Queensland Wetland Definition Guideline

Version 2.0

Queensland Government
Queensland
Wetlands Program

Queensland
Wetlands Program

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Contents

1 Introduction

The Queensland Wetlands Program (QWP) was established by the Australian and Queensland Governments in 2003 to support projects and programs that enhance the wise use and sustainable management of Queensland's wetlands. One of the first activities of the QWP was to establish a definition which could be used consistently to map and underpin other wetland management decisions (Environmental Protection Agency 2005, Department of Environment and Resource Management 2011).

At over 1.7 million square kilometres, with approximately 7,000 kilometres of coastline and containing over 2,000 islands, Queensland is a large state with diverse climate, geology, landform, rainfall, hydrological regimes, and ecosystems. It is the most biodiverse state in Australia and contains the greatest diversity of wetlands, the characteristics of which can vary significantly over time in association with factors such as rainfall, hydrological processes, and seasonal variations.

Wetlands are transition areas between land and water, a continuum from episodically wet areas to purely aquatic ecosystems. This makes it difficult to develop one definition that consistently and precisely describes and delineates all wetlands in Queensland. Some wetlands, such as permanent lakes and rivers, are easily identifiable as wetlands, while others are more difficult to identify.

Due to the broad range of habitats, the difficulties in identifying wetlands, and the wide range of purposes for which policy and legislation has been developed, there are currently a variety of wetland definitions in use in Queensland. However, since the Queensland Wetlands Program Definition was released in 2005 (Environmental Protection Agency 2005), many policies and programs now refer to this definition and its associated guidelines (Department of Environment and Resource Management 2011).

1.1 Purpose of this document

This document builds on the original Queensland Wetland Definition and Delineation Guideline - (Part A: A guide to existing wetland definitions and the application of the Queensland Wetlands Program definition 2011) and provides guidance on the range of wetland definitions used in Queensland, describes the QWP Wetland Definition (the Definition), and provide guidance on the interpretation and application of the Definition. This guideline is intended to assist government agencies, landowners, natural resource managers and others wanting to identify whether a feature[1] is a wetland for decision making and planning purposes. In addition to identifying wetlands, it is anticipated that this guideline will be useful for other activities relating to wetlands, including their delineation, mapping, classification, assessment, and management. This guideline applies to all wetland systems and types in Queensland but may be somewhat restrictive when applied to subterranean systems.

1.2 Version history

Table 1 Document version history and publication record

Version	Year of Release	Description
1.0	2011	Queensland Wetland Definition and Delineation Guideline - (Part A: A guide to existing wetland definitions and the application of the Queensland Wetlands Program definition 2011). Presents a guide to the range of existing wetland definitions used in Queensland and the application of the Queensland Wetlands Program wetland definition. Department of Environment and Resource Management (2011) Queensland Wetland Definition and Delineation Guideline, Queensland Government, Brisbane.
2.0	2023	Provides minor updates to the previous document including reorganised content and inclusion of related definitions of wetland systems.

[1] In this guide the term "feature" is used differently to the term "site", the latter of which is reserved to indicate the area for ground survey and may include surrounding non-wetland support areas. A site should not be confused with the actual wetland feature, that is a site may contain a wetland feature(s) but a site may also contain non-wetland features.

2 Wetland Definitions used in Queensland

This section provides a guide to the key wetland definitions used in Queensland including those in Queensland legislation. This section does not provide any commentary or guidance on the value or utility of these definitions or their legislative interpretation. It is important to read statutory definitions in their full legislative context and with any available interpretative material. The Wetland*Info* website contains a comprehensive list of policy, legislation and planning as they relate to wetlands. Queensland legislation and accompanying explanatory notes are available from the Office of the Queensland Parliamentary Counsel, and Australian legislation and accompanying explanatory notes are available from the Federal Register of Legislation. Wetland definitions may be described in several ways such as using qualitative criteria via a definition, entries on a schedule or list, references to a series of datasets or maps, description by metes and bounds, or a combination of these.

2.1 International Definitions

The internationally accepted wetland definition used in Australia is that in 'The Convention on Wetlands of International Importance' (1971) (also known as the 'Ramsar Convention on Wetlands (1971)' or 'the Ramsar Convention'). The Ramsar Convention is an intergovernmental treaty that provides a framework for national action and international cooperation on the conservation and wise use of wetlands. Australia is a contracting party to the Ramsar Convention.

Article 1 of the Ramsar Convention defines wetlands as "*areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water to the depth of which at low tide does not exceed six metres.*"

Additionally, Article 2.1 provides that wetlands "*may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands*".

The Ramsar Convention defines wetlands in a broad and inclusive manner that is applicable to all types of wetlands in all signatory nations. Ramsar definitions and classifications are relevant for Ramsar listed wetlands in Australia.

2.2 National Definitions

'A Directory of Important Wetlands in Australia' (DIWA) is a document that identifies nationally important wetlands and provides a classification system for them. The wetland definition used in DIWA is adopted from the Ramsar Convention, specifically Article 1.1. No specific reference is made in the DIWA definition to the additional areas covered in Article 2.1 of the Ramsar Convention.

2.3 State Definitions

2.3.1 Definitions in Policy

The 'Strategy for Conservation and Management of Queensland's Wetlands' (Environmental Protection Agency 1999) provides the overarching Queensland policy position on wetlands and has driven many achievements that benefit and will benefit wetland management into the future. This strategy defines wetlands as "*areas of permanent or periodic/intermittent inundation, whether natural or artificial, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 m.*"

This definition is largely consistent with the Ramsar definition with several alterations to make it more suitable to Queensland including removal of references to marshes, fens, and peatland as these are not terms commonly used in Queensland, and replacement of the term 'temporary' with 'periodic/intermittent' reflecting cyclical inundation (e.g. tidal changes), and ephemeral wetlands associated with Queensland's variable rainfall patterns.

Environmental Protection Agency (1999, p. 6) comments that "*Typically, wetlands include areas which show evidence of adaptation of soil or vegetation to periodic water logging — lakes, swamps, freshwater or brackish marshes, Melaleuca forests, lignum swamps, canegrass swamps, wooded swamps, claypans, ponded pastures and water storage dams; estuaries, rivers, streams, channels, waterholes and springs; intertidal sand flats, mud flats, salt flats, tidal marshes and mangroves; and shallow marine areas, such as seagrass beds or fringing coral reefs.*

Though entire floodplains could be interpreted as 'intermittent wetlands', this is not the definition's intention. Rather, intermittent wetlands — such as marshes, pot-holes, or shrub- or tree-dominated areas showing evidence of adaptation of soil to, or vegetation tolerant of, waterlogging — may occur as part of a mosaic of vegetation types on floodplains."

2.3.2 Definitions in Legislation

There are currently a variety of wetland definitions in use in Queensland due to the broad range of wetland habitats the difficulties in identifying wetlands, and the wide range of purposes for which policy and legislation has been developed. Further information on these wetland definitions is available on the Wetland*Info* website.

There are wetland definitions, references to wetlands, and related terms used in legislation applicable to Queensland, which reflect the many different purposes for the legislation. Several of these definitions are based on the Strategy for Conservation and Management of Queensland's Wetlands definition (Environmental Protection Agency 1999) such as the *Vegetation Management Act 1999* (Qld) that defines wetlands as "*area[s] of land that supports plants or is associated with plants that are adapted to and dependent on living in wet conditions for at least part of their life cycle*".

Other legislation defines wetlands as entries on a schedule or list such as the *Coastal Protection and Management Act 1995* (Qld) that includes a list comprised of "*tidal wetlands, estuaries, salt marshes, melaleuca swamps (and any other coastal swamps), mangrove areas, marshes, lakes or minor coastal streams regardless of whether they are of a saline, freshwater or brackish nature*", or as references to a series of datasets or maps such as the *Environmental Protection Regulation 2019* (Qld), and *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (Qld) that refer to "*area[s] shown as a wetland on the Map of Queensland wetland environmental values.*" However, the supporting guidelines for this map relate back to the Queensland Wetlands Program Definition.

3 The Queensland Wetlands Program Definition

The QWP wetland definition (the Definition) was developed at a series of stakeholder meetings in 2004 for use in Queensland Wetlands Mapping and Classification projects that provide the spatial basis for all other wetland projects. The Definition is conceptually similar to other wetland definitions in Australia (Department of Environment and Conservation 2007; Duguid et al. 2002; Department of Land and Water Conservation 1996; Paijmans et al. 1985) and the world (Committee on Characterisation of Wetlands 1992; Cowardin et al. 1979). The following section provides the details of the Definition.

3.1 Queensland Wetlands Program Wetland Definition

This following is the full text of the Definition and needs to be read in conjunction with wetland definition terms (Section 3.2) and other sections. Footnotes have been provided to clarify the intent of the definition; however, they do not form part of the definition.

Wetlands are areas of permanent or periodic/intermittent inundation[2], with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 metres. To be a wetland, the area must have one or more of the following attributes:

1. The land supports, at least periodically, plants or animals that are adapted to and dependent on living in wet conditions for at least part of their life cycle

2. The substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers[3]

3. The substratum is not soil[4] and is saturated with water, or covered by water, at some time[5].

The definition this document is the same as that described in Environmental Protection Agency (2005) or Department of Environment and Resource Management (2011) but it does not include the examples which were used in the previous definition.

The Definition has been adapted from international, national, and state definitions and was based on the definition developed for the Strategy for Conservation and Management of Queensland's Wetlands (Environmental Protection Agency, 1999). The definition text of Environmental Protection Agency (1999) was adopted as a starting point and built on through the inclusion of three additional criteria that an area must meet to be a wetland. These additional criteria define more precisely the intent of the Environmental Protection Agency (1999) definition that wetlands are areas that 'show evidence of adaptation of soil to, or vegetation tolerant of, water-logging'. The effect of these criteria is that wetlands are defined where wet conditions are a dominant environmental factor shaping the values of an area.

These three additional criteria provide a good description of a wetland environment, that is the observable attributes of plants and/or animals or soils associated with a wetland and help to overcome some of the difficulties associated with identifying wetlands in the field due to seasonal variations or disturbances. For example, a wetland may be identifiable due to the presence of wetland plant species, even though it is dry at the time. Alternatively, a wetland might be identifiable due to evidence of wetland soil conditions, despite lacking wetland plant species due to clearing.

[2] This footnote does not form part of the definition. The term 'inundation' includes saturation.

[3] This footnote does not form part of the definition. The term 'upper layers' is usually the top 0.3 m but may be deeper if overlain by permeable material.

[4] This footnote does not form part of the definition. Artificial water bodies with artificial bed and banks are not included (see Appendix 1 and Section 4.7).

[5] This footnote does not form part of the definition. When water is in a channel, the intent is to capture surface wetlands without soils, such as rocky riverbeds, waterfalls, boulders at headwaters, etc., and also subterranean wetlands. When water is outside a channel, the intent is to capture gamma holes and similar water holding depressions.

3.2 Wetland Definition Terms

The Definition consists of four criteria (Table 2) that more clearly define four wetland factors: hydrology, biota, soils, and non-soils/non-biota. This section provides an explanation of each term used in each criterion and their intended interpretation. This explanation should be used in order to gain an understanding of the Definition, and also in the event of any uncertainty or dispute as to the meaning or interpretation of any of the terms in the context of the Definition. Many terms have common dictionary definitions, while others have been modified to convey specific wetland related features. The Glossary (page 32) provides definitions not covered in this section excluding common words with standard dictionary definitions.

Table 2

Factor	Criterion
Hydrology	Wetlands are areas of permanent or periodic/intermittent inundation, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 metres.
Biotic	The land supports, at least periodically, plants or animals that are adapted to and dependent on living in wet conditions for at least part of their life cycle
Soil	The substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers
Non-soil, non-biotic	The substratum is not soil and is saturated with water, or covered by water, at some time.

3.2.1 Terms used in the hydrology criterion

Wetlands are areas of permanent or periodic/intermittent inundation, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 metres.

