Suisun Marsh

Ecological History and Possible Futures

Edited by

Peter B. Moyle, Amber D. Manfree,
and Peggy L. Fiedler

TABLES

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TABLE 2.1 Early European exploration and settlement.

Year	Event	Description
1542	Territory claimed by Spain	Juan Rodriguez Cabrillo explored the Pacific coast of North America; Spain claimed the Californias.
1772	First European land expedition encountered Suisun Marsh	Traveling along the south shore of Suisun Marsh, the Fages party encountered friendly Indians harvesting spring-run salmon. They prepared a map of San Francisco Bay, San Pablo Bay, and the Suisun area.
1775	First Nautical expedition: the *San Carlos* arrived at San Francisco Bay	The *San Carlos* was the first ship to pass through the Golden Gate. Lieutenant Juan de Ayala was injured, so first pilot Don Jose Cañizares and second pilot Don Juan B. Aguirre explored and mapped Suisun Bay.
1776	Second European land expedition encountered Suisun Marsh	The Suisun south shore was traversed by Captain Juan Bautista de Anza, Father Fray Pedro Font, and their party. They attempted to trade glass beads for fish, but the Indians would only trade for clothing.
1776	San Francisco Presidio and Mission established	Construction of San Francisco Presidio and Mission Dolores began.
1806	Russians visited San Francisco	A Russian party led by Langsdorff lodged on San Francisco peninsula and traveled by boat to south San Francisco Bay. Their goals were to obtain supplies and gain intelligence on Spanish California.
1809	Carquins moved to mission at San Francisco	The Carquins abandoned villages for Mission Dolores, leaving no buffer between Suisuns and missionaries.
1810–22	Suisuns moved to mission at San Francisco	The Suisuns abandoned villages to join the mission at San Francisco. Those who did not want to go to the mission moved east to join other Patwin tribes.
1812	Russian settlement at Fort Ross founded	The Spanish perceived Russian settlement as a territorial threat, increasing their determination to maintain missions.
1817	Mission San Rafael founded	Mission San Rafael Arcangel was established as a sanitarium in 1817 and became a full-fledged mission in 1822.
1823	Mexican Republic instated	This was a precursor to the fall of missions.
1823	Altimira explored north bay and established mission in Sonoma	Father Jose Altimira searched for a mission site between Petaluma and Suisun and then founded Mission San Francisco Solano in Sonoma. This is the only mission established during Mexican rule.
1824	Santa Eulalia Asistencia established by Altimira	Jose Altimira established the Santa Eulalia Asistencia and rancho near Rockville. This is probably the first sustained Spanish influence (cattle, plants, culture, etc.) near Suisun Marsh.
1833	Yount trapping foray	George Yount traveled through the Suisun area while hunting beaver and otter.
1833	Work Expedition	John Work's expedition camped at Suisun Creek while members went to the mission at Sonoma for ammunition.
1840–46	Mexican land grants near Suisun	Cattle ranching ratcheted up; in the Suisun area, ranchos included Suisun, Tolenas, Los Ulpinos, and Chimiles, totaling over 269 km^2 (66,000 acres).

TABLE 2.2 Threats to Suisun Marsh and nearby areas over 125 years.

Year	Event	Description
1846	Montezuma City	Montezuma City, intended to be a bustling Mormon colony, founded by Lansing W. Hastings. The plan never came to fruition.
1847	City of Francisca (Benicia) founded	A land speculator named Robert Semply planned a sprawling city in the present-day location of Benicia.
1848	Suisun City founded	Started as a bustling center for shipping via water and rail, but economy faltered after city was bypassed by highway I-80 in 1963.
1850	New York of the Pacific (Pittsburg) founded	Colonel Jonathan D. Stevenson founded "New York of the Pacific" at the present-day site of Pittsburg, hoping for a booming metropolis to rival New York City.
1853–54	Benicia declared capital of California	Benicia held sway as California's capitol for nearly 13 months. It would have become a much larger city if the capitol had not been moved to Sacramento.
1860s	Earliest salinity control planning	First discussions about shutting tide water out of Suisun Marsh to control salinity occur.
1860s	Collinsville (Newport City) founded	Three successive owners plan large town at present-day Collinsville. The town perpetually failed to thrive.
1880	Carquinez Strait tidal barrier	State Engineer W. W. Hall proposed a tidal barrier across Carquinez Strait to prevent saltwater intrusion.
1912–13	Calhoun's Solano City swindle	Patrick Calhoun invested over $1 million of public utility money in publicity and creation of a navigable channel to "Solano City" and "Solano Irrigated Farms" at the upstream end of Lindsey Slough. He later transferred ownership of worthless shares in "Solano Irrigated Farms" to the utility to compensate for the money he took.
1921; 1924	Dam from Richmond to San Quentin	Captain C. S. Jarvis of the U.S. Army Corps of Engineers (USACE) proposed a massive dam-and-lock project to turn San Pablo Bay and upstream waters into a giant freshwater reservoir.
1946	Reber Plan	John Reber presented the "ultimate solution" to Bay–Delta management "problems." His plan included a dam from San Quentin to Richmond, a 2,000-ft-wide causeway south of the Bay Bridge, ship locks, and a giant dredged ship channel along the east bay shoreline. A $2.5 million USACE feasibility study was undertaken. Drawbacks were determined to outweigh benefits. Two lasting vestiges exist: the Bay circulation model in Sausalito and the Bay Conservation and Development Commission.
1974	Giant garbage dump	Proposal was made to barge large quantities of garbage from urban areas to Potrero Hills, which would have involved major dredging and channel straightening in the Marsh. Present-day operation uses trucks.
1975	Dow Chemical Plant	Dow Chemical proposed $500-million project in Collinsville. Construction was fought down by concerned citizens and would have required 65 government permits; a sign of changing attitudes about the environment.

