5

Turtles of Cooper Creek – life in the slow lane

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Introduction

Cooper Creek in central Australia is one of the least likely places to be home to freshwater turtles. When it flows, it flows into one of the largest inland salt lakes in the world, Kati Thanda-Lake Eyre, and on the way fills waterholes, channels and floodplains in the semi-arid and arid regions, with median annual rainfall less than 200 mm/year (Kotwicki 1986). Yet turtles not only survive but thrive in the waterholes and billabongs along Cooper Creek.

Freshwater turtles in Australia are not only faced with a scarcity of water, compared to turtles in North America and Asia, but also the variability of when this water is available, given the considerable unpredictability in rainfall and resultant timing and magnitude of river flow and floodplain inundation. Turtles such as the Cooper Creek turtle (*Emydura macquarii emmottii*; Fig. 5.1), which survives in the driest part of our continent, cope in different ways with periodic drying and unpredictability, timing and duration of floods and dry periods.

Fig. 5.1. The endemic Cooper Creek turtle is a giant of freshwater turtles and a top predator living mainly in the large waterholes of the Cooper Creek catchment (photo, A. Emmott).

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The ecology of the Cooper has characteristic boom and bust periods (Kingsford *et al.* 1999; Bunn *et al.* 2006; see Chapter 1). Long dry periods of low productivity ('busts') dominate but are punctuated by widespread floods, usually driven by rainfall high in the catchment ('boom' periods) (Puckridge *et al.* 2000). For the freshwater turtles, the boom comes in two forms. First, when the river runs, the turtles take advantage of foods carried into their waterholes with the floodwaters; they often concentrate around the inflows. These are 'mini-booms' (Bunn *et al.* 2006), occurring with greater frequency than major floods. Second, there are the major floods which dramatically expand available habitat and access to new food sources.

The key message we convey here is how dependent these animals are on flows – on the timing and frequency of river runs, on the frequency, extent and duration of major floods, and on the pattern of floodplain inundation across the landscape, essential to the metapopulation dynamic that sustains the turtles. The hydrology of Cooper Creek has been little affected by water resource development, with the main driver of flow being natural climatic fluctuations that influence rainfall and runoff (Puckridge *et al.* 2000). Although Cooper Creek experiences low-level flows in most years, the discharge rates are extremely variable and episodic (Puckridge *et al.* 1998). One of the greatest threats to natural flow and flooding regimes is the diversion of flows. This water resource development in dryland rivers often decreases the frequency and duration of flow pulses, reducing floods and sometimes elevating base flows (Bunn *et al.* 2006). We argue that it is the alteration of these flow attributes through water resource development and deliberate or inadvertent water diversion in a landscape of very low relief that will be potentially catastrophic for turtle populations, and for other species with similar requirements and dispersal capabilities. We compare the biology of two turtles in the Lake Eyre Basin.

Eastern long-necked turtle

The eastern long-necked turtle (*Chelodina longicollis*; Fig. 5.2) is a carnivore, feeding on slow-moving prey such as macroinvertebrates, tadpoles, terrestrial insects that fall upon the water, and carrion (Georges *et al.* 1986; Kennett *et al.* 2009). It survives dry periods by migrating overland between temporary and permanent water (Roe and Georges 2008; Roe *et al.* 2010). Individuals have adaptations for surviving extended periods on land without access to food and water (Roe *et al.* 2008). During short dry periods, they move onto land and become semi-dormant (aestivate) in the leaf litter and other damp areas or waterholes, emerging when the rains come. They know the landscape well and navigate using the sun and an internal clock (Graham *et al.* 1996). They can maintain their body condition and water balance for up to a year, without access to freestanding water (Roe *et al.* 2008). During more extended dry periods, the turtles migrate from ephemeral swamps and wetlands to permanent water where their densities can reach 400 turtles/ha (Parmenter 1976). When there is insufficient food, the turtles stop growing and reproducing (Kennett and Georges 1990). Large populations in waterholes can enter a form of collective dormancy, waiting out the drought, like some fish and other reptiles. This contrasts with mammals whose populations crash and rebound when the good times return, or birds who move out and return during boom periods.

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Fig. 5.2. Eastern long-necked turtles live in the upper reaches of the Lake Eyre Basin, favouring temporary waters and taking advantage of the production boom in invertebrate life when they fill (photo, A. Emmott).

