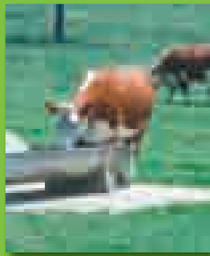
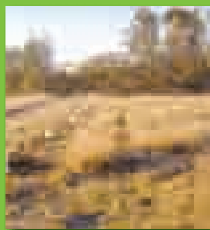
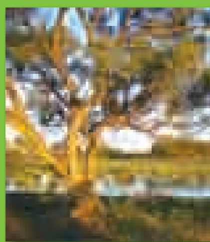
Recommendations for managing

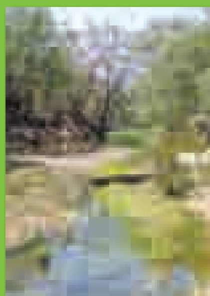
wetlands on farms

in inland NSW









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Recommendations for managing

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Wetland management: Recommendations for managing wetlands on farms in inland NSW

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Disclaimer

FOREWORD

I am quite convinced about just how important wetlands are to us as farmers in inland New South Wales. Wetlands are vital and we can all learn more about managing them sustainably. Recommendations for managing wetlands on farms in inland NSW provides both information and options to help us do so. Wetlands are among the most valuable and threatened ecosystems in the world. They have always been an important part of agricultural landscapes. In Australia, the vast majority of wetlands are on private land and many contribute to the major production values of the properties where they're found.

Wetlands are also important for their high levels of biodiversity and are vital to sustaining the healthy rivers on which our communities and production systems depend.

This publication has been produced primarily for landholders. It provides information about wetlands, why they are important and sustainable management options to ensure their health and longevity. It is a practical and useful document for any landholder with a wetland on their property, as well as for community groups, local and state government agency staff and other wetland managers.

I urge you to use this resource – not only your wetland will benefit.

Mark Etheridge
President
Australian Floodplain Association (AFA)
Wilcannia

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- Jim & Robyn Reid at 'Kallaroo', Armidale
- Malcom Starritt at 'Womboota Pastoral', Deniliquin
- Robert Webb at 'Dappo', Narromine
- Alan Wragge at 'Yaloke', Deniliquin

Abbreviations

CMA	Catchment Management Authority
DECC	Department of Environment and Climate Change
MWWG	Murray Wetlands Working Group
NSW DPI	New South Wales Department of Primary Industries

Note: A glossary, scientific names, contacts and resources are provided in the Appendices on the Compact Disk (CD).

CONTENTS

INTRODUCTION

The two key messages on which this document is based are:

1. **Healthy wetlands are associated with healthy catchments.**
   Wetlands do not stand alone: they are part of a river catchment and their health reflects the many interactions between land use, water and people that occur across the entire landscape.

2. **You can manage your wetland sustainably.**
   An understanding of how, and when, water arrives and leaves the wetland, and how the movement of water is affected by climate and agricultural activities, is the basis for sustainable management.

These recommendations are necessarily a simplification of a complex matter as no two wetlands are the same. This document brings together information common to all wetlands. A compact disk (CD) containing supporting information is also provided.

In wetland management there is some basic information and issues to consider before weighing up options for managing those issues. The colour coded sections in this document identify these important areas of wetland management.

- 1 Introduction

Wetland basics

- 2 Water
- 3 Soils
- 4 Plants and animals
- 5 Weeds and pests

Management guidelines

- 6 Managing impacts on wetlands

The focus of these recommendations is the wetlands of inland New South Wales. These wetlands fall into two broad groups: those of the slopes and tablelands, and those of the western plains (see Figure 1).

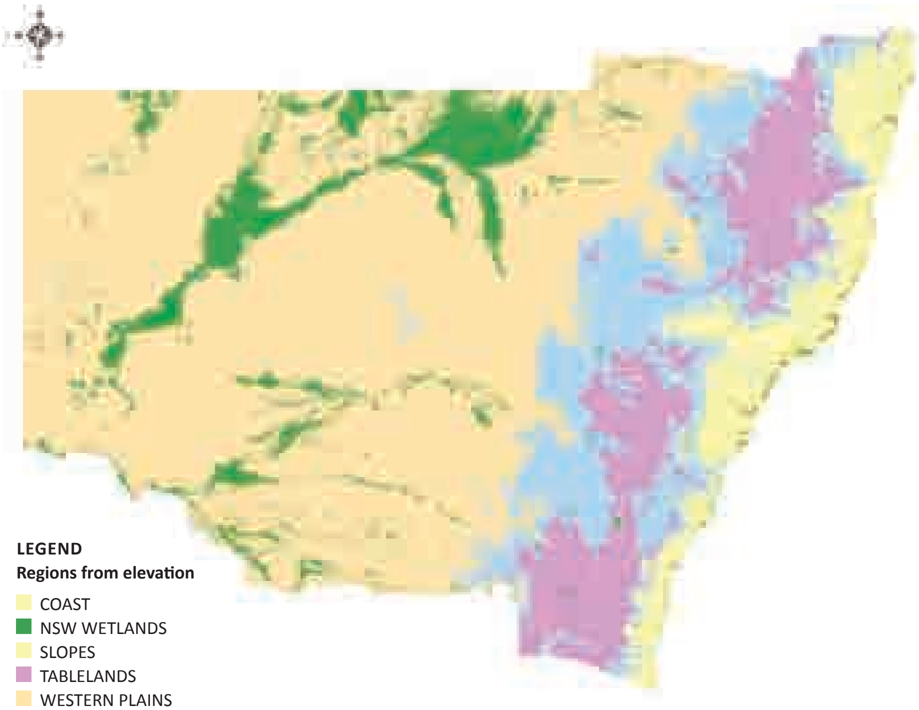


Figure 1: The distribution of wetlands in NSW. Source NSW DPI

Did you know these facts about wetlands in NSW?

- 5.6% (4.5 million hectares) of NSW is classified as wetland.
- 96% of wetlands are west of the Great Dividing Range.
- 93% are in areas with rainfall of less than 500mm per year.
- Most wetlands are on private land.

BENEFITS OF WETLANDS ON FARMS

Wetlands can be very beneficial on farms because they provide environmental, social and economic services.

Benefits of having a healthy wetland on your property include:

- provision of high nutrient value fodder for grazing animals, particularly during dry periods
- reduction of water flow rates in flood events, preventing erosion and infrastructure damage
- absorption of floodwaters including the ability to release the water back into the environment slowly
- replenishment of groundwater
- biodiversity 'hot spots' in drought prone or arid regions
- reducing the input of nutrients into waterways, reducing the chances of harmful algal blooms.

Healthy wetlands contribute financial and productivity benefits for landholders, including:

- increasing the value of the property
- improving production through improved pasture management and water quality
- reducing land degradation and associated repair costs
- contributing to, and maintaining, a healthy catchment.

Healthy wetlands can also contribute in less tangible ways to the quality of our lives. They provide a healthy landscape for native flora and fauna, healthier aquatic ecosystems and cleaner water downstream for communities and other producers. Healthy wetlands are also aesthetically pleasing and relaxing places to enjoy.

ABOUT WETLANDS

There are many definitions of wetlands. One appropriate for inland NSW is:

> *A wetland is any area of temporarily or permanently waterlogged land or inundated land, natural or artificial with water that is standing or running, ranging from fresh to saline, and where inundation by water influences the biota and ecological processes occurring at any time*[1]*.*

Image 1: Wetlands are amongst the most important, productive and undervalued ecosystems in Australia. This image shows an intermittent freshwater meadow at Trangie. This area is not always wet. It can be dry for long periods of time. The plants and animals that live here are adapted to being both flooded and remaining water-logged. Photo NSW DPI

[1] Brock M A., Boulton. A. J. (1999) Australian Freshwater Ecology, Processes and Management, National Library of Australia, Canberra.

There are many types of naturally occurring wetlands in inland NSW[2], including:

- floodplain wetlands — river and creek channels and adjacent inundated vegetation, which includes swamps, waterholes and shallow depressions and anabranches
- freshwater lakes — naturally occurring drainage basins of open water permanently or not permanently flooded
- saline lakes — naturally occurring inland drainage basins of saline open water such as salt lakes.

There are also constructed wetland areas, including irrigation drainage lines, farm dams and ponds and water storage areas.

Image 2: Freshwater lakes, such as Clear Lake in the Narran Lake Nature Reserve north western NSW, are part of a river's drainage basin. During a flood event Clear Lake fills from the Narran River and can hold water for 12 months. In years with good rain, such as 2008, the back channels and swamps became inundated and provided essential breeding conditions for birds. Photo Richard Kingsford.

