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MITIGATING IMPACTS TO WETLANDS AND ESTUARIES IN CALIFORNIA'S COASTAL ZONE

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The wetlands and estuaries of California's coastal zone are a diverse and bountiful resource. The coastal zone's 95,000 acres of the wetlands and estuaries (excluding San Francisco Bay) support waterfowl, shorebirds, gulls, waders, and other birds, and provide important spawning and nursery areas for fish and shellfish important to the State's sport and commercial fisheries. The diversity of the coastline's 142 wetland ecosystems offers a variety of recreation, nature observation, hunting, and fishing, particularly at the more than 70 wetlands in parks, reserves, ecological preserves, and wildlife refuges. College and university research centers use the State's wetlands for education and scientific inquiry.

California's coastal wetlands and estuaries have been particularly vulnerable to alterations which advanced economic development but destroyed their natural values. Coastal estuaries and wetlands have been dredged for ports and marinas, filled to provide new land for development, used as sumps for domestic sewerage and industrial waste, subjected to sedimentation from upland erosion, and deprived of freshwater inflow by water diversions. The natural value of 52 percent of our coast's original wetlands and estuaries have been destroyed by dredging or filling. Of our remaining estuaries and wetlands, 81 percent have been subjected to moderate or severe damage. This habitat damage has been especially severe in southern California, where 75 percent of the coastal estuaries and wetlands have been destroyed or severely altered by man since 1900 (California Coastal Zone Conservation Commission. 1975).

STATUTORY REQUIREMENTS FOR MITIGATING IMPACTS TO WETLANDS AND ESTUARIES

In response to these threats to coastal estuaries and wetlands, the California Coastal Act of 1976 (Cal. Pub. Res. Code 3000 - 30900), the centerpiece of the State's coastal zone management

program (Fischer. 1985), establishes the State's policy to maintain and, where feasible restore, the biological productivity and quality of wetlands and estuaries. The law limits dredging, diking, or filling in wetlands and estuaries to eight uses (1). Development permits for dredging, diking, or filling of wetlands and estuaries can be approved only where there is no feasible less environmentally damaging alternative. Mitigation measures must be provided to minimize adverse environmental effects and to maintain or enhance the functional capacity of the wetland or estuary. Where diking or filling is permitted in wetlands, mitigation measures must include, at a minimum, either acquisition of equivalent areas of equal or greater biological productivity or opening up equivalent areas to tidal action. If no appropriate restoration site is available, permittees may dedicate to a public agency an in-lieu fee sufficient to provide an area of equivalent productive value or surface area.

PROCEDURES FOR REVIEW OF MEASURES TO MITIGATE IMPACTS TO WETLANDS AND ESTUARIES

Procedures for review of dredging, diking, and filling in wetlands and estuaries were addressed in the Coastal Commission's

"Statewide Interpretive Guideline for Wetlands and Other Wet Environmentally Sensitive Habitat Areas" (California Coastal Commission. 1981). The guideline, adopted after more than 18 months of preparation and ten public hearings, defines wetlands and other environmentally sensitive aquatic habitats, describes when the Coastal Act permits development in these habitats, outlines necessary development application information, discusses mitigation, buffer area, and other requirements of developments in wetlands and estuaries, and summarizes wetland restoration goals and procedures (Metz and DeLappa. 1980). The guideline is an important tool in the Commission's review of coastal permit applications and local coastal programs which affect wetlands, estuaries, and other aquatic habitats, but has not been adopted as an administrative regulation. Adherence to the guideline may vary from case to case.

Under the guideline, planning to mitigate impacts to wetlands and estuaries begins prior to the submittal of a permit application with a study of the sensitive habitats on the project site, a description of the project's impacts upon them, and consideration of project alternatives and mitigation measures to reduce or avoid significant adverse effects. In many cases, this information is part of environmental impact reports required for projects by the

California Environmental Quality Act (Cal. Pub. Res. Code 21000 - 21176) or is prepared for local governments' land use plans. The guideline recommends that mitigation measures, including plans for restoration and buffer areas, be included with permit applications.

The guideline's discussion of mitigation required for development in sensitive habitats remains a useful starting point for developing wetland restoration projects and other measures to reduce developments' adverse effects. The guideline recommends that mitigation measures for dredging projects include limitations on the type of operation, quantity of dredging, timing, and location of the disposal site. Spoils must be transported to longshore currents for beach nourishment where feasible. Compensation for unmitigated impacts may include creating wetlands in upland areas, removing fill from degraded wetlands, opening up areas to tidal action, removing dikes, improving tidal flushing, or other restorative measures.

Where a project involves diking or filling of a wetland, the guideline recommends that the permittee submit a detailed plan to purchase and restore an area of equal or greater biological productivity, and to dedicate the area to a public agency or otherwise retain the site as permanent open space. The restoration plan submitted with the application includes scaled diagrams of the

area to be restored, any alterations to natural landforms, a list of plant species to be used, the method of their introduction, and when restoration work will begin and be completed. Well written restoration plans include a clear statement of the fish and wildlife habitat objectives sought in the restoration, including descriptions of the type and extent of the various habitats to be created or enhanced and projections of the kinds of plants, fish, or wildlife expected to occupy the area when the restoration is complete. A description of the applicant's responsibilities in maintaining the restored area to assure that the project will be successful may also be sought. Monitoring of the restoration site is encouraged to provide information on vegetation, invertebrates, fish, and wildlife abundance and to assess whether repair or modification of the restoration site is necessary to achieve the plan's restoration objective. Once approved, the plan becomes an agreement between the applicant and Coastal Commission guaranteeing that restoration under the plan's objectives will occur within the time specified.

The guideline recommends that mitigation measures restore areas which are no longer functioning in a manner beneficial to wetland species. The preferred restoration program is one which removes fill from a formerly productive wetland or estuary which is now

biologically unproductive dry land, establishing an adequate tidal prism to assure flushing. In some cases, an applicant may open an equivalent area to tidal action or provide other sources of surface water. Improving tidal flushing by removing tidegates, digging tidal channels, or clearing culverts may be adequate mitigation if it restores an area to equal or greater value than the area damaged, but converting a diked freshwater marsh to saltwater would not. If no restoration sites are available, the applicant is required to pay an in lieu fee to an appropriate agency for purchase and enhancement of a restoration site.

