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Quantifying Wildlife Home Range Changes

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1. Introduction

In wildlife research, telemetry data are often converted to home ranges. The concept of an animal's home range can be defined as the ". . . area traversed by the individual in its normal activities of food gathering, mating and caring for young" (Burt, 1943, pg. 351). The delineation and analysis of home ranges is common in wildlife research, and several reviews of home range studies exist (Harris et al., 1990; Laver & Kelly, 2008). Site fidelity (Edwards et al., 2009), population abundance (Trewhella et al., 1988), prey-predatory abundance (Village, 1982), impacts of human disturbance (Apps et al., 2004; Berland et al., 2008; Frair et al., 2008; Rushton et al., 2000; Thiel et al., 2008), feeding strategies (Hulbert et al., 1996) and ecological correlates of critical habitat (Tufto, 1996; Fisher, 2000) are examples of topics addressed using home range as the analysis unit.

Home ranges are typically delineated with polygons. Locations within the polygon are considered part of the animal's home range, and locations outside are not. As evidenced by the large number of home range studies, such binary approaches have been useful. However, landscape use by wildlife is spatially heterogeneous (Johnson et al., 1992; Kie et al., 2002). Edges (Yahner, 1988), disturbances (i.e., roads and forest harvesting) (Berland et al., 2008), and patch size (Kie et al., 2002) are just a few landscape features that cause heterogeneity in the geographic distribution of wildlife within home ranges. To account for spatial heterogeneity within a home range, core areas, defined as those used most frequently and likely to contain homesites, along with areas of refuge and dependable food sources (Burt, 1943) are sometimes delineated to create categories of habitat use (e.g., Samuel et al., 1985). Characterizing the spatial variation in wildlife distributions should improve our understanding of habitat use, especially in conjunction with the growing spatial extents of wildlife data sets.

Arguably, the two most common approaches to demarcating a home range are the minimum convex polygon and kernel density estimation (Harris et al., 1990). The minimum convex polygon tends to overestimate home range size by including all the unused areas between outermost locations and increasing in area with large sample sizes (Börger et al., 2006a; Katajisto & Moilanen, 2006). As such, kernel density estimation is often preferred when demarcating a home range (Seaman & Powell, 1996; Marzluff et al., 2004; Börger et al., 2006a; Laver & Kelly, 2008). Although used to delineate binary home ranges, kernel density estimation generates a surface of values within the home range, which is useful for characterizing spatial variability in wildlife intensity. Kernel density surfaces are often referred to as utilization distributions as they give values that indicate higher and lower utilization of locations by individuals.

Regardless of how the home range is calculated, there are benefits to converting point-based telemetry data to polygonal home ranges. First, unless telemetry data are collected at a very high temporal frequency, almost continuously, telemetry data represent a sample of locations visited by an individual. Conversion to a polygon is an attempt to represent the complete range of possible movements. Second, conversion to a utilization distribution has the additional benefit of being useful for integrating telemetry data with environmental data sets. Often stored within a Geographic Information System (GIS), many environmental data sets are represented using raster grids. A common example is elevation data sets, which are stored in grid cells, of varying size. Kernel density estimated values are also stored as grid cells enabling efficient integration of utilization distributions with other map-based data sets.

As telemetry data sets have grown in temporal extent, it has become useful to employ home ranges to assess wildlife movement and habitat use through time. Characterizing the temporal change in home ranges has been used to study seasonal movement (Georgii, 1980), relate home range size to population abundance (Lowe et al., 2003) and land use (Viggers & Hearn, 2005), and characterize the spatial interactions of predator and prey (Village, 1982). Typically, when quantifying home range change, areal sizes are compared (e.g., Lurz et al., 1997; Lowe et al., 2003; Edwards et al., 2009) or the proportions of areal overlap enumerated (e.g., Georgii, 1980; Atwood & Weeks, 2003). In a few examples, spatial-temporal patterns of home ranges are quantified in greater detail. For instance, the multi-temporal persistence of home ranges has been related to landscape disturbance (Berland et al., 2008). Two additional approaches were identified by Kie et al. (2010) as showing potential for identifying temporal changes in home ranges. The first approach uses mixed effect models to relate temporal variation in patterns of telemetry data to climate, habitat, and age/sex variables of deer (Börger et al., 2006b). The second considers spatial variation in habitat use (represented by utilization distributions, defined below) continuous in time and representative of four dimensions (latitude, longitude, elevation, and time) (Keating & Cherry, 2009). Using a product-kernel, temporal patterns in space use were characterized using a circular time scale. Improved approaches to wildlife data collection, such as satellite and global positioning system (GPS) collars, in combination with concerns over climate change and growing anthropogenic pressures on wildlife, have increased the number of possible multi-temporal wildlife research questions. Development of new analytical approaches has begun and must continue if high temporal resolution telemetry data can be used to their full potential.

Here, I present three novel approaches to quantifying spatial-temporal change in home ranges. The first method, Spatial Temporal Analysis of Moving Polygons (STAMP), uses topological relationships of home range polygons to quantify spatial-temporal patterns of home ranges. The second method detects statistically significant change between two kernel density-estimated surfaces, and is utilized to characterize statistical change in intensity of habitat use within home ranges. The third method, an integration of methods one and two, simultaneously quantifies both the spatial-temporal pattern and change in wildlife intensities within home ranges. Described below, the new methods are demonstrated on caribou (*Rangifer tarandus* caribou) data from western Canada, and their benefits are outlined and compared to traditional approaches. To begin, home range delineation and typical approaches to change detection are presented as the basis for comparison with these novel approaches.

