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BICYCLE SAFETY HIGHWAY USERS
INFORMATION REPORT

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DISCLAIMER

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B I C Y C L E S A F E T Y A N D I N F O R M A T I O N
R E P O R T

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EXECUTIVE SUMMARY

This report presents a comprehensive picture of the type and frequency of bicycling accidents common to adult bicyclists using America's streets and highways. The estimated 500,000 to 1,000,000 bicycle accidents that occur on our roadways each year have never been fully understood. Much of the data is elusive. This report attempts to "crack" at least a part of that wall, developing accident frequencies by type, offering profiles of accident versus non-accident riders, listing primary and secondary accident causes, and showing the interrelationship between cyclist behavior, motorist influence, roadway conditions, and bicycling accidents.

This detection is made possible as a result of the operation of the Bikecentennial event, a well-documented, summer-long inauguration of a bicycle route across the United States. During the summer of 1976, 4,065 cyclists, who rode 10.4 million miles through 10 states on all types of roadways, served as a source of detailed information on riding habits, highway conditions, and accident experiences.

Throughout, and immediately following the event, stringent and probing records were kept of all accidents, providing Bikecentennial with a unique set of data to study the hazards of riding on shared roadways, and to learn ways to improve facilities, education programs, and enforcement in the future. This report is in response to the National Highway Traffic Safety Administration's Order Number NHTSA-7-3200, requesting a complete analysis of Bikecentennial's findings.

Findings

1.) Effective Class III Route Design Reduces Accidents. Bicyclists riding along the TransAmerica Bicycle Trail experienced only 50-75% of the accidents anticipated based on the number of accidents normally encountered in 10.4 million miles of exposure. In a study of proficient adult bicyclists by Jerry Kaplan (FHWA study of League of American Wheelmen bicyclists), a base rate of 113 accidents per million miles was established. In contrast, Bikecentennial riders experienced an average of 80 accidents per million miles. When riding off the trail, the accident rate often doubled, or even quadrupled. In a few states, where route selection was considered excellent, the accident rate dropped to lows of 29-35 accidents per million miles. Route design criteria leading to these low accident rates are included in the Appendix of this report.

2.) Accident Versus Non-Accident Rider Profile Established. By studying characteristics differentiating accident riders from non-accident riders, a typical profile was established for each. Youthful riders between 16-20 accounted for 41% of all accidents, although they only made up 27% of the population. Safety messages targeted to this group should be strengthened.

Accident Riders. This group rarely had a set plan of action for handling specific hazards, did not have a set riding technique, produced greater wear to their bikes and carriers, were less likely to obey traffic regulations, often rode alone, rarely wore bright clothing, and failed to make periodic safety checks of their bikes.

Non-Accident Riders. In contrast, this group typically was older (26 to 35 and 46 to 55) and married. They established definite riding technique, normally obeyed traffic regulations, always wore bright clothing, made

periodic safety checks to their equipment, normally rode with care, and seldom needed to make any repairs.

3.) Bicyclists Need Set Plan of Action. As shown by the profile, bicyclists who have anticipated and developed plans for dealing with road hazards and other crises are much less likely to have an accident than those bicyclists who have not thought about or do not have established procedures for hazards. Practicing techniques such as emergency braking, abandonment of road, riding through a patch of gravel, and other hazard avoidance can reduce the frequency and seriousness of accidents.

4.) Accurate Accident Base Rates Established. On the average, a bicyclist using the TransAmerica Trail, or similar roadways, can anticipate having an accident requiring first aid treatment every 12,500 miles. An accident leading to a permanent injury can be anticipated every 250,000 miles, and a fatality every 5.2 million miles. This report explores differing accident base rates, demonstrating how women, bicyclists carrying their own equipment, different age groups, and bicyclists using different portions of the trail have markedly different accident rates. These base rates allow a standard for future program or facility improvements in safety.

5.) Frequency of All Accident Causes Established. Due to the extreme accuracy of reporting, it was possible to establish the major and minor causes of all bicycle accidents common to this group. Motor vehicles were involved in 17.5% of the total accidents, and resulted in a 10% higher rate of injury seriousness. The single most frequent cause of accidents was one bicyclist running into another, producing 20% of all accidents.

A breakdown of the most common major accident causes appears as follows:

Bicyclist hit bicyclist.....	20.1%
Pothole or broken pavement.....	10.7%
Car hit bike.....	7.8%
Loss of control.....	6.5%
Bike crashed trying to miss car.....	5.8%
Loose gravel on roadway.....	5.2%
Rider fell off bike.....	4.9%
Slipped on gravel road.....	2.6%

6.) Downhills Are High Risk Areas. Between 50 and 75% of the accidents involving a bike hitting a hole, skid or crash, bike hitting animal, and loose gravel on pavement occurred on downhills. The majority of all lacerations and 80% of all fractures occurred on downhills. Improved highway maintenance on hilly terrain and extra caution on descents can dramatically reduce bicycle accidents. Cyclists should be made aware of the hazards of increased speed in all situations, and receive special training in braking techniques for high-speed descents.

7.) Road Condition Blamed for 27% of All Accidents. Bicyclists listed faulty roadway design or maintenance as the direct or indirect cause of roughly one out of four accidents. Major problems include potholes, broken pavement, steep road edge, loose gravel, and lack of signs or other warnings notifying users of hazards. Roadway design and maintenance is credited for primary reduction of accident rates in such states as Missouri and Montana (30 and 38 accident victims per million miles). In contrast, poor maintenance and design is largely responsible for the high accident rate in Kentucky (101.5 accident victims per million miles).

8.) Fatigue Contributes to Accidents. On the days bicyclists were scheduled to ride more than 75 miles, 75% of the accidents occurred after they had ridden 70 miles. Bicyclists should be cautioned on the hazard of pushing beyond safe limits.

9.) Equipment on Bike Dramatically Increases Accident Rate. Bicyclists who had their equipment transported for them had only a third the number of accidents of those riding fully loaded bicycles. Although this rate difference can be accounted for, in part, by the slightly different and older group of riders making up this group, this added equipment load stands out as a dramatic added safety risk and should be explored further.

10.) Educators/Students at Opposite Extremes in Safety Record. Educators comprised nearly 15% of all bicyclists on the TransAmerica Trail and held the greatest safety record. Students, who made up the greatest percentage of riders by class (34%), held the poorest safety record, perhaps associated with age. Study should be given to having educators who ride actively take special bicycle courses and teach bicycling in community education programs.

11.) Injury Types, Frequency, Severity Established. Scrapes and cuts occurred in 51% of all accidents. Other major injury types include 13.2% bruises, 7.2% lacerations requiring stitches, 4.9% sprains, 3.3% fractures, 3.3% concussions, and 11.8% miscellaneous injuries or combinations of injuries. Motor vehicle-related accidents resulted in a slightly higher percentage of serious injuries (50% requiring more than first aid as opposed to 40% average of all accidents). Hospital treatment was required in 28.5% of all accidents, and 5% of all accident victims were kept in the hospital overnight or longer. Permanent injuries were reported by 6.2% of all riders injured or .01% of all riders. Of these, roughly one out of four were serious enough to be considered disabling. There were two fatalities along the TransAmerica Trail, both resulting from an overtaking automobile. ✓

12.) Most Accidents Go Unreported. As few as 10% of the bicyclists reported their accidents to law enforcement officials, and only 32% reported

the accident to medical or insurance officials. Accidents most often reported include motor vehicle-related injuries and other injuries requiring more than first-aid treatment.

13.) Leaders and Groups Shift Nature and Seriousness of Accidents. The presence of trained leaders and small heterogeneous group involvement had the effect of lifting even inexperienced riders into an experience level normally achieved by cyclists who have been bicycling for five or more years. Group riding, with specific use of a buddy system, may have increased the number of bike/bike accidents but is felt to have reduced the risk of motor vehicle-related accidents and other more serious incidents.

14.) Improved Carrier, Pack, Bike Systems Needed. Although the lightweight, multigeared, ten-speed bicycle was proven to be particularly suited to the needs and requirements of the long-distance bicycle tourist, attention must be paid to design and selection of equipment. The nearly triple accident rate of those carrying equipment can be answered, in part, due to the need to alter bike requirements, and to use carriers and packs of superior design to those being commonly used today. Carriers and packs recorded failure rates of 14% and 15%, respectively. Bikes designed primarily for racing, of large frame size, and thin-gauge tubing are prone to a hazardous shimmy effect on fast downhill descents. Ill-designed carriers and packs create a whiplash effect, activating this shimmy, increasing the number and seriousness of downhill-related accidents. Additional study is suggested.

15.) Helmets, Bright Clothing, Safety Triangles, Accessories Can Reduce Frequency and Seriousness of Accidents. Bicyclists using helmets experienced a reduced number of head and facial injuries. In several instances, helmets are believed to have prevented serious or fatal

concussions. It is estimated that 25% of the helmets carried on the trip were not in use while riding, due to inadequate ventilation. Bright clothing and safety triangles are credited in having reduced the frequency of motor vehicle-related accidents. Cyclists using rearview mirrors were not involved in any motor vehicle overtaking accidents.

✓ 16.) Motor Vehicle Air Blast or Suction Serious Cause Factor. Large vehicles traveling at high rates of speed can produce an air blast or suction knocking cyclists from roadway, or under vehicle. This factor is especially serious with small riders and on narrow roads with frequent crosswinds. Semi-trucks were involved in 50% of all such incidents.

17.) Shared Highway Use Compatibility Demonstrated. Although 54 bicyclists were injured (2 fatalities) through shared use of roadways, an unusually high degree of shared responsibility and courtesy dominated motorist and bicyclist behavior. Law enforcement officials and motorists mentioned incidents of some bicyclists causing traffic to back up. However, the predominant attitude was one of great cooperation, through proper use of bicycles, use of bright clothing, demonstrated courtesy, and helpful and friendly attitudes. In Eastern Kentucky, where heavy coal truck traffic could not be avoided, the two groups of users worked out effective communication systems (truckers used CB's to warn of bicyclist location); and there was extra courtesy on the part of the bicyclists.

✓ 18.) Laws, Rules of the Road, Local Enforcement. There is significant disparity between bicycling laws of different states or towns, causing confusion and noncompliance. Adherence of national uniform laws is suggested. Bicyclist behavior was tied to their understanding of what is right and wrong in shared highway use, based on gut feelings, respect, and desire for

acceptance. Officials seeking compliance with specific laws issued warnings to bicyclists, which has positive but often local effect. Law enforcement officials are reluctant to arrest bicyclists, due to lack of support at the judiciary level. This failure appears to weaken the entire enforcement and, hence, education efforts of local communities.

Concluding Remarks. Throughout the analysis of the event and study, we have been impressed with the tremendous potential for reducing accidents through the encouragement of preferred bicycle roads. By selecting and improving potentially popular bicycling corridors, initiating an effective education and enforcement program, we believe it is possible to reduce bicycling accidents in America by up to 50% of the current rate. Bicyclists must be alerted to the major causes of accidents, taught standard rules of the road and defensive riding techniques, and become aware of the importance of bright clothing, safety accessories, and correct use of equipment. This system must be backed up with greater uniformity in laws, stern enforcement, and judicial support. Bicycling safety in America must be viewed as a system.

THE AUTHORS

Bruce Burgess. Bruce is the cofounder and partner of a Richmond, Virginia, architectural firm ARCHIMEDIA. He is past president of one of the more active bicycling clubs in America, the Richmond Area Bicycling Association (RABA). Bruce is the director of the 1977 GEAR (Great Eastern Area Rally) which was run for more than 1,600 bicyclists over a four-day period. For the past two years Bruce has served as the Coastal Regional Director of the League of American Wheelmen, a national bicycling organization interested in bike safety, legislation, and promotion. In writing this report, Bruce has drawn upon his work in helping with the design of the TransAmerica Trail through Virginia, his development of 40 illustrated bike maps, his participation in leadership training courses, and his experience as a leader of 8 group members on a Bikecentennial tour through Virginia. Bruce has been active in bicycling for the past 12 years and lives in Richmond with his wife Beth and two children.

Dan Burden. Dan and his wife Lys are the founders of Bikecentennial. For the past 3½ years Dan has served as the executive director of Bikecentennial and has been active in the design of the trail, the leadership courses, and directing the event. During this period he has worked closely with state, regional, and federal agency officials, law enforcement officers, and educators. Dan has taught six bicycling courses through the University of Montana and has written numerous articles on bicycling for major U.S. magazines. He is the founder of the Hemistour Expedition (see May 1973 National Geographic), and rode the first 9,600 miles through North America. Dan has been active in bicycling for 15 years and lives with his wife Lys and daughter Jodi in Missoula, Montana.

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BRIEF BACKGROUND

"A revolution in bicycling has taken place since about 1968; adults have replaced children as the prime users of bikes. Adults' interest in physical fitness, escape from total dependence on fuel-consuming, polluting automobiles, and improvements in bicycles are given as the main reasons for this change." -*Christian Science Monitor*, 12/22/76.

Whatever the reason, adult use of the bicycle has grown at a dramatic rate, and the new mix of autos and bikes on highways designed for the former vehicle results in an estimated 500,000 to 1,000,000 accidents each year. Adults are involved in roughly half of the total accidents and a fair percentage of the 1,000 fatalities each year (51 %).

This is the first report of reliable data from a known bicycling audience with time and mileage of exposure carefully documented. Although these Bikecentennial tour riders are in general more knowledgeable and sophisticated in their riding than most bicyclists (3.5 years riding experience), they provide us with an important key to where the activity is heading and some measures to reduce the number of accidents for all bicyclists, including children.

One thing is certain, for the next several decades the bicycle is not likely to go away. The pattern indicates increased use, with growing competition on busy highways. Many countries in Europe made a smooth transition when the auto was first introduced, and can report a very low rate of accidents. We have not been so lucky. Although bicyclists lobbied for the first paved roadways in America, the bicyclists yielded to autos at the turn of the century and are only now making a significant comeback.

Highway design and behavior patterns cannot be changed overnight. We must do all we can to facilitate this transition.

LIMITATIONS OF APPLICATION

The scope of this report is limited to shared highway use--more specifically, shared use of lightly traveled highways where traffic counts are between 200-1000 Average Daily Traffic Count (ADT). The sample studied included cyclists from 7 to 86 years of age who were engaged in the sport of bikepacking (loaded bicycles) and cycle touring. The experience of the riders ranged from those with 10-15 adult riding years to others with only a few days or weeks experience.

Although the activities of the Bikecentennial participants did not involve commuting via bicycle, it did involve activities that were very closely related to utility cycling (trips to the market, etc.). Therefore many of the principles of bicycling (skills, road hazards, laws, traffic mix) examined in our study are relevant to commuters and urban recreational bicyclists.

However, almost all of the participating cyclists were exposed to small group techniques that involved group safety procedures and guidance from a trained leader. When riding on the TransAmerica Trail, the riders were in an environment that had been predetermined and selected for its low hazard potential. Therefore, the results of this study might not be as directly applicable to bicyclists outside of these influences.

INTRODUCTION

Interest in bicycling is unlikely to slow in the next decade, especially while we search for ways to cut fuel consumption, and to devote more and more time to both outdoor leisure and physical exercise. Americans who already own bicycles are likely to increase the number of miles they ride, and many others are expected to take up the activity. Neither bicyclists nor motorists are prepared for this sudden mix on highways designed largely for a single mode of travel. Action by planners, law enforcement officials, educators, legislators, and organizations is needed to help reduce the number of injuries.

This report has been prepared for the National Highway Traffic Safety Administration by a large bicycling organization, Bikecentennial, in order to help identify how and why many adult bicycle accidents take place. This report not only outlines new data from observing 4,065 bicyclists during the summer of 1976, but also blends the knowledge of two professional bicyclists/bike planners in an interpretation of that data. By sharing this added perspective on bicycling accidents we hope to aid in your efforts to improve facilities, laws, enforcement, and education programs.

Approach. Bicycle accident data is elusive. Very few of the 80-100 million men, women or children riding bicycles are able to give an accurate account of the miles or hours spent riding their bikes. Most accidents are of a minor nature and hence go unreported. Even the few reports that make their way to insurance, hospital, or police files are often brief and inadequate. Most accident forms are too general in nature to give an accurate picture of

the incident, and investigators are rarely trained in bike accident causation. Many statements simply read, "rider fell while making turn." Little consideration is given to highway design, debris, other traffic, the rider's experience level, and other important factors.

This study examines the riding habits, attitudes, exposure, and equipment of a known group of mostly adult bicyclists and takes into account the design of the 4,200 miles of Class III (shared highway) bikeways they rode during the summer season. It is the first known study that can relate actual exposure in miles and hours to an accurate count of total accidents. Perhaps even more important, *it not only presents a profile of men and women having accidents, but also contrasts that group with others who rode without accidents.* This is one of the first bicycling studies with such a built-in control group. Through this investigation we have been able to determine base rates of accidents per million miles ridden by accident type.

Background History. During the summer of 1976, 4,065 men and women from around the United States and 16 other nations joined together to participate in the inauguration of the longest recreation trail in the world, the TransAmerica Bicycle Trail. Almost half (44%) of these bicyclists rode the entire 4,200 mile trail from Oregon to Virginia.

The idea behind the TransAmerica Trail was to find a good cross-country route on existing back roads which were already maintained and would require no further development costs to be used for bicycle travel. The route would follow country roads and lightly traveled state highways as much as possible. The quiet back roads would encourage an intimacy with the land that wide, noisy highways could never allow. The trail avoids large urban areas almost entirely.

About 80% of the riders traveled in small groups of 8-12 riders. Although these men and women often rode in even smaller groups (usually two riders together), they had the benefit of sharing their experience with the entire group in the evenings and had the aid of a trained leader. The remaining 20% of the riders traveled independently, and usually teamed up with one or more other independent or group riders during the day. Tours lasted anywhere from 12-82 days, covering 350 to 4,200 miles. Some bicyclists carried their equipment in saddlebags and handlebar bags, while others relied on trucks to carry their gear.

Cyclists taking part in Bikecentennial were well-educated urbanites whose families had middle income salaries. Roughly 45% of the riders were either students or educators. Men outnumbered women 3:1 on the long trips, and 2:1 on the short trips. Only 30% of the riders had toured any appreciable distance on a bicycle before (700 total touring miles). The average Bikecentennial rider had been bicycling for 3.5 years. During fair weather, these men and women put in an average of 250 miles per month. (The majority of the riding (78.2%) is for one-day rides.) Slightly more than half of the riders used their bikes for commuting (58.6%), regular exercise (61.0%), and minor shopping trips (56.8%).

Each of the riders were issued maps and guidebooks and a health/accident insurance policy. They received publications in advance discussing conditioning, equipment selection, bicycling hazards and riding techniques. In addition, most riders went through an orientation session at the trailheads, during which common accidents and hazards were discussed.

The route these bicyclists traveled was carefully chosen not only for scenic and cultural interest, but for safety as well. In most regions

traffic counts were between 200-1000 ADT (Average Daily Traffic Count).

About 25-35% of the trail was under 500 ADT. On approaches to large towns such as Pueblo, Colorado, and in some sections of Wyoming, counts climbed to 1200 ADT or higher.

One of the goals of Bikecentennial was to encourage the shift of long-distance bicycle travel onto specific roadways lighter in traffic, and then to work toward the elimination of hazards on these roads through local, state, and federal agencies. By focusing on a major transcontinental route during the bicentennial year, it was possible to rally enough support to get the 4,200 mile route developed in the brief span of three years. The success of this trail has already served as an inspiration to others, helping foster similar routes through California, Washington, Oregon, the Northeast, and North Carolina.

PURPOSE OF THIS REPORT

The specific objective of this report is to provide new ideas and data on bicycling safety. After pouring over the mounds of data, interviews, tables, charts, and summaries, we have chosen to make an informal presentation. Our statements are based not only on fact, but on our years of experience as well. We feel that the most value can be offered by this writing if we interject the perspective of the active bicyclist. By doing this we are able to leave behind the cold world of statistics and relate more clearly just why bicycling accidents take place. Many studies on bicycling accidents fail to take into account such things as the different attitudes bicyclists have toward traffic and roadways, the limitations of the equipment they ride and design of the roadways they share.

We are sticking our necks out a bit to suggest fresh ideas that should be tried. We feel that the art of bicycle safety is developing too slowly. Very few funds have been earmarked for either research or programs. Blame for accidents is passed from manufacturers, to educators, to highway designers, to motorists, and to the bicyclists themselves. In reality, the problem and the solution must be placed squarely on each of our shoulders. The dominant purpose of this report is to get each and every one of us to accept this responsibility.

To help meet this responsibility this report outlines existing and new data related to bicycling safety, including but not limited to:

- Identification of hazards
- Relation of roadway design, maintenance, riding habits, motorist behavior, and education to frequency of bicycling accidents
- Importance of signing and law enforcement
- List of major design and maintenance hazards
- Bicycle, and accessory design and use
- Equipment
- Motor vehicle design and operation
- Rules of the road

OVERALL PROBLEM

In America, there are between 80 and 100 million bicyclists who use the nation's highways for recreation, commuting, or utilitarian purposes. An increasing number of these men and women are randomly using all highways. This creates major confusion, congestion and conflict. Below we explore a number of conditions leading to the overall problem.

Facilities. In some areas bikeways have been established to pull some of the bicycle traffic back onto a corridor where emphasis can be given to safe routing and other hazard avoidance. Although there are many good, working bikeways in America, there are more that are poor for one or more reasons. Many communities and states launch plans without consulting technicians to learn the state of the art. The resulting problems include misinterpretation of the need, faulty design, poor placement, and inadequate maintenance.

The majority of all bikeways have been built for a limited recreation user. The utility and commuter bicyclist has often been overlooked. Some communities do not want to encourage bicycling, they simply want to deal with what they see as a problem. Often the problem was not a problem at all, but rather a need, and it may not have been met.

Class I (separate facility) and Class II (special lane) bikeways can be designed, placed and maintained to help meet the needs of a greater number of bicyclists. However, it is likely that a majority of all bicycling will continue to be on shared highways, owing to the greater abundance of these facilities and the greater freedom and opportunity for the bicyclist. Thus it becomes important for communities and states to help identify and improve

the best routes for shared use. In this way bicycling hazards can be reduced to a minimum and traffic congestion will be lessened.

The Bicyclist. After reviewing our accident data we have concluded that up to 80% of the accidents could have been avoided if the rider had taken greater care, been trained in new riding skills, and been aware of the hazards unique to bicycling. A railroad crossing signal warns the motorist of the great risk of a train/car collision. To the bicyclist, the threat is more immediate--unless the rails are crossed at a 90-degree angle a serious fall is likely. Many adults who grew up using the bicycle as a toy learn how serious such hazards are only by taking a spill. Hazard avoidance ideas must be shared with new adult riders in order to avoid such accidents.

The Bicycle/Motor Vehicle Mix. America has been without a balance of motor vehicle and bicycle traffic for so long that this sudden thrust of mixed traffic creates confusion and conflict. It is like two men sitting down to a checkerboard (the highway), one playing with chess pieces and the other playing checkers. Both are confused--the result is conflict.

The most serious problem directly involving the bicyclist and the motorist is visibility. The bicyclist incorrectly assumes he is always visible. The motorist has a fixed "mind set" of what he expects to see. In this mind set are large, often rapidly moving vehicles, such as other cars, trucks, or campers. The motorist may physically see the bicyclist, but his mind is not trained to react, so the visual image goes unheeded until too late. The bicyclist and motorist must be aware of this. It may be many years before motorists are trained to "see" bicyclists. Until this transition takes place, we must all be aware of this great risk.

Although the "mind set" phenomena is perhaps the most serious problem between bicyclists and motorists, there are many other hazards that must be understood by the bicyclist and motorist. One example is the six-inch pothole along the side of the road which goes unnoticed by the motorist. To the bicyclist, the break in the pavement can cause a serious or fatal fall--the adult rider will swerve to avoid it at almost any cost, including sometimes riding into the path of the unseen or unheard automobile. Motorists need to know these special problems faced by the bicyclist, just as well as the bicyclist needs to understand and react to the very real needs of the motorist trying to share the highway with a slow-moving bicycle.

The Educator. Different systems of teaching bicycle safety have been tried in America with varying degrees of success. In many cases the responsibility is placed on the shoulders of the police department or civic-minded groups. Although many departments have developed effective training programs, the information nationwide is not uniform, and there is little monetary support. Often the school, law enforcement, or civic groups do a good job of teaching; but the parents give a different message. Confusion is the result.

Summary. There is no single cause of bicycle accidents--and the solution must be based on greater sharing of information and work between planners, educators, law enforcement officers, agency officials, motorists, and bicyclists. In the pages that follow we examine in detail elements of the shared highway safety problem. Our approach is to show the interrelation of the major elements that lead to increased safety.

THE BICYCLE USER

Bicyclists found on today's roadways range from the very young through those in their retirement years. In the past, the majority of bicyclists were teenagers or younger. A recent trend, beginning in the '60's, has more nearly balanced adult and younger riders. Today many bicyclists use bikes for additional purposes of utility, commuting, and planned recreation trips.

The behavior of the bicycle rider is often tied to the very specific type of user. A middle-aged businessman may ride a \$600 bike at a brisk pace along a rutted roadway, at times darting around a bit of debris. On the other hand, a pre-teen may travel a bit slower, ride right through the debris, and then make an erratic left-hand turn into a friend's house without checking for traffic from the rear. Thus, it is important to identify different riders according to the general behavior we may anticipate. Only in this way can we target our specific safety messages for the greatest effect.

For the purposes of this study we will describe one very specific class of riders--the bicycle tourist--whose riding style and behavior is among the most predictable and cautious. Certain characteristics of the bicycle tourist are true of all bicyclists, but be careful to not assume these patterns are uniform.

Bikecentennial Riders. Cyclists taking part in Bikecentennial were well-educated urbanites whose families had middle-income salaries. In their life-style and habits, these bicyclists formed a unique group concerned with ecology, safety, health and nutrition. In general, the riders were outgoing

and appreciative of contact with other riders and the people in the communities through which they traveled. There was very little evidence of littering or vandalism. Law enforcement officials were highly complimentary of the riders, with the exception of a few bicyclists who were discourteous on the highways.

