fore and after rumble strip installation at the locations where rumble strips were installed in 1978 or 1979. The average rate for the run-stop-sign type of accident is 3 percent higher following the installation of rumble strips.

In a comparison of 111 intersections with rumble strips installed before 1978 with 111 comparable intersections without rumble strips the control locations show lower accident rates. The difference is 21 percent in the case of total accidents and 14 percent in the case of run-stop-sign accidents. These differences are not statistically significant.

Because no safety benefit is apparent from the installation of rumble strips on secondary roads, analysis of these data failed to identify any variables that were significantly associated with a favorable effect on accident experience. Regression analyses were undertaken by using several different subsamples based on the type of location. None was successful in demonstrating that rumble strips could be expected to improve accident experience in association with any particular characteristics of an intersection. Cross-classification analyses and discriminant analyses were equally unsuccessful.

Further evaluation were carried out by using only the before-and-after sample. No accidents were recorded at 28 of the 85 locations during both periods, before and after the installation of rumble strips. Accident experience improved following installation of rumble strips at 27 of the other 57 locations, worsened at 26 locations, and was unchanged at 4 locations. Analyses of single-vehicle run-off-the-road accidents at T-intersections showed no differences between the before and after experience. The proportions of accidents that occur at night also exhibited no change following the installation of rumble strips.

CONCLUSIONS

The frequency of accidents at rural locations on secondary roads was independent of the presence or absence of rumble strips. No factors were identified that characterize locations where a reduction in accident frequency could be expected to result from the installation of rumble strips. Although secondary road intersections that have accident rates higher than 2.5 accidents/MEV always showed a reduction in accident rate following the installation of rumble strips, this reduction would be expected by chance given the low traffic volumes and infrequent occurrence of accidents at these locations.

Notice: The research reported here was carried out by the Engineering Research Institute, Iowa State University. It was sponsored by the Highway Division, Iowa Department of Transportation, through the Iowa Highway Research Board. The author, however, retains responsibility for the interpretations of factual input to the research and for its findings and conclusions, which are not necessarily those of the Highway Division of the Iowa Department of Transportation.

Sign Vandalism—Costly and Dangerous National Problem

HIMMAT S. CHADDA AND EVERETT C. CARTER

Sign vandalism has become a costly and often deadly national problem. In addition to the millions of dollars in cost to replace vandalized signs, this situation denies motorists the critical information necessary for safe driving and increases the potential for severe traffic accidents. Nationally, the replacement costs for vandalized signs are startling—about $50 million annually in direct costs and indirect costs for injuries and tort liability claims of about the same magnitude. The accident statistics on fatalities, property damages, and personal injuries that result from vandalized or missing signs are frightening and point out the magnitude of the problem. Some jurisdictions have become alarmed at the increasing rate of sign vandalism and its adverse economic, social, and safety impacts. The nature, magnitude, and criticality of the sign vandalism problem requires a strong concerted effort at both the national and local levels to combat this costly and dangerous traffic safety problem. A grass roots approach is suggested for a full understanding of who vandalizes signs, why they do so, when and where sign vandalism is more pronounced, and the true consequences of this prankishness. Positive and problem-specific countermeasures (physical, legal, judicial and enforcement, and educational) that should be pursued at the national, state, and local levels are discussed in this paper. A systems approach framework for selecting countermeasures for local and problem-specific sign vandalism was developed and partly tested. This approach should be fully implemented.

Sign vandalism has become a costly and often deadly national problem. In addition to the millions of dollars taxpayers spend to replace vandalized signs, vandalism denies the motorists the critical information necessary for safe driving and increases the potential for severe and often tragic traffic accidents. Nationally, the replacement costs for vandalized sign are startling. According to FHWA estimates, total annual direct costs to the states, counties, and cities are $50 million (1). Indirect costs for injuries and tort liability claims are estimated to be the same. Accident statistics on fatalities, property damages, and personal injuries from vandalized or missing signs (especially intersection-control signs and STOP signs in particular) are rather frightening and are indicative of the magnitude of the problem.

State and local jurisdictions and the federal government have become alarmed at the increasing rate of sign vandalism and its adverse impact on local agency budgets and the safety of highway users. The nature, magnitude, and criticality of the sign vandalism problem requires a strong concerted effort at both the national and local levels to combat this costly and dangerous traffic safety problem.

SCOPE OF SIGN VANDALISM PROBLEM

Vandalism as defined in the Webster's Dictionary means "willful or malicious destruction or defacement of public or private property." In the area of traffic engineering, vandalism has affected different types of traffic control devices. Traffic control devices and equipment that are routinely vandalized include signals (especially lenses for pedestrian indications and pedestrian push buttons), signs (all types of regulatory, warning, informational, and directional), traffic cones, delineators, traffic counters, reflectorized pavement markers and buttons, and occasionally pavement markings.

In the past few years sign vandalism has created

major hazards on national, state, and local highways, and in national parks, campgrounds, and forests. The problem becomes more acute each year. The escalating replacement and rehabilitation costs, the tort liability claims, and the ever-present danger to the motoring public are all of concern.