[2]Kingsford, R. T., Brandis, K.R., Thomas, P. Crighton, Knowles, E., Gale, E. (2003) The distribution of wetlands in New South Wales, New South Wales National Parks and Wildlife Service, Hurstville.

WETLAND MANAGEMENT STORIES

Historically, wetlands were viewed as unproductive, swampy areas that harboured pest species and provided little productive value. Many wetlands were drained, filled with soil and planted with dryland species. As the knowledge and understanding of these complex ecosystems has increased, perceptions and attitudes are changing. People now recognise the many ways that wetlands are important within a catchment and on a farm.

Recommendations for managing impacts on wetlands are provided in the section on wetland management (page 39). Detailed case studies describing how farmers are managing their wetlands (and reaping the benefits) can be found in Appendix 6 (see the accompanying CD). The two short case studies that follow showcase some of this inspiring work.

Image 3: A paddock west of Dubbo before reinstating natural wetting and drying cycles.

Image 4: The same paddock after the natural cycles were reinstated, 15 years on

The wetland at Rob Webb's property 'Dappo', near Narromine, forms part of what's locally known as the Backwater Cowal. This occasional watercourse flows only after local heavy rain and is a series of wetlands connected by a wide, low-relief channel with a small licensed weir that allows water to be held or released.

Over the years the health of the wetland had declined continuously. The most obvious indicator of this was a reduction in wetland vegetation, with little regeneration of the surrounding river red gums (*Eucalyptus camaldulensis*) and disappearance of the native sedges and other specialist wetland plants.

Since 1995 Rob has been managing the wetland areas on his property and sees the benefits as:

- an extremely attractive wetland that adds aesthetic and financial value to the property
- a noticeable increase in the birdlife in and around the wetland, including regular breeding of black swans and brolgas
- the integration of the wetland into the farm's primary production, with opportunistic grazing.

Rob has been working on his wetland for over fifteen years and is very happy with what he has achieved. For more information the full case study is on the CD.

Alan Wragge's property "Yaloke" on the Wakool River at Deniliquin contains a black box depression wetland. It fills from local heavy rainfall along drainage lines conveying the runoff to the wetland which holds water for short periods without top-ups.

This 240ha wetland was part of a large grazing paddock subjected to a set-stocking grazing regime for over 60 years. The health of the wetland particularly of the black box *(Eucalyptus largiflorens)* and other wetland plants was in serious decline. Weeds had rapidly increased and the aged black box was struggling to survive and there was little natural regeneration due to reduced inundation and overgrazing.

In 2001, Alan received funding and technical advice to erect fencing to control stock accessing the wetland. In the following year he was able to source environmental water via existing and new irrigation channels to water up to 80% of the wetland. The benefits of both these actions were clear and demonstrated:

- dramatic improvement in the health of the black box trees and other wetland vegetation
- significantly increased water bird numbers
- reduced the area of weeds and gave better stock control.

Alan has seen the benefits of sustainable wetland management and is reaping a range of benefits. For more information the full case study is on the CD

WATER

Wetlands and water go hand-in-hand, even though wetlands are not always wet. To understand wetlands we need to know how landscapes and water interact and where the water goes after it falls as rain.

Changes in the landscape, whether natural or imposed by us, can alter water pathways drastically, and thus change the natural functioning of the wetland. Examples of changes that we have made which continue to affect wetlands in inland NSW include weirs, diversion channels, clearing of native vegetation, planting of pine forests and over-grazing.

Water regime and source

The water regime refers to how often, when and for how long water is in the wetland. A water regime is naturally affected by rainfall, flooding, climate, temperature and droughts.

Australian wetlands are generally characterised by extremely variable water regimes as a result of natural variations in climate that occur both within and between years and over decades. Mound spring wetlands in the Great Artesian Basin of NSW are an exception as they are characterised by stable, permanent water regimes.

A wide range of human impacts have resulted in changes to wetland water regimes throughout Australia. The ecological functions of wetlands are impaired if water regimes are changed to the point that the wetland is either:

- not inundated enough, or as frequently, or
- inundated too much and/or too frequently.

For example, draining of permanent wetlands can result in acid sulfate soils (see page 28). Figure 2 shows how dependant water, plants and animals are on each other in the wetland ecosystem.

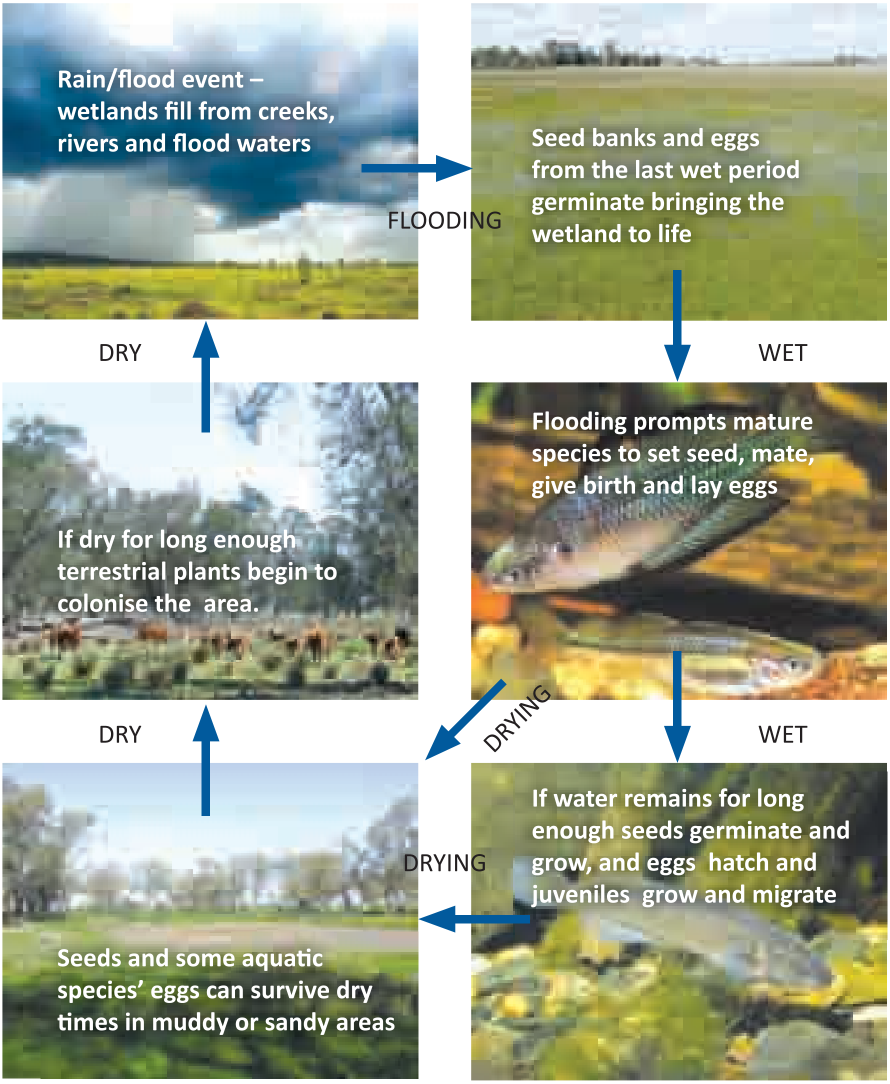


Figure 2: Wetting and drying cycles typical of many inland wetland systems.

Retaining water in a wetland that would dry out under its natural regime stops germination, growth, flowering and seed setting of some water plants. The disappearance of specific plant species will have flow-on impacts, some of which can affect the health of the wetland by, for example, reducing the abundance of insects which means less food for frogs, fish and water birds.

In addition, wetlands that are artificially and permanently wet provide habitat that feral species prefer. For example, feral fish such as carp, redfin and mosquito fish are more common in permanently wet wetlands.

Where the frequency and duration of regulated flows have been increased, permanent swamps have been created. Where flows have been excluded, wetlands have been significantly modified or may not have received water for up to 50 years. This means, for example, that a shallow open water or reed-bed swamp may eventually turn into a dry pasture or forest habitat.

Run-off and evaporation

Most of the rain falling on an unaltered or pastoral landscape falls on surfaces that absorb it quickly and replenish the soil moisture. Usually, most of the water evaporates or taken up by plants, so little if any reaches a watercourse.

In those places in Australia with a semi-arid climate, evaporation generally outpaces the rainfall. For example, evaporation rates in Western NSW exceed 2m each year whereas rainfall maybe less than 250mm per year. Our creeks typically remain dry for long periods and flow only when rainfall continues long enough to first saturate the soil, then run-off over the surface and into the waterway. Experience shows that only about 13% of annual rainfall ever appears as streamflow, although this may vary widely (from 0% to 80%) and depends on seasonal conditions.

