Environmental Protection Authority

Land

Environmental Factor Guideline

Subterranean Fauna

The objective of the factor *Subterranean Fauna* is:

To protect subterranean fauna so that biological diversity and ecological integrity are maintained.

Purpose

The purpose of this guideline is to outline how the factor *Subterranean Fauna* is considered by the Environmental Protection Authority (EPA) in the environmental impact assessment (EIA) process.

Specifically, the guideline:

- describes the factor *Subterranean Fauna* and explains the associated objective
- describes EIA considerations for this factor
- discusses the environmental values of subterranean fauna, and their significance
- describes issues commonly encountered by the EPA during EIA of this factor
- identifies activities that can impact on subterranean fauna
- provides a summary of the type of information that may be required by the EPA to undertake EIA related to this factor.

What are subterranean fauna?

For the purposes of EIA, subterranean fauna are defined as fauna which live their entire lives (obligate) below the surface of the earth. They are divided into two groups:

- stygofauna – aquatic and living in groundwater
- troglofauna – air-breathing and living in caves and voids.

Subterranean fauna often display evolutionary adaptations to underground life, particularly reduced pigment and reduced, poorly functioning or non-existent eyes. Fauna that use a subterranean environment for only part of the day or season (e.g. soil-dwelling or burrowing species, cave-dwelling bats and birds) are not considered as subterranean fauna for the purposes of this guideline.

There are both invertebrate and vertebrate subterranean species, although invertebrates predominate. Examples of invertebrate groups with subterranean representatives in Western Australia include crustaceans, insects (cockroaches and beetles), arachnids (spiders, pseudoscorpions), myriapods (millipedes), worms and gastropod snails. Stygofauna communities are often dominated by crustaceans whereas troglofauna can include a wide range of taxonomic groups.

There are only a few examples of vertebrate subterranean fauna recorded in WA. These are from Cape Range, Barrow Island and mainland Pilbara and include three fish (two gudgeons and an eel) and one reptile (blind snake).

The presence of subterranean fauna is strongly linked to geology and hydrology and the availability of suitable micro-habitats, e.g. air-filled voids or caves for troglofauna, and aquifers that are not hypersaline for stygofauna. Despite these known associations between subterranean fauna, geology and hydrology, it can be difficult to predict the presence of subterranean fauna with confidence due to the lack of understanding of habitat requirements.

How this factor links with other environmental factors

The EPA recognises that there are inherent links between the factor *Subterranean Fauna* and other environmental factors and that individual factors should not be considered in isolation. For example, impacts or changes to landforms, hydrological processes, inland waters environmental quality and flora and vegetation can impact subterranean fauna.

The environmental objective for subterranean fauna

The EPA's environmental objective for the factor *Subterranean Fauna* is: "To protect subterranean fauna so that biological diversity and ecological integrity are maintained".

In the context of this objective:

Ecological integrity is the composition, structure, function and processes of ecosystems, and the natural range of variation of these elements.

Considerations for environmental impact assessment

The obligate underground existence of subterranean fauna greatly increases the likelihood of short range endemism and the possibility that a species' conservation status may be impacted as a result of the implementation of a proposal.

Considerations for EIA for the factor *Subterranean Fauna* include, but are not necessarily limited to:

- application of the mitigation hierarchy to avoid or minimise impacts to subterranean fauna, where possible
- the subterranean fauna affected by the proposal
- the potential impacts and the activities that will cause them, including direct and indirect
- the implications of cumulative impacts
- whether surveys and analyses have been undertaken consistent with EPA technical guidance
- the basis used to determine subterranean fauna habitat connectivity and species distributions and the level of confidence underpinning the predictions
- the scale at which impacts to subterranean fauna are considered
- the significance of the subterranean fauna values and the risk to those values
- the current state of knowledge of the affected species/assemblages of subterranean fauna and the level of confidence underpinning the predicted residual impacts
- whether proposed management and mitigation approaches are technically and practically feasible.

Environmental values of subterranean fauna and their significance

Subterranean fauna are relicts from previous climatic conditions. They have evolved from ancient lineages which were originally found in surface environments, but colonised underground habitats as Australia began to dry out about five million years ago. Western Australia's subterranean fauna is recognised as being globally significant because of its extraordinarily high species richness and high levels of endemism. It has been estimated that the total number of subterranean fauna species is around 4,000, most of which are unnamed or yet to be recorded.

Subterranean fauna occur in most regions of the State, with particularly high diversity occurring at Cape Range, Barrow Island, the Yilgarn and Pilbara regions. The significance of subterranean fauna at Cape Range has been recognised globally.

