5.0 Compatible Use Strategies

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Photo 5-1. Coronado Bridge Over San Diego Bay.

This chapter summarizes management strategies from the human use or project planning point of view. An overview of current activities on the Bay summarized from Chapter 3 is followed by a description of the regulatory framework under which activities are undertaken. Various Bay activities are then addressed individually along with strategies for fostering their compatibility with Bay natural resources. Pollution concerns, and then strategies for managing cumulative effects, close the chapter.

5.1 Within-Bay Project Strategies

This section describes the continuing need for dredging projects in the Bay, the permitting environment in which these operations are conducted, the environmental issues associated with dredging, and finally, opportunities to use necessary dredging work for environmental enhancement.

5.1.1 Dredge and Fill Projects

Specific Concerns

The following specific concerns address both dredging and dredge material disposal.

- With the unique nature of each project and over 30 major environmental statutes and regulations governing dredging projects, consistency in their application is difficult if not impossible.
- There is a need for predictability, timeliness, and stability in the decision-making process so that the Port of San Diego can remain competitive in a world market and the Navy's need for a major homeporting facility can be facilitated.
- There is an underlying lack of public confidence that environmental concerns are being addressed, which can contribute to a lack of predictability for project sponsors, project delays because of public challenges to environmental compliance, and unanticipated costs.
- There are uncertainties regarding the scientific ability to evaluate risks from metallic or organic contaminants to human and ecological health from dredging contaminated sediments and their disposal.
- Resuspension of bioaccumulative contaminated sediments may have effects on biota.
- There are air quality compliance concerns due to dredging and transport of dredged materials.
- New dredging could produce persistent and significant changes in Bay hydrodynamics as a result of channel deepening, especially in shallow and intertidal portions of south Bay where changes in cross-sectional geometry could have the maximum effect on circulation patterns and, as a result, the distribution of salinity, dissolved oxygen, and other important environmental parameters.
- While hydrodynamic models for the Bay has been developed to help predict the fate of contaminants and oil spills based on predicted changes in the current profile, these two-dimensional and three-dimensional models lack ground truthing and are too coarse to be site specific. The ecological implications of a change in current, salinity, or dissolved oxygen in the most sensitive habitats, such as intertidal areas, are unresolved.
- The need to dredge, especially close to the shoreline, leads to a need to stabilize the shoreline with non-native hard substrate due to unnaturally steep slopes that erode with wave and current action. It also leads to a loss of sandy beach areas from erosion, and potentially a loss of eelgrass.
- Dredging that leads to an increase in Naval and maritime activity may lead to progressive and cumulative impacts on Bay wildlife values, such as boat traffic disturbance of waterbirds. In addition, an increase in activity will result in a higher probability of accidents such as spills.
- The beneficial reuse of dredged material within San Diego Bay is hampered by the lack of identified habitat enhancement projects, especially within

the intertidal zone. Also, criteria have not been developed for characterization of the material appropriate for these projects.

- Beneficial reuse of dredged material in Waters of the US may, in and of itself, have to be mitigated due to loss of Bay surface area or of habitat values that provide for one class of species over another, such as fishes versus shorebirds. Opportunities for creation of intertidal habitat may be lost due to lack of a Baywide agreement and planning for this need.
- Mitigation for dredging projects has resulted in a loss of shorebird values in the Bay, apparently due to a lumping of all intertidal elevations as equivalent in terms of their wildlife value, and a preference in practice for enhancement of lower intertidal elevations at the expense of other intertidal communities.
- Opportunities for beneficial reuse of dredged material for work in the Bay may be lost without a regional plan that addresses both beach nourishment and habitat enhancement projects. The current SANDAG-sponsored plan addresses beach nourishment only.
- The core sampling methodology used to characterize sediment in advance of dredging in order to anticipate disposal requirements does not detect anomalies, such as in the recent case of the presence of ordnance, which makes sand unsuitable for beach nourishment. To date, there is no satisfactory technology to operate dredges with screens or grates that is 100% effective at removing ordnance.
- There is a lack of identification, coordinated planning, and prioritization of beneficial use sites for dredge disposal Baywide, so that opportunistic dredging may be taken advantage of for erosion control, shoreline stabilization, or habitat creation or enhancement.
- Habitat enhancement within the Bay can be more costly than ocean dumping. There is a need to address funding issues associated with habitat enhancement using dredge spoils that fulfill objectives of this Plan.
- There is a shortage of upland and nearshore confined disposal sites for sediment unsuitable for aquatic disposal.
- There is uncertainty about the capacity of the LA-5 ocean disposal site.

Background

The dredging and dredge disposal requirements for maintaining San Diego Bay as a vital, economically successful port will not lessen in the foreseeable future. The trend is for deeper draft, power-intensive vessels in both the shipping industry and the Navy. Dredging is conducted by the US Navy, USACOE, the Port of San Diego, and some commercial marina operators. Major dredging first occurred in the early 1900s. See Map 2-2 for the history of dredge and fill in San Diego Bay.

- Dredging is conducted by the US Navy, USACOE, the Port of San Diego, and some commercial marina operators.

Bay users have both new and maintenance dredging needs to be met. Maintenance dredging is required because of new material entering the Bay, and existing material becoming suspended and displaced by currents and wave action. Relatively minor amounts of new material enter San Diego Bay compared to other bays because of low rainfall and the damming and diversion of river waters that would naturally provide intermittent sediment supply. As a result, maintenance dredging has never been conducted in the life of some projects. In the case of some Naval Station piers it has occurred about every five years (P. McCay, US Department of the Navy South Bay Focus Team, pers. comm.). A long-term estimate of the volume involved with maintenance dredging from interior channels is about 3.4 x $10^5 m^3$ over 29 years; at least one unmaintained channel has persisted for more than 30 years (Smith 1976).

- Most material dredged from San Diego Bay was removed prior to 1970 and used to fill wetlands and to develop the Bayfront.

Table 5-1 shows some recent and proposed dredge projects. The historical volume of material dredged from San Diego Bay over the years is estimated to be between 180 and 190 million cubic yards (mcy) (Smith 1977, in US Navy 1992). Most of the material was dredged prior to 1970 (See Map 2-2). The volume of recent or proposed dredging within San Diego Bay cumulatively totals approximately 24.3 mcy. Historically, most of this material was used for filling wetlands and developing the Bayfront. A small percentage has been disposed of at the LA-5 Ocean Disposal Site (about 5 to 8 mcy historically, and less than 0.5 mcy recently or proposed). About 35 mcy were placed along Silver Strand Beach, in nearshore waters on the ocean side and in-Bay waters at NAB Coronado. Approximately 147 mcy were used around the Bay as fill. Recent trends have shown more material shipped to LA-5. Only a fraction has been used for habitat enhancement.

Photo © 1998 US Navy Southwest Division.

Photo 5-2. Dredging in San Diego Bay.

Current Management

Authority over dredging and dredge disposal in the ocean, the Bay, or on land is implemented through a variety of federal and state permit processes. The USACOE is responsible for any fill, construction, or modification of navigable waters and wetlands by authority of the Rivers and Harbors Act (33 USC.A. Sec. 401 et seq.); Section 404 of the CWA, and the MPRSA or "Ocean Dumping" Act; 16 USC.A. Sec. 1431 and 1447 et seq.; and 33 USC.A. Sec. 1401 and 2801 et seq.). NEPA and CEQA documentation must also be fulfilled for dredging and dredge disposal.

- Although USACOE actually issues the permits, the EPA participates in the entire permit process and can object to permit issuance under certain conditions.

The EPA provides regulatory oversight authority over dredging, to ensure that it does not have significant adverse effects on marine and estuarine resources. EPA establishes the environmental criteria and guidelines that must be applied by USACOE and met by dredging projects, and EPA reviews all project proposals based on these criteria and guidelines. The USACOE is prohibited from issuing a permit if the EPA finds the proposed disposal does not meet criteria for disposal

Table 5-1. Summary of Existing and Potential Dredging Projects and Disposal Methods since 1988[1].

Project	Type[2]	Total cubic yards	Beach Nourishment	Ocean Disposal (LA-5)	Upland Landfill	Habitat Enhancement (eelgrass)	New Fill Fastland Construction	Left in Place
Navy Bravo Pier (M1-90) 1995	M	123,000	+[3]	123,000	+			
Navy Fuel Pier 180 1998		21,000	+		21,000			
Naval Amphibious Base (P-187)1992	N	9,000	+			9,000		
Naval Amphibious Base (P-211) Pier 21	N	40,500	+		17,800	22,700		
Naval Station San Diego (M10-90) (various sites) 1993	M		+	116,000	390,000			33,255 Paleta Cr.
Naval Station San Diego (P-332S) 1995		180,000	+	+	+			
Naval Station San Diego (P-338S) 1994	N	300,000	+	172,000	+			158,000 pending
Navy Magnetic Silencing Ranges 1992	N	14,000						14,000 entrance channel
US Coast Guard Pier at Ballast Point 1995		40,000	+40,000					
Carrier Homeporting I	N	9,200,000	+	+	+		+	
Carrier Homeporting II	N	582,466				+	+	
Chollas Creek 1997	M	100,000		42,000	58,000			
San Diego Bay Harbor Maintenance 1996	M	175,000	175,000 Nearshore Silver Strand	+				
San Diego Bay Entrance Channel 1988	M	250,000	+			+		
SDG&E South Bay Channel 1992–1993	M	1,000,000	+	+1,000,000				
Port of San Diego/USACOE Central Bay Channel Deepening 10th Ave.	N	500,000	+	+				
Scripps Inst. of Oceanography, Nimitz 1995	M	47,000	47,000					
National City Marine Terminal—Channel Deepening	N	9,000,000			+			
Commercial Ship Repair Yards (ongoing)	M	15,000			15,000			
Dredged Material Sand Bar Feeder Berm 1988		150,000	+					
Cleanup Contaminated Sites (hot spots)	M	50,000/yr			+50,000			
City of SD Point Loma Outfall Extension								
Misc. undefined dredge projects		100,000/yr	+	+			+	

1. Data courtesy of P. McCay, US Navy South Bay Area Focus Team, M. Perdue and G. Rogers, US Navy Southwest Division; SANDAG; Port of San Diego.
2. N= new; M = maintenance.
3. + = Anticipated

site selection (Sec. 102 of the MPRSA). USACOE, under CWA Sec. 404(e)(1), must also provide notice and opportunity for public hearings. While the EPA itself does not issue permits, it participates in the entire permit process, including pre-application consultation, technical assistance, commenting, recommending special permit conditions, and postproject enforcement. The EPA can object to permit issuance under certain conditions. Procedures for management of dredge material and compliance with CWA, MPRSA, and NEPA are published in EPA/USACOE (1992), Framework for Dredge Material Management, available at http://www.epa.gov/OWOW/oceans/framework.

- A federal permit for dredge disposal cannot be issued unless it is in compliance with California water quality standards, or federal water quality criteria.

Under Sec. 401 of the CWA, a federal permit for dredge disposal, or any other activity under Sec. 401, cannot be issued unless the SWRCB issues or waives a certification that disposal in California waters is in compliance with California water quality standards, or federal water quality criteria for offshore waters. The SWRCB also regulates disposal into state waters through its Waste Discharge Requirements and specifies what must be considered in regulating dischargers (CWC Sec. 13263). Specific regulations for disposal of waste (dredged spoils) are contained in California Code of Regulations Title 27 (the former Chapter 15 regulations).

- If disposal is at an upland site or LA-5, the RWQCB waives establishment of Waste Discharge Requirements for dredging projects that are not expected to have an adverse effect on the environment and consist of 5,000 cubic yards or less.

The RWQCB waives establishment of Waste Discharge Requirements for dredging projects of 5,000 cubic yards or less that are not expected to have an adverse effect on the environment, and the disposal is at an upland site or at LA-5. Determination of environmental effect is made on a case by case basis considering the protection of beneficial uses, with mitigation requirements evaluated in consideration of other regulatory agency and public comment (Regional Water Quality Control Board 1994). The dredging operation itself has been waived pursuant to the San Diego Basin Plan. For upland disposal, the project proponent must still request authorization to discharge under a Regional Board waiver; for disposal at LA-5, the Regional Board defers to USACOE decisions (B. Morris, Regional Water Quality Control Board, pers. comm.). RWQCB can issue a waiver of its certification consistent with the Basin Plan, Bays and Estuaries Plan, Ocean Plan, and California Drinking Water Standards. Criteria for the waiver are disposal is outside of the 100 year flood zone, capped with construction materials or 2 ft (0.6 m) of "noncontaminated clean" fill, 100 ft (30 m) away from any surface water, 5 ft (2 m) above highest anticipated groundwater level, and outside of basins designated for municipal and domestic drinking water supply.

- Federal agencies must make consistency determinations for activities, while applicants for federal permits make consistency certifications.

The CCC exercises its authority over dredged material disposal by way of federal consistency and certification provisions of the CZMA, its Reauthorization Amendments (see also Section 3.6 "Overview of Government Regulation of Bay Activities"), and the CCA. Federal agencies must make consistency *determinations* for activities, while applicants for federal permits make consistency *certifications*. To be consistent with the CZMA, every effort must be made to use sandy material for beach nourishment or habitat restoration or enhancement. For beach nourishment, the material must meet USACOE criteria, which require that particles be mostly greater than 74 microns (i.e. sand, gravel, or rock), compatible with sediments at the receiving site; and substantially the same as the disposal site. Provisions of the CCA relevant to dredge disposal are summarized in Table 5-2.

For the Port, Chapter 8 of the CCA requires that the Port's master plan identify acceptable development uses. Under the master plan, dredge and fill operations cannot occur without establishing:

1. a demonstrated need for the dredge or fill operation;
2. the severity of impacts from dredge or fill on marine life and other activities within the port; and
3. a consensus between state and federal regulatory agencies regarding the adequacy of potential mitigation options (California Resources Agency 1997).

Table 5-2. Provisions of the CCA Relevant to Dredge Disposal.

In-Bay Habitat Enhancement/Restoration:

Section 30230. Marine resources shall be maintained, enhanced, and where feasible, restored. Special protection shall be given to areas and species of special biological or economic significance. Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes.

Section 30231. The biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes appropriate to maintain optimum populations of marine organisms and for the protection of human health shall be maintained and, where feasible, restored through, among other means, minimizing adverse effects of waste water discharges and entrainment, controlling runoff, preventing depletion of groundwater supplies and substantial interference with surface water flow, encouraging waste water reclamation, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alteration of natural streams.

Section 30233. (a) The diking, filling, or dredging of open coastal waters, wetlands, estuaries, and lakes shall be permitted in accordance with other applicable provisions of this division, where there is no feasible less environmentally damaging alternative, and where feasible mitigation measures have been provided to minimize adverse environmental effects, and shall be limited to the following:...(7) Restoration purposes.

Beach Nourishment:

Section 30233. (b) Dredge spoils suitable for beach replenishment should be transported for such purposes to appropriate beaches or into suitable long shore current systems.

- Through SANDAG, local, state, and federal resources are being used to develop a shoreline preservation strategy using dredge material.

The San Diego Association of Governments (1993) has spearheaded effective use of local, state, and federal resources to develop a consensus-based shoreline preservation strategy for the region. The Shoreline Erosion Committee has made a regional priority of beach nourishment, tailoring to local needs the CZMA statewide policy for the reuse of dredged material that gives priority to beach nourishment and enhancement/restoration projects. Since 1993, ten opportunistic sand dredging projects have resulted in the replenishment of four million cubic yards of sand to the region's beaches. SANDAG, by way of the Shoreline Erosion Committee, also arranged for cost-sharing of the Navy's dredging and disposal needs for the CVN homeporting project to benefit eroding beaches of the region.

Attempts to resolve dredging and disposal issues in advance take place in the NEPA- and CEQA-driven environmental review process. Standard mitigations for the environmental effects of dredging itself are employed: silt curtains, avoidance of the California least tern season, hooded shields, match boxes, anti-turbidity overflow systems, or closed bucket or clamshell. Maintenance dredging is usually issued a Finding of No Significant Impact, such as the recent dredging by the Navy at Chollas Creek, even though this site was shoaled up to near-zero water level. New dredging, however, will require at least an EA. However, these documents do not always successfully anticipate the complications a dredging operation can encounter, as exemplified by recent Navy dredging for a new nuclear-class aircraft carrier at NASNI.

- To determine the appropriate disposal alternative, sediment must be characterized. Both "green book" and "gold book" testing manuals include a similar tiered-testing approach and compare sediment test results to those of off-site reference sediment. This helps avoid potential adverse environmental impact.

Potential alternatives for San Diego Bay's dredged material disposal include beach replenishment, habitat restoration/enhancement, ocean disposal, incineration, upland disposal without treatment, upland disposal with treatment, confined aquatic disposal, and capping at reuse sites. Some of these alternatives can have significant environmental benefit. Starting in 1977, sediment testing was required for aquatic disposal of dredge material under EPA guidelines developed under the Ocean Dumping regulations (40 CFR Part 227). The sediment must be characterized prior to dredging in order to determine the appropriate disposal alternative. Disposal protocols for the ocean are defined in the "green book" (US Environmental Protection Agency Testing Manual Evaluation of Dredged Material Proposed for Ocean Disposal, February 1991, No. 503/8-91/001). The EPA/USACOE also has published a "gold book" national testing manual for disposal in inland areas of Waters of the US (Evaluation of Dredged Material Proposed for Discharge in Waters of the US—Inland Testing Manual [US Environmental Protection Agency and US Army Corps of Engineers 1994]). Both manuals adopt a similar testing framework, including a tiered testing approach, multispecies benthic and water column testing of appropriately sensitive organisms, 28 day bioaccumulation testing, and comparison of benthic test results with those of offsite reference sediment. Tiered testing promotes cost effectiveness by focusing the least effort on the disposal operations where the potential (or lack thereof) for unacceptable adverse environmental impact is clear, and expending the most effort on those operations requiring more extensive investigation to understand the potential impacts. For example, during the first CVN homeporting project, Tier 1 (existing information and chemical data only) testing and Tier 2 (Tier 1 with some water quality modeling) testing were performed in the channel areas because they were away from a contaminant source. Tier 3 testing (including bioassays) was performed at the turning basin that was close to existing berthing areas and known potential contaminant sources (P. McCay, pers. comm.).

- Due to different characteristics of each site, project sponsors and agencies must work to develop site-specific testing protocols and waste discharge requirements.

Upland disposal of dredged material is treated as a solid waste. Concerns are centered around contaminants becoming soluble and mobilizing into surface or groundwater. Data from in-water testing programs are often inadequate for determining the suitability of dredged material for upland or landfill disposal because of differences in solubility of the contaminants and different exposure pathways. Generally, project sponsors must work individually with the agencies involved to develop site-specific testing protocols and waste discharge requirements for each project, largely due to differences in the engineering characteristics of each site, proximity to ground or surface water, and other factors. Typical testing requirements include total and soluble metals, and total organics such as BTEX, PCBs, pesticides, chlorinated solvents, and total recoverable petroleum hydrocarbons as waste oil or diesel.

Contaminant testing for disposal in wetlands is not standardized on a national level. Because these sites have exposure pathways similar to both in-water and upland sites, appropriate testing may involve some in-water and some upland approaches. These decisions are made on a site-specific, case by case basis.

- The recent Navy dredging operation for homeporting a new aircraft carrier is an example of the many issues that can arise with a large dredging project.

The recent Navy dredging operation for homeporting a new aircraft carrier is an example of the many issues that can arise with a large dredging project, including the need to mitigate for socioeconomic impacts, air quality compliance, adequate sediment testing, complications in meeting CZMA consistency obligations, and the public voice in obtaining the maximum value of the dredge material as a resource. The project was viewed as a "once in a generation" source of beach nourishment for the region's eroding coastline (San Diego Association of Governments 1997b). The CZMA and the Shoreline Erosion Committee's (elected officials of all coastal cities and the City of San Diego, the SDUPD Commissioner, and a US Navy representative) policies viewed the beach nourishment as required mitigation due to the socioeconomic impacts of the homeporting project. SANDAG agreed to arrange for matching funds for the carrier project mitigation so that the Navy could pump the dredged sand ashore onto desired beaches rather than place it at four nearshore sand berms from which the material could be washed onto beaches by wave action and currents over time. After ordnance was discovered in the dredged material, the Navy attempted to screen the sand with a grate to prevent delivery of ordnance to beaches. However, the 3 inch grate reduced production to 20,000 cubic yards (cy)/day from 36,000 cy/day with a 12 inch grate (Lt. T. Allen, Naval Air Station North Island, pers. comm.), and the extra work load on the dredge also resulted in violations of air quality standards. While coastal communities pushed strongly for the sand delivery to continue, the Navy could not guarantee and refused to accept liability for delivery of ordnance-free sand originating in San Diego Bay to beaches. The CCC then filed suit against the Navy for not meeting its CZMA consistency obligations. The Navy delivered dredged material from San Diego Bay to LA-5 and has committed to dredging clean sand from ocean sources to meet its beach nourishment obligations. This will require Congressional funding to accomplish. In addition, the Navy has agreed to investigate alternatives for beach nourishment in the future, ranging from using ocean borrow pits as sand sources to improved ordnance detection during dredging. This approach allowed Bay dredging to continue after costly work stoppages, but to date has not provided a long-term solution to the testing and screening for ordnance and beach nourishment issue for future dredging projects.

Evaluation of Current Management

- Opportunities exist to use dredge material as a valuable resource with a substantial *net* benefit to the environment.

Dredging is necessary for safe navigation of commercial, navigational, and recreational vessels in channels, turning basins, docking slips, and marinas. While the process of dredging itself and disposal of dredge material may have adverse environmental effects, opportunities exist to use dredge material as a valuable resource with a substantial *net* benefit to the environment, rather than disposing of it as a waste. Most of the short-term environmental effects of dredging can be mitigated. The following is a discussion of potential environmental effects and benefits of dredging and dredge disposal.

Contaminated Dredge Material

Generally, the greatest potential for environmental effects from the disposal of dredged material is related to the benthic exposure pathway. Benthic organisms, those living or feeding on or in deposited material, are the most likely pathways for adverse environmental effects from contaminated sediment. Acute toxicity to various benthic species is used as a measure of the potential for direct effects to exposed organisms. Tissue bioaccumulation is a measure of bioavailability, and thereby the potential for chronic or food web effects (including human health effects from eating contaminated seafood) of sediment contaminants in longer-term exposures (US Army Corps of Engineers *et al.* 1998).

On the other hand, dredging can reduce contaminant levels in the Bay by removing contaminated sediment. This is evident by the general trend of increasing toxicity, ammonia, and fine sediment with distance away from the Bay's opening, except where dredging has occurred.

Recolonization of Benthics after Disturbance

- Recolonization of benthic organisms after disturbance depends upon the degree of disturbance, life span of the organism, and proximity of the seed source.

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Effects on benthic invertebrates at the dredge site are apparently temporary, and the potential for persistent environmental effects due to maintenance dredging is very small (Marine Board Commission 1985), unless maintenance dredging is so frequent that the area never has a chance to completely recolonize. Soule and Oguri (1976) looked at recolonization of infaunal species after dredging, compared to a reference site. Colonizing populations were less diverse than established populations; they were dominated by opportunistic, stress-tolerant species. Two to three years were required for the community to stabilize (Rhoads *et al.* 1978). This time requirement was similar to the one Reish (1961) found for the initial colonization of the benthos in newly established marinas. A wide range of studies from many regions report a range of time to reestablish a stable community at between 1 1/2 and 12 years. The overall impact of these results to Bay productivity are probably negligible due to the small area affected (Marine Board Commission 1985).

Turbidity

- Dredging and disposal increase turbidity. Filter feeding organisms that live on the surface, such as mussels, are the most sensitive. Other vulnerable species and the portion of their life history during which they are vulnerable have not been identified.

Dredging and disposal of dredged material temporarily increase turbidity; may deplete dissolved oxygen influencing bottom-feeding communities at and near disposal sites; and may affect the behavior and physiology of fish, foraging birds, and other organisms. It may also redistribute toxic pollutants and increase their availability to aquatic organisms (Marine Board Commission 1985). Filter feeding organisms that live on the surface, such as mussels, are the most sensitive to disturbance due to turbidity. While a variety of studies have shown them to tolerate short periods of turbidity up to 1,000 mg/l or even benefit from it due to increased pumping and nutrient supply (Marine Board Commission 1985), data still suggest that effects can be lethal at persistent high concentrations greater than 750 mg/l, such as in the immediate vicinity of the dredge, or with shallow burial (<0.4 in [1 cm]) (Marine Board Commission 1985). Because of this, some ports around the country limit dredging activity during the spawn-and-set period of commercially valuable species of shellfish.

Turbidity reduces light available to subtidal plants, such as eelgrass and algae. In turn, animals such as anemone in a symbiotic relationship with algae may be affected. Dredging and associated turbidity may also temporarily reduce primary production in the Bay. Turbidity may also hinder the ability of those fish, birds, or other creatures that rely on their sight to locate and capture their prey.

Turbidity concerns are maximized in relatively restricted areas where plumes would affect a large proportion of an inlet or embayment. While avoidance of least tern season or use of silt curtains can avoid or minimize effects of turbidity, effects on other biota are usually not considered in the assessment process. Other vulnerable species and the portion of their life history during which they are vulnerable have not been identified.

Hydrologic Changes

The potential for persistent environmental effects associated with dredging for new work may be more significant than for maintenance work. It is a function of the quality of materials dredged, the changes in channel geometry, and the local hydrologic regime. Such changes can affect the fate of sediment and contaminants, as well as biota sensitive to changes in current, salinity, and dissolved oxygen. This is one of the questions being addressed in a model of Ecological Risk Assessment being conducted at SPAWAR (K. Richter, pers. comm.).

Biological Effects by Dredging and Transport Method

- Four types of dredges are currently used in the Bay. See Table 5-3.

