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AERIAL FALLOUT OF DDT

The comparison of chlorinated hydrocarbon inputs presented in the previous article indicates that, during 1973 and 1974, aerial fallout contributed almost as much DDT and its residues to the coastal ecosystem as did municipal wastewater, the largest single source of the pesticide. In light of the decreasing concentrations of DDT in the municipal effluents, it appears that aerial transport will be the dominant input route of the future. Thus, with the support of the U.S. Environmental Protection Agency, we have investigated the fallout rates of chlorinated hydro-carbons onto the Bight in considerable detail over the last 2 years.

Utilizing a glass plate and mineral oil collection technique first developed by Dr. Vance McClure (National Marine Fisheries Service, Tiburon, California), approximately 1,000 samples were taken in replicate 1-week collections made during two 13-week periods at 14 coastal stations and 6 island stations between Point Conception and the U.S./ Mexico border. These samples have yielded a large body of data on several DDT compounds in dry aerial fallout, at levels free of apparent chromatographic interferences or significant contributions from analytical blanks.

The results for p,p,'-DDT, and p.p'-DDE (plus p,p'-DDD for the second survey) have been converted to estimated mean daily fluxes (10~9 g/sq m/day) for each sampling, applying a collection efficiency factor of 50 percent. The Wilcoxon signed-rank test was used to determine if there was any statistically significant difference between the two seasonal values of total DDT fallout onto the Bight. None was demonstrated at 95 percent confidence level; therefore, the weekly data for the individual components were averaged over the entire 26-week collection period. Figure 1 presents the resultant mean for total DDT. The average ratio of p,p'-DDT to o,p'-DDT observed in the Bight was 2.5 to 1, and these two isomers constituted approximately 70 percent of the "total" measurable flux of DDT compounds onto the Bight. In contrast, p,p'-DDE is the principal component observed in JWPCP wastewater and in the ocean bottom sediments around the site of this major discharge: Approximately three-quarters of the total DDT is made up of p.p'-DDE in the surface sediment samples.

Northern Baja California is often used as a control zone in Project studies; thus, during the first seasonal collection, a few weekly samples also were taken by student volunteers at the Institution for Oceanographic Investigations, Universidad Autonoma de Baja California, in Ensenada, Mexico. The results indicated that one of the highest coastal flux values for total DDT observed in the Bight during summer 1973 occurred at Ensenada. This is an agri-cultural region of the Baja California peninsula, and these higher fallout values appear to reflect greater or more recent local usage of DDT than to the north.

One of the most striking results of this Bight-wide survey was that, with the exception of the Ensenada results, the total DDT fallout values generally increased toward Los Angeles. This was surprising, as the major agricultural areas of the coastal plain lie to the north and south of this highly-urbanized region. Because the results of this research had indicated that dry aerial fallout was a relatively important source of DDT compounds .to the Bight, the project conducted its own fallout survey within the Los Angeles Basin to further investigate this finding.

Between 26 April and 24 May 1974, we sampled 24 stations during 4 successive weeks. Because of the past history of dramatic DDT pollution of the Bight, apparently as a result of waste discharges from Montrose Chemical Company, four stations were established within a few

blocks of this industrial plant in the city of Torrance. Four sites also were established around the sanitary landfill in Rolling Hills Estates on the Palos Verdes Peninsula, operated by the County Sanitation Districts of Los Angeles County. It is reported that this landfill received DDT wastes from the Montrose plant up until about 1972. In addition, four sites were established around a private sanitary landfill owned by Ben K. Kazarian and located near the city of West Covina where the Montrose wastes are now taken.

In this survey, both the DDT constituents and 1254 PCB were clearly identified at levels at least an order of magnitude above those found in process blanks. The results showed two regions of relatively high DDT fallout, located in the vicinity of the Montrose plant and the Rolling Hills sanitary landfill. The highest of the values in each region generally occurred at the south or southeast stations. As the prevailing coastal winds are from the northwest, this suggests two separate sources. Wind data for the interior of the Basin are being analyzed to further investigate this subject.