The absence of light in subterranean ecosystems results in limited energy resources being available. As a consequence, subterranean fauna have evolved to survive in unique environments and are often highly specialised with morphological, physiological and biological adaptations that reflect severe environmental constraints.

Subterranean fauna species may be considered to be significant for a range of reasons including, but not necessarily limited to the following:

- being identified as a threatened or priority species
- locally endemic
- potential new species
- occupying restricted habitats
- forming part of a Threatened or Priority Ecological Community.

Subterranean fauna assemblages may also be significant and this has been recognised through the listing of nine Threatened Ecological Communities and 80 Priority Ecological Communities (as of 2016), each supporting subterranean fauna in the State.

Stygofauna may also have important ecosystem service functions, such as the maintenance of water quality in groundwater aquifers.

Issues

The following issues are matters that are commonly encountered by the EPA due to the nature of proposals that are referred to it. Background on these issues is provided here to help proponents and the community engage with EIA. This issues section will be updated from time to time to reflect new issues as they arise in referrals and EIA.

Short range endemism

Subterranean fauna species usually have small distributions and do not move outside their specific habitats due to poor dispersal ability and the discontinuous nature of their habitats. This has resulted in high rates of endemism and, as a consequence, they are vulnerable to impacts.

Determining presence of subterranean fauna habitat

While understanding of subterranean fauna habitats in Western Australia is incomplete, it is accepted that suitable pores or voids are necessary to allow air or water to be present. Some types of geology are known to have a high likelihood of containing pores or voids suitable for subterranean fauna habitat. The types of geology known to support stygofauna include calcretes; alluvial formations, particularly when associated with alluvial or

palaeochannel aquifers; fractured rock aquifers, and karst limestone. Troglofauna are likely to be present in karst, channel iron deposits, banded iron formations, alluvium/colluviums in valley-fill areas, and weathered or fractured sandstone. While the basic habitat features are understood it can be difficult determining the extent of habitat present and habitat connectivity due to lack of available habitat data. Where subterranean fauna habitat is identified, survey will be required for EIA.

State of knowledge

Knowledge of subterranean fauna has significantly increased in WA in recent years, with a strong focus on the description of new species and determination of evolutionary relationships. Research is increasingly showing that subterranean habitats contain more species than previously recognised and Western Australian species make up a significant proportion of global biodiversity. There are still many gaps in knowledge regarding the habitat requirements and natural history of subterranean fauna such as mobility, reproduction and mechanisms for dispersal. These have implications for understanding population size, viability, distribution and ecological limitations. New species are regularly discovered during EIA surveys and provide a challenge when assessing impacts.

Vouchering

It is important for informed and timely decision making that specimens and accompanying data, including DNA sequences, are available in the Western Australian Museum as part of the State collections. This enables identifications to be verified, and ensures that biodiversity data are safely and permanently stored.

Defining species

Species can be difficult to define and this issue is particularly pronounced for invertebrate subterranean fauna. Cryptic species (that look morphologically similar but are genetically distinct) can also contribute to taxonomic difficulty. Genetic analysis is generally required to resolve uncertainty regarding species identification and distribution, as it allows accurate identification of cryptic species.

Changing climate

Biological diversity is vulnerable to a changing climate. Subterranean fauna are evolved from ancient lineages that colonised underground habitats as Australia began to dry out. It is unknown whether they will be adversely affected by a changing climate. The scale, rate and nature of projected change, and the interactions between other threatening processes, will determine to what extent they are impacted.

For the purposes of EIA, the EPA is concerned with proposal specific impacts that, when considered in combination with climate change, are likely to exacerbate impacts to subterranean fauna.

Impacts

Impacts on subterranean fauna may be direct or indirect.

Direct impacts include the removal of habitat, drawdown of groundwater, inundation, and water quality changes. The main threats include excavation of geologies known to support subterranean fauna; groundwater extraction for process or domestic purposes; dewatering for below water table excavation, and groundwater reinjection of waste or excess water.

Indirect impacts include changes to hydrology, siltation, void collapse, alteration to nutrient balance and contamination. The main threats include changed surface topography due to compaction or creation of hard surfaces resulting in altered groundwater flow paths, increased runoff, and reduced infiltration and aquifer recharge; clearing of surface

vegetation leading to sedimentation and changed nutrient inputs; potential leaks or leaching including tailings and waste water resulting in alterations to ground water chemistry and quality, and introduction of toxins or radiation; and salinisation due to intrusion of saline water into freshwater aquifers and leaching from pit voids.

Information required for EIA

Technical guidance for survey standards and information required for assessment are available on the EPA's website.

Environmental Protection Authority 2016, *Environmental Factor Guideline: Subterranean Fauna*, EPA, Western Australia.

This document is available in alternative formats upon request.

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