Table 5-3 is an evaluation of the comparative biological effects of four types of dredges currently used in the Bay. While there are distinct differences, project sponsors do not always have a choice as to which dredge system is employed. Cutter head dredges are preferred for excavating hard, rocky material or alluvium in relatively protected areas. Hopper dredges would be favored in the main channel where dredge materials are not hard, rocky, or indurated. Suction dredges would be selected for dredging under and around piers and adjacent to other structures where a hopper is difficult to operate, and where a cutterhead may damage structures. The choice of dredge depends upon these factors and the *availability* of a particular dredge, environmental sensitivity, volume of the material to be dredged, physical and chemical characteristics of the material, dredging depth, method of disposal, production rate required, distance of dredging from disposal sites, contamination level of sediments, expected waves and currents, and cost (US Navy 1992, US Army Corps of Engineers *et al.* 1998).

Dredge Disposal for Beneficial Use

When properly designed and sited, habitat restoration or enhancement projects can result in a net benefit to habitat quality and water quality by improving sediment retention, filtration of pollutants, and shoreline stabilization. Innovative dredge disposal for habitat restoration or enhancement could benefit the Bay.

- Any habitat enhancement project using dredge material will inevitably involve some degree of habitat trade off. Decisions will be required about the relative value of existing habitat types compared to the habitat targeted for restoration or enhancement by dredge disposal.

Some degree of habitat trade off is inevitable with almost any habitat restoration project using dredged material. Decisions will be required about the relative value of existing habitat types compared to the habitat targeted for restoration or enhancement by dredge disposal. Mitigation for impacted resources may, in fact, be required by regulators despite the resulting net benefit in another habitat type. This has been the case in San Diego Bay when intertidal habitat is restored from vegetated or unvegetated shallow subtidal habitat. Whether restoration intended to support sensitive species or a certain habitat will result in a net benefit is a case by case decision. In other locations, such decisions are made in the context of a regional Plan such as this one (e.g. San Francisco Bay's Long-term Management Strategy for dredging requires that such decisions be consistent with comprehensive regional plans of the area). The challenge of using dredge material for habitat enhancement is to maximize existing environmental benefits while minimizing the related losses of other, important habitat values. (US Army Corps of Engineers *et al.* 1998)

- In San Diego Bay, dredge material has been used successfully for habitat enhancement. Medium-depth habitat has been built up to shallower-depth habitat so that eelgrass could be planted.

San Diego Bay project sponsors are developing some experience with habitat enhancement using dredge material. Dredge spoil has been used successfully within the Bay to build up medium-depth habitat to shallower depths appropriate for eelgrass planting. This has occurred at Navy Eelgrass Mitigation Sites 1, 4, and 6. Fill deposited at NAB has now become prime habitat for the California least tern and western snowy plover, as well as subtidal eelgrass. The CVWR is a 32 acre (13 ha) island within the Bay that was created from placing dredge spoil in subtidal habitat to mitigate for development of the Chula Vista Marina.

Table 5-3. Biological Effects of Various Dredging Methods Available in San Diego Bay.[1]

Dredging System (mechanism and transport method)	Description	Biological Effects
Stuyvesant (cutter head and hopper)	The Stuyvesant is a self-contained hydraulic unit. It dredges and disposes in pulses. Dredging occurs for about three to four hours, then the unit moves offsite for about five hours to dispose of the dredged material. Usually for maintenance dredging.	Cutter-head dredges reportedly cause less turbidity than hoppers and clamshells (US Army Corps of Engineers1986), but at least some operation of the Stuyvesant in the Bay has resulted in more turbidity both from the head itself and from the overflow slurry, (M. Perdue, US Navy, pers. comm.). However, the intermittent operation allows turbidity to settle and appears to have increased foraging opportunities for the California least tern, brown pelican, and other fish-foraging species that congregate around the dredge apparently awaiting periods when the turbidity plume dissipates (M. Perdue, pers. comm.). Also, turbidity from a cutter-head-type dredge appears to contain material to within the immediate vicinity of the dredge compared to other dredge types (US Army Corps of Engineers 1986). However, overflow of the hopper can cause a large increase in the turbidity plume, suggesting that some restriction on overflow may be necessary if a hopper is used to remove contaminated sediment (US Army Corps of Engineers 1986). Observations in several locations indicate concentrations adjacent to the hopper overflow port at more than five orders of magnitude above background (Marine Board Commission 1985).
Florida (cutter head and scow)	The Florida operates continuously with scows coming and going to dispose of the dredged material. It does not move far from its location, which occupies about a 656 ft (200 m) diameter site. Use is limited by distance from an electrical source.	The combination of continuous operation and use of a cutter head results in increased turbidity. The Florida is an electric dredge, so it has reduced air emissions than other types.
Dutra (clamshell and scow)	Used to dredge the turning basin for the CVN project, the Dutra mechanical dredge operates continuously, with scows coming and going to dispose of the dredged material. A clamshell dredge is typically used in areas where hydraulic dredges cannot work because of proximity to docks, piers, etc. Can be used for maintenance and new-work dredging.	Continuous operation does not provide an opportunity for turbidity to settle and avian foraging to resume. Resuspension of solids (turbidity) from a clamshell is typically higher than for most cutterheads, especially when the scow is allowed to overflow (US Army Corps of Engineers 1986). During dredging for the carrier Stennis CVN, the clamshell turbidity plume to 12 in (30 cm) depth (believed to be the depth of importance to the foraging California least tern) never persisted more than one hour and never extended more than a 98 ft (30 m) circumference from the dredge point during Navy operations (M. Perdue, pers. comm.). The clam shell produces more localized turbidity nearer the water surface than the cutter head (Raymond 1984).
Suction (cutter head and hydraulic pump to fill site)	This method uses continuous, self-contained dredging and pumping by way of a hydraulic pipe to the disposal site. Currently used to move material from the north end of NAB to the disposal site. It is only useful for smaller projects.	The primary effects are temporary increases in turbidity and destruction of benthic infaunal community at the dredge and fill sites.

1. The extent of effects depends upon variables such as sediment characteristics, dredging methods, and hydrodynamic characteristics of the dredging site.

- Other mitigation using dredge spoil has been proposed, including some projects that were introduced in the South Bay Enhancement Plan.

Other mitigation projects using dredge spoil have been proposed within the Bay, many of which are described in Section 4.2.2 “Mitigation and Enhancement” and Map C-6. For example, the South Bay Enhancement Plan (MBA 1990) proposed a number of projects for general enhancement of Bay productivity, some of which could be supported with dredge material. An example is expanding intertidal, salt marsh and shallow subtidal eelgrass habitats such as at Emory Cove. Least tern nesting sites at Lindbergh Field, NASNI (six sites totaling 23 acres [9 ha]), Delta Beach North (about 18 acres [7 ha]) and Delta Beach South (about 60 acres [24 ha]) could also benefit from dredge material to enhance the substrate and expand the site for least tern nesting. Islands for colonial nesting birds could be created with dredge material, such as at or near the Salt Works. The CVWR could benefit from enhancement, as it is settling. The surrounding levee system is eroding, and California least terns or other sensitive species appear to use it sporadically (US Navy 1992). Finally, salt pond levees could benefit from substrate enhancement to improve the success of many birds attempting to nest there.

Proposed Management Strategy—Dredge and Fill Projects

Objective: Conduct necessary dredging and dredge disposal in an environmentally and economically sound manner.

I. Ensure the protection of portions of the Bay ecosystem that may be sensitive to dredging and dredge disposal.

A. Ensure sediment is adequately characterized chemically, physically, and biologically based on the exposure pathways of concern at a particular site. Do as much as possible of this work in advance of projects.

1. Ensure that current regulations adequately identify appropriate design or operational features necessary to control all contaminant pathways of concern at a disposal site using worst-case scenarios.
2. Identify constraints, including potential contaminant exposure pathways, in advance of potential projects. Use information from the Ecological Risk Assessment currently being developed for the Bay by SPAWAR (K. Richter, pers. comm.) to identify key susceptible organisms in each habitat/ecosystem, and the critical exposure pathway.
3. Identify and seek to correct gaps in existing sediment testing criteria, such as the need to detect ordnance in advance. Expand on current work being conducted by the Navy to predict the likelihood of ordnance encounters during dredging.

B. Synthesize existing and develop new criteria, practices, and mitigation measures for successful dredge and fill in a Bay ecosystem context, using existing regulations and mitigation practices to start. The criteria should include timeliness, maximizing scheduling outside of breeding season for the California least tern and perhaps other organisms at risk, minimizing periods of turbidity, minimizing contaminant exposure, etc.

1. Investigate the possibility of other organisms having seasonal vulnerabilities to turbidity in certain locations or habitats in the Bay, such as migratory birds or the larval stages of susceptible fish or filter-feeding invertebrates. Review and schedule dredging with this information.
2. Consider the use of target management species that may be affected by the short-term or cumulative effects of dredging practices. Consider effects on such species in environmental documentation. For example, any visual predator may be affected by an increase in turbidity.

C. Define habitat values and vulnerable species in sufficient detail at both the site of impact and the mitigation site to ensure impacted values are adequately mitigated.

1. Delineate intertidal habitat values for fishes, invertebrates, and shorebirds so that all are addressed and protected.

D. First avoid, and then minimize, the need for dredging close to shore, which can contribute to the loss of intertidal habitats and the need to armor the shoreline.

1. Consider restricting new dredging to locations where the shoreline is already armored.
2. Locate or design new dredge channels to minimize the need for shoreline protection.
3. Maximize use of existing channels rather than creating new ones.

E. Minimize air quality emissions during large dredging operations.

1. Evaluate project emissions and obtain permits well in advance of implementation to stay within air quality thresholds.
2. Where air emissions are of concern and use of an electric dredge is feasible, use this approach to minimizing emissions.

F. Establish means for project sponsors to routinely learn about and incorporate the latest research and mitigation practices.

II. Maximize the use of dredge material for beneficial reuse / habitat enhancement in the Bay consistent with the habitat objectives and policies of this Plan and other comprehensive, regional planning efforts.

A. Habitat enhancement trade offs should be guided by priorities of this Plan or other regional plans, and on a case by case basis depending on resource values at the site.

1. Priorities and policies for beneficial reuse within the Bay should be based on habitat scarcity in relation to historic proportions (see Table 2-3), until research provides a more functional understanding of habitat values and interconnections.
2. When mitigation for filling in Bay waters is required, consideration should be given to habitat values of the site impacted compared to the resulting fill. This should include disturbance, such as at an industrial site, as well as an evaluation of the relative scarcity of the habitats affected and created.
3. Beneficial reuse projects should where possible be developed specifically for proactive habitat enhancement and restoration aimed at a net gain in current habitat values in the Bay, rather than arising solely from reactive mitigation projects aimed at avoiding a net loss of habitat values.

B. Develop a comprehensive inventory of projects for the beneficial reuse of dredged material around the Bay.

1. Identify areas of the Bay for which dredged material could be used for habitat restoration and enhancement, beginning with Map C-6 and Table 4-3 in this Plan.
2. Establish criteria for material suitable to use for restoration at each site.
   - *a.* Any dredged material used for habitat enhancement or restoration should remain water-saturated, reduced, and near-neutral in pH, since these characteristics have a great influence on the environmental activity of any chemical contaminants that may be present (Regional Water Quality Control Board 1994).
   - *b.* Identify what characteristics constitute sediment that would be suitable for least tern nesting substrate enhancement.

   c. Characterize sediment suitable for enhancing habitat for target species and communities.

  3. Identify and seek funding support since such enhancement can be much more expensive than other disposal alternatives.

- **C.** Identify a multi-user beneficial reuse site for habitat restoration or enhancement in the Bay (e.g. 'LA-5-type' site for the Bay, Emory Cove, or abandoned channels in south Bay).
  1. Develop a site plan.
  2. Develop sediment criteria for reuse at specific sites in advance of dredging projects.
  3. Allow for public comment on the site.
  4. Consider the new National Wildlife Refuge at the Salt Works for future enhancement opportunities.

- **D.** Investigate new locations for both upland and nearshore confined disposal sites.
  1. Seek a means to combine habitat enhancement with nearshore confined disposal sites.

III. Obtain consistency, predictability, and timeliness in decisions involving dredging regulation and implementation.

- **A.** Improve coordination and integration of agency policies by establishing a comprehensive dredging plan for the Bay or region, which ties into the Shoreline Erosion Committee's policies on beach nourishment and would seek to:
  1. Eliminate unnecessary dredging.
  2. Maximize the use of dredged material as a resource.
  3. Ensure that dredging and disposal is conducted in the most environmentally sound fashion.
  4. Reduce the need for some studies and tests associated with the Environmental Assessment process.
  5. Reduce the need for separate Environmental Assessments for each project.

- **B.** Develop a biological effects database for bioaccumulative contaminants (Maritime Administration Recommendation, Report to Congress). Identify contaminant hotspots where additional testing/alternative use scenarios may be needed.

- **C.** Identify opportunities to "streamline" testing needs by accomplishing some work in advance on a comprehensive basis.

IV. Sponsor research on dredging, dredge disposal, and their environmental effects in support of the regulatory process and impact analysis.

- **A.** Support studies that help establish criteria for successful implementation of dredging projects, especially beneficial reuse of dredge material.

B. Establish the effects of changes in channel configuration that may result in changes in salinity, sediment accumulation, or erosion of sensitive intertidal habitats, or affect aquatic organisms.

1. Seek better understanding of the behavior and fate of sediment in the Bay.
2. Determine if alteration of substrate and changes in circulation and sedimentation patterns due to dredge and fill activities are affecting the salt marsh and intertidal habitats of south Bay.

C. Research methods for detecting anomalies in the site to be dredged, such as ordnance that would facilitate beneficial reuse without excessive cost to the project sponsor.

D. Research designs for shoreline protection close to deep channels that provide more shallow subtidal or intertidal habitat.

E. Identify alternative dredging practices and general design considerations for new projects to reduce dredge material volumes.

V. Support the Port's need to find environmentally beneficial mitigation solutions. Seek implementation of the Coastal Conservancy's recommendations in their reporting (required under Assembly Bill 2356 [Chapter 751, Statute 1989]) on issues with ports and mitigation needs, timeliness, acceptability, and effectiveness.

A. As recommended in AB 2356, the Coastal Conservancy should prepare restoration plans for candidate Port mitigation sites.

B. The State of California Resources Agency and Coastal Conservancy should continue supporting the SCCWRP or other appropriate banking mechanism that would enable ports to satisfy their mitigation requirement.

C. Resource agencies should form joint ventures with ports for habitat enhancement and mitigation.

D. Procedures should be developed to avoid future delays associated with the use of funds generated on public trust lands to implement mitigation projects outside the boundaries of port jurisdictions.

E. Port and agency directors should participate consistently and productively in regional mitigation working groups.

F. The Coastal Conservancy and CDFG should take the lead in completing projects to help develop the mitigation credit appropriate for developing artificial reefs. Determine if this is appropriate for San Diego Bay. Also, consider mitigation credit for improvement in habitat values of armored shorelines. (This latter item was not part of Coastal Conservancy recommendations.)

5.1.2 Ship and Boat Maintenance and Operations

This section addresses ship and boat maintenance practices performed at Navy installations, commercial shipyards, boatyards, and marinas (including yacht clubs), which are leased from the Port for public and private uses.

Specific Concerns

- Antifouling coatings, or biocidal paint, on boats and ships are significant contributors of copper and other metal contaminants in the Bay due to leaching and cleaning of hulls.
- Pollution is a problem at marinas due to improper practices related to boat cleaning, fueling operations, and marine head discharge.
- Pollutants accumulate in areas of high vessel density and low hydrologic flushing.
- Navy installations and private marinas in the Bay are not presently regulated under waste discharge permits, with the boating community pursuing a voluntary compliance program.
- Potential remains high for continued exotic species introduction from ballast water purged during ship maintenance and moorage.

- See also Sections 5.2.2 "Storm water Management," 5.3.1 "Remediation of Contaminated Sediments," and 4.3.1 "Exotic Species."

Background

Water quality issues are the main concern with boat and ship maintenance practices. A secondary issue is the potential to introduce invasive, exotic marine species from ships as the result of ballast flushing at shipyards during maintenance.

Ship maintenance occurs at both Naval installations and commercial shipyards in the Bay. While aircraft carriers dock at NASNI, major repairs and maintenance of carriers are performed outside of San Diego Bay. Repair and maintenance of most other Navy ships occurs at NAVSTA San Diego, located at the foot of 32nd Street. In 1991, the NAVSTA was home to 87 surface ships while the NAB at Ballast Point serviced 19 submarines, 2 submarine tenders, and 2 dry docks.

Navy dry docks are used for performing certain repairs and maintenance, such as paint removal and repainting with an anti-fouling coating. While in port, wastes are transferred from carriers and other ships to tanker trucks and transported to the Navy onshore industrial waste treatment facility for processing. These wastes include bilge water, boiler blowdown, equipment cooling water, and evaporator brine (US Department of the Navy 1995).

- Copper derived from anti-fouling coatings on the hulls of Navy ships continues to be leached into the Bay's water and sediments.

Discharges from the hull and exterior of docked ships were an issue addressed in the Navy's Homeporting EIS (US Department of the Navy1995). The underwater hull surface of Navy ships has copper anti-fouling coatings to control the build up of marine fouling organisms and other organic matter. Copper unfortunately leaches into the marine environment at a rate of about 10 micrograms/cm^2/day. In 1995, the 72 Navy ships then homeported in San Diego Bay had a maximum potential copper leaching of about 60 lbs (27 kg) per year according to the Homeporting EIS (US Department of the Navy 1995). As the number of Navy ships in the Bay continues to decline, the amount of newly contributed copper to the Bay at ship docks and yards accumulates at a slower rate. However, the anti-fouling paints used on Navy ships presently contain higher levels of toxicants than those used on commercial and recreational vessels (Regional Water Quality Control Board 1994). Copper is a heavy metal that is toxic to many marine organisms in large concentrations. Existing copper in marine sediments can continue to be removed—expensively and gradually—through dredging of the contaminated sites and sediment remediation technology (San Diego Unified Port District 1995a).

Commercial ship yards are located along the east side of the Bay: NASSCO (north of NAVSTA), Southwest Marine, Continental Maritime, and Campbell Shipyard. Maintenance and construction of ships, such as tankers and container ships, also occur at the yards. A detailed description of shipyard activities and their water quality issues can be found in a Regional Board staff report (Regional Water Quality Control Board 1994).

- Natural leaching from hull paint is the greatest source of the copper, followed by in-water hull cleaning during ship and boat maintenance.

The annual copper load to San Diego Bay from all sources is estimated at almost 83,000 lbs (38,000 kg) (PRC Environmental Management 1996). The same report estimated that leaching of copper from anti-fouling hull paint, which includes copper from leaching, hull cleaning, and ship and boat yards, accounts for about 82% of this load, or 68,000 lbs (31,000 kg). These estimates contrast sharply with the estimated contribution of Navy ships to annual copper loads discussed above. In-water hull cleaning has been or is still being carried on at Naval installations and commercial shipyards, boatyards, and marinas.

Underwater hull cleaning of ships is usually performed by a diver-operated brush (using a Scamp or a Brush Kart) to remove the slime layer of diatoms and algae. If a hull has gone too long without cleaning, then barnacles can accumulate on the surface roughened by the slime layer. At this stage, hull cleaning by a Scamp can also rip off anti-fouling paint, which releases copper into the water and sediments. Presently, no underwater hull cleaning is occurring in civilian shipyards in the Bay (P. Michael, pers. comm.). However, Navy installations continue the practice as well as marinas. The Navy uses large diving operators under contract who operate with a workboat and hoses. At boatyards and marinas, incidental underwater cleaning by divers is presently an unregulated activity conducted by an estimated 75 divers.

- Management of exotic species introductions from ship ballast water is discussed in Section 4.3.1 "Exotic Species."

Besides water quality issues, the potential is high for the continued introduction of exotic species when ship ballast tanks are emptied at dry dock. This problem and a management strategy are described in detail in Chapter 4, under Section 4.3.1 "Exotic Species."

Current Management

A combination of regulatory action and water quality monitoring, primarily by the state, is ongoing to help improve boat and ship maintenance practices in San Diego Bay. Citizen advocacy groups, such as the Environmental Health Coalition, also monitor the actions of the regulatory agencies to help ensure that adequate water quality protections are being taken.

- One biocidal paint ingredient, TBT, is no longer allowed on most boats and smaller ships due to its damaging water quality and ecological effects.

Tributyltin was commonly used as an anti-fouling paint on boats in the 1980s. By 1986, high concentrations of TBT were detected in the surface waters and in the tissues of bay mussels at yacht harbors and marinas within San Diego Bay (Valkirs 1986). Due to TBT's water quality and ecological impacts, the federal government restricted the use of TBT in 1988 to only aluminum vessel hulls, vessel hulls over 82 ft (25 m) in length, or to the outboard motor or lower drive unit of a boat of any size (Richard and Lillebo 1988; US Congress 1988; California Department of Boating and Waterways 1993). Anti-fouling paints containing TBT may only be applied to vessels by certified applicators and may not be applied to docks, piers, or fishing equipment. In addition to EPA, the California Department of Pesticide Regulation regulates the application of anti-fouling paints.

- Water quality violations by eight boatyards led to a state-mandated cleanup of contaminated sediments and soil.

In 1986, the monitoring of boatyards, shipyards, and marinas led to eight Cease and Desist orders from the RWQCB San Diego. Seven boatyards were also issued Cleanup and Abatement Orders for violating allowable levels of copper, mercury, and TBT in their NPDES Permits (Regional Water Quality Control Board 1990a). These sites were cleaned up in 1995. Boatyard sites also perform out-of-water hull cleaning and painting, an activity that can be more closely controlled but which is subject to storm water runoff problems. Campbell Shipyard is presently under a Cleanup and Abatement Order by the Regional Board to remediate copper-contaminated sediment and soil.

- All commercial boatyards and shipyards in the Bay are regulated by recent NPDES permits that require BMPs be implemented.

Instead of individual permits, waste discharge from all eight of the boatyards in the Bay is now regulated by one General NPDES Permit (pursuant to Sec. 402 of the CWA, as amended), most recently issued in 1995 from the Regional Board (Regional Water Quality Control Board 1995). Shipyard discharges are regulated under two General NPDES Permits approved in 1997 (Regional Water Quality Control Board 1997a and b). In addition to specific prohibitions, discharge specifications, and other provisions, each discharger must prepare and implement a BMP Program that includes specific BMPs for the prevention, control, treatment, and response for pollution. These permits supersede the earlier individual discharge permits that had expired. All shipyards are also subject to the statewide General Industrial Storm water Permit.

The federal CZARA of 1990 required EPA to develop the reference “Guidance Specifying Management Measures for Sources of Nonpoint Source Pollution in Coastal Waters,” which includes measures for marinas and recreational boating and their “economic achievability” (US Environmental Protection Agency 1996). States were to incorporate these measures in their own Nonpoint Source Pollution plan (California Coastal Commission 1996). California’s answer was a two part program. If a problem is detected, then Phase 1 would recommend that industry regulate itself.

- Underwater hull cleaning of recreational boats is still under a voluntary program.

BMPs have been proposed by underwater diving contractors working on recreational boats (Bear 1989; McCoy and Johnson 1995b). A training program for boat cleaners is underway now in the state, advising on such practices as no power tools, use the least aggressive removal technique, clean the hull once a month after the paint loses its effectiveness to remove slime layer and to keep barnacle larvae from settling; advising boat owners when paint is starting to fail (up to two years), and hauling the boat to a boatyard. If the RWQCB determines that not enough boatyards use the self-certification program, then the Board can initiate a mandatory program.

Boat discharge of sewage also remains a management issue. The portion of the Bay that is less than 30 ft (9 m) deep MLLW is a No Discharge Zone for treated or untreated sewage, as declared by the EPA (Regional Water Quality Control Board 1994). In deeper waters, discharge of treated sewage through a properly functioning USCG certified Type I or Type II marine sanitation device is allowed.

Educational Efforts

- Informative pamphlets and boater education seminars are part of the local pollution prevention program by the Port and UC Sea Grant for the boating community.

Major educational efforts of the boating community are underway to address pollution problems. The University of California, San Diego (UCSD), Sea Grant Program, has prepared a series of pamphlets on pollution prevention for marinas and recreational boating, based on a scientific literature review, industry and boater recommendations, and comments by local stakeholder groups (Clifton *et al*. 1995; McCoy and Johnson 1995a–e). Sea Grant also has held several boater education seminars around the Bay that were well attended and received (R. Kolb, Port, pers. comm.). The Port distributes the Sea Grant informational materials to the boating community during monthly inspections at marinas as part of the Municipal Storm water Program (San Diego Unified Port District 1995b). Commercial and environmental representatives have also produced useful clean water materials for marinas and boaters in San Diego Bay (Bear 1989; Environmental Health Coalition 1991). Management measures for polluted runoff from marinas and recreational boating are proposed in the CCC's procedural guidance manual, primarily to inform regulatory and land use planning decisions (California Coastal Commission 1996).

- A new Boater's Best Management Practices Guide was written by and for the local boating community.

In 1997, the local Clean Vessel Act Oversight Committee of the Coast Guard Auxilliary received an $18,000 grant from the California Department of Boating and Waterways for educational materials: pamphlets, reprinting costs, tote bag distribution, and public service announcements for television, among other items. Their success was rewarded with an enlarged grant of $30,000 for 1998. Since visiting boaters can come from marinas to the north, the group also has established links with the Santa Monica Bay National Estuary Program's educational efforts (P. Michael, pers. comm.). A1998 product was an attractive, easy-to-read, 40 page booklet entitled the Boater's Best Management Practices Guide, which presents alternative practices to reduce or eliminate pollution from recreational boats and was written by a member of the local boating community (B. Dysert, US Coast Guard, Clean Vessel Act Oversight Comm., pers. comm.).

- Shipyards and a boat anchorage site were identified as high priority "hot spots" in recent Bay monitoring.

