

Bell, T. P. (2009). "A novel technique for monitoring highly cryptic lizard species in forests." *Herpetological Conservation and Biology* 4(3): 415-425.

There are few effective or efficient methods for monitoring arboreal forest lizards, especially in areas with low lizard densities. This is problematic for their conservation and research. I developed a novel technique for capturing lizards using closed-cell foam covers as artificial retreats placed on tree trunks. I tested the method at three sites in New Zealand by comparing lizard occupancy rates with the outcomes from conventional methods (lizard houses, g-minnow traps, pitfall traps, Onduline artificial retreats, and spotlighting). At the site where Duvaucel's Geckos (*Hoplodactylus duvaucelii*) were abundant, most methods detected their presence, but the foam cover technique detected geckos much more effectively (39 geckos per 100 observations). Also, I was able to sample juvenile lizards better using foam covers than any other technique, and both sexes used foam covers equally. On a per unit effort basis, night spotlighting resulted in 0.6–1.6 geckos per hour, whereas covers returned 3.1 geckos per hour. At the other two sites where either Pacific Geckos (*H. pacificus*) or Forest Geckos (*H. granulatus*) were at low densities, only foam covers detected them. Lizard houses typically caught either zero to one gecko per 100 observations; whereas, at these sites, foam covers returned four geckos per 100 observations, despite low gecko abundance. This is a significant improvement in detection. Foam covers offer improved population sampling of arboreal forest lizards, improved efficiency, and lower costs compared to other sampling techniques. They may also reduce some potential biases experienced when using other sampling techniques. This study suggests that foam covers are an effective method for inventorying and monitoring arboreal lizard communities.

Besson, A. A. (2009). Effects of cool temperature on egg incubation, thermoregulation and physiological performance of tuatara (*Sphenodon punctatus*): implications for conservation programmes. Dunedin, University of Otago.

Bishop, P. J., A. J. M. Haigh, et al. (2009). Consultative Draft Native Frog (*Leiopelma* species) Recovery Plan, 2009–2019, New Zealand. Wellington, Department of Conservation.

Chamberlain, A. J. (2009). Exploring the Unknown: Existence and Inheritance of Personality in McCann's Skink, *Oligosoma maccanni*. Dunedin, University of Otago: 73.

Chapple, D. G. and M. B. Thompson (2009). "Isolation and characterization of microsatellite loci from the invasive delicate skink (*Lampropholis delicata*), with cross-amplification in other Australian *Eugongylus* group species." Conservation Genetics Resources 1: 55-58.

Curtis, N., M. E. Jones, et al. (2010). "Predicting muscle activation patterns from motion and anatomy: modelling the skull of *Sphenodon* (Diapsida: Rhynchocephalia)." Journal of the Royal Society Interface 7: 153-160.

The relationship between skull shape and the forces generated during feeding is currently under widespread scrutiny and increasingly involves the use of computer simulations such as finite element analysis. The computer models used to represent skulls are often based on computed tomography data and thus are structurally accurate; however, correctly representing muscular loading during food reduction remains a major problem. Here, we present a novel approach for predicting the forces and activation patterns of muscles and muscle groups based on their known anatomical orientation (line of action). The work was carried out for the lizard-like reptile *Sphenodon* (Rhynchocephalia) using a sophisticated computer-based model and multi-body dynamics analysis. The model suggests that specific muscle groups control specific motions, and that during certain times in the bite cycle some muscles are highly active whereas others are inactive. The predictions of muscle activity closely correspond to data previously recorded from live *Sphenodon* using electromyography. Apparent exceptions can be explained by variations in food resistance, food size, food position and lower jaw motions. This approach shows considerable promise in advancing detailed functional models of food acquisition and reduction, and for use in other musculoskeletal systems where no experimental determination of muscle activity is possible, such as in rare, endangered or extinct species

Gebauer, K. (2009). Trapping and identification techniques for small-scaled skinks (*Oligosoma microlepis*) Wellington, Department of Conservation: 24.

The small-scaled skink (*Oligosoma microlepis*) is a small, diurnal, heliothermic skink that is known from a number of small, scattered and isolated populations in the central North Island, New Zealand. This study presents the first attempt to estimate population sizes of this species at five sites near the Springvale Bridge in the Rangitikei River region. Funnel traps made of fly-screen and strong wire mesh were successfully used to catch small-scaled skinks. At easily accessible rock piles, noosing proved to be a more efficient capture technique than trapping, with more skinks caught over a smaller amount of time. Small-scaled skink individuals were successfully identified by their natural markings. Population estimates and densities were derived from the resighting of photographed individuals at five sites at Springvale Station. The results of this study can now be incorporated into future studies to assess the status of the species and gain more knowledge about its population ecology.

