

REFERENCES

Electronic resources are referenced in accordance with International Standard ISO 690-2 *Information and documentation - Bibliographic references - Part 2: Electronic documents or parts thereof* recommended by Edinburgh University Library.

- Abrahams, M.V. (1986) Patch choice under perceptual constraints: a cause for departures from an ideal free distribution. *Behavioural Ecology and Sociobiology*, **19**, 409-415.
- Abrams, P.A. (2000) The impact of habitat selection on the spatial heterogeneity of resources in varying environments. *Ecology*, **81**, 2902-2913.
- Acocks, J.P.H. (1953) Veld types of South Africa. *Memoirs of the Botanical Society of South Africa*, **57**.
- Adams, J. (2000) *A quick background to the Pliocene* [online]. Environmental Sciences Division, Oak Ridge National Laboratory. Available from: <http://www.esd.ornl.gov/projects/qen/pliocene.html> [Accessed 18/01/2004].
- ADDS (1996) *Rain Stations: Zimbabwe Data Files* [online]. Africa Data Dissemination Service, U.S. Agency for International Development (USAID). Available from: <http://edcw2ks21.cr.usgs.gov/adds/mapdatas2.php?type=stat&area=zi> [Accessed 18/01/2004].
- Adler, P.B. & Hall, S.A. (*subm.*) The evolution of forage production and utilisation along distance-from-water gradients. *Landscape Ecology*.
- Adler, P.B., Raff, D.A. & Lauenroth, W.K. (2001) The effect of grazing on the spatial heterogeneity of vegetation. *Oecologia*, **128**, 465-479.
- Adogla-Bessa, T. & Aganga, A.A. (2000) Responses of Tswana goats to various lengths of water deprivation. *South African Journal of Animal Science*, **30**, 87-91.
- Adolph, E.F. (1943) *Physiological Regulations*. Cattell Press, Lancaster, PA.
- Ahmed, M.M.M. & El Hadi, H.M. (1996) Water metabolism and dehydration in two types of cattle given poor and good quality roughages. *Journal of Arid Environments*, **34**, 225-233.
- Akaike, H. (1973) Information theory and an extension of maximum likelihood principle. In *International Symposium on Information Theory*, 2nd edition (editors B.N. Petran & F.Csàaki), Akadèmiai Kiadi, Budapest, Hungary, pp267-281.
- Alexander, McN., R., Langman, V.A. & Jayes, A.S. (1977) Fast locomotion of some African ungulates. *Journal of Zoology*, London, **183**, 291-300.
- Altman, P.L. & Dittmer, D.S. (1968) *Metabolism*. Federation of the American Society of Experimental Biologists, Bethesda, Md.

- Andrew, M.H. (1988) Grazing impact in relation to livestock watering points. *Trends in Ecology and Evolution*, **3**, 336-339.
- Andrew, M. & Lange, R.T. (1986a) Development of a new piosphere in arid chenopod shrubland grazed by sheep. 1. Changes to the soil surface. *Australian Journal of Ecology*, **11**, 395-409.
- Andrew, M. & Lange, R.T. (1986b) Development of a new piosphere in arid chenopod shrubland grazed by sheep. 2. Changes to the vegetation. *Australian Journal of Ecology*, **11**, 411-424.
- Archibald, S. & Bond, W.J. (2003) Growing tall vs growing wide: tree architecture and allometry of *Acacia karroo* in forest, savanna, and arid environments. *Oikos*, **102**, 3-14.
- Arditi, R. & Dacorogna, B. (1988) Optimal foraging on arbitrary food distributions and the definition of habitat patches. *American Naturalist*, **131**, 837-846.
- Arnold, G.W. & Maller, R.A. (1985) An analysis of factors influencing spatial distribution in flocks of grazing sheep. *Applied Animal Behaviour Science*, **14**, 173-189.
- Åström, M., Lundberg, P. & Danell, K. (1990) Partial prey consumption by browsers: trees as patches. *Journal of Animal Ecology*, **59**, 287-300.
- Auger, P. (1990) Dynamics in a hierarchically organized system - biological examples. *Mathematical Computer Modelling*, **14**, 680-685.
- Ayeni, J.S.O. (1975) Utilisation of waterholes in Tsavo National Park (East). *East African Wildlife Journal*, **13**, 305-323.
- Ayeni, J.S.O. (1977) Waterholes in Tsavo National Park, Kenya. *Journal of Applied Ecology*, **14**, 369-378.
- Bailey, D.W. (1995) Daily selection of feeding areas by cattle in homogeneous and heterogeneous environments. *Applied Animal Behaviour Science*, **45**, 183-200.
- Bailey D.W., Dumont B. & WallisDeVries, M.F. (1998) Utilisation of heterogeneous grasslands by domestic herbivores: Theory to management. *Annales de Zootechnie*, **47**, 321-333.
- Bailey, D.W., Gross, J.E., Laca, E.A., Rittenhouse, L.R., Coughenour, M.B., Swift, D.M. & Sims, P.L. (1996) Mechanisms that result in large herbivore grazing distribution patterns. *Journal of Range Management*, **49**, 386-400.
- Bailey, D.W., Rittenhouse, L.R., Hart, R.H. & Richards, R.W. (1989) Characteristics of spatial memory in cattle. *Applied Animal Behaviour Science*, **23**, 331-340.
- Bailey, D.W. & Sims, P.L. (1998) Association of food quality and locations by cattle. *Journal of Range Management*, **51**, 2-8.
- Baird, D.R. (1996) *Predicting East African ungulate diversity from satellite sensor imagery*. Unpublished MRes, University of Edinburgh, Scotland, UK.
- Ball, G.L. & Gimblett, R. (1992) Spatial dynamics emergent hierarchies simulation and assessment system. *Ecological Modelling*, **62**, 107-121.

- Ball, P. (2000) *H₂O A Biography of Water*. Phoenix.
- Balster, H., Braun, P.W. & Kohler, W. (1998) Cellular automata models for vegetation dynamics. *Ecological Modelling*, **107**, 113-125.
- Barker, J.R., Herlocker, D.J. & Young, S.A. (1989) Vegetal dynamics along a grazing gradient within the coastal grassland of central Somalia. *African Journal of Ecology*, **27**, 283-289.
- Bascompte, J. & Solé, R.V. (1998) Spatiotemporal patterns in nature. *Trends in Ecology and Evolution*, **13**, 173-174.
- Beecham, J.A. & Farnsworth, K.D. (1998) Animal foraging from an individual perspective: an object orientated model. *Ecological Modelling*, **113**, 141-156.
- Behrensmeyer, A.K., Todd, N.E., Potts, R. & McBinn, G.E. (2003) Late Pliocene faunal turnover in the Turkana Basin, Kenya and Ethiopia. *Science*, **278**, 1589-1594.
- Bergandi, D. (2000a) Eco-cybernetics: the ecology and cybernetics of missing emergences. *Kybernetics*, **29**, 929-942.
- Bergandi, D. (2000b) "Reductionist Holism": an oxymoron or a philosophical chimera of E.P. Odum's Systems Ecology? In *Science of Synthesis: An Introduction to the Philosophy of Ecology*. Golley, F.B. & Keller, D.R. (eds.). The University of Georgia Press.
- Bergandi, D. & Blandin, P. (1998) Holism vs. reductism: do ecosystem ecology and landscape ecology clarify the debate? *Acta Biotheoretica*, **46**, 185-206.
- Beukes, P.C. & Ellis, F. (2003) Soil and vegetation changes across a Succulent Karoo grazing gradient. *African Journal of Range & Forage Science*, **20**, 11-19.
- Blackshaw, J.K., Allan, D.J. & McGreevy, P. (2003) *Notes on some topics in applied animal behaviour*. School of Veterinary Science, University of Queensland, St. Lucia, Brisbane, Queensland, 4067, Australia. ISBN 0 9592581 0 8.
- Blackwell, P.G. (1997) Random diffusion models for animal movement. *Ecological Modelling*, **100**, 87-102.
- BOA (1981) *Effect of Environment on Nutrient Requirements of Domestic Animals*. Board on Agriculture (BOA), Subcommittee on Environmental Stress, National Research Council. The National Academies Press, pp168.
- Borland (1991) *Turbo C++ 3.1 For Windows: Programmer's Guide*. Borland International. Scott's Valley, CA.
- Borland (1999) *C++ Builder 4 For Windows 95, Windows 98, & Windows NT: Developer's Guide*. Imprise Corporation. Scott's Valley, CA.
- Boroski, B.B. & Mossman, A.S. (1998) Water use patterns of mule deer (*Odocoileus hemionus*) and the effects of human disturbance. *Journal of Arid Environments*, **38**, 561-569.
- Bothma, J. du P. (1996) *Game Ranch Management*. J.L. van Schaik Uitgewers, Pretoria.

- Braack, L. (1997) *A revision of parts of the management plan for the Kruger National Park, Volume VII: An objectives hierarchy for the management of the KNP*. National Parks Board, South Africa.
- Bradbury, J.W., Vehrencamp, S.L., Clifton, K.E. & Clifton, L.M. (1996) The relationship between bite rate and local forage abundance in wild Thomson's Gazelles. *Ecology*, **77**, 2237-2255.
- Briske, D. D. Fuhlendorf, S. D. & Smeins, F. E. (2003) Vegetation dynamics on rangelands: a critique of the current paradigms. *Journal of Applied Ecology*, **40**, 601-614.
- Brits, J., van Rooyan, M.W. & van Rooyan, N. (2002) Ecological impact of large herbivores on the woody vegetation at selected watering points on the eastern basaltic soils in the Kruger National Park. *African Journal of Ecology*, **40**, 53-60.
- Brown, L.E (1966) Home range and movement of small mammals. In *Play, Exploration and Territory in Mammals*. Jewell, P.A. & Loizos, C. (eds.). Symposia of the Zoological Society of London, **18**. Academic Press, New York.
- Brown, B.J. & Allen, T.F.H. (1989) The importance of scale in evaluating herbivory impacts. *Oikos*, **54**, 189-194.
- Brown, J.R. & Stuth, J.W. (1993) How herbivory affects grazing tolerant and sensitive grasses in a central Texas grassland: integrating plant response across hierarchical levels. *Oikos*, **67**, 291-298.
- Buckland, S.T., Anderson, D.R., Burnham, K.P. & Laake, J.L. (1993) *Distance sampling: Estimating abundance of biological populations*. Chapman & Hall, London.
- Buckland, S.T., Burnham, K.P. & Augustin, N.H. (1997) Model selection: an integral part of inference. *Biometrics*, **53**, 603-618.
- Buddenbrock, W.V. (1934) Uber die kinetische and statische Leistung grosser und kleiner Tiere und ihre bedeutung für dem Gesamtstoffweschel (On the kinetic and static abilities of big and small animals and its meaning for the whole metabolism). *Naturwissenschaft*, **22**, 675-680.
- Carter, R.V. & Abrahams, M.V. (1997) Predicting the distribution of organisms among a few patches: Problems with detecting departures from the ideal free distribution. *Oikos*, **78**, 388-393.
- Casaer, J., Hermy, M., Verhagen, R. & Coppin, P. (1999) Appropriateness of the linear correction method for GPS positional fixes in wildlife studies. *Wildlife Biology*, **5**, 125-128.
- Caughley, G. (1979) What is this thing called carrying capacity? In *North American Elk: Ecology, Behaviour and Management*. Boyce, M.S. & Hatdn-Wing, L.D. (eds.). University of Wyoming, Laramie. pp 2-8.
- Charnov, E.L. (1976) Optimal foraging, the marginal value theorem. *Theoretical Population Biology*, **9**, 129-136.