SOURCES: *Los Angeles Times,* March 10, 1974; *New York Times,* January 21, 1977; Hogan and Papineau 1980; Arnold 1996; Stone 1996.

TABLE 2.3 Environmental legislation, actions, and agreements affecting Suisun Marsh.

Year	Event
1963	Suisun Resource Conservation District formed
1965	San Francisco Bay Conservation and Development Commission formed
1970	Four-Agency Memorandum of Agreement
1972	Clean Water Act
1973	Endangered Species Act
1974	Nejedly-Bagley-Z'Berg Suisun Marsh Protection Act
1976	Suisun Marsh Protection Plan
1977	AB 1717: The Suisun Marsh Protection Act of 1977
1978	State Water Resources Control Board (SWRCB) Water Rights Decision 1485
1979–80	Roaring River and Morrow Island distribution systems and Goodyear Slough outfall constructed
1984	Plan of Protection for Suisun Marsh
1987	Suisun Marsh Preservation Agreement (SMPA)
1988	Suisun Marsh Salinity Control Gate constructed
1990–95	Planning for the Western Salinity Control Project
1991	Cygnus and Lower Joyce facilities constructed
1994	Bay–Delta Accord
1995–98	SWRCB Water Quality Control Plan
1995	Amendment 3 to the SMPA
1999	SWRCB Water Rights Decision 1641
2000	Draft Jeopardy Biological Opinion
2000	CALFED Suisun Marsh Charter
2001	Suisun Marsh Charter Implementation Plan
2001	CALFED Grant Proposal
2003	Habitat Management, Preservation, and Restoration Plan
2004	Bay Delta Science Consortium Suisun Marsh Science Workshop
2011	Suisun Marsh Habitat, Preservation, and Restoration Plan

TABLE 4.1 Special-status plant taxa within estuarine wetlands, wetland–terrestrial ecotones, and terrestrial habitat of the Suisun Marsh region.

Family	Taxa	Common names	Listing status		
			USA	*State*	*CNPS*
Apiaceae (Carrot)	*Cicuta maculata* var. *bolanderi* (S. Watson) G.A. Mulligan	Bolander's water hemlock			2
Asteraceae (Sunflower)	*Cirsium hydrophilum* (Greene) Jeps. var. *hydrophilum*	Suisun thistle	FE		
	Lasthenia conjugens Greene	Contra Costa goldfields	FE		
	Isocoma arguta Greene	Carquinez goldenbush		SC	1B
	Symphyotrichum lentum (Greene) G.L. Nesom	Suisun Marsh aster		SC	1B
Chenopodiaceae (Goosefoot)	*Atriplex cordulata* Jepson	Heartscale			1B
	Atriplex parishii S. Watson var. *depressa* Jepson	Brittlescale			1B
	Atriplex joaquinana (A. Nelson) E.H. Zacharias	San Joaquin saltbush			1B
Fabaceae (Legume)	*Lathyrus jepsonii* Greene var. *jepsonii*	Delta tule pea		SC	1B
	Astragalus tener A. Gray var. *tener*	Alkali milkvetch			1B
Orobranchaceae (Broomrape)	*Chloropyron molle* (A. Gray) A. Heller subsp. *molle*	Soft salty bird's-beak	FE	R	1B
PLANT TAXA FORMERLY CONSIDERED SPECIAL STATUS:[a]					
Apiaceae (Carrot)	*Lilaeopsis masonii* Mathias & Constance[b]	Mason's lilaeopsis		R	1B
Scrophulariaceae (Figwort)	*Limosella australis* R. Br. (syn. *L. subulata,* naturalized)	Australian (Delta) mudwort			2

NOTE: Listing status: FE = federally listed as endangered and critical habitat designated; R = rare under California Native Plant Protection Act; SC = species of special concern. CNPS (California Native Plant Society) designations: 1B = rare and endangered in California and elsewhere; 2 = rare, threatened, or endangered in California but more common elsewhere.

[a] Recent taxonomic clarifications warrant removal from rare species lists.

[b] See Bone et al. 2011; Fiedler et al. 2011.

TABLE 5.1. Main waterfowl species present in Suisun Marsh.

