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16. Abstract

Straightforward and powerful reasons exist for lowering the legal limit of blood alcohol concentration (BAC) from 0.10 to 0.08. In 1964, Borkenstein et al. showed that drivers who had been drinking were more likely to be involved in a crash than sober drivers, and that beginning with low BACs, the greater the level of intoxication, the higher the probability of being in a crash. Other investigators have replicated and refined Borkenstein et al.'s original findings. More recently, Mounce and Pendleton (1992) extended this line of research by showing that driver BAC is associated with the probability of being *responsible* for a crash in which they were involved.

The objective of the current study was to review the fatal crash experience of all of the states that have lowered BAC limits to 0.08; however, many of these states have not had sufficient experience with the lower BAC limit to provide meaningful statistical inferences. At the time this study was begun, 11 states had sufficient experience with 0.08 BAC laws to conduct a statistical analysis.

In summary, the analysis of the impact of 0.08 BAC laws found that 5 of the 11 states that implemented such laws experienced significantly lower rates of alcohol involvement among fatalities, and that five of these states experienced significantly fewer high-BAC and alcohol related fatalities during the period after implementation. While some of these states were apparently already experiencing either a long-term or short-term downward trend in alcohol involvement, due possibly to other factors such as the presence of laws (ALR), the use of sobriety checkpoints, or a general societal trend for reduced alcohol consumption, this alone does not account for the reductions observed. Each and every state in the group exhibiting a significant association between 0.08 and reductions in alcohol involvement already had an administrative license revocation law in effect (Vermont, Kansas, North Carolina, Florida and New Mexico). An additional 2 states (California and Virginia) experienced significant reductions after ALR was in place, when the effects of 0.08 and ALR (implemented about 6 months apart) were considered as a single intervention. Clearly, other factors may be at work, as evidenced by the presence of declines in alcohol involvement that began around 1992, which coincided with the implementation of neither 0.08 nor ALR. While it is difficult to pinpoint exactly what factors may be responsible, the data and analyses are clearly suggestive that 0.08 BAC laws have some deterrent effect, leading to reductions in drinking and driving, most notably in conjunction with the presence of other drunk-driving laws and practices, especially administrative license revocation.

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EXECUTIVE SUMMARY

Straightforward and powerful reasons exist for lowering the legal limit of blood alcohol concentration (BAC) from 0.10 to 0.08. In 1964, Borkenstein et al. showed that drivers who had been drinking were more likely to be involved in a crash than sober drivers, and that beginning with low BACs, the greater the level of intoxication, the higher the probability of being in a crash. Other investigators have replicated and refined Borkenstein et al.'s original findings. More recently, Mounce and Pendleton (1992) extended this line of research by showing that driver BAC is associated with the probability of being *responsible* for a crash in which they were involved. Research also shows that virtually all drivers, even experienced drivers, are significantly impaired with regard to critical driving tasks at 0.08 BAC. The strong relationship between BAC level, probability of crash involvement, and increased impairment, has led a growing number of states to lower their legal BAC limits. To date, 16 states and the District of Columbia have lowered the BAC limit to 0.08 for adult drivers.

It is hypothesized that implementing a 0.08 BAC law has a synergistic effect on the other components of the anti-drunk driving system, namely the enforcement, adjudication, judicial, licensing, and public information and education components. The U.S. experience suggests that combating drunk driving is most effective when ALL of the components are at play. This was the approach espoused by the U.S. Department of Transportation as early as 1970, in its $88 million Alcohol Safety Action Program, which emphasized a *systems approach* to reduce alcohol-impaired driving. Even with legislation itself, the enactment of multiple initiatives (often called "omnibus bills") has generally resulted in more public awareness, and often more impact, than the enactment of single-initiative legislation. In the case of 0.08 BAC legislation, it is anticipated that implementing such laws builds upon legislation and other activity already in place. The expectation is that the publicity surrounding 0.08 BAC legislation serves to remind the public about the dangers of drinking and driving and may catalyze the enforcement, judicial, and licensing communities to refocus its efforts on the importance of removing drunk drivers from the nation's roads.

The objective of the current study was to review the fatal crash experience of all states that have lowered their BAC limits to 0.08 and to determine the impact of this legislation on alcohol-related fatalities. However, in several of these states, there was not sufficient experience with the lower BAC limit to provide meaningful statistical inferences. At the time this study was begun, eleven states had sufficient experience with 0.08 BAC laws to conduct a meaningful analysis.

In summary, our analysis found that the rate of alcohol involvement in fatal crashes declined in eight of the states studied after the effective date of the 0.08 BAC law. Further, 0.08 BAC laws were associated with significant reductions in alcohol-related fatalities, alone or in conjunction with administrative license revocation (ALR) laws, in seven of the eleven states. In five of these seven states, implementation of the 0.08 BAC law itself was followed by significantly lower rates of alcohol involvement among fatalities. These results take into account any pre-existing downward trends the states were already experiencing, due possibly to other factors such as the presence of other laws, sobriety checkpoints, or a general societal trend for reduced alcohol consumption.

Two of the seven states which showed impact (California and Virginia) exhibited significant reductions in alcohol-related fatalities when the 0.08 and ALR laws, implemented within about 6 months of one another, were modeled as a single intervention.

These findings are consistent with the hypothesis that 0.08 laws work best in conjunction with other laws, especially ALR laws. All of the states which exhibited a significant association between a 0.08 BAC law and a reduction in alcohol involvement already had an administrative license revocation law in effect (Vermont, Kansas, North Carolina, Florida and New Mexico). In two states the reductions occurred when 0.08 BAC and ALR laws were enacted in close temporal proximity to each other (California and Virginia).

Again, it is clear that many factors have been at work since the early 1980's, which have resulted in long-term declines in alcohol-related fatalities in most states. Some of these factors were in operation prior to the implementation of the 0.08 BAC laws. While it is difficult to pinpoint all the factors that have been responsible for these long-term declines, it is likely that the declines resulted from a combination of legislative, enforcement, judicial, sanctioning, and public information activities implemented in the states. These analyses suggest that the 0.08 BAC laws added significantly to this impact in several of the states studied, usually in conjunction with the presence of administrative license revocation laws.

Reduction of the legal BAC limit from 0.10 to 0.08 also appears to be associated with a reduction in beer consumption in 4 of the 5 states for which consumption data were available. The association is strong in two of these five states (California and Vermont). The association in California is weaker and is clouded by increased volatility following implementation of the 0.08 law. The absence of an association in Oregon could be due to an artifact. A substantial reduction in annual beer consumption occurred two years before the 0.08 law was implemented. This sharp reduction may have made it difficult for an additional reduction to occur.

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INTRODUCTION

Straightforward and powerful reasons exist for lowering the legal limit of blood alcohol concentration (BAC[1]) from 0.10 to 0.08. Borkenstein et al. (1964) showed that: (1) drivers who had been drinking were more likely to be involved in a crash than sober drivers, and (2) beginning with low BACs, the greater the level of intoxication, the higher the probability of being in a crash. Other investigators have replicated and refined Borkenstein et al.'s original findings (Baker and Spitz, 1970; Hurst, 1970; Farris, Malone, and Lilliefors, 1976; Mayhew et al., 1986; Zador 1991). For reviews of these and other research, see NHTSA (1991a) and NHTSA (1992). More recently, Mounce and Pendleton (1992) extended this line of research by showing that driver BAC is associated with the probability of being *responsible* for a crash in which they were involved. Research also shows that virtually all drivers, even experienced drivers, are significantly impaired with regard to critical driving tasks, such as braking, lane changing, and divided attention, by the time they reach 0.08 BAC (Moscowitz, 1988). The strong relationship between level of intoxication and probability of crash involvement, as well as the impairment research, has led a growing number of states to lower their legal BAC limits. To date, 16 states and the District of Columbia have lowered the BAC limit to 0.08 for adult drivers.

While the desired impact of lowering BAC limits is obvious, predicting the actual effects is complex because of many uncertainties. Who, for example, will be affected by lower BAC limits, and what is the mechanism through which they will be impacted? To begin with, there is the question of how many and which drinkers are aware of a change in BAC laws. Assuming that drinkers know the legal limit, do they understand its meaning – not in terms of grams of ethanol per deciliter of blood (g/dl), but in terms of how many drinks of alcohol (of what kind) they can have without reaching or exceeding the limit? In other words, can drinkers correctly estimate the number of drinks, or, if they cannot, do they consistently underestimate the number (see Apsler and Harding, 1997). There is also the question of whether drivers know at what BAC level they are too impaired to drive safely.

There are also questions about which drinkers are affected by lowering the BAC limit and how they are affected. Perhaps all drinkers are affected in much the same way. Light drinkers decide to drink less just to be safe, even though their previous level of drinking may have kept them well below the new, lower BAC limit. Heavier drinkers also may decide to reduce the amount they drink before driving in order to lessen their chances of being arrested for driving while intoxicated. The scenario where light drinkers cut back their alcohol consumption to further reduce their risk of an alcohol-related crash engenders opposition from alcohol-makers and vendors. They argue that sales will suffer without significant benefits to public safety. Another possibility is that the change in BAC laws will only affect the target group of heavy drinkers, who contribute disproportionately to alcohol-related crashes. Or, the publicity accompanying changes in BAC limits could contribute to a general anti-drinking climate and result in a broad decline in

[1]BAC refers to either blood alcohol concentration, stated as grams per deciliter (g/dl) of blood, or breath alcohol concentration, stated as grams per 210 liters of breath.

alcohol consumption that is not limited to drivers. Because of these and other uncertainties, it is important to investigate what actually happens when states lower their BAC limits for drivers.

PART I: THE IMPACT OF 0.08 LAWS ON ALCOHOL CONSUMPTION

One likely consequence of lowering BAC limits is that consumption of alcohol among drivers declines. While likely, a decline in consumption is not actually necessary for lowered BAC limits to be effective in reducing crashes. Crashes should decline if drivers who drink heavily consume their usual amount of alcohol and then wait long enough for their BAC to drop below .08 before driving, or use a designated driver who does not drink, or drink in a location (e.g., home) where they do not have to drive. However, it is probably much easier for most individuals to avoid driving with a BAC greater than 0.08 by reducing their alcohol intake than by waiting for their BAC to drop, or by planning ahead and using a designated driver. Even moderate drinkers could decide to drink less before driving just to be certain that they do not exceed the new, lower BAC limit.

METHODS

No suitable data exist for conducting a rigorous, direct test of the impact of 0.08 legislation on alcohol consumption by drivers. The best available data consist of annual alcohol consumption figures for each state and for the nation as a whole for the years 1977 through 1994 (Williams et al., 1996). In this report, we present the data on beer consumption (data on wine and liquor are also available), the most widely consumed alcoholic beverage and the beverage most frequently implicated in alcohol-related arrests and crashes. Beer is the preferred type of alcoholic beverage of drinking drivers by a factor of about two-to-one over other beverages (NHTSA, 1990). Unfortunately, several factors severely restricted the utility of these data. First, the data reflect consumption for all drinkers and do not differentiate between drivers and non-drivers. Second, the data are available only on an annual basis, thereby providing few data points. Third, only five of the thirteen 0.08 states (as of 1997) passed their laws early enough so that at least three data points were available following implementation of the law. Data from these five states could not be combined in an effort to improve reliability, since their laws were passed at different times.

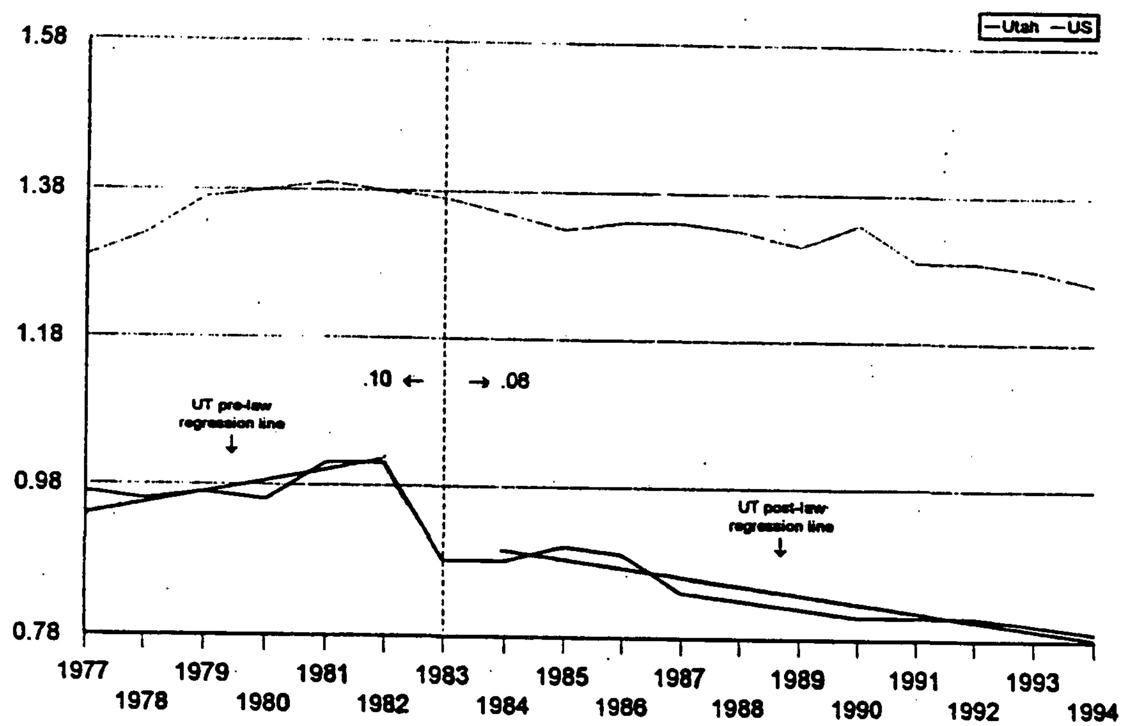
Because of the paucity of data points and the inadvisability of combining data across states, we relied on visual examination of plotted consumption data. The analysis took two factors into account. First, each state's annual alcohol consumption trend during the period prior to the 0.08 law was compared with the annual consumption trend in the period following the law's implementation. Second, each state's alcohol consumption trends were compared with national trends. It was necessary to show that changes in state alcohol consumption that coincided with the reduction in the legal BAC limit were not simply a consequence of external factors reflected in similar changes in the national pattern of alcohol consumption. To make detection of changes in consumption trends clearer, separate regression lines were plotted for the period before and the period after implementation of the 0.08 law.

RESULTS

Utah

As Exhibit 1 shows, a dramatic reduction in Utah's annual beer consumption occurred from 1982 to 1983, just before implementation of the 0.08 law. This phenomenon of a law producing an impact on behavior shortly before implementation is not uncommon in the traffic safety area. The most likely explanation is that passage of the 0.08 law was preceded by extensive news coverage which sensitized many people to the issue of drunk driving and motivated them to drink less. Official implementation of the law did not produce additional behavior change. Aside from the dramatic drop in alcohol consumption immediately preceding implementation of the lower legal BAC, Utah's annual consumption closely tracks the national pattern of alcohol consumption.

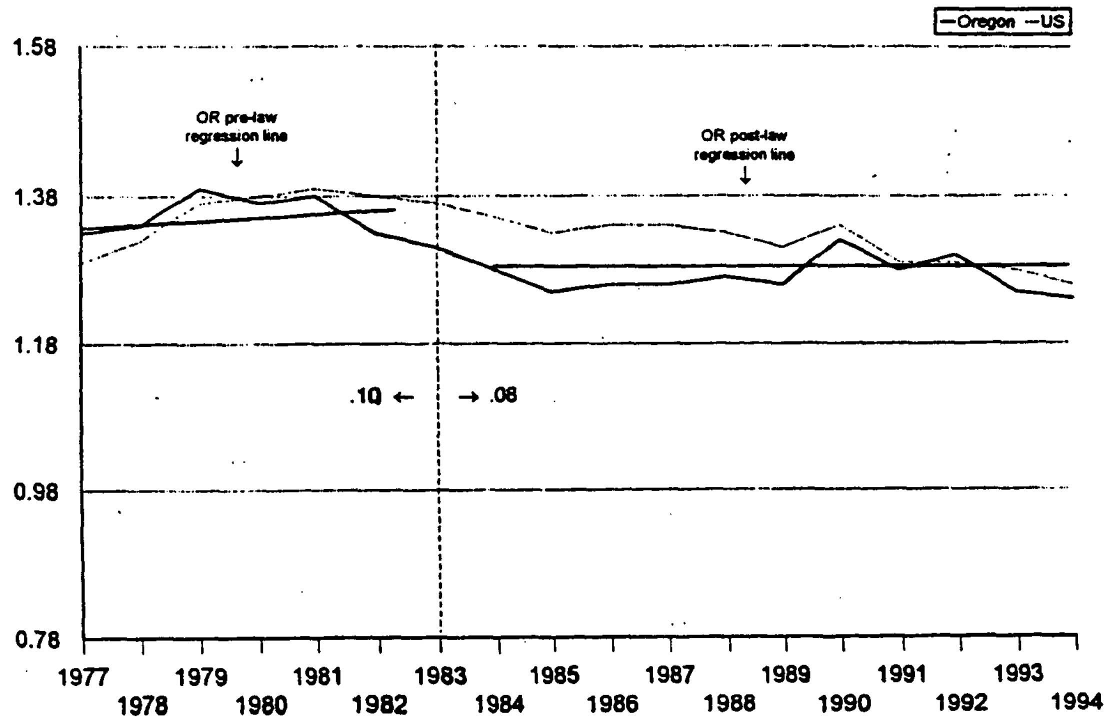
Exhibit 1
Mean Beer Consumption in Utah
1977 to 1994



Oregon

Trends in Oregon's alcohol consumption differed markedly from those in California and Maine. As Exhibit 2 shows, annual beer consumption in Oregon decreased substantially between 1981 and 1982, before the legal BAC limit was reduced in 1983. After dropping below the national average in 1981 and 1982, annual beer consumption continued to decrease, but it decreased at roughly the same rate as the national average. Thus, the reduction in the legal BAC limit appears to have had no effect on beer consumption in Oregon.

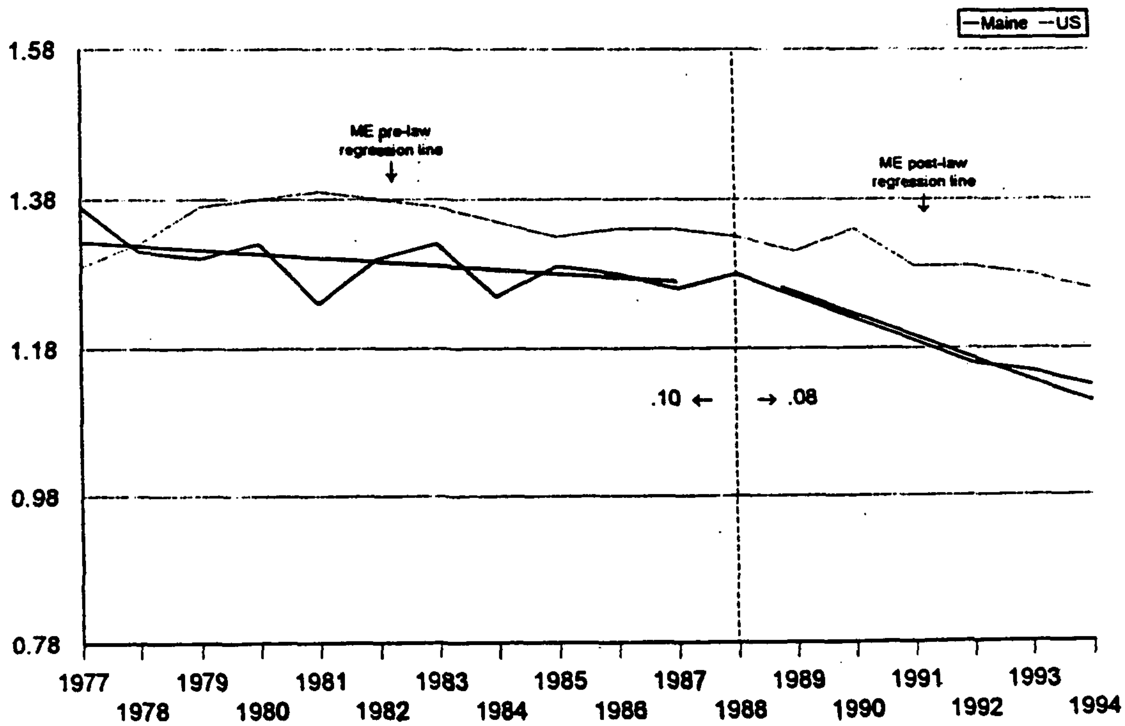
Exhibit 2
Mean Beer Consumption in Oregon
1977 to 1994



Maine

As Exhibit 3 shows, the results for Maine are similar to those for California. The slope of the post-implementation regression line drops more steeply than the pre-implementation period regression line. Furthermore, the pre-implementation period regression line is nearly parallel to the plot for average beer consumption in the United States, suggesting that Maine residents responded to the same influences that affected the country as a whole. In the post-implementation period, however, Maine's annual beer consumption declined somewhat more rapidly than the United States average, indicating that different influences were affecting Maine versus the rest of the country.

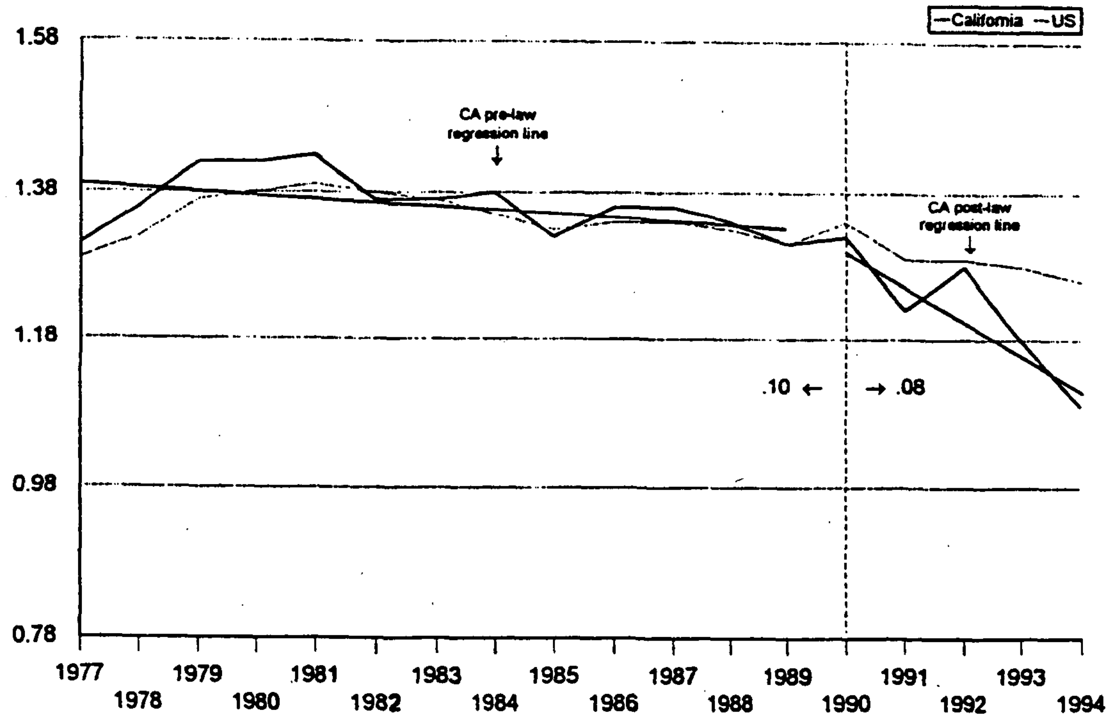
Exhibit 3
Mean Beer Consumption in Maine
1977 to 1994



California

As Exhibit 4 shows, beer consumption in California decreased following implementation of the 0.08 law in 1990. The decrease in consumption is evidenced in two ways. First, the downward slope of the post-implementation regression line is steeper than the slope of the pre-implementation line. Second, the plot of California's annual beer consumption closely tracked national annual beer consumption from 1982 through 1989. In 1990, however, California's average beer consumption fell under the national average and remained beneath the national figures through 1994.

