Southern California Bight 1994 Pilot Project:

V. Demersal Fishes and Megabenthic Invertebrates

M. J. Allen[1], S. L. Moore[1],
K. C. Schiff[1], S. B. Weisberg[1], D. Diener[2], J. K. Stull[3],
A. Groce[4], J. Mubarak[2], C. L. Tang[3], and R. Gartman[4]

[1]Southern California Coastal Water Research Project
[2]MEC Analytical Systems, Inc.
[3]County Sanitation Districts of Los Angeles County
[4]City of San Diego, Metropolitan Wastewater Department

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Southern California Coastal Water Research Project
7171 Fenwick Lane, Westminster, CA 92683-5218
Phone: (714) 894-2222 · FAX: (714) 894-9699
http://www.sccwrp.org

SOUTHERN CALIFORNIA BIGHT PILOT PROJECT TRAWL REPORT GROUP MEMBERS

Dr. M. James Allen -- Southern California Coastal Water Research Project
Jeff Armstrong -- County Sanitation Districts of Orange County
Dr. Gregory Deets -- City of Los Angeles, Environmental Monitoring Division
Dr. Douglas Diener -- MEC Analytical Systems, Inc.
Dr. Masahiro Dojiri -- City of Los Angeles, Environmental Monitoring Division
Robin Gartman -- City of San Diego, Metropolitan Wastewater Department
Ami Groce -- City of San Diego, Metropolitan Wastewater Department
Dr. C. Irwin Haydock -- County Sanitation Districts of Orange County
Mike Mengel -- County Sanitation Districts of Orange County
Shelly L. Moore -- Southern California Coastal Water Research Project
Jason Mubarak -- MEC Analytical Systems, Inc.
George Robertson -- County Sanitation Districts of Orange County
James Roney -- City of Los Angeles, Environmental Monitoring Division
Kenneth C. Schiff -- Southern California Coastal Water Research Project
Janet K. Stull -- County Sanitation Districts of Los Angeles County
Chi-Li Tang -- County Sanitation Districts of Los Angeles County
Dr. Stephen B. Weisberg -- Southern California Coastal Water Research Project

FOREWORD

Although more than 10 million dollars is spent annually monitoring southern California's coastal waters, some basic questions about the ocean's condition, such as how many acres of ocean bottom are impaired, can not be answered. The principal limitation is that less than 5% of the area on the mainland shelf of the Southern California Bight (SCB) is routinely monitored. Moreover, the constituents measured, as well as the frequency and methodology by which they are measured, typically differ among monitoring programs in the SCB. These limitations reflect the predominant association of monitoring in southern California with discharge permit requirements that are focused on site-specific, single-source issues. While these programs generally collect high quality data, they are not designed to describe changes which occur on regional scales or to assess cumulative impacts from multiple sources whose fates commingle.

Recognizing the need for integrated assessment of the southern California coastal ocean, 12 governmental organizations, including the four largest municipal dischargers and the five regulators of discharge in southern California, collaborated to conduct a comprehensive regional monitoring survey in the summer of 1994. Referred to as the Southern California Bight Pilot Project (SCBPP), the monitoring survey included measures of the water quality, sediment chemistry, sediment toxicity, benthic infauna, and demersal fishes. This report summarizes the demersal fish and megabenthic invertebrate portion of the study. Other reports are available on the web (www.sccwrp.org) or from the Southern California Coastal Water Research Project.

Participating Agencies in the SCBPP
United States Environmental Projection Agency, Office of Research and Development
United States Environmental Projection Agency, Region IX
City of Los Angeles, Environmental Monitoring Division
County Sanitation Districts of Los Angeles County
County Sanitation Districts of Orange County
City of San Diego, Metropolitan Wastewater Department
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EXECUTIVE SUMMARY

Demersal fishes and megabenthic invertebrates inhabit the soft-bottom habitat and hence are widely distributed on the mainland shelf of the Southern California Bight (SCB). Populations of these sedentary fishes and invertebrates have been monitored extensively during the past 25 years to assess impacts resulting from the discharge of treated wastewater to the shelf. Although inputs of chlorinated hydrocarbon compounds and other anthropogenic contaminants to the SCB are presently low, historical deposits in the sediments may still affect populations of these organisms. While much is known about demersal populations in discharge areas, less is known about their condition throughout Southern California. Thus, a regional trawl study of the mainland shelf of Southern California was conducted to assess the variability and condition of fish and invertebrate populations and assemblages, and the extent of contamination of demersal fish on the shelf.