2. Home range methods

2.1 Telemetry data

The methods presented and compared in this chapter are applied to data on the Swan Lake woodland caribou herd, located in the southern Yukon, near Swift River (60°10'N,

131°07′W), and northern British Columbia, east of Teslin Lake (59°59′N, 132°25′W). Data were collected using very high frequency (VHF) transmitters. In 2006, 128 telemetry locations were obtained from 27 animals. In 2007, 68 telemetry locations were obtained from 18 animals (Fig. 1).
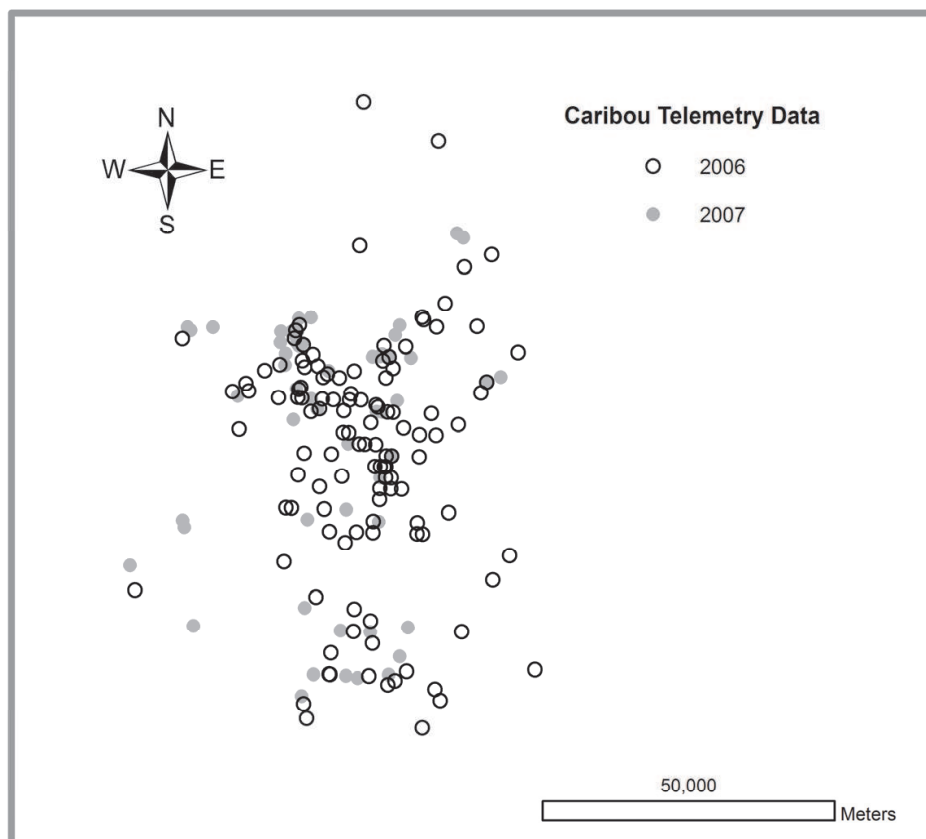

Fig. 1. Caribou telemetry data for 2006 and 2007.

2.2 Home range delineation and standard change analysis

Home ranges were delineated using kernel density estimation, a nonparametric approach for generating a continuous intensity surface (Seaman & Powell, 1996). Theoretically, the intensity $\lambda(z)$ of observations at each location z in a study area A is estimated using the kernel density estimator

$$\hat{\lambda}(z) = \frac{\text{the number of events in a neighbourhood centred on } z}{\text{area of the neighbourhood}} \tag{1}$$

A more exact estimate, $\hat{\lambda}_\tau(z)$, can be calculated using

$$\hat{\lambda}_\tau(z) = \left\{ \sum_{i=1}^{n} \frac{1}{\tau^2} k\left(\frac{(z - z_i)}{\tau} \right) \right\} \quad z \in A, \tag{2}$$

where z and A are defined as above, τ is the radius or bandwidth of a circular neighbourhood centred on z, $k()$ is the probability density function that is symmetric about

z, and z_i (i =1, …, n), are the locations of n events. For home range delineation, the bandwidth size is typically selected via least-square cross-validation (LSCV) and a 95% threshold used to demarcate the home range boundary (Seaman & Powell, 1996; Seaman et al., 1999).
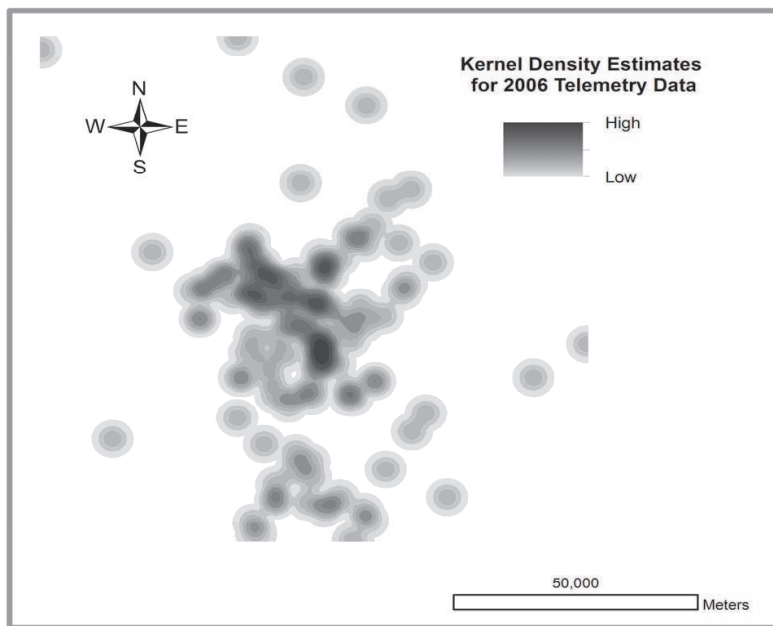

