

**APPENDIX A**  
**Geographical Information System (GIS) Maps**

Introduction

Map Legends

Maps



## Introduction

An integral part of this report is the production of color maps that display, at a landscape level, the historical and current distribution of aquatic habitats in the five ecologically different regions. The maps also locate the geographic features that are mentioned in the main text. The maps are produced with “layers” from digitally based geographic information systems (GIS) so that different kinds of information from different sources can be displayed and analyzed. With GIS the extent of the historical and current aquatic habitats can be readily compared and displayed on one map.

The intent is to use available regional GIS databases that are suitable for landscape level analysis of historical and current habitat and hydrography. A number of completed and in-process GIS databases were evaluated for suitability. Not unexpectedly, the biggest gap is digital geographic information for the extent of historical (pre-disturbance) aquatic habitat and hydrography. For the San Francisco Bay and portions of the Delta hydrography, historical information is digitally available. For the Central Valley lowland and Delta habitats, it is necessary to interpret and digitize 19th century maps or use indirect indicators of habitat (e.g., riparian soils) from existing databases.

The historical maps are useful for showing the broad scale distribution and extent of the floodplain and intertidal habitats, but must be used with caution for interpreting the precise location or areal extent of a particular habitat. The historical maps that are digitized are very small scale (at least 1:500,000) and the accuracy of the map information used for georeferencing is unknown. The indirect indicators of aquatic habitat, such as soils, provide a highly generalized view of where a particular habitat could potentially occur. Locational discrepancies can also result from actual changes over time between historical and modern conditions (e.g. river location), or differences in two different digital data sets.

A total of fourteen color maps are produced for this report. The lowland ecosystem was divided into the three sub-basins (Sacramento Valley, San Joaquin Valley, Tulare Lake Basin) because the data availability for each area was different. One map for the entire region would have been too large to make a meaningful comparison of the historical and current aquatic habitats. Even at the sub-basin level it is difficult to distinguish the small acreage of aquatic habitats that currently exist.

All of the maps except for G1 and G14 should be viewed as pairs: the left-hand side provides the historical view of the aquatic ecosystem and the right-hand side shows the current aquatic ecosystem. The current ecosystem maps also show the former extent of the historical aquatic ecosystem. Each map has a corresponding legend that follows this introduction which provides an overview of the map and the sources used to develop it. Where appropriate further elaboration is provided for the individual map categories or “layers” of information.

On all the maps the digital hydrography is provided by the California Department Fish and Game under license from the Teale Data Center, unless noted otherwise.

## **G1 The San Francisco Bay-Delta Aquatic Ecosystem Distribution**

The watershed may be subdivided into five broad regions with respect to dominant aquatic ecosystems present in each. The distribution and extent of these are presented in a watershed-scale perspective. The map also sub-divides the Central Valley into its three basins: the Sacramento River, the San Joaquin River, and the Tulare Lake Basins.

### **Legend Categories:**

Upland - The upland watershed delineation is constructed from the California Department of Fish and Game hydrologic unit code (HUC) basins, 250,000 scale. The total area is 38,296 square miles.

Lowland - The lowland (alluvial) valley delineation is constructed from the HUC basins. This map was cross-checked against geologic maps depicting valley floor alluvial deposits. The boundary generally corresponds with the 300 foot contour line in the central part of the lowland region. The total area is 20, 609 square miles.

Delta - The Delta delineation is based on the legal definition of the Delta under Section 12220 of the water code. This places the Delta's western boundary approximately four miles west of the confluence of the Sacramento and San Joaquin Rivers. The legal Delta extends northward to near Sacramento and southward to near Vernalis. The digital boundary is from the REGIS database at the University of California at Berkeley. The total area is 1,154 square miles

San Francisco Bay - This region is defined as the water and land within the historical (pre-development) tidal zone in and around San Francisco Bay and Suisin Bay. The outer boundary is the landward margin of the historical extent of the tides not including the tidal reaches of the major creeks and rivers. It does not include the watershed area contributing runoff to the Bay. The outer tidal boundary is derived from the historical bayland coverage in the Bay Area EcoAtlas Version 1.50, San Francisco Estuary Institute. The total area is 815 square miles.

Nearshore Ocean - The area for this region is bounded to the north by Point Reyes, to the south by the southernmost end of Half Moon Bay, and to the west by the continental shelf break. The total area is 1,439 square miles.