On hillslopes some of the water that enters the soil percolates downhill, slowly, as subsurface flow. Often, this percolating water is deeper than plant roots, so it does not get taken up by plants or evaporate. Rather, it accumulates in volume as it moves down the slope until it exceeds the soil's capacity to carry it as subsurface flow. Where this occurs, the soil becomes saturated to the surface, and springs can often be seen or upland swamps develop.

Image 5: An upland swamp south of Guyra. In an upland swamp the ground is wet and stays wet long after rain ceases. These saturated zones can most often be seen at the foot of hillslopes, especially where a break in the slope occurs, or as narrow belts of wet areas adjoining creek lines. They occasionally become permanent and a wetland community develops. Photo NSW DPI

More often, the saturated zones are ephemeral (intermittent) but provide sufficient moisture for a community of semi-aquatic plants to thrive or survive. But these areas play a vital role by influencing the amount, persistence and quality of runoff that reaches the watercourse. The water that exudes from the saturated soil has already passed through a massive physical and biological filter - the soil cover on the hillside. The water is characteristically very clean, and contains only dissolved constituents such as naturally occurring organics, which often colour the water. However, it may also contain salt and cause local 'dryland salinisation' (whether this occurs depends on the local soil type and its geological history).

Flows from seepage areas and springs are persistent, often lasting through the most severe droughts, developing their own groundwater dependent ecosystems. Their lasting nature makes them vital for sustaining dry-weather flows in creeks and for the wetland plants and fauna that depend on a continuous supply of moisture. Finally, when rain is actually falling, runoff into creeks often occurs only from these saturated areas, due to the relationship between infiltration, saturated soil and water movement. Groundwater extraction affects the level and movement of water.

Water quality

Wetlands can improve water quality by retaining, detaining or breaking down the pollutants. Wetlands also readily oxygenate the water, trap suspended solids and kill pathogens (disease causing organisms). A combination of shallow marsh, deep pools or a chain of ponds will have the greatest 'cleansing' effect.

However, wetlands have a finite capacity to assimilate pollution and they can become a problem area. Elements such as the metals and phosphorus do not 'go away' nor are they broken down. For example, phosphorus that is washed into a wetland, may be washed through, detained or retained — but it is not lost and therefore 'enriches' the catchment system and creates an ideal environment for problems such as weeds.

Wetlands should not be seen primarily as a means of mitigating the effects of poor practices elsewhere. It is better to improve management practices to stop excess nutrients or pollutants entering a water system.

Nutrients and eutrophication

Phosphorus and nitrogen are two key plant nutrients that drive many plant processes. In excess these nutrients, for example, fertiliser or stock faeces, 'overfeed' or 'enrich' the system. This is known as 'eutrophication'.

Eutrophication results in the rapid growth of the plants and micro-organisms, specifically phytoplankton and algae. If this occurs, oxygen in the water may become depleted and some organisms, including fish will die. This further depletes the amount of oxygen available in the water as bacteria in the water break down dead organic matter. This can even lead to 'black water' where, in the anaerobic conditions, bacteria thrive releasing bubbles of foul smelling hydrogen sulphide (commonly called 'rotten egg gas').

Wetlands and farm dams with eutrophication problems often become dominated by algae and regularly produce blooms of filamentous or blue-green algae. Alternatively, the excessive growth of some free-floating native waterplants such as ferny azolla or duckweeds cover the water surface and degrade the ecology of the wetland. These species are often not a problem when less numerous.

Image 6: Excess nutrients in this western NSW waterway are encouraging the growth of algae. The green scum is an indicator that too many nutrients are entering the system. Photo NSW DPI

Using wetland water

WATER EXTRACTION OR DIVERSION

Potential impacts of groundwater and wetland water extraction on wetlands include:

- over extraction leading to loss of aquatic species
- insufficient ground cover and/or wetland buffer
- erosion
- altered water regime
- development of acid soils
- salinity
- combined effects of above contributing to weed infestation.

! Water interception and/or extraction are regulated activities.

Banks across floodplains can spread water and redirect flow away from wetlands or natural creek channels. In addition, tracks, fence lines and roads also change the flow of water across the landscape.

WATER RE-USE

Effluent produced from intensive agriculture, sewage treatment works and septic systems can be treated by wetlands, or re-used or managed with a combination of both systems. There are many issues associated with water re-use, including:

- residual build-up of contaminants in the soil
- movement of persistent pollutants leaching into the ground water
- flooding and excess rain and run-off
- the health of animals and humans if pathogens are present.

A thorough investigation is required before considering water re-use as part of your wetland management.

Constructed wetlands

Wetlands are constructed for many reasons, including:

- retaining water as a source for other uses, including for stock
- slowing down the flow, effectively detaining water for longer
- aesthetics and recreation
- conservation and habitat for fish, frogs and birds
- improving a degraded area on the farm
- water quality and waste treatment — runoff from intensive farming can be treated before it enters a natural wetland.

Specific management issues are associated with constructed wetlands, but they are not the focus of this publication[3].

Upsetting the water balance

Many of things we do to 'manage' the land and produce income can change how water moves through a catchment, often upsetting the balance, especially downstream:

- clearing native forest and establishment of exotic plantations, pasture or cropland
- regular application of fertilizers
- introducing hard-hoofed livestock for long periods
- 'reclamation' and drainage of low-lying areas
- regulation of natural water flows and waterway 'improvement' works
- urban development and stormwater drainage.

[3] See Department of Land and Water Conservation (DLWC) Constructed Wetlands Manual Volume 1 and Volume 2 for additional information resources relating to constructed wetlands

SOILS

Soils vary from site to site and range from alkaline sands to acid heavy soils and all variations in between. If the area has been inundated by the sea in recent geological times (particularly areas of inland Australia) there is potential for acid sulfate soils to be present.

Understanding your wetland soil is important, especially if there are likely to be modifications to the areas that are wet or to the pattern of wetting and drying. The development of acid sulfate soils, for example, is counterproductive, both for the wetland and for farm production.

Image 7: Wetland soils vary widely and contribute to the diversity of habitats. Cracked drying mud retains seeds and eggs of aquatic flora and fauna providing habitat. Photo NSW DPI

Acid wetlands

This section relates to wetlands that are permanently wet or are only dry during periods of very low rainfall. There are short term problems with allowing a permanent wetland to become unnaturally dry and these depend on how long the wetland stays dry. However, in all cases, when the water is returned to the wetland the major long-term problem that arises is sulphur.

There are three main issues with sulphur when returning water to an unnaturally dry wetland:

- acid sulfate soils
- sulfidic sediments
- monosulfidic black ooze.

ACID SULFATE SOILS

Acid sulfate soil is the most common type of soil found in permanent wetlands in inland NSW. These soils contain iron sulfides which are trapped in a layer of waterlogged soil. This layer can be clay or sand and is usually dark grey and soft. A surface layer of water prevents oxygen in the air reacting with the iron sulfides in the waterlogged soil.

When the iron sulfides are exposed to air by drying wetlands and produce sulfuric acid, they are known as acid sulfate soils. The soil itself can neutralise some of the sulfuric acid. The remaining acid moves through the soil, acidifying soil water, groundwater and, eventually, surface waters. This acid water

Image 8: Sulfidic soil profile. This sulfidic soil profile actually contained acid sulfate soils in the upper half. It also shows the mottling and 'gleying' that can be associated with sulfidic soils. Photos MDFRC (2007)

kills vegetation and affects aquatic animals severely. Acid water discharge can cause fish kills.

Under natural conditions iron sulfide layers are covered by water and colonised by native vegetation. In severe droughts plant roots can take up so much of the water in the soil that the watertable drops and exposes the iron sulfide layer to air. When this occurs, acid is generated. When floods follow dry periods or a dry wetland is reflooded, acid can be released into the water.

Acid sulfate soils reduce farm productivity. The sulfuric acid lowers pH, which makes several soil nutrients less available to plants. The acid mobilises iron and aluminium from the soil so that they become available to plants in toxic quantities in soil water. These conditions reduce plant growth, and only acid-tolerant plants can survive. This effectively means the loss of drought-refuge swamp pastures used in the past by farmers to graze stock.

Animal productivity is affected by acid sulfate soils. The acid discourages good quality pasture. Grazing animals may take in too much aluminium and iron by feeding on acid-tolerant plant species and drinking acid water.

Despite their bad reputation, acid sulfate soils are naturally occurring and are not actually a problem so long as they remain waterlogged.

SULFIDIC SEDIMENTS

An increasing problem for inland wetlands is high levels of sulfidic sediment. The general concentration of sulfates in NSW freshwater systems has increased due to increases in water salinity and the use of agricultural chemicals. This is another reason why acid sulfate soils have become a bigger threat than originally anticipated.