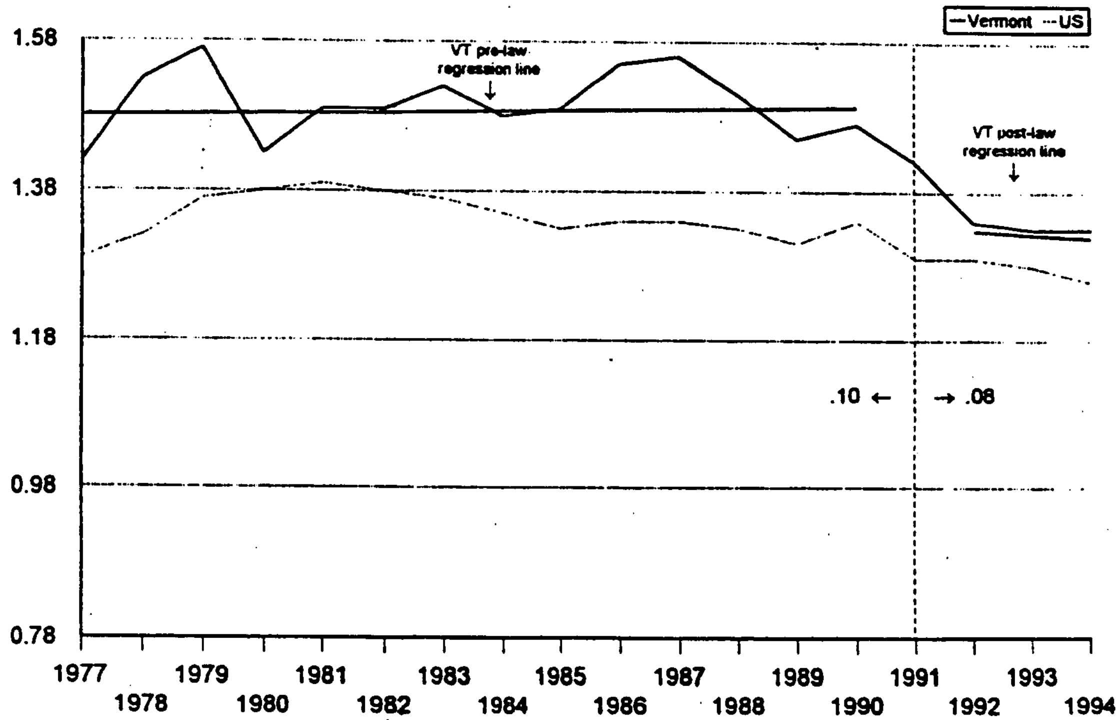
Exhibit 4
Mean Beer Consumption in California
1977 to 1994



Vermont

A substantial drop in Vermont's annual beer consumption may be associated with implementation of the lower legal BAC (see Exhibit 5). As was the case in Utah, annual beer consumption decreased strongly just before implementation of the law (from 1990 to 1991). However, national beer consumption decreased strongly during the same period. Thus, the factors responsible for the national decline in beer consumption probably also affected Vermont. The decline in Vermont continued in the year following implementation of the law, while the national trend leveled off. Here, Vermont beer consumption clearly diverged from the national trend and may well have been the result of lowering the legal BAC limit.

Exhibit 5
Mean Beer Consumption in Vermont
1977 to 1994



Conclusion

Reduction of the legal BAC limit from 0.10 to 0.08 appears to be associated with a reduction in beer consumption in four of the five states. The association is strong in only two of these five states: California and Vermont. The association in California is weaker and is clouded by increased volatility following implementation of the 0.08 law. The absence of an association in Oregon could be due to an artifact. A substantial reduction in annual beer consumption occurred two years before the 0.08 law was implemented. This sharp reduction may have made it difficult for an additional reduction to occur.

PART II: THE IMPACT OF LOWER BAC LIMITS ON MOTOR VEHICLE CRASHES

Very Low BAC Limits for Underage Drivers

Most of the research examining the impact of lowering BAC limits has investigated the effects of very low BAC limits targeted at underage drivers. Blomberg's (1992) evaluation of Maryland's 0.02 law for drivers under the age of 21 is the most rigorous of these studies. His research used a time series-intervention analysis research design with a non-equivalent control group to test the impact of the 0.02 law, and also whether an experimental education campaign enhanced the law's effects. Models developed with Box-Jenkins analysis were used to characterize the trends in crash-involved drivers under the age of 21 judged by the investigating officer to have been drinking. The two models presented by Blomberg are consistent with a significant decline in crashes resulting from implementation of the 0.02 law. Conversely, analyses of time series for two types of drivers who should not have been influenced by the new law – drivers 21 and older judged to have been drinking and drivers under the age of 21 not judged to have been drinking – produced no significant changes. Therefore, the reduction in crashes observed for young drivers judged to have been drinking cannot be due to a general decrease in either alcohol-involved crashes for drivers of all ages or of all crashes involving drivers under the age of 21.

An education campaign aimed at enhancing the effects of the law lowering the BAC limit for drivers under the age of 21 was administered in two Maryland counties. It consisted of: (1) the dissemination of information about the new law through the mass media and distribution of brochures and posters; (2) efforts to inform police agencies about the law and to engage them in the public information campaign; and (3) invitations asking local groups to help with the information campaign. Pre and post surveys conducted in both treatment and control counties showed small but significant increases in youths' estimates of the percentage of drinking drivers arrested on a typical night. Youths in the treatment counties were also more likely than youths in control counties to know the BAC limit in the new law. More importantly, crash data also supported the effectiveness of the education campaign. The percentage of drivers in crashes under age 21 who were judged to have been drinking declined substantially more in the counties where the education campaign was conducted than in control counties (44% in the treatment counties and 30% in the control counties).

In sum, Maryland's 0.02 law had the intended effect of reducing the number of crash-involved drivers under the age of 21 judged to have been drinking. The addition of a public information and education campaign directed at increasing awareness of the new law heightened the effect. Finally, the care with which the analyses explored and discarded the possibility that the results were due to factors other than the 0.02 law markedly strengthen confidence in the validity of the findings. One weakness of this study was the use of police-reported alcohol involvement as the measure in crashes, rather than BAC test results. Studies show that police crash reports tend to underestimate alcohol involvement in crashes absent any BAC testing.

Hingson et al. (1991) evaluated the effectiveness of lowered BAC limits for underage drivers by comparing adolescent crashes in states with and without these laws. Four states with low BAC limits for adolescents were paired with the closest state having the most similar drinking age laws, but no low BAC limit for underage drivers. Maine was paired with Massachusetts, New Mexico with Arizona, North Carolina with Virginia, and Wisconsin with Minnesota.

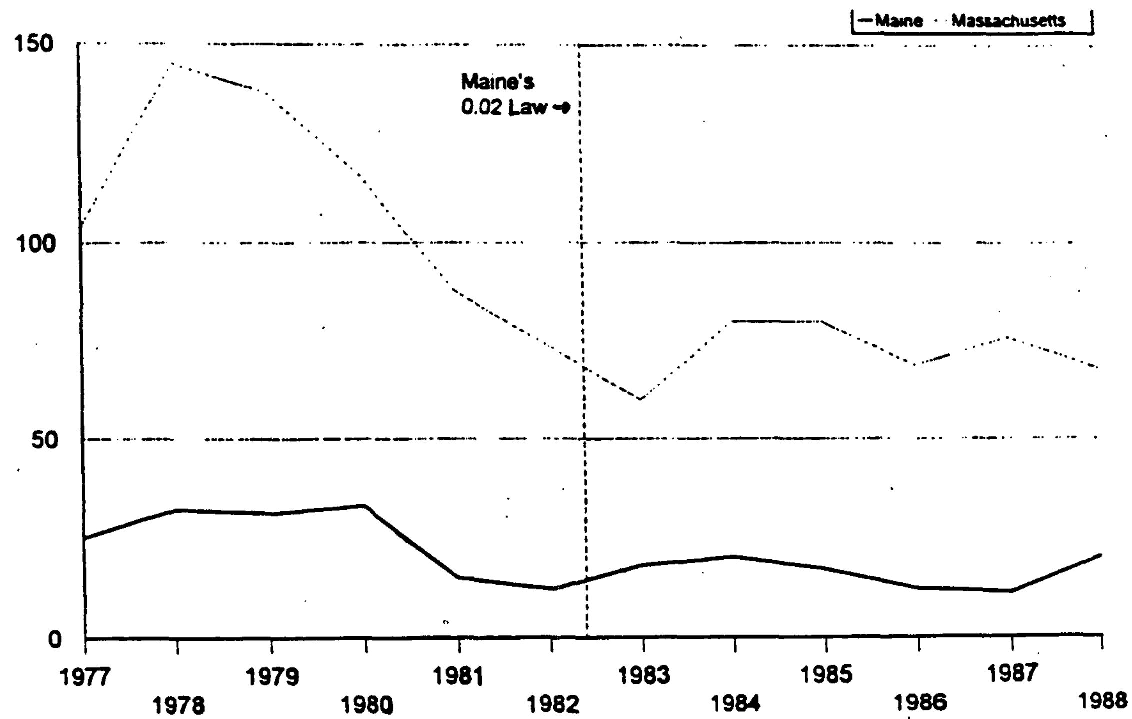
The authors' endorsement of low BAC limits for adolescents is not completely supported by their data. For each state, Hingson et al. aggregated the number of adolescent night fatal crashes during a pre-law period and then again in a post-law period (the length of both periods was the same within a pair of states but varied among pairs). The authors state, "As can be seen in [Exhibit 6], night fatal crashes among adolescents in Maine were 38% lower in the post-law period than they had been in the pre-law period" (p. 121). While this statement is accurate, inspection of their data (see Exhibit 6) indicates that the decline was apparently unrelated to Maine's 0.02 law. A large decline in Maine teen night fatal crashes occurred from 1980 to 1981, long before the 0.02 law was enacted in mid-1982. Inspection of the authors' figures for Wisconsin and Minnesota night fatal crashes involving teenagers show long, gradual trends with no hint of an abrupt effect before or after passage of the low BAC laws for underage drinkers. In sum, the authors' results could have been an artifact of the time periods and comparison states chosen for the study. The crash trends they present for teenagers provide no clear evidence of an impact of the low BAC laws.

Hingson, Heeren, and Winter (1994) studied the impact of laws lowering BAC limits for young drivers in 12 states where such laws had been in place for at least one year. In addition, they examined differences among four specific BAC limits that had been established for young drivers: 0.00, 0.02, and 0.04 to 0.06. Each of the 12 states that had lowered its BAC limit for young drivers was paired with a nearby state in which BAC limits were the same for drivers of all ages. Control states were matched "... as closely as possible for legal drinking age and timing of changes in that law." Further details of the matching process were not presented. The authors employed a surrogate measure of alcohol-involved crashes – single-vehicle night fatal crashes. In order to control for the total number of fatal crashes, they created a ratio of the number of single-vehicle night fatal crashes to the total number of crashes. The laws changing BAC limits for young drivers affected different age groups in different states. The age ranges targeted by different states included drivers under age 18, drivers under age 19, drivers under age 21, and drivers under age 22. The authors did not include the target age group in their analysis.

A notable feature of the data is their great variability. The authors present a table showing the proportion of fatal crashes that involved single vehicles at night among young drivers for pre- and post-law periods in each treatment and control state. The percentage change from pre- to post-law periods among states that lowered their BAC limits for young drivers ranged from a decrease of 31% (the desired direction of change) to an *increase* of 201%. Variation in the control states was less, ranging from a decrease of 22% to an increase of 46%.

The authors employed the unusual analytical approach of aggregating all fatalities in the low BAC states to compute a single, overall proportion of single-vehicle night fatal crashes involving teens to all fatal crashes. This overall proportion decreased more from pre- to post-law periods (a decrease of 16%) than the single proportion calculated by combining the fatalities from all control states (an increase of 1%). If the authors had treated each state as a separate case, they would have reached a different conclusion. The average change for low BAC states was an *increase* of 23% from pre- to post-law periods in the proportion of single-vehicle night fatal crashes involving teens to the total number of fatal crashes. The average change for control states was an increase of 20%. The authors' results appear to depend more on which states were chosen as controls and on the manner in which the data were aggregated than on the effects of the BAC laws.

Exhibit 6
Massachusetts and Maine Night Fatal Crashes Involving Teenage Drivers
Before and After Maine's 0.02 Law for Teenage Drivers



Evaluations of 0.08 Laws

The authors of the first attempt to evaluate a 0.08 law emphasized two crucial factors that severely limited the study's usefulness (NHTSA, 1991b). The study was unable to distinguish between the effects of California's 0.08 law and an administrative per se law that became effective six months later (complicated by the fact that public information about both new laws began months prior to the effective date of the first). Furthermore, only six months of data were available for the period following passage of the administrative per se law. While this study did find an effect for 0.08 and not for ALR, the authors point out that the two laws were implemented too close to one another separate the effects of one law from the other.

One study published in a refereed journal examined the effect of lowering legal blood alcohol limits to 0.08 (Hingson, Heeren, and Winter, 1996). However, questions about the research design and methods may undermine their conclusion that adoption of a 0.08 law reduces fatal crashes. To evaluate 0.08 laws, the authors paired the five states that lowered their BAC limits from 0.10 to 0.08 prior to 1992 with a "... nearby state that retained a 0.10% limit." The resulting pairs were: Utah with Idaho, Oregon with Washington, Maine with Massachusetts, California with Texas, and Vermont with New Hampshire. They chose as a dependent measure the proportion of fatal crashes involving fatally injured and other drivers with blood alcohol levels at or above 0.08.

The authors provide no additional information about how the comparison states were chosen and do not explore the effect on the results of selecting alternative states for the comparison. Several anomalies among their pairings of states suggest that the results of the study may not be generalizable. For example, Maine, a largely rural state, was paired with Massachusetts, a state with a large, cosmopolitan, urban center. Unlike other pairings, Texas and California are not "nearby." The danger of relying on a single comparison state for each 0.08 state is demonstrated by the extreme variability among the comparison states. In the control state of Idaho, for example, the proportion of fatal crashes with a fatally injured driver whose blood alcohol was 0.08 or more increased 43% from the before period (before Utah passed its 0.08 law) to the after period. The comparable change in New Hampshire, the comparison state for Vermont, was a decrease of 31%. Not only did these two states change in opposite directions, the absolute magnitude of their changes is more than double the change in any other comparison or treatment state.

This study also suffers from the weakness noted previously with Hingson et al. (1991) and Hingson, Heeren, and Winter (1994), namely that the pre- to post-law comparisons are based on aggregated data on fatal crashes. The possibility exists, then, that the aggregate change may mask year to year variability within a state that is not consistent with the hypothesis that the 0.08 law lowered fatal crashes. For example, there may have been large reductions in crashes before passage of the law, but this troubling fact is obscured by combining crash data for several years prior to the change in the BAC laws.

Even assuming that the authors' claim of a reduction in alcohol-involved fatal crashes for four of the five 0.08 states, relative to their control states, is correct, their conclusions about the cause of the reduction are unwarranted. The article's abstract states under *Conclusions*, that "If all states adopted 0.08 legal blood alcohol limits, at least 500 to 600 fewer fatal crashes would occur annually." However, in the discussion section of the article, the authors observe that all five of the 0.08 states had administrative license revocation laws in place during the period of the study. Furthermore, three of these states implemented their license revocation law within one year of their 0.08 law. Conversely, only one of the comparison states had an administrative license revocation law during the study period. Since the authors were unable to differentiate between the impacts of the two laws, it is impossible to know whether the 0.08 law contributed anything unique to a reduction in fatalities.

In an early NHTSA study, which was published in a peer reviewed medical proceedings (Johnson and Fell, 1995), decreases in various measures of alcohol involvement in fatal crashes were found in 4 out of 5 states after implementation of 0.08 laws. The study did not attempt to separate or control for the presence of other laws, most notably ALR, that might have been implemented around the time of 0.08, nor was any attempt made to account for possible long-term trends in the data.

Evaluations of Administrative License Revocation Laws

As Hingson, Heeren, and Winter (1996) noted, several states lowered their BAC limits to 0.08 within a few months after implementing administrative license revocation laws. Administrative license revocation laws allow the immediate, administrative suspension of a driver's license when a driver: (1) is arrested for DUI, (2) agrees to a chemical test for the presence of alcohol, and (3) produces a BAC at or above the legal BAC limit. The logic behind these laws is that administrative license revocation is applied swiftly and with certainty to individuals arrested for DUI. This insures that a large percentage of DUI offenders receive what has been found to be one of the most effective sanctions against DUI recidivism.

Several investigators have found that administrative license revocation laws are effective general deterrents in reducing crashes (Zador et al. 1988; Klein 1989; Lacey et al. 1990). Other research found that implementing administrative license revocation laws is cost-effective for states (Lacey, Jones, and Stewart 1991) and that, typically, license revocation does not result in a severe negative impact on offenders' jobs and income. It is because of the greater support shown for the effectiveness of administrative license revocation laws that they cannot be ignored by evaluations of 0.08 laws. Analyses of the impact of lowering BAC limits must identify and attempt to isolate the impact of administrative license revocation to be certain that its effects are not mistaken for the results of 0.08 legislation.

CURRENT STUDY METHODS

Dependent Measures

To assess the impact of 0.08 laws, we chose three indices maintained for all states since 1982 by NHTSA's Fatality Analysis Reporting System (FARS). FARS contains information about motor vehicle crashes on public roadways that result in an occupant's or nonmotorist's death within thirty days of the crash. We examined two possible effects of 0.08 legislation. The first is that of reducing the level of intoxication among individuals who drive after drinking. This was measured with a FARS index of the number of fatalities in crashes in which any driver produced a BAC $\geq$ 0.10. If individuals decrease the amount they drink before driving, then fewer drivers in fatal crashes should demonstrate a relatively high level of intoxication after 0.08 laws take effect. Another possible effect of lower BAC limits is that many individuals become more cautious about the amount of drinking before driving. Even individuals who do not drink enough to reach a BAC of 0.10 might reduce the amount they drink before driving. Thus, 0.08 legislation could decrease the number of crashes in which drivers are moderately impaired. This possibility was measured with a FARS index of the number of fatalities in which any driver tested positive for alcohol (BAC $>$ 0.00).

The third FARS index was employed as an internal comparison (control) measure to help isolate the causal role of 0.08 legislation. There is no reason to expect that lowering BAC limits will affect drivers who do not drink. Thus, if 0.08 legislation operates as anticipated, the number of intoxicated drivers involved in fatal crashes should decline as a result of the law while the number of sober drivers involved in fatal crashes remains unaffected. Conversely, if a decline occurs for both intoxicated *and* sober drivers involved in fatal crashes, the cause of the reduction might be a general phenomenon that affects both intoxicated and sober drivers. The third FARS index was chosen to test whether reductions occurred for only drinking drivers or for both drinking and sober ones. This index consists of the ratio of the number of fatalities in crashes involving intoxicated drivers (BAC $\geq$ 0.10) to the number of fatalities in crashes with no drinking drivers (BAC=0.00).

Analyses

Time series analysis is currently the most powerful statistical tool employed by traffic safety researchers for assessing the impact over time of laws aimed at changing driving behavior. With time series analysis, it is possible to detect the impact of an intervention, such as 0.08 legislation, and also distinguish the effects of that intervention from many other influences on driving behavior, such as seasonal variation, long-term trends unrelated to the passage of a new law, and implementation of other legislation, such as administrative license revocation.

We used the Box-Jenkins (1970) ARIMA modeling process for analyzing each of the three FARS indices for each state that: (1) had lowered its BAC limit from 0.10 to 0.08, and (2) for which a minimum of one year of FARS data existed for the period following implementation of the law. The modeling process consisted of three steps. First, the characteristics of a time-series were examined and a tentative model was derived. Second, the parameters of the tentatively identified model were estimated. Third, the model was checked for statistical accuracy (over and under specified) and the residuals were checked for randomness. Initially, each series was plotted for visual observation. If any extreme values were observed, they were smoothed using the averages (this was crucial in dealing with the ratio series). Each series was tested for stationarity. If a series was not stationary, differencing (regular and/or seasonal) was performed to achieve stationarity. Autocorrelation and partial autocorrelation (ACF and PACF) procedures were employed to arrive at a tentative autoregressive-integrated-moving average (ARIMA) model. Using the tentatively identified model, we estimated parameters and checked for statistical significance, and residuals were analyzed for randomness. Based on these diagnostics, the ARIMA model was adjusted, and parameters were re-estimated. This iterative procedure was repeated until a statistically correct ARIMA model was achieved.

The above univariate process extracts all of the statistical information inherent in serially and/or seasonally correlated data, such as crash-related measures. However, time-series are often affected by various external events commonly known as interventions. When such interventions are known to us, we can evaluate their effect by using the "intervention models" of Box and Tiao (1975).

In the case of a single intervention, the form of the Box-Tiao intervention model is

$$Y_t = C + \frac{\omega(B)}{\delta(B)} I_t + N_t$$

Y_t is the time series under study. C is a constant. The rational polynomial ($\omega(B)/\delta(B)$) characterizes the effects of the intervention. The operator in the numerator, $\omega(B)$, represents the impact of the intervention and the length of time it takes the intervention to affect the time series. The operator in the denominator, $\delta(B)$, represents the way in which the effect of an intervention dissipates. I_t is a binary vector that defines the period of the intervention. It is assigned the value 0 for the pre-intervention period and the value 1 for the intervention and post-intervention period. N_t is the *noise series*, or *disturbance* and can be modeled as an ARIMA process.

In the present situation, two intervention variables are possible, namely 0.08 laws (I_{1t}) and ALR laws (I_{2t}). Therefore, the intervention model is of the type:

$$Y_t = \frac{\omega_1(B)}{\delta_1(B)} I_{1t} + \frac{\omega_2(B)}{\delta_2(B)} I_{2t} + N_t$$

Since we are using differenced series to achieve stationarity, the constant term, C, representing a long-term serial or annual trend, may or may not appear. In all our analyses of FARS data, C was zero.

The steps in the intervention analysis are similar to those used for univariate analysis and consist of identifying the model, estimating the parameters, and diagnostic checking and improving the model until a statistically correct model is obtained. The objective of this process is to determine whether or not the transfer functions, which represent the impact of a law, are statistically significant.

Exhibit 7
Effective Dates of 0.08 Laws and Administrative License Revocation Laws

State	0.08 Date	ALR Date
California	1/90	7/90
Florida	1/94	10/90
Kansas	7/93	7/88
Maine	8/88	1/84
New Hampshire	1/94	7/92
New Mexico	1/94	7/84
North Carolina	10/93	10/83
Oregon	10/83	7/84
Utah	8/83	8/83
Vermont	7/91	12/89
Virginia	7/94	1/95

Separate analyses of 0.08 and administrative license revocation laws were conducted on a state-by-state basis in order to assess the independent impact of these two types of legislation. However, it is unreasonable to expect that the analyses can distinguish independent effects of these laws in states where they were passed within close temporal proximity of one another, e.g., one year or less, as was the case in California, Oregon, Utah, and Virginia. This is especially true since the analysis considers data back to 1982. For example, California's 0.08 law was in effect during January 1990-December 1995, while ALR was in effect during July 1990-December 1995. With only six months between the two laws, there is little or no chance that any type of analysis could distinguish between the individual effects of the two laws. The remaining seven states enacted their 0.08 legislation more than one year after passage of an administrative license revocation law (Florida, Kansas, Maine, New Hampshire, New Mexico, North Carolina, and Vermont).

State-by-State Analyses

The state-by-state analyses of the impact of 0.08 BAC and ALR laws are presented in chronological order, based on the effective date of the 0.08 BAC law. In most cases, these states implemented administration license revocation laws prior to or (essentially) coincident with 0.08 BAC laws.

