Data Analysis of Deer-Train Collisions in Eastern Hokkaido, Japan[1]

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Summary: The data of 696 deer-train accidents which occurred on 330.95 km distance in eastern Hokkaido, Japan from April 1988 to March 1995 was statistically analyzed. Many of the accidents occurred at particular sites and night hours, which suggests the relation with the habitat and diel activity of deer. Relative densities of deer were estimated where the train runs were constant.

1. Background

One of the serious problems between human and animals is deer-train collisions. It includes the breakdown of or damage to trains, hence the disturbance to the train diagram, and the death or injury of deer. Although several studies were published on deer-car accidents (Allen and McCullough (1976), Schafer and Penland (1985), Waring et al. (1991), Reeve and Anderson (1993)), no actual data of deer-train accidents has been studied. Recently the number of accidents between the train and the Sika deer (*Cervus nippon yesoensis*) greatly increased from year to year in eastern Hokkaido, Japan.

We have produced a data set including a total of 696 cases of deer-train accidents from April 1987 to March 1995 (8 years) based on the driver reports of the Kushiro Branch of Hokkaido Railway Company. Determining the altitude and representative vegetation at 0.5 km distance along the Line on the basis of 1/50000 scale topographical maps by the National Geographical Survey Institute, Japan and 1/50000 scale actual vegetation maps (Environment Agency, 1988), we have created another data set consisting of the number of accidents per 0.5 km and environmental conditions. We present the results of statistical analysis on the data sets and an estimation of the relative densities of deer.

2. Statistics

Fig. 1 shows that the number of accidents increased year by year except for 1991. Since the number of train runs per year was almost the same, it is suggested the increase in the number of deer that passed across the railway track, hence the increase of the population of deer. Fig. 2 gives the hourly change in the number of accidents. Most of the accidents (79%) occurred between 16:00 to 23:00, when the deer activity is high. Fig. 3 presents the number of accidents per 10 km from Kamiochiai to Nemuro stations on the Nemuro
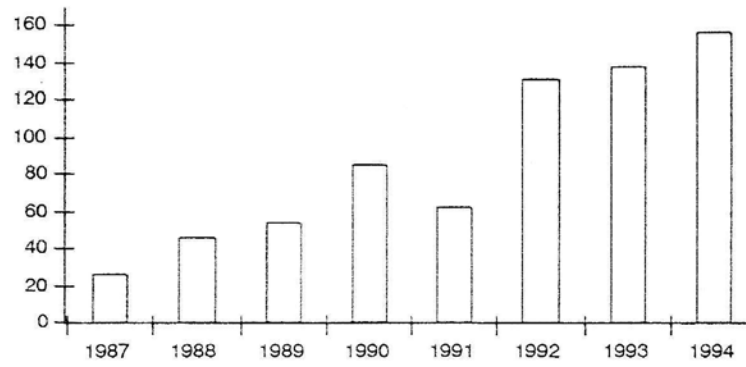
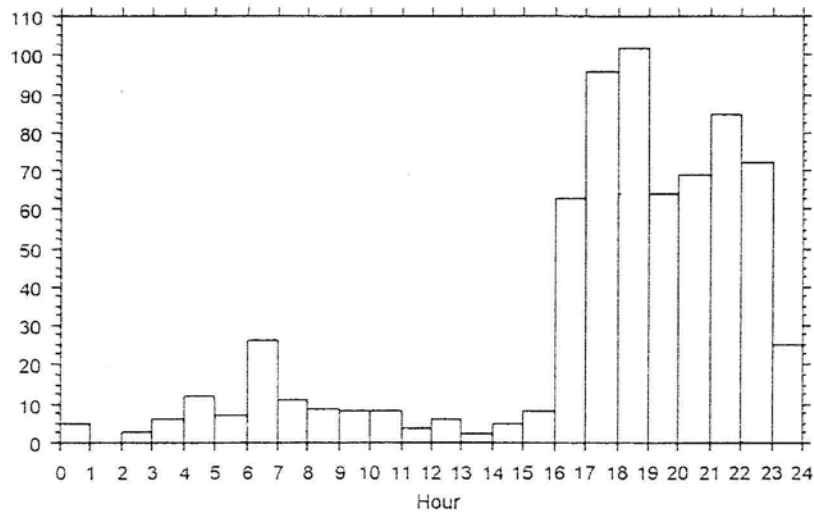**Fig.1:** Yearly Change in the number of train-deer

