SAN FRANCISQUITO CREEK BAYLANDS

LANDSCAPE CHANGE METRICS ANALYSIS

June 2016

SFEI | AQUATIC SCIENCE CENTER
SAN FRANCISCO ESTUARY INSTITUTE & THE AQUATIC SCIENCE CENTER

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Historical synthesis mapping of San Francisquito Baylands (developed by SFEI for this report).

VERSION

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Introduction

Project Background

Over the past century and a half, lower San Francisquito Creek and the surrounding tidal landscape have been highly modified. From the late 1800s through the early 1900s, levees were built along sections of the lower creek and adjacent tidal wetland areas were drained and converted to agricultural land. By the mid-20th century, the lower creek channel had been completely rerouted and flanked with flood control levees to convey flood flows more rapidly to San Francisco Bay and to remove tidal wetland areas from regular tidal inundation. This allowed for wetland filling and the building of roads, residential and commercial structures, a wastewater treatment plant, a golf course, and an air field. Land reclamation also included removing a portion of the tidal wetlands to make way for a harbor. Although tidal wetlands still exist around the mouth of San Francisquito Creek, the changes to the tidal landscape have resulted in a considerable decrease in the overall extent and have affected the physical processes that sustained the baylands ecosystem.

Study Goal and Objectives

The goal of this study is to develop a high level overview of the physical and ecological changes to lower San Francisquito Creek and the surrounding tidal marshes and mudflats (referred to here as "baylands") since the beginning of intensive European-American settlement. Building upon a previous reconnaissance-level historical ecology study (Hermstad et al. 2009), this study analyzes the changes in key landscape features (or landscape metrics) within lower San Francisquito Creek and baylands through comparisons of reconstructed historical (mid-1800s) and contemporary (2011/2012) conditions. The results from this study are intended to provide baseline information that can be used to help with developing restoration and flood control redesign alternatives and appropriate habitat restoration targets.

This study is one component of the Flood Control 2.0 project, a regional effort funded by the U.S. EPA to help design flood control channels at the Bay interface that support tidal habitats while maintaining the required level of flood protection. Emerging strategies for flood protection focus on reconnecting channels to floodplains and tidal marshes and using available dredged sediment as a resource to increase marsh elevations and help keep pace with sea level rise. Lower San Francisquito Creek is one of three implementation projects that have partnered with Flood Control 2.0 to assess the benefits of an integrated approach for flood control and habitat management at the Bay interface.

(Above) **Lower San Francisquito Creek** before entering San Francisco Bay (Scott Dusterhoff, July 2013).

Study Area

This study focuses on lower San Francisquito Creek and the baylands surrounding the creek mouth near the cities of Palo Alto and East Palo Alto (fig. 1). The study area extends from the Ravenswood Open Space Preserve at the northern edge south to Charleston Slough, covering the historical extent of tidal marsh and intertidal mudflat (or bayflat) around the mouth of San Francisquito Creek. This study area is slightly larger than area of the previous historical ecology study (Hermstad et al. 2009) and includes more historical habitat types. The extent is designed to cover a natural unit for shore management, or "Operational Landscape Unit."

Historically, the extensive tidal marsh in the study area provided abundant habitat for endemic wildlife species such as Ridgway's rail *(Rallus obsoletus),* black rail *(Laterallus jamaicensis),* common yellow-throats *(Geothlypis trichas),* Alameda song sparrow *(Melospiza melodia pusillula),* and salt marsh harvest mouse *(Reithrodontomys raviventris).* Large numbers of waterfowl passed through seasonally, resting and foraging in the marsh pannes, pools and channels. The broad mudflats provided foraging habitat for shorebirds and haul out areas for harbor seals *(Phoca vitulina).* The adjacent marsh-upland transition zone supported Pacific chorus frogs *(Pseudacris regilla),* red-legged frogs *(Rana draytonii),* and grassland/wet meadow birds including savannah sparrows *(Passerculus sandwichensis)* and meadowlarks *(Sturnella neglecta).* The creek also once supported a healthy steelhead *(Oncorhynchus mykiss)* population, as well as other fish including California roach *(Hesperoleucus symmetricus)* and hitch *(Lavinia exilicauda).* The complex channel network within the baylands supported resident fish including long-jawed mudsuckers *(Gillichthys mirabilis),* provided rearing habitat for steelhead, and provided additional habitat for Bay fish including leopard sharks *(Triakis semifasciata).*

The conversion of large amounts of tidal marsh to managed salt ponds and developed land over the past century and a half has limited the habitat available to marsh wildlife. However, large remaining tidal marsh patches in the Palo Alto Baylands, Laumeister Tract in East Palo Alto, and Faber Tract north of the San Francisquito Creek mouth provide some of the best remaining tidal marsh habitat in the South Bay. Tidal-terrestrial transition zones in this area have been largely lost, removing habitat that supports amphibians and upland bird species. In addition, the loss of riparian vegetation has impacted habitat conditions for fish and riparian birds.

