

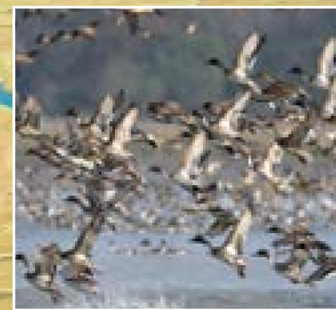

RESTORING THE

Estuary

To Benefit Wildlife and People

A Framework for the Restoration of Wetlands and Wildlife in the San Francisco Bay Area

2022 Implementation Strategy of the San Francisco Bay Joint Venture

The San Francisco Bay Joint Venture is a voluntary, cooperative, public-private partnership with a mission to protect, restore, increase, and enhance habitats throughout the San Francisco Bay region for the benefit of birds, other wildlife, and people.

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A Framework for the Restoration of Wetlands and Wildlife in the San Francisco Bay Area

2022 Implementation Strategy of the San Francisco Bay Joint Venture

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Please forgive any unintentional omissions.

LETTER FROM THE IMPLEMENTATION PLANNING TEAM

We are pleased to present this update to the San Francisco Bay Joint Venture (SFBJV) Implementation Strategy, a framework for habitat, wildlife, and bird conservation through 2035. Over the last two decades, the SFBJV has forged a lasting and effective partnership resulting in on-the-ground conservation projects, scientific advancement, and strong environmental policy support for habitat and bird conservation throughout the region.

Our updated Implementation Strategy supports the continuation of this successful trajectory, while also expanding where and how we work to embrace emerging challenges amid the uncertainties of a changing climate. The unique niche of the SFBJV partnership is our focus on conserving natural habitats to support wildlife and incorporating nature-based solutions as the primary way to address climate adaptation. Our updated habitat goals are broader than our original goals and include areas that will provide marsh migration, high tide refugia, and shoreline resiliency.

Since the release of our first Implementation Strategy in 2001, our partnership has implemented ground-breaking conservation projects that have advanced the science of restoration and secured long-term funding for the future of wildlife in our region. However, conservation challenges continue to mount. Many seemingly "simple" projects remain - needing only a project champion and dedicated funding - but much of what we face are complex undertakings requiring diverse stakeholder engagement, public support, and cross-disciplinary technical expertise. In the face of climate change, and the impacts from rising seas, this work is more time-sensitive than ever. The pace and scale of habitat protection and restoration must dramatically accelerate if we are to rise to these challenges.

While the obstacles to making progress are daunting, we believe that, working together, we can achieve a better future for both wildlife and people of the San Francisco Bay region, and beyond. This Implementation Strategy charts a course forward towards that future.

Signed,

SFBJV Implementation Planning Team:

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NOTE FROM THE MANAGEMENT BOARD CHAIR

As chair of the San Francisco Bay Joint Venture Management Board, I want to acknowledge our partners for their significant contributions to helping achieve our goals and thank them for their tireless efforts. After a history of degradation of the Estuary and its surrounding watersheds, over the past two decades we have made meaningful progress toward reversing those trends and turning the tide for the benefit of the animals and people these wetland habitats support.

Still, we are at a time of rapid change, emerging challenges and an ever-increasing need to respond with urgency. How we approach the next 10-15 years will be pivotal in determining the health and resilience of the San Francisco Estuary much further into the future.

This framework outlines a well-researched and achievable vision for the restoration of the Estuary and other important habitats throughout the SFBJV region. It embraces and expands upon the 2015 Baylands Ecosystem Habitat Goals Update, while working in concert with other regional plans like the 2022 Estuary Blueprint to provide needed guidance to those in and beyond our partnership who will be carrying on this work in the years ahead.

With our shared passion and ambitious goals, I believe we are well positioned to positively impact the quality of life for the birds, other wildlife and people of the Bay Area in the years to come.

Caitlin Sweeney, Chair

Russ Lowgren

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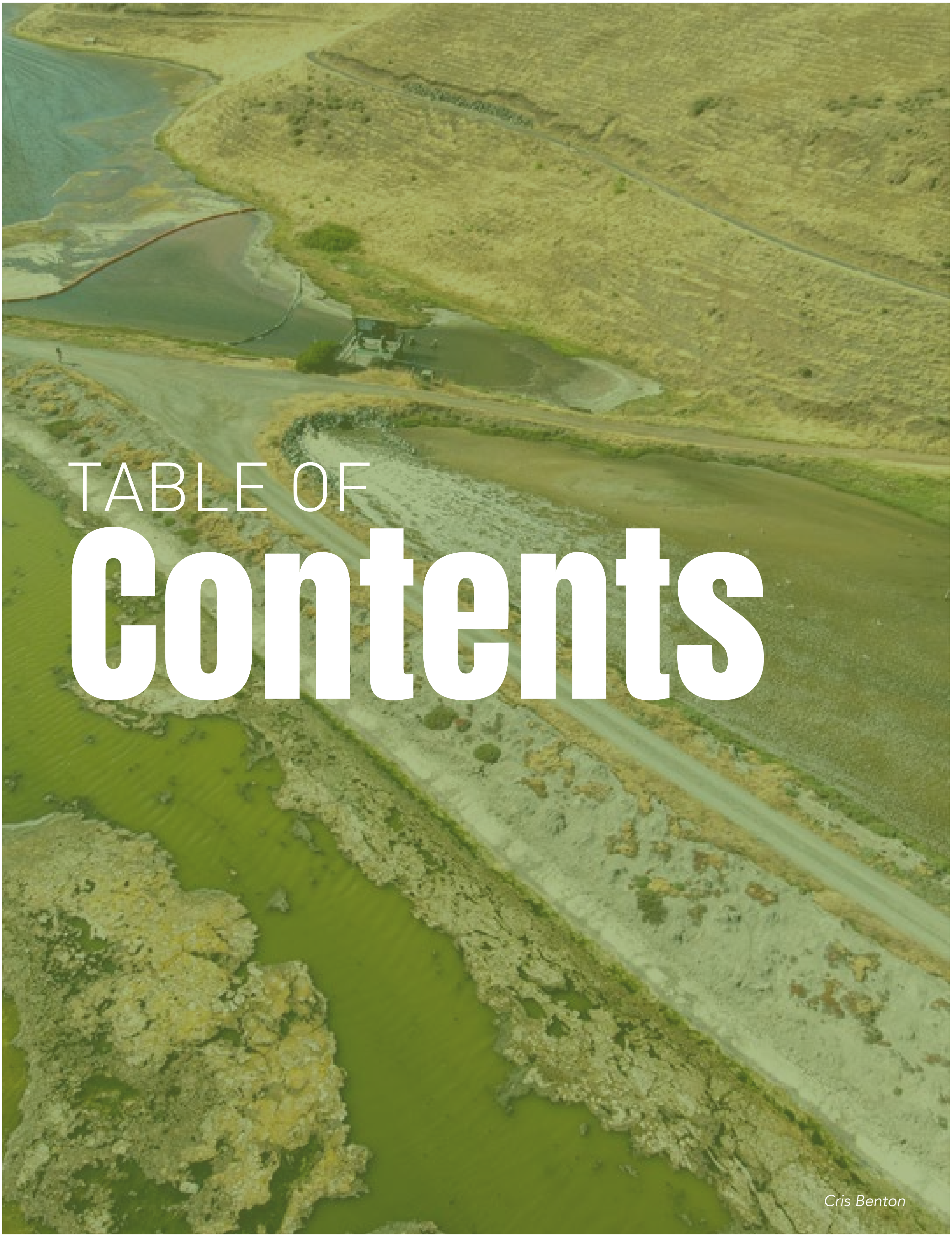

Cris Benton

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CHAPTER 1: INTRODUCTION

1.1 An Estuary of International Significance

The San Francisco Estuary is the largest estuary on the west coast of North America, supporting 77% of California's remaining perennial estuarine wetlands (BCDC 2002). Many designations identify it as a critical environment for wildlife and for birds in particular. Over a million shorebirds use the Estuary during migration each year (Page et al.,1999) and it is one of only 23 "Hemispheric Reserves" certified by the Western Hemisphere Shorebird Reserve Network. The Estuary is a high-priority area for waterfowl as recognized by the North American Waterfowl Management Plan (NAWMP), supporting over half the diving duck population of the Pacific Flyway, and has also been designated a "Wetland of International Importance" under the Ramsar Convention on Wetlands.

More broadly, the nine-county San Francisco Bay Area's diverse habitats are home to an impressive array of wildlife, from Black-throated Gray warblers on oak-covered hills to humpback whales feeding on anchovies at the Golden Gate. It contains several "Important Bird Areas" as identified by the National Audubon Society. The Bay Area also harbors 26 animal species protected by the federal or State Endangered Species Acts. These species rely on many of the habitats for which the JV has set goals.

This biologically rich region faces both continuous and emerging challenges. From local issues that are specific to restoring tidal wetlands, for example, to the more universal and drastic developments caused by our changing climate to include longer droughts, catastrophic fires, increasingly severe floods, and rising sea levels. At this time, we are also in the midst of a global decline in many bird species (Lees et al., 2022) and a biodiversity crisis (WWF 2020). Preserving biological diversity and an ecologically functioning Estuary and Region is our most important work.

1.2 The Emergence of the SFBJV Partnership

With the 2001 publishing of the initial implementation strategy, *Restoring the Estuary*, the San Francisco Bay Joint Venture (SFBJV) partnership was set into motion. With a stated mission "*to protect, restore, increase and enhance habitats throughout the San Francisco Bay region for the benefit of birds, fish and other wildlife"*, the strategy established a framework for action to achieve shared regional habitat goals identified by three other seminal plans that preceded it: the *North American Waterfowl Management Plan (1986)*, the *San Francisco Estuary Comprehensive Conservation & Management Plan (1993)* and the *Baylands Ecosystem Habitat Goals Report (1999)*. Whereas each of these provided guidance and goals for improving habitats, *Restoring the Estuary (2001)* has served as a concept plan for partners of the Joint Venture to implement these "on the ground" recommendations in habitat conservation projects throughout the nine county Bay Area.

By the time the SFBJV was formed, what originally constituted 190,000 acres of tidal marsh before humans significantly altered the shoreline had been reduced to approximately 36,000 acres (Goals Project, 1999). In 2022, thanks in large part to our coordinated efforts, we are well under way towards our collective goal of restoring tidal marsh and other habitats around the Bay. In the first two decades of the 2000s, many other notable strides were made toward a healthier Bay, including two voter-approved statewide propositions (Props 1 & 68) and a regional tax measure (Measure AA) to fund restoration. The SFBJV also has grown in size and sophistication, embracing more refined priorities and effective strategies.

Migratory Bird Joint Ventures

Figure 1. Map of the 22 Migratory Bird Joint Ventures

Through our partnership of resourceful and ingenious people, we believe we can engage our collective talents to tackle existing and emerging challenges in the years ahead. In the pages that follow, we lay out a forward-looking framework for how the SFBJV intends to address emerging issues, sustain and strengthen lasting relationships, and accelerate the pace and scale of our conservation efforts over the next two decades.

1.3 Who We Are and What Guides Our Work

The SFBJV is part of the international Migratory Bird Joint Venture Program (MBJV), which is based on the principle that we can be more effective working together than individually. MBJVs are built by and for the voluntary, non-regulatory partnerships within the region each JV serves.

Established in 1986 as a program under NAWMP and administered by the U.S. Fish and Wildlife Service, MBJV's were given the charge of addressing waterfowl habitat conservation issues found within their geographic region. Over time, the MBJV program has evolved to become "all bird", implementing multiple federal bird conservation plans, while adhering to Strategic Habitat Conservation (SHC) principles in their programs.

Although the MBJV program has grown to cover almost all of the U.S., Canada, and Mexico, each MBJV is different: from their geographic boundaries and the species they work to protect, to the people who comprise their partnerships, budgets, and the number of staff each group employs. Recognizing that, in part, the well-being of our nation depends upon the health of our landscapes and wildlife, all MBJVs share a vision of a North American Landscape where diverse populations of native birds thrive. And, for all MBJVs, partnerships are the cornerstone of this important work. Indeed, the program has served as a national model for collaborative conservation since its inception, and has an impressive track record of success. As of 2022, MBJVs have collectively leveraged every dollar of Congressional funds appropriated to the program by 36:1 to help conserve more than 33 million acres of essential habitat for birds and other wildlife across the North American continent.

Geographically the smallest of the 22 Habitat Joint Ventures, the SFBJV is also the most urban, with a wealth of groups that share an interest in conservation, but not necessarily with protection of bird habitat as their primary motivation, which is a niche of the SFBJV. We are guided by a management board with diverse representation and staff from nearly one hundred other organizations and agencies who participate on five working committees, and our implementation actions are determined through a collaborative, non-regulatory approach focused on where we can collectively make the most impact.


Beth Huning

Geographic Boundary Changes

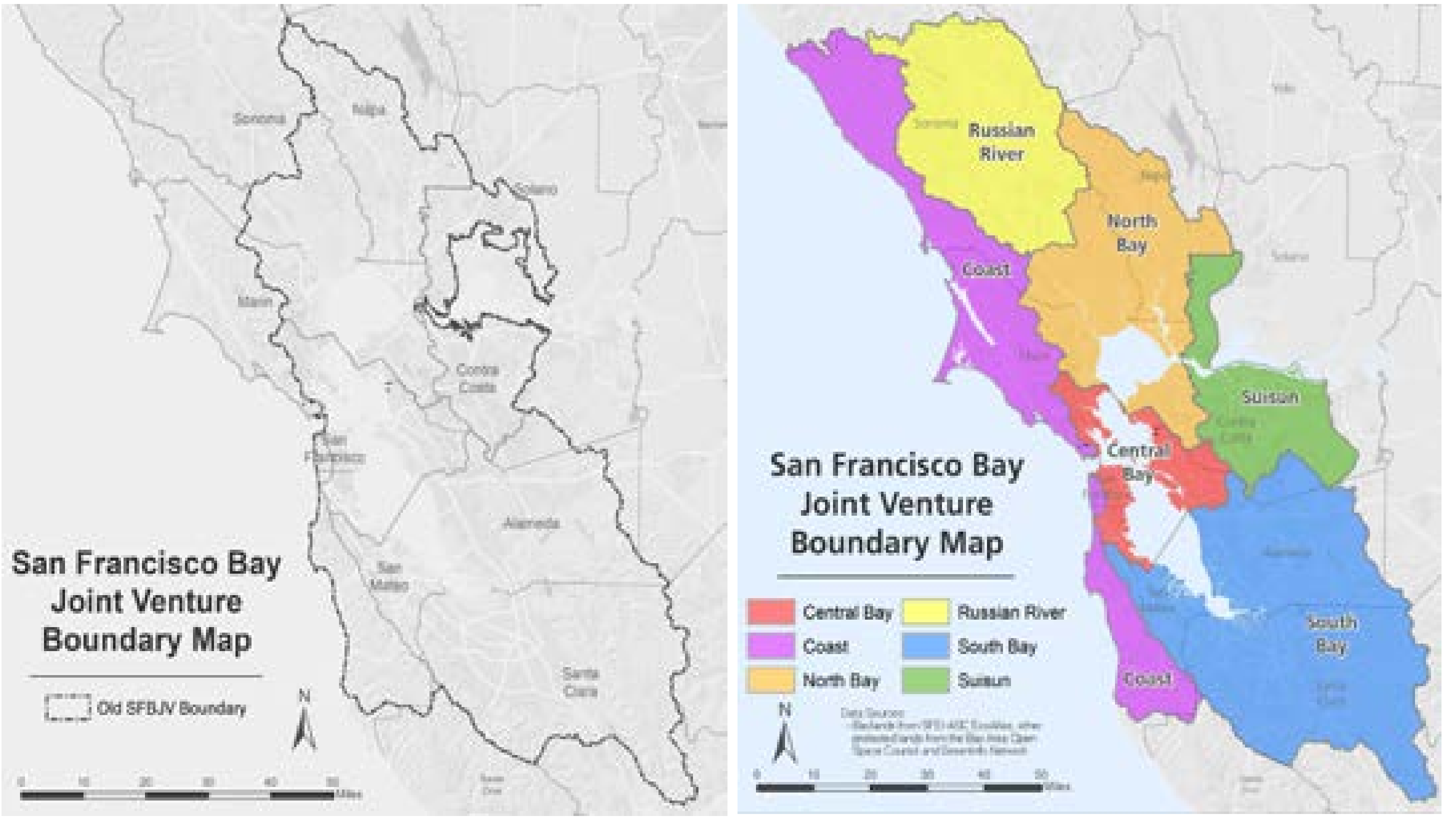


Figure 2. Maps of the San Francisco Bay Joint Venture Geographic Scope and Subregions. The 2001 map is on the left above with the current scope on the right.

From the original 2001 Implementation Strategy and the growth of the SFBJV partnership in the intervening years, the JV boundaries reflected above changed as follows:

- East Contra Costa County was added to facilitate coordination with the East Bay Regional Park District via the SFBJV (rather than requiring coordination with two JVs)
- Diked marshes of Suisun are included and are linked with the Central Valley Joint Venture, reflecting Suisun's importance to Central Valley waterfowl management efforts
- Marin and Sonoma County coastal watersheds were added, from the Golden Gate to the mouth of the Russian River at Jenner
- The Russian River watershed in Sonoma County was included

1.4 What is in this 2022 Restoring the Estuary Strategy

This updated Implementation Strategy maps out the next leg of our journey, reflecting progress made and lessons learned. It also responds to new urgency, as the list and intensity of stressors on wildlife and habitat grows. This framework includes revised habitat and waterfowl goals, wildlife indicators, ten clear priorities and strategies that form the foundation of our work, information on how we get things done, and how we measure progress along the way. We expect the content to hold true for the lifespan of the strategy, additionally supported by appendices and links to reports and other "living" documents that may change over time. This framework will guide the SFBJV annual planning process.

Our revision builds on the extensive body of knowledge that has brought us to this moment of better understanding the issues, the science, and what is needed to achieve these SFBJV goals, which increase the aspirations for accelerated conservation action to maximize opportunity in the face of uncertainty.

1.5 How our Work Contributes to the Larger Landscape

Efforts (from local to international) are coalescing around the need for multiple-benefit conservation initiatives, designed to simultaneously benefit local communities of people, enhance ecological function, and improve habitat quality for fish and wildlife (Gardali et al., 2021). The work of the SFBJV described in this strategy can and will contribute to these state, federal, and international initiatives including, for example, California's Pathways to 30x30, the United States' America the Beautiful initiative, and the United Nations Decade on Ecosystem Restoration. These larger landscape efforts, and more, will only be successful if regional efforts like the SFBJV are successful at conserving and restoring the lands and waters for multiple benefits.

1.6 A Call to Dramatically Increase the Pace and Scale of Action

We call for a dramatic increase in the pace and scale of protection, restoration, and enhancement action. While this strategy intends to guide actions through 2035, in tidal systems there is urgency to achieve our habitat goals by 2030 to give these habitats the best chance of successful establishment. This will require unprecedented funding levels, strong collaborative efforts, and accelerated planning timelines.

Cris Benton

1.7 Intended Audiences

While we welcome all readers and appreciate any interest in our work, we have written this strategy expressly for those who can influence or otherwise help achieve our goals. This may include 1) public and private land owners and managers; 2) scientists and others who will use it to guide decision making for all phases of restoration; 3) those in such decision- making positions as funders, legislators, city and county planners, permitting/regulatory agencies; and those who may turn to it simply to better understand the SFBJV and get involved and engaged in implementation through our partnership. We also invite all members of the public to read the Strategy and hope it will lead to increased support for implementing the Plan's goals.

HIGHLIGHTING KEY ISSUES *Box 1*

The staggering realization in 2019 that we have lost one in four birds since 1970, even among common birds, indicated a shift in our ecosystem's ability to support basic birdlife. The first-ever comprehensive assessment of net population changes in birds across the U.S. and Canada, released by Cornell Lab of Ornithology, American Bird Conservancy and others found that numbers of birds had plummeted to an estimated loss of 3 billion birds! In the full manuscript, authors declare, "slowing the loss of biodiversity is one of the defining environmental challenges of the 21st century" (Rosenberg et al. 2019).

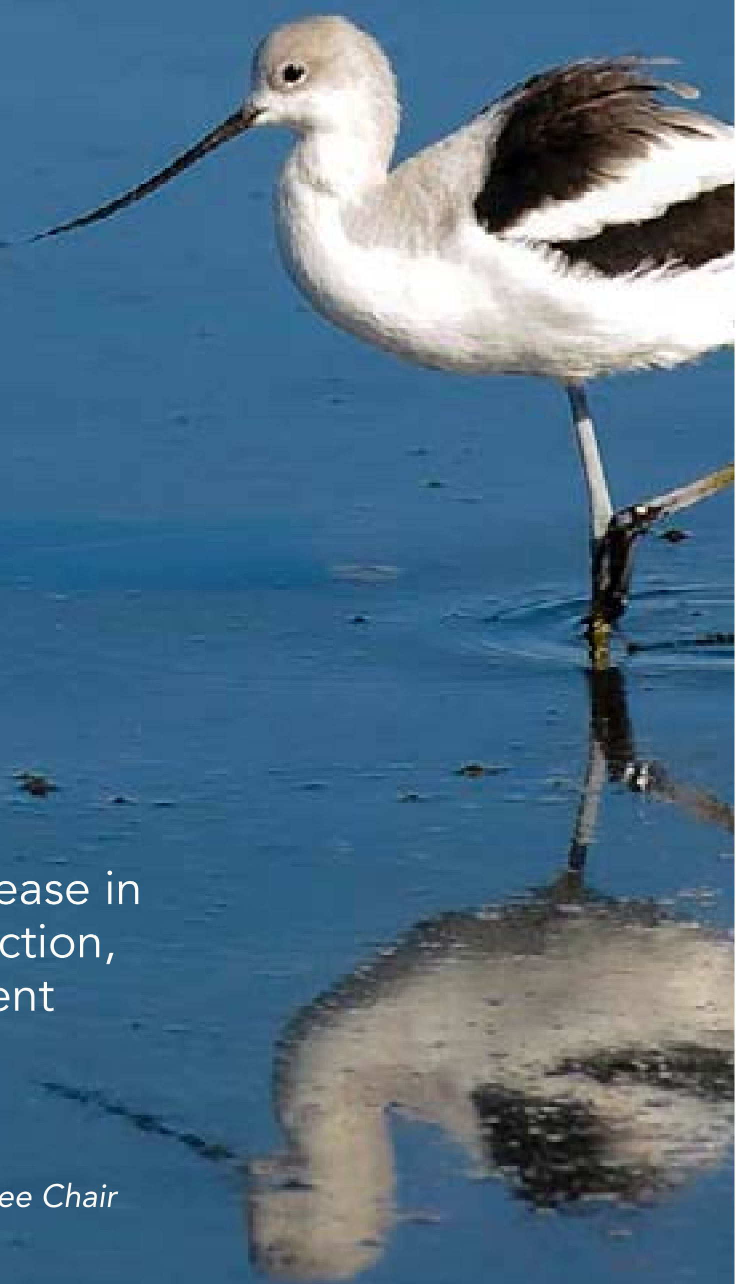
One bright spot in the report was that waterfowl had increased by 56%, a recovery made possible by conservation investments in wetland protection and restoration, indicating that strong partnership programs such as Joint Ventures, can and do make a difference for birds. In response, the Migratory Bird program has nationally stepped up to address this pressing concern and loss. Here in the Bay Area, our habitat acreage goals will provide a roadmap for species recovery through the protection, restoration, and enhancement of habitat. Other crucial strategies may involve expanding partnerships and leveraging additional funding.

ADDRESSING THE LOSS OF 3 Billion Birds

This "2022-2035" framework will be used to:

- coordinate, expand, inspire and accelerate conservation actions for habitat restoration across the nine Bay Area counties
- align strategies with driving forces of change to increase ecological resilience
- explore and put into practice innovative approaches and solutions
- facilitate, measure, evaluate, and improve movement and success towards our mission, goals and objectives
- influence political will to work toward a better future

> "We call for a dramatic increase in the pace and scale of protection, restoration, and enhancement action."
>
> *– Renee Spenst, SFBJV Science Committee Chair*



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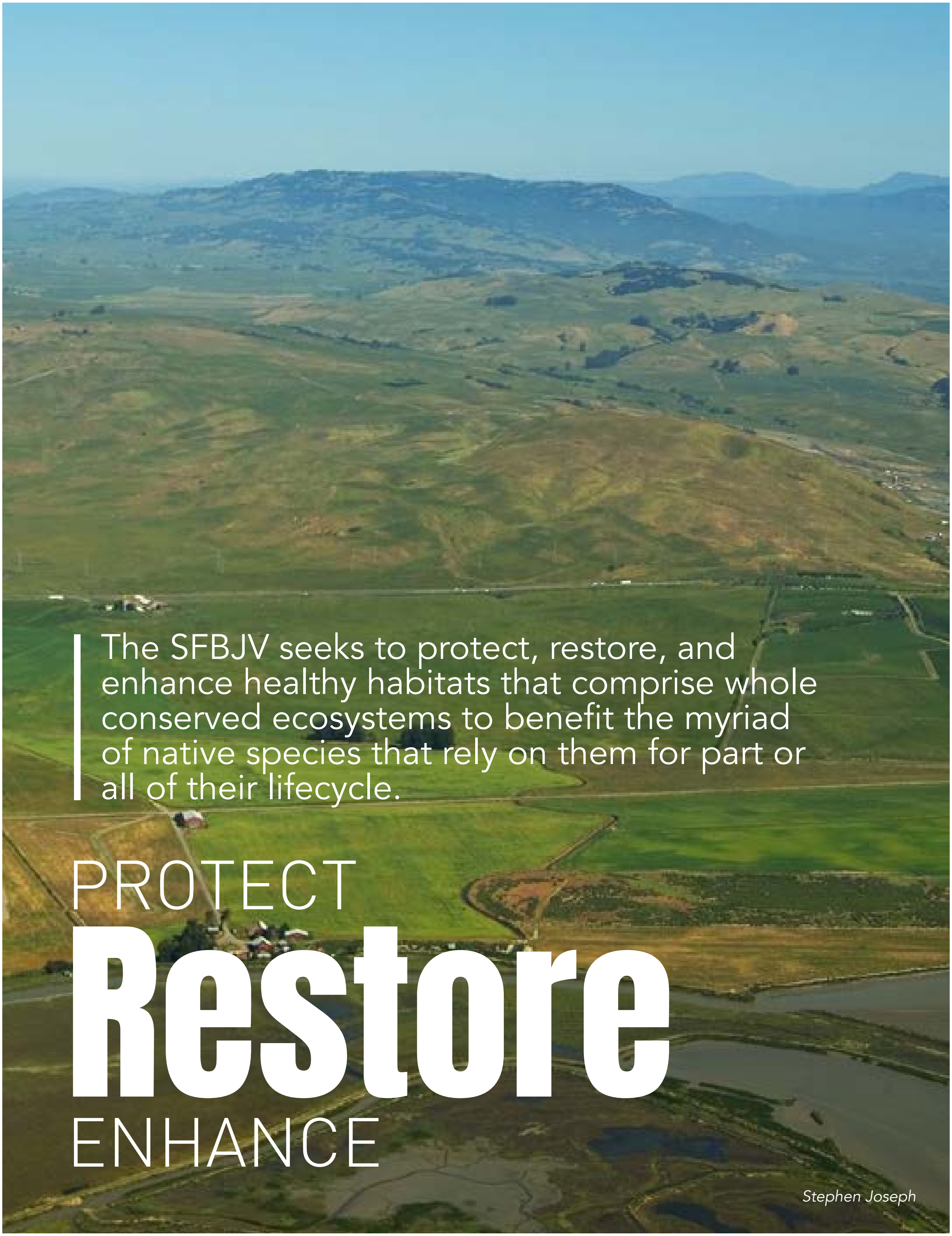


The SFBJV seeks to protect, restore, and enhance healthy habitats that comprise whole conserved ecosystems to benefit the myriad of native species that rely on them for part or all of their lifecycle.

PROTECT Restore ENHANCE

Stephen Joseph

CHAPTER 2: CONSERVATION GOALS

2.1 Introduction

DEFINITIONS OF KEY TERMS IN THIS CHAPTER *Box 2*
Activity Type: The type of conservation action in on-the-ground projects. Within this strategy we primarily use protection, restoration, and enhancement.
Protection: Activity type that encompasses acquisition, preservation, and protection. Acquisition refers to the purchasing of land to protect it from development and/or with the intention to restore or enhance habitat. Preservation refers to maintaining the land in its current state. Protection refers to the removal of a threat to the land as described by the Activity Type. For the SFBJV, this also includes protection by conservation easement.
Restoration: Activity type that refers to restoring habitat that was once present but is no longer present. Re-establishment results in a net increase in habitat area and function.
Enhancement: Activity type that refers to targeted improvement of specific function(s) of existing habitat.
Functional Goals: Goals that are descriptive (rather than numeric) and focus on maintaining and/or creating desired ecological processes and health of the habitat in terms of physical properties and wildlife support (e.g., natural and managed processes that maintain physical structure and biological communities). Like numeric acreage goals, functional goals will largely be met through restoration and enhancement.
Marsh migration space: Potential spaces for marshes to move landward as sea levels rise.

The SFBJV seeks to protect, restore, and enhance healthy habitats that comprise whole conserved ecosystems to benefit the myriad native species that rely on them for part or all of their lifecycle. Both the numeric and functional goals contained herein will galvanize and direct conservation efforts for the benefit of waterfowl, other wildlife, and people, and will help ensure healthy and resilient San Francisco Bay, coastal, and watershed habitats. Notably, our San Francisco Bay tidal restoration goals reflect roughly ***a fourteen-fold increase in the pace and scale*** beyond tidal restoration that has occurred thus far. To keep ahead of the challenges we face, protection, restoration, and enhancement efforts must dramatically accelerate through added capacity and funding. The net beneficial nature of these projects must be recognized if we are to meet the challenges posed by a changing climate, sea-level rise, and decreasing sediment availability.

This chapter presents our updated habitat acreage and waterfowl population goals, habitat values, and goal-setting methods. While not all species that rely on this geography are represented here with population goals, the habitats included in this strategy were chosen in part because of their importance to the spectrum of waterbirds, shorebirds, landbirds, and other wildlife populations. The SFBJV supports regional planning and implementation efforts to benefit all native species that rely on wetland and aquatic habitats, including the monitoring of bird indicators as outlined in Chapter 3.

The habitats selected by the SFBJV are grouped into three categories: San Francisco Estuary (SF Estuary), Watersheds, and Outer Coast (Table 1). These represent habitats sustained in large part by natural processes or their functional equivalents that provide the support and recovery of a wide range of species. This approach reflects the overall conservation goal of restoring natural ecosystems and functions to the landscape. We acknowledge that many habitats require varying degrees of management to support desired functions, but also stress that such management is an important *means* rather than a *goal* of conservation. Many of the numeric acreage and functional goals described in this strategy have been incorporated from other Estuary planning and research efforts from SFBJV partners. The numeric acreage goals represent the range of conservation ***actions*** that are needed to sustain healthy habitats, specifically: ***protection*** (acquisition or conservation easement); ***restoration*** (restoring habitat that was once present but is no longer present); and ***enhancement*** (increasing the ecological function or value of a habitat).

The SFBJV is an implementation-focused partnership performing on-the-ground actions. These actions are effectively measured in acres for most habitats, and by qualitative functional goals for the remainder. Setting numeric goals with habitat acres has many advantages because acres are: relatively easy to measure; easy for funders, elected officials, and the public to understand; and relatively easy to track progress over time. Qualitative functional goals are also included for habitats that are a secondary focus for the JV partnership, and are intended to promote and inspire collaborative work on these habitats. These goals are descriptive and focus on maintaining and restoring desired ecological functions and health of the habitat in terms of both physical properties and wildlife support.

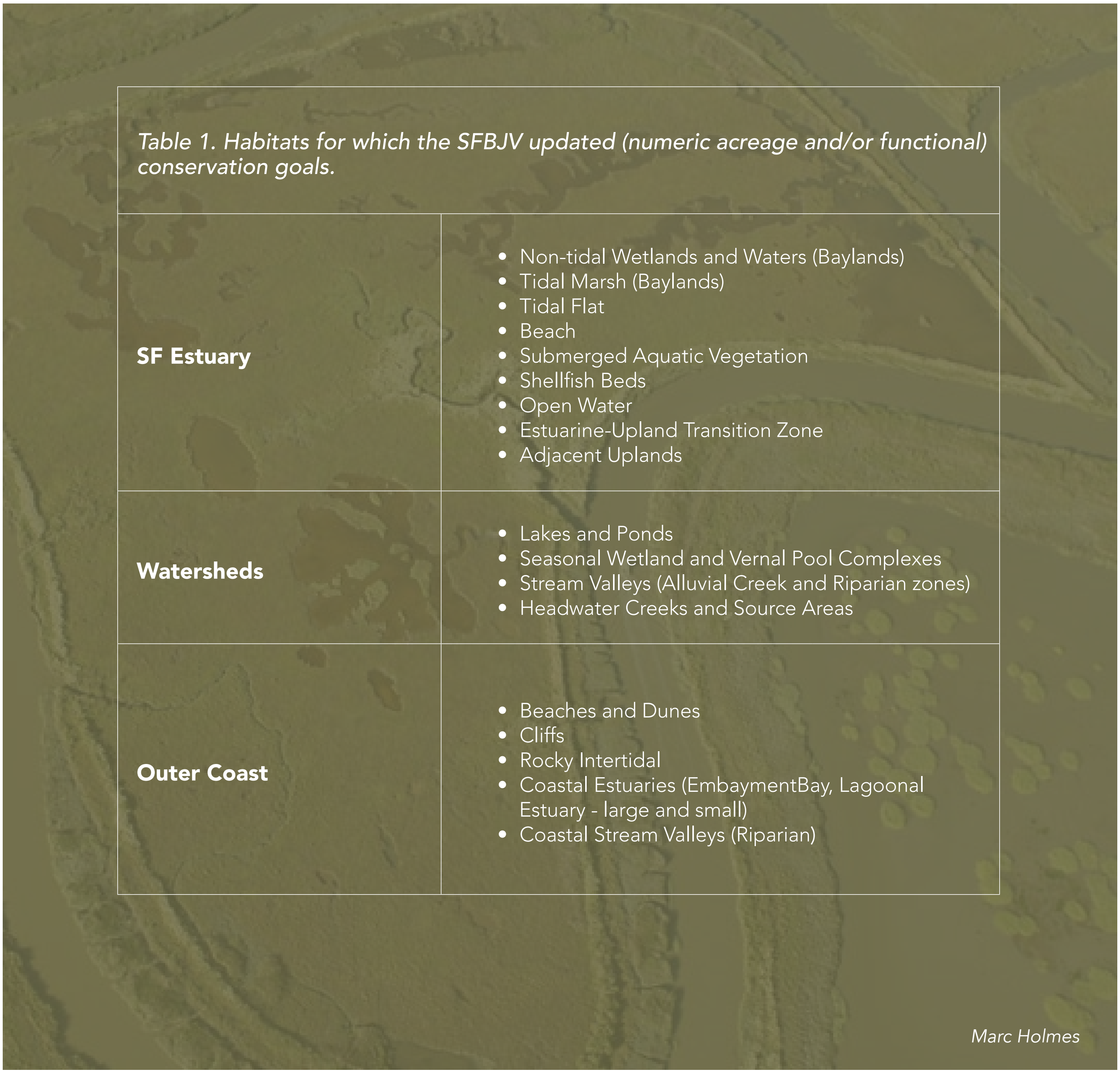


Table 1. Habitats for which the SFBJV updated (numeric acreage and/or functional) conservation goals.

SF Estuary	• Non-tidal Wetlands and Waters (Baylands) • Tidal Marsh (Baylands) • Tidal Flat • Beach • Submerged Aquatic Vegetation • Shellfish Beds • Open Water • Estuarine-Upland Transition Zone • Adjacent Uplands
Watersheds	• Lakes and Ponds • Seasonal Wetland and Vernal Pool Complexes • Stream Valleys (Alluvial Creek and Riparian zones) • Headwater Creeks and Source Areas
Outer Coast	• Beaches and Dunes • Cliffs • Rocky Intertidal • Coastal Estuaries (EmbaymentBay, Lagoonal Estuary - large and small) • Coastal Stream Valleys (Riparian)

Marc Holmes

Our goals are based on the best available information from existing plans, [Project Tracker](#)/[EcoAtlas](#) data, and GIS-based habitat maps, as well as working sessions with technical experts. Additional details on habitat descriptions and goal-setting methods can be found in Appendix A. The goal-setting process included input from a wide range of habitat experts, conservation leaders, and public landowning entities.

2.2 Habitat Goals

2.2.1 The Need for Updated Habitat Goals

In the more than 20 years since completion of the original 2001 SFBJV Implementation Strategy, ***Restoring the Estuary,*** the amount of protected and restored habitat has increased (see Ch. 3 and Appendix A). Our understanding of emerging threats to our ecosystems has advanced, causing us to rethink our strategies and goals in a fundamental way. We have updated and increased our new habitat conservation goals from those in the original Implementation Strategy. The revised strategy: 1) incorporates our accomplishments to date; 2) includes an expanded and modified geographic scope; 3) includes goals based on habitat function and need for connectivity of habitats to restore whole, functional, and intact ecosystems; 4) addresses accelerating challenges posed by sea level rise and other drivers; and 5) addresses the urgency to achieve habitat goals as quickly as possible because of both decreasing sediment availability for restoration purposes and increasing sea level rise rate.

2.2.2 Building from Partner Efforts

Although the SFBJV acreage goals build from such other initiatives as the Baylands Ecosystem Habitat Goals (Goals Project,1999 and 2015), the SFBJV still needed to establish its own set of updated acreage goals for the following reasons: 1) the geographic scope of the SFBJV differs from that of other efforts, 2) some of the acreage goals from other efforts had not been recently updated, and 3) the SFBJV includes additional habitat types not covered by other plans.

CONSERVATION GOALS IN THE BAY AREA

Box 3

The SFBJV draws its goals from four foundational goal-setting documents that represent different habitat groups or biomes- subtidal, baylands, and uplands. The importance of connecting different habitats and an emphasis on restoring whole ecosystems is a common thread in all four of the planning documents and is also a priority for the SFBJV.

Baylands Ecosystem Habitat Goals - Source of the original quantitative baylands habitat goals for San Francisco Bay (Goals Project, 1999).

Subtidal Habitat Goals Report - Conservation planning for the submerged areas of San Francisco Bay (Subtidal Goals, 2010).

Baylands Ecosystem Habitat Goals Science Update - Comprehensive qualitative restoration goals for the San Francisco Bay (Baylands Goals Science Update, 2015). Quantitative goals were not updated from the 1999 Bayland Goals report.

Conservation Lands Network 2.0 - Regional conservation strategy for San Francisco Bay Area upland habitats (CLN, 2019).

Building upon the seminal Baylands Ecosystem Habitat Goals Report (1999) and the more recent Baylands Goals Science Update (2015), the SFBJV has made meaningful advancements in setting goals for conservation of baylands, upland transition zones, and uplands adjacent to the edges of the bay. These latter critical habitats were elevated to include acreage targets, given the limited opportunities to restore whole ecosystems around the bay, and yet "marsh transgression space" provides the most certain opportunity for marsh persistence in the future.

2.2.3 Habitat-Specific Acreage and Functional Goals

The SFBJV was founded to conserve the SF Estuary, and our estuarine habitat acreage goals remain the focus of our partnership conservation efforts (Tables 2 and 3). Our reach has also expanded to include watershed habitat acreage goals from the Conservation Lands Network (CLN) 2.0 (Table 4), and goals for outer coast habitats, presented as qualitative functional goals (Table 5) because the SFBJV recognizes the importance of conserving these habitats. For each SF Estuary and watershed habitat, acreage goals are grouped into three actions: protection, restoration, and enhancement.

2.2.3.1 San Francisco Estuary Habitats

SF Estuary habitats are lands touched by the tides, and lands that the tides would touch in the absence of any levees or other built structures (SFEI 'historic extent of the Bay') within the geographic area covered by the SFBJV, generally including South Bay, Central Bay, San Pablo Bay, and part of Suisun Bay (see boundary map: Figure 2, Chapter 1). The habitats selected by the SFBJV build from those described in existing plans, with a notable difference being that the SFBJV has a broader habitat category of non-tidal wetlands and waters that encompasses diked baylands and includes diked wetlands, managed ponds, and salt ponds (see Appendix A for habitat crosswalks to other regional plans). Adjacent uplands are included because they can provide important connectivity, sediment transport, and migration space as sea level rises. A detailed description of the methods used to develop these goals is provided in Appendix A.

SF Estuary habitat goals include goals for two noteworthy subtidal habitats (shellfish beds and submerged aquatic vegetation), tidal flats and beaches, baylands (including both tidal marsh and non-tidal wetlands and waters), upland transition zone, and adjacent uplands (Table 2).


Jak Wonderly


Beth Huning

(Left) Figure 3. SF Estuary Baylands boundary map (SFEI Historic and Modern Baylands 1998).

Table 2. Acreage and functional habitat goals for SF Estuary habitats. Goals represent remaining conservation needs. Numeric goals can overlap among the conservation action categories (protect, restore and enhance, meaning that the same acre may need to be both protected and restored and/or enhanced).

SF Estuary Habitats	Protect	Restore	Enhance
Baylands[1]— Non-tidal Wetlands and Waters	59,000	NA	27,000
Baylands[1]—Tidal Marsh	59,000	72,000	11,000
Tidal Flat[2]	12,000	4,000	6,000
Beach[3]	36 miles	*See functional goals	
Submerged Aquatic Vegetation[4]	8,000	8,000	
Shellfish Beds[4]	Protect all existing native oyster beds	8,000	
Estuarine-upland Transition Zone[5]	16,500	15,100	2,500
Adjacent Uplands[6]	14,000	NA	NA

Definitions, values, and a brief description of some goal-setting methods for SF Estuary habitats are included below. More detailed definitions and method descriptions can be found in Appendix A.