The hydrology criterion of the Definition is adapted from Environmental Protection Agency (1999) and presents the general parameters of a wetland.

Areas — Area refers to “any particular extent of surface, region or tract” (Yallop 2005). Area is also used in the mapping sense to refer to a discrete polygon showing the boundaries of a spatial unit at a specified scale.

Permanent — "Lasting or tending to last indefinitely; remaining unchanged" (Yallop 2005). In the context of the guideline, permanent refers to the ability to have or maintain water continuously in all seasons and all years.

Periodic — "Characterised by periods or rounds of recurrence, occurring or appearing at regular intervals, or "intermittent" (Anon 2005). Inundation events include the daily, monthly, or annual tidal systems or are associated with other reasonably predictable events.

Intermittent — "That intermits, or ceases for a time: an intermittent process, or (of streams, lakes, or springs) recurrent; showing water only part of the time" (Yallop 2005). Alternately wet and dry but less frequently and regularly than annual cycles (Paijmans et al. 1985).

Inundation — "Overspread with a flood; overflow; flood, deluge or overwhelm" (Yallop 2005). In relation to wetlands in Queensland, inundation can occur from flooding, ponding, or saturation from underground water.

Static — Static means not flowing. Static water usually occurs in closed depressions, lakes, dammed water courses, marshes, or other lentic waters where the water cannot flow.

Flowing — Moving generally occurs in riverine channels or floodplains and other lotic water bodies but also in areas subject to tidal influences or underground water flow.

Fresh	Water that contains only minute amounts of dissolved salt (not discernible by taste). Water that has a salt concentration up to a maximum of 0.5 parts per 1,000 or an electrical conductivity up to a maximum of 1.5 mS/cm.
Brackish	Water that is slightly salty, being more salty than fresh water but not as salty as marine water, having a salts solution concentration of less than the lower marine standard of 34 parts per 1,000 but above the fresh water maximum salt solution concentration of 0.5 parts per 1,000. Brackish can be applied to marine and estuarine waters with mixohaline salinity and not applied to inland waters.
Salt	Mineral chemicals readily soluble in water. The concentration of dissolved salts in water is used to define water as fresh, brackish, or marine.
Marine water	Marine water is water associated with oceans and seas that has a uniform salinity of approximately 34–36 parts per 1,000 or an electrical conductivity of approximately 52–54 mS/cm. Note the level and source of salinity does not determine if a feature is a wetland or not.
Low tide	Low tide will be considered as the lowest depth of that tide and occurs between the mean sea level and lowest astronomical tide. Lowest astronomical tide may also be referred to as “datum of predictions” and “port datum”.

3.2.2 Terms used in the biotic criterion

1. The land supports, at least periodically, plants or animals that are adapted to and dependent on living in wet conditions for at least part of their life cycle

The biotic criterion of the Definition defines wetland plants and animals as indicators of a wetland habitat.

Periodically	Characterised by periods or rounds of recurrence, or occurring or appearing at regular intervals or intermittently (Yallop 2005). The occurrence of wetland biota will vary in response to seasonal conditions, which may encompass seasonal, intermittent, and episodic hydrological regimes (Paijmans et al. 1985).
Plants	Any organism from the plant kingdom.
Animals	Any organism from the animal kingdom.
Adapted	Possessing a feature that fits the organism to the environment. Environmental Protection Agency (1999) comments that ‘typically, wetlands include areas which show evidence of adaptation of soil or vegetation to periodic water-logging’, and it is this adaptation that differentiates wetland soils, vegetation and also wetland animals from the terrestrial soils and species.
Dependent	Relies on the provision of essential resources required to support critical life cycle functions including reproduction, certain (even all) life stages, water, food, shelter, refuge and so on.
Wet conditions	Defined as areas where the root zone becomes periodically saturated or inundated during the growing season.
Life cycle	The cyclic events of life through which individuals pass, including seed, fertilisation, propagation, survival to maturity, producing of offspring and death.

3.2.3 Terms used in the soil criterion

2. The substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers

The soil criterion of the Definition separates wetland soil from terrestrial soil and, therefore, aids wetland delineation.

Substratum	Land surface. Soils and regolith underlying a spatial area.
Predominantly	> 50% of area.
Undrained soils	Soils that hold water when water is available (may not have a large water holding capacity).
Saturated	"Soaked, impregnated or imbued thoroughly." When saturation occurs for sufficient periods of time it produces hydric (also known as hydromorphic) soil conditions that deprive soil of the capacity to re-oxygenate, thereby creating the low oxygen soils typical of wetlands. Soil saturation also prevents many terrestrial organisms accessing their oxygen requirements thereby excluding them from this environment. However, wetland organisms have adapted to the low oxygen environment of water saturated soils and can survive in this environment.
Flooded	Covered by overflowing water, usually stormwater but may be tidal or storm surge.
Ponded	Water that has accumulated against an obstruction, such as a depression or a barrier that prevents its flowing or overspreading further.
Anaerobic conditions	Conditions that do not have or need the presence of free oxygen to function; they may require the absence of oxygen, or at least are not destroyed by it. Organisms living in these conditions have adaptations to survive the low oxygen environment.
Upper layers	Refers to the top layers, usually the top 0.3 m but may be deeper if overlain by permeable material (Bryant et al. 2009).

3.2.4 Terms used in the non-soil, non-biotic criterion

3. The substratum is not soil and is saturated with water, or covered by water, at some time.

The non-soil, non-biotic criterion of the Definition covers wetlands that have a bed that is not soil (e.g. rock or ice). Subterranean wetlands, and surface wetlands with no soils, such as rocky river beds and gamma holes, are captured in this way.

Not soil	Natural substrates that are predominately not soil, such as rock or ice. Within a wetland the substratum may partially be formed of artificial materials, such as concrete, metal, composite materials (such as fibreglass and carbon fibre), plastics, or synthetic geotechnical materials. If such material covers approximately 50 % of the bed and all banks, then the area contained by this construction is not a wetland.
Saturated with water	The condition of being soaked, impregnated, or imbued thoroughly or completely with water.
Covered by water at some time	Has water spread over, even deeply, so as to limit contact with the free gasses of the atmosphere. For the purposes of this guideline, the area must be covered by water so that when water is in a channel, the intent is to capture surface wetlands without soils, such as rocky river beds, waterfalls, boulders at headwaters, etc., and also subterranean wetlands. When water is outside a channel, gamma holes and similar water holding depressions are captured.

3.3 Wetland Definition Examples

Examples under the Definition include:

- Rivers, streams, creeks swamps, lakes, marshes, waterholes, wetlands, billabongs, pools, or springs
- Wetland vegetation communities
- Areas containing recognised wetland flora species
- Saturated parts of the riparian zone
- Waterbodies not connected to rivers or flowing water, such as billabongs and rock pools
- Artificial waterbodies such as farm dams

Examples under the Definition exclude:

- Areas covered by water but do not meet the biotic or soil criteria
- Floodplains that are intermittently covered by flowing water but do not meet the biotic or soil criteria
- Riparian zone above the saturation level

3.4 The distinction between wetlands, waterholes, and waterbodies

The following definition of waterholes is biophysical and in no way limits the definition of waterholes that may be used in a legislative or statutory context. Waterholes are often a component within a larger wetland (e.g., a waterhole within a riverine wetland) and are highly variable as they can fluctuate both spatially and temporally (Arthington et al. 2005). Waterholes are referred to by a range of different names (e.g., billabongs, lagoons, and waterbodies) due to their wide geographic range, from the wet-dry tropics to the arid zone of far western Queensland (Gibling, Nanson & Marolis 1998; Jardine et al. 2012), their morphological variability, and presence within different wetland types (Box et al. 2008; Costelloe et al. 2007; Medeiros & Arthington 2008).

A waterhole is a wetland[6] where water pools in a depression[7] within a landform element[8] at a defined spatial scale (Department of Environment and Science 2020b)

Contrastingly, a waterbody is not necessarily a wetland rather it is a "body of water" (Department of Environment and Science 2020b). The definition of waterbody is scale independent.

[6] Section 3 presents the full text of the Queensland Wetlands Program Wetland Definition including clarifying footnotes and further information to support definition interpretation.

[7] A depression is a landform element that stands below all, or almost all, points in the adjacent terrain (National Committee on Soil and Terrain 2009).

[8] A landform element is a sub-component of a landform type that can be characterised mainly by its morphology (shape, steepness, orientation, moisture regime) (Macmillian & Shary 2009).

4 Wetland System Definitions

This sub-section presents the definition of each of the major wetland systems that represent "complex[es] of wetlands and deepwater habitats that share the influence of similar hydrologic, geomorphologic, chemical, or biological factors" (Cowardin et al. 1979). Intertidal and subtidal ecosystems may be composed of components of estuarine and/or marine systems. Intertidal and subtidal ecosystems are distinguished from each other based on the biophysical attribute of inundation in contrast to estuarine and marine systems that are separated six metre depth contour below the lowest astronomical tide which is unsurveyed for most of the Queensland (Department of Environment and Science 2020a). Therefore, intertidal and subtidal ecosystems are easier to map, and their use is preferable (Department of Environment and Science 2020a).

4.1 Estuarine Wetland System (Department of Environment and Resource Management 2011a)

Definition

Estuarine Systems consist of wetlands with oceanic water that is at least occasionally diluted with freshwater run-off from the land (adapted from Cowardin et al. 1979).

For those estuarine systems within a channel and which consequently often contain water, the Queensland Water Quality Guideline (Environmental Protection Agency 2005a) definition of estuaries has been adapted. An estuary is:

(1) the mouth of a river where the tidal effects are evident and where freshwater and seawater mix; and/or

(2) the part of a tidal river that widens out as it approaches the coastline; and/or

(3) a body of water semi-enclosed by land with sporadic access to water from the open ocean, and where the ocean water is at least occasionally diluted by freshwater run-off from the land; and/or

(4) a body of water where salinity is periodically increased by evaporation to a level above that of the open ocean (such a water body is termed a reverse estuary).

Limits

For those estuarine systems within a channel, the upstream boundary is determined to be upstream limit of tidal influence at mean high water springs. The mean high water strings is the theoretical upstream limit for the mixing of salt water and represents the cut-off where the salt concentration is deemed to be low enough for the water to be considered fresh. This means that an area of tidal influence (the freshwater area that is moved back and forward by the tide but not saline) is included in the freshwater or “riverine” part of the system. However, in some large estuaries, slow rates of mixing and the constant inflow of freshwater means there is a permanent body of freshwater in the upper tidal reaches. This creates an anomaly if estuaries are taken to be where salt and freshwater mix. However, for water quality purposes, the tidal upper reaches are much more akin to an estuarine environment than a riverine environment.

For those estuarine systems outside a channel, the upstream boundary is determined to be the landward limit of tidal inundation or highest astronomical tide.

The downstream boundary of an estuarine system is determined to be its boundary with fully saline marine waters at the coast. The boundary divides estuarine systems at or out from the mouth of an estuarine channel (where there is typically some residual mixing between fresh and marine waters) from marine systems where there is typically no residual freshwater influence except under extreme conditions such as major flood events.

Where estuaries flow directly into open oceanic waters or for passages, the downstream limit is defined as the mouth of the estuary or passage, enclosed by adapting the semicircle rule (Beazley 1978). Generally, the entrance is defined by the downstream limits of the drainage catchment of the passage or estuary (the heads).

4.2 Intertidal Wetland System (Department of Environment and Science 2020a)

The following definition of an intertidal wetland system is adopted from Department of Environment and Science (2020a).

Definition

Intertidal wetlands consist of estuarine and/or marine systems located "between the level of high tide and low tide" (Department of Environment and Science 2020a, OzCoasts n.d. a).

Limits

Intertidal wetlands are subject to the cumulative boundary conditions of estuarine and marine systems.

Description

Intertidal wetlands experience "fluctuating influences of land and sea" with ecosystems "exposed at low tides" (Department of Environment and Science 2020a). These wetlands "may be composed of parts of both estuarine systems and marine systems" (Department of Environment and Science 2020a).

