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Introduction

Contrary to popular belief, geographers are interested in more than place names and global trivia. By training and inclination geographers study a wide range of subject matter, much of which relates to the human use of the earth as evidenced by distinctive cultural landscapes. Cultural landscapes have traditionally been a focal point for geographic inquiry. In our contemporary “throw-away” society, which is a by-product of industrialization, media-generated demand, and subsequent hedonistic mass-consumption, litter has become a conspicuous part of the cultural landscape. Given the spatial and temporal dimensions of litter, it is a logical subject for applied geographic research which can identify, measure, and offer recommendations relative to a specific environmental problem.

The State of California is concerned about the litter problem and what to do about it. Since the first step in finding possible solutions to any problem is information gathering, the State Legislature directed that a litter survey be initiated in California in 1980. Geographers were selected to investigate and report on the situation.¹

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The Problem

The California Litter Survey of 1980-1981 evolved as a carefully controlled, two-person research effort that resulted in the collection and analysis of litter items from 105 sites throughout the state. The objective of the survey was to acquire a comprehensive overview of the nature of the littering problem in California. Prior to actual initiation of the survey, staff members of the California State Solid Waste Management Board (SWMB), in conjunction with the Survey Team, designated general target areas for study and agreed that specific survey sites would be selected in the field. Sites had to be identifiable for future reference and geographically representative of the state in terms of: land use, road type, population density, socio-economic status, and environmental conditions.

Locations to be sampled were selected in forty-two of the fifty-eight counties of California. These counties encompassed 97 percent of the state's population in 1980 (Map 1). After selecting and clearing all sites of accumulated litter, the survey effort was separated into two time phases. Of the 105 selected sites, fifty-two were surveyed on a bimonthly basis for fourteen months; that is, every two months litter was removed and audited, and the totals were then combined into consolidated bimonthly data. The remaining fifty-three locations served as control sites and were audited on an annual basis; that is, litter was allowed to accumulate for a full year before it was collected and analyzed. To facilitate comparison with previous studies conducted by the Survey Team, one-third of all sites were monitored for beverage containers only. The remaining sites were audited for all litter items larger than 1 sq. cm. in size (the size of a cigarette filter).²

During the survey period, every reasonable attempt was made NOT to influence local littering patterns. Previous research by the Survey Team established that littering activity is influenced by the perception that a place is clean, is being cleaned, or being watched. Also, there is a threshold level of interference beyond which the removal of litter from a particular
MAP 1
COUNTIES AUDITED
BY THE
CALIFORNIA LITTER SURVEY,
1980-1981
(AUDITED COUNTIES OUTLINED)
site becomes noticeable. Once this occurs, survey work influences “normal” littering behavior. Field testing established that minimum site perimeters of 30.5 m. x 30 m. were sufficiently large to provide a valid sample of the quantity and composition of litter on the individual sites. At the same time, the surveyed areas in their general settings did not appear to be changed in any way by the research effort.

One of the requirements for the California Litter Survey of 1980-1981 was to determine accurately the relative composition of the litter stream in the state, that is, to find out what percentage of litter was beverage containers, beverage related, metal, glass, plastic, Styrofoam, paper or other items. Data collected on sixty-nine all-litter-count sites provided the basis for this determination. Individual litter items recovered and recorded were grouped together into the following categories:

1. Beverage Containers (steel, aluminum, glass, etcetera)
2. Beverage Related Items (caps, corks, pull-tabs, carriers)
3. Metal (auto related, nails, screws, wire, food and juice containers, foil, etcetera)
4. Glass (auto related, food and juice containers, etcetera)
5. Plastic (bags, bottles, cups, lids, tubs, utensils, straws, wrap, auto related, etcetera)
6. Styrofoam (cups, plates, tubs, wrap, packaging, etcetera)
7. Paper (bags, printed materials, boxes, cups, plates, tubs, wrap, containers, napkins/tissue, etcetera)
8. “Other” Items (tobacco, cloth, leather, rubber, wood, oil containers, air and oil filters, sports related, diapers, binding, etcetera)

Thirty-six sites were audited for beverage containers only. These locations were utilized to establish comparability with earlier surveys and demonstrate the value of using only one
type of litter as a surrogate for all other litter forms. Moreover, after removing only beverage containers from a specific site, that locale continued to have the appearance of being littered. During the survey, "normal" littering behavior continued in those places where only beverage container litter was monitored.

