Managing the Garden: Agriculture, Reclamation, and Restoration in the Sacramento-San Joaquin Delta

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Abstract

This paper examines land and water use in the Delta from before European contact in 1769 to the beginning of the twenty-first century. The focus lies, first, on the ecological transformation of the region during the late eighteenth and early nineteenth century from a tidal wetland to an engineered, reclaimed agricultural landscape, as well as on some of the individuals most responsible for that transformation and, second, on more recent environmental conditions in the Delta, especially water quality issues, and on the restoration of wetlands around the Delta's margins. This paper begins with the Delta's geological origins, and then discusses how Native Americans used and modified the land, and accounts for the activities of Spanish, Mexican, and early Anglo explorers in the region, as well as the consequences of those activities for indigenous peoples. It then traces the various stages of Delta reclamation from the time of California statehood, beginning with Swamp and Overflowed Lands Act of 1850. It examines the challenges of levee building, which was carried out at first by hand largely by Chinese laborers, and later by mechanized equipment, most notably clamshell dredges. Once reclaimed, Delta mineral and peat soils yielded a wide variety of agricultural products, including potatoes, grains, asparagus, sugar beets, and orchard fruits, among others, which are discussed in some detail. This paper also examines the history of salmon fishing and canning in the Delta before turning more broadly to the twentieth-century federal and state water projects that have affected the Sacramento and San Joaquin rivers in different ways and that at various times have both improved and degraded water quality in the Delta. It concludes by coming full circle to late-twentieth century conservation efforts that have aimed to restore parts of the Delta and that have led to the creation of a variety of state, federal, and other protected lands, primarily along the Delta's fringes, even while the heart of the Delta continues to grapple with seemingly intractable issues of water quality and water conveyance.

The Sacramento-San Joaquin Delta is one of the most ecologically altered landscapes in California. Modern methods of reclamation have transformed the Delta from a tidal wetland partially protected by natural levees and rich in natural resources to an intensively cultivated, highly engineered agricultural landscape. According to the Delta Protection Act of 1959, the legal boundaries of the Sacramento-San Joaquin Delta encompass 738,000 acres, including its

primary and secondary zones, which extend approximately 24 miles from east to west and 48 miles from north to south, and are bounded, roughly, by the cities of Sacramento to the north, Stockton to the east, Tracy to the south, and Antioch to the west.[1] The legal Delta comprises parts of Sacramento, San Joaquin, Contra Costa, Solano, and Yolo counties, with the major portion lying within San Joaquin County. The boundaries used for this "Delta Narratives" project, which reflect a greater Delta cultural area, are more expansive, however, and extend further along the Delta margins and also include Suisun Bay and its shoreline. [See Map 1, p. 73, for the waterways, islands and tracts, and cities of the Delta, many of which are discussed in this paper.]

Historical Geography

Geologically, the Delta is a relatively recent creation. Warming temperatures at the beginning of the Holocene Epoch, approximately 11,700 years ago, caused glaciers to melt and sea levels to rise, creating over thousands of years the historical Delta. By 10,000 B.P. (before present) the Pacific Ocean advanced eastward from the edge of the Farallon Islands through the Golden Gate; it soon flooded the valleys that became San Francisco Bay, and by 6,000 B.P. exerted tidal influence through the Delta. The advancing ocean backed the Sacramento and San Joaquin rivers out of their channels, creating a labyrinth of hundreds of miles of sloughs and dozens of low-lying islands. By 4,000 B.P. the Delta resembled its early nineteenth-century visage. The rate of sea level rise decreased dramatically by that time (from approximately 20 mm/yr. to 1–2 mm/yr.), and the rate of sedimentation in the Delta matched the slowing rate of

[1] Delta Protection Act of 1959, California Water Code, Section 12220; California Department of Water Resources, *Sacramento-San Joaquin Delta Atlas* (Sacramento: California Department of Water Resources, 1993), 1.

submergence. Most land in the Delta was close to mean sea level, and wetland vegetation, partially decomposing over thousands of years, formed layers of peat up to 60 feet thick in the central Delta and thinner layers toward the inland fringes, which have been subject to tidal influences for a much shorter time.[2] The fertile peat soils of the Delta would prove to be an enticing target for reclamation in the years after California statehood.

Native American Land Use in the Delta

Definite evidence for the presence of indigenous people in California dates to 9,000–10,000 years B.P.—part of the overall migration from Siberia to North America, either across the former Beringian landmass or via a coastal route, or both—and Native Americans lived in the Delta, harvested its resources, and altered its environment for at least the past 6,000 years, antedating the tidal development of the region caused by rising sea levels.[3] Of an estimated pre-contact Native American population of approximately 310,000 for all of California, approximately 160,000 lived in the densely populated Sacramento and San Joaquin valleys, including the Delta. For the Delta itself, a population in the range of 10,000 individuals has been claimed, but that estimate may be too low, as it is based on overall population estimates for

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[2] A. A. Whipple et al., "Sacramento-San Joaquin Delta Historical Ecology Investigation: Exploring Pattern and Process" (Prepared for the California Department of Fish and Game and Ecosystem Restoration Program. A Report of SFEI-ASC's Historical Ecology Program, Publication #672, San Francisco Estuary Institute-Aquatic Science Center, Richmond, California, 2012), 8; Jeffrey F. Mount, *California Rivers and Streams: The Conflict between Fluvial Process and Land Use* (Berkeley and Los Angeles: University of California Press, 1995), 77–79.

[3] For a useful treatment of the more recent coastal migration theory, see Jon M. Erlandson and Todd J. Braje, "From Asia to the Americas by Boat? Paleogeography, Paleoecology, and Stemmed Points of the Northwest Pacific," *Quaternary International*, no. 239 (2011).

California that were later revised dramatically upward.[4] Native Americans of the Delta were divided among five linguistic groupings, all within the Penutian language stock. The Nisenan occupied the far northeastern part of the Delta, occupying lands to the east of the Sacramento River between the Cosumnes and American rivers (as well as territory to the north beyond the Delta margins). The Plains Miwok occupied both banks of the Sacramento River from just below Sacramento to Rio Vista as well as much of the eastern Delta from the Cosumnes River to the Mokelumne River. The territory of the Northern Valley Yokuts included the southern Delta, defined here as the region south of the Mokelumne River (and beyond into the San Joaquin Valley, to the great bend of the San Joaquin River). The Bay Miwok occupied the far western portion of the Delta from Rio Vista to the southern shore of Suisun Bay (and as far south as Mt. Diablo). The Patwin occupied the extreme northwestern portion of the Delta from west of the Montezuma Hills, to the north shore of Suisun Bay, and beyond to the northeastern tip of San Pablo Bay (as well as far into the Sacramento Valley to the north).[5]

Native American villages are usually associated with low mounds, ranging in height from 6 inches to more than 7 feet above the surrounding land surface. The mounds, which may be 300 or more feet in diameter, are assumed to be natural rises on or near the banks of major watercourses that were enlarged by the gradual accumulation of midden and that may have also

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[4] Robert F. Heizer and Albert B. Elsasser, *The Natural World of the California Indians* (Berkeley and Los Angeles: University of California Press, 1980), 27; Whipple et al., "Sacramento-San Joaquin Delta Historical Ecology Investigation: Exploring Pattern and Process," 16; Sherburne F. Cook, "Historical Demography," in *Handbook of North American Indians. Volume 8: California*, ed. Robert F. Heizer (Washington, D.C.: Smithsonian Institution, 1978), 91.

[5] James West and Patrick Welch, "Draft Interim CALFED Cultural Resources of the Sacramento-San Joaquin Delta" (Sacramento, CA: U.S. Bureau of Reclamation, Mid-Pacific Region, 1996), 7–9; Norman L. Wilson and Arlean H. Towne, "Nisenan," in *Handbook of North American Indians. Volume 8: California*, ed. Robert F. Heizer (Washington, D.C.: Smithsonian Institution, 1978); Richard Levy, "Eastern Miwok," ibid.; William J. Wallace, "Northern Valley Yokuts," ibid.; Patti J. Johnson, "Patwin," ibid.

been intentionally modified.[6] Indigenous people in the Delta region did not practice agriculture, but they harvested a variety of food sources, including acorns, grasses and forbs, and various wetland plants, as well as shellfish, including freshwater clams and mussels; fish, including chinook salmon and sturgeon; waterfowl; and large game, including deer, pronghorn antelope, and elk.[7] Native Americans capitalized on the Delta's waterways and wetlands in a variety of ways. The Plains Miwok, for example, captured fish using four distinct kinds of nets, and also caught sturgeon with hook and line, and salmon with two-pronged harpoons. Salmon was a particularly important resource for Native Americans in the Sacramento-San Joaquin River system, and recent estimates of indigenous consumption of salmon in the Central Valley range from 8.5 million pounds to 11 million pounds annually, depending on population estimates used. The latter figure indicates that Native American harvests of salmon may have equaled or even exceeded that of the Euro-American commercial fishing industry during the late nineteenth-century, by which time factors in addition to harvest operated to reduce salmon production, as discussed later in the paper.[8] Native Americans were efficient hunters of waterfowl as well. Again using the Miwok as an example, abundant ducks and other waterfowl that inhabited the Delta's wetlands were harvested with nets, either by pulling a net over the birds while they were feeding, or quickly raising a net in the path of groups of low-flying birds.[9]

In addition to harvesting plant and animal resources, indigenous people in the Delta modified their environment in important ways, including the practice of vegeculture (which,

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[6] West and Welch, "Draft Interim CALFED Cultural Resources of the Sacramento-San Joaquin Delta," 4; Whipple et al., "Sacramento-San Joaquin Delta Historical Ecology Investigation: Exploring Pattern and Process," 16.
[7] West and Welch, "Draft Interim CALFED Cultural Resources of the Sacramento-San Joaquin Delta," 7–9.
[8] Ronald M. Yoshiyama, "A History of Salmon and People in the Central Valley Region of California," *Reviews in Fisheries Science* 7, no. 3&4 (1999): 203.
[9] Levy, "Eastern Miwok," 403–404.

unlike agriculture, does not entail intentional planting) and, likely, the use of fire. Vegecultural practices included pruning plants while leaving the vegetative reproductive structures intact, and harvesting by seedbeating, which ensured that at least some seed fell at the source for future germination.[10] The use of anthropogenic fire in the Delta, while not as well documented as for interior valleys and coastal regions, including the San Francisco Bay area, is suggested in several accounts from the late eighteenth and mid-nineteenth centuries, including the diary of Father Pedro Font, a member of Juan Bautista de Anza's 1776 exploratory party, who refers to "ashes of the burned tule" in the vicinity of Byron, although the intentionality of the ash-producing fire cannot be determined.[11] Despite the paucity of evidence for fire in the Delta, it is known that Central Valley inhabitants used fire widely to manage game, stimulate the production of food crops, decrease insect pests, and facilitate food gathering.[12] The Wukchumni Yokuts of the San Joaquin Valley, for example, burned freshwater marshes to provide space for emergent plants that served as animal forage, and to promote the growth of tules, the long, straight stalks of which provided an important building material, including rafts known as tule balsas. Regular burning cleared out old growth that would otherwise have choked marshlands, and allowed space for waterfowl movement and nesting and enhanced wetland habitat for wildlife in general.[13]

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[10] Kat Anderson, "Native Californians as Ancient and Contemporary Cultivators," in *Before the Wilderness: Environmental Management by Native Californians*, ed. Thomas C. Blackburn and Kat Anderson (Menlo Park, California: Ballena Press, 1993).

[11] Whipple et al., "Sacramento-San Joaquin Delta Historical Ecology Investigation: Exploring Pattern and Process," 322–324; Herbert Eugene Bolton, ed., *Font's Complete Diary, A Chronicle of the Founding of San Francisco* (Berkeley: University of California Press, 1931), 407.

[12] Henry T. Lewis, "Patterns of Indian Burning in California: Ecology and Ethnohistory," in *Before the Wilderness: Environmental Management by Native Californians*, ed. Thomas C. Blackburn and Kat Anderson (Menlo Park, California: Ballena Press, 1993); Kat Anderson, "Native Californians as Ancient and Contemporary Cultivators," ibid., ed. Thomas C. Blackburn and Kat Anderson, 165.

[13] M. Kat Anderson, Michael G. Barbour, and Valerie Whitworth, "A World of Balance and Plenty: Land, Plants, Animals, and Humans in a Pre-European California," in *Contested Eden:*

Early Explorations, Punitive Expeditions, and Land Grants

The world of the indigenous people of California was altered by Spanish exploration, beginning with the 1769 expedition of Gaspar de Portolá and Franciscan priest Junípero Serra, which intended to establish the new colony of Alta California, construct a network of missions and presidios (forts), and, overall, fortify the northern frontier of New Spain. The first documented European discovery of the Delta occurred three years later when an exploratory party out of Monterey led by Captain Pedro Fages and Father Juan Crespi, traveling eastward from the Carquinez Strait, reached Suisun Bay and recognized the junction of the Sacramento and San Joaquin rivers beyond. In 1776, when Juan Bautista de Anza and Father Pedro Font travelled through the region, they continued further east, skirting the southwest portion of the Delta. The Spanish returned to the Delta during the period 1806–1812, seeking possible mission sites. Expeditions led by Gabriel Moraga in 1806, 1808, and 1810 crossed and named the San Joaquin River, visited the lower Stanislaus and Calaveras rivers, and surveyed the plains to the southwest of the Delta.[14]

Increasingly belligerent relations with the Native Americans of the Delta ultimately precluded the establishment of Spanish missions in the interior. Spanish expeditions became increasingly punitive in character, as the Spanish attempted to capture Native American fugitives from the missions and to reclaim the livestock that mission fugitives had taken. In 1813, José

California Before the Gold Rush, ed. Ramón A. Gutiérrez and Richard J. Orsi (Berkeley and Los Angeles: University of California Press, 1998), 35.

[14] John Thompson, "Discovering and Rediscovering the Fragility of Levees and Land in the Sacramento-San Joaquin Delta, 1870–1879 and Today" (Sacramento: California Department of Water Resources, Central District, 1982), 88–96; Warren A. Beck and Ynez D. Haase, *Historical Atlas of California* (Norman: University of Oklahoma Press, 1974), 17.

Argüello led the first punitive expedition into the interior, to capture runaway neophytes (converts) from the Mission San José. Entering the Delta, the Spaniards:

> …gained no decision because of the difficulties of the terrain, where it was necessary in places to walk in water up to the knees. The Indians were much favored by very close thickets in which they could hide. Although they were dislodged from that place, the river was very near and they all jumped in to swim, some crossing to the opposite island, others hiding in the dense tule swamps where they could not be followed. For this reason it was not possible to capture anyone.[15]

An 1817 expedition led by José Argüello's son, Luis, and Father Narciso Durán explored the lower Sacramento River as far north as a point between the present Clarksburg and Freeport, then returned downriver past Grand Island, eventually also following the North Fork of the Mokelumne River to the San Joaquin River.[16] By this time the Spanish had gained a fairly comprehensive understanding of the geography of the Delta, and, while no further attempts were made to site a mission in the region, punitive expeditions continued throughout the Spanish and, after 1821, Mexican periods. Spanish and then Mexican authorities faced increasingly militant Plains Miwok and Northern Yokut forces, who had stolen horses from the missions and learned to fight effectively on horseback.[17]

The Delta thus served as both a source of natural resources and as a place of refuge for Native Americans. For the Spanish and their Mexican successors, the Delta represented a lost opportunity to colonize the interior and to subjugate the Native inhabitants. Nevertheless, the Mexican government had tried to stabilize the interior, under the 1824 General Law of

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[15] Letter from José Argüello to Governor Arrillaga, San Francisco, October 31, 1813, in Sherburne F. Cook, "Colonial Expeditions to the Interior of California: Central Valley, 1800–1820," *University of California Publications: Anthropological Records* 16, no. 6 (1960): 266.
[16] Thompson, "Discovering and Rediscovering the Fragility of Levees and Land in the Sacramento-San Joaquin Delta, 1870–1879 and Today," 96–100; Beck and Haase, *Historical Atlas of California*, 21.
[17] Albert L. Hurtado, *Indian Survival on the California Frontier* (New Haven, Connecticut: Yale University Press, 1988), 34.

Colonization, through a series of land grants, including several around the periphery of the Delta, although not in the frequently flooded lands of its interior. The earliest grant in the Delta vicinity dates to 1835, when Jose Noriega received the Los Meganos ranch, located near Mt. Diablo in what is now Contra Costa County. In 1837 Noriega sold the ranch to Dr. John Marsh, the first naturalized Californian to take up residence in the region. In 1839 the Los Medanos ranch was established on the mainland at the western edge of the Delta, fronting the San Joaquin River to the north. In 1839, John Sutter, a Swiss émigré who would come to play a central role in the geopolitics of the interior, occupied New Helvetia at the location of present day Sacramento, and received title to the grant in 1841, when he became a Mexican citizen. Two grants were designated in 1843 at the southern extremity of the Delta: El Pescadero along the west side of the San Joaquin River, and, adjacent and just to the north, Paso del Pescadero along the upper reaches of Old River, a branch of the lower San Joaquin. These grants appear to have derived their names from the Spanish name for Old River, Río del Pescadero, translated as "River of the Place of Plentiful Fish," in recognition of the abundant salmon found in the river.[18] In 1844, John Bidwell, who had arrived in California as a member of the Bidwell-Bartleson party, and who would later make his fortune in the Gold Rush and found the city of Chico, received Los Ulpinos, a grant on the western side of the Sacramento River below Cache Slough.[19] In the same year, just beyond the eastern margins of the Delta, the Sanjon de los Moquelumnes grant, lying to the south of the Cosumnes River and extending to the Mokelumne River, was established as well, but does not appear to have been occupied. Also in 1844, the Rancho Campo del los

[18] Yoshiyama, "A History of Salmon and People in the Central Valley Region of California," 207–208.

