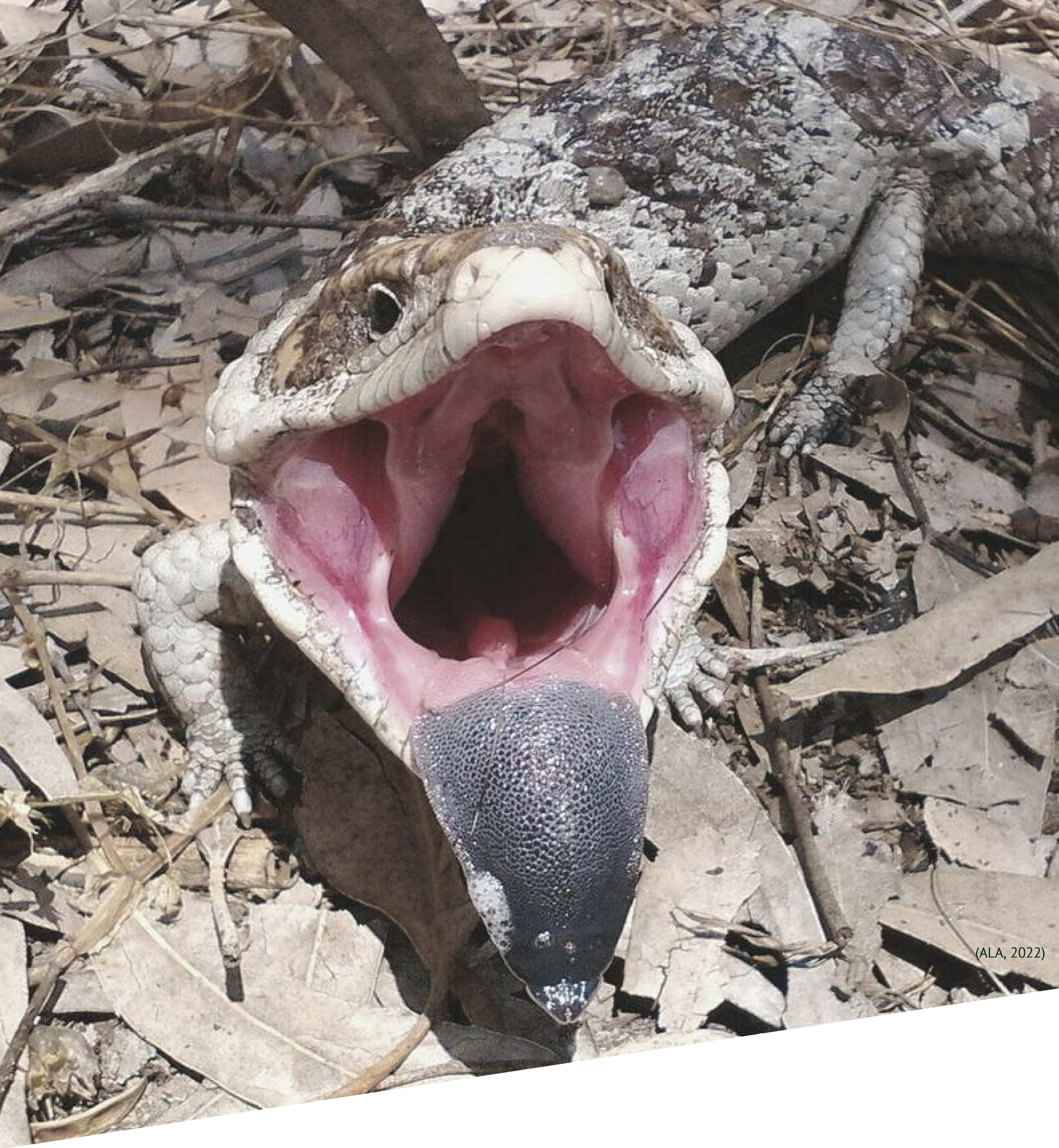


(ALA, 2022)

Identification of habitat requirements and life history of bobtail (*Tiliqua rugosa*) to inform best practice and improve the connectivity of naturelinks in the greater perth region

NOV 2022// LUISA FALLA

NatureLink Perth

Murdoch University

ACKNOWLEDGEMENT

THANK YOU DR JANE CHAMBERS FOR GIVING ME THE OPPORTUNITY TO PARTICIPATE IN THIS INTERNSHIP, FOR YOUR ADVICE AND MENTORSHIP. THANK YOU TO THOSE WHO CONTRIBUTED INFORMATION ON BOBTAIL SIGHTINGS, ESPECIALLY MARGARET, AND LASTLY, THANK YOU TO YASMIN FROM DARLING RANGE WILDLIFE SHELTER FOR YOUR INSIGHT ON BOBTAILS AS PATIENTS

BOBTAIL MOVEMENT CHARACTERISTICS

Home-range is define as the "area traversed by an individual in its normal activities of food gathering, mating, and caring for young" (Powell et al., 2012). Bobtail movement is then mostly delimited within this area making it a key concept to understand their movement. The size of their home-range has been set to be from 3 to 9 hectares in studies made in South Australia (Norval et al., 2019), however, this number was much reduced for populations in Western Australia rounding the 1.66 hectares (Cole, 2021). Differences in home-range size have been attribute to different factors, one of them being the degree of anthropogenic disturbance restricting movement and reducing the availability of shelter (Price-Rees et al., 2013), another suggestion refers to the ability to access water sources as a limitation for home-range size (Norval et al., 2019). Juveniles hold smaller home-range which may lead to the suggestion that size relates to food requirements and energetic needs, however there have been contradicting opinions in this matter (Bull et al., 1998). Either way, Bobtail home-range size compared with carnivore lizards is smaller suggesting their omnivorous diet allows them more adaptability and less specialisation (Norval et al., 2019).

Within the home-range Bobtails are seen to move over special activity places known as exclusive core areas (Norval et al., 2019). Typically, they are moderately located across the home-range and vary from two to four (Kerr et al., 2006). These areas are associated to specific structures that provide the best refugee sites (Price-Rees et al., 2013). It has been seen that some are linked to dome-shaped perennial bushes and other near or on a mammal burrow as they sometimes use other animal shelter (Kerr et al., 2006).

Home-range fidelity is very high with some Bobtails maintaining them at least 5 years (Cole, 2021).

Core areas are kept exclusive; however, the remaining patch can present a 60-80% overlap (Price-Rees et al., 2013). Within, males usually overlap greatly with other males and the presence of scale damage and fights may suggest territoriality (Kerr et al., 2006). Females on the other hand hardly ever overlap each other (Kerr et al., 2006). Intersexual overlapping within the home range is explained by the monogamous nature of Bobtails (Price-Rees et al., 2013).

It is suggested that Bobtails are able to identify their home range and paths of other lizards through chemical signs (Bull et al., 1999), and that scent marking is used to identify their area instead of scat pilling like other lizards (Norval et al., 2020).

Bobtail movement comes as a result of various drivers. Seasonality influenced primarily by temperature and food availability determines the frequency and pattern of movement (Taggart et al., 2017). Bobtail activity presents a variation from unimodal, from late winter to spring when their activity peaks during midday with warmer temperatures, to a bimodal model from late spring to summer, when their activity runs through early mornings and afternoons as temperatures are cooler (Norval et al., 2020). During winter, once temperatures drop below 10C, Bobtails become inactive and emerge from their shelters briefly to bask on sunny days (Haight, 2007). Food consumption reduces significantly as they survive on reserves stored during warmer months in their tails and abdomen fat pads (Haight, 2007).

Food availability associates with activity and movement patterns as they need to disperse in order to reach foraging grounds followed by activity related to digestion (Price-Rees et al., 2014). Bobtails are set to have low step frequency and their foraging movement varies according to temperature, environmental conditions, and sex, for example, during periods of drought, Bobtails acquire energy maximisation strategies avoiding movement and saving more energy (Kerr et al., 2006).

Another driver for movement is sex and reproduction. Prior to mating, males have a higher step count compared to females (Kerr et al., 2006), this may come as a result of males actively seeking their mates or additional pairings, as they sometimes can be polygynous, foraging, and as they keep a close association with their mates for about 6-8 weeks (Norval et al., 2020). After mating, male activity decreases while females need to keep foraging in order to support the embryos (Norval et al., 2020). Gravid females are reported to be more sedentary and hold smaller home-range remaining in areas with good food availability and shelter (Koenig et al., 2001), this could have a significance in terms of population dynamics as males face higher mortality due to their active movement as opposed to females (Koenig et al., 2001), however, as long as there are enough males for females to reproduced population viability should not be affected (Koenig et al., 2001).

