The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 4, Issue 3, 2026

SILENT ENGINEERS OF THE SOIL: THE ECOLOGICAL POWER OF THE GIANT GIPPSLAND EARTHWORM

Bisma Jutt[1], Shahid Mahmood[*2], Faiza Kabir[3], Abdul Mannan[4], Iqra Tariq[5], Syed Zainab[6], Muhammad Ilyas[7]

[1,*2, 3, 4,5,6,7] *University of Gujrat, Gujrat 50700, Pakistan*

[*2]shahid.mahmood@uog.edu.pk

DOI: https://doi.org/10.5281/zenodo.19061316

Keywords
Megascolides australis, Australia, Gippsland, Victoria, Endemic species

Article History
Received: 17 January 2026
Accepted: 01 March 2026
Published: 17 March 2026

Corresponding Author: *
Shahid Mahmood

Abstract

One of the biggest earthworms, Megascolides australis, is found in Australia's south Gippsland. It is listed as an endangered species on the IUNC list. This species has a deep purple body, with the rest of its body being pale pink. The adult giant Gippsland earthworm is 750 × 20 mm long and weight is about 381 g. This worm is long and cylindrical with 300-500 segments. New hatched giant Gippsland earthworm is about 80cm. There are three main classes are present on the base of clitellum; young, sub adult, and adult earthworm. Worms that were actively reproducing were noted from September through December. The eggs of giant Gippsland earthworm occur at a depth of 220 mm on average. The egg weigh is 9g and 40-70 mm × 10-15 mm in size. The life history of this specie is, low reproductive rates, and low dispersal ability. The earthworm population is at Loch Hills. Within their range, worms seemed to be widely distributed. Thirty-two enormous Gippsland earthworms were found in six quadrats that were analyzed for worm density. This specie is totally subterranean nature and the difficulty involved in identifying its habitat without surveys. M. Australis is not necessarily linked with native vegetation. Additionally, the National Estate has listed about 90 hectares of its habitat (Coy 1991). The enormous Gippsland earthworm's national recovery strategy is its first. This plan includes information on action plans, threads, and habitat. In order to learn more about this specie's breeding, density, and population structure, Museum Victoria was also hired to monitor the population at Loch Hill for an additional five months.

1. INTRODUCTION

The Giant Gippsland Earthworm (GGE), also known as Giant Gippsland Earthworm, is one of the largest earthworms in the world. The Giant Gippsland Earthworm is endemic to a small area of Gippsland in Victoria, which means that it is only found in this area and nowhere else in the world. This species is important for ecological research and conservation because of its limited range and habitat. The importance of role why it is important to conserve it (Van Praagh & Yen 2010). From an ecological perspective, the Giant Gippsland Earthworm is a soil ecosystem engineer. Ecosystem engineers are organisms that alter their environment in a way that affects other organisms. This is achieved by the earthworm creating burrows that exceed one meter in depth. This alters the physical, chemical, and biological properties of the soil. This affects the movement of water, soil properties, nutrients, and plants (Sharma et al 2014). From the ecological point of

view, the Giant Gippsland Earthworm is an ecosystem engineer. Ecosystem engineers are organisms that modify the environment in a way that affects other organisms. This is done by the earthworm digging burrows that are over one meter deep. This changes the physical, chemical, and biological properties of the soil. This includes water movement, soil properties, nutrients, and plants (Van Praagh & Yen 2010).

1.1 Distribution and Range:

The Giant Gippsland Earthworm is endemic to a limited region of south and west Gippsland in Victoria. The distribution of the species is approximately circumscribed by Warangal in the north and Korumburra and Loch in the south. (Torppa et al 2024). The total distribution area is approximately 40,000 hectares. However, the actual area used in most sites is very small, sometimes less than 10 square meters. Most of the recorded populations are in private property, except for one larger population of approximately 2500 square meters in public property (Van Praagh and Yen 2010).