[19] For recent treatments of John Sutter and John Bidwell, see Albert L. Hurtado, *John Sutter: A Life on the North American Frontier* (Norman, Oklahoma: University of Oklahoma Press, 2006); Michael J. Gillis and Michael F. Magliari, *John Bidwell and California: The Life and Writings of a Pioneer 1841–1900* (Spokane, Washington: The Arthur H. Clark Company, 2003).

Franceses, located mostly south of the Calaveras River and east of the San Joaquin River, was granted to Guillermo Gulnac, who sold his interest to Charles M. Weber in 1845. Weber first settled on the grant in 1847 and laid out a town, which he called Tuleburg, in 1849, quickly renaming it Stockton after Commodore Robert F. Stockton, hero of the Mexican-American War.[20]

Fur Trappers and Malaria

Simultaneous to the growing resistance by Native Americans and the issuance of the Mexican land grants, British, American and Russian (from Fort Ross) fur trappers were penetrating the Delta region. Two immediate consequences of the activities of the fur trappers were the destruction of populations of fur-bearing mammals, primarily beaver and freshwater otter, and the introduction of malaria, the latter of which would have long-term consequences for the history of the Delta and the Central Valley as a whole. The first of the trappers to arrive was Jedediah Smith, who entered California in 1826 through the Mojave Desert and followed the Old Spanish Trail via Cajon Pass to Mission San Gabriel. After meeting with Governor José Maria Echeandia in San Diego, and receiving an order to leave California via the route he had come, Smith instead proceeded northward over Tejon Pass and into the San Joaquin Valley. He reached the vicinity of the Mokelumne and Cosumnes rivers in May 1827, before leaving most of his company behind and returning briefly to Utah, becoming the first Anglo to cross the Sierra

[20] John Thompson, "The Settlement Geography of the Sacramento-San Joaquin Delta, California" (Ph.D. Dissertation, Stanford University, 1957), 112–122; Beck and Haase, *Historical Atlas of California*, 28–30. In Hispanic California, grants were generally measured in leagues; a single league measured 4,428.4 acres. The dimensions of the grants discussed in the text are as follows: Los Meganos, 13,316 acres; Los Medanos, 8,859 acres; New Helvetia, 48,839 acres; El Pescadero 35,446 acres; Paso del Pescadero 35,546 acres; Los Ulpinos, 17,726 acres; Sanjon de los Moquelumnes, 35,508 acres; and Rancho Campo del los Franceses, 48,747 acres.

Nevada from west to east. In 1828 Smith rejoined his company in the Delta, where beavers were numerous in the rivers and swamps. The party then journeyed northward to Oregon via the Sacramento Valley and California's North Coast, ultimately reaching the Hudson's Bay Company outpost at Fort Vancouver, located just north of the Columbia River.[21] Acting upon Smith's positive reports of the large quantity of beavers in the Delta region, the Hudson Bay Company sent two trapping parties into the Central Valley between 1828 and 1830. One party, under Alexander Roderick McLeod, advanced as far south as Stockton, while a second party, under Peter Skene Ogden, trapped along the lower San Joaquin River to its mouth.[22] John Work's Hudson's Bay Company expedition of 1832–1833, recounted in his detailed journal, spent the summer of 1833 trapping along the lower Sacramento and San Joaquin rivers, reaching as far south as the Stanislaus River. This expedition coincided with that of an American, Ewing Young, but both parties achieved only limited success. By this time furs had already become scarce, Native Americans were often hostile and stole horses frequently, mosquitoes were troublesome, and malaria had entered the region.[23]

Malaria reached the Central Valley in late 1832, following in the wake of British fur trappers entering California from Oregon, where an outbreak had begun along the Columbia River in 1830. The epidemic expanded from the head of the valley, first down the Sacramento River to the Sacramento-San Joaquin Delta and then up the San Joaquin River. Numerous accounts from the period point to the extent and the severity of the epidemic, citing the classic malarial symptoms of fever and ague. The first mention of the malaria epidemic that would

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[21] *Historical Atlas of California*, 43; Thompson, "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 101–103.
[22] "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 103–104.
[23] Alice Bay Maloney, ed., *Fur Brigade to the Bonaventura: John Work's California Expedition, 1832–1833, for the Hudson's Bay Company* (San Francisco: California Historical Society, 1945), xix.

ravage the Native American population of the Central Valley, including the Delta, appears in an entry of John Work's journal for December 2, 1832, in which he noted: "There appears to be some sickness resembling an ague prevailing among [the natives]" in the vicinity of the Feather River in the northern Sacramento Valley.[24] This is the first mention in the journal of disease in the Central Valley. After journeying as far south as the San Joaquin portion of the Delta, Work's party returned northward in 1833. Passing through the Sacramento Valley in the vicinity of the Feather River once again, fever struck members of the party in late July. On August 1, Work recorded that: "A great many of the Indians are sick[,] some of them with the fever."[25] From August 6 to 19, the trapping party appears to have witnessed the most severe effects of the epidemic. In the entry for August 6 Work observed that: "The villages which were so populous and swarming with inhabitants when we passed that way in Jany or Febry [sic] last seem now almost deserted & have a desolate appearance. The few wretched Indians who remain…are lying apparently scarcely able to move."[26] Only after the party climbed northward out of the valley floor did Work report on August 19 that the "Indians…don't appear to be sick like those below."[27]

Colonel J. J. Warner, a member of Ewing Young's expedition, provides greater detail for the epidemic, as well as a touch of pathos:

> In the fall of 1832 there were a number of Indian villages on King's [sic] River, between its mouth and the mountains; also on the San Joaquin River from the base of the mountains down to, and some distance below, the great slough…. [M]any of these villages contained from fifty to

[24] *Fur Brigade to the Bonaventura: John Work's California Expedition, 1832–1833, for the Hudson's Bay Company*, 19.
[25] *Fur Brigade to the Bonaventura: John Work's California Expedition, 1832–1833, for the Hudson's Bay Company*, 69.
[26] *Fur Brigade to the Bonaventura: John Work's California Expedition, 1832–1833, for the Hudson's Bay Company*, 70.
[27] *Fur Brigade to the Bonaventura: John Work's California Expedition, 1832–1833, for the Hudson's Bay Company*, 72.

one hundred dwellings….The banks of the Sacramento River, in its whole course through the valley, were studded with Indian villages….

On our return, late in the summer of 1833 we found the valleys depopulated. From the head of the Sacramento to the great bend and slough of the San Joaquin, we did not see more than six or eight Indians; while large numbers of their skulls and dead bodies were to be seen under almost every shade-tree near water, where the uninhabited and deserted villages had been converted into graveyards; and, on the San Joaquin River, in the immediate neighborhood of the larger class of villages, which, in the preceding year, were the abodes of a large number of those Indians, we found not only graves, but the vestiges of a funeral pyre.[28]

According to Sherburne Cooke, who was the first to argue persuasively that this horrific epidemic was in fact malaria, at least 20,000 Native Americans died on the river systems of the Central Valley, from Red Bluff in the north to Tulare Lake in the south, in 1833 alone, and the Native American population in the affected parts of the valley may have been reduced by as much as seventy-five percent between 1833 and 1846, in the wake of successive outbreaks.[29] Such profound depopulation reduced survivors' resistance to the wave of white settlers who arrived in the valley during the Gold Rush and appropriated Native American territory, precipitating the final collapse of independent Delta cultures and mirroring statewide trends.[30] The indigenous population of California plummeted in the decade of 1845 to 1855, from approximately 150,000 to 50,000.[31] As historian Albert Hurtado has shown, during that brief period the labor of surviving Native Americans was in demand for agriculture and mining, but beginning in the 1850s many of the remaining Native Americans were driven onto reservations away from economically valuable areas, including the Central Valley.[32]

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[28] Warner's account is reproduced in Sherburne F. Cook, "The Epidemic of 1830–1833 in California and Oregon," *University of California Publications in American Archaeology and Ethnology* 43, no. 3 (1955): 318.
[29] "The Epidemic of 1830–1833 in California and Oregon," 320–322.
[30] West and Welch, "Draft Interim CALFED Cultural Resources of the Sacramento-San Joaquin Delta," 9.
[31] Cook, "Historical Demography," 93.
[32] Hurtado, *Indian Survival on the California Frontier*.

In addition to the toll it took on Native Americans, the introduction of malaria into the Central Valley was important because it provided an additional incentive to drain and reclaim the wetlands of the Delta and lower Sacramento and San Joaquin rivers, and thus to begin the transformation of the Delta from a wetland region rich in natural resources to an agricultural garden. Although the cause of malaria was not yet known—it was thought to originate from miasma, an imagined unhealthy gas associated with swamp land—the disease weighed heavily on the minds of nineteenth-century settlers in the Delta and Central Valley as a whole. It would not be until the close of the nineteenth century that the true cause of the disease—the presence in red blood cells of parasitic protozoa of the genus *Plasmodium*—was discovered. In 1897 Sir Ronald Ross published his proof that malaria is transmitted by mosquitoes, and the following year Giovanni Battista Grassi demonstrated that *Plasmodium* completes the sexual reproductive phase of its life cycle only in the *Anopheles* mosquito.[33] The groundbreaking discovery of the life cycle of *Plasmodium* proved that malaria is transmitted from humans to mosquitoes and back to humans; hence any person suffering from malaria is capable of introducing the disease into any locale in which *Anopheles* mosquitoes are present.[34] Because mosquito larvae develop in stagnant water, once malaria was introduced into the Delta and the surrounding Central Valley in the 1830s, the poorly drained wetlands of the region remained associated with high malaria endemicity. As late as 1883, the records of the Central Pacific Railroad Hospital indicate that of the 2,525 railroad employees admitted that year, 1,200 were treated for "fevers, malarial."[35] It is

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[33] Kenneth Thompson, "Irrigation as a Menace to Health in California," *The Geographical Review* 59, no. 2 (1969): 196.
[34] Gordon Harrison, *Mosquitoes, Malaria and Man: A History of the Hostilities Since 1880* (New York: E. P. Dutton, 1978), 59.
[35] Central Pacific Railroad, *Statement of the Workings of the Railroad Hospital, at Sacramento, Cal. For the Year 1883* (Sacramento: H. S. Crocker & Co., Printers, 1884), 5–9. Sacramento Railroad Museum Archives, Sacramento, California.

not surprising that malaria incidence did not begin to measurably decline until after 1880, when the pace of wetland reclamation accelerated.[36] In this way the Delta mirrored conditions in other regions of the country that suffered from high malaria endemicity, most notably the lower Mississippi Valley. In California the groundwork for reclamation was laid in the same year as California statehood, with the passage of the federal Swamp and Overflowed Lands Act of 1850.

The Delta Landscape and the Swamp and Overflowed Lands Act

The pre-reclamation Delta formed a heterogeneous landscape, not simply an estuarine marsh defined by impenetrable stands of vegetation. The "tule" lands, or freshwater tide lands, were indeed dominated by bulrush thickets but also by grasses, the latter of which supported livestock grazing, especially in the San Joaquin part of the Delta, by the 1860s. The higher lands along the island margins and on scattered mounds in the central Delta supported shrubs, predominately willows. Along the major rivers, and especially the Sacramento River, high natural levees formed by depositions from overbank flows supported a woodland of oak, sycamore, alder, walnut, and cottonwood, along with a dense understory of diverse species, including bunchgrasses, willows, and thickets of blackberry and wild rose. Vegetation in the bottomlands of the streams that entered the Delta was similar to that of the levees, and the land in between the streams was characterized by extensive plains. North of the Calaveras River, the

[36] Kenneth Thompson, "Insalubrious California: Perception and Reality," *Annals of the Association of American Geographers* 59, no. 1 (1969): 63. For context on the disease environment in the Central Valley of California, see Linda Nash, *Inescapable Ecologies: A History of Environment, Disease, and Knowledge* (Berkeley and Los Angeles: University of California Press, 2006).

plains consisted of grassy woodland of evergreen and deciduous oaks, but south of the river the plains stretched nearly treeless southward to the Stanislaus River. [37]

The natural levees of the Delta's rivers decreased in width and height as the rivers approached the central Delta, adding to the challenge of reclamation. Along the Sacramento River, levees of ten feet near Freeport declined to seven or eight feet at upper Andrus Island; by Sherman Island, near the mouth of the river, levees stood only one or two feet above mean high tide. A similar situation existed along the Mokelumne River, where levees along Tyler and Staten islands deceased from seven or eight feet at their northern end to about two feet at their southern end. Levees along the Delta segment of the San Joaquin River and its main distributaries, Middle River and Old River, were generally less developed than those along the Sacramento and the Mokelumne rivers, and hence reclamation would proceed more slowly there. Throughout much of the central Delta, tidal waters either overtopped natural levees or penetrated them through numerous, branching sloughs to reach interior marshes. High tides twice daily covered the bowl-like interior of many islands with six to twelve inches of water, while approximately two feet of water covered the islands during ordinary flood stages of the rivers. Winter rains and spring snowmelt from the Sierra Nevada regularly flooded the Central Valley prior to its reclamation, and great volumes of water originating from overflow of the Sacramento

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[37] Thompson, "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 51–55; "Discovering and Rediscovering the Fragility of Levees and Land in the Sacramento-San Joaquin Delta, 1870–1879 and Today," 4–6. The historical ecology of the pre-reclamation Delta has been painstakingly researched and compiled by the San Francisco Estuary Institute-Aquatic Science Center. See note 2, supra. The Center for Sacramento History in Sacramento, California, holds drawings of the undeveloped, pre-reclamation Delta waterways, including a "Chart of the Sacramento River from Suisun City to the American River by Cadwalader Ringgold, 1850." The Holt-Atherton Special Collections at the University of the Pacific Library, Stockton, California, contains approximately 50 historical maps of the Sacramento-San Joaquin Delta, beginning around the mid-nineteenth century. Many of these maps may be viewed online at http://digitalcollections.pacific.edu/cdm/search/collection/deltamaps.

and San Joaquin rivers and their tributaries entered the Delta from the north, east, and south. One of the great reclamation challenges would be to tame the floodwaters that entered the Delta from the north through the Yolo Basin via Cache Slough. Grand, Brannan, lower Andrus, and Twitchell islands were regularly flooded by this deluge, and the flood waters continued southward across the Delta to join the San Joaquin River.[38] Flooding in this part of the Delta was further compounded by the fact that flood discharges from Cache Slough backed up the mouth of Steamboat Slough, and prevented it from relieving flood flows upstream on the Sacramento River.[39]

Natural levees provided a foundation for the construction of the earliest artificial levees. By 1852–53, levees had been raised in several locations, including Merritt Island, the east bank of the Mokelumne River upstream of the river's fork, the east bank of the Sacramento River, upper Tyler and Grand islands, and near the mouth of the Calaveras River. Between 1855 and 1861, more levees were constructed on Grand Island, along the eastern bank of the Sacramento River as far south as Brannan Island, on Sherman Island, and, in the southern portion of the Delta, on Roberts and Union islands. Levees also appeared near the mouth of Marsh Creek,

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[38] John Thompson, "Early Reclamation and Abandonment of the Central Sacramento-San Joaquin Delta," *Sacramento History: Journal of the Sacramento County Historical Society* VI, no. 1–4 (2006): 46.