Wetlands provide ideal conditions for forming sulfate sediments as the wetness forms a seal to prevent oxygen reaching the underlying soil.

If untreated water that is unnaturally high in chemical sulfides is allowed to enter a wetland it can exacerbate the effects of acid sulfate soils or even create them.

Although wetlands can filter harmful sediments from water, unnaturally high levels of pollutants can have a negative effect on the wetland system itself.

MONOSULFIDIC BLACK OOZE (MBO)

Flooding of drained land can also stir up toxic sediments known as 'monosulfidic black ooze' (MBO) which strips the remaining oxygen from the water. MBO is a gel-like substance deposited on the bottom of channels and is commonly associated with the oxidation of acid sulfate soils in the presence of vegetation. So the inundation of weedy drains is an ideal situation for MBO formation.

Image 9: A farmer with a shovel full of monosulfidic black ooze. A teaspoon of monosulfidic black ooze can strip all the available oxygen from 1 litre of water in just 30 seconds! Photo NSW DPI

Salinity

Salinity is a major threat to naturally non-saline wetlands of inland NSW. Salinity can impact significantly on productivity and biodiversity by making an area less suitable for native plants and animals. There are two distinct types of salinity: dryland salinity and irrigation salinity.

Dryland salinity is caused when the rising water table brings natural salts in the soil to the surface. The salt remains in the soil and becomes progressively concentrated as the water evaporates or is used by plants. One of the main causes for rising water tables is the removal of deep rooted perennial trees and plants, shrubs and grasses and their replacement by annual crops and pastures that do not use as much water.

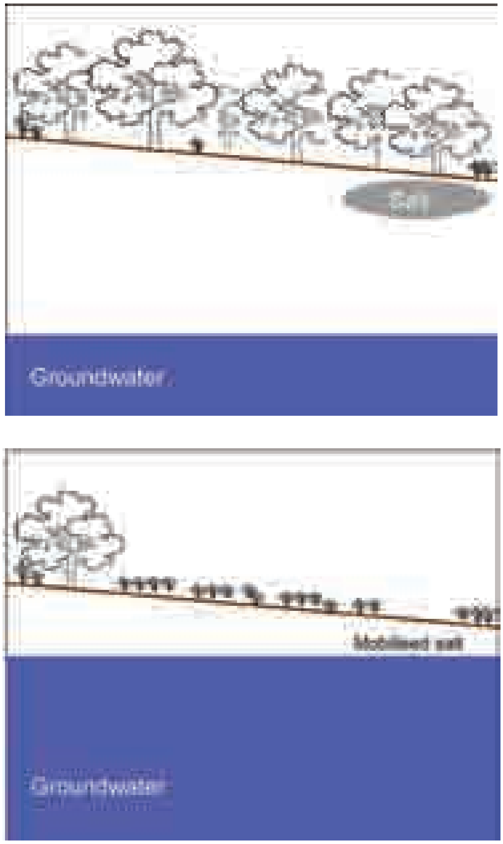


Figure 3: Illustration of the effect of vegetation clearing on the watertable and the appearance of salt on the surface. Source NSW DPI

Irrigation salinity occurs when irrigation water soaks through the soil area where the plant roots grow, adding to the existing water. The additional irrigation water causes the underground water table to rise, bringing salt to the surface. When the irrigated area dries and the underground water-table recedes, salt is left on the surface soil. Each time the area is irrigated the process is repeated.

Image 10: A salinity scald on a low-lying area within the Murrumbidgee Irrigation Area. Photo NSW DPI

However natural saline areas contain salt tolerant plants and these are important stabilisers of soil, and do provide grazing for native animals and livestock.

PLANTS

Wetland plants are essential for a wetland to perform its valuable ecological and productive functions. Wetland plants:

- oxygenate the water
- filter excess nutrients, such as phosphorous, out of the water
- stabilise mud and banks where erosion could occur
- provide food, shelter and nesting material for birds and habitat for fish and numerous other animals.

What plants grow in a wetland and how many there are depends on what nutrients are available, and water, temperature and light.

Freshwater wetland plant communities tend to occur in distinct zones based on water level or how often they are flooded.

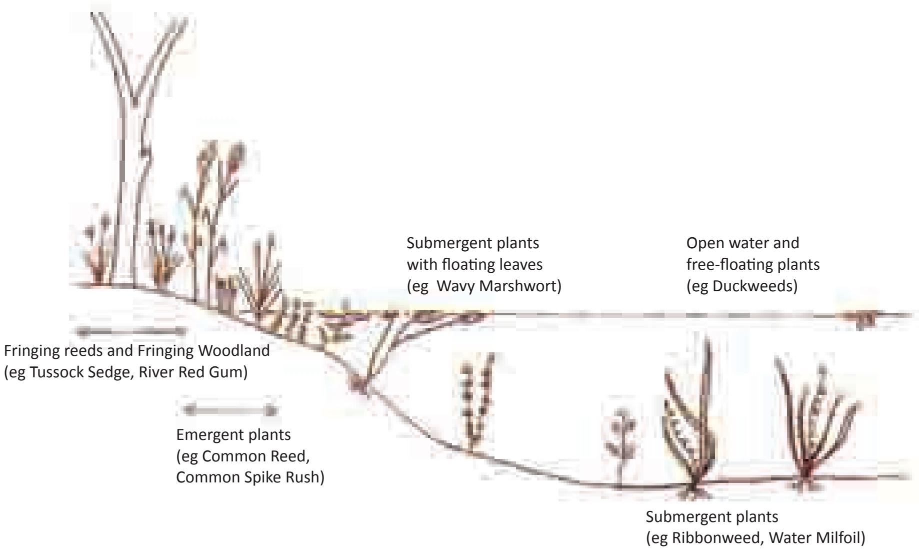


Figure 4: Within a wetland, grasses, sedges and submerged aquatic plants tend to colonise wherever water ponds for any length of time. Emergent plants generally do not colonise water deeper than 2m. Image source Margaret Brock

Plant diversity

Different wetlands will have different types of plants depending on water depth, the duration and frequency of wetting and drying, soil, size of the wetland, location, rainfall and water quality. Plant species that live in or near the wetland have evolved to breed in and survive extreme and contrasting seasons.

Wetland plants are often rapid colonisers of temporarily wet depressions. They include emergent rushes, sedges and grasses, and plants like canegrass and lignum that grow in floodplains and shallow depressions that are frequently or infrequently wetted.

The floating-attached plants include water snowflake, floating pondweed and swamp lily. A few species are free-floating and include azolla and duckweed.

The submerged plants are rooted in the bottom of the pool or stream and include ribbonweed, and some species of pondweed.

Not all wetland types have naturally high plant species diversity. Some healthy and well functioning wetlands can actually have relatively low plant species diversity. Wetlands dominated by lignum or canegrass, for example, may or may not actually represent a wetland in poor health. Therefore, careful classification is needed to provide a benchmark for assessing wetland health.

Image 11: This dry lignum floodplain in western NSW has low species diversity, but is in good condition and suited to either long dry periods or wet periods. Lignum provides important habitat for a variety of animals. Photo NSW DPI