Trawl samples were collected from 114 stations at depths of 10-200 m from Point Conception, California to the United States-Mexico international border in July-August 1994. The stations were selected from a stratified random sampling design. Fish and invertebrate populations were sampled by small (7.6-m headrope) semiballoon otter trawls from July to August 1994. Fish and invertebrates were identified to species, counted, weighed by species to the nearest 0.1 kg, and examined for anomalies. Fish lengths were measured to centimeter size classes. Sample collection and processing, and taxonomic identification of fishes and invertebrates used predetermined sampling protocol from a specially designed field manual, with quality control checks conducted before, during, and after the survey.

In addition, samples of Pacific sanddab (Citharichthys sordidus), longfin sanddab (Citharichthys xanthostigma), and Dover sole (Microstomus pacificus) were collected at 63 stations for tissue contamination analysis, composited individually in the field, and frozen. Prior to chemical analysis, samples of these flatfishes were thawed and dissected to remove livers. Livers were analyzed for 14 chlorinated hydrocarbon classes which included (13 pesticides and polychlorinated biphenyl [PCB]) using gas chromatography/mass spectrometry (GC/MS).

Data were analyzed for the SCB as a whole and for specific subpopulations. Regional subpopulations included the northern region (Point Conception to Point Dume), central region (Point Dume to Dana Point), and southern region (Dana Point to the United States-Mexico international border). Depth zone subpopulations included inner shelf (10-25 m), middle shelf (26-100 m), and outer shelf (101-200 m). Anthropogenic influence areas included publicly owned treatment work (POTW) monitoring areas and non-POTW areas. Fish and invertebrate data were analyzed separately. Data were summarized, presented as cumulative distribution functions, and tested for differences among subpopulations. Recurrent groups (i.e., groups of frequently co-occurring species) of fishes and invertebrates were described separately using Fager's recurrent group analysis. Separate cluster analyses also were conducted separately for fish and invertebrate data. Site groups were described using cluster analysis with square-root transformation of

abundance data, Bray-Curtis dissimilarity index, and an agglomerative, hierarchical, flexible sorting method. The results of the cluster analysis were displayed in dendrograms and two-way tables.

Of 140 targeted trawl stations, 114 (81%) were successfully sampled. Most of the 26 unsampled stations were abandoned due to the unsuitability of the seafloor for trawling. Almost 100% of the fish and 97% of the invertebrates counted were identified to species. Approximately 99% of the fish counted were measured. Measurement error was higher for biomass than for counts of individuals because biomass measurements were made on a moving boat. Anomalies audited in the field were correctly identified.

A total of 87 species of fish, representing 14 families and 3 classes, were collected in this survey. Catches were dominated by pleuronectiform (flatfish) species. Twenty-one species occurred in 20% or more of the stations on the mainland shelf. The most frequently occurring species were Pacific sanddab (Citharichthys sordidus), Dover sole (Microstomus pacificus), and hornyhead turbot (Pleuronichthys verticalis). Nineteen species occupied more than 20% of the area of the shelf and six species individually occupied more than 50% of the area. Pacific sanddab, Dover sole, and plainfin midshipman (Porichthys notatus) occupied the largest area of the shelf. Twenty-six species cumulatively comprised 95% of the fish abundance but only six accounted for more than 5% each. The most abundant species were Pacific sanddab, plainfin midshipman, and slender sole (Eopsetta exilis). Twenty-eight species comprised 95% of the fish biomass and five accounted for more than 5% each. California halibut (Paralichthys californicus), Pacific sanddab, and white croaker (Genyonemus lineatus) had the highest total biomass in the survey. However, although Pacific sanddab occurred at 66% of the stations, California halibut and white croaker were found at 20% and 5% of the stations, respectively. California halibut had high individual biomass and white croaker occurred in large numbers at one station. Fish captured in this survey ranged in size from 1.5 cm to approximately 1 m in length. Most of the fish were small, with approximately 95% ranging in size from 2.5 to 18.5 cm in length. The modal size class (6.5 cm) of the fish comprised 10% of the catch.