BOBTAIL METROPOLITAN USAGE

Bobtails are well known and beloved through Perth Metropolitan areas and are considered one of the most "urban-adapter" reptile species (Wolfe, 2017). Some of the traits associated to this term include the ability to persist in regions with high urbanisation by using the resources available adapting to be around anthropogenic made structures for living such as gardens, be able to persist in patches from different sizes, tolerate or ignore people, and be a habitat generalist by using shrubs and rocks (Wolfe, 2017).

In order to assess Bobtail activity in Perth Metropolitan and Peel region in Western Australia, I analysed a total of 702 Bobtail sightings recorded in the Atlas of Living in Australia (ALA, 2022) and provided by members of the community as a response to NatureLink newsletter.

Based on the location of the sightings I identify the type of area in which they were seen as well as calculated an approximate distance (km) to the nearest Natural area where Bobtails were found in Urban and Residential areas. The dataset also provides Bobtail behaviour when given, the name of the natural area in which they were seen as well as their location.

In Perth, Bobtails are found to occupy diverse greenspaces such as fragmented reserves, residential backyards, parks, and other areas (Wolfe, 2017). This was seen in this research while analysing a multitude of sightings across the Perth Metropolitan and Peel region, results evidenced that 64% of Bobtails were seen in Reserves and Parks, 13% in residential areas, and the remaining 23% in other urban settings such as cleared areas with non-native vegetation, schools, golf course, industrial zones and others (Figure 1).

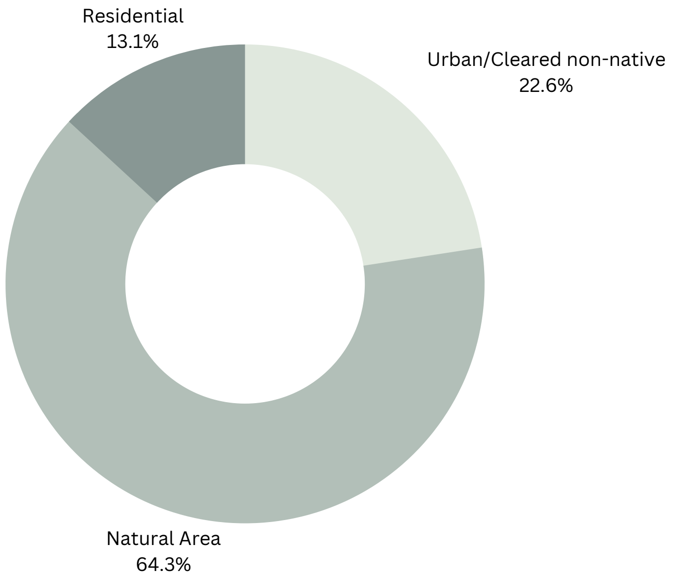


Figure 1: Bobtail (Tiliqua rugosa) location within sightings (n=702) across Perth Metropolitan and Peel area in Western Australia grouped into the following habitat types: Residential (housing), Reserve/Park: Natural allocated areas, National Parks, undisturbed suburban parks, and patches), and Urban/Cleared non-native (modified areas, schools, industrial areas, cleared patches of vegetation and similar).

Research done in the suburban population of *Tiliqua scincoides*, another species of blue-tongued lizard in Sydney found that as habitat generalists they were also able to exploit the urban areas and interestingly enough when presented with the opportunity to live in a forest natural area vs an artificial garden they prefer the later one (Koenig et al., 2001), it was suggested that these gardens provide an abundance of food resources compared to less modified areas (Koenig et al., 2001). They were also found in un-kept areas, draining pipes and concrete crevices (Koenig et al., 2001).

Sightings increased significantly between September and October with 112 and 195 records respectively (Figure 2). On the contrary, June and July presented the least activity with only 13 and 12 sights respectively (Figure 2). Comparing the number of sightings with seasons, it is clear that temperature plays a vital role in bobtail movement (Taggart et al., 2018). As Spring commences, the breeding season begins and the frequency of sightings is higher. Once temperature rise in summer, Bobtails change their activity patterns becoming more inactive and seeking sun at different periods.

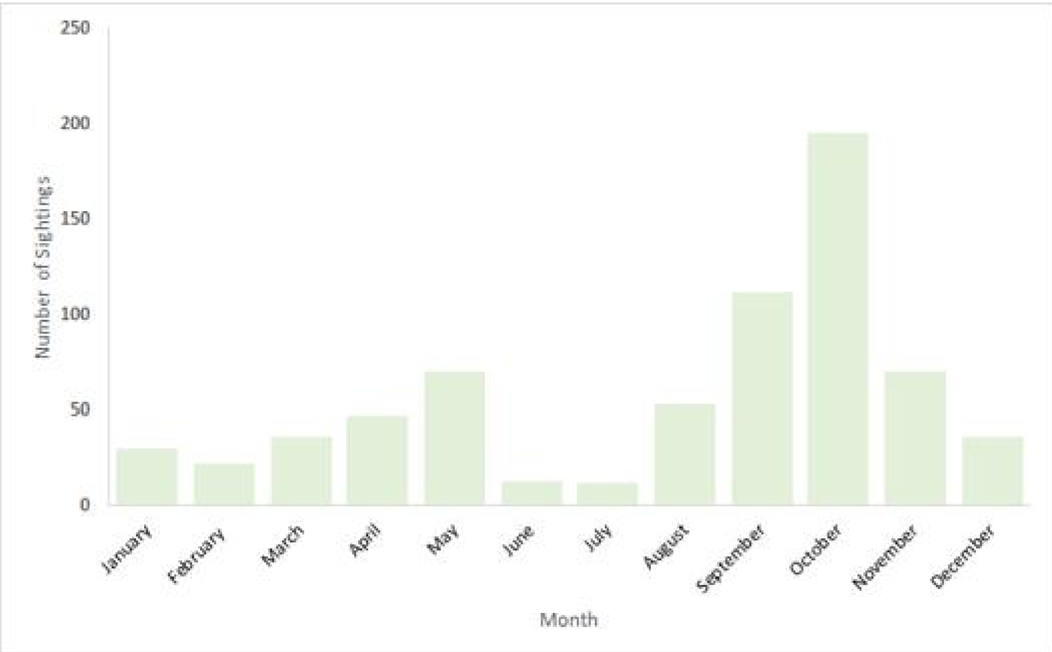


Figure 2: Number of sightings of Bobtail (Tiliqua rugosa) across Perth Metropolitan and Peel area in Western Australia (n=702).

