Northeast 2010 Litter Survey

A Baseline Survey of Litter at
288 Street And Highway Locations
in Maine, New Hampshire and Vermont

Conducted for

American Beverage Association

by

Environmental Resources Planning, LLC

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Acknowledgements

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Executive Summary

Environmental Resources Planning LLC ("ER Planning") conducted three separate litter surveys between July and August of 2010 in the states of Maine, New Hampshire and Vermont in order to compare the types and quantities of litter in each of the three states. Field crews physically surveyed 288 sites, 96 in each state, covering approximately 2.2 million square feet along more than 27 miles of roadways.

ER Planning employed the Visible Litter Survey (VLS) methodology, which has been used to characterize and analyze litter in more than 70 statewide litter surveys. This approach allows comparison of the results of this survey with those from other state surveys utilizing the same methodology. These include surveys conducted in New Jersey (2004), Georgia (2006) and, Tennessee (2006), all managed by ER Planning's principal.

The unadjusted data for each state was derived by locale weighting and extrapolation of data obtained for each site along with ambient site conditions. Correcting the data in each state for factors known to affect litter rates, such as population, traffic levels and proximity to urban areas, yielded an adjusted litter rate that reflected the influence of these variables.

Vermont yielded a lower base litter rate than Maine or New Hampshire. Once litter rates were adjusted to reflect differences in variables such as population and traffic levels, Vermont yielded the highest litter rate of the three states.

Table ES-1 shows the unadjusted and adjusted litter rates for each state. On an unadjusted basis, Vermont averaged 521 items per each mile, while New Hampshire averaged 907 items per mile and Maine averaged 830 items per mile. Vermont's lower litter rate is not surprising since Vermont's population is less than half the population of Maine or New Hampshire. On an adjusted basis, Vermont yielded a higher litter rate (2,035 items per mile, adjusted) than either Maine (1,609 items per mile, adjusted) or New Hampshire (1,387 items per mile, adjusted). Since Vermont's population is much lower than Maine or New Hampshire, adjusting the items per mile to population levels would, by itself yield a higher litter rate in Vermont.

Table ES-1 – Litter per Mile, Adjusted & Unadjusted Rates

State	Unadjusted	Adjusted
Maine	830	1,609
New Hampshire	907	1,387
Vermont	521	2,035

Field crews recorded data for each component of litter by type (e.g., soft drink, bottled water, etc.) and by material (e.g., glass, plastic, etc.). Table ES-2 shows the composition of litter found for all three states. For each of the three states: Miscellaneous paper and plastic (odd scraps of material) comprised the two largest components of litter; Candy, snack wrappers, and fast food packaging together represented between 29 and 30 percent of litter; and beverage containers was similar, ranging from 5.6 percent to 7.9 percent.

Table ES-2 – Components of Litter

Category	VT	ME	NH
Misc. Paper	19.0%	25.1%	20.5%
Misc. Plastic	18.5%	20.5%	18.4%
Candy & Snack Wrappers	16.3%	13.5%	14.6%
Fast Food Packaging	13.4%	16.4%	14.7%
Beverage Containers	6.4%	5.6%	7.9%
Misc. Metal	4.1%	3.7%	2.5%
Tobacco Products	3.9%	2.6%	2.3%
Vehicle Debris	3.8%	4.6%	5.0%
Toiletries and Personal Items	3.4%	2.9%	4.4%
Newspapers and Magazines	2.7%	0.5%	1.9%
Bottle Caps, Pull Tabs & Carriers	2.4%	1.9%	2.7%
Construction Debris	2.2%	0.7%	1.4%
Advertising Materials	1.8%	0.8%	2.2%
Home Food Packaging	1.4%	0.2%	0.2%
Misc. Glass	0.7%	0.9%	0.5%
Other	0.0%	0.2%	0.7%
TOTAL	**100%**	**100%**	**100%**

Similar statewide litter surveys, which ER Planning staff managed, showed that miscellaneous paper and plastic together were also the most frequently found components of roadside litter in Tennessee (39.1 percent) and Georgia (40.9 percent). Candy and snack wrappers were higher in all three states compared to Georgia (9.4 percent) and Tennessee (9.7 percent.) Vehicle debris was much lower in all three states than in Georgia (9.1 percent) or Tennessee (14.4 percent).

All three states had significantly lower litter rates than other state surveys in which our staff was involved: Georgia, Tennessee, New Jersey, and North Carolina. The composition of litter was also similar in all three states. The top four categories of litter (paper scraps, plastic scraps, candy & snack wrappers, and fast food packaging) collectively accounted for 67%-76% of total litter in all three states. Beverage containers littered was similar in all three states.

Background

The presence of litter is a bellwether for quality of life in a community. As noted in George Kelling's landmark study about "Broken Windows," as a measure of a community's self-image, signs of physical decay such as broken windows and litter are early invitations to further community decay.

Nowhere is litter more of a visual blight than along our nation's roadways. Each day we travel along a variety of roads (local, county, state and highways) to work, shop, travel and site-see, and return home. It is unlikely for a day of these travels to pass without seeing the litter that is along virtually every roadway in our nation, due in part to apathy, carelessness and sometimes malicious behavior.

This dilemma is similar to Garrett Hardin's "Tragedy of the Commons," which occurs when citizens share the use of a public good without bearing the true cost. To the extent that individuals seek to maximize their selfish interest, each will likely ignore the costs that must eventually be shouldered by others in the community. When a majority of individuals follow such behavior, a tipping point is reached and the consequences are subtle, but significant.

While many of those who litter consider their bad habit to be harmless, a national study of litter costs, led by ER Planning's principal in 2008 and 2009 (KAB National Litter Study), estimated that the costs of litter cleanups and related activities were close to $10.8 billion annually. Additional follow-up research currently being conducted by ER Planning suggests that the number likely exceeds $25 billion annually, more than the combined annual budgets of the Department of the Interior and the entire US-EPA in 2010.

The 2010 Northeast Litter Survey shows that, despite isolated abatement programs that have been put in place, the presence of roadside litter continues to cause blight on state and local communities, potentially affecting tourism, business development and property values. Without a clear commitment to comprehensive education and enforcement, volunteers and highway cleanup crews are merely cleaning up behind litterers. When studying litter and its effects, two different dynamics come into play: the actual act of littering and how quickly that litter is removed. These dynamics overlay the level of educational efforts in schools and the commitment to enforcement efforts. In addition, disconnects between signage warning about potential enforcement and actual enforcement efforts has been shown to cause a decrease in legal compliance.

Methodology

Environmental Resources Planning LLC ("ER Planning") conducted three separate litter surveys in the states of Maine, New Hampshire and Vermont in order to compare the types and quantities of litter in each of the three northeast states. The results and recommendations in this report are based on these surveys, which were conducted between July and August of 2010.

ER Planning employed the Visible Litter Survey (VLS) methodology, used previously for characterizing and analyzing litter in more than 70 statewide litter surveys. This approach allows comparison of the results of this survey with those from other state surveys utilizing the same methodology. These include surveys conducted in New Jersey (2004), Georgia (2006) and, Tennessee (2006), all managed by ER Planning's principal.

A detailed explanation of the survey methodology is included in Appendix B. A stratified random sampling of all roadways in each state was conducted using the following breakdown of road types:

Table 1 – Roadway Locale Descriptions

Roadway Type	Acronym	Description
Rural Freeways and Toll Roads	RFT	Interstate highways, toll roads and limited access highways outside of urban areas.
Other State Rural Highways	OSR	U.S. and State highways outside of urban areas without limited access.
Rural Local Roads	RLR	Public roads outside of an urban area that are locally maintained (e.g. city, county).
Urban Freeways and Toll Roads	UFT	Interstate Highways, toll roads and limited access highways within an urban area.
Vacant, Industrial, Un-maintained Frontages	VIU	Urban streets in front of vacant lots, industrial sites or unmaintained buildings.
Commercial Frontages	COM	Urban streets in front of businesses such as convenience stores, restaurants and stores.
Public Facility Frontages	PUB	Urban streets in front of a public use building such as a courthouse, park, school or library.
Residential Frontages	RES	Urban streets in front of neighborhood homes.

For the 2010 Northeast Litter Survey, field crews surveyed approximately 2.2 million square feet along more than 27 miles of roadways. The crews studied litter in detail from 288 sites – 96 each in the states of Maine, New Hampshire and Vermont. The survey yielded a littering rate and a characterization and quantification of litter for each of the three states.

Results – Litter Rate

The littering rate representing the average amount of litter found per mile along all roadways within each state. Table 2 shows the adjusted and unadjusted litter rates for each of the three states.

Table 2 – Litter per Mile, Adjusted & Unadjusted Rates

State	Unadjusted	Adjusted
Maine	830	1,609
New Hampshire	907	1,387
Vermont	521	2,035

On an unadjusted basis, Vermont averaged 521 items per each mile, while New Hampshire averaged 907 items per mile and Maine averaged 830 items per mile. Vermont's lower litter rate is not surprising since Vermont's population is less than half the population of Maine or New Hampshire.

On an adjusted basis, Vermont yielded a higher litter rate (2,035 items per mile, adjusted) than either Maine (1,609 items per mile, adjusted) or New Hampshire (1,387 items per mile, adjusted).

The unadjusted data for each state was derived by locale weighting and extrapolation of actual conditions observed at and data obtained for each site and does not account for the differences in demographics between the states. Using a model that can adjust the data to reflect these differences provides a better basis for comparing base amounts of litter across the states. The adjustment factors utilized in this survey take into account a number of variables known to affect the amount of litter along roadways, including population, traffic levels, recent rainfall and temperature levels, and proximity to populated areas. The model then corrects for the differences in these variables, eliminating their biasing effect and allowing an unbiased comparison of litter data between states.

Figure 1 compares the amount of fresh litter found on an adjusted and unadjusted basis.

