# Owl Assemblages and Their Value for Environmental Reconstructions

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Owls are predatory birds (raptors) that sleep during the day and hunt at night. They almost never scavenge and therefore do not ingest bones from large animals. In Australia, disc-faced owls (*Tytonidae* spp.) frequently occupy caves, whereas the eagle-faced owls (*Strigidae* spp.) tend to prefer to roost in trees (Andrews 1990; Lundelius 1966) (Figure 1). There are a number of ways bones can accumulate in caves, but large assemblages are almost always accumulated by predators. Caves typically form in water-soluble alkaline rocks such as limestone. Due to its high pH, limestone caves buffer and protect bones from degradation, making them more likely to be preserved for long periods of time.

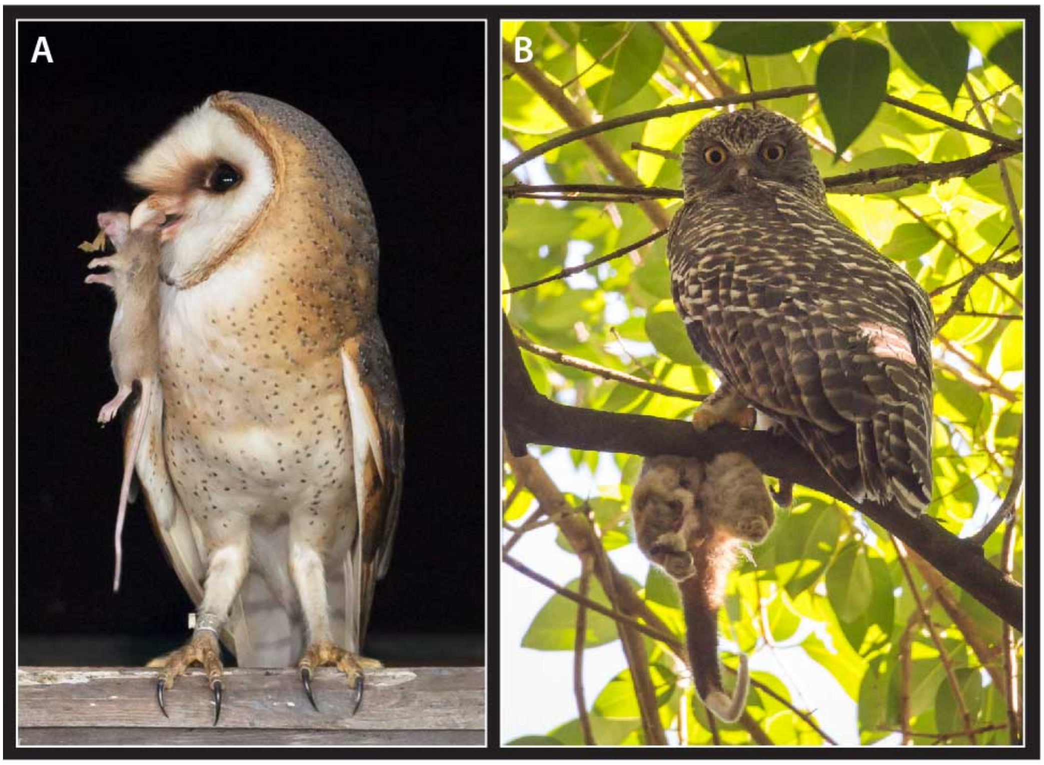


**Figure 1**. A: Eastern Barn Owl (*Tyto javanica*) with rodent prey. Note the disk of white feathers around its face, that helps collect sound to pinpoint prey. B: Powerful Owl (*Ninox strenua*) with prey, a Ring-tailed Possum (from www.flickr.com/ Creative Commons).

Disk-faced owls typically hunt rodents and other small terrestrial mammals, but have been known to subsist primarily on reptiles (McDowell & Medlin 2009) and even fish (Broughton et al. 2006). The bones of their prey are typically characterised by largely intact/unbroken long-bones, intact or disarticulated skulls, complete/unbroken dentaries and little or no digestive erosion.

Each species of owl has a maximum prey size. Masked Owls and Barn Owls usually hunt terrestrial and arboreal mammals with a maximum adult weight of 200 g, though they also prey on juveniles of larger species.

Unlike most other birds, owls do not have a crop, the loose throat sac that most birds use to store food for later consumption. Owls typically swallow small prey whole, though larger prey is torn into manageable pieces before swallowing. Once swallowed, food passes directly into their digestive system.

Owl stomachs consist of two parts:

- The glandular stomach or proventriculus, which produces enzymes, acids, and mucus that begin the process of digestion.
- The muscular stomach, or ventriculus, also known as the gizzard which, unlike the glandular stomach, lacks digestive glands.

The undigestible parts of the prey such as the bones and fur are held in the gizzard, while the digestible parts can pass from the muscular stomach to the rest of the digestive system. Digestive enzymes are secreted into the small intestine where the food is absorbed into the body. Several hours after eating, the bones and fur that were retained in the muscular stomach are compressed into a mucus-coated pellet before being regurgitated (Figure 2, Video 1).

**Figure 2**. Eastern Barn Owl (*Tyto javanica*) pellets (photo by Graham Medlin).

**Video 1**. Eastern Barn Owl (*Tyto javanica*) regurgitating an owl pellet (video by Holger Kirk).

Pellets are typically regurgitated just before the owl goes out hunting again. This process is repeated every night, quickly resulting in a large accumulation of pellets at the owl's roost. Over time these pellets decompose, leaving the bones of their prey in the cave sediment (Figure 3). As the small mammals that owls prey on typically only live for 1–2 years, their bones can provide a sensitive record of environmental change.