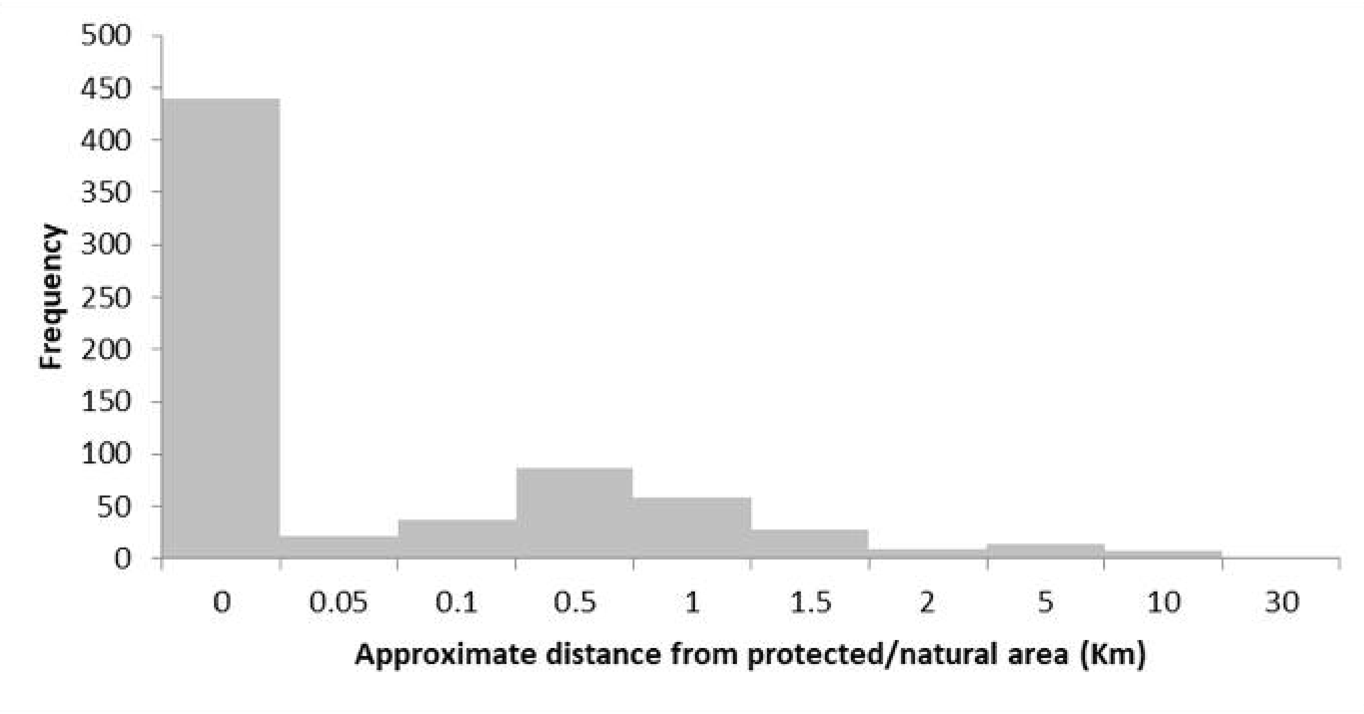


Figure 3: Approximate distance (Km) to a natural area of Bobtails (Tiliqua rugosa) seen in Urban and Residential areas across Perth Metropolitan and Peel area in Western Australia (n=702).

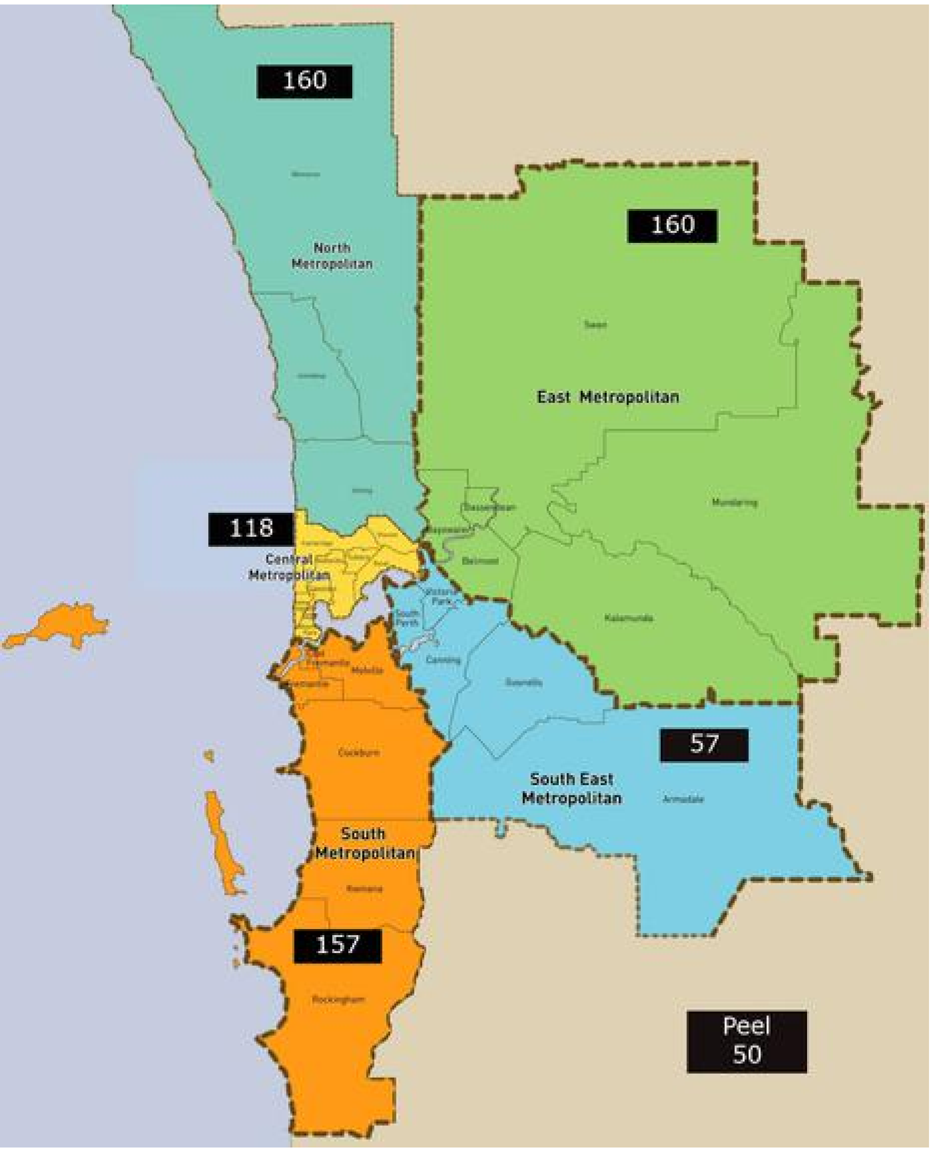
Looking at the location of the sightings it was clear that the majority of Bobtails were spotted within a reserve or park (439 sightings) (Figure 3). Approximate distances from natural areas were calculated for those seen in urban and residential areas resulting in frequencies of 21, 37, 86, and 59 Bobtails for distances of up to 50m, 100m, 500, and 1km respectively (Figure 3). A total of 59 Bobtails were seen beyond the 1km mark (Figure 3).

Bobtail home range is an area in need of further research, especially in WA. Studies done on Bobtail populations in South Australia have found their home range to be around 4ha exceeding the 200m mark (Bull et al., 1999), however, these populations were mainly inhabiting arid areas with no urbanization which could influence their range and movement as resources and environmental conditions varied (Cole, 2021).

In Western Australia, studies done in urban and peri-urban areas coincide in a much smaller home range ranging from around 1.66ha to 2.17ha (Cole, 2021).

Considering this information, NatureLinks would be important to achieve connectivity within smaller distances of up to around 100m, however, further research is needed to understand Bobtail movement. As the majority of Bobtails were located beyond their home range distance the need to provide a safe environment for Bobtails to live in, in non-native areas, is imperative.

Looking at the number of Bobtail sightings per zones within Perth Metropolitan and Peel, North Metropolitan, East Metropolitan and South Metropolitan recorded most of the sightings with 160, 160, and 157 sights respectively (Figure 4).



On the contrary, the least amount of sightings was recorded through the Peel region with 50 sights, and South East Metropolitan with 57 (Figure 4). These results could provide a grasp as to the main locations for Bobtails within the region, which in return would help to centralise the efforts for NatureLinks depending on the areas of concern, however, deeper research must be done into population abundance and distribution to state any claim. Additional information that could be analysed from this would come from looking at each zone itself and its characteristics, for example, looking at the human population, housing, vegetation, and presence of Nature reserves among others. This would provide an inside in the impact on Bobtails, availability of habitat and trace of potential NatureLinks.

Figure 4: Number of sightings of Bobtail (Tiliqua rugosa) across Perth Metropolitan and Peel area in Western Australia grouped by local government zones (n=702). Image modified from WALGA website.

The presence of Bobtails in urbanised areas comes with a series of threats they are exposed to as a result of this environment. As the breeding season begins and they become more active with the warming weather, there is an increasing trend of Bobtail admissions in Wildlife clinics as seen through this research where 45% of patients were admitted in Spring and only 13% during Winter (Figure 5). This follows reptile biology traits as they become inactive once weather conditions are not favourable for activity (Norval et al., 2020). The peak activity months were October and November with 54 and 48 patients respectively, while the least was admitted in July with only 10 individuals (Figure 6). These results suggest the importance to increase awareness of Bobtails as well as improvement of NatureLink conditions especially through high mobility months.

