Developing the Goals

Years ago, shortly after the Goals Project began, the RMG adopted a general approach for establishing habitat goals. This chapter describes this approach and explains how the Goals were developed.

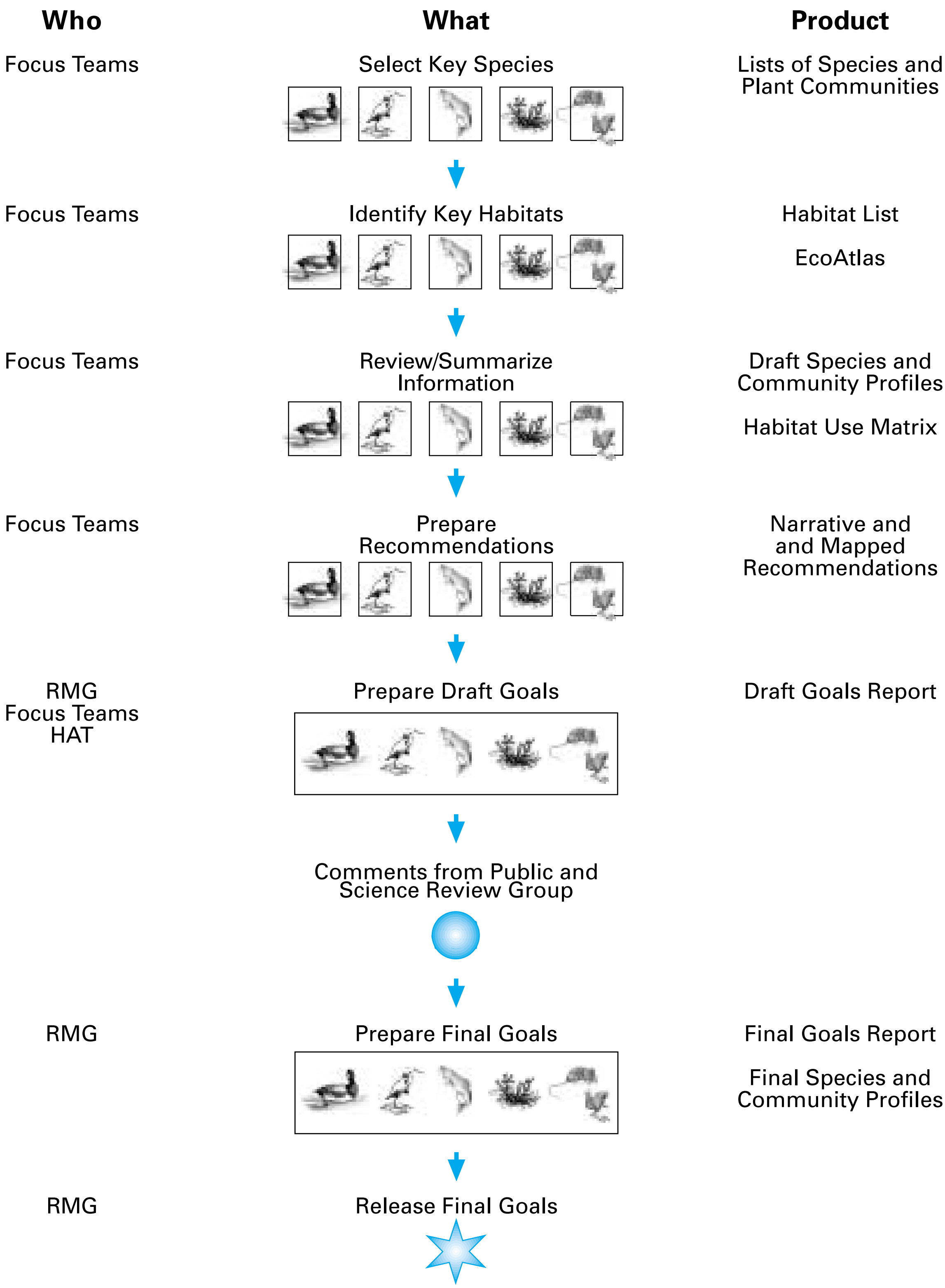
The approach for developing habitat goals involved several steps, including selecting key species and habitats, assembling and evaluating information on the species and habitats, preparing recommendations, and integrating recommendations into goals (**Figure 3.1**). The RMG oversaw the process and was ultimately responsible for the contents of the final Goals. Under the general guidance of the RMG, and with support from the Estuary Institute, five focus teams did the bulk of the scientific work. RMG members led the focus teams and were responsible for relaying information between the groups.

Recognizing that the Project's success depended on the participation of qualified experts, the RMG used considerable care in forming the focus teams. From an initial list of more than 100 candidates, it enlisted 65 team members. After considering several possible ways to structure the teams, the RMG formed five teams to focus on plants and animals and one to advise on hydrology and geology. The teams included:

- Plants Focus Team
- Fish Focus Team
- Mammals, Amphibians, Reptiles, and Invertebrates (MARI) Focus Team
- Shorebirds and Waterfowl Focus Team
- Other Baylands Birds Focus Team
- Hydrogeomorphic Advisory Team (HAT)

The RMG encouraged the focus teams to modify the approach as needed and made every effort to respond to their suggestions. Although this lengthened the time necessary to develop the Goals, it ultimately produced more meaningful results.

FIGURE 3.1 **Process for Establishing Goals**



The Focus on Species

During the Project's early stages, Project participants discussed the proposed emphasis on habitats as support for plant, fish, and wildlife species. Some believed that the Project should also consider other important wetland functions such as primary production, nutrient cycling, flood control, shoreline protection, tidal prism conservation, and water filtration. The RMG considered many options and decided that the Project should emphasize restoring and protecting habitats for living resources.

This decision was justified because concern about species and human health drives most federal and state environmental laws and policies. Also, most of the available scientific information on the baylands is about wildlife and their habitats. The RMG believed that protecting key species by improving their habitats would concurrently improve other important wetland functions.

Guiding Principles

At the recommendation of the Science Review Group, the RMG prepared a set of principles to guide the development of the habitat goals. In essence, the principles comprise the RMG's assumptions of what the Goals should be. The RMG solicited comments from the public, the focus teams, the HAT, and the Science Review Group before preparing the final list of guiding principles. According to these principles, the Goals should:

- Present a vision of habitat changes needed to improve the Bay's ecological functions and biodiversity.
- Increase the quantity and quality of wetlands without trying to "reach" the past.
- Be based on evaluations of the habitat needs of representative species.
- Give priority to the habitat needs of native species.
- Emphasize protecting and restoring wetlands that support threatened, endangered, and other special-status species while ensuring adequate habitat for other species.
- Enhance the Bay's ability to support resident and migratory species.
- Recognize that it will be impossible to maximize habitat for all species.
- Recognize the habitat values provided by some existing land uses such as farming and salt production.
- Include recommendations for habitats adjacent to the baylands.
- Be based on existing biological information, knowledge of historical conditions, and sound professional judgment.
- Be modified in the future to reflect improved scientific understanding and practical experience in wetland restoration.

The focus teams also developed principles, or tenets, to help guide their work (**Table 3.1**). The RMG encouraged each team to do this by looking exclusively at the habitat needs of its key species, and this explains the narrow perspective of some of these tenets.

TABLE 3.1 Focus Team Tenets

Plants Team

- Consider the needs of plant species from a community perspective.
- Develop recommendations for communities rather than for species.
- Consider plant communities within and near the Project boundary.
- Develop recommendations that reflect plant communities which are present today, as well as those which were present before European settlement.
- Evaluate the plant species of a given community in the context of the following criteria:

  -Dominant species -Rare species -Populations in decline -Locally extinct species

Fish Team

- Consider the needs of fishes and aquatic invertebrates first.
- Assign highest priority to native and special-status species.
- Preserve and restore habitats that improve species diversity.
- Restoration activities should not go against natural trends.
- Natural, self-sustaining habitats are better for fishes and aquatic invertebrates than are managed habitats.
- A few large, contiguous patches of habitat are preferable to many small, separate patches.

Mammals, Amphibians, Reptiles, and Invertebrates Team

- Increase the amount of available wetlands and associated uplands.
- Preserve native species.
- Include buffers wherever possible as refugia from flooding, as transitional areas or ecotones between wetlands and uplands, and as safe havens from humans and non-native or feral animals.
- Preserve and enlarge wetland habitats with existing source populations.
- Preserve and enlarge wetland habitats with endangered or sensitive species.
- Systems should be self-maintaining. Energy should originate primarily from the sun, or from tides or other hydrologic sources, and not from artificially maintained and costly equipment.
- Control non-native species (e.g., red fox, Norway rat, and feral cats and dogs) that negatively affect native species.

Shorebirds and Waterfowl Team

- Protect, preserve, and enhance waterfowl and shorebird habitats.
- Protect specific local areas that are critical to key species.
- Convert specific local habitats important to key shorebird and waterfowl species only if the habitat values are replaced elsewhere.

Other Baylands Birds Team

- Use umbrella or keystone species to represent habitat types and larger assemblages of species.
- Protect and enhance habitat for native species.
- Emphasize sensitive species endemic to the estuary over species that have become more abundant or have colonized the Bay as a result of habitat alterations.
- Minimize habitat fragmentation.
- Maintain or restore historical habitat gradients to express a full range of biodiversity within the estuary.
- Emphasize restoration of self-maintaining systems.
- Restore large patches of habitat to provide a diversity of habitat functions and to support larger bird populations. Small habitat patches can provide important connections between larger patches.

Selecting Key Species and Habitats

Once the focus teams were established, the RMG asked them to select key species of plants, fish, and wildlife and to identify the habitats that support them. The RMG defined key species as those species that collectively represent the overall complexity of the baylands ecosystem[1]. Protecting and supporting these species was the objective of the focus team recommendations and the final habitat goals. There was substantial iteration between selecting key species and identifying the support habitats, and these first two steps of the process took many months. The following sections summarize this work, starting with the selection of plants by the Plants Focus Team.

Key Plants

The Plants Focus Team considered the ecological needs of plants from a community perspective, and so it selected key plant communities rather than key species. This focus on communities is partly due to the Projects emphasis on major habitats that are shared by many plant species.

The Plants Focus Team selected four key bayland communities: shallow bay and intertidal bayland, tidal marsh, diked bayland, and salt pond (**Table 3.2**). In addition, it also identified several plant communities of the bayland/upland ecotone, including riparian forest, willow grove, grassland, oak woodland, and evergreen forest. As the following section on key habitats explains, these ecotone communities are integral parts of the baylands ecosystem.

Several unique plant species evolved along the edge of the baylands.

USCS 1857

[1] In other Project documents, key species are sometimes called indicators, evaluation species, or target species.

TABLE 3.2 Key Plant Communities and Representative Plant Species

Species	*Botanical Name*	Ecological Significance*
Intertidal and Subtidal Baylands		
Eelgrass	*Zostera marina*	D, KS, PE
Tidal Marsh		
Sea-pink	*Armeria maritima* ssp. *californica*	SM: UE, X
California saltbush	*Atriplex californica*	SM: UE, X
Fat-hen, spear scale	*Atriplex triangularis*	C, UE
Johny-nip, salt marsh owl's clover	*Castilleja ambigua* ssp. *ambigua*	SM: PE, RR, UE
Suisun thistle	*Cirsium hydrophilum* var. *hydrophilum*	BM: FTE, R, STE, UE
Point Reyes bird's-beak	*Cordylanthus maritimus* ssp. *palustris*	SM: RR, UE
Soft bird's-beak	*Cordylanthus mollis* ssp. *mollis*	BM: FTE, PE, R, UE
Dodder	*Cuscuta salina*	SM: C-D
Saltgrass	*Distichlis spicata*	D, UE
Alkali-heath	*Frankenia salina*	SM: C
Gumplant	*Grindelia stricta* var. *angustifolia*	C, UE
Jaumea	*Jaumea carnosa*	SM: C
Baltic and salt rush	*Juncus balticus* and *J. lesueurii*	BM: C
Smooth goldfields	*Lasthenia glabrata*	PE, RR, UE
Delta tule pea	*Lathyrus jepsonii* var. *jepsonii*	BM: R, RR, UE
Pepper grass	*Lepidium latifolium*	D, IA
Mason's lilaeopsis	*Lilaeopsis masonii*	BM: R, STE
Sea lavender, marsh rosemary	*Limonium californicum*	SM: UE
Silverweed	*Potentilla anserina* ssp. *pacifica*	BM: C, UE
Pickleweed	*Salicornia virginica*	SM: D, KS
Hardstem bulrush (tule)	*Scirpus acutus*	BM
California bulrush (tule)	*Scirpus californicus*	BM: C
Alkali bulrush	*Scirpus maritimus*	BM: D, KS
Olney's bulrush	*Scirpus pungens*	BM: C
Smooth cordgrass	*Spartina alterniflora*	D, IA
Dense-flowered cordgrass	*Spartina densiflora*	IA
Pacific cordgrass	*Spartina foliosa*	D, KS
Saltmeadow cordgrass	*Spartina patens*	IA
California sea-blite	*Suaeda californica*	SM: FTE, UE, X
Cattails	*Typha* spp.	BM: C

* Key:

BM	Brackish marsh	SM	Salt marsh
C	Common	D	Dominant
FTE	Federally listed as threatened or endangered	IA	Invasive alien (exotic)
KS	Keystone species (habitat structure or trophic)	L	Found locally or very locally within this community
NA	Naturalized alien (exotic)	PE	Partly extirpated within San Francisco Bay estuary
R	Rare	RR	Regionally rare in San Francisco Bay estuary
STE	State-listed as threatened or endangered	U/D	Uncommon or declining
UE	Upland ecotone, high marsh, upper marsh edge	X	Extirpated

TABLE 3.2 *(continued)*

Species	*Botanical Name*	Ecological Significance*
Lagoon		
Wigeon grass	*Ruppia maritima*	C, KS
Diked Baylands (includes diked wetlands and diked agricultural lands)		
Oat bent-grass	*Agrostis avenacea*	C, NA
Wild mustards	*Brassica* spp. and *Hirschfeldia incana*	D, NA
Goosefoot	*Chenopodium berlandieri*	NA, C
Poison hemlock	*Conium maculatum*	NA, C
Brass-buttons	*Cotula coronopifolia*	D, NA
Saltgrass	*Distichlis spicata*	D
Dittrichia	*Dittrichia graveolens*	C, IA
Watergrass	*Echinochloa crus-galii*	C, NA
Fennel	*Foeniculum vulgare*	NA, C
Barley	*Hordeum marinum* var. *gussoneanum*	D, NA
Baltic and salt rush	*Juncus balticus* and *J. lesueurii*	C
Pepper grass	*Lepidium latifolium*	D, IA
Bird's foot trefoil	*Lotus corniculatus*	C, NA
Loosestrife	*Lythrum hyssopifolia*	D, NA
Sago pondweed	*Potamogeton pectinatus*	C
Dock	*Rumex crispus*	C, NA
Pickleweed	*Salicornia virginica*	D, KS
Alkali bulrush	*Scirpus maritimus*	C, KS
Cattails	*Typha* spp.	C
Salt Pond		
Dunaliella	*Dunaliella salina*	D, KS
Ecotonal Communities (communities related to the edges of key plant communities)		
• **Riparian Forest**		
Box elder	*Acer negundo californicum*	C
Giant reed	*Arundo donax*	C, IA
Santa Barbara sedge	*Carex barbarae*	D
Creeping wildrye	*Leymus triticoides*	D
Western sycamore	*Platanus racemosa*	L
Cottonwood	*Populus fremontii*	D

