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Elseya lavarackorum (White and Archer 1994) – Gulf Snapping Turtle, Gulf Snapper, Riversleigh Snapping Turtle, Lavarack's Turtle

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Summary. – The Gulf Snapping Turtle, *Elseya lavarackorum* (Family Chelidae), is a medium to large-sized short-necked turtle (carapace length to ca. 350 mm, potentially to 500 mm), endemic to a small area of northern Australia in the vicinity of the Queensland – Northern Territory border. The species inhabits deep pools on permanently flowing spring-fed waterways in the upper to middle reaches of rivers, reaching its highest densities adjacent to intact native riparian vegetation. Adult *E. lavarackorum* are almost exclusively herbivorous, feeding predominantly on fruit, leaves, and algae. The species nests in the dry season (May–July), with a clutch size that varies from 6 to 9 eggs. Nests are laid in fine sand or alluvial substrate on banks close to the water. Primary threats are thought to be feral pig predation on nests and degradation of native riparian vegetation by weeds and fire. Large females, in particular, are subject to harvesting by traditional landowners, but this is not presently considered a significant conservation threat.

Distribution. – Australia. The species has a limited distribution in the upper and middle reaches of the Gregory–Nicholson and Calvert catchments, with unconfirmed reports from the Robinson River in northwest Queensland and northeastern Northern Territory.

Synonymy. – *Emydura lavarackorum* White and Archer 1994, *Elseya lavarackorum, Elseya dentata lavarackorum*.

Subspecies. – None currently known.

Status. – IUCN 2014 Red List: Not Evaluated (NE); TFTSG Draft Red List: Data Deficient (DD, assessed 2011); CITES: Not Listed; Australia: Environmental Protection and Biodiversity Conservation Act: Endangered; Territory Parks and Wildlife Conservation Act: Protected; Queensland Nature Conservation Act: Vulnerable.

Taxonomy. — This species was originally described by White and Archer (1994) as *Emydura lavarackorum* from Pleistocene fossil material found at Riversleigh on the Gregory River, northwest Queensland (holotype QM F24121, type locality at 18º35'S, 138º35'E). The name honors Jim and Sue Lavarack, who discovered the fossil. The fossil consists of an essentially complete plastron and the anterior half of the carapace, sufficient to later diagnose the specimen as genus *Elseya*, not *Emydura* (Thomson et al. 1997). Furthermore, the fossil was not distinguishable in any important respect from an extant *Elseya* that occurs in the Gregory River. For many years, members of the genus *Elseya* in Queensland were referred to as *Elseya dentata*. However, *Elseya* in Queensland is now viewed as a complex of four species which form a monophyletic clade within *Elseya* (sensu lato) and sister to the *Elseya novaeguineae* complex (Georges and Adams 1992, 1996; Todd et al. 2014; Georges et al. 2014). Many of these species await formal naming (Thomson et al. 2006; Thomson and Georges, in prep.). *Elseya lavarackorum* was the first new species recognized from this complex and is the nominate form for the Queensland *Elseya* subgroup of the genus *Elseya* (Thomson et al. 1997; Georges and Thomson 2010). Cann (1998) added a second new species, *Elseya irwini*, which is the sister species to *E. lavarackorum*. Thomson et al. (2006) described *Elseya albagula* from southeast Queensland, also a member of this clade. Le et al. (2013) presented a phylogenetic hypothesis which placed the Northern Territory species *E. dentata* as sister to *E. irwini* within the *E. lavarackorum* clade. However, subsequent work (Todd et al. 2014) has indicated that sequences that were identified as *E dentata* by Le et al. (2013) were actually *E. irwini*, which means that Northern Territory *Elseya* were in fact not sampled in their study. Todd et al. (2014) and Georges et al. (2014) examined molecular data for all *Elseya* taxa and showed that despite its close geographical proximity to the Northern Territory species *E. dentata, E. lavarackorum* is most closely related to species on the northeast coast of Queensland, *E. irwini* and *E.* sp. (Daintree River), and more distantly related to *E. albagula* of southeast Queensland. More recent work indicates that

Figure 1. Adult female *Elseya lavarackorum* from the Gregory River, Riversleigh Station, Queensland. Photo by John Cann.

subgeneric status may be considered for Queensland *Elseya* (Thomson and Georges, in prep.).