Procedures for the development of wetland mitigation plans have also been included in coastal management programs adopted by local governments. Los Angeles County's Marina del Rey/Ballona land use plan requires the preparation of a habitat restoration plan, including description of the restoration activities proposed and designation of a habitat manager, as part of rezoning studies authorizing development in the area. Orange County's Bolsa Chica land use plan includes similar provisions for preparation of a wetland restoration plan prior to rezoning of the site for development.

Humboldt County included detailed wetland restoration procedures within its coastal zoning ordinance. The County

ordinance requires submittal of a tentative restoration plan outlining the habitat values of the project site, the project's impacts upon the site, and a statement of the habitat restoration and management proposed, including an assessment of its ability to compensate for the project's effects. A preliminary analysis of alternative restoration sites and designs which satisfy the mitigation objectives and meet applicable hydrologic, soils, and other engineering criteria is prepared, and the sites are ranked based upon biological objectives, engineering feasibility, and cost. A preliminary plan for restoration and management of the preferred site is then submitted and reviewed by the County in conjunction with the project's development permit. If a coastal development permit for the development and related mitigation project is approved, the applicant submits a detailed final restoration plan for administrative approval. The County's requirement for early public consideration of alternative restoration areas is intended to avoid premature commitment of acquisition and design funds to restoration areas which may prove inadequate, and to encourage competition in the acquisition price of potential restoration areas.

KINDS OF WETLAND AND ESTUARINE IMPACT MITIGATION

The Coastal Commission has approved over twenty one wetland mitigation programs since 1973. The programs restore and enhance estuaries and wetlands at Redwood Creek (Humboldt County), Humboldt Bay (Humboldt County), Bodega Bay (Sonoma County), El Estero (Santa Barbara County), Mugu Lagoon (Ventura County), Ballona Creek (Los Angeles County), Sims Pond (Los Angeles County), Bolsa Chica (Orange County), Upper Newport Bay (Orange County), Bataquitos Lagoon (San Diego County), Los Penasquitos Lagoon (San Diego County), and San Diego Bay (San Diego County).

The earliest mitigation programs approved by the Commission provided for the restoration of diked tidelands in Humboldt Bay. Typical of these projects are two adjacent restorations located on Freshwater Slough, a brackish tributary of Humboldt Bay. The earlier project, the Park Street restoration, restored 17 acres of salt marsh and 2 acres of riparian habitat at an abandoned lumber mill. The project sponsors restored tidal influence to the site by breaching a dike surrounding the area. A low dike and drainage controls were constructed along a flank of the restored area to protect freshwater habitats from saltwater intrusion. No aquatic

vegetation was planted. Revegetation of the site occurred through natural succession following the restoration of tidal action. The project mitigated the impacts of dredging 7 acres of shallow subtidal flats and 5.5 acres of intertidal mudflat, and the fill of .5 acres of salt marsh and 4 acres of riparian woodland for construction of a marina. The project sponsor, the Humboldt Bay Harbor, Recreation and Conservation District, carried out the restoration work and manages the site. According to the Department of Fish and Game, 80 per cent of the site now supports the vegetation intended. Shorebird use of the site is moderate, but fisheries use of the site does not equal that lost to the marina dredging due to differences in salinity between the dredging site and restoration area (Chamberlain. 1982). Tidal exchange at the site could have been improved by better design of the dike's breach and the construction of tidal channels in the restored area. The cause of recent declines in the productivity of freshwater habitats is unknown.

The adjacent Freshwater Slough restoration site, approved in 1984 but not yet constructed, would restore 23 acres of diked tideland pastures to saltmarsh with tidal channels and create 9 acres of open pond and 9 acres of willow swamp by excavating the pond's basin, constructing a low dike and spillway to impound

Table 1. Wetland and estuarine impact mitigation programs approved by the California Coastal Commission.

Project	Impact	Restoration Type and Acreage	Completed?
US 101 Bypass Redwood Nat'l Park (CD 18-84; CD 20-85; CD 7-86)	3500 tons of sedimentation annually; long term sedimentation of 425 tons annually	Restore estuary depth and fresh water inflow, Redwood Creek, Humboldt County	No
Old Arcata Rd Humboldt Co. (NCRC 80-P-69)	1.25 acres diked tideland pastures filled	Create 1.75 acres of freshwater marsh by removal of fill from diked tideland pastures, Humboldt Bay Humboldt County	Yes
Eureka City Schools (Appeal 33-80); Eureka Pocket Marshes	2.0 acres salt marsh filled	Create 6 acres salt marsh by removal of fill from upland, Bracut, Humboldt Bay	Yes
Woodley Island Marina, Humboldt Bay HRCD (NCRC 76-C-369)	335,000 CY sediment dredged from 7 acres shallow subtidal flats and 5.5 acres intertidal mudflats, .5 acres saltmarsh and 4 acres riparian woodland filled	Restore 17 acres saltmarsh and 2 acre riparian woodland at diked millsite, Humboldt Bay	Yes
Exxon Samoa Penninsula OCS Platform Jacket Assembly Yard (CCC 1-84-69)	70,000 CY sediment dredged from 1.63 acres intertidal and subtidal sandflats; 8 acre freshwater pond and 12 acres riparian woodland filled	Create 10 acre freshwater pond, 33 acre salt marsh with tidal creek, and 9 acres riparian woodland in diked tideland pastures, Freshwater Slough, Humboldt Bay, and create 11.3 acres willow swamp in sand dunes, Elk River, Humboldt Bay	No
Wright, Schuchart, Harbor Co Samoa Penninsula OCS platform jacket assembly yard(CCC 1-83-154)	52,000 CY sediment dredged from .85 acres intertidal and 2 acres subtidal sandflats	2 acres eel grass planted, Humboldt Bay	No
Wright, Schuchart, Harbor Co Eureka OCS platform module assembly yard (CCC 1-86-61)	32,000 CY sediment dredged from .4 acres intertidal and subtidal mudflat	1 acre eel grass planted, Humboldt Bay	Yes

Table 1 (cont'd). Wetland and estuarine impact mitigation programs approved by the California Coastal Commission.