* Key:

BM	Brackish marsh	SM	Salt marsh
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UE	Upland ecotone, high marsh, upper marsh edge	X	Extirpated

TABLE 3.2 *(continued)*

Species	*Botanical Name*	Ecological Significance*
Ecotonal Communities (communities related to the edges of key plant communities; *continued*)		
• **Riparian Forest** *(continued)*		
Valley oak	*Quercus lobata*	L
California wild rose	*Rosa californica*	C
California blackberry	*Rubus vitifolius*	C
Red willow	*Salix laevigata*	D
Arroyo willow	*Salix lasiolepis*	D, KS
Elderberry	*Sambucus caerulea*	C
California bay laurel	*Umbellularia californica*	L
• **Willow Grove**		
California blackberry	*Rubus vitifolius*	D
Red willow	*Salix laevigata*	D
Arroyo willow	*Salix lasiolepis*	D, KS
• **Grassland**		
Wild oat	*Avena fatua* and *A. barbata*	D, NA
Ripgut brome	*Bromus diandrus*	D, NA
Soft chess	*Bromus hordeaceus*	D, NA
Santa Barbara sedge	*Carex barbarae*	U/D
Creeping wildrye	*Leymus triticoides*	U/D
Italian ryegrass	*Lolium multiflorum*	D, NA
Purple needlegrass	*Nassella pulchra*	U/D
• **Moist Grassland**		
Santa Barbara sedge	*Carex barbarae*	C
Baltic rush	*Juncus balticus*	C
Iris-leaved rush	*Juncus xiphioides*	C
Creeping wildrye	*Leymus triticoides*	C
Italian ryegrass	*Lolium multiflorum*	D, NA
• **Grassland/Vernal Pool Complex**		
Downingia	*Downingia pulchella*	D
Coyote-thistle	*Eryngium aristulatum*	D
Goldfields	*Lasthenia* spp.	C
Loosestrife	*Lythrum hyssopifolium*	C, NA
Popcorn flower	*Plagiobothrys bracteatus*	D

* Key:

BM	Brackish marsh	SM	Salt marsh
C	Common	D	Dominant
FTE	Federally listed as threatnened or endangered	IA	Invasive alien (exotic)
KS	Keystone species (habitat structure or trophic)	L	Found locally or very locally within this community
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UE	Upland ecotone, high marsh, upper marsh edge	X	Extirpated

TABLE 3.2 *(continued)*

Species	*Botanical Name*	Ecological Significance*
Ecotonal Communities (communities related to the edges of key plant communities; *continued*)		
• **Coastal Prairie**		
Sweet vernal grass	*Anthoxanthum odoratum*	D, NA
Pacific reedgrass	*Calamagrostis*	C
California oatgrass	*Danthonia californica* var. *californica*	U/D
Pacific hairgrass	*Deschampsia cespitosa* ssp. *holciformis*	U/D
Velvet grass	*Holcus lanatus*	D, NA
Douglas iris	*Iris douglasiana*	C
• **Coastal Sage**		
California sagebrush	*Artemisia californica*	D (southern)
Coyote brush	*Baccharis pilularis*	D (northern)
• **Coast Live Oak Woodland**		
Pacific madrone	*Arbutus menziesii*	C
Toyon	*Heteromeles arbutifolia*	C
Cream bush	*Holodiscus discolor*	C
Coast live oak	*Quercus agrifolia*	D, KS
California blackberry	*Rubus vitifolius*	D
Creeping snowberry	*Symphoricarpos albus* var. *laevigatus*	C
Poison oak	*Toxicodendron diversilobum*	D
• **Foothill and Valley Oak Woodland**		
Common manzanita	*Arctostaphylos manzanita*	C
Santa Barbara sedge	*Carex barbarae*	C
Buckbrush	*Ceanothus cuneatus*	C
Creeping wildrye	*Leymus triticoides*	D
Digger pine	*Pinus sabiniana*	C
Blue oak	*Quercus douglasii*	LD, KS
Valley oak	*Quercus lobata*	LD, KS
California coffeeberry	*Rhamnus californica*	C
Pink-flowering currant	*Ribes anguineum*	C
• **Mixed Evergreen Forest**		
Bigleaf maple	*Acer macrophylum*	C
Madrone	*Arbitus menzeisii*	C
Coyote brush	*Baccharis pilularis*	D
Poison oak	*Toxicodendron diversilobum*	D
California bay laurel	*Umbellularia californica*	D, KS
California huckleberry	*Vaccinium ovatum*	C

* Key:

BM	Brackish marsh	SM	Salt marsh
C	Common	D	Dominant
FTE	Federally listed as threatnened or endangered	IA	Invasive alien (exotic)
KS	Keystone species (habitat structure or trophic)	L	Found locally or very locally within this community
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Key Fish and Wildlife

Each of the four animal focus teams developed criteria for selecting key species (**Table 3.3**). Although the selection criteria varied among the teams, there were many similarities. These similarities led to the development of a set of standardized selection criteria (**Table 3.4**) which the RMG later used to help evaluate the adequacy of the lists of key species.

Using their selection criteria, the focus teams screened several hundred species and ultimately selected 131 key species (**Table 3.5**). As the table shows, the teams selected most of the key species because they were dominant species, or habitat or community indicators. Each team included sensitive species and some teams included important commercial or recreational species.

Key Habitats

Once the focus teams had initial lists of species, they had to identify, name, and describe their habitats. The RMG considered using the list of habitat types described in the San Francisco Estuary Project's *Status and Trends Report on Wetlands and Related Habitats*[2], but realized the need for more detail. The RMG also wanted to be able to show habitat distributions, and so desired to use habitat types that could be readily mapped.

After several refinements by Project participants, the RMG finalized the list of key habitats. Within the baylands, the key habitats include tidal flat, tidal marsh, lagoon, diked wetland, agricultural bayland, salt pond, and treatment/storage pond. Key habitats outside of the baylands but within the baylands ecosystem include deep bay/channel, shallow bay/channel, willow grove, riparian forest, grassland, oak woodland, and mixed evergreen forest.

The Estuary Institute mapped the location of the key habitats on the EcoAtlas and developed estimates of their past and present acreage. It also helped organize the list of habitats and develop a classification system or "typology" for the Project. Chapter 4 presents the habitat typology and describes the key habitats.

Plants blur the boundaries between baylands and uplands.

Elise Brewster

[2] Habitats described in the Estuary Project's *Status and Trends Report on Wetlands and Related Habitats* include: subtidal and tidal waters, intertidal mudflat, tidal salt marsh, tidal brackish marsh, diked seasonal and perennial wetlands, salt ponds, lakes and ponds, adjacent riparian woodland, and adjacent upland.

TABLE 3.3 Criteria Developed by Focus Teams for Selecting Key Species

Estuarine Fish and Associated Invertebrates

Species selected because it:

- Is protected due to concern over low population numbers, loss or degradation of habitat, etc. (e.g., federal or state-listed threatened or endangered species).
- Is a principal element (e.g., prey item) in the food web or webs of the estuarine ecosystem.
- Inhabits ecotones or moves across habitat-type edges in such a way as to establish an ecological link between them.
- Has recognized commercial or recreational values.
- Is considered an indicator species for a particular habitat type.
- Is native to the San Francisco Bay estuary.
- Is, or has been, relatively abundant in one or more of the subregions of the estuary and baylands (e.g., Suisun Bay).
- Has available sufficient information about it to enable establishing regional habitat .
- Represents or is an indicator species for a particular taxon, guild, life history characteristic, or some other feature of the ecosystem deemed to have significant value.

Mammals, Amphibians, Reptiles, and Invertebrates

Species selected because it is:

- Threatened or endangered.
- Essential to threatened or endangered species.
- Keystone for larger communities.
- Keystone in food webs.
- Important for productivity, diversity, or other ecological standard.
- Dependent on wetland habitat.
- An indicator of wetland health.
- A major or dominant prey item for a key species selected by other focus teams.
- Unique to the Project area.
- A significant non-native pest (to be controlled or removed).
- A native pest of historical and current significance.

Shorebirds and Waterfowl

Species selected because it:

- Is currently, or was historically, very abundant in the Bay.
- Is strongly associated with marine or estuarine habitats.
- Relies on the Bay as a critical area within the Pacific Flyway.
- Relies on the Bay as a major wintering area.
- Nests in the Bay region.
- Is dependent on specific habitat (e.g., fresh or brackish wetland, salt pond, rocky intertidal).
- Is federally listed as threatened or endangered, or is a candidate for such listing.
- Is of economic or recreational importance or is harvested for food.
- Has symbolic value within our society.

TABLE 3.3 *(continued)*

Other Baylands Birds

Species selected because it:

- Requires large, well-developed tidal marsh habitat.
- Uses salt pond or shallow saline pond habitat.
- Uses high tidal marsh and upland transition area.
- Is representative of a particular habitat type, such as riparian, seasonal ponds, freshwater marshes, adjacent uplands, open bay, and rocky shores or islands.
- Depends on baylands habitats for critical support function, i.e., breeding, foraging, or migration.
- Is representative of a broader group or guild of species that use the baylands.
- Is endemic to, or breeds only in, the baylands.
- Is locally or regionally limited in number and distribution.

TABLE 3.4 Standardized Selection Criteria

1. Community Indicator: Species is indicative of a community, guild, or assemblage of species. A community indicator can represent other species because of similar habitat requirements.
2. Habitat Indicator: Species is indicative of a key habitat. The presence of the species helps define the habitat.
3. Sensitive Species: Slight changes in habitat conditions might cause large changes in population status, or the species has been recommended for legal protection (differentiated from "candidate" status below).
4. Protected Species: Species is listed, or is a candidate to be listed, for protection under state and/or federal law because it is rare, threatened, or endangered.
5. Economic Indicator: Species is an important commercial or recreational species.
6. Dominant Species: Species strongly influences community structure as a major prey item, keystone species, pollinator, or ecological engineer. In the strictest sense, a keystone species is a predator that exerts a strong measurable influence on the relative abundance of other species in the community. In the Project, the term applies to any species, predator or not, that exerts such influence. An ecological engineer is a plant or animal that changes the physical environment in a way that strongly affects other species.
7. Pest Species: Species is an invasive species or a pest to people.
8. Practical Species: Species is a convenient indicator of a community, guild, assemblage or habitat because it is well studied or easily studied. This criterion helps to select among the many possible community or habitat indicator species.

TABLE 3.5 Key Fish and Wildlife Species and Standardized Selection Criteria

Common Name	Scientific Name	Standardized Selection Criteria
Estuarine Fish and Associated Invertebrates		
Chinook salmon	*Oncorhynchus tshawytscha*	2,4,5,6,8
Steelhead	*Oncorhynchus mykiss*	2,5,6,8
White sturgeon*	*Acipenser transmontanus*	1,2,4,6,8
Striped bass	*Morone saxatilis*	2,5,6,8
Sacramento splittail	*Pogonichthys macrolepidotus*	2,4,5,6,8
Pacific herring	*Clupea pallasi*	2,4,6,8
Northern anchovy	*Engraulis mordax*	2,4,6,8
Arrow goby	*Clevelandia ios*	1,2,6,8
Bay goby	*Lepidogobius lepidus*	2,4,6,8
Delta smelt	*Hypomesus transpacificus*	2,4,6,8
Jacksmelt	*Atherinopsis californiensis*	5,6,8
Topsmelt	*Atherinops affinis*	2,5,6,8
Longfin smelt	*Spirinchus thaleichthys*	6,8
Pacific staghorn sculpin	*Leptocottus armatus armatus*	5,6,8
Prickly sculpin	*Cottus asper*	6,8
Rainwater killifish*	*Lucania parva*	2,8
Plainfin midshipman*	*Porichthus notatus*	2,5,6,8
Shiner perch	*Cymatogaster aggregata*	2,5,6,8
Tule perch	*Hysterocarpus traski*	2,6,8
Three-spined stickleback	*Gasterosteus aculeatus*	6,8
White croaker	*Genyonemus lineatus*	2,5,6,8
Leopard shark	*Triakis semifasciata*	1,4,6,8
Bat ray	*Myliobatus californica*	2,6,8
Brown rockfish	*Sebastes auriculatus*	2,5,6,8
California halibut	*Paralichthys californicus*	2,5,6,8
Starry flounder	*Platichthys stellatus*	2,5,6,8
Longjaw mudsucker	*Gillichthys mirabilis*	2,5,6,8
Dungeness crab	*Cancer magister*	2,4,6,8
Rock crab	*Cancer antennarius*	2,4,6,8
Rock crab	*Cancer productus*	2,4,6,8
Mud crab*	*Hemegrapsus oregonensis*	1,4,6,8
California bay shrimp*	*Crangon franciscorum*	2,4,6,8
Blacktail shrimp*	*Crangon nigricauda*	6,8
Opossum shrimp	*Neomysis mercedis (relicta)*	2,6

* Species profile not prepared.
1. Community Indicator
2. Habitat Indicator
3. Sensitive Species
4. Protected Species
5. Economic Indicator
6. Dominant Species
7. Pest Species
8. Practical Species