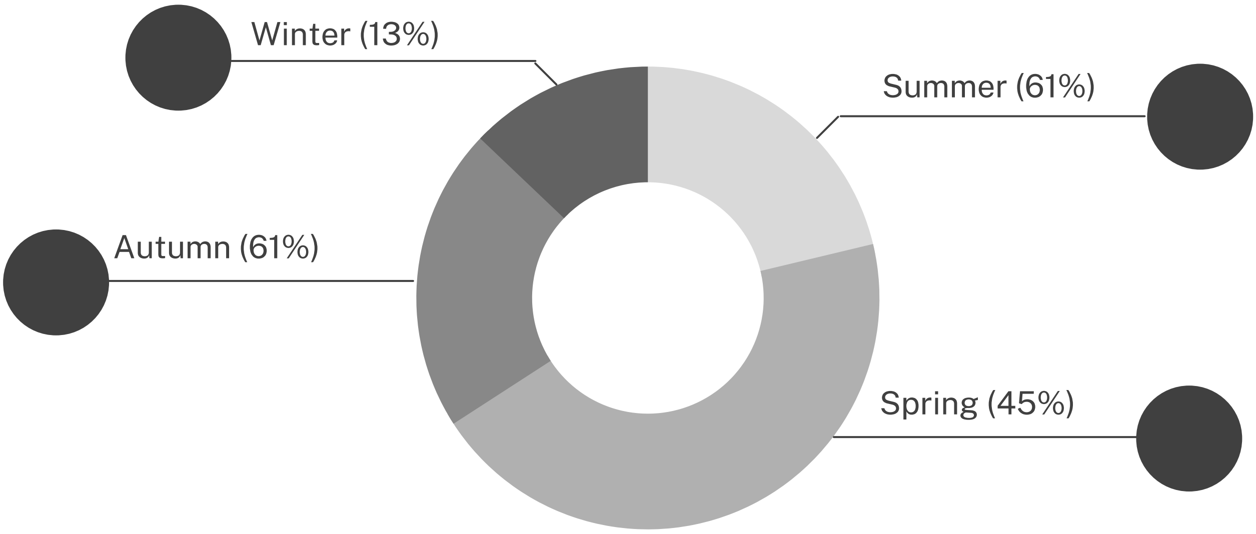


Figure 5: Proportion of Bobtails (Tiliqua rugosa) admitted at Darling Range Wildlife Shelter, WA per seasons from January 2018 to October 12th of 2022 (n=287).

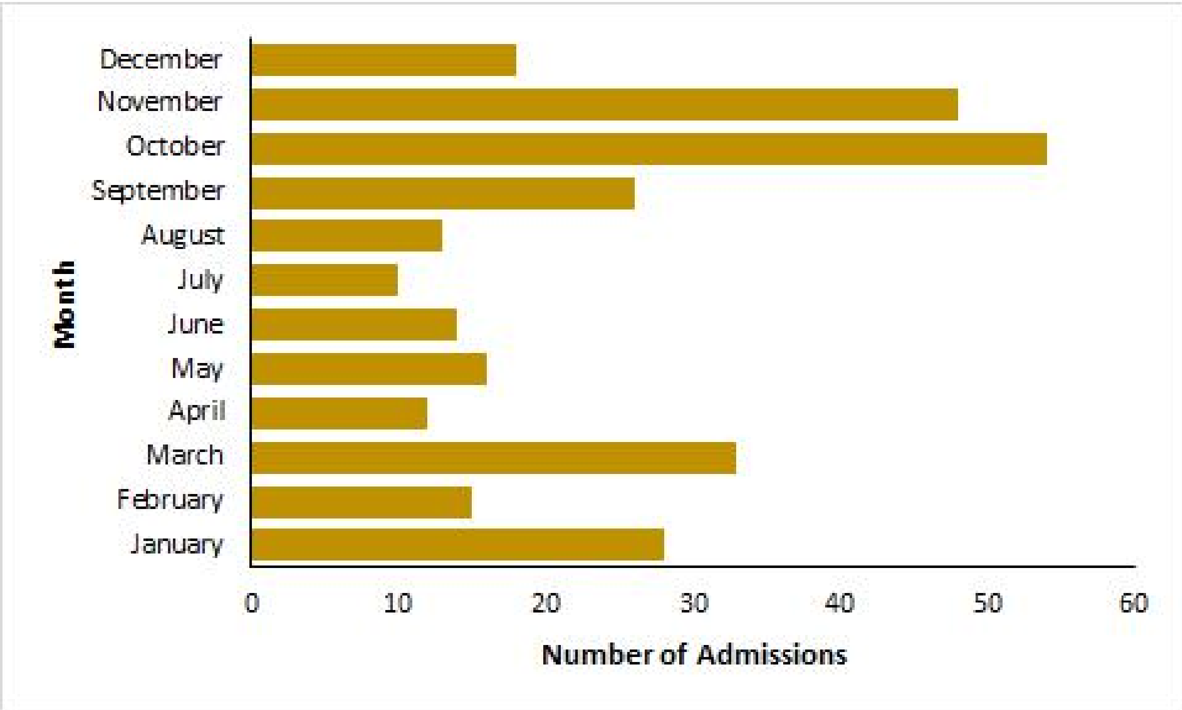


Figure 6: Number of monthly admissions of Bobtail (Tiliqua rugosa) at Darling Range Wildlife Shelter, WA from January 2018 to October 12th of 2022 (n=287).

Bobtail admissions showed additional factors. In regard to age, patients were primarily adults with 203 admissions, followed by Juveniles with 60 and Hatchlings or Newborn with 25 (n=287) (Figure 7). Reasons for admission varied, Bobtail flu was the main cause with 30%, followed by dog attacks with 27% of patients (Figure 8). Bobtails found on the road or those who suffered from a motor vehicle accident represented 12% of total admissions (Figure 8).

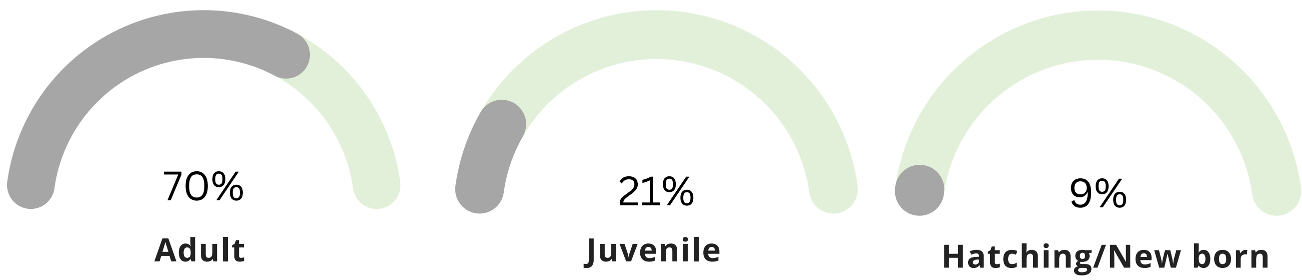


Figure 7: Age proportion of Bobtails (Tiliqua rugosa)) admitted at Darling Range Wildlife Shelter, WA from January 2018 to October 12th of 2022 (n=287). Adult (n=203), Juvenile (n=60), and Hatchling/New born (n=25)