Project	Impact	Restoration Type and Acreage	Completed?
CalTrans' Eureka Freeway (CCC Appeal 89-75) and Mad River Slough Bridge (NCRC 79-P-72)	Fill of one acre of salt marsh and nine acres diked tideland pasture	17 acre salt marsh restored in diked tideland pasture, Elk River, Humboldt Bay	Yes
Spud Point Marina Sonoma County RPD (NCCRC 145-80)	225,000 CY sediment dredged from 19.5 acres shallow subtidal mudflats	3.3 acres of eelgress planted Bodega Bay, Sonoma County	Yes
Guadalupe Dunes oil development Union Oil Co (SCCRC 314-09) Husky Oil Co (SCCRC 314-07) Union Oil Co (SCCRC 409-24)	oil and gas development adjacent to wetlands; crude oil pipeline crossing of Santa Maria River	directionally drilled wells from consolidated drill pads; revegetation of disturbed areas; automatic shutoff valves at pipeline's river crossing; conservation easement over undeveloped area, Guadalupe Dunes, San Luis Obispo and Santa Barbara Counties	Yes
El Estero Improvement Project, Santa Barbara Co FCD and State Coastal Conservancy (CCP 1-83)	86,000 CY sediment dredged from tidal creeks	restore 15 acres salt marsh and create 1 acre salt marsh by removal of fill, enhance tidal circulation 27.5 acres of salt marsh, El Estero, Santa Barbara County	No
Revlon Slough Flood Control Project, Ventura Co FCD (SCCRC 168-22)	223,000 CY sediment dredged from tidal creek	maintain temporary wildlife pond during construction, revegetate disturbed areas, Mugu Lagoon, Ventura County	Yes
Mugu Lagoon mosquito abatement, Pacific Missile Test Center (CD 5-83)	23 acres salt flat land planed	revegetate disturbed area, enhance tidal circulation to 23 acres salt flat, Mugu Lagoon	Yes
Marina del Rey/ Ballona Land Use Plan	12 acres degraded salt marsh filled plus pile supported 2 to 4 lane roadway	163 acre wetland and 35 acre upland habitat restored, 11 acre buffer maintained, Ballona Creek, Los Angeles County	No
Vermont Enterprises (SCRCC P-9-6-77-1778)	Subdivsion and access road adjacent to degraded wetland	Restore Sims Pond, Los Angeles County	Yes

Table 1 (cont'd). Wetland and estuarine impact mitigation programs approved by the California Coastal Commission.

Project	Impact	Restoration Type and Acreage	Completed?
Upper Newport Bay Ecological Reserve (CCC 5-84-560 and 5-81-126; SCRCC P-80-7257)	Construction and reconstruction of bulkheads and fill of saltmarsh and shallow intertidal estuarine flats in Lower Newport Bay	Applicants pay in-lieu fee to Department of Fish and Game to cover pro-rata share of Upper Newport Bay Ecological Reserve restoration program, Orange County	Yes
County Sanitation Districts of Orange Co (SCRC 91-81)	sewer line laid in wetland	7 acre freshwater marsh created by removal of fill, Upper Newport Bay, Orange County	Yes
Bolsa Chica Land Use Plan	775,000 CY sediment dredged from 107 acres salt marsh and shallow subtidal flats, 42 acres salt marsh and shallow subtidal and intertidal flats filled	63 acres fill removed and 852 acres degraded salt marsh enhanced, 87 acre upland habitat and buffer created, Bolsa Chica, Orange Co.	No
Pactex marine terminal, tank farm and pipeline Port of Los Angeles and Pacific Texas Pipeline Co (CCC 5-85-623)	11.28 million CY sediment dredged from 287 acres subtidal bottoms and 141 acres subtidal filled; net loss of 203 acres soft bottom benthic habitat	554 acres degraded wetland enhanced (226 acres subtidal estuarine flats, 168 acre intertidal mudflat, 130 acre salt marsh, and 30 acre freshwater marsh), 34 acre least tern nesting area created, watershed sediment controls, modified ocean outlet, Los Bataquitos Lagoon, San Diego County	No
North City Land Use Plan	Sedimentation from upstream urbanization	636 acres degraded wetland enenhanced, sediment controls and modified ocean outlet, Los Penasquitos Lagoon, San Diego County	No
Chula Vista small boast basin, San Diego UPD (SDRCC 1976)	Dredging	80 acres salt marsh created by placement of dredged spoil on shallow subtidal mudflat	Yes

freshwater, developing water wells to supplement freshwater runoff at the site, and planting the salt marsh and willow swamp. The project, together with creation of 11 acres of willow swamp at another site, was intended to compensate for the dredging of 3 acres of intertidal sandflat and the filling of an 8 acre pond and 12 acres of willow swamp for an offshore oil platform jacket on Humboldt Bay's Samoa Penninsula. The project has not yet begun. The restoration work would be carried out by the project sponsor.

These two projects are typical of mitigation programs restoring diked tidelands. A third mitigation project which restored wetlands in diked tidelands has been conducted at Elk River in Humboldt Bay. The restoration sites' location adjacent to existing wetland habitats, the low level of site modification required, and ready access to water have made these projects attractive to both regulators and project sponsors. Typical restoration costs at these sites have been $5000 to $7500 per acre (1980). Restoration in diked tidelands has resulted in reintroduction of salt and freshwater wetland vegetation and increased invertebrate, fish, and wildlife populations. Inadequate site elevations, poorly designed tidal connections, improper salinities, or slower than anticipated revegetation are the causes which observers attribute to those diked tideland restorations which have not yet resulted in anticipated habitat improvements.