[39] Letter from Dr. W. M. Ryer, n.d., in E. E. Tucker, California State Engineering Department, "Field Notes," Bk. 91, 22–24. Tucker's field notes, filed in 1879, are a valuable source of information for reclamation during the 1860s and 1870s. The seven notebooks include his direct observations, and reports and letters from numerous prominent figures in Delta reclamation. They contain material on 22 islands and tracts, some of which had been organized into one or more of 21 Swamp Land Districts, extending from Joice Island (north of Suisun Bay) in the west to Rough and Ready Island in the east, and the Runyon District (now the Pierson District) in the north to Union Island in the south. The book numbers (89–95) and page numbers cited herein are those of a typescript of the original notebooks. Copy held at the California Lands Commission Archives, Sacramento, California. Subsequent citations are made as Tucker.

located about nine miles east of Antioch, and along the east bank of the San Joaquin River south of French Camp Slough.[40]

In 1861, reclamation of the diverse Delta landscape entered a more coordinated phase, with the creation of the State Board of Swamp Land Commissioners. The preconditions for the creation of the Swamp Land Commission and subsequent reclamation efforts must be understood in a national context. The prevailing nineteenth-century view of wetlands (then generally referred to as "swamp lands") was that they represented an obstacle to cultivation, settlement, and the fulfillment of America's Manifest Destiny. Draining and reclaiming such lands, perfecting what was perceived as an imperfect nature, was a national imperative, and in 1849 Congress passed the first Swamp Land Act, in which it granted to the state of Louisiana "the whole of those swamp and overflowed lands which may be or are found to be unfit for cultivation."[41] On September 28, 1850, Congress broadened this program of reclamation via the Swamp and Overflowed Lands Act, which extended the federal land grant to twelve additional states, including California, all of which encompassed extensive wetlands.[42] After considerable controversy between the state and federal governments over what truly constituted swamp land—a controversy exacerbated because of the seasonality of flooding in parts of California, especially along the lower Sacramento and San Joaquin rivers, where lands that flooded during the winter and spring tended to be dry by summer and fall—the federal government ultimately

[40] Thompson, "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 211–213.
[41] 9 *Stat.* 352.
[42] 9 Stat 519. The additional states were Alabama, Arkansas, Florida, Illinois, Indiana, Iowa, Michigan, Mississippi, Missouri, Ohio, and Wisconsin.

deeded 2,193,965 acres of swamp land to California, including nearly 500,000 acres within the Delta.[43]

California struggled with devising an orderly plan for disposing of the federal swamp land grant. In 1855 the legislature passed the state's first act providing for the sale of swamp and overflowed lands. The act authorized county surveyors to survey tracts of land upon the application of anyone desiring to purchase them, and also provided for the filing and recording of the surveys with the state surveyor general. The price was one dollar per acre, and individuals were limited to 320 acres.[44] In 1858, a State Land Office was finally established, and a new act provided that all revenues received from swamp land purchases be placed in a state swamp land fund.[45] The 1858 act was amended the following year, increasing the maximum land purchase from 320 to 640 acres.[46] In order to provide for actually reclaiming the lands purchased, in 1861 the California legislature passed "An act to provide for the Reclamation and Segregation of Swamp and Overflowed, and Salt Marsh and Tide, Lands, donated to the State of California by Act of Congress."[47] For the next five years, California conducted a short-lived experiment with coordinated reclamation. The 1861 law provided for the organization of reclamation districts (called "swamp land districts" at that time) and created the State Board of Swamp Land Commissioners to oversee them. Upon petition of the purchasers of one-third of a tract of swamp and overflowed land, the commissioners were to appoint an engineer to plan its reclamation;

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[43] Paul W. Gates, "Public Land Disposal in California," *Agricultural History* 49, no. 1 (1975): 161. Gates updated the oft-cited figure of 2,192,506 acres, as found in "Report to the Director of the Bureau of Land Management to the Secretary of the Interior for the Fiscal Year Ended June 30, 1950, Statistical Appendix," 126; Jay R. Lund et al., *Comparing Futures for the Sacramento-San Joaquin Delta* (Berkeley and Los Angeles: University of California Press, 2010), 20.
[44] 1855 *Statutes of California* ch. 151.
[45] 1858 *Statutes of California* ch. 235.
[46] 1859 *Statutes of California* ch. 314.
[47] 1861 *Statutes of California* ch. 352.

however, the 1861 act provided no method by which lands could be reclaimed if the cost of reclamation exceeded the one dollar per acre purchase price. Hence, upon the recommendation of the Swamp Land Commission in its first report to the legislature in December 1861, the following year the legislature granted county boards of supervisors the power to levy assessments for the completion of reclamation in the districts, which were then to be set aside by the state in a special swamp land fund for each district.[48]

Although a legal framework for reclaiming the swamp lands was now in place, the Swamp Land Commission faced a number of daunting challenges. The knowledge, expertise, and technology necessary for effective flood control—and hence effective reclamation—were almost completely lacking. The flood of the winter of 1861–1862, the greatest in recorded California history, brought the problem into sharp relief.[49] Many opposed the strategy of the Commission's engineers, who continued to argue for the closing off of sloughs, which would otherwise have provided natural outlets for surging rivers and hence reduced the likelihood of catastrophic floods.[50] Despite opposition to its engineering methods, by late 1865, fifty-four reclamation districts had been recognized, fourteen of which had advanced to the point that monies received into the state Swamp Land Fund had been separately appropriated for

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[48] California Board of Swamp Land Commissioners, "First Annual Report of Swamp Land Commissioners" (Appendix to Journals of Senate and Assembly of the Thirteenth Session of the Legislature of the State of California, 1862), 10; California Department of Public Works, "Bulletin No. 37. Financial and General Data Pertaining to Irrigation, Reclamation and Other Public Districts in California" (Sacramento: California Department of Public Works, Division of Water Resources, 1930), 109–110.

[49] Keith Porter, Anne Wein, et al., "Overview of the ARkStorm Scenario: U.S. Geological Survey Open-File Report No. 2010-1312" (U.S. Geological Survey, 2011), 2. http://pubs.usgs.gov/of/2010/1312/

[50] Richard H. Peterson, "The Failure to Reclaim: California State Swamp Land Policy and the Sacramento Valley, 1850–1866," *Southern California Quarterly* 56, no. 1 (1974): 54.

reclamation; surveys were underway in thirteen others.[51] Many of these more active districts were located in or adjacent to the Delta and included District No. 1, the American Basin; District No. 2, the Sacramento Basin; District No. 3, Grand Island; District No. 4, Tyler Island; District No. 5, located between the Mokelumne River and Sycamore Slough; District No. 7, located between the Sacramento River and Cache and Linda sloughs; District No. 8, Andrus Island; District No. 17, stretching for ten miles along the east side of the San Joaquin River above Stockton; District No. 38, Staten Island; District No. 39, along the right bank of the Cosumnes River; District No. 41, "the eastern portion of an island…formed by Miner, Sutter, Cache, and Merritt sloughs" (apparently Ryer Island); and District No. 46, located slightly north and west of District No. 17.[52] Of these districts, only District No. 3 and District No. 17 remain active in their original configuration.[53]

Some reclamation progress was indeed achieved during these early years. District No. 18, the Yolo Basin, encompassing 164,318 acres west of the Sacramento River in Yolo and Solano counties, had succeeded by 1864 in constructing a twenty-five-mile drainage canal to facilitate flood runoff. In the Delta itself, ten miles of levees were built on Ryer Island in 1865, and beginning in 1861 and continuing through 1872, Grand Island was reclaimed with a six-foot levee. Work proceeded on Andrus, Brannan, Tyler, and Staten islands as well, but was not

[51] California Board of Swamp Land Commissioners, "Report of the Board of Swamp Land Commissioners, for the Years 1864 and 1865" (Appendix to Journals of Senate and Assembly of the Sixteenth Session of the Legislature of the State of California. Vol. II, 1865–1866), 3.
[52] California Department of Public Works, "Bulletin No. 37. Financial and General Data Pertaining to Irrigation, Reclamation and Other Public Districts in California," 115–118.
[53] The San Joaquin County Historical Museum, located in Micke Grove Regional Park in Lodi, California, holds archival records of various early reclamation districts, and as of 2015 was developing an exhibition, "The Delta Water Path," containing interpretative panels on reclamation and irrigation, as well as immigrant farm workers.

completed until the 1870s.[54] Despite being able to report a modicum of progress, the Swamp Land Commission continued to face criticism. Attempts to reclaim the American Basin, between the Sacramento and American rivers, and adjacent to the capital at Sacramento, faltered, and by 1866, facing unexpectedly high costs of reclamation, many of the districts had sunk deeply into debt. Responding to these problems, and to a wide range of critics, in April 1866 the state legislature abolished the Board of Swamp Land Commissioners, granting all the swamp and overflowed lands belonging to state, as well as the funds raised from the sale of those lands, to the individual counties.[55] Centralized, statewide reclamation was thus abandoned and authority devolved to the individual county boards of supervisors. This new arrangement would only last two years, however; reclamation was further localized in 1868, when the legislature placed the authority to plan and construct levees in the hands of the boards of trustees of each reclamation district. The county boards of supervisors lost their authority to evaluate and rule upon the plans of the individual reclamation districts, and taxes collected from the districts were now to be placed in county treasuries rather than in the state treasury. This law, known as the Green Act after its primary proponent, Will S. Green of Colusa County, marked the triumph of localism over centralized planning for flood control and reclamation.[56]

The Green Act contained no limitation on the number of acres of swamp and overflowed lands that an individual could purchase. From one perspective, the act addressed the problem that under the previous acreage restrictions sales were generally limited to the higher and more easily

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[54] Peterson, "The Failure to Reclaim: California State Swamp Land Policy and the Sacramento Valley, 1850–1866," 53.
[55] 1865–1866 *Statutes of California* ch. 570.
[56] 1867–1868 *Statutes of California* ch. 415. For context on reclamation and the development of flood control policy in the Sacramento Valley, see Robert Kelley, *Battling the Inland Sea: American Political Culture, Public Policy, & the Sacramento Valley, 1850–1986* (Berkeley and Los Angeles: University of California Press, 1989).

reclaimed lands. In order to reclaim the deep tule lands, such as those of the central Delta, larger capitalized efforts would be necessary, and the Green Act was intended to encourage such efforts. From another perspective, however, the act opened the floodgates to widespread land speculation. Between 1868 and 1871, nearly 800,000 acres of California's swamp lands—virtually all of the state's remaining tracts—passed into private hands, with the five Delta counties of Contra Costa, Sacramento, San Joaquin, Solano, and Yolo accounting for almost 300,000 acres of that total.[57] By far, the largest purchaser was George D. Roberts, a San Francisco mining speculator, who acquired 81,681 acres of swamp land in tracts extending from the Yolo Basin in the north to Union Island in the south Delta.[58] In 1869 Roberts and fellow San Francisco investors founded the Tide Land Reclamation Company to develop these lands, applying corporate principles and vast capital to the project. Combined with his personal holdings, Roberts amassed approximately 250,000 acres of swamp land in the Yolo Basin, the Delta, and Suisun Bay, nearly ten percent of all the privately owned swamp land in the state.[59] The Tide Land Reclamation Company initially sought revenue from enclosing a tract within a

[57] California State Joint Committee on Public and State Lands, "Report of the Joint Committee to Inquire into and Report upon the Condition of the Public and State Lands Lying within the Limits of the State" (Appendix to the Jounals of Senate and Assembly of the Nineteenth Session of the Legislature of the State of California, Vol. 2, 1872), 61; California State Surveyor-General, "Statistical Report of the Surveyor-General of California, for the Years 1869, 1870, and 1871" (Appendix to Journals of Senate and Assembly of the Nineteenth Session of the Legislature of the State of California, 1871–1872), 6–7.
[58] California State Joint Committee on Public and State Lands, "Report of the Joint Committee to Inquire into and Report upon the Condition of the Public and State Lands Lying within the Limits of the State," 62–64.
[59] Matthew Morse Booker, *Down by the Bay: San Francisco's History between the Tides* (Berkeley and Los Angeles: University of California Press, 2013), 86–87; Thompson, "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 201.

levee system and then selling it, rather than actually farming the land. Nevertheless, the company continued to own land in the Delta until the early 1900s.[60]

The Tide Land Reclamation Company was the largest operator during the early years of large-scale Delta reclamation, but was certainly not the only substantial one. The Glasgow-California Land and Reclamation Company was largely owned by Morton C. Fisher, who served until 1877 as its managing director. Individually and through his company, Fisher owned or controlled 55,000 acres on Roberts Island, title to which had passed from Robert's Tide Land Reclamation Company to Joel Parker Whitney, who in turn sold out in 1876 to the Glasgow-California Land and Reclamation Company.[61] In addition to the large reclamation companies, individual landowners played a significant role in early Delta reclamation. These included General Thomas H. Williams, who owned property throughout the Delta, including most of the 45,000 acres of Union Island; partners James Ben Ali Haggin and Lloyd Tevis, who owned the majority of Staten Island; and the Sargent brothers, led by Roswell C. Sargent, who gained possession of almost all of the land south of the Mokelumne River to Potato and White sloughs. These large land development companies and landowners were responsible for the early reclamation of much of the San Joaquin portion of the Delta.[62]

The First Decades of Large-Scale Reclamation

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[60] John Thompson and Edward A. Dutra, *The Tule Breakers: The Story of the California Dredge* (Stockton, California: The Stockton Corral of Westerners International, University of the Pacific, 1983), 222–223.

[61] *The Tule Breakers: The Story of the California Dredge*, 224; Richard Steven Street, *Beasts of the Field: A Narrative History of California Farmworkers, 1769–1913* (Stanford, California: Stanford University Press, 2004), 265.

[62] William D. Rogers, "The Delta Story" (second in series of twenty-four), *Stockton Record*, July 4, 1951; William D. Rogers, "The Delta Story" (seventh in series of twenty-four), *Stockton Record*, July 9, 1951; Thompson & West, *History of San Joaquin County, California* (Oakland, California, 1879; repr., 1968), 43–45.

Levees constructed for the reclamation of the Delta served different purposes based on location. Those that were raised above the natural sedimentary banks of the major rivers were expected to protect against all but the highest flood stages, while the levees constructed around the low-lying peat islands of the central Delta, which would prove to be the most difficult part of the Delta to reclaim, were intended primarily to protect the interior of the islands from intrusion by tidal water.[63] One consequence of the differences in Delta topography was that while few people inhabited the islands of the central Delta, by the 1870s the lands adjacent to the Sacramento River downstream of Sacramento were both populated and prosperous. Truck and dairy operations were established in the vicinity of Freeport and west across the river in the Lisbon District. Orchards, fields, and gardens flourished along the river from north of Courtland to south of Walnut Grove. Fruit trees thrived in the well-drained soils adjacent to the river, but fared poorly in the Delta's peat soils. Early orchards included stone fruits such as peach, nectarine, and plum, as well as apples and pears, but by the 1870s and 1880s alluviation—caused by the debris generated from hydraulic mining in the foothills of the Sierra Nevada—had elevated the bed of the Sacramento River, thereby raising the water table and reducing the quality and quantity of the stone fruits.[64] Pears, particularly the Bartlett variety, proved more tolerant of the higher water table and assumed greater importance relative to the stone fruits.[65]

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[63] Thompson, "Discovering and Rediscovering the Fragility of Levees and Land in the Sacramento-San Joaquin Delta, 1870–1879 and Today," 11.

[64] Hydraulic mining was conducted in California from 1853 until the environmentally destructive practice was effectively ended in 1884 by the decision in *Woodruff v. North Bloomfield Gravel Mining Company*, 18 F. 753 (9th Cir. 1884).

[65] Thompson, "Early Reclamation and Abandonment of the Central Sacramento-San Joaquin Delta," 47; "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 358–360; Steven Stoll, *The Fruits of Natural Advantage: Making the Industrial Countryside in California* (Berkeley and Los Angeles: University of California Press, 1998), 50.

South and east of the productive Sacramento River lands—and the region's new commercial center of Isleton, established by Dr. Josiah Poole in 1874—lay the peat islands and tracts.

Work began there in earnest after the passage of the Green Act, at which time "the process of enclosing, burning, and planting the tule lands progressed rapidly."[66] Much of the labor of reclaiming the Delta islands was carried out by Chinese laborers, who were often recruited from Chinatown boarding houses in Sacramento, Stockton, and San Francisco. The majority of them had immigrated during and after the Gold Rush from the Pearl River Delta or its periphery in Kwangtung Province in southeastern China; they were brought to the Delta not to farm but to carry out the difficult work of reclamation for white landowners.[67] The quantity of labor required, and the number of laborers employed, were staggering. Chinese laborers working for the Tide Land Reclamation Company alone had reclaimed thirty to forty thousand acres of the company's land by 1876, at which time Roberts had no less than 3,000 Chinese workers employed in levee building. Working in an era before mechanical dredges, under harsh conditions and with minimal pay, Chinese men using shovels and wheelbarrows manually "dammed sloughs, cut drainage ditches, built floodgates, and piled up levees."[68] The hand-constructed levees in the tule lands encircled entire islands and were usually eight to twenty feet wide at the base, four to six feet high, and three to six feet wide at the crown.[69] Construction of the early Delta levees was hard-won, as peat proved to be a difficult material for levee-building.

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[66] Thompson and Dutra, *The Tule Breakers: The Story of the California Dredge*, 19.
[67] Sucheng Chan, *This Bittersweet Soil: The Chinese in California Agriculture, 1860–1910* (Berkeley and Los Angeles: University of California Press, 1986), 16–17, 159.
[68] George Chu, "Chinatowns in the Delta: The Chinese in the Sacramento-San Joaquin Delta, 1870–1960," *California Historical Society Quarterly* 49, no. 1 (1970): 24.
[69] Thompson, "Discovering and Rediscovering the Fragility of Levees and Land in the Sacramento-San Joaquin Delta, 1870–1879 and Today," 11.

Historical geographer John Thompson thoroughly describes the challenges that this organic soil posed:

> The reclaimers learned that peat would compress and subside; that it would develop fissures due to compression stress, and shrinkage cracks while drying out; and that the drying levees would bend and float with a rising tide or freshet. The organic matter which comprised so much of the bulk of the levees would decompose into a duff, and fire would turn it into ash. Peat levees might slump from undercutting by waves or with the destabilizing of foundations by extremes of tides. Whatever the behavior of peat, however, it seemed unpredictable.[70]

The early reclamation of these problematic peat soils would not have been possible without the efforts of the Chinese workers, many of whom remained as laborers and as tenant farmers on the land they had reclaimed. Nowhere in California was the influence of the Chinese felt more than in the Delta, where they settled in the communities of Walnut Grove, Isleton, Courtland, and Rio Vista, and later founded the town of Locke.