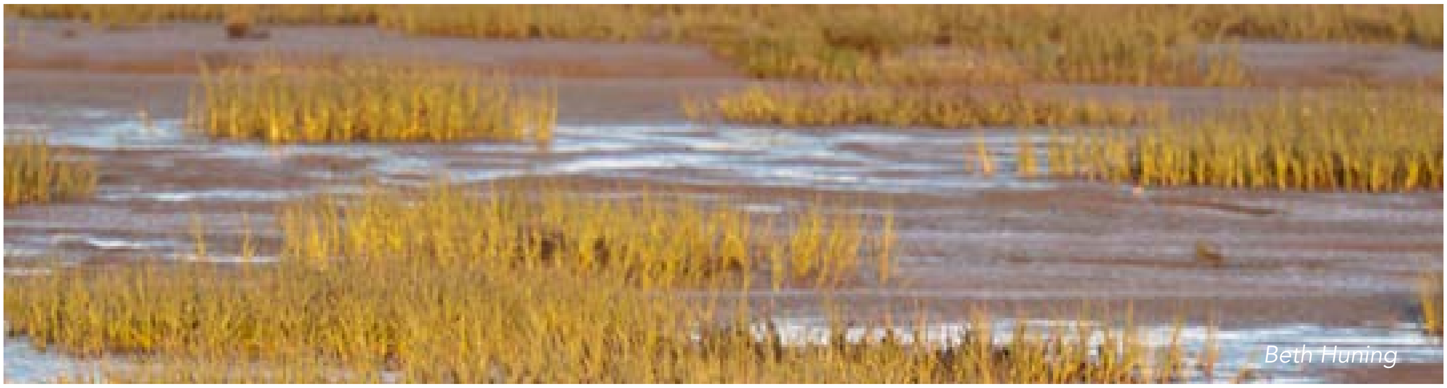
Baylands

Baylands include tidal marsh, non-tidal wetlands and waters (both defined below), and lands that would be under the influence of tidal waters in the absence of built levees, tide gates, or other barriers to tidal flows.

Robert Janover

Tidal Marsh

Tidal marsh is an emergent vegetated wetland subject to natural tidal action, which floods and drains via tidal movement. This habitat includes marsh pannes, low/middle/high marsh, and their channel networks with salinities ranging from low to hypersaline. Many listed and at-risk species depend on tidal marsh habitat including secretive marsh birds (e.g., California Ridgway's Rail and California Black Rail) and small mammals (salt marsh harvest mouse).



Tidal marsh habitat is the focus of most of the large conservation projects in the SF Estuary. The ultimate goal for most tidal restoration projects is mature marsh in an equilibrium state with the tides, and dominated by native mid- to high-marsh vegetation. The large tidal marsh restoration efforts in the SF Estuary occur predominantly in subsided former agricultural lands, salt ponds, and other diked baylands that make up the vast majority of the Estuary's undeveloped baylands.

The length of time required for these sites to reach mature marsh depends on an array of factors, including starting elevation, salinity, and sediment inputs. Deeply subsided sites as well as those situated further from open water or located on tributaries with less sediment inputs may take more time to reach mature marsh elevations, or may never mature under higher sea level rise scenarios and/or inadequate sediment supply conditions. Such sites may remain in an early phase of restoration, providing extensive tidally-influenced shallow water and tidal-flat habitats. Open water habitats, such as those provided by early-phase restoration, are beneficial to waterbirds, waterfowl, shorebirds, fish, and invertebrate species. Restoration projects augment favorable fish and wildlife habitat in the SF Estuary and create a shifting mosaic of landscapes, as different phases of tidal marsh restoration promote different guilds of species in different places at different times.

The Baylands Goals (Goals Project,1999) established a baseline acreage of existing tidal marsh, estimated at 40,000 acres. Since then, between 13,000-14,000 acres have been restored to tidal influence (State of the Estuary Report 2019, SFBJV Accomplishments Analyses 2021, *internal document*). We have incorporated the habitat goals and conservation strategies from the original Baylands Goals (1999) and the Bayland Goals Science Update (Goals Project, 2015) along with other key regional, state, and federal planning efforts, and fully support achieving the Baylands Goals of 100,000 acres of tidal marsh (Goals Project,1999). The updated goals in this strategy support connectivity up into the watersheds and into the submerged habitats, for the multiple benefits provided by each habitat separately and as a connected system.

The updated SFBJV habitat goals represent the need to protect, restore, and enhance all available undeveloped and low-development historical baylands, principally for tidal marsh, in order to address the need for more habitat for waterbirds, fish, and other wildlife and to offset the likely destruction due to the sea-level-rise drowning of many of our existing tidal marsh habitats. These goals also strive to accommodate the dynamic and changing environment, variable and decreasing sediment supply, and the unknown spatial and temporal aspects of conservation actions.

SF Estuary Tidal Marsh Restoration Goals

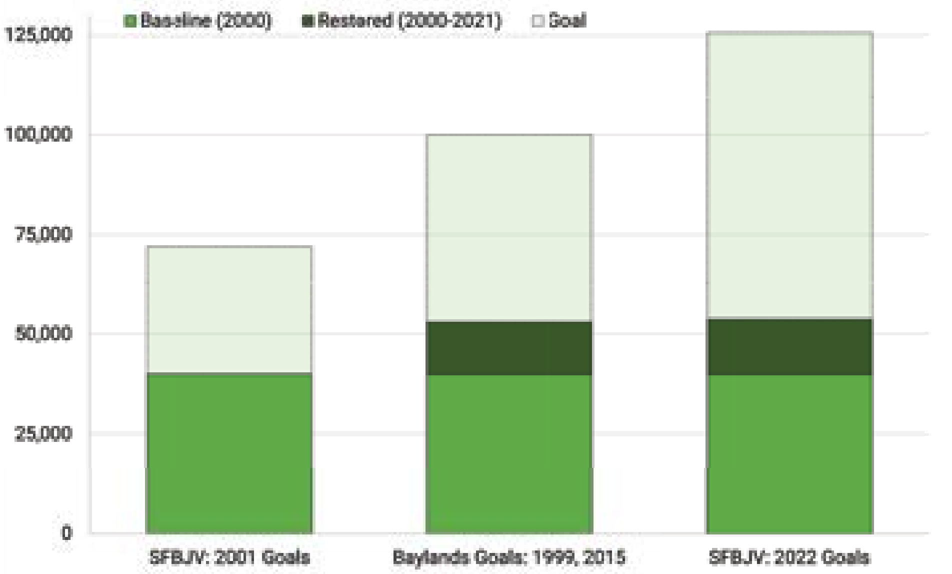


Figure 4. An overview of tidal marsh restoration goals from: the SFBJV's original implementation strategy (2001 Goals); the Baylands Goals (Goals Project, 1999 and 2015); and the SFBJV's updated implementation strategy (2022 Goals). The right two bars show the comparison between what has been accomplished and what is still remaining to reach the 1999 goals vs. the goals presented in this 2022 strategy.

A recent report estimates that "over the next 80 years, Bay Area communities will need to greatly supplement nature's supply of sediment to sustain healthy wetlands and mudflats, and the essential services they provide to people and wildlife" (Sediment for Survival, 2021). The SFBJV acknowledges a lack of enough sediment to restore an additional 72,000 acres to tidal marsh, and that doing so may reduce tidal flat extent or even put stress on existing tidal marsh habitat in a sediment-starved system.

As part of its progress tracking, the SFBJV will incorporate the latest science and monitoring on how tidal restoration may affect tidal flats and existing marshes. New strategies and prioritization schemes may need to be developed to address potential tradeoffs or conflicts in achieving goals across multiple baylands habitats, given the projected sediment deficit in the Estuary beginning after 2030. These strategies should prioritize working with natural processes and recognize that tidally restored habitats typically have greater value for fish and wildlife species than diked agricultural baylands or salt production ponds. Both systems will become increasingly difficult and expensive to maintain into the future, concomitantly increasing the risk of unintentional levee breaches. While we need an emphasis on tidal wetlands, other habitats are also important and need to be preserved to benefit the species that have come to rely on them.

Non-tidal Wetlands and Waters (NTWW)

Some areas of historic tidal marsh in the baylands that have been largely to completely isolated from tidal influence by dikes, levees, or other man-made structures. These non-tidal habitats replicate historic habitats that have almost entirely disappeared: salt pannes and pools, seasonal wetlands, and naturally muted tidal habitats. NTWW provide analogues to these habitats and have been present on the landscape providing habitat for more than a century, leading many species to utilize and rely on them. Preserving and enhancing NTWW is crucial to continue to provide habitat for these species, since many species depend upon them. This category contains a wide range of human-altered wetlands and waters, many of which are being managed to provide habitat for wildlife, including diked, managed seasonal wetlands and perennial marshes, artificially muted marsh, artificial lagoons, managed ponds, storage and treatment wetlands and ponds, current and former salt production ponds, and wetlands naturally forming in diked non-tidal baylands (including agricultural baylands).

Managed wetlands and salt ponds currently provide a mosaic of wetland habitats that range in depth and salinity and support diverse wildlife communities. Shorebirds, wading birds, and waterfowl flock to managed ponds in large numbers. Both dabbling and diving ducks rely on managed waters for foraging. The lowest salinity ponds can provide nursery habitat for forage fish, while higher salinity ponds support large numbers of green algae, brine flies, and brine shrimp. Salt evaporation ponds support halophylic bacteria and invertebrates, while only the halophylic bacteria can survive in crystallizer beds. The threatened Western Snowy Plover nests on the dry surfaces of former and existing salt ponds, managed to function like salt pannes. Both fully tidal and muted marshes can provide habitat for the endangered salt marsh harvest mouse, as can adjacent grasslands.

Baylands Protection Goal

Tidal marsh and non-tidal wetlands and waters were combined into a single "baylands" category for the purposes of setting a protection goal. Following the protection of any undeveloped or minimally developed lands within the historic baylands margin, the lands could either be enhanced to provide non-tidal wetlands and waters or restored to tidal marsh.

Baylands Restoration and Enhancement Goals

To calculate the baylands restoration and enhancement goals, the SFBJV utilized spatially explicit data to evaluate opportunities and account for accomplishments and baseline conditions, with expert input from landowners, species experts, and restoration practitioners in a series of workgroups to allocate proportions for tidal restoration and enhancement of NTWW. Additional details are provided in Appendix A. The workgroups evaluated goals on a regional basis to determine what percentage of the available acreage should be allocated to tidal restoration vs. NTWW for each Bay region. The workgroups also determined that 15% of the total restoration goal should be allocated for tidal marsh enhancement to improve functioning of existing tidal marshes and to counter threats related to climate change.

- Baylands protection goal = **59,000 acres**
- Tidal Marsh restoration goal = **72,000 acres**
- Tidal Marsh enhancement goal = **11,000 acres**
- Non-tidal Wetlands and Waters enhancement goal **= 27,000 acres**

Cris Benton

HIGHLIGHTING KEY ISSUES *Box 4*

State Route 37

Baylands Group: An Example of JV Partners Working for Nature-Based Climate Adaptation

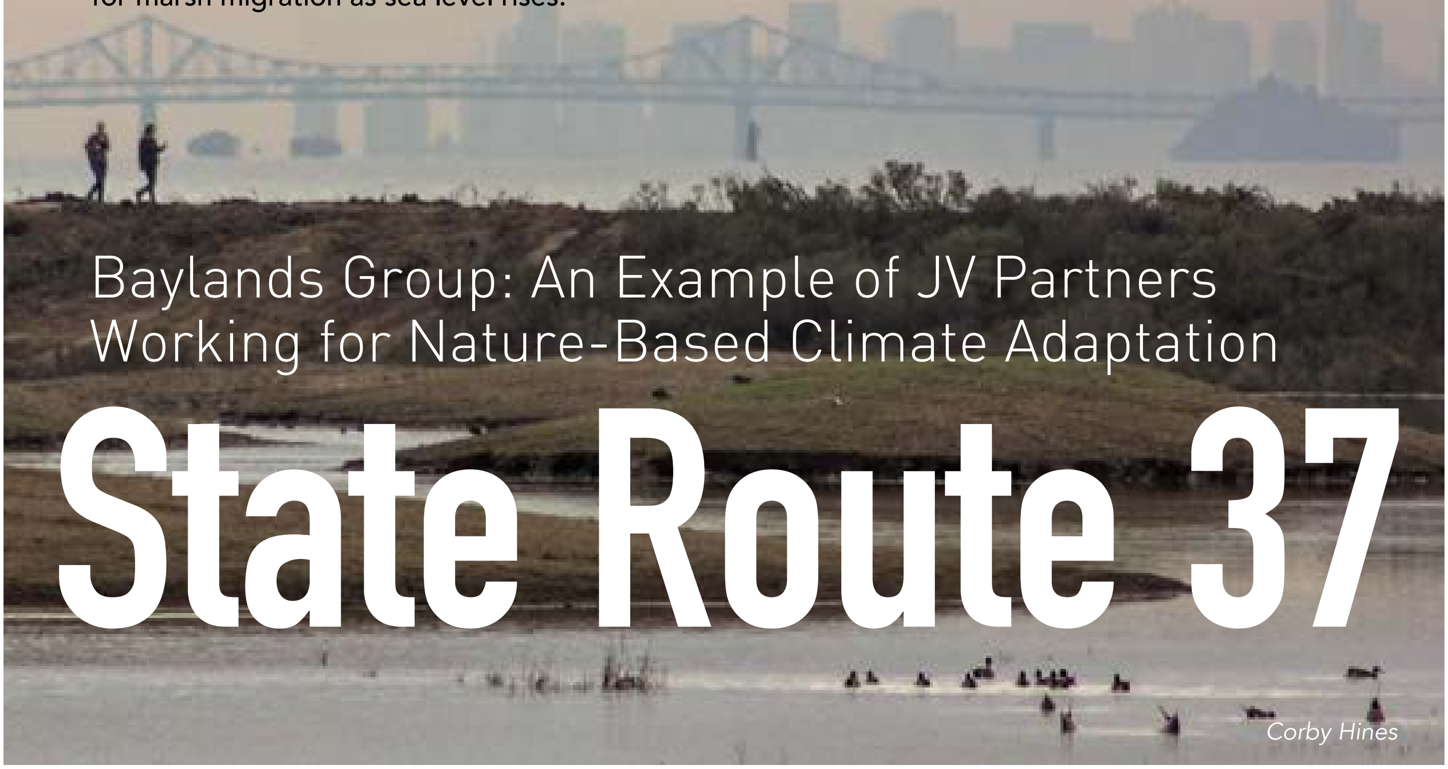
State Route 37 is a 21-mile highway that runs from Highway 101 in Novato to Highway 80 in Vallejo, crossing Marin, Sonoma, Napa, and Solano Counties. It is highly vulnerable to both near-term flooding and permanent inundation due to sea level rise. Dubbed the "Flyway Highway", it crosses marshes and ponds that support nearly half a million wintering and migrating Pacific Flyway waterfowl as they rest and forage. Many JV partners have invested over $600 million in acquisition, restoration, and enhancement of roughly 30,000 acres of the San Pablo Baylands to advance the goals set by the ecological restoration community.

The State Route 37 Baylands Group is composed of JV partners and other stakeholders interested in the conservation and restoration of the San Pablo Baylands. This group is committed to ensuring that the redesign of SR 37 is compatible with and advances the ecological restoration and conservation goals for the San Pablo Baylands and improves the climate resilience of both the built infrastructure and natural ecosystems.

The Baylands Group produced a white paper that included guiding principles; these principles have been incorporated in the plans and assessments developed by the transportation agencies working in the corridor. Baylands Group experts also helped the transportation agencies identify the pile-supported causeway as having less environmental impact than a hybrid design of causeway and embankment.

Members of the Baylands Group continue to engage in transportation-agency-led processes, while also proactively developing ecological landscape visions and associated recommendations for the highway and railroad (the Sonoma Creek Baylands Strategy and Petaluma River Baylands Strategy) that would facilitate restoration while keeping these structures out of harm's way.

The Baylands Group is similarly engaged in working with Sonoma Marin Area Rail Transit to elevate and co-locate the rail with SR 37. The existing rail line runs north/south along the west side of the Petaluma River, across the mouths of Petaluma and Tolay Creek, and north and east near the upland edges of Napa Sonoma marshes. Elevating it would enable full implementation of the Sonoma Creek and Petaluma River Baylands Strategies, and create significant opportunities for marsh migration as sea level rises.



Corby Hines

Tidal Flat

Extensive tidal flats, or mudflats, occur between mean tide and lower low tide in the more sheltered areas of the Estuary's margins. Tidal flat habitat can also occur in large channels and areas recently restored to tidal action before they become vegetated. Tidal flats protect marshes from erosion by attenuating wave energy and delivering sediment. Shorebirds and other waterbird species depend on tidal flats as foraging habitat because they are rich in invertebrates and other nutrients. San Francisco Estuary's tidal flat habitat is a critical link along the Pacific Flyway for shorebirds. The Western Shorebird Reserve Network considers it a site of Hemispheric Importance for more than a million shorebirds that rely on its tidal flats during migration.

Marilyn Latta

Tidal Flat Goals

Tidal flat acreage goals have been carried forward from *Restoring the Estuary* (2001; Table 2). This is due in part to a lack of accurate tidal flat mapping, for current or baseline conditions, over the entire JV area.

The goals for tidal flat habitat are as follows: **protect** 12,000 acres, **restore** 4,000 acres, and **enhance** 6,000 acres.

Beach

SF Estuary beaches are unconsolidated shoreline features made of cobble, gravel, sand, shell, or mixtures thereof. Though often narrow and steep, they still provide habitat for many aquatic and terrestrial animals including migratory birds. Unlike the other habitats with numeric goals, the protection goal for beach habitat is measured in miles for consistency with existing mapping efforts and because beach width, and therefore area, fluctuates seasonally.

Beach Goals

Functional goals have been added to numeric goals for restoration and enhancement because there is not enough existing information to estimate where these actions are needed or feasible.

Protect 36 miles of beach habitat which represents no net loss of existing habitat based on the Bay Shore Inventory (Doehring, 2016).

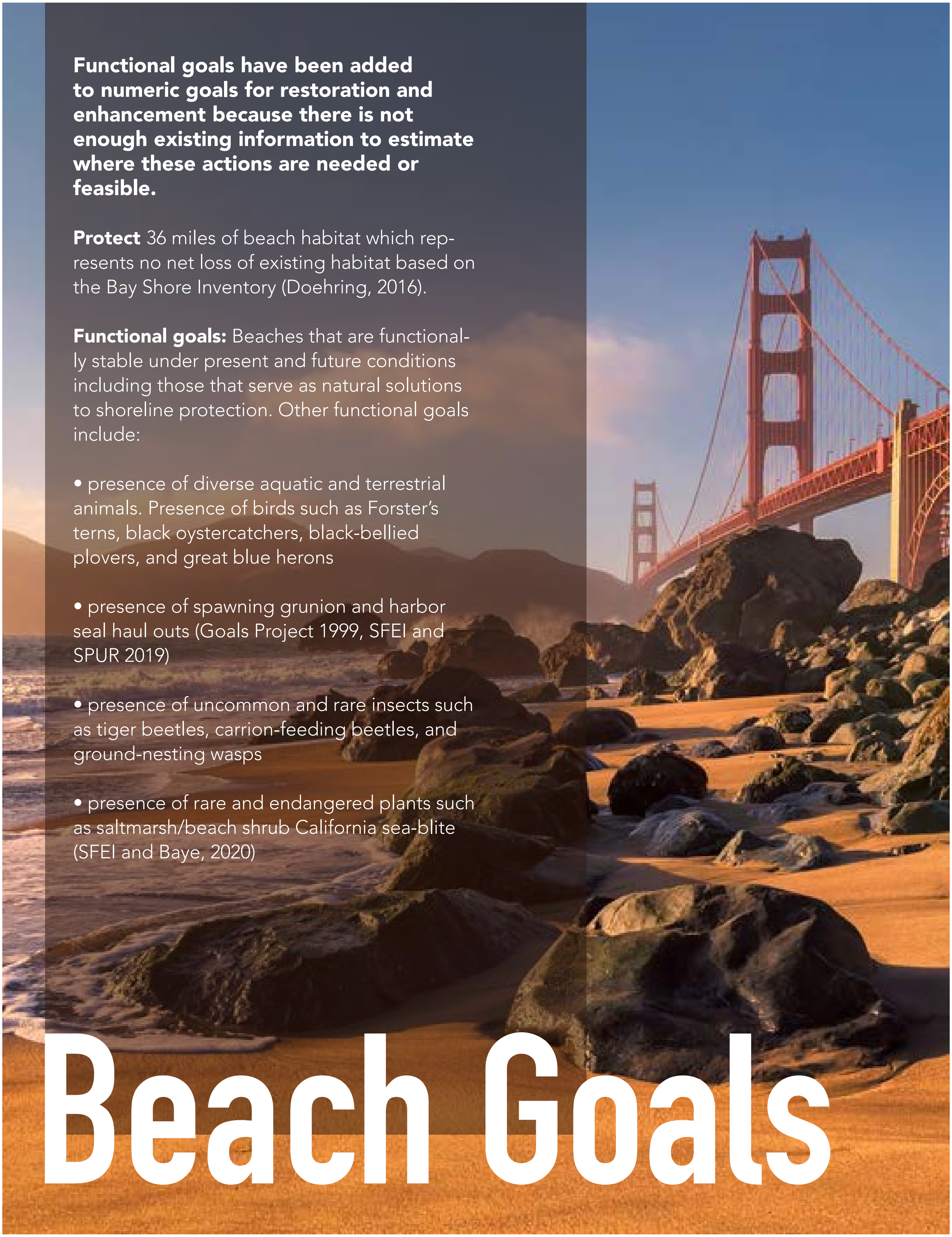
Functional goals: Beaches that are functionally stable under present and future conditions including those that serve as natural solutions to shoreline protection. Other functional goals include:

- presence of diverse aquatic and terrestrial animals. Presence of birds such as Forster's terns, black oystercatchers, black-bellied plovers, and great blue herons

- presence of spawning grunion and harbor seal haul outs (Goals Project 1999, SFEI and SPUR 2019)

- presence of uncommon and rare insects such as tiger beetles, carrion-feeding beetles, and ground-nesting wasps

- presence of rare and endangered plants such as saltmarsh/beach shrub California sea-blite (SFEI and Baye, 2020)



Submerged Aquatic Vegetation

The term "submerged aquatic vegetation" (SAV) refers to all underwater flowering plants that grow completely underwater except for periods of brief exposure at low tides. In the San Francisco Estuary, SAV includes sago pondweed, widgeongrass, and other species of seagrass, including eelgrass, and the surfgrasses (Schaeffer et al., 2007). Several freshwater plant species, mostly introduced, are found mainly in the upper Estuary (e.g., the Brazilian waterweed, an invasive nuisance species) and are outside of the geographic scope of this project. Goals for eelgrass beds were set due to the benefits they provide, functioning as nurseries for fish and invertebrates, natural spawning substrate for Pacific herring, foraging habitat for many fish and wildlife species including diving ducks, as well as wave attenuation and sediment stabilization. Eelgrass restoration is often combined with other habitat treatments in living shorelines approaches designed to protect and buffer local shorelines in the face of sea level rise and other climate stressors.

SAV Goals

SAV goals were combined across actions but otherwise follow the Subtidal Habitat Goals Report (2010), except for the protection goal, which has been updated as follows. The SFBJV seeks to protect 8,000 acres of subtidal and/or intertidal areas within a 50-year timeframe under a program of adaptive management with phased restoration. This is based on the acreage identified as moderately to highly suitable habitat (Merkel and Associates, 2005) less the baseline eelgrass extent. Periodic reviews will determine whether the knowledge is adequate to support proceeding to the next phase. Provisionally, the targets would be to increase native eelgrass habitat by 25 acres within 5 years,100 acres within 10 years, and up to 8,000 acres within 50 years, at 35 locations.

Protection includes the purchase of privately owned subtidal property from willing sellers, as well as creating protective buffers around SAV habitat, proposed eelgrass reserves, and collaboration with the boating community to reduce adverse impacts.

Protect 8,000 acres of existing SAV habitat and **restore and enhance** 8,000 acres of suitable eelgrass habitat.

Greg Lorenz

Stephanie Kiriakopolos

Shellfish Beds

Shellfish beds are locations where a shellfish species occupies more than 50% of an area of more than a few square meters (Subtidal Goals 2010, Schaeffer et al., 2007). The native Olympia oyster is the focus of shellfish bed conservation in SF, which occurs on natural and artificial hard substrates in intertidal and subtidal zones. Shellfish beds provide nearshore nursery and foraging habitat for fish, birds, and wildlife, filter and improve water quality, and, as part of a living shorelines approach, can be strategically sited to protect adjacent tidal marsh and other shoreline habitats from erosion.

Shellfish Beds Goals and Methods

Numeric goals for shellfish beds are consolidated for protection, restoration, and enhancement and come from the Subtidal Goals Report (2010). Although numeric acreage habitat goals are only set for shellfish beds and eelgrass, open bay habitats, seaweed beds, sand beds, rocky areas, and other submerged sites are important to the health and ecological function of the Estuary and are often considered essential fish habitat. Additionally, sand beds and seaweed beds provide other ecological values. A diverse community of invertebrates dwell in the soft bay mud and are part of a food web that support many commercially important species (e.g., Pacific herring, Northern anchovy, and Dungeness crab, Chinook salmon), diving ducks, sea ducks, and marine mammals.

Rhett Finley

Open Water

> While the SFBJV does not have explicit goals for open water habitat, we promote its protection and enhancement and will continue to address potential impacts to wildlife use as they arise.

The deeper open waters of the Estuary are used by many fish and wildlife species including diving ducks and sea ducks, anadromous fish, whales, seals, and sea lions. These species rely on disturbance-free open water for critical activities like foraging, spawning, and resting. Because the surface area of open water has not been dramatically reduced, unlike other listed habitats, we have no area-based habitat goals for open waters. Furthermore, increasing the area of open water would likely come at the expense of other at-risk habitats such as tidal marsh, and is a process that may occur, regardless, as sea levels rise. However, functional values of open water habitat can be negatively affected by activities related to shipping, public transportation, dredging, recreational activities, and other actions that can temporarily or permanently displace fish and wildlife, disrupt activities such as foraging that are critical for reproduction or survival, or otherwise affect species through such processes as sediment and contaminant mobilization. While the SFBJV does not have explicit goals for open water habitat, we promote its protection and enhancement and will continue to address potential impacts to wildlife use as they arise.

Upland Transition Zone

The Upland transition zone hosts distinct plant communities and provides critical high tide refugia for tidal marsh wildlife and connectivity between wetland and upland ecosystems. The upland transition zone is the landward limit between mean higher high water and extreme high water or the highest observed tides; however, this narrow definition does not fully capture its value as refugia for tidal marsh wildlife. The SFBJV recognizes that actions to protect, restore, and enhance transition zones need to consider high-water refuge for wildlife, and address key characteristics such as width and vegetation structure (Goals Project, 2015). The upper or landward portions of the upland transition zone overlap with "Adjacent Uplands," defined by its role in providing marsh migration space and resilience to sea-level rise as described below. Species that rely on upland transition zone habitat include many tidal marsh-dependent species that include rails and mice, but also additional upland species of insects, birds, and mammals.

Upland Transition Zone Goals

Protect 16,500 acres, to support all existing and desired tidal marsh acreage. To calculate the goal, a 60-meter buffer from the marsh edge was used, twice the minimum required to support habitat function (Thomson, 2013). This conservative approach recognizes the value of upland transition zones and provides added buffer, where available. This also ties into the adjacent upland goals, below.

Restore 15,100 acres, based on the assumption that the majority of protected upland transition zone will need to be restored to re-establish the native plant community and provide the support needed by tidal marsh wildlife.

Enhance 2,500 acres, to include levees and other transition zone areas that do not necessarily connect to uplands. The goal was calculated by applying a 10-meter buffer zone around existing levees and berms that were adjacent to tidal marsh. The vast majority of this area is in need of enhancement.

Adjacent Uplands

Adjacent uplands are located at the interface between estuarine and watershed habitats and serve key roles in both ecosystems. These uplands extend beyond the wetland-upland transition zone and support a variety of ecological and biophysical functions for both estuarine and terrestrial habitats. They also provide important refugia and foraging habitat for marsh- endemic species. Separate from uplands and transition zones, which have their own acreage and functional goals outlined elsewhere, adjacent uplands are being explicitly called out for their important role in long-term estuarine resilience to sea level rise. Specifically, these uplands provide potential spaces for marshes to move landward as sea levels rise, also referred to as "marsh migration space." Under higher rates of sea level rise, these uplands may be the few remaining places where marsh habitat can persist.

Adjacent Upland Goals and Methods

Acreage of adjacent uplands were quantified with the goal of enabling long-term marsh resilience. Protecting additional uplands along the existing bay margin also has the potential to assist with enhancing or restoring transition zones that are disconnected from the uplands. Table 3 (below) provides acreage goals for this "enhanced" marsh migration space within "undeveloped" land uses (ABAG 2006), since this currently provides the most potential for protection. We have also quantified the acreages of adjacent uplands that are within (or not within) protected areas using GreenInfo's CPAD database (CPAD 2020).

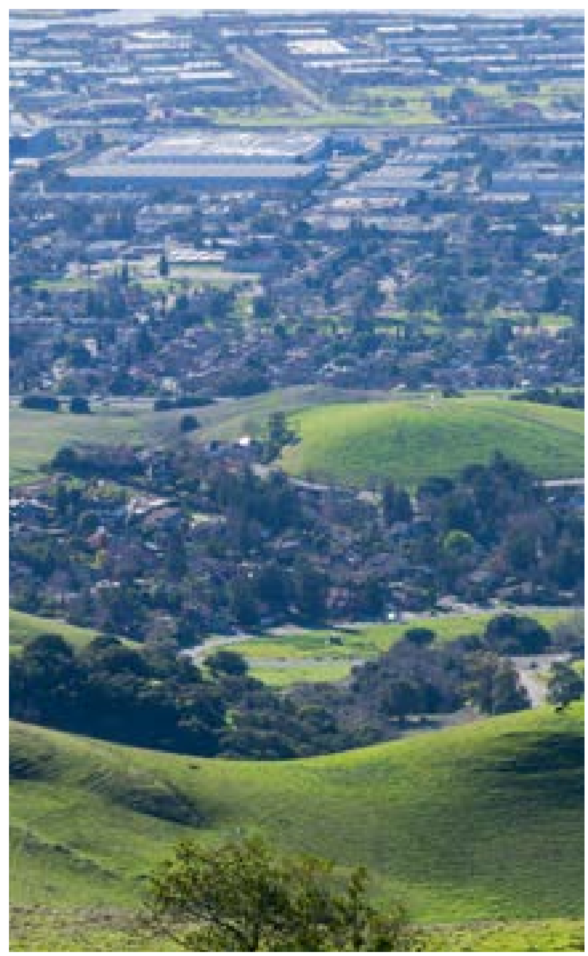
Table 3. Adjacent Uplands ("Marsh Migration space") Acreage Goals by Bay Unit*

Bay Unit	**Not Protected**	**Protected**	**Total**
Central Bay	1,281	760	2,042
North Bay	4,620	1,969	6,589
South Bay	2,811	2,709	5,520
Suisun Bay	5,306	924	6,230
Total (All Bays)	**14,019**	**6,364**	**20,383**

** Acreages only include undeveloped land uses*

2.2.3.2 Watershed Habitats

Watershed habitats occur from the inland edge of the baylands (SFEI 1999 "historic extent of the bay") to the outer boundaries of the nine Bay Area counties. These contain unique aquatic habitats, and provide important connectivity to the baylands, stopover habitat for migratory birds, and other conservation values that the SFBJV goals highlight. A watershed is defined as an area of land in which rainfall and snowmelt feed into a common set of streams and rivers that drain into a single larger body of water.



Watersheds in the SFBJV region are characterized generally by urban development and cultivated agriculture in valleys and plains; rural residential, livestock farms, and vineyards in the foothills; and oak woodlands and conifer forests in the steeper hills. Despite a human population of nearly 8 million, natural areas still abound in the SFBJV watersheds and intermix with rural residences and working farms, which often contain such valuable habitat as ponds and riparian corridors. A considerable amount (28%) of the region is permanently conserved as parks and preserves, including farmland, by the region's land trusts, park and open space districts, and water suppliers (CPAD, 2020).

Acreage goals were established for four key watershed habitats: lakes and ponds, seasonal wetland and vernal pool complexes, alluvial stream valleys (alluvial creeks channels, riparian zones, and terraces), and headwater creeks and source areas. Alluvial stream valleys and headwater creeks and sources areas were newly added to the 2022 update because of their importance in providing material inputs (e.g., fresh water, sediment, nutrients) that downstream and estuarine habitats require for long-term function. Goals for all four watershed habitats were adopted from a Bay Area region-wide assessment and vision for upland biodiversity conservation (Conservation Lands Network 2.0, 2019). See Table 4 for numeric goals for each watershed habitat.

Table 4. Habitat acreage goals for Watershed Habitats. Numeric goals represent what still requires conservation and can overlap among the conservation action categories (protect, restore, enhance), meaning that the same acre may need to be protected and restored and/or enhanced.

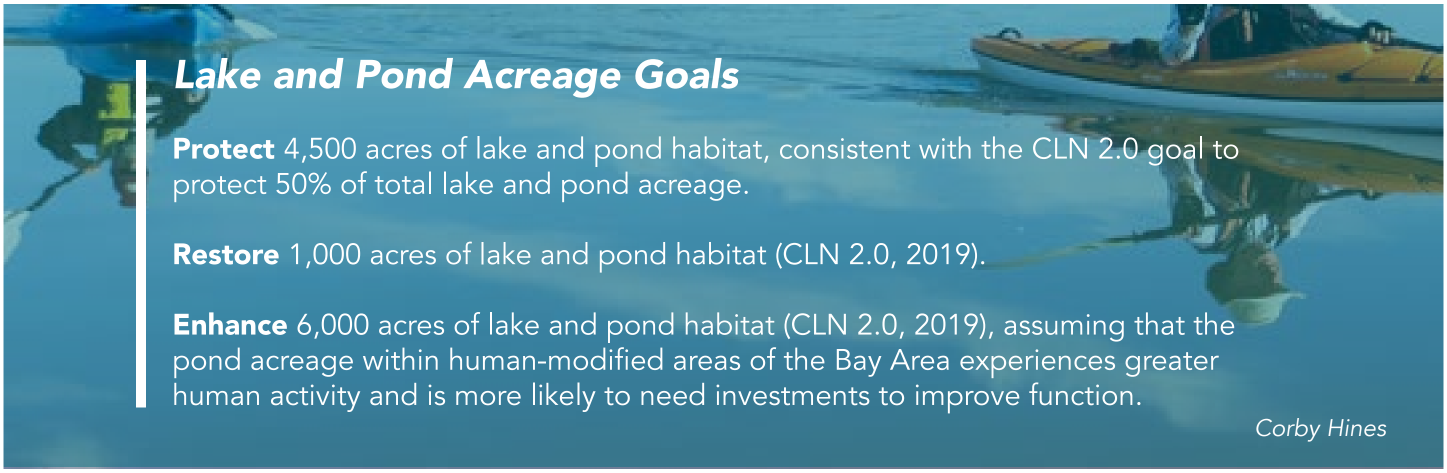
Watershed Habitats	Habitat Goals for Watershed Habitats (in acres)		
	Protect	Restore	Enhance
Lakes and Ponds	4,500	1,000	6,000
Seasonal Wetlands and Vernal Pool Complexes	5,000	2,500	3,500
Alluvial Stream Valleys	200,000	50,000	200,000
Headwater Creeks and Source Areas	270,000	50,000	100,000
TOTAL	**479,500**	**103,500**	**309,500**

Lakes and Ponds

Lakes and ponds are inland bodies of standing or slowly moving freshwater of various sizes and depths. The vast majority of the Bay Area's approximately 10,000 lakes and ponds are artificial stock ponds associated with livestock ranching. Natural lakes and ponds have often been highly altered and degraded, yet some still offer opportunities for restoration or enhancement (e.g., Tolay Lake). Other lakes and ponds in the region have been created for agricultural irrigation storage, domestic water storage, fire protection, and recreation.

Lake and Pond Goals

Lake and pond goals are derived from CLN 2.0 (2019) with acreage adjustments to account for the area encompassed by the SFBJV boundary. CLN 2.0 conservation goals were set at 75% of remaining lakes and ponds in the Bay Area and were drawn from multiple sources of lake and pond data, including the Bay Area Aquatic Resource Inventory (BAARI) and the National Wetland Inventory (NWI).



Lake and Pond Acreage Goals

Protect 4,500 acres of lake and pond habitat, consistent with the CLN 2.0 goal to protect 50% of total lake and pond acreage.

Restore 1,000 acres of lake and pond habitat (CLN 2.0, 2019).

Enhance 6,000 acres of lake and pond habitat (CLN 2.0, 2019), assuming that the pond acreage within human-modified areas of the Bay Area experiences greater human activity and is more likely to need investments to improve function.

Corby Hines

Functional goal: Improve networks of clustered lakes and ponds that exchange physical and biological processes with adjacent riparian and upland habitats. When lakes and ponds are clustered and the habitats between them are permeable, amphibians and other pond-breeding species (many of which are wetland bird prey species) are better able to disperse and reproduce. At the landscape scale, networks of clustered lakes and ponds thus improve the health of metapopulations of amphibians and other species. Specifically, this includes:

- Native pond shoreline plant cover, including tule, bullrush, and cattail, and surface and submerged plants, such as pondweed, Western milfoil, and pond lily.
- Presence of native pond-dwelling reptiles and amphibians, such as western pond turtle and red-legged frog.
- A lack of such invasive predatory fish as bass and carp.

Seasonal Wetlands and Vernal Pool Complexes

Seasonal wetlands and vernal pools are wetlands within a matrix of uplands, located outside of the historic extent of the baylands. These habitats typically occur along streams on plains and in wide valleys or in basins in relatively flat areas and on gently rolling ground where the water table is close to the ground surface, or where impermeable soils slow percolation and result in ponding. Many species of birds rely on seasonal wetlands and vernal pool complexes for food, water, and shelter, especially during migration and breeding. Aquatic and semi-aquatic plants and animals that have adapted to wide fluctuations in the presence of water occur in these vernal pools.

Cris Benton

Seasonal Wetlands and Vernal Pool Complex Goals

Seasonal wetlands and vernal pool complexes are derived from CLN 2.0 (2019) with acreage adjustments to account for the area encompassed by the SFBJV boundary. CLN 2.0 conservation goals for seasonal wetlands and vernal pool complexes were set at 90% of remaining wetlands and vernal pools in the Bay Area and were drawn from multiple sources of data, including the National Wetland Inventory (NWI), California Department of Fish and Wildlife (CDFW), and Existing Vegetation (EVEG) maps produced by the US Forest Service.

Protect 5,000 acres of Seasonal Wetlands and Vernal Pool Complexes which represents 90% of the remaining unprotected wetland and vernal pool complexes, and is consistent with the CLN 2.0 goal to protect 90% of total wetland and vernal pool complex acreage. This goal is double the 2001 Restoring the Estuary goal, an increase consistent with the large CLN 2.0 percentage goal (90% of remaining wetlands and vernal pools). More intensive ground-truthing and wetland mapping efforts have resulted in more detailed and extensive mapped records of wetlands and vernal pools.

Restore 2,500 acres of Seasonal Wetlands and Vernal Pool Complexes. This goal reflects the desire to restore half of the original seasonal wetlands and vernal pool complexes that have been destroyed, and reflects an increase of 500 acres (RTE, 2001).

Enhance 3,500 acres of Seasonal Wetlands and Vernal Pool Complexes. The goal is approximately equal to the sum of seasonal wetland and vernal pool acreage within human-modified areas of the SFBJV region.

Functional Goal: Seasonal wetlands and vernal pool complexes that functionally connect other wetlands and wetland complexes in ways that facilitate dispersal of wetland-dependent birds, wildlife, and plants. Specifically, this includes:

- Native plant cover in wetlands, including spikerush, lasthenia, and semaphore grass; and a lack of invasive plants.
- Normal nutrient-loading regimes to ensure that plant growth and succession is not artificially accelerated. Presence of native pollinators that support propagation of vernal pool flowering plants, to include goldfields, meadowfoam, downingia, and fleshy owl's-clover.
- Presence of such roosting trees as valley oak.

Alluvial Stream Valleys (Creeks and Riparian Zones)

Alluvial stream valleys, which include creeks and riparian zones, refer to the physical space needed to allow fluvial and ecological processes to occur over their natural spatial and temporal scales in medium- to low-gradient streams. Alluvial stream valleys are located primarily in the middle and lower parts of a watershed where stream flows and substrates are or have historically been suitable for spawning and rearing salmonids, and dynamic vegetation succession processes result in complex in-stream habitat and diverse riparian habitat. Additionally, riparian zones are critically important for birds, reptiles, amphibians, and other fish species even in the absence (currently or historically) of salmonids.

Alluvial Stream Valley Goals

Alluvial stream valleys were mapped in acres in terms of the approximate space required by streams for material and riparian function using up-to-date digital elevation models and modeling techniques (CLN 2.0, 2019). In CLN 2.0, remaining stream valleys were considered "Essential Habitat", the highest priority, to maintain current biodiversity levels, due to their extraordinarily high ecosystem value as water sources, cool air sources, and species movement corridors throughout the landscape. The recommended SFBJV protection, restoration, and enhancement goals reflect this modeling and priority level.

Modeled alluvial stream valleys were split into three categories: 1) natural stream valleys; 2) stream valleys converted to urban land ("converted - urbanized"); and 3) stream valleys converted to agriculture ("converted - cultivated"). Natural alluvial stream valleys are considered highly suitable for protection. Alluvial stream valleys converted to urban land are considered suitable for restoration. Alluvial stream valleys converted to agriculture are considered suitable for enhancement.

Protect 200,000 acres, representing 100% of all unprotected remaining alluvial stream valley habitat.

Restore 50,000 acres of alluvial stream valley habitat including in-channel enhancements in "converted - urbanized" stream valleys.

Enhance 200,000 acres of alluvial stream valley habitat which represents 50% of all "converted - cultivated" stream valleys.

Functional Goal: Achieve stream networks with intact fluvial processes (e.g., flooding, natural bank erosion and failure, sediment delivery, aquifer recharge, etc.) and ecological functions (e.g., large wood recruitment, vegetation growth and succession, organic matter input, shading, fish passage, etc.) that result in structural complexity, vegetation mosaics, and native species diversity. Specifically, this includes:

- A lack of bank armoring and other channelizing structures that inhibit widening and lateral migration of the channel
- Instream habitat heterogeneity with sand bars, pools, large woody debris, and connected floodplains
- Diverse riparian vegetation structure with willow spp, alder spp, valley oak, boxelder maple, big-leaf maple, Fremont cottonwood, and other riparian forest trees
- Presence of benthic macroinvertebrates and vertebrate species including salmonids, foothill yellow-legged frog, and northwestern pond turtle
- Presence of such riparian obligate bird species as the Black-headed Grosbeak, Yellow Warbler, Bell's Vireo, Willow Flycatcher, among others

Headwater Creeks and Source Areas

Headwaters are the upper parts of a watershed and are characterized by steeper hillslopes and high-gradient creeks and tributaries. Headwaters are considered source areas for materials that downslope and downstream natural communities need to viably function: adequate water, sediment, and nutrients. Headwaters capture precipitation and deliver cool water through stream networks or store it in soil and subsurface fractured rock geology which gets released over time. As natural erosion and mass wasting occur in headwater areas, sediments are delivered via streams to lower sections of the watershed, including the baylands, where the finest sediments are deposited and help maintain marsh elevation.

Headwater Creek and Source Area Goals

Protect 270,000 acres of hydrologically connected upper watershed area with the SFBJV region, which includes 650 miles of CLN 2.0 Priority 1 first-order (small tributary) streams. Protection goals were derived from the CLN 2.0 (2019) Headwater Source Areas found within the SFBJV region.

