

## 4.6.2 Wetland change over thousands of years

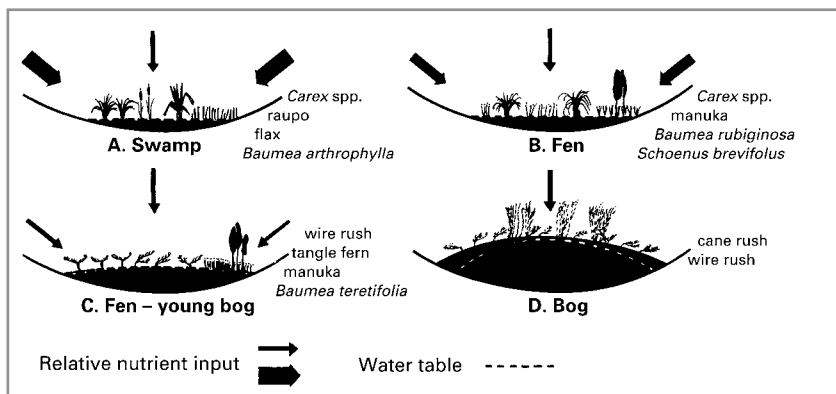


Fig. 140 Generalised sequence of bog development in the Waikato region over c. 10 000 years (based on Clarkson 2002).

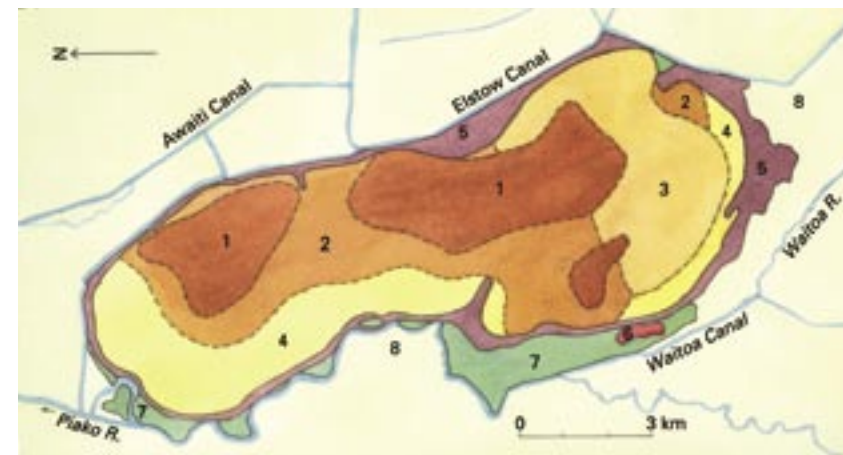


Fig. 141 Vegetation map (simplified from Irving et al. 1984) showing the modern wetland pattern on the Kopuatai Peat Dome. This is the largest New Zealand domed bog still in natural condition. The peat base lies at least 4 m below present sea level, and the highest point of the dome is only some 6 m above sea level. Although now surrounded by drainage canals and farmland developed from former peatlands, Kopuatai still shows a vegetation pattern that reflects water source, water movement, and hence nutrient status of the wetland types. The main vegetation types and habitats are:

1. *Sporadanthus ferrugineus* restiad rush bog on the rain-fed and least fertile dome crests;
2. *Schoenus brevifolius* - wire rush (*Empodisma minus*) rush bog surrounding the *Sporadanthus* communities;
3. *Baumea teretifolia* - *Empodisma* rush fen, typical of very wet areas in the south-east;
4. *Baumea teretifolia* - tangle fern (*Gleichenia dicarpa*) rush fen, fringing many margins of the dome and grading to the following;
5. Manuka scrub fen around the somewhat more fertile fringe of the peatland; this zone may be partly induced by the surrounding drainage and maybe also by fire;
6. Kahikatea forest swamp: one of the last remnants of a formerly widespread community;
7. Willow forest swamp, mainly grey willow (*Salix cinerea*), but also crack willow (*S. fragilis*) on wet mineral floodplain soils that were originally kahikatea forest swamp or flax - *Carex secta* swamp;
8. Surrounding farmland.

#### 4.6.3 Wetland change: short-term cycles in an upland fen

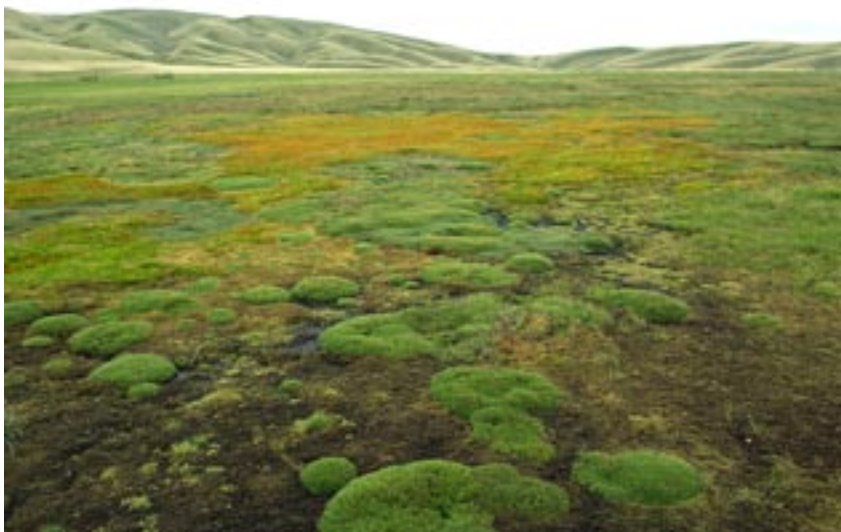


Fig. 142 Part of Teviot Swamp, Otago (see Fig. 24), a gently sloping fen nourished by groundwater that seeps from surrounding hills, and where slight changes in the rate and direction of downslope water movement cause short-term cycles in the dominant vegetation. At this site a slowing of drainage and a slight rise in water table have resulted in the demise and browning of sheets of *Sphagnum cristatum* moss, and their colonisation by young cushions of comb sedge (*Oreobolus pectinatus*). These cushions will rise above the water table, and themselves be invaded by other plants and lichens (see Fig. 88) during a phase when the hummocky ground becomes more bog-like.