In order to cultivate reclaimed land, it first needed to be cleared. Burning was the accepted method of removing the tule vegetation of the swamp lands, not only because it produced a fertile seedbed, but also because it was believed to prevent miasma. Burning of the tules commenced in the fall, after the tops of the plants had died and the sod was driest. They could first be mowed or rolled to ensure more thorough destruction. An early history of Contra Costa County describes the process: "The rollers are heavily weighted, double, ten feet in diameter, and are *pushed* into the *tules* [italics in original] by four horses, a man steering their course by means of a rudder wheel. The land is then plowed up in deep, wide furrows, and the roots of the weeds burned out."[71] Once the seedbed had been prepared by these methods, reclaimers often planted first potatoes and then beans, harvesting two crops during the first year. Despite the often spectacular yields, the burning of peat had several disadvantages. Fires did not

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[70] "Discovering and Rediscovering the Fragility of Levees and Land in the Sacramento-San Joaquin Delta, 1870–1879 and Today," 2.
[71] W. A. Slocum & Co., *History of Contra Costa County, California* (San Francisco, 1882), 54.

always burn evenly, sometimes penetrating too deeply, sometimes dangerously penetrating into the peat levees themselves, and other times leaving targeted areas unburned. Once dried and exposed to oxygen, peat naturally decomposes through oxidation and subsides; burning further contributed to subsidence of the land, rendering it more difficult to maintain drainage over time.[72] It would not be until the late 1870s that drainage pumps were introduced to the Delta, first making an appearance at Ryde, on Grand Island, in 1876.[73]

Attempts were made during the early reclamation years to use horse-drawn plows and scrapers as an alternative to human labor, but both horses and mechanical equipment often bogged down in the soft peat soils, even when special "tule shoes" (akin to the principle of snowshoes) were devised for the horses.[74] This problem would lead, a generation later, to the development of the Caterpillar tractor. To prevent miring in the soft soils, tractor wheels had become ever wider and higher until they reached a width of 18 feet and a height of 12 feet. Still, they were not completely effective. In 1904 Benjamin Holt, president of the Holt Manufacturing Company, which he had incorporated in 1892 as the successor to the Stockton Wheel Company, first added a caterpillar tread to a tractor. In 1906, after replacing the steam engine and boiler of earlier models with a gasoline engine, Holt sold his first Caterpillar tractor, which would soon revolutionize farming, not only throughout the Delta, but throughout the United States and the world.[75]

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[72] Thompson, "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 290–294.
[73] "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 277.
[74] The Center for Sacramento History in Sacramento, California, as part of its UC Davis Agricultural Engineering Collection, houses a Fresno scraper (ca. 1900) used in earth-moving projects for reclamation and road-building.
[75] William D. Rogers, "The Delta Story" (eleventh in series of twenty-four), *Stockton Record*, July 13, 1951; Thompson, "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 260–263. The Haggin Museum and Archive in Stockton, California, holds the Holt

Sherman Island and Twitchell Island were the sites of the earliest large-scale reclamation in the central Delta. During 1868–69, Swamp Land Districts Nos. 50 and 54 enclosed 14,000 acres on Sherman Island with over 40 miles of levees at a cost of $80,000. To carry out this task, Chinese laborers constructed and emplaced 250,000 cubic yards of peat blocks. The levees were widest and highest on the north shore along the Sacramento River, and smallest adjacent to Mayberry Slough, which at that time "was not dammed, the owners thinking it best to leave it open to facilitate the shipment of their crops; the slough was broad and deep and navigable almost to its head."[76] In 1869, one thousand acres of the island's peat interior was burned and seeded in wheat and barley. By 1871 the majority of the island was farmed and potatoes and onions were harvested as well. Land that had cost $1.25 an acre, once reclaimed sold for $30 an acre in 1869 and $75 an acre in 1870. Such speculative profits were short-lived, however. On Sherman Island, as well as throughout much of the Delta, levee breeches were common. A high river stage on the Sacramento in January 1872 caused a major breech below Horseshoe Bend, flooding the island and eventually breaking through the levee on the opposite side, along the San Joaquin River. Drainage and recovery were made more difficult by land subsidence. Burning and oxidation had already lowered much of the island's surface by two to three feet and in places by as much as five to six feet, making gravity drainage through tide gates impossible in some areas. The westernmost part of the island, below Mayberry Slough, lay at the junction of the Sacramento and San Joaquin rivers and flooded frequently and, in 1878, catastrophically. Efforts to reclaim this portion of the island would ultimately prove unsuccessful, and today it remains flooded as the Lower Sherman Island Wildlife Area. The remainder of the island suffered

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Manufacturing Company Archives and displays numerous artifacts from the reclamation era, including a Holt '75' tractor.

[76] Tucker, Bk. 91, 8.

repeated levee failures, and channels (which were called "cracks") opened up as water flowed under the levees and into the interior. In 1879 a crack broke through a levee and widened to 30 feet; tides flowed in and out of the island through the crack, and water depth was measured at up to 32 feet.[77] As a result of such calamities, by the early 1880s much of the initial investment in reclamation and agriculture on Sherman Island was lost. The eastern, and larger, part of the island would not be reclaimed again until 1896, when long-boom clamshell dredges completed the task.[78]

On Twitchell Island, located immediately to the north and east of Sherman Island, reclamation began in 1869. Originally organized as Swamp Land District No. 56 in 1866, much of the land was subsequently acquired by B. F. Mauldin, who had purchased nearly 11,000 acres of swamp land in the years following the passage of the Green Act.[79] Mauldin sold 2,400 acres of the island to George D. Roberts, whose Tide Land Reclamation Company constructed a levee system around the island in 1869–70, recruiting at least 235 Chinese laborers for the project, before selling the land in 1870 for $68,000 and realizing up to a $40,000 profit. The first wheat harvest yielded 40,000 bushels on 1,200 acres. The crop, which cost about $1,600 to seed, sold for $67,000, demonstrating the nearly unlimited profits that the fertile Delta soils could provide. However, serious troubles began in 1872, when the island was flooded, destroying that year's crop. Flooding incidents repeated in each of the next three years, and the flood of 1875 drowned 800 sheep and other livestock, at which time the owners abandoned the island. Like Sherman Island, Twitchell was not reclaimed again for many years, and then only with the use of long-

[77] Tucker, Bk. 93, 12–13.
[78] Thompson, "Early Reclamation and Abandonment of the Central Sacramento-San Joaquin Delta," 49–54; Thompson and Dutra, *The Tule Breakers: The Story of the California Dredge*, 22.
[79] California State Joint Committee on Public and State Lands, "Report of the Joint Committee to Inquire into and Report upon the Condition of the Public and State Lands Lying within the Limits of the State," 63.

boom clamshell dredges. The eastern part of the island began to be reclaimed in 1894, and the western part a decade later, although occasional flooding continued.[80]

The early 1870s witnessed reclamation projects throughout much of the Delta's peat lands. Webb Tract was leveed in 1870, and Bradford, Bacon, and Bouldin islands were enclosed by 1871.[81] Newly enclosed land was at times leased to San Joaquin Valley cattle and sheep ranchers for some time before it was planted. Bradford Island is one such example; it was leased for two years to the cattle barons Henry Miller and Charles Lux as a stock range.[82] During 1871–1872, the Tide Land Reclamation Company constructed levees on the southernmost portions of Brannan and Andrus islands. Mandeville and Venice islands were leveed in 1872 and Jersey Island in 1872–73. Work resumed on Staten Island in 1873, and Bethel Island was enclosed by 1875 and lower Roberts Island by 1876 or 1877. This levee system, averaging thirty feet wide at the base, ten to fifteen feet high, and five feet wide at the crown, was far more massive than the levees of the previous decade, and enclosed a total of approximately 100 square miles. Despite their large dimensions, the levees still could not effectively protect against flooding, and many of the islands were abandoned shortly after they had been reclaimed. Webb Tract and Mandeville islands were abandoned in 1874, and lower Brannan and Andrus islands were partially or completely inundated repeatedly between 1878 and 1886.[83]

The impact and consequences of flooding differed depending on location in the Delta. On northern Brannan Island, on Andrus Island above Isleton, and on bank lands upstream to

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[80] Thompson, "Early Reclamation and Abandonment of the Central Sacramento-San Joaquin Delta," 54–58; Thompson and Dutra, *The Tule Breakers: The Story of the California Dredge*, 22.
[81] Bacon Island had formed the northernmost part of Union Island until it was separated by a ditch in 1870. Tucker, Bk. 89, 10–11. Victoria and Woodward islands were also originally part of Union Island.
[82] Tucker, Bk. 89, 15.
[83] Thompson, "Early Reclamation and Abandonment of the Central Sacramento-San Joaquin Delta," 59–66.

Sacramento and along the Mokelumne and San Joaquin Rivers, floods were destructive but recovery was possible. In the low-lying islands at the center of the Delta, however, the bowl-shaped and subsiding interiors of the islands could not easily be drained after flooding, even at great expense, and much of this terrain was abandoned by the late 1870s.[84] The peat levee systems constructed in the central Delta during the 1860s and 1870s were largely destroyed or replaced by the 1890s. Those that did not succumb to tides or waves were buried under new and stronger levees formed from clays and alluvial material dredged from the channels by long-boom clamshell dredges, which had been an impossible feat for laborers working with shovels or even early ditchers and dredges.[85]

Clamshell Dredges and Effective Reclamation

The dredges that were used for levee building in the Delta and throughout the Central Valley evolved from early floating mechanical dredges that had been developed for harbor work in San Francisco Bay during the 1850s. Four main types of dredges were used in the valley during the late nineteenth and early twentieth centuries: dipper dredges, hydraulic pipeline dredges, bucket-ladder or endless-chain dredges, and clamshell dredges. The first successful use of dredges in the Delta dates to 1875, when Joel Parker Whitney used dipper dredges to reclaim the southern portion of Roberts Island, which he had purchased from the Tide Land Reclamation Company. Named *Samson* and *Goliath*, these dredges utilized a steam shovel mounted to a dipper arm, but had a limited reach of only 55 feet for the placement of material.[86] This problem would ultimately be resolved by the clamshell dredge, which proved the most effective of the

[84] "Early Reclamation and Abandonment of the Central Sacramento-San Joaquin Delta," 65–66.
[85] "Early Reclamation and Abandonment of the Central Sacramento-San Joaquin Delta," 43.
[86] Thompson and Dutra, *The Tule Breakers: The Story of the California Dredge*, 36, 224; Thompson, "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 266.

dredge types. As its name suggests, this dredge was fitted with a single bucket composed of a pair of hinged shells that closed around the material to be excavated and emplaced. The clamshell bucket was suspended from a movable boom, supported by an A-frame. Over time the length of the boom and the capacity of the bucket increased steadily, although the size of the bucket was also related to the type of soil; smaller buckets with clean cutting edges and short tonglike arms were adequate for lighter peat soils, while heavier clay soils required larger buckets with steel teeth and longer arms for greater leverage.[87] Clamshell dredges were first used in the Sacramento-San Joaquin Delta no later than 1879, where they were employed in the Lisbon District and on Bouldin Island, and from 1882 to 1893 in the Isleton District on Andrus Island. They were equipped with booms of 80 to 90 feet and buckets ranging from one and a half to two cubic yards in capacity.[88]

The success of these first projects increased interest in the use of dredges for levee construction, and between 1885 and 1895 seventeen clamshell dredges were introduced into the channels of the lower Sacramento, Mokelumne, and San Joaquin rivers. Booms grew longer, and the length increased to 100–130 feet during the 1880s and to over 200 feet during the 1910s, reaching 242 feet in 1917 on the dredge *Neptune*. By 1895 the dredges were large enough to handle buckets of 3 cubic yards, and in the years before World War I were massive enough to accommodate buckets of 6 cubic yards.[89] The most important attribute of the long boom was that a dredge so equipped could dig in a channel at a considerable distance beyond the outside of an extant levee, thus extracting alluvial and mineral soils—which made for more stable levees than the interior peat soils—while at the same time not excavating so close to the levee itself as to

[87] Thompson and Dutra, *The Tule Breakers: The Story of the California Dredge*, 91–96.
[88] *The Tule Breakers: The Story of the California Dredge*, 132–141.
[89] *The Tule Breakers: The Story of the California Dredge*, 132.

undermine it. Ironically, hydraulic mining debris, which caused many environmental problems, from increasing flood incidents by raising river beds to burying the spawning grounds of salmon, provided a good portion of the material dredged from the channels to build these effective levees.[90] The machinery for a substantial number of the clamshell dredges that finally reclaimed the Delta was built locally, by the Stockton Iron Works, which was established in 1868 and eventually specialized in this type of dredge. Over the course of three decades beginning in 1885, the company produced more than 30 clamshell dredges and over 600 dredge and ditcher buckets, which were so ubiquitous and successful that they became synonymous with the California dredge and the Stockton bucket.[91]

Names given to many of the dredges are evocative of locales throughout the Delta, and testify to their importance in reclaiming the region. During the 1880s and 1890s clamshell dredges appointed with the names *Staten Island, Mokelumne, Jersey Island, Andrus Island, Ryer Island, Calaveras, Merritt Island, Roberts Island, Grand Island, District 17,* and *Rough and Ready* all entered service. Other dredges (of various kinds) were named more fancifully as *Samson*, *Goliath*, *Atlas*, and *Hercules*, a reflection not only of their size, but also of the monumental task they were carrying out.[92] By 1920, they had succeeded in reclaiming nearly the entire Delta, including the difficult peat lands of the central region, rendering agriculture possible

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[90] Booker, *Down by the Bay: San Francisco's History between the Tides*, 93.
[91] "The Stockton Iron Works," *Byron Times*, Second Special Booster Edition, 1910, n.p.; Thompson and Dutra, *The Tule Breakers: The Story of the California Dredge*, 200. The Dutra Museum of Dredging in Rio Vista, California, holds the most extensive dredging collection in the Delta, including a 6-cubic-yard clamshell dredge bucket, 3 clamshell dredge models, linen drawings and schematics of old clamshell dredges, a collection of old clamshell dredge photos, and a large mural depicting the history of the Dutra family and their involvement with reclamation work in and around the Delta. The San Joaquin County Historical Museum in Lodi, California, displays the side-draft clamshell dredge bucket from the dredge *Columbia*, near the Museum entrance, and other earthmoving equipment in assorted exhibitions.
[92] *The Tule Breakers: The Story of the California Dredge*, 140.

on a large scale. Between 1870 and 1920, the years of peak reclamation, some 402,000 acres were reclaimed. Adding 15,000 acres of early reclamation between 1860 and 1870, and another 24,000 acres of late reclamation between 1920 and 1930, the cumulative total reaches 441,000 acres.[93]

Even with the success of the clamshell dredges, levee failure would remain an ever-present threat in much of the Delta in subsequent years. Most breaches have been repaired, although there have been a few notable exceptions in which reclaimed land has been permanently lost. A 1928 storm collapsed a levee on reclaimed land north of Oakley, and the drowned tract was declared to be once again part of the San Joaquin River. Today it is abutted by the Big Break Regional Shoreline, part of the East Bay Regional Park District.[94] Similarly, Franks Tract in the central Delta was flooded in 1936 and 1938 and reclamation efforts were then abandoned. The submerged land is now managed for boating and fishing as Franks Tract State Recreation Area.[95]

Dredges also made it possible to finally achieve effective flood control in the Sacramento Valley, which had been an elusive goal since the Gold Rush. Dozens of clamshell and other dredges were utilized from the 1910s through the early 1920s to complete the Sacramento Flood Control Project, an engineering feat on an unprecedented scale in the state at that time. This

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[93] Thompson, "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 238. Thompson (p. 239) contains a map of the sequence of Delta reclamation, decade by decade, from 1860 to 1930. That map has been visually enhanced in Chan, *This Bittersweet Soil: The Chinese in California Agriculture, 1860–1910*, 166. It also appears in that form in Philip Garone, *The Fall and Rise of the Wetlands of California's Great Central Valley* (Berkeley and Los Angeles: University of California Press, 2011), 114.

[94] http://www.ebparks.org/parks/big_break. In addition to viewing the exhibits in the Visitor Center, as part of the park's Delta Discovery Experience visitors may walk a 1,200-square-foot landscape model of the Delta watershed, and view a dredge bucket and collapsed dredge barge near the pier.

[95] William J. Rogers, "The Delta Story" (fifteenth in series of twenty-four), *Stockton Record*, July 18, 1951.

project channeled Sacramento River floodwaters through the Sacramento Valley's Sutter and Yolo basins via a system of weirs and bypasses until those waters rejoined the river far downstream, just above Rio Vista, thus protecting both towns and agriculture in the Sacramento Valley as well as the Delta. The Sacramento Flood Control Project, made possible by the state Flood Control Act of 1911—which created a State Reclamation Board to oversee the valley's reclamation—and the federal Flood Control Act of 1917, protects the Sacramento Valley and adjacent parts of the Delta to this day.[96]

There were ecological consequences to this transformation, of course. Wetland vegetation in the Delta and in the Sacramento Valley's natural flood basins all but disappeared and the dense concentrations of wildlife that had thrived in and around the tules vanished with them. The Delta's wetlands, which had once provided habitat for millions of waterfowl, were converted into fields of potatoes, beans, wheat, barley, celery, onions, asparagus, corn, and orchard crops.[97] It would not be until the last decades of the twentieth century, after a cultural sea change in attitudes about the natural world had taken place, that some of these wetlands—primarily along the Delta's margins—would be restored.

In the late nineteenth century it appeared that Suisun Marsh, a 140-square-mile wetland on the north shore of Suisun Bay, would follow the same trajectory as the Delta, its wetlands

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[96] For more detail on the use of dredges to reclaim the Sacramento Valley flood basins, see Thompson and Dutra, *The Tule Breakers: The Story of the California Dredge*, 284–304. For more detail on the political history that led to the Sacramento Flood Control Project, see Kelley, *Battling the Inland Sea: American Political Culture, Public Policy, & the Sacramento Valley, 1850–1986*, 273–293. In 1913, the state amended the 1911 Flood Control Act to unite the entire region of the Central Valley that was subject to flooding within a single Sacramento and San Joaquin Drainage District, which encompassed the Sacramento Valley, the Delta, and the lower San Joaquin Valley. 1913 *Statutes of California* ch. 170.