Evaluation of Current Management

Water and Sediment Quality Conditions

While many improvements have been made in management practices and in water quality conditions, the Bay continues to have pollution problems at shipyards, boatyards, and marinas. Sites ranking high priority for hot spot status in the State Bay Protection and Toxic Cleanup Program were most often associated with commercial shipyards, Naval installations and a boat anchorage area (Fairey *et al*. 1996). In addition to the copper pollution noted above were high concentrations of hubcaps, chlordane, and other metals. Toxicity and degraded benthic communities were other indicators of their relative pollution. No study has yet attempted to separate the relative contribution of historic sources and practices from current ones, although most would acknowledge that today's practices are better and a considerable amount of the contaminants in the Bay's sediments are a legacy of over a century of intensive ship and boat use and maintenance (Regional Water Quality Control Board 1994).

- TBT levels have significantly declined in many areas of the Bay since its use was severely limited.

By 1991, TBT surface water and mussel tissue concentrations had significantly decreased in San Diego Bay marinas (Valkirs *et al*. 1991). A more recent study also shows an overall decline in TBT sediment concentrations at commercial and Naval basin areas, although the concentrations are still higher than other areas in the Bay (Fairey *et al*. 1996). Pollution from TBT remains a serious concern, however, in areas of high vessel density and low hydrologic flushing (Regional Water Quality Control Board 1994).

- High copper levels have caused the north Bay's water quality to be listed by the state as impaired.

The North Bay's water quality is listed as impaired on the SWRCB's "303d list" under the CWA due to high levels of copper, mainly from leaching originating at boatyards. Following review by the state Office of Administrative Law and conclusion of the CEQA process, one area in the central Bay has been officially declared a "toxic hotspot."

Enforcement Efforts

- Contaminated sediment must be cleaned up at one site and prevention measures must be adequately implemented at two shipyards due to recent enforcement efforts.

Enforcement of the CWA's provisions is ongoing by both the RWQCB and by citizen advocacy groups. In September 1997, the Regional Board voted to fine the Port and two former boatyard tenants $132,000 collectively for missing deadlines to clean up contaminated sediment in ACH. High concentrations of copper and mercury in the sediment were noted to have come from the removal of anti-fouling paint during boatyard operations before 1988, the date of the first cleanup request. One large shipyard avoided a protracted legal battle with two environmental groups by arranging a settlement agreement over its storm water pollution program in 1996. Another shipyard was sued over inadequate containment of storm water runoff, with the judge recently ruling that the violations must be corrected.

- Shipyards are challenging the latest industrial storm water permit requirements in court.

The issuance of new NPDES permits with very specific and comprehensive conditions for the commercial shipyards in 1997 by the Regional Board may have addressed some of the lawsuit's issues. Board staff is reportedly "optimistic" that all five shipyards in the Bay will come up to required environmental standards (Manson 1997). To help ensure environmental compliance, the Port incorporates environmental clauses into tenant lease agreements, assists tenants with environmental compliance issues, maps known contamination sites, and provides permit assistance (San Diego Unified Port District 1995b). Local environmental groups have continued to question the capability of Regional Board and Port enforcement efforts (Manson 1997, Surfers Tired of Pollution 1997). As major NPDES dischargers, shipyards admittedly require a high level of regulatory effort (Regional Water Quality Control Board 1994). The two most recent NPDES permits for the shipyards were challenged by the permittees for being unreasonable and not achievable; after the permits were upheld by the State Board in September 1998, the dischargers have moved the issues to the court.

- Neither Naval installations nor the marinas at the Bay are under storm water permits.

No specific NPDES permits for Bay marinas and Navy installations (with the exception of a portion of the 32nd St. Navy installation) currently exist. They are on the list of "things to do with no timetable" due to the lack of experienced staff to be able to move on such complex permits (B. Posthumus, Regional Water Quality Control Board, pers. comm.). Many marinas across the country obtain NPDES permits for storm water discharge management (US Environmental Protection Agency 1996). However, there appears to be resistance by the Bay's boating community for such a permit because of the potential costs and anticipated regulatory hassles. The absence of such permits is not necessarily a violation.

Boat Sewage Discharge

In practice, the discharge of sewage or other pollutants from foreign vessels or small boats is difficult to regulate. The RWQCB has no enforcement arm active in the Bay (except the imposition of fines). The USCG is limited to dealing mainly with oil spills. The San Diego Harbor Police help to enforce the Port's ordinances. The CDFG can enforce Fish and Game Code Sec. 5650 on water pollution, but detection and proof are problematic. Since detected sewage pollution cannot be readily traced to an individual boat, an eyewitness is usually needed who is willing to go to court and testify. Clean boating brochures for the public warn that state and federal laws prohibit the dumping of plastic, garbage, and oil, but there is no such warning of a prohibition on sewage discharge (California Department of Boating and Waterways 1993; San Diego Unified Port District 1996b).

- The control of sewage discharge from recreational and live-aboard boats appears to be inadequate due to several problems.

Sewage discharges in recreational marinas are considered to be more significant than at Naval berthing areas (Regional Water Quality Control Board 1994). The cumulative effect of sewage from boats in combination with sewage from storm water runoff can produce sufficient contamination to cause a short-term beach closure to human water contact in the Bay (Gonaver *et al.* 1990). At present, 15 sewage pump-out stations are available to boaters in the Bay, with 7 of them free and others charging $5–10 per use. Two pump-out services are also available (B. Mount, San Diego Harbor Police, pers. comm.). However, boat users sometimes do not know how to use the pump-out equipment, are intimidated by it, are unaware of the facilities, or do not care. Besides marinas, anchorages can also be important sources of human pathogens from vessel sewage releases (Regional Water Quality Control Board 1994). Regular sewage pump-out from live-aboard boats would seem to be an obvious area for enforcement, but responsibility appears unclear. The Regional Board's 1994 Basin Plan states that a study is needed of the levels of sewage-related bacteria from vessel discharges to allow the Board to make decisions based on measured levels. Based on these studies, the Board could advise the County Health Officer, the Port, and the USCG "so appropriate actions could be taken to abate the effects of sewage discharges from vessels."

Monitoring and Research

- Monitoring needs to be designed to answer several different management needs related to water quality trends, BMP implementation and effectiveness, and water quality standard compliance.

The prospects for adequate monitoring of water and sediment quality in the marinas, boatyards, and shipyards remain uncertain. To answer the many management questions, monitoring needs to focus on several different functions: (a) Trend (e.g. measurements at regular intervals to determine long-term trend in certain conditions), (b) Effectiveness (e.g. determination if a BMP had desired effect), (c) Compliance (e.g. determination if specified water quality criteria are being met), (d) Implementation (e.g. whether activities, such as BMPs, were carried out as planned). Funding to support monitoring is needed (e.g. a consistent funding mechanism available from perhaps various sources, including dock and marina owners).

The State Bay Protection and Toxic Cleanup Program presently has no funding to continue its initial trend monitoring that had only begun to assess the pollution sources and sediment conditions for San Diego Bay (Fairey *et al.* 1996). As a condition of the general permits recently issued for all of the boatyards and shipyards, the RWQCB has required compliance monitoring of the water and sediment for each site. However, these sampling stations are not necessarily the same as those used for the State Bay Protection monitoring program and the data may not be comparable or useful as a means to assess the effectiveness of the Board's permit conditions (e.g. BMP Plan).

- Several promising nontoxic alternatives to copper-based hull coatings developed through research efforts are now in the testing stage.

Research is underway, particularly by the Navy, for nontoxic alternatives to copper and TBT (still used by large ships) as anti-fouling coatings. One promising new method is called "foul-release coatings" because their unique surface chemistry creates a surface to which fouling organisms cannot readily adhere (US Department of the Navy 1998). Since this type of coating uses a physical rather than a chemical mechanism, these silicone coatings have been ruled exempt from reporting under the Federal Insecticide, Fungicide, and Rodenticide Act, which usually requires a very lengthy (10 year estimate) process to register a new product. The bonding and durability of the new coatings are being tested in field demonstrations on a few Navy and USCG boat hulls (in the Great Lakes and the Atlantic Ocean). Another option is a hull paint additive derived from red chile peppers (capsaicin) that acts as a repellent to animals (Henry 1998). This additive, however, may need to comply with the Federal Insecticide, Fungicide, and Rodenticide Act's lengthy testing process. A strategy would need to be articulated for converting boaters to the new coatings.

Proposed Management Strategy Introduction—Ship and Boat Maintenance

- See also Implementation under Section 5.5 "Environmental Education."

As noted above, a voluntary compliance program for the boating community that uses an intensive educational campaign, in combination with peer pressure, began in 1997. Since this effort is just beginning, it should be fully promoted and then evaluated in five years or so to determine its effectiveness. Such an educational approach also follows the conclusions of a study of boat operators in the Bay, in which it appeared that anti-fouling biocides could be reduced by at least one third simply by educating boat owners about the chemical mechanisms involved in anti-fouling paints, by explaining the environmental and economic advantages of using slow-release paints, and by encouraging them not to repaint until their paint's useful life has expired (Nichols 1988).

- The Navy and Port have opportunities to improve pollution prevention at their ship and boat facilities through detailed, specific directions to their installations and leaseholders.

The Bay Panel made recommendations concerning some of the boat moorage and maintenance issues in its recent plan (San Diego Bay Interagency Water Quality Panel 1998). These suggestions are also included in the strategy below. Since shipyard activities pose such a significant threat to water quality, "it is critical that shipyard BMPs are effectively and diligently implemented" (Regional Water Quality Control Board 1994). In a national study of marina practices, exemplary marine operators claimed that "clean marinas are good for our business" and that their customers want to be part of a marina that is doing something good for the environment, such as protecting clean water, and are willing to pay for clean marinas (US Environmental Protection Agency 1996). This beneficial effect needs to be promoted more to the Bay's marina operators. Since the Regional Board is legally constrained in telling how dischargers must comply, an alternative would be for both the Navy and the Port to internally establish and enforce water quality protection procedures for their shipyards, boatyards, marinas, and anchorages.

A coordinated trend monitoring program of the Bay may be conducted by the Southern California Coastal Water Research Project (SCCWRP), as an extension of its Southern California Bight program. Advantages of such an effort include the sharing of costs by all of the dischargers, using standard monitoring methods and stations, and getting a better picture of the entire Bay. This effort could complement the State Bay Protection Program for toxic sediment monitoring and also assist with compliance monitoring of NPDES permits for shipyards and boatyards.

Proposed Management Strategy—Ship and Boat Maintenance

Objective: ***Manage the maintenance of boats and ships in San Diego Bay in a manner that achieves significantly improved water and sediment quality, healthier marine organisms, and economic good sense.***

- Pollution prevention through education and other voluntary means should continue to be promoted.

I. Promote opportunities for the prevention of pollution from shipyards, boatyards, marinas, and anchorage areas.

A. Encourage education about each boater's clean water responsibility.

1. Ensure that each boater is clearly educated about BMPs for proper boat maintenance.

2. Target boat dealers as a source for distributing information about BMPs in association with boat sales.

3. Fully promote the recent voluntary compliance program of the boating community. Reevaluate in at least five years to determine its effectiveness.
4. Support the regular scheduling of UC Sea Grant sponsored seminars and workshops for the boating community throughout the Bay.
5. Prepare and distribute Bay-specific radio and TV spots to educate about boating pollution, along with written handouts.
6. Work closely with nonregulatory, educational organizations such as the Coast Guard Auxilliary, UC Sea Grant, and boating organizations in the promotion of pollution prevention.

B. Advance the concept to marina operators that clean marinas are good for business (US Environmental Protection Agency 1996).

1. Ensure necessary facilities at sufficient bayfront sites for sewage pumpouts and waste oil receptacles for all boats.
2. Encourage marinas, yacht clubs, fuel docks, and the Port to establish standard fueling, waste oil handling, bottom cleaning, repair, preservation, and painting procedures that must be followed by boaters.
3. Encourage marina operators to practice BMPs that are beyond the minimum practices often expected, such as:
   a. Add green vegetated buffers at marina sites where possible for runoff control.
   b. Move power wash pads for boat hulls away from the bulkhead and adding filters to capture paint chips. Promote pollution prevention as a major priority to boatyards and shipyards.
4. Support improved practices at boatyards and shipyards by recognizing significant efforts through an annual Better Bay Award program.
5. Emphasize cost savings of preventative actions in comparison to remedial, cleanup actions (following spills and chronic discharges).

- Regulatory efforts must be supported when voluntary efforts are not adequate.

II. Support the application and enforcement of regulations when educational and voluntary practices are not sufficient.

A. Promote needed pollution control enforcement for boaters, marinas, and yacht clubs.

1. Encourage enforcement of marine debris regulations and the certificate of adequacy requirement of trash receptacles at all marinas and yacht clubs.
2. Encourage enforcement of marine sanitation device/holding tank regulations, and maintenance of sewage pumpout facilities for boaters and marinas throughout the Bay.
3. Based upon a study of the levels of sewage-related bacteria originating from vessel discharges, the RWQCB should advise the vessel operator, County health officer, the Port, and the USCG so appropriate actions could be taken to abate the effects of sewage discharges from vessels.
4. Ensure that regular, legal sewage pump-out occurs from live-aboard boats as a condition of their use. Enforce for noncompliance when necessary.

B. Ensure that BMPs are effective and diligently implemented. (See also: *IIIA* for effectiveness monitoring.)

1. Promote compliance of commercial boatyards and shipyards with existing NPDES permit conditions for BMP Plans and implementation.
2. Request that the San Diego RWQCB adopt a reasonable timetable to get Navy installations and commercial marinas under NPDES permits.
3. Incorporate internal pollution prevention plan requirements by the Navy for Navy installations through specific instructions and by the Port for Port ship and boat maintenance facilities through lease conditions, to include specific components:
   a. An audit of all pollutants generated by the facility and their sources within the operation.
   b. An analysis of appropriate pollution prevention methods to address each pollutant.
   c. A strategy to prevent pollution, including specific objectives to be accomplished.
   d. Anticipated short- and long-term costs and savings.
   e. A detailed description of tasks and time schedules for the above.

C. Promote coordination among all local, state, and federal regulatory agencies on conditions and measures for managing boat and ship maintenance areas.

1. Encourage local governments and the Port to address the water quality issues in their updated local coastal plans.
2. Seek regulatory consistency among conditions and measures to simplify compliance for the permittees.

D. Support an active, on-water presence for enforcement, investigation, assistance, early warning sampling, and deterrence.

- Monitoring and research must be better coordinated to aid management decisions.

III. Foster an improved, coordinated monitoring and research program for marinas, boatyards, and shipyards.

A. Develop the quality and quantity of information needed to better aid management decisions.

1. Ensure standard monitoring stations and methods among the various monitoring programs to perform trend, effectiveness, and compliance monitoring for boat and ship maintenance areas.
2. Evaluate the effectiveness of BMP plans for shipyards, boatyards, and marinas through effectiveness and implementation monitoring.
3. Continue to evaluate the relative contribution to water and sediment contaminant levels of historic sources and current sources, such as through the existing Bay Protection Program or the work of SCCWRP in the Bay.
4. Continue measuring the levels of sewage-related bacteria originating from vessel discharges in order to allow the Regional Board to make decisions based on measured levels, such as through current efforts by the County Environmental Health Division.

B. Promote research into methods and materials to reduce or eliminate pollution from boat and ship maintenance.

1. Encourage the development of less toxic and non biocidal anti-fouling paints for boat hulls.
2. Ensure testing of new paints is thorough and adequate to protect the environment but not to a point that creates expensive disincentives for alternative researchers.
3. Request field demonstration/pilot project of promising nontoxic coatings on ships and boats in San Diego Bay to help evaluate effectiveness of durability, bonding, and repellency (of fouling organisms) under local conditions.

- See also Section 4.3.1 "Exotic Species" for ballast water strategy.

IV. Actively support ballast water management for vessels entering and using San Diego Bay for maintenance or moorage. See relevant policies under Section 4.3.1 "Exotic Species."

A. During ship maintenance activities, encourage as condition of NPDES permits that the ballast water obtained from another port be transferred into holding tanks for transfer to an adequate waste treatment facility to ensure that any exotic marine organisms will be destroyed and not released into the Bay or waters entering the Bay.

5.1.3 Shoreline Construction

This section addresses construction and other disturbance in the shoreline environment. Habitat values intrinsic to these structures are discussed in Section 2.4.4.3 "Artificial Hard Substrate," and 4.2.1.7 "Artificial Hard Substrate." The types of activities addressed in this section include disturbance related to construction and maintenance of structures such as piers, docks, and wharves in the tidal zone, and roads, bridges, and buildings in the supratidal zone.

Photo © 1998 Tom Upton.

Photo 5-3. Sailing on San Diego Bay.

- See also Section 2.4.4.3 "Artificial Hard Substrate" and Section 4.2.1.7 "Artificial Hard Substrate."

Specific Concerns

- Current design of shoreline structures does not effectively consider habitat values.
- The addition of more piers, docks, and wharves over the Bay may create enough shade to interfere with foraging of sight-feeding fish and birds. Loss of light may impair growth of algae which support the invertebrate prey of birds and fishes.
- Effects of shoreline structures can go unmitigated due to lack of consideration of effects on adjacent habitats.
- Shoreline areas have values that need protection: (1) high tide refugia for birds, (2) habitat for species that utilize upland transition areas, (3) buffer zone between Bay habitats and the developed environment, and (4) sources of prey and juvenile nursery habitat for subtidal species.
- There is currently no regulatory driver to support improvements in habitat value of shoreline structures, which would probably be more expensive than traditional designs.
- Construction activity can generate turbidity, sedimentation, erosion, noise, and lighting that may hinder successful fish and wildlife use of the Bay.
- Current "rule of thumb" guidance for buffer zones from the CCC may be inadequate for protection of habitat values, especially at the salt marsh. A need exists for optimal sizes and types of buffers that effectively prevent disturbance to different species of birds at critical time periods.
- Creosote-impregnated pier pilings remain a significant source of polynuclear aromatic hydrocarbons in San Diego Bay (Katz 1995; Woodward-Clyde 1996), despite the fact their use has been banned in the Bay. This has been problematic for project planners.
- There are currently no regulatory or financial incentives to improve the habitat value of shoreline structures, to minimize their use, or to remove them in favor of a more natural shoreline.
- Increased lighting may make otherwise high value habitat unusable for some species. Night lighting may increase vulnerability of nesting birds to predation. Plants of the salt marsh may be affected by night lighting as it may disrupt photosynthetic processes. Effects of night lighting on wildlife are difficult to study and to prove, but the sensitivity of the resource merits further study and that a cautionary approach to use of lighting be taken.
- Construction of new or extended roads adjacent to the Bay can cause loss of wetlands or wetland functions through sedimentation and blockage of tidal action.
- New or widened bridges can cause sedimentation of wetlands or alter the natural drainage patterns that affect wetlands.
- Road, bridge, and building construction and maintenance practices adjacent to the Bay can produce sediment and contaminants that may enter Bay waters.
- The need for quality Navy housing and other uses of shore lands puts some of the Bay's scarcest habitats at risk: intertidal flats, salt marsh, and upland transition.

Background

Table 5-4 describes the Bay surface area, as opposed to shoreline, affected by fixed structures. Table 5-5 breaks this down by habitat. Projected net gains from Navy pier demolition and construction are shown in Table 5-6.

Some structures have positive value because they are often used as roosting sites for waterbirds to conserve energy and avoid harsh weather conditions. Floating docks in shallow water are used by roosting and foraging waterbirds (e.g. brown pelicans, cormorants, and gulls) because the sites are relatively undisturbed by human activity (US Department of the Navy 1995). Structures are also substrate for a diverse community of marine organisms that appear to attract schooling fish, foraging terns, and other waterbirds (Ogden 1994; US Department of the Navy1994).

Photo © 1998 US Navy Southwest Division.

Photo 5-4. Boat Ramp with Riprap.

All of the man-made structures can support a wealth of invertebrates and seaweeds, including many of the exotic species that have invaded the Bay. However, little scientific information is apparently available on the distributions of these various types of hard substrata and the biotic communities that they support within the Bay (S. Murray, California State University-Fullerton, pers. comm.).

Table 5-4. Bay Surface Area Occupied by Fixed Structures (Docks, Piers, Wharves) and by Ships and Boats Using these Sites.[1]

Surface Use	Area of Docks, Piers, or Wharves without Ships and Boats	Area Occupied at Capacity with Ships and Boats
Recreational	35 acres/14 ha	175 acres/71 ha
Commercial	3 acres/1 ha	14 acres/6 ha
Industrial	33 acres/13 ha	98 acres/40 ha
Navy	60 acres/24 ha	209 acres/85 ha
TOTAL	131 acres/53 ha	496 acres/201 ha

1. Acreages/hectares and estimates based on 11/95 aerial photos.

Table 5-5. Quantity and Type of Bay Habitat Surface Covered by Docks, Piers, Wharves, and Docked Ships and Boats at Maximum Use.[1]

Habitat Type	Recreational (acres/ha)	Commercial (acres/ha)	Industrial (acres/ha)	Navy (acres/ha)
Deep subtidal	9/4	2/0.8	42/17	161/65
Medium subtidal	77/31	6/2.4	51/21	33/13
Shallow subtidal	87/35	5/2	3/1	10/4
Intertidal	2/0.8	0.1/0.04	0.3/0.1	3/1
Eelgrass	0.1/0.04	0/0	2/0.8	2/0.8
TOTAL	175.1/70.84	14.1/5.24	98.3/39.9	209/12.8

1. In acres/hectares, rounded-off from estimates.

Table 5-6. Projected Net Gain or Loss in Bay Coverage from Navy Wharves, Piers, and Floating Docks.[1,2]

Proposed Project	Width (ft/m)	Length (ft/m)	Area (ft^2/m^2)	Net Gain/Loss in Pier Coverage Acres/Hectares	
Ramp notch P-211 (NAB)	–40/–12	–40/–12	–1600/–148	0	0
New Pier P-211 (NAB)	30/9	455/139	13650/1268	0	0
Pier 15 Demo P-211 (NAB)	–15/–5	–350/–107	–5250/–489	0	0
Floating Pier Ex P-144 (NAB)	14/4	60/18	840/78	0	0
Brow P-144 (NAB)	6/2	20/6	120/11	0	0
New Pier Section P-144 (NAB)	20/6	40/12	830/74	0	0
Jib Crane P-144 (NAB)	20/6	140/43	2800/260	0	0
CB Pier Demo (NAB)[3]			–15750/–1463	0	0
Recreational Pier (NAB)	14/4	100/30	1400/130	0	0
Small Craft Pier P-187 (NAB)	–15/–5	–412/–126	6180/574	0	0
New Pier P-326 (NAVSTA)	120/37	1458/444	174960/16254	4	1.6
Pier 11 Demo P-326 (NAVSTA)	–30/–9	–1458/–444	–43740/–4064	–1	-0.4
Pier 10 Demo P-326 (NAVSTA)	–30/–9	–1458/–444	–43740/–4064	–1	-0.4
New Pier P-327 (NAVSTA)	120/37	1458/444	174960/16254	4	1.6
2 Demo P-327 (NAVSTA)	–30/–9	–1458/–444	–43740/–4064	–1	-0.4
P-700 Wharf (NASNI)	90/27	1300/396	117000/10870	3	1.2
Mark V mooring P-653 (NASNI)			3096/288	0	0
Mark V floating piers P-653 (NASNI)			2466/229	0	0
P-700 Wharf (NASNI)	90/27	1300/396	117000/10870	3	1.2
Pier J/K Demo P-700A (NASNI)			–62360/–5793	–1	-0.4
Pier 9 Demo (ASW)			–12600/–1171	0	0
Ferry Pier (ASW)			2230/228	0	0
P-122 Demo (SUBASE)	–25/–8	–120/–37	–3000/–279	0	0
P-122 Pens (SUBASE)	12/4	186/57	2232/207	0	0
Total[4]			387954/36063	9	3.6

1. Data courtesy of P. McCay, South Bay Area Focus Team; US Navy, Southwest Division.

2. Calculation is for coverage only. Bay fill is usually mitigated by creating more Bay through excavation.

3. CB Pier Calculation based on 7 floating pier sections (25 x 90 ft/8 x 27 m) removed in May 1996. The CB Pier "brow" is not included in the calculation.

4. Numbers do not sum due to rounding.

Current Management

- In cases where shoreline construction may affect listed species, mitigation is also required under the USESA.

Shoreline construction or maintenance activity in Waters of the US is permitted under the CWA and also must comply with NEPA and CEQA environmental assessment requirements. In cases where listed species may be affected, mitigation is also required under the ESA. Above the mean higher high water line, construction activities must comply with provisions of the CCA and are permitted by the CCC. See Section 3.6 "Overview of Government Regulation of Bay Activities" for further details on laws affecting the shoreline environment. The Navy, for example, has a General Consistency Determination for periodic replacement of piers and shoreline structures dated 1998 (CD-070-98).

Current precedent for construction permitted by the CCC for buffer distances is 50 ft (15 m) in freshwater areas, and 100 ft (30 m) for the salt marsh. The CCC could adjust this requirement based on requests from commenting resource agencies (D. Lilly, California Coastal Commission, pers. comm.).

Permitting for riprap and other structures is primarily reviewed for the requirement for no net loss of jurisdictional waters of the US (a balanced cut and fill must be part of the site plan). Mitigation for fill is required, as well as for impacts to marine resources or listed species. However, there normally is no consideration of differences in habitat value of different designs or materials used in a structure. Typically, construction activities that generate noise or turbidity are restricted during the California least tern season to avoid impairing their foraging activities.

- In environmental assessments for Bay projects, the addition of rock has been considered a net benefit.

In environmental assessments for Bay projects, the addition of any kind of rock has sometimes been considered a net benefit because it can be more productive than soft bottom habitat. The hard substrate provides for the attachment of algal and invertebrate communities that would lead to enhanced fish populations. No mitigation would be required for this activity—for example, pier demolition normally does not require mitigation because of the assumed benefits of adding an "artificial reef" type of enhancement (the pier remains) to the Bay's generally soft-bottom habitat. Alternative consideration is that the technique needs testing and monitoring to understand any negative effects, such as loss of soft-bottom prey.

