# FINAL PROJECT REPORT

I **Name of the Cooperator:** Metro Regional Parks and Greenspaces

**Project Title:** Analysis of Vehicular – Wildlife Incidents from the Portland Metropolitan Area

**Cooperative Agreement Number**

**Date of Report:** August, 2003

**Project Time Period:** June, 2002 to July, 2003

II **Project Description:** The project highlights the hotspots for deer road kill in the three county areas, Multnomah, Clackamas and Washington. It identifies the timing of the road kill and determines if the hotspot could be predicted on the basis of habitat variables. Please see attached report

III **Actual Work Tasks implemented and the associated project schedule.**

Attached to this memo is a document summarizing the project.
Deer mortality data from the three county area was collected and input on a database, which was graphically depicted with the help of GIS software. Data was further analyzed to determine exact timing of road kill and relate it to the natural history lifecycle of the deer. Statistical analyses was conducted such as a chi-square test, and regression to determine if mortality was random and whether there was a correlation between vehicular mortality and habitat variables such as canopy cover, wetlands, riparian cover and growth (building permits).

Attached to this memo is also a document titled "Wildlife Crossings" which the Portland State University students developed as part of their master's thesis requirement. The purpose of this guidebook is to provide information to planners and community members interested in wildlife crossings or those involved in work on wildlife crossing projects. Results generated from the metro wildlife mortality study were incorporated into the Portland State University report.

**IV List of Project Staff and partners, and their roles. Include the number of volunteers and other participants, along with the number of hours contributed to the project.**

See Rachel Fox's memo to USFWS

**V Describe the project area, show any map and final project designs, plans etc.**

Please refer to the attachment for additional details

**VI A description of the methods used to implement the project and the effectiveness of those methods.**

Please refer to the attachment for additional details

**VII On-going tasks that will continue beyond the term of this Cooperative Agreement, such as monitoring or maintenance, or next steps.**

We will be working with the transportation staff to make sure that a project demonstrating a wildlife crossing is funded in the near future. We will also be advocating using criteria for wildlife crossings in the Metro Transportation Improvement Program (MTIP), based on our data, maps and recommendations made by the Metro and the Portland state student project.

**VIII Summary of expenditures and project costs, including the use of FWS funding and the amounts and sources of monetary and in-kind matching contributions.**

Matching contribution includes hours spent on this grant and on the Portland State University project on Wildlife Crossings

**IX Include observations and advice from this project experience that may assist others involved in similar work.**

**X Supplemental information such as copies of data, documents, scientific papers, printed material, or other products related to the project.**

Attached with report.

**Analysis of Vehicle-Wildlife Incidents from the Portland Metropolitan Area**

**Final Report**

## Background

Animals move across the landscape in the course of their daily routine, during juvenile dispersal, and when seeking mates and suitable habitat for rearing young. They move to follow seasonal changes in food availability and to survive seasonal climate change, as well as longer-term environmental change and natural disasters (Beier and Loe 1992). Increasingly, roads are fragmenting this landscape and curtailing wildlife movement to reproduce, raise young, or even survive.

In 2001, the conterminous U. S. contained approximately 6.3 million km of public roads (USDT 2002). The same area contained approximately 5.3 million km of streams and rivers (USEPA 2002). Thus roads approximate streams in terms of their systemic presence in ecosystems. Humans can drive to within a kilometer of 82% of all land in the conterminous U.S.: 16% of total land area is within 100 m of a road of any type, 22% is within 150 m, and 73% is within 810 m. (Riiters & Wickham 2003). Roads cover 1% of the surface of the continental U. S. (Forman et al. 2002).

Fragmentation of habitat by roads forces wildlife to cross roads to in order to meet daily and seasonal needs. As humans increasingly encroach on wild lands, animal-vehicle collisions pose a growing threat to the survival of wildlife populations. Few species of vertebrate are exempt from such encounters. Road kill occurs so frequently that it alters species' population demographics, hinders recovery attempts of endangered species, and places others on endangered lists (Trombulak & Frissell 1999). Animal-vehicle collisions are the major killer of U. S. wildlife (Forman & Alexander 1998). Humans also die in these collisions.

Surveys from the early 1990's, when there were fewer miles of road, indicate that approximately one million deer-vehicle accidents occurred annually in the U.S., causing more than $1 billion in vehicle damage and over 200 human fatalities (Conover et al. 1995). The Federal Highway Administration placed a monetary loss value of $1.5 million on each human fatality (Romin & Bissonette 1996). While there are no statewide or national figures available for the number of small animals killed on the highways--raccoons, skunks, squirrels, rabbits, badgers, native mice, voles, shrews, birds, reptiles and amphibians--Cook and Daggett (1995) have estimated the annual U.S. toll at tens of millions. Though appearing insignificant, the small mammals are the basis of the food supply for the larger charismatic mammals and birds.

Road kill is increasing in the suburban fringe, where increased road densities as well as traffic volume are a source of mortality for native wildlife (VanDruff et al. 1994). The growth occurring along the urban edge and out into rural countryside is often characterized

by the development of large house lots ( 0.5 ha to >4 ha). This rapid, dispersed, low-density development uses large amounts of wild land and causes an almost complete dependence on automobiles by separating essential places such as homes, offices, and shopping areas (Heimlich and Anderson 2001). In addition to more miles of road, in the past two decades, the number of vehicles, the speed of vehicles, the total number of vehicle miles driven have increased. At the same time, the size of vehicles has decreased. Thus there are more animal-vehicle collisions and humans are more vulnerable in collisions with large wild animals (Cook & Daggett 1995).

As roads and other forms of human development increasingly fragment wild lands, awareness of the need for corridors to link fragments is increasing (Soule et al. 1988; Forman, R.T.T. 1995). Biologists, wildlife managers, and transportation agencies have begun working together to research, design, and install appropriate crossing structures for wildlife, over and under roads (Finch 2000, Bank et al. 2002, Wagner et al. 1998). In the past 30 years, 100-200 underpasses and 6 overpasses have been built in North America, reducing wildlife road kill in those locations by 80% .

This project identifies wildlife road kill hotspots and seasonal road kill peaks within then urban-suburban-rural matrix of the tri-county area containing metropolitan Portland. It also attempts to predict road kills based on habitat features such as canopy cover, wetlands, streams and development (building permits).

## Study Site

Road kill data was gathered for all public roads and highways within the counties of Clackamas, Multnomah, and Washington. These counties encompass urban and suburban metropolitan Portland as well as twenty smaller cities and towns, all of which are expanding into the wild habitat surrounding them.