Sub-basin Boundary - The basin boundaries are from the HUC database.

## **G2 Connected Waterways of the Central Valley**

The connected waterways of the Central Valley transported water, nutrients, and sediment to the San Francisco Bay-Delta estuary. The waterways also provided habitat and transport corridors for the native biota, in particular the anadromous salmon. Not shown are the many sloughs and waterways that accommodated overflow from the main stem of the lowland Sacramento and San Joaquin Rivers. The surface water connection of Goose Lake in northeastern California into the Sacramento River watershed and of Tulare Lake in the southern Central Valley into the San Joaquin River watershed usually occurred only in the seasonal high water period or in a series of wet years.

### **Legend Categories:**

Historically Connected Reach - Except for the lowland Tulare Basin, major rivers are represented with modern hydrography from the Department of Fish and Game which adequately represents the historical reaches. The modern hydrography of the lowland Tulare Basin is so altered that portions of the major rivers were replaced by that shown on the Map of Public Surveys in California to Accompany Report of Surveyor General, 1859. The historical river courses were converted to digital form by ocular estimation.

Salmon Historically Present - A sub-set of the historically connected reaches are the river reaches of the major Central Valley rivers and streams used by salmon for transport, holding, and spawning. These are mapped by Yoshiyama et al. 1996 and digitized by staff of the Sierra Nevada Ecosystem Project. Yoshiyama et al. 1996 note that additional streams such as Thomes, Paynes, Cache, and, Putah creeks and perhaps a dozen other minor Sacramento Valley streams historically supported intermittent salmon runs when streamflows were adequate. Fresno Slough, although intermittent, is part of the historic range because it was used as transport corridor for the salmon that spawned on the Kings River.

Historical Lake - Clear Lake and Goose Lake in northeastern California are derived from the modern hydrography. Tulare Basin lakes are digitized from Hall, 1887 (Buena Vista and Kern Lakes) and Alexander et al. 1874 (Tulare Lake).

### **G3 The Transformed Watershed**

The transformation of the aquatic environment of the San Francisco Bay-Delta watershed is seen in this watershed view of the lost historical aquatic habitats and the major disconnected reaches. Nearly 5000 square miles of lowland floodplain and estuarine intertidal habitat, including 900 square miles of historical lake, has been lost in the past 150 years. Because of the barriers imposed by dams over a thousand miles of upland river is no longer available as salmon habitat; additional lowland river mileage is lost to salmon because of the dewatering of the San Joaquin River. Not all of the transformed habitat is lost to the system forever. Restoration of natural processes and rehabilitation of degraded habitats can bring some of this habitat back into the aquatic system.

#### **Legend Categories:**

Major Barrier - This represents the large, terminal storage reservoirs and dams that block the major rivers near the upland/lowland boundary. It does not include the thousands of smaller dams that occur throughout the watershed.

Disconnected Reach - This shows both disconnected upland and lowland river reaches. The upland rivers are disconnected from the lowland rivers by the large dams which block fish, sediment, and nutrient passage and create other discontinuities in water characteristics. Lowland barriers in the form of dewatered reaches and diversion dams disconnect river reaches within the lowlands.

Lost Salmon Habitat Due to Disconnection or Dewatering - A sub-set of the disconnected river reaches are the river reaches that no longer provide salmon habitat because they are disconnected by the major barriers or are dewatered. These are mapped by Yoshiyama et al. 1996 and digitized by staff of the Sierra Nevada Ecosystem Project. The disconnected reaches historically provided much of the spawning habitat for the salmon. As a result about 82% of the historical spawning habitat is no longer available to the salmon.

The white area represents the areal sum of all the former historical aquatic habitats identified in the other maps (Maps G3 through G13) including the riparian zone, freshwater tidal and non-tidal wetland, estuarine tidal wetland, and other floodplain habitat. It is assumed that the historical floodplain habitat that is currently not subject to inundation is no longer floodplain habitat.

## **G4 Sacramento Valley Historical River Floodplain Ecosystem**

The dynamic functioning of rivers and streams in the Sacramento Valley over the last 10,000 years created a diversity of floodplain habitats which covered a large area of the Sacramento Valley. The map delineates the areal extent of tule-dominated wetlands, the riparian zone, which represents potential riparian habitat, and the additional mixed habitat that was occasionally to frequently inundated by winter runoff. The wetland habitat was directly observed and mapped in the 19th century while the riparian zone and other floodplain habitats are derived indirectly from soils and historical accounts. Too small to show in this map view are riparian forests and woodlands along some of the smaller streams.

