Inputs and Distributions of Chlorinated Hydrocarbons in Three Southern California Harbors*

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ABSTRACT

Chlorinated hydrocarbons such as the pesticide DDT and industrial polychlorinated biphenyls (PCB) are major contaminants in southern California marine waters. As a result of a predominant DDT input from the large submarine discharge of Los Angeles County municipal wastewater, coastal mussels off Los Angeles contain up to 30 times more p,p'-DDE than do those off San Diego. Specimens of a bay mussel collected from San Diego Bay, Newport Harbor, and San Pedro Harbor also show this pattern of increasing DDT concentrations toward Los Angeles.

However, PCB 1254 concentrations are similar in mussels from the three harbors and are several times higher than in specimens collected from the nearby coastal waters. Estimates for total annual inputs of PCB 1254 to these harbors from municipal wastewater, industrial wastewater, surface runoff, aerial fallout, and vessel antifouling paints range from 1 kg/yr in Newport Bay to 150 kg/yr in San Pedro Harbor, with surface runoff and industrial wastewater constituting virtually all of the latter input.

Although antifouling paints presently constitute a completely insignificant mode for PCB input to these harbors, occasional high PCB concentrations in old paint chips and the correlation of mussel PCB concentrations with antifouling paint usage suggest that this may have been the predominant source of PCB to southern California harbors in recent years. It is not yet known how long these harbors will exhibit enhanced PCB contamination levels over those of the adjacent coastal waters.

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INTRODUCTION

Chlorinated hydrocarbons appear to be one of the most important classes of contaminants yet described in the marine ecosystem of southern California. Excessive concentrations of DDT residues have been found in anchovies, sand crabs, byssal mussels, flatfish, and bottom sediments collected near one Los Angeles coastal outfall that discharges municipal wastewater, and relatively high concentrations of polychlorinated biphenyls (PCB) have also been reported (Risebrough 1969; Burnett 1971; Southern California Coastal Water Research Project 1973; de Lappe et al. 1974). In addition, reproductive failures in the brown pelican at Anacapa Island rookeries off Los Angeles have been associated with the large accumulations of chlorinated hydrocarbons in this fish-eating bird (Risebrough et al. 1971).

The coastal plain of the Southern California Bight extends from Point Conception to northern Baja California, a distance of about 300 km (Figure 1). It is inhabited by more than 11 million persons, and the intense agricultural and industrial activities of this region have constituted an ample source of chlorinated hydrocarbons to the environment. During the past 3 years, the Coastal Water Research Project has been engaged in describing (1) the input rates of DDT and PCB compounds via major routes to the coastal marine waters and (2) the distributions of these materials in several important components of the ecosystem throughout the Bight. Our studies indicate that the numerous harbors located in the Bight may be significant sources of certain trace metals and organic compounds to the adjacent coastal waters (Southern California Coastal Water Research Project 1973).

During 1973, the Project began a detailed investigation of chlorinated hydrocarbon inputs and distributions in three major southern California harbors: San Pedro Harbor in Los Angeles County, Newport Bay in Orange County, and San Diego Bay in San Diego County. Our study focused on San Pedro Harbor,* which is the largest of the three harbors and the one with the greatest variety of inputs. Most of the direct industrial discharges into harbor waters in the Bight occur here; San Pedro Harbor is also the only one of the three harbors that receives a major discharge of municipal wastewater (from the Terminal Island Treatment Plant) and a major input of surface storm runoff (from the Los Angeles River channel). All of the large shipyards in the Bight are located in either San Pedro Harbor or San Diego Bay. In contrast, Newport Bay is almost entirely composed of either recreational craft moorings (in Newport Harbor) or relatively undisturbed wetlands (in upper Newport Bay).

*San Pedro Harbor is comprised of the Los Angeles and Long Beach Harbors.

The Project studied the principal input modes--antifouling paint application, direct industrial discharge, municipal wastewater discharge, surface runoff, and aerial fallout. Previous studies had demonstrated the usefulness of the coastal intertidal mussel *Mytilus californianus* in describing the extent and degree of nearshore contamination by chlorinated hydrocarbons (Southern California Coastal Water Research Project 1973; de Lappe et al. 1974). Therefore, we selected the bay mussel *Mytilus edulis* to describe the distributions of DDT and PCB compounds within these harbors. The use of *Mytilus* allowed us to compare concentrations in harbor mussels to those found in coastal specimens, which are more directly exposed to other sources of chlorinated hydrocarbons, such as the large submarine discharges of municipal wastewater.

SAMPLING

We obtained information on typical kinds and amounts of antifouling paints applied annually to recreational, commercial, and naval vessels in the Bight during 1973 by surveying both haulout yards and paint retailers in the vicinity of the harbors under investigation. Samples of principal paint brands currently being applied and paint scrapings from drydock areas were obtained for analysis of chlorinated hydrocarbon content. The survey results were used to estimate the average annual application rate of antifouling paint per recreational craft in the marinas of the Bight; quantities of antifouling paint used annually on commercial and naval vessels were determined directly from surveys of the major shipyards in the Bight.

Industrial discharges into San Pedro Harbor were grouped into several general categories. In the summer and fall of 1973, we collected approximately 20 composites of industrial effluents, each composed of four hourly grab samples from a variety of industries in each category. Replicate 7-day samples of Terminal Island municipal wastewater were obtained in early 1974 by compositing (according to flow) three grab samples per day. These samples were refrigerated soon after collection and preserved in pesticide-grade hexane until analyzed.

Samples of surface runoff were collected a few kilometers from the mouth of the Los Angeles River during four storms of Water Year 1973-74; we usually collected about ten samples per storm. The samples were taken at the center of the channel: An all-metal, depth-integrating sampler (patterned after a U.S.G.S. suspended sediment sampling device) was raised and lowered between the surface and the bottom of the stream at a steady rate until it was nearly full. Four-liter samples were preserved with hexane until analyzed.

In addition to the storm runoff collections from the Los Angeles River, we also sampled dry-weather flows in several southern California channels during the spring and summer of 1973.

Aerial fallout was sampled at two stations inside San Pedro Harbor, one on a beach lifeguard tower and the other on the roof of a boat barge anchored near the central breakwater. The Newport Bay station was located at an ocean pier just outside Newport Harbor, and San Diego stations were located at La Jolla and Imperial Beaches, a few kilometers north and south of San Diego Bay, respectively. Replicate week-long collections were made at the stations throughout the summer of 1973 according to a technique developed by McClure (personal communication).* Cleaned glass plates 0.1 sq. m. in area were sprayed with a light coat of mineral oil and placed on unpainted surfaces approximately 4 m. above the ground. Once a week, the plates were scraped and resprayed three times in succession; this provided high recovery of the sample and left a cleaned plate for the next collection.

Intertidal mussels 4 to 6 cm. long were collected during January 1974 at ten or more stations in each harbor and also at two or more coastal sites near the mouth of each harbor. The whole soft tissues were removed and analyzed for chlorinated hydrocarbons.

LABORATORY ANALYSIS

Paint samples were extracted using two different methods. Wet paint samples were extracted with diethyl ether-hexane solutions in a separatory funnel. Dry paint samples were hexane-extracted in a Soxhlet extraction apparatus. Both wet and dry paint extracts were cleaned using Florisil columns.

All water samples (municipal wastewater, direct industrial discharge, and surface runoff) were processed using one technique: The samples were extracted with diethyl ether-hexane solutions in separatory funnels, and the extracts were then cleaned, using Florisil columns.

The aerial fallout samples were passed through a silica gel column to separate the chlorinated hydrocarbons from the rest of the sample, according to a technique developed by McClure (personal communication).

