EVALUATION OF RADAR SENSING IN REDUICING VEHICLE-DEER COLLISIONS ON INDIANA TOLL ROAD I-80

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Joint Transportation Research Program
Project No. SPR-2495

CRASH COST

State	Fatal	Injury A	Injury B	Injury C	PDO
Arizona	$3,000,000	$210,000	$42,000	$22,000	$3,000
Iowa	$1,000,000	$150,000	$10,000	$ 2,500	$2,500
Louisiana	$3,000,000	$ 63,000	$63,000	$ 63,000	$2,300
Maine	$2,600,000	$180,000	$36,000	$19,000	$2,000
Nebraska	$3,770,000	$316,000	$66,900	$34,900	$6,200
Oregon	$1,350,000	$1,350,000	$55,000	$55,000	$13,000
Texas	$ 854,000	$854,000	$41,000	$41,000	$1,400
Vermont	$3,400,000	$260,000	$56,000	$27,000	$4,000

INDIANA: Yearly: ***16,000 deer-vehicle collision;***

$22 million Property damage; 3 Fatalities.

State Farm Reports nationwide from July 1, 2004 to June 30, 2005:

1 million deer_vevicle collisions; 150 deaths;

$1.1 Billion in vehicle damages: (Average PDO Claim=$11,100)

OBJECTIVE

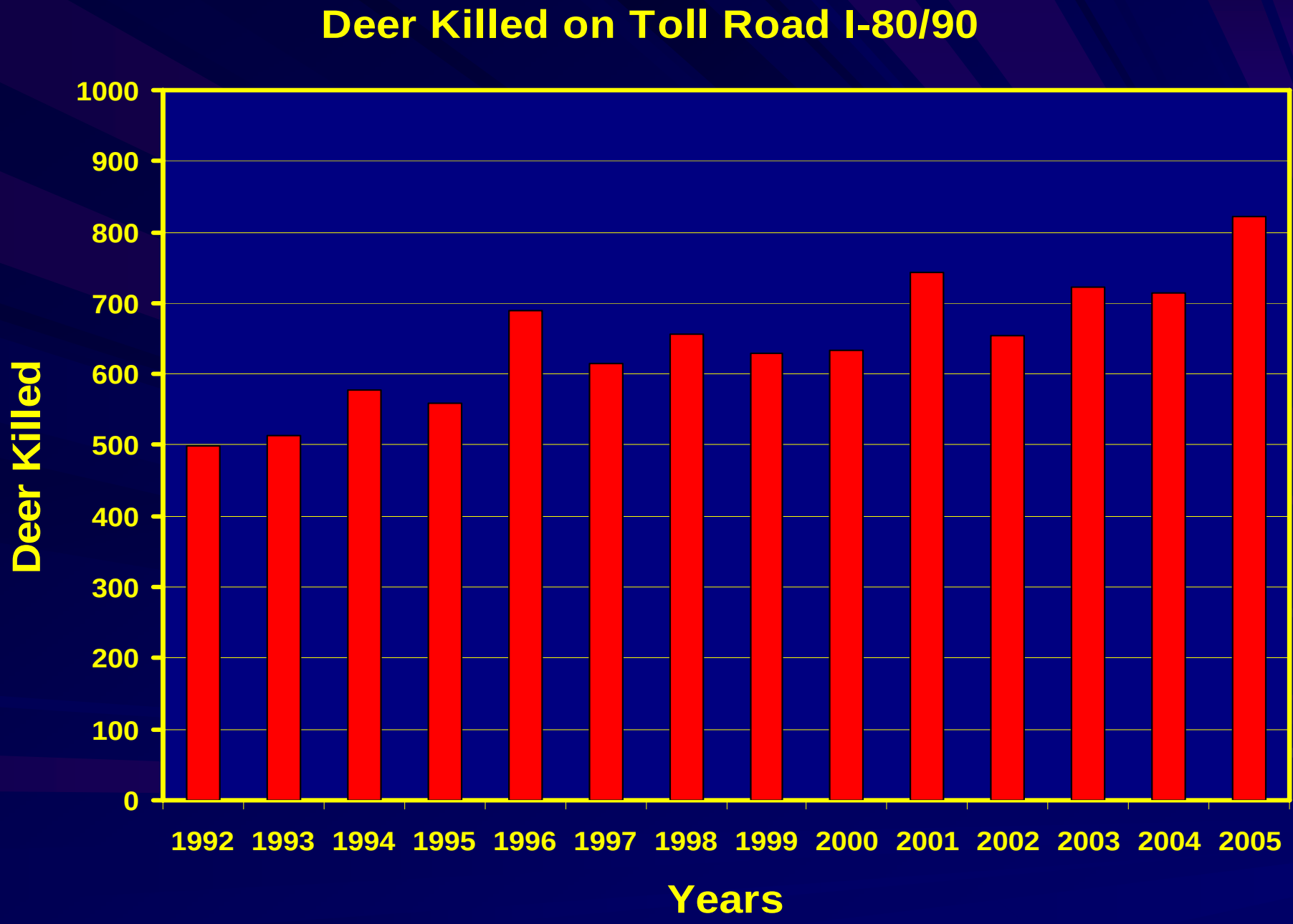
The overall objective of this project is to evaluate
The Radar Sensing Approach developed
by
“Sensor Technologies & Systems, Inc.”
in reducing vehicle-deer collisions
on Indiana Toll Road