Description. — *Elseya lavarackorum* is a medium to large-sized short-necked turtle. Fossil material indicates that it once obtained a size of over 400 mm and as much as 500 mm straight carapace length (CL) (Thomson et al. 1997); however, in the modern era no *E. lavarackorum* has been measured with a CL greater than 352 mm (Freeman, unpubl. data). The mean CL and mass of captured females, at 302.1 mm and 2904.8 g (n = 62; range 203.1–352.0 mm), respectively, is greater than that of males, at 219.2 mm and 1076.0 g (n = 49; range 196.1–242.4 mm) (Freeman, unpubl. data). The smallest gravid female recorded had a CL of 284.9 mm CL (n = 10), which suggests that female sexual maturity may be attained at a relatively large size; it is unknown at what size males reach sexual maturity. No data are available on age at sexual maturity of either females or males.

Figure 2. Adult male *Elseya lavarackorum* from Lawn Hill Creek, Boodjamulla National Park, Queensland. Photo by Alastair Freeman.

The carapace is broadly oval and dark brown to black in color. Marginals three to eight are upturned in adults and marginals eight to eleven are expanded and flared. There is no median keel present in adults, there is a small median keel in subadults, and juveniles are clearly keeled. Adults of this species have a serrated margin from marginal nine posteriorly; sub-adults and juveniles are similarly serrated from the posterior edge of marginal seven. Spiny protrusions on the ends of marginals are absent in this species at all growth stages. Subadults and adults alike have relatively flattened shells and shell depth relative to length appears to remain consistent with age. The scutes of this species are often pitted throughout, but in places are lustrous, differing from the other taxa in this group, which are dull. The plastral formula using midline length is pec = fem > abd = ana > int = hum > gul. The plastron is narrow, with an axillary width approximately 50% of the carapace width. The bridge is extensive, but not as large as that found in *E. dentata* or *E. novaeguineae*. Plastron color is brown to black. In parts of

Figure 3. Adult female *Elseya lavarackorum* from the Gregory River, Riversleigh Station, Queensland. Photo by John Cann.