Restore 50,000 acres of hydrologically connected upper watershed area.

Enhance 100,000 acres of hydrologically connected upper watershed area.

Functional goal: Headwater zones that support the physical and biological processes associated with functioning watersheds, including delivery of sediment, nutrients, and woody debris to habitats downstream, and the presence of plants and wildlife indicative of high-quality habitat.
Specifically, this includes:

- A lack of dams or other structures that block sediment, nutrient, or woody debris delivery downstream, or fish migration upstream
- A mix of montane tree species to include white alder, Oregon ash, willows, big-leaf maple, and redwood
- Presence of montane aquatic species such as foothill yellow-legged frog
- Presence of such forest bird species as Swainson's Thrush and Warbling Vireo

2.2.3.3 Outer Coast Habitats

Outer Coast habitats within the SFBJV boundary are located along the Pacific Coast in San Francisco, San Mateo, Marin, and Sonoma counties, and are influenced by coastal and marine conditions and processes including tides, waves/swell, coastal wind and fog, and longshore sediment transport. Outer coast habitat goals include beaches and dunes, cliffs, rocky intertidal, outer coast estuaries, and coastal stream valleys (Table 4). Most outer coast habitats herein were drawn from classifications developed by the Gulf of the Farallones National Marine Sanctuary (GFNMS, Duncan et al., 2013 and Hutto, 2016), and by The Nature Conservancy and Central Coast Wetlands Group (Heady et al., 2014). The coastal stream valleys and riparian habitats which include wetlands were drawn from the CLN.

Outer coast habitat goals reflect the uniquely dynamic nature of these habitats by focusing on functional goals. However, subsequent plans should consider integrating both functional *and* numeric goals to ensure adequate long-term, landscape-scale support for this region's diverse and economically critical species, communities, and ecosystems.

Table 5. SFBJVs functional goals for Outer Coast habitats. Functional goals are based on Gulf of the Farallones National Marine Sanctuary Climate-Smart Adaptation Report (Hutto, 2016) and CLN 2.0

Outer Coast Habitats	Functional Goals
Beaches and Dunes	Functional stability and ecological integrity under present and future conditions.
Cliffs	Natural erosional processes not influenced by armoring or other built infrastructure and with native plant species and nesting birds.
Rocky Intertidal	Natural erosional processes not influenced by armoring or other built infrastructure and the presence of a wide variety of native invertebrates, fish, pinnipeds, shorebirds, alcids, and other aquatic birds.
Coastal Estuaries (bay/ embayment, lagoon)	Optimize physical and biological function and processes of outer coast estuaries under present and future conditions.
Coastal Stream Valleys (riparian)	Wide, variable-width stream corridors and stream networks with natural fluvial processes and ecological functions that lead to healthy streams and riparian biodiversity.

Beaches and Dunes

Beaches and Dunes

Beaches are defined as fine-grained habitats along the shoreline that can build and erode in response to waves, winds, tides, longshore sediment transport, and other physical processes. Most beaches in the SFBJV region are dominated by sand, but some can contain a significant proportion of gravel and cobble. Dune habitat is typically wind-influenced and well above the reach of typical tides.

Functional Goal: Beach and dune habitat that have functional stability and ecological integrity under present and future conditions (Hutto et al. 2016). More specifically, this includes:

- Adequate space for beaches and dunes to move inland with sea level rise (beach transgression)
- Adequate sediment supply (from both longshore and fluvial sources) to support beach transgression
- Natural delivery and movement of sediment (sand, gravel, etc.) and water to and on the beach unimpeded by such management activities as armoring (e.g., revetments, seawalls, etc.), grading, and lagoon inlet management/breaching
- Native dune and beach plant communities with minimal or no invasive species, including ice plant and European dune grass that displace native species and/or interfere with natural sand movement
- Presence of thriving populations of special-status species such as the Western Snowy Plover which may require managing beach/dune recreational use to avoid or minimize impacts
- Diverse native plant and wildlife communities, including abundant invertebrates, foraging, roosting, and breeding habitat for shorebirds, a diverse native plants community including rare and/or special-status species, breeding and loafing habitat for pinnipeds, and breeding habitat for some fish (grunion)

Cliffs

Cliff habitat features steep, rocky faces that either plunge directly into the ocean or are fronted by narrow beaches which may be underwater at high tide. Cliff habitat stability and ecology is generally defined by the rock type, degree of weathering, and exposure to wave action. Cliffs are generally unstable and subject to erosion and collapse, which in turn provides sand to beach and dune habitats.

Functional Goal: Cliff habitat with natural erosional processes not influenced by armoring or other built infrastructure (Hutto et al. 2016) and with native plant species to include *Dudleya* spp. and such nesting birds as Common Murre.

Rocky Intertidal

Rocky coastlines between MLLW and MHHW, often at the base of cliffs, as well as offshore promontories. Rocky intertidal areas are typically subject to intense wave action and tidal inundation.

Functional Goal: Rocky intertidal with natural erosional processes not influenced by armoring or other built infrastructure (Hutto et al. 2016) and the presence of a wide variety of invertebrates (including but not limited to barnacles, limpets, abalone, mussels, sea anemones, and sea urchins), fish, pinnipeds, shorebirds, alcids, and other aquatic birds.

Coastal Estuaries

Coastal estuaries in the region exist along a landscape spectrum ranging from open embayments to lagoonal estuaries. Embayments are partially enclosed, marine-dominated, open water environments with unimpeded tidal influence that are often subject to wave surge from the open ocean. Tomales Bay, Drake's Estero, Bolinas Lagoon, and San Francisco Bay are examples of embayments in the region; SF Estuary is treated separately in this plan due to its size and importance to SFBJV. Lagoonal estuaries (large and small) are unique estuarine environments. They are generally open to marine influence via tidal and wave action through an open inlet across a beach berm during the wet season, and become predominantly freshwater systems during the dry season as flows subside, the beach berm grows, and the inlet closes. The only example of a large lagoonal estuary in the region is the Russian River Estuary in Sonoma County. Examples of small lagoonal estuaries in the region include Estero Americano in Sonoma County, Rodeo Lagoon in Marin County, and Pescadero Marsh in San Mateo County.

Coastal Estuaries

Functional Goal: Optimize physical and biological functions and processes of outer coast estuaries under present and future conditions (Hutto et al., 2016). More specifically, this includes the functional goals listed under "Beaches and Dunes" above, as well as:

- Adequate migration space along terrestrial and fluvial transition zones for peak dry-season water levels to move upslope and inland with sea level rise
- Natural inlet morphodynamics and backbarrier habitats free from management interventions including breaches and grey infrastructure such as levees, seawalls, and revetments that can contribute to "coastal squeeze"
- Clean waters with little to no impairment from point and nonpoint source pollution
- Physical and ecological connectivity between lagoons and adjacent terrestrial, fluvial, and marine habitats
- Natural hydrology with little to no impacts from surface water and groundwater extraction
- Presence of native lagoon flora and fauna, especially special-status species (e.g., salmonids, tidewater goby, western pond turtle, California red-legged frog, and San Francisco garter snake)

Christina Toms

Coastal Stream Valleys

Coastal stream valleys include riparian and floodplain habitats within the influence of coastal fog belts that support base flows through the dry season.

Functional Goal: Wide, variable-width stream corridors and stream networks with natural fluvial processes and ecological functions that lead to healthy streams and riparian biodiversity.
More specifically, this includes:

- Adequate buffers between stream corridors and adjacent land uses
- Adequate fish passage to rearing areas
- Natural hydrograph not influenced by surface water and groundwater extractions or damming
- Presence of native riparian plant communities
- Provision of water, shade, and large woody debris to streams
- Presence of healthy coastal riparian habitats that increase complexity and biodiversity

Coastal riparian habitats support a broad range of terrestrial and aquatic wildlife species, provide foraging and nesting habitat for resident and migratory birds, and are critical to support salmonid spawning and rearing.

Summary of Acreage and Functional Goals Tables for SF Estuary, Watersheds, and Outer Coast Habitats.

Figure 5. Goals represent remaining conservation needs. Numeric goals can overlap among the conservation action categories (protect, restore and enhance, meaning that the same acre may need to be both protected and restored and/or enhanced).

SF Estuary Habitats	Protect	Restore	Enhance
Baylands — Non-tidal Wetlands and waters	59,000	NA	27,000
Baylands — Tidal Marsh		72,000	11,000
Tidal Flat	12,000	4,000	6,000
Beach	36 miles	Beaches that are functionally stable under present and future conditions	
Submerged Aquatic Vegetation	8,000	8,000	
Shellfish Beds	protect all existing native oyster beds	8,000	
Estuarine-upland Transition Zone	16,500	15,100	2,500
Adjacent Uplands	14,000	NA	NA

Watershed Habitats	Habitat Goals for Watershed Habitats (in acres)		
	Protect	Restore	Enhance
Lakes and Ponds	4,500	1,000	6,000
Seasonal Wetlands and Vernal Pool Complexes	5,000	2,500	3,500
Alluvial Stream Valleys	200,000	50,000	200,000
Headwater Creeks and Source Areas	270,000	50,000	100,000

Outer Coast Habitats	Functional Goals
Beaches and Dunes	Functional stability and ecological integrity under present and future conditions.
Cliffs	Natural erosional processes not influenced by armoring or other built infrastructure and with native plant species and nesting birds.
Rocky Intertidal	Natural erosional processes not influenced by armoring or other built infrastructure and the presence of a wide variety of native invertebrates, fish, pinnipeds, shorebirds, alcids, and other aquatic birds.
Coastal Estuaries (bay/em-bayment, lagoon)	Optimize physical and biological function and processes of outer coast estuaries under present and future conditions.
Coastal Stream Valleys (riparian)	Wide, variable-width stream corridors and stream networks with natural fluvial processes and ecological functions that lead to healthy streams and riparian biodiversity.

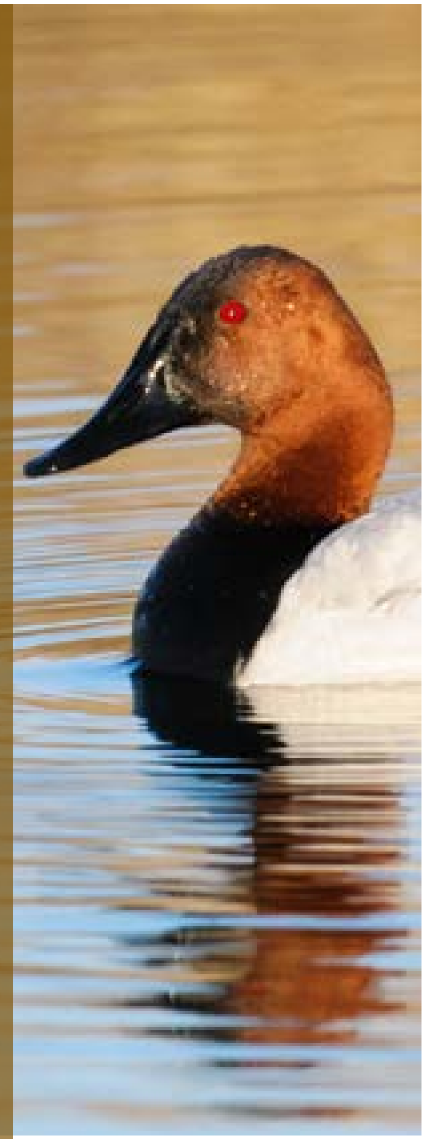
2.3 Waterfowl Population Goals

In addition to habitat acre goals, the SFBJV has updated its numeric goals for waterfowl. The SFBJV was originally established under the North American Waterfowl Management Plan (NAWMP) to reverse declining waterfowl populations. Setting clear and measurable goals is a key step in achieving successful outcomes for waterfowl.

The SFBJV was created after the national MBJV program expanded to include other species and priorities, and our habitat goals are intended to facilitate achieving goals for other related species detailed in other plans. (See chapter 3 for how the SFBJV will use indicator species to assess habitat quality and conservation success.)

However, numeric goals for wildlife within this plan are limited to waterfowl species and are consistent with NAWMP (NAWMP 2012, 2014) and other Joint Ventures (Petrie et al., 2011, Fleming et al., 2019). Continent-wide, the twenty-two habitat-based JVs work together to accomplish waterfowl habitat and population goals set by NAWMP.

Thus, MBJVs must use population abundance objectives derived from a consistent methodology to reduce planning redundancies among regions, and to elucidate the specific roles and contributions of each MBJV as we work toward achieving continental waterfowl population goals (Petrie et al., 2011).



2.3.1 Need for Updated Waterfowl Goals

Current waterfowl goals have been revised to align with the methods of Fleming et al. (2019). The NAWMP Science Support Team Committee recommended this approach to ensure that all JVs are using a consistent method for establishing population objectives for the non-breeding period (Petrie et al., 2011; Fleming et al., 2019). This method includes "stepping down" continental breeding population objectives to make meaningful and relevant goals at the regional scale. These objectives are then combined with regional harvest and midwinter survey data to attribute birds to specific counties in North America for fall and winter (NAWMP Committee 2012, 2014). Estimates for each county are then aggregated to create species-specific estimates for each Joint Venture (Fleming et al., 2019). Two different regional objectives were calculated: one using the revised NAWMP population objectives based on the Long-Term Average (LTA) breeding ducks (1955–2014), and a more aspirational set of objectives using the 80th percentile of long-term distribution of population sizes (NAWMP 2012, 2014; Fleming et al., 2019). The SFBJV will use the winter-period LTA values as the primary waterfowl population goals, and the 80th percentile values as aspirational goals (Table 7).

Some marked differences exist between the current population goals and those set in 2001 (see Table 8, Chapter 3). For example, LTA objectives derived by Fleming et al. (2019) set the goal abundance for mallards as 97% higher than that of the original 2001 Implementation Plan. Such discrepancies can be expected, given the differences in the way the goals were derived (local count data vs. estimates based on continental datasets). Additionally, the original objectives were set using peak numbers from several decades ago and some species (for example scaup, scoters) have been declining continentally as well as regionally, perhaps leading to lower LTA estimates. Discrepancies also may be explained by several methodological assumptions and uncertainties identified in Fleming et al. (2019). For example, the LTA values rely heavily on the assumption that distribution of harvest is a reliable index of fall and winter waterfowl distributions. In the SF Estuary, waterfowl harvest may be under-reported, and hunting in the Estuary has been on the decline; thus, harvest estimates may under-represent the abundance and distribution of some species in the Estuary. This may be particularly true for sea duck species such as Surf Scoter.

2.3.2 Waterfowl Goals

The SFBJV selected seven waterfowl focal species (Table 6) to collectively represent the 32 native waterfowl species of the San Francisco Estuary, as well as the habitats they depend upon. The focal species were first selected for the SFBJV 2001 Implementation Plan based on their historic abundances within the Estuary and the Pacific Flyway, as well as their representation of the range of Estuary waterfowl habitats. Canvasback, Surf Scoter, and scaup are considered the primary focal species for the SFBJV, owing to the importance of the Estuary for sea and diving ducks. Northern Pintail, Northern Shoveler, and Ruddy Duck were selected as the next most abundant species in the SFBJV region, and Mallard was selected because it is the most abundant locally breeding species and is a representative species for diked baylands and managed marshes. Although abundances of some of these species have changed in the interim, they still meet the original selection criteria parameters. These focal waterfowl species also serve as indicators in other regional plans and reports, within the Baylands Goals Science Update (2015), State of the Birds San Francisco Bay (Pitkin and Wood 2011), and State of the Estuary (2015), thus enabling standardization among programs.

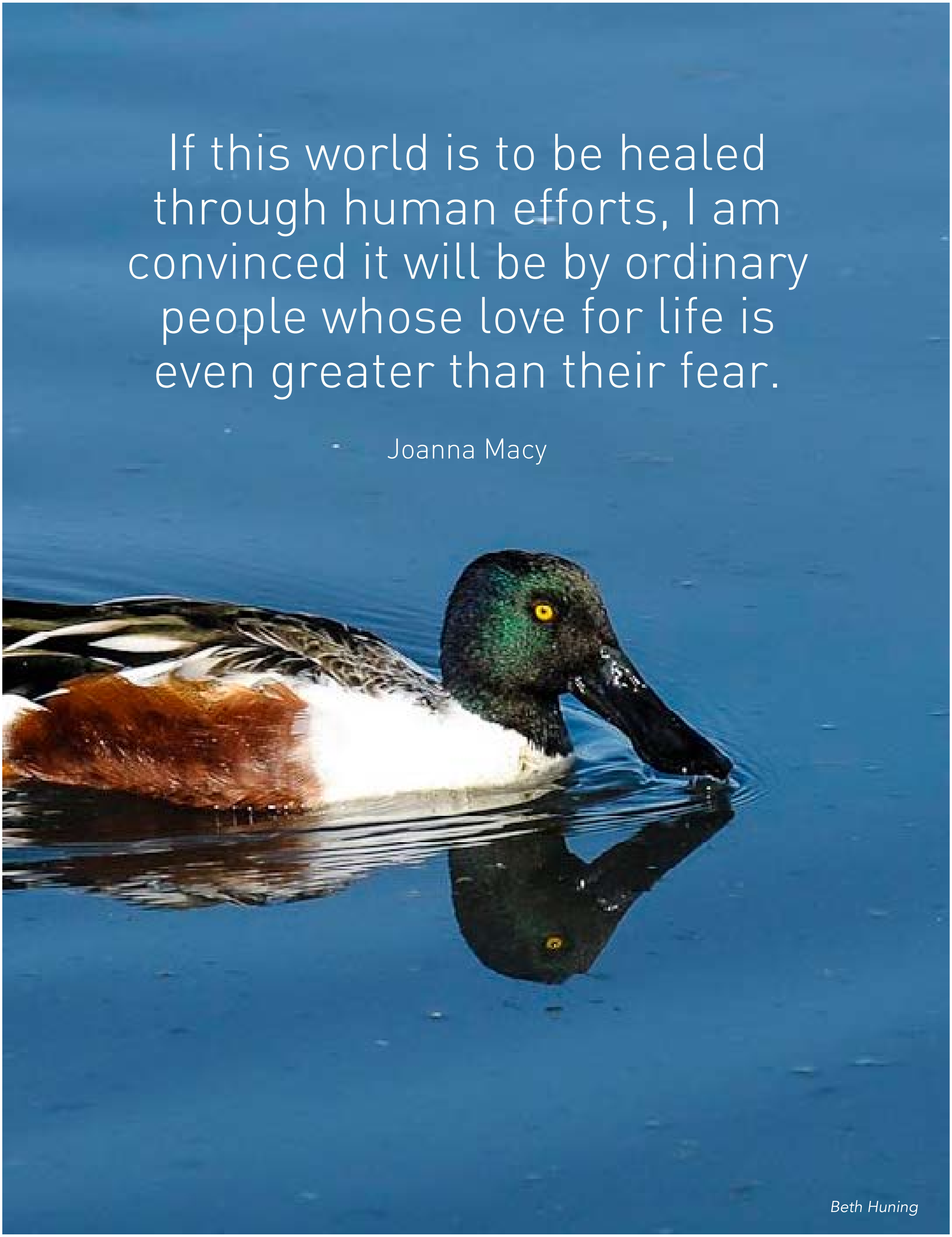
Table 6. SFBJV waterfowl population goals, based on Long-Term Average and 80th percentile long-term distribution population sizes for breeding waterfowl in North America from Fleming et al. (2019).

Species	Population Goals[1]	Aspirational Goals[2]
Dabbling Ducks		
Mallard	25,532	30,723
Northern Pintail	26,738	38,220
Northern Shoveler	15,062	21,512
Diving Ducks		
Canvasback	15,014	17,856
Ruddy Duck	16,580	16,580
Scaup (Greater and Lesser)	90,295	107,506
Surf Scoter[3]	6,615	6,615

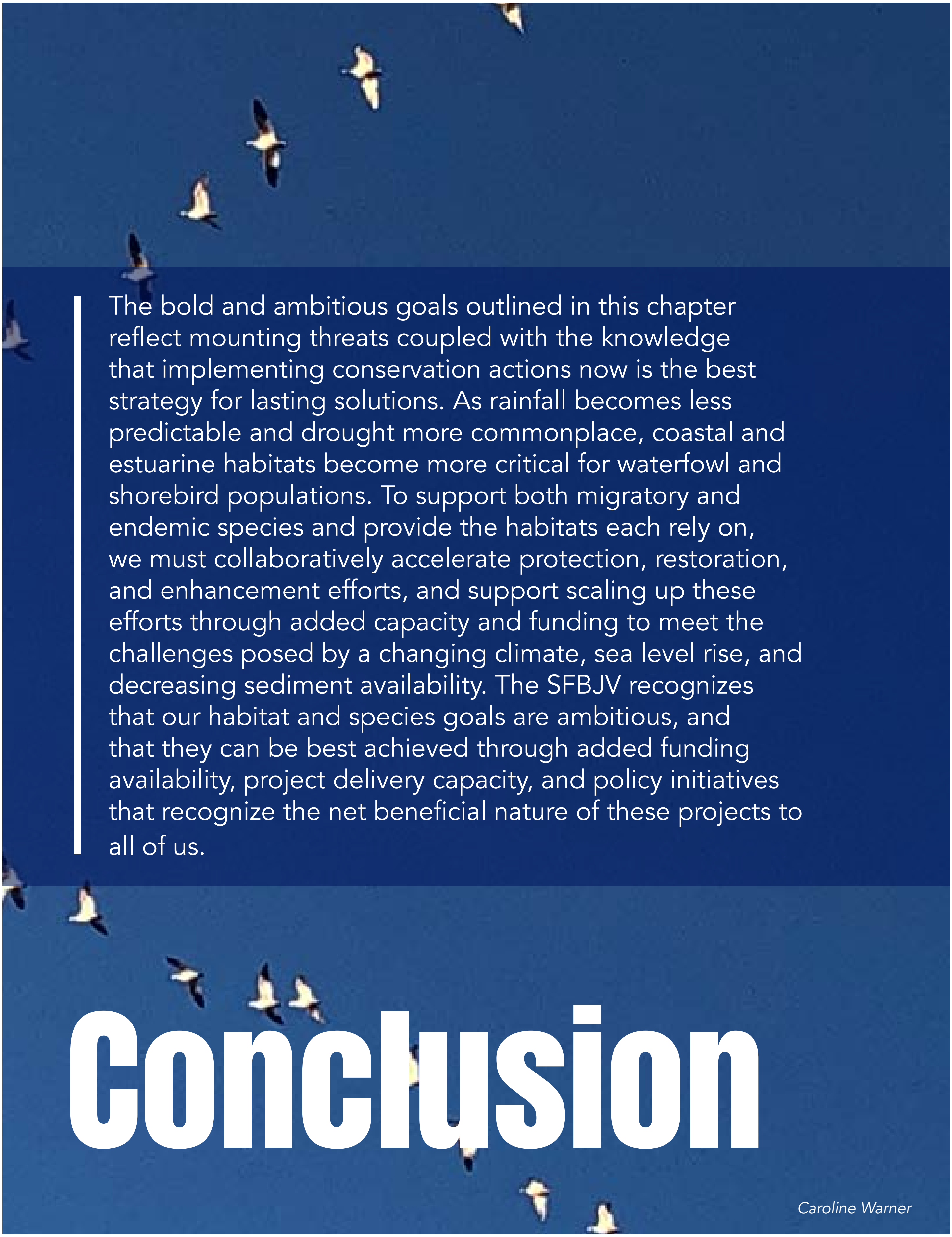
1. Long Term Average (LTA) Objective (Fleming et al. 2019).
2. 80th-Percentile Objective (Fleming et al. 2019).
3. The population goal for surf scoters is likely underestimated and will be re-evaluated.

If this world is to be healed through human efforts, I am convinced it will be by ordinary people whose love for life is even greater than their fear.

Joanna Macy



Beth Huning



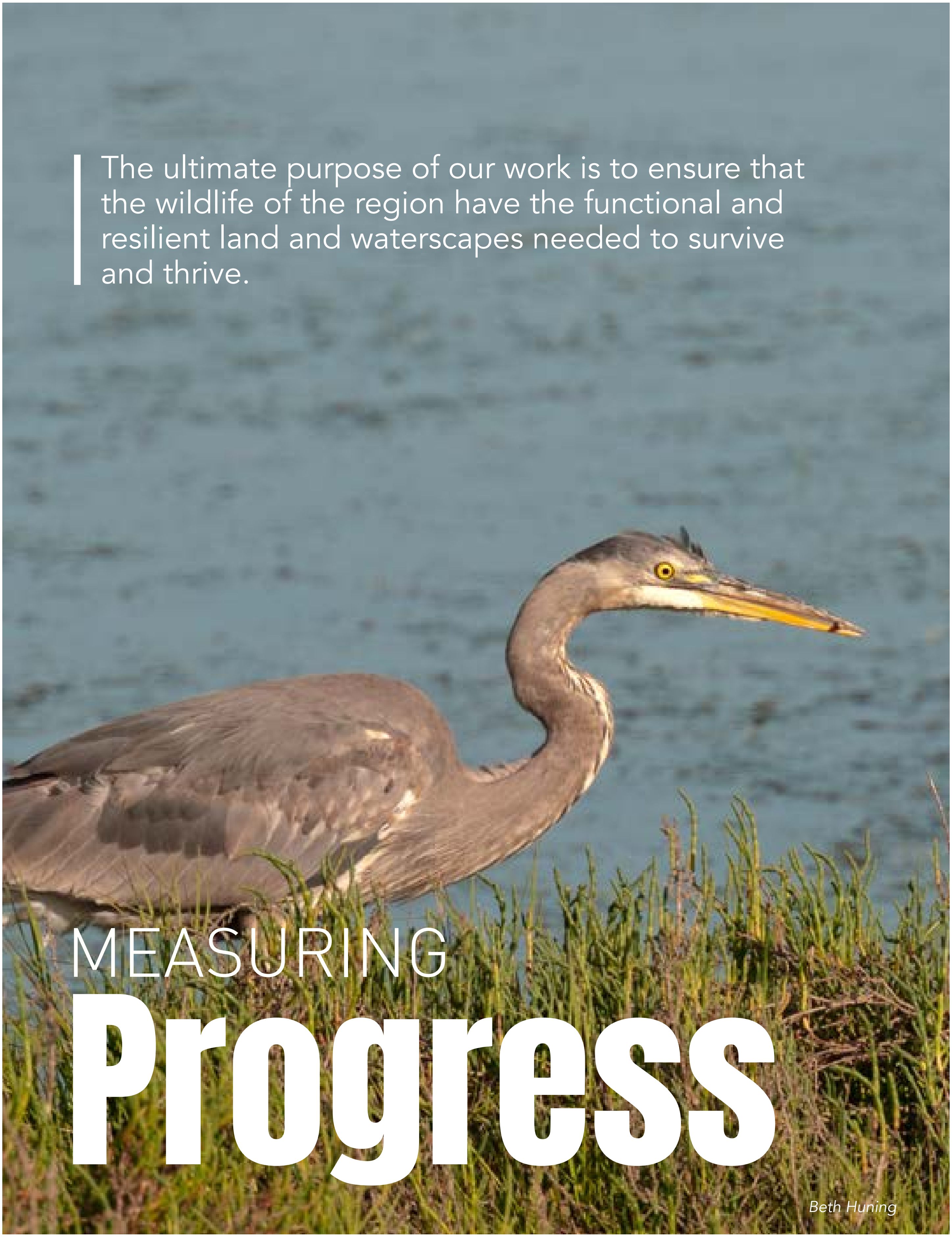
The bold and ambitious goals outlined in this chapter reflect mounting threats coupled with the knowledge that implementing conservation actions now is the best strategy for lasting solutions. As rainfall becomes less predictable and drought more commonplace, coastal and estuarine habitats become more critical for waterfowl and shorebird populations. To support both migratory and endemic species and provide the habitats each rely on, we must collaboratively accelerate protection, restoration, and enhancement efforts, and support scaling up these efforts through added capacity and funding to meet the challenges posed by a changing climate, sea level rise, and decreasing sediment availability. The SFBJV recognizes that our habitat and species goals are ambitious, and that they can be best achieved through added funding availability, project delivery capacity, and policy initiatives that recognize the net beneficial nature of these projects to all of us.

Conclusion

Caroline Warner

> The ultimate purpose of our work is to ensure that the wildlife of the region have the functional and resilient land and waterscapes needed to survive and thrive.

MEASURING Progress



Beth Huning

CHAPTER 3: MEASURING PROGRESS

3.1 The Importance and Challenges of Measuring Progress

Tracking progress allows the SFBJV to celebrate its impressive accomplishments and inspire action. We have helped protect, restore, and/or enhance more than 60,000 acres of diverse habitats since 1996, thanks to the dedication of the large network of SFBJV partners. Cumulatively, these projects have improved wildlife habitat in tangible ways. Assessing the impact of these actions over time, at the appropriate scales for many species, is one of our next great challenges.

Good conservation practice includes systematically assessing whether or not a project or program is on track to achieve its stated goals and objectives (Conservation Measures Partnership, 2020). As outlined in Chapter 2, the SFBJV partnership promotes conservation goals for protecting, restoring, and enhancing habitats in the San Francisco Estuary and region. To adhere to best practices for conservation, the partnership evaluates progress towards these goals and adjusts course as needed in response. However, many challenges remain to regularly measure progress at the different spatial scales needed to inform best practices. For example, quantifying the number of affected acres for projects with multiple habitats can be a struggle if not entered accurately into the project tracking system used by the SFBJV (EcoAtlas 2022). Assessing the cumulative impact across multiple projects with constantly evolving habitats also requires diligence. Perhaps most challenging is assessing improvements in habitat function and quality, both important goals for the SFBJV. This chapter summarizes our current knowledge regarding accomplishments to date and outlines a path forward for measuring success focused on SFBJV goals and is synergistic with partner tracking efforts. Implementing the tracking strategies described below will help the conservation community better understand landscape scale patterns of habitat change and to make progress toward stated goals.

Most conservation outcomes are not accomplished the day a property is acquired or a project is completed. Instead, that day marks only the beginning of each project's evolutionary trajectory toward its intended outcomes, a process that we have repeatedly observed can take several years to decades. Establishing milestones or benchmarks along the path toward our ultimate goal is central to adaptive management and allows us to acknowledge the value of all phases of restoration and long-term management, celebrate interim successes, and identify and correct problems along the way.

Cris Benton

Figure 6. Rapid habitat evolution from tidal flat (left image) to tidal marsh (right image) following a tidal breach in 2006 at Pond A21 in the South Bay. This is an example of how the habitat value of a restored parcel can change through time, creating challenges for measuring progress toward specific conservation outcomes.

Jak Wonderly

As illustrated in Figure 6, achieving this goal of fully vegetated tidal marsh habitat can take years. Yet, along the way, the early phases of tidal restoration (left three panels in Figure 6) can provide high-quality habitat for shorebirds and waterfowl. As the site becomes vegetated, the habitat value to shorebirds and waterfowl may change. Tracking these shifts in habitat types and how species use them leads to a greater understanding of bay-wide habitat availability. Information from habitat mapping allows conservation planners to adjust goals and strategies to ensure that we maintain enough high-quality habitat for all species. Setting clear objectives and assessing progress along the way allows us to modify strategies that aren't working well and to replicate those that are successful.

3.2 Success to Date

3.2.1 Assessing Progress in Achieving Habitat Goals

In Restoring the Estuary (2001), the SFBJV set 20-year habitat goals based on a proportion of 50-year baylands habitat goals developed by the original Goals Project (1999). In the 2001 plan, we also adjusted the SFBJV acreage goals to accommodate a larger geographic area and encompassed several additional habitats not addressed in the Goals Project. Most progress on the original SFBJV goals has been within Baylands habitat rather than Watershed or Coastal habitats, driven in large part by the South Bay Salt Pond Restoration Project, the Napa-Sonoma Marsh Restoration Project, and several other projects with large acreages.

SFBJV Habitat Conservation Accomplishments

The total acreages conserved to date towards the original goals set forth in Restoring the Estuary (RTE 2001) are presented in the following graph. Note that some caveats apply regarding both the challenges of tracking and the evolutionary trajectory of restoration projects. Projects noted as "complete" often indicate that groundwork has been completed, but projects still require varying timelines to develop into the desired habitat type.

Figure 7. Now 20 years into implementation, we have achieved close to half of our original Baylands protection goals, with over 31,000 acres protected of our original 63,000 acre goal. Restoration accomplishments for Estuary habitats are approaching 15,000 of our 37,000-acre goal, with enhancements that total more than 15,000 of the original 35,000 acre goal. We have fully achieved our Watersheds protection goals with just over 19,000 acres protected of our original 19,000-acre goal. Restoration accomplishments are approaching 4,200 of our 12,000-acre goal, and enhancement total just over 4,000 of the original desired 33,000 acres.

Project Successes

Conservation projects to protect, restore, and enhance habitats are the primary focus for the SFBJV partnership as we work toward achieving our habitat and wildlife goals. Projects are implemented by a broad range of JV partners and vary in size from small creekside plantings to thousands of acres of planned and evolving tidal marsh habitat. This broad network of dedicated partners work intensively to create designs, secure permits, and find the funding needed to get projects implemented, and successes to date are impressive.

These project successes include the largest tidal wetland project on the west coast, the South Bay Salt Pond Restoration Project, which has seen 15,000 acres of salt ponds acquired and in various stages of planning, management, and restoration. Large-scale conservation actions provide critical connectivity of baylands in the North Bay and include protection and restoration projects across the Napa Sonoma Marshes, Sears Point,

Skaggs Island, Haire Ranch, and Cullinan Ranch. Progress in Suisun Marsh, which has dual oversight with the Central Valley Joint Venture, includes many sloughs and islands that provide wildlife habitat for wintering and breeding waterfowl and other wildlife. Restoration efforts have focused above and below the tidal marsh zone throughout the Estuary, including the wetland-upland transition zone (e.g., Bair Island, Dixon Ranch, and Eden Landing), beach restorations (e.g., Aramburu Island and Albany Beach) and living shoreline approaches including subtidal eelgrass and oyster bed restorations (e.g. San Rafael Shoreline and Red Rocks Warehouse site in Richmond). In response to the Goals Update (2015) call to "restore whole ecosystems," projects like Giant Marsh in the Point Pinole Regional Shoreline, have responded by incorporating subtidal eelgrass and seaweed plantings, oyster beds, tidal marsh, and upland transition zones into the multi-habitat and multi-objective project. On the outer coast, projects like Giacomini Ranch have protected and restored important wetlands, while in the Laguna de Santa Rosa, the largest freshwater wetlands complex on the northern California coast, the Middle Reach Restoration Project has restored more than 180 acres to date of riparian forest, wet meadow, and oak woodland; and, multiple partners are completing a master restoration plan for other segments along the full 22-mile length floodplain (SFEI 2020).

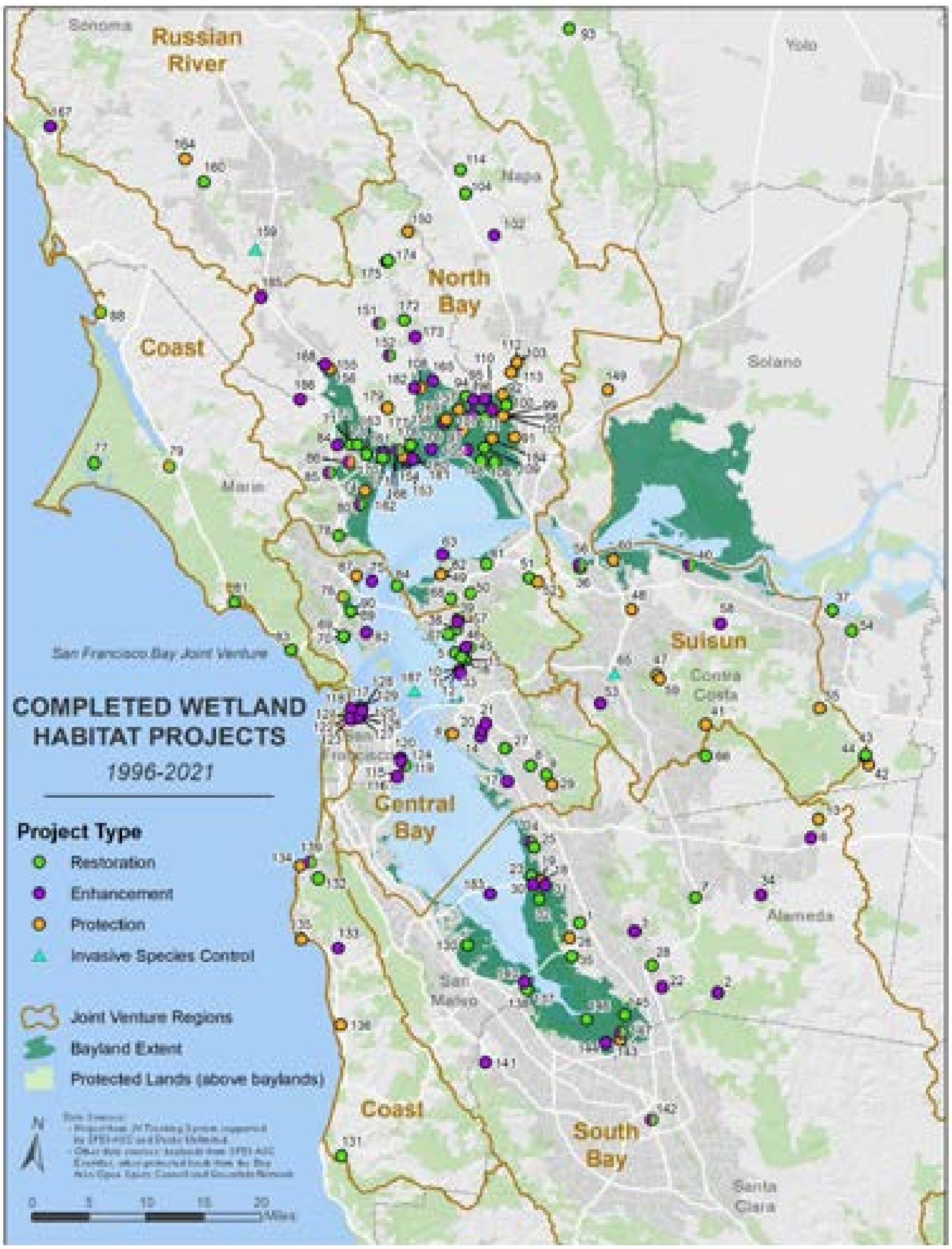


Figure 8. Map of completed protection, restoration, and enhancement projects from 1996 to 2021. Note that not all completed projects are mapped. For up-to-date summaries of active and completed projects, visit EcoAtlas.

Featured Projects

These are just a few examples of the nearly 300 projects completed by SFBJV partners over the last two decades. These example projects give a sense of the range of projects undertaken by SFBJV partners.

Bay Point Restoration and Public Access Project

Chris Barton

The Bay Point Restoration Project spans approximately 31 acres, much of which is diked former marshland, historically used for sand dredging operations, and in its current state sits as marginal- quality seasonal wetlands, tidal marsh, upland, and, in places, bare earth. Located at the approximate midpoint of the SF Bay and Delta, the restoration site is contiguous with existing tidal wetlands to the north, east, and west.

Completed in December of 2020, the project involved restoring wetlands and grasslands back to their original state before dredging and marine use. High areas that had been filled during sand dredging operations were lowered to restore tidal marsh. Excavating material helped to raise the level of the park's existing Harrier Trail, which includes "disabled" access, as well as flood protection, even during potential sea level rise due to climate change.

Presidio Trust - Tennessee Hollow Watershed Revitalization Project

Lew Stringer

Lew Stringer

Since the turn of the 21st century, the restoration of the Tennessee Hollow Watershed has been at the heart of the Presidio's transformation from military post to national park. A series of restoration projects has brought the watershed back to life, revitalizing native habits, returning long lost plant and wildlife species, and creating new ways for people to experience nature and appreciate history in this urban national park.

The Watershed comprises 271 acres, and contains three creek tributaries that ultimately merge into a single stream flowing into Crissy Marsh. The project has transformed a highly used urban area, proximal to the Golden Gate bridge, and revitalized multiple distinct habitats, including serpentine and coastal prairies, riparian, seasonal wet meadow, dunes, brackish marsh, and salt marsh.

Right Top: Before
Right Botton: After

Guiding Adaptive Management in the South Bay

Tobias Rohmer

The South Bay Salt Pond Restoration Project is the largest tidal wetland restoration project on the West Coast of North America, with plans to restore 15,100 acres of former industrial salt ponds to a rich mosaic of tidal wetlands and other habitats.

The Project's Science Program is guided by an Adaptive Management Plan, one of the foundational products of the long-term planning process for the Project. Under adaptive management, the Project undertakes restoration actions in phases, studies their impacts and outcomes, and weaves that learning into planning for the next phase of actions, to improve results.

The Science Program's goal is to bring the best and most relevant science into that adaptive management framework to assist and inform decision-makers in a timely fashion. Coordinating a series of applied studies, modeling, and ongoing monitoring by external researchers provides managers with a scientific basis for adaptive management decisions, and assists with measuring success toward meeting restoration targets. [SS1]

A Roadmap for Restoring Ecosystem Functions in an Altered Landscape: The Laguna de Santa Rosa Master Restoration Plan

Chad Surmick

The Laguna de Santa Rosa is an expansive freshwater wetland complex in Sonoma County that includes seasonal and perennial creeks, ponds and lakes, wet meadows, marshes, vernal pools, riparian forest, and oak savannas. It is home to over 200 species of birds, and is a major stopover for thousands of waterfowl as they traverse the Pacific Flyway. Although it remains a vital ecosystem today, the Laguna has considerably altered over the past two centuries from urbanization, agriculture, rerouting, and channelization. Over the past few decades, various approaches have helped preserve and enhance the Laguna, from land acquisition and water-quality improvements, to habitat-restoration projects.

The Laguna de Santa Rosa Master Restoration Plan (2021-23) is a comprehensive landscape-scale plan developed by Sonoma Water in partnership with the Laguna de Santa Rosa Foundation and San Francisco Estuary Institute (SFEI), supported by a Prop 1 grant from the California Department of Fish and Wildlife (CDWF). The Plan bases its long-term vision on an understanding of landscape functions from past, present, and potential future perspectives. It sets realistic expectations for restoring ecological processes to sustain habitat for native species, while considering flood management issues and the productivity of agricultural lands within the context of a changing climate. It includes project concepts at the 10% design level for multiple segments within the Laguna's 100-year floodplain, to establish implementable projects that collectively result in an approximate 20% increase in open water, an approximate 50% increase in mixed riparian forest, and a doubling of valley freshwater marsh and wet meadow. Local landowner support and adequate funding for implementation will-drive its ultimate success.