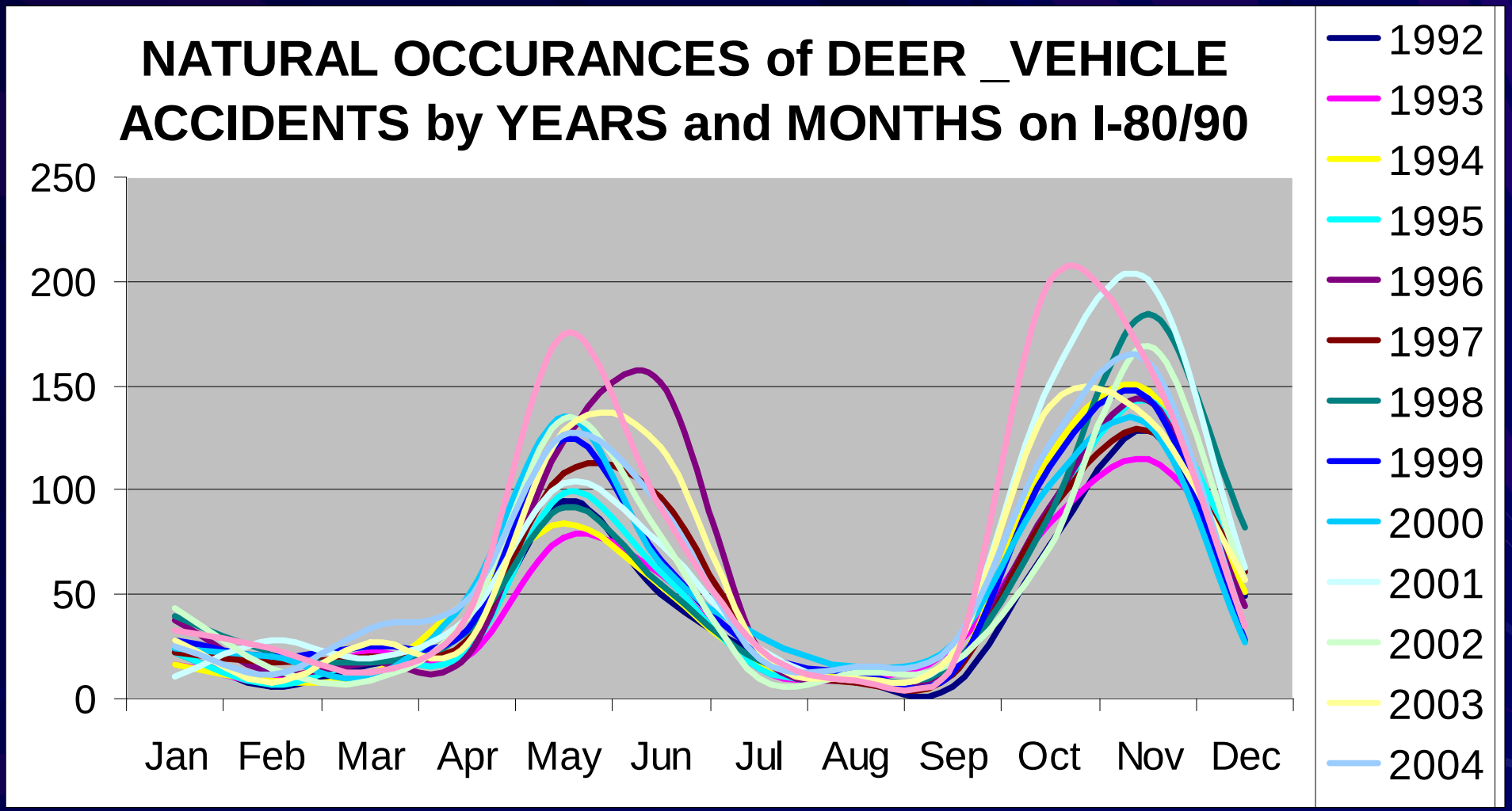
Expected Implementation and Study Benefits