### **Legend Categories:**

Riparian Zone Habitat - The riparian zone consists of the three habitat categories indented below. The riparian zone is defined by the soils mapped by Holmes et al. 1916 that are associated with riparian vegetation based upon the vegetation and location descriptions given in the Holmes text. In addition the riparian zone includes the riparian forest mapped by Dutzi 1979 that extends upstream of the riparian soils mapped by Holmes. The Holmes and Dutzi map were digitized by Steve Greco at the University of California at Davis. The riparian zone covers about 637,000 acres and represents the area that riparian forest and woodland could have occupied sometime in the last 10,000 or more years. It thus represents a potential maximum habitat area and includes about 87,000 acres that were mapped as wetlands in the 19th century (see below). Along the lower Sacramento and Feather Rivers the riparian soils generally correspond with the extent of the natural levees.

Riparian Forest Along Major Rivers and Streams - The forest area along the major rivers and streams is digitized from a map of "Native Woodlands of the Sacramento Valley circa 1800" prepared by Dutzi 1979 and shown in Figure II-F. The map was prepared mainly from soil surveys and the 19th century general land office field survey notes. This area, which covered about 364,000 acres, was primarily occupied by a heavy forest growth of willow, sycamore, and cottonwood along the immediate stream margins and by valley oak on the higher surfaces.

Riparian Soils with Woodland and Other Floodplain Habitat - This is the area within the riparian zone but outside the riparian forest and outside the area of wetlands mapped within the riparian zone. It covers about 186,000 acres. Much of it is located along the main-stem Sacramento extending out beyond the riparian forest. Historical accounts and the Dutzi 1979 map indicate that a considerable portion of this was occupied by valley oak woodland and savanna. Bunch grasses and other herbaceous vegetation as well as seasonal wetlands also occupied this part of the riparian zone.

Wetlands Mapped within Riparian Zone - These are tule dominated wetlands that are mapped on Columbia silt loams, a riparian soil in Holmes et al. 1916. They are digitized from a map in Alexander et al. 1874 which displays the swamp lands with a distinctive symbol that signifies the area had relatively permanent wetland vegetation, most commonly tule marsh. The Holmes soil map shows wetlands on the riparian soils. They cover about 87,000 acres out of a

total mapped wetland acreage of 301,000 acres. In addition to the tule marsh, this area included a range of habitats including semi-permanent shallow lakes, areas of wet meadow, and the occasional drier islands of valley oak and grass.

Wetlands Mapped Outside of Riparian Zone - These are tule dominated wetlands that are located on flood basin clay soils and other soils not considered to be riparian soils. These are the wetlands that occupied the lowest area of the flood basins that are assumed to have been flooded nearly every year. They are digitized from the map in Alexander et al. 1874. They cover about 214,000 acres or about 71% of the total mapped wetland acreage of about 301,000 acres in the Sacramento Valley.

Other Floodplain Habitat - This category is delineated by the soils that Holmes et al. 1916 described as occasionally to frequently inundated by local stream runoff or overflow from bigger streams and is not covered by mapped wetlands or the riparian zone. The Holmes soils were correlated to the soils in the State Soil Geographic Data Base (STATSGO) prepared by the Natural Resources Conservation Service (NRCS) in 1994. The STATSGO soils were then used to map the areal extent of this habitat which covers about 450,000 acres. The habitat was a mix of oak woodland and savanna, perennial bunch grass, and seasonally wet meadow and other wetland species. The Dutzi 1979 map shows that much of the other floodplain habitat to the north and east of the Sutter Buttes, and along the Feather River was covered with oak woodland and savanna.

## **G5 Sacramento Valley Current River Floodplain Ecosystem**

This map shows both the current, circa 1993, riparian and wetland habitat of the Sacramento Valley and the former extent of the historical river-floodplain habitat. The former habitat is shown by subtraction: the historical river floodplain habitat that does not have current wetland or riparian habitat is shown in white. Most of this “absent” habitat has been converted to agricultural or urban land. A small amount of the historical other floodplain habitat still contains oak woodland and savanna and is occasionally inundated. The map also shows the major reservoirs in the upland portion of the watershed.