## Project Objectives

1) To identify wildlife road kill hotspots in this three-county region.

2) To identify the timing of road kill. In what months was it most prevalent? What is the relationship of any seasonal peaks to the lifestyle of the species or human activities?

3) To determine whether hotspots could be predicted on the basis of surrounding landscape habitat variables.

## Method

Data on wildlife-vehicle collisions were sought from four sources:

- carcass pickup records from city, county, and state road maintenance departments
- animal-vehicle accident reports from Oregon Department of Transportation (ODOT)

- animal control agency records
- animal rehabilitators' records

Data were obtained from the following *sources:

- Clackamas County Road department
- Washington County Roads Operations and Maintenance
- Multnomah County Animal Control
- West Linn Animal Control
- Hillsboro Public Works Department
- Wilsonville Public Works
- Audubon society of Portland Wildlife Care Center

*See Appendix A, "Data Sources," for a full description of sources, as well as # of incidents and time period in which they occurred.

Data from the Oregon Department of Transportation (ODOT) represent known animal-vehicle collisions. Data from city, county, and state road maintenance departments; Multnomah County Animal Control (MCAC); West Linn Animal Control; and Audubon Wildlife Care Center represent situations in which a dead or injured animal was found on the road or road shoulder and assumed to have been hit by a vehicle. Generally, these collisions were not witnessed.

Initially, we collected incidents for all species of wildlife, including birds. However, data for wildlife other than deer and elk were excluded for this analysis due to the difficulty of determining the actual cause of unwitnessed death and injury in smaller mammals, birds, amphibians, and reptiles. We assumed that a deer or elk carcass on or near a highway or road was produced by a collision with a vehicle.

Approximately 2,200 deer/elk-vehicle incidents were identified in the tri-county area and mapped. Incidents occurred within a period ranging from 1987-2002, but were concentrated primarily within the period, 1996-2002.

**Description of Data Sources and Geographic Accuracy**

Our intention was to locate incidents within 0.25 mile of where they actually occurred. For many points, this was not possible because "locational impreciseness" was inherent in all of our data sources. Inconsistencies of records of deer kill also known as "locational impreciseness" are described below.

Carcass Pickup Records

Most of the data collected consists of carcass pickup records from road departments and animal control agencies. The intent of such a record is to enable a crew to locate the carcass for pickup rather than to record its exact location for research. For many incidents, the location is reported as the road (or highway) on which the incident occurred and the closest well-known intersection, which is often but not always *the closest* intersection. Incidents occurring in outer lying areas where there are few intersecting roads are often described as occurring between two intersecting roads that may be up to a mile apart. Some of the location descriptions are very local in nature, e.g., "half-way up 10:00 hill," or "in the curves outside of Molalla on highway X." So, the true accuracy of many data points is unknown. Accuracies of less than 0.25 miles were flagged in the data, but the incidents were used as they contribute to the impression of a hot spot.

ODOT Records

ODOT entries are the result of animal-vehicle accident reports. A report must be filed for any incident injures or kills vehicle occupants or causes at least $1,000 in damages to the vehicle. Per Sylvia Vogel, ODOT, the department does its best to assign accurate incident locations based on victim's accounts, but often victims are shaken up, accidents have occurred at night when visibility is poor, in areas with which victims aren't very familiar, or in rural landscapes with few landmarks. In other words, victims are guessing or estimating locations. In the case of ODOT records, both the victim's report and ODOT's attempt to assign a location are sources of inaccuracy.

Many ODOT incident records were described as mile points on highways. Since Metro's mapping program cannot read mile points, an intersecting road or an estimated address had to be used to describe these locations, injecting an additional source of inaccuracy.

Rehabilitators' Records

Again, the accuracy issues described in "Carcass Pickup Records" and "ODOT Records" apply when a person brings an injured animal into a rehabilitation center and is asked to describe the location of the incident.

Quality of Maps and Map Measurer Used to Locate Incidents

Locational impreciseness was also inherent in the maps, atlases, and map measurer used to assign locations. All were designed for popular use, so there was a lack of planimetric accuracy and contain abstracted road segments. Scale is not exact. We also found inaccuracies and omissions in the Clackamas County Road Intersection Book and in ODOT's Highway Inventory Summary. Maps, reference guides, and tools used are described in Appendix B "Resources and Tools Used."

## Areal and Temporal Coverage

Unfortunately, a number of agencies and organizations that participate in carcass pickup and wildlife rehabilitation do not keep records. These are listed in Appendix C, "Contacts Made That Resulted in No Data." For example, ODOT no longer keeps records of carcass pickups on state and federal highways. Among the smaller cities contacted, only Hillsboro in Washington County, and West Linn and Wilsonville in Clackamas County keep records that identify the species of the carcass and the pickup location. So, we lack uniform areal coverage of all counties and cities. In addition, some agencies have records dating back 2 years, others 6 years, so we also lack uniform temporal coverage.

Incident locations were geocoded to Metro's tri-county street centerline file and mapped. See incident maps for the tri-county region and Clackamas County (Appendices D & E). Where an exact address was given, it was used. Otherwise, the closest cross street was used. For all years in the tri-county area, 2,272 deer/elk-vehicle incidents were obtained; of these, 2,211 were geocodable.

## Analysis

We confined our analysis to Clackamas County as we had more uniform data for it than for the other counties. Clackamas County was partitioned using a square mile grid corresponding to township and range. This is a common grid frequently used for spatial analysis. Though each cell is not exactly one mile square, all are nearly identical in terms of area (square feet).

A Chi Square test using the SAS procedure FREQ was used to determine whether mortalities were randomly situated.

Road kill (dead animals), the dependent variable, was regressed against the independent variables listed below, using the SAS procedures REG and GLM for regression, and RSQUARE to optimize the model.

