# Expert statement: Wetland delineation and animals adapted to wet conditions

Ministry for the Environment
Manatū Mō Te Taiao

Te Kāwanatanga o Aotearoa
New Zealand Government

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**Context and background**

This expert statement was prepared for the Ministry for the Environment in 2024 by Manaaki Whenua – Landcare Research, with input from a panel of experts with extensive collective experience covering wetland delineation, enforcement action, wetland policy, wetland fauna, wetland flora, and wetland ecological assessments. The project was initiated in response to uncertainty around the suitability of wetland delineation protocols following a Court of Appeal decision (*Page v Greater Wellington Regional Council* [2024] NZCA 51.

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The authors would like to thank Dr Nicholas Dunn (Department of Conservation) for contributing content on non-migratory galaxias, and Mr Scott Bartlam (Manaaki Whenua – Landcare Research) for contributing content on earthworms. Ray Prebble (Manaaki Whenua – Landcare Research) provided editorial advice which improved an earlier version of this work.

This document may be cited as: Ministry for the Environment. 2024. *Expert Statement: Wetland delineation and animals adapted to wet conditions.* Wellington: Ministry for the Environment.

Published in November 2024 by the
Ministry for the Environment
Manatū mō te Taiao
PO Box 10362, Wellington 6143, New Zealand
environment.govt.nz

ISBN: 978-1-991140-52-4 (online)

Publication number: ME 1863

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# Executive summary

- A 2024 decision regarding wetland delineation, Page v Greater Wellington Regional Council [2024] NZCA 51, raised questions around wetland delineation that have affected regional council confidence in undertaking enforcement work.
- The Court of Appeal accepted an argument that evidence of wet-adapted animals was required in the criminal context for an area to legally be considered 'wetland' as defined by the Resource Management Act 1991 (RMA).
- Any requirement to provide site-specific evidence of animals adapted to wet conditions risks adding considerable costs to the current complex and expensive process of delineating wetlands.
- The authors agree that the requirement for putative wetland sites to support animals adapted to wet conditions is met by consideration of the wide diversity of species, especially soil invertebrates, that are adapted to wet conditions. These animal groups include earthworms, nematodes, molluscs, rotifers, flatworms, water mites, ticks, horsehair worms, nemertean worms and tardigrades, as well as fish and birds. Many of these invertebrate groups are microscopic and live as aquatic organisms in the wet films surrounding soil particles and leaf litter. Most of these organisms also possess adaptations to survive dry periods, meaning they are ubiquitous in soils that are wet or moist, even where that wetness is intermittent.
- Also, because the Court accepted that the RMA definition would be satisfied where it was "virtually certain" that permanent water features would support wet-adapted fauna without direct observation of the same, we suggest this reasoning can be extended to these ubiquitous, wet-adapted soil invertebrates.
- The authors agree that it is virtually certain that any areas defined as a wetland using the current wetland delineation protocols will support soil invertebrates adapted to wet conditions and probably many other wet-adapted species, and as a result will satisfy the requirement in the RMA that wetlands support wet-adapted animals.

# Expert statement

## Background

1. A 2024 Court of Appeal decision[1] cast doubts over the standard wetland delineation protocols that routinely evaluate plants, soils, and hydrology. The Court accepted an argument that evidence of wet-adapted animals was required in the criminal enforcement setting to support a finding of 'wetland' under the Resource Management Act 1991 (RMA). The relevant regional council had not tendered such evidence, and therefore most of the areas in question did not meet the standard of proof for a wetland. Specifically, the Court of Appeal determined that, among other things, evidence was required to satisfy the RMA wetland definition being "a natural ecosystem of plants **and animals** that are adapted to wet conditions" (emphasis added) to a criminal standard.

2. It is the authors' shared understanding that the decision has introduced uncertainty into the complex process of identifying and delineating areas of wetlands in Aotearoa New Zealand. We understand that this may affect council decisions to undertake enforcement action for unauthorised wetland damage or clearance, and risks increasing the investigation and monitoring costs associated with plan development and resource consenting for applicants, submitters, and councils. This uncertainty has been primarily driven by the stated need to satisfy the Court in criminal cases that wet-adapted animals are supported by the putative wetland.

3. Providing site-specific, field-based evidence of animals for wetland delineation purposes will be challenging, because many wet-adapted animal species are difficult to detect as they are cryptic, nocturnal, transient, subterranean, or minute, or require specialised experts to identify them.