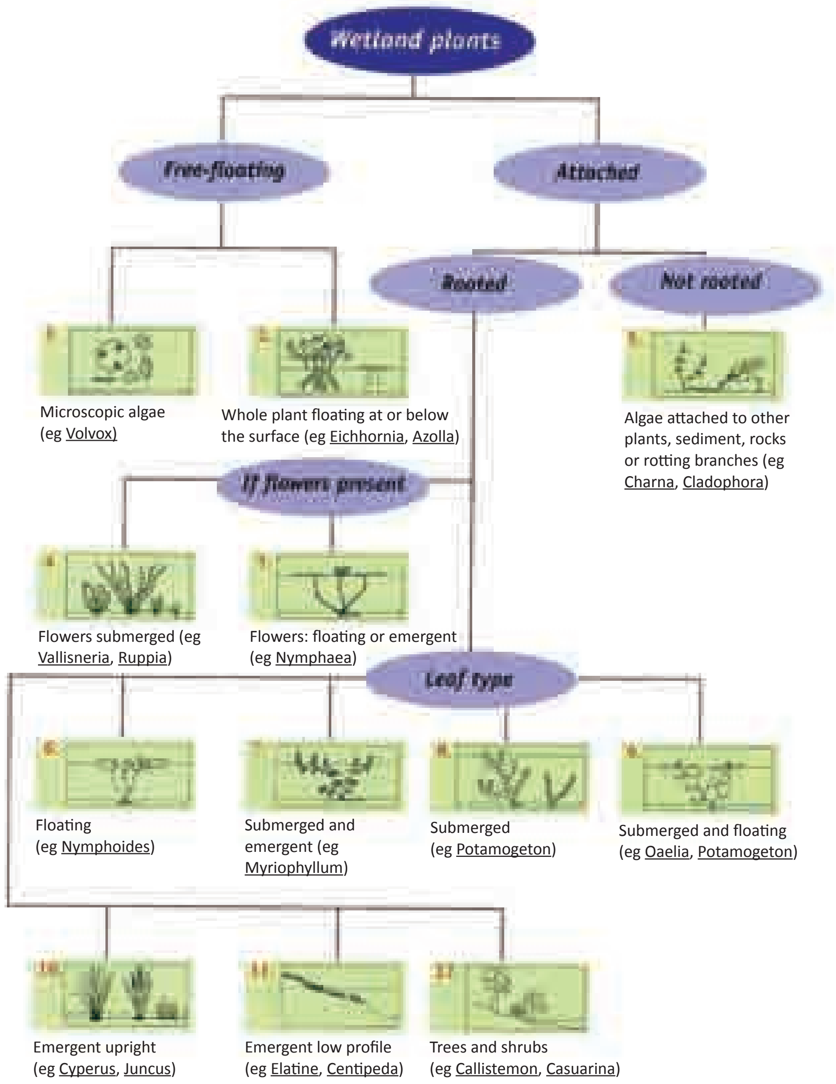


Figure 5: Growth forms of wetlands plants. Source Margaret Brock

The importance of waterplants

Wetland plants have the capacity to absorb and release large quantities of nutrients — what is referred to as 'nutrient cycling'. This cycling varies with season, plant type and growth stage, soil and water chemistry and how the water moves through the wetland system.

Wetlands can be highly productive areas. They produce a lot of 'biomass' (plant material). The productivity of wetlands is also governed by the supply of nutrients, water availability, temperature and light.

Submerged plants are important as they:

- reduce erosion by reducing flow rates and trapping suspended sediment
- add dissolved oxygen that supports aquatic life
- provide food directly or indirectly
- provide shelter from predatory fish
- strip nutrients from water
- provide breeding sites for fish, frogs and invertebrates
- help maintain habitat diversity and therefore the number and types of plants and animals present in the wetland.

Image 12: Red watermilfoil in Lake Brewster *(Myriophyllum verrucosum)* is a common submerged and emergent native wetland plant found in wetlands throughout NSW. This native species can be be confused with M. aquaticum and M. spicatum which are weeds. Photo Geoff Sainty

Emergent plants, like rushes, sedges and grasses, are visually appealing, and:

- stabilise banks
- provide food and shelter for animals, including nesting sites for birds
- provide a surface for a layer of algae to form on the plant surface ('bio-film') which removes nutrients from water and traps sediments
- reduce turbidity by causing sediment to fall out of the water column.

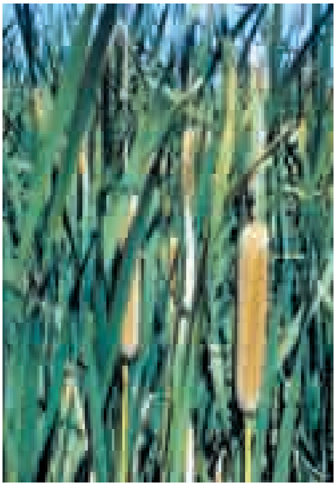


Image 13: Cumbungi is a common native emergent plant. Photo NSW DPI

A woodland often surrounds a healthy wetland, usually on slightly higher ground than the reeds, rushes and sedges. Trees making up the fringing woodland often include river red gums, black box, coolabah, river cooba and yapunyah. The fringing woodland helps protect a wetland and improves the diversity of the habitat.

Image 14: These young river red gums thrived only when the wetland received regular flooding. Photo CW CMA

Image 15: This semi-permanent wetland on the Paroo River in western NSW displays an excellent buffer zone of fringing woodland providing critical habitat for native species. Photo NSW DPI

Microbes

Microbes are found in every wetland and are critical for maintaining their function and health.

- Phytoplankton are microscopic plants, single-cell algae free living in the water column. They contribute substantially to the productivity of the wetland. The type and number of phytoplankton can be a result of physical and biological interactions with other animals, including the microscopic animals known as 'zooplankton'.
- Zooplankton are minute floating or weakly swimming animals. They are essential to food chains, forming the link between phytoplankton and fish and crustaceans.
- Algae can be divided into 1) microscopic species that live attached to the surface of plants and sediments, and 2) larger visible macro-algae that are either attached to rocks and plants or free-floating.
- Blue-green algae grow in all wetlands and, in spite of their name, are a type of photosynthetic bacteria called cyanobacteria. They have the same requirements for light, nutrients and carbon dioxide as plants. Cyanobacteria are one of the oldest forms of life on earth, dating back 3.5 billion years and are an important base of the food chain. From time to time blooms occur and these are occasionally toxic and/or make water unsuitable for drinking or stock.

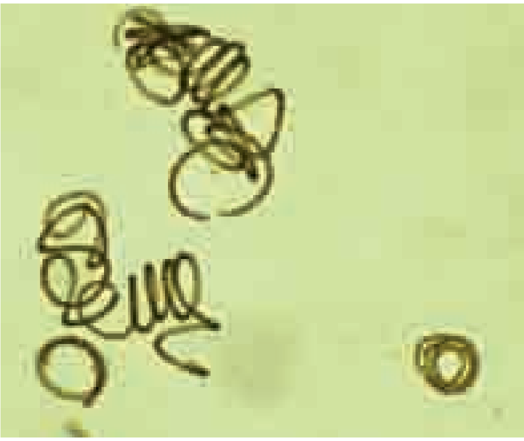


Image 16: Cyanobacteria, or blue green algae, are an essential part of aquatic food chains and are found in all wetlands. Photo NSW DPI

Assessing wetland health using plants

The presence/absence or abundance of plants can tell you a lot about the past and present physical conditions of the area. For example, the presence of only salt tolerant plants indicates the soil or water is salty. Weeds often indicate site disturbance and degradation.

'Health', in this context, is taken to mean an ecosystem that is appropriately diverse for the area and free of serious pests. The number, types and distribution of plants can therefore be used as indicators of wetland and catchment health.

The health of the catchment is strongly linked to plant health and subsequently wetland health.

Image 17: An example of a diverse plant community in a healthy wetland in the Lachlan River catchment. The presence of ribbonweed, sedges, azolla and fringing woodland is indicative of a healthy wetland. Photo Geoff Sainty

Animals

The types of animals in a wetland will vary depending on the duration and frequency of wetting and drying periods, soil type, wetland size, plants, location, threats, noise or disturbance around the wetland and water type and quality.

Animals that live in or near the wetland have often evolved specifically to breed, live and hunt only in wetlands. If the wetland habitats they depend on decline, then there is a very high likelihood of that animal becoming locally threatened or extinct.

Image 18: The freshwater or Murray crayfish is widespread in NSW, but seriously compromised by having its habitat altered, and at times poisoned by pesticides entering their habitat. Photo NSW DPI

Image 19: The water rat is one of the few native Australian mammals that have adapted to semi-aquatic life and can adapt well to habitat change. They are protected by law, but large numbers were killed in the past for fur. Photo NSW Government

Native fish

Not all wetlands have fish. If a wetland is ephemeral or not connected to a river it is unlikely that it will have a naturally healthy population of native fish.[4] Wetlands connected to rivers, either directly or through flooding, have important habitat value for native fish. Wetlands close to major river systems are especially important as they act as a 'fish nursery'. They provide young fish with plenty of food, shallow, clean water and shelter before they enter the strong currents and deep water of a river, lake or creek.

Image 20: The western carp gudgeon grows to 4.5 cm. It is usually found near aquatic plants. Photo Gunther Schmida

Image 21: The bony bream, a common wetland species throughout the Murray Darling Basin, can grow to about 45cm. Photo Gunther Schmida

Image 22: The southern pygmy perch is a vulnerable species. At 8.5 cm, it prefers weedy, slow flowing calm waters including shallow wetlands and irrigation channels. Photo Gunther Schmida.

As the number of healthy wetland habitats in NSW has diminished as a result of clearing, water extraction and grazing, the fish that use wetlands are, or are at risk of, becoming endangered or extinct. Dams and weirs should not be built in streams, but placed 'off line' so that the free passage of fish can take place.

[4] The NSW DPI brochure What fish is this? provides a more detailed list of freshwater fish in NSW (available at www.dpi.nsw.gov.au/fisheries/habitat/publications/fish-friendly-farming).

Water birds

Waterbirds are especially reliant on ephemeral wetlands for breeding. A big flood in the western plains may represent the only opportunity for breeding for a decade or more.