[97] It is not possible to generate a precise estimate of waterfowl numbers in the era before reclamation. However, a broad range may be extrapolated. See discussion of the Pacific Flyway later in this paper.

leveed, drained, and converted to agriculture. Suisun Marsh had been hunted by waterfowlers from at least the 1860s, and the marsh became much more accessible from the San Francisco Bay Area following the completion in 1879 of a Central Pacific Railroad line (later operated by the Southern Pacific) that extended from Benicia, across the marsh, to Suisun City. Facilitated by railroad access, the first duck clubs were established in the western portion of the marsh, beginning in 1879.[98] However, mirroring developments in the Delta, much of the marsh was diked and reclaimed for agriculture; the reclamation efforts began in the 1870s and generally proceeded from east to west. Dairy farms and cattle ranches were established first, followed by wheat, potatoes, and asparagus. Success was fleeting. Lying further west than the Delta, Suisun Marsh was more susceptible to salt water moving inland with the tides, and in dry years salt water moved up the sloughs. Agriculture faltered, and within a few decades many of the islands were intentionally reflooded within the dikes that had been constructed during reclamation, now to be managed as freshwater wetlands for the benefit of ducks and duck clubs, at least 380 of which have existed in the marsh at one time or another since 1879.[99]

Salinity issues would eventually become important in the Delta as well, as upstream diversions for agriculture on the Sacramento and San Joaquin rivers, combined with drought, reduced the total flow through the Delta and hence allowed salt water to advance inland through

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[98] Anthony Arnold, *Suisun Marsh History: Hunting and Saving a Wetland* (Marina, California: Monterey Pacific Publishing Co., 1996), 17–29; M. Hall McAllister, "The Early History of Duck Clubs in California," *California Fish and Game* 16, no. 4 (1930); Frank A. Hall, *They Came to Shoot: A History of California Duck Clubs and Wetland Conservation* (Sacramento: California Waterfowl Association, 2011), 83. The original Suisun Marsh clubs were the Hardland Club, established in 1879 (renamed the Ibis Gun Club in 1880); Cordelia Club, established in 1880; Teal Shooting Club, established in 1883; and Tule Belle Club, which relocated from Sherman Island to Suisun Marsh in 1883. *They Came to Shoot: A History of California Duck Clubs and Wetland Conservation*, 73–97.

[99] John Hart and David Sanger, *San Francisco Bay: Portrait of an Estuary* (Berkeley and Los Angeles: University of California Press, 2003), 81; Hall, *They Came to Shoot: A History of California Duck Clubs and Wetland Conservation*, 71.

Delta channels, affecting agriculture on the westernmost islands. Unlike in Suisun Marsh, agriculture did not fail in the Delta, and the salinity problem ultimately would be at least partially addressed by the Central Valley Project, discussed later in this paper.

The Evolution of Delta Agriculture

Delta agriculture experienced several phases as the popularity of different crops rose and fell, and new crops and processing methods were introduced. During the first decades of reclamation, potatoes, beans, and onions were the staple crops, although a variety of other vegetables and grains were harvested as well. By the early 1880s, the Delta was producing more than a million bushels of wheat and barley each year.[100] During this era of peak wheat production in the Delta, which paralleled the wheat boom in California as a whole, the Southern Pacific and Central Pacific railroads collected the wheat harvest from throughout the Central Valley and delivered it to waiting ships in San Francisco Bay and in the Carquinez Strait at Port Costa, the busiest wheat-shipping point in California at that time. The ships then carried the wheat around the world, especially to China, Australia, and Great Britain.[101]

Irrigated agriculture became common in the Delta during the 1870s, although it had been practiced earlier. Flood irrigation, with water delivered at high tide through tidal gates and removed at low tide through drainage ditches, was initially the most common method, but this

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[100] William D. Rogers, "The Delta Story" (eighth in series of twenty-four), *Stockton Record*, July 10, 1951.

[101] Richard B. Rice et al., *The Elusive Eden: A New History of California*, Fourth ed. (New York: McGraw-Hill, 2012), 255; Mae Fisher Purcell, *History of Contra Costa County* (Berkeley, California: The Gillick Press, 1940), 403; George Emanuels, *California's Contra Costa County: An Illustrated History* (Fresno, California: Panorama West Books, 1986), 181. The Port Costa Conservation Society holds archival material relating to the town's grain-shipping era, including a ledger of the operations of the McNear family, owners of an immense wharf with two grain warehouses.

system worked poorly on low-lying islands, and by the end of the decade began to be replaced by subirrigation. This method involves raising the water table by filling a system of unlined head ditches and small lateral ditches ("spud ditches"). First utilized for potatoes and beans or to encourage a volunteer hay crop, subirrigation gradually became the standard method for all crops grown.[102] In addition to field crops and grains, fruit-growing and dairying were also present in the 1870s, but these enterprises did not receive greater emphasis until the end of the decade. By that time, Delta agriculture had divided roughly across ethnic lines. While grains, orchards, and livestock were tended by American-born settlers, garden or truck farming remained largely in the hands of Chinese, Italian, and Portuguese tenant farmers. The Chinese also specialized in row crops, including potatoes. Truck farming remained the predominant activity throughout the late nineteenth century from the Freeport-Clarksburg area to Sacramento, from Stockton westward to the San Joaquin River, and at the margin of the Delta east of Antioch. The list of garden crops that were harvested is extensive: asparagus, cabbage, carrots, cauliflower, celery, lettuce, green onions, radishes, spinach, turnips, and table beets in January and February; green peas, string beans, summer squash, cucumbers, new potatoes, and new onions in March and April; and tomatoes, green corn, and other summer vegetables after May and June. Most of the Delta's produce was traded in Bay Area cities.[103]

During the first quarter of the twentieth century, perishable crops transitioned to more extensive field agriculture. During the first decade of the century, barley, which had replaced

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[102] Terry L. Prichard, "Agriculture in the Sacramento-San Joaquin Delta," *California Agriculture*, November-December 1979; "Irrigation and the Delta," *Byron Times*, Ninth Special Booster Edition, 1924–1925, 134–135. The Haggin Museum and Archive in Stockton, California, holds selected issues of the *Bryon Times* Booster Editions from 1910 through 1936-1937. These editions were special promotional magazines that highlighted "Contra Costa and San Joaquin Counties and the famous Delta Peat Lands."

[103] Thompson, "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 309–311, 325– 328.

wheat as the major winter grain crop, was the most extensive crop in area, but potatoes were the most valuable, followed by beans and asparagus. Other crops included onions, field corn, celery, sugar beets, sweet potatoes, flax and flaxseed, wheat, alfalfa, and rye. Animal husbandry, practiced from the earliest years of reclamation, would permanently decline in the Delta by the mid-1920s, but dairying remained important throughout much of this period, particularly in the San Joaquin Delta. In the Sacramento Delta, Bartlett pear orchards along the levees of the Sacramento River reached peak production. Processing and marketing methods were evolving at this time as well. Fruit and vegetable canneries had been introduced by the turn of the century, and marketing became more sophisticated as trade names and product standards were adopted.[104]

During the second quarter of the century, the most important crops in acreage were winter grains (primarily barley), asparagus, field corn, and alfalfa. Together, they occupied well over half of the acreage cultivated, although sugar beets, much of which was processed in or near the Delta, also grew in importance. By mid-century, asparagus and tomatoes were the most important cannery crops, but pears had declined in importance. The original staple trio of potatoes, beans, and onions were also declining, while feed crops, most of which were consumed by livestock in central California, were increasing.[105]

Changing market forces during the span of the reclamation period, ranging from extra-regional competition to demands of the cannery trade, largely determined the ratio at which Delta crops were grown. Potatoes, beans, orchard crops (especially pears), asparagus, sugar beets, wheat, barley, and alfalfa hay were each important components of the Delta's agricultural economy for at least some portion of the period from approximately 1860 to 1930. Other crops were ascendant at the end of this period. Tomatoes, which fare better on mineral soils than peat

[104] "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 312–315.
[105] "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 315–318.

soils, had been cultivated in small quantities as a fresh market crop since the mid-nineteenth century. They were raised for canning beginning in the early twentieth century, but became important for this purpose on an industrial scale after 1935, when Tillie Weisberg, in partnership with Italian canning executives, opened the first Delta tomato cannery in Stockton.[106] This plant was the first of several that would be established over the next few decades to process the harvest of expanding tomato acreage in San Joaquin and Yolo counties.

While an encyclopedic survey of each of the major Delta crops is not possible within the confines of this paper, several of them merit more detailed treatment. Potatoes and asparagus have been signature crops in the Delta, and, together, their widespread cultivation—with asparagus gradually replacing potatoes—spans the entire period. They are also associated with new marketing techniques and, in the case of asparagus, with the introduction of vegetable canneries to the Delta. Sugar beets were only grown on a large scale from the early twentieth century, but this crop is also an important part of the Delta's agricultural history because of its association with refineries in the region.

Potatoes—often grown in rotation with beans—were usually the first crop planted on newly reclaimed peat soils, and served as a major cash crop from the late 1860s, approximately at the beginning of large-scale reclamation, until the 1930s, when competition from Idaho and elsewhere altered market conditions. Grand Island was known for its potatoes by the 1870s, and Bouldin, Andrus, and Staten islands had large acreages at that time as well. Plantings could be extensive; in 1900 the majority of Tyler and Victoria islands were planted to the crop. By the turn of the century, the older potato districts in the Sacramento Delta were in decline, and

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[106] "Italian Canners Step into the American Picture." *Western Canner and Packer* 27, no. 5 (1935): 13–14. The Haggin Museum and Archive in Stockton, California, holds Tillie Lewis's industrial archives and artifacts such as the company's earliest vacuum pan, made in Italy and used to make tomato paste.

emphasis switched to the newly reclaimed land of the San Joaquin Delta. Potato varieties shifted over time as well, most notably in the 1890s, when the Burbank variety replaced the Early Rose. Over time, however, potatoes would diminish in importance as emphasis switched to asparagus. By mid-century, the potato-growing area of the Delta was limited to Bacon and McDonald islands and a few additional tracts to the north and east. [107]

Several influential individuals are associated with the success of potato cultivation in the Delta, including Chinese immigrant Chin Lung and Japanese immigrant George Shima. Chin Lung arrived in California in the early 1880s—close to the time of the passage of the Chinese Exclusion Act of 1882—and would become known as the Chinese "Potato King." Among the first Chinese to lease land in the Delta, from 1898 to 1924 he accumulated extensive leased properties on which he hired Chinese laborers to grow potatoes as well as beans, asparagus, onions, hay, and grain. He employed approximately 500 Chinese laborers each year to cultivate and harvest his crops, and mastered the tasks associated with large-scale tenant farming: negotiating leases, recruiting labor, housing and provisioning large numbers of laborers, and setting up distribution networks. In 1912, one year before the California legislature passed the Alien Land Law, which prohibited "aliens ineligible for citizenship" (defined as Japanese, Chinese, Koreans, Filipinos, and other East Asians) from owning land or possessing leases longer than three years, Chin Lung purchased an 1,100-acre tract northwest of Stockton. He named it the Sing Kee Tract, after a rice-importing firm that he had worked for when he first arrived in San Francisco. Despite the heavy Chinese presence in the Delta that dates back almost to the Gold Rush, this tract remains the only one of Chinese provenance. Chin Lung's career in California ended in 1924, effectively thwarted by the more restrictive 1920 Alien Land Law,

[107] Thompson, "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 330–337.

which explicitly prohibited ineligible aliens from leasing land in their children's name. When his leases expired in 1924, Chin Lung left the state for Oregon, eventually returning to China.[108]

The better-known Japanese "Potato King," George Shima, was born as Kinji Ushijima in Kurume, on the island of Kyushu. He arrived in San Francisco in 1889 and by the end of that year had relocated to the Delta, where he quickly advanced from farm worker to labor contractor to independent farmer. By 1899 Shima had begun to experiment with potato cultivation and was reclaiming 400 acres on Bradford Island before relocating to the flood-prone islands and tracts in the lower Delta northwest of Stockton, above the San Joaquin River. [109] Shima worked closely with Lee Phillips, a Los Angeles capitalist who formed California Delta Farms in 1906, the holdings of which expanded to 42,000 acres and included the Jones Tract, King Island, Bacon Island, Bouldin Island, the Rindge Tract, and islands in Contra Costa County to the west.[110] The company obtained unreclaimed land, leveed it, and leased it to Shima to be cleared and planted to potatoes.[111] To improve yields and quality, Shima consulted with agricultural experts at Stanford University and the University of California at Berkeley regarding seeds and planting and harvesting techniques.[112] Shima became the largest potato grower in California, and in 1910 began purchasing, rather than leasing, Delta farmland; his first purchase was an 800-acre parcel northwest of Stockton on what is now known as the Shima Tract. However, his reputation as the "Potato King"—with operations extending from San Francisco to Los Angeles—is at least as

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[108] Chan, *This Bittersweet Soil: The Chinese in California Agriculture, 1860–1910*, 203–212.
[109] Don and Nadine Hata, "George Shima: 'The Potato King of California'," *Journal of the West* 25, no. 1 (1986).
[110] For archival records of this important agricultural firm, see the California Delta Farms Collection, 1915–1934, San Joaquin County Historical Society and Museum, Lodi, California.
[111] Thompson, "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 235.
[112] Hata, "George Shima: 'The Potato King of California'."

much ascribable to his production and marketing innovations.[113] He is reportedly the first grower to wash potatoes before sacking them for shipment; to grade potatoes for sale by quality; and to sell potatoes under a trademark, using red bags. He also introduced the practice of growing potatoes on the same land for only three consecutive years to protect the crop from fungus that proliferated in the soil. Shima's innovations nevertheless offered him no more protection than Chin Lung from the xenophobic policies of the day, and until his death in 1926 he too was subject to the Alien Land Laws, which were primarily intended to target the large number of prospering Japanese agriculturists in California at that time.[114]

The potato was so spectacularly successful in the Delta that the Stockton Chamber of Commerce inaugurated an annual Potato Day Festival, the first of which was held on October 18, 1924; Luther Burbank was among the honored guests.[115] In that year, Frederick H. Rindge established the world record for potato production, harvesting 57,752 pounds of Burbank potatoes to the acre on the Rindge Tract, breaking the highest previous documented record of 53,760 pounds, held by Great Britain. The new record was announced with great fanfare at the Potato Day Festival.[116]

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[113] "World-Famous Japanese Potato King," *Byron Times*, Second Special Booster Edition, 1910, n.p.

[114] William D. Rogers, "The Delta Story" (third in series of twenty-four), *Stockton Record*, July 4, 1951.

[115] Letter from Luther Burbank to A. C. Oullahan, July 21, 1924, MSS 194: Oullahan Family Papers, Holt-Atherton Special Collections, University of the Pacific, Stockton, California.

[116] "Frederick H. Rindge—Scientific Farmer," *Bryon Times*, Tenth Development Edition, 1926–1927, 186; Potato Day records, MS 39, Underhill Collection, Box 1, Folder 1, San Joaquin County Historical Society and Museum; "Governor and Many Noted Men See Luther Burbank's Creation Win New Laurels, *Stockton Independent*, Oct. 19, 1924. A few years earlier, the Rindge Tract had been noted for the high quality of different crop, hemp (which did not become illegal in the United States until 1937). In text and photos, the *Byron Times* praised the 4,000 acres of the tract dedicated to hemp production in 1917. "F. H. Rindge's Model 4,000-Acre Tract," *Byron Times*, Sixth Booster Edition, 1918, 108.

During the late nineteenth century, asparagus became the most profitable vegetable in the Delta and acreage expanded rapidly, often at the expense of potatoes. Asparagus shipments from the Stockton area were consigned to San Francisco produce houses by the 1880s, and farmers near Sacramento were realizing healthy profits as well.[117] The development and proliferation of canneries in and around the Delta beginning in 1892 dramatically increased demand, driving up prices and accelerating the expansion of the crop. In that year Robert Hickmott built the Delta's first successful cannery on Bouldin Island, where he also raised the crop.[118] Railroads made possible the expansion of the asparagus market and in August 1900, the Hickmott Cannery shipped the first trainload of canned asparagus to an eastern market, sending at least twenty carloads to New York.[119] Other canneries appeared in short order after Hickmott. In 1899 the Golden State Asparagus Company constructed a cannery on Grand Island, soon planted 1,700 acres to asparagus on Andrus Island, and in 1904 moved its cannery to Isleton. The California Fruit Canners' Association opened a plant at Vorden, about three miles above Walnut Grove, and the Libby, McNeill & Libby Company of Chicago leased a plant in Pittsburg, and then constructed its own plant in 1907 at Isleton.[120] The canning companies owned most of the asparagus acreage, but they also purchased from independent growers, and during the first years of the century were paying up to $60 per ton for asparagus destined for their canneries, nearly triple the $20 per ton that fresh asparagus commanded.[121] In 1915 canneries purchased

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[117] Thompson, "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 340.
[118] "An Asparagus Cannery," *Stockton Daily Independent*, May 13, 1892.
[119] William D. Rogers, "The Delta Story" (ninth in series of twenty-four), *Stockton Record*, July 11, 1951.
[120] "Asparagus Growing in Delta," *Bryon Times*, Ninth Development Edition, 1924–1925, 240–242.
[121] Thompson, "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 341–342.

approximately 66.6 percent of the all asparagus grown in the Sacramento Delta, or just under 40 million pounds.[122] By the mid-1920s canning companies were located at Isleton, Walnut Grove, Rio Vista, Ryde, Sacramento, Antioch, and Pittsburg, as well as Oakland and San Francisco.[123] The canning process did not completely supersede the sale and marketing of fresh asparagus, however. Refrigerated railroad cars, or "reefers," became far more commonplace after the turn of the century, and made it possible to ship fresh, rather than canned, asparagus—as well as other fresh Delta produce— throughout the country.[124]

By the mid-1920s, ninety percent of all the asparagus grown in the United States was produced in the Delta and each spring hundreds of cars of fresh asparagus were shipped daily to points east.[125] As Stockton had done in 1924 with its Potato Day Festival, Isleton inaugurated an annual Asparagus Festival the following year, held on April 18 and 19.[126] The work of actually harvesting the asparagus, which required considerable skill and precision in cutting, was largely carried out during this period by Filipino laborers, who had begun to replace Chinese and Japanese workers after the Spanish-American War had opened up immigration opportunities for them. Following the passage of the Philippines Independence Act in 1934, however, immigration

