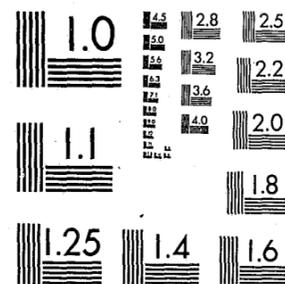


CRS
MF1

National Criminal Justice Reference Service



This microfiche was produced from documents received for inclusion in the NCJRS data base. Since NCJRS cannot exercise control over the physical condition of the documents submitted, the individual frame quality will vary. The resolution chart on this frame may be used to evaluate the document quality.



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Microfilming procedures used to create this fiche comply with the standards set forth in 41CFR 101-11.504.

Points of view or opinions stated in this document are those of the author(s) and do not represent the official position or policies of the U. S. Department of Justice.

National Institute of Justice
United States Department of Justice
Washington, D. C. 20531

DATE FILMED

8/28/81

77844



SUMMARY AND CRITIQUE OF THE LITERATURE
PERTAINING TO THE EFFECTS OF
INCREASED ENFORCEMENT OF TRAFFIC
LAWS ON IMPROVING TRAFFIC SAFETY
(REDUCING ACCIDENTS)

The Illinois Department of
Law Enforcement
Division of State Police
Field Operations Command

77844

U.S. Department of Justice
National Institute of Justice

This document has been reproduced exactly as received from the person or organization originating it. Points of view or opinions stated in this document are those of the authors and do not necessarily represent the official position or policies of the National Institute of Justice.

Permission to reproduce this copyrighted material has been granted by
Richard A. Raub

to the National Criminal Justice Reference Service (NCJRS).

Further reproduction outside of the NCJRS system requires permission of the copyright owner.

SUMMARY AND CRITIQUE OF THE LITERATURE
PERTAINING TO THE EFFECTS OF
INCREASED ENFORCEMENT OF TRAFFIC
LAWS ON IMPROVING TRAFFIC SAFETY
(REDUCING ACCIDENTS)

NCJRS

MAY 6 1981

ACQUISITIONS

R. A. Raub
December, 1979
Revised June, 1980

The Illinois Department of
Law Enforcement
Division of State Police
Field Operations Command

ACKNOWLEDGEMENT

The author wishes to acknowledge the contribution of Ms. Mary Roy and staff of the Transportation Library of Northwestern University. They were able to find all of the materials referenced and subsequently reviewed. Additionally, they suggested several other avenues of pursuit. While most of the summaries and critiques are based on other sources, the author assumes full responsibility for any misinterpretations or quotations out of context. All questions and comments should be directed to the author.

TABLE OF CONTENTS

ACKNOWLEDGEMENT 2

INTRODUCTION 4

INCREASED ENFORCEMENT OF TRAFFIC LAWS 4

 United States 6

 -California 6

 -Champaign, Illinois 7

 -Champaign County, Illinois 8

 -Creve Coeur, Illinois 8

 -El Paso, Texas 9

 -Evanston, Illinois 9

 -Flint, Michigan 10

 -Fort Lauderdale, Florida 11

 -Illinois 12

 -Michigan 13

 -Minnesota 14

 -North Dakota 14

 -Park Ridge, Illinois 16

 -Sacramento, California 16

 -Springfield, Illinois 17

 -Tacoma, Washington 17

 -Texas 18

 -Wisconsin 18

 Other Countries 21

 -Denmark 21

 -Great Britain 21

 -New Zealand 21

 -Toronto, Canada 23

ENFORCEMENT OF LAWS PROHIBITING DWI 25

RESEARCH RELATED TO ENFORCEMENT OF SPECIFIC LAWS 29

 Reduction in Speeds 31

 Effects on Driving Behavior 34

OTHER ASPECTS OF ENFORCEMENT 36

 General 37

 Cost-Benefit Analysis 42

SUMMARY 45

BIBLIOGRAPHY 46

SUMMARY AND CRITIQUE OF THE LITERATURE
PERTAINING TO THE EFFECTS OF
INCREASED ENFORCEMENT OF TRAFFIC
LAWS ON IMPROVING TRAFFIC SAFETY
(REDUCING ACCIDENTS)

INTRODUCTION

This summary and critique of traffic safety literature has been prepared to help uncover those elements of traffic law enforcement that have led to improvements in traffic safety, generally as measured by fewer accidents. Particular emphasis is placed on specific projects where the police have increased their enforcement, and the changes have been measured and reported. In some cases, the only report on a project is what has appeared in a trade journal. It has not included sufficient data to support the claims of the authors and to allow validation of those claims.

Each summary of a report generally includes a critique. This is limited to the conclusions drawn by the authors or criticisms by other authors. Often the results from the research cannot be validated either because of weaknesses in the methodology or inadequacies in supporting data. One common analytical fault is a failure to account for the phenomenon "regression to the mean." This occurs with random events such as traffic accidents which vary about an average over time. When the frequency is at its highest during a period, it is likely to decrease during the next. This fault can be avoided by using trends for the analysis and the use of controls or other comparisons wherever possible.

This paper generally is restricted to those reports describing changes in enforcement of traffic laws related to change in traffic accidents. It also

includes studies in which attempts have been made to measure the effect of increased enforcement on the reduction of traffic violations such as speeding and driving while under the influence of alcohol. Such research has been based on the assumption that reducing those violations will help lead to fewer accidents. While there may appear to be a logical connection between speeding and accidents, the research has not been sufficient to prove causality.

A second restriction attempted in this summary and critique is that the studies included have generally been completed during the last decade. Preferable would have been studies completed since 1974 (reflected particularly in the United States change in driving resulting from decreases in fuel supplies, increases in the price, and a nationally mandated speed limit of 55 m.p.h.). In general, this restriction was met particularly because the U.S. Department of Transportation, under sponsorship of the National Highway Traffic Safety Administration, has placed increasing emphasis on projects of increased enforcement. However, older studies have been included where their contributions are either unique or serve as a basis for subsequent research.

A majority of the discussion in this summary and critique appears in the first section which reviews research covering the increased enforcement of traffic laws and subsequent reduction in accidents. A second section presents a brief discussion of the substantially large body of literature covering the enforcement of laws prohibiting the driving while under the influence of alcohol. The remaining two sections describe the effects of increased enforcement and fewer traffic violations and cost-benefit analyses.

INCREASED ENFORCEMENT OF TRAFFIC LAWS

Since 1945, the end of World War II, there have been many attempts to study the effects of increased enforcement of traffic laws as it relates to improved driving. Some of the earlier studies were reported by Jeffcoate ("Effect of Motor Patrols on Accidents"), Kunz ("How Enforcement Affects the Driver's Behavior"), and Shumate ("The Effect of Decreased Patrol on Accidents, Diversion, and Speed"). These studies have not been limited to the United States; Great Britain, the European countries, New Zealand, and Australia each have participated in projects designed to measure the effects of increased enforcement of traffic laws on reducing accidents. However, the bulk of the work has been performed in the United States. The reason lies with the funds that have been made available by the U.S. Department of Transportation through the National Highway Traffic Safety Administration (NHTSA). During the past ten years, there have been three programs that have received funds and on which reports have been prepared: Fatal Accident Reduction Enforcement (FARE), Alcohol Safety Action Program (ASAP), and Selective Traffic Enforcement Program (STEP). It is the latter program that has served as a basis for many projects administered by the Illinois Department of Transportation through its Division of Traffic Safety. Their title has been Concentrated Traffic Enforcement Program (CTEP).

The studies that have been reported generally have not shown that increased enforcement of traffic laws definitely helps reduce traffic accidents.

There are several reasons:

- 1) Inadequate methodology in the design of the project of inadequate statistical analyses;
- 2) Interference from external factors where such interference was adequately assessed;

- 3) Periods of enforcement that were too short, or attempts at enforcing traffic laws at times or at locations where a change in accidents could not be measured; and
- 4) Sole concentration on enforcing the speed limits to the exclusion of all other enforcing laws or where speeding had not been shown to be a contributing factor to accidents.

The primary problem has been a lack of adequate methodology and statistical analyses. In some cases, this has resulted from the poor administration of the project. More often, however, the problem has lain with the failure to account for the randomness and variability of accidents, and most importantly, the failure to adequately deal with the effect of "regression to the mean." Some attempts have been made to solve these problems. Other administrative or political considerations, that have limited the selection of locations for patrol, times of patrol, and the availability of police officers, have thwarted these attempts.

This section of the summary and critique is divided into two sections: projects in the United States and projects outside the United States.

UNITED STATES

California

Operation 101, Final Report, Phase 1, Background and Accident Analyses, California Highway Patrol, Sacramento, August 1977.

This report includes a comparison of changes in accidents along a 35-mile segment of U.S. 101, Delmar to the San Diego County line. During the 12 months of 1974, the California Highway Patrol doubled the number of police vehicles on the highway, from 18 to 36 vehicles. There was not change in techniques of enforcement. During this year, there was a significant decrease in injury accidents, even though traffic had increased 5.7 percent. Influencing factors included engineering changes that were made in some spots. However, these changes did not appear to account for the substantial decrease in accidents that was measured. The measurement of the decreases was based on the analysis of the trend of accidents prior to the start of enforcement.

There was, however, no distinct correlation between the percentage increase in hours of patrol and the percentage decrease in accidents. The report includes no comparison of changes in accidents to statewide experience. Further, weather could have been a factor, although based on limited data, the authors concluded that the contribution appeared minimal. No other factors could be discerned. Even though there are weaknesses, this report indicates a positive effect from the increased enforcement.

Operation 101, Final Report, Phase IV, Part 1, Results of Violation Surveys, California Highway Patrol, Sacramento, November 1969.

For the program along U.S. 101, the researchers also performed surveys of motorists' violations before and during the increased enforcement on U.S. 101. They divided violations into three classes:

- 1) Lighting - headlights, etc.
- 2) Continuous - equipment, glass, etc.
- 3) Intermittent - Generally moving violations such as improper lane change, following too closely, and unsafe turn.

The most significant effect of increased enforcement was on intermittent violations. The rates of violations observed per 1,000 vehicles, measured during the year of enforcement, were approximately 50 percent lower than measured in the previous year. No attempts have been made to correlate decreases in violations with decreases in accidents.

The study is not clear on the definition of the types of violations and, more importantly, on the precise application of how the researchers measured the "intermittent violations."

A second part of the study was devoted to the measurement of changes in speed. During the period of enforcement, there were substantial decreases in "speed" violations. The authors do not draw any correlation between reduced speed and fewer accidents.

See also:

Operation 101, An Accident and Enforcement Study, California Highway Patrol, Sacramento 1972.

Mason, B., and Bieber, R. A., Operation 500, Final Report U.S. 101 Accidents. California Highway Patrol, March 1970.

Operation 500, A Study of the Effect of Increased Road Patrol, California Highway Patrol, Sacramento 1972.

Crittenden, B., "Operation 101," Police Chief, Vol. 31, 1966, pp. 8-16.

Champaign (City), Illinois

Benages, C., Concentrated Traffic Enforcement Program, Champaign, Illinois, Evaluation Report, Illinois Department of Transportation, Springfield, December 1978.

This report covers the first two years of operation of a program of selective enforcement of traffic laws in Champaign, Illinois, from 1976 to 1978. Based on accident data available from the files of the Department of Transportation (those from Champaign, according to the author, were unreliable), the project was not successful. Problems with the operation of the project included a failure by the police to use accident experience in establishing patrols and subsequent patrol where accidents were not occurring. They also included failure of the department to patrol during the hours accidents were most likely to occur, a singular concentration on the enforcement of the speed limit, and the use of erroneous data. The author concluded that the project could not be successful if continued. Substantial changes in the methodology were required.