In light of the large gradients in DDT fallout rates that were observed, and the implications regarding the sources, the survey was repeated during 2 weeks in September 1974; two additional stations were included in the pattern around the Montrose plant. The September DDT data were similar to those of the previous spring and indicate little seasonal effect.

The occurrence of an occasional anomalous value can strongly bias a small-sample mean, so for this basin study, we assumed the median of the six weekly values to be most representative of the fallout flux at a given station. These values for total DDT and 1254 PCB are illustrated in Figures 2 and 3, respectively.

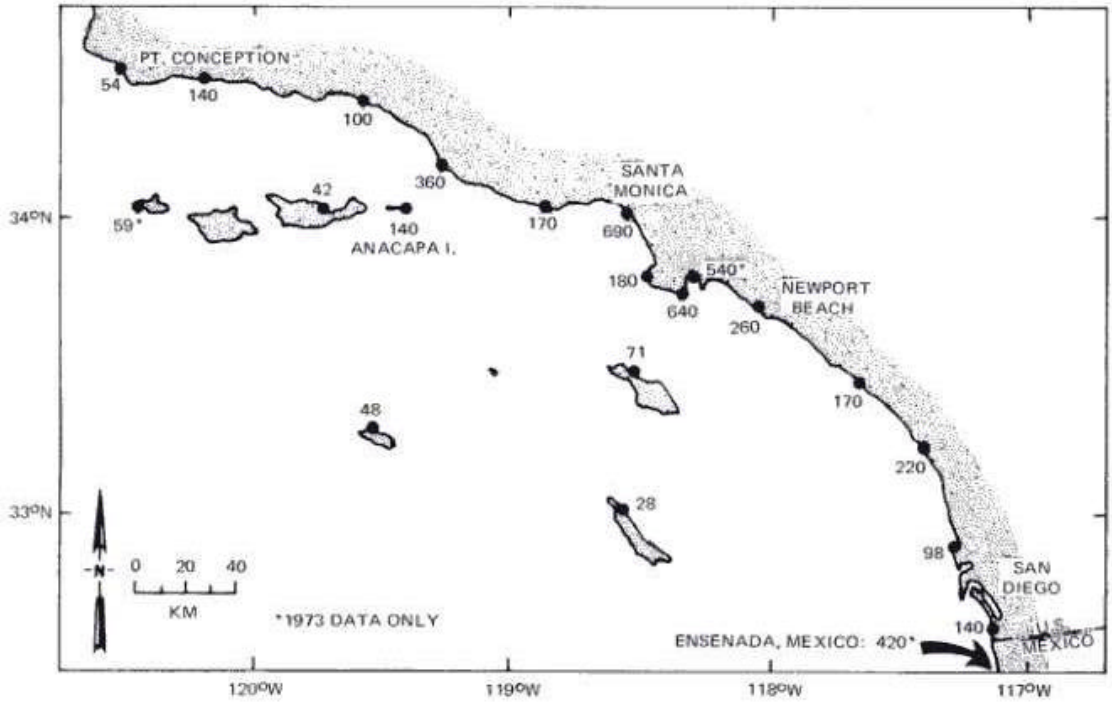
The data presented above indicate an apparent relationship between the DDT fallout distribution and the location of a major manufacturing facility and one of its past waste disposal sites. However, the level of DDT in the dry aerial fallout around the present disposal site (the Kazarian landfill) is not any higher than levels at other Basin stations. As the two principal constituents of the pesticide itself are p,p'-DDT and o,p'-DDT, we examined these two products of the manufacturing process in greater detail. We found a considerably larger value for the ratio of p,p'-DDT to o,p'-DDT around the two regions of highest fallout (10 sites) than in the rest of the Basin (15 sites); median values for the two groups are 5.0 and 3.2, respectively. This ratio may be an indication of the relative "freshness" of the DDT constituents collected on our fallout plates. Similarly, the para and ortho isomers together constitute the largest percentage of total measurable DDT at these 10 sites; median percentages for the two groups are 85 percent and 63 percent. This too may be related to effects of "weathering." Finally, to determine if the relatively high DDT fallout values around the manufacturing plant and its past waste depository could be due merely to higher deposition of particulates, we have normalized the values against 1254 PCB, which is not manufactured by Montrose Chemical Co. Distinctively higher values for this ratio are observed around the plant and the Rolling Hills landfill (median: 6.0) than in the rest of the basin (median: 1.2). Thus, it appears that the gradients in DDT fallout values we have observed do indicate two regions that are potentially important sources of DDT compounds to the Los Angeles Basin and the adjacent Southern California Bight.

