



Assessment of ecological change of the Whangamarino Wetland Ramsar Site, New Zealand

*He arotake i te whakaumu hauropi o te rohe
kooreporepo o Whangamarino, Aotearoa*

Applying an integrated cultural framework to assess ecological
character (health) of a wetland of international importance

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oranga hauropi o te kooreporepo e hirahira taapua nei, huri i te ao*

Hugh Robertson, Ruby Moynihan Magsig, James Blyth, Glen Tupuhi, Lorraine Dixon and Dean Sandwell

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This report has been prepared to fulfil New Zealand's international obligations under Article 3.2 of the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention).

Local te reo maori language conventions applied in this report:

Throughout this report we have used double letters instead of macrons in our te reo usage where appropriate to reflect preferred local practice (e.g., aa instead of ā), unless supplied as part of a quote, or existing publication. This approach aligns with established community conventions and ensures consistency with how the language is commonly written and understood in the local context.

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Executive Summary

Purpose

This report fulfils New Zealand's obligations under Article 3.2 of the Ramsar Convention on Wetlands to assess and report on changes in the ecological character of the Whangamarino Wetland, designated as a Wetland of International Importance in 1989. The assessment examines whether the wetland's health has declined since designation, particularly following the 2023 blackwater anoxia (low oxygen) event and the 2024 human-induced fire.

Assessment of change in ecological character (health) of a Wetland of International Importance

This report presents a detailed Article 3.2 assessment under the Ramsar Convention on Wetlands. It utilises available science, guided by the principles of the Convention, to evaluate whether there has been a decline in ecological character at the Whangamarino Wetland, as a Ramsar Wetland of International Importance, and whether this change is beyond a limit of acceptable change. This assessment has sought to integrate, where possible, the knowledge system of New Zealand's Indigenous people, known as Maatauranga Maaori. This knowledge assists in providing a more comprehensive understanding of the changes in ecological character, since the time the wetland was designated as a Ramsar site.

For each component of ecological character, the assessment describes whether the change in ecological character is:

- positive, negative, no change, or uncertain
- an actual or likely change
- beyond a limit of what is considered acceptable to maintain a healthy and functioning wetland ecosystem, relative to the state of the wetland at designation (listing) date.

Applying an integrated cultural assessment approach

The integrated assessment seeks to incorporate Waikato-Tainui's Maatauranga Maaori and tikanga (customary values) and practices into wetland ecosystem assessment alongside other sources of monitoring data following the underlying principles and guidance of the Convention.

The report honours Te Tiriti o Waitangi¹ partnerships and demonstrates how international Convention obligations can be met. The methodology offers a practical template for integrating Maatauranga Maaori with other science approaches to strengthen assessments of wetland ecosystem health and responds to Convention on Wetland resolutions calling for improved participation of Indigenous peoples and use of traditional knowledge.

Key Findings

A total of 18 indicators were evaluated as part of the assessment of ecological character. Based on available data and information, it was determined that 12 out of 18 indicators have declined, where evidence reveals a 'likely' or 'actual' negative change in ecological character. There is adequate information to confirm an 'actual' decline for four indicators.

A significant decline in ecological character, beyond the limit of acceptable change is confirmed for:

- river water-quality (nitrogen)
- wetland vegetation-habitat loss

¹ Te Tiriti o Waitangi/The Treaty of Waitangi, signed in 1840 between the British Crown and many Maaori chiefs, is New Zealand's founding document. It established British governance while guaranteeing Maaori ownership of their lands, resources, and cultural rights. Today, the Treaty remains central to New Zealand law, politics, and society, serving as a framework for partnership and reconciliation between the Crown and Maaori.

- the population of matuku (Australasian bittern), and
- ecosystem services especially provisioning and cultural services/benefits and uses recognised by mana whenua.

Maintaining and restoring the health of Whangamarino Wetland

Given the observed decline in ecological character, active intervention is critical to maintain or restore the ecological character of the Ramsar Site. Te Ture Whaimana o Te Awa o Waikato/The Waikato River Authority Vision and Strategy for the Waikato River calls for action to restore and protect the health and well-being of the Waikato River and its catchment. The Department of Conservation under its Arawai Kākāriki wetland restoration programme² and Waikato Regional Council through its Healthy Rivers Plan Change³ and other catchment programmes have ongoing initiatives to improve management of the Whangamarino Wetland. Maintaining prioritisation of this work remains important.

The restoration of the wetland's ecological and cultural values will require a coordinated and long-term approach to halt the further decline and restore this nationally and internationally significant wetland. Some management interventions have slowed degradation but have not addressed underlying pressures such as altered hydrology, invasive species, fire risk, and land-use impacts. A collaborative governance with iwi and stakeholders, targeted restoration actions and monitoring will be important to deliver enduring outcomes for wetland conservation.

The main drivers of the ecological character decline of Whangamarino relate to the wetland's hydrological regime (water levels, flows), water quality (particularly nutrients, dissolved oxygen and sediment), habitat disturbance (particularly fire) and invasive species (pest plants and animals). Recognising that implementation of management recommendations will need to be considered within the context of wider agency work programmes, supported by research and monitoring to inform effective action, the **priority activities to restore the ecological character of Whangamarino Wetland include** the following:

- **Water quality:** Review the catchment management approach to improve water quality in Whangamarino Wetland and implement priority actions to address poor water quality in upstream lake and river-catchments.
- **Fire:** Reduce the risk of human-induced fire by improving fire management procedures and rules.
- **Hydrology:** Improve that management of water levels to protect threatened species (i.e., Australasian bittern), sensitive wetland habitats and improve water quality. This may require a review of water management infrastructure.
- **Invasive species:** Increase available resources to control of pest plants and animals that have significant impact on wetland habitats and threatened taonga species.

Given the profound significance of Whangamarino to mana whenua, alongside their rights and responsibilities under the Waikato River Act and related instruments, future processes must be meaningfully inclusive of mana whenua. Building on the integration of Maatauranga Maaori with scientific knowledge and the principles of the Convention on Wetlands, future solutions should embed traditional knowledge indicators within ecological frameworks and act decisively to restore not only the wetland's ecology but also its mauri.

² See: <https://www.doc.govt.nz/our-work/freshwater-restoration/arawai-kakariki-wetland-restoration/sites/whangamarino>

³ See: <https://www.waikatoregion.govt.nz/council/policy-and-plans/healthy-rivers-plan-for-change>

1. Introduction

1.1 Background – The Ramsar Convention on Wetlands and the Whangamarino Wetland

The Convention on Wetlands of International Importance especially as Waterfowl Habitat (The Ramsar Convention on Wetlands, adopted in 1971) is a multilateral environmental agreement that promotes the conservation and wise use of wetlands and provides the international framework for the designation and management of the List of Wetlands of International Importance, also known as ‘Ramsar Sites’, among other responsibilities for the management of wetland ecosystems in New Zealand and around the world.

New Zealand became a signatory to the Convention in 1976 and has thus far designated seven Ramsar Sites to be included in the List of Wetlands of International Importance, including the Whangamarino Wetland in the Waikato district. The Department of Conservation (DOC) is the lead agency responsible for the Ramsar Convention in New Zealand.

In designating the Whangamarino Wetland as an international Ramsar Site, New Zealand has an obligation to promote the conservation of the Whangamarino Wetland and, as far as possible, the wise use of all wetlands (Article 3 (1)). The wise use of wetlands is defined as “*the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development*” (Res IX.1).

Each country has a commitment to ensure there is a management framework in place to monitor and detect changes and threats to a Ramsar Site’s ecological character and implement management practices to address these. Under Article 3.2, Parties are required to:

- i. “*arrange to be informed at the earliest possible time if the **ecological character** of any wetland in its territory and included in the List **has changed, is changing or is likely to change** as a result of technological developments, pollution or other human interference*”.
- ii. pass information on such changes without delay to the Ramsar Secretariat.

Ecological character is defined as: ‘the combination of the ecosystem components, processes and benefits/services that characterise the wetland at a given point in time. Changes in ecological character for the purposes of implementation of Article 3(2), means the “*human-induced adverse alteration of any ecosystem component, process, and/or ecosystem benefit/service*”.

There is an expectation on New Zealand to take steps to maintain or restore the ecological character of wetlands where an ecological change has occurred and to report to the Secretariat on any measures that have been put in place.

In 2023, the ecological state of the Whangamarino Wetland rapidly deteriorated due to degraded water entering the wetland. This ‘blackwater event’ characterised by very low oxygen levels, input of organic matter (including algae) and an avian botulism outbreak resulted in high mortality of birds (>1,500 dead birds collected), and fish deaths (native and introduced species). The blackwater event in 2023 had notable effects on wildlife, however, it is recognised that Whangamarino Wetland has been subjected to poor water quality for a prolonged period. Fish kills in 2010/11 and 2017 have also been attributed to the decline of dissolved oxygen (anoxia) during blackwater events following a period of high-water levels and water temperature.

In 2024 a human-induced fire then burnt over 1,039 hectares of the Ramsar Site. The wetland habitat impacted by the fire was a high conservation value peatland (raised bog) dominated by peat form plant species. The fire led to the loss of indigenous vegetation and significant habitat for threatened species.

A key objective of this report is to consider the impacts of the above events in combination with the continually changing ecological state of the Whangamarino Wetland to determine whether the health of the wetland has declined since its designation of a Wetland of International Importance in 1989.

1.2 Purpose of report

This report is prepared to comply with New Zealand's obligations under the Convention on Wetlands to report on any actual, or likely, changes in the ecological character of one of New Zealand's listed Wetlands of International Importance. The report provides an assessment of the ecological character of the Whangamarino Wetland Ramsar Site ('the wetland'). It describes the state and trend of critical components of the wetland's ecological and cultural values, where sufficient data or information exists and draws on the monitoring and expertise of DOC, Waikato Regional Council (WRC), mana whenua and Fish & Game. In particular, the assessment examines:

- whether a change in the ecological character of the wetland has occurred and the nature of that change
- whether the change in ecological character is likely to be permanent, and
- any changes to the wetland as observed using Indigenous peoples' traditional knowledge through the lens of Maatauranga Maaori, specifically from the mana whenua of Whangamarino.

1.3 Whangamarino Wetland Ramsar Site

Whangamarino Wetland was designated as a Wetland of International Importance (a Ramsar Site) under the Ramsar Convention on Wetlands on 4 December 1989.⁴ The Ramsar Site encompasses the public conservation land administered by the Department of Conservation, three blocks of land owned and managed by the Auckland/Waikato Fish and Game Association, and areas of river bed vested with Land Information New Zealand (a government department) that combined comprise approximately 83% of the Whangamarino Wetland.

The wetland is the second largest bog and swamp complex in the North Island. It comprises intact ecological sequences of natural wetland habitats encompassing river systems, low-lying swamp and marsh, through to fens and raised bog (peatland). The bog habitat is of high natural character and dominated by indigenous species. The mineralised swamp and marsh areas are dominated by non-native plant species, but remain ecologically significant, particularly as habitat for threatened species such as matuku (Australasian bittern).

The wetland supports an estimated 143 native vascular plant species and is a national stronghold for three endemic plants, *Corybas carsei*, *Schoenus carsei* and *Myriophyllum robustum*, and two native animals, the endemic black mudfish *Neochanna diversus*, and matuku (Australasian bittern) *Botaurus poiciloptilus*. Twenty-five nationally threatened or at-risk species have been recorded. The extent and diversity of wetland habitat frequently supports large numbers of bird species including local waterfowl populations. Bird guilds include open water divers, deep-water waders, shallow water waders, dabbling waterfowl, aerial hunting gulls and terns, swamp birds and riparian wetland birds.

The Ramsar Site meets 8 of the 9 Criteria for designation:

1. Contains a representative, rare or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
2. Supports vulnerable, endangered or critically endangered species, or threatened ecological communities.
3. Supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
4. Supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
5. Regularly supports 20,000 or more waterbirds.

⁴ Ramsar Convention. 1992. Ramsar Wetlands Information Sheet – Whangamarino Wetland. Prepared by the Department of Conservation.

6. Regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.
7. Supports a significant proportion of indigenous fish subspecies, species or families, life history stages, species interactions, and/or populations that are representative of wetland
8. benefits and/or values and thereby contributes to global biological diversity.
9. Is an important source of food for fish, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.
10. Regularly supports 1% of the individuals in a population of one species or subspecies.

1.4 Reporting on the ecological character of Ramsar Sites

A key requirement under the Convention on Wetlands is to report on the ecological character of Ramsar Sites through Ramsar Information Sheets at least every six years. New Zealand is also expected to provide a brief report on the state of ecological character, as part of the National Report to assess progress on implementation of the Convention every three years. During 2022, the Department submitted an updated 'Ramsar Information Sheet' to the Secretariat of the Convention that described the overall state of Whangamarino Wetland. At this time, both positive and negative changes in the ecological character of Whangamarino Wetland were identified. However, it was not determined whether the changes in ecological character were 'significant' and above the limit of acceptable change.

The aim of the current assessment is to evaluate if adverse changes in the ecological character have occurred at Whangamarino Wetland, including in response to the flood events and associated blackwater anoxia (low oxygen conditions) and botulism outbreak in 2023 and human-induced fire of 2024.

If adverse changes in ecological character are confirmed, which exceed limits of acceptable change, a report will be submitted to the Secretariat of the Convention on Wetlands. The information may also be used to update the Ramsar Information Sheet and included in National Reports for the Whangamarino Wetland.

1.5 2023 blackwater event and 2024 fire

Whangamarino Wetland was in poor ecological state in 2023 due to degraded water affecting the wetland. A 'blackwater event' characterised by very low oxygen levels and an avian botulism outbreak resulted in high mortality of birds (>1,500 dead birds collected), and fish deaths (native and introduced species). Waananga (meetings) with mana whenua, Waikato-Tainui, DOC and WRC in 2023 led to the activation of a raahui. An inter-agency response group for Whangamarino Wetland was also established. The blackwater anoxia event was exacerbated by heavy rainfall and catchment runoff following climatic events (Cyclones Hale and Gabrielle) and subsequent discharge of flood water from Lake Waikare and drainage water from low-lying agricultural areas, increasing water levels in the wetland. The water quality decline in 2023 had notable effects on wildlife, however, it is recognised that Whangamarino Wetland has been subjected to poor water quality for a prolonged period. Fish kills in 2010/11 and 2017 have also been attributed to the decline of dissolved oxygen (anoxia) during blackwater events following a period of high-water levels and water temperature.

In October 2024, a human-induced fire burnt over 1,039 hectares of the Whangamarino Wetland. The wetland habitat impacted by the fire was a high conservation value peatland (raised bog) dominated by wirerush (*Empodisma robustum*). The fire led to the loss of indigenous vegetation and significant habitat for threatened species.

A key objective of this report is to determine whether the health of the wetland had declined since its designation of a Wetland of International Importance in 1989, including in response to these events.



Flooding in the Whangamarino Wetland, 2023.

1.6 Waikato Tainui and the Whangamarino Wetland

This section introduces the local Indigenous people of the Whangamarino Wetland—Waikato Tainui and their spiritual, cultural and physical relationship to the Whangamarino Wetland. It provides the context for describing changes to the ecological character that Maaori have observed since the wetland was designated as an international Ramsar Site in 1989. It also acknowledges their observations of land change before 1989 and that impacts of environmental change are cumulative. It also introduces relevant legislation, policy and other instruments acknowledging Waikato Tainui’s authority and relationship to the Whangamarino. Waikato Tainui note that as a result of the land confiscations and displacement of Waikato Tainui from their ancestral lands in the 1860s, some of the Indigenous knowledge or Maatauranga of this unique wetland has been lost, though precious knowledge remains.

The Waikato-Tainui Tai Tumu Tai Pari Tai Ao Environmental Plan (2013) includes te maimai aroha, a lament composed by Kingi Taawhiao during the time that Waikato Tainui were being displaced from their lands, which expresses the loss, longing for and adoration of the taonga, and natural resources of his homeland. It also describes the flourishing and pristine surrounding environment of the Whangamarino Wetland during the 1960s. The maimai aroha of Kingi Taawhiao, included below, is the key driver and indicator of environmental health and wellbeing of the Waikato Environmental Plan. Waikato-Tainui aspires to restore the environment to the state that Kingi Taawhiao observed when he composed his maimai aroha and this vision underlies the management and use of environmental resources across Waikato-Tainui’s tribal lands and waters.

Te Whangamarino o Waikato – The Tranquil Harbour of Waikato

Te maimai aroha o Kiingi Taawhiao

Ka maatakitaki iho au ki te riu o Waikato
Aanoo nei hei kapo kau ake maaku ki te kapu o taku
ringa, Ka whakamiri noa i toona aratau
E tia nei he tupu pua hou.

Kia hiwa ake au i te tihi o Pirongia,
Inaa, hei toronga whakaruruhau moonā ki tooku
tauawhirotanga.

Anaa! Te ngoto o toona ngawhaa i ngoona uma kiihai
i aarika a Maungatautari, a Maungakawa,
ooku puke maunga, ngaa taonga tuku iho.
Hoki ake nei au ki tooku awa koiroa me ngoona
pikonga He kura tangihia o te maataamuri.

E whakawhiti atu ai i te koopuu maania o Kirikiriroa,
me ngoona maara kai, te ngawhaa whakatupu ake o
te whenua moomona,
Hei kawē ki Ngaaruawaahia, te huinga o te tangata.

Araa, te pae haumako, hei okiokinga oo taku Upoko,
hei tirohanga atu maa raro i ngaa huuhā o Taupiri.

Kei reira raa, kei te oroko hanganga o te tangata,
waahia te tuungaroa o te whare,
te whakaputanga moo te Kiingi.

I look down on the valley of Waikato,
as though to hold it in the hollow of my hand and
caress its beauty,
like some tender verdant thing.

I reach out from the top of Pirongia,
as though to cover and protect its substance with
my own

See how it bursts through the full bosoms of
Maungatautari and Maungakawa,
hills of my inheritance:
The river of life, each curve more beautiful than
the last.

Across the smooth belly of Kirikiriroa,
its gardens bursting with the fullness of
good things, towards the meeting place at
Ngaaruawaahia.

There on the fertile mound I would rest
my head, and look through the thighs of Taupiri.

There at the place of all creation...
let the King come forth

Te Repo o Whangamarino me toona hononga ki ngaa wai o Waikato

The observations of Kiingi Taawhiao above describes the Whangamarino Wetland and its inextricable link to the surrounding environment including Lake Waikare, the Waiterimu, Matahuru, Orini catchment and the tupuna awa Waikato (the ancestral river that created and fed the remnant water bodies of the northern Waikato). It describes a desired state that would be achieved when all of the aspirations had been met and the objectives and strategies in Te Ture Whaimana had been achieved (i.e., what is desired by the iwi and the wider community for the health and wellbeing of the Waikato River). The desired state is a thriving healthy ecosystem where Iwi (tribes) and hapuu (sub-tribes) were able to nourish themselves sustainably without diminishing the mauri or life force of the ecosystem. The Whangamarino has transformed substantially since Maaori first inhabited these lands and waters and further changes have occurred since Whangamarino became a Wetland of International Importance. These changes are described in section 2.4 below and woven further throughout the report.

The name Whangamarino reflects the nature of the place—“*whanga*”, meaning estuary, harbour, or backwater, and “*marino*”, meaning peaceful or tranquil. The shallow water bodies of the northern Waikato referred to as Te Riu o Waikato were formed in prehuman arrival when the Waikato River carved a path through the Taupiri gorge referred to in the lament of Kingi Taawhiao as the thighs of Taupiri. The re-direction and altered course of the river left the Mangawara bereft of a current to push the water across to the Hauraki valley and created a huge inland lake inundating and ultimately covering ancient forests the remnant of which are constantly being exposed today. Once the river carved a deeper channel gorge through what is now the Tuakau area to the sea the vast inland lake emptied leaving a cluster of shallow lakes Waikare being the largest.

Waikato horo pounamu Waikato taniwharau he piko he taniwha he piko he taniwha.