Cliff swallow at Lucy Evans Baylands Nature Preserve (Don DeBold, May 2015)

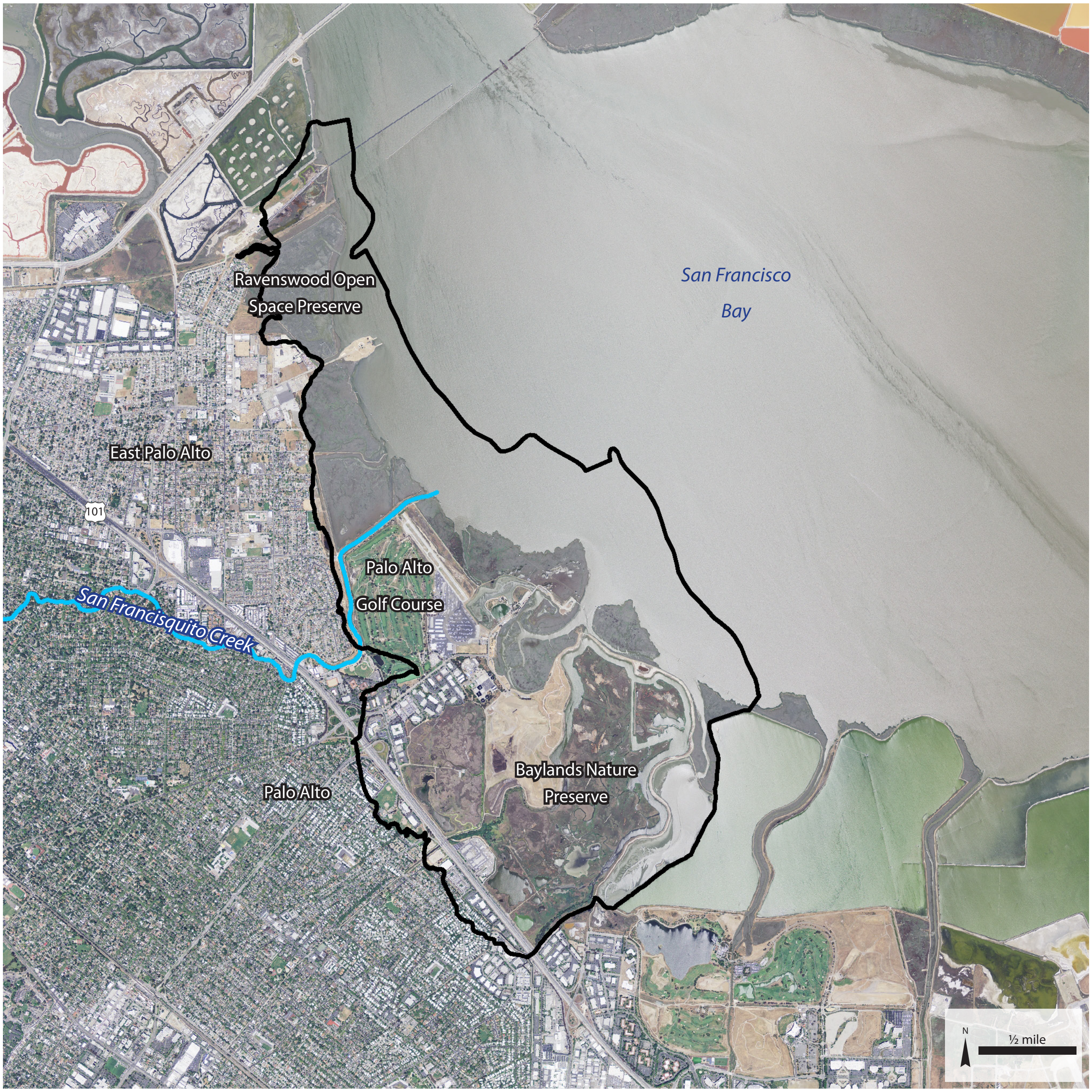


Figure 1. The study area (outlined in black) encompasses approximately 5 square miles, including lower San Francisquito Creek and the surrounding baylands. (NAIP 2012)

Methods

Historical Data Synthesis and Mapping

The historical analysis began by compiling existing GIS layers depicting the historical tidal channel network and bayland habitat types at the mouth of San Francisquito Creek. This effort focused on map layers created through SFEI's South San Francisco Baylands T-sheet mapping effort (SFEI 2003), which produced detailed historical baylands maps based on U.S. Coast Survey (USCS) and U.S. Coast and Geodetic Survey (USCGS) topographic sheets (T-sheets). We then used the historical bayland map for the mouth of San Francisquito Creek along with the map from the Hermstad et al. (2009) historical ecology study as the starting point for developing the channel and bayland habitat features required for this study.