4.3 Lacustrine Wetland System (Department of Environment and Resource Management 2011a)

The following definition of a lacustrine wetland system is adopted from Cowardin et al. (1979).

Definition

"The Lacustrine System…includes wetlands and deepwater habitats with all of the following characteristics: (1) situated in a topographic depression, natural channel constriction that acts as a dam, or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage; and (3) total area exceeds 8 ha…Similar wetland and deepwater habitats totalling less than 8 ha are also included in the Lacustrine System if an active wave-formed or bedrock shoreline feature makes up all or part of the boundary, or if the water depth in the deepest part of the basin exceeds 2 m…at low water. Lacustrine waters may be tidal or nontidal, but ocean-derived salinity is always less than 0.5‰" (Cowardin et al. 1979).

Limits

"The Lacustrine System is bounded by upland or by wetland dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. Lacustrine Systems formed by damming a river channel are bounded by a contour approximating the normal spillway elevation or normal pool elevation, except where Palustrine wetlands extend lakeward of that boundary. Where a river enters a lake, the extension of the Lacustrine shoreline forms the Riverine-Lacustrine boundary" (Cowardin et al. 1979).

Description

"The Lacustrine System includes permanently flooded lakes and reservoirs (e.g., Lake Superior), intermittent lakes (e.g., playa lakes), and tidal lakes with ocean-derived salinities below 0.5‰ (e.g., Grand Lake, Louisiana). Typically, there are extensive areas of deep water and there is considerable wave action. Islands of Palustrine wetland may lie within the boundaries of the Lacustrine System" (Cowardin et al. 1979).

4.4 Marine Wetland System (Department of Environment and Resource Management 2011a)

The following definition of a marine wetland system is adapted from Cowardin et al. (1979) and Blackman et al. (1992).

Definition

"The Marine System…consists of the open ocean overlying the continental shelf and its associated high-energy coastline" (Cowardin et al. 1979) down to a depth of 6 m below lowest astronomical tide. "Shallow coastal indentations or bays [or parts thereof] without appreciable freshwater inflow, and coasts with exposed rocky islands that provide the mainland with little or no shelter from wind and waves, are also considered part of the Marine System" (Cowardin et al. 1979).

"Marine habitats are exposed to the waves and currents of the open ocean and the water regimes are determined primarily by the ebb and flow of oceanic tides. Salinities exceed 30‰, with little or no dilution except outside the mouths of estuaries."

Limits

The Marine System is bounded by the landward limit of tidal inundation or highest astronomical tide, the boundary with the estuarine system, and the seaward limit of 6 m below lowest astronomical tide.

4.5 Palustrine Wetland System (Department of Environment and Resource Management 2011a)

The following definition of a palustrine wetland system is adapted from Cowardin et al. (1979) and Blackman et al. (1992).

Definition

"The Palustrine System…includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5‰" (Cowardin et al. 1979). It also includes wetlands lacking such vegetation, but with all the following three characteristics: (1) where active waves are formed or bedrock features are lacking; (2) where the water depth in the deepest part of basin less than 2 m at low water; and (3) the salinity due to ocean-derived salts is still less than 0.5‰ (adapted from Cowardin et al. 1979).

Limits

"The Palustrine System is bounded by upland or by any of the other four Systems" (Cowardin et al. 1979).

Description

"The Palustrine System was developed to group the vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie, which are found throughout the [world]. It also includes the small, shallow, permanent or intermittent water bodies often called ponds. Palustrine wetlands may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers. The erosive forces of wind and water are of minor importance except during severe floods" (Cowardin et al. 1979).

"The emergent vegetation adjacent to rivers and lakes is often referred to as "the shore zone" or the "zone of emergent vegetation" (Reid and Wood 1976), and is generally considered separately from the river or lake. As an example, Hynes (1970:85) wrote in reference to riverine habitats, "We will not here consider the long list of emergent plants which may occur along the banks out of the current, as they do not belong, strictly speaking, to the running water habitat." There are often great similarities between wetlands lying adjacent to lakes or rivers and isolated wetlands of the same class in basins without open water" (Cowardin et al. 1979).

4.6 Riverine Wetland System (Department of Environment and Resource Management 2011a)

Definition

"The Riverine System…includes all wetlands and deepwater habitats contained within a channel, with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and (2) habitats with water containing ocean-derived salts in excess of 0.5‰. A channel is 'an open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water' (Langbein and Iseri 1960:5)" (Cowardin et al. 1979).

Limits

"The Riverine System is bounded on the landward side by upland, by the channel bank (including natural and man-made levees), or by wetland dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. In braided streams, the system is bounded by the banks forming the outer limits of the depression within which the braiding occurs.

The Riverine System terminates at the downstream end where the concentration of ocean-derived salts in the water exceeds 0.5‰ during the period of annual average low flow, or where the channel enters a lake. It terminates at the upstream end where tributary streams originate, or where the channel leaves a lake. Springs discharging into a channel are considered part of the Riverine System" (Cowardin et al. 1979).

Description

"Water is usually, but not always, flowing in the Riverine System. Upland islands or palustrine wetlands may occur in the channel, but they are not included in the Riverine System. Palustrine Moss-Lichen Wetlands, Emergent Wetlands, Scrub-Shrub Wetlands, and Forested Wetlands may occur adjacent to the Riverine System, often on a floodplain. Many biologists have suggested that all the wetlands occurring on the river floodplain should be a part of the Riverine System because they consider their presence to be the result of river flooding. However, we concur with Reid and Wood (1976:72,84) who stated, 'The floodplain is a flat expanse of land bordering an old river…Often the floodplain may take the form of a very level plain occupied by the present stream channel, and it may never, or only occasionally, be flooded…It is this subsurface water [the ground water] that controls to a great extent the level of lake surfaces, the flow of streams, and the extent of swamps and marshes'" (Cowardin et al. 1979).

4.7 Subtidal Wetland System (Department of Environment and Science 2020a)

The following definition of a subtidal wetland system is adopted from Department of Environment and Science (2020a).

Definition

Subtidal wetlands consist of estuarine and/or marine systems "permanently below the level of low tide" (Department of Environment and Science 2020a, OzCoasts n.d. b).

Limits

Subtidal wetlands are subject to the cumulative boundary conditions of estuarine and marine systems including the seaward limit of 6 m below lowest astronomical tide.

Description

Subtidal wetlands "may be composed of parts of both estuarine systems and marine systems" (Department of Environment and Science 2020a).

5 Application of the Queensland Wetlands Program Definition

5.1 Evidence

The QWP Wetland Definition is satisfied if sufficient information is provided to demonstrate inundation (per the hydrology criterion) as well as one or more of the other three criteria (i.e., biota, soils, and non-soils/non-biota criterion). Each criterion is assessed by indicators that can be described by the collection of information or evidence from field survey or other sources. There may be a variety of indicators that can be used to determine that a criterion has been met ranging from those that are broadly applicable across Queensland (e.g., wetland indicator plants) to more specific indicators that may only be applicable in certain regions (e.g., some soil indicators).

More conclusive indicators can be used by themselves to determine that a criterion has been met, while other less conclusive indicators can be used only to suggest a feature has some wetland characteristics and require additional supporting evidence to determine if a criterion has been met. Under these circumstances the more and varied information available for a particular site, the stronger the evidence base and the more likely it is that the Definition will be applied correctly. If the feature is then found to be a wetland, the more and varied information is also likely to contribute to more accurate field delineation.

The Definition is, therefore, applied using a multiple-lines-of-evidence approach in which more conclusive indicators can be used on their own to reliably determine a criterion has been met, whilst less conclusive indicators are used with other information to determine if a criterion has been met. For example, soils that indicate the possible presence of anaerobic conditions, sightings of a few obligate wetland fauna species, or the presence of a few wetland plants indicate that the feature could be a wetland, but each line of evidence considered individually is not conclusive. Consideration of the combination of these lines of evidence together gives greater support to the interpretation that the feature may be a wetland. The best approach when investigating a site and applying the Definition is to collect as much information, from as many different reliable sources, about as many of the aspects of the Definition criteria as possible.

5.1.1 Characteristics of Wetland Indicators

The strength of evidence used depends on the type and quantity of the evidence base presence.

Type

Type refers to how accurate or reliable the evidence is as a wetland indicator. For example, some evidence conclusively identifies a wetland characteristic (e.g., the accumulation of organic materials identifies a wetland soil), whereas others are less conclusive (e.g., redox features may be relict landscape features and require consideration against the current hydrologic regime to assist in wetland identification, or some fauna are dependent on living in wet conditions but are not necessarily confined to a wetland). Some lines of evidence are also subject to greater variability in their interpretation than others (e.g., the utility of soil organic carbon content as a wetland indicator).

Quantity

Quantity encompasses the quantity of a particular piece of evidence and the quantity of different sources or pieces of evidence. Examples of the former include: replicated observations and/or multiple positive test indicators at the intensity appropriate to the scale of survey that provide more compelling evidence than just a single observation and/or positive indicator; a waterfowl breeding colony with many nests will be more conclusive than the sighting of a few waterfowl, or; dominance by wetland indicator plants in an area indicates that hydrology is the dominant environmental factor operating compared to areas where non-wetland plants dominate and wetland plants are sub-dominant. Examples of the latter include the: combination of results from a multiple soils observations conducted on site and soils mapping that indicated hydric soils in the area, or; combination of sighting of waterfowl and nests in the field with literature that suggests this is a nesting area.

5.1.2 Wetland Indicators

Indicators for the Hydrology Criterion

Hydrology is the most important environmental driver of wetlands. Ideally wetlands would be defined in terms of a hydrological regime, such as duration, timing, extent and depth and frequency of inundation or saturation. However, the hydrological regime that supports wetlands varies with wetland type, region and associated environmental factors. For example, flooding for 14 consecutive days each growing season is considered a minimum wetland hydrological regime in North America (Committee on Characterisation of Wetlands 1992), whereas, in inland Australia wetland soil characteristics can develop in areas saturated for less than five weeks every three years (Coventry and Williams 1984). This variability in saturation duration is compounded with generally little information from which to define minimum hydrological thresholds for many wetlands in Queensland. Therefore, the Definition is structured so that it requires indicators of the presence of inundation while the degree of inundation is assessed by the biotic and soils criterion. In other words, water-logging must be present for sufficient duration and/or frequency to create conditions that support wetland indicator plants, animals or soils.

Saturation in the root zone is fundamental for defining wetland hydrology (Tiner 1999). Thus water-logging generally must be within the upper 0.3 m of surface because this is the part of the substrate that influences most of the plants and animals. Inundation with water can be from a variety of sources including flooding from tidal inundation, water overflowing from water courses, or ponding by water collection in a depression or saturation from groundwater. This is consistent with the Queensland Wetland Strategy, which lists wetlands that receive water from a variety of sources (e.g. groundwater, floodplains) as well as definitions used elsewhere in Australia (Department of Land and Water Conservation 1996, Hill et al. 1996, Paijmans et al. 1985) and overseas (Ramsar Convention Secretariat 2006, Committee on Characterisation of Wetlands 1992, US Army Corps of Engineers 1987, Cowardin et al. 1979).

Direct evidence of saturation/inundation may be used as an indicator, however direct evidence is often difficult to obtain due to the temporal and spatial variability in wetland hydrology. Therefore, in the absence of direct hydrological information, the dominance of wetland plant or soil indicators, in conjunction with other indicators (e.g. landscape features and landform), may provide enough indirect hydrological evidence to determine that the hydrological criterion has been met.