Fig. 143 A portion of Teviot Swamp, where, in contrast to that in Fig. 142, the fen surface is receiving a re-invigorated supply of water. In response, *Sphagnum cristatum* is growing actively as a broad sheet, its vertical growth overwhelming an earlier phase of cushion plants, so that the foreground patches of *Phyllachne colensoi*, once convex cushions, are becoming saucer-like at their margins as the *Sphagnum* engulfs them. This phase of *Sphagnum* vigour is of benefit to the abundant flowering plants of *Gentiana amabilis*, growing upon the moss.

# FIVE

## Interpreting wetlands



Fig. 144 Working in a wetland; working out what it is: Shearer Swamp, Westland.

### 5.1 Use and application of the classification system

The New Zealand wetland classification system is designed for practical use by specialists and non-specialists alike. It seeks to circumscribe the units of classification, define terms, and standardise the naming of wetland types, in order to help unify wetland survey and management nationwide. As a scientific, functionally based classification system it is neither a taxonomic classification nor a regulatory one and does not focus on site evaluation related to environmental, social, cultural, or economic importance. The classification system is intended to complement the handbook on monitoring wetland condition by Clarkson et al. (2003) which outlines methods for recording wetland composition and for assessing condition and the impacts of changes.

The earlier sections of this book describe the units of classification and the ways in which wetlands function, at a level of detail intended to assist field workers to carry out relatively rapid survey and description of wetland sites, using mainly visual observations and simple recording techniques that are mostly qualitative or semi-quantitative, rather than involving systematic sampling or detailed analyses of data. The comments that follow are intended as additional introductory hints for efficient field studies of wetlands.

#### 5.1.1 The question of scale

The sequential tiers of the classification allow for wetlands to be recognised and described at different levels of detail, depending on what applications are intended. The higher levels in the hierarchy apply to large regions and are most applicable to broad-scale inventory, survey, or mapping, to sort wetlands into meaningful groupings for data storage, retrieval, and interpretation, for example for State of the Environment monitoring. The lower levels are most useful for the evaluation of wetland values and benefits, the management of hydrology and wildlife habitat, and the conservation of threatened organisms.

Mapping scale is closely linked to the levels of wetland classification that can be mapped. A map scale of 1:100 000 would be appropriate only for hydrosystems. The scale of 1:50 000, as used for the topographic map series NZMS 262, is sufficient for showing location of wetland sites, and large areas of wetland classes. For many wetland systems a scale of 1:10 000 will be appropriate for mapping vegetation classes and also some degree of detail of vegetation structural classes, but note that at this scale it is often considered difficult to label areas smaller than 0.1 ha. For mapping vegetation types based on composition and structure of vegetation, a scale of 1:500 may be most useful, at least for a small wetland, or else to portray a selected window of detail of a larger mapped wetland.

#### 5.1.2 Sources of background information

Field study of wetland sites for description and mapping will be most informative if available information is gathered beforehand. Location of wetland sites will be assisted by consulting topographic maps, aerial

photographs, and GIS (Geographic Information System) information, as is available from the New Zealand Land Cover Database Version 2 (Thompson et al. 2004). The LENZ (Land Environments of New Zealand) database should prove to be a valuable tool for future wetland studies (Ministry for the Environment 2003). This enables individual sites to be evaluated within the context of a wider ecosystem classification based on climate, landform, and soil variables. Other sources of information include geological and soil maps, site field reports, and historical data, such as can often be obtained through discussion with local agencies and people.

### 5.1.3 Aerial photos

Aerial photos are a great help in planning a field inspection. Modern vertical aerial photos tend to be in colour, but older black-and-whites are equally or even more informative, having often been taken at relatively low altitude. Study of aerial photos taken in different years and seasons can reveal changes that have taken place in a wetland over time, and features such as fire boundaries, or patterns of surface water, that may be present only at certain times of year or after climatic events. The use of stereo pairs of photos, viewed in 3D under a stereoscope, is much more informative than looking at single photos.

Aerial photos help with understanding the landform setting, the surface catchment and drainage system, and often also, by inference, the nature of subsurface water movement. Patterns of vegetation can be identified by different tones, textures, and colours, though each of these can differ with the season of photography.

### 5.1.4 Field survey

Be prepared to get wet in a wetland! The margin of a wetland is often the wettest and most forbidding part, but also least representative of the main body of the wetland. Most wetlands can be walked or waded through; the main challenge is usually climbing through dense vegetation rather than extricating yourself from the wet or the muck.

It is often informative to visit the same site in different weather conditions. For instance, you are more likely to identify levels of inundation after heavy rain, or extreme low levels during dry spells. It is preferable to visit the site

during the same season that the aerial photo you are using was taken. Some plants, sedges in particular, are easier to identify when they are flowering or fruiting, during summer.

Wetland surveys do not require a great deal of equipment unless specialist studies are being pursued. Besides normal outdoor gear, useful items include compass, GPS, camera, notebook with waterproof paper, plot recording sheets, shovel and probe for looking at soil structure, pH and conductivity meters, field guides for identification of organisms, and plastic bags for soil or plant samples. When collecting plant specimens for identification, either later by yourself or for an opinion by an expert, make a point of collecting not just a foliage sample but also material that includes diagnostic features such as flowers or fruits, and in the case of many grasses, sedges, and rushes, a basal portion of stem that shows the growth habit.

### 5.1.5 Water regime

Observations on hydrology are essential for defining wetland classes. The source of water is a key criterion, for which landform setting and slope are the main indicators as to whether a wetland is fed by rain only, receives surface water or groundwater, or is associated with a lake, river, tidal river, or estuary. Direction of flow and drainage characteristics are useful features to assess on-site, and the nature of ground surface micro-topography can assist with this. Water table level can be gauged after it has reached equilibrium in an excavated hole. Water fluctuation regime can often be estimated by checking the level reached by debris or silt accumulation along river or lake margins and also within palustrine wetlands, and this can help in allocating boundaries between hydrosystems.

The firmness or otherwise of a peatland site is broadly correlated with degree of water content of the substrate. Jumping on a wetland surface can result in a quaking movement of up to several metres in radius, and this can indicate a substrate charged with moving groundwater, having unconsolidated sediments, or the presence of well-decomposed peat.