Waikato Tainui’s peepaha above speaks of Waikato Taaniwharau, Waikato of a hundred taniwha or chiefs referring to the interrelated haapu and iwi at each bend along the length of the Waikato River. This suggests that Whangamarino was historically an abundant place for gathering kai (food) able to sustain a large Indigenous population.

1.6.1 Waikato Raupatu Claims (Waikato River) Settlement Act 2010

The Waikato Raupatu Claims (Waikato River) Settlement Act 2010 (Waikato River Act) acknowledges the importance of the principle of te mana o te Awa (the spiritual authority, protective power, and prestige of the river). For Waikato-Tainui, their relationship to the Waikato River, including the Whangamarino Wetland, is expressed through the following statement:

*“The Waikato River is our tupuna (ancestor) which has mana (spiritual authority and power) and in turn represents the mana and mauri (life force) of Waikato-Tainui. The Waikato River is a single indivisible being that flows from Te Taaheke Hukahuka to Te Puuaha o Waikato (the mouth) and includes its waters, banks and beds (and all minerals under them) and its streams, waterways, tributaries, lakes, aquatic fisheries, vegetation, flood plains, wetlands, islands, springs, water column, airspace, and substratum as well as its metaphysical being. Our relationship with the Waikato River, and our respect for it, gives rise to our responsibilities to protect te mana o te Awa and to exercise our mana whakahaere (authority and rights of control) in accordance with long established tikanga (values, ethics, governing conduct) to ensure the wellbeing of the river. Our relationship with the river and our respect for it lies at the heart of our spiritual and physical wellbeing, and our tribal identity and culture”.*⁵

⁵ Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010, Schedule 1 (1).

1.6.2 Te Ture Whaimana o Te Awa o Waikato The Vision and Strategy for the Waikato River

Waikato-Tainui negotiated a co-management framework, Te Ture Whaimana o te Awa o Waikato/the Vision and Strategy for the Waikato River, to ensure that all responsible agencies work towards an overarching purpose and encourage collective responses to environmental issues. This strategy is the primary direction-setting document for the Waikato River and activities within the wider catchment affecting the Waikato River including the Whangamarino Wetland. The vision, principles, and goals for restoring and protecting the health and well-being of the Waikato River and its catchment are defined in Te Ture Whaimana. It provides a framework to ensure that the river is managed in a way that respects both its environmental integrity and its cultural significance to Waikato-Tainui and other iwi with connections to the river.

Achieving the vision and goals of Te Ture Whaimana requires agencies working together to protect and restore the Whangamarino Wetland and provide for its co-management with tangata whenua (Indigenous peoples of the land), including their marae, and provide resources to protect the sanctity of the wetlands taonga, waters and spiritual guardians. It is the view of Waikato-Tainui, as tangata whenua, that having Whangamarino Wetland as an internationally designated Ramsar Site and maintaining and restoring its ecological character (health) assists with advancing their aspirations and the objectives under Te Ture Whaimana o te Awa o Waikato.

1.6.3 Waikato-Tainui Tikanga Concepts and Principles for Wetlands

The Waikato River Act (outlined above) recognises the deep cultural, spiritual, and historical relationship between Waikato-Tainui and the Waikato River. Building on this Act, Waikato-Tainui have developed a set of tikanga concepts and principles that underpin the cultural indicators and monitoring tools used in wetland management and restoration. Understanding these concepts is essential to appreciating the holistic approach that brings together Maatauranga Maaori (Indigenous knowledge) and modern scientific methods, which can be applied in assessment of changes in the ecological character (health) of wetlands in the Waikato rohe (area).

Tikanga is defined as a set of values, principles, understandings, practices, norms and mechanisms from which a person or community can determine the correct action in te ao Maaori.⁶ Tikanga also reflects ways of classifying Maaori knowledge and can be divided into the following two categories:

- a) Tikanga Maaori, which covers the core beliefs, values and principles broadly shared among Maaori and is informed by Maatauranga Maaori.
- b) Tikanga aa-iwi, which refers to the localised expressions of tikanga that are shaped by different Maaori groups' knowledge and experience.⁷

Te Mana o te Awa: The spiritual authority, protective power, and prestige of the river

The principle of Te Mana o te Awa reflects the structural concept of whakapapa (genealogical relationship) between people, water, land, species, and the spirit world. When wetlands such as Whangamarino are degraded, it is not just an ecological crisis—it is a violation of whakapapa and a spiritual trauma to the iwi. Te Mana o te Awa prioritises relational and spiritual integrity as central measures of health. This principle embodies the original treaty of relationship—not just between iwi and government, but between people and river. The Waikato River Act recognises Te Mana o te Awa as the guiding principle for all decisions affecting the River as well as requiring that all statutory bodies and agencies have 'particular regard' to Te Mana o te Awa in all decision-making and reporting.

Te Mauri o te Repo: Life-force and wellbeing of wetlands

Te Mauri o te Repo highlights the life-force and overall wellbeing of wetlands. Mauri is the vital essence that exists in all living things, and maintaining the mauri of wetlands is essential for their health and sustainability. From a cultural perspective, wetlands are part of an ancestor and function as the living

⁶ New Zealand Law Commission Study Paper 24, available at www.lawcom.govt.nz.

⁷ Ibid.

kidneys that hold genealogies and provide nourishment. They are integral to the cultural identity of Waikato-Tainui. From an environmental stewardship perspective, maintaining the ecological character of Whangamarino Wetland directly supports the restoration and protection of the mauri of the Waikato River and its associated wetlands.

Whakapapa: Genealogical relationships

Whakapapa refers to the genealogical relationships that connect humans, species, places, and deities. It is a fundamental concept in Maaori culture that emphasises interconnectedness and continuity. Whakapapa establishes the relationships between people and the natural world, highlighting the responsibility to care for the environment. Integrating whakapapa into environmental management includes ensuring that the river and its ecosystems are treated as interconnected entities.

Mana Whakahaere: Governance and responsibility

Mana Whakahaere denotes the right and responsibility of Iwi (tribe) to govern and manage their natural resources. It reflects the principle of self-determination and the authority to make decisions regarding the environment. The Waikato River Act establishes a co-management framework that includes Waikato-Tainui in the governance of the Waikato River. Mana Whakahaere empowers Waikato-Tainui to exercise their kaitiakitanga (guardianship) over the river and its resources, ensuring that their cultural values and knowledge are integrated into environmental management.



Whangamarino Wetland central bog before fire.

2. Establishing an integrated cultural framework to assess ecological character

2.1 Assessment approach

The Convention on Wetlands provides guidance on assessing changes in the ecological character of Ramsar Sites⁸ which draws upon numerous resolutions adopted by the Convention.⁹ A key resolution is *Resolution X.16 A Framework for processes of detecting, reporting and responding to change in wetland ecological character*.¹⁰ Some countries have published guidance on how to assess a change in ecological character, which has been reviewed in adopting the methodology for this present assessment.¹¹

The assessment approach for Whangamarino Wetland is based on the following underlying principles, concepts and elements which are drawn from the evolving resolutions, guidance and the Convention's 5th Strategic Plan:

- Ecological character is defined as the combination of the ecosystem components, processes and benefits/services that characterise the wetland at a given point in time.
- Notification of changes in ecological character is only needed if changes are adverse (negative) and a human induced change.
- Change in ecological character does not have to represent a change in the Ramsar Site criteria the wetland meets.
- Focus the assessment of changes in ecological character on the critical components, processes and ecosystem services for the Ramsar Site.
- Assessments need to be evidence based and require adequate data or information.
- Changes in ecological character are typically assessed relative to the state of the Ramsar Site at the time of designation (listing date).
- If changes in ecological character cannot be confirmed to be outside of natural variability, then only a 'likely change' can be concluded (not an actual change).
- Although ecological character is defined as the combination of the site's ecosystem components, processes and benefits/services, the 'trigger' for reporting under Article 3.2 may relate to only one component, process, or benefit/service. It does not depend on determining there has been or is likely to be a loss of the site's overall integrity.
- The concept of 'wise use' of wetlands, defined as "*the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development*" is the central principle of the Convention and underlies the assessment of ecological character change.
- The traditional knowledge and practices of Indigenous peoples relevant for the wise use of wetlands and their customary use of wetland resources are documented, respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention, with a full and effective participation of Indigenous peoples at all relevant levels.

⁸ See Handbook 19 Ramsar handbooks for the wise use of wetlands: Addressing change in the ecological character of Ramsar sites and other wetlands. 3rd Edition (2007).

⁹ Several key resolutions include: Resolution VI.1: Working definitions of ecological character, guidelines for describing and maintaining the ecological character of listed sites, and guidelines for operation of the Montreux Record, and Resolution VIII.8: Assessing and reporting the status and trends of wetlands, and the implementation of Article 3.2 of the Convention and Resolution XV.15 Restoration of degraded freshwater ecosystems to support ecological character, biodiversity and ecosystem services.

¹⁰ Ramsar Convention (2008a). Resolution X.16: a framework for processes of detecting, reporting and responding to change in wetland ecological character. Available at https://www.ramsar.org/sites/default/files/documents/pdf/res/key_res_x_16_e.pdf.

¹¹ See for example, DEWHA (2009). National Guidelines for Notifying Change in Ecological Character of Australian Ramsar Sites (Article 3.2). Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra.

The purpose of this report is to assess whether there has been a change in ecological character at the Whangamarino Wetland and whether this change is beyond a limit of acceptable change. This assessment has also sought to include, where possible, New Zealand's Indigenous people's knowledge systems known as Maatauranga Maaori, where this knowledge assists in providing a more comprehensive understanding of the changes in ecological character, since the time the wetland was designated as a Ramsar site.

For each component of ecological character, the assessment describes whether the change in ecological character is:

- positive, negative, no change, or uncertain
- an actual or likely change
- beyond a limit of what is considered acceptable to maintain and healthy and functioning wetland ecosystem, relative to the state of the wetland at designation (listing) date.

2.2 Critical components of ecological character

The ecological character of Ramsar Sites is the combination of:

- **physical components** – climate, water regime, sediment regime, nutrients, etc.
- **biological components** – includes noteworthy plant and animal species, invasive species
- **ecosystem services** – includes regulating services, provisioning services, cultural services
- **ecosystem processes** – carbon cycling, primary production, etc.

For the Whangamarino Wetland the assessment focuses on critical components of the ecological character that have a key function in the environmental processes of the wetland (e.g., hydrology and water quality) or relate to significant ecological values (e.g., vegetation, bird and fish communities). The assessment of how these components and processes have changed also draws on Maatauranga Maaori (Indigenous knowledge). Assessment is limited to physical, biological components and ecosystem services/processes with adequate data or expert knowledge to evaluate the change in condition from time of Ramsar Site designation (~1989), including in response to recent blackwater anoxia and fire events.

Ecosystem services are most commonly defined as the benefits humans obtain from ecosystems.¹² The concept of ecosystem services has evolved within the context of an ecosystem approach, especially under the Convention on Biological Diversity and the Ramsar Convention on Wetlands and seeks to connect functioning ecosystems and the direct and indirect services they provide with human wellbeing.¹³ In the Millennium Ecosystem Assessment (MEA), ecosystem services can be divided into supporting, regulating, provisioning and cultural services. Subsequent global expert bodies have built on the MEA to define ecosystem services as 'nature's contributions to people'.¹⁴

This technical report includes assessment of the changes to the provisioning, regulating and cultural aspects of ecosystem services from the perspective of Maatauranga Maaori. Provisioning services are the products that ecosystems provide to humans, for example the sources of food, textiles, timber, Rongoa (traditional medicine), and freshwater in the Whangamarino. Regulating services are the benefits that come from the regulation of ecosystem processes, for example, the water purification, climate and flood regulation that the Whangamarino provides. Cultural services are the experiential and intangible services related to ecosystems whose existence and functioning contributes to a range of cultural benefits, such as improved health, recreation or cultural rituals non-material benefits associated with ecosystems. In the Whangamarino, examples include cultural and spiritual connection, intergenerational astrological learning, whanaungatanga (relationships, kinship), connection or recreation and a sense of place. The critical components of the ecological character of Whangamarino Wetland applied in the assessment are described in Table 1.

¹² Millennium Ecosystem Assessment (2005).

¹³ R Moynihan, *Transboundary Freshwater Ecosystems in International Law: The Role and Impact of the UNECE Environmental Regime* (Cambridge University Press, 2021).

¹⁴ See IPBES (2019): *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages. <https://doi.org/10.5281/zenodo.3831673>.

Table 1. Critical components of the ecological character of Whangamarino Wetland applied in the assessment.

Aspect of ecological character	Indicator applied in assessment	Reason selected
Physical components	Water regime	Hydrological regime is a critical driver of wetland health; long-term data available
	Water quality – nutrients	
	Water quality – dissolved oxygen	
	Water quality – clarity	Recent observations of degraded water quality; long-term data available
	Water quality – temperature	
	Sediment regime	
Biological components	Bird community (noteworthy taxa)	Monitoring and observations of changes in threatened wetland bird and waterfowl populations; some long-term data available
	Fish community	Observations of recent fish kills and invasive species, limited data
	Vegetation community	Indigenous vegetation and habitat diversity supports wetland biodiversity, long-term data/mapping available; a >1,000 ha human-induced fire occurred in October 2024
Ecosystem services (benefits) and processes including cultural services	Ecosystem services especially provisioning, regulating and cultural services/benefits and uses recognised by mana whenua	Maatauranga Maaori informs the ecological assessment of Whangamarino, particularly provisioning, regulating and cultural services/benefits and uses that the wetland provides to mana whenua

2.3 Baseline or reference state

Whangamarino Wetland was designated as a Wetland of International Importance (a Ramsar Site) in 1989. The ecological character, or health, of the wetland during the late 1980s and 1990s represents the ‘baseline state’ against which to evaluate whether a negative, human-induced and significant change in the wetland has occurred. For a significant change in ecological character to be confirmed, evidence of a departure from the baseline state beyond what can be explained as a natural fluctuation is required. That is, evidence of a decline in water quality, water regime, the population of indicator species or other wetland values, based on data or expert consensus.

2.4 Maatauranga Maaori (Indigenous knowledge)

Maatauranga Maaori or Indigenous knowledge informs the ecological assessment of Whangamarino, both through observations regarding the ecological change that has occurred to the physical and biological components of the wetland as well as ecosystem services, particularly provisioning, regulating and cultural services/benefits and uses that the wetland provides to mana whenua.

Maatauranga Maaori is the traditional knowledge system of Maaori people. It is a holistic, place-based way of understanding the world that includes environmental science, cultural practice, spiritual belief, and intergenerational knowledge. Maatauranga Maaori has been developed through centuries of close observation of the natural world—including climate, species behaviour, and ecological changes—passed down through generations in the form of stories, seasonal calendars, rituals and daily practices. It recognises the interconnectedness of all living and non-living things through whakapapa (genealogy) and values the wairua (spiritual essence) and mauri (life force) of the environment. More than just Indigenous knowledge, Maatauranga Maaori is a living adaptive framework for monitoring decision-making and restoring ecosystems, offering insights that can provide a holistic understanding of the state of the environment. Maatauranga Maaori is one of the core essences of the mana of the Waikato people and at each bend of the river, a chief and his people holds their own Maatauranga Maaori.

2.4.1 Waikato-Tainui Cultural Monitoring Framework

The concepts of Te Mana o te Awa, Te Mauri o te Repo, Whakapapa, and Mana Whakahaere described in section 1.6.3 in combination with specific cultural indicators and tools in Appendix 2 below, provide a framework for integrating Indigenous knowledge with other scientific methods for wetland monitoring. The cultural monitoring framework can be applied to report on changes in Ramsar Site ecological character and support assessment of wetland health in relation to Te Ture Whaimana and the Waikato River Act.



Fire at Whangamarino Wetland, October 2024.

3. Assessment of changes in ecological character of the Whangamarino Wetland

3.1 Water regime

3.1.1 Change in water levels

Comprehensive monitoring of water levels within the Whangamarino River and associated waterbodies has been undertaken by the WRC and other agencies since the ~1960s. This provides a long-term record to evaluate changes in the hydrological regime of the riverine-influenced wetland habitat in the Ramsar Site. Prior to designation (the period 1960s to 1990s), Whangamarino Wetland experienced a decline in minimum water levels due to human-influence (e.g., river development works) (Figure 1). This led to lowering of the water levels in the Whangamarino River and connected streams, swamps and marshes and is associated with degradation of wetland habitat.

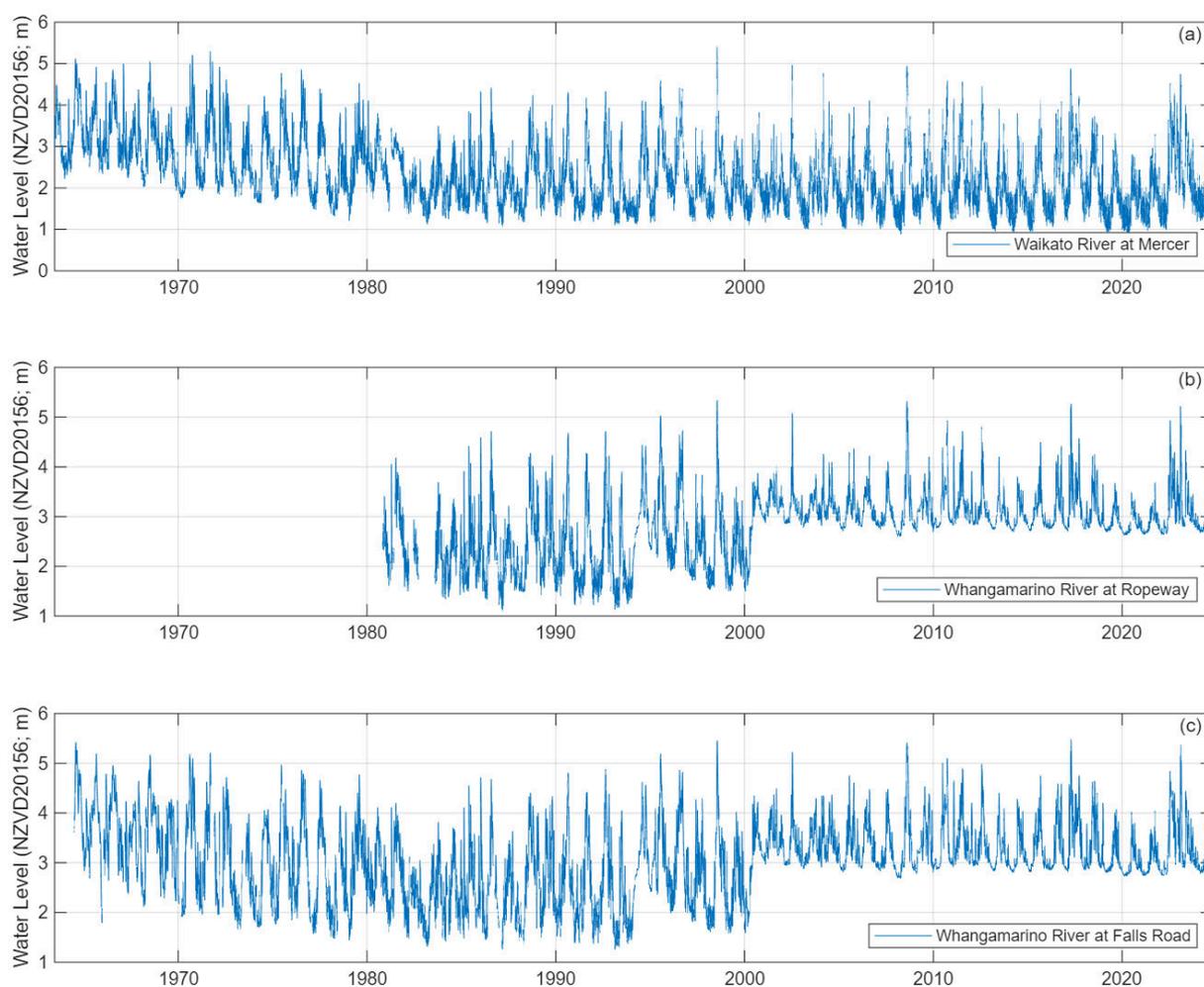


Figure 1. Water levels at three sites: (a) Waikato River at Mercer, 1963–2024; (b) Whangamarino River at Ropeway, 1980–2024; and (c) Whangamarino River at Falls Road, 1964–2024.