Table 3. Indicators for evaluating the hydrology criterion of the Queensland Wetlands Program Wetland Definition

Indicator	Description	Considerations	Source
Water Saturation/Inundation	Direct observation of water saturation/inundation. While direct evidence of saturation may be used as an indicator, this is often difficult to obtain due to the temporal and spatial variability in wetland hydrology and because a site often needs to be evaluated at one specific point in time.	Conclusive indicator to determine if criterion is met	Field observations
Water Saturation/Inundation	Aerial or satellite imagery record, hydrological records, and/or hydrological models can be used to quantify hydrological regime if obtained as a time series.	Conclusive indicator to determine if criterion is met	Historic records Time series aerial or satellite imagery Tidal level records Stream flow records
Water Saturation/Inundation	Analysis of topographical and groundwater contours may provide an indication of inundation or water-logging.	Conclusive indicator to determine if criterion is met	Groundwater records Elevation mapping and/or models
Wetland Plant	Vegetation dominated by wetland indicator plants	Conclusive indicator to determine if criterion is met depending on evidence of hydrological modification	Field observations Flora survey records
Wetland Soil	Presence of wetland soils (see Soil Indicators of Queensland Wetlands: Field Guide (Department of Natural Resources and Water 2008))	Conclusive indicator to determine if criterion is met depending on evidence of hydrological modification	Field observations Soils mapping
Landscape Features	Landscape features including micro-relief, debil debil, algal mats, aerial roots, floodmarks, and iron staining provide supporting evidence of a current hydrologic regime.	Conclusive indicator to determine if criterion is met depending on evidence of hydrological modification	Field observations
Landform	Wetlands typically occur in topographic settings where surface water collects or groundwater discharges (Tiner 1999). Thus, landform situations such as closed depressions, oxbows and clay-pans provide a useful indication of potential inundation or saturation.	Less conclusive indicators that requires additional information to determine if criterion is met	Field observations

Indicators for the Biotic Criterion

This criterion recognises that there are species that are adapted to and dependent on living in wetland conditions for all, or at least part of, their life. Wetland ecosystems are the product of co-evolution of flora and fauna in aquatic features to produce interacting ecosystems for mutual benefit.

Plants are widely used as indicators of wetlands overseas (Tiner 1999, Reed 1988, Committee on Characterisation of Wetlands 1979) and in Australia (Department of Environment and Conservation 2007, Duguid et al. 2002, Boulton and Brock 1999, Department of Land and Water Conservation 1996, Barson & Williams 1991). This is because there is often a strong relationship between soil saturation and the development of communities dominated by plants adapted to and requiring such conditions. Plants are also useful indicators for the delineation of wetlands as many lacustrine and riverine wetland types are often fringed with palustrine wetland vegetation along their upland edge (Figure 1) that can be used to delineate wetland boundaries even for water dominated wetlands.

A list of wetland indicator plants ('Flora Wetland Indicator Species List') that are adapted to and dependent on living in wet conditions for at least part of their life is available on Wetland*Info* to help identify wetlands. While the criterion in the definition includes land that supports wetland plants, to be conclusive it is considered that the vegetation has to be dominated by such plants, as this indicates that inundation with water is the dominant factor determining the types of plant (and animal) communities associated with the site (Cowardin et al. 1979). Plant dominance is determined as the dominant species within the ecological dominant layer, defined in Queensland (Neldner et al. 2019) and Australia (Walker and Hopkins 1990) as the layer of vegetation that makes the greatest contribution to the overall biomass at a site. Vegetation is assessed as being dominated by wetland plants when the ecological dominant layer is dominated by wetland plants. As there is generally a relationship between biomass and the commonly used abundance measures of crown cover or basal area, dominance can be assessed by estimates of these abundance measures using standard methodologies (Neldner et al. 2019). Under this definition dominant species are generally tree species, where present, rather than ground layer species, which are more likely to be influenced by short term environmental fluctuations such as drought, grazing or fire.

Figure 1. Fringing palustrine vegetation at Brown Lake, North Stradbroke Island (Photo: K. Stephens). Most water-dominated wetlands are fringed by palustrine vegetation that can be used to delineate the wetland boundary.

Figure 2. A bare, dry claypan in Currawinya National Park (Photo: J. Silcock). Many ephemeral wetlands in inland Queensland that are often dry and bare of vegetation.

Wetland fauna species' ancestors are considered to originally have been entirely aquatic and some have evolved into amphibian and terrestrial fauna, with some (e.g. dolphins and dugong) readapting to an entirely aquatic lifestyle. Wetland environments where no plants exist (e.g. shoals, extensive intertidal mud flats, and very saline features) can be inhabited entirely by fauna (Figure 2). Highly mobile fauna wetland species have an advantage of moving from wetland to wetland to maximise resource use (Figure 3). Less mobile species are usually able to either burrow and aestivate until water returns, or breed and leave non-desiccating eggs. A list of wetland indicator fauna ('Fauna Wetland Indicator Species List') contains an extensive suite of wetland species that have been selected by a justification process (Figure 4) and, therefore, can be used as one line of evidence when testing a feature for wetland status. For ease of use only significant larger fauna are included in the list.

Figure 3. Mobile wetland fauna, such as magpie geese, can be found in non-wetland areas so their presence alone may not be a conclusive wetland indicator (Photo: R. Jaensch).

Figure 4. Ibis nests in a lignum swamp on the Cooper Creek floodplain (Photo: R. Jaensch). Nesting of these water birds is a conclusive wetland indicator because they are known to require at least 90 days flooding to successfully breed in lignum swamps (Thoms et al. 2007).

Table 4. Indicators for evaluating the biotic criterion of the Queensland Wetlands Program Wetland Definition

Indicator	Description	Considerations	Source
Wetland Plant	Vegetation dominated by wetland indicator plants	Conclusive indicator to determine if criterion is met	Field observation Flora survey records
Wetland Plant	Presence of any flora species, or parts of these (e.g. underground perennating plant parts and seeds, although seeds can be found anywhere floodwaters go).	Less conclusive indicators that requires additional information to determine if criterion is met	Field observation Flora survey records
Wetland Plant	Wetland or vegetation mapping	Less conclusive indicators that requires additional information to determine if criterion is met	Wetland mapping Vegetation mapping
Wetland Fauna	Species recorded at lifecycle stage known to be dependent on wet conditions	Conclusive indicator to determine if criterion is met	Field observation Fauna survey records
Wetland Fauna	Species known to be dependent on wetlands for all stages of their lifecycle	Conclusive indicator to determine if criterion is met	Field observation Fauna survey records
Wetland Fauna	Presence of any species that are not confined to a wetland for all of life, or evidence of fauna (e.g. eggs, skeleton remains or shells)	Less conclusive indicators that requires additional information to determine if criterion is met	Field observation Fauna survey records

Indicators for the Soil Criterion

Comprehensive documents on Soil Indicators of Queensland Wetlands (Bryant et al. 2009) that details a state-wide assessment of wetland soil indicators and the accompanying Soil Indicators of Queensland Wetlands: Field Guide (Department of Natural Resources and Water 2008) have been prepared to support the interpretation of the Definition with respect to hydric soils. The field guide includes a key to help identify and delineate wetland soils and provides a user-friendly system for applying soil indicators to assist wetland identification across Queensland. These documents define the upper layer of soil as generally within 0.3 m of the surface but may be deeper if overlain by permeable material. Soil indicators may vary with climatic region, wetland system, and/or by inundation frequency.

Table 5. Indicators for evaluating the soil criterion of the Queensland Wetlands Program Wetland Definition

Indicator	Description	Considerations	Source
Wetland Soil	The presence of an accumulation of organic materials, and/or sulfidic materials and gleyed soil matrix colours.	Conclusive indicator to determine if criterion is met	Field observations Soil mapping and data
Wetland Soil	The presence of redox features (e.g. mottles, segregations, ferruginous root channel or pore linings, or decreasing soil matrix chroma) may indicate a current or relict hydrologic regime and require careful consideration against the current hydrologic regime.	Less conclusive indicators that requires additional information to determine if criterion is met	Field observations Soil mapping and data

Indicators for the Non-Soil, Non-Biotic Criterion

Some obvious wetland features in Queensland have no vegetation or soil present and cannot be consistently identified from fauna indicators. These features include water in a channel (e.g. rocky riverbeds, waterfalls, boulders, headwaters, etc.) and subterranean wetlands. When water is outside a channel, the intent is to capture features such as gamma holes, beaches and similar water holding depressions. Features not included in this criterion include areas with banks and bed made from artificial materials.

Table 6. Indicators for evaluating the non-soil, non-biotic criterion of the Queensland Wetlands Program Wetland Definition

Indicator	Description	Considerations	Source
Landscape Feature	The presence of beds and banks of creeks, rivers, and other drainage lines.	Conclusive indicator to determine if criterion is met	Field observations
Landscape Feature	Beaches below Highest Astronomical Tide but exposed at low tide.	Conclusive indicator to determine if criterion is met	Field observations Tidal records

5.2 Sources of Information

The Queensland Government provides public access to a wide range of spatial and non-spatial data and information via the Queensland Globe, WetlandMaps, Queensland Spatial Catalogue, Queensland Open Data Portal, WetlandInfo, QImagery, and Queensland Government Publications. Useful sources of existing information to consider include:

- aerial photography and satellite imagery of the site through time (QImagery)
- data and mapping
- wetland mapping (e.g. Queensland Wetland Data)
- vegetation mapping (e.g. Biodiversity of Pre-Clearing and Remnant Regional Ecosystems)
- flora and fauna survey data (e.g. Queensland CORVEG Database, WildNet database)
- elevation mapping (e.g. digital elevation models, contours)
- hydrological mapping (e.g. flow directed watercourse networks, hydrographic features)
- biogeographic data (e.g. biogeographic region and subregions)
- climatic data (e.g. climate, recent weather)
- flood mapping
- geological mapping
- land use mapping
- soil mapping and data (e.g. Soil and Land Information database)
- topographical mapping (contours, digital elevation models, flow accumulation models)
- Several resources are available on wetland indicators and survey methods and standards including:
  - Fauna Wetland Indicator Species List compiled to support the determination of wetland status for a site
  - Flora Wetland Indicator Species List compiled to support the determination of wetland status for a site
  - Soil Indicators of Queensland Wetlands (Bryant et al. 2009) that details a state-wide assessment of wetland soil indicators and the accompanying Soil Indicators of Queensland Wetlands: Field Guide (Department of Natural Resources and Water 2008)
- National soil and land survey methodologies provided in the Australian Soil and Land Survey Handbooks Series which can be purchased from CSIRO Publishing. Key products include:
  - the Australian Soil and Land Survey Field Handbook (National Committee on Soil and Terrain 2009) that provides a reference set of definitions for the characterisation of landform, vegetation, land surface, soil and substrate
  - the Guidelines for Surveying Soil and Land Resources (McKenzie et al. 2008) that promote the development and implementation of consistent methods and standards for conducting soil and land resource surveys in Australia
  - The Australian Soil Classification (Isbell & National Committee on Soil and Terrain 2016) which is also available as an online version from CSIRO
- Information from those who are recognised as having sound local knowledge of the site
- Methodology for Surveying and Mapping Regional Ecosystems and Vegetation Communities in Queensland (Neldner et al. 2019)

5.3 Scale

Scale is an essential consideration when applying the Definition for mapping and on-ground (i.e., field) assessment. Scale refers to the relationship between distance on a map and the corresponding distance on the ground. A larger scale has a smaller ratio between the distance on a map and the corresponding distance on the ground and therefore can capture smaller sized features in comparison to a smaller scale. The identified scale also determines the minimum size of wetland and non-wetland features that can be delineated at a site and the positional accuracy of a mapped boundary line (Table 7).