Two methods were used to calculate the amount of total DDT falling onto the basin annually. The first involved a strict linear interpolation between data points. For those stations where there were two or more sampling sites, the median flux was used to represent the station. It should be noted that in the case of the Rolling Hills landfill, one site has a significantly higher flux than the other three sites. As this value is the median of six weekly values, and this site had the highest weekly flux reported for the entire Basin study, it appears that the site represents a secondary source of DDT. However, the median flux of 1,400 X 10 - g DDT/sq m/day is a more representative value for that station. Because the location of sampling sites and the high values at Montrose bias the fallout estimate of 2.2 metric tons/yr derived from our contours, we consider this to be an upper limit. The median flux for the entire Basin, 930 X 10~9 g/sq m/day, was used

to estimate a lower limit. The fallout estimate calculated using this value is 0.5 metric tons/yr, resulting in an estimated range of 0.5 to 2.2 metric tons/yr.

One of the most important aspects of these findings is that there still may be a significant release of DDT wastes to the southern California environment from the manufacture of this pesticide in Los Angeles County, even though the discharge of liquid wastes to the County sewer system has been stopped. During 1974, the average level of total DDT in JWPCP final effluent was 3.0 \±/1, which alone exceeds the level allowed by the California State Water Resources Control Board "Ocean Plan" (2 u.g/1 on a 50 percent occurrence basis) for total identifiable chlorinated hydro-carbons in such wastewaters. The corresponding mass emission rate for total DDT was 1,400 kg/yr. We have estimated that a similar quantity (1,300 kg) of DDT compounds fell onto the coastal waters annually during 1973-74. A significant fraction of this material may have emanated from DDT wastes produced during manufacture of the pesticide in Los Angeles County, either directly from the plant or from its original land waste disposal site. Thus, a unified control plan to reduce marine inputs of this pollutant would require that attention also be paid to these potential sources of DDT to the atmosphere in Los Angeles Basin.

Figure 1. Average flux of total DDT (10^{-9} g/sq m/day) in dry aerial fallout, 1973-1974.



