystems caused by diversions for water supply.
- Using an integrated spatial approach to identify marine and coastal areas of high ecological and natural value, as well as areas that have local need and existing beneficial infrastructure, could effectively complement California's new desalination policies and help guide sustainable desalination development for California.
- Future work is needed to further define the elements of sustainable desalination projects and develop policies to incentivize adoption of those elements. Elements of sustainable desalination identified at the conference included projects that are smaller; that provide supply to meet a specific, clear local demand; that are located away from sensitive and valuable marine areas; and that are powered by renewable energy sources.
- California's new ocean desalination policy has taken important steps to reduce the environmental effects of both ocean water intakes and brine disposal, yet a need remains for further study in minimizing impacts in a site-specific context and in advancing technologies, particular technologies for surveying and monitoring such site-specific impacts. Better evaluation of data from facilities around the world and better monitoring of facilities built in California were both identified as important avenues for research.
- In making decisions about water supply, water managers may not have access to good information about the true costs of water from different sources, including financial costs, environmental impacts, impacts on the source community (if the water is imported) and potential economic impacts on the state as a whole. A rigorous examination of the full costs, benefits and trade-offs of desalination in the context of the full costs and sustainability of current water supply solutions would improve decisions about desalination and water supply more generally and the public's understanding of the trade-offs involved in those decisions.

IDENTIFIED FUTURE WORK

Inform and Engage the Public: The costs, benefits and limitations of desalination are not well understood by the California public. Misinformation and sweeping generalizations may lead the public to overestimate the potential usefulness of desalination as a drought response tool, to underestimate its true short- and long-term costs, or to fail to recognize when it is truly needed and appropriate. The sponsors of this uncommon dialogue could further public understanding of issues related to desalination in a

variety of ways that would help improve the collective understanding of water supply issues in the state, desalination generally, its costs and benefits and in what contexts it is most appropriate. The sponsors of this uncommon dialogue will work to put on a public conference (potentially at the Monterey Bay Aquarium) that will explore the issues raised in the report for a broader audience.

Provide a Sound Basis for Comparing the Costs and Benefits of Desalination to Other Sources of Water: An underlying problem in water management is the difficulty in assessing the true cost of water, including not only infrastructure, energy and other direct costs, but also environmental costs, impacts on other water users and other externalities. Developing better metrics for analyzing the true cost and sustainability of various water sources is critical to making better water management decisions, including choices about alternative water supply sources such as desalination.

Engage the Research Community: A larger, internationally focused conference on the broader impacts of desalination, hosted by, for example, the Monterey Bay Aquarium or other entities, would broaden the perspective of lessons from other nations as they address similar water supply issues through desalination technologies.

Clarify the Design, Siting, Operation and Water Supply Specifications of Sustainable Desalination: A variety of factors affect the overall environmental impact of desalination – size, energy consumption, the relevant water demand, the facility location, and the intake and discharge factors discussed in this report. Decisions about building and permitting desalination facilities, as well as public understanding, could benefit from a more integrated approach to these issues and a vision for what constitutes sustainable desalination, what was referred to by some conference participants as "desalination done right." Research areas include evaluating a framework for sustainable desalination, including true water needs, other potential water sources, best methods of water distribution, social and economic implications, greenhouse gas emissions and other factors, and then developing policies or other tools would promote that vision.

Define Attributes for Appropriate Siting: Previous siting for desalination facilities has been opportunistic and driven mainly by short-term economic interests. A spatial planning tool that includes a series of key ecological and community-based planning considerations (for example, coastal development type, value and status of marine ecosystem and proximity to high value areas) could aid water infrastructure planners, regulators and other decision-makers in making smart siting and planning decisions for future ocean desalination projects, and could complement California's new permitting policy. Developing a consensus around key factors to include in such a tool, and developing the tool itself, is an area ripe for future research and development. For example, the most prevalent impacts to coastal ecosystems from intakes and discharges may be reduced or alleviated by siting facilities in areas that are less environmentally sensitive.

Better Define Processes and Requirements for Public and Private Projects: The conference included discussion of at least two discernible categories of projects: public projects sponsored by water utilities and tailored to current and anticipated local demand, and private projects sponsored by for-profit companies in anticipation of future demand. Analysis of differences between public projects and private projects would provide clarity on the distinct processes and requirements in place for larger projects sponsored by private developers and smaller, more targeted public water supply projects. Although this distinction and its implications were discussed in the dialogue, the problem statement and its relevant considerations were not well defined. Future research could include analysis of the role that different projects might play in California under different policy scenarios, or how different economic drivers and regulatory regimes might affect key aspects of desalination projects and other issues.