4. A literal application of the RMA's "…and animals" as a mandatory step for wetland delineation purposes is therefore novel and potentially challenging.

5. In light of the complexity, the Ministry for the Environment contracted Manaaki Whenua – Landcare Research to assemble a team of suitably qualified experts to explore the ramifications of the Court of Appeal decision for wetland delineation. The focus for this group of experts was the "animals adapted to wet conditions" aspect of the decision.

6. This expert statement is the result of that exercise.

7. Collectively, the authors of this statement have over 275 years' experience in the application of environmental science. We are a collection of professionals who have expertise covering wetland delineation, enforcement action, wetland policy, wetland fauna, wetland flora, and wetland ecological assessments.

[1] *Page v Greater Wellington Regional Council* [2024] NZCA 51.

# Objectives

8. Review which animals are wet-adapted and supported by wetlands, such that they support the definition of wetlands in the RMA.

9. Assess whether existing wetland delineation tools are likely to indicate the presence of wet-adapted animals.

# Wetland delineation protocols

10. Defining and delineating wetlands is a first and fundamental step for their management and protection.

11. The New Zealand Resource Management Act 1991 defines 'wetland' as:

    *includes permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions.*

12. This definition is similar to an 'ordinary' definition of a wetland, rather than providing a specific direction from a policy or implementation perspective. It does not limit itself to indigenous plants and animals.

13. In order to assist regional authorities to delineate wetlands under the RMA, and the National Policy Statement for Freshwater Management (NPS-FM), the Ministry for the Environment published *Wetland Delineation Protocols* (Ministry for the Environment, 2022a).

14. The protocols comprise three key tools: the Vegetation Tool (Clarkson, 2014), the Hydric Soils Tool (Fraser et al, 2018), and the Hydrology Tool (Ministry for the Environment, 2021). Also, where it is desired to identify 'natural inland wetlands' under the NPS-FM, a Pasture Assessment Exclusion Methodology has been developed (Ministry for the Environment, 2022b). The approach is based on the USA wetland delineation system for regulatory purposes (Environmental Laboratory, 1987; US Army Corps of Engineers, 2008).

15. The wetland delineation protocols, and related precursor methodologies, are not mandated by the NPS-FM but are generally accepted standard practice across New Zealand. The protocols focus on the most reliably measurable and practical indicator of wetland presence, namely the plant community. They also include additional steps that involve tests for hydric soils and hydrology, if required, to confirm wetland conditions when the characteristics of the plant community are inconclusive, or when further evidence is required. There are no other broadly accepted, field-based wetland delineation tools in New Zealand.

# Introduction

16. Internationally, wetland delineation tends to focus firstly on vegetation, and then on supporting indicators such as soils and hydrology. This is because hydrophytic vegetation tends to indicate prolonged wet conditions, given the multi-year life cycles of most plants. Tiner (2017, p 25), in a comprehensive treatment of wetland delineation, set out this reasoning with respect to both vegetation and soils:

    *Plants and soil properties at a site are, in large part, the expressions or manifestations of site wetness and are the indicators of how wet the site really is, provided it has not been drained. For example, when water is observed in conjunction with floating-leaved aquatic plants (e.g., Nuphar, Nymphaea, and Brasenia), a well-reasoned interpretation would be that the area is permanently flooded or nearly so. However, if a cornfield is flooded, the interpretation is likely to be that the presence of water is temporary. The vegetation assists with the interpretation of the duration and frequency of wetness.*

17. Consistent with this, under the USA wetland delineation system (Environmental Laboratory, 1987; U.S. Army Corps of Engineers, 2008), vegetation is considered to be the first and sometimes only necessary indicator of wetland presence. Vegetation is assessed first, before soils, because the vegetation provides a relatively 'current' indication of site wetness. Hydric soils are treated as supporting evidence because they also indicate historical wetlands (Van Rees and Reed, 2014) and are therefore not sufficient evidence (i.e. in the absence of hydrophytic vegetation) of current wetlands. As with soils, because temporary flooding can be observed in the absence of wetlands, hydrology is considered as supporting and not sufficient evidence in and of itself of a wetland.

