Alcohol Availability, Consumption
and the Incidence of Alcohol-Related
Social and Health Problems in Michigan

Final Report

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16. Abstract
Cross-correlation, time-series-modelling and multiple regression analyses were utilized with available Michigan data to explore causal relationships between beverage alcohol licensing actions of the Michigan Liquor Control Commission, alcohol beverage distribution, and a number of major social and health problems. While conclusions are not definitive because of limitations in the data, it was found that mortality due to traffic accidents, occupational accidents, and total reported accidents is strongly and consistently associated with increases in alcohol availability and with draught and packaged beer distribution.

Other analyses determined that beverage alcohol distribution is highly predictable by using time-series analysis techniques. Multiple regression analyses, interpreted in connection with the other findings, suggested that wine distribution is probably more vulnerable to changes in licensing activities than beer or liquor distribution. Implications of the findings and suggestions regarding data collection adequacy in Michigan are offered.

17. Key Words Alcohol Availability; Alcohol-Related Mortality; Time-Series Analysis; Public Health

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SUMMARY

    The research reported is an examination of the statistical associ-
ation of beverage alcohol distribution, liquor licensing actions, and a
variety of social and health problems in Michigan between 1970 and 1976.
A review of social science, medical, and public health literature sup-
ported the hypothesis that a substantial proportion of several health
and social problems are directly related to alcohol consumption. Data for
Michigan and a subset of several Michigan counties were located in a
number of state agencies. Supplemental data were also obtained from the
Michigan Beer and Wine Wholesaler's Association.

    Time-series modeling techniques were used to determine the predict-
ability of draught and packaged beer distribution, wine distribution, and
table-top liquor sales. It was found that a major proportion of the
variance of these commodities can be predicted, with the amount of
variance explained ranging between 69% and 84%. The analyses found also
that violent assault and divorce frequencies are highly predictable by
using time-series analysis. The implications of the modeling are that
policy, program, or legislative interventions directed at alcohol avail-
ability or at social and health problems are fundamentally stationary
time-series and would allow evaluations of any major intervention with
considerable precision.

    Cross-correlation time-series analyses were conducted to identify
statistical relationships between alcohol distribution and social and
health problems, alcohol licensing actions and alcohol distribution, and
alcohol licensing actions and social and health problems. The most
critical finding suggests that total accident mortality, occupational
accident mortality, and traffic accident mortality are consistently
associated with increases in the distribution of draught and packaged

beer. Suicide and homicide mortality were found to be associated with
wine and draught beer distributions, repectively.

Combining the findings of cross-correlation tests and stepwise
multiple linear regression analyses, it was found that wine is more likely
than other kinds of alcoholic beverages to be affected by changes in
licensing activities of the Michigan Liquor Control Commission.

Recommendations are offered regarding the data requirements which
should be met before definitive research can be conducted in the area of
alcohol availability and most social and health problems in Michigan.
Suggestions for future research are offered.

PREFACE AND ACKNOWLEDGMENTS

This is the final report of a one-year study of alcohol availability, consumption, and the incidence of alcohol-related social and health problems in Michigan. The research was performed under contract for the Michigan Department of Public Health, Office of Substance Abuse Services, Lansing, Michigan.

Data were generously provided for our analyses from the Michigan Liquor Control Commission, the Michigan Department of Social Services, the Michigan Department of Public Health, the Michigan State Police, and the Michigan Beer and Wine Wholesaler's Association. In most recpects the analyses and findings of this investigation are exploratory and should be interpreted with careful regard to the considerable limitations in the data.

The assistance of Mr. Steven Stone was made possible by Alma College, Alma, Michigan. Ms. Patti DeBiasi participated in the final stages of the project as part of the field research placement through The University of Michigan School of Social Work.

While many others contributed valuable services, we remain fully responsible for the methodologies, findings, and interpretations contained in this report.

<div align="right">

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1. INTRODUCTION

The regulation and control of alcoholic beverages has received
considerable attention in recent years as a potentially viable means
of reducing social problems related to alcohol use and abuse. The
National Institute on Alcohol Abuse and Alcoholism reviewed the state
of knowledge in 1974, Bruun, et al. (1975), outlined a broadly based
control policy perspective in 1975, and a study contracted by Medicine
in the Public Interest, Inc. suggested a prevention role for alcoholic
beverage control laws in the United States in 1976. In a cross-
cultural study using an index of availability of alcohol derived from
a panel of "experts," Smart found no causal relationship between per
capita consumption and alcoholism rates (1977 b); however, other
studies have suggested that changes in availability have effects on
alcohol-related problems and consumption. Parker, Wolz, and Harford
(1978) reported that, when controlling for the effects of per capita
income, urbanism, and limitations by population on the number of sales
outlets, the effect of outlet availability is a significant factor in
both per capita consumption and rates of alcoholism. The effect was
found when comparing data from states with population-based outlet
availability against states without such controls.

The retail availability of alcoholic beverages was shown by Douglass
and Freedman (1977a) to co-vary over time with both traffic casual-
ties related to alcohol and with specific categories of alcohol con-
sumption in Michigan. The age of legal purchase was found to be a
major factor of alcohol availability, while less radical modifications
of retail licensure and control were also found to be associated with
increases in the number of retail establishments. While highly sug-
gestive of a causal relationship, the association of consumption,

alcohol-related problems, and increases in the number of retail establishments reported by Douglass and Freedman remains somewhat tentative and merits significantly more analysis. The precise relationships of court decisions, periodic and special census surveys of the population, legislative actions, and policy changes on the total number of retail sales establishments remain to be fully defined. Further, the relationships of changes in retail alcohol availability, consumption, and a host of alcohol-related social problems among the various regions and counties in Michigan have never been systematically analyzed.

Smart (1977b) reported that changes in availability were found to vary with increases in alcoholism treatment incidence of young people in Ontario following the lower legal drinking age in that province. He suggested, however, that more research would be required to determine if the discovered relationship was real or spurious. In the same paper Smart reported that there was no clear evidence that total per capita consumption of alcohol was affected by different levels of availability. In his discussion he commented that while alcoholism rates correlated positively with availability, the strength of the relationship was stronger for the effects of income and urbanism, suggesting that different degrees of affluence and population density should be analyzed simultaneously in studies of the effects of availability.

In a recent study, D. Ian Smith (1978) of the Road Traffic Authority, Perth, Australia reported that the introduction of Sunday sales of alcohol increased the traffic accident mortality rate during the three years subsequent to that legal change in July, 1970. This is in agreement with similar findings reported by Douglass and Freedman (1977) for Michigan in 1972.

The full range of social problems, of which a proportion are causally related to alcohol abuse, includes all forms of accidental injury and death, domestic and criminal violence, and several chronic disease mortalities, including the broadly defined alcoholism and narrowly defined alcoholic cirrhosis. These problems, of course, are

accompanied by problems such as divorce, work absenteeism, and others which are not well reported and are inconsistently recorded by public or private agencies.

The intention of this study is to learn more about the dynamics of alcohol availability, alcohol distribution, and several social and health problems which are, in part, associated with the abuse of beverage alcohol. If dynamic linkages are found between these factors and the activities of the Michigan Liquor Control Commission, the Legislature, or other agencies of state government charged with responsibility for maintaining and minimizing social and health problems, may be in a better position to recommend more reasonable and effective policies to reduce the incidence and prevalence of alcohol-related problems. At least, this analysis reveals opportunities to improve the collection of data critical to an understanding of these relationships, and provide a basis for knowing where major prevention or policy efforts will have difficulty showing a measurable reduction of alcohol problems. At best, the analysis identifies particular health or social problems likely to show improvement through well-defined policy changes or new prevention programs.

2. THE CONCEPTS OF AVAILABILITY AND ALCOHOL-RELATED PROBLEMS

The availability of alcoholic beverages has assumed an increasingly promiment role in the literature on problem-related alcohol consumption,* and yet it remains, to date, a concept whose precise theoretical definition has yet to be stated. Smart (1977) has outlined fragments of theories from differing disciplinary perspectives: economic availability, subjective, or perceived availability, and social availability. The differing emphases of these and other notions of alcohol availability reflect differing views as to which aspects of alcohol control policies are most relevant to drinking behavior. The resulting inquiry into the nature of alcohol availability, as developed from the several disciplinary starting points, is not refined enough to permit easy synthesis into a broadly defined theory of availability, and thus we must preface the term with the appropriate modifier to specify the kind of availability in which we are interested.

Economic availability has generally focussed on the aggregate relationship between the consumption of different types of alcoholic beverages, the prices of those beverages, and consumer income. Studies of economic availability have developed demand models for alcohol consumption that include, in addition to prices and income, an assortment of additional explanatory variables to attempt to isolate the effects of social and environmental factors on alcohol consumption. However, the focus of attention has largely been on the more traditional economic determinants of demand. Economic availability of alcohol, as it has been applied, does not differ appreciably from the economic availability of any other privately produced good. While estimates of aggregate

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*For a broader review of the literature, see Bruun, et al., (1975).

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alcohol demand undoubtedly constitute useful information, they provide no direct clues as to the possible effects on alcohol consumption that result from controllable changes in availability policy.

However, a closely related concept of availability, that of physical availability, provides a means by which to construct a more broadly defined theory of economic availability that can describe the process by which changes in availability policies (license issues, increased operating hours, etc.) are translated into changes in alcohol consumption. The model can be explained as follows: Consumers of alcoholic beverages adjust their consumption upward when the price of alcohol falls, as "traditional" economic availability studies have postulated. But, now we have

$$(2.1) \quad P^i = P_n^i + K$$

where P^i is the price of the ith type beverage, P_n^i is the nominal price (e.g., what retail price is charged for the beverage itself), and K is the search cost incurred to obtain that beverage. K measures, in dollars, the value to the individual of the time spent looking for a drink, as well as the costs of transportation to the point of sale. As such, K is a measure of an imputed cost (one that is not actually paid out or collected), whose magnitude can be expected to vary directly with fluctuations in physical availability. Thus, the "effective" price (= nominal price + imputed costs) of alcohol is affected by legal availability policies, with consequent consumer adjustments in consumption.

As we have noted above, any work making reference to availability must also spell out what kind of availability, since the theoretical and operational considerations surrounding the various types of availability are distinctly different. In this study we examine the type of availability we believe to be most relevant to policy-making, that of physical availability, and the term availability hereafter is to be understood as such. While, as we shall see, the methodological problems

in defining and measuring the physical availability of alcoholic beverages are formidable, at least on a conceptual level this approach has considerable intuitive appeal.

As Smart (1977b) points out, availability is obviously important as a necessary condition for alcohol consumption, yet no one would seriously maintain that it is merely a discrete, dichotomous phenomenon, either totally present or totally absent. It seems more plausible from casual empirical inspection that, excepting periods of general prohibition, that the evolution of availability over time has been characterized by incremental adjustments. Similarly, at any specific point in time cross-sectional differences in availability are typically differences in degree, and not total contrasts between strict prohibition and decadent indulgence. Since differences in availability lie along a continuum, and not just at two extremes, the question is, how do small changes in availability enter into individual decisions of how much alcohol to consume?

For several reasons, an economic approach is well-suited for such a problem. The first and most obvious is that to answer the posed question, comparisons must be made between items (e.g., difficulty in obtaining alcohol vs. satisfaction from drinking) which, until they are expressed in some common metric, remain impossible to objectively measure and thus weigh. In economics, that common metric is price, and it is measured through observation of individual decisions as they are reflected in market outcomes. Thus an individual reveals how much he likes a drink by what he gives up to obtain it: The money he pays for it, plus the value to him, expressed in dollars, of the travel time and/or inconvenience incurred to obtain it. A further justification for an economic approach to availability is that the analysis takes place on an aggregate level, almost by definition. Since any level of availability is necessarily the same for everyone in the relevant population, it follows that any changes in that level will affect everyone and will, to some extent, affect aggregate consumption. At this macro level, the personal idiosyncracies that may be dominant in explaining

individual consumption patterns can be thought of as mutually cancel-
ing, so that a focus on universal (e.g., economic) variables will be
more appropriate. Whether the fluctuations in aggregate consumption
caused by modifications of availability policy are relevant in explain-
ing the incidence of alcohol-related problems is a separate question
which we address below.

The price of a product, as observed in the marketplace, repre-
sents one of the fundamental determinants of demand for that product,
as has been recognized by economists, businessmen, and consumers for
centuries. The relationship between the retail price of alcohol and
consumption has been studied on both the individual and aggregate
levels. Johnson and Oksanen (1977) found price coefficients in a
demand model, estimated from pooled time-series and cross-sections of
Canadian provinces, to have the expected sign and to be highly signi-
ficant. These findings, according to the authors, were independent
of the effects of income and several sociological variables. In an
experimental setting Babor et al. (1977), found a reduction in price
to be highly correlated with increases in consumption, a relationship
that held up even among those individuals who were classified as
"heavy drinkers." Thus, the evidence would indicate that the retail
price of alcoholic beverages is a significant component in an in-
dividual's decision on how much to consume.

We have argued above that availability may be conceived of as a
component in the total price of alcoholic beverages, the sum of
nominal price (the retail price charged by establishments) and the
dollar value of the time and trouble required to acquire alcohol.
When viewed in this light, it is clear that the works of Johnson and
Oksanen, and others constitute a substantial prima facia case for the
existence of a relationship between availability and consumption, be-
cause availability may be thought to be negatively related to a more
broadly defined concept of price.

It is important to note the distinction between legal avail-
ability policy and physical availability. The relationship postulated

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above refers to the latter, since that is what has direct influence on individual consumption. The indirect effect of changes in legal availability policy is emphasized in Figure 2.1. Two points can be drawn from the simple causation model. First, changes in legal availability policy affect physical availability (that which is most apparent to the consumer) only through inducing changes and reactions in the private alcohol retail industry.* An increase in license issues, for example, will increase availability only if there exist individuals willing to buy them. In Michigan, at least, this seems to be a given, because there are long waiting lists for all categories of licenses. Secondly, it is clear that all changes in availability are not initiated by regulatory agencies. While the industry is undoubtedly closely regulated, there is in many cases considerable opportunity for changes in pricing and marketing of beverages as well as some freedom in the choice of location.

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┌─────────────────────┐         ┌─────────────────────┐
│ Changes in Legal    │────────▶│ Changes in Private  │
│ Availability Policy │         │ Market for Alcoholic│
│                     │         │ Beverages           │
└─────────────────────┘         └─────────────────────┘
                                           │
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                                ┌─────────────────────┐
                                │ Changes in Physical │
                                │ Availability        │
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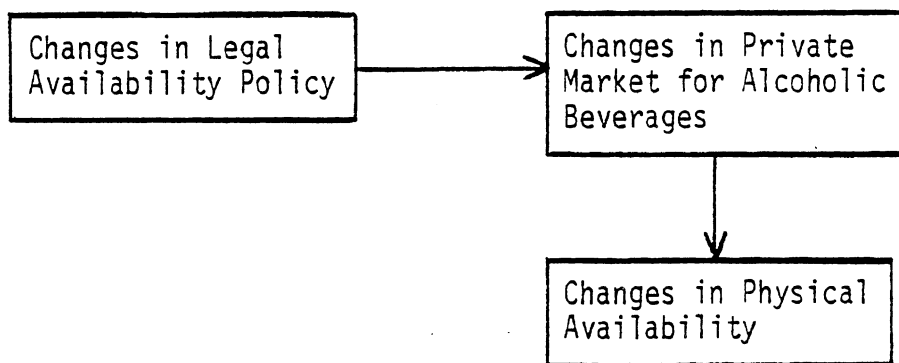
FIGURE 2.1.

*This, of course, is not true where the state itself is the retailer, but even in this case the manufacture and marketing of alcoholic beverages and carried out under private auspices.

Availability is, in part, the result of state and local policies governing the marketing and sale of alcohol. Those policies, in turn, are determined by popular sentiment and attitudes as to the "proper" place for establishments offering alcoholic beverages for sale, as defined by local norm and customs. For example, a working-class Irish community may agree to allow a level of availability that another community would find unacceptable. Thus, we can expect that areas with more relaxed attitudes toward the use of alcohol will exhibit higher levels of availability, relative to areas with tighter controls. The relationship between availability and consumption is therefore simultaneous, with high availability resulting in high consumption, and with the greater acceptance of alcohol (that gave rise to the high availability) contributing to higher consumption as well.

The above discussion can be summarized by the following simultaneous equation model:

(2.2) $\quad A_i = f(Y_i, R_i, E_i)$

(2.3) $\quad C_i = g(P_i, Y_i, R_i, E_i, A_i)$

where A_i is availability in the ith community, and is a function of Y_i, the median income, R_i, a vector of religious and ethnic variables, and E_i, a vector of environmental variables including things like urbanization and the unemployment rate. C_i, per capita consumption, is a function of P_n, the nominal price of alcohol, Y_i, R_i, and E_i defined as before, and the level of availability, A_i. In this model, changes in legal availability are thought to be determined by the arguments in (2.2), but in the actual case such determination may not take place. Availability may be determined by a statwide equation (2.2). Therefore, communities whose preferences differ substantially from the state norm are not necessarily able to bring local policies into agreement with local tastes and so we may want to include actions on legal availability in (2.2). In total, the model is intended only to illustrate the

interaction of consumption and availability, in that areas with high availability may have high consumption (this is at least partly a reflection of the fact that many of the factors explaining high consumption levels predict high levels of availability as well).

2.1 Availability Policy and Alcohol-Related Problems

Based on the conceptual model developed thus far, it can be seen that changes in availability policy are reflected in changes in the aggregate level of consumption. Although availability policies can be formulated that are group-specific (i.e., minimum legal drinking age), we consider here the more general effects of availability that are thought to affect individuals equally. This does not say that all individuals will react identically--that everyone will curtail his consumption when, say, permissable hours of operation are cut back--but only that the increase in the effective price of alcohol that is the result of such a decrease in availability is felt by all consumers of alcohol in a given area, rather than some subset. As we have attempted to illustrate, it may make sense to postulate that increases in availability will bring about increases in aggregate consumption, but what are the consequences for the incidence of alcohol-related problems?

The answer to the above question can be addressed with an investigation into the relationship between rates of alcohol-related social problems and the level of aggregate consumption, as has been attempted by Schmidt and Popham, and others (Schmidt and Popham, 1978; Parker and Harman, 1978; deLint and Schmidt, 1968). It is their contention that the frequency distribution of individual alcohol consumption, with relative frequency plotted against units of absolute alcohol consumed, is lognormal in form, with small numbers of very heavy drinkers skewing the distribution to the right (see Figure 2.2). Within this framework the effects of changes in availability policy on problem incidence can be seen to depend on (1) how those policies affect the distribution of consumption, and (2) where the problem-drinkers lie along the horizontal axis in Figure 2.2.
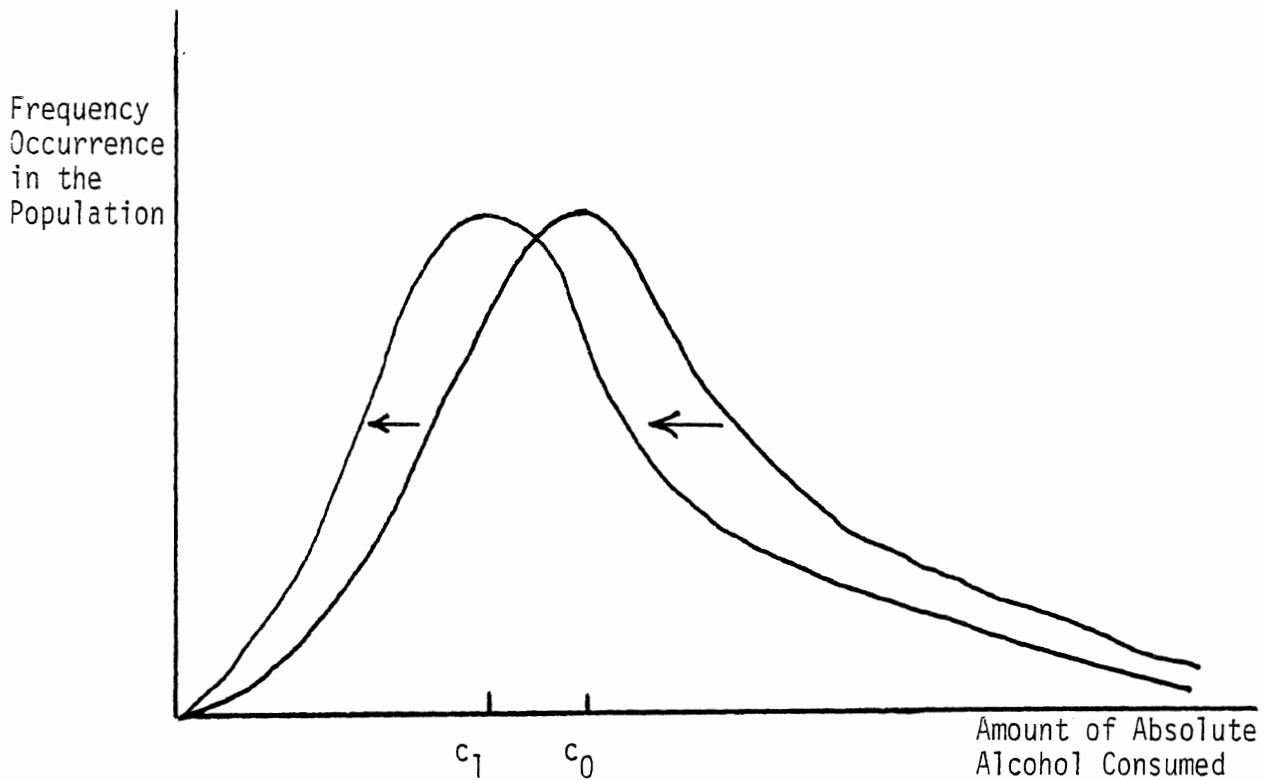
Figure 2.2. One Possible Effect of Restrictive Availability
Policies on the Distribution of Consumption

Suppose the effect of restrictive availability policies was to
shift the entire distribution to the left, shifting modal consumption
from c_0 to c_1 and causing the tail to shrink. This kind of shift implies
that everyone adjusts his consumption in response to the availability
change. Now if the incidence of problem-drinkers were concentrated in the
tail of the distribution, as we might expect with chronic problems such as
cirrhosis, the effect of restricted availability would be a decline in the
problem rates. That is, for those chronic problems for which heavy con-
sumption of alcohol is a necessary and sufficient condition, reduction in
consumption will result in reduced problem incidence. We should note,
however, that the time elapsed between the availability change and the
change in observed problem rates is likely to be quite large, perhaps as
long as ten years.

One can, of course, alter the possible scenario. We could postulate that availability policies will have an asymmetrical effect, with light drinkers reacting most to policy changes, and heavy drinkers hardly reacting at all. Such effects would imply that availability policies and incidence of alcohol-related problems for which alcohol itself is the primary cause will be unrelated. Finally, we might question the relevance of absolute alcohol as a measure of consumption replacing the single frequency distribution curve with a set of curves for separate beverage categories (Package Beer, Draught Beer, Wine, Packaged Spirits, On Premise Spirits), implying that availability policies affecting one or more types of beverage will have no effect on another type.

Without the light of facts, there is no basis for excluding any of these possible interpretations of availability policy changes within the single distribution theory framework, and there are countless other modifications that could be developed. However, the advantages in developing and testing these kinds of propositions are limited, because as a tool to examine the relation between consumption and those problems for which the consumption of alcohol is only a necessary condition, the single distribution theory is seriously flawed. Aggregate consumption, by itself, can only be used to predict chronic health problems; acute problems, such as motor vehicle and work accidents, homicides, and suicides, are logically related to quantities of alcohol consumed at given occasions and the physical availability of alcoholic beverages in the particular circumstances. This is not to say that availability and acute problems will be unrelated (quite to the contrary, we find in this report convincing reasons why they may be related), but only to point out the probable irrelevance of total consumption as an essential explanatory factor in predicting the incidence of many types of alcohol-related problems.

2.2 Operational Considerations

If what we are interested in is measuring availability, we have
a problem in that availability is an "unobservable" variable--that
is, the factors that are thought to contribute to the determination of
availability may be observed and measured, but unless we have, in
addition, observations on the levels of availability that correspond
to those observations of the independent variables, we have no way of
estimating the relative weights of those independent variables. If,
for example, Equation 2.1 were to be estimated using techniques of
mutliple regression, we would be trying to estimate the coefficients
without observations on the dependent variable, which is an impossible
task. We would like to be able to estimate (2.1) so that we could
determine the appropriate weights to assign the arguments in the
function, and use the results as a basis upon which to predict the
changes in availability that would take place when the independent
variables change, but our efforts are thwarted by our inability to
observe and/or fully measure "availability".

Several approaches present themselves as plausible solutions to
this problem of measurement. One is to think of availability as a
relative measure, as an aggregate index assuming variations in a num-
ber of components. These components might include items such as
levels of regulation (broken down into specific regulatory actions),
the density of establishments, and local customs regarding hours of
operations, conditions of sale, and so forth. The weights of these
components are calculated at those values that maximize the correlation
between the constructed index and observed alcohol consumption. Thus
the components of the index become our "observations" of availability,
with consumption data determining the particular form of the aggre-
gation.

While appealing as a simple availability measure, this procedure
is generally unsatisfactory. The measure, as formulated, is clearly
unsuitable for testing the relationship between availability and con-
sumption, because the index is constructed so as to make that

relationship as exact as possible. Thus, the influence of availability on consumption must be assumed, rather than tested. Moreover, even if this rather strong assumption is accepted, it does not necessarily follow that estimation of appropriate component weights from a single equation such as (2.2) above will yield consistent estimates of the parameters (in this case, the weights) involved. This is due to the simultaneous nature of the system. Since availability is both a dependent and an independent variable, the error terms in (2.2) and (2.3) will generally be correlated, and thus the parameter estimates will be biased and inconsistent (Kementa, 1971; 531-539). If availability itself were to be measured and employed as a variable, equations (2.2) and (2.3) would have to be estimated simultaneously.

A final reason against the use of a constructed index of availability is that such a measure necessitates the aggregation of the various components of availability (license issues of all types, transfers, new permits, and so forth) into a single, unidimensional figure. While appealing as a compact, summary measure, such an index would reflect subtle changes in availability in a rather crude manner. This drawback becomes especially severe when there are only certain aspects of availability that affect consumption in certain settings. For example, we might observe the situation where several bars and package liquor stores are located near a large factory that employs several hundred workers, and also has a certain rate of alcohol-related accidents. Suppose that, for various institutional reasons (e.g., the structure of work shifts and breaks, regulations concernings leaving the plant, etc.) drinking in the bars is mostly relegated to after-work hours, so that the accidents are largely associated, with alcoholic beverages that are purchased for off-premise consumption. Thus we might postulate that an increase in the number of bars would have a minimal effect on alcohol-related work accidents, and that an aggregate index of availability would similarly exhibit no significant relationship with accidents, unless changes in package liquor outlets happened to be part of that aggregate change in availability.

In light of these considerations, and in view of the exploratory nature of this study, we have decided against the use of a constructed aggregate index of availability in examining the role of availability as contributing to the incidence of alcohol-related social problems. As a practical matter, it is an extremely difficult task to incorporate all of the factors of availability into one's model, even short of measuring and collecting data on them. Therefore, we have focussed on those variables that Douglass and Freedman (1977) found to co-vary with aggregate consumption, and which were readily available for analysis: the daily summaries of concluded actions of the Liquor Control Commission. In doing so we realize that we are not including many of the factors that the conceptual model of availability developed in this chapter indicated should be included: the retail price of alcohol, the actual physical proximity of establishments, and private expenditures on marketing and advertising, to name a few. Of course, we must bear these facts in mind when interpreting the results, and hope that future inquiries into the nature of availability of alcoholic beverages will find them useful in constructing more refined and sophisticated models of physical availability.

2.3 Alcohol and Social Problems

The consumption of beverage alcohol is widely acknowledged as a contributing factor in a variety of social and health problems. Although of uneven quality, there is a voluminous body of literature documenting the deliterious consequences of the excessive consumption of alcohol. The present report will deal with several of the most important social problems related to alcohol use. First, the literature on the role of beverage alcohol in traffic and work-related accidents is reviewed. Second, various dimensions of family disorganization, such as divorce, aggressive and violent behavior between spouses, and child abuse/neglect, and their relationship to beverage alcohol consumption, are examined. Third, the literature on the role of alcohol in suicidal behavior is reviewed. Finally, the role of alcohol in homicide and violent assault is assessed. We wish to acknowledge the comprehensive review of the literature in several of these areas by Aarens, et al. (1977), upon which several of the following sections rely heavily.

2.3.1 Alcohol and Accidents. Each year millions of accidental injuries in the United States kill over 110 thousand persons, permanently disable over 10 million and permanently impair another half million individuals. A substantial proportion of these accidental deaths and injuries are associated with traffic crashes, yet a larger number each year occur at work, in the home, in public buildings and in other places and alternative forms of transportation. Accidental deaths are the leading cause of mortality among Americans in the first half of life's span (Baker, 1973; 14).*

Accidents, as a general term, is an unfortunate label to apply to such a vast public health problem. As Susan Baker (1973; 10) aptly stated:

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*These broad estimates were derived from documents from the National Safety Council, 1976.

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"Despite common misconceptions, no group of injuries has
a distribution that is known to be random. This is be-
cause of the differential distribution of hazards, the
numbers and kinds of people exposed to the hazards, and
of a wide variety of environmental and behavioral factors."

In other words, "accidents" are not accidental. Baker continues
her discussion of the concept, stating:

"Alcohol is the most important human factor known to be
causally related to severe injury. Although it is an
extrinsic rather than an intrinsic host factor, such as
sex, alcohol is discussed here because of its inter-
action with host factors. It should be noted that in
addition to its importance as a causal factor, alcohol
can increase the severity of the outcome (p.10)."

This statement was applied to a wide range of accidental deaths and
injuries by Demone and Kasey in 1966.

Deborah Wingard and Robin Room (1977) have produced the most ex-
tensive review of data of the role of alcohol in non-traffic accidents.
These authors, exercising great restraint in their interpretations of
an extensive but somewhat sketchy literature, concluded that while
alcohol contributes to some accidents it is one of several interacting
factors and, as we agree, a great deal remains to be learned. Like
traffic accidents, the largest number of accidents involve the young
or the aged and alcohol is directly associated with the severity of
the injuries, often culminating in death.

It is clear from the research which has been conducted that the
majority of studies have involved coroner's data or special purpose
populations such as alcoholics. Few studies of natural populations or
with controlled or quasi-experimental designs have been conducted and vir-
tually no studies have correlated accident mortality (other than traffic
accidents) with data on licensing, consumption or other factors of
availability in a political unit such as a state or county where, at
least, legal alcohol availability is held constant.

Accidents of all types are relatively rare events which is the main
reasons that most alcohol-related accident research has focussed on
specific kinds of accidents (drownings, fires, falls, occupational,

traffic) or on specialized populations. Thus, the critical comparison
groups, controls and other means of comparative analysis to isolate
the causal role of alcohol with many kinds of accidents are frequently
absent. High risk occupations including seasonal, construction, and
temporary labor are virtually never studied regarding accident in-
cidence and the role of alcohol. The industrial studies, which appear
scientific, are almost always based on working places which are re-
latively safe and well organized at both the management and labor
levels. Alcoholism treatment and troubled employees' programs tend
to be found in larger industries with enough fiscal slack to provide
such services; these are usually not the industries which have the
highest risk of accidental injury and are thus biased to small acci-
dent incidence rates. Wingard and Room concluded:

> "The empirical data suggests that alcohol is implicated
> in injury and particularly in mortality for a number of
> types of accidents and, in fact, for accidents in
> general. But we do not know much about the relative
> importance of the various mechanisms of connection and
> indeed we do not even know that removing alcohol entirely
> would substantially lower the accident rates (p.98)."