Channel Network

Tidal channels were mapped both as lines and polygons. The channels mapped as single lines on the T-sheet (e.g., small blind channels at the head of a discrete channel network) were digitized as lines, while the larger channels mapped as double lines on the T-sheet (e.g., tidal sloughs at the downstream end of a discrete channel networks) were digitized as polygons. In order to calculate historical channel areas, the small tidal channels depicted as lines were assumed to have a width (in meters) equal to their assigned Strahler stream order (Strahler 1952).

Bayland Habitat Types

Historical bayland habitat types were mapped as polygons. Mapped habitat types include tidal marsh, salt pond/panne, subtidal channel, channel flat, and bay flat. These habitat types are described briefly below. A more detailed description of the bayland habitat types can be found in the Goals Project (1999) report.

> **Tidal marsh** refers here to vegetated portions of the baylands dominated by pickleweed *(Sarcocornia pacifica)* and California cordgrass *(Spartina foliosa)*.
>
> **Salt pannes** are open water or unvegetated areas found on the marsh plain. They are associated with portions of the high marsh plain removed from frequent tidal flooding, and as a result often form along drainage divides.
>
> **Channel flats and Bay flats** are the portions of tidal channels and the Bay that dewater during low tide. Channel flats include the smaller tidal channels in the study area, as well as relatively wide areas along the edges of the larger channels.
>
> **Subtidal channels** are the portions of tidal channels that do not completely drain even at low tide; the deepest parts of lower San Francisquito Creek and Charleston Slough fall into this category.

Transition Zone

To characterize the transition zone at the boundary between tidal and terrestrial habitats, we performed a simplified version of the tidal-terrestrial interface analysis described in Beller et al. (2013). A linear interface was extracted from the boundary between the tidal marsh and adjacent upland habitats and each segment of this line was attributed with the type of historical habitat present on each side of the line. Since habitat types had not previously been mapped for the San Francisquito Creek watershed inland from the historical bayland margin, we used a simplified, binary classification system for the terrestrial interface that distinguished a low-gradient interface (i.e., tidal marsh to alluvial plain) from a high-gradient interface (i.e., tidal marsh to hillslope/bedrock, see also Salomon et al. 2015).

Comparison to Contemporary Conditions

We used Bay Area Aquatic Resource Inventory (BAARI) contemporary tidal and wetland GIS layers (SFEI 2011) in the comparison of historical and contemporary habitat areas for resident animal species within the study area. The BAARI wetlands GIS layer was used to account for non-tidal wetland features now present within the historical baylands footprint. Some minor modifications were made to the BAARI layers to suit the scale and scope of this study.

Results and Analysis

The following section details the extent and location of historical bayland features based on our mapping and compares historical to contemporary conditions. Several initial landscape ecological metrics are also analyzed.