A few years after Ramsar Site designation (>1993), Whangamarino River minimum water levels were raised through construction of a weir. The structure initially eroded prior to repair in 2000/01. The purpose of the weir was to restore minimum water levels in the river and connected wetland habitats to prevent drainage of wetland habitat. Since 2001, minimum water levels have increased by >1.3 m and are more similar to the minimum water levels observed during the 1960s (Figure 1). This has resulted in >1,000 hectares of low-lying wetland habitats being inundated.¹⁵ This indicates a positive change in the water regime of the wetland. While a recent decline in the minimum water level in Whangamarino Wetland has been observed, particularly over the last 5 years, the overall increase in minimum water levels since Ramsar Site designation has maintained wetland habitat dependent on riverine water sources.

Several large flood events have occurred since Ramsar Site designation, including events in 1998, 2002, 2008, 2017 and 2023. Prior to designation only one event exceeded a water level of 5.5 mRL (over a monitoring period of ~26 years). Since 1990 (a period of ~34 years) five flood events that exceeded 5.5 mRL have been recorded (Table 2).

Table 2. Number of maximum annual floods in Whangamarino Wetland. Derived from the Falls Road (Whangamarino River) station. Based on Moturiki vertical datum (MOT1953).

Hydrological period	Maximum annual flood	Count
Post-Designation (1990–2024; 34 years)	>5.5 mRL	5
	5.4–5.5 mRL	1
	5.3–5.4 mRL	1
Pre-Designation (1964–1989; 26 years)	>5.5 mRL	1
	5.4–5.5 mRL	4
	5.3–5.4 mRL	0

Larger magnitude floods (>5.3 mRL) inundate further into the wetland and deposit nutrients¹⁶ in low fertility peatland (bog) areas where rainfall is the primary water source. The change in flood frequency and nutrient deposition can modify indigenous vegetation and peat formation processes, leading to reduction in sensitive plant species such as wirerush (*Empodisma robustum*).

¹⁵ Blyth, J.M., Nation, T., & Taylor, G. 2024. Whangamarino Weir – Current Environmental State Assessment. Prepared for Department of Conservation and Fish and Game. Collaborations, Wellington.

¹⁶ Blyth, J., Campbell, D. & Schipper, L. 2012. Utilising soil indicators to explain historical vegetation changes of a peatland

Ecological character assessment – Water regime

Indicator: Minimum water levels

Change: Positive (actual)

Exceeds limit of acceptable change: Not applicable

The minimum water level in Whangamarino River and connected streams and wetland habitats has increased since Ramsar Site designation (1989), reinstating the minimum water levels that were present during the 1960s prior to river modifications. This is a positive (actual) change to ecosystem functioning as the water regime maintains wetland habitat, although noting that potential negative impacts of restoring minimum water levels on river water quality due to sediment, organic matter and nutrients in the river and wetland habitats (water quality is addressed in section 3.2).

Indicator: Frequency of flood events with inundation into sensitive wetland habitat (flood event >5.5m RL)

Change: Negative (likely)

Exceeds limit of acceptable change: Not applicable

The frequency of flood events (max. water level > 5.5 mRL) has increased since 1989. This represents a negative change to ecosystem functioning. However, it is not possible to determine if this is an 'actual' change to ecological character or represents natural climatic variability.

What does this mean?

Maintenance of a minimum water level is necessary to provide habitat for indigenous plants and animals, and for waterfowl. The restored water level, relative to 1989, has enhanced the extent of swamp and marsh habitat and maintained a functioning wetland ecosystem. Large flood events inundate nutrient sensitive regions of the wetland that are typically rain-fed (i.e., the raised bog). Increased flood frequency is likely to contribute to nutrient deposition that can lead to loss of peat forming plant species, peat soil degradation, and weed invasion.

From a Maatauranga Maaori perspective the health of the Waikato River is intrinsically linked to the concept of mauri (life force). Changes in water levels that disrupt the river's natural flow can be seen as diminishing its mauri, affecting not only the ecological balance but also the spiritual and cultural well-being of the Waikato-Tainui people. Such changes may impact traditional practices, including mahinga kai (customary food) gathering and the overall relationship between iwi and the river. Historically, Whangamarino's waterways provided mana whenua with vital transport routes connecting the Waikato River to Lake Waikare, but these pathways remain inaccessible today. While waka routes have been re-established on the main Waikato River, restoration through Whangamarino is hindered by flood protection infrastructure—gates and weirs installed before Ramsar designation—and decades of low water levels between 1961 and 2003. Although a new weir raised water levels in 2001, physical barriers and access challenges continue to prevent the revival of traditional navigation routes.

3.2 Water quality

Water quality has been routinely monitored within the Whangamarino River by the Waikato Regional Council and other agencies since 1994. This provides a long-term record to evaluate changes in water quality indicators since the wetland was designated as a Ramsar Site in 1989.

Monitoring data for nutrients, water temperature, visual clarity and dissolved oxygen are presented in Figures 2A-2E for the period 1994-2023.

3.2.1 Change in water quality

A summary of water quality trends throughout the period of Ramsar designation is presented for 30-year (1994-2024) and 10-year (2014-2024) periods (Table 3). Trends were based on Mann-Kendall and Sen-Slope statistical analysis (refer Appendix 3, Figures A1-A9).

The most significant change in water quality at Whangamarino Wetland since Ramsar Site designation is the increase in total nitrogen (TN) concentration, a nutrient that contributes to eutrophication of freshwater ecosystems. Since 1989/1990, the TN levels within Whangamarino Wetland increased from a median of 1.4 mg/l to 2.6 mg/l (Figure 2A). Increasing TN concentration corresponds directly to the increase in organic nitrogen (Figure 2A). The contribution of inorganic nitrate to water quality decline is less apparent.

The other water quality attributes where a long-term decline was observed were for ammoniacal-nitrogen (Figure 2A) and water temperature. Minimum water temperature increasing steadily overtime and now exceeding 10°C (Figure 2E). However, this data does not capture daily maximums and continuous water temperature monitoring is needed

No adverse changes in ecological character since designation were observed for other water quality attributes, however since 2014, increasing concentrations of total phosphorus (TP) were recorded.

Table 3. Change in water quality at Whangamarino River (Island Block Road monitoring site).

Water quality attribute	10-year (2014-2024)*	30-year (1994-2024)*	Adverse change in ecological character since designation
Total nitrogen (TN)	Increasing TN concentration	Increasing TN concentration	Yes
Organic nitrogen (OrgN)	Increasing OrgN concentration	Increasing OrgN concentration	Yes
Oxidised nitrogen (TON)	Increasing TON concentration	Potential decreasing TON concentration	Uncertain
Ammoniacal nitrogen (TAN)	Increasing TAN concentration	Increasing TAN concentration	Yes
Total phosphorus (TP)	Increasing TP concentration	Decreasing TP concentration	No (remains below TP target)
Dissolved reactive phosphorus (DRP)	Uncertain	Decreasing DRP concentration	No
Water temperature	Increasing temperature	Increasing temperature	Yes
Dissolved oxygen (DO)	Decreasing DO	Increasing DO	Uncertain (low oxygen events recorded)
Visual clarity	Decreasing visual clarity	Uncertain	Uncertain

* Waikato Regional Council (WRC) analysed the 10-year and 30-year trends of water quality for Whangamarino Wetland at Island Block Road. Note, only the last 10-year trend is presented; refer to **Appendix 3, Figures A1-A9**.

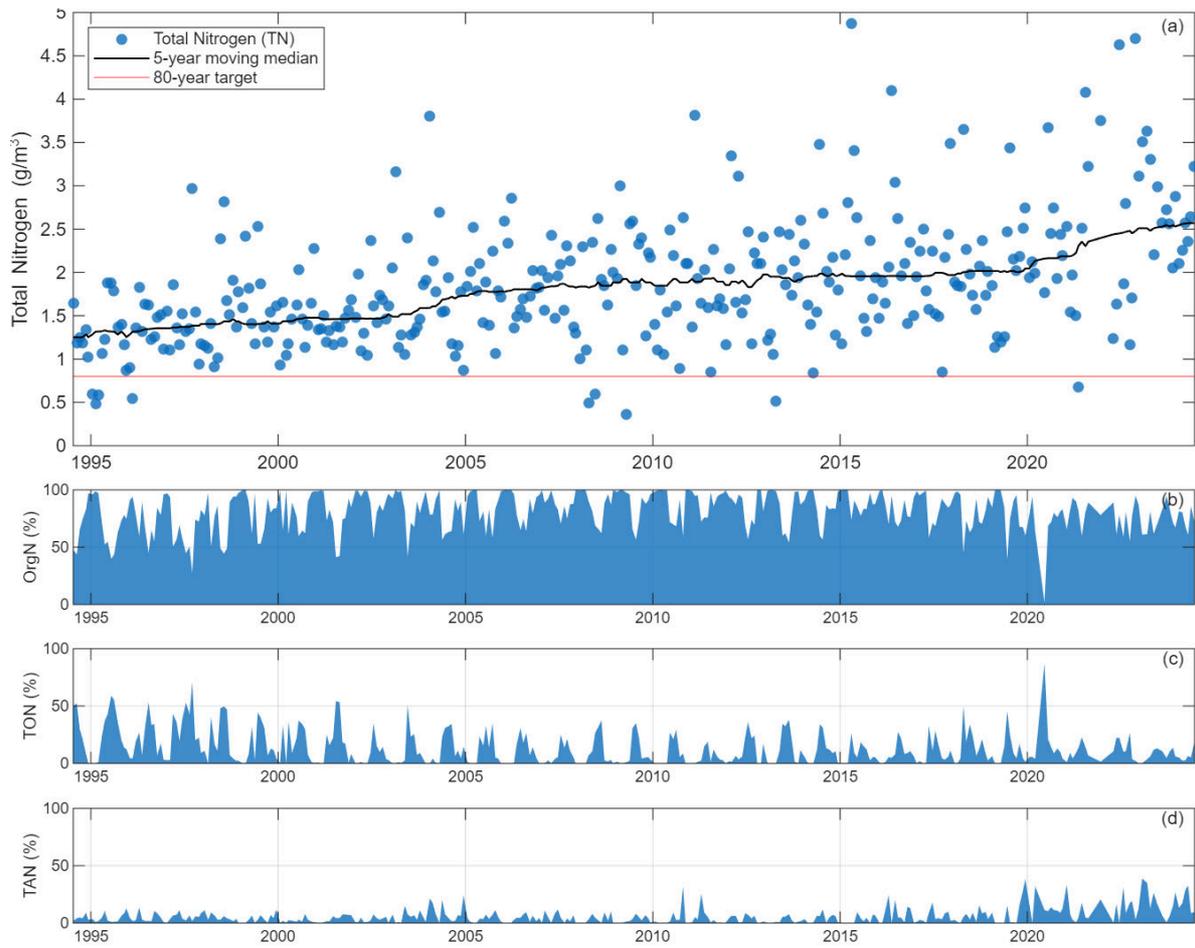


Figure 2A. (a) Total nitrogen (TN) concentration and proportional (%) contribution of (b) organic nitrogen (OrgN), (c) total oxidised nitrogen (TON), and (d) total ammoniacal nitrogen (TAN) at the Whangamarino River, Island Block Road (1994–2024). TN concentrations (g/m^3) presented relative to the Healthy Rivers 80-year TN target for water quality improvement.

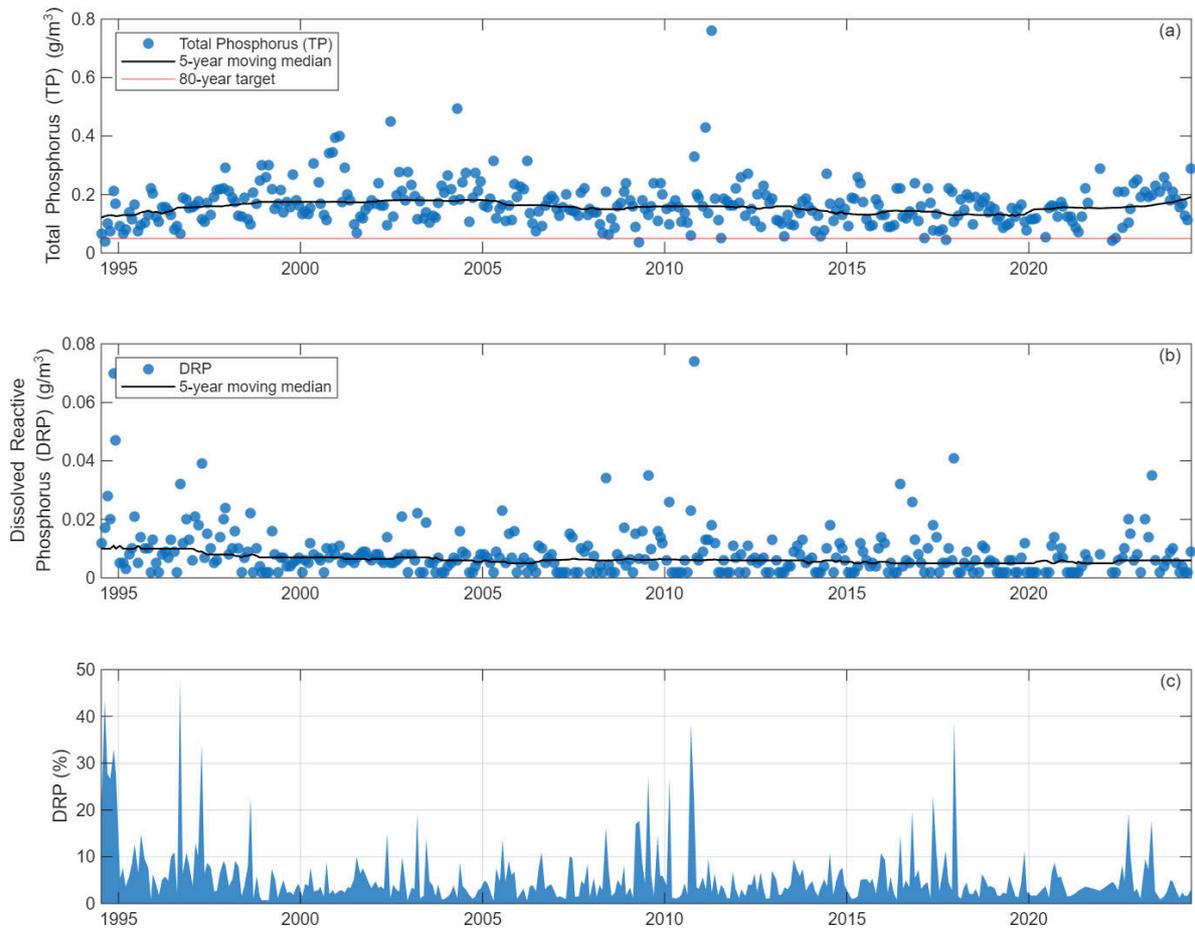


Figure 2B. (a) Total phosphorus (TP) and (b) dissolved reactive phosphorus (DRP) concentration at the Whangamarino River, Island Block Road (1994–2024). TP concentrations (g/m^3) presented relative to the Healthy Rivers 80-year TP target for water quality improvement. (c) Proportional (%) contribution of DRP to TP.



Figure 2C. (a) Visual clarity (VC; measured using black disc), (b) turbidity, and (c) absorption coefficients of dissolved organic matter (aCDOM) at the Whangamarino River, Island Block Road (1994-2024). VC presented relative to water quality state ranging from A (good) to D (poor). Turbidity represents the particle-scattering component of VC; aCDOM reflects the light absorption influence of organic matter on VC.

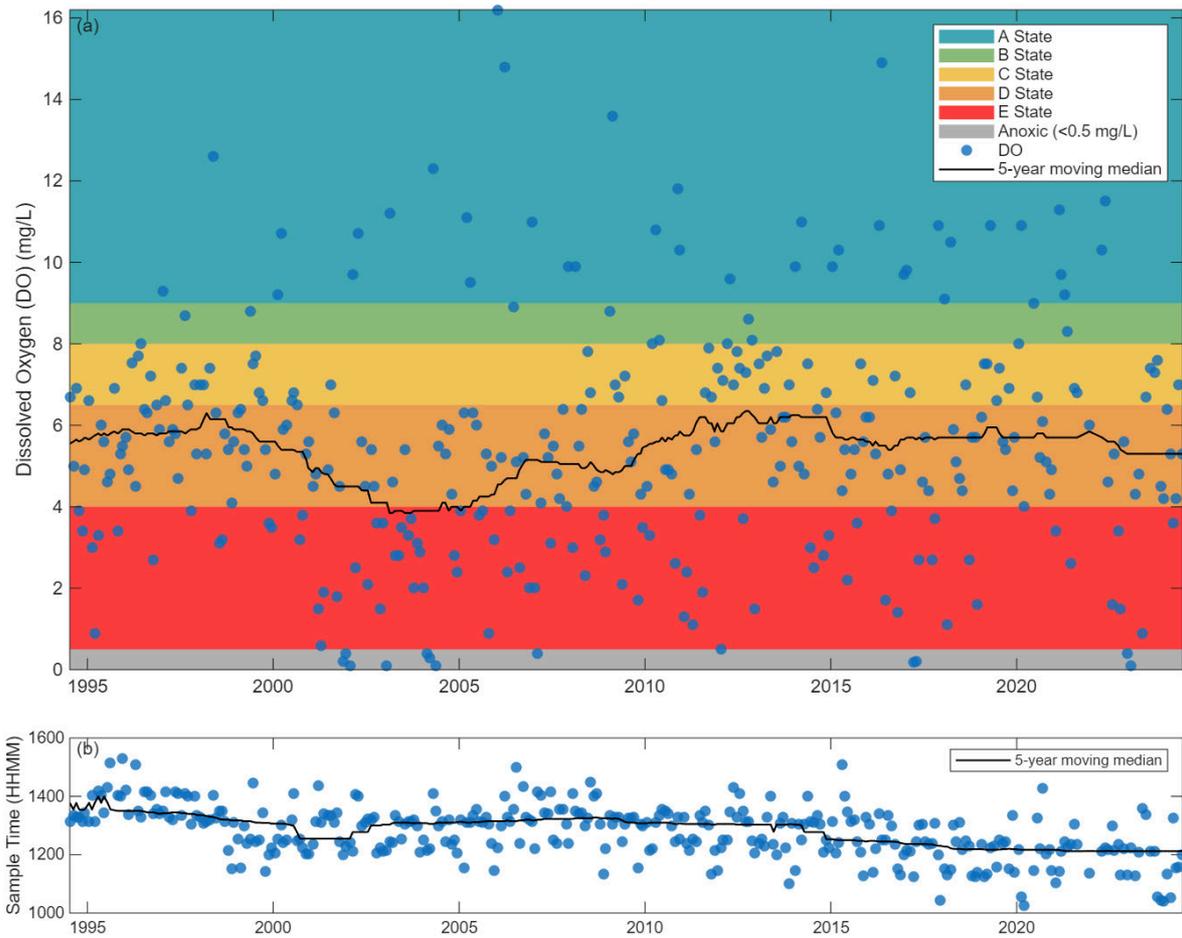


Figure 2D. (a) Dissolved oxygen (DO) concentrations and (b) sampling time at the Whangamarino River, Island Block Road (1994-2024). DO is monitored as discrete (spot) measurements and is presented relative to water quality state ranging from A (good) to E (poor), with an additional band for anoxic conditions (<0.5 mg/L). Sampling time is important as DO varies diurnally.