The impact of sign vandalism can be catastrophic. Missing or stolen signs, particularly STOP signs and other regulatory and warning signs at intersections, can result in needless and tragic traffic accidents. Precise statistics documenting accidents attributable to sign vandalism are not available; however, many fatal traffic accidents have been the direct result of sign vandalism. A recent survey of various states conducted by the National Safety Council (NSC) found that, in the seven states that kept records of sign vandal-related accidents, 14 fatalities were attributed to vandalism or theft of signs (2).

Costs associated with the replacement and rehabilitation of vandalized signs and the settlement of liability claims are startling. Thirty states reported in an NSC survey that costs ranged from $34,000 to $1.8 million, including inspection, material, labor, and liability settlements (2). The monetary costs alone are high, but the potential cost in lost human life is inexcusable.

The increasing costs of replacing vandalized highway traffic signs is becoming a serious concern. Approximately 10 percent of traffic signs must be replaced annually because vandals either stole, defaced, or mutilated them. Replacement costs hit all taxpayers in their pocketbooks.

Sign vandalizm is not limited to one geographic area or one political jurisdiction; it is universal. Sign vandalism is also widespread on forest service roads and campgrounds. According to a survey conducted by the U.S. Department of Agriculture Forest Service, Missoula, Montana, various districts of the Forest Service spent roughly $500,000 to replace vandalized signs in FY 1978; Overall, six percent of the total Forest Service sign inventory was vandalized in 1978, which amounted to about $3.25 million in damages (3).

A grass roots approach is necessary for a full understanding of who vandalizes signs, why they do, when and where sign vandalism is more pronounced, and what are the true consequences. Further, positive countermeasures--physical, legal, judicial and enforcement, and educational--should be pursued at the national, state, and local levels to combat sign vandalism.

ISSUES AND ASPECTS OF SIGN VANDALISM PROBLEM

Three major types of sign vandalism exist.

Destruction

Destruction includes traffic signs destroyed or damaged by bullets. Damage to signs may also be caused intentionally by flying objects (e.g., bottles, rocks, bricks, eggs, or tomatoes) thrown by vandals from moving vehicles. Damage to traffic signs can also be caused by physical force (e.g., the willful bending or twisting of the sign face, street name sign blades, or sign support; hitting with a hammer; cutting with a hacksaw; and other similar actions).

The most predominant destruction of traffic signs is by rifle shots, pistol fire, and shotgun blasts. This type of sign vandalism is common in the rural areas of many states. Sign damage caused by splattering of eggs, tomatoes, and the like on the sign face generally ruins the reflectivity of the sheeting and makes the sign unreadable and ineffective, particularly at night.

Figures 1-3 show various types of traffic signs vandalized by rifle, shotgun, and pistol shots. Figure 4a shows a street name sign twisted by vandals in Clark County, Washington, that consequently contributed to a fatal automobile accident. Figure 4b shows the solution used in this instance.

Mutilation

Sign mutilation occurs when the face of the sign or the sign support is altered in some manner. Sign mutilation is often accomplished by vandals using spray paint, posting political or similar unofficial sticker items on the sign face, altering the traffic sign messages (e.g., changing a speed limit from 25 mph to 85 or 125 mph), peeling off reflectorized sheeting from the sign face, and destroying the reflectors (used on sign messages or on borders) for improved night visibility. Spray paint appears to be the predominant means of mutilating sign faces, but signs are also defaced by paint and brush.

Figures 5-9 show examples of mutilated traffic signs. Such defaced regulatory signs can and often have resulted in serious automobile accidents.

Theft

Many students consider the removal of traffic signs from their support or the stealing of signs a harmless prank. In addition to stealing the sign faces, vandals sometimes remove or steal other parts of the sign structure such as the channels, pipes, street name sign blades, and other hardware. Traffic signs stolen from streets and intersections can be found in the dormitories, sororities, and fraternity houses of many American campuses.

Theft of regulatory signs, particularly STOP signs, often results in dangerous consequences. The potential for a serious or fatal accident is high, especially for motorists who are not familiar with the traffic control at a particular intersection.

Characteristics of Sign Vandals

People vandalize signs for various reasons, including the following:

1. Simply for sake of fun;
2. Defiance of authority;
3. Wall decorations, souvenirs, or trophies;
4. Scrap value of metal (mostly aluminum);
5. Gag or malicious behavior; and
6. Graffiti.

Sign vandals are almost always young people.

Disposition of Vandalized Signs

Stolen signs end up at various places. Most common among these are university dormitories, fraternities or sororities, bedrooms and basements, junk shops, ravines, creeks, and alleyways.

Types of Signs Commonly Vandalized

The STOP sign (R1-1) is probably the most often vandalized sign (i.e., either stolen, mutilated, or victimized with graffiti). Street name signs are a close second on the vandals' target list. Other signs commonly vandalized include various regulatory signs, warning signs, guide signs, and street name signs.

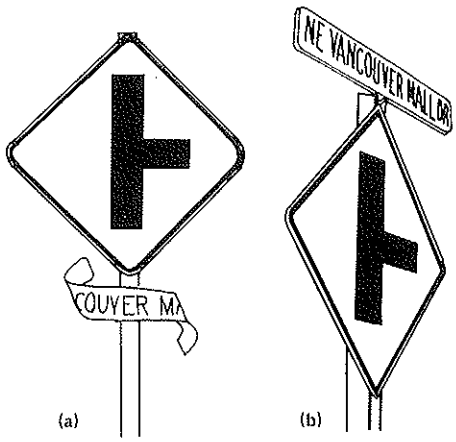
Street name signs are popular targets with certain groups of vandals. The street name signs that

Figure 1. Bullet-ridden STOP sign in Florida.