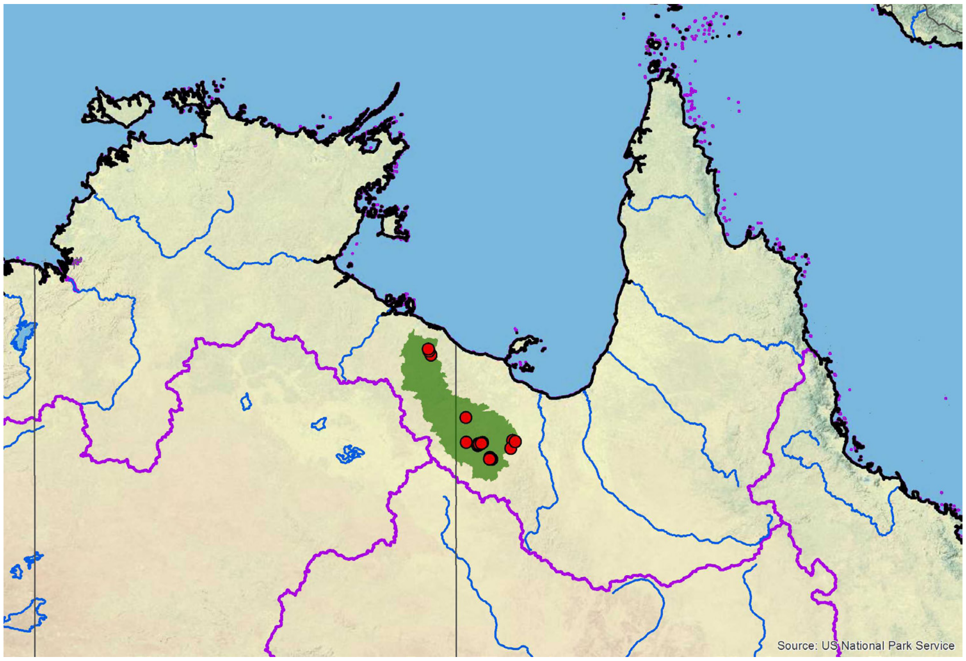

Figure 4. Distribution of *Elseya lavarackorum* in Northern Territory and Queensland, northern Australia. Purple lines = boundaries delimiting major watersheds (level 3 hydrologic unit compartments – HUCs); red dots = museum, literature, and field-based occurrence records of native populations based on recent and authors' data; green shading = projected native distribution based on GIS-defined HUCs constructed around verified localities and then adding HUCs that connect known point localities in the same watershed or physiographic region, and similar habitats and elevations as verified HUCs (Buhlmann et al. 2009; TTWG 2014), and adjusted based on authors' subsequent data.

the Lawn Hill Creek catchment the plastron is often covered in a thin layer of calcium carbonate which gives the plastron a muddy brown color. Axillary scutes are present but inguinal scutes are absent (Thomson and Mackness 1999; Thomson et al. 2006).

The head is large and extremely robust, similar in this regard to its nearest relatives, the coastal Queensland *Elseya* taxa; grey to brown on top, pale grey below. Larger females often have irregular cream blotches over their face and throat. The tomial sheath of the upper jaw is dark yellow with no vertical dark bars present. The head is covered in medium-sized hard scales and a head shield is present which extends from the posterior of the nasals over the parietals and to the back of the skull. The head shield does not continue down the parietal arches towards the tympani. The dorsal surface of the neck is covered with medium-sized pointed tubercles; parietal tubercles in adult females are not present in this species. The lower jaw has one or two large rounded barbels, which are larger than those in the *E. dentata* group. In adults of most *Elseya* species these barbels are surrounded by enlarged scales but this character does not occur in this species. The iris is green without a ring and the sclera is brown; there are eye spots anterior or posterior to the pupil, a feature often seen in some *Emydura* species, e.g. *E. subglobosa*, but unusual among *Elseya* (Thomson et al. 2006).

The remaining soft parts are dark grey dorsally and pale grey ventrally. There are four claws on the front feet

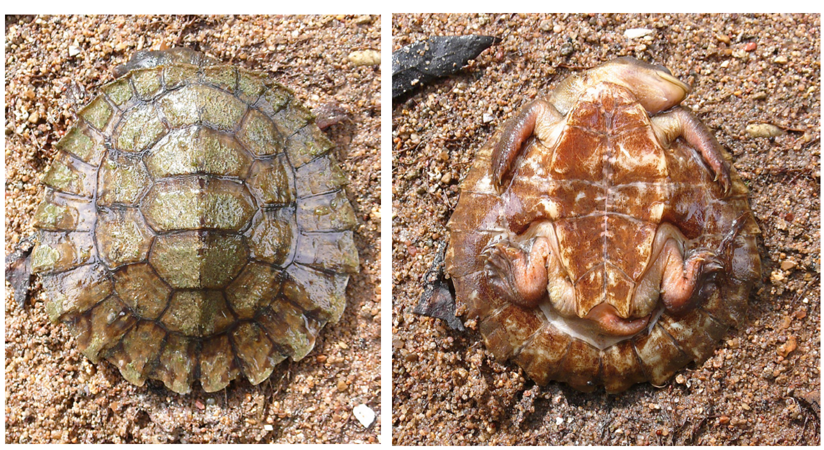

Figure 5. Small juvenile *Elseya lavarackorum*, Lawn Hill Creek, Boodjamulla National Park, Queensland. Photos by John Cann.

Figure 6. Adult male (left) and female (right) *Elseya lavarackorum* from Lawn Hill Creek, Boodjamulla National Park, Queensland. Photo by Alastair Freeman.

and five on the rear. A series of enlarged scales on the thigh and shin region of the hind leg form a skin flap which may assist in swimming; these enlarged scales reach the base of the tibia. There are no pre-anal glands present.