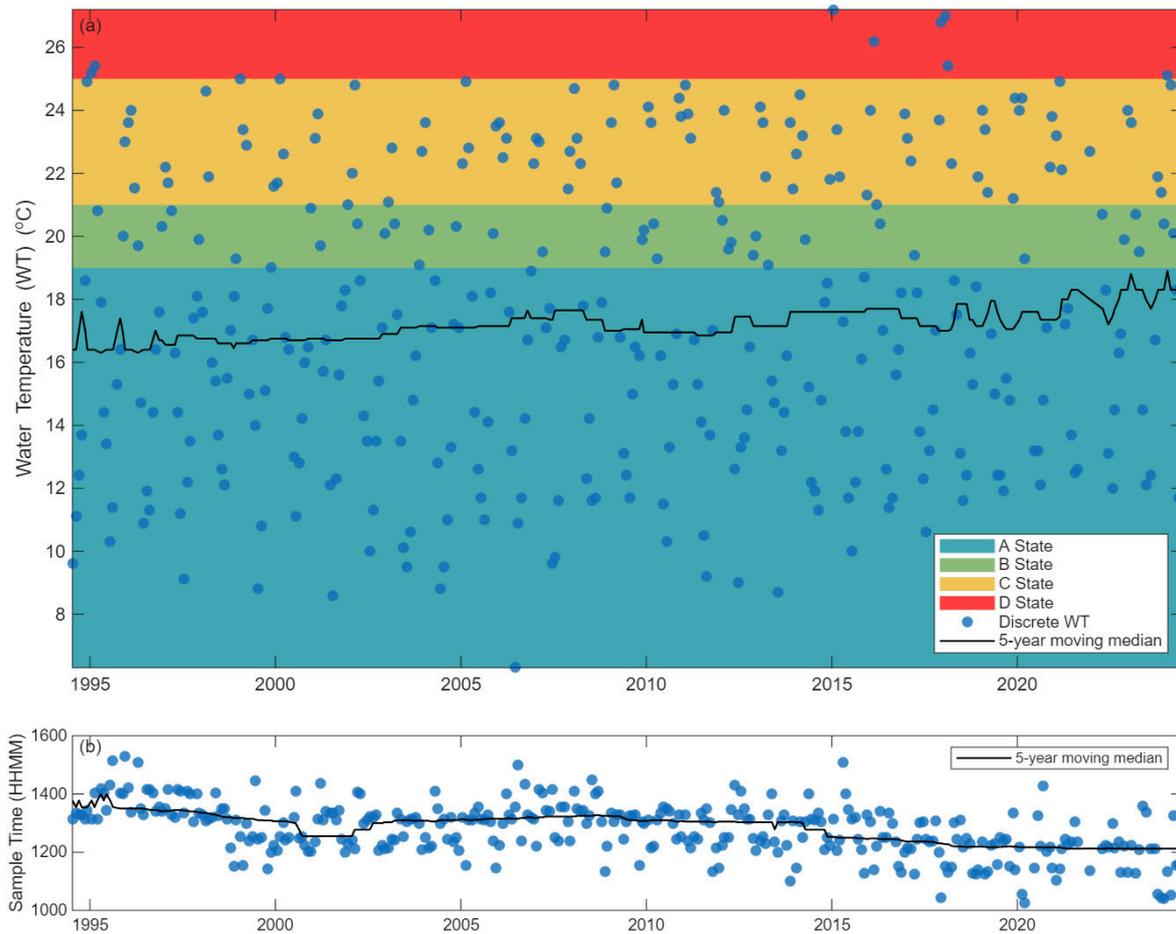


Figure 2E. (a) Water temperature (WT) and (b) sampling times at the Whangamarino River, Island Block Road (1994-2024). WT is monitored as discrete (spot) measurements and is presented relative to water quality state ranging from A (good) to D (poor). Sampling time is important as WT varies diurnally.

3.2.2 Blackwater anoxic (low oxygen) events

A blackwater anoxic event at Whangamarino Wetland occurred during the Summer 2022/2023 period. It resulted in very low levels of dissolved oxygen (<1 mg/L). The anoxic event was associated with a local flood event that contributed increased organic carbon.

Wetlands naturally have a higher probability of anoxia occurring as they are low oxygen environments, however, this is exacerbated by poor water quality, high nutrient and organic matter loading and high temperatures. At Whangamarino Wetland, fish and bird deaths during blackwater events have occurred primarily during La Niña (higher rainfall) when water levels are higher.

While the blackwater anoxia event during 2022/23 had an immediate, acute impact on wildlife (fish and birds), including due to the associated botulism outbreak, it is difficult to conclude whether anoxic events have increased in frequency since Ramsar Site designation. However, it is apparent there is an increased risk of anoxic events within the wetland, due to increased water temperature, periods of high-water levels and elevated nutrient loading. Blackwater anoxia in the rivers of the Whangamarino catchment were also documented in 2010/2011 and 2017 following large rainfall events and flooding.

Ecological character assessment – Water quality

Indicator: Nitrogen concentration

Change: Negative (actual)

Exceeds limit of acceptable change: Yes

A long-term and consistent increase in total nitrogen (TN) and total organic nitrogen (OrgN) concentrations has occurred in Whangamarino Wetland. TN levels within Whangamarino Wetland increased from ~1 mg/L to over 2 mg/L. The recommended TN limit for the wetland is 0.8 mg/L based on the recommended 80-year water quality targets for Whangamarino Wetland for the WRC Healthy Rivers Plan Change. The increase in nitrogen is due to the increase of organic nitrogen (OrgN), including an increase in ammoniacal nitrogen (NH₄-N) since Ramsar Site designation. The contribution of inorganic nitrate to water quality decline is less apparent. Nutrient deposition may be associated with flood events and elevated organic nitrogen due to high algal biomass.

Indicator: Phosphorus concentration (TP)

Change: Uncertain

Exceeds limit of acceptable change: Not applicable

Short term increases (since 2014) of total phosphorus (TP) are recorded, however, there was a decreasing trend since Ramsar Site designation. Further monitoring and reporting of changes in phosphorus levels is recommended. As at the time of designation, TP levels remain considerably higher (0.1–0.3 mg/L) than the recommended TP target for Whangamarino Wetland (0.05 mg/L) indicating phosphorus concentrations are a significant concern.

Indicator: Water temperature

Change: Negative (actual)

Exceeds limit of acceptable change: Uncertain

A long-term decline in water temperature is observed, with minimum water temperature increasing steadily overtime. Increasing water temperature can lead to greater likelihood of blackwater anoxia events. It is uncertain if the change in water temperature exceeds a limit of acceptable change in terms of the ecological character of Whangamarino Wetland.

Indicator: Dissolved oxygen (DO) concentration

Change: Uncertain

Exceeds limit of acceptable change: Not applicable

An increasing trend in DO levels was observed since Ramsar Site designation, however, there is a potential short-term decline (since 2014) that requires further monitoring and assessment. Multiple stressors are involved that contribute to anoxia events, and the severity and duration of low DO events is a concern. Warmer temperatures increase the likelihood of occurrence.

Indicator: Visual clarity

Change: No change

Exceeds limit of acceptable change: Not applicable

No clear trends in visual clarity were observed since Ramsar Site designation. However, observations of water quality typically indicate that water clarity is very low in the Whangamarino River.

What does this mean?

Water quality in the Whangamarino River within the Ramsar Site is poor overall, with nutrient levels (TN, TP) well above the water quality targets recommended for Whangamarino Wetland in the WRC Healthy Rivers Plan Change.

The degraded water quality has been persistent throughout the period of Ramsar Site designation, and in some cases (total nitrogen; water temperature) water quality indicators have declined. Some improvements in water quality were also detected, for example for total phosphorus. High nutrient levels promote dominance of invasive species (flora) in regularly inundated wetland areas (swamp and marsh wetland types). Poor water clarity (<15 cm on average) reduces light penetration (influencing invertebrates and macrophytes), effects native fish functioning and can contribute to disease. Some native wetland birds, including matuku huurepo (Australasian bittern) would struggle to capture fish due to poor water clarity. Low DO, high water levels and warm water temperatures can lead to blackwater anoxia events that increase the chance of botulism outbreaks.

From a Maatauranga Maaori perspective, the Whangamarino Wetland is part of the kidneys of the Waikato river which is considered as a tupuna (ancestor). If the water is polluted, discoloured, or foul smelling, it is a sign that the Whangamarino is unwell. That illness affects not just the environment, but also the spiritual, cultural, and emotional well-being of the people who descends from the river. It weakens the mana (authority), prestige and disconnects whakapapa (genealogy)—especially for rangatahi (youth) who no longer feel a living bond with their wetland.

“Ko te awa ko au, ko au ko te awa”/I am the river and the river is me. Mauri is the life force or vital essence of all living things. When water is clean, flowing naturally, and supports native species like tuna (eel) and kooura (freshwater crayfish), its mauri is considered strong. When contaminated by sediment, farm runoff, waste discharges, or excessive nutrients, that contributes to anoxic events, the mauri is weakened or lost.

The degraded state of water quality in the Whangamarino Wetland exceeds what is acceptable because: tuna and other taonga species are no longer abundant or healthy; the water can no longer be used safely for mahinga kai (food gathering); the water no longer supports spiritual practices like karakia and baptisms; people no longer feel safe or connected to the Whangamarino as they once did. Water quality affects the ability to carry out tikanga (customary) practices. When the water is degraded rahui (protective restrictions) are often placed to avoid spiritual and physical harm; cultural harvesting becomes unsafe or impossible; waananga (intergenerational knowledge transfer) is disrupted because the Whangamarino can no longer be used to teach, heal, or connect mokopuna (descendants) to their heritage.

While these activities were still undertaken by some in the early 1980s, by the mid 1990s (several years after the wetland was designated as a Ramsar Site) all such activities had ceased. Mana whenua are working to reinstate the mauri of the wetland and lake, to be able to see it, touch it, and feel it.

3.3 Sediment deposition

Sediment deposition in Whangamarino Wetland has been monitored on approximately 5-yearly increments by DOC and WRC, primarily to fulfil resource consent monitoring requirements. The monitoring examines sediment deposition within Whangamarino River and Pungarehu Stream and reports on changes in riverbed levels.

3.3.1 Change in sediment deposition

Sediment deposition can contribute to an increase in mean riverbed levels (MBL) and have an impact on water levels due to reduced channel capacity. Changes in sediment deposition patterns for the Whangamarino River and Pungarehu Stream from 2003 to 2020 are presented. Sediment deposition (MBL) increased from 2003 to 2014 but has been relatively stable between 2014 and 2020.

The increase in MBL varied from 0.2 to 1.4 m with greatest increases near to the confluence of Pungarehu Stream with Whangamarino River.

Additional WRC monitoring of sediment deposition for the Pungarehu Canal showed a decline in MBL between 2005 and 2008 (by ~0.03 m), followed by an increase in MBL from 2008 to 2012 (by 0.15–0.2 m). Over the last decade aggradation of Pungarehu Stream/Canal stabilised with MBL surveys oscillating by +/- 5 cm.^{17,18,19}

While sediment deposition within the river and stream areas is stabilising and may reflect a return to baseline conditions, there is insufficient data to confirm a change in ecological character of Whangamarino Wetland.

Furthermore, the wider Whangamarino Wetland remains under pressure from external sediment inputs. A high sediment load to the wetland continues to occur, including episodic inputs of >20,000 tonnes of sediment from upstream waterbodies. A particulate sediment budget for Whangamarino Wetland was estimated for the 2017 year (PDP 2018). This illustrates that Whangamarino Wetland is a sediment deposition basin, with up to 50% of particulate inflows remaining in the wetland. In 2017, nearly 70% of particulate/sediment inflows were attributed to Lake Waikare. Whangamarino River catchment from Waerenga Stream contributed ~20% of the sediment inflows (Figure 3).

The input of sediment from upstream sources was occurring prior to Ramsar Site designation. The Pungarehu Canal that provides a human-made connection between Lake Waikare and the wetland, for instance, was constructed during the 1960s. However, the relatively continuous inputs of sediment from different sub-catchments that have undergone changes in land use represent a negative (likely) change to the ecological character of Whangamarino Wetland that requires further urther investigation. The influence of wetland water level management on sediment deposition also needs further assessment.



Figure 3. Estimated particulate budget for Whangamarino Wetland for 2017.²⁰

¹⁷ WRC. 2015. Resource consent 101727 (Lake Waikare) – Sediment deposition survey results 2015.

¹⁸ HG. 2021. Lower Waikato Scheme Sediment Deposit Report. Prepared for Waikato Regional Council by Harrison Grierson.

¹⁹ Blyth, J.M., Nation, T., & Taylor, G. 2024. Whangamarino Weir – Current Environmental State Assessment: As part of S128 consent review. Prepared for Department of Conservation and Fish and Game.

²⁰ PDP. 2018. Whangamarino Wetland Sediment Monitoring Report. Prepared for Waikato Regional Council.

Ecological character assessment – Sediment deposition

Indicator: Sediment deposition (river channel and wetland)

Change: Negative (likely)

Exceeds limit of acceptable change: Not applicable

Sediment deposition with the Whangamarino River and Pungarehu Stream has increased throughout the period of Ramsar designation, with increases in riverbed (MBL) evident since ~2000. Over the last decade (from ~2012), sediment deposition on riverbeds appears to have stabilised. Ongoing inputs of sediment from different sub-catchments represent a negative (likely) change to the ecological character of Whangamarino Wetland. It is uncertain if the change in sediment deposition exceeds a limit of acceptable change.

What does this mean?

High rates of sediment deposition in river and stream channels can increase risk of anoxic events and reduce capacity of channels, resulting in more regular inundation of low-lying wetland habitats. Excessive sediment inputs also increase sediment transport to Whangamarino Wetland and leading to changes in wetland vegetation (dominance of invasive species) and low water clarity. The increase in riverbed sediment levels may reflect an adjustment back to natural bed levels, although there is insufficient data to confirm.

From a Maatauranga Maaori perspective, sediment is more than a physical issue; it represents a degradation of the mauri (life force) and a disruption to the ancestral relationship between the iwi and their repo (wetland).

Sedimentation accumulation alters the water clarity, thereby impacting its mauri. This degradation affects traditional practices such as mahinga kai (customary food gathering), where species like tuna (eels) and kooura (freshwater crayfish) are less accessible due to habitat changes. The diminished ability to engage in these practices erodes the cultural and spiritual connection to the wetland.

When floodgates artificially block or alter the flow of water, this prevents the Whangamarino Wetland from restoring and flushing itself naturally leading to: accumulation of sediment in unnatural places (e.g., behind floodgates, and within Whangamarino Wetlands). *“The mauri becomes stagnant, and so do the people’s connection”*.

Waikato-Tainui observe increased sedimentation as a tohu (environmental sign) that something is out of balance. Excessive sediment smothers tuna breeding grounds and kooura habitats; displaces native aquatic plants used for weaving and medicine; makes customary harvesting and spiritual practices unsafe or impossible; indicates the loss of ancestral water patterns and disruption of taniwha pathways (spiritual guardians) that move through water; changes the composition of peat soil used for traditionally preserving taonga or accelerate existing preserved taonga decomposition by introducing oxygen and nutrients and microorganisms into the layers of peat.

3.4 Biological components

3.4.1 Change in extent of indigenous wetland vegetation

The extent of indigenous and invasive vegetation types in Whangamarino Wetland has been monitored using remote sensing (aerial photographs) by DOC at regular intervals. Geospatial data on dominant vegetation classes for two time periods are presented, 1963–1993 and 1993–2017 (Table 4). The changes in vegetation extent between 1993 and 2017 align to the period of Ramsar Site designation.

Table 4. Vegetation class area (ha) from 1963 to 2017. Classes <10 ha in size have been removed.

Vegetation Class	1963 Area (ha)	1993 Area (ha)	2017 Area (ha)	Change 1963–1993 (ha)	Change 1993–2017 (ha)
Indigenous dominated					
Peat bog, sedges and rushes	3,395	2,412	2,185	-983	-227
Maanuka	955	1,477	1,238	523	-239
Carex sedgeland	1,263	27	345	-1,236	318
<i>Bolboschoenus</i> reedland	0	0	29	0	29
Kahikatea	13	22	18	8	-4
Raupo reedland	0	0	12	0	12
Exotic dominated					
Grey willow	261	1,306	1,537	1045	231
Seasonal adventives and grasses	192	765	921	573	156
Maanuka with royal fern	0	0	126	0	126
Crack willow	368	843	84	475	-758
Other					
Open water	0	0	153	0	153
Marginal vegetation	149	137	96	-12	-41

Prior to 1993, a significant decline in indigenous wetland was observed (e.g., Carex sedgeland decreased by 1,236 ha) with an associated increase of exotic vegetation (e.g., grey willow).

Since 1993 the rate of loss of indigenous vegetation classes has decreased considerably. Carex sedgeland, which represents one of the naturally dominant vegetation classes in Whangamarino Wetland increased (+318 ha). A reduction in peatland sedges and rushes was observed (-227 ha), although it is difficult to determine if this occurred due to invasion of maanuka with royal fern (+126 ha) or a general increase in Carex sedgeland and seasonal grasses. The decline in peatland sedges and rushes (e.g., *Empodisma robustum*) prior to 1993 was associated with maanuka invasion and increased nutrient deposition and altered water levels.²¹

In terms of exotic vegetation, a significant decline of crack willow has occurred (-758 ha) from 1993 to 2017. Grey willow increased in extent (+231 ha), however the net willow area (grey willow and crack willow) declined by 528 ha.

²¹ Blyth, J., Campbell, D. & Schipper, L. 2012. Utilising soil indicators to explain historical vegetation changes of a peatland subjected to flood inundation. *Ecohydrology* 1247. DOI:10.1002.