Figure 2. Curve warning sign damaged by rifle shots.

Figure 3. One-lane bridge sign victimized by buck shots.

Figure 4. Traffic and street name sign (a) twisted by vandals and (b) with mounting height increased to counter vandalism.



are most often stolen are associated with famous legends in popular books, rock groups, movie stars, or boy or girl friends. Experience in the urban counties of Maryland with street name sign vandalism highlights the magnitude of this problem. In Baltimore County, Maryland, the street name sign, YELLOW BRICK ROAD has been stolen 20 times in one year (the name Yellow Brick Road is connected with the popular Wizard of Oz). In Montgomery County, Maryland, street signs named KAREN PLACE and JUDY LANE each have been vandalized at least six times a year. In Howard County, Maryland, the street sign named MUSTANG PATH disappears the day after county crews install it.

In Anne Arundel County, Maryland, the story of the recent theft of the JOHNSON ROAD street sign is rather interesting. Two Johnson brothers who wanted to steal this sign at the Johnson Road and Johnson Avenue intersection failed in their initial attempt to remove the street name blades from the post. Subsequently, they brought a pickup truck and a hacksaw and were caught in the act when a resident called the police.

Similar experiences have been reported in other parts of the country. For example, in Arkansas, one of the most frequently stolen signs a few years ago was the BLACK OAK sign on AK-18 at the Black Oak, Arkansas, city limits (4). This occurred when the rock group, Black Oak Arkansas, was popular.

Spatial and Temporal Patterns of Sign Vandalism

Sign vandalism is not limited to one geographic area or one political jurisdiction. It has grown to be a universal problem. Sign vandalism covers all types of areas including urban developments, rural areas, forests, national parks, and campgrounds. In urban areas sign vandalism is more acute in residential areas, at intersections, pedestrian crossings, and in the vicinity of educational institutions. In rural areas signs are vandalized on Interstate roads, freeways, and other local roads. Sign vandalism on forest service roads, national parks, and campgrounds is also widespread.

Signs are vandalized all year, but experience indicates that vandalism becomes more pronounced during certain months, seasons, and community festivals. The following are typically high periods for sign vandalism:

1. Summer months when schools are closed,

Figure 5. Curve warning sign with advisory speed limit victimized by graffiti.

Figure 6. STOP sign defaced by spray paint.

2. Graduation time and the end of school year,
3. Hunting season,
4. Election time,
5. Halloween time,
6. First warm day of spring, and
7. Holiday periods.

Sign graffiti generally occurs at night.

Safety Impacts of Vandalized Signs

Sign vandalism results in economic, safety, and social impacts. Social impacts are somewhat difficult to quantify and are not discussed in this paper. Vandalism of regulatory signs, especially STOP signs, is most critical. Not only do missing, stolen, or vandalized signs deny the motorist important and often vital information about traffic controls and regulations but they also present a hazard. This vandalism can result in tragic consequences in terms of fatal and injury-type accidents.

From a safety standpoint, sign vandalism, especially sign removal by theft, is a significant factor in traffic accidents. Absence of traffic control signs creates confusion and safety hazards for all highway users. Several serious accidents (involving injuries and fatalities) and crashes have occurred because of missing or vandalized STOP signs. Missing street name signs deny motorists and operators of emergency equipment necessary directions.

Few states and local jurisdictions maintain rec-

Figure 7. Four-way STOP sign now displays class of 80.

Figure 8. Curve warning sign changed to killer turtle crossing.

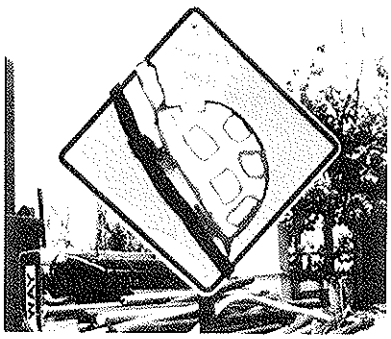


Figure 9. Vandalized pedestrian warning sign.

ords of automobile accidents attributable directly to sign vandalism. The following information has been developed on the basis of a review of available literature and documentation, press releases, newspaper stories, and discussions with local agencies and officials. The information, though somewhat informal, clearly highlights the hazardous and tragic consequences of sign vandalism.

An automobile accident that resulted in four fatalities (including two children) occurred in Salem County, New Jersey, on August 21, 1980, as the result of a missing STOP sign taken from one of the streets at the intersection hours before the accident (5). Unwarned, the driver of the ill-fated out-of-state automobile went through the intersection onto a highway and collided with a tractor trailer (6).

In Fairfax County, Virginia, an automobile accident involving a fatality was attributed to a missing STOP sign. The legal costs for this accident were reported to be in excess of $1 million. In McHenry County, Illinois, vandals removed a STOP sign from an intersection. Moments later an automobile accident occurred and four members of a family were killed in that collision.