The mussel samples were extracted by covering the tissue with acetonitrile and using a high-speed blender to homogenize the sample. The homogenate was filtered into a separatory funnel, and the sample was partitioned with hexane. The hexane fraction was cleaned, using a Florisil column.

*Dr. Vance McClure, National Marine Fisheries Service, Tiburon, Ca.

The instrument used for analysis was a Tracor MT 220 gas chromatograph equipped with two ^{63}Ni electron capture detectors. The carrier gas was purified nitrogen flowing at a rate of 80 ml/min. The injector, column, and detector temperatures were 225, 190, and 285 degrees C, respectively. The column was a 1/4-x 6-in. tube packed with 3 percent OV-1 on Chromosorb W, AW, DMCS, 60/80 mesh.

RESULTS

The survey of antifouling paint application in several marinas of the Bight indicated that about 75 percent of the boats in each marina were painted once a year and that, on the average, approximately 1 gal.* of paint was used per boat.** On the basis of this relationship and small craft inventories obtained from harbormasters, we estimated the use of antifouling paints in Newport Harbor and in several marinas of San Pedro Harbor and San Diego Bay (Table 1; the table also gives estimated quantities of antifouling paint applied annually to commercial and naval vessels in these anchorages).

Concentrations of PCB 1242 and 1254 observed in the major brands of antifouling paint currently in use in southern California are listed in Table 2; data on levels found in paint scrapings at haulout yards are listed in Table 3. The upper-limit values for total DDT generally were an order of magnitude lower than those for the sum of PCB 1242 and 1254.

Tables 4 and 5 present the concentrations of PCB and DDT compounds observed in effluent composites from major representatives of direct industrial dischargers to Los Angeles Harbor and Dominguez Channel of Long Beach Harbor. PCB concentrations were highest in effluents from several shipyards, but the discharge rates of these effluents were relatively low. Significant concentrations of both PCB and DDT compounds were found in the cannery wastes, which were discharged at the rate of several million gallons per day.

The lowest concentrations were found in cooling water discharges from a power plant in the Los Angeles Harbor area; effluents of this type account for approximately 80 percent of the 1,290 mgd of industrial discharges to San Pedro Harbor. The results of the replicate analyses of Terminal Island municipal wastewater released into the outer portion of San Pedro Harbor (Table 6) revealed higher concentrations of the chlorinated hydrocarbons in this effluent than in most of the direct industrial discharges.

*One gallon equals 3.78 liters.

**Inventory records generally apply to small craft between 16 and 65 ft (about 5 to 22 m) in length.

Figure 2 gives an example of the relationship between estimated discharge rate* and concentrations of suspended sediment, total DDT, and PCB 1254 in Los Angeles River storm runoff. Although there were relatively large variations in the chlorinated hydrocarbon concentrations, these values appeared to fluctuate with concentration of suspended sediment and discharge rate. Such a relationship implies that most of the runoff transport of these trace organics occurs during periods of peak discharge. Flow-weighted mean concentrations of these chlorinated hydrocarbons for four individual storms during Water Year 1972-73 are listed in Table 7, as are the overall storm flow-weighted means for the year. For comparison, corresponding values based on analyses by Risebrough and de Lappe**for Water Year 1971-72 are also listed. These overall means are in remarkably good agreement. Table 8 presents the results of the two seasonal collections of dry weather flow in channels discharging into or nearby the three harbors under investigation.

Figures 3 and 4 illustrate weekly values for flux via dry aerial fallout of PCB 1254 and p,p' DDT***measured from July to September 1973 at or near the three harbors. During the sampling period, winds were predominantly from the west. Investigations are now in progress to determine if higher fallout values occur during the winter when the sea breezes are less persistent and occasional strong winds from the east carry dust and other materials out over the Bight.

From these data, we have attempted to estimate typical annual inputs of measurable DDT and PCB compounds to the three harbors via the five routes investigated. As seen from Table 2, PCBs were detected in only 7 of the 28 wet paint samples analyzed. With the exception of the two samples with total PCB concentrations of approximately 40 mg/l each, levels generally were the order of 1 mg/l or below; neglecting inequality signatures in Table 2, median values for PCB 1242 and 1254 were 0.3 mg/l and 0.7 mg/l, respectively. Total DDT upper limits generally were an order-of-magnitude lower. We combined these values with the estimated quantities of antifouling paint applied annually to recreational, commercial, and naval vessels in the harbors (Table 1) and obtained estimated upper limits for this annual use of PCB and DDT in these harbors.

*Preliminary values; calculated from telephonic readings of depth of flow and appropriate calibration curves.

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***The predominant DDT compound observed in the fallout samples.

The estimates for industrial inputs to San Pedro Harbor were obtained by calculating flow-weighted concentrations of PCB 1254 and total DDT in three classes: power plant cooling water, fish cannery wastes, and "other industrial" discharges. These categories were initially selected* because of the relatively high flows of the power plant discharges and the relatively high DDT emissions from cannery wastes. The weighted concentrations were then multiplied by the reported total present flows for the three classes of industrial wastewaters into San Pedro Harbor;** these values are summarized below:

Class	Mean Flow (mgd)	Flow-Weighted PCB 1254	Mean Conc. (μg/l) Total DDT
Power Plant Cooling	1,021	0.01	0.002
Cannery Wastes	16	0.09	0.34
Other Industrial	254	0.10	0.02
Blank		0.004	0.002

There does not appear to be any significant discharge of industrial waste into Newport Bay;+ in San Diego Bay, some power plant cooling waters and cannery wastes are discharged,++ but these inputs have not yet been studied.

Estimates of annual PCB and DDT inputs to San Pedro Harbor via the discharge from the Terminal Island Municipal Wastewater Treatment Plant were calculated from the average concentrations listed in Table 6 and the mean discharge rate of approximately 10 mgd.

The long-term annual mean flow of surface runoff to San Pedro Harbor via Los Angeles River is 148 10^6 cu m/yr; of this, approximately 29 10^6 cu m/yr is dry-weather flow, and the remainder is attributable to storm flow.† By combining these data with the concentrations given in Tables 7 and 8, we obtain the estimated typical mass emission rates for total

*The industrial wastewater sampling and evaluation program is still in progress.

**Information supplied by Dr. Lewis Schinazi, California State Regional Water Quality Control Board, Los Angeles Region.

+Personal communication, Steven Harrera, California State Regional Water Quality Control Board, Santa Ana Region.

++Personal communication, Joseph Barry, California State Regional Water Quality Control Board, San Diego Region.

†Data provided by the Los Angeles County Flood Control District.

DDT and PCB 1254 (shown in Tables 9 and 10). Of these chlorinated hydrocarbon inputs, only about 2 percent occur via dry weather flow; thus, storm flow does appear to dominate annual runoff transport of these compounds in southern California. Although extensive records for Newport and San Diego Bays are not available, present best estimates for typical surface flow to these two bays are 7 and 12 10^{6} cu m/yr, respectively. Because storm flow PCB and DDT concentrations were not obtained in these two areas, we have assumed that the dry-weather flow relationships (Table 8) for the Orange County and San Diego County channels, relative to the Los Angeles River dry-weather concentrations, may be used to extrapolate the 1972-73 Los Angeles River storm flow averages (Table 7) to the Newport Bay and San Diego Bay runoff channels.