Table 7. Recommended data resolution for various map scales (adapted from Neldner et al. 2019)

	Minimum Size on Map	1:5,000	1:10,000	1:25,000	1:50,000	1:100,000	1:250,000
Area of smallest feature depicted	2 x 2 mm	0.05 ha	0.1 ha	0.25 ha	1 ha	4 ha	25 ha
Minimum width of linear features depicted	1 mm	5 m	10 m	25 m	50 m	100 m	250 m
Precision of line-work	±0.5 mm	5 m	10 m	25 m	50 m	100m	250 m

The appropriate scale for definition and delineation of wetlands will vary with the purpose of investigation and the characteristics of the site. Identifying an appropriate scale determines the minimum size of an area that can be identified under the Definition because smaller wetlands become distinguishable from the surrounding land only at certain scales. For example, a smaller scale may be appropriate for studies of frog habitat, wetland rehabilitation mapping, or road surveying, while a larger scale may be appropriate for studies of small, isolated, high value wetlands (e.g., spring wetlands) to enable their delineation. More detailed aerial or satellite imagery and/or field assessment can be used to distinguish smaller or more complex wetland systems. However, there is always a lower limit to the appropriate scale to use, beyond which the application of the Definition will separate out components within a community rather than different communities. Figure 5 shows several small areas (in yellow) within a larger wetland (in blue) that has been identified and delineated at a scale of 1:25,000. The small areas are below the minimum size of features delineated at the chosen scale (i.e., < 0.25 ha) so it is appropriate to consider and assess them as part of the larger delineated wetland.

Figure 5. Features below the minimum size of the specified scale can be appropriately considered and assessed as part of the larger delineated wetland.

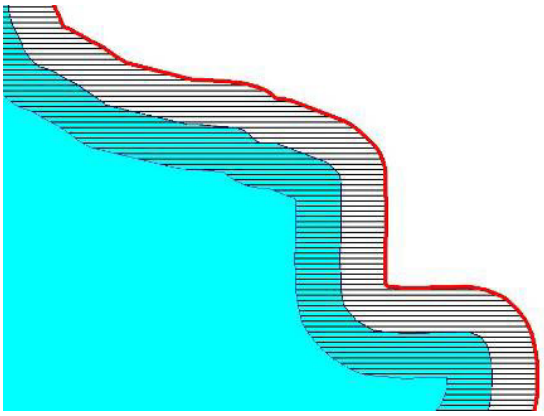


Figure 6. Wetland delineation line showing buffer that must be left to allow for specified error estimate.

State-wide wetland mapping and classification has been conducted for Queensland through the QWP at a scale of 1:100,000 to 1:25,000. Therefore, where larger scale mapping has occurred (e.g., Brisbane) wetlands larger than 0.25 ha or 25 m wide are distinguishable. Where smaller scale mapping has occurred, wetlands larger than 1 to 5 ha or 50 to 100 m wide are distinguishable. Generally, for state-wide assessment purposes an assessment or mapping scale of 1:25,000 that identifies areas to a minimum size of 0.25 ha is appropriate (Figure 6).

5.3.1 Mosaic Area

Mosaic areas is a term used to refer to areas defined at a specified scale that contain a mixture or mosaic of vegetation communities (Neldner et al. 2019). Mosaic wetland areas are mosaic areas that contain a mixture or mosaic of wetland and non-wetland vegetation communities. For example, the complex patterning in the channel country (Figure 6) where the green areas are lower, more frequently inundated, and support wetland plants and develop hydric soil characteristics are mixed with greyer areas that are higher, less inundated and support terrestrial plants and soils that do not exhibit hydric characteristics. At 1:25,000 the defined area contains a mixture or mosaic of green, frequently inundated palustrine wetland communities and grey, less frequently inundated non-wetland vegetation communities that cannot be spatially separated at the chosen scale. However, at a larger scale the area could be spatially delineated into separate areas of wetland and non-wetland communities.

Figure 8. Complex patterning of palustrine wetland and non-wetland vegetation on the Cooper Creek (Photo: B Wilson)

Mosaic wetland areas where wetland vegetation communities occupy greater than 50% of the defined area are defined as a wetland at the specified scale. In instances where wetland vegetation communities occupy 50% or less of the defined area, mosaic wetland areas are defined as containing wetlands at the specified scale.

5.3.2 Mosaic Ecosystem

Mosaic ecosystem refers to a single vegetation community that contains a mixture or mosaic of wetland and non-wetland components. These are distinguished from mosaic wetland areas as the scale required to spatially delineate wetland and non-wetland is beyond the appropriate scale to use the Definition and the application of the Definition would result in the separation of components within a community rather than different vegetation communities.

5.4 Process to Apply the Queensland Wetlands Program Definition

The QWP Wetland Definition is applied using a four-step process in which evidence is systematically collected and evaluated to determine whether the definition is satisfied and therefore, whether a feature is or is not a wetland. The following section provides general guidance only. Readers should refer to the Queensland Wetland Delineation and Mapping Guideline (Department of Environment and Science 2023a) and other sources for detailed sampling methodologies.

The process involves knowing and understanding the definition, planning of the investigation of a potential wetland feature, conducting the investigation and recording information, and applying the wetland decision tree. Once it has been determined that a wetland exists, the data recorded during the investigation can be used for related assessments to better understand the wetland such as delineating its extent, classification, and assessing its values.

5.4.1 Knowing and understanding the definition

Knowing and understanding the Definition, its features, and terminology is essential to being able to apply it correctly. Refer to sections 3.1 and 3.2 to extend understanding of the Definition and ensure an understanding of the meaning of terms used within the Definition and ensure they can be interpreted appropriately.

The QWP defines wetlands using ecological principles in a more systematic way than earlier definitions. In some cases, the application of the Definition is still likely to require assistance by experts taking note of the intent and values upon which the Definition is based.

5.4.2 Planning the investigation of a potential wetland feature

The investigation of a potential wetland feature will generally involve the consideration of existing information about the site and recording of new information during field work. It is important to:

- specify the purpose of the investigation, why the investigation is required
- identify what existing data is available
- review available biogeographic, climatic, ecological, and hydrological data including existing wetland mapping and aerial or satellite imagery
- develop a site description including location, climate, recent weather, geology, position within catchment and proximity to other known or potential wetland features, current and past uses, cultural characteristics, and artificial constructions.
- determine what data is required and what data is recordable
- determine the scale of the investigation and what accuracy is appropriate according to the investigation purpose. For example, an urban local government may need to consider wetlands at a more detailed scale for assessing development proposals at the property level than a regional planner who is developing a plan for a large river basin.
- determine how the resulting information will be used for applying the definition and other related assessments (see Section 3)
- determine the scale and position of the wetland site; where and how the wetland sits within the surrounding landscape including overall landform, hydrology, position within the catchment, etc.
- consider the wetland condition with regard to season (e.g. what migratory species will be present or absent), weather conditions, previous rainfall, flooding, drought, cyclonic wind damage, bush fire frequency and currency, tide, human interference (e.g. vegetation clearing, cutting-filling and hydrological alterations)
- decide if a survey is the most appropriate action, and if so:
    - determine the type of survey to define wetland type and existence (e.g. series of transects or other survey methods that best fit data recording objectives)
    - determine whether a single survey or several surveys are required according to the investigation purpose
    - determine the optimal times and durations to survey based on expected flora and fauna, potential breeding activity, and whether nocturnal surveys are necessary
    - determine whether the survey is a single disciplinary project or a multidisciplinary project (flora, fauna, soil, water, other data)
    - select the required personnel and equipment (including safety precautions, arrangements, and equipment)

Preparation for the field work is important to achieve the required outcomes. Field work requires careful planning, and the data collection increases in rigour when recorded over more than one site visit. It is beneficial to separate some activities from others that may disrupt or influence the outcomes. For example, combining some soil sampling techniques (e.g., mechanical coring) with bird or ground reptile surveys may be inconsistent with proper fauna observation due to the mechanical noise and vibrations that may bias the survey by preventing identification by call (e.g., bird calls), disturbing and/or causing some fauna to hide or leave. Some fauna surveys might require particular times when the fauna are present and observable, such as after rain, at night, or around dawn, and this may not fit with other survey techniques.

Climatic and seasonal events must be considered when planning and surveying because many wetlands and wetland processes are ephemeral. Therefore, the past and current climatic conditions and seasonal rainfall is very important to consider. Flooding and drought events can alter wetlands which then display vastly differing physical and ecological characteristics. Wetlands can progress from being difficult to identify and characterise because they are dry, to being difficult to identify because of flooding, within a few hours. A range of conceptual models are available on Wetland*Info* website to support consideration of climatic and seasonal events.

5.4.3 Conducting the investigation and recording information

On arrival at the site, check that the wetland condition is as expected and that any alterations are not so severe that the survey purpose is compromised. If proceeding with the survey, the site description should be modified as necessary to reflect actual conditions. To accurately investigate and record information:

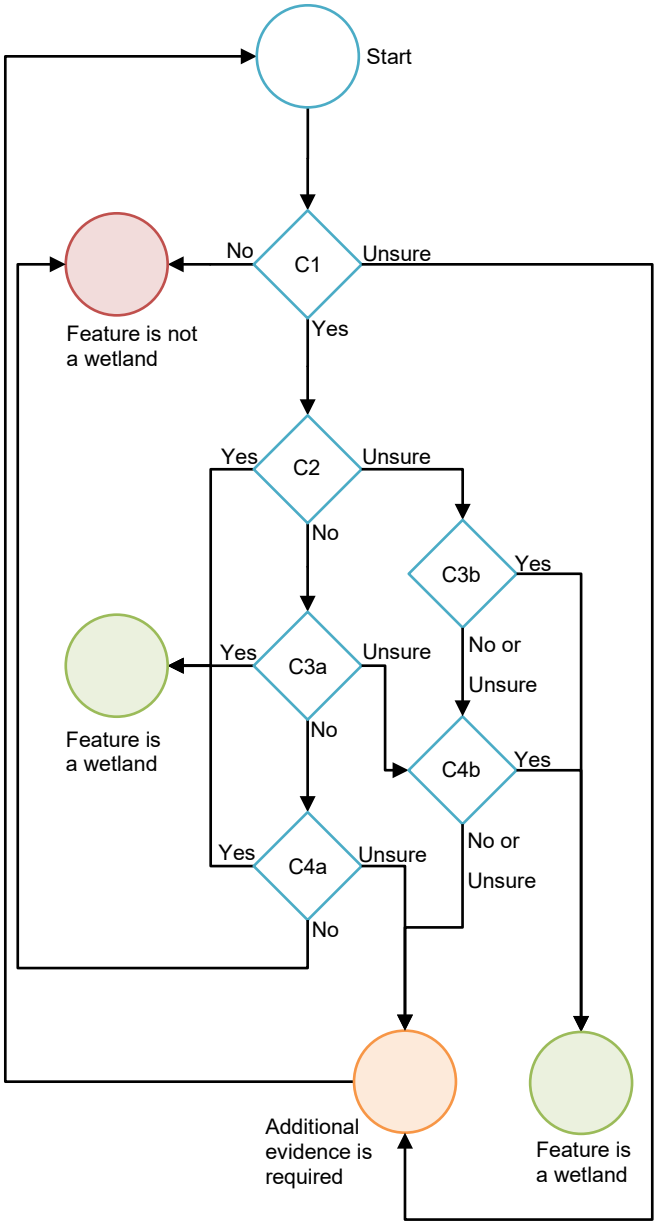
- fit the field surveys for optimum data rigour and organise the field data recording accordingly
- record habitat structure including dominant, overstorey, understorey, and groundcover, both within the proposed wetland and in adjacent area
- record information that relates to the wetland criteria set out in the QWP Wetland Definition: inundation, wetland plants or animals, wetland soils, and saturation of the substratum

The investigation should include sources of information identified during planning (e.g., literature, imagery, government documents, species lists, mapping and data products, etc.) as well as field data recorded from the site itself. Appropriate care should be taken with the use of existing information considering its accuracy, currency, and scale. Therefore, Queensland Wetlands Data should not be relied upon as the sole evidence of a wetland location. Identification and survey of wetland indicators using the process outlined in this section will be needed to map a more accurate wetland boundary at larger scales.

5.4.4 Applying the wetland decision tree

The wetland decision tree is applied to the collected information to determine whether a feature is a wetland in accordance with the QWP Wetland Definition. Available evidence should be assessed against each criterion even where it may not be required to determine whether the feature is a wetland as it provides a full appreciation of the feature's standing as a wetland. The wetland decision tree process should be repeated if an initial assessment of a site has identified inconclusive wetland indicator and/or the process identified the need for additional evidence.

