Soil properties within Giant Gippsland Earthworm *Megascolides australis* habitat

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Key Points

- The Gippsland Giant Earthworm (GGE) is listed as Vulnerable (EPBC Act 1999) and Endangered (FFG Act 1988)
- The GGE has a small range and habitat requirements are specific but separated by non-contiguous habitat conditions. This means small, isolated populations are at threat of local extinction and genetic bottlenecks.
- Soil moisture is generally thought to be a critical habitat determinant for GGE, based on patterns of known distribution in areas with consistently high soil moisture.
- The soil moisture and oxygen content within suitable habitat is not known, and addressing this key knowledge gap will provide better understanding of critical habitat conditions to support management for conservation of this species.

Abstract

The Giant Gippsland Earthworm *Megascolides australis McCoy 1878* is listed as Vulnerable (EPBC Act 1999) and Endangered (FFG Act 1988) and remains an enigma despite extensive research over the past 30 years. It spends its entire life underground in niche habitat areas within a small range in South and West Gippsland, Victoria. Spending the entirety of their life beneath the ground surface, the only indication of its presence is a gurgling sound when its moving through wet tunnels in the clay soils on hillslopes with terracettes and creek banks, usually in response to human or other large animal footsteps above. They are known to occur in the one location for their entire lifetime and movement between habitats is unlikely due to the non-contiguous nature of suitable habitat. While soil moisture plays a critical role in the distribution and survival of GGE, the specific hydrological parameters have not been identified and therefore the tolerance to hydrological change remains unknown. This information is critical for the conservation of the species given the hydrological alterations occurring within the range of the species.

Our team is collaborating to monitor known habitats, building on the existing streamside re-vegetation research to determine soil moisture conditions in their habitat, between habitats and at adjacent habitats. We hope to unravel the hydrological secrets of the GGE, and better understand the soil moisture conditions required to protect healthy but threatened populations.

Keywords

Giant, Gippsland, Earthworm, Threatened, soils, moisture, monitoring, threats

Introduction

The GGE is restricted to a relatively small range of south and west Gippsland, Victoria, in an area roughly bound in the north by Warragul, and in the south by Loch and Korumburra. The extent of this range is approximately 40,000 ha but the area of occupancy of most sites can be very small and can comprise areas of less than $10m^2$. Most known populations occur on privately-owned land (Van Praagh and Yen 2010) and one much larger population occurring within a $2500m^2$ area on public land is also known.