Finally, the estimates of aerial fallout inputs of PCB 1254 and p,p'-DDT to the waters of the harbors were calculated from the waterway areas and the fluxes measured in the three regions during summer 1973:

Harbor	Area (sq km)	10^{-9} g/sq m/day PCB 1254	p,p'-DDT
San Pedro Harbor	62	99	308
Newport Bay	6	102	136
San Diego Bay	40	50	38

The resulting estimated annual mass emission rates for the five routes are summarized in Tables 9 and 10. The distributions* of total DDT (principally p,p'-DDE) measured in the whole soft tissues of the intertidal byssal mussel *Mytilus* collected from the vicinities of the three harbors are illustrated in Figures 5 to 7; corresponding distributions* for PCB 1254 are illustrated in Figures 8 to 10.

DISCUSSION AND CONCLUSIONS

Our investigation shows that negligible quantities of DDT are now entering Newport and San Diego Bays via the five major input modes under study. Because of the large input of stormwater from the Los Angeles River, surface runoff is the dominant source of DDT to San Pedro Bay; however, the estimated total annual input of about 100 kg/yr through runoff is insignificant relative to the 4,000 kg from the Los Angeles County submarine outfalls (at Whites Point, just northwest of the harbor) during 1973. (The 1971 DDT input via this municipal wastewater discharge was approximately 19,000 kg, and previous annual inputs may have been considerably higher.)

*The concentrations shown have not been corrected for chemical yield, found to be approximately 90 and 95 percent for total DDT and PCB 1254, respectively.

The distributions of total DDT concentrations in the intertidal mussels, shown in Figures 5 to 7, support the hypothesis that the Whites Point submarine outfall system has been the dominant source of DDT to the coastal and harbor zones investigated. The maximum tissue concentration of 1,500 ug/wet kg (ppb) occured on the coast near Whites Point, at the base of the outfalls. With the exception of the surprisingly high concentration (1,300 ppb) within the Long Beach Marina, the levels found inside San Pedro Harbor ranged from 120 to 640 ppb and were similar to (but somewhat lower than) those along the breakwater (range: 360 to 960 ppb).

In general, the DDT values in mussels increased with proximity to the Whites Point outfall system. Values in the coastal specimens outside Newport Harbor, 40 km to the south, were also high (concentrations ranged from 110 to 260 ppb), although inside the harbor, somewhat higher values were observed (200 to 640 ppb). As the present known input rates of DDT to Newport Bay are negligible, these high values in the harbor mussels may be due to recycling of past accumulations of DDT within the restricted waters there.

The San Diego mussels showed the lowest DDT concentrations, with coastal values ranging from 4 to 61 ppb. The median coastal value was 51 ppb compared to the median harbor values of 32 ppb. These levels, which were not significantly different, were approximately 30 times lower than the concentration observed at the base of the Los Angeles County outfalls, 150 km to the north.

The following PCB summary indicates an important difference between the relative distributions of PCB and those of DDT discussed above.

Region	Coastal Median	Coastal Range	Harbor Median	Harbor Range
San Pedro	110	80-140	160	86-480
Newport*	69	53-100	210	86-880
San Diego*	47	44-61	320	19-860

The coastal PCB medians decrease by a factor of two from San Pedro to San Diego, but the harbor medians increase by a factor of two. This pattern indicates that, in contrast to the case for DDT, there appears to be more than one important source of PCB to nearshore waters of the Bight.

Past studies have shown that in 1971, PCB inputs from Los Angeles and Orange County ocean outfalls each exceeded 1,000 kg/yr, whereas the input from the San Diego Point Loma outfall was an order of magnitude lower (Southern California Coastal Water Research Project 1973). We would therefore expect coastal mussels off San Pedro and Newport

*Excluding *M. californianus* values.

Bays to be more influenced by PCB from the ocean outfalls than are those off San Diego; the median PCB concentrations just presented are consistent with this expectation. However, in all three regions, the values of PCB in harbor mussels exceed those in coastal specimens, implying that a specific harbor-related source may have been a dominant ubiquitous PCB input in recent years.

Although the data of Table 10 does not indicate which of the potential sources investigated is most likely to have been the dominant one, the fact that the high PCB concentrations are found wherever there is intense vessel activity suggests that this may well be the key. In all three harbors, the values are highest in the confined regions where recreational or commercial and naval vessels are present. This conclusion is strengthened particularly by the fact that some of the highest PCB concentrations observed occurred in Newport Harbor, an anchorage with a high density of recreational craft and with no significant discharge of industrial, municipal, or surface runoff wastewater. The occasional very high concentrations of PCB in dried chips of antifouling paint support this hypothesis, although other potential vessel sources, such as loss of hydraulic fluid, might also be the explanation.

Samples of pre-1970 antifouling paints are now being sought to further investigate this possibility. If the tentative conclusions attributing the relatively high PCB concentrations in harbor mussels to past inputs from this source are confirmed, it could mean that the prohibition of "open" use of PCB, such as in paints, has decreased the application of PCB to vessel bottoms by up to 10,000 kg/yr in the largest harbors of the Bight. Nevertheless, the restricted circulation in these harbors, and the proximity of harbor intertidal organisms to potential PCB sources, has resulted in significantly higher contamination levels of PCB than are exhibited by coastal mussels near present major submarine discharges of these chlorinated hydrocarbons.

ACKNOWLEDGMENTS

We thank Larry Miller, Newport Beach Chamber of Commerce, and Ray Berry, California Shipyards, for help in acquiring these data. Personnel of the Flood Control Districts and the California Regional Water Quality Control Boards in Los Angeles, Orange and San Diego Counties provided important information on surface runoff and industrial discharges. We also appreciate the cooperation of most of the owners and operators of drydocks and retail paint outlets at the harbors we investigated. Elliott Berkihiser, Joseph Johnson, and Paul Smokler of the Coastal Water Research Project participated in the field collections and laboratory analyses, and Deirdre McDermott and Robin Simpson, also of the Project, assisted in preparation of the manuscript.

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FIGURES

Figure 1. Location of the three harbors studied within the Southern California Bight.

Figure 2. Concentrations of chlorinated hydrocarbons and suspended sediments in Los Angeles River stormwaters, 11-12 March, 1973.

Figure 3. July through September 1973 flux of PCB 1254 at three major harbors in Southern California.

Figure 4. July through September 1973 flux of p, p'-DDT at three major harbors in Southern California.

Figure 5. Concentrations (µg/wet kg) of total DDT in whole soft tissues of *Mytilus edulis* in San Pedro Harbor, January 1974.

Figure 6. Concentrations (µg/wet kg) of total DDT in whole soft tissues of *Mytilus edulis* in Newport Bay, January 1974.

Figure 7. Concentrations (µg/wet kg) of total DDT in whole soft tissues of *Mytilus edulis* in San Diego Bay, January 1974.

Figure 8. Concentrations (μg/wet kg) of PCB 1254 in whole soft tissues of *Mytilus edulis* in San Pedro Harbor, January 1974.

Figure 9. Concentrations (μg/wet kg) of PCB 1254 in whole soft tissues of *Mytilus edulis* in Newport Bay, January 1974.

Figure 10. Concentrations (μg/wet kg) of PCB 1254 in whole soft tissues of *Mytilus edulis* in San Diego Bay, January 1974.