Age. The great majority of the riders (73.8%) were between the ages of 17 and 35. However, there was a fair distribution through the other age groups, with about 5% of the riders in their retirement years. The age range was from 7 to 86 years. The oldest known rider to complete the entire trail was 67, while the youngest were two 9-year-olds.

Sex. Men outnumbered the women 3:1 on the long trips, and 2:1 on the short trips.

Marital Status. Single riders predominated (72.5%) in both the long and short trips.

Race. Although not included as source information in either the survey or registration form, only a few black, native American, Spanish, or other minority group members were represented in the tours. As an example, only 4 of the known 4,065 riders were black.

Formal Schooling. Bikecentennial riders were well educated. Those having completed college or graduate school represented 49.5% of all riders. Another 28% had some college background, or were currently enrolled.

Occupations. The majority of the bicyclists were from white-collar or student groups. Roughly 45% were either students (34%) or educators (11%). The next highest category is for technicians (16%), with managers (7%) following. Only 4% of the riders labeled themselves as being unemployed.

Family Income. The single largest income category was for families earning \$22,500 or more (23.5%). The median income was established at \$15,500. Independent riders represented higher income levels (34% of all independents reported family earnings in excess of \$22,500).

Riding Experience. The bicyclists had been riding an average of 3.5 years, and rode their bikes 8 or 9 months out of the year. When off their bikes they drove an average of 7,500 miles per year. The average rider put in about 450 bicycle miles in 1976 before starting the Bikecentennial ride. Thirty-six percent owned more than one bike.

Behavior/Attitudes. The attitudes and resulting behavior of the bicycle tourists gave us important clues to their potential for accidents in a given situation. Such information also provided us with important data for law enforcement, bike route design, and education programs. Below are some common attitudes and a partial explanation for such a position.

Stop Signs. Only 40% of the Bikecentennial riders stated that they always obeyed stop signs. The majority (53.7%) sometimes do, and 5.5% rarely obey signs. Although most adult bicyclists realize the risk at intersections, many find it a nuisance to bring a bike to a complete stop as required by law, put their foot down, and then make a wobbly start. Many bicyclists approach the intersection at a slow pace, check the cross lane for traffic with both ears (cocking head slightly to side) and eyes, and then proceed with caution. The bicyclist who makes this type of "stop" actually spends as much time, or more, checking for traffic as the motorist. A not so obvious problem is that an adult rider using this technique might pass along a poor habit to an observing 8-year-old who fails to understand the risk involved.

Bikeway planners should be aware of the added problem they pose to the bike rider when designing a route of several miles laced with 6-10 stop streets. Either the bike rider will ignore the route entirely, or will soon abandon the cautious approach required by law. One solution is to change the traffic control, placing a yield sign or giving right of way to the bicyclist.

Traffic Lights. Intersections with traffic signals are approached more uniformly. A majority of the riders (78.3%) stated that they always stop at traffic lights. Unfortunately, there are another 20.3% who announce they sometimes stop. Of those 20.3% some are likely to be found who do not see the risk or understand the irritation this brings to others anticipating uniform observance. Lack of adequate law enforcement adds to this problem.

Signal Turns. Roughly one-fourth always signal turns, and an additional one-half sometimes do. Most bicycle tourists will signal their turns when in known traffic, but see the move as awkward when the need for the communication is not immediate, since this requires removing one hand from the handlebars at a time when balance is also important.

Two or Three Abreast. One of the most common complaints of the motorist sharing the highway with a group of bicyclists comes from a cluster of riders taking up the lane. Common courtesy, legal statutes, and safety dictate that when motor vehicle traffic approaches, riders should break from two or more abreast and go to single file to allow easy passing. The habit of riding three or more abreast is illegal and frowned upon in bicycling circles, since it is hard to disperse safely. However, the two-abreast pattern is both common, and often acceptable by most bicyclists, as long as the riders are attentive, on a lightly traveled roadway, and willing to move to

single file at the first indication of a motor vehicle. Riding two-abreast has certain added safety benefits. The biggest is the more dramatic visual impact two riders in the roadway ahead as opposed to the slender lone rider. Two riders sharing the same roadway also find the two-abreast position more social, with less chance of a bike/bike collision, which occasionally takes place if one rider is tailing another.

One-Way Street. Another behavior common to many bicyclists is riding the wrong way down a one-way street. Although 60% of the riders stated they never ride the wrong way, 31.6% rarely do, and 7.7% sometimes do. Again, the great freedom of the bike and the slight hassle of riding an additional block or two helps generate this illegal behavior.

Ride Against Traffic. One of the most dangerous riding habits for any bicyclist is to ride against the flow of traffic. Motorists often fail to perceive such bicyclists until it is too late. Although this behavior was not observed along the TransAmerica Trail, nearly 20% of the riders stated that they rarely will ride against traffic (presumably in an urban setting); the other 80% never ride against traffic.

Lane Use. There is a mixture of opinion among bicycling groups as to the safest approach to use of a traffic lane. The split is nearly 50/50 on riding to the right most of the time or using the entire lane.

This past summer there was a certain percentage of riders (1-3%) who had the habit of dominating a lane no matter what the traffic situation. This creates great hostility between motorist and biker, and poses serious safety to both the biker and cars backing up behind a prudent driver. Such traffic offenders should be made aware of the very serious problems they create. When traffic allows, those who ride in the center of the lane feel

that the position allows them greater safety. There are normally fewer potholes in the center of the lane, and on a downhill the position is essential for control. On uphills, bicyclists sometimes use a weaving motion across much of the entire lane. Although this is a hazardous practice in areas of traffic, it is done and should be anticipated.

Those who ride to the right are more cautious about traffic, but sometimes are annoyed that motorists fail to see them, or do not slow down because the rider is already showing care. Both bicyclists and motorists are confused on proper sharing of lanes.

Other. About 27% of the riders wore safety helmets, and 70% wore a bright orange triangle to help motorists pick them out from a distance as a slow-moving vehicle. Concern for riding safety also extended to nearly 70% of all riders wearing bright clothing at all times or frequently.

Summary. Convinced of his/her right to share in the use and responsibilities of the roadway, the bicycle tourist is normally predictable and visible. The long-distance bicyclist shares a unique set of commands and signals when riding with others, calling out potholes, traffic, notifying other riders when overtaking, or alerting a fellow rider to another hazard. The great majority are concerned for their own safety, and show courtesy to fellow highway users. The great freedom of the bicycle inspires some bicyclists to ride under unsafe and illegal conditions. This problem must be addressed by educators, law enforcement officials, and legislators.

METHODOLOGY

The majority of our report concerns the analysis of primary data obtained from an existing field survey conducted by Bikecentennial to eliminate hazards and improve safety along the TransAmerica Trail. Of the 4,065 cyclists who participated in Bikecentennial, 3,507 were sent the safety survey through bulk mailing techniques. The remaining 556 riders included nearly 400 International bicyclists and 156 domestic riders who could not be contacted due to the expense of overseas mail, or insufficient mailing information. Ultimately, Bikecentennial received more than 2,350 completed surveys from the riders. Of these, 2,069 arrived early enough to be tabulated and formed the basis for the data, conclusions, and recommendations presented herein.

The 67.0% rate of return (2,350 of 3,507) insures us of a very low sampling error. Through random phone calls, and (compared) early and late returns, we concluded that the respondents are typical of the total rider population.

Other portions of the report are based on exploratory research using such secondary data as, literature surveys, existing field surveys of law enforcement officials (Bikecentennial Law Enforcement Information Report), and analysis of selected accident cases. In addition, we were able to draw from medical records, insurance reports, and letters from the bicyclists.

SURVEY DESIGN

The Bikecentennial survey included 141 questions, divided into two broad sections. The first section dealt with general information that could be answered by all participants. The second section was intended only for those persons who experienced accidents on the TransAmerica Bicycle Trail during 1976. In the first section, questions were posed that allowed us to develop a detailed rider profile and evaluate the route. The second section allowed us to determine the cause of each accident and surrounding conditions. Many of the questions in the Bikecentennial questionnaire were taken from a National Safety Council study, in a report by Schupack and Driessen, entitled "Bicycle Accidents and Usage Among Young Adults: A Preliminary Study" so that the results could be compared directly. In addition to keypunching the data, we read *each accident form* to gain insights into the specific problems of the cyclists.

NON-ACCIDENT AND ACCIDENT RIDER PROFILES

Having a known population and a high response rate, we took the rare opportunity to develop a profile of the "accident" and the "non-accident" rider. To do this we looked for characteristics that would clearly identify a rider in either group. The test (difference of proportions, using the statistic Z) is explained in the Appendix. With this technique we examined experience, equipment, bicycle technique, and attitude. The major findings of this comparison are:

Accident Riders. Typically, accident riders were between the ages of 16 and 20, had just graduated from high school, and were single. These bicyclists had no set plan of action for handling an emergency or hazard, and did not have a set riding technique, such as always riding to the right, or always riding in the center of the lane. Accident riders made more frequent repairs to their bikes, especially those components that are related to the power train (derailleur, pedals, cranks, chain, gear cogs), and braking systems. They also had more problems with racks and bicycle packs, and had a higher proportion of flat tires.

The accident rider does not always obey stop signs, has no set procedure in using signal turns, often rides three abreast, has not made up his mind about riding wrong way on one-way streets, and has not decided whether he should or should not ride against traffic. Likewise, the accident rider does not have any set pattern for downhill procedure, and is undecided about where he normally rides. If an animal approaches, the accident rider normally increases speed and yells or screams to frighten the animal away.

Further characteristics include usually riding alone, riding in any weather, almost never wearing bright clothing, and either constantly tinkering with the bike or failing to make safety checks frequently enough. Typical speed is 14-20 MPH for the accident rider.

Non-Accident Riders. In contrast, those who had no accidents were between the ages of 26 to 35 and 46 to 55, were married, and had completed some postgraduate work. The non-accident riders had established definite techniques for riding, and can be characterized by the following attitudes and practices: always obeys stop signs, never rides three abreast, always wears bright clothing, brakes frequently on downhills, checks the mechanical condition of the bicycle before riding, is careful about accessories including packs and carriers, keeps the bike in good repair, seldom needs to make repairs of any kind (including flat tires), never rides at night, exercises care during adverse weather conditions, either continues normal speed or stops and walks if an animal approaches, and considers the automobile a hazardous vehicle. The typical non-accident rider maintains speed under 13 miles per hour.

Other Results. Also tested, but not shown as significant in this population: exposure to a bicycle course, number of miles driven in an automobile in the past twelve months, the number of years of active bicycle riding, and length of time bicycle was owned.

Hazard Recognition. A comparison between accident and non-accident groups was run for awareness of the most significant bicycling and roadway hazards. This test was run to determine if such awareness was significant in the prevention of accidents.

The most common cause of all accidents along the TransAmerica Trail, one bicyclist hitting another, was viewed by both groups as the least likely hazard of all. Such collisions made up 20% of all accidents. It is surprising that so many of the riders (both in the accident and non-accident groups) mistakingly perceived this as the least likely hazard.

The second most common cause of all accidents, potholes and broken pavement (10% of all accidents), was perceived as the single greatest cause of all accidents by both groups.

Motor vehicle traffic generated concern among both groups, with non-accident riders having a healthy respect for the hazards posed by the passenger car. Fear of the recreation vehicle generated the most concern of the combined groups, but was distinctly a characteristic of those cyclists who had experienced accidents. The accident group also expressed their concern for the semi- or tractor-trailer rig.

Railroad tracks were indicated as the number one area of caution by both groups.

In conclusion, it is unclear whether hazard recognition is a factor in accident prevention. Both groups had a similar awareness (or lack of awareness) of the real threats facing them. For a more complete discussion of the real hazards see page 40.

Important Findings. By studying the accident and non-accident rider profiles, we have learned that the group having the highest number of accidents (students) have a common meeting ground with those having the lowest number of accidents (educators)--the school system. Educators with bicycling experience should be encouraged to take additional course work in bicycling and to share their knowledge through the community education system.

Confusion and indecision are a clear characteristic of the accident rider, and should be recognized as an important target for increasing bicycle safety.

There are distinct age groups (16-20, 21-25) that should be targeted with a concentrated bicycle safety program, for maximum reduction of accidents. (Note: since there were relatively few riders under age 16 on Bikecentennial, it was not possible to establish accident rates for this age group.)

Summary. Youthful, single riders, in general, stand a better chance of having a bicycle accident, especially if they have no clear plan of action, travel at higher speeds, and take greater risk (common to the accident group). Regular road maintenance and observance of traffic regulations are important in reducing the frequency of bicycling accidents.

THE ACCIDENTS

Overview. Bikecentennial had the unusual advantage of an accurate tabulation of the total number of miles traveled and the accidents that took place along the TransAmerica Trail. This is one of the first reports on bicycling accidents able to identify how and why such incidents take place, to establish a base rate, to list probable major and minor causes, and to indicate the severity of all injuries, including those that often go unreported.

Two techniques were used in tabulating this information. First, a zero deductible medical insurance policy was carried on each rider, encouraging treatment for even the most minor injuries. The report from the insurance company helped in the tabulation of all medically treated injuries. A second source of accident information was an accident questionnaire sent to domestic riders by Bikecentennial.

The data in the tabulated questionnaires includes 399 accidents (308 individuals). In our questionnaire we defined an accident as any injury requiring first-aid treatment or greater care, or any incident resulting in more than \$25 damage to the bicycle. Of those riders responding to the questionnaire (67% response rate), one out of seven (14.8%) were involved in one or more accidents during the summer.

Accident Rates. Knowing which portion of the trail was ridden by each rider and how many accidents took place, we have established an accident base rate of great accuracy. The participants that responded rode a combined total of 4,998,617.7 miles and experienced 399 accidents. Thus the accident rate is 79.82 per million miles traveled. In simpler terms, a

rider in this group is likely to have an accident requiring first-aid treatment or greater attention every 12,500 miles. To simplify the reporting, we asked each accident victim to complete the questionnaire for their most serious accident only. Thus, although a total of 399 accidents were reported, only 308 accidents are explained in detail in this report. Please keep this in mind as you read this accident section. To maintain accuracy, we have given all further accident rates as "accident victims per million miles."

In the paragraphs that follow, a breakdown is made of accident rates by sex, age, region, etc., showing comparisons that identify where and how accidents are likely to take place.

Sex. The average male rode a third more miles than the average female, but the average female had an accident rate 31.05% higher. Women had more multiple accidents and reported more serious accidents than men. Although the cause for the higher accident rate among women is not known, possible factors include: women were quicker to use the additional medical treatment than men for less serious injuries, which may indicate that men ignored treatment in some cases, and, hence, accidents went unreported. Women responded to the survey in slightly higher numbers. It is conjectured that the additional weight of the bicycle and load (panniers) may have proven a handicap to some women, who were, on the average, 15 pounds lighter, and 6 inches shorter than the average man. There was nothing indicating women had less experience than men or were less cautious.

Age. The most vulnerable group was 16-20 years of age. They accounted for 40.9% of all the accidents reported, even though that group represented only 27.2% of the total population. Because this accident rate was so high, it

is difficult to determine what other factors may be related, such as education level or previous experience. Riders between 31 and 55 represented the cyclist who has fewer accidents than the average, while those over age 55 had slightly more accidents than the average. There is little indication that the 16-20 age group had less riding experience than the other groups; however, there is strong indication that this group was prone to taking more risks (see profile in preceding section).

Regions. The rate for all accidents along the TransAmerica Trail was 60.80 accident *victims* per million miles traveled. Although most of the states fell quite close to this norm, there were three states that varied markedly.

The two safest states of Missouri (29.49) and Montana (38.45) had rolling or mountainous terrain. Missouri is characterized by very quiet rural roads that are similar across the entire state. Although very rolling and quite steep in sections, the roads were well designed (good visibility, no sharp curves) and were well maintained. Potholes are very rare. Most drivers were well mannered and courteous. Similarly, in Montana cyclists found the highways to be wide, well maintained, with few turns. Although Montana has a slightly higher traffic count, overall, than most of the states, traffic was seldom a problem due to the wide roadways. Ironically, Montana and Missouri, while holding the lowest frequencies, were the sites of both bicyclist fatalities. The specific causes of these fatalities is discussed elsewhere in this report.

The two most hazardous states along the trail, in terms of frequency of accidents, were Kentucky (101.48) and Virginia (63.77). Kentucky's roadway system is dramatically different from that of Missouri. In the state of Kentucky, there is a definite difference between the topography west of

Berea (Lexington area) and the topography east of Berea, where a high rate of accidents occurred. East of Berea the roads are narrow and winding. There are many hidden turns and sharp hills. Terrain is often quite steep. Even more hazardous, the roadways are completely demolished for 30 to 40 feet at intervals as close together as one mile. Eastern Kentucky has many coal trucks that carry their loads at high speeds on roads that the cyclists were forced to share because of the lack of alternative routes. Although most truck drivers were courteous, these vehicles are often overloaded, carrying 30 tons each. The effect of the heavy loads on such rural roads is extreme wear, completely destroying the roadways in major sections. Bikecentennial literature and leaders continually warned the cyclists of the extreme hazards, perhaps holding down the accident rate yet the rate was nearly double that of most other states.

Virginia had a slightly higher-than-average accident rate. Although Virginia had a much better roadway surface than Kentucky, poor visibility and sharp turns with steep descents occurred through much of the state. Dense foliage also cut down on the overall visibility.

Two additional areas demanding concern for safety were Yellowstone National Park and the entire state of Wyoming, where traffic counts were often above 1,000 ADT. It is felt that the extreme care taken by the Officials of Yellowstone National Park and the Wyoming Highway Department helped prevent many potentially serious motor vehicle/bicycle conflicts. In Yellowstone precautionary steps included handouts to all motorists notifying them of the correct procedure to pass bicyclists and a requirement that extension mirrors for vehicles towing trailers must be removed any time the trailer is not being towed, and frequent radio announcements over the special park radio

station. The state of Wyoming posted large (8' wide) special warning signs every several miles and patrolled the highways frequently.

Cyclists Carrying Equipment. One surprising comparison is the great difference in accident rates between bicyclists riding unloaded and loaded bicycles. Those riding with packs and equipment (bikepacking) experienced nearly three times as many accidents as those riding an unloaded bicycle. Unfortunately, nearly 85% of all riders packed equipment. The accident victim rate per million miles traveled for each group on the trail was:

Camping groups.....	83.41
Bike-Inn groups.....	61.02
Independent cyclists.....	62.76
Full Service (no equipment).....	22.23

The full-service group riders rode the same portions of the trail as others with equipment. The only difference, outside of having an unloaded bike, was a slightly different group profile. However, the profile was similar to other short-tour groups that carried equipment and experienced the higher accident rates.

One possible cause of the 250+% increase of accidents among riders carrying their own equipment was the different responsiveness of a bike under a load. A heavily weighted rear wheel tends to unweight the front wheel, reducing the tracking power and steering action of that tire. An unweighted front wheel can slide out from underneath the rider on gravel. Higher downhill speeds are common, and objects such as potholes are not nearly so easily steered around. In short, the loaded bicycle is less responsive and may actually cause the rider to take a greater number of falls in tight situations. Other causative factors include carelessness in packing the bike,

faulty saddlebag or handlebar bag design causing items to fall into the wheel, and overload of a bike design (lightweight 10-speed) not suited to transport heavy loads. Although the 10-speed may structurally handle the added stress, the design may be inappropriate to the new riding style that must be mastered. Further study of loaded versus unloaded bicycles is recommended in order to reduce the number and severity of accidents.

Major Causes of Accidents. Walt Kelly, creator of the famous comic strip character Pogo, could just as well have been describing the major cause of accidents on the TransAmerica Trail when he wrote, "We have seen the enemy and he is us!" The largest portion of the accidents (20%) involved bicyclists colliding with bicyclists. In fact, the next greatest cause, potholes and broken pavement, accounted for only half as many accidents. A majority of these bike/bike collisions resulted from one bicyclist tailing another too closely. This practice, known as "drafting," or "taking a wheel," is often done to reduce the air resistance, especially on a windy day or at high speeds. Although the technique can be used effectively by skilled riders, it requires great attentiveness from all riders and is much more difficult with heavily loaded bicycles which are less responsive. Other causative factors include riders stopping in the road or an unannounced movement by one bicyclist to avoid debris or a pothole.

A contributing factor to this situation may have been the small group format of the Bikecentennial trips. A buddy system, where one rider was expected to ride within sight of another, was encouraged throughout the trail. In addition, the social aspect of group riding kept many riders close together. Although this may have helped in the reduction of serious accidents between motorists and bicyclists, it may have increased bike/bike accidents.

Potholes/Broken Pavement. The second greatest contributor to accidents (10.7%) was the presence of potholes and breaks in pavement. Although a fair percentage of these hazards can be avoided by keen eyesight, attentiveness, and quick reflexes, such obstacles pose a very real and serious hazard to bicyclists, especially on downhill stretches where increased speed and reduced reaction time combine to catapult the rider into a hard and serious fall.

Motor Vehicle Accidents. Motor vehicles were involved in two kinds of accidents--those in which a bicyclist was hit or ran into a motor vehicle (10.4%) and those in which a bicyclist was "brushed," "blown," or "frightened" off the roadway (7.1%). Together these incidents accounted for 17.5% of all the accidents on the trail, and 50% of these required more than first-aid treatment (as opposed to 40.5% average of all accidents). Both deaths, as well as the majority of the serious accidents, involved motor vehicles. Because of the seriousness of motor vehicle accidents, an entire section of this report is devoted to this cause of accidents.

Gravel. Loose gravel on paved roadways accounted for 5.2% of all accidents. Gravel is often found as debris at intersections, on curves, in areas of light road repair, and where driveways enter the highway. Gravel-related accidents are more common on downhill descents and far more serious because of increased speed. About 2.1% of the total distance of the trail was on all-gravel (unpaved) roads. These gravel roads accounted for 2.6% of all accidents. The narrow tires of the lightweight 10-speed bike are more susceptible to damage and more difficult to handle on gravel than the larger tires once standard. Very few of the riders felt comfortable riding on gravel

roads, and many chose alternate high-traffic roadways where more serious and frequent injuries occurred.

Downhills. Although only about 15% of the TransAmerica Trail is steep enough to be thought of as a downhill, a full 38% of all accidents took place while riders were making a descent. In fact, downhills accounted for between 50% and 75% of the accidents in each of the following categories:

- 1) Bike hit hole.
- 2) Bike skidded and crashed.
- 3) Rider fell off.
- 4) Bike hit animal.
- 5) Loose gravel on pavement.

Downhills also accounted for 80% of all fractures and most lacerations. Because of the frequency and severity of downhill-influenced accidents, it is suggested that major emphasis be placed on this added hazard. Especially steep descents should be marked, gravel and potholes should be eliminated, and bicyclists should be advised of the potential of taking a serious fall.

Time of Day. Analysis of time of day failed to reveal any peak periods. Allowing for a slightly higher rate for periods in which most bicyclists would be on the road (10:00 AM through 3:00 PM), the pattern of accidents remained fairly uniform. There was no indication of a greater rate of accidents during the first hour of riding or during the heat of the day. However, a significant increase in motor vehicle-related accidents took place during afternoon and late afternoon hours (see section on motor vehicle-related accidents).

Fatigue. Fatigue may have played a major role in accidents of trips involving daily rides exceeding 70 miles. For persons who planned rides of over 75 miles in one day, 75% of the accidents occurred after they had

ridden 70 miles. In contrast, bicyclists riding shorter daily distances did not experience a sudden rise toward the end of their mileage for the day. This suggests fatigue was an important factor for those who rode distances beyond 70 miles in one day.

Accident Reporting. Although the zero deductible medical plan encouraged reporting of accidents, 67.6% of all accidents went unreported to either the insurance company or police. Approximately 10% of the bicyclists reported their accidents to local police departments. Those accidents most often reported included motor vehicle accidents and injuries requiring medical or hospital treatment. Accidents requiring no more than first-aid treatment are rarely reported.

Bicycle/Part Failure. Bikecentennial riders were asked if malfunction of a specific part of their bike caused the accident. Out of the 308 accidents, 21 have been ascribed to part malfunction. Of these, 5 were attributed to brakes, 3 to forks, 2 to cranks, 3 to chains or derailleurs, 5 to panniers, handlebar bags or carriers, and 3 to wheels. Further study is needed to determine if these accidents are related to product design and manufacturing or to poor maintenance. Many accidents were attributed to faulty design of panniers and handlebar bags, which might break loose on a downhill descent and jam the wheel. Of even greater concern is the marked rise in accidents (nearly triple) of those using lightweight bikes to carry 20-40 pounds of camping gear. Additional study is needed to determine the best design for *bikepacking* type bikes.

Roadway Condition. A dramatic 59% of the riders reported that the roadway condition was a factor in the accident. Of these, 35% listed bad shoulder as the factor, 20% gravel conditions, 16.6% potholes, 10% wet/

slippery conditions, and 7.0% debris. Bumps, uneven pavement, sharp unmarked curves, and rough railroad crossings made up the remaining miscellaneous factors.

Speed. The average speed at the time of accidents was 12-14 mph. In contrast, the average speed of all the riders throughout the summer is reported at 11-13 mph. Although there is not a marked difference in speed, the more serious injuries are tied directly to greater speed. For example, those cyclists who suffered cuts while traveling less than 15 mph were less likely to require stitches than those who were traveling at more than 16 mph. Sixty percent of the riders who suffered fractures were traveling at a rate of 16 mph or greater. One out of four of the accident victims reported they were traveling above their normal speed at the time of their accident. Thus, although higher speeds do not appear to be a major cause of accidents, speed increases the likelihood of a more serious injury, and suggests a greater rate of accidents. Actual speed may not be as great a factor as the loss of control experienced by traveling at a higher rate than normal for the rider. The higher speed of more youthful riders seems to be a factor in their greater-than-average accident rate.