### 5.1.6 Substrates

The ease with which you can sink a probe will help to differentiate organic from mineral soils. A probe or auger will indicate depth of a substrate,

and also the nature of underlying basement (e.g. rock, silt, sand) or the presence of buried wood or a hard pan in the profile. Peat can usually be recognised by its black or brownish colour. Its decomposition stage can be assessed using the von Post index (see Table 4). Inorganic matter in a substrate is usually paler, but may be dark from humus staining. Material that is of sand or larger particle size can be felt by its grittiness between the fingers. Finer silty material can be detected by its smooth and soapy feel, while clay is characteristically sticky, at least after some moistening and kneading. Soils that experience waterlogging may be detected by the presence of gleyed (greyish) horizons, various types of iron-mottling, and by sulphurous smells that indicate anaerobic processes.

Field measurement of conductivity is a general indicator of salinity and/or nutrient status, and field measurement of pH will help with assigning a wetland class name to a site (see Table 2). Sampling of soils for laboratory analysis of carbon and nutrient values will further confirm the class of wetland. Taste is a fair indicator of salinity. Hypersaline conditions, which occur in parts of estuaries subject to much evaporative drying, may be indicated by visible salt encrustations.

### 5.1.7 Describing and mapping vegetation

For the purposes of mapping wetland vegetation and undertaking rapid survey, the classification system provides the lowermost tiers of structural class (Section 2.7) and composition of vegetation (Section 2.8). Recognition of structural classes, i.e. the general growth form of vegetation or else the leading type of ground surface, is a straightforward exercise that does not require any detailed knowledge of plant identity. Likewise, composition of vegetation can be named with this system by being able to recognise just the dominant plants present in the canopy. So the entity we loosely refer to as a wetland type, being the combination of dominant plant with structural class, as in *Carex* sedgeland, is quite easy to recognise, and the system of Atkinson (1985) provides the diagnostic criteria and standard procedure for naming.

In practice, any vegetation study of a wetland, even at a general survey level, will involve recording vegetation at a level of detail somewhat beyond that required for naming and mapping wetland types. Thus the plot forms designed for use in assessing wetland condition (Clarkson et al. 2003)

prompt the recording of plant cover not only of canopy dominants, but also of subcanopy and ground layers.

Plant cover, usually expressed as a percentage, is one of several measures used for recording the composition of vegetation. Other measures include density (number of plants or stems per unit area), frequency (proportion of occurrences in a total number of samples), and biomass. There are several ways of measuring cover precisely, but for rapid survey it is simply estimated 'by eye'. This can be done to a moderate degree of accuracy only, but a quick check can be done, before moving on from a study site, to see whether the recorded cover values add up to the 100% total expected of canopy cover, this being what one would see in 'bird's-eye' view (see appendix VII in Clarkson et al. 2003). Note that if vegetation is being considered across several tiers of vegetation it is quite valid for the cover values of plant species to come to a total exceeding 100%. Note also that a subcanopy tier, considered alone, will very often have less than 100% cover, and that cover recorded for the ground tier is likely to include a proportion of unvegetated surface such as bare ground, litter, or standing water. Beware of the tendency to over-estimate the cover of plant species that are especially conspicuous, such as cabbage trees scattered through a sedgeland, and of plants having erect foliage or stems, such as some sedges and reeds, for while these may appear dense when seen from the ground in side view, the vertical view would show them to be less so.

Detailed ecological studies of wetlands would aim to use rigorous sampling and recording procedures, to produce data capable of statistical analysis. Such methodology is beyond what we are describing, but it should be noted that the wetland classification system can also be applied to the results of such studies.

Many wetlands are nearly flat so their features can be difficult to locate on the ground. A few wetlands can be viewed from adjacent high ground. Prominent landmarks are worth identifying before entering a wetland, and these can be located, with grid references, upon a laminated copy of an aerial photo, topographic map, or sketched base map, upon which annotations can be made with a wetland-proof marker pen. GPS (Geographic Positioning System) technology provides a modern aid to navigating around a wetland.

The approach commonly used for mapping involves the identification of areas of homogeneous cover that are then delineated as closed areas of whatever size and shape. A preliminary sketch map, usually based on an aerial photo, can be drawn to show prominent wetland features and the most obvious boundaries between map units. While some boundaries will be quite distinct, such as those between contrasting vegetation structural classes, others will be less so and must be mapped with less certainty, for example with a dotted line rather than a solid one. Quite often with wetlands, the intricate degree of patterning that can occur at many scales means that some units of mapping may need to be identified as mixtures of more than one vegetation or habitat type. However, by adopting the '80 / 20 rule', whereby the boundary of a relatively homogenous unit is demarcated in such a way that alien inclusions comprise less than 20% of the total, then the unit can be labelled as the dominant type.

The preliminary sketch map will help in the choice of sites to be visited for ground-truthing. Often this will take the form of planning routes that traverse what is believed to be a representative sample of the wetland diversity. Both on aerial photos and on the ground, look out for places where different types of habitat or vegetation abut, suggesting sites where a sequence of types can be most clearly related to environmental gradients. As noted above, the choice of mapping scale will dictate the level of detail that will be recorded in the field. However, a useful mapping record of a wetland site may often combine a broad-scale overall map with window maps of smaller areas to illustrate finer detail of typical or localised examples of patterns of wetland types. Profile diagrams are a good way to show examples of zonation patterns along particular environmental gradients.

Depending on the purpose of a wetland study, be it for biodiversity, assessment of habitat for birds or fish, catchment understanding, condition monitoring, or for values associated with traditional uses, recreation, education, or scenery, the observer will target observations on particular facets. But even when wetland inventory and mapping is the principal aim, field workers should look out for indicators of influences and processes that might affect how wetland types are interpreted.