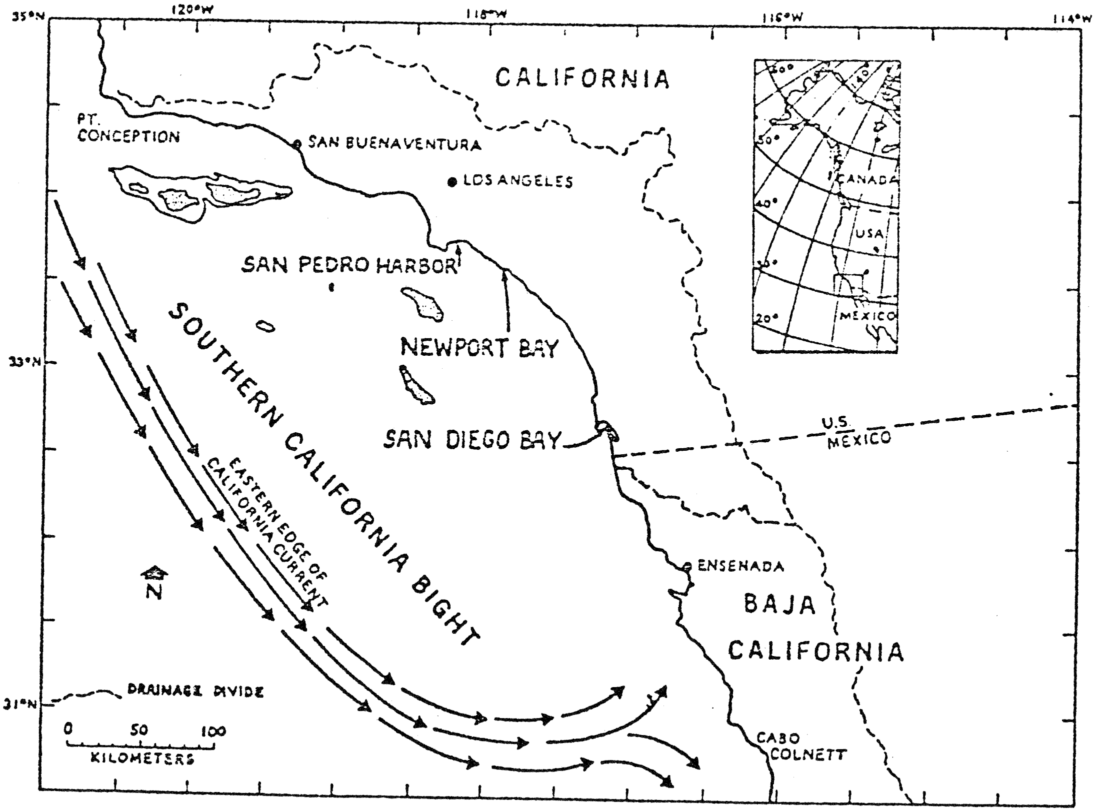


FIGURE 1.

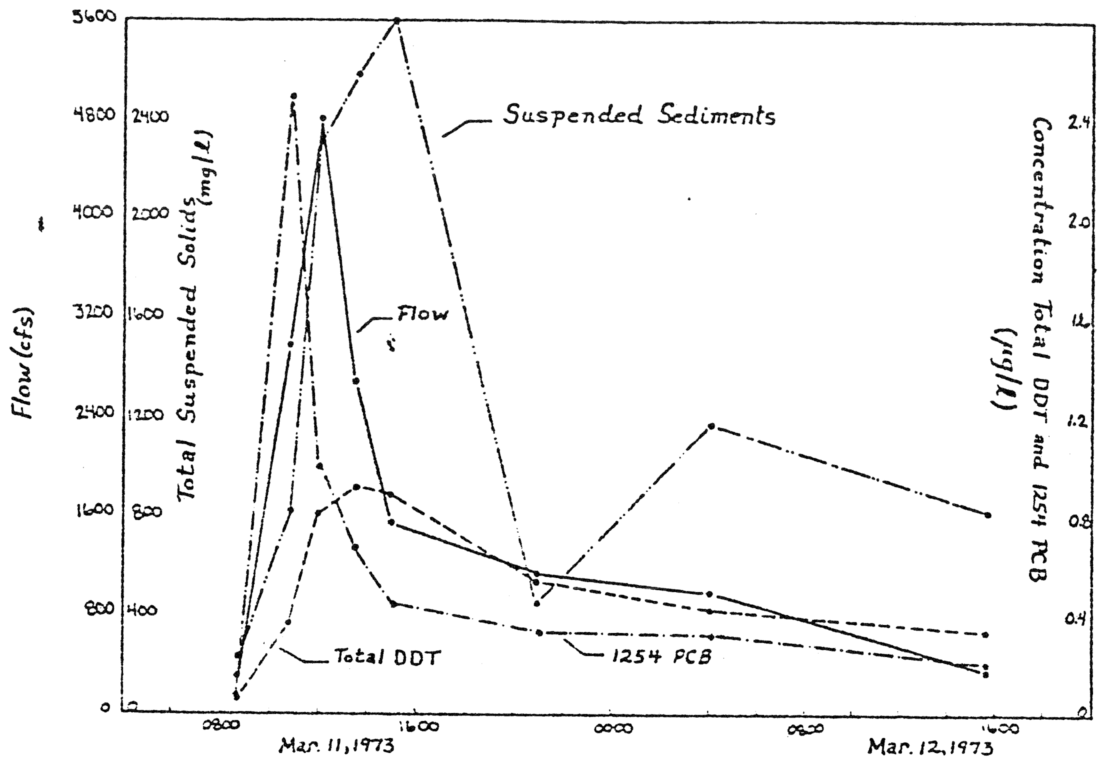
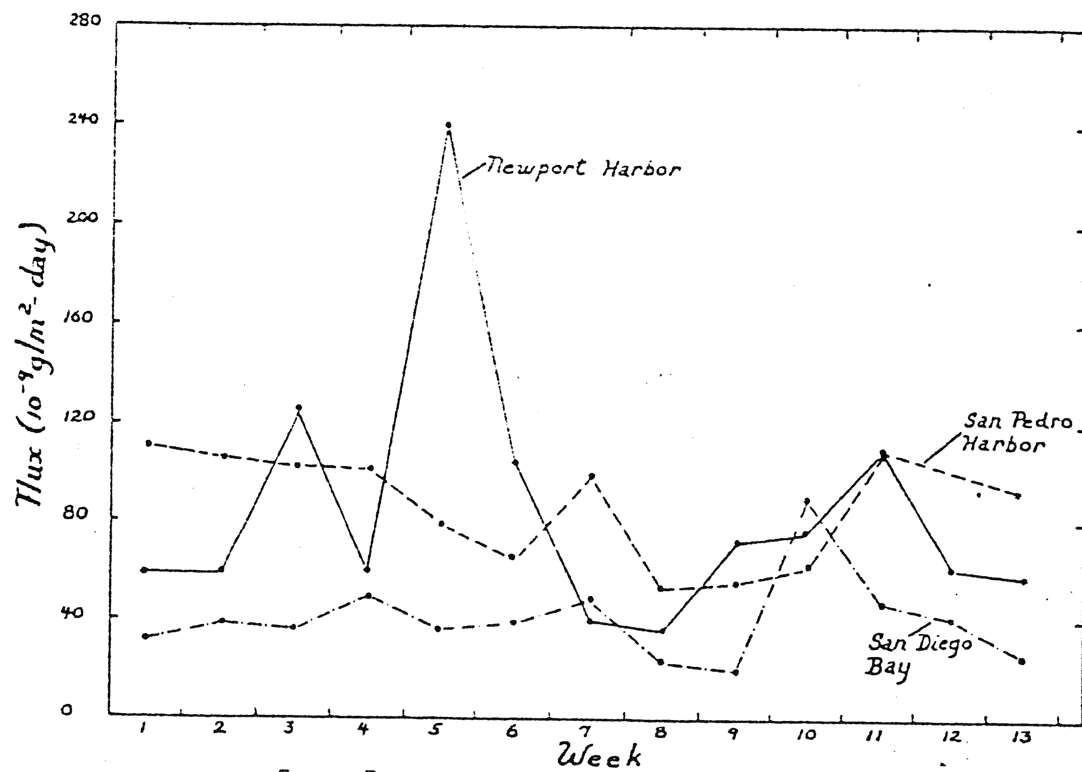


FIGURE 2.