TABLE 3.5 *(continued)*

Common Name	Scientific Name	Standardized Selection Criteria
Estuarine Fish and Associated Invertebrates (continued)		
Softshell clam*	*Mya arenaria*	2,6,8
Japanese littleneck clam*	*Tapes japonica*	2,4,6,8
Ribbed horsemussel*	*Arcuatula demmisum*	2,4,6,8
California horn snail*	*Cerithidea californica*	2,6,8
Amphipods*	Amphipoda spp.	1,2,6,8
Other Invertebrates		
Franciscan brine shrimp	*Artemia franciscana (salina)*	2,5,6,8
Conservancy fairy shrimp*	*Branchinecta conservatio*	4,2,3
Fairy shrimp*	*Branchinecta lynchi*	2,3
Fairy shrimp*	*Linderiella occidentalis*	4,2,3
California vernal pool tadpole shrimp	*Lepidurus packardi*	2,3,4,6
Reticulate water boatman	*Trichocorixa reticulata*	2,3,6,8
Delphacid planthopper*	*Prokelisia marginata*	1,2,6,8
Cixiid planthopper	*Cixius praecox*	1,2,6
Tiger beetle	*Cicindela haemorrhagica*	2,3
Tiger beetle	*Cicindela oregona*	2,3
Tiger beetle	*Cicindela senilis senilis*	2
Diffuse water scavenger beetle*	*Enochrus diffusus*	2,6
Minute moss beetle*	*Ochthebius rectus*	2
Western tanarthrus beetle	*Tanarthrus occidentalis*	2,3,6
Leaf beetle*	*Erynephala morosa*	2,6
Inchworm moth	*Perizoma custodiata*	2,6,8
Pygmy blue butterfly	*Brephidium exilis*	2,6,8
Summer salt marsh mosquito	*Aedes dorsalis*	2,7,8
Winter salt marsh mosquito	*Aedes squamiger*	2,7,8
Washino's mosquito	*Aedes washinoi*	2,7,8
Western encephalitis mosquito	*Culex tarsalis*	2,7,8
Winter marsh mosquito	*Culiseta inornata*	2,7,8
Grodhaus's midge*	*Tanypus grodhausi*	2,6
Flower fly*	*Eristalinus aeneus*	6
Cinereus brine fly	*Ephydra cinerea*	1,2,6,8
Millbrae brine fly	*Ephydra millbrae*	1,2,6,8
Riparian shore fly (brine fly)*	*Ephydra riparia*	2
Brine fly	*Lipochaeta slossonae*	2,6,8
Jamieson's compsocryptus wasp	*Compsocryptus jamiesoni*	2,3

* Species profile not prepared.
1. Community Indicator
2. Habitat Indicator
3. Sensitive Species
4. Protected Species
5. Economic Indicator
6. Dominant Species
7. Pest Species
8. Practical Species

TABLE 3.5 *(continued)*

Common Name	Scientific Name	Standardized Selection Criteria
Amphibians		
California tiger salamander	*Ambystoma californiense*	1,3,4
California toad	*Bufo boreas halophilus*	2,6
Pacific treefrog	*Hyla regilla*	2,6
California red-legged frog	*Rana aurora draytonii*	1,2,3,4
Reptiles		
Western pond turtle	*Clemmys marmorata*	1,2,3,4
California alligator lizard	*Elgaria multicarinata multicarinata*	6
Central coast garter snake	*Thamnophis atratus atratus*	2,6
Coast garter snake	*Thamnophis elegans terrestris*	2,6
San Francisco garter snake	*Thamnophis sirtalis tetrataenia*	3,4
Mammals		
Salt marsh harvest mouse	*Reithrodontomys raviventris*	1,2,3,4,6
California vole	*Microtus californicus*	6,8
Salt marsh wandering shrew	*Sorex vagrans haliocoetes*	1,2,3,4,6
Suisun shrew	*Sorex ornatus sinuosis*	1,2,3,4,6
Ornate shrew	*Sorex ornatus californicus*	2,6
North american river otter	*Lutra canadensis*	2,3
Southern sea otter	*Enhydra lutris nereis*	2,3,4
Harbor seal	*Phoca vitulina richardi*	2,3
California sea lion	*Zalophus californianus*	2,3
Norway rat	*Rattus norvegicus*	7
Roof rat	*Rattus rattus*	7
Red fox	*Vulpes vulpes regalis*	7
Waterfowl		
Tule greater white-fronted goose	*Anser albifrons gambelli*	1,2,3,4
Mallard	*Anas platrhynchos*	1,2,5
Northern pintail	*Anas acuta*	1,2,5
Canvasback	*Aythya valisineria*	1,2,5
Surf scoter	*Melanitta perspicilata*	1,2
Ruddy duck	*Oxyura jamaicensis*	1,2
Shorebirds		
Western snowy plover	*Charadrius alexandrinus nivosus*	2,3,4
Marbled godwit	*Limosa fedoa*	1,2
Black turnstone	*Arenaria melanocephala*	1,2
Red knot	*Calidris canutus*	1,2,3
Western sandpiper	*Calidris mauri*	2
Long-billed dowitcher	*Limnodromus scolopaceus*	1,2
Wilson's phalarope	*Phalaropus tricolor*	1,2,3

* Species profile not prepared.
1. Community Indicator
2. Habitat Indicator
3. Sensitive Species
4. Protected Species
5. Economic Indicator
6. Dominant Species
7. Pest Species
8. Practical Species

TABLE 3.5 *(continued)*

Common Name	Scientific Name	Standardized Selection Criteria
Other Baylands Birds		
Eared grebe	*Podeceps nigricollis*	2
Western/Clark's grebe	*Aechmophorus occidentalis*	2
American white pelican	*Pelecanus erythrorhynchus*	2,3
Brown pelican	*Pelecanus occidentalis*	2,3
Double-crested cormorant	*Phalacrocorax auritus*	1
Snowy egret	*Egretta thula*	2
Black-crowned night heron	*Nycticorax nycticorax*	2
Northern harrier*	*Circus cyaneus*	2,3
Peregrine falcon*	*Falco peregrinus*	1,2,3,4
California clapper rail	*Rallus longirostris obsoletus*	2,3,4
California black rail	*Laterallus jamaicensis corturniculus*	2,3,4
Common moorhen	*Gallinula chloropus*	2
California gull	*Larus californicus*	6
Western gull*	*Larus occidentalis*	6
California least tern*	*Sterna antillarum browni*	1,2,4
Forster's tern	*Sterna forsteri*	1,2
Caspian tern	*Sterna caspia*	1,2
Burrowing owl	*Speotyto cunicularia hypugaea*	2,3
Belted kingfisher*	*Ceryle alcyon*	2
Horned lark*	*Eremophila alpestris*	2
Yellow warbler*	*Dendroica petechia*	2
Salt marsh common yellowthroat	*Geothlypis Trichas sinuosa*	2,3
Savannah sparrow	*Passerculus sandwichensis*	2
Song sparrow (3 subspecies)	*Melospiza melodia samuelis*	2,3
	Melospiza melodia pusillula	2,3
	Melospiza melodia maxillaris	2,3

* Species profile not prepared.
1. Community Indicator
2. Habitat Indicator
3. Sensitive Species
4. Protected Species
5. Economic Indicator
6. Dominant Species
7. Pest Species
8. Practical Species

Checking Species and Habitat Lists

After preliminary lists of key species, communities, and habitats were prepared, the RMG asked the focus teams to undertake several exercises to ensure that the lists were appropriate and adequate, and to help initiate the transfer of relevant information between focus teams. The teams were asked to document, to the extent practicable, complex biological relationships such as trophic structure, species interrelationships, and overall representation of community complexity along gradients of tidal elevation and degree of tidal influence and salinity.

As part of this work, several teams developed functional matrices or tables to show which habitats support which species, and in what ways. The Estuary Institute compiled the focus team matrices into a single large matrix. This matrix was extremely detailed, and showed which habitats and habitat components provide support for each species. For example, within shallow channel habitat, the matrix showed the support functions provided by channel bottom, channel bank, and open water; and within mid-tidal marsh habitat, it showed support functions provided by vegetated plain, salt pan, channel, and so on.

The matrix, while initially developed to help evaluate the sufficiency of the lists of key species and habitats, also served other purposes — it identified species that share key habitats or components of habitats, and it helped to identify species that would be most affected by changes in habitat quality, distribution, and abundance.

Figure 3.2 presents an abbreviated form of the matrix. The matrix indicates the resting, foraging, and breeding support functions provided by each of the key habitats for each of the key species. Please keep in mind that Figure 3.2 provides general information regarding habitat function and is not a site-specific guide.

Assembling and Evaluating Information

The next step in the process required the focus teams to assemble available data on their key species, communities, and habitats. The Plants Focus Team compiled information regarding plant community composition, distribution, and habitat controls. The animal focus teams compiled data on life history, use of habitats, and historical and current distribution. The teams summarized this information in brief papers referred to as "profiles."

The purpose of the profiles was to provide Project participants with information needed to develop goals. However, some participants suggested that the materials might be more generally useful. Accordingly, the Project published them as a companion document entitled *Species and Community Profiles* (Goals Project 2000). The profiles provide additional background information for the Goals, and some identify additional research needs that are not discussed in this report. Also, many of the profiles list species-specific recommendations that may be helpful when planning and managing projects to support particular species or suites of species.

FIGURE 3.2 Abbreviated Habitat Support Function Matrix

	Shallow Bay or Channel	Tidal Flat	Lagoon	Beach	Rocky Shore	Low Tidal Marsh	Mid Tidal Marsh	High Tidal Marsh	Muted Tidal Marsh	Diked Wetland	Agricultural Baylands	Salt Pond	Storage or Treatment Pond	Riparian Forest	Willow Grove	Grassland	Oak Woodland	Mixed Evergreen Forest
Fish and Related Invertebrates																		
Chinook salmon	F	F				RF	R.F	RF										
Steelhead	F																	
White sturgeon	F	F				RF												
Striped bass	F	F				F	F	F										
Sacramento splittail	RF	RF				RFB	RFB	RFB										
Pacific herring	FB	FB																
Northern anchovy	FB																	
Arrow goby	RFB	RFB				RF												
Bay goby	RF																	
Delta smelt	F					RFB												
Jacksmelt	FB	FB																
Topsmelt	FB	FB				F	F	F										
Longfin smelt	F																	
Pacific staghorn sculpin	RF	FB				F	F	F										
Prickly sculpin						F	F	RFB										
Rainwater killifish						RFB		RFB										
Plainfin midshipman	RFB	RFB																
Shiner perch	FB	F																
Tule perch						RFB	RFB	RFB										
Threespine stickleback						RFB	RFB	RFB										
White croaker	FB	F					F											
Leopard shark	FB	F																
Bat ray	RF	RF				RF												
Brown rockfish	RF																	
California halibut	RF	RF																
Starry flounder	RF	RF				F												
Longjaw mudsucker		RFB				RFB	FB	FB										
Dungeness crab	RF	RF				RF												
Rock crab	RFB				RF	RF												
Mud crab	FB	FB				FB	RF	RF										
California bay shrimp	RF	RFB				RF												
Blacktail shrimp	RF	RFB				RF												
Opossum shrimp	F					F	F											
Softshell clam		RFB			RFB													
Japanese littleneck clam		RFB			RFB													
Ribbed horsemussel							RFB	RFB										
California horn snail		RFB				RFB	RFB	RFB										
Amphipods	RFB	RFB			RFB	RFB	RFB	RFB										

Key: R = Resting, F = Foraging, B = Breeding, ! = Uses vernal pools in this habitat, * = Uses artificial structures in this habitat.

FIGURE 3.2 *(continued)*

	Shallow Bay or Channel	Tidal Flat	Lagoon	Beach	Rocky Shore	Low Tidal Marsh	Mid Tidal Marsh	High Tidal Marsh	Muted Tidal Marsh	Diked Wetland	Agricultural Baylands	Salt Pond	Storage or Treatment Pond	Riparian Forest	Willow Grove	Grassland	Oak Woodland	Mixed Evergreen Forest
Other Invertebrates																		
Franciscan brine shrimp												RFB						
Conservancy fairy shrimp																RFB!		
Fairy shrimp																RFB!		
California vernal pool tadpole shrimp																RFB!		
Reticulate water boatman			RFB					RFB	RFB	RFB	RFB							
Delphacid planthopper						RFB												
Cixiid planthopper								RFB	RFB	RFB	RFB							
Tiger beetle (*C. oregona*)						RFB	RFB	RFB	RFB									
Tiger beetle (*C. senilis*)								RFB	RFB			RFB						
Tiger beetle (*C. haemorrhagical*)								RFB	RFB	RFB								
Diffuse water scavenger beetle								RFB	RFB	RFB	RFB							
Minute moss beetle								RFB	RFB	RFB	RFB							
Western tanarthrus beetle								RFB				RFB						
Leaf beetle						RFB	RFB	RFB	RFB	RFB	RFB							
Inchworm moth							RF	RFB	RFB	RFB	RFB							
Pygmy blue butterfly								RFB	RFB	RFB	RFB							
Summer salt marsh mosquito			RFB				RFB	RFB	RFB	RFB	RFB			RF		RFB		
Winter salt marsh mosquito			RFB				RF	RFB	RFB	RFB	RFB					RFB		
Washino's mosquito														RFB	RFB			
Western encephalitis mosquito			RFB					RFB	RFB	RFB	RFB		RFB	RFB		RFB		
Winter marsh mosquito									RFB	RFB	RFB		RFB	RFB		RFB		
Grodhaus's midge			RFB				RFB	RFB		RFB	RFB					RFB		
Flower fly			RFB				RFB	RFB	RFB	RFB	RFB	RFB						
Cinereus brine fly						RFB	RFB	RFB		RFB		RFB						
Millbrae brine fly						RFB	RFB	RFB		RFB		RFB						
Riparian shore fly														RFB	R			
Brine fly (*L. slossonae*)							RFB	RFB		RFB		RFB						
Jamieson's compsocryptus wasp							RF	RF	RFB	RFB		RF						
Amphibians																		
California tiger salamander										RFB	RFB			RFB		RFB	RF	RF
California toad			RFB			F	RFB	RFB	RFB	RFB	RFB		RF	RFB	RFB	RFB	RF	RF
Pacific treefrog			RFB			F	RFB	RFB	RFB	RFB	RFB		RF	RFB	RFB	RFB	RF	RF
California red-legged frog			RFB				RFB	RFB	RFB	RFB	RFB			RFB	RFB	RFB		F
Reptiles																		
Western pond turtle			RF			RF	RF	RF	RF	RFB	RFB		RFB	RFB	RB	RFB	RB	RB
California alligator lizard			RF			RF	RFB	RFB	RFB	RFB	RFB		RFB	RFB	RFB	RFB	RFB	RFB
Central coast garter snake			RF			F	RFB	RFB	RFB	RFB	RFB		RFB	RFB	RFB	RFB		
Coast garter snake			RF			F	RFB	RFB	RFB	RFB	RFB		RFB	RFB	RFB	RFB	RFB	RFB
San Francisco garter snake			RF			F	RFB	RFB	RFB	RFB	RFB			RFB		RFB		

Key: R = Resting, F = Foraging, B = Breeding, ! = Uses vernal pools in this habitat, * = Uses artificial structures in this habitat.