In Clark County, Washington, a traffic sign twisted by vandals contributed to a fatal automobile accident (7). The legal and court costs of litigation resulting from this accident were approximately $1.5 million. King County, Washington, suffered a tragic fatality in 1976 that was directly attributed to sign vandalism (8). Again, in 1979 another sign vandalism-related accident occurred and the life of a Public Works Department employee was lost (8). The victim in this fatal accident was the father of four children (9).

An automobile accident in West Virginia involving out-of-state travelers resulted in six fatalities. This accident occurred because of a missing STOP sign that was stolen.

In Wisconsin, several automobile accidents involving injuries have occurred that could be attributed directly to vandalized signs. The most serious accident occurred during the Labor Day weekend in 1975 (10) in which a motorist was killed because of a missing STOP sign.

Costs Associated with Sign Vandalism

Several components of cost are associated with sign vandalism. These include sign replacement and rehabilitation costs (including inspection, material, and labor), medical costs (for injuries resulting from accidents), and tort liability settlements.

Sign replacement costs vary from $50 to $100/sign, depending on the type and size of sign. Sign replacement cost can be enormous when the unit replacement cost is multiplied by several thousand signs that have been vandalized. Local jurisdictions are hit hard by tort liability claims that can run from several thousand to a few million dollars, depending on the type of accident, the property damage, and the number of people killed. Two examples of tort liability settlements discussed in the previous section (Fairfax County, Virginia, and Clark County, Washington) are eye openers.

Some local jurisdictions and states have started to maintain separate records for the number of signs vandalized by type of sign and vandalism, hours spent in replacing and rehabilitating signs, cost data, and associated legal expenses. Thirty states that maintain sign vandalism data reported in response to a recent survey questionnaire that approximately 1.2 million vandalized signs were replaced during 1980 (2). On a national basis this figure can be safely extrapolated to approximately 2 million signs replaced due to vandalism. The same survey revealed two additional interesting facts.

1. Cost of signs vandalized ranged from $34,000 to $1.8 million each year for such items as inspection, material, labor, and liability settlements.
2. The average overall replacement due to vandalism or theft was 28 percent of all signs replaced, with percentages ranging from less than 10 percent to 71 percent for the 25 states that responded to this question.

Review of available literature and documents on sign vandalism and discussions with local agency officials revealed some interesting data on the number of signs vandalized and associated replacement costs. Some of the pertinent information is described in the following paragraphs.

Replacement costs for signs vandalized in New Jersey exceeded $1 million each year (5). One out of every 10 traffic signs is stolen annually. Vermont reported that 4,542 signs were vandalized in 1979, which cost taxpayers $182,469 at an average cost of $40/sign.

Georgia has experienced a chronic problem with sign vandalism. During a one-year period (1979-1980) 83,818 signs were reported vandalized, which cost the state taxpayers approximately $1,084,655 to replace. In Virginia more than 40,000 traffic signs are vandalized or stolen each year, which costs taxpayers approximately $1 million. The Washington State Department of Transportation estimated a sign vandalism cost in 1970 of $117,000 for the following types of vandalism: 21 percent gunshots, 50 percent defaced, and 29 percent stolen. According to a press release issued in 1976, the annual sign vandalism cost was estimated to be $270,000.

The Idaho Transportation Department estimated that the sign vandalism cost for one year was approximately $90,000. The Wisconsin Department of Transportation estimates the number of signs vandalized per year as follows:

Year	No. of Signs Vandalized	Percentage of Total Signs Replaced
1978	2,520	3.5
1979	2,129	2.8
1980	3,255	4.1
1981	2,551	2.8

Replacement costs on a yearly basis range from $175,000 to $227,850, based on a unit sign cost of $70.

Annual sign vandalism costs estimated by some other states are as follows:

State	Cost ($000s)
Montana	300
Alaska	100
South Carolina	500
New Mexico	300
Connecticut	60
Louisiana	70

Sign vandalism costs for counties vary considerably depending on the location and density of population. Typical estimates range between $10,000 and $100,000. Replacement and rehabilitation costs and tort liability settlement costs resulting from vandalized signs are astronomically high. A cost that can never be measured is the cost in deaths and injuries.

EFFORTS AND TECHNIQUES USED TO COMBAT SIGN VANDALISM PROBLEM

Sign vandalism is a national problem that will re-

quire a concerted effort at the national level and by state and local governments to correct and combat. Lawmakers, enforcement officials, and traffic engineering professionals recognize the need to curb the serious problem of sign vandalism. Sign vandalism is a crime and vandals should be charged with a criminal offense. Unfortunately, sign vandals are rarely caught. Prosecution and conviction for sign vandalism are difficult. Evidence is normally lacking unless a witness to the crime (usually a nearby resident) reports the incident to the police or the vandals are caught in the act.

Some local jurisdictions and states, where sign vandalism has resulted in tragic accidents have taken the lead in their efforts to counter this growing problem. Wisconsin, Virginia, New Jersey, South Carolina, Arkansas, and Mississippi have developed anti-sign-vandalism programs and legislation. Likewise, some local jurisdictions, for example, several counties in Washington State (King County, Clark County, Douglas County, and Spokane) have taken positive steps to combat sign vandalism (11).