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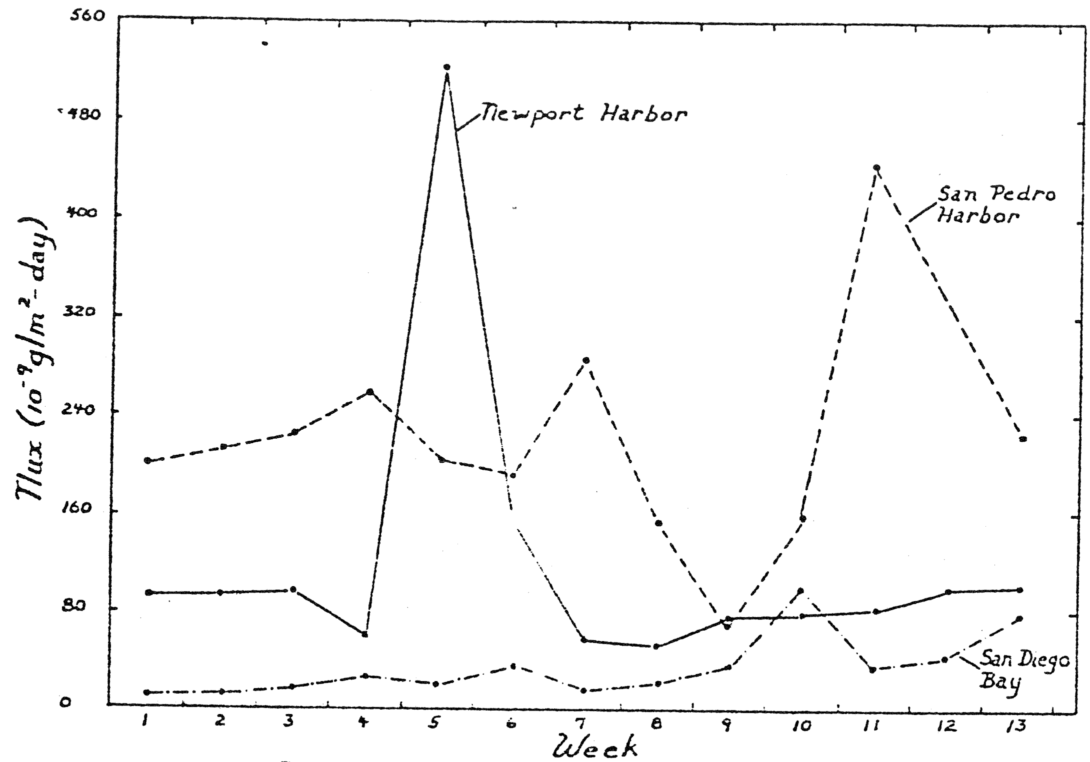
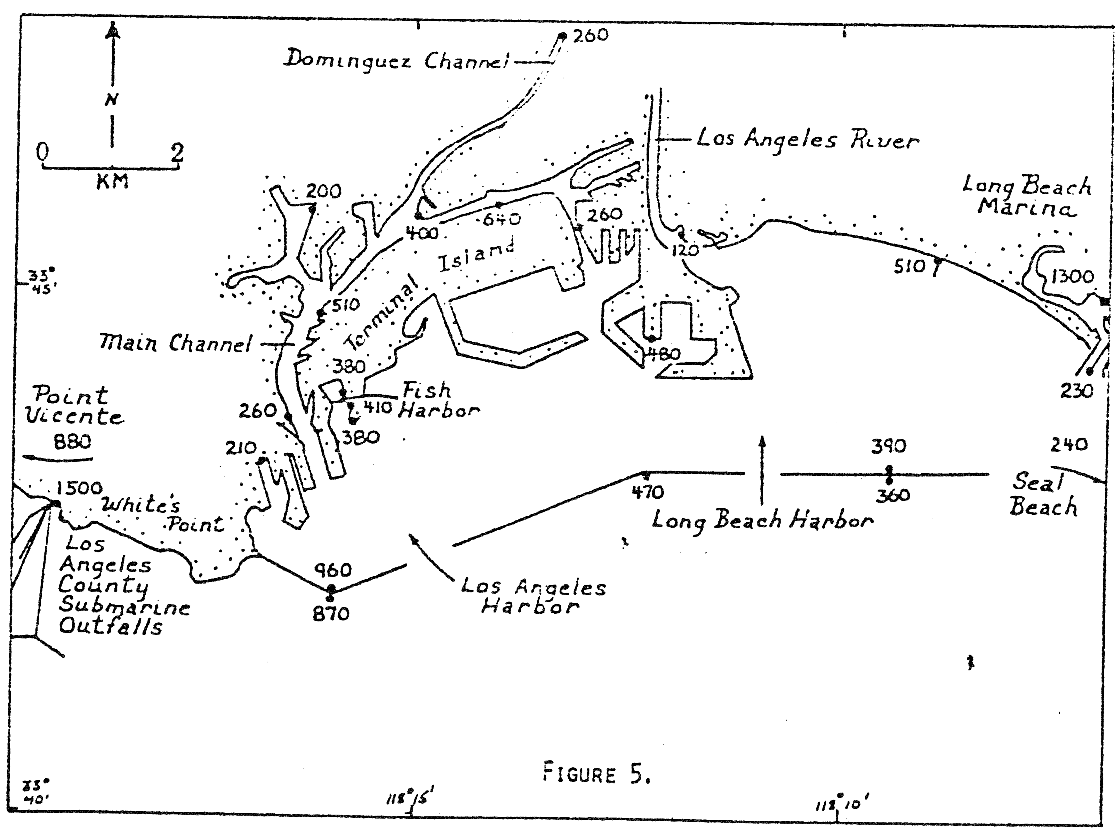


FIGURE 4.



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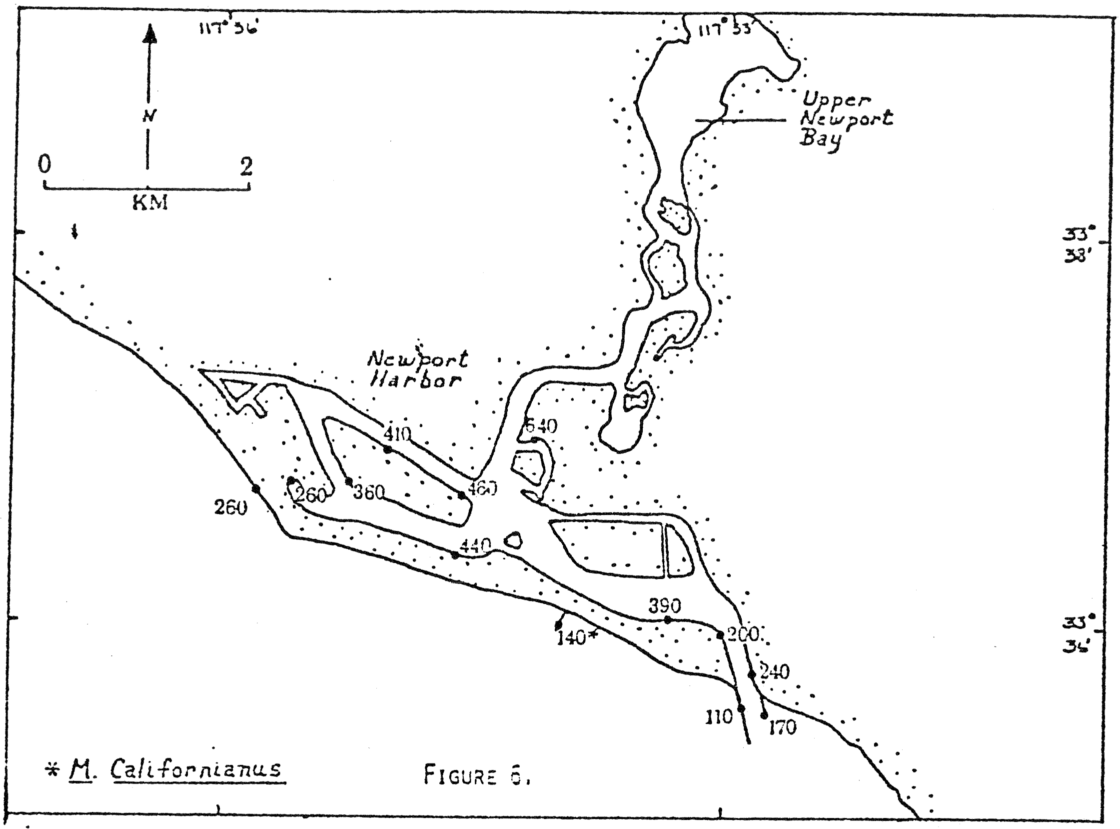


