THE EFFECT OF DAYLIGHT SAVING TIME ON THE NUMBER OF MOTOR VEHICLE FATALITIES

BY

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A study of the effect of daylight saving time on motor vehicle fatalities indicates that a considerable number of injuries and deaths might be avoided annually if clocks were advanced one hour throughout the nation from the first Sunday in April to the last Sunday in September. This result is suggested by a study of the 1938 and 1939 motor vehicle accident record of sixteen large cities, each with a population in excess of 250,000. Fatal motor vehicle accidents numbered 5,731 in these cities during the two years embraced in the study.

Ten of the sixteen cities were not on daylight saving time during 1938 and 1939. These ten cities with their total population of 6,830,000, gave rise to 2,138 fatal accidents. Six of the cities were on daylight saving time. They had a total population of 13,280,000 and gave rise to 3,593 fatal accidents during the period under observation. The individual cities covered by this analysis are listed under Appendix "A".

The hour-by-hour fatal accident record of these cities clearly shows the increased hazard brought on by darkness. The table and chart under Appendix "B" illustrate the increase in the number of fatal accidents that occur when an hour is dark as compared to when it is light. In spite of certain irregularities due to the inadequacy of the data the probable reduction in fatal accidents that would result from substituting an hour of light for an hour of darkness is clearly indicated.

The following exhibit shows that after taking into account the changes in traffic volume, fatal accidents average almost three times higher during hours of darkness than during hours of daylight. Details supporting this exhibit appear under Appendix "C".

	Average number of fatal accidents occurring each hour of each month per 10,000,000 population recognizing relative traffic volume by hour of day	
	Cities Without Daylight Saving Time	Cities With Daylight Saving Time
Daylight hours.....	7.4	6.7
Dark hours.....	21.4	17.6
Increase	14.0	10.9
% of incr.....	189.2%	162.7%

That changing an hour from darkness to daylight would result in a reduction in fatal accidents also is indicated by a comparison of the fatal accident record of each hour from 5 P. M. to 9 P. M. when it is light and when it is dark. Fatal accidents during each of these hours are roughly three times more numerous during months in which the hour is dark than during months in which it is light.

	Average number of fatal accidents per month per 10,000,000 population			
	Cities Without Daylight Saving Time		Cities With Daylight Saving Time	
	Light	Dark	Light	Dark
5-6 P.M.	6.6	23.9	5.4	19.1
6-7 "	5.7	21.8	5.2	15.9
7-8 "	8.8	16.8	4.4	12.0
8-9 "		10.7	4.0	9.0

A comparison between the fatal accident record of cities on standard time and cities on daylight saving time for the three hours from 6 P. M. to 9 P. M. indicates that a considerable number of lives were saved during 1938 and 1939 through the use of daylight saving time. In cities with daylight saving time these hours showed a reduction in accidents during the daylight saving months of 55% whereas these hours in cities that remained on standard time showed a reduction of only 38%.

	Average number of fatal accidents per month per 10,000,000 population 6-9 P.M.	
	Cities Without Daylight Saving Time	Cities With Daylight Saving Time
7 Mos. unaffected by D. S. T....	47.4	35.8
5 Mos. affected by D. S. T.....	29.3	15.9
Decrease	18.1	19.9
% of decr.....	38.2%	55.6%

It also is illuminating to compare the number of fatal accidents occurring during the last hour of daylight in the cities using daylight time with the same clock hour in cities using standard time. This hour is light in both groups of cities during the 7 months that are unaffected by daylight time whereas during the 5 months that are affected it is light in daylight time cities and dark in standard time cities. During the 5 months that are affected by daylight saving there is a reduction in fatal accidents in the case of daylight time cities whereas in the case of standard time cities fatal accidents more than double.

	Average number of fatal accidents per month per 10,000,000 population (Last hour of daylight in D. S. cities)	
	Cities Without Daylight Saving Time	Cities With Daylight Saving Time
7 Mos. unaffected by D. S. T....	6.9	5.9
5 Mos. affected by D. S. T.....	13.9	4.7
Increase	7.0	—1.2
% of incr.....	101.4%	—20.3%

Motor vehicle fatalities were not available during 1938 for the hours from 4 A. M. to 7 A. M. for most of the cities included in the survey, but the information is available for the year 1939 and it indicates that the extra hour of darkness in the morning would result in only a negligible increase in motor vehicle fatalities for the reason that the volume of traffic is so light. The available data are inadequate to form the basis for a reliable conclusion, but the figures taken at their face value point to an increase in fatalities for cities with daylight saving time of 0.6% during the five month period.