Falls. In analyzing the severity of injuries we learned that falls from a bicycle resulted in the most severe injuries. Hospitalization was required more frequently when the bicyclist was hit by a car, the rider fell off, or the bicyclist hit an animal.

Severity of Accidents. Accidents were classified according to treatment of injuries. Those requiring no first aid or medical attention were considered the least serious, and those resulting in permanent injury or death as the most serious. A breakdown by classification appears as follows:

(Note: Figures exceed 100% due to use of multiple questions.)

No Treatment Required.....	13.0%
First-Aid Administered.....	59.1%
Additional Medical Treatment.....	35.7%
Length of Hospital Stay:	
a) Does not apply.....	70.4%
b) Released same day.....	20.1%
c) Overnight stay.....	01.3%
d) 2-3 days.....	02.3%
e) 4-6 days.....	04.2%
f) 1 week or longer.....	00.6%
Permanent Injury.....	06.2%
Death.....	00.6%

(Above figures based on 308 most serious accidents out of 399 reported.)

Permanent Injuries. Out of the 399 accidents reported during the summer, 19, or 6.2% resulted in a permanent injury. Of these, 16 were severe enough to prevent completion of the trip. The greatest percentage of permanent injuries involved injury to the head or face. Since the respondent used his/her own judgment in listing an injury as permanent, a portion of these 19 injuries may be moderate, limited to a major scar, slight disfigurement, or minor nerve loss. Of these permanent injuries, our best judgment leads us to believe that roughly one out of four injuries was severe enough to be considered disabling to any degree. Disabling injuries included partial loss of hearing, some restriction in limb movement, or severe loss of limb movement.

Fatalities. During the operation of the trail in 1976, two cyclists were killed by overtaking motor vehicles. Further details of these incidents are presented in the special section on motor vehicle accidents.

Accident Costs. Another opportunity of this study was a complete analysis of the costs associated with the accidents. Bikecentennial contracted a major medical insurance company to underwrite all participants with a zero deductible accident/health plan for all illnesses or injuries up to \$1,500 per incident. Although the zero deductible plan may have encouraged many bicyclists to seek treatment for relatively minor injuries such as cuts and scrapes, the plan obviated non-treatment that may have led to serious infections or permanent scars. It is interesting to note that along portions of the trail quite distant from a hospital, relatively few bicyclists sought treatment beyond first aid. Thus areas near hospitals showed increased accident rates. A breakdown of cost percentages appears as follows:

Accidents resulting in medical costs under \$25.....	16.2%
Accidents resulting in medical costs under \$50.....	93.2%
Accidents resulting in medical costs exceeding \$300.....	3.6%
Accidents resulting in property losses under \$50.....	88.0%
Accidents resulting in property losses over \$100.....	7.8%

Accident damage to bicycles occurred in 55.8% of all cases, and other property loss in 11.7% of all cases.

Types of Injuries. Most bicycle injuries include a fall at moderate speed (8-15 mph) resulting in sliding or tumbling along the road or road edge. Since much of the riding occurred on warm days, bicyclists wore very little protective clothing. The reported injuries by type are listed below:

<u>Non-Injurious</u>	7.9%
<u>Non-Incapacitating</u>	
Cuts and Scrapes.....	51.0%
Bruises.....	13.0%
Sprains.....	4.9%
<u>Incapacitating</u>	
Lacerations Requiring Stitches.....	7.2%
Fractures.....	3.3%
Concussions.....	3.3%
<u>Fatal</u>6%
<u>Miscellaneous/Multiple Injuries</u>	11.8%

Summary. Although this concludes our coverage of data on accident severity and causation along the TransAmerica Trail, it serves only as an overview of the real and serious nature of bicycling accidents. These other important facts were uncovered. Bicycle accidents are almost always multiple caused. Poor road design, inattentive riding, or high-volume traffic do not by themselves lead to an accident; however, a combination of two or three factors makes an accident more likely. It is our belief that as many as 70% of all trail accidents could have been avoided, with greater knowledge and care by bicyclists. Bicyclists in the 16-20 age group need to understand the very special risks they encounter because of their riding style. All bicyclists need to be aware of the nearly tripled accident rate when riding a fully loaded bicycle. The likelihood of bike/bike collisions should be explained to those who plan to ride close together. The added risk of downhill riding is evidently not obvious enough to those riding mountainous terrain.

Roadway design and maintenance improvements, we believe, could also help prevent many accidents. Debris, potholes, lack of adequate shoulders,

unmarked hazards, and gravel on paved roadways should be eliminated in all areas of frequent bicycle traffic.

MOTOR VEHICLE/BICYCLE ACCIDENTS

Overview. We have chosen to emphasize motor vehicle/bike accidents because the potential for extended injury and the added problems of shared highway use are serious concerns. Our investigation showed that an unusually high number of motor vehicle-related accidents go unreported, especially the incidents where a motorist crowded a cyclist off the road. Motor vehicle-related accidents caused both deaths along the trail and a higher percentage (10%) of injuries requiring treatment beyond first aid. Motor vehicle-related accidents introduce another element to the safety issue--many motorists are unfamiliar with how to respond to non-motorized vehicles. In this section we discuss each of these issues and suggest ways of improving the present situation.

Rate of Motor Vehicle/Bike Accidents. Motor vehicles were involved in 54 of the 308 documented accidents (17.5%) or an average of 5.20 accident victims per million miles traveled. Of the bicyclists involved, 45.8% reported being frightened, blown, or brushed off the roadway. The other 54.2% of the accidents involved a motor vehicle hitting a bike (24 cases), a bike hitting a parked car (5 cases), or a bicyclist running into moving car (3 cases).

Type of Involvement.

A) Overtaking Motor Vehicle. Most bicyclists have a fear of being hit from behind by an overtaking vehicle. Although only eight such accidents were reported on the trail (2.6% of accidents), each was quite serious. Both deaths and four other injuries leading to permanent disabilities were the

result of accidents with overtaking vehicles. Likewise, many motorists are concerned with the safest means of passing a bicyclist and sometimes pass with nervous concern. On open highways, where the closing speed is often 40-50 mph, overtaking accidents are a serious threat.

B) Hit from the Side. A similar number of bicyclists (eight, or 2.6%) were hit from the side. These accidents took place either at intersections or where the motorist made a turn into a driveway or entranceway. Although not as serious a threat, since the speeds are usually reduced, such incidents can also prove fatal.


C) Brushed by Car. This type of accident usually involved an indirect hit to the bike and rider hard enough to cause a fall. Eleven such accidents were reported, several resulting in serious injuries. Often the motorist was not aware of hitting the bicyclist, and continued on, perhaps narrowly missing other bicyclists further down the road. A few such incidents involved motorists who were attempting to frighten the bicyclist or simply did not wish to yield. One motorist was caught after having assaulted four bicyclists by punching them off the roadway by using his fist through an open window.

D) Blown Off Road. Fifteen bicyclists listed the cause of their accident as being blown off the roadway by a passing motor vehicle. In all but 3 cases the riders weighed under 150 pounds, and 60% of the incidents involved a semi-tractor trailer. A more serious related accident took place several weeks before a rider was to start the trail. A strong cross wind and passing truck created a suction that literally drew a Whittier, California rider beneath the wheels, leading to immediate death. Cyclists and motorists alike need to be alert to the very special risk of overtaking vehicles on

windy days. A bicyclist learns to lean into a cross-wind that exceeds 15-20 mph. When a large vehicle (a car is large enough) suddenly blocks a cross-wind from the rider's left, the rider can literally fall beneath the wheels of the vehicle. Our limited study of suction and air blast accidents leads us to believe that additional research should be conducted, and specific warnings should be issued to both bicyclists and motorists. Professional truck drivers should be specially targeted to be informed of techniques for passing a bicycle.

E) Frightened Off Road. Thirteen accident victims were frightened or forced off the road by a passing motor vehicle. Several such incidents involved motorists traveling at a high rate of speed and sounding their horns at the last instant. Several serious falls resulted. In several instances the bicyclist became aware that the motorist was not going to yield and left the roadway to avoid a more serious injury.

F) Miscellaneous. Other motor vehicle/bicycle-related accidents of great potential threat were experienced. At least two bicyclists simply did not look to the rear and turned directly into the path of a passing vehicle. One girl in Yellowstone Park narrowly missed death when she made such a turn. The truck driver locked his brakes, skidded into the bike, and pushed the fallen bike and rider nearly 30 yards. The bicycle pannier locked in the truck's wheels, preventing the truck from riding over the bike and bicyclist. A second serious mishap occurred on a steep downhill when the rider lost control, entered the opposing traffic lane, and skidded beneath the chassis of a passing automobile. The bicyclist escaped with abrasions and minor lacerations.



Types of Vehicles. Although no record was kept of the percentage of motor vehicle types that used the trail, accident victims identified the following as involved in their accident:

Automobile.....	39.0%
Recreation Vehicle.....	9.0%
Pick-up Truck.....	12.0%
Semi Truck.....	20.0%
Other.....	17.5%

In general, because of the differences in traffic, truck-involved accidents took place during the normal work week, and automobile and RV accidents increased during the weekends.

Time of Day. Anticipating that motor vehicle accidents would increase dramatically after 4:00 PM because of dim light, glare, fatigue, increased traffic, and potential for drunken drivers, bicyclists were encouraged to be off the road as early in the day as possible. Most of the accidents that involved motor vehicles occurred in the afternoon, and rarely before 11:00 AM. The only two exceptions involved coal trucks, at 8:00 AM and 9:00 AM.

Coal Trucks. One of the most hazardous areas of the trail was a band of roads through the coal seams of eastern Kentucky. Members of the coal industry, the Kentucky Highway Department, and others were involved in selecting the safest possible roadways. Nevertheless, at least two days of riding through very poorly maintained coal transport roads were necessary. Riders and truck drivers were asked to be on the alert and to help one another whenever possible. Many of the coal trucks were rated at 30 tons and they often carried even more. Drivers work against the clock to pay off their trucks, so delays on the road cut into the family's wage. Fortunately, most bicyclists and truck drivers, anticipating one another's needs, worked out a good

plan for sharing the roads. Truck drivers used their CB messages to alert each other to the location of the bicyclists, and bicyclists, being alert to the sound of an approaching coal truck, usually dismounted and waved a friendly greeting as the trucker passed.

Unfortunately, not all accidents were avoided, but the majority of incidents were limited to a bicyclist being forced off a roadway.

Intersections. Although the TransAmerica Trail is quite rural in design and had very few intersections, 13% of the accident victims reported that their most serious accident occurred at an intersection. This confirms the results of most other studies that investigate the importance of intersections and traffic conflict in the role of accidents. Our statistics show: the majority of the accidents that involved a bike hitting a moving or parked car occurred at an intersection; when an accident involved a motor vehicle collision at an intersection, the cyclist was most likely to be hit from the side; and thirty percent of all concussions and 20% of all fractures occurred at an intersection.

Location. Aside from incidents at intersections, the majority of motor vehicle-related accidents occurred in Wyoming, Kentucky, and Virginia. As discussed in a previous section, both Kentucky and Virginia have narrow, winding roads with no shoulders and poor visibility. Lush vegetation and steep hills can hide motor vehicles (or cyclists) until it is almost too late. In Wyoming heavy traffic, high winds, and lack of variety in terrain added to the hazards of shared use. These factors point out the extreme importance of blending good highway design with motorist and cyclist education, in order to reduce the risk of accidents. It was often the compounding of factors that led to serious accidents.

Vehicle Design and Accessories. Extension mirrors, commonly used when towing trailers, have long been a grave concern to bicyclists. Several bicyclists on the trail were hit by such mirrors, and one bicyclist who continued on his own after finishing the trail was critically injured by a passing vehicle's extension mirror. Other hazards include sharp ornaments or projections on cars that may cause a serious direct blow to the cyclist in the event of a collision. Manufacturers and motorists should be alert to the potential hazard these designs pose to the non-motorized traveler.

Fatalities. During the operation of the trail in 1976, two cyclists were killed, both as a result of motorists overtaking cyclists. The two victims, ironically, were members of the same group. One incident took place in Missouri, while the second happened in Montana. These states were listed as having the lowest rates of bicycling accidents. Our investigation of the accidents revealed the following:

--Both accidents occurred in mid or late afternoon, on highways less than 25 feet wide, with no traffic, good visibility, on good pavement, and during good weather.


--Both bicycles were demolished, the right side of the automobile windshield was shattered, and neither driver (male age 28, male age 35) was injured. Both were driving alone at the time of the accident. Details of the two accidents follow.

Particulars of Death of Female Cyclist. The female cyclist was the only woman in a group of male cyclists that constituted a TransAmerica camping group. The group was riding east to west and were approaching the town of Ash Grove, Missouri. Although the young woman had stated in her letter of application to Bikecentennial that she had always dreamed

of riding a bicycle across the country, she had little experience in bicycle touring other than what she had gained in riding through Virginia, Kentucky, Illinois, and the eastern part of Missouri. Our reports indicate that the young woman was a source of friction among the other group members in that she was the slowest rider of them all. Consequently, she was always to be found at the rear of the group, followed only by the assistant leader or leader of the group. On the day of the accident, the young female cyclist was riding alone behind the majority of her group. The leader of the group and another male cyclist (the cyclist later to be killed in Montana) had stopped behind the female cyclist for an ice-cream cone.

The roads in Missouri are well paved, providing good visibility for both bicyclists and motorists. Like other roads in that state, the road on which the accident occurred traversed rolling hills. The road surface was dry asphalt, the weather was clear, and the traffic was light. No other motor vehicle was in the vicinity of the accident when the collision occurred. The highway on which the victim was traveling in a southbound direction was in open country that had scattered residences. The accident occurred 0.6 mile north of the town of Ash Grove, Missouri.

At the time of the accident, the accident victim was proceeding up a long incline. The driver of the car involved in the collision stated that he was coming down a hill and saw a girl in the distance on a bicycle with heavy laden packs. He stated that the cyclist was moving slowly and her bicycle was moving from side to side. As he attempted to pass, the bicycle swerved into the auto. He indicated that he thought he had sufficient clearance to pass the cyclist, but just as he started to go by her, she swerved over and then started to swerve back to the right. The cyclist was



thrown on to the hood and struck the windshield. The driver slowed to a stop so as not to throw her off the roof. The cyclist then fell off onto the grass on the shoulder of the highway. The automobile proceeded a short distance further before coming to a complete stop. The force of the collision broke out the top right corner of the windshield. Her head hit the top right corner of the windshield, but it was her shoulder that went into the windshield. The top of the roof line of the car made a very deep cut across the victim's right shoulder and down her back. She also had a hole in the back of her head. It was later determined that she also suffered lacerations about the head, shock, and a broken right arm and right leg. Cause of death was listed as four small heart attacks and a rapid loss of blood. It was determined that she had severed an artery in her right shoulder. The investigating officer reported that the collision was not a hard impact as the speed of the motorist was only 30 to 35 miles an hour. He speculated that the cyclist might not have died had she not hit the windshield and roof line of the automobile. First aid was administered to the victim by a hospital employee who attempted to stop bleeding by applying pressure. The person who was administering first aid stated that she had experience in treating this type of injury. The cyclist was never conscious in the investigating officer's presence and never regained consciousness before she died a couple of hours later.

It was determined that the motorist had tried to pass the cyclist while straddling the line in the middle of the highway. The right side of his car was three feet to the right of the center line. The area was designated as a passing zone. The vehicle that collided with the cyclist was a 1968 two-tone, two-door Dodge automobile. The bicycle belong to the female cyclist

appeared to have been hit directly from behind. The seat stays, the chain stays, and the rear wheel were crushed directly toward the front of the bicycle. Items such as cosmetics and other breakables that were located in the cyclist's panniers were also broken. The driver of the vehicle was issued a citation for careless and imprudent driving and improper passing.

A possible explanation of the cyclist's behavior, as reported by the motorist, could be as follows: after riding all day in the hot sun over "roller coaster" hills of Missouri, an exhausted female cyclist found herself at the limit of her endurance. Pedaling a fully loaded bicycle equipped for bicycle camping, she encountered the last long grade before reaching her destination for the evening. Although not out of control, her slow speed required that she consciously steer the bicycle underneath her to prevent a fall. A side-to-side motion would have given the cyclist a slight advantage over an upgrade by reducing the slope, much as a downhill skier traverses a downhill ski slope to reduce the grade or a sail boat tacks from left to right across a headwind. A combination of these movements and inadequate clearance allowed by the motorist resulted in the collision death of the female cyclist. We conclude that the responsibility for the accident belonged to both the motorist and the cyclist.

It is our recommendation that cyclists who operate heavy laden bicycles be aware of the potential for sideward movements on an upgrade. Adequate downgearing should be implemented before the bicycle begins such motion. Likewise, it should be brought to the attention of motorists that there exists a potential for underestimating the clearance that must be given a cyclist on the roadway.

The ironic conclusion to this case was that the driver of the automobile was acquitted of criminal charges because of a technicality. The judge who heard the case refused to let the police department enter evidence that the person charged with imprudent driving and improper passing was actually the driver of the automobile. The judge maintained that since the car was not occupied at the time the police arrived, no one could testify that the person charged was the driver.

Particulars of Death of Male Cyclist. The male cyclist who was a member of a TransAmerica camping group left the group in Fairplay, Colorado, and continued westward as a registered independent. Approximately two and a half miles outside of Dillon, Montana, this male cyclist was struck by a van and killed. Although no longer a member of a group, the cyclist had joined one other male cyclist in West Thumb in Yellowstone Park approximately one week before his death. Both cyclists were proceeding single file in a southwesterly direction into Dillon. The cyclist who was killed was the rear biker.

The male cyclist who was hit was 34 years of age and had previous bicycling experience. The deceased cyclist was known to be conscious about bicycle safety techniques and utilized these techniques on the roadway. He always wore a helmet, he rode in a straight line and close to the right-hand edge of the pavement, and he always wore bright clothing. The cyclist was also wearing a fanny bumper (an orange triangle highly visible to the rear which indicates a slow-moving vehicle) around his waist. In addition, the panniers that he carried were red and so was the sleeping bag strapped to the top of the panniers.

At the coroner's court, the surviving cyclist stated that they were proceeding in a southwesterly direction about 50 to 100 yards apart at a speed of 10 miles per hour. He indicated that the road that they were traveling upon was unmarked and had just been repaved. It lacked markings on the side or center of the road. The first cyclist stated that he was able to view the activities from behind through the use of a small rearview mirror attached to his glasses. He stated that he saw a van overtaking from the rear that appeared to be passing the second cyclist. He said it was in the middle of the road, entering the passing lane, while the second cyclist was off to the side of the road as usual. No other cars were in the vicinity. The first cyclist next recalled that he heard a noise that sounded like a shotgun going off and then a moan that sent him off the road into a ditch. Immediately afterward he saw the van pass. The first cyclist returned to the second cyclist who was lying off to the side of the road on his side and not moving. He stated that there were bicycle parts all over the road. He called the cyclist's name but there was no response. At that time the first cyclist left to summon help. He later recalled that the sun was in his eyes earlier as the two came into town; but as soon as the two cyclists entered the section of unmarked blacktop, the sun went behind the clouds so that they were in a shaded area.

The driver of the van testified that he had left Billings earlier in the day in a company van on route to Idaho Falls, Idaho. He testified that the vehicle was a 1976 Chevrolet Maxi Van that he had been driving for about four and a half hours that afternoon. The driver stated that he had consumed a beer for lunch but only a soft drink between that time and the time of the accident. He indicated that it was extremely hot in the van and the

ventilation was bad. Although he had indicated to the investigating officer at the scene of the accident that he might have been drowsing, he testified later that he was not. He was just exhausted and very hungry. His attention was on a fast-food restaurant up ahead in Dillon. Just as that thought went through his mind, the accident occurred. At first he thought that he had hit a trash barrel or a sign post, but after the sudden shock of the impact, he saw that he continued to be in the road. At that time he slowed down and went back to investigate what he had hit. He stated that he had not even noticed the bicyclists. Although the sun was coming in the front windshield, the driver of the vehicle did not wear sunglasses as they were not prescription and he could not see well enough with them. The driver of the vehicle recalled that it was partly cloudy and partly sunny. He did remember seeing the sun reflecting in the broken glass shortly after the accident but that it could have been cloudy at the time of the impact. He could not remember. He did recall that earlier he was fighting the sun a little bit and that the visor was down in the van most of the time. The driver rationalized his inability to see the cyclist as the result of sitting at a very high elevation in the van--when he looked off in the distance, he was not aware of the cyclists immediately in front of him.

As a result of the accident, the driver of the van was found unintentionally negligent. The bicyclist who was killed died of a broken neck and suffered other injuries.

The deceased cyclist had attended a week-long training course for Bikecentennial leaders earlier in the summer. He had traveled from Yorktown, Virginia, to western Montana. He took necessary precautions to be visible and rode in a responsible manner. He used bicycle safety equipment that

included a helmet and a fanny bumper. He was traveling in a straight line approximately 12 inches from the right-hand edge of the pavement. There was no evidence that the bicyclist made any erratic movements immediately prior to the accident.

The driver of the van had been on the road the entire afternoon. The sun was in his eyes and he was hot and thirsty. His thoughts were directed to other matters than the roadway conditions.

This is a case where the two participants in an accident situation had a high degree of experience in operating their vehicles on the roadway. In the light of the facts that were presented at the Coroner's Court, we conclude that the bicyclist was not responsible for the accident. Further, that even experienced bicyclists are susceptible to chance conditions on the highway.

We recommend the following:

1. That bicyclists be alerted to the potential for severe accidents even when all precautionary procedures have been taken.
2. That cyclists be encouraged to incorporate their sense of hearing with safety devices such as rearview mirrors to aid in their perception of the location and closing rate of overtaking vehicles.
3. That drivers of motor vehicles be continued to be made aware of safety precautions that include rest breaks in long trips, clean windshields for good visibility, and the necessity for glare reduction sunglasses when driving into the sun.

Summary. The motor vehicle is a part of the cyclist's environment over which he has limited control. There is little uniformity in how bicyclists or motorists approach one another for greatest safety. The relative difference in mass and speed between the 30-pound bicycle traveling at 15 mph and the 60,000-pound coal truck at twice or three times the speed should be of concern to everyone contemplating sharing such roadways. The development of sensitivity on the part of every highway user in understanding the other driver's problem is a must. As mentioned before, until the motorist is able to recognize the special problems confronting bicyclists and understands how best he may share the roadway, unavoidable accidents will continue. The cyclist who insists that the safest point on the road is always the center of his lane may one day learn the motorist too has a very special need to be understood. Loads may shift, windshields may be dirty, and the sudden recognition of a cyclist and opposing traffic may leave little chance to the driver to allow enough room. Attention to highway and route planning and increased understanding can reduce bike/motor vehicle accidents dramatically.

BICYCLE EQUIPMENT, PARTS, ACCESSORIES

Overview. During the last half of the 1960's a radical shift in bicycle purchases took place. The modern lightweight ten-speed bicycle began its domination of the bicycle market in America. The new user was the adult. In the next ten years more than 45 million new bikes were added to the market, more than doubling the number of bicycles in America. Today, following light sales in 1975 and 1976, strong growth has returned to the bicycle market, with annual sales during the next five years projected at 8-10 million per year. A healthy percentage of these will be ten-speeds (50%).

This section of the report discusses the handling characteristics of the adult ten-speed, safety factors, safety accessories, bright clothing, and what effect equipment has on cause and prevention of accidents.

The Bicycle. The bicycles used by the participants of Bikecentennial were lightweight ten-speed machines. A few participants used three-speed bicycles, and one person cycled across the country on a single-speed bicycle. Ten- and fifteen-speed (a variation of the ten-speed that has an additional chain ring) bicycles, in fact, comprised 98.9% of all bicycles in use on the trail. All but 10% of the bikes in use on the trail had 27-inch narrow tires ($1\frac{1}{4}$ -inch). The bikes averaged 28-30 pounds in weight.

This bike is often selected for long-distance touring for its lightness, low-rolling friction, responsive handling, and flexibility for meeting the challenging terrain. Used properly, the bike allows greater bicycling efficiency. Following a few days of practice, distances of 40-60 miles can be handled with relative ease, and a day of 100 miles is within the reach of many.

Equipment Features. There are many options in equipment on the ten-speed, and several play an important role in its handling and the safety of its use for touring. The most basic part of the bike, the frame, is one of the more critical factors. The predominant frame type used on the trail was the diamond (traditional men's frame). Although nearly one-third of all riders were women, only 2.9% of the frames were the (women's) dropped tube frame; another 3.6% were the slanted mixte frame. The diamond frame accounted for 91.2% of all frames in use. Another 1.6% of the frames were tandem.

The diamond frame has excellent handling characteristics, is the lightest in weight and the strongest on the commercial market. Few people pay attention to their frame selection, other than to buy a size that feels right. However, when purchasing a frame for touring purposes it is important to choose a model that is not likely to shimmy. Bikes which are designed primarily for racing, or have a short wheel base, thin guage tubes, or short fork rake, are all prone to shimmying on fast downhill descents. This phenomena is especially likely when 20-30 pounds of weight is added to the rear of the bike (panniers), and sets up a swaying motion when the bike is turned. The hazard is especially pronounced for tall people who require frame sizes above 23 inches. Bicyclists are cautioned to check with their local bike dealer and announce the intended purpose of the bike, so that characteristics that lead to shimmying can be avoided. Also important in handling, a frame should be "tracked" when the bike is being set up by a bike shop. This simple, but precise, procedure is rarely done, but adds dramatically to the overall performance of a bicycle.

Wheels. Most of the bicyclists (90%) rode the trail on the thin 27" x 1¼" tires found as standard equipment on most ten-speeds. Although this wheel

is one of the most efficient and responsive in use, it is more fragile and prone to abuse. The wheel will not hold up to potholes, debris, and gravel as well as the once standard lightweight (26" x 1 3/8"). We do not have sufficient data to suggest which wheel performs with greatest safety. For the time being it is suggested that bicyclists be informed of the different handling characteristics and be alerted to the specific hazards that may cause trouble.

