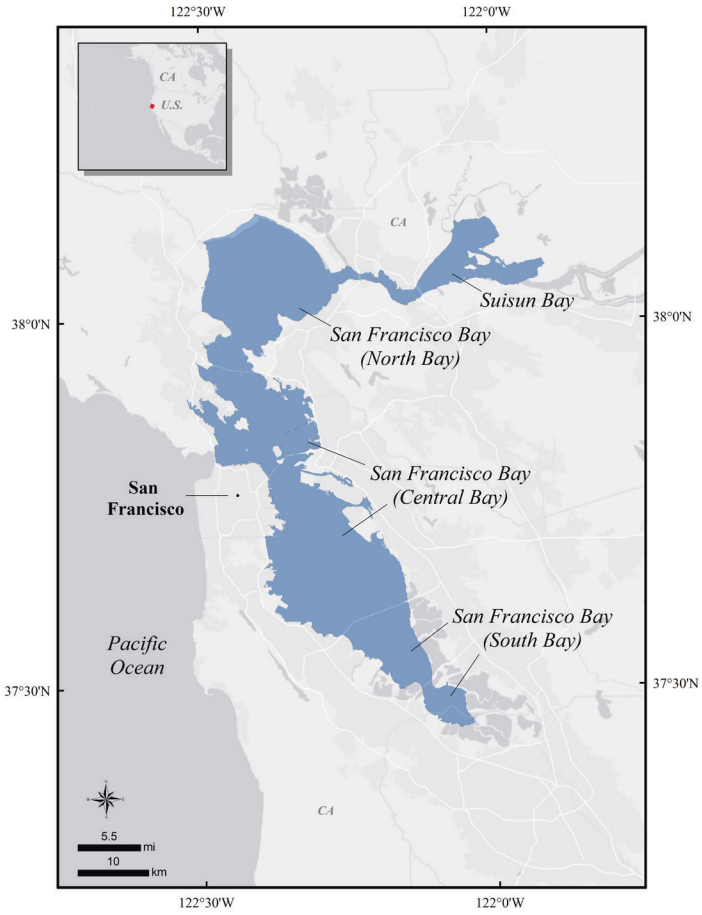
Key Site 1: San Francisco Bay, California

Location: 37°47'39"N, 122°20'60"W

Size: 1081 km^2

Description: San Francisco Bay and Delta is the largest estuary on the Pacific Coast of North America and drains nearly 40% of California's watersheds, including those in the Sierra Nevada mountains (Conomos 1979). San Francisco Bay-Delta has long been recognized as a site of continental importance to waterfowl by the North American Waterfowl Management Plan (North American Waterfowl Management Plan 2018) and is designated a Ramsar Wetland of International Importance (Ramsar 2021). San Francisco Bay is comprised of four adjacent regions that facilitate freshwater runoff from the Sacramento and San Joaquin rivers and smaller regional creeks, with regular tidal interchange through the Golden Gate strait to the Pacific Ocean. Each of the open bay regions, including Suisun Bay, North (or San Pablo) Bay, Central Bay, and South Bay, are characterized by a unique combination of tidal range, water depth, salinity, and sediments, as well as adjacent tidal channel networks, marsh and intertidal mudflats creating a rich diversity of wetland habitats and food resources. For consistency and comparison with long-term Mid-Winter Waterfowl Surveys (MWS), the San Francisco Bay key habitat site is limited to these four open bay portions of the estuary (Accurso 1992), which constitute the most important areas for sea ducks within San Francisco Bay-Delta. Suisun Bay (116.9 km^2), with a mean depth of 4.3 m (Monroe et al. 1992), experiences relatively small fluctuations in salinity dependent upon the amount of freshwater runoff coming through the Sacrament-San Joaquin Delta. An adjacent network of channels interspersed among managed wetlands of the Suisun Marsh provide shelter and food for Bufflehead (*Bucephala albeola*) and goldeneyes (*Bucephala clangula* and B. *islandica*), while the open shallow waters of Suisun Bay provide benthic foods for Surf Scoter (*Melanitta perspicillata*) and other diving ducks.