The level of detail that we've come to expect in traffic accident
data simply does not exist for other types of accident mortality and
morbidity, particularly not for statewide or smaller political units.
The data which were available in Michigan include mortality incidence
from the Department of Public Health, by month and by county for
traffic accident deaths, occupational accident deaths and a general
category of all accidental deaths. Because of the limitations of the
analysis we were ultimately able to conduct, the remainder of this
discussion will focus on those accidents in the working place and,
briefly, with traffic accidents, which are associated with alcohol abuse.

2.3.1.1 <u>Traffic Accidents and Alcohol</u>. The relationship of alcohol
and driving has been extensively researched and documented for many
years, with the general conclusion that alcohol consumption prior to
driving is a major contributing factor in approximately half of all
automobile crashes each year in the United States. As early as 1938,

Holcomb reported that while only 12% of the general driving population in Evanston, Illinois had been drinking, 46% of 270 injury-producing accidents involved a drinking driver.

Freimuth, Watts, and Fisher (1958) found that of 500 fatal accidents occurring in Baltimore between 1951 and 1956, 95 of the 156 fatally injured drivers were alcohol-impaired. A series of studies conducted during the period 1961-1969 by Selzer, Weiss, and Ehrlich (1966, 1969, 1969) determined on the basis of interviews that 38-40% of the fatally injured drivers in the Ann Arbor, Michigan area were not only alcohol-impaired, but were chronic alcoholics. Selzer comments that the rate of alcoholism is ten times higher among automobile drivers involved in fatal accidents than in the general population.

Waller and Goo (1969) determined from two studies in Oakland, California that problem drinkers constitute 76-87% of all drunken driving arrests. Persons with chronic diseases, including alcoholism, have higher mean citation rates than comparison groups from the same population. Crancer and Quiring (1969) found that in the time period immediately preceding hospitalization for alcoholism, chronic alcoholics had a traffic violation rate 93% higher than the general population.

Recent work at the Highway Safety Research Institute (HSRI) has provided further evidence of the drinking-driving problem. Filkins and Clark (1969) investigated the alcohol-related histories of accident fatalities reported by the Wayne County, Michigan, morgue. Using independent sources of information, these investigators found that 22.6% of all driver fatalities were alcoholics or problem drinkers. However, 63.1% of the studied population was known to be alcohol-impaired and 48.8% showed evidence of being alcoholic, on the basis of blood-alcohol concentrations, at the time of death. These investigators concluded that available methods of identifying target populations of drinking drivers fail to find almost half of the individuals in drinking-driving target populations.

Douglass (1974, 1975, also Voas, 1974) found that approximately 60% of nighttime crashes with a single vehicle and a male driver are associated with alcohol, yet many other factors must be considered before a true target group of crash-bound drivers can be identified before a traffic crash. In 1977 Douglass and Freedman concluded that increases in alcohol availability were directly responsible for increased crash involvement of 18- to 20-year-old drivers in Michigan between 1972 and 1975.

Thus, the fact of alcohol's role in individual crash involvement, and on a macro-system level as well, is well known and understood. The present study has deferred extensive further analyses of this relationship, with the hypothesis that other categories of "accidents" might well be similarly associated with misuse of beverage alcohol.

2.3.1.2 <u>Alcohol and Accidents in the Working Place</u>. Work related accidents due to abusive drinking are frequently discussed in the research literature. There are some problems with defining accidents operationally, however, some of which were introduced in Section 2.3.1. Data on accidents, for example, most often reflect only the number of accidents, ignoring crucial considerations like severity of the accident, the duration of time lost due to the accident, and the amount of exposure to accident-related job activities. The literature also suggests that for operationalizing this variable a dichotomy is called for between <u>on</u>-the-job and <u>off</u>-the-job accidents which are both related, causally, to abusive drinking in the working place.

Trice and Roman (1972) summarized several studies employing the accident variable. They concluded that, although there is a widespread belief that the frequency for on-the-job accidents is high for deviant drinkers, it is not true except for <u>early-stage drinkers</u>. To explain this discrepancy, the authors suggest consideration of the predominance of deviant drinkers in routine jobs, their use of extra caution, their protection by co-workers, absenteeism when accident prone, and assignment by supervisors to less hazardous work. Even when one study

developed standards of accident exposure, it was found that although jobs correlated with identified deviant drinkers were more exposed to accidents, these drinkers had no more accidents on the job than other employees. The importance of the distinction between on and off the job accidents were exhibited in one study which (utilizing a control group) found that deviant drinkers did have more off-the-job accidents which did result in loss of working time and other industrial costs.

Asma, Eggert, and Hilker (1972) utilized accident rates as a means of indirectly measuring job performance. Accident rates were calculated as 1) on-the-job (defined as any that required medical treatment) and 2) off-the-job (defined as more than seven days absence). The study, based on a pre-test/post-test format, analyzed data on over 400 alcoholics for a period of five years prior to entering a treatment program and for five subsequent years. The authors found that both on-the-job and off-the-job accidents which resulted in medical care for absenteeism decreased with the implementation of an alcoholism treatment program, thus confirming the relationships of both accident categories with drinking problems at the working place.

In order for an accident to be recorded as "on the job", it must take place while an employee is actually conducting the work at the working place. The indirect influences of serious drinking (family and legal problems), which also are alcohol-related, contribute to accident frequency but are not likely to be identified as alcohol involved, because alcohol is not necessarily in the worker's physical system at the point in time when the accident occurs. In other words, the lag effect of a drinking problem on the acute accident event is not obviously related, although causally necessary to the events contributing to alcohol related accidents on the job. This is a situation very similar to suicide, divorce and other problems with long term (chronic) and complex psychosocial etiologies.

The subset of all accidents that is most likely to be reported is that set which results in fatalities. The resulting mortality reports are routinely recorded and are highly reliable and valid. Alcohol

involvement, however, in occupational fatal accidents is not well measured (see Section 3.4). Fatal accidents on the job are more likely to be alcohol-related than non-fatal accidents; a phenomenon which is found also among traffic accidents, recreational accidents, and domestic accidents.

2.3.2 <u>Family Disorganization and Alcohol</u>. Since the family is one of the core institutions of our society, lawmakers dealing with beverage alcohol policy should be aware of the impact of alcohol consumption on the family. The family is a social system in which the behavior of each member affects all other members of the system, as well as the nature of the system as a whole. Since it is the social system characterized by more intimate relationships than any other social system, we expect that alcohol consumption of family members will have significant impacts on the family system. The psycho-physiological effects of excessive alcohol consumption, such as the early euphoric state and the tiredness, sleepiness and depression which follows (Ekman, <u>et al</u>., 1964), may lead to inadequate performance is likely to lead to marital conflict and instability. Although the amount of research on the impact of alcohol consumption on the family is limited, some evidence documenting the relationship between alcohol consumption and marital conflict/divorce, intra-family aggressive and violent behavior (spouse abuse, child abuse), and child neglect has accumulated.

2.3.2.1 <u>Divorce</u>. Early large-scale studies of marital satisfaction mention consumption of alcohol as a source of marital unhappiness (Terman, 1938; Burgess and Cottrell, 1939). In examining a sample of English soldiers (diagnosed as neurotic) and their wives, Slaten and Woodside (1951) found that the most frequent stated cause of marital discord among their parents was drinking. Bullock and Mudd (1958), Bailey, <u>et al</u>. (1965), and Gorad (1971) all mention the high levels of conflict found in alcohol complicated marriages. Analysis of divorce court testimonies indicates that drinking is

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frequently given as a source of marital dissatisfaction (Kephart, 1954; Levinger, 1965, 1966; and Byles, 1978). Levinger (1966) found that of 600 couples seeking divorce in greater Cleveland, 26% of the wives complained about their husband's drinking.

Lisansky (1957, 1958) studied two separate samples of female and male alcoholics, one from a Connecticut prison farm and one from an out-patient clinic in New York. In both samples considerable differences occurred between alcoholics and the general population in proportions that were separated and divorced. Wechsler, et al., (1972), using a sample of 8461 emergency service patients (aged 16 and over) at Massachusetts General Hospital, found that divorced or separated patients had significantly higher blood alcohol content than patients who were single, married, or widowed.

O'Donnell, et al., (1976), using a nationwide probability sample (rather than limited clinical or divorce court samples as in the above studies) of 2510 males aged 20 to 30, found that 19% of the men reported having some alcohol-related problems with a wife or girl-friend.

In summary, although most of the studies used limited, nonre-presentative samples the weight of the evidence is consistent with the view that alcohol consumption often has adverse effects on the marital relationship and consequently on the stability of the family system.

2.3.2.2 Aggression. Another area which has received attention in the literature is the impact of alcohol consumption on aggressive behavior. Since a large proportion of aggressive acts, particularly physical violence, are committed against family members, the relation-ship between alcohol consumption and aggressive behavior is important in any investigation of the effect of drinking on the family. Many studies have demonstrated the importance of the family in a large proportion of violent acts. Assaults and homicides frequently involve family members: 25% of homicides in Philidelphia studied by Wolfgang (1958), 52% of assaults and 21% of homicides in a Detroit sample

studied by Boudouris (1971), and 47% of the homicides in a Chicago sample studied by Voss and Hepburn (1968), involved family members. Further evidence documenting the high proportion of homicides occurring between family members is given by McClintock (1963), Palmer (1965), Parnas (1967), United States Federal Bureau of Investigation (1967), Wolfgang and Ferracuti (1967), Campbell (1967), Maldonado (1968), Mecir (1968), Siciliano (1968), Willie (1970), Bard and Zacker (1971), Sadoff (1971), Field and Field (1973), Katz (1973), and McCarthy (1974).

Several investigators have examined the role of alcohol in general aggression, which includes but is not limited to physical violence. Tamerian and Mendelson (1969) report a significant increase in assertiveness in four alcoholics during sessions of programmed drinking. Shuntich and Taylor (1972) and Taylor and Gammon (1975) modified the Buss (1961) procedure* to make it more true-to-life and found that subjects gave stronger shocks after drinking than those who did not drink alcohol. These authors, in another similar experiment using students (Taylor, et al., 1976), found that intoxicated students administered more intense shocks (i.e., were more aggressive) than the non-intoxicated students only under a threatening condition and not under a non-threatening condition. Results contrary to the above are reported by Bennett, Buss, and Carpenter (1969) who found in a laboratory setting the various doses of alcohol did not change the level of aggressive behavior.

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*The Buss procedure is a widely used procedure to assess subjects' aggressiveness, usually after some experimental stimulus. The subject is instructed to teach another (confederate) subject by punishing the learner whenever she/he makes an incorrect response. The subject uses the "aggression machine" to give shocks of various intensities to the learner as punishment for incorrect responses. The intensity of the shock administered by the subject is the usual measure of aggressiveness used. For further information see Buss (1961) or Baron, et al. (1974, pp.277-278).

In experimental situations that are closer to real-life drinking environments it appears that there is a relationship between alcohol consumption and aggression. Boyatzis (1974, 1975), attempting to make his experiment as close to a natural drinking environment as possible, found that alcohol consumption is related to aggressive behavior. Further support for the observed relationship between alcohol and aggression in social or "natural" settings is reported by O'Donnell, et al. (1976). In their nationwide probability sample mentioned earlier, they found that 27% of the men report having had been in a fight as a result of alcohol.

There is additional evidence supporting the view that the relationship observed between alcohol consumption and aggressive or violent behavior is due, not to the pharmacological effects of alcohol, but rather is a consequence of the individual's perceptions of the social situation. Lang (1975) found that the belief that one had been drinking, rather than the actual amount of alcohol consumed, explained most of the variation in aggression levels. The importance of the individual's perceptions is also noted by Wilson and Lawson (1976).

A person's consumption of alcohol (or believed consumption) may lead to aggressive behavior because of the cultural acceptance and expectancy of increased aggressiveness after drinking (especially for males). The individual perceives the environment as a "drinking situation" in which increased aggressiveness is socially accepted. Since people tend to act in a manner congruent with the expectations of those around them, increased aggressiveness is likely in drinking environments. This interpretation is supported by the work of MacAndrew and Edgerton (1969) on the cultural determinants of drunken comportment. Gelles and Straus (1974) also holds to this type of reasoning, arguing that the social definition of alcohol consumption as reducing individual responsibility for deviant acts "functions to neutralize or disavow the deviance of violence" (p.113). In effect, on occasion a person consumes alcohol to use it as an excuse for the commission of a violent act.

Additional support for the view that the relationship between alcohol consumption and aggressive behavior is also due to environmental factors rather than only the pharmacological effects of alcohol follows from the work of Schacter and Singer (1962). These authors argue that although emotional arousal is often initiated by ingesting a drug, the direction and quality of the emotional experience and the resulting behavior depends on the label or definition the person applies to the situation (social environment). Alcohol may have an initially stimulating effect (Jones, et al., 1976), but the manner in which the individual experiences that pharmacological effect and the behavioral consequences depend on the subject's interpretation of the situation. Dengerink and Fagan (1978) in an experimental test of Schacter and Singer's theory applied to the question of alcohol and aggression found the theory supported by their data.

In summary, it appears that beverage alcohol does not have a direct pharmacological effect which can lead to aggressive behavior. The association between alcohol consumption and aggression may be due to an interaction between the pharmacological effects of alcohol and social cultural norms as perceived by the drinking individual, and the expectations of the influence of drinking by the drinkers.

2.3.2.3 <u>Marital Violence and Alcohol</u>. A limited amount of research has been conducted on the role of alcohol in the two major types of intra-family violence, spouse abuse and child abuse. Byles (1978), using court data on 139 persons, found that violence is more than twice as likely to occur in families with alcohol problems (twice as numerous as those without alcohol abuse). Gelles (1974) studied a sample of 44 families in which violence occurred. In 48% of the cases the offender had been drinking according to self-reports and reports of the spouse. Gerson (1976) found that about a quarter of family assaults have alcohol present. On the other hand, Bard and Zacker (1974) report, of 252 police calls in which a domestic assault allegedly took place, only 6% of the alleged offenders had been drinking according to spouse report. Furthermore, of 330 police calls in which an officer

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judged that an assault had taken place, 21% of the offenders had been drinking according to police reports. Finally, of the total sample of 1388 calls requesting assistance in domestic disturbances, police officers perceived alcohol to be primary in the origins of the disputes in 14% of the cases. Bard and Zacker concluded that it does not appear that alcohol plays a significant role in family violence.

Finally, Gayford (1975) studied 100 English wives who had been physically abused by their husbands and sought help from a human service agency. In 44% of the cases the wives reported that their husband had been drunk at the time of the assault. Furthermore, 52% of the wives reported that their husbands were frequently drunk and an additional 22% reported episodic drunkenness. The work of Gayford supports the view that a history of problem drinking as well as consumption at the time of the event is related to marital violence.

The results of the few studies that have been done on alcohol and domestic violence indicate various degrees of relationship. However, because all the studies indicate that excessive drinking or alcoholism was present in some proportion of cases, one can conclude that alcohol may be an important factor in some domestic violence situations.

2.3.2.4 <u>Child Abuse and Alcohol</u>. The second major type of intra-family violence, child abuse, has received more attention in the literature than marital violence. Numerous studies have documented a relationship between a history of drinking problems and child abuse.

Several investigators have examined samples of child abusers and found that many of the abusers are problem drinkers or alcoholics. Nau (1967) found that 50% of a sample of 105 child abusers (clinic and police records) were alcoholics. Grislain, <u>et al</u>. (1968) and Mainard, <u>et al</u>. (1971) identified 32 cases of child abuse in hospital records and observed that those records mentioned excessive alcohol use in 65% of the cases. In a sample of 85 families with abused children (reported to a child welfare agency) Johnson and Morse (1968) reported that 25% of the fathers and "a few" of the mothers "drank to excess" according to caseworker records. Pospivil-Zarrvki and Turvin

(1968) found that 37% of 62 persons tried for abusing minors were alcoholics. Fitch, et al., (1975) report that 32% of their sample of abusers used alcohol dysfunctionally. Of 74 families in which child abuse occurred and who were referred to a children's center, Gould (1976) reported that 16% had on-going problems with alcohol and/or other drugs.

On the other hand, Scott (1973) examined 29 cases in which the father or father substitute was charged with murdering his child of less than five years of age. He found that only 3% were diagnosed by a mental hospital as alcoholics. Steele and Pollock (1968) also found no significant incidence of alcoholism in 60 families in which child abuse occurred.

In contrast to the above studies in which a sample of abuse cases is examined to determine the proportion in which alcoholism is present, Speiker and Mouzakitis (1976) looked at the records on 42 alcoholism program clients and found 52% also to be child abusers. Another study using an approach different than the bulk of the research on alcoholism and child abuse is that done by Booz-Allen and Hamilton (1971), who surveyed children of alcoholics and found that 10% reported physical abuse by their parents. Other investigators supporting the view that alcoholism is an important factor in child abuse include Stetic (1966), Fontana (1971a, 1971b), and Pawlikoski (1972).

As the above studies indicate, most of the research in the area of alcohol and child abuse has focused on drinking histories. However, several studies have also examined the presence of alcohol consumption or intoxication at the time of the abusive event.

Nau, in his 1967 study mentioned above, found that 34% of his sample of 105 child abusers were under the influence of alcohol at the time of the abuse incident. Gil (1973), in the most comprehensive study of child abuse to date, reported that the perpetrator was intoxicated in 13% of 1380 cases of physical child abuse reported through legal channels in the United States. On the other hand, Scott (1973), in his

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above mentioned study of 29 fathers charged with murdering their children, found none to be significantly intoxicated at the time of the event.

With the exception of Gil's general population survey, the research on child abuse is based on samples from social service agencies, hospitals, and court records. Epstein, et al., (1977) after reviewing much of the literature on alcohol and child abuse, pointed out several important limitations on the generalizability of the research results. The inadequacies of the existing research include: 1) small samples are usually used, 2) lack of comparable control groups, 3) most cases are unreported (Light, 1973; Helfer and Kempe, 1976) and therefore cannot be included in studies, 4) reported incidents of child abuse are likely to differ in significant ways from unreported cases (Gil, 1971), 5) use of existing records which are often inconsistent as a result of the variety of workers involved in the record keeping process, and finally, 6) the data usually represent the observations and judgments of caseworkers which cannot be verified or interpreted reliably.

Given the above-mentioned limitations and the fact that the studies reviewed examined various populations with different measures of alcoholism, alcohol in the event, and child abuse, a wide range of results is to be expected. However, it is clear that the bulk of the research done on alcohol and child abuse is consistent with the view that alcohol, both in the immediate event and through the long-term deleterious consequences of heavy drinking, probably plays an important role in some proportion of child abuse cases.

In 1977 Freedman and Douglass reported that there was a strong suggestion of alcohol abuse being associated with child abuse and neglect. However, the proportion of the incidence of these social problems that is actually the result of abusive drinking is unknown. After a more extensive review of the research literature and after considering similar reviews by others it remains our conclusion that the role of alcohol in child abuse and neglect has not yet received the

kind of attention that could provide us with any confident conclusions which might lead to prevention programs or other interventions. Child abuse and/or neglect as a psycho-social problem is highly complex in etiology, poorly measured in society, and amendable to a wider range of operational definitions than any of the other problem areas we have considered in this study.

The definitions of child abuse range from child homicide to less severe physical or emotional harassment. Determination of social intervention, by a department of social services, protective services, or police seems to us to be (at this point in time) a more realistic approach to measuring child abuse incidence when considering the multitude of factors that affect defining the problem by any other means. We fully recognize that the use of such reporting statistics reflects the data collection process as much, or more, than the phenomenon, and is certainly going to result in a gross underestimate of true abuse incidence, with a bias toward the most severe and exotic cases which occur. As mentioned above, Gil (1973) has produced the only analysis of legally reported child abuse with an explicit inquiry to the concurrent role of intoxication of the abuser. He found that 13% of these cases were determined by a social worker to be directly associated to alcohol abuse. Epstein, Cameron and Roizen (1977) reviewed Gil's findings and pointed out that other etiologic factors play considerably more predictable and significant roles in the causation of child abuse.

Many writers in this area combine child abuse and child neglect into a single variable on the maltreatment of children and treat the two dimensions as having similar causes. The present authors use the term child abuse to refer specifically to intentional physical injury or abuse (sexual, emotional) of children, and child neglect to refer to an act of omission where adequate care for children is not provided.

A few studies have investigated the relationship of alcoholism to child neglect. Young (1964) studied 300 cases of child neglect (reported to child welfare agencies) and found that in 62% of the families

drinking was a primary family problem. Of the 496 parents involved, 38% were severe or chronic drinkers. Andreini and Green (1975) noted alcohol abuse in 24% of 63 families with reported child abuse or neglect (including sexual abuse). Polansky, Holly and Polansky (1975) also mention alcoholism as an important factor in the etiology of child neglect. On the other hand, a recent study comparing a sample of alcoholic with a sample of non-alcoholic parents failed to find any statistically significant differences in the proportion neglecting their children (Scientific Analysis Corporation, 1976).

The role of alcohol in the course of child abuse is seen by most authors as different in several respects from child neglect. Polansky and Polansky, in their review of neglect, discuss the incapacitation of heavy drinking, which impairs a parent's ability to perform even the most basic tasks or to meet the most essential needs of their children. The abuse problem, on the other hand, has been discussed in connection with alcohol as a more intentional, albeit regretted, set of behaviors directed at a child.

Alcohol has been discussed as a trigger to environmental or personality problems in relationship to child abuse. Albreclt and Gift (1975) discussed the role of life crises and the necessity of parents to be capable of managing their crises. If alcohol is included in the parent's repertoire of coping mechanisms with crises, it is possible that, like other violent behaviors, some drinking parents will then act out their fears on their children. But it is more than the presence of life crises and personal failures that must interact with alcohol if the interaction is to predictably produce child abuse because the vast majority of parents can cope with failures and crises successfully, with or without alcohol.

Spinetta and Rigler (1972) have reviewed various surveys and other studies of the demographic characteristics of abusing parents, and the influence of their social and economic environments. Such studies refer to chronic family tensions, the number and spacing of children, proverty and unemployment. In effect, such studies suggest

that child abuse is a form of "striking out" against personal inadequacies or against memories of the parent's own childhoods when they, themselves, were abused. Gil (1973) discussed these environmental factors, which include alcohol abuse among parents, and concluded that most child abuse was the consequence of a seemingly random series of environmental factors. He suggested that "global control of environmental factors would prevent the catacylsm which leads to child abuse." Spinetta and Rigler (1972) and others have pointed out, however, that this unfortunately does not answer the basic question of why some people abuse their children and others in virtually the same situational and social context do not. Most current research in child abuse has become increasingly directed at hypotheses which portray the abusing parent as one with an underlying developmental flaw, with the environmental context providing the trigger or immediate cause of the acts of abuse. This recent conclusion in the field parallels many investigations of alcoholism in which basic personality or developmental patterns interact with environmental triggers which leads to the onset of alcoholism. Clearly, the etiologies of child abuse and neglect include both long term processes and acute triggers. Alcohol is most likely an essential factor in some proportion of child abuse cases, however it is still premature to conclude that any fraction estimate is accurate.

2.3.3 <u>Suicide and Alcohol</u>. Alcohol has long been thought to be a contributing factor in suicide. Studies have been conducted in an attempt to document the role of alcohol in completed suicides and in suicide attempts. This body of literature is divided into three major types of studies: 1) those examining the drinking histories of suicide victims or attempters, 2) those reporting the proportion of labelled alcoholics that attempt or commit suicide, and finally, 3) those studies which examine the presence of alcohol at the time of the suicide event. Following a brief review of these three groups of studies, the

possibility that alcohol consumption functions as a contributing factor in suicide is discussed.*

2.3.3.1 Drinking Histories. The literature on the drinking histories of suicide victims will be reviewed first. Table 2.3.3.1 lists the results of studies that examine samples of suicide victims and indicate the proportion who were alcoholics or heavy drinkers. The reported percent of alcoholics among those who have committed suicide ranges from a low of 2% to a high of 48% with a median of 12%, in the studies reviewed. Since the proportion of alcoholics in the general population is usually estimated at approximately 5% (Efron, et al., 1974), one could conclude from the studies in Table 2.3.3.1 that alcoholics, or those with a history of heavy alcohol consumption, are over-represented among those who commit suicide.

From studies of samples of suicide attempters, of 20 investigations (see Table 2.3.3.2), the proportion of alcoholics or heavy drinkers ranges from 0.5% to 33% with a median of 15%. The proportion of alcoholics among suicide attempters is similar to the proportion of alcoholics among those who commit suicide. These studies of suicide attempters, like those on completed suicides, support the argument that those with a history of drinking problems are over-represented among suicides, and therefore alcohol may be a contributing factor.

2.3.3.2 Labelled Alcoholics. Another approach to the investigation of the relationship between suicide and a history of problems with alcohol is to follow up samples of alcoholics (from hospital or clinic records) and determine the proportion that commit or attempt suicide. Numerous studies are reported in the literature. The percentage of alcoholics that are found to complete suicide ranges from 0.1% to 8% (see Table 2.3.3.3).

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*The great majority of the citations in this section are taken from the review by Aarens and Roizen (1977).

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Table 2.3.3.1

Proportion of Samples of Completed Suicides
Characterized as Alcoholic or Heavy Drinkers

Casper, 1825	28%	Palola, et al., 1962	31%
Heller, 1900	48%	Pitts and Winokur, 1964	10%
Schakwitz, 1927	29%	Gorceix and Zimbacca, 1965	24%
Schmid, 1933	10%	Krupinski, 1965	6%
Dahlgren, 1945	30%*	James, 1966	17%
Ispen, et al., 1952	2%	Attkisson, 1970	10%
Sainsbury, 1955	6%	Achte and Lonnquist, 1971	8%
Stengel and Cook, 1958	12%	Overstone and Kreitman, 1973	27%
Tuckman and Lavell, 1958	10%	Barraclough, et al., 1974	15%
Robins, et al., 1959	23%	Haberman and Badan, 1974	9%
Yessler, et al., 1961	10%	Patel, 1974	13%

*composite from several studies

Table 2.3.3.2

Proportion of Samples of Attempted Suicides
Characterized as Alcoholic or Heavy Drinkers

Moore, 1939	11%	Kessle, 1965	9%
Arief, et al., 1948	22%	Krupinski, et al., 1965	8%
Wallinga, 1949	16%	Bridges and Koller, 1966	0.5%
Batchelor, 1954	22%	Achte and Ginmen, 1966	13%
Schmidt, et al., 1954	13%	Harenko, 1967	15%
Ettlinger and Flordh, 1955	18%	Bratfos, 1971	27%
		Ripley, 1973	28%
Epps, 1957	24%	Morgan, et al., 1975	10%
Ringle and Rotter, 1957	8%	Beck, 1976	33%
Stengel and Cook, 1958	20%	Baker, P.M., et al., 1977	24%
Palola, et al., 1962	23%		

Table 2.3.3.3

Proportion of Samples of Labelled Alcoholics Who Commit
Suicide

Dahlgren, 1951	0.6%	Clompi and Eisert, 1969	7%
Lemere, 1953	11%	Schmidt and deLint, 1972	0.8%
Norvig and Neilson, 1956	7%	Dijk, et al., 1973	0.5%
Kessel and Grossman, 1961	8%	Pell and D'Alonzo, 1973	0.2%
Tashiro and Lipscomb, 1963	5%	Nicholls, et al., 1974	5%
Battegay, 1965	3%	Schuckit and Gunderson, 1974	3%
Davies, 1965	0.1%	Choi, 1975	0.2%
Kendall and Staton, 1966	8%	deLint and Levinson, 1975	2%
Brenner, 1967	0.7%	Medhus, 1975	5%
Ritson, 1968	3%	Adamica and Ciganik, 1976	3%

As can be seen from Table 2.3.3.4, studies reporting the pro-
portion of alcoholics who have admitted attempting suicide vary from
12% to 25%. Most of the studies indicate that about 20% of clinical,
skid row, or Alcoholics Anonymous samples report attempts to commit
suicide.

Table 2.3.3.4

Proportion of Samples of Labelled Alcoholics Who Attempt
Suicide

Glatt, 1954	23%	Battegay, 1965	21%
Daumezon, et al., 1955	12%	Koller and Castanos, 1968	20%
Lerch, 1959	20%	Chandler, et al., 1969	25%
Palola, et al., 1962	12%*	Ohara, 1972	15%
Palola, et al., 1962	24%**	Adamica and Ciganik, 1976	6%

*sample of skid row alcoholics

**sample of Alcoholic Anonymous alcoholics

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2.3.3.3 <u>Alcohol in the Event</u>. In addition to the studies on
drinking histories of suicide victims and attempters and studies of
labelled alcoholics, there are a number of studies investigation the
extent of alcohol use at the time of the suicidal act. Most of the
studies use the criterion of .01% blood alcohol content or higher as
indicating alcohol presence at the time of a successful suicide.

First, looking at the data on alcohol presence at the time of
completed suicides, we note that the proportion of suicides with alcohol
present ranges from 3 to 45% (see Table 2.3.3.5). The majority of the
studies report that alcohol was present in 18 to 29% of the suicides
investigated.

Table 2.3.3.5

Proportion of Samples of Completed Suicides with
Alcohol Use at Time of Event

Spain, 1951	19%	Edwards and Whitlock, 1968	26%
Wilentz, 1953	27%	Attkisson, 1970	27%
Hansen, 1956	32%	Cutler, 1971	36%
Bowden, 1958	3%	Deasy, 1971	40%
Shneidman and Farberow, 1961	18%	Alha, 1974	37%
		Haberman, 1974	26%
James, I.P., 1966	20%	Ovenstone and Kreitman, 1974	45%

Secondly, looking alcohol presence at the time of attempted
suicide, Table 2.3.3.6 shows that investigators have found 15 to 64% of
samples of suicide attempters had been drinking or were intoxicated at
the time of the attempt. From Tables 2.3.3.5 and 2.3.3.6 one could
conclude that alcohol use appears more frequently in suicide attempts
than in completed suicides.

Table 2.3.3.6

Proportion of Samples of Attempted Suicides with
Alcohol Use at Time of Event

Batchelor, 1954	20%	James, I.P., 1972	62%
Ringel and Rotter, 1957	15%	Ripley, 1973	25%*
Whitlock and Schapira, 1967	46%	Ripley, 1973	43%**
Harenko, 1967	30%	Honkanen and Visuri, 1976	64%
Gay, et al., 1970	42%		

*Edinburgh, Scotland
**Seattle, Washington

2.3.3.4 Discussion of Alcohol and Suicide. Prior to making any
conclusions on the basis of the large number of studies reviewed above,
one must be fully aware of the severe inadequacies of the existing
literature on alcohol and suicide. A major problem in all of the
studies is the inconsistent operational definitions of excessive drink-
ing, problem drinking, alcoholism, had been drinking, or intoxication.
The wide range of definitions severely limits the ability to compare
the study results. Not only is it difficult to compare a particular
study's results with another, but it is also risky to compare the per-
centage of alcoholics in a particular suicide sample with the pre-
valence of alcoholics in the general population. The operational
definitions of alcoholism used in general population prevalence esti-
mates are seldom the same as those used in the suicide studies. Be-
cause none of the suicide studies employed a general population control
group, the significance of the reported proportion of alcoholics among
completed or attempted suicides is difficult to assess.

Another significant limitation of the suicide and alcohol studies
is the small, parochial samples used. The studies have been conducted
over an extensive time period in a variety of areas of the United
States as well as a number of foreign countries. The local

"accidental" samples used severely restrict the generalizability of results.