Mitigation measures which restore wetlands in filled uplands have been less common. One early project restored salt marsh through the removal of fill from a mill site at Bracut on Humboldt Bay (Camp, Dresser, and McKee, Inc. and Madrone Assoc. 1980; Winzler and Kelly Engineers. 1980). Six acres of salt marsh and an 8 acre alder woodland buffer were restored to compensate for the filling of 2 acres of small, isolated saltmarshes in industrial zones in the nearby city of Eureka. The project's design was modified during construction when unanticipated debris was uncovered in the site's fill. Soil used to cap the mill debris was coarser than that of native marshes nearby, and resulted in site elevations higher than anticipated. As a result, revegetation of the site was slower than expected. Cordgrass planted in the restoration area has expanded only slowly. Pickleweed invading the site is widely distributed but the plants are not robust. An additional project benefit is the protection of an open space buffer for the Humboldt Bay National Wildlife Refuge. The restoration site was acquired and developed by the State Coastal Conservancy with in-lieu fees assessed against projects in the development area. Other mitigation programs which restore wetlands in filled uplands have been carried out at Freshwater Slough in Humboldt Bay (Humboldt County Department of Public Works. 1980) and at Big Canyon in Upper Newport Bay, Orange County (EDAW, Inc. 1982).

Projects which mitigated impacts to wetlands and estuaries by removal of fill have been advocated by wildlife agencies because they offer the greatest potential for increasing habitat value. Others have criticized the high costs of these projects. Wetland restoration in filled lands has cost $23,700 (in 1981) per acre. Regulators have been hesitant to require mitigation programs which require removal of fill from uplands because of the uneven performance of past restoration attempts in these sites.

An opposite approach to mitigating the impacts of wetland and estuarine fills and dredging is being undertaken in San Diego Bay (San Diego County). There the San Diego Unified Port District has created an 80 acre salt marsh by placing dredge spoils on mudflats in the bay. The project is intended to compensate for dredging for a marina at Chula Vista (San Diego Unified Port District. 1976; Smith, et.al. 1975). Dewatering of the spoils has been slower than expected. Initial revegetation efforts, begun in 1984, included successful plantings of cordgrass. Additional plantings were made this summer. It is not yet clear whether the habitat benefits gained by converting the site from mudflat to salt marsh will fully compensate for the impacts of marina construction. The restoration work is being carried out by the port district, which owns and manages the restoration site.

Adverse impacts of dredging has been mitigated by planting eel grass on unvegetated estuarine flats in Humboldt Bay and Bodega Bay (Sonoma County). In the best studied of these efforts, the Sonoma County Regional Parks Department planted 3.3 acres of eel grass in shallow unvegetated estuarine flats in Bodega Bay to compensate for the dredging of 225,000 cubic yards of sediment from 19.5 acres of mudflat for the Spud Point commercial fishing marina. The eelgrass transplanted to shallow subtidal flats became well established and is expanding, but transplant attempts on channel sideslopes have been unsuccessful due to slumping of unconsolidated sediments and other problems (Connors. 1986). Eel grass planting as mitigation for dredging in shallow estuarine flats has also been approved in coastal development permits for channel dredging associated with OCS platform jacket and module assembly sites in Humboldt Bay. One of these projects was begun in summer, 1986. Initial results appear promising.

The National Marine Fisheries Service has encouraged eel grass planting because of the high marine fishery use of eel grass habitats (Hoffman. 1986). The low cost of eel grass plantings, about $10,000 to $15,000 (1982) per acre (Fonseca, et. al. 1982), is attractive to project sponsors. Others have questioned the long term success of establishing eel grass in sites which it does not presently occupy.

Programs which restore depths in open estuarine waters and provide upstream sediment detention facilities have been used to compensate for projects' unmitigated upstream erosion and estuarine sedimentation. One such project is at the estuary of Redwood Creek, Redwood National Park (Humboldt County). There the National Park Service (NPS) and California Department of Transportation are restoring freshwater inflows and dredging the estuary to remove accumulated sediments and improve circulation in tributary sloughs. Additional components of the Redwood Creek estuary enhancement program include restoration of a small freshwater marsh and management of estuarine water levels to prevent flooding of adjacent farmlands. An extensive program of upstream erosion control and sediment detention, including revegetation of riparian corridors, construction of temporary sediment detention structures, and recontouring and replanting of graded areas is also being undertaken. The project is intended to enhance habitat for juvenile chinook salmon and steelhead, compensating for adverse effects of sedimentation to upstream salmonid spawning and nursery habitats from realignment of US Highway 101 (USDI National Park Service. 1984). Populations of juvenile salmonid in the estuary increased after completion of early phases of the program. Portions of the project intended to mitigate for the highway's

sediment impacts are carried out by the National Park Service with funds provided by CalTrans and the Federal Highway Administration.

A comparable program in southern California is at Los Penasquitos Lagoon, San Diego County. There the State Coastal Conservancy and San Diego County have agreed on a program of dredging to restore the estuary's depth to compensate for adverse effects of erosion and sedimentation in the lagoon from residential development in the watershed (Los Penasquitos Lagoon Foundation and State Coastal Conservancy. 1985; Prestegaard. 1978). In addition, the project includes reconstruction of the lagoon's ocean outlet to increase the estuary's tidal prism and reduce the duration of the outlet's closure to the ocean. The project is intended to remove sediments and improve water quality in the lagoon through increased tidal flushing. The project is partially funded by an assessment levied on new development in the lagoon's watershed.

The Los Angeles Port District and Pacific Texas Pipeline Company are committed to undertake a complex restoration and enhancement project at Bataquitos Lagoon in San Diego County. The project as presently proposed would result in 226 acres of shallow subtidal estuary, 168 acres of intertidal mudflat, 130 acres of salt marsh, a 30 acres freshwater marsh, and a 34 acre least tern nesting area, together with modifications of the lagoon's ocean

outlet and construction of watershed sediment controls. The enhancement project will mitigate for the loss of 208 acres of subtidal soft bottom benthic habitats in San Pedro Bay from PacTex's crude oil marine terminal and pipeline, including the dredging of 15 million cubic yards of sediment from 287 acres of shallow water habitat, the filling of 141 acres of open waters, and additional impacts to least tern populations (USDI Bureau of Land Management and Port of Los Angeles. 1985).