It might be argued that the adoption of daylight saving time disturbs the flow of traffic from hour to hour and that the seasonal migration of our population between the South and the North tends to invalidate certain of the comparisons which have been drawn. The influence of such changes is largely discounted when comparison is made of the combined fatal accident record for the four evening hours from 6 P. M. to 10 P. M. with the five daylight hours from 10 A. M. to 3 P. M. for cities with and without daylight saving time respectively. During the five months which are affected by daylight time, these four evening hours have 31% more

fatal accidents than the five daylight hours in the case of Daylight Time cities whereas they have 71% more in the case of Standard Time cities.

	Average number of fatal accidents per month per 10,000,000 population (Five summer months)	
	Cities Without Daylight Saving Time	Cities With Daylight Saving Time
10 A.M. - 3 P.M.	21.5	17.7
6 P.M. - 10 P.M.	36.7	23.2
Increase	15.2	5.5
% of incr.	70.7%	31.1%

The foregoing comparisons show that cities with daylight saving time had a better accident record during the hours influenced by daylight saving than did cities without daylight saving time, and the figures provide fairly conclusive evidence that the extra hour of daylight was the major factor contributing to this difference in the record. The actual saving in lives resulting from the adoption of daylight saving is estimated at 6.7% for the five daylight saving months and 2.5% for the twelve months. (Supporting details are given in Appendix "D").

The study indicates that more than 80 lives were saved during 1939 in areas using daylight saving time as a result of the extra hour of daylight. Less than 20% of the aggregate motor vehicle fatalities occurred in areas that were under daylight saving time. In estimating the additional lives that might be saved in extending daylight saving time to the month of April throughout the Nation and to areas that had not adopted daylight saving time in 1939, we are confronted with the problem of judging whether or not a test made of the accident record of sixteen large cities is indicative of the results that would be secured if the test had covered smaller cities and rural areas. Traffic is proportionately greater during the evening hours in urban than in rural areas and this in itself suggests that the savings would not be as great in rural communities. In arriving at the minimum number of lives that might be saved, the percentage savings indicated by the survey were applied to incorporated areas exclusively. So doing indicated that at least 350 deaths and probably at least 12,500 personal injuries might be avoided annually in the future if clocks were

advanced one hour from the first Sunday in April to the last Sunday in September. If similar savings were to be realized in rural areas as well, an aggregate of almost 900 deaths and over 30,000 personal injuries might be avoided each year. Details supporting these estimates appear in Appendix "E".

With so many lives at stake the question naturally arises whether or not it would be desirable to adopt daylight saving time throughout the year. There are two important reasons why such a step might not be a wise one. The first reason is the large volume of traffic that moves during the hour from 7 to 8 A. M. This traffic would be forced to move in darkness during the winter if daylight saving time were adopted on a year around basis. The second reason is the fact that business hours are set so as to utilize the maximum of the available daylight hours. It appears possible that the benefits derived from the adoption of year-around daylight saving time might be nullified over a period of time because of the readjustment of business hours and the resultant readjustment of traffic volumes.

The statistical evidence that has been presented makes it appear desirable from the standpoint of eliminating unnecessary suffering and loss of life to adopt daylight saving time throughout the country from the first Sunday in April to the last Sunday in September. It is of interest that this time schedule is substantially the schedule that was in use in Europe prior to the current war. France, Belgium and Portugal had daylight saving time during the period from April to September, and Great Britain had it from the middle of April to early in October.

Appendix "A"

The time of sunrise and sunset differs between cities and this creates distortion in the results when studying the effect of daylight saving time for combinations of cities. In order to minimize this distortion, cities whose "sun" time varies from the average by more than one-third of an hour were excluded from the study. The accompanying map shows the areas from which the cities were selected. Following are the sixteen cities, each with population in excess of 250,000, embraced in the diamond shaped areas that meet the described time limitations.