Standard materials used for piers and pilings vary. Waterfront structures such as piers and wharves are normally concrete decks with pre-stressed concrete piles. Fender systems depend on ship berthing requirements. The Navy currently uses the following systems in San Diego Bay:

- Foam-filled rubber fenders backed by concrete reaction piles.
- Pneumatic rubber fenders backed by concrete reaction piles for submarines.
- Recycled plastic piles, with plastic "camels" in the water spanning over three piles.
- Plastic pile clusters for corner protection, with rubber buckling fenders.
- Fiberglass piles filled with concrete, again with the plastic camels.
- Prestressed concrete piles.
- Untreated timber piles.

- Choice of systems is based on the berthing energy of the ship(s) using the system, and type of materials. Plastic composite pilings are expensive; however, they last longer than wood pilings.

The choice of systems is based on the berthing energy of the ship(s) using the system as well as the type of materials. NAVSTA and SUBASE are no longer using treated timber within the tidal range; the Navy ships use foam-filled fenders on concrete reaction piles. In between the ship berths, there are plastic piles used as a secondary system for small craft, and to keep debris from accumulating under the pier and damaging the structural piles or utility systems. At the corners of the piers, there is a system of plastic piles with rubber buckling fenders (out of the water) to prevent damage to the ship and pier in case of accidental impact. On the quaywall, concrete piles with rubber cylindrical fenders (out of the water) are generally used, since larger vessels pull up there. On a couple of piers, the Navy is trying the concrete-filled fiberglass piles for berthing barges, since they need stronger fenders than the plastic system. At SUBASE, the primary system for submarines is pneumatic fenders (similar to foam-filled, except that they are filled with air and configured vertically rather than horizontally). The Navy is experimenting with plastic pier pilings (made from recycled plastic) as a replacement for chemically treated timber pilings at SUBASE. A three year demonstration and study of steel-reinforced plastic pilings is ongoing at NASNI Pier Bravo, where the pilings will be evaluated primarily for durability, strength, cost, and environmental integrity (US Department of the Navy 1997). NAVSTA is using untreated wood pilings on an interim basis and is experimenting with plastic, concrete, and fiberglass pilings. NASNI is also using untreated wood piling on a temporary basis. NAB obtained approval for a one time use of arsenic-zinc treated wood pilings and is seeking funding to use composite plastic piling in the future. The plastic composite pilings are triple the cost of wood pilings, but according to manufacturer claims, last three times longer than conventional wood pilings.

Evaluation of Current Management

Many examples exist around the Bay of structures with clear differences in habitat value. For example, Shelter Island has better low tide habitat than Harbor Island where the structures and slope are too steep (R. Ford, pers. comm.). Some riprap niches have been filled in with concrete, while others are filled with invertebrate fauna. Man-made structures need “gradual slope with lots of relief, places to retain water at low tides, some protection from wave attack, and a recruitment source.” Three dimensional habitat complexity has been shown to enhance biodiversity in many marine habitats (J. Meigs, National Oceanic and Atmospheric Administration, pers. comm.).

Plastic pilings have apparently been functioning well at NAVSTA and other locations where they are being tested. They are expected to have a very long life. Levels of PAH (petroleum hydrocarbon residues), a contaminant tied primarily to weathered creosote pilings, has decreased around NAVSTA where the plastic pilings were installed, and there has been a slight decrease Baywide in the 1990s (Katz 1995). From a regulatory standpoint, nearly all PAH measurements are below proposed EPA water quality criteria for California.

Little scientific study has been conducted on the effects of noise or lighting on species and habitats of concern in this Plan. Mitigation requirements are based on biologist judgment and experience. One study in San Diego Bay of the effects of pile-driving noise on fish found that topsmelt were less bothered than northern anchovy. The fish showed behavioral accommodation, initially showing some fright and then gradually dispersing into normal school behavior (Ford and Platter-Rieger 1989).

- A preliminary study is in progress characterizing biological communities along an environmental gradient of shading, to determine if the shading might affect the forage base for fish.

A preliminary study funded by the Navy on wharf shading impacts is in progress (Merkel and Associates 1999). The purpose of the study is to characterize biological communities along an environmental gradient of shading under pile-supported structures, to determine if shading might affect the forage base for fish. The results provided evidence that shaded areas beneath structures continued to support an infaunal community. A numerically greater number of organisms was found under the piers than outside them. The pile community was not as rich as that along pier edges; however a developed pile community existed in all areas. Fish communities were poorly represented in the study, probably due to the sampling season, so no conclusions were reached with respect to differences in their abundance along the shade gradient.

The Navy's Regional Shoreline Infrastructure Planning process is considering alternative shoreline options on Navy properties around the Bay. For the Navy Radio Receiving Facility, current considerations are for use as a golf course, for bachelors' quarters, Navy family housing, warehousing, and ordnance storage.

- Appropriate native and water-conserving landscaping designs called "bayscaping" can be adopted to reduce chemical runoff, conserve water, and enhance the wildlife value of properties.

Typical buffer distance requirements from the CCC on development permits are probably inadequate for construction adjacent to the salt marsh or other Bay habitats. Also, opportunities for enhancing buffer areas for habitat value have not been identified or taken advantage of along Bay margins. For example, in Chesapeake Bay, appropriate native and water-conserving landscaping designs called "bayscaping" have been adopted to reduce chemical runoff, conserve water, and enhance the wildlife value of properties adjacent to that bay (Reshetiloff 1998). The designs minimize the use of pesticides and fertilizers that may run off into adjacent waters. Such an approach could also help prevent exotic introductions. Locally, the San Diego County Water Authority has a native plant list available, and Tree of Life Nursery has a 20 page guide for homeowners on native landscaping. Demonstration gardens may be viewed at Chula Vista Nature Interpretive Center and the Tijuana Estuary. National City has adopted a native plant "palette" for landscape design.

Proposed Management Strategy—Shoreline Construction

Objective: Seek improved habitat value of developed shorelines and marine structures and their functional contribution to the ecosystem.

I. Protect habitat values of existing sites.

A. Discourage the construction of seawalls, revetments, breakwaters, or other artificial structure for coastal erosion control, unless each of the following criteria is met (existing state policy):

1. No other nonstructural alternative is practical or preferable.
2. The condition causing the problem is site specific and not attributable to a general erosion trend, or the project reduces the need for a number of individual projects and solves a regional erosion problem.
3. It can be shown that a structure(s) will successfully mitigate the effects of shoreline erosion and will not adversely affect adjacent or other sections of the shoreline.
4. There will be no reduction in public access, use, and enjoyment of the natural shoreline environment, and construction of a structure will preserve or provide access to related public recreational lands or facilities.

5. Any project-caused impacts on fish and wildlife resources will be offset by adequate fish and wildlife preservation measures.
6. The project aims to protect existing development, public beaches, or a coastal-dependent use and does not contribute to further shoreline loss.

B. Recommend set backs for CCC permits for new construction that effectively protect habitat values, especially of sensitive habitats such as salt marsh/tidal flats.

C. Ensure that the Navy's Regional Shoreline Infrastructure Planning integrates the goal and objectives of this Bay Ecosystem Plan.

II. Encourage the refitting of developed shorelines and existing structures to enhance habitat values.

A. Besides providing their engineered function, design shoreline structures to mimic the original habitat structure and function (this refers to situations where the native substrate is a hard one). Maximize benefit to native Bay species of fishes, birds, and invertebrates.

B. Incorporate estuarine habitat attributes as elements of modified habitats in urbanized areas of the Bay.

C. Encourage appropriate native and water-conserving landscaping designs ("bayscaping") that minimize the use of pesticides and fertilizers on properties adjacent to the Bay to enhance habitat value, prevent pollution, conserve water, and control exotic introductions.

1. Promote an award system for the best use of appropriate landscape designs.
2. Produce and disseminate a brochure on appropriate landscaping for Bayside properties, using existing materials and demonstration gardens as a start (San Diego County Water Authority, National City's native plant "palette" for landscape design, local Resource Conservation District (RCD) guidelines, local nurseries that specialize in native plants, demonstration gardens at Chula Vista Nature Interpretive Center, and the Tijuana Estuary).

III. Promote experimentation and application of alternative shoreline and underwater habitat structures.

A. Develop objective design criteria.

1. Incorporate the best understanding about the attributes of the target habitat that promote the desired function.
2. Designs should incorporate several options or variations of a particular attribute to constitute a legitimate test of the concept, and to provide an adaptive direction towards design modification.
3. Incorporate contingency plans for each design element.

B. Follow the results of the Navy demonstration and study (1996–1999) of plastic pilings at NASNI Pier Bravo. The Navy and Port should produce a report on the effectiveness of using creosote-soaked pilings in San Diego Bay.

C. If shown to be environmentally safe, durable, strong, and cost effective, promote a replacement program for all chemically treated wood pilings within the Bay.

1. Set priorities and a reasonable schedule for replacement.
2. Consider designating the PAH "hot spots" as high priority for experimental use of plastic pilings.
3. Promote evaluation monitoring in pier replacement sites to evaluate change.

D. Follow the success of the fish enhancement structures installed as part of the Navy CVN mitigation.

E. Monitor changes in invertebrate and algae populations that can result from enhancement.

F. Disseminate the results of the wharf shading study, which looked at the effect structural shading on the Bay has on sight-feeding organisms, and how this relates to the ecosystem as a whole (Merkel and Associates 1999).

G. Identify and prioritize desired ecological function of artificial structures, including 1) trophic support for native fishes and birds, 2) habitat for migratory birds, 3) nursery/refugia for subtidal species, and 4) habitat for endangered and other special status species.

IV. Provide a regulatory environment conducive to the objectives of compatible use within the Bay.

A. Seek an agreement among regulators to support improvement in habitat value of shoreline structures.

B. Seek mitigation credit for enhancing the habitat value of shoreline structures.

C. Develop a consensus among regulators about the effects of placing artificial hard substrates in intertidal and shallow subtidal habitat.

5.1.4 Water Surface Use and Shoreline Disturbances

Photo © 1998 Tom Upton.

Photo 5-5. Waterbirds of the Bay.

Specific Concerns

- Commercial and military traffic is expected to increase in the Bay area.
- Boating is an important and growing recreational use of the Bay and pressure on Bay birds is not well known.
- Federal law, enforced by the USCG, protects the right to navigation in waters of the US.
- Special boating events, permitted by the USCG, can significantly affect bird populations if not properly planned.
- Disturbance by human activities like boating can result in direct mortality, cause displacement from habitats and excess energy expenditure, disrupt feeding and nesting or roosting, and expose sensitive bird species to predation.
- Sensitivity to disturbance may vary depending on the species of bird, type of watercraft, distance between birds and the disturbance, migratory vs resident birds, and prior exposure to boats.
- Boating trends are more toward smaller, faster watercraft, which tend to be the most disruptive class of boats to wildlife.
- The effects of sediment plumes from deep draft military and commercial vessels stirring up contaminants have not been considered.
- Injury to the green sea turtle by watercraft has been documented in San Diego Bay.
- The effects of special recreational events permitted by the USCG on sensitive resources of the Bay.

Background

Birds are affected by disturbances to varying degrees and with often poorly understood consequences to their long-term well-being at local and regional scales. We do know with some certainty that anthropogenic disturbances out on open water or at the shoreline can change activity budgets of birds and reduce

Photo 5-6. Jet Skier with Navy Carrier.

their production and survival in several ways (see also Section 4.3.4 "Birds" and references in Dahlgren and Korschgen 1992 and York 1994). These effects are likely always negative, and their magnitude is dependent on one or more contributing factors. Characterizing the local nature of these disturbance factors—and relating them to the current regulatory environment—are necessary to developing practical management strategies aimed at addressing local conservation priorities for birds in the San Diego Bay area.

- Repeated disturbance at nesting and roosting sites may disrupt pair and family bonds, force birds into sub-optimal habitats, cause them to repeatedly flush or permanently abandon nests, and expose birds and eggs to higher predation rates.

The rate or frequency of disturbance may be the most important factor influencing severity of effects to birds, possibly more so than the single magnitude of a temporary disturbance. Speight (1973) noted that the frequency of human presence seemed to have more of an impact on waterbirds than the number of people involved in creating any particular disturbance. Repeated disturbance at nesting and roosting sites may disrupt pair and family bonds, force birds into sub-optimal habitats, cause birds to repeatedly flush or permanently abandon nests, and expose birds and eggs to higher predation rates (for example, MacInnes 1962; Cooch 1965; Choate 1967; Mickelson 1975; Bartelt 1987; Purdy *et al*. 1987; Pomerantz *et al*. 1988). Frequent disturbance may also exact substantial energetic consequences to staging birds by repeatedly forcing them into lower quality feeding areas and reducing time spent foraging and building up fat reserves necessary for successful migration (Belanger and Bedard 1989, 1990). Dahlgren and Korschgen (1992) equated the effects of excessive disturbance of birds to that of loss of habitat in that both scenarios diminished the availability of preferred habitat to birds.

Timing of disturbance can also contribute to the magnitude of effects. For example, energetic consequences of disturbance may be greater for some species like canvasback in the spring than in the fall (Kahl 1991). Birds may also be more wary and sensitive to disturbance seasonally or coinciding with important physiological cycles, such as while nesting or during seasonal molts when birds are temporarily rendered flightless (Speight 1973; Anderson 1978). Finally, the frequency and severity of disturbance may be greatest on weekends, simply because more people are coming into contact with birds than during the week (Hartman 1972; Evenson *et al*. 1974).

The severity of disturbance may also be related to the type of bird and the habitat in which birds experience the disturbance. For example, as a group, diving ducks may be more sensitive to disturbance than dabbling ducks (Sincock 1966), shorebirds more than waterfowl (Purdy *et al*. 1987), and migratory birds more than resident ones (Figley and VanDruff 1982). Speight (1973) believed that birds of open habitats, like waterbirds exposed out on deep water habitats, are especially susceptible to disturbance. Bratton (1990) found that birds of the Ciconiiformes order (herons, egrets, bitterns) were more likely to flush in estuaries than from shores.

- Boating can directly or indirectly damage substrate and vegetation in the Bay.

Boating can also directly damage habitat by removing vegetation and reducing submerged vegetation (Liddle and Scorgie 1980; Bouffard 1982). This has occurred on eelgrass beds in the Bay (R. Hoffman, pers. comm.), and as boats enter salt marsh areas at high tide in south Bay. This can be either a direct result of propeller and boat contact with substrates or vegetation loss at the shoreline from repeated wakes caused by boats and water skiers. Recovery of the marsh vegetation may be very slow. The impacts of propeller and collision injuries to sea turtles would be an additional concern in the Bay (see Section 4.3.6.1 “Green Sea Turtle”).

Disturbance of birds can also result from excessive noise out on the open water or at the shoreline, landings by boaters at sensitive areas protected from the landward side but not at the water, and excessive levels of night lighting from associated commercial and industrial areas.

Birds that have been documented as being especially sensitive to disturbance include goldeneye, scoter, gadwall, merganser, ring-necked duck, green-winged teal, northern shoveler, scaup, and black brant (especially by low-flying aircraft) (see reviews in Dahlgren and Korschgen 1992 and York 1994).

- In general, waterbirds use all regions of the Bay, although there may be some differences in habitat values among the regions.

Abundance and distribution of waterbirds in the San Diego Bay area based on Ogden (1994), USFWS (1994), USFWS (1995a), and Copper (pers. comm.) are summarized in Table 2-20 and discussed in detail in Section 2.5.5 “Birds.” In general, waterbirds such as diving ducks, geese, and brant use all regions of the Bay although there may be some differences in habitat values among the regions. The south Bay and central Bay are especially important to shorebirds, dabbling ducks, and sea birds. Little is known of the historic distribution of waterbirds along the Bay. Almost certainly, regions of the Bay that have experienced excessive habitat losses—for example, intertidal areas in the north Bay—were used considerably more by birds than is seen today. Conversely, sites like the Salt Works in the south Bay have become important secondary habitats compensating to some degree for the loss of primary habitats and preventing further development in the far south Bay.

There are seasonal differences in how birds use the Bay. Winter (effectively from mid-November to the end of February) is most important for migratory, rafting waterfowl. Summer (April through July) is critical at the Salt Works and elsewhere to breeding seabirds. Shorebird migration occurs in the spring and fall from about March 1 through April and mid-August through October.

- Larger, slow-moving ships have not been identified as a major disturbance to birds on the Bay.

On the open water of San Diego Bay, boating is the primary surface use that may disturb birds. Being a relatively small bay, conflicts between watercraft and birds may occur more often than in bays where uses are not so compressed, such as San Francisco Bay (M. Kenney, pers. comm.). Disturbances may be from commercial ship traffic, military ships, recreational water vessels, and low-flying aircraft associated with the military bases and the San Diego airport. For the latter, there is no information about effects on birds. Map 3-6 shows boat traffic patterns on San Diego Bay based on 1995–1996 data from several sources. In general for boating, the large military and commercial vessels are confined to the deep channel in the central and north Bay (with the exception of some cross-bay ferry excursions in north Bay). These larger, slow-moving ships have not been identified as a major disturbance to birds on the Bay. Their direct impact might be expected to be primarily from displacement of rafting birds.

Photo © 1998 Tom Upton.

Photo 5-7. Waterbirds and Boats on San Diego Bay.

- Disturbance from recreational use takes place on the open water and at the shoreline where people embark and disembark from their boats.

Recreational surface uses of the Bay in the form of jet skis, powerboating, waterskiing, sailing, and kayaking likely represent greater sources of disturbance to birds than military and commercial craft when considering the disturbance factors discussed above. This disturbance would be both on the open water and at the shoreline where people embark and disembark from their boats. Because of their mobility, most of the Bay regions could be considered accessible to recreational boats and boaters. However, activities and locations of especially concentrated use based on the earlier surveys are sailing in the north Bay, jet skis in and around Glorietta Bay in the central Bay and points north, and powerboating and waterskiing along the Silver Strand in the central and south Bay regions. The pattern for the south and central Bay may change with the proposed development of the National City Marina along the Sweetwater Channel. Canoes and kayaks are not known to be a substantial disturbance source for birds, although this has not been specifically investigated. At this time, they are probably not a major disturbance, though Huffman (1999) saw incidences of birds disturbed as shallow draft boats came close to the shoreline.

Current Management

At this time, the management activity with the most direct implications to boating disturbance of birds is the 5 mph speed limit in south Bay. This speed limit could be effective in minimizing disturbance to birds if it is adhered to by boaters and if used in concert with other management measures that minimize close proximity contact between birds and boaters. Beginning in 1997, the San Diego Harbor Police organized a four-officer personal watercraft team to patrol and enforce no-wake zones in the far south Bay.

In addition, there are restrictions on public access to the channels entering the Sweetwater Refuge and to the Salt Works. Finally, a fisherman's quick reference guide to sea bird protection was developed as an interagency project to inform the fishing and boating public about ways to minimize disturbance and harm to sea birds.

Evaluation of Current Management

- Priorities for research and management of surface use effects on wildlife will need to be established.

The extent to which current levels of disturbance diminish the health of birds and how best to manage those disturbances is not well measured and understood (but see discussion on the south Bay survey report by Huffman below). The high recreational, commercial, and military values of the Bay to boaters cannot be minimized, and it will be important to compatible management of surface uses and bird and other wildlife populations to properly weigh the costs and benefits of further surface use restrictions. Priorities for research and management of surface use effects on wildlife will need to be established. At the same time, local populations of birds and other animals would likely benefit from management aimed directly at minimizing their displacement from preferred habitats and enhancing their survival and production. Disturbance sources and intensities of especially sensitive and declining birds must be considered and properly addressed in management plans.

- There are alternative management strategies that have been proposed and used elsewhere to protect bird species and important use areas from disturbance.

Alternative management strategies that have been proposed or used in other areas to protect priority bird species and important use areas from harmful levels of disturbance include: (1) posting nesting colonies; (2) establishing temporary or permanent buffer zones and setback areas; (3) creating no-wake or non-motorized boating zones; (4) establishing inviolate refuges; (5) restricting certain activities such as fishing or hunting; (6) increasing public awareness; (7) increasing the quantity, quality, and distribution of habitats to alleviate overcrowding; and (8) providing alternative refugia away from disturbance (see Dahlgren and Korschgen 1992 and York 1994).

Most birds are very susceptible to human disturbance. Lights, noise, boats, other people, free-running pets and feral animals may determine levels of bird use more than the biological suitability of the habitat. Waterfowl sensitized to boating disturbance will often flush when a boat motor approaches within 0.6 mi (1 km) or more (Kahl 1991). There is evidence that migratory birds are more vulnerable and disturbance effects more serious. Migratory birds do not accustom themselves to boat movements as resident birds do (Figley and Vandruff 1982). Effects on foraging birds attempting to build energy reserves before continuing their migration can be significant enough at a physiologically vulnerable time to affect their productivity. A high level of disturbance can decrease the carrying capacity of an area to these birds, so disturbance may perhaps be considered no less harmful than habitat destruction (Dahlgren and Korschgen 1992). Disturbance by human activity can cause displacement, excess energy expenditure, disruption of feeding and nesting or roosting, and exposure of sensitive bird species to predation.

Future reasons for fluctuations in Bay bird populations may be due to:

- Loss, fragmentation, and degradation of salt marsh, sandy beaches, mudflats, and upland transition habitats.
- New introductions of natives not previously observed in the Bay due to expanded ranges, perhaps due to problems elsewhere. This has occurred with the black skimmer, elegant tern, and gull-billed tern.
- Community level changes, such as the invasion of crows, as a result of continuing urbanization.
- Loss of breeding grounds outside the Bay.
- Bioaccumulation. The brown pelican, peregrine falcon, and double-crested cormorant are all recovering from past effects from bioaccumulation. Bonaparte's gulls may be susceptible due to its proclivity for sewage outfalls. Birds migrating from southern latitudes may be more susceptible to this problem.
- Boat traffic disturbance.
- Over-harvesting of prey. Commercial fishing operations often crop 50 to 70% of fish production so that little is left for natural predators (Furness and Ainley 1984, cited in Baird 1993). While such harvesting does not occur in the Bay itself, fishing offshore can affect populations that migrate into the Bay or use the Bay for juvenile life stages, and are used as forage by sea birds.
- Climatic cycles or change.

We have little understanding of the relative importance of each of these factors, and some are beyond the control of Bay managers.

Huffman (1999) studied the effect of boating disturbance in south Bay. This study consisted of 25 days (6 hours per day for a total of 150 hr) of observations between mid-January and the end of March 1998. The study examined specific disturbance types, number of boats per day, hour and month; differences among subareas of south Bay; and differences between high and low tides. Bird reactions were recorded for both flush length and flush time. Flush length refers to the total distance the bird traveled from when first flushed to resting location. Flush time was the total duration the bird was in flight. Average and total disturbances by month and by type are presented in Table 5-7.

During surveys of central Bay in 1994, Ogden (1995) summarized 637 observations on bird flushing distances from a 23 ft (7 m) survey boat, shown in Table 5-8**.** These numbers suggest at least some energetic loss of these species.

Huffman noted that the speed limits in the south Bay were rarely adhered to and largely only when the Harbor police were seen in the near vicinity. She developed several recommendations for managing boating and non-boating human disturbances of birds in the south Bay region during the months of January through March: (1) restrict access of the far south Bay to non-motorized boats, (2) strict enforcement of the 5 mph speed limit that was routinely violated by boaters during her study, (3) restricting all human access to the extreme end of the south Bay including all of the salt ponds, marshes, and intertidal mudflats associated with the Salt Works where the birds were at their highest densities and were least exposed or acclimated to human disturbance, (4) enforce a no-(human) activity buffer zone of 328 ft (100 m) off the main shoreline, CVWR, and parts of the Silver Strand and prohibit watercraft of any kind from landing at the Reserve, and (5) prohibit low-altitude flyovers by aircraft, mainly blimps.

Table 5-7. Totals and Averages for Specific Disturbance Types for the Entire South Bay Study Area.[1]

Disturbance Type	Totals			
	January	February	March	Totals
Pedestrians	123	297	142	562
Speed boats	22	50	68	140
Sailboats	22	91	21	134
Dogs	24	50	28	102
Kayaks	4	39	38	81
Wind surfers	1	39	31	71
Fishing boats	9	29	18	56
Cabin cruisers	21	25	8	54
Helicopters	16	23	8	47
Jet skis		14	18	32
Canoes			14	14
Dinghies	2	4	8	14
Planes	10	2		12
Blimps	3	6		9
Catamarans		3	2	5
Long boats		1	4	5
Harbor patrol	2		2	4
Speed boats w/skier			5	5
Row boats	1	2	1	4
Tug boats	2	1		3
Trucks		1		1
Schooners		1		1
Pontoons			1	1
Barges			1	1
TOTALS	262	678	417	1,357
Total days/month	5	10	10	25
Total hours/month	30	60	60	150
Disturbance/day	52.4	67.8	41.7	54.3
Disturbance/hour	8.7	11.3	6.95	9
Water craft/day	17.2	29.9	23.9	25
Water craft/hour	2.9	5	4	4.2

1. Huffman 1999.

Table 5-8. Percentage of Birds Sampled Avoiding Survey Boat by Distance Category in Central San Diego Bay[1]*.*

	Flushing Distance Interval (feet)			
Species	0 to 10	11 to 100	More than 100	Sample Size
Bufflehead	1.0%	**66.5%**	32.5%	197
Surf scoter	1.3%	43.3%	**55.3%**	150
Double-crested cormorant	0.0%	**64.6%**	35.4%	79
California brown pelican	1.6%	**67.2%**	31.1%	61
Eared grebe	11.9%	**74.6%**	13.6%	59
Great blue heron	0.0%	**75.0%**	25.0%	52
Brant's cormorant	0.0%	**69.2%**	30.8%	39

1. *Numbers in bold indicate the highest proportion of avoidance behaviors.*

Proposed Management Strategy—Water Surface Use and Shoreline Disturbances

Objective: Properly balance the various surface uses of the Bay as a navigable waterway and associated shorelines with conservation priorities for water- and shorebirds.