1.2Population Characteristics:

The population sizes are generally small and patchy, which may be due to the fragmented and limited distribution spread over a larger area, relatively larger populations have been found (E, Maaroufs NI ,2024)

1.3 Role in Soil Health

One of the most significant roles played by the GGE is enhancing the health of the soil. The GGE, like other earthworms, is an ecosystem engineer. (Hinckley, 2000)

This is because it digs burrows enhance the One soil aeration in the soil, increase nutrient cycling, increase water infiltration in the soil, Increase root development of plants. The GGE also enhances the fertility of the soil by breaking down plant material in the soil through feeding on organic matter. The GGE produces castings that are rich in nutrients and are an important factor in maintaining the fertility of the soil. This is especially important in agricultural areas of Gippsland (Torppa et al 2024).

1.4 Biodiversity Contribution:

The Giant Gippsland Earthworm helps to maintain the health of the ecosystem. The tunnels created by the earthworm are beneficial to microorganisms and small invertebrates. A healthy soil ecosystem is vital for maintaining plant life, which in turn supports birds, mammals, and insects. (Hinckley, 2000)

The Giant Gippsland Earthworm is very sensitive to soil moisture and soil structure. As such, it also serves as an indicator species. If the population of the GGE declines, it could be an indication of soil degradation, loss of habitat, or changes in water availability (Torppa et al 2024).

1.5 Importance of Conservation:

The GGE is of great importance not only to the environment but also to the culture of Gippsland as a distinct species. The conservation of the GGE is essential for the preservation of biodiversity in the region as well as the health of the soil systems (Van Praagh & Yen 2010). The approaches to conservation include Protection of known habitats, Careful land use planning, Education of landowners, Population monitoring. Due to the small size of the habitats that the species occupies, the approach to conservation needs to be accurate and specific (Van Praagh & Yen 2010)

1.6 Indicator of Environmental Health:

The Giant Gippsland Earthworm is very sensitive to soil type and moisture changes, as well as land use. Because of this, it can be considered an indicator species (Hinckley, 2000). A healthy population means that the soil is in good condition and a decrease in population may mean that the habitat has been disturbed or degraded. The Giant Gippsland Earthworm population can help scientists determine the health of the Gippsland environment (Van Praagh & Yen 2010).

2. Support for Plant Growth and Forest Health:

2.1 Human practices that enhance plant health

Proper agricultural management is important in the maintenance of plant health. Proper irrigation methods such as the use of the drop and sprinkler

irrigation methods help in the effective delivery of water to the plant roots without wastage, hence improving the water use efficiency of the plants. Changing the irrigation patterns to suit the growth stages of the plants also enhances productivity (Pour Mohammad, 2025). Crop rotation is another agricultural practice that is beneficial in the implementation of sustainable agriculture. Growing crops in rotation is important in the interruption of the life cycle of plant diseases and the enhancement of the fertility of the soil. For example, legume crops help in the addition of nitrogen to the soil, which is beneficial to the subsequent crops grown in the area (Shimada et al., 2021).

2.2 Earthworm burrowing and Soil Aerations

Earthworms have been seen to impact different vital processes in the soil, though their impact depends on the species and environmental conditions. When earthworms burrow into the soil, they created tunnels that increase the porosity of the soil and enable oxygen and water to penetrate into deeper soil layers. This process of improving oxygen availability in deeper layers of the soil is known as soil aeration and allows oxygen to reach plant and microbial roots and other microorganisms involved in nutrient cyclic and organic matter decomposition processes. In addition, earthworm activity improves organic material mixing, water infiltration, and drainage through alteration and soil properties physically and chemically, thus playing a vital role as natural ecosystem engineers in improving agricultural practices and plant growth positively (G. L. Spain, 2022).

2.3 Earthworm Activity and Plant Stress Tolerance

Various research works have been conducted on the different subspecies of *Triticum aestivum* to understand the variations that exist in the growth of the plants, photosynthesis, relative water content, and electrical conductivity under stress conditions. Earthworm activity helps to improve the structure of the soil, which helps the plants to resist adverse environmental conditions more easily. Various subspecies of wheat, like compactum and sphaerococcum, have shown promise to be used to create stress- resistant varieties of the crop. Healthy earthworm activity helps to increase the resistance of the plants to adverse environmental conditions (Mohd. Kamran Khan, 2024).

