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Distribution of Freshwater Turtle Rock Art and Archaeological Sites in Australia: a Glimpse into Aboriginal Use of Chelonians

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***Abstract.*—Turtles and tortoises have been an important part of the diet and cultural practices of Indigenous peoples throughout the world since the dawn of humanity. In Australia, freshwater turtles are an integral part of Aboriginal culture, which manifests itself in their rock art, mythology, and as a food source. Despite that, not much of the historical use of turtles by Aboriginal people has been documented, nor which species were potentially used and featured specifically in cultural lore and traditions. To fill this gap, we reviewed the published literature and collated information from rock art sites featuring freshwater turtles and records of turtle remains in archaeological sites in Australia. We report dating, if available, and overlapped records with turtle distribution maps. We recorded 130 Aboriginal art sites featuring freshwater turtles and 30 archaeological sites with freshwater turtle remains; both were most common in the Northern Territory. Using species distribution maps, we were able to confirm some turtle species identified by the original authors. Specifically, 17 of 25 turtle species in Australia have potentially been featured in rock art and 15 of the 25 have potentially been used as a food source. There is evidence that freshwater turtles were part of the diet of Aboriginal people for at least 24,000 y. Turtles were culturally important, owing to the variety of styles presented in the rock art, with turtle paintings up to about 6,000–10,000 y old. Our study expands the understanding of freshwater turtle use by Aboriginal people, and we suggest future investigations to understand current use of turtles in the country.**

Key Words.—conservation; dendroglyph; ethnobiology; mythology; painting; petroglyph; pictograph; tortoise; traditional use

Introduction

Turtles have been associated with early hominin archaeological sites for millions of years, dating back to the late Pliocene and early Pleistocene on the African continent (4.4–2.6 Mya, Rhodin et al. 2015). The rise of stone tools and signs of turtle shell crushing and butchering show a definitive record of turtle consumption by early humans in Africa at around 2.6–2.5 Mya (Rhodin et al. 2015). As early humans dispersed from Africa, turtles continued to be part of their varied diet, with records of hominin turtle consumption in Eurasia (Spain: 1.2 Mya, Israel: 200,000 y BP, Italy: 120,000 y BP), North America (12,000 y BP), and South America (11,700–9,880 y BP; Rhodin et al. 2015). Additionally, turtles have also been part of ancient cultural practices of Indigenous people throughout the world, with turtle shells serving as musical instruments in the USA (Gillreath-Brown and Peres 2017), clay reliefs in Africa (Zubieta 2016), and ceramic art in Panama (Cooke 2004), St. Vincent and the Grenadines (Waldron 2011). Rock art depictions have been documented in New Guinea (Röder 1939), South Africa (Rudner and Rudner 1968), Canada (Lanoue 1990), Somaliland (Mire 2008), Honduras (Palka 2010), India (Nihildas 2014), and in Alabama (Henson 1986), Nevada (Schneider and Everson 1989), Montana (McCleary 2016), Kentucky (Coy et al. 1997), Wyoming (Loendorf et al. 2005), Arizona (Bostwick 2002), and California (Whitley 2005) in the USA.

In Australia, there is evidence that Aboriginal people first arrived on the continent by around 65,000–50,000 y ago (Clarkson et al. 2017; Bradshaw et al. 2021), from Southeast Asia to the northwest of Australia (Clarkson et al. 2017; Crabtree et al. 2021), and so may represent the oldest surviving human culture in the world (Flood 2013). Throughout the archaeological record, Aboriginal people have consumed a great variety of fauna, including freshwater turtles (O'Connor 1999; Brockwell et al. 2011; Martin 2011). Up to the present day, some Australian turtle species (e.g., Northern Snake-necked Turtle, *Chelodina rugosa*; Chaloupka 1993, and Northern Snapping Turtle, *Elseya dentata*; Guse 2005) are still consumed by Aboriginal people in a traditional way, representing an important source of protein (Chaloupka 1993; Fordham et al. 2006).

Australia is the richest continent for rock paintings (pictographs) and engravings (petroglyphs) in the world (Taçon 2000). Many aspects of the daily life of Aboriginal peoples, including historical events, cultural practices and spirituality, and their regional plants and animals, including ancient megafauna, were portrayed in pictographs (Taçon 2000; Flood 2013; Taçon and Webb 2017), representing a unique archaeological source (Taçon 2000). The depictions of fauna in Australian rock art has had several interpretations, including food items consumed, maintenance of natural species, hunting magic, and totem portrayals (Flood 2013), but they can go beyond mere depictions of food animals, representing narratives of the traditional past (Taçon 1989).

Freshwater turtles are among the animals depicted in Aboriginal rock art in Australia (McCarthy 1983; Layton 1992; David and Lourandos 1998; Taçon et al. 2003; Veth et al. 2018) and the scientific importance of it cannot be underestimated, as illustrated by the case of the Pig-nosed Turtle (*Carettochelys insculpta*). The *C. insculpta* in Australia only came to the attention of science in 1970, when its presence in the Daly River in the Northern Territory was reported (Cogger 2000), though eggs of the species from the East Alligator River had languished unidentified in the collection of the Victoria Museum since the early 1900s (Georges et al. 2000, 2008). In the meantime, a pictograph of *C. insculpta* at Nourlangie Rock prompted scientists to look more closely at the rivers draining the Arnhem Land Plateau where the species was soon found to occur (Chaloupka 1993; Georges et al. 2000). Despite the long evidence of Aboriginal people associated with freshwater turtles in Australia (Chaloupka 1993; O'Connor 1999; David and Lourandos 1998), there have been no systematic studies to document the ancient country-wide use of this resource. Our investigation aims to fill this gap by reviewing published literature and: (1) recording the distribution of rock art sites with freshwater turtle art and presenting dates of the records if available; (2) recording archaeological sites in Australia containing turtle remains, and presenting dates if available; and (3) identifying, if not available in the original literature, the potential freshwater turtle species depicted in the rock art or present in the archaeological findings, through the overlap of such records with species distribution maps.