- total number of building permits
- total length of river/streams
- total length of streets

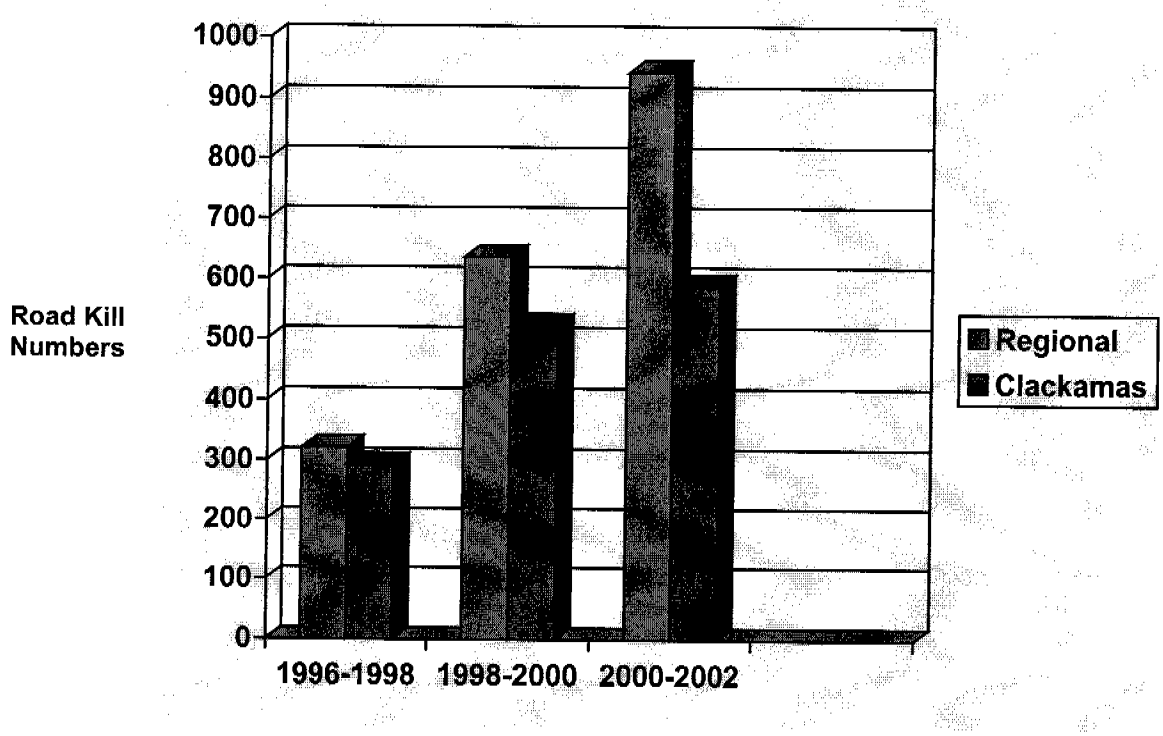
- total canopy cover and other vegetation structure based on the 1998 Landsat land cover classification
- total wetland area

These variables were summed in each grid cell for each two-year period, 1996-98, 1998-2000, and 2000-2002 and regressed against habitat variables. One discrepancy in this approach was that even though road kills varied from year to year, data for some habitat variables were not available for all the time periods. Total road kill was also regressed against these habitat variables to determine if there was a correlation between total kills and habitat factors.

In addition, incidents were analyzed to determine peak month(s) of occurrence.

## Results

**Road kill fatalities by year within the tri-county area and Clackamas Co.**




***Data for Washington and Multnomah Counties are incomplete for these time periods**

### Randomness

The Chi-Square test indicated that mortalities were nonrandomly distributed. The following hotspots were identified.

**Tri-County Area:** (1996-2001 in descending order of kills - top 20):

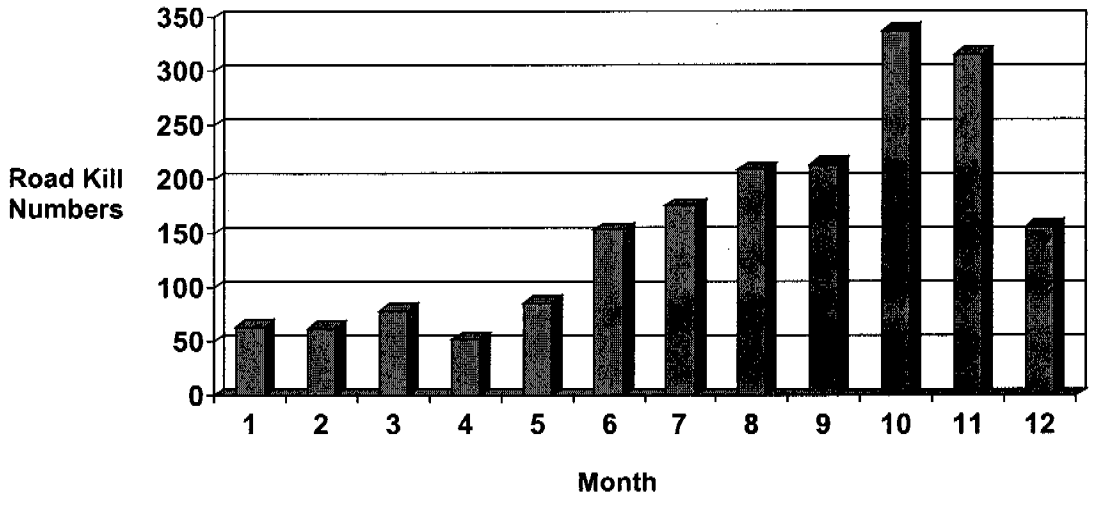
Redland Road, Springwater Road, Beavercreek Road, Union Mills Road, Sawtell Road, Henrici Road, Stafford Road, Sunnyside Road, South End Road, Dickey Prairie Road, Rosemond Road, Hwy 26 (Mt. Hood Hwy.), Scholls Ferry Road, Lower Highland Road, Upper Highland Road, Hattan Road, Wildcat Mountain Road, Mountain Road, Beef Bend Road, and Redland Road.

**Road kill numbers in Clackamas Co., 1996-2002** (in descending order - top 7):

| Road | Road kill Numbers |
|---|---|
| Redland Rd | 54 |
| Springwater Rd | 50 |
| Beavercreek Rd | 49 |
| Union Mills Rd | 35 |
| Highway 26 to Mt Hood | 33 |
| Sawtell Rd | 31 |
| Henrici Rd | 28 |

**Seasonality**

Analysis for seasonal road kill distribution indicated that road kill numbers rise throughout the summer, peaking in October and November.



### Habitat Analysis

Regression of the dependent variable, dead animals (road kill), against the independent variables listed above indicated that the full model has no statistical significance at the 1/4 mile grid size (F=1.651, Prob = 0.1453, R2 = 0.0191) and the 1 mile grid size (F=1.297, Prob = 0.2665, R2 = 0.0301). At the 1 mile grid size, because of the difference in magnitude between mortality per cell and some of the variables, the analysis was repeated with the larger independent variables transformed to natural logarithms. There was no difference in results.