Particular problems arise in drawing conclusions from the studies of the drinking histories of those who commit or attempt suicide. First, there is an inherent bias in these studies since the investigator, ex post facto, examines the history of one who has committed or attempted suicide in an effort to find evidence of alcohol-related problems. It is possible that if one took a random sample of individuals from the general population, and conducted a detailed case study looking for evidence of alcohol problems, a significant proportion of the sample could be characterized as having had problems related to alcohol consumption.

Even if one were to accept as established a relationship between alcoholism and suicide it would still not be clear whether alcoholism is a necessary etiological factor in suicide. The observed relationship between alcoholism and suicide may be spurious due to the relationship of both alcoholism and suicide to socioeconomic status or other contributing factors. Several studies have found a relationship between suicide and socioeconomic status (Schmidt, 1933; Farberow and Shneidman, 1957; Powell, 1958; Breed, 1963; Seagen and Flood, 1965; and Rushing, 1968). A number of studies have found employment status to be related to suicide (Sainsbury, 1955; Robins, et al., 1957; Tuckman and Lavell, 1958; Chodorkoff, et al., 1961; Bruhn, 1962; Bree, 1963; Dublin, 1963; Warkov, et al., 1965; Rushing, 1968). Suicide rates are also known to vary by occupation, religion, sex, and age (Aarens and Roizen, 1977). The studies of suicide and alcoholism to date have not adequately considered the possible effect of such socio-demographic variables. The excess alcoholism found among those who attempt or commit suicide (over the general population figures) may simply be due to the over-representation of certain socio-demographic groups among known suicide victims and attempters.

In addition to the general problems of the alcohol and suicide literature, the studies of labelled alcoholics present a further

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difficulty in that the length of time the samples were followed up varies from six months to 60 years. Although no consistent relationship is observed between the length of the follow-up period and the proportion reported as committing suicide, the differential follow-up period is one more complicating factor in comparing the studies with each other and generalizing to the overall population of alcoholics.

Many of the investigators of alcohol use at the time of suicide attempts relied on self-reported alcohol use. James (1972) compared blood alcohol level with self-reported alcohol use in suicide attempts and found that half of the subjects did not report alcohol intoxication when in fact their blood alcohol levels were over .15%. It was determined that attempters were reluctant to report alcohol use at the time of the event since they felt it might reduce the perceived urgency of the message they had wished to convey through the suicidal act. It is clear, then, that statistics on alcohol use in the event may be characterized by serious under-reporting.

The interpretation of the apparent relationship between alcohol use in the event and suicide is further complicated by the fact that alcohol can play two distinct roles in the suicide event. First, alcohol consumption can be viewed as an etiological factor that increases the probability that a suicide prone individual will commit suicide at a particular time. The popular idea of alcohol as providing the courage necessary to go through with an unpleasant act is relevant here. Beck, et al., (1976) have found that suicide attempters who are under the influence of alcohol are likely to inflict more damage upon themselves than those who were sober at the time. In addition to the role of alcohol as a contributing cause of the suicidal act, alcohol can also be used by the subject as an agent to inflict the desired damage. A significant number of suicide attempters admit to consuming alcohol in an effort to increase the effect of other drugs also taken (Whitlock and Schapira, 1963). It is important in interpreting an observed relationship between alcohol use in the event and

suicide to distinguish between the role of alcohol as causing the suicidal <u>act</u> or its role in causing physical <u>injury</u> or death.

Earlier it was noted that a number of studies have reported a relationship both between alcoholism or drinking histories and suicide, and between alcohol use at the time of the event and suicide. Thus far in this review these two relationships have been treated independently. However, as Aarens and Roizen (1977) point out, the association between alcoholism and suicide may be a direct result of the association between alcohol in the event and suicide. Numerous studies report that the great majority of alcoholic suicide attempters or victims are found to have been drinking at the time of the event (Batchelor, 1954; Palola, 1962; Achte and Ginman, 1966; James, 1966; Virkkunen, 1971; Ripley, 1973). Alcoholism may cause suicide only through the intervening influence of alcohol in the event. This model is contrary to the popular view that alcoholism leads to suicide in-dependently of alcohol use in the event through the depression and disruption of life that is seen to result from alcoholism.

The event of suicide, either attempted or completed, is not necessarily an acute event, it may be the final stages of a long term or chronic mental, emotion, or situational condition. The role of alcohol and abusive drinking, therefore, can be fixed into either an acute or a chronic causal sequence. Drinking can be the "release mechanization" that allows an inhibited person to go ahead with plans to attempt suicide, in which case alcohol is directly causally related to an acute event. In some cases alcohol might render the would be self-destructing individual incapable of completing plans and would reduce the likelihood of a successful suicide.

The loss of status, self-esteem, job and social supports often associated with serious drinking problems renders abusive drinking an indirect, but still causal factor in other suicides. While the stated reasons for a suicide might be loneliness and depression, these are commonly caused by excessive drinking. Thus, suicide like many other social and alcohol-related problems is both acute and chronic and the

causal roles of alcohol are most likely to be equally acute and chronic.

2.3.3.5 Conclusions Regarding Alcohol and Suicide. Any conclusions made after reviewing the literature on 1) the drinking histories/alcoholism of those who attempt or commit suicide, 2) the prevalence of suicidal acts among labelled alcoholics, and 3) the frequency of alcohol use at the time of suicidal acts, must be made cautiously, taking into account the many inadequacies in the existing literature. Two recent reviews of the literature on alcohol and suicide conclude that some relationship is evident between alcohol and suicide (Goodwin, 1973; Aarens and Roizen, 1977). Aarens and Roizen argue that the existing literature suggests that

> ...alcoholics do end their lives in suicide uncommonly frequently, samples of suicides do include disproportionately high numbers of people with drinking problems, and drinking is a common accompaniment to suicide (p. 507, emphasis in original).

However, it is important to emphasize that the literature suggests these relationships but does not establish their existence. Recalling the problems with existing studies discussed above, the results of existing sample studies are not necessarily generalizable to larger populations. Furthermore, it is likely that the relationships vary depending on the particular subgroups of the general population under consideration.

2.3.4 Alcohol and Violent Assault. The relationship between alcohol use and violence has received considerable attention by the research community. Many of these studies have suggested heavy concentrations of alcohol to be part of the long-term behavioral pattern of aggressive offenders. These studies also indicate that alcohol is often present in victims or offenders in an assault situation. Pittman and Handy (1964), indicated that there is an "intimate association between homicide and aggrevated assaults". With this relationship noted, Roizen and Schnebark (1977), suggested that alcohol is more than a "criminogenic" or "victimogenic" factor, the role of

alcohol in aggressive interactions should be studied as well. Mayfield (1976), indicated that 67% of problem drinkers in his sample had past criminal records (exclusive of alcohol offenses) and more often committed previous assaults (50%) than non-alcoholic subjects (32%).

Mayfield reported that of the individuals drinking at the time of an assault, 53% were likely to be problem drinkers. He also noted that problem drinking was far from uncommon (23%) in the subjects who were sober at the time of the crime. Also, 55% of the intoxicated assaulters were likely to commit their crime in a drinking setting while 56% of their victims were likely to have been drinking. In the same study, 58% of 307 men convicted of assault were drinking at the time of the crime. Mayfield concluded that, "in the majority of the cases in the present study, the assault probably would not have occurred in the absence of alcohol use".

Other studies indicate associations between alcohol consumption and apprehended assault victims and offenders. Shupe (1954), found that 48% of persons arrested for assault had positive alcohol blood tests. Similarly, the District of Columbia Crime Commission (1966), reported 35% of 121 apprehended assault offenders, and 46% of 131 victims of assaults had been drinking at the time an assault took place.

2.3.5 Alcohol and Homicide. Homicide is the most extreme consequence of assault and it is also the most adequately measured. Often an assault leads to an unanticipated homicide which makes the population of homicides a subset of all assaults. Because of the greater severity and better data availability on homicide, many studies have been conducted investigating the correlates of homicide, including the role of alcohol consumption.

Roizen and Schnebert (1977), found the estimated presence of alcohol in the homicide situation (40 to 60%) to be remarkably consistent across studies over time. Other work has indicated the presence of alcohol in the homicide victim. Joss (1947), noted 38% of the homicides studied had high blood alcohol levels. Shupe (1954),

found that 67% of those arrested immediately following the commission of a specific crime were legally intoxicated.

The Baltimore Criminal Justice Commission (1967), in a study from 1960 to 1964 in Baltimore, Maryland, found alcohol to be present in 47% of 578 victims. Gonzales, et al. (1937), Wolfgang (1958), and the District of Columbia Crime Commission (1966) all found figures similar to the Baltimore study.

Many other studies have been conducted in which the presence of alcohol is noted in the offender as well as the victim after the commission of a homicide.* Wolfgang (1958), found either or both the victim and offender had been drinking immediately prior to the homicide in nearly two-thirds of the cases studied.

The studies cited above are useful in determining that alcohol is often present in a homicide situation; however, some current research is being redirected toward finding a behavioral basis for alcohol involvement in homicide which may modify this apparent relationship. Berry and Boland (1977), suggested that while alcohol is a contributing factor in a proportion of homicide cases, available evidence and knowledge are not sufficient to allow assignment of specific proportions to alcohol abuse. Roizen and Schneberk (1977), concluded that both criminal and certain drinking behaviors have a common cause in the psychic disorganization of the criminal. Goodwin, et al. (1971), found that alcoholics in a criminal population showed earlier manifestations of deviance than did non-alcoholics. Robbins (1966), demonstrated that sociopathic children were likely, as adults, to manifest patterns of excessive drinking, arrests, and incarerations. And finally, Goodwin, et al. (1971), suggested that criminality preceded the development of a drinking problem.

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*It should be noted that these studies may be biased since some individuals elude apprehension or are measured for blood alcohol content only after blood alcohol levels are reduced.

As with assault, a number of studies have concentrated on determining if there is a relationship between victims and offenders in alcohol-related homicide cases, which would have serious implications for prevention efforts. Wolfgang (1958), found that 51% of criminal homicides in Philadelphia were committed in the home of either the victim or the offender. In a more recent study, Pokorny (1965) revealed that, of the criminal homicides in Houston, 42% were committed in the home of either victim or offender. Voss and Hepburn (1968), found 37.6% of male victims and 61.5% of females were slain in their home. Mayfield (1972) found that 46% of homicide cases were committed in the home. According to Curtis (1974), approximately 50% of the homicides are committed at home, and of these, alcohol was a factor in about one-half.

In summary, although most of the studies of homicide use limited and often parochial samples, the studies reviewed affirms the view that alcohol is a contributory factor in some homicides. The proportion of homicides in which alcohol is a contributing factor appears to be approximately 50%.

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3. DATA SOURCES AND DATA CHARACTERISTICS

This chapter discusses the source and nature of the major operation-
alized variables used in the analysis. The variables used to test the
hypothesized relationships between alcohol availability, consumption and
alcohol-related social and health problems were obtained from a variety of
Michigan agencies. Major data-sets were obtained from the Michigan Liquor
Control Commission, the Department of Social Services, and the Department of
Public Health. Data were also acquired from the Michigan Beer and Wine
Wholesaler's Association and the Michigan State Police. As is often the
case with the use of data collected for administrative or other purposes, a
variety of characteristics of the data obtained restricted their usefulness
in testing the hypotheses of the present investigation. We turn now to a
discussion of the nature of the data obtained from each of these sources.

3.1 Liquor Control Commission: Wholesale Distilled Spirits Sales

The amount of distilled spirits, measured in wholesale dollars,
purchased by retailers from state liquor stores was used as a sur-
rogate measure of distilled spirits consumption. Records kept by the
Commission divide consumption into two major categories. Specially
Designated Distributors (SDD) sales, or sales for off-premise con-
sumption (by the bottle), are compiled for individual retail outlets,
and aggregated for the separate counties for each year 1970-1977.
Table-top sales, those sales for on-premise consumption (by the
glass) are compiled by the Liquor Control Commission for individual
establishments, but are aggregated for state liquor stores, rather
than counties, for the years 1970-1975, in statewide totals, and
county totals for Kent and Oakland counties. Sales data from the
Department of Commerce for 1976 and 1977, like SDD sales, are

aggregated by county and are available for each county in the state. Although most state stores are centrally located within individual counties, the use of stores rather than counties as the unit of analysis for the years 1970-1975 presents problems to the extent that proprietors of establishments purchase their distilled spirits at stores located in counties other than their county of operation. This problem is particularly significant in the Detroit metropolitan area, where there are multiple stores in each county and some of them are located near their mutual borders.

In addition to these concerns for accuracy of point of final sale for the sales data, there is also an unknown amount of error in presuming the date of wholesale purchase to covary closely with the date of actual consumption. Liquor stores and drinking establishments, like all businesses, must maintain inventories and adjust these inventories periodically through wholesale purchases in response to actual or anticipated levels of demand. Despite the indirect nature of the relationship between wholesale sales and consumption, however, the small scale of operations of most outlets for distilled spirits do not require exceedingly large inventories and thus the lag of wholesale purchases following demand fluctuations is likely to be minimal.

The incompleteness of the sales data on distilled spirits table-top sales has placed restrictions on the analysis in this study. For three of the largest counties in the state no data were available for the years 1970-1975, limiting the ability to extend and test relationships discovered at the state level to the separate counties. The Michigan Liquor Control Commission was unable to provide regularly measured data for beer or wine. These data were provided by the Michigan Beer and Wine Wholesaler's Association, by month, however only statewide aggregate measures were available.

3.2 Liquor Control Commission: Summaries of Concluded Actions

Daily summaries of concluded licensing actions by the Liquor Control Commission were coded into monthly frequency counts for each county for the period 1970-1977. Actions by the Commission include the granting of new licenses and permits, transfer of ownership of existing licenses and transfers of license classification.* The summaries include only successful completion of license transactions; the denial of request or the revocation of licenses is not recorded. Moreover, the actions are recorded in the month they are completed, though it is known that applications can be pending for a considerable length of time prior to their resolution.

The impact of legislative and court actions, seasonal patterns and occasional changes in commission policy on the frequencies of actions was documented by Douglass and Freedman (1977). A special census gave rise to a substantial increase in new SDD (package liquor) outlets in 1975; a court decision was the impetus for a dramatic increase in Sunday Sales permits in 1972. These characteristics must be recognized when dealing with the data, but they do not affect the quality of the data themselves. However, the failure of the recorded summaries to indicate the expiration of licenses and the revocation of permits does inject an upward bias in the estimates of overall numbers of licenses calculated from cummulative totals of new license issues. The construction of these estimates was made necessary by the inability of the Liquor Control Commission to provide information on the precise numbers of active licenses of all types in existence in the separate counties for all points in time considered in the analysis. Thus the number of new licenses of a certain type issued over a time span overstate to some extent the growth of outlets in a given area.

The estimates of active licenses were calculated as follows. Figures detailing the number of licenses in existence, by county, were provided by the Commission for four discrete points in time. The

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*For a detailed description of license categories and the coding process see Douglass, R. L. and Freedman, J. A., 1977, pp.55-61.

figures for the first time point, May 1971, were used as a baseline figure in calculating the estimates, and the remaining three time points were used as reference points with which to assess the estimate's accuracy. The estimated number of licenses of a particular type in existence in a given county at any point in time was calculated as the sum of the cumulative total of new license issues since May 1971, plus the baseline figure. For example, the esti-. mated number of active SDD licenses in Kent County in May 1975 would be calculated as

Estimated number of SDD = Baseline Figure (May 1971) + CUM.SDD
licenses as of May 1975

where CUM.SDD is cumulative total of new SDD license issues in Kent County over the period May 1972 - May 1975.

Information provided by the Liquor Control Commission detailing the number of licenses of different types in existence as of selected points in time helped determine the magnitude of the bias. Table 3.2.1 gives descriptive statistics on the percentage error of the estimates of numbers of licenses based on the cumulative totals. The number of checks for accuracy that can be made on the estimate based on cumulative totals are limited to the number of points in time for which information concerning numbers of licenses is available from Liquor Control Commission.

As can be noticed from the table, the errors are highest for SDM licenses, by far the most prevalent type. The average percent errors reflect the nearly uniformly consistent positive bias of the estimates based on cumulative totals, but also indicate the average overstatement is on the order of 8% or less.

For the purposes of this study an error of this magnitude is tolerable, yet further analysis of retail beverage availability requires that the number of retailing outlets of different types be known with greater precision at all points in time. This in turn requires that attrition of existing licenses, through revocation,

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expiration or transfer to another jurisdiction, be accounted for so
that a more accurate account can be made of both the expansion and the
contraction of the number of retail outlets.

Table 3.2.1

Descriptive Statistics on the Percentage Error of Estimate
of Active Licenses Based on Cumulative Totals of New Licenses,
by Type of License*

License Type	N	Minimum	Maximum	Mean	Standard Deviation
SDD	21	-4.10	5.04	0.73	2.70
SDM	21	.45	17.15	8.12	5.31
BAR**	21	-2.00	13.27	3.64	4.44

*The errors were calculated as

$$\% \text{ Error} = \frac{\text{Estimate Based on Cumulative Totals} - \text{Actual Number of Licenses in Existence (Source: LCC)}}{\text{Actual Number of Licenses in Existence}} \times 100$$

**A composite category including Class C, A Hotel, B Hotel, Tavern, and
Club Licenses.

## 3.3 Department of Social Services Data Description

The Michigan Department of Social Services, Office of Children and Youth Services, Protective Service Division provided data on the incidence of reported child abuse and neglect in Michigan. These data are based on child abuse/neglect reporting forms* received by the state Department of Social Services from county D.S.S. offices. The number of Children's Protective Services referrals was obtained, stratified by month and by county, for the January 1970 through December 1977 time period. As can be seen in Figure 3.3.1, reported incidence of substantiated child abuse/neglect was relatively low in 1970, increasing in 1971 and 1972, and relatively constant through 1973, 1974 and most of 1975. In October of 1975, the Department of Social Service's manual recording system was replaced by an automated data processing system. Coincident with this change was a large decrease in reported abuse/neglect incidence followed by a gradual climb in 1976. This gradual climb could be a result of increasing familiarity with the new system among staff.** The incidence dropped again in December 1976 when a change in the data processing system was made. It is also evidence from Figure 3.3.1, that the frequency of substantiated child abuse and neglect after the change to an automated record keeping system (October 1975) is lower than that under the manual recording system. It is unlikely that this represents a decrease in the true incidence of child abuse/ neglect but may indicate underreporting due to the avoidance of paperwork by workers whereby limited services are provided without formally "opening" the case.

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*National Standard Form of the Children's Division, The American Humane Association, Denver, Colorado.
**Cottrell, L., Jr. Program Specialist, Children's Protective Services, Office of Children and Youth Services, Michigan Department of Social Services; letter dated May 17, 1978 and personal communication May 25, 1978. Many of the insights into these data were generously provided by Mr. Cottrell.

FIGURE 3.3.1. REPORTED INCIDENCE OF CHILD ABUSE AND NEGLECT, STATE OF MICHIGAN 1970-1977

Source: Michigan Department of Social Services

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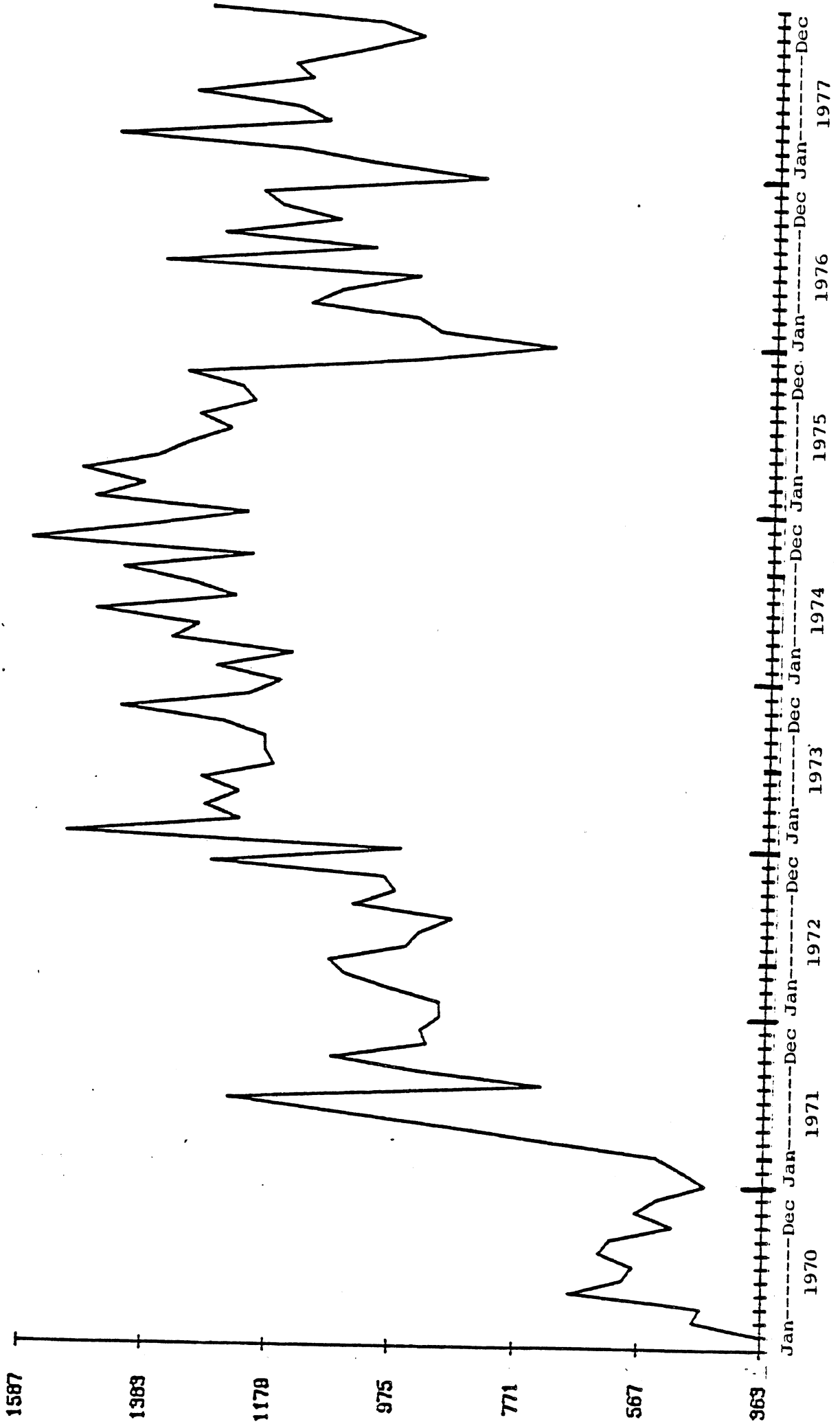
The data available from the Central Registrar on child abuse and neglect in Michigan undercount by about 33% the number of abuse/neglect referrals received by county D.S.S. offices. Numerous referrals received by local offices are not entered into the Central Registry because of uncodeable forms and other data processing difficulties. Incidence counts also do not include counties which report fewer than ten referrals per year. It is also believed that the completeness of reporting varies among counties, with the larger metropolitan counties reporting more rigorously than small rural counties.

Because the present study is concerned with the role of alcohol in child abuse/neglect, counts of Child Protective Services case closings (including both substantiated and unsubstantiated cases) in which "chemical dependence" services were sought, needed, or provided were obtained. These data were of limited usefulness for the following reasons: (1) there is no consistent operational definition for "chemical dependence" services, i.e., each local office indicates whether such services were provided according to its own definition of "chemical dependence"; (2) "chemical dependence" is much broader than alcohol use with which the present study is primarily concerned; (3) the date of the case closing may bear little relation to the time of the abusive event, making the interpretation of time-series data difficult; and (4) the data were available by county, by quarter (not by month) and for calender year 1975, 1976 and 1977 only, limiting their usefulness for time-series analysis.

As a result of a change in the American Humane Association standard child abuse/neglect reporting form, data on "alcohol dependence" were available for 1977. The item on the form entitled "factors present" now includes the response category "alcohol dependence". However, the only instructions given workers filling out the form is to "circle all applicable letters". Again we have a variable with no consistent operational definition across counties, among different workers filling out the forms, or between time periods.

Each worker circles the "alcohol dependence" response if it is a "factor present" in his/her own judgment. Discussion with local Child Protective Service workers indicates wide variation in criteria used in the determination of alcohol dependence as a factor present in a particular child abuse/neglect case.

In addition to the problems resulting from the lack of a specified operational definition, the data were of limited usefulness in the present study because they were available by year by county for 1977 only. Lack of monthly totals and the limited time span restrict the usefulness of this variable.

It should be noted that the provision of these data required extensive time and effort by Department of Social Services personnel. It is recommended that Department of Social Services be provided with the resources necessary to continue and accelerate the development of efficient automated data processing systems. The inexpensive and rapid retrieval of data on child abuse/neglect in Michigan will aid in gaining a better understanding of this social problem.

It is also suggested that comprehensive operational specifications of alcohol dependence and alcohol use in abuse/neglect cases be developed. Adequate training and monitoring should then be provided for workers at the local level so that these operational specifications are consistently applied, providing reliable data for the jurisdictions in Michigan across time.

3.4 Department of Public Health Data Description

The Michigan Department of Public Health, Office of Vital and
Health Statistics provided mortality data by county by month for
January 1972 through December 1976. Data for the following causes
of death were obtained: All accidents, motor vehicle accidents,
work-related accidents, suicide, homicide, and Laennic's (alcoholic)
cirrhosis. The data for each cause of death, with the exception of
Laennic's cirrhosis, was dichotomized on the basis of whether or not
alcohol was indicated as a causal factor in the death.

Of more interest to the present study are the alcohol-involved
deaths. However, all of the alcohol-involved mortality variables were
of limited usefulness because of the infrequency with which alcohol
is mentioned as a factor in the death. These data on alcohol-
involved mortality are obtained from Certificates of Death wherein a
physician is requested to complete the following: "Death was caused
by: (a) immediate cause, (b) due to, or as a consequence of, (c) due
to, or as a consequence of". A second item requests "other signifi-
cant conditions: Conditions contributing to death but not related to
cause given in Part I(a)". Thus, for alcohol to be recorded as
involved in a particular death the attending physician must judge
that alcohol consumption was a "cause" or a "significant condition"
and record that judgment on the death certificate. The analysis of
these data on alcohol involved mortality is complicated by the lack
of a clear specification of the conditions under which alcohol is to
be mentioned as a factor in the death. These specifications should
be formulated and should then be consistently followed by all
physicians completing certificates of death. It is clear from the
data that physicians currently are very rarely mentioning alcohol as
a factor in deaths. It appears that beverage alcohol consumption is
not within most physicians frames of reference when determining cause
of death. For example, although the number of deaths attributed to
motor vehicle accidents in Michigan normally ranges from 100 to 200
per month, the number recorded with alcohol involvement is usually

between 0 and 4 per month (see Figure 3.4.1 and 3.4.2). However, it is well known from other data that in a much larger proprotion of motor vehicle fatalities alcohol is a contributing factor. According to the Michigan State Police in 1977 there were 853 alcohol-related fatal accidents out of a total of 1,741 fatal traffic accidents, or 49%. The proportion of drivers involved in alcohol-related traffic accidents which resulted in at least one death was 31.1%.* Thus it is clear that the mortality data seriously understate the role of alcohol in traffic accident mortality.

Other causes of death are also characterized by very low reported frequencies of alcohol involvement. Although the literature indicates that about one-quarter of all suicides are likely to be alcohol-involved (see Tables 2.3.3.5 and 2.3.3.6), less than 1% of the suicides in Michigan are recorded as alcohol involved. As can be seen in Table 3.4.1, the proportion of all deaths from a specific cause recorded with mention of alcohol involvement is less than 1% for all causes of death studied except for deaths caused by all types of accidents, where 1.8% are recorded with mention of alcohol. The magnitude of the underreporting of alcohol-related accidents can readily be seen in Figure 3.4.3 and 3.4.4.

The Office of Vital and Health Statistics also provided data on the number of completed divorces by county by month for 1970 through 1976. Data were incomplete for three counties, including Wayne County for which data were missing for all of 1973 and 1974.

*Michigan Department of State Police. Alcohol-Related Fatal Motor Vehicle Traffic Accident Study, Lansing, Michigan, June 1978.