Materials and Methods

Our investigation focused on Aboriginal art and archaeological sites in Australia that had evidence of use. We also focused on the value placed on freshwater turtles by Aboriginal people, as a food source and/or that were of cultural significance. We considered records of freshwater turtles in: (1) rock art, including petroglyphs, pictographs, and stone arrangements; (2) tree carvings (dendroglyphs); (3) and any archaeological finding that showed evidence of turtle use, including the presence of bones in pits and middens. Owing to several interpretations of why animals are portrayed in the rock art in Australia, such as a food source or to show there was plenty of food in the area, totemism, hunting magic and mythology (Taçon 1989; Layton 1992; Flood 2013), when we refer to the use of turtles in the rock art context in the manuscript, we are considering it in a broader sense, its cultural value, which also includes it as a food item.

We conducted a literature review by searching for keywords that were related to the use of freshwater turtles in Australia on Scopus, Google Scholar, and Google. We also searched keywords in library databases in Australia, including the National Library of Australia, Australian Capital Territory (ACT) libraries, Australian Museum, University of Canberra (UC) library, and the Mura® Collections Catalogue and Photographic Collection of the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS). The keywords searched consisted of numerous combinations of the following: aboriginal people, aboriginal, Australia, fauna, wildlife, animal, rock art, freshwater turtle, turtle, tortoise, painting, rock painting, petroglyph, zoomorph, motifs, myth, mythology, pig nosed turtle, excavation, archaeology, bone, Murray River, pit, mound, and midden. As freshwater turtles in Australia are also locally called tortoises, we included this term in our search. We did not search for local Aboriginal names of freshwater turtles as such names are rarely presented in the title or abstract of publications. We intend to catalogue the Aboriginal names of turtles in a different study.

Our review collected evidence of freshwater turtle use in space and time, the species used, and the species attributed by the original authors, if available. We recorded the approximate location of the records (e.g., site name and location) from the original literature. For rock art depicting freshwater turtles, we considered each known location available in the literature as one record. We used this approach because a site occasionally had several turtle pictographs; consequently, this would be an impartial way to compare the amount of rock art sites among Australian states. If the date of the rock art or archaeological finding was present in the publication, we reported it, following the methods presented by the original authors, such as BP (years before present, meaning before AD 1950; Aubert 2012) or AD (*anno domini*, years in the Western calendar). We used abbreviations for each Australian state and territory throughout the text: Australian Capital Territory (ACT), New South Wales (NSW), Northern Territory (NT), Queensland (Qld), South Australia (SA), Western Australia (WA), Victoria (Vic) and Tasmania (Tas).

To aid in the identification of the turtle species in the rock art, archaeology, and/or carved tree sites, if not identified by the original authors, we created distribution maps of each freshwater turtle species in Australia, following taxonomy as presented in Van Dyke et al. (2018), with recent changes according to Kehlmaier et al. (2019). Distribution records were obtained from two databases: Wildlife Tissue Collection and Distribution Records at the University of Canberra (http://georges.biomatix.org/uc-wildlife-tissue-collection-turtles), and Atlas of Living Australia (https://www.ala.org.au/), with ArcGIS (version 10.8: esri, Redlands, California, USA) and Google Earth Pro. We then overlapped the turtle distributions with the rock art, archaeology and carved tree sites records, and presented the potential species that could be featured in each site. If the original record used a common name such as turtle or tortoise, we presented all potential turtle species with distributions overlapping the record. On the other hand, if the original record used a more detailed common name, such as long-necked turtle or short-necked turtle, we presented the potential long-necked turtle species or short-necked species, respectively. Lastly, if the original record used a specific scientific name, we checked if it was within the distribution range of that species.

Although the distribution of each turtle species presented in this study is considered current, we are assuming that the historical distribution of the Australian freshwater turtles might have expanded or contracted but that the core distribution has not changed much over the last 5,000 y. For example, the aridity in the Murray-Darling basin from the mid- to late-Holocene is similar to present day levels (Helfensdorfer 2020), and sea level stabilized to similar levels as present at around 3,500 y BP in the Murray estuary (Bourman et al. 2000), and at about 6,000 y BP in northern Australia (Taçon et al. 1996). Because much of the rock art and archaeological sites with assigned dates are not older than 5,000 y (Appendix, Supplemental Information Table S1), we assumed that the rock art and archaeological records found within a turtle species distribution should be valid and accurate.