Fire has affected many New Zealand wetlands, so that a wetland currently vegetated with, say, sedgeland, might have had a previous and originally more natural cover of forest or scrub, and might actually be in the process

of reverting to that vegetation. Some influences, such as drainage or an increase in nutrient status arising from adjacent land uses, may take many years to be fully reflected in the vegetation. One complication to interpreting wetland types from their vegetation is that some wetland sites can have enigmatic mixtures of plants that would otherwise be interpreted as indicating very different habitat conditions. Part of the reason for these situations can be if a wetland is undergoing a shift in plant composition, for whatever reason, and that this is happening relatively slowly, so that the observed plant cover is one which belongs to the past as well as the present.

A full record of a wetland site would include an attempt to note not only the vegetation, i.e. the composition, structure, and pattern of the vegetation types, but also the flora, i.e. a list of all plant species present in the area. This would include, and maybe highlight, any threatened plants and weeds.

Above all, make your own notes in your own style about what you see, irrespective of anyone else's style or templates. It is important, however, to always record standard data such as date, location, and observer. Much modern environmental emphasis is placed upon monitoring, yet some of the best monitoring is actually accomplished by the simple processes of thoughtful observation and careful recording. Environmental indicators are also in vogue, but this is not an exact science, and the best indicators are those organisms that tell a reliable story about what is happening in nature. This knowledge is gained by repeated looking, wondering, and surmising. Wetlands are great places for practising all three.

Give the wetland classification system a fair trial. Add to it and refine it as will inevitably be necessary. And argue about it, as we have.

## 5.2 Guide to further information

For full bibliographic references see Section 6.

### Textbooks on wetlands

Haslam (2003)  
 Keddy (2000)  
 Mitsch & Gosselink (2000)  
 Tiner (1999)  
 US Army Corps of Engineers (1987)

### Overseas wetland classification systems

Bridgham et al. (1996)  
 Brinson (1993)  
 British Environment Agency (1997)  
 Cowardin et al. (1979)  
 Farinha et al. (1996)  
 Ramsar (2000)  
 Semeniuk & Semeniuk (1995)  
 Warner & Rubec (1997)  
 Zoltai & Vitt (1995)

### References on New Zealand wetlands

Burrows (1969)  
 Buxton (1991)  
 Campbell (1983)  
 Cockayne (1928)  
 Cranwell (1953)  
 Cromarty & Scott (1995)  
 Dobson (1979)  
 Irwin (1975b)  
 Johnson & Brooke (1998)  
 Mew (1983)  
 Stephenson (1986)  
 Stephenson et al. (1983)  
 Thompson (1987)  
 Vant (1987)  
 Ward & Lambie (1998, 1999a,b)  
 Wardle (1977, 1991)  
 Wilson (1987)

### International internet sites

- The Ramsar Convention Secretariat (<http://www.ramsar.org>) is the organisation responsible for the International Convention on Wetlands, signed in the Iranian city of Ramsar in 1971. It has information about World Wetlands Day, wetlands of international significance, wetland inventory and monitoring, and international wetland issues. It also has a page on wetland centres around the world.
- [http://www.ramsar.org/links\\_index.htm](http://www.ramsar.org/links_index.htm) provides links with the key wetland websites around the world, including those of Ramsar's four international organisation partners (IUCN, WWF, Wetlands International, and BirdLife International), those of related convention secretariats, and those of all other important sites for wetland-related information (check the websites, and their links, of agencies such as the US Fish and Wildlife Service, Environment Canada, and MedWet for further information on national and regional wetland classification systems in North America and Europe).
- <http://www.wetlandshelp-line.com> provides a service designed to assist wetland managers, owners, and policy makers primarily from Australia, New Zealand, and the Pacific Island countries of the Oceania Region. It includes links with the key management agencies and NGOs of the region.

### New Zealand internet sites

- The Department of Conservation (<http://www.doc.govt.nz>) has information on New Zealand wetlands of international significance and the New Zealand Wetland Conservation Awards, as well as many publications relating to New Zealand wetlands. Follow the link 'Publications' then 'Science and research'.
- Fish and Game New Zealand (<http://www.fishandgame.org.nz>) has information on World Wetlands Day, wetland wildlife, and tips for creating ponds for waterfowl. Follow the 'wetlands' link.
- Environment Waikato (<http://www.ew.govt.nz>) and Christchurch City Council (<http://www.ccc.govt.nz>) have pages on how to manage wetlands and streamsides.
- The Ministry for the Environment (<http://www.mfe.govt.nz>) has information on the State of the Environment, and provides access to wetland reference manuals.
- The Environmental Reporting Programme (<http://www.environment.govt.nz>) has published a series of reports that give metadata descriptions for environmental databases, classification systems, and spatial frameworks in New Zealand.
- The National Wetland Trust (<http://www.wetlandtrust.org.nz>) was established in 1999 to increase the appreciation of wetlands and their values by all New Zealanders. The objectives of the Trust are to increase public knowledge and appreciation of wetland values, to increase understanding of wetland functions and values, and proactive commitment to wetland protection, enhancement, and restoration.

## SIX

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## SEVEN

### Glossary

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<b>algae</b>	(singular: alga) diverse plant groups of simple construction, including single-celled plankton, filamentous growth forms, charophytes, and the green, brown and red seaweeds.
<b>algalfield</b>	a vegetation structural class having cover of algae 20–100%, exceeding that of any other growth form or bare ground.
<b>amictic</b>	(of lake waters): having no periods of thermal stratification or mixing each year.
<b>anaerobic</b>	of an organism, especially some bacteria, able to live in the absence of free oxygen; and of substrates where decay by such organisms often results in production of sulphur compounds.
<b>backswamp</b>	a swamp located on a floodplain where drainage is poor behind a river levee.
<b>backwater</b>	a body of relatively calm water, usually parallel with, and connected at its bottom end, to a river or stream.
<b>blanket peat</b>	peatland which extensively covers much of the land, irrespective of underlying topography.
<b>bed</b>	the floor of a lake, river, or other body of open water; a growth of plants upon such a substrate; also a layer of sediment or other deposited material (e.g. shell bed).
<b>bog</b>	a wetland class: a peatland receiving its water supply only from precipitation, and therefore virtually unaffected by moving groundwater and nutrients from adjacent or underlying mineral soils; bogs are oligotrophic (nutrient-poor), usually markedly acid, and their water table is at or near the surface.
<b>brackish</b>	water of intermediate salinity between seawater (c. 35‰ marine salts) and freshwater (<5‰ marine salts).
<b>braided river</b>	a river with high sediment load having numerous channels which repeatedly branch and rejoin, forming a pattern of low islands and shallow bars.