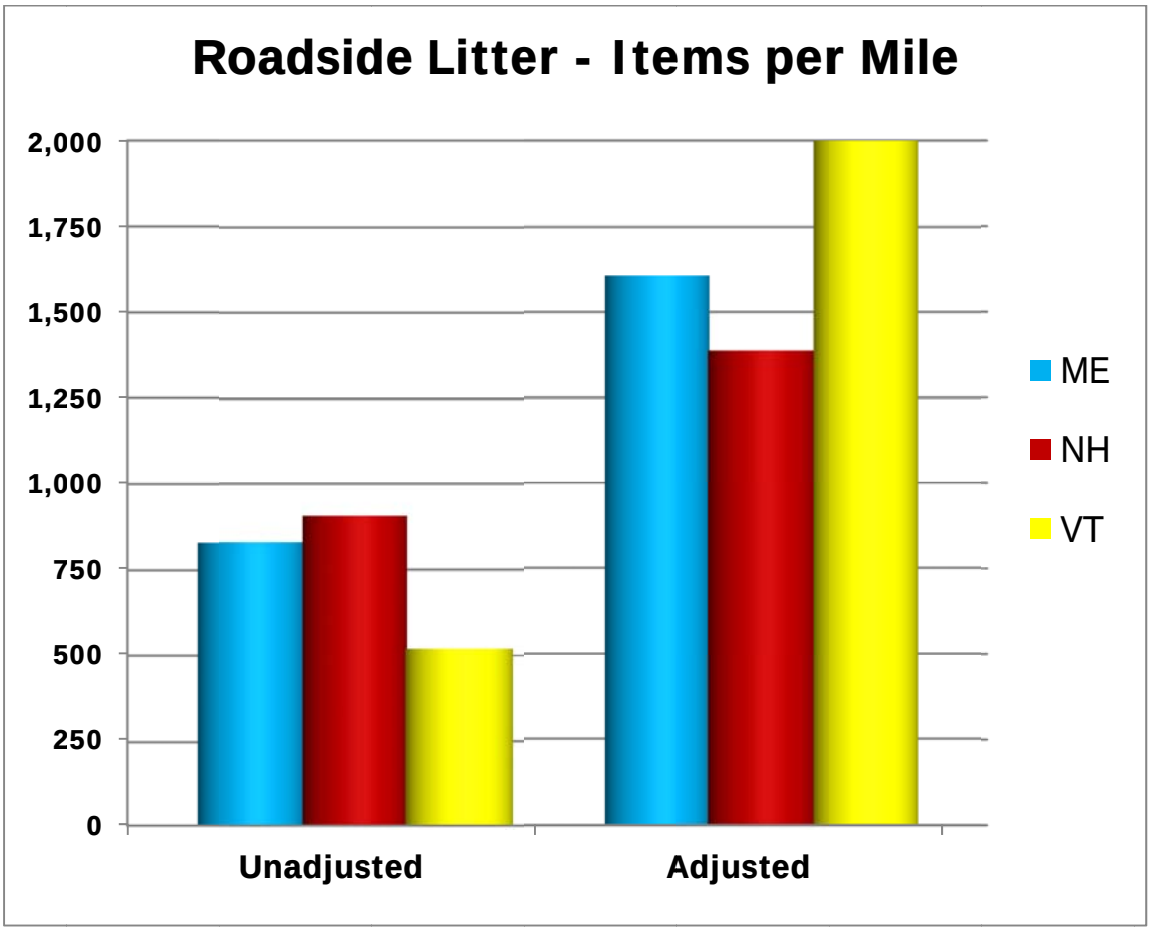

Figure 1– Unadjusted and Adjusted Roadside Litter per Mile

Results – Composition of Litter

Data was recorded for each component of litter by type (e.g., soft drink, bottled water, etc.) and by material (e.g., glass, plastic, etc.). Table 3 shows the composition of litter found for all three states. For each of the three states: Miscellaneous paper and plastic (odd scraps of material) comprised the two largest components of litter; Candy, snack wrappers, and fast food packaging together represented between 29 and 30 percent of litter; and beverage containers was similar, ranging from 5.6 percent to 7.9 percent.

Table 3 – Composition of Litter

Category	VT	ME	NH
Misc. Paper	19.0%	25.1%	20.5%
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Advertising Materials	1.8%	0.8%	2.2%
Home Food Packaging	1.4%	0.2%	0.2%
Misc. Glass	0.7%	0.9%	0.5%
Other	0.0%	0.2%	0.7%
TOTAL	**100%**	**100%**	**100%**

Similar statewide litter surveys, which ER Planning staff managed, showed that miscellaneous paper and plastic together were also the most frequently found components of roadside litter in Tennessee (39.1 percent) and Georgia (40.9 percent). Candy and snack wrappers were higher in all three states compared to Georgia (9.4 percent) and Tennessee (9.7 percent). Vehicle debris was much lower in all three states than in Georgia (9.1 percent) or Tennessee (14.4 percent).

Beverage Container Litter

Beverage containers were broken down into two major categories:

1. Beer and soft drinks
2. Other beverages (water, sports drinks, iced teas, fruit beverages, wine, liquor, aseptic containers, etc.)

In addition, data was recorded for each individual component by type (e.g., bottled water, etc.) and by material (e.g., glass, plastic, etc.), as shown in Figure 2. The litter rates for beverage containers found in each state are shown in unadjusted and adjusted rates, as detailed on page 9.

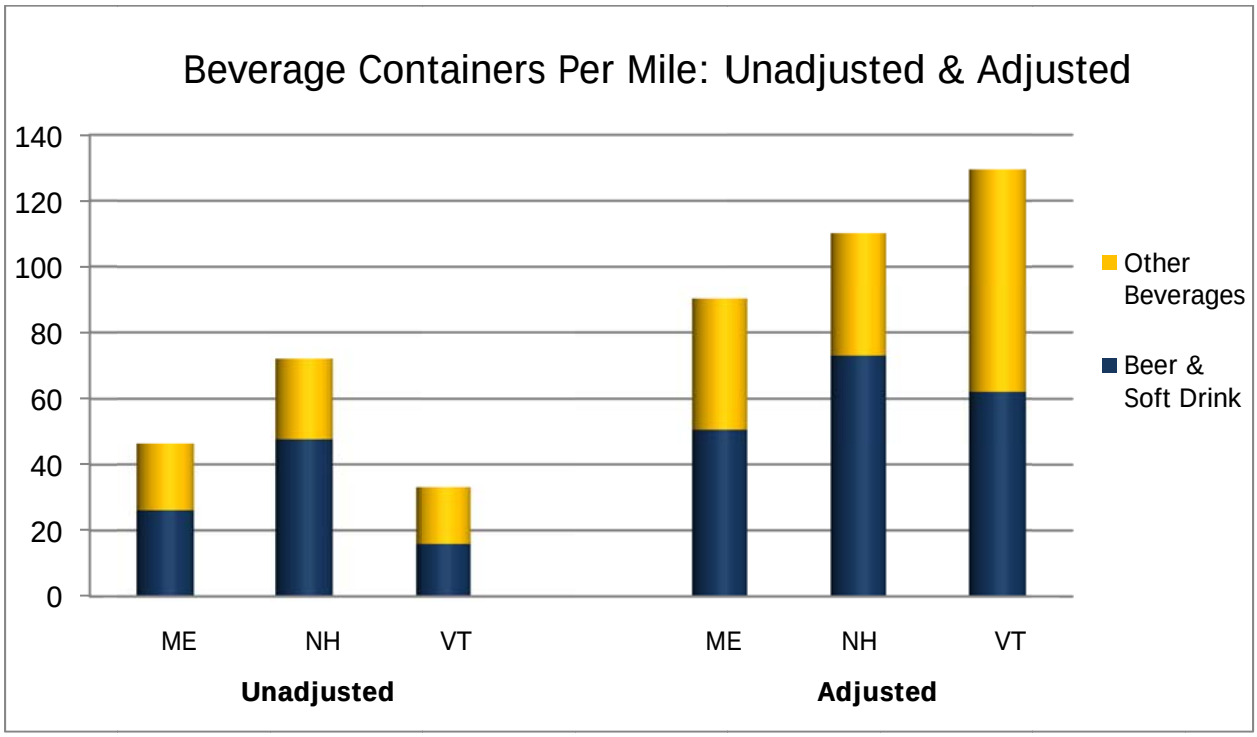

Figure 2 – Beverage Containers per Mile: Unadjusted & Adjusted

Beer and carbonated soft drink containers comprised 53 percent of the beverage containers found in Maine, 63 percent of the beverage containers found in New Hampshire and 47 percent of those found in Vermont.

On an unadjusted basis, 33 beverage containers were littered per mile on Vermont roadways compared to an average of 47 in Maine and 72 in New Hampshire. Applying the adjustment factors described earlier to this data, yielded 130 beverage containers per mile in Vermont, 90 in Maine and 110 in New Hampshire.

Table 4 – Beverage Containers per Mile

	Unadjusted Data			Adjusted Data		
	Beer & Soft Drinks	Other Beverages	All Beverages	Beer & Soft Drinks	Other Beverages	All Beverages
Maine	26	20	47	51	40	90
New Hampshire	48	24	72	73	37	110
Vermont	16	17	33	62	67	130

The percentage of beverage containers found in litter was similar for each of the three states. This comparison excluded related materials such as bottle caps and carriers. The range for these three states (between 5.6 percent and 7.9 percent) was comparable to similar surveys conducted more recently, as shown in Table 5.

Table 5 – Beverage Container Litter in Recent Surveys

Survey	Year	Percent
Mississippi	2000	10.5%
North Carolina	2001	9.0%
New Jersey	2004	8.9%
New Hampshire	***2010***	***7.9%***
Kentucky	1998	6.8%
Columbia, MO	1996	6.4%
Vermont	***2010***	***6.4%***
Maine	***2010***	***5.6%***
Tennessee	2006	5.4%
Lawrence, KS	1996	5.0%
Pennsylvania	1999	4.7%
Georgia	2006	4.4%

Data from a waste composition study of roadside litter conducted in Vermont by the Association of Vermont Recyclers (AVR) in 2009 was provided to ER Planning for comparison of beverage container data. The AVR litter survey yielded 33 bags of roadside waste, which were collected from ten towns, representing five Waste Management Districts in Vermont. Samples were collected from the following road types in each region: Rural/Highway, Residential, City, and Interstate. The samples were sorted, weighed and counted to provide composition data.

An average bag contained eight beverage containers with returnable deposit for Vermont and between five and six beverage containers lacking returnable deposit for Vermont. The composition by weight showed that 19.9 percent of all items collected were beverage containers. Slightly more than half of these were covered by current deposit legislation, a significant amount in a state where beverage container legislation has been in place since 1973.

A total of the 267 beverage containers found were covered by current deposit legislation, while 183 were not.[1] Results from the AVR study correlated with data from this study, showing a higher percentage of beverage containers in litter than what was expected.

[1] "GUD Data.xls" provided by AVR.

The methodology utilized in ER Planning's 2010 litter survey measured litter from the edge of roadways to a depth of 15 feet. While litter rates along roadway edges were higher in New Hampshire, litter rates were more similar once field crews surveyed further inward away. It's possible that litter cleanups focusing on the edge of roadways and placing less emphasis on the area further inward could account for this.

Plastic Bags and Expanded Polystyrene Products in Litter

While conducting these three statewide litter surveys, field crews specifically characterized all plastic bags and expanded polystyrene foam products found at each of the 288 sites surveyed. Plastic bags included all types of bags and wraps (e.g., trash, groceries, merchandise, dry cleaning, shrink wrap, bulk product wraps, etc.) from retail, commercial and industrial sources. Expanded polystyrene foam included all types of packaging "peanuts" and blocks; beverage cups, clamshells and plates; ice chests and other food insulating products; as well as construction-related insulating sheets and pieces from retail, commercial and industrial sources.

As shown below in Table 6, plastic bags constituted between 2.4 percent and 3.8 percent of all roadside litter for an average of 3.1 percent. Expanded polystyrene foam items constituted between 1.3 percent and 2.7 percent for an average of 1.8 percent of all roadside litter.

Table 6 – Plastic Bags and Expanded Polystyrene Foam in Litter

Category	ME	NH	VT	Average
Plastic Bags & Wraps	2.4%	3.0%	3.8%	3.1%
Expanded Polystyrene Foam	1.3%	1.4%	2.7%	1.8%

Tobacco Litter

Cigarette butts were not included in the base litter study because they did not meet the size threshold of one square inch or larger. Tobacco-related litter quantified in this survey included cigarette packages and wrappers as well as matches, pouches, tins and lighters that met the size criteria. Table 7 shows that Vermont had the most tobacco-related litter of the three states surveyed in 2010. These percentages are similar to other states recently surveyed.