On beverage-container-only sites, all steel, aluminum, glass, plastic, and bimetal containers that previously had contained soft drinks, beer, wine or liquor were collected, tabulated, and removed. In this case, broken glass containers were counted as whole containers if bottle necks could be recovered and identified. Soft drink and beer containers were itemized and tabulated by brand and container material. Wine and liquor were categorized generically, for example, bourbon, scotch, gin, rum, wine, mixed drinks, etcetera, and by type of container material.

In tabulating results, the Survey Team based its work on the total count method; that is, each separate piece of litter was counted as a single item. This method was utilized because in a litter clean-up each item has to be individually retrieved; for example, removal of one cigarette butt requires the same effort as picking up one large paper bag. Since the cost of litter removal is really based upon the number of things collected, it was determined that in this survey all litter down to and including items the size of a cigarette filter would be picked up and tabulated. While litter items as small as cigarette butts and broken glass frequently are not perceived as litter, both are hazardous (potentially causing either fire or cuts) and in concentrations are a litter problem. During the 1980-1981 California Litter Survey, 166,982 items were collected, tabulated, and properly consigned to solid waste disposal facilities.

**Survey Results**

The number of litter items collected, enumerated and analyzed from the 105 survey sites during the fourteen-month period was impressive in terms of both quantity and diversity.
Determination of the composition of the litter within identifiable categories was a major requirement for the study, but other useful information also emerged from the data. For example, sources of litter were found to be consistent and fairly limited; attrition of some forms of litter occurred over time due to differing, site-specific, environmental conditions; and, littering, a behavioral problem, appeared to be clearly cyclical with the change of seasons. Each of these observations warrants further attention.

In terms of general composition, the litter recovered from the Annual all-item-count sites was predominantly glass (37.4 percent), paper (31.9 percent), “other” litter items (18.7 percent), and plastic (5.5 percent); the lowest relative percentages were tallied for Styrofoam, beverage related items, whole beverage containers, and metal in that rank order (Figure 1A). In the Consolidated Bimonthly Surveys paper gained in litter significance. On those sites, paper accounted for 35.2 percent of all litter; glass represented 29.1 percent; while “other,” plastic, Styrofoam, and beverage related items retained their positions in the bimonthly composition ranking. Metal and beverage containers switched relative positions in the two surveys (Figure 1B).

Lower recorded percentages in plastic, Styrofoam, paper, and “other” litter items in the Annual Survey data illustrate an attrition rate for those categories of litter more subject to deterioration due to environmental conditions. Conversely, Bimonthly Surveys recover a relatively higher proportion of those items that are most susceptible to deterioration. For example, paper products are much more influenced by the weathering processes than beverage containers; so the longer a site is left littered, the more obvious beverage containers become. Consequently, increased relative percentages in accumulated beverage containers and glass evident in the Annual Survey data are definite indicators that when these items are not removed from the environment within a reasonable length of time their significance vis-a-vis other litter increases.
Figure 1
LITTER COMPOSITION

A. ANNUAL SITES

GLASS (37.9%)
PAPER (31.9%)
OTHER (18.7%)
METAL (1.1%)
BEV.CON. (1.4%)
BEV.REL. (1.9%)
STYROFOAM (2.1%)
PLASTIC (5.5%)