If the results of the study statistically show a significant reduction in deer kills, the Indiana Toll Road will install radar-sensing devices on the Toll Road at sensitive locations. INDOT will likely install the same equipment on other state routes with a history of vehicle-deer collisions.

Accumulative Deer Kill Reports on Toll Road

Year	J	F	M	A	M	J	J	A	S	O	N	D	Total
1992	22	6	16	24	95	50	21	9	6	73	128	49	**499**
1993	16	9	22	20	77	60	14	10	24	84	115	62	**513**
1994	16	9	12	47	84	54	16	11	13	116	148	51	**577**
1995	22	7	18	22	98	61	14	10	14	89	143	61	**559**
1996	38	13	17	20	124	152	23	9	15	92	143	44	**690**
1997	22	17	20	28	108	97	23	8	12	90	128	61	**614**
1998	40	22	17	32	92	55	18	10	16	88	184	82	**656**
1999	28	20	25	33	125	67	22	13	13	111	144	28	**629**
2000	24	20	11	48	135	65	30	15	26	102	131	27	**634**
2001	11	28	19	39	103	74	24	9	22	151	201	63	**744**
2002	43	14	9	39	134	78	10	13	17	72	169	57	**655**
2003	28	8	27	26	128	121	23	10	21	140	134	57	**723**
2004	25	12	34	47	126	93	19	15	26	122	161	35	**715**
2005	33	24	13	40	175	92	24	9	16	200	160	35	**821**


Deer Killed on Toll Road I-80/90
Deer Killed
1000
900
800
700
600
500
400
300
200
100
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Years


NATURAL OCCURANCES of DEER _VEHICLE ACCIDENTS by YEARS and MONTHS on I-80/90
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004

There are two Peaks as seen in the graph:

1) **Smaller peak (May to June);**

   more probably due to:

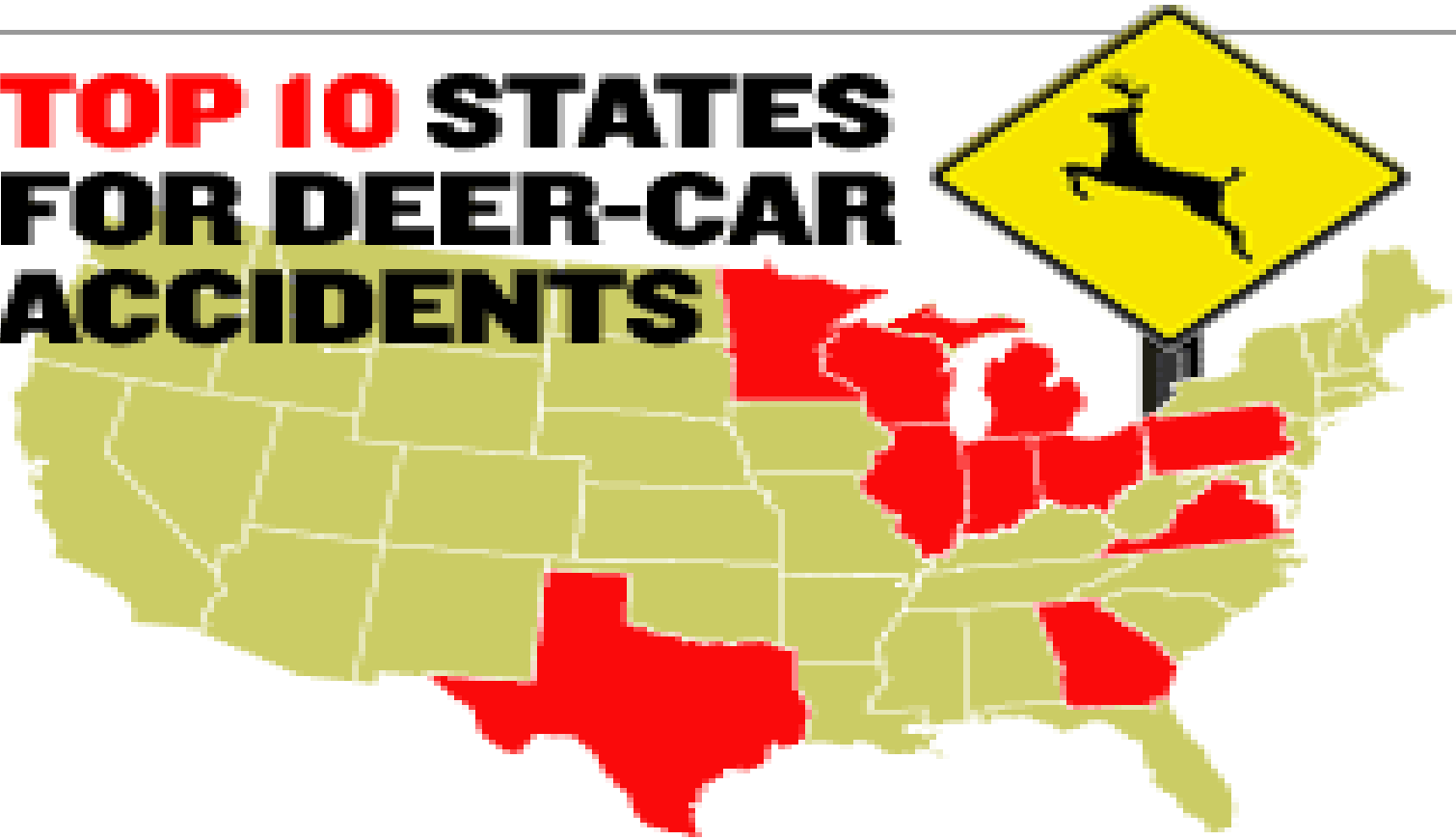
   - **Fawning and**
   - **Increased nutritional requirements of razing young cause females to travel more.**
   - **Availability of high quality of food cause travel**

2) **Larger Peak (October to November):**

   more probably due to:

   - **Breeding season; animals are more active and careless**
   - **Hunting season cause extensive movement**
   - **Lack of food can cause greater travel.**