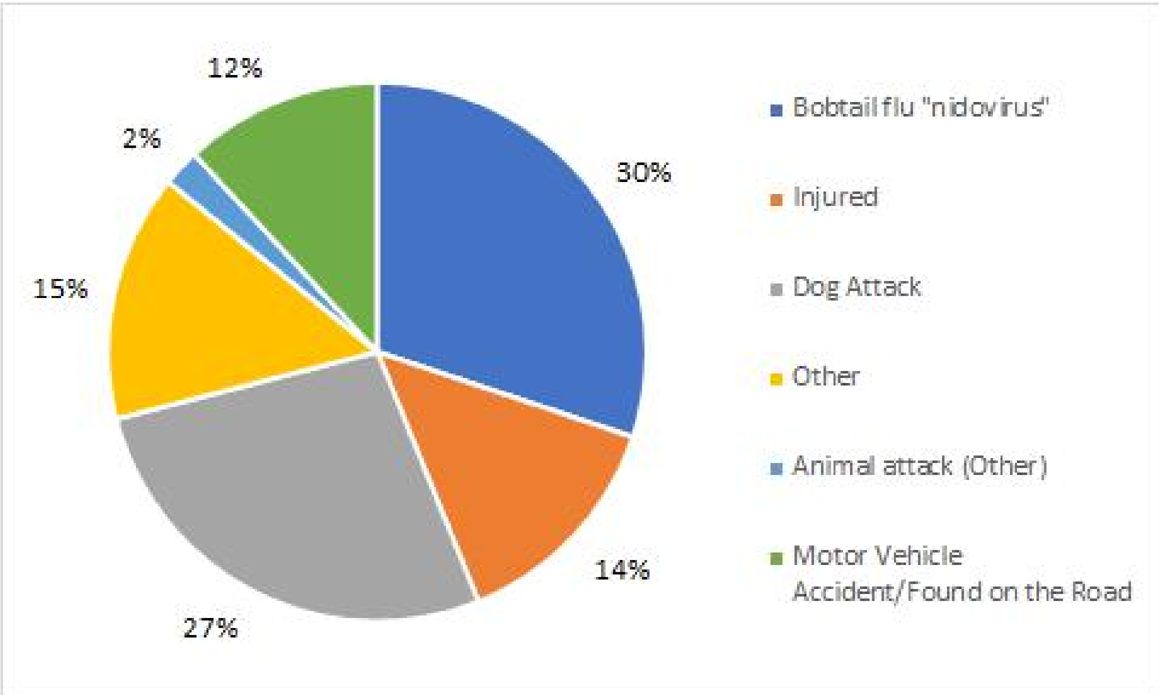


Figure 8: Main causes for admission of Bobtails (Tiliqua rugosa) at Darling Range Wildlife Shelter, WA from January 2018 to October 12th of 2022 (n=287).

Part of making a NatureLink safe for Bobtails to use comes from the prevention or minimisation of threats. As previously seen, dogs and roads pose a significant danger to these animals. Dog attacks increase exponentially as Bobtails breeding season begins from September to November with 11, 20, and 22 out of 73 patients admitted for this reason (Figure 9). On the other hand, road accidents were also significantly higher around the same season with October and November admissions reaching 11 and 12 patients affected out of 32 (Figure 9).

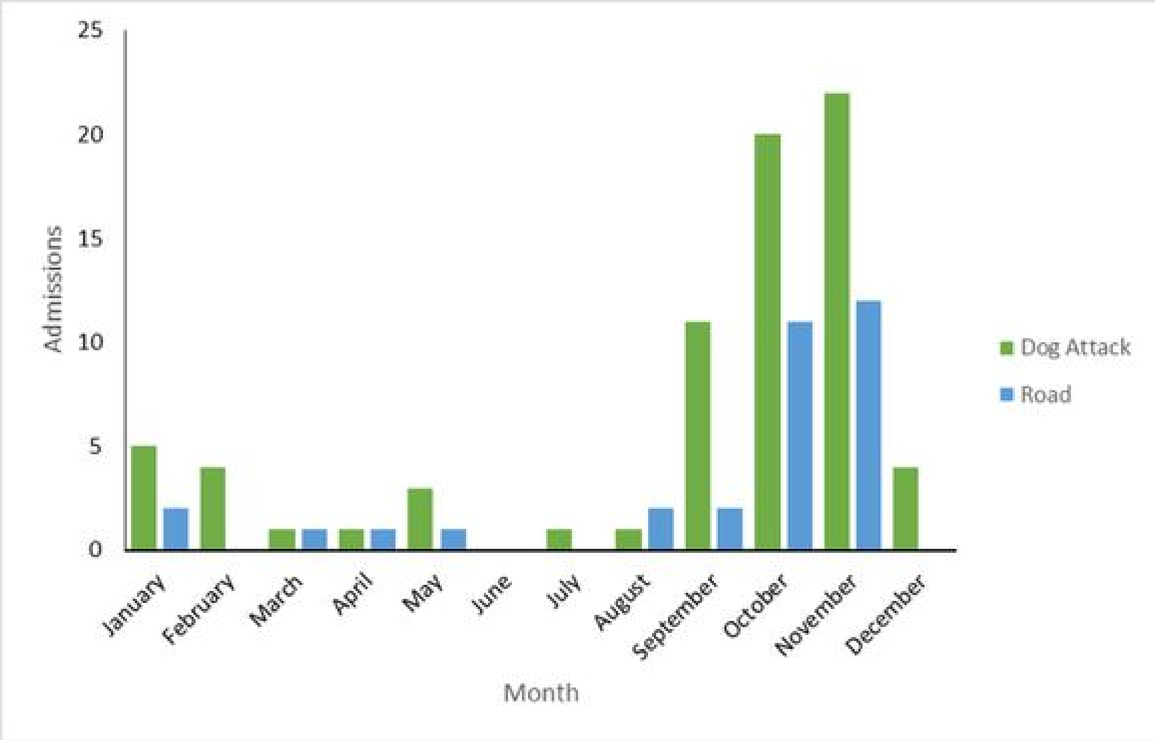


Figure 9: Proportions of dog attacks and road related admissions of Bobtail (Tiliqua rugosa) at Darling Range Wildlife Shelter, WA from January 2018 to October 12th of 2022 (n=105).

Dog attacks are a main concern for Bobtails in an urban environment. Due to the morphological characteristic of Bobtails, combine with the bite force and dog behaviour, they are able to inflict life-threatening injuries as a result of internal organs getting punctured and potential complications with maggots, prolapsed organs, and dehydration between others (Haight, 2007). Out of all the patients, only 50% survive these attacks and many endure long and painful deaths (Kanyana, 2022). As dog presence is inevitable along NatureLinks, it is fundamental to promote strategies to minimise or control their interactions with Bobtails.

Besides dog interactions, Bobtails can come face to face with predators, in South Australia, Dingos and Carpet pythons could represent a threat (Bull, 1995). However, looking at the populations in the Perth Metropolitan area and Peel, introduce species such as Foxes (Vulpes vulpes) could be the place to look at (Bull, 1995).

As an advantage, Bobtails have great camouflage and quiet nature when inactive which can help them avoid interactions (Bull, 1995). While identifying NatureLinks, the presence and abundance of Foxes could be a decisive factor, however, this area needs more research.

Roads represent another significant threat. Their presence contributes to habitat fragmentation, reduction of gene flow and direct mortality to name a few (Wolfe, 2017). Living in the urban area, Bobtails are met with the necessity to cross them in order to reach natural patches risking being struck by moving cars. In addition, they can be seen scavenging for food or basking in them (Wolfe, 2017). The presence of flowers and vegetation on verges makes Bobtails more vulnerable to being struck as they approach them to feed (Bull, 1995).