Germano, J. M., F. Molinia, et al. (2009). "Urinary hormone analysis assists reproductive monitoring and sex identification of bell frogs (*Litoria raniformis*)."
Theriogenology **72**: 663-671.

Hay, J. M., S. D. Sarre, et al. (2009). "Genetic diversity and taxonomy: a reassessment of species designation in tuatara (*Sphenodon*: Reptilia)."
Conservation Genetics DOI **10.1007/s10592-009-9952-7**.

Hoare, J. M., C. F. J. O'Donnell, et al. (2009). "Optimising the sampling of skinks using artificial retreats based on weather conditions and time of day." Applied Herpetology **6**(4): 379-390.

Artificial retreats are a low-cost, low-impact and effective technique for detecting cryptic taxa, such as herpetofauna, and have potential as a monitoring tool. The success of using artificial retreats for monitoring is dependent on our ability to maximise detection and minimise variability in sightings within a sampling period. Because ectotherms use retreats for their thermal properties, it may be possible to identify weather conditions during which animals consistently use retreats and design a monitoring protocol based on optimal conditions. We investigated the use of artificial retreats by common skinks, *Oligosoma polychroma*, in mixed grassland habitat in southern New Zealand under various weather conditions and at a range of times of day. We recorded 1175 sightings of skinks during 1800 artificial retreat checks over a nine day period in early summer 2008. Ambient temperature, rainfall, humidity and time of day were the strongest predictors of skink sightings beneath retreats. Skink sightings were highest and least variable: (1) in an ambient temperature range of 12-18°C, (2) during light or no rain, and (3) at low levels of relative humidity. Under optimal weather conditions, skink counts were similar during the day (8 a.m. to 5 p.m. inclusive) but lower during the evening (8 p.m.). Observer variability, type of substrate beneath the retreat and retreat colour did not significantly influence the number of skinks sighted. We highlight the need to optimise protocols for checking artificial retreats on a species- and site-specific basis before attempting to evaluate their use as a monitoring tool for herpetofauna.

Jones, M. E. H. and A. K. Lappin (2009). "Bite-force performance of the last rhynchocephalian (Lepidosauria: *Sphenodon*)."
Journal of the Royal Society of New Zealand **39**(3): 71-83.

We present the first empirical measurements of bite-force performance from adult *Sphenodon* (Rhynchocephalia), the only extant non-squamate lepidosaur. Using raw bite-force data, we calculated maximum bite forces at the anterior and posterior extremes of the lower tooth row: 81.8 N and 163.5 N (female) and 119.1 N and 238.3 N (male). Combining our results with published data from juvenile animals, we calculated scaling coefficients of bite force on linear morphometrics of body and head size as c. 2.7 (anterior) and c. 3.5+ (posterior). These exceed isometric scaling predictions (2.0), yet are similar to those for other non-avian reptiles. This supports previous views that *Sphenodon* cannot bite as hard as agamid lizards. We discuss the role of bite force in the behavioural ecology of *Sphenodon*, propose that the lower temporal bar, unique among extant lepidosaurs, does not necessarily constrain bite force, and evaluate possible effects of other morphological characteristics on bite-force performance.

Kikillus, K. H., K. M. Hare, et al. (2010). "Minimizing false-negatives when predicting the potential distribution of an invasive species: a bioclimatic envelope for the red-eared slider at global and regional scales." *Animal Conservation* doi: **10.1111/j.1469-1795.2008.00299.x**.

Lee, M. S. Y., M. N. Hutchinson, et al. (2009). "Miocene skinks and geckos reveal long-term conservatism of New Zealand's lizard fauna." *Biology Letters* **5**: 833-837.

The New Zealand (NZ) lizard fossil record is currently limited to late Quaternary remains of modern taxa. The St Bathans Fauna (early Miocene, southern South Island) extends this record to 19–16 million years ago (Myr ago). Skull and postcranial elements are similar to extant *Oligosoma* (Lygosominae) skinks and *Hoplodactylus* (Diplodactylinae) geckos. There is no evidence of other squamate groups. These fossils, along with coeval sphenodontines, demonstrate a long conservative history for the NZ lepidosaurian fauna, provide new molecular clock calibrations and contradict inferences of a very recent (less than 8 Myr ago) arrival of skinks in NZ.

Lettink, M., G. Norbury, et al. (2010). "Removal of introduced predators, but not artificial refuge supplementation, increases skink survival in coastal duneland." *Biological Conservation* **143**(1): 72-77.