Table 7 – Tobacco-Related Litter [2]

State	Survey Year	Percent
Kentucky	1998	7.9%
Pennsylvania	1999	7.2%
Lawrence, KS	1996	5.4%
Columbia, MO	1996	4.9%
North Carolina	2001	4.8%
New Jersey	2004	4.0%
Vermont	***2010***	***3.9%***
Mississippi	2000	3.6%
Georgia	2006	2.9%
Maine	***2010***	***2.5%***
New Hampshire	***2010***	***2.3%***
Tennessee	2006	1.3%

Previous VLS surveys conducted in Georgia and Tennessee included sub-sorts at each site to better understand the impact of cigarette butts as a source of litter. These studies showed that cigarette butts were more than eight times the amount of all other litter items combined on roadway edges. This is due, in part, to the fact that cleanups do not normally pick up cigarette butts. Thus the count of cigarette butts represents an accumulation over time that does not tend to occur with larger items of litter.

While quantifying cigarette butts was not part of this litter study, field crews were asked to note the presence of cigarette butts at each site as an ambient condition. For all three states, the cigarette litter observed was greater than all other litter quantified in this survey.

Litter in Adopt-A-Highway Sites

Litter surveys using the VLS methodology normally compare litter surveyed in Adopt-A-Highway sites to litter surveyed in sites that had not been adopted. Comparisons can provide insights into the efficacy of Adopt-A-Highway programs, but that was not possible for this report, as only one Maine site and six New Hampshire sites in this survey were located in adopted areas. No roads surveyed in Vermont were labeled as adopted.

Adopt-A-Highway programs focus on litter cleanups more than educational efforts, although signage provides a simple form of anti-litter messaging. Cleaning up littered sites helps establish that littering is not acceptable as a community standard.

[2] Excludes cigarette butts.

Maine created an Adopt-A-Highway Program in 1999, although only nine of its municipalities have currently implemented this program[3]. Maine did not have additional information about this program. New Hampshire reported that, in 2010, its Sponsor-a-Highway program had 487 groups that collected 18,417 bags of litter along 1,447 miles of roadways, collected by volunteer groups and through private firms such as Adopt-A-Highway Litter Removal Service of America[4]. Vermont reports that it has no adopted roadway program in place[5].

Mowed and Non-Mowed Sites

The field survey team made detailed notes regarding a variety of ambient site conditions known to affect the presence of litter as well as littering rates. One of the most significant of these is whether the site sampled appeared to have been recently mowed. If litter in the site is shredded by the mower, then the apparent quantity of litter items can be exponentially increased. This variable indicates whether litter is collected before mowing. The amount of litter in a given area can be significantly reduced by collecting and removing accumulated litter before mowing.

Of the sites surveyed in Maine and Vermont, 40 sites in each state appeared to be recently mowed while 56 did not. In New Hampshire, 44 sites appeared to have been recently mowed. This provided an excellent opportunity to compare the effect of mowing on sites surveyed in all three states.

In this survey, the amount of litter in mowed areas was less than in areas that had not been recently mowed in New Hampshire (50 percent less) and in Maine (12 percent less) indicating that in many cases crews in these states are cleaning up before mowing, as shown in Table 8. In contrast, Vermont sites were 28 percent more littered in mowed areas, suggesting that crews are mowing without cleaning up litter first.

Table 8 – Effect of Mowing

State	Mowed	Not Mowed	Percent
Maine	712	812	–12%
New Hampshire	734	1,470	–50%
Vermont	727	570	28%
Average	**724**	**951**	**–24%**

Mowed sites were cleaner in New Hampshire indicating cleanup efforts by crews in nearly all settings except public facility frontages and other state roads (rural, non-interstate). The results in Maine and Vermont were more mixed as shown in Table 9.

[3] http://www.maine.gov/mdot/community-programs/aah-program.php
[4] Personal communication.
[5] Personal communication.

Mowed sites were cleaner on Rural Local Roads and Vacant Industrial and Unmaintained Frontages for all three states, while Public Road sites that had been recently mowed were more littered across the board.

Table 9 – Effects of Mowing by Locale and State

Maine

Locale	Mowed	Not	Difference
COM	474	469	1%
OSR	675	1,382	-51%
PUB	479	444	8%
RES	625	586	7%
RFT	1,632	523	212%
RLR	386	500	-23%
UFT	795	1,469	-46%
VIU	632	1,125	-44%
	712	812	-12%

New Hampshire

Locale	Mowed	Not	Difference
COM	404	873	-54%
OSR	716	677	6%
PUB	972	596	63%
RES	803	3,661	-78%
RFT	1,154	1,749	-34%
RLR	877	936	-6%
UFT	649	2,607	-75%
VIU	298	665	-55%
	734	1,470	-50%

Vermont

Locale	Mowed	Not	Difference
COM	1,053	677	55%
OSR	237	285	-17%
PUB	442	326	35%
RES	447	368	21%
RFT	1,241	778	60%
RLR	285	436	-35%
UFT	1,351	753	79%
VIU	762	935	-18%
	727	570	28%

All Three States

Locale	Mowed	Not	Difference
COM	643	673	-4%
OSR	543	781	-31%
PUB	631	456	38%
RES	625	1,538	-59%
RFT	1,342	1,016	32%
RLR	516	624	-17%
UFT	932	1,609	-42%
VIU	564	908	-38%
	724	951	-24%

Figure 3 shows litter rates broken down by locale type for each state. Assessing the litter rate by locale provides a more informative picture of how states differ. Maine had the highest litter rates on Other State Roads, Residential Roads and Vacant, Industrial and Unmaintained Frontages; New Hampshire had the highest rates for Public Frontages, Rural Local Roads and both Rural and Urban Highways, while Vermont had the highest litter rate on Commercial Roads.

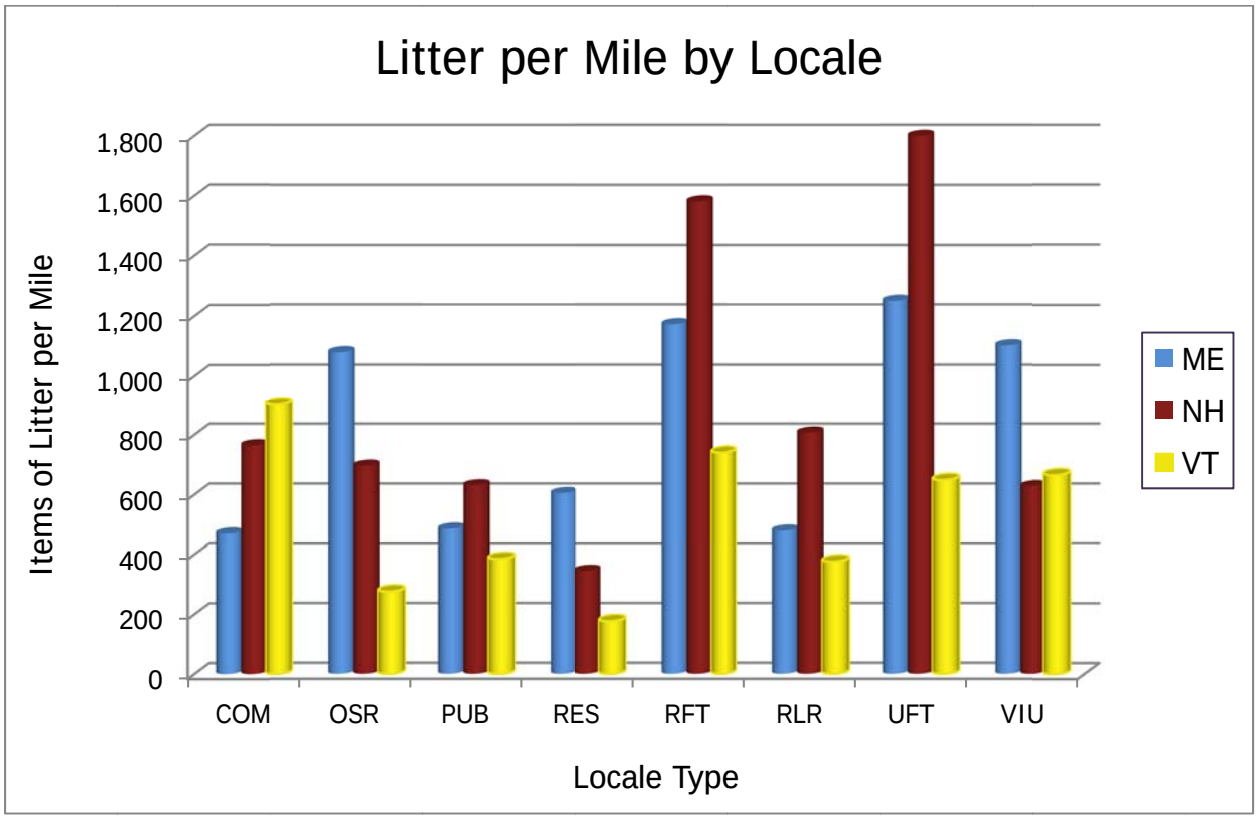

Figure 3 – Roadside Litter per Mile by Locale

Deliberate and Negligent Litter

One of the policy benefits of conducting litter surveys is that the composition of the litter suggests its likely source; that information helps determine which litter abatement approaches will have the most significant impact on litter rates. Each category of litter identified and quantified in this study was categorized as either deliberate litter (intentionally dropped, thrown, or abandoned) or negligent litter (litter that falls, blows, or is otherwise unintentionally caused). The term negligent litter is preferred over terms such as accidental litter or passive litter to reflect responsibility for littering that occurs regardless of the cause.

Snack wrappers, take-out food packaging and beverage-related litter have historically been linked to deliberate littering. Items such as newspapers, flyers, construction debris and miscellaneous scraps of paper or plastic have been categorized as negligent litter. Studies continue to show that such materials are more likely to originate from the back of a vehicle or from wind-blown materials.

Some of the most common sources of negligent litter are:

- Automobile accidents
- Construction and demolition activity
- Improperly secured recycling and garbage trucks
- Insufficiently maintained trash and litter receptacles
- Tire blowouts
- Untarped open-bed vehicles

Based on these definitions and the assignment of material categories to deliberate and negligent litter, as shown in Table 10, deliberate litter in all three states is slightly less than half of all roadside litter. Of the three states, Maine has the lowest percentage of deliberate litter (42.9 percent), with New Hampshire at 46.7 percent and Vermont at 45.9 percent.

Free newspapers (those mass-delivered to homes without subscription or request) and advertising fliers constitute a special category of negligent litter known as "instant litter." Such items, although a smaller portion of litter, can end up on roadways or in private areas, especially when winds pick up. After exposure to rain and sun, fliers in particular can become difficult to identify and yet remain for months before breaking down completely. These items can create unsightly conditions that encourage further littering.