Exhibit 8
Utah

		BAC Level			Ratio
		≥ 0.10	≥ 0.01	0.00	≥ 0.10/0.00
0.08 & ALR Aug 1, 1983	Estimate	-0.7123	-0.6672	1.1395	-0.0870
	Std Error	0.8766	1.0107	1.3176	0.0624
	t-value	-0.81	-0.66	0.86	-1.39

Note: ***Bold italics*** indicates statistically significant reduction (α=0.05, one-tailed test, t = -1.645)

Both the ALR law and the 0.08 law became effective on August 1, 1983 in the State of Utah, leaving only 19 months of baseline data upon which to make an assessment of the combined effects of 0.08 and ALR. Therefore, any estimates should be interpreted with caution. None of the graphical presentations of these data indicate any noticeable shift before vs. after the implementation of these two laws; the statistical models corroborate this observation, with none of the measures showing significant changes before vs. after the August 1983 effective date. However, another factor worth noting for the State of Utah in 1982 is that their alcohol-involvement rate in fatal crashes was substantially lower than the national average to begin with, and lowering it even further would probably have been difficult.

Exhibit 9
Oregon

		BAC Level			Ratio
		≥ 0.10	≥ 0.01	0.00	≥ 0.10/0.00
0.08 Oct 15, 1983	Estimate	2.6223	4.3968	-0.4142	0.1574
	Std Error	2.2225	2.5600	2.5991	0.1168
	t-value	1.18	1.72	-0.16	1.35
ALR Jul 1, 1984	Estimate	-4.9693	-6.4567	8.6646	-0.6032
	Std Error	2.0430	2.3676	2.2875	0.1044
	t-value	***-2.43***	***-2.73***	3.79	***-5.78***

Note: ***Bold italics*** indicates statistically significant reduction (α=0.05, one-tailed test, t = -1.645)

Oregon's 0.08 law became effective on October 15, 1983 and the ALR law on July 1, 1984. Due to the relatively early implementation dates for the two laws, there are not much historical data to perform reliable analyses. To complicate matters, the two laws became effective less than ten months apart, so any attempt to develop separate estimates for the two laws will suffer from the potentially confounding influences of each piece of legislation, and the surrounding public information, upon one another. Visual inspection of the graphs of high-BAC fatalities and alcohol-related fatalities leaves the distinct impression that there was little impact in the 2-3 years after both 0.08 and ALR became effective. The most dramatic changes in these alcohol series appear to have begun around the spring of 1990, where both high-BAC and alcohol-related fatalities dropped relatively precipitously, and remained at this lower level throughout the analysis period (December 1995). The fact that this occurred 5-6 years after implementation of these laws strongly suggests that some other factor was at play. At the same time, sober fatalities were increasing throughout the period 1982 through 1989, approximately doubling in this seven-year period, which is probably the driving force behind the decline in the high-BAC to sober fatality ratio, which demonstrated a significant decline before vs. after the July 1984 implementation of ALR. In spite of the short interval between the two laws, the ratio series did not decline until after ALR implementation.

Exhibit 10
Maine

		BAC Level			Ratio
		≥ 0.10	≥ 0.01	0.00	≥ 0.10/0.00
0.08 Aug 4, 1988	Estimate	-0.4384	-0.5637	0.6980	0.0887
	Std Error	0.9613	1.1278	0.6542	0.1573
	t-value	-0.46	-0.50	1.07	0.56
ALR Jan 1, 1984	Estimate	0.9481	1.7187	2.0892	0.1030
	Std Error	0.8708	1.0194	0.9238	0.1415
	t-value	1.09	1.69	2.26	0.73
Trend term	Estimate	-0.3054	-0.3681		-0.0607
	Std Error	0.1350	0.1585		0.0219
	t-value	***-2.26***	***-2.32***		***-3.07***

Note: ***Bold italics*** indicates statistically significant reduction (α=0.05, one-tailed test, t = -1.645)

Maine's ALR law became effective on January 1, 1984 and the 0.08 law on August 4, 1988. Unfortunately, there are only 24 months of historical baseline data available to analyze the effect of the ALR law. From a conceptual standpoint, the 24-month baseline period is less valuable than would 24 months of experimental experience at the end of the data series. Thus, while the analysis considered the January 1984 implementation of ALR, the reliability of these estimates, as indicators of ALR effectiveness, is suspect. As Maine is a relatively small state, monthly fatalities are of relatively low frequency. However, the low level of monthly fatalities still exhibits some fairly strong tendencies, including a 12-month seasonal cycle and an overall long-term downward trend. This trend term was estimated in the statistical models, which was found to be statistically significant in the high-BAC and alcohol-related fatality series, as well as in the high-BAC to sober fatality ratio. In the presence of this significant downward trend, neither of the reductions in high-BAC and alcohol-related fatalities after the August 1988 implementation of the 0.08 BAC law were found to be statistically significant. The analysis of the ratio series, also exhibiting a significant long-term trend, did not find statistically significant reductions associated with either 0.08 BAC or administrative license revocation.

Exhibit 11
California

		BAC Level			Ratio
		≥ 0.10	≥ 0.01	0.00	≥ 0.10/0.00
0.08 Jan 1, 1990	Estimate	-7.4815	-6.3439	15.1137	-0.0669
	Std Error	9.5967	11.4227	11.3757	0.0609
	t-value	-0.78	-0.56	1.33	-1.10
ALR Jul 1, 1990	Estimate	-33.0588	-42.4927	-34.9109	-0.0445
	Std Error	9.6122	11.4237	11.2403	0.0604
	t-value	***-3.44***	***-3.72***	***-3.11***	-0.74

Note: ***Bold italics*** indicates statistically significant reduction (α=0.05, one-tailed test, t = -1.645)

California's 0.08 law became effective on January 1, 1990 and the ALR law on July 1, 1990. Due to the temporal proximity of the effective dates of these laws, any observed effect may be due to either one or the combined effect of both of these laws. California experienced a statistically significant decrease of 33 high-BAC fatalities (BAC ≥ 0.10+) per month associated with the July 1990 ALR effective date, and a significant reduction of 42 alcohol-related fatalities per month. During the same time period, there was a statistically significant decrease among sober fatalities of approximately 35 per month. The combination of high-BAC fatalities per sober fatalities (ratio) did not exhibit a significant decline. As stated earlier, the implementation of the 0.08 and ALR laws occurred only six months apart. In light of this, it seemed reasonable to estimate a statistical model using only one intervention, beginning January 1990, to represent the "combined" effect of both the 0.08 and ALR laws. The results of this analysis appear below.

Exhibit 11a

California – Supplemental Analysis of Combined 0.08 & ALR Intervention

		BAC Level			Ratio
		≥ 0.10	≥ 0.01	0.00	≥ 0.10/0.00
Combined Effect of 0.08 & ALR Jan 1, 1990	Estimate	-26.7105	-31.4670	-9.8774	-0.0977
	Std Error	6.9125	8.5888	8.1865	0.0425
	t-value	***-3.86***	***-3.66***	-1.21	***-2.30***

Note: ***Bold italics*** indicates statistically significant reduction (α=0.05, one-tailed test, t = -1.645)

As can be seen in the above Exhibit, both high-BAC fatalities and alcohol-related fatalities exhibit statistically significant decreases before vs. after January 1990. In contrast to the previous analysis, however, the ratio of high-BAC to sober fatalities now yields a statistically significant reduction, associated with the combined effect of 0.08 and ALR, which is represented in the analysis as a single intervention beginning in January, 1990.

Exhibit 12

Vermont

		BAC Level			Ratio
		≥ 0.10	≥ 0.01	0.00	≥ 0.10/0.00
0.08 Jul 1, 1991	Estimate	-1.0317	-1.5047	1.2823	-0.4824
	Std Error	0.5122	0.6817	0.7018	0.2299
	t-value	***-2.01***	***-2.21***	1.83	***-2.10***
ALR Dec 1, 1989	Estimate	-0.1440	-0.3516	-0.8188	-.0809
	Std Error	0.4813	0.6509	0.6839	0.2247
	t-value	-0.30	-0.54	-1.20	0.36

Note: ***Bold italics*** indicates statistically significant reduction (α=0.05, one-tailed test, t = -1.645)

Vermont's ALR law became effective in December 1989, and 0.08 BAC became effective in July 1991. Being a small state, Vermont's data series show a great deal of month-to-month variability. None of the alcohol series, nor the sober fatalities nor the ratio show any statistically significant declines associated with the implementation of ALR. On the other hand, both high-BAC and alcohol-related fatalities, as well as the ratio of high-BAC to sober fatalities show significant reductions after the implementation of law 0.08 law in July 1991. A trend term introduced into the statistical model failed to reach statistical significance (t = -0.75) and was, therefore, dropped from the model.

Exhibit 13
Kansas

		BAC Level			Ratio
		≥ 0.10	≥ 0.01	0.00	≥ 0.10/0.00
0.08 Jul 1, 1993	Estimate	-0.4118	-1.5406	3.6169	-0.1475
	Std Error	1.2679	1.3730	1.3954	0.0689
	t-value	-0.32	-1.12	2.59	***-2.14***
ALR Jul 1, 1988	Estimate	-1.0843	-2.1598	-2.9491	0.0006
	Std Error	1.1186	1.1343	1.0888	0.0522
	t-value	-0.97	***-1.90***	***-2.71***	0.01

Note: ***Bold italics*** indicates statistically significant reduction (α=0.05, one-tailed test, t = -1.645)

Kansas' ALR law was effective on July 1, 1988, and the 0.08 law became effective on July 1, 1993. Neither the early implementation of ALR nor the later 0.08 law was associated with a statistically significant reduction in high-BAC fatalities, which appeared to reach a peak around January 1987 and then begin to decline, a full 18 months before ALR became effective. These fatalities again began to decline around January 1991, approximately midway between the implementation of the two laws. This same pattern is observed for alcohol-related fatalities, except that the reduction associated with ALR, which was about double that for high-BAC fatalities (2.1598 vs. 1.0843 per month) was found to be statistically significant. The pattern for sober fatalities is very similar, with the major distinguishing feature that in January 1993, sober fatalities experienced a relatively large increase, and remained at this increased level during the period January 1993-December 1995. The ratio of high-BAC to sober fatalities exhibited essentially no change before vs. after the July 1988 ALR implementation. In contrast, however, this ratio was found to be significantly less during the period of the BAC 0.08 law (beginning July 1993). A review of the fatality ratio graph indicates that this series began to decline in early 1991, several years before 0.08 BAC became effective. A trend term, added to the statistical model, was found to be nonsignificant (t = -0.64) and thus, it was dropped from the model.

Exhibit 14
North Carolina

		BAC Level			Ratio
		≥ 0.10	≥ 0.01	0.00	≥ 0.10/0.00
0.08 Oct 1, 1993	Estimate	-2.3864	-2.4834	9.4335	-0.0765
	Std Error	2.3523	3.0269	2.4815	0.0426
	t-value	-1.01	-0.82	3.80	***-1.80***
ALR Oct 1, 1983	Estimate	1.3357	2.3339	21.1776	-0.2219
	Std Error	2.4598	3.1662	2.7483	0.0447
	t-value	0.54	0.74	7.71	***-4.97***
Trend Term	Estimate	-1.1769	-1.5020		-0.0158
	Std Error	0.2603	0.3350		0,0047
	t-value	***-4.52***	***-4.48***		***-3.37***

Note: ***Bold italics*** indicates statistically significant reduction (α=0.05, one-tailed test, t = -1.645)

North Carolina's ALR law became effective on October 1, 1983 and the 0.08 law on October 1, 1993. This early implementation of ALR yields only 22 months of baseline data for studying the impact of ALR. A review of the respective graphs indicates little change before a downturn that began around January 1989, over five years after implementation of ALR. A similar pattern of change is associated with the 0.08 BAC law, which became effective in October 1993. These same graphs indicate that high-BAC and alcohol-related fatalities began a long-term decline in early 1987, which appeared to accelerate beginning around January 1992, about 21 months prior to 0.08 implementation. The statistical models incorporated a long-term trend in each of the models estimated, which appeared to account for most of the decline in the alcohol-related and high-BAC fatality series. However, for the high-BAC to sober fatality ratio, statistically significant reductions (t = -1.80 for 0.08 and -4.97 for ALR, with a critical value of -1.645 for α = 0.05 one-tailed test) were found for both 0.08 and ALR, in light of a statistically significant long-term downward trend. The reduction around the implementation of 0.08 was relatively pronounced and very stable, remaining at this lower level throughout the remainder of the time period under study (December 1995). At the same time, sober fatalities began a pronounced climb beginning in January 1993 and continued to increase through December 1995, leading to a pronounced decline in the ratio of high-BAC to sober fatalities during the 0.08 BAC law time period. North Carolina has unusually strict enforcement of DWI and the arrest rate is higher than the national average. Several checkpoint campaigns were initiated in the 1990's which could account for the decrease that was observed to have begun in 1992.

Exhibit 15
Florida

		BAC Level			Ratio
		≥ 0.10	≥ 0.01	0.00	≥ 0.10/0.00
0.08 Jan 1, 1994	Estimate	-10.6090	-12.2759	20.8136	-0.1453
	Std Error	2.8960	3.4807	4.3869	0.0313
	t-value	***-3.66***	***-3.53***	4.74	***-4.64***
ALR Oct 1, 1990	Estimate	-23.8206	-30.0966	-24.7723	-0.0982
	Std Error	3.0587	3.6710	4.6174	0.0228
	t-value	***-7.79***	***-8.20***	***-5.36***	***-4.31***
Trend Term	Estimate	1.2147	1.4041	2.8777	
	Std Error	0.3934	0.4737	0.6187	
	t-value	***3.09***	***2.96***	***4.65***	

Note: ***Bold italics*** indicates statistically significant reduction (α=0.05, one-tailed test, t = -1.645)

The effective dates for Florida's laws were: ALR on October 1, 1990, and 0.08 on January 1, 1994, leaving only 2 years of data (24 data points) for analysis during the post-0.08 time frame. A review of the graphs for the State of Florida indicates the presence of an increasing trend during the period 1982 through mid-1989. Long-term trends were included in each of the statistical models, and were found to be statistically significant (t = ± 1.96, α = 0.05, two-tailed test) and greater than zero, confirming the presence of the baseline upward trend. The October 1990 implementation of the ALR law is associated with statistically significant reductions in both high-BAC fatalities and alcohol-related fatalities (BAC ≥ 0.01), as well as a significant reduction in sober fatalities (although there is no reason to believe this was causally related). A similar pattern was observed for the January 1994 implementation of the 0.08 law, with significant reductions in both high-BAC and alcohol-related fatalities. During this time frame, sober fatalities, which began increasing about mid-1992, continued to increase to the point where they exceeded their level during any time since the beginning of the 1982 baseline period. The ratio of high-BAC to sober fatalities experienced statistically significant declines associated with both the October 1990 ALR law implementation and the January 1994 BAC 0.08 law implementation. A trend term estimated in the ratio series failed to reach statistical significance (t = -0.0038) and was, therefore, dropped from the model.

Exhibit 16
New Hampshire

		BAC Level			Ratio
		≥ 0.10	≥ 0.01	0.00	≥ 0.10/0.00
0.08 Jan 1, 1994	Estimate	0.2937	0.5256	-0.7659	0.1597
	Std Error	0.9232	1.1252	0.9716	0.3692
	t-value	0.32	0.47	-0.79	0.43
ALR Jul 13, 1992	Estimate	-2.8392	-3.4313	0.0185	0.3160
	Std Error	0.767	1.0573	0.7886	0.2861
	t-value	***-3.70***	***-3.25***	0.02	1.10

Note: ***Bold italics*** indicates statistically significant reduction (α=0.05, one-tailed test, t = -1.645)

The ALR law was implemented in the State of New Hampshire on July 13, 1992; 0.08 BAC became effective on January 1, 1994. Being a small state, New Hampshire's monthly fatalities occur with relatively low frequency, and the timing of the two laws leaves 24 months of 0.08 BAC law experience upon which to base an assessment. From all indications, none of the data series exhibited statistically significant declines during the 0.08 BAC time period. ALR, which became effective in July 1992, was associated with statistically significant decreases in high-BAC and alcohol-related fatalities. However, a review of the graph suggests that both series began their declines around January 1992, seven months before the law became effective. At the same time, the ratio of high-BAC to sober fatalities appears to have begun its decline even earlier, in the fall of 1991, almost one year before ALR became effective.

Exhibit 17
New Mexico

		BAC Level			Ratio
		≥ 0.10	≥ 0.01	0.00	≥ 0.10/0.00
0.08 Jan 1, 1994	Estimate	-1.6780	-1.4533	2.9498	-0.3636
	Std Error	1.6046	1.8216	1.1475	0.0976
	t-value	-1.05	-0.80	2.57	***-3.72***
ALR Jul 1, 1984	Estimate	0.8070	1.0169	-0.9824	-0.0586
	Std Error	1.5626	1.7782	1.0520	0.0897
	t-value	0.52	0.57	-0.93	-0.65
Trend Term	Estimate	-0.5327	-0.6967		
	Std Error	0.1836	0.2153		
	t-value	***-2.90***	***-3.24***		

Note: ***Bold italics*** indicates statistically significant reduction (α=0.05, one-tailed test, t = -1.645)

New Mexico's ALR law became effective on July 1, 1984 and the 0.08 BAC law took effect on January 1, 1994. Reviewing the graphs for alcohol-related and high-BAC fatalities suggests the presences of a long-term trend during the 1982 through 1993 time frame, and thus, terms representing this trend were included in each of the statistical models. Significant trend terms were found for both the alcohol series, while neither the sober fatality nor ratio series yielded statistically significant trends, and thus, were dropped from the models. While the estimated change in high-BAC fatalities (-2.2826 per month) was found to be statistically significant, a review of the graph suggests that this is almost invariably due to the drop in high-BAC fatalities that began in mid-1990, six years after the ALR law took effect. Alcohol-related fatalities show a very similar pattern, although the estimate (-2.4005) just failed to reach statistical significance (t-value of -1.59 vs. the critical value of -1.645). In any case, the ratio of high-BAC to sober fatalities does not demonstrate a statistically significant reduction associated with ALR. On the other hand, the 0.08 BAC law, which was effective in January 1994 (leaving 24 months of post-0.08 experience for analysis) is associated with statistically significant reductions in high-BAC fatalities, alcohol-related fatalities, and the ratio of high-BAC to sober fatalities. Inspection of the graphs of these series indicate the drop beginning in January 1994 was relatively easy to see. A trend term, added to the statistical model for the high-BAC to sober fatality series failed to reach statistical significance (t-value of -1.54 vs. the critical value of -1.645) and was dropped from the model. However, even the model containing this term yielded a statistically significant decline for 0.08 (t-value of -1.92).

Exhibit 18

Virginia

		BAC Level			Ratio
		≥ 0.10	≥ 0.01	0.00	≥ 0.10/0.00
0.08 Jul 1, 1994	Estimate	-3.0888	-4.1830	6.7277	-0.1336
	Std Error	3.4273	4.4738	3.7646	0.0896
	t-value	-0.90	-0.93	1.79	-1.49
ALR Jan 1, 1995	Estimate	-2.1217	-1.3853	-4.4790	0.0083
	Std Error	3.7400	4.8893	4.1694	0.0998
	t-value	-0.57	-0.28	-1.07	0.08

Note: ***Bold italics*** indicates statistically significant reduction (α=0.05, one-tailed test, t = -1.645)

The 0.08 BAC law became effective in the State of Virginia in July 1994. This was followed by implementation of the administrative license revocation law, six months later, in January 1995. Being so close to the end of the time period under study, there was only 12-18 months of data to study the impact of these laws. None of the alcohol fatality series (high-BAC, alcohol-related fatalities and the ratio) exhibited statistically significant reductions associated with either of these laws. However, as stated earlier, when two interventions occur in such close temporal proximity, it is essentially impossible to estimate the separate impacts of each. Therefore, as was done previously, a supplemental analysis was conducted, using a single intervention variable, beginning in July 1994, to represent the combined impact of both 0.08 and ALR. The results are presented below.

Exhibit 18a

Virginia – Supplemental Analysis of Combined 0.08 & ALR Intervention

		BAC Level			Ratio
		≥ 0.10	≥ 0.01	0.00	≥ 0.10/0.00
Combined Effect of 0.08 & ALR Jul 1, 1994	Estimate	-4.5637	-5.1332	3.6260	-0.1273
	Std Error	2.2928	3.0193	2.4907	0.0588
	t-value	***-1.99***	***-1.70***	1.46	***-2.17***

Note: ***Bold italics*** indicates statistically significant reduction (α=0.05, one-tailed test, t = -1.645)

The analysis of the combined effect of Virginia's 0.08 and ALR implementation shows that high-BAC and alcohol-related fatalities were significantly fewer for the period July 1994 through December 1995, compared with 1982 through June 1994. However, inspection of the graph of these data indicates that the reductions in high-BAC and alcohol-related fatalities began at the start of 1991, three and one-half years prior to implementation of these laws. These alcohol fatalities appeared to reach a new level in 1992, and remained at this level throughout the period under study (December 1995). No noticeable decline occurred in these alcohol-related fatalities after July 1994. In contrast to these data, the high-BAC to sober fatality ratio appears to have declined beginning around September 1994, about midway between the implementation of these two laws. This is likely associated with the increase in sober fatalities that began just after 0.08 implementation (July 1994), leading to a decline in the ratio.

Discussion of Fatality Analyses

Exhibit 19
Effects of 0.08 BAC Laws on High-BAC (BAC ≥.10) Fatalities,
Alcohol-Related Fatalities (BAC ≥0.01) and the Ratio of High-BAC to Sober Fatalities

		BAC Level		
State	Effective Date	0.10+ Fatalities	0.01+ Fatalities	Ratio High-BAC / Sober
Utah *	Aug 1983	N	N	N
Oregon *	Oct 1983	N	N	N
Maine	Aug 1988	N	N	N
California *	Jan 1990	N	N	N
Vermont	Jul 1991	***Y***	***Y***	***Y***
Kansas	Jul 1993	N	N	***Y***
North Carolina	Oct 1993	N	N	***Y***
Florida	Jan 1994	***Y***	***Y***	***Y***
New Hampshire	Jan 1994	N	N	N
New Mexico	Jan 1994	N	N	***Y***
Virginia *	Jul 1994	N	N	N
Significant Reductions		*2 States*	*2 States*	*5 States*

Notes: * Administrative License Revocation and 0.08 Laws passed within one year of each other.
***Y* in bold italics indicates statistically significant reduction.**
***California* and *Virginia* experienced significant declines with 0.08 & ALR were treated as a single factor.**

Evaluating social science interventions, where the ability to "control" the characteristics of the treatment (or intervention) applied is a complex process. The mere passage or implementation of a law or policy may be marked by only a point in time, or it may be accompanied by various levels of public information and education campaigns. In addition, implementation of such a law or policy may be linked to the opportunity to publicize other countermeasure areas, such as enforcement, drawing the public's attention to the fact that their risk of detection, apprehension and conviction for drinking and driving may be greater now than it used to be. The new law may make it possible to apply other sanctions, such as administrative license revocation, to a broader category of offender, who previously had not been *eligible* for such a sanction. All of these possibilities, and others, may be applied in varying degrees from state to state, making it that much more difficult to draw comparisons from the implementation of what appears to be a simple, uniformly defined law or policy. BAC 0.08 laws are no different; neither are administrative license revocation laws. The definition of each of these laws can be described briefly and in very simple terms. Their actual implementation, however, can vary greatly from state to state, and possibly even among jurisdictions within the state. Both of these laws are likely to have been implemented in differing ways among the states, with differing degrees of enforcement and public information. It is not always a matter of better or worse, but rather different, as differing policies and needs exist among the various municipalities. Thus, it is not surprising when such laws and policies yield mixed results, both over time, and across political jurisdictions.

The early experiences with 0.08 BAC laws (the States of Utah and Oregon, both became effective in 1983) did not demonstrate statistically significant reductions in the either the raw numbers of high-BAC or alcohol-related fatalities, nor the rate of alcohol-involved fatalities (as evidenced by the ratio of high-BAC to sober fatalities). At the time of their 0.08 implementation, neither state had an ALR law on the books. Utah implemented ALR at the same time as their 0.08 law (August 1983), while Oregon implemented ALR 10 months after its 0.08 effective date (July 1984); Oregon's ALR law was found to be associated with a statistically significant reduction in alcohol-related fatalities as well as the ratio of high-BAC to sober fatalities.