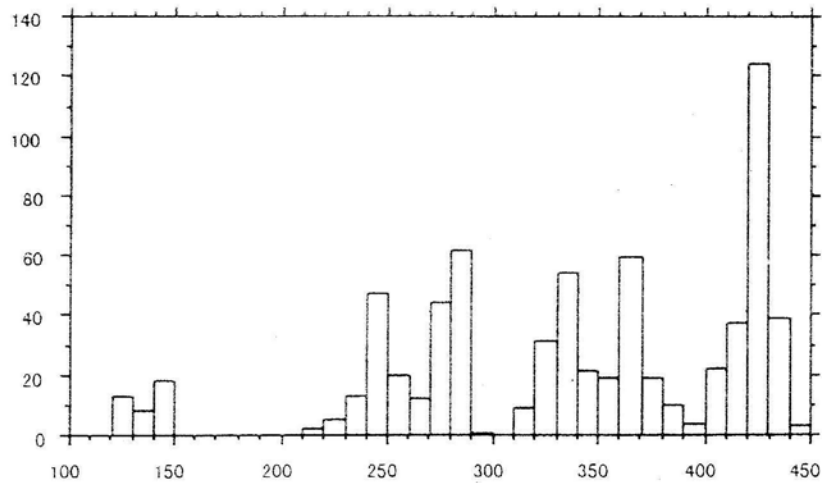**Fig. 2:** Hourly change in the number of deer-train accidents

Fig. 3: Number of accidents per 10km. Numerals on abscissa are distances in km from the Takigawa station.

Line. Many accidents occurred between Kushiro and Nemuro stations, where hunters reported that many deer lived.

Table 1 gives the number of cases in which numbers deer were found. From January to April the number of deer was great and the mean ranged from 4.1 to 5.0. However, the number of deer which collided with trains ranged from 1 to 4 (0 means a nearmiss), and among these the cases of 1 occupied 94.1% (Table 2). This situation is similar in every month.

Table 1: Number of cases in which numbers deer were found

Month	\multicolumn{8}{c}{Number of deer found / case}	Total	Mean
	1	2	3	4	5	6-9	0-19	20-	Total	Mean
Jan	16	12	9	10	10	6	6	1	70	4.1
Feb	17	15	14	1	7	9	6	3	72	4.7
Mar	12	18	17	10	6	11	8		82	4.2
Apr	6	1	5	3	5	9	4		33	5.0
May	12	8	4	2	3	4	0		33	2.8
Jun	4	6	1	1		1	1		14	3.0
Jul	17	13	9	2		0	0		41	1.9
Aug	14	13	4	3		2	0		36	2.1
Sep	19	17	3	5	1	4	1		50	2.6
Oct	33	25	7	5	5	1	0		76	2.0
Nov	47	23	12	5	6	14	0		107	2.6
Dec	24	15	11	10	5	7	3		75	3.1
Total	221	166	96	57	48	68	29	4	689	3.2

Tab. 2: Frequency distribution of the number of deer which collided with trains.

Month	\multicolumn{6}{c}{Number of deer which collided with trains}	Total	Mean number of deer when collided
	0	1	2	3	4	unknown	Total	deer when collided
Jan		63	6	1			70	1.11
Feb	7	58	6		1	1	73	1.14
Mar	5	68	5	1		4	83	1.09
Apr	4	25	2	2			33	1.21
May	2	31					33	1.00
Jun		12		1		1	14	1.23
Jul	2	34	3	1		1	41	1.13
Aug	1	35				1	37	1.00
Sep	4	45	2				51	1.04
Oct	5	68	1	1		2	77	1.04
Nov	2	100		1		5	108	1.02
Dec		71	4			1	76	1.05
Total	32	610	29	7	2	16	696	1.08