Regression repeated at both grid sizes for five partial models indicated that they were no better predictors than the full model. See Appendix F, "Regression Models," for partial model composition and $R^2$ values.

## Discussion

Our data is incomplete, in both an areal and temporal sense. Many cities within Washington County do not keep carcass pickup records. Though thorough, our data from Washington County Road Dept. covered only 2.5 years. Multnomah County Animal Control (MCAC) picks up carcasses for all city and county roads, including Portland and the portion of it that lies in Washington County. We have records from MCAC dating from 10/6/98-5/16/02. However, we learned at the conclusion of the study (from an MCAC officer) that there are deer/elk carcass pickup incidents hidden in records to which we did not have access. This probably accounts for the fact that we have only 72 incidents for all of Multnomah County.

The data for Clackamas County is more complete, but we still lack data for most of the cities in the county. The Oregon Department of Transportation (ODOT) picks up all carcasses on state and federal highways, but no longer maintains records. ODOT accident reports are filed only when the vehicle sustains at least $1,000 worth of damage, or an occupant of the vehicle is injured or killed. Obviously, many more animal-vehicle collisions are occurring on state and federal highways than there are accident reports for.

Our best data set is from Clackamas County road Department for the period 1996-2002. Though our map of Clackamas County road kill shows a remarkable number of deer/elk-vehicle collisions occurring on rural roads in the county, the number is understated, due to lack of record keeping by agencies. The appearance of hotspots in both our data and on our maps is in part a reflection of record keeping and our ability to access records. Counties and cities that keep good records are more likely to appear to have hot spots.

The seasonal peak for road kill in October and November corresponds to the rutting season for deer and elk as well as the hunting season. Males are increasingly active at this time, searching for mates and avoiding hunters.

While our study determined that mortality is not random with regard to location and that it peaks in the fall of the year, it is inconclusive in relating mortality to habitat factors. Regression of road kill against traffic volume and pattern, driver behavior, and road characteristics may be useful. Additional field studies are needed to relate adjacent habitat to hot spots. The ideal study would focus on segments of road that our current study has identified as hotspots, maintaining records of GPS-located animal-vehicle incidents for 3-4 years. In this way, the inaccuracies and the lack of coverage that we encountered in our present data sources could be avoided.

## Additional Recommendations

Outreach efforts to all cities and county maintenance workers are recommended. Road maintenance workers need to be aware of the species of carcasses collected on the street and have their location accurately located on site. Additionally, hot spots for road kills could be identified in Clackamas County and either culverts should be retrofitted to provide passage for larger mammals or bridges should be placed where appropriate.

## Acknowledgments

Funds and personnel were provided by the U.S. Fish and Wildlife Service, Metro, and Portland State University.

Grant personnel included:

Jennifer Budhabhatti, Senior Environmental Planner, Metro Parks and Greenspaces

J. O. Price, Associate GIS Specialist, Metro data Resource Center

Luis Ruedas, Assistant Professor and Director of the Museum of Vertebrate Biology, Department of Biology, Portland State University

Linda Anderson, Masters Candidate in Biology, Portland State University

## Bibliography

Bank, F. G., Gray, M. E., Paulson, D., Irwin, C. L., Hagood, S., Ruediger, B., Evink, G. L., Kinar, J. R., Sauvajot, R. M., Levy, A. 2002. Wildlife habitat connectivity across European highways. Report No. FHWA-PL-02-011 from the International Technology Exchange Program. Federal Highway Administration. U.S. Department of Transportation, Washington, D. C.

Beier, P., S. Loe. 1992. A checklist for evaluating impacts to wildlife movement corridors. *Wildl. Soc. Bull* 20:434-440.

Conover, M. R., W. C. Pitt, K. K. Kessler, T. J. DuBow, and W. A. Sanborn. 1995. Review of human injuries, illnesses, and economic losses caused by wildlife in the United States. *Wildlife Society Bulletin* 23:407-414.

Cook, K. E. and P. Daggett, 1995. Highway roadkill, safety, and associated issues of safety and impact on highway ecotones. Task Force on Natural Resources (A1F52), Transportation Research Board, National Research Council. Unreviewed report.

DeStefano, S. and R. M. DeGraaf. 2003. Exploring the ecology of suburban wildlife. *Frontiers in Ecology and the Environment* 1(2): 95-101.

Federal Highway Administration Website: www.fhwa.dot.gov. *Highway Statistics 2000.*

Finch, G. 2000. Critter crossings: Linking habitats and reducing road-kill. Pub. No. FHWA-EP-00-004. Office of Natural Environment, Federal Highway Administration. U. S. Department of Transportation, Washington D. C.

Forman, R.T.T. 1995. Woodland corridors as wildlife conduits. Pp. 198-207 in Land Mosaics: The Ecology of Landscapes and Regions. Cambridge University Press, New York.

Forman, R. T. T. and L. E. Alexander. 1998. Roads and their major ecological effects. Annual Review of Ecology and Systematics 29: 207-231.

Forman, T. T. T., D. Sperling, J. A. Bisonette et al? 2002. Road ecology: science and solutions. Island Press, Washington, D.C.

Harmon, R. Feb. 19, 2003. E-mail correspondence with

Heimlich, R.E. and w. D. anderson. 2001. Development at the urban fringe and beyond, impacts on agriculture and rural land. U.S. Department of Agriculture, Washington, D.C. As cited in DeStefano & DeGraaf 2003.

Riiters, K. H. and J. D. Wickham. 2003. How far to the nearest road? *Frontiers in Ecology and the Environment* 1(3): 125-129.

Romin, L. A. and J. A. Bissonette. 1996. Deer-vehicle collisions: status of state monitoring activities and mitigation efforts. *Wildlife Society Bulletin* 24 (2):276-283.

Romin, L. A. and Bissonette, J. A. 1996. Temporal and spatial distribution of highway mortality of mule deer on newly constructed roads at Jordanelle Reservoir, Utah. *Great Basin Naturalist* 56(1), 1-11.

Soule, M.E., Bolger, d. T., Alberts, A. C., Wright, J., Sorice, M., and Hill, S. 1988. Reconstructed dynamics of rapid extinctions of chaparral-requiring birds in urban habitat islands. *Conservation Biology* 2(1): 75-92.

Trombulak, S. C. and Frissell, C. A. 1999. Review of ecological effects of roads on terrestrial and aquatic communities. *Conservation Biology* 14(1): 18-30.