Similar programs to restore estuarine depths, increase tidal circulation, and reduce sedimentation, have been incorporated in flood control and mosquito abatement projects at Mugu Lagoon, Ventura County, and El Estero, Santa Barbara County, and in restoration work at Upper Newport Bay, Orange County.

Increasing tidal flushing in southern California estuaries has been encouraged by the California Department of Fish and Game and US Fish and Wildlife Service to improve water quality and enhance habitat for endangered clapper rails and Belding's savannah sparrows, which depend on cordgrass and pickleweed marshes, and for species which benefit from shallow water embayments, such as topsmelt, halibut, and endangered waterbirds such as least terns. Projects constructed to date, however, have required maintenance dredging to maintain the estuaries' depths and their enlarged ocean

outlets. Design problems and the impacts of disposing dredge spoils have limited the success of these restoration efforts.

When oil and gas development has been permitted in wetlands, provisions to minimize wetland disturbance, consolidate facilities, and phase development with habitat restoration measures have been required to reduce adverse effects. Permits for drilling and redrilling of several hundred wells in the Guadalupe Dunes field in Santa Barbara and San Luis Obispo Counties required directionally drilled wells from consolidated well pads to avoid damage to environmentally sensitive areas. The permits' conditions also required revegetation of disturbed areas, special construction of new drill pads or pipelines adjacent to wetlands, the installation of automatic shutoff valves on those portions of the pipeline crossing the Santa Maria River, and dedication of a conservation easement protecting undeveloped portions of the field as habitat and open space. Similar provisions have been incorporated in permits for exploratory wells affecting wetlands in Humboldt County and in local coastal programs. Humboldt County's Local Coastal Program, for example, specifies minimum mitigation measures for onshore oil and gas development in diked wetlands, including standards for consolidation, abandonment, restoration of drill sites, removal of equipment and earthen sumps from drilling

operations, recontouring and reseeding of the site, and location and management of pipeline right of ways.

A new class of projects propose restoration and enhancement of entire habitat areas to compensate for projects' effects. Los Angeles County's Marina del Rey/Ballona land use plan proposes to restore a 209 acre habitat area, including 163 acres of enhanced wetland, 35 acres of upland habitats, and an 11 acre, 150 foot wide buffer area. The restoration project would compensate for 12 acres of fill and the effects of a four lane pile supported highway in degraded salt marsh and salt flats at Ballona Creek. The restoration and fill are part of a mixed use development including a 750 to 950 slip marina, more than 3300 hotel rooms, and 7200 residential units. The project proponent is required to donate all lands for the restoration project, pay the cost of its construction, provide an endowment sufficient for long term management of the area, and, if the total costs do not exceed $10 million, to construct a nature interpretive center and endow interpretive programs for visitors. Restoration and management of the Ballona Creek habitat area will be undertaken by the National Audubon Society.

Orange County's Bolsa Chica land use plan proposes an even more complex restoration program which combines programs to consolidate

existing oil wells in the wetland with a mixed use marina, resort, and residential development (Orange County Environmental Management Agency. 1985). Implementation of the plan will restore an 835 acre habitat area, including removal of 63 acres of fill and enhancement of 686 acres of estuary, salt marsh and salt flats. The restored habitats would be managed together with the an adjacent 166 acres of existing restored marsh in the California Department of Fish and Game's Bolsa Chica State Ecological Preserve. The resulting habitat area is planned to include habitat 488 to 515 acres of shallow subtidal estuarine waters, 200 acres of salt marsh, 150 acres of salt flat, 50 acres of brackish and freshwater marshes, up to 50 acres of riparian woodlands, and 87 acres of upland habitats, together with additional buffer areas to be identified by the California Department of Fish and Game. The restoration project would compensate for 42 acres of fill and the effects of a potential 775,000 cubic yards of dredging from 107 acres of degraded wetland. Existing oil wells would be consolidated in islands within the restored wetland as part of the phased wetland restoration program. When oil production is no longer feasible, oil facilities would be removed and the areas converted to wildlife habitat. The restoration, dredging, and oil well consolidation are part of a mixed use development including a 1700 boat marina, 550

hotel rooms, and 5700 residential units. The project proponents are required to donate all lands for the restoration project and pay its entire cost. A restoration and management agency for the Bolsa Chica habitat area has not yet been selected.

An additional class of restoration projects now under consideration involves restoration of large wetland acreages prior to the intiation of developments requiring mitigation of dredging, filling, or sedimentation impacts. Developers would then pay an in-lieu fee to the restoration agency to offset their projects' pro-rata share of the cost of buying, restoring and managing the habitat area. The California Department of Transportation's (CalTrans) Elk River restoration site in Humboldt Bay was operated as the first coastal zone wetland mitigation bank. Development permits for the project identify 11 percent of the site as mitigating impacts for a Humboldt Bay bridge replacement project, 53 percent of the site as mitigating impacts for a Eureka freeway project, and 36 percent as available to mitigate other CalTrans projects in the future. The project was entirely funded by CalTrans and was available for CalTrans projects only.

Humboldt Bay's Bracut marsh restoration project provided another early experiment in mitigation banking. The project was intended to compensate for fill of five small wetlands in the City

of Eureka. An additional 4 acres of the Bracut site were available to mitigate filling or dredging of other Humboldt Bay wetlands. Restoration costs were born by the State Coastal Conservancy and repaid through fees imposed on individual developments. IN Orange County, the impacts of bulkheading in Lower Newport Bay are offset through permit applicants' payments of in-lieu fees to the Department of Fish and Game to repay costs of Upper Newport Bay restoration activities in a program similar to a mitigation bank.