After a 5 year hiatus, Maine became the third state to implement a 0.08 BAC law, in August 1988. Maine experienced fewer high-BAC and alcohol-related fatalities, as well as a lower rate of alcohol involvement after 0.08 implementation, compared to the prior period. Visual inspection of the above graph indicates that the high-BAC to sober fatality ratio had already begun to decline as early as mid-1985, three years prior to 0.08 implementation, making it difficult to attribute reductions to 0.08. At the same time, Maine had already implemented its ALR law in January 1984. Long-term trend factors, included in the Maine analyses, were found to be statistically significant for all of the alcohol-related series (high-BAC, any alcohol, and the ratio), leaving the observed reductions associated with both 0.08 and ALR to be not statistically significant. Thus, while there was apparently no immediate impact of Maine's ALR law, it would be worthwhile to investigate whether enforcement or administrative policies were changed during the mid-1985 time frame, that would point to a possible delayed effect of ALR on fatal crash alcohol involvement. This type of investigation was beyond the scope of the present study.

With the onset of the 1990's the pace of 0.08 implementation sped up. The next state to implement 0.08, California, experienced declines in both high-BAC and alcohol-related fatalities.

However, the rate of alcohol involvement remained essentially unchanged for approximately 12 months after implementation of 0.08 (and six months after ALR). Whether this "delayed effect" was due to a maturation of these policies or changes in enforcement or other countermeasure areas is beyond the scope of this study. However, there is no question that the rate of alcohol involvement and the numbers of high-BAC and alcohol-related fatalities have declined dramatically in the State of California, and have continued to remain at these lower levels, especially after implementation of ALR. As demonstrated in the previous section, when the two laws (implemented only six months apart) are treated as a single intervention, a statistically significant reduction results, with the major portion of the reduction still occurring 12 months after the 0.08 effective date.

Vermont was the next state to implement a 0.08 BAC law. While fatalities in the State of Vermont occur with very low frequency, leading to relatively wild swings, the analysis indicates that both alcohol-related fatality series, as well as the high-BAC to sober fatality ratio experienced statistically significant reductions after the implementation of 0.08. It is also clear that the rate of alcohol involvement had not been declining prior to 0.08 implementation (the estimate for long-term trend was small and not approaching statistical significance), and thus, these reductions cannot be considered a continuation of an already existing downward trend. At the time of 0.08 implementation, ALR had been in effect since December 1989.

The next six states to implement 0.08 BAC laws did so over a relatively short period of time (the 13 months from July 1993 through July 1994). Four of these six states are associated with significant reductions in the rate of alcohol involvement, (five, if the combined effect of 0.08 and ALR in Virginia is considered), although at least some of these states may have implemented their law in the midst of an existing downward trend in the alcohol involvement rate (North Carolina, Florida and New Mexico).

In the State of Kansas, neither high-BAC fatalities nor alcohol-related fatalities exhibited statistically significant reductions associated with 0.08 implementation. Both alcohol measures appeared to have peaked in early 1991 and began a decline about two years prior to the effective date of the 0.08 BAC law. In Kansas, non-alcohol-related fatalities increased relatively dramatically around the time of the 0.08 BAC law, leading to decline in the rate of alcohol involvement; although this decline appears to have also begun as early as 1991.

North Carolina's implementation of 0.08 appears to have occurred in the presence of an already existing downward trend in both alcohol fatality measures and the rate of alcohol involvement, all of which appeared to begin in early 1992, about 18 months prior to 0.08 implementation. While the statistical models, which compare the October 1993 through December 1995 period to the 11+ prior years of data, demonstrate statistical significance, it is difficult to attribute all of this reduction, in a causal way, to 0.08 implementation. Statistically significant long-term trends are apparent in the high-BAC and alcohol-related fatality series, yielding nonsignificant reductions in the raw numbers of fatalities. In contrast, the significant reduction in the rate of alcohol-involved fatalities, even after accounting for the significant long-term trend, is evidence of at least some impact being associated with 0.08 BAC laws.

The experience in the State of Florida is very similar to that in North Carolina, wherein the rate of alcohol involvement appears to have been declining beginning in early 1992, but also continued to decline, reaching new lows after the implementation of 0.08 in January 1994. Florida also experienced significant reductions in both alcohol-related fatality measures, while at the same time experienced dramatic growth in non-alcohol-related fatalities beginning in January 1992.

New Hampshire exhibited no impact in any of its measures associated with the January 1994 implementation of its 0.08 BAC law. However, the July 1992 implementation of ALR was associated with statistically significant reductions in high-BAC and alcohol-related fatalities; no significant change in the rate of alcohol involvement was found.

After the January 1994 implementation of its 0.08 law, New Mexico experienced a significant reduction in the rate of alcohol involvement. Significant downward trends were found in the high-BAC and alcohol-related fatality series, leaving 0.08 associated with nonsignificant reductions in the raw numbers of alcohol-related fatalities.

Lastly, the State of Virginia implemented 0.08 in July 1994, leaving only 18 months of data for analysis in this study. None of the alcohol measures in Virginia showed statistically significant reductions during the six months after 0.08, but prior to ALR implementation. However, the State of Virginia did experience significant declines after the January 1995 implementation of ALR.

A clear effect of 0.08 legislation is in reducing beer consumption. In four of the five states (California, Maine, Utah and Vermont) for which sufficient beer consumption data were obtained, annual consumption trends indicate decreases associated with implementation of a 0.08 law. The association, however, was strong in only two of the four states (California and Vermont). The absence of a decrease in the fifth state, Oregon, may be due to a large decrease in beer consumption that occurred earlier, making it difficult for a further decline to occur when the 0.08 law was passed.

In summary, the analysis of the impact of 0.08 BAC laws found that 5 of the 11 states that implemented such laws experienced significantly lower rates of alcohol involvement among fatalities, and that 2 of these states experienced significantly fewer high-BAC and alcohol-related fatalities during the period after implementation. Four of these states (Maine, North Carolina, Florida, and New Mexico) were apparently already experiencing a downward trend in alcohol involvement, due possibly to other factors such as the presence of laws (ALR), the use of sobriety checkpoints, or a general societal trend for reduced alcohol consumption. Two additional states of the 11 (California and Virginia) experienced statistically significant reductions in the rate of alcohol involvement among fatalities when the 0.08 and ALR laws, which became effective within about 6 months of one another, were modeled as a single intervention.

Each and every state in the group exhibiting a significant association between 0.08 and reductions in alcohol involvement either already had an administrative license revocation law in effect (Vermont, Kansas, North Carolina, Florida and New Mexico), or that reductions did not occur until after ALR was in place (California and Virginia). Clearly, other factors may be at work, as evidenced by the presence of declines in alcohol involvement that began around 1992, which coincided with the implementation of neither 0.08 nor ALR. While it is difficult to pinpoint exactly what factors may be responsible, the data and analyses are clearly suggestive that 0.08 BAC laws have some deterrent effect, leading to reductions in drinking and driving, most notably in conjunction with the presence of other drunk-driving laws and practices, especially administrative license revocation.

Does merely changing the definition of the legal blood alcohol concentration driving limit result in significant reductions? It is hypothesized that implementing a 0.08 BAC law has a synergistic effect on the other components of the anti-drunk driving system, namely the enforcement, adjudication, judicial, licensing, and public information / education components. It is strongly suggested that combating drunk driving is most effective when ALL of the components are at play, in the same vein as the approach espoused by the U.S. Department of Transportation's $88 million Alcohol Safety Action Projects of the 1970's and 1980's, which emphasized the systems approach to addressing this societal problem. Implementing 0.08 BAC laws and the publicity surrounding them serves to remind the public about the dangers of drinking and driving, and may catalyze the enforcement, judicial and licensing communities to refocus its efforts and draw renewed attention to the importance of removing drunk drivers from the nation's roads.

Exhibit 20
Effects of ALR Laws on High-BAC (BAC ≥.10) Fatalities,
Alcohol-Related Fatalities (BAC ≥0.00) and the Ratio of High-BAC to Sober Fatalities

		BAC Level		
State	Effective Date	0.10+ Fatalities	0.01+ Fatalities	Ratio High-BAC / Sober
Utah *	Aug 1983	N	N	N
North Carolina	Oct 1983	N	N	***Y***
Maine	Jan 1984	N	N	N
Oregon *	Jul 1984	***Y***	***Y***	***Y***
New Mexico	Jul 1984	N	N	N
Kansas	Jul 1988	N	***Y***	N
Vermont	Dec 1989	N	N	N
California *	Jul 1990	***Y***	***Y***	N
Florida	Oct 1990	***Y***	***Y***	***Y***
New Hampshire	Jul 1992	***Y***	***Y***	N
Virginia *	Jan 1995	N	N	N
Significant Reductions		*4 States*	*5 States*	*3 States*

Note: * Administrative License Revocation and 0.08 Laws passed within one year of each other.
***Y* in bold italics indicates statistically significant reduction.**
***California* and *Virginia* experienced significant declines when 0.08 & ALR were treated as a single factor.**

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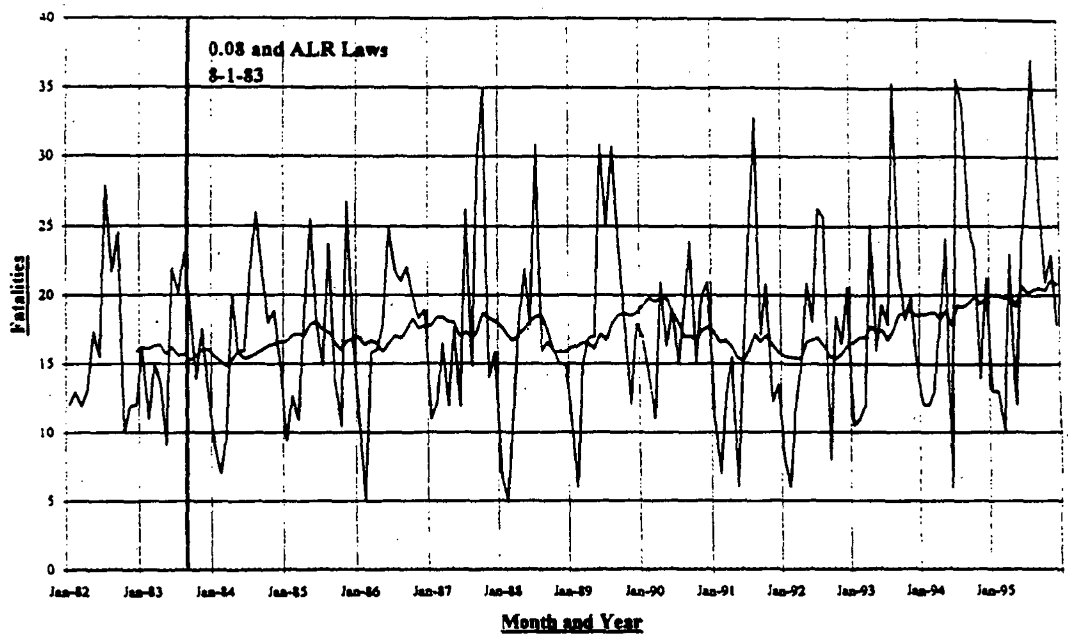
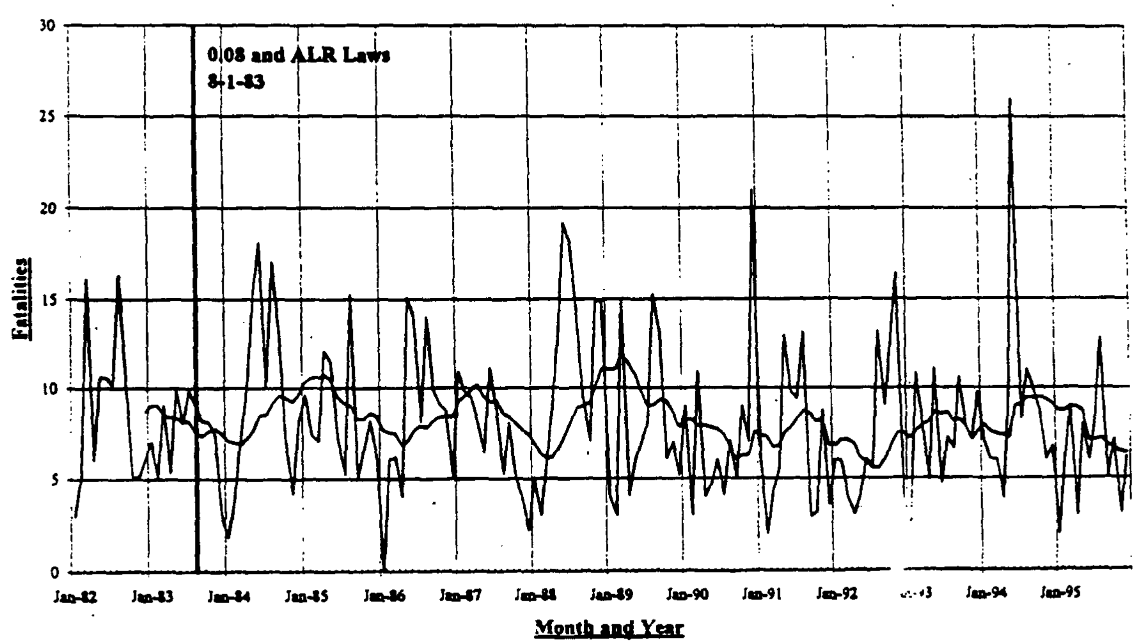
APPENDIX

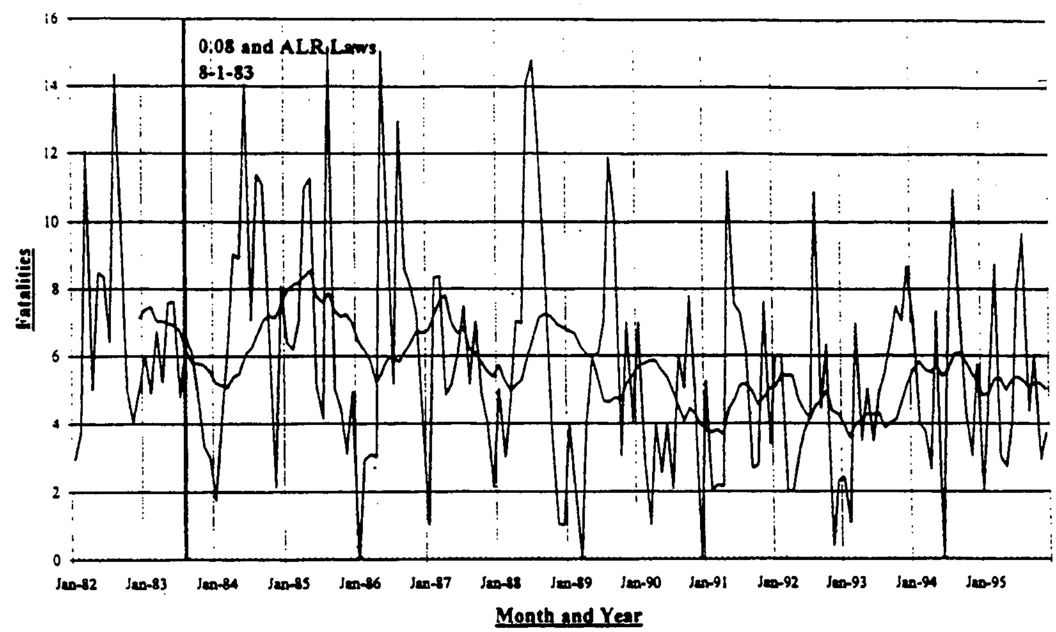
UTAH STATE
Non-Alchohol Related Fatalities (BAC 0.00)
with Trendline



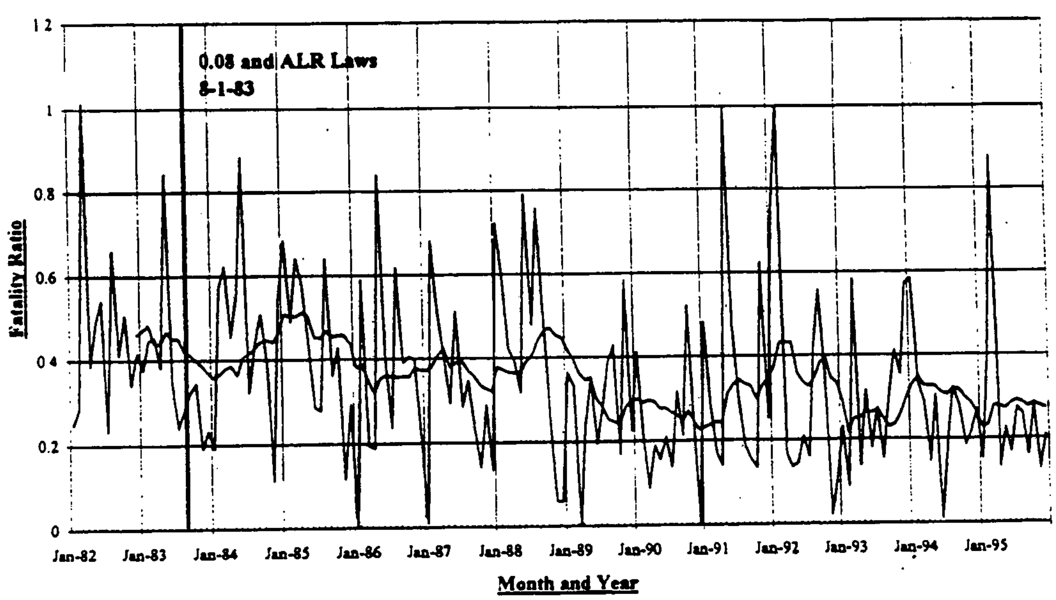
UTAH STATE
Alchohol Related Fatalities (BAC>0.01)
with Trendline



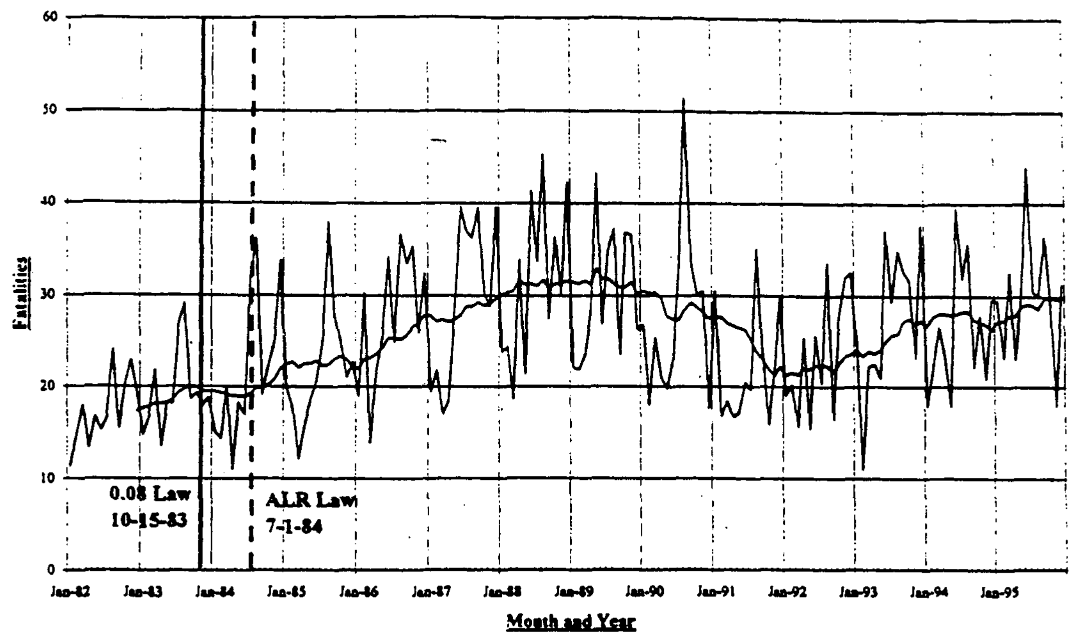
UTAH STATE
Alchohol Related Fatalities (BAC 0.10+) with Trendline



UTAH STATE
Ratio of Alchohol Related Fatalities (BAC 0.10+) to Non-Alchohol Related Fatalities (BAC 0.00) with Trendline



OREGON STATE
Non-Alchohol Related Fatalities (BAC 0.00) with Trendline



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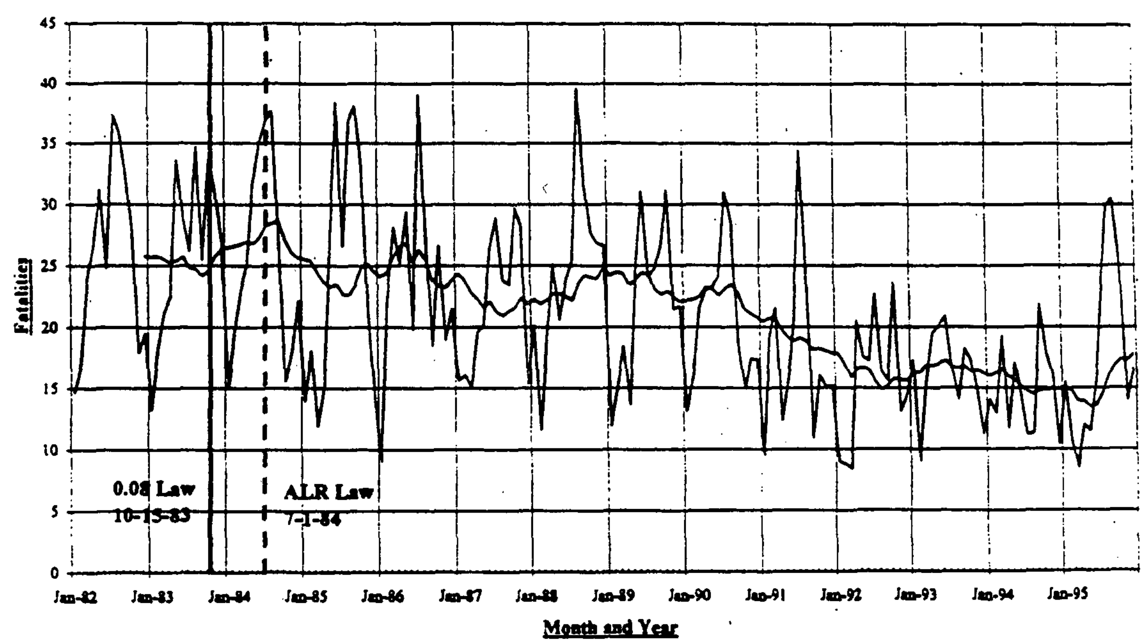
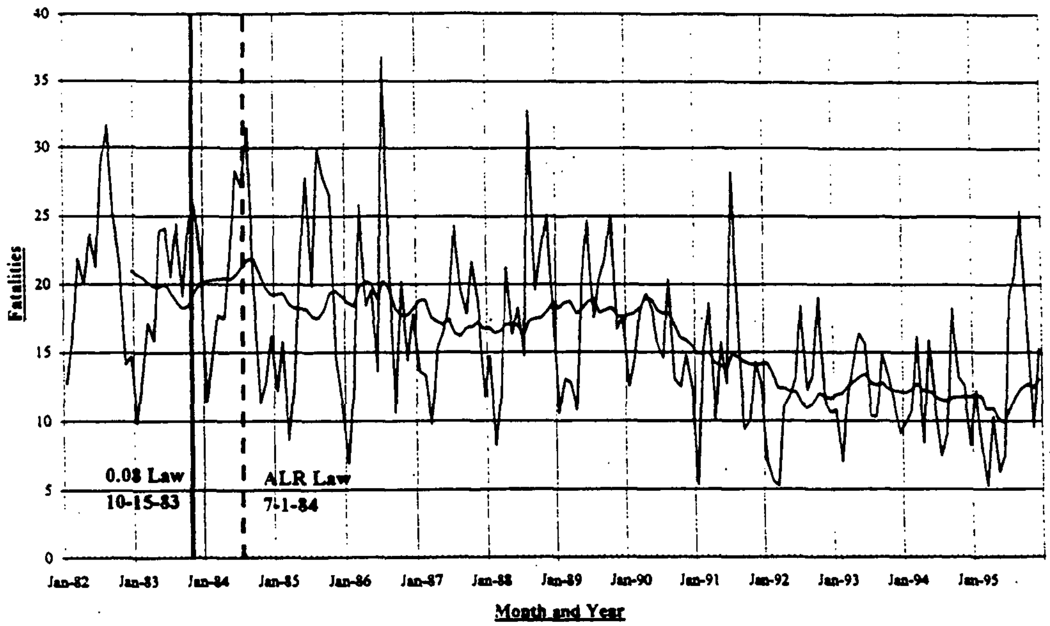
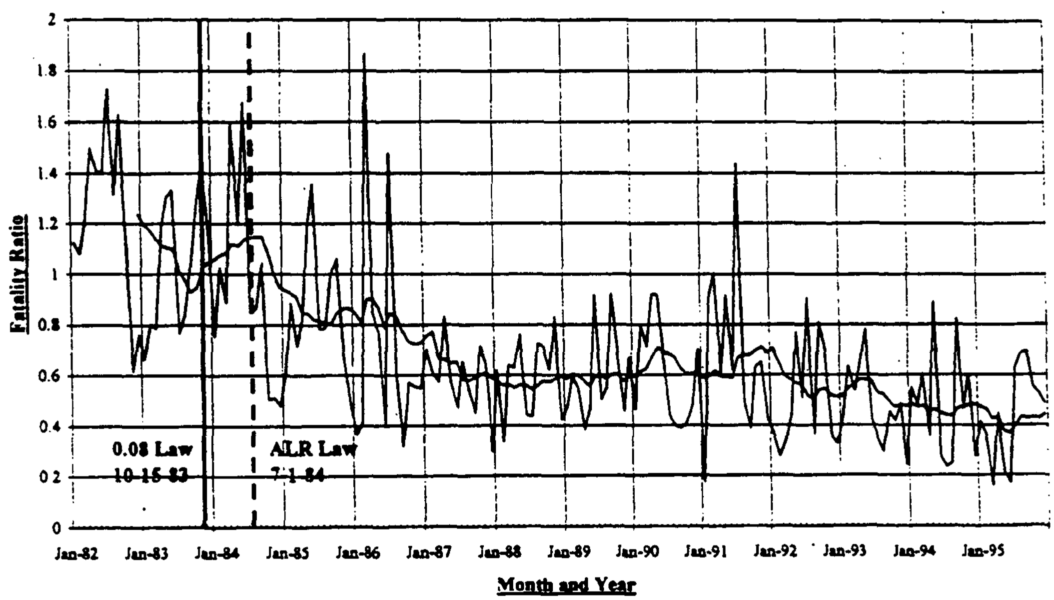
Alchohol Related Fatalities (BAC>0.01) with Trendline