Birds are useful indicators of wetland health.

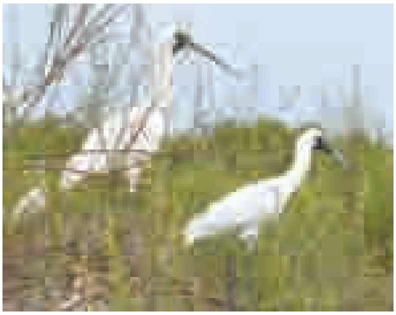


Image 23: An adult and juvenile spoonbill at Narran Lakes. The spoonbills bred in the 2008 flooding. Photo Kate Brandis

Image 24: Ibis nests. Birds are able to move quickly into wetland areas when conditions are favourable for breeding. Photo David Heap

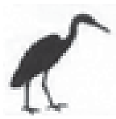
Group	Preferred type of wetland and area within wetland	
Swans and Geese	Large, open water, fresh, brackish or salt, flooded pastures	
Ducks	Well vegetated swamps, grasslands. Fresh, brackish or saline wetlands	
Grebes	Large, open wetlands with rich fringing vegetation	
Cormorants and Darters	Freshwater lakes, dams, rivers, creeks, estuaries, coastal waters	
Pelicans	Large, shallow waters – fresh, brackish, saline, coastal and inland	
Egrets and Herons	Shallow, freshwater, brackish and saline wetlands, farm dams, rivers, irrigation channels, estuaries, tidal mudflats	
Bitterns	Densely vegetated freshwater marshes, swamps and creeks	
Spoonbills and Ibis	Shallow, freshwater, estuaries, tidal mudflats	

Table 1: An indicative guide to the types of birds that might be present in your wetland. Source: Lloyd, P. & Alexander, P. (2003) *Wetlands Watch: A field Guide for Monitoring Wetlands in the Southern Section of the Murray-Darling Basin* 2nd Edition, Murray Wetlands Working Group Inc., Albury

WEEDS

Weeds can be plants growing outside their native environment and are often invasive. Weeds can have negative effects on the biodiversity, bank stability and water quality of wetlands. They tend to be vigorous, more disease resistant than native vegetation, rapid colonisers and able to take advantage of disturbed lands. Generally, they are less attractive to grazing animals.

Weeds are everywhere, and there are now more than 2500 weeds naturalised in Australia. Of the 20 plants listed under law as 'Weeds of National Significance'[5] six have potential to be serious weeds of wetlands in inland NSW. They are: alligator weed, athel pine, blackberry, cabomba, olive hymenachne and salvinia.

Other water weeds which locally may be more serious are: alisma, arrowhead, blue water speedwell, celery buttercup, creeping buttercup, dense waterweed, elodea, hygrophila, ludwigia, parrots feather, reed sweetgrass, sagittaria, Senegal tea, spiny rush, torpedo grass, watercress, water hyacinth, water lettuce, water poppy and yellow waterlily.

Image 25: An infestation of salvinia. This weed is capable of completely smothering the surface of a waterway or wetland. Photo Geoff Sainty

[5] Under the National Weeds Strategy, twenty introduced plants are identified as Weeds of National Significance (WONS). These weeds are regarded as the worst weeds in Australia because of their invasiveness, potential for spread, and economic and environmental impacts.

Image 26: An Alligator weed infestation can suffocate a wetland or waterway, with serious implications for the health of the area (above). Appropriate control methods can be effective as the photograph below taken from the same position demonstrates. Follow up monitoring and control is vital for the long-term control of weeds such as Alligator weed. Photos NSW DPI

PESTS

There are a number of introduced animals that have impacts on the wetlands of inland NSW. Most of these animals are also considered to have negative impacts on primary production and biodiversity in general. The major pest animal species for wetlands in NSW include foxes, cats, pigs, goats, rabbits, wild dogs, donkeys, camels, carp and mosquito fish. To a lesser extent some bird species (eg, muscovy ducks) are an issue.

Fish

There are eleven introduced fish known to be in NSW waterways, nine of which inhabit inland habitats. All nine feral fish listed below are found in inland waters and compete with native Australian fish in wetlands and waterways for food and habitat.

- carp
- brown trout
- brook trout
- goldfish
- mosquito fish
- oriental weath-erloach
- rainbow trout
- redfin perch
- tench

Image 27: Common carp. Photo Gunther Schmida

Carp, redfin perch and mosquito fish live in a wide variety of habitats, but prefer still or slow-flowing waters and therefore they can all dominate in wetlands.

Carp are very versatile, and can live in a great variety of habitats including highly degraded areas. Over the past few decades carp have spread to the point that they are now the most abundant large freshwater fish in some areas, including most of the Murray-Darling Basin. They spread rapidly into wetlands and streams—they are first to move with the flood and unlike native fish, the last to leave.

Redfin are voracious predators and consume a wide variety of fish and invertebrates, including small native species such as pygmy perch, rainbow fish and carp gudgeons, and the eggs and fry of larger fish such as silver perch, golden perch, Murray cod and introduced trout. This predation can seriously impact populations of native species. They also carry a disease called Epizootic Haematopoietic Necrosis (EHN) which can be a serious threat to native fish.

Mosquito fish give birth to live young: no Australian native fish do this. So, mosquito fish start their life-cycle with a distinct advantage over our natives.

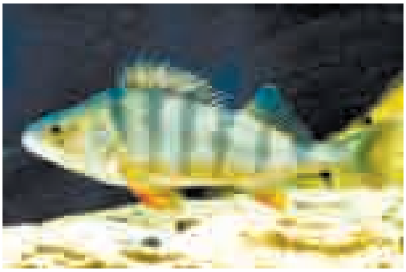


Image 28: Redfin perch. Photo Gunther Schmida

Image 29: Mosquito fish. Photo NSW DPI

Mosquitoes

Disease spread by mosquitoes can be a major issue. Existing mosquito-borne diseases include Ross River Virus and Murray Valley Encephalitis. Shallow water isolated from permanent pools is likely to become mosquito infested, and edges that have insufficient slope to fully drain are potential mosquito habitats. Mosquitoes are controlled in wetlands that maintain sufficient numbers of invertebrates and fish that prey on mosquito larvae.

WETLAND MANAGEMENT

Poor farm management practices can create potential impacts on wetlands. Some practices that are of particular concern when considering the health of wetlands are illustrated in Figure 6. These include:

- uncontrolled burning and clearing of riparian vegetation
- no erosion control measures
- unrestricted and constant stock access to the wetland
- nutrient flow from stock defecating, fertiliser and spraying pesticides in and around the wetland
- uncontrolled weed infestations in and around the wetland
- groundwater extraction and the diversion of overland flow into dams and away from wetlands.

Some farm management practices that help develop and maintain a healthy wetland are illustrated in Figure 7. Things to note in this illustration include:

- stock access to the wetland is controlled i.e. cell or rotational grazing allowing plants to flower, seed and regenerate
- off-stream/wetland watering points are provided
- spraying is done when any wind drift is away from the wetland
- run-off from cultivated areas is directed to a storage dam, not back into a wetland or river
- erosion is minimised by maintaining vegetated riparian areas and adequate levels of groundcover set by the local CMA
- soils are tested to monitor salinity and acidity
- nutrient run-off (weed invasion and algal blooms) is minimised through managing stock access and maintaining vegetated riparian areas.