The available data supports the author's conclusions. Accidents and their severity apparently had not changed except as might be expected from random occurrences.

Interestingly, this report presents the opposite conclusions to one by Dougherty, D. A., Selective Traffic Enforcement Program, Champaign, Interim Evaluation

Report, Illinois Department of Transportation, Springfield, May 1977. In this report, Dougherty based his findings on data submitted by the City of Champaign. These data were, as Benages clearly indicated, erroneous. Therefore, the conclusions presented by Dougherty could not be accepted.

Champaign County, Illinois

Huffman, W. J., et al., "The Effectiveness of an Emphasis Patrol by the Illinois State Police in District 10 on a Selected Highway," Traffic Safety Research Review, 58:3, March 1961, pp. 17-29.

The Illinois State Police assigned additional troopers to U.S. 45 in Champaign County for a six-month period in 1958. A comparison of changes in accidents on a county-wide basis showed decreases from 1957 to 1958 and a subsequent leveling in 1959. The authors did not complete an analysis of trends even though data from 1956 was available. If the accidents for the five months immediately prior to patrol are used as a comparison, no change can be found. This suggested that decreases had already occurred before increased enforcement was begun. The authors also suggested that even after the patrol was finished, the effects (success) were maintained. Again, no effort was made to determine if accidents would have been at the level that occurred had the patrol not been available. Because the conclusions rest on invalid analytical methods, the conclusions themselves are suspect.

Creve Coeur, Illinois

Dougherty, D., Police Traffic Unit, Creve Coeur, Illinois, First Year Report, Illinois Department of Transportation, Springfield, Illinois, March 1977.

The Police Traffic Unit is a variation on the program of Selective Traffic Enforcement in which a separate division of police is organized in order to enforce traffic laws. This preliminary report of one such unit in Illinois was prepared because the initial accident data from Creve Coeur, covering one year from January to December 1976, showed reductions in accidents. The project was considered successful based on existing data.

What is clearly shown in this report is the danger of using only one year of data and the potential for regression to the mean. In the second year of operation, according to subsequent data available from the city, the number of accidents increased significantly. The increase was such that, for the two-year period, the number of accidents increased even faster than had been expected by trend. This report shows the need to withhold conclusions regarding success or failure until two or more years of operations have been recorded. It also shows the need for time-series analysis to help eliminate faulty conclusions derived from regression to the mean and the randomness of accident data.

El Paso, Texas

McEwen, T., El Paso, Texas, Selective Traffic Enforcement Program, Final Report, PRC Public Management Services, Inc., El Paso Police Department, Texas, August 1976.

The police carried out six experiments of increased enforcement using two different types of patrol: stationary and line. They selected both intersections and street segments for increased patrol. The selections were based upon accident data. In addition, the police carried out extensive public information at least prior to one of the holiday experiments. They were unable to establish control locations in the city; however, such failure was supposed to be the result of a lack of sufficient detailed accident data. No discussion was made regarding the infeasibility of using controls, particularly in light of the many variables that are associated with accidents.

The project ran from January 1972 through June 1974. In the first six-month experiment, accidents increased at a greater rate than for the remainder of the city. During this time, the police operated only line patrol, generally at intersections, they made one stop approximately every 85 minutes. There is a "before/after" comparison but no trend analysis.

In a second six-month experiment, there were decreases only along one of the segments chosen. Here the authors claim that there was a relationship between speeding citations per mile and decreases in accidents' however, one of the segments used in the analysis (and on which there had been success) was repaved during the experiment. Thus, the claim cannot be validated. Again, patrol of an area or segment seemed more likely to be successful than patrol of intersections, but the authors give no reasons for the variability noted in the findings.

The only test that showed some payoff based upon a trend analysis was when there was both an extensive public information and concentration of patrol within one small area. However, this lasted for only one month and there is no way to distinguish between the immediate and longer range effects. After this initial success, the concept was then applied during the last remaining eight months of the project, supposedly successfully. Yet this remaining experiment ran from November 1973 to June 1974 and coincided with the sudden decrease in driving resulting from the energy shortage, thus confounding the findings.

In general, the program administrators did not stick with one technique long enough to examine longer term effects. The author did not use accident trends in evaluating the effects of increased patrol. The program did not appear successful.

Evanston, Illinois

Raub, R. A., Concentrated Traffic Enforcement Program, Evanston, First Year Report, Illinois Department of Transportation, Springfield, June 1978.

According to this report, a project of increased and selective enforcement of traffic laws along four streets in Evanston, Illinois, had measurable success. Unlike the preliminary report for a project in Creve Coeur, Illinois, which also covered one year, the findings in this project were compared to trends and to accidents on streets that did not receive added enforcement. Subsequent studies by the Evanston Police Department show that, although accidents in Evanston increased during the second year, the IR number and rate remained below those expected had the ten-year trend of accidents continued.

The author suggests that the following actions by the police helped reduce accidents:

- 1) Frequent and visible patrol during the hours and days and at the locations where accidents were most likely to occur.
- 2) Frequent stops of motorists (at a rate of approximately two per hour).
- 3) Enforcement of a wide variety of traffic laws; the enforcement of the speed limit accounted for approximately 50 percent of the stops. This was far below the same type of percentage found in Champaign, Creve Coeur, or Park Ridge, Illinois, where similar projects did not work.

This report also points out the problems with using only one year of data rather than three years. Unfortunately, the city discontinued the project after two years of operation; thus, a three-year evaluation could not be completed. Also, the availability of a report covering the first two years was not assured.

Flint, Michigan

Rutherford, J. W., "Flint's Selective Enforcement Unit Proves Successful," Traffic Digest and Review, Vol. 19, No. 4, April 1971, pp. 9-13

This program ran for three years from July 1, 1969 to June 30, 1972. The officers involved were part of the Division of Traffic. They operated both VASCAR and radar city-wide during the afternoon and early evening. This period represented the time when 50 percent of the accidents had occurred. A comparison of the first 12 months to the four years prior showed decreases in fatal accidents. The reductions exceeded 50 percent for several months. Overall deaths decreased from 2.6 per 10,000 registered vehicles to 1.0 per 10,000. During this same period, the Enforcement Index increased from 14.7 to 29.5.

The article gives no history. Total patrol time, stops, and other details, also, are not available, nor are costs. The results, while impressive, cannot be validated. The situation in Flint appears to be one of the police moving from a very low amount of enforcement to substantial enforcement to help reduce

fatalities. Unfortunately, the numbers used for comparison, fatalities, are too small for adequate statistical analyses. There are not enough other support data.

See also:

Several other periodical articles under different authorship, each containing similar information, e.g., "How Flint Cut Its Traffic Toll," Journal of American Insurance, 47:4, April 1969, pp. 22-41.

Fort Lauderdale, Florida

Francis, D., McEwen, T., and Lynn, P., Fort Lauderdale Selective Traffic Enforcement Program, Final Evaluation, PRC Public Management Services, Inc., McLean, Va., August 1976.

This is a report of three experiments of increased enforcement. In one experiment, during a six-month period of February to August 1973, patrol was increased at intersections. There were 3,300 man-hours of patrol. At one intersection, engineering changes were made in addition to the patrol. During the period of increased patrol, according to the report, only property damage accidents decreased. Even this did not occur at all intersections. There were no adequate statistical tests of the data. Also comparisons were made for periods before and after the increased patrol, but not for its duration.

A second experiment conducted from August 1973 to September 1974 was based on a two-month assignment of personnel in selected areas. The authors were not able to show that increased enforcement was effective. More than 21,000 hours were spent on patrol.

In a final experiment of increased patrol, the police conducted intensive enforcement at intersections for three-week periods. This took place from October 1974 through June 1975. There were no apparent changes.

This project dealt primarily with increased enforcement at intersections. The analyses are buried in a too lengthy paper that is not well organized. In none of the experiments was any overall success shown, yet these experiments involved more than 30,000 hours of patrol. Unfortunately, no conclusions are drawn from the failure; no changes are suggested.

See also:

Taubenslag, W. N. and Taubenslag, M. M., Selective Traffic Enforcement Program-STEP-BAC Study in Fort Lauderdale, Florida, Fort Lauderdale Police Department, Florida, August 1976.

Illinois

Berroyer, C., Concentrated Traffic Enforcement Program, Illinois State Police Evaluation of First Year, Illinois Department of Transportation, Springfield, April 1979.

The Illinois State Police has conducted a project of increased enforcement of traffic laws at 45 sites throughout the State of Illinois since September 1977. These sites were selected because they represented locations at which accidents had occurred far more frequently than expected for the type of road and traffic. Enforcement was only increased for six months of the year; however, the periods of patrol, including time of day and day of week, generally coincided with the periods when accidents had most frequently occurred.

Based on the previous year, accidents at the sites selected for patrol did not increase as rapidly during the hours of patrol when compared to hours when the increased patrol was not present. This finding, however, does not account for the trends. The potential for regression to the mean remains high. It will take at least two years, perhaps three, before sufficient data has been collected for more thorough analyses.

The important findings from this first year of operation are:

- 1) Increased patrol was more effective at rural locations than at urban locations.
- 2) No correlation was found between changes in accidents and the ratio of citations to warnings. The author suggests, however, that the ratio of citations to warnings, e.g., less than three to one, may be detrimental.
- 3) There was a positive correlation of the enforcement of speed to fewer accidents but only on rural Interstate highways. In more urban locations, the correlation was negative, i.e., the higher the percentage of citations written for speeding, the less likely the reduction in accidents.

An evaluation of both the second and third years of this project are planned. These ought to be more definitive in their findings than the first-year evaluation.

See also:

Benages, C., Concentrated Traffic Enforcement Program, Illinois State Police, Interim Evaluation Report, Illinois Department of Transportation, Springfield, July 1978.

Raub, R. A., et al., Concentrated Traffic Enforcement Program, Illinois State Police, Operation and Evaluation Plan, Illinois Department of Transportation, Springfield, November 1977.

Concentrated Traffic Enforcement Program, Illinois State Police, Second Year Data Base, Illinois Department of Transportation, Springfield, March 1979.

Michigan

Fatal Crash Reduction Program, A Demonstration Project, National Highway Traffic Safety Administration, February 1973.

This is one part of a review and evaluation of two demonstration projects, one in Michigan and one in Texas (see also "Texas", this section), that led to the 1973 program of Fatal Accident Reduction Enforcement (FARE). This program (FARE), however, was short-lived and gave way to the more extensive Selective Traffic Enforcement Program (STEP). There has been a large number of reports covering projects that received funds for selective enforcement.

Rural fatal accidents were the basis for measuring change for this program in Michigan. Five counties were selected for increased patrol from 11 counties that had a consistently high frequency of fatal crashes from 1968 to 1971. The five that were selected had the highest frequencies during the previous year. An analysis of time of day and day of week showed that patrols were needed from 6:00 p.m. Friday to midnight Sunday. A total of \$285,000 was spent for a five-month project, August to December 1972. Based on a comparison of predicted accidents for the five-month period, there occurred 42 fewer fatal accidents than had been projected based on the trend. This report also shows a cost-benefit ratio of 41 to 1.

However, the authors failed to account for regression to the mean which was clearly the case based upon the methodology used to select the counties. As shown by Williams and Robertson in a subsequent review, the changes in the five counties were no different than changes in five other counties in Michigan that also had the highest number of fatalities based on the same period of 1968-1971. Further, five counties in neighboring Indiana, selected by the same criteria as used in Michigan, showed similar decreases even though there was no increased enforcement. Compounding the problem was the use of the first seven months of 1972 to predict accidents for the last five months when these first seven months were unlike any previous similar periods. Finally, the substantial benefits for the costs incurred should have immediately made the findings suspect.