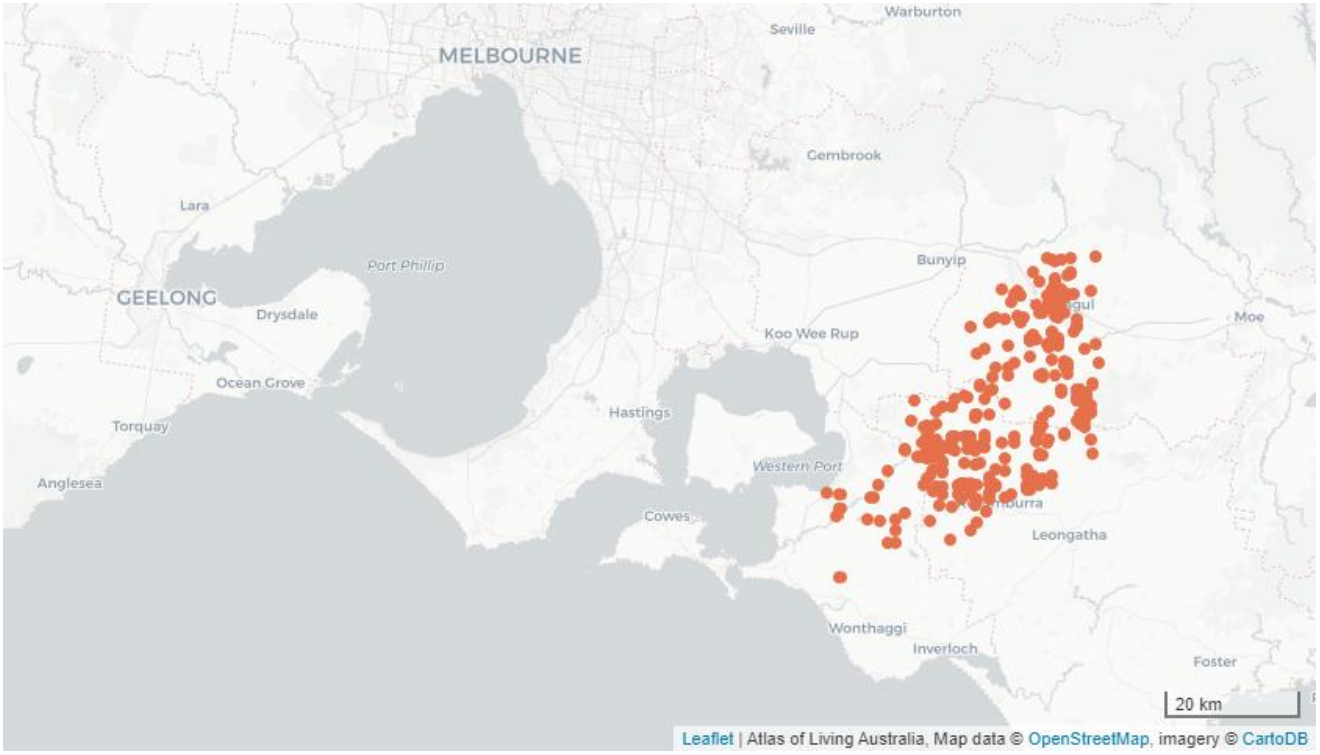

Figure 1: Known recordings of GGE (Source: Atlas of living Australia May 2024)

The number of individuals within a population varies but is usually quite small, possibly due to the limited availability of contiguous habitat. In some instances, only one or two individuals per site have been observed. However, where suitable conditions are more extensive, larger populations have been found. Soil type appears critical and this species is either located in deep blue-grey clayey soils in the south of their range (Figure 2) or red-clay soils around the north of their range (Figure 3) or the alluvial areas throughout. Habitat includes soaks, roadsides and gullies and, on some occasions, even clay vehicle tracks. In addition, the species may be found on steep wet slopes with a southerly or westerly aspect (Van Praagh and Yen 2010). Habitat variabilities are shown in Figures 4, 5 and 6 (exert from https://www.giantearthworm.org.au).

Figure 2: Blue grey clay-soils of the south

Figure 3: Red clay soils common around Warragul

Figure 4: Gullies and creek banks (above flood level)

Figure 5: Major Stream Terraces

Figure 6: Steep slopes (south facing)

In these habitats they are associated with the following ecological vegetation classes: Damp Forest (EVC29), Wet Forest (EVC30), Warm Temperate Rainforest (EVC32), Swampy Woodland (EVC937), Swampy Riparian Woodland (EVC83) and Riparian Forest (EVC18). The species can also be found within steep slopes, usually within terracettes associated with underground springs or landslips. Associated habitats are generally identified as Damp Forest (EVC29) or Wet Forest (EVC30) in these locations.

Damp Forest can generally be found on well-developed colluvial soils. Wet Forest is found on fertile, well-drained loamy soils and, within the Strzelecki Ranges, is restricted to protected sites in gullies and on southern aspects of hills and mountains where rainfall is high and cloud cover at ground level is frequent. Warm Temperate Rainforest is restricted to the lowlands where it grows on protected slopes adjacent to streams and along minor gullies. Swampy Riparian Woodland is generally located near low energy streams and Swampy Woodland occurs on poorly drained, seasonally waterlogged heavy soils. Riparian Forests are generally located along river banks and alluvial terraces and associated with alluvial soils, with regular inundation.

Whilst these EVC's were once more widespread prior to European settlements, subsequent land clearing across the majority of south and west Gippsland for farmed agriculture has resulted in the vegetation in the majority of these areas consisting of pasture grasses and devoid of native vegetation.

Localised habitat along streamside zones in this region is often associated with several species of Gippsland Burrowing Crayfish (*Engaeus* spp.), including a number that are also listed as threatened. The presence of these crayfish is often indicated by a distinguishing crayfish chimney extending upward from the muddy bank where a burrow occurs beneath. Plant species associated with moist areas and co-inhabiting with GGE habitat includes Buttercup *Ranunculus* spp. in streamside areas (Figure 7).