Their primary habitat, timing of use of Suisun Marsh, past and current population size index for Suisun Marsh and California, and long-term (1953–2011) and short-term (1990–2011) population trends for each species in Suisun Marsh, California, and proportional trend in Suisun Marsh in relation to the statewide population size index. Waterfowl population indices are based on annual midwinter waterfowl surveys conducted by plane. Surveys were not conducted in Suisun Marsh in 2010 or 2011 because of inclement weather. Data are from U.S. Fish and Wildlife Service and California Department of Fish and Wildlife

					Midwinter waterfowl index				Winter waterfowl population trends[a]					
					(Mean: 1953–62)		*(Mean: 2000–09)*		*1953–2011*			*1990–2011*		
			Use of Suisun Marsh											
Species (Family/Subfamily/Tribe)	Scientific name	Main habitat	*October–March*	*April–September*	Suisun Marsh	California	Suisun Marsh	California	Suisun Marsh	California	Proportion in Suisun Marsh vs. California	Suisun Marsh	California	Proportion in Suisun Marsh vs. California
DABBLING DUCKS (ANATIDAE/ANATINAE/ANATINI)														
Northern shoveler	*Anas clypeata*	Freshwater wetlands	X	X	21,262	171,576	17,196	532,612	≈	+	≈	≈	+	≈
Northern pintail	*Anas acuta*	Freshwater wetlands	X	X	235,845	1,770,961	14,061	1,210,806	–	–	–	–	+	–
American wigeonb	*Anas americana*	Freshwater wetlands	X		31,962	710,976	7,472	523,962	–	–	≈	≈	≈	≈
American green-winged teal	*Anas crecca*	Freshwater wetlands	X		11,679	163,597	7,296	405,451	≈	+	–	–	+	–
Mallard	*Anas platyrhynchos*	Freshwater wetlands	X	X	22,530	541,384	6,402	341,705	–	–	≈	–	≈	≈
Gadwall	*Anas strepera*	Freshwater wetlands	X	X	2,014	20,168	2,034	166,881	≈	+	–	≈	+	≈
Cinnamon teal	*Anas cyanoptera*	Freshwater wetlands	X	X	105	1,454	55	6,888	≈	+	≈	≈	≈	≈
PERCHING DUCKS (ANATIDAE/ANATINAE/CAIRININI)														
Wood duck	*Aix sponsa*	Riparian, freshwater wetlands	X	X	0	1,550	0	1,686	na	≈	na	na	≈	na
STIFF-TAILED DUCKS (ANATIDAE/ANATINAE/OXYURINI)														
Ruddy duck	*Oxyura jamaicensis*	Freshwater wetlands	X	X	2,269	37,108	1,439	85,834	≈	+	≈	+	+	+
DIVING DUCKS (ANATIDAE/ANATINAE/AYTHYINI)														
Scaup[b]	*Aythya affinis and Aythya marila*	Open bay, wetlands	X		495	81,316	1,025	111,307	≈	+	≈	≈	≈	+
Canvasback	*Aythya valisineria*	Open bay, wetlands	X		3,768	55,557	657	50,987	≈	≈	≈	≈	+	≈
Ring-necked duck	*Aythya collaris*	Freshwater wetlands	X		44	648	105	57,970	≈	+	≈	≈	+	≈
Redhead	*Aythya americana*	Open bay, wetlands	X	X	116	589	17	1,629	≈	+	≈	≈	≈	≈
Sea ducks (Anatidae/Anatinae/Mergini)														
Bufflehead	*Bucephala albeola*	Open bay, wetlands, lakes	X		17	2,512	552	25,750	+	+	+	≈	≈	+
Common goldeneye[b]	*Bucephala clangula*	Open bay, lakes	X		20	2,522	84	2,998	≈	≈	+	≈	≈	≈
Common merganser[b]	*Mergus merganser*	Rivers, lakes	X		0	335	1	5,875	≈	+	≈	≈	≈	≈
Surf scoter[b]	*Melanitta perspicillata*	Open bay, coastal ocean	X		0	13,308	0	30,604	≈	+	≈	≈	-	≈

(continued)