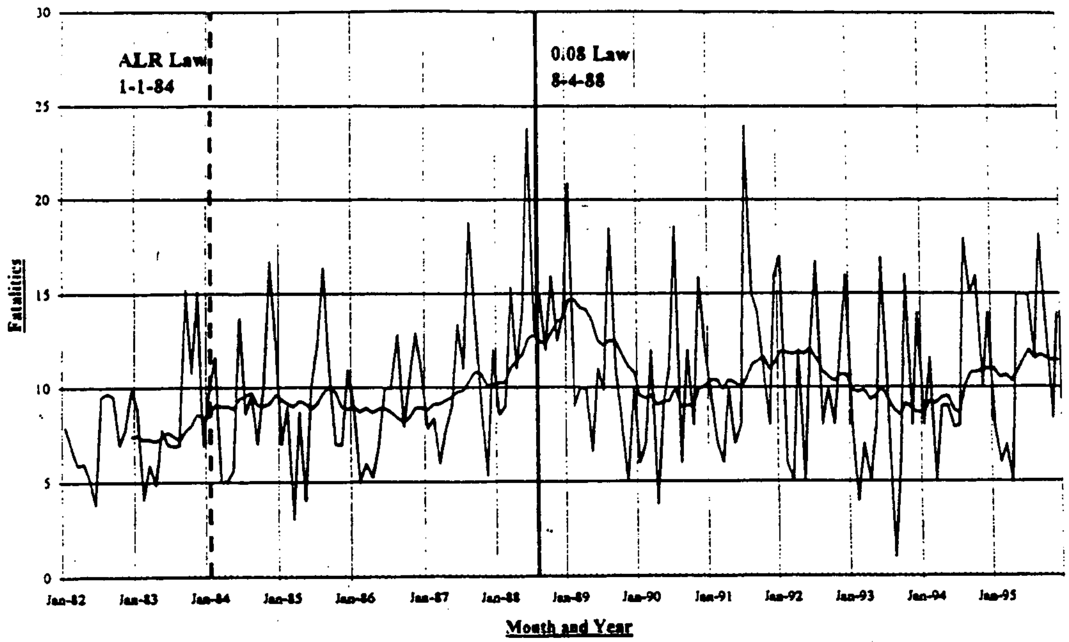
OREGON STATE
Alchohol Related Fatalities (BAC 0.10+) with Trendline



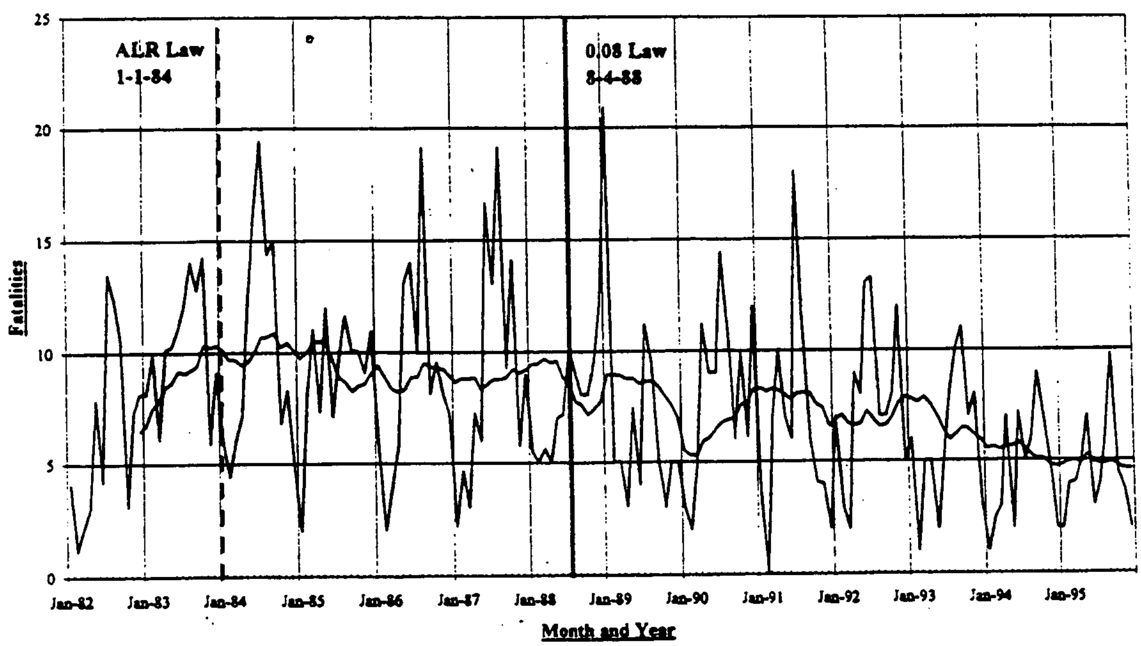
OREGON STATE
Ratio of Alchohol Related Fatalities (BAC 0.10+) to Non-Alchohol Related Fatalities (BAC 0.00) with Trendline

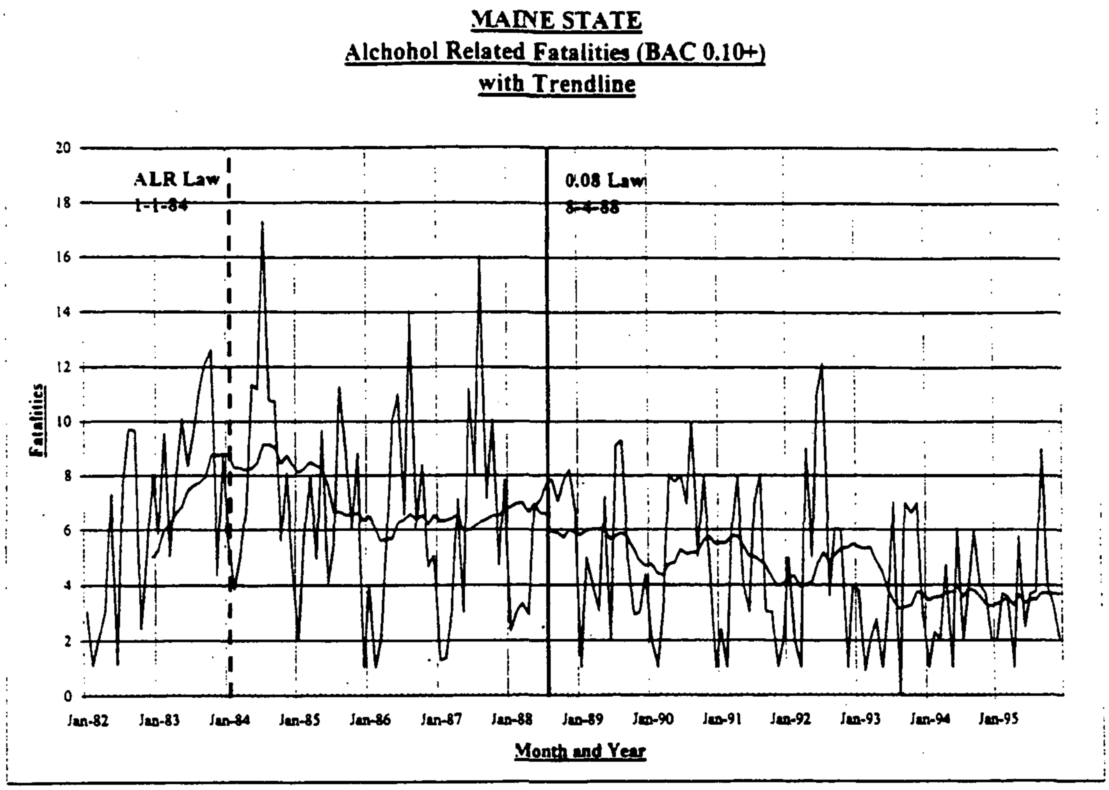


MAINE STATE
Non-Alchohol Related Fatalities (BAC 0.00) with Trendline



MAINE STATE
Alchohol Related Fatalities (BAC>0.01) with Trendline




MAINE STATE
Alchohol Related Fatalities (BAC 0.10+)
with Trendline
ALR Law
1-1-84
0.08 Law
8-4-88
Fatalities
0
2
4
6
8
10
12
14
16
18
20
Jan-82
Jan-83
Jan-84
Jan-85
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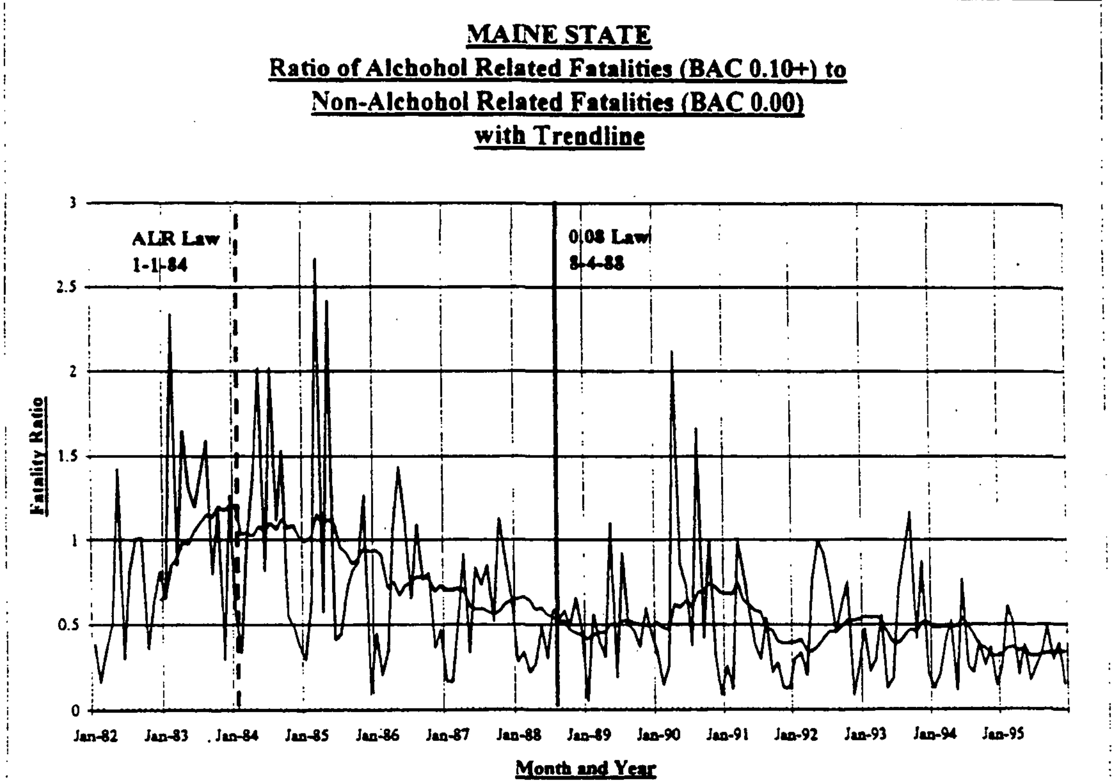
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Month and Year


MAINE STATE
Ratio of Alchohol Related Fatalities (BAC 0.10+) to
Non-Alchohol Related Fatalities (BAC 0.00)
with Trendline
ALR Law
1-1-84
0.08 Law
8-4-88
Fatality Ratio
0
0.5
1
1.5
2
2.5
3
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
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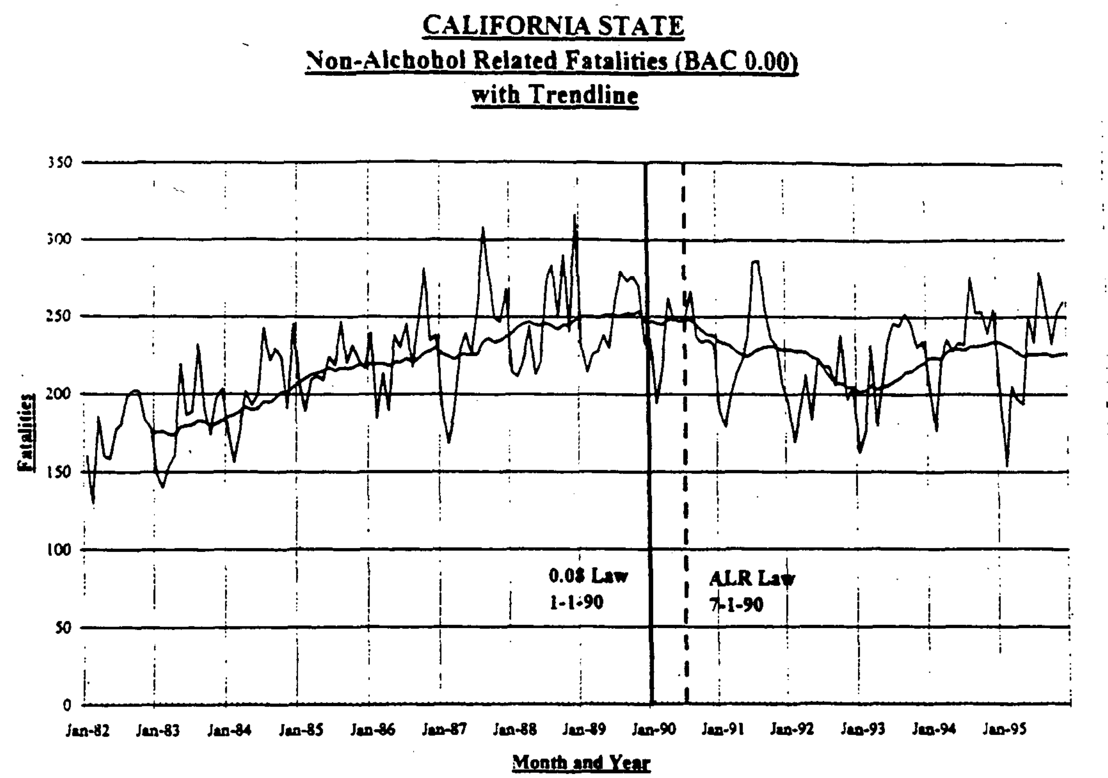
Jan-93
Jan-94
Jan-95
Month and Year


CALIFORNIA STATE
Non-Alchohol Related Fatalities (BAC 0.00)
with Trendline
350
300
250
200
150
100
50
0
Fatalities
0.08 Law
1-1-90
ALR Law
7-1-90
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
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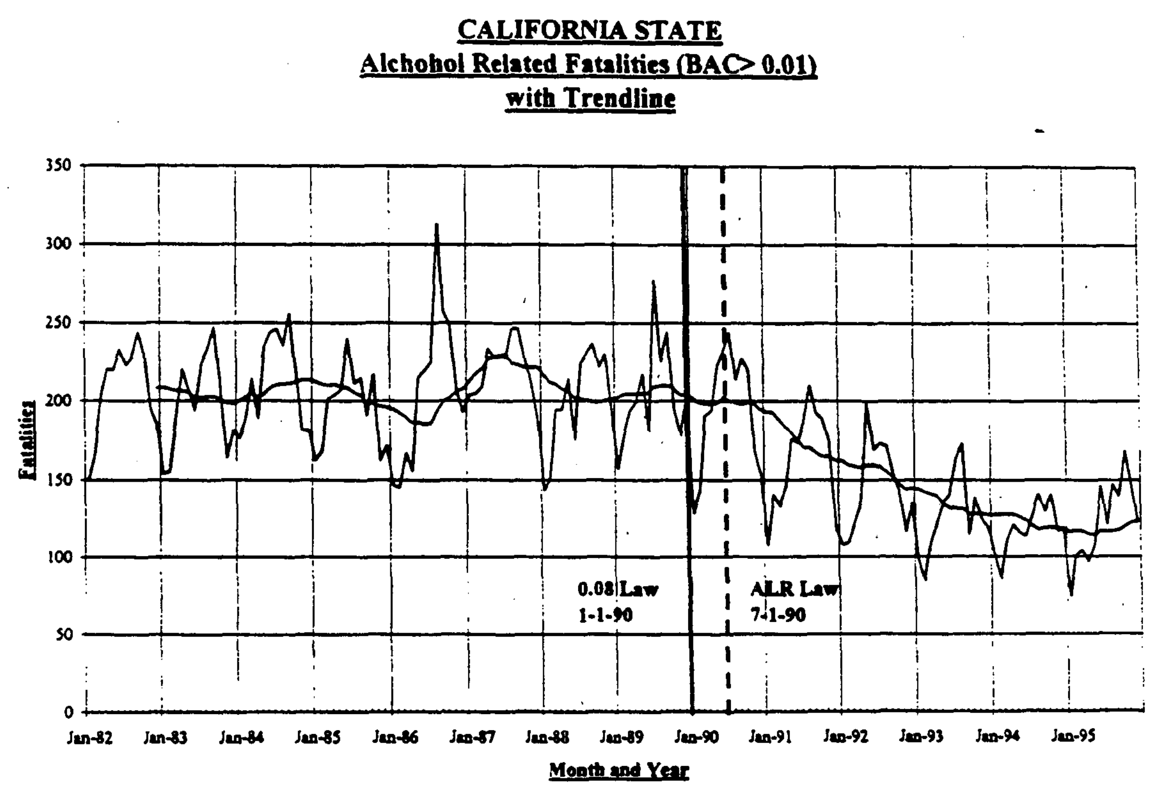
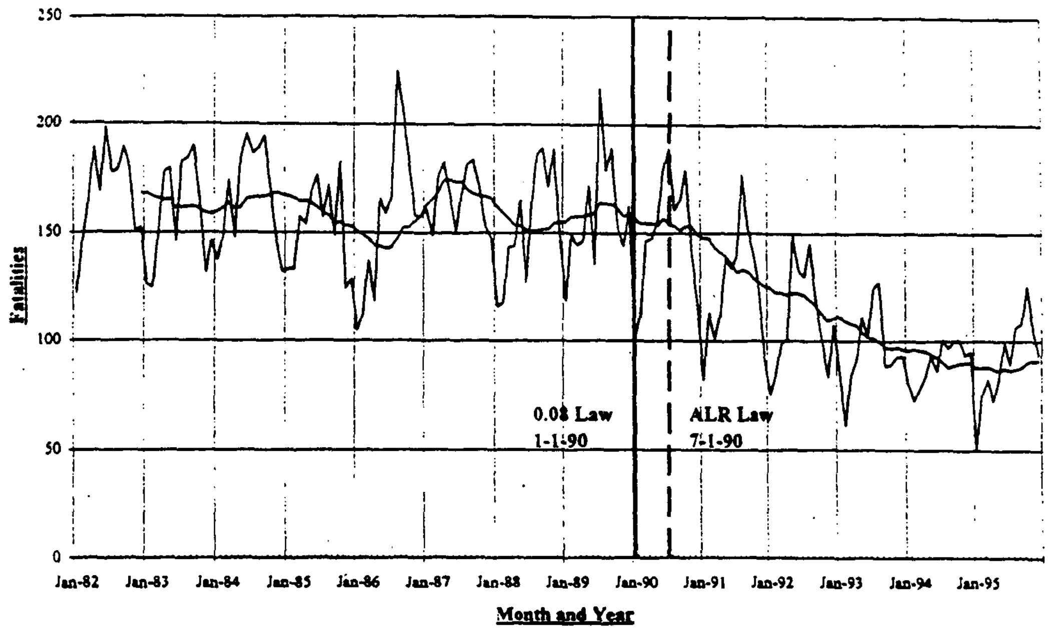
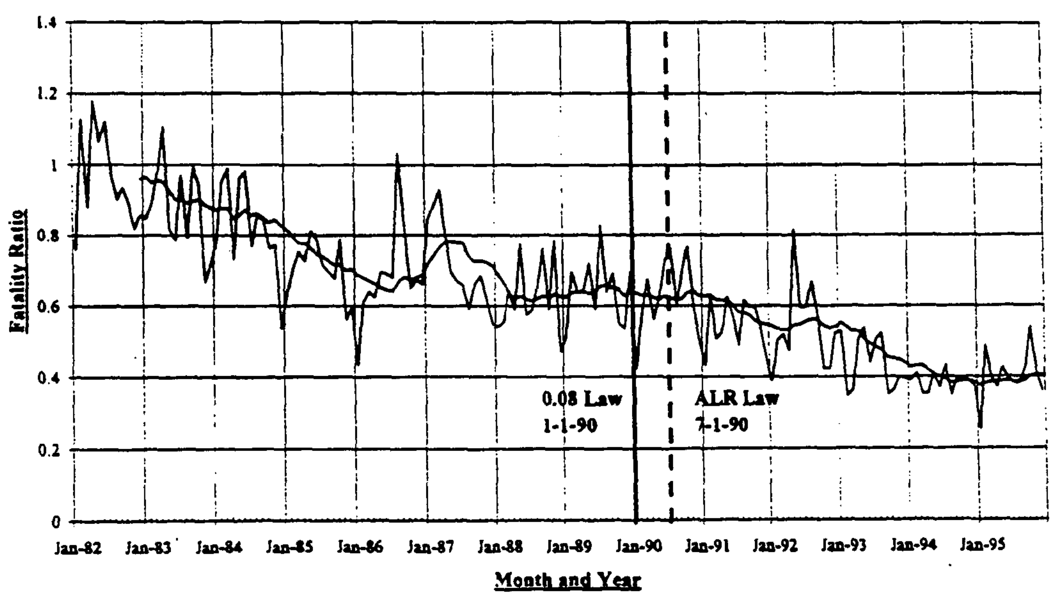
Jan-94
Jan-95
Month and Year