FIGURE 3.2 *(continued)*

	Shallow Bay or Channel	Tidal Flat	Lagoon	Beach	Rocky Shore	Low Tidal Marsh	Mid Tidal Marsh	High Tidal Marsh	Muted Tidal Marsh	Diked Wetland	Agricultural Baylands	Salt Pond	Storage or Treatment Pond	Riparian Forest	Willow Grove	Grassland	Oak Woodland	Mixed Evergreen Forest
Mammals																		
Salt marsh harvest mouse			RFB			RF	RFB	RFB	RFB	RFB	RF							
California vole			RFB				RFB	RFB	RFB	RFB	RF		RFB			RFB	RFB	
Salt marsh wandering shrew						F	RFB	RFB	RFB	RFB	RFB							
Suisun shrew						F	RFB	RFB		RF	RF							
Ornate shrew									RFB	RFB	RFB		RFB			RFB	RFB	
North American river otter	F		RFB	R	R	RFB	RFB	RFB	RFB				RF	RFB				
Southern sea otter	RFB	F		RF														
Harbor seal	F	RB	F	R	RB	RF												
California sea lion	RF			R	R													
Waterfowl																		
Tule white-fronted goose	RF		RF	R		RF	RF	RF		RF	RF		RF			RF		
Mallard	RF	F	RF	R		F		RFB	RF	RFB	RFB	RF	RFB	RFB		RFB		
Northern pintail	R		RF			F		RFB	RF	RFB	RFB	RF	RFB			RFB		
Canvasback	RF	F	RF						RF	RF		RF	RF					
Surf scoter	RF																	
Ruddy duck	RF	F	RF			RFB	RFB	RFB	RF	RFB	RFB	RF	RFB					
Shorebirds																		
Western snowy plover		F		RF								RFB						
Marbled godwit		RF	RF	RF	R	RF	RF	RF	RF	RF	RF	R	R			F		
Black turnstone		RF	R	R	RF	R	R	R	R									
Red knot		RF	R	R	R	RF	RF	RF	RF			RF	R					
Western sandpiper		RF	RF	RF	R	RF	RF	RF	RF	RF	RF	RF	RF					
Long-billed dowitcher		RF	RF	R	R	RF	RF	RF	RF	RF	RF	RF	RF			F		
Wilson's phalarope		F	RF	R						RF	RF	RF	RF					

Key: R = Resting, F = Foraging, B = Breeding, ! = Uses vernal pools in this habitat, * = Uses artificial structures in this habitat.

In addition to the information summarized in the species profiles, the MARI, Other Baylands Birds, and Shorebirds and Waterfowl focus teams assembled data on species distribution and abundance and displayed them on various kinds of maps. The MARI team displayed the distribution of many of its species on printed maps of the EcoAtlas. The bird teams used the EcoAtlas to analyze data and to prepare maps.

Focus Team Recommendations

The next step in the process required the focus teams to formulate habitat recommendations. The teams differed markedly in their approach to this step — some teams prepared acreage recommendations, some indicated specific habitat locations, and some described habitat arrangements or features. The MARI and Other Baylands Birds focus teams summarized their habitat recommendations on EcoAtlas maps. The Shorebirds and Waterfowl, Plants, and Fish teams did not illustrate their goals on maps; instead, they reviewed and commented on the maps

FIGURE 3.2 *(continued)*

	Shallow Bay or Channel	Tidal Flat	Lagoon	Beach	Rocky Shore	Low Tidal Marsh	Mid Tidal Marsh	High Tidal Marsh	Muted Tidal Marsh	Diked Wetland	Agricultural Baylands	Salt Pond	Storage or Treatment Pond	Riparian Forest	Willow Grove	Grassland	Oak Woodland	Mixed Evergreen Forest
Other Bayland Birds																		
Eared grebe	RF	F	RF			RF		RF		RFB		RF	RF					
Western/Clark's grebe	RF	F	RF							RFB		RF						
American white pelican		R	RF	R					F	RF		RF	RF					
Brown pelican	R*F	R	RF	R		RF			R	RF		RF		RF				
Double-crested cormorant	RFB*	R	F	R	R	RF			F	F		RFB	RF					
Snowy egret		F	F	RF	RB	RF	RF	RFB	RFB	RFB	F	RF	RFB	RFB	B		B	
Black-crowned night heron	RF	F	RF	RF	RF	RF	RF	RF	RF	RFB	F	RF	F	RFB	B		RB	RB
Northern harrier		F	F			F	F	RFB	RF	RFB	R.F.B	F	F		RF	RFB		
Peregrine falcon	RFB*	RF	F	F	F	R*F	F	R*FB	F	R*FB	F	R*FB	F		RF	F	RF	
California clapper rail		F				RFB	RFB	RFB	RF	R								
California black rail							F	RFB										
Common moorhen								RFB	RFB	RFB								
California gull	RF	RF	RF	RB	R	F			RF	RF	RF	RFB	RF			RF		
Western gull	R*FB	RF	RFB	RF	RF	RFB		RFB	RFB	RF	RF	RFB	RF			F		
California least tern	RF	RF	RFB	RB		F	F	F	RF	F		RFB	F					
Forster's tern	RFB	RF	RF	R		F	F	F	RFB	RFB		RFB	F					
Caspian tern	F	RF	RFB	R	R	F			RFB	RB		RFB	F					
Burrowing owl								F	RFB	RFB	R.F.B	RFB				RFB		
Belted kingfisher	RF	F	RF			RF			RF	RF		RF	RF	RFB				
Horned lark										RF	RF					RFB		
Yellow warbler							F	F						RFB		RF		
Salt marsh common yellowthroat			RFB			F	RFB	RFB	RF	RFB	RFB			RFB				
Savannah sparrow						F	F	RFB	RFB	RFB	RFB	RF				RFB		
Song sparrow						F	RF	RFB	RFB	RF	RF	RF						
Red-winged blackbird							RF	RFB	RF	RFB	RFB		RFB	RF	RFB	RFB		
Western meadowlark								RFB		RFB	RFB	RF				RFB		
Barn swallow	RF	F	RFB			RF	RF	RFB	RFB	RFB	RFB	RFB	RF	RFB	RF	F		

Key: R = Resting, F = Foraging, B = Breeding, ! = Uses vernal pools in this habitat, * = Uses artificial structures in this habitat.

produced by the two other teams. Each of the focus teams ultimately produced preliminary recommendations that reflected the habitat needs of its species.

Formulating preliminary recommendations enabled the focus teams to begin sharing their perspectives with each other. To facilitate this, the focus teams asked the RMG to organize a series of joint team meetings. Most of these meetings involved pairs of teams, but as many as four teams attended some meetings. After a couple of meetings, the HAT joined the discussions to help the teams better understand physical habitat controls. These meetings proved to be extremely valuable as they enabled the focus teams and the HAT to discuss their views, and to identify potential conflicts. They also enabled the teams to begin modifying their recommendations to accommodate other key species.

By the end of 1997, the focus teams had completed their joint meetings and prepared final recommendations. Their recommendations ranged from very general to very specific, and while many were complementary, some were in

The Use of Data

Data are systematic observations. When data are interpreted in the context of other appropriate information, they can lead to understanding.

Tables of measurements of such things as species population size and location are one kind of data. Other kinds may include descriptions of animal behavior, unwritten recollections, or sightings of a species. Many kinds of data are potentially useful.

While the quality of data is important, its interpretation is equally significant. The scientists who collect and analyze data frequently understand more than the data directly show, and the knowledgeable scientist will draw on experience to help interpret the information and draw reasonable conclusions.

The Goals Project relied on many kinds of data. The recommendations in this document reflect not only the data used, but also the collective understanding of the scientists who participated in the Project.

conflict. Besides recommendations for habitat placement and acreage, there also were suggestions regarding habitat design and management, needed research, and a host of other related topics, such as the use of dredged materials, control of non-native invasive species, and restoration phasing. In total, the focus team materials contained nearly 200 recommendations. Appendix C contains the focus team recommendations and information prepared by the HAT.

Integrating the Recommendations

The final step in preparing draft Goals required blending all of the focus team recommendations into a conceptual vision that balanced, to the extent possible, the competing needs of the many baylands species. Originally, the RMG had planned to undertake this task independently, using the information provided by the focus teams. However, since many of the teams had already begun integrating their recommendations through their joint meetings, the RMG decided to continue this process by working with the focus teams. To do this, they planned an all-hands integration workshop where all Project participants could consider the collective recommendations and help craft them into a unified vision.

To prepare for the integration workshop, the RMG reviewed the species and community profiles, focus team recommendations, and the MARI and Other Bayland Birds focus team maps. It then endeavored, using the MARI and Other Bayland Birds maps as a starting point, to display all of the recommendations on a single "integration map." The RMG consulted with the focus team members when recommendations were unclear, and referred to the Project's guiding principles to help resolve conflicts. When the RMG completed the draft integration map, the Estuary Institute entered it into the EcoAtlas. In this way, the RMG was able to calculate acreage for each of the key habitats and to prepare tables comparing the proposed future acreage to the historic and modern acreage.

The integration workshop spanned five days in early 1998 and was attended by 30 to 35 participants each day. During the first workshop day, the focus teams presented their recommendations and the HAT gave an overview of

Scientists come to terms.

Elise Brewster

Are the Goals Scientific?

An important precept of the Project was that the Goals should be based on the best available science. The RMG acknowledged that the Goals were not developed through experimental testing of scientific hypotheses — the data were too thin for this approach. Rather, the Goals were developed using the best available data, reasonable inference based on these data, and the collective best professional judgment of the regional community of environmental scientists and managers.

The Goals were *developed by scientists and are based on scientific information*; to this extent they are scientific.

Elise Brewster

Howard Cogswell...

important physical considerations. Participants then developed descriptions of high quality habitat, and recommendations for design and management practices to optimize habitat functions. They also discussed and described ways that the various habitat types should be arranged on the landscape.

During the next three workshop days, participants reviewed recommendations for each of the Project subregions and critiqued the RMG's integration map. They also made additional habitat recommendations, many of them very specific. Recommendations that received general support with no emphatic objections were recorded for inclusion in the Goals. The RMG developed two main products from these sessions — a revised integration map (Appendix D), and a listing of potential habitat improvement sites with corresponding maps (Appendix E).

On the final workshop day, participants discussed many issues relevant to implementing the Goals and made recommendations on several topics. During the final workshop session, they reviewed the revised integration map and the list of habitat improvement sites, and agreed on how to present the Goals in the draft report.

...his maps speak volumes.

Howard Cogswell

Preparing the Goals Report

Following the integration workshop, Project staff and the RMG summarized the information and recommendations provided by the participants in an administrative draft report. Project participants (including the Science Review Group) reviewed this report in April 1998. The RMG revised the report, based on the comments received, and released a public draft report in June 1998.

In July 1998, the RMG presented the draft Goals at four public workshops. After the close of the public comment period following the workshop, the RMG considered the verbal and written comments and prepared this final report.

Science Review

The RMG established a Science Review Group (SRG) to provide critical review of the Project's process and products. It carefully selected the SRG members to assure a strong review panel with expertise in a broad range of disciplines including ecosystem analysis, integrated resource planning, and conservation biology. The


Robin Grossinger

Public truthing sessions helped to improve the EcoAtlas.

RMG considered this sort of "big picture" critiquing an essential complement to the scientific peer review provided by the focus teams.

The SRG convened in February 1997 (20 months into the process), at about the time the focus teams had completed selecting species and habitats and were beginning to formulate their recommendations. The RMG asked the SRG to review past Project activities and to help chart a course for future action. In response, the SRG provided many helpful suggestions.

In reviewing the Project activities, the SRG confirmed that the Project's species-based approach was generally sound. It also agreed that it was reasonable to rely on the collective knowledge of local scientific experts. The SRG encouraged the RMG to develop Project tenets and principles to help assure more cohesive goals and to have the Hydrogeomorphic Advisory Team immediately begin working with the focus teams. It also recommended presenting draft Goals to the public for comments before finalizing them, and suggested presenting the Goals as maps and text. The SRG also made recommendations on other issues including the habitat classification system, the proposed timeline for completing the Goals, and the role of consensus and public comment.

The SRG made many significant contributions that helped to improve the process and resulted in more technically sound and useable Goals.

Public Outreach

During the Project's early stages, the Administrative Core Team developed a public outreach program to inform the public about the Project. The outreach program included a series of workshops, meetings, brochures, and reports. It also provided an opportunity for the public to communicate with the RMG. This section summarizes the main public outreach events.

At the Project's kick-off workshop in June 1995, organizers presented a Project overview and introduced the participants. Nearly 100 persons representing local, state, and federal agencies, environmental groups, landowners, and other interests attended this two-day workshop. Many of the environmental scientists that attended were later asked to join the Project. The RMG and Administrative Core Team used comments from this workshop to revise the Project's process.

Participants provided a Project update at a second public workshop in October 1995. An information package distributed at the workshop included Project background information, a list of Project participants, and details of the process. The Administrative Core Team asked the attendees for input on the proposed public outreach program and used comments received to help improve the program.

An informational brochure produced in May 1996 presented the Project history, explained public participation opportunities, and described some potential uses for the Goals. Over the next two years the Estuary Project and Administrative Core Team distributed thousands of brochures throughout the Bay Area.

During June and July 1997, RMG members and Project staff made some 30 presentations to local planning departments, resource conservation districts, environmental organizations, mosquito abatement districts, and park districts. Presentations included general information about the Project and the potential uses of the final Goals.

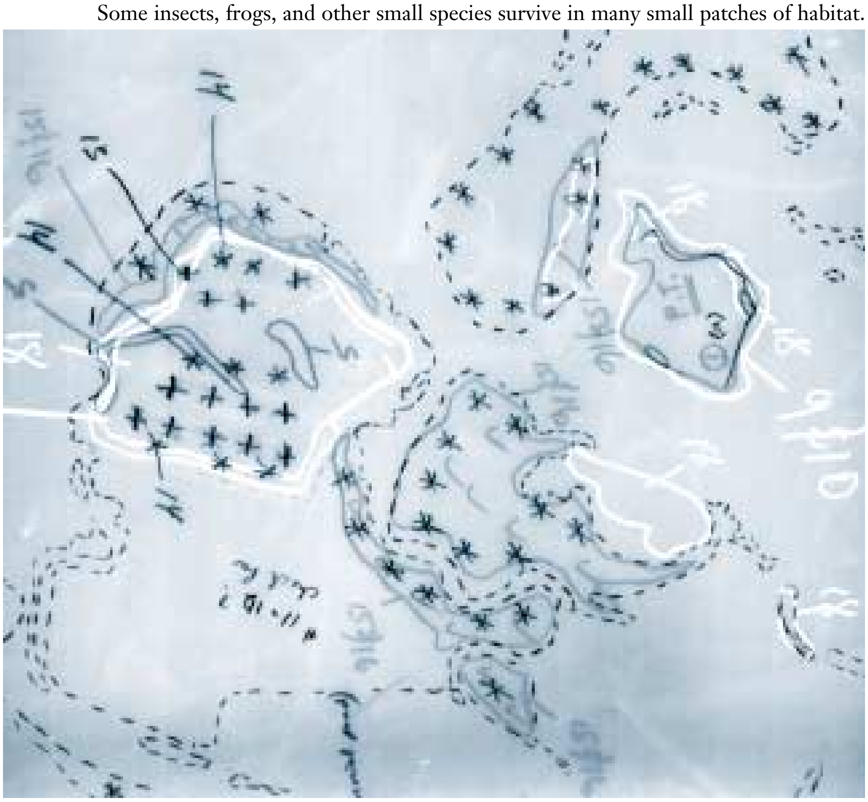
The RMG provided another Project update and presented its guiding principles at evening workshops in July 1997. The focus teams also described their work and presented their preliminary recommendations. A progress report distributed at the workshops listed the key species and habitats and introduced the Project's habitat typology. In response to RMG questions, the attendees commented on the Project's guiding principles and expressed their preferences for the format and level of specificity of the Goals.