Exotic predators can have detrimental impacts on indigenous fauna. Lethal predator control is commonly used to reduce predator impacts, but is not always feasible, effective or ethical. A promising non-lethal alternative is refuge supplementation for prey. We conducted a Before–After Control–

Impact (BACI) experiment over 3 years to determine the relative effects of predator removal (by enclosure fencing) and artificial refuge supplementation on survival of McCann's skink (*Oligosoma maccanni*) in duneland on Kaitorete Spit (South Island, New Zealand). Skink populations on 0.0625 ha-grids were randomly assigned to four treatment groups, each replicated four times: (a) predator enclosure only; (b) artificial retreats only; (c) enclosure + artificial retreats, and (d) control (no enclosure or artificial retreats), and monitored annually by pitfall trapping. Capture–recapture analysis was used to estimate the difference in annual survival probability between pre- and post-treatment periods. On average, survival increased only at grids that received the enclosure-only treatment (effect size of 0.03 (0.017–0.043; unconditional 95% CI)). Reduction in predator abundance (by lethal predator control or predator exclusion), but not artificial refuge supplementation, is predicted to benefit McCann's skink. Our findings add to other studies highlighting the detrimental impacts of exotic predators on indigenous prey and calls for improved means of reducing predator impacts.

Metsers, L. (2008). Movement behaviour and habitat use of domestic cats in relation to threatened native lizard habitat. Dunedin, University of Otago: 144.

Mitchell, N. J., F. W. Allendorf, et al. (2009). "Demographic effects of temperature-dependent sex determination: will tuatara survive global warming?" Global Change Biology doi: [10.1111/j.1365-2486.2009.01964.x](https://doi.org/10.1111/j.1365-2486.2009.01964.x).

Mo, J.-Y., X. Xu, et al. (2010). "The evolution of the lepidosaurian lower temporal bar: new perspectives from the Late Cretaceous of South China." Proceedings of the Royal Society B **277**(1679): 331-336.

Until recently, it was considered axiomatic that the skull of lizards and snakes arose from that of a diapsid ancestor by loss of the lower temporal bar. The presence of the bar in the living New Zealand Tuatara, *Sphenodon*, was thus considered primitive, corroborating its status as a 'living fossil'. A combination of new fossils and rigorous phylogeny has demonstrated unequivocally that the absence of the bar is the primitive lepidosaurian condition, prompting questions as to its function. Here we describe new material of *Tianyusaurus*, a remarkable lizard from the Late Cretaceous of China that is paradoxical in having a complete lower temporal bar and a fixed quadrate. New material from Jiangxi Province is more complete and less distorted than the original holotype. *Tianyusaurus* is shown to be a member of the Boreoteiioidea, a successful clade of large herbivorous lizards that were dispersed through eastern Asia, Europe and North America in the Late Cretaceous, but disappeared in the end-Cretaceous extinction. A unique combination of characters suggests that *Tianyusaurus* took food items requiring a large gape.

Moore, J. A., C. H. Daugherty, et al. (2009). "Seasonal monogamy and multiple paternity in a wild population of a territorial reptile (tuatara)." Biological Journal of

the Linnean Society **98**: 161-170.

Moore, J. A., C. H. Daugherty, et al. (2009). "Large male advantage: phenotypic and genetic correlates of territoriality in tuatara." Journal of Herpetology **43**(4): 570-578.

Morgan-Richards, M., R. D. Smissen, et al. (2009). "A review of genetic analyses of hybridisation in New Zealand." Journal of the Royal Society of New Zealand **39**: 15-34.

Müller, R. K. (2009). A novel survey technique to detect the diurnal arboreal gecko *Naultinus gemmeus* using clear PVC solariums. Münster, University of Münster: 12.

Nájera-Hillman, E., P. King, et al. (2009). "Effect of pest-management operations on the abundance and size-frequency distribution of the New Zealand endemic frog *Leiopelma hochstetteri*." New Zealand Journal of Zoology **36**: 389-400.

In New Zealand, introduced mammals, especially rats, have been considered a primary factor in the extinction of amphibians. *Leiopelma hochstetteri* is a riparian frog, and is the most widespread of the surviving species of native frogs in New Zealand. At present, all populations of this frog species coexist with introduced mammals, which in some cases have been subject to pest-management operations without monitoring the potential benefits or damage to the frogs. We investigated the influence of a 7-year rat management operation on frog abundance in the Waitakere Ranges, New Zealand. We identified which habitat characteristics had significant influence on frog abundance; confirmed that the study areas represented similar habitats both inside and outside the pest-managed area, and finally evaluated the effects of the pest-management activities. Frog abundance was positively correlated with percentage area covered by boulders and percentage area covered by water. Since the study sites were similar in terms of those variables, we could make a reliable comparison of frog abundance in relation to pest management. Presence/absence of pest-management operations did not have any significant effect on frog abundance. Size-frequency distribution data suggest that there has been recruitment of young frogs both inside and outside pest-management areas in the past 7 years.