Williams, A. F., and Robertson, L. S., "The Fatal Crash Reduction Program, A Reevaluation," Accident Analysis and Prevention, 7:1 1875, pp. 37-44.

This paper points out the mistakes in methodology and errors in subsequent findings from the demonstration project of increased enforcement carried out in Michigan. While NHTSA estimated saving 42 lives based on an expenditure of \$285,000, these findings cannot be supported because of the following errors in methodology:

- 1) Most severe cases were chosen, resulting in regression to mean. The same changes were found in other counties and states when the same method for selection was used. These changes occurred even though enforcement was not increased in these counties.
- 2) Slight increase in percentage of accidents occurring on weekends; yet, increased patrol took place on weekends.
- 3) Savings based on estimate using previous seven months which represented the highest similar seven-month period ever recorded.

Minnesota

"A.P.O." 1970, Minnesota Highway Patrol, Safety Research Section, October 1970.

Increased enforcement by 12 officers and two supervisors was done on two county highways in Minnesota during the month of August 1970. According to the report, there were fewer accidents in this month when compared to the same month of the previous year. However, there were no analyses of the data that could have been used to validate the changes noted. Other related measures, such as the amount of patrol (stops per hour of patrol) and violations that contributed to accidents, were not included. Further, external factors are not taken into account. The paper presents a summary of costs and violations for which stops were made. It cannot be used to support additional increased enforcement because of a lack of adequate analyses.

"A. P. O." 1972, Minnesota Highway patrol, Safety Research Section, February 1973.

The project reported was similar to the one reported in "A.P.O." 1970, two years earlier. Findings are also similar to the earlier ones. This report also has the same drawbacks: the period of increased enforcement was only one month; there was no trend analysis; and there was no relation of other activity or external factors to the changes that occurred.

North Dakota

Blackman, K.D. and Hayes, L. B., North Dakota Selective Traffic Enforcement Program (STEP), Final Evaluation, North Dakota State High Patrol, Bismark, April 1976.

This is an evaluation of two separate projects conducted in two counties in North Dakota. Mixed results were found. The first project in Grand Forks County showed the best results; the results of the second in Cass County were contaminated by fuel shortages and the change to a 55-m.p.h. speed limit that occurred in 1974.

Grand Forks County

Overall, based on all five sites (which were segments of highway), there was a 20.7 percent decrease in accidents and a 28.8 percent decrease in injury and fatal accidents on a per-month basis for the 18 months from August 1972 through January 1974. The baseline used for the comparisons was a three-year period from August 1969 through July 1972. All statistical tests used showed significant changes. There is also a comparison of changes at sites to changes statewide. The changes at sites were in opposite direction, decreases instead of increases, and were significantly different. This further supports the claim for effectiveness. The authors were unable to find other factors that may have caused the changes. They concluded that the increased enforcement had been effective.

There was an average of 1,460 hours of patrol per month at the five sites; however, there was no correlation between the hours spent and changes. Unfortunately, no other measures, such as hours per mile of road, citations, activity, public information, etc., were examined. The authors also did not adequately account for the contamination caused by energy shortages starting in November 1973. Even with these faults, the findings of this report are well supported by the trends. There is a relatively good indication that the increased enforcement of traffic laws in Grand Forks County may have been effective in reducing accidents.

Cass County

An attempt to relate added enforcement of the speed limit to changes in accidents was done in Cass County. This study was contaminated by the change to a national speed limit of 55 m.p.h. and the lack of gasoline that occurred in 1973 and 1974. The authors were able to show an inverse relationship between man-hours worked and accidents, but could not, in this case, eliminate other influencing factors. The researchers also concluded that line patrol was not an effective means of enforcing the 55-m.p.h. limit. Even this finding was questionable because the researchers were unable to collect reasonable, untainted data for the speed studies.

See also:

Bensen, O. C., North Dakota Selective Traffic Enforcement Program - Project Directors Report, North Dakota State Highway Patrol, April 1976.

Park Ridge, Illinois

Pivovarnik, D. L. and Raub, R. A., Concentrated Traffic Enforcement Program, Park Ridge, Final Report, Illinois Department of Transportation, Springfield, July 1978.

The police department in Park Ridge, Illinois, operated a project of increased enforcement for a one-year period from July 1976 to June 1977. The police increased patrol along on street within the city during the times of day and days of the week when accidents had occurred. The project was not successful. According to the authors, the greatest problems were lack of adequate administration and supervision of the personnel and selection of a location that had significant engineering problems. Because of the problems encountered, the city terminated the project at the end of one year of operation. One of the findings common to a number of similar projects was the failure of the police to enforce those traffic laws, the violation of which had contributed to accidents. In Park Ridge, a large percentage of the stops were made for violations of the speed limit, usually in those areas where the number of accidents had been minimal. Other violations such as illegal signalling, failure to stop or yield, which had been considered contributory to accidents, were virtually ignored.

Sacramento, California

McEwen, T. and Brazil, F., Sacramento, California, Selective Traffic Enforcement Program, Final Report, PRC Public Management Services, Inc., Sacramento Police Department, California, August 1976.

This project operated from July 1971 to December 1973 at a cost of approximately \$1.3 million. Every two months enforcement was concentrated in two different areas of the city. Both stationary and line patrol were used. Stationary patrol did not appear to have a payoff. In only one case line patrol may have helped reduce accidents. However, when accident trends were analyzed, there generally were no statistically significant changes. Most importantly, none of the patrols were operated during those periods (time or days) when accidents most likely would occur.

The report shows mathematically how it is difficult, if not almost impossible, to select a set of streets as a control in terms of a classical design. Where areas were selected, there was no correlation among experimental and control areas in terms of changes in accidents. The greatest likelihood of effectiveness appeared in a business rather than residential area (in fact the only longer term reduction was in a business area). Not only was stationary patrol ineffective, but also increased enforcement was not effective in areas with a low frequency of accidents.

The authors claim that enforcement of driving while under the influence laws reduced fatal accidents. However, an analysis of the data shows that reductions took place even where there was no enforcement. Further, this portion of the project took place during those months when fuel was in short supply. There was no other supporting data to substantiate the claim.

Springfield, Illinois

Dougherty, D. A., Selective Traffic Enforcement Program, Springfield (High Impact), Interim Evaluation Report, Illinois Department of Transportation, Springfield, March 1977.

During the first year of this project, July 1976 to June 1977, there were no changes in accidents as a result of increased enforcement of traffic laws. The most significant problems encountered included the inability of the police to extract from their files reliable accident data, the concentration of enforcement at very few spots (at some spots there had not been any accidents), overdependence on enforcing the speed limit, and lack of adequate publicity.

The author addresses two critical points. First, even though a number of violations were shown to be contributory to accidents, the police in Springfield did not enforce the laws related to those violations. Rather, they enforced the speed limit. This was done even at locations where the speed limit may not have been correctly posted. The second problem was a lack of extensive publicity covering the project. Except in its initial stages, the police gave practically no publicity during the project. This project was terminated at the end of its first year.

Tacoma, Washington

McConnell, R. H., Serdinov, S. M., and David, N. S., City of Tacoma Selective Traffic Enforcement Program (STEP), Tacoma Police Department, Washington, April 1976.

This project was conducted by the Tacoma Police Department with assistance for its evaluation from Stanford Research Institute. The evaluation is unable to show that traffic enforcement as applied by the police, regardless of techniques, helped reduce accidents. Some short-term, as well as isolated effects, occurred. Two other findings were:

.No apparent differences in recidivism regardless of whether a citation or oral warning was issued; however, documentation of oral warnings was needed.

.A maximum of three hours of duty per day before problems with officer morale set in.

The project seemed to pay off more in terms of police training than in accident reduction. The cost was \$729,000 for three years, from June 1972 to June 1975. Ten officers were assigned full-time to the patrol, Monday through Friday. The concentrated enforcement was conducted at 20 sites throughout the city, but two officers were never at the same location at the same time. Time spent at one location for a given period ranged from three to twenty-four weeks with time off in between. There was no continuous coverage for at least 52 weeks. The officers on patrol varied between stationary and moving patrol (on a planned basis). They also varied the experiments with giving only citations or only oral warnings or a combination. Accidents did not decrease in the areas patrolled by the police. Further no halo effect could be measured.

Texas

Fatal Crash Reduction Program, A Demonstration Project, National Highway Traffic Safety Administration, February 1973.

This is part of a review and evaluation of two demonstration projects, one in Michigan and one in Texas, that led to the 1973 program of Fatal Accident Reduction Enforcement (FARE). This program (FARE), however, was short-lived and gave way to the more extensive Selective Traffic Enforcement Program (STEP). There are a large number of reports covering projects that received funds for selective enforcement.

One county in Texas increased patrol on a seven-day-a-week schedule with extra patrol when fatal accidents were most likely to occur. The project was conducted in Harris County using 15 additional, two-man units each day. The total cost of this project was \$225,000, spent over a four-month period. Based on the trends, from January through August, there were ten fewer fatal accidents. Of the total number of expected fatal accidents, 120, this decrease could have occurred by chance with greater than a 50 percent probability. Further, the analyses of data suffered from the same faults as noted in a similar study in Michigan. It is a good example of a report used to perpetuate an ineffective program where it should have been used for the opposite purpose.

Wisconsin

Shumate, R. P., The Effect of Increased Patrol on Accidents, Diversion, and Speed, Northwestern University, Traffic Institute, 1957.

This is a report of a two-year study of increased enforcement on highways in Wisconsin starting in 1956. The author found that there was a relationship between the number of patrol vehicles per 100 miles and decrease in accidents. He suggests a rate of 0.4 patrol vehicles per mile. However, Michaels later challenged the statistical validity of this finding even though Shumate had based

it on an analysis of trends rather than a simple one-year "before/after" study. The major reductions occurred in the more severe accidents. Shumate also found that, as a result of enforcement, speeds decreased and more importantly, the variation in speeds was less than before. However, the author in a subsequent review of this study prepared for the International Association of Chiefs of Police, revised his findings. He questioned that the presence of police could have been correlated to the changes measured.

Shumate, R. P., The Long Range Effect of Enforcement on Driving Speeds, International Association of Chiefs of Police, Field Services Division, Project No. 553, (undated).

The author completed a review of the earlier study done in Wisconsin. In the earlier study, Shumate had concluded that the presence of the police did affect the speeds of motorists, particularly the variance in speeds. In this review of the data (following an earlier review by Michaels), the author questions his own findings. In all cases, according to the author, there was a limited but not statistically significant effect of police enforcement on average speed, percentage exceeding the limit, and variance.

Michaels, R. M., "The Effects of Enforcement on Traffic Behavior," Public Roads, 31:5, December 1960, pp. 109-124.

This is a reassessment of the data presented by Shumate's study of enforcement on Wisconsin highways in 1956. By the use of statistical methods different from those of Shumate, Michaels shows an indirect link between increased enforcement and fewer accidents. When the changes were compared to what had occurred on control routes, they were considered statistically significant. However, the test routes had four times the accidents of control routes; thus, larger changes on the control routes could have occurred by chance. Further, there was no examination of changes during hours of patrol. As Michaels states, "accidents are an obviously inefficient measure." There were too many complicating factors to simply isolate patrol.

There is no demonstrated effect of increased police patrol on average speeds or volumes. However, Michaels concludes that there were significant decreases in variance of speed on patrolled routes. (Interestingly, Shumate later disputed even this finding.)

The author also feels that possibly reducing the variance in speeds is sufficient to reduce "frequency of extreme judgments and decisions" This is supposed to be the reason for fewer accidents. While it may be true, in part, for rural driving, this conclusion ignores other factors such as highway surface, weather, the automobile, and similar factors not related to speed. Finally, Michaels concludes that time-varying characteristics of the highway system prevents the establishment of any real experimental control in the field situation."