Countermeasures, techniques, and efforts to combat sign vandalism developed and used thus far are categorized in the following sections.

Legal Countermeasures

Legal countermeasures include enactment of anti-sign-vandalism laws, rewriting of existing inadequate laws concerning prosecution and conviction of vandals, and the proper enforcement of these laws.

Wisconsin has enacted a new law dealing with sign vandalism. The following paragraphs highlight the major elements of the statute.

> 86.192 Penalty for injuring guide board, markers, etc., (1) No person may injure, deface or remove any sign, guide board, mile post, signal or marker erected by the state or by any municipality thereof for the warning, instruction or information of the public. The following warning shall be affixed to the front of each such sign, guide board, mile post, signal or marker: "WARNING $25 to $100 fine or imprisonment for removing or tampering with this sign."
>
> (1) No person may possess any sign, guide board, mile post, signal or marker of the type erected by the state or by any municipality for the warning, instruction or information of the public, unless the person can demonstrate he or she obtained it in a legal manner. Possession of such a sign, guide board, mile post, signal or marker creates a rebuttable presumption of illegal possession. In this subsection, "possession" means the presence of such a sign, guide board, mile post, signal or marker on premises owned or controlled by the person, including but not limited to a rented apartment, rented room or dormitory room. Persons who voluntarily notify a law enforcement agency of the presence on their premises of such a sign, guide board, mile post, signal or marker shall be exempt from prosecution under this subsection.
>
> (2) Any person who violates this section shall be fined $25 for the first violation, $100 for a subsequent violation, or imprisoned not exceeding 30 days for the first violation, or 60 days for a subsequent violation, or both fined and imprisoned at the discretion of the court. The court may, in addition, order any such person either to restore or replace any such damaged sign, mile post, signal or marker, or to pay the cost thereof.
>
> (3) On conviction of any person of a violation of this section, the person or persons who informed against and aided in the prosecution of such offence to conviction shall be paid by the court one-half of the amount of the fine paid into the court.
>
> (4) Any person who violates this section shall be fined up to $10,000 or imprisoned not more than 2 years, or both fined and imprisoned, if the injury, defacement or removal causes the death of a person.

The state made a successful campaign of publicizing the revised statute and the penalties associated with it. Sign vandalism has been reduced since the enactment of the law. During 1976 sign vandalism was reduced by 57 percent on the 12,000 miles of state trunk system (10). The New Jersey State legislature has passed a bill that imposes stiff penalties for sign vandalism offenses, including prison terms up to 10 years for the theft of a traffic sign, including street name signs (6).

Virginia, Texas, and Mississippi have also enacted similar laws to counter sign vandalism. Arkansas treats sign vandalism as a criminal offense that is punishable by a fine not to exceed $1,000 and possible imprisonment of up to one year (4). South Carolina also treats sign vandalism as a criminal offense. The law states (12):

> No person shall willfully without lawful authority attempt to or in fact alter, deface, injure, knock down or remove any official traffic-control device or any railroad sign or signal or any inscription, shield or insignia thereon or any part thereof.
>
> Violation of this law is a misdemeanor and if convicted the person could be fined $1,000 or imprisoned for not less than one year nor more than five years, or both. The convicted person's driver's license will be revoked for not less than five years, also.

Physical Countermeasures

Physical countermeasures include the following efforts:

1. Use of property identification seals or decals at the back of signs to prevent theft;
2. Use of vandal-resistant material on the sign face;
3. Use of vandal-resistant or tamper-proof hardware or fasteners;
4. Use of medium- and high-density plywood products for the substratum (13);
5. Raising of the height of street name sign blades to be out of reach of teenagers [Clark County, Washington, increased the height of road name signs after a fatal accident was caused by a twisted sign (7) (see Figure 4b). A similar problem with vandalized pedestrian signals in Baltimore was solved by raising the signals from 7 to 11 ft.];
6. Use of tough and impact-resistant panels for signs (e.g., Lexan, a product manufactured by General Electric Company);
7. Use of double name signs--one on each side of the post and the ends are riveted together for extra strength to deter twisting (7);
8. Use of vandal-resistant sign supports (e.g., Signfix, a product manufactured by Signfix at North America, Inc.);
9. Use of plywood backing to prevent signs from being bent or twisted by vandals (7);
10. Use of good sign maintenance practices including development and upkeep of a traffic sign inventory (an inventory of signs assists in the

location of signs on the road, identifies the type of signs, and ensures prompt replacement of reported missing or vandalized signs.);

11. Improved securing of sign posts to the ground or foundation to prevent their removal by vandals; and

12. Prevention of theft of signs by applying lock tight, a metal filler or adhesive, on the threaded connections or by peening the end of the bolt to prevent removal of signs from the post, as is done by Connecticut.

Educational Programs

Educational techniques used to combat sign vandalism include the following:

1. Recruit parents and school officials to identify and report missing or vandalized signs;
2. Formation of antivandalism committees with participation from citizens, civic groups, professional associations, and law enforcement officials;
3. Emphasis on economic costs and severe safety consequences of sign vandalism in driver education classes;
4. Seminars for young school children and teenagers emphasizing through the use of pamphlets, graphics, motion pictures, and slides the adverse effects of sign vandalism such as (a) how much it costs taxpayers for sign replacement, (b) the type of accidents that can occur, (c) how signs lose their reflectivity and effectiveness at night when defaced with spray paint or when shot with rifles or pistols, and (d) how signs lose reflectivity when beer, milk, and acidic products are thrown on them; and
5. Anti-sign-vandalism slogans and theme.