Other Parts. The drop style handlebars made up 95.7% of all handlebars along the trail. Brakes were hand controlled in 97.4% cases, with 22.1% of the riders using the brake extension levers as an added feature. An unusually high percentage of riders (94.8%) used toe clips for added efficiency. Used properly, toe clips cut down on accidents by preventing foot slippage.

Breakdowns, Part Failures. Bikecentennial riders were asked to list any parts that failed during the summer. The ten-speed bike, if well maintained, continues to perform well. However, many riders started out on ill-maintained bikes, and subjected the machines to severe conditions. The "working parts" of the ten-speed bicycle are exposed to the elements. Derailleurs, chain, crankset, sprockets, free wheel, and brakes are all components that are vulnerable to damage from impact, mud, grit, maladjustment and wear. In order to enjoy a bicycle to the fullest extent and with the greatest safety, the rider must have at least some basic knowledge of the mechanical principles required to keep a bike well maintained. Derailleur cables and brake cables need to be set at the proper length, front and rear derailleur adjustment screws have a proper setting, spokes must have the proper tension to provide wheel alignment and roundness, tires must be kept at proper inflation pressure,

and all bearings, including those found in the headset, bottom bracket, pedals, and axles, have a proper adjustment.

The influence of a trained leader and the environment of a small group were ideal for the instruction of *basic* maintenance and impromptu seminars on the care of various bicycle components. We feel confident that this was a contributing factor in reducing bicycling accidents for the long-distance cyclists.

Of the accessories and parts that did fail, the components associated with the power train (sprocket, chain, free wheel, cluster, and derailleurs) failed most frequently.

Power Train Parts that Failed

Rear Derailleurs.....	8.8%
Front Derailleurs.....	5.9%
Chains.....	9.0%
Free Wheels.....	9.0%
Cranksets.....	6.8%

Non-Power Train Parts that Failed

Pedals.....	5.5%
Brakes.....	3.4%
Rims.....	6.4%
Seats.....	4.1%
Seat Posts.....	0.6%
Handlebars.....	0.2%
Hubs.....	4.6%
Spokes.....	29.6%
Headsets.....	2.5%
Other Items.....	10.9%

Accessories. The common accessories used by a bicycle tourist include a rear carrier, rear panniers, front handlebar bag, water bottles, and a tire pump. In addition, tents, sleeping bags, campstoves, and cooking pots are often strapped to the rear of the bicycle with shock cords. Since we noted a nearly triple accident rate for bicyclists transporting equipment with packs and carriers, we examined accessories closely.

Carriers. Most everyone used a bolt-on carrier, which lacks rigidity under a load and tends to allow the weight to shift back and forth, especially when climbing a mountain or in a sudden turn to avoid a pothole, gravel or debris. An unexpectedly high percentage (13.8%) of riders reported that their carrier failed. A well-designed carrier system should include:

- 1) Rigidity
- 2) Low center of gravity
- 3) Secure frame attachment (brazed or clamped at two points)
- 4) Structural stays capable of supporting load
- 5) Level top
- 6) Access to brake mechanism

Panniers and Handlebar Bags. Bicycle panniers, packs, and handlebar bags received a thorough workout during the summer's activities. Most of the problems with these accessories centered around the fastening devices. Velcro straps came loose, and some metal snaps sheered off. In either case the bag could fall into the wheel, causing a serious accident. The failure rate for panniers and handlebar bags was 15.1%. Our feeling is that considerable study is needed toward reducing the frequency and seriousness of these accidents.

Safety Accessories. To encourage safety, Bikecentennial recommended basic safety equipment to aid in visibility of the cyclist, detection of overtaking traffic, and protection of the head. These safety items and their value is discussed below.

Rearview Mirror. The most popular mirror is a small one-inch square glass mounted on eyeglass frames or the visor of a helmet. The design resembles the standard dentist's mirror. Worn two inches from the eye, the mirror provides an excellent view of approaching traffic with a slight twist of the head. This allows the rider to be aware of any potential

hazard without having to turn around, a maneuver that causes the rider to sway into traffic. It is difficult to estimate how many accidents were avoided through the use of such a mirror; however, about 16% of the riders used such mirrors, and no riders using such mirrors were hit by an overtaking motor vehicle. Further, it was through the use of a rearview mirror that a cyclist had information to testify at a coroner's court in Dillon, Montana, about the events that led to the death of one of the TransAmerica bicyclists. Other types of mirrors in use include a wrist-mounted mirror and a standard handlebar-mounted mirror. The handlebar-mounted mirrors are not popular among bicycle tourists due to their ineffectiveness due to vibration, difficulty of adjustment, weight, and potential of being brushed by an overtaking auto.

Helmets. Bicycle helmets are credited with having protected several riders from serious concussions. About 27% of the riders reported they used a helmet on their trip. However, those having accidents disclosed that only 22% were wearing a helmet at the time of their accident. Hot weather and other factors led to a number of helmets being carried on the back of the bike, leaving the rider unprotected. Getting adequate ventilation and head protection is a real dilemma for the bicyclist, since most tourists ride during the hot summer months. Inadequate ventilation could cause heat exhaustion or other illness. Additional study is needed in helmet design.

Important characteristics of the well-designed helmet are as follows:

- 1) Lightness in weight
- 2) Protection from axially and radially directed impacts
- 3) Ventilation
- 4) Light color and reflectivity

Fanny Bumpers and Safety Flags. Bikecentennial issued a fanny bumper or safety flag to all group cyclists to increase their visibility on the

road. A fanny bumper is an orange fluorescent triangle, international symbol of slow-moving vehicles. These items, along with bright clothing and equipment, are credited with reducing the number of overtaking accidents. About 70% of the riders stated they frequently wore bright clothing. In contrast, 52.3% of the accident victims said that they were wearing bright clothing on the day of their accident. Fanny bumpers and safety flags could be seen from distances of 200-600 yards, often well before the actual rider was clearly distinguishable. Motorists have been reported to be more cautious in their approach to riders displaying these added safety devices. Based on our observations, it is our belief that bright clothing and reflective safety devices such as fanny bumpers and flags are a helpful deterrant to bike/motor vehicle-related accidents. The value of such items becomes especially important during twilight, in fog, and on cloudy days. It is recommended that bicycle touring equipment such as packs and handlebar bags be manufactured in bright colors, such as yellow, orange, or red.

ROADWAY DESIGN AND MAINTENANCE

Overview. Accident rates varied as much as 300% between different roadway conditions along the TransAmerica Trail. This single bit of evidence, backed up by other statistics on where and how accidents occur, lead us to believe that one of the most effective ways of reducing bicycling accidents is to locate and promote the use of lightly traveled roadways that meet safe bicycling design criteria. In this section of the report, we discuss the criteria found most helpful for reducing roadway influenced accidents, the need for maintenance, liability problems, and a list of route characteristics cyclists prefer.

Rate of Roadway-Influenced Accidents. As discussed earlier in this report, accident rates varied from a low of 29.4 accident victims per million miles traveled in Missouri to a high of 101.5 in Kentucky. A few areas had estimated rates of more than 1,000 accidents per million miles. Bicyclists left the trail occasionally in favor of faster or better paved roadways. Although off-trail riding was estimated to be only 2-6% of the trail length, 18.6% of all accidents during the summer took place off the designated trail. Other evidence that use of casually selected highways leads to greater accidents includes the following:

- Jerry Kaplan's (FHWA) study of League of American Wheelmen (adult) cyclists in 1975 showed an accident rate of 113 accidents per million miles. This contrasts with 79.8 on the TransAmerica Trail.
- At least 3 deaths and 20 serious injuries were reported to Bike-centennial as having happened to bicyclists using casual routing to or from the trail. These accidents were not included in the data base for this report.

Design of the TransAmerica Trail. The TransAmerica Trail was developed over a three-year period, requiring the cooperation of 10 states and more than 90 municipalities. The work was coordinated by Bikecentennial and was based on criteria established through work with the Federal Highway Administration, U.S. Department of Transportation; Bureau of Outdoor Recreation, U.S. Department of Interior; and several private research and user groups. A complete description of the criteria is given in the Appendix. In many areas the trail was not ideal. Whenever possible, the roads incorporated as many of these specifications as practicable: low traffic volume (below 1,000 ADT's); smooth unbroken pavement, clear of potholes, bumps, or debris; maximum road width; road edge blends with paved shoulder; good visibility; low volume of cross traffic; gradual grades and curves; area of low urban development potential; attractive scenery; easy access of nearness to centers of great population; popularity with local bike club; and direct route.

It was difficult to apply the above criteria to a route spanning the entire nation. Several of the criteria, such as "near centers of great population" and "low traffic volume," are contradictory; and we preferred the low traffic volume. As much as 2.4% of the trail is on gravel roads to avoid heavy traffic. To give insight into which of the design criteria are most suited to the *wants* and *needs* of bicyclists, our survey included specific questions on design preference.

Cyclist Preferences. In order to learn what hazards are of greatest concern to bicyclists, we included in our survey questions regarding road conditions, specific hazards, and vehicles. Note the difference between perceived hazards and actual percentages of accidents. The hazards are listed in the order in which they were perceived by the cyclists, and the percentages indicate the actual frequency of accidents caused by these hazards.

<u>Road Condition</u>	(Frequency)	<u>Other Hazards</u>	(Frequency)	<u>Vehicles</u>	(Frequency)
(1) Broken Pavement.....	10.7%	Railroad Tracks.....	1.6%	Recreation Veh....	8.9%
(2) Gravel on Pavement.....	5.2%	Animals.....	2.0%	Tractor-trlr....	20.2%
(3) Gravel Road.....	2.6%	Cattle Grates.....		Automobile.....	39.0%
(4) Unmarked Hazard.....		Bridges.....		Other.....	17.5%
(5) Debris.....		Tunnels.....		Local Trucks....	

High Volume Traffic. Of great concern to most bicyclists is the noise, pollution, and nervousness accompanying having to share roadways with large numbers of cars. To indicate just how serious bicyclists were about avoiding such roadways, Bikecentennial riders were asked to choose among alternatives. Their responses appear as follows:

Hills. To bypass a busy roadway section of 25 miles, 81% of the respondents would use a less traveled roadway that had 10 to 30% more hills. In support of this, most bicyclists preferred the mountainous terrain of Oregon, Idaho, Montana, Wyoming, Colorado, Missouri, Kentucky, and Virginia to that of Kansas. Varied terrain adds dramatic variety to a route without appreciably slowing the rider. Novice bicyclists, or those using a route for commuting or utility use, may not seek such variety.

Distance. To bypass a busy roadway section of 25 miles, 89.8% of the riders would use a less traveled roadway that added 5 miles to their overall mileage. Again, utility or commuter bicyclists may not choose such an option.

Gravel. In order to avoid a busy roadway section of 25 miles, cyclists would travel a gravel roadway as follows:

33% would ride 5 miles on gravel
48% would ride 3 miles on gravel
62% would ride 2 miles on gravel
80% would ride 1 mile on gravel
2.3% would not ride on gravel

It is interesting to note that, despite a serious aversion to gravel roads by most riders, traffic is of enough concern for them to consider up to 1 mile of gravel. Sections of gravel along the TransAmerica Trail were ridden by as few as 10% of the riders, although it was clear that the alternative paved roads were far more hazardous because of high traffic density.

Preferred Roadway Improvements. The best improvement to a busy roadway was selected as follows:

Identify Bike Lane.....	52.3%
Separate Bike Path.....	34.1%
Widen Pavement.....	12.7%
Reduce Speed to 45 mph.....	0.6%

One of the most acceptable heavily traveled roadways in North America is the Canadian National Park road between Jasper and Banff National Parks. Two full lanes of one direction traffic allow the motorist to use one lane for travel and another for stopping. The right lane is ideal for bicycle traffic, offering exceptionally low risk to both users. An adaption of this system might be workable in short sections of a route where high auto and bike traffic are common, such as along U.S. Route 101 on the Pacific Coast. Such routes would need periodic removal of debris for maximum safety.

Road Conditions. A coarsely paved 25-mile stretch with some potholes, but deserted of almost all traffic is preferred over a smooth, well-maintained road that has heavy traffic by 88.4% of all riders. Again, cyclists fearing the great hazard of motor vehicles along with noise, pollution, and anxiety,

would prefer a slower, less-maintained roadway. Further reinforcing selection of the more typically rural roadways, 95.6% of the cyclists prefer rural roads with little traffic and with only occasional services available to a roadway with frequent services but heavy traffic. And 87.2% of the cyclists preferred a route that meanders through quiet back country and occasionally returns to dramatic geography such as the Pacific Coast for short 20 to 70-mile stretches, as opposed to 11.9% who felt they could cope with 500 miles of moderate-to-heavy traffic on a route that hugged such dramatic geography.

Signing. One of the most significant factors in the development of the TransAmerica Trail was the success of the Bikecentennial organization in eliciting participation by 8 of the 10 states in placing bike route signs along the trail. Missouri approved the signs but was unwilling to bear 100% of the costs and hence did not post them. Idaho claimed liability to be a problem and avoided signing. The bike route signs in use provided route verification for cyclists and notified motorists that they were sharing the road system. Wyoming used an impressive large warning sign cautioning motorists and cyclists. This sign is credited with having reduced the potential conflict on several sections of especially hazardous roadways.

When the cyclists were asked how important bike route signs were to them, 6.1% said they were not significant, 34% felt they provided information use only, 35.9% felt there was some safety benefits derived from their use, and 22.9% felt that signing the route was a major safety benefit.

Liability. The question of signing, approving, or encouraging use of specific roadways for bicycling is of growing concern to many states. As mentioned earlier, 27 states have now incorporated Bikecentennial design

criteria in selecting a bike route. Many highway departments are concerned with the question of liability, especially in light of eroding sovereign immunity. States, and local units of government are being sued for negligence and many of them are losing.

Generally, the agency responsible for the care and maintenance of highways is required to construct safe thoroughfares and keep them that way. The highway user should expect to travel that thoroughfare in a safe and efficient manner without having to search or be on guard for unseen hazardous conditions. He should not be caught unawares or be expected to anticipate dangers to which his attention is not directed.

Subsequent to proper design is a maintenance and inspection program to provide safe highways. Should unsafe conditions be discovered, it is the governing agency's responsibility to alert highway users to the condition prior to and during the elimination of the hazard.

State law concerning liability for signing, road improvement, and maintenance varies widely from one state to another. These laws are created primarily by court decisions in response to individual controversies rather than by statute. It is safe to say, however, that state liabilities for design effects are increasing, and that the state may not always avoid liability by doing nothing. A state may be found to be negligent either because it signs roads improperly or because it does not sign them at all. The use of potential liability as an excuse for not providing signs is usually to avoid admitting what the state does not want to do in any event.

Several states on the TransAmerica Trail still retain absolute sovereign immunity, steadfastly refusing to modify or waive it without clear legislative authority. Three such states are Virginia, Missouri, and Wyoming.

Colorado has a representative body through which citizens may seek redress for the state's negligence even though that state retains sovereign immunity.

A major development in the field of signing for bicyclists is now taking place. The National Advisory Committee on Uniform Traffic Control Devices had adopted two new parts for publication in the Manual on Uniform Traffic Control Devices. Part VIII, entitled "Traffic Control Systems for Railroad Crossings," was adopted in October of 1976. Part IX, entitled "Traffic Control for Bicyclists," was adopted January 21, 1977, and was scheduled for publication in the spring of 1977. Publication of the latter section will go a long way toward standardizing the field of bicycle route designation.

Roadway Classifications. Whenever possible, Bikecentennial routed the trail along quiet rural roads. In major sections of the nation this was difficult or impossible. An estimate of the relative percentages of roadway lengths by classification is as follows:

Federal Primary.....	25%
State Primary.....	28%
State Secondary.....	24%
County.....	23%

Bicycles on Controlled Access Highways. Of the 4,212.2 miles that make up the TransAmerica Trail, 21 miles are part of Interstate 80 between Rawlins, Wyoming, and the Walcott exit at State Route 130. I-80 is a four-lane freeway with medium-to-heavy traffic. Two accidents occurred on the interstate; both resulted in sprains to the riders. One rider caught his tire in a crack between the road and shoulder while traveling over 30 miles per hour. The fall resulted in a sprained wrist. The other injury occurred as

a vehicle swerved into the shoulder of the interstate, brushing the cyclist. The rider fell with both feet still in his pedals and toe clips and sprained his left arm or hand. The accident rate for this stretch of highway was the same as the average for the trail--one accident for every 9.4 miles ridden.

At present various states take different positions with respect to whether or not bicycles are prohibited or allowed on controlled access highways. Of the ten states that contain part of the TransAmerica Trail, five have taken positions relative to allowing or prohibiting bicycles on controlled access facilities. Colorado allows bicycles inside the right of way, but only on separate pathways. Wyoming allows bicycles on the shoulders of the interstate. Montana encourages use on interstates rather than the narrower service roads. Idaho is considering prohibiting bicyclists from using interstate highway shoulders because of the danger from passing trucks. Oregon permits bicycles on controlled access facilities, except where they are prohibited in the Portland area.

Bicycle travel on the shoulder of interstate highways is feasible but should be examined on a state-by-state basis for safety and other considerations, including availability of alternative routes. The wide shoulder provides the cyclist sufficient room to avoid buffeting winds from large vehicles. A disadvantage of interstate riding would be the high volume of debris that collects on the shoulders and the noise, pollution, and tension posed to the bicyclist. Cyclists permitted to use interstate shoulders should be required to exit at each ramp in order to avoid conflict with motor vehicles.

Summary. Routes planned to take bicycle traffic and kept in good maintenance can reduce bicycling accidents dramatically. Although many bicyclists would strongly oppose being prohibited from particular roadways, the great majority would prefer safer, more tranquil back roads that are properly maintained. Such action would lead to improved traffic flow on all highways and encourage safe, convenient bicycle travel. Improving the design of unlimited access roads for bicycling and assuring proper maintenance would benefit all highway users. Most bicyclists will not find these safer roads uninformed. Local and state agencies can assist their efforts by locating and posting such preferred routes. Such a program should include improvements in signing and road repairs to reduce one of the primary elements of bicycling accidents.

LAW ENFORCEMENT, RULES OF THE ROAD

Overview. The majority of roadways along the TransAmerica Trail are seldom patrolled because of the low traffic priority of the roadways. In several areas enforcement was quite effective. In this section we discuss the effect of law enforcement, the general rules of the road followed by bicyclists, and general recommendations given by agencies for effective programs. Also discussed is the degree of interjurisdictional uniformity among the ten states and the need for greater judicial support.

Interjurisdictional Uniformity. Although the Uniform Vehicle Code was amended in 1975 to include many new changes in the laws that pertain to bicyclists, none of the states have updated their laws pertaining to bicyclists. Therefore, the information provided in the book Bicycling Laws in the United States (NCLUTLO, 1974) remains substantially correct. Compliance with the Uniform Code ranged from a low of 0% in Missouri to a high of 100% in Idaho. The National Committee on Uniform Traffic Laws and Ordinances is the caretaker organization of the Uniform Vehicle Code and the Model Traffic Ordinance. Their goal is to establish uniformity in traffic laws and ordinances among different states and municipalities. Part of the confusion both bicyclists and motorists have with rules of the road results from irregular regulations. Until regulations are uniformly adopted, motorist and bicyclist behavior cannot be adequately anticipated or controlled.

Local Enforcement. Local enforcement of bicycle ordinances tends to have a more immediate effect over cyclists' behavior than do state laws. Only in a few instances were cyclists even remotely aware of either state or local

statutes. However, word spread fast if a local ordinance, say in Fairplay, Colorado, was being enforced. Most bicyclists heard by word of mouth nearly 500-1,000 miles before arriving in town that they should not speed going downhill into the town.

Although most law enforcement officials seldom gave out tickets to bicyclists, numerous warnings were issued on local levels with positive effect.

Rules of the Road. When reviewing the effect of traffic laws and their relationship to Bikecentennial cyclists' behavior it must be remembered that these riders were transients, unfamiliar with local ordinances. What they did have was a basic understanding that they were obligated to follow the same rules of the road that affect motorists, and that they were due the same rights afforded motorists as well. Until clear, meaningful national statutes are adopted, it is likely that the behavior of bicyclists will be most closely tied to common sense or gut feelings about the rules of the road.

Police Interviewed. Local law enforcement officials were surveyed after the event to learn their reaction to the bicycling traffic. In general, officials stated visiting cyclists had respect for highway users, appeared to know how to handle their bikes, took precautions that included wearing bright clothing, safety triangles, helmet, and safety flag, were cooperative and friendly, and were the kind of visitors they would like to have around again. Common infractions included failure to ride single file when traffic was on the highway or, in Kansas, riding at night without lights. Evidently the intense heat of the summer, the pleasantness of the evening, and the quality of Kansan roadways were conducive to travel at night for some riders.

Overall, local police were very protective of the cyclists. Early in the summer, observing a good nature and behavior of most cyclists, officials took major steps to insure their protection. This included, in some cases, aggressive enforcement of speed limits, jailing a local citizen who struck a bicyclist, and, in Wyoming, a coordinated pursuit and capture of the motorist and passenger who struck several bicyclists. Officials in Yellowstone required cars using side extension mirrors to remove them when not towing trailers.

Roanoke, Virginia, increased patrol along the route, resulting in an increased awareness of the cyclists. In Kremmling, Colorado, bicyclists and motorists complained about each other. The police department's openness to complaints between the two groups led to the posting of signs and eventual agreement between bicyclists and motorists. Jackson, Wyoming, instituted a rigorous enforcement program and Astoria, Oregon, used radio spots to warn motorists of cyclists.

Judicial Support. Although perhaps not characteristic of the behavior along the trail, many bicyclists are scoflaws. They fear no threat of punishment and feel free to ignore traffic regulations. They pass stop signs, ride in the lane facing traffic or down one-way streets against traffic, obstruct traffic lanes, and break other laws. Such infractions hold back the positive image of bicycling and lead to dramatically increased accident rates. Most adult bicyclists and motorists would like to see more strict enforcement of bicyclist behavior. The city of Santa Barbara, in "A Study of Bicycle Related Motor Vehicle Accidents, 1973," stated that they found that *bicyclists' disregard of basic traffic laws was a major factor in most accidents*. Violation

rates among bicyclists ranged to 90%. The study recommended a comprehensive enforcement program with emphasis on public acceptance of the regulations.

At the heart of enforcement is judicial support. A frequent reason given by enforcement agencies to explain lack of enforcement was the lack of support afforded the arresting officer by judges. Many officers have told us that even though they enforce bicycling laws that are currently on the books, when they get to the courtroom the judges belittle them in front of the court for bringing such ridiculous cases to him when violent crimes are going on in the streets.

More time must be devoted to seemingly minor traffic offenses, or bicycle/motor vehicle deaths and injuries will continue unchecked. Without judicial support of enforcement, education programs will only be partially effective.

Summary. As a result of our study, we conclude that local traffic laws have little influence over the behavior of long-distance bicyclists. Greater uniformity is needed to gain compliance. Enforcement of local ordinances among transient bicyclists tends to be difficult but does produce a more immediate effect over the cyclist's behavior, although the effect may be limited. Of more importance to reducing bicycle accidents are the "gut feeling" of the cyclists of what is right and what is wrong and the relationship and mutual understanding between cyclists and motorists. Effective enforcement, judicial support, uniformity, and education can all be used together to reduce the congestion, conflicts, and accidents on public roadways.

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BICYCLING SKILLS

Mastery of the modern ten-speed bicycle or the complex traffic mix of the seventies is difficult for the beginning bicyclist. It is essential to master the handling of a lightweight and rather sophisticated bicycle--the ten-speed--which allows a rider to reach speeds of 16-20 mph with relative ease. If only the bicycle had to be mastered, the task would be much simpler. The compounding factors are making use of roadways not designed for pedestrians or other self-propelled travelers and sharing these facilities with drivers of high-speed, heavy-mass vehicles who are not accustomed to the low profile of a bicyclist.

To minimize conflict, the bicyclist and motorist must learn to recognize danger and be able to react. In the sections below are outlined some of the basic principles the bicyclist must master in order to feel at ease and ride safely on the modern highway. As in other sections of this report, emphasis is given to Class III riding conditions, although application may be appropriate to most riding situations.

The ten-speed bicycle is more delicate than the older, more traditional three-speed or middleweight bicycle. It cannot be ridden through potholes, and is more prone to skidding on loose gravel or other roadway debris. Fortunately, its lightness and design permit much greater balance and control, allowing the rider some advantage toward facing these hazards. Due to the lightness and greater efficiency of the ten-speed, higher speeds are usually maintained. The *skilled* bicyclist can thus ride with greater advantage and safety in low-speed urban traffic.

Here are some additional special conditions affecting the well-being of the bicyclist.

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Motorists. Motorists have a *mind set* to expect large objects to be entering or sharing their roadway. At intersections or in congested areas they often will not see a bike rider. If they recognize the rider, they may fail to react properly, misjudging the speed of the bicyclist or not understanding his needs.

Roadways. Roadways selected by the bicyclist often have a low-priority maintenance schedule and may be deeply rutted or heavily strewn with gravel and other debris. A number of bicyclists do not have sufficient skill to avoid these hazards. Some roadway features are designed for the motor vehicle and not the bicyclist and pose serious additional hazard to the rider. Included in these are railroad tracks, bridges, sewer grates, tunnels, and traffic control devices.