B. CONSOLIDATED BIMONTHLY SITES

GLASS (29.1%)
PAPER (35.2%)
METAL (1.1%)
BEV.CON. (0.8%)
BEV.REL. (1.7%)
STYROFOAM (2.6%)
PLASTIC (7.0%)
A more useful technique for analyzing litter composition was developed by identifying and combining litter products by their origins. For example, an initial assumption of the Survey Team was that recovered glass would be derived from a wide variety of sources. However, this was not the case. Field data disclosed that fully 96 percent of all broken glass recovered from the all-item-count survey sites was obviously broken beverage container material. This revised perception of the origin of glass litter dramatically underscored the significance of beverage products in the total litter stream. The next logical step was to lump the broken beverage container glass with the data for whole beverage containers and beverage related items. The resultant grouping encompassed all the packaging products put to use by the malt brewers, soft drink manufacturers, and the wine and distilled spirits industries. In short, the low relative percentage of whole beverage containers in the total litter data belied the beverage industries' real contribution to the overall litter problem. Some 39.2 percent of all litter in the Annual Survey and 30.4 percent in the Consolidated Bimonthly Surveys was traced directly to the beverage industry.

Other sources of litter also were identified from the total count data. Materials listed in the metal category, for example, were predominantly associated with the transportation industry and included such items as: nuts, bolts, screws, and other automotive parts. In the Annual Survey, fast foods packaging and convenience items, for example, gum, candy, and similar snacks, accounted for 94 percent of all plastic litter, 59 percent of all Styrofoam, and 32 percent of all paper. Together these categories represented 16.6 percent of the litter tabulated in the Annual Survey. In the Consolidated Bimonthly Surveys, those same products represented 20.5 percent of all litter recovered.

Tobacco products, cigarettes, and cigars dominated the ubiquitous "other" category, which included those items not noted elsewhere in the data. In the Annual Survey, tobacco litter accounted for 90 percent of the "other" category. With packaging included, tobacco products represented 18.8 percent
of the litter that was allowed to accumulate on those sites for one full year. In the Consolidated Bimonthly Surveys, tobacco products comprised 94 percent of the “other” class and 21.2 percent of all litter recovered. Tobacco related litter, including packaging, matchbooks and the like, represented 24.3 percent of the total litter stream monitored on a bimonthly basis.

Miscellaneous paper, a subcategory, included those small paper items which were difficult to identify due to chopping by roadside maintenance equipment and deterioration because of weathering. Miscellaneous paper represented 17.3 percent of the annual accumulation and 15.5 percent of the bimonthly litter. Realistically, this litter probably was derived from beverage related packaging or wrapping associated with fast food and convenience items and should have been lumped in those groupings. However, due to their small size and attendant identification problems, miscellaneous paper was considered separately.

By logically grouping the data, major product categories or sources of litter were determined. Almost 92 percent of the litter audited on Annual all-item-count sites was identified with: the beverage industry (39.2 percent), the tobacco industry (18.8 percent), miscellaneous paper (17.3 percent), and fast food and convenience items (16.6 percent) (Figure 2A). Likewise, the same categories of data on the Bimonthly all-count sites represented over 90 percent of the total litter, that is, the beverage industry (30.4 percent), the tobacco industry (24.3 percent), fast food and convenience items (20.5 percent), and miscellaneous paper (15.5 percent) (Figure 2B). *All other* litter combined made up less than 10 percent of the total litter stream in both the Annual and Consolidated Bimonthly data.

Data collected on the thirty-six beverage-container-only sites provided further insights into the beverage products industries' contribution to the total litter stream. Notably, the relative percentages of beverage types in both the Annual and the Consolidated Bimonthly surveys are strikingly comparable. For example, beer containers constituted 78.6 percent of the Annual
Figure 2
LITTER SOURCES

A. ANNUAL SITES

B. CONSOLIDATED BIMONTHLY SITES
and 76.9 percent of the Consolidated Bimonthly beverage container litter. The difference between the two relative percentages as a proportion of the total beverage container litter is only 1.7 percent and is statistically insignificant. Using the same format, soft drink containers comprised 14.4 (Annual) to 12.9 percent (Consolidated Bimonthly) of all beverage container litter, and wine and liquor containers made up 7.0 to 10.2 percent respectively (Figure 3AB).