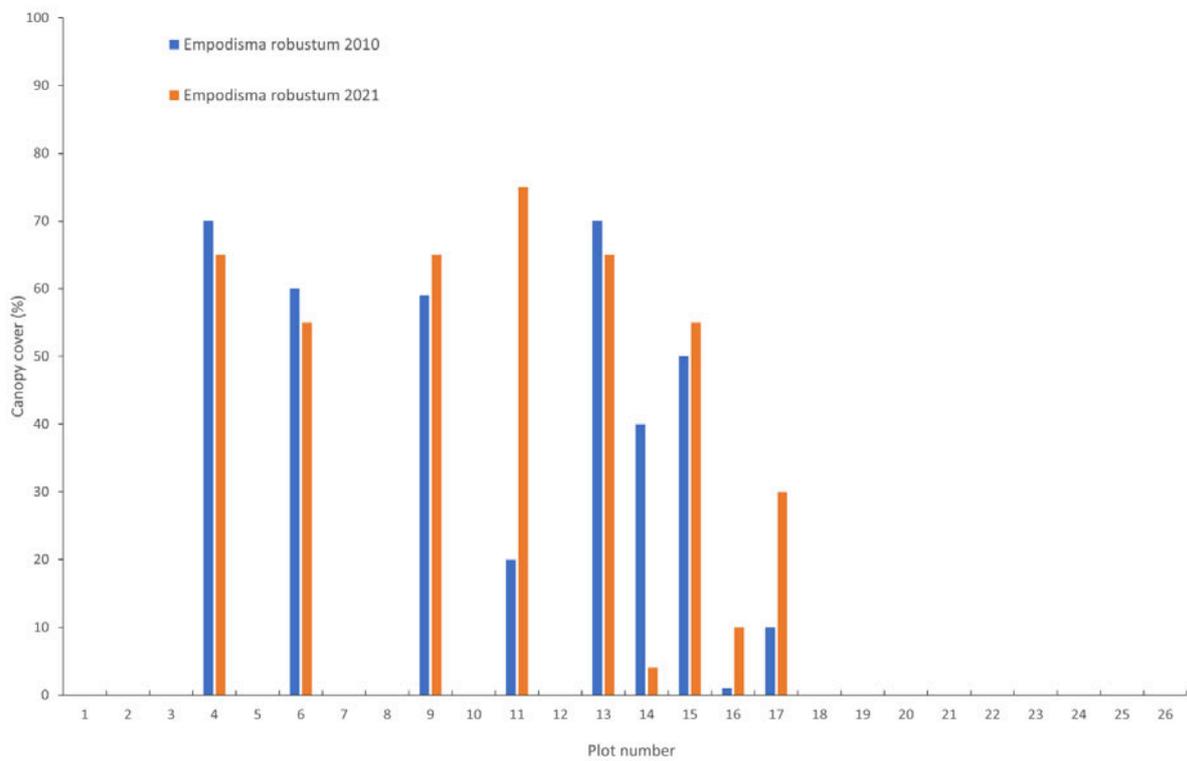
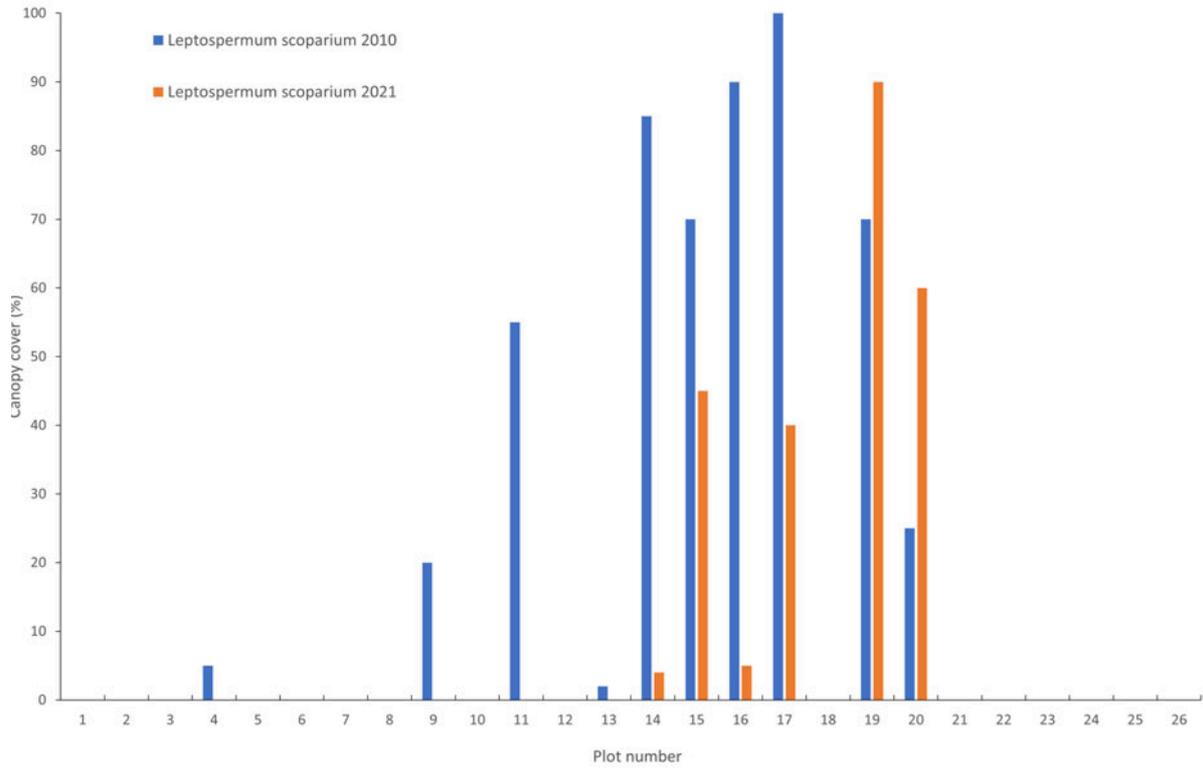


Figure 4. Canopy cover observations for maanuka *Leptospermum scoparium* (a) and wirerush *Empodisma robustum* (b) along a 2.3 km transect line from farmland (plot 1) to Whangamarino River (plot 26).

Since 2000 the restored water levels appear to have had a positive effect. Large areas may be reverting to peat-forming plant communities, with tangle fern (*Gleichenia dicarpa*) and replacing maanuka dominated vegetation.²² However, the long-term ability for natural succession to peatland (restiad-dominated bog vegetation) will depend on other environmental factors. Increased water levels may have also prevented re-establishment of crack willow in marsh habitats where it was controlled between 1999–2008. Vegetation in these areas has changed from crack willow to aquatic vegetation dominated by the native *Persicaria decipiens* and the exotic *Ludwigia peploides* subsp. *montevidensis*.

Vegetation plot monitoring in the southern bog of Whangamarino Wetland through restiad bog and maanuka stands support the observations of recovering sedge and wirerush vegetation and declining maanuka stands. Between 2010 and 2021, maanuka canopy cover increased closer to the Whangamarino River, but declined further into the restiad bog. Wirerush (*Empodisma robustum*) cover appears stable and potentially increasing in some habitats (Figure 4).



Whangamarino Wetland central bog after fire.

²² WRC. 2018a. Internal WRC memo referenced by S128 decision – WRC Doc#13606142.

3.4.2 Habitat loss (human-induced fire)

A large fire (1,039 ha) burnt the central raised bog of the Ramsar Site during October 2024. The fire was human-induced and required an immediate fire response (Figure 5). The area burnt was a relatively intact peatland dominated by wirerush (*Empodisma robustum*) and associated sedges (e.g., *Machaerina* spp.).



Figure 5. Photograph of human-induced fire at Whangamarino Wetland, October 2024.

The fire led to almost complete loss of above ground vegetation with bare ground exposed and few remaining plants. Consequently, the fire caused loss of significant habitat for wetland-dependent and threatened species, including threatened and at-risk bird species (e.g., fernbird). The water table in the burn area was near to the ground surface that meant the loss of soil carbon was limited. The natural (undrained) water table may also enable recovery of wetland vegetation from subsurface propagules not impacted by the fire. However, the vegetation disturbance and exposed soils may enable the establishment of exotic vegetation.



Figure 6. Satellite imagery that indicates the extent (1,039 ha) of the October 2024 fire at Whangamarino Wetland. The fire extent is shown by the green pixels.

Ecological character assessment – Wetland vegetation

Indicator: Extent (ha) of indigenous wetland vegetation

Change: Positive (likely)

Exceeds limit of acceptable change: Not applicable

Indigenous vegetation observed decline prior to designation has slowed or ceased. A reduction in dominant invasive species (particularly willow; -528 ha net) also observed. Maanuka expansion had led to further loss of peatland sedge/rushes (-227 ha) between 1993 and 2017. However, plot monitoring in 2021 observed some recovery of these habitats occurring with wirerush (*Empodisma robustum*) increasing in extent where mature maanuka canopy was declining. Overall, the change in wetland vegetation appears positive (likely) although some exotic plant species are continuing to expand and establish in some habitats.

Indicator: Extent of habitat loss (ha) due to human-induced fire

Change: Negative (actual)

Exceeds limit of acceptable change: Yes

Human-induced fire in October 2024 resulted in the loss of wetland vegetation from 1,039 hectares (ha) of the Ramsar Site. The fire was situated within the central raised bog (peatland) area and burnt most wetland vegetation and led to significant loss of habitat. More than 15% of the Ramsar Site was adversely affected.

What does this mean?

Lowering of wetland water levels prior to Ramsar Site designation resulted in relatively large-scale loss of wetland habitat and shifts in dominant vegetation, with establishment of exotic plant species. Restoring minimum water levels has reduced drainage, promoting wetter habitats that can support indigenous wetland vegetation. Active weed control remains necessary to manage exotic vegetation that affect the ecological character of Whangamarino Wetland.

Ongoing flood inundation of sensitive habitats, and associated transport of sediment and nutrients remains a pressure on wetland plant communities, as exotic species (e.g., introduced grasses) may increase productivity and peat-forming vegetation are adapted to low nutrient conditions.

Human-induced fire leads to rapid loss and degradation of vegetation and significant habitats for wetland-dependent and threatened species. Fires also contribute carbon emissions and may enable the establishment of exotic vegetation.

From a Maatauranga Maaori perspective loss of indigenous vegetation causes erosion of traditional knowledge, passed down through generations, which are closely tied to the presence and health of native flora. The decline of these plants disrupts the transmission of cultural practices and ecological understanding. This also impacts on mahinga kai and provision of native plants such as harakeke (flax), raupo, sedges and manuka, used in traditional weaving baskets and traps for mahinga kai.

Use of wetland vegetation has been integral to specific traditions and practices. For example, manuka was used to make crayfish pots, tuna baskets, paddles, gardening tools, and bird spears. The degradation of vegetation affects the availability of these resources, undermining food sovereignty and cultural rituals. Loss of indigenous vegetation also diminishes kaitiakitanga—the ability to exercise guardianship over the land and waterways which is compromised when the natural indicators and resources that guide stewardship are lost.

Every plant, insect, fish, bird and person descend from a shared lineage ('Ngaa taonga tuku iho - deities') where each species has a role and obligation in the whakapapa (genealogy). The whakapapa of the food web from a Waikato-Tainui perspective is not just about who eats whom—it's a sacred relationship of balance, reciprocity, and mauri (life force). When one element disappears, the whakapapa chain is broken. The loss of indigenous wetland vegetation removes the habitats and breeding grounds for insects, fish and birds. This means that taonga species no longer have a whakapapa place where they cannot 'return home' or complete their life cycles. This breaks the intergenerational access for iwi to engage in the mahinga kai or Rongoa (medicinal practices) and the human role in the food web gets lost as well. *"When raupo is gone, not only the puweto disappears - so does the story of our tupuna who used to harvest here"*.

3.4.3 Change in wetland bird populations (noteworthy species)

The abundance of Nationally Critical matuku huurepo (Australasian bittern) and the At-Risk (Declining) fernbird and puuweto (spotless crane) have been routinely monitored in Whangamarino Wetland by DOC since 2010. This provides detailed information on short-term (2010–2023) population trends. The primary source of baseline information on bird populations is a 1980s survey²³, which reported the wetland had the largest number of breeding Australasian bitterns, and possibly fernbirds, within New Zealand.

Assessment of changes in bird population for this report is limited to those species where adequate data or observations are available, specifically for: Australasian bittern, fernbird, spotless crane and waterfowl (duck) populations. Qualitative evidence is available for waterfowl (mallards) based on harvest counts and field observations, but no quantitative population counts are available. Since designation as a Ramsar Site, the status of wetland bird populations has been variable between species.

Australasian bittern

Whangamarino Wetland has previously been referred to as a national stronghold for bittern. However, the population has been declining nationally over the last 50 years²⁴ and within the wetland. Field observations of booming males provide an indicator of population status. Monitoring records show bittern call counts consistently declining to very low abundance between 2019 and 2022 (Figure 7).

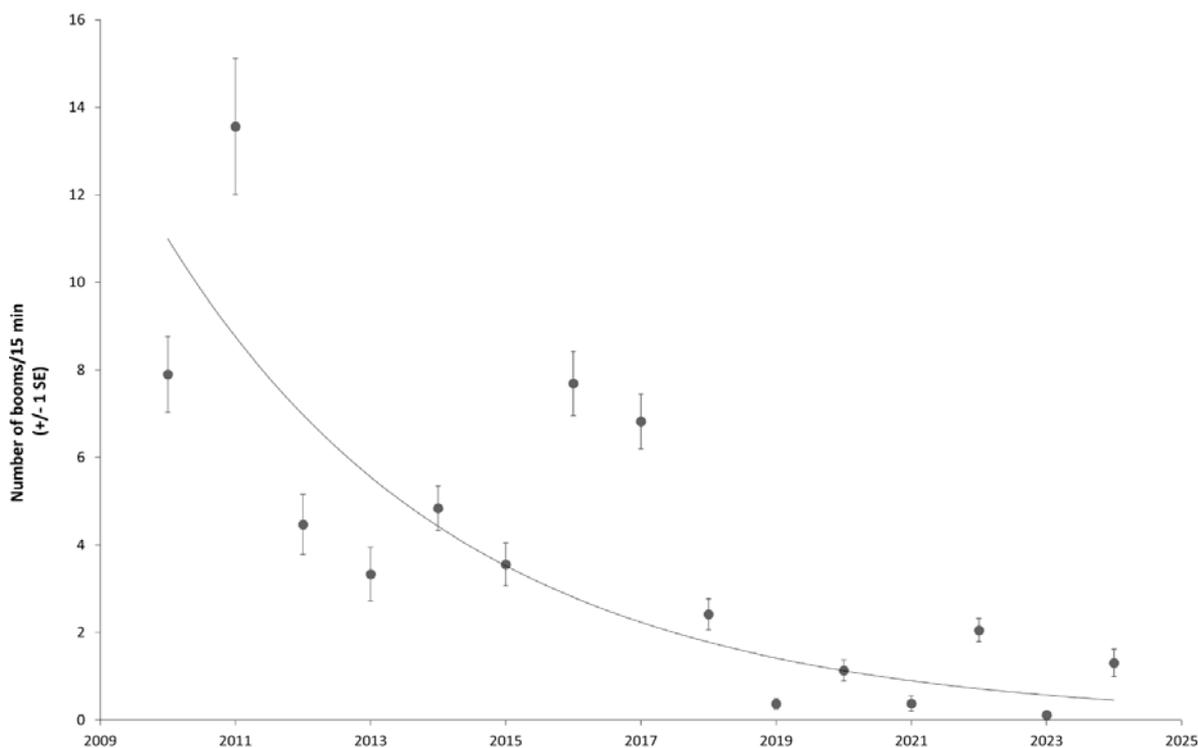


Figure 7. Annual call counts of male bittern at Whangamarino at untrapped stations (under auto recorders protocol) from 2010 to 2022.

The decline in the population of Australasian bittern represents a significant and negative decline in the ecological character of Whangamarino Wetland. The 1981 survey, for comparison, recorded some 145 bitterns in the wetland that far exceeds the current abundance of birds.

²³ Ogle, CC., & Cheyne, J. 1981. The wildlife and wildlife values of the Whangamarino Wetlands. N.Z. Wildlife Service.

²⁴ O'Donnell C.F.J.; Robertson, H.A. 2017. Changes in the status and distribution of Australasian bitterns (*Botaurus poiciloptilus*) in New Zealand, 1800s–2011. *Notornis* 63: 152–166.

Fernbird and spotless crane

Maataataa (fernbird) and puuweto (spotless crane) monitoring stations are situated within both trapped and untrapped areas of Whangamarino Wetland. The call-counts provide an indicator of population status trend, and data from 2013–2023 indicates that pest (mammalian predator) trapping has a positive effect on the abundance of both species, particularly for fernbirds (Figure 8). Spotless crane populations are also higher overall in 2023 than 2013.

Observations from experts involved in fauna and flora surveys in the 1980s and 90s in Whangamarino Wetland, however, advise that spotless crane and fernbird numbers were significantly greater at the point of designation than what is currently present, despite recent trapping success. The 1981 survey recorded a count of 569 fernbirds, and at least 89 spotless crane.

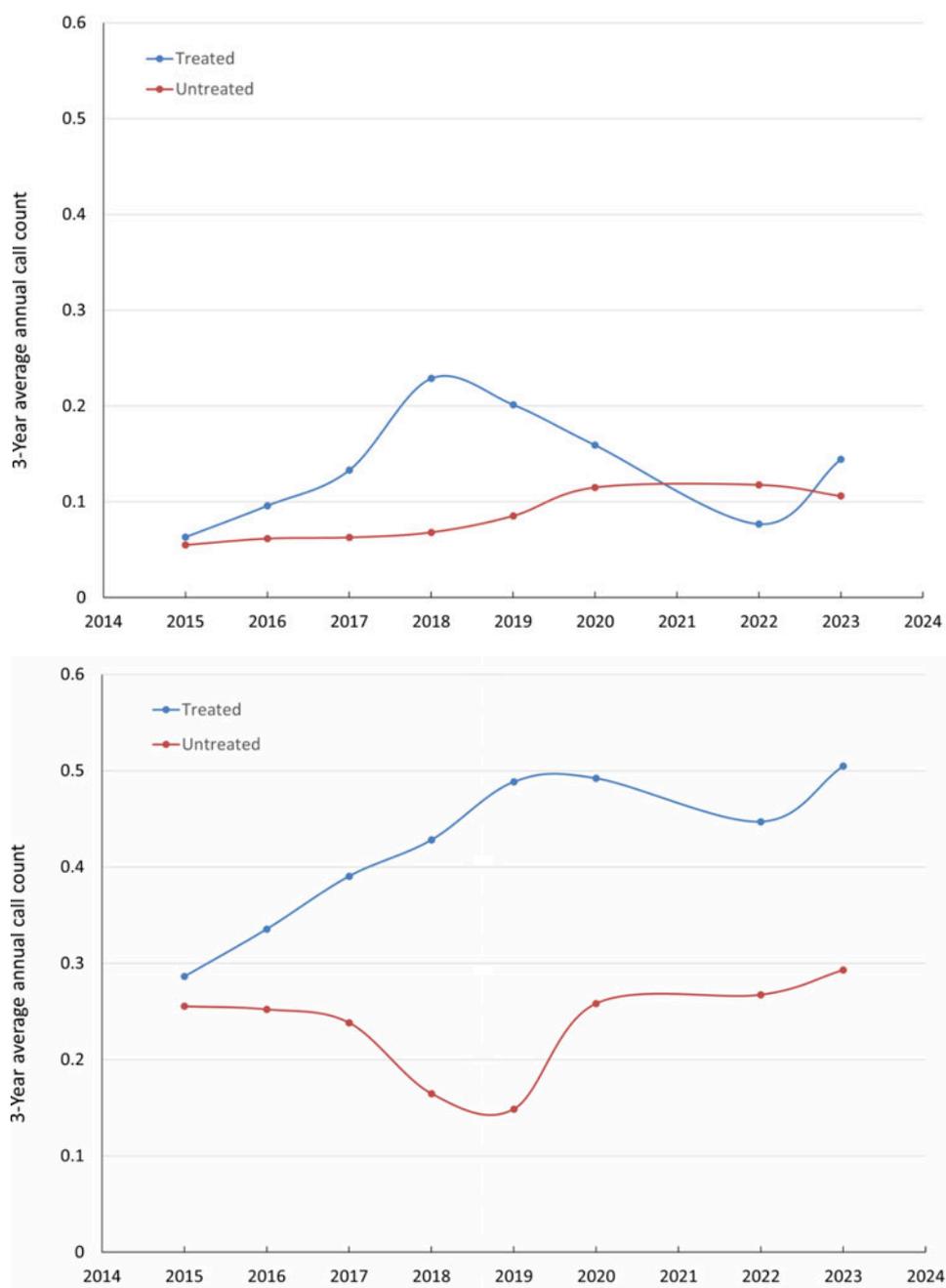


Figure 8. 3-year rolling average call counts for spotless crane (a) and fernbird (b) in trapped and untrapped areas of the wetland. Data period covers 2013 to 2023.

Waterfowl

The 1981 survey of Whangamarino Wetland estimated at least 30,000 waterfowl used the wetland at that time. Recent observations, based on anecdotal reports from Fish and Game staff including harvest and banding counts, indicate the total abundance of waterfowl (c. 2024) is significantly less than at Ramsar Site designation. This decline has been region wide, and populations are variable depending on climatic conditions, with the successive dry years from 2019 not conducive for optimal breeding. Waterfowl populations in Whangamarino Wetland were also affected by blackwater anoxia events in 2022, where >2,000 birds were killed due to avian botulism.

The observed decline represents a negative (likely) change in the Site's ecological character. There is insufficient monitoring data to confirm an 'actual' decline in waterfowl populations.

Ecological character assessment – Wetland bird populations

(noteworthy species)

Indicator: Matuku huurepo (Australasian bittern) population

Change: Negative (actual)

Exceeds limit of acceptable change: Yes

Monitoring since 2010 provides evidence of a persistent decline in Australasian bittern to a record low abundance during the period 2019–2022. Historical survey (1981) and expert observations confirm the abundance of bittern in Whangamarino Wetland was significantly higher during the 1980s/1990s. The decline exceeds the limit of acceptable change given the very low abundance of bittern now recorded and the viability of the population is under critical threat

Indicator: Puuweto (spotless crane)

Change: Negative (likely)

Exceeds limit of acceptable change: Not applicable

The population of spotless crane has increased during the period 2013–2023, which represents a short-term positive change. Expert observations and previous (1981) survey records, however, note spotless crane were significantly greater at the point of designation than what is currently present. Further assessment is required to confirm if this represents a negative (actual) change of ecological character.