FIGURE 3.4.1.   FREQUENCY OF DEATH DUE TO MOTOR VEHICLE ACCIDENTS, STATE OF MICHIGAN, 1972-1976

Source: Michigan Department of Public Health
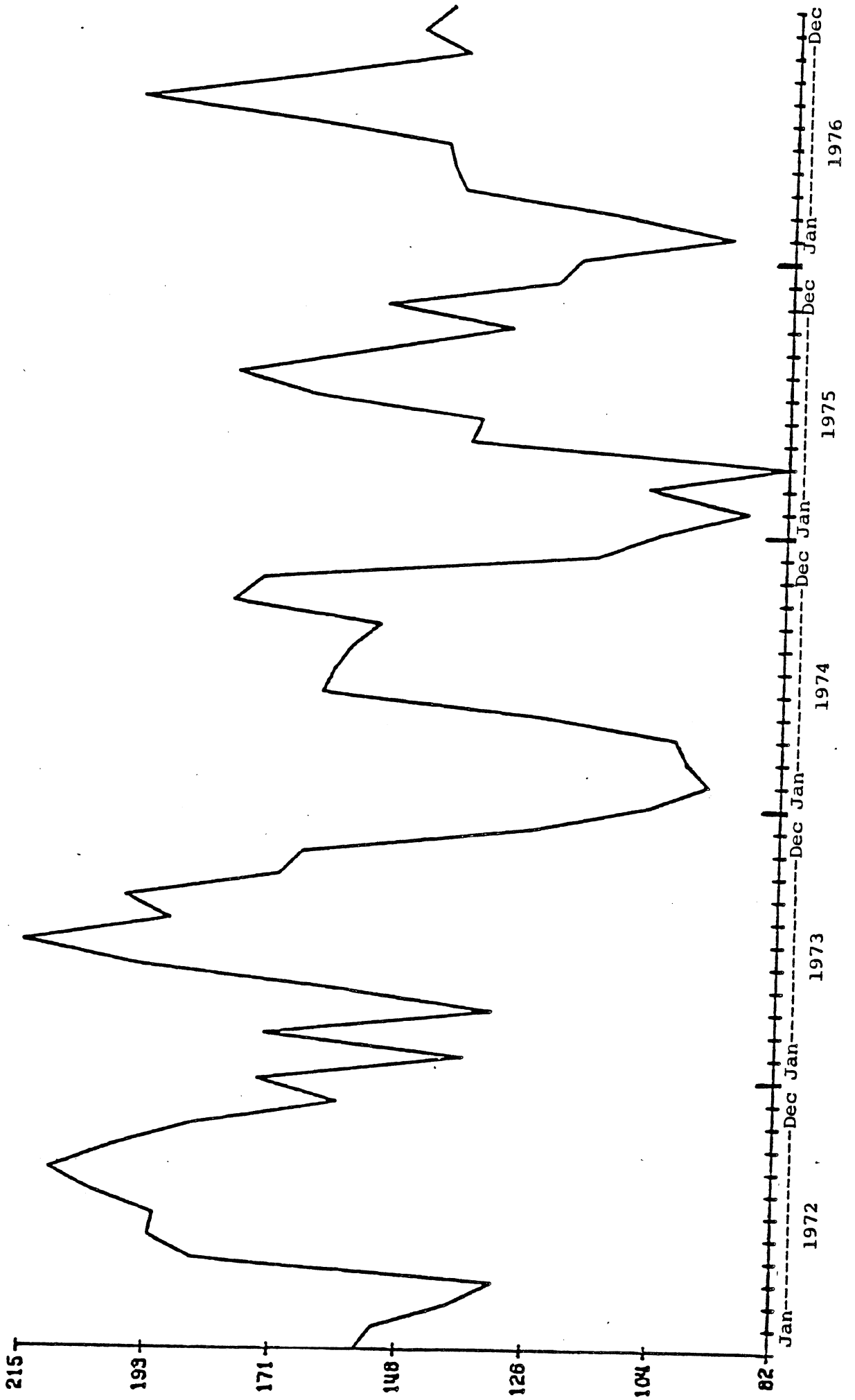
FIGURE 3.4.2. MICHIGAN DEPARTMENT OF PUBLIC HEALTH DATA ON ALCOHOL INVOLVED MOTOR
VEHICLE ACCIDENTS, DEMONSTRATING UNDERREPORTING, STATE OF MICHIGAN,
1972-1976

Source: Michigan Department of Public Health

69
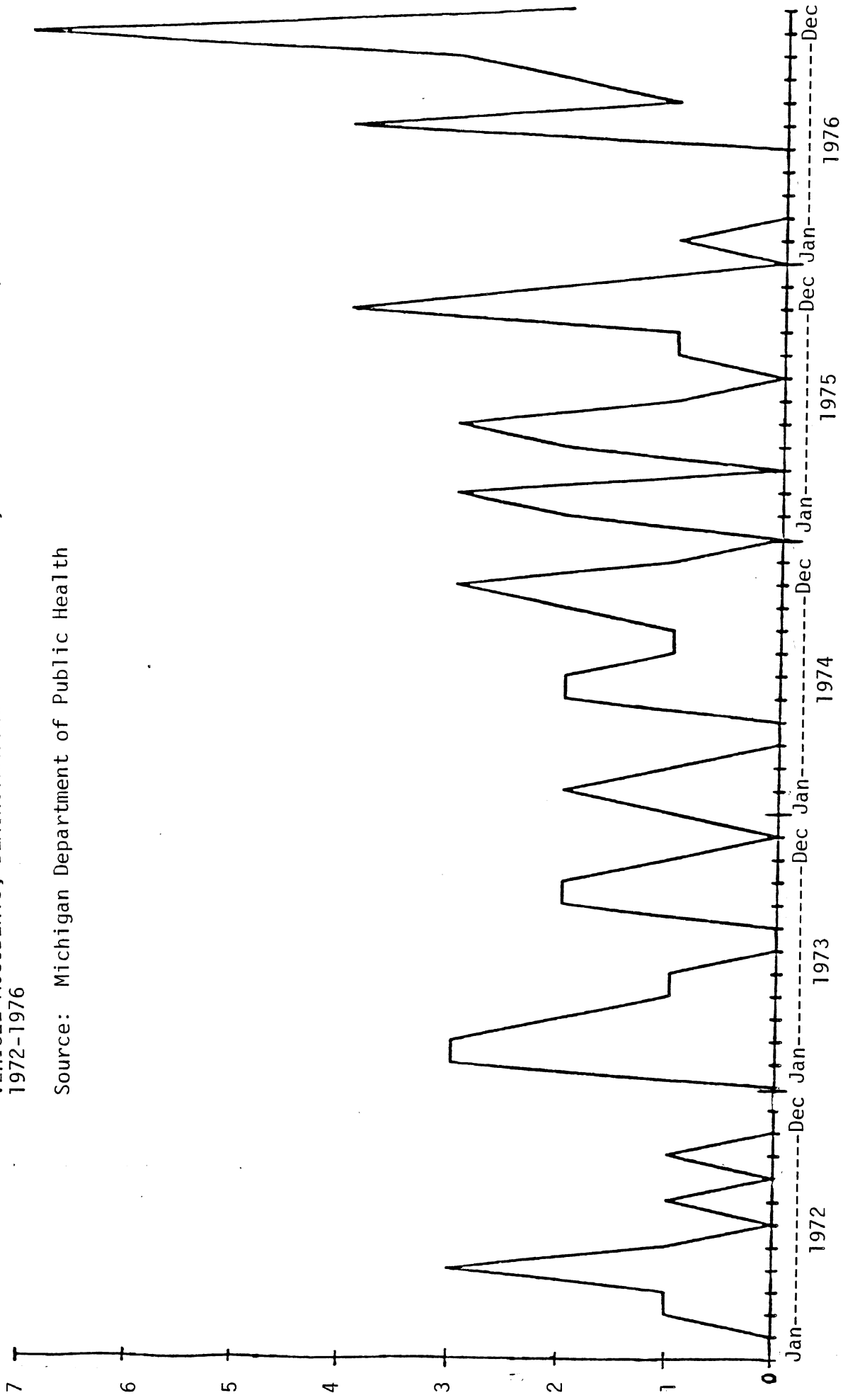
FIGURE 3.4.3. FREQUENCY OF DEATH DUE TO ALL TYPES OF ACCIDENTS, STATE OF MICHIGAN, 1972-1976

Source: Michigan Department of Public Health

70
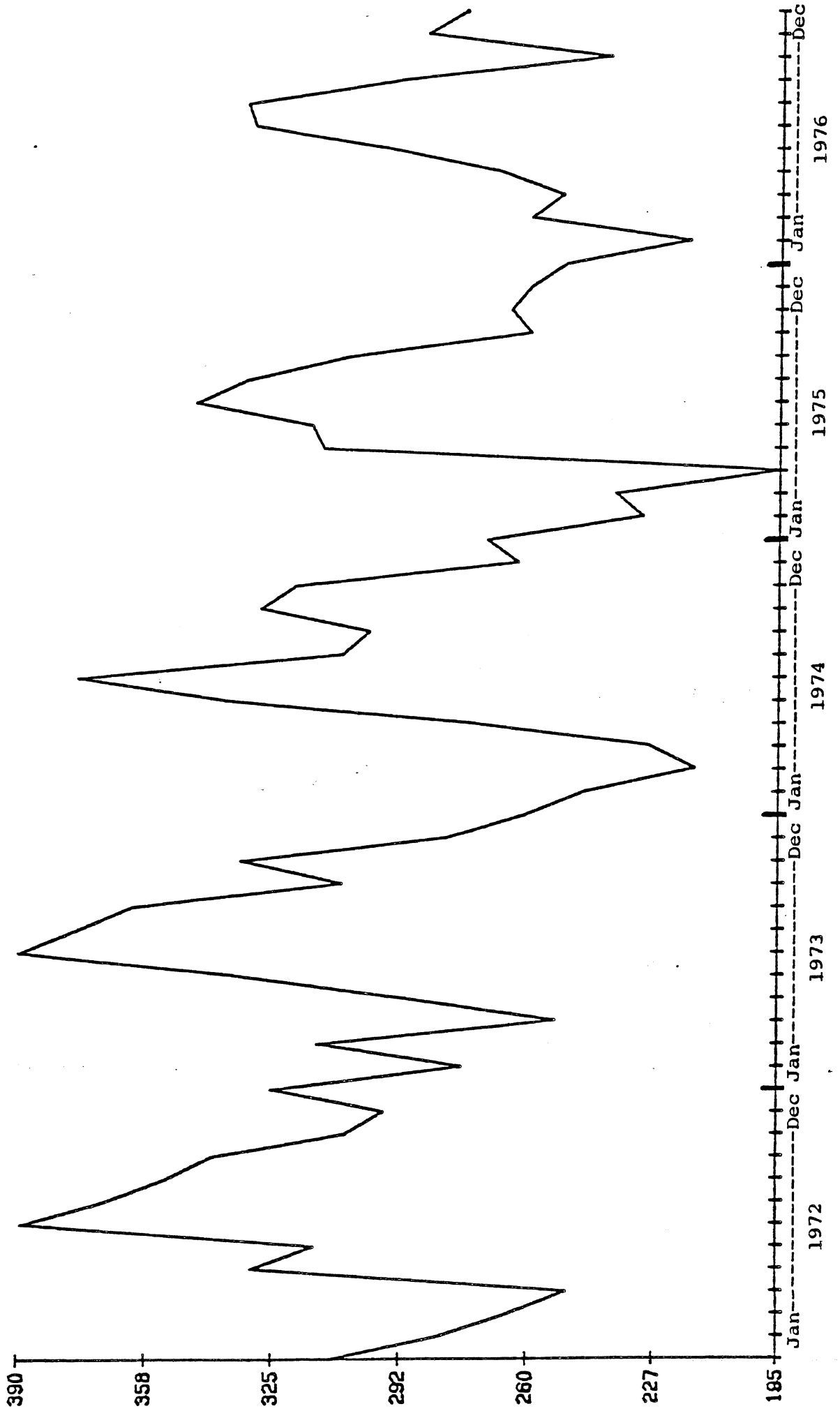
FIGURE 3.4.4. MICHIGAN DEPARTMENT OF PUBLIC HEALTH REPORTED FREQUENCY OF DEATH DUE TO
ALL TYPES OF ALCOHOL INVOLVED ACCIDENTS, DEMONSTRATING UNDERREPORTING,
STATE OF MICHIGAN, 1972-1976

Source: Michigan Department of Public Health
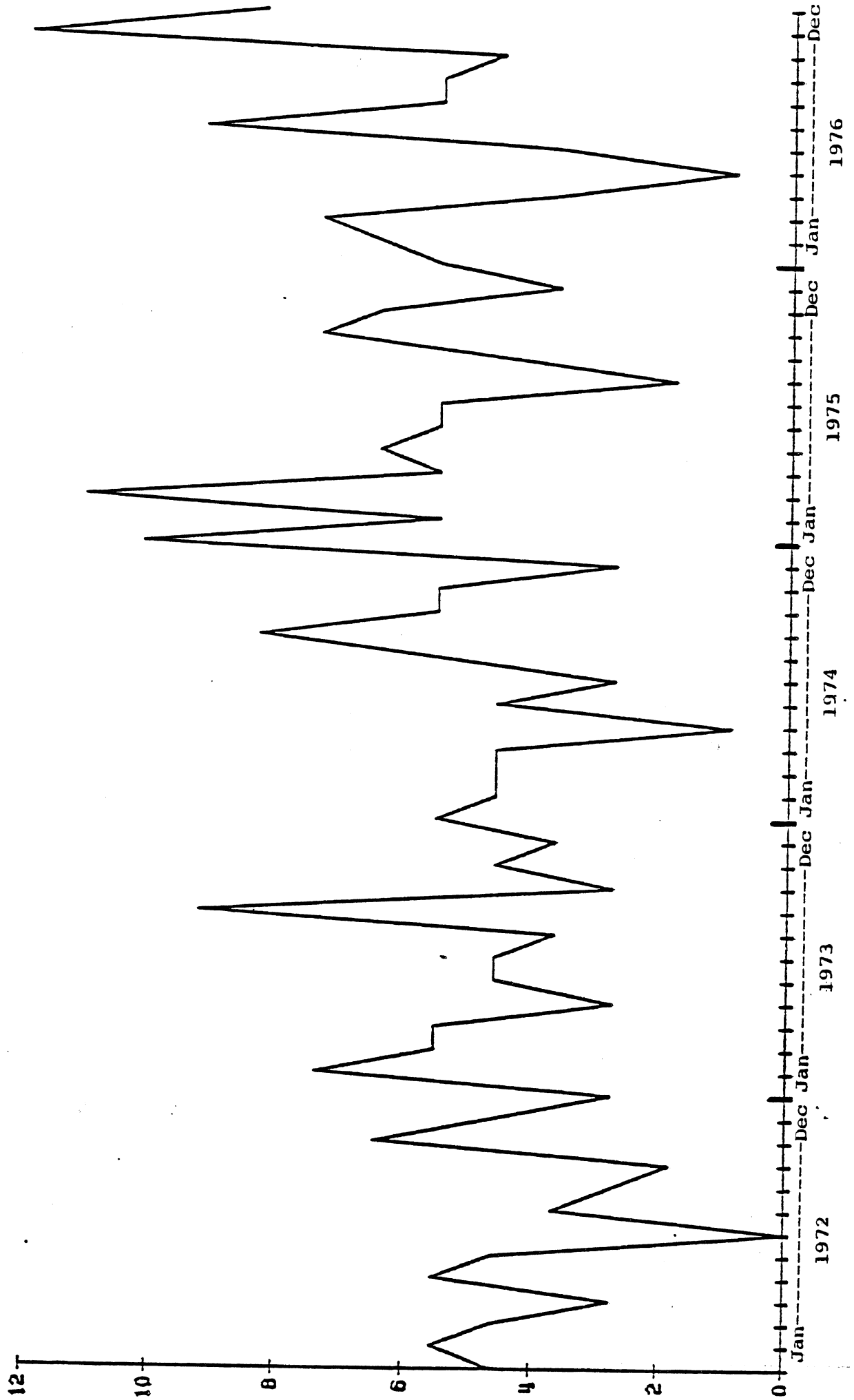
Table 3.4.1

Selected Monthly Total and Alcohol-Related Mortality,
1972-1976, State of Michigan
Displaying Under-reporting of Alcohol Involvement

| Cause of Death | Mean Monthly Incidence | | Percent of Total Incidence Reported as Alcohol Involved |
	Without Mention of Alcohol Involvement	With Mention of Alcohol Involvement	
Accidents, all types	296.1	5.33	1.8%
Motor Vehicle Accidents	151.4	1.30	0.85
Work-Related Accidents	13.08	0.05	0.38
Suicide	92.68	.817	0.44
Homicide	91.45	.217	0.24

3.5 State Police Data

Homicide and assault data were supplied by the Michigan State Police, Records Division. The data were compiled from state, local, and county police departments, and were available for an eight year period from 1970 through 1977.

Assault data were available for the five largest counties in the state and on a statewide basis in annual totals only. The assault data were of limited utility since the reporting methods changed twice between 1974 and 1976.

Homicide data, on the other hand, were consistently reported over time and were available for each of the five largest counties and the entire state for the eight year period covered in this study. The data available included all types of homicide, including first, second and third degree, non-negligent homicide, and manslaughter (non-traffic). The homicide data included monthly totals for only two years, however, limiting their usefulness in the analysis of time-series variables.

4. ANALYSIS AND RESULTS

The previous chapters have described the state of current knowledge of alcohol in relation to several major social problems, Michigan data which are available in these problem areas, and the conceptual framework within which the analyses must function. This chapter will explain the analytical approaches which were used in this study and the results of the analysis of available data.

A basic limitation in developing appropriate analytical approaches in this study was a data base with differing levels of detail, different jurisdictional representation, and inconsistent time period coverage. Some data were available for the state, by county, by month, for six or seven years, while others were available only for statewide coverage or for short time periods. Some variables could only be measured as annual sums which prevented any time-series analyses requiring monthly observations. Thus the "crazy quilt" data set matrix described in Chapter 3 prevented any comprehensive analyses which included all variables in all jurisdictions for matched time periods.

As discussed in earlier sections, the concept of alcohol availability has a range of meanings and has been operationalized in several different ways. The concept is elusive as well in that the optimum combinations of "macro system" variables (such as age of majority limits, hours of operation, density of retail outlets, and other variables) and "micro system" variables (price at point-of-sale, age and income of consumer, costs incurred during purchase, physical condition of consumer, etc.) simply are not available.

An additional difficulty in the current analyses was the absence of any "natural experiment" to monitor the consequences of a change

in alcohol availability in a controlled quasi-experimental design, such as the legal drinking age change and its effects on traffic crash involvement. The lack of manipulated changes in availability forced the analysis into regression and correlational designs. This non-experimental situation presents considerable limitations on the kinds of interpretations that can be validly pursued regarding the direct, and defensably causal, relationships between levels of availability, levels of mortality, morbidity, and other reported problems, and alcohol distribution volumes.

The analysis designs are essentially descriptive. The main categories will include stationary time-series model constructions and assessments of the predictive adequacy of derived models; multivariate models of consumption (distribution), availability (licensing actions), and problem frequencies; and cross-correlation analyses to reveal time-related associations and to exploit the time-series data base to a fuller extent than static correlations alone can provide.

It is essential to mention here that these analysis approaches fall short of being adequate to demonstrate relationships of probable cause. It will be possible to measure covariation, and in some instances relative contribution (partial correlation), and in a few two-variable relationships, a degree of time-order. A full control over spurious correlations or competing explanations is not possible with the current dataset and we will make no attempt to extend the interpretations beyond the legitimate boundaries of the analysis tools and data available.

4.1 Time Series Modeling

A time-series is a number of values for a particular variable, X_t where $t=1,2,3,\ldots,T$, such that the interval between X_t and X_{t+1} is fixed and constant (Ostrom, 1978). An event that is depicted by a time-series can be continuous, occurring constantly, or discontinuous, occurring only in discrete instances (Kendall, 1973). In either case the value of the time-series variable at any point $\underline{t}$ often is an aggregation over a specified time period, for example, a month or a year. The beverage alcohol consumption variables of primary concern in the present section (package beer sales, draught beer sales, wine sales, and table-top (on premise) liquor sales) are conceptualized as discontinuous variables, with the time-series consisting of a monthly aggregation of beverage alcohol sales. Similarly the social problem variables dealt with in this section, the frequency of assault and the frequency of divorce, are also monthly aggregations of discontinuous or discrete events.

One potential problem in the analysis of these variables as time-series arises as a result of measuring the phenomenon in terms of monthly aggregations. Since months differ in the amount of time covered the data technically do not form a time-series since the interval between X_t and X_{t+1} is not fixed and constant.* Although this difficulty can be corrected by weighting each monthly value by a function of the length of the month, the differences in monthly values due to the differing time periods covered is unlikely to appreciably affect the results of the analysis, and therefore the unweighted monthly values are used in the subsequent analysis. It should be pointed out that ignoring variation as a result of intrinsic characteristics of monthly data is a conservative approach and would reduce the fit of a proposed model to time-series based on monthly aggregation.

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*Another potential confounding factor in the use of monthly aggregations is that months vary in the number of weekends they include.

Finally, an important characteristic of time-series variables that must be considered prior to analysis is the consistency over the time period covered by the time-series of the definition used in the measurement of the phenomenon. It appears that no major changes in the operational definitions of these variables occurred during the time period studied.

There are a variety of potential objectives for the analysis of time-series variables. One may wish to construct a model to <u>describe</u> the series. Another objective may be to <u>explain</u> the series in terms of other variables by constructing a multivariate model to account for the series. The value of the series at some future time point may be <u>forecasted</u> with the use of either a univariate or multivariate model. Finally, one may wish to manipulate the independent variables of a multivariate model and observe the impact of the manipulation on the series, using the time-series as a dependent variable in <u>experimentation</u>. First, the description of the time-series variables using a model based on time-series decomposition will be considered.

A time-series is usually conceptualized as a functional combination of four components (Kendall, 1973; Douglass and Freedman, 1977): 1) trend, the long term movement, 2) cyclic component, a more or less regular fluctuation about the trend, 3) seasonality, a regular cyclic seasonal factor, and 4) a residual or irregular component. Since the time-series available for the present analysis are of insufficient length, no cyclic component was identifiable. Any cyclic component that might be present could not be estimated and will therefore be included in the residual component for the remainder of this analysis.

The model used to describe the time-series variables considered in the present report conceptualizes each time-series as an additive composite of trend, seasonality, and an irregular component. Trend

$$Y = T + S + I$$

is defined as the linear growth component associated with economic and population growth. Seasonality is defined as the expected monthly value of the variable under consideration. It must be recognized that by viewing each time-series as an additive composite of the three components we are imposing a model on the situation. Multiplicative ($Y = T \cdot S \cdot I$) and other more complex models could also be proposed. The utility of any model is determined by the degree to which the data fit the model. In the interests of parsimony, the simplest model with which the data fit well is to be preferred. As shall be seen shortly, the simple additive model fit the data surprisingly well.

Each time-series was decomposed using the following procedure. First, a least squares linear regression was run on each time-series to estimate the variance explained by the linear trend. The residuals from this regression were used to compute the mean value of each month (i.e., average of all the Januarys, average of all the Februarys, etc.). The seasonal component was then removed from the residual series by subtracting from each month in the series its mean value. The resulting time-series represents the irregular component, the variation in the original time-series that is not explained by trend and seasonal components.

Applying this simple additive model to the beverage alcohol distribution variables for which monthly time-series data are available, it is observed that about three-fourths of the variance in these variables can be explained by linear trend and cyclic seasonal factors. The high degree of fit between the data and the model can readily be seen in Figure 4.1.1, where both the actual draught beer consumption and its predicted values are plotted. As can be seen from Table 4.1.1, the relative contribution of trend or seasonality in explaining the variance in alcohol consumption varies with the type of beverage under consideration. Most of the variance in beverage alcohol consumption is a result of a dominant seasonal component in the series (see Figures 4.1.2, 4.1.3, 4.1.5). This does not hold true for wine

Table 4.1.1

Percentage of Variance in Michigan Beverage Alcohol Consumption
Explained by Trend and Seasonal Components

	Trend	Seasonality	Total
Packaged Beer Sales	16%	68%	84%
Draught Beer Sales	1	72	73
Wine Sales	49	20	69
Table-top Liquor Sales	11	58	69

consumption, however, the variation in wine consumption is dominanted by a linear upward trend explaining 49% of the variance, with a moderate seasonal factor explaining an additional 20% of the variance (see Figure 4.1.4).

Turning to the social problem variables, it is again observed that more than three-fourths of the variance in assault and divorce is accounted for by the additive time-series model (see Table 4.1.2 and Figures 4.1.6 and 4.1.7). However, an important difference in the two series is evident. Most of the variance explained by the model is a result of the seasonal variation in assault but most of the variation in frequency of divorce is a result of the upward linear trend.*

In conclusion, it is clear that the time-series variables analyzed are characterized by a high degree of fit to the additive time-series model $Y = T + S + I$. The predictive power of the model is particularly high for packaged beer sales and frequency of assault; in each case over 80% of the variance was accounted for. Important differences were noted in the relative contribution to explained variance of trend and seasonality.

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*The percent of variance in assault accounted for by the model should be interpreted with caution since only 24 data points were used.

Table 4.1.2

Percentage of Variance in Frequency of Assault and Divorce
in Michigan Explained by Trend and Seasonal Components

	Trend	Seasonality	Total
Assault	13%	77%	90%
Divorce	69	7	76

With regard to the objectives of time-series analysis discussed earlier, it is clear that the additive model functions very well as a description of the time-series. This is important not only for an understanding of the event but also because the tested model can be used to forecast future values of the variable under consideration. In using a model such as the one outlined above for forecasting, it is assumed that there is sufficient momentum in the system to ensure that future events will occur as they have in the past. As a result, forecasting can be done without knowledge of the specific causal system operating to bring about the event. Obviously, such a fore-case could be seriously in error if a major occurrence (such as a significant change in beverage control laws or a war) to impact on the causal system during the period to which the forecast applied. Therefore, caution must always be exercised when forecasting without adequate knowledge of the causal factors operating.

Another use of a highly predictive time-series model is to eliminate the variation accounted for by the model prior to further analysis of relationships between time-series variables. However, the elimination of variation due to trend and seasonality prior to further analysis assumes that the determinants of the trend and seasonal variation are clearly known. Since the causes of trend and seasonal variation in Liquor Control Commission licensing actions, beverage alcohol consumption variables, and social/health problem variables are not fully known at this time, analysis of the

relationship between these variables were conducted using the original time-series variables, including trend and seasonal components, rather than the irregular component only. It is possible that the trend and seasonal components of Liquor Control Commission licensing actions, alcohol consumption, and social problems are related. Since our knowledge is limited concerning the causal mechanisms that bring about trend and seasonal variation in these variables, all the components of variance are included in the subsequent analysis of cross-correlations among the variables.

FIGURE 4.1.1. WHOLESALE DRAUGHT BEER SALES DEMONSTRATING TREND AND SEASONAL COMPONENTS, STATE OF MICHIGAN, 1970-1977

Source: Michigan Beer and Wine Wholesalers Association

- - - LINEAR TREND Y-(S+I) = T
----- TREND AND SEASONALITY Y-I = T+S
――― DRAUGHT BEER DISTRIBUTION (x1,000 barrels)

33
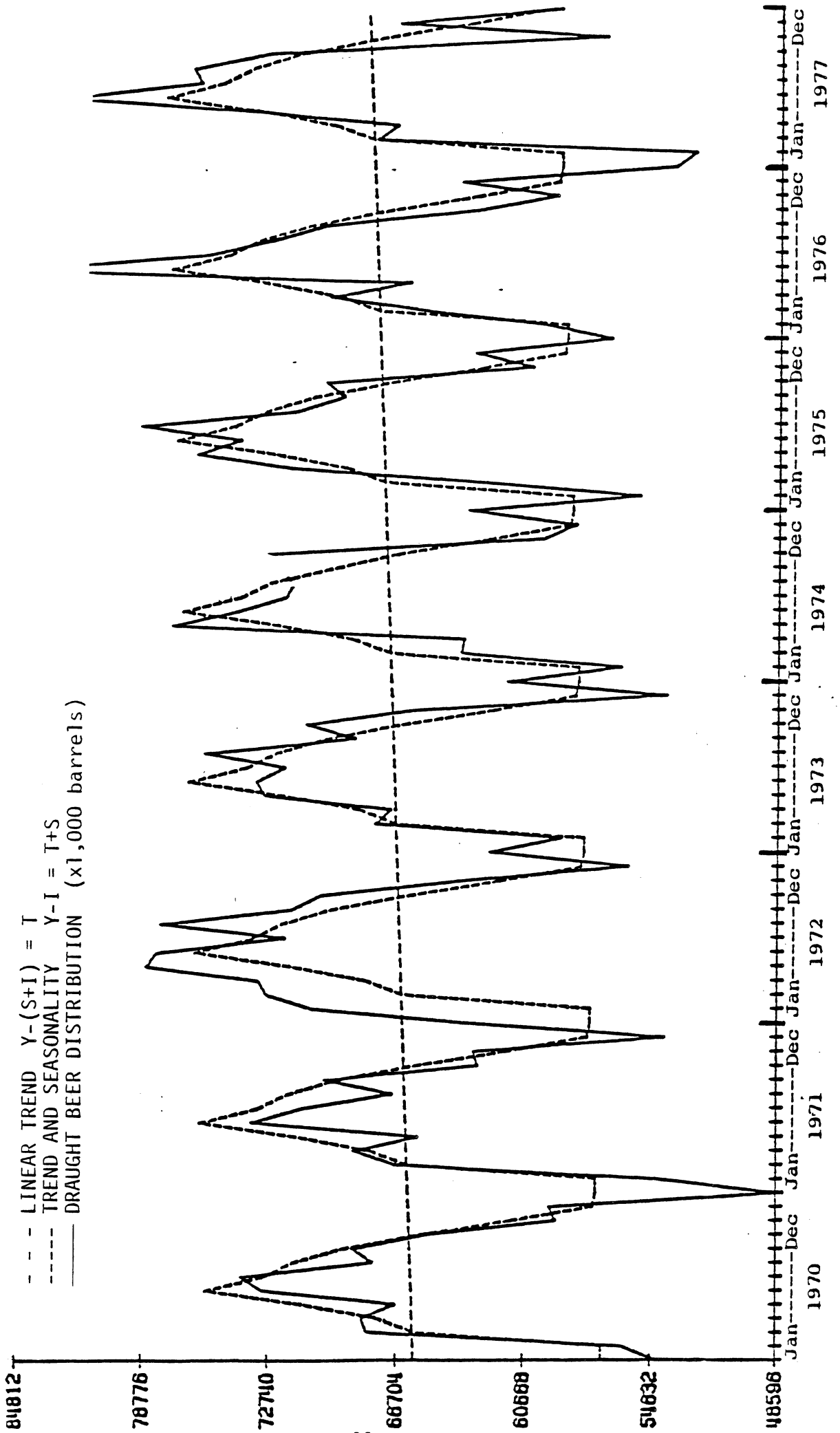
FIGURE 4.1.2.   WHOLESALE PACKAGED BEER SALES (barrels), STATE OF MICHIGAN, 1970-1977

Source: Michigan Beer and Wine Wholesalers Association

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FIGURE 4.1.3.   WHOLESALE DRAUGHT BEER SALES (x1,000 barrels), STATE OF MICHIGAN, 1970-1977

Source: Michigan Beer and Wine Wholesalers Association

DRAFT BEER SALES
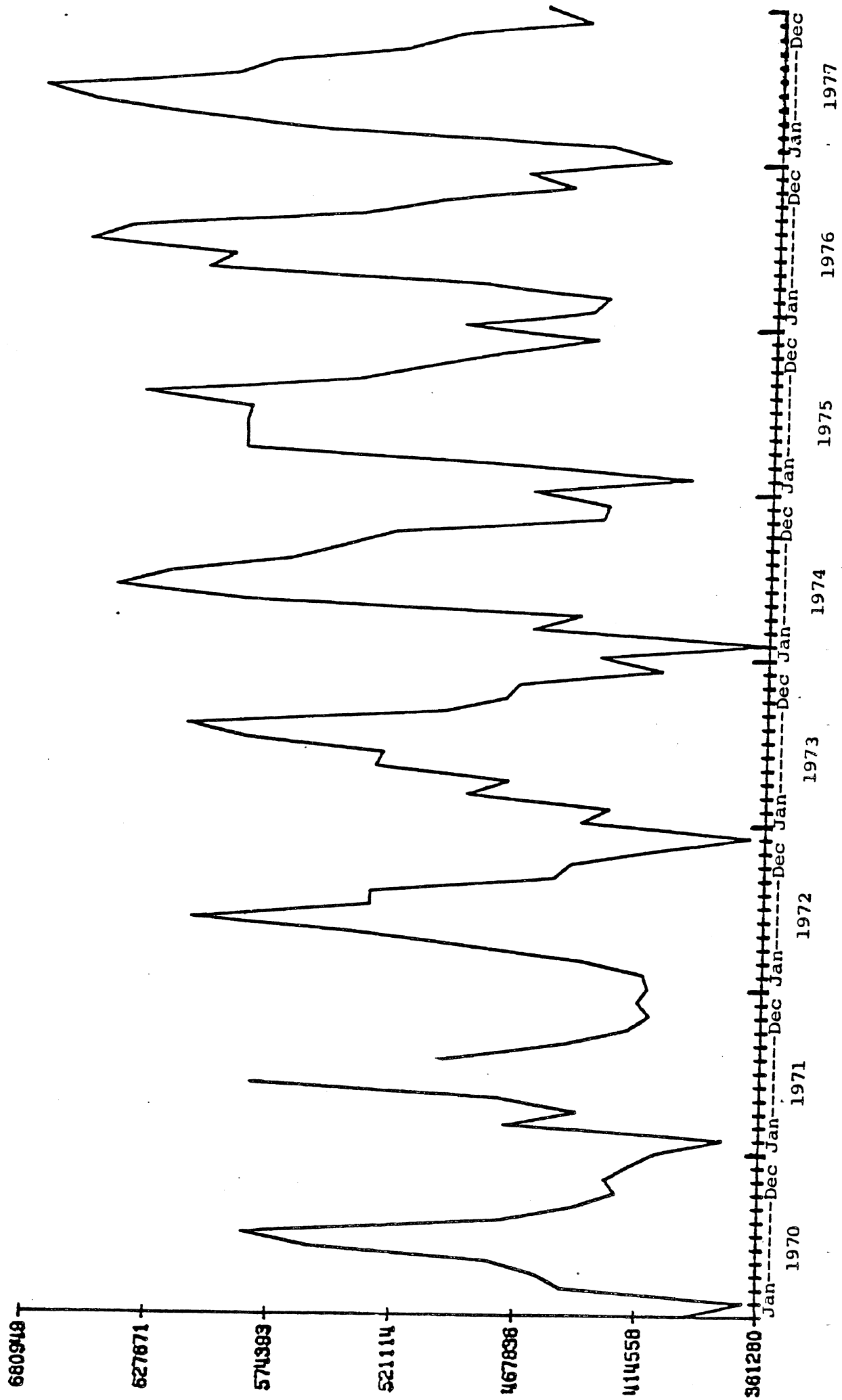
FIGURE 4.1.4.   WHOLESALE WINE SALES (gallons), STATE OF MICHIGAN, 1970-1977