I. Establish priorities for managing disturbance to birds that use the open water and shorelines of the Bay.

- ***A.*** Identify species of primary concern and their habitats within each group that uses the Bay (waterfowl, shorebirds, sea birds, and marsh birds).
- ***B.*** Identify types, location, and frequency of disturbance to these birds and their habitats around the Bay.
- ***C.*** Identify specific standards of acceptable levels of disturbance for these species using criteria such as the rarity of the species and its habitat, sensitivity to disturbance, and period when birds may be most susceptible to and impacted by disturbance.
- ***D.*** Identify zones of overlap among several important bird habitats and high disturbance to help prioritize disturbance management.

II. Establish specific management measures to minimize disturbance at high priority sites for conserving birds of special concern within each group.

- ***A.*** Expand the Port's Boater's Guide or produce another outreach document to include avoidance of eelgrass, surface bird use, green sea turtle areas, and marsh sites.
- ***B.*** Locate, time, and permit special boating events to minimize disturbance to high-use areas for birds.
- ***C.*** Retain the 5 mph speed limit in existing areas and identify other sensitive areas needing speed limits (see also recommendation in San Diego Bay Interagency Water Quality Panel 1998).
- ***D.*** Adopt the recommendations of Huffman (1999) for the south Bay region during the months of January through March.
- ***E.*** Review whether some or all of Huffman's recommendations are relevant to manage disturbance in other regions of the Bay.
- ***F.*** Protect critical shoreline and transitional habitats from excessive land- and water-based disturbance through creation of buffer zones and setback areas of sufficient size for the species and type of disturbance. The buffer zones and setbacks may be seasonal to address lower levels of disturbance at critical times (e.g. nesting) or they may need to be permanent to address higher levels of disturbance (e.g. creation of new developments nearby).
- ***G.*** Predation may be the greatest source of mortality and nesting failure of birds in the transitional habitats and a Baywide predator management strategy needs to be developed.
- ***H.*** Develop a Baywide policy to address the harmful disturbance and predation of birds and nests by domestic pets at key sensitive sites.

I. Develop a Baywide strategy and regulatory standards for minimizing the effects of lighting on sensitive habitats and sites.

1. Establish setbacks for new construction in association with other techniques that establish a no-net increase of ambient light that affects plant growth or other values at the Sweetwater Refuge and other important nesting and roosting sites.
2. Recommend that larger setbacks be a condition of permits issued by the CCC.

III. Recognize through regulatory oversight the extremely high foraging, nesting, and refugia values the remnant intertidal and transitional habitats represent to birds that use and rely on the Bay.

A. Establish a policy of no net-loss of intertidal and transitional habitats.

B. Reestablish habitats that will promote populations of birds throughout the Bay, such as intertidal habitats in north Bay.

C. Consider these areas while planning, providing environmental documentation for, and permitting special boating events.

D. Develop a management plan that ensures maintenance and enhancement of the habitat values of the salt evaporation ponds at the Salt Works.

IV. Expand the public information and education program targeting surface disturbance of birds and habitats.

A. Expand the concept of the "Fisherman's Quick Reference Guide" to all segments of the recreational, commercial, and military boating publics.

B. Involve and work with the boating community to arrive at a solution to bird-boater conflicts.

5.2 Watershed Management Strategies

5.2.1 The Watershed Management Approach

- A watershed refers to an area in which all surface waters flow to a common point.

What is Watershed Management?

Defining a watershed is much easier than defining "watershed management." A watershed is commonly used to refer to an area in which all surface waters flow to a common point, such as a lake, river, groundwater supply, or coastal waterbody. Some people use the term "drainage basin" or "catchment basin" to be synonymous. However, confusion often occurs when terms are used inconsistently to try to describe the relative size or scale of watersheds. A recommended hierarchy for consistent watershed terminology in relative order of size from largest to smallest is Region, Subregion, River Basin, Subbasin, Watershed, Subwatershed, Drainage, and Site (McCammon 1994).

- Embedded in the concept of watershed management is the recognition of the interrelationships among land use, soil and water, and the linkages between uplands and downstream areas.

Combining the definition of "management" with the word "watershed" does not capture the meaning of watershed management. Embedded in the concept of watershed management is the recognition of the interrelationships among land use, soil, water, and air, and the linkages between uplands and downstream areas (Brooks 1991). Planning agencies now recognize that a watershed is defined by natural hydrology and represents a logical unit for managing natural resources (San Diego Association of Governments 1998). Habitat, soil erosion, flood protection, water supply, and water quality are all interrelated and function at the watershed scale. Air pollutants and precipitation act together to link atmosphere and water.

Federal and State Watershed Initiatives

The EPA has promoted the "watershed protection approach" since at least 1991 (US Environmental Protection Agency 1991, 1995). That agency defines the approach as "a strategy for effectively protecting and restoring aquatic ecosystems and protecting human health." The presumption is that many water quality and ecosystem problems are best solved at the watershed level rather than at the individual waterbody or waste discharger level. Four major features are involved: (1) targeting priority problems, (2) a high level of stakeholder involvement, (3) integrated solutions that make use of the expertise and authority of multiple agencies, and (4) measuring success through monitoring and other data gathering. This approach is a departure from EPA's traditional focus on regulating specific pollutants and pollutant sources by instead encouraging an integration of regulatory and nonregulatory programs.

- USEPA and the State Board recognize that many water quality and ecosystem problems are best solved at the watershed level, by integrating regulatory with non-regulatory programs.

The SWRCB and the nine RWQCBs pursued the EPA approach by calling for a Watershed Management Initiative in their 1995 Strategic Plan. They wanted their actions and decisions to be guided by a comprehensive perspective that considers all water-related impacts occurring in a watershed. Officially begun in July 1997, the Initiative is expected to be a long-term process that will take years to accomplish.

The federal Safe Drinking Water Act of 1996 has also created another reason to focus on watershed management. In response to the act, the California Department of Health Services is implementing a Drinking Water Source Assessment and Protection Program. By addressing existing and potential sources of pollution of surface and groundwater within the watershed, local water districts can save money implementing drinking water source protection rather than expend extra dollars on new facilities to perform expensive treatment measures. Bacterial and viral contamination sources are of major concern to drinking water suppliers.

- Federal and state programs provide grants for local watershed restoration efforts.

Watershed restoration at the local level is also the focus of the CCC as well as the Coastal America Partnership Project of federal agencies (Coastal America 1994; Kier Associates 1995). Grant programs are available to assist local government and watershed organizations with watershed planning, management, and restoration project implementation.

San Diego County's Watershed Approach

- Community-based watershed organizations began in the County in the early 1990s.

Watershed-based efforts in San Diego County have developed by different organizations for a variety of reasons. Several local grassroots and government-based groups using a type of watershed approach began in San Diego County in the early 1990s, before the official push by EPA and the SWRCB (Johnson 1999). These community-based watershed organizations came together to address a multitude of issues, including water quality restoration, flood and floodplain management, water supply, invasive riparian species management, and storm water management. While initial attempts with cooperative, diverse watershed groups in the Santa Margarita River and San Luis Rey River watersheds did not succeed, renewed efforts are now being attempted that may be more successful.

- Collaborative watershed planning and management have been promoted in many local plans and reports.

In 1992, the Bay Panel began focusing through its consensus process on ways to coordinate management activities of public, private, and non-profit organizations that could affect the Bay. Watershed management is one of the strategies promoted in its final Comprehensive Management Plan (San Diego Bay Interagency Water Quality Panel 1998). The UCSD Cooperative Extension also incorporated elements of the watershed management approach in its nonpoint source pollution education program for the agricultural and boating communities during 1991–1996 (Johnson 1999). In addition, a report produced by the Port Tenants' Association, called the "Bay White Paper," highlights the growing role of nonpoint source pollution, most notably from storm water runoff, in the Bay's watershed. It encourages the use of a coordinated, watershed-based management approach to nonpoint source pollution (Science Applications International Corp. 1998). The importance of watershed planning, the overlay of watersheds with multiple local jurisdictions, and the population and current and projected land uses for each of the region's major watersheds were the subject of a recent SANDAG publication (San Diego Association of Governments 1998).

- The Watershed Management Approach was adopted by the San Diego RWQCB in 1998.

Carrying out the watershed approach at the regional level is the strategy adopted by the RWQCB San Diego. In May 1998, it published the Watershed Management Approach (Regional Water Quality Control Board 1998). This Board, along with the other Boards, will be producing a Watershed Planning "Chapter" for the state initiative that will contain certain elements, such as prioritized activities and a schedule for completing identified tasks. One of the added incentives for watershed planning is the need to accomplish Total Maximum Daily Load (TMDL) Plans for all waters that are listed as impaired under CWA Sec. 303(d) (e.g. Chollas Creek and the Bay at the mouth of Chollas Creek). Regional Board staff are now assigned to actively participate in watershed management groups as part of their job responsibilities.

- The San Diego Bay Watershed Task Force and the County Watershed Working Group were recently formed to help coordinate, facilitate, and provide leadership.

The San Diego Bay Watershed Task Force was created in 1998 as an outgrowth of the Bay Panel program by SDUPD Commission Chair David Malcolm (Johnson 1999). In addition, the County of San Diego has a Watershed Working Group. Chaired by a representative from the UCSD Cooperative Extension (Sea Grant Program), this group has undertaken several tasks: (1) watershed management leadership for the county; (2) developing watershed management readiness among county departments; and (3) coordinating with the San Diego Bay Watershed Task Force. Hosting the first San Diego County Watershed Leadership and Coordination Conference in December 1998, the Watershed Working Group has decided to assist in facilitating the transition to watershed management for existing watershed-oriented groups, which is occurring very rapidly (Johnson 1999). It also prepared a San Diego County Directory of Watershed Groups, Agencies, and Organizations, with plans to put the directory on the Internet.

Subwatershed Management Efforts

- Subwatershed boundaries are delineated in Maps 1-2 and C-1.

The San Diego Bay Watershed Task Force process has established committees for the three major sub-watersheds of the Bay: Otay River, Sweetwater River, and Chollas Creek (Johnson 1999). Other sub-watersheds include Point Loma, north Bay, Switzer Creek, Paleta Creek, Paradise Creek, Telegraph Canyon Creek Basin, and south Bay.

- A watershed management plan is underway by the Sweetwater River Water Authority and watershed stakeholders.

The Sweetwater River Water Authority has developed a "total watershed management" program for the 40 mi (64 km) long ephemeral river and 200 mi^2 (518 km^2) watershed over several decades (Reynolds 1997). Protection of the quality of water stored in its Sweetwater Reservoir, used for drinking water by 174,000 residents, is the first priority. Urban runoff and degraded groundwater sources were the original focus of proactive strategies. In 1998, the Authority began to involve stakeholders in the watershed to help protect the resources of the Sweetwater River since it only owns less than four percent of the watershed lands (Bostad 1999). A framework for a watershed management plan is under development, with some SWRCB financial assistance. Its approach encompasses urban runoff diversion, demineralization of groundwater, groundwater storage, habitat management, and public outreach and education.

Since Chollas Creek is listed by the Regional and State Boards as water quality impaired, the Chollas Creek watershed will be the focus of a TMDL study and watershed plan in 1999–2000 to address the causes of the impairment (Regional Water Quality Control Board 1999). The City of San Diego is sponsoring the Chollas Creek Enhancement Project, which is presently directed at recreational and public access needs along and near the creek rather than at the watershed management level (C. Frost, City of San Diego, pers. comm.).

Work being done in the Otay and Penasquitos watersheds may eventually lead to a Special Area Management Plan (SAMP) under the federal Coastal Zone Management Act. This is a coordinated, regional approach to problem-solving and addressing conflicting management interests. An example of a SAMP is the Chesapeake Bay Program, while another is the 3,400-acre San Bruno Mountain SAMP. The CZMA describes a SAMP as a "comprehensive plan providing for natural resource protection and reasonable coastal-dependent economic growth containing a detailed and comprehensive statement of policies; standards and criteria to guide public and private uses of lands and waters; and mechanisms for timely implementation in specific geographic areas within the coastal zone" (16 U.S.C. S. 1453(17)). SAMPs may be a mechanism to address mitigation issues related to the Clean Water Act or Endangered Species Act in a coordinated and cooperative manner.

5.2.2 Storm water Management

Specific Concerns

- Contaminants and sediment are delivered to the Bay from the Bay's large watershed due to nonpoint sources through storm water runoff.
- Polluted runoff is also delivered directly to the Bay from shipyards, boatyards, roads and bridges adjacent to the Bay.
- Many residents and other users of the Bay's watershed are under the impression that storm drains connect to treatment plants and that their daily activities do not affect the Bay's quality.
- Storm water runoff carrying sewage from leaking sewer lines and other sources has caused beach closures and fish consumption warnings in the Bay as well as along the San Diego coast.

Background

- Storm water runoff is a significant source of pollution in the Bay and one of the hardest to grasp for solutions.

Storm water runoff is a significant source of pollution in the Bay and one of the hardest to grasp for solutions. As point sources of pollution (e.g. discharge from pipes) have been better controlled or removed from the Bay, nonpoint sources have increased as a higher proportion of the problem. Some studies conclude that nonpoint source runoff is "likely the principal continuing source of pollution to San Diego Bay" (Science Applications International Corp. 1998). Runoff of pollution through storm water is the primary means of delivery to the Bay.

- Over 200 storm drain outfalls are located in and dump into San Diego Bay.

Over 200 storm drain outfalls are located in San Diego Bay. Although many of the outfalls are located on the Port's shoreline property, the source of much of the runoff comes from the 278,550 acre (112,726 ha) watershed draining into the Bay. Two rivers and five creeks provide natural drainages into the Bay in addition to the artificial storm drainage system. For example, Chollas Creek contributes copper, lead, zinc, and bacteria to the Bay while Switzer Creek also delivers high levels of bacteria and sediment during rain events (R. Kolb, pers. comm.; San Diego Unified Port District 1995a).

Sources of storm water pollution in the watershed are numerous. Copper contamination, for instance, can come from the normal degradation of automobile and truck brake shoes. During a rain storm, especially the first of the season, the particles that have fallen to highways, streets, parking lots, and driveways become washed into roadside ditches, which dump into storm drains or creeks, and eventually into the Bay. Other sources of urban nonpoint pollution include automobile oil and grease, illegal dumping of chemicals, animal wastes, sewage from leaking sewer lines, lawn fertilizers, and sediment from soil erosion (San Diego Unified Port District 1995a).

- Storm drains are not connected to sewers or a sewage plant.

Storm drains are not connected to sewers or a sewage plant. Unless natural or artificial filtering systems exist, every contaminant in the storm drains or creek systems is delivered into the Bay.

Current Management

Regulatory Approach

While pollution entering the storm drains is usually from diffuse or nonpoint sources, the outfalls of storm drains represent a point source of discharge into the Bay. The federal CWA, as amended in 1987 (Sec. 402[p]), and the CZARA of 1990 (Sec. 6217) are the driving regulatory forces in addressing nonpoint source pollution from storm water runoff.

- Storm water discharge to the Bay is prohibited unless an NPDES permit is obtained.

Storm water discharge to navigable waters is prohibited unless an NPDES permit is obtained. The EPA has delegated responsibility for the NPDES program to the SWRCB. In turn, the RWQCB San Diego implements the program at the regional level. The CZARA requires EPA and the state to develop and implement management measures to control nonpoint pollution in coastal waters, which California has done through a procedural guidance manual produced by the CCC (California Coastal Commission 1996). The relation of the CWA and CZARA programs is described in more detail in other sources (State Water Resources Control Board 1994; California Coastal Commission 1996).

- EPA's storm water permit program is a phased approach, with large cities and industries first required to comply.

A tiered approach is used by EPA in implementing the storm water permit program. Phase I requires NPDES permits for municipal storm sewers serving large and medium sized populations (greater than 250,000 or 100,000 people) and for storm water discharges associated with industrial activity that is already permitted. Phase II will address smaller municipalities, small construction sites, and other activities and probably will not go into effect until 2002. The CZARA's requirements for management measures apply to those activities not covered by

Phase I, such as construction activities on sites less than 5 acres (2 ha) and discharges from wholesale, retail, service, and commercial activities, including gas stations (State Water Resources Control Board 1994).

Local Permits and Programs

- A new Municipal Storm water Permit will soon be issued for the cities and county. Local storm water ordinances help to implement.

Before EPA's implementing guidelines were issued, the San Diego Regional Board issued an "early permit" for the General Municipal Storm Water Permit for all the 18 cities within San Diego County as well as the County and the Port. The Regional Board sought to renew this initial permit in July 1995 but revisions were made to the permit through public comments and meetings over several years, with the new permit to be issued in 1999 (F. Melbourn, Regional Water Quality Control Board, pers. comm.). The cities and county also have representatives on the local Storm Water Permit Task Force. A Storm Water Working Group was also established for County Departments by the Director of Land Use and Environment (Johnson 1999). Chaired by a representative of the Environmental Health Department, this group has lead responsibility for coordinating city and county compliance with the new municipal storm water permit.

One of the means of implementation is for the permittees to adopt and enforce a storm water ordinance. Each of the cities and the county has such ordinances. The Port manages storm water problems under existing Port ordinances (#61, #62 and #217) and the enforcement of member cities' storm water ordinances. However, the Port is in the process "of developing an ordinance specific to storm water discharges, combining all activities into one ordinance" (San Diego Unified Port District 1995b).

Ordinances usually recommend or require the use of storm water BMPs. EPA's management measures and BMPs for urban runoff address six source categories: developing areas; construction sites; existing development; onsite disposal systems; general sources; and roads, highways, and bridges (California Coastal Commission 1996). Handbooks describing storm water BMPs applicable for California are available for municipal, commercial/industrial, and construction BMPs (Camp Dresser and McKee *et al*. 1993).

- Port staff are implementing storm water BMPs in many ways.

One of the Port's Clean Bay Program goals is "to monitor and improve the quality of San Diego Bay through the development and implementation of BMPs by the Port, industry, commercial, construction activities, and public education programs" (San Diego Unified Port District 1995b). Port staff are implementing storm water BMPs in many ways: as erosion control measures on construction projects, in staff training and reporting of new storm water pollution sources, integrated pest management to prevent pesticide runoff, and environmental review of proposed tenant improvements. Tenants are given storm water BMP materials and recommendations for improvements.

- A poster of a great blue heron on the Bay with the caption "Your Storm Drain Ends Here" and a Port hotline number to call are a part of public education efforts. See also Section 5.5 "Environmental Education."

Public education efforts by the Port include a poster of a heron at the Bay with the caption "Your Storm Drain Ends Here" and a regional hotline toll free number to call 1-888-THINK BLUE, and an extensive nonpoint source pollution education program with local schools through a contract with the Resource Conservation District of Greater San Diego. (See Section 5.5 "Environmental Education" for a more extensive description.)

- See Section 5.1.2 "Ship and Boat Maintenance and Operations" for discussion of shipyard permits and pollution issues. The Port maintains NPDES industrial storm water permits for the airport and its two marine terminals.

An Industrial Storm Water Program is also ongoing. The Port has coverage under three storm water permits: the statewide General Industrial NPDES Storm Water Permit, the statewide General Construction NPDES Storm Water Permit, and the municipal NPDES Storm Water Permit. The Port has applied for storm water coverage of the industrial activities of its tenants at three locations: the Lindbergh Field airport, the Tenth Avenue Marine Terminal, and the Twenty-fourth Street Marine Terminal. At these three locations the Port has assumed responsibility for reviewing Storm Water Pollution Prevention Plans, monitoring reports, and submitting annual reports for its tenants' industrial activities. A shipyard or other industrial facility located on Port tidelands, but not located at the airport or at the two Marine Terminals, must obtain its own individual coverage under the statewide General Industrial Storm Water Permit or under another NPDES permit that incorporates storm water requirements. An example of such a permit is the General Shipyard NPDES Permit, a permit that only applies within the San Diego Region. Construction projects on Port tidelands are covered under the statewide General Construction NPDES Permit. Either the Port or other developers may obtain coverage for individual construction projects. The Port also participates in the twenty-member group referred to as the "San Diego County Co-Permittees" under the municipal permit. The municipal permit covers all storm water discharges, including those addressed by the industrial and construction permits. A description of the Port staff efforts in this program is found in the Port's Five Year Action Plan (San Diego Unified Port District 1995b). Contaminants from storm water runoff from shipyards are now being systematically contained by having berms or collection troughs built around them. While point source discharges from the commercial shipyards and boatyards on the Bay are regulated through recent NPDES permits, the RWQCB is also working with shipyards to write new permits to control runoff (Regional Water Quality Control Board 1995, 1997a, b; Pete Michael, pers. comm.).

- Navy efforts are directed at reducing the quantity of hazardous substances that could potentially contaminate storm water.

The Navy has coverage under two storm water permits: the statewide General Industrial NPDES Storm Water Permit and the statewide General Construction NPDES Storm Water Permit. The Navy is not covered at this time under an individual NPDES permit, nor the municipal NPDES Storm Water Permit for San Diego County. Application for the latter is a first-year priority for the Navy, as is participation in the "San Diego County Co-Permittees" group. The Navy has filed a Notice of Intent with the RWQCB under the industrial storm water program. Naval facilities at the Bay have already implemented the Consolidated Hazardous Material Reutilization and Inventory Management Program. As a result, the Navy believes it has significantly reduced the quantity of hazardous substances that could potentially contaminate storm water. Used Oil Management Plans and Spill Prevention Control and Countermeasures Plans have been developed, implemented, and routinely updated to identify sources, recycling options, and oil product storage containment (San Diego Bay Interagency Water Quality Panel 1998).

Monitoring Efforts

- Ongoing wet weather monitoring is being conducted by the municipal permittees. Only two monitoring sites are within the Bay's watershed.

To comply with the monitoring requirement of the San Diego Municipal NPDES Storm Water Permit, the co-permittees have included 214 constituents for measurement under their Joint Wet Weather Monitoring Program (R. Kolb, pers. comm.). Sampling frequency is three times a year: at "first flush" following the first significant rainfall of the season, before February 1st, and after February 1st. Although 12 stations are monitored in the County, only 2 are located within San Diego Bay's watershed: Chollas Creek near Harbor Drive (SD 8) and a large outfall on the Bay at Solar Turbines (SD13) (Schiff and Stevenson 1996). These two are classified as mass loading stations drained from areas with a mixed land use. The copermittees have contracted out to do the Wet Weather Monitoring Program, which seeks to understand pollutant loading to the Bay and also to evaluate changes that could be attributed to the effectiveness of BMPs. In addition, the Port visually inspects and screens selected storm drains biweekly, with flows screened for 18 water quality indicators (San Diego Unified Port District 1995a). The City of San Diego's Environmental Health Division continues to sample certain storm drains to help identify and correct contaminant inputs to the Bay (San Diego Bay Interagency Water Quality Panel 1998).

In 1998, San Diego Bay became part of the Southern California Coastal Water Research Project, the largest regional water quality monitoring program of its kind in the country. Using standardized monitoring procedures, the project should help implement some of the San Diego Bay Panel's monitoring recommendations. Some sample results from this work are available at {www.SCCWRP.org}.

Another recent sampling effort was performed under a 319(h) grant by the Southern California Coastal Water Research Project (SCCWRP) in conjunction with the Regional Board. This toxicity identification element (TIE) project has identified the pesticide diazinon, and to a lesser extent chlorpyrifos (Dursban), as organic pollutants in Chollas Creek runoff causing toxicity to test animals.

The Bay Panel sponsored a mass loading determination for copper and PAH during the late 1990s, also under a section 319(h) CWA grant. Information from the mass loading study is now being used in conjunction with other data to target pollutant sources in watersheds surrounding the Bay. The Bay Panel also identified a secondary list of Bay pollutants of concern for subsequent follow-up, such as zinc, tributylin (TBT), mercury, and PCBs.

- The Regional Board is promoting a watershed management approach to help address storm water runoff issues from the Bay's 435 mi^2 (1,127 km^2) watershed.

As mentioned above, the Regional Board is promoting a watershed management approach to help address storm water runoff issues from the Bay's 435 mi^2 (1,127 km^2) watershed (Regional Water Quality Control Board 1998). Federal regulations will eventually require all three elements of a storm water program: individual level, regionwide organization (for more coordination), and watershed level organization (Order 90-42; Frank Melbourn, pers. comm.). If desired, watershed management efforts can be at a finer or smaller level.

Evaluation of Current Management

Water and Sediment Quality Conditions

Monitoring of the Port's three industrial storm water permit sites has indicated no major pollution discharge (San Diego Unified Port District 1995b). An evaluation of the data collected under the San Diego Municipal NPDES Storm Water Permit since 1995 was not available. There is a need for a single, frequently-updated, and accessible database of storm drain runoff and water quality data for San Diego Bay.

In the mid-1990s, storm drains were identified as an important contributor of contaminants in San Diego Bay as based on the State Bay Protection and Toxic Cleanup Program's monitoring report (Fairey *et al.* 1996). In particular, high concentrations of metals and chlordane near the downtown anchorage monitoring station were attributed to the presence of a large storm drain and numerous smaller storm drains that empty into the Bay near this station. Parking lots and light industrial and commercial areas contribute to these storm drains. Near the 10th Avenue Marine Terminal is a large storm drain system draining residential and industrial areas that appear to be additional sources for the elevated levels of chlordane and PAHs detected at the stations. Chlordane concentrations may be due to its primary use as a home and agricultural insecticide (Science Applications International Corp. 1998). Other storm drains are also listed as contributors.

Implementation and Enforcement Efforts

- Chollas Creek will be one of the first TMDLs prepared by the Regional Board due to its storm water runoff concentration of contaminants.