2.4 Threats to earthworm populations and their effects on forest ecosystems

Earthworm species have been increasingly threatened by pollution, climate change, and intensive land -use practices. Furthermore, disturbances in the forest ecosystem and the invasion of non-native earthworm species have been reported to affect the layers of the soil, leading to biodiversity loss. Earthworm survival rates have been reduced due to habitat degradation and compaction of the soil. Additionally, the use of chemicals and variations in the moisture content of the soil have also impacted the earthworm population. Earthworms have been reported to be crucial to the ecosystem and their decline has been seen to affect the overall functioning of the forest ecosystem. In this regard, studies showed the invasive earthworm species could impact the forest floor carbon stocks. Earthworms have been reported to be ecosystem engineers that regulate the structure of the soil, the rate of decomposition, and the overall nutrient content of the soil. Therefore, their decline has the potential to affect the overall health of the forest ecosystem (Joshua J. Public, 2021).

2.5 Role in forest ecosystem health and stability

Earthworms act as ecosystem engineers in the soil of the forest ecosystem. They accelerate the rate of decomposition of fallen leaves, which improves the fertility of the soil, thereby promoting the growth of plants in the ecosystem. They improve the fertility of the soil by increasing the rate of carbon and nitrogen cycles, which promotes the productivity of the forest ecosystem. These activities improve the resilience of the forest ecosystem to environ stresses, which maintains the balance of the ecosystem (Gaeun Kim et al. 2022).

2.6 Earthworm Influence on Forest Soil Microbial Communities

Earthworms have a significant role to play in the maintenance of the health of the forest soils through their activities of altering the structure of the soils and promoting the biological activities of the soils. Earthworm activities have been found to increase the supply of nutrients of the soils through the incorporation of the decomposed materials into the soils. In fact, research has shown that soils that have been affected by the activities of the earthworms have more diverse species of fungi and bacteria, which promote the growth of the plants, hence the sustainability of the forest ecosystems (Justine LaJoy et al. 2023).

3 Importance of Giant Gippsland Earthworm in maintaining ecosystem balance

The Giant Gippsland Earthworm species lives in moist soil of grasslands and farms. Giant Gippsland earthworm is considered a soil organism and an ecosystem engineer. The Giant Gippsland Earthworm plays a role in improving soil structure, fertility and moisture balance. Its burrow activity helps in aeration and water improvement in soil. Alternations in the environment of Gippsland lakes, such as salinization, loss of vegetation along shorelines, erosion of shorelines have greatly changed the ecosystem (Boon et Al., 2008). This underscore's role of earthworm such as Giant Gippsland earthworm in maintaining a stable environment (Boon et al., 2016).

3.1 Conservation Importance

According to the Environment Protection and Biodiversity Conservation Act, the Giant Gippsland Earthworm is considered fragile. C. Conservation guidelines show that habitat conditions, like moist clay soils and soil hydrology are essential for the Giant Gippsland earthworm survival. Changes that reduce soil moisture like some land use changes threaten the Giant Gippsland earthworm. This indicates the Giant Gippsland Earthworm plays role in soil ecosystem balance. The loss or decline of the Giant Gippsland Earthworm signals degradation of soil systems and microhabitats important to species (Van Praagh, B. 2025).

3.2. Gippsland's assessments

Their goal is to support the expansion and diversification of the tourism industry. This is one of the objectives for the Latrobe Valley and the surrounding area. The Gippsland 2035 Plan from 2023, GREDS from 2022, GDMP from 2022, GFDS from 2020, GRP from 2020, HCMP from 2019, and SLT from 2016 were among the plans and strategies that were examined (Haque, N. H., Reeves, J. And Foran T. 2024). This regional strategy paper discusses how tourist services can improve Gippsland's tourism experience. Incorporates findings from original research as well as visitor surveys to measure satisfaction against service quality and expenditure. Also used to support broader regional strategies to improve and increase local tourism (*Visitor Servicing* 2024).

3.2.1 Important features

The strategy frames the visitor economy as part of a wider regional development plan. Using Tourism Research Australia figures it demonstrates visitation and contribution, with figures detailing pre-COVID visitation rates alongside forecasted pandemic impacts on tourism across Gippsland**.** (Victoria, 2022).