USDT (US Department of Transportation). 2002. Highway statistics 2001. Federal Highway Administration, Office of Highway Policy Information. http://www.fhwa.dot.gov/ohim/hs01/as published. Viewed 8 Feb 2003. As seen in Riiters and Wickham 2003.

USEPA (US Environmental Protection Agency). 2002. 2000 national water quality inventory. Office of Water, Report EPA-841-R-02-001. http://www.epa.gov/305b/2000report. Viewed feb 2003. As seen in Riiters and Wickham 2003.

VanDruff, L. W., E. G. Bolen, and G. San Julian. 1994. Management of urban wildlife. In: Bookhout, T. A. (Ed.), Research and management techniques for wildlife and habitats. The Wildlife Society, Bethesda, MD.

Wagner, P., Carey, M., and Lehmkuhl, J. 1998. Assessing habitat connectivity through transportation corridors on a broad scale: an interagency approach. In G. Evink (ed.) Proceedings of the International Conference on Wildlife Ecology and Transportation. U.S. Department of Transportation, Federal Highway Administration, Fort Myers, Florida.

## Appendices

### Appendix A: "Data Sources"

Data were obtained from the agencies and organizations listed below. This section includes contact information for data sources, # of incidents, time period of occurrence, and relevant comments on the data.

| | |
|---|---|
| **Source:** | **Oregon Department of Transportation (ODOT)** |
| Original data form: | Hard copy |
| # of records: | Clackamas County: 152<br>Multnomah County: 66<br>Washington County: 133 |
| Supplier: | Sylvia Vogel, Crash Reporting Technician<br>Department of Transportation<br>Transportation Development Branch<br>Mill Creek Office Building<br>555 13th Street NE<br>Salem, OR 97310<br>503-986-4240 |

The Oregon Department of Transportation (ODOT) maintains a database of animal-vehicle collisions occurring on all roads and highways. The vehicle owner must file a report for each collision that results in at least $1,000 damage to the vehicle and/or injury to vehicle occupants. This is the only source of road kill information for state and federal highways (as well as county and city roads), as ODOT road maintenance crews keep no records of carcass pickups. The disadvantage to this data is the possibility of duplicating incidents, e.g., if we included both the ODOT record for the incident and a county or city road maintenance or MCAC record for carcass pickup or a rehabilitator's intake record.

To avoid this possibility, we used all ODOT records for state and federal highway incidents, but eliminated those for incidents on county or city roads that fell within the time ranges of records collected from county or city road maintenance departments, MCAC, or rehabilitators. Identifying duplicates is difficult because of the potential difference between the incident date and carcass pickup request date and because the same incident location is often described in different ways.

Thus, we eliminated all ODOT crash reports that occurred in the following jurisdictions and time frames:

| City | County | Time Period |
|---|---|---|
| West Linn | | 5/98-6/02 |
| Tigard | | 7/01-7/02 |
| Wilsonville | | 1/81-7/02 |
| Hillsboro | | 7/01-6/02 |
| | Washington | 10/99-6/02 |
| | Clackamas | 6/96-8/02 |
| All city and county roads in Multnomah County | | 10/98-6/02 |

In the original ODOT data for Multnomah, Clackamas and Washington Counties, state, U.S., and interstate highways are identified by their ODOT Highway Numbers and their names. The ODOT highway number is different than the posted highway number seen on highway signs and popular maps. These were translated into posted route names and numbers using the "ODOT Posted Route Number Cross Reference."

Clackamas county roads are identified by their road numbers, which were translated into road names using the Clackamas County Road Intersection Book. Except for a few city roads, the closest intersection to the incident is shown as a mile point. These were translated into named intersections and addresses which the Metro GIS system can read, by using the Road Intersection book and/or the Map Mate Pro to determine mile points on maps.

Washington county roads are identified by their road numbers. These were assigned names using a document entitled "County/City Codes Alphabetical Order," which gives road names for Washington County road numbers.

Incident locations for Multnomah County state, U.S., and interstate highways are identified by mile point. We used the ODOT web site entitled Highway Inventory Summary (listed above) to convert milepoints to intersecting roads and addresses.

| | |
|---|---|
| **Source:** | **Clackamas County Road Department** |
| Original data form: | Hard copy and electronic copy<br>ClackCounty_DeadanimalReq_060196to080802.xls<br>On zip disk |
| # of records: | 1,451 |
| Supplier: | Shelly Leis<br>Clackamas County Road Department<br>902 Abernethy Road<br>Oregon City, OR 97045 |

503-650-3765
ShellyL@co.clackamas.or.us

This data ranges from 6/1/96 to 8/7/2002.

**Source:** **Multnomah County Animal Control**

Original data form: Electronic copy (MCAC Wildlife Calls (original data).xls)
On zip disk

# of records: 72

Supplier: Doug Carpenter, Field Services Supervisor
Multnomah Animal Control
1700 W Columbia River Highway
Troutdale, OR
503-248-3066, x.253
503-704-2196 (c)

This data ranges from 10/6/98-5/16/02. 72 deer/elk entries were extracted from a huge database which must have included every field incident for all mammals, birds, herps handled by MCAC. Multnomah County Animal Control picks up any roadkill within the county on all county and city roads, i.e., it picks up for the cities of Fairview, Gresham, Lake Oswego, Portland, Troutdale, and Wood Village. MCAC also picks up roadkill for that portion of the City of Portland within Washington County.

**Source:** Washington County Roads Operations and Maintenance

Original data form: Hard copy

# of records: 354

Supplier: Janelle
Washington County Roads Operations and Maintenance
1400 SW Walnut
Hillsboro, OR
503-846-7623

This data ranges from 10/12/99 to 4/22/02. It is a hand-written "Dead animal Pickup Log" for all county roads in Washington County. Most of the animals recorded in it are deer, with a few elk.