18. The New Zealand wetland delineation protocols are based on, and apply the same logic as, the USA approach.

19. We are not aware of any international examples of wetland definitions that use fauna as an obligate criterion to determine an area of wetland. Queensland, Australia, does have a fauna tool to confirm wetland extent where it is otherwise unclear, but the methodology makes clear that a wetland can be confirmed at any stage prior to the fauna assessment stage, which is the last stage to be undertaken (Department of Environment and Science, 2023). Relying on animals as a necessary indicator for wetland delineation purposes is an unusual approach. The reason for this is that many wet-adapted animal species are difficult to detect because they are cryptic, nocturnal, transient, subterranean, or minute, or require specialised experts to identify them.

20. This difficulty notwithstanding, to assess which animals may qualify as being 'adapted to wet conditions', we first define our treatment of other relevant words in the legislative clause.

# Definitions and considerations

21. We take ‘animals’ to have the ordinary definition as belonging to the Kingdom Animalia.

22. We take ‘adapted to wet conditions’ to mean having some physiological, morphological or behavioural modification, at some stage in their life cycle that makes the organism either dependant on, or capable of existing for prolonged periods in wet conditions, or as being acknowledged to regularly utilise aquatic habitats. Species that have such adaptations may also be capable of inhabiting and utilising terrestrial habitats, but we consider this does not preclude them from being wet-adapted animals.

    a. For example, many birds are wet-adapted species. Wet-adapted birds have many morphological, physiological and behavioural adaptations to living in aquatic habitats. Wet-adapted bird species include deep-water waders with medium-long legs and often long bills that allow them to forage in water depths of > 200 mm as well as shallow water (eg, stilts, herons, oystercatchers); shallow-water waders with short legs that restrict them to water < 90 mm deep, and with either short bills for feeding in the water column or long bills for probing the substrate for aquatic invertebrates (eg, waders, terns, gulls); and dabbling waterfowl with webbed feet that enable feeding while floating in open water or while on wetland turf and saltmarsh (eg, ducks, swans, and geese).

    b. Another example is fish. Fish are vertebrates that require aquatic habitat to complete their life cycle (Ishimatsu et al, 2018). In New Zealand at least 29 species of non-diadromous *Galaxias* and *Neochanna* fishes (family Galaxiidæ) complete their entire life cycle in the same freshwater habitats. The habitats of this group range across a hydrological continuum, from lakes, through slow-flowing wetlands, to fast-flowing, steep streams (Dunn et al, 2020; O’Brien and Dunn, 2007). The five New Zealand *Neochanna* mudfish species are considered wetland specialists, including wetland habitats that can be seasonally intermittent (Ling, 2001; O’Brien and Dunn, 2007). Migratory fish species, such as eels and whitebait, utilise both freshwater and saltwater habitats at different stages of their lives. Because migratory species require different habitats to complete their life-cycle, they also require the presence of suitable passage between these habitats. Fish passage opportunities do not need to be continuously available to be potentially important, and species such as longfin and shortfin eels can utilise ephemeral flow channels to access more permanent water features upstream or downstream. This may include, for example, shortfin eels wriggling or swimming up a damp gully or temporarily flowing stream to access a permanent pond in an upstream area.

    c. Another example of wet-adapted animals are earthworms, whose cutaneous respiratory system requires a moist body surface and whose excretory systems require sufficient amounts of water to function correctly (Lee, 1985).

    d. There are also invertebrates that are fully aquatic during their immature phase as larvae or nymphs. Examples are dragonflies, caddisflies and mosquitoes.

    e. Meiofauna (very small invertebrates; see para 29) include obligate aquatic dwellers (eg, copepods and rotifers) and facultative aquatic dwellers (eg, nematodes, tardigrades or mites). These generally require wet conditions but often at a microhabitat scale (eg, wet films or waterlogged soil rather than open water) and possess adaptations against desiccation that allow them to persist in areas or microhabitats that are only intermittently wet.

23. We consider all the examples above meet the requirement to be 'wet-adapted', even where the organism is not always found in aquatic environments (as with birds and earthworms, adult aquatic insects, aestivating mudfish and cyst-forms of meiofauna).

24. For the term "support" in the RMA definition, we consider an area will support fauna where it provides habitat for wet-adapted animals. We adopt the definition of habitat as the resources and conditions present in an area that produce occupancy – including survival and reproduction – by a given organism (Hall et al, 1997). Hall et al (1997) note that habitat is species specific, and relates species presence to an area's physical and biological characteristics, but includes more than just vegetation. As such, 'habitat' may take multiple forms. In addition to permanent occupancy, habitat may produce temporary occupancy via food resources, sheltering or resting areas, and breeding or nesting areas.