TOP 10 STATES FOR DEER-CAR ACCIDENTS

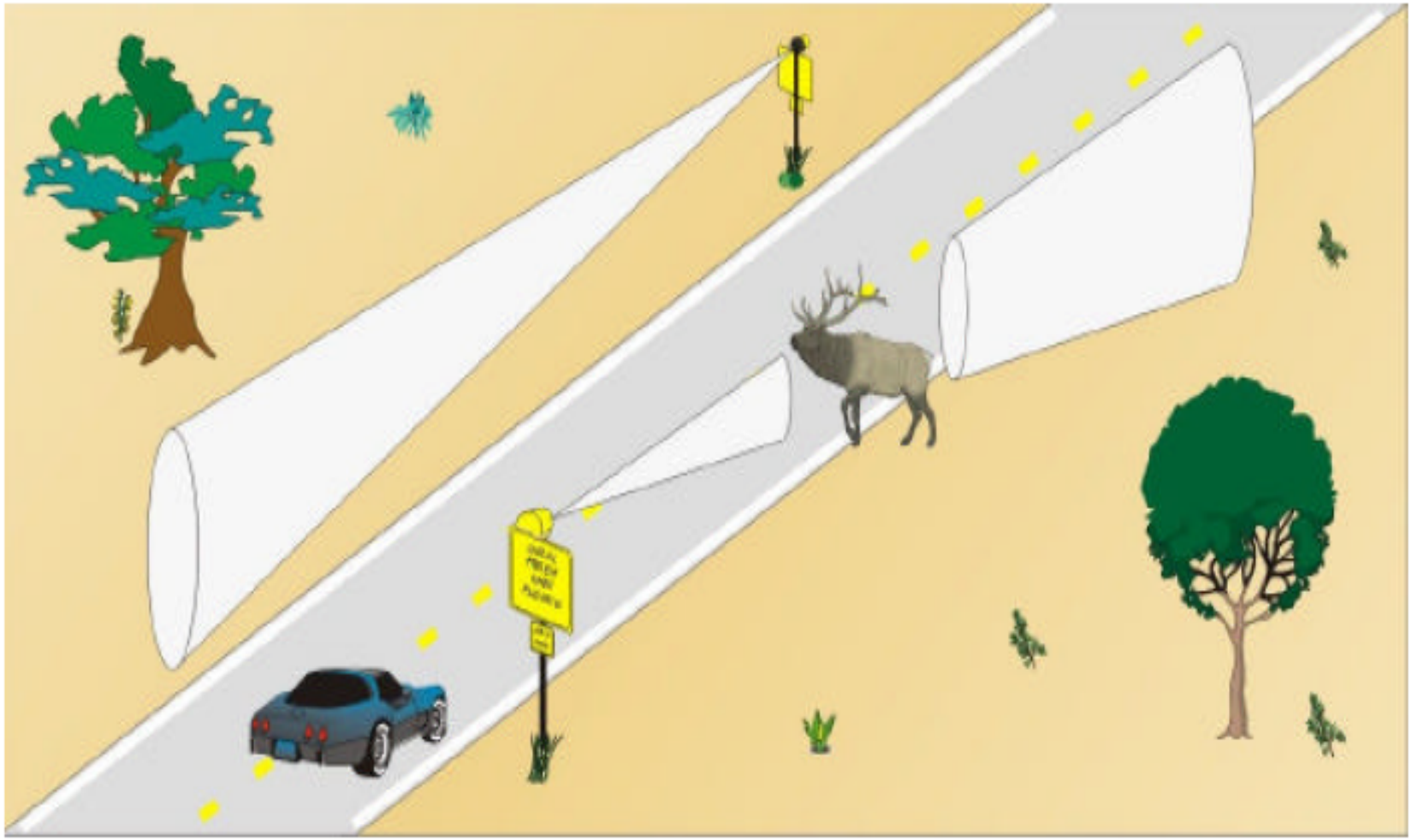


1. Pennsylvania
2. Michigan
3. Illinois
4. Ohio
5. Georgia
6. Minnesota
7. Virginia
8. Indiana
9. Texas
10. Wisconsin

Location of the the experiment on I-80/90 between Mile Markers 130 and 143.

RADS

Roadway Animal Detection System



RADS in Operation

DESIGN OF EXPERIMENT

The Following is the Design of Experiment actually used to place radar sensors and the control sections in between on I-80/90 Toll Road in Indiana.

There is two replicates and this design is statistically sound and valid.

The radar system has been functional since October 2004 and deer-vehicle accident data has been collected daily and reported monthly. The unit of data for the Poisson Regression is the total amount of Deer-Vehicle collisions per mile.