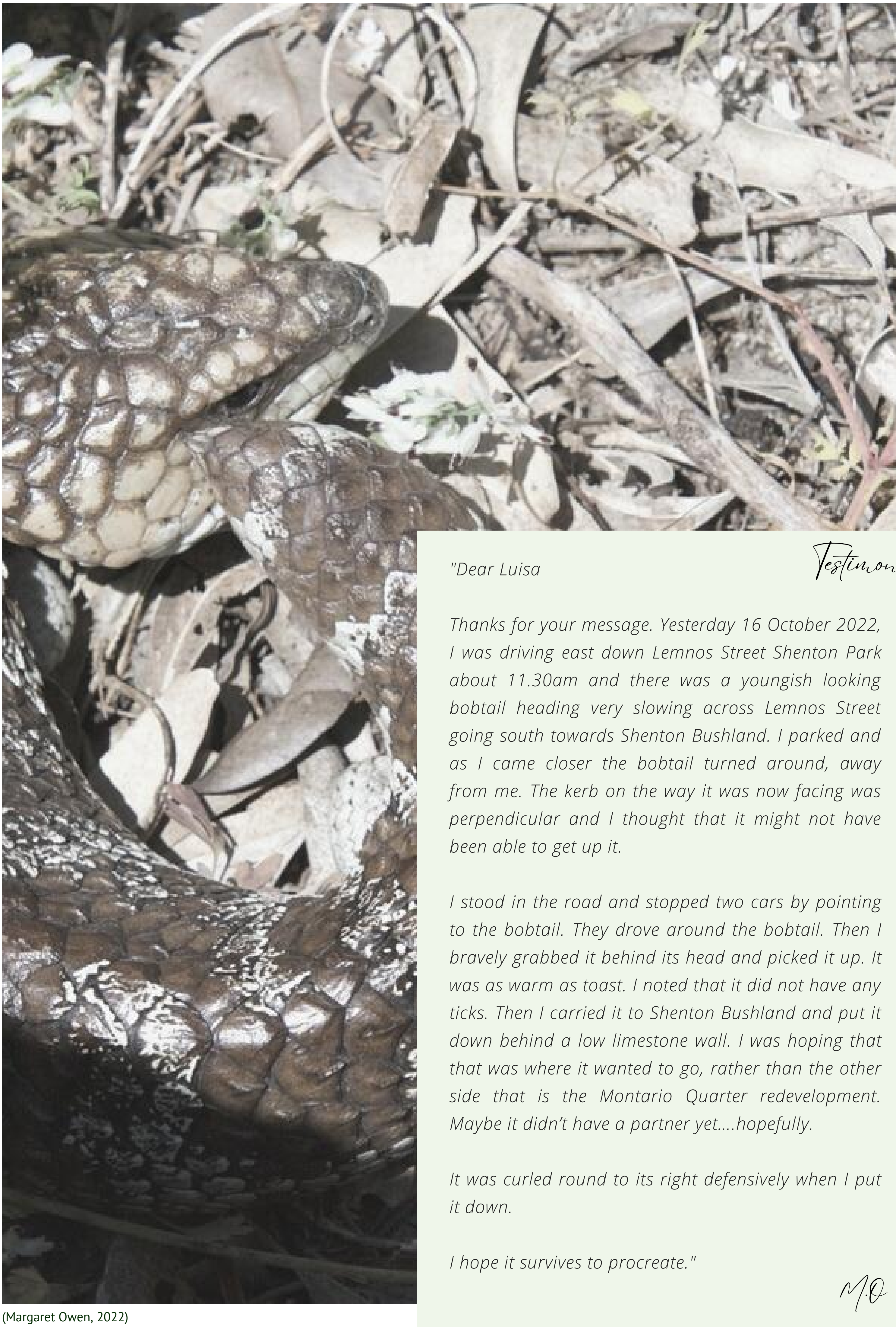
Studies have found that not only their slow nature makes them more vulnerable, but also motorist attitudes towards wildlife and especially reptiles can play an important role in overall road collisions (Wolfe, 2017). Reptiles affected by road accidents that do not die immediately and are admitted to local clinics usually face a mortality rate of more than 75% (Wolfe, 2017).

A study made in Western Australia (Wolfe, 2017) presents very interesting aspects in regard to attitudes towards reptiles (Bobtails and snakes) on roads. As a result of their research, it was seen that Western Australians have a general positive attitude towards reptiles, drivers were most likely to ignore Bobtails on the side of the road with only one person stopping to move the animal to a safer location, they also did not record any intentional strikes (Wolfe, 2017). Even though this seems promising, Bobtail Road collisions are still highly probable with a 75% probability and occur frequently (Wolfe, 2017). It has been calculated that around 3% of adult Bobtails are killed by cars (Bull, 1995).

It is important to notice that some research has found that Bobtails often try to avoid roads and use corridors of vegetation through the fence line (Koenig et al., 2001), however, depending on the location and characteristics of the area this may not be possible all the time. Looking at the sightings dataset created for my project, it was clear in many situations, Bobtails would need to face roads to achieve connectivity, either a highway or a suburban street, making roads a focus for a care plan.

The inclusion of underpasses through NatureLinks could help minimise the need to cross roads by Bobtails. Fauna underpasses are being included more recently in road constructions, research made in the Perth Metropolitan area found that Bobtails do use them while monitoring underpasses in Safety Bay, Paganoni Swam between other locations (Chambers et al., 2013). It was recommended the inclusion of median strips with vegetation to connect smaller areas to control underpass length Chambers et al., 2013).


(Margaret Owen, 2022)



(Margaret Owen, 2022)

Testimony

"Dear Luisa

Thanks for your message. Yesterday 16 October 2022, I was driving east down Lemnos Street Shenton Park about 11.30am and there was a youngish looking bobtail heading very slowing across Lemnos Street going south towards Shenton Bushland. I parked and as I came closer the bobtail turned around, away from me. The kerb on the way it was now facing was perpendicular and I thought that it might not have been able to get up it.

I stood in the road and stopped two cars by pointing to the bobtail. They drove around the bobtail. Then I bravely grabbed it behind its head and picked it up. It was as warm as toast. I noted that it did not have any ticks. Then I carried it to Shenton Bushland and put it down behind a low limestone wall. I was hoping that that was where it wanted to go, rather than the other side that is the Montario Quarter redevelopment. Maybe it didn't have a partner yet….hopefully.

It was curled round to its right defensively when I put it down.

I hope it survives to procreate."

M.O

BOBTAILS CARE PLAN IN URBAN AREAS

- **Roads:**

-Use of fences or walls as a barrier from the road to improve protection and provide guidance to a suitable area in the NatureLink to cross.
-Use "Bobtail crossing" signs where the NatureLink crosses a road, especially during the breeding season.
-Increase Bobtail awareness and educate on actions to take when encountering Bobtails on the road within drivers.

- **Dogs:**

-Target pet owners in NatureLink areas and promote training dogs to avoid wildlife.
-Be aware of Bobtails while walking dogs and remove any from danger.
-Use barricades or cover the lower part of yard fences to prevent Bobtails from getting inside the property If dogs are allowed outside.
-Ensure dogs are walked with a leash and limit walks to permitted areas. Do not walk dogs in National Parks.

- **NatureLinks**

-While designing the NatureLink, favour slow-speed areas and avoid main roads or multilane streets.
-Ensure NatureLink counts with corridors of dense vegetation to provide shelter and hiding places.
-While tracing the NatureLink, include alternative crossings to roads such as underpasses
-Use signs to inform the local community of the NatureLink and the presence of its Bobtail users.

- **Awareness/Education**

-Inform the community through printed media, local websites, social media, and local venues of any NatureLink around their area. By providing information on their use and intend people would be motivated to be part of it and aware of wildlife.
-Increase Bobtail knowledge using resources such as fact sheets with a focus on movement characteristics, breeding, behaviour, and habitat use to improve the understanding of the species.

-Provide awareness of the main threats Bobtails suffer while living in an urban area, this would put reality into perspective and motivate change in the community. At the same time, educate them on their role as seed dispersers and pest control.
-List and provide sources of Bobtails information such as Rewild.

- **Bobtail Friendly Yard/Garden**

-Plant native grasses, shrubs, and ground cover to provide shelter. Alternatively, nest-boxes and terracotta pots can be used when installed under shrubs and covered with leaves. PVC piping along the fence line provides good hiding places.
-Allow leaf litter on the ground and mulch plants
-Include logs, rocks, barks or brick for basking and aid in rubbing shed skin.
-Be aware of Bobtails prior to mowing lawns
-Provide clean shallow bowls with water filled regularly
-Ensure foraging areas are available planting native fruiting plants and allowing the presence of invertebrates and snails.
-Avoid using pesticides, chemicals, and snail pellets in the garden as they can cause poisoning if consumed by Bobtails.