Humboldt Bay is also the site of a more ambitious mitigation banking program now under consideration by Humboldt County and the State Coastal Conservancy. As presently envisioned, the Humboldt Bay mitigation bank would involve the acquisition of up to 200 acres of diked tidelands and their restoration in a mixed ecosystem of tidal creek, saltmarsh, brackish and freshwater marsh, and riparian woodland habitats. The project is intended to compensate for the filling or dredging of up to a 135 acres of wetlands and estuary under full implementation of the County's Humboldt Bay area plan. Preliminary siting and design studies have been completed, and an interagency working group has prepared initial restoration objectives for the site. Feasibility studies now underway on the proposal are focused on hydrology, drainage characteristics, and impacts on adjacent private lands. Additional work is needed to

identify the agency who will restore and manage the area, and to determine methods for assessing in-lieu fees required of individual projects repaying the restoration's cost.

ASSESSING THE ADEQUACY OF MITIGATION PROPOSALS

Assessing the adequacy of mitigation measures for wetland dredging, diking, filling, and sedimentation has frequently been a contentious aspect of wetland mitigation in California. The Coastal Act's standards that mitigation measures be the best feasible, maintain and enhance the functional capacity of the wetland or estuary, and provide equal or greater biological productivity as the area lost have provided a broad field for disagreement among biologists, permit applicants, and reviewing agencies.

The wetland guideline recommends that mitigation measures assure that a project does not alter plant or animal populations in a way that would impair the ecosystems' long term stability. Scarce habitat types, rare or endangered species, and the diversity and abundance of other plants, fish, and wildlife populations should be essentially unchanged once the restoration project is completed. The values of the ecosystem for recreation, hunting,

fishing, education, and scientific uses should not be significantly reduced. The guideline recommends that a mitigation area provide equivalent or greater habitat values to the same plant and animal species which use the project area. These standards are the starting point for assessment of the adequacy of mitigation measures.

Assessing the adequacy of a mitigation proposal begins with a habitat inventory of the project area and mitigation site. Baseline information describing the character and size of habitat areas and inventorying fish, wildlife, and recreational or educational uses of the area provide the basis for evaluating the mitigation proposal. For small projects, this information may be limited to simple descriptions of the area of habitat types present at the project and mitigation sites. More complex proposals include many years of inventories of invertebrate, fish, and wildlife populations as well as estimates of waterfowling, fishing, birdwatching, and educational use. Collection of adequate baseline data is essential to the evaluation of large projects, reducing conflicts later in the evaluation process. The selection of the Los Angeles Museum of Natural History to prepare baseline data for the Marina del Rey/Ballona LUP helped reduce disagreement about the habitat values affected by that project.

The assessments of the small projects involved in early mitigation efforts were based largely on the size and type of habitat affected. For example, evaluation of the Park Street mitigation project as compensation for the Woodley Island marina was based only on the requirement that the applicant replace 15 to 20 acres of wetland habitat without regard to the type of wetland restored or its utility for the fish and wildlife species affected by the marina project. Subsequent variations of this approach attempted to assign qualitative values of high, medium, or low to the areas affected by the project, and required that restoration areas provide some proportional increase over the size of the habitat affected. These early examples resulted in a focus on the "mitigation ratio" which related the size of habitat areas impacted and restored. Typical requirements ranged from requirements of one to one replacement where the resources affected were small and the restoration occurred through removal of fill from developed sites to restorations from two to 13 times the size of the affected area where mitigation occurred through the enhancement of diked wetlands.

The time required for a site to become fully restored varies greatly. Because there is a lag between initiation of a restoration project and its achievement of full habitat values, there may be an intervening loss of fish and wildlife. In

addition, restored habitats seldom achieve the fish and wildlife diversity of undisturbed native habitats damaged by a project. In order to mitigate these losses, acreage may be added to the restored area. In other cases, projected fish and wildlife values may be based on existing restoration projects, anticipating the time required to establish fish and wildlife populations. The Freshwater Slough restoration project combined both of these approaches. The size of restored freshwater habitats was 20 percent larger than the size of those damaged to compensate for the lower initial value of the restored area. The size of restored salt marsh was based on results of the adjacent Park Street restoration, considering the Park Street site's lower utility for wildlife in comparison to well established native salt marshes.

Mitigation requirements based primarily on the surface area of habitat damaged have been successful in maintaining regional wetland inventories and providing new habitats for fish and wildlife. However, these projects have not always met the wetland guideline's objective that mitigation areas provide equivalent or greater habitat values to the same type and variety of plant and animal species which use the project area. For small projects, in kind replacement of equivalent areas of habitat may remain the most practical mitigation approach. Because the funds necessary for

more complex analysis are not available from small project sponsors, alternative evaluation methods are frequently unavailable.

The effect of a project on indicator species has also been used to assess the adequacy of a mitigation program in compensating for project impacts. The evaluation of Humboldt Bay's Freshwater Slough restoration site as mitigation for Exxon's Humboldt Bay OCS platform assembly yard used shorebird densities as an indicator of the biological productivity of some of the habitats damaged by the development or restored in the mitigation program. Shorebirds were selected as an indicator for impact assessment on sandflats, diked lands, and restored salt marsh because they were common in these habitats and because, as predators on invertebrates or prey for raptors, they indicated habitat values at other levels of the food chain. The project's mitigation program was based on a comparison of shorebird densities on the habitats damaged by the project with those expected to occur on the completed restoration area to assure the adequacy of the impact compensation (see Table 2). The use of indicator species provided a useful comparison of the value of the different habitats affected by the project and its mitigation program. Additional increases in the size of the mitigation area were offered to offset the anticipated low habitat value of the restoration site during early phases of the mitigation effort. The

Table 2. Evaluation of Mitigation Requirement's of Exxon's Samoa Penninsula OCS Platform Jacket Assembly Project (from CCC 1-84-69)

Impact	Estimated Shorebird Loss(1)	Mitigation Required(4)
Dredge and fill 3.25 acres intertidal sandflat	18 birds	9 acres diked farmland restored to saltmarsh (2)
Fill 8 acre pond	Not applicable	Create 9.6 acre pond
Fill 12.2 acres of willow swamp	Not applicable	Create 11.3 acres of willow swamp at Elk River and 9 acre willow swamp at Freshwater Slough (3)
Loss of 18.5 acres diked farmland for pond and willow swamp creation	47 birds	23.5 acres of diked farmland restored to saltmarsh (2)