Require and Conduct Sufficient Long-Term Monitoring of Impacts: California is unique, and its complex shoreline is diverse in terms of form, function and processes. Comprehensive monitoring should be required and conducted to understand the relatively novel impacts of desalination along California's complex shore. In particular, long-term monitoring of the point source and cumulative impacts of brine disposal is warranted. Similarly, the long-term implications of subsurface intakes should be monitored, including initial disturbance to place the infrastructure, any disturbance associated with maintenance, and any accumulated long-term impacts associated with the technique.

Advance Technological Research: Advancing knowledge about relationships between intake mortality and ecosystem health would be beneficial. Similarly, innovative technologies for monitoring the effects of brine outflows that include remote sensing and autonomous underwater vehicles would provide more data and a means to decrease impact on coastal ecosystems.

APPENDIX A: WORKSHOP AGENDA

Uncommon Dialogue: Marine and Coastal Impacts of Desalination in California

January 14-15, 2016
Harborview Conference Room
99 Pacific St., Suite 100A, Monterey, CA

Workshop Description

Dialogue Goals and Objectives:

1. Exchange information and promote an open discussion regarding best available science, technology, and policy on marine and coastal impacts of desalination projects in California and elsewhere.
2. Identify key issues and knowledge gaps for both research and policy development with respect to marine and coastal impacts of desalination in California and elsewhere.

Possible Dialogue Outputs:

1. Report or white paper for the research and NGO communities highlighting key issues and recommendations for further work.
2. One or more policy briefs targeted directly at key decision-makers working on desalination issues in California.
3. Building relationships between the conference sponsors (Stanford, Monterey Bay Aquarium, The Nature Conservancy) and policy-makers and researchers to help move forward on effective work related to marine and coastal impacts of desalination.

Meeting Details:

When: January 14-15, 2016 (1.5 days)
Where: Monterey Bay Aquarium Heritage Harbor Conference Room
Hotel: InterContinental – The Clement Monterey, 750 Cannery Row

Attendees:

The workshop will be attended by a selected group of approximately 35 representatives of NGOs, government agencies, and research institutions focused on marine and coastal environments and water management, primarily in California.

Conference Hosts and Sponsors:

- Stanford University Woods Institute for the Environment: Water in the West and Center for Ocean Solutions
- Monterey Bay Aquarium
- The Nature Conservancy

AGENDA

Thursday, January 14

9:00 – 9:30 **Light Breakfast**

9:30 – 10:00 **Welcome & Introductions**

10:00 – 12:00 **Session I: Potential scope of ocean desalination in California and current regulatory context**

Panel Speakers

Newsha Ajami, Water in the West
Topic: Overview of potential extent of ocean desalination in California, including currently planned or proposed facilities, potential quantities of water, and potential role in California's water supply portfolio.

Tom Luster, California Coastal Commission
Topic: Overview of state policies and regulations with respect to ocean desalination facilities.

Moderated Discussion (Ashley Erickson, Center for Ocean Solutions)

Potential Topics for Discussion:

- Projected water resources outlook for California and the potential role of ocean desalination in the state's water supply portfolio.
- Likely locations of future facilities.
- Role of desalination in the context of other "new" sources of water, including conservation and reclamation.
- Desalination's potential to displace water demand from stressed surface and ground waters.
- How current policies and agency resources will address the challenges of the pace of desalination development in California.

12:00 – 1:00 **Lunch**

1:00 – 2:45 **Session II: Sea water intakes**

Panel Speaker

Peter Raimondi, University of California at Santa Cruz
Topic: Overview of impacts of ocean intakes on the marine environment, mitigation strategies, and implications of the new California policy regarding ocean intakes.

Moderated Discussion (Letise LaFeir, Monterey Bay Aquarium)

Potential Topics for Discussion:

- Comparison of seawater intake approaches.
- Adequacy of existing data, studies, and other information for understanding intake impacts and how best to mitigate them.
- Experience in California with marine impacts of ocean water intakes, including desalination facilities and power plants.
- California policies and regulations, including compensatory mitigation frameworks and assessment of gaps.
- How intake issues, including relevant California policy, affect siting possibilities and decisions.