The distances at which drivers found deer ranged 0 to 300 m. Fig. 4 is box plots for the distances in the daytime (8:00-16:00) and at night (20:00-24:00). Drivers found deer farther in front of them in the daytime than at night. The mean distance at which drivers
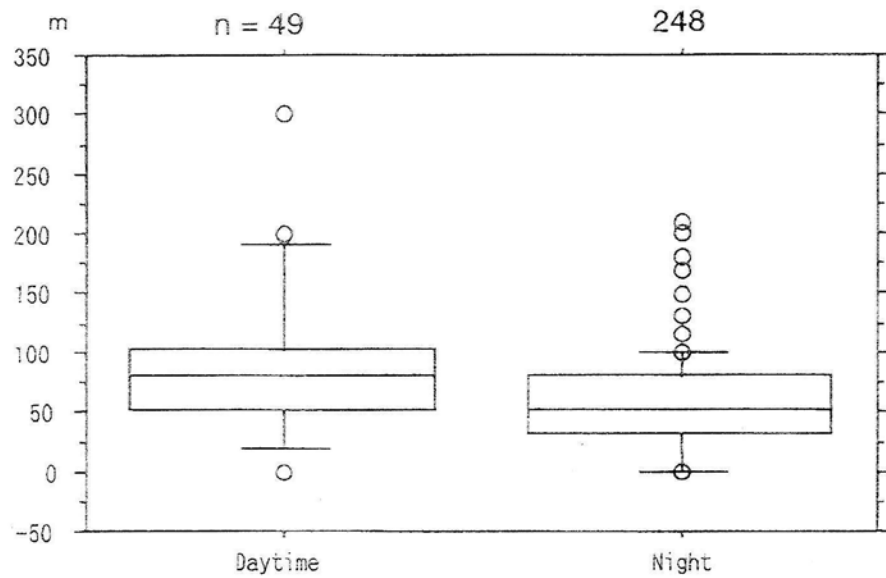
Fig. 4: Distances at which drivers found deer in the daytime and at night

found deer is in the daytime is 89 m with a standard deviation of 53 m in the daytime, but it is 56 m ($SD=41$ m) at night. Namely the distance in the daytime is on average 33 m longer than that at night.

Fig. 5 is box plots for the distances at which drivers found deer on 5 weathers. The distances were shorter in rainy or misty situations than in fine or cloudy ones. The difference in the means is about 18 m.
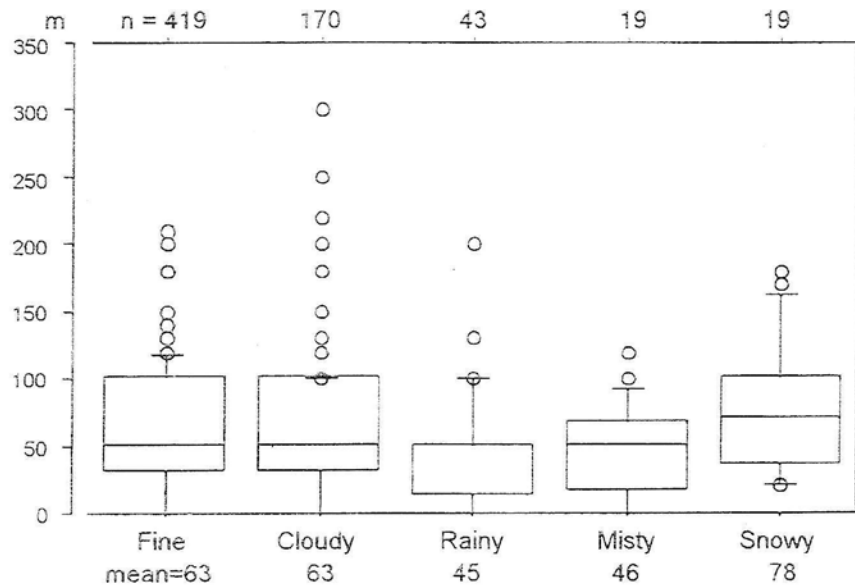