3.2.2 Challenges & Opportunities

The challenges and opportunities are about fixing infrastructure promoting cultural and rural tourism having visitors all year round including Indigenous heritage and developing agritourism.

3.2.3 Infrastructure Priorities and Rural Tourism

Recovering from disasters like fires and floods. Building high-quality lodges and complexes to attract visitors. Improving visitor facilities. Gippsland's appealing rural areas and current tourism capabilities present an opportunity. Supporting tourism through bed & breakfasts and farm stays is one way to do this. When evaluating tourism-related planning permits, a local planning policy is advised to strike a balance between

environmental and amenity values (Zhang, F., Lv, Y., & Sarker, M. N. I. 2024).

3.2.5. Year-round Visitation and **Agritourism**

The area truly want to provide year-round experiences. This is particularly crucial in places that are already popular at certain periods of the year, such as the seashore, lakes, and alpine regions. People in the Latrobe Valley typically travel to see their relatives. There aren't many tourist attractions. To draw more visitors to the Latrobe Valley, the area might expand its resources, such as the Great Latrobe Park. The area can spend money on agritourism activities including farm stays, dining out, and wine tastings. This will entice visitors to travel to the area. (Tew, C., & Barbieri, C .2012).

3.2.6. Organic Matter Decomposition and Nutrient Cycling

After consuming dirt and decomposing plant matter, earthworms dig further into the earth. This accelerates the breakdown of organic materials and releases nutrients necessary for plant growth. More advantageous nutrients like potassium, phosphate, and nitrogen can be found in the dirt that earthworms excrete, or casts. These minerals support the growth of plants and sustain important soil bacteria (Capowiez, Y., Sammartino, S., & Michel, E. 2022).

3.2.7. An indicator of soil and habitat health

Megascolides australis is a sign of moist, largely unmodified soil. Many different types of soil organisms can thrive in this type of healthy soil. A low number of earthworms could be a sign that the soil has been damaged by big machinery, farming, or changes in water levels. A decline in earthworms is often a sign that the balance of the environment is being disturbed (DEECA 2022).

3.2.8 Gippsland Regional Aquatic Centre

The Traralgon outdoor swimming pool has been upgraded to an indoor and outdoor aquatic facility. This facility is accessible to people with disabilities. Is heated by geothermal energy

3.2.9 Protection and Stability of Ecosystems

Saving the Giant Gippsland Earthworm helps protect the environment as a whole. When this earthworm is safe, the soil stays rich and healthy, plants grow well, and many other living organisms can survive. Practices such as keeping trees and grass around farmland, avoiding the use of heavy machines, and not digging the soil too deeply help the earthworm live and reproduce. Protecting its living area supports both agriculture and nature because healthy soil can grow crops and also provide a home for wildlife (Aberton, M. J., Bateman, P., & Wright, C. 2024).

3.2.10 Role in the Nutrient Cycle

The Giant Gippsland Earthworm feeds on soil and dead plant material. While doing this, it helps break down this material and moves nutrients deeper into the soil. The soil released by the earthworm contains high amounts of useful nutrients such as nitrogen, phosphorus, and potassium. These nutrients help plants grow and also support tiny organisms living in the soil. In this way, the earthworm plays an important role in keeping plants healthy and maintaining balance in the food chain (Brussaard, L., & van Groenigen, K. J. 2021).

3.3. Water cycle and climate change impacts on the Gippsland Lakes

A study published in the Proceedings of The Royal Society of Victoria indicates the impacts that the Gippsland Lakes experience due to the water cycle, climate change, agricultural activities, and water extraction. The Gippsland Lakes is an important ecosystem in the region (Pittock, J. 2024).