Source: Michigan Beer and Wine Wholesalers Association

WHOLESALE WINE SALES (gallons), STATE OF MICHIGAN, 1970-1977

13744489
12320033
10896686
8472279
8044873
6624466
5200060

Jan-----Dec Jan-----Dec Jan-----Dec Jan-----Dec Jan-----Dec Jan-----Dec Jan-----Dec Jan-----Dec
1970   1971   1972   1973   1974   1975   1976   1977

FIGURE 4.1.5. WHOLESALE SALES OF TABLE TOP DISTILLED SPIRITS (DOLLARS),
STATE OF MICHIGAN 1970-1977

Source: Michigan Liquor Control Commission

87
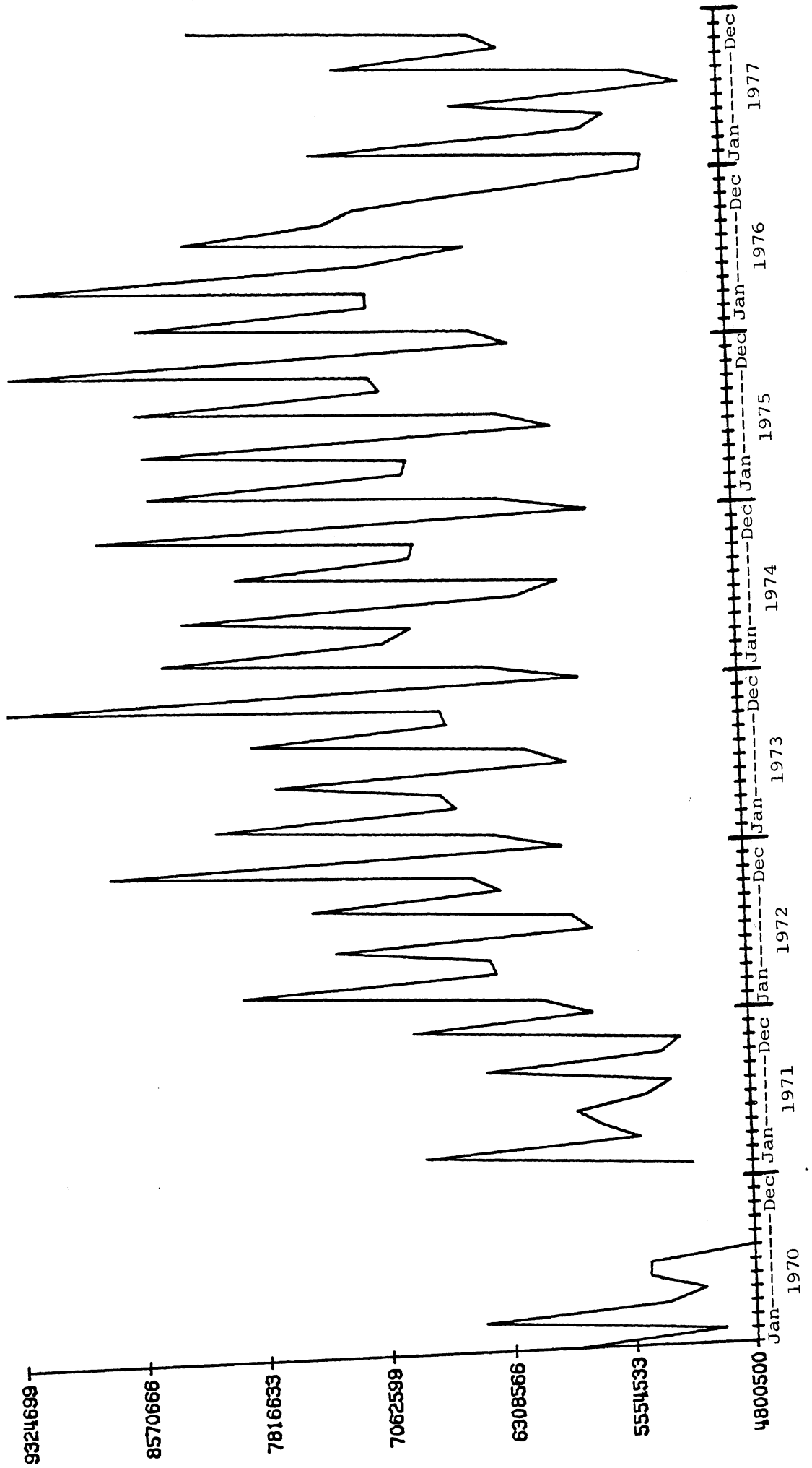
FIGURE 4.1.6. FREQUENCY OF AGGRAVATED ASSAULT, STATE OF MICHIGAN, 1974-1975

Source: Michigan State Police
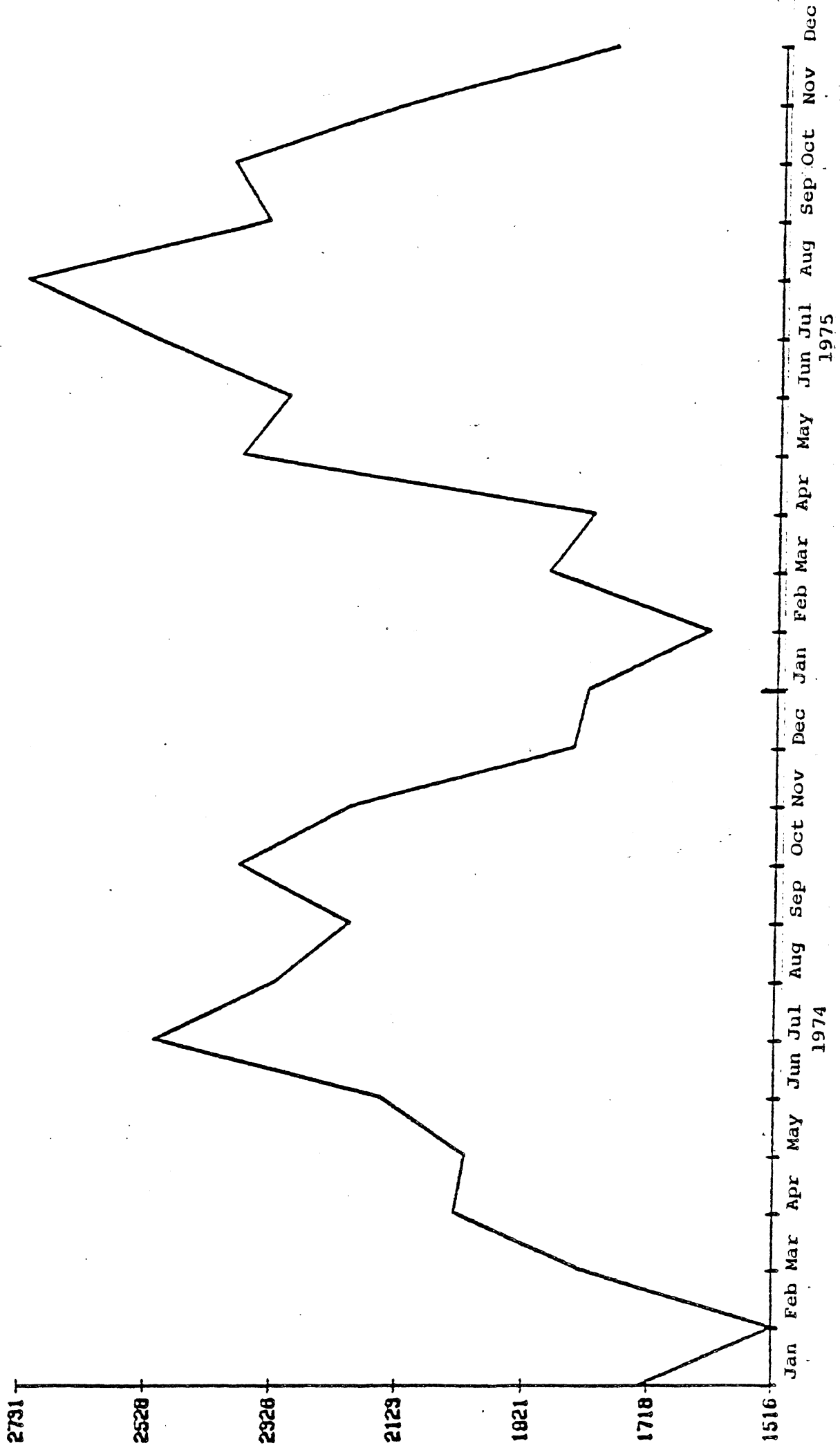
FIGURE 4.1.7. FREQUENCY OF DIVORCE, STATE OF MICHIGAN, 1970-1976

Source: Michigan Department of Public Health

89
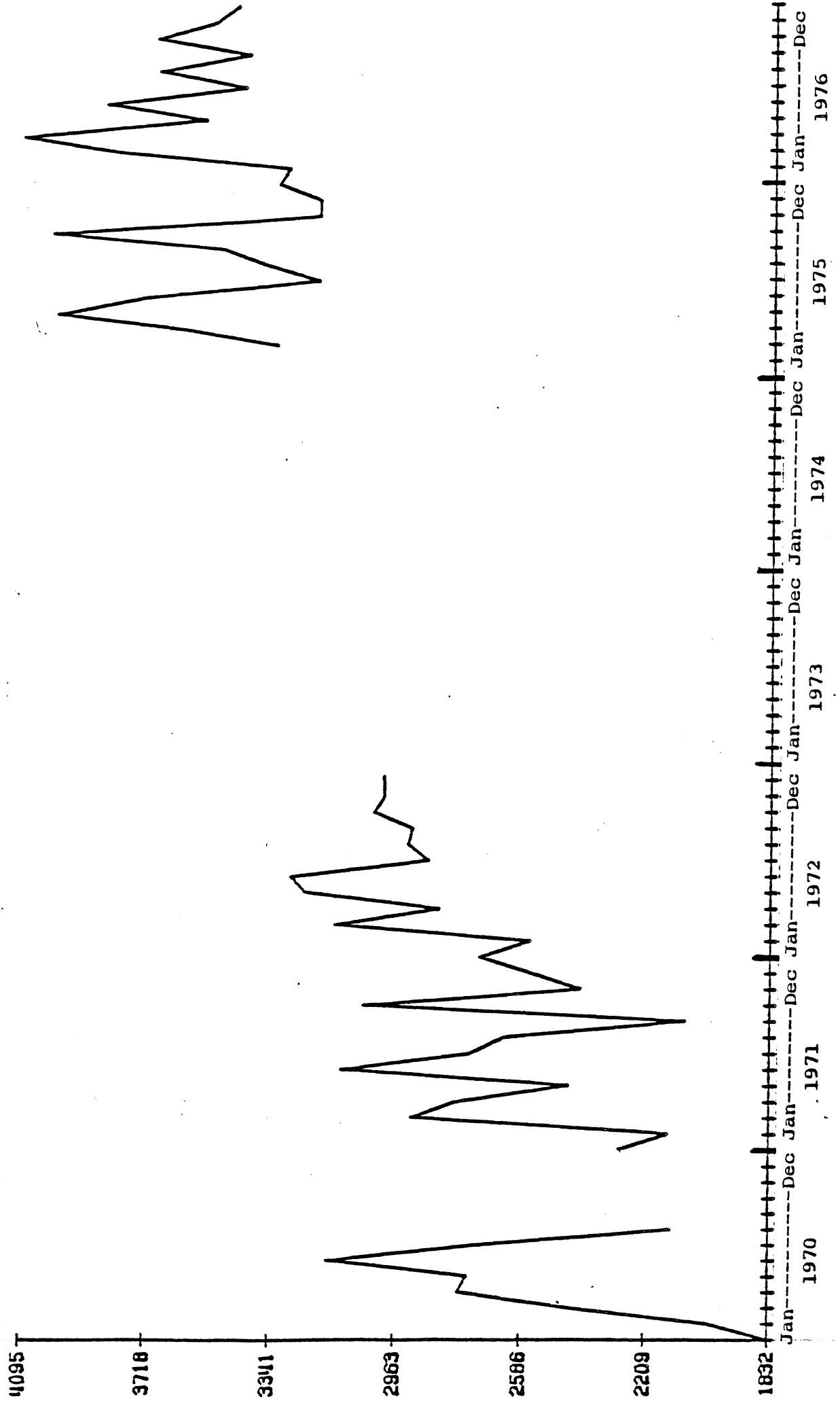
4.2 Cross-Correlation Analyses

Time-series data present opportunities for examining the relationships among variables which are not possible when observations are made only at singular or irregular points in time. The availability of time-series data permit analyses which, while not totally conclusive, are capable of indicating relationships which exhibit strong probabilities of causality, that are not possible with other techniques. This section of the analysis will approach the data base with the intention of identifying those relationships which demonstrate statistical association and proper time order.

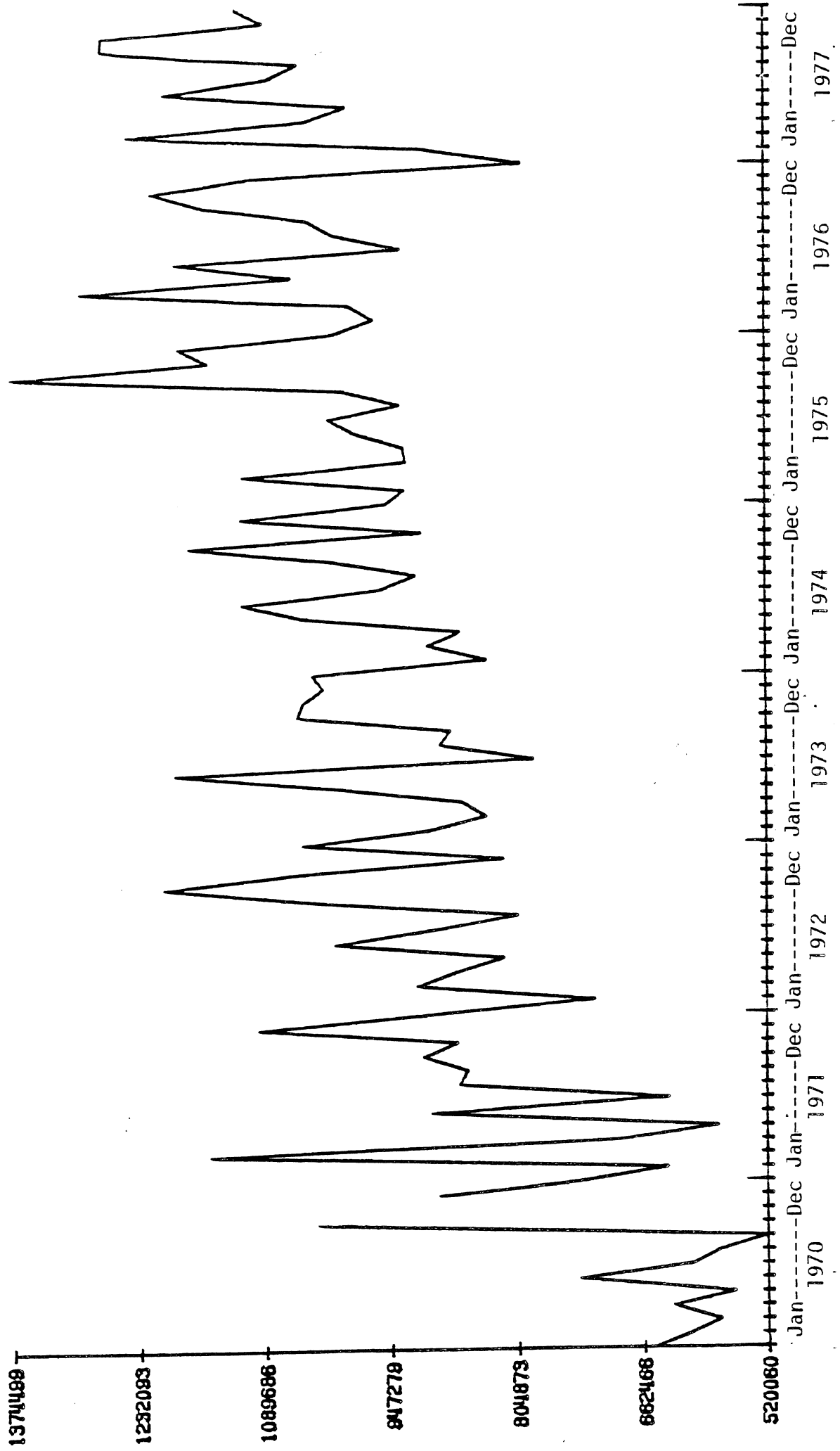Determination of a causal relationship between one social factor, such as a new law, a change in a regulation, an increase in alcohol consumption, or an increase in the number of beverage outlets in a jurisdiction, and an outcome or consequence variable, such as increased numbers of traffic accidents, is the central focus of the current study of the impacts of changes in alcohol availability. There are four basic requirements which must be met if a causal X-Y relationship is to be substantiated. First, there must be covariation, or systematic change, in both terms. The number of package liquor outlets in Kent County, Michigan could hardly be deemed responsible for a sudden surge in package liquor sales if there was no associated increase in the numbers of outlets with SDD licenses. Secondly, the causal X variable must preceed the outcome Y. The argument that X causes Y could not be supported if changes in Y were followed by changes in X. Third, and very important, the X-Y relationship must hold even when other factors are held constant. This means that alternative, or spurious, competing independent terms (X_i) must be tested for their grouped or independent influences on Y. Finally, the presumed causal relationship must make sense. Even with co-variation, proper time sequence, and an apparent absence of competing causal influences, no increase in alcohol consumption would be attributed to a conceptually unrelated social change.

The measurement, over time, of the frequencies of retail alcohol outlet licensing, marketing changes (changes in permits held), beverage distribution (consumption by beverage type) and a range of reported social and health problems and mortalities, allow analyses of covariation and time ordering sequences. Full control over spurious sources of influence on outcome measures (consumption, problems, and mortalities) are not possible. Some analytic techniques, however are possible which can determine the strength of covariation, the probability of covariation and the direction of the relationships; use of these techniques aids the analyst in a preliminary interpretation of X-Y relationships which are most likely to be truly causal. Cross-correlation analysis is the technique we chose to employ. This technique will now be discussed, followed by the results of the analyses. Box and Jenkins present a detailed discussion on the cross-correlation technique to which the reader is referred.*

4.2.1 <u>Cross-Correlation Methodology</u>. A classification of statistical analysis of parallel time series data termed transfer function models deals with the interactive relationships between two phenomena measured at equally spaced intervals in time. These bivariate processes involve potentially causal X-Y relationships and serve to measure the probabilities that time-ordered association is consistent and statistically significant. Bivariate processes in the present analysis may involve dependent variables of licensing activities or consumption and independent variables of consumption or social/health morbility and mortality. The hypotheses, thus, include postulations that increases in new or transfers of retail sales outlets are followed by increases in alcohol consumption and/or to increases in specific social or health problems, which are, to some extent, etiologically related to alcohol consumption and abuse.

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*Box, G. E. P. and Jenkins, G. M. <u>Time Series Analysis: Forecasting and Control</u>, Chapter II. Holden-Day, San Farancisco, 1970.

The cross-correlation function measures not only the association of the time-ordered X and Y variables at the same point in time, but also the association with systematic time leads or lags. Figure 4.2.1.1. schematically represents this capability; along the time dimension t, correlations between t_{-k} lags and t_{+k} leads are all tested. X and Y terms may exhibit variation at the same time when there is no lead or lag, or when one preceeds or follows the other with positive leads or negative lags.

Cross-correlations of k=0 determine the association of bivariate time-series at the same points in time. When k values are negative, the relationship reflects dynamics in which the Y term increases before the X term. When k values are positive, the X term changes preceed the dependent variable Y; a necessary prerequisite for a causal relationship between the variables.

Figure 4.2.1.2 shows the cross-correlation function in its purest form--that of a variable against itself, a perfect correlation. It can be seen that the shape of the function $r_{xy}(k)$ when X and Y are identical is perfectly symmetrical with a correlation r_{xy} k=0 of 1.0 (unity). The correlations for negative k values (-1 to -6) and positive values (+1 to +6) are symmetrical and identical, indicating that each change in X is associated with an identical change in Y.

A more meaningful relationship is one between variables in our analyses which are hypothesized to be related. Figure 4.2.1.3 is the cross-correlation function of Michigan Draught Beer Distribution against Traffic Accident Mortality. It can be seen that the k=-1 to -6 lag coefficients and the k=+4 to +6 lead coefficients are very small, however the k=0, +1, +2 and +3 coefficients are reasonably large. This indicates that increases in draught beer distribution are followed by increases in traffic accident deaths and that the relationship is consistent over time within a k=0 to +3 (month) time frame.

Another example will aid in illustratng the meanings of this analytic approach (see Figure 4.2.1.4 - Cross-Correlation Analysis of Michigan New Class C License Approach Against Cirrhosis Mortality). In this analysis there is no strong relationship at all, with the k=-1 coefficient only at the value of .228. Essentially this analysis demonstrates that increases in the number of Class C establishments is unrelated to increases in cirrhosis deaths.* These examples should assist the reader in interpreting the tabular findings of the cross-correlation analyses below.

The interpretive power of these analyses is clearly that the strength of the associations of bivariate processes and the time-dimensions are both inherently part of the analysis. It is possible, therefore to screen all potential bivariate processes for the possibility of relationships which are meaningful and then to determine the possibility of causality in regard to proper time ordering of changes in the variables.

4.2.2 <u>Results of Cross-Correlation Analyses</u>. Table 4.2.2.1 displays all important cross-correlation results for the full set of licensing and alcohol distribution independent variables and the alcohol distribution, health and social problem dependent measures. Table 4.2.2.2 provides detailed information about each bivariate relationship. Few consistent findings are apparent in the county analyses which may be the result of the events measured being relatively infrequent events. In Wayne County, however, there are observable relationships, with positive k lead values between accidental mortality frequencies and New SDM licenses and New Sunday Sales Permits. Analyses of data from Genesse and Oakland counties also reveal relationships between accidental mortality measures (Total, Traffic, Occupational) and licensing activities.

With a larger population base and the availability of licensing activity measures plus alcohol distribution variables, the statewide data are of greatest interest in these analyses. Although the police data on homicide and assault generated impressive cross-correlation

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*Within the time frame of the data sets.

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coefficients (with negative k lags) the data are limited to a 24
month series which greatly inflates the values of r. These analyses,
however can be considered against the public health homicide
mortality data, which are more satisfactory, and a reasonable inter-
pretation of the relationships between availability, distribution
and homicide can be made. There appears to be weak, positive re-
lationships between new SDM licenses and homicide, and between
draught beer sales and homicide.

The most striking result of these statewide tests is the
dominant interactions between accidental mortality measures, both
categories of beer volumnes, and the independent test variables.
Those coefficients which explain the greatest amount of variance are
exclusively interactions testing the relationships of accidental
mortality and beer. New SDM licensing is consistently and strongly
associated with traffic accident and work accident mortality; both
package and draught beer distributions are associated with total
accident mortality.

Coefficients explaining between 10 and 20% of variance were
found when correlating licensing activities and alcohol distribution.
Of the seven interactions which produced 10 or more percent of
variance explained, only those between licensing changes and wine
or table-top spirits were noteworthy. This may reflect a stable beer
distribution pattern over time which is not as easily influenced as
sales of spirits or wine.

Few consistent relationships were identified in the county data
sets between cirrhosis or suicide mortality and the licensing data.
This continued to be true with the statewide data where only the
relationship between wine distribution and suicide mortality even
approached importance; furthermore, this relationship was at the k=0
paired observations in which no time ordering is evident.

The most important bivariate relationships involved package and
draught beer, as mentioned above. On Table 4.2.2.2 it is clearly
shown that the strength of the relationships between beer distribution

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FIGURE 4.2.1.1. SCHEMATIC REPRESENTATION OF CROSS-CORRELATION ANALYSIS
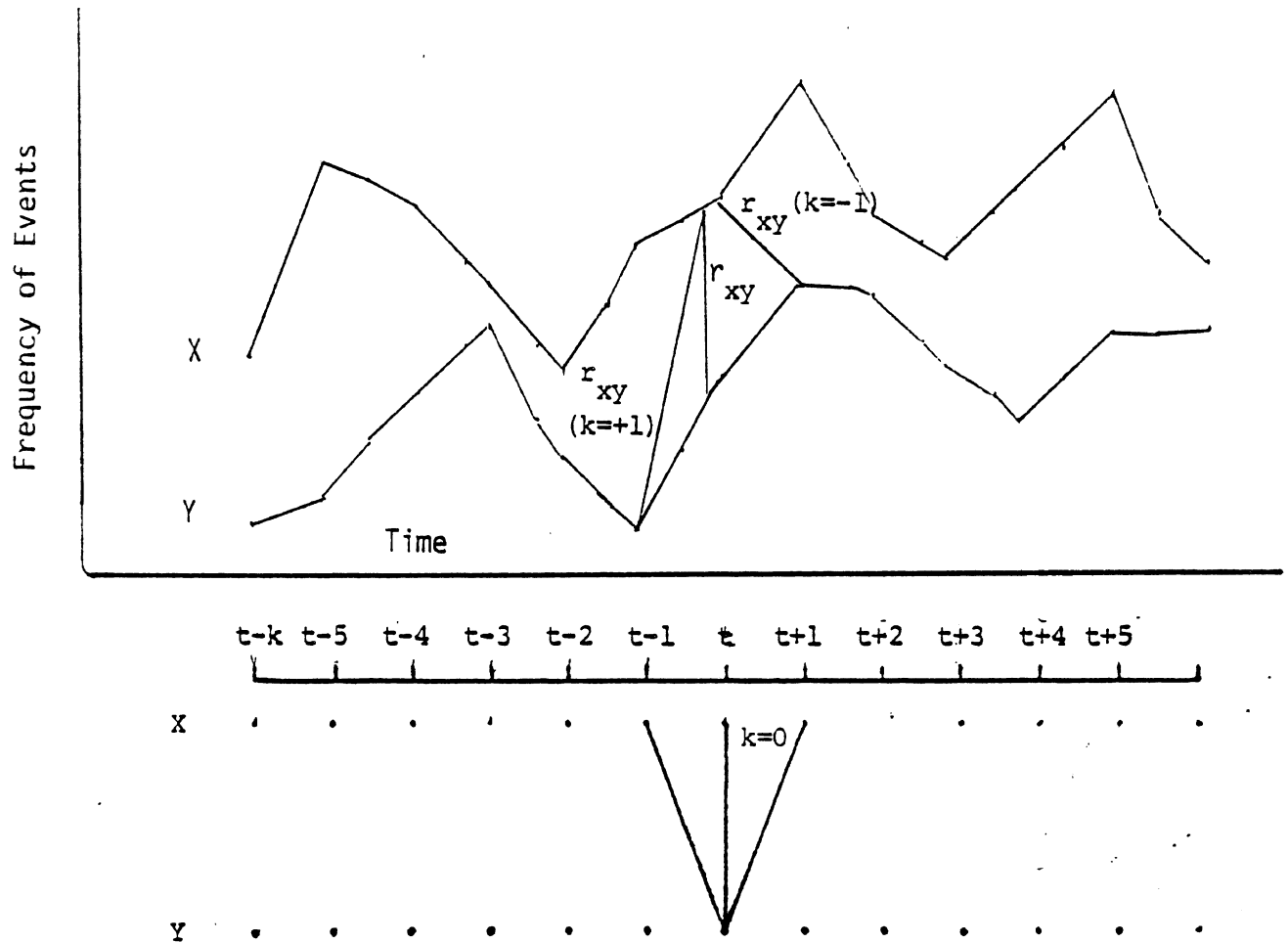
FIGURE 4.2.1.2. CROSS-CORRELATION ANALYSIS OF MICHIGAN NEW SDM LICENSE APPLICATION
APPROVALS AGAINST NEW SDM LICENSE APPLICATION APPROVALS, 1970-1976
k = 12 month lead and lag

2.NEWSDM VS. 2.NEWSDM K=(-12 TO +12)   N= 93 OUT OF 96 Monthly Intervals
ABSOLUTE TIME RANGE= 96

```
        .12946  -                      2
        .07137  -             1
       -.01322  -       0
       -.02723  -     9
       -.00597  -   8
        .05389  -                7
        .08287  -              6
        .07594  -              5
        .14187  -
        .31011  -                           3
        .40551  -                                       2
        .61827  -                                                         1
  0.    .00000  +
        .61827  +                                                         1
        .40551  +
        .31011  +                           3
        .14180  +
        .07594  +              5
        .08287  +              6
        .05389  +
       -.00597  +8
       -.02723  +     9
       -.01322  +       0
        .07137  +
        .12946  +               2
```
-.59711 -2 .13582 .21750 .32935 .44113 .55290 .66468 .77645 .88823 COEFFICIENTS
                                                                              1.0000

2.NEWSDM VS. 2.NEWSDM K=(-12 TO +12)   N= 93 OUT OF 96 Monthly Intervals

FIGURE 4.2.1.3. CROSS-CORRELATION ANALYSIS OF MICHIGAN DRAUGHT
BEER DISTRIBUTION AGAINST TRAFFIC ACCIDENT
MORTALITY, 1971-1975


```
.DRAUBEER VS. Traffic Accident Mortality  k = (-6 to +6)
           ABSOLUTE TIME RANGE= 60   N= 59 OUT OF 59 Months
-.42599   -        6
-.54649   -5
-.56889   -4
-.43801   -        3
-.12452   -                    2
 .13048   -                              1
 .48262                                                 0
 .67695   +                                                     1
 .67161   +                                                  2
 .46996   +                                        3
 .24103   +                               4
-.00417   +                    5
-.30039   +        6
          +----+----+----+----+----+----+----+----+----+----+
    -.56889           -.70551 -1              .42778   COEFFICIENTS
            -.31972              .17862              .67695
```
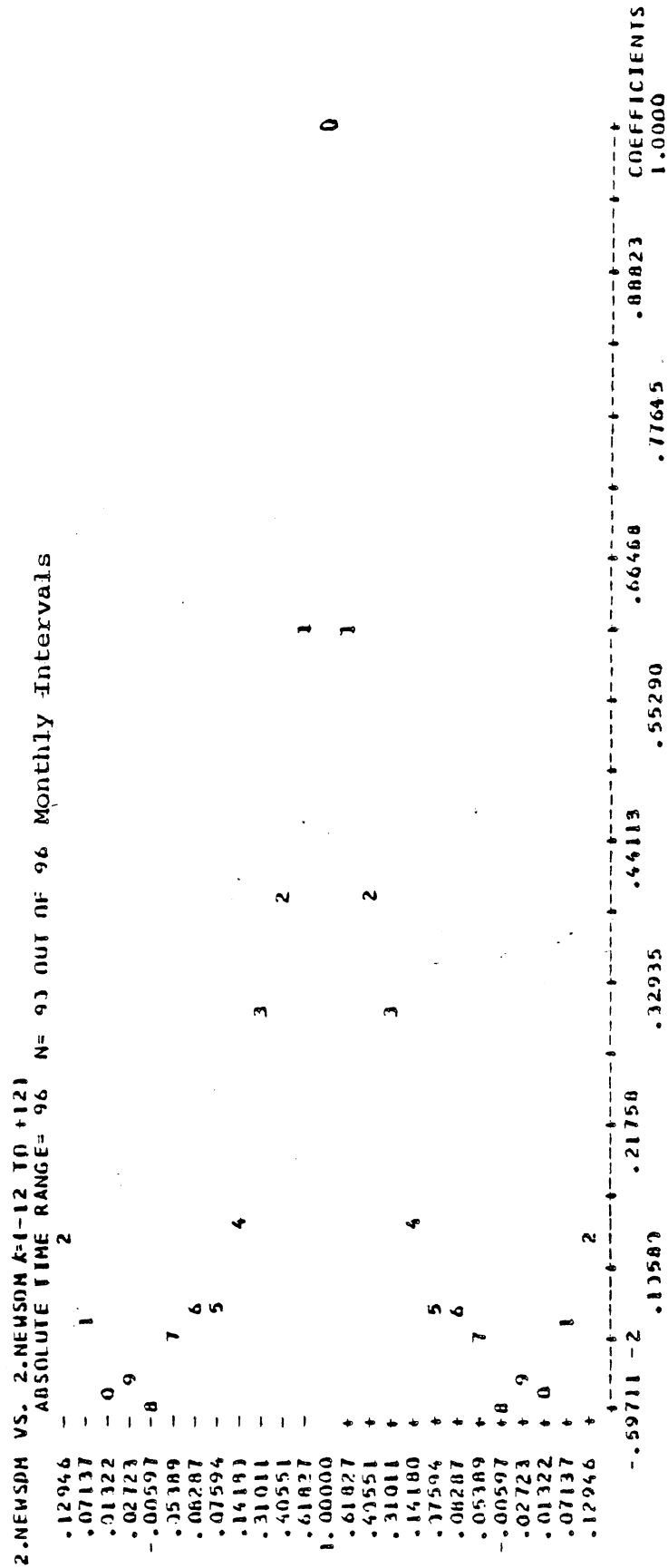
FIGURE 4.2.1.4. CROSS-CORRELATION ANALYSIS OF MICHIGAN NEW CLASS
C LICENSE APPROVALS AGAINST CIRRHOSIS MORTALITY


```
.NEW.C VS. Cirrhosis Mortality  k = (-6 to 6)
           ABSOLUTE TIME RANGE= 60   N= 60 OUT OF 60  Months
 .04693   -                              6
-.01196   -                  5
 .07135   -                        4
 .06761   -                    3
 .10082   -                        2
 .22778   -                                                 1
-.06438                0
-.15533   +1
 .05331   +                        2
-.10325   +        3
-.03169   +            4
 .03719   +                    5
-.04721   +                6
          +----+----+----+----+----+----+----+----+----+----+
    -.15533           -.20885 -2              .15116   COEFFICIENTS
            -.78711 -1             .74534 -1          .22778
```

and all three categories of accident mortality, and the direction of these relationships (k=0 to k=+3) strongly suggest causality. It is apparent that increases in beer distribution are consistently followed by increases in total accident mortality, traffic accident mortality, and accidental deaths in the working place. The lag between the maximum alcohol distribution increases and mortality increases is generally one or two months (k=+1,+2) which would be an appropriate time sequence if these relationships are truly causal.