TABLE 5.1. *(continued)*

Species (Family/Subfamily/Tribe)	Latin	Main habitat	Use of Suisun Marsh		Midwinter waterfowl index				Winter waterfowl population trends[a]					
					(Mean: 1953–62)		*(Mean: 2000–09)*		*1953–2011*			*1990–2011*		
			October–March	*April–September*	Suisun Marsh	California	Suisun Marsh	California	Suisun Marsh	California	Proportion in Suisun Marsh vs. California	Suisun Marsh	California	Proportion in Suisun Marsh vs. California
American coot	*Fulica americana*	Freshwater wetlands	X		57,375	445,528	12,810	438,216	–	≈	–	≈	+	≈
Taxon groups														
Dabbling ducks[c]	*Anas and Aix*	Freshwater wetlands	X	X	325,397	3,381,666	54,515	3,189,992	–	–	–	–	+	≈
Dabbling ducks (no pintail)[c,d]	*Anas and Aix*	Freshwater wetlands	X	X	89,552	1,610,705	40,454	1,979,186	–	≈	≈	≈	+	≈
Diving ducks[e]	*Aytha and Oxyura*	Open bay, wetlands	X		6,643	167,085	3,243	307,728	≈	+	≈	≈	+	≈
Sea ducks	*Melanitta, Bucephala, and Mergus*	Open bay, coastal ocean, lakes	X		38	18,677	637	65,228	+	+	+	≈	–	+
Dark geese[f]	*Branta and Anser*	Agricultural fields, freshwater wetlands	X	X	27,252	307,852	1,490	371,169	–	≈	–	≈	+	≈
White geese[f]	*Chen*	Agricultural fields, freshwater wetlands	X		8,117	354,278	0	564,321	–	+	–	≈	+	≈
Swans	*Cygnus*	Freshwater wetlands	X		281	15,940	364	73,771	≈	+	≈	≈	+	≈
Total waterfowl	*Anseriformes*	All of the above	X	X	367,728	4,245,498	60,249	4,572,209	na	na	na	na	na	na

[a] Waterfowl trends were analyzed using linear regression with alpha = 0.05. Key: + population is significantly increasing, – population is significantly declining.
[b] Some species are not differentiated during midwinter waterfowl surveys, and we have listed the predominant species only. However, Canada goose includes lesser, Taverner, dusky, and western canada goose; cackling goose includes Aleutian and small cackling goose; American wigeon may include some Eurasian wigeon; scaup includes both lesser scaup and greater scaup; surf scoter may include some black scoter and white-winged scoter; common goldeneye may include some Barrow's goldeneye; and common merganser may include some hooded merganser and red-breasted merganser.
[c] Wood ducks were included in dabbling duck taxa group.
[d] All dabbling ducks except northern pintail.
[e] Ruddy ducks were included in diving duck taxon group.
[f] The dark geese taxon group includes all Canada geese races (*Branta* spp.) and white-fronted goose. The white geese taxon group includes snow goose and Ross' goose.

TABLE 5.2. Percent species composition of waterfowl in Suisun Marsh and California.

Based on (A) midwinter waterfowl surveys and (B) hunter-harvested birds. Midwinter waterfowl surveys were started in 1953 but were not conducted in Suisun Marsh in 2010 or 2011. Hunter-harvest surveys were started in 1961. Midwinter waterfowl survey data are from U.S. Fish and Wildlife Service and California Department of Fish and Game; hunter harvest data are from U.S. Fish and Wildlife Service's Parts Collection Survey.