High Risk Practices

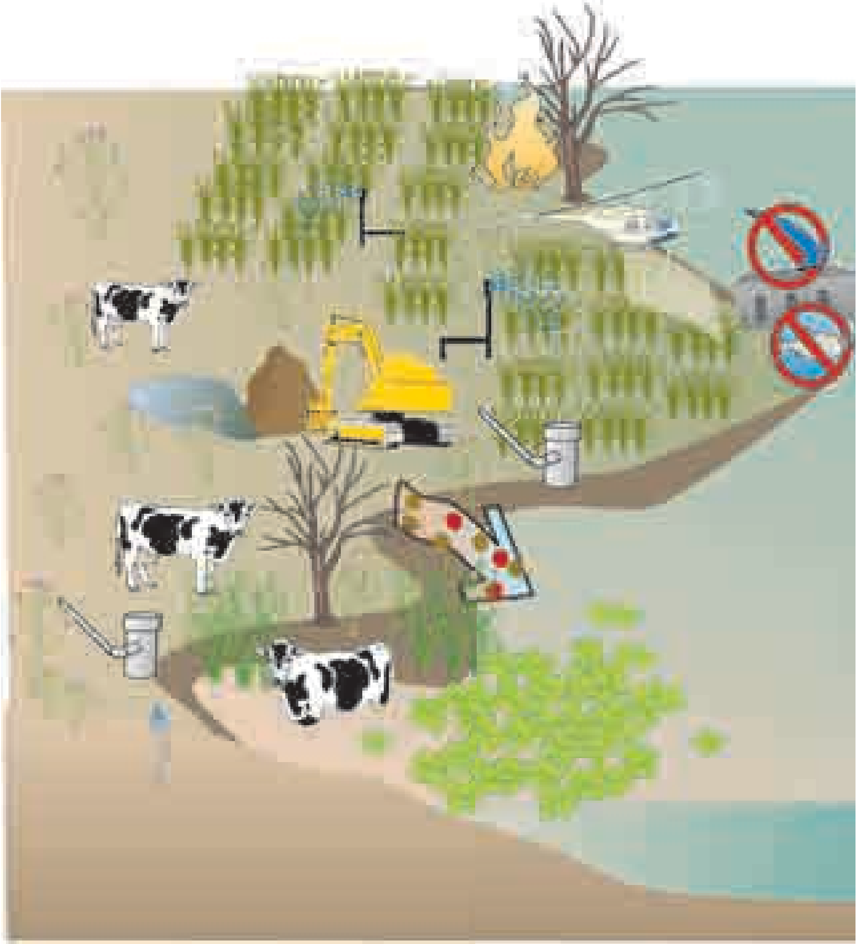


Figure 6: A conceptual diagram detailing land management practices that harm wetlands. See following page for legend. Source NSW DPI. Adapted from QLD EPA WetlandInfo

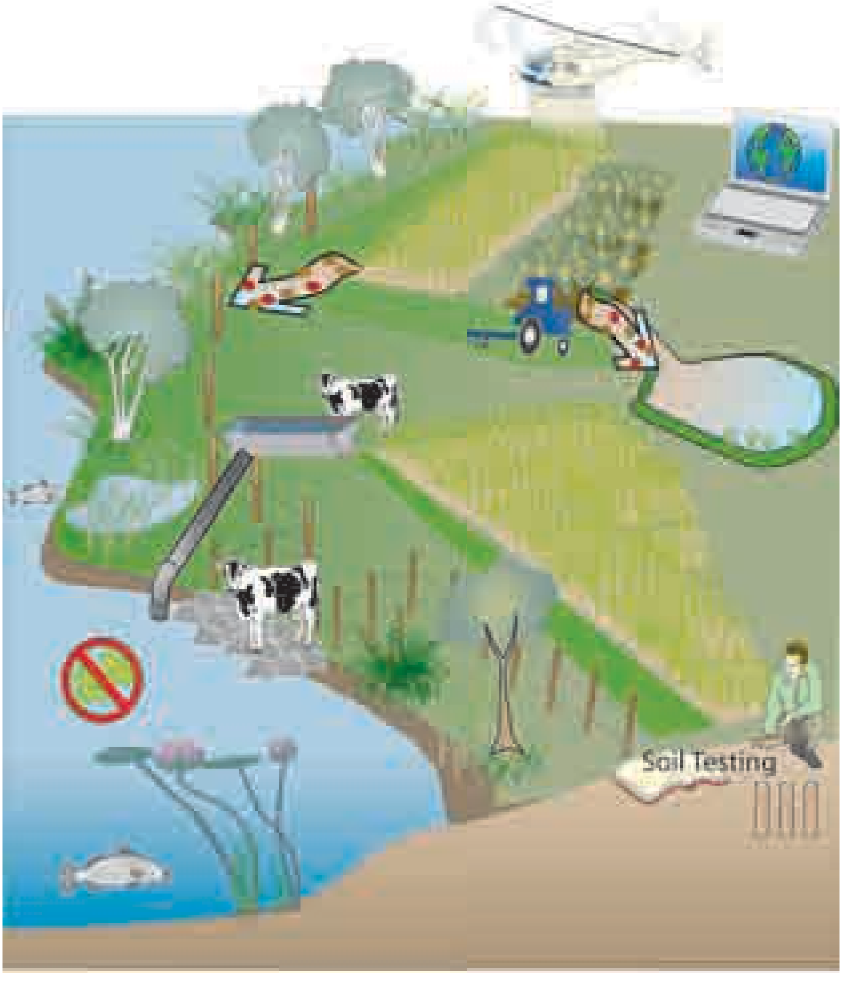


Figure 7: A conceptual diagram of land management practices that help maintain a healthy wetland. See following page for legend. Source NSW DPI. Adapted from QLD EPA WetlandInfo

Draining and filling

Hydrological modifications that alter flow and inhibit fish passage

Nutrient run-off from production areas encouraging excessive weed and algal growth

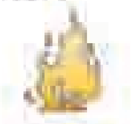
Excessive withdrawal of water for irrigation reduces the ability of wetlands to treat nutrients

Inadequate vegetative buffer type and width between the production area and the waterway

Poorly managed headlands that supply sediments and nutrients from the production area to waterways

Herbicide and pesticide drift or run-off

Overgrazing or unmanaged stock access to wetland or waterways



Fire regimes that are too hot and too often

Poor weed management causing invasive species to degrade wetland values

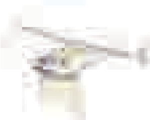
Recording and managing nutrient applications through the use of soil testing and record keeping

Sediment management - filter strips and riparian buffer zones

Fish passage

Wetland weed management

Constructed wetlands and sediment traps



Management of spray drift

Accessing and utilising wetland mapping and management tools from WetlandInfo

Stock access

Wetlands and their surrounding vegetation are often used to provide water and shade for stock. If the wetland is unfenced, stock will naturally camp close to water and shade.

KEY ISSUES

- When stock drink directly from streams they reduce water quality, cause bank and stream bed erosion, destroy riparian vegetation and stir up sediments. This means a decline in water quality and habitat for fish and other wildlife.
- Cattle defecate 25% of the time when drinking, particularly standing in a wetland. One kg of phosphorus from manure can lead to 500 kg of algae. Such algal blooms can choke waterways and may be toxic to fish, livestock, water plants and people.
- Weed seeds and rhizomes can be transported by stock via dung, hoofs or coats, thus spreading infestations or introducing new weeds to wetland areas.
- Uncontrolled grazing can result in plant species being over-grazed, reducing the recruitment opportunities and thus the chances of the species surviving over time.

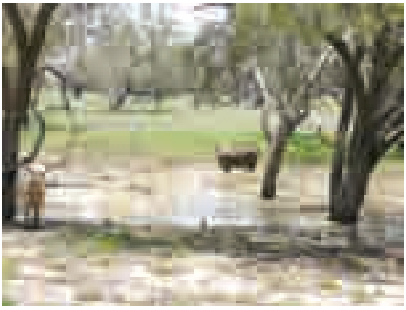


Image 30: Cattle in wetlands can cause damage through pugging and added nutrients from defecation. Photo NSW DPI

Image 31: Erosion, compaction and degradation of the riparian zone due to stock access. Photo NSW DPI

RECOMMENDATIONS FOR GOOD MANAGEMENT

Manage and control access points and water troughs

- locate access points and water troughs as far from the wetland as possible, on flat ground or aprons. This will help minimise erosion and sediment into the wetland or waterway
- locate stock and vehicle access points on higher areas but not on a slope of more than 4:1
- where livestock access to your wetland is unavoidable, ensure that the access point is not shaded and is gravelled or rocked to the water. This will help minimise erosion and discourage stock from using the area as a camp or for shade.

Install fencing and gates

- control access to wetlands via a gate or drop down fence
- appropriately designed fences will be a useful tool to limit constant stock access to your wetland.

Image 32: Controlling stock access is an important aspect of wetland management. Photo NSW DPI.

Grazing

Wetlands can provide valuable grazing land for domestic stock, and can be used as short-term drought fodder refuges. Historically, Australian wetlands have been grazed by native animals such as kangaroos, wallabies or wombats. More recently, feral animals such as rabbits, pigs, camels, horses and donkeys all contribute to total grazing pressure.

The challenge is to use the grazing benefit of the wetland sustainably, without permanently degrading its ecological and production values.

KEY ISSUES

Overgrazing or inappropriately managed grazing by livestock can degrade the value of the wetland by:

- trampling vegetation
- compacting soil
- disturbing sediments in water
- increasing water nutrient levels
- adding pathogens
- contributing to weed infestation and spread.

Image 33: This riparian area has been heavily grazed and pugging has occurred. Damage to the reeds and the soil structure is evident. Photo NSW DPI

RECOMMENDATIONS FOR GOOD MANAGEMENT

Understand your wetland

Know the answers to these questions:

- What plant and animal species occur in and around your wetland?
- What are their lifecycles and the sensitive periods of wetland species (including flowering, seed setting, nesting)?
- What are the wet/dry cycles?
- When are the better grazing times, at what stocking rates and for how long?