Fig. 2. Kernel density estimated surface generated from 2006 caribou telemetry data.

For the woodland caribou data, the bandwidth was defined as the mean LSCV for 2006 and 2007 data, which is 2.18 km (Fig. 2 and 3). For kernel-based change detection, it is beneficial to have consistent bandwidths (Bowman & Azzalini, 1997, pg. 114). The annual home range size was 1999.31 km² and 1231.28 km² in 2006 and 2007, respectively. Home ranges overlapped by 781.48 km² (31.91%) (Fig. 4).
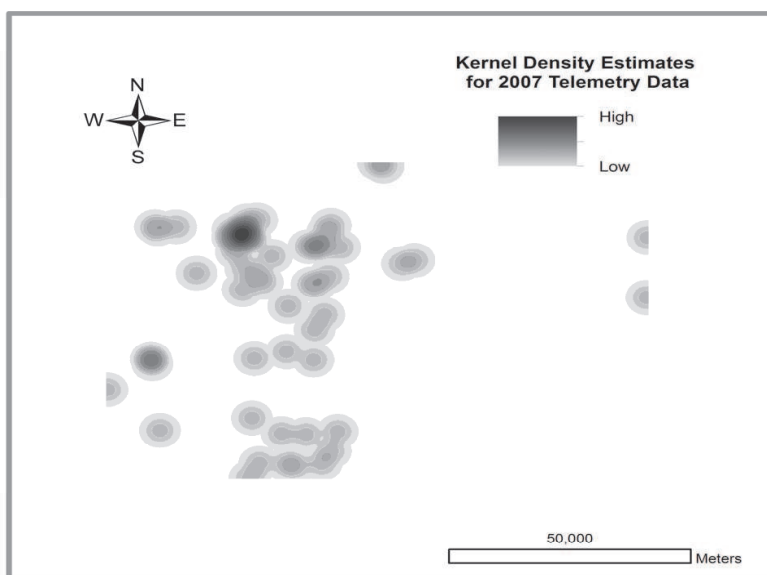

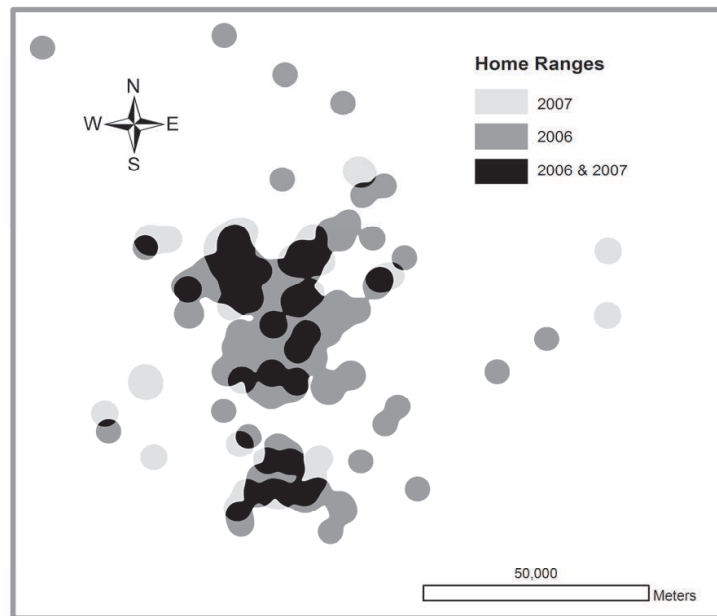Fig. 3. Kernel density estimated surface generated from 2007 caribou telemetry data.

Fig. 4. Caribou home ranges for 2006 and 2007, generated using kernel density estimation.