DESIGN OF EXPERIMENT

Typical Layout

Replicate 1							Replicate 2						
T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14
Mile Posts							Mile Posts						
130	131	132	133	134	135	136	137	138	139	140	141	142	143

T1, T2, ….., T14 ARE TREATMENTS

1-Mile Radar Sensor

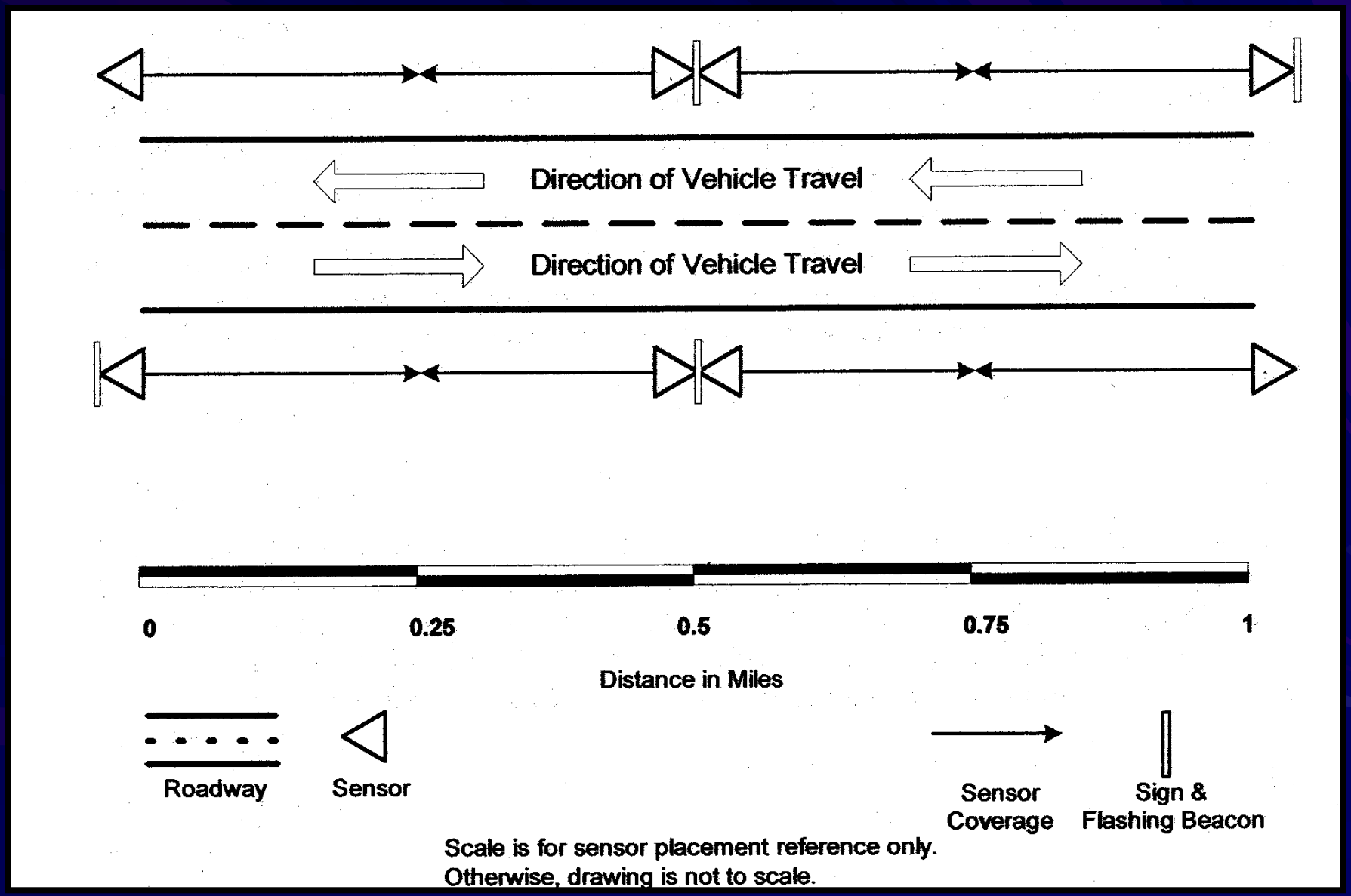
1-Mile Control

POISSON REGRESSION ANALYSIS will be used to analyze the data

Dependent Variable: Number of Deer-Vehicle Collisions

Explanatory Variables: Month, Replicate, Treatments, AADT, etc.