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[122] W. F. Bailey, *Asparagus in California: The Culture, Marketing Problems and History*, State Commission Market of California, Bulletin No.1 (California State Printing Office, 1916), 12.
[123] "Asparagus Growing in Delta," *Bryon Times*, Ninth Development Edition, 1924–1925, 240–242. "Canneries Working on Asparagus and Spinach; Crops May Be Short," *Sacramento Bee*, April 7, 1923. The Isleton Museum in Isleton, California, exhibits framed photos of cannery workers from several canneries in or near Isleton.
[124] Linda Danes-Wingett, "The Ice Car Cometh: A History of the Railroad Refrigerator Car," *The San Joaquin Historian* 10, New Series, no. 4 (1996). See also John H. White, *The Great Yellow Fleet: A History of American Railroad Refrigerator Cars* (San Marino, California: Golden West Books, 1986). For context on the role of railroads in promoting agriculture and shipping agricultural produce from California and the West, see Richard J. Orsi, *Sunset Limited: The Southern Pacific Railroad and the Development of the American West, 1850–1930* (Berkeley and Los Angeles: University of California Press, 2005), especially Part IV.
[125] "Union Island—A 23,000-Acre Delta Empire," *Bryon Times*, Ninth Development Edition, 1924–1925, 231; "Asparagus Growing in Delta," *Bryon Times*, ibid., 240–242.
[126] "Festival for Asparagus Is Isleton Plan," *Stockton Independent*, March 31, 1925.

from the Philippines was severely restricted (to 50 admissions per year) and the Filipinos would gradually be replaced in subsequent decades by Mexican workers.[127]

The older asparagus districts in the Sacramento Delta, including the Pierson District and Grand, Twitchell, Andrus, Bouldin, and Jersey islands, began to decline in productivity by 1924, at which time eighty-four percent of the Delta's 52,600 asparagus acres was located in that region. A combination of the limited commercial life of asparagus-producing fields, the difficulty of replanting because of the fungal disease known as fusarium wilt, and limited opportunities for expansion because of the relatively high cost of land all contributed to this reversal of fortune. Within three decades, paralleling this decline, all of the canneries along the Sacramento River in the old centers of Walnut Grove, Isleton, and Rio Vista would cease operations. Production shifted to the San Joaquin Delta during the 1930s, and by the mid-1940s the peat lands of that region had become the Delta's major asparagus producing area, with significant acreage on Union, Victoria, and Lower Roberts islands, and the Fabian, Clifton Court, Byron, Wright, and Shima tracts. By 1952, ninety-five percent of the Delta's asparagus acreage was located in the San Joaquin Delta, a significant reversal from just a quarter-century earlier.[128]

The development of physical infrastructure, such as the canneries that helped promote asparagus, also led to increased production of other Delta crops, including sugar beets. The first sugar beet refinery was established in Isleton as early as 1876, although the crop did not become commercially important until the WWI era, when sugar shortages encouraged greater production. During the war years, the Spreckels Company established a refinery near the Delta at Manteca,

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[127] Reed Ueda, *Postwar Immigrant America: A Social History* (Boston and New York: Bedford Books of St. Martin's Press, 1994), 170.
[128] Thompson, "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 343–347.

and the Pacific Sugar Company constructed a plant north of Tracy.[129] In the north Delta, sugar beets became a principal crop in the Clarksburg area after 1920, when the Alameda Sugar Company (predecessor of the Holly Sugar Company) contracted with local farmers to grow them. In the late 1920s, 2,600 acres were planted to the crop in the neighboring Lisbon District alone.[130] Acreages would increase dramatically after the Amalgamated Sugar Company moved its Smithfield, Utah, refinery to Clarksburg in 1934, encouraging further development of sugar beets on the mineral soils along the Sacramento River and in the Yolo Basin.[131] When Congress passed the Sugar Act of 1935, which set quotas, standards for fertilization and rotation, and wage rates for the sugar industry, production accelerated still further, and in 1936 reached nearly 42,000 acres in Yolo County. The following year, the American Crystal Sugar Company took over and enlarged the Clarksburg plant, which remained in operation under various owners until 1993.[132] Rising costs of production and increased competition from overseas and other regions of the U.S. contributed to the closure of additional California sugar refineries, including the Spreckels Sugar Plant in Manteca in 1996, and sugar beet production in the Delta plummeted. In 2000, renovations began to convert the Clarksburg plant into a multi-tasting-room venue and wine production facility. The venue, renamed the Old Sugar Mill, opened to the public in 2005.

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[129] "The Settlement Geography of the Sacramento-San Joaquin Delta, California," 354.
[130] "Spreckels Sugar Company Growing 15,000 Acres of Beets in Sacramento Valley," *Bryon Times*, Eleventh Development Edition, 1928–1929, 131.
[131] Photos of the plant's reconstruction may be found at the Clarksburg Public Library, Clarksburg, California.
[132] Shipley Walters, *Clarksburg: Delta Community* (Woodland, California: Yolo County Historical Society, 1988), 36.

Salmon Fisheries and Canneries

The ways in which people made a living off the land through agriculture were not the only aspects of life in the Delta that evolved over the century or so from the Gold Rush to the completion of reclamation. The Delta's water resources, especially its chinook salmon (*Oncorhynchus tshawytscha*), were also exploited during this era on an increasingly industrial scale. Salmon are anadromous fish; after hatching in rivers, they spend most of their adult lives at sea, and then return to those same rivers in mass migrations, called runs, to spawn. The presence of four salmon runs—spring, fall, late fall, and winter—gave rise during the last third of the nineteenth century to a thriving fishery and a cannery industry, before the fishery collapsed dramatically by 1900.[133] Nearly a century later, when conservationist impulses were ascendant, concern over threatened salmon runs would give rise to important restoration measures for the Delta's rivers and floodplains.

By the early 1850s, some five dozen boats were already fishing the Sacramento River for salmon from its confluence with the American River to its outlet into Suisun Bay. Capital for this enterprise came largely from New England entrepreneurs, although Italian immigrant fishermen have also been credited with the earliest establishment of the commercial fishery around 1850. Much of the labor of harvesting the fish was carried out by Italian, Greek, Portuguese, and Spanish immigrants. Rio Vista emerged as the main landing station, and the salmon fishery brought significant wealth to the town through the 1880s. In 1864, William Hume opened the first cannery on the Sacramento River, on a scow moored on the west bank across from Sacramento. Local demand for the canned product was not yet extensive, however, as fresh

[133] For detail on the four salmon runs and their relative abundances, see Ronald M. Yoshiyama, Frank W. Fisher, and Peter B. Moyle, "Historical Abundance and Decline of Chinook Salmon in the Central Valley Region of California," *North American Journal of Fisheries Management* 18, no. 3 (1998).

salmon was still readily available in the San Francisco Bay area, so in 1867, when a market for canned salmon was developing in Australia, the firm of Hume, Hapgood, and Company relocated to the Columbia River, which contained bigger runs.[134]

Canneries reappeared on the Sacramento River in the mid-1870s, and the industry grew rapidly after 1878, in response to rising prices and heavier fish runs. Unlike the fishermen themselves, most of the cannery workers were Chinese laborers working under American or European supervisors. By 1883, more than 1,500 boats were serving 21 canneries operating on the river, the highest number of canneries recorded. Collectively, the canneries packed 123,000 cases of salmon harvested from the lower Sacramento and San Joaquin rivers. But by then the runs were already declining; the peak production had occurred the previous year, when 19 canneries packed 200,000 cases.[135] Overfishing was one cause of the decline. The excessive number of gill nets in the water had not allowed an adequate number of salmon to survive the journey upstream to spawn. But if Native Americans harvested similar quantities of salmon, presumably for generations, as scholars have argued, then overfishing alone could not have been the main cause of the decline. Instead, overharvesting combined with destruction of the salmon's spawning beds by the deposition of sediment from hydraulic mining appears to account for the diminishment of the runs. As the California Fish Commission noted in 1880:

> The numbers of salmon that could have been taken in this [Sacramento] river, before the greater part of their spawning beds had been destroyed by sediment from the gold mines, can never be known. It is the testimony of all the pioneer miners that every tributary of the Sacramento, at the

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[134] Arthur F. McEvoy, *The Fisherman's Problem: Ecology and Law in the California Fisheries, 1850–1980* (Cambridge: Cambridge University Press, 1986), 70–71; Yoshiyama, "A History of Salmon and People in the Central Valley Region of California," 211.

[135] McEvoy, *The Fisherman's Problem: Ecology and Law in the California Fisheries, 1850–1980*, 71; Yoshiyama, "A History of Salmon and People in the Central Valley Region of California," 212.

commencement of mining, was, in the season, filled with this fish, hurrying and struggling as if to reach the very sources of these streams.[136]

The 1884 court decision that effectively ended hydraulic mining in California, *Woodruff v. North Bloomfield Gravel Mining Company*, was predicated on damage to property resulting from the exacerbation of flooding and from debris flows, but indirectly the decision aided salmon in the long run by improving spawning conditions. Nevertheless, it would take several decades for the smothering sediment to be flushed downstream, and yields from the river fishery continued to decline, although not completely linearly, until the last Sacramento River cannery closed in 1919. By that time, the commercial salmon fishing industry was already relocating to coastal waters, and ocean trolling methods gradually replaced gillnet fishing on the rivers. At the end of the 1957 season, nearly four decades after the demise of the Delta salmon cannery industry, the state legislature officially terminated commercial gillnet fishing in the Sacramento-San Joaquin Delta.[137]

Water Projects and Water Quality in the Delta

Salmon populations, and ultimately the entire Delta ecosystem, would be affected by California's two most massive water projects, the federal Central Valley Project, the construction of which began in the 1930s, and the State Water Project, begun a generation later, in the 1960s. Much has been published on the genesis, realization, and consequences of these projects, and it is

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[136] California Fish Commission (CFC), *(6th Biennial) Report of the Commissioners of Fisheries of the State of California, for the year 1880* (Sacramento, California: 1880), 3, quoted in "A History of Salmon and People in the Central Valley Region of California," 210.
[137] "A History of Salmon and People in the Central Valley Region of California," 213; McEvoy, *The Fisherman's Problem: Ecology and Law in the California Fisheries, 1850–1980*, 72.

beyond the scope of this paper to replicate that history here.[138] However, a brief account of water development in the Central Valley, placed in national context, will set the stage for subsequent water quality problems in the Delta, and for late-twentieth century restoration efforts.

The Central Valley Project would bring water for irrigation from the relatively moist Sacramento Valley through the Delta to the more arid San Joaquin Valley, while also providing enhanced flood control for the Sacramento Valley and regulation of saltwater intrusion into the Delta. The project marked the culmination of a decades-long drive for the coordinated development of water resources in California and for federal involvement in irrigation projects in the arid lands of the American West. The earliest irrigation works in the Central Valley were constructed on a small scale by individual farmers and, by the 1870s, by private irrigation companies. In response to fears that water in the valley would become monopolized by such firms, in 1887 the state legislature passed the Wright Act, named after C. C. Wright, a Modesto lawyer who drafted the bill. The act created irrigation districts, which were modeled administratively on the reclamation districts first established a generation earlier.[139] The Wright Act achieved some success, but the majority of the early districts failed, and Californians increasingly looked toward the federal government to develop irrigation projects. They were aided by events at the national level. Drought on the Great Plains during the 1890s had led to a

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[138] The literature on the Central Valley Project is vast. Documents from various government agencies, including the California Division of Engineering and Irrigation, California Division of Water Resources, California Department of Water Resources, and the U.S. Bureau of Reclamation account for many of the primary sources. Secondary sources that cover this topic in great detail include Norris Hundley, Jr., *The Great Thirst: Californians and Water: A History*, Revised ed. (Berkeley and Los Angeles: University of California Press, 2001); Garone, *The Fall and Rise of the Wetlands of California's Great Central Valley*.

[139] 1887 *Statutes of California* ch. 34; Donald J. Pisani, *From the Family Farm to Agribusiness: The Irrigation Crusade in California and the West, 1850–1931* (Berkeley and Los Angeles: University of California Press, 1984), 252–273.

national irrigation crusade, the leaders of which called for an expansion of federal responsibility from the improvement of navigation and flood control to irrigation as well.[140]

Responding to this pressing demand, in 1902 Congress passed and President Theodore Roosevelt signed the Newlands Reclamation Act, which created the Reclamation Service (renamed the Bureau of Reclamation in 1923) and applied to sixteen western states and territories, including California. The act established a "reclamation fund" for collecting monies received from the sale and disposal of public lands; the funds were to be used for the surveying of arid and semiarid lands, and for the storage, diversion, and development of waters for the reclamation of that land.[141] In this case reclamation took on a different shade of meaning from that of draining water *from* the Delta's swampy islands and tracts. Under the Newlands Act, reclamation would mean bringing water *to* arid land. These two sides of reclamation nevertheless shared a common goal; the end result would be to make agriculture possible in places where it had not been possible before. Thirty-five years after the passage of the Newlands Act, the Bureau of Reclamation would become the agency tasked with the construction of the federal Central Valley Project, which began as the California State Water Plan.

Beginning in the early 1910s, California moved toward developing a truly comprehensive unified water plan for managing irrigation, reclamation, water storage, flood control, drainage, and municipal water supplies. Local conditions in the Delta provided one of the driving forces behind this effort. As part of the Sacramento-San Joaquin River drainage, the Delta is affected by

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[140] See William E. Smythe, *The Conquest of Arid America*, Lawrence B. Lee, ed. (Seattle: University of Washington Press, 1969).

[141] 32 *Stat.* 388. The Reclamation Act applied to the 13 states of California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming, and the territories of Oklahoma (admitted to statehood in 1907) and Arizona and New Mexico (both admitted to statehood in 1912). Texas was included in the Reclamation Act in 1906.

changes in water use along those rivers. In the Sacramento Valley the commercial production of rice began in 1912 and the industry expanded rapidly, increasing the demand for irrigation water.[142] In only four years, from 1915 to 1919, irrigation diversions of Sacramento River water doubled from 1.15 million acre-feet to 2.30 million acre-feet.[143] These diversions drastically reduced the inflow of the Sacramento River to the Delta, and Delta and Suisun Bay water users alike blamed the rice producers in the Sacramento Valley for the increasing penetration of ocean salinity that resulted. When this situation coincided with a serious drought in 1920, which exacerbated the salinity problem, the Delta city of Antioch and ninety-seven Delta landowners filed suit against upstream irrigators in Alameda Superior Court, which granted an injunction against upstream diversions, only to be overturned by the state supreme court.[144] Although the Antioch suit was ultimately unsuccessful, this important case prompted the state Division of Engineering and Irrigation and its successor, the Division of Water Resources, to search for a solution to the salinity problem, which by 1931 became officially known as the State Water Plan.

Throughout the 1920s Delta farmers continued to press the state for a solution to their fresh water shortages. They called attention to the fact that saltwater intrusion into Delta channels negatively affected Delta agriculture in two significant ways, either rendering irrigation impossible because of the high salt content in the water, or damaging soils and crops as salt water penetrated through porous levees. They called for either a physical saltwater barrier in the Carquinez Strait, between Suisun and San Pablo bays—an idea under serious consideration at the time, but one that state engineers ultimately found to be too problematic—or for a storage dam

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[142] Jack H. Willson, ed. *Rice in California* (Richvale, California: Butte County Rice Growers Association, 1979), 50.
[143] W. Turrentine Jackson and Alan M. Paterson, "The Sacramento-San Joaquin Delta: The Evolution and Implementation of Water Policy: An Historical Perspective" (California Water Resources Center, University of California, Davis, Contribution No. 163, 1977), 2.
[144] *Town of Antioch v. Williams Irrigation District*, 188 Cal. 451 (1922)

on the Sacramento River to provide minimum downstream flows.[145] Severe drought expedited the realization of the state's plan. In 1931, when the flow of the Sacramento River past the city of Sacramento fell briefly to zero, tidal salinity with a chloride concentration at or above 1000 ppm (the generally accepted upper limit for irrigation) spread over ninety percent of the Delta, reaching as far inland as Stockton, the greatest extent ever recorded.[146] Finally, in August 1933 the state legislature passed the Central Valley Project Act to bring the State Water Plan to fruition.[147] The act was welcomed by Delta residents, who believed that the project would secure the future of agriculture not only in the Delta, but throughout the Central Valley.[148] However, having passed the Central Valley Project Act during the height of the Depression, California was unable to finance the project and appealed to the federal government for assistance. Congress responded and in 1935 authorized its initial construction by the U.S. Army Corps of Engineers under its authority for maintenance and improvement of navigation. Shortly thereafter President Roosevelt approved it as a reclamation project, and in 1937 Congress reauthorized the project, now to be constructed by the U.S. Bureau of Reclamation.[149]

The Central Valley Project called for a dam on the upper Sacramento River—the future Shasta Dam—to regulate the river's flows to control salinity problems in the Delta; store water for irrigation in the Sacramento Valley; and provide enhanced flood control, improvement of navigation, and generation of hydroelectric power. In the San Joaquin Valley, a dam on the San

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[145] "The Delta and the Irrigation Problem," *Byron Times*, Tenth Development Edition, 1926–1927, 134.
[146] Jackson and Paterson, "The Sacramento-San Joaquin Delta: The Evolution and Implementation of Water Policy: An Historical Perspective," 6, 30.
[147] 1933 *Statutes of California* ch. 1042.
[148] "Water Plan Assures California's Future," *Byron Times*, Fifteenth Development Edition, 1934–1935, 111.
[149] 49 Stat. 1028; 50 Stat. 884; U.S. House of Representatives, "Central Valley Project Documents: Part One: Authorizing Documents" (House Document No. 416, 84th Congress, 2d Session, 1956), 562–567.

