

THE  
*Baylands*  
AND  
*Climate Change*

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WHAT WE CAN DO

BAYLANDS ECOSYSTEM HABITAT GOALS  
SCIENCE UPDATE 2015



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BAYLANDS ECOSYSTEM HABITAT GOALS  
SCIENCE UPDATE 2015



PREPARED BY  
THE SAN FRANCISCO BAY AREA  
WETLANDS ECOSYSTEM GOALS PROJECT

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## FOREWORD

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Climate change is altering the natural world at an accelerating pace, particularly in low-lying coastal areas like San Francisco Bay. Today management of the bay's shores must account for a future of rising sea levels and more extreme weather events while continuing to address the challenges posed by the demands of a growing urban population. Climate-change science has advanced greatly since the 1999 Baylands Ecosystem Habitat Goals were developed, spurring the need for a technical synthesis of climate-change projections and updated recommendations. The findings of this Science Update indicate clearly that restoring a vibrant and functioning baylands ecosystem will make our future shorelines more resilient to these stresses. Baylands restoration is not a luxury but an urgent necessity as ecological change accelerates.

This Science Update documents and celebrates the remarkable progress made toward achieving the 1999 Baylands Ecosystem Habitat Goals over the past decade and a half. Restoration managers have begun to reverse over a century of habitat loss in the baylands, recommitting tens of thousands of acres to the natural world through a comprehensive and adaptive restoration approach that enhances wildlife habitat, recreational opportunities, water quality, and flood protection.

The variety of uncertainties affecting the baylands requires transitioning from a static to a dynamic approach to planning, one that values flexibility and innovation. An increased commitment to long-term collaboration among diverse regional and local constituencies is essential, as is a willingness to study and learn from our inevitable missteps. This Science Update identifies strategies that are within the current experience of restoration managers but also calls for novel actions that are well beyond the scope of previous activities. Such a bold vision—along with improved

monitoring, governance, and financial investment—is required for an estuary that will support a thriving economy and quality of life in the more dynamic environment that the region now faces.

Achieving such a bold vision will require great focus and long-term resolve, and the successes in restoring the estuary to date show that local managers can devise solutions, learn their strengths and



Restoration of the baylands will be increasingly important in the coming century.

weaknesses, and expand actions when policy, funding, science, and regulation align effectively. The Science Update, however, highlights many unmet needs in achieving such an effective alignment. The scope and pace of scientific experimentation and monitoring must increase, relevant policies and regulations must support innovative strategies, and efficient and cost-effective paths to implementation are critical. In addition, it is quite possible that the pace of climate change will be faster than currently projected or that efforts to effectively mitigate its impacts will lag.

Consequently, now is the time to prepare to adapt—to experiment with new ideas and learn what novel techniques can be most effectively scaled up. We must also act quickly to implement the strategies known to work, to give the baylands the best chance to take advantage of current conditions while they last. At the same time, long-term opportunities to envision the shoreline will take decades to realize, and planning must begin now.

This Science Update is a nonregulatory, voluntary effort to point the Bay Area toward a more resilient future, with strategies that were developed over several years by several hundred experts and practitioners in the region. It is a first step on a long journey to learning how to live, work, and play with a changing estuary, an estuary where ecological processes and ecosystems are used to best advantage.

This region has the distinct advantage of a populace that recognizes the critical importance of the San Francisco Bay estuary and baylands to its economy and quality of life. We invite you to participate in this, the journey to our future bay.

*The Baylands Ecosystem Habitat Goals Steering Committee  
October 2015*

# Baylands Goals Science Update

SCIENCE REVIEW PANEL

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October 2015

The San Francisco Bay ecosystem represents habitat of national and global significance as well as providing important ecosystem services for the region. The 1999 Baylands Ecosystem Habitat Goals report was a seminal document that provided a comprehensive scientific vision for non-tidal and tidal wetland restoration in the baylands ecosystem. This update incorporates new science available since that report and addresses the challenges resulting from the present-day understanding—of climate change and other key drivers—needed to maintain a resilient bayland ecosystem through 2100. The Science Review Panel (SRP) was convened to review the science included in the updated report, identify gaps in the individual chapters, and provide feedback to the Chapter authors and the Steering Committee. The SRP met twice with the Workgroup Chairs to review initial chapter drafts and to discuss issues, concerns, and feedback about our impressions of the scientific concepts, content, and general organization of the individual chapters. The SRP provided a written report and series of recommendations for the entire draft.