CALIFORNIA STATE
Alchohol Related Fatalities (BAC> 0.01)
with Trendline
350
300
250
200
150
100
50
0
Fatalities
0.08 Law
1-1-90
ALR Law
7-1-90
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Month and Year

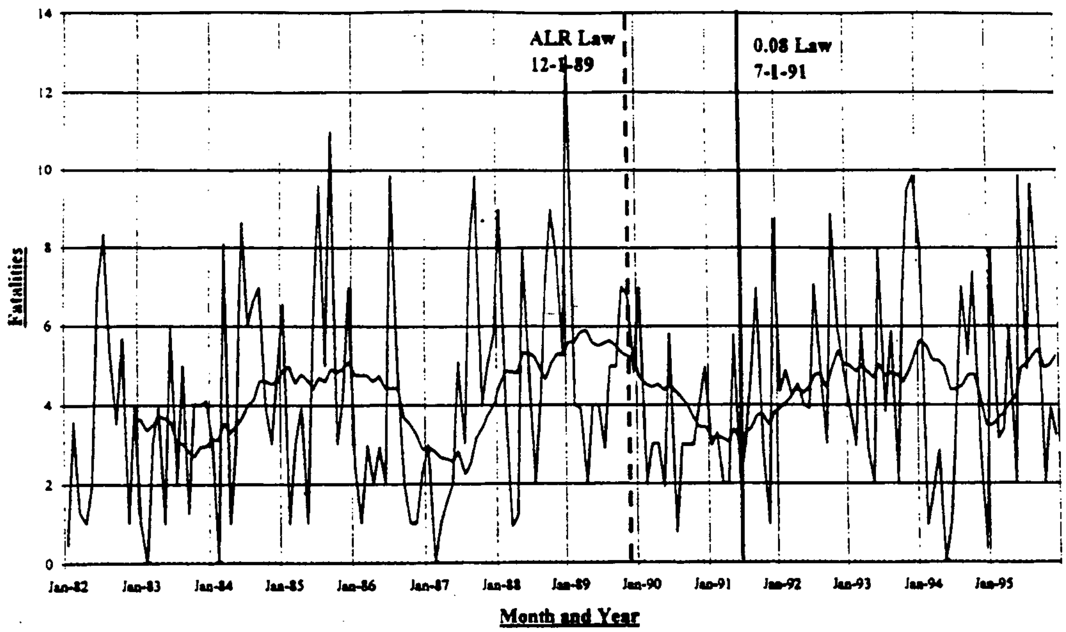
CALIFORNIA STATE
Alchohol Related Fatalities (BAC 0.10+) with Trendline



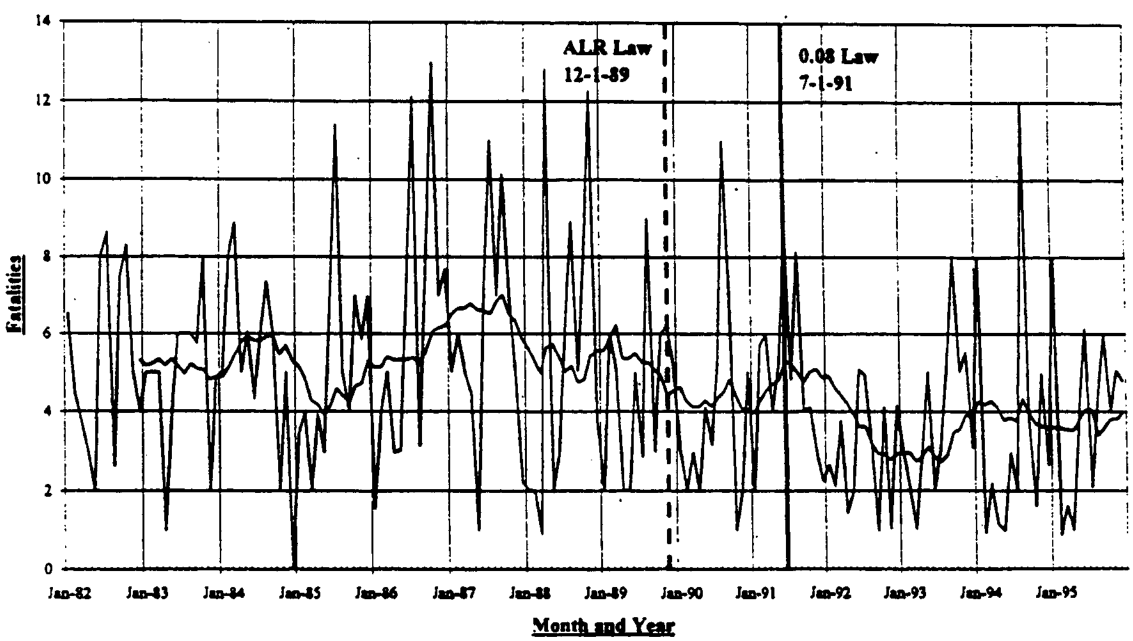
CALIFORNIA STATE
Ratio of Alchohol Related Fatalities (BAC 0.10+) to Non-Alchohol Related Fatalities (BAC 0.00) with Trendline



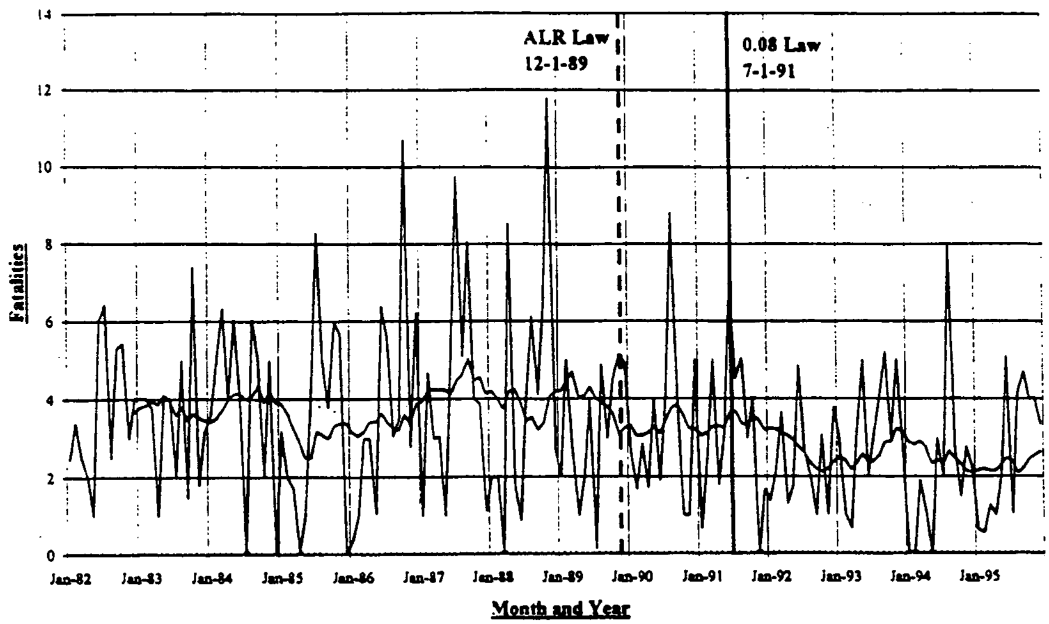
VERMONT STATE
Non-Alchohol Related Fatalities (BAC 0.00) with Trendline



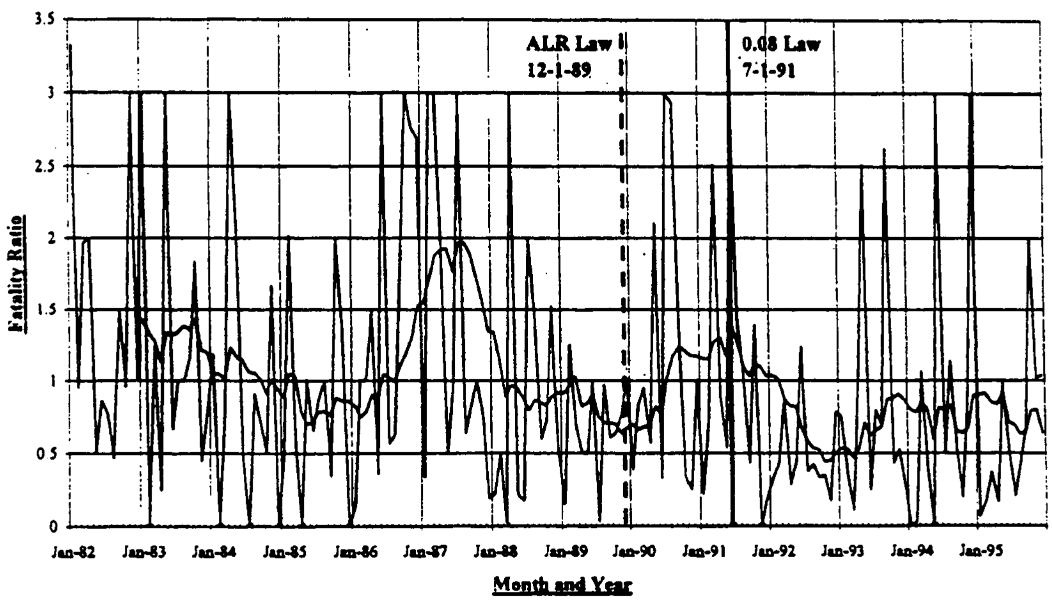
VERMONT STATE
Alchohol Related Fatalities (BAC>0.01) with Trendline



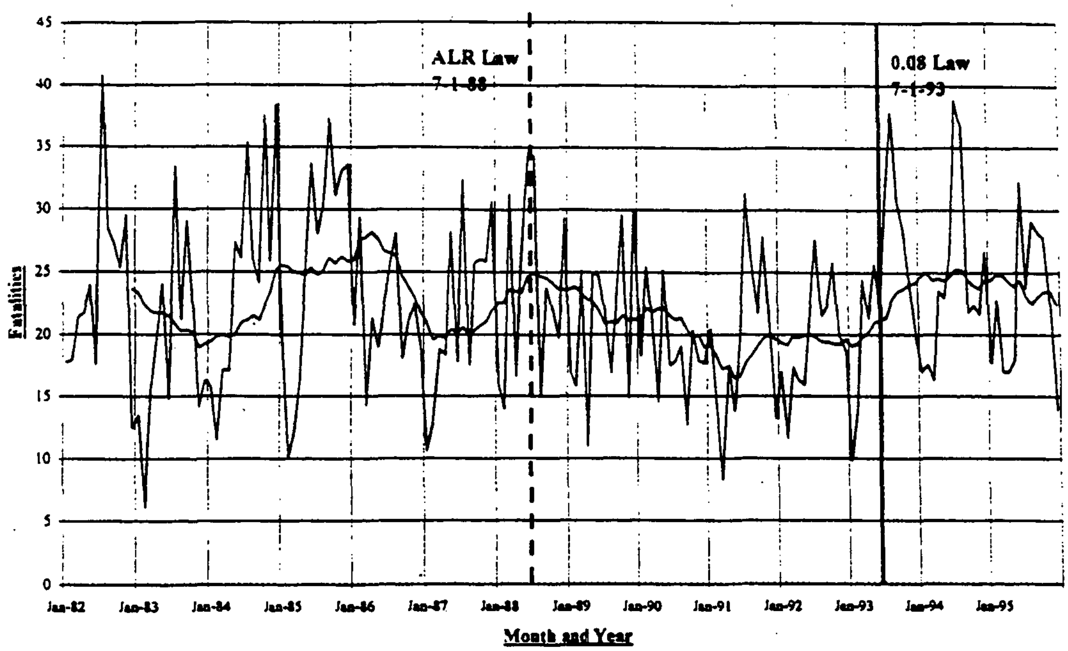
VERMONT STATE
Alchohol Related Fatalities (BAC 0.10+)
with Trendline



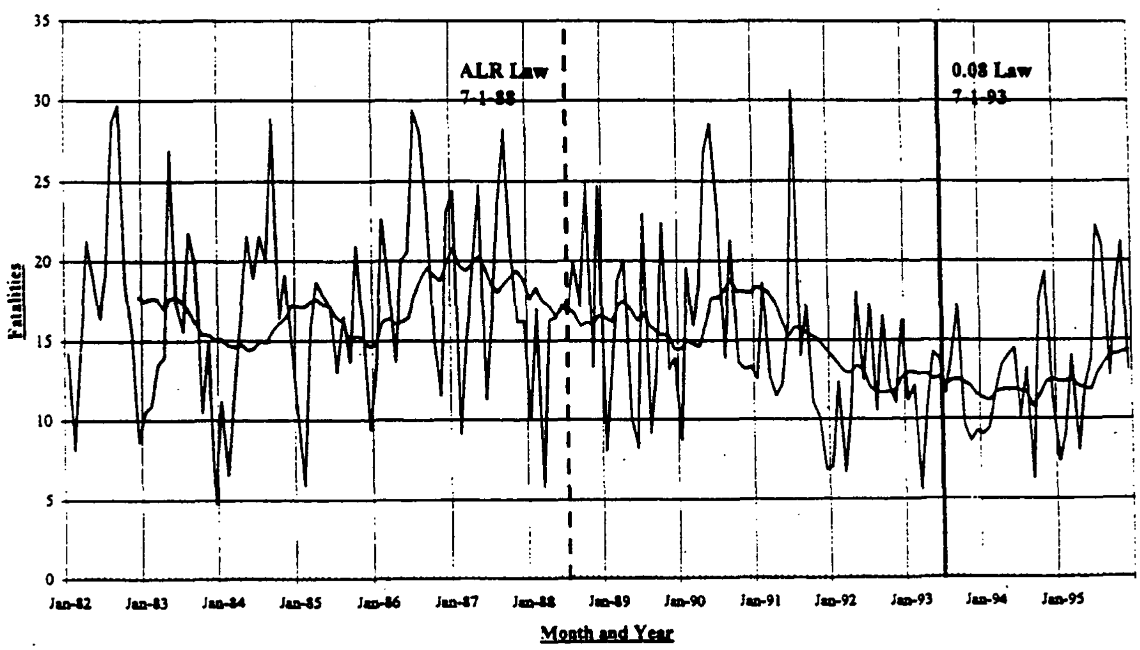
VERMONT STATE
Ratio of Alchohol Related Fatalities (BAC 0.10+) to
Non-Alchohol Related Fatalities (BAC 0.00)
with Trendline



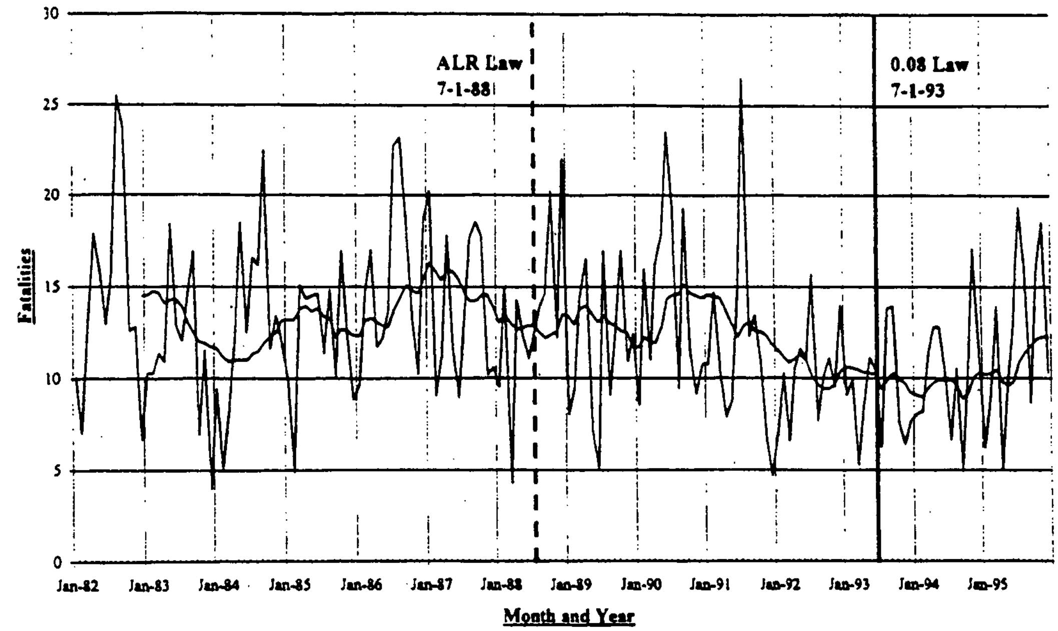
KANSAS STATE
Non-Alchohol Related Fatalities (BAC 0.00)
with Trendline



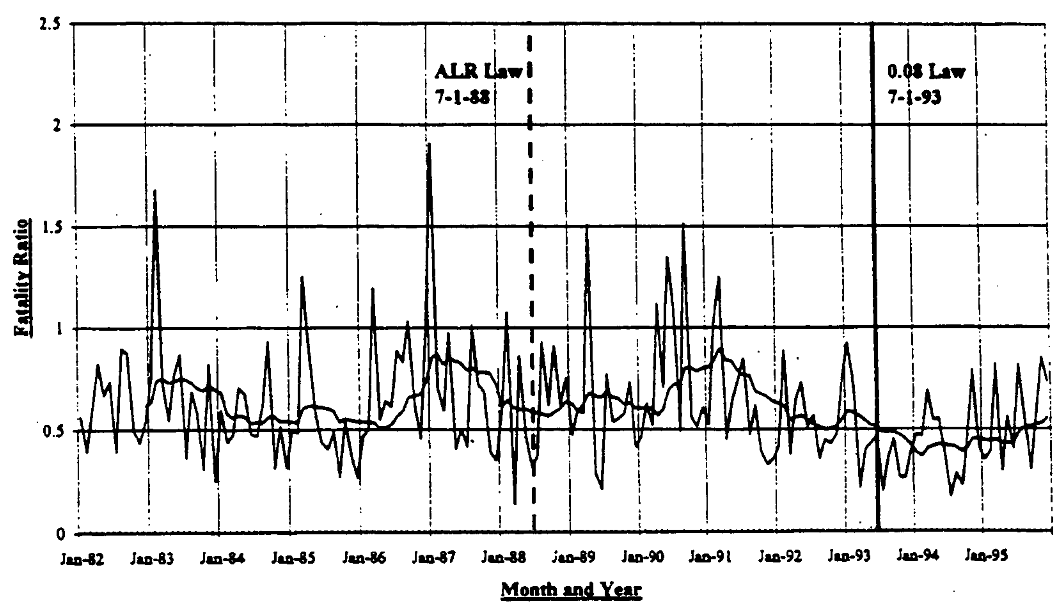
KANSAS STATE
Alchohol Related Fatalities (BAC>0.01)
with Trendline



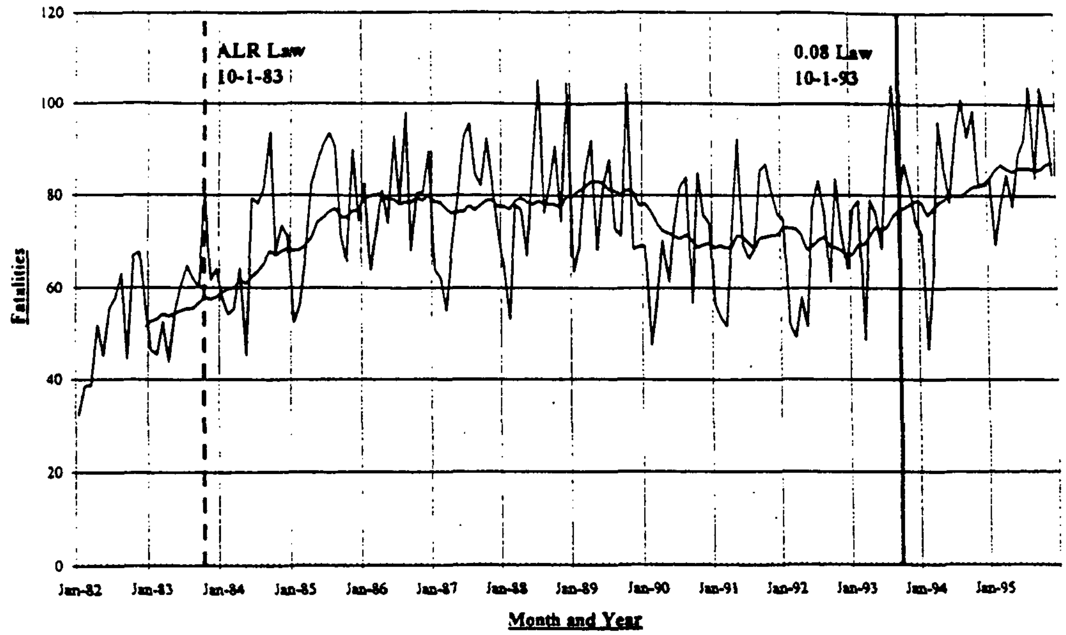
KANSAS STATE
Alchohol Relat**d Fatalities (BAC 0.10+)**
with Trendline



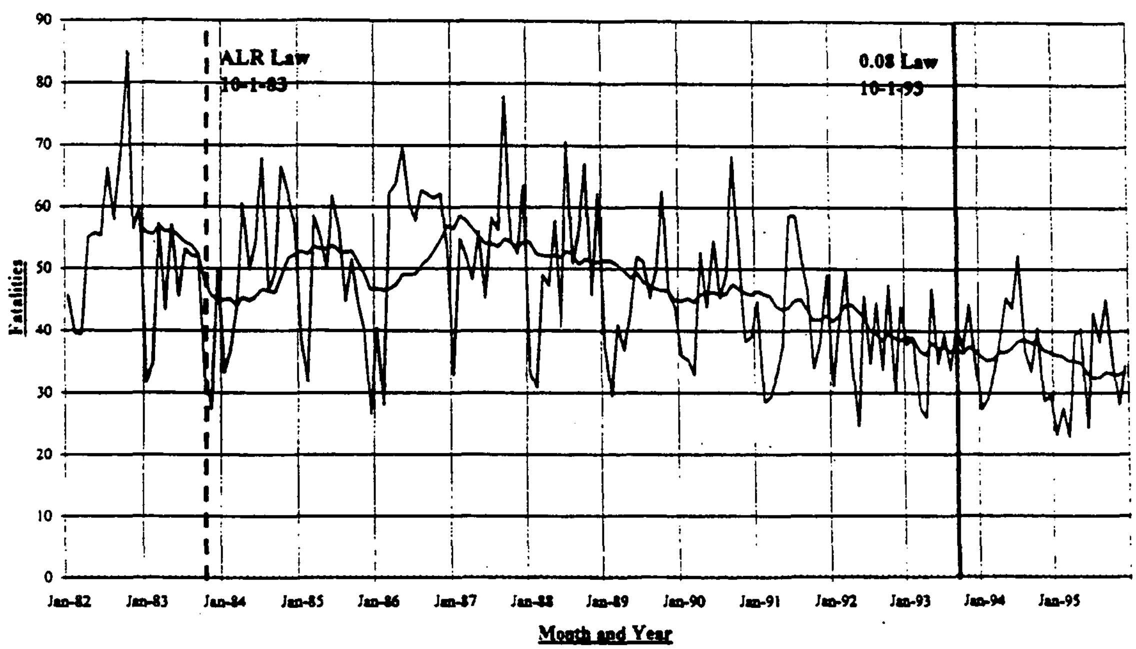
KANSAS STATE
Ratio of Alchohol Related Fatalities (BAC 0.10+) to
Non-Alchohol Related Fatalities (BAC0.00)
with Trendline