- Chave, J. & Levin, S. (2003) Scale and scaling in ecological and economic systems. *Environmental and Resource Economics*, **26**, 527-557.
- Child, G., Parris, R. & Le Riché, E. (1971) Use of mineralised water by Kalahari wildlife and its effects on habitats. *East African Wildlife Journal*, **9**, 125-142.
- Cid, M.S. & Brizuela, M.A. (1998) Heterogeneity in tall fescue pastures created and sustained by cattle grazing. *Journal of Range Management*, **51**, 644-649.
- Clark, C.W. & Dukas, R. (2003) The behavioral ecology of a cognitive constraint: limited attention. *Behavioral Ecology*, **14**, 151-156.
- Clifford, P., Richardson, S., & Hemon, D.(1989). Assessing the significance of the correlation between 2 spatial processes. *Biometrics*, **45**, 123-134.
- CluttonBrock, T.H., Illius, A.W., Wilson, K., Grenfell, B.T., MacColl, A.D.C. & Albon, S.D. (1997) Stability and instability in ungulate populations: An empirical analysis. *American Naturalist*, **149**, 195-219.
- Coates Palgrave, K. (1996) *Trees of Southern Africa*, 2nd ed. Struik, Cape Town.
- Coe, M.J. Cumming, D.H.M. & Philipson, J. (1976) Biomass and production of large African herbivores in relation to rainfall and primary production. *Oecologia* (Berlin), **22**, 341-354.
- Collinson, R. (1983) Pilanesberg's policy on providing artificial water points for game. Part 4: The implications of providing artificial water points indiscriminately. *Tshomarelo News*, **13**, 17-26.
- Connell, J.H. & Slatyer, R.O. (1977) Mechanisms of succession in natural communities and their role in community stability and organization. *American Naturalist*, **111**, 1119-1144.
- Coomes, D.A., Rees, M. & Turnbull, L. (1999) Identifying aggregation and association in fully mapped spatial data. *Ecology*, **80**, 554-565.
- Cooper, S.M. & Owen-Smith, R.N. (1986) Effects of plant spinescence on large mammalian herbivores. *Oecologia*, **8**, 446-455.
- Coppolillo, P.B. (2001) Central-place analysis and modeling of landscape-scale resource use in an East African agropastoral system. *Landscape Ecology*, **16**, 205-219.
- Cottan, G. & Curtis, J.T. (1956) The use of distance measures in phyto sociological sampling. *Ecology*, **37**, 451-460.
- Coughenour, M.B. (1991) Spatial components of plant-herbivore interactions in pastoral, ranching, and native ungulate ecosystems. *Journal of Range Management*, **44**, 530-542.
- Coughenour, M.B. (1993) *Savanna - Landscape and regional ecosystem model. Users guide*. Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO, USA.
- Cowley, R.A. (2001) *The Effect Of Changing Water Distribution From Linear To Point Source On Vegetation And Soil Following Piping Of An Artesian Bore*

- In A Semi-Arid Mulga Paddock*. Unpublished Ph.D. Thesis, University of Queensland.
- Cowley, R.A. & Rogers, R.W. (1995) Linear vs point water sources: possible effects on vegetation with change over from linear to point water sources in the Mulgalands. Pp. 219-223. In *Ecological research and management in the mulgalands, - conference proceedings*. Page, M.J. & Beutel, T.S. (eds.). Lawes: University of Queensland, Gatton College.
- Cressie, N.A.C. (1993) *Statistics for Spatial Data*. Wiley Series in Probability and Mathematical Statistics, New York.
- Cridland, S. & Stafford Smith, D.M. (1993) *Development and dissemination of design methods for rangeland paddocks which maximise animal production and minimise land degradation*. Department of Agriculture, Kalgoorlie, western Australia, Miscellaneous Publication 42/93, ISSN 0725-847X.
- Cumming, D.H.M. & Cumming, G.S. (2003) Ungulate community structure and ecological processes: body size, hoof area and trampling in African savannas. *Oecologia*, **134**, 560–568.
- Danckwerts, J.E. & Trollope, W.S.W. (1980) Assessment of the disc pasture meter on natural veld in the False Thornveld of the Eastern Province. *Proceedings of the Grassland Society of Southern Africa*, **15**, 47-52.
- Dangerfield, J.M., Perkins, J.S. & Kuanda, S.K. (1996) Shoot characteristics of *Acacia tortilis* (Forsk.) in wildlife and rangeland habitats of Botswana. *African Journal of Ecology*, **34**, 167-176.
- Danley, P.D. & Kocher, T.D. (2001) Speciation in rapidly diverging systems: lessons from Lake Malawi. *Molecular Ecology*, **10**, 1075–1086.
- Darwin, C. (1859) *The Origin of Species by means of Natural Selection; or, the Preservation of Favoured Races in the Struggle for Life*. John Murray, London.
- Dean, W.R.J., Hoffman, M.T., Meadows, M.E. & Milton, S.J. (1995) Desertification in the semi-arid Karoo, South Africa: review and assessment. *Journal of Arid Environments*, **30**, 247-264.
- Dean W.R.J. & MacDonald, I.A.W. (1994) Historical changes in stocking rates of domestic livestock as a measure of semi-arid and arid rangeland degradation in the Cape Province, South Africa. *Journal of Arid Environments*, **26**, 281-298.
- de Leeuw, J., Waweru, M.N., Okello, O.O., Maloba, M., Nguru, P., Said, M.Y., Aligula, H.M., Heitkönig, I.M.A. & Reid, R. (2001) Distribution and diversity of wildlife in northern Kenya in relation to livestock and permanent water points. *Biological Conservation*, **100**, 297-306.
- Derry, J.F. (1998) Modelling ecological interaction despite object-oriented modularity. *Ecological Modelling*, **107**, 145-158.
- Derry, J.F., Morris, C.D. & Zacharias, P.J.K. (1998) *MLE*. Department of Range and Forage Resources, University of Natal, Pietermaritzberg, SA.

- Desta, S. & Coppock, D.L. (2002) Cattle population dynamics in the southern Ethiopian rangelands, 1980–97. *Journal of Range Management*, **55**, 439-451.
- Detling, J.K. (1998) Mammalian herbivores: ecosystem-level effects in two grassland national parks. *Wildlife Society Bulletin*, **26**, 438-448.
- Dolman, P.M. & Sutherland, W.J. (1997) Spatial patterns of depletion imposed by foraging vertebrates: theory, review and meta-analysis. *Journal of Animal Ecology*, **66**, 481-494.
- du Toit, J.T. (1990) Regrowth and palatability of Acacia shoots following pruning by African savanna browsers. *Ecology*, **71**, 149-154.
- Dumont, B. & Boissy, A. (1999) Impact of social on grazing behaviour in herbivores. *Productions Animales*, **12**, 3-10.
- Dunning, J.B., Stewart, D.J., Danielson, B.J., Noon, B.R., Root, T.L., Lamberson, R.H. & Stevens, E.E. (1995) Spatially explicit population models: current forms and future uses. *Ecological Applications*, **5**, 3-11.
- Duraiappah, A.K. & Perkins, J.S. (1999) *Sustainable Livestock Management in the Kalahari: An Optimal Livestock Rangeland Model (OLR)*. CREED Reports WP23. IIED, IVM. 27pp.
- Dutilleul, P. (1993). Modifying the t-test for assessing the correlation between 2 spatial processes. *Biometrics*, **49**, 305-314.
- Dutilleul, P. (1998a) Incorporating scale in ecological experiments: Study design. In *Ecological Scale: Theory and Applications*. Peterson, D.L. & Parker, V.T. (eds.). Complexity In Ecological Systems. Columbia University Press, NY.
- Dutilleul, P. (1998b) Incorporating scale in ecological experiments: Data analysis. In *Ecological Scale: Theory and Applications*. Peterson, D.L. & Parker, V.T. (eds.). Complexity In Ecological Systems. Columbia University Press, NY.
- Dye, P.J. & Spear, P.T. (1982) The effects of bush clearing and rainfall variability on grass yield and composition in South-West Zimbabwe. *Zimbabwe Journal of Agricultural Research*, **20**, 103-118.
- Dye, P.J. & Walker, B.H. (1987) Patterns of shoot growth in a semi-arid grassland in Zimbabwe. *Journal of Applied Ecology*, **24**, 633-644.
- Eberhardt, L.L. (1969) Similarity, allometry and food chains. *Journal of Theoretical Biology*, **24**, 43-55.
- Edwards, G.R., Newman, J.A., Parsons, A.J. & Krebs, J.R. (1994) Effects of the scale and spatial distribution of the food resource and animal state on diet selection: an example with sheep. *Journal of Animal Ecology*, **63**, 816-826.
- Edwards, G.R., Newman, J.A., Parsons, A.J. & Krebs, J.R. (1996) The use of spatial memory by grazing animals to locate food patches in spatially heterogeneous environments: an example with sheep. *Applied Animal Behaviour Science*, **50**, 147-160.
- Edwards, G.R., Newman, J.A., Parsons, A.J. & Krebs, J.R. (1997) Use of cues by grazing animals to locate food patches: an example with sheep. *Applied Animal Behaviour Science*, **51**, 59-68.

- Ellis, J.E., Coughenour, M.B. & Swift, D.M. (1993) Climate variability, ecosystem stability and the implications for range and livestock development. Pp1-30. In *Range Ecology at Disequilibrium*. Behnke, R.H., Scoones, I. & Kerven, C. (eds). London: ODI.
- Ellis, J.E. & Swift, D.M. (1988). Stability of African pastoral ecosystems: alternate paradigms and implications for development. *Journal of Range Management*, **41**, 450-459.
- Elston, D.A. (1998) Estimation of denominator degrees of freedom of F-distributions for assessing Wald statistics for fixed-effect factors in unbalanced mixed models. *Biometrics*, **54**, 1085-1096.
- Eltringham, S.K. (1984) *Wildlife Resources and Economic Development*. John Wiley & Sons Ltd, Norwich.
- Eriksson, L., Hydbring, E., Tuomisto, L., MacDonald, E., Kokkonen, U.-M. & Olsson, K. (1994) Intraruminal fluid administration to goats: Effects of handling and fluid temperature. *Acta Veterinaria Scandinavica*, **35**, 289-298.
- Ermentrout, B & Lewis, M. (1997) Pattern formation in systems with one spatially distributed species. *Bulletin of Mathematical Biology*, **59**, 533-549.
- ESRI (1998) ARCVIEW GIS version 3.1. Environmental Systems Research Institute.
- Estes, R.D. (1991) *The Behavior Guide to African Mammals*. University of California Press.
- Etzenhouser, M.J., Owens, M.K., Spalinger, D.E. & Murden, S.B. (1998) Foraging behaviour of browsing ruminants in a heterogeneous landscape. *Landscape Ecology*, **13**, 55-64.
- FAO. (1987) Committee on Agriculture (Ninth session). Improving Productivity of Dryland Areas. FAO, Rome.
- Farnsworth, K.D. (1996) Spatial data and analysis for models of animal ranging behaviour. In *Modelling in Applied Biology: Spatial Aspects*. Aspects of Applied Biology, 46. E.M. White, L.R. Benjamin, P. Brain, P.J.C. Hamer, M.A. Mugglestone, G. Russell & C.F.E. Topp (eds). The Association of Applied Biologists, c/o Horticulture Research International, Wellesbourne, Warwick.
- Farnsworth, K.D. & Beecham, J.A. (1999) How do grazers achieve their distribution? A continuum of models from random diffusion to the Ideal Free Distribution using biased random walks. *American Naturalist*, **153**, 509-526.
- Farnsworth, K.D. & Illius, A.W. (1996) Large grazers back from the fold: generalising the prey model to incorporate mammalian herbivores. *Functional Ecology*, **10**, 678-680.
- Farnsworth, K.D. & Illius, A.W. (1998) Optimal diet choice for large herbivores: an extended contingency model. *Functional Ecology*, **12**, 74-81.
- Fauchald, P. (1999) Foraging in a hierarchical patch system. *American Naturalist*, **153**, 603-613.