The Baylands Goals Science Update includes the work of over 100 scientists who represent an outstanding cross section of expertise and experience in the San Francisco Bay area. A considerable amount of work has been invested in the Baylands Goals Science Update, which reflects the wealth of new information available since 1999. The SRP was able to engage in robust discussions with the Chapter leads about the scientific information in their chapters. We commend all the authors and contributors for their efforts in completing this report, which represents a critically important long-term vision and consensus scientific basis for guiding the development of a resilient ecosystem that can respond to the environmental challenges of the 21st century. We fully expect that as the scientific understanding of these systems and their physical drivers change through continued research and monitoring, further updates will be produced and used in an adaptive management feedback process.



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*Please forgive any unintentional omissions.*



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## Online Materials: Appendices and Science Foundation Chapters

The appendices to this report, the Science Foundation Chapters, and related materials are found at [www.baylandsgoals.org](http://www.baylandsgoals.org).

- ▶ **New Understanding—The Baylands and Climate Change: Appendices**
  - Appendix A: Process for Updating the Baylands Goals
  - Appendix B: Change in the Extent of Baylands Habitat
  - Appendix C: Changes in the Configuration of Baylands Habitats
  - Appendix D: Future Scenarios Evaluated
  - Appendix E: Habitat Types
  
- ▶ **Science Foundation Chapters**
  - Chapter 1: The Dynamic Workings of the Baylands
  - Chapter 2: Projected Evolution of Baylands Habitats
    - Appendix 2.1: Vertical Accretion Models of Future Marsh Evolution*
  - Chapter 3: Connections to the Bay
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  - Chapter 5: Risks from Future Change for Wildlife
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THE  
*Baylands*  
AND  
*Climate Change*

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WHAT WE CAN DO

BAYLANDS ECOSYSTEM HABITAT GOALS  
SCIENCE UPDATE 2015

OVERVIEW





# Ensuring a Healthier Bay Shore

## **RESTORE WETLANDS TODAY, FOR THE FUTURE**

The wetlands at the shore of the San Francisco Bay are an integral part of the region's iconic beauty, and they provide numerous benefits for our economy and quality of life. These baylands support abundant wildlife, clean water, open space for recreation, and flood protection. More than 100 scientists who study the bay, its wetlands, and watersheds have concluded that now is the time to ensure that these ecosystems continue to provide such benefits. Sea-level rise and climatic and other changes have brought about a critical moment. The extensive bay marshes and mudflats can be sustained for decades to come, but it will require a bold approach to restoring their natural processes. Meanwhile, we must also accelerate the concerted action of the past two decades to restore tidal habitats.



This page, from top: marshland near San Pablo Bay, a young volunteer. Facing page: endangered salt marsh harvest mouse; a stream channel wall; cities around San Francisco Bay.

Much progress has been made on restoring San Francisco Bay's tidal wetlands since the *Baylands Ecosystem Habitat Goals* report was released in 1999. This science update to that report provides guidance for sustaining a healthy and vibrant shore. Carrying out its recommendations will help meet state and federal objectives for the conservation of endangered and threatened species. And it will implement federal strategies (*Tidal Marsh Ecosystem Recovery*) and state plans (*Safeguarding California*) to withstand the impacts of climate change.



## A BAY SURROUNDED BY WALLS AND CONCRETE?

Projections show that if we don't act, rising seas and greater erosion will cause the baylands to shrink. We would lose the protection these wetlands provide to our shoreline by buffering storm waves, and the cost-effectiveness of a natural infrastructure that adjusts as sea levels rise. The bay would fundamentally change, with hardened edges and little vegetation.

Eventually, this damage would be irreversible. The region would be obliged to construct and maintain more sea walls and levees, and larger ones. (In places where wetlands are not naturally sustainable, other forms of sea level rise adaptation will be required in any case.) The baylands would eventually retract to narrow strips at the base of these structures or disappear altogether. Water quality could degrade as the baylands would no longer absorb excess nutrients from wastewater or filter contaminants. The diversity and abundance of native animals and plants would be drastically reduced. Several endangered species found only in San Francisco Bay could go extinct, and millions of migratory waterbirds would lose critical feeding and wintering grounds.