See also:

"Selective Enforcement Prove Cost Effectiveness in Crash Containment," Wisconsin Traffic Safety Report, February 1975, pp. 1-2.

OTHER COUNTRIES

Denmark

Lund, M. B. and Joergensen, N. O., The Effect of the Increased Police Enforcement on the A1, Report No. 16, Danish Council for Road Safety Research, September 1974.

During 1970, the Danish police increased patrol (amount not indicated) on a primary highway in Denmark. This increase lasted one year. During the same period, they used another primary highway as a control. The report concludes that there were no changes in speed or in accidents as a result of police patrol. However, the authors also point out that the police were frequently not visible enough to have any major effect on the drivers' behavior. This experiment was conducted on a fairly long road network. The times and amount of enforcement did not coincide with the periods of the highest frequencies of accidents.

Great Britain

Munden, J. M., An Experiment in Enforcing the 30 MPH Speed Limit, Road Research Laboratory, Report No. 24, Harmondsworth, England, 1966.

In Great Britain, police increased patrol on six segments of road that had a 30-m.p.h. speed limit. The police increased their hours of patrol on the selected segments from 3.5 to 14 times the previous amounts. The researchers measured speeds before and during patrol as well as the frequencies of accidents. Enforcement was continued for one year from July 1964 to June 1965. As a result of the enforcement, according to the author, there was a reduction in average speeds except for trucks and statistically significant reductions in accidents, particularly serious injury accidents, at all except two sites. These reductions occurred even though there were increases in accidents along other sections of roads in the same general areas. There were no other variables that might have accounted for these changes. Unfortunately, the study does not indicate what efforts by the police may have influenced these changes. Further, there is not an adequate assessment of how the times of patrol may have contributed to the changes, and the study does not show a relationship between the reduction in speed and in serious injury accidents.

New Zealand

Rice, R. A., "A Study of Varying Degrees of Speed Limit Enforcement", Papers, National Road Safety Symposium, Canberra, New Zealand, March 1972, pp. 94-104.

In Canberra, New Zealand, an increase in the issuance of speed citations had two apparent results: a decrease in persons killed in vehicles and a decrease in pedestrians killed. However, the decrease in pedestrians killed also may have resulted from improvements in roadway lighting which occurred at the same time as the program. The increased enforcement of the speed limit was done by reducing the original 15-m.p.h. leeway.

This report suggests that an enforcement index (moving violations divided by injury accidents) of 25 was a good measure. However, there were no other supporting studies or controls to validate this.

Toomath, J. B., Eng., M. The Hamilton Traffic "Blitz", (paper, 1974 Conference of New Zealand Traffic Engineers), Ministry of Transport, Traffic Engineering Section, Wellington, New Zealand, 1974.

A one-month increase of enforcement of traffic laws in Hamilton, New Zealand, apparently helped reduce accidents by one third along the streets where the enforcement took place. Additionally, there was an extensive public relations effort before and during the program. Surveys showed that the residents were generally aware of the program. The greatest decrease occurred in injury accidents. There was no attempt to examine changes by time of day and day of week. Further, enforcement was not specifically directed to the peak period of accidents. The shortness of the project does not answer the question of how effective it would have been over a longer period. Further, no attempts were made to match the number of officers to the apparent problem (20 additional officers were added).

Toomath, J. B., Eng., M., "Short-term Traffic 'Blitzes'", Traffic Research Report, No. 11, Ministry of Transport, Traffic Research Section, Wellington, New Zealand, 1975.

In Christ Church, New Zealand, a one-month increase in traffic enforcement, with approximately 100 percent more citations, resulted in a significant decrease in accidents. This study resulted in a significant decrease in accidents. This study followed an earlier one (both were conducted in 1973) in Hamilton (also reported by Toomath). Both showed measurable successes in the short-term reduction of accidents. The largest decrease was in injury accidents. The decrease was significant in light of the increases that had been occurring previously. The number of accidents used for the analyses were relatively small, and there is some question regarding the validity of the findings. The problem was that each of these studies lasted only one month. In both Christ Church and Hamilton, studies of driver violations taken before, during, and after showed an expected pattern of decreases during the enforcement. After the enforcement returned to earlier levels, the numbers of violations reverted to those previously measured. The public seemed to perceive the increased enforcement in a relatively favorable light according to public opinion surveys that were conducted.

See also:

The Christ Church Traffic "Blitz", Ministry of Transport, Traffic Research Section, Wellington, New Zealand, 1974.

Toronto, Canada

Hauer, E. and Cooper, P. J., "Effectiveness of Selective Enforcement in Reducing Accidents in Metropolitan Toronto," Transportation Research Record, 643, 1973, pp. 18-22.

The Toronto, Canada, Police Department publishes a monthly list of intersections and midblock sections that have had the most accidents in the prior month. This list is posted and is used to direct increased enforcement at the worst locations. The authors found that once the intersection or section achieved a high rank and was brought under selective enforcement, accidents decreased. All high-ranked intersections were treated with no control group. Although the authors claim that enforcement proved effective, they could not adequately account for regression to the mean. Compounding this problem was the lack of a control group of intersections. Both Hauer and Cooper subsequently tested and reported on the effects of increased enforcement on conflicts and violations of intersections.

Cooper, P. J., "Effects of Increased Enforcement at Urban Intersections on Driver Behavior and Safety", Transportation Research Record, 540, 1975, pp. 13-21.

Cooper tested the effects that increased numbers of police officers patrolling intersections in Toronto, Canada, had on reducing conflicts and traffic violations. Patrols were restricted to six intersections, with an additional intersection set aside as a control. The patrol lasted for four weeks. Measurements of data on conflicts and violations were made before, during, and after the increased enforcement. The results of measurements at the experimental sites were compared to those made at the control. Cooper found significant decreases in violations and conflicts during enforcement. However, once enforcement was removed, the driving behavior returned to its earlier level.

This study does not show a clear relationship between violations and accidents. The relationship is assumed. In addition, the period of study may have been too short to measure changes in accidents, particularly at sites such as intersections, which (individually) generally had relatively low numbers of accidents. Further, the author concluded that the changes seemed "to be related more to an instinctive reaction to visual evidence than to a typical learning process."

See also:

Cooper, P. J., Effectiveness of Traffic Law Enforcement: A Study to Assess the Effectiveness of Different Levels of Police Enforce-

ment on Driver Behavior and Safety at Urban Intersections, Ministry of Transport, DeLeuw, Cather, and Co. of Canada, 1974.

Hauer, E., Estimation of the Effectiveness of Some Selective Enforcement Procedures, Phase 1, Department of Civil Engineering, University of Toronto, Toronto, Canada, December 1975.

Hauer, E., Estimation of the Effectiveness of Some Selective Enforcement Procedures, Phase 2, Department of Civil Engineering, University of Toronto, Toronto, Canada, December 1975.

Other

(Kingman, Arizona) "Reduced Traffic Toll Through Strict Enforcement in Kingman, Arizona" Traffic Safety, 66:2, June 1966, p. 21.

(Montana) McKay, R. N., "Montana's Accident Prevention Unit Cuts Crashes at Selected Locations," Traffic Safety, January 1974, pp.12-14.

(Newport Beach, California) Sanders, R. R. and Hamilton, R. S., City of Newport Beach Traffic Safety Project, Newport Beach, California, 1973.

(Oakland County, Michigan) A Safety Demonstration Program for Oakland County, Michigan, Oakland County Traffic Improvement Association, Pontiac, Michigan (undated).

ENFORCEMENT OF THE LAWS PROHIBITING D.W.I.

Although the reduction of driving while intoxicated (DWI) is not the major thrust of this summary; a few reports are reviewed because the projects reported, effectively, were similar to those of concentrated traffic enforcement. The major criticism of these reports that noted positive results, e. g. decreases in accidents, is that the researchers could not separate the effects of increased enforcement from those of enforcement of DWI laws. Further, what apparently worked in one place could not be replicated. In addition to those reports summarized here, the reports on projects of Selective Traffic Enforcement in Fort Lauderdale, in North Dakota, and in Sacramento, in part, analyzed experiments performed with enforcing the prohibitions of driving while intoxicated.

Alcohol Safety Action Projects. Evaluation of Operations 1974, Volume II Detailed Analysis, "Chapter 1, ASAP Evaluation Methodology and Overall Program Impact," National Highway Traffic Safety Administration, Washington, D.C., (undated).

A review of 29 individual projects (see also Hawkins, Southwest Research Institute) shows mixed results. A comparison of day to night crashes shows a reduction in night crashes as a ratio to day crashes in cities where there was increased enforcement of traffic laws with emphasis on stopping DWI. However, researchers were unable to separate the effects of traffic enforcement from that of DWI enforcement.

This report on an evaluation shows that a descriptive (subjective analysis) was performed in 17 (58.6 percent) of the 29 projects. In only six was any formal analysis prepared, and only one, New Orleans, showed positive results in terms of reduction of fatal crashes. Another two, Fairfax County, Virginia, and South Dakota suggest favorable effects for personal injury crashes. The results from New Orleans were based on a trend from 1970 through 1974 (program started in 1972). Although fatal accidents decreased, there was no correlation between this and changes in BAC levels taken during three roadside surveys. In Fairfax County changes were based on predicted levels of injury crashes using a 10-year regression analysis of trends. However, Fairfax County has been the center of rapidly changing neighborhoods and has had a rapidly changing population. There was no evidence that the predictions were based either on traffic volumes or population. The change in South Dakota was the result of an even weaker comparison and should not be considered valid.

Hause, J., et al., Increased D.W.I. Enforcement Program, Stockton, California Second Annual Report, Stockton Police Department, Stockton, June 1977.

The city of Stockton, California, received a grant to conduct a one-year experiment of the effect of increasing enforcement against DWI and reducing accidents. The project started in January 1973. The city was divided in half with one side, "A" serving as control and "B" as experimental. After six months "A" became experimental and "B" the control. During the first six months, accidents decreased in both parts. During the next six months accidents continued to decrease in "A" but began to increase in "B", even though the police were concentrating their enforcement on side "B". The patrol was made up of ten-man teams of police working eight-hour shifts during periods generally associated with drinking and driving.

There is no correlation between efforts of the task force and reductions in accidents in the area worked. There was a decrease, not significant, in accidents related to alcohol city-wide, but it was a chance effect. The relationship to the increase of enforcement or public relations cannot be identified. In fact, decreases were often noted when officers were not present. The increased presence of officers seemed to have an immediate effect on all accidents. Decreases occurred initially; however, after one year there were no further decreases.

There is no discussion of what factors may have affected accidents. It is clear from the report that increased enforcement played little or no role. The methodology and design of the study was originally sound, but events showed that attempts to use a control group for accident analyses were difficult and led to uninterpretable results. The study does not contribute substantially to the overall program of reducing DWI driving through increased enforcement.

See also:

Hause, J., et al., Increased DWI Enforcement Program, Stockton, California, Project Evaluation, Interim Report, Stockton Police Department, California, January 1977.

Selective Traffic Enforcement Program, Stockton, California, Final Report, Stockton Police Department, California 1978.

Hawkins, T. E., et al., Summary of ASAP Results for Application to State and Local Programs. Volume I - ASAP Findings, Southwest Research Institute, San Antonio, Texas, August 1976.

The Alcohol Safety Action Programs (ASAP) had mixed success. According to this report, there were some "successes," but most of the projects resulted in no change. The authors, however, do not review individual reports and critique these reports.