- Fernandez-Gimenez, M.E. & Allen-Diaz, B. (1999) Testing a non-equilibrium model of rangeland vegetation dynamics in Mongolia. *Journal of Applied Ecology*, **36**, 871-885.
- Fernandez-Gimenez, M.E. & Allen-Diaz, B. (2001) Vegetation change along gradients from water sources in three grazed Mongolian ecosystems. *Plant Ecology*, **157**, 101-118.
- Foran, B.D. (1980) Change in range condition with distance from watering points and its implications for field survey. *Australian Rangeland Journal*, **2**, 59-66.
- Forcadi, S., Marcellini, P. & Montanaro, P. (1996) Do ungulates exhibit a food density threshold? A field study of optimal foraging and movement patterns. *Journal of Animal Ecology*, **65**, 606-620.
- Ford, R.G. (1983) Home range in a patchy environment - Optimal foraging predictions. *American Zoologist*, **23**, 315-326.
- Fortin, D. (2001) An adjustment of the extended contingency model of Farnsworth & Illius (1998). *Functional Ecology*, **15**, 135-139.
- Fortin, D., Fryxell, J.M. & Pilote, R. (2002) The temporal scale of foraging decisions in bison. *Ecology*, **83**, 970-982.
- Freeland, S.J. (2002) The Darwinian genetic code: an adaptation for adapting? *Genetic Programming and Evolvable Machines*, **3**, 113-127.
- Fretwell, S.D. & Lucas, H.L., Jr. (1970) On territorial behaviour and other factors influencing habitat distribution in birds. I. Theoretical development. *Acta Biotheoretica*, **19**, 16-36.
- Friedel, M.H. (1988) The development of veld assessment in the Northern Transvaal Savanna. II. Mixed bushveld. *Journal of the Grassland Society of southern Africa*, **5**, 55-63.
- Friedel, M.H. (1990) Where the creeks run dry or ten feet high: pastoral management in arid Australia. *Proceedings of the Ecological Society of Australia*, **16**, 185-194.
- Friedel, M.H., Chewings, V.H., & Bastin, G.N. (1988) The use of comparative yield and dry-weight rank techniques for monitoring arid rangelands. *Journal of Range Management*, **41**, 430-434.
- Fritz, H. & de Garine-Wichatitsky, M. (1996) Foraging in a social antelope: effects of group size on foraging choices and resource perception in impala. *Journal of Animal Ecology*, **65**, 736-742.
- Fritz, H., de Garine-Wichatitsky, M. & Letessier, G. (1996) Habitat use by sympatric wild and domestic herbivores in an African savanna woodland: the influence of cattle spatial behaviour. *Journal of Applied Ecology*, **33**, 589-598.
- Fritz, H. & Duncan, P. (1994) On the carrying capacity for large ungulates of African savanna ecosystems. *Proceedings of the Royal Society of London*, **256**, 77-82.
- Fryxell, J.M. (1998) Functional responses to resource complexity: an experimental analysis of foraging by beavers. In *Herbivores: Between Plants and*

- Predators*, pp 371-396. Olff, H., Brown, V.K. & Drent, R.H. (eds.). Blackwell Science, Oxford.
- Fryxell, J.M., Fortin, C.B.D. & Wilmschurst, J. (2001) *On the scale dependence of foraging in terrestrial herbivores*. XIX International Grasslands Congress, San Paulo, Brazil, February 2001.
- Fryxell, J.M., Hussell, D.J.T., Lambert, A.B. & Smith, P.C. (1991) Time lags and population fluctuations in White-tailed deer. *Journal of Wildlife Management*, **55**, 377-385.
- Funston, P.J., Skinner, J.D. & Dott, H.M. (1994) Seasonal variation in movement patterns, home range and habitat selection of buffaloes in a semi-arid habitat. *African Journal of Ecology*, **32**, 100-114.
- Gadd, M. E., Young, T. P. & Palmer, T. M. (2001) Effects of simulated shoot and leaf herbivory on vegetative growth and plant defense in *Acacia drepanolobium*. *Oikos*, **92**, 515-521.
- Gamma Design (1999) *GS+ Geostatistics for the Environmental Sciences* [online], version 3.11.12 Professional Edition. Gamma Design Software. Available from: <http://www.gammadesign.com/> [Accessed 18/01/2004].
- Ganskopp, D., Cruzb, R. & Johnson, D.E. (2000) Least-effort pathways?: a GIS analysis of livestock trails in rugged terrain. *Applied Animal Behaviour Science*, **68**, 179-190.
- Gardner, M. (1971) Mathematical games. *Scientific American*, **224**, 112-117.
- Gause, G.F. (1934) *The Struggle for Existence* [online]. Williams & Wilkins, Baltimore. (Reprinted in 1969 by Hafner, New York) Available from: <http://www.ggause.com/Contgau.htm> [Accessed 18/01/2004].
- Gaylard, A., Owen-Smith, R.N. & Redfern, J. (2003) Surface water availability: Implications for heterogeneity and ecosystem processes. In *The Kruger Experience: Ecology and Management of Savanna Heterogeneity*. du Toit, J.T., Rogers, K.H. & Biggs, H.C. (eds.). Island Press, Washington.
- GENSTAT 5 Committee (1993) *Genstat 5, release 3, reference manual*. Oxford University Press, Oxford, UK.
- GENSTAT 5 Committee (1996) *Genstat 5 release 3.2 Second Edition*. Copyright 1996. Lawes Agricultural Trust (IACR - Rothamsted).
- GENSTAT 7 Committee (2003) *Genstat 7 release 1*. Copyright 2003. Lawes Agricultural Trust (IACR - Rothamsted).
- Georgiadis, N.J. (1987) *Responses of savanna grasslands to extreme use by pastoralist livestock*. PhD dissertation, Syracuse University, New York.
- Gibb, M.J. & Ridout, M.S. (1986) The fitting of frequency distributions to height measurements on grazed swards. *Grass and Forage Science*, **41**, 247-249.
- Ginnett, T.F. & Demment, M.W. (1999) Sexual segregation by Masai giraffes at two spatial scales. *African Journal of Ecology*, **37**, 93-106.

- Glantz, M.H. (1977) Water and inappropriate technology: deep wells in the Sahel. In *Water Needs for the Future*. (V.P. Nanda ed.) pp305-318. Westview Press, Boulder, Colorado.
- Goldstein, P.Z. (1999) Functional ecosystems and biodiversity buzzwords. *Conservation Biology*, **13**, 247-255.
- Goodman, P.S. (1982) *The dilemma of artificial water points in Mkuzi Game Reserve*. Unpublished report.
- Gordon, I.J. (2003) Browsing and grazing ruminants: are they different beasts? *Forest Ecology and Management*, **181**, 13-21.
- Gordon, I.J. & Illius, A.W. (1988) Incisor arcade structure and diet selection in ruminants. *Functional Ecology*, **2**, 15-22.
- Gordon, I.J. & Illius, A.W. (1996) The nutritional ecology of African ruminants: a reinterpretation. *Journal of Animal Ecology*, **65**, 18-28.
- Goudie, A.S. & Thomas, D.S.G. (1985) Pans in southern Africa with particular reference to South Africa and Zimbabwe. *Zeitschrift für Geomorphologie*, **29**, 1-19.
- Gowda, J.H. (1996) Spines of *Acacia tortilis*: what do they defend and how? *Oikos*, **77**, 279-284.
- Graetz, R.D. & Ludwig, J.A. (1978) A method for the analysis of piosphere data applicable to range assessment. *Australian Rangeland Journal*, **1**, 126-136.
- Gray, R.D. & Kennedy, M. (1994) Perceptual constraints on optimal foraging: a reason for departures from the ideal free distribution? *Animal Behaviour*, **47**, 469-471.
- Gross, J.E., Shipley, L.A., Hobbs, N.T., Spalinger, D.E. & Wunder, B.A. (1993) Functional response of herbivores in food-concentrated patches: tests of a mechanistic model. *Ecology*, **74**, 778-791.
- Gross, J.E., Zank, C., Hobbs, N.T. & Spalinger, D.E. (1995) Movement rules for herbivores in spatially heterogeneous environments: responses to small scale patterns. *Landscape Ecology*, **10**, 209-217.
- Grünbaum, D. (1998) Using spatially explicit models to characterize foraging performance in heterogeneous landscapes. *American Naturalist*, **151**, 97-115.
- Haase, P. (1995) Spatial pattern-analysis in ecology based on Ripley K-function - introduction and methods of edge correction. *Journal of Vegetation Science*, **6**, 575-582.
- Hamilton, A.G. (1992) *Linear Algebra*. Cambridge University Press. 2nd edition.
- Hanan, N.P., Prevost, Y., Diouf, A. & Diallo, O. (1991) Assessment of desertification around deep wells in the Sahel using satellite imagery. *Journal of Applied Ecology*, **28**, 173-186.
- Harestad, A.S. & Bunnell, F.L. (1979) Home range and body weight - a reevaluation. *Ecology*, **60**, 389-402.

- Harrington, R. (2002) *The effects of artificial watering points on the distribution and abundance of avifauna in an arid and semi-arid mallee environment*. Unpublished Ph.D. Thesis, University of Melbourne.
- Harris, A.T. & Asner, G.P. (2003) Grazing gradient detection with airborne imaging spectroscopy on a semi-arid rangeland. *Journal of Arid Environments*, **55**, 391-404.
- Haschick, S.L. & Kerley, G.I.H. (1997) Browse intake rates by bushbuck (*Tragelaphus scriptus*) and boergoats (*Capra hircus*). *African Journal of Ecology*, **35**, 146-155.
- Haskell, J.P., Ritchie, M.E. & Olff, H. (2002) Fractal geometry predicts varying body size scaling relationships for mammal and bird home ranges. *Nature*, **418**, 527-530.
- Hassan, G.A., El-Nouty, F.D. & Salem, M.H. (1989) Water requirements and metabolism during pregnancy in sheep and goats. *Indian Journal of Animal Sciences*, **59**, 40-46.
- Heitkönig, I.M.A. & Owen-Smith, R.N. (1998) Seasonal selection of soil types and grass swards by Roan antelope in a South African savanna. *African Journal of Ecology*, **36**, 57-70.
- Heshmatti G.A., Facelli J.M. & Conran J.G. (2002) The piosphere revisited: plant species patterns close to waterpoints in small, fenced paddocks in chenopod shrublands of South Australia. *Journal of Arid Environments*, **51**, 547-560.
- Hester, A.J., Gordon, I.J., Baillie, G.J. & Tappin, E. (1999) Foraging behaviour of sheep and red deer within natural heather grass mosaics. *Journal of Applied Ecology*, **36**, 133-146.
- Hewitson, L. (2002) *The foraging behaviour of sheep in response to environmental uncertainty*. Unpublished PhD Thesis, University of Edinburgh.
- HilleRisLambers, R., Rietkirk, M., Van den Bosch, F., Prins, H.H.T. & de Kroon, H. (2001) Vegetation pattern formation in semi-arid grazing systems. *Ecology*, **82**, 50-61.
- Hitchcock, D. (1996) Wildlife observed in Kutse Game Reserve, Botswana, at pans with either artificial or natural water sources. *African Journal of Ecology*, **34**, 70-74.
- Hobbs, N.T., Gross, J.E., Shipley, L.A., Spalinger, D.E. & Wunder, B.A. (2003) Herbivore functional response in heterogeneous environments: A contest among models. *Ecology*, **84**, 666-681.
- Hodgins, I.W. & Rogers, R.W. (1997) Correlations of stocking with the cryptogamic soil crust of a semi-arid rangeland in southwest Queensland. *Australian Journal of Ecology*, **22**, 425-431.
- Hodgson, J. (1985) The control of herbage intake in the grazing ruminant. *Proceedings of the Nutrition Society*, **44**, 339-346.
- Holling, C. S. 1959. Some characteristics of simple types of predation and parasitism. *Canadian Entomologist*, **91**,385-398.

- Hooge, P.N. & Eichenlaub, B. (1997) *Animal movement extension to Arcview* [online] ver. 1.1. Alaska Science Center - Biological Science Office, U.S. Geological Survey, Anchorage, AK, USA. Available from: <http://www.absc.usgs.gov/giba/gistools/index.htm> [Accessed 18/01/2004].
- Hossaini-Hilali, J., Benlamlih, S. & Dahlborn, K. (1993) Fluid balance and milk secretion in the fed and feed-deprived black Moroccan goat. *Small Ruminant Research*, **12**, 271-285.
- Hossaini-Hilali, J., Benlamlih, S. & Dahlborn, K. (1994) Effects of dehydration, and hyperhydration in the lactating and non-lactating black Moroccan goat. *Comparative Biochemistry and Physiology. A: Comparative Physiology*, **109A**, 1017-1026.
- Hosten, P.E. & West, N.E. (1995) *Using a piosphere approach to examine change in sagebrush steppe plant communities along gradients of livestock impact in North Laidlaw Park, Idaho*. Fifth International Rangeland Congress, Salt Lake City, Utah, July 23-28, 1995.
- Hosty, M. & Mulqueen, J. (1996) Soil moisture and groundwater drawdown in a dry grassland soil. *Irish Journal of Agricultural and Food Research*, **35**, 17-24.
- Howery, L.D., Bailey, D.W., Ruyle, G.B. & Renken, W.J. (2000) Cattle use visual cue to track food locations. *Applied Animal Behaviour Science*, **67**, 1-14.
- Howery, L.D., D.W. Bailey, G.B. Ruyle & W.J. Renken. (1999) *Can cattle use artificial visual cues to track food locations?* Abstr. 52nd Annual Mtg. Soc. Range Manage.
- Hsi, J.P., Carter, J.P. & Small, J.C. (1994) Surface subsidence and drawdown of the water table due to pumping. *Geotechnique*, **44**, 381-396.
- Hudson, R.J. (1985) Body size, energetics and adaptive radiation. In *Bioenergetics of Wild Herbivores*. Hudson, R.J. & White, R.G. (eds.). CRC Press, Inc. Florida.
- Huenneke, L.F., Clason, D. & Muldavin, E. (2001) Spatial heterogeneity in Chihuahuan desert vegetation: implications for sampling methods in semi-arid ecosystems. *Journal of Arid Environments*, **47**, 257-270.
- Hunt, L.P. (2001a) Heterogeneous grazing causes local extinction of edible perennial shrubs: a matrix analysis. *Journal of Applied Ecology*, **38**, 238-252.
- Hunt, L.P. (2001b) Low seed availability may limit recruitment in grazed *Atriplex vesicaria* and contribute to its local extinction. *Plant Ecology*, **157**, 53-67.
- Hunter, J.S. (1986) The exponentially weighted moving average. *Journal of Quality Technology*, **18**, 203-210.
- Hunter, M.D. & Price, P.W. (1992) Playing chutes and ladders: heterogeneity and the relative roles of bottom-up and top-down forces in natural communities. *Ecology*, **73**, 724-732.
- Huntley, B.J. (1982) Southern African Savannas. In *Ecology of Tropical Savannas*. Huntley, B.J. & Walker, B.H. (eds.). Springer-Verlag.
- Hutchings, N.J. & Gordon, I.J. (2001) A dynamical model of herbivore-plant interactions on grasslands. *Ecological Modelling*, **136**, 209-222.