**Source:** Hillsboro Public Works Department

Original data form: Hard copy

# of records: 1

Supplier: Julia
Hillsboro Public Works Department/WA County LUT
142 SE Maple
Hillsboro, OR
503-615-6509

This data ranges from 6/21/02-7/14/01. It is a hand-written list with just one elk entry. Since that is described as elk head and carcass, we did not include it in the spread sheet. HPW is included here because it does maintain records.

| | |
|---|---|
| **Source:** | Wilsonville Public Works |
| Original data form: | Hard copy |
| # of records: | 16 |
| Supplier: | Gail Parents/Linda Anderson<br>Wilsonville Public Works<br>City of Wilsonville<br>503-682-9772 |

This data ranges from 6/19/87 to 4/19/02. We collected it from 3 types of work orders: "Internal Work Orders," "Action Report Citizen Concern," and "Action Report Service Request." All, essentially, are the result of requests from citizens for carcass pickups. We actually looked at records back to 1981, but found no carcass pickup requests for the period 1981-1986.

| | |
|---|---|
| **Source:** | West Linn Animal Control |
| Original data form: | Hard copy |
| # of records: | 26 |
| Supplier: | Gabby Deets<br>West Linn Animal Control<br>West Linn Police Department<br>22825 Willamette Drive<br>West Linn, Oregon 97068<br>503-655-6214, x. 405 |

:

This data ranges from 6/6/98 to 4/30/02. It is a handwritten list of animals reported "hit by car" by callers within the city of West Linn.

| | |
|---|---|
| **Source:** | Audubon Society of Portland Wildlife Care Center |
| Original data form: | Hard copy |
| # of records: | 3 |
| Supplier: | Bob Salinger<br>Audubon Society of Portland Wildlife Care Center<br>5151 NW Cornell RD<br>Portland, OR<br>503-292-0304 |

This data contained seven deer entries but only three had incident locations.

**Appendix B: "Resources and Tools Used"**

The following books, atlases, maps, and tools were used in locating incidents:

Clackamas County Road Maps, Clackamas County Department of Transportation and Development, Clackamas County Geographic Information Systems, October 2001. Township and Range system with house number grids. Lists most roads and bridges in Clackamas County alphabetically and by road number. Keyed to the following:

Clackamas County Road Intersection Book, Transportation Maintenance Division, 2002 Edition. Lists roads by road number and gives mile point locations for intersecting roads.

Clackamas County 2001 Roadmap. Clackamas County Geographic Information Systems. Clackamas County.

Cole Directory for Greater Portland, 1998-99. Cross-referenced directory listing every business and residence owner, by name and address, in order in which they occur along a particular road.

"County/City Codes Alphabetical Order." This document matches Washington County roads names with road numbers.

ODOT Highway Inventory Summary. Data source refreshed on 8/28/2002. Web address: www.odot.state.or.us/transview/highwayreports/aml_summary_parms.csm. This web source shows milepoints for all state, U.S., and interstate highways by ODOT Highway Number.

ODOT Posted Route Number Cross Reference. 9/24/02. Web address: http://www.odot.state.or.us/tdb/traffic_monitoring/cros-ref.htm. Translates ODOT Highway Numbers to Posted Oregon Route Numbers, Posted US Route Numbers, and Posted Interstate Route Numbers.

Oregon Atlas & Gazetteer (4th Edition, 2001). DeLorme Publishers. Yarmouth, Maine.

Pittmon's Map of Clackamas County, Oregon. Oregon Blue Print Co., Portland, OR. Crude map but includes many outlying roads.

Pittmon's Map of Washington County, Oregon. Oregon Blue Print Co., Portland, OR. Crude map but includes many outlying roads.

Thomas Guide: Portland Metro Area Street Guide and Directory. Thomas Bros. Maps. Rand McNally. 2001. Doesn't cover outlying areas of Clackamas, Multnomah, and Washington counties.

Map Mate Pro. Map measurer for determining mile points along roads. Digital display. Accuracy not stated on package. I tested and it seemed to be within about .02 inch.

**Appendix C: "Contacts Made That Resulted in No Data"**

The following contacts resulted in no road kill records. They are listed here because they contribute to the big picture regarding road kill recording keeping in the tri-county area.

I contacted 50 wildlife rehabilitators on the Oregon Wildlife Rehabilitation List, obtained from Holly Michaels of Oregon Department of Fish and Wildlife. Of those returning my calls, most worked out of Audubon and none rehabilitate deer or elk.

I visited Dr. Janet Ackermann's facility, American Wildlife Federation, at 31812 S Hwy 213, Molalla, OR, 503-829-9567, and examined her records back to 1998. There were two intake records for deer hit by vehicles, but there was no incident location on either record, nor those of other species of wildlife. She will keep records of incident locations in the future.

I talked with Leslie Winup Rapacki, Hawk Haven, 503-630-7623. She does not rehabilitate deer.

I spoke with Christopher Allori, Trooper, Oregon Dept. of State Police, Fish and Wildlife Division, 3700 S.E. 92nd Ave., 503-731-3027, x. 263; 503-301-1305 (c). He doesn't keep records of carcass pickups or roadkills.

I visited Dove Lewis Emergency Animal Hospital, 1984 NW Pettygrove, Portland, OR, and spoke with Dr. Frank Pipers, Director, 503-228-7281, and with veterinarian Laura Wood. Injured deer/elk are not brought to the Dove Lewis clinics.

I contacted the Oregon Humane Society and spoke with Autumn, Receiving Supervisor, 503-285-SPCA. They refer all native animals to Audubon and rarely receive nonnative ones (once a month).

I contacted Metro South Transfer Station, 503-234-3000 and was told that the transfer stations don't do carcass pickups.

I spoke with State Farm Insurance agent Laura Cheshareck, Gresham, OR, 503-665-3797, and with Eric, an adjuster for Safeco Insurance. Per their research, neither company keeps detailed records of animal-vehicle collisions because they constitute such a small percentage of their business. Laura referred me to Christe Fisher, Executive Director, Insurance Information Service of Oregon and Idaho, 503-241-1757. She had summarized data on animal-vehicle incidents, but no record of individual incident locations. She too emphasized that they constitute a very small percentage of total incidents involving insurance.

I contacted Critter Gitters, 503-253-5584. They don't pick up roadkills.

I contacted the following ODOT districts:

District 2A, Ceylene, 503-229-5002. No records kept now. I also spoke with Tom Woodward, 503-229-5201, a 25-year veteran of the department, who confirmed that records are not kept.

District 2B, Darcy, 503-653-3086. She referred me to Dave Millikan, Road crew, who reported that they don't keep track of pickups.

District 2C, Sabrina, 503-665-4193. They don't keep current records and have disposed of the old ones.

I spoke with Dave Cox, Federal Highways Administration, 503-399-5749, Salem, OR who explained that the federal government does not own or maintain highways. It provides money to the states to construct and maintain highways posted as U.S. Highways.

Clackamas County Dog Pound picks up dogs only. Large animals like deer and elk are picked up by Clackamas County Road Department. Small native mammals are not picked up.