<b>bryophyte</b>	a general term embracing the non-vascular sporing plants mosses, liverworts, and hornworts.	<b>emergent</b>	of aquatic plants, those which are rooted in water but have stems or foliage above the water surface; of terrestrial plants, those with a crown held above the level of the surrounding vegetation canopy.
<b>canopy</b>	the layer or layers of uppermost plant crowns in vegetation, i.e. that foliage which faces upwards to the sky and would be seen in 'bird's eye' view.	<b>ephemeral</b>	of a system that is a saturated or submerged wetland for some periods, yet becomes in effect a dry habitat for substantial alternate periods.
<b>carr</b>	a European term for a wetland dominated by woody vegetation.	<b>ephemeral wetland</b>	a wetland class, typically occupying a closed depression that lacks a permanent surface outlet channel, having mineral soil and a marked seasonal alternation between being ponded and dried, the wetness and the wetland tending therefore to be ephemeral.
<b>cascade</b>	a section of a stream or river where water descends over steep rocks (steeper and less obstructed than rapids, less precipitous than a waterfall).	<b>episodic</b>	(of saturation or inundation): rarely, say once every few years.
<b>charophyte</b>	a member of the distinctive family of algae (Characeae) having erect stems and whorled branches, often important in freshwater aquatic habitats; New Zealand charophytes seldom become encrusted with lime so the term 'stonewort' is not relevant here.	<b>estuarine</b>	a hydrosystem that includes the subtidal and intertidal zones of estuaries themselves, coastal river mouths, and coastal lagoons affected by the mixing of freshwater and seawater, tidal reaches of rivers, and supratidal zones of coasts affected by splash and spray. The inland boundary of the estuarine hydrosystem is where marine salt concentration measures 5‰.
<b>clay</b>	chemically-weathered mineral fragments <0.002 mm diameter, i.e. finer than silt.	<b>estuary</b>	a coastal body of water, partly enclosed by land but open to the sea, where seawater is diluted by land drainage, and where tidal effects are evident; often located at the widened funnel-shaped mouth of a river.
<b>cushionfield</b>	a vegetation structural class having cover of cushion plants 20–100%, exceeding that of any other growth form. Cushion plants include herbaceous, semi-woody, and woody plants with such dense branchlets and close-set leaves as to form convex cushions. Cushion plants of wetlands include species of <i>Donatia</i> , <i>Gaimardia</i> , <i>Centrolepis</i> , <i>Oreobolus</i> , and <i>Phyllachne</i> .	<b>eutrophic</b>	nutrient-rich, fertile.
<b>cyanobacteria</b>	(Cyanophyta; formerly known as blue-green algae) simple plants including unicellular and filamentous forms, often with a mucilaginous covering; important as aquatics and on wetland soil surfaces.	<b>evapotranspiration</b>	the total loss of water as water vapour, from ground and vegetation to the atmosphere, by the combination of evaporation and transpiration through the membranes or pores of plants.
<b>delta</b>	a fan-shaped accumulation of alluvial sediment, usually with several water channels at a river or stream mouth.	<b>facultative</b>	(of a wetland organism): occurring in wetland habitats but also in dryland ones (cf. obligate).
<b>domed bog</b>	a domed (or raised) bog has accumulated its greatest depth of peat in its most poorly drained and constantly wet centre, producing a convex surface.	<b>fall</b>	(waterfall): a steep section of a river or stream where the descent of water is precipitous.
<b>dominant cover</b>	usually one or more dominant plants (e.g. bog pine, wire rush) but sometimes a bare substrate (e.g. mud, sand).	<b>fen</b>	a wetland class: a peatland receiving inputs of water and nutrients from adjacent mineral soils, and having the water table usually close to the peat surface; fens have low to moderate acidity and nutrient status.
<b>dune slack</b>	a vegetated depression between sand dune ridges where the water table is close to or above the sand surface; or a hollow between sandbanks which periodically holds slack – or scarcely flowing – water at times of highest tides.	<b>fernland</b>	a vegetation structural class having canopy cover of ferns 20–100%, exceeding that of any other growth form.
<b>dystrophic</b>	water having significant dark staining from humic matter and an associated deficiency in nutrients.	<b>flark</b>	a permanently or temporarily flooded depression within a peatland, occupied by sparse, weakly peat-forming vegetation.
<b>ecotone</b>	transition zone between plant communities.	<b>flashy</b>	(of a riverine channel): having flows that allow development of little more than microalgal felts.