Fish population attributes (abundance, biomass, numbers of species, and diversity) varied by region and depth. Regionally, the northern region had significantly lower fish biomass than the other regions and higher numbers of species than the central region. The central region had significantly lower fish diversity and the southern region had significantly higher abundance than the other regions. Bathymetrically, numbers of species and diversity were significantly lower on the inner shelf; fish biomass was significantly higher on the outer shelf; and fish abundance increased with increasing depth, differing significantly between each of the depth zones.

Of 87 species of fish collected in 1994, only 28 formed recurrent groups or were associates of recurrent groups. Five recurrent groups of fishes were described with two to eight species per group. Each group was characteristic of different bathymetric zones. Major recurrent groups changed slightly (by addition or deletion of species) between the early 1970s and 1994, probably as a result of oceanic warming since the early 1980s.

However, four core recurrent groups (representing the most characteristic and persistent species groups on the mainland shelf of the Bight) were found in both periods: 1) Inner/Middle Shelf Group; 2) Middle Shelf Group; 3) Middle/Outer Shelf Group; and 4) Outer Shelf Group.

Five major station clusters and four major species clusters of fishes, with minor subgroupings, were delineated by cluster analysis. Station clustering roughly corresponded to water depth with some overlap between station groups, and corresponded to a lesser extent to sediment grain size patterns, which also tend to be correlated with water depth. Station Cluster 1 generally included the shallowest stations sampled while Station Cluster 5 included the deepest stations. All five station clusters were broadly distributed throughout the SCB study area except for Station Cluster 1 which was not represented in the western portion of the Santa Barbara Channel and Station Cluster 3, which was predominantly representative of the middle shelf areas of the northern SCB.

A total of 204 species of megabenthic invertebrates representing 110 families, 20 classes, and 8 phyla were collected in the survey. Mollusks were the most diverse phylum, malacostracan crustaceans the most diverse class, and right-handed hermit crabs (Paguridae) the most diverse family. Thirteen species occurred at more than 20% of the stations on the mainland. The most frequently occurring species were California sand star (Astropecten verrilli), ridgeback rock shrimp (Sicyonia ingentis), and white sea urchin (Lytechinus pictus). Twelve species occupied 20% or more of the area and two occurred in more than 50% of the area. California sand star, ridgeback rock shrimp, and gray sand star (Luidia foliolata) occupied the most area. Ten species of invertebrates comprised 95% of the abundance and biomass, but only five accounted for more than 5% each for both measures. White sea urchin, brokenspine brittlestar (Ophiura luetkeni), and ridgeback rock shrimp were the most abundant. However, California sea cucumber (Parastichopus californicus), fragile sea urchin (Allocentrotus fragilis), and California heart urchin (Spatangus californicus) had the highest biomass.

Invertebrate population attributes varied by region and depth. Regionally, the northern region had significantly higher invertebrate abundance whereas the central region had significantly lower biomass and higher diversity than the other regions. Bathymetrically, invertebrate abundance and numbers of species were significantly lower and diversity was significantly higher on the inner shelf than on the middle and outer shelf zones. Biomass increased with increasing depth, differing significantly between each of the depth zones.

Of 204 species of invertebrates collected, only 31 formed recurrent groups or associates. Seven recurrent groups of invertebrates with two to six species per group were described. Each group was characteristic of a different bathymetric zone but some also represented specific habitats within a depth zone (e.g., shelf-break, submarine canyons). The most frequently occurring species comprised the Middle/Outer Shelf Group. Most of the recurrent group species were also dominant species in earlier descriptions of megabenthic assemblages based on ordination and classification analysis. Although recurrent groups

have not previously been described, megabenthic invertebrate core groups are likely to comprise part or all of the Middle/Outer Shelf and Outer Shelf Groups.

Five major station clusters and three major species clusters of invertebrates, with many minor subgroupings, were delineated by cluster analysis. Stations were roughly clustered according to water depth and to a lesser degree by sediment grain size measures. Station cluster 1 generally included the shallowest stations sampled while station cluster 5 included the deepest stations. Stations in all five clusters were broadly distributed throughout the study area except for stations in cluster 1 which were found only in the central portion of the SCB.