Some examples of anti-sign-vandalism slogans and themes include the following:

1. Stop-sign vandalism is killing us (Wisconsin),
2. Sign vandalism kills real people,
3. Quit making traffic sign souvenirs (Alaska),
4. Save signs--save lives (King County, Washington),
5. Stop sign destruction (King County, Washington),
6. Do your part--report sign destruction (King County, Washington), and
7. Save a sign--save yourself (Douglas County, Washington).

Figure 10. Sassy, the sign bird, says.

Public Information Campaigns

Some of the efforts for minimizing sign vandalism include the following:

1. Statewide media campaign on sign vandalism (a program targeted at the teenage audience),
2. Publicizing the state statute and penalties associated with sign vandalism crime (Wisconsin has made extensive use of this approach), and
3. Proclamation of Highway Sign Amnesty Month or Week by the state and local jurisdications [This technique has been used successfully in Wisconsin; the Highway Sign Amnesty Month campaign harvested more than 2,500 signs and markers plus traffic cones, barricades, flares, and utility hole covers (10). A similar amnesty campaign at Rutgers University produced a significant response by college students (14)].

South Carolina conducted an antivandalism campaign in 1979. It consisted of news releases to the media, statewide distribution of antivandalism posters, and a memorandum to school officals (11). Virginia's Department of Transportation Safety has produced a 15-min, 16-mm color film, "Designs of Life," related to the hazards created by removing traffic signs. The film is designed for use in high school driver education classes. Virginia also has developed a series of radio spots that have an antivandalism message (60 sec, 30 sec, and 15 sec). These are used primarily by local radio stations as public service announcements. Some states have placed warning decals on the back of traffic signs to inform would-be vandals about the ownership and legal consequences of stealing the signs.

Clark and King Counties, Washington, have conducted antivandalism campaigns, including countywide educational programs, public service announcements, and sign-up programs (11). Clark County has developed a novel public information technique and logo entitled, Sassy, The Song Bird says--save your signs--save yourself (see Figures 10 and 11). The purpose is to enlist the support of children. Additional concepts for eliciting the interest of children, with Sassy as the main character include a Sassy costume design contest, a parade contest (with costumes), advertisements in the paper, and a traffic sign coloring contest (7,11).

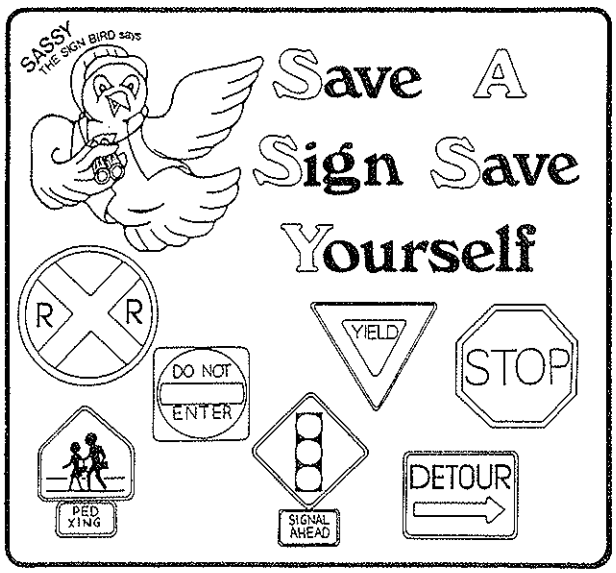
A nonprofit organization, Vandalism Limited Concern, established in Seattle, Washington, has addressed vandalism from several points of view: use of vandal-proof hardware, conduct of vandalism countermeasure symposium, and other programs to educate the public about the harmful effects of vandalism (15).

Summary

The major thrust of anti-sign-vandalism efforts described falls into three distinct categories:

1. Emphasis on laws and associated penalties for sign vandalism, as in Wisconsin;
2. Emphasis on the detrimental effects of sign vandalism and positive educational and public information programs, both Clark and King Counties, Washington, follow these concepts; and
3. Physical actions to deter vandalism. (Although only limited data are available on the effectiveness of most physical countermeasures, the

Figure 11. Sassy, the sign bird, contest poster.



results from some applications indicate a definite reduction in vandalism.)

The success of each technique can be measured by the end result; i.e., reduction in sign vandalism. The techniques described have reduced the incidence of sign vandalism. Wisconsin's campaign to eliminate sign vandalism was an overwhelming success--sign vandalism was reduced by 57 percent on the state trunk system in 1976 and a savings of $240,000 was realized. When county and municipal roads are included the estimated cost savings is approximately $500,000 (10).

The anti-sign-vandalism campaigns used by both Clark and King Counties, Washington, have also shown encouraging results. Data from King County show a progressive drop in sign vandalism since the inception of the program in January 1980 (16,17). A comparison of data for the first 6 months of 1979 and 1982 shows a reduction in sign vandalism ranging from 61.8 percent (March) to 49.6 percent (February).