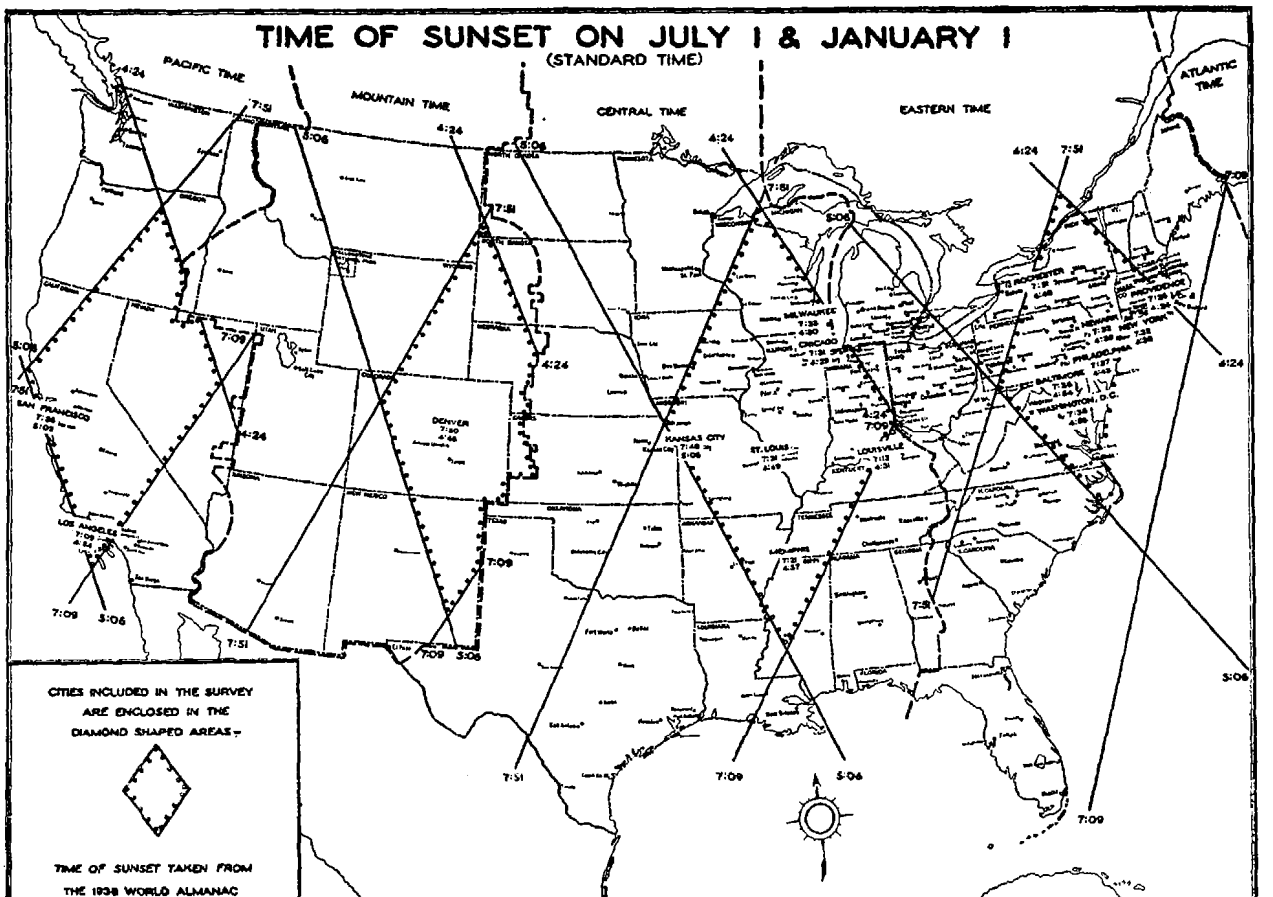
CITIES WITHOUT DAYLIGHT SAVING TIME

City	Population	No. of Fatal Accidents		
		1938	1939	Combined
Baltimore	805,000	108	125	233
Denver	288,000	56	65	121
Kansas City	340,000	63	28	91
Los Angeles	2,208,000	468	443	911
Louisville	308,000	35	46	81
Memphis	253,000	43	30	73
Milwaukee	578,000	44	56	100
St. Louis	822,000	82	81	163
San Francisco	634,000	95	106	201
Washington, D. C.	594,000	84	80	164
Total	6,830,000	1,078	1,060	2,138