The most positive element of ASAP was an opportunity to examine the whole of DWI enforcement in relation to its many aspects: education, enforcement, equipment, judicial, referrals, etc. There were 29 ASAP projects, and, overall, there was some demonstrated reduction in the ratio of night to day crashes. However, the data generally are not adjusted for trends or for the reduction in driving that occurred during late 1973 and 1974.

Zylman, E., "DWI Enforcement Programs: Why Are They Not More Effective," Accident Analysis and Prevention, Vol. 7, 1975, pp. 179-190.

The 29 projects of DWI enforcement (ASAP) conducted throughout the country were not apparently effective when comparing changes in fatal crashes to two measures:

- 1) Increasing numbers of arrests (reduction in accidents usually occurred with smallest increases).
- 2) Number of arrests per 1,000 residents (negative correlation).

The authors in support of their position give a quote from the NHTSA evaluation (Vol. II), "It may be that the type of person arrested is not the type of person heavily involved in fatal crashes."

Other

Clay, T. R., "Selective Enforcement of Drunken Driving in Phoenix, Arizona," Journal of Safety Research, Fall 1978, pp. 130-138.

Lee, M. A., An Analysis of ASAP Patrol Activity, South Dakota University, Vermillion, South Dakota, May 1974.

Scott, R. D., "Preventative Enforcement Against Drunk Drivers," Traffic Digest and Review, 18:10, October 1970, pp. 1-5.

Zador, P., Statistical Evaluation of the Effectiveness of Alcohol Safety Action Programs, Insurance Institute of Highway Safety, Washington, D. C., 1974.

RESEARCH RELATED TO ENFORCEMENT OF SPECIFIC LAWS

In addition to the measures of changes in accidents as a result of increased enforcement and enforcement of laws prohibiting driving while under the influence of alcohol, there have been measures of changes in specific violations. The most comprehensive measures have been those related to the reduction of speed and the "halo" effect, in terms of reduced speeds, of police patrol. There also has been research performed to test the effect of increased enforcement and decreased violations of all traffic laws. Again, this research has been overlapping with that of reductions in accidents. For example, both the California Highway Patrol's work along U. S. 101 (Operation 101 - Results of Violation Surveys, et al.) and Hauer's and Cooper's work in Toronto ("Effectiveness of Selective Enforcement in Reducing Accidents in Metropolitan Toronto," et al.) have also included analyses of the effects of increased enforcement on violations. Two problems have occurred with interpreting the results of research on reduction of violations. First, and most importantly, there has been no correlation between a specific violation and accidents. This has been most clearly pointed out with speeding in excess of the posted limit. Although the attempt has been made to enforce the speed limit, researchers generally are in agreement that the variance in speeds, particularly the excessively fast or slow driver are the primary dangers. Thus, simply to slow the driving public will not necessarily be effective.

The second problem is that there is no clear method of identifying violations other than speeding. Perhaps the best approach was taken by the California Highway Patrol (U. S. 101 study previously cited) where they divided violations into three categories. However, the ones most likely to lead to

accidents, intermittent ones such as illegal land usage, failure to yield, etc., were not clearly defined in terms of how they were measured.

The subsequent portion of this summary examines two aspects described in the various reports: reduction in speeds and effects on driving behavior.

Reduction in Speeds

Campbell, D. T. and Ross, H. L., "The Connecticut Crackdown on Speeding: Time-Series Data in Quasi-Experimental Analysis," Law and Society Review, 3:8, August 1968, pp. 33-53.

After a period of increasing numbers of fatalities in Connecticut, the state increased penalties for speeding, e.g., loss of license on first offense, and began to more strictly enforce the speed limits. At the end of one year, fatalities had decreased. This decrease was significant in light of the fact that based on trend analysis an increase would have been expected. Further, this decrease occurred during a period when increases continued both in New York and New Jersey. The authors point out the decreases as indicators of success. However, the authors fail to deal with two critical points. First, because the number of fatalities in the year prior was the highest ever, changes could have occurred simply as a result of regression to the mean. Glass (noted on the following page) in this same issue of Law and Society Review clearly points out the limitations in the analyses when regression to the mean is taken into account. The second factor that could have contributed to the decrease was the increased presence of the police. Any changes that occurred could have been related to this increased presence and not to the more severe penalties for speeding per se. There was no attempt made to compare increased police enforcement with the specific crackdown on speeding.

Council, F. M., A Study of the Immediate Effects of Enforcement on Vehicular Speeds, University of North Carolina Safety Research Center, Chapel Hill, March 1970.

This is a report describing how well drivers obeyed speed limits in the presence of both moving and stationary police vehicles. The findings show that speeds decreased significantly in the immediate presence of stationary patrol vehicles but not in the presence of a moving patrol vehicle. There were no long-term influences as a result of either stationary or moving patrol. The speeds of vehicles increased once past the patrol. In fact, the drivers, once past a moving patrol, increased their speeds above the previous average. Here the authors suggest that this occurred because the drivers now felt safer because the patrol was moving away.

The authors justify this study on the basis that the amount of speeding, as a measure, is a surrogate for a measure of accidents. There are several studies cited to support this hypothesis, but none of the studies referenced are wholly able to substantiate the finding. The author notes that "drivers who operated in the extremes of the speed distribution" were more likely to be involved in an accident, but assumes "extremes" and speeding above the limit are the same. Thus the primary conclusion from the study is that stationary police cars helped reduce speeds in their immediate presence and somewhat downstream. There is no measurement of how far downstream the "halo" existed. However, even with the findings, authors are unable to show a relationship between the findings and improved safety on the highways.

Dart, O. K. and Hunter, W. W., "Evaluation of the Halo Effect in Speed Detection and Enforcement," Transportation Research Board, 609, 1976, pp. 31-33

The presence of a stationary police vehicles acted to decrease mean speed and the variance at the vehicle's location. However, there was no clearly demonstrated "halo" effect. Speeds began increasing within 1,000 feet of the police vehicle and any change that had been recorded disappeared within three miles. This report gives a distance to the "downstream" described in Council's report (above).

Glass, G. B., "Analysis of Data on the Connecticut Speeding Crackdown as a Time-Series Quasi-Experiment," Law and Society Review, 3:8, August 1968, pp. 55-76.

This study reviews the data presented by Campbell and Ross. It compares the changes in fatalities on Connecticut highways, after a crackdown on speeding, to the fatalities in other states by the use of sophisticated statistical and mathematical analyses. The basis for comparison is a time-series analyses of monthly changes of fatalities. The conclusions are similar to those of Campbell and Ross in that the fatality data for Connecticut shows decreases after the start of the crackdown, whereas those from neighboring states do not show similar changes. The authors conclude, as a result of their study, that a rigorous mathematical analyses can be applied to a highly random and variable measure such as accidents. However, caution must be exercised in the interpretation because of possible effects of regression to the mean.

Raub, R. A., Effects of Enforcement on Speeds of Motorists, Illinois Department of Transportation, Springfield, May 1978.

The Springfield Police Department (Illinois) operated daily radar enforcement of the speed limit during a six-hour period along one of the city's major north-south streets. This continued from April 1977 through September 1977. Measurements of motorists' speeds were made at different locations along the street, before, during, and approximately six months after the enforcement. The findings show a marked decrease in the average, 85th and variance in speeds during the project. Although speeds had increased within six months after the end of continuous enforcement, these speeds were still significantly lower than those recorded before the project began. No further follow-up was performed. Also, there was no attempt to correlate the changes in speeds and changes in accidents.

See also:

Raub, R. A., Nitzel, J. J., and Dougherty, D. A., Effects of Enforcement on Speeds of Motorists, Proposal for Study, Illinois Department of Transportation, Springfield, March 1977.

Smith, R. D., The Effect of Enforcement on Driving Behavior, International Association of Chiefs of Police, Field Service Division, 1962.

Tests along a segment of road showed that the greatest decrease in vehicle speeds occurred in the presence of a marked police vehicle traveling in the same direction as the vehicles whose speeds were measured. Thus, the author concludes that the effect of enforcement lasted for three miles. However, subsequent research has not been able to substantiate this finding. As shown by Council (previous page) in North Carolina, for example, the maximum effect occurred in the presence of a stationary patrol vehicle. Even this effect apparently dissipated within one mile. Dart (previous page) also found that three miles was the maximum limit of any reduction in speed. Again, Dart's study was performed using a stationary police vehicle.

See also:

Smith, R. D., "The Effect of Enforcement on Driving Behavior," Police Chief, 29:12, 1962

Effects on Driving Behavior

Calica, A. B., Crowther, R. F., and Shumate, R. P., Enforcement Effect on Traffic Accident Generation, Indiana University, Department of Police Administration, August 1963.

This is a mathematical study of enforcement, traffic accident generation, and traffic-flow theories. In addition, the researchers attempted to test theories of speed and its relation to accidents in 72 different areas of the State of Indiana. They used linear regression techniques, comparing changes in both measures to patrol by police. The findings showed very weak relationship between increased enforcement and decreases in speeds or accidents. Where differences were noted, the stronger effects occurred with passenger vehicles but not trucks. The project operated in all areas for less than six months. There was no long-term exposure in any area, nor was there sufficient publicity accompanying the project. There was an immediate effect from the police presence, but this fell off rapidly as the symbol left. The authors question the enforcement of speed per se in that it might not have been appropriate technique. In this project, the police used only citations and arrests. No attempt was made to use warnings.

Joscelyn, J. D., et al. A Study of the Effects of Law Enforcement on Traffic Flow Behavior, Indiana University, Institute for Research in Public Safety, Bloomington, Indiana, January 1972.

The principal conclusion drawn after a short period of testing increased enforcement on sections of highway using both stationary and moving patrol was that the greatest effect, in terms of decreases in vehicle speeds and driver violations, occurred when stationary patrol was used. However, all these decreases occurred in the immediate vicinity of the patrol. There was a rapid fall-off, but the distance was not adequately defined. The researchers found some reductions in these same two categories when moving patrol was employed. However, the reduction was not as large as with stationary patrol. Again there was a rapid fall-off. This study follows the methodology established by Calica et al.

Syvanen, M., Effect of Police Supervision on Perception of Traffic Signs and Driving Habits, Report No. 6, TALJA, Statistical and Research Bureau, Helsinki, Finland, 1967.

This is a report of a two-day test of presence of police vehicles and their effect on drivers. The researchers found some effects but nothing statistically significant. The method for measuring the effects was on a basis of interview of 1,672 drivers. While the results might be useful in terms of measuring immediate effect of police vehicles, the time allotted for the study was too short.

Other Studies

Cooper, D. F. and McDowell, M. R. C., "Police Effects on Accident Risks at T-Junctions," Traffic Engineering and Control, 18:10, October 1977, pp. 486-491.

Sabey, B. E., Experience of Speed Limits in Great Britain, Odense University Press, Denmark, 1975.

Baker, J. S., "Effects of Enforcement on Vehicle Speeds, Highway Accidents and Related Factors," Bulletin 91, Highway Research Board, Washington, D. C., 1954.

Baker, J. S., "Effect of Enforcement and Licensing on Driver Attitude," Transactions of the National Safety Council, Chicago, 1954.

Hand, N. and Hills, P. M., Determination of the Effect of Various Police Activities on Observance of Speed Limits by Drivers, Police Scientific Development Report, Great Britain, 1967.

Hurford, R., The Effects of Police Presence on Road User Behavior, London Metropolitan Police, London, (undated).

Tykkylaninen, N., The Effect of Increased Enforcement on Traffic Behavior, Finland, 1970.

Fitts, G. L., An Evaluation of the Effectiveness of Police Written Warning as a Deterrent to Traffic Law Violations in Tucson, Arizona, University of Arizona, Tucson, 1966.

Dart, O. K., "Effects of the 88.5 km/hr (55 m.p.h.) Speed Limit and Its Enforcement on Traffic Speeds and Accidents," Transportation Research Record, 643, Transportation Research Board, Washington, 1977, pp. 23-32.