### **Legend Categories:**

Current Wetland - The current wetlands are derived from the Wetlands and Riparian GIS database prepared for the California Department of Fish and Game (CDFG) by Ducks Unlimited. It is a combination of the two categories “seasonally flooded palustrine emergents” and “permanently flooded palustrine emergents,” which cover a total of about 68,000 acres. Less than half of that or about 28,000 acres remains on lands that were historically mapped as wetland, thus there has been about a 90% reduction in the historically mapped wetland acreage. The other 40,000 acres are on lands that were categorized in the historical map as “other floodplain habitat.”

The current wetlands mainly consists of highly managed areas that can vary in seasonality, location, and extent based on varying management schemes. Much of the current wetland is managed in federal or state protected areas; the privately owned wetlands are mainly in duck clubs or nature preservers. There is relatively little current unmanaged wetland that exists as a result of the natural overflow of the principal rivers. The historical wetlands on the clay soils in the flood basins have been largely replaced by agriculture, primarily ricelands.

Current Riparian - The current riparian is also from the CDFG Wetlands and Riparian GIS database and represents the category “riparian woody.” The 30 meter resolution allows relatively small patches of riparian vegetation to be mapped. The distribution of the current riparian is scattered in small patches and generally confined to the immediate stream margins. This patchiness makes it difficult to see the extent. Larger, more continuous extents are found on the upper reaches of the lowland Sacramento and Feather Rivers.

About 38,000 acres of current riparian exists which represent about 7% of the historic riparian zone or about 10% of the riparian forest shown on Map G4. This comparison must be interpreted very cautiously because the habitat quality of the current riparian is not described (some of it is impacted human activities and is degraded) and the historical riparian zone does not represent the actual historical riparian acreage but rather the potential riparian acreage as explained in the text.

## **G6 San Joaquin Valley Historical River Floodplain Ecosystem**

The San Joaquin Valley's river floodplain ecosystem was geographically more heterogeneous and not quite as extensive as that found in the Sacramento Valley. The San Joaquin Valley did not have the Sacramento's large flood basins and high and wide natural levees. The nearly continuous area of marsh and other floodplain habitat in the trough of the San Joaquin Valley occurred around the main stem river, the multiple branching sloughs, and the confluence with tributary streams. The riparian forests were relatively narrow compared to the Sacramento Valley but wide plains of oak woodlands occurred broadly beyond the rivers in the northern part of the valley. The wetlands were mapped by 19th century surveyors and the riparian zone and other floodplain habitat were determined indirectly from soil surveys and geologic maps.

### **Legend Categories:**

Riparian Zone Habitat - The riparian zone consists of the two habitat categories indented below. The riparian zone is delineated by a combination of soils and riverine (stream channel) deposits. The soils are from the STATSGO database prepared by the Natural Resources Conservation Service (NRCS) and were chosen to correspond to the soils described by Nelson et al. 1915 as having riparian vegetation (The Nelson map has not been digitized unlike the corresponding one for the Sacramento). The Quaternary stream channel deposits ( $Q_{sc}$ ) were digitized from the California Division of Mines and Geology (CDMG), 250K series and corresponded fairly well with the soil units. The stream channel deposits were used in addition to the soils because they extend beyond the soil units into areas along the tributaries where it is known from historical documents that riparian vegetation occurred. The riparian zone covered about 329,000 acres. As in the Sacramento, the riparian soil zone represents the area that riparian forest and woodland could have occupied sometime in the last 10,000 years. It thus represents a potential maximum habitat extent along the major rivers and streams and includes about 43,000 acres of wetlands mapped by 19th century surveyors.

Riparian Soils with Forest, Woodland and Other Floodplain Habitat - This is the area within the riparian zone but outside the area of wetlands mapped on riparian soils (see below). There was no map for the San Joaquin that differentiated the riparian forest from the woodland and other floodplain habitat. Historical accounts indicate that the area along the stream and slough margins had dense riparian forest or willow thickets while on higher surfaces further away from the stream, oak woodland would tend to occur. The areal extent of the riparian vegetation along the upstream reaches of the Merced, Toulumne, and Stanislaus was limited by confining bluffs. Relatively narrow areas of riparian vegetation surrounded by a vast marsh occurred along the multiple waterways around the main-stem San Joaquin River.