Washington County Dog Control picks up dogs only. Deer, elk, and farm animals are picked up by Washington County Roads Operation and Maintenance.

**Cities in Clackamas County:**

Gladstone Public Works, 503-656-7957. They don't see deer and elk on highways.

Oregon City Public Works, Street Department, Chuck, 503-657-8241. No records kept.

Lake Oswego Public Works, Road Maintenance, Julie Reynolds, 503-635-0280. No records kept.

Milwaukie Public Works, Jeannie, 503-786-7600. Milwaukie keeps no records. Roadkill is picked up by garbage haulers and live, injured animals reported to ODFW. I contacted or left messages for the following garbage haulers: Clackamas Garbage Co., Inc., 503-656-9633; Deines Brothers Sanitary Service, Inc., 503-654-1449; Mel Deines Sanitary Service, Inc., 503-654-0632; Oak Grove Disposal Co., 503-654-6118; Pear Deines Sanitary Service, Inc., 503-654-0632; Waste Management of Oregon, Inc., 503-249-8078; and Terry Waddell, 503-655-4303. The garbage haulers that returned my calls reported that they keep no records.

Sandy Public Works, 503-668-5533. ODOT picks up roadkill on the state highway, where city offices are located. The city keeps no records of pick up for city streets.

**Cities in Washington County:**

Portland Road Maintenance, 503-823-4000. MCAC does all pickup for them.

Beaverton Road Maintenance, Teri, 503-526-2220. Beaverton keeps no records. They have rendering companies pick up the large animals. I contacted Denley's Rendering Co., 503-625-6616. They seldom pick up carcasses, and they keep no records. I also contacted Comets, Bob Sork, 503-731-4703. They do pickups, but everything in their records is described as "debris," including actual garbage, and there is no way to distinguish between garbage and animals. I contacted Bud Weaver, trapper for USDA Wildlife Services for Washington County, 503-359-1170. He doesn't pick up road kill.

Cornelius Public Works, Linda Carter, 503-357-3011. Seldom receives request to pick up deer or elk carcass and keeps no records.

Tigard Road Maintenance, Public Works, John Roy, 503-639-4171. Keep records but don't keep record of species picked up, but it's usually raccoons and opossums. Sent me list of 25 pickups for the period from 7/16/01 to 712/02. Said I would have to go through 2,000 customer service calls to identify species for the 25. I didn't do it, as there were probably few deer and elk among them.

Sherwood Road Maintenance, 503-625-5522. Keeps no records. Calls State Police or Clackamas County for deer carcass pickups.

Tualatin Road Maintenance, Ernie, Street Supervisor for Operations, 503-691-3091. Keeps no records.

Forest Grove Public Works, Cal Bowersox, 503-992-3258. Doesn't see deer killed. Inconsistent about record keeping.

## Appendix D: "Map of Road Kill Incidents in the Tri-County Area"

## Appendix E: "Map of Road Kill Incidents in Clackamas County"

## Appendix F: "Regression Models"

**Are mortalities random or non–random?**

Mortalities:

| | Observed N | Expected N | Residual |
|---|---|---|---|
| .00 | 148 | 19.1 | 128.9 |
| .00 | 148 | 19.1 | 128.9 |
| 1.00 | 59 | 19.1 | 39.9 |
| 1.00 | 59 | 19.1 | 39.9 |
| 2.00 | 37 | 19.1 | 17.9 |
| 2.00 | 37 | 19.1 | 17.9 |
| 3.00 | 25 | 19.1 | 5.9 |
| 3.00 | 25 | 19.1 | 5.9 |
| 4.00 | 15 | 19.1 | -4.1 |
| 4.00 | 15 | 19.1 | -4.1 |
| 5.00 | 12 | 19.1 | -7.1 |
| 5.00 | 12 | 19.1 | -7.1 |
| 6.00 | 10 | 19.1 | -9.1 |
| 6.00 | 10 | 19.1 | -9.1 |
| 7.00 | 17 | 19.1 | -2.1 |
| 7.00 | 17 | 19.1 | -2.1 |
| 8.00 | 8 | 19.1 | -11.1 |
| 8.00 | 8 | 19.1 | -11.1 |
| 9.00 | 10 | 19.1 | -9.1 |
| 9.00 | 10 | 19.1 | -9.1 |
| 10.00 | 5 | 19.1 | -14.1 |
| 10.00 | 5 | 19.1 | -14.1 |
| 11.00 | 3 | 19.1 | -16.1 |
| 11.00 | 3 | 19.1 | -16.1 |
| 12.00 | 4 | 19.1 | -15.1 |
| 12.00 | 4 | 19.1 | -15.1 |
| 13.00 | 4 | 19.1 | -15.1 |
| 13.00 | 4 | 19.1 | -15.1 |
| 15.00 | 2 | 19.1 | -17.1 |
| 15.00 | 2 | 19.1 | -17.1 |
| 16.00 | 1 | 19.1 | -18.1 |
| 16.00 | 1 | 19.1 | -18.1 |
| 17.00 | 1 | 19.1 | -18.1 |
| 17.00 | 1 | 19.1 | -18.1 |
| 19.00 | 1 | 19.1 | -18.1 |
| 19.00 | 1 | 19.1 | -18.1 |
| 20.00 | 1 | 19.1 | -18.1 |
| 20.00 | 1 | 19.1 | -18.1 |
| Total | 363 | | |
| Total | 363 | | |

Test Statistics

| | Mortalities |
|---|---|
| Chi-Square | 1122.193 |
| Chi-Square | 1122.193 |
| df | 18 |
| Asymp. Sig. | .000 |
| Asymp. Sig. | .000 |

Mortalities are non–randomly distributed throughout cells.

**Can we model the mortalities using regression?**

First pass: use ¼ mile grid size.

```
DATA QRTMILE;
INPUT
ROADKILL AREACRE KM2 FRSTARAC FRSTARKM OTHRVGAC OTHRVGKM CONPERM H2OLFT
H2OM RDLFT RDLM;

[data]

PROC REG;
MODEL ROADKILL = FRSTARKM OTHRVGKM CONPERM H2OM RDLM / ALL ;
```

Dependent Variable: ROADKILL

Analysis of Variance

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 5 | 37.18963 | 7.43793 | 1.651 | 0.1453 |
| Error | 423 | 1905.69615 | 4.50519 | | |
| C Total | 428 | 1942.88578 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 2.12254 | R-square | 0.0191 |
| Dep Mean | 2.47086 | Adj R-sq | 0.0075 |
| C.V. | 85.90295 | | |

**No: This model, given the independent variables as outlined, has no statistical significance.**

Are any of the partial models any better predictors?