Distribution. — *Elseya lavarackorum* is known from parts of the upper and middle reaches of the Gregory and Nicholson drainages of northwestern Queensland and northeastern Northern Territory in Australia (Thomson et al. 1997; Horner 1998; Cann 1998; White 1999; Georges and Merrin 2008; Georges and Thomson 2010; White 2012; Cogger, 2014; Freeman, unpubl. data). It has also been recorded in the upper reaches of the Calvert River in the Northern Territory near the border with Queensland (Woinarski et al. 2007; White 2012; Australian Wildlife Conservancy website; R. Lloyd, pers. comm.). West of the Calvert River, the Garawa, traditional landowners of this country, have confirmed that the white-headed turtle that occurs in the Calvert also occurs in the upper reaches of the Robinson River (R. Lloyd, pers. comm.). However, a local landowner who is familiar with the "short-neck with white nose" (female *Elseya* sp.) on the Calvert River has never observed them on the lower reaches of the Robinson River (R. Lloyd, pers. comm.). Reports of this species occurring in the Roper River (White 1999; Thomson et al. 2006; Wilson and Swan 2013) have been proven to be incorrect, with recent analysis of the phylogenetic relationships in this genus using molecular data confirming that the snapping turtle species in the Roper and more easterly Limmen–Bight catchments is *E. dentata* (Todd et al. 2014).

Suggestions that *E. lavarackorum* occurs in the Leichardt River and other rivers that enter the Gulf of Carpentaria around the lower Cape York to the east of the Gregory Nicholson catchment (Wells 2007) are unfounded, as there are as yet no confirmed reports of snapper-like turtles occurring in these river systems (Cann, pers. obs.; Freeman, unpubl. data). These river systems also lack the rocky escarpments in their upper reaches which appear to be the preferred habitat of this species. Similarly, the Settlement Creek catchment between the Nicholson and Calvert catchments also appears to be unsuitable for the same reason.

In Queensland, the known habitat of *E. lavarackorum* is largely confined to the North West Highlands Bioregion, an area characterized by stony hills and escarpments which rise above the alluvial plains of the Gulf Plains Bioregion, in the far northwest of the State (Sattler and Williams 1999). Similarly, in the Northern Territory, the limited distribution data available indicate that *E. lavarackorum* occurs among the stony hills and escarpments in the upper reaches of the Calvert and Robinson Rivers.

Habitat and Ecology. — *Elseya lavarackorum* occurs in deep water pools in the upper catchment of permanently flowing spring-fed rivers. It reaches its highest densities adjacent to areas of good quality riparian vegetation. Recent studies have indicated that certain key plant species may play a significant role in the distribution of the species (Freeman 2010). For example, there is a strong positive correlation between *E. lavarackorum* density and cluster figs, *Ficus racemosa*. Cluster figs can be prolific fruiters and will fruit on a spasmodic basis all year round (Brock 2001; Freeman, pers. obs.). The fruit and leaves of this species feature prominently in the diet of *E. lavarackorum* (White 1999; Freeman 2010).

There is also a similarly strong correlation between the density of *E. lavarackorum* and the plant species *Pandanus aquaticus*. This species appears to fulfill multiple roles in the ecology of *E. lavarackorum*; as well as a food source, the dense foliage, submerged branches, and curtains of submerged roots of *P. aquaticus* provide structural complexity to bank-

Figure 7. High quality riparian habitat, Lawn Hill Creek, Boodjamulla National Park; *Pandanus aquaticus* at water level overtopped by a continuous layer of *Ficus racemosa* and *Nauclea orientalis*. This site had one of the highest densities of *Elseya lavarackorum* recorded. Photo by Alastair Freeman.