Figure 9. The wetland decision tree for assessing whether a feature is a wetland in accordance with the Queensland Wetlands Program Wetland Definition (adapted from Department of Environment and Resource Management 2011).



Criterion 1

Does the evidence support the statement "areas of permanent or periodic/intermittent inundation, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 metres"?

Criterion 2

Does the evidence support the statement "the land supports, at least periodically, plants or animals that are adapted to and dependent on living in wet conditions for at least part of their life cycle"?

Criterion 3 (a and b)

Does the evidence support the statement "the substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers"?

Criterion 4 (a and b)

Does the evidence support the statement "the substratum is not soil and is saturated with water, or covered by water, at some time"?

Criterion 1 (C1). Does the evidence support the statement "areas of permanent or periodic/intermittent inundation , with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 metres"?

Yes……Proceed to Criterion 2

No……Feature is not a wetland

Unsure……Additional evidence is required

Criterion 2 (C2). Does the evidence support the statement "the land supports, at least periodically, plants or animals that are adapted to and dependent on living in wet conditions for at least part of their life cycle"?

Yes……Feature is a wetland

No ……Proceed to Criterion 3a

Unsure……Proceed to Criterion 3b

Criterion 3a (C3a). Does the evidence support the statement "the substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers"?

Yes……Feature is a wetland

No ……Proceed to Criterion 4a

Unsure……Proceed to Criterion 4b

Criterion 3b (C3b). Does the evidence support the statement "the substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers"?

Yes……Feature is a wetland

No ……Proceed to Criterion 4b

Unsure……Proceed to Criterion 4b

Criterion 4a (C4a). Does the evidence support the statement "the substratum is not soil and is saturated with water, or covered by water, at some time"?

Yes……Feature is a wetland

No ……Feature is not a wetland

Unsure……Additional evidence is required

Criterion 4b.(C4b) Does the evidence support the statement "the substratum is not soil and is saturated with water, or covered by water, at some time"?

Yes……Feature is a wetland

No …… Additional evidence is required

Unsure……Additional evidence is required

5.5 Related assessments

Once the wetland has been identified, information collected as part of this process can be used for other purposes as described below.

5.5.1 Delineation

Often it is important not just to identify the presence of a wetland but to delineate the wetlands, that is, to establish and describe the boundary between wetlands and non-wetland areas. In many situations there may be agreement about the existence of a wetland but disagreement about how far the wetland extends towards the terrestrial boundary. The Queensland Wetland Delineation and Mapping Guideline (Department of Environment and Science 2023a), the guideline for survey and delineation of wetlands, provides more detailed methodology.

5.5.2 Classification

The QWP Wetland Definition provides a basis for determining if an area is a wetland or not but does not provide a classification system that can be used to characterise and describe different types of wetlands. For many purposes it is useful to classify and group the diversity of wetlands into broad types. There are many ways to classify wetlands depending on the purpose. The Queensland Wetland Mapping and Classification Methodology (Department of Environment and Science 2023b) provides more detail on the broadest level of classification used in Queensland to discriminate wetland systems and to subdivide the wetland systems based on attributes such as water regime, salinity, climatic zone, vegetation and geomorphology.

5.5.3 Values

Establishing whether a feature is or is not a wetland and assessing its values (e.g. environmental, economic, recreational, socio-cultural, etc.) are separate assessments. Although wetland values do not form or directly influence the use of the Definition, it is often the values of a wetland that make its identification and delineation important.

Wetland values include any aspect of wetland ecology, health, or economics, and can also encompass public amenity and safety. In natural wetland systems, wetland functions (or processes) can be considered wetland values that should be managed or protected in any wetland, as they are necessary for the other values of the wetland to be maintained. For example, a wetland's hydrological value can be compromised by draining or water diversion, this in turn will impact on other wetland values such as the capacity for the wetland to carry out nutrient cycling and/or the provision of habitat. Wetland functions that should be managed or protected include hydrology, food webs, habitats, nutrient cycling, and sediment trapping and stabilisation. Further information on wetland values can be found on the Wetland*Info* website. These values can be used as the starting point for identifying the environmental values of a specific wetland.

5.5.4 Condition

Information collected as part of wetlands identification may also be used for other assessment purposes including the monitoring of wetland extent and condition.

5.6 Difficulties associated with applying the Queensland Wetlands Program Wetland Definition

Sometimes using the criteria and indicators in this document to identify and determine wetland boundaries can be difficult or result in inconsistent determinations. Examples of situations where this can occur include wetlands that have been modified, are predominantly ephemeral, where there is a broad ecotone (i.e., transition zone) between the wetland and adjacent landscape, or where the scale of assessment makes it difficult to determine if an area is identified as a wetland or not. The following sections provide details on undertaking assessments in some of these situations.

5.6.1 Floodplains

Floodplains are alluvial plains characterised by frequently active erosion and aggradation by channelled over-bank stream flow. The area inundated by floodwater may include various landform elements associated with floodplains such as stream channel (i.e., stream bed and bank), plain, bar, scroll, levee, back plain, swamp, oxbow and lakes. Flooding presents challenges to identifying features of the landscape that are wetlands, adjacent to wetlands, or that are not wetlands. When floodwaters recede, the highest parts of the floodplain are drained and exposed to drying first, while the lower features within the floodplain hold floodwater for a longer period. Although periodically inundated, many parts of a floodplain do not remain wet for long enough to generate anaerobic wetland soils or to host obligate wetland species. Hence, according to the QWP Wetland Definition, many parts of floodplains are not wetlands though a floodplain may contain large areas of wetlands (sometimes referred to as floodplain wetlands).

5.6.2 Ephemeral wetlands

The arid regions of Queensland commonly contain wetlands that naturally dry up entirely. These wetlands may often be dry for years and may only be wet for a short period (i.e., ephemerally). This makes their identification difficult. Some of these sites will require careful analysis and expertise to identify and include when dry. Often wetlands soils may indicate that a wetland exists. Other indicators may be identifiable remains of wetland plants and animals. These include traces of plants or seeds within the soil, the presence of shells, bones or scales of wetland animals (such as mussels, snails, crabs, crayfish, turtles and fish), the presence of eggs in the soil with some species may be underground waiting for the water's return, and traces of obligate animal burrows.

5.6.3 Modified or disturbed wetlands

Natural wetlands may be modified or disturbed through human activities to such an extent that, although still wetlands, they may be difficult to identify as such. For example, modification can occur when wetlands are cleared of their native vegetation, drained for long periods, filled, modified by urban, commercial, or industrial development, or have been laser levelled, ploughed, and cropped. In some cases, modification may have resulted in a change of wetland type, condition, or values. Conversely, areas that have been drained may exhibit wetland indicators, such as hydric soils, which are relicts and no longer reflect the current hydrological regime. Applying the QWP Wetland Definition to highly modified wetlands require careful investigation and recognition that some wetland attributes or processes have changed in nature but still may be present and active in the area of interest.

5.6.4 Artificial wetlands

An artificial wetland is taken to mean one built where there was no wetland prior to the construction. This differs from a modified wetland where a pre-existing wetland has been modified through construction, extraction, etc. Artificial wetlands meet the QWP Wetland Definition and incidentally provide some wetland values (e.g., aquatic flora and waterbirds using a water treatment facility); however, this is not their primary purpose.

Some examples of artificial wetlands that can provide wetland values include: large water storage areas (ring tanks); ponds, farm dams, stock ponds; aquaculture ponds; irrigated land and channels (including tail-water recycling systems); and seasonally flooded farm land (including ponded pastures). These areas can mimic natural wetland processes, such as trapping sediment, nutrient processing, and attenuation (slowing) of overland flows, or provide habitat for plants, birds and fish. There can be many variations in the values provided by artificial (or natural) wetlands and in some cases artificial wetlands can provide higher quality habitat than some natural wetlands.

Artificial waterbodies where its base and sides (i.e., bed and banks) are fully constructed of artificial materials such as concrete, metals, fibreglass, synthetic geotechnical materials and composites are not included in the QWP Wetland Definition. These artificial constructions with an artificial base and sides (i.e., bed and banks) are not included because they are not 'wet lands' and as such generally function in an artificial way with very different values to wetlands. Examples of constructed water bodies with artificial bases and sides include swimming pools, some water channels, some reservoirs, and constructed irrigation viaducts and piped watercourses.

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7 Acronyms and Abbreviations

Acronym or Abbreviation	Acronym or Abbreviation Name
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DIWA	Directory of Important Wetlands in Australia
QWP	Queensland Wetlands Program
sp.	Species
Spp.	Several species

8 Units of Measurement

Unit of Measurement	Unit of Measurement Name
%	Percent
‰	Per mille (i.e. parts per thousand)
cm	Centimetre
ha	Hectares
km	Kilometre
m	Metre
mm	Millimetre
mS/cm	Millisiemens per Centimetre
ppt	Parts per Thousand
uS/cm	Microsiemens per Centimetre

9 Glossary

Term	Definition
Accuracy	"The condition or quality of being accurate; precision or exactness" (Yallop 2005)
Adapted	See 3.2.2 Terms used in the biotic criterion
Aerial Root	Aerial roots are an adaptation of plants to a waterlogged environment (Department of Natural Resources and Water 2008).
Aestivate	"To enter into a dormant condition in response to high temperatures and aridity" (Yallop 2005).
Aggradation	To raise the level of a stream bed by depositing detritus (Yallop 2005).
Amphibian Fauna	Living both on land and in water (Yallop 2005).
Anaerobic	Without free, available oxygen (Yallop 2005).
Anaerobic conditions	See 3.2.3 Terms used in the soil criterion.

Animals	See 3.2.2 Terms used in the biotic criterion
Aquatic	Of or relating to water or living or growing in water (Yallop 2005)
Areas	See 3.2.1 Terms used in the hydrology criterion
Artificial	Made by human skill and labour, as opposed to natural (Yallop 2005)
Artificial Wetland	Within this guideline the term ‘artificial wetland’ refers to a wetland that is human made to substantially provide the ecosystem services of a wetland. See 5.6.4 Artificial wetlands.
Attenuation	To weaken or reduce in force, intensity, effect, quantity, or value (Yallop 2005)
Attributes	"Descriptive characteristics or features of…ecosystems" (Department of Environment and Science 2020a)
Back Plain	"Large flat resulting from aggredation by over-bank stream flow at some distance from the stream channel and in some cases biological (peat) accumulation; often characterised by a high water table and the presence of swamps or lakes" (National Committee on Soil and Terrain 2009).
Bank	"Very short, very wide slope, moderately inclined to precipitous, forming the marginal upper parts of a stream channel and resulting from erosion and aggradation by channelled stream flow" (National Committee on Soil and Terrain 2009).
Bar	"Elongated, gently to moderately inclined low ridge built up by channelled stream flow" (National Committee on Soil and Terrain 2009).
Basal Area	"A measure of the total cross-section area of stems at breast height (1.3 metres above the ground)" (Neldner et al. 2019).
Basin	See 'Catchment'
Bay	"A bay is a well-marked indentation whose penetration is in such proportion to the width of its mouth as to contain land locked waters and constitute more than a mere curvature of the coast. An indentation shall not, however, be regarded as a bay unless the area is as large as or larger than that of a semi-circle whose diameter is a line drawn across the mouth of that indentation." (Environmental Protection Agency 2005b)
Beach	"Short, low, very wide slope, gently or moderately inclined, built up or eroded by waves, forming the shore of a lake or sea" (National Committee on Soil and Terrain 2009).
Bed	"Linear, generaly sinuous open depression forming the bottom of a stream channel eroded and locally excavated, aggraded or built up by channelled stream flow." (National Committee on Soil and Terrain 2009).
Biodiversity	"Biodiversity (or biological diversity) is the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species (genetic diversity), between species (species diversity), of ecosystems (ecosystem diversity), and of ecological processes." (Aquatic Ecosystems Task Group 2012)
Biogeographic region	An area of land that is dominated by similar broad landscape patterns that reflect major structural geologies and climate, as well as major floristic and faunal assemblages (Sattler and Williams 1999).
Biomass	The quantity of living matter contributed to a given habitat [or ecosystem] by one or several kinds of organism (Yallop 2005).
Biota	The total animal and plant life (Yallop 2005).
Bog	"A peatland that is nutrient poor because it lacks access to substantial quantities of mineral-rich water" (Brinson 1993). This term is not commonly used in Queensland.
Brackish	See 3.2.1 Terms used in the hydrology criterion