OTHER ASPECTS OF ENFORCEMENT

In addition to the experiments designed to test the effectiveness of increased enforcement of traffic laws, a number of authors have attempted to model or describe the expected effects of such enforcement on drivers. Such discussions have often served as the basis for subsequent experiments. There has also been discussion which has attempted to measure the costs of enforcement and the benefits that have apparently been accrued. These latter discussions have faced two major drawbacks. First, despite the large number of experiments conducted by increasing the enforcement, there has been no clearly demonstrated effectiveness in terms of fewer accidents. An attempt to estimate the value of the benefits is thus questionable. Further, the degree of these benefits has been based on the supposed cost of an accident. While using such costs are valid in terms of determining the most beneficial approach among many, the assignment of costs to a singular task of increased enforcement are meaningless. Because the supposed costs of a fatal accident are so high, any calculation that has included fatal accidents has automatically shown a substantial return, even with one less accident. The failure of such measures was clearly shown in the Michigan study (Fatal Crash Reduction Program) reviewed in a previous section.

Finally, there have been some different approaches to enforcement, both through the use of airplanes and as applied to bicyclists. Along with the cost benefit and theoretical studies, these are reported in the following section.

General

Benages, C. J., Bicycle Rules Enforcement, Skokie, Illinois, Illinois Department of Transportation, Springfield, January 1977.

This is a somewhat unusual study in regard to its product, reduced bicycle accidents. However, it is an appropriate study in terms of reduced accidents, because of the uses of increased enforcement of bicycle rules to help prevent accidents involving bicyclists. The author suggests that there was some effectiveness from this project. The problem with a study of this nature is that bicycle accidents occur so infrequently that a statistical measurement of change, even when based on trends, is not possible. Thus, a statement of success must be hedged by the condition, that statistical significant change could not be measured. A series of such projects, when the data was combined, might serve as an adequate base for evaluation.

Cramton, R. C., "Driver Behavior and Legal Sanctions: A Study of Deterrence," Michigan Law Review, 67:3, January 1969, pp. 421-454.

This is a philosophical discussion of the effectiveness of laws as a deterrent to improper driving behavior. As the author states, the knowledge of the odds of being involved in an accident ("unpleasant occurrence") are more influential in shaping driver behavior than the knowledge of the potential severity of that accident. Because the odds of the risk of getting caught for a violation is even greater, this then should be a greater factor in shaping behavior. It should serve as a deterrent to unsafe driving. However, the element of being caught may not be sufficient because of a relatively low risk of apprehension for the mileage driven. The causal relationship between violations and accidents is not clearly established.

The low risk of apprehension occurs primarily because of the lack of a victim in the sense of other criminal activity. Detection generally happens only in the presence of a police officer. Except when there are many officers present, the odds against detection are high (estimated by Zimring in an unpublished thesis in 1966 for speeding to be 1:7,600). The relationship of violations, particularly that of speeding, to accidents is questionable. While enforcement of the unrealistic speed limit on such occasions may reduce average speeds, it is questionable whether such enforcement reduces the frequency of accidents. The author concludes that enforcement must be directed at behavior that is likely to make a difference in accidents, but gives no supporting research to back this conclusion.

One interesting point is made: From the experiment in Connecticut (see Campbell and Ross, "The Connecticut Crackdown with Speeding: Time-Series Data in Quasi-Experimental Analysis"), the author notes that as the severity of the penalty increased, the number of arrests for that violation, as well as

subsequent convictions, decreased. Further, arrests were made at approximately the same rate, but a lower percentage was made for the violation with the more severe penalty. This observation is interesting, particularly in light of the very severe penalties legislated for driving while under the influence of alcohol or drugs and the relatively low number of arrests and subsequent convictions.

The Driver, Wichita Police Department, Kansas, December 1938.

This is one of the earliest studies (1938) into the role of police traffic enforcement and accident reduction. One of the more important conclusions was that the reduction in severity of penalty, from only arrest and booking to an option of written warnings had no apparent effect on the number of accidents. This was based on records from Wichita covering a two-year period. The warning notice by itself was least effective. However, the notice did help increase the motorists' perception of police presence.

O'Brien, J. P. and Sidhu, C. S., Evaluation of Aerial Patrol of Interstate Highways by the Illinois State Police, Illinois Department of Transportation, Springfield, April 1980.

With assistance of a grant from the U. S. Department of Transportation, the Illinois State Police have used aircraft for line patrol of rural Interstate Highways. The pilots of the airplanes have requested assistance from ground vehicles to stop and cite traffic violators, assist stranded motorists, and handle accidents. According to this evaluation performed by the Illinois Department of Transportation, this patrol has helped reduce accidents along the patrolled sections of highways. The analyses include comparisons of accidents before and during patrol, between daylight (when the airplanes are operating) and darkness, and between those Interstate Highways with patrol and those without. The authors claim a 9.1 to one (1) ratio of benefits to costs as a result of the patrol. Because no experimentation has been performed in which ground support was increased to the relative equivalent to the aerial patrol, the benefit-cost ratio is not meaningful. Even with this one exception, however, the report suggests substantial benefits are to be gained from using airplanes regardless of their costs compared to those of ground patrol.

See also:

Cunningham, C. L., Assessment of the Illinois State Police Concept of Aerial Patrol of Interstate Highways, Illinois Department of Transportation, Springfield, March 1976.

Madona, P. P. and Raub, R. A., Interstate Aerial Patrol, Illinois State Police, Interim Evaluation, Illinois Department of Transportation, Springfield, May 1979.

Raub, R. A., Interstate Aerial Patrol Effect on Speeds of Motorists Along I-57, Illinois Department of Transportation, Springfield, March 1979.

Raub, R. A., Interstate Aerial Patrol, Illinois State Police, Evaluation Plan, Illinois Department of Transportation, Springfield, September 1978.

Raub, R. A. and Wolfson, B. J., Comparison of Aerial and Ground Speeds, Illinois Department of Transportation, Springfield, September 1978.

Research on Traffic Law Enforcement: Effects of the Enforcement of Legislation on Road User Behavior and Traffic Accidents, Organization for Economic Cooperation and Development, Paris, April 1974.

This is a survey of existing literature from all countries dealing both with the theory of enforcement from the point of view of the police, courts, and road user, and the research into the effects of enforcement on traffic offenses and on traffic accidents. The report also suggests the need for future research. Given below are summaries:

(Traffic violations only)

(Finland) - Stationary police vehicle effective only in immediate vicinity. Longer distances were found suitable for the moving patrol car. Most positive effect of regular patrol was on regular users of highways, but regular users rapidly became aware of times when patrol car was on highway.

(Germany) - Warning signs, signals, etc., were effective only for short distance. The signs without corresponding enforcement lost effectiveness in two months.

(Japan) - Experimented solely with speed reduction. Found that violation rate and variance decreased in presence of police. Similar effect found in Great Britain; however, the referenced study done by the London Metro Police was not valid.

(U. S.) - Shumate and Smith experimented with effects of police vehicles on speeds. Both found that there were immediate effects, particularly in terms of smaller variances, but no halo or long-term effects. Also discusses studies of the effectiveness of warnings versus arrests, where the Wichita Police and Fitts in Tucson both found that a greater number of subsequent violations were committed by those who received warnings as opposed to citations.

(Traffic violations and accidents)

(Great Britain) - Several studies of increased enforcement and accident reduction did not prove conclusive.

(U. S.) - Kunz in Springfield, Massachusetts, conducted the first rigorous study of traffic law enforcement in 1945. He found substantial decreases in fatalities and injuries, but there was a lack of statistical control and subsequent follow-up to validate the findings. In Operation 101, the California Highway Patrol apparently had some favorable results on rural highways. There existed a rough correlation between the increased hours of patrol and the decrease in accidents. Other studies, including those in Minnesota, Illinois, and Wisconsin, showed no valid results.

(Norway and Sweden) - Increased patrol may have a potential for decreasing violations and accidents, but there is no clear link between patrol and violations or accidents.

This summary of literature was prepared before projects in both STEP and ASAP had been completed in the U. S.; thus, a large body of literature was not yet available for review. The summary also points out the major deficiencies in studies done to date:

- . Insufficient sample sizes
- . No measurement of the longer-term effects
- . Lack of controls
- . Failure to separate publicity from enforcement
- . No differences measured among degrees of enforcement.

Ward, P. B., Woods, G. D., and Brennan, P., A Review of Legislation and Enforcement in Relation to Road Safety, Sydney University, Institute of Criminology, Canberra, Australia, November 1971.

This review follows a 1968 report by Fennessy and Joksch on the effects ("Police Traffic Services and Road Safety: An Evaluation of the Literature") of enforcement as related to fewer accidents. Since that report, with the exception of the program of the California Highway Patrol conducted along U. S. 101, there have been no well conducted studies in this area of research. This has been especially true for traffic enforcement in urban areas. This review points to the methodological weakness of before and after comparisons based on the highly variable and random occurrence of accidents. The author also points to the drawing of conclusions of success from poorly prepared studies or analyses of data. For an example, the authors use the study by Bankhead and Herm ("Reducing Accidents by Selective Enforcement"). This report is directed in general toward the implementation of programs in Australia and does not deal extensively with currently operating projects in other countries.

See also:

Fennessy, E. F. and Joksch, H. C., Police Traffic Services and Road Safety on Evaluation of the Literature, Travellers Research Center, U. S. Department of Transportation, Washington, 1968.

Laxer, G. D., A Review of the Literature in the Effectiveness of Formal Enforcement Activities in Reducing Road Accidents Frequency, Ontario Department of Transportation Research Branch, Toronto, 1967.

Cost-Benefit Analysis

Evaluation of Selective Traffic Enforcement Programs, PRC Management Services, Inc., McLean, Virginia, May 1974.

This is a review of three projects of Selective Traffic Enforcement: El Paso, Texas; Chattanooga, Tennessee; and Sacramento, California. Nine of the fourteen countermeasures published by the National Highway Traffic Safety Administration (NHTSA) were supposedly tested. According to the authors, the most effective seemed to be "Patrol and Cite" as demonstrated in El Paso (although this is not adequately validated in the El Paso study). The authors also claim that "quality" or arrests (DWI) in Sacramento may have contributed to decreases in accidents, while other places showed increases during the same period. The authors base this claim for effectiveness on a small sample, a change from 16 to 11 accidents. The projects reviewed were considered only for changes in accidents. The only possible successes in El Paso, for example, came when the police were patrolling segments or areas. No specific success could be shown in any of the three cities as a result of intersection patrol. For example, in Chattanooga, fatal and injury accidents decreased during the first period of testing from 39 to 31 but increased during the second period from 15 to 21.

This report seems to have been written to satisfy contractual arrangements with NHTSA. It justifies the one million dollars in federal safety funds spent on these three projects, but it fails to take a critical look at those projects. Examination of the individual projects clearly points to their weaknesses. These weaknesses are overlooked in this generalized review.

See also:

Jeffcoate, G. O., "Effect of Motor Patrols on Accidents," Nature, Vol. 166, 1950, pp. 639-640.

Kunz, F. M., "How Enforcement Affects the Driver's Behavior," Traffic Section, Federal Bureau of Investigation, (Greater New York Safety Convention), Washington, D. C. 1950.

Hooker, R. W., Traffic Accident Costs and the Effectiveness of Highway Safety Expenditures in Wyoming. University of Wyoming, Division of Business and Economic Research, Laramie, November 1966.