Table 10 – Deliberate and Negligent Litter

Component – Deliberate	ME	NH	VT
Beer & Soft Drink Containers	3.1%	5.3%	3.1%
Other Beverage Containers	2.5%	2.7%	3.3%
Bottle Caps	1.7%	2.6%	2.4%
Pull Tabs	0.1%	0.2%	0.0%
Bev Carriers	0.1%	0.1%	0.0%
Cup, Lids, Straws	10.7%	8.5%	7.1%
Candy & Snack Wrappers	13.5%	14.6%	16.3%
Take-out Packaging	1.6%	2.8%	2.9%
Tobacco Products	2.6%	2.3%	3.9%
Napkins, Bags, Utensils	4.1%	3.4%	3.4%
Toiletries	2.9%	4.2%	3.4%
Total – Deliberate	**42.9%**	**46.7%**	**45.9%**

Component – Negligent	ME	NH	VT
Newspapers, Magazines	0.5%	1.9%	2.7%
Advertising Materials	0.8%	2.2%	1.8%
Home Food Packaging	0.2%	0.2%	1.4%
Vehicle-Related	4.6%	5.0%	3.8%
C&D	0.7%	1.4%	2.2%
Misc. Paper	25.1%	20.5%	19.0%
Misc. Plastics	20.5%	18.4%	18.5%
Misc. Metals	3.7%	2.5%	4.1%
Misc. Glass	0.9%	0.5%	0.7%
Other Negligent	0.2%	0.7%	0.0%
Total – Negligent	**57.1%**	**53.3%**	**54.1%**
Total – All Litter	**100%**	**100%**	**100%**

Recent VLS litter surveys have shown that negligent litter is becoming a larger percentage of litter over time, compared with deliberate litter. As shown in Figure 4, negligent litter is a larger portion of total litter in all three states compared to deliberate litter. The studies are shown in the order in which they were performed and indicate that negligent litter may need to be a larger focus for litter prevention.

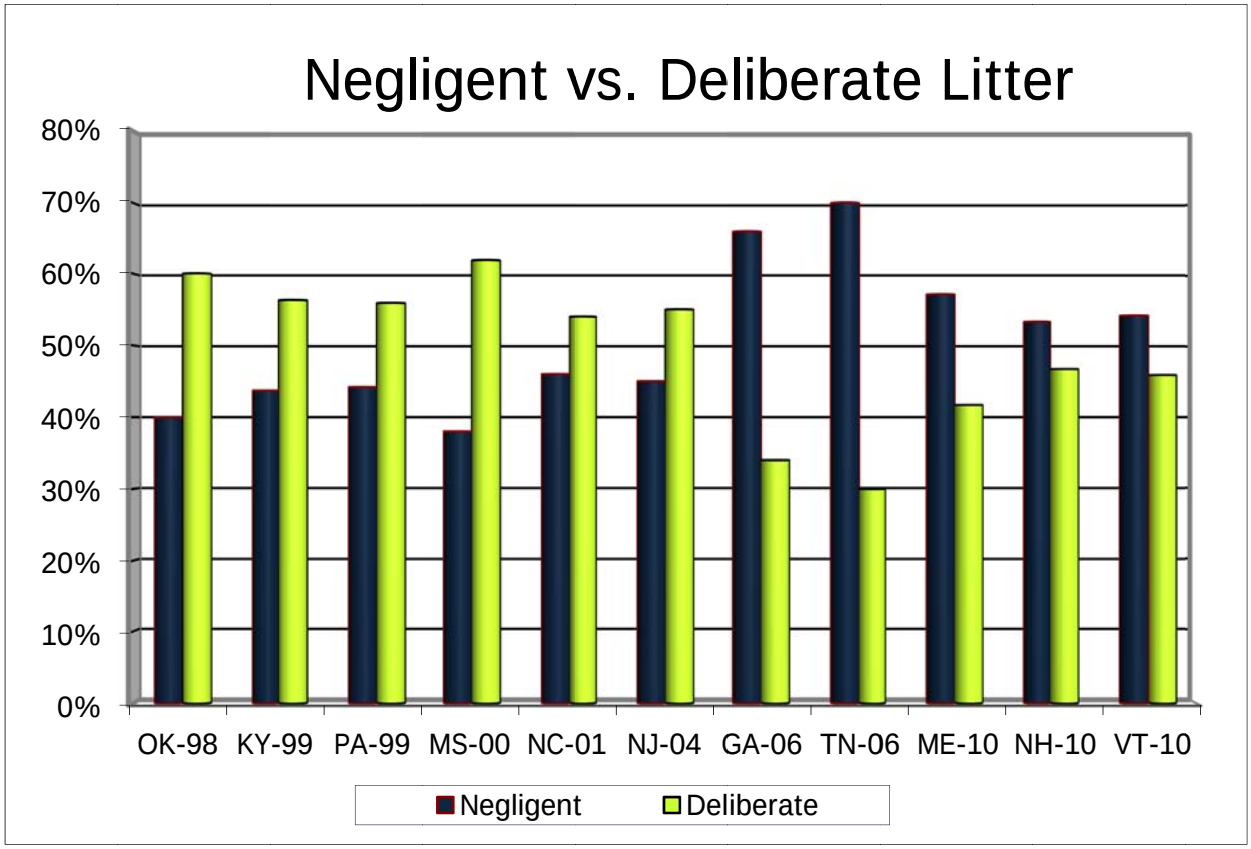

Figure 4 – Negligent and Deliberate Litter

This is not surprising given the growth in curbside recycling programs across the U.S. since 1988. In 2010, the US-EPA reported that approximately 9,000 curbside recycling programs were currently in place[6]. Recycling dumpsters have also become pervasive next to trash dumpsters in parking lots outside many retail establishments. These containers facilitate recovery of a significant amount of material that would otherwise be discarded. They also provide additional opportunities for unintentional littering, spillage of materials during the collection process.

Litter Profiles

In past litter surveys, people observed in the act of littering were found to be predominantly young males aged 18-24. This data matches the results of more than 70 similar litter surveys conducted over the past 30 years, which suggest that state and community programs should target this population group when designing programs to reduce litter.

Littered items found along roadways are categorized as either deliberate or negligent litter, based on an observation-correlation methodology established with data obtained from 53 litter surveys conducted in 20 states in the U.S. and in three Canadian provinces.

This observation-correlation methodology was developed based on analyzing the ages of litterers, the products they littered and whether the acts were deemed deliberate or negligent. The litter composition from 424 acts of littering observed in the U.S. and Canada correlated closely with the litter composition measured from over 250,000 items of littered counted at over 4,200 different sites in 40 surveys in the U.S. and Canada.

The correlation between the type of material that was observed being littered and the composition of litter measured was statistically significant. A more detailed discussion of this methodology can be found in Appendix B.

The littering profiles are generally similar across the three states. When litter is broken down into negligent and deliberate components, the profiles become more clearly defined. Negligent litter, items that fall, blow or are otherwise unintentionally caused, is more pervasive across the various age groups while more than half of all deliberate litter, items intentionally dropped, thrown or similarly discarded, on all roadways can be attributed to those ages 11-24 (see Figure 11). This provides a clear target for litter reduction by focusing on educational efforts in schools.

[6] http://www.epa.gov/wastes/nonhaz/municipal/pubs/msw2009rpt.pdf

Table 11 – Age group of Litterers by State

Maine		
Age	Delib.	Negl.
< 11	4.8%	4.6%
11–17	20.6%	5.5%
18–24	29.5%	15.4%
25–29	12.0%	11.2%
30–34	9.8%	16.4%
35–39	1.4%	16.8%
40–44	4.7%	11.3%
45–54	13.1%	13.1%
55+	4.1%	5.6%
Total	100.0%	100.0%

New Hampshire		
Age	Delib.	Negl.
< 11	7.4%	6.1%
11–17	22.4%	7.7%
18–24	28.9%	16.9%
25–29	10.8%	10.7%
30–34	9.4%	14.9%
35–39	1.8%	14.7%
40–44	4.1%	10.1%
45–54	11.9%	13.7%
55+	3.2%	5.1%
Total	100.0%	100.0%

Vermont		
Age	Delib.	Negl.
< 11	5.1%	4.0%
11–17	20.5%	6.0%
18–24	28.8%	16.2%
25–29	11.8%	11.0%
30–34	9.9%	16.8%
35–39	1.3%	15.8%
40–44	4.7%	11.4%
45–54	13.7%	13.2%
55+	4.2%	5.5%
Total	100.0%	100.0%

The litter product composition data for all three states was analyzed along with the age group distribution for the historical distribution of the same categories of litter. The totals for negligent and deliberate littering were calculated as a weighted average using the visible items per mile rate for each product. Figure 5 shows the target age groups likely to be the most persistent litterers in each of the three states. The predominant source of litter for all three states is young adults aged 18-24.

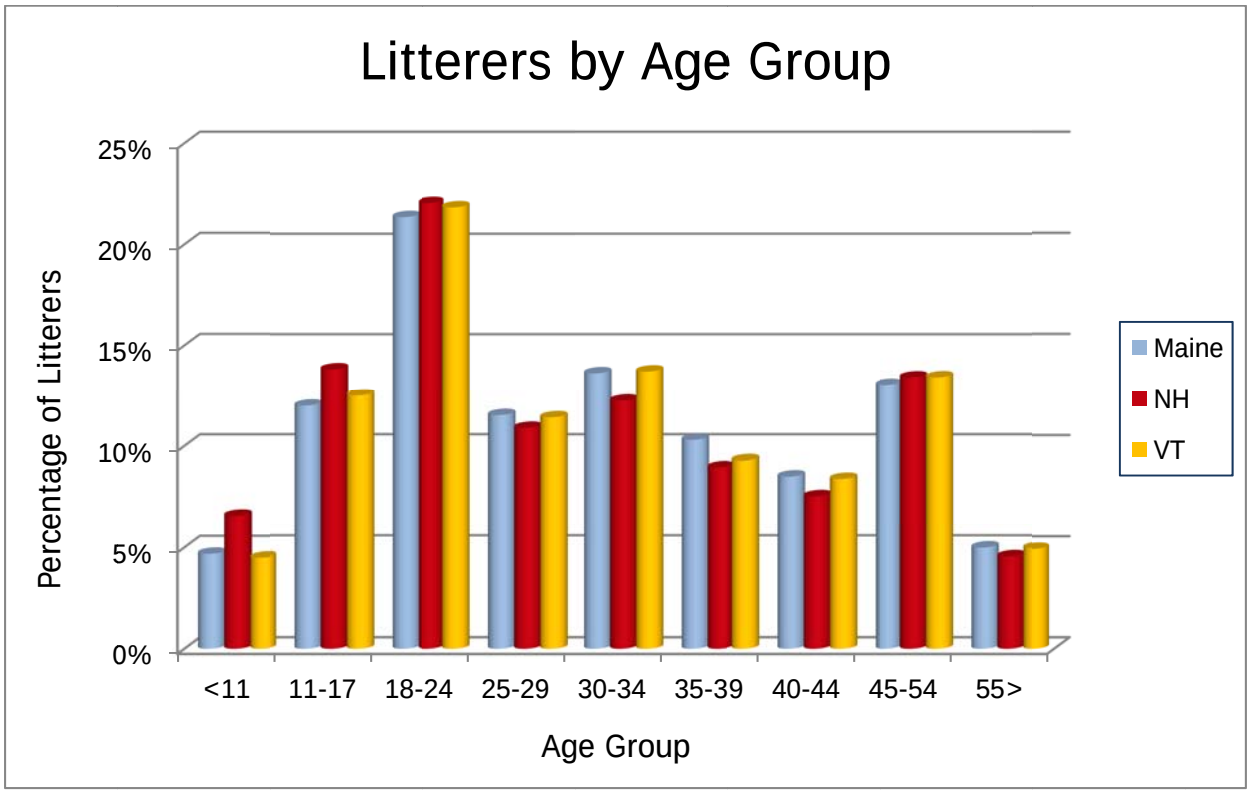

Figure 5 – Litterers by Age Group

Figure 6 shows the average age profile for litterers for all three states together. When litter is broken down into negligent and deliberate components, the profiles become more clearly defined. Negligent litter is pervasive across various age groups while more than half of all deliberate litter on all roadways can be attributed to those ages 11-24. This provides a clear target for litter reduction by focusing on educational efforts in schools. Table 10 shows that the littering profiles utilizing this composition were generally similar for each of the three states.