Overall experience with the Washington and Wisconsin approaches is too limited to generalize the outcome for universal application. An appropriate blend of the approaches may be more desirable.

Figure 12. Decision process for selection of countermeasures.

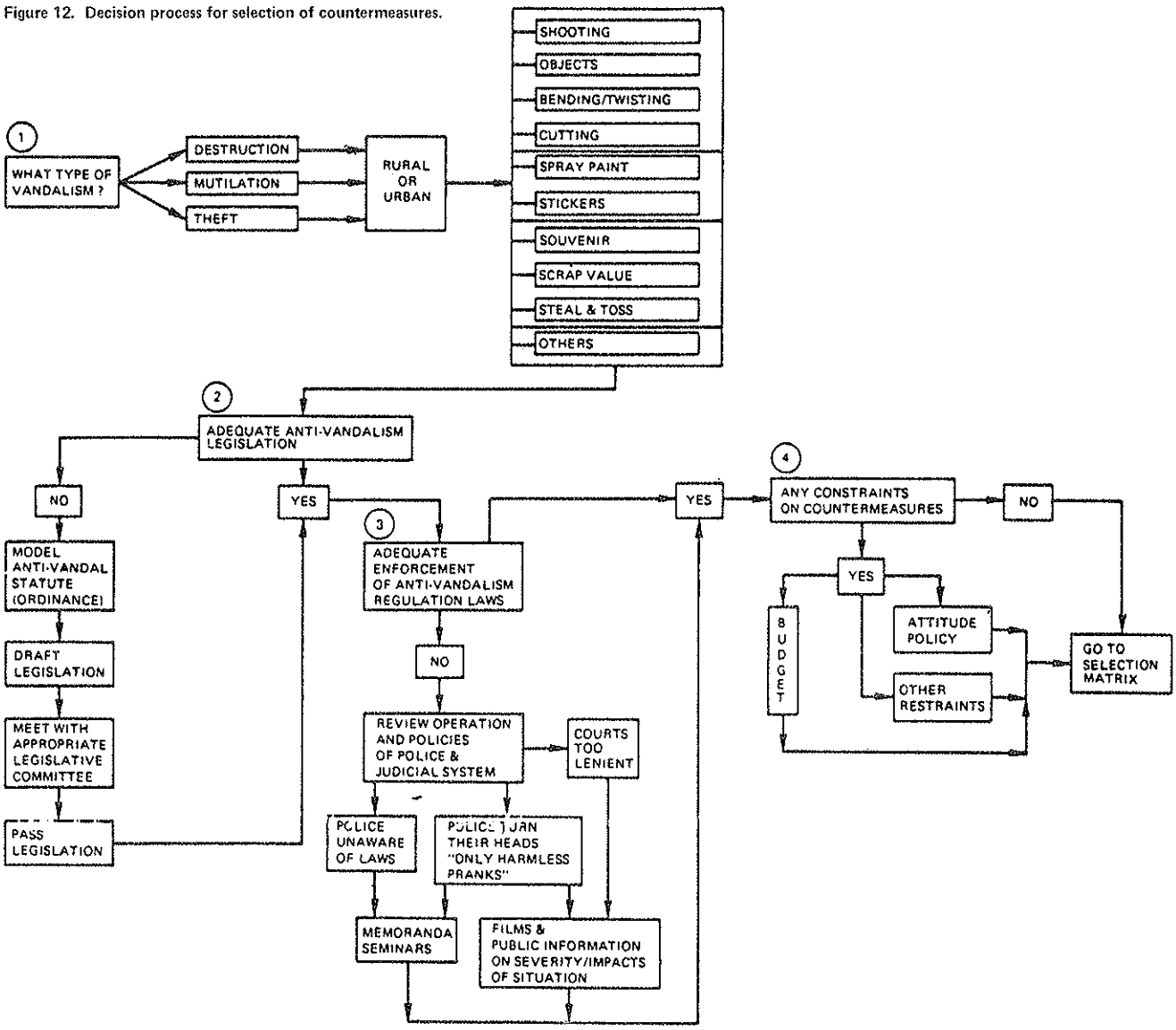


Figure 13. Matrix of sign vandalism problem versus countermeasures.

Counter-Measures / Type of Sign Vandalism Problem	Use of Plywood Signs		Use a Graffiti Resistant Finish		Use of Vandal Proof Fasteners		Continue With all Feasible Countermeasures ⇨	
	COST	Range in% Reduction	COST	Range in% Reduction	COST	Range in% Reduction		
Shooting in Rural Areas	Moderate	10-20	High	0-5%	Low	0%		
Graffiti in Urban Residental Areas	Moderate	0-10%	High	25-50%	Low	0%		
Signs Being Stolen	Moderate	10-15%	High	0-%	Low	40-60%		
Continue for each Type of Problem								
⇩								

Overemphasis on criminality and penalties can possibly be counterproductive and may even increase sign vandalism in some areas. Some of the educational programs are less expensive and may be more beneficial in the long run. A balanced technique, involving the best elements of all approaches, deserves serious consideration.