Wetlands within Riparian Zone - These are tule dominated wetlands that are mapped on the stream channel deposits and riparian soils. They are digitized from a map in Alexander et al. 1874. The marsh in this area was interlaced with stream and slough channels with bordering riparian vegetation. It covered 43,000 acres out of the total mapped wetland acreage of 93,000 acres.

Wetlands outside of Riparian Zone - These are tule dominated wetlands that are located on basin deposits of clay and silt. They are digitized from the map in Alexander et al. 1874. They

cover about 50,000 acres out of the total mapped wetland acreage of 93,000 acres in the San Joaquin Valley. Considerably more acreage of wetlands occurred along the lower San Joaquin River but that area was within the legal Delta boundary.

Other Floodplain Habitat - This area is delineated by the basin deposits on the CDMG maps and is not already covered by the riparian zone or mapped wetlands. The basin deposits result from flood waters that deposited mostly fine silt and clay and some fine sand. They correlate well with the soils that are described in Nelson et al. 1915 as occasionally to frequently inundated by local stream runoff and overflow from bigger streams. The habitat was a mix of oak woodland and savanna, perennial and annual grasses, and seasonally wet meadow and other wetland species.

## **G7 San Joaquin Valley Current River Floodplain Ecosystem**

This map shows both the current, circa 1993, riparian and wetland habitat of the San Joaquin Valley and the former extent of historical river floodplain habitat. The former habitat is shown by subtraction: the historical river floodplain habitat that does not have current wetland or riparian habitat is shown in white. Most of this “absent” habitat has been converted to agricultural or urban land. A small amount of the historical other floodplain habitat still contains oak woodland and savanna and is occasionally inundated. The map also shows the major reservoirs in the upland portion of the watershed although a digital outline of a full New Melones Reservoir was not available.

### **Legend Categories:**

Current Wetland - The current wetlands are derived from the Wetlands and Riparian GIS database prepared for the California Department of Fish and Game (CDFG) by Ducks Unlimited. It is a combination of the two categories “seasonally flooded palustrine emergents” and “permanently flooded palustrine emergents,” which cover a total of about 55,000 acres. A small portion of that or about 4,200 acres remains on lands that were historically mapped as wetland, thus there has been about a 95% reduction in the historically mapped wetland acreage. The other 51,000 acres are on lands that were categorized in the historical map as “other floodplain habitat .”

Compared to the Sacramento Valley far more of the current wetland acreage in the San Joaquin Valley is privately managed wetlands, usually in duck clubs. Another difference is that most of the current wetlands in the San Joaquin Valley is not found in areas that were historically mapped as wetlands but rather are found in what is historically classified as “other floodplain habitat” in the clay and silt basin deposits. These areas had perched water tables and were inundated occasionally historically but probably did not receive the surface water overflow as frequently as the wetlands closer to the main-stem river. As in the Sacramento Valley the current wetlands mainly consist of highly managed areas that can vary in seasonality, location, and extent based on varying management schemes. There is relatively little current unmanaged wetland that exists as a result of the natural overflow of the principal rivers.

Current Riparian - The current riparian is also from the CDFG Wetlands and Riparian GIS database and represents the category “riparian woody.” The 30 meter resolution allows relatively small patches of riparian vegetation to be mapped. The distribution of the current riparian is scattered in small patches and generally confined to the immediate stream margins. This patchiness makes it difficult to see the extent. Larger extents of riparian vegetation can be found on the lower Stanislaus and San Joaquin Rivers and the upper Tuolumne River.

About 16,000 acres of current riparian exists which represent about 5% of the historic riparian zone shown on Map G6. This comparison must be interpreted very cautiously because the habitat quality of the current riparian is not described (some of it is impacted human activities and is degraded) and the historical riparian zone does not represent the actual historical riparian acreage but rather the potential riparian acreage as explained in the text.

## **G8 Tulare Lake Basin Historical Wetland Ecosystem**

The aquatic environment of the Tulare Lake Basin was dominated by large, fluctuating lakes which were circumscribed and connected by tule dominated wetlands. These lakes were the termini of the runoff from the watershed except when wet years caused them to overflow in a cascading fashion starting with Kern Lake which overflowed into Buena Vista Lake which overflowed into Tulare Lake which could overflow into the San Joaquin River via the Fresno Slough. The map shows Tulare Lake at a relatively high stand with an area of about 700 square miles. There was no reliable or easily digitizable information on the historical extent of riparian vegetation in the Tulare Lake Basin; reliable and consistent indirect indicators through soils or geology were also lacking. As a result only the extent of the wetland habitat and the lakes is shown. Historical accounts indicate that riparian vegetation occurred along the major rivers and streams and a large area of oak woodland stretched from the Tule River north to the Kings River (see text).