Eastern long-necked turtles live in the Cooper catchment, but only as far south as Lake Dunn, near the town of Aramac. Further south along the Cooper becomes problematic for this species because of the long dry periods between flooding and the distances between waterholes which make overland migration difficult.

Cooper Creek turtle

Surprisingly, the Cooper Creek turtle (Fig. 5.1) survives in Cooper waterholes (Fig. 5.3), all the way down to Innamincka. It also occurs at low densities in the Diamantina River. Unlike the Eastern long-necked turtle, the Cooper Creek turtle must have access to free-standing water at all times to survive. As a subspecies of Murray River turtle (*Emydura macquarii*), the Cooper Creek turtle is catholic in its diet, eating algae, freshwater sponges, flowers, fruits and leaves of terrestrial plants when they become available as litterfall or through inundation, and various sedentary animals, including aquatic and terrestrial insects, crustaceans and carrion. As a short-necked turtle, it lacks the long neck of eastern long-necked turtle, and so is unable to secure moving prey such as fish and some mobile invertebrates (Chessman 1986).

The turtles can move extensively onto the floodplains during floods. For example, one individual moved 20 km between Broadwater billabong on Lochern National Park to

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Fig. 5.3. Waterholes along Cooper Creek are deep and critically important aquatic habitat for turtles, which need to survive through prolonged dry periods. They form along the main channel during dry times. These waterholes are vulnerable to reductions in flows resulting from future water resource development (photo, R. T. Kingsford).

Waterloo billabong on Noonbah Station). They were observed walking just in front of a flood on the floodplain of South Galway Station, near Windorah, far from the nearest permanent waterhole (Sandy Kidd, pers. comm.). The turtles probably know the landscape well, and use the floods to move between waterholes and floodplains where there is plentiful food. The food source then concentrates as the boom period ends and floodplains dry out and fish, crustaceans and insects concentrate in the waterholes where the only water remains. Cooper Creek turtles are giants of the turtle world in Australia (Fig. 5.1).

They reach sizes up to 37 cm in shell length (White 2002). It could be that their size reflects these periods of considerable plenty, punctuating the relatively extensive periods of scarcity. Food resources are partitioned between maintaining essential body functions (cellular maintenance and sustenance), body growth and reproduction (Bowden *et al.* 2011). When food is limiting, turtles allocate their resources more tightly. For example, *Emydura macquarii nigra* on Fraser Island partition food resources for maintenance and growth until

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they are sexually mature, and then they reallocate resources into maintenance and reproduction. Growth slows dramatically at maturity and body sizes are limited by this dynamic partitioning (Georges 1985).

In the boom–bust Cooper Creek, resources bounce between severe depletion and plenty. During the bust times, Cooper Creek turtles direct their resources almost entirely to maintenance, sometimes even surviving in the mud (Fig. 5.4). Similarly, eastern long-necked turtles in wetlands near Jervis Bay in New South Wales partition their resources (Kennett and Georges 1995). In the boom times, there is abundant food, probably allowing Cooper Creek turtles to direct their energy to maintenance, reproduction and growth in a way not possible in more stable systems. This allows them to grow to be giants, albeit sporadically, throughout their lives.

The pressures of booms and busts and these life history tactics mean that populations of Cooper Creek turtles vary in a fascinating way, along the waterholes of Cooper Creek. Juveniles and adult males and females can be distinguished (Georges *et al.* 2006). The

Fig. 5.4. During bust periods, turtles in Cooper Creek can die when waterholes dry up. Some individuals can survive briefly by seeking refuge in the mud, such as this Cooper Creek turtle from Lake Dunn, but they soon die (photo, J. Cann).

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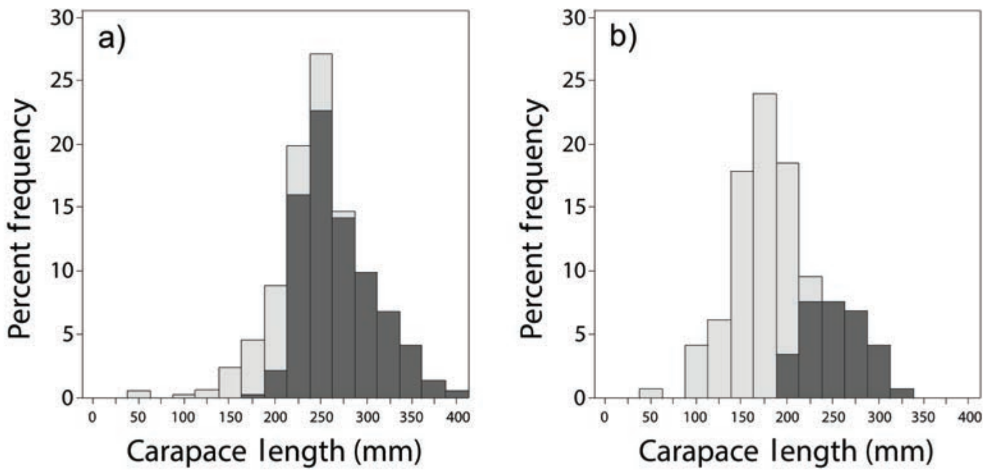