<b>flaxland</b>	a vegetation structural class having canopy cover of flax ( <i>Phormium</i> spp.) 20–100%, exceeding that of any other growth form.		
<b>flooding</b>	inundation by storm runoff from adjacent land, overflow from a stream or river, or the rise in water associated with tidal inflow (cf. ponding).		
<b>floodplain</b>	alluvial land adjacent to a river which continues to be affected by flood overflows from the present river.		
<b>flush</b>	a type of seepage which carries a periodic pulse of moving surface water from a higher level, as from a rain event or snow melt.		
<b>forest</b>	a vegetation structural class having >80% canopy cover of trees and shrubs, with tree cover exceeding that of shrubs. Trees (including tree ferns) are those having a trunk $\geq 10$ cm dbh (diameter at breast height); cf. treeland.		
<b>geothermal</b>	a hydrosystem where volcanic activity produces hot surface waters, or heated wet soils (30°C or more) or where geothermal chemistry affects wetland habitats.		
<b>gleying</b>	processes that occur in wet, poorly aerated soils, where chemical reduction especially of iron compounds produces grey zones, often with rusty mottling.		
<b>glide</b>	a gently flowing, unruffled reach of shallow water in a river or stream.		
<b>grass</b>	a member of the grass family (Poaceae = Gramineae), the leaves having a narrow blade and a sheath clasping a rounded hollow stem.		
<b>grassland</b>	a vegetation structural class having canopy cover of grasses 20–100%, exceeding that of any other growth form or bare ground. Tussock grasses belong in tussockland.		
<b>gravel</b>	fragments of rock 2–60 mm in diameter.		
<b>groundwater</b>	subsurface water that is in the saturated zone, including underground streams.		
<b>gumland</b>	land formerly occupied by forest of kauri ( <i>Agathis australis</i> ) in northern New Zealand, the soils once exploited for kauri gum, prone to waterlogging, and having heathland vegetation.		
<b>habit</b>	the external appearance or growth form of a plant.		
<b>habitat</b>	the environment occupied by an organism or community.		
<b>heathland</b>	a vegetation / habitat type characterised by a high proportion of heaths (strictly shrubs of the families Ericaceae and Epacridaceae, but also		other woody plants having similar small leaves, persistent acid litter, and fine roots) usually in conjunction with ferns, sedges, and lichens.
		<b>herbfield</b>	a vegetation structural class having cover of herbs 20–100%, exceeding that of any other growth form or bare ground. The herb growth form includes all herbaceous and low-growing semi-woody plants that are not separated as tussocks, ferns, reeds, rushes, sedges, grasses, cushion plants, turf, mosses, or lichens.
		<b>humus</b>	dark brown to black, amorphous, well-decomposed organic matter in a soil or suspended in water.
		<b>hydrosystem</b>	wetland ecosystem differentiated by broad landform and hydrological settings, and by water salinity, water chemistry, and temperature.
		<b>hypersaline</b>	having salinity in excess of 40‰, i.e. higher than that of seawater (c. 35‰), such as can occur where wet soils or ponded water are subject to high evaporation rates.
		<b>inflow wetland</b>	a wetland which receives inflowing surface or groundwater but has no outflow (especially an ephemeral wetland in a depression; cf. outflow wetland, throughflow wetland).
		<b>inland saline</b>	a hydrosystem embracing sites in semi-arid climates in inland basins where localised areas of saline soils are associated with seasonally wet habitats.
		<b>inorganic</b>	derived from non-biological material; i.e. mineral matter (cf. organic).
		<b>intermittent</b>	(of inundation or saturation): in one or a series of wet years, but not every year.
		<b>intertidal</b>	the shore zone of marine and estuarine waters between highest and lowest tides.
		<b>kettle</b>	a depression, often bowl-shaped and usually without surface drainage, formed among glacial deposits at a time of glacial retreat.
		<b>lacustrine</b>	a hydrosystem associated with lakes and other bodies of open freshwater which are large enough to be influenced by characteristic lake processes such as permanent non-flowing deep water, fluctuating water level, and wave action.
		<b>lagg</b>	the marginal stream or swamp surrounding or fringing a domed bog.
		<b>lagoon</b>	a shallow lake, especially one near to and permanently or intermittently connected with a river, lake, or the sea; in New Zealand most often applied to coastal lagoons impounded behind beach ridges or associated with river mouths, but the term is also used for inland examples.

<b>lake</b>	a large body of water surrounded by land, its major dimension generally 0.5 km or more, though smaller bodies of water can be validly referred to as lakes on the basis of depth, permanence, or local custom.	<b>monomictic</b>	(of lake waters): having a single period of thermal stratification and mixing each year.
<b>levee</b>	an embankment of flood alluvium built up alongside a river and typically with lower-lying land behind.	<b>mossfield</b>	a vegetation structural class having cover of mosses and / or liverworts 20–100%, exceeding that of any other growth form or bare ground.
<b>lichenfield</b>	a vegetation structural class having cover of lichens 20–100%, exceeding that of any other growth form or bare ground.	<b>mud</b>	a mix of silt- and / or clay-sized particles with water.
<b>litter</b>	plant material (leaves, twigs, etc.) that has recently fallen to the ground surface.	<b>near-permanent</b>	(of saturation or inundation): throughout the growing seasons of most years.
<b>littoral</b>	the shore zone of a lake or pond between uppermost water level and the depth limit of rooted plants; also the intertidal zone of coasts.	<b>nival</b>	a hydrosystem embracing snowfields and glaciers; a type of wetland insofar as snow and ice can be a habitat for algal communities.
<b>lowland</b>	(of a riverine channel): having a low gradient with slow runs and pools.	<b>obligate</b>	(of a wetland organism): confined to wetland habitats (cf. facultative).
<b>macrophyte</b>	a macroscopic plant, the term used mainly to distinguish relatively large aquatic plants from small algae and microscopic plants.	<b>oligotrophic</b>	nutrient-poor, infertile.
<b>mangrove</b>	a tropical and subtropical saltmarsh community of shrubs or trees which typically produce erect aerial roots; in New Zealand the term is applied also to the only plant of this type which occurs here: manawa ( <i>Avicennia marina</i> subsp. <i>australasica</i> ).	<b>ombrogenous</b>	a wetland deriving its water supply entirely from rainfall.
<b>marine</b>	a hydrosystem including saline open waters (c. 35‰ marine salts), the seabed, and the foreshore of open sea coasts.	<b>ombrotrophic</b>	‘rain-fed’, having low nutrient status as a result of receiving water only from rainfall.
<b>marsh</b>	a wetland class: a mineral wetland which may have a peat component that is periodically inundated by standing or slowly moving water; water levels may fluctuate markedly. Marshes are usually of moderate to high nutrient status.	<b>organic</b>	living matter or material derived from it (cf. inorganic).
<b>meander</b>	one of a series of sinuous turns produced by a mature stream or river as it swings and shifts course across its floodplain.	<b>outflow wetland</b>	a wetland (mainly bog or pakihi) which receives water only from precipitation, and where flow of surface or groundwater is only outwards (cf. inflow wetland, throughflow wetland).
<b>mesotrophic</b>	of moderate nutrient status; intermediate between oligotrophic and eutrophic.	<b>oxbow</b>	a river bend returning almost upon itself, forming an oxbow lake when the bend is cut off.
<b>midland</b>	(of a riverine channel): having overall flows of moderate gradient dominated by runs / riffles.	<b>pakihi</b>	a general term for areas of flat to rolling land, mainly on the West Coast, having infertile mineral to organic soils of poor drainage and a fire-prone vegetation of scrub with ferns, sedges, and restiads.
<b>mineral</b>	of substrate materials that are inorganic; they may be bedrock, or sediments of particle size ranging from clay, silt, sand, gravel, to stones and boulders.	<b>pakihi and gumland</b>	a wetland class characterised by mineral or peat soils of very low fertility and poor drainage because of leached and impervious basement materials on land which is level or of low relief, with the water supply being mainly from precipitation.
<b>minerotrophic</b>	having relatively high nutrient status derived from mineral materials in the substrate or within groundwater inputs.	<b>paludification</b>	the process of peat accumulation.
<b>mire</b>	a general term that embraces all peat-forming wetlands.	<b>palustrine</b>	a hydrosystem of all freshwater wetlands fed by rain, groundwater, or surface water, but not directly associated with estuaries, lakes, or rivers.
		<b>patterned wetland</b>	a wetland displaying recognisable and repeated pattern in the arrangement of vegetation and landform components.
		<b>peat</b>	an accumulation of partially decomposed remains of living organisms, mainly detritus from former plant growth.
		<b>peatland</b>	a general term embracing all land having peat substrates.