Joaquin River at Friant would capture the river's flow, almost the full volume of which would then be diverted to irrigate the eastern side of the valley via the 36-mile-long Madera Canal and 152-mile-long Friant-Kern Canal. As a result of these diversions to the north and south, respectively, the river's average annual flow of nearly 1.8 million acre-feet—measured at Friant—would be reduced to a trickle below the dam, quickly destroying the San Joaquin River's once impressive salmon runs, the southernmost on the Pacific Coast of the Americas. In contrast, Shasta Dam blocked only the upper third of the Sacramento River and the river was not diverted out of its channel below the dam, thus proving far less detrimental to that river's salmon runs. Before the completion of Friant Dam in the early 1940s, salmon runs in the San Joaquin River still exceeded 80,000 fish despite the hindrance of two smaller downstream dams that had been constructed by Miller and Lux during the late nineteenth century. With Friant Dam in place, San Joaquin River salmon would be largely gone by the late 1940s. At that time, few people, other than sportsmen and the landowners who would be directly affected by the dewatering of the river, protested the river's impending demise.[150] A new canal would be constructed to deliver "substitute" water from the Delta to the lower San Joaquin River at the great bend of the river near Mendota—where the river turns from west to north and begins its journey down the center of the San Joaquin Valley toward the Delta—for irrigating cropland in the lower San Joaquin Valley. Even with this Delta-Mendota Canal in place, the 59-mile stretch of the river from Mendota upstream to Friant Dam was left with little water, and, within this reach, the 23 miles

[150] The landowners filed suit against the Bureau of Reclamation and other defendants in 1947 over the legality of the taking of their water rights to the river. The case, *Rank v. Krug*, which the landowners ultimately lost, would be litigated for the following 16 years. See *Rank et al. v. Krug et al.*, 90 F. Supp. 773 (S.D. Cal. 1950); *Rank et al. v. Krug et al.*, 142 F. Supp. 1 (S.D. Cal. 1956). The figure of 1.8 million acre-feet is from the 1956 decision, which reported that from 1897 to 1944, the average annual flow of the San Joaquin River at Friant was 1,797,260 acre-feet.

directly above Mendota were completely dewatered. Salmon cannot swim up a dry river channel and even if they could, they would then have faced a 319-foot-high concrete dam.

More than a half century would pass before attitudes toward wild rivers and the fish and other fauna and flora they support changed enough to set in motion a process to restore the San Joaquin River. A 1988 lawsuit against the Bureau of Reclamation spearheaded by the Natural Resources Defense Council would lead, sixteen years later, to U.S. District Court Judge Lawrence K. Karlton's ruling against the Bureau. This momentous 2004 decision required the agency to maintain adequate water in the San Joaquin River below Friant Dam to sustain the river's fish populations.[151] Two years later the parties reached an agreement, ending the protracted legal dispute, and leading to the passage in 2009 of the San Joaquin River Restoration Settlement Act, signed by President Obama on March 30 of that year. The act required substantial river channel improvements and sufficient releases from Friant Dam to sustain naturally reproducing spring-run and fall-run Chinook salmon and other fish populations from the dam downstream to the confluence with the Merced River, the San Joaquin River's first major tributary.[152] The first water releases, called interim flows, began in 2009, and in March 2010, as interim flows approached 1,000 cubic feet per second (cfs), the San Joaquin River filled its historical channels below Friant Dam and flowed continuously to San Francisco Bay for the

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[151] *Natural Resources Defense Council v. Patterson (Patterson II)*, 333 F. Supp. 2d 906 (E.D. Cal. 2004). The ruling was based primarily on California's *Fish and Game Code* section 5937, which required that "The owner of any dam shall allow sufficient water at all times to pass through the fishway, or in the absence of a fishway, allow sufficient water to pass over, around or through the dam to keep in good condition any fish that may be planted or exist below the dam."

[152] Stipulation of Settlement, September 13, 2006, in *Natural Resources Defense Council v. Rodgers*, CV-S-88-1658 LKK/GGH (E.D. Cal.). The San Joaquin River Restoration Settlement Act was part of a landmark wilderness bill, the Omnibus Public Land Management Act, Public Law 111-11, that set aside more than two million acres in nine states.

first time in more than six decades.[153] Despite political resistance and drought conditions, the most ambitious restoration project in California history is proceeding.[154]

The Central Valley Project thus yielded mixed results for the valley's rivers and for the Delta. It regulated the flow of the Sacramento River at Shasta Dam and thus protected the Delta from salinity intrusion, but it also reengineered and nearly obliterated the San Joaquin River, destroying its salmon runs in the process, a consequence only now undergoing remediation. In addition, the project's Delta-Mendota Canal established a precedent for water transfers across the Delta from the Sacramento Valley to the San Joaquin Valley. The magnitude of those transfers, and the problems for the Delta associated with them, would increase dramatically after the 1960s, when the State Water Project—this time truly a state project—was constructed.

The State Water Project was the manifestation of part of the California Water Plan, "a comprehensive master plan for the control, protection, conservation, distribution, and utilization of the waters of California," which the California Department of Water Resources developed over the decade from 1947 to 1957.[155] The State Water Project was launched after the legislature passed the Water Resources Development Bond Act (also known as the Burns-Porter Act) in 1959 and California voters narrowly approved it the following year. The project would dam the Feather River at Oroville and transport part of the flow of that river, mingled with that of the Sacramento River, across the Delta and into the new California Aqueduct, to provide fresh water to the west side of the San Joaquin Valley and beyond to the cities of Southern California.[156] Water first reached the San Joaquin Valley in 1968, and crossed the Tehachapi Mountains in

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[153] Carolyn Jones, "San Joaquin River: Water Now Flowing Freely Again," *San Francisco Chronicle*, March 31, 2010, A1.
[154] See the San Joaquin River Restoration Program website, at http://restoresjr.net/index.html.
[155] California Department of Water Resources, "Bulletin No. 3. The California Water Plan" (Sacramento: California Department of Water Resources, 1957), xxv.
[156] 1959 *Statutes of California* ch. 1762.

1971.[157] Increased diversions through the Delta led to a number of problems, including salinity intrusion and declining overall water quality. In addition, the enormous pumps in the south Delta below the Clifton Court Forebay that lift water into the California Aqueduct and the Delta-Mendota Canal are powerful enough to reverse the direction of flow in some Delta channels. Fish were drawn into the pumps, where they were killed.[158] During times of low river flow and drought, saline water advances far enough inland to be drawn into the aqueduct and the canal, requiring temporary shutdown of the pumps to avoid potentially contaminating water supplies for the San Joaquin Valley and Southern California.[159]

In truth, the salinity problem had re-emerged even before the California Aqueduct began transporting water southward, a result of increased consumption of fresh water by Delta communities and farms, as well as reduced runoff to the Delta from the tributaries of the San Joaquin River, the flows of which were increasingly transported by aqueducts to rapidly growing Bay Area cities. To address this problem, in 1965 federal and state agencies proposed as the long-planned second phase of the State Water Project a Peripheral Canal to transport fresh water from the Sacramento River around the Delta to the intakes of the Delta-Mendota Canal and California Aqueduct. This unlined, 43-mile-long canal would swing in an arc beginning on the Sacramento River fifteen miles below Sacramento, near Hood, then skirt the eastern margins of the Delta, and finally curve westward to the pumping plants on the southern edge of the Delta. The Peripheral Canal pitted Delta residents— who were not confident that the canal offered the Delta adequate water quality protection and who feared that the canal would result in a water

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[157] Hundley, *The Great Thirst: Californians and Water: A History*, 291.
[158] *The Great Thirst: Californians and Water: A History*, 314. Fish-salvage techniques, including the construction of fish-collection facilities, have since been implemented near both pumping plants to reduce losses.
[159] The Harvey O. Banks Pumping Plant serves the California Aqueduct and the C.W. "Bill" Jones Pumping Plant (formerly the Tracy Pumping Plant) serves the Delta-Mendota Canal.

"grab" by the southern part of the state—against residents of the San Joaquin Valley and Southern California. After fifteen years of north-south tensions over the canal, in 1980 the Peripheral Canal bill passed the state legislature, only to be overturned in 1982 in a statewide referendum by a sixty-three percent majority.[160]

Little progress was made on water quality issues in the Delta during the 1980s, but the 1990s began with greater promise. In 1992 Congress passed the Central Valley Project Improvement Act (CVPIA), which, among its many provisions, required operation of the Central Valley Project to include protective measures for the Delta and Suisun Marsh.[161] That same year witnessed the passage by the California legislature of the Delta Protection Act, which created the Delta Protection Commission and declared that "the Sacramento-San Joaquin Delta is a natural resource of statewide, national, and international significance, containing irreplaceable resources, and it is the policy of the state to recognize, preserve, and protect those resources of the delta [sic] for the use and enjoyment of current and future generations."[162] The following year, the U.S. Fish and Wildlife Service and the California Fish and Game Commission declared the Delta smelt (*Hypomesus transpacificus*) an endangered species. A small (2–3 inch) native fish endemic to the San Francisco Bay-Delta Estuary, the environmentally sensitive smelt is considered an indicator species for the condition of the Delta ecosystem. The listing heightened federal and state responsibility for Delta water quality and led to the signing of the Bay-Delta Accord in 1994, prompting the creation of CALFED, an interagency program designed to address four

[160] Hundley, *The Great Thirst: Californians and Water: A History*, 313–332.
[161] The CVPIA was passed as Title 34 of the Reclamation Projects Authorization and Adjustment Act of 1992, Public Law 102-575, 106 *Stat.* 4706.
[162] The Delta Protection Act is incorporated into the *California Public Resources Code*, Sections 29700–29716; quotation at 29701.

issues crucial to the long-term restoration and management of the Bay-Delta estuary: ecosystem restoration, water supply reliability, water quality, and levee rehabilitation.[163]

While CALFED achieved some success with ecosystem restoration efforts in areas upstream from the Delta, it proved less capable of ameliorating water quality conditions in the Delta itself. The decline of the Delta ecosystem is a complex problem and cannot be attributed to one single cause; rather, a combination of invasive species, water pollution from toxic chemicals, and excessive water exports are to blame.[164] During the CALFED decade (mid-1990s to mid-2000s) conditions in the Delta continued to deteriorate and fish populations, including that of the endangered Delta smelt as well as salmon and steelhead, declined. State Water Project exports increased sharply under CALFED, and the program's competing goals and lack of effective mechanisms to carry out its charge led to its demise.[165]

The state adopted a new approach in 2007 when Governor Arnold Schwarzenegger convened a Delta Vision Blue Ribbon Task Force to recommend institutional changes that would allow California to more effectively manage the state's competing water interests. The Task Force called on the legislature to create a new governance structure capable of working toward the "co-equal goals" of protecting, restoring, and enhancing the Delta ecosystem and creating a more reliable water supply for the state.[166] In 2009, the state legislature passed the Delta Reform Act, which created a Delta Stewardship Council and charged it with achieving the co-equal

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[163] The formal name of the Bay-Delta Accord is "Principles for Agreement on Bay-Delta Standards between the State of California and the Federal Government. It was published in January 1995 in the *Federal Register*, at 60 *Fed. Reg.* 4664.
[164] Matt Weiser, "Delta Danger," *Sacramento Bee*, July 3, 2005, B1.
[165] Ellen Hanak et al., *Managing California's Water: From Conflict to Reconciliation* (San Francisco: Public Policy Institute of California, 2011), 63–64.
[166] Delta Vision Blue Ribbon Task Force, "Our Vision for the Delta" (Sacramento: State of California Resources Agency, 2007); "Delta Vision Strategic Plan" (Sacramento: State of California Resources Agency, 2008).

goals.[167] Concurrently, the Bay Delta Conservation Plan (BDCP), initiated in 2006, began to be negotiated by federal and state water managers and regulators, local water users, water exporters, and environmental interests.[168] The BDCP aimed to create a comprehensive habitat conservation and management plan to protect the Delta ecosystem while also maintaining export of water by the State Water Project and Central Valley Project, but became mired in acrimonious debate over its proposed "Water Conveyance Facility," otherwise known as the Delta Tunnels, the latest plan to convey Sacramento River water south of the Delta. In April 2015, the administration of Governor Jerry Brown separated achievement of the co-equal goals into two new initiatives, renaming the tunnels portion of the BDCP the California Water Fix, and placing habitat restoration under California Eco-Restore, a move which will almost certainly face legal challenges.[169] Meanwhile, as 2015 marked California's fourth year of drought, Delta and Suisun Bay fish populations continue to plummet, and the California Department of Fish and Wildlife has reported that, in its 2014 annual fall survey, pelagic (open water) fish, including the Delta smelt, striped bass, longfin smelt, threadfin shad, and American shad, were indexed at or near their lowest levels since surveys began in 1967.[170]

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[167] S.B. X7 1 (2009).
[168] See the BDCP website at http://baydeltaconservationplan.com/Home.aspx.
[169] David Siders and Phillip Reese, "Jerry Brown's Revised Water Tunnels Plan Adds Political Problems," *Sacramento Bee*, April 30, 2015. The most vocal group that has opposed the Tunnels Plan is "Restore the Delta." This organization of Delta landowners and their advocates has produced a documentary, *Bridge Over Troubled Waters* (narrated by Ed Begley, Jr.), prepared responses to the Bay Delta Conservation Plan, and documented Delta issues since 2009. The group also maintains a repository of hundreds of photographs. See the "Restore the Delta" website at www.restorethedelta.org.
[170] Steven Slater, Environmental Scientist, Region 3, California Department of Fish and Wildlife, to Scott Wilson, Regional Manager, Region 3, California Department of Fish and Wildlife, Memorandum: "Fall Midwater Trawl 2014 Annual Fish Abundance Summary," January 7, 2015. Indexing is based on extensive sampling, the results of which are used to estimate abundance.

Wetland Protection and Restoration

While the complexity of the Delta's ecosystem and the large number of competing stakeholders have thus far caused recovery efforts for the Delta's waterways to falter, significant progress has been achieved in wetland protection and restoration along the margins of the Delta. The creation, during the last decades of the twentieth century, of the Cosumnes River Preserve, Stone Lakes National Wildlife Refuge, and Yolo Bypass Wildlife Area is the culmination of a century of changing attitudes toward wetlands and the waterfowl and other wildlife they support. At the foundation of this story is the early twentieth-century discovery of the Pacific Flyway, and of the Central Valley's importance for its maintenance.

The Pacific Flyway is the westernmost of the four great North American transcontinental flyways for migratory waterfowl and other avian species.[171] The flyway stretches from the arctic and subarctic regions of Alaska and western Canada, across the western United States, to western Mexico and beyond. For millions of years migratory waterfowl of the flyway have bred in the far North, during the short arctic summer, and then migrated southward during the fall to overwinter in places with more moderate climates, only to return to northern latitudes during the spring and repeat the cycle of life. The maintenance of this annual migration depends on the condition of both the northern breeding grounds and the southern wintering grounds. The primary wintering grounds for the Pacific Flyway are located in the Central Valley of California, including the Delta and Suisun Marsh. Although the valley's estimated four million acres of permanent and seasonal wetlands at the time of statehood were reduced to only several hundred thousand acres by the mid-twentieth century—primarily because of conversion to agriculture—the valley still supports an astonishing sixty percent of all the wintering waterfowl of the Pacific Flyway, the

[171] The three additional flyways, from west to east, are the Central Flyway, Mississippi Flyway, and Atlantic Flyway.

total population of which has averaged about 6.6 million birds since record-keeping began in 1955.[172] This local abundance of waterfowl accounts for their importance to Native Americans during the pre-contact era as well as the proliferation of waterfowl hunting clubs in Suisun Marsh and the Delta during the late nineteenth century, as discussed earlier in this paper.

During the first half of the twentieth century, waterfowl faced three major threats in the wetland wintering grounds of the Central Valley. Illegal market hunting was rampant, resulting in the slaughter of many thousands of birds annually. Avian diseases, especially botulism, claimed the lives of many birds that were increasingly concentrated on fewer and smaller remaining wetlands. As more and more of the valley's wetlands were eliminated, birds faced shortages of natural foods and increasingly took advantage of the valley's croplands, especially the rice fields in the Sacramento Valley. This last problem—costly crop depredations—would lead to the establishment of the Central Valley's first refuges, which were designed primarily as feeding grounds to keep the hungry birds away from the fields.[173] Between 1929 and 1932, utilizing revenues from hunting license fees, California acquired land for four state waterfowl refuges, one of which was located in the greater Delta region. Joice Island Waterfowl Refuge, purchased in 1932, was a natural tidal wetland on the northern edge of Suisun Marsh, between Suisun and Montezuma sloughs. The 1,100-acre refuge provided important habitat for waterfowl

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[172] Wetland acreages are from W. E. Frayer, D. D. Peters, and H. R. Pywell, "Wetlands of the California Central Valley: Status and Trends—1939 to mid-1980s" (Portland, Oregon: U.S. Department of the Interior, Fish and Wildlife Service, 1989), 17–18. The 60 percent figure is from U.S. Fish and Wildlife Service, "Concept Plan for Waterfowl Wintering Habitat Preservation: Central Valley, California" (Portland, Oregon: U.S. Department of the Interior, Fish and Wildlife Service, 1978), 11. The flyway population figure is from Steven M. Olson, "2014 Pacific Flyway Data Book: Waterfowl Harvests and Status, and Hunter Participation and Success in the Pacific Flyway and United States" (Vancouver, Washington: U.S. Fish and Wildlife Service, 2014), 86.

[173] For greater detail on these threats on the wintering grounds, see Garone, *The Fall and Rise of the Wetlands of California's Great Central Valley*, 142–150.

and helped hold them in the marsh, away from the Central Valley, until after the rice harvest.[174] This first step toward wetland protection for waterfowl in the Central Valley was followed in 1937 by the creation of the valley's first federal refuge, the Sacramento National Wildlife Refuge, located in Glenn and Colusa counties.[175] In 1947, the California legislature passed the Wildlife Conservation Act, which created the Wildlife Conservation Board and charged it with identifying lands and waters suitable for the preservation, protection, and restoration of wildlife, and allocating funds for their purchase.[176] Based on their dearth of wetlands, nearly all of which had been reclaimed and converted to agriculture, the Wildlife Conservation Board identified the Sacramento and San Joaquin valleys and the Suisun Bay-Delta region as those portions of the state most in need of additional areas for wintering waterfowl.[177] The board's funds made it possible to create three new protected areas, called waterfowl management areas, one of which was again in Suisun Marsh, the 8,600-acre Grizzly Island Waterfowl Management Area, created in 1950.[178] Joice Island would later be incorporated into this refuge, as the Joice Island Unit of the renamed Grizzly Island Wildlife Area.