- Hutson, G.D. (2000) Behavioural principles of sheep handling. In *Livestock Handling and Transport*. 2nd edition. Grandin, T. (ed.). CAB International.
- IEA (2000) *African Mammals Databank IEA* [online]. Istituto di Ecologia Applicata. European Commission Directorate-General for Development Division VIII/A/1. Available from: <http://gorilla.bio.uniroma1.it/amd/index.htm> [Accessed 18/01/2004].
- Illius, A.W. (*in prep.*) Linking functional responses and foraging behaviour to population dynamics. In *Large Herbivore Ecology and Ecosystem Dynamics*. Danell, K. & Pastor, J. (eds.). Blackwells.
- Illius, A.W., Derry, J.F. & Gordon, I.J. (1996a) *Components, processes and dynamics of semi-arid grazing systems. A review of current knowledge*. Report to NRI. University of Edinburgh. pp 46.
- Illius, A.W., Derry, J.F. & Gordon, I.J. (1996b) *Modelling the dynamics of semi-arid grazing systems*. Report to NRI. University of Edinburgh. pp 64.
- Illius, A.W., Derry, J.F. & Gordon, I.J. (1998) Evaluation of strategies for tracking climatic variation in semi-arid grazing systems. *Agricultural Systems*, **57**, 381-398.
- Illius, A.W., Derry, J.F. & Gordon, I.J. (2000) Evaluation of strategies for tracking climatic variation in semi-arid grazing systems (vol 57, pg 381, 1998). *Agricultural Systems*, **63**, 73-74.
- Illius, A.W., Duncan, P., Richard, C. & Mesochina, P. (2002) Mechanisms of functional response and resource exploitation in browsing roe deer. *Journal of Animal Ecology*, **71**, 723-734.
- Illius, A.W. & Fitzgibbon, C. (1994) Costs of vigilance in foraging ungulates. *Animal Behaviour*, **47**, 481-484.
- Illius, A.W. & Gordon, I.J. (1987) The allometry of food intake in grazing ruminants. *Journal of Animal Ecology*, **56**, 989-999.
- Illius, A.W. & Gordon, I.J. (1991) Prediction of intake and digestion in ruminants by a model of rumen kinetics integrating animal size and plant characteristics. *Journal of Agricultural Science*, **116**, 145-157.
- Illius, A.W. & Gordon, I.J. (1992) Modelling the nutritional ecology of ungulate herbivores: evolution of body size and competitive interactions. *Oecologia*, **89**, 428-434.
- Illius, A.W. & Gordon, I.J. (1993) Diet selection in mammalian herbivores: Constraints and tactics. In *Diet Selection: An Interdisciplinary Approach to Foraging Behaviour*. Hughes, R.N. (ed.). Blackwell Scientific Publications.
- Illius, A.W. & Gordon, I.J. (1999) Scaling up from functional response to numerical response in vertebrate herbivores. In *Herbivores: Between Plants and Predators*. Olff, H., Brown, V.K. & Drent, R.H. (eds.). Blackwell Science.
- Illius, A.W., Gordon, I.J., Elston, D.A. & Milne, J.D. (1999) Diet selection in goats: a test of intake-rate maximization. *Ecology*, **80**, 1008-1018.

- Illius, A.W. & O'Connor, T.G. (1999) On the relevance of nonequilibrium concepts to arid and semiarid grazing systems. *Ecological Applications*, **9**, 798-813.
- Illius, A.W. & O'Connor, T.G. (2000) Resource heterogeneity and ungulate population dynamics. *Oikos*, **89**, 283-294.
- Illius, A.W., Wood-Gush, D.G.M. & Eddison, J.C. (1987) A study of the foraging behaviour of cattle grazing patchy swards. *Biological Behaviour*, **12**, 33-44.
- ISI (2002) *ISI Web of Knowledge* [online]. Thomson ISI. Available from: <http://wos.mimas.ac.uk/> [Accessed 18/01/2004].
- Jarman, P.J. (1972) The use of drinking sites, wallows and salt licks by herbivores in the flooded Middle Zambezi Valley. *East African Wildlife Journal*, **10**, 193-209.
- James, C.D., Landsberg, J. & Morton, S.R. (1999) Provision of watering points in the Australian arid zone: a review of effects on biota. *Journal of Arid Environments*, **41**, 87-121.
- Janis, C.M. (1989) A climatic explanation for patterns of evolutionary diversity in ungulate mammals. *Palaeontology*, **32**, 463-481.
- Janis, C.M., Damuth, J. & Theodor, J.M. (2002) The origins and evolution of the North American grassland biome: the story from the hoofed mammals. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **177**, 183-198.
- Jeltsch, F., Milton, S.J., Dean, W.R.J. & Van Rooyen, N. (1996) Tree spacing and coexistence in semiarid savannas. *Journal of Ecology*, **84**, 583-595.
- Jeltsch, F., Milton, S.J., Dean, W.R.J. & Van Rooyen, N. (1997) Simulated pattern formation around artificial waterholes in the semi-arid Kalahari. *Journal of Vegetation Science*, **8**, 177-188.
- Jongman, R.H.G., Ter Braak, C.J.F. & van Tongeren, O.F.R. (1995) *Data Analysis in Community and Landscape Ecology*. Cambridge University Press.
- Kalikawa, M.C. (1990) Baseline vegetation description at artificial watering points of Central Kalahari Game Reserve. *African Journal of Ecology*, **28**, 253-256.
- Karban, R., Agrawal, A.A., Thaler, J.S. & Adler, L.S. (1999) Induced plant responses and information content about risk of herbivory. *Trends in Ecology and Evolution*, **14**, 443-47.
- Kareiva, P. (1994) Space: The final frontier for ecological theory. *Ecology*, **75**, 1.
- Kay, R.N.B. (1997) Responses of African livestock and wild herbivores to drought. *Journal of Arid Environments*, **37**, 683-694.
- Kelly, R.D. & Walker, B.H. (1976) The effects of different forms of land use on the ecology of a semi-arid region of south eastern Rhodesia. *Journal of Ecology*, **64**, 553-576.
- Kennedy, M. & Gray, R.D. (1997) Habitat choice, habitat matching and the effect of travel distance. *Behaviour*, **134**, 905-920.
- Khan, M.S. & Ghosh, P.K. (1983) Body water turnover in Indian desert mammals. *Journal of Arid Environments*, **6**, 173-175.

- Khan, M.S., Sasidharan, T.O. & Ghosh, P.K. (1978) Water economy of the Barmer goat of the Rajasthan desert. *Journal of Arid Environments*, **1**, 351-355.
- Kiker, G.A. (1998) *Development and comparison of savanna ecosystem models to explore the concept of carrying capacity*. PhD Thesis, Department of Agricultural and Biological Engineering, Cornell University, Ithaca, New York.
- King, J.M. (1983) *Livestock water needs in pastoral Africa in relation to climate and forage*. ILCA Research Report No. 7. Addis Ababa: International Livestock Centre for Africa. 95pp.
- Kingdon, J. (1997) *Kingdon Field Guide to African Mammals*. Academic Press.
- Klopfer, P.H. (1969) *Habitats and Territories: A Study of the Use of Space by Animals*. Basic Books, Inc., N.Y., London.
- Knight, M.H. (1995a) Tsama melons, *Citrullus lanatus*, a supplementary water supply for wildlife in the southern Kalahari. *African Journal of Ecology*, **33**, 71-80.
- Knight, M.H. (1995b) Drought-related mortality of wildlife in the southern Kalahari and the role of man. *African Journal of Ecology*, **33**, 377-394.
- KNP (1997) *Biodiversity workshop*, Skukuza, Kruger National Park, South Africa, 11-13 February, 1997.
- Knoop, W.T. & Walker, B.H. (1985) Interactions of woody and herbaceous vegetation in southern African savanna. *Journal of Ecology*, **73**, 235-253.
- Koenig, W. (1999) Spatial autocorrelation of ecological phenomena. *Trends in Ecology and Evolution*, **14**, 22-26.
- Kotliar, N.B. & Weins, J.A. (1990) Multiple spatial scales of patchiness and patch structure: a hierarchical framework for the study of heterogeneity. *Oikos*, **59**, 253-260.
- Krebs, F. & Bossel, H. (1997) Emergent value orientation in self-organization of an animat. *Ecological Modelling*, **96**, 143-164.
- Krink, T. & Vollrath, F. (1998) Emergent properties in the behaviour of a virtual spider robot. *Proceedings of the Royal Society, London B*, **265**, 2051-2055.
- Laca, E.A. & Demment, M.W. (1991) Herbivory: the dilemma of foraging in a spatially heterogeneous food environment. Pp. 29-44. In *Plant defenses against mammalian herbivory*. PALO, R.T. & ROBBINS, C.T. (eds). Boca Raton, Florida: CRC Press.
- Laca, E.A. & Ortega, I.M. (1996) Integrating foraging mechanisms across spatial and temporal scales. In *Proceedings of the Fifth International Rangeland Congress, Society for Range Management*, West, N.E. (ed.), Salt Lake City, Utah, July 23-28, 1995, pp. 129-132.
- Laca, E.A., Ungar, E.D. & Demment, M.W. (1994) Mechanisms of handling time and intake rate of a large mammalian grazer. *Applied Animal Behavioural Science*, **39**, 3-19.

- Lachica, M., Somio, R., Barroso, F.G., Boza, J. & Prieto, C. (1999) Goats locomotion energy expenditure under range grazing conditions. *Journal of Range Management*, **52**, 431-435.
- Lailhacar, S., Mansilla, A., Faundez, L. & Tonini, P. (1993) The piosphere effect of a goat corral on the productivity of arid mediterranean-type rangelands in northern Chile. *Proceedings of the XVII International Grassland Congress*, **17**, 73-75.
- Lamprey, H.F. (1963) Ecological separation of the large mammal species in the Tarangire Game Reserve, Tanganyika. *East African Wildlife Journal*, **1**, 63-92.
- Landsberg, J., James, C.D., Morton, S.R., Hobbs, T.J., Stol, J., Drew, A. & Tongway, H. (1997) *The effects of artificial sources of water on rangeland biodiversity*. CSIRO Wildlife and Ecology, Biodiversity Technical Paper, No.3. ISBN 0 642 27010 4.
- Lange, H. (1999) Are Ecosystems Dynamical Systems? *International Journal of Computing Anticipatory Systems*, **3**, 169-186.
- Lange, R.T. (1969) The piosphere, sheep track and dung patterns. *Journal of Range Management*, **22**, 396-400.
- Lange, R.T. & Willcocks, M.C. (1978) The relation between sheep-time spent and egesta accumulated within an arid zone paddock. *Australian Journal of Experimental Agriculture and Animal Husbandry*, **18**, 764-767.
- Langvatn, R. & Hanley, T.A. (1996) Feeding-patch choice by red deer in relation to foraging efficiency - an experiment. *Oecologia*, **95**, 164-170.
- Legendre, P. (1993). Spatial autocorrelation - trouble or new paradigm. *Ecology*, **74**, 1659-1673.
- Levin, S.A. & Pacala, S.W. (1997) Theories of simplification and scaling of spatially distributed processes. In *Spatial Ecology: The Role of Space in Population Dynamics and Interspecific Interactions*. Tilman, D. & Kareiva, P.M. (eds.). Monographs In Population Biology, Princeton University Press.
- Lewis, M. (1994) Spatial coupling of plant and herbivore dynamics: the contribution of herbivore dispersal to transient and persistent "waves" of damage. *Theoretical Population Biology*, **45**, 277-312.
- Li, B.L. (2000) Why is the holistic approach becoming so important in landscape ecology? *Landscape and Urban Planning*, **50**, 27-41.
- Li, H. & Reynolds, J.F. (1995) On definition and quantification of heterogeneity. *Oikos*, **73**, 280-284.
- Lind, M., Rasmussen, K., Adriansen, H. & Ka, A. (2003) Estimating vegetative productivity gradients around watering points in the rangelands of Northern Senegal based on NOAA AVHRR data. *Geografisk Tidsskrift - Danish Journal of Geography*, **103**, 1-15.