25. We understand that there is no restriction on how long qualifying support is provided to 'fauna' under the RMA definition. As such, support to wet-adapted fauna will qualify regardless of time of year or length of time an area is wet or saturated.

# Wet-adapted fauna supported by wetlands are ubiquitous

26. The Court of Appeal determined that evidence of an ecosystem with animals adapted to wet conditions is required to satisfy, to a criminal standard, that a site meets the definition of a wetland under the RMA.

27. We understand that evidence may not need to be direct observation. For example, the Court of Appeal acknowledged that areas of permanent inundation (a pond and nearby inundated areas if permanently inundated) could be satisfied to have met the test under the RMA for fauna on the basis of statements in court by Dr Vaughan Keesing, such as (para 79):

> *I am virtually certain given the water presence and the plant species presence that there will be aquatic invertebrates in both the pondings of [Area] 2 and the pondings of [Area] 4, not necessarily the drier vegetation above the open water.*

28. These statements were made in the absence of direct sampling. All authors agree with Dr Keesing's statement that given the presence of open water or permanent inundation, it can be assumed that animals adapted to wet conditions (ie, aquatic invertebrates) will be present, such that the definition of 'wetland' in the RMA is satisfied.

29. With the benefit of time and reflection, all experts consider that animals adapted to wet conditions are also certain to be found in other typical wetland areas, such as damp soils, wet soils and wet films (eg, microhabitats within mosses or within damp leaf litter), where these areas satisfy the wetland delineation protocols. The animals that are certain to be present include meiofauna.

30. The term 'meiofauna' loosely defines a group of tiny organisms such as nematodes, copepods, rotifers, tardigrades and ostracods. Many of these animals often go unnoticed despite their widespread and almost ubiquitous distribution. For freshwater sampling, macroinvertebrates are considered to be animals that are caught and retained on a 0.5 mm sieve, whereas the meiofauna are animals that pass through this size sieve but that

are caught on a smaller mesh, usually between 45 and 60 µm mesh.[2] As a result, many smaller invertebrates, such as the meiofauna, have been historically under-represented in the few studies that do exist on the aquatic invertebrate communities of New Zealand wetlands, because these smaller animals would simply pass through the mesh of sampling equipment used to collect macroinvertebrates. Many of these meiofauna are considered to be wet-adapted due to specific adaptations, such as: feeding structures adapted to wet conditions; obligate life cycles in wet areas, with adaptations such as persistence (similar to hibernation) during dry conditions; excretory systems that require wet conditions to function; and so on. We set out supporting information in the following paragraphs, including examples of invertebrates that are likely to be ubiquitous in wetland habitats.

31. Rotifers are an example of a widespread but often unnoticed member of the meiofauna. They are well adapted to survive and thrive in various aquatic habitats, from temporary puddles to permanent lakes. Rotifers are primarily filter feeders and are characterised by their feeding apparatus at their head: a ciliated structure called a corona, which is a wet adaptation. This structure contains many hundreds of small hairs (cilia) that beat to create water currents that help move and capture food particles.

32. Nematodes are the most abundant multicellular group of animals on earth. Many nematode species are microscopic and fall within the meiofauna size category. There are both parasitic and free-living forms, with free-living forms occurring widely in soils and freshwater environments, among other habitat types. All nematodes are essentially aquatic animals that live and move in fluids. When they occur in soils, they inhabit the wet films around soil particles. As with many other wet-adapted meiofaunal species that can persist through dry conditions, nematodes are tolerant to desiccation and starvation through their ability to form resistant cyst stages.

33. Tardigrades can be found just about anywhere there is liquid water, including on lichens and mosses, soil and leaf litter, and in freshwater sediments. Some tardigrades live exclusively in freshwater, but most are found in terrestrial environments, often in very damp micro-environments (eg, bryophytes). They are among the most resilient animals known and can tolerate air deprivation, dehydration and starvation. If the liquid water habitat they require dries up, they can form a cyst and suspend their metabolism and wait many years for wet conditions to return. Most tardigrade species are in the meiofauna size category.

34. Hydrachnidia, also known as ‘water mites’, Hydrachnidiae, Hydracarina or Hydrachnellae, are among the most abundant and diverse groups of benthic arthropods, comprising 6,000 described species. They are ubiquitous in nearly all freshwater habitats in every continent except Antarctica. Typical habitats include streams and marshes. They have complex life cycles, which include two separate resting stages, and can persist in soils and intermittent or ephemeral aquatic habitats during dry periods as part of an ‘invertebrate seedbank’.