North Bay, also referred to as San Pablo Bay (303.7 km^2), with a mean depth of 2.7 m, is characterized by broad shallow mudflats to the north and large eelgrass beds along the southern shoreline, with the greatest fluctuation in salinity levels



between the Carquinez Strait and the San Rafael-Richmond bridge. The shallow mudflats of northern San Pablo Bay and adjacent Napa-Sonoma marshes provide an extensive network of sloughs and protected shorelines between the Napa and Petaluma Rivers. Seasonal fresh water from smaller regional creeks create ideal habitats for bivalve beds, which are critical to foraging sea ducks. Bufflehead and goldeneyes, and other waterfowl, likely move between open bay and adjacent marsh and pond habitats depending on seasonal and daily wind and tide conditions.

Central Bay (528.2 km^2), between San Rafael-Richmond and San Mateo bridges, has a mean depth of 10.7 m and is the deepest of the four regions with strong alternating tidal currents, which limit suitable foraging habitats to shorelines and protected embayments, particularly along the western shoreline. Notably, Richardson Bay supports about 80% of all spawning Pacific herring in San Francisco Bay and contains the second largest eelgrass bed in San Francisco Bay and is the most consistently

used herring spawning site (California Department of Fish and Game 2019), supporting large concentrations of scoters, Bufflehead and scaups (*Aythya affinis* and *A. marila*) during spawning events. Additionally, the eastern shoreline between San Leandro and the San Mateo bridge consistently supports Surf Scoters throughout the season (Accurso 1992, De La Cruz et al. 2014). For these reasons, both sites are listed as Audubon Important Bird Areas (IBA Audubon 2021).

South Bay (130.8 km^2), includes the open waters and intertidal mudflats south of the San Mateo Bridge South Bay and is characterized by shallow waters (mean depth of 3.4 m) ringed by intertidal mudflats and adjacent ponds including some that are managed for migratory birds.

Precision and Correction of Abundance Estimates Presented: Bird abundance and density estimates presented for this key habitat site are based upon aerial surveys designed to maximize coverage of shallow subtidal and intertidal waters in the four open bay regions of San Francisco Bay (Accurso 1992, Richmond et al. 2014, Strong 2018). No species-specific visibility correction factors (VCF) have been generated for these data. Therefore, abundance and density values provided should be considered minimum estimates.

Biological Value: Sea duck distribution and abundance data were collected through the MWS following the same transects from 1988 to 2020 (Accurso 1992), and periodically summarized by sub-region and surrounding saltmarsh and managed pond habitats (Richmond et al 2014, Strong 2018). While these counts focus on the midwinter period, Accurso (1992) and subsequent studies have demonstrated the seasonal nature of habitat use throughout San Francisco Bay. Distribution and abundance of birds among regions in San Francisco Bay is driven largely by dynamics in prey abundance and distribution (Rowan et al. 2011), which enables sea ducks to meet their energetic requirements from October through March (Accurso 1992, Lovvorn et al. 2013, De La Cruz et al. 2014).

San Francisco Bay is a dynamic and diverse estuarine system comprised of a wide variety of wetland habitats including subtidal and intertidal zones, and freshwater river estuaries, resulting in conditions especially important to Surf Scoters of the Pacific Flyway during winter and migration. The site is a major wintering location for Surf Scoter and Bufflehead, with nine other species of sea ducks observed in low abundance, or with infrequent or rare sightings, including White-winged Scoter (*Melanitta deglandi*) and Black Scoter (*Melanitta americana*), both goldeneyes, all three merganser species (*Mergus* spp.), Long-tailed Duck (*Clangula hyemalis*), and Harlequin Duck (*Histrionicus histrionicus*). The wintering count of sea ducks in the open and intertidal reaches of San Francisco Bay was estimated at 50,616 birds in 1989–1990 (Appendix 1; subset from Accurso 1992), but this estimate is a minimum count. Even these minimum estimates indicate high sea duck density, greater than 47 birds per km^2. The most abundant species were Surf Scoter and Bufflehead, with lesser abundance of goldeneyes (Appendix 1). Richmond et al. (2014) and Strong (2018) summarized more recent estimates following the same aerial survey protocols for San Francisco Bay, where the 'open bay' components of the MWS were identifiable, highlighting the variability in abundance of the less commonly encountered species groups in open water portions of San Francisco Bay (Appendix 1). Species-specific descriptions follow:

Scoters. During the MWS, scoters are lumped as a group and not identified to species. Surf Scoter is the most abundant sea duck species in San Francisco Bay. White-winged Scoter are regularly detected in low numbers and Black Scoter are a predictable rarity during winter but these two species combined make up less than 1% of the total scoter count (Accurso 1992). Repeated estimates from all four open bay regions of San Francisco Bay repeatedly report minimum densities greater than 10.0 scoters per km^2, with a high winter count of 48,203 scoters in January 1990 (Appendix 1). Richmond et al. (2014) documented 15,204 scoters in these same open bay regions during January 2012, which was 63% below scoter population target identified by the San Francisco Bay Joint Venture (SFBJV; SFBJV 1999), and reported a significant negative trend for scoter species counts in San Francisco Estuary in January between 1981–2012. A comparable survey effort was conducted in January 2018, documenting 13,068 scoters (Strong 2018). Despite these low counts, minimum scoter densities have ranged between 12.1 to 14.1 scoters per km^2 in San Francisco Bay, with highest densities documented in North (9.0 to 27.0

per km^2), Central (9.2 to 16.6 per km^2), and South Bays (12 to 16.4 per km^2; Appendix 1). Scoters were the only species group to show significant declining trends, exceeding 7% decline per year in North, Central and South Bays since 1989 (Nur et al. 2015).

Bufflehead. Bufflehead are consistently abundant in San Francisco Bay, scattered across all four regions with distribution likely influenced by the surrounding tidal sloughs, wetland and managed pond systems. Minimum densities of 7.1 birds per km^2 were recorded during January 2012, with the highest density of 18.8 birds per km^2 in South Bay (Richmond et al. 2014).

Goldeneye. Goldeneyes are thought to be predominantly Common Goldeneye, with Barrow's Goldeneye comprising less than 1% of the total goldeneye count (Accurso 1992). Peak density of goldeneyes was recorded as at least 39.9 birds per km^2 in Suisun Bay during January 2018 (Strong 2018).

Other Sea Duck Species. No reliable winter estimates exist for the other species of sea ducks encountered in San Francisco Bay. Mergansers were the only other sea ducks detected during aerial MWS surveys, but very few individuals were counted. Ancillary information from Christmas Bird Counts and eBird sightings includes limited, but confirmed, sightings of all three merganser species, Barrow's Goldeneye, White-winged Scoter, Black Scoter, Long-tailed Duck, and Harlequin Duck ranging from small flocks to individuals, particularly in the Central Bay region.

While aerial winter survey estimates clearly indicate the importance of the San Francisco Bay during winter months, this site also hosts thousands of sea ducks, particularly scoters, during fall and spring migration. De La Cruz et al. (2009, 2014) documented interannual movements among the four regions and intra-annual site fidelity by Surf Scoter marked with VHF and PTT transmitters throughout San Francisco Bay. Several studies describe seasonal distribution patterns; for example, Suisun and San Pablo Bays predictably experience use by sea ducks during periods of constrained freshwater inflows from the Sacramento and San Joaquin River Delta during the fall and early winter period. Surf Scoter distribution shifts in December and January, corresponding with declines in bivalve densities in San Pablo Bay and when seasonal patterns of precipitation and runoff lowers the salinity gradient throughout San Francisco Bay (Lovvorn et al. 2013, De La Cruz et al. 2014). Selection and use of sites within Central Bay were correlated with the seasonal presence of Pacific herring spawn, particularly in Richardson Bay near Sausalito, CA (De La Cruz et al. 2014). The most consistent use occurs along the eastern shoreline of South Bay north of the San Mateo bridge near San Leandro, CA, a region of high bivalve densities (De La Cruz et al. 2014).

Sensitivities: Sea ducks in San Francisco Bay are vulnerable to habitat degradation from chronic contaminants (Ohlendorf et al. 1986, 1991, Ackerman et al. 2014), oil spill events (De La Cruz et al. 2013, Golightly et al. 2019), changes in profitable prey due to competition with invasive species (Poulton et al. 2004, Richman and Lovvorn 2004, Lovvorn et al. 2013), and lesser documented diseases (Skerrat et al. 2005) which may be exacerbated by climate change. These perturbations may potentially cause reduced body condition and survival which in turn negatively influence migration schedules and reproductive potential. Additionally, future development around San Francisco Bay increases the likelihood that disturbance from shipping, ferry traffic, recreational boating (De La Cruz et al. 2014), and other influences will reduce roosting areas or foraging area profitability (Lovvorn et al. 2013). These threats have the greatest potential impact during spring when energetic demands are high and birds are more vulnerable to cross-seasonal impacts, and when herring spawn events concentrate birds in the Central Bay.