3. Quantifying spatial-temporal change in home ranges

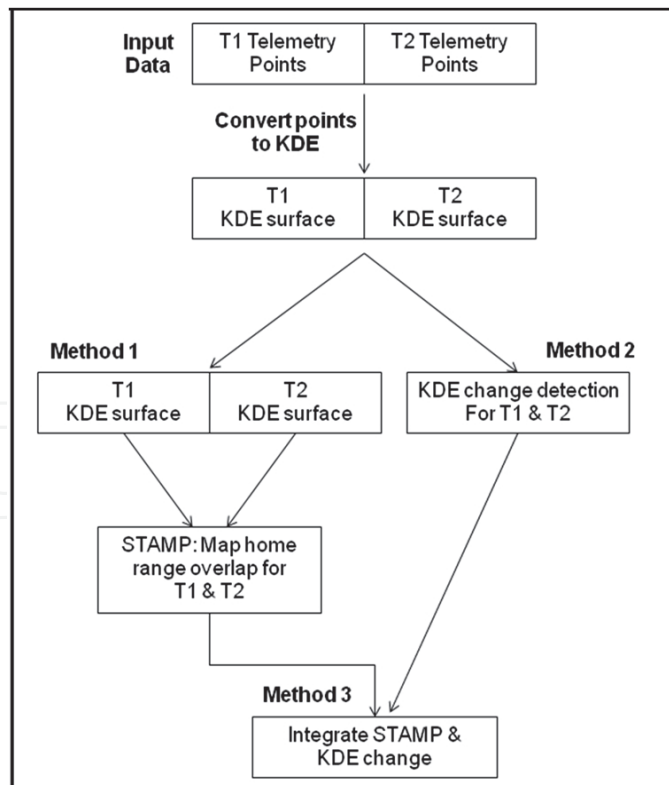An overview of the three methods presented is provided in Fig. 5.

Fig. 5. An overview of the three methods presented: STAMP, kernel density estimation (KDE) change detection, and the integration of STAMP and KDE change detection. T1 and T2 indicate time period 1 and time period 2, respectively.

3.1 Spatial-temporal analysis of moving polygons (method 1)

STAMP employs topological relationships of polygons to characterize spatial-temporal patterns of home range change between two time periods (*t* and *t*+1) (Sadahiro, 2001; Sadahiro & Umemura, 2001; Robertson et al., 2007). By intersecting home range polygons for two time periods, within a GIS, polygon relationships may be used to categorize space-time patterns of change. New polygons are produced by the intersection, and each is classified based on the polygon state (home range or not) in both time periods and the space-time patterns of adjacent polygons. Polygons are assigned to one of five pattern categories: stable, disappearance, contraction, generation, and expansion (Fig. 6). Stable patterns are locations where the home range is present in *t* and *t*+1. In stable locations there is consistent habitat use or site fidelity (e.g., Edwards et al., 2009). Disappearance and contraction patterns indicate that a location is part of a home range in *t* but not *t*+1. Disappearance patterns are spatially isolated, as opposed to contraction patterns which are spatially adjacent to other home range areas that have changed in a different way. Generation and expansion patterns both indicate that a location was not part of a home range in *t*, but became part of a home range in *t*+1. While generation patterns are spatially isolated, expansion events are spatially adjacent to home range areas that have changed in other ways. Disappearance, contraction, generation, and expansion all indicate different types of home range drift (e.g., Edwards et al., 2009).
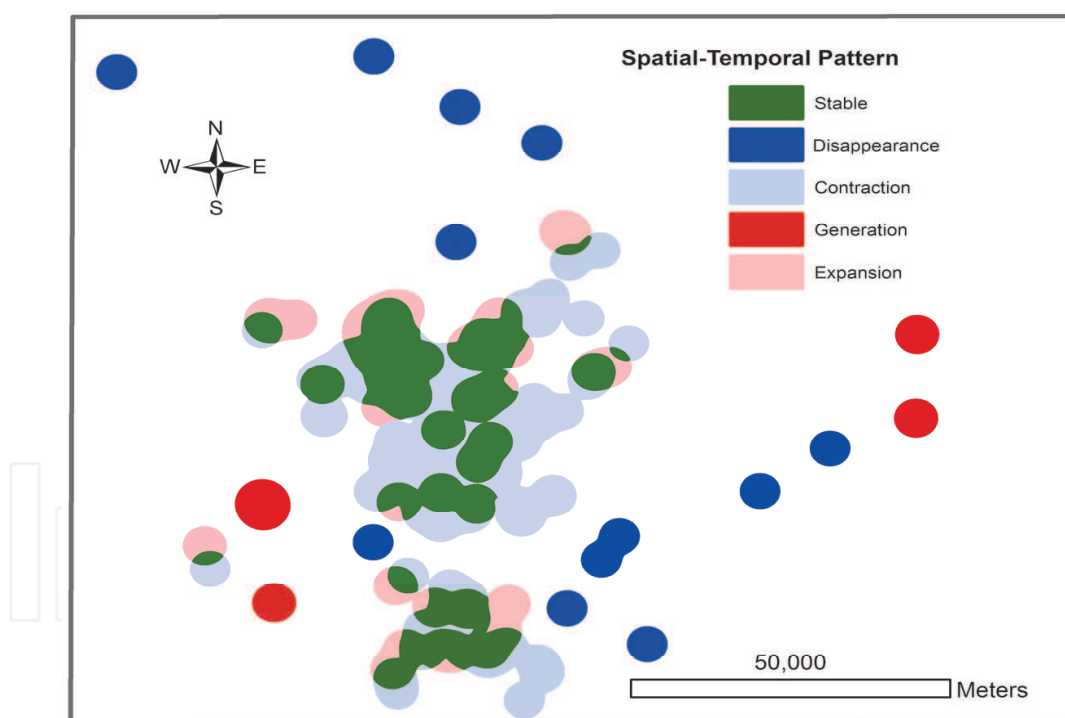

Fig. 6. Spatial-temporal patterns in 2006 to 2007 caribou home ranges. Spatial-temporal patterns are defined by STAMP or topological relationships between home range polygons.