Results

We found reports of 128 rock art sites in the reviewed literature that recorded freshwater turtle depictions in Australia, in addition to two sites with turtle dendroglyphs (carved trees) (Table 1, Fig. 1, Supplemental Information Table S1). Rock art sites with turtle motifs were most common in the NT, with the highest number of sites reported in Arnhem Land and Kakadu National Park, followed by Qld, NSW, WA, SA and ACT, with no records found from Vic and Tas (Table 1, Fig. 1). The most featured type of Aboriginal art with turtle images was rock paintings (pictographs; Fig. 2–5), followed by engraving (petroglyphs), charcoal drawing, stone arrangement and dendroglyphs, and beeswax figure (Table 1). Additionally, there were 30 archaeological sites with the presence of freshwater turtle remains in the reviewed literature, with most records in NT, followed by NSW and SA, Qld, WA, Vic, and no record available for the ACT and Tas (Table 2, Fig. 1, Appendix). Although the large majority of freshwater turtle rock art and archaeological sites were found inland (Fig. 1, Appendix, Supplemental Information Table S1), there were four records of freshwater turtle rock art on islands in Qld (Cliff, Flinders, Stanley and Clack Island), three in WA (Dampier Archipelago and Depuch Island), two in the NT (Groote Eylandt and Bickerton Island; Supplemental Information Table S1), and one archaeological site with freshwater turtle bones on Koolan Island, WA and Moreton Island, Qld (Appendix). The most inland records were found in NSW, with a turtle stone arrangement in Angledool (550 km from the coast), a turtle tree drawing in Bulgeraga Creek (460 km), a turtle petroglyph in Mootwingee (440 km) and an

Table 1. Number of rock art sites and types of Aboriginal art, per state, which have depiction(s) of freshwater turtle motifs in Australia. State abbreviations are ACT = Australian Capital Territory, NSW = New South Wales, NT = Northern Territory, Qld = Queensland), SA = South Australia, WA = Western Australia, Vic = Victoria, and Tas = Tasmania. Dendroglyph (carved tree) is considered here to illustrate another type of Aboriginal art that represents historical use of, or the value placed on, freshwater turtles.

State	Rock painting (pictograph)	Charcoal drawing	Dendroglyph (carved tree)	Engraving (petroglyph)	Stone arrangement	Beeswax	Total	%
ACT	3	0	0	0	0	0	3	2.3
NSW	4	6	2	7	1	0	20	15.4
NT	60	0	0	3	0	1	64	49.2
Qld	22	0	0	0	1	0	23	17.7
SA	2	0	0	2	0	0	4	3.1
WA	11	0	0	5	0	0	16	12.3
Vic	0	0	0	0	0	0	0	0.0
Tas	0	0	0	0	0	0	0	0.0
Total	102	6	2	17	2	1	130	

Figure 1. Distribution of sites with freshwater turtle motifs in Aboriginal rock art and dendroglyphs (tree drawing), and turtle remains in archaeological sites in Australia.

Figure 2. Aboriginal rock art painting (pictograph) of the Pig-nosed Turtle (*Carettochelys insculpta*) in Kakadu National Park, Northern Territory, Australia. We acknowledge the Bunitj, Manilagarr, and Mandjurlgunj people, the Traditional owners of this land and we pay our respects to their Elders, past, present, and emerging. The painting was touched up with Reckitts Blue by the artist in the early 1960s. (Photographed by Arthur Georges).

archaeological site in Menindee Lakes (414 km; Fig. 1, Appendix, Supplemental Information Table S1).

Turtle species identified in rock art.—Most of the freshwater turtle rock art motifs were identified to common names, such as turtle, tortoise, freshwater turtle, freshwater tortoise, long-necked turtle, long-necked tortoise, and short-necked turtle by the original authors (Supplemental Information Table S1). A few records, however, were more detailed and authors were able to identify genus and species: *E. dentata* in Mount Tolmer area in Litchfield Park, NT (Guse 2005); *C. insculpta* in Ubirr (McKenzie 1978; Taçon 1989; Layton 1992; Chaloupka 1993; Flood 1996; Smith 1998) and Nawurlandja, both in Kakadu National Park (Kimber 1975; Chaloupka 1993), and in Namarrgon site complex in Arnhem Land, NT (Chaloupka 1993); *C. rugosa* in Namarrgon site complex and Mikginj, both in Arnhem Land, NT (Chaloupka 1993); and the Steindachner's Long-necked Turtle (*Chelodina steindachneri*) in Murujuga, Dampier Archipelago, WA, (Veth et al. 2018; Supplemental Information Table S1). All these records and species names were corroborated by our species distribution maps, as the identified turtle species by the original authors fell within their respective species distributions (Supplemental Information Table S1, Supplemental Information Fig. S1). For the other records without a species name, we indicated the potential turtle species that could have been featured in each rock art site (Supplemental Information Table S1, Supplemental Information Fig. S1). Of all the 25 species of freshwater turtles in Australia (Van Dyke et al. 2018), 17 potentially could have been featured in the rock art according to our study (Supplemental Information Table S1), and these are the potential species in each state: NSW (Eastern Long-necked Turtle, *Chelodina longicollis*, Broad-shelled Snake-necked Turtle, *C. expansa*, Murray River Turtle, *Emydura macquarii*, and Bell's Sawshelled Turtle, *Myuchelys bellii*); ACT (*C. longicollis*); NT (*C. insculpta*, *C. rugosa*, Sandstone Snake-necked Turtle, *C. burrungandjii*, Cann's Long-necked Turtle, *C. canni*, Worrell's Short-necked Turtle, *Emydura subglobosa worrelli*, Northern Yellow-faced Turtle, *E. tanybaraga*, Northern Red-faced Turtle, *E. victoriae*, Yellow-bellied Snapping Turtle, *Elseya flaviventralis*, *E. dentata*, Gulf Snapping Turtle, *E. lavarackorum*, and Common Sawshelled Turtle, *M. latisternum*); Qld (*C. expansa*, *C. longicollis*, *C. canni*, *C. rugosa*, *E. macquarii*, *E. tanybaraga*, *M. latisternum*,

Figure 3. Aboriginal rock art depicting dingo, kangaroo, turtle, and emu in Namadgi National Park, Australian Capital Territory, Australia. We acknowledge the Ngunnawal people, the Traditional owners of this land and we pay our respects to their Elders, past, present, and emerging. (Photograph courtesy of National Library of Australia; C.S. Daley, 1925, PIC Box PIC/15299 #PIC/15299/2, NLAref149406).