35. To demonstrate the widespread nature of wet-adapted invertebrates, and in support of this expert statement, Dr Suren interrogated the Wilderlab database of eDNA data collected from 3,987 sites in freshwater environments throughout New Zealand, of which 199 were sites identified as wetlands. The total invertebrate list from the eDNA records was refined to separate freshwater and terrestrial invertebrates by examining databases such as the World Register of Marine Species (WORMS) and the Global

[2] We note that a micrometre (µm) is 0.001 mm.

Biodiversity Information Facility. This analysis identified 834 taxa associated with freshwater phases and included a wide range of animals including insects, annelids, crustacea, molluscs, nematodes, bryozoans, rotifers, springtails, cnidarians, gastrotichs, nemertea, flatworms, rotifers and tardigrades.

36. Informed by this analysis, the authors agree that wetlands, whether permanently saturated, intermittently saturated, or ephemeral, are virtually certain to support at least some of the wet-adapted species identified above. Intermittently wet or ephemeral waterbodies will tend to be dominated by species with rapid colonisation ability or the ability to resist desiccation. Aquatic insects with short generation times and/or the ability to colonise areas rapidly are among this group. In wetland soils that are not saturated, the wet-adapted animals that are not filter feeders include annelids, nematodes, springtails, nemertea and flatworms.

37. Members of the haplotaxid order of earthworms are some of the more conspicuous soil-inhabiting invertebrates. The native earthworm *Hologynus bipapillatus* lives in and is adapted to anaerobic wet soils (Lee, 1959). It is common in swamps and has been observed in highly acidic peat bogs. The exotic Lumbricid earthworm *Allolobophoridella esieni* is adapted to wet bog soils. There is also a range of exotic earthworms that are adapted to intermittent wet conditions and very commonly found in wetlands. The earthworm's cutaneous respiratory system requires a moist body surface to perform its vital role, and their excretory systems require sufficient water to function correctly (Lee, 1985). The earthworm cocoon stage can tolerate permanent saturation (Lowe and Butt, 2005), which we consider to be a wet adaptation (allowing persistence for the entire cocoon stage in saturated soils). Also, the common observation of adult earthworms surfacing after rainfall is attributed to an adaptation for dispersal (Wetzel et al, 2016). Earthworms can live for days in water, so moving to the surface is not an avoidance of 'drowning'. Rather, moving over the land surface is more efficient than moving through the soil, but is often not possible because the surface is usually too dry for earthworms' thin permeable skin. Rainfall provides a wet surface for earthworms to utilise for movement, and their behaviour during rainfall is an adaptation to explore new habitat (Wetzel et al, 2016).

# Additional fauna often supported by wetlands

38. We recognise that there is a wide variety of other fauna supported by wetlands. Those that are *wet-adapted* are described above in para 22.

39. Wetland *obligate* species are those that exist only in wetland habitats; however, not all these species can be considered wet-adapted according to our definition. An example is the moth *Houdinia flexilissima*, which lives within the obligate wetland species *Sporadanthus ferrugineus*. *Houdinia flexilissima* occurs only in wetlands; its larvae live entirely within the *Sporadanthus* rush stems. However, the adult moth is a terrestrial organism and because neither larvae nor adults are in direct contact with water during their life cycle, we cannot justify a finding of 'wet adaptation'. While we find this to be unsatisfying from an ecological perspective, insofar as our position on ubiquitous wetland fauna is accepted, the practical outcome is that wetlands passing the wetland delineation protocols will be defined as wetlands because other ubiquitous wet-adapted fauna will be present, and therefore this is a philosophical rather than pragmatic concern.

# Drier wetlands

40. There are some wetland types that are intermittently wet and dry (Johnson and Gerbeaux, 2004). We considered whether dune lakes, pākihi and gumlands, and ephemeral wetlands might pass the test for supporting wet-adapted fauna when most of the 'support' provided might be during winter periods or during persistent wet weather. Outside of these wetter periods these wetland types may otherwise present as relatively dry. However, given the ubiquity of the meiofauna and their tolerance to periodic droughts, we do consider that such species will almost certainly be present and therefore will meet the definition of wetland under the RMA.

# Conclusion

41. We conclude that there will always be wet-adapted animals in situations where the wetland delineation protocols have otherwise been satisfied, such that the 'support' test for animals under the RMA is met.

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