For the Swan Lake caribou, all five spatial-temporal patterns were identified (Fig. 6, Table 1). Contraction was the dominant pattern (37.50%), while generation was least common (5.82%). Stable patterns occurred for 31.91% of the home range area, and expansion and disappearance occurred in similar proportions, 12.54% and 12.22% respectively.

	Spatial-Temporal Patterns	
	km²	%
Stable	781.48	31.91
Disappearance	299.38	12.22
Contraction	918.45	37.50
Generation	142.63	5.82
Expansion	307.17	12.54
Total	2449.11	100.00

Table 1. Area and proportion of spatial-temporal patterns of home range change from 2006 to 2007.

Traditional methods demonstrate that the Swan Lake caribou's home range declined from 2006 (1999.31 km²) to 2007 (1231.28 km²). The STAMP analysis indicates that while a decline in home range area dominates, in some regions new habitat was used. For instance, Fig. 2 indicates that caribou were using new habitat to the east. In addition to providing a more complete spatial representation of space-time habitat use, the results of STAMP are mappable. Mapped spatial-temporal patterns can be related to additional data sets in order to evaluate hypotheses associated with home range change. For example, associations between resources and space-time patterns may be hypothesized and tested by integrating the spatial-temporal patterns with resource availability data.

3.2 Kernel density estimation change detection (method 2)

A method of change detection designed specifically for use with kernel density estimated surfaces is well suited to characterizing change in the intensity of habitat use within home ranges (Nelson et al., 2008). Kernel density estimation change detection identifies locations of statistically significant positive and negative changes, and enables the rate of change, considered significant, to vary spatially (Bowman & Azzalini, 1997, pp. 112-117). This method is a square root variance stabilizing transformation of the difference between two kernel density estimated surfaces, and is most appropriate for use when kernel estimates are generated using the same bandwidth (Bowman & Azzalini, 1997, pg. 114). The difference between the square root kernel density estimates at location i, for two time periods t and $t+1$, change$_{i\Delta t}$, is measured in terms of pooled standard deviations by calculating

$$\text{change}_{i\Delta t} = \frac{\sqrt{\hat{\lambda}_{i,t}} - \sqrt{\hat{\lambda}_{i,t+1}}}{\sqrt{se_t^2 + se_{t+1}^2}} \tag{3}$$

where $\hat{\lambda}_{i,t}$ is the kernel density estimate at location i in year t, and $\hat{\lambda}_{i,t+1}$ is the kernel density estimate at the same location in the following year. se_t and se_{t+1} are the standard errors in the respective years.

The standard error is a measure of the variance of the kernel function. Kernel density variance is dependent on the shape or curvature of the kernel, the search radius, and the total sample size. For traditional kernel density estimators, these parameters are invariant over space. Therefore, the standard error is a constant defined as

$$se = \sqrt{\frac{\left[\int\left(k(\mathbf{z})\right)^2 d\mathbf{z}\right]^2}{4n\tau^2}}$$ (4)

where $k(z)$ is the Gaussian kernel with a mean of zero and a standard deviation of $\sqrt{2}$.

Significant positive change (α = 0.05) occurs at location i when change$_{i\Delta t}$ > 1.96 and significant negative change occurs when change$_{i\Delta t}$ < -1.96. Otherwise, no significant change is assumed to have occurred. Calculating change$_{i\Delta t}$ in this way does not produce an exact measure of statistically significant change. Kernel density estimators produce estimates, and the standard error or variance can be thought of as a confidence envelope around that value. Therefore, significant change is also estimated (Bowman & Azzalini, 1997, pg. 116; Fotheringham et al., 2002, pg. 205).

When change in the caribou home range is quantified as the intersection of two binary home ranges, 31.81% of the area is found to overlap, suggesting that change has occurred in 68.09% of the home range. However, when change is defined by statistical significance, only 31.39% of the area has changed and change can be categorized as increasing use (positive change, 5.39%) or decreasing use (negative, change 26.00%) (Fig. 7). By assessing change with statistical significance, and enabling the rate of significant change to vary over space, no change is identified near edges of the home range, where intensity values are small and/or zero. Changes in intensity, not captured with binary approaches, are emphasized.
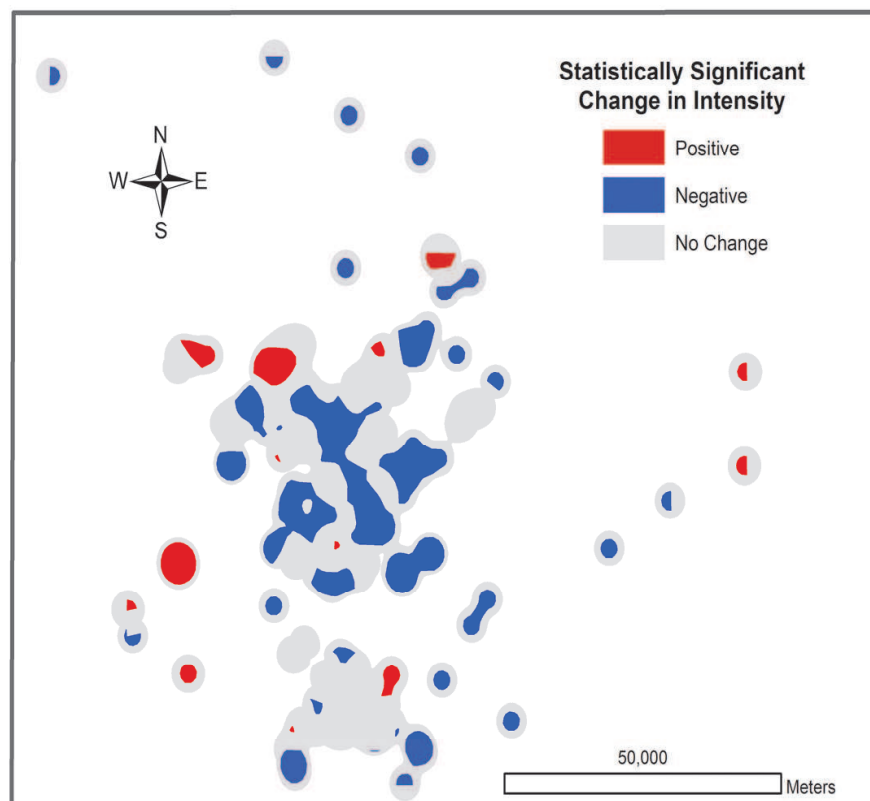