**Figure 3**. Small mammal bones from Kelly Hill Cave, Kangaroo Island, South Australia, retained in a 1 mm sieve (photo by Matthew McDowell).

Caves can also be occupied, or even just used as a latrine, by mammalian predators. For example, Figure 4 documents the characteristics of bones from a Tasmanian Devil latrine assemblage from the deeper layers of Seton Rockshelter on Kangaroo Island, South Australia (McDowell et al. 2015). Compared with owl roost deposits, in many parts of the world accumulated mammal bone assemblages are quite rare.


**Figure 4.** Bones from the deeper layers of Seton Rock shelter, Kangaroo Island, South Australia. All bones shown are coated with the predator's faeces. A: Coprolite containing bones from families Peramelidae and Muridae. B: Magnified section of 'A', showing a murid tibia with spiral, or green-bone, fracture. C: Long-bone fragment showing two compression fractures (outlined by dashed lines) probably caused by mammalian mastication. D: Dorsal view of a macropodid calcaneus showing digestive erosion. E: Fragment of macropodid pelvis showing rounded edges along breaks, and thinning typical of digestive erosion. F: Distal view of a macropodid humerus showing digestive erosion of the articular surface. All scale bars = 1 cm (after McDowell et al. 2015).

By studying living animals to learn about their environmental, dietary and sheltering needs—also known as a species' 'environmental envelope'—researchers can begin to interpret how bone assemblages have accumulated within a site. Such understandings can also help researchers predict where different species might live today, as well as where they may have lived in the past. We can also invert this interpretative capacity, and use the environmental envelope to identify the environmental conditions that occurred wherever a given species has been found, including of the predator through their regurgitated fossil bones.

Arguably the most important contribution owl roost assemblages can make to ecology is the establishment of realistic biodiversity baselines that can be used to measure biodiversity loss and establish restoration targets (e.g. Benayas et al. 2009; Froyd & Willis 2008; Higgs 1997). As Rodrigues et al. (2019) have cogently noted, 'Ecological baselines—reference states of species' distributions and abundances—are key to the scientific arguments underpinning many conservation and management interventions, as well as to the public support to such interventions'.

By studying the palaeobiogeography and distribution of recent fossil remains, researchers can set realistic ecological baselines for present day species abundance and avoid the problems associated with 'baseline shift' (McDowell 2014). Baseline shift (or 'shifting baseline syndrome') occurs when an arbitrary baseline is accepted and used to evaluate change with no consideration of prior human-induced ecological modification (Miller 2005). These factors can also be projected into the future (forecasting) and the past (hindcasting) when trying to better understand the past, present and future of environmental change.

## References


Andrews, P. (1990). *Owls, Caves and Fossils*. Chicago: University of Chicago Press.

Benayas J. M. R., Newton A. C., Diaz A. & Bullock J. M. (2009). Enhancement of biodiversity and ecosystem services by ecological restoration: A meta-analysis. *Science* 325: 1121–1124. https://doi.org/10.1126/science.1172460

Broughton, J. M., Cannon, V. I., Arnold, S., Bogiatto, R. J. & Dalton, K. (2006). The taphonomy of owl-deposited fish remains and the origin of the Homestead Cave ichthyofauna. *Journal of Taphonomy* 4: 69–95. https://content.csbs.utah.edu/~broughton/Broughton%20PDFs/Broughton%20et%20al.%202006.pdf

Froyd C. & Willis K. (2008). Emerging issues in biodiversity and conservation management: The need for a palaeoecological perspective. *Quaternary Science Reviews* 27: 1723–1732. https://doi.org/10.1016/j.quascirev.2008.06.006

Higgs E. S. (1997). What is good ecological restoration? *Conservation Biology* 11: 338–348.

Lundelius, E. L. (1966). Marsupial carnivore dens in Australian caves. *Studies in Speleology* 1: 174–181.

McDowell M. C. & Medlin G. C. (2009). The effects of drought on prey selection of the barn owl (*Tyto alba*) in the Strzelecki Regional Reserve, north-eastern South Australia. *Australian Mammalogy* 31: 47–55. https://doi.org/10.1071/AM08115

McDowell, M. C. (2014). Holocene vertebrate fossils aid the management and restoration of Australian ecosystems. *Ecological Management & Restoration* 15(1): 58–63. https://doi.org/10.1111/emr.12075

McDowell, M. C., Prideaux, G. J., Walshe, K., Bertuch, F. & Jacobsen, G. E., (2015). Re-evaluating the Late Quaternary fossil mammal assemblage of Seton Rockshelter, Kangaroo Island, South Australia, including the evidence for late-surviving megafauna. *Journal of Quaternary Science* 30(4): 355–364. https://doi.org/10.1002/jqs.2789

Miller J. R. (2005). Biodiversity conservation and the extinction of experience. *Trends in Ecology & Evolution* 20: 430–434. https://doi.org/10.1016/j.tree.2005.05.013

Rodrigues, A. S., Monsarrat, S., Charpentier, A., Brooks, T. M., Hoffmann, M., Reeves, R., Palomares, M. L. & Turvey, S. T. (2019). Unshifting the baseline: A framework for documenting historical population changes and assessing long-term anthropogenic impacts. *Philosophical Transactions of the Royal Society B* 374(1788): 20190220. https://doi.org/10.1098/rstb.2019.0220