Using Nature-Based Solutions - Sears Point Wetland Restoration Project on San Pablo Bay


Corby Hines

On October 25, 2015, Sonoma Land Trust (SLT) breached a levee along the north edge of San Francisco Bay at Sears Point Ranch. This 285-foot-wide breach allowed salt water to fill a recently constructed 1,000-acre tidal marsh basin for the first time in over a century.

The site development was as hoped with surprisingly rapid sediment accretion in the first five years. However, the gently sloping habitat levee experienced significant wind wave erosion in advance of vegetation establishment. In 2021, SLT worked with a team of ecologists and engineers to plan and implement an adaptive management plan, using a nature-based solution to stem the erosion while rebuilding the habitat levee edge. The project used hundreds of salvaged logs, thousands of cubic yards of strategically placed dried bay mud and gravel, and thousands of tidal wetland and transition-zone plants to rebuild the toe of the habitat levee and resist future erosion. The project harnesses the natural energy of wind driven waves to suspend and redeposit placed bay mud to form swash bars for plant colonization. The logs, mimicking treefall that historically washed into the bay from the Sierra a century ago, serve to dissipate much of the wave energy while the gravel provides an early hand in stabilizing the freshly graded scarp along the levee shoreline.

Beneficial Use of Sediment - Cullinan Ranch Restoration Project


Steve Carroll

In the late 1800s, Cullinan Ranch was diked and drained for agricultural operations. Believed to be one of the first areas converted to agriculture in the North Bay the area was farmed for oats and hay until the 1980s, then sat fallow for ten years. In 1991, the U.S. Fish and Wildlife Service purchased the property under the authority of the Endangered Species Act, with an intent to restore the area to tidal marsh for the benefit of federally listed species, including the salt marsh harvest mouse and Ridgway's Rail. In January 2015, three breaches reconnected over 1,200 acres of Cullinan Ranch to surrounding tidal sloughs. Like much of the land adjacent to the Bay and cut off from tidal action, Cullinan Ranch had subsided to between five and six feet below sea level. The process of allowing sediment to accumulate naturally was expected to take 60 years before supporting tidal marsh vegetation. In order to accelerate the accretion rate and habitat development, project partners designated a 290-acre area to receive dredge material from projects throughout SF Bay (e.g., Richmond Harbor), and the site likely will elevated enough to support tidal marsh habitat by 2025, thanks to the beneficial use of sediment. The multi-partner led SediMatch program was inspired by the vision of beneficially using dredged sediment and other materials in wetland restoration projects to create more habitat in and around the SF Estuary. It brings together the wetland habitat restoration, flood control, and dredging communities to discuss challenges and find mutually beneficial strategies to achieve this vision. An accompanying webtool helps match projects and people who have sediment with those who need it.

Giacomini Wetland Restoration Project

In 2000, the National Park Service acquired the Waldo Giacomini Ranch and Olema Marsh to begin the process of restoring and improving the overall ecological health of degraded wetlands that for years had been cut off from their hydrologic connectivity with Lagunitas creek by levees made for roads and dairy farms.


Robert Campbell

The restoration, accomplished in phases, culminated with a breach in 2008, ultimately reclaiming 500 acres of historic wetlands. Soon after, waterbirds began to return in increasing numbers, particularly dabbling ducks, with a record high number of more than 11,000 counted on one day in December 2011. The wetlands now support a wide variety of wildlife and native salt marsh vegetation, including increases in California Black Rails, waterbirds, shorebirds, and some of such riparian associates as the Saltmarsh Common Yellowthroat.

When planning for project implementation began, few people other than scientists even talked about global warming, climate change, sea level rise, and the impact on wetlands. Now we know that climate change can affect coastal wetland systems through a myriad of direct and indirect effects, including changes in air and water temperature, wind, precipitation, freshwater hydrology, sediment supply and transport, sea level rise, and ocean circulation. With the acceleration of climate change impacts, current sea-level-rise rates are likely to increase, with the exact magnitude of that increase still a matter of considerable debate. Without levees to restrict access of flood flows to marshplains, sediment from the upper portion of the Lagunitas Creek watershed should add deposits to the newly restored Giacomini Wetlands floodplains, helping make them more resilient to sea level rise and other impacts from a changing climate.


Russ Lowgren

3.2.2 Progress Towards Achieving Waterfowl Goals

Recent waterfowl trends in the SFBJV have been mixed, with dabbling ducks numbers generally increasing with some indicator diving duck species (specifically scaup and Surf Scoter trending downward (Table 7). Based on a comparison between historic (1989-1993) and more recent (2010-2014) Midwinter Waterfowl Survey (MWS) data for three regions (North, Central, and South Bays), total abundance of dabbling duck species has increased significantly in all three sub-bays (Nur et al., 2015). For diving duck species, the trends were mixed, with Canvasback and Ruddy Duck increasing slightly and scaup and scoter species decreasing. Overall, diving ducks decreased by 59% in the North Bay and 71% in the Central Bay, while they increased by 21% in the South Bay (Nur et al., 2015), which was attributed to shallow water ponds managed for wildlife by the South Bay Salt Pond Restoration Project. SFBJV's annual work planning will determine strategies to reverse diving duck declines and achieve waterfowl goals, and could include actions that encourage habitat restoration and enhancement locations provide designs to increase support for diving ducks. Updated waterfowl goals in Chapter 2, Table 6, developed by NAWMP, are discussed in the chapter.

Table 7. Progress toward achieving 2001 SFBJV waterfowl population goals (see below) in the SF Estuary (the goal is met if the survey mean is above the 2001 population goals). Updated population goals are based on Fleming et al. 2019 and are consistent with NAWMP and MBJV program guidance. Trend arrows indicate increase ↑ or decrease ↓ in abundance between historic Midwinter Waterfowl Survey (1989-1993, values not shown here) and recent surveys (2010-14) as calculated in Nur et al. 2015.

Species	2001 Goal	Mean (2013-18)[1]	2001 Goal Met	Updated Population Goals	Trend
Dabbling Ducks					
Mallard	702	1,255	Yes	25,532	↑
Northern Pintail	12,415	6,240	No	26,738	↑
Northern Shoveler	48,079	31,780	No	15,062	↑
Diving Ducks					
Canvasback	29,818	21,635	No	15,014	↑
Ruddy Duck	24,073	40,852	Yes	16,580	↑
Scaup	139,214	40,022	No	90,295	↓
Surf Scoters	61,248	5,369	No	6,615[2]	↓

1. San Francisco Bay Estuary Midwinter Waterfowl Survey: 2013- 2018 Summary Results (Strong, 2018). Not all regions of the Estuary were surveyed each year
2. The population goal for surf scoters is likely underestimated and will be re-evaluated.

3.3 Tracking Progress Moving Forward

3.3.1 Tracking Habitat Goals

SFBJV goals noted in Chapter 2 include habitat acreage targets (quantitative) and desired functional capacity (qualitative) of our habitats to support wildlife and provide resilience to climate impacts. We plan to use a variety of methods to track progress toward these two types of goals, including a combination of project tracking, habitat mapping, and assessment of wildlife indicators. The SFBJV can leverage the work and goals of its partners, which makes reporting results more efficient and powerful. In addition, the use of citizen science is an emerging and powerful tool in measuring progress. This section describes the different tracking methods in use or proposed, how they connect to partner efforts, and how they relate directly to SFBJV goal statements.

Project Tracking

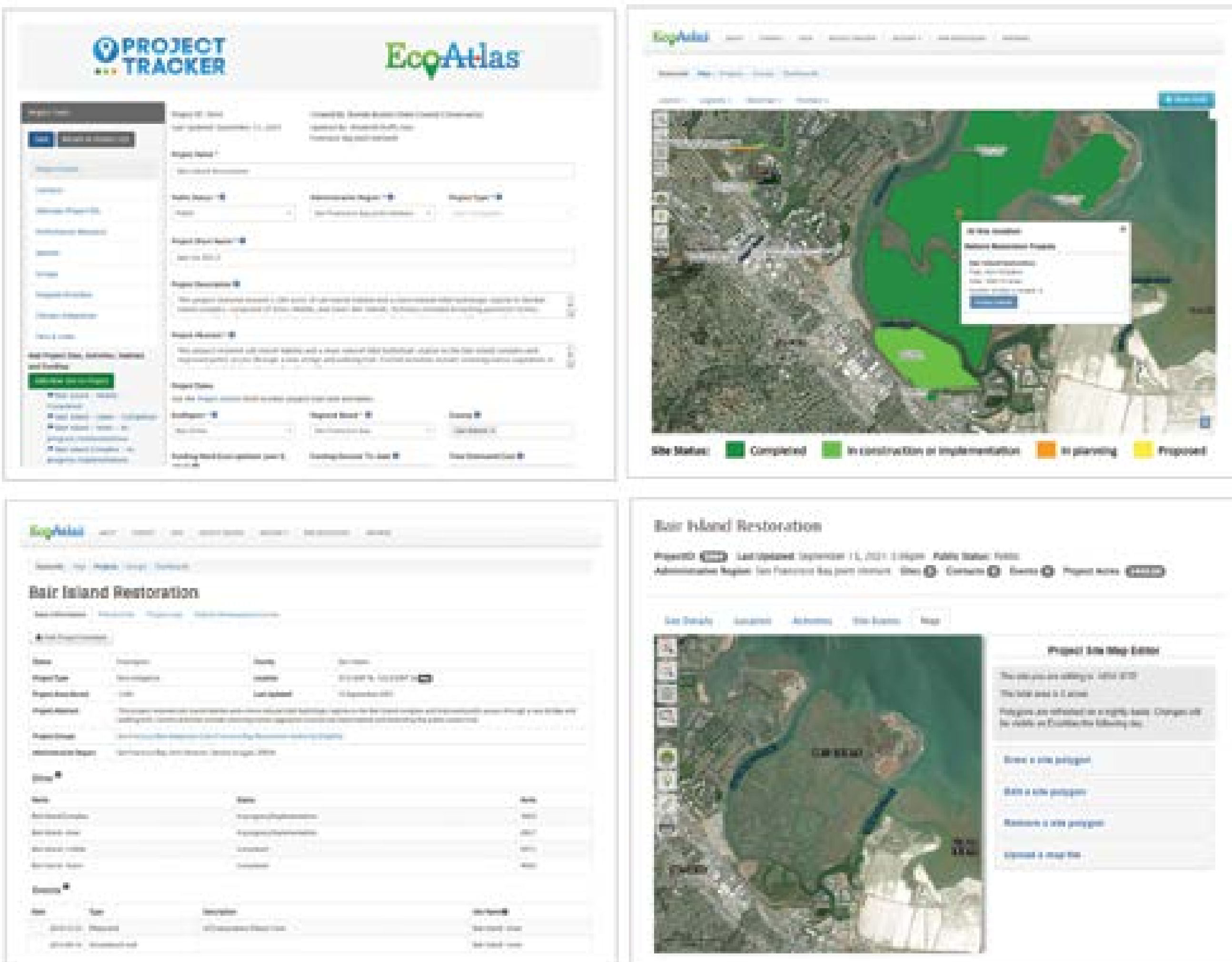
The SFBJV will continue to use a well-established online system, called "Project Tracker," to track the progress of individual projects. Project Tracker captures a range of information from areas protected, restored, or enhanced, to project goals, costs, completion dates, and narrative background details. The California EcoAtlas displays this information, along with maps and other tools to create a complete picture of aquatic resources in the landscape, and incorporates streams, wetlands, restoration project information, monitoring results, and other land cover layers. EcoAtlas can generate up-to-date project lists, regional project maps, and arange of data summaries. Thanks to the cumulative actions of our partnership, our ability to present this regional picture of conservation success provides a unique and highly valued service to the SFBJV community and beyond. We expect Project Tracker to grow in its capacity and utility in the coming years, with recent expansions in user groups and data contributors.

Susan De La Cruz

PROJECT TRACKER AND ECO-ATLAS

Box 5

Project Tracker (http://ptrack.ecoatlas.org/) is a data entry tool for uploading and editing information on wetland restoration, mitigation, and habitat conservation projects throughout California. Project information such as acres, goals, costs, etc. can be viewed and downloaded along with other data layers on EcoAtlas (https://www.ecoatlas.org/).



Habitat Mapping or Regional Habitat Tracking

The development of geospatial mapping and tracking of habitat change at the project and regional level is an identified priority of our Science Committee. Figure 11. Illustrates how the SFBJV partnership hopes to link habitat mapping and Project Tracker information to enable comprehensive and accurate tracking of project actions and the resulting habitats.

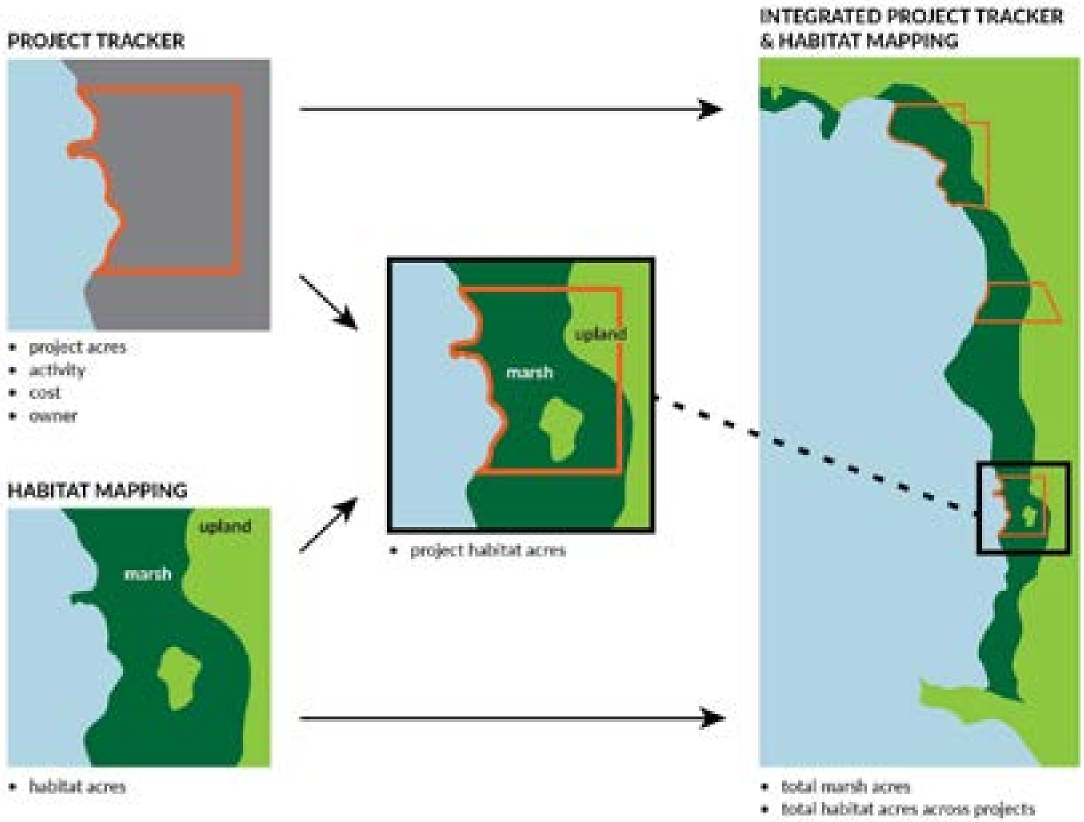
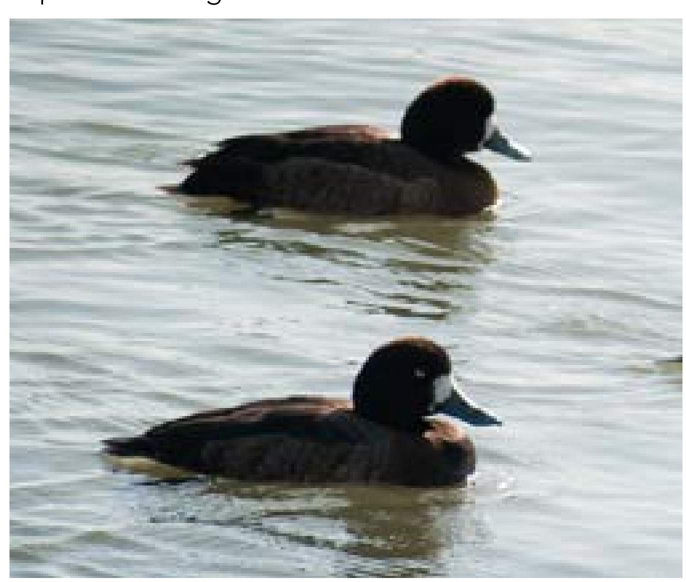


Figure 9. Conceptual diagram illustrating how Project Tracker information, project location, area, activity, cost, and landowner information (top left image) can combine with Estuary scale habitat mapping (bottom left image) to determine project-specific acres of resulting habitats (middle image). Tracking progress toward regional goals (right image) will span regions and actions (protection, restoration, enhancement) in project-specific habitat acres.

3.3.2 Tracking Wildlife Habitat Quality

The ultimate purpose of our work is to ensure that the wildlife of the region have the functional and resilient land and waterscapes needed to survive and thrive. In order to do this, we must make sure SFBJV-sponsored actions indeed improve conditions for the wildlife we seek to protect. Using wildlife indicators to track habitat quality gives us a framework to adjust priorities and strategies as needed. Many of the indicator species selected by the SFBJV also represent conservation goals for partners (e.g., increasing Ridgway's Rail populations as a common goal for tidal marsh restoration projects). The indicator-species approach provides a way to report on the impact of SFBJV actions in terms of benefits to birds, mammals, and other taxa that resonate with stakeholders and the voting public, to whom we can report on project accomplishments by action or by habitat. Ultimately these reports can be used to generate success stories as well as build support for and inspire confidence in our work, since they will demonstrate how conservation dollars can and do produce tangible results for wildlife.



Beth Huning

The SFBJV does not currently have such a wildlife (or habitat quality) tracking system in place, nor the funds to implement one, yet here we describe the basics of such a system, along with one or two identified wildlife indicators to measure habitat quality for each Estuary habitat (Table 9). Appendix B details how we selected these indicators and metrics.

We have engaged scientists, resource managers, and restoration practitioners in developing criteria and selecting indicators. In brief, some of the criteria for indicators include strong association with a SFBJV habitat type, credibility or usefulness for habitat quality, feasibility of collecting information, and other criteria relating to spatial and temporal scale. Metrics were described broadly for each indicator. Going forward, these will need to specify details including protocols used and methods of analysis. Evaluating habitat quality using migratory species will also require other considerations, since factors outside of the San Francisco Estuary region may impact both population numbers and results. In such cases, population metrics at different spatial scales may help put local population results into context.

Table 8. List of high-priority wildlife indicators of habitat quality for SFBJV Estuary habitats.

Estuary Habitat Type	Indicator	Metrics
Non-tidal Wetlands and Waters	Ducks (dabbling, diving)	Mid-winter abundance
	Breeding waterbirds	Abundance or nest success
Estuarine-upland Transition Zone (UTZ)	UTZ focal bird spp.	Area search abundance
Tidal Marsh	Tidal marsh birds	Point count abundance
	Salt marsh harvest mouse	Capture Efficiency
Tidal Flat	Wintering shorebirds	SF Estuary Shorebird Survey abundance
Beach	Resident marine mammals	Abundance
	Shorebirds	SF Estuary Shorebird Survey abundance
Subtidal: Submerged Aquatic Vegetation	Diving ducks	Mid-winter abundance
Subtidal: Shellfish Beds	Black Oystercatcher	SF Estuary Shorebird Survey abundance

Defining progress and success using the wildlife indicators in quantitative terms is a next step for the SFBJV. In general, successful restoration projects will have positive wildlife indicator trends that are on track to meeting their goals usually defined in terms of achieving mature habitat conditions. However, for some habitats such as tidal marsh, intermediate habitat types often develop as a project site evolves towards mature condition (Figure 12). We can assess the habitat value of these intermediate steps using the indicators listed for that habitat type in Table 8. In the tidal marsh restoration example, the shorebird indicator can help assess the health and function of the tidal flats that occur during the early stages of tidal restoration.

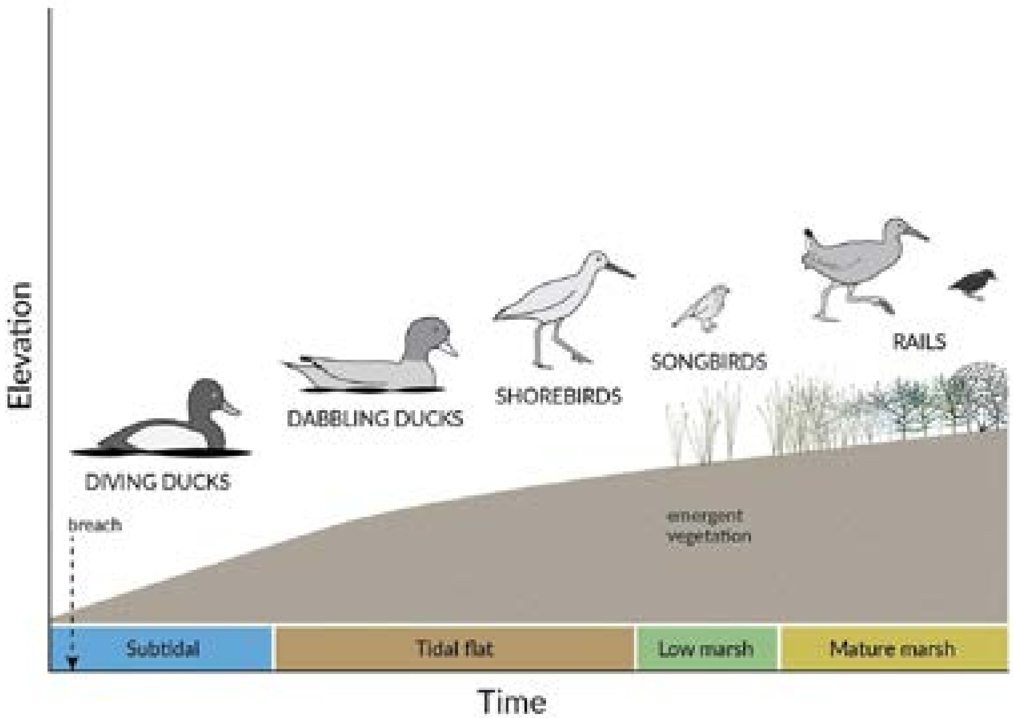


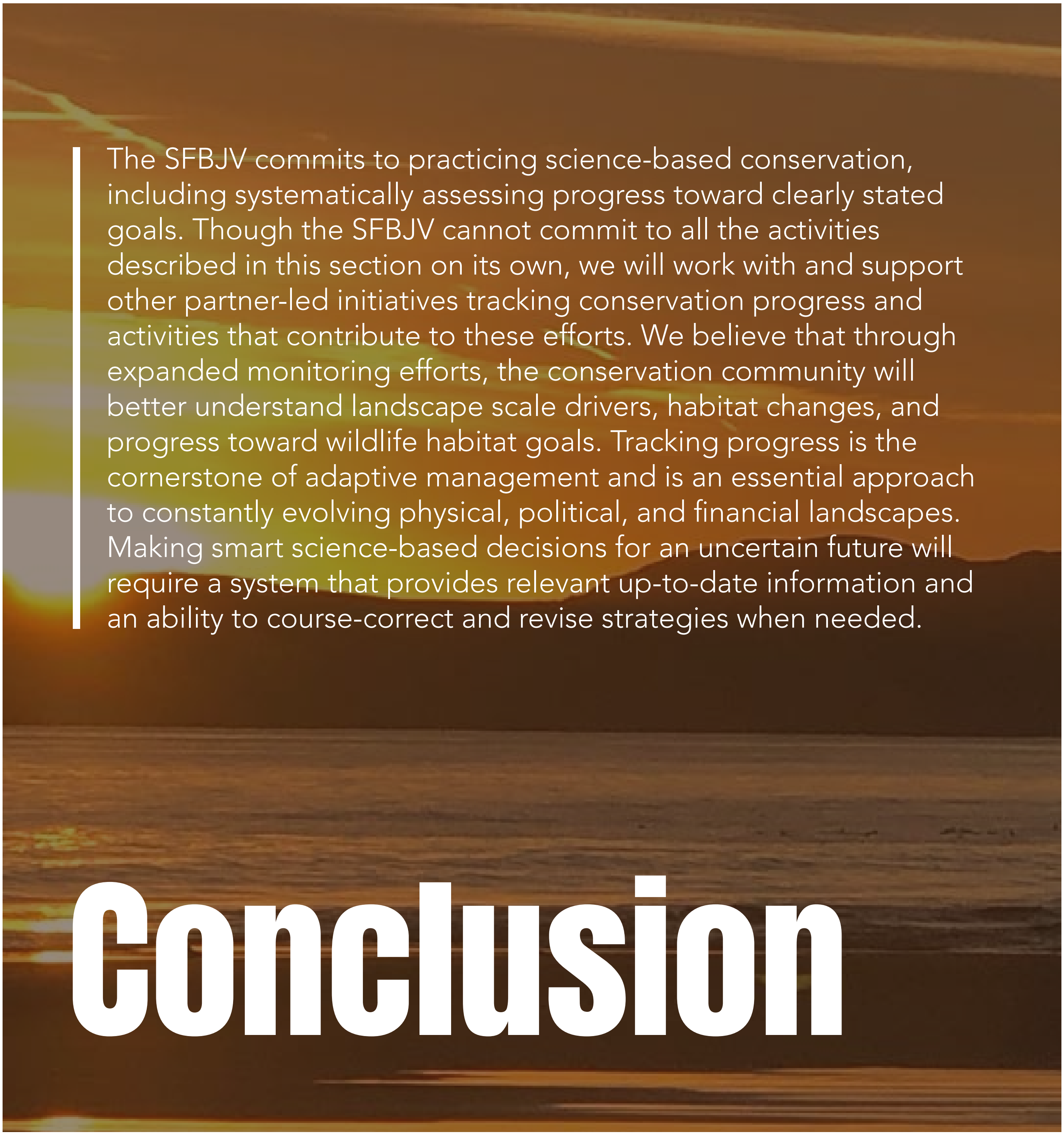
Figure 10. Habitat evolution showing birds. Evolution of a tidal restoration project shows how sediment accretion raises site elevation and creates subtidal, tidal flat, then vegetated marsh habitat over time. SFBJV bird indicator taxa corresponds with each habitat stage, though some taxa can serve as indicators for multiple habitat stages.

Measuring progress towards SFBJV goals will require information on wildlife indicators at both the project and estuary scale, and involve mature and restoring areas. Collaboration with partners will also be essential to advance synergistic efforts, increase the efficiency of data collection, and increase the quality and usefulness of the results. Because partner initiatives and monitoring efforts are constantly evolving, our monitoring strategies will adapt with the most current information found within annual planning documents. Exploring new ways to use citizen science can also be an efficient way to measure progress. Datasets such as ebird (www.ebird.org) and iNaturalist (www.inaturalist.org) cover much more area than traditional monitoring programs, and new tools for analyzing these data can unlock their potential.

3.3.3 Tracking Numeric Waterfowl Goals

The SFBJV also has species-specific population goals for waterfowl. Tracking progress toward these goals differs from the habitat-focused approach described above. Some overlap may exist between tracking numeric waterfowl population goals and using waterfowl as indicators to assess habitat quality for NTWW at the regional scale (i.e. both efforts could rely on the same survey and analytical methods). Unlike tracking project progress or using regional trend indicators, the effort to assess progress toward regional numeric population goals requires a robust estimate of the number of individuals present in the Estuary for each of the target waterfowl species. From 1981-2018, the USFWS mid-winter waterfowl survey tracked progress toward numeric waterfowl goals. The survey uses a series of flights where observers count waterfowl in the open bay and adjacent wetlands from the air. These surveys have been essential to the region's understanding of waterfowl population numbers and trends. Although the method was halted in 2018, a survey re-design is under consideration and will be crucial for ensuring the SFBJV can track numeric waterfowl goals.

Among new approaches being considered is combining observer data collected during the traditional aerial survey with ground-based and imagery-based survey methods. A redesign effort could also include an evaluation of existing survey and telemetry data to help refine survey areas, improve survey detection probabilities, and partition survey efforts to improve accuracy for specific species or guilds. The redesign team may eventually recommend transitioning to a survey based entirely on unoccupied aircraft system (UAS)-derived or other aircraft based imagery as these technologies advance. The new effort could coordinate with other imagery-based survey efforts currently being developed for seabirds and otters along the California coast. Despite changes in survey methodology, correction factors that would allow for continued utility of the long-term mid-winter dataset will be an integral part of a survey redesign.



> The SFBJV commits to practicing science-based conservation, including systematically assessing progress toward clearly stated goals. Though the SFBJV cannot commit to all the activities described in this section on its own, we will work with and support other partner-led initiatives tracking conservation progress and activities that contribute to these efforts. We believe that through expanded monitoring efforts, the conservation community will better understand landscape scale drivers, habitat changes, and progress toward wildlife habitat goals. Tracking progress is the cornerstone of adaptive management and is an essential approach to constantly evolving physical, political, and financial landscapes. Making smart science-based decisions for an uncertain future will require a system that provides relevant up-to-date information and an ability to course-correct and revise strategies when needed.

Conclusion

WETLANDS REGIONAL Monitoring Program (WRMP)

In order to meet ambitious tidal wetlands goals, regional partners are coming together to track project performance and wetland health. As we learn from habitat projects, we can adapt and improve future restoration projects in the process, maximizing impact along the way. The San Francisco Estuary Wetlands Regional Monitoring Program (WRMP) provides just that approach, building on work of SFBJV partners to advance coordinated regional monitoring. Comprising a diverse set of partners including state and federal agencies, NGOs, scientists and Tribes, the program brings to light restoration successes and challenges.

The WRMP is rooted in developing indicators to understand successes and learn from challenges in wetland restoration. This approach requires a fine-tuned understanding of stakeholder perspectives and needs. WRMP is also working to better serve diverse audiences through the information generated, and to broaden the scope of wetland science to include social sciences, racial and environmental justice, traditional ecological knowledge and community based participatory research.

CHAPTER 4: CONSERVATION IMPLEMENTATION: A FRAMEWORK FOR COLLABORATIVE ACTION

4.1 How We Work - Collaboration, Adaptation, and the Unique Niche of the SFBJV

The unique niche of the SFBJV

With many organizations, agencies, and other partnerships throughout the San Francisco Bay Area and Coast region focused on distinct and sometimes overlapping areas of conservation interest, what makes the SFBJV unique? Ours is a broad, non-regulatory, voluntary public/private partnership with a focus on implementation actions that provide habitat for wildlife, with a strong focus on birds. The SFBJV is guided by the belief that the work needed to protect and restore the region's habitats is best achieved through collaboration. Partners include land managers, scientists, regulators, planners, engineers, public agencies, private foundations, private industry, non-profits, and advocates. The SFBJV provides key forums where we all come together to share information, discuss regional issues, identify priorities, and take action. With representation across sectors, our partnership gives everyone an equal voice and fosters real opportunities to work together toward solutions that span policy, regulation, and science, and translate into on-the-ground action.

How we get it done - the mechanisms

The mission of the SFBJV is to "protect, restore, increase, and enhance habitats throughout the San Francisco Bay region to benefit birds, fish, and other wildlife. With support from a small staff focused on coordination of the partnership, the scope of the SFBJV's work depends on its active network of conservation partners ranging from wildlife and permitting agencies to scientific institutions and advocacy organizations. These partners make up the SFBJV Management Board and committees, and bring the diverse viewpoints of the individuals and their respective organizations. The differences of perspective that come with people's personal and organizational backgrounds are especially meaningful when this group reaches consensus on issues, which happens much more often than not.

To organize its work across disciplines, the SFBJV is structured into program areas and working committees. With direction from the SFBJV Management Board, the working committees implement actions to advance the conservation goals outlined in Chapter 2, guided by the priorities and strategies outlined in Section 4.2 below. Each committee has a unique composition, and their own operating procedures. Our management board is composed of Bay Area leaders who support our mission and can advocate for and/or represent the interests of the SFBJV across our geography. As a self-directed partnership, the Board is responsible for overall policy and direction and delegates responsibility for day-to-day operations to the SFBJV Coordinator. The primary responsibility of the Board is to set, revise, and accomplish the goals established in our Implementation Strategy.


Beth Huning

Susan De La Cruz

4.2 SFBJV Priorities and Strategies

The Framework for Action

The foundation of our collective work is guided by **priorities** and accompanying **strategies** (Box 7). SFBJV priorities and strategies are either based on our programs and functions, or are issue-based. Functional priorities are the key elements of how we work towards our goals with the management board and within the programs, while issues elevate drivers that impact our work, and must be considered within the partnership's conservation actions.

PRIORITY	STRATEGY
Conservation	Protect, enhance, restore and adaptively manage habitats.
Scientific Foundation	Utilize a strong science foundation to inform habitat conservation actions, guide policies, and to help identify funding and research needs.
Communications	Effectively communicate the story of the SFBJV, its partners, and projects to support the mission, goals, and priorities of the SFBJV partnership.
Coordination	Coordinate the implementation of federal, state, and regional conservation plans and projects that have been adopted by the SFBJV or support our mission.
Collaboration	Provide formal and informal regional forums to facilitate collaborative conservation action.
Funding	Increase funding for SFBJV programs, partner programs, and projects that work towards JV goals.
Proactivity	Identify and address emerging issues and barriers to conservation.
Monitoring	Conduct coordinated, regional, and project-specific monitoring to guide decision making, contribute to adaptive management, and improve conservation outcomes.
Climate Change	Ensure that protected and restored habitats are resilient to the impacts of a changing climate.
Equity	Ensure that the work of the SFBJV contributes to a more environmentally just and equitable future for the Bay Area.

The actions the SFBJV takes to fulfill these priorities and strategies are identified in annual work planning sessions, prioritized based on urgency, capacity, and how the partnership can most effectively make a difference. These priorities and strategies will cover the lifespan of this strategy, while annual actions will respond to emerging science, current events, and drivers of change.

The SFBJV takes action on our priorities in a variety of ways. For example, coordination and communications is done largely by SFBJV staff, whereas restoration and monitoring happens when SFBJV partners do the work of their respective organizations. Successful implementation requires continued, combined, and coordinated efforts by the SFBJV staff and partners.

The SFBJV's Overarching Priorities and Strategies in Detail

1. Conservation: Protect, restore, enhance, and adaptively manage habitats.

Habitat conservation and management is the foundation of the JV partnership. Many partners actively participate in on-the-ground actions, while others create opportunities, advocate for, and implement projects and programs that advance conservation through a variety of mechanisms. The SFBJV collectively supports and facilitates this work to achieve the species and habitat goals outlined in Chapter 2 by taking action to review, advise, and adopt conservation project plans, and to increase visibility, funding, and rate of implementation. Examples include project tracking and reporting to elevate project visibility and accountability, providing regional forums to discuss and adopt "Priority Projects", using the latest science to provide guidance on best practices, hosting project tours for elected officials and others, supporting grant applications, and more.

2. Science: Utilize a strong science foundation to inform habitat conservation actions, guide policies, and to help identify funding and research needs.

Our Science Program works closely with the Conservation, Policy, and Communications Programs to ensure that the SFBJV's work continues to use the best science available when making decisions and recommendations. These efforts not only include traditional disciplines of restoration ecology, species' biology, spatial planning/GIS, engineering, geomorphology, hydrology and toxicology, but also the social sciences and human dimensions of conservation.

3. Communications: Effectively communicate the story of the SFBJV, its partners, and projects to support the mission, goals, and priorities of the SFBJV partnership.

Effective communication plays a vital role in all ten strategies. Telling the story of SFBJV partners and sharing accomplishments are foundational to maintaining relevance, building strong partnerships, sustaining funding, and achieving our habitat and species goals. The partnership is committed to being innovative with our tools and approaches to increase partner engagement, facilitate inclusive exchanges of ideas or knowledge, solve problems around emerging issues, and to address other needs as they arise.

4. Collaboration: Provide formal and informal regional discussion forums to facilitate collaborative conservation action.

Convening and collaborating is at the heart of the SFBJV. The partnership relies on the expertise of its members to build collaborative solutions and take collective action. This cannot be done effectively without regional forums where shared problem-solving and action plans develop. Forums range from Management Board and formal Working Committee meetings to less formal, issue-based strategy sessions, or task groups working on a joint proposal or a decision-support tool.

5. Coordination: Coordinate the implementation of federal, state, and regional conservation plans adopted by the SFBJV to support our mission.

For conservation successes to be collaborative, broadly supported, and long-lasting, coordination is essential. The SFBJV exists to advance our goals along with recommended actions from several key conservation plans noted throughout this document. The San Francisco Bay Area provides a complex setting for implementing conservation actions, with numerous landowners, regulatory agencies, non-profits, businesses, municipalities, and infrastructure interests (e.g., highways, roads, rail, electric and gas lines, airports) focused on varied priorities. The SFBJV brings partners together to discuss and take action on everything from project design and objectives, innovations in research, and policy approaches, mobilizing efforts to respond to both threats and opportunities, and ultimately creating meaningful conservation solutions.

6. Funding: Increase funding for SFBJV programs, partner programs, and efforts that work towards JV goals.

Adequate funding is key to achieving on-the-ground conservation outcomes for the species and habitats we work to protect. On the federal level, SFBJV partners work to support the full funding of Congressionally-authorized programs and seek to create new opportunities to increase funding availability for conservation projects in support of our goals. At the state level and more locally, the SFBJV works to increase and help guide funding towards conservation, provides input on funding legislation (e.g., state bonds, regional funding mechanisms), and prepares letters of support for projects that will help us achieve our goals.

7. Proactivity: Identify and address emerging issues and barriers to conservation.

Many of the threats and drivers impacting Bay Area wetlands, waterbirds, and other conservation targets persist over time. Yet, emerging issues and barriers to conservation can and do arise, and may require immediate action and/or new approaches. The SFBJV strives to stay engaged with cutting-edge science and policy that identify and develop strategies to address these issues.

8. Monitoring: Conduct coordinated, regional, and project-specific monitoring to guide decision making, review of results to implement the full adaptive conservation cycle, and improve outcomes.

Monitoring is vital to understanding and responding to change. SFBJV partners focus on project-specific, regional, and/or landscape-scale monitoring of habitat and wildlife. The SFBJV supports these monitoring efforts, particularly those seeking to gain regional understanding of environmental change, in order to guide current and future conservation action. The SFBJV also seeks improvements and advancements in techniques, data sharing, and coordination of monitoring efforts to improve conservation outcomes.

9. Climate Change: Ensure that the work of the SFBJV accounts for, provides resiliency to, and adapts to climate change predictions.

Climate change is a clear and accelerating threat to the habitats and species of the San Francisco Bay-Delta Estuary and its watersheds (Mahoney, et al 2018). The impacts of climate change include sea level rise, more intense storm surges, more extensive tidal and backwater flooding, risk of catastrophic levee failure, rising ocean temperatures, ocean acidification, changing precipitation patterns and prolonged droughts, and increased fire frequency and intensity. Potential solutions should integrate with the continued implementation of the habitat goals of the SFBJV to safeguard ecosystem function and landscape resiliency into the future. This partnership will take the effects of climate change into consideration every step of the way, as the SFBJV works to implement programs and achieve its goals.

10. Equity: Ensure that the work of the SFBJV contributes to a more environmentally just and equitable future for the Bay Area.

SFBJV leads the way on where and how to protect, enhance, and restore Bay Area habitats. While the JV mission is to improve habitat for wildlife, our work is set against a backdrop of historical and ongoing environmental injustices throughout the Bay Area. Because of this, the SFBJV recognizes a fundamental responsibility of the conservation community to work towards environmental justice, equity, diversity, and inclusion. Further, SVBJV goals are best recognized and achieved through efforts by a broad intersection of our region's communities. Creating more diverse, inclusive spaces improves restoration outcomes by building community support for projects, bringing new and expanded knowledge to the process, and increasing the number of people working towards shared goals.

4.3 SFBJV Programs

Four program areas with established committees tackle the actions needed to support the SFBJV priorities identified above in Box 4: Conservation, Science, Policy, and Communications. Each committee has a chair, and a charter, supported by SFBJV staff. Actions that come from committee work planning integrate across programs, represent a diversity of opinions, and offer a multi-disciplinary approach to addressing the major conservation challenges across the region. Each program and committee works a little differently, as explained below.

4.3.1 Conservation Program

Conservation and the SFBJV

The primary purpose of the Conservation Program is to facilitate the implementation of on-the-ground, habitat-focused conservation projects to meet SFBJV goals, or in other words, to help get projects done.

The SFBJV Conservation Program is guided by a Conservation Committee (CC), comprising partners who design, regulate, study, and implement conservation projects, including restoration, land management, and wildlife monitoring. The CC interfaces closely with the management board and the other committees on conservation implementation, policy, and planning. Their work is guided by current science, including biological, ecological, and social science research, and monitoring results. Working across all SFBJV programs helps improve these conservation outcomes.

One example of CC work through the committee forum has partners coming together to review restoration projects in various stages of development and implementation and consider recommending them for adoption by the SFBJV Management Board. Through this process, the CC provides expert peer review which can improve project design, enhance competitiveness for funding, and increase project visibility to both decision-makers and the greater conservation community.

The Conservation Program is informed by, and in turn informs, several major planning programs and reports, within which the JV works. Examples include how the SFBJV works closely with the San Francisco Estuary Partnership to set and track habitat goals and projects, or how SFBJV implementation planning goals are informed by such key regional reports as the *Baylands Ecosystem Habitat Goals Report* and *Science Update.*

4.3.2 Science Program

Science and the SFBJV

The primary goal of this program is to support and develop a strong science foundation, to inform Strategic Habitat Conservation (National Ecological Assessment Team 2006) and advance the mission of the SFBJV. Restoring the Estuary presents several compelling challenges, as well as the confluence of multiple scientific disciplines to inform conservation including engineering, hydrology, ecology, quantitative and population biology, toxicology, and many other fields of scientific expertise. The JV holds a unique position at the intersection where science meets conservation action, filtered and interpreted with a focus on habitat acreage and function, in addition to species abundance and health.

The Science Committee (SC) guides the Science Program, with representatives from management board agencies and organizations who have requisite science capacity and expertise. The SC brings together scientists who do the design, research, and/or monitoring to inform project implementation, land management, and regulatory action. The committee identifies and supports the research needed to advance our understanding of key questions, as it focuses on science priorities that address such concerns as: how is the partnership meeting implementation and species conservation goals, or where is collaborative action needed.

The SC science priorities reflect the needs of managers. Scientific results are communicated effectively to inform management decisions and conservation actions and can also help inform and shape policies to achieve more efficient, effective, and timely implementation of habitat conservation goals. The SFBJV succeeds where these efforts come together, utilizing the collaborative approaches to address existing and potential future habitat areas, to benefit wildlife and/or the status and trends of species populations that rely on them.