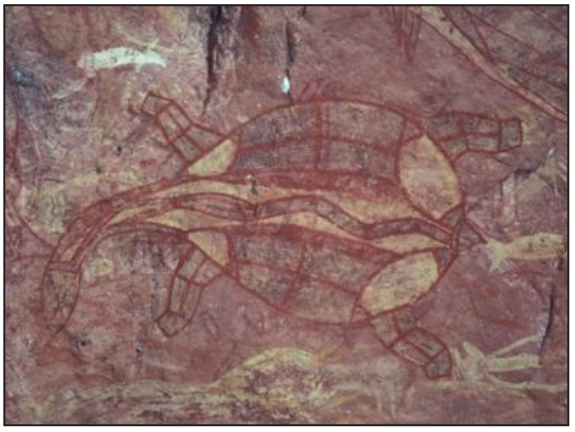

Figure 4. Aboriginal rock art paintings (pictographs) of Long-necked Turtles (*Chelodina rugosa*) in Kakadu National Park, Northern Territory, Australia. We acknowledge the Bunitj, Manilagarr, and Mandjurlgunj people, the Traditional owners of this land and we pay our respects to their Elders, past, present, and emerging. (Photographed by Arthur Georges).

Figure 5. Aboriginal rock art painting (pictograph) of a Long-necked Turtles (*Chelodina rugosa*) in Kakadu, Northern Territory, Australia. We acknowledge the Mirarr people, the Traditional owners of this land and we pay our respects to their Elders, past, present, and emerging. These images and the designs and motifs depicted are the Indigenous Cultural Intellectual Property of the Mirarr People. Traditional law and custom apply to them including the right to control their use and reproduction. These images must not be copied or reproduced without the consent of the Mirarr People who can be contacted via Gundjeihmi Aboriginal Corporation (https://www.mirarr.net). (Photograph courtesy of AIATSIS; JONES.R20.CS-000148825, Kakadu, Northern Territory, Jones 1981, and the Gundjeihmi Aboriginal Corporation).

and White-throated Snapping Turtle, *Elseya albagula*); SA (*C. expansa*, *C. longicollis*, and *E. macquarii*), and WA (*C. steindachneri*, *C. burrungandjii*, *C. rugosa*, *E. dentata*, and *E. victoriae*; Supplemental Information Table S1, Supplemental Information Fig. S1).

Turtle species identified in archaeological findings.—The common names found in the literature for archaeological sites were: tortoise, freshwater turtle, turtle, long-necked turtle, freshwater tortoise, and Chelid turtle (Appendix). The species identified were:

Table 2. Number of archaeological sites and survey methods, per state, which have freshwater turtle remains (bones, shell fragments) and indicate Aboriginal use of this resource in Australia. State abbreviations are ACT = Australian Capital Territory, NSW = New South Wales, NT = Northern Territory, Qld = Queensland), SA = South Australia, WA = Western Australia, Vic = Victoria, and Tas = Tasmania.

State	Ashy grey deposits	Excavation	Midden (mound)	Site survey	Open site	Total	%
ACT	0	0	0	0	0	0	0.0
NSW	1	2	2	1	0	6	20.0
NT	0	4	4	0	1	9	30.0
Qld	0	4	1	0	0	5	16.7
SA	0	6	0	0	0	6	20.0
WA	0	3	0	0	0	3	10.0
Vic	0	0	1	0	0	1	3.3
Tas	0	0	0	0	0	0	0.0
Total	1	19	8	1	1	30	

C. rugosa in Ji-bena mound (Brockwell et al. 2005) and Arafura Swamp (Peterson 1973), both in Arnhem Land, in Kina (South Alligator River), NT (Meehan et al. 1985), and in Anbangbang I and Djuwarr I (Deaf Adder Gorge), both in Kakadu National Park, NT (Foley 1985); *C. insculpta* in Anbangbang I and Djuwarr I (Deaf Adder Gorge), both in Kakadu National Park, NT (Foley 1985); *C. longicollis* in Lapstone creek open site, western Cumberland Plain, NSW (Kohen 1986), and in Fromm's Landing (Pate 1997), Devon Downs Shelter and Tartanga site (Hale and Tindale 1930), all in Nildottie, SA; *E. macquarii* in Fromm's Landing (Pate 1997), Devon Downs Shelter and Tartanga site (Hale and Tindale 1930), all in Nildottie, SA; and *C. expansa* in Gyranda region, Dawson River, Qld (Morwood and Godwin 1987), and Devon Downs Shelter, Nildottie, SA (Hale and Tindale 1930; Appendix). All these records and species names were corroborated by our species distribution maps, as the identified turtle species by the original authors fell within their respective species distribution (Appendix, Supplemental Information Fig. S1). Fifteen turtle species of a total of 25 species in Australia (Van Dyke et al. 2018), potentially could have been present in archaeological findings according to our study (Appendix, Supplemental Information Fig. S1), and these are the potential species in each state: NSW (*C. expansa*, *C. longicollis*, and *E. macquarii*); NT (*C. insculpta*, *C. rugosa*, *C. burrungandjii*, *E. dentata*, *E. flaviventralis*, and *E. tanybaraga*); Qld (*C. expansa*, *C. longicollis*, *E. macquarii*, *E. subglobosa worrelli*, *M. latisternum*, *E. albagula*, and *E. lavarackorum*); SA (*C. expansa*, *C. longicollis*, and *E. macquarii*); Vic (*C. longicollis*); and WA (South-western Long-necked Turtle, *C. oblonga*, *C. burrungandjii*, and *E. victoriae*; Appendix, Supplemental Information Fig. S1).