<b>permanent</b>	(of saturation or inundation): always.	<b>rheotrophic</b>	'flow-fed', having moderate nutrient status because of inputs of groundwater as well as rain.
<b>pH</b>	the reciprocal logarithm of hydrogen ion concentration, giving a scale where pH 7 is neutral, lower values indicate acidity, and higher values alkalinity.	<b>riffle</b>	a shallow section of a river or stream where water flows swiftly and the water surface is broken into waves.
<b>physiognomy</b>	the characteristic appearance of a vegetation type or plant community.	<b>riparian</b>	situated along the immediate margin of a river or stream.
<b>piping</b>	the channelling in a tubular cavity of an underground stream.	<b>riverine</b>	a hydrosystem associated with rivers, streams, and other open channels, both natural and artificial, where the dominant function is continually or intermittently flowing freshwater. Although many wetlands occupy landforms such as valley floors, floodplains, and deltas which owe their genesis to river processes, the riverine hydrosystem extends only so far as flowing channels retain a current influence, which can be defined as the extent covered by the mean annual flood.
<b>plateau bog</b>	a form of raised bog having sloping margins but a plateau surface rather than a fully convex one; the term does not refer to a bog upon an underlying plateau landform.	<b>run</b>	a section of a river or stream where water flows swiftly.
<b>plutonic</b>	a hydrosystem of underground wetlands, especially waterways that run through cave systems where lack of light excludes any plant production, but other organisms may be present.	<b>rush</b>	strictly, any species of the plant genus <i>Juncus</i> , but applied also to other plants of similar form (see below).
<b>polymictic</b>	(of lake waters): having several periods of thermal stratification and mixing each year.	<b>rushland</b>	a vegetation structural class having canopy cover of rushes 20–100%, exceeding that of any other growth form or bare ground. The rush growth form is characterised by those species of <i>Juncus</i> that have stiff, erect stems or similarly non-flattened leaves, but includes members of other genera (some <i>Baumea</i> spp., <i>Lepidosperma australe</i> , <i>Eleocharis acuta</i> , <i>Isolepis nodosa</i> ) of similar growth form, and all species of the restiad genera <i>Sporadanthus</i> , <i>Empodisma</i> , and <i>Apodasmia</i> . The term restiad rushland may be used for vegetation dominated by these three genera, and wire rushland for vegetation dominated by <i>Empodisma</i> .
<b>pond</b>	a body of non-flowing freshwater, smaller than a lake but larger than a pool; natural but more often artificial.	<b>salinity</b>	the quantity of dissolved salts in water, especially of seawater or its diluted products. Salinity is recorded, by convention, as parts per thousand (‰), i.e. grams of salts per litre of water.
<b>ponding</b>	the process of water collecting in a depression or basin (cf. flooding).	<b>saltmarsh</b>	a wetland class embracing estuarine habitats of mainly mineral substrate in the intertidal zone, but including those habitats in the supratidal zone and inland, which although non-tidal, have similar saline substrates and constancy of soil moisture.
<b>pool</b>	a small body of still water; also a slow-flowing and relatively deep reach of a stream or river.	<b>sand</b>	grains of mineral detritus of particle size range 0.06–2 mm diameter.
<b>raised bog</b>	a raised (or domed) bog has accumulated its greatest depth of peat in its most poorly drained and constantly wet centre, producing a convex surface.	<b>saturation</b>	maximum water content: a soil or substrate is saturated when all the interstices are filled with water.
<b>rand</b>	the sloping margin of a domed bog, typically leading down to a lagg.	<b>scrub</b>	a vegetation structural class having canopy cover of shrubs and trees >80%, with shrub cover exceeding that of trees. Shrubs are woody plants with stems <10 cm dbh (diameter at breast height).
<b>rapid</b>	a section of a river or stream where water flows more swiftly than usual and the water surface is broken by obstructions.	<b>seasonal</b>	(of saturation or inundation): during one or more seasons of the year.
<b>reed</b>	a tall erect herb, emergent from shallow water, having unbranched leaves or stems that are either hollow or have very spongy pith. Examples include <i>Typha</i> , <i>Bolboschoenus</i> , <i>Schoenoplectus</i> , <i>Phragmites</i> , <i>Phalaris</i> , <i>Zizania</i> , <i>Baumea articulata</i> , <i>Eleocharis sphacelata</i> , and <i>Glyceria maxima</i> .		
<b>reedland</b>	a vegetation structural class having canopy cover of reeds 20–100%, exceeding that of any other growth form or open water.		
<b>restiad</b>	reed- or rush-like plants belonging to the family Restionaceae; the genera <i>Apodasmia</i> , <i>Empodisma</i> , and <i>Sporadanthus</i> occur in New Zealand.		