FIGURE 6.

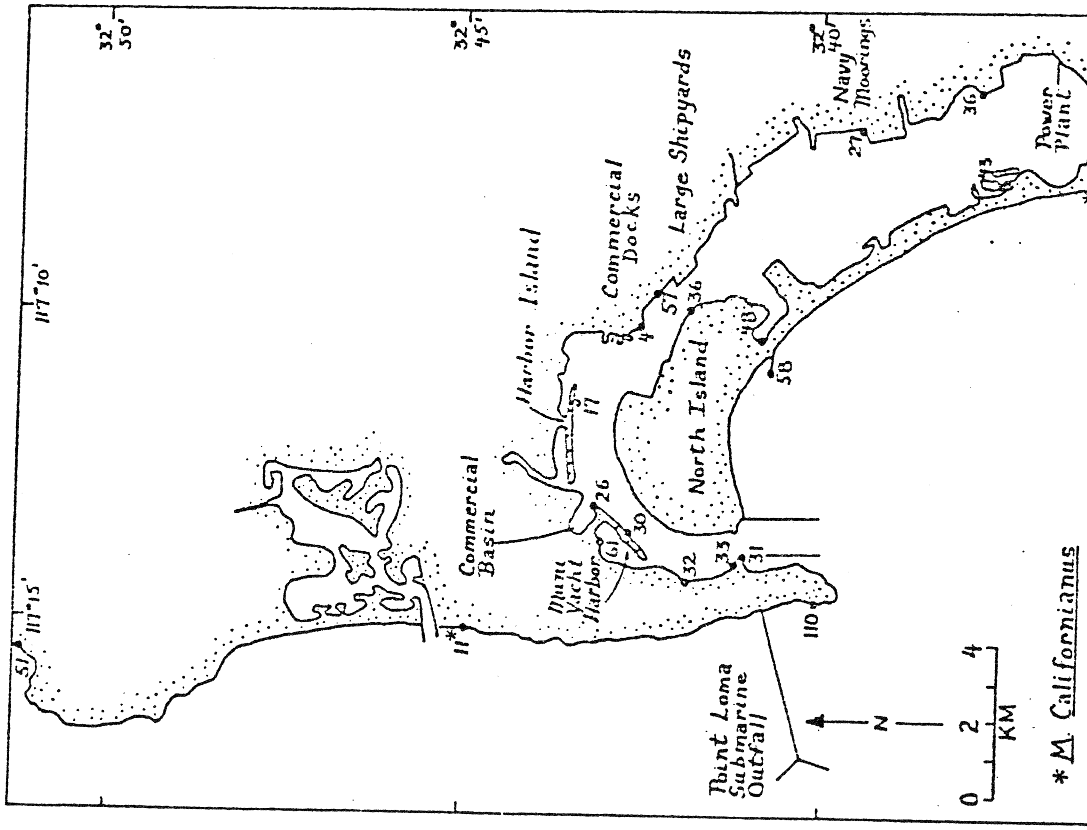


FIGURE 7.

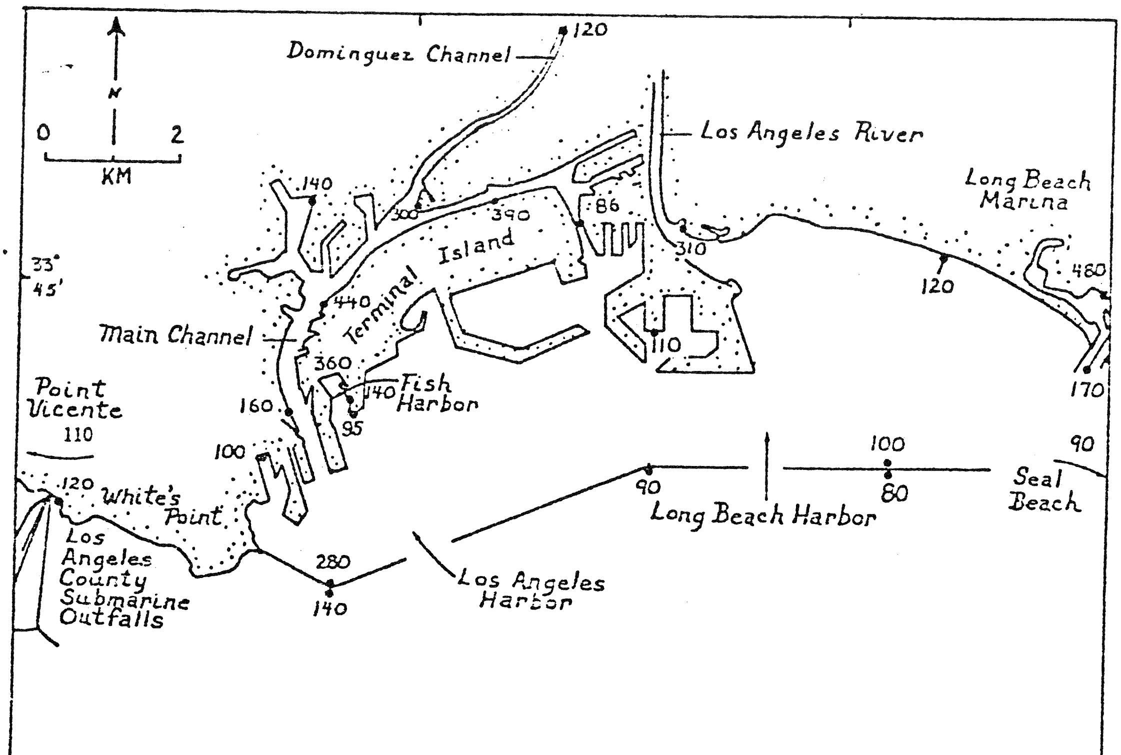


FIGURE 8.