Age records in rock art and archaeology.—The only direct dated turtle image found was of a short-necked turtle, executed in beeswax, in Western Arnhem Land, NT (Age: 4,460 BP ± 80; see Nelson et al. 1995 and Watchman and Jones 2002; Supplemental Information Table S1). The other dated turtle motifs were estimates based on archaeological findings within the site, and chronology of environmental changes and description of periods or phases associated with those changes by the author (Chaloupka 1993; Morwood and Hobbs 2002). For example, there are some old turtle pictographs from the end of the Pre-estuarine period in Arnhem Land, NT, which are approximately 6,000–10,000 y old (Morwood and Hobbs 2002; Taçon et al. 2020; Supplemental Information Table S1). Other old petroglyphs and pictographs of turtles are found in Dampier Archipelago (12,000 y BP ± 3,000 y; Mulvaney 2011), WA, and Kakadu National Park (5,000–8,000 y ago, *C. insculta*; Chaloupka 1993), NT, respectively (Supplemental Information Table S1). There is also evidence of recent turtle rock art in Barunga, NT, which were probably painted between 1976 and 1990 (Smith et al. 2016; Supplemental Information Table S1). The earliest known record of freshwater turtle fragments in archaeological sites was found in Koolan Island, WA, which is at least 24,000 y BP (O'Connor 1999; Appendix). Other ancient records are found in Abercrombie Creek, NSW, and Murray Bridge, SA, which are approximately 4,000 y BP (Appendix).

Discussion

Our investigation is one of the few to document the country-wide historical use of and value placed on a whole vertebrate group by Indigenous people in Australia (for whales, dolphins and dugongs see Taçon 2017, and birds of prey see Taçon 2020). By reviewing Aboriginal art and archaeological records, we were able to demonstrate that freshwater turtles were used in most Australian states, and 17 of 25 turtle species in Australia were potentially featured in rock art and 15 of the 25 used as a food source, including five species (*C. longicollis*, *C. rugosa*, *C. expansa*, *E. macquarii* and *C. insculpta*) identified by the original authors at archaeological sites. Additionally, there is evidence that freshwater turtles were part of the diet of Aboriginal people for at least 24,000 y and they were culturally important owing to the variety of styles presented in the rock art records, with turtle paintings up to about 6,000–10,000 y old.

The NT was the state with the highest concentration of sites with both freshwater turtle motifs in the rock art and archaeological turtle remains. This could potentially be related to the area being one of the early routes of migration of Aboriginal people into Australia (Bradshaw et al. 2021; Crabtree et al. 2021), with evidence of early colonization of the Arnhem Land at around 65,000 y ago (Clarkson et al. 2017), translating into an early association of Aboriginal people with the land and the local natural resources (Brockwell 1996, 2006; Russell-Smith et al. 1997). The Arnhem Land, and the NT more broadly, is also one of the richest and oldest areas in rock art sites in Australia (McDonald and Clayton 2016; David et al. 2017), but also one of the most studied areas in the country (McDonald and Clayton 2016). Another factor could be that the three freshwater turtle species mainly depicted in rock art and recovered from archaeological sites in the NT (*C. rugosa*, *C. insculpta* and *E. dentata*, Foley 1985; Taçon 1989; Chaloupka 1993; Brockwell et al. 2005; Guse 2005), show a long association with aboriginal people and their cultural beliefs, spanning at least 5,000–8,000 y (Chaloupka 1993). Interestingly, *C. rugosa* is still consumed by Aboriginal people up to this day, likely being harvested since Aboriginal people arrived in Australia and representing one of the oldest

sustained harvests of a reptile species in the world (Kennett et al. 2014).

In a similar manner, freshwater turtles do play important cultural, mythical, and economic roles to some Aboriginal Australian groups, with some examples of the relative proportion of turtle motifs in the rock art compared to other fauna. For example, in a site in Laura, Qld, turtle motifs ranked fifth out of 19 animal species reported, behind catfish, kangaroo, fish in general, and birds in general (Morwood and Hobbs 2002). On the other hand, turtles were more common in figurative motifs (excluding anthropomorphs) in Mitchell River, Qld, ranked fourth together with eel/catfish, in a total of 11 animals (David 1994), fourth out of 12 animals in Jowalbinna Station, Qld (excluding anthropomorphs and cultural items, David 1994), and third out of six animal depictions in Koolburra Plateau, Qld (excluding therianthropes and anthropomorphs; David 1994). Also, according to the archaeological record and rock art depictions, turtle consumption increased over time (Brockwell et al. 2005; Brockwell and Akerman 2007), in addition to the increase in turtle motifs (Taçon et al. 2003), as a consequence of changes in the environment and climate, including increases in wetlands available in the last 1,000 y in some parts of the NT.