The SC works to elevate and address highest priority science needs, including understanding the distribution and health of the region's wetlands, and how wildlife are responding to environmental change and conservation action. The SC has promoted scientific monitoring within the region, particularly large-scale monitoring aimed at gaining a broader understanding of the trends and dynamics of evolving habitats and species. Related scientific efforts of importance to the SFBJV seek to document and map current habitat conditions within the San Francisco Estuary. These efforts intend to improve our understanding of how the region's ecosystems have responded to past environmental changes, management, and other human modifications. These mapping efforts and products then support models of how habitats will respond to future changes and enable the partnership to more effectively achieve conservation goals. This includes studies that highlight where nature-based adaptation measures are feasible and could provide or enhance habitat and increase the resilience of species.

4.3.3 Policy Program

Policy and the SFBJV

The densely populated geography unique to the SFBJV has experienced a high rate of habitat loss and degradation as well as large-scale species declines (USFWS 2013). The region faces a highly complex regulatory system meant to manage often competing priorities between habitat conservation, threatened and endangered species management, and urban development. Additionally, the SFBJV must face issues within the context of a changing climate, highly altered ecological processes, historical and ongoing environmental injustices, and limited financial resources to address myriad threats. Given this context, project implementation, scientific research, and biological planning on their own will not achieve the SFBJV habitat and species goals. Engaging on policy issues is, and always has been, integral to the framework and success of the partnership.

The 1986 North American Waterfowl Management Plan (NAWMP), created the federal policy framework for the Migratory Bird Joint Venture program. More recently, NAWMP's 2018 update underscored the value and success of the Joint Ventures in protecting waterfowl and wetlands across North America. The 2018 update also expanded the policy foundations for supporting "people's relationship with nature into the North American waterfowl conservation enterprise" (NAWMP 1998). Since inception, these federal policies have helped guide the SFBJV, and the SFBJV has in turn worked to inform and educate federal decision makers through collaboration with the Association of Joint Venture Management Boards (AJVMB). Each year the AJVMB coordinates an event in Washington, D.C., where JV partners from across the U.S. meet with key legislators and Administration personnel to share the importance of the work of the Joint Ventures.

Engaging in Policy Work

Influencing policy decisions at the federal, state, and local levels can directly impact the ability of the SFBJV to deliver habitat projects and to accomplish its goals. The SFBJV provides input to inform agency rules and regulations. This information helps agencies understand how their policies will impact the SFBJV and its partners. To some extent, the SFBJV's educational efforts can influence funding, appropriations, and the framing of bonds and ballot measures to ensure that financial resources are available for SFBJV partners' work in designing and delivering projects. Legislative opportunities also exist where SFBJV efforts can help generate and influence policy to support SFBJV goals. Examples of this include the federal Water Resources Development Act (WRDA) efforts to support beneficial reuse of dredge material by the US Army Corps of Engineers; and the regional "Measure AA", or the San Francisco Bay Clean Water, Pollution Prevention and Habitat Restoration Measure (passed in 2016), which funds the San Francisco Bay Restoration Authority.

Policy work of the SFBJV can occur at multiple levels. The Policy Committee is responsible for analyzing policy issues and recommending policy positions to the management board for approval and adoption. Importantly, this committee serves as a regional, collaborative forum for discussing, analyzing, and (when appropriate) elevating policy issues of interest to the SFBJV and its partners. Through this education, the SFBJV can inform positions taken by SFBJV partner organizations. The SFBJV may also take unified positions within a partnership on legislation, regulations, policies, and appropriations that could promote or detract from its ability to deliver on its habitat goals. The SFBJV is able to take these positions because of a voting structure that allows agency personnel to engage in discussion, yet recuse themselves from voting on any endorsement or issue that would be considered advocacy.

In certain cases, Management Board discussions provide opportunity for early input on regional planning and policy development, including, for example, the San Francisco Bay Restoration Regulatory Integration Team (BRRIT) and the Wetlands Regional Monitoring Program (WRMP). In other cases, the SFBJV relies on partners from nongovernmental organizations to conduct policy advocacy work when appropriate. This can happen in the form of engagement with elected officials and/or regulatory agency representatives during annual trips to Washington D.C., to the State Capitol, and during discussions and meetings with stakeholders and representatives within the districts.

PRINCIPLES FOR SFBJV POLICY WORK	Box 7
Proposed policy positions originate through SFBJV working committees and can be adopted by the management board.	
The JV may take collective action to move a position forward, and may also evaluate the impacts of a proposed policy and provide information on those impacts.	
Partners who have the ability to use that tool may engage in direct lobbying, while the SFBJV provides a point of coordination and information.	
Agencies usually recuse themselves from participation and rely on the collective actions of those within the JV who can advocate on their behalf.	
Advocacy should be tied to goals in the Implementation Strategy and annual work plans. However, the SFBJV should position itself to act quickly when unforeseen issues arise.	
SFBJV policy positions may be reactive, responding to opportunities or requests by our partners to support positions on policies, regulations, or legislation. However, the SFBJV may also be proactive, determining policies or positions we want to promote.	
SFBJV policy positions must rest on the best available science.	
The most elaborate and resource-intensive educational tool is the white paper, which should be utilized rarely. The SFBJV produced a white paper [LINK?] on when this tool is the most appropriate and potentially effective option.	

4.3.4 Communications Program

Strategic Communications and the SFBJV

Communication plays a vital role in supporting the ten priorities outlined at the beginning of this chapter. As a partnership, the SFBJV offers a bird's-eye view on the ongoing collective work to restore wetland habitats in the nine-county Bay Area, and its singular role as a convening body for this purpose. Telling our story, sharing accomplishments, and creating forums for discussion are foundational to maintaining relevance, building strong partnerships, sustaining funding, and ultimately achieving our goals. The SFBJV commits to being innovative with our tools and approaches to achieve such goals as increased partner engagement, facilitating an inclusive exchange of ideas or knowledge, and problem-solving around emerging issues.

The Communications Program functions somewhat differently than our other programs, in its set of tools and tactics explicitly designed to support the work of all the other SFBJV programs. To be strategic with our communications, the SFBJV works to understand our audiences, desired actions, appropriate timing, and how best to engage and listen. As an example, with a goal to increase beneficial reuse of sediment in restoration projects, the SFBJV works with our partners to bring together those who have sediment with those who need it. Our workshops and other settings bring together the dredgers and excavators, project managers, transporters, permitters, and regulators, who all must be a part of the discussion to better understand each other's needs, issues, and challenges. Information gathered helps to develop and improve our SediMatch program and web tool, to help expedite project matchmaking and, in the process, generate more understanding of our program's value and role.

Target Audiences

The primary audience for the SFBJV Communications Program is our internal audience - those who make up the partnership. These include the land and project managers, representatives of member organizations, scientists, engineers, teachers, leaders and visionaries of the Bay Area conservation community. The program promotes the SFBJV mission and encourages active engagement in helping achieve shared goals. In addition, the program supports partners by promoting their projects, creating value-added tools and other resources, and by offering forums or events where partners can advance their work.

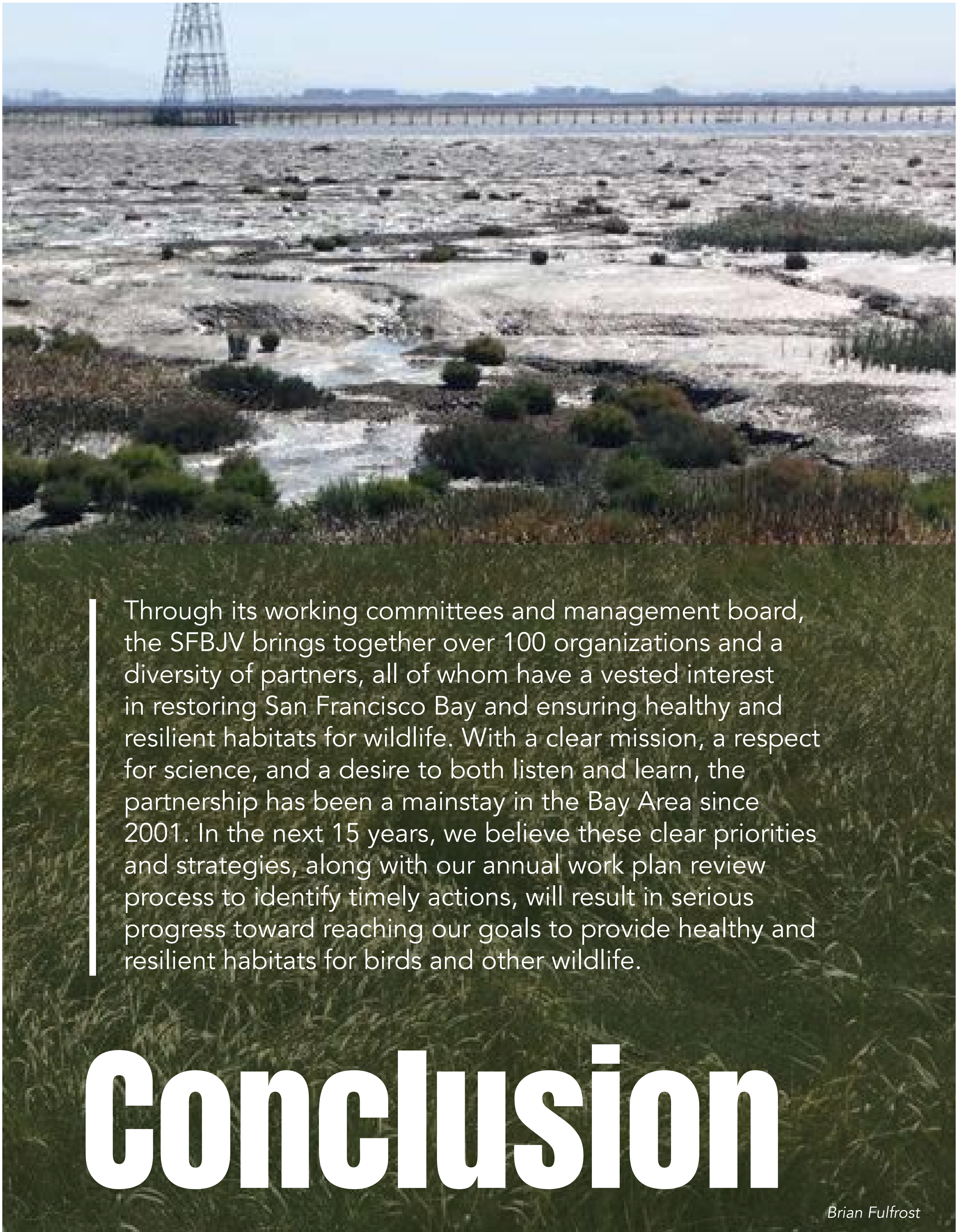
The SFBJV Communications Program also reaches out to limited external audiences, who can vary from year to year. These may include local, state and federal decision makers, funders, planners, the business community, and others who have influence over our ability to achieve goals or may simply be interested in who we are, what we do, and/or how we do it.

4.3.5 Equity, Diversity, and Inclusion

In 2021, the SFBJV management board formed an Equity, Diversity, and Inclusion (EDI) Committee to begin to incorporate EDI practices into the operations of the SFBJV partnership. The goal of this committee is twofold - it will integrate equity, diversity, and inclusion values into meetings, partnerships, and projects, as well as explore ways to meld them into conservation goals.

Although equity conversations within the SFBJV are not new, the strategic weaving of EDI principles throughout the fabric of SFBJV work is. This newly formed committee will address head-on the challenges and opportunities that come with this work.

Beth Huning



Through its working committees and management board, the SFBJV brings together over 100 organizations and a diversity of partners, all of whom have a vested interest in restoring San Francisco Bay and ensuring healthy and resilient habitats for wildlife. With a clear mission, a respect for science, and a desire to both listen and learn, the partnership has been a mainstay in the Bay Area since 2001. In the next 15 years, we believe these clear priorities and strategies, along with our annual work plan review process to identify timely actions, will result in serious progress toward reaching our goals to provide healthy and resilient habitats for birds and other wildlife.

Conclusion

Brian Fulfrost

APPENDIX A. SFBJV HABITAT CONSERVATION GOALS

A Synthesis of Existing Guidance, Accomplishments, Methodology, & Updated Goals

Introduction

The San Francisco Bay Joint Venture (SFBJV) habitat conservation goals have been updated and increased from those in the original Implementation Strategy, *Restoring the Estuary* (RTE 2001) in order to help:

1. incorporate accomplishments to date;
2. include an expanded and slightly modified geographic scope;
3. include goals based on habitat function and need for connectivity of habitats to restore whole, functional, and intact ecosystems; and
4. address accelerating challenges posed by sea level rise and other drivers that add urgency to achieving habitat goals as quickly as possible.

Goal Habitats

Goal habitats (Table 1) focus on aquatic resources and adjacent transition and upland habitats. The SFBJV sets numeric acreage goals for the protection, restoration, and enhancement of the habitats in this strategy, particularly those within the SF Estuary. Given the urgency to restore habitat, despite limited resources and capacity, the SFBJV predominantly focuses on implementing projects within the SF Estuary. To address valuable habitats throughout our geographic scope, provide summaries of current status and recommendations from key planning documents, and inspire action by partners able to take action within these other habitat groupings, we also include Watershed and Outer Coast goals. Goals for these two additional groupings incorporate the most up-to-date sources from regional experts. Goals from the Conservation Lands Network (CLN) 2.0 have been incorporated into Watershed Habitats updates, including the addition of two new Watershed habitats: *Stream Valleys and Headwater Creeks and Source Areas*. For the remaining goal habitats of the Outer Coast, the SFBJV has instead adopted qualitative and/or functional goals. The inclusion of Watershed and Outer Coast habitats also provides a foundation for coordination and action by the SFBJV, should additional resources become available.

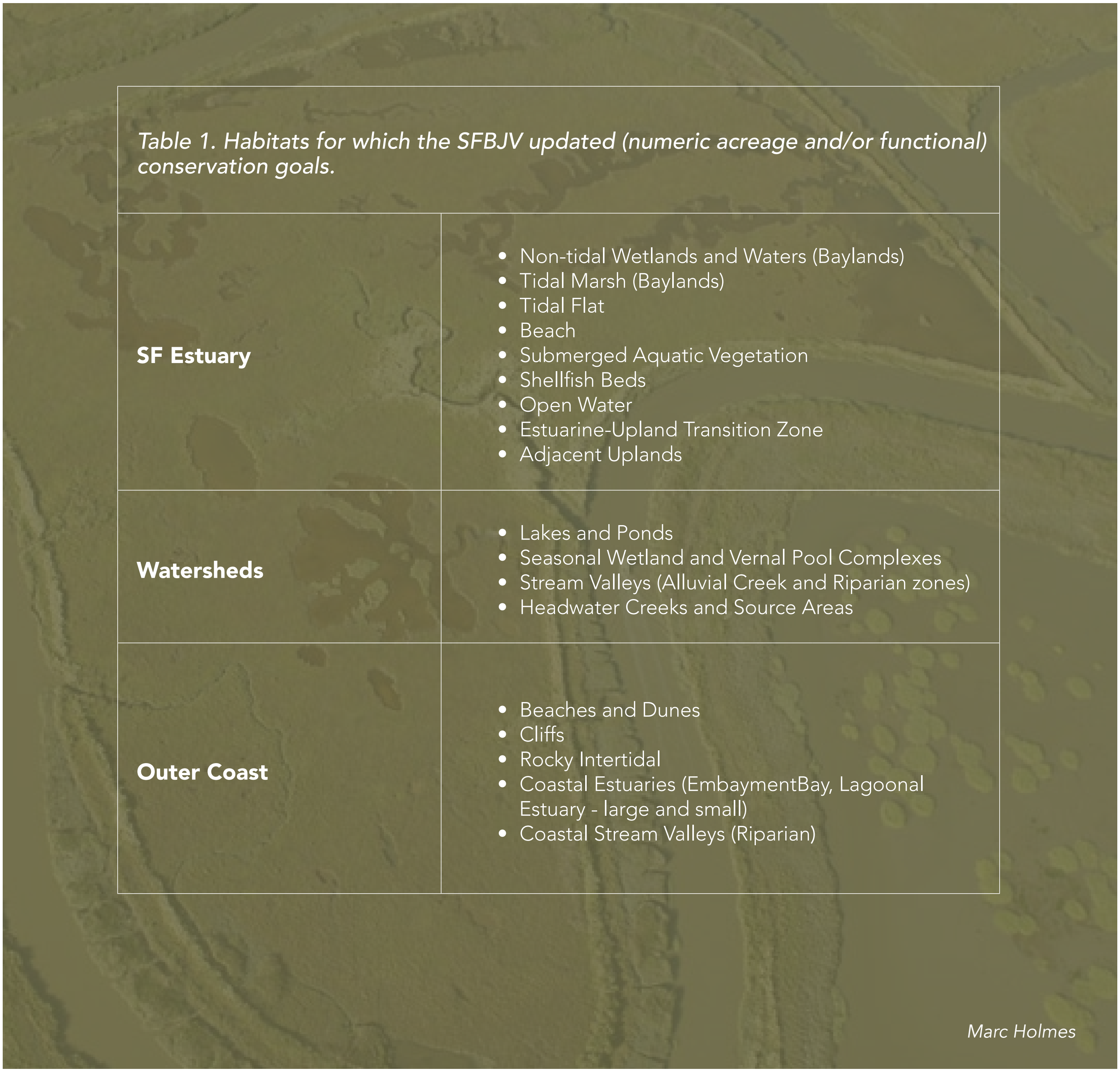


Table 1. Habitats for which the SFBJV updated (numeric acreage and/or functional) conservation goals.

SF Estuary	• Non-tidal Wetlands and Waters (Baylands) • Tidal Marsh (Baylands) • Tidal Flat • Beach • Submerged Aquatic Vegetation • Shellfish Beds • Open Water • Estuarine-Upland Transition Zone • Adjacent Uplands
Watersheds	• Lakes and Ponds • Seasonal Wetland and Vernal Pool Complexes • Stream Valleys (Alluvial Creek and Riparian zones) • Headwater Creeks and Source Areas
Outer Coast	• Beaches and Dunes • Cliffs • Rocky Intertidal • Coastal Estuaries (EmbaymentBay, Lagoonal Estuary - large and small) • Coastal Stream Valleys (Riparian)

Marc Holmes

Habitat Crosswalks

The habitats selected by the SFBJV build from those described in existing plans. The SFBJV habitats are crosswalked to their corresponding habitat(s) from other regional plans in the tables below. This includes San Francisco Bay Estuary habitats (Table 2), San Francisco Bay Estuary watershed habitats (Table 3), and outer coast habitats (Table 4).

Table 2. San Francisco Bay Estuary habitats and their corresponding habitat(s) from other regional plans.

SFBJV Ecosystem	SFBJV Habitats	Other Plans
SF Estuary	Non-tidal Wetlands and Waters	Diked Baylands: Diked Wetland, Managed Pond, Salt Pond (Baylands Goals Science Update)
	Tidal Marsh	Tidal Baylands: Tidal Marsh (Baylands Goals Science Update)
	Tidal Flat	Tidal Baylands: Tidal Flat (mudflat) (Baylands Goals Science Update)
	Beach	Non-wetland (sandy/shell beach) (Baylands Goals Science Update)
	Submerged Aquatic Vegetation	Submerged Aquatic Vegetation (Subtidal Goals)
	Shellfish Beds	Shellfish beds (Subtidal Goals)
	Upland Transition zone	Transition Zone (Baylands Goals Science Update)
	Adjacent Uplands	Uplands (CLN)

Table 3. San Francisco Bay Estuary watershed habitats and their corresponding habitat(s) from other regional plans.

SFBJV Ecosystem	Habitats	Other Plans/Reports
Watersheds	Stream Valleys (creeks and riparian zones)	Adjacent: riparian forest, willow grove (Goals Project 2015); Stream Valleys (CLN 2.0)
	Lakes and Ponds	Adjacent: Perennial pond (Goals Project 2015)
	Seasonal Wetland and Vernal Pool Complex	Adjacent: grassland (Goals Project 2015); Adjacent: grassland/vernal pool complex; Grassland (CLN 1.0)
	Headwater creeks and source areas	Headwater creeks and source areas (CLN 2.0)

Table 4. San Francisco Bay Joint Venture outer coast habitats and their equivalents as described in other regional plans.

SFBJV Ecosystem	Habitats	Other Plans/Reports
Outer Coast	Beaches and Dunes	GFNMS Climate-Smart Coastal Adaptation Report: Beaches and Dunes
	Cliffs	GFNMS Climate-Smart Coastal Adaptation Report: Cliffs
	Rocky Intertidal	GFNMS Climate-Smart Coastal Adaptation Report: Rocky Intertidal
	Coastal Estuaries (embayment/bay, lagoonal estuaries - small & large)	GFNMS Climate-Smart Coastal Adaptation Report: Outer Coast Estuaries; Nursery Functions of US West Coast Estuaries: Embayment/Bay, Lagoonal Estuary
	Coastal Stream Valleys (riparian)	CLN 2.0: Stream Valleys

The following steps were included to update the SFBJV goals:
A) The Habitat sub-team revised the original **SFBJV habitat types and definitions** to reflect conservation of a broader landscape mosaic of connected, functional, and healthy habitats that would support the recovery and abundance of a wide range of species that depend upon them and allow space for transgression of marshes' upslope as sea level rises with extensive input from the management board, working committees, and partners.

B) To account for progress made, habitat **conservation accomplishments** were summarized based on Project Tracker, Annual reporting by the SFBJV to the USFWS, and a variety of reports by SFBJV partners, including State of the Estuary Report and the Bay Area Protected Areas Database.

C) The recommendations for goal updates takes the **modified geographic scope** into account, where applicable (e.g., seasonal wetlands, etc.). The SFBJV boundary from the 2001 Implementation Strategy has made four boundary adjustments: East Contra Costa County was added to facilitate the East Bay Regional Park District coordination with one, rather than two JVs regarding seasonal wetlands efforts. Diked marshes of Suisun are included and linked with the Central Valley Joint Venture, reflecting Suisun's importance to Central Valley waterfowl management efforts. Marin and Sonoma County coastal watersheds were added from the Golden Gate to the mouth of the Russian River at Jenner. The Russian River watershed in Sonoma County was added.

We included the southern portion of Suisun in the SFBJV boundary in the mapping effort for the protection goal update. Since Suisun Marsh is shared between the SFBJV and the Central Valley Joint Venture, SFBJV has adopted the Suisun Marsh Management Plan (2014) restoration targets for Suisun Marsh.

D) **Guidance from relevant regional plans** informed the revision of habitat acreage goals either by aligning with existing goals (e.g. Subtidal and Watershed habitats), when applicable, and expert consultations were used to update goals when additional information was needed (e.g. Baylands, Upland Transition Zone, Adjacent Uplands).

E) The Habitat sub-team **adjusted for emergent and accelerating drivers** like climate change and sea-level rise by adding goal habitats, like Upland Transition Zone and Adjacent Uplands, that will provide migration space as habitats shift landward and/or to higher elevations. Additional adjustments include supporting more ambitious acreage goals and such policies as "beneficial use of sediment" to help accelerate the pace of habitat restoration.

Habitat Conservation Goals

Activity Definitions

In the original Implementation Strategy, *Restoring the Estuary* (2001), numeric acreage goals were determined for conservation activities that included habitat acquisition, restoration, and enhancement.

For our revised plan, the SFBJV has reviewed and adopted the activity definitions below from EcoAtlas and Project Tracker, as modified below. They are currently in broad usage in both the region and throughout the State, developed by the California Wetland Monitoring Workgroup. The SFBJV has found in practice a substantial overlap between the definitions for Restoration/Rehabilitation and for Enhancement. The SFBJV will direct partner organizations to select either Restoration /Reestablishment or Enhancement when entering SFBJV projects.

Acquisition/Preservation/Protection: The SFBJV refers to this overall category as "Protection". Acquisition refers to the purchasing of land to protect it from development and/or with the intention to restore or enhance habitat. Preservation refers to maintaining the land in its current state. Protection refers to the removal of a threat to the land as described by the Activity Type. For the SFBJV, this also includes protection by conservation easement.

- **Restoration:** Restoration refers to restoring habitat that was once present but is no longer present. Re-establishment results in a net increase in habitat area and function.
- **Enhancement:** Enhancement refers to targeted improvement of specific function(s) of existing habitat.
- **Creation/establishment:** Creation refers to the construction of habitat that has yet to occur, or would not progress naturally, in a particular location.
  Acreage calculations also include lands considered "Protected" within calculations of potential area available for other conservation activity.
  Protected: Land already **protected** refers to public lands (or lands protected by conservation easement) dedicated to a habitat type, including lands proposed for restoration of the habitat type.

Previous Goals

The majority of the 2001 *Restoring the Estuary* numeric acreage goals were based on the San Francisco Bay Area Bayland Ecosystem Goals Project (1999), Historical and Modern Baylands acreage maps, Goals Project regional ecological goals, estimates of currently protected lands, and estimates of potential 20-year accomplishments. A summary of acreage estimates and goals are found in Table 5.

Table 5. Historic acreage as of approximately 1800, as of 1998, and numeric acreage goals as of 2001 for the protection (P), restoration (R), and enhancement (E) of goal habitats in SFBJV's original Implementation Strategy (Restoring the Estuary 2001).

<table>
<tr><th>Goals Habitats</th><th>Acres in 1800</th><th>Acres in 1998</th><th>P (2001)</th><th>R (2001)</th><th>E (2001)</th><th>Goal Sub Habitats</th><th>Acres in 1800</th><th>Acres in 1998</th><th>P (2001)</th><th>R (2001)</th><th>E (2001)</th></tr>
<tr><td rowspan="5">Bay Habitats</td><td rowspan="5">175,780</td><td rowspan="5">98,070</td><td rowspan="5">63,000</td><td rowspan="5">37,000</td><td rowspan="5">35,000</td><td>Beach</td><td>200</td><td>70</td><td>113</td><td>60</td><td>35</td></tr>
<tr><td>Tidal Flat</td><td>49,000</td><td>28,000</td><td>12,000</td><td>4,000</td><td>6,000</td></tr>
<tr><td>Tidal Marsh</td><td>125,000</td><td>32,000</td><td>43,000</td><td>32,000</td><td>20,000</td></tr>
<tr><td>Salt Pond</td><td>1,500</td><td>34,000</td><td>6,000</td><td>1,000</td><td>7,500</td></tr>
<tr><td>Lagoon</td><td>80</td><td>4,000</td><td>1,500</td><td>50</td><td>1,500</td></tr>
<tr><td rowspan="2">Seasonal Wetlands*</td><td rowspan="2">84,000</td><td rowspan="2">71,000</td><td rowspan="2">12,000</td><td rowspan="2">7,000</td><td rowspan="2">11,000</td><td>Diked Wetland*</td><td>0</td><td>18,000</td><td>5,000</td><td>6,000</td><td>5,500</td></tr>
<tr><td>Grassland & Associated Wetlands*</td><td>84,000</td><td>53,000</td><td>7,000</td><td>1,000</td><td>5,500</td></tr>
<tr><td rowspan="2">Creeks, Lakes and Ponds</td><td rowspan="2">69,000</td><td rowspan="2">14,500</td><td rowspan="2">7,000</td><td rowspan="2">5,000</td><td rowspan="2">22,000</td><td>Lakes and Ponds</td><td>na</td><td>12,000</td><td>3,000</td><td>1,000</td><td>6,000</td></tr>
<tr><td>Creek & Riparian Zone</td><td>69,000</td><td>2,500</td><td>4,000</td><td>4,000</td><td>16,000</td></tr>
</table>

**Updated in 2011 (Petrik 2011: Seasonal Wetlands Opportunity Analysis)*

Accomplishments

Compiling and summarizing habitat accomplishments was an important, yet challenging step toward updating SFBJV acre goals. Accomplishment data were collected from Ecoatlas Project Tracker and USFWS accomplishment reporting from 2001 through 2021. Each data entry was manually reviewed for project activity definition, habitat type, and location, and missing entries were researched. Inconsistent tracking and reporting over the decades have led to imprecisions in accomplishments data. For example, the same activity might be described as enhancement by one project manager, while it is called restoration by another. Where necessary, ecosystem, habitat type, or activity were regrouped to align with Ecoatlas definitions. All projects that focused solely on Invasive Species Control (ISC) were grouped into a separate category. All non-tidal wetlands and waters (NTWW) and seasonal wetland creation projects were categorized as baylands restoration. Subtidal habitat projects were grouped into restoration of SAV or Shellfish Beds (about half were classified as enhancements). These reporting differences speak to a need for shared understanding of definitions for restoration and enhancement.

We summarized accomplishments to date by broad habitat and activity type (Figure 1). Since 2001, we have protected 31,420 acres of SF Estuary Habitat and restored 14,604 acres of tidal marsh complex, over 19,000 watershed acres and 1,316 acres on the outer coast. The SF Estuary and Watersheds accomplishments reflect the 2001 habitat goals in Figures 2 and 3.

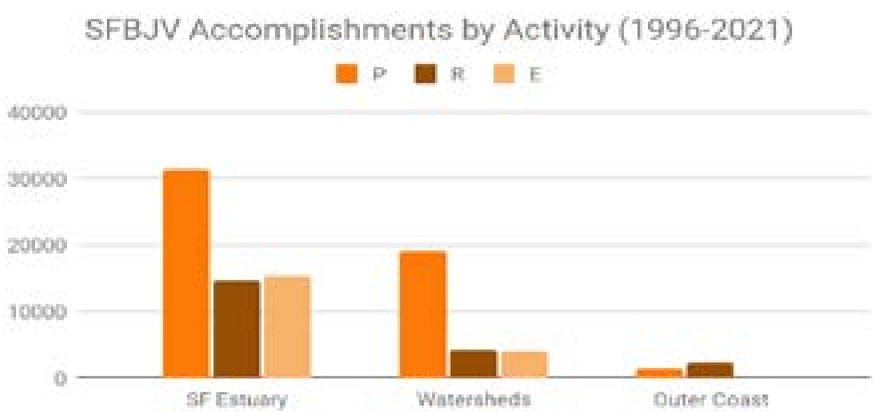


Figure 1. *Habitat conservation work completed in the San Francisco Bay Estuary between 1996-2021, by broad habitat type and activity type. Activities included Protection (P), Restoration (R), and Enhancement (E). Habitat types included SF Estuary, Watersheds, and Outer Coast.*

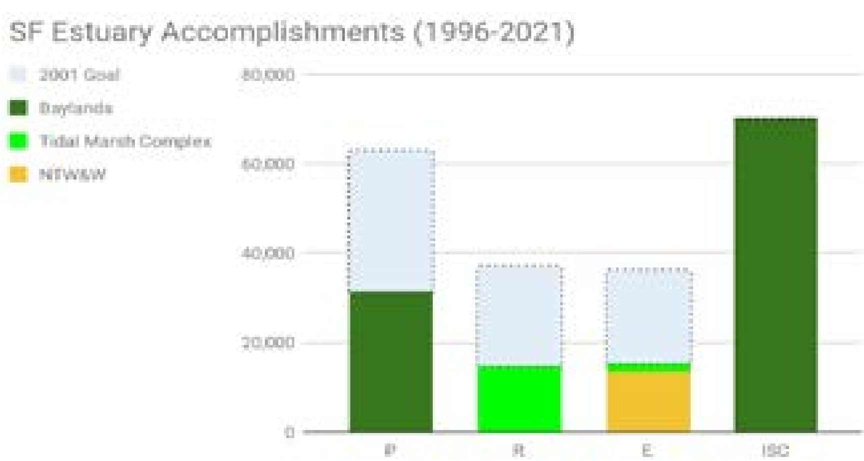


Figure 2. *Habitat conservation work completed in the San Francisco Bay Estuary between 1996-2021, by habitat type and activity type, showing progress towards SFBJV's 2001 Habitat Goals (2001 Goals; Restoring the Estuary 2001). Activities included Protection (P), Restoration (R), Enhancement (E), and Invasive Species Control (ISC). Habitat types included non-tidal wetlands and waters (NTWW), tidal marsh complex), and Baylands (a summary category for habitats within the Historic Baylands).*

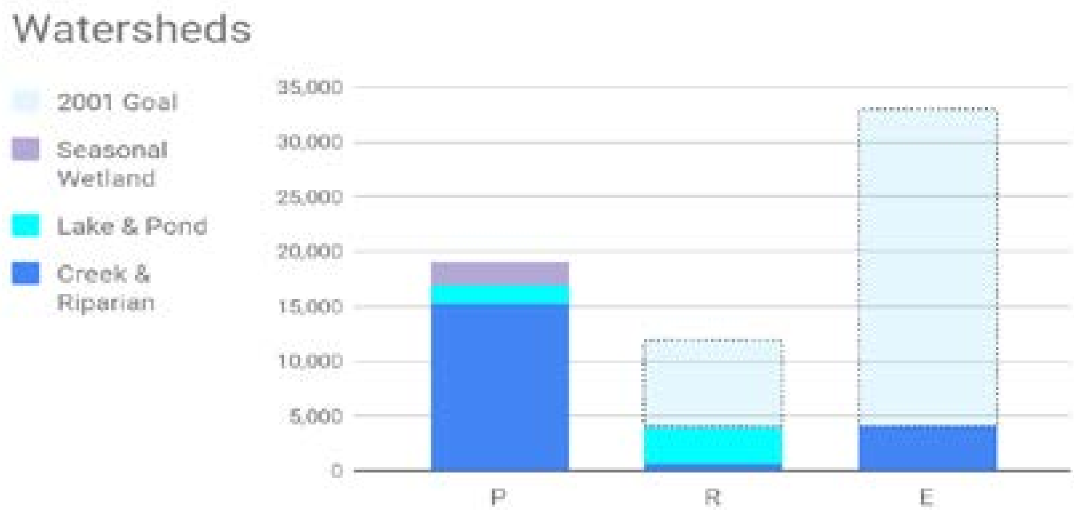


Figure 3. *Habitat conservation work completed in the San Francisco Bay Watersheds between 1996-2021, by habitat type and activity type, showing progress towards the San Francisco Bay Joint Venture's 2001 Habitat Goals (2001 Goals; Restoring the Estuary 2001). Activities included Protection (P), Restoration (R), and Enhancement (E). Habitat types included seasonal wetlands, lakes and ponds, and creek and riparian habitats.*

Current Habitat Conservation Goals

This section summarizes SFBJV's updated habitat conservation goals, adding to and building upon the achievements of the last two decades, beginning with the SF Estuary Habitats, which are the primary focus of the SFBJV partnership, as outlined above. Relevant calculations, sources, and recommendations for further work are included within each section.

Table 6 represents a summary version of the previous (RTE 2001) and current (2022) habitat goals.

Table 6. Summarizes original (2001) and updated (2022) goals for broad SFBJV habitat categories. Numeric acreage goals are proposed for the protection, restoration, and/or enhancement of SF Estuary habitats and Watershed Habitats. Functional Goals are noted for Outer Coast habitats.

2001				**2022**			
	P	R	E		P	R	E
SF Estuary Habitats	63,000	37,000	35,000	SF Estuary Habitats1	110,000 acres & 36 miles of estuarine beaches	107,000	63,000
Watershed Habitats[2]	19,000	12,000	33,000	Watershed Habitats	479,500	103,500	309,500
NA				Outer Coast Habitats 3	Qualitative goals aimed at protecting, restoring, and enhancing ecological function		

Notes: 1. Habitat categories added to 2021 SF Estuary Habitats include: Adjacent Uplands, Non-tidal Wetlands and Waters, Estuarine-Upland Transition Zone, Submerged Aquatic Vegetation, and Shellfish Beds. Subtidal habitat acreages are counted in both the restore and enhance totals. 2. 2001 Watershed Habitats included Creeks, Lakes and Ponds as well as Seasonal Wetlands (that Petrik's 2011 analysis of season wetlands goals modifies). 3. Outer Coast Habitats added as a SFBJV habitat.

Table 7. Compares the current 2022 goals with the original goals laid out in *Restoring the Estuary* (2001). This comparison also illustrates habitats for which new acre goals are being set, including subtidal habitats, estuarine-upland transition zone, and adjacent uplands, as well as new functional goals for coastal habitats.

SF Estuary Habitats	Protect		Restore		Enhance	
	Original (2001)	Updated (2022)	Original (2001)	Updated (2022)	Original (2001)	Updated (2022)
Non-tidal Wetlands and Waters[1]	n/a	59,000	n/a	n/a	n/a	27,000
Tidal Marsh[2]	43,000	59,000	32,000	72,000	20,000	11,000
Tidal Flat[3]	12,000	12,000	4,000	4,000	6,000	6,000
Beach[4]	113	36 miles	60	*See functional goals	35	*See functional goals
Submerged Aquatic Vegetation[5]	n/a	8,000	n/a	8,000	n/a	8,000
Shellfish Beds[5]	n/a	Protect all existing	n/a	8,000	n/a	8,000
Estuarine-upland Transition Zone[6]	n/a	16,500	n/a	15,100	n/a	2,500
Adjacent Uplands	n/a	14,000	n/a	n/a	n/a	n/a
Watershed Habitats	Protect		Restore		Enhance	
	Original (2001)	Updated (2021)	Original (2001)	Updated (2021)	Original (2001)	Updated (2021)
Lakes and Ponds[7]	3,000	4,500	1,000	1,000	6,000	6,000
Seasonal Wetlands and Vernal Pool Complexes[8]	12,000	5,000	7,000	2,500	11,000	3,500
Alluvial Stream Valleys[9]	4,000	200,000	4,000	50,000	16,000	200,000
Headwater Creeks and Source Areas[10]	4,000	270,000	4,000	50,000	16,000	100,000
Outer Coast Habitats	Functional Goals (2022)					
Beaches and Dunes11	Maintain functional stability, protect, and enhance the ecological integrity of the beach and dune environment under present and future conditions.					
Cliffs11	Protect existing cliff habitat from accelerated degradation (goals combined with beaches and dunes)					
Rocky Intertidal11	Ensure that viable and ecologically functioning rocky intertidal habitat remains present in the region.					
Coastal Estuaries (Bay/Embayment, Lagoon)1[1]	Optimize physical and biological function, and processes of outer coast estuaries under present and future conditions.					
Coastal Stream Valleys (Riparian)12	Protect wide, variable-width stream corridors and stream networks and restore/enhance the fluvial processes and ecological functions that lead to healthy streams and riparian biodiversity.					

Notes: 1. Guidance: Goals Project 2015, SFEI Shoreline Adaptation Atlas 2019; 2. Guidance: Goals Project 2015, SFEI Shoreline Adaptation Atlas, RTE, SOTER 2019; 3. Guidance: Goals Project 2015, RTE; 4. Guidance: SFEI Shoreline Adaptation Atlas, SFEI & Baye 2020; 5. Source: Subtidal Goals 2010; 6. Guidance: Fulfrost & Thomson 2015, Fulfrost 2018; 7. Source: CLN 2.0 (Bay Area Aquatic Resource Inventory [SFEI]; National Wetland Inventory); 8. Source: CLN 2.0 (National Wetland Inventory, California Department of Wildlife); Human Modification (The Nature Conservancy Omniscape 2018); 9. Source: CLN 2.0 (USGS); 10. Source: CLN 2.0 (National Hydrography Dataset, CalWater 2.2.1, USGS); 11. Source: Hutto et al. 2016: GFNMS Climate-Smart Adaptation Report; 12. Source: CLN 2.0.

San Francisco Estuary Habitats

San Francisco Bay Estuary habitats include both subtidal and baylands habitats in and around San Francisco Bay, including lands touched by the tides, and lands that the tides would touch in the absence of any levees or other unnatural structures (1999 CLN shapefile or updated version, if available). For the purposes of this strategy, this generally includes San Francisco Bay, Central Bay, San Pablo Bay and part of Suisun Bay (see map, Figure TBD). The SFBJV also identifies adjacent uplands, which provide important connectivity and migration space as sea level rises.

The habitats selected by the SFBJV build from those described in existing plans (Table 2). The updated SF Estuary habitat goals are described in the following sections for seven habitat types, with numeric acreage recommendations and justifications.

Table 8. Acreage and functional habitat goals for SF Estuary habitats. Goals represent remaining conservation needs. Numeric goals can overlap among the conservation action categories (protect, restore and enhance, meaning that the same acre may need to be both protected and restored and/or enhanced).

SF Estuary Habitats	Protect	Restore	Enhance
Baylands[1]— Non-tidal Wetlands and Waters	59,000	NA	27,000
Baylands[1]— Tidal Marsh	59,000	72,000	11,000
Tidal Flat[2]	12,000	4,000	6,000
Beach[3]	36 miles	*See functional goals	
Submerged Aquatic Vegetation[4]	8,000	8,000	
Shellfish Beds[4]	Protect all existing native oyster beds	8,000	
Estuarine-upland Transition Zone[5]	16,500	15,100	2,500
Adjacent Uplands[6]	14,000	NA	NA

Notes: 1. Freeman and Spenst Baylands Opportunities Analysis 2021 with technical expert input, building on guidance from: Goals Project 2015, SFEI Shoreline Adaptation Atlas, RTE, SOTER 2019; 2. Guidance from: Baylands Goals/RTE; 3. Guidance from: SFEI Shoreline Adaptation Atlas, SFEI & Baye 2020; 4. Source: Subtidal Goals 2010; 5. Fulfrost Upland Transition Zone Opportunities Analysis 2020, building on guidance from: Fulfrost & Thomson 2015, Fulfrost 2018, SFEI Adaptation Atlas, EcoAtlas, Bay Shoreline Inventory; 6. Fulfrost Adjacent Uplands Opportunities Analysis 2020, building on guidance from: SFEI Shoreline Adaptation Atlas 2019, Our Coast Our Future 2014, GreenInfo California Protected Areas Database 2020.

Baylands Habitats

Baylands habitats in and around San Francisco Bay are the areas between high and low tide elevations, including lands that the tides would touch in the absence of any levees or other unnatural structures. While protection acreage is combined in this strategy, for the purpose of restoration and enhancement goal setting, baylands were split into two habitat types: tidal marsh habitat, and non-tidal wetlands and waters (baylands that have been cut off from tidal influence).

As of this update, the habitat goals have broadened to include protection, restoration, and/or enhancement of all available historic baylands. Despite progress made, tens of thousands of acres of crucial opportunities for baylands for protection, restoration, and enhancement still exist, and include agricultural lands, lands in salt production, and other undeveloped lands in the historic baylands margin. These habitats are defined below, followed by descriptions of their corresponding protection, restoration, and enhancement goals.

Non-tidal Wetlands and Waters

Definition: Non-tidal Wetlands and Waters (NTWW) are areas of historic tidal marsh in the Baylands that have been largely to completely isolated from tidal influence by dikes, levees, or other man-made structures. This category includes a wide range of human-altered wetlands and waters. Many of these areas are managed to provide habitat for wildlife.

Sub-habitats: These include diked, managed seasonal wetlands and perennial marshes, artificially muted marsh, artificial lagoons, managed ponds, storage and treatment wetlands and ponds, current and former salt production ponds, wetlands naturally forming in non-tidal historic baylands (including agricultural baylands).