Catchment	The total area draining into a river, reservoir or other body of water (Australian and New Zealand Environment and Conservation Council, and Agriculture and Resource Management Council of Australia and New Zealand 2000).
Channel	"Linear, generally sinuous open depression in parts eroded, excavated, or built up by channelled stream flow. This element comprises stream bed and banks" (National Committee on Soil and Terrain 2009).
Channel bank	See 'Bank'
Classification	"A process of simplifying complex, and sometimes continuous, data and information and converting it into practical categories to make it more usable." (Department of Environment and Science 2020a)
Community	An assemblage of organisms characterised by a distinctive combination of species occupying a common environment and interacting with one another (Australian and New Zealand Environment and Conservation Council, and Agriculture and Resource Management Council of Australia and New Zealand 2000).
Continental Shelf	"Portion of a continent submerged under relatively shallow sea" (Yallop 2005)
Contour	"A line joining points of equal elevation on a surface" (Yallop 2005)
Covered by water at some time	See 3.2.4 Terms used in the non-soil, non-biotic criterion
Criteria	See 'Criterion'.
Criterion	"An established rule or principle for testing anything" (Yallop 2005).
Crown cover	*"Sensu* Walker and Hopkins (1991) is the percentage of the ground surface covered by the vertical projection of the periphery of plant crowns. Crowns are treated as opaque meaning that small gaps within the crown are ignored. Crown cover (%) of a stratum is measured for the stratum as a whole i.e. ignoring crown overlaps within a stratum." (Neldner et al 2019)
Currency	The fact or state of passing in time (Yallop 2005)
Current	A portion of a large body of water, or of air, etc., moving in a certain direction (Yallop 2005)
Debil Debil	"Small hummocks rising above the planar surface. They vary from rounded, both planar and vertically, to flat-topped, relatively steep-sided and elongate. They are usually closely and regularly spaced, ranging from 0.06 m to 0.6 m in both vertical and horizontal dimensions." (National Committee on Soil and Terrain 2009).
Delineation	To trace the outline of; sketch or trace in outline; represent pictorially (Yallop 2005). In this document, delineation relates to the process of establishing and describing the boundary between wetland and non-wetland ecosystems.
Dependent	See 3.2.2 Terms used in the biotic criterion
Depression	"Landform element that stands below all, or almost all points in the adjacent terrain" (National Committee on Soil and Terrain 2009).
Depression (Closed)	"A closed depression stands below all such points [in the adjacent terrain" (National Committee on Soil and Terrain 2009).
Depression (Open)	"An open depression extends at the same elevation, or lower, beyond the locality where it is observed" (National Committee on Soil and Terrain 2009).
Dominant species	Species that contributes most to the overall aboveground biomass of a particular stratum. (Neldner et al. 2019)
Drought	Prolonged dry weather; lack of rain in a region (Yallop 2005)
Ecologically dominant	The layer or species making the greatest contribution to the overall biomass of the site and the

layer	vegetation community (National Land and Water Resources Audit 2001).
Ecosystem	"An ecosystem is a dynamic combination of plant, animal and micro-organism communities and their non-living environment (e.g. soil, water and the climatic regime) interacting as a functional unit." (Aquatic Ecosystems Task Group 2012)
Ecotone	The transition zone between two plant communities (Yallop 2005)
Emergent Layer or Species	The tallest layer/stratum is regarded as the emergent layer if it does not form the most above-ground biomass, regardless of its canopy cover (Neldner et al. 2019)
Emergent Vegetation	See 'Emergent Layer or Species'
Ephemeral	Lasting only a day or a very short time; short-lived; transitory (Yallop 2005)
Episodic	Dry most of the time with rare and very irregular wet phases (Paijmans et al. 1985).
Erosion	The process by which the surface of the earth is worn away by the action of water, glaciers, winds, waves, etc. (Yallop 2005)
Estuarine system	See 4.1 Estuarine Wetland System
Estuary	See 4.1 Estuarine Wetland System
Evaporation	The act or processs of turning to vapour; pass off in vapour (Yallop 2005)
Fauna	See 'Animals'
Feature	Refers to the actual wetland feature
Fen	"A peatland that is fed by groundwater." (Brinson 1993). Fens are shallow, swampy, peat-forming wetlands that are fed by water sources other than precipitation, usually from upslope surface water or groundwater sources. This term is not commonly used in Queensland, however, some fens (known as patterned fens) occur in Queensland and are characterised by vegetated bed ridge systems separated by less productive hollows.
Flat	"Planar landform element that is neither a crest nor a depression and is level or very gently inclined" (National Committee on Soil and Terrain 2009)
Flooded	See 3.2.3 Terms used in the soil criterion
Floodplain	Alluvial plain characterised by frequently active erosion and aggradation by channelled or over-bank stream flow. Unless otherwise specified, ‘frequently active’ is to mean that flow has average recurrence interval of 50 years or less (National Committee on Soil and Terrain 2009).
Floodplain Wetlands	Wetlands, including lacustrine, palustrine and riverine wetland systems, that occur on a floodplain.
Flowing	See 3.2.1 Terms used in the hydrology criterion
Fresh	See 3.2.1 Terms used in the hydrology criterion
Geologic	Of or relating to the earth, the rocks of which it is composed, and the changes which it has undergone or in undergoing (Yallop 2005).
Geomorphic	Of or relating to the characteristics, origin, and development of landforms (Yallop 2005).
Gleyed Soil Matrix	A gleyed soil matrix is a bluish-grey or grey colour that occupies 50 % or more of a layer starting within 0.3 m of the soil surface (Department of Natural Resources and Water 2008)
Groundwater	Water that is present in the pores and cracks of the saturated and capillary zones of soils, regolith and rocks and water that is present in caves (Glanville et al. 2015)
Habitat	"The environment where an organism or ecological community exist and grows for all or part of its life" (Aquatic Ecosystems Task Group 2012).

Highest astronomical tide	The highest level that can be predicted to occur under average meteorological conditions and any combination of astronomical conditions (Environmental Protection Agency 2005b).
Hydric soil	Soils that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part of the soil (Department of Natural Resources and Water 2007)
Hydrologic	Of or relating to water on the land, or under the earth's surface, its properties, laws, geographical distribution, etc. (Yallop 2005).
Indicator	Organism, ecological community, or structural feature so strictly associated with a particular environmental condition that its presence indicates the existence of the condition.
Intermittent	See 3.2.1 Terms used in the hydrology criterion
Intertidal	"Part of the shoreline that is found between the high tide and low tide, experiencing fluctuating influences of land and sea" (Department of Environment and Science 2020a)
Inundation	See 3.2.1 Terms used in the hydrology criterion
Inventory	"Involves the recording of standardised data about a taxonomic group, habitat or ecosystem from available data sources or through survey" (Department of Environment and Science 2020a)
Lacustrine system	See 4.3 Lacustrine Wetland System
Landform	Any of the numerous features which make up the surface of the earth (Yallop 2005)
Landform Element	A landform element is a sub-component of a landform type that can be characterised mainly by its morphology (shape, steepness, orientation, moisture regime) (Macmillian & Shary 2009)
Lentic	Pertaining to, or living in, still, freshwater in lakes and ponds. (Yallop 2005).
Levee	"Very long, very low, nearly level sinuous ridge immediately adjacent to a stream channel, built up by over-bank flow. Levees are built, usually in pairs bounding the two sides of a stream channel, at the level reached by frequent floods." (National Committee on Soil and Terrain 2009).
Life cycle	See 3.2.2 Terms used in the biotic criterion
Lotic	Pertaining to, or living in, flowing water. (Yallop 2005).
Low tide	See 3.2.1 Terms used in the hydrology criterion
Lowest Astronomical Tide	The lowest level that can be predicted to occur under average meteorological conditions and any combination of astronomical conditions (Australian Hydrographic Office n.d.).
Map	Graphic representation that facilitate a spatial understanding of things, concepts, conditions, processes, or events in the human world (Harley and Woodward 1987).
Mapping	See 'Map'
Marine system	See 4.4 Marine Wetland System
Marine water	See 3.2.1 Terms used in the hydrology criterion
Marsh	"A wetland with emergent, herbaceous vegetation." (Brinson 1993). This term is not commonly used in Queensland.
Mean High Water Springs	"Long term average of the heights of two successive high waters during those periods of 24 hours (approximately once a fortnight) when the range of tide is greatest, at full and new moon" (Environmental Protection Agency 2005b)
Micro-Relief	"Microrelief refers to relief up to a few metres about the plane of the land surface" (National Committee on Soil and Terrain 2009)

Mixohaline	Water with salinity of 0.5 to 30 ‰, due to ocean salts. (Cowardin et al. 1979)
Mosaic Wetland	See 5.3 Scale.
Mud	"Wet soft earth composed predominantly of clay and silt-fine mineral sediments less than 0.074 mm in diameter (Black 1968; Liu 1970)" (Cowardin et al. 1979).
Not soil	See 3.2.4 Terms used in the non-soil, non-biotic criterion
Obligate	Restricted to a particular condition of life (Yallop 2005)
Oceanic Water	See 'Marine Water'
Organic carbon	Generally carbon which is chemically bonded to other carbon atoms, although methane (one carbon atom only) and its derivatives are considered organic (Australian and New Zealand Environment and Conservation Council, and Agriculture and Resource Management Council of Australia and New Zealand 2000).
Organic materials	These are plant-derived organic accumulations that are either: a) saturated with water for long periods or are artificially drained and, excluding live plant tissue, (i) have 18% or more organic carbon [Walkley-Black x 1.3 or a total combustion method. (Rayment and Higginson 1992, Methods 6A1 or 6B2).] if the mineral fraction is 60% or more clay, (ii) have 12% or more organic carbon if the mineral fraction has no clay, or (iii) have a proportional content of organic carbon between 12 and 18% if the clay content of the mineral fraction is between zero and 60%; or b) saturated with water for no more than a few days and have 20% or more organic carbon (Isbell and National Committee on Soil and Terrain 2016).
Organosol	Soils that are not regularly inundated by saline tidal waters and either: i. Have more than 0.4 m of organic materials within the upper 0.8 m. The required thickness may either extend down from the surface or be taken cumulatively within the upper 0.8 m. or ii. Have organic materials extending from the surface to a minimum depth of 0.1 m; these either directly overlie rock or other hard layers, partially weathered or decomposed rock or saprolite, or overlie fragmental material such as gravel, cobbles or stones in which the interstices are filled or partially filled with organic material. In some soils there may be layers of humose and/or melacic horizon material underlying the organic materials and overlying the substrate (Isbell and National Committee on Soil and Terrain 2016).
Oxbow	Long, curved commonly water-filled closed depression eroded by channelled stream flow but closed as a result of aggradation by channelled or over-bank stream flow during the formation of meander plain landform pattern. The floor of an oxbow may be more or less aggraded by over-bank stream flow, wind, and biological (peat) accumulation (National Committee on Soil and Terrain 2009).
Palustrine system	See 4.5 Palustrine Wetland System
Peat	A mass of dark brown, partly decomposed, fibrous plant debris (Kearey 2001)
Peatland	Wetlands that have soils composed of peat. This term is not commonly used in Queensland.
Periodic	See 3.2.1 Terms used in the hydrology criterion
Periodically	See 3.2.2 Terms used in the biotic criterion
Permanent	See 3.2.1 Terms used in the hydrology criterion
Permeable	Capable of being permeated (i.e. to pass through the substance or mass) (Yallop 2005)
Persistent emergent	Plants that stand above water surface and "normally remain standing at least until the beginning of the next growing season" e.g. spikerush (Eleocharis spp.) or bulrushes (Typha spp.) (Cowardin et al. 1979).
pH	The negative log of the hydrogen (hydronium) ion concentration (Brinson 1993)