A SYSTEMS APPROACH TO SELECTION OF COUNTERMEASURES

In order for an agency to select appropriate countermeasures, the vandalism problems must first be identified and defined. The agency personnel should then decide what countermeasures are available as well as any constraints on the use of any of them. Finally, the major objective of the selection process is to choose countermeasures that are most cost effective in preventing, discouraging, and mitigating the effects and minimizing the costs of the particular sign vandalism problem. A two-stage approach to selecting countermeasures is proposed as follows:

1. Flow diagram (decision process for selecting countermeasures)--step-by-step procedures that allow one to gradually focus on the types of countermeasures that would be applicable for the specific problem and environment (see Figure 12), and
2. Matrix of sign vandalism problems versus countermeasures--following the above step-by-step screening process, the selection matrix will allow reasonable choices of problem-specific countermeasures to be made quickly (see Figure 13).

For example, if theft of traffic signs is the predominant vandalism problem in a particular area, it can be prevented by using countermeasures that include the following:

1. Physical--use of vandal-proof hardware (e.g., tufnuts), improved mounting of signs (increase in sign height), improved structural components (e.g., channel and foundation), and improved street lights (especially if vandalism incidents occur at night);
2. Enforcement--stakeout in area of sign vandalism; and
3. Educational--educating teenagers about the adverse impacts of sign vandalism.

Physical countermeasures may prove more effective or even cost effective to curb the sign vandalism problem, especially in rural areas. Enforcement and improved street lights may be more effective in deterring sign vandalism in urban areas. Stakeout by enforcement personnel tends to be expensive and thus is not generally cost effective.

SUMMARY

This paper has attempted to identify, describe, and emphasize the major issues and characteristics of the sign vandalism problem. The seriousness of the problem warrants a concerted effort to correct it. Various countermeasures--physical; legal, judicial, and enforcement; and educational and public information--have been discussed. A potential systems approach that uses the best elements of the various countermeasures to solve the problem has also been suggested. It is hoped that this paper will stimulate public agencies and researchers to continue their efforts toward a systematic, cost-effective, and lasting solution to this serious national problem.

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Public Good Relative to Right-Turn-on-Red in South Carolina and Alabama

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The effects of South Carolina's and Alabama's right-turn-on-red (RTOR) laws on highway safety, fuel consumption, and air pollution were investigated. Accidents at signalized intersections involving right-turning vehicles (RT) before and after the passage of RTOR laws in both states were studied and compared with accidents at signalized intersections that did not involve vehicles making a right turn (NRT). Data for two years before and three years after the effective date of South Carolina's RTOR law were analyzed; the Alabama data included three years before and five years after. The findings of this study indicated that the rate of change of RT property damage accidents in South Carolina was significantly higher for RT property damage accidents in the after period than the corresponding change for NRT accidents. The rate of change of RT property damage accidents in Alabama was not found to be significantly higher for RT accidents in the after period than the corresponding change for NRT accidents. The findings of this study also indicated that there was no significant difference in the rates of change of RT fatality or injury accidents when compared with the corresponding change for NRT fatality or injury accidents in both South Carolina and Alabama. This study could find no evidence that pedestrian accidents in either state increased as a result of RTOR operations. A further analysis was performed on fuel and travel time savings resulting from RTOR operations. Based on the findings of this study and the benefits estimated, no changes are warranted in either Alabama's or South Carolina's RTOR law, and the laws should remain in effect.

Right-turn-on-red (RTOR) is now permitted in some form in all of the states. Adoption of RTOR was accelerated in 1975 after Congress passed the Energy Policy and Conservation Act, which requires each state to develop a state energy conservation plan. One of the requirements of this plan is state adoption of RTOR. In addition, an FHWA study (1) undertaken after the passage of the Conservation Act reported that the RTOR feature would increase intersection capacity, reduce delay especially for right-turning vehicles, and reduce fuel consumption and automobile emissions. The study further reported that the number of accidents as a result of the adoption of RTOR would be insignificant.

Despite the results of many other studies supporting the fuel savings from RTOR and supporting the general conclusion that RTOR does not significantly lower the safety of signalized intersections (SIs), RTOR operations have recently become the subject of much scrutiny. Vast amounts of data have been generated both in favor of and against RTOR. A study by Zador (2) reported that the increase in the overall frequency of RTOR crashes in the states that adopted permissive RTOR laws exceeded by more than 20 percent the comparable change in states that retained the same laws. Furthermore, this study reported that pedestrian accidents had increased substantially after the adoption of RTOR. The increase among children was reported as 30 percent, the increase among adults was about 100 percent, and among the elderly the increase was about 110 percent. Computer files of all accidents reported to the police were obtained from six study states (New Jersey, Oklahoma, South Carolina, Tennessee, Virginia, and Wisconsin) and three comparison states (Maryland, Texas, and Washington) for 1974-1977 for use in this study. The RTOR accident experience in the comparison states may not be comparable with the data from the study states because of possible differences in drivers and demographic factors. The data from half of the comparison states were for an after period of 1 year or less. This is probably not sufficient time for the drivers to adjust to the effects of the change in the law.

More recently, Hochstein (3) stated that RTOR accident data, fuel savings, psychological impact, installation and maintenance costs, and legal liabilities have not been researched thoroughly. Hochstein