Figure 8. Degraded riparian habitat, Lawn Hill Creek, Boodjamulla National Park in 2010; native riparian vegetation smothered by the introduced invasive vine *Passiflora foetida*. By 2013 the riparian habitat had improved substantially due to the weed control efforts of National Park rangers. Photo by Alastair Freeman.

side habitat (Freeman 2010). During the day and at night *E. lavarackorum* have been observed using the submerged branches of *P. aquaticus* as "resting" sites, with up to four turtles perched on a single branch (Freeman, pers. obs.). Below the waterline at the base of *P. aquaticus,* undercuts created by erosion and "curtained" by walls of long, dense roots, were often used by *E. lavarackorum*. Not only were turtles observed within these undercuts, they were also seen on occasion to retreat into these "hideaways" when pursued by snorkelers (Freeman and T. Curran, pers. obs.). Above water the thick *P. aquaticus* foliage provides a high degree of protection from terrestrial predation, including human hunters.

Densities of *E. lavarackorum* are invariably lower adjacent to riparian vegetation that is degraded either by weed invasion and/or fire. The riparian ecosystem that supports the food trees used by *E. lavarackorum* is a fire sensitive system. In some parts of its range fires that are too hot kill vegetation and open up the canopy, creating ideal conditions for weed invasion that results from the deposition of weed seeds from upstream during seasonal floods (Freeman 2010).

Population Structure. — In the upper Gregory catchment the mean straight carapace length and mass of adult female *E. lavarackorum* is larger than that for males. In contrast to the range of adult size classes caught at this site there is a lack of individuals in the smallest (immature) size classes. Among the turtles collected specifically for measuring between 2010 and 2012 (n = 118), only one had a CL of less than 110 mm, and the proportion of turtles identified as juveniles (n = 5) was less than 6% of the total (Freeman, unpubl. data). The percentage of juveniles recorded during snorkelling transects was similarly small at 14 % (n = 44). Specific surveys for the smallest (< 80 mm or 2–3 year-old) juveniles in the upper Gregory catchment in 2010 were also largely unsuccessful despite encompassing areas of high quality habitat (Freeman 2010). The few that were caught (n = 8) were among sandy gravel substrate in shallow pools and riffle zones, on woody debris or among *P. aquaticus* on the edge of the main river channel and deep water (Freeman 2010). In contrast, the percentage of juvenile *E. irwini* (Johnstone drainage) recorded over four years of monitoring on the Atherton Tablelands was 37% (85 of 227, with 28% being < 80 mm in CL), despite no specific sample targeting of this size class (Freeman and Curran 2009, 2010; Freeman, 2012; Freeman, unpubl. data). Similarly, across four populations of *E. irwini* (Johnstone drainage) on the lowlands of the Wet Tropics, O'Malley (2007) recorded 57.4% juveniles. The lack of small juveniles in *E. lavarackorum* is evidence of an adult-biased population structure, and in other studies has been attributed to the effects on recruitment of significant nest predation (Thompson 1983; Hamann et al. 2007). This may also be the case for *E. lavarackorum*.

Diet. — Adult *E. lavarackorum* are almost exclusively herbivorous. Of 23 scats collected in Boodjamulla National Park in the upper Gregory catchment, 98% of the total weight of the material collected was leaf, algae, or fruit, with the other 2% comprising shell fragments from freshwater mussels, insect larvae, and unidentified arthropods (Freeman 2010).

The most common identifiable food items found in scats between May and July were the fruit and flesh of the cluster fig (*Ficus racemosa*) (Freeman 2010). This species, which fruits throughout the year (Brock 2001; Freeman, pers. obs.) is present in high densities in parts of the Gregory River upper catchment, particularly in the Lawn Hill Gorge area in northwest Queensland (Freeman and Freeman, unpubl. data). In this area, the quantity of ripe fruit varied from a small amount on individual trees from April through June to mass fruiting across most figs in the riparian zone in mid- to late July. During this period

Figure 9. *Elseya lavarackorum* congregating below fruiting cluster fig, *Ficus racemosa*, Middle Gorge area, Boodjamulla National Park, Queensland. Photos by Alastair Freeman.

turtles are often observed congregating under fruiting figs and consuming any fruit that falls into the water (Freeman 2010). On these occasions, it is not uncommon to witness antagonistic behavior between individual turtles over access to fallen fruit. Similar observations of turtles congregating under fruiting trees have previously been made elsewhere on the Gregory River (Legler 1976), where large congregations of *E. lavarackorum* (referred to as *E. dentata*) were observed under figs consuming fallen fruits as soon as they hit the water. *Elseya lavarackorum* has also been observed raising its head and neck out of the water to crop fruit on an overhanging fig tree (White 1999). The species has also been observed exiting the water at night and feeding on fallen fig fruit on the river bank (L. Little and D. Chew, pers. comm.).

