Executive Summary

Coronado Bridge and downtown San Diego.

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This assessment of environmental conditions in San Diego Bay was performed pursuant to a memorandum of understanding between the San Diego Regional Water Quality Control Board (RWQCB) and the City of San Diego. The general purpose of the study was to address concerns expressed by the San Diego Bay Interagency Water Quality Panel (Bay Panel). The Bay Panel was composed of 31 federal, state and local organizations and was formed to provide technical information and advice to the RWQCB regarding the status of various environs in the Bay. Major goals of the Bay Panel were to characterize the overall ecological state of San Diego Bay, identify long-term environmental trends within the Bay, and to address public concerns about the exposure to contaminants from eating fish captured in the Bay.

This report was designed to address the interests of the Bay Panel using data collected from San Diego Bay in conjunction with the Southern California Bight 1998 Regional Monitoring Project (Bight'98). Each of the major sampling components of the Bight'98 survey was used to characterize the state of subtidal habitats in San Diego Bay at the time. These components were sediment particle size and chemistry characteristics (see Chapter 2), macrobenthic invertebrate communities (see Chapter 3), trawl-caught fish and invertebrate communities (see Chapter 4), and contaminant levels in fish tissues (see Chapter 5).

Sediment Quality

Sediment samples were collected at 46 stations distributed throughout San Diego Bay at depths ranging between 3 and 16 m. All samples were analyzed to determine particle size composition and concentrations of various trace metals, chlorinated pesticides, polychlorinated biphenyl compounds **(**PCBs), and polycyclic aromatic hydrocarbons **(**PAHs). Sediment contamination was widespread in the Bay, with many of the "contaminants of concern" previously listed for San Diego Bay being present. These contaminants included the metals chromium, copper, lead, mercury and zinc, the biocide tributyltin, the pesticide chlordane, PCBs and PAHs. Chromium, copper, lead, mercury, zinc and PAHs were found in more than 70% of the sediment samples. In contrast, PCBs and tributyltin were detected much less frequently (< 26% of samples), while chlordane was not detected at all. Concentrations of various contaminants were evaluated using established sediment quality thresholds (i.e., ERL, ERM, TEL, PEL). Concentrations of nine metals, DDT and PAHs exceeded at least one of these thresholds. Sites at which multiple contaminants exceeded the thresholds typically had high percentages of fine sediments (i.e. > 60% fines) and were located near or within marinas or shipyards; this distribution pattern was similar to those described in previous studies. Compared to the other bays and harbors sampled during Bight'98, San Diego Bay ranked among the top three in average sediment contamination for only four contaminants: antimony, mercury, copper and PAHs. Additionally, the Bay ranked fourth in terms of PCB contamination, fifth for chromium, and sixth for zinc. Finally, San Diego Bay had lower levels of pesticides than any other embayment studied.

Macrobenthic Communities

Macrobenthic community structure was summarized for each of the 46 stations described above and then compared to various environmental and sediment parameters (e.g., depth, percentage fines, total organic carbon, nitrogen, and several contaminants of concern). Additionally, ordination and classification analyses were performed to compare the similarity of the different assemblages present in the Bay. Overall, 38,187 macrobenthic organisms representing 340 taxa were identified, of which polychaetes, molluscs and crustaceans were the dominant groups. Many taxa (> 27%), however, were composed of a single rare or unidentifiable individual. Non-indigenous species were an important component of the Bay benthos, comprising at least 18 species and representing about 24% of the total macrofauna. Two species of polychaete worms, the capitellid *Mediomastus* sp (likely a species complex) and the spionid *Prionospio (Prionospio) heterobranchia*, occurred at all stations. *Mediomastus* sp was also numerically dominant, comprising 13% of all animals collected. The non-indigenous bivalve *Musculista senhousia* was the second most abundant species, followed by the sabellid polychaete *Euchone limnicola*. Hydrodynamic conditions such as tidal flushing appear to be the primary factor influencing the distribution of macrobenthic assemblages throughout the Bay, while anthropogenic impacts may represent a secondary factor.

Most of the animals common in San Diego Bay were also present in the other bays and harbors sampled during Bight'98. For example, many of the most abundant taxa in San Diego also occurred in high numbers in the other bays. Likewise, widely distributed species in San Diego Bay had similar broad distributions in the other embayments. Differences among assemblages in all bays and harbors, however, appeared to be due to multiple environmental and biological factors, including different hydrodynamic conditions, anthropogenic impact, and the presence of dominant, habitat altering species.

Demersal Fishes and Megabenthic Invertebrates

Demersal fishes and megabenthic invertebrates were collected by otter trawl at 16 stations in San Diego Bay. Fish populations appeared healthy in the Bay, with no physical abnormalities detected on any fish. Trawl catches of fishes were relatively small, with only 16 species and 349 individuals captured. Dominant species that occurred frequently in relatively high numbers were the round stingray, spotted sand bass, barred sand bass and California halibut. Almost all of the California halibut and barred sand bass captured were juvenile fish, which supports previous findings that these two species use the Bay as a nursery.