2:45 – 3:00 **Break**

3:00 – 5:00 **Session III: Siting issues and community impacts**

Panel Speakers

Walter Heady, The Nature Conservancy
Topic: Overview of spatial considerations for desalination development in California including marine and coastal habitats, vulnerability to sea level rise, and other environmental and infrastructure considerations.

Jason Burnett, Mayor, Carmel-by-the-Sea
Topic: Community perspective on desalination approval and siting decisions, including overview of process for proposed desalination facility on the Monterey Peninsula.

Moderated Discussion (Lily Verdone, The Nature Conservancy)

Potential Topics for Discussion:

- Lessons learned from the approval and siting process for desalination plants in California to date.
- The interrelationship between once through cooling power plants and desalination plants, and the potential need to move away from colocation under new California policy regarding intakes.
- Climate impacts of desalination, and impacts of climate change (ocean level rise) on siting decisions.
- The impacts and benefits of desalination facilities for coastal communities.
- The community dynamics related to the need for desalination and the facility approval process.

5:30 – 6:30 **Reception at The InterContinental Hotel – The Clement Monterey**

6:30 – 7:30 **Dinner**

Friday, January 15

8:00 – 9:00 **Breakfast**

9:00 – 10:30 **Session IV: Brine disposal**

Panel Speaker

Phillip Roberts, Georgia Institute of Technology
Topic: Overview of potential marine impacts of brine disposal, state of knowledge about those impacts, and existing technology for brine disposal.

Moderated Discussion (Jeff Koseff, Stanford Woods Institute for the Environment)

Potential Topics for Discussion:

- Adequacy of existing data, studies, and other information for understanding brine impacts and how to best mitigate them.
- Assessment of technologies and methods for mitigation of brine disposal effects.
- How potential impacts may vary in different coastal environments in California.
- California policies and regulations, including assessment of gaps.

10:30 – 10:45 **Break**

10:45 – 12:00 **Session V: Wrap up – Leon Szeptycki, Water in the West**

12:00 – 1:00 **Lunch**

APPENDIX B: PARTICIPANT LIST

Newsha Ajami, Water in the West (Organizing Committee)
Matt Armsby, Resources Legacy Fund
Steven Bay, Southern California Coastal Water Research Project
John Bohn, DeepWater Desal, LLC
Kristi Boosman, Center for Ocean Solutions (Note Taker)
Jason Burnett, Carmel-by-the-Sea, CA
Meg Caldwell, David and Lucile Packard Foundation
Heather Cooley, Pacific Institute
Larry Crowder, Stanford University
Ashley Erickson, Center for Ocean Solutions (Organizing Committee)
Karen Grimmer, Monterey Bay National Marine Sanctuary
Eric Hartge, Center for Oceans Solutions (Organizing Committee)
Walter Heady, The Nature Conservancy (Organizing Committee)
Tim Hogan, Alden Research Laboratory
Charlie Hogg, Stanford University
Susan Jordan, California Coastal Protection Network
Jeffrey Koseff, Stanford Woods Institute for the Environment (Organizing Committee)
Manish Kumar, Penn State University
Letise LaFeir, Monterey Bay Aquarium (Organizing Committee)
Minh Le, Executive Office of the President
Tom Luster, California Coastal Commission
Robert MacLean, California American Water
Sandi Matsumoto, The Nature Conservancy
Barbara Meister, Monterey Bay Aquarium (Organizing Committee)
Molly Melius, Stanford University
Sarah Newkirk, The Nature Conservancy
Joe Phelan, Tenera
Pete Raimondi, University of Santa Cruz
Carol Reeb, Hopkins Marine Station, Stanford University
Philip Roberts, Georgia Institute of Technology
Athena Serapio, Water in the West (Event Coordinator)
Deborah Sivas, Stanford University
Margaret Spring, Monterey Bay Aquarium
Leon Szeptycki, Water in the West (Organizing Committee)
Lily Verdone, The Nature Conservancy (Organizing Committee)
Kristen Weiss, Center for Ocean Solutions (Note Taker)
Paige Welsh, Center for Ocean Solutions (Note Taker)
Vicky Whitney, State Water Resources Control Board
Eric Zigas, Environmental Science Associates

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