ADDITIONAL RESOURCES

-

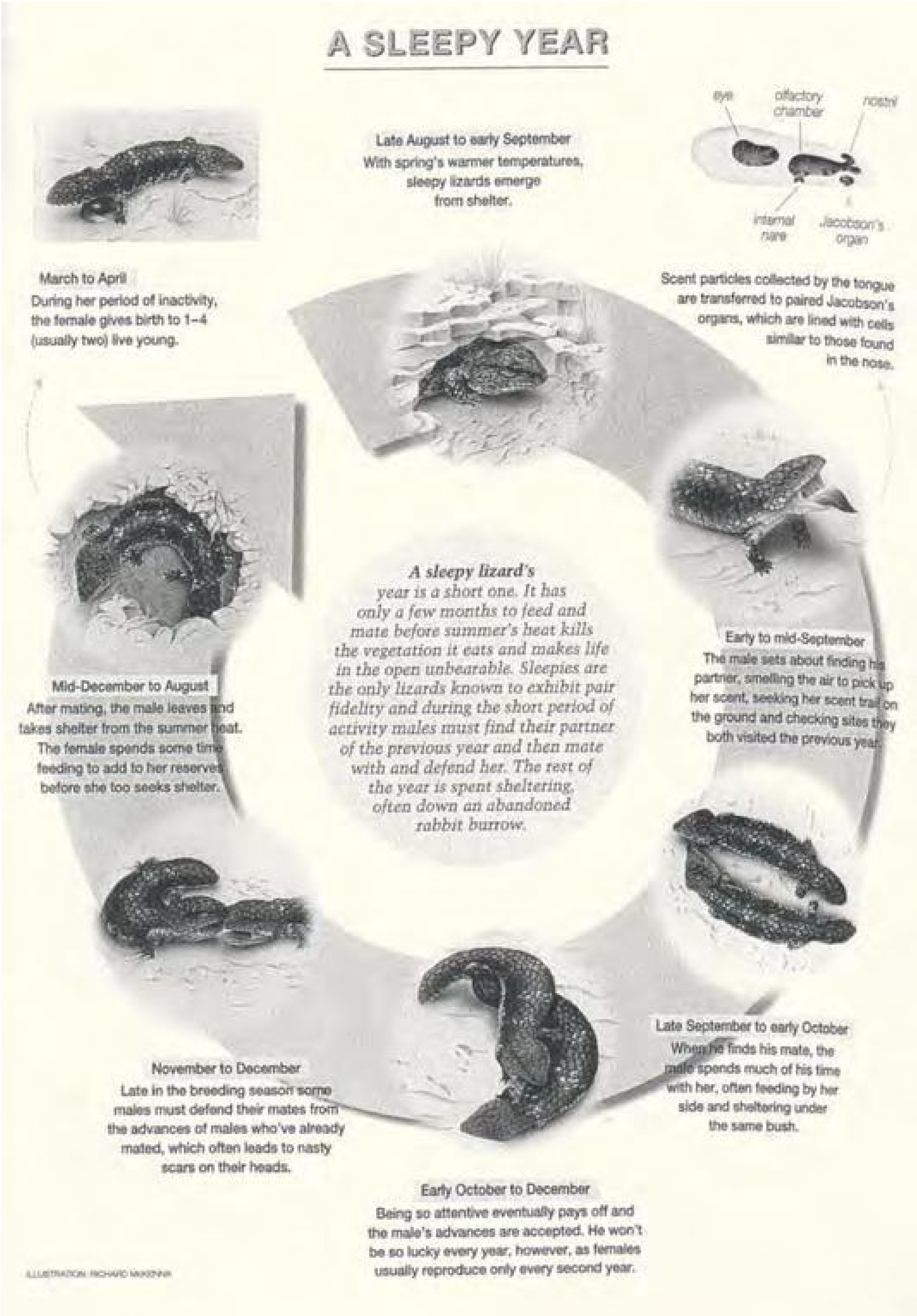


Figure 9: Bobtail (Tiliqua rugosa) breeding cycle and movement (Titmuss, 2007)

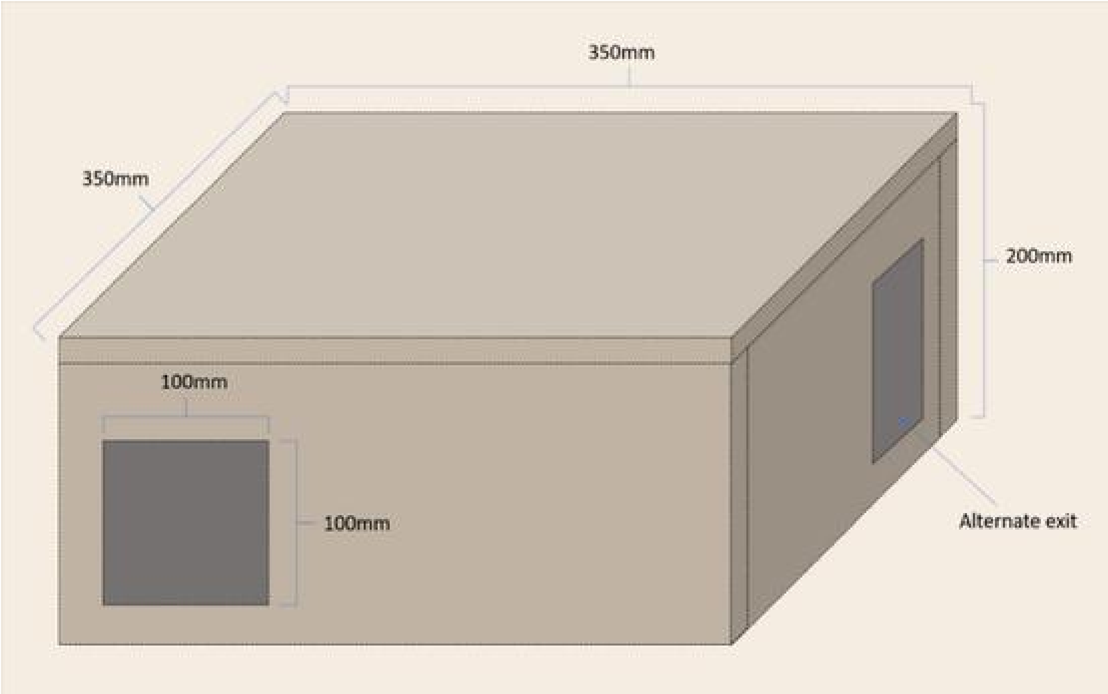


Figure 10: Nest-box design alternative for Bobtail (Tiliqua rugosa) (Rewild, 2022)

BOBTAILS CARE PLAN IN URBAN AREAS

ROADS

-Use fences or walls as a barrier from the road to improve protection and provide guidance to a suitable area in the NatureLink to cross.

-Use "Bobtail crossing" signs where the NatureLink crosses a road, especially during the breeding season.

-Increase Bobtail awareness and educate on actions to take when encountering Bobtails on the road within drivers.

DOGS

-Target pet owners in NatureLink areas and promote training dogs to avoid wildlife.

-Be aware of Bobtails while walking dogs and remove any from danger.

-Use barricades or cover the lower part of yard fences to prevent Bobtails getting inside the property If dogs are allowed outside.

-Ensure dogs are walked with a leash and limit walks to permitted areas. Do not walk dogs in National Parks.

NATURELINKS

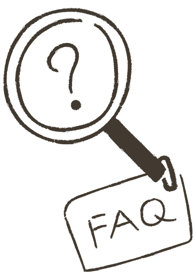
-While designing the NatureLink, favour slow-speed areas and avoid main roads or multilane streets.

-Ensure the NatureLink counts with corridors of dense vegetation to provide shelter and hiding places.

-While tracing the NatureLink, include alternative crossings to roads such as underpasses

-Use signs to inform the local community of the NatureLink and the presence of its Bobtail users.

AWARENESS/EDUCATION



-Inform the community through printed media, local websites, social media, and local venues of any NatureLink around their area. By providing information on their use and intention people would be motivated to be part of it and aware of wildlife.

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-List and provide sources of Bobtails information such as Rewild.

BOBTAIL FRIENDLY GARDEN

-Plant native grasses, shrubs, and ground cover to provide shelter. Alternatively, nest-boxes and terracotta pots can be used when installed under shrubs and covered with leaves. PVC piping along the fence line provides good hiding places.