*"This report tells us what we need to do today to ensure a healthy San Francisco Bay into our future. If we have the courage to act now and follow scientific recommendations, we can secure much of what is most precious about living in the Bay Area, and ensure the gratitude of our grandchildren."*

Sam Schuchat, Executive Officer,  
California Coastal Conservancy;  
Chair, Baylands Ecosystem Habitat Goals  
Update Steering Committee





## HOW DID WE GET TO THIS POINT?

The forces that control the balance of land and water in San Francisco Bay are changing. The sea level is rising, weather patterns are shifting, and the sediment supply that has helped nourish the baylands since the Gold Rush appears to have been exhausted. Without enough sediment to sustain bay wetlands as sea levels rise—especially coupled with a greater frequency of extreme storms, flooding, droughts, and heat waves—most of the marshes are projected to be damaged or destroyed by 2100 unless we intervene now.

Our response to these events will be fundamental to the fate of wildlife populations. We will either choose to actively support population recovery after a disaster or exacerbate the harm with inappropriate responses. Higher average temperatures, a greater intrusion of seawater into the bay, and new invasions by exotic species will also affect natural communities.

This pivotal moment comes after nearly two centuries of habitat loss and degradation as well as the modification of key natural processes such as freshwater flows, tidal exchange, flood-plain productivity, and invasion by nonnative species. Our levees, flood-control channels, roads, railways, storm drains, garbage dumps, and sewage treatment systems have all been built at the edge of the bay. This alteration of the shore has left a legacy of fragmented habitats with small and stressed native wildlife populations and fixed, inflexible systems for controlling water and sediment flows. Neither our critical human-built infrastructure nor the remaining natural habitats are expected to be resilient to coming changes without significant new investment in adaptation and resilience strategies.



*“Rising sea level, more extreme weather events, and other impacts of climate change are already altering our region’s ecosystems, and this will accelerate in coming decades. By using our new scientific understanding to highlight important actions for visionary management, this document provides a vital basis for sustaining the iconic beauty and valuable services of our remarkable baylands for future Bay Area residents.”*

Carl Wilcox, California Department of Fish and Wildlife, project co-chair and contributing author of *Baylands Ecosystem Habitat Goals* report (1999)

This page, from top: bicyclists on a levee; assessing health of baby tern. Facing page, top: volunteers put in marsh plants.

## NEW APPROACHES, NEW POLICIES

To arrive at a future with functioning, dynamic baylands, we must act immediately. Resilience to sea-level rise depends on natural processes that work over years and decades. We need to adjust our policies to encourage the rapid restoration and enhancement of the natural infrastructure that cost-effectively protects people and property while also supporting native plants and animals.

## STRATEGIES FOR A HEALTHY SHORE

The scientists that developed this report suggest regional strategies to maintain healthy baylands and the benefits they provide. These strategies are summarized below and listed in full in the second chapter of the report.

### Restore complete baylands systems.

To achieve and maintain the Baylands Goals (100,000 acres of tidal marsh and the targets for other habitat types), we should maximize baylands resilience. This means restoring complete wetland systems with their many interconnected habitat types, along with the physical processes that sustain them. Reconnecting the baylands to nearby open lands is also crucial to provide wildlife with refuge during high-water events and for



Below: Artist's conceptual rendering shows a future Bay Area shoreline that has successfully accommodated significant sea-level rise through the restoration of baylands and the processes that sustain them. Reconnected waterways provide adequate sediment and freshwater to sustain marshes, while diverse connected marsh habitats allow wildlife to flourish and migrate near urban areas. Gradually sloping undeveloped areas also provide space for marshes to move inland as the sea level rises. These restored baylands enhance the lives of millions of people, protect built infrastructure, return wildlife to our communities, and improve water quality.





the baylands to move landward as sea levels rise. Diverse, connected baylands habitats will foster diverse wildlife populations that can survive extreme conditions, move where they need to go, and evolve with the changing environment. Management techniques can be refined to prevent further subsidence, increase organic matter accumulation, reduce greenhouse gas emissions, and sequester more carbon. Even though they are not naturally resilient systems, artificially managed ponds are a valuable component of future baylands ecosystems to support waterbirds and compensate for the extreme loss of wetlands across California.

*“These updated Goals provide an urgently needed roadmap to secure the future of the San Francisco Bay region during this time of rapid change. Produced by leading scientists, managers, and decision makers, these practical, climate-smart recommendations will guide habitat restoration and management to sustain wildlife and people for decades to come.”*

Ellie Cohen, President and CEO,  
Point Blue Conservation Science;  
co-founder, Bay Area Ecosystems  
Climate Change Consortium

### **Accelerate restoration of complete baylands systems by 2030.**

Restore tidal flows to strategic areas and manage sediment to establish tidal marsh ecosystems. Tidal marshes that are established by 2030 are more likely to flourish and provide ongoing benefits when the sea-level rise accelerates in the middle of this century. To achieve this goal, the planning, permitting, and construction of restoration projects on currently available lands must be accelerated.