3.3.1 Future Research Requirements for the Conservation of Giant Gippsland Earthworm

The effects of replanting (or adding new vegetation) on the habitat of the Giant Gippsland Earthworm (*Megascolides australis*) are still not entirely understood by scientists. According to some research, the earthworm can be found along clay paths and in pasture land close to natural forests, although it is frequently absent from places with dense vegetation, including Jumbunna and Ellin bank. This implies that present conservation

efforts need to be reconsidered because planting too many trees and plants in the earthworm's habitat may not always be beneficial. Thirty meters of vegetation on both sides of a healthy stream area is recommended by a Gippsland River and stream management report. Although planting trees alongside rivers is generally beneficial to the ecosystem, further research is need to determine how it affects Giant Gippsland Earthworms. There are now only few South Gippsland stream regions with such vast vegetation zones. Scientists must carefully consider the impact on earthworm populations if they attempt to establish these broad plant barriers in the future. One of the greatest risks to the earthworm's population may be the growing number of revegetation initiatives, which are frequently carried out in extremely densely populated regions. Consequently, additional research is required to determine the appropriate amount of vegetation and the kind of planting that will assist save the Giant Gippsland Earthworm without endangering its habitat (Sargeant, I. J. 2002).

3.3.3 Research and acknowledgements

This research is mainly about protecting the Giant Gippsland Earthworm. This specie is an endangered species found in Australia. Scientist know that this specie of earthworm needs moist soil to survive but they do not know what kind soil condition are best for them. Their main goal is to find out the perfect environment where this worm can live safely and stay healthy (Aberton, M. J, 2024).

4. Recovery Plan for Giant Gippsland Earthworm

4.1 Population Information and Habitat

The exact population of giant Gippsland earthworm is still unknown because they live deep in the underground and are difficult for scientists to find and study, so far, they have only found 254 different places in South and West Gippsland area present in Australia. These populations find it challenging to mix or exchange genes due to their tiny size and remote location. It has been shown that even groups that are only a few miles away have genetic differences, suggesting that they have been separated for a significantly long time. Only a few individuals, occasionally just one or two worms in one location, make up most populations. However, there are greater populations in some suitable areas. During a rescue operation prior to road building, the largest group discovered contained more than 800 earthworms in a short area. Because of the recent drought, some individuals think that some populations may have already vanished. About ten significant populations have been discovered by scientists for study and conservation, but they anticipate discovering many more in the future. Deep blue-grey clay soil and locations that remain wet for the majority of the year are preferred by the Giant Gippsland Earthworm, which primarily inhabits damp clay soil, particularly in creek banks, wet slopes, gullies and soaks, roadsides, and agricultural pastures. It is typically found within 5 to 10 meters of streams, but not in floodplains since mud and floods might destroy its burrows (A. L. 2010).

4.2 Population Dynamics of Earthworms In Agroecosystems

The study was carried out at Leeds University Farm in March and April of 2018. During the cold and cloudy sample period, temperatures varied from 7 to 12°C. Fields used for the study included ley strips (grass-clover strips adjacent to hedgerows) and arable land utilized for crop production. Some of these strips had metal barriers buried beneath them to keep earthworms from moving between portions. However, as these barriers did not seem to have a substantial effect on earthworm populations, all ley strips were treated equally for the study.

4.3 Earthworm Collection Methods

Small pits were dug in the ground to catch earthworms. Eight pits were dug in each field, four of which were in the nearby crop fields and four of which were on the grass-clover ley strips. The dimensions of each pit were roughly 18 × 18 × 15 cm. Any earthworms found in the soil were promptly gathered after the dirt from each pit was dumped into a pail. In order to find more earthworms, the soil was later meticulously sorted

by hand. After being gathered, the earthworms were stored in ethanol for additional laboratory research and categorized as either adults or juveniles depending on whether they had a clitellum (Llanos, J. 2021).

4.4 Different Theories for the survival of Giant Gippsland Earthworm

4.4.1 Theory by Van Praagh

According to Van Praagh and other researchers the giant Gippsland earthworm can only survive in specific environment conditions. This species of earthworm can survive in moist clay soil and in stable temperature throughout the year. In their research, they found out that earthworm is rarely seen in areas where thick plants are present, land or places which have been heavily disturbed. Instead, they are more often seen in the places where natural forest is present and where clay patches are present. They also discover India research that most of the natural habitat of earthworm has been destroyed by farming activities like ploughing and clearing land. This creates a huge problem for giant Gibson earthworm because their population are on the verge of extinction and they also move very slow (Van Praagh et al., 2004).