-Allow leaf litter on the ground and mulch plants

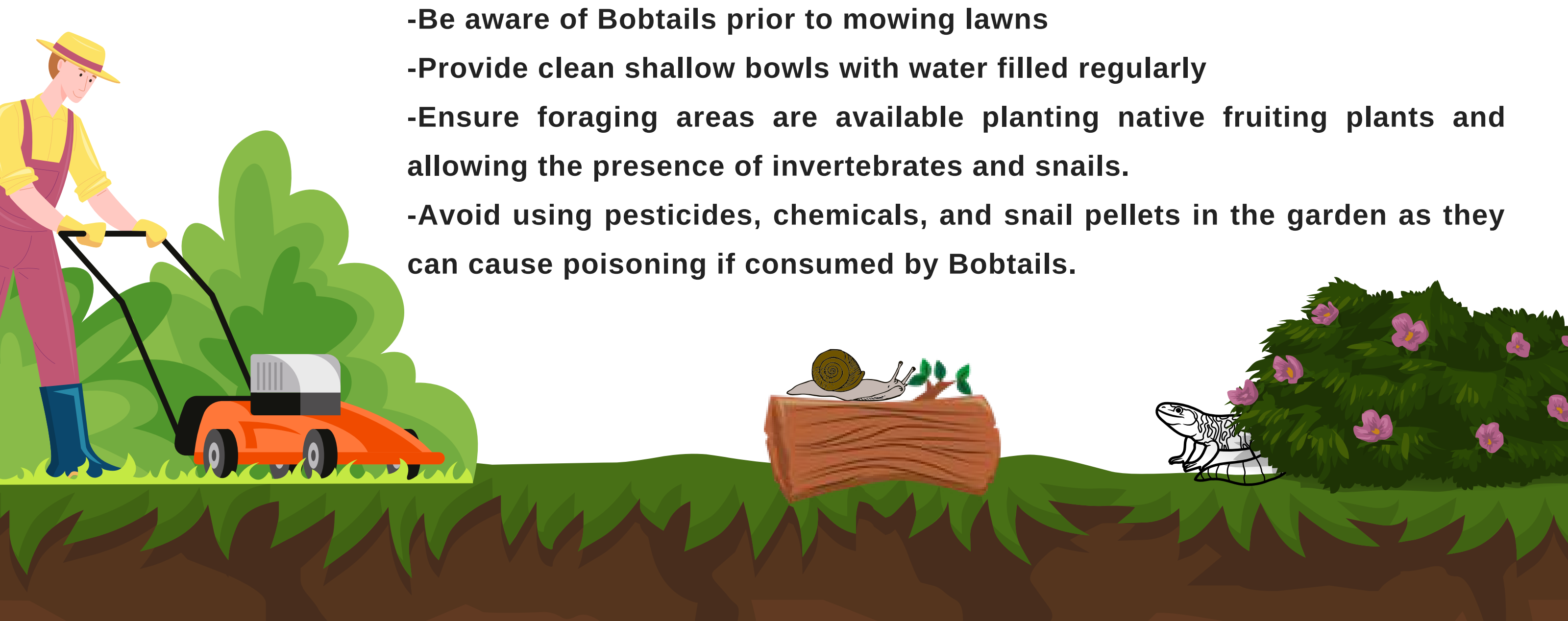
-Include logs, rocks, barks or brick for basking and aid in rubbing shed skin.

-Be aware of Bobtails prior to mowing lawns

-Provide clean shallow bowls with water filled regularly

-Ensure foraging areas are available planting native fruiting plants and allowing the presence of invertebrates and snails.

-Avoid using pesticides, chemicals, and snail pellets in the garden as they can cause poisoning if consumed by Bobtails.



BOBTAIL *Tiliqua rugosa (Gray, 1825)*

Common names: Bobtail, Boggi, Shingle-Back, Sleepy Lizard, Stumpy-Tail

(ALA, 2022)

·Classification

Kingdom: Animalia
Phylum: Chordata
Class: Reptilia
Subclass: Lepidosauria
Order: Squamata
Suborder: Lacertilia
Family: Scincidae
Genus: Tiliqua
Species: *rugosa*
-*rugosus* (south-western Australia)
-*asper* (eastern Australia)
-*konowi* (Rottnest Island)
-*palarra* (mid-west coast of WA)
(Cogger, 2018)

·Conservation Status: *Tiliqua rugosa* is considered a Least Concern under the IUCN Red list. *Tiliqua rugosa kunowi*, found in Rottnest Island is considered Vulnerable. (ALA, 2022).

Figure 1: Australian distribution of *Tiliqua rugosa*. (IUCN, 2022)

·Distribution and Habitat

Endemic to the southern parts of Australia, except the coast along the east and south-east (Cogger, 2018), Tiliqua rugosa can be found from Queensland right through Western Australia inhabiting a variety of habitats (Figure 1). Preferring areas where shrubs are dominant instead of the tall canopy (Norval et al., 2020), they can be found in eucalypt woodlands, coastal heaths, arid Acacia scrublands, spinifex-dominated deserts, and urban areas (Cogger, 2018).

·Longevity/Mortality

Mortality rates are high among juveniles with 16% reaching their first year (Titmuss, 2007), due to predation, parasitism and environmental conditions (Norval et al., 2020). Adult mortality is low and they are known to reach up to 50 years (Norval et al., 2020).

(ALA, 2022)

·Taxonomic Characteristics/Identification:

Large and robust with an average SVL of 30cm and a mass of 600g (Kerr et al., 2006). Broad triangular head, bright blue tongue, short limbs with short, fat toes. Large, rough scales, and short, blunt tails measuring around 20-25% of the SVL (Cogger, 2018). Colouration varies with their location from dark brown with scattered clear markings to cream (ALA, 2022). Bobtails are ectotherms preferring body temperatures between 33 to 35C (Norval et al., 2020), with conical teeth as a result of their diet (Norval et al., 2020).

·Diet

Bobtails are considered opportunistic feeders eating small invertebrates, insects, snails, and carrion, with a preference for a herbivore diet feeding on herbs, blossoms, seedlings, fruits, and the dominant food available in the area at the time making their diet seasonal and highly variable (Norval et al., 2020). They are known to feed for a short period of time and move around to feed on a different area for an average of <12min per day (Norval et al., 2020) eating up to 30% of their body weight (Titmuss, 2007). Their diet is important to allow growth and reproduction, and its high variety allows them to persist in urban areas.

·Reproduction (Life history/Breeding behaviours)

Tiliqua rugosa is viviparous bearing one to three young per little after a 5-month gestation period (Norval et al., 2020). Juveniles reach maturity within 3 to 5 years which is considered long for skinks, but short considering bobtails long longevity (Norval et al., 2020). Although they do not exhibit parental care, mothers are known to identify their young and allow them to live within the same home range before they disperse after a year (Norval et al., 2020).

The mating season runs from September to December, when the weather warms, and mating occurs between late October and early November (Norval et al., 2020). Sleepy lizards are known to display **monogamy** in which pairs are strongly bonded lasting multiple years. Commonly initiated by males, the partners re-establish during the mating season, mate, and then separate but remain in overlapping core areas within their home ranges (Norval et al., 2020). Prior to mating, males are known to be more active as they look for their pair and fight potential rivals (Cole, 2021), while females are post-mating as they must nourish better to maintain their young (Cole, 2021).

Monogamy is beneficial for males to improve their success genetically in reproduction, and females as they are protected from threats and allow to move and feed more freely.

·Predators/Threats

Sleepy lizards can be preyed upon by dingos, introduced feral foxes and cats, large snakes such as carpet pythons, and predatory birds like kookaburras and falcons (ALA, 2022). As a defence mechanism, bobtails display their blue tongue along with a hissing sound attempting to scare off the predator and can bite if needed (ALA, 2022).

Tiliqua rugosa is commonly parasite by reptile ticks that attach to the ear canal and under the scales (ALA, 2022), such as *Amblyomma albolimbatum* and *Bothriocroton hydrosauri*, they have an important impact on bobtails affecting their activity levels, moving speed and ability to retain or find their pairs (Norval et al., 2020).

Habitat loss due to increased urbanisation, road traffic, lawnmowers and snail baits are caused of mortality in the urban area (Titmuss, 2007).

·Activity/Behaviour

Bobtails are slow-moving with short stamina (Kerr et al., 2006), they are diurnal with activity patterns linked to the season and time of the day. During late winter and spring, they are active during the mid-part of the day when is warmer (Norval et al., 2020). During late spring and summer, when temperatures are higher, their main activity occurs in the morning and cooler afternoon periods Norval et al., 20201). Mainly solitary except for their breeding season with pick activity in spring as mating behaviours commence (Cole, 2021).

As ectotherms, they show a basking behaviour to maintain body temperature and are able to pant when overheating (Titmuss, 2007). During the winter, as the temperatures drop below 12C, they enter a state of brumation (Titmuss, 2007).

·Shelter/Refugee

In the wild, Bobtails select their refugee sites instead of being a random act. Preference for dome-shaped bushes with foliage reaching the ground and those with thorns are seen (Kerr et al., 2003). Refugee use varies with activity periods, in Spring Bobtails make use of several sites, once the temperatures increase and their activity decreases, they change to single-use refuges (Kerr et al., 2003). It is believed that the selection of shape and size of bushes influence the amount of shade and temperature control for Bobtails, additionally, thorns provide a degree of protection from predators (Kerr et al., 2003). Bobtails also use burrows from other animals as shelter when conditions are not favourable (Norval et al., 2020).

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