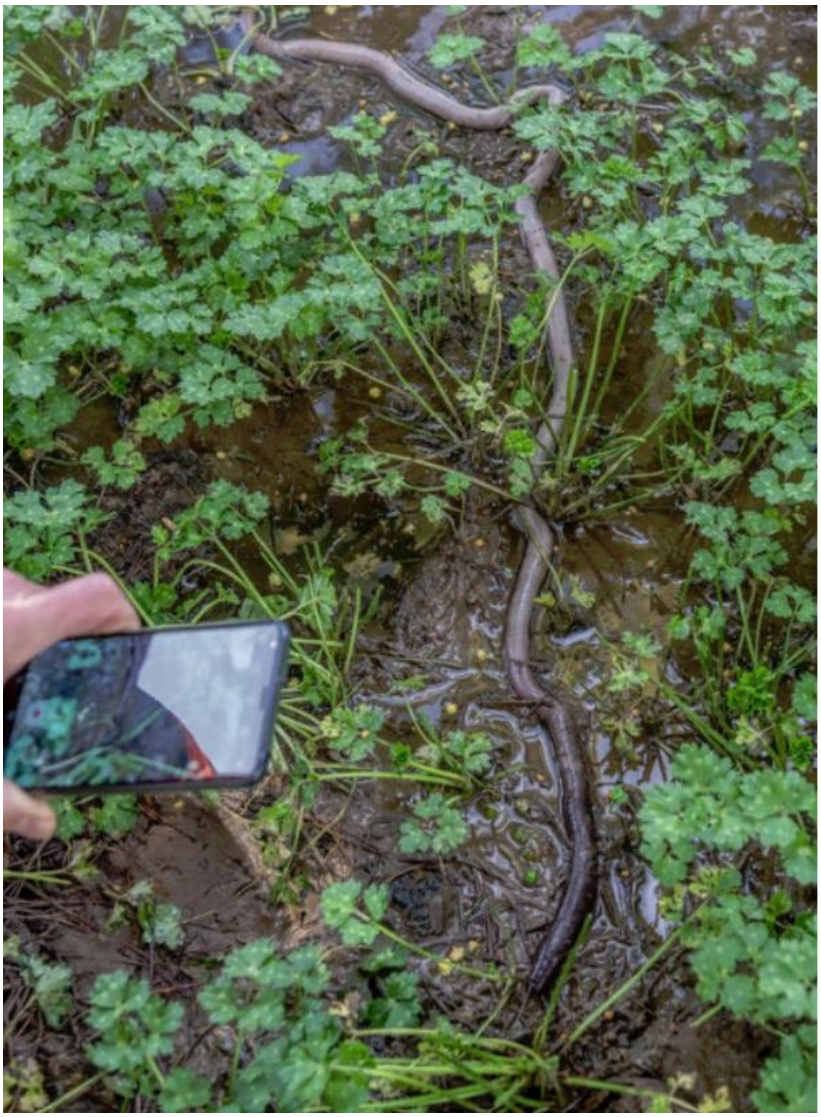

Figure 7: A GGE forced to surface due to ground saturation, also showing creeping buttercup

Dependence on soil moisture

The GGE habitats are all, to some extent, moisture-dependent. Underground hydrological processes and proximity to water are important factors in determining the suitability of a habitat. It is believed that soil moisture maintained all year round may be critical for the survival of this species (Van Praagh *et. al* 2007).

This dependence on soil moisture and water availability is shared with other earthworm species. A number of physico-chemical parameters of soil, including moisture, play a critical role in the distribution of 10 species of earthworm in cultivated and non-cultivated agro-ecosystems (Singh *et al* 2020). The population density of Lumbricid earthworms in Swedish grasslands has also been shown to correlate with moisture indicators (Torppa *et al* 2024). Positive correlation has also been found between soil moisture and species distribution for nine species of earthworms, possibly due to the cutaneous mode of respiration (Sharma *et al* 2014).The GGE is exclusively air-breathing and the soil moisture content is therefore likely to play a key role in its survival, noting that it travels towards the soil surface as the water table rises (Eve 1974). Whilst moisture is essential for activity and enabling natural processes, excess moisture within soil is likely to reduce oxygen diffusion in some earthworm species.

Key Threats

Physical disturbance/impact to the soil

Ploughing and the use of pesticides near stream banks and gullies are threats to this species (van Praagh 1999). Historical evidence suggested thousands of GGE were ploughed up during the 1930's within West Gippsland (cited within van Praagh and Yen 2010). In addition, the impact of streambank erosion may expose habitat in some instances. Cattle pugging especially in winter can cause soil disturbance to the surface above the GGE habitat. Exclusion of cattle from areas of GGE habitat can help prevent cattle impacts to soil surface and enable growth of vegetation.