Historical Landscape Reconstruction

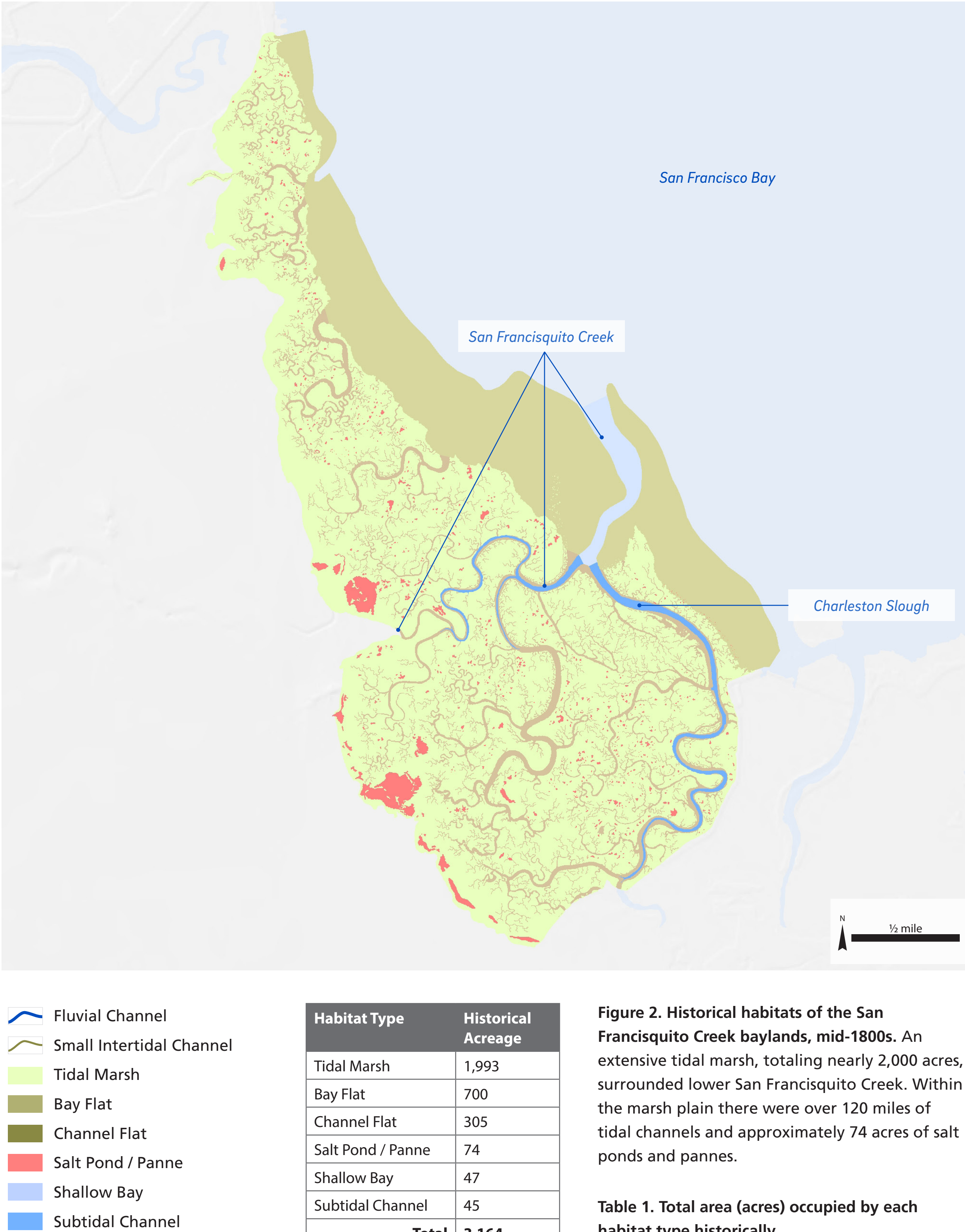
Our analysis shows that in the mid-1800s, an extensive tidal marsh plain covering over 2,000 acres existed at the mouth of San Francisquito Creek between the present-day Ravenswood Open Space Preserve south to Charleston Slough (fig. 2 and table 1). Within the marsh plain area were many salt pannes and several tidal channel networks connected to large sloughs. A broad bay flat over a half a mile wide separated the tidal marsh from the Bay at low tide. The large subtidal channel that bisected the bay flat was located just downstream of the confluence of San Francisquito Creek and Charleston Slough.

San Francisquito Creek and Tidal Channel Network

The historical tidal channel network in the San Francisquito Creek baylands included over 124 miles of channels. The vast majority (86%) of the network consisted of 1st through 3rd order channels branching from San Francisquito Creek and the other 5 major tidal sloughs (see fig. 2). Lower San Francisquito Creek made up 2 miles, or 2%, of the total channel length.

Bayland Habitat Types

The baylands at the mouth of San Francisquito Creek historically covered over 3,160 acres, with extensive tidal marsh covering the majority (63%) of the total baylands area and bay flat being the next most dominant habitat type (22% of the total area) (fig. 2 and table 1). The tidal channel network covered over 350 acres (11% of the total area) and included approximately 300 acres of channel flat and approximately 45 acres of subtidal channels. Nearly 900 pannes and salt flats covering over 70 acres (2% of the total area) dotted the marsh interior. The largest of these (approximately 10-20 acres in size) were located at the boundary between the marsh plain and upland where tidal water would evaporate and cause hypersaline soil conditions.



Habitat Type	Historical Acreage
Tidal Marsh	1,993
Bay Flat	700
Channel Flat	305
Salt Pond / Panne	74
Shallow Bay	47
Subtidal Channel	45
Total	**3,164**

Figure 2. Historical habitats of the San Francisquito Creek baylands, mid-1800s. An extensive tidal marsh, totaling nearly 2,000 acres, surrounded lower San Francisquito Creek. Within the marsh plain there were over 120 miles of tidal channels and approximately 74 acres of salt ponds and pannes.

Table 1. Total area (acres) occupied by each habitat type historically.