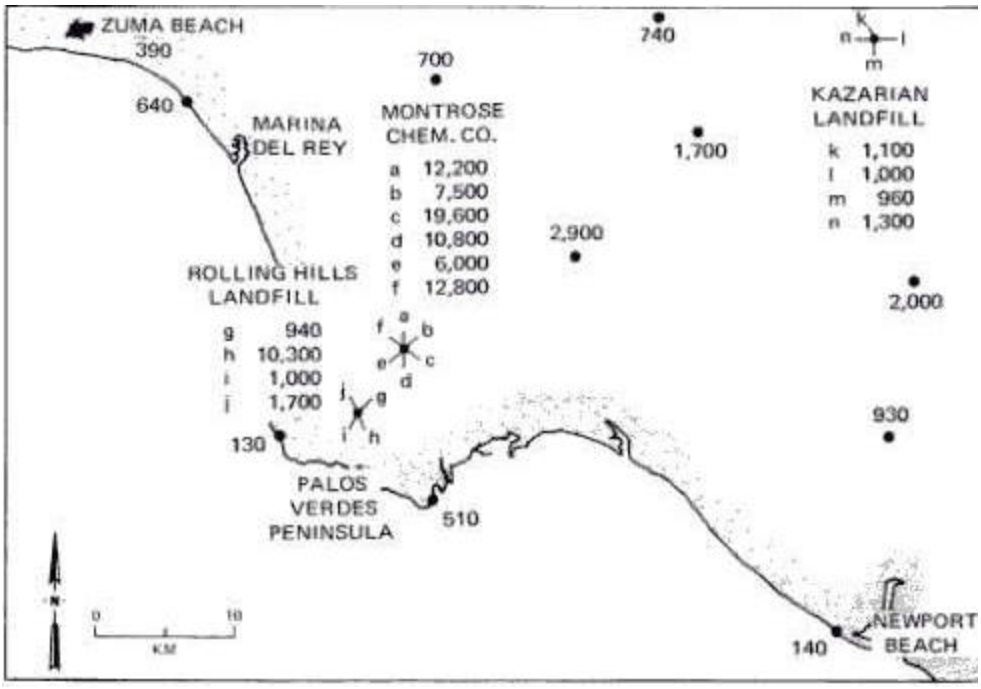


Figure 2. Median flux of total DDT (10^{-9} g/sq m/day) in dry aerial fallout collected during 6 weeks of 1974.

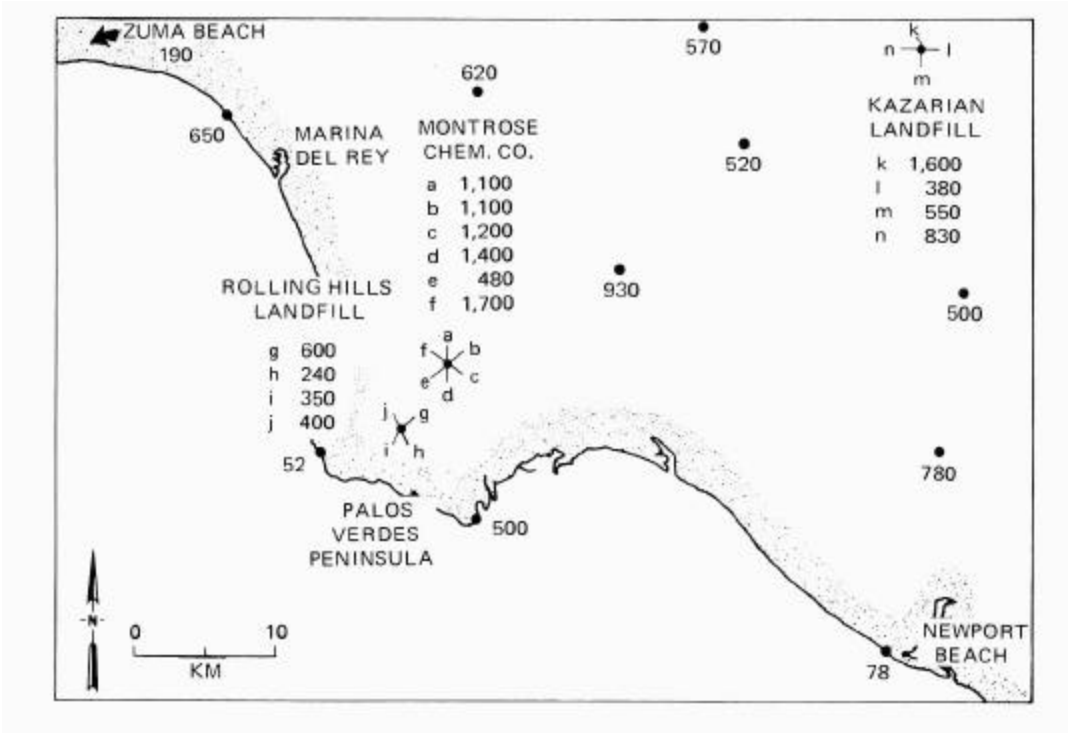


Figure 3 Median flux of 1254 PCB (10^{-9} g/sq m/day) in dry aerial fallout collected during 6 weeks of 1974.