### **Plan ahead for the dynamic future.**

Create regional policies for the shore that anticipate change over time, using projections of sea-level rise and expected shifts in habitat types, locations, and connectivity. Baylands can better sustain themselves as sea levels rise if they can migrate landward. We should prepare for this migration by conserving the transition zone between the baylands and adjacent lands.

Develop and implement a comprehensive regional plan to reuse suitable dredged, excavated, or naturally occurring

This page, from top: salt ponds in the south bay; scientist prepares a native oyster restoration experiment. Facing page: volunteers plant willows; children study the bay.



sediment. This sediment could come from the bay, local rivers and streams, flood control channels, reservoirs, and other sources.

Prepare for the likely increases in extreme weather events such as floods and drought. Extreme events will inevitably cause damage, but they will also provide opportunities to rebuild more-resilient shores. We can buffer wildlife populations against extreme events and prevent extinctions by monitoring them and taking protective action at strategic moments.

### Increase regional coordination.

Creating a resilient and healthy shore will be more successful if the responsible agencies and interested stakeholders collaborate to build consensus, identify barriers to action, solve problems, and promote shared learning and aligned benefits from individual projects. Regionally coordinated research, monitoring, and implementation are critical for rapid innovation and large-scale, complex restoration. This approach will foster the adoption of the most promising techniques for restoration and management, build understanding for and support of necessary new policies, and establish coalitions to obtain the public funding required for a healthy future shore.

THE SUCCESS we have already achieved with baylands restoration provides us with the opportunity to continue this work. But this opportunity is available only if we act now. Restoring the baylands is a necessary part of creating a resilient and healthy shore that supports our economy and maintains the remarkable natural heritage of the Bay Area.



*“The recommendations provided by over 100 of the region’s leading scientists are invaluable for helping managers, scientists and decision-makers continue to make progress in restoring our valuable wetlands. We now know we must accelerate our restoration efforts, and adopt new watershed and in-bay management practices to ensure there is sufficient sediment for the baylands to continue to provide a multitude of beneficial functions with our rising seas.”*

Michael Monroe, lead author and project co-chair for the *Bayland Ecosystem Habitat Goals* report (1999)





## ABOUT THIS SCIENCE UPDATE

This report is an update to the 1999 *Baylands Ecosystem Habitat Goals* that for the first time set comprehensive restoration goals for the San Francisco Bay estuary. It synthesizes the latest science— particularly advances in the understanding of climate change and sediment supply— and incorporates projected changes through 2100 to generate new recommendations for achieving healthy baylands ecosystems.

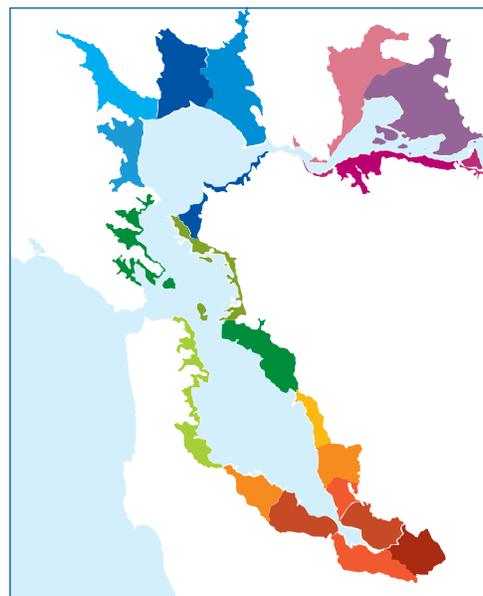
The habitat acreage goals set in 1999 remain the same. Recommendations have been updated—and many new restoration approaches are suggested—for the region, its major subregions, and local shorelines. These actions must be integrated with civic and economic planning to arrive at appropriate implementation strategies. This report provides technical information that policy makers and others can use in deciding how to maximize ecosystem health.

## TO OBTAIN THE REPORT

Access the full Science Update at [www.baylandsgoals.org](http://www.baylandsgoals.org).

Available on the website are PDFs of the full report, maps, and appendices, as well as Science Foundation chapters that provide the technical background to the report.

For inquiries, please contact [info@baylandsgoals.org](mailto:info@baylandsgoals.org).



The report provides updated recommendations for the region, its major subregions, and local shorelines.



Top: Mud Slough; above: endangered Ridgway's rail