4.2.3 <u>Discussion of Cross-Correlation Analyses</u>. If one were to construct an hypothetical continuum based on the social and medical etiologies of each of the social and health dependent variables used in these analyses, it would be possible to rank-order the problem areas and mortality categories along a "most simple" to "most complex", or most acute to most chronic, scale. If this were done the three categories of accident mortality, assault, and homicide would probably be classified as relatively acute, while divorce, child abuse, and suicide would be more complex and more chronic. Cirrhosis mortality certainly be listed as the most chronic. The general impression that emerges from the cross-correlation analyses is that the most acute social and health problems, particularly the acute accident mortality measures, are most likely to be statistically associated <u>and</u> appropriately time ordered which suggests causal relationships with increased alcohol availability. Further, increases in the distribution of draught beer and package beer appears to be associated with acute mortality including total accident deaths, accident deaths in the working place, and traffic accidents mortality. Although explaining only a small percentage of the variable, changes in the licensing of beverage alcohol sales outlets does appear to be consistently related to wine and distilled spirits distribution. Beer distribution, in the form of package sales or draught beer, is apparently unaffected to changes in the licensing actions of the Liquor Control Commission.

TABLE 4.2.2.1. FULL DESIGN CROSS-CORRELATION ANALYSIS OF ALCOHOL LICENSING, DISTRIBUTION OF ALCOHOLIC BEVERAGES AND SELECTED SOCIAL AND HEALTH PROBLEM FREQUENCIES, STATE OF MICHIGAN 1970-1976

Jurisdiction

Columns (left to right): Statewide, Rural Counties, Genesee, Kent, Macomb, Oakland, Wayne

Under each jurisdiction the measures are grouped as Mortality and Frequency (Statewide also includes Wholesale Distributions).

Mortality sub-measures: Homicide, Suicide, Cirrhosis, Work Accidents, Motor Accidents, Accidents ALL, Assault (Police), Homicide (Police), Traffic Accidents

Frequency sub-measures: Child Abuse, Divorce

Wholesale Distributions: Table Top Wine, Draught Beer, Package Beer

Row labels (top to bottom):

- New SDD Licenses
- New SDM Licenses
- New C Licenses
- New Tavern Licenses
- New Sunday Sales Permits
- Transfer SDD Licenses
- Transfer SDM Licenses
- Transfer C Licenses
- Transfer Tavern Licenses
- Package Beer
- Draught Beer
- Wine
- Table Top Spirits

Legend:

$\dagger$ = $R^2 \pm$ lag/lead 6 $\geq$ .09 = $(1 - R^2)$ = at most .91

x = $R^2 \pm$ lag/lead 6 $\geq$ 0.20 = $(1 - R^2)$ = at most .80

$*$ = $R^2 \pm$ lag/lead 6 $\geq$ 0.36 = $(1 - R^2)$ = at most .64

TABLE 4.2.2.2. SUMMARY OF SIGNIFICANT CROSS-CORRELATION ANALYSES BY JURISDICTION, LEAD/LAG DESIGNATION, STATE OF MICHIGAN

Variable Match	r	Lead/Lag*
New C License vs (Police) Homicide†	.52	-6
New Tavern License vs (Police) Homicide	.35	-1
New Sunday Sales Permit vs (Police) Homicide	.58	-5
Transfer of SDD vs (Police) Homicide	.57	-4
Transfer of SDM vs (Police) Homicide†	.63	-4
New C License vs (Police) Assault	.53	-6
New Tavern License vs (Police) Assault	.36	-1
New Sunday Sales Permit vs (Police) Assault	.56	-5
Transfer SDD vs (Police) Assault	.56	-4
Transfer SDM vs (Police) Assault	.63	-4
Transfer C vs (Police) Assault	.36	-4
New SDM Licenses vs Total Accident Mortality	.51	0
New SDM Licenses vs Total Accident Mortality	.60	+1
New SDM Licenses vs Total Accident Mortality	.57	+2
New SDM Licenses vs Traffic Mortality	.58	0
New SDM Licenses vs Traffic Mortality	.60	+1
New SDM Licenses vs Work-Related Fatal Accidents	.46	0
New SDM Licenses vs Public Health Homicide Mortality	.32	+3
New Tavern Licenses vs Total Accident Mortality	.32	+1
New Tavern Licenses vs Total Accident Mortality	.38	+2
New Tavern Licenses vs Traffic Mortality	.34	+1
New Tavern Licenses vs Work-Related Fatal Accidents	.42	+2
New Tavern Licenses vs Work-Related Fatal Accidents	.35	+2
New Sunday Sales Permits vs Total Accident Mortality	.40	+1
New Sunday Sales Permits vs Total Accident Mortality	.53	+2
New Sunday Sales Permits vs Total Accident Mortality	.50	+3

Variable Match	r	Lead/Lag*
New Sunday Sales Permits vs Traffic Mortality	.40	+1
New Sunday Sales Permits vs Traffic Mortality	.48	+2
New Sunday Sales Permits vs Traffic Mortality	.52	+3
New Sunday Sales Permits vs Traffic Mortality	.38	+4
New Sunday vs Work-Related Fatal Accidents	.44	+1
New Sunday vs Work-Related Fatal Accidents	.33	+2
New Sunday vs Cirrhosis Mortality	.37	0
New Sunday vs Cirrhosis Mortality	.38	-1
Transfer of C Licenses vs Work-Related Fatal Accidents	.37	-3
Transfer of Tavern Licenses vs Work-Related Fatal Accidents	.30	+1
New C Licenses vs Table Top Spirits Distribution	.25	0
New C Licenses vs Table Top Spirits Distribution	.26	+4
Transfer of C Licenses vs Table Top Spirits Distribution	.20	0
Transfer of C Licenses vs Table Top Spirits Distribution	.22	+6
New SDD Licenses vs Wine	.43	0
New SDD Licenses vs Wine	.39	+1
New C Licenses vs Wine	.46	0
Transfer SDD Licenses vs Wine	.33	0
Transfer SDD Licenses vs Wine	.33	+2
Transfer SDM Licenses vs Wine	.32	0

Variable Match	r	Lead/Lag*
Package Beer vs (Police) Homicide	.30	-6
Package Beer vs Total Accident Mortality	.42	0
Package Beer vs Total Accident Mortality	.55	+1
Package Beer vs Total Accident Mortality	.45	+2
Package Beer vs Traffic Mortality	.35	0
Package Beer vs Traffic Mortality	.55	+1
Package Beer vs Traffic Mortality	.45	+2
Draught Beer vs Total Accident Mortality	.49	0
Draught Beer vs Traffic Mortality	.48	0
Draught Beer vs Traffic Mortality	.68	+1
Draught Beer vs Traffic Mortality	.67	+2
Draught Beer vs Traffic Mortality	.47	+3
Draught Beer vs Work-Related Fatal Accidents	.35	0
Draught Beer vs Work-Related Fatal Accidents	.45	+1
Draught Beer vs Work-Related Fatal Accidents	.42	+2
Draught Beer vs Work-Related Fatal Accidents	.37	+3
Draught Beer vs Public Health Homicide	.32	+1
Wine vs Suicide Mortality	.30	0
Table Top Spirits Sales vs (Police) Homicide	.40	0
Table Top Spirits Sales vs (Police) Assault	.38	0

† Police data have only 23 monthly observations which greatly inflates values of r.

*Lead/Lag in Months

TABLE 4.2.2.2. SUMMARY OF SIGNIFICANT CROSS-CORRELATION ANALYSES (continued)

Genesee County			Kent County			Macomb County		
Variable Match	r	Lead/Lag	Variable Match	r	Lead/Lag	Variable Match	r	Lead/Lag
New C Licenses vs Child Abuse Frequency	.32	0	New SDM Licenses vs Child Abuse Frequency	.31	-6	New SDD Licenses vs Divorce	.46	-4
New SDM Licenses vs Work-Related Accident Mortality	.39	+2	New SDM Licenses vs Child Abuse Frequency	.30	-3	New C Licenses vs Divorce	.32	-4
New Sunday Sales Permits vs Total Accident Mortality	.32	-5	New SDD Licenses vs Cirrhosis Mortality	.34	-3	Transfer SDM Licenses vs Divorce	.32	0
New Sunday Sales Permits vs Traffic Mortality	.36	+1	Transfer SDD Licenses vs Traffic Accident	.38	-4	New SDD Licenses vs Child Abuse	.33	-4
						New C Licenses vs Child Abuse	.34	-5
Transfer of SDD Licenses vs Work-Related Accident	.35	-4				New C Licenses vs Child Abuse	.33	-4
						Transfer SDM Licenses vs Child Abuse	.45	-2
Transfer of C Licenses vs Cirrhosis Mortality	.31	+3				Transfer SDM Licenses vs Child Abuse	.35	-2
						Transfer SDM Licenses vs Child Abuse	.33	-4
						New SDD Licenses vs Suicide	.36	-1
						New Tavern Licenses vs Cirrhosis	.42	-1
						New Sunday Sales Permits vs Suicide	.40	-2

Oakland County			Rural Counties			Wayne County		
Transfer SDM vs Divorce	.34	+1	New SDD Licenses vs Divorce	.31	0	New SDM Licenses vs Child Abuse	.36	+5
New SDD Licenses vs Child Abuse Frequency	.39	+3	New SDD Licenses vs Work-Related Accident Mortality	.43	+5	New SDM Licenses vs Child Abuse	.35	-4
New SDD Licenses vs Child Abuse Frequency	.36	+2	New SDD Licenses vs Work-Related Accident Mortality	.43	+4	New SDM Licenses vs Traffic Mortality	.33	-2
New SDD Licenses vs Child Abuse Frequency	.35	+4	New SDD Licenses vs Work-Related Accident Mortality	.36	+6	New SDM Licenses vs Work-Related Accident Mortality	.33	-3
New SDD Licenses vs Child Abuse Frequency	.32	-2	New SDM Licenses vs Cirrhosis Mortality	.36	-1	New Sunday Sales Permits vs Total Accident Mortality	.38	+2
New SDD Licenses vs Child Abuse Frequency		-4	New C Licenses vs Work-Related Accident Mortality	.43	+2	New Sunday Sales Permits vs Total Accident Mortality	.33	+3
Transfer SDM Licenses vs Child Frequency	.31	0	New C Licenses vs Work-Related Accident Mortality	.43	+3	New Sunday Sales Permits vs Traffic Mortality	.33	+4
Transfer C Licenses vs Child Frequency	.30	-3	Transfer Tavern Licenses vs Cirrhosis Mortality	.36	-1	New Sunday Sales Permits vs Traffic Mortality	.31	+5
Transfer SDM Licenses vs Traffic Mortality	.32	-1				New Sunday Sales Permits vs Cirrhosis Mortality	.55	-1
New Tavern Licenses vs Work-Related Accident Mortality	.41	-1				New Sunday Sales Permits vs Cirrhosis Mortality	.54	-2
New Sunday Sales Permits vs Work-Related Accident Mortality	.34	+1				New Sunday Sales Permits vs Cirrhosis Mortality	.47	-3
Transfer Tavern Licenses vs Work-Related Accident Mortality	.38	+4				New Sunday Sales Permits vs Cirrhosis Mortality	.39	-4
						Transfer Tavern Licenses vs Suicide	.30	0

These findings suggest that, from a public health perspective, prevention of a portion (alcohol-related) of accident mortality might be accomplished through changes in certain licensing actions. It is also clear that, while package and draught beer distribution are more strongly associated with accident mortality than wine or distilled spirits, beer distribution is probably more resistant to influences of licensing activities than other alcoholic beverages. Thus we are faced with a dilemma. The availability of beer is the most strongly related to accident mortality but it is the category of alcoholic beverages least effectively regulated by the state.

4.3 Multivariate Analyses

Stepwise multiple regression analyses were conducted for a large number of potentially interacting sets of variables, primarily with Michigan statewide data. This discussion includes the conceptual structure of the models and the results of several of the analyses.

4.3.1 Introduction and Conceptual Models. One of the basic assumptions of this study has been that because the relationships between alcohol consumption, alcohol distribution, licensing activities, and the incidence of alcohol-related problems are enormously complex, an equally complex approach to an understanding of the variables is necessary. Multivariate analysis is one means of addressing the complexities of the problem. Multiple stepwise regression analysis was used to identify potentially useful models which order a set of independent variables (predictors) regarding a single dependent variable.

The Conceptual Framework of the Regression Analysis

Consumption. A function of licensing activities of Michigan Liquor Control Commission where consumption is defined as monthly distribution of Packaged Beer, Draught Beer, Wine, or Table Top Sales Distilled Spirits; licensing activities include frequencies of New SDD, SDM, Class C, Tavern, Club and Hotel licenses, frequencies of New Dance Permits, Entertainment Permits, Sunday Sales Permits, and Transfers of SDD, SDM, Class C, Hotel licenses and Transfers of Tavern to Class C licenses.

Social/Health Problems. A function of consumption where the dependent variables were monthly frequencies of Traffic Accident Mortality, Assault incidence, Suicide mortality and other social and health problems; consumption included monthly distribution volumes of packaged and draught beer, wine, and table top sales of distilled spirits.

Statewide data were used because beer and wine data were not available at the county level. Package sales of distilled spirits were

Table 4.3.2.1

Results of Stepwise Multiple Regression Analysis -
Prediction Model for Packaged Beer

Dependent Variable: Package Beer Distribution   N = 90

Candidate Independent Variables:

New SDD	Dance Permit
SDM	Entertainment Permit
C	Sunday Sales Permit
Tavern	Transfers SDD
Club	SDM
Hotel	C
	Hotel
	Tavern to C

Summary of Analysis

Analysis Step	R^2	Variable	Contributed Partial R	Significance
1	.10	Transfer of Tavern	-.32	.00
2	.17	New SDM	.27	.01
3	.21	Transfer of SDD	.22	.04
4	.24	New Tavern	.1%	.07

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Table 4.3.2.2

Results of Stepwise Multiple Regression Analysis -
Prediction Model for Draught Beer

Dependent Variable: Draught Beer Distribution   N = 90

Candidate Independent Variables:

New SDD	Dance Permit
SDM	Entertainment Permit
C	Sunday Sales Permit
Tavern	Transfers SDD
Club	SDM
Hotel	C
	Hotel
	Tavern to C

Summary of Analysis

Analysis Step	R^2	Variable	Contributed Partial R	Significance
1	.08	New C	.29	.00
2	.13	New Club	.27	.01
3	.20	New SDM	.24	.03

Table 4.3.2.3

Results of Stepwise Multiple Regression Analysis -
Prediction Model for Wine

Dependent Variable: Wine Distribution   N = 89

Candidate Independent Variables:

New SDD	Dance Permit
SDM	Entertainment Permit
C	Sunday Sales Permit
Tavern	Transfers SDD
Club	SDM
Hotel	C
	Hotel
	Tavern to C

Summary of Analysis

Analysis Step	R^2	Variable	Contributed Partial R	Significance
1	.26	New Tavern	-.51	.00
2	.38	New C	.40	.00
3	.45	New SDD	.34	.00
4	.49	New Entertainment Permit	-.27	.01
5	.54	New Dance Permit	.30	.01
6	.56	New SDM	-.23	.03
7	.58	New Sunday Sales Permit	-.21	.06
8	.61	Transfer of C License	.26	.02

unavailable at monthly intervals providing insufficient degrees of freedom for the statistical procedures.

The most important models which emerged from the analyses are discussed below. The general form of a multiple stepwise regression model is

$$Y = a + b_1 x_1 + b_2 x_2, \ldots, + b_i x_i + e$$

in which the order of inclusion of the independent variables into the equation is a function of each independent variable's unique contribution to the multiple correlation coefficient, which is the variance explained, expressed as R^2. At each step of the analysis the partial correlation coefficient for all terms not included are computed and the largest (with included variables held constant) are identified. Thus at step 1 all indepdent variables are candidates, then at each subsequent step fewer variables can be considered for inclusion. The process continues until additional variables fail to produce a statistically significant improvement in the model.

4.3.2 <u>Results of Multiple Regression Analyses</u>. Tables 4.3.2.1 - 4.3.2.3 display the models derived for three kinds of alcoholic beverage distribution with licensing action variables as the independent variables. The first model, with packaged beer as the dependent variable, indicates that package beer distribution is associated with licensing activities affecting tavern licensees and package sales outlets (see Table 4.3.2.1). It is useful to note that the majority of SDD licenses also hold SDM licenses which is probably a source of duplication in this analysis. Twenty-four percent of the variance of package beer sales volumes is explained by frequencies of transfers and new tavern licenses, new SDM, and transferred SDD licenses.

Draught beer distribution (Table 4.3.2.2) was predicted first by new class C licenses, which is expected because most draught beer is for consumption on premise. Other predicting variables included new Club and new SDM licenses. The variance explained was 20%.

Wine distribution (Table 4.3.2.3) proved to be affected by a large number of licensing activities and 61% of the variance was explained with a model including eight independent variables. In Michigan, wine is almost exclusively sold in bottle form and therefore is a common commodity for most varieties of licenses in the state. It is unusual to find a model, however, which explains such a large proportion of the variance and it suggests that wine distribution may be vulnerable to changes in licensing and regulatory activities.

Table top distilled spirits distribution was not modeled with the licensing variables in this analysis, a curiosity in that the cross-correlation analyses did identify a time-ordered relationship between table top sales and certain licensing actions. These models of the relationships between alcoholic beverage distribution and licensing activities do not simultaneously include other potential explanatory variables such as population growth and economic variables. It would be essential to replicate the analyses at county level to fully under-stand the influences of different population bases and other exogenous variables.

Two models relating health and social problem incidence with beverage alcohol distribution (by category) emerged as worthy of mention. Tables 4.2.3.4 and 4.2.3.5 identify wine, package beer and table top distilled spirits as being predictive of 24% of the variance of total traffic accident mortality, and package and draught beer predicting 35% of the variance of frequency of assult. When viewed in light of the results of the cross-correlation analyses it is unclear why draught beer failed to enter the model for traffic accident mortality. On the other hand, the dominance of beer distribution in the cross-correlation tests is supported in the multiple regression model for frequency of assault.

4.3.3 Discussion of Multiple Regression Analyses. Multiple regression analysis is a convenient means of identifying sets of pre-dictive models within the limits of a given data set. Only the variables in the data set, of course, are eligible to be included in the analyses and often the quality of measurement of each variable is the most

Table 4.3.2.4

Results of Stepwise Multiple Regression Analysis

Dependent Variable: Traffic Accident Mortality   N = 60

Candidate Independent Variables:

> Package Beer Distribution
> Draught Beer Distribution
> Wine Distribution
> Table Top Spirits Sales

Summary of Analysis

Analysis Step	R^2	Variable	Contributed Partial R	Significance
1	.12	Wine	.35	.01
2	.19	Package Beer	.27	.04
3	.24	Table Top Spirits	.25	.05

Table 4.3.2.5

Results of Stepwise Multiple Regression Analysis

Dependent Variable: Assault Frequency (statewide)   N = 24

Candidate Independent Variables:

        Package Beer Distribution
        Draught Beer Distribution
        Wine Distribution
        Table Top Spirits Sales

Summary of Analysis

Analysis Step	R^2	Variable	Contributed Partial R	Significance
1	.16	Package Beer	.40	.05
2	.35	Draught Beer	-.47	.02

important factor regarding the resulting models. The technique is useful in suggesting relationships which deserve further study and eliminating potential models which are not as likely to be important in terms of understanding the multivariable phenomena of inquiry. Five models were identified using multiple stepwise regression analysis which suggest that certain sets of licensing activities may have a direct relationship with beer and wine distribution. Regression models did not confirm this relationship for distilled spirits which was suggested in the cross-correlation analysis. The models for package and draught beer conflict with the absence of relatively significant cross-correlation results of beer distribution and singular licensing activity frequencies.

The model developed for wine is characterized by fairly large partial contributions for each of the eight predictor variables. The individual contributions of independent variables to the beer models, on the other hand, are quite small. These differences in partial contributions are most likely to explain why the cross-correlation analyses clearly indicated that wine was strongly associated with categories of licensing activity, which is supported with the multiple regression analyses, and apparently conflicting results emerged regarding package and draught beer. We have no explanation regarding the absence of a multivariate model for table top sales distilled spirits while such a model would be expected on the basis of the cross-correlation analyses.

No multiple regression models emerged that would suggest conflicting findings regarding the relationships of beverage distribution and health/social problem incidence. Two models, for traffic accident mortality and assault, were presented which suggest a role for beer, wine and distilled spirits distribution in the social etiology of these problems. They are consonant with the findings of the cross-correlation analyses in which "acute" problems rather than "chronic" problem incidence was found to be most probably associated with alcohol beverage distribution. No multiple regression models emerged for any of the more chronic social or health problems.

5. CONCLUSIONS AND DISCUSSION

In many respects this study has been exploratory. Regarding hypothesis testing, the clear intention was to clarify potentially testable hypotheses as well as to raise new research issues from which new hypotheses might be developed in the future. Also exploratory were our many efforts to find and utilize data resources which might aid in the research process; in a practical sense we suspect that, in the short run, our discoveries of widespread data collection and the strengths and weaknesses of those data will have the largest benefit to the State of Michigan.

Analyses of several data sets were designed to provide empirical guidance for future, more definitive, research regarding the fundamental relationships between beverage alcohol availability, consumption and distribution, and alcohol-related morbidity, mortality and social problems. In each of the analyses both design and data restrictions were significant and the results should be viewed as suggestive regarding the continuing study of the phenemenon or for policy development.

5.1 Data Availability for Research Analysis

The major strength with regard to data on alcohol availability, consumption, and social and health problems is that in Michigan a variety of systems exist that collect data relevant to alcohol availability, consumption and alcohol-related social and health problems. The Office of Vital and Health Statistics routinely processes data on a wide variety of causes of death and on other social problems (such as divorce) which are potentially related to alcohol availability and consumption. These data are easily accessible in machine readable format facilitating their use for research and monitoring efforts. Similarly the Liquor Control Commission maintains a large dataset that

is potentially relevant to public health policy monitoring and evaluation. Other state or local government units, such as the Department of Social Services, and the Michigan Department of State Police, keep regular records that are useful for monitoring the impacts of public policy on alcohol-related problems. These existing data collection systems could be effectively used to compile a continually up-dated data file. This file would be appropriate to monitor the effect of a wide variety of state policy changes on alcohol availability, consumption and social and health problems. If the existing data resources are to be fully exploited for the purpose of policy evaluation, significant deficiencies in the quality and comprehensiveness of data collected should be corrected. These deficiencies are discussed below.

5.1.1 Michigan Liquor Control Commission Data. The daily summaries of recorded actions of the Liquor Control Commission constitute a rich resource for research into the nature and effects of availability in Michigan. From these summaries, monthly totals of the entire range of licensing activities of the commission were coded for each county. These data provided the opportunity for carrying out a detailed descriptive analyses, both in comparing individual county jurisdictions at single points in time, and in tracing the dynamic processes of increasing availability over the time period of 1970 to 1977.

Unfortunately, other forms of data acquired from the Commission were considerably less comprehensive, and in some cases, missing or inadequate. Our efforts to test hypotheses relating licensing actions to patterns of alcohol distribution were seriously hampered by the inadequacies of alcohol distribution data that are presently available; the problem is most disturbing in the case of beer and wine, which are not monitored by the Commission.

We conclude in 6.4 below that the alcoholic beverage categories that are most likely to be associated with the frequency of alcohol-

related social problems are draught and packaged beer. In view of this fact, and in light of the statistical evidence showing a long-run increase in the proportion of total alcohol consumption accounted for by beer, we feel that the present state of information concerning the patterns of consumption of this extremely popular beverage is seriously inadequate. The data on beer and wine consumption employed in this study were generously provided by the Michigan Beer and Wine Wholesaler's Association. These data included statewide aggregations of both draught and packaged beer, and wine. The Liquor Control Commission at the present time keeps no regular data on the distribution of beer or wine in the state, and we find this to be a serious omission that not only limits the effectiveness of the Commission in fulfilling its mandated responsibilities, but makes certain further research, at the level of county or region, impossible.

The recording of data on the sale of distilled spirits, both by the bottle (SDD) and for sale by the glass (table-top) is undertaken by the Liquor Control Commission as the liquor is dispensed by the Commission's state stores. The problems encountered with these data are two-fold. First, are the inadequacies of the records in attempting any kind of systematic comparative analysis of the relationship between availability and consumption. Data on packaged distilled spirits sales were available for the separate counties, but only at yearly intervals. Monthly table-top sales figures were available, but were restricted to the statewide level. One can easily envision the difficulty in matching such data sets that are stratified across time or by jurisdiction, but not both. The incompatibility of the separate data sets along common dimensions of time and jurisdiction resulted in a large reduction in the number of cases that were available for analyses, with consequent reductions in the confidence one can place in the analytic results.

Secondly, we must question the validity of recorded sales of distilled spirits at state liquor stores as a measure of a county's consumption. The procedure of recording of all sales of spirits at a

particular state store as being for retail sale at establishments with-
in the same county injects an unknown amount of error in the measure of
county-specific consumption. This error follows from the fact that not
all spirits purchases at state stores in a particular county are
necessarily consumed within that county, since the raw sales figure is
all that is recorded, rather than the county in which the proprietor
who makes the purchase operates. As a unit of analysis, the state
liquor store is not the most appropriate for the recording of data on
spirits distributions.

Finally, we repeat a statement from Section 3.1, where it was
pointed out that the actual density of establishments of a particular
category at any point in time was not readily available for the sepa-
rate counties. In its place, estimates based on cumulative totals of
new license issuance were used, as detailed in 3.1. The problem with
these estimates was that they were unable to account for the attrition
of active licenses, through expiration, relocation, or revocation.
Thus the estimates tended to overstate the number of currently active
licenses in a given area.

In light of the preliminary evidence concerning the effect of
variations in availability on the distribution of alcoholic beverages,
we submit that the growth of retail outlets merits better accounting.
While precise information concerning the number of outlets in a given
county represents only a first approximation of retail availability,
it is one that any minimally acceptable criteria for assessing avail-
ability would demand. We therefore recommend that the number of cur-
rently active licenses and permits of all types in the separate counties
be recorded monthly by the Liquor Control Commission, so that com-
parisons across time of availability be made on the basis of timely and
accurate information.

5.1.2 Vital and Health Statistics. The major problem of the mor-
tality statistics collected by the Office of Vital and Health Statistics
is the extremely poor documentation of the role of alcohol in most

reported deaths. The role of alcohol should be considered to be a
potential contributing factor in mortality by coroners and physicians
and those deaths where alcohol is involved should be recorded as such.
The Office of Vital and Health Statistics already records deaths
separately depending upon whether or not alcohol involvement is
mentioned on the death certificate. However, as was discussed in
Section 3.3, apparently physicians or others responsible for submitt-
ing death certificates very rarely mention the alcohol involvement in
cases where the role of alcohol in the death is clearly evident (in
most traffic accident deaths, for example). There is ample evidence
from a large and growing literature that most of the mortality classi-
fications which were used in the present analysis had substantial
portions associated with alcohol abuse, yet only a minute fraction of
any cause of death was designated to be alcohol-related in the data
which were utilized.

    5.1.3 _Social Service Data_. The data on the incidence of child
abuse and neglect provided by the Department of Social Services were of
limited usefulness because of the lack of a consistently used operational
definition of reportable cases of child abuse, as evidenced by the large
variation in reporting levels found among counties and over time.
Furthermore, the recording of "alcohol dependence" as a factor in in-
cidences of child abuse and neglect is not uniform across counties nor,
apparently, among protective service workers. Complete recording across
the state of all child abuse/neglect cases in which alcohol consumption
was a factor, according to a specific operational definition, would pro-
vide useful data for monitoring the effects of alcohol policies on that
portion of child abuse/neglect that is related to alcohol consumption.
These data should be recorded in machine readable format with aggregate
data easily available for analysis.

5.2 _Alcohol Availability and Alcohol Distribution_

    It is apparent that, singularly and in combination, licensing acti-
vities which increase the numbers of licensees and which change the mix

of existing licenses and permits are associated with increased distribution of alcoholic beverages. Wine distribution is the most consistently affected beverage category, followed by draught and packaged beer and distilled spirits sold by the drink. No adequate data were available to test the association of alcohol licensing activities with the distribution of packaged distilled spirits.

Except in combination, licensing activities have a less pronounced effect on beer distribution than on wine or distilled spirits (table-top sales). The relative lack of responsiveness of beer distribution to licensing activity, compared to wine and distilled spirits, might be due to the size of the beer market or the strong seasonal cycles of that market. These conclusions are based on both cross-correlation and multiple regression analyses which, while not always precisely identical, produced results which were in general agreement. It is safe to conclude that the general influence of the Michigan Liquor Control Commission's licensing activities appears to be substantial regarding the volumes of wine and distilled spirits, and to a lesser degree with beer, which are distributed for sale throughout the state.

Other exogenous factors have not been analyzed which might contribute to a more thorough understanding of the association of licensing and distribution. Population changes and economic variations, which were not tested, in part because certain county level data were unavailable as described in Section 6.2.1 above. We do not believe that the statistical associations relating availability and distribution would be totally negated with the inclusion of appropriate test variables (population, economic growth, etc.), however, this is somewhat speculative and suggests that further research is required.