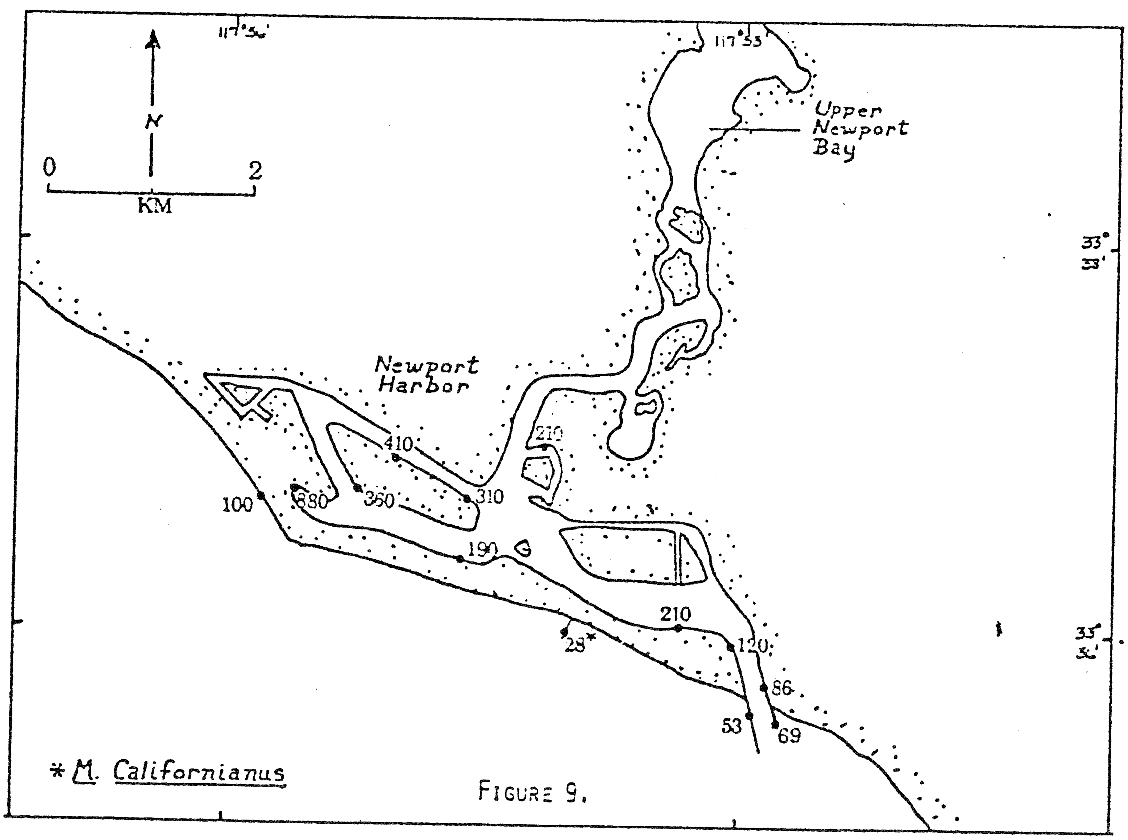
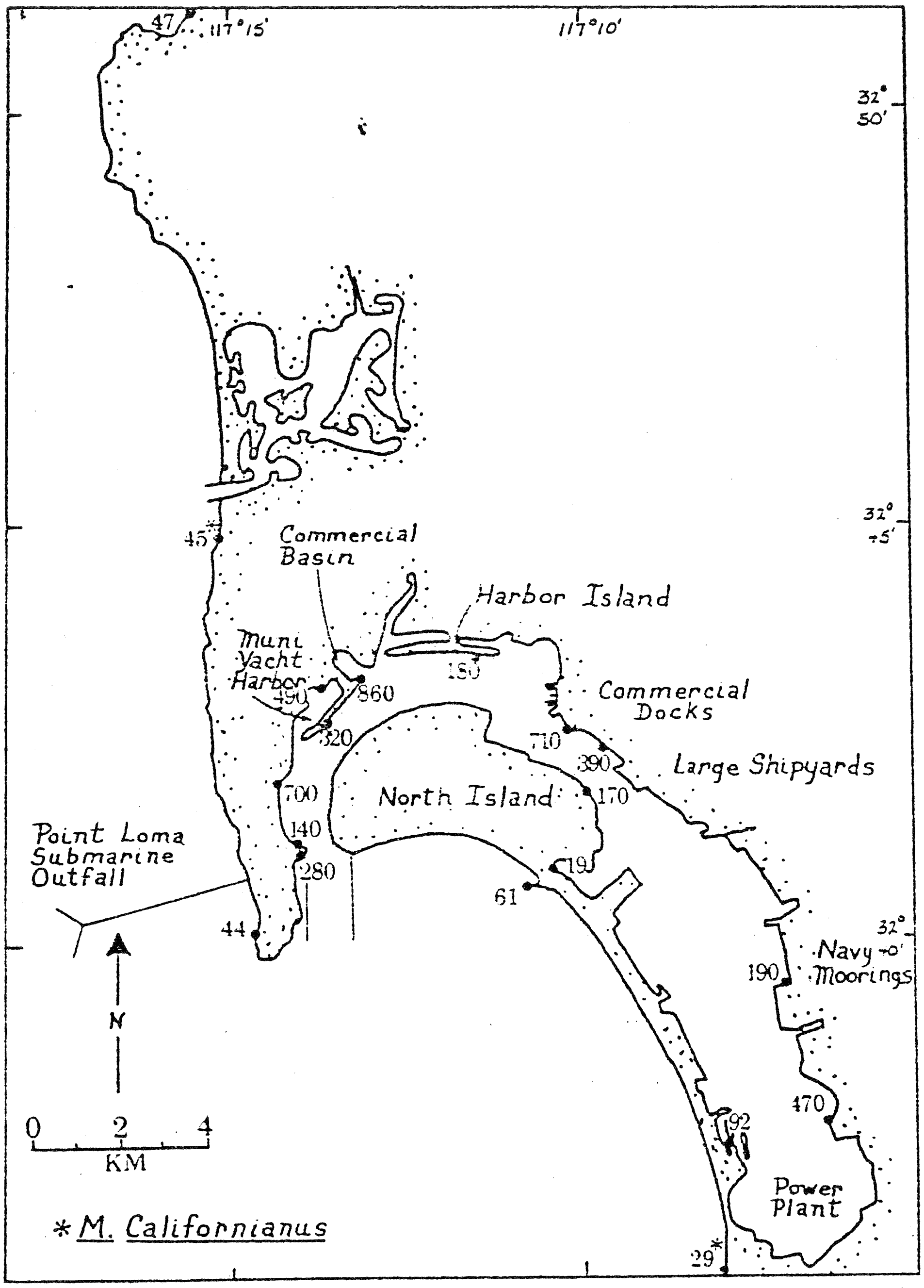


FIGURE 9.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Commercial Basin
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Large Shipyards
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North Island
700
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280
19
61
Point Loma Submarine Outfall
Navy Moorings
190
470
92
Power Plant
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* M. Californianus

FIGURE 10.

TABLE 1. ESTIMATED NUMBER OF RECREATION CRAFT AND AMOUNTS OF ANTIFOULING PAINTS APPLIED IN THREE SOUTHERN CALIFORNIA HARBORS.

HARBOR	NUMBER OF BOATS	ANTIFOULING PAINTS (L/YR)
SAN PEDRO HARBOR		
LOS ANGELES HARBOR	3,600	
LONG BEACH HARBOR	2,700	
LONG BEACH MARINA	2,500	
SUBTOTAL	8,800	25,000
COMMERCIAL AND NAVAL	-	115,000
NEWPORT HARBOR	8,600	25,000
SAN DIEGO BAY		
MUNI. YACHT HARBOR	1,900	
COMMERCIAL BASIN	800	
HARBOR ISLAND	600	
CORONADO MARINA	200	
OTHERS	100	
SUBTOTAL	3,600	10,000
COMMERCIAL AND NAVAL*	-	75,000
TOTAL	21,000	250,000

*ESTIMATES BASED PARTIALLY ON DATA FROM Barry (1972).

Table 2. Polychlorinated biphenyl concentrations in antifouling paints used in southern California.