<b>sedentary peat</b>	peat accumulating <i>in situ</i> , beneath the plants which produced it; the term autochthonous – found in the place of origin – has also been used to describe sedentary peat.	<b>steepland</b>	(of a riverine channel): having overall flows of high gradient, well-aerated with broken water surfaces.
<b>sedge</b>	a member of the sedge family ( <i>Cyperaceae</i> ).	<b>storm beach</b>	a ridge of gravel or stones piled by storm waves on the upper shore of a beach on a coast or lake.
<b>sedgeland</b>	a vegetation structural class having canopy cover of sedges 20–100%, exceeding that of any other growth form or bare ground. The sedge growth form includes those sedges having grass-like but usually coarser leaves, especially <i>Carex</i> , <i>Uncinia</i> , <i>Isolepis</i> , <i>Cyperus</i> , <i>Carpha</i> , and <i>Schoenus</i> . Note that several sedges belong in tussockland, reedland, rushland, and cushionfield.	<b>stratification</b>	(or thermal stratification): the process in a lake whereby changes in temperature at different depths, result in horizontal layers of different densities.
<b>sediment</b>	particulate materials that have settled out from suspension in water.	<b>string mire</b>	a peatland of distinctive pattern where numerous pools are arranged stepwise downslope, their long axes often aligned across the slope, the pools being separated by ridges of raised peat – or strings.
<b>sedimentary peat</b>	peat which settles out as humic particles on the bed or margins of a water body such as a swamp pool or channel; the term allochthonous – material transported from outside the system – also describes sedimentary peat.	<b>structural class</b>	level III of the wetland classification, based on the general growth form or structure of the vegetation, or else the leading type of ground surface.
<b>seepage</b>	a wetland class: an area on a slope which carries a moderate to steady flow of groundwater, often also surface water, including water that has percolated to the land surface, the volume being less than that which would be considered as a stream or spring.	<b>substrate</b>	the ground upon which vegetation grows or that underlying a non-vegetated wetland; a general term including rock, sediments, peat, or soil.
<b>shallow water</b>	a wetland class: aquatic habitats with water generally less than a few metres deep, having standing water for most of the time, and including the margins of lakes, streams, rivers, and estuarine waters plus small bodies of water which may occur within or adjacent to other wetland classes.	<b>subsystem</b>	level IA of the wetland classification, which allows hydrosystems to be further described according to the water regime.
<b>shrubland</b>	a vegetation structural class having canopy cover of shrubs 20–80%, exceeding that of any other growth form.	<b>subtidal</b>	the shore zone of marine and estuarine hydrosystems below the level of lowest tide; permanently inundated.
<b>silt</b>	fragments of mineral material of particle size range 0.002–0.06 mm diameter.	<b>succession</b>	the ecological process of community change over time, especially the progressive replacement of one vegetation type by another.
<b>snowbank</b>	a mountain site where accumulated snow thaws gradually during a relatively short growing season, to nourish mineral soils of downslope seepages; some snowbanks become seasonally dry while some are not saturated for long enough to be considered wetland.	<b>supratidal</b>	the shore zone above highest tide level of marine and estuarine waters; influenced by splash and spray, and including areas inundated by storm surges.
<b>soligenous</b>	a wetland where water supply is augmented by groundwater seepage or surface runoff that has been in contact with mineral materials in adjacent land and carries inputs of dissolved nutrients and often also suspended inorganic sediment.	<b>swale</b>	an elongated depression between coastal dunes or beach ridges, aligned roughly parallel to the coast.
<b>spring</b>	a stream emerging to the surface from underground, as a single point source of groundwater discharge.	<b>swamp</b>	a wetland class: a soligenous wetland, usually combining mineral and peat substrates, having moderate water flow and fluctuation, and often the presence of leads of standing water or surface channels; swamps are relatively rich in nutrients.
<b>stable</b>	(of a riverine channel): having flows that allow attached macrophytes and mosses to persist from year to year.	<b>sward</b>	vegetation of grasses or sedges of lawn-like stature.
		<b>tarn</b>	a small body of standing water in the mountains, often having no significant tributaries: the term tends to bridge the gap between pond and lake, and is a useful one for upland situations.
		<b>temporary</b>	(of saturation or inundation): for periods of about two weeks or less during the growing season.
		<b>throughflow wetland</b>	a wetland which both receives and produces flowing water (fens, swamps, rivers, and most lakes; cf. inflow wetland, outflow wetland).

- tidal** influenced by rise and fall of twice-daily tides, of bimonthly spring and neap tides, or by ebb and flow in tidal reaches of rivers.
- topogenous** a term occasionally used for a wetland formed behind a topographic barrier that impedes drainage, especially in situations having a relatively small catchment and therefore receiving a water supply mainly from rainfall.
- treeland** a vegetation structural class having 20–80% canopy cover of trees, tree cover exceeding that of any other growth form, but tree canopy discontinuous above lower non-woody vegetation; cf. forest.
- turf** a vegetation structural type of low stature (generally <3 cm tall) of mainly herbaceous vascular plants forming a ground-hugging and often dense carpet of intertwined plants of numerous species.
- tussock** a densely tufted grass or sedge >10 cm tall with fine linear leaves that arch upwards and outwards from a densely clumped base; wetland tussocks include species of *Chionochloa*, *Cortaderia*, *Gahnia*, *Carex*, and *Cyperus*, and *Schoenus pauciflorus*.
- tussockland** a vegetation structural class having canopy cover of tussocks 20–100%, exceeding that of any other growth form.
- variable** (of a riverine channel): having flows that allow development and scouring of macroalgae.
- water regime** the combination of four main hydrological factors: water source, movement, fluctuation, and periodicity of wetness.
- water table** the level below which a substrate is fully saturated; the term is also commonly applied in New Zealand to roadside ditches.
- wetland class** level II of the wetland classification, where the units are differentiated by distinctive combinations of substrate factors, water regime, nutrient status, and pH.
- wetland complex** a wetland area comprising several adjoining wetland classes, or even more than one hydrosystem; many wetland sites are complexes; likewise mire complex, pool complex, etc.
- wetland form** level IIA of the wetland classification, being descriptors of landforms which wetlands occupy, or forms which they create or contain.
- wire rushland** rushland dominated by wire rush (*Empodisma minus*).
- zonation** the distribution of organisms or vegetation types in distinctive layers or zones.

## Index

All references are to page numbers. References are to the principal text treatment of topics, terms, localities, plant genera, and plant common names, and to illustrations (bold type). Note that glossary definitions are not included in the index; these can be found alphabetically on pages 169–180.

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