Fig. 7. Spatial-temporal change in 2006 to 2007 caribou home ranges. Change is defined as statistically significant variation in kernel density estimates generated from telemetry data. (The semicircles of positive and negative change are edge effects created by the software used for detecting change.)

As an example, when home ranges are binary, no change will be detected at a location associated with one telemetry point in the first time period and twelve in the second time period. The kernel approach, in contrast, has the potential to identify these as significant changes. As with STAMP, output of the kernel density approach is mappable, accounts for spatial variation in home range patterns, and integrates with other GIS data.

3.3 Integrating STAMP and kernel change approaches (method 3)

In the final method, STAMP and kernel density estimation change detection are integrated to characterize how wildlife intensity varies for different spatial-temporal home range patterns. The amount of statistically significant change in intensity can be determined for each spatial-temporal home range pattern. For disappearance and contraction, only negative change or decreasing use will occur; for generation and expansion, only positive change or increasing use will occur; and for stable patterns, both types of change may be present.

With the caribou data, stable patterns have both positive and negative change, and differentiating the types of change identifies how intensity of use is varying within areas used consistently through time (Table 2). In the caribou example, 3.73% and 12.99% of stable pattern areas had statistically significant positive and negative change, respectively. Given the general decline in home range areas, stable areas that have had an increased use, or no decline in use, may be the most important habitat for conservation.

	Positive Change		Negative Change		No Change		Total	
	km²	%	km²	%	km²	%	km²	%
Stable	29.17	3.73	101.52	12.99	650.79	83.28	781.48	100.00
Disappearance	0.00	0.00	83.58	27.92	215.80	72.08	299.38	100.00
Contraction	0.00	0.00	453.90	49.42	464.55	50.58	918.45	100.00
Generation	50.08	35.11	0.00	0.00	92.55	64.89	142.63	100.00
Expansion	52.75	17.17	0.00	0.00	254.42	82.83	307.17	100.00

Table 2. Area of statistically significant changes in kernel density estimates and the proportion of significant change for each spatial-temporal pattern of home range change from 2006 to 2007.

Integrating results of STAMP and kernel density change demonstrate that 27.92% of the area of disappearance patterns had statistically significant negative change, while 49.42% of contraction area was associated with negative change (Table 2). One might anticipate that the spatially isolated disappearance events would have more negative change, as these are locations within regions where habitat use has ceased. However, in the caribou example, disappearance is often associated with a single telemetry point in t followed by no use in $t+1$. Greater magnitude changes in intensity are occurring in central portions of the home range where many telemetry points are identified in t and in an area associated with contraction in spatial-temporal patterns.

4. Conclusion

Data on wildlife locations are increasingly detailed in both space and time. Conversion to binary home range maps has been useful. However, the methods presented here take

advantage of greater data detail and enable new spatial-temporal research questions to be addressed. There is a general dearth of temporal methods for geographical data, and efforts are underway to develop new methods for space-time analysis that will likely have applications and benefits in wildlife and ecological studies (e.g., Rey & Janikas, 2006). Spatially explicit methods will be increasingly important as data sets continue to increase in size.

All the methods presented in this chapter are mappable and can be integrated with other GIS data sets. For instance, locations of change can be correlated to environmental variables (elevation or landscape fragmentation), resource selection functions (e.g., Boyce and McDonald, 1999), roads, or human disturbance data. Existing literature is useful for generating hypotheses on space-time home range patterns and changes in home range intensity. By quantifying observed patterns and integrating additional data, it is possible to determine if the patterns are different from or similar to our expectations. Linking patterns of change with additional data sets will enable testing of hypotheses on processes driving change.

Knowing where change is occurring is essential for conservation and management of wildlife and habitat. Methods that not only locate, classify, and quantify change, but that integrate change maps with data on environmental and human activities, are essential for conservation. The methods presented here are applicable to any wildlife research where home ranges are defined by kernel density estimation and two or more home ranges occur in a study area. While I have demonstrated approaches for detecting change between two time periods, these methods are also useful when comparing spatially overlapping home ranges of individuals or populations, such as analysis of predators and prey home ranges.