Other species that occur in the diet of *E. lavarackorum* include the fruit and seeds of the Leichardt tree (*Nauclea orientalis*) and the cabbage palm (*Livistona rigida*), as well as the introduced weed, stinking passionfruit (*Passiflora foetida*) (Freeman 2010). Unlike the cluster fig, these species are only available seasonally (Smith 1995; Brock 2001). *Elseya lavarackorum* has never been recorded taking unripe or green fruit.

The Gulf Snapping Turtle may play a role in seed dispersal for some riparian forest species, as seeds pass through the digestive tract intact and have been shown to be viable (Freeman 2010). However, the significance of the species as a seed disperser is hard to quantify. All the fruit species that have been identified in the scats of *E. lavarackorum* are also known to be dispersed by birds. *Elseya lavarackorum* could play a significant role in seed dispersal if they transported seeds to upstream areas. It has been suggested that the only means by which the large water-borne seeds of the semi-aquatic *P. aquaticus* are dispersed upstream would be turtles (Kennett and Tory 1996). However, there was no evidence for this in scats collected from *E. lavarackorum* from the upper catchment of the Gregory River, despite *P. aquaticus* being present and fruiting in the immediate area during the course of this study (Freeman 2010).

While hard to quantify, scat analysis and observations have also highlighted the importance of leaves and algae in the diet of *E. lavarackorum*. Leaf material in scats of *E. lavarackorum* has been tentatively identified as coming from *P. aquaticus* and cluster figs. *Elseya lavarackorum* have also been observed feeding on cluster fig leaves, the foliage of *Lobelia quadrangularis,* the leaves of stinking passionfruit, and on the flowers of mistletoe (*Dendrophthoe glabrescens*) that had fallen in the water (Freeman 2010). They have also been observed feeding on the droppings of flying foxes (*Pteropus* spp.) hanging in trees over a stream (White 2012).

The consumption of algae appears to be common, but seasonal, with individual turtles often observed cropping algae on rocks in December, but seldom observed doing this between April and July (Freeman 2010). In captivity they have been recorded consuming meat in preference to plant food (Cann 1998).

Reproduction. — As with similar species from northern Australia (Kennett 1999; Turner 2004), *E. lavarackorum* is a dry season nester. Nesting has been reported from mid-April to mid-July (Legler 1985, in Cann 1998:188; White 2012) while more recent accounts have noted the capture of gravid females from May to July and nesting in July (Freeman 2010). The Waanyi, the traditional landowners of areas that encompass *E. lavarackorum* habitat in northwest Queensland, have observed them nesting in May (Freeman 2010). It is assumed that this pattern ensures that hatchling emergence corresponds with the onset of the monsoonal wet season in January to February, which is thought to enhance hatchling survivorship (Kennett 1999; Hamann et al. 2007), while at the same time avoiding nest mortality as a result of flood inundation associated with the wet season.

Until as recently as 2010, there was no description of nest sites other than vague reports of nesting in loamy banks (Cann 1998). Recent work carried out in the upper Gregory River catchment reported the first direct observations of *E. lavarackorum* nesting (Freeman 2010). Seven nests were found close to the water (< 4 m away) in alluvial soils or a sand/soil mix on steep and gentle sloping banks. As with most Australian species, oviposition took place in response to rain, in this case after a long dry period. There was no indication that *E. lavarackorum* congregates at mass nesting sites; instead nesting occurred in ones and twos at dispersed localities along the watercourse (Freeman 2010).