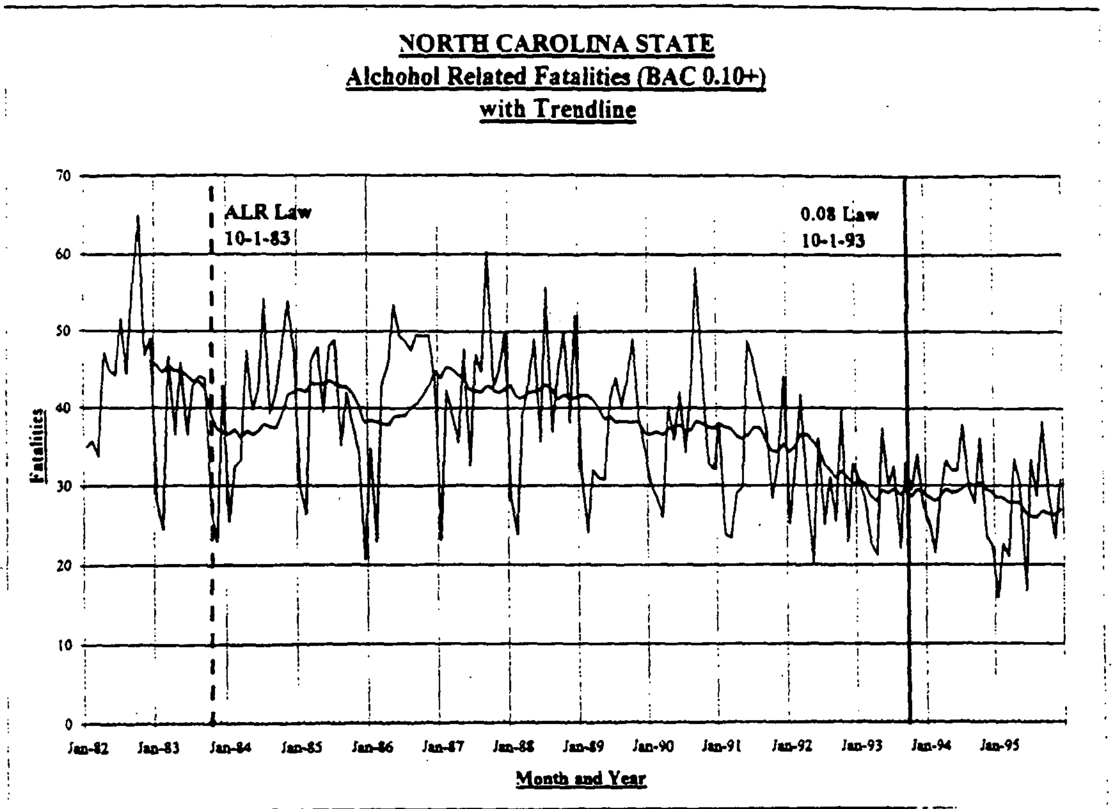


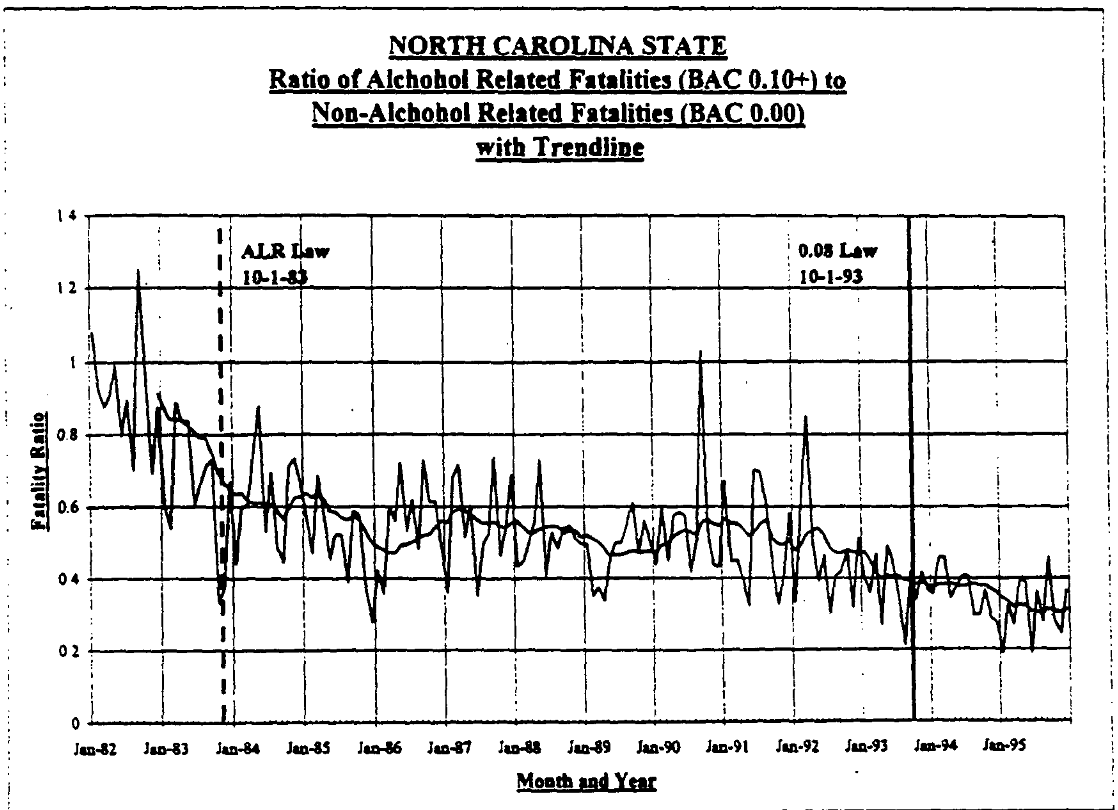
NORTH CAROLINA STATE
Non-Alchohol Related Fatalities (BAC 0.00)
with Trendline

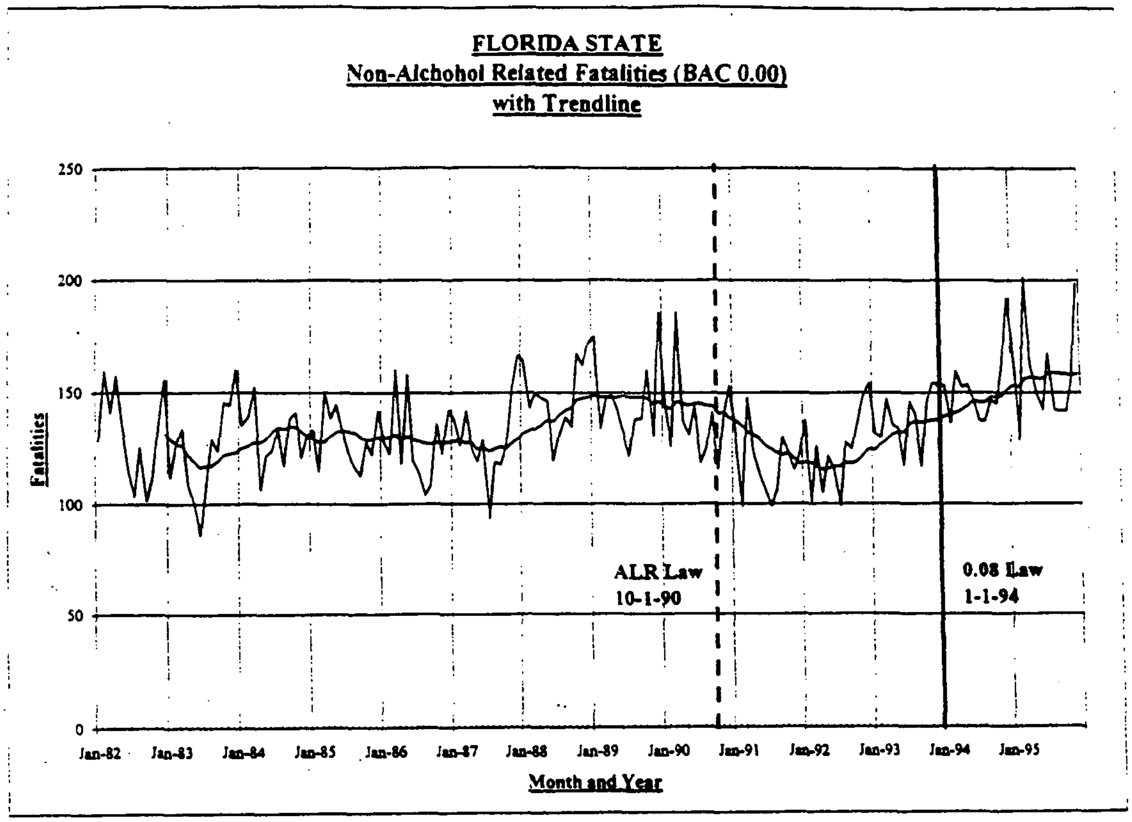


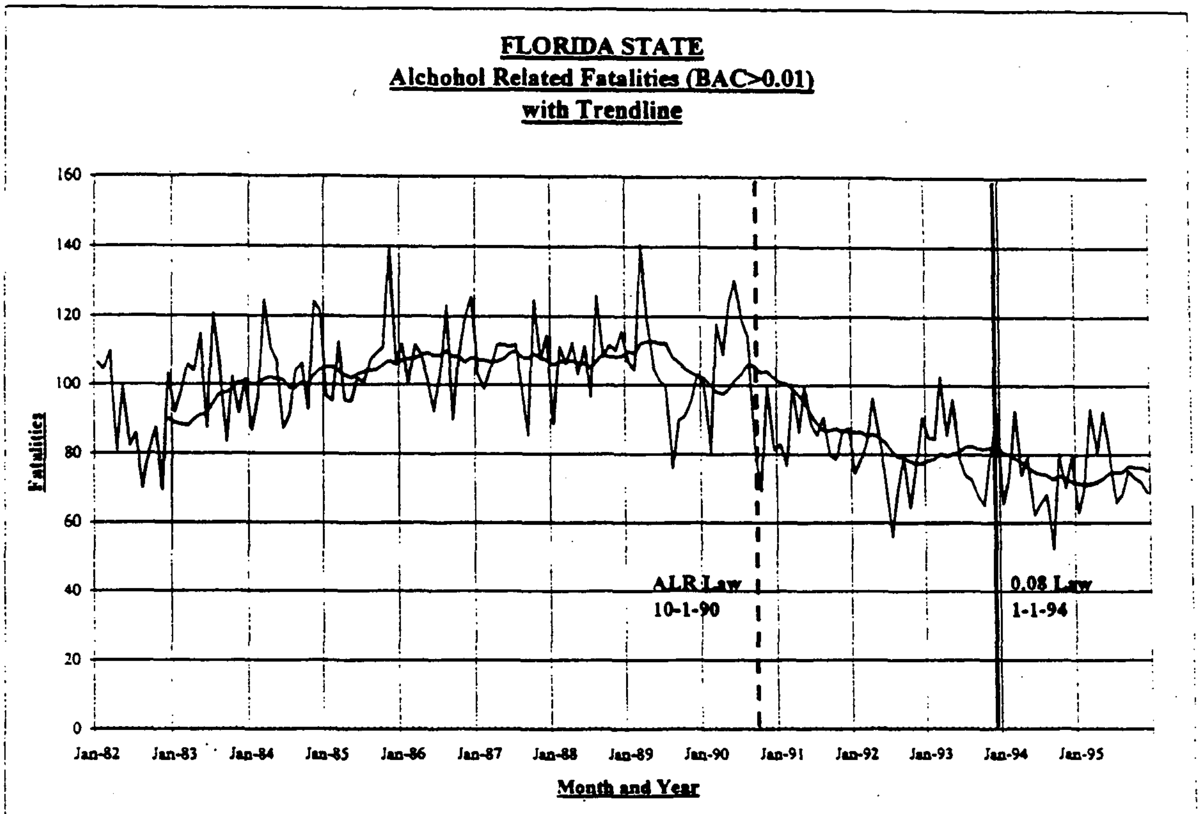
NORTH CAROLINA STATE
Alchohol Related Fatalities (BAC>0.01)
with Trendline




NORTH CAROLINA STATE
Alchohol Related Fatalities (BAC 0.10+)
with Trendline
ALR Law
10-1-83
0.08 Law
10-1-93
Fatalities
70
60
50
40
30
20
10
0
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Month and Year


NORTH CAROLINA STATE
Ratio of Alchohol Related Fatalities (BAC 0.10+) to
Non-Alchohol Related Fatalities (BAC 0.00)
with Trendline
ALR Law
10-1-83
0.08 Law
10-1-93
Fatality Ratio
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Month and Year


FLORIDA STATE
Non-Alchohol Related Fatalities (BAC 0.00)
with Trendline
250
200
150
100
50
0
Fatalities
ALR Law
10-1-90
0.08 Law
1-1-94
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Month and Year


FLORIDA STATE
Alchohol Related Fatalities (BAC>0.01)
with Trendline
160
140
120
100
80
60
40
20
0
Fatalities
ALR Law
10-1-90
0.08 Law
1-1-94
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
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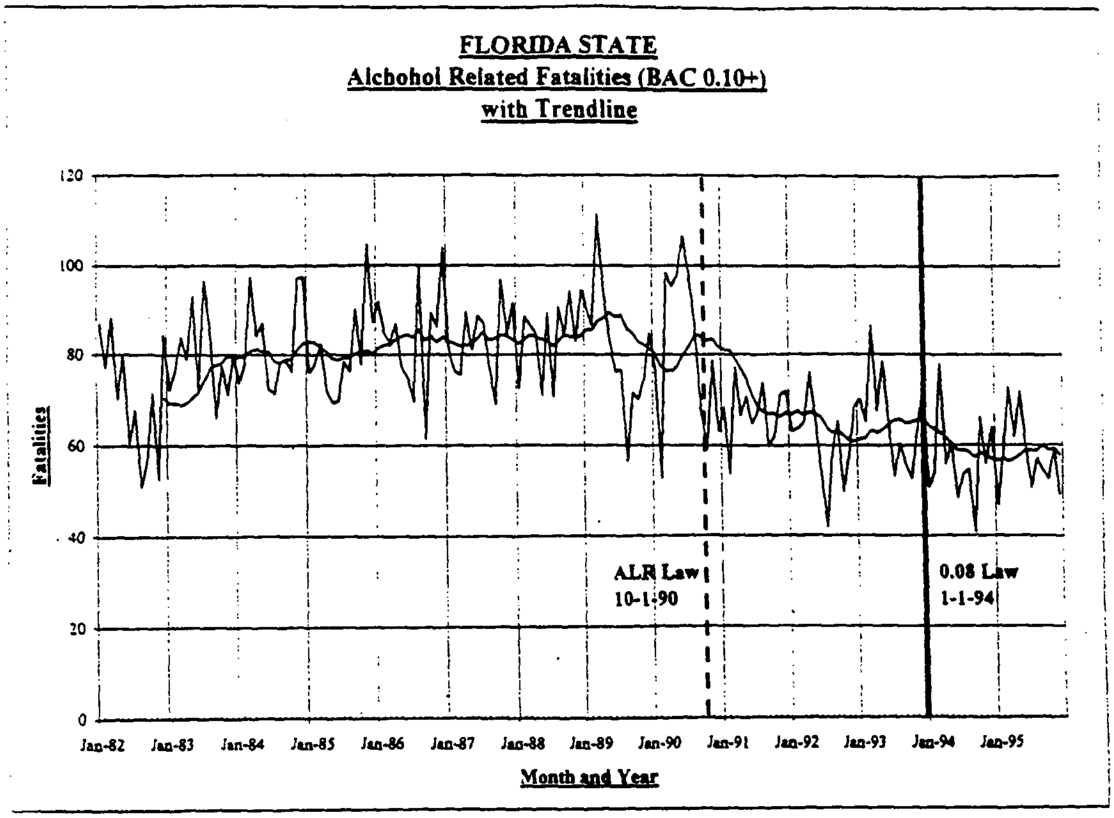
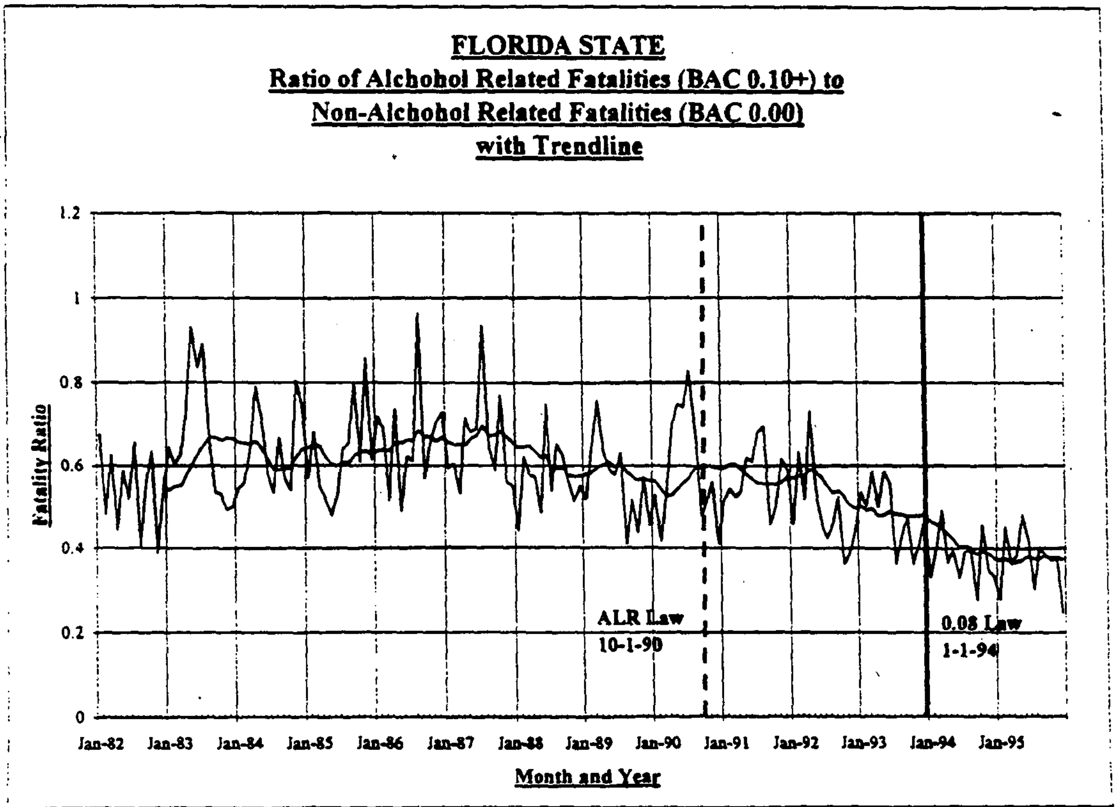
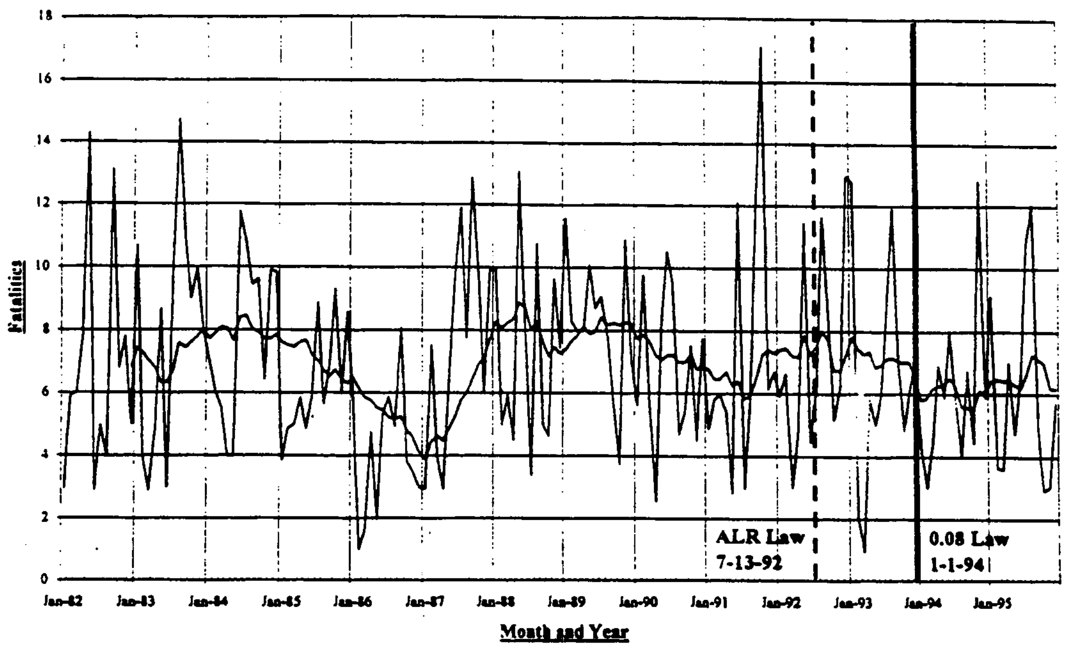
Jan-92
Jan-93
Jan-94
Jan-95
Month and Year

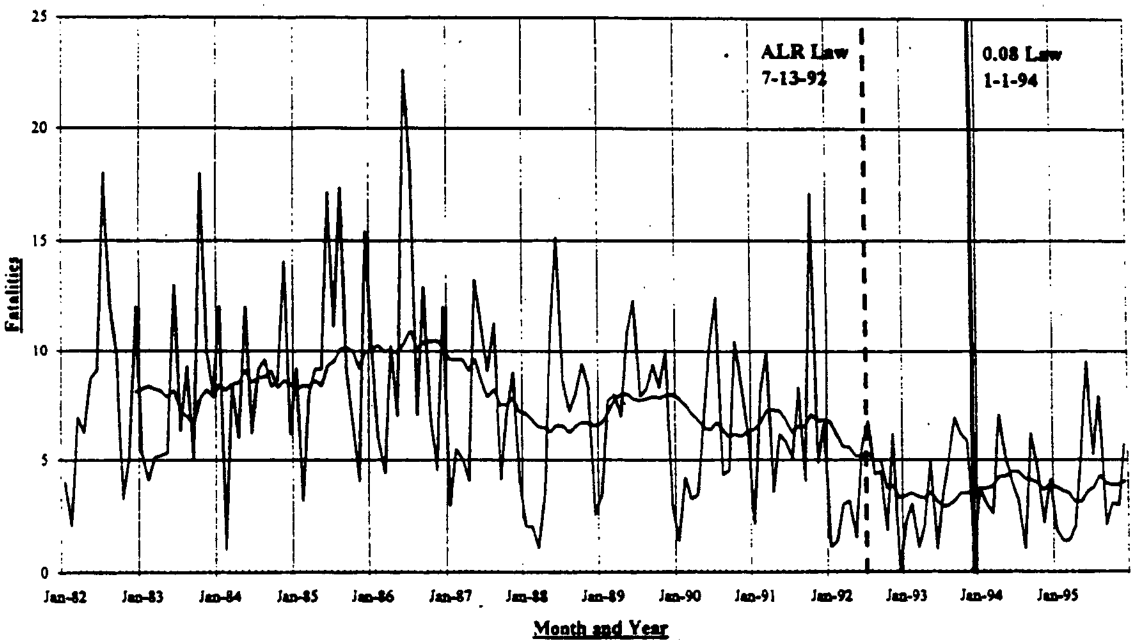

FLORIDA STATE
Alchohol Related Fatalities (BAC 0.10+)
with Trendline
Fatalities
120
100
80
60
40
20
0
ALR Law
10-1-90
0.08 Law
1-1-94
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Month and Year


FLORIDA STATE
Ratio of Alchohol Related Fatalities (BAC 0.10+) to
Non-Alchohol Related Fatalities (BAC 0.00)
with Trendline
Fatality Ratio
1.2
1
0.8
0.6
0.4
0.2
0
ALR Law
10-1-90
0.08 Law
1-1-94
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Month and Year