(1) Shorebirds were utilized as indicator species for impact assessment on sandflats, diked farmlands, and restored salt marsh because of these birds' close relationship with these habitat types. Shorebirds are among the most common types of wildlife in these habitats. In addition, because shorebirds forage on invertebrates and are in turn prey for raptors, shorebirds are a good indicator of habitat values at other levels of the food chain. Shorebird utilization of the affected habitats is summarized below:

Habitat Type	Peak Winter Shorebirds per Acre	Source
Sandflat	6.73	Gerstenberg (1972)
Tidal Channel	23.47	Gerstenberg (1972)
Restored saltmarsh	4.44	Springer (1984)
Diked farmland	2.52	Gerstenberg (1972)
		Hoff (1979)

(2) Based on the average gain of 2 shorebirds for each acre of diked farmland restored to saltmarsh. One acre of tidal channel restored may be substituted for ten acres of farmland restored, subject to hydrologic conditions and design constraints appropriate to the site.

(3) Mitigation requirements for impacts to pond and willow swamp habitats are described in Roberts (1984).

(4) Saltmarsh restoration proposed to compensate for impacts to wildlife in intertidal habitats and farmlands will also compensate for impacts to marine life in intertidal and shallow subtidal estuarine habitats.

National Park Service's (NPS) Redwood Creek estuary restoration project use salmonids as an indicator species, enhancing the estuary's ability to support juvenile salmonids to compensate for the impacts of erosion and sedimentation on salmonid spawners and larvae in the creek's tributaries (Wood, et. al. 1982).

State agency use of the US Fish and Wildlife Service's habitat evaluation procedure (HEP) in evaluating mitigation proposals is just beginning in California's coastal zone. The evaluation of Pactex's Bataquitos Lagoon mitigation program is based on a HEP analysis. Habitat evaluation using USFWS HEP procedure is anticipated in the proposed Humboldt Bay mitigation bank and future projects in southern California where long lead times, high project costs, and the complex demands on wetland resources justify the use of more sophisticated evaluation techniques.

In practice, an informal process of consultation and negotiation among fish and wildlife experts, project proponents, and regulatory agencies underlies the evaluation of mitigation proposals. The advice of fish and wildlife agency biologists and other experts is sought. Reviewing actions on similar projects along the coast and the experience gained from restoring wetlands in California's estuarine sanctuaries and wildlife refuges has been useful in anticipating the outcome of mitigation programs. Advice

from academics, including US Fish and Wildlife Cooperative Research Field Stations and participants in the California SeaGrant Colleges program, has also been helpful.

Agreement on the Bolsa Chica habitat restoration program was achieved only through a more formal consultation and negotiation process. In 1983, the California Legislature, frustrated by over a decade of acrimony surrounding the Bolsa Chica, enacted Senate Bill 429 to resolve the long standing dispute through development of a Habitat Conservation Plan (HCP). The HCP was prepared by the State Coastal Conservancy and the Department of Fish and Game in consultation with Orange County and the major landowner, Signal Landmark, Inc. The Conservancy acted as lead agency for the identification of land use alternatives, while DFG was lead agency for wetland identification purposes. The plan describes the extent and type of habitats to be restored as well as the program of marina, resort, and residential development. Once prepared, the plan was submitted jointly by the Conservancy and Department of Fish and Game for the Coastal Commission's review and approval. Once approved, the plan was incorporated in the County's local coastal program for the area.

The Ballona Creek LUP used a different process to reach agreement on the adequacy of wetland mitigation measures. Los

Angeles County's land use plan identified only the acreage and general configuration of wetlands to be restored. Decisions about the mix and extent of the various habitat types to be created was deferred until additional studies of the area had been completed. The plan requires submittal of the detailed restoration program prior to rezoning of the area for development. This phased approval of the Ballona Creek restoration program reduced the complexity of issues before the Coastal Commission in its initial action on the land use plan and relieved the pressure of time and politics on the restoration planning process.

The US Army Corps of Engineers Section 404 and Section 10 permits provide an additional opportunity for review of development within the coastal zone or on adjacent federal lands. During the review of these permits, the Coastal Commission must certify that development by non-federal parties is consistent with the State's federally approved coastal zone management program. For federal agency projects or projects on federal land the Commission must concur in the federal agency's determination that the project is consistent with with the State's federally approved coastal zone management program to the maximum extent practicable. For example, in its review of the Corps of Engineers nationwide 404 permit No. 26, the Coastal Commission found that it could concur with the

Corps' proposed approval of the permit only if the Corps stipulated that the permit would not be applied to alterations of wetlands of less than one acre in the coastal zone. The Commission's ability to review these federal actions provides another avenue for coordination and consultation on federal permits and other actions affecting coastal wetlands. In practice, the close scrutiny of projects receiving coastal development permits has meant that few issues remain to be resolved at the federal permit level.

MANAGING MITIGATION AREAS

Well designed mitigation programs include a clear set of restoration objectives relating the habitat improvements to be accomplished with the impacts of the project they accompany. Once initial restoration actions have been completed, management of the mitigation area is required to assure success that the restoration objectives are met. Decades of wildlife refuge management have demonstrated that wetlands can be managed to achieve fish and wildlife habitat goals if the management tools are available.

An active monitoring program is central to effective management of restored areas. Trained biologists will need to periodically inspect the restored site, surveying its plant, fish, and wildlife

populations to determine if the restoration objectives are being met, or if changes to the system are required. Data gathered through careful monitoring of projects can also enhance knowledge applicable to future mitigation activities. When restoration is phased, monitoring of initial activities can improve the success of later stages.

In some cases monitoring reveals that habitat objectives are not being met. Incorrect design assumptions, unanticipated site conditions, competition from undesirable plants, and poor site management can limit restoration projects' success in meeting habitat objectives. These projects can be improved if remedial changes can be made after construction. Pumps, dikes, weirs, and other water control structures incorporated in the project design can be used to alter the areas which receive water, its depth, and the season or duration of water coverage. Structures, such as dikes, also allow easy access for the heavy equipment required for remedial actions.