5. Acknowledgement

6. References

Apps, C.D., McLellan, B.N., Woods, J.G., & Proctor, M.F. (2004). Estimating grizzly bear distribution and abundance relative to habitat and human influence. *Journal of Wildlife Management*, Vol.68, No.1, (January 2004), pp. 138–152

Atwood, T.C., & Weeks, H.P. (2003). Spatial home-range overlap and temporal interaction in eastern coyotes: the influence of pair types and fragmentation. *Canadian Journal of Zoology*, Vol.81, No.9, pp. 1589–1597

Berland, A., Nelson, T., Stenhouse, G., Graham, K., & Cranston, J. (2008). The impact of landscape disturbance on grizzly bear habitat use in the Foothills Model Forest, Alberta, Canada. *Forest Ecology and Management*, Vol.256, No.11, (November 2008), pp. 1875–1883

Börger, L., Franconi, N., De Michele, G., Gantz, A., Meschi, F., Manica, A., Lovari, S., & Coulson, T. (2006a). Effects of sampling regime on the mean and variance of home range size estimates. *Journal of Animal Ecology*, Vol.75, No.6, (November 2006), pp. 1405–1493

Börger, L., Franconi, N., Ferretti, N., Meschi, F., De Michele, G., Gantz, A., & Coulson, T. (2006b). An integrated approach to identify spatio-temporal and individual-level determinants of animal home range size. *American Naturalist*, Vol.168, No.4, (October 2006), pp. 471–485

Bowman, A., & Azzalini, A. (1997). *Applied Smoothing Techniques for Data Analysis: The Kernel Approach*. Claredon Press, Oxford

Boyce, M.S., & McDonald, L.L. (1999). Relating populations to habitats using resource selection functions. *Trends in Evolution and Ecology*, Vol.14, No.7, (July 1999), pp. 268–272

Burt, W.H. (1943). Territoriality and home range concepts as applied to mammals. *Journal of Mammalogy*, Vol.24, No.3, (August 1943), pp. 346–352

Edwards, M.A., Nagy, J.A., & Derocher, A.E. (2009). Low site fidelity and home range drift in a wide-ranging, large Arctic omnivore. *Animal Behaviour*, Vol.77, No.1, (January 2009), pp. 23–28

Fotheringham, A.S., Brunsdon, C., & Charlton, M. (2002). *Geographically Weighted Regression: The Analysis of Spatially Varying Relationships*. John Wiley & Sons Ltd, London

Fisher, D.O. (2000). Effects of vegetation structure, food and shelter on the home range and habitat use of an endangered wallaby. *Journal of Applied Ecology*, Vol.37, No.4, (August 2000), pp. 660–671

Frair, J.L., Merrill, E.H., Beyer, H.L., & Morales, J.M. (2008). Thresholds in landscape connectivity and mortality risks in response to growing road networks. *Journal of Applied Ecology*, Vol.45, No.5, (October 2008), pp. 1504–1513

Georgii, B. (1980). Home range patterns of female red deer (*Cervus elaphus L.*) in the Alps. *Oecologia*, Vol.47, No. 2, pp. 278–285

Harris, S., Cresswell, W.J., Forde, P.G., Trewhella, W.J., Woollard, T., & Wray, S. (1990). Home-range analysis using radio-tracking data—a review of problems and techniques particularly as applied to the study of mammals. *Mammal Review*, Vol.20, No.2/3, (June 1990), pp. 97–123

Hulbert, I.A.R., Iason, G.R., Elston, D.A., & Racey, P.A. (1996). Home-range sizes in a stratified upland landscape of two lagomorphs with different feeding strategies. *Journal of Applied Ecology*, Vol.33, No.6, (December 1996), pp. 1479–1488

Johnson, A.R., Wiens, J.A., Milne, B.T. & Crist, T.O. (1992). Animal movements and population dynamics in heterogeneous landscapes. *Landscape Ecology*, Vol.7, No.1, pp. 63–75

Katajisto, J., & Moilanen, A. (2006). Kernel-based home range method for data with irregular sampling intervals. *Ecological Modelling*, Vol.194, No.4, (April 2006), pp. 405–413

Keating, K., & Cherry, S. (2009). Modeling utilization distributions in space and time. *Ecology*, Vol.90, No.7, (July 2009), pp. 1971–1980

Kie, J.G., Bowyer, T., Nicholson, M.C., Boroski, B.B., & Loft, E.R. (2002). Landscape heterogeneity at differing scales: effects on spatial distribution of mule deer. *Ecology*, Vol.83, No.2, (February 2002), pp. 530–544

Kie, J.G., Matthiopoulos, J., Fieberg, J., Powell, R.A., Cagnacci, F., Mitchell, M.S., Gaillard, J.-M., & Moorcroft, P.R. (2010). The home-range concept: are traditional estimators still relevant with modern telemetry technology? *Philosophical Transactions of the Royal Society B*, Vol.365, pp. 2221−2231

Laver, P.N., & Kelly, M.J. (2008). A critical review of home range studies. *Journal of Wildlife Management*, Vol.72, No.1, (January 2008), pp. 290–298

Lowe, C.G., Topping, D.T., Cartamil, D.P., & Papastamatiou, Y.P. (2003). Movement patterns, home range, and habitat utilization of adult kelp bass *Paralabrax clathratus* in a temperate no-take marine reserve. *Marine Ecology Progress Series*, Vol.256, (July 2003), pp. 205–216