Essential Skills. Very few of today's adult riders are skilled at riding. Many poor habits are carried over from childhood. Most bicycle safety classes are designed to point out the obvious hazards of hitching a ride on the back of a truck or riding double, and the necessity of obeying traffic laws. Some states and organizations are now helping sponsor more detailed courses. Emphasis is given to using sight and hearing to greater advantage, recognizing common hazards, and perfecting skills. Among the information presented to Bikecentennial riders last year was the following:

Bike Size and Adjustment. Cycling comfort, ease, and safety require a bike that fits the rider properly. Frame size is the first consideration. The frame height is measured from the top of the seat tube to the center of the crank. With a diamond-shape or men's frame--which is the strongest and best for touring for either men or women--a good test for determining the

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right height is to stand straddling the top tube with both feet flat on the ground. If one can lift the bike more than an inch, the frame is too small. For a ladies' or mixte frame, this test can be made by having a friend hold a broom handle or pole where the top tube on the diamond-shape frame would be.

The distance from the front of the saddle to the center of the handlebars should be the same as the distance from one's elbow to the middle finger of the outstretched hand.

The saddle should be level--not slanted--and adjusted to a height where one can extend a leg fully with the heel resting on the pedal at its lowest point. After the saddle is adjusted, the seat post should extend at least three inches into the frame to avoid hazardous breakage. The top of the handlebars should be set about the same height as the saddle.

Riding Skills. Once properly fitted to a bicycle, one can begin to concentrate on the essentials of balance and straight, efficient, smooth riding. Both cadence and ankling must be mastered in order to ride safely.

Cadence. The rate at which one pedals is of primary importance. Pedaling too fast (in too low a gear for the speed the bike is traveling) can be very tiring and tends to fatigue one's knees. A slow, laborious, grinding cadence (riding in too high a gear for bike speed, load or terrain) results in instability, causing your body and bike to wobble and sway. Proficient cycling requires a brisk, steady cadence of 65-80 pedal revolutions per minute. Pedaling speed usually will increase as one gets used to riding long distances and becomes more skilled at working the gears.

Ankling. Ankling allows distribution of effort evenly over the whole pedal revolution and further increases riding efficiency and smoothness. Ankling is executed by placing the ball of the foot on the pedal (toe clips

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help greatly to keep feet in place) and concentrating on pointing the toe down at the bottom of the revolution, then lifting the pedal up. When first practicing this technique one must make a conscious effort to put pressure on the toe clips, as though determining where one's toes are when trying on new shoes.

Riding with body weight poised evenly over the bike and using the technique of ankling, one can use many more muscle groups for propulsion than are available when seated upright on a standard bike. The result is more control and less fatigue.

Drafting. "Taking a wheel" or "pacing" is a nice way, particularly when riding into a headwind, for a small group of experienced riders to reduce wind resistance. When drafting, each rider stays 6-18 inches back of the one ahead, and 6-8 inches off to the side. The lead rider shouts "rock" when one presents a danger, and then steers around it. The last rider shouts "car!" when one starts to pass. All riders relay all messages in both directions. When passing another cyclist, always give the warning, "on your left," and pass on the left. Drafting should never be attempted on busy highways or by beginners.

Steering. Steering is accomplished not only by turning the handlebars, but by leaning in the direction one wants to turn (this is especially important on mountain descents). Steering should be practiced in an empty paved lot, with the bike loaded as if on a trip.

Emergency Braking. Emergency braking should be mastered by everyone riding a bike. This technique entails three phases which must be practiced until one can perform them as a continuous motion: while shifting body weight rapidly but smoothly rearward on the saddle, one must move the hands

down into braking position, and apply firm, equal pressure to both brakes. With normal riding position, more than half of the braking force is in front, so the rear wheel has a tendency to skid or even leave the ground, which can cause a spill. Shifting body weight back counteracts this tendency, enabling a smooth, fast stop. One must slide back on the saddle and bend forward in any tight riding situation. Check the condition and adjustment of your brakes frequently.

Challenging Conditions.

Mountain Descents. Mountain descents and other long or steep downhill must be approached cautiously, particularly with the added weight of touring gear. Before starting down one must be sure that brakes, cables, and wheels are in good shape and the load is secure. Special note of the condition of the tires must be taken--a blowout while descending a mountain can be fatal. If it's chilly, the wind and reduced exertion may call for an extra layer of clothing. Even if one coasts all the way down one must keep moving the legs from time to time so they're not stiff when power pedaling is resumed.

On long grades it's deceptively easy to reach speeds of 40, 50, or even 60 mph without realizing it. One must keep speed low enough to maintain complete control. If this requires much braking, the brakes should be pumped alternately rather than applying both continually, to avoid overheating the tire rims and risking a blowout. On a bike with drop handlebars (definitely recommended), one should ride with hands on the drops for proper body position and quick braking ability. Weight should be kept low and back on the bike. The road should be scanned well ahead for rocks, chuckholes, wet or icy spots, and other hazards. Glass and loose gravel are especially treacherous. One should always slow down *before* entering a curve, remembering to lean as one

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turns. To stop to enjoy the scenery or let the rims cool, one should leave the road after checking for gravel and other roadside hazards.

Uphill Stretches. When encountered in roller-coaster series, uphill stretches can often be conquered by maintaining speed through the low dips between them. One must maintain brisk cadence and accentuate ankling but not try to grind one's way to the top. Long climbs, especially, take time and patience. Experience and practice will enable the anticipation of stress and the need to shift to a lower gear *before* losing the cadence and hence stability. One should not stop at the top of a hill unless intending to get off and walk around a bit to relax leg muscles lest they stiffen up. If one must stop midway up, the road must be abandoned first. One should always be ready to leave the road if traffic backs up. Some hills require walking.

Gravel Roads. These areas require slow, steady, relaxed riding. On thick patches, slightly increased cadence (in a lower gear) is a good idea. When riding on gravel, one should keep hands well apart on the handlebars and eyes trained on the road surface ahead. Hills with loose gravel should be carefully tested and walked over if necessary.

High Winds. High winds tax one physically and limit hearing. Ride with extra caution on windy days. Side winds cause one to lean such that if a truck passes or one passes a structure, the sudden blockage of wind can throw one off balance, causing the bike to swerve.

Hazards. Bicycle touring is as safe as cyclists make it. *All* roads, even the most carefully thought-out bike routes, have traffic and other hazards. One must *always* ride with caution.

Motor Vehicle Traffic. Motor vehicle traffic presents the greatest danger to life and limb. One should remember that cars, trucks, and

motorcycles are heavier and usually faster than bicycles and anticipate that the next driver met may be about to do something bizarre. When a car or truck overtakes a rider he should always assume that there is a line of traffic following it, and that the second driver back has not seen the rider.

One must interpret the sound of vehicles approaching from the rear, listening especially for signs of motorists taking or failing to take precautions. An experienced bicyclist can detect whether a driver has stopped accelerating or is maintaining speed. A laboring engine may warn of a swerving trailer or other heavy load. Towing units often are equipped with mirrors which protrude far to the side and can clip an unsuspecting cyclist. Small mirrors are made for mounting on a rider's helmet or glasses and are a good idea.

Lumber, coal and other large trucks need extra space, and a rider must be ready to leave the roadway if necessary. These professional drivers are earning their living on the road, while cyclists are using it for recreation. A friendly wave will usually be returned.

Time of Day. Time of day is often an important safety consideration. Temperatures are usually best, and traffic lightest, in the early morning. Leaving or approaching major population centers during rush hours or the noon hour should be avoided. One should be off the road before 5 PM--poor light, fatigue, and the drinking driver make this the most dangerous time of day.

Night Riding. This is not recommended. Riding at night requires wearing bright, reflective clothing, using lights and reflectors front and rear, and listening for traffic. One must leave the roadway when a car is heard or seen approaching.

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Fog. Fog is another form of bad news for cyclists. Riding in heavy fog requires treating it like nighttime. Under conditions like these, helmets, safety flags, safety triangles, and rear-view mirrors make even more sense.

Tunnels. Tunnels are almost never designed for the car-bicycle traffic mix. One must use lights. Stand at a safe point just inside to allow the eyes to adjust to the poor light. One should ride with great care, as far to the right as possible. For long tunnels, a group may want to appoint one person to carry a flag to warn motorists there are other cyclists ahead, but this person will still have to get through. A better idea, when possible, is to flag down a sympathetic motorist who'll follow your group through with flashers going.

Stationary Hazards. The majority of cycling mishaps are accounted for by stationary hazards. One should watch out for oil, wet leaves, hot tar, parked cars, bicyclists so foolish as to stop in the roadway, ice, rocks, broken pavement, loose gravel (especially at intersections and where side roads or driveways enter), and railroad crossings. In the west, one encounters an invention that makes an urban storm-sewer grating ride like a breadboard by comparison--the cattle guard, a series of 5-8 rails perpendicular to the line of travel, spaced 3-6 inches apart so that cattle will not try to cross. It is possible to ride across some of these, but others will require walking. This can be tricky--the bike will help maintain balance.

Moving Hazards. Moving hazards are particularly risky at intersections. Because of the large size of recreational vehicles, drivers who are unaccustomed to them may be the greatest motorized threat, along with the hotrod crowd. One should give both a wide berth. Other things that move and are

dangerous include bicyclists, small children (on and off bicycles), dogs, and other animals. Friendly dogs that upset bikes in their enthusiasm may present as serious a problem as those that rush out threateningly.

Adherence to all traffic laws, as well as to those rules of the road dictated by common courtesy, is a requisite of safe and pleasant bicycle touring. One must note carefully all signs, signals, and one-way streets. Courtesy must be shown to motorists and pedestrians as well as fellow cyclists. Any wrong or discourteous actions of fellow bicyclists should be corrected with a friendly reminder. One should record the license number of any motorist showing *extreme* discourtesy or violation of traffic laws and report it to authorities if necessary. The same holds true for vicious dogs, serious road hazards, etc.

Cycling proficiency, safety consciousness, and visibility are the keys to safe touring. Most bicycle deaths and serious injuries either result from a bicyclist's error or could at least have been avoided by skillful and attentive riding.

BICYCLE MAINTENANCE CHECK LIST

Brakes

- Brake mechanism is tightly attached to the bike.
- When released, the brake pads do not rub the rim or tire.
- When applied, the pads contact only the rim, and as much of the pad surface is used as possible.
- When the brakes are tightly engaged, the brake lever should be only about halfway to the handlebars.
- Cables are intact, not frayed at the ends.
- Brake levers are in a convenient position and fastened securely to the handlebars.

Wheels and Tires

- Tires are inflated to the correct pressure (as marked on tire).
- Tires have no bald spots, and are fitted properly to the rim.
- All spokes are intact.
- The wheels spin true, with as little wobble as possible. Wobbles should be fixed if they cause rubbing against the brake blocks or hamper smooth riding.
- The hubs do not have play but run smoothly.
- The wheel axle is secure in the frame dropouts, and in the right position.
- The bearings are lubricated.

Handlebars

- Handlebars are adjusted correctly.
- Stem is secure; it does not rock when the front brake is on and forward pressure is applied.
- Stem is not too high, especially when luggage weight is being suspended from handlebars.
- Handlebars are taped (recommended).
- Ends are plugged.

Frame

- The frame is intact with no cracks, buckles or faulty lugs where two sections meet.
- Headset is adjusted correctly; it does not have play or offer resistance to turning forks.

Seat

- At least 3 inches of the seat tube remains in the frame.
- Saddle is level or pointed slightly up in front.
- Seat is at the correct height and is secure.

Pedal and Bottom Bracket

- Pedals are secure on cranks.
- Cranks are secure on spindle (where the two cranks are attached going through the frame or hanger).
- Bearings are lubricated.
- Cones are adjusted correctly.
- Spindle turns freely without play.
- Toe clips (if any) are secure.

Power System

- Chain is clean and lightly lubricated.
- Gear changers work smoothly and do not slip.
- Front derailleur is adjusted correctly, so that the chain is never off the sprockets.
- Rear derailleur is adjusted to stop at the right places.
- Derailleurs are clean, lightly lubricated, and secure on the frame.
- Freewheel is lubricated.
- For three speeds, hub is well oiled and gears are adjusted so that they all work.

BICYCLE MAINTENANCE "QUICK CHECK"

During the normal riding season bicycles should be thoroughly adjusted on a periodic basis so that they are functioning efficiently and safely. In addition, every morning before starting out on a day's ride bicyclists should run the following *quick check* to make sure all vital parts are functioning properly. The entire check can be done in 3-7 minutes. Here are the steps:

- Clamp on the front brake and push the bike forward against the brake (don't let it roll) to check for play in the headset.
- Clamp on the rear brake to make sure it grabs and holds the wheel from turning.
- Grab the unloaded bicycle by the saddle and shake it vigorously to check for loose parts. Always investigate rattles and unusual noises.
- Pick up the bicycle by the handlebars (make sure they are tight) so that the front wheel is off the ground. Check tire for hardness (using thumb) and check the wheel to see that it has no side-to-side play and spins freely.
- Do the same thing for the rear wheel. Pick the bike up by the saddle or rear carrier and check to be sure the tire is pumped up properly. Check the wheel to make sure it spins freely and there is no play.
- On three-speed bikes, check the gear shift lever in each position and see that each gear is working (Push pedal forward. If everything is in proper adjustment, it will engage in each of the gear settings.). Be sure to backpedal *before* shifting from high to a lower gear.
- Check the crank hangers for side and vertical play--there should be none.
- Pack the bicycle carefully with all gear securely tied down and no loose straps or strings hanging.

BICYCLE SAFETY/INFORMATION REPORT

b-5

- Recheck front and rear wheels to see if they spin freely and that nothing is interfering with their movement.
- Shake the bike from side to side to make sure all gear is securely mounted on the bike.

DIFFERENCE OF PROPORTIONS

c-1

COMPARISON OF NON-ACCIDENT AND ACCIDENT SAMPLES

In the comparison of non-accident and accident samples, a test was made to determine the significance level of the individual comparisons and to reveal null hypotheses. The statistic Z was obtained using the following formula:

$$Z = \frac{(\bar{p}_1 - \bar{p}_2) - 0}{\sqrt{\bar{p} \bar{q} \left(\frac{1}{n_1} + \frac{1}{n_2} \right)}}$$

where \bar{p}_1 = frequency percentage of non-accident sample

\bar{p}_2 = frequency percentage of accident sample

\bar{p} = frequency percentage of combined sample

$\bar{q} = (1 - \bar{p})$

n_1 = frequency of non-accident sample

n_2 = frequency of accident sample

Those comparisons marked with one or more asterisks have a level of significance as follows:

(*) = $\alpha .10$
 $Z \geq 1.65$

(**) = $\alpha .05$
 $Z \geq 1.96$

(***) = $\alpha .01$
 $Z \geq 2.58$

Comparisons exceeding these levels of significance are applicable to an infinite population.

INCREASE IN FREQUENCY PERCENTAGE
BETWEEN
NON-ACCIDENT AND ACCIDENT SAMPLE

c-2

EXPERIENCE	non-accident	accident	Z
Sex (1)			
Male		2.9	.47
Female	2.8		.97
Age (2)			
15 or less	1.6		1.72 *
16 - 20		16.1	5.85 ***
21 - 25		1.0	.38
26 - 30	4.7		2.01 **
31 - 35	5.3		3.22 ***
36 - 45	2.1		1.19
46 - 55	5.7		3.38 ***
56 - 65		1.1	1.00
Over 65	.3		.63
Height (3)			
5' or less		.5	.67
5'1" - 5'3"		1.0	.59
5'4" - 5'6"	-	-	-
5'7" - 5'9"	2.6		.96
5'10" - 6'0"	.9		.31
6'1" - 6'3"		2.7	1.31
6'4" or over	.4		.52
Weight (4)			
Under 110		1.1	.91
110 - 125	.2		.10
126 - 140		1.9	.74
141 - 155		1.5	.57
156 - 170	1.6		.66
171 - 185	2.1		1.05
186 - 200		.6	.46
201 - 215	.1		.14
Over 215	.8		1.55
Education (5)			
Less than high school diploma		3.2	1.52
High school diploma		5.6	3.09 ***
Some college		3.5	1.19
College graduate	.8		.30
Post graduate work	11.0		4.12 ***
Vocational or technical school	.5		.54

INCREASE IN FREQUENCY PERCENTAGE
BETWEEN
NON-ACCIDENT AND ACCIDENT SAMPLE

c-3

EXPERIENCE (cont.)	non-accident	accident	Z
Marital status (6)			
Single		15.7	5.47 ***
Married	14.5		5.36 ***
Divorced	1.7		1.40
Separated		.5	.86
Which hand favored (7)			
Right	5.2		2.26 **
Left		2.8	1.51
Either		2.4	1.62
Community population (8)			
Rural		.3	.20
Small town	.5		.27
Small city		1.2	.48
Medium size city		.6	.25
Suburbs of medium size city	.4		.32
Large city	.9		.36
Suburbs of large city	.3		.13
Other	-	-	-
Occupation (9)			
Management	.2		.12
Clerical	.9		.85
Laborer	.5		.36
Technician	.9		.40
Student		14.1	4.83 ***
Educator	5.0		2.52 **
Sales	.3		.23
Military	.4		.84
Unemployed	1.3		1.07
Other	3.5		2.62 ***
Retired	.2		.25
Number miles driven last 12 months (11)			
None		1.9	1.30
Less than 1000		3.1	1.37
1001 - 5000	2.2		1.19
5001 - 10000	2.0		.74
10001 - 15000		.7	.30
15001 - 20000	.2		.14
20001 - 25000	.5		.47
Over 25000	.9		1.24

INCREASE IN FREQUENCY PERCENTAGE
BETWEEN
NON-ACCIDENT AND ACCIDENT SAMPLE

c-4

EXPERIENCE (cont.)

Number of years ridden bike 100+ miles(12)

One		.6	.27
Two		2.6	1.31
Three	1.1		.48
Four	3.9		1.85 *
Five		3.0	1.37
6 - 10		1.2	.50
11 - 15		.3	.22
16 or more	1.8		1.51

Number of months/year ride bike (13)

None		1.0	.86
1 - 2		1.1	1.01
3 - 4	3.0		1.57
5 - 6	2.0		.82
7 - 8	.1		.04
9 - 10		1.6	.75
11 - 12		1.1	.41

Miles biked before Bikecentennial in '76(14)

None		.1	.17
10 - 100	2.3		1.20
101 - 300		2.0	.75
301 - 1000		1.4	.46
1001 - 3000	1.5		.64
3001 or more		.7	.42

Own more than one bike (15)

Yes	.3		.10
No		.9	.30

Ever taken bike course (41)

Yes		5.1	2.15 **
No	5.3		2.21 **

Length of time owned bike (16)

Less than 1 month		1.6	1.03
1 - 6 months		2.5	.98
7 - 12 months	1.8		.90
1 - 2 Years	.5		.17
3 - 4 years	.2		.07
5 - 10 years	.8		.55
More than 10	.6		1.09
Don't own bike	.4		.69

INCREASE IN FREQUENCY PERCENTAGE
BETWEEN
NON-ACCIDENT AND ACCIDENT SAMPLE

c-5

EQUIPMENT CHARACTERISTICS

	non-accident	accident	Z
Frame style (17)			
Men's		2.7	1.54
Women's	.3		.28
Mixte	1.5		1.30
Tandem	.7		.90
Frame size (18)			
17"			1.08
18"	.3		.77
19"		.3	.83
20"		1.2	.71
21"		.8	.85
22"	2.1		.84
23"	1.5		1.46
24"		4.1	.21
25" or more		.4	.63
	1.5		
Wheel size (19)			
22"			.54
24"	.2		.60
26"		.5	1.31
27"	.5		.65
28"		1.4	.77
	.5		
Gears (20)			
1-speed	.1		.51
3-speed		.2	1.02
5-speed	.9		1.74 *
10-speed		2.6	1.40
15-speed	2.1		1.19
Brakes (21)			
Coaster type	.2		.72
Side pull hand type		4.0	1.57
Center pull hand type	2.4		.90
Coaster / hand type combo	.4		.83
Extension levers (22)			
Extension levers	5.4		2.10 **
No extension levers		6.0	2.27 **
Handlebars (23)			
Regular type	.9		.78
Drop style		1.6	1.27
Toeclips (24)			
Toeclips		2.4	1.75 *
No toeclips	2.5		1.91 *

	non-accident	accident	Z
Parts that failed (29)			
Pedals		4.9	3.48 ***
Brakes		3.7	3.30 ***
Rim		6.5	4.36 ***
Front derailleur	.2		.14
Rear Derailleur		3.8	2.17 **
Chain		7.4	4.18 ***
Freewheel		4.3	2.43 **
Seat		2.5	2.04 **
Seatpost	-	-	-
Handlebars		.4	1.44
Hubs		2.5	1.93 *
Crankset		2.4	1.54
Spokes		4.9	1.73 *
Headset		1.6	1.66 *
Other		4.3	2.23 **
No parts failed	.6		1.09
Accessories that failed (30)			
Packs		7.1	3.21 ***
Carrier		10.5	4.93 ***
Straps or Cords		1.0	1.13
Trailer	.3		.89
Other		1.7	1.25
No accessories failed	1.3		1.79 *
Tires (31)			
Clinchers		4.3	2.27 **
Sew-ups	2.5		1.43
Flats (31)			
1	4.2		1.87 *
2	1.5		.78
3		3.3	1.82 *
4		1.4	.96
5		3.9	2.57 ***
6		1.6	1.30
7		1.9	1.83 *
8		1.7	1.91 *
9 or more		7.7	3.75 ***
0	16.0		5.64 ***
Using bicycle packs (43)			
Using bicycle packs		9.7	4.14 ***
Not using bicycle packs	9.6		4.17 ***

INCREASE IN FREQUENCY PERCENTAGE
BETWEEN
NON-ACCIDENT AND ACCIDENT SAMPLE

c-7

OPERATIONAL CHARACTERISTICS

	non-accident	accident	Z
Stop signs (34)			
Always obey	9.4		3.11 ***
Sometimes obey		9.0	2.9. ***
Rarely obey		.9	.64
Never obey	.5		1.28
Unknown		.1	.23
Traffic lights (35)			
Always obey	3.5		1.39
Sometimes obey		2.8	1.12
Rarely obey		.7	1.35
Never obey	.2		1.02
Unknown		.3	.77
Signal turns (36)			
Always	2.5		.89
Sometimes		2.0	.65
Rarely	.3		.14
Never		.2	.19
Unknown		.7	1.79 *
Ride three abreast (37)			
Often		1.9	2.71 ***
Sometimes		.1	.03
Rarely		2.9	.94
Never	5.1		1.80 *
Unknown		.2	.51
Ride wrong-way on one-way street (38)			
Often		.4	1.28
Sometimes		.1	.00
Rarely		3.3	1.14
Never	4.4		1.45
Unknown		.8	2.36 **
Ride against traffic (39)			
Often		.1	.36
Sometimes	.4		.41
Rarely		1.5	.61
Never	1.8		.69
Unknown		.5	2.56 ***
Where normally ride (40)			
As far right as practicable	2.6		.84
Periodically use entire lane	2.0		.66
Often use entire lane(Little traffic)		3.7	2.26 **
Use entire lane under most conditions	-	-	-
Unknown		1.0	2.30 **
Normal Speed (42)			
5-8 mph	2.6		2.29 **
9-10 mph	4.1		1.61
11-13 mph	5.4		1.79 *
14-16 mph		8.5	3.16 ***
17-20 mph		5.0	3.38 ***
21 mph or faster		.2	.51
Don't know	1.3		1.23

	non-accident	accident	Z
Downhill procedure (44)			
Brake frequently	7.0		2.53 **
Brake before most curves	4.0		1.37
Go all out		4.9	2.49 **
No set pattern		5.8	2.14 **
Frequency used bright clothing (45)			
Always	9.0		3.15
Frequently		1.8	.60
Sometimes		3.5	1.34
Almost never		3.2	2.29 **
Never		.5	.66
Bike safe flag (46)			
Used safety flag	2.3		1.08
Did not use safety flag		2.6	1.21
Frequency displayed safety triangle (47)			
Always	2.2		.78
Frequently		5.7	3.27 ***
Sometimes	1.2		.99
Almost never	.2		.19
Never	2.1		.99
Helmet (48)			
Used helmet		2.1	.77
Did not use helmet	2.1		.96
Frequency checked mechanical condition (49)			
Several times a day		4.1	1.74 *
Once a day	8.8		2.86 ***
Weekly or twice weekly		5.8	2.26 **
Less than once a week	.9		.71
Never	.7		1.20
Use of road this summer (50)			
As far as right as practible	3.5		1.18
Periodically use entire lane		.9	.29
Often use entire lane (little traffic)		3.1	1.80 *
Used entire lane under most conditions	.3		.88
When abandoned roadway (51)			
When any truck approached	.7		.32
When any vehicle passed	.2		.27
When any vehicle sounded horn		.7	.30
When traffic was backing up		2.1	.68
Rarely abandoned roadway		.6	.20
Never abandoned roadway	2.5		1.40

	non-accident	accident	Z
Procedure if animal approached (52)			
Continued normal speed	3.7		1.87 *
Slowed, watched with care	1.5		.59
Stopped and walked	1.7		1.66 *
Readied with defensive action with object		2.9	1.11
Talked to animal in calm voice, kept going	3.4		1.49
Other (increased speed and yelled)		5.5	2.10 **
Unknown		1.4	1.61
Rode at night (53)			
Never	16.0		5.18 ***
Used lights, when caught after dark		5.4	2.00 **
No lights, when caught after dark		3.4	1.80 *
Rode at night sometimes with lights		3.9	2.03 **
Rode at night sometimes w/o lights		3.3	2.72 ***
Weather conditions (54)			
Rode through any weather		5.4	1.83 *
Stopped during sever storms		2.7	.91
Did not stop in storm but careful	5.6		2.08 **
Stopped for rain or inclement weather	1.0		1.03
Riding companions (55)			
Usually rode alone		4.2	1.68 *
Usually used buddy system (riders in sight)	3.9		1.29
Always used buddy system or with group	1.4		.60
Rode while ill (57)			
Rode while feeling ill		17.4	5.78 ***
Did not ride while feeling ill	17.2		5.70 ***