The depiction of turtle motifs in the rock art, but also their habitat and behaviour show an intimate knowledge of Aboriginal people with the local fauna, in addition to some mythological relations. For example, there is a painting in the NT of a *C. rugosa* in its subterranean home, hibernating in the mud until the next rainy season (Chaloupka 1993). The same turtle species is also depicted in a different painting with supposed supernatural features, portrayed as a hunter, with a spear and a goose-wing fan (Chaloupka 1993). The interpretation of rock art motifs may sometimes be influenced by the associated landscape and motifs, such as a 4-m water lily motif associated with a turtle, because turtles bury themselves in the mud of lagoons and are dug up and caught by Aboriginal people (Welch 2003). The use of what are termed x-ray pictographs, where the internal organs are shown, is also a way of showing their detailed knowledge on the anatomy of the animal (Taçon 1989), with many x-ray pictographs of turtles in the NT (Taçon 1989; Layton 1992; Chaloupka 1993). Another cultural example is the four paired turtle motifs in central Qld, which form a 75 km line that crosses the Great Dividing Range and served as a territorial boundary between Aboriginal groups (Morwood and Hobbs 2002). It also ran parallel with another mythological track of a Rainbow serpent and both paths link sites at which water was available (Morwood and Hobbs 2002). Additionally, there are many other ancient stories and myths in the Aboriginal oral history that include freshwater turtles (Taçon 1989; Taçon et al. 1996; McKay et al. 2001).

Tasmania was the only state that did not have turtle rock art depictions nor turtle remains in archaeological sites. This is unsurprising because there are no extant native freshwater turtles inhabiting Tasmania, and a fossil turtle found there (an *Emydura* species related to *E. macquarii*) is of Oligocene-Miocene age (Warren 1969); consequently, there was no evidence of interaction of local Aboriginal people with turtles. Victoria had one archaeological site record with turtles (Coutts et al. 1976) but no turtle motifs in the rock art recorded. This could be because the motif range in the state is limited, 80% concentrated in the Grampians region and mainly composed of anthropomorphs, with the remainder consisting of geometric figures and bird tracks (McDonald and Clayton 2016). Although no turtle remains were present in the archaeological record in the ACT, the territory has turtle depictions in the rock art in Namadgi National Park (Officer 1989; Layton 1992), and only one turtle species occurring in the territory (*C. longicollis*). Interestingly, there were some records of freshwater turtle motifs on islands off the coast of Qld, WA and NT, and an archaeological site on islands offshore from WA and Qld. Freshwater turtles on such islands were probably relict populations from the time of the supercontinent of Sahul, when Australia and New Guinea were connected during the Last Glaciation Maximum at around 21,000 y ago and sea levels were approximately 125 m lower (Williams et al. 2018). The use of turtles by Aboriginal people on these islands could have occurred within the last glaciation (Koolan Island, WA, at around 24,000 y BP; O'Connor 1999) or when sea levels were similar to the present day, over the last 6,000 y. Additionally, there is some ethnographic evidence of the use of freshwater turtles on other Qld islands, such as North Stradbroke Island (Ross et al. 2010) and Wellesley Islands (Memmott and Horsman 1991).

One of the limitations of the present study is that the identification of potential turtle species present in Aboriginal art is mainly based on distribution maps and not on specific anatomical features of the turtle paintings. This is due to the nature of the literature review, where in many cases the original author presented a list of faunal species featured in paintings in a site, for example, but did not provide an image of the freshwater turtle painting itself. In such cases, we provided all the turtle species that had their distribution overlapping with the painting record (Supplemental Information Table S1); however, in cases where the original author presented common names such as short-necked turtle, or a turtle painting with a long neck, we were able to limit the potential species based on those more detailed records and the maps of distribution. Another limitation is that there is no doubt more records of turtle motifs in the

rock art and turtle remains in archaeological sites in Australia that remain undocumented to science or yet to be discovered. The representation of the findings within each state and territory should be a reasonable representation of historical use of freshwater turtles by Aboriginal people in Australia.

We believe that the results presented here, based on the literature reviewed, show an early association of Aboriginals with freshwater turtles that might have some conservation and management implications. For example, there is no evidence of any freshwater turtle species becoming extinct in mainland Australia since Aboriginal arrival. Two giant terrestrial horned turtles (family Meiolaniidae) in Qld went extinct in the late Pleistocene, however, where aridification of their habitat and human exploitation could have played a role (Rhodin et al. 2015). Thus, the main reasons for Australian freshwater turtle population declines are not apparently due to indigenous overharvesting but related to more recent events after European colonization, such as the introduction of invasive species such as foxes and pigs, vehicle collisions, habitat modification, and disease (Fordham et al. 2006; Santori et al. 2018; Van Dyke et al. 2018, 2019).

Our study expands the current understanding of ancient use and the value placed on Australian freshwater turtle species by Aboriginal people. By reviewing Aboriginal rock art and archaeological records, we were able to demonstrate that freshwater turtle motifs were present in rock art sites in all Australian states, except for Victoria and Tasmania, and there was evidence of freshwater turtle consumption throughout the country. Through the use of turtle species distribution maps, we were also able to identify potential turtle species that might have been featured in the rock art and in remains found in the archaeological sites. Future studies should focus on understanding where in Australia Indigenous people are still using freshwater turtles, which species and their local names, and ecological and cultural values associated with turtles. This is important because: (1) freshwater turtles are totems to some Aboriginal groups, such as *C. expansa* for the Yorta Yorta people (Howard et al. 2011); (2) to keep stories and traditions alive for young Indigenous people (Turnbull 2016); (3) to help researchers uncover turtle behaviors unknown to western science, such as underwater nesting by *C. rugosa* (Kennett et al. 1993); (4) to aid in species identification, such as the case of *C. insculpta* occurrence in the NT (Chaloupka 1993; Georges et al. 2000) and the potential species identification in our study; and (5) to understand how traditional knowledge and mythology might help in protecting habitats and conserving turtle species (Ferronato and Cruzado 2013).