- Louw, G.N. (1970) Physiological adaptation as a criterion in planning production from wild ungulates. *Proceedings of the South African Society of Animal Production*, **9**, 53-56.
- Loza, H.J., Grant, W.E., Stuth, J.W. & Forbes, T.D.A. (1992) Physiologically based landscape use model for large herbivores. *Ecological Modelling*, **61**, 227-252.
- MacFarlane, W.V. & Howard, B. (1972) Comparative water and energy economy of wild and domestic mammals. *Symposia of the Zoological Society of London*, **31**, 261-296.
- Maestre, F.T., Cortina, J., Bautista, S., Bellot, J. & Vallejo, R. (2003) Small-scale environmental heterogeneity and spatiotemporal dynamics of seedling establishment in a semiarid degraded ecosystem. *Ecosystems*, **6**, 630-643.
- Makhabu, S.W., Marotsi, B. & Perkins, J.S. (2002) Vegetation gradients around artificial water points in the Central Kalahari Game Reserve of Botswana. *African Journal of Ecology*, **40**, 103-109.
- Maltz, E., Silanikove, N. & Shkolnik, A. (1982) Energy costs and water requirement of black Bedouin goats at different levels of production. *Journal of Agricultural Science, Cambridge*, **98**, 499-504.
- Martin, P. & Bateson, P. (1993) *Measuring Behaviour*. 2nd edition. Cambridge University Press.
- Mazor, E. (1982) Rain recharge in the Kalahari - a note on some approaches to the problem. *Journal of Hydrology*, **55**, 137-144.
- McDonald, P., Edwards, R.A & Greenhalgh, J.F.D. (1977) *Animal Nutrition*. 2nd edition. Longman, London & N.Y.
- McDowell, R.E. (1972) *Improvement of livestock production in warm climates*. W.H. Freeman & Co., San Francisco.
- Moleele, N.M. (1994) *Ecological change and piospheres: Can the classical range succession model and its modification explain changes in vegetation and soil around boreholes in eastern Botswana?* Unpublished MSc. Thesis, University of Canberra.
- Moleele, N.M. & Perkins, J.S. (1998) Encroaching woody plant species and boreholes: is cattle density the main driving factor in the Olifants Drift communal grazing lands, south-eastern Botswana? *Journal of Arid Environments*, **40**, 245-253.
- Mordelet, P., Menaut, J-C. & Mariotti, A. (1997) Tree and grass rooting patterns in an African humid savanna. *Journal of Vegetation Science*, **8**, 65-70.
- Morgan, R.A., Brown, J.S. & Thorson, J.M. (1997) The effect of spatial scale on the functional response of fox squirrels. *Ecology*, **78**, 1087-1097.
- Morris, C.D. (2002) *The influence of environment and livestock grazing on the mountain vegetation of Lesotho*. Unpublished PhD Thesis, UNP, Pietermaritzburg.

- Morris, C.D., Derry, J.F. & Hardy, M.B. (1999) Effect of cattle and sheep grazing on the structure of Highland Sourveld swards in South Africa. *Tropical Grasslands*, **33**, 111-121.
- Morris, D.W. (1992) Scales and costs of habitat selection in heterogeneous landscapes. *Evolutionary Ecology*, **6**, 412-432.
- Mphinyane, W.N. (2001) *Influence of livestock grazing within piospheres under free range and controlled conditions in Botswana*. Unpublished PhD Thesis, University of Pretoria.
- Müller, F. (1998) Gradients in ecological systems. *Ecological Modelling*, **108**, 3-21.
- Müller, F., Hoffmann-Kroll, R. & Wiggering, H. (2000) Indicating ecosystem integrity - theoretical concepts and environmental requirements. *Ecological Modelling*, **130**, 13-23.
- Murray, M.G. (1982) Home range, dispersal and the clan system of impala. *African Journal of Ecology*, **20**, 253-269.
- Murray, M.G. (1991) Maximizing energy retention in grazing ruminants. *Journal Of Animal Ecology*, **60**, 1029-1045.
- Murray, M.G. (1995) Specific nutrient requirements and migration of wildebeest. In *Serengeti II: Dynamics, Management, and Conservation of an Ecosystem*. A.R.E. Sinclair & P. Arcese (eds.). University of Chicago Press. pp231-256.
- Murray, M.G. & Illius, A.W (1996) Multispecies grazing in the Serengeti. In *The ecology and management of grazing systems*. J. Hodgson, & A.W. Illius (eds.). CAB International, Oxon, UK.
- Mysterud, A. (1998) The relative roles of body size and feeding type on activity time of temperate ruminants. *Oecologia*, **113**, 442-446.
- Nagy, K. A. (1987) Field metabolic rate and food requirement scaling in mammals and birds. *Ecological Monographs*, **57**, 111-128.
- Nangula, S. & Oba, G. (2004) Effects of artificial water points on the Oshana ecosystem in Namibia. *Environmental Conservation*, **31**, 47-54.
- Nash, M.S., Jackson, E. & Whitford, W.G. (2003) Soil microtopography on grazing gradients in Chihuahuan desert grasslands. *Journal of Arid Environments*, **55**, 181-192.
- Nash, M.S., Whitford, W.G., de Soyza, A.G., Van Zee, J.W. & Havstad, K.M. (1999) Livestock Activity and Chihuahuan Desert Annual-Plant Communities: Boundary Analysis of Disturbance Gradients. *Ecological Applications*, **9**, 814-823.
- National Security Council (1996) *National Security Council Fact Sheet: U.S. Global Positioning System* [online]. Office of Science and Technology Policy, Washington D.C., USA. Available from: <http://www.navcen.uscg.gov/ftp/GPS/FACTSGPS.PDF> [Accessed 18/01/2004].
- Nicholson, M.C. & Husband, T.P. (1992) Diurnal behavior of the agrimi, *Capra aegagrus*. *Journal of Mammalogy*, **73**, 135-142.

- Nicholson, M.J. (1985) The water requirements of livestock in Africa. *Outlook on Agriculture*, **14**, 156-164.
- Nikora, V.I., Pearson, C.P. & Shankar, U. (1999) Scaling properties in landscape patterns: New Zealand experience. *Landscape Ecology*, **14**, 17-33.
- NMSU (1988) *Modeling: Three approaches to predicting how herbivore impact is distributed in rangelands*. Agricultural Experiment Station, Research Report 628. College of Agriculture and Home Economics, New Mexico State University. A Western Regional Research Publication.
- O'Brian, P. (1984) Feral goat home range: Influence of social class and environmental variables. *Applied Animal Behavioural Science*, **12**, 373-385.
- O'Connor, T. G. (1985) A Synthesis of Field Experiments Concerning the Grass Layer in the Savanna Regions of Southern Africa. South African National Scientific Programmes Report 114 CSIRO, Pretoria.
- Odum, E.P (1953) *The Fundamentals of Ecology*. W.B. Saunders Company, Philadelphia. (later editions in 1959 and 1971).
- Ollason, J.G. & Yearsley, J.M. (2001) The approximately ideal, more or less free distribution. *Theoretical Population Biology*, **59**, 87-105.
- Olson, R.L. & Sequiera, R.A. (1995) An emergent computational approach to the study of ecosystem dynamics. *Ecological Modelling*, **79**, 95-120.
- Olsson, K., Benlamih, S., Hossani-Hilali, J. & Dalhborn, K. (1997a) Regulation of fluid balance in goats and sheep from dry areas. In *Recent Advances in Small Ruminant Nutrition*. Lindberg, J.E., Gonda, H.L. & Ledin, I. (eds.). Zaragoza: CIHEAM (Centre International de Hautes Etudes Agronomiques Méditerranéennes)/FAO (Food and Agriculture Organization of the United Nations)/Institut Agronomique et Vétérinaire Hassan II. 253pp.
- Olsson, K., Cvek, K. & Hydbring, E (1997b) Preference for drinking warm water during heat stress affects milk production in food-deprived goats. *Small Ruminant Research*, **25**, 69-75.
- Olsson, K. & Hydbring, E. (1996) The preference for warm drinking water induces hyperhydration in heat-stressed lactating goats. *Acta Physiologica Scandinavica*, **157**, 109-114.
- Olsson, K., Josater-Hermelin, M., Hossani-Hilali, J., Cvek, K., Hydbring, E & Dalhborn, K. (1996) Reproductive period affects water intake in heat-stressed dehydrated goats. *Comparative Biochemistry and Physiology. A: Comparative Physiology*, **113**, 323-331.
- Olsson, K., Josater-Hermelin, M., Hossani-Hilali, J., Hydbring, E & Dalhborn, K. (1995) Heat-stress causes excessive drinking in fed and food-deprived pregnant goats. *Comparative Biochemistry and Physiology. A: Comparative Physiology*, **110**, 309-317.
- Orians, G.H. & Pearson, N.E. (1979) On the theory of central-place foraging. In *Analysis of ecological systems*. Horn, D.J., Mitchell, R.D. & Stairs, G.R. (eds.). Ohio State University Press, Columbus, Ohio, USA. pp 154-177.

- Orians, G.H. & Wittenberger, J.F. (1991) Spatial and temporal scales in habitat selection. *American Naturalist*, **137**, S29-S49.
- Owen-Smith, R.N. (1982) Factors influencing the consumption of plant products by large herbivores. In *Ecology of Tropical Savannas*. Huntley, B.J. & Walker, B.H. (eds.). Springer-Verlag.
- Owen-Smith, R.N. (1988) *Megaherbivores. The influence of very large body size on ecology*. Cambridge University Press.
- Owen-Smith, R.N. (1994) Foraging responses of kudus to seasonal changes in food resources: elasticity in constraints. *Ecology*, **75**, 1050-1062.
- Owen-Smith, R.N. (1996) Ecological guidelines for waterpoints in extensive protected areas. *South African Journal of Wildlife Research*, **26**, 107-112.
- Owen-Smith, R.N. (2002) A metaphysiological modelling approach to stability in herbivore-vegetation systems *Ecological Modelling*, **149**, 153-178.
- Owen-Smith, R.N. & Novellie, P. (1982) What should a clever ungulate eat? *American Naturalist*, **119**, 151-178.
- Owens, M. & Owens, D. (1986) *Cry of the Kalahari*. HarperCollins, New York.
- Pacala, S. & Deutschman, D.J (1996) Details that matter: the spatial distribution of individual trees maintains forest ecosystem function. *Oikos*, **74**, 357-365.
- Packard, N.H. & Wolfram, S. (1985) Two-dimensional cellular automata. *Journal of Statistical Physics*, **38**, 901-946.
- Palmqvist, E., Lundberg, P. & Jonzen, N. (2000) Linking resource matching and dispersal. *Evolutionary Ecology*, **14**, 1-12.
- Parker, G. (1997) *Animal interactions at waterholes in a region of high elephant density*. BSc. Project, ICAPB, Edinburgh.
- Parker, A.H. & Witkowski, E.T.F. (1999) Long-term impacts of abundant perennial water provision for game on herbaceous vegetation in a semi-arid African savanna woodland. *Journal of Arid Environments*, **41**, 309-321.
- Palmer, S.C.F., Hester, A.J., Elston, D.A., Gordon, I.J. & Hartley, S.E. (2003) The perils of having tasty neighbours: grazing impacts of large herbivores at vegetation boundaries. *Ecology*, **84**, 2877-2890.
- Parrish, J.K. & Edelstein-Keshet, L. (2000) Complexity, pattern and evolutionary trade-offs in animal aggregation. *Science*, **284**, 99-101.
- Parrish, J.K. & Turchin, P. (1997) Individual decisions, traffic rules, and emergent pattern: a Lagrangian analysis. In *Animal Aggregations: Three-Dimensional Measurement and Modeling*. Parrish, J.K., Hammer, W.M., Prewitt, C.T. (eds.). Cambridge University Press, Cambridge. Pp 126-142.
- Parsons, T. (1937) *The Structure of Social Action: A Study in Social Theory with Special Reference to a Group of European Writers*. New York NY: McGraw-Hill. Reprinted by Glencoe IL: The Free Press, 1949.