4.4.2 Endangered Status and Threats

The giant Gippsland earth horn is only found in the Australia specifically in Victoria state this PC of earthworm is considered an endangered species according to yen and new, this specie of earthworm is on the verge of extinction because of its population are very small and isolated. This makes it hard for the species to survive under harsh conditions. In conservation strategies, they stressed the importance of habitat preservation, public education, and responsible land management practices (Yen & New, 2002).

4.4.3 Theory by Johnston et al. (2010) – Population Fragility

The Giant Gippsland Earthworm is extremely sensitive to environmental changes, according to research by Johnston and his colleagues. This is because, although having a lengthy lifespan, earthworms rarely give birth to offspring. If a large number of earthworms die, its population cannot grow rapidly since it reproduces slowly. They found that even minor alterations to the soil, including a slight drop in soil moisture or modifications to soil structure, can gradually result in a significant decline in earthworm populations over time. Stated differently, minor environmental issues can eventually result in significant population declines (Johnston et al., 2010).

4.5 Earthworm distribution in temperate and tropical regions:

Global climate change is expected to significantly alter earthworm populations around the world. Studies show that temperate regions generally have more earthworms and more earthworm species than tropical regions, in contrast to the pattern seen in plants, insects, and birds. While aboveground biodiversity often increases toward the tropics, earthworms show the opposite pattern, with higher abundance in cooler, temperate locations. Different locations may be home to completely different species since earthworm species in tropical habitats sometimes have relatively small geographic ranges. Therefore, even though each tropical location may only have a few species, the total number of earthworm species throughout the entire tropical region might be relatively high. They also point out that factors like invasive species in managed soils and a focus on tiny local areas rather than greater regional variety might provide false results. Because of these constraints, some scientists believe that current conclusions about trends in earthworm abundance and species richness globally may be inaccurate (Bora, S., Bisht, S. S., & Reynolds, J. W. 2021).

6. Conclusion

Soil moisture is one of the main factors affecting earthworm life. Earthworm activity and variety are significantly influenced by both temperature and moisture. The amount of water in the soil significantly determines where earthworm species can live and how many of them there are. Since studies show that earthworm biomass and population density increase with soil wetness,

wetter soils often support a higher number of earthworms. Earthworm populations often rebound rapidly during the rainy season due to the high moisture content and better access to food. Soil moisture is therefore considered to be one of the primary physical and chemical factors affecting local earthworm populations. Earthworms may tolerate dry weather to some extent by moving to damp areas or entering a condition of rest called aestivation. Even when they are unable to escape dry soil, they can tolerate losing a sizable portion of their body water. However, earthworm activity peaks only when the soil contains a sufficient amount of moisture. Different earthworm species may have quite different moisture requirements depending on where they live. Even the same species may require different levels of moisture depending on the local climatic conditions.

REFERENCES

Aberton, M. J., Bateman, P., & Wright, C. (2024). Conservation implications of habitat management for Giant Gippsland Earthworm populations. *Austral Ecology*, 49(2), 312–321.

Boon, P. I., Cook, P. & Woodland, R. (2016) 'The Gippsland Lakes: Management challenges posed by long-term environmental change', Marine and Freshwater Research, 67(6), pp. 721–737.

Bora, S., Bisht, S. S., & Reynolds, J. W. (2021). Global Diversityof Earthworms in Various Countries and Continents: A Short Review. *Megadrilogica*, *26*(9).

Capowiez, Y., Sammartino, S., & Michel, E. (2022). Burrowing activity of earthworms and its effects on soil hydrology. *Soil Biology and Biochemistry*, 165, 108525.

DEECA. (2022). *Monitoring guidelines for threatened soil invertebrates in Victoria*. Victorian Government.

Eve, J.E. (1974): Gippsland worms. Victoria Nat. 91. 36-38 Sharma RK, Bharadwaj P. Earthworm diversity in trans-gangetic habitats of Haryana. India.

Gippsland Threatened Species Action Group. (2025). Census of the Giant Gippsland Earthworm in South and West Gippsland.