Since the recent data collected on Chollas Creek indicate elevated storm water runoff concentrations of cadmium, copper, lead, and zinc, which impair aquatic life, the Creek was placed on the State Board's 303(d) list of "water quality limited" waterbodies under the CWA. The Bay at the mouth of the creek is also listed due to benthic community degradation and toxicity in the sediment. As a result, the Regional Board has selected the Chollas Creek watershed as one of its first "TMDLs," a federal-state program under the CWA to address allowable pollution levels based on TMDL for listed constituents. The Board's intent is to have a Chollas Creek TMDL ready for submittal to EPA by April 2000. Public workshops on the topic began in early 1999 (Regional Water Quality Control Board 1999). A second TMDL is planned for the Shelter Island Yacht Harbor area.

Improvements in the implementation of BMPs under the Port's industrial storm water program have been documented by the Port (San Diego Unified Port District 1995b). The environmental community credits regulation and mitigation with bringing about the improvements in the Bay's overall cleanliness and argues that fair and effective regulation should be maintained (Kuehner-Hebert 1998). However, the regulated community is concerned that excessive regulation could become counterproductive (Cloward 1997).

Training of municipal, Port, and Navy employees in BMPs has benefited implementation. While several technical workshops have been held in the past six years, many more are needed (R. Kolb, pers. comm.). Smaller cities, for example, may lack the staff, funding, or understanding of what needs to be done. SANDAG also encourages municipalities to adopt a Water Quality Element as part of their general plans in order to better address watershed and nonpoint source management, but it is not known if any local communities have pursued this option (San Diego Association of Governments 1997a).

A recent university study of the diverse storm water BMP approaches implemented in southern California communities revealed that, while BMPs have only been implemented by cities for a short time, effective BMP programs can include both structural and nonstructural measures, both prevention and remediation activities, and both active and passive programs. (Struble and Hromadka 1999). Environmentally and economically, a diverse array of BMPs is deemed most effective. In addition, programs for the assessment of BMP effectiveness are needed. The most frequent storm water BMPs used were street sweeping, storm drain system maintenance, household hazardous waste collection centers, public education, and recycling.

Public education efforts are often enthusiastic and have reached a fairly broad audience (Resource Conservation District of Greater San Diego 1997). However, very individualized efforts by each municipality have tended to produce a diluted or confusing message. Public service announcements on the radio and television may be needed since studies elsewhere show that these media are the most effective, while pamphlets are the least effective but most commonly used technique (Pellegrine Assoc. 1997). There is still a sense by the general public that storm drains go into sewage plants, which creates an "out-of-sight, out-of-mind" attitude. People working on their cars in the streets and releasing oils and grease into a street 10 mi (16 km) from the Bay need to become aware of their impact on the Bay.

- Biologists support the use of natural and artificial wetlands within the watershed to help regulate the quality and quantity of storm water runoff.

Biologists have observed the need for natural filters within the Bay's watershed to help trap runoff, sediment, and pollutants (M. Kenney, pers. comm.). Natural and artificial wetlands, such as ponds, riparian zones, swales and salt marsh can store sediment and its associated contaminants. Aquatic and riparian vegetation, such as cattails and bulrush, can also take up or alter some of the excess nutrients and contaminants. In contrast, concrete-lined ditches, storm drains, and flood control channels offer no filtering effects through the soil or the vegetation but instead flush contaminants directly to the end of the drain. Managed wetlands or sediment ponds can collect contaminants during rain storms and store sediment under controlled conditions. A series of natural and artificial wetlands, including vegetated swales adjacent to roads, can regulate both the quality and quantity of storm runoff to the Bay as part of a more comprehensive watershed management strategy.

- There is still a sense by the general public that storm drains go into sewage plants, which creates an "out-of-sight, out-of-mind" attitude.

Monitoring and Research

Other than some upper storm drain sites monitored by the City of San Diego, no stations are apparently located within the middle or upper areas of the watershed, though there are proposed "land use" monitoring stations for catchment basins in residential areas. The monitoring sites are primarily selected for the purpose of compliance monitoring rather than for effectiveness monitoring of specific BMPs or for trend monitoring of different reaches or tributaries of the streams. Water districts within the watershed also monitor reservoir inflow quality for compliance with drinking water standards. Information useful to detect storm water "hot spots" and to evaluate urban runoff BMPs could be derived from effectiveness and trend monitoring programs in the watershed.

Automatic samplers could sample for metals, non-volatiles, and stable organics. CDFG scientists at the Moss Landing laboratories also can sample for low levels of persistent organic chemicals in water, such as pesticides and PCBs, through the deployment of experimental foam material which concentrates the organics. The containers can be deployed for weeks or months and may act similarly to the California mussel which bioconcentrates organic chemicals many fold. Coloform bacteria can be sampled, but an operator must make many trips to the lab to stay within holding times. So, bacteria can be sampled, but at great expense.

Proposed Management Strategy—Storm Water Management

- Support a voluntary program of storm water pollution prevention in the Bay's watershed.

***Objective:* Reduce and minimize storm water pollutants harmful to the Bay's ecosystem from entering the Bay from watershed users.**

The recommendations of the San Diego Bay Panel are included in this strategy, as well as others (San Diego Bay Interagency Water Quality Panel 1998).

I. Encourage the further development and implementation of new or existing storm water pollution prevention and water quality protection efforts throughout the Bay's watershed.

- ***A.*** Promote an effective public education program.
  - *1.* The Navy and Port should survey storm water education and pollution prevention efforts with the goal of updating these efforts.

2. The Navy, Port, and cities should identify pollutants and potential pollutants in storm water runoff for all installations around the San Diego Bay.
3. The Navy should provide the Regional Water Quality Control Board and the Coast Guard with a report on the progress of the Navy's oil spill reduction program.

B. Provide consistency with a similar message and the pooling of financial resources among the municipal copermittees and watershed educators in the outreach efforts.

1. Support the completion and maintenance of storm drain stenciling around the Bay's watershed to alert the public of the endpoint of any dumping in storm drains.
2. Target education efforts to focus on watershed subareas and main contributors and problem inputs of nonpoint source pollution to the Bay.
3. Employ a multi-lingual effort to better communicate with all neighborhoods and businesses.
4. Employ focused and frequent public service announcements on local radio and television.
5. Evaluate the before-and-after levels of public understanding of the problem and solutions and adjust the education strategy as needed to be more effective.
6. Use nonregulatory, educational organizations to help enhance and extend the educational messages to a broader audience, including private landowners.
7. Form a storm water/BMP team to address and assist tenants with storm water compliance.

C. Promote the San Diego Bay Watershed Task Force in developing a pilot program aimed at solving contamination of the Bay from runoff.

1. Include the existing Municipal Storm Water Education Committee as a core group.
2. Identify demonstration projects and locations that could serve as local models.
3. Identify and obtain the necessary funding to design and implement demonstration projects.
4. Encourage the development of and work closely with cooperative, community-based watershed groups in developing watershed problem and need assessments, in identifying and implementing BMPs, in monitoring their effectiveness, and in communicating their successes and challenges to others.

D. Promote urban runoff BMPs that support storm water pollution prevention and reduction.

1. Explore the opportunity for better use of natural and artificial wetlands as upslope filters to trap runoff sediment and pollutants.
2. Investigate where retention basins and engineered treatment facilities may be effective.

3. Work closely with community-based watershed groups in evaluating the effectiveness of BMPs, and communicate the technological challenges and successes to others.
4. Identify products (e.g. lawn fertilizers, car soaps/waxes, etc.) least likely to yield harmful input to Bay waters.
5. Implement a hazardous materials collection event or station for marinas.

E. Promote construction of sewer infrastructure improvements to minimize sewer overflows.

- Help improve the effectiveness of existing storm water management efforts.

II. Improve the effectiveness of the water quality regulators and the municipal and industrial storm water permittees in cleaning up storm water runoff.

A. Improve coordination and communication among all of the Bay's municipalities, including the Port and Navy, in the design and implementation of an urban and industrial runoff program.

1. Address the general problem of access, collation, and interpretation of storm drain and water quality data in San Diego Bay by storing these data in a single database.
2. The Navy and Port should attend RWQCB TMDL workshops for the Bay.

B. Develop an improved training program for appropriate government and private sector employees.

1. Support regular workshops on the need, design, and implementation of BMPs.
2. Train selected employees to train others.

C. Encourage agencies to improve relevant administrative and planning practices.

1. Encourage municipalities to adopt Water Quality Elements as part of their general plans in order to better address watershed and non-point source management.
2. Support the coding of all existing and new RWQCB permit applications and Notices of Intent with a hydrologic subarea.
3. Ensure that storm water quality controls are considered during the site planning and design phase and not tacked on after the fact.
4. Examine location and evaluate need to reposition outfalls in relation to effects on sensitive Bay habitats.
5. Identify ways to improve response times and avoid or minimize the release of episodic sewage runoff into the Bay from sewer pipe breaks.

D. Target monitoring efforts to evaluate the effectiveness of BMPs and trends in water quality of sub-basins leading into the Bay, and not just for permit compliance.

1. Position monitoring stations at key sites within sub-basins to better track "hot spot" sources of storm water pollution.

2. Place auto samplers where there are data gaps, or use experimental foam in containers.
3. Evaluate the effectiveness of the applied urban runoff BMPs through the use of a targeted effectiveness and trend monitoring in the watershed.
4. Determine the sources of improper discharges through dry season storm water monitoring.
5. Re-evaluate the design and use of BMPs based on the results of the monitoring program.

5.2.3 Freshwater Inflow Management

Specific Concerns

- Changes in freshwater runoff amounts and timing have affected salt marshes and the ability to restore them.
- If low salinities persist due to hydrologic modifications, brackish marsh vegetation and exotic species can invade the coastal wetland site and marine fish and invertebrates can be eliminated.
- Imported municipal water creates an artificial water regime in the Bay's watershed, with irrigation and other runoff occurring during unnatural times of the year and creating too much fresh water out-of-season.
- Channelization of streams has prevented them from fulfilling their natural functions, which include species support, nutrient filtering, groundwater recharge, aesthetic and recreational values.
- Wildfires in large portions of the Bay watershed could seriously damage vegetation and impact the quantity and quality of runoff into the Bay.

Background

Freshwater inflows into San Diego Bay were first significantly altered when San Diego River was permanently diverted into Mission Bay in 1875. Lower and upper Otay and Sweetwater reservoirs were constructed for water storage in the late nineteenth century to "save the greatest floods" for supplying drinking water to the growing communities around the Bay (Boone 1912).

Before these diversions, fresh water would flow into the Bay during the rainy season from November to April. Runoff and streamflow mimicked the rainfall amount and patterns, with rarely any snowpack in the mountains to sustain prolonged flows. The streams were ephemeral or intermittent during the dry season, at least in their lower reaches. This leads to higher salinity in the southern portions of the Bay. Sub-surface flows of groundwater into the streams and the Bay may extend beyond the period of upstream surface flows. High rainfall seasons, drought, and floods have always cycled and brought annual and seasonal fluctuations to freshwater inflow to the Bay.

Excess freshwater runoff, especially during low tides, can harm intertidal animals (Martin *et al*. 1996). While marine invertebrates living in the intertidal zone are generally well adapted to fluctuations in temperature, pH, oxygen, and carbon dioxide, extreme reductions in salinity ("hyposalinity") in their environment can lead to stress. Stress can cause disease, slower growth, increased susceptibility to parasites, and even death. Runoff at artificial outfalls that is prolonged over several days during low tide is potentially "extremely detrimental" to marine organisms, particularly those that cannot move away from the source (e.g. sessile animals). Drought years can even lead to an increase in the population and diversity of intertidal animals.

Lowered salinities caused by prolonged reservoir discharge, irrigation runoff, and street drains can also cause a shift in species distributions downstream into the estuarine marshes (Zedler 1991). For example, the southern cattail is not a salt marsh species but it was able to invade the San Diego River marsh following the 1980 flood and the prolonged period of reservoir discharge. While its population declined after several low flow years, it was not eliminated and now competes with native plants. In the Sweetwater River marsh, curly dock was able to invade the periphery of the salt marsh when conditions of low salinity (<10 ppt) persisted beyond the normal wet winter season.

- Sweetwater and Otay marshes no longer receive natural nutrient inputs because of dams upstream.

Freshwater inflows would normally have delivered sediment from the watershed into the salt marshes once located at the mouths of each tributary to the Bay. With dams trapping the sediment upstream, the remaining marshes (Sweetwater and Otay) are no longer receiving these natural nutrient inputs and sources of habitat maintenance and dynamics. Researchers have found that infrequent streamflow influxes of nitrogen have impaired the development of constructed marshes and the maintenance of existing marshes (Langis *et al.* 1991).

Current Management

Reservoir management is under the jurisdiction of several local entities. The two reservoirs on Sweetwater River, Lake Loveland and Sweetwater, are owned and managed by the Sweetwater Authority and have a combined capacity of 53,500 acre-ft of water storage. Lower Otay Reservoir is owned by the City of San Diego and stores 49,500 acre-ft of water (California Department of Water Resources 1993). These reservoirs are apparently managed to store water for water supply rather than for flood control purposes.

Water management within the Bay's watershed is also provided by municipal water purveyors. The Sweetwater Authority provides water to the City of Chula Vista (Otay Water District) and National City. Imperial Beach's water is purveyed by the California American Water Company. The City of San Diego has its own water department. The San Diego Water Authority wholesales imported water from the State Water Project and other sources to the local water purveyors and to large agricultural water users.

- Much of the water in the watershed is imported from outside the region.

Much of the water presently used by residential, commercial, industrial, and agricultural customers in the watershed is imported from outside the region. While most is probably consumed and delivered to the sewage system for export or lost through evaporation during storage and irrigation, runoff amounts are increased by this additional water to the watershed.

Storm water runoff is being managed by all of the local jurisdictions, as noted in the above section. The emphasis of the state and federal storm water management programs is on improving the quality of urban runoff, not the quantity.

Sediment in the local reservoirs is periodically dredged and removed to a legal fill site to maintain their storage capacities.

Evaluation of Current Management

Besides the issue of the quality of storm water runoff (wet and dry weather), the effect of the timing and quantity of freshwater inflows to the Bay does not appear to be a significant issue that is being addressed by local watershed managers.

If municipalities are able to shift their treated wastewater discharges from the existing ocean outfalls to coastal rivers (live stream discharge), as some have proposed, then wetlands ecologists fear that streamflow regimes for coastal water bodies will be permanently altered (Zedler 1991).

This freshwater inflow management issue was not addressed in the plan prepared by the Bay Panel (San Diego Bay Interagency Water Quality Panel 1998).

Experiments with pulsed-discharge of fresh water and wastewater from constructed wetlands during outgoing tides were attempted in the Tijuana Slough National Wildlife Refuge (Zedler *et al*. 1992). Results were promising, demonstrating that such wetland designs can be used to protect downstream coastal wetlands from excess reduction in salinity. More demonstration projects of this type are needed in the Bay watershed. Eventually, excess fresh water flows in all 200 storm water outfalls and each creek should be addressed.

Proposed Management Strategy—Freshwater Inflow Management

Objective:* *Encourage water managers within the Bay watershed to manage freshwater inflows to help maintain the natural salinity and nutrient levels of the Bay's wetlands and intertidal zone.

I. Seek methods of water management that will mimic the natural, prediversion, regime of runoff (frequency, duration, and amount).

- ***A.*** Promote demonstration projects of pulsed-discharges from artificial wetlands within the watershed.
- ***B.*** Maintain good tidal flushing and rapid dilution when discharges must be made.

II. Manage the runoff input of needed sediment to the Bay.

- ***A.*** Seek opportunities to use dredged sediment from the reservoirs for nutrient and organic supplements to the natural and artificial salt marshes in the Bay.

III. Prevent new channelization of streams discharging into the Bay and restore natural floodplains and overbank areas, where possible. Adopt ecologically sound engineering designs in balance with the need to manage for floods.

IV. Conduct research on whether nitrogen/nutrient input from streamflows is excessive or limiting, and what role it plays in Bay productivity.

5.3 Cleanup of Bay Use Impacts

5.3.1 Remediation of Contaminated Sediments

Specific Concerns

- While pollution abatement measures have been very effective in eliminating the inflow of contaminants from many major sources, they have had no effect on the toxic chemicals still resident in the bottom sediments.
- storm water runoff and other freshwater runoff from urban and industrial areas, contaminant particles settling from the air, accidental spills, and illegal discharges, all continue to contribute pollutants to the sediments of San Diego Bay.
- Contaminants can have an adverse effect on the health and survival of marine organisms associated with the sediment. These include not only benthic algae and the invertebrate infauna and epifauna (Fairey *et al.* 1996), but also fishes and crustaceans that live and feed near the bottom.
- Contaminated sediment can also lead to bioaccumulation and biomagnification of sediment contaminants in organisms up the food chain. Bioaccumulation is the process in which biological uptake and retention of contaminants in the tissues of an organism results from feeding, contact with the sediments and overlying water, or some combination of these. In this process, concentrations of many contaminants can biomagnify in body tissue concentrations as they move up through the food web from small invertebrates to fishes, birds, and even to humans.
- The effects of bioaccumulation on migratory birds is a concern, including for listed species like the brown pelican and California least tern. Fish and wildlife can be affected by direct mortality, or at lower contamination levels by sublethal effects on reproduction and survivability of young.
- Another area of specific concern is the possible adverse effects of contaminated Bay sediments on human health. These involve three primary pathways of exposure:
  - Consumption of fish and also shellfish, such as California spiny lobsters, rock scallops, clams, and mussels, that live or feed in areas of San Diego Bay where contaminated sediments are present (Gonaver *et al.* 1990).
  - Direct skin contact with heavily contaminated sediment by swimmers, divers, and others working in the Bay.
  - Accidental ingestion by humans of contaminated sediment or suspensions of it in the water column.
- Certain sportfish species in the Bay are known to accumulate PCBs and mercury at levels that could pose health risks for consumers. Bioaccumulation of potentially toxic chemicals by organisms in the food chain is a concern that is still being studied. A first priority for the study in the Bay is with fish species that may be consumed by humans (Macdonald *et al.* 1990; San Diego Bay Interagency Water Quality Panel 1998). One study compared the Bay to nonurban sites and found high concentrations of PCBs in liver tissues of white croaker, barred sandbass, and black croaker from several sites (McCain *et al.* 1992). Barred sandbass showed symptoms of fin erosion. A health risk study of the Bay in 1990 determined that mercury and PCB levels in selected fish species could pose a limited health risk, if significant quantities of fish were consumed.

Background

An important environmental issue for San Diego Bay involves the problems of contaminated bottom sediments and associated management, and regulatory and technological approaches to remediation. Based on discussions at the 1990 San Diego Bay Symposium, Barker (1990) provided a comprehensive summary of sediment contamination problems in San Diego Bay, application of remediation methods to them, and the consequences of remediation.

Contaminated sediments are those containing chemical substances at levels that can adversely affect the environment, associated communities of organisms, or human health. Contamination of sediments occurs primarily because toxic chemicals have an affinity for sediment particles, effectively making these pollutants an integral part of the benthos. This problem is seriously compounded by the fact that many contaminant chemicals become concentrated at very high levels in the bottom sediments and persist there for long periods of time. Also, these chemicals can become biomagnified at higher trophic levels.

- Prior to the 1970s, systems for collecting and treating sewage and industrial wastes before discharging these into the Bay either were not employed or were relatively ineffective.

From 1900 to 1963, substantial population growth and commercial development, coupled with lax environmental management practices prevalent at that time, led to serious contamination of sediments in many parts of San Diego Bay. Prior to the 1970s, systems for collecting and treating sewage and industrial wastes before discharging these into the Bay either were not employed or were relatively ineffective. By the 1950s, volumes of sewage and industrial discharges reached 50 million gallons per day, and in some areas produced sewage sludge deposits up to 6 ft (2 m) in thickness (Macdonald *et al*. 1989). Industrial and military waste discharges included toxic trace metals, chlorinated hydrocarbon compounds, solvents, degreasers, waste oil, and paints. Because of the tendency of many pollutant chemicals to become concentrated at high levels in the bottom sediments, these discharges had serious cumulative effects on the benthos in some areas (San Diego Unified Port District 1995a; Fairey *et al*. 1996). Relatively weak natural tidal flushing action, particularly at central and inner Bay locations, also contributed to large accumulations of toxic chemicals from these waste discharges.

Following completion of the Point Loma Municipal Sewage Treatment Facility in 1963, sewage discharges to the Bay ended. In the 1970s and 1980s, industrial and military discharges were also reduced or eliminated and water quality criteria and their associated discharge limitations were established.

Current Management

As described by Barker (1990) and others, the cleanup or remediation of polluted sediment in San Diego Bay is regulated by several state and federal statutes. The primary laws that apply, or may apply in some instances, are summarized in Section 3.6 in Chapter 3. The most important of these is the Porter-Cologne Water Quality Control Act, which forms part of the California Water Code.

Similarly, several different federal, state, and local governmental or regulatory agencies have official responsibility for issues involving contaminated sediments in San Diego Bay, as shown in Table 5-9. Agency roles are described in Section 3.6 in Chapter 3. The lead agencies are the RWQCB, the EPA, and the USACOE. Both the Navy and the Port have major roles in the process, as does the San Diego County Department of Health Services for sediment issues related to human health.

The Navy has active research and development studies underway to evaluate sediment contamination at Navy sites in San Diego Bay and the effectiveness of methods for remediation. The primary project objectives are to characterize existing

Table 5-9. Federal and State Statutes Affecting Management of Contaminated Sediment.

Federal Statutes	State Statutes
Clean Water Act	California Water Code, Division 7
Rivers and Harbors Act of 1899	California Health and Safety Code
Marine Protection, Research, and Sanctuaries Act	California Fish and Game Code
National Environmental Policy Act	California Environmental Quality Act
Fish and Wildlife Act	California Food and Agricultural Code
National Historic Preservation Act	California Harbor and Navigation Code
Endangered Species Act	California Coastal Zone Management Act

sediment contamination at this site, evaluate the processes that control contaminant levels and transport processes, and study the treatability of these contaminants (B. Chadwick, Space and Naval Warfare Command, pers. comm.) The Navy's Remediation Research Laboratory, at SPAWAR, conducts studies on science and technology issues that are relevant to remediation of contaminated soils and sediments, including those in San Diego Bay (S. E. Apitz, Space and Naval Warfare Command, pers. comm.; RRL Internet Web site).

As the lead regulatory agency, the RWQCB San Diego fulfills its two primary functions in dealing with contaminated sediment issues in San Diego Bay:

1. to ensure reasonable protection of beneficial uses in the Bay; and
2. to ensure the prevention of nuisance conditions resulting from excessive discharges of waste.

The State Water Resources Control Board adopted a Statewide Consolidated Toxic Hot Spot Cleanup Plan on June 18, 1999. The Regional Board has the authority to take enforcement action against those who violate its waste discharge requirements or discharge prohibitions as they apply to sediment contamination. The three primary enforcement remedies available to the Board are:

1. cease and desist orders;
2. cleanup and abatement orders; and
3. administrative civil liability monetary penalties.

Major sediment remediation projects in San Diego Bay resulting from the issuance of cleanup and abatement orders (Figure 5-1) are described by Barker (1990) and SDUPD (1995b). These included major efforts such as at East Harbor Island Lagoon (PCBs), Paco Terminals (copper ore concentrate), and several sites in Shelter Island Commercial Basin (mercury and copper).

- The California State Water Resources Board in cooperation with other agencies conducted a Bay Protection and Toxic Hot Spots Program (1992–1994) to characterize the condition of contaminated sediments.

The present condition of contaminated sediments in representative areas of San Diego Bay can be characterized from the results of the recent Bay Protection and Toxic Hot Spots Program conducted during 1992 through 1994 by the SWRCB in cooperation with other agencies (Fairey *et al.* 1996). This program is significant because it provided the first comprehensive evaluation of the severity of impacts and the occurrence of adverse biological effects resulting from contaminated sediments in San Diego Bay. Equally important, the conclusions were based on multiple indicators of environmental health, which increases confidence in the interpretations reported by Fairey *et al.* (1996). Sampling was conducted at 350 sites in the San Diego region (including Mission Bay, San Diego River Estuary, and Tijuana River Estuary). It employed measurements of chemical contaminants in sediments, evaluations of infaunal invertebrate assemblages in those sediments, and laboratory-based toxicity tests to define the health of unconsolidated sediment habitats throughout the Bay.

The study identified five toxic "hot spots" under the State Bay Protection and Toxic Cleanup Program. These were: the area between the B Street and Broadway piers; the mouth of Switzer Creek; the foot of Evans Street; the mouth of Chollas Creek; and the Seventh Street Channel at the mouth of Paleta Creek. These sites correspond to regions of the Bay that were affected historically by sewage sludge and industrial waste discharges and are now affected by storm water discharges. Most of the sites given moderate rankings are adjacent to commercial shipyard and Naval installation operations near the Coronado Bridge, while sites with low priority rankings are spread throughout the Bay. Considerably larger numbers of sites were given moderate or low rankings, 43 and 57 stations, respectively.

Some voluntary assessments have been conducted. In 1990, the RWQCB entered into agreements with the major civilian shipyard on San Diego Bay that the companies would perform voluntary site assessments at their yards. The Campbell Shipyard sampled Bay sediment and determined target sediment cleanup levels using the apparent effect threshold (AET) approach. Subsequently, the National Steel and Shipbuilding Company (NASSCO) shipyard discussed the possibility of using the Campbell sediment cleanup target levels to determine cleanup levels for a maintenance dredging project.

- Contaminants of concern were identified by comparing measured sediment concentrations with proposed sediment quality guidelines.

Contaminants of concern in the Fairey *et al.* study were identified by comparing measured sediment concentrations with proposed sediment quality guidelines (note that no sediment quality criteria presently exist). Contaminants of greatest concern were metals (copper, mercury, and zinc), a pesticide (chlordane), a chlorinated hydrocarbon (PCBs), and PAHs. It should be noted that the use of PCBs and chlordane has been banned for decades. The presence of these contaminants represents remnants of these persistent compounds that remain in the watershed and in the bottom sediments of San Diego Bay.