	Suisun Marsh							California						
Species[a]	*1953–59*	*1960–69*	*1970–79*	*1980–89*	*1990–99*	*2000–09*	*2010–11*	*1953–59*	*1960–69*	*1970–79*	*1980–89*	*1990–99*	*2000–09*	*2010–11*
(A) MIDWINTER WATERFOWL POPULATION INDEX														
Northern pintail	54.3%	56.6%	48.8%	43.7%	22.4%	19.6%	na	41.5%	39.1%	52.2%	35.7%	25.5%	26.5%	27.6%
American wigeon	9.7%	7.8%	3.9%	5.5%	10.8%	12.6%	na	14.8%	15.8%	10.6%	11.4%	10.9%	11.5%	7.9%
Mallard	7.1%	4.9%	7.0%	10.5%	13.1%	13.0%	na	13.2%	8.5%	8.6%	11.5%	11.2%	7.5%	4.5%
Northern shoveler	5.4%	11.7%	13.9%	21.4%	26.3%	27.8%	na	3.9%	5.1%	10.1%	8.9%	9.8%	11.5%	13.3%
Greater white-fronted goose	4.2%	4.2%	8.6%	1.9%	0.4%	0.3%	na	2.9%	3.2%	1.5%	1.9%	4.2%	6.6%	7.5%
American green-winged teal	2.6%	5.9%	1.8%	7.8%	15.6%	12.7%	na	3.5%	5.7%	3.4%	6.5%	9.5%	8.7%	10.5%
Snow and Ross's goose	1.5%	2.0%	0.4%	0.0%	0.0%	0.0%	na	7.1%	10.9%	6.7%	11.4%	12.8%	12.1%	14.2%
Cackling goose	1.3%	3.3%	4.6%	0.0%	0.0%	0.0%	na	2.7%	2.9%	1.1%	0.7%	0.9%	0.6%	1.0%
Gadwall	0.8%	1.1%	0.2%	0.6%	2.7%	3.3%	na	0.4%	1.1%	0.3%	1.3%	2.7%	3.7%	3.7%
Ruddy duck	0.7%	0.4%	1.1%	2.4%	1.6%	2.6%	na	0.8%	1.9%	1.3%	2.4%	2.2%	1.9%	2.4%
Canvasback	0.6%	1.2%	7.7%	1.4%	2.3%	0.8%	na	1.5%	1.1%	1.0%	1.0%	0.9%	1.1%	1.5%
Canada goose	0.3%	0.4%	1.0%	1.4%	1.6%	2.4%	na	1.0%	0.5%	0.8%	1.0%	0.9%	0.6%	0.3%
Scaup	0.2%	0.0%	0.8%	2.3%	1.1%	2.6%	na	1.8%	2.0%	0.9%	2.4%	2.8%	2.5%	2.0%
Redhead	0.1%	0.0%	0.0%	0.0%	0.3%	0.0%	na	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Cinnamon teal	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%	na	0.0%	0.1%	0.0%	0.1%	0.2%	0.2%	0.1%
Tundra swan	0.0%	0.1%	0.0%	0.0%	0.5%	0.5%	na	0.3%	0.7%	0.8%	1.4%	1.7%	1.6%	1.3%
Ring-necked duck	0.0%	0.0%	0.0%	0.2%	0.1%	0.2%	na	0.0%	0.0%	0.0%	0.2%	0.7%	1.2%	1.1%
Common goldeneye	0.0%	0.0%	0.0%	0.0%	0.5%	0.2%	na	0.0%	0.1%	0.0%	0.0%	0.1%	0.1%	0.0%
Bufflehead	0.0%	0.0%	0.0%	0.3%	0.2%	1.2%	na	0.1%	0.1%	0.1%	0.5%	0.6%	0.6%	0.3%
Black brant	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	na	0.1%	0.0%	0.0%	0.0%	0.1%	0.1%	0.3%
Eider	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	na	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	na
Common merganser	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	na	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.0%
Surf scoter	0.0%	0.0%	0.1%	0.2%	0.1%	0.0%	na	0.3%	0.5%	0.4%	1.1%	1.5%	0.7%	0.2%
Wood duck	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	na	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%
(B) HUNTER HARVEST														
Northern pintail	na	46.6%	50.7%	28.3%	13.1%	8.6%	9.3%	na	31.6%	35.9%	22.5%	11.9%	9.1%	14.2%
American wigeon	na	13.4%	12.2%	13.0%	16.0%	14.4%	13.5%	na	12.8%	11.1%	10.5%	12.2%	13.7%	13.2%
Northern shoveler	na	11.4%	10.6%	11.4%	14.6%	12.9%	19.9%	na	9.1%	8.4%	9.5%	11.0%	12.2%	12.9%
Mallard	na	10.6%	8.3%	22.0%	23.7%	25.4%	27.7%	na	18.0%	15.5%	23.1%	26.1%	23.5%	19.4%
American green-winged teal	na	9.6%	11.1%	14.1%	19.0%	19.7%	17.6%	na	15.9%	17.7%	19.3%	23.9%	24.4%	23.0%
Gadwall	na	1.4%	1.1%	3.5%	5.2%	6.6%	3.7%	na	2.7%	2.4%	4.7%	7.0%	7.8%	7.3%
Greater white-fronted goose	na	1.1%	0.6%	0.4%	0.2%	0.9%	1.4%	na	3.2%	2.2%	1.2%	1.5%	3.6%	4.0%
Canada goose	na	1.1%	0.8%	0.3%	0.5%	2.1%	0.7%	na	4.2%	3.8%	3.5%	2.4%	3.3%	4.0%
Ruddy duck	na	1.0%	0.8%	0.6%	0.1%	0.4%	1.0%	na	1.2%	1.1%	0.7%	0.4%	0.2%	0.7%

(continued)

TABLE 5.2. *(continued)*

	Suisun Marsh							California						
Species[a]	*1953–59*	*1960–69*	*1970–79*	*1980–89*	*1990–99*	*2000–09*	*2010–11*	*1953–59*	*1960–69*	*1970–79*	*1980–89*	*1990–99*	*2000–09*	*2010–11*
Cinnamon teal	na	0.9%	0.8%	1.4%	1.5%	2.0%	1.0%	na	3.2%	2.9%	3.3%	3.0%	3.4%	2.8%
Scaup	na	0.8%	0.5%	1.2%	2.1%	2.1%	0.6%	na	1.9%	1.4%	1.6%	1.2%	1.4%	0.8%
Canvasback	na	0.7%	1.2%	1.8%	1.1%	0.7%	0.0%	na	0.7%	1.2%	1.1%	1.1%	0.8%	1.0%
Ring-necked duck	na	0.4%	0.3%	0.5%	0.4%	0.3%	0.6%	na	0.7%	0.7%	1.4%	1.8%	1.7%	2.2%
Bufflehead	na	0.3%	0.1%	0.4%	0.8%	0.9%	0.8%	na	0.9%	0.4%	0.7%	0.8%	0.8%	0.5%
Common goldeneye	na	0.2%	0.1%	0.4%	0.8%	1.4%	1.0%	na	0.4%	0.2%	0.3%	0.3%	0.4%	0.3%
Snow and Ross' goose	na	0.2%	0.2%	0.3%	0.0%	0.3%	0.0%	na	3.9%	4.3%	4.0%	4.1%	4.0%	4.1%
Redhead	na	0.2%	0.1%	0.2%	0.4%	0.2%	0.0%	na	0.4%	0.5%	0.7%	0.7%	0.6%	0.4%
Wood duck	na	0.1%	0.1%	0.2%	0.4%	0.4%	0.8%	na	1.1%	1.2%	1.9%	2.3%	2.4%	2.0%
Black brant	na	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	na	0.5%	0.2%	0.0%	0.3%	0.1%	0.0%
Common merganser	na	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	na	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Surf scoter	na	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	na	0.1%	0.1%	0.1%	0.0%	0.0%	0.3%