Altered hydrology

Flooding of habitat and unearthing caused by erosion of streambanks are believed to be the only time that this species naturally leaves its subterranean tunnels and once exposed is very prone to injury and death. Many earthworm species become dehydrated as they are exposed to the terrestrial elements.

Local site hydrology and ground water levels appear important habitat features for the GGE. Soil moisture content within burrows is important for worm movement and respiration, and burrows occupied by GGE are very wet with some free flow of groundwater. Therefore, a certain amount of groundwater flow is likely to be critical (van Praagh and Yen 2010). Streamside habitats are important to this species, particularly banks above the active flood plain. Flooding and siltation of the larger river-banks may explain the absence of the species from these sites (van Praagh and Yen 2010).

On a catchment scale, changes in soil moisture resulting from altered hydrology may also impact the habitat of this species. Impacts associated with land development and modified drainage have potential to increase surface water runoff and reduce soil moisture as a result of diversion of natural groundwater flows. Altered hydrology may have contributed to local extinction of GGE at Loch during road construction works in the mid 1990's. The associated changes to drainage is suspected have lowered the water table, and the known GGE population could not be located after the works (Van Praagh and Hinkley 2000).

While GGE co-exists with the current agricultural systems of South Gippsland, the relationship may be very fragile because of the fragmented species distribution, life history characteristics and soil moisture dependancy. The high proportion of adults found in most studies and their apparent longevity may indicate that some populations may not be sustainable in the long term; it is possible that these populations will take many years (even decades) to become extinct unless ongoing recruitment is viable (Van Praagh and Yen 2020).

Implications for land and waterway management

As a high proportion of the habitat has been previously cleared for agriculture over the past 150-200 years, many of the sites do not contain native vegetation and the species is found predominantly in exotic pastures used for dairying (Van Praagh and Yen 2010). Unlike many native terrestrial species impacted by the clearing of native vegetation, the GGE has persisted in these modified landscapes, albeit its distribution has likely withdrawn into localised and limited habitats such as creekbanks or steep hillsides with terracettes.

Previous studies determined that most of the populations of the GGE are located within 40m of a stream bank and often restricted to 5-10m from the bank (Van Praagh 1999). For this reason, it is imperative that streambanks are protected and part of that protection may involve fencing from livestock which restricts ground pugging and compaction activity allowing natural recruitment and revegetation. Assuming that GGE has a dependence on soil moisture, recommendations around re-vegetation may include reducing the density and dominance of larger shrubs and trees that have the potential to alter local soil moisture conditions. This is important in other projects funded by Melbourne Water, Landcare groups and private landowners to ensure that GGE habitat requirements, including soil moisture, are considered appropriately in the planning of the revegetation of streamside zones.

Previous projects funded by the Victorian Government under the Biodiversity Response Planning program and Federal Government project "Building Capacity To Manage GGE Habitat on Farms" were to protect GGE habitat while demonstrating the planting of indigenous vegetation adjacent to colonies that once grew in the south- western Strzeleckis before European settlement. This is achieved by fencing GGE habitat to protect them from grazing pressures such as compaction and pugging and creating a buffer around the colonies where a modified planting method is used in different buffer zones. This includes lower planting densities and selection of specific lifeforms from the appropriate EVC (Van Praagh in https://www.giantearthworm.org.au/gge-habitat-landform.htm).

Reason for this research

Although it is generally understood that soil moisture is essential to their survival, the specific soil and hydrological factors that provide suitable habitat for GGE are not known. The study aims to address this knowledge gap needed to aid the conservation of this species by monitoring habitats for soil moisture content, soil temperature and soil oxygen levels. As the project has just kicked off in late May, results are inconclusive and cannot be published in this paper.

Acknowledgments

We would like to acknowledge the funding awarded under by the Australian Governments Department of Climate Change, Energy the Environment and Water, through the Saving Native Species program and supported by the Australian Governments Department of Industry, Science and Resources. We wish to thank all of those who assisted with the fund application and review process who have not been listed as authors from the Bass Coast Landcare Network, South Gippsland Landcare Network, Trust for Nature, INVERT-ECO, Drift Media and the Gippsland Threatened Species Action Group. All photos and references supplied by Inver-Eco and contributors of webpage.

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