In a study of costs and accidents, Hooker claimed that for each dollar invested in the Wyoming Highway Patrol, there was a 12 dollar payoff in fewer accidents. This was derived by the use of multiple regression analyses taking into account such variables as: hours worked (by police), safety expenditures, local police expenditures, maintenance expenditures, snow and ice removal expenses, expenses for traffic services, etc. Also included in the regression

analyses were registrations, mileage, and days of ice and snow. This study has been strongly criticized for its failure to adequately use multiple regression techniques. By using the same data as Hooker, Joksch (noted below) showed that costs of safety education were positively related to accidents, an increase in the costs of safety education were followed by an increase in traffic accidents.

Joksch, H. C., "A Critique of a Study by Hooker of Highway Patrol Effect on Accidents," Traffic Digest and Review, 17:6, June 1969, pp. 7-9.

Hooker, in Wyoming, estimated that one dollar spent by the Wyoming Patrol saved \$12.83 in accident costs. This estimate was based on regression analysis performed by Hooker. Joksch criticizes the statistical methodology and shows that by using the same data a negative effect, not positive, is as easily shown. Hooker's conclusions must be questioned.

Shoup, D. C., "Cost Effectiveness of Traffic Law Enforcement," Journal of Transport Economics and Policy, Vol. 7, No. 1, January 1973, pp. 32-57.

In order to measure cost-benefit of increased enforcement, the City of Los Angeles participated in an experiment of increasing the number of patrol officers at various locations. Although there were relationships between the number of officers and changes in accident, these changes were both positive and negative. The simple increase in patrol officers did not help reduce accidents. Yet, an attempt was made to show that such increases were cost-effective.

Other

A Preliminary Study of the Issuance of Written Warnings by State Law Enforcement Agencies in Certain Violations of Traffic Laws, University of Michigan, School of Police Administration and Public Safety, Ann Arbor, 1964.

Bailey, S. E., "Can the Influence of Police Action on Driver Behavior, Traffic Flow, and Accidents Be Quantified," Police Research Bulletin, Number 2, 1972, pp. 37-41.

Bryne, E. C., "Preventive and Selective Enforcement of Traffic Laws," Law and Order, June 1975, pp. 181.

Darling, J., "The Respective Role of Education and Enforcement," Papers, National Road Safety Symposium, Canberra, Australia, 1972, pp. 632-638.

Influencing Road User Behavior, Institute for Road Safety Research, Voorburg, Netherlands, 1975.

Middendorff, W., The Effectiveness of Punishment, Especially in Relation to Traffic Offenses, Rothman, London, 1968.

Sabey, B. E., "Potential for Accident and Injury Reduction in Road Accidents," Proceedings, 29, Traffic Safety Research Seminar, Road Traffic Safety Research Council, New Zealand 1976.

Slavin, J. M., "Problems of Law Enforcement," Proceedings, 13th Annual Conference, Canadian Highway Council, 1967.

Slavin, J. M., "Role of Traffic Law Enforcement in Traffic Accident Prevention," Traffic Quarterly, October 1967, pp. 611-620.

Watts, L. P., Alcohol/Drug Literature Related to Law Enforcement - Alcohol Countermeasures Literature Review, National Safety Council.

Wilson, R. P., "The Effects of Police Withdrawal from Traffic Control: A Comparative Study," Journal of Criminal Law, December 1970, pp. 567-572.

SUMMARY

The major shortcoming with the experiments that have been conducted has been the lack of any clear causal link between increased traffic law enforcement and reduced accidents. There has been a number of studies where success has been shown. In most, however, the researchers have not been able to adequately separate the effects of other influencing variables including highway geometrics, weather, auto usage, etc., from the effects of increased traffic law enforcement alone. Further, even where there has been a fairly clear correlation between increased enforcement and decreased accidents, there has been no clear indication of those factors within enforcement, e.g. the issuance of citations for violations, that have contributed to the reductions. This is not to say that increased enforcement is ineffective. Rather, there are no clearly identified links between increased enforcement and improved traffic safety. What is known is that when the number of police officers on traffic patrol is increased, and they patrol at those times of the day and days of the week and at locations that have had relatively high frequencies of accidents, there is a good likelihood that traffic accidents will decrease.

BIBLIOGRAPHY

- "Alcohol Safety Action Projects" Evaluation of Operations - 1972, Volume II, Detailed Analysis, National Highway Traffic Safety Administration, Washington, 1973.
- "A.P.O." 1970, Minnesota Highway Patrol, Safety Research Section, St. Paul, October 1970.
- "A.P.O." 1972, Minnesota Highway Patrol, Safety Research Section, St. Paul, 1972.
- Ayoob, M. F., "Getting in Step with CTEP," Law and Order, 1978, pp. 66-68.
- Baker, J. S., "Effect of Enforcement on Vehicle Speeds, Highway Accidents, and Related Factors," Bulletin 91, Highway Research Board, Washington, D. C., 1954.
- Baker, J. S. "Effect of Enforcement and Licensing on Driver Attitude," Transactions of the National Safety Council, Chicago, 1974.
- Bankhead, K. and Herms, B. F., "Reducing Accidents by Selective Enforcement," Traffic Digest and Review, 18:1, January 1970, pp. 1-5.
- Beitel, G., Shart, M., and Glauz, W. D., "Probability of Arrest While Driving Under the Influence of Alcohol," Journal of Studies of Alcohol, Vol. 36, 1975, pp. 109-116.
- Benages, C. J., Bicycle Rules Enforcement Program, Skokie, Illinois, Illinois Department of Transportation, Springfield, January 1977.
- Benages, C., Concentrated Traffic Enforcement Program, Champaign, Illinois, Evaluation Report, Illinois Department of Transportation, Springfield, December 1978.
- Benages, C., Concentrated Traffic Enforcement Program, Illinois State Police, Interim Evaluation Report, Illinois Department of Transportation, Springfield, July 1978.
- Bensen, O. C., North Dakota Selective Traffic Enforcement Program - Project Director's Report, North Dakota State Highway Patrol, April 1976.
- Berroyer, C., Concentrated Traffic Enforcement Program, Illinois State Police, Evaluation of First Year, Illinois Department of Transportation, Springfield, April 1979.
- Brenner, R. and Fisher, G. R., "Statistical Analysis of Accident Data as a Basis for Planning Selective Enforcement," Highway Research Record, Highway Research Board, Washington, 1967.

- Byrne, E. C., "Preventive and Selective Enforcement of Traffic Law," Law and Order, June 1975, pp. 181.
- Calica, A. B. and Crowther, R. F., Enforcement Effect on Traffic Accident Generation, Indiana University, Department of Police Administration, Bloomington, 1963.
- Campbell, D. T. and Ross, H. L., "The Connecticut Crackdown on Speeding: Time-Series Data in Quasi-Experimental Analysis," Law and Society Review, 3:8, August 1968, pp. 33-53.
- "Can the Influence of Police Action on Driver Behavior, Traffic Flow, and Accidents be Quantified," Police Research Bulletin, Number 2, 1972, pp. 37-41.
- The Christ Church Traffic 'Blitz', Ministry of Transport, Traffic Research Section, Wellington, New Zealand, 1974.
- Clay, T. R., "Selective Enforcement of Drunken Driving in Phoenix, Arizona," Journal of Safety Research, Fall 1978, pp. 130-138.
- Cohen, J. and Preston, B., Causes and Prevention of Road Accidents, Faber, London, 1968.
- Concentrated Traffic Enforcement Program, Illinois State Police, 2nd Year, Illinois Department of Transportation, Springfield, March 1979.
- Cooper, D. F. and McDowell, M. R. C., "Police Effects on Accident Risks at T-Junction," Traffic Engineering and Control, 18:10, October 1977, pp. 486-491.
- Cooper, P. J., Effectiveness of Traffic Law Enforcement; A Study to Assess the Effectiveness of Different Levels of Police Enforcement on Driver Behavior and Safety at Urban Intersections, Ministry of Transport, Canada, DeLeuw, Cather, and Company of Canada, Toronto, 1974.
- Cooper, P. J., "Effects of Increased Enforcement at Urban Intersections on Driver Behavior and Safety," Transportation Research Record, 540, Transportation Research Board., Washington, 1975, pp. 13-21.
- Council, F. M., A Study of the Immediate Effects of Enforcement on Vehicular Speeds, Highway Safety Research Center, North Carolina University, March 1970.
- Cramton, R. C., "Driver Behavior and Legal Sanctions," Michigan Law Review, 67:3, 1969, pp. 421-454.
- Crittenden, B., "Operation 101," The Police Chief, Vol. 31, 1966, pp. 8-16.
- Darling, J., "The Respective Role of Education and Enforcement," Papers, National Road Safety Symposium, Canberra, Australia, 1972, pp. 632-638.

- Dart, O. K., "Effects of the 88.5 km/h (55 m.p.h.) Speed Limit and Its Enforcement on Traffic Speeds and Accident," Transportation Research Record, 643, Transportation Research Board, Washington, 1977, pp. 23-32.
- Dart, O. K. and Hunter, W. W., "Evaluation of the Halo Effect in Speed Detection and Enforcement," Transportation Research Record, 609, Transportation Research Board, Washington, 1976, pp. 31-33.
- Dougherty, D. A., Police Traffic Unit, Creve Coeur, Illinois, First Year Report, Illinois Department of Transportation, Springfield, March 1977.
- Dougherty, D. A., Selective Traffic Enforcement Program, Champaign, Interim Report, Illinois Department of Transportation, May 1977.
- Dougherty, D. A., Selective Traffic Enforcement Program, Springfield Interim Report, Illinois Department of Transportation, Springfield, March 1977.
- The Driver, Wichita Police Department, Wichita, Kansas, 1938.
- "Enforcement Must be Planned," Proceedings, 22nd, Institute of Traffic Engineering, 1961, pp. 40-45.
- The Enforcement of Traffic Laws, Michigan University, Highway Safety Research Institute, Lansing, 1967.
- Ennis, H. P., "Traffic Citations Are More Effective Than Written Warnings," Traffic Digest and Review, 15:7, July 1967, p. 4.
- Evaluation of Selective Enforcement Programs, Interim Report, PRC Public Management Services, Inc., McLean, Virginia, May 1974.
- Fatal Crash Reduction Program, Demonstration Project, National Highway Traffic Safety Administration, Washington, 1973.
- Fennessy, E. F. and Joksch, H. C., Police Traffic Services and Road Safety: An Evaluation of the Literature, Travellers Research Center, U. S. Department of Transportation, Washington, 1968.
- Fitts, G. L., An Evaluation of the Effectiveness of Police Written Warnings as a Deterrent to Traffic Law Violations in Tucson, Arizona, University of Arizona, Tucson, 1966.
- Francis, D., McEwen T., and Lynn P., Fort Lauderdale Selective Traffic Enforcement Program Final Evaluation, PRC Public Management Services, Inc., Ft. Lauderdale, August 1976.
- Freckleton, S., Traffic Policing Effectiveness Measurement and Resource Allocation, Plenum Press, New York, pp. 299-315.
- Glass, G. V., "Analyses of Data on the Connecticut Speeding Crackdown as a Time-Series Quasi-Experiment," Law and Society Review, 3:8, August 1968, pp. 55-76.

Goodson, G. L., "Manpower Allocation and Countermeasure Evaluation," Special Report 153, Transportation Research Board, Washington, 1975, pp. 241-244.

Hackman, K. D. J. and Hayes, H. B., North Dakota Selective Traffic Enforcement Program (STEP), Final Evaluation, North Dakota State Highway Patrol, NHTSA, Final Report, April 1976.

Haddon, W., Suchman, E. A., and Klein, D. V., Accident Research: Methods and Approaches, Harper and Row, New York, 1964.

Hand, N. and Hills, P. M., Determination of the Effect of Various Police Activities on Observance of Speed Limits by Drivers, Report Number 19, Police Scientific Development, Great Britain, 1967.