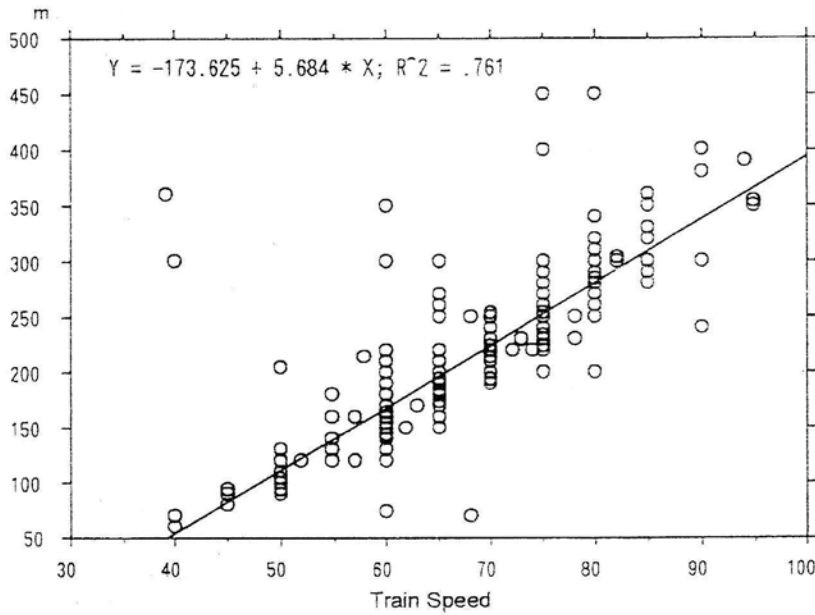Fig. 5: Distance at which drivers found deer on each weather

Fig. 6: Relation between train speed and distance to stop (ordinate)

Fig. 6 shows the relation between train speed and distance to stop. As is expected, the greater the train speed is, the greater the distance becomes.

3. Relative densities of deer

Since the number of train runs was different between hours and stations, the number of accidents cannot be used as a direct indicator of the population density of deer. However, the 8 selected train runs (train numbers 5638, 5639, 5640, 5641, 5642, 5645, 5647, and 3644) between 16:00 and 22:00 together gave a total of 6 runs between Kushiro and Nemuro stations, also giving hourly runs nearly constant, so we may use the number of accidents on the 8 train runs as relative densities of deer along the railway.
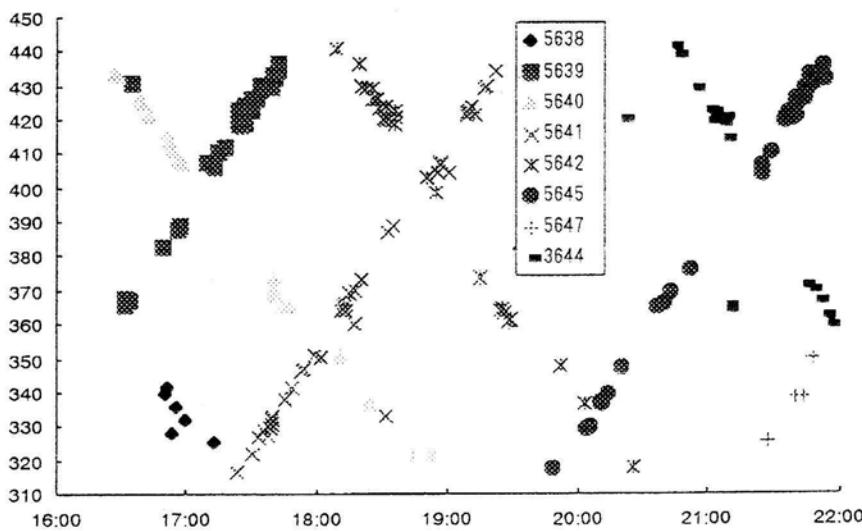

Fig. 7: The accidents occurred on the 8 trains between Kushiro and Nemuro stations. Ordinate: distance from the Takigawa Station in km.

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