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TRACE METALS IN HARBOR MUSSELS

The objective of this research program was to evaluate harbors as potential sources of coastal contamination. As a complimentary effort to the study of chlorinated hydrocarbons and trace metals in seawater from harbor mouths (described earlier in the report), we conducted a limited survey of the bay mussel (*Mytilus edulis*) from three major harbors—San Pedro, Newport, and San Diego; the survey was supported by the California Cooperative Fisheries Investigations. Last year's report discussed our findings on DDT and PCB compounds in this bioindicator. Here we report results for four trace metals of interest--copper, chromium, nickel, and zinc. Harbor water levels of these potential pollutants are discussed elsewhere in this report.

The mussels were collected in January 1974; specimens 5 cm in length were placed in plastic bags and frozen until dissected. Using cleaned carbon steel scalpels, the whole soft tissues (excluding byssal threads) from three males and three females per station were separated into four categories—digestive glands, gonads, adductor muscle tissue, and the remainder. In collaboration with George Alexander (University of California at Los Angeles), these portions were freeze-dried and analyzed by optical emission spectroscopy. The digestive glands from all six specimens from each station were included in this analysis; for the remaining tissues, one male and one female per station were chosen for analysis.

In the San Pedro and San Diego Harbors regions, we selected six sites thought to be most representative of four station types: Inner harbor (judged from vessel observations and high PCB levels to be subject to intense vessel activity), harbor mouth, coastal municipal outfall base, and coastal control. Only three stations were selected from Newport Bay, a much smaller harbor. Almost 200 individual tissue samples were analyzed, resulting in more than 4,000 elemental concentrations. Analysis of this large body of data is still in progress. Here we will discuss in detail the copper, chromium, nickel, and zinc results from the survey of the San Diego stations (shown in Figure 1). We selected the median concentration obtained for a given metal in each of the four tissue classes at a station as the representative value for that station. The results are listed in Table 1.

These data indicate a discernable gradient only in the case of copper. Distinctly higher digestive gland concentrations were found at the four stations (Stations A through D) within the Harbor itself, than at the coastal outfall and control stations (Stations E and F, respectively) . There appears to be a correlation between these values and the levels of 1254 PCB previously measured in the soft tissues of mussels from the same collections. The highest PCB concentration (860 ppb) was found at Station B, just outside the commercial basin, where extensive vessel bottom scraping and repainting activity takes place. This station also had the highest copper concentrations for three of the four tissues analyzed; it had the second highest concentration of copper in adductor muscle. This correlation is consistent with the fact that both PCB and copper have been associated with vessel activities in the past. In contrast, no elevated levels of any of these metals were observed in the mussel specimens collected from the base of the Point Loma submarine outfalls.

Similar results for PCB and copper were observed inside and outside Newport Harbor. Mussels from the inner harbor station, located near a "haul-out" facility for vessel bottom repainting, contained 880 ppb of 1254 PCB in the soft tissues, compared to 100 ppb measured in coastal specimens collected from Newport Pier just across the strand, less than 0.5 km away. (The pier

station is several kilometers to the southeast of the Orange County Sanitation Districts submarine outfalls.) Corresponding harbor-to-coastal enrichment ratios for copper in digestive glands, gonads, adductor muscle, and remaining tissues were 9.1, 9.1, 9.8, and 9.1 respectively. Smaller but distinct enrichment ratios were also observed for zinc (2.4, 4.2, 2.9, and 2.7, respectively). However, levels of chromium and nickel in specimens from within this harbor were not noticeably higher than elsewhere. Copper and zinc concentrations in mussels collected from the jetty mouth were also similar to those from the coastal station.

The survey of the San Pedro region produced considerably different results. At the three harbor stations where the highest 1254 PCB mussels concentrations were found, corresponding medium copper concentrations in the digestive glands were only slightly higher than the estimated coastal baseline (20 ppm). However, a median value of 47 ppm was found in the six digestive gland samples obtained near the base of the JWPCP submarine outfalls at Royal Palm State Beach, 6 km to the west of the nearest harbor entrance. In addition, concentrations in the gonadal and "remainder" tissues from the outfall region were three to four times higher than those found at the three harbor stations. Therefore, off Los Angeles, this outfall system appears to be the predominant cause of elevated copper levels in mussels growing at the base of the out-fall.

Of the four potentially toxic trace metals considered in this study, copper values were most anomalous: Both San Diego and Newport harbor specimens had significantly higher tissue levels of this metal than did the coastal controls. Vessel antifouling paints, which often have high levels of copper, are a likely source. The sub-marine discharges of municipal wastewater off San Diego and Newport Beach do not appear to have caused increased levels of these metals in the coastal specimens. However, copper values in *M. edulis* collected from the base of the JWPCP outfalls a few kilometers west of San Pedro Harbor were two to four times higher than those in specimens collected elsewhere. Although intertidal mussels are very useful indicators of nearshore marine contamination, we do not yet know whether or not these metal levels are damaging to the biota.

Table 1. Concentrations of copper, chromium, nickel, and zinc (ppm, dry weight) and 1254 PCB (ppb, wet weight) in tissues of intertidal mussels (*Mytilus edulis*) from San Diego Harbor and adjacent coastline.

