Geospatial and temporal patterns of stoat (*Mustela erminea*) activity in Tongariro Forest, central North Island, New Zealand.

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Abstract

Spatial and temporal characteristics of stoat (*Mustela erminea*) activity in Tongariro Forest were quantified using two well documented monitoring methodologies : i) radio telemetry using motion sensitive radio collars provided high detail measurement of individual activity of a number of stoats, and ii) footprint tracking tunnels provided measurement of population-level tendencies in activity, abundance and habitat use. The specific objectives were to identify predictable times of high and low stoat activity, and identify habitat types and specific locations within Tongariro Forest where stoat visitation to a control station is likely to be especially high and low. Prior to field data collection the radio transmitters were assessed and calibrated using captive stoats and video equipment to compare telemetry signals with actual behaviour. Two motion sensitivities where tested (fine and coarse), and the fine sensitivity transmitter was identified as most suitable for a field study. Estimates of locomotor activity derived from telemetry data correlated with directly observed behaviours at hourly and greater time scale, and verified suitability of activity transmitters for field study of stoat activity. Eleven stoats were tagged with motion-sensitive radio transmitters and monitored in the field in Tongariro Forest to quantify temporal patterns in wild stoat activity. Four monitoring 'seasons' representing early and late summer, autumn and spring seasons of the year, provided a total of 896 hours of stoat activity. On average, stoats were active 28% of the 24-hour day (seasonal range 16-41%). Both the total time spent active per day and the partitioning of this activity through the day varied between seasons. Tracking tunnel visitation indices obtained in subsequent years showed similar seasonal patterns to the data obtained using telemetry, except during early summer when tracking rates were lower than the equivalent locomotor activity estimate. Most radio-tagged stoats were predominantly diurnal in all seasons. Winter and spring had the largest proportions of daytime activity even though daytime was on average about 4 hours shorter during these seasons than in summer. Crepuscular peaks in activity were apparent in all seasons but particularly so during late summer. Activity was least structured in early summer, when it was spread more or less evenly throughout the 24 hours of the day. Active periods usually lasted at least 40 min, and up to 43% of activity was maintained continuously for >3 hours. Variability in activity between and within stoats was high, but variability in spring was marginally lower than in the other seasons. Temperature had some influence on activity at an hourly timescale, and the correlation between activity and temperature strengthened with increasing timescale. Autumn activity comprised more extended bouts of movement so might represent a time of year when stoats are ranging further, or exploring or searching within their ranges more intensively. This suggests that stoat control and monitoring devices might be most effective in autumn. Habitat use by stoats was quantified using a Geographical Information System (GIS) approach and statistical modelling with multi-year tracking tunnel records to data-mine for terrain variables that predict stoat visitation to stations in a New Zealand indigenous forest. Spatial analysis scale was found to be important for modelling outcomes, and an optimal model equation was derived using model selection techniques assessing at a range of relevant scales. The sensitivity of the model to different terrain parameters was tested by systematically substituting each variable and calculating the difference this made to the model derived estimates of stoat visitation. The most dominant terrain predictors influencing stoat visitation were proximity to tracks, altitude, northerly and easterly aspect, mean curvature, topographical position and slope. Proximity to tracks and mean curvature were the most sensitive variables to analysis scale. Indices of mouse and rat activity, which are known prey of stoats, and autocorrelation factors for previous and nearby stoat visitation, significantly improved the model and reduced the effects of terrain. Visitation to tracking tunnels was negatively correlated with rat visitation suggesting possible prey aversion of predators. Mouse visitation had no detectable effect on stoat tracking rates. Relevance for management and fit with known stoat ecology are discussed.

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