Indicator: Maataataa (fernbird)

Change: Negative (likely)

Exceeds limit of acceptable change: Not applicable

The population of fernbird has increased during the period 2013–2023, which represents a short-term positive change. Expert observations and previous (1981) survey records, however, note fernbird were significantly greater at the point of designation than what is currently present. Further assessment is required to confirm if this represents a negative (actual) change of ecological character.

Indicator: Waterfowl (duck) population

Change: Negative (likely)

Exceeds limit of acceptable change: Not applicable

Expert observations indicate the total abundance of waterfowl (c. 2024) is significantly less than at Ramsar Site designation. Waterfowl populations were also affected by blackwater anoxia events in 2022, where >2,000 birds were killed due to avian botulism. There is insufficient monitoring data to confirm an 'actual' decline in waterfowl populations.

What does this mean?

The bird species with a life-history that depends on wetland water levels (i.e., bittern and waterfowl) have recorded significant reduction in their population in Whangamarino Wetland. Both bittern and waterfowl are also vulnerable to poor water quality, due to botulism outbreaks or as they are visual feeders that rely on water clarity. Rapid fluctuations in water levels, or prolonged dry periods, may have an impact on breeding. The abundance of fernbird and spotless crane has also apparently declined since the 1980s and 1990s. Active predator control has supported some population recovery over the past decade.

From a Maatauranga Maaori perspective the loss of indigenous wetland bird populations due to habitat degradation is not simply a matter of biodiversity decline, it represents a deep rupture in whakapapa, kaitiakitanga, spiritual balance, and cultural identity. Wetland birds are more than species, they are messengers, ancestors, guardians, and indicators of mauri (life force). The feathers, bird motifs and associated plants like raupo used for manu (bird) habitats are culturally significant. In the korero tuku iho (oral histories) many of the wetland birds are linked to atua (deities), ancestors, or (narratives) about the creation and identity of place. When birds vanish from the repo (wetland), it signals a spiritual silence of breaking of relationship between ancestors, the land and the people.

The loss of wetland habitat caused by draining, invasive species, altered hydrology and sedimentation contributes towards the displacement or local extinction of taonga manu (sacred birds). The loss of kaitiaki species that hold spiritual roles (e.g., matuku huureo is often seen as a guardian in wetlands), is a sign of collapse of ecological indicators that are used in tikanga (customs). For example, the puuweto was a traditional tohu (sign) for tuna migration and karakia (rituals) to acknowledge new seasons or guide harvesting align with bird calls or return patterns. The matuku haunting call was once a normal sound at dusk in the wetland. Now its absence is a sign that the mauri of the repo is weak. When these birds decline or disappear, it causes the silencing of stories where Tamariki (children) are no longer raised with the sound, sights, or activities that their tupuna experienced. There is also a loss of applied Maatauranga where without these birds, the related knowledge system degenerates. Broken tikanga emerges where the rituals, words and practices that rely on those manu lose purpose or mana. *"The manu were our teachers. Without them, we cannot teach in the way we were taught."*

Loss of manu in the wetland causes loss of sound, movement and wairua. In a living wetland, birds sing, flap, soar, dive, nest and dance. They fill the space with sound, vibration and presence. From a Waikato-Tainui worldview sound is spiritual as birdsong awakens the mauri of a place. The movement is vitality where birds flying and interacting with water are signs of environmental health; stillness or silence is a tohu: where a quiet repo is not peaceful and it becomes wairua-pouri (spiritually dark or sad). When wetland birds disappear, the wetland becomes spiritually mute. There's no karanga (calling) of puuweto, no matuku that cries at dusk; the place feels tapu (sacredly disturbed) like a marae without people, or a whare without breath. The connection to ancestors and atua is severed. Manu are often seen as a kaitiaki or spiritual messengers and their absence is more than physical loss; it's a relational loss. *"A repo with no birds is like a house with no soul."*

From a Waikato-Tainui perspective, the threshold is spiritual and cultural as much as ecological. The change is considered unacceptable when manu no longer return with the seasons thus disrupting maramataka cycles and people no longer feel spiritually safe to enter the repo. Rituals and customs can no longer be performed properly and tamariki cannot name or imitate the birds that their ancestors knew.

The limit of acceptable change for wetland bird populations is surpassed not when numbers hit zero, but when the meaning, memory, and mana associated with a species is extinguished. A single manu may remain, but if its song is no longer recognised or used, the cultural extinction has already occurred. Even before the last bird is gone, the ability to connect to it may already be lost.

3.4.4 Change in fish populations

Native freshwater fish population (abundance)

Limited monitoring or published records of fish populations within Whangamarino Wetland are available prior to Ramsar Site designation, and over the subsequent 34 years. A comprehensive fish survey was undertaken in 2007/2008²⁵ that describes the diversity of native and exotic fish species, however no data on population trends is available to confirm changes in ecological character.

The previous fish survey identified 14 different species including banded kookopu, common bullies, black mudfish, tuna (eels) and introduced species (such as koi carp). Prior to 2001, lower water levels (Figure 1) would have restricted habitat to river channel and tributaries and limited overall fish abundance. Increase in minimum water levels since 2001, inundated more wetland habitat for fish, likely resulting in abundance increases of both native and introduced species.

Prior to Ramsar Site designation (the period 1980–1993), there was <37 ha of suitable fish habitat with water depths >7 cm for 75% of time. Since water levels increased, the suitable fish habitat increased to ~1,215 ha.²⁶ The extent of fish habitat is not a direct indicator of freshwater fish populations and therefore the change in ecological character is uncertain.

Tuna (eel) population

Tuna populations (shortfin and longfin eel) were historically a significant resource to iwi at Whangamarino Wetland. Mass migration events (heke) occurred during floods, particularly between the Lake Waikare and Whangamarino Wetland prior to the Pungarehu Canal being constructed (prior to 1960s).

Reports of local community, suggest tuna fishery catch rates and volumes around Whangamarino and Lake Waikare have declined since Ramsar Site designation. Maatauranga Maaori identifies the effect of poor water quality and flood scheme infrastructure on tuna migration and health, for example, tuna were unable to migrate through Whangamarino Wetland due to the installation of the flood control gates, in particular prior to construction of the fish bypass at Lake Waikare. The records of declining tuna abundance align with information on the tuna fishery Catch Per Unit Effort (CPUE) for the 1970s and 1980s, which declined from 6.5 kg per net in 1977–78 to 1.4 kg per net in 1983–84²⁷ or the Lake Waikare/Whangamarino area. Although the information is for a period prior to the Ramsar Site designation (1989), it highlights the pressures on the tuna fishery.

Koi carp abundance

There is limited monitoring or published records of koi carp populations, an invasive fish species, within Whangamarino Wetland, except for the preliminary survey of 2007/08²⁸ and from Waikato University regional assessment (Hicks 2007). The koi carp biomass reported at Whangamarino Wetland during ~2005 was 594 kg per hectare. Koi carp were likely to be present in the wetland at designation however their abundance is observed to have increased since 1989. It was noted that the size-frequency distribution of koi carp suggests that they were still increasing in abundance in the Waikato.²⁹ The increase of inundated wetland habitat has also provided more habitat for freshwater fish. Consequently, a negative change in ecological character is 'likely' in terms of the koi carp population.

²⁵ Lake et al. 2011

²⁶ Blyth, J.M., Nation, T., & Taylor, G. 2024. Whangamarino Weir – Current Environmental State Assessment: As part of S128 consent review. Prepared for Department of Conservation and Fish and Game.

²⁷ McLea, M.C. (1986). Ohinewai regional resource study – Biological and water quality. Waikato Valley Authority Technical Publication No. 37.

²⁸ Lake, M., Brijis, J., & Hicks, B. J. 2011. Fish Survey of the Whangamarino Wetland 2007/2008. Prepared for the Department of Conservation, Waikato Area Office.

²⁹ Hicks, B. J. 2007. How many koi? Preliminary estimates of koi carp abundance from boat electrofishing. CBER Contract Report No. 59. Centre for Biodiversity and Ecology Research, The University of Waikato, Hamilton, New Zealand. 18 pp.

Ecological character assessment – Fish population

Indicator: Native freshwater fish population (abundance)

Change: Uncertain

Exceeds limit of acceptable change: Not applicable

Due to limited monitoring of fish populations, it is uncertain whether there has been an increase or decrease in native freshwater fish population. It is likely that since designation, changes to water levels have increased fish habitat for both native and invasive species.

Indicator: Tuna (shortfin and longfin eel) population (abundance)

Change: Negative (likely)

Exceeds limit of acceptable change: Not applicable

Tuna fishery catch rates and volumes around Whangamarino and Lake Waikare are likely to have declined since Ramsar Site designation. No published information to confirm an ‘actual’ change in tuna populations.

Indicator: Koi carp abundance

Change: Negative (likely)

Exceeds limit of acceptable change: Not applicable

Koi carp were likely to be present in the wetland at designation however their abundance is observed to have increased since 1989. Due to limited monitoring or published records of koi carp populations it is not possible to determine if this represents an ‘actual’ change in ecological character.

What does this mean?

The extensive wetland habitat at Whangamarino Wetland supports a range of freshwater fish species and it previously supported a significant tuna (shortfin and longfin eel) fishery. It is not possible to report accurately on the status and trend of fish populations due to the lack of monitoring data. However, it is known that poor water quality can affect certain fish species (e.g., banded kookopu) and barriers to migration and modified water levels may have influenced the tuna fishery.

From a Maatauranga Maaori perspective, the potential decline in indigenous fish populations such as tuna (longfin eel), iinanga (whitebait), paatiki (flounder), and kooura (freshwater crayfish) due to habitat loss is not merely a biological concern. It represents a collapse in whakapapa-based relationships, a breach of cultural obligations, and a spiritual and ecological imbalance that directly impacts the mana, mauri and tikanga of the people and the wetland.

Fish are whakapapa, not just resources in te ao Maaori (Maaori worldview), they are considered taonga with ancestral lineage descending from Tangaroa, the atua (guardian) of the oceans and waterways. Tuna for instance, is considered a kaitiaki and a spiritual traveller who connects generations through ritual, sustenance, and story.

Each fish species is woven into the whakapapa of the people and place and their presence affirms the mauri (life force) of the river and the Whangamarino Wetland, and their migration cycles are aligned with maramataka (Maaori luna calendar), guiding harvest times and ceremonies. *“When we see our tuna healthy, we know that our river and wetland are healthy. When they’re gone, something deeper is broken.”*

Prior to changes in land use and the development of the flood protection scheme, before the designation of the Ramsar Site, mana whenua harvested and traded vast quantities of tuna during flood events and were able to catch kanae (mullet) for kai (food). From this time on there a steady decline in the tuna migration and kanae population

has been observed. While it is difficult to quantify the changes observed since 1989, mana whenua have observed an increase in koi carp (over catfish, perch, kanae (mullet) and tuna). Kanae (mullet), as of the 1990 to early 2000s, appear to be locally extinct from Whangamarino and Lake Waikare. Whitebait was also traditionally caught when in season, while the adult fish were not utilised to any great extent. However, this activity has all but ceased in the Whangamarino Wetland since the early 1990s for mana whenua.

The limit of acceptable change from a Maatauranga Maaori perspective is not defined by minimum viable populations, it is defined by cultural disconnection. This threshold has already been breached within the Whangamarino Wetland, including prior to Ramsar Site designation. “*When we place our hiinaki in the water and pull up nothing, we don’t just lose food, we lose the Maatauranga that goes with it.*”³⁰ The inability to gather kai from the Whangamarino Wetland is a direct threat to mana Motuhake (self-determination) and mana whenua (customary authority) over land and water. Mahinga kai practices are embedded in waananga, manaakitanga, and the exercise of rangatiratanga. Without accessible, safe fish populations, iwi become dependent on store-bought food thus leading to cultural, physical, and spiritual malnourishment. The ceremony of giving and hosting with river and wetland kai is weakened, affecting identity, obligations and mana.



Tuna (longfin eel) (© EOS Ecology)

³⁰ Oral interviews and gathered knowledge from Maatauranga knowledge holders of Waikato Tainui.

3.5 Changes in the ecosystem services (benefits and uses) provided by the Whangamarino for mana whenua

This section summarises changes to ecosystem services, benefits and uses provided by the Whangamarino for mana whenua. It is the view of mana whenua that the ecosystem services of the wetland have declined since 1989, although this decline began before Ramsar Site designation.

According to Maatauranga, the water regime of the Whangamarino has significantly transformed since Indigenous peoples first settled around the wetland. Prior to European contact, the labyrinth of Whangamarino watercourses were connected to the upper Maramarua River and the headwaters of the Hapuakohe to Rataroa maunga and the Hunua ranges that physically separate Waikato and Hauraki and into the Waitakaruru River and Tikapa moana. Much of the Waikato River, is now confined to a single river channel. Previously during the annual wet season, the river would flood the waters of Whangamarino Wetland providing connections to the Taniwha (chiefs) and supporting the reliance on those water bodies and the rivers that interconnected them.

Prior to and during early European settlement in Aotearoa, Waikato Tainui iwi utilised all waterways of the Whangamarino catchment for kai, rongoa, transportation and trade. These activities continued for many years and during what is referred to as the golden years of Maaori commerce, in the mid 1800s, these watercourses aided Iwi and hapuu to actively participate in the trade with the fledgling settlements of Auckland, Sydney and further afield. A centrally organised collective of Waikato based hapuu grew produce that was delivered to collection points along the Waikato River and transported to Manukau harbour, a significant logistical undertaking. This Waikato pan-hapuu commercial activity of that period was a remarkable achievement of mutually beneficial communal ownership under Pootatau Te Wherowhero who was a Waikato Tainui chief and became the first Maaori King in 1858. The Waikato River, Lake Waikare and Whangamarino played a vital role in the production and logistical trade and transportation of that commerce and sustained the livelihoods of Waikato Tainui. Much of Waikato Tainui's connections to and utilization of the Whangamarino were lost long before the designation of the Whangamarino as a Ramsar Site of international importance.

Prior to the 1960s, the Whangamarino provided Waikato Tainui with much needed textiles and rongoa (medicinal herbs). With the continually changing land use, drainage and nutrient inputs in the Whangamarino catchment, the use of the waterways by Waikato Tainui as a mahinga kai (food) source has significantly diminished. The taonga fish species have also been replaced almost completely by introduced invasive species.

Lake Waikare and Whangamarino were considered the puna spawning grounds of the taonga species inanga, matamata, piharau (whitebait) that sustained the once thriving fisheries of the lower Waikato. Mana whenua have observed a likely decline in the abundance of taonga species since 1989.

The declining ecosystem has impacted the cultural ecosystem services for Waikato Tainui's pathways for intergenerational learning. Whangamarino was previously a critical place for Maaori learning and astrology. Whare waananga (ancient universities of higher learning) were scattered across the region where ancient theology, rites, rituals and practises were preserved and taught. Several marae (meeting houses) carry the evidence of this learning where a prominent marae, Matai Whetu—matai means to study observe—and whetu means star constellations. Adjacent to that sacred site is Koopu—Venus, west of that is Koopu-arahi Venus leading the constellation across the heavens. Further west in a straight line across Whangamarino Wetland to the banks of the Waikato River is Meremere, Meremere Tuu Ahiahi—Venus on the descent. There are other such places that have celestial astrological and astronomical relevance for the Indigenous people, for example Pungarehu a river in Whangamarino is an abbreviated reference to recitals in ancient oratory as Te Puu Tahitanga o Rehua—Antares. Maramarahi the full moon near the ancient Te Totara Paa site just south of Thames to Maramarua east of Whangamarino is possibly a reference to an eclipse or the reflection of the moon on the tranquil waters of Whangamarino and Marama Tuu Tahu, the moon that stands alone is a place near the Tauhei area, and is also the name of a Ngati Wairere tuupuna—ancestor.

From an ecosystem services provisioning perspective, the Whangamarino once offered abundant kai including tuna, kooura, iinanga, paatiki, and waterfowl. These resources were integral to manakitanga, ceremonial practices and intergenerational knowledge transmission. This abundance has sharply declined, and continued since Ramsar Site designation in 1989. Fish and bird populations have decreased, traditional harvesting areas have become inaccessible or unproductive, and there is evidence of

bioaccumulated pollutants in food species. The hiinaki (eel trap) returns empty, a tohu that the mauri of the wetland is depleted. The taste, texture, and health of kai are compromised, and with this comes a breach in tikanga. This change signifies more than loss of food; it represents a disruption of relationships, a disconnection from whenua and the collapse of cultural integrity.

Supporting services have also deteriorated. Taniwha—protective spiritual beings representing ecological guardianship—are absent, a tohu of environmental distress. Indigenous vegetation decline and invasive species encroachment have undermined habitat integrity, representing disruption in whakapapa.

The loss of cultural ecosystem services is perhaps most profound. For Waikato-Tainui, the Whangamarino functioned as a living waananga—a space of teaching, ceremony, and spiritual renewal deeply interwoven into whakapapa. The loss of bird sound, decline of matuku-huurepo, and diminishing taonga species represent silence in the ancestral narrative. This disappearance of spiritual tohu where seasonal indicators like manu (bird) calls or plant bloomings means that ceremonies cannot be held in their proper context. The wairua of the repo is assessed by kaumaatua and kaitiaki as heavy, disoriented, and disconnected—especially following the October 2024 peat fires which destroyed over 1,000 hectares of raised bog. The inability to conduct karakia, harvest during specific moon phases, and engage in traditional education has transformed Whangamarino from a source of life to a site of cultural mourning.

Ecological character assessment – Ecosystem services, benefits and uses recognised by mana whenua

Indicator: Change in the ecosystem benefits and uses recognised by mana whenua

Change: Negative (actual)

Exceeds limit of acceptable change: Yes

Mana whenua report a significant and ongoing decline in the ecosystem services of the Whangamarino Wetland since 1989, with impacts deeply felt across provisioning, supporting, and cultural domains. Once a thriving source of kai and cultural practice, the wetland is now a place of ecological and spiritual degradation—evidenced by declining taonga species, polluted food sources, and the disruption of tikanga. Traditional indicators such as empty hiinaki, altered taste and texture of kai, and the absence of tohu like bird calls and seasonal blooms reflect a loss of mauri and cultural integrity. Supporting services have also deteriorated due to hydrological modifications and habitat fragmentation, undermining both natural functions and ancestral relationships with the repo. The wetland’s role as a waahi waananga—a place of learning, ceremony, and renewal—has been compromised, with the loss of spiritual and cultural markers rendering many practices impossible.



Sediment deposition in Whangamarino Wetland

4. Synthesis

4.1 Assessment of changes in the ecological character of Whangamarino Wetland

This report is prepared to comply with New Zealand's obligations under the Convention on Wetlands to report on any actual, or likely, changes in the ecological character of Whangamarino Wetland. It describes the state and trend of critical components of the wetland's ecological and cultural values, where sufficient data or information exists. For each indicator, the assessment describes whether the change in ecological character for the wetland is:

- positive, negative, uncertain (or no change)
- an actual or likely change
- beyond a limit of acceptable change (i.e., what is considered acceptable to maintain and healthy and functioning wetland ecosystem, relative to the state of Whangamarino Wetland at designation date (December 1989).

A total of 18 indicators were evaluated as part of the assessment of ecological character. Based on available data and information, it is determined that 12 out of 18 indicators have declined, that is evidence reveals a 'likely' or 'actual' negative change in ecological character (Table 5). There is adequate information to confirm an 'actual' decline for four indicators, specifically: Water quality – Nitrogen, Water quality – Temperature, Wetland vegetation – Habitat loss, the bird population of matuku (Australasian bittern) and ecosystem services especially provisioning and cultural services/benefits and uses recognised by mana whenua.