Tidal-Terrestrial Transition Zone

The San Francisquito Creek Baylands historically supported a relatively wide, contiguous low-gradient tidal-terrestrial transition zone. The 6-mile long zone marked the transition between tidal marsh and adjacent lowland alluvium. This was the more common of the two types of transition zone around the entire South San Francisco Bay prior to major land modification in the 19th and 20th centuries (Beller et al. 2013).

Comparison to Contemporary Conditions

The San Francisquito Creek Baylands have experienced a considerable reduction in tidal inundation extent and habitat area since the mid-1800s. The current tidal marsh area is approximately one-half of what it was historically. Similarly, the once-extensive tidal channel network and marsh-upland transition zone have been greatly diminished. These landscape changes are associated with corresponding decreases in ecological functions.

San Francisquito Creek and Tidal Channel Network

Today, lower San Francisquito Creek and the adjacent tidal channel network look much different than they did historically. In the early 20th century, the creek channel was rerouted and constrained by flood control levees to allow for land reclamation and development. This led to the modification and infilling of much of the tidal channel network to the south of the rerouted channel. The channel rerouting resulted in an overall reduction in San Francisquito Creek channel length from 2 miles to 1 mile (50% reduction) (fig. 3). Similarly, the modification or infilling of tidal channels (major sloughs and tributaries) in the study area resulted in a total channel length reduction from 122 miles to 40 miles (67% reduction).

Bayland Habitat Types

Overall, there has been a 36% loss in baylands area within the study area, from approximately 3,160 acres to approximately 2,000 acres (fig. 4). This trend has been largely driven by considerable reduction in tidal marsh area, which decreased from approximately 1,990 acres to approximately 890 acres (55% reduction) as a result of infilling and diking around the mainstem channel. The area of salt ponds/salt pannes has remained relatively static (<5% reduction), the channel flat area decreased from 300 acres to approximately 180 acres (40% reduction), and the bay flat area increased from approximately 700 acres to approximately 840 acres (20% increase) due to the inland migration of the shoreline (i.e., the marsh-bayflat boundary). Today, the baylands also contain tidal lagoons (~110 acres), non-tidal open water features (~20 acres), and non-tidal wetlands (~170 acres) that were created over the past several decades. Combined, these new features comprise approximately 10% of the total current baylands area.

Transition Zone

The once extensive and contiguous transition zone between the tidal marsh and broad, low-gradient upland areas is almost completely gone, decreasing from approximately 6 miles to less than 0.5 miles (95% reduction) (fig. 5). The tidal marsh is now mostly boarded by steep-sloped levees constructed to confine San Francisquito Creek and protect surrounding uplands from flooding. These levees are assumed to have little to no habitat value currently and prohibit future inland marsh migration as sea level rises.