[a] Some species are not differentiated during midwinter waterfowl surveys, and we have listed the dominant species only. However, canada goose includes lesser, Taverner, dusky, and western canada goose; cackling goose includes Aleutian and small cackling goose; American wigeon may include some Eurasian wigeon; scaup includes both lesser scaup and greater scaup; surf scoter may include some black scoter and white-winged scoter; common goldeneye may include some Barrow's goldeneye; common merganser may include some hooded merganser and red-breasted merganser; and eider includes *Somateria* spp.

TABLE 6.1 Important terrestrial vertebrates of Suisun Marsh and their likely role in future Suisun Marsh management.

These species are listed under state or federal endangered species acts, are species of special concern, or are especially charismatic. "Marsh importance" reflects the likelihood of influencing management decisions in the Marsh and/or the importance of the species' role in the ecosystem. Ducks and geese are covered in chapter 5.

Common name	Scientific name	Status	Marsh importance	Notes
MAMMALS				
Suisun ornate shrew	*Sorex ornatus sinuosus*	SC/EN	H	Endemic to Marsh
Salt marsh harvest mouse	*Reithrodontomys raviventris halicoetes*	FE/SE	H	Endemic to region
California vole	*Microtus californicus*	CH	H	Keystone prey species; represents rodents in food webs
Brown rat	*Rattus norvegicus*	APC	M	Preys on eggs etc. of birds
American beaver	*Castor canadensis*	CH	H?	Role not well understood
Small-footed myotis bat	*Myotis ciliolabrum melanorhinus*	SC	L	Represents 14 species of bats, many SC
Tule elk	*Cervus elaphus nannodes*	CH	H	See box 6.1
Wild swine	*Sus scrofus*	APC	M	Growing importance
River otter	*Lantra canadensis*	CH	H	High abundance
Raccoon	*Procyon lotor*	CH	M	
Striped skunk	*Mephitis mephitis*	CH	M	Represents guild of small-medium predators
Coyote	*Canis latrans*	CH	H	Important predator
Red fox	*Vulpes fulva*	APC	L	Controlled by coyotes?
House cat	*Felis catus*	APC	M	Most important on marsh edges
BIRDS				
Grebes				
Western grebe	*Aechmorphoris occidentalis*	CH	M	Represents migratory grebes
Pelicans and allies				
American white pelican	*Pelecanus occidentalis*	CH	H	Nonbreeding habitat
Double crested cormorant	*Phalacrocorax auritus*	CH	L	
Herons and allies				
American bittern	*Botaurus lentiginosus*	CH	M	
Least bittern	*Ixobrychus exilis*	SC	L	
Great blue heron	*Ardea herodias*	CH	M	
Great egret	*Ardea alba*	CH	H	
Snowy egret	*Egretta thula*	CH	M	
Black-crowned night heron	*Nycticorax nycticorax*	CH	M	
White-faced ibis	*Plegadis chihi*	CH	L	
Vultures				
Turkey vulture	*Cathartes aura*	CH	M	Marsh scavenger

(continued)

TABLE 6.1 *(continued)*

Common name	*Scientific name*	Status	Marsh importance	Notes
Northern harrier	*Circus cyaneus*	SC/CH	M	Abundant
White-tailed Kite	*Elanus leucurus*	ST/CH	M	
Red-tailed hawk	*Buteo jamaicensis*	CH	M	Represents diverse hawks
Swainson's hawk	*Buteo swainsoni*	ST/SFP/CH	L	
Ferruginous hawk	*Buteo regalis*	SC/CH	L	
Cooper's hawk	*Accipiter cooperii*	CH	L	Represents other non-special concern raptors
Bald eagle	*Haliaeetus leucocephalus*	FT/CH	L	
Golden eagle	*Aquila chrysaetos*	CH	M	Nests in uplands
Osprey	*Pandion haliaetus*	CH	L	
Peregrine falcon	*Falco peregrinus anatum*	SFP/CH	L	
Prairie falcon	*Falco mexicanus*	SC/CH	L	
Rails and allies				
California black rail	*Laterallus jamaicensis coturniculus*	ST/SFP	H	
California clapper rail	*Rallus longirostris obsoletus*	SE/FE/EN	H	Regional endemic
Yellow rail	*Conturnitop snoveboracensis*	SC	M	Edge of range
Shorebirds				
Marbled godwit	*Limosa fedoa*	SC/CH	M	Represents shorebirds
Long-billed curlew	*Numenius americanus*	SC/CH	L	
Western snowy plover	*Charadrius alexandrinus nivosus*	SC	L	Limited breeding
Gulls and terns				
Black tern	*Chlidonias niger*	CH	L	
California least tern	*Sterna antillarum browni*	FE/SE	M	Limited breeding
Owls				
Long eared owl	*Asio otus*	CH	L	
Short-eared owl	*Asio flammeus*	CH	M	
Western burrowing owl	*Athene cunicularia hypugea*	FE/SC/CH	M	Important upland bird
Other birds of interest				
Yellow-breasted chat	*Icteria virens*	CH	L	
Allen's hummingbird	*Selasphorus sasin*	SC	L	
Loggerhead shrike	*Lanius ludovicianus*	SC	H	
Tricolored blackbird	*Agelaius tricolor*	SC	M	Colonial nester
Suisun song sparrow	*Melospiza melodia maxillaris*	SC/EN	H	Endemic to Marsh
Salt Marsh common yellowthroat	*Geothylpis trichas sinuosa*	SC/EN	H	Regional endemic
Common raven	*Corvus corax*	CH	M	Common in upland areas
European starling	*Sturnus vulgaris*	APC	M?	Abundant but effects not known