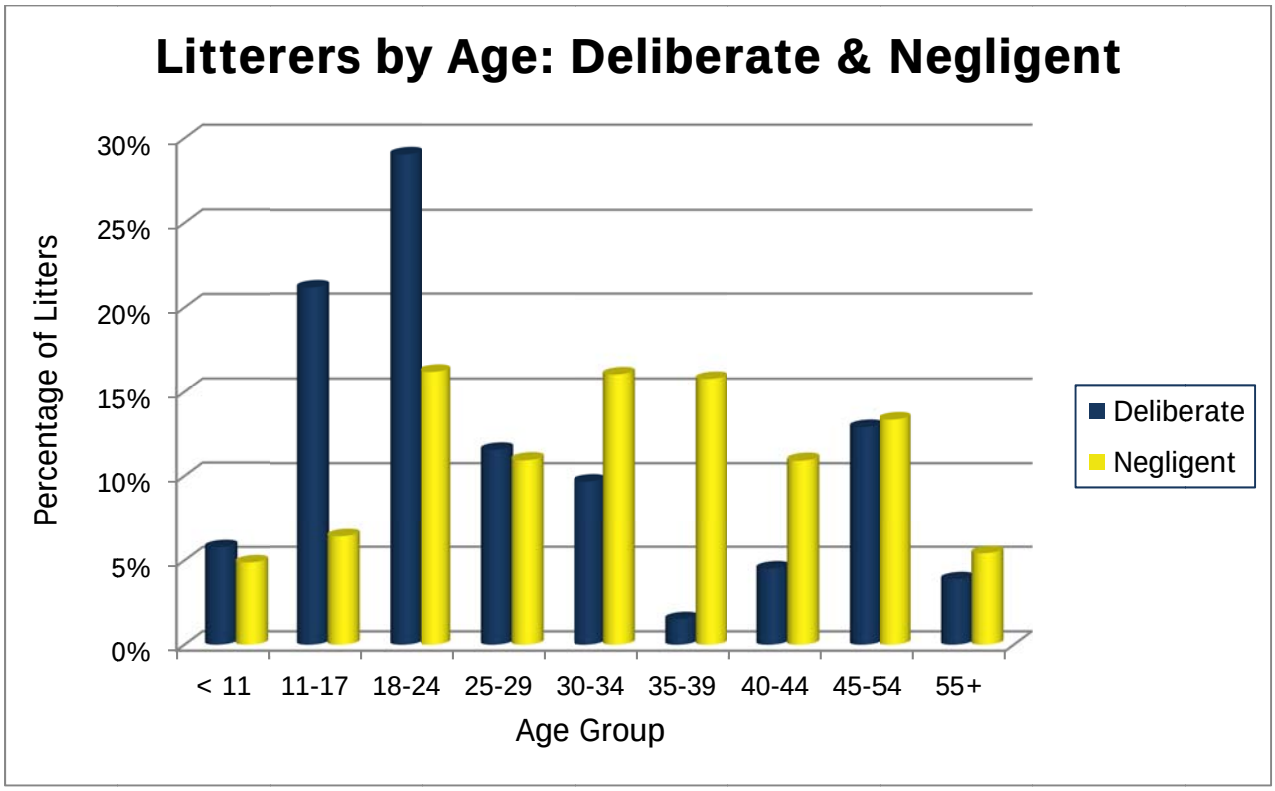

Figure 6 – Littering by Age Group: Deliberate & Negligent

Conclusions

- All three states had significantly lower litter rates than other state surveys in which ER Planning staff was involved: Georgia, Tennessee, New Jersey, and North Carolina.

- The composition of litter was generally similar in all three states. The top four categories of litter (paper scraps, plastic scraps, candy & snack wrappers, and fast food packaging) collectively accounted for 67%-76% of total litter in all three states.

- Miscellaneous scraps of paper and plastic constituted 37.5%-45.6% of litter in all three states. This is similar to results from surveys that our staff managed in Georgia and Tennessee.

- Vermont yielded a lower base litter rate than Maine or New Hampshire, due in part to Vermont's lower population and traffic level. Once litter rates were adjusted to reflect differences in variables such as population and traffic levels, Vermont yielded a higher per-capita litter rate than either Maine or New Hampshire.

- Negligent litter (items that fall, blow, or are otherwise unintentionally caused), continues to grow as a larger percentage of overall litter compared to deliberate litter (items intentionally dropped, thrown, or abandoned).

- Field crews surveyed 15 feet inward at each site. While less litter was found along roadway edges in Vermont and Maine than in New Hampshire, litter rates among the three states became more uniform as field crews surveyed further inward from the edges of the roads. This suggests that Vermont and Maine may clean up litter along roadway edges more than the deeper areas.

- The percentage of beverage containers in roadside litter was slightly higher in Vermont (6.4 percent) than in Maine (5.6 percent), but lower than in New Hampshire (8.0 percent).

- The percentage of beverage containers found in roadside litter in Vermont was similar to the findings of a study conducted by Association of Vermont Recyclers.

Recommendations

- The large percentage of paper and plastic scraps found along roadways in all three states suggests that a significant portion of litter may be related to insufficiently secured trash and recycling collection vehicles as well as open-bed vehicles that are not tarped or otherwise properly secured.

- Focused education campaigns and enforcement programs, supporting effective regulations, can substantially reduce this source of litter, particularly near strategic locations such as solid waste and recycling facilities. This, in turn, can save each state a substantial amount of money currently dedicated to cleaning up litter.

- Negligent and deliberate littering are attributable to different age profiles. Targeting educational efforts to reduce deliberate littering should focus on those aged 11-24, while efforts to reduce negligent littering should have a broader message of awareness that reaches all age groups.

- Discussions with organizations involved in litter abatement within each of these three states suggest that each state would benefit from improved coordination of litter awareness and abatement programs. This will produce more synergistic effects in reducing litter.

- Enforcement of effective regulations can help reduce litter, particularly along roadways to strategic locations such as solid waste and recycling facilities.

- Studying the relationship between the enforcement of litter laws and the prevalence of litter will help to establish the benefits of enforcement for each state since enforcement of laws in general tends to improve compliance.

- Follow-up litter surveys in states such as Connecticut, Massachusetts and New York can help provide a more comprehensive picture of littering issues in the Northeast and Mid-Atlantic regions.

Appendices

Appendix A – Project Manager: Selected Projects

- **President's National Infrastructure Advisory Council (NIAC)** – Contributor to a study advising the President on mobilizing community resources.
- **California Food Packaging Industry –** Project manager for litter survey of beaches in Santa Monica and Malibu; Subject Matter Expert for evaluating impacts of various materials on water quality. Lead author for subsequent report.
- **Keep America Beautiful (KAB)** – Project manager for KAB's 2009 National Litter Survey which determined the amount, types and recycling rates of various commodities found in roadside litter as well as the direct and indirect costs of litter to our communities and national economy.
- **KAB** – Project manager for the revision of KAB's Litter Index into its *Community Appearance Index*.
- **KAB** – Lead author of *Litter: Literature Review*.
- **Ocean Conservancy** – Survey Director for the Chincoteague Island Site in Ocean Conservancy's *National Marine Debris Monitoring Program* (Pro Bono).
- **Keep Tennessee Beautiful** – Project manager for Tennessee's statewide litter survey and lead author for subsequent report.
- **State of Georgia** – Project manager for Georgia's statewide litter survey and subsequent educational workshops and lead author for subsequent report.
- **State of New Jersey** – Project manager for New Jersey's statewide litter survey and subsequent educational workshops and lead author for subsequent report.
- **North Carolina** – Co–authored statewide litter survey report.

Educational Background

- **Ph.D. Coursework –** *Environmental Science*, SUNY College of Environmental Science and Forestry (SUNY ESF). Courses at the doctoral level focused on studying the dynamics underlying littering.
- **M. Sci.** – *Natural Resource Policy and Management* (Focus of Studies: Macroeconomics of Asian-U.S. recycling industry and sustainable policy initiatives), Syracuse University and SUNY ESF. Master's thesis examined the implications of public policy intervention in creating sustainable recycling markets.
- **B. Sci. (Cum Laude)** – *Environmental Studies* (Concentrations: Waste Management and Environmental Law), Syracuse University and SUNY ESF. Teaching assistant for Dr. Allen Lewis's *Introduction to Environmental Studies* course. Internship with the New York State Department of Environmental Conservation.

Appendix B – Methodology

Survey Objective

The objective of the Visible Litter Survey (VLS) methodology is to measure the rate and composition of visible litter along a state's urban and rural streets and highways so that the source and extent of litter in each state may be calculated and compared with the rates in other states using the same methodology. This survey will provide data suggesting the most effective types of program for reducing litter. It will also provide a baseline against which subsequent surveys may be compared to assess the effectiveness of litter control efforts in each state.

Sampling Sites

Sites to be sampled were allocated in proportion based both on the population distribution within the counties of each state and in proportion to the Annual Vehicle Miles in Millions (AMVM) of traffic on all highways and street locales within each state. Those locales with less than 10 percent of a state's AMVM were allocated 10 sites each to minimize any potential sampling error. For stratification purposes, this methodology combines two or more adjacent counties with a population of 50,000 or more into a single multi-county cluster.

All roadways were broken down into seven possible categories for surveying purposes:

Roadway Type	Acronym	Description
Rural Freeways and Toll Roads	RFT	Interstate highways, toll roads and limited access highways outside of urban areas.
Other State Rural Highways	OSR	U.S. and state highways outside of urban areas without limited access.
Rural Local Roads	RLR	Public roads outside of an urban area that are locally maintained (e.g. city, county).
Urban Freeways and Toll Roads	UFT	Interstate Highways, toll roads and limited access highways within an urban area.
Vacant, Industrial, Un-maintained Frontages	VIU	Urban streets in front of vacant lots, industrial sites or unmaintained buildings.
Commercial Frontages	COM	Urban streets in front of businesses such as convenience stores, restaurants and stores.
Public Facility Frontages	PUB	Urban streets in front of a public use building such as a courthouse, park, school or library.
Residential Frontages	RES	Urban streets in front of neighborhood homes.

The distribution of sample sites using AMVM was used because it historically approximates the frequency of encountering litter. The encounter frequency has been found to be a function of the litter rate, the number of road miles and the daily traffic volume in each locale. This distribution, along with the allocation proportionate to county population size assures that the final survey results reflect the statewide average litter rate.

Distribution of Sites within Counties

The distribution of sites selected for each county or multi-county cluster was allocated to the eight basic locale categories utilizing a stratified random generation matrix. If two or more sites were allocated to a given county, they were split among the locale categories so that the county was assigned both rural and urban sites. Because smaller counties do not usually have cities with UFTs, such sites are usually assigned to the large counties or multi-counties. Conversely, some counties are so urbanized that they have few areas where RFT, OSR or RLR sites can be found. Thus it was necessary to allocate a higher proportion of RFT, OSR and RLR sites to smaller county groups and a larger proportion of urban street and UFT sites to larger county groups.

Urban sites were located in cities, census designated places (CDP) and other municipalities (such as towns) with populations greater than 1,500. The appropriate data for each city, town and CDP was obtained from the 2000 U.S. Census. Google Maps, DeLorme Street Atlas software and DeLorme Street Atlas and Gazetteers were used to determine specific site locations and to print out maps of the selected sites and surrounding areas as needed. The residential sites were chosen through random selection of minor street segments.