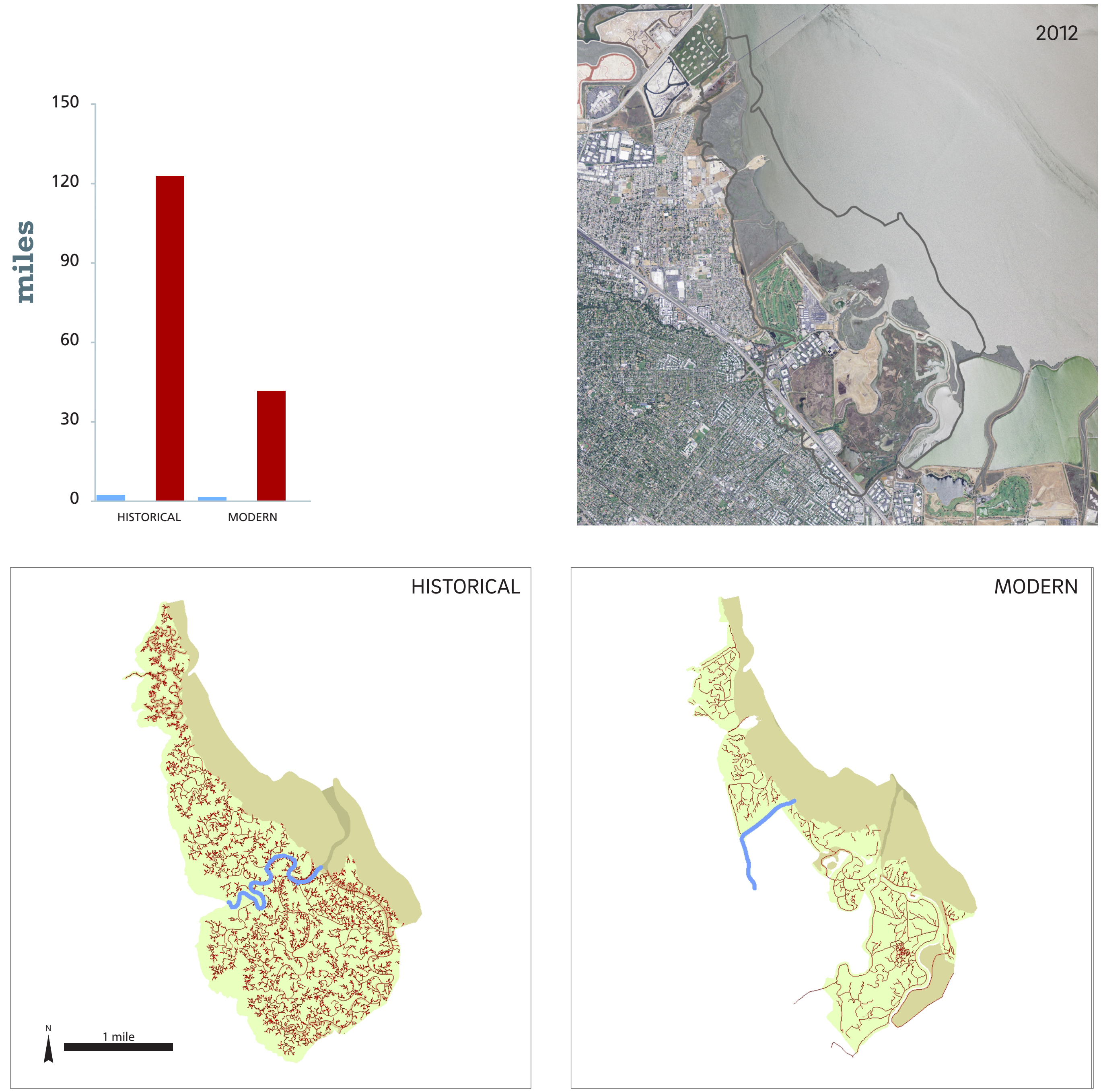


Figure 3. Historical and contemporary channel length for lower San Francisquito Creek mainstem and tributaries. The San Francisquito Creek mainstem has decreased in length by approximately 50% due to channel rerouting and the total length of tributary channels in the surrounding baylands has decreased by approximately 67%. See fig. 2 for habitat type legend. (NAIP 2012)