### **Legend Categories:**

Wetland - The wetland extent is derived from the Hall 1887 map. The Tulare Lake Basin wetlands in Hall 1887 and Alexander et al. 1874 are very similar in extent. Hall 1887 is used because it had better registration with the hydrography. The wetlands displayed on the map covered about 428,000 acres. Considerable variation in wetland acreage occurred because the lake and wetland boundary fluctuated with the climate.

Historical Lake - Tulare Lake area is digitized from Alexander et al. 1874 because it shows Tulare Lake at a relatively high stand, covering about 700 square miles. The Buena Vista and Kern Lake area is from Hall 1887 because it had more detailed mapping in that part of the basin.

## **G9 Tulare Lake Basin Current Wetland Ecosystem**

This map shows both the current, circa 1993, wetland habitat of the Tulare Lake Basin and the former historical wetland and lake habitat. The former habitat is shown by subtraction: the historical wetland or lake habitat that does not have current wetland or lake is shown in white. Most of this “absent” habitat has been converted to agricultural or urban land. The Tulare Basin has the most altered environment and greatest amount of lost habitats of the three sub-basins. The historical lakes are essentially gone, only re-surfacing as flooded cells in wet years. The current wetland acreage is less than occurs in the San Joaquin and Sacramento Valleys and is much smaller in comparison to the historical acreage. Although not shown on this map the remaining riparian forest along the primary stream channels of the Kings, Kern, and Kaweah and the oak woodlands on the intervfluves of the Kaweah and Tule River are a fraction of what is estimated to have existed historically.

### **Legend Categories:**

Current Wetland - The current wetlands are derived from the Wetlands and Riparian GIS database prepared for the California Department of Fish and Game by Ducks Unlimited. It is a combination of the two categories “seasonally flooded palustrine emergents” and “permanently flooded palustrine emergents,” which cover a total of about 23,000 acres. A small portion of that or about 7,300 acres remains on lands that were historically mapped as wetland, thus there has been about a 98% reduction in the historically mapped wetland acreage.

## **G10 The Delta Historical Aquatic Ecosystem**

The Delta is defined by both its habitat and hydrography. This map shows the inter-tidal and non-tidal wetlands, the supra-tidal elevated landforms and the sub-tidal channels that carry the riverine and tidal water. The scale of the map view and source data limitations masks the heterogeneity of the dominant tule marsh environment. Not shown because of the scale are some of the small islands of elevated land, mainly dunes, in the Central Delta and areas of riparian vegetation along the San Joaquin, Mokelumne, and Sacramento Rivers and their distributaries. In addition there were perennial lakes throughout the Delta and extensive areas of mudflats around the mouth Cache Slough displayed on historical maps that were not digitized.

### **Legend Categories:**

Intertidal Wetlands - The approximate upstream boundary of the intertidal wetlands was mapped by Atwater 1982 and digitized for this report. That boundary is the upstream extent of tidal action within the wetlands. Tidal influence in the sub-tidal waterways, by, for example, raising the river stage, could go further upstream. The intertidal wetlands on this map cover about 380,000 acres.

Non-tidal Wetlands - The non-tidal wetland area is digitized from Alexander et al. 1874 and covers about 145,000 acres. It includes Merrit and Sutter Islands in the northern Delta, which were encircled by levees that protected them from normal high tides.

Elevated Landforms/Riparian Zone - This area was topographically above the perennial wetlands in the surficial geology maps made by Atwater 1982 who mapped that area as levee and splay deposits. The Alexander et al. 1874 map also demarcates the same approximate area as being free of marsh vegetation. Historical accounts and the Holmes et al. 1916 soil survey indicate that some of this area is covered with riparian vegetation. The areal extent was digitized from the Atwater maps and taken from the soils in the STATSGO database (prepared by the Natural Resources Conservation Service) that correlate with the riparian soils in Holmes et al. 1916. It covered about 42,000 acres.