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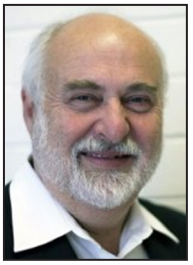

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Appendix. Archaeological sites in Australia with evidence of freshwater turtle use by Aboriginal people. State abbreviations are ACT = Australian Capital Territory, NSW = New South Wales, NT = Northern Territory, Qld = Queensland), SA = South Australia, WA = Western Australia, Vic = Victoria, and Tas = Tasmania. Species are Pig-nosed turtle (*Carettochelys insculpta*), Sandstone Snake-necked Turtle (*Chelodina burrungandjii*), South-western Long-necked Turtle (*Chelodina oblonga*), Broad-shelled Snake-necked Turtle (*Chelodina expansa*), Eastern Long-necked Turtle (*Chelodina longicollis*), Northern Snake-necked Turtle (*Chelodina rugosa*), White-throated Snapping Turtle (*Elseya albagula*), Northern Snapping Turtle (*Elseya dentata*), Yellow-bellied Snapping Turtle (*Elseya flaviventralis*), Gulf Snapping Turtle (*Elseya lavarackorum*), Murray River Turtle (*Emydura macquarii*), Worrell's Short-necked Turtle (*Emydura subglobosa worrelli*), Northern Yellow-faced Turtle (*Emydura tanybaraga*), Northern Red-faced Turtle (*Emydura victoriae*), and Common Sawshelled Turtle (*Myuchelys latisternum*). One asterisk (*) means this is within the distribution of the identified species by the original author, and two asterisks (**) is edge: archaeology record found slightly outside of any turtle species distribution, where the closest species was assigned to it.

Type	Survey method	Species (original author)	Site Name and items found	Location	State	Date	Author	Potential species (present work)
archaeology	site survey	*Chelodina longicollis*	Lapstone creek open site. Femur and shell	western Cumberland Plain	NSW		Kohen 1986	*Chelodina longicollis**
archaeology	excavation		Abercrombie Arch Shelter. Carapace	Bathurst	NSW		Johnson 1977	*Chelodina longicollis, Emydura macquarii*
archaeology	mound (excavation)		Ravensworth 3. Shell fragments and leg-bone	Abercrombie Creek system	NSW	4,100 BP - 3,800 BP	Martin 2011	*Chelodina expansa, Chelodina longicollis, Emydura macquarii*
archaeology	ashy grey deposits		Shell	Menindee Lakes	NSW		Pardoe 2003	*Chelodina expansa, Chelodina longicollis, Emydura macquarii*
archaeology	midden (excavation)		Bone fragments	Moira State Forest	NSW		Bonhomme 1990	*Chelodina expansa, Chelodina longicollis, Emydura macquarii*
archaeology	excavation			Seelands	NSW		McBryde 1974	*Chelodina longicollis, Emydura macquarii*
archaeology	excavation		Birriwilk rockshelter. Fragment of carapace or plastron	southwest Arnhem Land	NT	50 to 750 years BP	Aplin et al. 2016	*Carettochelys insculpta, Chelodina rugosa, Elseya flaviventralis, Emydura tanybaraga*
archaeology	mound (excavation)		Middle Point. Carapace	Adelaide River	NT	2,040 BP ± 260	Brockwell 1996, 2006	*Carettochelys insculpta, Chelodina rugosa, Elseya dentata, Emydura tanybaraga*
archaeology	mound (excavation)	*Chelodina rugosa*	Ji-bena mound	Arnhem Land	NT	810 BP ± 80	Brockwell et al. 2005	*Chelodina rugosa**
archaeology	mound (excavation)	*Chelodina rugosa*	Kina	South Alligator River	NT	280 BP ± 40	Meehan et al. 1985	*Chelodina rugosa**
archaeology	mound (excavation)	*Chelodina rugosa*	Arafura Swamp. Bone and shell	Arnhem Land	NT		Peterson 1973	*Chelodina rugosa**

Appendix (continued). Archaeological sites in Australia with evidence of freshwater turtle use by Aboriginal people. State abbreviations are ACT = Australian Capital Territory, NSW = New South Wales, NT = Northern Territory, Qld = Queensland), SA = South Australia, WA = Western Australia, Vic = Victoria, and Tas = Tasmania. Species are Pig-nosed turtle (*Carettochelys insculpta*), Sandstone Snake-necked Turtle (*Chelodina burrungandjii*), South-western Long-necked Turtle (*Chelodina oblonga*), Broad-shelled Snake-necked Turtle (*Chelodina expansa*), Eastern Long-necked Turtle (*Chelodina longicollis*), Northern Snake-necked Turtle (*Chelodina rugosa*), White-throated Snapping Turtle (*Elseya albagula*), Northern Snapping Turtle (*Elseya dentata*), Yellow-bellied Snapping Turtle (*Elseya flaviventralis*), Gulf Snapping Turtle (*Elseya lavarackorum*), Murray River Turtle (*Emydura macquarii*), Worrell's Short-necked Turtle (*Emydura subglobosa worrelli*), Northern Yellow-faced Turtle (*Emydura tanybaraga*), Northern Red-faced Turtle (*Emydura victoriae*), and Common Sawshelled Turtle (*Myuchelys latisternum*). One asterisk (*) means this is within the distribution of the identified species by the original author, and two asterisks (**) is edge: archaeology record found slightly outside of any turtle species distribution, where the closest species was assigned to it.