Potential Conflicts: This key habitat site is adjacent to major urban population centers that are inhabited by over 7.7 million people as of 2020 (U.S. Census Bureau 2020). Run-off from major port cities of San Francisco and Oakland, along with San Jose and numerous other expanding bayside urban centers, may degrade water quality and sea duck habitats, as documented by the San Francisco Bay Conservation and Development Commission (2020). Urban storm water is the largest source of pollution to San Francisco Bay, with oil, pesticides, fertilizers and household chemicals reaching Bay waters (State Water Resources Control Board 2006). Additional potential impacts on sea ducks include marine boat traffic, habitat loss, degraded food resources, oil spills, and climate change (see Sensitivities). Contaminant studies in the 1980s documented that

Surf Scoters in San Francisco Bay had high liver concentrations of mercury, selenium, certain heavy metals and organocholorines that increase the longer birds the birds were in the Bay (Ohlendorf et al. 1986, 1991). Eagles-Smith et al. (2009) showed that mercury concentrations remained elevated in Surf Scoters just prior to spring migration, inferring potential cross-seasonal burdens. It is not understood how climate change impacts including sea-level rise and salinity changes in San Francisco Bay will affect the availability and profitability of sea duck prey, food densities, and competition among sea ducks and other benthic foraging waterfowl and fish species (State Coastal Conservancy 2010, Lovvorn et al. 2013), emphasizing the need for future monitoring of benthic resources (Rowan et al. 2011).

Status: The SFBJV established population targets for focal waterfowl species in the San Francisco Bay based on peak abundance estimates from surveys conducted from October–April 1988–1990 (Accurso 1992). The SFBJV's primary waterfowl goal is to provide enough high-quality wetland and open water habitat to consistently support wintering populations of canvasback, greater and lesser scaup, and scoters at peak population levels recorded in 1989–90. Because the timing of peak abundance varies by species, the MWS tends to underestimate the actual peak abundance for some species. To account for this, Accurso's data from the 1988–1990 period was used to derive species-specific correction factors that convert MWS abundance estimates to annual peak estimates (Richmond et al. 2014). The conversion factors are based on data from three years of fall through spring surveys conducted by Accurso (1992). To obtain the annual peak estimate, the MWS abundance estimate is multiplied by the corresponding conversion factor (SFBJV 1999). Therefore, a population target of 61,248 scoters for San Francisco Bay would correspond to a MWS count of 41,481; this target has not been met since 2001 (Richmond et al. 2014).

This key site includes 10 Important Bird Areas (IBAs) associated with San Francisco Bay, with three designated as Globally Significant, justified in part because of their importance to Surf Scoters. The IBAs in this key site include extensive intertidal mudflats and adjacent marshes, but also include three open water IBAs acknowledging the importance of benthic food resources and eelgrass beds that provide substrate for Pacific herring spawn. Surf Scoter is one of ten priority bird species in the San Francisco Bay Program (Audubon 2020).

Three National Wildlife Refuges, managed by the U.S. Fish and Wildlife Service, and ten state Wildlife Areas and Ecological Reserves, managed by the California Department of Fish and Wildlife, are within the San Francisco Bay region, consisting of managed tidal wetlands, managed ponds, extensive networks of tidal sloughs, and some of the largest expanses of tidal marsh remaining on the Pacific Coast of North America. Tidal restoration projects have targeted intertidal mudflat and tidal marsh habitats that have benefits to a variety of wetland-dependent wildlife, including Surf Scoter, Bufflehead, and other benthic foraging waterfowl species. Uniquely, the San Pablo Bay National Wildlife Refuge and San Pablo Bay Wildlife Area both include open water regions of San Pablo Bay within their boundaries. The revised and updated San Francisco Bay Plan recognized that habitats of the open bay provide essential resting and feeding places for waterfowl during winter and migration (San Francisco Bay Conservation and Development Commission 2020). Restoration goals and adaptation strategies for these important habitats are guided by several regional efforts, including the San Francisco Bay Subtidal Habitat Goals Project (State Coastal Conservancy 2010), the USFWS Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California (U.S. Fish and Wildlife Service 2013), the Baylands Ecosystem Habitat Goals Science Update (Goals Project 2015) and the San Francisco Bay Shoreline Adaptation Atlas (Beagle et al. 2019).

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