The results of this study are important from a management standpoint, because they provide the first clear, quantitative picture of sediment contamination and its biological effects in San Diego Bay. It should serve as a model for the additional research on sediment contaminants in the Bay that is needed.

Although it is beyond the scope of this section to describe specific methods of remediation in detail, it is important to consider the different approaches currently in use for Bay sediments. Excellent, detailed descriptions and evaluations of these technologies are provided in the SEDTEC New Directory of Removal and Treatment Technology, distributed in CD ROM format by Environment Canada (<Ian.orchard@ec.gc.ca>), as well as in EPA (1985) and National Academy Press (1989,1997).

Barker (1990) also provided a characterization of cleanup and remediation methods that apply to San Diego Bay. These are summarized in Figure 5-1. As shown in this diagram, remedial measures can be classified as either removal actions or nonremoval actions. As the term indicates, removal actions involve the physical removal of contaminated sediment, normally by dredging, and its disposal with or without treatment. Nonremoval methods can include in situ remediation by capping (the method used in the East Harbor Island Lagoon project), use of a chemical sealant, or grouting with cement or other materials (Barker 1990). The other nonremoval approach is to take no action, simply allowing the contaminated sediment to be buried by natural sedimentation processes, to naturally degrade, or to disperse from the site.

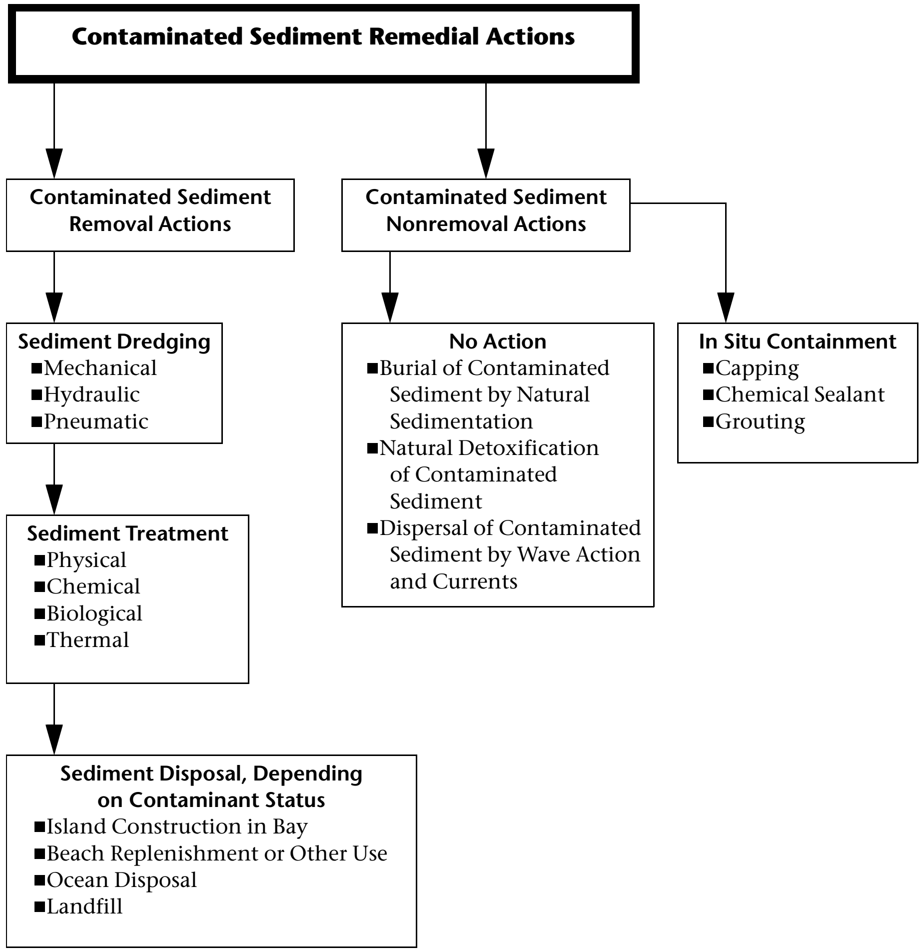


Figure 5-1. Contaminated Sediment Remedial Actions Flowchart (After Barker 1990).

- Nonremoval methods of cleanup and remediation include capping, which is a relatively new technology. Its effectiveness has not been evaluated over the long term.

As Barker (1990) and others have noted, remedial methods that involve capping or surface sealing with cement, quicklime, or other grouting materials are relatively new technologies. The effectiveness and reliability of these methods over the long term have not yet been evaluated. For this and other reasons, they require a substantial monitoring program during and following implementation.

Taking no action may be the preferred alternative in cases where dredging or otherwise disturbing the contaminated sediment would produce more adverse environmental effects than if it were left in place. On the other hand, the length of time required for natural processes to isolate or disperse the contaminants must also be considered in making this decision. That time period may be unacceptably long.

Evaluation of Current Management

The environmental effects of contaminated sediment, as well as the effective remediation of these problems, are both relatively new areas of concern, study, and technology. In light of this, it is very important to review both past and current management and regulatory practices for contaminated sediments in San Diego Bay. Clearly, the current regulatory focus of the RWQCB San Diego, as well as the recent investigations sponsored by the SWRCB and Navy laboratories at

SPAWAR, are sound management and research practices. The most serious problem is that there is lots of catching up to do. An increased level of effort in both research and remediation is essential.

Barker (1990) has pointed out that there are many valid reasons for the delays that have occurred in the remediation of contaminated sediments in San Diego Bay. These include time-consuming appeals by entities responsible for funding the remediation, and limited funds for staffing at the RWQCB and other agencies. In addition, attaining the desired level of cleanup or remediation at a given site often takes a substantial amount of time. This associated planning process is also hampered by the lack of clear criteria, such as sediment quality objectives, on which to base decisions about the most appropriate remediation method to use. Finally, there are many technical difficulties and unknowns in applying relatively new remediation methods, such as capping, or even in applying established methods under different site conditions. As knowledge in the field of contaminant remediation advances, many of these problems will be alleviated.

Proposed Management Strategy—Remediation of Contaminated Sediments

The problems associated with remediation of contaminated sediment are obviously complex and most remediation methods themselves are costly. The following approaches are recommended as a management strategy to increase the efficiency of the process in San Diego Bay. These are the same approaches recommended in the Comprehensive Management Plan for San Diego Bay (San Diego Bay Interagency Water Quality Panel 1998).

Objective: Ensure that San Diego Bay finfish and shellfish are safe to eat, and that risks are minimized to recreational and commercial water contact users.

I. Collect and distribute data on sediment contamination.

- ***A.*** The Navy should participate with the RWQCB, other organizations, and industrial interests, and the public in identifying sediment data for San Diego Bay.
- ***B.*** The Navy and the Port should participate in RWQCB sediment workshops to discuss the means of determining clean levels or targets for sites,
- ***C.*** The Navy and Port should continue to update source control programs, both on the Bay and upstream.
- ***D.*** The Navy and Port should update point-source pollution prevention plans for facilities on the Bay.

II. Protect the public from health risks associated with consuming seafood by ensuring that San Diego Bay finfish and shellfish are safe to eat.

- ***A.*** Characterize consumption of seafood organisms taken from San Diego Bay.
  1. Evaluate existing information on shellfish abundance and consumption from the Bay, and conduct a survey of consumption rates and patterns if necessary.

2. Building on the results of the San Diego Bay Health Risk Study, evaluate the fish consumption from the Bay and conduct a follow-up survey if necessary.

B. Establish baseline contaminant levels in selected San Diego Bay seafood species.

1. Conduct a baseline analysis of metals, PCBs, and DDT levels in topsmelt as important prey for fish, seals, and other Bay fauna.
2. Conduct a baseline analysis of dioxin and radionuclide levels in spotted sand bass and barred sand bass.
3. Conduct a baseline analysis of dioxin levels in other fish species that have been determined to be consumed in significant quantities.
4. Review existing data on shellfish contaminants to evaluate their adequacy for establishing baseline estimates of risks to consumers, as well as the need for future monitoring.

C. Characterize risks resulting from consumption of chemically contaminated fish and shellfish from San Diego Bay.

D. Combine available consumption and analytical data as determined above to quantify risks to human consumers.

E. Periodically update risk estimates as trend monitoring data become available.

F. Monitor trends in contaminants determined to be present in seafood organisms at levels that may pose significant risks to human consumers.

1. Monitor trends of metals, PCBs, DDTs, and dioxins in spotted sand bass and barred sand bass.
2. Monitor trends of metals, PCBs, and DDT in Pacific mackerel (*Scomber japonicus*).

G. Develop and implement strategies for minimizing the exposure of seafood consumers to contaminants determined to pose significant health risks.

1. Support the development and implementation of pollution prevention practices (e.g. integrated pest management) for land owners and businesses surrounding San Diego Bay and its watershed with the goal of eliminating discharges of toxic substances.
2. In the cleanup of sediments, priority should be given to sites where sediments contain elevated levels of persistent and/or bioaccumulative toxic contaminants, as well as sites that may have lower contaminant concentrations but a higher chance of exposure to consumers. Use the Ecological Risk Assessment model under development at SPAWAR (K. Richter, pers. comm.).
3. Issue consumption advisories or bans when potentially significant health risks to shellfish consumers are determined to be present.
4. Provide education and counseling about potential health risks to consumers of San Diego Bay fish and shellfish with consideration given to the diversity of the population catching and consuming fish from the Bay.

III. Minimize risks to recreational and commercial water contact users.

A. Characterize patterns of water contact use in San Diego Bay.

1. Compile and evaluate existing information to determine patterns of recreational and commercial water contact uses.
2. Conduct a survey of recreational and commercial water contact use patterns if existing data are not adequate.

B. Characterize bacteriological water quality at selected locations around San Diego Bay.

1. Monitor indicator bacteria (total and fecal coliform bacteria) to determine compliance with state recreational water standards or other relevant criteria.
2. Monitor and evaluate temporal trends in indicator bacteria at selected locations.
3. Minimize the exposure of recreational and commercial users to pathogens.
4. Design and implement management practices to prevent the introduction of pathogens to the Bay.
5. Identify and implement methods to inform the public in a timely manner about testing results (e.g. weekly updates in the local papers).

C. Quarantine water contact areas when potentially significant health risks to recreational commercial users are determined to be present.

IV. Minimize risks to wildlife species.

A. Monitor topsmelt for potential for bioaccumulation of metals, PCBs, and DDT, since it is a resident of the Bay and is a primary prey for federally-listed and other migratory birds.

B. Ensure that Bay-wide monitoring programs are designed to consider the lower contaminant levels that can affect successful reproduction and survivability of young, such as those programs implemented through SCCWRP, County Environmental Health, California Office of Environmental Health Hazard Assessment, San Diego Toxic Substances Monitoring Program, CDFG, USEPA, and USFWS.

C. Conduct autopsies within 24 to 48 hours on birds found dead in the Bay area.

V. Conduct planning and research in support of the management objective.

A. Support a cooperative research program based on USGS' PORTS (Physical Oceanography Real-time System) to enhance oil spill prediction and response, understand what drives sediment redistribution, and analyze compatible use of boat traffic/recreational water contact users in the Bay.

B. Participate in RWQCB's effort to set sediment cleanup targets.

5.3.2 Oil Spill or Hazardous Substance Prevention and CleanUp

Specific Concerns

- Cumulative effects of small, medium, and large oil spills from boats, personal watercraft, and ships can contaminate the Bay and affect biological resources.
- Coordinated planning for oil spill cleanup activities should be integrated with protection priorities of this Plan.

Current Management

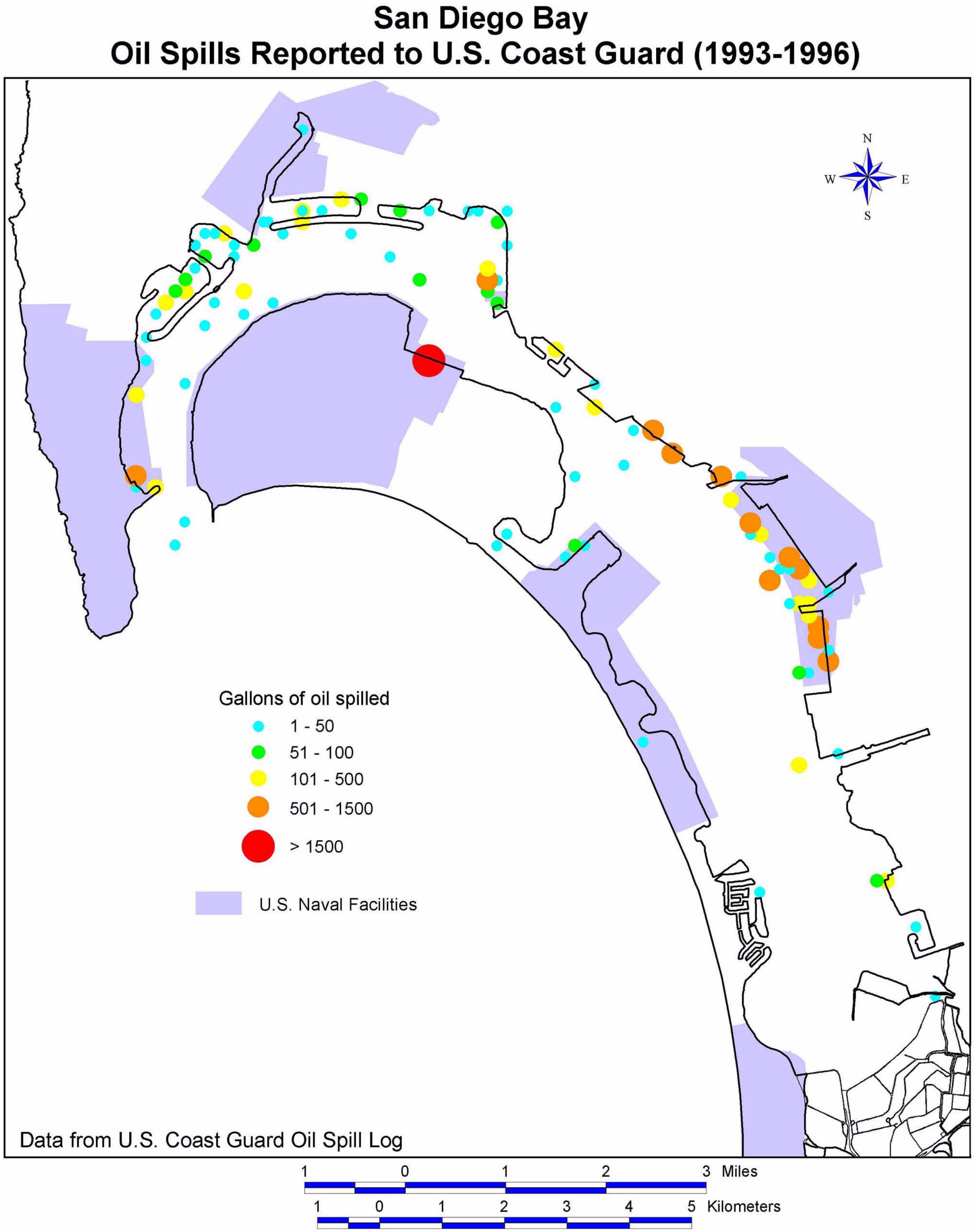
The oil spill history map covers all reported spills in San Diego Bay from 1993 to 1996 (see Map 5-1) and shows hot spots at 32nd Street NAVSTA, the NASNI Carrier Basin, and the installations under Coronado Bridge, with smaller hot spots around the SUBASE, FISC Fuel Depot pier, and NAB. Non-Navy related hot spots are likely at Commercial Basin, 10th Avenue Terminal, and 24th Street Pier. The USCG responded to 1,309 spills in San Diego County from 1993 through 1996 (1,460 days). This equates to approximately one spill per day.

- The authority to direct state and local agencies with pollution control in bays and coastal waters belongs to the US Coast Guard. Area Contingency Plans are developed by Area Committees. The Area Contingency Plans, in conjunction with the National Contingency Plan, are adequate to remove a worst-case oil or hazardous discharge. The Area Committee decides which are top protection areas in the Bay.

The USCG, lead agency for oil spill prevention and response, and under the Oil Pollution Act of 1990, is authorized to direct state and local agencies in controlling pollution in bays and coastal waters. The Act addressed the development of a National Planning and Response System. As part of this system, an Area Committee is formed to develop a preparedness document called the Area Contingency Plan to protect the area's environmental integrity. The Committee is comprised of personnel authorized to make decisions on behalf of federal, state, and local agencies which advise on the Plan development and implementation. The Area Contingency Plan is implemented in conjunction with the National Contingency Plan and shall be adequate to remove a worst-case discharge of oil or hazardous substance, and to mitigate or prevent a substantial threat of such a discharge from a vessel, offshore facility, or onshore facility operating in or near the geographic area. Each Area Committee is also responsible for working with state and local officials to preplan for joint response efforts, including appropriate procedures for mechanical recovery; dispersal; shoreline cleanup; protection of sensitive environmental areas; and protection, rescue, and rehabilitation of fisheries and wildlife. The Area Committee is encouraged to solicit advice, guidance, or expertise from subcommittees comprised of facility owners/operators, shipping company representatives, cleanup contractors, emergency response officials, marine pilots associations, academia, environmental groups, consultants, response organizations, and concerned citizens (US Coast Guard 1997).

The Draft Area Contingency Plan for San Diego Area contains site Priority Rankings (A through F) for the Bay based on decisions of the Area Committee. The top protection areas (categories A and B) in the Bay are, from north to south: marine mammal pens, Magnetic Silencing Facility, marine mammal pens of central Bay Delta Beach, Paradise Marsh, Emory Cove, Sweetwater Refuge, Otay River Channel, and the CVWR.

The US Coast Guard's Marine Safety Office, other agencies, and waterfront businesses spent about $1 million cleaning up oil and other hazardous materials in San Diego Bay in 1996. According to USCG records, 13,586 gal (51,429 L) of oil spilled in the Bay in 1996, with the Navy responsible for 11,760 gal (1,572 L) of that. Of the total spilled, 8,335 gal (31,551 L) (61%) were recovered (M. Cunningham, pers. comm. to A. Siedsma in Siedsma 1997). The USCG fines pleasure craft owners from $50 to $1,000 for spills, while spills of over 500 gal (1,893 L) cost $250 to $25,000 per day as long as the violation lasts. Civil penalties may also be imposed (Siedsma 1997).



Map 5-1. San Diego Bay Oil Spills Reported to US Coast Guard (1993–1996).

For Navy-generated spills, the COMNAVSURFPAC has developed a database for all Pacific Fleet ships. These data show:

- The largest quantities of oil spilled occur on Fridays (41%).
- The largest causes of oil spills are equipment failure (30%) and procedural errors (29%).
- Over two years (September 1994 to October 1996), the trend was toward less oil spilled overall but an increasing number of spill incidents.

Some believe the increased number of incidents but smaller amounts has to do with personnel cutbacks on ships, combined with improved technology.

- All ships using the 32nd Street Facility will pump their oily waste for treatment at the Bilge Oily Waste Treatment Facility.

The Navy has started implementing a $24 million Bilge Oily Waste Treatment Facility at 32nd Street. Operating like a sewer for oily waste, all ships using the 32nd Street facility will pump their oily waste for treatment there. The plan is to have a Bilge Oily Waste Transportation System at every pier., in which bilge waste will be pumped directly to storage facilities on shore for treatment. To further reduce the risk of in-port spills, the Navy no longer required its ships to keep their tanks full of fuel while in port. Instead, they hook up with an oiler once they depart the Bay. As of 1997, the Navy has invested over $10 million into oil spill response equipment including oil recovery skimmers, over 31,000 ft (9,449 m) of containment booms, and work boats and storage barges. NAVSTA, NASNI, and SUBASE all have spill response teams with Boston whalers, water pump boats, and oil absorbing material.

Three tenant firms of SDUPD, with the assistance of the Port, form the San Diego Spill Alliance. Arco Products Company, Chevron Products Company, and Jankovich and Sons, Inc., which operates the Port's bunker fuel facility, are part of a mutual aid agreement to provide personnel and oil spill containment and recovery equipment to any member of the Alliance who requests assistance in dealing with an oil spill. All three of these firms are located in close proximity to the Tenth Avenue Marine Terminal. Although not a signatory to the Alliance, the Port provides support by making space available at its piers and wharves without charge to member firms for the deployment of equipment during training exercises and actual oil spills.

Proposed Management Strategy—Oil Spill Prevention and Cleanup

Objective: Prevent spills of oil and other hazardous substances, and ensure the effectiveness of prevention and response planning.

I. Integrate the protection priorities of this Plan into spill response planning.

  A. Use the new GIS (Geographic Information System) layers of Bay natural resources to support preparedness planning.

II. Continually enhance oil and hazardous substances spill response capabilities through equipment procurement, training, and participation in drills and area exercises, and continue active membership in the Harbor Safety Committee and Area Contingency Planning Committee.

  A. Continue to test the local Area Contingency Plan with exercises and drills.

  B. Continue spill response, regardless of its source, in partnership with the USCG in accordance with the existing MOU between the USCG and the Navy.

III. Support continuation of the Navy's radiological environmental monitoring program in the San Diego area to monitor possible spills (San Diego Bay Interagency Water Quality Panel 1998).

IV. Support the sharing of EPA data regarding radiological operations and environmental monitoring with appropriate California and local agencies, and the public (San Diego Bay Interagency Water Quality Panel 1998).

5.4 Cumulative Effects

Specific Concerns

- As in other ecosystems, significant piecemeal habitat loss and fragmentation continues in San Diego Bay, and species continue to be listed, despite the intent of cumulative effects analysis under NEPA and other laws.
- Certain habitat losses are so severe in the Bay that the remaining fragments have become increasingly more precious. The cumulative effect of additional loss would be the deciding factor in determination of a significant impact, even though the project footprint itself may be small. However, there traditionally has been little documentation available to support a determination.
- Despite the obligation of agencies to quantify the effects of projects from a cumulative perspective, we are technically unable to do this because it entails a need to quantify connections among species and among habitats, and between the proposed project and all past, present, and reasonably foreseeable future actions at a site.
- There is no mechanism to ensure the quality of discussion on cumulative effects in environmental documents, especially for projects that are small but that are repeated on a wide scale. There is no way to identify at what point a loss becomes significant and at what scale of analysis.
- Incomplete or inadequate information sharing among agencies makes it difficult for project proponents to summarize past actions.

Photo © 1998 Tom Upton.

Photo 5-8. Riprap Armoring near Coronado Cays.

Current Management

- Under NEPA, cumulative effects are those that result from the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of which agency (federal or nonfederal) or person undertakes those actions.

The definition of cumulative effects is different under NEPA than under the ESA. Under NEPA, cumulative effects are those that result from the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of which agency (federal or nonfederal) or person undertakes those actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

- Under the ESA, cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered in a biological assessment or opinion.

The definition under the ESA is narrower. Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered in a biological assessment or opinion. Future federal actions that are unrelated to the proposed action are not considered because they require separate consultation pursuant to Sec. 7 of the ESA (US Fish and Wildlife Service and National Marine Fisheries Service 1998). Usually, the NEPA/CEQA cumulative effects analysis is taken and applied to the narrower ESA definition. Potential cumulative effects from Bay projects include:

- Habitat conversion, loss, and fragmentation.
- Changes in sediment or salinity dynamics due to dredging.
- Habitat degradation for birds with growth-inducing projects that increase boat traffic.
- Increased risk of oil spills and exotic species invasions with increased maritime traffic.
- Increased risk to water quality and air quality.
- Increased hardening of the intertidal zone.
- Increased disturbance of birds using shoreline areas.

- Cumulative impacts may be defined as the sum of all individual impacts to a system.

Cumulative impacts may be defined as the sum of all individual impacts to a system. Individual projects may have little measurable ecological effect beyond the project footprint. However, dozens of similar projects could very measurably change sediment erosion and deposition patterns, organic matter production and movement, as well as affect types and areas of habitat within the Bay. Modeling of cumulative impacts requires quantification of links between habitat "quality" and biological resource use, and these are generally poorly understood. For example, the cumulative effects of armoring on habitat functions other than resource use are not predictable at present, such as changing longshore drift velocities and lowering of the beach profile such that organic deposition on beaches is altered, as well as nutrient flux from sediments (Thom *et al.* 1994).

Evaluation of Current Management

- NEPA and ESA both fail to provide means to ensure the proper consideration of cumulative effects.

Congress passed NEPA out of concern that our limited natural resources are being lost in "small but steady increments" (S. Rep. No. 296, supra note 2, at 5, as cited in Thatcher 1990). However, the law provides no mechanism to ensure the proper consideration of cumulative effects, with the quality of the analysis dependent on the author of the environmental documentation. Typical cumulative effects sections in environmental documents are brief and vague, and they are recycled from report to report (Parry 1990).

Proposed Management Strategy—Strategy for Cumulative Effects

Objective: Minimize adverse cumulative effects on habitats and species of the Bay ecosystem.

I. Standardize the format by which cumulative effects are discussed in environmental documentation (Parry 1990) as shown below and in this outline (sections *II* and *III*):

- ***A.*** Documentation should be presented at different hierarchical scales that are standardized to the extent possible from lowest to highest scales, such as by inlets, the Bay as a whole, Southern California Bight, state of California, or the Pacific Flyway.
- ***B.*** Ensure standardization of the habitat classification system to be used in cumulative effects documentation.
- ***C.*** The assessment should provide a check on the fragmentation and loss of connectivity of remaining habitats.
- ***D.*** The assessment should provide a check on the minimum size of viable habitat parcels, using target management species to define "viable" parcels.
- ***E.*** The format should support an information base on local extirpations or declines of species at risk, both listed and others of concern, so that additional effects to these species from a project can be more easily reported upon.

II. Properly bound the spatial and temporal extent of projects, such that all other projects that overlap in time and space are considered.

