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METALS IN SEAFOODS NEAR OUTFALLS

Past Project studies have shown municipal wastewater discharges to be the single largest source of most trace metals entering the coastal waters off southern California. Because of the importance of fishing in this region, we have investigated the degree of trace metal contamination in a variety of popular sport fish and shellfish living in the vicinity of two outfall systems off Los Angeles and Orange Counties. This study, supported in part by the California Water Resources Control Board, revealed no demonstrable metals contamination of the edible portion (muscle) of the six fish species surveyed. There was some evidence of metals contamination in three of the six invertebrate species studied; however, with one major exception, median values of the metals in question in outfall specimens were never more than three to four times those measured in the controls.

The outfall areas selected for this study were the Palos Verdes shelf, which is the site of the outfall system of Los Angeles County's Joint Water Pollution Control Plant (JWPCP), and the area off Newport Beach in which the Orange County Sanitation Districts' outfalls are located. Two different types of control regions were also included to increase the amount of control data obtained:

- Island control area—Santa Catalina Island, 35 km south of the JWPCP outfalls and 45 km southwest of the Orange County outfall system.
- Coastal control sites—Point Dume (located at the northern edge of Santa Monica Bay, 55 km northwest of the JWPCP outfalls) and La Jolla (located in central San Diego County 20 km north of the city of San Diego's Point Loma municipal wastewater outfall system).

A list of the species included in this investigation is given in Table 1. Most of the specimens analyzed were collected by bottom trawl or scuba divers during 1975 and 1976. The rock scallops were collected during 1974, and metals analyses were performed on samples of their digestive gland, gonad, and muscle tissue; although the results were discussed in de-tail in last year's annual report (Young and Jan 1976), the concentrations measured in muscle tissue are included here for comparison.

Upon collection, the specimens were rinsed free of adhering sediment in clean seawater; they were then placed in new polyethylene bags and frozen. In the laboratory, muscle tissue (or gonadal tissue in the case of the red sea urchin) was carefully excised before the specimen was fully thawed; the dissections were performed on a clean teflon sheet using carbon steel scalpels

and teflon-coated forceps that were frequently rinsed in deionized water. Care was taken not to introduce contamination from the surface of a specimen (such as the skin of a fish) or the digestive tract or other internal organs, which were assumed to contain higher concentrations of the metals of interest. Approximately 2 wet grams of muscle tissue were placed in an acid-washed Nalgene vial, which was then tightly capped and frozen, pending analysis by atomic absorption spectromety. Our analytic procedures were discussed in detail in last year's annual report (Young and Jan 1976).

Because the objective of this study was to scan a relatively large number of popular seafood organisms for metals contamination, and because extreme care was required in dissection and analysis, we generally limited the analyses to three individuals per species from each study area. How-ever, the scallop results are based on analyses of eight individuals from the JWPCP discharge zone and six individuals collected off Santa Catalina and Santa Barbara Islands. In addition, up to ten individuals of the various species were analyzed for mercury. The median value for each metal was assumed to be most representative, and our results (corrected for procedural blanks) are presented in Table 2.

In general, we found very low concentrations of the tar-get trace metals in muscle tissue of the fishes surveyed. It does not appear that the specimens from the vicinity of the JWPCP or Orange County wastewater discharges had accumulated these metals to concentrations significantly above natural levels. In contrast, it does appear that certain of the invertebrates from the JWPCP outfall zone concentrated a number of these metals to levels two to three times those occurring in the control zone specimens (few invertebrate specimens were obtained in the Orange County outfall zone). For example, median values for silver in muscle tissue of the abalone, scallop, and lobster collected near the JWPCP discharge were approximately three times higher than those in the muscle tissue of control specimens. Similarly, the concentrations of cadmium in muscle of the JWPCP scallops and lobsters were two to three times those measured in the controls. The JWPCP scallops also appeared to contain somewhat more than twice as much copper and mercury in their adductor muscle than did the Santa Catalina Island specimens. How-ever, the values for mercury in outfall specimens were an order of magnitude below the 0.5 ppm limit of the U.S. Food and Drug Administration (mercury is the only metal for which such a limit has been established). The JWPCP abalone, scallops, and sea urchins also appeared to contain two to three times as much nickel as did the controls; the median value for nickel in the crab was six times the control value.

The greatest accumulation of chromium was found in the muscle of abalone and scallops; in both cases, the median concentrations in the JWPCP specimens were ten times those measured in the animals collected from Santa Catalina Island. In themselves, chromium concentrations of this magnitude (1 ppm in the abalone and 0.3 ppm in the scallop) would not be expected to reduce the value of these shellfish as a sea-food resource—surveys of the U.S. nutritional situation have indicated that marginal deficiency of chromium in

the diet is of greater concern than overexposure (National Academy of Sciences 1974). However, shellfish from the outfall area may contain other contaminants (such as chlorinated hydrocarbons) that are known to be detrimental to human health and that are often concentrated in other organisms living in outfall areas (Young et al. 1976; McDermott et al. 1976). In addition, the form of the chromium in the shell-fish—a nutritionally important factor—is not known.