CITIES WITH DAYLIGHT SAVING TIME

City	Population	No. of Fatal Accidents		
		1938	1939	Combined
Chicago	3,376,000	634	664	1,298
Newark	442,000	50	60	110
New York	6,930,000	782	760	1,542
Philadelphia	1,951,000	275	271	546
Providence	253,000	15	11	26
Rochester	328,000	36	35	71
Total	13,280,000	1,792	1,801	3,593

APPENDIX "A"


TIME OF SUNSET ON JULY 1 & JANUARY 1
(STANDARD TIME)
PACIFIC TIME
MOUNTAIN TIME
CENTRAL TIME
EASTERN TIME
ATLANTIC TIME
CITIES INCLUDED IN THE SURVEY ARE ENCLOSED IN THE DIAMOND SHAPED AREAS
TIME OF SUNSET TAKEN FROM THE 1938 WORLD ALMANAC

APPENDIX "B"

FATAL ACCIDENTS AND TRAFFIC VOLUMES DURING EACH HOUR OF THE DAY

Hour	Estimated % of Total Traffic Volume in each hour	Cities Without Daylight Saving Time		Cities With Daylight Saving Time	
		No. of Mos. in which the specified hour is in darkness	% of Tot. Fatal Accidents Occurring in each hour	No. of Mos. in which the specified hour is in darkness	% of Tot. Fatal Accidents Occurring in each hour
A.M.					
12-6	1.2	—	2.8	—	3.2
6-7	2.2	2	1.5	2	2.2
7-8	5.3	0	2.1	0	2.1
8-9	6.2	0	2.2	0	2.2
9-10	4.8	0	1.9	0	2.0
10-11	4.7	0	2.8	0	2.2
11-12	4.9	0	2.2	0	3.1
P.M.					
12-1	4.7	0	2.4	0	3.2
1-2	4.8	0	2.9	0	3.0
2-3	5.1	0	3.6	0	3.1
3-4	5.7	0	3.4	0	4.2
4-5	6.7	0	4.6	0	4.9
5-6	7.8	3	8.4	3	7.9
6-7	5.9	6	10.5	6	9.4
7-8	5.4	10	11.8	7	7.9
8-9	5.6	12	8.2	10	7.2
9-10	4.9	12	5.8	12	6.2
10-11	4.5	12	5.1	12	5.0
11-12	3.7	12	3.7	12	4.8

APPENDIX "C"

Average Number of Fatal Accidents Occurring Each Hour of Each Month per Unit of Traffic and per Unit of Population

It was assumed in this and other comparisons that darkness comes thirty minutes after sunset (approximate period of civil twilight) and that an hour is dark if an average of one-half or more of it comes after the assumed time of darkness. This assumption had to be made because accident data are not available for units of less than one hour.

Fatal accidents were not available by hour from midnight to 6 A. M. for most of the cities and since part of this period is dark and part is light it was necessary to exclude this time interval in determining the averages that are shown.

	Cities With D. S.		Cities Without D. S.	
	Light	Dark	Light	Dark
(1) Fatal accidents	776	1,000	1,426	1,468
(2) Total hours	294	138	304	128
(3) Average number of fatal accidents each hour of each month	2.64	7.25	4.69	11.47
(4) Sum of traffic volume percentages	1546.4	683.2	1601.2	628.4
(5) Total hours	294	138	304	128
(6) Average percent of traffic during each hour	5.26	4.95	5.27	4.91
(7) Population (in thousands)	6,830	6,830	13,280	13,280
(8) Average number of fatal accidents occurring each hour of each month, per 10,000,000 population, recognizing relative traffic volume by hour of day. (3) ÷ [(6) × (7)]	7.4	21.4	6.7	17.6

APPENDIX "D"

During the five months* in which daylight saving time was in effect the daylight saving cities showed an increase in fatal accidents during the hours of 6 P. M. - 10 P. M. as compared to the hours of 10 A. M. - 3 P. M. of 31.1% whereas standard time cities showed an increase of 70.7%. If standard time cities had as good a record as daylight saving cities they would have had a fatal accident rate during the hours of 6 P. M. - 10 P. M. of 28.2 fatal accidents per month per ten million population. This estimated accident rate represents a saving from the actual rate of 23.3% for the four hours. This indicated saving is equivalent to 7.3% for all hours of the summer months and to 2.7% for all hours of the year.