Potential commercial areas were selected using Google Maps data, as were public sites such as schools, churches, civic centers, hospitals and libraries. While mapping software programs showed the locations of areas such as parks, potential VIU sites (railroad frontage, vacant, industrial and other un-maintained areas) usually cannot be located on maps before the survey takes place. The target counties and municipalities for VIU sites were thus made prior to the beginning of the field survey, with specific locations selected on an as-encountered basis.

Selection of Freeway, Toll Roads and Rural Roadside Sites

The RFT, OSR, RLR and UFT sites within counties were also selected using a stratified random matrix.

Prior surveys have shown that litter composition within a state does not usually vary significantly by region and that if traffic volume, county population size and distance to the nearest city were taken into account, litter rates for any given locale do not vary significantly within the state.

Hence the selection procedure followed was to randomly select the counties for sampling and then conduct sampling in randomly located urban areas within each selected county. Rural freeway and roadway sites were then randomly selected from a list of potential roadways that met the criteria for each locale type.

In establishing the specific surveying area for each sampling site, a random point on the highway or road was selected based on a cross-street or similar identifiable marker. For each site, the field crew identified the location of the fixed reference point (mile post marker, sign, bridge abutment, OSR intersection, etc.) and began the site survey at a random determined point past the fixed reference point, in tenths of a mile.

Field Survey Data Acquisition

Field logs were used to record the primary field survey data acquired in the field. As each site was visited, data regarding its type and location, length and site boundaries, traffic counts and litter counts were recorded. A detailed classification of visible litter was recorded on a separate form.

Site Identification and Location

Each site was located where it was safe and legal to conduct sampling and where there was sufficient space to pull the vehicle completely off the roadway. Locations in certain road construction zones, on blind curves adjacent to steep embankments, on bridges or on highway entrances and exits were avoided for safety reasons, as were median strips. Since medians are not safe zones to survey litter, this methodology employs a statistical estimate of median litter based, in part, on the litter observed on the site and utilizing an empirically derived adjustment factor dependent on median width.

Determination of Site Length

Determining the site length was conducted using a measuring wheel to count the length in feet. A set of multiple tally counters were used to measure pedestrian and vehicle traffic levels, vehicle types, the number of passengers per vehicle along with the type and quantity of visible litter observed. This count began with the observer tallying the visible data at the beginning of each site and continuing along 500 feet of roadway. The site length, in feet, was recorded along with a description of starting and ending points. Field crews recorded each site's street or highway and the side of the roadway where the count was taken was also recorded. Short frontages (less than 500 feet) were avoided, to maintain statistical credibility.

Performing the Litter Count

The field crew conducting the count walked at a steady pace along the side of the road or street and counted all visible items of litter observable beginning with the edge of the street and ending on a width of 15 feet into the public right of way.

The crews were instructed to walk more slowly where heavy concentrations of litter were found and where parked cars, shrubbery or ground cover impeded visibility.

Items to Be Counted

Litter is defined as misplaced solid waste. It includes both manufactured items and non-manufactured items such as tree trimmings and lawn clippings that have been specifically discarded onto a specific site not designated to receive solid or green waste. It excludes naturally occurring materials such as wind-blown leaves, branches and animal droppings and includes illegally dumped items such as furniture, appliances and construction debris. Accidentally dropped items such as money, jewelry and tools are also counted as litter, although they are not normally considered to be intentionally abandoned. On the other hand, children's toys on a front lawn and workers' tools near a construction site or automobile repair location are not usually counted as litter, but rather as outside storage, which constitutes a different dynamic.

An analysis of litter studies and the methodologies employed indicates that reliable and reproducible litter counts can best be made if items smaller than a bottle cap (about a 1-inch diameter) are excluded. Thus cigarette butts, small fireworks and small scraps of paper and plastic are not counted. Counting all broken fragments from a single brittle glass or ceramic container as one single item has been found to greatly increase the accuracy and repeatability of litter trend measurement. Establishing such a minimum cut-off size does not inhibit the ability to track reductions in cigarette or container litter, since experience has shown that the reduction of cigarette packages as well as whole bottles or cans is usually accompanied by a similar reduction in cigarette butts and container fragments.

Likewise, the percentage of items attributable to cigarettes in the form of butts is usually not affected significantly by this size restriction, since reducing the minimum size to include cigarette butts will also necessitate including a very large number of very small paper and plastic scraps, particularly in urban areas or where roadside mowing has occurred. An additional tally was also made of beverage containers along with the count of other items during the first pass walking at the edge of each site.

Litter Composition Tally

After the first pass has been completed and the visible litter counts recorded, a second pass of the site was made returning to the starting point. On this pass a, classification count was made meandering across a width of 15 feet at a slower pace. The objective of this pass was to record the litter composition precisely. Once an item was encountered it was classified and counted as one of the following categories:

Convenience Products

- Beer and Soft Drink Containers
- Juice, Wine, Liquor
- Sports Drinks
- New Age Beverages
- Bottled Water
- Aseptic Containers
- Other Beverage Containers
- Bottle Caps, Crowns, Seals
- Pull Tabs
- Beverage Carriers, Six-Ring Binders, Cartons
- Cups, Lids, Straws, Straw Wrappers
- Candy, Gum, Snacks, Nuts, Chips, Ice Cream and Cookies Wrappers
- Other Take-out Food Packaging (Bags, Boxes, Holders, Condiment Packaging)
- Napkins, Tissue, Bags, Picnic Supplies, Utensils, Ice Bags
- Cigarette Packages, Matchbooks, Tobacco Pouches, Lighters
- Toiletries, Sundries, Drugs, Clothing, Recreational Equip, Toys, Games, Lottery Tickets

Other Products/Packaging

- Newspapers, Magazines, Books
- Advertising Leaflets, Signs, Cards
- Home Food Packaging, Food Remnants, Bones, Milk Containers (more than 1 pint)
- Vehicle Parts, Supplies, Debris
- Construction & Demolition Debris, Wood, Cable, Rope, Cord
- Other Misc. Paper, Cardboard, Cartons
- Other Misc. Plastic
- Other Misc. Metal, Foil, Appliances
- Other Misc. Glass, Ceramic
- Yard Trimmings, Other Wood, Furniture
- Other (e.g., carpeting, burlap bags, unidentifiable)

Items found that were unidentifiable as to product source, or were products or packaging not otherwise listed, were classified by their predominant material as other miscellaneous paper, plastic, metal glass & ceramic.

Observation – Correlation

The division into deliberate and negligent litter is based upon an observation-correlation methodology established with data obtained from 53 litter surveys conducted in 20 states in the U.S. and in three Canadian provinces.

Observations of the ages of litterers, the products they littered and whether the acts were deliberate or negligent have been useful in improving the effectiveness of anti-litter advertising programs. This information has been used in conjunction with litter survey composition data to develop messages aimed at the age groups most likely to litter. Because of the geographical diversity of the surveys and the long time interval, it is important to assess the general applicability of this prior survey data.

The first test of the validity of using acts of littering sightings was to see how well the composition of objects from the acts witnessed correlated with the composition of litter actually found at survey sample sites. The litter composition from the 424 acts of littering observed in the U.S. and Canada correlated closely with the litter composition measured from over 250,000 items of littered counted at over 4,200 different sites in 40 surveys in the U.S. and Canada. The close correspondence between the type of material that was witnessed being littered and the composition of littered measured at the sample sites were also statistically significant.

The average difference between witnessed and measured litter for any product/packaging component was only 1.5 percent. A calculation was then made of the percentage of littering performed by males. This percentage ranged from 68 percent to 84 percent for the five groups, with an overall average of 78 percent. A statistical analysis revealed that none of the five regional groups' averages differed significantly from the overall average at the 90 percent confidence level.

It was also possible to show that, for the most part, region-to-region differences in the ages of people observed littering was not statistically significant. The percent of littering witnessed that is committed by people age 15 to 34 is fairly consistent from one region of the country to another. The approximate 90 percent confidence interval for the difference between the average for all regions and the percentage for any region suggests if the percentage values for the different regions fall within a statistically significant range.

In considering the applicability of data from litter sightings, it was also important to assess whether littering behavior has changed over the past three decades that these observations had been made. It would be essential to know, for example, whether there has been a significant change in litter composition during the time that acts of littering have been observed.

In the 24 surveys performed between 1974 and 1988, fresh litter composition was obtained by revisiting sites that had first been cleaned of accumulated litter. Since 1988 an improved survey methodology was used that measured the rate and composition of visible accumulated litter.

By using factors developed in five pairs of surveys where both fresh and accumulated litter were measured, it proved possible to convert the percentage composition from one type of survey to another by quantifying, for each product component, the combined effects of the degradation rate and the ability to detect litter. Thus it was possible to compare the average composition measured during surveys between 1974 and 1988 with those measured between 1988 and 2010.

The average difference in composition between the two systems of measurement for all products was only 0.7 percent. Considering the difficulties in classifying and counting more than 270,000 items of litter from 4,700 locations over a 35 year period, this was an extremely small number. Furthermore, most of the differences between the two estimates that were at least 1 percent or greater have simple explanations:

- Beer and soft drink container litter has been reduced by increased access to recycling, both curbside and commercial, particularly since 1990.
- Pull-tabs were banned in 1986.
- Take-out food sales have continued to increase steadily since the 1960s.
- Vehicle debris from blown tires has increased significantly since trucking deregulation in the 1980's relaxed controls on tire construction and maintenance.

This does not imply, however, that there have not been any changes in the rate of littering. Preliminary results from 62 surveys since 1974 show that, after accounting for changes in traffic volume, county population, weather, and litter control activities, there has been an average per capita reduction in the overall litter rate of 1.7 percent per year.

Traffic Count

While one field crew member counted and classified litter, a second member counted the number and characteristics of vehicles moving through the site. Pedestrians passing by, standing, working, playing, crossing the street or getting out of cars in proximity to the sampling site were also counted. To perform this count, the field crew measuring traffic first found a point from which most of the site was visible.

After noting the count start time, the person counting then recorded the vehicles in four categories:

1. Single-occupant closed vehicles
2. Two-occupant closed vehicles
3. Three or more-occupant, closed vehicles including buses.
4. Open-bed vehicles such as pick-up trucks, open-bed trailers or uncovered boats.

At sites with medians, or on any site where traffic was too heavy to count both directions at once, one side was counted and so noted on the field form. Bicyclists were counted as pedestrians, while motorcycles were classified as vehicles. The count continued as long as the team was surveying litter at the site. Longer counts tend to increase the accuracy of the traffic volume estimated from these counts, since the time when the count was finished was also recorded.

Additional Field Data

While at the site, the crews recorded other data regarding representation of the litter in that locale was recorded, including:

- Date and day the site was surveyed
- Beginning and ending time of the site survey
- Weather conditions
- Median width (if any)
- Evidence of recent mowing
- Designation as an adopted or sponsored highway/road
- Ambient Conditions
    - Construction activity
    - Vehicle breakdowns
    - Traffic slowdowns
    - Other ambient conditions that may affect the traffic or littering at the site

Factors

This methodology makes use of a number of statistically relevant factors known to affect the incidence of litter in a given area. Along with a rainfall and temperature index, population, vehicle types and occupancy, proximity to a populated area, seasonal trend, time of day, day of the week, and median income data also made use of constants and coefficients, developed over time, to process the data.