The succession of state protected-area designations from waterfowl refuge, to waterfowl management area, to wildlife area is meaningful. Hunting was banned on the first state refuges (as it would be on the first national wildlife refuges), so they truly were waterfowl "refuges."

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[174] The other three refuges were the 3,000-acre Los Banos Waterfowl Refuge, purchased in 1929; the 2,540-acre Gray Lodge Waterfowl Refuge, purchased in 1931; and the 1,100-acre Imperial Waterfowl Refuge, purchased in 1932.

[175] The original name of the Sacramento National Wildlife Refuge was the Sacramento Migratory Waterfowl Refuge.

[176] 1947 *Statutes of California* ch. 1325.

[177] Seth Gordon, "California's Fish and Game Program: Report to the Wildlife Conservation Board" (Sacramento: The Senate of the State of California, 1950), 154.

[178] The other two waterfowl management areas were the 8,500-acre Mendota Waterfowl Management Area, created in 1954; and the 5,600-acre Wister Unit, also created in 1954 as an addition to the Imperial Waterfowl Refuge, which had since been renamed as the Imperial Waterfowl Management Area.

When hunters demanded access to the refuges, which were being supported almost entirely by their fees, parts of the refuges were opened to sport hunting, and hence they became waterfowl "management areas." By around 1970, these refuges were redesignated as "wildlife areas," reflecting a more expansive notion of conservation that had moved beyond a singular focus on waterfowl to other species of birds and other animals as well. One illustrative example of this more inclusive notion of conservation is the work of the Central Valley Joint Venture (CVJV). The CVJV, established in 1988, is one of nearly twenty collaborative efforts between government agencies and private conservation organizations in the Unites States that were formed to implement the North American Waterfowl Management Plan, a 1986 agreement between the United States and Canada (and, in 1994, Mexico) to promote waterfowl conservation and habitat protection.[179] The CVJV has expanded beyond its initial objective of protecting, restoring, and enhancing wetlands for the benefit of waterfowl and currently works to protect all wetland-dependent birds, including shorebirds, other waterbirds, and riparian songbirds. Recognition of the value of agricultural lands for wildlife has led to an emphasis on deferred tillage, which increases the amount of waste grain available to birds by delaying the deep plowing of fields after harvest, and, especially, on winter flooding of harvested fields, which increases access to agricultural food resources as well as aquatic invertebrates.[180] Even more broadly, by the late twentieth century refuges and preserves in the Central Valley would include protection of entire ecosystems, with all their biodiversity. These transitions are

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[179] Canadian Wildlife Service and U.S. Fish and Wildlife Service, "North American Waterfowl Management Plan" (Washington, D.C.: Environment Canada and U.S. Department of the Interior, 1986); Central Valley Habitat Joint Venture, "Central Valley Habitat Joint Venture Implementation Plan: A Component of the North American Waterfowl Management Plan" (Central Valley Habitat Joint Venture, 1990). The Central Valley Joint Venture was originally named the Central Valley Habitat Joint Venture.

[180] Central Valley Joint Venture, "Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat" (Central Valley Joint Venture, 2006), 15.

illustrative of a profound shift in the way humans have perceived their relationship to the natural world. They also provide context for the protected areas that have been created in and around the Delta in recent years.

In 1984 the Nature Conservancy purchased a conservation easement on 85 acres of riparian oak forest along the lower Cosumnes River above its junction with the Mokelumne River, at the eastern edge of the Delta. After acquiring 1,400 additional acres, the Nature Conservancy formally dedicated the Cosumnes River Preserve in 1987. Since then this preserve along the last undammed river flowing out of the Sierra Nevada—now managed by many partners—has grown to more than 50,000 acres of permanent and seasonal wetlands as well as private agricultural and grazing lands that are managed in wildlife-compatible ways to attract wintering waterfowl.[181] Over the years the mission as well as the size of the preserve has expanded and now includes floodplain restoration. Accidental and intentional breaching of levees on the preserve has resulted in a proliferation of cottonwood and willow trees and has demonstrated that the restoration of flood regimes is a cost-effective means to accelerate habitat restoration. Recent studies of the Cosumnes River floodplain have found that it is of particular importance for native fish species, including the Chinook salmon and Sacramento splittail. Juvenile salmon experience higher growth rates in the floodplain than in adjacent river habitats, while the splittail is dependent for successful spawning on the vegetation found in the floodplain. These and other native fish species have developed the ability to find their way off the floodplain before receding waters disconnect it from the river, and in this way they benefit from the

[181] Partners include The Nature Conservancy, U.S. Bureau of Reclamation, Sacramento County Department of Regional Parks, California Department of Fish and Wildlife, Ducks Unlimited, Inc., California Department of Water Resources, California State Lands Commission, Natural Resource Conservation Service, and Galt Joint Union Elementary School District. See http://www.cosumnes.org/about-the-preserve/.

temporary floodplain habitat but avoid fatal stranding.[182] The Cosumnes River Preserve is thus managed as a natural floodplain, not only for the protection and restoration of riparian habitat and of wintering habitat for migratory waterfowl and other waterbirds of the Pacific Flyway, but also for the protection of endangered species of native fish. The striking success of the preserve has shown that agriculture and grazing can be compatible with habitat restoration and floodplain management.[183]

A few miles to the northwest of the Cosumnes River Preserve lies one of the newer additions to the National Wildlife Refuge System, the Stone Lakes National Wildlife Refuge, officially established in 1994, although many years in the making. Located about ten miles south of downtown Sacramento between Courtland to the west and Interstate 5 to the east, the refuge is contained within the Beach Lakes-Stone Lakes Basin and historically was a mecca for wildlife, including migratory birds, elk, pronghorn, and grizzly bears. Development pressure from the greater Sacramento metropolitan area led to efforts to protect the Stone Lakes Basin floodplain, and in the early 1970s the State of California and the County of Sacramento purchased approximately 2,600 acres and managed them within their respective park systems. By the 1980s, discussion of creating a national wildlife refuge in the basin gained traction; a refuge could serve as a buffer from urban encroachment and could potentially provide a link to the Cosumnes River Preserve. From 1990 to 1992 the U.S. Fish and Wildlife Service coordinated a

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[182] Carson A. Jeffres, Jeff J. Opperman, and Peter B. Moyle, "Ephemeral Floodplain Habitats Provide Best Growth Conditions for Juvenile Chinook Salmon in a California River," *Environmental Biology of Fishes* 83, no. 4 (2008); Peter B. Moyle, Patrick K. Crain, and Keith Whitener, "Patterns in the Use of a Restored California Floodplain by Native and Alien Fishes," *San Francisco Estuary and Watershed Science* 5, no. 3 (2007).

[183] Anna Steding, "Restoring Riparian Forests and Natural Flood Regimes: The Cosumnes River Preserve," in *Sustainable Use of Water: California Success Stories*, ed. Lisa Owens-Viani, Arlene K. Wong, and Peter H. Gleick (Oakland, California: Pacific Institute for Studies in Development, Environment, and Society, 1999), 233, 237.

public planning process that resulted in an approved refuge boundary of up to 17,600 acres. The refuge was then dedicated upon the first land acquisition two years later, and has grown to include 6,500 acres owned or managed by the Fish and Wildlife Service and an additional 5,000 acres owned by Sacramento County and several state agencies.[184] Composed of a rich mosaic of habitats, including wetlands, vernal pools, grasslands, valley oak woodlands, and riparian forests, the refuge nonetheless faces a number of challenges. Developers have purchased some of the lands within the approved refuge boundaries, and the rapidly growing city of Elk Grove abuts the refuge's border, threatening its water quality. As a result of these threats, in the mid-2000s the National Wildlife Refuge Association rated the Stone Lakes National Wildlife Refuge among the top six threatened refuges in the country.[185]

Along the northwest fringes of the Delta, between the cities of Davis and Sacramento, wetland protection has also been achieved, despite proximity to urban areas. In 1997, President Bill Clinton formally dedicated the new 3,700-acre Yolo Bypass Wildlife Area, located within the Yolo Bypass in the shadow of Sacramento's skyline. For the past century, the nearly 60,000-acre leveed Yolo Bypass, constructed during the 1910s as part of the Sacramento Flood Control Project, has served to channel Sacramento Valley winter floodwaters through the Yolo Basin and past the city of Sacramento. Constructed by the U.S. Army Corps of Engineers and Ducks Unlimited, the Yolo Bypass Wildlife Area is managed by the California Department of Fish and Wildlife to be completely compatible with the bypass's flood control function, even as it is

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[184] http://www.fws.gov/refuge/Stone_Lakes/about.html; "Reviving Central Valley Wetlands: Upper Beach Lake Wildlife Enhancement and the Beach Lake Mitigation Bank," in *Sustainable Uses of Water: California Success Stories*, ed. Lisa Owens-Viani, Arlene K. Wong, and Peter H. Gleick (Oakland, California: Pacific Institute for Studies in Development, Environment, and Society, 1999), 224–225.

[185] National Wildlife Refuge Association, "State of the System: An Annual Report on the Threats to the National Wildlife Refuge System" (Washington, D.C.: National Wildlife Refuge Association, 2005), 9.

restored to the wetland habitat for Pacific Flyway ducks, geese, and shorebirds that it had been prior to reclamation. The wildlife area was expanded in 2001 to approximately 16,000 acres with the purchase, approved by the California Wildlife Conservation Board, of more than 12,000 additional acres, including a 10,000-acre cattle ranch studded with vernal pools. The new parcels increased the ecological diversity of the Yolo Bypass Wildlife Area, which includes permanent and seasonal wetlands, vernal pool grasslands, riparian forests, and managed agricultural lands.[186] In addition, the Yolo Bypass seasonal floodplain— much like the Cosumnes River floodplain—has been found to support juvenile Chinook salmon and spawning Sacramento splittail, as well as 13 other native fish species and 42 fish species in total.[187] Here, as elsewhere in the Central Valley, wetlands, once drained and reclaimed as an obstacle to development, are proving compatible with other land uses, including the maintenance of California's hydraulic infrastructure.

The Cosumnes River Preserve, Stone Lakes National Wildlife Refuge, and Yolo Bypass Wildlife Area are the largest and perhaps the best known protected areas in the Delta region, but there are others as well. The Woodbridge Ecological Reserve, also known as the Isenberg Sandhill Crane Reserve, encompasses several hundred acres located along Woodbridge Road in the eastern Delta between Hog and Sycamore sloughs. As its name suggests, the reserve provides habitat for greater sandhill cranes, which are listed as a threatened species in California, as well as lesser sandhill cranes. The White Slough Wildlife Area adds 880 protected acres just to the

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[186] http://yolobasin.org/about-wildlife-area/; Peter J. Hayes, "Yolo Bypass Wildlife Area: Birth of a Wintering Waterfowl Wildland," *Outdoor California* 60, no. 1 (1999); Dave Feliz, "Yolo Fly By," ibid. 65, no. 5 (2004). In 1999, the original 3,700-acre parcel of the Yolo Bypass Wildlife Area was renamed the Vic Fazio Wildlife Area, after California congressman Victor H. Fazio, who lobbied for its creation.

[187] Ted Sommer et al., "California's Yolo Bypass: Evidence That Flood Control Can Be Compatible with Fisheries, Wetlands, Wildlife, and Agriculture," *Fisheries* 26, no. 8 (2001).

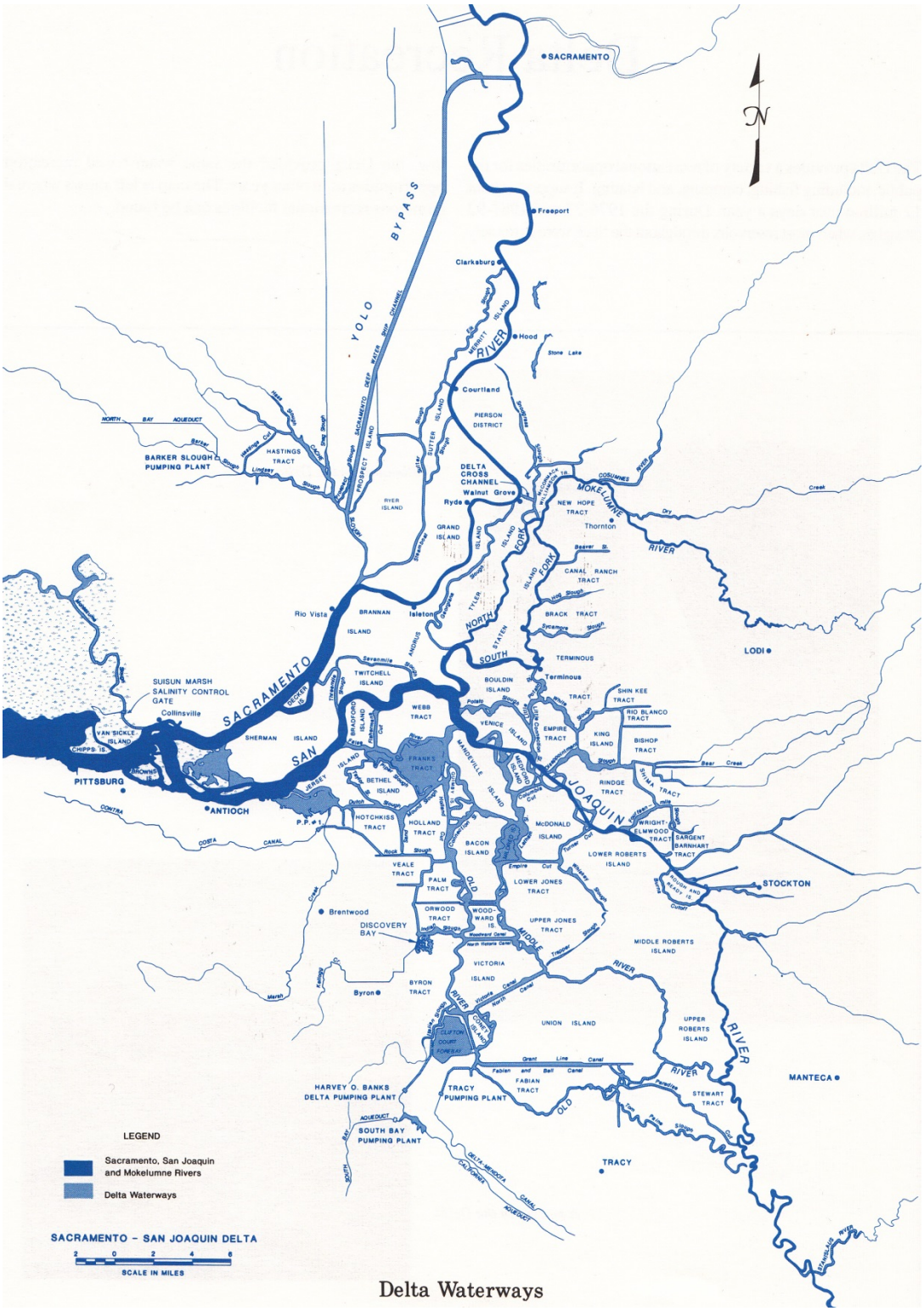
south of the Woodbridge Ecological Reserve, and at the western extreme of the Delta region the Hill Slough Wildlife Area protects over 1,700 acres just north of the Grizzly Island Wildlife Area, discussed earlier. Together, these various refuges, created through efforts of nonprofit conservation organizations and the state and federal governments, have restored relatively small but ecologically important parts of the Delta, and although these refuges are managed landscapes, they offer a glimpse of the Delta and its abundance of wildlife in a time before reclamation.

Conclusion

Today, after more than a century and a half of reclamation and development, the Delta remains a "garden," supporting over one hundred crops on some 500,000 acres of agricultural land, and generating hundreds of millions of dollars in annual farm revenue. The balance of crops has continued to shift, as it always has, and in 2012 the top ten crops in acreage were corn, alfalfa, wheat, wine grapes, processing tomatoes, safflower, asparagus, almonds, rice, and oats.[188] But, despite its tremendous agricultural bounty, the Delta is also much more than a garden. Among its many land uses, the Delta now includes a variety of types of protected lands, including some on which agriculture is managed to be compatible with wildlife. Even as small parts of the region have been restored to some semblance of the pre-reclamation era, maintaining them requires direct human intervention, and that reality points to just how highly engineered the entire Delta has become. Profoundly affected by the consequences of the Central Valley Project and State Water Project, the Delta lies at the epicenter of disputes over water allocation and distribution, and suffers from a prolonged decline in the quality of the water in its channels and

[188] http://ucanr.edu/sites/deltacrops/

in the ability of its aquatic ecosystem to support life. All of these accomplishments and challenges point to a robust, yet still fragile, contemporary Delta. The Delta's complex history, from its Native American inhabitants, Spanish explorers, and Mexican land-grant recipients to its contemporary residents—a history studded by wealthy land reclaimers and poor immigrant agricultural laborers, by fishermen and cannery workers, and by many other individuals who contributed to its evolution and development—deserves to be studied and commemorated, as this environmental history has attempted to do. And most of all, because of its rich history, its vibrant economy, and its ecological importance, the Delta needs to be protected.



Map 1. Delta Waterways, Islands and Tracts, and Cities. Sacramento–San Joaquin Delta Atlas (Sacramento: California Department of Water Resources, 1993), 10. Courtesy of the California Department of Water Resources.

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