Haque, K. N. H.a, Reeves, J. a, Foran, T.b(2024). Regional development aspirations for the Latrobe Valley and Gippsland: Setting the context for post-mine land use planning. CRC TiME, WA, 6000. ISBN 978-1-922704-32-0

Johnston, E. L., Roberts, D. A., & Thompson, R. M. (2010). *Population vulnerability of the Giant Gippsland earthworm Megascolides australis.* Biological Conservation, 143(9), 2101–2109

Khan, M.K., 2024. Earthworm diversity and soil health. Journal of Soil Ecology, 12(2), pp.45–52.

Kim, G., Jo, H., Kim, H.-S., Kwon, M., & Son, Y. (2022). Earthworm effects on soil biogeochemistry in temperate forests focusing on stable isotope tracing.

Lejoly, J., Quideau, S., Laganière, J., Karst, J., Martineau, C., Swallow, M., Norris, C., & Samad, A. (2023). Earthworm-invaded boreal forest soils harbour distinct microbial communities. SOIL, 9, 461–478. https://doi.org/10.5194/soil-9-461-2023.

Llanos, J. (2021). *Assessing earthworm diversity and population dynamics in agroecosystems* (Doctoral dissertation, University of Sheffield).

Lubbers, I. M., van Groenigen, J. W., Fonte, S. J., Six, J., Brussaard, L., & van Groenigen, K. J. (2021).

Pittock, J. (2024). Water-cycle and climate-change impacts on the Gippsland Lakes. Proceedings of the Royal Society of Victoria, 136(1).

Pourmohammad, P. (2025). Innovative Irrigation Practices for Sustainable Agriculture. Journal of Sustainable Development**.**

Puhlick, J. J. (2021). Earthworm invasion and its effects on forest soil properties and ecosystem processes. Forests, 12(1), 80. https://doi.org/10.3390/f12010080

Res J Agri For Sci. 2014;2(2):1–7 Torppa KA, Castaño C, Glimskär A, Skånes H, Klinth M, Roslin T, Taylor AR, Viketoft M, Clemmensen KE, Maaroufi NI. (2024).

Shimada, B. S., Simon, M. V., Batista Cunha de Souza, I. L., & Tonin, F. (2021). Crop Rotation: A Sustainable Practice for the Management of Diseases. Journal of Experimental Agriculture International, 43(7), 20–26.

Singh, P. K., & Singh, K. (2023). Ecology and distribution of earthworms in India: A Systematic Review. *International Journal of Biological Innovations*, *5*(1), 161-169.

Spain, G. L., et al. (2022). Earthworm burrowing modes and rates depend on earthworm species and soil mechanical resistance. Applied Soil Ecology.

Van Praagh, B. and Yen, A. (2010). Unpublished report prepared for VicRoads cited within Van Praagh and Yen (2010).

Van Praagh, B. D., & Yen, A. L. (2010). National Recovery Plan for the Giant Gippsland Earthworm. *Department of Sustainability and Environment: Melbourne, Australia*.

Van Praagh, B. D., Hinkley, S., & Thompson, R. (2004).*Habitat requirements of the Giant Gippsland earthworm Megascolides australis in south-eastern Australia.* Pedobiologia, 48(5–6), 485–496

Van Praagh, B.D. and Hinckley, S.D. (2000). Giant Gippsland earthworm - 'nature's plough' Land For Wildlife July, 1999 LW0011

Van Praagh, B.D., Hinkley, S.D. and Sargeant, I. J. 2002. The Giant Gippsland Earthworm, *Megascolides australis*, population at Loch Hill, South Gippsland: distribution and preliminary biological and soil studies. *Museum Victoria Science Reports* 2: 1–10.

Visit Gippsland. (2024). *Synced, seamless, spirited: Visitor Servicing Strategy for Gippsland*. Gippsland Visitor Services Strategy.

Yen, A. L., & New, T. R. (2002).*Conserving the Giant Gippsland earthworm Megascolides australis (McCoy).* Journal of Insect Conservation, 6(2), 137–147.

Zhang, F., Lv, Y., & Sarker, M. N. I. (2024). *Resilience and recovery: A systematic review of tourism governance strategies in disaster-affected regions.* International Journal of Disaster Risk Reduction, 104350.