Plain	"Large very gently inclined or level [landform] element, of unspecified geomorphological agent or mode of activity" (National Committee on Soil and Terrain 2009).
Plants	See 3.2.2 Terms used in the biotic criterion
Playa	"Large, shallow, level-floored closed depression, intermittently water-filled, but mainly dry due to evaporation, bounded as a rule by flats aggraded by sheet flow and channelled stream flow" (National Committee on Soil and Terrain 2009).
Polygon	In mapping terminology, a polygon is an area enclosed by lines on a map. (Neldner et al. 2019)
Ponded	See 3.2.3 Terms used in the soil criterion
Predominant Species	See 'Dominant Species'
Predominantly	See 3.2.3 Terms used in the soil criterion
Redox	Redox reactions include all chemical processes in which atoms have their oxidation number (oxidation state) changed (Department of Natural Resources and Water 2007).
Redox Features	Features that are formed primarily through the oxidation and reduction of iron (Department of Environment and Resource Management 2011b).
Regional Ecosystem	A vegetation community or communities in a bioregion that is consistently associated with a particular combination of geology, landform and soil. (Neldner et al. 2019)
Relict	Left remaining after some earlier activity or change (Yallop 2005).
Riparian	Of or relating to or located on the banks of a river or stream (Environmental Protection Agency 2005b).
Riparian	Of, relating to, or situated or dwelling on the bank of a river or other body of water (Yallop 2005).
River	"A large natural stream of water (larger than a creek)" (Environmental Protection Agency 2005b)
Riverine	Of or relating to a river (Yallop 2005)
Riverine system	See 4.6 Riverine Wetland System
Saline	General term for waters containing various dissolved salts.
Salinity	The presence of soluble salts in or on soils or in waters (Department of Natural Resources and Water 1997).
Salt	See 3.2.1 Terms used in the hydrology criterion
Saturated	See 3.2.3 Terms used in the soil criterion
Saturated with water	See 3.2.4 Terms used in the non-soil, non-biotic criterion
Scale	The parameter that describes the level of geographic resolution and extent, the context of space and time and helps define the positional accuracy (Quattrochi and Goodchild 1997)
Scroll	"Long, curved very low ridge built up by channelled stream flow and left relict by channel migration" (National Committee on Soil and Terrain 2009).
Seasonal	Alternatively, wet and dry every year according to season (Paijmans et al. 1985).
Seawater	See 'Marine Water'
Shrub	Woody plant multi-stemmed at the base (or within 200 mm from ground level), or if single-stemmed less than 2 m tall (Walker and Hopkins 1990).

Site	Refers to an area for ground survey and may include surrounding non-wetland support areas.
Soil	"Pedologic organisation (McDonald et al. 1990) is used to distinguish soil materials. This is a broad concept used to include all changes in soil material resulting from the effect of the physical, chemical and biological processes that are involved in soil formation. Results of these processes include horizonation, colour differences, presence of pedality, texture and/or consistence changes." (Isbell and National Committee on Soil and Terrain 2016).
Species	A group of organisms that resemble each other to a greater degree than members of other groups and that form a reproductively isolated group that will not produce viable offspring if bred with members of another group (Australian and New Zealand Environment and Conservation Council, and Agriculture and Resource Management Council of Australia and New Zealand 2000).
Spring	Springs are hydrogeological features by which groundwater discharges naturally to the land surface or cave. This includes springs with: permanent and non-permanent (i.e. intermittent or ephemeral) saturation regimes; dynamic or static spatial locations; and/or diffuse or point source spatial locations. (Glanville et al. 2015)
Static	See 3.2.1 Terms used in the hydrology criterion
Static	Relating to or characterised by a fixed or stationary condition (Yallop 2005).
Substrate	"The sediment and other material that comprises the seabed (or floor)" (Department of Environment and Science 2020a)
Substratum	See 3.2.3 Terms used in the soil criterion
Subtidal	"Permanently below the level of low tide, i.e. continuously submerged within tidal waters" (Department of Environment and Science 2020a)
Sulfidic	Materials containing detectable inorganic sulfides that can exist as horizons or layers at least 0.03 m thick or as surficial features (Isbell and National Committee on Soil and Terrain 2016)
Swamp	An emergent wetland in which the uppermost stratum of vegetation is composed primarily of trees (Brinson 1993)
Tidal	"Of or pertaining to tides; caused by tides; having tides; periodically rising and falling, or following and ebbing; as, tidal waters" (Environmental Protection Agency 2005b).
Tidal land	Any land at or below the highest astronomical tide mark, including mudflats, sandbanks, ‘reefs, shoals and other land permanently or periodically submerged by waters subject to tidal influence’ (Couchman and Beumer 2007).
Tree	"Woody plant more than 2 m tall with a single stem or branches well above the base" (Neldner et al. 2019)
Undrained soils	See 3.2.3 Terms used in the soil criterion
Upper layers	See 3.2.3 Terms used in the soil criterion
Waterbody	See 3.4 The distinction between wetlands, waterholes, and waterbodies
Watercourse	A stream of water, as a river or brook; the bed of such a stream (with or without water) a natural channel conveying water; a channel or canal made for the conveyance of water.
Waterhole	See 3.4 The distinction between wetlands, waterholes, and waterbodies
Waterlogging	To soak or saturate with water (Yallop 2005)
Wet conditions	See 3.2.2 Terms used in the biotic criterion
Wetland	See 3 The Queensland Wetlands Program Definition
Wetland Indicator	Flora species adapted to living in wetlands and are dependent on them for all or part of their life

Plant	cycle.
Wetland Plant	Plants that grow around and in wet areas (WetlandInfo)
Wetland Soil	"Under the Australian Soil Classification only Organosols can be called a wetland soil. The exception is Organosols present at higher altitudes which may not form under saturated conditions." (Department of Natural Resources and Water 2008)
Wetland System	"Complex[es] of wetlands and deepwater habitats that share the influence of similar hydrologic, geomorphologic, chemical, or biological factors" (Cowardin et al. 1979).
Wetland Type	Identified group of wetlands based on the hierarchical application of a set of rules to the attribute classification (Department of Environment and Science 2020a)

Appendix 1. Daly's Lagoon Case Study

This case study presents a summary of the process and outcomes of the application of the Queensland Wetlands Program Wetland Definition to Daly's Lagoon in Ipswich City Council, South East Queensland. This example illustrates one way that data could be collated to aid the decision-making process. This case study uses baseline information from 2001 with updates from recent field visits (up to September 2008).

Synthesis of Site Information

The following table presents a synthesis of existing information and collected information on Daly's Lagoon that is relevant to wetland definition.

Feature	Details for Daly's Lagoon
Name	Daly's Lagoon (also known as one of the 'Bundamba lagoons')
Location	Latitude 27.7345 South, Longitude 152.8382 East (Geocentric Datum of Australia 1994)
Biogeographic Region	South-eastern Queensland
Biogeographic Subregion	Moreton basin
Local Government Authority	Ipswich City Council
Size	~ 80 ha
Elevation	~ 75 m
Wetland System	Historically lacustrine system but is now mainly palustrine system
Other Wetlands in the Same Aggregation	One small wetland is present approximately 250 m upstream of Daly's Lagoon on Bundamba Creek. This wetland has extensive *Typha* sp. present.
Description	The wetland is situated in a depression between hills that rise 30 m near the site and to over 200 m within a few kilometres of the site. The wetland is considered to have been modified by the damming effect of a roadway, possibly established by early settlers around 100 years ago.
Physical Features	The wetland has a long history as a perennial lacustrine system. It is set in the foothills of the Mt. Perry–Spring Mountain range, 15 km south of Ripley. The core water body covers 20 to 25 ha, which can increase by approximately 40 ha in high rainfall events.
Geology, Soils, and/or Substrata Features	"There is principally one soil type in the area, yellow duplex soils (yellow podzolics/orthic solonetz). The soil is sodic and dispersive, and water-logs when the subsoil is wet. The topsoil is a loamy sand that seals and disperses rapidly on wetting (National Resource Information Centre 1991, Northcote et al. 1975)." (Knight 2002)
Hydrological Features	Daly's Lagoon is filled periodically by surface runoff from a small catchment, and sedimentation processes are significant. The combined ponded and marsh areas may triple in extent during very wet seasons. The water quality of the lake is unusual. "One site survey during March 2001 found an elevated pH of pH 9.2 to 9.4 and electrical conductivity levels of more than 750 uS/cm. However, the water is clear and has elevated dissolved oxygen levels exceeding 100 % capacity, and there are no signs of eutrophication. In comparison, a survey by Leggett (during May 1999)[11] during May 1999 found a water pH of pH 7.8, although water temperature was 8°C less at that time. The lake's minimal thermocline might be responsible for some water quality changes." (Knight 2002)
Ecological Features	No significant ecological values are generally apparent. Loafing waterfowl (ducks and swans) noted. No wetland raptors prey species recorded and no wetland raptors recorded.
Significance	A natural wetland, slightly modified, which has been impacted by grazing, herbicidal and mechanical weed control.
Notable Flora	None (in 2001). This wetland is devoid of the edging vegetation of sedges, *Typha* spp.,

	waterlilies, and wetland grasses. Small areas (<8 cm by <6 cm) of blue-green algae were noted at one place on the land edge. Small samples of water couch, *Paspalum dilatum* and some algae noted. Native palustrine herbs and sedges have recolonised marshy areas since grazing has ceased (2005).
Notable Fauna	None. Some waterfowl loaf, in small numbers, on the water, no breeding or feeding was observed over two visits of several hours each. This lake is scarce in food resources for invertebrates and vertebrates. Not surveyed for frogs but no frogs noted by visitors, although a freshwater snake was observed in 2001.
Land Tenure	On site: freehold land. Surrounding areas: freehold and Ipswich City Council environmental reserve.
Land Use	On site: Queensland Rifle Shooters Club Inc with shooting ranges. Cattle grazed until 2005 and is now included in a property environmental management plan. Surrounding areas: surrounding properties include acreage living with some cattle. Recreation and military training.
Disturbances or Threats	Suffers from past grazing, herbicidal and mechanical weed control practices. However, the current property owner has prepared an environmental management plan in association with the Ipswich City Council and the University of Queensland, Gatton campus. The plan includes extensive revegetation, maintaining the destocking of the property, slashing and a fire control regime. The Queensland Rifle Shooters Club Inc intends to manage this property on a long term basis.
Management Authority and Jurisdiction	Queensland Rifle Shooters Club Inc.

Application of the Wetland Definition Decision Tree

Criterion 1. Does the evidence support the statement "areas of permanent or periodic/intermittent inundation , with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 metres"?

Yes……..……..…….Proceed to Criterion 2

No……Feature is not a wetland

Unsure……..……..……Additional evidence is required

Rationale for Criterion 1: The feature has an area of permanent inundation by water that is static or flowing and fresh.

Criterion 2. Does the evidence support the statement "the land supports, at least periodically, plants or animals that are adapted to and dependent on living in wet conditions for at least part of their life cycle"?

Yes…….Feature is a wetland

No ……..……..…..Proceed to Criterion 3a

Unsure……..… Proceed to Criterion 3b

Rationale for Criteria 2: The feature supports modest levels of wetland plants and animals.

Assessment of the evidence found that Criterion 1 and 2 both apply and therefore the feature is a wetland under the Queensland Wetlands Program Wetland Definition.

The evidence was further assessed against the remaining two criteria to gain a full appreciation of the feature's standing as a wetland.

Criterion 3. Does the evidence support the statement "the substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers"? **Unsure** as there is insufficient information to determine if the substratum has anaerobic conditions.

Criterion 4. Does the evidence support the statement "the substratum is not soil and is saturated with water, or covered by water, at some time"? **No** as this does not apply to this feature.