A significant decline in ecological character, beyond the limit of acceptable change is confirmed for **Water-quality – Nitrogen, Wetland vegetation – Habitat loss**, the population of **matuku (Australasian bittern)** and **ecosystem services** especially provisioning and cultural services/benefits and uses **recognised by mana whenua** (Table 5), that is:

- The levels of nitrogen measured in Whangamarino River have deteriorated substantially since Ramsar Site designation (Figure 2A) and greatly exceed the recommended water quality target for the wetland (<0.8 mg/L).
- Human-induced fire in October 2024 resulted in the loss of wetland vegetation from 1,039 hectares (ha) of the Whangamarino Ramsar Site. The fire was situated within the central raised bog (peatland) area of the wetland and burnt most wetland vegetation. More than 15% of the Ramsar Site was adversely affected.
- The population of Australasian bittern within the wetland has decreased significantly, with near record low levels of bittern for the period 2019–2022 (Figure 7). Historical survey (1981) and expert observations confirm the abundance of bittern was substantially higher during the 1980s/1990s. The decline exceeds the limit of acceptable change given the very low abundance of bittern now recorded and the viability of the population is under critical threat.
- Mana whenua report significant and ongoing decline in the Whangamarino Wetland's ecosystem services since 1989, with impacts across provisioning, supporting, and cultural services/benefits evidenced by declining taonga species, empty hiinaki (traps), absence of seasonal tohu (indicators), and loss of mauri (life force). This degradation has transformed the wetland from a thriving source of kai (food) and waahi waananga (learning) into a site of ecological and cultural mourning, undermining whakapapa (ancestral relationships) with the repo (wetland).

The blackwater anoxia events of 2022/2023 had an acute and immediate effect on the ecological character of Whangamarino Wetland. The low dissolved oxygen levels contributed to a botulism outbreak that caused widespread mortality of waterfowl, and freshwater fish. While low anoxic events can occur naturally in wetland ecosystems, the events are exacerbated by external inputs of nutrients and organic matter and higher water temperatures. It is difficult to conclude whether anoxic events have increased in frequency

since Ramsar Site designation. It is apparent, however, that there is an increased risk of anoxic events within the wetland, due to increased water temperature and elevated nutrient loading. Similarly, the human-induced fire of October 2024 also had an immediate and negative effect on the ecological character of the wetland.

Drawing on the evidence and knowledge above, it is concluded that there has been a negative change to the ecological character of the Whangamarino Wetland.

Table 5. Summary of ecological character assessment for Whangamarino Wetland.

Ecological Character component	Change Ecological Character	Actual or likely change	Exceeds limit of acceptable change
Hydrology - Minimum water level	Positive	Actual	-
Hydrology - Flood frequency	Negative	Likely	-
Water quality - Nitrogen	Negative	Actual	Yes
Water quality - Phosphorus	Uncertain	-	-
Water quality - Temperature	Negative	Actual	Uncertain
Water quality - Dissolved oxygen	Uncertain	-	-
Water quality - Clarity	Uncertain	-	-
Sediment deposition	Negative	Likely	-
Wetland vegetation - Indigenous dominance (extent)	Positive	Likely	-
Wetland vegetation - Habitat loss (fire)	Negative	Actual	Yes
Bird populations - Australasian bittern	Negative	Actual	Yes
Bird populations - Spotless crane	Negative	Likely	-
Bird populations - Fernbird	Negative	Likely	-
Bird populations - Waterfowl	Negative	Likely	-
Fish populations - Native fish	Uncertain	-	-
Fish populations - Tuna fishery	Negative	Likely	-
Fish populations - Koi carp (invasive)	Negative	Likely	-
Ecosystem services recognised by mana whenua	Negative	Actual	Yes

4.2 Future management and wetland recovery

This report establishes whether or not ecological character change has occurred at the Whangamarino Wetland Ramsar Site. A separate process led by Waikato Regional Council is developing a response plan to address future management and wetland recovery recommendations. This section provides brief insights from this assessment that may inform that process.

The assessment of changes in the ecological character of the Whangamarino Wetland identified a concerning decline of threatened species (matuku (Australasian bittern)), water quality (elevated nitrogen), habitat loss and loss of ecosystem, particularly cultural services for mana whenua. These represent major shifts in ecological character, beyond a limit of acceptable change. Negative trends are also likely to be occurring in terms of sedimentation, flood frequency, water temperature, fish populations (e.g., tuna) and other wetland birds and waterfowl.

Given the observed change in ecological character, there is an expectation to take steps to maintain or restore the ecological character of the Ramsar Site and to report on any measures that have been put in place to the Convention on Wetlands. The Secretariat of the Convention has requested New Zealand, as resources allow, to fully assess the threats affecting the ecological character of the Ramsar Site, establish a mitigation plan, and update the Convention annually, until such time that the Site's ecological character is judged by New Zealand to no longer be threatened.

The restoration of the wetland's ecological and cultural values will require a coordinated and long-term approach to halt the further decline and restore this nationally and internationally significant wetland. Te Ture Whaimana o Te Āwa o Waikato/The Vision and Strategy for the Waikato River calls for action to restore and protect the health and well-being of the Waikato River and its catchment. The Department of Conservation under the Arawai Kākāriki wetland restoration programme³¹ and Waikato Regional Council through its Healthy Rivers Plan³² and other catchment programmes have ongoing initiatives to improve management of the Whangamarino Wetland. Maintaining prioritisation of this work remains important.

The main drivers of the ecological character of Whangamarino relate to the wetland's hydrological regime (water levels, flows), water quality (particularly nutrients and sediment), habitat disturbance (particularly fire) and invasive species (pest plants and animals). These drivers are influenced both directly and indirectly by land use and water management in the surrounding catchments. For example, the status of water quality in lakes and rivers upstream of Whangamarino have a direct influence on water quality within the wetland. Climate projections for the Waikato region predict that over the next 40–80 years temperature will increase, and rainfall will decrease³³. Climate change may further exacerbate the pressures on Whangamarino Wetland, such as increased risk of peatland fire due to a dry environment.

³¹ See: <https://www.doc.govt.nz/our-work/freshwater-restoration/arawai-kakariki-wetland-restoration/sites/whangamarino/>

³² See: <https://www.waikatoregion.govt.nz/council/policy-and-plans/healthy-rivers-plan-for-change/>

³³ See: <https://environment.govt.nz/facts-and-science/climate-change/climate-change-projections/climate-projections-summary-dashboard/>

To be effective, it is recommended the response strategy for Whangamarino Wetland is focused on addressing the components of ecological character that are in decline, as outlined in Table 5. Coordinated and targeted restoration action will be important, including scoping of mitigation options likely to make a meaningful difference in both the short-term and long-term health of the Ramsar Site.

Recognising that implementation of management recommendations will need to be considered within the context and priorities of wider agency conservation programmes, the key activities to restore the ecological character of Whangamarino Wetland include:

- **Water quality:** Review the catchment management plan to improve water quality in Whangamarino Wetland and implement priority actions to address poor water quality in upstream lake and river-catchments.
- **Fire:** Reduce the risk of human-induced fire by improving fire management procedures and rules.
- **Hydrology:** Improve that management of water levels to protect threatened species (i.e., Australasian bittern) and sensitive wetland habitats. This may require a review of water management infrastructure.
- **Invasive species:** Increase available resources to control of pest plants and animals that have significant impact on wetland habitats and taonga (threatened) species.

Given the profound significance of Whangamarino to mana whenua, alongside their rights and responsibilities under the Waikato River Act and related instruments, future processes must be meaningfully inclusive of mana whenua. Building upon the valuable integration of Maatauranga Maaori with other scientific information in this report and principles from the Convention on Wetlands.

The integrated assessment has demonstrated that the ecological character of this wetland has declined. However, it is Maatauranga Maaori that illuminates the deeper narrative—the connections and meaning that a place holds for Maaori but which can also resonate with non-Maaori alike. Effective management renewal requires that all actors can connect meaningfully with deteriorating ecosystems and embrace responsibility for their care. Maatauranga Maaori can provide this essential bridge, fostering the cultural and emotional connection necessary to inspire collective action to reverse environmental decline³⁴. The restoration of this internationally significant wetland requires collaborative commitment from all actors within the wetland catchment to revive both the ecology and mauri of Whangamarino.

³⁴ R Moynihan Magsig, 'Advancing High Seas Area-Based Management in the South Pacific: Reconciling Regional Fisheries Management with the BBNJ Agreement and Indigenous Approaches' in *International Journal of Coastal and Marine Law* (Forthcoming 2026).

Appendix 1:

Glossary of Maaori terms

Maaori term	English meaning
Aotearoa	New Zealand
Atua	Ancestral deity or spiritual being
Awa	River
Hapuu	Sub-tribe of a tribe
Hiinaki	Traditional eel trap
Huringa tau	Seasonal changes
Iinanga heke	Whitebait migration
Iwi	Tribe or tribal group
Kai	Food
Kaitiaki	Generational Indigenous peoples as guardian or caretaker of people, places and taonga
Kaitiakitanga	Practice of guardianship and environmental stewardship
Kaakahi	Freshwater mussel
Karakia	Prayer or incantation for spiritual guidance and protection
Kooura	Freshwater crayfish
Koorero tuku iho	Intergenerational narratives of place
Mahinga kai	Customary food gathering practices and places
Mana	Prestige, spiritual power, authority
Manaakitanga	Hospitality, generosity, and support for others
Mana motuhake	Autonomy, independence, self-determination
Mana whakahaere	Authority and responsibility for decision-making, particularly over natural resources
Maramataka	Maaori luna calendar guiding planting, harvesting, and environmental rituals
Mauri	Life force present in all living and non-living things
Maatauranga Maaori	Maaori knowledge system incorporating spiritual, ecological, and empirical knowledge
Matuku-huurepo	Australasian bittern, a wetland bird and taonga species
Mokopuna	Grandchildren or future generations
Ngaa taonga tuku iho	Treasures handed down by ancestors; includes language, land, practices
Paatiki	Flounder, a culturally important fish species
Papatuuuanuku	Earth mother
Peepeha	A Maaori traditional custom used as an introduction, often in formal settings, to acknowledge and honour one's connection to their ancestors, the land, and the people one is meeting. It's a way to establish identity and heritage within a Maaori context.
Puuweto	Spotless crane, a native wetland bird species
Raahui	Temporary prohibition or restoration purposes
Repo	Wetland
Rere o ngaa wai	Waters that flow
Rongoa	Traditional healing practice using native plants and spiritual knowledge
Rohe	Tribal region or territory

Ruunanga	Governing council or assembly within Iwi or hapuu
Taiao	The natural world/environment
Taonga	Treasure, something highly prized or cultural significant
Tangaroa	Atua (deity) of the ocean and all water bodies
Taniwha	Ancestral guardian being of spiritual entity residing in rivers or lakes
Te Ao Maaori	The Maaori world and worldview
Te kore	State of nothingness
Te Mana o te Awa	The spiritual authority and dignity of the river
Te Tiriti o Waitangi	The Treaty of Waitangi
Tika/Tikanga	Correct process, Maaori customs, protocols, and practices
Tohu	Sign, signal, or environmental indicator
Tuna	Short and longfin eel; a spiritually and culturally significant fish
Tuna heke	Migrating eels
Tuupuna	Ancestors
Waikato	Region and river in the central North Island: means 'flowing water'
Waikato-Tainui	Tribal confederation descended from the Tainui waka based in the Waikato region. It can also represent those that have genealogical ties to the 68 marae within the tribal confederation.
Wai	Water
Wairua	Spirit of spiritual essence
Waahi tapu	Sacred or spiritually restricted site
Waananga	Education forum or traditional place of learning and discussion
Whakapapa	Genealogy; relational and ancestral connections between people, land, and beings
Whaanau	Extended family or kin group
Whenua	Land; also refers to placenta, symbolising deep connection to Papatuaanuku (earth mother)
Whanaungatanga	Relationship, kinship, and sense of connectedness and collective responsibility
Whakawhanaungatanga	The process of establishing and maintaining relationships
Whakatupu	Growth, development
Whakaaro	Thought, idea, opinion
Whakahaere	Administration, governance

Appendix 2: Cultural monitoring methods applied to assess changes in ecological character for the Whangamarino Wetland

Ngaa Tohu o te Taiao Environmental signs and seasonal knowledge

Ngaa Tohu o te Taiao represents centuries of ecological observation encoded in Maatauranga Maaori systems including maramataka (lunar calendars) and huringa tau (seasonal cycles). This methodology uses environmental signs to assess wetland health and hydrology.

Environmental signs monitored include:

- tuna heke (eel migration) timing indicates wetland vitality and hydrological conditions
- koowhai and harakeke flowering patterns signal water quality and nesting conditions
- presence of specific manu (birds) such as matuku (Australasian bittern) and kotuku (white heron) reflects water levels and insect populations.

Monitoring Tools – Digital applications enable systematic documentation of seasonal observations:

- marae-observed Tohu Tracker app that maps these seasonal signs spatially and temporarily (e.g., Rongo – Kaitiaki Observation Tool).
- Cyber Tracker (<https://cybertracker.org>): established Indigenous observation system with similar functionality.

Example at Whangamarino Wetland: Kaumaatua observed a three-week delay in tuna migration post-2018, indicating disrupted hydrological patterns. This cultural indicator provided early warning of environmental change prior to formal water quality assessments.

Koorero tuku iho Intergenerational narratives of place

Methodology – Includes structured interviews and storytelling sessions with kaumaatua document historical ecological knowledge, including:

- species previously abundant in the wetland
- sensory indicators (sounds, smells, or absence thereof) that signal ecosystem change
- decline or relocation of Rongoa (medicinal plant) species.

Monitoring Tool – Koorero Atlas: A digital archive that geotags narratives and tracks intergenerational changes in environmental conditions using a scoring system.

Example at Whangamarino Wetland: Kaumaatua noted the absence of 'rere o ngaa wai' (the natural sound of clean wetland waters flowing) as an indicator of degraded conditions. This silence signifies that the wetland no longer 'breathes'—a cultural indicator of compromised ecological function.

Wairua & mauri assessments

Spiritual health surveys

Methodology – These assessments involve waananga (forum for learning and discussion), a deliberate process of knowledge sharing and collective understanding and guided karakia (prayer) to assess shifts in:

- wairua (spiritual presence)
- mauri (life force) and energetic vitality
- emotional resonance of place.

Monitoring Tool – Mauri-o-Meter: A five-point cultural wellbeing index that rates site mauri on a scale from maauui (degraded) to ora (thriving).

Example at Whangamarino Wetland: Rangatahi (youth) described experiencing ‘te kore’ (emptiness, void) at a site where spiritual presence was historically strong. Water quality analysis subsequently confirmed toxic algal proliferation, corroborating the cultural assessment of degraded mauri.

Mahinga kai resilience index

Methodology – Mahinga kai resilience focuses on assessment of traditional food resources including:

- availability of key traditional food species (tuna (eels), kaakahi (freshwater mussels), puuhaa (sow thistle), waatakirihi (watercress))
- access rights and customary harvest practices
- quality and quantity thresholds for sustainable harvest.

Monitoring Tool – Kai Scorecard: An annual assessment conducted by local marae evaluating species abundance, ease of harvest and intergenerational knowledge transfer and use.

Example at Whangamarino Wetland: Kaakahi (freshwater mussel) populations declined below viable harvest thresholds due to poor water quality. Youth participants in a wetland waananga detected this decline before it appeared in formal Department of Conservation surveys, demonstrating the sensitivity of cultural monitoring. Mahinga kai monitoring links food security to ecological health. This approach identifies when a wetland can no longer sustain its cultural and nutritional functions for the community.

Whakapapa connectivity

Methodology – An assessment of genealogical connections between places and species, including:

- movement of tuna between repo (wetlands) and awa (rivers)
- maintenance of traditional water pathways
- presence of ancestral markers (urupaa (burial grounds), paa (fortified villages), and other culturally significant sites).

Monitoring Tool – Whakapapa Web Mapper: A digital system mapping ecological and ancestral relationships as interconnected living systems.

Example at Whangamarino Wetland: Restoration work that reconnected wetland areas to ancestral river sections resulted in revitalised kooura (freshwater crayfish) populations. This outcome confirmed that restoring whakapapa relationships supports ecosystem recovery. While biodiversity surveys and monitoring provide numerical species counts, whakapapa mapping reveals functional and spiritual relationships within ecosystems. This approach explains not only what has been lost, but why those losses matter to cultural and ecological integrity.

Tikanga compliance

Methodology – Monitoring of environmental management actions to ensure adherence to cultural protocols and customs, including:

- obtaining consent from mana whenua
- conducting karakia before interventions
- avoiding disturbance to waahi tapu (sacred sites).

Monitoring Tool – Tikanga Audit Matrix: A compliance framework co-created with marae committees and monitored by Waikato-Tainui.

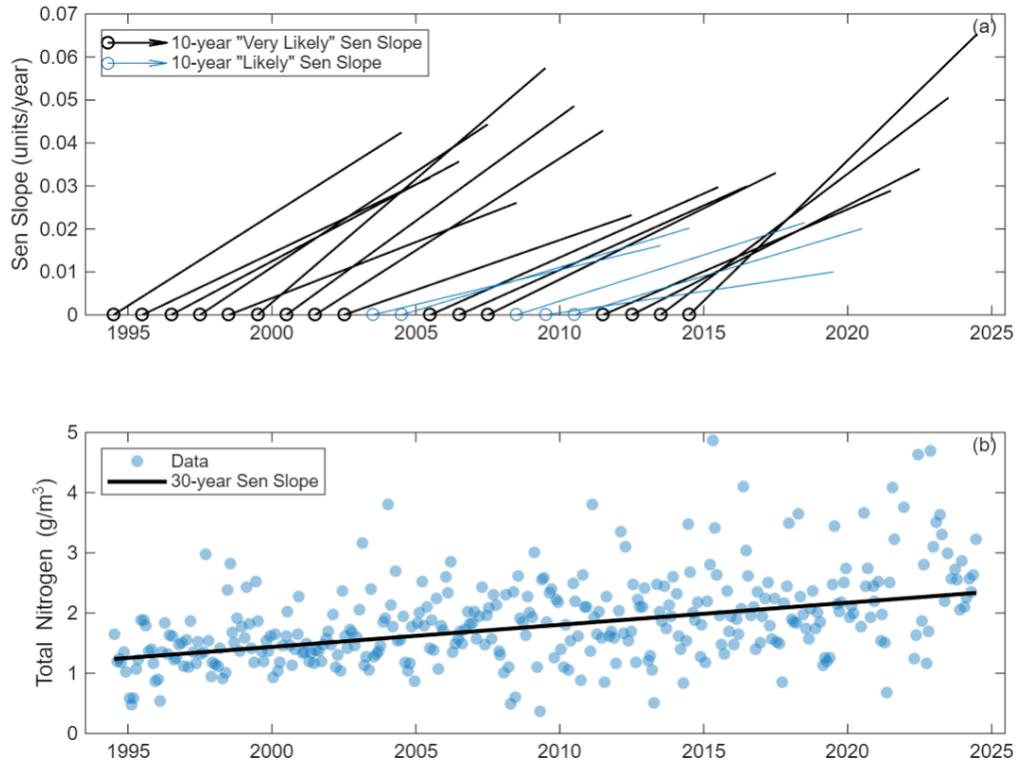
Example at Whangamarino Wetland: Department of Conservation weed control operations were redirected after tikanga monitors identified unnotified activity near waahi tapu, demonstrating the effectiveness of cultural protection protocols.