Key habitat attributes: Sheltered waters of variable depths that are surrounded by levees (or earthen berms) and water control structures; aquatic habitats managed for nesting, roosting, and/or foraging of waterfowl and shorebirds; dry and/or salt-crusted pond bottoms managed for Western Snowy Plover habitat; diked marsh managed for salt marsh harvest mouse habitat.

This goal habitat includes a wide range of sub-habitats, termed Diked Baylands by the Goals Project and noted in several RTE habitats including Salt Ponds (Bay Habitats), possibly Lagoon (Bay Habitats), Diked Wetlands (Seasonal Wetlands), and Grasslands and Associated Wetlands (Seasonal Wetlands). Many "Seasonal Wetlands" habitats in RTE were in the Historic Baylands (up to ~3,600 acres as determined in Petrik's seasonal wetland goals update, 2011) and have been reclassified into this NTWW category, instead of the Seasonal Wetlands habitat in the Watersheds. Seasonal wetlands in the Historic Baylands may be included in certain project-specific instances, which we generally consider sustainable when restored outside the historic baylands margin.

The NTWW of the Bay provide different ecosystem functions and call for varying management actions based on land use. Managed wetlands and salt ponds currently provide substantial wildlife habitat. Shorebirds, wading birds, and waterfowl flock to managed ponds in large numbers. Diving ducks, in particular, rely on managed waters for foraging. Salt ponds can provide nursery or overwintering habitat for Pacific herring, three-spined stickleback, Pacific staghorn sculpin, longfin smelt (state listed), and grass shrimp. The threatened Western Snowy Plover nests on the cracked, dry surfaces of former and existing salt ponds, managed to function like salt pannes.

Most diked baylands of the Estuary have subsided significantly below Mean Sea Level (MSL) and are at heightened risk of flooding due to sea level rise and intensified storm systems (SOTER 2019). In areas removed from tidal action, natural processes have been disrupted and the land continues to sink when not augmented by sediment brought in on the tides, or on elevation-building marsh plants. Climate change is an important part of the equation when setting goals for protection, restoration, and enhancement of NTWW. As sea level continues to rise, managing the risk to shoreline communities and agricultural lands will be ever more challenging and costly, yet important to consider. Diked baylands, along with managed ponds and other NTWW areas, provide necessary functions for humans and wildlife.

RTE (2001) goals called for the protection of 7,500 acres of salt ponds and lagoons and 16,000 acres of diked wetlands. We have made significant progress toward this goal since 2001. Notably, 15,100 acres were protected in 2003 with the acquisition of the South Bay Salt Ponds complex. While creating more non-tidal wetlands in the bay is not a focal SFBJV goal, diked baylands and managed salt ponds do provide critical habitat for birds, small mammals, sensitive plants, and invertebrates. Managed ponds (both salt ponds and storage treatment ponds) are especially valuable to many waterbird species, the threatened Western Snowy Plover, as well as the endangered salt marsh harvest mouse. Non-tidal wetlands provide nesting, foraging, roosting, and high tide refugia habitat. In some cases, conversion to tidal action can have negative impacts to waterbird foraging habitat, indicating the importance of protecting and enhancing these non-tidal environments (Baylands Goals 2015).

Tidal Marsh

Definition: Emergent vegetated wetland subject to natural tidal action, which floods and drains via tidal movement of the San Francisco Estuary. Tidal marsh occurs throughout much of the Bay from the lowest extent that vascular vegetation will grow down into the tidal frame to the top of the intertidal zone (at the maximum height of the tides). Tidal marsh also exists in the tidal reaches of rivers and streams. In the fresher parts of the Estuary, it occurs at lower elevations in the intertidal zone. Tidal marsh plant communities correlate strongly to salinity and flooding patterns and to other factors, such as substrate, wave energy, marsh age, channel complexity, sedimentation, and erosion, and are often categorized into tidal salt and tidal brackish marsh (Goals Project 2015).

Sub-habitats: Low/middle/high marsh and their channel networks with salinities ranging from low to hypersaline, marsh pannes.

Key habitat attributes: Foraging and nursery habitat for a variety of fish and wildlife including endangered San Francisco Bay endemic populations (salt marsh harvest mouse and Ridgway's Rail), and plant species like soft bird's beak, Suisun thistle, and California seablite; sediment trapping; carbon sequestration; filtering contaminants; flood reduction and prevention; wave attenuation.

We must continue to acknowledge the human destruction causing the loss of 80% of the Bay's tidal marshes over the past 200 years (Baylands Goals 2015). While full restoration to the baylands of pre-1800s is not possible, tidal marsh habitat in the estuary is making a comeback. From the Historical Baylands' estimated acreage of 190,113 (SFEI 1997a) to 40,500 by 1997, the current estimate of tidal marsh extent is 54,604 acres (SFBJV Accomplishments Analysis 2021, *internal document*). Since 2001, protection, restoration, and enhancement projects have contributed towards reviving this invaluable ecosystem.

Tidal marsh habitat has been a primary focus for protection and restoration throughout the Estuary among SFBJV partners. We consider marshes important indicators of SF Estuary health because they provide foraging and nursery habitat for a variety of fish and wildlife, including several endangered and endemic species. Examples of tidal marsh residents include: longjaw mudsucker, dabbling ducks, Ridgway's Rail, Black Rail, tidal marsh Song Sparrow, saltmarsh Common Yellowthroat, Suisun shrew, salt marsh harvest mouse, as well as broad-leaf plants and graminoids.

In addition to biodiversity, tidal marshes provide a suite of ecosystem services. Marshes have a unique capacity for sediment trapping, carbon sequestration, filtering contaminants, flood reduction and prevention, shoreline protection, and wave attenuation. These ecosystem functions are especially relevant when thinking about the stressors of such climate change as sea level rise or increased storm severity and frequency. Tidal marshes can suppress levee erosion and levee overtopping, reduce wave action on infrastructure during intense storms, and provide refugia for wildlife during storm events (SFEI & Spur, 2019).

Tidal marsh in the SF Estuary is still susceptible to habitat loss via pressures of urban development, decreased sediment supply, and climate change. Sea level rise alters baylands ecosystems through erosion of the bayward edge of tidal marshes, in addition to marsh drowning. Long-term research indicates lateral (wave-induced) erosion is a primary driver of tidal marsh habitat loss in the SF Estuary (SFEI & Baye 2020). Water levels, waves, currents, and sediment supply are all factors to consider when striving to restore or enhance tidal marshes and their corresponding tidal flats. The Wetlands Regional Monitoring Program (WRMP), which combines regional monitoring of benchmark sites with ongoing monitoring at project sites, will be important to convey how adaptive management can work to increase the resiliency of tidal marshes and connected habitats.

Recommendations

Protect 59,000 Acres of Baylands habitat

The protection goal directs efforts toward any undeveloped or minimally developed land within the Historic Baylands margin. Following protection, these lands could either be enhanced to provide non-tidal wetlands and waters beneficial to wildlife, or restored to provide tidal marsh habitats. By grouping tidal marsh and NTWW into a single baylands protection goal, we seek to protect functional habitat regardless of the changing landscape.

Feedback from SFBJV's science and conservation committees, along with the IPT, led the team to conduct a spatially explicit mapping exercise, vetted by regional working groups, to better quantify the existing conservation opportunities in the baylands. The baylands protection map included parcels under private ownership, intended only for estimating total acres and not for distribution. The SFBJV is clear that any parcels identified with conservation value will only be acquired voluntarily from willing landowners.

To begin the spatial exercise, the SFEI Historical and Modern Baylands layer (1998) defined the landward and bayward edges of baylands habitat. Within the baylands' footprint and the SFBJV updated boundary, parcel data referenced all nine Bay Area counties. Parcels excluded from the protection goals included subtidal areas, properties that were already protected as habitat (BPAD 2018), highly developed areas (e.g., active marinas, dumps, oil refineries, housing developments), and parcels slated for development. City, county, water district, flood control land, and regional airports in the North Bay with conservation value we now include in the protection goal.

We convened three working sessions to share the draft protection goal and to solicit input from regional experts. Attendees walked through the maps parcel-by-parcel to review assumptions and to make adjustments and corrections as needed. The North Bay working session occured on March 11th, 2021, and included the following participants: Toby Rohmer, Invasive Spartina Project; Dean Kwasny, NRCS; Larry Wycoff, CDFW; Karen Taylor, CDFW; Greg Martinelli, CDFW; Kendall Webster, Sonoma Land Trust; Julian Meisler, Sonoma Land Trust; Barbara Salzman, Marin Audubon; Ben Pearl, SFBBO; and Melisa Amato, USFWS SPB Refuge. The

South Bay meeting on March 11th included: John Krause, Ca Department of Fish and Wildlife; Toby Rohmer, Invasive Spartina Project; Rachel Tertes, USFWS Don Edwards Refuge; Arthur Feinstein, Citizens Committee to Complete the Refuge; and Dave Halsing, South Bay Salt Pond Restoration Project. The Central Bay meeting on March 15th, 20201 was attended by Chris Barton, East Bay Regional Park District; Barbara Salzman, Marin Audubon; Arthur Feinstein, Citizens Committee to Complete the Refuge; and Ben Pearl, San Francisco Bay Bird Observatory. The Suisun region within SFBJV jurisdiction was reviewed in both the North and Central Bay meetings.

Each meeting resulted in valuable discussion and goal refinements, including the following changes to the protection goal:

- Including parcels in city or county ownership in the protection goal;
- Including some parcels smaller than 10 acres in the protection goal because they often contain critical habitat (esp. in the Central Bay, mouth of Petaluma River);
- Including several regional airports with conservation value (North Bay);
- Including water distinct and flood control land (baywide);
- Excluding parcels that had been recently developed or slated for development.

After incorporating feedback from the March 2021 working sessions, the new total acreage of bayland parcels in need of protection came to 57,680 acres. The Implementation Planning Team (IPT) made the decision to round this number to 59,000 acres, to include any areas that had been overlooked, and to account for the potential to acquire smaller parcels. During these workshops, participants were asked if they could specify what portion of land within each embayment should be restored or enhanced. Workshop participants indicated they could not provide that information for a variety of reasons (e.g., lack of information about on-the-ground conditions; need for more study; and, land in private ownership ripe for future conservation, landowner goals would also be a factor).

Restore 72,000 acres of Tidal Marsh habitat; Enhance 11,000 acres of Tidal Marsh habitat and 27,000 acres of NTWW habitat

- South Bay: Restore 75% of baylands to tidal action; Enhance 25% to maintain nontidal habitat;
- Central Bay: Restore 80% of baylands to tidal action; Enhance 20% to maintain nontidal habitat;
- North Bay: Restore 40% of baylands to tidal action and enhance 60% to maintain nontidal habitat, while working towards a 70% tidal: 30% nontidal goal;
- Suisun Bay: Defer to Suisun Marsh Management Plan (2014) goal of restoring 5,000 – 7,000 acres of tidal marsh and enhancing over 40,000 acres of managed wetlands.

Table 9. Baylands Restoration and Enhancement Acre Goals

	North Bay		Central Bay	South Bay	Total baylands acres
	Interim goal (40% tidal)	Long-term goal (70% tidal)	(80% tidal)	(75% tidal)	(using N. Bay long-term goal)
Restore Tidal Habitat	18,000	32,000	8,000	32,000	72,000
Enhance NTWW	28,000	14,000	2,000	11,000	27,000

The updated goal of restoring and enhancing 110,000 acres of baylands habitat reflects the urgency for accelerated habitat conservation actions on the landscape. We incorporated new mapping data and the best available knowledge to develop newly ambitious goals to capitalize on our success and to face the threats of climate change.

The process of restoration and enhancement goal setting for baylands habitat began as a literature review, which elucidated that the existing acreage goals, and estimates of future habitat (Goals Updates 2015; Appendix B), were too low to preserve functional habitat, given current sea-level rise projections. Goal-setting recommendations from the IPT included: keep it high level, use existing literature as a basis, include opportunities for adaptive management, use a species-specific basis (to the extent it can be readily incorporated), and support for hosting regional working sessions to agree on tidal/non-tidal percentages.

Given the gaps in existing literature and the need to set more ambitious restoration and enhancement goals to reflect the new 59,000-acre protection goal, SFBJV hosted two workshops (1. North Bay, 2. Central and South Bay) on July 26th, 2021, to gather input from regional experts. The SFBJV took care to curate a list of invitees that included public landowners and managers in the baylands, species specialists, and ecologists. During each workshop, the participants reviewed maps of the baylands by subregion and provided feedback to develop percentages for tidal restoration and nontidal enhancements. Attendees walked through the map by sub-region to make decisions about priorities and to consider other factors, including infrastructure, to develop ambitious yet achievable goals for restoration and enhancement.

Meeting attendees for the North Bay working session included: Melisa Amato (USFWS), Meg Marriott (USFWS), Toby Rohmer (ISP), Dean Kwasny (USDA), Kendall Webster (SLT), Julian Meisler (SLT), Barbara Salzman (Marin Audubon), Jeanne Hammond (OEI/ISP), Laura Hollander (SFBRA), Larry Wycoff (CDFW), Karen Taylor (CDFW), Greg Martinelli (CDFW), Scott Jennings (ACR), Blake Barbaree (Point Blue), Ben Pearl (SFBBO), Chris Barr (USFWS), Julian Wood (Point Blue), and Isa Woo (USGS). The attendees of the Central/ South Bay session included: Blake Barbaree (Point Blue), Joy Albertson (USFWS), Ben Pearl (SFBBO), Susan De La Cruz (USGS), Julian Wood (Point Blue), Dave Halsing (SBSPRP), Matthew Brown (USFWS), John Krause (CDFW), Chris Barr (USFWS), Chris Barton (EBRP), Karen McDowell (SFEP), Laura Hollander (SFBRA), Alexandra Thomsen (SFEP), Caroline Warner (SFBJV), Greg Martinelli (CDFW), and Jen McBroom (OEI/ISP).

The questions framing each session were: What percentage of your region would you like to see in managed wetlands and aquatic habitats, and what percentage as tidal within the timeframe of 2030? Species' needs and management costs were considered, as were large infrastructure constraints such as State Route 37 and the SMART rail line, with the reminder to keep the goal ambitious and high-level. Session participants looked at the protection map by region to discuss what would be restorable. They considered a parcel-level analysis, but landowners in the workshops advised this would be difficult, given all of the unknowns in future property ownership (particularly of unprotected lands). Workshop attendees shared insightful knowledge, regionally-specific goals, and questions. Some of the main points and recommendations from the meetings are listed below:

- The suite of species that rely on SF Bay require a combination of aquatic and tidal marsh habitats.
- Therefore, restoration & enhancement efforts should incorporate all these habitat types.
- Complexes and corridors are important.
- Non-tidal areas should be scattered about and strategically placed.
- We need the percentage of managed wetlands feasible to maintain given the cost, while also meeting wildlife needs.

Each region made collective agreements about restoration and enhancement goals. These included: restore 75% of South Bay baylands to tidal action, while enhancing 25% as some form of nontidal wetland; restore

80% Central Bay's baylands to tidal action, while enhancing 20% nontidal habitat; provide in the North Bay an interim goal of restoring 40% to tidal action and keeping 60% as managed wetlands while working towards a 70% tidal: 30% non-tidal goal. Percentages are based on the instincts and best judgment of the experts in the working sessions, not a quantitative analysis. We considered this to be the best available strategy to develop restoration and enhancement acreage goals.

In the South Bay Region, the South Bay Salt Pond Restoration Project (SBSPRP) comprises a large portion of the opportunities for conservation, with thousands of acres of nearby potentially restorable lands not yet part of SBSPRP. As a starting point, the workgroup discussed whether it might consider the bookend goals of the SBSPRP to aid regional goal setting. South Bay attendees talked at length about the migratory waterbirds, and other wildlife that rely on non-tidal habitats in the South Bay, contrasted with the difficult reality of maintaining dikes, levees, and pumps as sea level rises. Participants agreed that maintaining 25% as non-tidal until at least 2030 follows a measured approach, allowing flexibility of managed ponds.

Future opportunities can create more tidal marsh (both actively and passively), while more difficult and expensive to revisit as sea level rises and as levees are breached. The South Bay goal to restore 75% of restorable land to tidal action was justified with the understanding that 90% tidal marsh (as defined in the SBSPRP) maximum tidal restoration bookend goal would not be appropriate for the entire region. Reasons for setting the goal at 75% include: restorable lands outside of the scope of the SBSPRP, wildlife needs for managed ponds and wetlands greater than 10%, and infrastructure constraints. We based the Central Bay goal to restore 80% to tidal action on the agreement that most of what would potentially be available should be restored in the limited areas of the region, while keeping 20% managed wetlands to sustain wildlife. Experts estimated that approximately 20% of the landscape is currently non-tidal wetland, and that area can support wildlife needs and is what is realistic to maintain.

The North Bay has several characteristics unique to this region, causing the participants to set an interim goal. In comparison to the Central and South Bays, vast lands exist with restoration potential in the North Bay, with the most extensive opportunities to restore entire marsh ecosystems from subtidal to uplands beyond Suisun Marsh; however, many of these lands are constrained by infrastructure, (e.g., Highway 37 and SMART Rail). These lands are also deeply subsided and will require more sediment than is currently available in the North Bay from dredging or construction starts (currently the two most common offsite sources of material used to raise elevation of restoration projects) to be restored to tidal marsh. The North Bay group discussed various habitat needs for freshwater species, shorebirds, waterfowl, and SMHM. Additionally, infrastructure considerations, stormwater detention, and management capacity also informed the goals. Experts concluded that an interim goal of 40% tidal marsh would be realistic within the timeframe of this strategy. They set the long-term goal of restoring 70% in the North Bay to tidal action, while acknowledging that infrastructure would limit marsh restoration beyond 70%, and that maintaining more than 30% as managed wetlands would become prohibitively expensive and difficult, as sea level continues to rise. Infrastructure constraints also occur in the South and Central bays, and the baylands are also bordered by much more urbanized areas, with the majority of the bay area's residents living in the Central and South Bays. While the possibility of an interim goal was discussed, participants concluded it was not necessary. The regional goals are ultimately very similar, and the process of going through this exercise by region was crucial to obtaining expert input, and to use the best available information to develop these habitat goals.

Suisun Marsh is shared between the SFBJV and the Central Valley Joint Venture, and a separate management plan, entitled the Suisun Marsh Management Plan (2014), which targets restoration of 5,000–7,000 acres to tidal marsh. SFBJV has adopted these targets for Suisun Marsh.

After the workshop, the project team estimated the acreage that could be conserved using SFEI Modern Baylands Layer, parcel data representing protection targets, and Bay Area Protected Areas Database, totaling 140,000 acres. This 140,000 acres of undeveloped and minimally developed baylands was sorted by region for the goal-setting process (North Bay, Central Bay, South Bay). We then subtracted the acreage of mature tidal marsh pre-existing on the landscape, as documented in the original Baylands Goals Project (1999). Pre-existing tidal marsh acreages, derived from EcoAtlas mapping, were detailed by region in Appendix B of the 1999 Goals Report. The total provided in the Goals Report (1999) was 40,000 acres of pre-existing tidal marsh, which included nearly 14,000 acres in Suisun Marsh. The relevant quantities for North, Central, and South Bays, totaling 27,000 acres of marsh existing prior to 1998, were deducted from the acreage available for conservation. The next step was to account for accomplishments post-1998. Acres previously restored to tidal action (14,405 acres; SFBJV Accomplishments Analysis 2021, *internal document*) were deducted from the total acreage for each region (9,401 acres North Bay; 788 acres Central Bay; 4,216 acres South Bay). The regional percentages (40/70% North Bay, 80% Central Bay, and 75% South Bay) were used to determine how many acres will be restored to tidal action., in the realm of what is possible and not yet restored or mature tidal marsh. The remaining acres of restorable baylands define the NTWW enhancement goal. Previous enhancement projects were not subtracted from the enhancement goals because we recognize the need to enhance baylands habitat both in an ongoing capacity, and, increasingly, as sea level rises. Table 9 shows acreages for baylands restoration and enhancement goals, by region and baywide.

While tidal marsh enhancements are not the focus of the enhancement goal, enhancement projects are important for improving both the ecological function and structure of existing tidal marsh habitats. Given the relatively short timeframe of this goal, the primary objective of this strategy is implementation, i.e. restoring tidal habitat. The updated tidal marsh enhancement goal (11,000 acres) was set as 15% of the restoration goal to account for the need to sustain tidal habitat now and as sea level rises. Marsh enhancement projects come in many shapes and sizes, ranging from volunteer plantings to large-scale topographic adaptations. Habitat improvements might include the creation of marsh mounds, upland transition zone habitats, or an improved network of tidal channels, all of which are beneficial to marsh wildlife, and can support marsh accretion. Enhancing native communities by removing invasive vegetation (e.g., *Spartina alterniflora* and spartina hybrids), and planting such marsh natives as gumplant (*Grindelia stricta*) and cordgrass (*Spartina foliosa*), can provide nesting substrate and predator protection to wildlife. Enhancing the transition zone between tidal marsh and other baylands habitats is also critical for wildlife and for climate adaptation approaches to sea level rise.

The emphasis of NTWW's 27,000-acre enhancement goal is to enhance baylands habitats to promote healthy wildlife populations. This may include improving aquatic habitat values, muted or fully managed wetlands, and seasonal wetlands. Acreage surrounding diked baylands and managed ponds is often limited by urban development and infrastructure around the bay, which means that restoration to tidal influence is not always feasible. However, management decisions can influence wildlife abundance and diversity in these habitats. Non-tidal waters can improve for waterbirds and other wildlife through a variety of management strategies, including changing the salinity and reducing the water depth of managed ponds. More intense and frequent storm events, increased water levels, and changes in salinity will need to be accounted for in management decisions. Habitat enhancements to managed ponds and diked baylands can help alleviate stressors like levee erosion and overtopping, ponds flooding, and damage to water control structures (SFEI and Spur, 2019). Adaptive management of diked baylands and ponds is crucial not only to sustain target wildlife habitat but to protect roadways and vulnerable communities around the Bay in the face of sea level rise.

Monitoring is critical to understanding how waterbirds and other wildlife respond to habitat enhancements. The Wetland Regional Monitoring Program (WRMP) is a collaborative monitoring program that has been under development since 2018. The WRMP will use a science-based framework to monitor key habitat indicators across the estuary to improve the protection and restoration of tidal marsh ecosystems in the Bay. Habitat enhancements such as altering water levels, levee improvements, or creation of islands/high tide refugia, should coincide with consistent monitoring to assess how species respond to these management actions. Monitoring is also important to assess and protect water quality and the spread of mosquito-borne illness in managed wetlands (SFEI and Spur, 2019). Monitoring data from the SBSP Restoration Project indicates that these managed ponds now support nesting shorebirds, and are a nursery for grass shrimp, native fish species, and other aquatic organisms. Given the broadened scope of this habitat category, and the recognized importance for wildlife, the maintenance and enhancement of NTWW will be a key focus in the near future.

Tidal Flats and Beaches

Tidal flats and beaches serve critical roles to help dissipate wave energy. Both also provide important habitat features.

Tidal Flats

Occurs from between Mean Tide Level (MTL) to Mean Lower Low Water (MLLW) and supports less than 10% cover of vascular vegetation. Tidal flat tends to occur less in brackish or freshwater areas compared to more saline areas because, under fresher conditions, marsh vegetation grows lower in the intertidal zone (Goals Project 2015). About 90% of intertidal flat habitat occurs on the edges of the Bay, and the remainder is associated with shallow tidal channels (Goals Project 1999).

Sub-habitats: Mudflat, sandflat, shellflat.

Key habitat attributes: Roosting and foraging habitat for shorebirds; important habitat for demersal fishes and benthic invertebrates, including mussels and oysters, haul- out habitats for marine mammals, substrate for biofilm, and wave attenuation.

Functional Goals: Tidal mudflats exist at the interface of the subtidal and intertidal zones. They are an important component of the mosaic of habitats that make up a resilient and functional estuary. Tidal flats serve a number of important ecological functions and assist with biophysical processing between the intertidal and tidal zones. This includes crucial support for a variety of flora and fauna, and help in the filtering of sediment between terrestrial sources and the bay that serve a water-quality function by filtering sediments resuspended by wind and wave action (San Francisco Bay Joint Venture 2001). The maintenance and resilience of tidal mudflats is primarily reliant on sediment availability (among other factors). Tidal mudflats in turn also protect salt marsh from wave action, and are critical in providing sediment for marsh development. Tidal mudflats are an important food resource, including both invertebrates and biofilm (i.e. microphytobenthos), for roosting and foraging shorebirds (Goals Project 2015). The current Natural Resource Management Plan for the San Francisco Estuary identifies the importance of mudflats, stating "up to 1 million shorebirds can be counted foraging on the Bay's extensive mudflats at the peak of spring migration" (USFWS 2019, p. 4). Tidal mudflats provide an important habitat for demersal fishes and benthic invertebrates, and marine mammals also use them as haul-out locations.

We can assess how well mudflats are functioning by a number of direct and indirect metrics, which can be used in conjunction with each other. In addition to mapping the extent and distribution of mudflats (and biofilm), mudflat slope and shape "control to some degree the balance between marsh erosion and progradation" (Goals Project 2015). Faunal counts on mudflats can also assist with better evaluating ecological functioning. These include but are not limited to bird counts and usage, fish and benthic (micro and macro) invertebrate counts, as well as marine mammal counts, and usage. We should also pay attention in identifying potential invasive species, such as invasive spartina, which can colonize mudflats reducing its acreage and function, as well as shorebird foraging habitat space and food resource quality, as well as invasive invertebrates, who can often compete native species. These locations should likely be the focus of enhancement efforts.

Recommendations

Protect 12,000 acres of Tidal Mudflats

Restore 4,000 acres of Tidal Mudflats

Enhance 6,000 acres of Tidal Mudflats

The acreage goals included here are taken directly from the existing *Restoring the Estuary* report and have not been updated. We base these goals for tidal mudflats on historic and modern mudflat extents, an assessment of required shorebird support, and an estimate of potential 20 year accomplishments (San Francisco Bay Joint Venture 2001). The acreage target for tidal mudflats in the 50–100-year time-frame was set to be the same as the historic acreage (~49,000 acres). Acreage goals for protection and restoration were set to be 75% of the habitat goals, while the remaining 25% would be for enhancement (San Francisco Bay Joint Venture 2001). Unfortunately, we cannot confidently assess current changes to mudflats in the SF estuary or calculate accomplishments since 1999, mostly due to the lack of data on changes to mudflat acreage (i.e., extent and distribution). Although some useful datasets exist in the South Bay (Fulfrost 2017; Jaffee and Foxgrover 2005), no dataset covers the entire estuary. In addition, restorations or enhancements outside of the South Bay have not focused on mudflats, or, where part of other restoration efforts have not been adequately cataloged.

Without mudflat acreages acquired directly from restoration projects, we can assess potential progress toward acreage goals by comparing the baseline data from 1999 with updated maps of mudflats. However, using existing datasets, this is not always easy to assess, even in the South Bay, where data is available. When we compared the EcoAtlas (1999) with updated data, we have of mudflats in the South Bay from 2016 produced for the SFBJV (Fulfrost, 2017), that appears to reflect an increase in mudflat extent. However, tidal mudflats mapped by USGS in 2005 (Jaffee and Foxgrover, 2005) indicate a significantly different extent and shape than in the same areas shown in the EcoAtlas from 1998 (SFEI 1998). At the same time, the shape and extent of mudflats from 2016 in the South Bay are quite similar to the shape and extent of mudflats from the 2005 USGS report. The area covered by both mapping datasets (south of the San Mateo bridge) has possibly seen an increase in acreage, mostly in the "center" of the extreme South Bay. This area *might* be a good target for meeting protection or enhancement goals. Alternatively, this "change" in extent and acreage could be an artifact of inaccuracies in the 1999 baseline, or differences in mapping methodologies with the 2016 (or 2005) datasets.

Efforts at evaluating how well the SFBJV is meeting its habitat goals for tidal mudflats would greatly benefit from (a) SF Estuary-wide maps of mudflat extent updated every five to ten years, using a consistent mapping methodology; and, (b) project-specific maps of mudflat restoration and enhancement made available through mechanisms like the Project Tracker. As the SFBJV moves forward with efforts to meet its acreage goals in specific locations, we should endeavor to use the most up-to-date and accurate maps of tidal mudflat distribution to assess potential protection, restoration, and enhancement actions.

Protecting and enhancing existing mudflats provide the easiest paths for meeting acreage goals. In 1999, 8,000 acres of tidal mudflats were under protection (San Francisco Bay Joint Venture 2001). Acreage goals for protection call for an increase of 12,000 acres for protection, for a total of 20,000 acres, or about 40% of the total target. Without updated datasets about mudflat extent it is difficult to assess changes to protection. A good starting point would be to combine the baseline data (EcoAtlas 1999) with updated datasets (Fulfrost, 2017) and overlay them with the current CPAD database (CPAD 2021b) to get a better understanding of current protection acreage. Since this has not been done, progress towards goals set in 1999 cannot be assessed.

Tidal mudflat restoration requires a significant amount of sediment, from sources such as dredging, and has been less of a focus of restoration efforts in the bay. However, if tidal mudflats are lost in one area of the estuary, we should make effort to restore tidal mudflats in other areas of the estuary, ideally in locations that provide the overall net benefits to estuarine functioning (Goals Project 2015). Enhancement serves as a potentially easier path to maintain progress towards acreage goals. This can include recharging of sediment to an existing mudflat, or finding other ways to increase availability of bay or terrestrial sediment sources.

Other Considerations

We can evaluate the potential of a site to help meet and maintain acreage goals through a number of environmental parameters that influence mudflat resilience. These include: the status of adjacent submerged aquatic vegetation, salt marsh and other habitats like ponds; the availability of both tidal and watershed-based sediment sources; and, the presence of invasive species (although the ISP appears to have significantly reduced the impact of invasive spartina on mudflats). At locations of salt marsh restoration, special attention should also focus on and monitor potential impacts on (e.g., erosion) adjacent mudflats.

Since sea level rise will likely lead to "inundation and significant loss of tidal marsh and mudflats-key habitats used by shorebirds and waterfowl" (USFWS 2019), we should also pay attention to protecting and restoring mudflats that meet current needs, but with an eye towards how sea level rise might influence the location and timing of protection or restoration efforts.

Beach

Definition: SF Estuary beaches are unconsolidated shoreline features made of cobble, gravel, sand, shell, or mixtures thereof. Bay beaches tend to be relatively narrower, steeper, lower-energy environments than their marine counterparts, with most wave action driven by short-period wind-waves instead of long-period swell. Unlike beaches along the outer Pacific coast, Bay beaches only extend above mean sea level, fronted by broad intertidal mudflats that tend to dissipate wave energy before it reaches the shoreline. Most Bay beaches are either swash-aligned pocket beaches pinned between natural and/or artificial headlands (e.g., Radio Beach, Oakland), or drift-aligned fringing barrier beaches like Shell Beach in Foster City (SFEI & Baye, 2020).

Sub-habitats: Pocket, and barrier beaches; sand, gravel, and shell beaches; cobble beaches and lag shores.

Key habitat attributes: Beach width, orientation, and substrate; cover/composition of vegetation communities; adjacency to marsh and/or other estuarine habitats; spawning substrate for forage fish; haul-out habitats for marine mammals.

Beaches of sand, oyster shell, gravel, or cobble are dynamic features in the estuary, serving multiple ecosystem functions. Prior to the large-scale diking and filling that began in the 1800's, beaches were a widespread and integral component of the Estuary, now reduced to a small fraction of the shoreline (Goals Project 2015). Modern examples of beaches in the Bay include sand beaches (Radio Beach), shell hash beaches (fronting Foster City), mixed grain composite beaches (coarse gravel and sand beaches of Point Pinole and China Camp), and such cobble beaches as Red Rock Island (SFEI & Spur 2019).

Estuarine beaches provide habitat for both aquatic and terrestrial animals. Birds including the Forster's Tern, Black Oystercatcher, Black-bellied Plover, and Great Blue Heron use beaches for foraging and roosting. Beaches provide spawning habitat for grunion (*Leuresthes tenuis*) and haul-out spaces for harbor seals (*Phoca vitulina*) (Goals Project 1999, SFEI & SPUR 2019). Estuarine beaches host such uncommon and rare insects as tiger beetles (*Cicindela* spp.), carrion-feeding beetles, and ground-nesting wasps. Sand beaches and bluffs also offer habitat for the rare and endangered saltmarsh/beach shrub California sea-blite (*Suaeda californica*) (SFEI & Baye, 2020).

Beaches may have tremendous utility as a multi-benefit sea level rise adaptation strategy. With the ability to attenuate wave energy while simultaneously providing habitat, beaches are a better long-term solution to flooding and erosion than armored shorelines. Beaches lend themselves well to integration with existing infrastructure for hybrid green-gray shoreline protection measures (SFEI & SPUR 2019). Constructing beaches in front of roads or levees vulnerable to wave overtopping can also provide the first line of defense to tidal marshes. With declining sediment supplies and rising sea levels causing marsh edges to retreat, marsh-fringing beaches are invaluable for their ability to slow rates of erosion and act as zones for vertical accretion (SFEI & Baye, 2020). In highly developed areas where salt marshes cannot migrate, a marsh-fringing beach can reduce erosion and provide habitat and connectivity to adjacent wetland habitats. Coarse gravel and cobble beaches—more resistant to erosion than fine-sand beaches—can dissipate wave energy over shorter distances and prevent shoreline erosion. These coarse beaches can tolerate high water levels and extreme wave events, due to their permeability and large pore size (SFEI and Spur 2020). Sustaining estuarine beach habitat in the Bay will require an understanding of sediment supply, shoreline setting, tidal regime, and other climatic variables. Many of the tributaries that have also historically brought sands, gravels, and cobbles to the bay shoreline have been substantially altered and no longer do so. Pilot studies may assess where to establish beaches and what maintenance intervals are necessary to sustain them.

Recommendations

The overarching goal is to protect and increase suitable habitat for Bay beaches. Some restoration projects from Project Tracker include Albany Beach Restoration and Public Access Project - McLaughlin Eastshore State Park (9 acres) and Radio Beach Expansion Project - McLaughlin Eastshore State Park (4 acres). Changes from the RTE goals (protect 113, restore 60, and enhance 35 acres) include using mileage rather than acreage to account for Estuary beaches. The linear proportion of the shoreline fronted by beach is a more relevant metric because beach width fluctuates seasonally. Furthermore, the existing data on beach coverage is predominately in mileage (e.g., BayShore Inventory 2016). Functional goals have replaced numeric goals for restoration and enhancement because not enough information exists to estimate where beaches will be feasible.

Protect 36 miles of Beach habitat

BayShore Inventory mapping indicates there are 36 total miles of beach in the bay, with the largest extent of shoreline features 27 miles fronted by beaches in the Central Bay (Doehring et al., 2016). The baseline baseline for beach protection is 36 miles, while recognizing the importance of increasing beach coverage in the Bay. In order to create more beaches, protection will be needed wherever there is adequate coarse sediment and wave action. Until we have a more fine-scaled understanding of where in the Bay beaches can be supported by physical process, we must ensure, at minimum, no net loss of existing beach habitat.

Restore and create beaches as green and green-gray hybrid solutions to protect shoreline and create habitat.

Unfortunately, in recent decades, armored shoreline designs (i.e. riprap, seawalls) had precedence over beach restoration. Reestablishing marsh-fringing beaches as a living shoreline approach to reduce erosion is a current priority (Baylands Goals 2015; SFEI & Baye, 2020), along with restoring the physical processes to nourish and sustain beaches. Beaches and marsh berms bordering tidal marshes provide the first line of defense against wind-wave erosion during extreme high tides and storms. Estuarine beach projects have lower net costs than armored projects, due to their ability to adapt to storm events and sea level rise, reduce erosion by dampening waves, and increase wildlife habitat benefits (SFEI 2016). Beaches, in lieu of armored shoreline, create multi-benefit ecosystem functions. Beaches additionally provide recreation opportunities, connecting people to the Bay.

In the recent publication, *New Life for Eroding Shorelines* (SFEI & Baye 2020), authors discuss the relevance of marsh-fringing barrier beaches as solutions to marsh-edge erosion. Included in the report is an assessment of beach habitat pilot projects—Pier 94 San Francisco beach enhancement, and the Aramburu Island shoreline Protection and Enhancement Project—and lessons learned from these long-term beach restoration and monitoring efforts. One such lesson is the utility of cobble beaches for shoreline protection and habitat enhancement. Cobble beaches (e.g., Aramburu Island) with cobble embedded in bay mud are very stable and resistant to erosion. Fine sediment can collect between the embedded cobbles, providing foraging and sheltering habitat. When combined with gravel berms and beach faces, these cobble beaches provide erosion protection, as well as habitat and recreational opportunities not found along revetments.

SFEI Shoreline Adaptation Atlas (2019) names many places around the Bay where beach creation for wave attenuation might be feasible. Coarse beaches could replace riprap along the narrower, steeper shorelines, (e.g, Marin Headlands); or protect existing marsh scarps from wave erosion (e.g., Muzzi Marsh). The barrier beaches fronting wetlands at Point Pinole Regional Shoreline could serve as a model for future restoration projects. Because they lend themselves to hybrid solutions while providing the benefits of living shoreline, beaches can be restored in places they may not necessarily naturally occur. Beaches integrate with tidal flats and marshes but also stand alone as discrete shoreline elements. Maintaining a beach versus a seawall requires fewer long-term inputs or repairs, while enhancing ecosystem services.

Beach form and function will vary depending on site conditions and issues being addressed. Management should consider beach nourishment and the feasibility of transporting coarse-grained material. Hybrid features, including groins or artificial headlands, may be necessary to maintain beaches, and we may have to redeposit material onto the beach periodically to maintain it. The wave-deposited beach crest is another feature to consider when restoring coarse beaches. Beach crests move landward and increase in height during storms, all of which depends on space available and sediment supply (SFEI & Baye, 2020). On beaches with especially high-drift shorelines, retention structures (groins), including woody debris, can be installed (SFEI & Spur, 2019).

Enhance estuarine beaches with natural and hybrid features to improve connectivity, habitat quality, and natural armoring potential.

Estuarine beach enhancement goals aim to improve ecological functioning and connectivity to mudflats, tidal marsh, and upland transitional habitats. Information on local variation of beach shape/size, sediment source, and geophysical processes should fit into project designs. Enhancement strategies likely involve nourishment of created or restored beaches, as well as erosion-prone marsh scarps, via natural or artificial transport. Nourishment with sand, cobble, gravel, or shell will enhance erosion protection and improve connectivity between beach, marsh, and intertidal habitats. Placement of large wood features such as tree trunks or limbs, artificial logs, or cut lumber sections can also support beach function. These structures may act as micro-groins on exposed beach faces, improving wave-damping, and erosion prevention. Large wood features also may enhance habitat by providing wildlife roosting sites (SFEI & Baye 2020).

Beaches provide resilient high tide refuge, an essential habitat element that can integrate into beach enhancement projects. Berms and washover deposits can create high marsh zones, facilitating increased plant diversity. Planting native vegetation along washovers, berms, or beach ridges would enhance high tide refuge for native birds and mammals. SF beach communities often include a mix of maritime, inland sandy riparian, and high salt marsh dominant species (SFEI & Baye 2020). Several rare and endangered plants often thrive within current and historic estuarine beach localities. Habitat for species including salt marsh bird's-beak (*Chloropyron maritimum* subsp. *palustre*), smooth goldfields (*Lasthenia glabrata* subsp. *glabrata*), and owl's-clover (*Castilleja ambigua* subsp. *ambigua*) could be recovered via beach enhancement projects. Incorporating California Sea Blite into re-vegetation projects could result in multiple habitat benefits. This species can climb over driftwood and dunes, and grow above the highest tides, providing stabilization and high tide refugia (SFEI & Baye, 2020).

Subtidal Habitats

Many valuable subtidal habitats exist in the SF Estuary. Two of these, submerged aquatic vegetation, and shellfish beds, are particularly noteworthy and have specific habitat conservation goals, because of the array of habitat attributes each provides.

Submerged Aquatic Vegetation (SAV)

Definition: The term "submerged aquatic vegetation" (SAV) refers to all underwater flowering plants; they grow completely underwater except for periods of brief exposure at low tides. In the San Francisco Estuary, SAV includes sago pondweed (*Stuckenia pectinata*, formerly *Potamogeton pectinatus*), eelgrass (*Zostera marina*), and other species of seagrass, including the surfgrasses (*Phyllospadix torreyi* and *P. scouleri),* and widgeongrass (*Ruppia maritima*) (Schaeffer et al., 2007). Several freshwater plant species, mostly introduced, are found mainly in the delta (e.g., the Brazilian waterweed *Egeria densa*, an invasive nuisance species), and are outside of the geographic scope of this project.

In the SF Estuary, the focus is on eelgrass for the benefits that healthy eelgrass beds provide, including: nurseries for fish and invertebrates, natural spawning substrate for Pacific herring, foraging habitat for many fish and wildlife species including diving ducks, wave attenuation, and sediment stabilization. Eelgrass restoration is often combined with other habitat treatments in living shorelines approaches designed to protect and buffer local shorelines in the face of sea level rise and other climate stressors.

Key habitat attributes: Nursery and foraging habitat for diving ducks, fish, and invertebrates; spawning substrate for Pacific herring; wave attenuation; sediment stabilization; important foraging habitat for diving ducks; potential for carbon sequestration and amelioration of ocean acidification when co-located with shellfish beds.

Submerged aquatic vegetation (SAV) are foundation species providing critical ecosystem services in the intertidal/subtidal zone and beyond. Eelgrass is the most extensive type of SAV in the SF Estuary. Growing in underwater meadows, it dampens waves, reduces currents, and traps fine sediment. As a result, SAV (in conjunction with tidal flats) functions to limit shoreline erosion. Eelgrass beds create structure in shallow-water areas, serving as vital wildlife habitat. Pacific herring favor eelgrass beds as spawning substrate, and eelgrass serves as nursery and foraging habitat for many other fish including pipefish, staghorn sculpin, and three-spined stickleback (Subtidal Goals 2010). Invertebrates—in particular, amphipods—as well as geese and ducks, can rely on eelgrass for grazing. Greater and Lesser Scaup are known to forage in the eelgrass in Richardson's Bay (Audubon 2018).

Existing seagrass beds face many threats in the Bay, primarily disturbance from shipping and boating, anchoring, dredging, pollution, and pressures associated with climate change. Higher water temperatures can increase disease-related dieoffs and sea level rise may contract the habitable range. As deepening waters make the lower extent of their range unsuitable, eelgrass beds will migrate landward, limited only if seawalls cover much of the shoreline. Changes in salinity with sea level rise may also impact the distribution and phenology of eelgrass in the Bay (Subtidal Goals 2010).