COMPARISON OF NORMAL PROCEDURES WITH PROCEDURE FOLLOWED ON DAY OF ACCIDENT FOR
ACCIDENT SAMPLE

INCREASE IN FREQUENCY PERCENTAGE
BETWEEN
NON-ACCIDENT AND ACCIDENT SAMPLE

ATTITUDINAL CHARACTERISTICS	non-accident	accident	Z
Opinion of most hazardous road condition (65)			
Broken pavement		4.3	.95
Debris	1.1		.38
Gravel on paved road	2.6		.50
Unmarked hazard		10.0	2.31 **
Gravel road	3.3		.67
Opinion of most hazardous vehicles (66)			
Fellow bicyclist		.5	.21
Automobile	25.8		5.39 ***
Recreation Vehicle		10.3	1.78 *
Local delivery truck	.1		.04
Semi-truck		.9	.16
Other	1.2		.71
Opinion of other hazardous conditions (67)			
Animals		4.7	.85
Tunnels	2.4		.84
Bridges	.5		.13
Cattle grate		9.4	1.95 *
Railroad tracks	1.4		.25

TOTAL MILES RIDDEN BY ALL B76 RIDERS

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TRIP	TRIP LENGTH	MILES ACCUM.	% OF TOTAL
CC	355.5	65767.5	(.7)
CT	859.1	88487.3	(.9)
LC	1433.7	149104.8	(1.6)
OW	456.3	180238.5	(1.9)
CR	398.9	38294.4	(.4)
GW	2055.6	460454.4	(4.9)
GE	2274.9	370808.7	(3.9)
GP	473.6	10419.2	(.1)
OT	634.9	39998.7	(.4)
OF	1240.8	127802.4	(1.4)
AP	749.6	131929.6	(1.4)
BG	491.2	106590.4	(1.1)
CV	386.2	165293.6	(1.7)
TA	4212.2	7514564.8	(79.6)

TOTAL		9449754.3	(100.0)
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MILES RIDDEN BY SEX OF RESPONDANTS BY TRIP TAKEN

TRIP	TRIP LENGTH	MILES ACCUM. MEN	MILES ACCUM. WOMEN	TOTAL MILES ACCUM.
CC	355.5	19552.5	13864.5	33417.0
CT	859.1	30068.5	7731.9	37800.4
LC	1433.7	47312.1	18638.1	65950.2
OW	456.3	54756.0	27834.3	82590.3
CR	398.9	10371.4	6781.3	17152.7
GW	2055.6	166503.6	61668.0	228171.6
GE	2274.9	104645.4	47772.9	152418.3
GP	473.6	2368.0	1420.8	3788.8
OT	634.9	10158.4	5079.2	15237.6
OF	1240.8	45909.6	28538.4	74448.0
AP	749.6	44226.4	26985.6	71212.0
BG	491.2	33401.6	31436.8	64838.4
CV	386.2	49819.8	41709.6	91529.4
TA	4212.2	2754778.8	850864.4	3605643.2
TOTAL		3373872.1	1170325.8	4544197.9

c-12

[illegible]

NUMBER OF MALE RESPONDENTS IN EACH STATE

	OR	ID	MT	WY	CO	KS	MO	IL	KY	VA
CC	55									
CT	35	35	35							
LC	33	33	33	33						
OW			120	120						
CR				26	26					
GW	81	81	81	81	81					
GE					46	46	46	46	46	46
GP					5	5				
OT						16	16	16		
OF							37	37	37	37
AP									59	59
BG							68	68	68	
CV										129
TA	654	654	654	654	654	654	654	654	654	654
<hr/>										
	858	803	923	914	812	721	821	821	864	925

NUMBER OF FEMALE RESPONDENTS IN EACH STATE

	OR	ID	MT	WY	CO	KS	MO	IL	KY	VA
CC	39									
CT	9	9	9							
LC	13	13	13	13						
OW			61	61						
CR				17	17					
GW	30	30	30	30	30					
GE					21	21	21	21	21	21
GP					3	3				
OT						8	8	8		
OF							23	23	23	23
AP									36	36
BG							64	64	64	
CV										108
TA	202	202	202	202	202	202	202	202	202	202
<hr/>										
	293	254	315	323	273	234	318	318	346	390

TOTAL 1151 1057 1238 1237 1085 955 1139 1139 1210 1315

SEX OF RESPONDENTS BY TRIP TAKEN

TRIP	MEN (%)	WOMEN (%)	TOTAL
CC	55 (58.5)	39 (41.5)	94
CT	35 (79.5)	9 (20.5)	44
LC	33 (71.7)	13 (28.3)	46
OW	120 (66.3)	61 (33.7)	181
CR	26 (60.5)	17 (39.5)	43
GW	81 (73.0)	30 (27.0)	111
GE	46 (68.7)	21 (31.3)	67
GP	5 (62.5)	3 (37.5)	8
OT	16 (66.7)	8 (33.3)	24
OF	37 (61.7)	23 (38.3)	60
AP	59 (62.1)	36 (37.9)	95
BG	68 (51.5)	64 (48.5)	132
CV	129 (54.4)	108 (45.6)	237
TA	654 (76.4)	202 (23.6)	856

TOTAL 1364 (68.3) 634 (31.7) 1998

% OF ALL B76 RIDERS RESPONDING BY TRIP TAKEN

TRIP	TOTAL POP.	<u>SAMPLE</u> <u>POP.</u> %
CC	185	(50.8)
CT	103	(42.7)
LC	104	(44.2)
OW	395	(45.8)
CR	96	(44.8)
GW	224	(49.1)
GE	163	(41.1)
GP	22	(36.4)
OT	63	(38.1)
OF	103	(58.3)
AP	176	(54.0)
BG	217	(60.8)
CV	428	(55.4)
TA	1784	(48.0)

TOTAL 4063 (49.2)

TOTAL NUMBER OF RIDERS IN EACH STATE

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	OR	ID	MT	WY	CO	KS	MO	IL	KY	VA
CC	185									
CT	103	103	103							
LC	104	104	104	104						
OW			395	395						
CR				96	96					
GW	224	224	224	224	224					
GE					163	163	163	163	163	163
GP					22	22				
OT						63	63	63		
OF							103	103	103	103
AP									176	176
BG							217	217	217	
CV										428
TA	1784	1784	1784	1784	1784	1784	1784	1784	1784	1784

2400	2215	2610	2603	2289	2032	2330	2330	2443	2654
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TOTAL RIDER DAYS IN EACH STATE BY TRIP CODE

	OR	ID	MT	WY	CO	KS	MO	IL	KY	VA
CC	2220									
CT	1333	714	117							
LC	1644	720	969	307						
OW			3690	1258						
CR				271	881					
GW	3176	1390	1871	2148	1495					
GE					495	1693	1153	527	1652	1815
GP					86	178				
OT						305	532	107		
OF							6	420	1318	1449
AP									921	2775
BG							12	866	1726	
CV										5136
TA	18382	9846	13249	15215	15924	18240	12419	5671	17792	19549

26755	12670	19896	19199	18881	20416	14122	7591	23409	30724
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TOTAL RIDER DAYS = 193641 (530.523 YEARS) 48.8 MILES/DAY

MILES RIDDEN BY SEX OF RESPONDENTS IN EACH STATE BY TRIP CODE

TRIP	SEX	OR	ID	MT	WY	CO	KS	MO	IL	KY	VA
CC	55 M	19552.5									
	39 F	13864.5									
CT	35 M	18525.5	9922.5	1620.5							
	9 F	4763.7	2551.5	416.7							
LC	33 M	21370.8	9355.5	12589.5	3996.3						
	13 F	8418.8	3685.5	4959.5	1574.3						
OW	120 M			40224.0	14532.0						
	61 F			20447.2	7387.1						
CR	26 M				2444.0	7927.4					
	17 F				1598.0	5183.3					
GW	81 M	52455.6	22963.5	30901.5	35486.1	24696.9					
	30 F	19428.0	8505.0	11445.0	13143.0	9147.0					
GE	46 M					7065.6	24159.2	16449.6	7511.8	23565.8	25893.4
	21 F					3225.6	11029.2	7509.6	3429.3	10758.3	11820.9
GP	5 M					768.0	1600.0				
	3 F					460.8	960.0				
OT	16 M						3283.2	5721.6	1153.6		
	8 F						1641.6	2860.8	576.8		
OF	37 M						85.1	6042.1	18955.1	20827.3	
	23 F						52.9	3755.9	11782.9	12946.7	
AP	59 M								11015.3	33211.1	
	36 F								6721.2	20264.4	
BG	68 M						156.4	11104.4	22140.8		
	64 F						147.2	10451.2	20838.4		
CV	129 M									49819.8	
	108 F									41709.6	
TA	654 M	346162.2	185409.0	249501.0	286517.4	299859.0	343480.8	233870.4	106798.2	335044.2	368136.6
	202 F	106918.6	57267.0	77063.0	88496.2	92617.0	106090.4	72235.2	32986.6	103484.6	113705.8
TOTALS	1364 M	458066.6	227650.5	334836.5	342975.8	340316.9	372523.2	256283.1	132610.1	410721.2	497888.2
	634 F	153393.6	72009.0	114331.4	112198.6	110633.7	119721.2	82805.7	51199.8	153585.4	200447.4
	1998 M+F	611460.2	299659.5	449167.9	455174.4	450950.6	492244.4	339088.8	183809.9	564306.6	698335.6

		LENGTH OF TRAIL IN EACH STATE BY TRIP CODE										
TRIP	TRIP LENGTH	OR	ID	MT	WY	CO	KS	MO	IL	KY	VA	
CC	355.5	355.5										
CT	859.1	529.3	283.5	46.3								
LC	1433.7	647.6	283.5	381.5	121.1							
OW	456.3			355.2	121.1							
CR	398.9				94.0	304.9						
GW	2055.6	647.6	283.5	381.5	438.1	304.9						
GE	2274.9					153.6	525.2	357.6	163.3	512.3	562.9	
GP	473.6					153.6	320.0					
OT	634.9						205.2	357.6	72.1			
OF	1240.8							2.3	163.3	512.3	562.9	
AP	749.6									186.7	562.9	
BG	491.2							2.3	163.3	325.6		
CV	386.2										386.2	
TA	4212.2	529.3	283.5	381.5	438.1	458.5	525.2	357.6	163.3	512.3	562.9	

PERSONS REPORTING ACCIDENTS - ALL TRIPS COMBINED

LOCATION OF ACCIDENT

TOTAL OR ID MT WY CO KS MO IL KY VA

WORST INJURY (102)

1. Scrape, cut	98M 47F	10M 9F	4M 3F	9M 3F	9M 6F	10M 3F	15M 3F	6M 2F	2M	16M 7F	11M 11F	6M
2. Bruise	29M 13F	1M 2F	2M 1F	1M	2M 1F	2M 1F	4M	1M	1F	8M 6F	6M 1F	2M
3. Sprain	13M 2F	1M		1F 3M	2M	2M	2M		1M	2M 1F	2M	
4. Fracture	7M 3F	2M 2F				1M				2M	2M 1F	
5. Lacer./Stitches	15M 7F	2M 1F	1M 1F	1M			1M	1F	1M 1F	4M 3F	5M	
6. Concussion	4M 6F		1F	1F	2M 1F	1F	1F		1F	1M 1F		1M
7. Other	20M 4F	3M 1F	1F	3M	1M 1F	1M			1M	4M	6M 1F	1M
No injury	1F			1F								
Scratched eye	1F									1F		
Dog bite	1F									1F		
Shoulder jammed	1F									1M		
Shoulder strain	2M											
Shoulder sep.	1M											
Broke tooth	1M											
Chip tooth	1M											
Internal inflm.	1F											
of knees	1M											
Knee cartilage	1M											
Knee popped	1M											
Broken hip,	1M											
severe cuts	2M											
Dislocate thumb	1M											
Bump on head	1F											
Break req. pin	1F											
Jammed neck, back	1F											

LOCATION OF ACCIDENT

3 Accidents added to this tabulation (Deaths on trail - no form completed)

PERSONS REPORTING ACCIDENTS - TRIP LENGTH 12 - 15 DAYS (CC, OW, CR, GP, OT, BG, & CV)

LOCATION OF ACCIDENT

TOTAL OR ID MT WY CO KS MO IL KY VA

WORST INJURY (102)

1. Scrape, cut	12M 9F	2M 1F	4M 1F	1F	1M	1M	1M	1M	1F	3M 5F
2. Bruise	1M 1F				1M				1F	
3. Sprain	1M							1M		
4. Fracture	1F									1F
5. Lacer./Stitches	5M 1F				1M			1M	1F	3M
6. Concussion										
7. Other										
No injury	2M 1F		1M	1M						1F
Broke tooth	1M			1M						
Shoulder strain	2M							1M	1M	
Internal inflm. of knees	1F									

24M 14F 2M 1F 5M 2F 2M 1F 1M 2M 4M 3F 7M 7F

PERSONS REPORTING ACCIDENTS - TRIP LENGTH 21 DAYS (CT & AP)

LOCATION OF ACCIDENT

	TOTAL	OR	ID	MT	WY	CO	KS	MO	IL	KY	VA	UNK.
WORST INJURY (102)												
1. Scrape, cut	4M 3F				1F					1M	1M 2F	2M
2. Bruise	2M									1M	1M	
3. Sprain												
4. Fracture	1M										1M	
5. Lacer./Stitches												
6. Concussion												
7. Other												
No injury	2M										2M	
	9M 3F				1F					2M	5M 2F	2M

PERSONS REPORTING ACCIDENTS - TRIP LENGTH 31 - 35 DAYS (LC & OF)

LOCATION OF ACCIDENT

	TOTAL	OR	ID	MT	WY	CO	KS	MO	IL	KY	VA
ORST INJURY (102)											
1. Scrape, cut	4M 2F	1M 1F		1M						2M 1F	
2. Bruise	2M 2F	1M			1M					2F	
3. Sprain											
4. Fracture	1M									1M	
5. Lacer./Stitches	2M 1M	1M								1M 1F	
6. Concussion											
7. Other											
No injury	2M	1M							1M		
Dog bite	1F									1F	
Shoulder jammed	1F									1F	
	11M 7F	4M 1F		1M	1M				1M	4M 6F	

PERSONS REPORTING ACCIDENTS - TRIP LENGTH 45 DAYS (GW & GE)

LOCATION OF ACCIDENT

	TOTAL	OR	ID	MT	WY	CO	KS	MO	IL	KY	VA
WORST INJURY (102)											
1. Scrape, cut	10M 3F	M F	2M		1M 2F	1M	1M			3M	1M
2. Bruise	2M 3F		1M 1F							1F	1M 1F
3. Sprain	1M						1M				
4. Fracture											
5. Lacer./Stitches	1M	1M									
6. Concussion	1M									1M	
7. Other											
No injury	4M 1F				2M	1M 1F				1M	
Scratched eye	1F			1F							
	19M 8F	2M 1F	3M 1F	1F	3M 2F	2M 1F	2M			5M 1F	2M 1F

PERSONS REPORTING ACCIDENTS - TRIP LENGTH 55 - 82 DAYS (TRANSAM)

LOCATION OF ACCIDENT

TOTAL OR ID MT WY CO KS MO IL KY VA

WORST INJURY (102)

1. Scrape, cut	68M 30F	6M 6F	2M 3F	4M 2F	8M 2F	9M 3F	13M 3F	6M 2F	1M	9M 5F	6M 4F	4M
2. Bruise	22M 7F	2F	1M	1M	1M 1F	1M 1F	4M	1M	1F	7M 2F	4M	2M
3. Sprain	11M 2F	1M		1F	3M	2M	1M		1M	1M 1F	2M	
4. Fracture	5M 2F	2M 2F				1M				1M	1M	
5. Lacer./Stitches	7M 5F	1F	1M 1F		1M			1F	1M 1F	2M 1F	2M	
6. Concussion	3M 6F		1F		1F	2M 1F	1F		1F	1F		1M
7. Other												
No injury	10M 2F	2M 1F	1F							3M	4M	1M
Broken hip, severe cuts	1M									1M		
Poison ivy	1M										1M	
Dislocate thumb	2M				1M					1M		
Chip tooth	1M											
Bump on head	1M					1M						
Break req. pin	1F		1F									
Shoulder sep.	1M			1M								
Jammed neck, back	1F											1F

LOCATION OF ACCIDENT

	TOTAL	OR	ID	MT	WY	CO	KS	MO	IL	KY	VA
WORST INJURY (102)											
Other (cont.)											
Rupture achilles	1M		1M								
Pulled tendon	2M		1M			1M					
Flat'n tendons	1M										1M
Knee cartilage	1M										
Knee popped	1M				1M						
Injured tailbone	1F										
Cracked elbow	1M										1M
Exhaust burn	1F						1F				
Abras'n of palms	1F								1F		
Back pain	1M 2F		1F				1F			1M	
Disentery	1M									1M	
Contusions	1F					1F					
Sunburn	1M									1M	
Crushed chest, pneumothorax	1M										
Deaths	1M 1F			1M					1F		
	145M 63F	12M 14F	6M 7F	7M 3F	16M 4F	16M 7F	19M 6F	7M 4F	3M 4F	28M 10F	21M 4F 10M

INDEPENDENT RIDERS REPORTING ACCIDENTS - ALL TRIPS COMBINED

LOCATION OF ACCIDENT

TOTAL OR ID MT WY CO KS MO IL KY VA

WORST INJURY (102)

1. Scrape, cut	27M	9F	2M	2F	2M	1F	5M	2M		4M	1F	2M	1M
2. Bruise	5M	2F				1M					1F	3M	
3. Sprain	4M					1M				1M		2M	
4. Fracture	2M		1M							1M			
5. Lacer./Stitches	1M								1M				
6. Concussion	1M	1F				1F							1M
7. Other	5M		1M					1M				2M	
No injury													
Break req. pin	1M	1F				1F							
Back pain	1M	2F									1F		
Shoulder sep.	1M												
Exhaust burn		1F									1F		
Pulled tendon	1M												

48M 16F 4M 3F 3M 3F 6M 2F 2M 3F 5M 1F 5M 2F 3M 1M 8M 2F 9M 2M

CAMPING RIDERS REPORTING ACCIDENTS - ALL TRIPS COMBINED

LOCATION OF ACCIDENT

TOTAL OR ID MT WY CO KS MO IL KY VA

WORST INJURY (102)

1. Scrape, cut	43M 27F	4M 6F	2M 2F	4M 1F	7M 3F	6M 2F	6M 3F	2M 1F	2M	5M 4F	3M 5F	2M
2. Bruise	13M 3F	1F	1M	1M	1M		4M			3M 1F	2M 1F	1M
3. Sprain	5M 1F	1M		1F	2M	1M	1M					
4. Fracture	2M 2F	2F				1M				1M		
5. Lacer./Stitches	6M 3F	1M 1F		1M				1F		2M 1F	2M	
6. Concussion	4F				1F	1F			1F	1F		
7. Other	8M 2F	1F	1F	1M	2M					1M	3M	1M
No injury	1M				1M							
Broke tooth												
Scratched eye	1M				1F					1M		
Sunburn												
Abras'n of palms	1F								1F		1M	
Flat'n tendons	1M											
Pulled tendon	1M		1M									
Crack in elbow	1M											
Contusions	1F					1F						1M
Disentery	1M									1M		
Injured tailbone	1F											
Crushed chest,												
pneumothorax	1M											1M
Deaths	1M 1F			1M				1F				
	85M 47F	6M 12F	4M 3F	7M 3F	14M 4F	8M 4F	11M 3F	2M 3F	2M 2F	14M 7F	11M 6F	6M

BIKE-INN RIDERS REPORTING ACCIDENTS - ALL TRIPS COMBINED

LOCATION OF ACCIDENT

TOTAL	OR	ID	MT	WY	CO	KS	MO	IL	KY	VA
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WORST INJURY (102)

1. Scrape, cut	23M	6F	2M		1M	1F	1M	4M	2M	1F	6M	2F	4M	2F	3M
2. Bruise	11M	7F	1M	1F	1M	1F	1M	1M	1F	5M	3F	1M	1M		1M
3. Sprain	5M	1F			1M		1M	1M	1M	1M	1F				
4. Fracture	2M		1M										1M		
5. Lacer./Stitches	6M	3F	1M	1M	1F		1M	1M	1F	2M	1F				
6. Concussion	3M	1F			2M		1F								
7. Other	7M	1F	2M	1M	1F					2M	1F		1M		
No injury															
Dog bite															
Shoulder jammed															
Broken hip,															
severe cuts	1M														
Poison ivy	1M														
Dislocate thumb	2M														
Chip tooth	1M														
Rupture achilles	1M														
Bump on head	1M														
Popped knee	1M														
Knee cartilage	1M														
Jammed neck, back		1F													

66M	22F	8M	1F	2M	2F	6M	1F	5M	3F	7M	1F	4M	1F	3M	2F	19M	9F	8M	2F	4M
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FULL SERVICE RIDERS REPORTING ACCIDENTS - ALL TRIPS COMBINED

LOCATION OF ACCIDENT

TOTAL OR ID MT WY CO KS MO IL KY VA

WORST INJURY (102)

1. Scrape, cut

5M 5F 2M 1F 1M 2M 4F

2. Bruise

1F 1F

3. Sprain

4. Fracture

1F 1F

5. Lacer./Stitches

2M 1F 1F 2M

6. Concussion

7. Other

No injury
Internal inflm.
of knees
Shoulder strain

1F 1F 1F 1M 1M

9M 10F 2M 1F 1F 2M 2F 5M 6F

AVERAGE TOTAL RESPONDENT DAYS PER ACCIDENT VICTIM BY STATE

OR	M = 476/A F = 193/A T = 346/A	KS	M = 317/A F = 391/A T = 332/A
ID	M = 509/A F = 178/A T = 354/A	MO	M = 717/A F = 407/A T = 604/A
MT	M = 539/A F = 409/A T = 497/A	IL	M = 535/A F = 268/A T = 417/A
WY	M = 314/A F = 286/A T = 307/A	KY	M = 193/A F = 160/A T = 183/A
CO	M = 339/A F = 279/A T = 322/A	VA	M = 305/A F = 331/A T = 312/A

RANK BY STATE

MALE	FEMALE	TOTAL
(Highest Accident Rate)		
KY	KY	KY
VA	ID	WY
WY	OR	VA
KS	IL	CO
CO	CO	KS
OR	WY	OR
ID	VA	ID
IL	KS	IL
MT	MO	MT
MO	MT	MO

(Lowest Accident Rate)

AVERAGE TOTAL ACCIDENTS PER MILLION MILES BY STATE

TOTALS M = 56.3/mm, F = 73.78/mm, T = 60.80/mm

OR	M	39.69/mm	KS	M	56.12/mm
	F	100.73/mm		F	45.55/mm
	T	55.00/mm		T	52.82/mm
ID	M	35.93/mm	MO	M	24.82/mm
	F	100.99/mm		F	43.90/mm
	T	51.57/mm		T	29.49/mm
MT	M	35.29/mm	IL	M	34.27/mm
	F	47.69/mm		F	71.01/mm
	T	38.45/mm		T	44.50/mm
WY	M	69.79/mm	KY	M	95.17/mm
	F	64.81/mm		F	118.37/mm
	T	61.26/mm		T	101.48/mm
CO	M	53.42/mm	VA	M	63.90/mm
	F	65.73/mm		F	63.48/mm
	T	56.44/mm		T	63.77/mm

RANK BY STATE

MALE	FEMALE	TOTAL
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(Highest Accident Rate)

KY	KY	KY
WY	ID	VA
VA	OR	WY
KS	IL	CO
CO	CO	OR
OR	WY	KS
ID	VA	ID
MT	MT	IL
IL	KS	MT
MO	MO	MO

(Lowest Accident Rate)

RIDER DAYS PER ACCIDENT BY TRIP

TOTAL	M = 329/A	F = 259/A	T = 307/A
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SHORT TRIPS

CC (Oregon)	M = 330/A	F = 468/A	T = 376/A
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CV (Virginia)	M = 221/A	F = 185/A	T = 203/A
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BG (Kentucky)	M = 135/A	F = 170/A	T = 150/A
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OW (Montana)	M = 224/A	F = 285/A	T = 242/A
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MEDIUM TRIPS

GW (Oregon)	M = 574/A	F = 425/A	T = 524/A
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GW (Montana)	M = No Acc.	F = 251/A	T = 927/A
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GW (Total)	M = 405/A	F = 270/A	T = 357/A
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GE (Kentucky)	M = 93/A	F = 213/A	T = 113/A
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GE (Virginia)	M = 256/A	F = 234/A	T = 249/A
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GE (Total)	M = 207/A	F = 315/A	T = 464/A
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LONG TRIPS

TA (Oregon)	M = 561/A	F = 148/A	T = 339/A
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TA (Montana)	M = 694/A	F = 500/A	T = 635/A
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TA (Kentucky)	M = 233/A	F = 201/A	T = 225/A
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TA (Virginia)	M = 341/A	F = 553/A	T = 375/A
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TA (Total)	M = 367/A	F = 263/A	T = 336/A
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AVERAGE TOTAL ACCIDENTS
PER MILLION MILES BY TRIP MODE

(RIDERS WITH LOADED BIKES)

CAMPING	M =	70.43/mm
	F =	119.70/mm
	T =	83.41/mm

BIKE INN	M =	63.97/mm
	F =	62.59/mm
	T =	64.02/mm

INDEPENDENT	M =	54.34/mm
	F =	94.87/mm
	T =	62.76/mm

(RIDERS WITH UNLOADED BIKES)