Type	Survey method	Species (original author)	Site Name and items found	Location	State	Date	Author	Potential species (present work)
archaeology	open site (excavation)		Scotch Creek I	Adelaide River floodplain	NT	approx. 3,000 BP	Brockwell et al. 2011	*Carettochelys insculpta, Chelodina rugosa, Elseya dentata, Emydura tanybaraga*
archaeology	excavation		Wulk Lagoon. Bone fragments	northwestern Arnhem Land	NT		Wesley et al. 2017	*Carettochelys insculpta, Chelodina rugosa, Elseya flaviventralis, Emydura tanybaraga*
archaeology	excavation	*Carettochelys insculpta*, *Chelodina rugosa*	Anbangbang I (Nourlangie Massif)	Kakadu National Park	NT		Foley 1985	*Carettochelys insculpta**, *Chelodina rugosa**, *Chelodina burrungandjii*
archaeology	excavation	*Carettochelys insculpta*, *Chelodina rugosa*	Djuwarr I (Deaf Adder Gorge)	Kakadu National Park	NT		Foley 1985	*Carettochelys insculpta**, *Chelodina rugosa**, *Chelodina burrungandjii*
archaeology	excavation		Broadbeach site	Gold Coast	Qld		Pate 1997	*Chelodina expansa, Myuchelys latisternum*
archaeology	excavation	*Chelodina expansa*	Gyranda region	Dawson River	Qld	1,520 BP ± 80	Morwood and Godwin 1987	*Chelodina expansa**
archaeology	midden (excavation)		Toulkerrie midden	Moreton Island	Qld		Hall 1984	*Chelodina expansa, Chelodina longicollis, Emydura macquarii*
archaeology	excavation		Contact Cave. Carapace	Cania Gorge	Qld		Westcott et al. 1999	*Chelodina expansa, Chelodina longicollis, Elseya albagula, Emydura macquarii, Myuchelys latisternum*
archaeology	excavation		Bunnengalla 1 - Musselbrook Creek	Boodjamulla National Park	Qld	approx. 900 BP	Slack et al. 2005	*Elseya lavarackorum, Emydura s. worrelli*
archaeology	excavation	*Chelodina longicollis*, *Emydura macquarii*	Fromm's Landing (Devon Downs)	Nildottie	SA		Pate 1997	*Chelodina longicollis**, *Emydura macquarii**
archaeology	excavation		Bones	Swanport	SA		Stirling 1911	*Chelodina expansa, Chelodina longicollis, Emydura macquarii*

Appendix (continued). Archaeological sites in Australia with evidence of freshwater turtle use by Aboriginal people. State abbreviations are ACT = Australian Capital Territory, NSW = New South Wales, NT = Northern Territory, Qld = Queensland), SA = South Australia, WA = Western Australia, Vic = Victoria, and Tas = Tasmania. Species are Pig-nosed turtle (*Carettochelys insculpta*), Sandstone Snake-necked Turtle (*Chelodina burrungandjii*), South-western Long-necked Turtle (*Chelodina oblonga*), Broad-shelled Snake-necked Turtle (*Chelodina expansa*), Eastern Long-necked Turtle (*Chelodina longicollis*), Northern Snake-necked Turtle (*Chelodina rugosa*), White-throated Snapping Turtle (*Elseya albagula*), Northern Snapping Turtle (*Elseya dentata*), Yellow-bellied Snapping Turtle (*Elseya flaviventralis*), Gulf Snapping Turtle (*Elseya lavarackorum*), Murray River Turtle (*Emydura macquarii*), Worrell's Short-necked Turtle (*Emydura subglobosa worrelli*), Northern Yellow-faced Turtle (*Emydura tanybaraga*), Northern Red-faced Turtle (*Emydura victoriae*), and Common Sawshelled Turtle (*Myuchelys latisternum*). One asterisk (*) means this is within the distribution of the identified species by the original author, and two asterisks (**) is edge: archaeology record found slightly outside of any turtle species distribution, where the closest species was assigned to it.

Type	Survey method	Species (original author)	Site Name and items found	Location	State	Date	Author	Potential species (present work)
archaeology	excavation		Glen Lossie Midden and Burial site. Carapace (0.3 grams)	Murray Bridge	SA	4,155 ± 35 BP	Wilson 2017	*Chelodina expansa, Chelodina longicollis, Emydura macquarii*
archaeology	excavation		Pomberuk. Carapace	Murray Bridge	SA	4,140 ± 70 BP	Wilson 2017	*Chelodina expansa, Chelodina longicollis, Emydura macquarii*
archaeology	excavation	*Chelodina longicollis*, *Emydura macquarii*, *Chelodina expansa*	Devon Downs Shelter	Nildottie	SA		Hale and Tindale 1930	*Chelodina expansa**, *Chelodina longicollis**, *Emydura macquarii**
archaeology	excavation	*Chelodina longicollis*, *Emydura macquarii*	Tartanga site	Nildottie	SA		Hale and Tindale 1930	*Chelodina longicollis**, *Emydura macquarii**
archaeology	mound (excavation)		Hopkins River	Warrnanbool District	Vic		Coutts et al. 1976	*Chelodina longicollis*
archaeology	excavation		Windjana Gorge Water Tank Shelter	Windjana Gorge National Park	WA		O'Connor et al. 2008	*Chelodina burrungandjii, Emydura victoriae*
archaeology	excavation		Koolan Shelter 2. Bone	Koolan Island	WA	prior to 24,000 BP	O'Connor 1999	*Emydura victoriae* (**edge)
archaeology	excavation		Caladenia Cave. Shell	northern Swan Coastal Plain	WA	1,346 BP ± 20	Thorn et al. 2017	*Chelodina oblonga*