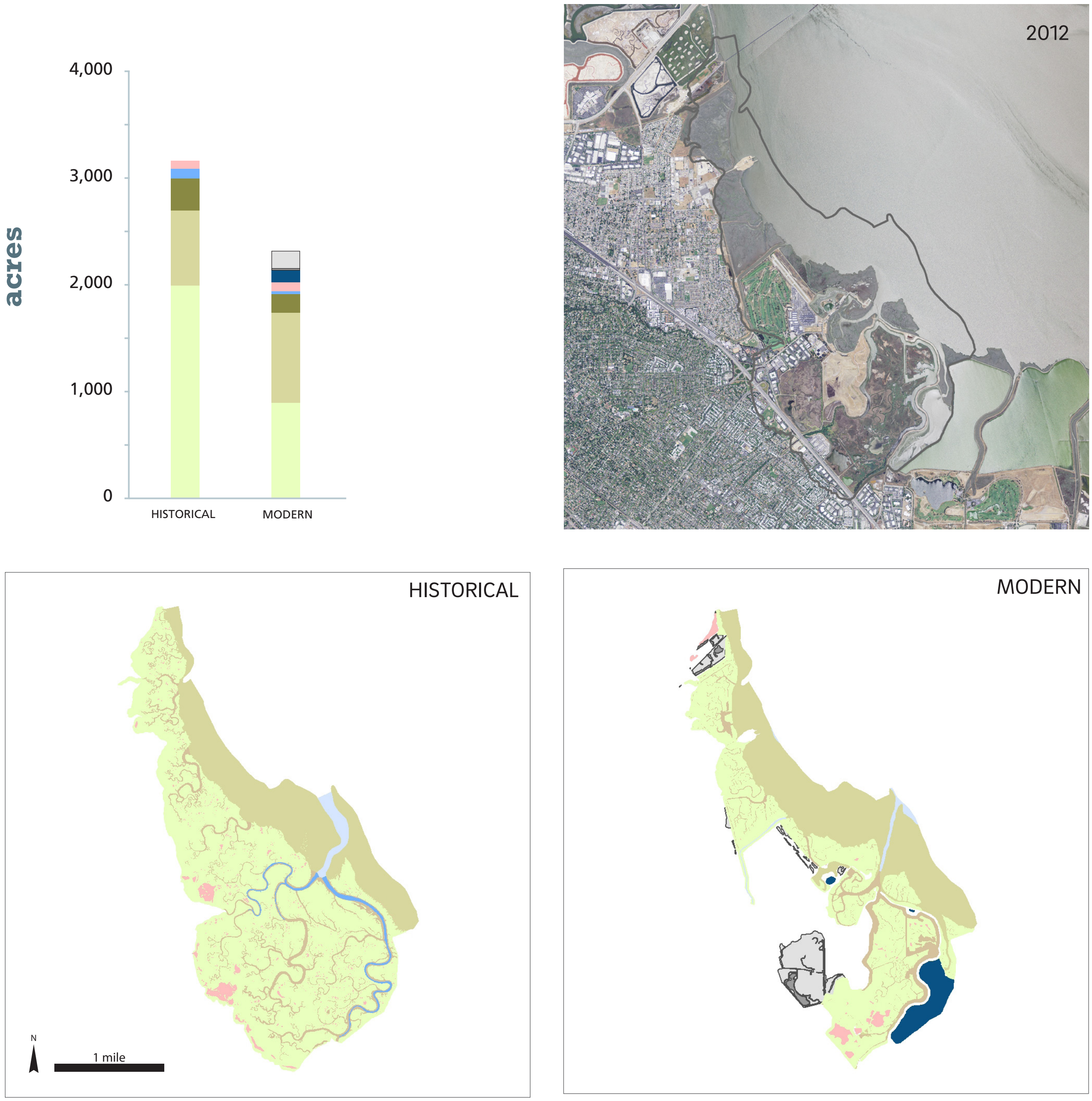


Figure 4. Historical and contemporary extent of tidal wetlands. Overall bayland area has been reduced by approximately 36%, including a 55% loss of tidal marsh area, <5% loss of panne area, and a 40% loss of channel flat area. Bay flat area has increased by approximately 20% due to inland shoreline migration. Several wetland habitat types can be found in the contemporary baylands that did not exist historically, including tidal lagoons, non-tidal open water, and non-tidal wetlands. These new features comprise approximately 10% of the current baylands area. (NAIP 2012)

- Fluvial Channel
- Small Intertidal Channel
- Tidal Marsh
- Bay Flat
- Channel Flat
- Salt Pond / Panne
- Shallow Bay
- Subtidal Channel
- Lagoon
- Non-tidal Wetland
- Non-tidal Open Water