- Penning, P.D., Newman, J.A., Parsons, A.J., Harvey, A. & Orr, R.J. (1997) Diet preferences of adult sheep and goats grazing ryegrass and white clover. *Small Ruminant Research*, **24**, 175-184.
- Pennycuik, C.J. (1979) Energy costs of locomotion and the concept of "foraging radius". In *Serengeti: Dynamics of an ecosystem*. (Sinclair, A.R.E. & Norton-Griffiths, M., eds.). pp164-184. University of Chicago Press, Chicago.
- Perkins, J.S. (1991) *The impact of borehole dependent cattle grazing on the environment and society of the eastern Kalahari sandveld, Central District, Botswana*. Pages 357. Unpublished PhD thesis. University of Sheffield, UK.
- Perkins, J.S. (1996) Botswana: fencing out the equity issue. Cattleposts and cattle ranching in the Kalahari Desert. *Journal of Arid Environments*, **33**, 503-517.
- Perkins, J.S. & Thomas, D.S.G. (1993a) Spreading deserts or spatially confined environmental impacts? Land degradation and cattle ranching in the Kalahari desert of Botswana. *Land Degradation and Rehabilitation*, **4**, 179-194.
- Perkins, J.S. & Thomas, D.S.G. (1993b) Environmental responses and sensitivity to permanent cattle ranching, semi-arid western central Botswana. Pp. 273-286. In *Landscape Sensitivity*. Thomas, D.S.G. & Allison, R.J. (eds.). John Wiley, London.
- Peters, R.H. (1983) *The Ecological Implication of Body Size*. Cambridge University Press, Cambridge, UK.
- Phillips, C.J.C. (1993) *Cattle Behaviour*. Farming Press Books, Ipswich, UK.
- Phillips, E.M. & Pugh, D.S. (1994) *How to get a PhD: a handbook for students and their supervisors*. 2nd edition. Open University Press.
- Pickup, G. (1994) Modelling patterns of defoliation by grazing animals in rangelands. *Journal of Applied Ecology*, **31**, 231-246.
- Pickup, G. (1995) A simple model for predicting herbage production from rainfall in rangelands and its calibration using remotely-sensed data. *Journal of Arid Environments*, **30**, 227-245.
- Pickup, G. & Bastin, G.N. (1997) Spatial distribution of cattle in arid rangelands as detected by patterns of change in vegetation cover. *Journal of Applied Ecology*, **34**, 657-667.
- Pickup, G., Bastin, G.N. & Chewings, V.H. (1994) Remote-sensing-based condition assessment for nonequilibrium rangelands under large-scale commercial grazing. *Ecological Applications*, **4**, 497-517.
- Pickup, G., Bastin, G.N. & Chewings, V.H. (1998) Identifying trends in land degradation in non-equilibrium rangelands. *Journal of Applied Ecology*, **35**, 365-377.
- Pickup, G. & Chewings, V.H. (1988) Estimating the distribution of grazing and patterns of cattle movement in a large arid zone paddock: an approach using animal distribution models and Landsat imagery. *International Journal of Remote Sensing*, **9**, 1469-1490.

- Pickup, G. & Stafford Smith, D.M. (1987) Integrating models of soil dynamics, animal behaviour and vegetation response for the management of arid lands. *Australian Geographer*, **18**, 19-24.
- Pidwirny, M. (2001) *Geography 210: Introduction to Environmental Issues* [online]. Department of Geography, Okanagan University College. Available from: http://www.geog.ouc.bc.ca/conted/onlinecourses/geog_210/210_2_10.html [Accessed 18/01/2004].
- Pienaar, D., Biggs, H., Deacon, A., Gertenbach, W. Joubert, S., Nel, F., van Rooyan, L. & Venter, F. (1996) A revised water-distribution policy for biodiversity maintenance in the KNP. In *Kruger National Park Mission Statement*. Scientific Services, Skukuza, Kruger National Park, National Parks Board, South Africa.
- Piggins, D. & Phillips, C.J.C. (1996) The eye of the domesticated sheep with implications for vision. *Animal Science*, **62**, 301-308.
- Porter, J.H. & Dooley, J.L. (1993) Animal dispersal patterns: a reassessment of simple mathematical models. *Ecology*, **74**, 2436-2443.
- Poupon, H. (1976) La biomasse et l'évolution de sa répartition au cours de la croissance d'Acacia senegal dans une savane sahelienne (Sénégal). *Bois Forêts Tropicales*, **166**, 23-38.
- Press, W.H. (1992) *Numerical Recipes in C*. Cambridge University Press.
- Pringle, H.J.R. & Landsberg, J. (2004) predicting the distribution of livestock grazing pressure in rangelands. *Austral Ecology*, **29**, 31-39.
- Prins, H.H.T. (1989) Condition changes and choice of social environment in African buffalo bulls. *Behaviour*, **108**, 297-324.
- Provenza, F.D. (1995) Tracking variable environments - there is more than one kind of memory. *Journal of Chemical Ecology*, **21**, 911-923.
- Provenza, F.D. & Balph, D.F. (1988) Development of dietary choice in livestock on rangelands and its implications for management. *Journal of Animal Science*, **66**, 2356-2368.
- Pyke, G.H. (1984) Optimal foraging theory: a critical review. *Annual Review of Ecology*, **15**, 523-575.
- Raats, J.G., Webber, L.N., Pepe, D. & Tainton, N.M. (1996) Feeding behaviour of fistulated Boer goats as affected by period of occupation and season. *Bulletin of the Grassland Society of Southern Africa*, **7** (Supplement 1), p.74.
- Ramel, G. (2004) *Sight and the Mammal Eye* [online]. Earth-Life Web Productions. Available from: <http://www.earthlife.net/mammals/vision.html> [Accessed 18/01/2004].
- Ranta, E, Lundberg, P & Kaitala, V. (1999) Resource matching with limited knowledge. *Oikos*, **86**, 383-385.
- Ranta, E., Lundberg, P. & Kaitala, V. (2000) Size of environmental grain and resource matching. *Oikos*, **89**, 573-576.

- Rapp, A. (1976) Sudan. In *Can Desert Encroachment be Stopped? A Study with Emphasis on Africa*. (A. Rapp, Le Houerou, H.N. & Lundholm, B. eds.) pp155-164. Ecological Bulletins No. 24. Swedish Natural Science Research Council, Stockholm.
- Redfern, J.V., Grant, R., Biggs, H. & Getz, W.M. (2003) Surface-water constraints on herbivore foraging in the Kruger National Park, South Africa. *Ecology*, **84**, 2092–2107.
- Reiss, M. (1988) Scaling of Home Range Size: Body Size, Metabolic Needs and Ecology. *Trends in Ecology and Evolution*, **3**, 85-86.
- Renshaw, E. (1991) *Modelling Biological Populations in Space and Time*. Cambridge Studies in Mathematical Biology 11. Cambridge University Press.
- Ricker, W.E. (1973) Linear regressions in Fishery Research. *Journal of the Fisheries Research Board of Canada*, **30**, 409-434.
- Rietkerk, M., Ketner, P., Burger, J., Hoorans, B. & Olf, H. (2000) Multiscale soil and vegetation patchiness along a gradient of herbivore impact in a semi-arid grazing system in West Africa. *Plant Ecology*, **148**, 207-224.
- Rietkerk, M., van den Bosch, F. & van de Koppel, J. (1997) Site-specific properties and irreversible vegetation changes in semi-arid grazing systems. *Oikos*, **80**, 241-252.
- Rietkerk, M. & van de Koppel, J. (1997) Alternate stable states and threshold effects in semi-arid grazing systems. *Oikos*, **79**, 69-76.
- Riginos, R. & Hoffman, M.T. (2003) Changes in population biology of two succulent shrubs along a grazing gradient. *Journal of Applied Ecology*, **40**, 615–625.
- Ripley, B.D. (1981) *Spatial Statistics*. Wiley, New York.
- Ritchie, M.E. (1998) Scale-dependent foraging and patch choice in fractal environments. *Evolutionary Ecology*, **12**, 309-330.
- Ritchie, M.E. & Olf, H. (1999) Spatial scaling laws yield a synthetic theory of biodiversity. *Nature*, **400**, 557-560.
- Ritter, R.C. & Bednekoff, P.A. (1995) Dry season water, female movements and male territoriality in springbok: Preliminary evidence of water-hole-directed sexual selection. *African Journal of Ecology*, **33**, 395-404.
- Robertson, P.A., Aebischer, N.J., Kenward, R.E., Hanski, I.K. & Williams, N.P. (1998) Simulation and jack-knifing assessment of home-range indices based on underlying trajectories. *Journal of Applied Ecology*, **35**, 928-940.
- Rodriguez, S.J. (1995) *Artificial waterholes: A study of day-time utilisation of artificial waterholes by large mammals and the subsequent impact on vegetation in Gonarezhou National Park, Zimbabwe*. Durrell Institute of Conservation and Ecology, University of Kent, Canterbury. Unpublished report.
- Rogers, R.W. & Stride, C. (1997) Distribution of grass species and attributes of grasses near a bore drain in a grazed semi-arid subtropical grassland. *Australian Journal of Botany*, **45**, 919-927.

- Rook, A.J. (1998) Design and sampling issues in grazing studies. *Proceedings of the IXth European intake workshop*, North Wyke. North Wyke Agricultural College, North Wyke, UK
- Rook, A.J. (1999) The use of groups or individuals in the design of grazing experiments (reply to Phillips, 1998). *Applied Animal Behaviour Science*, **61**, 357-358.
- Rook, A.J. & Huckle, C.A. (1995) Synchronization of ingestive behaviour by grazing dairy cows. *Animal Science*, **60**, 25-30.
- Rook, A.J. & Penning, P.D. (1991) Synchronization of eating, ruminating and idling activity by grazing sheep. *Applied Animal Behaviour Science*, **32**, 157-166.
- Rooney, S.M., Wolfe, A. & Hayden, T.J. (1998) Autocorrelated data in telemetry studies: time to independence and the problem of behavioural effects. *Mammalian Review*, **28**, 89-98.
- Rutherford, M. C. (1984) Relative allocation and seasonal phasing of growth of woody plant components in a South African savanna. *Progress in Biometeorology*, **3**, 200-221.
- Ruxton, G.D., Humphries, S. & Farnsworth, K.D. (2001) Non-competitive phenotypic differences can have a strong effect on ideal free distributions. *Journal of Animal Ecology*, **70**, 25 -32
- Sæther, B-E. (1997) Environmental stochasticity and population dynamics of large herbivores: a search for mechanisms. *Trends in Ecology and Evolution*, **12**, 143-149.
- Schaefer, J.A. & Messier, F. (1995) Habitat selection as a hierarchy: the spatial scales of winter foraging by muskoxen. *Ecography*, **18**, 333-344.
- Schneider, D.C. (1998) Applied Scaling Theory. In *Ecological Scale: Theory and Applications*. Peterson, D.L. & Parker, V.T. (eds.). Complexity In Ecological Systems. Columbia University Press, NY.
- Schoener, T.W. (1974) Resource partitioning in ecological communities. *Science*, **185**, 27-39.
- Scholes, R.J. (1990) Change in nature and nature of change: interactions between terrestrial ecosystems and the atmosphere. *South African Journal of Science*, **86**, 350-354.
- Scholes, R.J. & Walker, B.H. (1993) *An African Savanna*. Cambridge University Press, Cambridge.
- Schwinning, S. & Parsons, A.J. (1999) The stability of grazing systems revisited: spatial models and the role of heterogeneity. *Functional Ecology*, **13**, 737-747.
- Scoones, I. (1994) New directions in pastoral development in Africa. In *Living With Uncertainty*. Scoones, I. (ed.). Intermediate Technology Publications, London. pp. 1-36.