ABBREVIATIONS: FE = federally endangered, FT = federally threatened, SE = state endangered, SC = state species of concern, SFP = state fully protected, CH = charismatic or important species for ecosystem function, EN = endemic species to region, APC = alien predator or competitor, H = high importance, M = moderate importance, and L = low importance.

(continued)

TABLE 6.1 *(continued)*

Common name	*Scientific name*	Status	Marsh importance	Notes
AMPHIBIANS				
California red-legged frog	*Rana draytonii*	SC/FT	L	Scarce in marsh
Pacific chorus frog	*Pseudacris regilla*	CH	L	Probably common but overlooked
Bullfrog	*Lithobates catesbeiana*	APC	M	Common in duck club ponds
Western spadefoot toad	*Spea hammondii*	SC	L	
California Tiger Salamander	*Ambystoma californiense*	FE	M	Upland species
REPTILES				
Giant garter snake	*Thamnophis couchi gigas*	ST/FT/EN	M	
Western skink	*Plestiodon skiltonianus*	FT	L	Upland species
Pacific pond turtle	*Emys marmorata marmorata*	SC/CH	M	

ABBREVIATIONS: FE = federally endangered, FT = federally threatened, SE = state endangered, SC = state species of concern, SFP = state fully protected, CH = charismatic or important species for ecosystem function, EN = endemic species to region, APC = alien predator or competitor, H = high importance, M = moderate importance, and L = low importance.

APPENDIX 7.1 Fishes and macroinvertebrates of Suisun Marsh collected in the University of California (Davis) fish study, 1979–2012.

Common name	Scientific name	Native/ Alien
FISHES		
American shad	*Alosa sapidissima*	A
Bay pipefish	*Sygnathus leptorhynchus*	N
Bigscale logperch	*Percina macrolepida*	A
Black bullhead	*Ameiurus melas*	A
Black crappie	*Pomoxis nigromaculatus*	A
Bluegill	*Lepomis macrochirus*	A
Brown bullhead	*Ameiurus nebulosus*	A
California halibut	*Paralichthys californicus*	N
Chinook salmon	*Oncorhynchus tshawytscha*	N
Common carp	*Cyprinus carpio*	A
Delta smelt	*Hypomesus transpacificus*	N
Fathead minnow	*Pimephales promelas*	A
Golden shiner	*Notemigonus crysoleucas*	A
Goldfish	*Carassius auratus*	A
Green sturgeon	*Acipenser medirostris*	N
Green sunfish	*Lepomis cyanellus*	A
Hitch	*Lavinia exilicauda*	N
Largemouth bass	*Micropterus salmoides*	A
Longfin smelt	*Spirinchus thaleichthyes*	N
Longjaw mudsucker	*Gillichthys mirabilis*	N
Mississippi silverside	*Menidia audens*	A
Western mosquitofish	*Gambusia affinis*	A
Northern anchovy	*Engraulis mordax*	N
Pacific herring	*Clupea harengeus*	N
Pacific lamprey	*Lampetra tridentata*	N
Pacific sanddab	*Citharichthys sordidas*	N
Plainfin midshipman	*Porichthys notatus*	N
Prickly sculpin	*Cottus asper*	N
Rainwater killifish	*Lucania parva*	A
Redear sunfish	*Lepomis microlophus*	A
Sacramento blackfish	*Orthodon microlepidotus*	N
Sacramento pikeminnow	*Ptychocheilus grandis*	N
Sacramento splittail	*Pogonichthys macrolepidotus*	N
Sacramento sucker	*Catostomus occidentalis*	N
Shimofuri goby	*Tridentiger bifasciatus*	A
Shiner surfperch	*Cymatogaster aggregata*	N
Shokihaze goby	*Tridentiger barbatus*	A
Staghorn sculpin	*Leptocottus armatus*	N
Starry flounder	*Platichthys stellatus*	N
Steelhead	*Oncorhynchus mykiss*	N