Typical Layout of the radar sensing systems



Deer Sensors
Milepost 130 – Milepost 142
I-80/90 Indiana Toll Road

The Indiana Toll Road in cooperation with the Indiana Department of Transportation Research Division, Purdue University and the University of Montana installed 72 sensors (6 per mile rather than 4 due to over-pass bridges and curving) and are testing an animal detection/warning system.

The system uses radio frequency transmitters and receivers to send a beam parallel to the road. If an animal (most likely a deer) breaks the beam, the flashing yellow beacons turn on and flash for two minutes to warn the drivers.

STATISTICAL APPROACH

Poisson Regression

$$P(y = r) = \frac{\left(\mu^{r} e^{-\mu}\right)}{r!} \cdots r = 0,1,2,\ldots$$

where : $\mu = E(y) =$ *Expected Value*

$\mu > 0$ *then* μ *can be* log *linear function of* X'*s*

$$Log(\mu_i) = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \cdots + \beta_p X_{ip}$$

This can make μ *positive for any values of* X'*s or* β'*s*.

X'*s are Explanotor y Variables such as* :

Months , *Years* , *Geographic al rating of the test*

sec *tions* , *replicate* , *the previous year* (1998) *as a* cov *ariate* .

The Following Warning Sign was used.

This sign was used in Europe

~~129.8 EASTBOUND~~


130.0 EASTBOUND
MILE
130
ANIMAL
PRESENT
WHEN
FLASHING
NEXT
MILE

Radar Systems in Place


142.2 EASTBOUND
END TEST
SECTION

The system is 100% solar powered and each mile of the test area operates independently from the other locations.

Each system is connected to a cell phone for remote monitoring, checking and data collection.

The system was activated in 10/2004.

PRELIMINARY STATISTICS

YEAR	MONTH	GROUP	DEER - VEHICLE COLLISION
2005	January	Control	5
2005	January	Radar	1
2005	April	Control	3
2005	April	Radar	2
2005	May	Control	13
2005	May	Radar	12
2005	June	Control	10
2005	June	Radar	3
2005	October	Control	11
2005	October	Radar	13
2005	November	Control	8
2005	November	Radar	13

PRELIMINARY CONCLUSIONS

1. High Accident Months Data **(May to June& October to November) will be used in the statistical analyses.**
2. Current data from 2004 to 2006 was not enough to make any statistical conclusion
3. Data collection will continue for another 2 or 3 years.
4. Following variables were selected for Poisson Regression Models:
   a. Dependent variable:

      Number of Deer_vehicle collisions per mile per month.

b. Independent Variables

Months, Years and

Treatments, 14 of them:

(1-mile long radar sections , total of 6
and

1-mile long control sections, total of 8).

5- The Vehicle-Deer collisions data will be used to compare these 14-treatments to evaluate the effectiveness of radar sensing systems combined with reactions of drivers.

RADAR SPECIFICATIONS & CONTACT INFORMATION

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www.sensor-tech.com

RADS SPECIFICATIONS

SYSTEM

Animal Sizes	Deer, Elk, Moose, Bear, etc.
Maximum Range per Sensor	402 meters
Network Range – Typical	1.6 km increments, extendable
Minimum Sensor Range	0 meters
Approximate Weight	3 kg
Outputs – Hardware	Relay Contact Closure
Outputs – Data	Time/Date of Crossing, Segment, Duration
Communications	Dedicated Short Range Wireless in Network Cell Phone for Remote Access of Data & Maintenance
Power	12 VDC
Power System	Solar with Batteries or AC Power as Available

ENVIRONMENTAL

Temperature	-40°C to +85°C
Humidity	0 to 95% RH, non-condensing (60°C max)
Altitude (above sea level)	-150 to 4270 m (-500 to +14,000 ft.) operating -150 to 12,190 m (-500 to +40,000 ft.) storage
Wind	45 meters/second maximum
Weather	All weather conditions

QUESTIONS