- Sefe, F., Ringrose, S., Matheson, W. (1996) Desertification in North Central Botswana - Causes, processes, and impacts. *Journal of Soil and Water Conservation*, **51**, 241-248.
- Seghieri, J. (1995) The rooting patterns of woody and herbaceous plants in a savanna; are they complementary or in competition? *African Journal of Ecology*, **33**, 358-365.
- Seitshiro, G. (1978) *Gradient analysis of five non-operational boreholes in the Kweneng District*. Unpublished Ministry of Agriculture Report, Gabarone, Botswana.
- Senft, R. L. (1989) Hierarchical foraging models: effects of stocking and landscape composition on simulated resource use by cattle. *Ecological Modelling*, **46**, 283-303.
- Senft, R.L., Coughenour, M.B., Bailey, D.W., Rittenhouse, L.R., Sala, O.E. & Swift, D.M. (1987) Large herbivore foraging and ecological hierarchies. *Bioscience*, **37**, 789-796.
- Senft, R.L., Rittenhouse, L.R. & Woodmansee, R.G. (1983) The use of regression models to predict spatial patterns of cattle behaviour. *Journal of Range Management*, **36**, 553-557.
- Senzota, R.B.M. & Mtahko, G. (1990) Effect on wildlife of a water-hole in Mikumi National Park, Tanzania. *African Journal of Ecology*, **28**, 147-151.
- Shalizi, C.R. (2001) *Emergent Properties* [online]. Center for the Study of Complex Systems, University of Michigan. Available from: <http://www.santafe.edu/~shalizi/notebooks/emergent-properties.html> [Accessed 18/01/2004].
- Shigesada, N, Kawasaki, K. & Teramoto, E. (1986) Traveling periodic waves in heterogeneous environments. *Theoretical Population Biology*, **30**, 143-160.
- Shiple, L.A. & Spalinger, D.E. (1992) Mechanics of browsing in dense food patches - effects of plant and animal morphology on intake rate. *Canadian Journal of Zoology*, **70**, 1743-1752.
- Shiple, L.A., Gross, J.E., Spalinger, D.E, Hobbs, N.T. & Wunder, B.A. (1994) Scaling of functional response in mammalian herbivores. *American Naturalist*, **143**, 1055-1082.
- Shiple, L.A., Spalinger, D.E., Gross, J.E., Hobbs N.T. & Wunder, B.A. (1996) The dynamics and scaling of foraging velocity and encounter rate in mammalian herbivores. *Functional Ecology*, **10**, 234-244.
- Shiple, L.A., Illius, A.W., Danell, K., Hobbs, N.T. & Spalinger, D.E. (1999) Predicting bite size selection of mammalian herbivores: A test of a general model of diet optimization. *Oikos*, **84**, 55-68.
- Shkolnik, A., Borut, A. & Choshniak, J. (1972) Water economy of the Beduin [sic] Goat. *Symposium of the Zoological Society of London*, **31**, 229-242.

- Silanikove, N. (1994) The struggle to maintain hydration and osmoregulation in animals experiencing severe dehydration and rapid rehydration: the story of ruminants. *Experimental Physiology*, **79**, 281-300.
- Sinclair, A.R.E. (1983) The adaptations of African ungulates and their effects on community function. In *Tropical Savannas* (F. Bourliere, ed.) Elsevier, Amsterdam.
- Sinclair, A.R.E., Dublin, H. & Borner, M. (1985) Population regulation of Serengeti wildebeest: a test of the food hypothesis. *Oecologia*, **65**, 266-268.
- Sinclair, A.R.E. & Fryxell, J.M. (1985) The Sahel of Africa: ecology of a disaster. *Canadian Journal of Zoology*, **63**, 987-994.
- Skarpe, C. (1986) Plant community structure in relation to grazing and environmental changes along a north-south transect in the western Kalahari. *Vegetatio*, **68**, 3-18.
- Smythe, R.H. (1975) *Vision in the animal world*. New York: St. Martins Press. 165pp.
- Sneddon, J.C. & Argenzio, R.A. (1998) Feeding strategy and water homeostasis in equids: the role of the hind gut. *Journal of Arid Environments*, **38**, 493-509.
- Sokal, R.R. & Rohlf, F.J. (1995) *Biometry*. 3rd edition. W.H. Freeman & Co., NY.
- Spalinger, D.E. & Hobbs, N.T. (1992) Mechanisms of foraging in mammalian herbivores: new models of functional response. *American Naturalist*, **140**, 325-348.
- Spencer, H.G., Kennedy, M. & Gray, R.D. (1996) Perceptual constraints on optimal foraging: the effects of variation among foragers. *Evolutionary Ecology*, **10**, 331-339.
- SPSS Inc. (1997) *SigmaPlot for Windows Version 4.00*. Copyright© 1986-1997 SPSS Inc.
- Stafford Smith, D.M. (1988) *Modeling: three approaches to predicting how herbivore impact is distributed in rangelands*. New Mexico Agricultural Experimental Station Regional Research Report 628, 1-56.
- Stafford Smith, D.M. (1990) Waters and the patterns of animal use. *Proceedings of the Australian Rangelands Society Conference*, Carnarvon. p35-44.
- Stafford Smith, D.M. & Foran, B.D. (1990) RANGEPACK: the philosophy underlying the development of a microcomputer-based decision support system for pastoral land management. *Journal of Biogeography*, **17**, 541-546.
- Stafford Smith, M. & Pickup, G. (1993) Out of Africa, looking in: understanding vegetation change. In *Range Ecology At Disequilibrium*. Behnke, R.H., Scoones, I. & Kerven, C. (eds). pp 1-30. ODI, London.
- Starfield, A.M. & Bleloch, A.L. (1991) *Building Models for Conservation and Wildlife Management*. Edina, Minnesota: Burgess International Group Inc.
- Starfield, A.M., Shapiro, S.M., Furniss, P.R., Sears, M. Retief, P.F., Van der Walt, P.T. & Mills, M.G.L. (1982) A developing computer model of the Auob river

- ecosystem, Kalahari Gemsbok National Park. Pp. 611-625. In *Ecology of Tropical Savannas*. Huntley, B.J. & Walker, B.H. (eds). Springer-Verlag, Berlin.
- StarPal (1999) *How to choose a GPS System to meet your needs* [online]. StarPal Inc.. Available from: http://www.starpal.com/GPS_DGPS.html [Accessed 18/01/2004].
- Steel, R.G.D. & Torrie, J.H. (1980) *Principles and Procedures of Statistics: A Biometrical Approach*. 2nd. Edition. McGraw-Hill Inc., Singapore.
- Steele, M. (1996) *Goats*. Tropical Agriculturalist Series, CTA Macmillan.
- Steinberg, E.K. & Karieva, P. (1997) Challenges and Opportunities for Empirical Evaluation of "Spatial Theory". In *Spatial Ecology: The Role of Space in Population Dynamics and Interspecific Interactions*. Tilman, D. & Kareiva, P.M. (eds.). Monographs In Population Biology, Princeton University Press.
- Stephens, D.W. & Krebs, J.R. (1986) *Foraging theory*. Princeton University Press, Princeton, NJ, 247 pp.
- Stephens, D.W. & Stevens, J.R. (2001) A simple spatially explicit ideal-free distribution: a model and an experiment. *Behavioural Ecology and Sociobiology*, **49**, 220-234.
- Stokes, C.J. & Yeaton, R.I. (1994) A line-based vegetation sampling technique and its application in succulent karoo. *African Journal of Range Forage Science*, **11**, 11-17.
- Stroteny, Y.J. & Mentis, M.T. (1989) Vegetation response to wagon wheel camp layouts. *Journal of the Grassland Society of Southern Africa*, **6**, 105-108.
- Stuart, C.T. & Stuart, M.D. (1993) *Field Guide to the Mammals of Southern Africa*, 2nd edition. Struik Publishers (Pty) Ltd., Cape Town, SA.
- Stuth, J. (1991) Foraging Behavior. In *Grazing Management - An Ecological Perspective* [online]. Heitschmidt, R. & Stuth, J. (eds.). Timber Press. Portland, Oregon. Available from: <http://cnrit.tamu.edu/rlem/textbook/textbook-fr.html> [Accessed 18/01/2004].
- Sullivan, L.M. (1999) *Wildlife Skull Activities* [online]. College of Agriculture and Life Sciences, University of Arizona. Available from: <http://ag.arizona.edu/pubs/natresources/az1145.pdf> [Accessed 18/01/2004].
- Sullivan, S. & Rohde, R. (2002) On non-equilibrium in arid and semi-arid grazing systems. *Journal of Biogeography*, **29**, 1595-1618.
- Swihart, R.K. & Slade, N.A. (1985) Testing for independence of observations in animal movements. *Ecology*, **66**, 1176-1184.
- Taylor, C.R. (1968) The minimum water requirements of some East African bovids. *Symposium of the Zoological Society of London*, **21**, 195-206.
- Taylor, C.R. (1972) The desert gazelle: a paradox resolved. *Symposium of the Zoological Society of London*, **31**, 215-227.

- Taylor, C.R. (1978) Energetics of locomotion: primitive and advanced mammals. In *Comparative Physiology: Primitive Mammals*. Schmidt-Nielsen, K., Bolis, L. & Taylor, C.R. (eds.). Cambridge University Press.
- Tear, T.H., Mosley, J.C. & Ables, E.D. (1997) Landscape-scale foraging decisions by reintroduced Arabian oryx. *Journal of Wildlife Management*, **61**, 1142-1154.
- ter Braak, C. J. F. & Prentice, I. C. (1988) A theory of gradient analysis. *Advances In Ecological Research*, **18**, 271-313.
- Thrash, I. (1993) *Implications of providing water for indigenous large herbivores in the Transvaal lowveld*. PhD Thesis, University of Pretoria.
- Thrash, I. (1997) Infiltration rate of soil around drinking troughs in the Kruger National Park, South Africa. *Journal of Arid Environments*, **35**, 617-625.
- Thrash, I. (1998a) Impact of large herbivores at artificial watering points compared to that at natural watering points in Kruger National Park, South Africa. *Journal of Arid Environments*, **38**, 315-324.
- Thrash, I. (1998b) Impact of water provision on herbaceous vegetation in Kruger National Park, South Africa. *Journal of Arid Environments*, **38**, 437-450.
- Thrash, I. (2000) Determinants of the extent of indigenous large herbivore impact on herbaceous vegetation at watering points in the north-eastern lowveld, South Africa. *Journal of Arid Environments*, **44**, 61-72.
- Thrash, I. & Derry, J.F. (1999) The nature and modelling of piospheres: a review. *Koedoe*, **42**, 73-94. Pretoria. ISSN 0075-6458.
- Thrash, I., Nel, P.J., Theron, G.K. & Bothma, J. du P. (1991) The impact of the provision of water for game on the basal cover of herbaceous vegetation around a dam in the Kruger National Park. *Koedoe*, **34**, 121-130.
- Thrash, I., Theron, G.K. & Bothma, J. Du P. (1993) Impact of water provision on herbaceous plant community composition in the Kruger National Park. *African Journal of Range & Forage Science*, **10**, 31-35.
- Tilman, D. & Kareiva, P. (1997) *Spatial Ecology: The Role of Space in Population Dynamics and Interspecific Interactions*. *Monographs In Population Biology*; 30. Princeton University Press.
- t'Mannetje, L.H. & Haydock, K.P. (1963) The dry-weight-rank method for the botanical analysis of pasture. *Journal of the British Grassland Society*, **18**, 286-275.
- Tobler, M.W., Cochard, R. & Edwards, P.J. (2003) The impact of cattle ranching on large-scale vegetation patterns in a coastal savanna in Tanzania. *Journal of Applied Ecology*, **40**, 430-444.
- Tolkamp, B.J., Allcroft, D.J. and Kyriazakis, I. (1999) Estimating meal criteria for meal pattern analysis of dairy cows. P. 203 in *Proceedings of the British Society of Animal Science Winter Meeting 1999*. British Society of Animal Science, Penicuik, UK.