FULL SERVICE	M =	18.10/mm
	F =	31.07/mm
	T =	22.23/mm

TOTAL RESPONDENT DAYS BY SEX IN EACH STATE BY TRIP CODE

		OR	ID	MT	WY	CO	KS	MO	IL	KY	VA
CC	M	660									
	F	468									
CT	M	453	243	40							
	F	116	36	10							
LC	M	522	228	307	98						
	F	206	90	121	38						
OW	M			1121	382						
	F			570	194						
CR	M				74	238					
	F				48	156					
GW	M	1148	503	676	777	541					
	F	425	186	251	288	200					
GE	M					140	478	325	149	466	512
	F					64	218	149	68	213	234
GP	M					19	41				
	F					12	24				
OT	M						78	135	27		
	F						39	68	14		
OF	M							2	151	474	520
	F							1	94	294	323
AP	M									309	930
	F									188	568
BG	M							4	271	541	
	F							4	255	509	
CV	M										1548
	F										1296
TA	M	6739	3609	4857	5578	5837	6687	4553	2079	6522	7167
	F	2081	1115	1500	1723	1803	2065	1406	642	2015	2214
<hr/>											
	M	9522	4583	7001	6909	6775	7284	5019	2677	8312	10677
	F	3296	1427	2452	2291	2235	2346	1628	1073	3219	4635

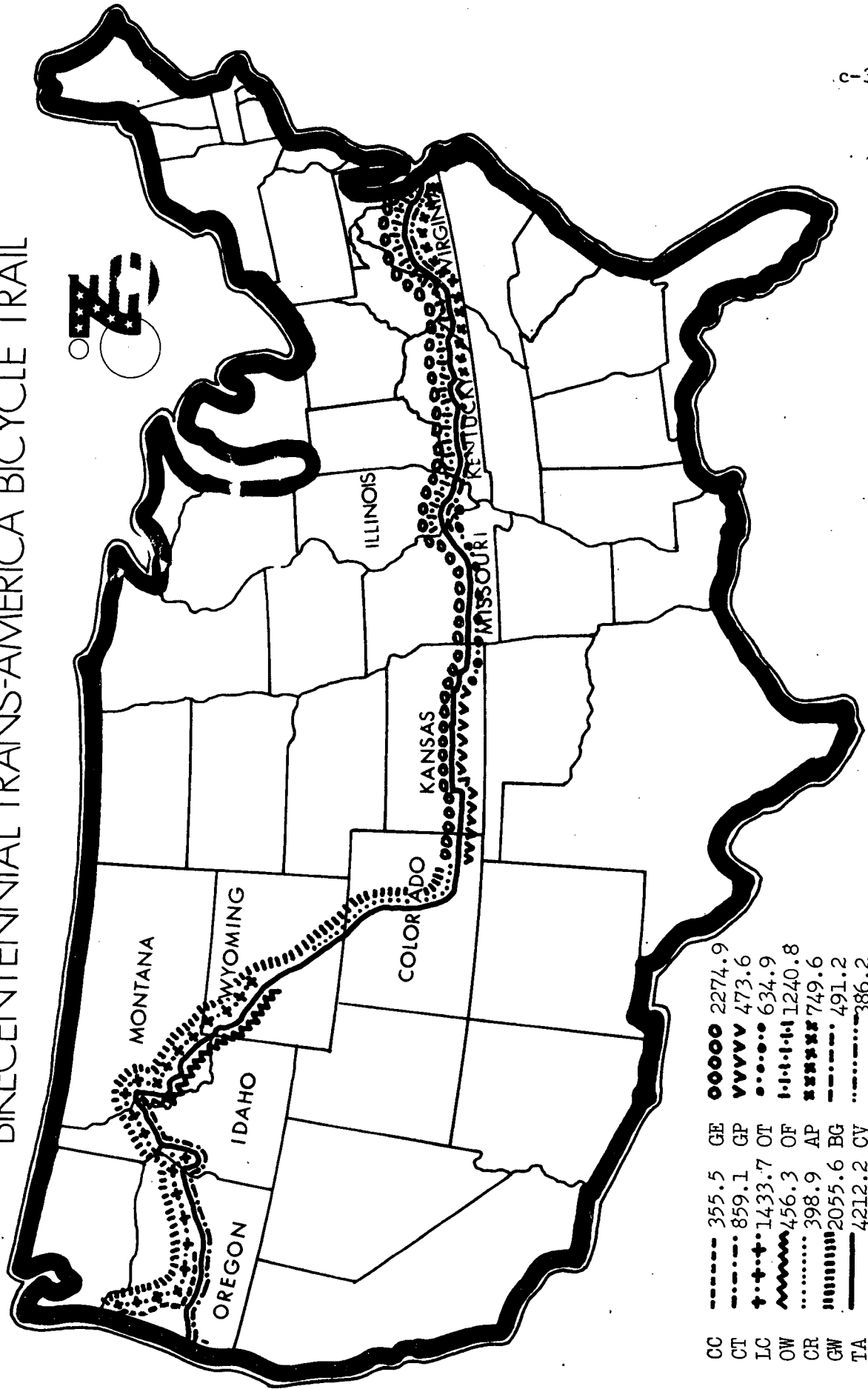
12818 6010 9453 9200 9010 9630 6647 3750 11531 15312

TOTAL RESPONDENT DAYS = 93361 (255.783 YEARS) 48.67 MILES/DAY

TOTAL MALE RESPONDENT DAYS = 68759 (188.38 YEARS) 49.06 MILES/DAY

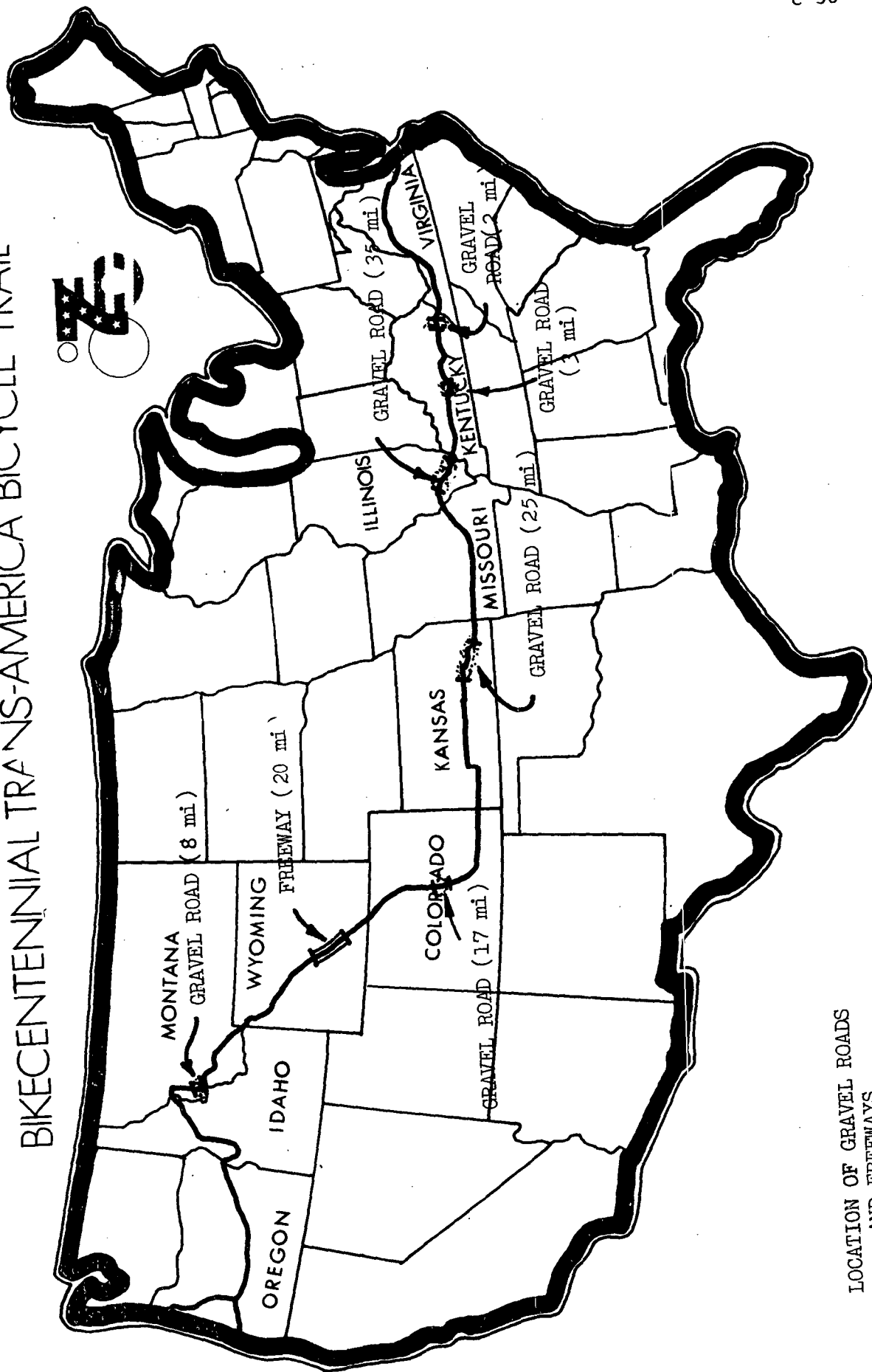
TOTAL FEMALE RESPONDENT DAYS = 24602 (67.40 YEARS) 47.57 MILES/DAY

BIKECENTENNIAL TRANS-AMERICA BICYCLE TRAIL



LOCATION OF BIKECENTENNIAL TRIPS AND TRIP LENGTHS

BIKECENTENNIAL TRANS-AMERICA BICYCLE TRAIL



LOCATION OF GRAVEL ROADS
AND FREEWAYS

DIRECTOR GENERAL NATIONAL SCENIC TRAIL

c-37

HAZARDOUS TRAFFIC CONDITIONS

RECREATIONAL VEHICLES

HIGHWAY TRAFFIC

COMPUTER TRAFFIC

COAL TRUCKS

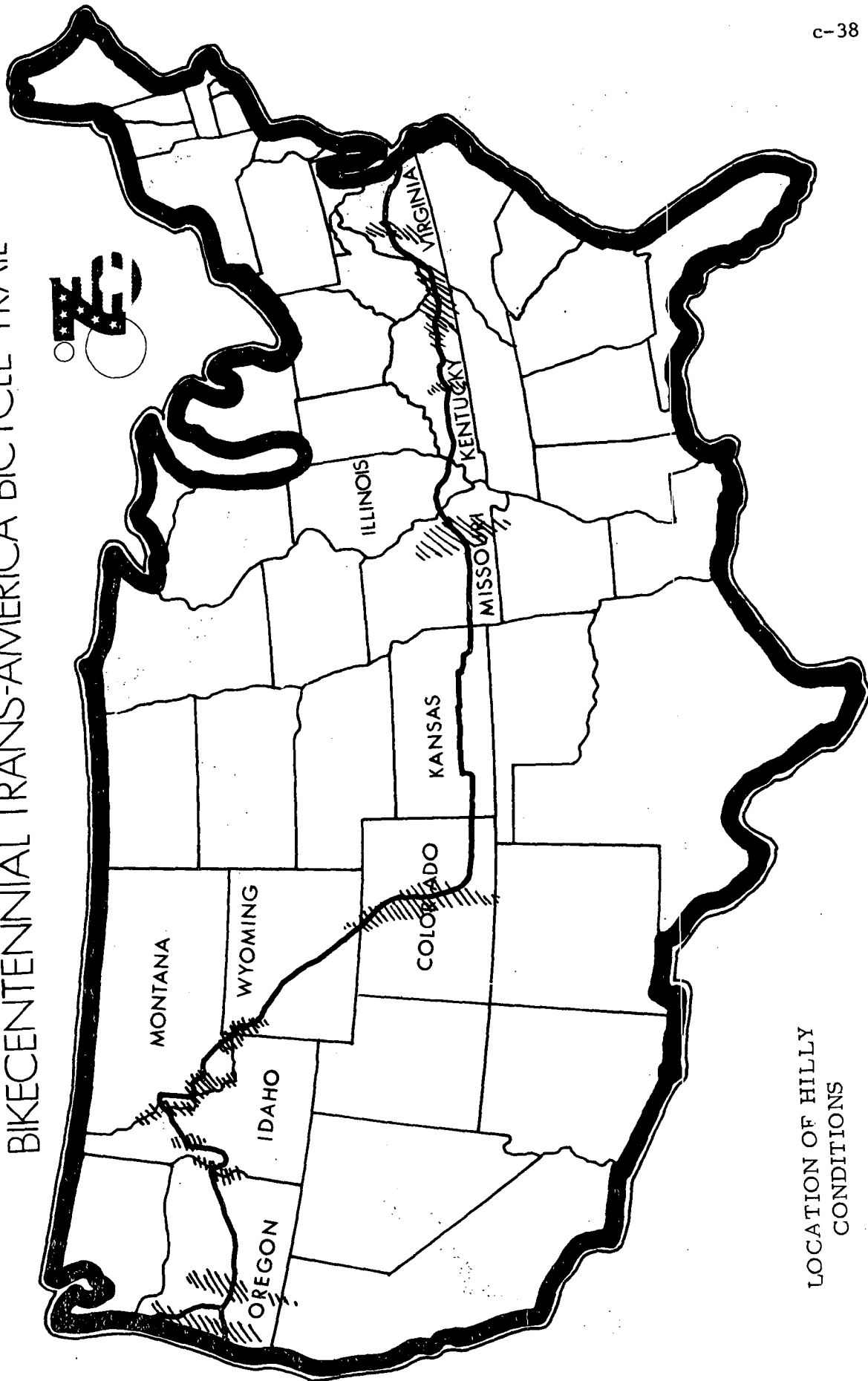
Note: In order to avoid a 25 mile stretch of gravel, cyclists would take a busy highway off the trail.

RECREATIONAL VEHICLES

c-37

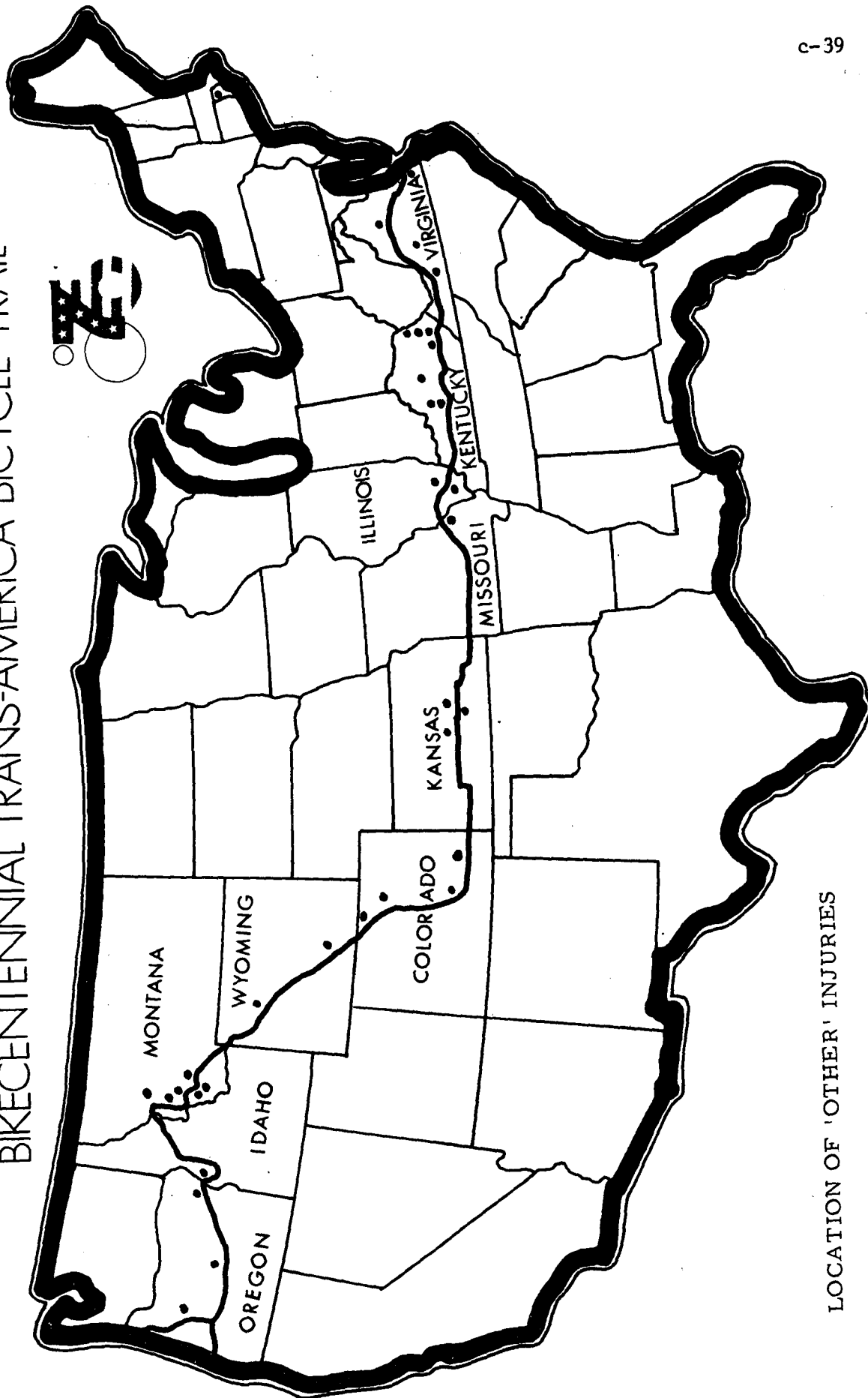
Note: In order to avoid a 225 mile stretch of gravel, bicyclists would take a busy highway off the trail.

BIKECENTENNIAL TRANS-AMERICA BICYCLE TRAIL



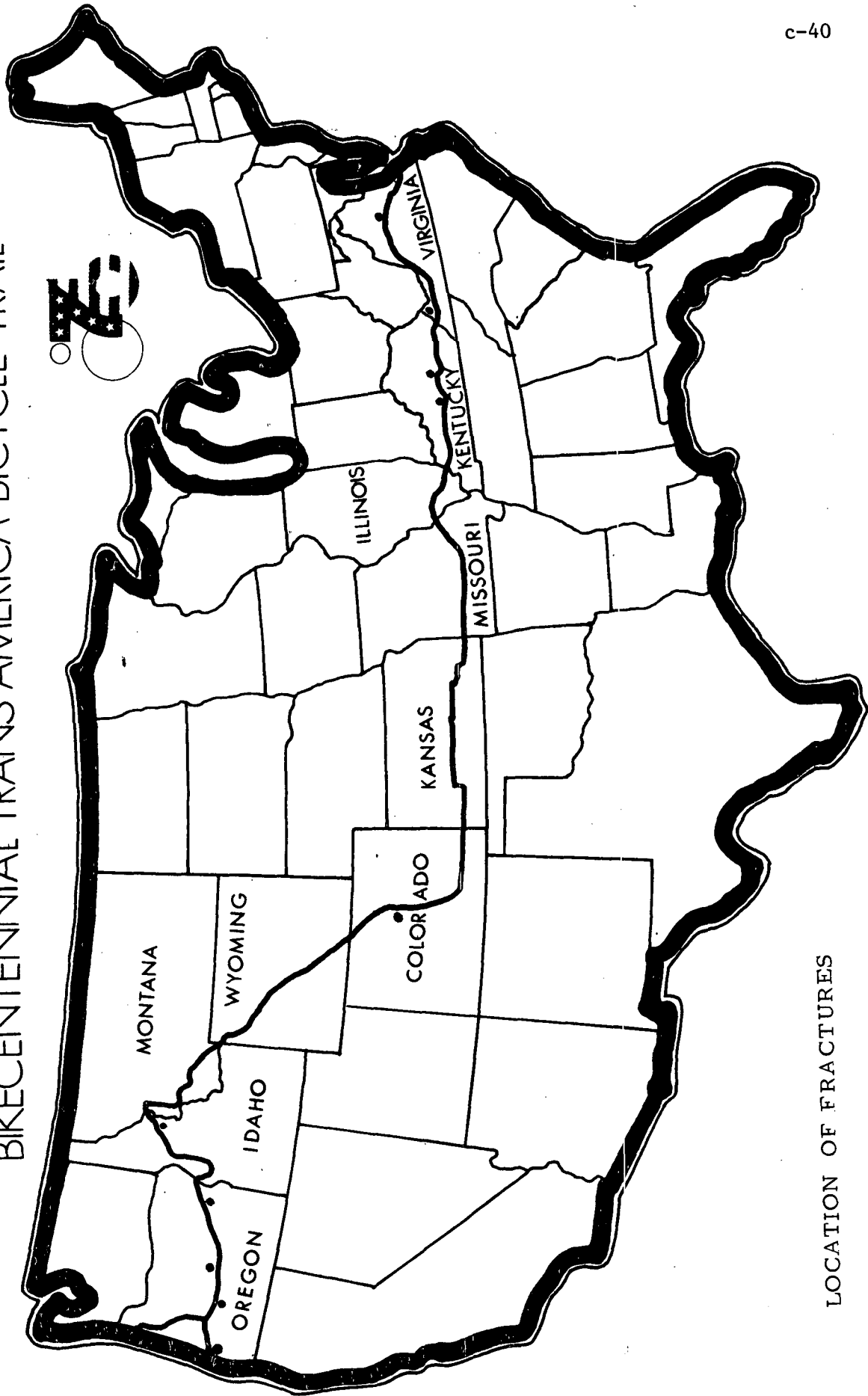
LOCATION OF HILLY
CONDITIONS

BIKECENTENNIAL TRANS-AMERICA BICYCLE TRAIL



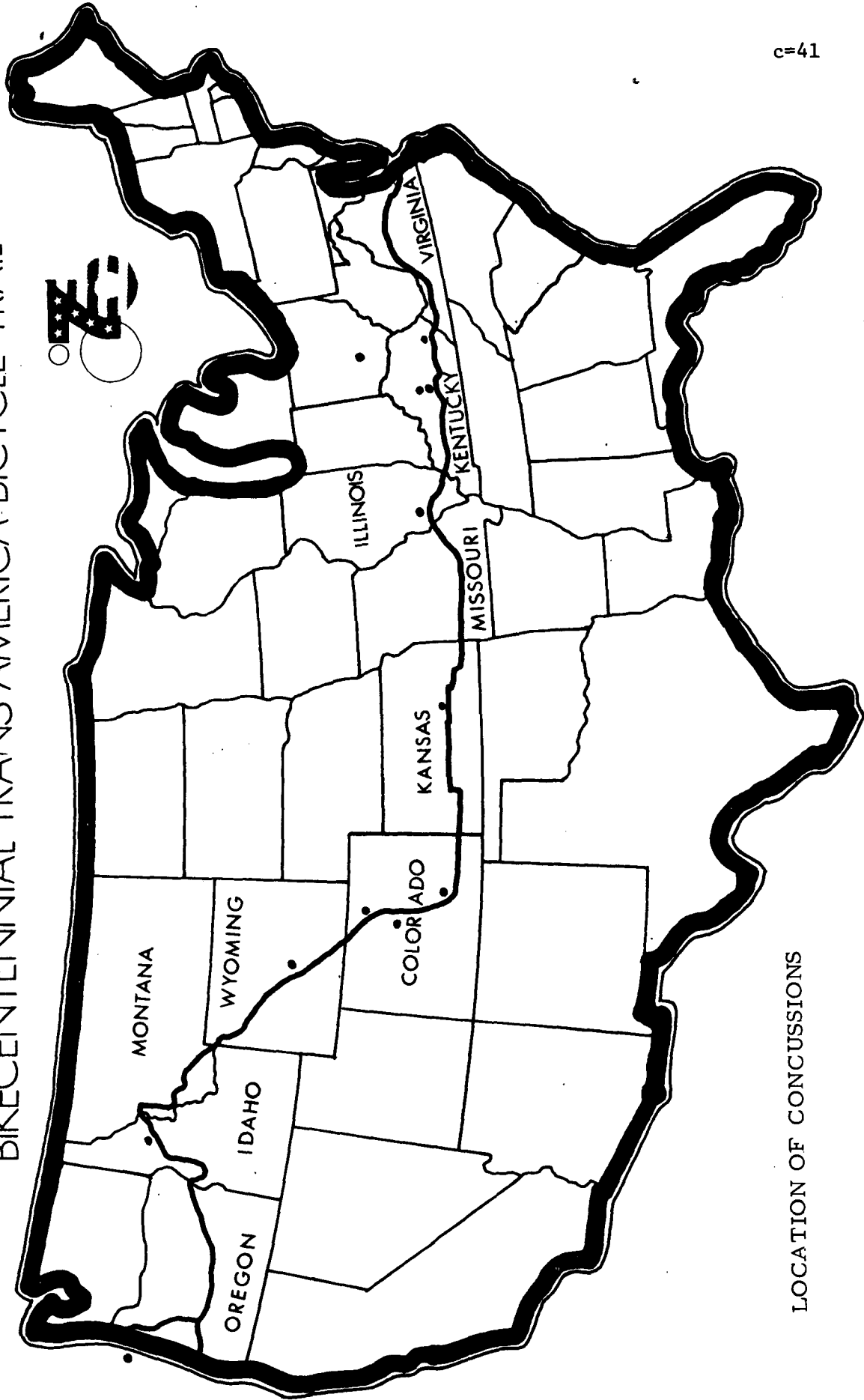
LOCATION OF 'OTHER' INJURIES

BIKECENTENNIAL TRANS-AMERICA BICYCLE TRAIL



LOCATION OF FRACTURES

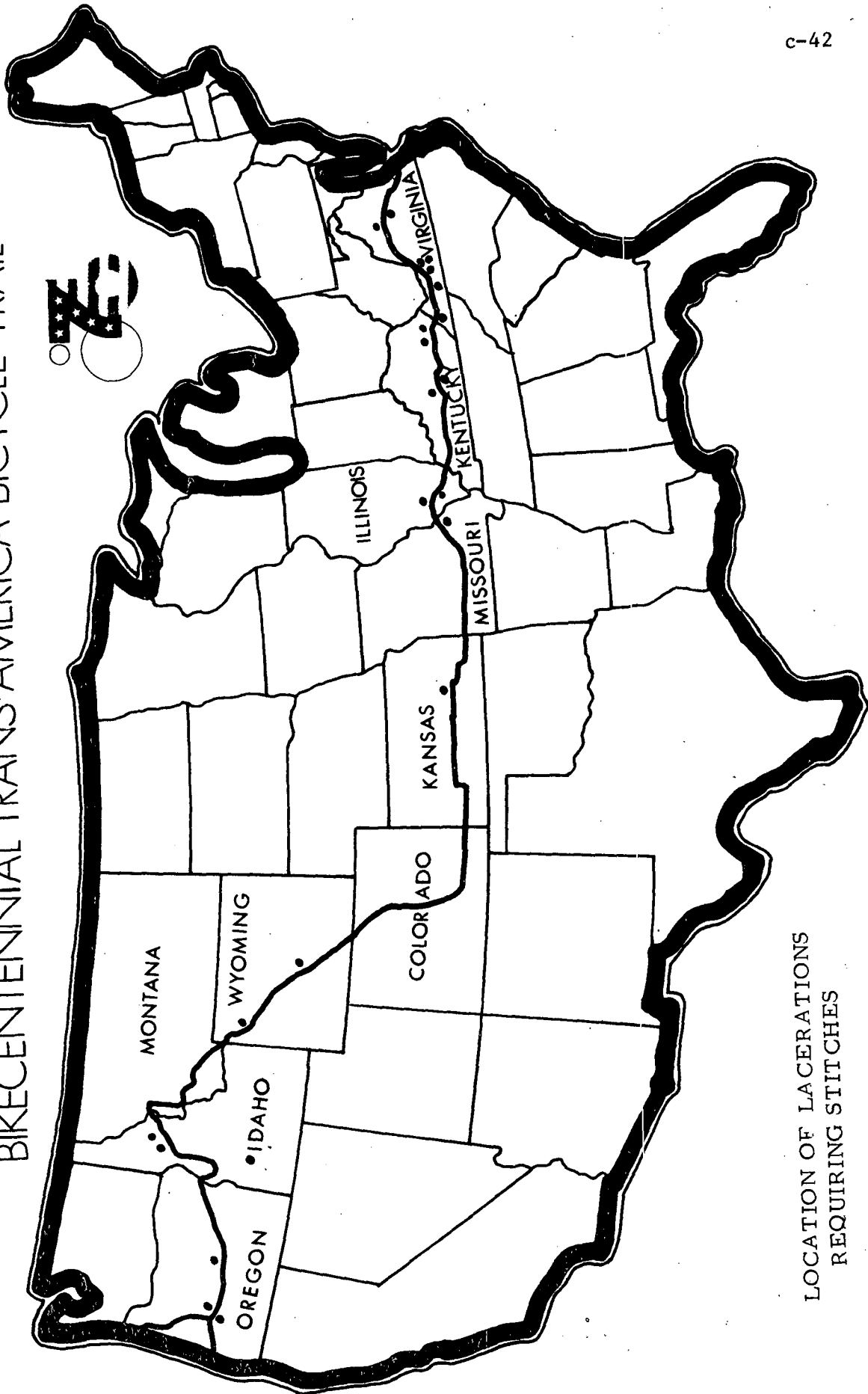
BIKECENTENNIAL TRANS-AMERICA BICYCLE TRAIL