The RMG presented the draft Goals report at a series of public workshops in July 1998. The workshops were held in the evenings and in each of the four subregions to encourage attendance by landowners and others who might not have been able to attend during the day. More than 150 persons attended the workshops, many provided comments or asked questions, and more than 60 individuals, groups, and agencies subsequently submitted written comments. The RMG and Project staff considered these comments before preparing the final report.

Public outreach also included seeking comments on technical materials; for example, the Estuary Institute invited the public to review and comment on draft versions of the EcoAtlas. This enabled many important corrections of habitat designations and boundary locations.

Public outreach for the Goals Project was extensive and provided many benefits. These benefits included a better sense of the issues of concern, improved technical products, and ideas on how to present the Goals in a way that would make them most useful.

Some insects, frogs, and other small species survive in many small patches of habitat.



Wes Maffei and Mark Jennings

CHAPTER 4

Key Habitats of the Baylands Ecosystem

Large-scale habitat restoration and enhancement requires a thorough understanding of habitat features and functions. Without this understanding, one cannot expect to improve habitat conditions for a particular species or group of species. This chapter describes the Project's key habitats and identifies some of the plant and animal species that inhabit them.

An important step in understanding the similarities and dissimilarities of various habitats involves organizing the habitats into a conceptual framework. In the Goals Project, the RMG and the Estuary Institute undertook this step with considerable input from the focus teams.

The RMG considered various ways to organize the list of key habitats and recognized that each habitat contains many important components. For example, seasonal ponds occur within agricultural baylands; within a seasonal pond, the bottom substrate, water column, and edge each provide unique habitats essential to the survival of some key species. Likewise, tidal marsh contains channels of various dimensions, and each channel type has several important habitat components. This perspective led to the development of a hierarchical classification or "typology" of baylands in which habitat components of one level are nested within the next higher level. In developing the typology, Project participants identified the varied habitat support provided by each of the major habitat types and its components. **Figure 4.1** shows a very abbreviated typology of the baylands ecosystem habitats. Although this typology was appropriate and useful for the purposes of establishing regional habitat goals, it may be appropriate to modify it as more information is developed on the distribution and function of various wetlands and related habitats of the baylands ecosystem. **Table 4.1** compares the Project's habitat classification with the classification used by the San Francisco Estuary Project and the general framework for habitats developed by Cowardin et al. (1979).

Bruce Orr

Managed marsh changes through the seasons.

FIGURE 4.1 Abbreviated Typology

Baylands Ecosystem

Bay

- Deep Bay
- Deep Channel
- Shallow Bay
- Shallow Channel

Baylands

Tidal

- Tidal Flat
- Tidal Marsh
  - Salt Marsh
  - Brackish Marsh
- Lagoon

Diked

- Diked Wetland
  - Managed Marsh
  - Diked Marsh
- Agricultural Bayland
- Salt Pond
- Storage/Treatment Pond

Adjacent Habitats

- Riparian Forest
- Willow Grove
- Grassland
  - Non-native Annual Grassland
  - Moist Grassland
  - Grassland/Vernal Pool Complex
  - Coastal Prairie
- Oak Woodland
  - Coastal Live Oak Woodland
  - Valley Oak Woodland
  - Foothill Oak Woodland
- Mixed Evergreen Forest

Elise Brewster

The tide reaches across many habitats.

Please note that one of the habitats — agricultural bayland — actually is a kind of land use rather than a type of wetland or related habitat. It was included in the habitat typology because it represents a major part of the baylands ecosystem and provides a variety of important ecological support functions for baylands species. It also has habitat components — non-tidal salt marsh, non-tidal brackish marsh, and seasonal ponds — that could be described with existing information. Also, "agricultural bayland" or "farmed bayland" are regional terms that have been in common use for years.

Different types of habitats often blend, or intergrade, with one another in a transition zone called an ecotone. Ecotones can vary in width from a few feet, as at the upper edge of a riprapped shoreline, to hundreds of yards, as at the boundary of high tidal marsh and adjacent grassland. In the baylands, there are ecotones from deep bay to shallow bay, shallow bay to tidal flat, tidal flat to tidal marsh, and so forth. There are also ecotones between the components within a habitat type, and between the saltwater and freshwater extremes of the salinity gradient. The beaches, rocky shoreline, levees, and tidal reaches of adjacent streams are all part of the ecotone from the baylands to the adjacent uplands. Ecotonal areas are important because they support especially diverse groups of plants and animals.

Salt marsh builds against the hills.

The following section describes the key habitats of the baylands ecosystem and notes some of the organisms that use them. It presents the habitats in three groups — Bay Habitats, Baylands Habitats, and Adjacent Habitats — in accordance with the Project's typology. **Table 4.2** and **Figure 4.2** indicate some sites where one can observe good examples of the habitats. Chapter 7 presents information on the design and management of many of the habitats. For more thorough descriptions of the structure and associated biota of these habitats, please refer to the Goals Project's *Species and Community Profiles* (Goals Project 2000) and other appropriate materials listed in the References section of this report.

TABLE 4.1 Comparison of Wetland Classification Systems

Cowardin et al. (1979) (System/Subsystem)	S.F. Estuary Project (Category)	Goals Project (Key Habitats)
Estuarine/Subtidal	Open Water Shallow Bay & Channel	Deep Bay & Channel Shallow Bay & Channel
Estuarine/Intertidal	Mudflat Rocky Shore Tidal Channel Tidal Marsh	Tidal Flat Tidal Marsh (& channels) Lagoon
Riverine	Tidal River Nontidal River Perennial & Intermittent Creeks	Lowland Creek
Lacustrine	Perennial Lakes & Ponds Salt Evaporator Crystallizer Bittern pond	Storage/Treatment Pond Salt Pond
Palustrine	Diked Vegetated Wetlands Seasonal & Permanent Vegetated Wetland Seasonal Pond Farmed Wetland Freshwater Marsh	Diked Wetland Agricultural Bayland
	Riparian Forest	Riparian Forest/Willow Grove
	Adjacent Upland	Grassland Oak Woodland Mixed Evergreen Forest

For a more detailed comparison of the Cowardin habitat classifications and the San Francisco Estuary Project's wetlands and related habitat categories, please refer to Meiorin et al. (1991), page 23.

Bay Habitats

Bay habitats are intricately tied to the baylands and are components of the baylands ecosystem. They are especially important for aquatic organisms, sea birds, and some mammals that move back and forth between deep and shallow waters. Bay habitats are divided into two categories: areas of deep water (Deep Bays and Channels) and areas of shallow water (Shallow Bays and Channels).

Deep Bay and Channel

Deep bays and channels are the parts of the Project area that are deeper than 18 feet below Mean Lower Low Water (MLLW). They include the deepest portions of the Bay and the largest tidal channels.

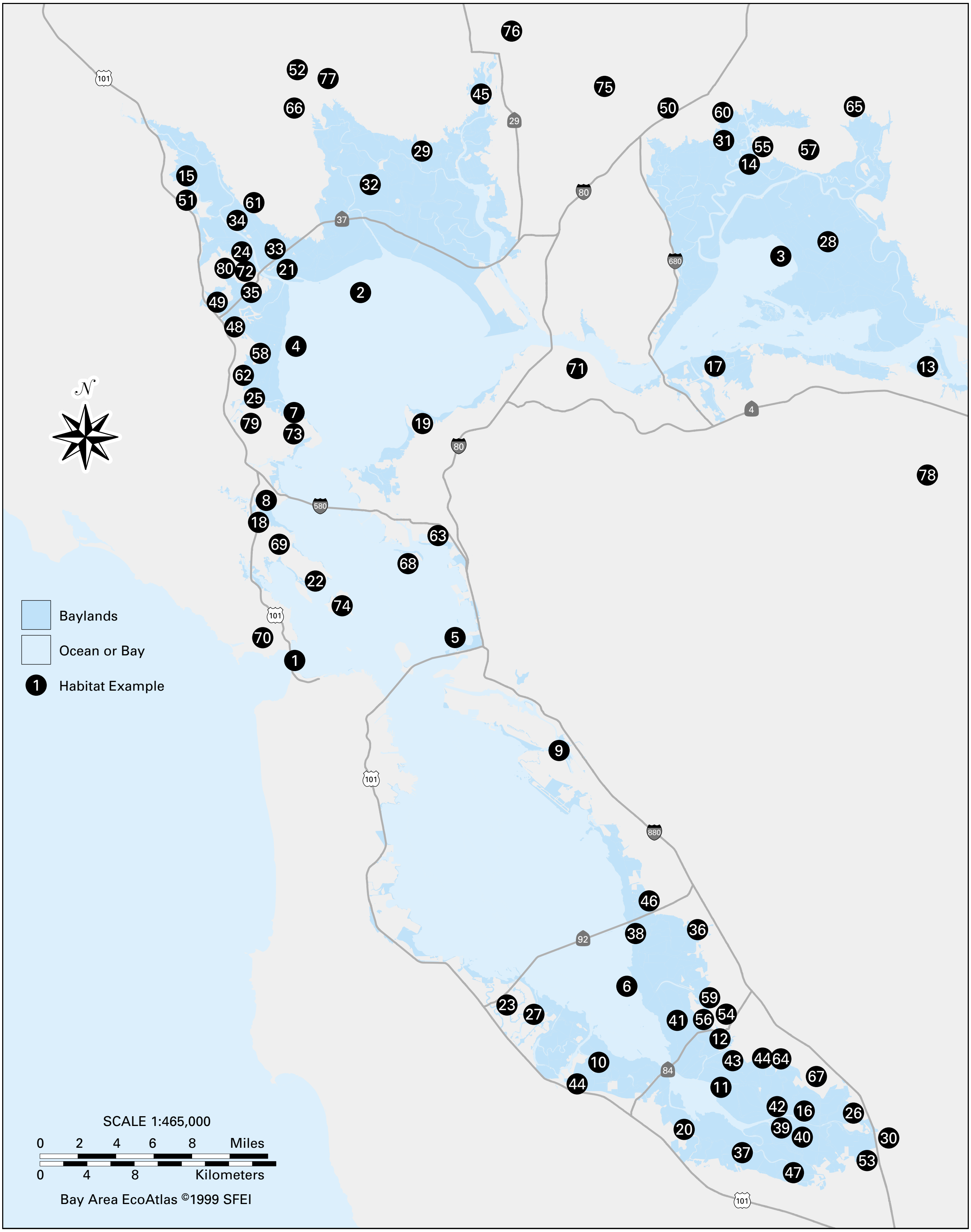
The sediments of deep bay and channel habitat vary widely in character, from coarse sand to very fine clays and silts. In the parts of the Bay where currents are strong, especially as in the deeper reaches of San Pablo Bay and Central Bay, the bottom is mostly coarse sand. In Suisun Bay and South Bay, however, most of the bottom is covered with mud, a mixture of material with more than 80 percent silt and clay (Nichols and Thompson 1985).

TABLE 4.2 List of Habitat Example Sites

Habitat Type	Site	Location
Deep Bay/Channel	1.	Golden Gate (CB)
Shallow Bay/Channel	2.	San Pablo Bay (NB)
Tidal Flat	3.	Grizzly Bay (S)
	4.	Marin Shoreline (NB)
	5.	Emeryville Crescent (CB)
	6.	South Bay (SB)
Tidal Salt Marsh	7.	China Camp (NB)
	8.	Heerdt Marsh (CB)
	9.	Arrowhead Marsh (CB)
	10.	Greco Island (SB)
	11.	Mowry Slough (SB)
	12.	Upper Newark Slough (SB)
Tidal Brackish Marsh	13.	Brown's Island (S)
	14.	Rush Ranch (S)
	15.	Petaluma Marsh (NB)
	16.	Triangle Marsh (SB)
Muted Tidal Marsh	17.	Pacheco Slough (S)
	18.	Marta's Marsh (CB)
	19.	Point Pinole (NB)
	20.	Charleston Slough (SB)
Lagoon	21.	Sonoma Baylands (NB)
	22.	Belvedere Lagoon (CB)
	23.	Foster City (SB)
Diked Wetland	24.	Western Marsh and Central Lowlands at Bahia (NB)
	25.	Gallinas Creek (NB)
	26.	Fremont Airport (SB)
	27.	Area H, Redwood Shores Peninsula (SB)
	28.	Suisun Marsh (S)
	29.	Huichica Unit, Napa-Sonoma Marsh (NB)
	30.	Santa Clara Valley Water District Pond (SB)
Agricultural Bayland	31.	Suisun Marsh (S)
	32.	Skaggs Island (NB)
	33.	Leonard Ranch (NB)
	34.	Twin House Ranch (NB)
	35.	Black Point (NB)
	36.	Oliver Hayfield, Hayward (SB)
Salt Pond, low salinity	37.	Pond B1/B2, Mtn. View (SB)
	38.	B10 Baumberg (SB)
	39.	Pond A9, Alviso (SB)
Salt Pond, mid salinity	40.	Ponds A10-A14, Alviso(SB)
	41.	Ponds 2-8, Coyote Hills (SB)
	42.	Ponds 2-6, Mowry Slough/Coyote Creek (SB)
Salt Pond, high salinity	43.	Ponds 10 and 26, Newark (SB)
	44.	Crystallizers, Newark and Redwood City (SB)
Storage/Treatment Pond	45.	Napa (NB)
	46.	Hayward (SB)
	47.	Sunnyvale (SB)
	48.	Ignacio Pond (NB)
	49.	Hahn Flood Basin (NB)
Riparian Forest	50.	Suisun Creek (S)
	51.	San Antonio Creek (NB)
	52.	Sonoma Creek (NB)
	53.	Coyote Creek (SB)
Willow Grove	54.	Coyote Hills Regional Park (SB)
Native Grassland	55.	Rush Ranch (S)
Community (Remnants)	56.	Coyote Hills (SB)
Non-native Annual	57.	Potrero Hills (S)
Grassland	58.	Hamilton Field (NB)
	59.	Coyote Hills (SB)
Moist Grassland	60.	Near Fairfield (S)
	61.	Petaluma River Area (NB)
	62.	St. Vincent's/Silveira Ranch (NB)
	63.	Richmond Field Station (CB)
	64.	Upper Reach Mowry Slough (SB)
Grassland/Vernal Pool	65.	Near Fairfield (S)
Complex	66.	Sonoma Creek Area (NB)
	67.	Warm Springs (SB)
Coastal Prairie	68.	Brooks Island (CB)
	69.	Ring Mountain Preserve (CB)
	70.	Golden Gate National Recreation Area (CB)
Coast Live Oak	71.	Carquinez Strait (S)
Woodland	72.	Black Point to Rush Creek (NB)
	73.	China Camp (NB)
	74.	Angel Island (CB)
Valley Oak Woodland	75.	Green Valley Creek Area (S)
	76.	Lower Napa River Area (NB)
	77.	Sonoma Creek Area (NB)
Foothill Oak Woodland	78.	Black Diamond Mine Regional Park (S)
Mixed Evergreen Forest	79.	San Pedro Ridge (NB)
	80.	Black Point to Rush Creek (NB)

S = Suisun, NB = North Bay, CB = Central Bay, SB = South Bay

FIGURE 4.2 Map of Habitat Example Sites



NASA 1995/96

Bays deepen.