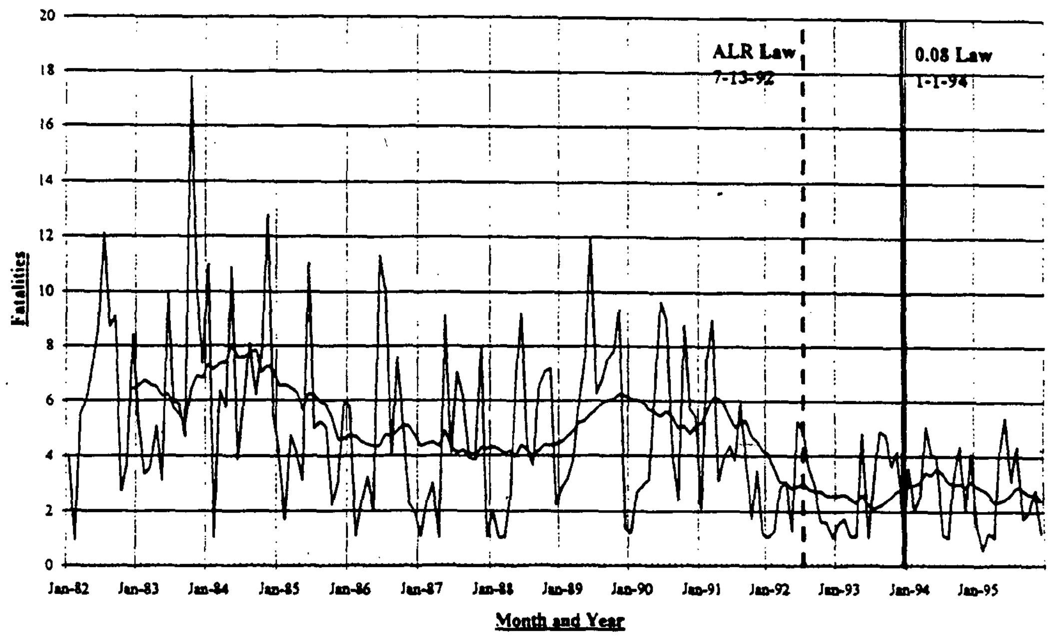
NEW HAMPSHIRE STATE
Non-Alchohol Related Fatalities (BAC 0.00)
with Trendline



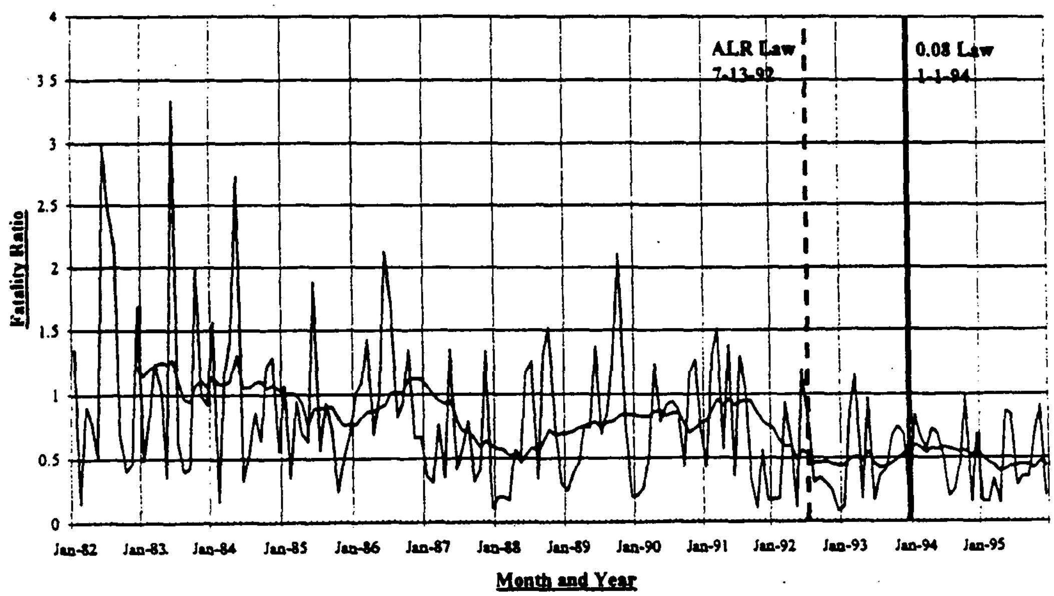
NEW HAMPSHIRE STATE
Alchohol Related Fatalities (BAC>0.01)
with Trendline



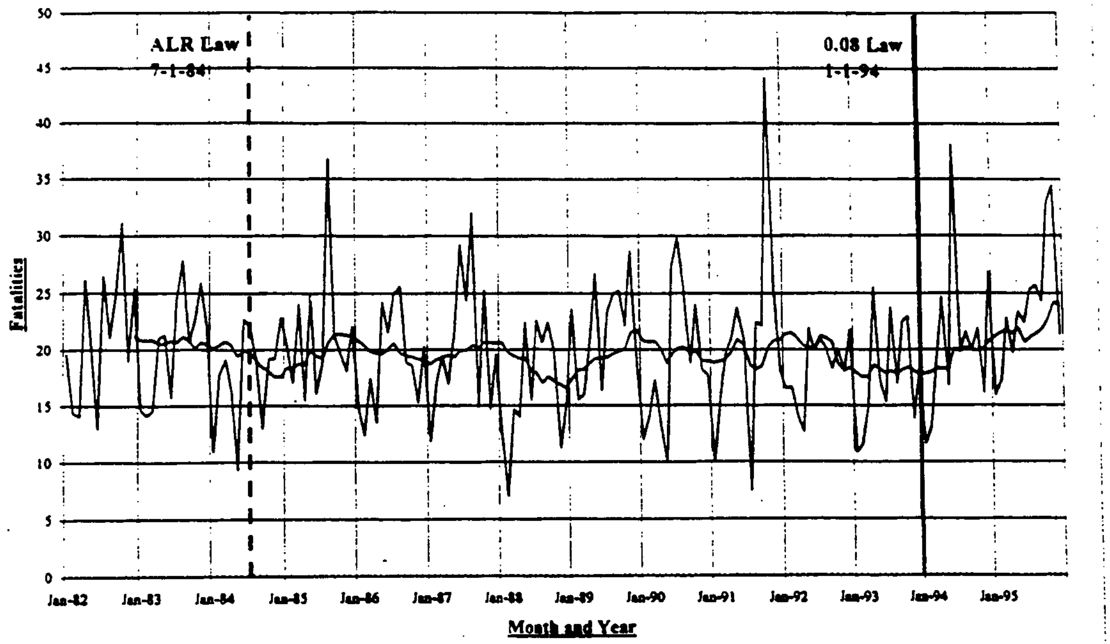
NEW HAMPSHIRE STATE
Alchohol Related Fatalities (BAC 0.10+)
with Trendline



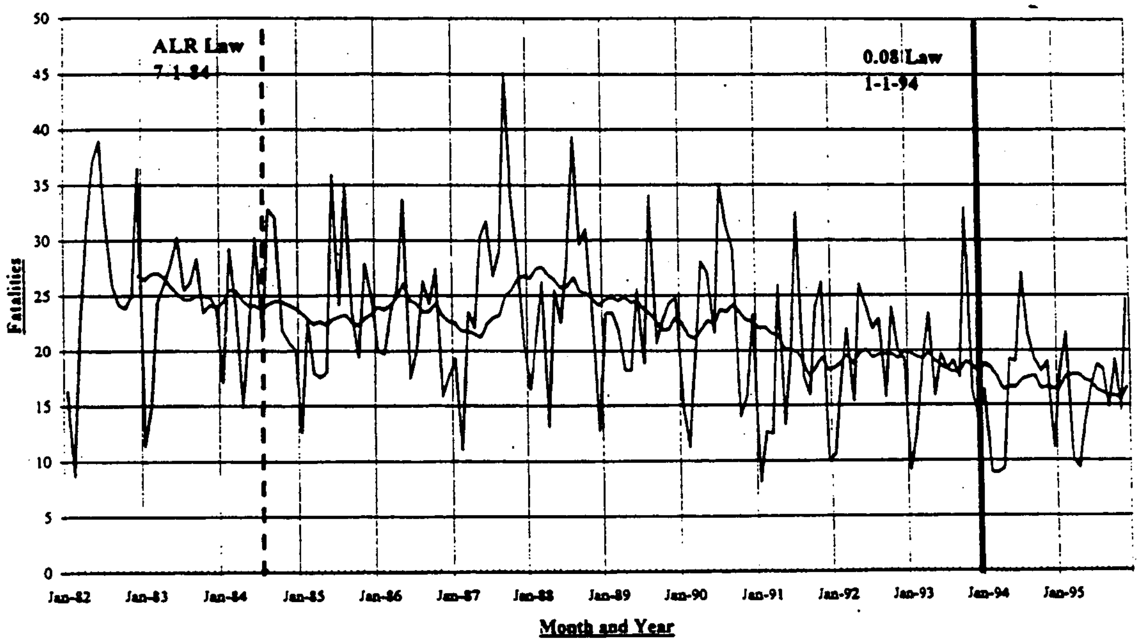
NEW HAMPSHIRE STATE
Ratio of Alchohol Related Fatalities (BAC 0.10+) to
Non-Alchohol Related Fatalities (BAC 0.00)
with Trendline



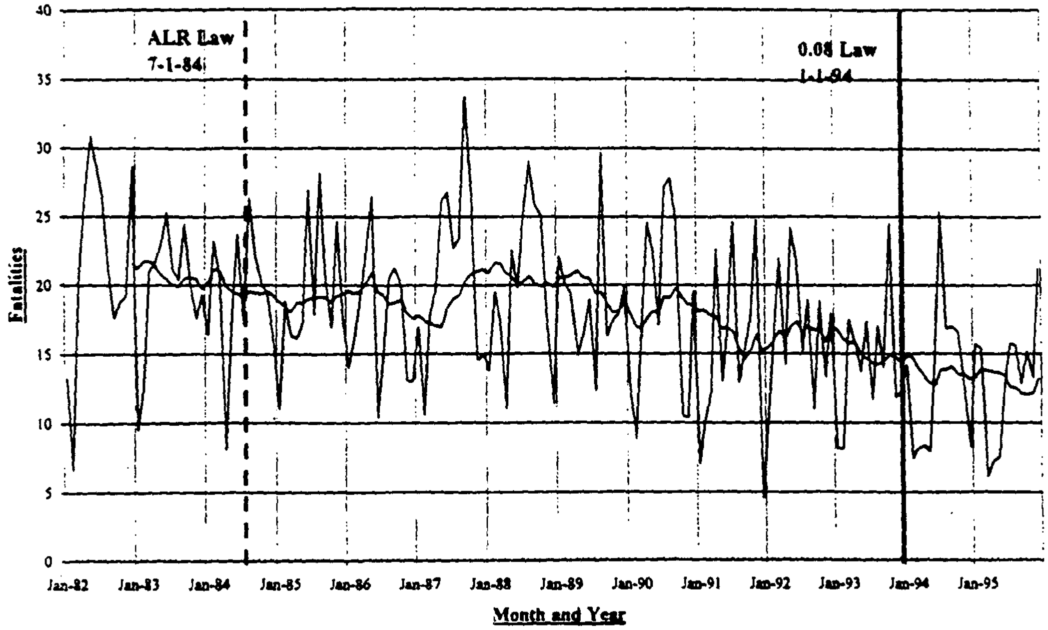
NEW MEXICO STATE
Non-Alchohol Related Fatalities (BAC 0.00) with Trendline



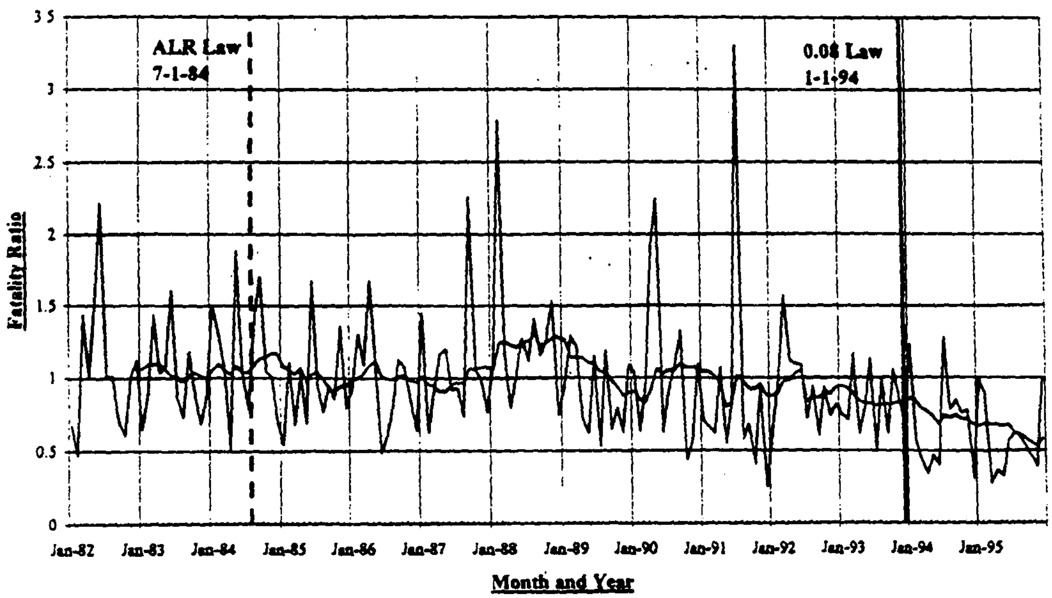
NEW MEXICO STATE
Alchohol Related Fatalities (BAC>0.01) with Trendline



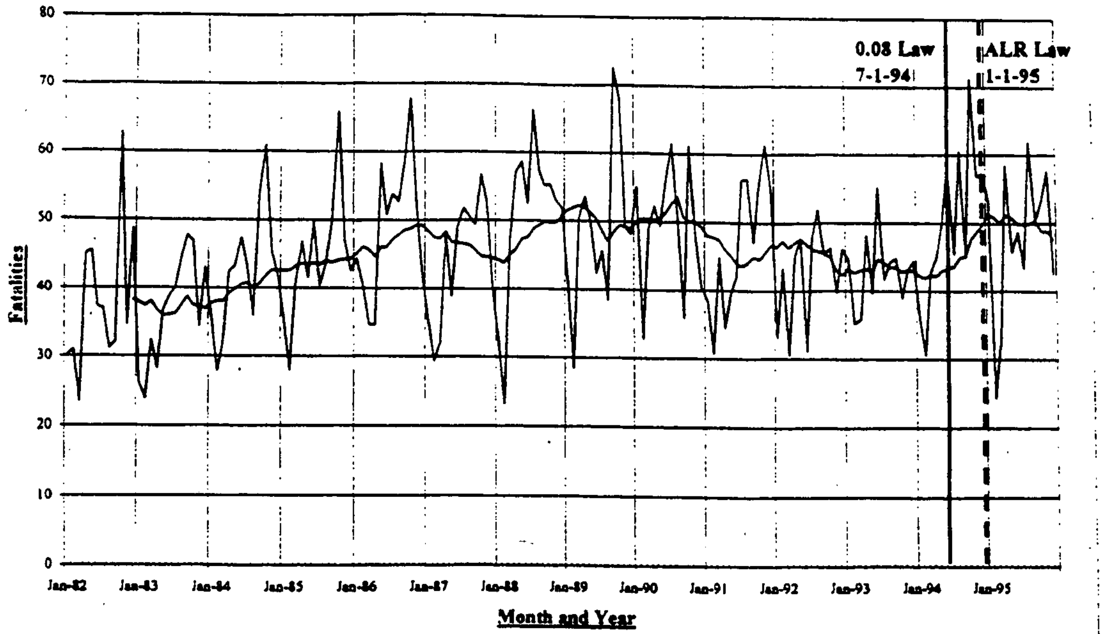
NEW MEXICO STATE
Alchohol Related Fatalities (BAC 0.10+)
with Trendline



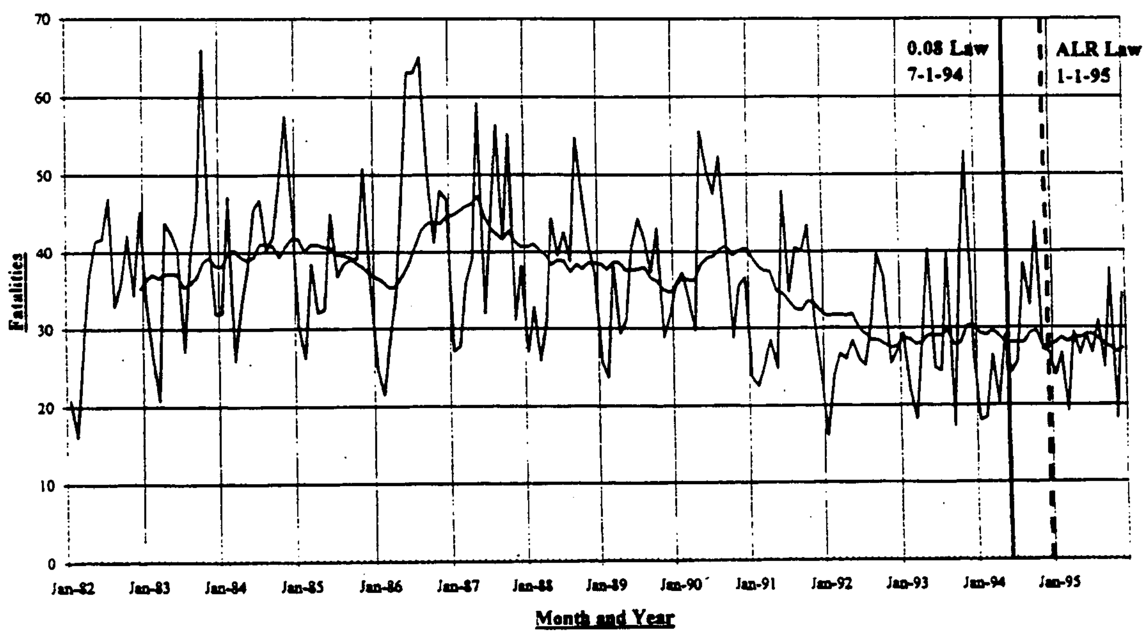
NEW MEXICO STATE
Ratio of Alchohol Related Fatalities (BAC 0.10+) to
Non-Alchohol Related Fatalities (BAC 0.00)
with Trendline

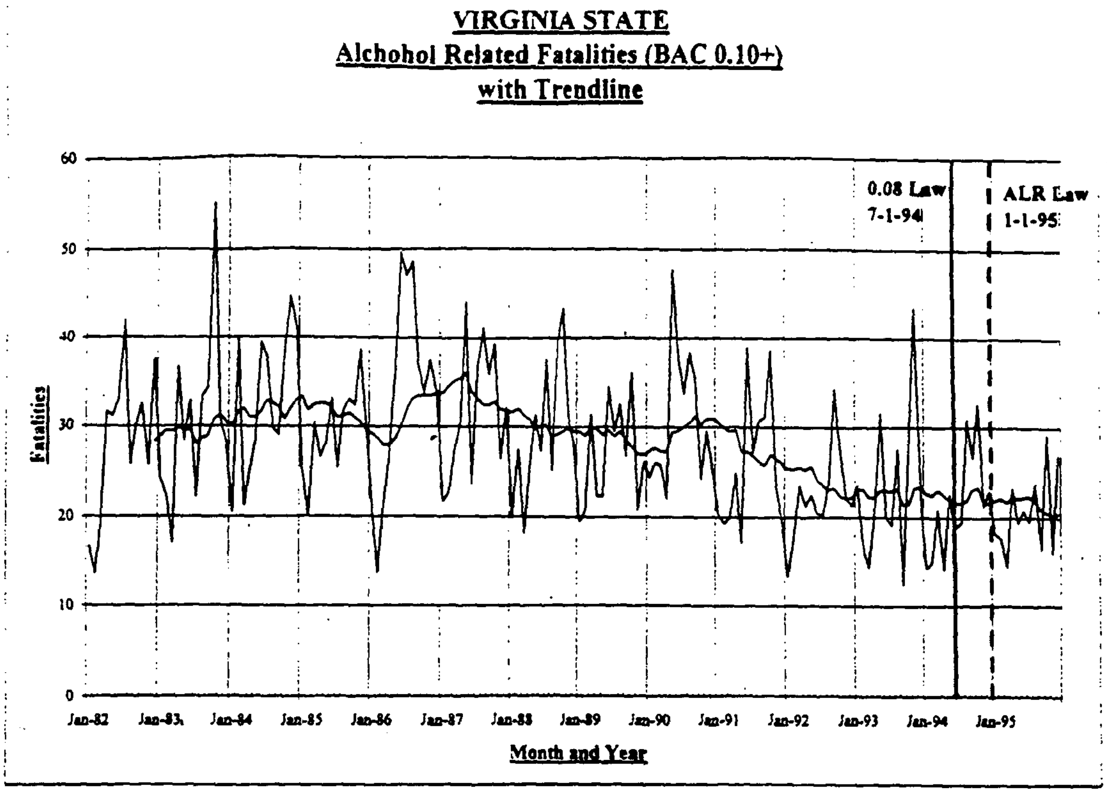


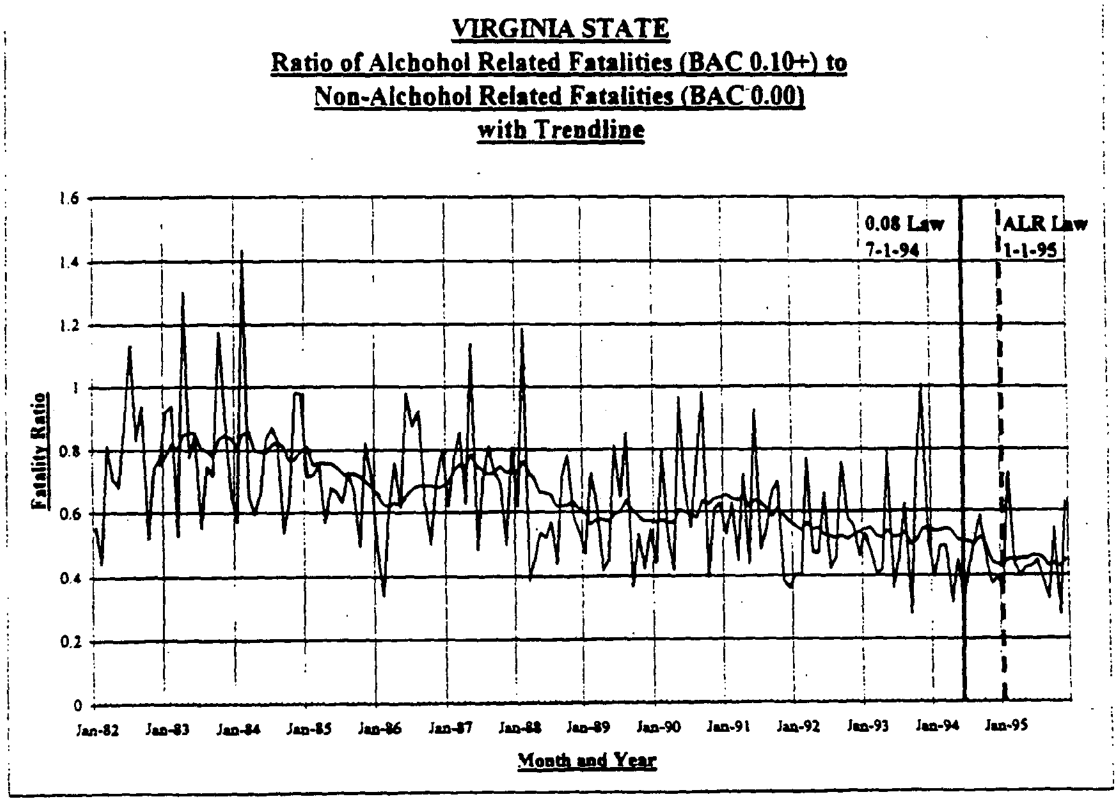
VIRGINIA STATE
Non-Alchohol Related Fatalities (BAC 0.00)
with Trendline



VIRGINIA STATE
Alchohol Related Fatalities (BAC>0.01)
with Trendline




VIRGINIA STATE
Alchohol Related Fatalities (BAC 0.10+)
with Trendline
0.08 Law
7-1-94
ALR Law
1-1-95
Fatalities
60
50
40
30
20
10
0
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Month and Year


VIRGINIA STATE
Ratio of Alchohol Related Fatalities (BAC 0.10+) to
Non-Alchohol Related Fatalities (BAC 0.00)
with Trendline
0.08 Law
7-1-94
ALR Law
1-1-95
Fatality Ratio
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
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Month and Year

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