Selection of a restoration area manager is a key to successful impact mitigation. Mitigation programs should include an agreement identifying the management agency, the responsibility of the project sponsor to fund monitoring and remedial activities, and provisions for public use of the site. CalTrans' Elk River

mitigation bank, for example, is managed under a memorandum of understanding between the Coastal Commission, Department of Fish and Game, and CalTrans which describes the impacts to be mitigated by the program, its restoration objectives, and CalTrans' responsibilities to monitor the site for a 10 year period and carry out remedial actions up to $25,000 in cost. The memorandum provides that title and management of the site may be assumed by the Department of Fish and Game if CalTrans abandons the site. The duration of sponsors' responsibility for such management has varied from one to ten years or more.

Bonding requirements guaranteeing performance of the restoration project have not been required in wetland mitigation projects. The many uncertainties affecting the performance of wetland restoration projects have made bonding companies reluctant to provide bonds for mitigation activities.

LESSONS FROM CALIFORNIA'S WETLAND AND ESTUARINE IMPACT MITIGATION PROGRAM

California's experience in mitigating impacts to coastal zone wetlands and estuaries offers valuable lessons. Mitigation projects carried out so far have reduced impacts of dredging,

diking, and filling. Most projects have been successful in reestablishing the vegetative communities anticipated in their restoration plans. The diversity of restoration activities attempted has increased our knowledge of restoration techniques. Projects completed have been successful in offsetting loss of wetland acreage and recreating wetland and estuarine vegetative communities. Their compensation for impacts to fish and wildlife has been less complete. Most projects, however, have been only recently established and may yet show additional fish and wildlife benefits. Time heals many, if not all, wounds. The restoration projects carried out have mitigated impacts from permitted development, but have not provided salvation for declining fish and wildlife populations threatened by damage to coastal wetlands and estuaries.

Our procedures for preparation, review, and implementation of mitigation programs work well. Where necessary, creative new processes of conflict resolution and phased mitigation planning have been established. Our mitigation planning could be improved by more extensive collection of baseline data about the wetlands and estuaries planned for development and about completed restoration efforts. A renewed program of close consultation with academics studying wetland systems and with those monitoring

restoration programs could improve the mitigation of projects' effects.

Our wetland evaluation procedures work best when we focus on species and their habitat needs. The sharp focus on the size of habitat area restored has sometimes resulted in restoration of large areas inadequately suited for the species adversely affected by development. Attention to offsetting losses of fish and wildlife populations may open new opportunities for mitigation of wetland impacts through management of habitat attributes such as water quality or competition with introduced species. Consideration of a broader range of ecosystem impacts to fish and wildlife populations, in addition to our past attention to offsetting habitat loss, can result in mitigation programs that better compensate for projects' impacts.

The long term success of mitigation projects depends upon the commitment of restoration area managers. The quality of construction, the monitoring of fish and wildlife, the willingness to undertake remedial activities, and the daily care of restored fish and wildlife habitats depend on the restoration area manager. Yet, little attention has been paid to the selection of management agencies as a key element in mitigation programs. Greater emphasis on the selection of restoration managers committed to achieving the

project's fish and wildlife objectives could improve the long term compensation for project impacts.

Renewed attention to regional wetland management goals would help the preparation and evaluation of mitigation programs. Much of our wetland management is focused on offsetting impacts of the development at hand. As a result, the character of wetland and estuarine habitat restoration may be influenced less by the needs of fish and wildlife than by those of developers seeking project approval. A positive plan for management of coastal fish and wildlife and their habitats, including consideration of the need to offset impacts of anticipated development together with objectives for restoring populations of threatened species and other desired fish and wildlife, would improve the framework for preparing and evaluating mitigation programs. In California, the impacts of the wetland and estuarine development authorized by port plans and local government land use plans can now be anticipated. Careful examination of these plans, coupled with renewed efforts to draw together recommendations of endangered species recovery plans, the US Fish and Wildlife Service's Concept Plan for Waterfowl Wintering Habitat (1979), the acquisition recommendations of the Department of Fish and Game (1974), and other regional wetland restoration plans (Gates. 1982; Zentner. 1982; Los Penasquitos Lagoon

Foundation and State Coastal Conservancy. 1985) could provide the basis for an overall plan for the management of coastal fish and wildlife habitats.

Mitigation banking, coupled with more traditional fish and wildlife refuge acquisition, expands our opportunity to implement an overall plan to protect and restore wetland and estuarine habitats. The large complex habitat areas which could be restored through such a program could accommodate a variety of fish and wildlife management objectives, including the mitigation needs of anticipated development projects. Because the restoration work would be completed in advance of the development for which it provided mitigation, uncertainty about the ability of the restoration program to compensate for project impacts would be reduced. The time required to prepare, review, approve, and implement individual mitigation plans could be cut. The uncertainty over regulatory acceptance of a project's mitigation proposal could be replaced by a firmer, market transaction to repay the mitigation bank's development costs, enabling developers to more predicably analyze projects' finances. At the same time, in lieu fees assessed against developers using the bank's mitigation areas could include charges to monitor and manage the site, assuring adequate care of the restored habitat area. Additional

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NOTES

1. The eight uses permitted in estuaries and wetlands are port, energy, and coastal dependent industrial facilities, including commercial fishing facilities; maintaining navigation channels, turning basins, vessel berthing and mooring areas, and boat launching ramps; entrance channels for new or expanded boating facilities; in open estuarine waters, new or expanded boating facilities and pilings for public recreational piers; in degraded wetlands, boating facilities if at least 75 percent of the degraded

wetland is restored to productivity; incidental public service purposes, including burying cables and pipes, inspection of piers, and maintenance of existing intake and outfall lines; mineral extraction, including sand for restoring beaches (except in environmentally sensitive areas); restoration purposes, nature study, aquaculture, or similar resource dependent activities.

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