Recommendations

Goals for SAV habitat are based on guidance from the Subtidal Goals Report (2010) and expert consultation (ref call w/ K.Boyer and M.Latta, 2020). The 2010 report includes enhancement actions under the definition for restoration. Rather than extrapolate the Subtidal Goals (2010) to fit the protection, restoration, and enhancement definitions used in this document (see pg. 3), Subtidal Goals Report (2010) definitions serve as references for SAV goal-setting. This includes one numeric acreage goal for SAV protection, restoration, and enhancement. We will also discuss functional goals in the following paragraphs. A synopsis of the SAV habitat goals is as follows:

- **No net loss** of existing eelgrass beds
- **Protecting areas with potential f**or future eelgrass expansion, restoration, or creation (~8,000 acres of suitable subtidal/intertidal area)
- Increasing native eelgrass populations **within 8,000 acres** of suitable habitat using a phased approach conducted within a framework of adaptive management

Currently, a collaborative effort led by Dr. Kathy Boyer, Merkel & Associates, and Audubon California is underway, to update the eelgrass habitat suitability model. Restoration and management decisions will improve through updates to the ELVS habitat model (the Ecological Limits, Viability, and Sustainability [ELVS] model produced by Merkel & Associates in the early 2000s). Additional and more precise data layers will improve the ability to determine if the current SAV suitability acreage estimates are accurate. Various climate change scenarios will also influence model updates. Climate change data will be crucial when prioritizing future eelgrass protection and restoration sites.

Protect: Ensure no net loss of existing eelgrass beds; protect 8,000 acres of suitable habitat for future eelgrass expansion.

The protection goal adheres to the Subtidal Goals Report (2010) objectives of no net loss of existing eelgrass beds, and of protecting areas with potential for future eelgrass expansion, restoration, or creation. Subtidal Goals recommends protecting 8,000 acres of subtidal or intertidal area within a 50-year time-frame. Baywide surveys indicate approximately 3,000 acres of eelgrass in the Bay (Merkel & Assoc., 2014). The 3,700 acres of existing eelgrass cited in the Subtidal Goals Report were on the high end of what has been measured across the three baywide surveys to date. Habitat suitability modeling identified 23,440 acres of suitable habitat in the Bay (Merkel & Associates 2005), approximately half of that area classified as moderately to highly suitable for eelgrass. After subtracting the current eelgrass extent (3,700 acres in 2009) from the 11,700 acres of moderately to highly suitable habitat predicted, approximately 8,000 acres of suitable habitat remain. Note these estimates are based on the best currently available data; with updates to the habitat suitability model, these acreage estimates may change.

Protection of existing beds is a priority to allow for natural eelgrass recruitment and to ensure sufficient source populations for future restoration projects. Existing eelgrass beds that could be potential Reserve sites include Keil Cove, Point San Pablo, Point Molate, Richardson Bay, Crown Beach, Bay Farm Island, Eden Landing

Ecological Reserve, and Coyote Point (Subtidal Goals 2010). Subtidal Goals (2010) names many strategies for protecting existing eelgrass beds, to include raising public awareness about stewardship goals, promoting best boating practices, establishing no wake zones and avoidance areas, creating 150-foot buffer zones around beds, and reconstructing docks and piers with light-transmitting materials.

While scientists have estimates for current eelgrass extent, the historic distribution in the Bay is not well documented, and no quantitative information exists prior to the 1980's (Subtidal Goals 2010). Because we cannot rely on historic data to choose protection or restoration sites, we must take physical parameters into consideration. Salinity and light availability (impacted by turbidity and depth) are two limiting factors, generally constraining eelgrass beds to western portion of Carquinez Strait, and not present in areas of the far South Bay. Protection should be paired with consistent Estuary-wide SAV surveys so we can begin to understand long-term patterns of distribution and abundance. This information will inform future protection and restoration strategies.

Eelgrass beds in the Estuary concentrate in the eastern shore of San Pablo Bay and Richardson Bay, with smaller beds distributed in the South and Central bays. Increasing eelgrass coverage throughout the Bay will increase biodiversity and productivity in subtidal and intertidal habitats. Protecting a range of tidal elevations, in a shifting mosaic from subtidal to upland, will result in a more complete system of connected habitats.

Restore: Increase native eelgrass populations within 8,000 acres of suitable habitat; use habitat suitability updates when selecting future restoration sites

Subtidal Goals (2010) calls for restoring [to include creation and enhancement] native eelgrass beds within 8,000 acres of suitable habitat. Eelgrass would not be restored throughout the entire 8,000 acres, but at a subset of locations within this larger area. To achieve this acreage goal, Subtidal Goals Report (2010) recommends a phased restoration approach conducted within a framework of adaptive management. Provisionally, the targets would be to increase native eelgrass habitat by 25 acres within five years, 100 acres within ten years, and 8,000 acres within a 50-year time frame (2010 through 2060). Because we still have much to learn about eelgrass ecology, a step-wise approach allows time to conduct field surveys, replicated experiments, and long-term monitoring to increase understanding and inform future restoration.

Subtidal goals (2010) identified 35 locations for prospective eelgrass restoration projects in the Estuary, based on recommendations from previous monitoring and restoration projects. Habitat suitability modeling (Merkel & Associates 2005) indicated the largest areas of suitable habitat are at depths less than two meters in the Central Bay and southern San Pablo Bay. Bathymetry and side scan data,still needed in much of the shallower nearshore portions of the Bay,will help clarify the suitability of these areas. We need to consider in-situ surveys of substrate, salinity, current speeds, and turbidity at each restoration site. Proximity to native eelgrass beds for rhizomatous propagation or seed dispersal is also an important site selection criterion.

Despite 23,400 potential acres of suitable habitat, eelgrass beds currently only cover a small fraction of subtidal land. Restoring 8,000 acres is an ambitious goal, achievable through a series of bite-sized projects adapted to site-specific conditions. SFEI's Shoreline Adaptation Atlas (2019) identifies 13 OLUs with high suitability for eelgrass restoration. As suspended sediment concentration decreases, and as water quality improves, conditions will be increasingly favorable for eelgrass establishment in the Estuary.

Enhance eelgrass beds wherever feasible; enhance ecosystem functions by integrating multiple habitats.

The enhancement goal aims to improve eelgrass habitat quality and increase the connectivity of adjacent habitats. Many different strategies work to enhance existing eelgrass beds as well as opportunities to improve future restoration projects. We have explored the living shoreline approach since 2010 as a strategy for restoring habitat and increasing shoreline resiliency, particularly in the face of climate change. With extensive monitoring, initial pilot work by restoration (with extensive monitoring) the State Coastal Conservancy and partners can couple eelgrass and oyster in the SF Estuary, to successfully create habitat, enhance ecosystem function and connectivity, and test the ability of the treatments to slow wave energy and reduce erosion. Ongoing projects involve the integration of SAV with oyster reef structures, emergent tidal marsh vegetation (including Pacific cordgrass), such native seaweeds including Pacific Rockweed, upland transition zone ecotones, and coarse-grained beaches. With a strong mosaic of subtidal and intertidal and tidal wetland habitats, a greater capacity exists for maintaining coastal processes, preventing excessive shoreline erosion, and increasing habitat connectivity and biological support values and food-chain support for many species. This approach is being tested by the San Francisco Bay Living Shorelines Project at several pilot sites since 2012 with State Coastal Conservancy and partners, and more than ten landowners in the Central Bay are currently developing a programmatic approach to design and permit the next ten project sites based on best practices and lessons learned to date (SFEI et al., 2021).

Beyond high-level connectivity, opportunities to enhance eelgrass beds use a more fine-scaled approach. Increasing genetic diversity at restored sites can enhance SAV resiliency to such stressors as high temperatures and herbivory (Subtidal Goals 2010). We accomplish this by collecting eelgrass seed from native beds with high genetic diversity, using a combination of seeding and transplanting at restoration sites, or collecting propagules at distances greater than 10 meters.

Several strategies enhance light availability, often a limiting factor for SAV photosynthesis. Modifications to the substrate can impact eelgrass development. Coarse sand is less likely to resuspend than fine silt or clay,a trait that allows for greater light availability. Strategic placement of coarse sand at restoration sites can raise elevation and enhance light availability for eelgrass (Subtidal Goals 2010). Another method for increasing light availability is to place 150-ft buffers around beds to limit turbidity and shading. Light available to SAV is often limited by such hard structures as piers, wharves, and docks on the shoreline.

Shellfish Beds

Definition: Locations where a shellfish species occupies more than 50% of an area of more than a few square meters (2010 Subtidal Goals, p. 93). Of five species of shellfish that occur in the SF Estuary, the Olympia oyster (*Ostrea lurida*) is by far the most abundant and is the only native species confined to estuaries (2010 Subtidal Goals, p. 95). Olympia oysters have been documented from shoreline areas out to a depth of more than 9m (>30 ft) based on observations of pilings removed at Crockett Marine facility, old Dumbarton Bridge walking pier, and others (Marilyn Latta, pers. communication). *Sub-habitats*: Olympia oyster beds (co-occuring with eelgrass) and mussel beds can support more than 100 species of fish, plants, invertebrates.

Key habitat attributes: Foraging habitat for a variety of wildlife; sediment trapping; bed-forming; water filtration; higher-relief reef restoration designs – all can provide erosion protection.

Shellfish bed habitat in the SF occurs in the intertidal and subtidal zones on natural and artificial hard substrate (including hybrid reef materials such as baycrete made of a mixture of sand, shell, and concrete; clean Pacific oyster half shell; or combinations of these and other materials). Five species of shellfish inhabit the Estuary: native Olympia oysters (*Ostrea lurida*), California mussels (*Mytilus californianus*), hybridized Bay mussels (*Mytilus trossulus/galloprovincialis*), non-native ribbed-horse mussel (*Geukensia demissa*), and green bag mussel (*Musculista senhousia*) (Subtidal Goals 2010). Of these five, the Olympia oyster is by far the most abundant, the only species native to confined estuaries, and will be the focus of this discussion.

Shellfish beds provide several ecosystem functions in the Bay. As a foundational species, shellfish alter the subtidal landscape by adding rough, uneven surfaces to the bay floor. Such structures reduce current speeds and facilitate sediment trapping (Subtidal Goals 2010). Shellfish beds increase habitat complexity, providing habitat for a higher diversity of marine invertebrates than surrounding, unstructured environments. High invertebrate abundance provides food for greater numbers of fish, birds, and crabs surrounding shellfish beds. These heterogeneous habitats may also provide spawning sites for Pacific herring (*Culpea pallasii*), and facilitate eelgrass (*Zostera marina*) establishment.

Native oysters exist throughout the Estuary from Carquinez Strait to Alviso. While the precise abundance of Olympia oysters in the Bay is not known, due to sampling constraints, prior intertidal zone surveys found many oysters concentrated in the Central Bay and to a lesser extent in the San Pablo and South Bays (Subtidal Goals 2010). Oysters exist on armored shorelines, including seawalls and rip-rap, boulders, and cobbles and shells, as well as plastic debris. Native oysters are likely limited by natural and complex hard substrate, which is lacking in many parts of the Bay. Recruitment, growth, and mortality demographics of native oysters are key focused areas of study in experimental restoration projects. Food limitation is likely, given the low chlorophyll concentrations in the northern reaches of the Estuary (Subtidal Goals 2010).

Olympia oyster populations have been severely impacted by over-harvesting, pollution, and introduced species have severely impacted Olympia oyster populations. If oysters can be restored in high numbers, nutrient cycling, and, in turn, water quality, may be improved in the Bay. Shellfish beds may provide filter-feeding functions to areas where filter feeders are not present (Subtidal Goals 2010). Research also suggests that oysters and oyster-restoration substrate can alter hydrographic regimes, providing shoreline protection from flooding and erosion.

Recommendations

Protect, restore, and enhance 8,000 acres of the identified suitable native oyster habitat by 2060.

Goals for shellfish bed habitat focus on protecting existing native oyster beds, restoring and enhancing additional beds, and improving understanding of ecosystem services, factors influencing the beds, and restoration methods. These recommendations come directly from the Subtidal Habitat Goals Report (2010), which remains the most comprehensive and relevant source for shellfish habitat goal setting and are also supported by the report "A Guide to Olympia Oyster Restoration and Conservation" (Wesson et al., 2015). The 2010 report uses slightly different definitions of restoration and enhancement from the definitions stated herein (see pg. 3). Restoration is defined as "actions taken in a converted or degraded natural habitat that result in the reestablishment of ecological processes, functions, and biotic/abiotic linkages and lead to a persistent, resilient system integrated within its ecological landscape." In the Subtidal Habitat Goals Project, the term restoration also means to include actions such as create, enhance, remediate, and rehabilitate" (Goals Project 2010). For the sake of clarity, protection, restoration, and enhancement will be included in one numeric goal, to best align with the Subtidal Goals' framework.

The 8,000-acre restoration goal is derived from UC Davis researchers' estimates of the total potential area at preferred sites within the shoreline segment out to a 2-meter depth. This acreage is approximately 9% of the total intertidal and subtidal habitat, from the shoreline to a 2-meter depth. The area research outlined is meant to represent a footprint of potential Olympia oyster habitat. Native oysters would not be restored throughout the entire 8,000 acres, but at a subset of locations within these larger areas. The long-term acreage targets were developed with the assumption that without restoration efforts, native oyster abundance will remain relatively stable.

Protect: Ensure no net loss to existing native oyster populations; increase understanding of oyster population dynamics; expand awareness of climate change impacts to native shellfish.

Long-term, multi-site demographic studies on native oysters are lacking for San Francisco Bay populations. The distribution and abundance of oyster populations shift regularly, due to climatic variables, recruitment, disease, and predation; however, these factors are only now beginning to be understood (Cheng et al., 2022).

Less is known about how stressors due to climate change, such as more frequent and intense storms, will impact native oysters. More intense storm events will result in greater amounts of sediment and decreased salinity, both of which impede oyster survival (Cheng et al., 2016). Rising ocean temperatures, and increased acidification and hypoxia will likely also impact oyster reproduction, growth, and shell-building (Hollarsmith et al., 2020). Further research on population dynamics and its intersection with climate change will inform where to prioritize shellfish bed protection. Protecting spaces landward of the current intertidal and subtidal zones may be necessary for preserving shellfish bed habitat as sea level rises.

Native oysters are found both above and below mean sea level, and fare better in areas with higher salinity and lower turbidity. Opportunities to protect oyster habitat occur throughout the Estuary, and more opportunities may arise as turbidity declines. In the highly urbanized Central Bay, existing oyster beds (in combination with eelgrass) can be used to create living breakwaters, protecting landward habitats and infrastructure. In the South Bay, oyster reefs should be protected wherever possible, especially adjacent shoreline that would benefit from physical protection including tidal mudflats and marshes. Subtidal Goals (2010) lists many locations along the shoreline for native oyster protection:

- Sausalito shoreline
- Richardson Bay shoreline in front of the Audubon Center
- the Tiburon Peninsula
- Angel Island
- Point San Quentin south and north of the Richmond-San Rafael bridge
- hard substrate along the southeastern shoreline of San Pablo Bay between Point San Pablo and Point Pinole
- shoreline from eastern edge of San Francisco Bay between the Oakland Outer Harbor and Point San Pablo
- Alameda shoreline and surrounding marinas; Sailing Lake shoreline
- Shoreline segment from Candlestick Park Point to Oyster Point.

Protecting shellfish beds requires a focus on policy and public education, will also support the goal of no net loss. Subtidal Goals (2010) discusses many strategies to promote a culture for native oysters. Some examples include:

- inspiring community stewardship through education and outreach particularly at high-density intertidal sites and at restaurants serving oysters ;
- minimizing recreation impacts to habitat, keeping construction and dredging projects away from high density shellfish habitat;
- conducting pre-construction surveys of native shellfish; locating water intake structures away from existing native shellfish beds.

Restore large areas of suitable habitat for native oysters; increase understanding of oyster recruitment and survival.

A primary goal for native oyster restoration is improving our understanding of factors influencing oyster recruitment and survival, ecosystem services, and long-term restoration strategies. Incorporating research with management, the goal is to restore large areas of habitat suitable for native oysters, using a phased, adaptive-restoration approach. Restoration targets are based on the acreage of shoreline areas out to a depth of 2m where native oysters have been documented, and correlate with recent monitoring data regarding distribution.

Native oysters should be restored at a subset of locations within these larger areas, paired with eelgrass restoration when feasible. Subtidal Goals (2010) recommends focusing restoration projects in the Central and South bays where salinity is less variable. Specifically, areas south of China Camp and Point Pinole are more suited to oyster reef creation. Subtidal Goals names 24 sites as priorities for native oyster restoration (see Subtidal Goals Chapter 7, pg. 112).

While pilot oyster restoration project teams have made progress gathering "first of its kind" monitoring data in the SF Estuary to date, gaps still exist in understanding in both what limits oyster populations in the Bay, and how to most effectively approach restoration. For example, we must continue gathering data about the degree of connectivity between Bay populations (Bible et al., 2016). Knowing what influences the movement of larvae, and in turn recruitment patterns is essential to the development of restoration approaches. Restoration accomplishments in the Bay to date have been implemented via relatively small-scale projects. Oyster restoration requires installing hard substrate, which is limited in the Estuary. Artificial reefs created from bags of clean oyster half shells or other such structures as reef balls can serve as sites in shallow and deep intertidal and subtidal areas (Subtidal Goals 2010). Other challenges to reef installation projects include settlement on the substrate by both native and non-native fouling organisms, burial by sediments, exposure to low salinities, heat stress at low tides, and predation by non-native oyster drills.

Prior restoration suggests that reef installations function best in several rows, with spacing in between to allow for movement of water and propagules,and when paired with additional habitat restoration including eelgrass bed plantings (Boyer et al., 2017). Where possible, oyster restoration should incorporate into larger habitat restoration projects and shoreline protection projects. Many such projects are already in the works. The San Francisco Bay Living shorelines: Near-shore Linkages Project is an experimental effort to increase understanding of native oyster and eelgrass restoration and their synergistic effects. Oyster reefs, eelgrass beds, as well as additional seaweed, tidal marsh, and upland ecotone approaches, have been part of science-based pilot demonstration projects from 2012 through 2022 at the San Rafael Shoreline, Eden Landing Ecological Reserve, former Red Rocks Warehouse location at Point San Pablo in the City of Richmond, and Giant Marsh within Point Pinole Regional Shoreline. These efforts have resulted in oyster population growth and successful recruitment of millions of oysters and dozens of species utilizing the habitats, while also reducing wave energy and accreting sediment (State Coastal Conservancy and partners, 2016). Oyster reef balls have highly complex surface areas, which function to enhance oyster and fish habitat and additionally dissipate wave energy and prevent shoreline erosion.

Enhance native oyster beds wherever feasible; enhance ecosystem functions by integrating multiple habitats.

Shellfish habitat can be enhanced by increasing connectivity to adjacent subtidal and wetland habitats. Integrated subtidal-wetland designs can incorporate such multiple habitat types as eelgrass beds, native oyster beds, kelp and algal fringes, rocky intertidal, and intertidal sandy beaches (Subtidal Goals 2010). When integrated, such habitats have a much greater capacity to dampen wave energy, prevent shoreline erosion, trap sediments, improve nutrient cycling and water quality, and provide food and shelter for marine organisms. Monitoring should be a key component of integrated designs, to measure habitat benefits.

Smaller-scale management projects can also enhance habitat quality for shellfish beds. Some examples include the removal and planting of invasive species, creating no-wake zones around shellfish beds, and substrate enhancement. The non-native cordgrass *Spartina alterniflora* x *foliosa* threaten to colonize mudflats and intertidal habitats via aggressive monocultures (Neira et al. 2005, 2006). The California Coastal Conservancy's Invasive *Spartina* Project (ISP) is leading efforts around the Estuary to eradicate non-native *Spartina* species to improve habitat functions and value to wildlife. Removal of artificial structures, specifically creosote pilings, can improve water quality and enhance the surrounding habitats. A recent example of this strategy is the San Francisco Bay Creosote Piling Removal and Pacific Herring Restoration Project. In this collaborative effort, CA State Coastal Conservancy and partners integrated creosote piling removal with oyster, eelgrass, and rockweed habitat restoration and monitoring. Future installation projects should ensure that new substrate designs mimic natural habitat features and consist of non-toxic materials (Subtidal Goals 2010).

Estuarine-Upland Transition Zone (UTZ)

Definition: Landward limit between mean high water and extreme high water or the highest observed tides. This boundary between water and land represents an area where the ecosystem services are predominantly controlled by measurable interactions between tidal, fluvial, and terrestrial processes or events, and typically includes distinct plant communities. De facto UTZ's also occur along the upland margins of non-tidal wetlands and waters, and share many attributes with their tidal counterparts.

Sub-habitats: Naturally sloping ecotones at marsh edges (spoil banks), transition ramps (levees), islands within marshes, barrier beaches.

Key habitat attributes: connectivity between wetland and upland ecosystems; high tide refugia for wildlife; UTZ habitats harboring distinct plant communities, providing critical wildlife support to adjacent ecosystems, and playing an important role in linking estuarine and terrestrial processes (CADS). The transitional areas used by individual wildlife species moving in and out of wetlands may span the UTZ and adjacent uplands. Many species rely on UTZ during periods of tidal marsh inundation, including such secretive marsh birds as Ridgway's Rail and Black Rail, and small mammals such as the salt marsh harvest mouse. A healthy UTZ also provides habitat connectivity for wildlife species including gray fox and coyote, flowering plants for pollinators including hummingbirds and insects, and nesting and foraging opportunities for many bird species (e.g., Lesser Goldfinch, Golden-crowned Sparrow, and Savannah Sparrow).

We outline here two related but separate habitat goals: numeric acreage goals and "functional" goals. Our numeric acreages are based on previous research (Fulfrost and Thomson, 2015; Fulfrost, 2018), habitat goals for tidal marsh outlined in this document, and expert knowledge. Functional goals came from these same sources, which focus on restoring and enhancing the ecological functions and biophysical processes of estuarine-upland transition zones. The numeric goals serve to guide high-level estuary-wide targets, in order to best enable overall estuary function. The functional goals primarily serve as qualitative criteria, used in conjunction with numeric acreage goals, to guide the location, extent and type of conservation action (protection, restoration and enhancement) and to assess their effectiveness.

Functional Goals for Estuarine-Upland Transition Zone Habitat

Estuarine-upland transition zone works as part of a habitat mosaic that comprises a resilient estuary. The fragmented nature of the SF Estuary provides few existing examples of a fully functioning estuarine-upland transition zone. Despite the lack of UTZ, it provides an important role in the overall ecological functioning of the estuary and adjacent uplands by connecting biophysical processes between terrestrial, fluvial, and estuarine systems. Increasing acreage of functional UTZ through enhancement and restoration is crucial to long-term resilience. Two important functions of UTZ include its role as high tide refugia for obligate fauna (SMHM and Ridgway's Rail) as well as potential migration space for marshes under pressure by sea level rise. We have included key functional goals for UTZ below, followed by any appropriate and useful attributes/ metrics to assess those functions.

Enable the movement of biological and geophysical processes between terrestrial/fluvial and estuarine systems.

Size and Depth (30 meters minimum, or greater): Adequate depth helps to reduce possible predation for obligate fauna and other species who might use the transition zone as high refugia or as transit area moving between terrestrial and estuarine habitats. It also allows for successful and resilient floral colonization, contributing to healthy function. UTZ with depths of 30 meter or more (and as topography allows) will enhance ecological functioning and biophysical processes (Thomson, 2013).

Shared boundary with adjacent tidal marsh and with adjacent uplands: The more continuous the size and extent of the boundary with adjacent tidal marsh (and upland), the better to help prevent habitat "choke points", more advantageous for predation, and restrict biophysical flows between habitats.

Tidal elevations (from slightly above MHHW to HOWL): Elevations of given locations of the zone are dependent on local tides and topography. For example, the location of MHHW and HOWL and the planar distance between them varies based on tidal action and local topography. These tidal range limits have been used (Fulfost and Thomson 2015; Fulfrost 2017) to determine the underlying distribution of UTZ both within current tidal frames as well as under different sea level rise scenarios. Tidal elevations serve as an underlying foundation for determining the extent and distribution of potential UTZ. Once the tidal elevation has been mapped, both size and depth can also be determined. However, they cannot serve alone to fully assess ecological function or process. This requires, at the very least, to understand habitat adjacency.

High tide refugia for obligate and other fauna.

Unique plant community: The tidal elevations that comprise UTZ provide the necessary conditions to enable a unique mixture of mostly high marsh and upland species. The vegetation serves as habitat and refugia for obligate fauna, as well as habitat for a variety of species, and serves as an attribute for enabling movement of species across habitats. Both San Francisco Bay Bird Observatory and Save the Bay have developed unique seed mixes for use in UTZ restoration.

Potential space for marsh migration: See "Tidal elevations' above.

A "healthy" transition zone fosters a number of ecological functions and biophysical processes. These functions and processes can be characterized by a number of habitat "attributes" that support ecological functions. Metrics of these attributes listed briefly above and detailed elsewhere (Thomson, 2013; Fulfrost and Thomson, 2015; Fulfrost, 2018), provide metrics of habitat function.

Recommendations: Acreage Goals for Estuarine-Upland Transition Zone Habitat

Acreage values included here reflect acreage of undeveloped UTZ that could stablize and recover without substantial changes in land use, to purposefully best enable overall estuary habitat function and "health". When considered in conjunction with functional goals, they exist as important targets for bay area-wide habitat conservation and management.

The acreage goals outlined here derive relative to the acreage of adjacent tidal marsh. Since acreage goals for UTZ were not included in either the original bayland habitat goals or in recent management plans, we first quantified the acreage goals for tidal marsh by combining existing tidal marsh (54,604 acres = 40,000 acres baseline from 1999 + 14,604 restored since 1999) with our updated restoration goals (~72,000 acres), resulting in a total target of ~126,604 goal acres of tidal marsh habitat. We used a very simplified "adjacency model" to identify an adequate acreage of UTZ required to support this amount of tidal marsh. To calculate a "high level" approximation of tidal marsh perimeter, we buffered existing tidal marshes using SFEI's EcoAtlas. We added a 60-meter buffer to tidal, managed, and muted marshes, which was twice the distance (30 meter) identified as the minimum required to support habitat function (Thomson, 2013). Since we only were approximating the need for UTZ on the landward edge, we divided the total acreage of this buffer in half. The total area of this 60-meter buffer was a 13% proportion of the buffered marshes. This resulted in ~16,500 acres of UTZ to support the final tidal marsh goal (~126,604 acres). To identify our restoration targets, we then subtracted existing transition zone acreage using data provided by the SFBJV (~1,416 acres of habitat connecting tidal marsh with uplands) from the 16,500 acres of needed UTZ (see below).

Protect 16,500 acres of Estuarine-Upland Transition Zone Habitat

We used the acreage of UTZ calculated through our simplified tidal marsh adjacency model (see above) as the acreage target for protection. The current amount of existing UTZ is ~1,416 acres (Fulfrost, 2018). Only 630 acres (44%) of these locations are currently within a protected area, leaving 786 acres (56%) unprotected. These existing unprotected UTZ habitats should be a priority for protection and can be identified using SFBJV's UTZ GIS dataset (Fulfrost, 2018, also see link below). The large percentage (although not all) of remaining areas needing protection most likely remain within either existing marshes or "adjacent uplands". These areas either fall within the range of current tidal elevations that characterize UTZ, but are behind water control structures, and can be mapped using the SF Bay Margin Decision Support System (Fulfrost, 2015; http://climate.calcommons.org/dataset/san-francisco-bay-estuarine-terrestrial-transitional-zone-decision-support-system), or are above the existing tidal elevation ranges that comprise UTZ, identified by using the "marsh migration" space GIS datasets produced for this report (contact the SFBJV to request access).

Examples of UTZ, (e.g., tidal elevations only adjacent to tidal marshes, not upland), continue to serve important ecological functions. However, the majority of these "within marsh" UTZ locations are already within existing tidal marshes and have therefore been included within our tidal marsh habitat goals.

Restore 15,100 acres of Estuarine-Upland Transition Zone Habitat

The focus of UTZ restoration should be to create and restore ***additional*** UTZ in support of the targeted tidal marsh acreage goals. In addition to the adjacent uplands mapped as migration space, UTZ GIS datasets created for the SFBJV map the extent of UTZ tidal elevations and habitat attributes (https://sfbayjv.org/resourcedocs/SFBJV_baseline_Tzone_whitepaper_final_100518.pdf), also containing values for the functional attributes listed above, can help to identify and evaluate the individual locations' potential for restoration (or enhancement). In accordance with SFBJV's prior work on UTZ, ***our targets for restoration focus on a transition zone that fully connects tidal marsh to upland*** (referred to as "backshore" by the SFBJV UTZ report). Therefore, tidal elevations adjacent to both tidal marsh and upland serve as the representative transition zone targeted for restoration. The targeted acreage goals for restoration were set by subtracting the amount of existing UTZ (1,416 acres) from the total acreage goal (16,350 acres) and rounding up, to complement a number of successful UTZ restorations throughout the bay.

Enhance 2,500 acres of Estuarine-Upland Transition Zone Habitat

The existing estuary lacks enough UTZ to support even the current extent of tidal marsh. Unfortunately, few locations with tidal elevations ranges remain that could serve as UTZ. Those suitable uplands adjacent to the estuary exist mostly behind water control structures (and their distribution around the bay is heterogeneous). Many UTZ restoration projects have occurred in sub-optimal locations adjacent to existing tidal marsh but not necessarily adjacent to uplands. These restorations still provide valuable support for flora and fauna, as well as for marsh development, although they do not enable processing between upland and estuary. These locations continue to provide some of the functions of UTZ, including high tide refugia, although certainly some locations work more effectively than others (possibly related to connectivity between sub-habitats). The majority of these "marsh adjacent" areas exist on levee flanks throughout the SF Estuary, especially (although not exclusively) in the South Bay. Since these levee flank restorations already enhance estuarine function (Nur et. al., 2018), we included them in our acreage goals for UTZ.

To determine the acreages for enhancement, a buffer around the SF Bay Shore Inventory (SFEI 2016) was created, and berms, embankments, water control structures and levees that were adjacent to tidal marsh were buffered by a 10 meter (one sided) buffer around these shoreline structures. This method helped set the goal of 2,500 acres of UTZ for enhancement, since some of these levees have already contributed to restoration or enhancement efforts. Of this acreage, 72% (1,800 acres) was within (or adjacent to) current UTZ tidal elevations (see definition above), indicating the high potential for these sites to perform at least some of the functions of UTZ. Considering overall estuary-wide goals will help prioritize which of these locations will need enhancement. (e.g. Combining fragmented "patches" of *within marsh* UTZ with levee flanks create a larger, more functional habitat, vegetation plantings, etc.) can be best determined at the local level.

Geographic Consideration

The distribution and availability of transition zones varies around the bay shoreline. These differences provide added challenges and opportunities to reach habitat goals.

- In the South Bay, UTZ primarily now exists along levee flanks where the tops of levees themselves poorly serve as upland. In these locations, we should prioritize protecting or restoring remaining tidal elevations that can fully serve as the transition from estuary to upland. Since these areas are limited, enhancing mid-marsh or levee flanks that serve some UTZ function (e.g., high tide refugia) should also be a priority. Although we find more potential tidal elevations in the South and Central bay, these are entirely within urbanized areas, providing less opportunity for restoration.
- The North Bay provides more opportunities for restoration and enhancement. With restored hydrology, more acres of *potential UTZ* become more suitable elevations, adjacent to both baylands and to adjacent *undeveloped* uplands in San Pablo and Suisun bays, than other parts of the estuary. Ensuring these areas are protected and restored should be an estuary-wide priority, and their protection will greatly assist with potential marsh migration under climate and other pressures.
- We did not necessarily consider Estuary-wide acreage goals for different habitats in relation to the extant mosaic of existing habits in a given location. As the SFBJV and other agencies move forward to implement these goals, additional projects that focus on local habitat needs we *should* consider within the context of overall JV's acreage and functional goals, to meet both "local needs" (to enhance, restore, and protect habitat) and regional goals.

The SFBJV and its partners can use the GIS datasets produced by Fulfrost and Thomson (2015, 2018), or datasets similar to it, to guide *where* protection, restoration, and enhancement should occur. These data can help to assess habitat function (i.e., attributes) to identify potential focus of restoration and enhancement at the estuary level.

Additional Habitat Considerations

In order to mitigate *climate pressure* (i.e., sea level rise) and to prepare for marsh migration, acreages and locations of protection (and ultimately restoration/enhancement) should likely be supplemented by potential UTZ tidal elevations under sea level rise. Mapped distributions of UTZ tidal elevations under different sea level rise scenarios (Fulfrost and Thomson, 2015) can serve as an important guide to identify places that might support potential UTZ in the future, as well as space for marsh migration.

Ultimately, we must consider restoration or enhancement of UTZ, relative to adjacent tidal marsh, available topography, and other pressures (e.g., sea level rise and land use). *Tidal marshes without any adjacent functioning transition zone* should be a high priority for UTZ restoration across the estuary.

Adjacent Uplands

Adjacent uplands are located at the interface between estuarine and watershed habitats and serve key roles in both ecosystems. These uplands extend beyond the wetland-upland transition zone and support a variety of ecological and biophysical functions for both the estuary and terrestrial habitats. They also provide important refugia and foraging habitat for endemic marsh species. Separate from uplands and transition zone, which have their own acreage and functional goals outlined elsewhere, adjacent uplands are being explicitly called out for their important role in long-term estuarine resilience to sea level rise. Specifically, these uplands (also referred to as "marsh migration space") provide potential spaces for marshes to move landward as sea levels rise. Under higher rates of sea level rise, these uplands may constitute the few remaining places where marsh habitat can persist and thrive.

Adjacent Upland Goals and Methods

We quantified acreage of adjacent uplands with the goal of enabling long-term marsh resilience. Protecting additional uplands along the existing bay margin also has the potential to assist with enhancing or restoring transition zones that are disconnected from the uplands. Table 3 below, provides acreage goals for this enhanced marsh migration space within "undeveloped" land uses (ABAG 2006), since this currently provides the most potential for protection. We have also quantified the acreages of adjacent uplands that are within (or outside of) protected area boundaries, using GreenInfo's CPAD database (CPAD 2020).

While its sub-habitats are essentially covered in the Watershed Habitats, these lands provide some unique and critical functions discussed below:

- Generally, this habitat extends from the upper edge of the estuarine-upland transition zone (just above the highest observed water line) up to seven meters elevation (to account for the 2150 extreme SLR scenario (OPC 2018)).
- Adjacent Uplands are mappable features important to the functions and health of UTZ, connecting estuarine to terrestrial/fluvial habitats.
- Adjacent Uplands connect fresh water and tidal marshes, with the UTZ biological and biophysical characteristics of both estuary and terrestrial systems.
- Adjacent uplands can provide critical habitat for plants and wildlife, increasingly important under the pressures of sea level rise.
- Adjacent uplands also serve as conduits enabling biophysical exchanges between terrestrial/fluvial and estuarine habitats.
- The specific ways these habitats provide support for flora and fauna and biophysical flows, as they relate to the estuary, require more study.
- Adjacent uplands, crucially, provide crucial potential migration space for tidal marshes as they shift landward from sea level rise.

The focus here is to quantify acreage of adjacent uplands as potential marsh migration space that will better enable long-term marsh resilience. We used available datasets (Beagle, J., Lowe, J., et al., 2019; Stralberg D., Veloz, S., et al., 2012; Fulfrost, 2018) to highlight the importance of protecting and restoring these areas to provide space for marshes as they migrate landward under sea level rise and other pressures. This "migration space" might not contain the mosaic of different estuarine habitats everywhere in the future, depending on the timing and extent of sea level rise, as well as important factors like sediment accretion and organic accumulation. As the SFBJV's partners evaluate these locations for protection, we recommend using other predictive models for estuary habitats under sea level rise, to better determine what specific estuarine sub-habitats (e.g. UTZ or high marsh) might be more advantageous at a given location, based on elevation, habitat adjacency or other constraints.

We quantified the acreages of potential adjacent uplands that could serve as marsh migration primarily using two existing datasets. The foundation of the acreages listed here are based on the marsh migration datasets developed by SFEI for their Adaptation Atlas report (Beagle, J., Lowe, J., et al., 2019). The GIS dataset of marsh migration space used in SFEI's report identifies areas above the current Highest Astronomical Tide (HAT) to 2 meters of sea level rise, as mapped by Our Coast Our Future (Barnard, P.L., et al., 2014). The recommended goals add a "buffer" to this marsh migration space to include a more conservative estimate for future planning. We amended the marsh migration datasets by adding an area landward, based on tidal elevation (as opposed to Euclidean distance), so that the additional area better reflects the "maximum" flood potential from the OCOF modeling for 2 meters of sea level rise as opposed to the mean flood potential (Barnard, P.L., et al., 2014) which SFEI used. We did this by extending the migration space from SFEI to include all the area up to the top of the predicted UTZ under a similar sea level rise scenario (Fulfrost, 2018), since the additional area was closer to the predicted inundated elevations under OCOF's maximum flood potential (for 2m of sea level rise). Protecting additional uplands along the existing bay margin also has the potential to assist with enhancing or restoring acreages of UTZ if the enhancement or restoration of these uplands connects them to UTZ, currently connected only to the estuary (and not uplands). Table 10, below, provides acreage goals for this "enhanced" marsh migration space. We have only included acreage goals for marsh migration space within "undeveloped" land uses (ABAG 2006), since this currently provides the most potential for protection. We have also quantified the acreages of adjacent uplands within (or not within) protected areas, using GreenInfo's CPAD database (CPAD 2020).

Table 10. Adjacent Uplands ('Marsh Migration space') Acreage Goals* by Bay Unit

Bay Unit	Not Protected	Protected	Total
Central Bay	1,281	760	2,042
North Bay	4,620	1,969	6,589
South Bay	2,811	2,709	5,520
Suisun Bay	5,306	924	6,230
Total (All Bays)	14,019	6,364	20,383

** Acreages only include undeveloped land uses*

Watershed Habitats

Watershed habitats occur from the inland edge of the baylands (SFEI 1999) to the outer boundaries of the nine Bay Area counties. A watershed is defined as an area of land in which rainfall and snowmelt feed into a common set of streams and rivers that drain into a single larger body of water, such as a large river, bay, or ocean. For the purposes of the update to the Implementation Plan, Watershed Habitats correspond to **Adjacent Habitats** (BEHGU), **Upland Habitats** (CLN), and **Seasonal Wetland,** and **Creeks, Lakes and Ponds** (RTE, p. 97) habitats.

Although all parts of the ecosystem are important for habitat function, four key watershed components are essential to protect, restore, and enhance in order to achieve SFBJV objectives. These watershed components include: Lakes and Ponds, Seasonal Wetland and Vernal Pool Complexes, Stream Valleys (Alluvial Creeks & Riparian zones), and Headwater Creeks and Source Areas. The latter two habitat types are new to the Implementation Plan and have been added in order to promote and track the conservation of areas that provide both direct habitat for Joint Venture priority species, and the material inputs (e.g., water, sediment, nutrients) that downstream and estuarine habitats require for long-term function.

The present update to the Implementation Plan incorporates data, findings, and goals from the 2019 release of the Conservation Lands Network (CLN 2.0), a Bay Area region-wide assessment and vision for upland biodiversity conservation.

Table 11. Habitat acreage goals for Watershed Habitats. Numeric goals represent what we still need to conserve. Numeric goals can overlap among the conservation action categories (protect, restore and enhance), meaning that the same acre may need to be both protected, restored, and/or enhanced).

Watershed Habitats	Protect	Restore	Enhance
Lakes and Ponds[7]	4,500	1,000	6,000
Seasonal Wetlands and Vernal Pool Complexes[8]	5,000	2,500	3,500
Alluvial Stream Valleys[9]	200,000	50,000	200,000
Headwater Creeks and Source Areas[10]	270,000	50,000	100,000

Notes 7. Source: CLN 2.0 (Bay Area Aquatic Resource Inventory [SFEI]; National Wetland Inventory); 8. Source: CLN 2.0 (National Wetland Inventory, California Department of Wildlife); Human Modification (The Nature Conservancy Omniscape 2018); 9. Source: CLN 2.0 (USGS); 10. Source: CLN 2.0 (National Hydrography Dataset, CalWater 2.2.1, USGS); 13.

Lakes and Ponds

Definition: Inland bodies of standing or slowly moving freshwater of various sizes and depths. Size of water bodies in the Bay Area vary greatly. Seismically-formed sag ponds, that often teem with life, can be as small as a few hundred square meters, while Lake Berryessa, an artificial reservoir in Napa County and Audubon Important Bird Area (IBA), is over 19,000 acres, equal to the size of the City of Richmond. The vast majority of the Bay Area's approximately 10,000 lakes and ponds are artificial stock ponds associated with livestock ranching. Natural lakes and ponds have often been highly altered and degraded, and some still offer opportunities for restoration or enhancement (e.g. Tolay Lake). Other lakes and ponds in the region have been created for agricultural irrigation storage, fire protection, and recreation. Artificial ponds can support a wide range of birds (including migratory) and other wildlife species. Presence of bullfrog, bass, and other non-native invasive species significantly reduces value to native species.

Sub-habitats: Lakes, reservoirs, natural sag ponds, artificial stock and irrigation ponds.

Key habitat attributes: Size, depth, surrounding vegetation types, water source, saturated soils, temperature and oxygen strata, pH level, age (succession) of water body (older bodies of water having greater amounts of nutrient-rich mud on the bottom), and width of riparian zone along edges. Lakes and ponds are important water sources for terrestrial wildlife and provide: roosting, nesting, and foraging habitats for resident waterfowl; stopovers for migratory waterfowl; and habitats for reptiles and amphibians, including listed species such as California red-legged frog (*Rana draytonii*), California tiger salamander (*Ambysotoma californiense*), and Western pond turtle (*Actinemys marmorata*).

Functional goal: Protect (from development or degradation) water bodies, surrounding riparian and upland habitat and hydrology, with an emphasis on ponds close in proximity to (or clustered with) other ponds within the Conservation Lands Network.

Many species of birds and wildlife often depend on both aquatic and terrestrial habitats and the transitional riparian habitats between the two. For example, upland bird species, such as the Belted Kingfisher, rely on ponds for foraging or nesting while requiring upland trees for roosting. Western pond turtles are aquatic but use uplands for nesting, and, in some cases, hibernate in nearby woodlands or ground squirrel burrows. Garter snake forage in ponds and use upland shrubs and grasslands for cover. Tri-colored Blackbirds nest and forage in pond/wetland bulrush, but also forage grasshoppers in adjacent grasslands.

Recommendations

Protect 4,500 acres of lake and pond habitat

Change from 3,000 to 4,500 acres. Rationale: 50% of total lake and pond acreage within SFBJV watersheds, which is approximately 9,000 acres. The 50% goal is consistent with CLN 2.0 lake and pond goals.

Restore 1,000 acres

Keep the 1,000-acre goal. Rationale: More information is needed to understand the scope of degradation and destruction of historical lakes and ponds in the Bay Area's uplands, thus the current need for restoration. Lacking a comprehensive assessment of historical loss complicates recommending any change in restoration acreage goals. We also recommend formulating a plan for conducting a comprehensive assessment to improve understanding of opportunities for conservation, restoration, and enhancement, and in particular, the role of historic lake and pond habitat to groundwater recharge.