Another set of analyses investigated the predictability of alcoholic beverage distribution as a time-ordered process. Utilizing additive time-series models it was found that alcohol distribution, over time, is highly regular and predictable. Draught beer distribution is remarkably consistent with stable and dominant seasonal cycles. The time-series models of wine and distilled spirits demonstrated relatively less seasonal

dominance, yet linear trend (growth) was stable and predictable. These findings are of importance because such stability in the data on beverage distribution accommodates analytic requirements to evaluate the impact of specific changes in licensing rules and regulations on the distribution of alcoholic beverages. The relative effectiveness of legal, regulatory or administrative changes can be evaluated if it is possible to predict beverage distribution into the future with reasonable confidence. It is very clear that highly accurate predictions of beer, wine and distilled spirits distribution levels can be made with straightforward time-series modelling. Therefore rigorous and scientifically satisfactory impact analyses are feasible.

5.3 Alcohol Distribution and the Frequency of Health and Social Problems

Certain categories of beverage alcohol distribution are associated with increases in the frequency of specific acute health and social problems. Distribution of package and draught beer are associated jointly with licensing and certain mortality frequencies. While not definitive, these associations support the hypotheses that licensing (availability) is associated with consumption (beverage distribution) which directly results in certain increases in specific kinds of social and health problems. Much more analysis, however, is required before a full understanding of these relationships is known.

All categories of accidental mortality were found to be consistently associated with several kinds of licensing and permit actions by the Liquor Control Commission. Neither the consistency nor the strength of statistical associations were found between most other social and health problems and licensing and regulatory activities. Total accident mortality, occupational accident mortality and traffic accident deaths were consistently related to beer distribution in both package and draught categories. Traffic accident mortality is predicted by liquor sales by the glass, wine and beer distribution. In addition draught beer is associated with homicide mortality and assault frequency is predicted by draught and package beer distribution.

In general the more acute (from our set of mortality, morbidity and frequency of reported social problems) social or health problems are predicted better by alcohol distribution than "chronic" problems such as cirrhosis mortality, suicide, divorce or reported child abuse, where "chronic" refers to problems with long, time-ordered, and complex etilogies.

Two remarks should be made in interpreting these results. First, we note that variations in beer consumption were, by a large margin, dominant in explaining subsequent variation in the incidence of social problems. The seasonal variation in beer consumption was examined in Section 4.1, where it was found that the seasonal and trend components accounted for nearly all of the fluctuations in consumption that were observed. With beer consumption also having such a pronounced seasonal pattern when plotted against time, we must be aware that to the extent that other, causally unrelated variables covary with time, they will appear to be related to beer consumption. Secondly, the finding that chronic problems do not covary greatly with aggregate consumption need not mean that the two are independent - it may simply indicate that they are tied together in a more complicated way.

These analyses refer to one jurisdiction and the dynamics, mostly increases, in beverage distribution and reported frequency-of-events over time. The limitations of our analyses, therefore do not preclude the validity of findings which are based on comparative analyses of different jurisdictions and the effects of different kinds and levels of availability and alcohol distribution on the public health. Such a finding was recently reported by Parker, Wolz and Harford (1978)* regarding the limits of the number of sales outlet effects of population based on alcoholism rates. The authors concluded that "alcohol availablity should become a public health issue"; a conclusion that is supported by our analyses of Michigan data.

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*Parker, D.W., Wolz, M. and Harford, T. "The Prevention of Alcoholism: An Empirical Report on the Effects of Outlet Availability". Alcoholism: Clinical and Experimental Research, Vol. 2, No. 4, October 1978.

APPENDIX A

TIME-SERIES PLOTS OF SELECTED MICHIGAN ALCOHOL
CONSUMPTION AND DISTRIBUTION OF LICENSING VARIABLES

FIGURE A.1. WHOLESALE DISTILLED SPIRITS SDD SALES (millions of dollars), STATE OF MICHIGAN 1970-1977

Source: Michigan Liquor Control Commission
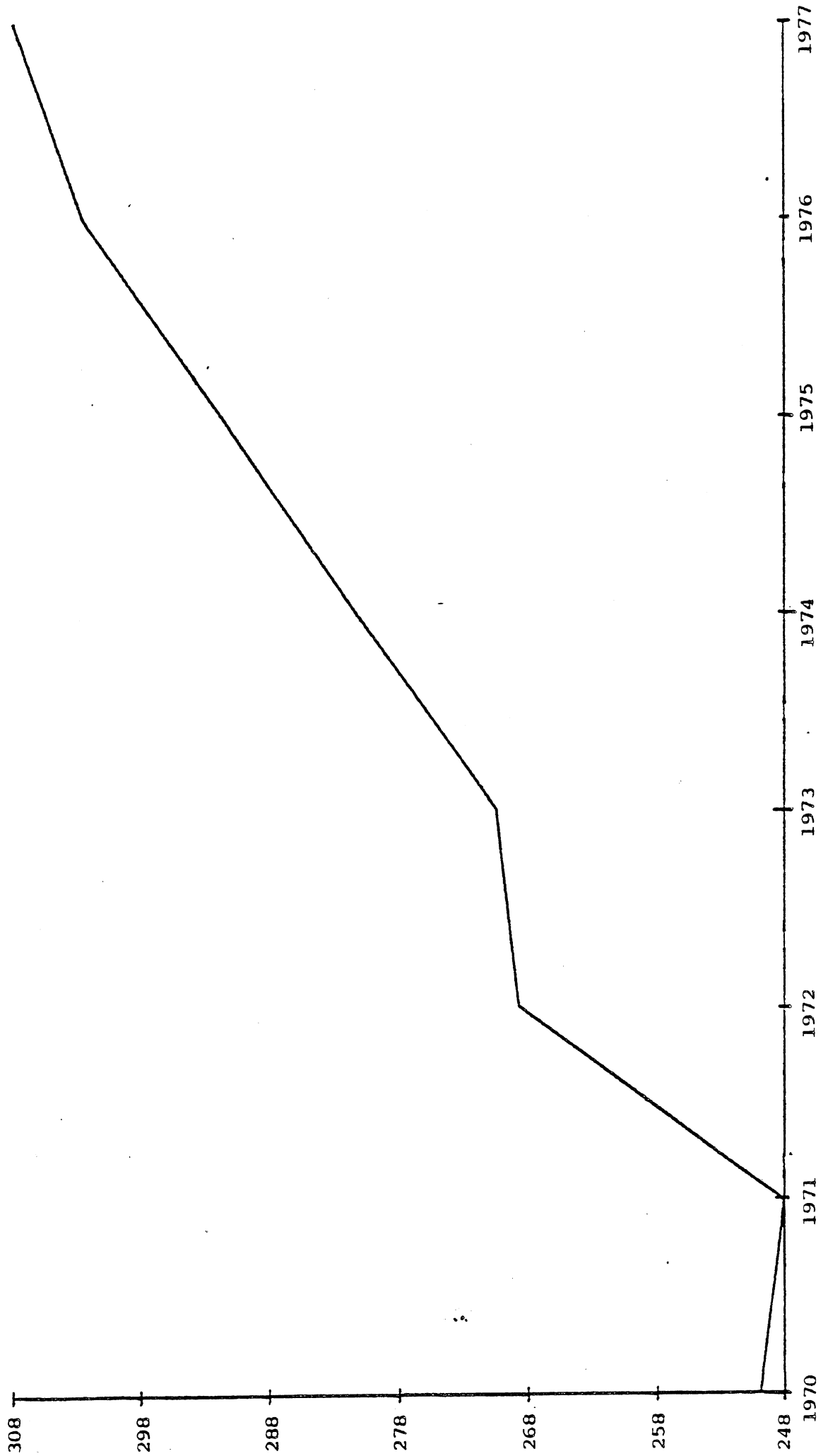
FIGURE A.2. FREQUENCY OF TRANSFER OF CLASS C LICENSES, STATE OF MICHIGAN, 1970-1976
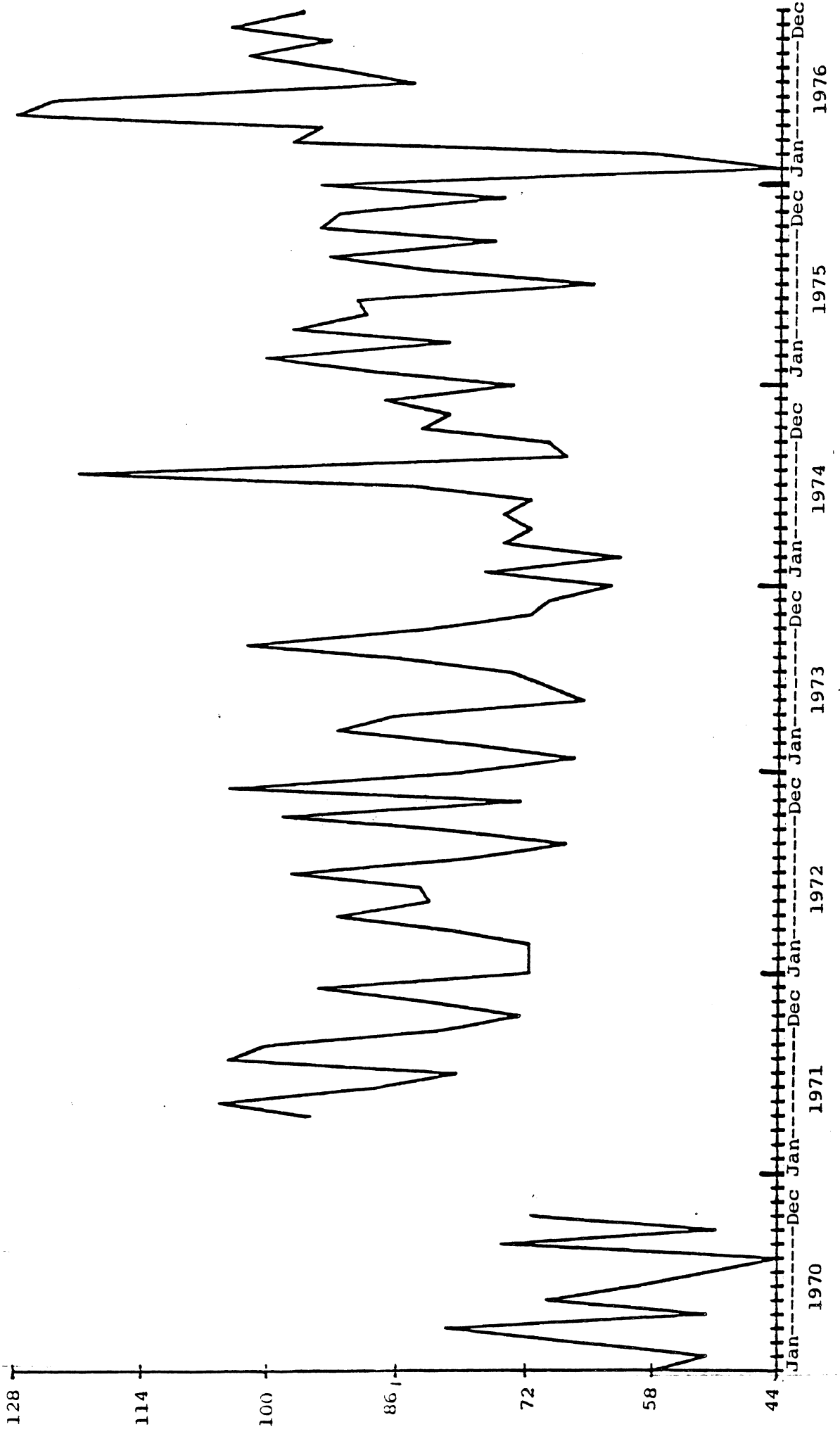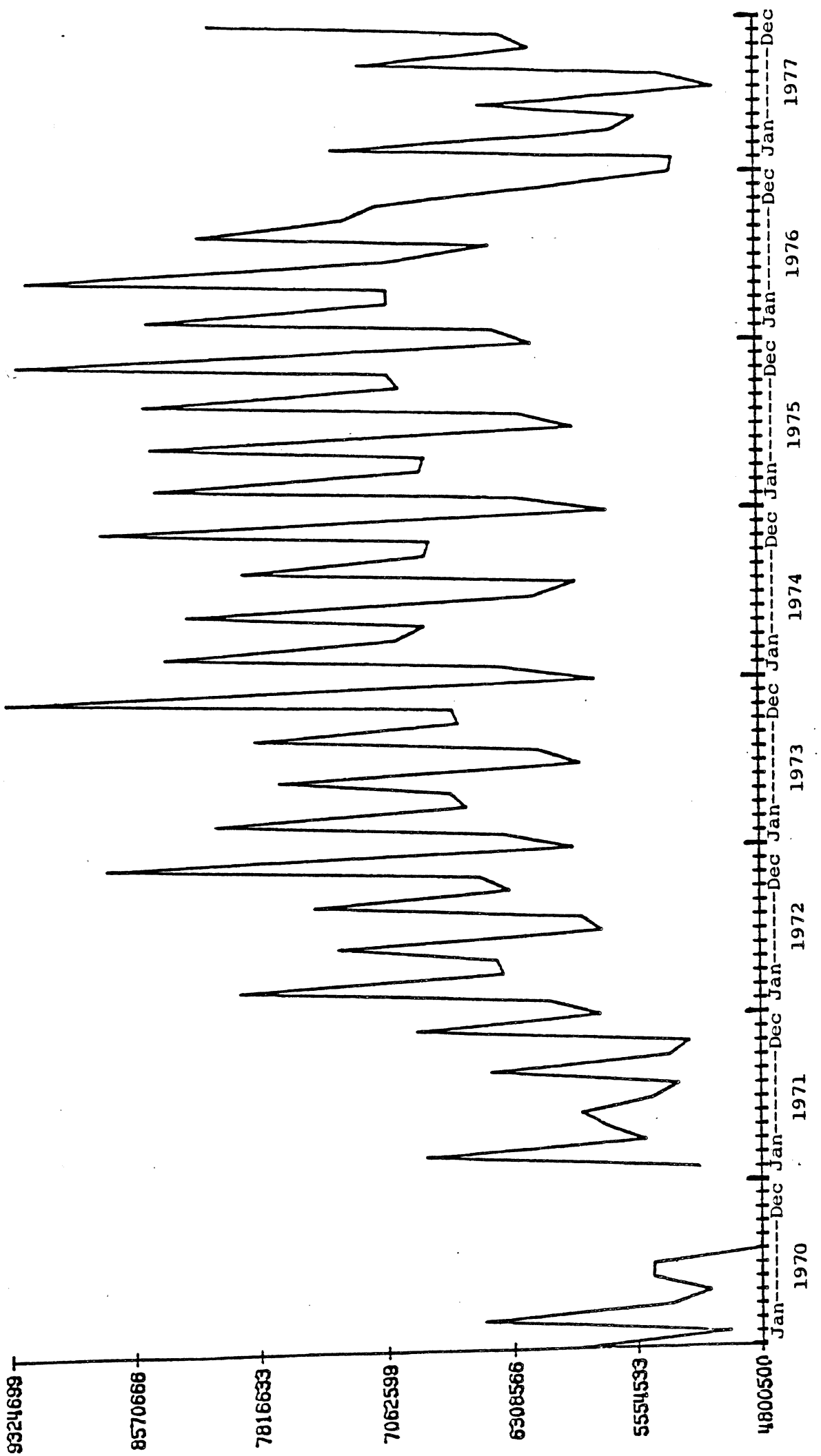
Source: Liquor Control Commission

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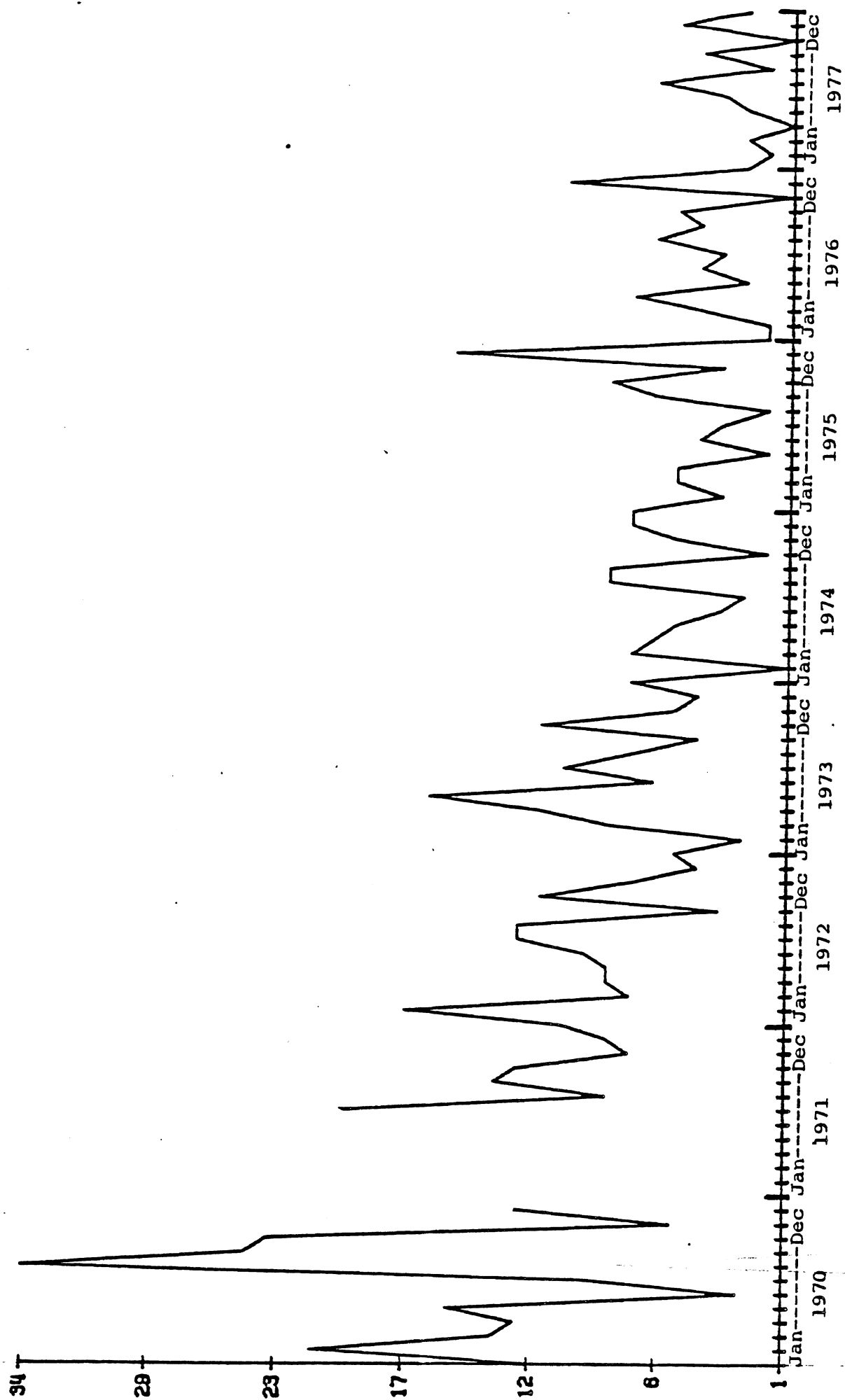FIGURE A.3. WHOLESALE DISTILLED SPIRITS TABLE-TOP SALES (dollars), STATE OF MICHIGAN, 1970-1977

Source: Michigan Liquor Control Commission

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FIGURE A.4. FREQUENCY OF TRANSFER OF TAVERN LICENSES, STATE OF MICHIGAN, 1970-1977

Source: Michigan Liquor Control Commission

FIGURE A.5. FREQUENCY OF NEW SDD LICENSE TRANSACTIONS, STATE OF MICHIGAN, 1970-1977

Source: Michigan Liquor Control Commission

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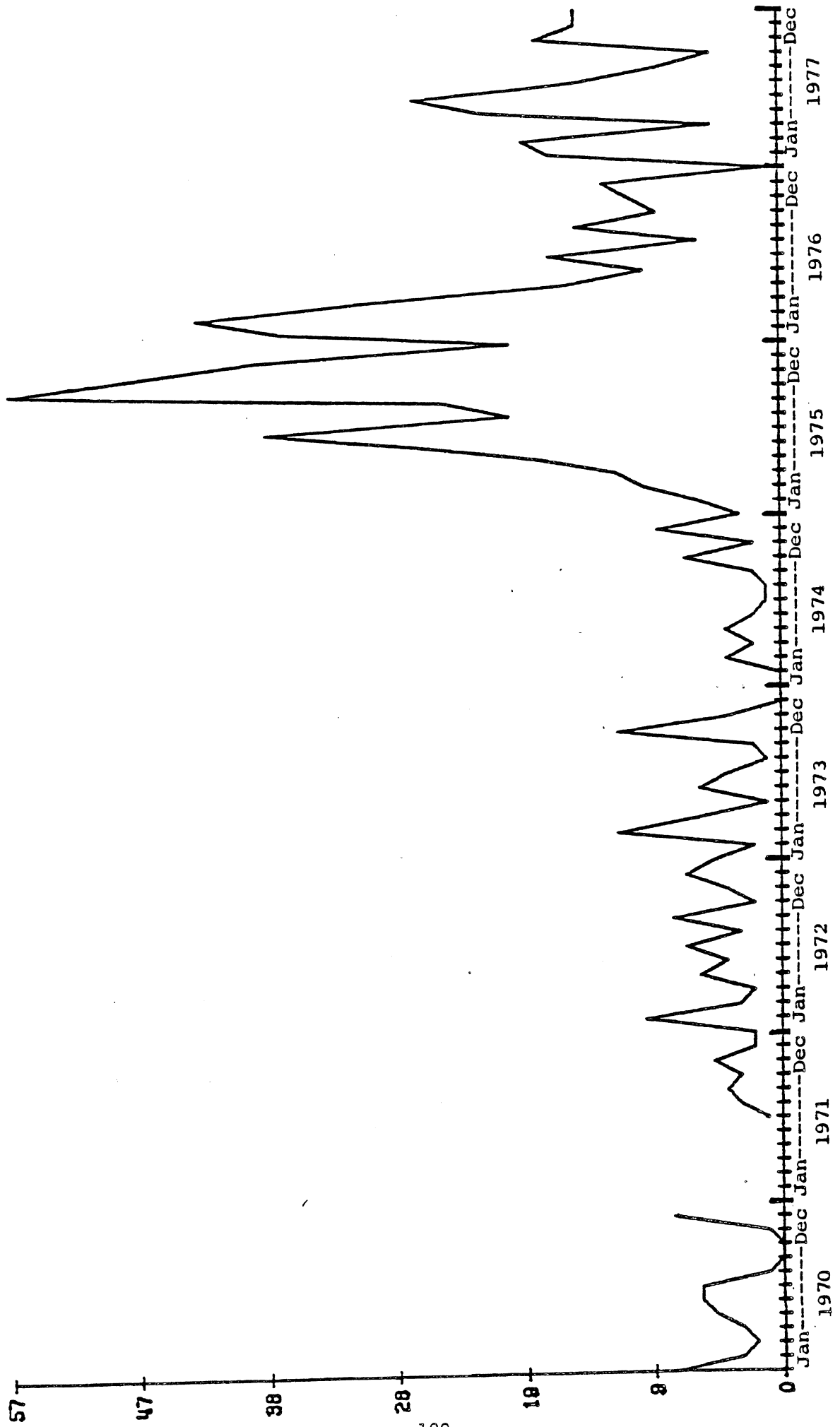
FIGURE A.6. FREQUENCY OF TRANSFER OF SDD LICENSES, STATE OF MICHIGAN, 1970-1977

Source: Michigan Liquor Control Commission

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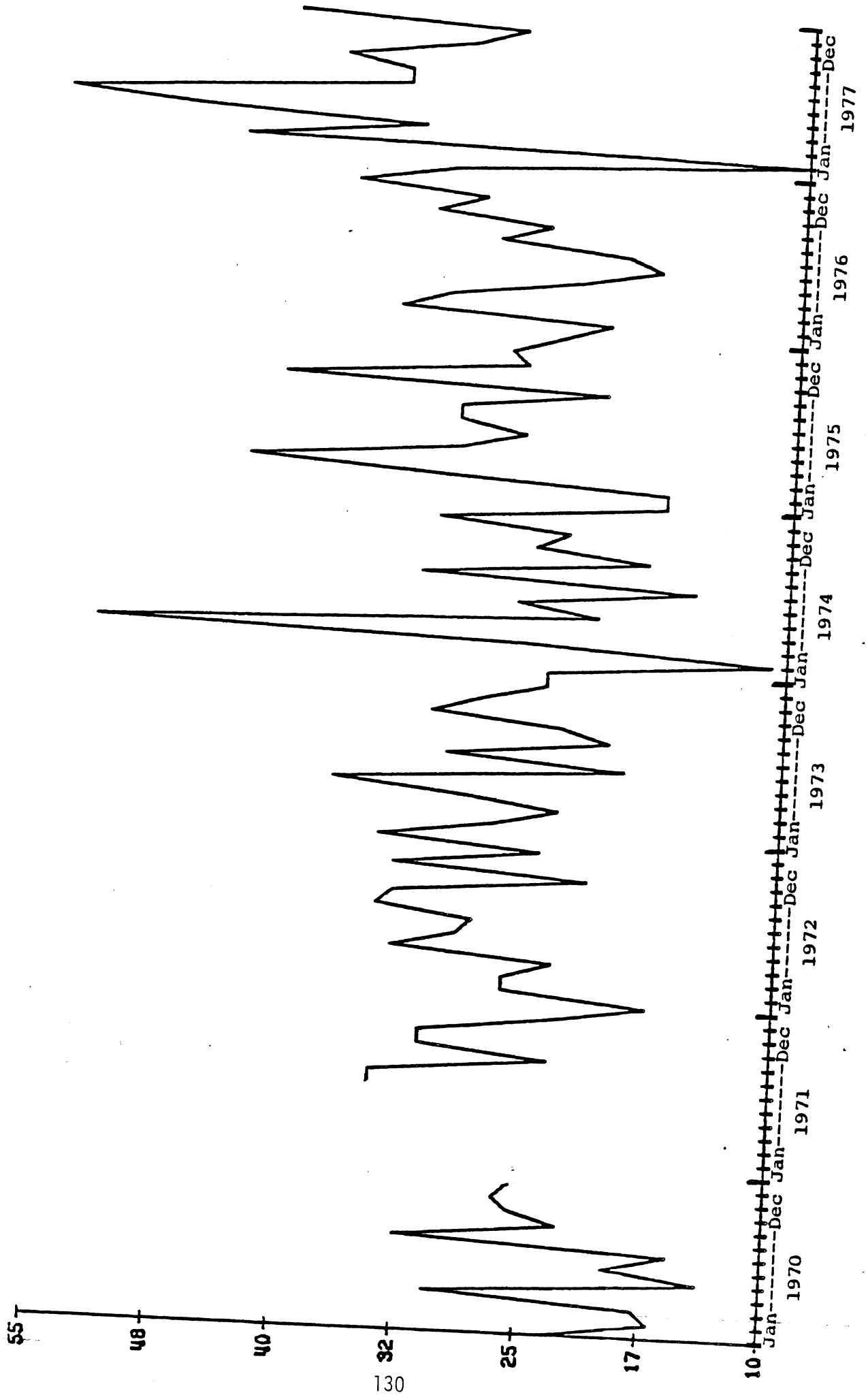
FIGURE A.7. FREQUENCY OF NEW SDM LICENSE TRANSACTIONS, STATE OF MICHIGAN, 1970-1977

Source: Michigan Liquor Control Commission

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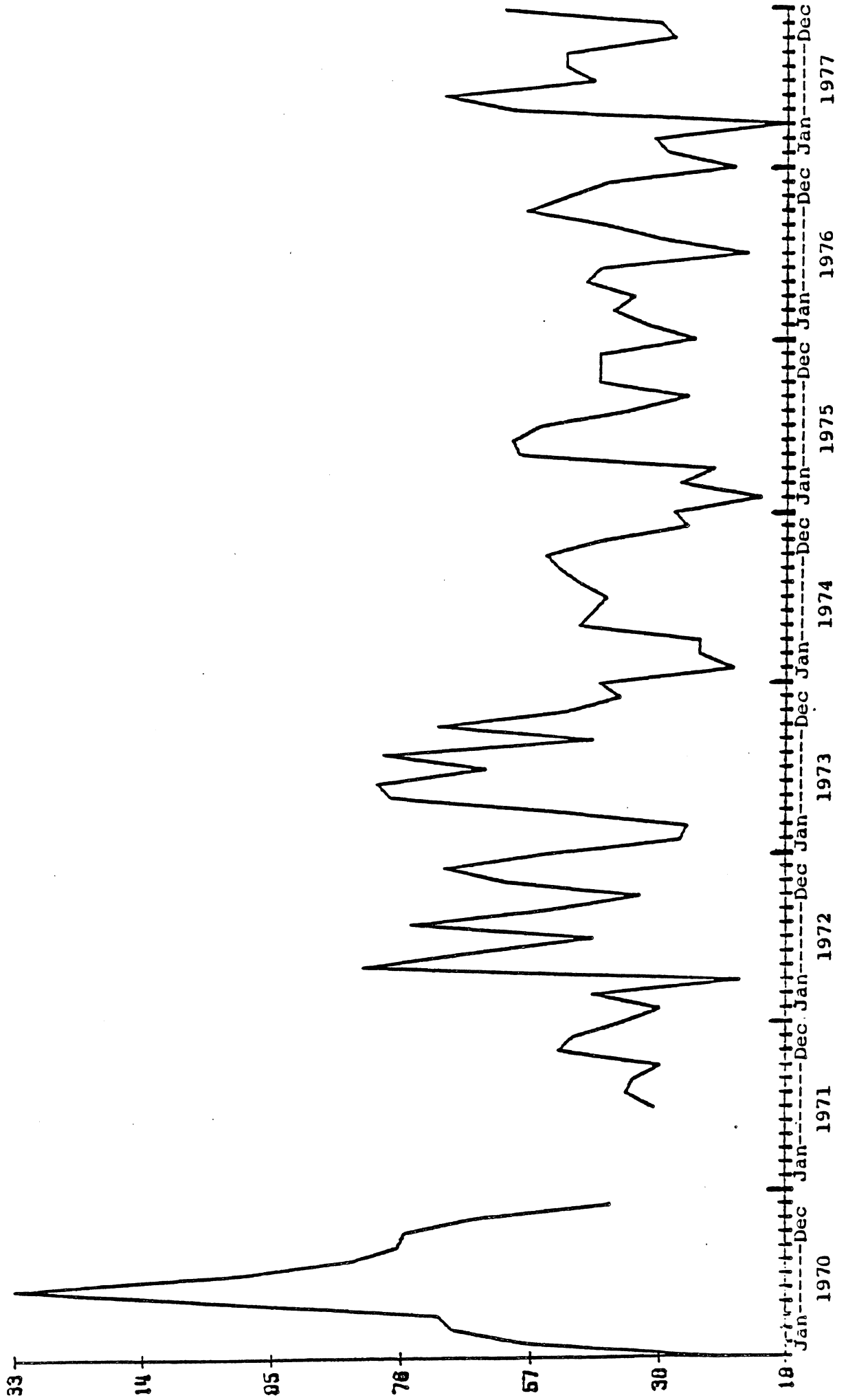
FIGURE A.8. FREQUENCY OF NEW TAVERN LICENSE TRANSACTIONS, STATE OF MICHIGAN, 1970-1977