Other Floodplain Habitat - This category is delineated by the soils that Holmes et al. 1916 described as occasionally to frequently inundated by local stream runoff or overflow from bigger streams and is not covered by mapped wetlands or the riparian zone. The Holmes soils were correlated to the soils in the STATSGO database. The STATSGO soils were then used to map the areal extent of this habitat. It is a mixed habitat of seasonally wet meadow grass, emergent vegetation, and drier islands of perennial bunch grass and oak woodland and savanna.

Other Delta Habitat - This is the unclassified upland area of the Delta.

Subtidal Waterways - The principal historical river and slough courses were initially derived from the hydrography in the 1985 National Wetlands Inventory (NWI) by the U. S. Fish and Wildlife Service. The detailed channel mapping inside the red box was digitized from the maps in Atwater 1982 by the U. S. Bureau of Reclamation. Outside the red box additional historical hydrography was converted to digital form by ocular estimation of the maps in Atwater 1982.

## **G11 The Delta Current Aquatic Ecosystem**

This map shows the current aquatic habitat and hydrography and the dramatic loss in the historical aquatic Delta habitat. The large white area represents the historical aquatic habitat that has been converted mostly to farmland or are now flooded islands. The current hydrography is much simpler and shorter compared to the complex network of historical tidal sloughs that twice daily “bathed” the historical wetlands have been largely eliminated by reclamation. The large river channels and man-made channels are the principal means of dispersing and transporting water through the Delta.

### **Legend Categories:**

Remaining Historical Sub-Tidal Waterways - These represent the river and distributary channels that have not been straightened, dug-out, or deepened. Historical hydrography of the major channels from the 1985 National Wetlands Inventory (NWI) database and Atwater 1982. Changes interpreted from existing topographic maps. The smaller tidal channels that are shown on Map G10 in the interior Delta no longer exist on the modern hydrography.

New Sub-Tidal Waterways, Channelized, and Open Water - These represent new pathways for water by straightening existing channels (e.g. Stockton ship channel), creating new channels (Sacramento ship channel), or permanently former islands (e.g. Frank’s Tract). All the new water areas are identified by comparing the historical hydrography on the Atwater 1982 maps with the underlying modern hydrography on those maps and the NWI database.

Current Intertidal and Nontidal Wetland - The current wetlands are derived from the Wetlands and Riparian GIS database prepared for the California Department of Fish and Game (CDFG) by Ducks Unlimited. It includes the seasonal and permanent palustrine emergents for the area east of the confluence at Collinsville, which cover about 20,000 acres. Between Collinsville and the western side of the legal Delta boundary it includes only the tidal estuarine emergents and which cover about 1,600 acres. The total current wetland acreage of about 21,600 acres represents about 4% of the historical intertidal and non-tidal wetland acreage. Most of the current wetland is the managed and diked palustrine wetlands in the northern Delta. The largest remaining area of naturally inundated intertidal wetland is in the western Delta.

Riparian on New or Historical Waterways - The current riparian is also from the CDFG Wetlands and Riparian GIS database and represents the category “riparian woody.” They are generally small, narrow patches and are thus hard to see at the scale of the map. Except for a patch at the confluence of the Sacramento River and Steamboat Slough, most of the current riparian is located on the upstream reaches of the main-stem and distributary channels of the principal rivers of the Delta. Most of the historical riparian zone has been converted to farmland and other land uses.

Other Delta Habitat - This is upland Delta habitat that has not been classified by the 1985 NWI.

## **G12 San Francisco Bay Historical Aquatic Ecosystem**

The historical distribution of and tidal wetland, tidal mudflat, and shallow and deep open water circa 1770-1820 is based upon the Native Landscape View of the Bay Area EcoAtlas (San Francisco Estuary Institute 1998). The Native Landscape View is a composite of thousands of historical data integrated by SFEI to illustrate native conditions in the Estuary. Major data sources include the U. S. Coast Survey Hydrographic and Topographic Sheets, other early federal maps, Mexican land-grant surveys and diseños, city and county surveys, explorers' journals, and oral histories. For further documentation, view the Bay Area EcoAtlas at [www.sfei.org](http://www.sfei.org).

### **Legend Categories:**

Tidal Wetland - Tidal wetland occurs mostly between mean lower low water (MLLW) and mean higher high water (MHHW) and supports at least 10% cover of vascular vegetation. It combines the categories of old high tidal marsh, young low/mid tidal marsh, muted tidal marsh, and salt pond in muted tidal marsh in the SFEI database. The total area was approximately 192,000 acres or about 37% of the total land and water area in the historical Bay ecosystem as defined in the native landscape view of the Bay Area EcoAtlas.