Hauer, E., Estimation of the Effectiveness of Some Selective Enforcement Procedures, Phase 1, Department of Civil Engineering, University of Toronto, December 1975.

Hauer, E., Estimation of the Effectiveness of Some Selective Enforcement Procedures, Phase 2, Department of Civil Engineering, University of Toronto, December 1975.

Hauer, E. and Cooper, P. J., "Effectiveness of Selective Enforcement in Reducing Accidents in Metropolitan Toronto," Transportation Research Record, 643, Transportation Research Board, Washington, 1977, pp. 18-22.

Hause, J., et al., Increased DWI Enforcement Program, Stockton, California - Project Evaluation Interim Report, Stockton Police Department, California, January 1977.

Hause, J., et al., Increased DWI Enforcement Program, Stockton, California - Second Annual Report, Stockton Police Department, California, June 1977.

Hawkins, T. E., Summary of ASAP Results for Application to State and Local Projects, Vol. 1, ASAP Findings, Southeast Research Institute, Dallas, Texas, August 1976.

Hirsch, P., "Radar Reduces Accidents," Public Roads, 86:7, 1955, pp. 83-84.

Hooker, R., Traffic Accidents and the Effectiveness of Highway Safety Measures in Wyoming, Division of Business and Economic Research, University of Wyoming, Laramie, November 1966.

"How Flint Cut Its Traffic Toll," Journal of American Insurance, 47:4, April 1969, pp. 22-41

Huddleston, B., "Operation Saturation," Law and Order, June 1968, pp. 86-91.

Huffman, W. J., et al., "The Effectiveness of an Emphasis Patrol by the Illinois State Police in a District on a Selected Highway," Traffic Safety, 5:1, 1961, pp. 17-29.

Hurford, R., The Effects of Police Presence on Road User Behavior, London Metropolitan Police (undated).

Influencing Road User Behavior, Institute for Road Safety Research, Voorburg, Netherlands, 1975.

Jeffcoate, G. O., "Effect of Motor Patrols on Accidents," Nature, Vol. 166, 1950, pp. 639-640.

Joksch, H. C., "A Critique of a Study by Hooker of Highway Patrol Effect on Accidents," Traffic Digest and Review, 17:6, June 1969, pp. 7-9.

Joscelyn, K. B., et al., A Study of the Effects of Law Enforcement on Traffic Flow Behavior, Indiana University, Institute for Research in Public Service, Bloomington, 1971.

Klein, D. and Waller, J. A., Causation, Culpability, and Deterrence in Highway Crashes, National Highway Traffic Safety Administration, Washington, 1970.

Kunz, F. M., How Enforcement Affects the Driver's Behavior, Greater New York Safety Convention, Traffic Section, FBI, Washington, D. C., 1950.

Laxer, G. D., A Review of the Literature on the Effectiveness of Formal Enforcement Activities in Reducing Road Accidents Frequency, Ontario Department of Transport, Research Branch, Toronto, 1967.

Lees, M. A., An Analysis of ASAP Patrol Activity, South Dakota University, Vermillion, May 1974.

Lund, M. B. and Joergensen, N. O., "The Effect of the Increased Police Enforcement on the A1," Report Number 16, Danish Council for Road Safety Research, September 1974.

Madonia, P. P. and Raub, R. A., Interstate Aerial Patrol, Illinois State Police, Interim Evaluation, Illinois Department of Transportation, Springfield, May 1979.

Mason, B. and Bieber, R. A., Operation 500, Final Report, U. S. 101 Accidents, California Department of Highway Patrol, Sacramento, March 1970.

McConnell, R. H., Serdinov, S. M., and David, N. A., City of Tacoma Selective Traffic Enforcement Program, Tacoma, Washington, Tacoma Police Department, Washington, April 1976.

McEwen, T., El Paso Selective Traffic Enforcement Program, El Paso City Police Department, Texas, August 1976.

McEwen, T. and Brazil, F., Sacramento, California, Selective Traffic Enforcement Program, Sacramento City Police Department, California, August 1976.

McKay, R. N., "Montana's Accident Prevention Unit Cuts Crashes at Selected Locations," Traffic Safety, January 1974, pp. 12-14.

Michaels, R. M., "The Effects of Enforcement on Traffic Behavior," Public Highway, 1960, pp. 109-113.

Middendorff, W., The Effectiveness of Punishment, Especially in Relation to Traffic Offenses, Rothman, London, 1968.

Moore, S. E. and Lowrie, P. R., "Further on the Effects of Coordinated Traffic Signal Systems on Traffic Accidents," Proceedings Volume 8, Australia Road Research Board Conference, 1976, pp. 10-15.

Munden, J. M., An Experiment in Enforcing the 30 m.p.h. Speed Limit, Road Research Laboratory, England, 1966.

O'Brien, J. P., Concentrated Traffic Enforcement Program, McHenry County, First Year Evaluation Report, Illinois Department of Transportation, Springfield, September 1979.

O'Brien, J. P. and Sidhu, C. S., Evaluation of Aerial Patrol of Interstate Highways By the Illinois State Police, Illinois Department of Transportation, Springfield, April 1980.

Operation 101, An Accident and Enforcement Study, California Department of Highway Patrol, Sacramento, 1972.

Operation 101: Final Report, Phase I Background and Accident Analysis, California Highway Patrol, Sacramento 1970.

Operation 101 - Results of Violation Surveys, California Highway Patrol, November 1969.

Operation 500, A Study of the Effect of Increased Road Patrol, California Department of Highway Patrol, Sacramento, 1972.

Pivovarnik, D. L., and Raub, R. A., Concentrated Traffic Enforcement Program, Park Ridge, Final Report, Illinois Department of Transportation, Springfield, July 1978.

A Preliminary Study of the Issuance of the Written Warning by State Law Enforcement Agencies in Certain Violations of Traffic Laws, University of Michigan, School of Police Administration and Public Safety, Ann Arbor, 1964.

Promisel, D. M., et al., Manual for a Selective Traffic Enforcement Program for Alcohol Related Motor Vehicle Crashes, National Highway Traffic Safety Administration, Washington, 1972.

Raub, R. A., Effects of Enforcement on Speeds of Motorists, Illinois Department of Transportation, Springfield, May 1978.

Raub, R. A., Interstate Aerial Patrol, Effect on Speeds of Motorists Along I-57, Illinois Department of Law Enforcement, December 1979.

Raub, R. A., Interstate Aerial Patrol, Illinois State Police, Evaluation Plan, Illinois Department of Transportation, Springfield, December 1977.

Raub, R. A., Selective Traffic Enforcement Program, Evanston, First Year Report, Illinois Department of Transportation, Springfield, June 1978.

Raub, R. A., Nitzel, J. J., and Dougherty, D. A., The Effects of Enforcement on the Speeds of Motorists - A Proposal for Study, Illinois Department of Transportation, Springfield, March 1977.

Raub, R. A. and Wolfson, B. J., Comparison of Aerial and Ground Speeds, Illinois Department of Transportation, Springfield, September 1978.

Raub, R. A., et al., Concentrated Traffic Enforcement, Illinois State Police, Evaluation Plan, Illinois Department of Transportation, Springfield, November 1977.

"Reduces Traffic Toll Through Strict Enforcement in Kingman, Arizona," Traffic Safety, 66:6, June 1966, p. 21.

Research on Traffic Law Enforcement, Organization for Economic Cooperation and Development, Paris, 1974.

Rice, R. A., "A Study of Varying Degrees of Speed Limit Enforcement," Papers, National Road Safety Symposium, Queensland, Australia, March 1972, pp. 94-104.

Rutherford, J. W., "Flint's Selective Enforcement Unit Proves Successful," Traffic Digest and Review, 19:4, April 1971, pp. 9-13.

Sabey, B. E., Experience of Speed Limits in Great Britain, Odense University Press, Denmark, 1975.

Sabey, B. E., "Potential for Accident and Injury Reduction in Road Accidents," Proceedings - Traffic Safety Research Seminar, 29, Road Traffic Safety Research Council, New Zealand, 1976.

A Safety Demonstration Program for Oakland County, Michigan, Oakland County Traffic Improvement Association, Pontiac, Michigan (undated).

Saunders, R. R. and Hamilton, R. S., City of Newport Beach Traffic Safety Project, Newport Beach, California, 1973.

Scott, R. D., "Preventive Enforcement Against Drunk Drivers," Traffic Digest and Review, 18:10, October 1970, pp. 1-5.

"Selective Enforcement Prove Cost Effectiveness in Crash Containment," Wisconsin Traffic Safety Report, February 1975, pp. 1-2.

Selective Traffic Enforcement Program, Stockton, California, Final Report, Stockton Police Department, California, 1978.

Shoup, D. C., "Cost Effectiveness of Urban Traffic Law Enforcement," Journal of Transportation Economics and Policy, January 1973, pp. 32-57.

Shumate, R. P., The Effect of Increased Patrol on Accidents, Diversion, and Speed, Northwestern University, The Traffic Institute, Evanston, Illinois, 1957.

Shumate, R. P., The Long Range Effect of Enforcement on Driving Speeds, Project 533, International Association of Chiefs of Police, Washington, D. C. (undated).

Slavin, J. M., "Problems of Law Enforcement," Proceeding 13th Annual Conference, Canadian Highway Council, 1967.

Slavin, J. M., "Role of Traffic Law Enforcement in Traffic Accident Prevention," Traffic Quarterly, October 1967, pp. 611-620.

Smith, R. D., The Effects of Enforcement on Driving Behavior, International Association of Chiefs of Police, Research and Development Section, Washington, D. C., 1962.

Smith, R. D., "The Effect of Enforcement on Driving Behavior," Police Chief, 29:12, 1962.

Smith, R. D., et al., Police Traffic Responsibilities - Manpower Requirements, Allocations, Distributions, International Association of Chiefs of Police, July 1969.

Syvanen, M., Effect of Police Supervision on the Perception of Traffic Signs and Driving Habits, TALJA, Report No. 6, Helsinki, Finland, 1968.

Taubenslag, W. N. and Taubenslag, M. H., Selective Traffic Enforcement Program - STEP - BAC Study in Fort Lauderdale, Florida, Fort Lauderdale, Florida Police Department, August 1976.

Toomath, J. B. and Eng, M., The Hamilton Traffic "Blitz", New Zealand Transport Ministry, February 1974.

Toomath, J. B. and Eng, M., "Short Term Traffic Blitzes," Report Number 11, Ministry of Transport, New Zealand (undated).

Tykkylaninen, N., The Effect of Increased Enforcement on Traffic Behavior, Finland, 1970.

Ward, P. G., et al., A Review of Legislation and Enforcement in Relation to Road Safety, November 1971.

Watts, L. P., Alcohol/Drug Literature Related to Law Enforcement - Alcohol Countermeasures Literature Review, National Safety Council, Chicago, October 1977.

Williams, A. J. and Robertson, L. S., "The Fatal Crash Reduction Program: A Reevaluation," Accident Analysis and Prevention, May 1975, pp. 37-44.

Willmer, M., An Assessment of Various Methods of Policing a Motorway, Home Office, Scientific Advisors Branch Police Report, London, 1964.

Wilson, P. R., "The Effects of Police Withdrawal from Traffic Control: A Comparative Study," Journal of Criminal Law, December 1970, pp. 567-572.

Zador, P., Statistical Evaluation on the Effectiveness of Alcohol Safety Action Programs, Insurance Institute of Highway Safety, Washington, D. C., 1974.

Zylman, R., "DWI Enforcement Programs: Why Are They Not More Effective," Accident Analysis and Prevention, 7:3, September 1975, pp. 179-190.

END