Norbury, G., R. Heyward, et al. (2009). "Skink and invertebrate abundance in

relation to vegetation, rabbits and predators in a New Zealand dryland ecosystem." New Zealand Journal of Ecology **33**(1): 24-31.

We explored the relationships between ground vegetation, ground fauna (native skinks and invertebrates), rabbits, and predators in a modified New Zealand dryland ecosystem. We hypothesised that vegetation cover would provide habitat for ground fauna. We also hypothesised that rabbits (*Oryctolagus cuniculus*) would reduce the abundance of these fauna by reducing vegetation, and by providing prey for mammalian predators (cats *Felis catus* and ferrets *Mustela putorius*) that consume ground fauna as secondary prey. We measured these variables at 30 sites across three pastoral properties in the South Island in 1996 and 2002. There were mostly positive relationships between vegetation ground cover and fauna captures in pitfall traps. Relatively few beetles and caterpillars were caught where cover was less than 80%, no millipedes were caught where cover was less than 70%, and few spiders and mostly no skinks, crickets, flies or slugs were caught where vegetation cover was less than 50%. Most grasshoppers were caught where cover ranged from 30 to 80%. Faunal species richness was also positively related to cover. This supports our hypothesis that ground vegetation provides habitat for skinks and invertebrates in this ecosystem. The introduction of rabbit haemorrhagic disease in 1997 provided a natural experiment to test the hypothesised indirect effects of rabbits on ground fauna. Declines in rabbits varied between properties, and vegetation cover and predator abundance changed according to the magnitude of these declines. However, skink and invertebrate abundance did not track these changes as expected, but instead varied more or less consistently between properties. Some fauna increased (skink captures quadrupled and cricket captures nearly doubled), others declined (flies, caterpillars and spiders), and some did not change (beetles, millipedes, slugs and grasshoppers, and faunal species richness and diversity). Therefore, rabbits, predators and vegetation did not affect changes in skinks and invertebrates in consistent ways. The dynamics of ground fauna are likely to be more influenced by factors other than those we measured

Ogden, J. and J. Gilbert (2009). "Prospects for the eradication of rats from a large inhabited island: community based ecosystem studies on Great Barrier Island, New Zealand." Biological Invasions **11**: 1705-1717.

Great Barrier Island (c. 27,400 ha) is the largest off-shore Island in New Zealand. Some of the

most serious introduced mammalian pests of New Zealand are absent, but feral cats and rodents are present. Community based trusts are spear-heading ecological studies to support conservation and a pest eradication programme. Rodent numbers are greatest in late summer/autumn and lowest in winter/early spring. Maximum abundances were recorded in riparian and coastal vegetation, and in mature forest. Monitoring shows that trapping alone is not able to reduce rat numbers sufficiently for safety in avian reintroductions. A combination of trapping and strategically pulsed toxin baits, however, achieved low levels of rats. Ecosystem recovery is demonstrated by increases in key tree seedlings, large invertebrates and lizards in managed compared to unmanaged areas, and by the survivorship of translocated robins (*Petroica longipes*). The Great Barrier Island Charitable Trust is communicating these benefits, and associated risks, to the Island community, with a view to promoting pest eradication as a key component in an ecology-based economy, centred on eco-tourism.

Oldman, J. M. (2008). Non-surgical methods for sexing small juvenile tuatara (*Sphenodon punctatus*). Dunedin, University of Otago: 92.

Patterson, G. B. and T. P. Bell (2009). "The Barrier skink *Oligosoma judgei* n. sp. (Reptilia: Scincidae) from the Darran and Takitimu Mountains, South Island, New Zealand." *Zootaxa* **2271**: 43-56.

A new species of alpine skink, *Oligosoma judgei*, is described from the Darran and Takitimu Mountains, South Island, New Zealand. This species is diagnosed on the basis of morphological, ecological, and genetic differentiation from the following congeners: *O. pikitanga*, *O. acrinasum*, *O. infrapunctatum*, *O. otagense*, *O. taumakae*, *O. waimatense* and *O. grande*. The new species is characterized by a black base colour with bright green or yellow dorsal speckles, a white belly with occasional black speckles, and distinctive head scalation. The conservation status of the new taxon appears secure due to the altitude and extensive habitat in the Darran Mountains and apparently wide range extending to the Takitimu Mountains.