Deep bays and channels are important for large aquatic invertebrates including California bay shrimp, Dungeness crab, and rock crab, and for fishes such as white sturgeon and brown rockfish. They also are migratory corridors through which pass anadromous fishes including Chinook salmon and steelhead.

Deep bays and channels are habitat for several species of water birds including brown pelican, double-crested cormorant, greater and lesser scaup, surf scoter, and Caspian tern. Marine mammals such as harbor seal and California sea lion are also found here.

This habitat accounts for about one-third of the Bay's area and occurs in all four subregions. The deepest portion is in Central Bay at the Golden Gate.

Shallow Bay and Channel

Shallow bays and channels include the portion of the Project area where the bottom is entirely between 18 feet below MLLW and MLLW.

The sediments of shallow bays and channels are primarily mud. An exception is a large portion of the eastern side of South Bay, which is covered with shell fragments, remnants of the native and introduced oysters that once occurred in the area (Nichols and Pamatmat 1988).

Shallow bays and channels are important for many invertebrates, fishes, and water birds. This rich environment is an especially productive feeding area for many fishes including Pacific herring, splittail, northern anchovy, and jacksmelt. It is also an important migratory corridor for anadromous fishes such as Chinook salmon and steelhead.

A few of the many bird species that occur in this habitat include western grebe, American wigeon, canvasback, Forster's tern, and least tern. Some of the mammals found here are the harbor seal and California sea lion.

Eelgrass is a particularly important plant species found in the upper reaches of shallow bays and on mudflats in Central Bay. The Bay's only rooted seagrass, eelgrass provides feeding, escape, or breeding habitat for many species of invertebrates, fishes, and some waterfowl. The economically important Pacific herring spawns in eelgrass beds, and least terns forage on small fishes that are found there. Eelgrass also has been found to be an obligate food for black brant along the Pacific flyway (Einarsen 1965).

Shallow bays and channels account for about two-thirds of the Bay's area, and they occur in all four subregions. A good example of this habitat type is at the northern edge of San Pablo Bay.

Bayland Habitats

Bayland habitats include the parts of the Project area that lie between MLLW and the highest observed tide. As described in Chapter 2, the baylands' boundaries and areal extent have changed over the years as a result of sedimentation, diking, and filling.

Bayland habitats support a broad variety of plants and animals and provide areas for feeding, breeding, nesting, roosting, resting, and other functions. The discussion below divides bayland habitats into two categories: Tidal Baylands and Diked Baylands.

What is an Ecosystem?

The ecosystem concept was developed by research scientists so that a patch of the earth, of any convenient size, could be studied to see how life worked there. The boundaries drawn around ecosystems are arbitrary and selected for convenience in studying each system. Thus, an ecosystem can be a planet, a tropical rain forest, an ocean, a fallen log, a puddle of water, or a culture of bacteria in a petri dish.

Generally, an ecosystem is a natural community of living organisms that interact with each other and with their physical environment in a way that perpetuates the community.

adapted from G. T. Miller, Jr., (1985), *Living in the Environment*

Tidal Baylands

The key habitats within tidal baylands are tidal flat, tidal marsh, and lagoon.

Tidal Flat

Tidal flat habitat includes mudflats, sandflats, and shellflats. It occurs from below MLLW (at the elevation of the lowest tides) to Mean Tide Level (MTL) and supports less than 10 percent cover of vascular vegetation, other than eelgrass. About 90 percent of intertidal flat habitat occur on the edges of the Bay, and the remainder is associated with shallow tidal channels. Historically, a greater proportion of tidal flat occurred along the edges of tidal marsh channels (Bay Area EcoAtlas 1998).

Mudflats comprise the largest area of tidal flat habitat. These expanses of fine-grained silts and clays support an extensive community of diatoms, worms, and shellfish, as well as algal flora including green algae, red algae, and sea lettuce. Eelgrass, described previously under shallow bay and channel habitat, can also be a component of mudflats.

During the twice-daily high tides, Bay water inundates tidal flats and provides foraging habitat for many species of fishes including longfin smelt, staghorn sculpin, and starry flounder. During low tides, tidal flats are the major feeding areas for many species of shorebirds; mudflats, in particular, are rich in shorebird food items. Shorebird species that feed on tidal flats include semipalmated plover, American avocet, willet, marbled godwit, western sandpiper, and dunlin. Few mammals, however, frequent tidal flats; the harbor seal is the most notable exception (Fancher and Alcorn 1982).

Tidal flat habitat occurs in each of the Bay's four subregions, but there naturally tends to be less in brackish or freshwater areas compared to more saline areas. This is because, under fresher conditions, marsh vegetation grows lower in the intertidal zone (Atwater 1979, Grossinger 1995). As a result, there is little tidal flat habitat in Suisun, the subregion with the freshest water. About one-third of the Bay's tidal flat habitat is in North Bay, and more than one-half is in South Bay. Given the South Bay's large acreage of tidal flats, most biologists consider it to be the region's most important area for shorebirds.

Tidal flat, East Bay.

Josh Collins

Examples of tidal flat exist in Grizzly Bay, along the Marin shoreline, at the Emeryville Crescent, and throughout much of South Bay.

Tidal Marsh

Tidal marsh is vegetated wetland that is subject to tidal action. It occurs throughout much of the Bay from the lowest extent of vascular vegetation to the top of the intertidal zone (at the maximum height of the tides). Tidal marsh also exists in the tidal reaches of local rivers and streams. In the fresher parts of the Estuary it occurs at lower elevations in the intertidal zone.

Tidal marsh plant communities vary markedly from one part of the Estuary to another. This variation correlates strongly to salinity patterns and to other factors such as substrate, wave energy, marsh age, sedimentation, and erosion.

In the more saline parts of North, Central, and South bays, tidal marsh is referred to as tidal salt marsh. In the more brackish areas, where there is significant freshwater influence — as in Suisun, along the middle reaches of the Petaluma and Napa rivers, and at the mouths of several streams in South Bay — it is referred to as tidal brackish marsh. Because the plant communities of these two general marsh types differ, tidal marshes in different parts of the Bay look very different. For example, a tidal marsh on Montezuma Slough in Suisun (with tall tules and cattails along the channels) looks very different compared to a tidal marsh on the Palo Alto bayfront (with low-growing pickleweed and Pacific cordgrass along the channels).

Three general zones of vegetation, each of which is related to tidal elevation and distance from shore, typically characterize both tidal salt marsh and tidal brackish marsh. Low tidal marsh occurs between the lowest margin of the marsh and Mean High Water (MHW). Middle tidal marsh occurs between MHW and Mean Higher High Water (MHHW). High tidal marsh occurs between MHHW and the highest margin of the marsh.

The high marsh vegetation in a tidal salt marsh or tidal brackish marsh typically intergrades with upland plant species in the marsh/upland ecotone. The width of this zone is determined primarily by the slope of the land; in flatter areas, such as in Suisun, it may be hundreds of yards wide, whereas in Central Bay, with its relatively steep shorelines, the zone is usually much narrower. The marsh/upland ecotone is very important ecologically as it is characterized by a diverse assemblage of vegetation and may provide especially valuable habitat for many species of wildlife.

Tidal marshes have a variety of important components including tidal channels and, sometimes, pans. Large tidal channels and their smaller tributaries form drainage networks that distribute tidal waters throughout the marsh. Where the marsh plain is fairly level, channels tend to be sinuous, but where it slopes more steeply, they tend to be straighter. Channel density (i.e., the amount of channel habitat per area of marsh plain) is directly related to tidal prism, the volume of water that flows into and out of the marsh. A high marsh with a small tidal prism typically will have fewer channels than a low marsh with a larger tidal prism. Also, channel density may be related to salinity; salt marshes generally have denser networks of tidal channels than do brackish marshes (Grossinger 1995).

Tide goes out in shallow channels.

Josh Collins

Marsh pans, referred to as pannes in some references, are typical features of extensive, well-developed tidal marshes. The term refers to natural ponds that form in the marsh plain. These ponds, usually less than one foot in depth, fill with tidal water only during very high tides. They may be hypersaline in late summer, but they do not develop thick deposits of salts as do natural or commercial salt ponds. Most pans are unvegetated, but some support wigeongrass and green macroalgae. There tend to be fewer but larger pans in brackish marshes compared to salt marshes (Grossinger 1995).

Mark Barnby

Pans sit on the marsh top.

Pans also occur at the backshore edge of marshes at the tidal marsh/upland ecotone, where they receive infrequent tidal flows. Here, they tend to be elongate, with the long axes parallel to the marsh/upland boundary. Local influences of topography, microclimate, groundwater, and freshwater runoff affect the salinity of these pans, which is highly variable. Examples of pans exist at the base of Potrero Hills at Rush Ranch in Suisun, at the eastern end of the tidal marsh that fringes Highway 37 in North Bay, at the edge of the Emeryville Crescent in Central Bay, and near Mowry Slough in South Bay.

A microtidal marsh is a tidal marsh that receives less than full tidal flow because of a physical impediment; locally, the term "muted" is frequently used to describe this kind of marsh. An impediment to tidal flow may be natural (such as a sand spit) or man-made (such as a culvert, tide gate, or other water control structure). Muted tidal marshes exhibit many of the same features as fully tidal marshes, but they often lack a full range of plant diversity. Although muted tidal marshes may be very important to some wildlife groups (particularly for shorebirds during the fall migration), muting typically excludes some species. Examples of muted tidal marsh include the marshes near the mouth of Pacheco Slough in Suisun, Marta's Marsh in North Bay, Point Pinole in Central Bay, and Charleston Slough in South Bay.

Development in the baylands has severely affected tidal marshes, especially high marsh zones and high marsh/upland ecotones. Filling marshes and isolating the remnants from sediment and natural freshwater flows has greatly reduced tidal marsh plant diversity. Past floral accounts of the Bay note a much greater diversity of marsh plants than exists today; research by the Project's Plants Focus Team indicates that more than 50 plant species found in the Bay marshes at the turn of this century are now extinct or exist only in isolated populations (Goals Project 1999). Most of these plant species resided in the high marsh or in the marsh/upland ecotone. Locally extinct species include Point Reyes bird's-beak, sea-pink, salt marsh owl's clover, and smooth goldfields (all extirpated in the South Bay); and California sea-blite and California saltbush (extirpated throughout the estuary). Today, rare plant species of tidal marsh include Point Reyes bird's-beak, soft bird's-beak, Suisun thistle, Mason's lilaeopsis, and Delta tule pea.

High-quality tidal marshes provide a complex habitat for many fish and wildlife. In Suisun Bay, splittail, Delta smelt, Chinook salmon, and longfin smelt occur in the marsh channels. Common fishes of Central Bay and South Bay tidal marshes include topsmelt, arrow goby, yellowfin goby, and staghorn sculpin. In North Bay, tidal marshes support gobies, sculpins, and three-spined stickleback. Some bird species associated with tidal marshes include snowy egret, northern harrier, California clapper rail, California black rail, willet, short-eared owl, salt marsh yellowthroat, Alameda song sparrow, San Pablo song sparrow, and Suisun song sparrow. Small mammal species that rely primarily on tidal marsh include salt

"The habitat of an organism is the place where it lives, or the place where one would go to find it."
— E. Odum 1971

marsh wandering shrew, Suisun shrew, and salt marsh harvest mouse. Red fox, coyote, and other predators prey on these species in middle and high marsh. Harbor seals utilize tidal marsh, especially areas adjacent to sloughs in South Bay, as resting or haul-out sites during high tides.

Tidal marsh occurs throughout the Project area, but the largest patches are on the northern edge of San Pablo Bay and along the Petaluma River. Suisun Bay, too, supports a substantial acreage of tidal marsh, while Central Bay supports relatively little.

Tidal Salt Marsh — Pacific cordgrass and common pickleweed are the dominant plant species in tidal salt marsh. Pacific cordgrass is usually the primary colonizer on broad tidal mudflats that fringe tidal marsh plains, and it occurs in virtually pure stands in low marsh between about MTL and MHW. Midway within this tidal range, it intermixes with annual pickleweed, especially in depressions in the marsh plain.

In middle tidal salt marsh, at elevations near and above MHW, Pacific cordgrass yields to common pickleweed. A perennial succulent, pickleweed dominates salt marsh plains around the Bay. In high tidal salt marsh, between about MHW and the maximum extent of the tides, common pickleweed is found in association with peripheral halophytes including saltgrass, fathen, and alkali heath.

Additional plant species on tidal marsh plains include fat hen, marsh rosemary, alkali heath, and jaumea. Dodder, a parasite on common pickleweed, is often a dominant species of salt marshes; it is widespread and abundant in North Bay and South Bay. Levees within tidal marshes support coyote brush and gumplant.

Recent research indicates that hybrid cordgrass (a cross between native Pacific cordgrass and smooth cordgrass) is a new dominant in many East Bay salt marshes (Antilla et al. 1998). As described in Chapter 6, this new species has a potential for affecting the structure and function of tidal marshes and is spreading to other parts of the Bay.

Examples of tidal salt marsh are found at China Camp, Heerdt Marsh at Corte Madera Ecological Reserve, Arrowhead Marsh, Greco Island, Mowry Slough, and Upper Newark Slough.

Tidal Brackish Marsh occurs in parts of the Bay where freshwater reduces salinities. Salinities vary markedly from season to season and from year to year, depending largely on rainfall patterns, and the marsh plant communities reflect these changes.

