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Dingoes, Quolls, Foxes, Monitors: Competition Between Predators in Myall Lakes National Park, New South Wales

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Recent improvements in ecological monitoring techniques have helped to shed light on how animals affect other species within their environment. Predator species, those which eat other animals to survive, have been shown to affect the structure and functioning of some ecosystems, particularly by consuming herbivores, which become overabundant in their absence, and by suppressing the impacts of other predators. The most famous example of this interaction is from wolves (*Canis lupus*), which were reintroduced to Yellowstone National Park in the United States in the 1990s, which increased the levels of fear in overabundant elk (*Cervus canadensis*) populations in the park. This fear caused the elk to change their behaviour and reduced their foraging of tree saplings, which previously had not been able to develop fully. The altered behaviour of the elk transformed parts of the park from open grasslands to a forest, benefitting many plant and animal species, such as willows and beavers.

While there were many winners from wolf reintroduction, there were also losers; coyotes (*Canis latrans*), numbers of which had expanded significantly after the removal of the wolf, experienced a significant population decline, as much as fifty percent in some areas. This population decline is an example of trophic cascade theory in action, particularly the mesopredator release hypothesis. This hypothesis suggests that larger, dominant predators, in this case, the wolf, 'interfere' with smaller predators, the coyote (one-third the size of wolves), by outcompeting them for resources and through killing when they come into direct contact with each other. This competition between species again has flow-on benefits for other species. For example, red foxes (*Vulpes vulpes*) in Yellowstone National Park benefitted from the presence of wolves, as the high densities of coyotes in the park were previously suppressing them.

The mesopredator release hypothesis has support in numerous ecosystems across the world. In Africa, lions (*Panthera leo*) suppress populations of smaller predators like African wild dogs (*Lycaon pictus*). In coral reefs, larger sharks suppress populations of smaller stingrays. In many environments in Australia, the dingo (*Canis dingo*) affects the abundance and behaviour of red foxes.

The negative impacts of the invasive red fox in Australian environments are well documented. Introduced to Australia in the 1850s, foxes have been implicated in the decline and extirpation of many of our unique Australian fauna, including species such as the bettong (*Bettongia penicillata*), greater bilby (*Macrotis lagotis*), and the bridled nail-tail wallaby (*Onychogalea fraenata*). Additionally, foxes are purported to impact some of our native Australian predators. The spotted-tail quoll (*Dasyurus maculatus*), our largest extant marsupial predator, has experienced severe population reductions and is listed as Endangered in Australia, and encounters competition with similarly sized foxes listed as a key threatening process. Similarly, the lace monitor (*Varanus varius*), in some areas of New South Wales, has higher population sizes in areas where foxes are lethally controlled than in areas where they are not.

Myall Lakes National Park, located on Worimi Country on the mid-north coast of New South Wales, is a highly biodiverse environment consisting of closed angophora woodland, coastal dunes, heathland, swamp, freshwater lakes, and patches of rainforest. Dingoes, Australia's apex mammalian predator, spotted-tail quolls, foxes,

Camera trap image from Myall Lakes National Park, showing a spotted-tail quoll (*Dasyurus maculatus*) investigating chicken from a bait tube. Image: Camera Trap Footage. Image: Dr Brad Smith.

Top: Brendan is a PhD Candidate in the Centre for Ecosystem Science at the University of New South Wales Sydney. Brendan has an interest in species interactions, particularly between competing predators.

and lace monitors (all mesopredators), are present in the park. Dingoes are highly visible in the area, often visiting campgrounds and occurring in high density in the town of Hawks Nest at the southern edge of the park. The dingo population in Myall Lakes has been studied since 2018 as part of the Myall Lakes Dingo/Dapin Project, in collaboration with the Centre for Ecosystem Science at the University of New South Wales Sydney, Taronga Conservation Society, MidCoast Council, NSW National Parks and Wildlife Service, and Karuah and Foster Aboriginal Land Councils.

Many individual dingoes in the area are known to the Myall Lakes Dingo/Dapin Project. This project aims to improve the management of dingoes, which can cause conflict when they come into close contact with people, by improving our understanding of their social dynamics, behaviour, and broader ecological impacts. In a prior population survey, twenty-seven adults and thirteen pups were individually identified, predominantly using camera traps. Camera traps, which take photos or videos when motion is detected in front of the camera, have revolutionised the studies of animals, particularly cryptic species which are difficult to observe directly in the wild.

Our study aims to estimate the densities and abundance of dingoes, foxes, quolls, and monitors in the Myall Lakes region and explore the relationships between their spatial distributions. While the relationships between dingoes and foxes have been extensively studied in some ecosystems, the relationships and interactions between all four predator species mentioned above have not previously been studied simultaneously. Additionally, previous studies looking at the relationships between predators in Australia predominantly used indices, such as track counts or spotlight surveys, to estimate abundance. Camera traps have enabled researchers to identify individuals of species with variable pelage patterns, such as quolls, dingoes, and monitors. This technology opens the possibility of using spatial capture-recapture (SCR) models to estimate density, which requires individual identification and is considered the 'gold standard' of population abundance estimation in wildlife monitoring.

To estimate the populations of monitors, dingoes, foxes, and quolls, sixty-one camera trap stations have been deployed throughout Myall Lakes National Park. These cameras will be serviced and monitored for three months during the summer of 2022-2023. Twenty-two road-based camera stations, consisting of two cameras placed on opposite sides of trails and roads, will target dingoes and foxes that predominantly use trails. Thirty-nine baited camera stations, pointed at an inaccessible food lure, will target quolls and monitors. The densities of each predator species will then be modelled by identifying as many individuals as possible from the camera trap images. The spatial relationships of each predator across the study area will be compared, as well as their interactions and visitation times at different camera stations.

A dingo (*Canis dingo*) pup born in 2021 was identified from camera trap footage during a dingo population survey in Myall Lakes National Park. Image: Camera Trap Footage.

Our study aims to highlight some of the ecological roles that dingoes play in this environment, which will aid in the management of dingoes generally. We expect that where dingo densities are high, the densities of foxes will be low, as predicted by the mesopredator release hypothesis. Mesopredators, quolls, and monitors may also be suppressed by high densities of dingoes, although a reduction in competition with foxes due to their suppression by dingoes may counter these effects.

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A dingo (*Canis dingo*) at Mungo Brush Campground is looking for a snack at a barbecue table. Dingoes are often a source of human-wildlife conflict when they become habituated to humans, particularly when they are used to receiving food. Image: Dr Neil Jordan.