Clutch size varies between 6 and 9 eggs (n = 5) (Freeman 2010). An observation of a disturbed nest that contained 25 eggs was almost certainly an example of nesting attempts by multiple females at the same exact site (Freeman 2010). At this nest 12 eggs remained buried while 13 had been uncovered to some degree or another; the majority of the exposed eggs were intact with no sign of predation. While disturbance of covered nests by subsequent nesting attempts is not uncommon at mass turtle nesting sites, particularly in marine turtles (Freeman, pers. obs.), it has rarely been observed in a freshwater species such as *E. lavarackorum* that nests in small numbers at dispersed sites along a watercourse.

Eggs are hard-shelled and oblong in shape. Mean length and width is 50.3 x 28.6 mm (n = 36). Weight of eggs varies between 18.5 and 28.9 g (mean = 25 g) (n = 36) (Freeman, unpubl. data). It is currently not known how long eggs take to hatch in the wild, but may be hypothesized to be similar to the closely related *E. dentata*, at around 150–188 days (Kennett 1999). Clutch frequency and age at sexual maturity remain unknown for this species.

Figure 10. A camera trap image of a feral pig on a streamside bank adjacent to Lawn Hill Creek, Queensland. Turtle tracks and at least one *E. lavarackorum* were also recorded on this bank, while two depredated nests were found on an adajacent bank within 20 m of this site in July 2010.

Reproductive behavior between males and females has been observed in wild *E. lavarackorum* in April and May. Behavior included "trailing", riding, cloacal and neck "nuzzling", "kissing", and shell standing (Freeman 2010; Freeman, unpubl. data).

Population Status. — There are currently no good population data or density estimates for this species, although a density estimate in the low thousands was calculated at one site based on very low recapture rates (Freeman 2010). This calculation was based on very limited data from an area that contains the highest population densities known for the species and needs to be confirmed with further research. Most studied populations appear to be reasonably robust, but no range-wide estimates are yet available.

Threats to Survival. — While evidence is limited, primary threats to survival are thought to be nest predation by feral pigs (*Sus scrofa*) and degradation of riparian vegetation (Freeman 2010). Predation by feral pigs has been identified as a major threat to nesting turtles, both marine and freshwater (Cann 1978; Environment Australia 2003; Doherty 2005; Fordham et al. 2006). It is thought that the northern and southern Gulf region (including areas where *E. lavarackorum* occurs) may have some of the highest densities of feral pigs in Australia (Davis and Dowe 2005). During the 2010 nesting season, in a part of the upper Gregory Catchment, four out of a total of seven nests were destroyed by feral pigs shortly after laying. The three nests that were not predated were in an area that was largely inaccessible to pigs (Freeman 2010). Pigs were also recorded traversing and digging up suitable nesting banks in the area.

Elseya lavarackorum is a species that prefers waterways adjacent to riparian vegetation which is relatively intact, areas where the density of weed species is low and the proportion of native vegetation is high. More specifically, densities of *E. lavarackorum* have been positively correlated with the number of cluster figs (*F. racemosa*) and Leichardt trees (*N. orientalis*) and with the bank-side density of pandanus (*P. aquaticus*) (Freeman 2010). In contrast, sites with low densities or no *E. lavarackorum* are characterized by degraded riparian vegetation which has often resulted from hot fires killing native riparian species, opening up the canopy and facilitating weed invasion. Weeds of concern include wild passionfruit (*Passiflora foetida*), noogoora burr (*Xanthium occidentale*), and butterfly pea (*Clitoria ternata*) (Freeman 2010). Over the period of 2010–13 there has been a dramatic improvement in riparian habitat quality as a result of the weed control efforts of National Parks staff and volunteers in parts of the upper Gregory within Boodjamulla National Park. Between 2010 and 2013 the number of turtles observed along one of the most degraded snorkelling transects improved from 7.8 turtles seen per 30 min of underwater observation to 27.7 (Freeman, unpubl. data). This increase is thought to be attributable to the improvement in riparian condition as a result of weed control efforts.