Code	Brand and Type	PCB (mg/ℓ) 1242	1254
RECREATIONAL			
	Brolite 2-Spar		
P23	2000	<0.06	<0.16
P43	Multitox	<0.05	1.6
P34	Colortox	--	0.29
P53	Killer (B-90)	<0.3	<0.6
P37	A-1316 (1969)	<0.4	<1.2
	Woolsey		
P24	Vinelast (Blue)	<0.3	<1.0
P39	Vinelast (Red)	<0.1	<0.3
	International		
P28	Inter-lux 62	<0.2	<0.6
P26	Bottomkote 69	<0.4	<1.1
P20	Vinyl-lux	<0.03	<0.07
P19	Tri-lux	<0.1	<1.0
P18	Copper-lux	<0.06	<0.15
	Pettit		
P25	Unepoxy	<0.01	<0.03
P51	Trinidad 75 (red)	<0.09	<0.2
P31	Pacific Special	1.7	1.2
	Mariner's		
P2	1034 Lido	<0.3	<0.6
	Singapore		
P32	696 Blue	<0.4	<1.2
	Devoe-Reynolds		
P30	Navicote	<84	<220
P63	Triple C	12.0	28.0
COMMERCIAL			
	Devoe-Reynolds		
P54	Super Tropical	18	23
P58	3407	<0.005	<0.023
P59	213	<0.92	<0.29
P64	Hot Plastic	1.30	3.00
P55	Cold Plastic 105	<1.6	<4.0
	Amarcoat		
P62	Emeron 67	1.20	2.80
	Proline		
P57	1080	<0.17	<0.72
NAVY			
	Devoe-Reynolds		
P60	121/63	<0.1	<0.4
P61	129/63	<0.1	<0.4

TABLE 3. POLYCHLORINATED BIPHENYLS IN ANTI-FOULING PAINT SCRAPINGS FROM SOUTHERN CALIFORNIA DRYDOCKS

ORIGIN	PCB (MG/DRY KG) 1242	1254
FIBERGLASS HULL	.1	3.0
TRASHCAN	1.3	1.4
TRASHCAN	9.5	3.5
DRAIN 1	28	3,300
DRAIN 2	7.5	8.3
DRAIN 2	110	160
WOOD HULL		19
WOOD HULL	3,000	53,000
WOOD HULL		150,000
YARD	2.8	0.3
WOOD HULL	0.9	20
WOOD HULL	1.1	1.1
FIBERGLASS HULL	1.0	4.2
WOOD HULL	0.5	0.8
WOOD HULL	3.7	1.9

TABLE 4. CONCENTRATIONS (μg/ℓ) OF CHLORINATED HYDROCARBONS IN INDUSTRIAL DISCHARGE: LOS ANGELES HARBOR, 1973

TYPE DISCHARGE	FLOW (MGD)	PCB 1254	TOTAL DDT
FISH CANNERY			
WASTE	5.55	0.05	0.49
WASTE	3.20	0.17	0.10
RETORT DISCHARGE	0.12	0.02	0.007
SHIPYARD			
COOLING WATER	0.04	0.65	0.003
COOLING WATER	0.43	0.01	0.001
OIL TANKER CLEANDOWN	0.25	2.10	0.18
SHIP BALLAST	0.04	1.52	-
SHIP BALLAST	0.29	0.02	-
OIL REFINERY			
COOLING WATER	0.02	0.02	0.002
POWER PLANT			
COOLING WATER	257	0.01	0.002
CHEMICAL PLANT			
COMB. PROCESSES	5.51	0.03	0.002
BLANK		< 0.004	< 0.002

TABLE 5. CONCENTRATIONS (μg/ℓ) OF CHLORINATED HYDROCARBONS IN INDUSTRIAL DISCHARGE: DOMINGUEZ CHANNEL-LONG BEACH HARBOR, 1973

TYPE DISCHARGE	FLOW (MGD)	PCB 1254	TOTAL DDT
OIL REFINERY			
COOLING WATER	0.047	0.01	0.01
COOLING WATER	0.200	0.03	0.12
COOLING WATER	0.319	0.03	0.01
COOLING WATER	0.270	0.04	0.10
CHEMICAL PLANT			
COOLING WATER	0.047	0.02	0.02
COOLING WATER	0.040	0.01	0.13
COOLING WATER	0.529	0.004	0.004
MISCELLANEOUS			
AUTO WASH	0.040	0.01	0.003
YARD RUNOFF	0.004	0.18	0.09
COOLING WATER	0.125	0.16	0.13
BLANK		< 0.004	< 0.004

Table 6. Concentrations ($\mu g/\ell$) of Chlorinated Hydrocarbons in Replicate Composites of Municipal Wastewater from Terminal Island Treatment Plant,* 19-25 February 1974.

Constituent	R-1	R-2	Average	Blank
PCB 1254	0.21	0.09	0.15	<0.006
p,p'-DDT	0.14	0.06	0.10	<0.001
o,p'-DDT	0.03	0.01	0.02	<0.001
p,p'-DDD	0.15	0.09	0.12	<0.001
p,p'-DDE	0.03	0.03	0.03	<0.001
Total DDT	0.35	0.19	0.27	<0.004

*Mean annual discharge approximately 10 mgd.

Table 7. Flow-Weighted Mean Concentrations ($\mu g/\ell$) of Chlorinated Hydrocarbons in Los Angeles River Storm Runoff

Date	PCB 1254	Total DDT
1971-72 Average	1.03	0.88
1972-73 Average	0.77	0.78
4-7 Dec 1972	0.52	0.67
27 Feb-1 Mar 1973	0.85	0.99
6-9 Mar 1973	0.91	0.73
11-12 Mar 1973	0.73	0.60
Average Blank	<0.003	<0.004

Table 8 . Concentrations ($\mu g/\ell$) of Chlorinated Hydrocarbons in 1973 Collections of Dry Weather Flow.

Channel	County	PCB 1254 Spring	PCB 1254 Fall	PCB 1254 Avg.	Total DDT Spring	Total DDT Fall	Total DDT Avg.
Los Angeles R.	L.A.	0.10	0.14	0.12	0.15	0.01	0.08
San Juan Cr.	Orange	0.01	0.01	0.01	0.01	0.01	0.01
San Luis Rey R.	S. Diego	0.01	0.02)	0.04	0.02	0.02)	0.02
San Diego R.	S. Diego	-	0.08)		0.02	0.03)	
Blanks		<0.002	<0.02	<0.01	<0.001	<0.007	<0.004

TABLE 9. ESTIMATED TYPICAL ANNUAL MASS EMISSION RATES OF TOTAL DDT (KG/YR) TO THREE SOUTHERN CALIFORNIA HARBORS.

	SAN PEDRO HARBOR	NEWPORT BAY	SAN DIEGO BAY
MUNICIPAL WASTEWATER	4	~ 0	~ 0
DIRECT INDUSTRIAL	17	~ 0	-
SURFACE RUNOFF	96	0.7	2
AERIAL FALLOUT*	7	0.3	0.6
ANTIFOULING PAINTS	< 0.1	< 0.1	< 0.1
TOTAL	124	1.1	2.7

*p,p'-DDT only

TABLE 10. ESTIMATED TYPICAL ANNUAL MASS EMISSION RATES OF PCB 1254 (KG/YR) TO THREE SOUTHERN CALIFORNIA HARBORS

	SAN PEDRO HARBOR	NEWPORT BAY	SAN DIEGO BAY
MUNICIPAL WASTEWATER	2	~ 0	~ 0
DIRECT INDUSTRIAL	51	~ 0	-
SURFACE RUNOFF	96	0.4	3
AERIAL FALLOUT	2	0.2	0.8
ANTIFOULING PAINTS	0.1	<0.1	<0.1
TOTAL	151	0.7	3.9