Source: Michigan Liquor Control Commission

132
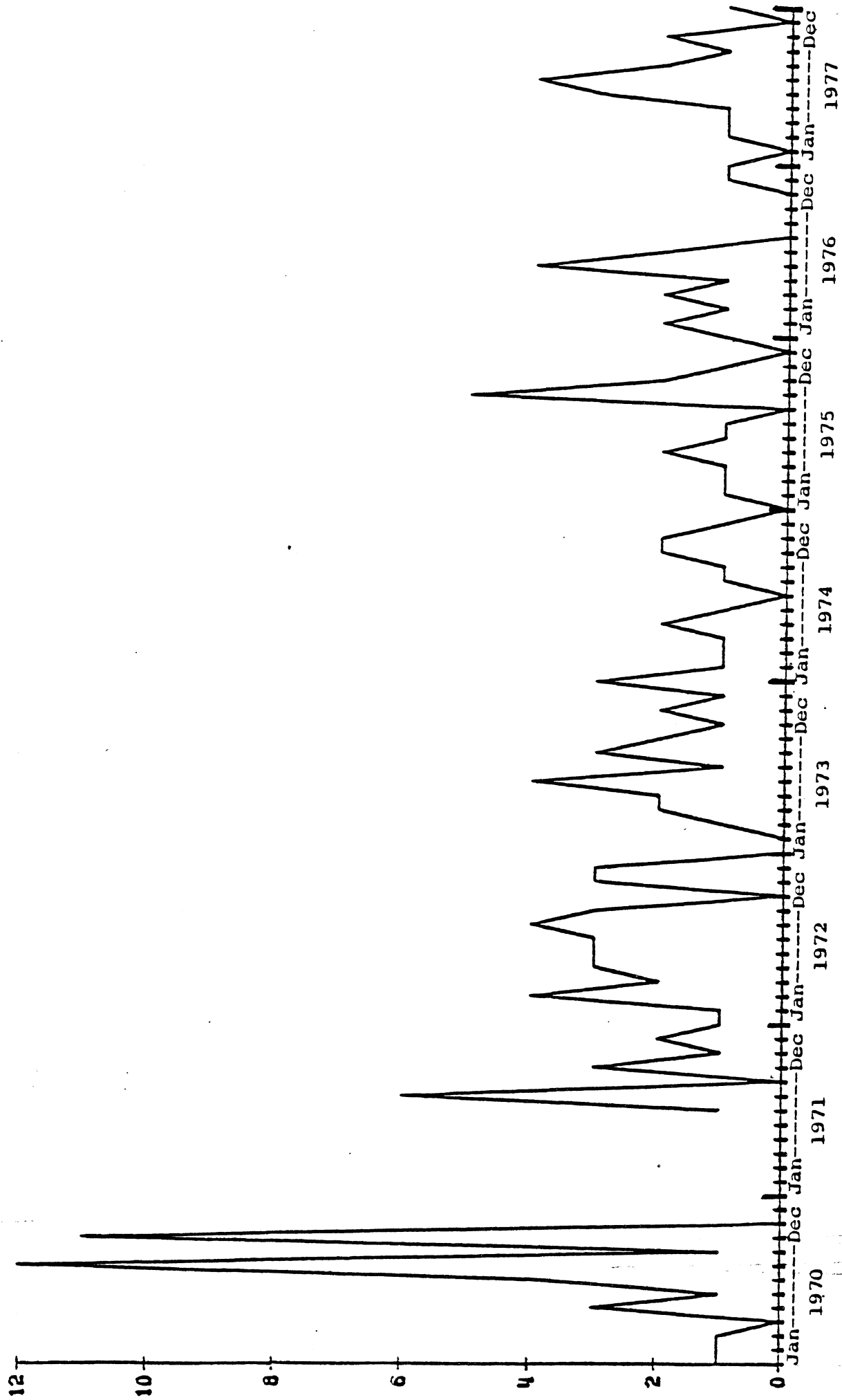
FIGURE A.9. FREQUENCY OF TRANSFER OF SDM LICENSES, STATE OF MICHIGAN, 1970-1977

Source: Michigan Liquor Control Commission

133
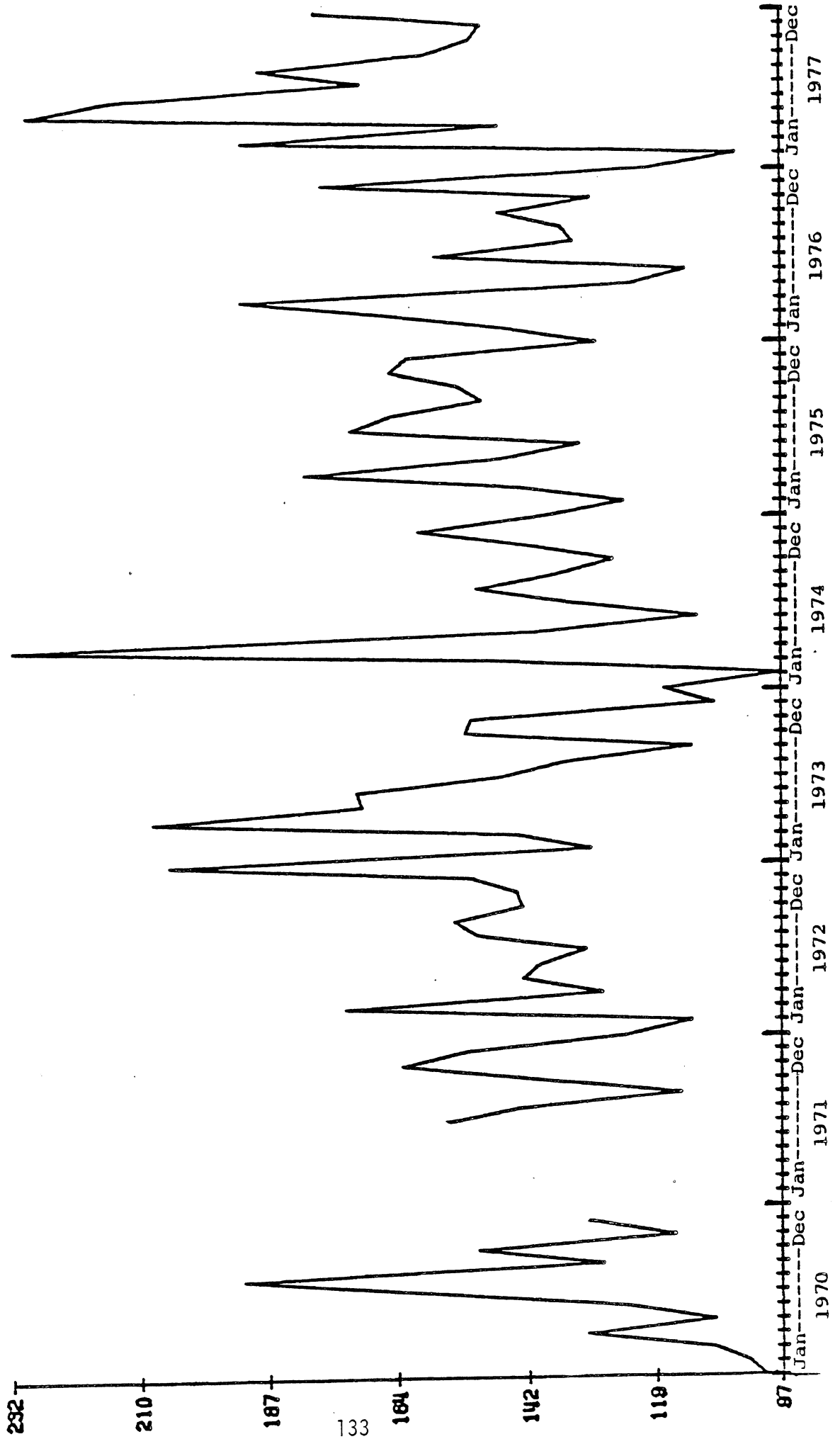
FIGURE A.10. FREQUENCY OF NEW CLASS C LICENSE TRANSACTIONS, STATE OF MICHIGAN, 1970-1977

Source: Michigan Liquor Control Commission

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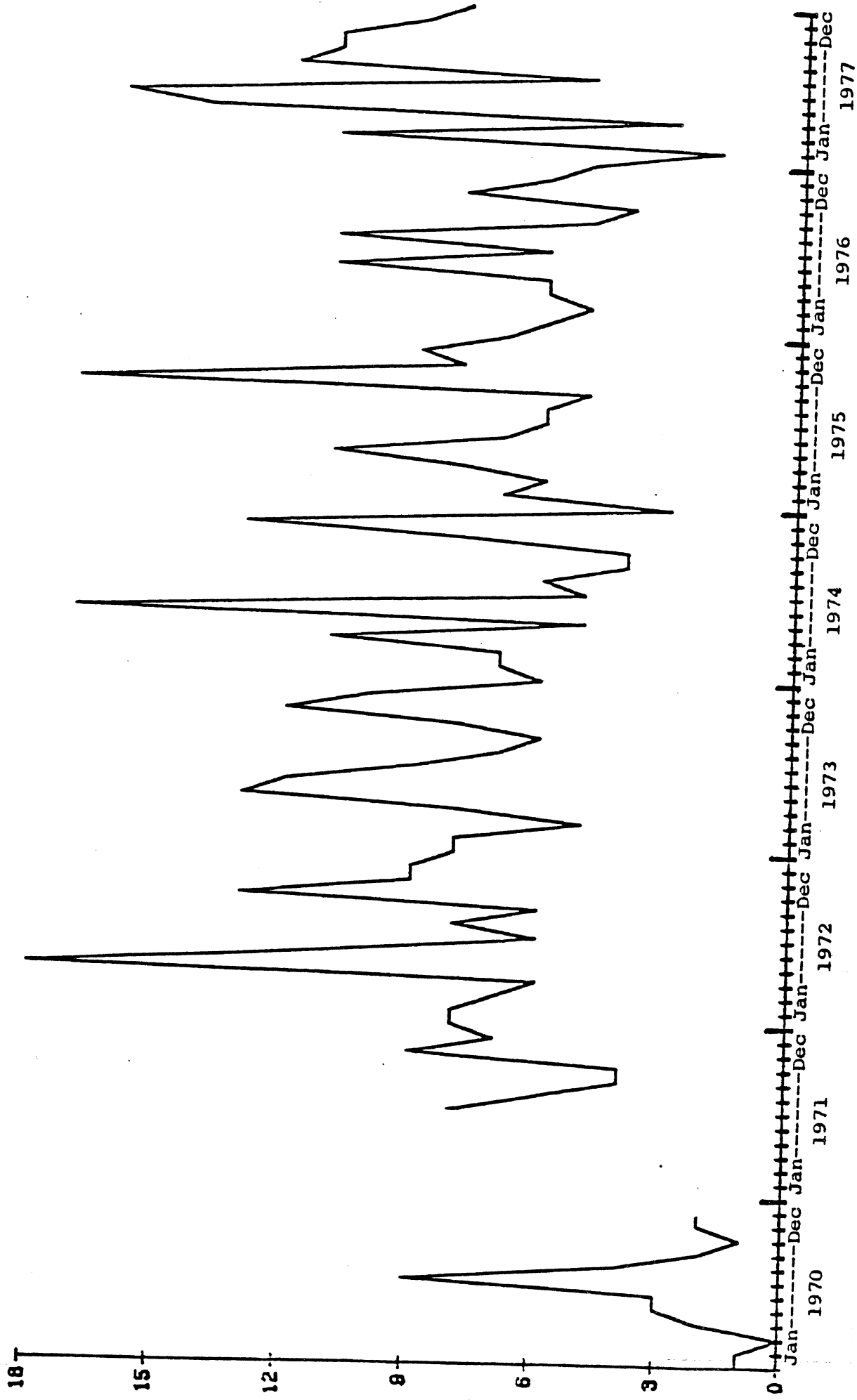
APPENDIX B

TIME-SERIES PLOTS OF SELECTED MICHIGAN HEALTH

AND SOCIAL PROBLEM FREQUENCIES

FIGURE B.1. FREQUENCY OF MURDER AND NON-NEGLIGENT MANSLAUGHTER, STATE OF MICHIGAN 1974-1975

Source: Michigan State Police

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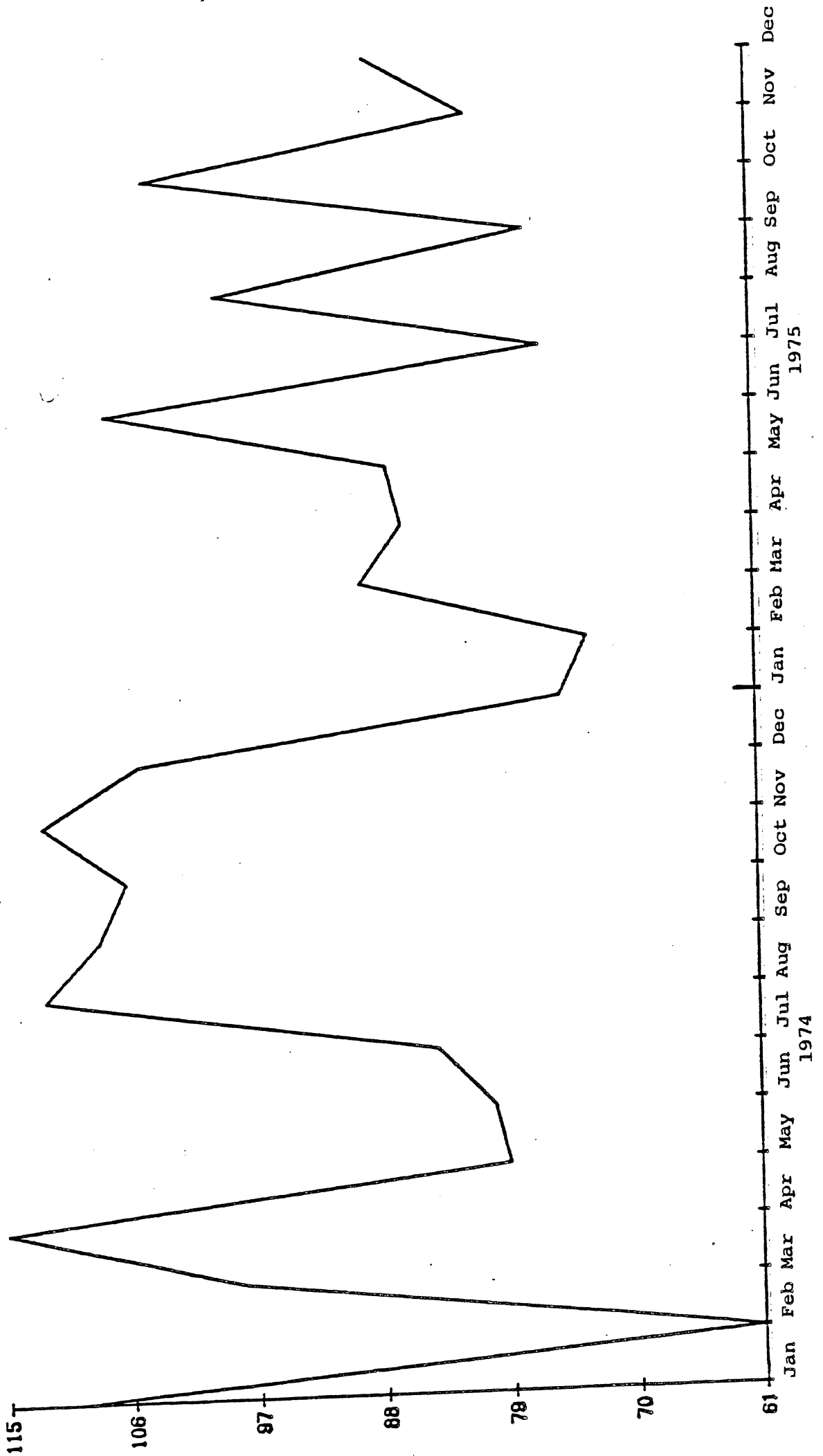
FIGURE B.2. FREQUENCY OF DEATH DUE TO LAENNIC'S CIRRHOSIS, STATE OF MICHIGAN, 1972-1976

Source: Michigan Department of Public Health
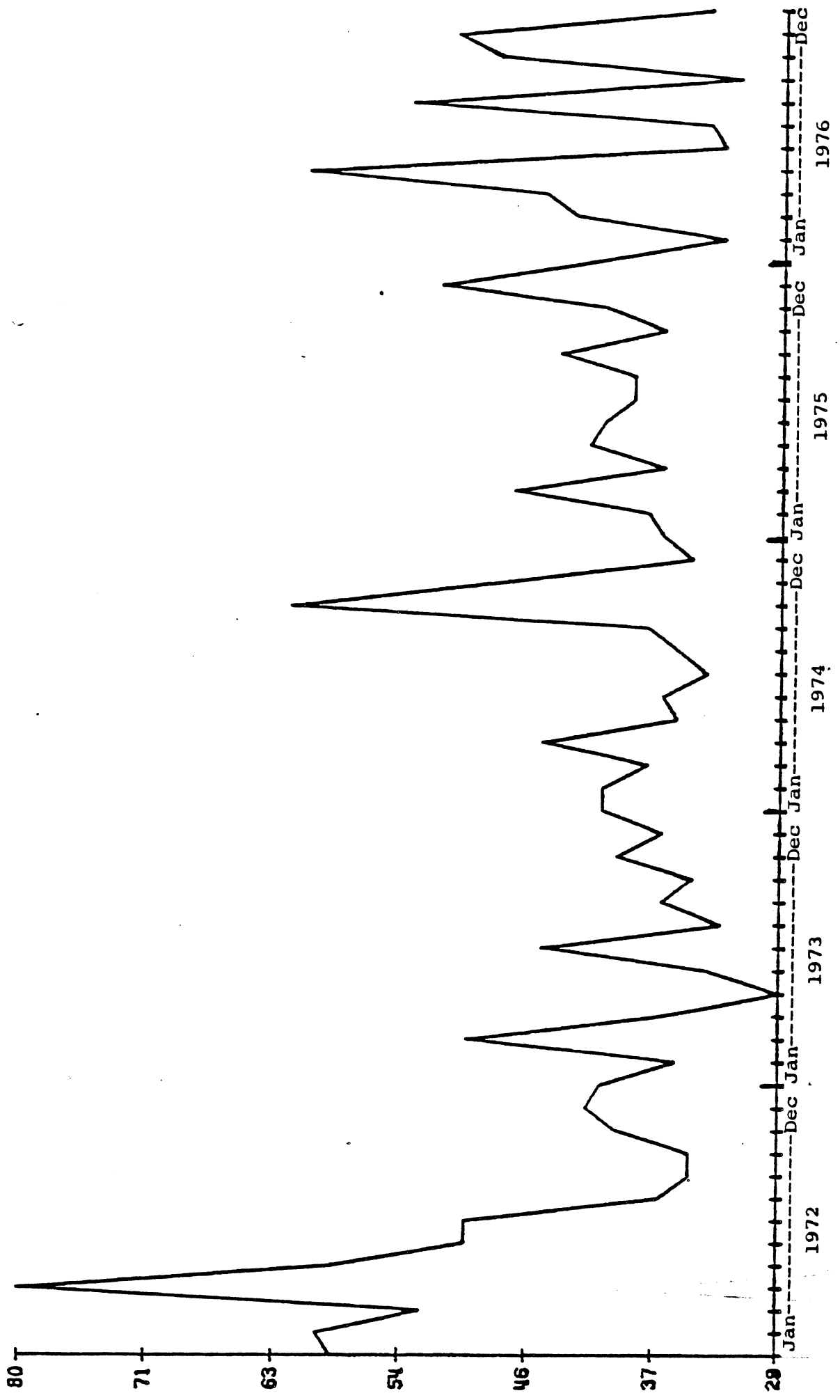
FIGURE B.3.   FREQUENCY OF DEATH DUE TO SUICIDE, STATE OF MICHIGAN, 1972-1976
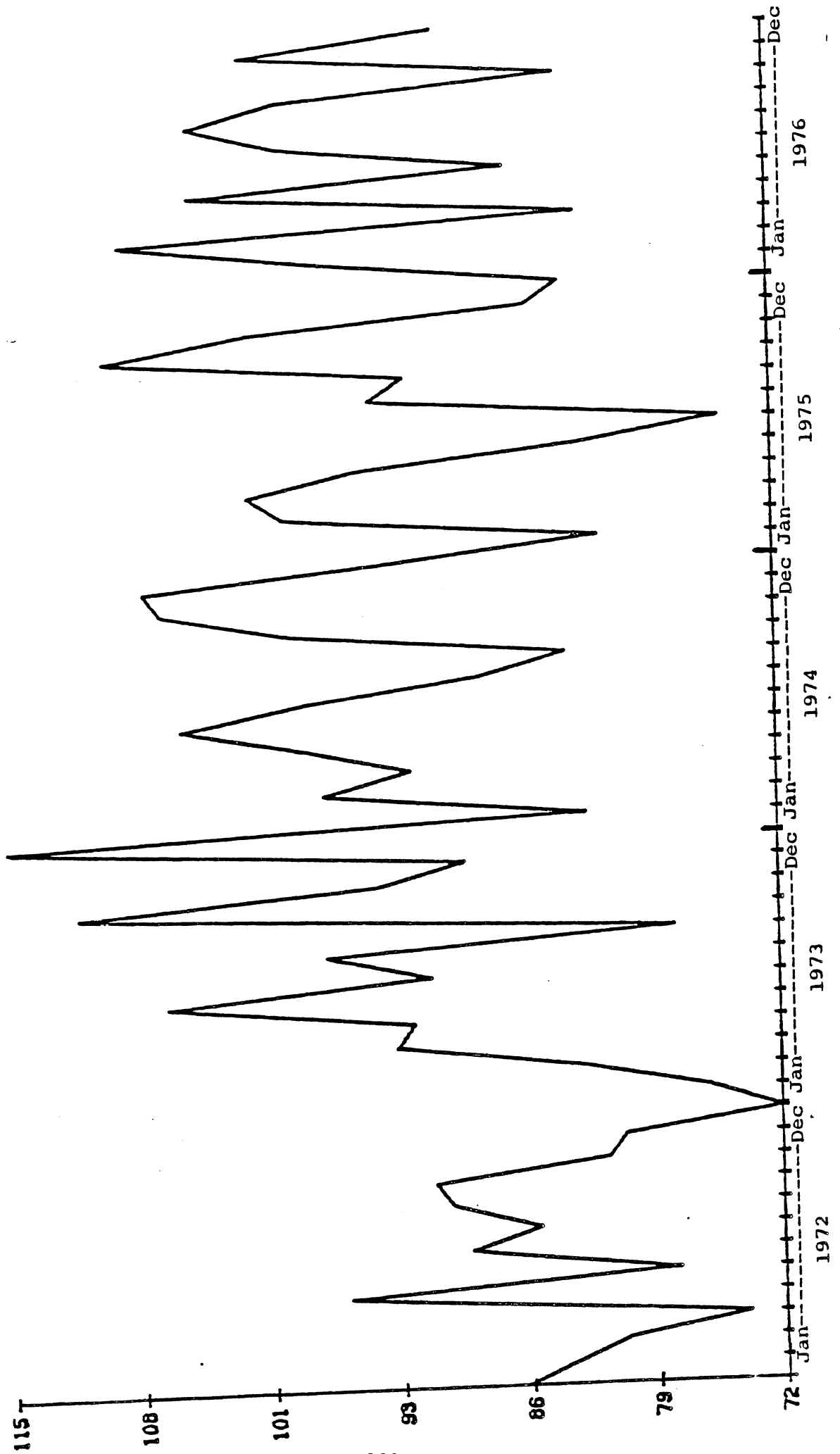
Source: Michigan Department of Public Health

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FIGURE B.4. FREQUENCY OF DEATH DUE TO HOMICIDE, STATE OF MICHIGAN, 1972-1976

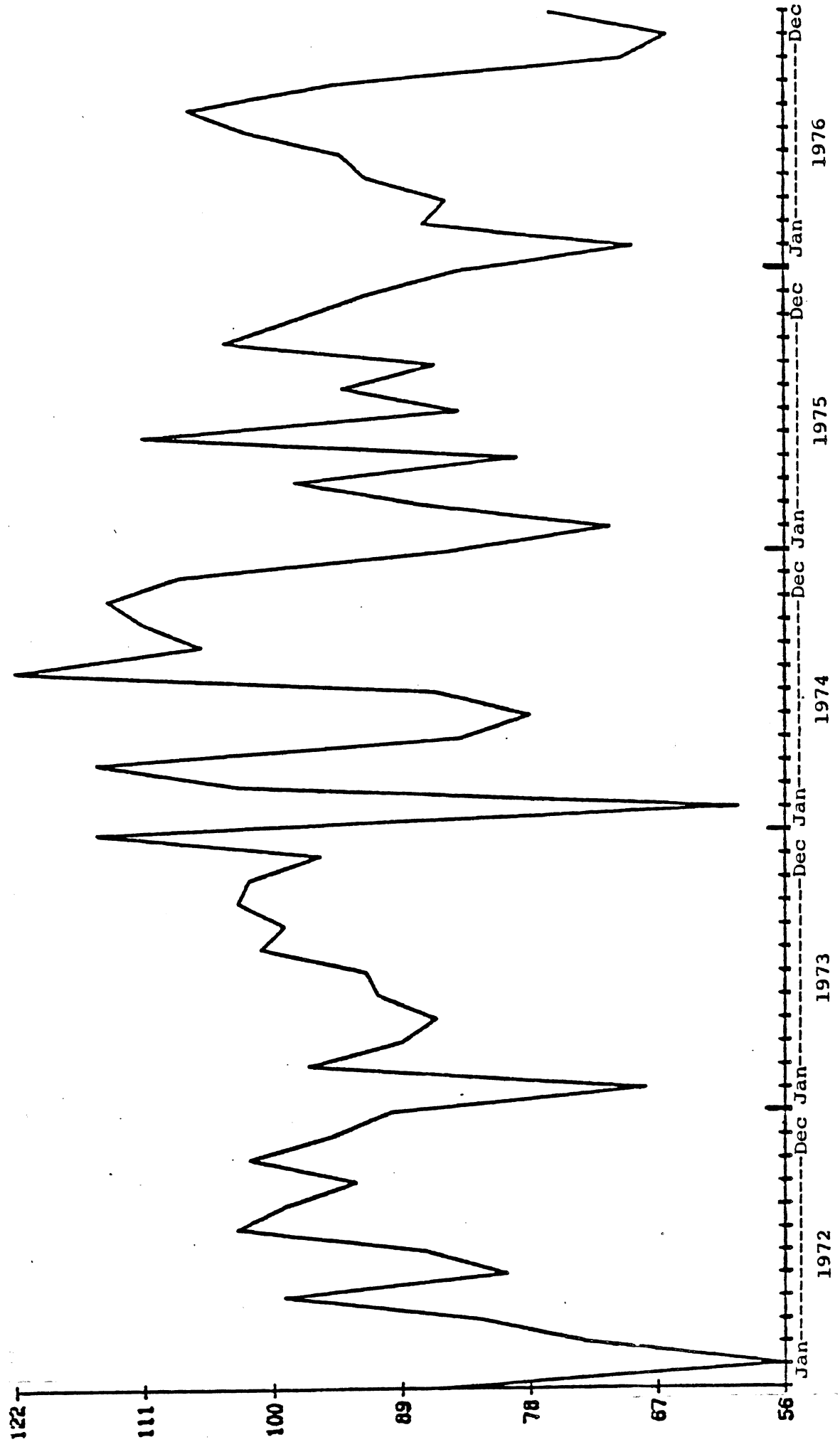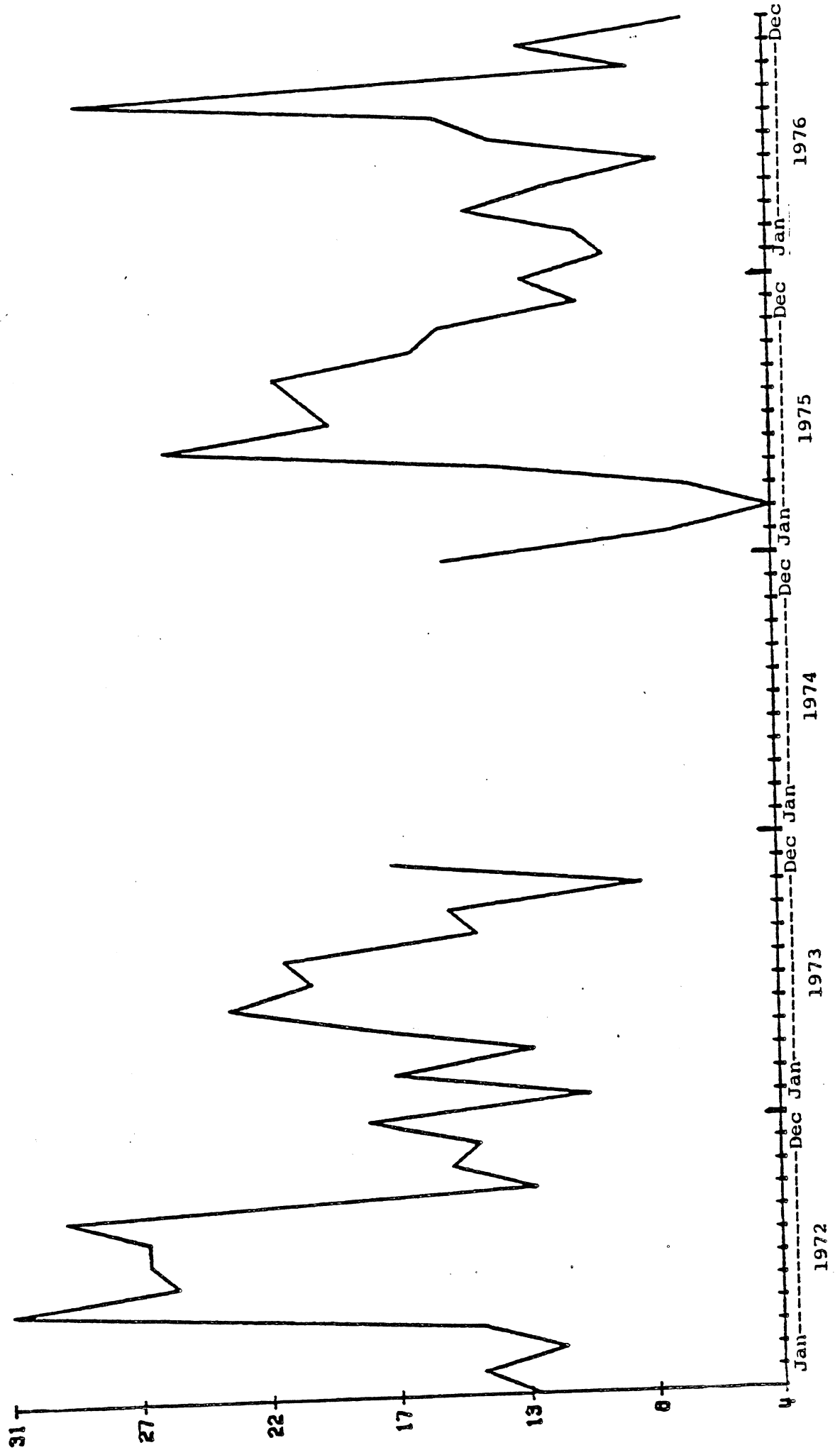Source: Michigan Department of Public Health

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FIGURE B.5. FREQUENCY OF DEATH DUE TO OCCUPATIONAL ACCIDENTS, STATE OF MICHIGAN 1972-1976

Source: Michigan Department of Public Health

APPENDIX C

ESTIMATED POPULATION,

STATE OF MICHIGAN,

1970-1976

FIGURE C.1. ESTIMATED POPULATION, STATE OF MICHIGAN 1970-1976

Source: Based on data furnished by the Michigan Department of Public Health

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