N = 429 Regression Models for Dependent Variable: ROADKILL

| Number in Model | R-square | Variables in Model |
|---|---|---|
| 1 | 0.00653212 | H2OM |
| 1 | 0.00422873 | OTHRVGKM |
| 1 | 0.00078518 | CONPERM |
| 1 | 0.00001045 | FRSTARKM |

| | | |
|---|---|---|
| 1 | 0.00000638 | RDLM |
| 2 | 0.00916884 | OTHRVGKM H2OM |
| 2 | 0.00876599 | FRSTARKM OTHRVGKM |
| 2 | 0.00723129 | CONPERM H2OM |
| 2 | 0.00703140 | FRSTARKM H2OM |
| 2 | 0.00657646 | H2OM RDLM |
| 2 | 0.00511682 | OTHRVGKM RDLM |
| 2 | 0.00460909 | OTHRVGKM CONPERM |
| 2 | 0.00105908 | CONPERM RDLM |
| 2 | 0.00078543 | FRSTARKM CONPERM |
| 2 | 0.00001609 | FRSTARKM RDLM |
| 3 | 0.01534414 | FRSTARKM OTHRVGKM H2OM |
| 3 | 0.01181602 | FRSTARKM OTHRVGKM RDLM |
| 3 | 0.00997629 | OTHRVGKM H2OM RDLM |
| 3 | 0.00956170 | OTHRVGKM CONPERM H2OM |
| 3 | 0.00876836 | FRSTARKM OTHRVGKM CONPERM |
| 3 | 0.00764604 | CONPERM H2OM RDLM |
| 3 | 0.00761851 | FRSTARKM CONPERM H2OM |
| 3 | 0.00706558 | FRSTARKM H2OM RDLM |
| 3 | 0.00637959 | OTHRVGKM CONPERM RDLM |
| 3 | 0.00106047 | FRSTARKM CONPERM RDLM |
| 4 | 0.01868268 | FRSTARKM OTHRVGKM H2OM RDLM |
| 4 | 0.01534619 | FRSTARKM OTHRVGKM CONPERM H2OM |
| 4 | 0.01237549 | FRSTARKM OTHRVGKM CONPERM RDLM |
| 4 | 0.01121788 | OTHRVGKM CONPERM H2OM RDLM |
| 4 | 0.00796532 | FRSTARKM CONPERM H2OM RDLM |
| 5 | 0.01914144 | FRSTARKM OTHRVGKM CONPERM H2OM RDLM |

**No:** at the quarter mile grid size, none of the partial models are any better predictors than the full model.

## Second pass: use 1 mile grid size.

```
DATA ROADKILL;
INPUT
IDNUM RDKILL ACRES AREAKM2 FOREST FORESTKM satdat OVEG OVEGKM BPERMIT H2OL
H2OLM RDLONG RDLM ;
lh2O=log(H2OLM);
lroad= log(rdlm);
if satdat=0 then delete;

[data]

model ROADKILL = FORESTKM  OVEGKM BPERMIT H2OLM RDLM / all;
```

## Results:

Dependent Variable: ROADKILL

Analysis of Variance

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 5 | 96.16533 | 19.23307 | 1.297 | 0.2665 |
| Error | 209 | 3099.43467 | 14.82983 | | |
| C Total | 214 | 3195.60000 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 3.85095 | R-square | 0.0301 |
| Dep Mean | 4.40000 | Adj R-sq | 0.0069 |
| C.V. | 87.52164 | | |

Results summary:

Using the 1 $mi^2$ grid *and cells for which satellite data are available*, there is **no significant relationship** between mortalities and the full model.

**N. B.** Because of the difference in magnitude between mortality per cell and some of the variables, I repeated this analysis with the larger independent variables transformed to natural logarithms. There was no difference in the results.

**Is there a relationship at the 1 $mi^2$ grid level between mortalities and any partial model?**

N = 215 Regression Models for Dependent Variable: ROADKILL

| Number in Model | R-square | Variables in Model |
|---|---|---|
| 1 | 0.01492022 | H2OLM |
| 1 | 0.00991253 | OVEGKM |
| 1 | 0.00125308 | RDLM |
| 1 | 0.00088025 | FORESTKM |
| 1 | 0.00000000 | BPERMIT |
| 2 | 0.02105006 | OVEGKM H2OLM |
| 2 | 0.01581991 | FORESTKM H2OLM |
| 2 | 0.01493396 | H2OLM RDLM |
| 2 | 0.01492669 | BPERMIT H2OLM |
| 2 | 0.01482340 | FORESTKM OVEGKM |
| 2 | 0.01018383 | OVEGKM BPERMIT |
| 2 | 0.01001070 | OVEGKM RDLM |
| 2 | 0.00223873 | FORESTKM RDLM |
| 2 | 0.00162934 | BPERMIT RDLM |
| 2 | 0.00089639 | FORESTKM BPERMIT |
| 3 | 0.02333118 | FORESTKM OVEGKM H2OLM |
| 3 | 0.02206950 | OVEGKM H2OLM RDLM |
| 3 | 0.02116914 | OVEGKM BPERMIT H2OLM |
| 3 | 0.02035042 | FORESTKM OVEGKM RDLM |
| 3 | 0.01719409 | FORESTKM OVEGKM BPERMIT |
| 3 | 0.01586424 | FORESTKM BPERMIT H2OLM |
| 3 | 0.01584669 | FORESTKM H2OLM RDLM |
| 3 | 0.01493458 | BPERMIT H2OLM RDLM |
| 3 | 0.01019063 | OVEGKM BPERMIT RDLM |
| 3 | 0.00247920 | FORESTKM BPERMIT RDLM |
| 4 | 0.02998852 | FORESTKM OVEGKM H2OLM RDLM |
| 4 | 0.02451689 | FORESTKM OVEGKM BPERMIT H2OLM |
| 4 | 0.02209580 | OVEGKM BPERMIT H2OLM RDLM |
| 4 | 0.02117065 | FORESTKM OVEGKM BPERMIT RDLM |
| 4 | 0.01586874 | FORESTKM BPERMIT H2OLM RDLM |
| 5 | 0.03009304 | FORESTKM OVEGKM BPERMIT H2OLM RDLM |

**No:** there is no statistical significance to any full ***or*** partial regression model.