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Table 1. Common and scientific names of organisms collected for survey of trace metals in seafood, 1975-76.

Common Name	Scientific Name
INVERTEBRATES	
Black abalone	*Haliotis cracherodii*
Purple-hinged rock scallop	*Hinnites multirugosus*
California spiny lobster	*Panulirus interruptus*
Yellow crab	*Cancer anthonyi*
Ridged-backed prawn	*Sicyonia ingentis*
Red sea urchin	*Strongylocentrotus franciscanus*
FISHES	
White croaker	*Genyonemus lineatus*
Pacific sanddab	*Citharichthys sordidus*
California scorpionfish	*Scorpaena guttata*
California halibut	*Paralichthys californicus*
Bocaccio	*Sebastes paucispinis*
Kelp bass	*Paralabrax clathratus*

Table 2. Median concentrations (mg/wet kg) of eight trace metals in the edible tissue of twelve seafood organisms from southern California municipal wastewater outfall and control sites, 1975-76*.

	Silver	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Zinc
INVERTEBRATES								
Abalone								
JWPCP	0.03	0.04	1.0	3.4	0.011	0.68	<0.12	13
Island control	<0.01	0.03	0.1	3.9	0.009	0.20	<0.08	7.1
Scallop								
JWPCP	0.022	0.92	0.31	0.29	0.056	0.22	<0.03	24
Island control	0.006	0.33	≤0.03	0.11	0.024	0.10	<0.03	22
Lobster								
JWPCP	0.05	0.02	0.03	6.1	0.28	<0.05	<0.23	8.6
Coastal control	0.02	<0.01	0.04	6.4	0.28	<0.05	<0.20	11
Island control	0.01	<0.01	<0.02	14	0.25	<0.06	<0.21	14
Crab								
JWPCP	0.10	<0.01	0.08	7.9	0.034	0.26	0.14	25
Coastal control	0.22	0.01	0.04	13	0.071	<0.04	<0.15	97
Prawn								
JWPCP	<0.01	0.03	<0.02	2.0	0.080	<0.03	<0.01	9.8
Orange County	0.02	0.06	0.12	8.0	0.040	<0.04	<0.12	13
Coastal control	<0.01	0.04	0.02	–	0.046	0.04	0.16	–
Sea urchin								
JWPCP	<0.01	0.13	0.14	0.27	0.006	0.12	<0.01	4.2
Island control	<0.01	0.44	0.18	0.26	0.024	0.04	<0.01	11
FISHES								
White croaker								
JWPCP	0.02	<0.01	0.06	0.21	0.048	0.42	0.29	3.6
Orange County	0.03	<0.01	0.06	0.17	0.18	0.16	0.41	3.0
Coastal control	0.02	<0.01	0.04	0.11	0.33	0.61	0.71	1.3
Pacific sanddab								
JWPCP	<0.01	<0.01	0.03	0.20	0.095	0.06	0.02	3.2
Orange County	<0.01	<0.01	0.03	0.09	0.11	0.05	0.03	2.0
Coastal control	<0.01	<0.01	0.02	–	–	0.04	0.28	–
Island control	<0.01	<0.01	0.06	0.17	0.072	0.08	0.24	3.9
Scorpionfish								
JWPCP	0.02	<0.01	0.04	0.15	0.38	0.15	0.64	3.8
Orange County	0.02	<0.01	0.07	0.10	0.28	0.85	2.0	4.0
Coastal control	0.02	<0.01	0.04	0.15	0.24	0.11	1.1	1.9
Halibut								
JWPCP	<0.01	<0.01	<0.01	0.13	0.25	<0.02	<0.01	2.8
Coastal control	<0.01	<0.01	<0.02	<0.02	0.22	<0.01	<0.01	2.4
Bocaccio								
JWPCP	<0.01	<0.01	<0.01	0.15	0.14	0.06	0.08	4.3
Orange County	<0.01	<0.01	0.02	–	0.13	0.04	0.20	–
Island control	<0.01	<0.01	0.01	0.13	0.32	<0.05	<0.08	1.8
Kelp bass								
Orange County	<0.01	<0.01	0.02	0.19	0.45	0.06	<0.01	3.7
Island control	<0.01	<0.01	0.02	0.13	0.43	0.04	<0.01	4.0

*The gonads of sea urchins were analyzed; in all other cases, the tissue analyzed was muscle. The scallops were collected in 1974; "island control" data for this species are based on analyses of specimens from Santa Catalina and Santa Barbara Islands. In all other cases, island control data are based on analyses of specimens from Santa Catalina Island; coastal control specimens were from Point Dume and La Jolla.