In tidal brackish marsh, cattails, California bulrush, and alkali bulrush dominate low marsh. A diverse assemblage of plant species including bulrushes, spike rush, Baltic rush, silverweed, and salt grass dominates middle marsh. Common pickleweed, saltgrass, gumplant, and alkali-heath characterize the plants of the high marsh.

Tidal brackish marsh exists throughout the Suisun subregion and along the middle and upper tidal reaches of the larger rivers and streams of the three other subregions. The most natural examples of this habitat type are at Brown's Island near the confluence of the Sacramento and San Joaquin rivers, Rush Ranch at First Mallard Slough in Suisun Marsh, Petaluma Marsh near the confluence of the Petaluma River and San Antonio Creek, and Triangle Marsh in South Bay.

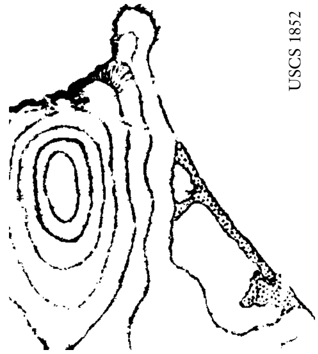
Lagoon

A lagoon is an impoundment of water that is subject to at least occasional or sporadic connection to full or muted tidal action. The impoundment may or may not receive a stream or other form of uplands runoff, and it can be natural (e.g., formed behind a barrier beach along an indented shoreline) or artificial.

Lagoons support many of the same species of aquatic invertebrates and fishes that occur in nearby shallow bays and channels. They also provide feeding or loafing habitat for a variety of water birds such as brown pelican, canvasback, greater and lesser scaup, bufflehead, and ruddy duck.

Recent information indicates that lagoons may be sites of early colonization by introduced aquatic species (Cohen 1995).

Historically, natural lagoons occurred in Central Bay on the Marin shoreline and along the San Francisco Peninsula. Today, no historical natural lagoons remain in the Bay, but artificial ones occur in North Bay, Central Bay, and South Bay. Examples are the lagoons at Tolay Creek, Sonoma Baylands, Belvedere Lagoon, and Foster City. Nearby, but outside of the Project area, natural lagoons occur in Tomales Bay and at Drakes Estero.



USCS 1852

Lagoons form behind beaches.

Diked Baylands

Diked baylands exist in parts of the Bay that once were tidal but are now isolated from the tides. Their physical origins are generally similar in that most were initially diked or "reclaimed," beginning in the mid-1800s, for some kind of agricultural use or for salt production. Reclamation typically involved the construction of earthen levees along the margins of the marsh plains where they bordered mudflats or large tidal channels. Today, diked baylands consist of several major habitats. In this report, key diked bayland habitats include diked wetland, agricultural bayland, salt pond, and storage/treatment pond.

Diked Wetland

Diked wetlands are areas of historical tidal marshes that have been isolated from tidal influence by dikes or levees, but which maintain primarily wetland features. In this report, diked wetlands are differentiated from diked agricultural baylands in that they typically support much more wetland vegetation and they produce no agricultural crops. For purposes of developing habitat recommendations, the Project divided diked wetlands into two general categories: managed marsh and diked marsh.

The plant communities of diked wetlands vary greatly from site to site and can resemble those of local tidal salt marsh, tidal brackish marsh, non-tidal perennial freshwater marsh, or seasonally wet grasslands. Some also have characteristics similar to components of tidal marshes that are now regionally scarce or extinct, such as tidal marsh pans and alluvial high marsh/upland ecotones. However, they usually have fewer native species than their analogous natural tidal plant communities, and often a larger component of exotic plant species. Common native plant species of diked wetlands include common pickleweed, saltgrass, alkali bulrush, bulrush, and cattail.

Managed marsh is habitat for many waterfowl species.

Josh Collins

Managed marsh is diked wetland habitat that is managed for wildlife, primarily waterfowl. It accounts for about 80 percent of the diked wetland habitat in the Project area. Managed marshes are located in private duck clubs and on publicly owned wildlife management areas and refuges. Fresh to brackish tidal water taken from streams or sloughs is the primary water source for managed marshes; this water is delivered through tide gates and along artificial channels. Specific management objectives determine the timing, duration, depth, and extent of water ponding in a managed marsh. They also influence the vegetation management practices.

Marshes traditionally managed for waterfowl have been designed to favor alkali bulrush, barley, brass buttons, fat hen, and sago pondweed (Miller et al. 1975). Wigeongrass and watergrass commonly occur on ponds within these marshes. In the more brackish managed areas, Baltic rush, saltgrass, and pickleweed occur; other species that have colonized these wetlands include goosefoot, dock, celery, sea purslane, and pepper grass.

Suisun Marsh is the largest managed marsh in the Estuary and is managed primarily to provide wintering feeding habitat for migratory waterfowl (Rollins 1981, Arnold 1996). This marsh has a great diversity of habitats due to water and land management practices. Marsh management is usually designed to favor mixtures of shallow submerged mud, perennial and seasonal open ponds, and floating and rooted emergent vegetation. Other managed marshes, although much smaller than Suisun Marsh, also exist in North Bay and South Bay. Vegetation in North Bay marshes includes many of the same species that are in Suisun Marsh. In South Bay, however, managed marsh vegetation is mostly that of the salt marsh community.

Managed marshes typically provide excellent habitat for many species of waterfowl such as mallard, northern shoveler, northern pintail, and blue-winged teal. They also provide habitat for many species of other birds, mammals, reptiles, amphibians, and invertebrates; for example, more than 20 species of shorebirds occur in Suisun Marsh, along with many species of hawks and owls. Some of the many mammal species that occur in Suisun Marsh include opossum, weasel, river otter, mink, salt marsh harvest mouse, beaver, striped skunk, red fox, coyote, and tule elk.

Examples of managed marsh are Suisun Marsh, the Huichica Unit of the Napa-Sonoma Marsh, and the Santa Clara Valley Water District pond adjacent to Coyote Creek.

Diked marsh usually occurs in low areas adjacent to levees or dikes that have no or poor drainage. This kind of wetland is not actively managed for wildlife, although many diked marshes may have been subject to some kind of management (including agriculture) in the past. Because rainfall and, in some areas, runoff from adjacent lands are their primary water sources, diked marshes are seasonal wetlands. Annual rainfall patterns determine the timing, duration, depth, and extent of ponding and soil saturation. In some years, they are ponded continuously for weeks or months; in other years, they are alternately dry and wet; and in some years, they may remain nearly dry.

Although diked marshes are not intensively managed, they may provide important habitat for a variety of wildlife, especially waterfowl, shorebirds, and small mammals. Where they are located near or adjacent to tidal marshes, they can be especially valuable as high tide refugia for small mammals and as roosting habitat for shorebirds and waterfowl. Sites which pond water in winter months often are good foraging and roosting habitat for shorebirds.

Examples of diked marsh are at the Western Marsh and Central Lowlands at Bahia near the Petaluma River, Gallinas Creek, the abandoned Fremont Airport, and Area H on the Redwood Shores Peninsula.

Agricultural Bayland

Agricultural bayland consists of diked, former tidal marshes that are intensively cultivated for agricultural production (primarily oat hay) or are grazed by cattle, sheep, or horses. This habitat type also includes ruderal areas where agricultural production ceased relatively recently. Most agricultural baylands support shallow, seasonally ponded wetlands and some upland plants, and would support a more diverse array of wetland and upland plants if active agricultural management were to cease.

During the wet season, large areas of agricultural baylands become waterlogged or inundated. The patterns of waterlogging and inundation depend principally on the relict tidal marsh topography, the extent and effectiveness of artificial drainage, soil permeability, and the amount and seasonal distribution of rainfall. Successfully raising a crop such as oat hay in these areas requires careful management of ground water levels, soil salinity, and levees.

Until the middle part of this century, farmers controlled water levels on agricultural baylands with gravity-driven systems of drainage ditches. Subsurface and surface water flowed from fields to adjacent marshes through these ditches via one-way flapgates. These systems had limited efficiency, and low places in the fields (relict tidal channels and pans) often remained poorly drained well into the crop-growing season. Today, diked agricultural baylands have subsided to the point at which gravity-driven drainage systems are ineffective, and farmers must pump water from their fields. Although pumping is relatively expensive, it allows farmers more control over water levels in their fields.

After many years of intensive draining and flushing with rainwater, baylands soils tend to become subsaline to nonsaline and support a variety of marsh plants in addition to cultivated crops. Agricultural fields that are disked annually typically support a mixture of native annual wetland plants (e.g., popcornflower, toadrush), and non-native annuals (e.g., loosestrife, brass buttons, barley) and perennials (e.g., birdsfoot trefoil, coyote thistle, and Pacific bentgrass).

Agricultural baylands provide habitat for many species of wildlife. They are important as roosting and feeding habitat for wintering shorebirds including greater yellowlegs, long-billed curlew, least sandpiper, dunlin, and long-billed dowitcher. They may be especially important for smaller shorebirds, whose size prevents them from foraging on nearby tidal mudflats during each tidal cycle for as long as longer-legged larger species (Page, pers. comm.). Waterfowl such as mallard and northern pintail use fields when they pond. Other bird species commonly found on farm fields include snowy egret, black-crowned night heron, northern harrier, horned lark, savannah sparrow, red-winged blackbird, and western mead-

Water ponds on farmed baylands.

Ruth Pratt

owlark. Some of the mammal species that use this habitat are California vole, California ground squirrel, striped skunk, coyote, and black-tailed deer.

Within agricultural baylands, areas of shallow seasonal ponds are the most important habitats for shorebirds and waterfowl. These ponds, typically less than six inches deep, have feathered edges and a minimum of emergent vegetation. The areal extent and duration of ponding vary markedly from year to year and are highly influenced by pumping and rainfall patterns. Areas with the highest habitat values are those that pond every year and which are frequently or continuously inundated during the wet season.

Pastures in grazed agricultural baylands, especially those that are not frequently cultivated or mowed, provide abundant cover and food for wildlife. They also allow year-round use by more wildlife species than do intensively farmed areas. As most pastures are allowed to pond more extensively and for longer periods than oat hay fields, they often provide better wintering habitat for shorebirds and waterfowl. And because grazing reduces dense plant cover, it improves access for birds.

Ruderal areas — uncultivated and ungrazed — support more upland grasses and other vegetation than do cultivated fields. Wild mustard, fennel, and poison hemlock are dominant members of the plant community. Some ruderal areas, especially the wetter lower portions of some sites, support a variety of amphibians, reptiles, birds, and small mammals.

Nearly all of the agricultural baylands are in the North Bay subregion, although some agricultural production occurs in Suisun Marsh and in South Bay. Examples of this major habitat type are at the northwestern edge of Suisun Marsh, Skaggs Island, Leonard Ranch, Twin House Ranch, Black Point, and Oliver West.

Salt Pond

Salt ponds are large, persistent hypersaline ponds that are intermittently flooded with Bay water. They occur within the historical areas of tidal salt marsh in North Bay and South Bay.

Historically, there were natural salt ponds along the eastern edge of South Bay, primarily near San Lorenzo Creek and Mt. Eden Slough near Hayward (Ver Planck 1951, 1958). Native Americans obtained salt from these ponds for their own use and for trade; later, so did the region's Spanish and other settlers. The largest pond complex, extending over some 1,000 acres, was called Crystal Pond. In the mid-1800s, as the demand for salt rose, the first artificial salt ponds were developed in the East Bay as extensions and improvements of the natural salt ponds. Today, artificial salt ponds have entirely displaced their natural forerunners and no natural salt-crystallizing ponds remain in the Bay.

Salt appears in a salt pond.

Bob Walker

The process of making salt in the artificial ponds involves moving Bay water through a series of ponds, known as concentrators or evaporators, over a period of six or seven years. During this time, solar evaporation increases the water's salinity from about 35 parts per thousand (ppt) to more than 180 ppt. The precipitation of sodium chloride salt from the highly saline water, or brine, takes place in ponds known as crystallizers (Ver Planck 1958). The salinity of any given salt pond is determined by management practices rather than by its location.

The Project's bird focus teams described and compared habitat functions of salt ponds according to salinity. Their salinity categories differed somewhat from those of another recently developed salt pond classification system (Javor 1989) because they were based on observations of birds rather than of plants and microinvertebrates. In the Project's classification system, low-salinity ponds usually have salinities less than 60 ppt, medium-salinity ponds usually have salinities between 60 and 180 ppt, and high-salinity ponds usually have salinities greater than 180 ppt, with crystallizer salinities approaching 360 ppt at saturation.

Salt ponds support a distinctive and highly specialized salt-tolerant to salt-loving biota consisting of microalgae, photosynthetic bacteria, and invertebrates (e.g., brine fly and brine shrimp). The dominant species are single-celled green alga and numerous species of blue-green and other bacteria. Ponds with salinities closer to marine salinities support macroalgae, such as sea lettuce, and marine plankton.

Salt ponds, especially those with low to mid-salinities, provide important habitat for many species of wildlife, particularly birds. They are of primary importance to migratory shorebirds and waterfowl, and they also provide year-round foraging habitat for a number of resident species such as American avocet, black-necked stilt, and western snowy plover. These and several other species — California gull, western gull, Forster's tern, and Caspian tern — nest on partly dry salt ponds, on levees, and on salt pond islets and islands. In all, more than forty species of birds are common on salt ponds. Ponds managed as crystallizers provide habitat for wildlife including shorebirds, gulls, and other water birds; however, given their comparatively high salinities, their habitat quality for most species of birds is not as high as the lower-salinity ponds.

The construction of artificial salt ponds in the Bay enabled increased populations of several bird species. These species include eared grebe, white pelican, bufflehead, western snowy plover, black-necked stilt, American avocet, Wilson's phalarope, red-necked phalarope, California gull, Caspian tern, and Forster's tern (Harvey et al. 1988). Eliminating artificial salt pond habitats without concomitantly restoring natural salt ponds and tidal salt marshes with pans could reduce or even extirpate some of these species from the Bay.

All salt ponds that are actively producing salt for commercial purposes are in South Bay, south of the San Mateo Bridge. In North Bay, none of the salt ponds west of the Napa River is managed to produce salt. The California Department of Fish and Game manages these "inactive" ponds for wildlife purposes.

As currently managed, examples of low-salinity salt ponds are Pond B1/B2 in Mountain View, Pond 1 at Mowry Slough, and Pond A9 at Alviso. Examples of mid-salinity salt ponds are Ponds A10–A14 at Alviso, Ponds 2–8 at Coyote Hills, and Ponds 2–6 at Mowry Slough/Coyote Creek. Examples of high-salinity salt ponds are Ponds 10 and 26 at Newark and the crystallizers at Newark and Redwood City.