Partially offsetting these reductions is the indicated increase in the number of fatal accidents during the hours of 4 A. M. - 7 A. M. During 1939 this increase was 0.6% for the five summer months and 0.2% for the year. Therefore, the indicated net saving in lives which would result from the adoption of daylight saving time in these cities amounts to 6.7% for the five summer months and to 2.5% for the year.

Computations follow:

(1) Average number of fatal accidents per month per 10,000,000 population during the summer months for the hours of 10 A.M.-3 P.M. in cities that remained on standard time 21.5

(2) Increase during the hours of 6 P.M.-10 P.M. (comparable to that shown by D. S. cities..... 6.7
(1) × 31.1%

(3) Estimated fatal accident rate of standard time cities if they had adopted daylight saving time..... 28.2
(1) + (2)

(4) Total fatal accidents with estimated rate (3) times population in ten millions times the number of months..... 192.6
(28.2) (.6830) (10) = 192.6

(5) Actual number of fatal accidents during hours of 6 P.M.-10 P.M..... 251

(6) Saving during hours of 6 P.M.-10 P.M..... 23.3%
$\frac{(5)-(4)}{(5)} = \frac{251-192.6}{251} = 23.3\%$

(7) Saving during summer months..... 7.3%
$\frac{(5)-(4)}{805} = \frac{251-192.6}{805} = 7.3\%$

(8) Annual saving..... 2.7%
$\frac{(5)-(4)}{2138} = \frac{251-192.6}{2138} = 2.7\%$

* Daylight saving time is ordinarily in effect from the last Sunday in April to the last Sunday in September but the limitations of available data require that it be assumed to be in effect from May 1 to September 30.

APPENDIX "E"

How More Than 350 Lives Might Be Saved by the Nationwide Adoption of Daylight Saving Time