- Tolsma, D.J., Ernst, W.H.O. & Verwey, R.A. (1987) Nutrients in soil and vegetation around 2 artificial waterpoints in eastern Botswana. *Journal of Applied Ecology*, **24**, 991-1000.
- Turchin, P. (1991) Translating foraging movements in heterogeneous environments into the spatial distribution of foragers. *Ecology*, **72**, 1253-1266.
- Turchin, P. (1998) *Quantitative Analysis of Movement: Measuring and Modeling Population Redistribution in Animals and Plants*. Sinauer Associates Inc., Sunderland, MA.
- Turing, A.M. (1952) The chemical basis of morphogenesis. *Philosophical Transactions of the Royal Society of London, Series B*, **237**, 37-72.
- Turner, M.D. (1998a) Long-term effects of daily grazing orbits on nutrient availability in Sahelian West Africa: I. Gradients in the chemical composition of rangeland soils and vegetation. *Journal of Biogeography*, **25**, 669-682.
- Turner, M.D. (1998b) Long-term effects of daily grazing orbits on nutrient availability in Sahelian West Africa: 2. Effects of a phosphorus gradient on spatial patterns of annual grassland production. *Journal of Biogeography*, **25**, 683-694.
- Turner, M.D. (1999) Spatial and temporal scaling of grazing impact on the species composition and productivity of Sahelian annual grasslands. *Journal of Arid Environments*, **41**, 277-297.
- Turner, M.G., Arthaud, G.J., Engstrom, R.T., Hejl, S.J., Liu, J., Loeb, S. & McKelvey, K. (1995) Usefulness of spatially explicit population models in land management. *Ecological Applications*, **5**, 12-16.
- Turner, M.G., Wu, Y., Romme, W.H. & Wallace, L.L. (1993) A landscape simulation model of winter foraging by large ungulates. *Ecological Modelling*, **69**, 163-184.
- Turner, M.G., Wu, Y., Wallace, L.L., Romme, W.H. & Brenkert, A. (1994) Simulating winter interactions among ungulates, vegetation, and fire in northern Yellowstone Park. *Ecological Applications*, **4**, 472-496.
- Turner, S.J., O'Neill, R.V., Conley, W., Conley, M.R. & Humphries, H.C. (1991) Pattern and Scale: statistics for landscape ecology. In *Quantitative methods in landscape ecology*. Turner, M.G. & Gardner, R.H. (eds.). Springer-Verlag, NY.
- Tyler, J.A. & Hargrove, W.W. (1997) Predicting spatial distribution of foragers over large resource landscapes: a modeling analysis of the Ideal Free Distribution. *Oikos*, **79**, 376-386.
- Underwood, R. (1983) Feeding behaviour of grazing African ungulates. *Behaviour*, **84**, 195-243.
- University of California Cooperative Extension (1996) *Beef Care Practices* [online]. Animal Care Series. Beef and Range Workgroup, University of California. Available from: http://www.vetmed.ucdavis.edu/vetext/INF-BE_CarePrax.html [Accessed 18/01/2004].

- van de Koppel, J., Huisman, J., Van Der Wal, R. & Olf, H. (1996) Patterns of herbivory along a productivity gradient - an empirical and theoretical investigation. *Ecology*, **77**, 736-745.
- van de Koppel, J. & Prins, H.H.T. (1998) The importance of herbivore interactions for the dynamics of African savanna woodlands: an hypothesis. *Journal of Tropical Ecology*, **14**, 565-576.
- Van der Schijff, H.P. (1957) 'n *Ekologiese studie van die flora van die Nasionale Krugerwiltuin*. D.Sc. Thesis, Potchefstroom Universiteit vir Christelike Hoër Onderwys, Potchefstroom.
- Van der Schijff, H.P. (1959) Weidingsmoontlikhede en weidingsprobleme in die Nasionale Krugerwiltuin. *Koedoe*, **2**, 96-127.
- van Diggelen, F. (1998) GPS accuracy: Lies, damn lies, and statistics. *GPS World*, **9**, 41-45.
- van Heezik, Y., Ismail, K. & Seddon, P.J. (2003) Shifting spatial distributions of Arabian oryx in relation to sporadic water provision and artificial shade. *Oryx*, **37**, 295-304.
- van Rooyen, N., Bezuidenhout, D., Theron, G.K. & Bothma, J. du P. (1990) Monitoring of the vegetation around artificial watering points (windmills) in the Kalahari Gemsbok National Park. *Koedoe*, **33**, 63-88.
- van Rooyen, N., Bredenkamp, G.J., Theron, G.K., du Bothma, J., Leriche, E.A.N. (1994) Vegetational gradients around artificial watering points in the Kalahari-Gemsbok-National-Park. *Journal of Arid Environments*, **26**, 349-361.
- Verlinden, A., Perkins, J.S., Murray, M. & Masunga, G. (1998) How are people affecting the distribution of less migratory wildlife in the southern Kalahari of Botswana? A spatial analysis. *Journal of Arid Environments*, **38**, 129-141.
- Wade, T.G., Schultz, B.W., Wickham, J.D. & Bradford, D.F. (1998) Modeling the potential spatial distribution of beef cattle grazing using a Geographic Information System. *Journal of Arid Environments*, **38**, 325-334.
- Walker, B.H. (1976) An approach to the monitoring of changes in the composition and utilisation of woodland and savanna vegetation. *South African Journal of Wildlife Research*, **6**, 1-32.
- Walker, B.H. (1979) Game ranching in Africa. In *Management of semi-arid ecosystems*. B.H. Walker (ed.). Elsevier Scientific Publishing Company, Amsterdam. pp. 55-82.
- Walker, B.H. (1999) The ecosystem approach to conservation: reply to Goldstein. *Conservation Biology*, **13**, 436-437.
- Walker, B.H., Emslie, R.H., Owen-Smith, R.N. & Scholes, R.J. (1987) To cull or not to cull: lessons from a southern African drought. *Journal of Applied Ecology*, **24**, 381-401.

- Walker, B.H. & Langridge, J. (1996) Modelling plant and soil water dynamics in semi-arid ecosystems with limited site data. *Ecological Modelling*, **87**, 153-167.
- Wallis De Vries, M.F., Laca, E.A. & Demment, M.W. (1998) From feeding station to patch: Scaling up food intake measurements in grazing cattle. *Applied Animal Behaviour Science*, **60**, 301-315.
- Wallis De Vries, M.F., Laca, E.A. & Demment, M.W. (1999) The importance of scale of patchiness for selectivity in grazing herbivores. *Oecologia*, **121**, 355-363.
- Walls, G.L. (1942) *The Vertebrate Eye and its Adaptive Radiation*. Cranbrook Institute of Science, Bloomfield Hills, Michigan.
- Wardlaw, A.C. (1985) *Practical Statistics for Experimental Biologists*. 'A Wiley-Interscience publication'. John Wiley & Sons, Ltd.
- Waterloo Maple Inc. (1998) *Maple V Release 5.1*. Waterloo Maple Inc.
- Watson, J.D. & Crick, F.H.C. (1953) Molecular structure of Nucleic Acids. A structure for Deoxyribose Nucleic Acid. *Nature*, **171**, 737-738.
- Weber, G.E., Jeltsch, F., Van Rooyen, N. & Milton, S.J. (1998) Simulated long-term vegetation response to grazing heterogeneity in semi-arid rangelands. *Journal of Applied Ecology*, **35**, 687-699.
- Weber, G.E., Moloney, K. & Jeltsch, F. (2000) Simulated long-term vegetation response to alternative stocking strategies in savanna rangelands. *Plant Ecology*, **150**, 77-96.
- Webster, R. (1996) What is Kriging? In *Modelling in Applied Biology: Spatial Aspects*. Aspects of Applied Biology, 46. E.M. White, L.R. Benjamin, P. Brain, P.J.C. Hamer, M.A. Muggleston, G. Russell & C.F.E. Topp (eds). The Association of Applied Biologists, c/o Horticulture Research International, Wellesbourne, Warwick.
- Weir, J.S. (1967) Seasonal variation in alkalinity in pans in central Africa. *Hydrobiologia*, **32**, 69-80.
- Weir, J.S. (1971) The effect of creating additional water supplies in a Central African National Park. Pp. 367-385. In *The scientific management of animal and plant communities for conservation*. Duffey, E. & Watt, A.S. Blackwell Scientific Publications, Oxford.
- Weir, J. & Davison, E. (1965) Daily occurrence of African game animals at water holes during dry weather. *Zoologica Africana*, **1**, 353-368.
- Western, D. (1975) Water availability and its influence on the structure and dynamics of a savannah large mammal community. *East African Wildlife Journal*, **13**, 265-286.
- Westoby, M., Walker, B.H. & Noy-Meir, I. (1989) Opportunistic management for rangelands not at equilibrium. *Journal of Range Management*, **42**, 266-274.

- Wiegand, K., Schmidt, H., Jeltsch, F. & Ward, D. (2000) Linking a spatially-explicit model of acacias to GIS and remotely-sensed data. *Folia Geobotanica*, **35**, 211-230.
- Wiegand, T., Moloney, K.A. & Milton, S.J. (1998) Population dynamics, disturbance, and pattern evolution: identifying the fundamental scales of organization in a model ecosystem. *American Naturalist*, **152**, 321-337.
- Wiegand, T., Moloney, K.A., Naves, J. & Knauer, F. (1999) Finding the missing link between landscape structure and population dynamics: a spatially explicit perspective. *American Naturalist*, **154**, 605-627.
- Wiens, J. (1976) Population responses to patchy environments. *Annual Review of Ecological Systems*, **7**, 81-120.
- Wiens, J. (1984) On understanding a nonequilibrium world: myth and reality in community patterns and processes. In *Ecological Communities: Conceptual Issues and the Evidence*. Strong, D.R., Simberloff, D., Abele, L.G. & Thistle, A.B. (eds.). Princeton University Press, Princeton.
- Wilmhurst, J.F., Fryxell, J.M. & Bergman, C.M. (2000) The allometry of patch selection in ruminants. *Proceedings of the Royal Society of London, Series B - Biological Sciences*, **267**, 345-349.
- Wilmshurst, J.F., Fryxell, J.M., Farm, B.P., Sinclair, A.R.E. & Henschel, C.P. (1999) Spatial distribution of Serengeti wildebeest in relation to resources. *Canadian Journal of Zoology*, **77**, 1223-1232.
- Wilson, S.F., Shackleton, D.M. & Campbell, K.L. (1998) Making habitat-availability estimates spatially explicit. *Wildlife Society Bulletin*, **26**, 626-631.
- With, K.A. (1994) Using fractal analysis to assess how species perceive landscape structure. *Landscape Ecology*, **9**, 25-36.
- Witham, T.G., Maschinski, J., Larson, K.C. & Paige, K.N. (1991) Plant responses to herbivory: The continuum from negative to positive and underlying physiological mechanisms. In *Plant-Animal Interactions: Evolutionary Ecology in Tropical and Temperate Regions*. (eds. Price, P.W., Lwensohn, T.M., Fernandes, G.W. & Benson, W.W.). Wiley, New York.
- Wolfram, S. (1983) Statistical mechanics of cellular automata. *Review of Modern Physics*, **55**, 601-644.
- Wolfram, S. (1984) Cellular automata as models of complexity. *Nature*, **311**, 419-424.
- Wolfram, S. (2002) *A New Kind of Science*. Wolfram Media Inc..
- Wu, J. & Levin, S.A. (1994) A spatial patch dynamic modelling approach to pattern and process in an annual grassland. *Ecological Monographs*, **64**, 447-464.
- Wu, J. & Loucks, O.L. (1995) From balance of nature to hierarchical patch dynamics: a paradigm shift in ecology. *The Quarterly Review of Biology*, **70**, 439-466.
- Wu, J. & Hobbs, R. (2002) Key issues and research priorities in landscape ecology: An idiosyncratic synthesis. *Landscape Ecology*, **17**, 355-365.

- Xin, X.P., Gao, Q., Li, Y.Y. & Yang, Z.Y. (1999) Fractal analysis of grass patches under grazing and flood disturbance in an alkaline grassland. *Acta Botanica Sinica*, **41**, 307-313.
- Young, E. (1970) *Water as faktor in die ekologie van wild in die Nasionale Krugerwildtuin*. Unpublished DSc Thesis. University of Pretoria, SA.
- Zambatis, N. (1985) The relationships between evaporation and certain physical parameters of circular pans and rectangular troughs. *Koedoe*, **28**, 87-92.
- Zar, J.H. (1996). *Biostatistical Analysis*, 3rd edition. Prentice-Hall, Upper Saddle River, New Jersey.
- Zollner, P.A. & Lima, S.L. (1999) Search strategies for landscape-level interpatch movements. *Ecology*, **80**, 1019-1030.