Enhance 6,000 acres

Keep 6,000-acre goal. Rationale: The existing acreage goal of "Enhance" approximately equals the sum of pond acreage within human-modified areas of the Bay Area. In order to estimate which existing ponds likely require enhancement, we used an approximation of human modification of the environment developed by The Nature Conservancy, "California" Chapter (Landscape Connectivity using Omniscape, unpublished data, 2018; online description). The assumption is that lakes and ponds situated within landscapes that experience greater human activity are more likely to need investments to improve function.

Seasonal Wetlands and Vernal Pool Complexes

Definition: Wetlands within a matrix of uplands, located outside of the historic extent of the baylands. These habitats typically occur along streams on plains and in wide valleys or in basins in relatively flat areas and on gently rolling ground where the water table is close to the ground surface, or where impermeable soils slow percolation and result in ponding. Winter rain swells the extent of streams or fills depressions and either drains slowly due to downstream topography or hydrography or evaporates throughout the dry season. Examples of seasonal wetlands include the Laguna de Santa Rosa on the Santa Rosa Plain (a Ramsar-designated wetland of international importance), Tolay Lake and Laguna Lake in southern Sonoma County, Laguna Seca in Coyote Valley in southern Santa Clara County, and the Warm Springs Unit of Don Edwards San Francisco Bay NWR in southern Alameda County. Vernal pools exist throughout the Bay Area, but the largest complexes lie east of Travis Air Base in Solano County, on the Santa Rosa Plain in Sonoma County, east of Mt. Diablo in Contra Costa County, and in Livermore Valley (Alameda County), and Coyote Valley in Santa Clara County.

Sub-habitats: Seasonal wetlands or marshes, wet meadows, moist grasslands, vernal pools, seeps, seasonal ponds.

Key habitat attributes: Important foraging areas for shorebirds and waterfowl, including migratory species; unique plant and invertebrate communities; supports burrowing owls; important habitats for reptiles and amphibians (e.g., the California tiger salamander and California red-legged frog.

Functional Goal: Conservation of the physical habitat structures and hydrologic processes that support seasonal wetlands and vernal pool complexes. Structures include the low-gradient landforms or depressions that become flooded or otherwise collect water, ancient soils that slow percolation, and water-flow pathways, including surface and groundwater, that feed and naturally drain wetlands over time. Conserve lands that functionally connect wetlands and wetland complexes in order to facilitate dispersal of wetland-dependent birds, wildlife, and plants. Success comes through land conservation of wetlands, their associated riparian zones, and connecting lands (habitat linkages), and, through reducing nearby water diversions for human uses.

Recommendations

Protect 5,000 acres of Seasonal Wetlands and Vernal Pool Complexes

Increase from 2,500 to 5,000 acres. Rationale: The new acreage goal reflects the CLN 2.0 goal of 90% of remaining unprotected wetland (2,150 acres) and vernal pool complexes (3,150 acres).

Restore 2,500 acres of Seasonal Wetlands and Vernal Pool Complexes

Increase from 2,000 to 2,500 acres. Rationale: It is estimated that 90% of California's vernal pools have been destroyed. We estimate that it is feasible to restore another 50% of existing seasonal wetlands and vernal pools, which, according to several sources (NWI, CDFW, SFEI) totals approximately 5,500 acres in the SFBJV region.

Enhance 3,500 acres of Seasonal Wetlands and Vernal Pool Complexes

Keep 3,500-acre goal. Rationale: Acreage approximately equals the sum of seasonal wetland and vernal pool acreage within human-modified areas of the Bay Area, human-modified areas mapped using a GIS layer of human modification of the environment developed by The Nature Conservancy, California Chapter. (*Landscape Connectivity using Omniscape,* Unpublished data 2018; online description.)

Alluvial Stream Valleys

Definition: This term refers to the physical space needed to allow fluvial and ecological processes to occur over their natural spatial and temporal scales in medium- to low-gradient streams. Alluvial Stream Valleys include all parts of the fluvial system along alluvial stream reaches (channel, side channels, and floodplains), but also the terraces and the transitional upland fringe (see Figure 4) that capture precipitation and recharge the riparian aquifer and contribute sediment and nutrients to the stream. Alluvial Stream Valleys locate primarily in the middle and lower parts of a watershed where stream flows and substrates are suitable for spawning and rearing salmonids, and where dynamic vegetation succession processes result in complex in-stream habitat and diverse riparian habitat.

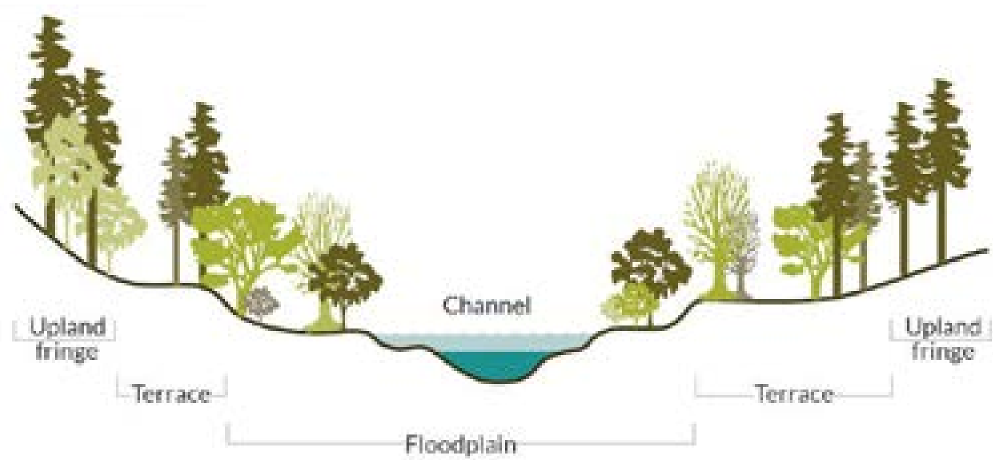


Figure 4. Stream Valley Cross-section. Functions of the floodplain include bank stability, shading, and organic matter inputs. Terrace and upland fringe functions include wood recruitment, sediment, and nutrient retention, and provision of habitat for riparian obligate species. Adapted from Eubanks, 2004.

Sub-habitats: Channel, floodplains, terraces, and upland fringe. Vegetation communities that serve riparian ecological function, to include riparian obligate communities (e.g,, mixed hardwoods, sycamore alluvial woodlands), valley bottom specialists (e.g., valley oak woodlands, coast redwood forests), and uplands-associated communities (e.g., grasslands, live oak woodland, Douglas-fir forest).

Key habitat attributes: Floodplain: bank stability, shading, sediment recruitment, and organic matter inputs; Terrace and upland fringe: wood recruitment, sediment and nutrient retention, and habitat for riparian-obligate species. Wildlife corridors: important habitats for neotropical migratory birds, native mammals, salmonids, amphibians (including foothill yellow-legged frog), and other wildlife; unique plant and animal communities; biofilters; sediment transport; flood reduction; important water sources.

Functional Goal: Conservation of stream networks and the fluvial processes (e.g., flooding, natural bank erosion and failure, aquifer recharge, etc.) and ecological functions (e.g., large wood recruitment, vegetation growth and succession, organic matter input, shading, etc.) that drive structural complexity, vegetation mosaics, and hydrological conditions that all lead to healthy stream habitats and riparian biodiversity. We help to accomplish this by conserving wide, variable-width corridors along streams.

Recommendations

We recommend setting acreage goals for stream valleys instead of stream miles. The CLN 2.0 project mapped stream valleys using up-to-date digital elevation models (see Figure 5). The areas identified approximate the space required by streams for material and riparian function. Stream valleys classify as natural, urbanized, or cultivated, using current land use-land cover data (California Department of Conservation). The recommended SFBJV protection, restoration, and enhancement goals below reflect these classes.

Protect 200,000 acres of Alluvial Stream Valley Habitat

Rationale: To protect 100% of the unprotected natural stream valleys within the SFBJV region.

Restore 50,000 acres of Alluvial Stream Valley Habitat

Rationale: Urbanized stream valleys typically have only their channel and a narrow strip of natural vegetation remaining. Consider in-channel enhancements in "converted - urbanized" stream valleys.

Enhance 200,000 acres of Alluvial Stream Valley Habitat

Rationale: Successful "threshold" = 50% of the "converted - cultivated" stream valleys within SFBJV region.

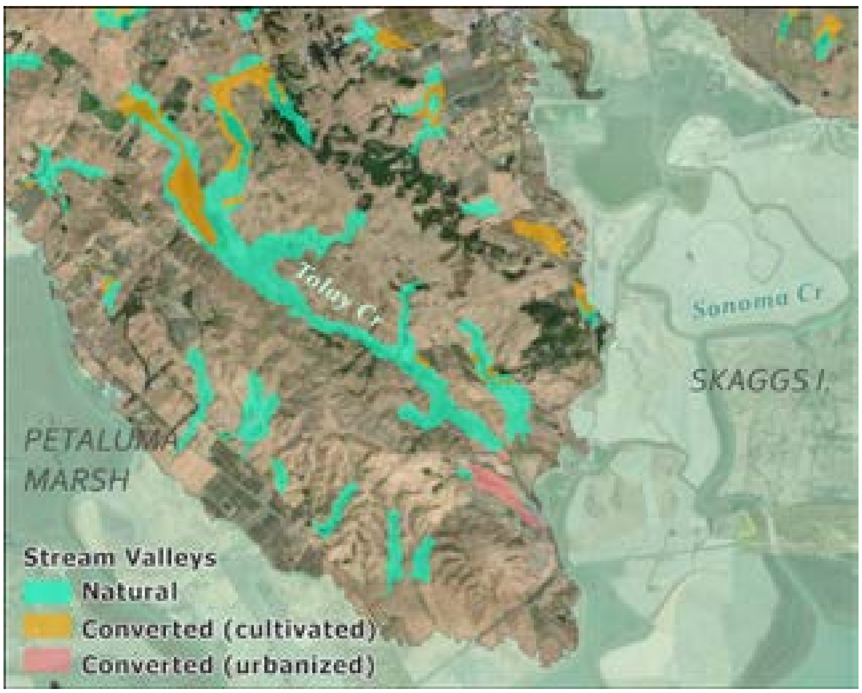


Figure 5. Stream valleys from CLN 2.0 classified by cover: Natural (teal), cultivated (orange), and urbanized (red) from CLN 2.0. Stream valleys, identified using terrain analysis of a 10-meter Digital Elevation Model.

Headwater Creeks and Source Areas

Definition: Headwaters, the upper part of a watershed, providing important benefits to the entire watershed (Figure 6). Small, entrenched tributaries in headwaters capture water, sediment, and organic matter, and deliver these materials to lower parts of the watershed and estuary. In forested coastal headwaters, fallen logs and other large woody debris deposit into the stream and contribute to the creation of complex habitat for anadromous fish and other aquatic life in the lower sections.

Sub-habitats: Small, high-gradient creeks, steep wooded or forb-dominated hillslopes.

Key habitat attributes: water, sediment, and organic material transport to lower parts of the watershed and estuaries; flood damage risk reduction (via limiting impervious surfaces and artificial drainages in headwaters).

Functional goal: Maintain or enhance integrity of headwater lands that collect and contribute material (i.e., water, sediment, nutrients, etc.) to the SF Estuary, Laguna de Santa Rosa, and other plains and wide valleys throughout the SFBJV region.

Recommendations

Align goals with CLN 2.0 headwater goals.

Protect 270,000 acres of hydrologically connected upper watershed area, which includes 650 miles of priority, 1st-order headwater streams that deliver water, organic nutrients, and sediment to lower reaches and the estuary.

Watershed area rationale: Unprotected CLN 2.0 priority network lands within Headwater Source Areas within the SFBJV region.

Restore 50,000 acres of hydrologically connected upper watershed area.

Rural road repair and erosion mitigation treatments, conservation forestry, working lands, sediment delivery. Rationale: 50,000 acres approximately equals *half the sum* of Headwater Source Areas within *moderately high human-modified areas* (e.g., medium density rural residential and agricultural areas) of the Bay Area. Human-modified areas were mapped using a GIS layer of human modification of the environment developed by The Nature Conservancy, California Chapter. (*Landscape Connectivity using Omniscape,* Unpublished data 2018; online description).

Enhance 100,000 acres of hydrologically connected upper watershed area.

Flow enhancement projects (e.g., onsite storage of stormwater, summer releases); Conservation forestry (working lands, sediment delivery). Rationale: 50,000 acres approximately equals *one-third the sum* of Headwater Source Areas within *low to moderately human-modified areas* (e.g., low density rural residential areas) of the Bay Area. Human-modified areas, mapped using a GIS layer of human modification of the environment developed by The Nature Conservancy, California Chapter. (*Landscape Connectivity using Omniscape,* Unpublished data 2018; online description).

Figure 6.Headwater creeks and source areas (blue) from CLN 2.0. Headwater areas were identified by calculating the upper elevation values for each CalWater 2.2.1 watershed.

Outer Coast Habitats

Definition: Habitats along the Pacific Coast in San Francisco, San Mateo, Marin, and Sonoma counties influenced by coastal and marine conditions and processes including tides, waves/swell, coastal wind and fog, and longshore sediment transport. This category includes coastal estuaries that are influenced by both marine and watershed/fluvial processes, as well as the riparian habitats that drain into these estuaries, with the exception of San Francisco Bay, discussed in detail above. Definitions for these habitats are based in part on the classifications developed by the Gulf of the Farallones National Marine Sanctuary (Duncan et al., 2013) and by The Nature Conservancy and Central Coast Wetlands Group (Heady et al., 2014).

Table 12. SFBJVs functional goals for Outer Coast habitats. Functional goals are based on GFNMS Climate-Smart Adaptation Report (Hutto 2016) and CLN 2.0.

Outer Coast Habitats	**Functional Goals**
Beaches and Dunes[11]	Maintain functional stability, protect, and enhance the ecological integrity of the beach and dune environment under present and future conditions.
Cliffs[11]	Protect existing cliff habitat from accelerated degradation (goals combined with beaches and dunes).
Rocky Intertidal[11]	Ensure that viable and ecologically-functioning rocky intertidal habitat remains present in the region.
Coastal Estuaries[11] (Bay/Embayment, Lagoon)	Optimize physical and biological function and processes of outer coast estuaries under present and future conditions.
Coastal Stream Valleys[12] (Riparian)	Protect wide, variable-width stream corridors and stream networks, and restore/enhance the fluvial processes and ecological functions that lead to healthy streams and riparian biodiversity.

Source: Hutto et al., 2016 : GFNMS Climate-Smart Adaptation Report ; 12. Source : CLN 2.0 ; 13.

Beaches and Dunes

Definition: Fine-grained habitats along the shoreline that can build and erode in response to waves, winds, tides, longshore sediment transport, and other physical processes. Examples of beaches in the region include Ocean Beach in San Francisco and the many state beaches in Sonoma and San Mateo counties. Most beaches within the region are dominated by sand but some, such as Rodeo Beach in the Marin Headlands, can also contain significant proportions of gravel and cobble. The term "beach" generally applies to wave- and tide-influenced habitats extending from the low tide line landward to the next geomorphic/habitat type (e.g., a dune or cliff), while the term "dune" typically applies to wind-influenced (eolian) habitats well above the reach of typical tides. Examples of dunes in the region include the dunes at Lawson's Landing near the mouth of Tomales Bay, and dunes at Half Moon Bay State Beach. Together, beaches and dunes are often referred to as "coastal strand" habitats.

Sub-habitats: Beaches: foreshore/beach face (flat, gently sloped area between MLW and the beach berm crest, exposed to wave action), backshore (the beach landward of the beach berm, generally not exposed to wave action). Dunes: foredunes (sparsely vegetated dunes closest to the ocean), central dunes (taller, more vegetated dunes landward of the foredunes), hind-dunes (most sheltered dunes farthest from the ocean), interdunal/dune slack wetlands (wetlands in between dunes supported by groundwater and/or surface water).

Key habitat attributes: Beaches: Beach width, hypsometry (exposure at different tidal stages), grain size, orientation, adjacency to related habitats (e.g,. lagoonal estuaries, dunes, etc.). Beaches provide an invertebrate prey base and foraging, roosting, and breeding habitat for shorebirds, as well as breeding and loafing habitat for pinnipeds, and breeding habitat for some fish (grunion). Beaches also front lagoonal estuaries, and help determine their habitat characteristics.
Dunes: Dune width, height, orientation, vegetative cover (native vs. non-native), presence/distribution/permanency of dune slack wetlands. Dunes provide roosting and breeding habitat for shorebirds, as well as habitat for native plants, many of which are "rare and/or special-status."

Functional Goal: Maintain functional stability, protect, and enhance the ecological integrity of the beach and dune environment under present and future conditions (GFNMS Climate-Smart Adaptation Report - Hutto et al., 2016). More specifically, this includes:

- Maintaining adequate space for beaches and dunes to move inland with sea level (beach transgression)
- Maintaining adequate sediment supply (from both longshore and fluvial sources) to support beach transgression
- Avoiding/ minimizing beach management activities that interfere with the natural delivery and movement of sediment (sand, gravel, etc.) and water to and on the beach, including armoring (e.g., revetments, seawalls, etc.), grading, lagoon inlet management/breaching, and related activities
- Protecting and restoring native dune and beach plant communities, and minimizing/eliminating invasive species including ice plant (*Carpobrotus edulis*) and European dune grass (*Ammophila arenaria*) which displace native species and/or interfere with natural sand movement
- Managing beach/dune recreational use to avoid/minimize impacts to special-status species such as Western Snowy Plover

Cliffs

Definition: Habitats that feature steep, rocky cliffs that either plunge directly into the ocean (where, between MLLW and MHHW, they are considered rocky intertidal habitat) or are fronted by narrow beaches that may be underwater at high tide. Examples of cliffs in the region include the Marin Headlands and Devil's Slide in San Mateo County. The stability and ecology of these systems is generally defined by the rock type, degree of weathering, and exposure to wave action. In much of the region, cliffs are generally unstable, and subject to erosion and collapse. Cliff erosion in many locations provides a critical source of sand to support and nourish beach and dune habitats.

Sub-habitats: N/A

Key habitat attributes: Rock type, degree of weathering, and exposure to wave action. Cliffs provide habitat for native plants, many of which are rare and/or special-status, as well as roosting and breeding habitat for some shorebirds, alcids, and raptors.
Functional Goal: Protect existing cliff habitat from accelerated degradation (GFNMS Climate-Smart Adaptation Report – Hutto et al., 2016). More specifically, this includes:

- Avoiding/minimizing armoring of cliffs, to facilitate natural erosional processes;
- Protecting cliffs from poaching of commercially valuable native plant species, to include *Dudleya* spp.

Rocky Intertidal

Definition: Rocky coastlines between MLLW and MHHW, often at the base of cliffs as well as offshore promontories. Examples of rocky intertidal areas include sea stacks off the Sonoma and Marin coasts, and the extensive tidepools at Fitzgerald Marine Reserve in Half Moon Bay. Rocky intertidal areas are typically subject to intense wave action as well as tidal inundation. Many invertebrate species that live in rocky intertidal habitats have limited to no mobility, and can therefore be exposed to extreme temperature and related environmental swings between high and low tides.

Sub-habitats: N/A

Key habitat attributes: Rock type, degree of weathering, exposure to wave action, surface area between MLLW and MHHW. Rocky intertidal habitats are among the most diverse and productive coastal habitats, and provide habitat for a wide variety of invertebrates (including but not limited to barnacles, limpets, abalone, mussels, sea anemones, and sea urchins), fish, pinnipeds, shorebirds, alcids, and other aquatic birds.

Functional Goal: Ensure that viable and ecologically functioning rocky intertidal habitat remains present in the region (GFNMS Climate-Smart Adaptation Report - Hutto et al., 2016). More specifically, this includes:

- Avoiding/minimizing armoring of rocky intertidal areas, to facilitate natural erosional and ecological processes
- Managing recreational use of rocky intertidal areas to avoid/minimize impacts such as overharvesting
- Reducing the risk of oil spills and related events that can smother rocky intertidal organisms

Coastal Estuaries

Definition: These embayments and bays are partially enclosed, primarily marine open water environments continually open to unimpeded tidal influence, and often subject to wave surge from the open ocean. Examples of embayments/bays in the region include Tomales Bay, Drakes Estero, and Bolinas Lagoon, as well as San Francisco Bay, which is treated separately in this report.

Sub-habitats: Coastal estuaries are generally large areas that can support many of the other coastal habitats described here, including beaches, dunes, cliffs, rocky intertidal, marshes, and large and small lagoonal estuaries (discussed below). They can also support such important subtidal habitats as eelgrass and surfgrass beds.

Key habitat attributes: Size, shape, bathymetry, swell exposure, substrate, catchment size/land use, presence/distribution of submerged aquatic vegetation (SAV).

Lagoonal Estuary - Large and Small: Lagoonal estuaries are unique estuarine environments generally open to marine influence via tidal and wave action through an open inlet across a beach berm during the wet season, and become predominantly freshwater systems during the dry season as flows subside, the beach berm grows, and the inlet closes. Upon inlet closure, water surface elevations in the estuary can often rise to supratidal elevations as watershed drainage backs up behind the closed beach berm, inundating backbarrier (landward of the berm) habitats to include marshes, floodplains, and ponds. The eventual return of the wet season usually brings with it watershed flows and ocean waves that breach the beach berm, draining the lagoon and any backbarrier habitats, and restarting the inlet morphodynamic cycle. Thus, lagoonal estuaries in the region tend to invert expected patterns of inundation in the region's Mediterranean climate, with deeper and more extensive flooding in the dry season (when the inlet is closed) than during the wet season (when the inlet is open). For purposes of this report, a lagoonal estuary is considered to be **Large** when it forms at the confluence of the Pacific Ocean and a major river. The only example of a **Large Lagoonal Estuary** in the region is the Russian River Estuary. Examples of **Small Lagoonal Estuaries** in the region include the Esteros de San Antonio and Americano along the Sonoma Coast, Rodeo Lagoon in the Marin Headlands, and the Pilarcitos Lagoon, San Gregorio Lagoon, and Pescadero Marsh in San Mateo County.

Sub-habitats: Lagoonal estuaries generally support multiple sub-habitats including open water channels and ponds, vegetated backbarrier marshes, dunes, beaches, mudflats, and coastal riparian/floodplain habitats.

Key habitat attributes: Lagoon inlet morphodynamics (which are, in turn, governed by beach and watershed characteristics), bathymetry/topography, vegetation communities, watershed and adjacent land uses, geologic setting. Lagoonal estuaries provide critical habitat for numerous native and special-status species (e.g., CA red-legged frog, CA tiger salamander, western pond turtle, tidewater goby, and multiple bird guilds), and can be especially valuable rearing habitat for coastal salmonids.

Functional Goal: Optimize physical and biological function and processes of outer coast estuaries under present and future conditions (GFNMS Climate-Smart Adaptation Report - Hutto et al., 2016). More specifically, this includes the functional goals listed under "Beaches and Dunes" above, as well as:

- Maintaining adequate space for lagoon habitats and peak dry-season water levels to move inland with sea level rise;
- Avoiding/minimizing management actions (such as breaching) that interfere with natural inlet morphodynamics and the evolution of backbarrier habitats;
- Minimizing point and nonpoint source pollution in lagoonal estuaries;
- Maximizing physical and ecological connectivity between lagoons and adjacent terrestrial, fluvial, and marine habitats;
- Avoiding/minimizing surface water and groundwater extractions that could impact lagoon hydrology;
- Protecting and restoring native lagoon flora and fauna, especially such special-status species as salmonids, tidewater goby, western pond turtle, California red-legged frog, and San Francisco garter snake.

Coastal Stream Valleys

Definition: Coastal stream valleys include riparian and floodplain habitats within the influence of coastal fog belts that support base flows through the dry season. These often narrow bands of habitat play a key role in mediating watershed and groundwater flows to downstream habitats and lagoonal estuaries, as well as shading and cooling streamflows. By serving as a source of large woody debris to streams, healthy coastal riparian habitats increase the complexity and biodiversity of in-stream habitats. Coastal riparian habitats also increase the delivery of allocthanous carbon to in-stream habitats, supporting the aquatic food web. Examples of coastal stream valley habitats in the region include areas along the Russian River and Salmon Creek in Sonoma County, Redwood Creek in Marin County, and Pilarcitos, San Gregorio, Pescadero, and Butano Creeks in San Mateo County.

Sub-habitats: Stream, floodplain, riparian habitats.

Key habitat attributes: Width, length, slope, creek flows (perennial vs. ephemeral), vegetation communities (e.g. woody, herbaceous), adjacent land use (especially, in grazing lands, presence/absence of fencing). Common coastal riparian vegetation communities in the region include willow, alder, blackberry, and poison oak alliances. Coastal riparian habitats support a broad range of terrestrial and aquatic wildlife species, provide foraging and nesting habitat for resident and migratory birds, and are critical to support salmonid spawning and rearing.

Functional Goal: Protect wide, variable-width stream corridors and stream networks and restore/enhance the fluvial processes and ecological functions that lead to healthy streams and riparian biodiversity. More specifically, this includes:

- Providing adequate buffers between stream corridors and adjacent land uses (development, agriculture, logging, etc.);
- Minimizing/eliminating barriers to fish passage in coastal streams;
- Minimizing the impacts of watershed roads and road crossings on stream habitats and fluvial processes;
- Avoiding/minimizing surface water and groundwater extractions that could impact stream flows and riparian vegetation;
- Protecting and restoring native riparian plant communities, and minimizing/eliminating invasive species such as tamarisk (*Tamarix* spp.), Cape ivy (Delairea odorata), and English ivy (Hedera helix) that displace native vegetation.

APPENDIX B. SFBJV WILDLIFE METHODS

Introduction

Since its inception, the SFBJV's mission has included conservation actions benefitting a spectrum of birds, not just waterfowl. National and continental bird conservation plans have expanded and now cover all major bird groups. Conservation goals within this plan include numeric goals for waterfowl populations within the Estuary. With numeric goals not yet set for other wildlife, the SFBJV recognizes the need to assess wildlife populations, to ensure that actions to protect, restore, and enhance habitats will result in tangible benefits to wildlife. Monitoring all species of interest is cost-prohibitive, requiring a wildlife-species indicator approach to measure habitat quality. The wildlife-indicator approach serves two important purposes: 1) to allow the SFBJV to measure wildlife response to conservation actions, and 2) to help the SFBJV identify threats to wildlife populations and discover new opportunities to address those threats.

Wildlife Indicators

Wildlife use of the SFBJV region

The San Francisco Bay Area's diverse habitats support an impressive array of wildlife, from Black-throated Gray Warbler in oak-covered hills to humpback whales feeding on anchovy at the Golden Gate. The San Francisco Bay Estuary has many designations identifying it as a crucial place for wildlife, and for birds in particular. Over a million shorebirds use the Estuary during migration each year (Page et al., 1999), and is one of only 15 "Hemispheric Reserves" certified by the Western Hemisphere Shorebird Reserve Network. NAWMP has recognized the Estuary as a high-priority area for waterfowl,and has also been designated a "Wetland of International Importance" under the Ramsar Convention on Wetlands. It contains several "Important Bird Areas" as identified by the National Audubon Society. The Bay Area also harbors 26 animal species protected by either the federal or state Endangered Species Acts. These species rely on many of the habitats for which the SFBJV has set specific acreage goals. Two of the most iconic endangered species of the Bay Area's baylands, the California Ridgway's Rail and the salt marsh harvest mouse, both depend on tidal marsh and continue to benefit from restoring tidal marsh habitats.

Many resources describe the wealth of wildlife diversity in the region, including their natural history, species' status, habitat requirements, threats, and conservation needs. We list (below) the wildlife species and species groups selected as indicators, but acknowledge the number of important species meriting study, and conservation investments go well beyond what the SFBJV and its partners can consistently track and measure. Our efforts' ultimate purpose is to steward this region of "global importance" for all Earth's creatures who depend on it, including us.. The links below provide more information on some of these key wildlife species, their status and distribution, habitat needs, in response to conservation efforts.

The Baylands Ecosystem Habitat Goals Project provides 29 Case Studies on the region's most distinctive species, including invertebrates, fish, mammals, and birds (Goals Project 2015). Each case study describes a species or species group, habitat issues, population status and threats, and conservation needs.

The State of the Estuary Report (2015) describes the status and trends of indicators of ecosystem health to cover benthic invertebrates, fish, harbor seals, waterfowl, shorebirds, herons, egrets, and tidal marsh birds. The only wildlife indicators in the most recent State of the Estuary Report (2019) were indices of native fish.

State of the Birds San Francisco Bay 2011 summarizes our knowledge regarding the Bay's bird populations, detailing the actions needed to keep birds and their habitats thriving as sea levels rise and extreme storm events increase from global climate change (Pitkin and Wood, 2011). We organize bird species by habitat type, including subtidal, tidal flats, tidal marsh, managed ponds, and uplands.

Recovery plan for Tidal Marsh Ecosystems of Northern and Central California includes detailed information on the habitat needs and status of two federally endangered animals, the California Ridgway's Rail and the salt marsh harvest mouse (***Reithrodontomys raviventris***), (USFWS 2013).

North American Waterfowl Management Plan focuses on waterfowl, their habitats, and the people who value them (NAWMP 2018).

Using Wildlife to Assess Progress

While actions of the SFBJV focus on protecting, restoring, and enhancing habitats within our geographic scope, the ultimate purpose of our work is to ensure that wildlife of this region have the functional and resilient land and waterscapes needed for them to survive and thrive. The "habitat for wildlife through collaborative conservation" approach implemented by the JV program since its inception 30 years ago has been incredibly successful, as evidenced by the recent NABCI report (2019).

While the SFBJV does not outline specific numeric population objectives for our wildlife species, aside from waterfowl objectives from the North American Waterfowl Management Plan, we instead adopt a wildlife-indicator approach that tracks the status of key species using SFBJV habitat types. This allows us to be more "intentional" in tracking wildlife response to our collective conservation actions, and gives us the framework to adjust priorities as needed. The indicator selection effort focused on vertebrate wildlife species and did not include invertebrates, vegetation, or physical indicators, even though those are important "known" drivers for wildlife.

Many of the indicator species selected are also conservation targets for SFBJV partners, and we can leverage species data collected to assess habitat quality to track population changes at multiple spatial and temporal scales. Finally, the indicator-species approach provides a way to report on the impact of SFBJV actions in terms of benefits to birds, mammals, and other taxa that resonate with both stakeholders and the voting public. With the information gained from tracking wildlife response to actions, the SFBJV can report on project accomplishments by action or by habitat, and generate success stories to build support. Most importantly, the SFBJV can identify such problems as declining populations, or new stressors, and can work to identify the source of the issue and take any necessary and appropriate actions within our geography.

The Science of Using Indicators

Using indicator species can be useful in describing a concept such as "habitat quality" when we can't measure everything that is potentially important. Rather than measuring hundreds of ecosystem components, managers can instead focus on components that represent either the desired habitat conditions or ecosystem functions. The best indicators provide early warning of responses for environmental impacts, directly indicate the cause of change, provide continuous assessment over a wide range of stressor intensities, and are financially feasible to measure. Collecting and using information on rare species is not always useful in making decisions to protect or improve ecological integrity (Chase et al., 2000), which is often too costly (and sometimes physically "impossible") to acquire sufficient sample sizes from small populations dispersed over large areas. Endangered and rare species are often sensitive to specific stressors that may not be related to either ecosystem integrity or restoration success. To assess "ecological integrity", Carrignan and Villard (2002) recommended that managers: 1) include multiple species representing diverse life histories, 2) select indicator species based on quantitative data from the region, and 3) use caution in distinguishing signals from variations not directly related to ecological integrity. For more discussion on selecting indicator species, and for what purpose, see Siddig et al. (2016).

How the SFBJV Indicators were Developed

The SFBJV reviewed the following reports, plans, and initiatives that use wildlife species as indicators of habitat or ecosystem function to develop a comprehensive list of potential indicator species and species groups:

- Wetlands Regional Monitoring Program (WRMP 2020)
- USFWS Refuge Natural Resource Management Plan for the San Francisco Bay National Wildlife Refuge Complex (USFWS 2019)
- State of the Estuary Report (State of the Estuary 2015)
- Climate Adaptation Decision Support (Mattsson et al., 2015)
- North American Waterfowl Management Plan (NAWMP 2018)
- State of the Birds San Francisco Bay (Pitkin and Wood, 2011)
- Baylands Ecosystem Habitat Goals Update (Goals Project 2015)
- San Francisco Bay Joint Venture Monitoring and Evaluation Plan (SFBJV 2011)
- Conservation Lands Network (Bay Area Open Space Council 2019)
- Subtidal Habitat Goals Report (Subtidal Goals Project 2010)

The SFBJV then established a Wildlife Working Group (Table 1) whose goal was to identify and prioritize these potential indicator species, and the metrics for target habitats. For each habitat type, the workgroup developed a list of l indicator species drawn largely from the comprehensive list the SFBJV provided. The Working Group identified potential metrics, associated monitoring efforts, and other information relevant to the indicator species or species group.

Table 1. Wildlife Working Group members and their affiliations, with SFBJV staff also participating and assisting.

Name	Affiliation
Julian Wood (Chair)	Point Blue Conservation Science
Joy Albertson	US Fish and Wildlife Service, Don Edwards SF Bay NWR
Susan De La Cruz	US Geological Survey
Colin Grant	US Fish and Wildlife Service, Tidal Marsh Recovery Plan
Nadav Nur	Point Blue Conservation Science
John Takekawa	Suisun Resource Conservation District
Isa Woo	US Geological Survey

The workgroup also reviewed and provided feedback on criteria for prioritizing the indicators (Table 2). Concurrent with this effort, the WRMP also developed criteria for selecting physical and biological indicators of tidal marsh ecosystem function. Because the WRMP and SFBJV had similar goals for the use of indicator species (e.g., to measure habitat health and wildlife support), and with many stakeholders involved in both efforts, the indicator selection criteria were similar.

The Conservation and Science committees jointly hosted a Wildlife Symposium in 2019.Approximately 55 partners attended including regional wildlife scientists, planners, land managers, and other conservation practitioners. Presentations on potential indicators followed a template with information on habitat affiliation, field protocols used, length-of-time series, data availability, use in decision-making processes, and use in State of the Estuary and other reports. Symposium participants also provided feedback on the criteria used to select the final indicators, and on the suite of "potential" indicators. The Symposium's goals included:

- Sharing information on potential wildlife indicators for SFBJV habitats,
- Refining the list of proposed indicators, indicator characteristics, and criteria for indicator selection.

Presentations included:

Indicator uses

- State of the Estuary Indicators - ***Letitia Grenier, San Francisco Estuary Institute***
- USFWS Refuge Wildlife Targets - ***Joy Albertson, USFWS Refuge***
- Climate Adaptation Decision Support Indicators - ***Joy Albertson, USFWS Refuge***
- Wetland Regional Monitoring Program - ***Heidi Nutters, San Francisco Estuary Partnership***
- State of the Birds for San Francisco Bay - ***Julian Wood, Point Blue***

Wildlife surveys

- Pacific Shorebirds Flyway Survey - ***Blake Barbaree/Matt Reiter, Point Blue***
- Mid-winter Waterfowl and Sea Ducks - ***John Takekawa, Suisun RCD and Susan De La Cruz, USGS***
- Marsh Birds - ***Julian Wood/Nadav Nur, Point Blue***
- Herons, Egrets, and Cormorants - ***Nils Warnock/Scott Jennings, Audubon Canyon Ranch***
- Salt Marsh Harvest Mouse/Small Mammals - ***Isa Woo, USGS***
- Harbor Seals - ***Sarah Allen, National Park Service***

We assessed the potential indicators based on the criteria in Table 2. This was a collaborative and qualitative process, as few quantitative measures related to the criteria were available for most indicators. We did not employ an explicit weighting scheme, given that the criteria were not assumed to be of equal importance. All criteria were deemed important, but the single most important criterion was that the indicator be strongly associated with one of the SFBJV habitat types. Using indicators that rely on multiple habitats within the SFBJV region limits the ability to attribute indicator status changes to SFBJV actions in any particular habitat, and limits the ability to develop corrective actions to reverse downward trends. For some migratory species, including shorebirds, the Estuary provides critical foraging and stopover areas. Although most migratory species use multiple habitat types, we prioritized species that relied on one SFBJV habitat type more than others. We also acknowledge that forces external to the San Francisco Estuary may drive changes in populations; however, tracking these indicator species can still shed light on species benefits from local habitat use.

Table 2. Criteria used to assess the utility of proposed indicators assessing habitat quality.

Criteria	Criteria Description
Relevance	Indicator is strongly associated with a SFBJV habitat type.
Credibility	Indicator has been tested for its usefulness and accuracy. Other entities and initiatives rely on the indicator.
Ongoing effort	Collecting data on the indicator reflects an existing and ongoing effort.
Length-of-time series	The number of years of data that can establish baselines and benchmarks.
Geographic scale	The indicator can be assessed at multiple geographic scales from rangewide, sub-bay, complex, Estuary, and site-specific levels.
Influence	Management decisions generated, based on indicator information in ways that positively influence conservation actions and outcomes.
Data standards	Data are collected using a detailed field protocol, and the data structure is standardized and centralized.
Feasibility	The data can be collected and summarized efficiently, and made available within a relevant time-frame.

Below, we describe the indicator selection process for tidal marsh habitat using the tidal marsh bird indicator as an example,) (e.g., California Ridgway's Rail, California Black Rail, Saltmarsh Common Yellowthroat, and three endemic subspecies of Song Sparrows). The primary metric proposed was breeding-season abundance, derived from two different standardized point count protocols; a 5-minute point-count survey focused on passerines (Saltmarsh Common Yellowthroat and Song Sparrow); and, a 10-minute point-count survey covering secretive marsh birds (California Ridgway's Rail and California Black Rail). Working through each criterion, the tidal marsh bird indicator was qualitatively assessed in Table 3.

Table 3: An example of the qualitative assessment process for *tidal marsh birds* as indicators of *tidal marsh habitat condition and quality* following the criteria in Table 2.

Criteria	Indicator Description and Justification
Relevance	Each species has strong association with tidal marsh habitat within the SFBJV boundary, spending its entire life cycle within the target habitat.
Credibility	Multiple studies demonstrate that indicators have a positive relationship with tidal marsh characteristics associated with high-quality reference conditions (e.g., fully tidal mature intact marshes with dendritic channel networks that are dominated by native plant species). The indicator utilized in the State of the Estuary Report 2015.
Ongoing effort	Efforts by Point Blue, the Invasive Spartina Project, USFWS, CDFW, among others, to collect data on the abundance of tidal marsh bird species, are ongoing.
Length-of-time series	Standardized surveys began in 1996 for passerine species and in 2005 for secretive marsh bird species.
Geographic scale	Multiple sites throughout the Estuary and Delta. Approximately 20 sites for tidal marsh passerines, and over 100 sites for secretive marsh birds.
Influence	Limited for tidal passerine species. Major restoration and development decisions by regional, state, federal and NGO entities influenced by California Ridgway's Rail data, due to its endangered species status.
Data standards	The data are collected using well-documented field protocols, the data structure standardized and centralized in the Avian Knowledge Network.
Feasibility	One trained observer can obtain annual, efficient data collection over the course of three mornings for a single marsh site. Data are generally available within one year. Summaries are produced annually, but synthetic analyses (density estimates and trends) are sporadic and dependent on funding.

Based on the descriptors in Table 3, tidal marsh birds rank highly as useful indicators of tidal marsh habitat quality for the SFBJV. The other proposed tidal marsh habitat indicator that ranked highly was the salt marsh harvest mouse, due in part to its exclusive year-round reliance on tidal marsh habitat and ongoing survey efforts. One potential indicator that did not rank as highly was the multi-species fish indicator. These indicators are not solely dependent on tidal marsh habitat for survival, and are more sensitive to conditions in open waters. Species that inhabit shallow waters and even tidal marsh (e.g., the long-jawed mudsucker) may be more indicative of marsh health, but are not part of this ongoing effort, due in part because of the difficulty in surveying marshes and shallows for fish.

High Priority Wildlife Indicators

We strove to select at least one, and no more than two, wildlife indicators for each of the Estuary habitats (Table 4). Indicator selection for watershed and coastal habitat types was still in progress, and is not included in this version. Selecting indicators, metrics, and identifying data sources to represent additional habitats may feature in future iterations of this plan. In addition, the methods used to develop the metric (e.g., ways to "calculate" density) will also need further development in later stages. For some indicators and metrics, the SFBJV will leverage and build upon summaries and reports developed by partners including the State of the Estuary Report (2015), the Baylands Ecosystem Habitat Goals (Goals Project 2015), and State of the Birds San Francisco Bay (Pitkin and Wood, 2011).

Table 4. List of high-priority wildlife indicators for SFBJV Estuary habitats.

Estuary Habitat Type	Indicator	Metrics
Non-tidal Wetlands and Waters	Ducks (dabbling, diving)	Mid-winter abundance
	Breeding waterbirds	Abundance or nest success
Estuarine-upland Transition Zone	UTZ focal bird spp	Area search abundance
Tidal Marsh	Tidal marsh birds	Point count abundance
	Salt marsh harvest mouse	Capture Efficiency
Tidal Flat	Wintering shorebirds	SF Estuary Shorebird Survey abundance
Beach	Resident marine mammals	Abundance
	Shorebirds	SF Estuary Shorebird Survey abundance
Subtidal: Submerged Aquatic Vegetation	Diving ducks	Mid-winter abundance
Subtidal: Shellfish Beds	Black Oystercatcher	SF Estuary Shorebird Survey abundance

How the Indicators and Metrics will be Adaptive

The metrics for several non-wetland indicators in Table 4 are not yet defined and will need further "description" before we can use them to evaluate habitat quality. The metrics for other indicators are stated only broadly (e.g., abundance of tidal marsh birds) and lack important details related to survey protocols and analytical methods. Coordinating the development of these metrics with other groups takes time but will lead to efficiencies in survey and reporting efforts. It will be more efficient for organizations to use metrics that rely on sharing data instead of each organization funding its own set of surveys that can't easily coordinate with other efforts. Standardized survey protocols and data-sharing structures give organizations access to more information, allowing them flexibility to assess habitat quality at different spatial scales, and to assess the effectiveness of different conservation actions. The SFBJV will need to stay engaged and adapt, as organizations move toward standardized metrics.

Redoubled efforts in developing and using indicators to assess habitat quality and response to restoration are underway. The WRMP, for example, expects to develop detailed metrics for wildlife indicators of tidal marsh habitat and management practices at the regional and subregional scales. The USFWS has described in detail the field and analytical methods for secretive marsh birds, one of the key indicators for tidal marsh quality (Wood et al. 2017). The wildlife species metrics, used in the State of the Estuary Report (The State of the Estuary 2015) and the State of the Birds of San Francisco Bay (Pitkin and Wood, 2011), also serve as examples for evaluating habitat quality.

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