The data recorded calculated the litter rate in visible items per mile, the vehicle and pedestrian traffic volumes and other site data such as the percent of vehicles that are open-bed, the occupants per vehicle, and the median household income, adjusted for changes from 1980 to 2000 changes. PVIM site litter rates are used to calculate weighted percent composition.

The multi-linear regression (MLR) analysis that derived the coefficients used to correct litter rate data for changes in traffic, weather, income and other factors, was based on 1980 census data. Between the 1980 and 2000 census there have been increases in income levels throughout the U.S. Adjusting for these changes precludes the need to repeat the entire MLR analysis.

Thus, the current 2000 MHI levels at each site area were adjusted for the average change that occurred between 1980 and 2000 in the cities and towns sampled. This allowed the use of base coefficients while preserving the same average MHI value of all the sites sampled. Most importantly, the adjustment modified an individual site's 1980 MHI up or down in proportion to the extent to which the sites' MHI changed between 1980 and 2000 relative to the average change.

With these adjustments, a site that in 2000 was now 20 percent above the average of sites sampled in the state, would have its 1980 MHI value corrected to a level 20 percent above the 1980 average of sites sampled in the state.

Data Analysis

Because incomes tend to increase more in the larger urban areas than in medium and smaller sized population centers, the analysis examines the sites in larger counties (with a population greater than 50,000) separately from those below that level. For sites in census tracts in the larger counties, the average MHI for both 1980 and 2000 was calculated and the ratio of the 1980 average to the 2000 average determined. Each of the 1990 tract MHI values was then multiplied by this ratio, deriving a 1980 MHI than has been adjusted for the 1980 to 2000 change. A similar procedure was followed for the cities selected in the smaller counties. This process allowed the influence of relative income levels on litter rates to be taken into account while incomes were generally increasing.

Data regarding daily temperature, rainfall amounts and the number of days with rainfall of at least one-half inch were obtained from weather stations located in the regions where litter sites were situated was analyzed. Depending on the locale type, data was obtained for the period prior to the current survey where research shows the bulk of the litter measured was actually deposited. This varied from 37 days for residential, public and commercial sites, to 81 days for vacant un-maintained and urban freeway sites to 116 days for rural freeways, state highways and county roads.

This temperature and rainfall data were combined to create an IRT index that research has shown correlates with litter rates. The percent of days with rainfall .05 inches and above during the buildup period, called RNAA, was also calculated.

This RNAA data was used along with other factors to correct traffic volumes measured at the time the litter was counted to the average level that occurred in the litter buildup period. The IRT value was also used as an independent factor to correct litter rates for differences in weather.

The average daily rainfall, the average daily maximum temperature and the number of prior days with more than .05 inches of rain were obtained and recorded for all weather stations.

For each of the three locale groups (RFT/OSR/RLR, UFT/VIU, and COM/PUB/RES), a different set of rainfall, temperature and number of rainy days was obtained for different periods prior to the sampling. Rural sites, for example, have periods 1-30 days prior, 31 to 60 days prior and 61 to 116 days prior.

The IRT index and percent rain days (RNAA) for each prior period were calculated using the following formulas, where ADR represents the average daily rainfall and AMT represents the average maximum temperature:

1. Lower than 54°: IRT = e^(–4.188+.0565)*(AMT)–.189*(ADR)
2. Between 54° and 75°: IRT = (–1.4813+.0331)*(AMT)–.189*(ADR)
3. Higher than 75°: IRT = (–.4221+.0596)*(AMT)–.460*(ADR)

The derivation of these formulas was based on a log normal curve that was fitted to the relationship between litter rate and temperature for temperatures below 54°, hence the exponential formula for temperatures below 54 degrees.

RNAA = (Prior Days With rainfall>=.05 inches)/ (Number of Days in Buildup Period)

Weighted Average Calculation

The weighted average of the buildup periods for IRT and RNAA using the appropriate weighting factors was then calculated.

Weather stations were selected in the same climatic region (similar temperatures and rainfall) and as close as feasible to the sites being sampled. The IRT coefficients developed in the MLR analysis incorporated the uncertainties involved in the relationships, between litter on the ground and weather parameters measured some distance away.

The composition percentage average for each product/packaging component was calculated by locale as a simple average of the percentages (Xi) and as a rate weighted percentage (Xr), where the percentages at each site were weighted by the raw litter rate for the site.

The total raw PVIM rate for each site was used to calculate the component litter rates for each site. The locale averages of these sites constitute the rate weighted average component litter rate expressed as PVIM. Dividing each of these component rates by the locale total rate PVIM yields the weighted average percent for the locale (Xr).

The two different locale average percent values represent two different ways of calculating component average percentages for locales.

The Xi, which is the simple average of individual site percent, is the easier to calculate, but can give distorted results where the total visible item count at a site is small. (A count of two different items at a site would yield 50 percent each for that site, and might overwhelm the smaller percent for those components at the other sites.)

The rate weighted average component percentages (Xr) are more difficult to calculate but give a locale average that is less likely to be distorted by small total visible item counts at any given site. Although the field sampling instructions recommend a minimum of 50 visible items at each site, it is not always possible to achieve this. Using the Xr percent calculation protects against those situations where small sample sizes are forced by sites with small frontage distances.

A third method of calculating locale averages is to total all items for a component from all the sites in a locale, and then divide this by all of the component items from all of the sites. This pooled average (Xp) is even easier to calculate than Xi, but gives distorted picture if say 70 percent of the total items counted at sites in a local stem from one site.

Because of its stability and reduced risk of distortion by unusually small or large counts at one site, the Xr rate weighted component percent is preferred and used in the analysis conducted for this study.

Constants and Coefficients

The values for constants that reflect state average conditions were derived from a combination of empirical data and results from the current survey. Certain statewide averages for IRT, INCA, KCOPOP, and MTC were derived for each state as well.

The values for constants reflecting U.S. average conditions were derived from an analysis run using total traffic and mileage data along with average data for IRT, INCA, KCOPOP, and MTC derived for each state. An approximate estimate of average U.S. LPY was derived using LPY and other data obtained from 47 surveys in 16 states.

Locale Weighting Factor Calculation

The locale weighting factors (LWF's) were calculated using mileage and annual millions of vehicle miles (AMVM) data. It also utilizes the occupants per vehicle data (OPV) input for each site along with state urban population data as well as historical vehicle and pedestrian speed data. Once mileage and AMVM data have been transferred, this model estimates the street miles, AMVM and AADT for VIU, COM, PUB and RES locales.

Once the urban population data from the most recent census has been entered, the model estimates urban AADP volumes using relational factor between pedestrian volume and the ratio of urban street miles to urban population. It also estimated the rural AADP volumes by multiplying the AADT vehicle volume by the average percent of rural vehicle traffic that was pedestrian traffic.

The average vehicle and pedestrian speeds from survey series along with mileage, occupants and vehicle or pedestrian volumes, were used to estimate the daily statewide vehicle and pedestrian exposure hours and the locale weighting factors. The locale weighting factors provide an approximate estimate of the percent of time spent by persons in a state in various locales as pedestrians or motorists.

Mileage, AMVM and AADT Data

Data for mileage and AMVM was assembled from Federal Highway Statistics data, and corrected for differences in databases to achieve estimates applicable to locale categories used in the litter survey. For example, the federal tables show mileage in terms of jurisdiction (state, county etc.) as well as function (arterial, collector etc.), while the AMVM data was only shown in terms of function. As a check, the worksheet also calculates the statewide AADT.

Mileage and AMVM data was obtained from the Federal Highway Administration's "Roadway Extent, Characteristics and Performance" data. The following tables were used:

- HM10 – Miles by Jurisdiction
- HM20 – Miles by Functional System
- HM 35 – Federal Aid Highway Miles by Traffic Lanes and Access Control
- VM2 – Functional System Travel by Annual Vehicle Miles
- VM3 – Federal Aid Highway Travel by Annual Vehicle Miles

Once the required values were input, additional output values were automatically calculated. The following estimates, based on historical survey data, were used in these calculations to estimate AMVM data for those roadway categories where the AMVM functional definition differed from the AMVM jurisdictional definition:

1. The AMVM for Non-Interstate Rural Freeways (Divided Highways, Full Access Control) was estimated by multiplying the National Highway Total System AADT by 1.5 and substituting in the formula: AMVM= Miles*AADT*365/1,000,000

2. The AMVM for Other Rural State Highway = 90% of Non-Interstate Total Arterial and Collector AMVM minus Federal Park, Forest, Reservoir AMVM

3. The AMVM for Rural County Road = Local Roads (County + State) AMVM minus 10% of Non-Interstate Total Arterial and Collector AMVM

4. The AMVM for Federal Park, Forest, Reservoir roadway = Miles of Federal Park, Forest, Reservoir Roadway * Local Roads (County + State) AADT*1,000,000/365

Calculation of COPOP and MTC

The average county population (COPOP) for each locale category was calculated based on the average COPOP and the total cities with 1,500 and higher population that are traversed by RFTs. Similarly, it uses the average COPOP for urban freeways derived from the input of total and urban population as well as the number of cities with 1,500 and higher population that are intersected by OSR highways.

Using a state highway map, make a county-by-county list of all the RFT routes in the state. The routes should include all the rural interstates, tollways and other fully controlled access routes. Groups of counties identified as "Multi Counties" during the survey planning process are treated as a single county. The MTC values represent the average distance from an urban area with a population of 1,500 or more to the sites sampled.

Calculation of Litter Composition Percent Summary

The weighted average litter component percent for each locale were calculated and then weighted by locale litter rates that have already been determined. This weighting by rates that have been corrected to different conditions is used when comparing the composition of one state with a baseline survey composition, with another state or with the U.S. average.

Similar calculations were performed to show how the composition of litter was affected by mowing. The separate component percentages or rates for urban and rural locales and are also calculated and the composition was consolidated by locales from 22 product categories to 11 for use in the targeting analysis.

The raw weighted average component percentages from each locale are used along with the PVIM litter rates at state average conditions calculated as well as the locale weighting factors for state conditions.

The survey average litter rates, corrected to state average conditions, are used to weight the locale average percentages (Xr). Dividing each component of PVIM rate by the total PVIM produces a set of weighted average percentages for state conditions. A similar process produces a breakdown into rural and urban locale percentages and the weighted average PVIM rate for each component.

Similar component percentages and rates were derived for the current survey composition at base survey conditions and for the current survey at U.S. average conditions. A comparison of the litter composition rate at U.S. Conditions with the U.S. average, as measured historically, was also determined.

In this comparison, the composition from 22 product groups was condensed into 11 product groups to simplify the discussion. A similar consolidation of product composition percentages into 10 categories was used in the targeting analysis.

A similar procedure was followed to determine how the composition of litter was affected by Adopt-A-Highway and KAB programs. Use was made of the subgroup rates and compositions that have been calculated. These results were used for interpreting the results and producing tables and graphs for the survey final report.

The results expressed in product component rates were also useful in expressing the difference between litter composition in a base line survey with that of a follow up survey or between the average rates measured for a given state and for the U.S. average measured in other surveys.

Correction of Current Survey Rates to Base Survey, State or U.S. Average Conditions

Ultimately, the underlying purpose of this analysis was to address three important questions:

- How do the current litter rates compare with those of prior surveys?
- What is the state average litter rate and which locales have the highest rates.
- How do the current litter rates compare with the rates measured in other states?

To determine these comparisons, the current litter rates were corrected to three sets of conditions (levels of traffic, income, weather and other factors) that represent the baseline prior survey, the state average and the U.S. average. These results were used to determine litter composition, targeting, evaluations of litter control programs or measures and margin of error.