Sewage treatment pond.

NASA 1995/96

Storage/Treatment Pond

The storage/treatment pond designation refers to diked, perennial shallow or deepwater pond habitat that has been constructed to store or treat runoff, sewage, or industrial discharges. These ponds support relatively little vascular vegetation. Most of them are parts of municipal wastewater treatment works that store treated effluent before it is recycled or discharged to the Bay. As they are similar in many respects to lagoons, they tend to support many of the same species, especially with regard to birds. Ponds typically provide habitat for mallard, northern shoveler, pied-billed grebe, scaup, bufflehead, and American coot.

Examples of storage/treatment ponds are at the wastewater treatment facilities in Napa, Hayward, and Sunnyvale. Other examples are Ignacio Pond in Novato and the Hahn flood basin in Corte Madera.

Adjacent Habitats

There are several key habitats that are part of the baylands ecosystem, but which occur mostly outside of the baylands. These include riparian forest, willow grove, grassland, oak woodland, and mixed evergreen forest, and they are described below.

Riparian Forest

Riparian habitats border the edges of rivers and streams. They comprise the ecotone between the river or stream and the rest of its watershed. Natural riparian habitats are characterized by steep and variable gradients of moisture and light, lush vegetation, and very high biological diversity. Of all the riparian habitats in the Bay Area, riparian forests are the most complex and support the greatest total number of plant and animal species.

The species composition of the riparian forests differs among the subregions. In South Bay, the list of common native riparian trees includes western sycamore and cottonwood. In North Bay, the list includes ash and California bay laurel, and box elder is locally abundant. Some species of willow (red willow, arroyo willow) and oak (coast live oak, valley oak) are common riparian trees. Non-native trees, like acacia and eucalyptus, occur in the riparian forests of urban and suburban landscapes. Common riparian understory species are elderberry, wild rose, and blackberry.

In the Bay Area, natural riparian habitats tend to be long and narrow. Historically, this was because the natural rivers and streams were entrenched within their canyons and valleys, such that the active flood plains were below the valley floors. The downstream reaches of some of these rivers and streams have since filled with sediment, so that the valleys sometimes flood, but the lateral extent of the riparian habitat is usually constrained by adjacent land use or flood control levees. Therefore, the riparian forests on either side of a river or stream are typically less than a few trees wide. In urban settings, riparian forest often is unnaturally broken into a number of short segments, most of which are less than a block long. There are only a few remaining examples of riparian forests that extend from the upper reaches of local watersheds all the way to the Bay.

A creek floods.

Laurel Collins

Riparian forest is often reported to be among the most valuable habitats available to wildlife (SFEP 1992). The complexity of microhabitats created by the layering of trees, shrubs, and herbaceous and aquatic vegetation promotes very high wildlife species diversity. For example, of all the wildlife habitat types surveyed in the Sacramento-San Joaquin Delta, just upstream of the Project area, researchers have found that riparian vegetation supports the greatest diversity of wildlife species (Madrone Associates et al. 1980). It also enhances the functions of in-stream habitats, and adjacent upland habitats such as grasslands or farm fields, and is most valuable when it exists in an unbroken corridor throughout the length of a watershed.


Josh Collins

Willows shade a managed marsh.

A few representative wildlife species that use riparian forest include Pacific treefrog, California newt, ring-necked snake, ornate shrew, broad-footed mole, deer mouse, opossum, striped skunk, raccoon, coyote, and black-tailed deer. Bird species that occur in this habitat include wood duck, great-horned owl, downy woodpecker, tree swallow, northern oriole, scrub jay, and song sparrow.

Examples of riparian forest exist along Suisun Creek, San Antonio Creek adjacent to Petaluma Marsh, Sonoma Creek, and Coyote Creek.

Willow Grove

A willow grove is a patch of willow trees that is associated with groundwater discharge, perennial ponds, or seasonal ponds. In some instances, particularly in South Bay, willow groves also occur where intermittent streams terminate before reaching the Bay. The dominant species is arroyo willow and associated species include California blackberry and silverweed.

Willow groves support many species of amphibians, birds, and small mammals that also frequent the baylands or occur in riparian forests. Representative species include Pacific treefrog, snowy egret, black-crowned night heron, northern harrier, raccoon, and striped skunk.

In the Bay Area, willow groves were historically associated with springs and areas of groundwater discharge along the margins of the Bay, especially in the South Bay subregion. One of the few remaining examples of willow grove is at Coyote Hills Regional Park.

Grassland

Vegetation dominated by grasses and sedges was widespread along the shores of the Bay prior to European settlement. Native perennial grassland predominated near the Bay on valley floors and on hillslopes with southwest aspects. These grasslands were composed primarily of perennial bunch grasses and rhizomatous grasses, and were dominated by purple needlegrass and creeping wild rye. Example remnants of this community are at Rush Ranch in Suisun and Coyote Hills near Newark.

Today, grasslands are still widespread in the Bay Area, although their botanical makeup differs markedly from historical conditions. The Project's Plants Focus Team organized them into three general groups: non-native annual grassland, moist grassland, and grassland/vernal pool complex.

Robin Grossinger

Ducks rest in moist grassland.

Non-native annual grassland — The introduction of European grazing and agriculture in the 1800s shifted the region's grassland communities from native perennials to Eurasian non-native annuals. Dominant species of these communities are wild oats, soft chess, ripgut brome, and Italian ryegrass. Non-native annual grassland occurs in the interior valleys surrounding the baylands, on the unforested hillslopes with southwest aspect, and on the alluvial plains. Examples of non-native annual grassland exist at Potrero Hills, Hamilton Field, and Coyote Hills.

Annual grasslands adjacent to the baylands are frequented by many species of wildlife. In summer, amphibians such as the tiger salamander aestivate in grassland soil to avoid heat stress. Reptiles associated with grasslands include racer, coachwhip, and gopher snake. In winter, grasslands provide important foraging habitat for sandhill crane, Canada geese, and many species of migratory shorebirds. Some of the other bird species commonly associated with grasslands include turkey vulture, black-shouldered kite, red-tailed hawk, northern harrier, American kestrel, burrowing owl, western meadowlark, and savannah sparrow. Mammals that reside in grasslands include ornate shrew, broad-footed mole, coyote, California ground squirrel, botta pocket gopher, western harvest mouse, and California vole. Many of these species occur in the baylands year-round, and others move into the baylands at certain times of the year, primarily to forage.

Moist grassland — Much of the landscape adjacent to the baylands was formed by water-deposited sediments and is therefore nearly flat. The soils that have evolved here (e.g., Dublin adobe soils, Clearlake adobe clay, Zamora adobe clay, Lindsey clay loam, Yolo silty clay loam, and others) are composed primarily of clay and silt. These tight soils slow the downward movement of surface water. As a result, they tend to be saturated for relatively long periods and frequently support moist grassland and depressional seasonal wetlands. Dominant moist grassland species include Italian ryegrass, Baltic rush, iris-leaved rush, Santa Barbara sedge, and creeping wildrye.

Many of the wildlife species that occur in non-native annual grasslands also utilize moist grasslands. Overall, however, moist grasslands, especially areas that have seasonal wetlands, attract more species than drier grasslands. Representative species include western toad, western skink, meadowlark, horned lark, savannah sparrow, and western harvest mouse.

Historically, moist grasslands existed in large expanses near Suisun Marsh, in the upper reaches of Sonoma Creek and the Petaluma River, and adjacent to much of the baylands in South Bay. Today, examples of large areas of this habitat exist near Fairfield and in the Petaluma River area. Smaller areas of moist grasslands with seasonal wetlands are in Marin at St. Vincent's/Silveira Ranch. In South Bay, development has destroyed most of the historical moist grasslands; notable exceptions exist east of Coyote Hills in the Ardenwood area and near the upper reach of Mowry Slough in Newark.

Grassland/Vernal Pool Complex is an area of annual grassland where there are vernal pools. Vernal pools are surface depressions usually less than 6 inches deep that are underlain by an impervious substrate of natural materials. They are ponded by direct rainfall or nearby runoff during the wet season, and desiccated by evapotranspiration early in the dry season. Typical native vernal pool species include goldfields, popcornflower, *Navarretia*, and *Downingia*.

Robin Grossinger

Flowers bloom in vernal pools.

Some wildlife species associated with vernal pools include fairy shrimp, tadpole shrimp, California tiger salamander, western spadefoot toad, common garter snake, black-necked stilt, and American avocet. Some waterfowl, especially mallard and cinnamon teal, nest in this habitat where there are pools. Small mammals, including California vole and black-tailed hare, also occur here.

Historically, large areas of grasslands with vernal pools occurred in the Project area in only three areas: adjacent to Suisun Marsh, along Sonoma Creek, and in the Warm Springs area in South Bay. Although they have been degraded by farming and filling, vernal pool complexes still exist in these areas.

Coastal prairie is a type of grassland that occurs in limited distribution near the Bay in areas that are frequently exposed to moist marine air and which have clay soil. Dominant species include Douglas iris, reedgrass, oatgrass, and hairgrass. Examples occur at Brooks Island, at Ring Mountain Preserve, and at the Golden Gate National Recreation Area.

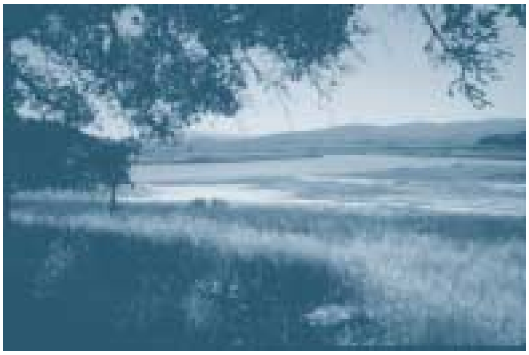
Oak Woodland

Vegetation with an overstory dominated by oak trees is common throughout California's valleys, foothills, and lower mountain ranges. In the Bay Area, there are three recognized types of oak woodland, based on species dominance: Coast live oak woodland, Valley oak woodland, and Foothill oak woodland.

Oak woodlands are an integral part of the baylands ecosystem as they provide important foraging, roosting, and breeding habitat for many species of amphibians, reptiles, birds, and small mammals that frequent the baylands. Some representative species associated with oak woodlands include ensatina, southern alligator lizard, gopher snake, red-tailed hawk, California quail, acorn woodpecker, western scrub jay, California ground squirrel, Audubon's cottontail, and black-tailed deer.

Coast live oak woodland occurs on hillslopes where there are thin soils and moderate to large amounts of rainfall. The dominant species is coast live oak. Associated species include madrone, California blackberry, creeping snowberry, cream bush, and poison oak. Examples exist on the north-facing slopes along the Carquinez Strait, on the ridge between Black Point and Rush Creek near Novato, at China Camp, and on Angel Island.

Elise Brewster


Tidal marsh reaches oaks.

Valley oak woodland occurs in a few places on the alluvial plains, valleys, and piedmonts adjacent to the baylands. Valley oak is the dominant species. Associated species include creeping wild rye and Santa Barbara sedge. This community is not widespread in the Bay Area. Examples exist along Green Valley Creek near Cordelia, along the lower Napa River, and along Sonoma Creek near Schellville.

Foothill oak woodland occurs on hillslopes with deep soils and small to moderate amounts of rainfall. The dominant species is blue oak. Associated species include digger pine, manzanita, deerbrush, coffeeberry, and pink-flowered currant. This community is not widespread on the lands near the Bay. An example exists at Black Diamond Mine Regional Park near Antioch.

Mixed Evergreen Forest

Mixed evergreen forest is mostly restricted to north-facing hillslopes in the North Bay and Central Bay areas. The dominant species include California bay laurel, bigleaf maple, and madrone. Associated species are coyote brush, California huckleberry, and poison oak.

This vegetation complex provides habitat for a variety of wildlife that also occurs in the baylands. Some representative species are common garter snake, western fence lizard, Cooper's hawk, Nuttall's woodpecker, wrentit, dark-eyed junco, hermit thrush, purple finch, dusky-footed woodrat, brush rabbit, and gray fox. Examples of mixed evergreen forest occur in the headward reaches of north-facing draws of San Pedro Ridge near China Camp and on the northern side of the ridge between Black Point and Rush Creek.

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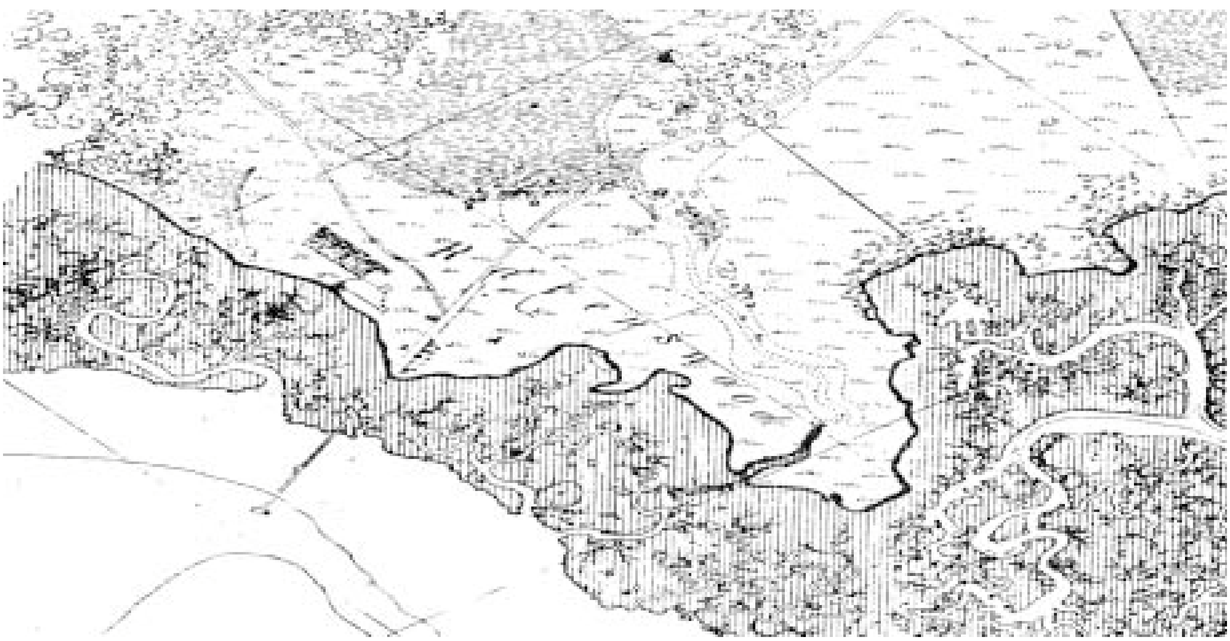
Habitat boundaries are habitats too.