(continued)

APPENDIX 7.1 *(continued)*

Common name	Scientific name	Native/ Alien
Striped bass	*Morone saxatilis*	A
Surf smelt	*Hypomesus pretiosus*	N
Threadfin shad	*Dorosoma petenense*	A
Threespine stickleback	*Gasterosteus aculeatus*	N
Tule perch	*Hysterocarpus traski*	N
Wakasagi	*Hypomesus nipponensis*	A
Warmouth	*Lepomis gulosus*	A
White catfish	*Ameiurus catus*	A
White crappie	*Pomoxis annularis*	A
White croaker	*Genyonemus lineatus*	N
White sturgeon	*Acipenser transmontanus*	N
Yellowfin goby	*Acanthogobius flavimanus*	A
MACROINVERTEBRATES		
Black Sea jellyfish	*Maeotias marginata*	A
Siberian prawn	*Exopalaemon modestus*	A
Oriental Shrimp	*Palaemon macrodactylus*	A
California bay shrimp	*Crangon franciscorum*	N
Opposum shrimp	*Neomysis mercedis*	N
Overbite clam	*Corbula amurensis*	A
Asian clam	*Corbicula fluminea*	A
Harris mud crab	*Rhithropanopeus harrissii*	A

APPENDIX 7.2 Likely responses of selected fishes and macroinvertebrates in Suisun Marsh to changes in key variables resulting from sea-level rise and climate change.

Common name	Scientific name	Habitat	Present status	Higher salinity	Higher temperatures	More shallow open water	Less pelagic food	Likely population response
FISHES								
Delta smelt	*Hypomesus transpacificus*	P	Rare	--	--	+	--	Decrease
Longfin smelt	*Spirinchus thaleichthys*	P	Abundant	0	-	+	-	Decrease
Striped bass*	*Morone saxatilis*	P/L/B	Abundant	0	0	+	-	No change
Threadfin shad*	*Dorosoma petenense*	P	Abundant	--	+	+	-	Decrease
Chinook salmon	*Oncorhynchus tshawytscha*	P/L	Common	0	-	+	-	Decrease
Northern anchovy	*Engraulis mordax*	P	Rare	++	-	+	-	Increase
Mississippi silverside*	*Menidia audens*	P	Abundant	0	++	++	-	Increase
Black crappie*	*Pomoxis nigromaculatus*	L	Common	--	+	+	0	Decrease
Shiner perch	*Cymatogaster aggregata*	L	Rare	+	-	+	0	Increase
Threespine stickleback	*Gasterosteus aculeatus*	L	Abundant	0	+/-	+	0	No change
Sacramento splittail	*Pogonichthys macrolepidotus*	B	Abundant	0	0	+	0	Increase
White sturgeon	*Acipenser transmontanus*	B	Common	0	0	0	0	No change
White catfish*	*Ameiurus catus*	B	Abundant	--	+	0	0	Decrease
Staghorn sculpin	*Leptocottus armatus*	B	Common	+	0	+	0	Increase
Yellowfin goby*	*Acanthogobius flavimanus*	B	Abundant	0	+	0	0	Increase
Common carp*	*Cyprinus carpio*	B	Abundant	-	+	+	0	Decrease
Starry flounder	*Platichthys stellatus*	B	Common	++	0	+	0	Increase
Speckled sanddab	*Citharichthys stigmaeus*	B	Rare	+	0	0	0	Increase
MACROINVERTEBRATES								
Black Sea jellyfish*	*Maeotias marginata*	P	Abundant	+	+	0	-	Increase
Siberian prawn*	*Exopalaemon modestus*	P/B	Abundant	--	+	+	0	Decrease
Oriental Shrimp*	*Palaemon macrodactylus*	P/B	Common	+	?	+	?	Increase
California bay shrimp	*Crangon franciscorum*	P/B	Abundant	+	0	+	-	Increase
Opossum shrimp	*Neomysis mercedis*	P/B	Common	0	-	+	-	Decrease
Overbite clam*	*Corbula amurensis*	B	Abundant	+	+	0	-	Increase
Asian clam*	*Corbicula fluminea*	B	Abundant	-	+	0	-	Decrease

NOTE: Asterisk indicates alien species. Habitat abbreviations: P = pelagic, B = benthic, and L = littoral (shallow water edge). Response key: + = positive response, - = negative response, 0 = no response, and ++ and -- indicate especially strong responses.

TABLE 8.1 Drivers of the rate (faster or slower) at which tidal marsh restoration evolves.

Driver	High magnitude	Low magnitude
Sediment supply	More sediment = faster	Less sediment = slower
Hydrodynamic energy	More energy = slower	Less energy = faster
Initial elevation	Higher elevation = faster	Lower elevation = slower
Salinity and vegetation	Higher salinity = slower	Lower salinity = faster