Procedure

First, the LWFs, which weight the locale average rates and other factors in proportion to the estimated time that people spend in each of those locales, were entered for all eight locales.

Then, additional sets of weighting factors were calculated for parameters that apply to or reflect rural and urban locales along with the values for the BEDT, BEDP, INCA, IRT, COPOP, OPV, MTC and LPY constants. The coefficients used to correct the litter rates to base, state, or U.S. conditions were also calculated.

The litter rates were corrected to base survey, state and U.S. conditions. Additional analysis was performed to calculate the averages of the 4 urban and 4 rural locales. An impact analysis permits visualization of how much of the total correction between current and base conditions was attributable to each of the 8 variables.

Correction of Current Survey Rates to Base Survey, State or U.S. Average Conditions

To compare litter rates at adopted, KAB and mowed sites with other unaffected sites, the sites comprising the controlled and uncontrolled subgroups were first identified where the subgroup average litter rates and controlling parameters were calculated. This data for the subgroups were then translated into the appropriate data sets. The raw litter rates for both subgroups were then corrected to the same statewide average conditions so that the effect of the control on litter rates can be evaluated.

The number of sites for the locales included in the controlled category was entered. The weighting factors for these locales were then calculated. The weighting was calculated by sample size (*n*) of the control subgroups rather than by exposure. The statewide average values used for the BEDT, BEDP, INCA, IRT, COPOP, OPV, MTC and LPY were entered along with locale subgroup averages of raw data for the same parameters from the current survey. The same coefficients used to correct the litter rates were also used in this calculation.

This analysis calculates an average of the litter rates for the control sites corrected to state average conditions. This average was then compared against an equivalent mix of similarly corrected uncontrolled sites. This equivalent mix comparison is not valid where a larger number of sites were available in all locales in both controlled and uncontrolled subgroups. In such cases, such as comparing the sites in the northern part of a state with a similar number in the southern part, the exposure weighting average can be used.

Age Group Targeting

The litter composition data measured in the survey was combined with acts of littering data from prior studies to show the distribution of age groups associated with different kinds of litter. The resulting analysis makes it possible to identify the age groups that are causing the preponderance of deliberate and negligent litter in both urban and rural road locales.

The Observed acts of Littering by Age Group data were combined with the current survey composition data with this age distribution data from other surveys to produce a profile, by product group, of the ages of persons associated with the littering of that product.

This information shows, for 10 age groups, the percentage of both deliberate and negligent litter attributable to each age group for the two major locale groupings. The next step in making targeting recommendations was determining which type of litter (negligent or deliberate) in which locale grouping (urban vs. freeway/rural) was the most in need of litter reduction.

This was done by comparing the percent difference between the U.S. average litter rate (based on the average of data from prior states surveyed) and the current state litter rates. The percent differences should be calculated for both types of littering in both urban and freeway/rural locale categories.

Targeting Recommendations

- The procedure for selecting targets for anti-litter advertising involves the following steps:
- Determine the locales (urban vs. freeway/rural) and types of litter (deliberate vs. negligent) that are most in need of improvement and could benefit most from additional litter reduction effort.
- The degree of need for improvement can be determined by identifying the locales and litter types that have shown the least reduction in litter rate since the baseline survey.

The determination of which locales or litter type could most benefit from added reduction efforts can also be made by determining which locales or litter types have the highest litter rates relative to the U.S. average or the rates attained by the most advanced litter control programs.

Determining the age groups that litter reduction efforts using advertising should focus on is subject to several constraints. The primary one is to try to spend advertising dollars most efficiently. Because most radio and TV programs are designed to attract audiences of specific age groups rather than the population as a whole, it may be best to limit the range of the ages to be targeted to groups that contain at least 65 percent of the litterers without involving an age span in excess of 20 years.

It was for this reason that targeting the urban street litterers who typically peak between 6 and 24 years might deserve a higher priority than the 11 to 54 year age span needed to target the peak years of negligent litterers. An additional consideration is the question of the advertising message content itself. Generally, the smaller age group spans will be more homogeneous in terms of receptiveness to advertising messages and the ease in which such messages can be framed and pitched.

Experience has also been that most anti-litter advertising of necessity is limited by available funding and the desire to minimize commercial production costs in order to maximize air time. Accordingly it may be best to give litter program managers several options for directing litter control efforts. It is also well to remember that even programs that, say, target 18 to 35 year olds attract some viewers older and younger than the primary focus span. Thus the goal should be to select the age span that best defines the bulk of the litterers for a particular locale or litter type.

The accuracy of this targeting analysis in identifying littering is influenced by how applicable the observed acts of littering data derived from surveys in other states is to the littering behavior in the state being analyzed. A recent analysis indicates that the distribution of items observed being littered in 19 U.S. states and 3 Canadian provinces match the litter found on the ground during surveys. Equally important, the analysis of items being seen littered in the U.S. and Canada indicates that there were no statistically significant differences between regions.

Another concern is small number of samples associated with some products being seen littered. To alleviate this concern, the acts of littering data has been analyzed to weight the observations for specific product groupings in terms of sample size so that with smaller samples the negligent or deliberate subtotals are given more weight than the acts involving specific product groups. To this end, there is a need to encourage additional observations of actual littering behavior to decrease the reliance upon such weighting techniques.

This data can be used to identify target age groups for single locales, rather than the rural and urban groupings shown. Because of the greater accuracy inherent in the larger samples of rural and urban locales as opposed to single locales, less reliance can be placed on single locale results.

Appendix C – Glossary

Accumulated Litter
The buildup of items found along roadways that have been littered over an unknown period of time.

ADDT (Average Dry Day Vehicle Traffic)
ADT adjusted for rainfall during time vehicle count was made to reflect vehicle traffic on dry days.

ADP (Average Daily Pedestrian Traffic) Number of pedestrians per day, as measured, as measured from short term counts and expanded to 24 hour estimated volume.

ADDP (Average Dry Daily Pedestrian Traffic)
ADP adjusted for rainfall during time the pedestrian count was made to reflect pedestrian traffic on dry days.

ADR (Average Daily Rainfall)
The average precipitation in a given area as measured by the National Weather Service over a 24-hour period.

ADT (Average Daily Vehicle Traffic)
Number of vehicles per day, as measured from short-term counts and expanded to 24 hour estimated volume.

AMT (Average Maximum Temperature)
The average maximum temperature in a given area as measured by the National Weather Service over a 24-hour period.

BEDT (Before Daily Vehicle Traffic)
ADDT adjusted for a seasonal traffic factor (STF) and the percentage of days preceding the survey with total rainfall over 0.5 inch (RNAA). Adjusts observed counts for the historical month to month seasonal trends and actual percent of days of rainfall during time litter was building up.

BEDP (Before Daily Pedestrian Traffic)
The ADDP adjusted for a seasonal traffic factor (STF) and the percentage of days preceding the survey with total rainfall over 0.5 inch (RNAA). Adjusts observed counts for the historical month to month seasonal trends and actual percent of days of rainfall during time litter was building up.

CDP (Census Designated Places)
Defined by the U.S. Census as a densely settled concentration of population that is not incorporated but which resembles an incorporated place in that it can be identified with a name.

Comprehensive Litter Control Program
A litter control program that incorporates a variety of activities and measures aimed at reducing litter. Typically includes education, public awareness, neighborhood or roadway cleanup, promotion of anti-litter legislation and litter law enforcement, litter hot lines and beautification programs;

Contiguous Cities
A combination of urban areas (Cities, CDP's, Boroughs) greater than 1,500 population whose boundaries touch each other or are no more than 3 miles apart.

Convenience Products
Products intended primarily for immediate consumption and limited reuse, as opposed to more durable products with longer intended lives. This category includes snacks, beverages and take-out food (as opposed to home prepared food) as well as disposable lighters, CDs and disposable utensils.

Deliberate Litter
Material or products that are usually seen being thrown, dropped, discarded or left behind intentionally in inappropriate locations.

Exposure (see Locale Weighting Factor)

Fresh Litter
Items that have been freshly littered or deposited during a specified preceding period of time since a prior cleaning, usually a two week period (see accumulated litter).

IAF (income Adjustment Factor)
The factor for correcting census income data for state-to-state differences in the cost of living.

INC (Neighborhood Income)
The median household income for a city, CDP, borough or census tract.

INCA (Adjusted Neighborhood Income)
INC corrected for state-to-state differences in the cost of living.

IRT (Index of Rainfall and Temperature)
An empirically-derived factor reflecting the combined effects of rainfall and temperature on litter rates, calculated from data obtained from weather reporting stations and used for correcting litter rates for the effects of weather prior to the survey.

Kv, Kp (Vehicle and Pedestrian 24-hour Expansion Factors) Used to convert hourly vehicle and pedestrian traffic volumes to 24-hour volume estimates.

Kw, Kwp (Vehicle and Pedestrian Day-of-Week Correction Factors)
Used to adjust traffic volumes for the day of the week on which the sampling was done.

Krs, Krsp (Vehicle and Pedestrian Rainfall Correction Factors)
Used to adjust traffic volumes for effects of rainfall at the time the traffic count was performed.

Litter
Items negligently or intentionally discarded along roadways and in community areas.

Locale
A breakdown of all roadway and street frontages into types defined by specific characteristics (listed in detail in Appendix B – Methodology).

LWF (Locale Weighting Factor)
The proportionate amount of time people spends in a locale as motorists or pedestrians. It takes into account the amount and speed of traffic, occupancy rate of vehicles and the total length of road in a locale category. Derived from US-DOT data, current survey data, and derived factors from surveys in other states.

MHI (Median Household Income)
Total per-household income exceeded by half of the households in target tracts or cities. This data is used as a more stable and representative parameter than income averages, which tend to become skewed.

MTC (Miles to City)
Distance from rural sites to the nearest urban area with a population of 1,500 or over.

Negligent Litter
Material or products that are usually deposited unintentionally, such as vehicle debris from accidents or wear, material that falls from loaded vehicles and items that fly out of open bed vehicles. This includes items that spill from overloaded or tipped trashcans and items dropped or left behind unintentionally by persons.

OPV (Occupants per Vehicle)
Number of persons in a vehicle.

OBV (Open Bed Vehicles)
Fraction of total vehicles which have passenger or cargo compartments that are fully or partially uncovered, including towed trailers and uncovered boats.

Photodegradation
The process whereby materials decompose due to the effects of sunlight.

PVI (Pedestrian Visible Items)
Littered items within a survey site which are larger than 1 inch in area that are visible to a pedestrian walking along the side of a street or roadway.

PVIM (Pedestrian Visible Items per Mile)
PVI expressed as rate per mile.

RNAA (Rain Adjustment Average)
The percentage of days in the litter build-up period prior to survey sampling in which at least one-half inch of precipitation has occurred.

STF (Seasonal Trend Factor)
This data, derived from US-DOT, is used to adjust the measured ADDT traffic volume to the average level during the one to four month litter build-up period.

Visible Litter
Items of accumulated litter one square-inch or greater in size that can be detected by a person walking along the edge of a street or roadway at a normal gait (two-three mph).

Weighted Average
An average of values adjusted to reflect the relative contribution of the individual sources of the values. For example, a weighted average of the litter rates from all locales is calculated using the Locale Weighting Factors that reflect the relative amount of time people spend in each locale as motorists and pedestrians (See also LWF).

For further information, go to: *www.erplanning.com*

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