Lurz, P.W.W., Garson, P.J., & Wauters, L.A. (1997). Effects of temporal and spatial variation in habitat quality on red squirrel dispersal behaviour. *Animal Behaviour*, Vol.54, No. 2, (August 1997), pp. 427–435

Marzluff, J.M., Millspaugh, J.J., Hurvitz, P., & Handcock, M.S. (2004). Relating resources to a probabilistic measure of space use: forest fragments and Steller's Jays. *Ecology*, Vol.85, No.5, (May 2004), pp. 1411–1427

Nelson, T.A., Duffus, D., Robertson, C., & Feyrer, L.J. (2008). Spatial-temporal patterns in intra-annual gray whale foraging: Characterizing interactions between predators and prey. *Marine Mammal Science*, Vol.24, No.2, (April 2008), pp. 356–370

Rey, S.J., & Janikas, M.V. (2006). STARS: Space-time analysis of regional systems. *Geographical Analysis*, Vol.38, No.1, (January 2006), pp. 67–86

Robertson, C., Nelson, T.A., Boots, B., & Wulder, M.A. (2007). STAMP: spatial-temporal analysis of moving polygons. *Journal of Geographical Systems*, Vol.9, No.3, (September 2007), pp. 207–227

Rushton, S.P., Barreto, G.W., Cormack, R.M., MacDonald, D.W., & Fuller, R. (2000). Modelling the effects of mink and habitat fragmentation on the water vole. *Journal of Applied Ecology*, Vol.37, No.3, (June 2000), pp. 475–490

Sadahiro, Y. (2001). Exploratory method for analyzing changes in polygon distributions. *Environment and Planning B: Planning Design*, Vol.28, pp. 595–609

Sadahiro, Y., & Umemura, M. (2001). A computational approach for the analysis of changes in polygon distributions. *Journal of Geographic Systems*, Vol.3, No.2, (May 2001), pp. 137–154

Samuel, M.D., Pierce, D.J., & Garton, E.O. (1985). Identifying areas of concentrated use within the home range. *Journal of Animal Ecology*, Vol.54, No.3, (October 1985), pp. 711–719

Seaman, D.E., & Powell, R.A. (1996). An evaluation of the accuracy of kernel density estimators for home range analysis. *Ecology*, Vol.77, No.7, (October 1996), pp. 2075–2085

Seaman, D.E., Millspaugh, J.J., Kernohan, B.J., Brundige, G.C., Raedeke, K.J., & Gitzen, R.A. (1999). Effects of sample size on kernel home range estimates. *Journal of Wildlife Management*, Vol.63, No.2, (April 1999), pp. 739–747

Thiel, D., Jenni-Eiermann, S, Braunisch, V., Palme, R., & Jenni, L. (2008). Ski tourism affects habitat use and evokes a physiological stress response in capercaillie *Tetrao urogallus:* a new methodological approach. *Journal of Applied Ecology*, Vol.45, No.3, (June 2008), pp. 845–853

Trewhella, W.J., Harris, S., & McAllister, F.E. (1988). Dispersal, distance, home-range size and population density in the red fox (*Vulpes vulpes*): a quantitative analysis. *Journal of Applied Ecology*, Vol.25, No. 2, (August 1988), pp. 423–434

Tufto, J., Andersen, R., & Linnell, J. (1996). Habitat use and ecological correlates of home range size in a small cervid: the roe deer. *Journal of Animal Ecology*, Vol.65, No.6, (November 1996), pp. 715–724

Viggers, K.L., & Hearn, J.P. (2005). The kangaroo conundrum: home range studies and implications for land management. *Journal of Applied Ecology*, Vol.42, No.1, (February 2005), pp. 99–107

Village, A. (1982). The home range and density of kestrels in relation to vole abundance. *Journal of Animal Ecology*, Vol.51, No.2, (June 1982), pp. 413–428

Yahner, R.H. (1988). Changes in wildlife communities near edges. *Conservation Biology*, Vol.2, No.4, (December 1988), pp. 333–339
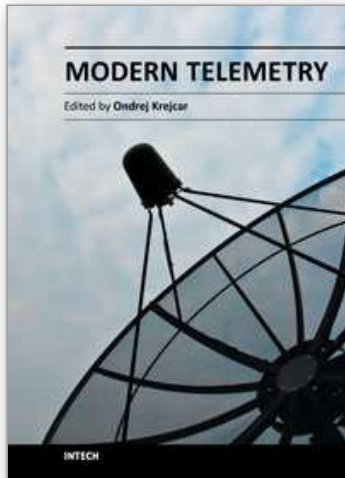
Modern Telemetry

Edited by Dr. Ondrej Krejcar

Telemetry is based on knowledge of various disciplines like Electronics, Measurement, Control and Communication along with their combination. This fact leads to a need of studying and understanding of these principles before the usage of Telemetry on selected problem solving. Spending time is however many times returned in form of obtained data or knowledge which telemetry system can provide. Usage of telemetry can be found in many areas from military through biomedical to real medical applications. Modern way to create a wireless sensors remotely connected to central system with artificial intelligence provide many new, sometimes unusual ways to get a knowledge about remote objects behaviour. This book is intended to present some new up to date accesses to telemetry problems solving by use of new sensors conceptions, new wireless transfer or communication techniques, data collection or processing techniques as well as several real use case scenarios describing model examples. Most of book chapters deals with many real cases of telemetry issues which can be used as a cookbooks for your own telemetry related problems.

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