Freshwater turtles, including *E. lavarackorum,* are considered to be an important food item by local indigenous hunters and landowners in northwest Queensland. In this area they are mainly caught at a few accessible localities; the vast majority of turtle habitat is not accessed for hunting. The impact from traditional hunting has also been reduced by the current ban on hunting in the Middle Gorge area of Boodjamulla National Park. This ban provides protection for the most important, accessible and highest density population of *E. lavarackorum* currently known. This species is also harvested in the Northern Territory (Freeman 2010), although there is no information on the impact of this harvest.

Hunting targets adult females as these are the largest individuals with the most meat and during the nesting season are likely to contain eggs. However, their flesh is considered inferior to that of the conspecific *Emydura subglobosa worrelli* (Freeman 2010). While the hunting of *E. lavarackorum* as it is currently practiced is probably sustainable, a change in hunting practices and/or increased accessibility to previously inaccessible turtle habitat may change this.

Mortality associated with drowning in traps used by recreational fishers to catch red claw and freshwater prawn has been identified as a possible threat (Cann 2008). As well as traps, set nets may also be a threat to *E. lavarackorum*. Scientists carrying out fish surveys in the Lawn Hill Creek and Gregory River observed evidence of the illegal use of gillnets in these freshwater catchments (Davis and Dowe 2005); these authors stated that a number of local landholders were concerned over the level of illegal netting that is taking place. What impact recreational and illegal fishing practices may be having on *E. lavarackorum* populations is unknown.

A further potentially significant threat to *E. lavarackorum* may come from climate change. Some preliminary observations from the 2010 nesting season suggest that most embryos in nests on unshaded nesting banks do not survive the high temperatures associated with the late dry season (October–November) (Freeman, unpubl. data). While in 2010 this is thought to have been a natural event it may well be indicative of the potential impacts of increased temperatures on nesting success.

Conservation Measures Taken. — *Elseya lavarackorum* is protected in the Northern Territory under the Territory Parks and Wildlife Conservation Act 1998 and in Queensland under the Queensland Nature Conservation Act 1992. Nationally it is listed as Endangered under the Environmental Protection and Biodiversity Conservation Act 1999, while in Queensland it has been listed as Vulnerable.

The most significant population currently known is protected within Boodjamulla (Lawn Hill) National Park, Queensland, while the Australian Wildlife Conservancy protects significant areas of *E. lavarackorum* habitat in the Northern Territory. Boodjamulla National Park currently has targeted weed and feral animal control and fire management programs in areas where *E. lavarackorum* occurs (Freeman and Ezzy 2012).

Conservation Measures Proposed. — *Elseya lavarackorum* has yet to be officially evaluated or listed on the IUCN Red List, and the IUCN Tortoise and Freshwater Turtle Specialist Group provisionally assessed it as Data Deficient in 2011. However, on the basis of recent research (Freeman 2010) it should probably be considered for listing as Near Threatened or possibly Vulnerable, based on the following Red List criteria: A4 (c+e), B1 (a+biii), B2 (a+biii), and C1.

The maintenance of the Boodjamulla National Park populations of this species should be a priority; in particular, continuation and, if possible, expansion of the successful weed and feral pig control program that is currently occurring in important *E. lavarackorum* habitat areas. It is vital that the hunting ban in the Middle Gorge area of the park is maintained, as this helps protect the most significant population of this species currently known.

At a species level the distribution of *E. lavarackorum* is still unclear. In particular, there is a need to clarify the extent of the western population distribution. Within catchments where it is currently known to occur, the downstream extent of the species also needs clarification. However, the presence of estuarine crocodiles (*Crocodylus porosus*) in the lower reaches of all rivers inhabited by *E. lavarackorum* makes surveys in these areas difficult, and might also limit the distribution of the species.

Captive Husbandry. — None known.

Current Research. — The Threatened Species Branch of the Department of Environment and Heritage Protection, in association with Boodjamulla National Park rangers, have developed control programs for feral pigs and weeds that specifically targets these pests in areas of the park that are most important for *E. lavarackorum*. Ongoing monitoring is being carried out in these areas to ascertain the success of these programs in the conservation management of this important population. It is also hoped that future work will attempt to quantify the extent of indigenous harvest in northwest Queensland and, in cooperation with local traditional landowners, develop a cooperative management program in regards to the hunting of this species.

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