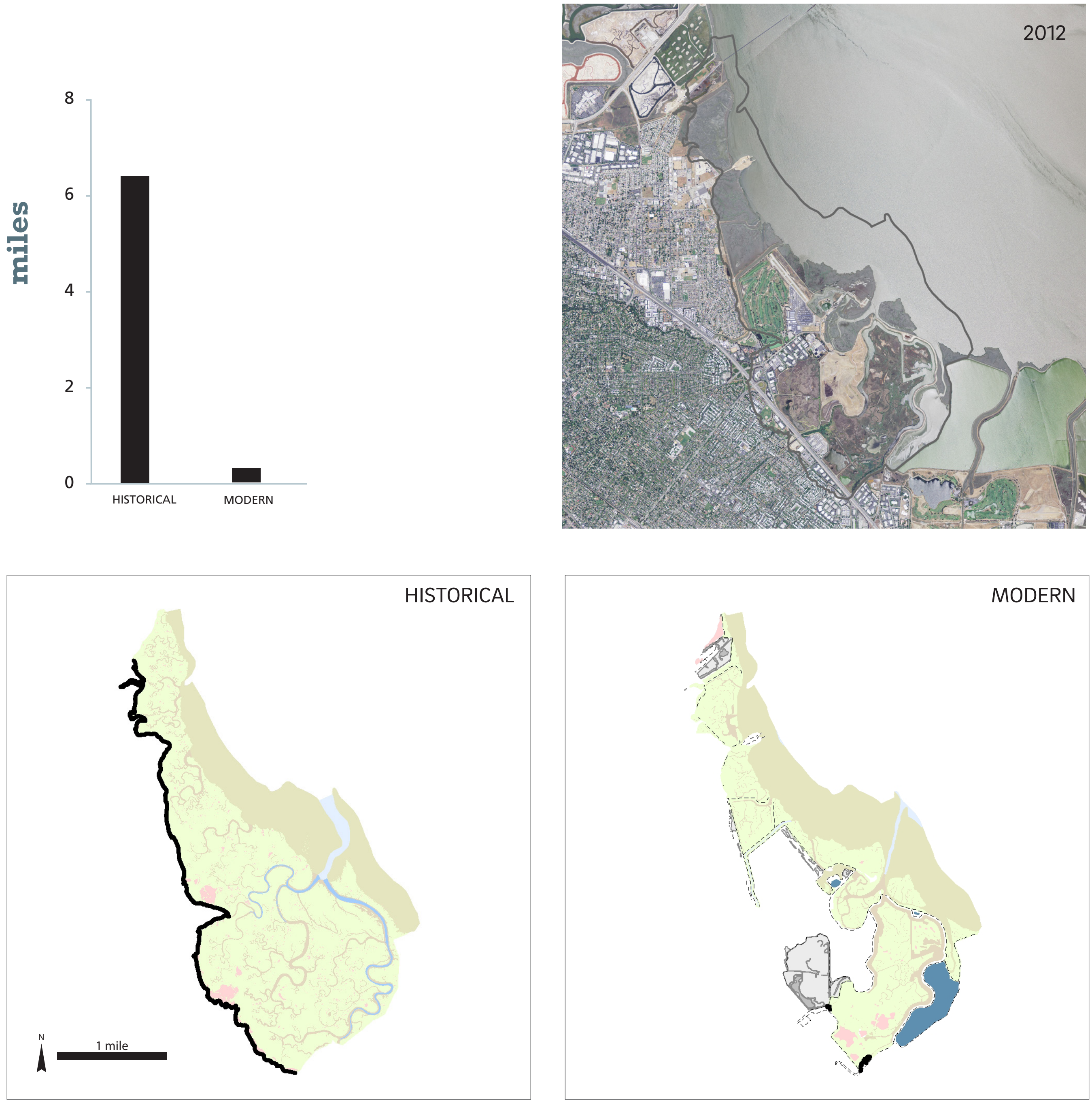


Figure 5. The historical and contemporary linear extent of the tidal-terrestrial interface (ecotone) along the San Francisquito Creek Baylands. The length of the low-gradient interface has been reduced by over 95%. The tidal marsh is now mostly bordered by relatively steep-sloped levees. See Fig. 4 for habitat type legend. (NAIP 2012)

Broad Ecotone (Lowland)

Levee

Summary and Synthesis

Major Findings

Over the past 150 years, lower San Francisquito Creek and the adjacent baylands have been modified for the sake of land reclamation and flood control. This study focused on developing an understanding of the magnitude of habitat change since the mid-19th century through comparisons of key historical and contemporary landscape-scale habitat features, as well as several key landscape metrics that relate to ecological functions and landscape resilience. The major findings from the analyses conducted for this study are as follows:

- Historically, the San Francisquito Creek Baylands included a mosaic of habitat types, including an extensive tidal marsh plain with salt pannes and an expansive tidal channel network, a broad bay flat, and a relatively wide contiguous low-gradient tidal-terrestrial transition zone.
- Since the late 19th century, a combination of land reclamation and the inland migration of the shoreline has resulted in a 55% decrease in tidal marsh area, a 67% decrease in total tidal channel length, a 40% reduction in channel flat area, a 20% increase in bay flat area, and a 95% decrease in tidal-terrestrial transition zone length.
- Land reclamation has also resulted in the creation of new features that did not exist in the area historically including tidal lagoons, non-tidal open water features, and non-tidal wetlands.

Recommendations

The findings from this study provide insight into the drivers for and magnitude of habitat change within the San Francisquito Creek Baylands, and can therefore help inform climate-resilient approaches for regaining some of the lost landscape features and ecological functions. Specific management recommendations developed from the study findings are as follows:

- The dramatic decrease in tidal marsh area and associated tidal channel length since the mid-1800s make tidal marsh restoration a high priority. To make restored areas sustainable over the long-term, restoration should include reestablishing regular tidal inundation as well as reestablishing a connection with San Francisquito Creek and the delivery of freshwater and fine sediment. Restoration efforts should focus on large contiguous areas with minimal infrastructure and should ideally be done sometime over the next decade to ensure the restored areas will have a chance of surviving the sharp increase in the rate of sea level rise that is predicted to occur around 2030 (Goals Update 2015).
- Similarly, the dramatic decrease in the tidal-terrestrial transition zone makes it a high priority for any restoration vision for this area. The transition zone provides distinct ecological services and marsh migration space, and is in need of restoration throughout the South Bay. Since most of the upland land along the historical tidal-terrestrial transition zone is currently developed, near-term restoration efforts should focus on creating transition zone habitats on the bayside of flood risk management levees (Goals Update 2015).
- The landscape metrics used in this study (tidal habitat area, tidal channel length, and tidal-terrestrial interface length) can be used to help design resilient landscape restoration and adaptation strategies around the mouth of San Francisquito Creek. Specifically, the metrics can be used to assess the long-term ecological benefit associated with various processes-based restoration approaches (i.e., approaches that create habitat features and establish physical processes required for habitat resilience). Additional useful landscape metrics are being developed as part of the Resilient Silicon Valley project (see Robinson et al. 2015).

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