A total of 1,172 megabenthic invertebrates, representing 43 taxa, were also collected in San Diego Bay. The bivalve *Musculista senhousia* was present in more than 70% of the samples, making it the most widely distributed trawl caught invertebrate in the Bay. Other common invertebrates that were present in at least one third of the samples included two undescribed species of sponge, Porifiera sp SD4 and Porifera sp SD5, the ascidian *Microcosmus squamiger*, the bivalve *Argopecten ventricosus*, and the gastropod *Crepidula onyx*. *Musculista senhousia* and *Microcosmus squamiger* together, both non-indigenous species, accounted for over 50% of the total catch.

The most important factor influencing the distribution of trawl-caught fishes and invertebrates in San Diego Bay appeared to be distance from the entrance to the Bay. In general, the fish and invertebrate assemblages present in the central and southern parts of San Diego Bay differed from those found near the mouth of the Bay. The species that characterized these central and southern areas in 1998 were typical of embayments in general. In contrast, assemblages found towards the entrance of the Bay and in some of the other southern California bays and harbors (e.g., LA/Long Beach Harbor) during the Bight'98 project were typically characterized by species more representative of open coastal areas.

Bioaccumulation of Contaminants in Fish Tissues

Five species of fish were collected at 24 stations in San Diego Bay and analyzed to measure the accumulation of contaminants in their tissues. Whole fish samples of California halibut were collected at seven stations and analyzed for the presence of pesticides and PCBs. The contaminant levels present in these fish were compared to those found in whole halibut samples from the other southern California bays and harbors, as well as to predator protection limits for mammals and birds. Samples of muscle tissue were also collected from halibut and four other species of sport fish (i.e., calico bass, spotted sand bass, barred sand bass, yellowfin croaker) at the remaining 17 stations in the Bay. These muscle tissue samples were analyzed for the presence of metals, pesticides, and PCBs, and the results were then compared to human health consumption limits.

All whole fish samples of California halibut collected in San Diego Bay during 1998 contained detectable levels of PCBs and DDT. Concentrations of PCBs exceeded the predator protection limits for mammals, while DDT concentrations exceeded the protection limits for both mammals and birds. Overall, San Diego Bay ranked fourth out of the five southern California embayments sampled for whole fish in terms of total DDT. The Bay ranked first in terms of total PCBs, with the average detected value in San Diego Bay halibut being an order of magnitude higher than in fish from the other bays and harbors.

Muscle tissues contained many of the 'contaminants of concern' previously listed for San Diego Bay. For example, PCBs and the metals mercury and zinc were detected in almost all of the muscle tissue samples, while the other contaminants of concern occurred much less frequently or not at all in Bay fishes. Of the metals and pesticides for which thresholds are available, chromium and arsenic exceeded human health consumption limits in only a single sample each. Overall, PCB concentrations were very high in the muscle tissues of San Diego Bay fish, especially when compared to species of flatfish, rockfish and sand bass sampled off the outer coast of San Diego over the past several years.

SUMMARY

Contamination remains widespread in San Diego Bay sediments and affects the tissues of various species of fish that are subject to human consumption. Contaminants previously identified to be of concern in the Bay, such as chromium, copper, lead, mercury, zinc, PCBs and PAHs continue to be present at levels that exceed one or more sediment quality criteria thresholds. This is particularly true for sites where the percentage of fine sediments is high. Such areas are typically located near or within marinas or shipyards where currents are less strong, and where various physical structures

reduce tidal flow or create eddies that allow suspended particles to settle. Several of these contaminants also occurred in relatively high concentrations in the tissues of fish from the Bay. For example, mercury, zinc, PCBs and DDT occurred in over 80% of fish tissues, and both PCBs and DDT exceeded at least one of the mammal and bird predator protection thresholds.

Long-term trends in sediment and fish tissue contamination were difficult to determine for San Diego Bay due to differences between surveys in analytical methods (e.g., procedures and equipment) and species of fish analyzed. Such differences often preclude the direct comparison of data from one survey to the next. In general, however, the overall level of contamination in the Bay appears less than in previous decades. For example, concentrations of copper, mercury, tin, tributyltin and PAHs were lower in the sediments in 1998 than in previous studies. Additionally, contaminant loads of DDT, mercury and selenium in fish tissues were also less in 1998. In contrast, arsenic levels in fish tissues were slightly higher in 1998 than in previous surveys, while concentrations of chromium remained about the same. Finally, the absence of any evidence of fin erosion in fishes also suggests that conditions have generally improved since 1984 -1988 when the prevalence of fin erosion in black croaker and barred sea bass was relatively high.

Species of both macrobenthic and megabenthic invertebrates as well as bottom-dwelling fishes encountered in San Diego Bay were similar in 1998 to those reported previously. The composition and structure of these assemblages typically varied with distance from the entrance to the Bay, and these differences generally paralleled local hydrodynamic conditions. Anthropogenic impacts, including the deposition of contaminants and the presence of invasive or non-indigenous species, may represent a secondary factor that influences the distribution of assemblages in the Bay.

The 1998 survey of San Diego Bay provides valuable data against which future changes in fish and invertebrate communities may be measured. For example, being able to monitor population densities of non-indigenous species such as the bivalve *Musculista senhousia* may be vital to understanding any changes that take place in these communities. Finally, since impact assessments require thorough knowledge of the natural processes that influence community structure, further investigations into the relationship between hydrodynamics and resident fish and invertebrate assemblages will be central to the proper management of a healthy ecosystem in San Diego Bay. Such studies will provide a more detailed understanding of this unique and valuable ecosystem, upon which to base future management decisions.