- ***A.*** Geographic boundaries of a proposed action should be defined by actual effects, not administrative or ownership boundaries.
- ***B.*** The immediate geographic boundary of an analysis should be expanded until trends show that project effects diminish sharply.
- ***C.*** Identify crucial agents of connection or interaction between habitats that may be affected by projects, such as water/watershed, sediment movement, animal movement, and wind transport.
- ***D.*** If information is not available, such as a project site is known but no other supporting engineering or natural resource data, use data from this Plan to support the analysis.

III. Use target management species identified in this Plan that represent values at risk for a particular project, both directly and due to connections up the food chain or among habitats, to help focus the analysis of potential impacts.

IV. Once a standardized format is established, make the information accessible to project proponents and agencies to update and include in cumulative effects documentation.

V. Support research to improve the adequacy of cumulative effects analysis at predicting when habitat or species effects become significant.

A. Promote research on connections among habitats and species, and the relationship between habitat "quality" and resource use.

B. Support research on the effects of habitat fragmentation, using indicators.

C. Support research on the minimum size and proximity of habitat parcels as viable habitat for animals of different sizes and dispersal capabilities.

VI. Develop means to mitigate for cumulative effects.

5.5 Environmental Education

Specific Concerns

- Other than its use as a setting or backdrop for activities occurring in the Bayside municipalities, there are few events that showcase the Bay as a resource unto itself.
- There is a need to improve the public's sense of ownership of the Bay and its resources. Part of the problem is that there is limited access to Bay waters for the general public.
- Education about the Bay is poorly integrated into the existing network of professionals in natural resource interpretation.
- Understanding of the Bay's cultural value, how it has been viewed and used past and present, is an information gap that needs to be filled in order to make education programs effective at reaching target audiences.
- Existing, well-developed efforts on clean water and watershed education, treat the Bay simply as receiving waters and do not consider the richness of its living organisms.
- Adult education is not as well targeted as K-12 school-level education. Professionals who manage the Bay and political decision-makers should also be targeted.
- Secure, long-term funding is needed to ensure the continuance of environmental education programs at San Diego Bay.

Current Environmental Education Initiatives

Teaching people about the Bay's natural resources, their need for protection, and the watershed's influence on the Bay is an important component of an ecosystem management strategy. Environmental education is presently targeted at both school-age children and adults but usually through separate programs. A sampling of existing environmental outreach projects on the Bay include:

- County Water Authority programs
- SDNHM Watershed Program
- Storm Drain Stenciling Program
- Paradise Creek Watershed Project
- Strand Beautification Program
- County Office of Education - Watershed Program
- Friends of Famosa Slough
- Baykeepers - clean-up

- San Diego Audubon - clean-up, environmental education, Audubon adventures
- Environmental Health Coalition - clean-up
- City of San Diego - "Think Blue"
- City of San Diego Storm Water Office - "Stream Team"
- The Making of a Naturalist - A Marsh Program (SDNHM)
- Municipality Programs - Chula Vista
- San Diego Divers Association - underwater clean-up
- Resource Conservation District - Watershed Program

A variety of local efforts that pertain to the Bay are ongoing and are described below. The SDUPD has had an active Clean San Diego Bay campaign since 1992 that has involved many environmental education projects (San Diego Unified Port District 1995a). As an initial effort, the Port's Environmental Education Programs Committee produced a comprehensive guide to environmental education resources available within the San Diego Bay watershed (San Diego Unified Port District 1995b). One of their hopes of the project was to get many of the 31 identified organizations and agencies to develop partnerships. Current watershed education projects by the Port include a school program of presentations for students and teachers on watersheds, nonpoint source pollution, and their relation to the Bay; a "Your Storm Drain Ends Here" poster, with a picture of a heron and a hotline phone number to call to report storm drain problems, an Annual Pollution Prevention Award, and watershed awareness stickers. In one Port-sponsored project, Paradise Creek in National City is now adopted by a nearby elementary school and some devoted residents to protect its wetlands and wildlife (Taylor 1999).

Environmental education signs about the Bay's wildlife are displayed at several key points along the Bay, a cooperative community project from several years ago. During the Port's South Embarcadero Urban Development planning process, it was realized that few opportunities to learn about and interact with the Bay existed (Sasaki Associates 1996). As a result, a goal was proposed for the area's plan: "Enhance public awareness of the Bay as an environmental resource" and several principles were suggested, such as providing locations where the public can interact with the water. Adult education efforts by the Port focus on pollution control practices for the boating community and on storm water management practices for Port and City employees.

Chula Vista Nature Center offers natural history interpretation of the SMNWR for school children and the general public. Exhibits at its museum feature the ecological zones of the marsh, coastal and marine animals and plants displayed in aquaria and terraria, a unique display on the light-footed clapper rail, and a shark and ray "petting tank." Managed by the non-profit Chula Vista Bayfront Conservancy Trust and its broad-based Board of Directors, the Center depends on a small staff and many volunteers to carry out its programs. For example, every year work groups from the Audubon Chapter, San Diego Bay Keeper, and other community groups help remove tons of trash that drift into the Sweetwater Marsh National Wildlife Refuge.

The RCD assists with storm water education outreach to elementary school classrooms around the Bay with the help of funding from the Port. The RCD also sponsors an annual Backyard Stewardship Poster Contest, Project WET (Water Education for Teachers) workshops for school teachers, scholarship awards, and speech contests, among other educational efforts.

A public event to increase resident and tourist awareness and appreciation of the area's bird populations is the Imperial Beach Bird Fest, which began in 1997 and is becoming an annual event with free walks and guides. This event has expanded recently to include the whole Bay as well as adjacent environments. Diverse support is provided by San Diego Natural History Museum, Chula Vista Nature Center, Tijuana River NWR, San Diego Audubon Society, Imperial Beach Chamber of Commerce, and the Chula Vista Convention and Visitor's Bureau.

A good example of the contribution of volunteers is the Paradise Creek watershed Project. A small group of community activists, teachers, students and sponsors joined together to preserve and restore one-half mile stretch of Paradise Creek, a tidal salt marsh that runs adjacent to Kimball Elementary School in National City. Paradise Creek connects San Diego Bay and the Sweetwater National Wildlife Refuge to the community of National City. A grass-roots group formed the Paradise Creek Educational Park Inc., a legally incorporated non-profit organization with a mission to protect and restore Paradise Creek, and assist with projects associated with Paradise Marsh and Sweetwater Marsh, the downstream National Wildlife Refuge. The group's mission includes raising funds and support to develop environmental education programs, and to operate Paradise Creek Educational Park and a proposed Science Center in National City.

The first program initiated by the group is the after-school program for the students in the community called "The Egret Club." Students participate in after-school and weekend events such as trail and creek cleanups, removal of non-native plants along the creek shoreline, and propagation and planting of wetlands and uplands plants. In addition, they take part in a monthly birdwatching bike trip around San Diego Bay. The future plans of the non-profit group include expanding the Egret Club and producing watershed and non-point source pollution materials in paper and electronic forms through the Paradise Creek Watershed Project.

The Paradise Creek Watershed Project is planning to develop a Habitat restoration guide that will assist the community in understanding the environmental goals and objectives of their work at Paradise Creek. This guide will be in four languages, English, Spanish, Tagalog, and Braille. Secondly, a disabled access guide for Paradise Creek is planned. The group seeks to be a role model for all park development in the region and a "must see," experience for groups that serve the disabled community. Thirdly, a braille and touch experience" sign program is planned for Paradise Creek Educational Park. This sign program will involve three dimensional models for hands-on experience for the blind. Braille text messages will be part of all signage at the park. Involving the ethnic and disabled communities in conservation is expected to expand their education and recreational opportunities while adding to the growing body of advocates for this little urban creek.

In addition, Paradise Creek will explore funding opportunities to expand the restoration of Paradise Creek up and downstream and to design and build a Science Center in National City to promote environmental knowledge and stewardship to the community of National City and the region.

Evaluation of Current Environmental Education Initiatives

Most data sets and studies have been generally inaccessible to educators and the public, having been presented in this Plan sometimes for the first time beyond the offices of the sponsoring agencies. The Bay is also generally out of the public mindset, with most news being negative, the occasional sewage spill or concern about contaminants. Few understand the global significance of some natural resources here.

Only one program evaluation was available during the development of this Plan (Resource Conservation District of Greater San Diego 1997). In the RCD's third year of its Watershed Awareness program (1996–1997), watershed education reached 40 schools, 126 teachers, and 4,482 students through its 143 presentations. A pre- and postevaluation of the participants' awareness on the topics of watersheds, nonpoint source pollution, and individual responsibility to San Diego Bay showed a 20% increase in understanding. With a $14,000 annual budget, the cost of the program per participant was $3.04, or, assuming one parent per student also became aware, $1.52 per person. Evaluating whether any of these educational efforts have affected the Bay's natural resources is a long-term and somewhat indirect effort. Changes in adult awareness, attitude, and behavior with respect to the Bay could be measured more directly, but have not been beyond the school effort mentioned above.

Volunteers from the community are an essential ingredient in helping to make these educational efforts a success beyond their often meager budgets. During its tenth anniversary celebration in 1997, the Chula Vista Nature Center noted that 571 volunteers had officially helped them over the years, contributing 125,000 hours, worth at least $656,250 at minimum wage (Chula Vista Bayfront Conservancy Trust 1997). Funding for the Center's projects has come from a variety of sources, such as private donations and bequests, awards from legal settlements, and grants from the State Coastal Conservancy and the Port. However, the Bayfront Conservancy Trust believes the best long-term source of support for the museum and its programs is a local assessment district (Chula Vista Bayfront Conservancy Trust 1997).

Most of the educational emphasis relating to the Bay and its watershed is on school children. Adult education appears to receive less attention. Since much regulatory attention and agency funding is presently focused on water quality, educational efforts tend to reflect that issue rather than an ecosystem viewpoint. An exception is the Chula Vista Nature Center, which seeks to impart knowledge about food chain relationships and habitat needs for species. While marine ecosystems are well depicted at the Birch Aquarium-Museum in La Jolla, the Aquarium needs encouragement to develop more interpretive displays and materials on wetlands as an important natural resource and the San Diego Bay as a unique, local ecosystem.

So, environmental education about the Bay is in its infancy, and poorly integrated into the existing, rather substantial network of professionals in volunteers in the arena of natural resource interpretation. There is much room to expand target audiences, and to improve the effectiveness and efficiency at which the message is developed and delivered.

Proposed Management Strategy

■ A sense of ownership and responsibility for the Bay may be fostered by a curriculum of stories to be told about living resources that share residence with San Diegans.

Teaching about the Bay should blend the culture of San Diegans with local natural resource values. In order to develop caring and responsibility for the Bay's resources, an educator's job is to foster a "sense of place" (Nabhan 1998), or ownership in the living organisms that share residence with San Diegans. This is facilitated by developing a curriculum of stories to be told about living resources and how people relate to them now, or have related to them in the past. To build the stories, educators require direct access to technical data sets, and accurate summaries of these data sets so that they can be effectively interpreted in a manner that captures the public's attention and imagination.

During two workshops held in late 1999 to generate ideas for teaching about the Bay, separate lists of sample target audiences, potential implementers of environmental education programs, and potential funding sources were identified. These are shown in Table 5-10.

Table 5-10. Sample target audiences, implementers, and funding sources for environmental education projects.

Target Audiences	Potential Project Implementers	Potential Funding Sources
• Adults (through media) • Compatible recreation groups - windsurfers, kayakers, etc. • Decision makers • Developers • Families (through children) • Housing developments / residents • Industries / Businesses • Navy families • Port Tenants - boating community • Schools and youth organizations • Aquarium Trade • Bike riders • Educators • Environmental and Civil Engineers (water quality) • Fishermen • Landscape Architects • Planners • Shoreline Project Engineers • Tourists • Zoo members and members of other partners	• Baykeeper (clean-ups) • California Coastal Commission (clean-ups) • California CREEC - San Diego County Environmental Education Coordinator • Chula Vista Nature Center • City of San Diego • City of San Diego "Think Blue" • City Storm Water Office - "Stream Team" • Convention and Visitor's Bureau • County Office of Education - Watershed Program • County Water Authority • Ducks Unlimited • Environmental Health Coalition - educate county organizations, Clean Bay Campaign • Friends of Famosa Slough • Friends of SDBNWR • Girl and Boy Scouts / 4-H Clubs / Other Youth Clubs • Heal the Bay (now up in Los Angeles) • Housing developments / "bayscaping" • I Love A Clean San Diego • Local television and radio personalities • Navy public relations funds • NOAA/NMFS • Port of San Diego • Resource Conservation Districts • San Diego Audubon (clean-ups, elementary education, Audubon adventures) • San Diego Natural History Museum • Birch Aquarium • Sea World • Surfrider, Surfers Tired of Pollution • USFWS National Wildlife Refuges • West Marine • Zoological Society of San Diego	• California Coastal Commission • California Department of Boating and Waterways • City Attorneys Office • City of San Diego • District Attorneys Office • EPA • Federal Attorneys Office • Individual / corporate donors, such as Kelco • Lucky sponsors, etc. • NOAA/NMFS • Packard and other private foundations • Port of San Diego • San Diego County Wildlife Commission • State Department of Education • Visa

Proposed Management Strategy—Environmental Education

Objective: Establish a culture of conservation for the Bay as an ecosystem, including the relationship to its watershed.

I. Conduct an assessment of how this Plan can be integrated into the current environmental education network as a precursor to a marketing plan for natural resources of the Bay to county residents. This may be a requirement of some funders, and should be accomplished in consultation with the EPA.

- **A.** Begin the process of integrating the Bay Plan into all the other, existing thinking processes on environmental education under an umbrella concept of developing a "Sense of Place" for county residents.
- **B.** The top priority is to build on and expand existing partnerships and programs.

II. Improve access for environmental educators to studies, data sets, and summary reports so that curriculum development can be facilitated.

III. Develop community festivals, ceremonies, and ecotourism that involve direct interaction between the public and San Diego Bay.

- **A.** Begin a San Diego Bay Education Campaign
  1. Partner with the City of San Diego's "Think Blue" and use their spokesperson.
  2. Organize "Earth Day on the Bay" or "Bay Days" as community events.
  3. Bring the Shorebird Sister School Program and the Black Brant Internet Project to San Diego. Organize events around when these birds arrive in San Diego Bay for their migratory stopovers.
- **B.** Expand existing bird festivals and encourage bird-a-thons as a means to learn about diversity, habitat, and trends. Demonstrate their economic benefit to municipalities and other decision makers.

IV. Establish a new or build on an existing community-based restoration program, in cooperation with government agencies and private non-profit groups already involved in the Bay or environmental education, e.g. SDNHM, Chula Vista Nature Center, Paradise Creek Watershed Project, Environmental Health Coalition, Oceans Foundation, U.C. Sea Grant, NMFS, etc.

- **A.** Support and publicize existing or nearby efforts. Examples might be:
  1. Paradise Creek marsh restoration
  2. Chollas Creek Linear Park
  3. Chula Vista Bayfront Development
  4. Otay River Wetlands Working Group watershed management effort.
- **B.** Target new locations for restoration.
  1. Exotic plant removal at Chollas Creek--City of San Diego, US Navy

2. Sweetwater River edge softening--City of Chula Vista, National City
3. Dune restoration on both sides of Silver Strand--City of Coronado, US Navy
4. Interpretive signs along the bikeway--Imperial Beach, Coronado, USFWS
5. Mouth of the Otay--USFWS, City of Chula Vista
6. Intertidal enhancement at Biological Study Area and CDPR lease site--US Navy, CDPR, County of San Diego.
7. Power Plant property, if the future use allows for it--Port of San Diego.

V. Expand existing educational partnerships among nonprofit organizations, the Port, government, schools, and businesses that focus on the Bay.

A. Foster cooperative agreements between each city and local environmental education, interpretive, or nature centers.

1. Distribute "Trekking the Refuge" backpacks--San Diego Zoo, Chula Vista Nature Center, USFWS.

B. Initiate a "Bay Camp" oriented towards high school students that includes a mentorship program pairing students with Bay researchers.

C. Cosponsor workshops, seminars, literature, web page, and other outreach activities.

D. Institutionalize permanent interactive environmental educational programs with local schools about the Bay and its watershed.

1. Promote the use of the South Bay Marine Biological Study Area by universities for education and research studies. Place an interpretive sign and birdwatching platform there.
2. Schools should be given real problems with real data sets to work with. Involve high schools in long-term monitoring of basic measurements.
3. Expand the use of boats for educational field trips, as proposed by the Maritime Museum, Baykeepers, etc.
4. Support the development of a K-12 curriculum that includes and accurately describes the Bay's ecosystem. To assess the program's viability, start with a Bay "road show" for which funding agencies support an educator to visit schools.

E. Support training and use of volunteers to provide additional outreach to adults and children.

1. Provide recognition of volunteer contributions.

VI. Support ecotourism by expanding interpretive activities.

A. Take advantage of interpretive opportunities where and how people currently access the Bay.

1. Involve municipalities in developing a regional "Walk of Discovery" map that shows Bay access and points of interest. Also target bicyclists.
2. Install biological and cultural interpretive signs at key viewing areas of wildlife activity or interest that detail features of the viewpoint. This could be done by the Port, cities, USFWS or US Navy. Good examples exist at the observation platform at Kebdall-Frost Marsh, Mission Bay.
    a. Maintain the signs current, clear, and in good condition.
    b. Hand out informational brochures at key locations. One could be an "Environmental Dictionary for San Diego Bay" which defines words like "eelgrass," "intertidal habitat," etc.
3. Create observation decks and boardwalks, where appropriate and compatible, to improve bird-watching possibilities and appreciation of the Bay's environment. See Table 5-11 and Map 5-2 for suggestions on locations.
4. Encourage the Birch Aquarium-Museum to include a display on San Diego Bay's ecosystem.
5. Expand the Port's Boater's Guide or create a new brochure explaining the need to avoid eelgrass, rafting birds, green sea turtles, and marshes.
6. Promote appreciation of San Diego Bay's native wildlife and habitats through public art: unique tourist postcards, children's coloring books, posters, art contests, murals on buildings, statues in public areas, and other forms of public art.

B. Develop new access opportunities by partnering with private and non-profit or public groups.

1. Construct a marsh boardwalk associated with any new hotels.

VII. Target awareness for city commissioners and planners, engineers, Port personnel, Navy personnel, Coastal Commission, and other managers and decision makers.

A. Announce and carry out a highly visible pilot project in which different types of materials and designs are tested for shoreline structures that improve habitat value.

B. Develop a presentation that explains the economic benefits of a healthy Bay to the public and decision makers.

- *"Lessons learned through observation of nature benefit all."*
  ~Les Perhacs, artist and creator of loon statue at Lindbergh Field

C. Promote awareness of this Plan and its use as a reference tool.

VIII. Evaluate the effectiveness of existing environmental education programs.

A. Compare the before-and-after awareness level of the participants.

B. Set a target for desired awareness levels on different topics for each age group, including adults.

1. Topics should include diversity of fish and wildlife, wetlands, watershed connection to Bay, nondisturbance of bird foraging and nesting sites, stewardship, recreational impacts, and historical and current habitats.

C. Adjust the programs if desired awareness is not achieved.

IX. Secure long-term funding to ensure the continuance of environmental education programs about San Diego Bay.

A. Explore use of “bed-tax” from visitors’ hotel tax as a source of interpretation funds at tourist sites.

B. Seek private foundation funding for special projects.

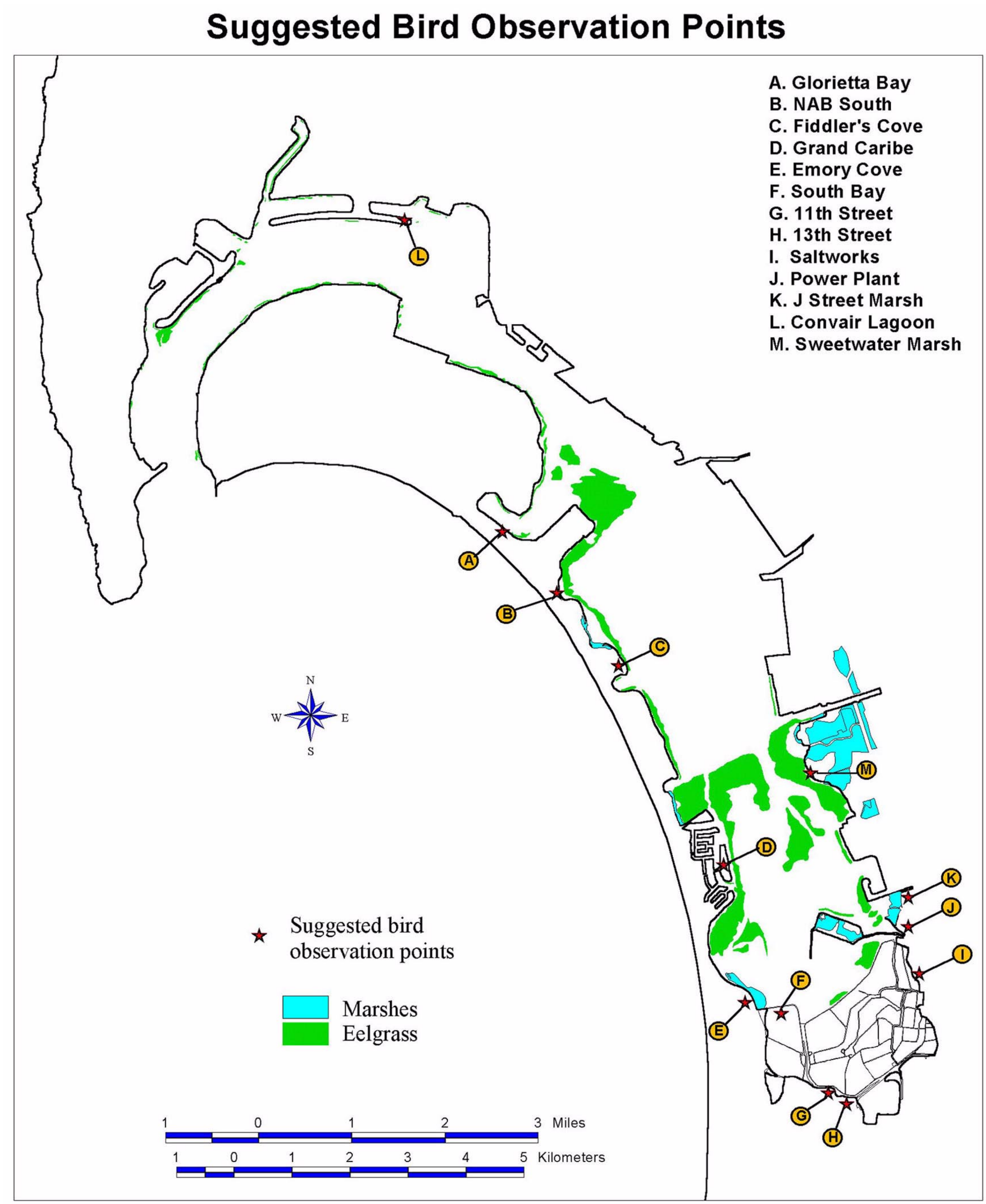
C. Explore use of environmental license plate funds from state’s special coastal license plate.

Table 5-11. Suggested bird observation locations for public access or long-term monitoring.

Site	Advantages	Disadvantages
A: Near the seawall in Glorietta Bay, just south of Coronado City Hall.	• Views of Glorietta Bay • Golf course shores (fairly extensive, exposed on low tides) • Entrance channel waters	• On Coronado City property • Limited parking except on weekends • Slightly limited car access
B: On Silver Strand immediately south of Naval Amphibious Base.	• City of Coronado has already installed an observation platform	• Accessible only to walkers, bikers • Nearest car parking is approximately 1/4 mile away and is intended for NAB personnel • No signage at platform
C: Land at the mouth of Fiddler’s Cove, the Navy marina on the strand.	• Wide view of the Bay, especially the breakwaters installed at the mouth of the cove • Well-used haul out/loafing/roosting site for marine mammals and birds	• Closed to public access • Construction debris dump site
D: Anywhere on the Bay side of Grand Caribe.	• Wide view of bay near eelgrass beds	• Proposed development plans are currently awaiting approval or denial.
E: On top of the bluff above Route 75 opposite the marsh.	• Entire scope view of the South Bay	• No public access • No site development
F: The juncture of the broad dike at South Bay Observatory and the Bayside marsh edge.	• Entire view of the whole area • Heart of the winter range of thousands of birds • Could be enlarged to include the rest of the dike	• Construction of a small boardwalk along the marsh edge would be required • Limited car access • No site development • No signage or interpretive materials
G: Foot of 11th Street.	• Otay River bank is exposed during low tide • Elevation above river • Views of adjacent ponds • Easy car access	• Location is an existing parking lot • Fence separates bike path and parking lot from river
H: Foot of 13th Street.	• Adjacent to Otay River • Wide view of existing ponds	• No site development • Access partly limited by termination of bike path • Adjacent to commercial/industrial site

Table 5-11. Suggested bird observation locations for public access or long-term monitoring.

Site	Advantages	Disadvantages
I: Adjacent to crystallized ponds and dikes on east side of ponds, East of a large dredge, permanently ensconced in the salt ponds.	• Summer months host nesting sites of several tern species • Access from Bay Blvd.	• Private property parking lot
J: On the shoreline West of the present power plant tanks.	• Currently a reserve	• Access difficult • Traffic could jeopardize the reserve function
K: The J Street marsh.	• Boardwalks work well to allow observation without causing disturbance • Might make a developed site at Chula Vista Preserve unnecessary	• Construction of a boardwalk extending south from the east-west causeway around the marina would be required
L: Convair Lagoon area.	• Lots of water birds, especially in winter months • Elevated above water	• Currently a parking lot for private business • Access is restricted by parking lot • No current attention from wildlife perspective
M: Sweetwater NWR	• Existing public access at end of trail • Eelgrass bed visible from shore	•



Map 5-2. Suggested bird observation points for public viewing or for a long-term monitoring program.