c=41

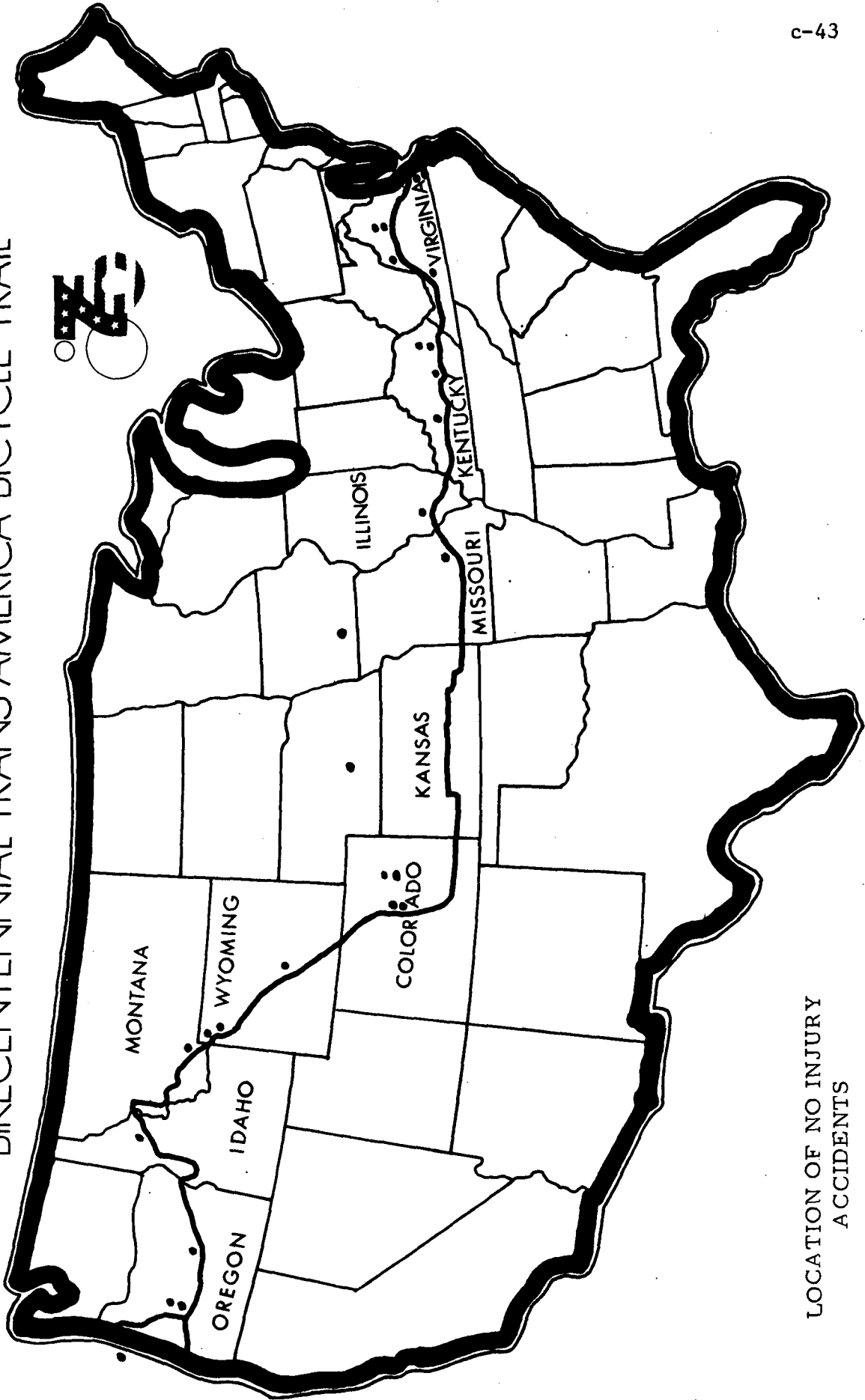
LOCATION OF CONCUSSIONS

BIKECENTENNIAL TRANS-AMERICA BICYCLE TRAIL



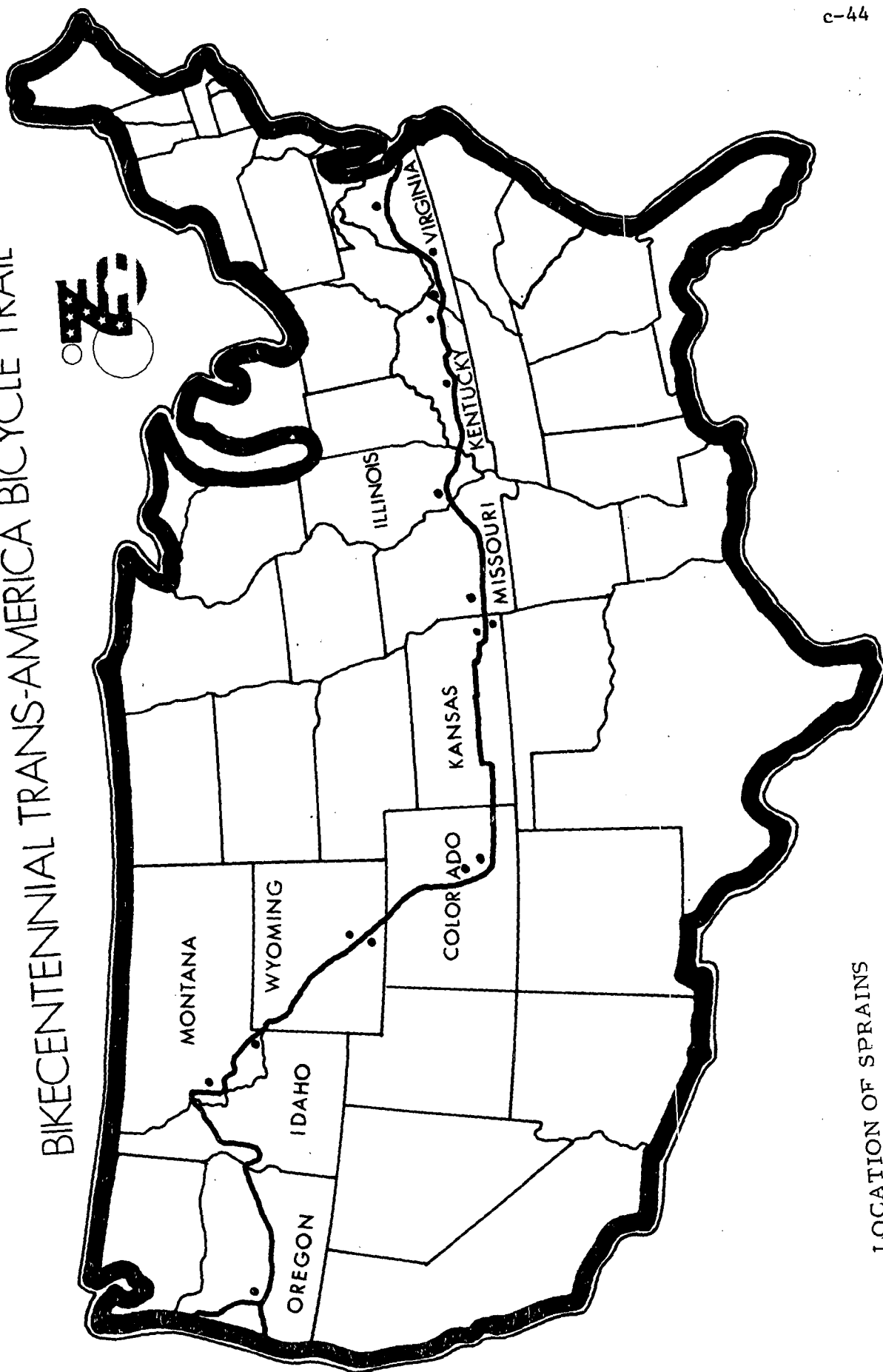
LOCATION OF LACERATIONS
REQUIRING STITCHES

BIKECENTENNIAL TRANS-AMERICA BICYCLE TRAIL



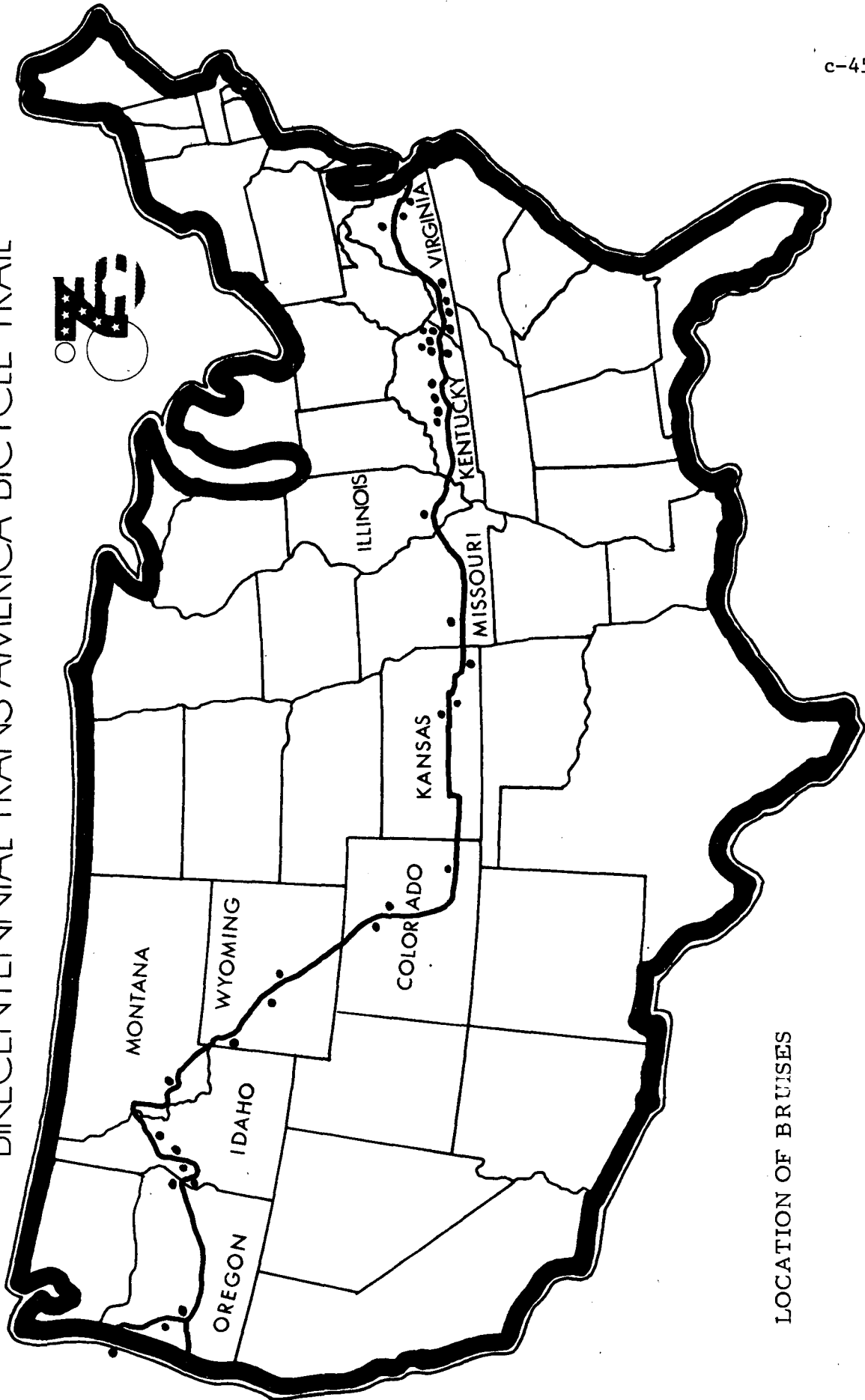
LOCATION OF NO INJURY
ACCIDENTS

BIKECENTENNIAL TRANS-AMERICA BICYCLE TRAIL



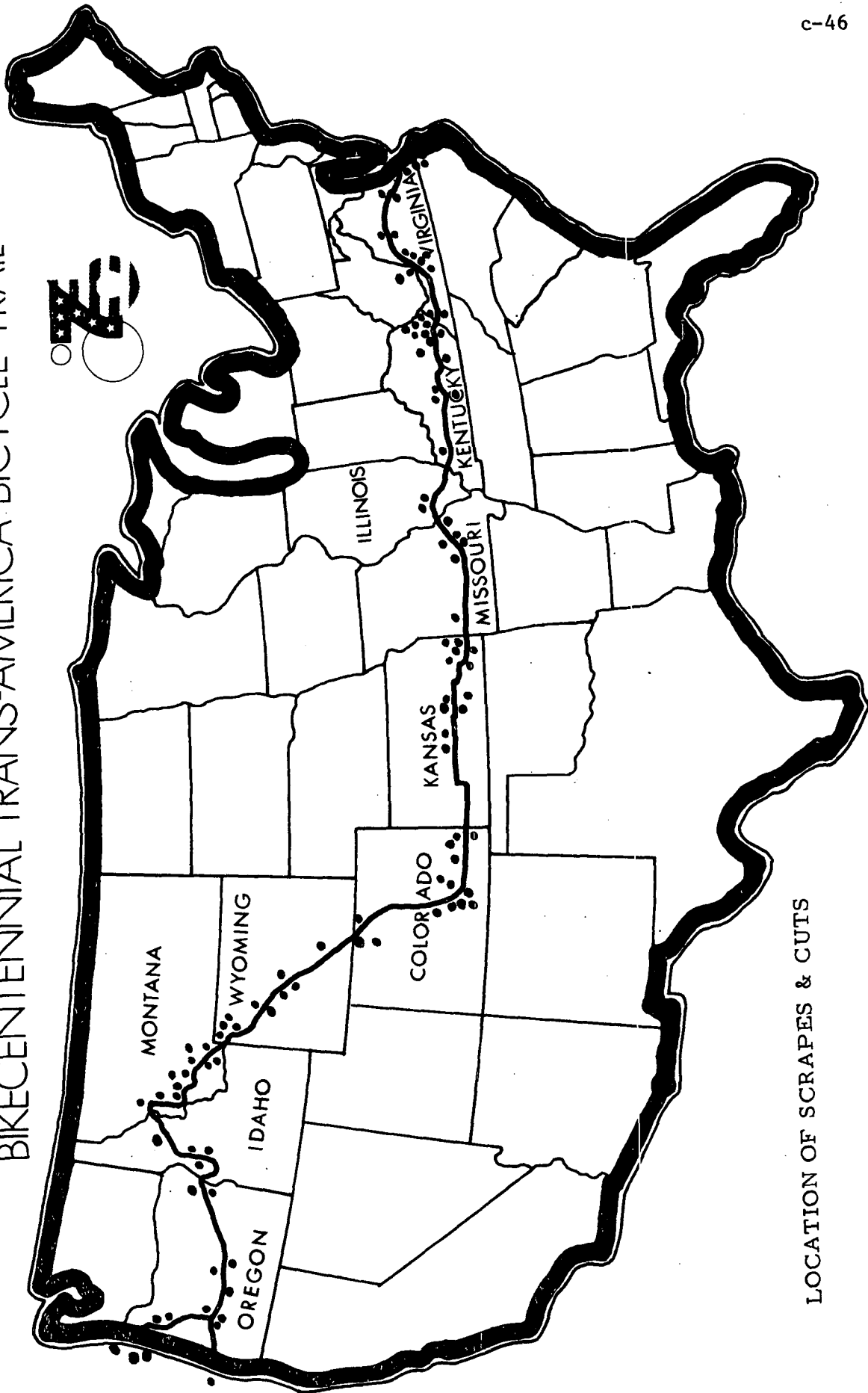
LOCATION OF SPRAINS

BIKECENTENNIAL TRANS-AMERICA BICYCLE TRAIL



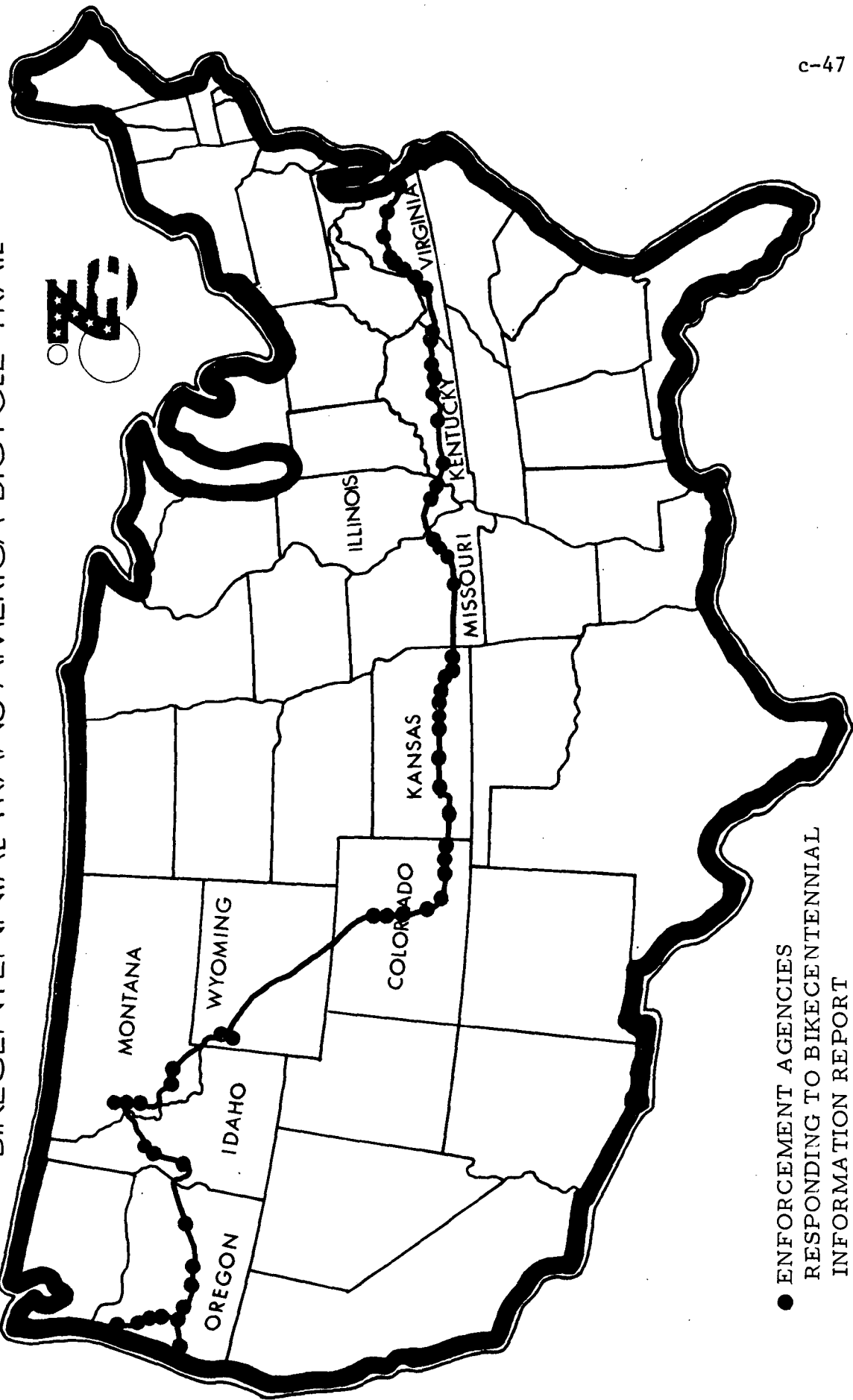
LOCATION OF BRUISES

BIKECENTENNIAL TRANS-AMERICA BICYCLE TRAIL



LOCATION OF SCRAPES & CUTS

BIKECENTENNIAL TRANS-AMERICA BICYCLE TRAIL



● ENFORCEMENT AGENCIES
RESPONDING TO BIKECENTENNIAL
INFORMATION REPORT

COMPARATIVE ACCIDENT RATE BY AGE

Age Group

	15 -	16-20	21-25	26-30	31-35	36-45	46-55	56-65	65 +
No. of reported accidents	4	173	106	48	14	24	11	15	1
No. of respondents	48	563	502	358	160	184	167	68	12
Accident rate/ 100 persons	8.33	30.73	21.11	13.41	8.75	13.04	6.59	22.06	8.33

Percentage of persons
in group of 100 that had:

1 Accident	4.17%	15.63%	12.15%	10.06%	3.75%	11.41%	5.39%	16.18%	8.33%
2 Accidents	2.08%	5.51%	3.19%	1.12%	2.50%	-	.60%	2.94%	-
3 Accidents	-	.88%	.20%	-	-	.54%	-	-	-
4 Accidents	-	.36%	-	.28%	-	-	-	-	-
5 Accidents	-	-	.40%	-	-	-	-	-	-
Any accidents	6.25%	22.38%	15.94%	11.46%	6.25%	11.95%	5.99%	19.12%	8.33%

ACCIDENT VICTIM RATE PER MILLION MILES

WHEN

c-49

MOTOR VEHICLE HIT CYCLIST

Reported Collision Victims

Vehicle	Total	Men	Women
Car	2.20/mm (1.60/mm)	1.88/mm (1.35/mm)	3.10/mm (2.33/mm)
Recreational vehicle	.80/mm (.40/mm)	.81/mm (.54/mm)	.77/mm (-)
Vehicle w/ trailer	.60/mm (.20/mm)	.54/mm (.27/mm)	.77/mm (-)
Pick up truck	.60/mm (.40/mm)	.81/mm (.54/mm)	- (-)
Semi	.80/mm (-)	.54/mm (-)	1.55/mm (-)
Coal Truck	.20/mm (-)	.27/mm (-)	- (-)
Van	.20/mm (.20/mm)	.27/mm (.27/mm)	- (-)
Total	5.20/mm (2.60/mm)	4.85/mm (2.69/mm)	6.22/mm (2.33/mm)

AVERAGE RIDER DAYS PER ACCIDENT

WHEN

MOTOR VEHICLE HIT CYCLIST

Reported Collision Victims

Vehicle	Total	Men	Women
Car	8487/a (11670/a)	9823/a (13752/a)	6151/a (8201/a)
Recreational vehicle	23340/a (46681/a)	22920/a (34380/a)	24602/a (-)
Vehicle with trailer	31120/a (93361/a)	34380/a (68759/a)	24602/a (-)
Pick up truck	31120/a (46681/a)	22920/a (34380/a)	- (-)
Semi	23340/a (-)	34380/a (-)	12301/a (-)
Coal truck	93361/a (-)	68759/a (-)	- (-)
Van	93361/a (-)	68759/a (68759/a)	- (-)
Total	3590/a (7182/a)	3820/a (6876/a)	3075/a (8201/a)

ACCIDENT VICTIM RATES

WHEN

CYCLIST CRASHES AVOIDING MOTOR VEHICLE

Reported Collision Victims

All vehicles	Total	Men	Women
Rate / million miles	6.60/mm (1.80/mm)	6.20/mm (.81/mm)	7.77/mm (4.66/mm)
Rider days / accident	2829/a (10373/a)	2990/a (22920/a)	2460/a (4100/a)