Fig. 5.5. Size distributions of adult (dark grey) and juvenile (light grey) Cooper Creek turtles, measured as carapace length which is a good indication of age from (a) a permanent waterhole on Cooper Creek (Eulbertie Waterhole) compared with (b) a typical waterhole that periodically undergoes complete drying (Tanbar Homestead Waterhole).

permanency of waterholes becomes critical. There are many waterholes of different size and permanency along Cooper Creek (Silcock 2010). Large waterholes with permanent water since European settlement (e.g. Eulbertie Waterhole) are dominated by large mature individuals, with few juveniles and no evidence of recent recruitment (Fig. 5.5a). This represents a climax state where the population has matched the capacity of the waterhole to sustain a turtle population of a certain size. Contrastingly, some waterholes dry completely (e.g. Tanbar Waterhole in 1983; Fig. 5.5b), presumably killing all the turtles. In these waterholes, when they fill up, juveniles, including small individuals, dominate. These waterholes are colonised by a few individuals from more permanent waterholes. They follow an upswing, inevitably followed by a catastrophic decline when the waterhole dries again, perhaps decades later.

There is a dynamic built around the different successional waterholes from some completely dry to others remaining as a chain of small pools (e.g. Fish Billabong and Broadwater Billabong in Lochern National Park) and the permanent ones. Turtle sizes and growth rates track this gradient between ephemeral and permanent waterholes. There is added complexity with the variability of floods and their effects on waterhole permanency. All along the Cooper, there are local extinctions of turtles and climax populations from which recruits then colonise waterholes when they fill. These processes unfold over decades, affecting dynamics in the slow lane, but allowing this water-dependent turtle to persist in the desert rivers of the Lake Eyre Basin.

Turtle sustainability

Natural river flows and flooding have produced healthy but highly dynamic populations of turtles, intricately locked into the dynamics of the rivers. Boom periods are pivotal in their production of widespread flooding, which also produces high productivity of plants and

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animals (Kingsford *et al.* 2014) as well as cattle (see Chapters 10 and 11). Native fish species cope with this episodic flooding, breeding in large numbers during boom periods and then dispersing across the floodplains (see Chapters 3 and 4). Waterbirds also capitalise on the large feeding areas created by the floods before congregating on lakes in the Lake Eyre Basin or other wetlands in Australia (Kingsford *et al.* 1999).

The freshwater turtles of the Cooper Creek employ different strategies. They can live for a long time (likely more than 100 years, though hard data are difficult to obtain), with their low metabolism and energy needs, allowing them to wait out bleak dry periods. Their success in this difficult environment depends on food delivered by flows into the Cooper waterholes when the river 'runs'. These 'in between' (Bunn *et al.* 2006) flows sustain the waterholes, allowing some to persist, even in the dry times, and then colonising waterholes which may dry out after breeding in the boom times. Abstraction of water from the rivers of the Lake Eyre Basin could have devastating consequences on the Cooper Creek turtle. The eastern long-necked turtle is less susceptible but still threatened. For Cooper Creek turtles, diversion of water from the river may push permanent waterholes to dry out, even if small flows are taken out (Bunn *et al.* 2006). The impacts on turtle populations would be devastating. The climax populations could become locally extinct, not only removing them from the river but also halting the ability of these stable populations to provide juveniles to the waterholes along the Cooper. Ultimately, there could be thresholds exceeded, which might threaten the species with extinction. The key message is that these animals depend on flows – all of them. It is the timing and frequency of river runs, as well as the frequency, extent and duration of major floods and how these floods spread across the floodplain which is critical. Alteration of flows through deliberate or inadvertent water diversion will be catastrophic for Cooper Creek turtles.

Conclusion

It is critical to ensure that natural flow regimes are maintained in this incredibly important river system.

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