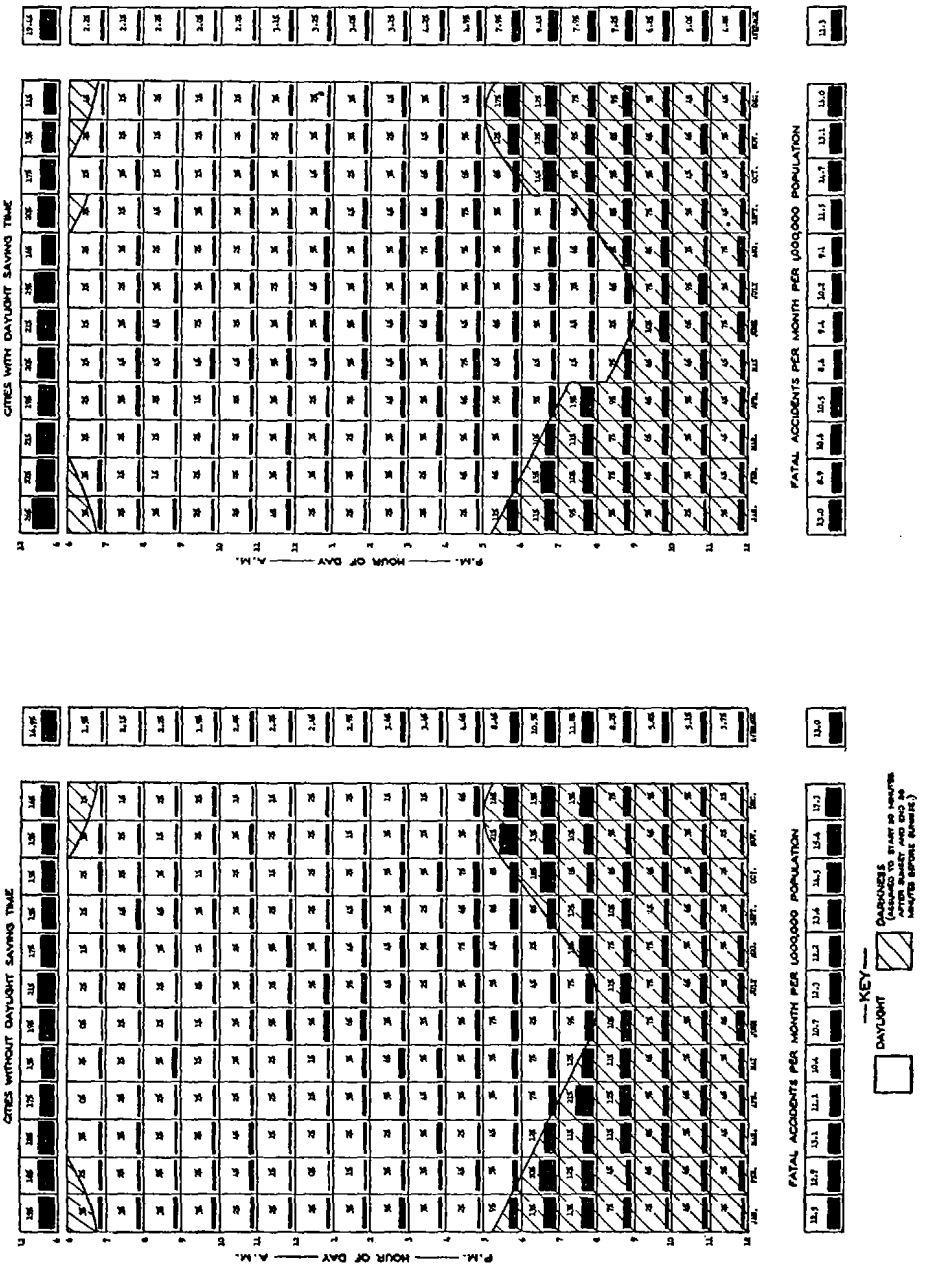
It was demonstrated in Appendix "D" that motor vehicle fatalities in certain large cities were reduced 2.5% by the adoption of daylight saving time from the last Sunday in April to the last Sunday in September. It is estimated that the extension of daylight saving to the month of April would have the effect of decreasing April fatalities by 6.7% (average decrease per month shown by daylight saving cities between May 1 and September 30). This represents a saving for the year of 0.5% and combined with the potential saving for the five months of 2.5% (per annum) makes the total potential saving per annum 3.0%.

Although darkness increases the hazards of driving in both urban and rural communities it is entirely possible that the saving in lives in rural areas would not be as great as that indicated in a study of cities over 250,000 population because the volume of traffic in rural areas is not as heavy during the evening hours. If the 3.0% saving suggested was realized in incorporated areas only it would mean 360 fewer deaths and 12,600 fewer personal injuries per year. If this saving was realized in unincorporated areas as well it would mean 893 fewer deaths and 31,255 fewer personal injuries annually. It appears therefore that the true saving would be somewhere between these figures.

Computations follow:

	Incorporated Areas	Nationwide
(1) Annual motor vehicle fatalities (Average of last three years)	14,675	34,940
(2) Fatalities occurring in areas that were under D. S. during 1939 (estimated)	3,200	6,200
(3) Estimated present saving in fatalities $\frac{(2)}{97.5\%} - (2)$	82	159
(4) Fatalities in areas not under D. S. during 1939	11,475	28,740
(5) Lives saved by adoption of D. S. in those areas not using it 3.0% of (4)	344	862
(6) Lives saved by extension of D. S. to April in areas now using it 0.5% of (2)	16	31
(7) Total saving in lives	360	893
(8) Decrease in personal injuries (7) × 35*	12,600	31,255

* Estimated ratio of injuries to each death.


CITIES WITHOUT DAYLIGHT SAVING TIME
CITIES WITH DAYLIGHT SAVING TIME
P.M. —— HOUR OF DAY —— A.M.
FATAL ACCIDENTS PER MONTH PER 1,000,000 POPULATION
—KEY—
DAYLIGHT
DARKNESS (ASSUMED TO START 90 MINUTES AFTER SUNSET AND END 90 MINUTES BEFORE SUNRISE)