Overall, depth was more important than geographical area or sediment type in determining the organization of fish and invertebrate assemblages and the magnitude of population attributes. Most population attributes were lower on the inner (shallow) shelf and higher in deeper water.

Contamination of flatfish livers was widespread on the mainland shelf of the SCB, but was limited to two of the 14 chlorinated organic compound classes examined -- total dichlorodiphenyltrichloroethane (DDT) and total PCB. Virtually all of Pacific sanddab and longfin sanddab populations were contaminated with DDT and PCB. Also, DDT contaminated the majority (64%) of the Dover sole population on the mainland shelf. The other 12 pesticides and their metabolites were not detected in any of the target species. The PCB measurements were dominated by 12 congeners (52, 66, 87, 101, 105, 118, 128, 138, 153, 170, 180, and 187), which averaged 95% of the combined mass of the 27 congeners analyzed. Sediment concentrations (normalized by total organic carbon content [TOC]) accounted for most of the variability observed in tissue concentrations (normalized by lipid content) for 8 of these 12 congeners and total PCB. Normalized sediment concentrations were also significantly correlated to normalized tissue concentrations for total DDT and p,p'-DDE.

Anomalies were rare in fish and invertebrates; incidences were scattered throughout the SCB. A total of 197 of 18,912 fish (1%) had anomalies; most of these were pigment anomalies (diffuse pigmentation or ambicoloration) or parasites. Ten fish (all Dover sole) had tumors, seven had lesions, and one (a Dover sole) had fin erosion. The 1% anomaly rate probably represents background influences, as similar background anomaly rates have been found on the eastern coast of the United States.

No population or assemblage measure was useful in indicating from a single sample whether the fish assemblage at a site was impacted by human activities. Fin erosion, one of the best indicators of human impact to the fish populations in the past was virtually absent in 1994.

Fish and invertebrate population attributes were generally higher on the middle shelf in POTW monitoring areas than in non-POTW areas. Site clustering did not reveal any pattern of fish assemblages associated with potential sources of contamination and only showed a slight pattern for invertebrates.

Anthropogenic debris occurred in 14% of the area of the mainland shelf. Anthropogenic debris (consisting largely of bottles, cans, and fishing gear) was most common in the central region, outer shelf, and POTW areas, suggesting that marine vessel activity and fishing were the primary sources.

Fish and invertebrate health, populations, and assemblages have changed during the past 25 years. The prevalence of fish and invertebrate anomalies has decreased since the 1970s, with occurrences in 1994 scattered along the mainland shelf rather than focused in specific areas. Mean fish and invertebrate population attributes are generally similar when comparing the results of the 1994 regional survey with historical data from accumulated local and semiregional surveys for the mainland shelf of the SCB. However, fish abundance and number of species have apparently increased to the south and fish diversity has increased to the north since the late 1970s. Dominant species of fish have also changed somewhat over time. Major fish recurrent groups changed slightly in species composition during this period as the ocean warmed during the 1980s. However, four core recurrent groups were found in both periods.

Contaminant levels in flatfish livers from reference areas in the SCB have decreased during the past decades. Total DDT and total PCB liver concentrations decreased one to two orders of magnitude in Pacific and longfin sanddabs between 1985 and 1994. Similarly, in Dover sole, liver concentrations of these contaminants decreased 5- to 35-fold between 1977 and 1994. These comparisons are potentially confounded by differences in sample design and analytical methods, as well as the variability inherent in fish catch, size class, and life history. However, the reductions in tissue concentrations appear to transcend these technical differences, since they occurred over several depths, species, and locations. Decreases in flatfish contamination during this period are likely the result of reduced inputs of contaminants and decreased contaminant levels in the sediments.

Overall, demersal fish populations on the mainland shelf of Southern California in 1994 appear to be relatively healthy compared to the early 1970s. With the exception of the wide distribution of detectable levels of DDTs and PCBs in flatfish livers, the area of demonstrable anthropogenic influence to these populations and to the habitat was relatively limited.

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