Rexer-Huber, K. M. J. (2009). Freezing frogs: the ecophysiology of winter survival in the brown tree frog, *Litoria ewingii*. Dunedin, University of Otago: 102.

Thierry, A., M. Lettink, et al. (2009). "Thermal properties of artificial refuges and their implications for retreat-site selection in lizards." *Applied Herpetology* **6**:

307-326.

Artificial retreats or refuges (ARs) provide a useful method for sampling lizards and a possible means of restoring habitat to aid population persistence. Previous research suggests that preferences for ARs may vary among species and between different designs. To test these ideas further, we examined the influence of thermal and structural characteristics on use of three types of ARs by the nocturnal common gecko (*Hoplodactylus maculatus*) and diurnal McCann's skink (*Oligosoma maccanni*), two lizards endemic to New Zealand. The field study confirmed that the three ARs (triple-layered Onduline, triple-layered iron, solid concrete) differed in retreat-site temperatures provided during each of three seasons (winter, spring and summer). In their top spaces, Onduline ARs were the warmest by day, coolest by night, and thus displayed the largest diel variations in temperature. In the laboratory, common geckos showed a significant preference for Onduline whether ARs were exposed to a radiant overhead heat source or not, whereas skinks did not display any preference among the three types of ARs regardless of heating. The three types of ARs provided field temperatures within the thermal preference range of both species (data obtained from the literature) but only for the top spaces of the ARs and only during summer. Onduline was the only AR to consistently provide the temperatures preferred by pregnant females. Although this study suggests that structural properties alone may be sufficient to explain the preference of geckos for triple-layered Onduline stacks, it does not eliminate the possibility that attractive thermal properties also contribute. Long-term studies are needed to test the effects of artificial refuge supplementation on reptiles, and on their predators and competitors.

Towns, D. R. (2009). "Eradications as reverse invasions: lessons from Pacific rat (*Rattus exulans*) removals on New Zealand islands." Biological Invasions **11**: 1719-1733.

Eradications of kiore or Pacific rats (*Rattus exulans*) from islands around New Zealand have been followed by responses from resident species of coastal plants, invertebrates, reptiles and seabirds. These responses are compared with an invasion by ship rats (*Rattus rattus*), which devastated populations of invertebrates, birds and bats.

Post-eradication responses only approximate the effects of invasions because recovery is limited to the residual pool of native species. Greater effects of kiore are indicated by adding incompatible species confined to rat-free locations. The extended list includes at least 15 species of invertebrates, two species of frogs, tuatara (*Sphenodon punctatus*), 11 species of lizards and 9 species of seabirds. The analyses indicate direct and indirect effects of kiore similar to those reported after ship rat invasions. This is despite indications from the literature that kiore are the least damaging of the three commensal rat species.

van Heezik, Y., A. Smyth, et al. (2010). "Do domestic cats impose an unsustainable harvest on urban bird populations?" Biological Conservation **143** (1): 121-130.

We assessed the impact of domestic cats on population persistence of native and exotic urban bird populations using a model adjusted for habitat-specific catch rates, cat ownership and hunting activity data. GPS-derived home ranges of 32 cats and resource selection indices demonstrated the degree of penetration and preference for native vegetation fragments. Owners reported on prey brought back by 144 domestic cats in Dunedin, New Zealand, during 12 months. One third of cats never brought back prey, and 21% returned more than one item/month. Cats brought back a mean of 13.4 prey items/year (median = 4), with cats aged <1 year returning more prey than older cats. Birds were the most common prey, followed by rodents. Although cats penetrated adjacent vegetation fragments they did not catch more birds and preferred garden habitat, suggesting that predation pressure may be reduced in fragments. Cat home range size appears to be constrained by cat density while the number of birds caught depends on the density of available prey. Estimates of city-wide catch for six bird species were either more than total urban population size estimates or close to lower confidence intervals. Modelling of three species indicated low likelihood of population persistence with cat predation. The observed persistence of these prey species suggests a meta-population structure with urban populations acting as sinks with source populations located on the city fringe.

Wallis, G. P. and S. A. Trewick (2009). "New Zealand phylogeography: evolution on a small continent." Molecular Ecology **18**: 3548-3580.

White, H. A. (2009). The role of kinship in schooling behaviours of *Litoria raniformis* larvae. Dunedin, University of Otago: 81.