	Station					
Constituent	A	B	C	D	E	F
1254 PCB	710	860	700	280	44	47
Copper						
Digestive gland	52	77	34	36	19	24
Gonads	15	23	11	12	13	9.6
Muscle	7.0	34	7.2	12	7.7	53
Remainder	17	34	15	11	12	15
Chromium						
Digestive gland	7.4	5.4	3.8	7.3	4.0	7.0
Gonads	3.0	< 2.0	1.0	1.9	0.7	0.8
Muscle	1.0	1.6	0.7	2.5	1.0	11
Remainder	1.8	0.8	1.8	3.4	1.2	1.6
Nickel						
Digestive gland	6.0	4.6	2.3	3.0	3.9	5.2
Gonads	< 2.6	< 1.0	< 1.1	< 1.0	–	–
Muscle	2.8	2.4	< 1.0	2.0	–	14
Remainder	2.9	< 2.0	< 1.9	< 1.9	< 1.0	< 2.6
Zinc						
Digestive gland	152	124	125	185	116	119
Gonads	180	93	114	122	121	112
Muscle	156	138	103	156	172	162
Remainder	244	166	169	153	192	175

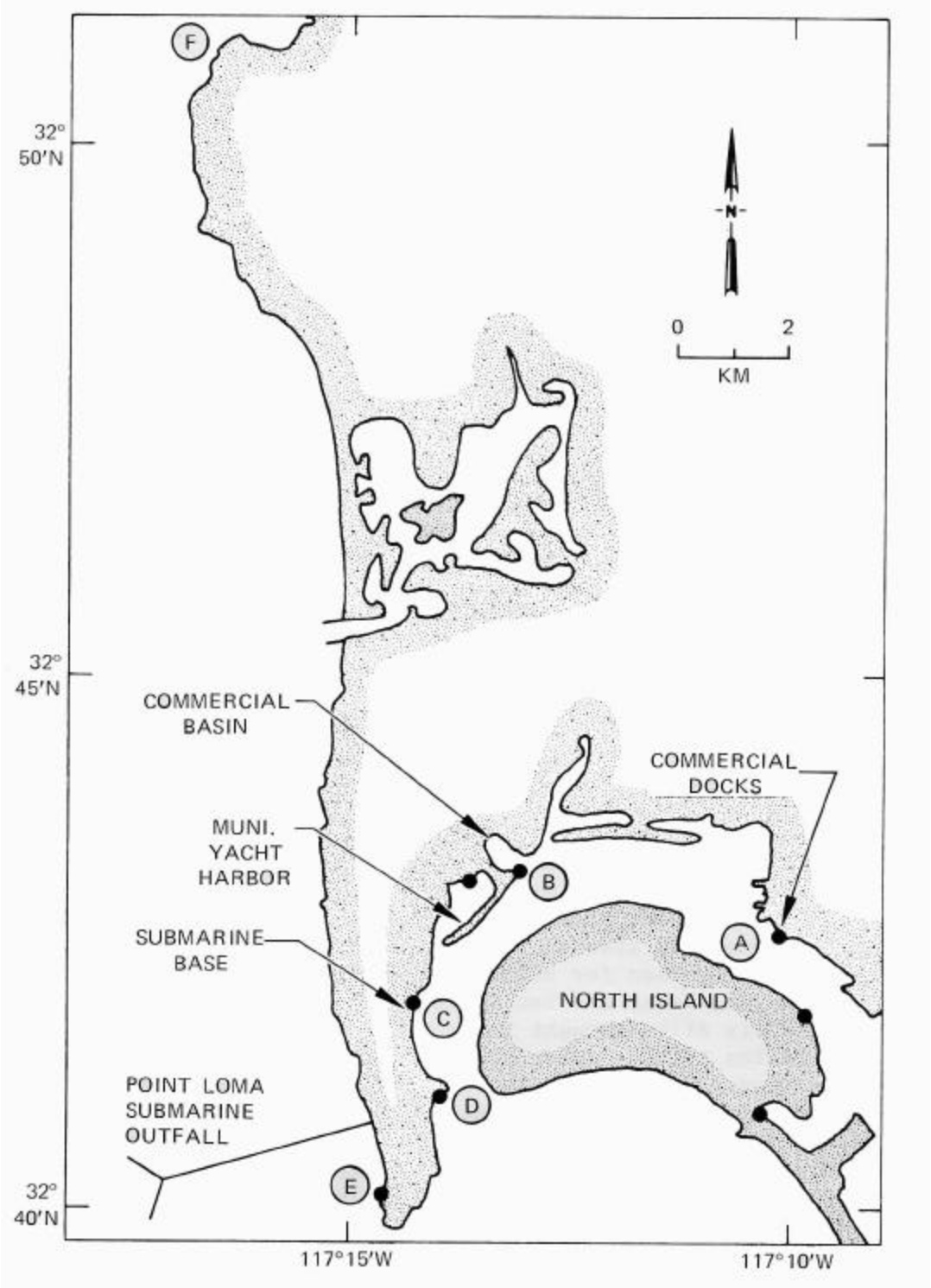

Figure 1. Location of sampling stations for the bay mussel, *Mytilus edulis*, in and around San Diego Harbor.