Analysis of the composition of beverage container litter by type of container material, that is, steel, aluminum, glass, plastic, and "other" (bimetal mixed alcoholic beverage containers) provided perspective on the nature of the packaging materials utilized by the beverage industry and the impact those materials have on the beverage container litter stream (Figure 4AB). Most notably, whether the data were derived from the Annual or Bimonthly surveys, glass containers constituted the highest proportion of all beverage container litter from that category of sites (83.5 to 78.4 percent). Aluminum containers, a recyclable product, represented 12.4 to 18.3 percent of the beverage container litter recovered from the same sites; steel containers ranged from 3.0 to 2.3 percent; plastic containers varied slightly from 0.5 to 0.4 percent; and "other" containers represented 0.6 percent in both surveys.

As has been noted, beer container litter accounted for over three-fourths of all beverage container litter recovered by either Annual or Bimonthly audits on the beverage-container-only sites (Figure 3AB). Only about 1 percent of all beer containers were steel, a reflection of the industry's rapid shift from steel containers to other types of packaging beginning in the 1970's. Recovered aluminum containers represented between 12.0 and 17.8 percent of the beer container litter, an illustration of the effectiveness of aluminum recycling since virtually all non-glass beer containers are aluminum. Glass dominated the beer container litter (87.0 to 81.3 percent) and further underscored the impact of aluminum recycling. The proportion of non-returnable glass beer container litter increases as more
Figure 3
BEVERAGE CONTAINER LITTER BY PRODUCT

A. ANNUAL SITES

B. CONSOLIDATED BIMONTHLY SITES
and more aluminum is recycled. However, it is important to note that beer advertising, in general, tends to emphasize glass packaging; an actual increase in this component, therefore, would be expected.

Soft drinks accounted for between 12.9 and 14.4 percent of the total container litter recovered from the beverage-container-only sites (Figure 3AB). Steel containers made up 15.4 to 13.0 percent of the soft drink containers recovered. There was also a shift in packaging in the soft drink industry in the 1970's. Consequently, aluminum accounted for between 20.5 (Annual) and 36.2 (Bimonthly) percent of the soft drink container litter. The differences between the Annual and Bimonthly figures illustrate that the longer beverage container litter remains on a site, the greater the likelihood for aluminum gleaning. Aluminum recovery increases the significance of other types of containers in the litter stream. For example, between 60.8 and 47.9 percent of the soft drink container litter was glass; as expected, the highest percentage was recorded in the Annual data.

Plastic containers, a relatively new beverage packaging material in 1980, represented approximately 3 percent of the soft drink container litter. Plastic beverage container packaging poses new problems for litter abatement and solid waste management; however, the number of plastic containers recovered during 1980-1981 only hints at a future significance not yet assumed.

Wine and liquor container litter ranged from 7.0 to 10.2 percent of all container litter recovered from the beverage-container-only sites (Figure 3AB). Glass containers dominated this beverage category (90.7 to 94.0 percent); the only other type of container collected was bimetal (9.3 to 6.0 percent).

It is apparent that the longer any type of litter is left on a site, the more apt it is to be modified by human activity and/or environmental conditions. In analyzing the composition of litter from both Annual and Bimonthly sites, for example, it is clear that over time there is an attrition in some forms of litter,
Figure 4

BEVERAGE CONTAINER LITTER BY CONTAINER TYPE


A. ANNUAL SITES

- Glass (83.5%)
- Other (0.6%)
- Plastic (0.5%)
- Aluminum (12.4%)
- Steel (3.0%)

B. CONSOLIDATED BIMONTHLY SITES

- Glass (78.4%)
- Other (0.6%)
- Plastic (0.4%)
- Aluminum (18.3%)
- Steel (2.3%)