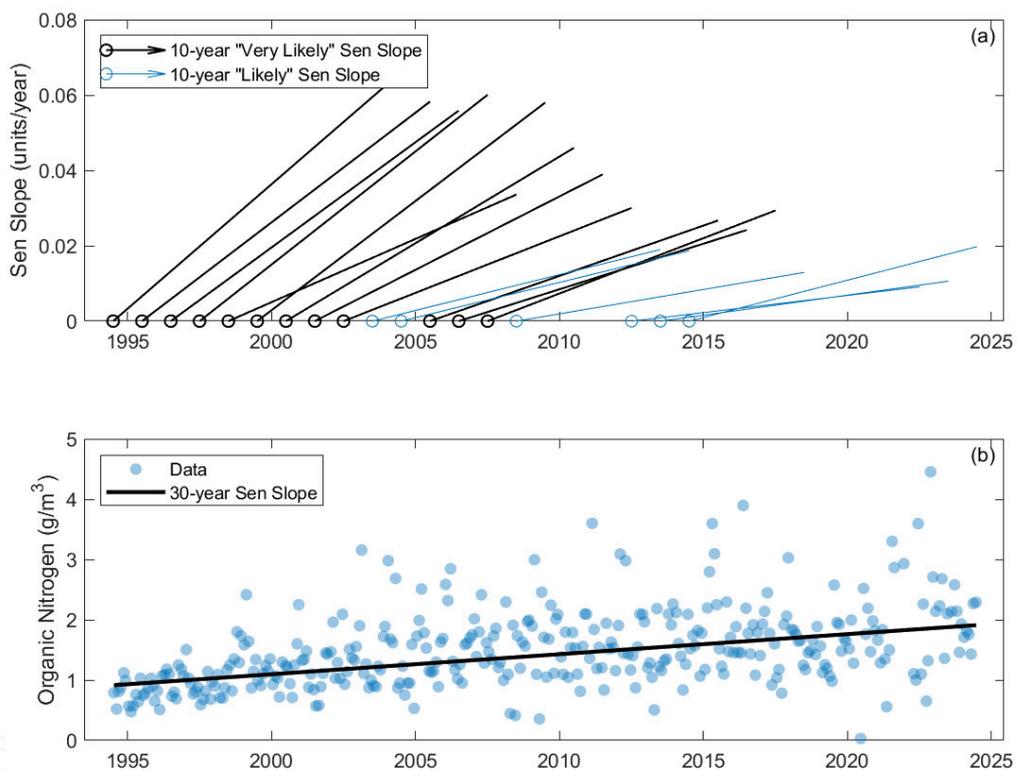
Native orchid (Thelymitra spp.) in Whangamarino Wetland

Appendix 3: Water quality trend analysis

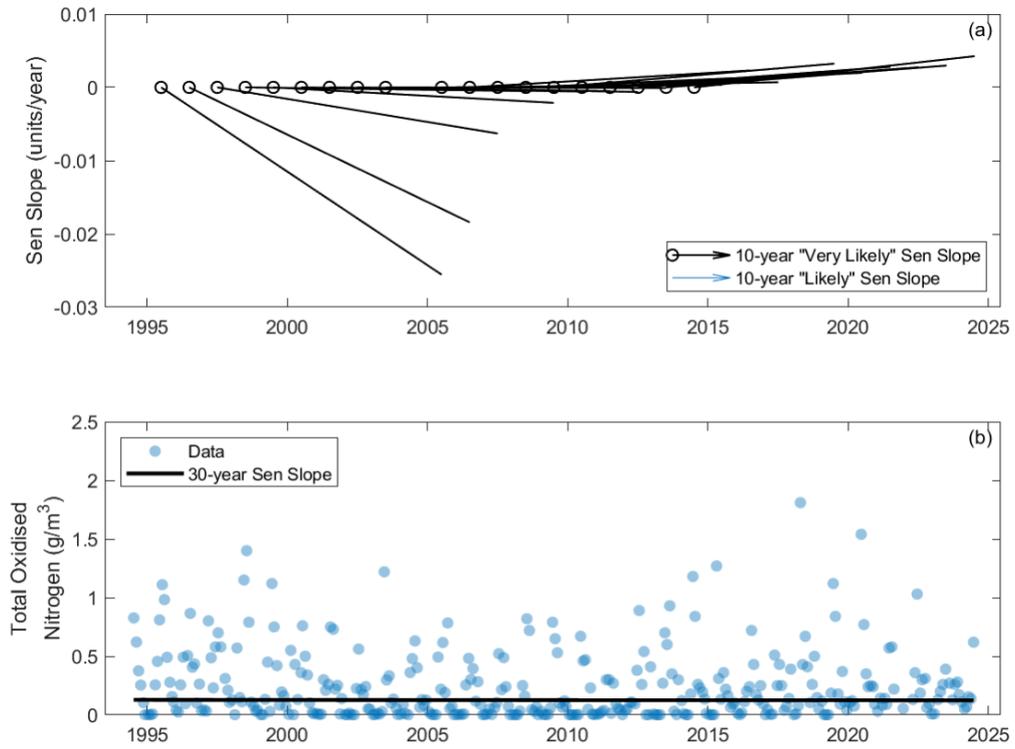
A1.a Total nitrogen (TN)



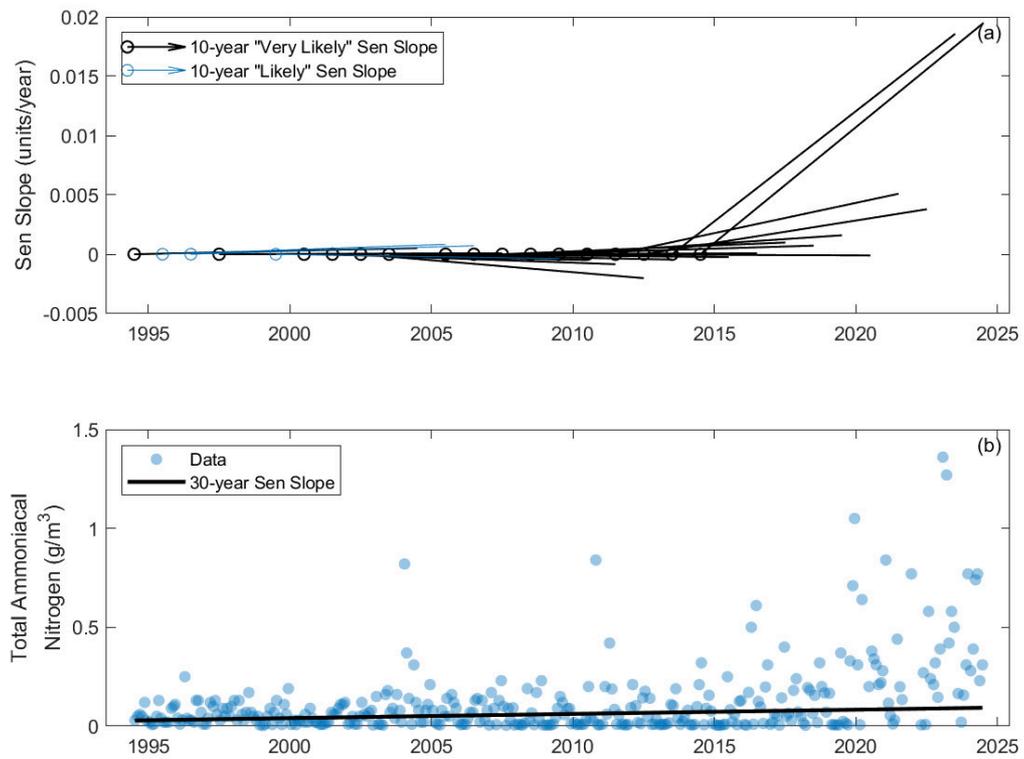
A1.b Organic nitrogen (OrgN)



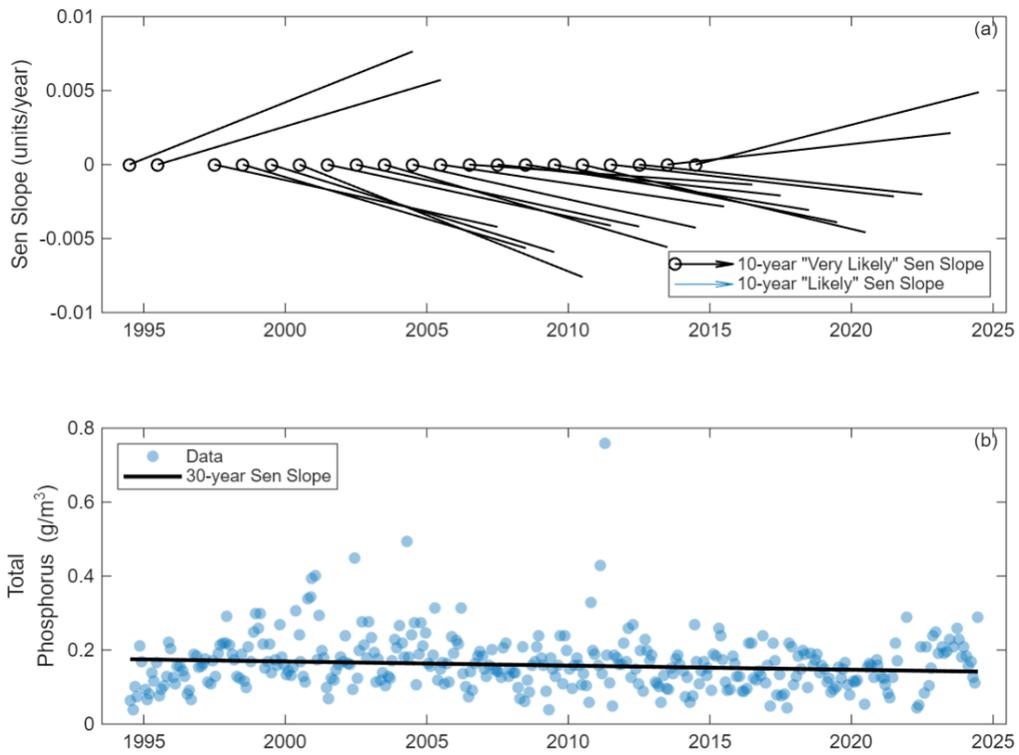
A2. Oxidised nitrogen (nitrate-nitrite)



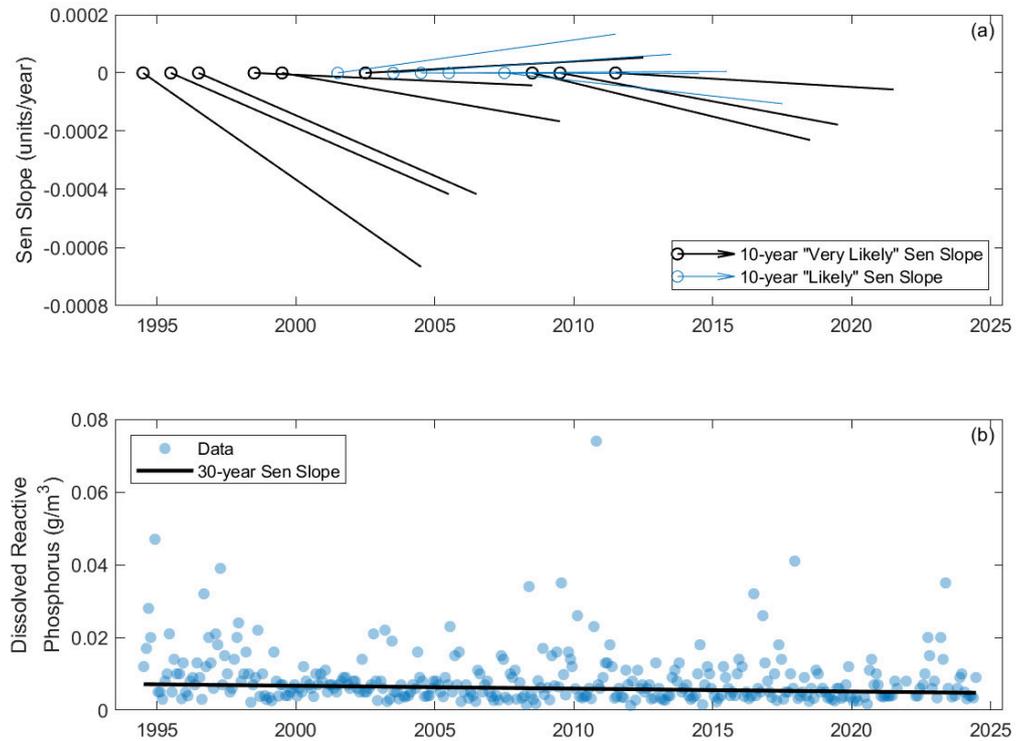
A3. Ammoniacal nitrogen ($\text{NH}_4\text{-N}$)



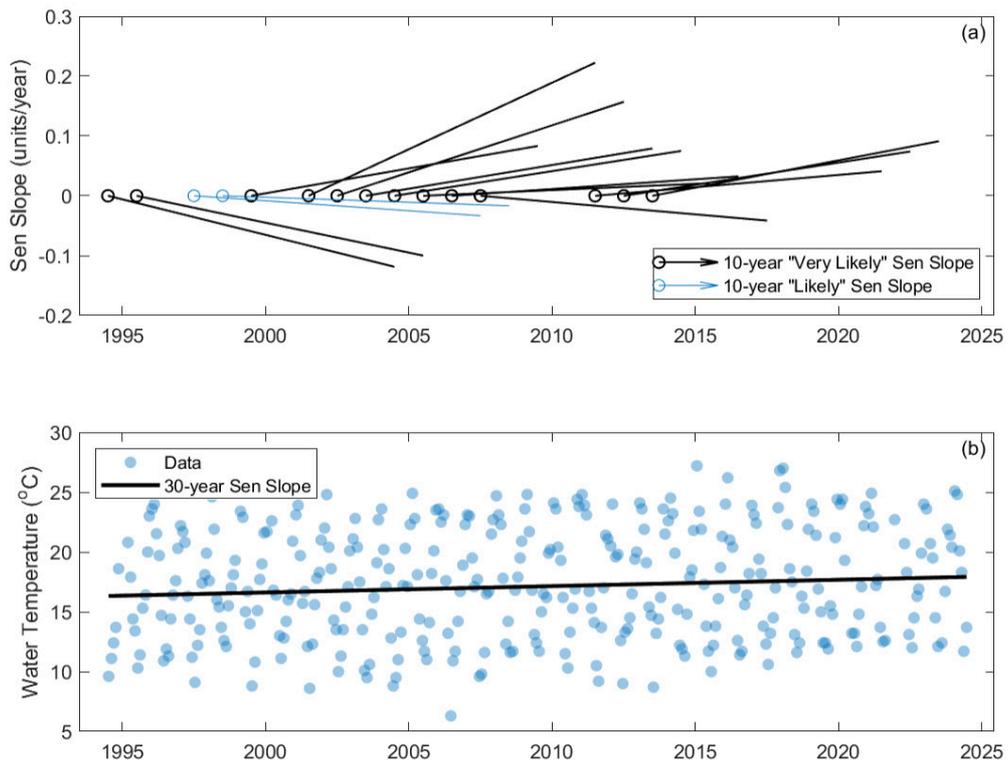
A4. Total phosphorus (TP)



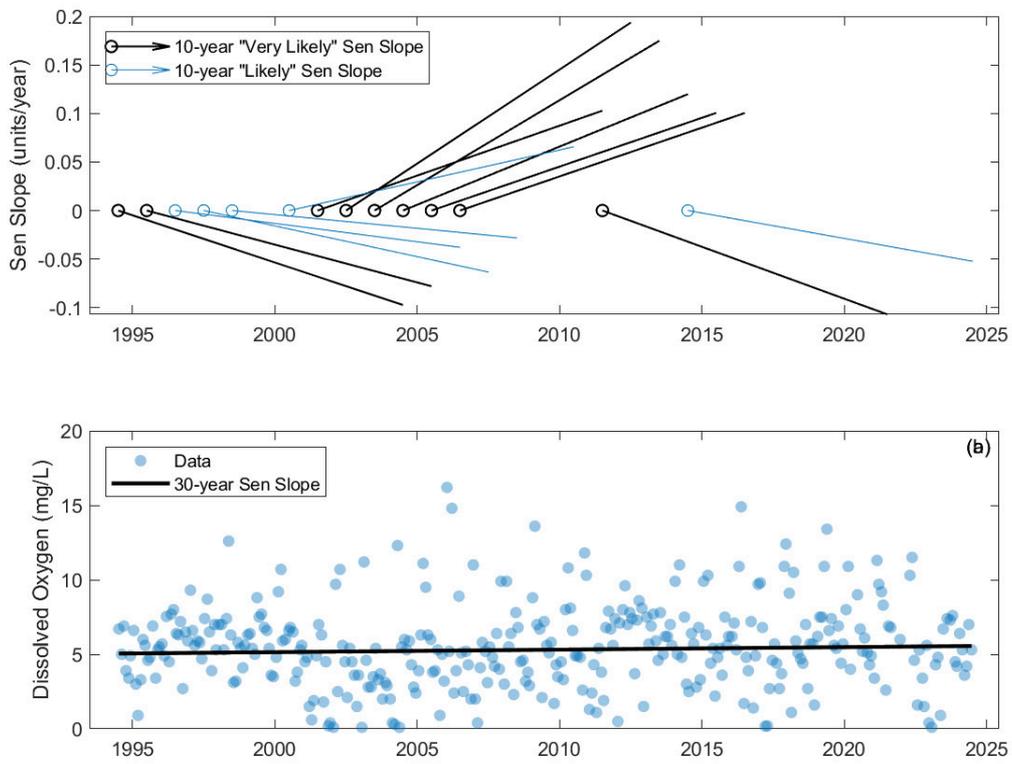
A5. Dissolved reactive phosphorus (DRP)



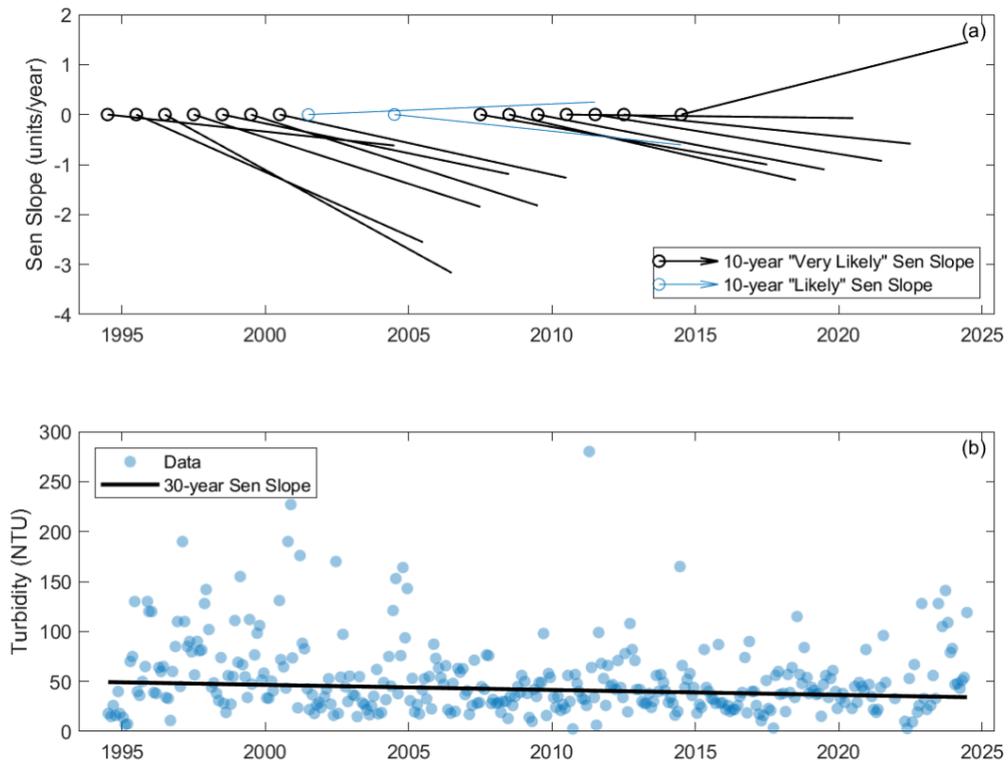
A6. Water temperature



A7. Dissolved oxygen (DO)



A8. Turbidity



A9. Visual clarity