Tidal Mudflats - Tidal mudflats occurred between MLLW and the lower edge of marsh vegetation. Where no marsh is present, tidal flats extend to the natural edge of dry land. It includes the categories of bay flat, channel flat, and shell flat in the SFEI database. The total area was approximately 51,000 acres or about 10% of the total land and water area in the historical Bay ecosystem.

Shallow Bay and Channel - Shallow bay and tidal channels occurs between MLLW and 18 feet below MLLW. It occupied approximately 174,000 acres or about 33% of the total land and water area in the historical Bay ecosystem.

Deep Bay and Channel - Deep bay and tidal channel is deeper than 18 feet below MLLW. It occupied approximately 100,000 acres or about 19% of the total land and water area in the historical Bay ecosystem.

### **G13 San Francisco Bay Current Aquatic Ecosystem**

This map shows the current, circa 1997, aquatic habitat and the former extent of the historical aquatic habitat. The combined historical wetland, tidal, and open water that no longer exists is shown by subtraction: historical habitat areas that do not have current aquatic habitat is shown in white and have been converted to urban, industrial, and agricultural uses. The current distribution of deep bay, shallow bay, tidal flat, and tidal wetland is based upon the Modern Landscape View of the Bay Area EcoAtlas (San Francisco Estuary Institute 1998). Major data sources for the Modern Landscape View are the 1985 National Wetlands Inventory, winter 1995-96 NASA infra-red (IR) photography, and intensive “truthing sessions” conducted by SFEI to involve regional and local experts in the revision of earlier versions of the EcoAtlas. For further documentation, view the Bay Area EcoAtlas at [www.sfei.org](http://www.sfei.org).

#### **Legend Categories:**

Remaining Historical Tidal Wetland - This represents the wetland, principally the old high tidal marsh in the SFEI database, that was present historically and still remains. It occupies about 16,000 acres which is about 3 % of the current Bay ecosystem and about 8 % of the former extent of about 192,000 acres (map G12). This category did not include approximately 6,200 acres of muted tidal marsh since that marsh receives less than full tidal flow as a result of a physical impediment. The historical tidal wetland has been converted to diked and managed wetlands mainly in Suisin Bay (63,000 acres), farmed and grazed wetlands in North Bay and Suisin Bay (32,000 acres), salt evaporators in North and South Bays (37,000 acres), and most of the balance (20,000 acres) to urban uses in the Central and South Bay. The loss of tidal wetland represents the greatest area of aquatic habitat loss in the Bay ecosystem.

Tidal Wetland Formed Since Historical Period - This represents the wetland that occurs today but was not historically present. This newly created wetland formed in historical tidal flats and shallow water. It occupies about 18,000 acres which is about 4 % of the current Bay ecosystem.

Current Tidal Mudflats - This represents both channel and bay flat that existed historically and has been created since the historical period. The newly created tidal mudflat occurs in the North and South Bay. The total area of the current tidal mudflat is about 29,000 acres or about 6% of the current Bay ecosystem compared to about 51,000 acres or about 10% of the historical ecosystem.

Shallow Bay and Channel - Shallow bay and channel occurs between MLLW and 18 feet below MLLW. It currently occupies about 172,000 acres or about 33% of the Bay ecosystem. There has been only a slight decrease in this category despite significant areas of it being reclaimed for human uses. It has gained area at the expense of deep bay and channels as those areas accumulate sediment.

Deep Bay and Channel - Deep bay and channel is deeper than 18 feet below MLLW. It currently occupies about 83,000 acres or about 16% of the Bay ecosystem. There has been about a 17,000 acre decrease in deep bay and channel as those areas became shallower through sedimentation. Dredging for navigation maintains the deep bay.

#### **G14 Nearshore Ocean: Habitat and Bathymetry**

The defined portion of the ocean environment is meant to depict that most interactive, in terms of exchange of water, sediments, and dissolved materials, and organisms, with the remainder of the watershed. It is bounded to the north by Point Reyes, to the south by the southernmost end of Half Moon Bay, and to the west by the continental shelf break. Depth contours (bathymetry) and natural habitat distribution are taken from modern surveys, but probably do not differ greatly from conditions at the time of the Gold Rush. The bathymetry is from the United States Environmental Protection Agency. The shoreline habitat is from the Farallons National Marine Sanctuary.