Use conservative stocking rates

- Conservative stocking rates allow for changes in seasons and short-term climate periods
- Stocking rates should be based on the response of the most sensitive parts of the ecosystem
- Use an appropriate rotation of stock type. Different species, breeds, types and age classes of stock behave and graze differently and have different effects on the wetland.

Controlled grazing

- ensure regular spelling of wetlands and surrounding areas allowing recovery time for plants, increasing ground cover and building up organic matter in the soil
- control stock access to the wetland areas by using temporary or permanent fencing and use rotational grazing practices, not set-stocking
- locate alternative water sources away from the wetland, to reduce nutrient run-off, erosion, soil compaction and degradation of the canopy species from stock undermining tree roots.

Time the grazing

- consider the potential introduction or spread of weed species from hooves and coats of animals from other weedy areas
- control or avoid grazing at critical times, eg. when desired plants are flowering and setting seed
- control or avoid grazing when the wetland is flooded or is drying to avoid bogging stock
- avoid denuding all vegetative cover in a dry wetland particularly when wetland plants are stressed
- put stock in for short periods, that is crash or cell graze, as this is preferable to set stocking stock for long periods
- remove stock during re-wetting periods (if water flow is controlled or when flooding). Wetlands grazed during dry times should be de-stocked once they are re-wetted to allow plants to seed and invertebrates, fish and birds to breed.

Image 34: Sustainable grazing helps maintain groundcover and plant biodiversity. Photo NSW DPI

Cropping

There is increasing pressure to use floodplains and lakebeds for cropping to provide grain for intensive farming and supplementary grazing fodder. This may be only every 10 years when flooding occurs, however even opportunistic cropping has significant impacts, such as loss of perennial floodplain and ephemeral swamp plants and grasses.

Potential impacts include habitat destruction, removal of perennial species e.g. lignum and the contamination of waterways following the use of/or cumulative effect of use of pesticides, herbicides and fertilizers to improve crop outputs.

There are specific considerations regarding the cultivation of lakebeds in the Western Division that must be addressed before cropping can occur.[6]

KEY ISSUES

Lake bed cropping significantly increases the threat to wetland health by:

- disturbing soil structure and creating compaction
- destroying the resting stages (eggs) of wetland invertebrates
- destroying existing plants and native seed banks
- increasing the chance of weed infestation
- contamination by fertilizers, herbicides and pesticides.

! Approvals must be obtained to cultivate land within the Western Division of NSW. Contact the Department of Lands Western Region

[6] Please contact your local Department of Lands office for more information.

RECOMMENDATIONS FOR GOOD MANAGEMENT

Minimise the use of chemicals

- use integrated pest and weed management strategies to reduce reliance on chemical control methods.

Maintain buffers

- maintain adequate buffer zones around your crop and other vegetation. Buffers up to 100m wide are needed to protect the wetland, for example, in the Western Division.

Allow for wildlife refuges

- leave a section (up to 15%) in the middle of your lakebed uncropped as a wildlife refuge and as a reference point to compare soil conditions.

Do a trial run

- undertake a trial in a small area of your lakebed to test the feasibility of cropping and cultivation practices before carrying out on a broader scale. Develop a sustainable cropping plan.

Minimize the chances of erosion

- choose crop and pasture rotations to maximize groundcover
- use no-till practices. Retaining stubble can help maintain ground cover and provide organic matter for the soil
- use soil conservation earthworks where appropriate, including graded banks and gully fill.[7]

[7] Note: such works will require permits. Check with your local CMA.

Timber harvesting and plantations

In the past, trees grown in or near wetlands were sometimes harvested. Now **all vegetation is subject to the regulations of the *Native Vegetation Act* 2003.**[8] In the Western Division, landowners must also adhere to provisions from the *Forestry Act* 1916. The only trees harvested commercially for timber are river red gums, mainly from the Murray, Murrumbidgee and Lachlan river floodplains.

Tree cropping (plantations) take up large amounts of water and this can result in the drying of creeks downstream in the catchment. Wetland areas can become dry, losing wetland plants and animals.

KEY ISSUES

Harvesting dead or living trees will:

- reduce bird nesting sites and destroy shelter sites for reptiles, insects and other native animals
- affect river red gum survival. Regeneration of river red gums and some of their associated vegetation depend heavily on flooding frequency which can be modified by harvesting and building plantation infrastructure

RECOMMENDATIONS FOR GOOD MANAGEMENT

Fencing

- fence harvested areas off to allow for natural regeneration (if grazed).

Revegetation

- allow natural regeneration of red gums and other local native species particularly understory.

[8] Under the *Native Vegetation Act* 1993, it is illegal to clear native vegetation without a permit. Contact your local CMA office for advice.

Buffer zones

A buffer zone is the area of land between the wetland edge and the surrounding land where the vegetation changes from water-dependant to dryland species. It is land located between an area of activity (e.g. cropping or pasture) and the wetland. These areas are in need of special protection and require active management.

KEY ISSUES

When native vegetation is replaced by shallow-rooted crops or pasture, the seasonal evaporation from hill slopes or undulating land is likely to change. Most crop or pasture plants do not extract water from deeper parts of the soil. The net effect is that hillside soils become saturated more easily in wet periods, leading to increased storm runoff. In addition, cultivation increases the erodibility of surface soils. So, the potential for erosion and transport of contaminants (especially sediments and fertilizers) into waterways increases. As a result, there are greater extremes of water flow and contaminant inputs compared with natural conditions.

RECOMMENDATIONS FOR GOOD MANAGEMENT

Shape the buffer zone

- make the shape of the buffer zone similar to the shape of the wetland as far as possible
- make the buffer zone as large as possible. The size will depend on location, slope, soil type, substrate, vegetation and their purpose. There are some legislative requirements: for example, the *Native Vegetation Act* 2003 states that a 20m buffer is required between any 'Routine Agricultural Management Activity' (RAMA) and a watercourse and up to 100m in the Western CMA.

Install fencing

- fence the buffer zones to protect the areas from stock and enhance the health of the wetland.

Pesticides and other chemicals

Pesticides and other chemicals can be a problem if applied incorrectly or inappropriately. Chemical pollution can occur as:

- ‘point source’: there is a defined source of the pollution, for example, a leaking container, an off-line aerial spray or drift from a spray run
- ‘diffuse source’: the pollution occurs over a wide area and is associated with particular land uses, as opposed to individual point source discharges. In farming areas non-point sources of pollution include pesticides, fertilisers, animal faeces and soil washed into streams in rainfall runoff.

KEY ISSUES

If used inappropriately, the use of chemicals in and around wetlands can:

- contaminate the water supply for stock or domestic use
- cause algal blooms due to excess nutrients and create ideal conditions for weed growth
- lead to the loss of beneficial plant and animal species, including fish and insects.

Image 35: The impact of spray drift from aerial application to crops on trees and other native vegetation can be severe, causing death or serious dieback. Photo NSW DPI

RECOMMENDATIONS FOR GOOD MANAGEMENT

Manage nutrient levels

- use fertilisers efficiently by monitoring soil nutrient levels and crops carefully to determine their specific nutrient requirements.

Reduce chemical use

- apply integrated pest management strategies to minimise chemical use. Use alternative control measures rather than chemicals where possible, such as competitive crops and pastures or strategic grazing
- minimise the use of surfactants in herbicides when near waterways. Many aquatic organisms, including birds, frogs and fish, find them highly toxic
- choose the application method that minimises both the amount of chemical required and its dispersal (within the label recommendations for both quantities and application method). For example, use wiping or injecting rather than spraying.

Use chemical effectively and efficiently

- only use the registered rate to achieve the desired result and ensure spraying application equipment is properly and regularly calibrated. Comply with directions on the container
- only use staff or contractors trained for safe chemical use
- ensure that run-off from chemical treatment, dip pump-out sites and septics cannot enter waterways or wetlands by the use of well grassed, concrete or deep soil bunded areas.

Maintain buffer zones

- maintain vegetated buffer zones around the wetland/s and waterways.

Restrict treated livestock accessing the wetland

- restrict access to wetlands for livestock that have received chemical treatment, both internal and external treatments, for at least the recommended withholding period.

Erosion

The loss of stabilizing vegetation around wetlands (buffer zone) combined with an increase in down-slope movement of surface soil results in the loss of 'living soil' and creates major erosion problems.

Image 36: Gully erosion in the central west. The erosion is made worse by stock access and the lack of groundcover. Photo NSW DPI

Current knowledge allows us to predict many things that help with the prevention and management of erosion, including:

- the location and seasonal behaviour of saturation zones (hydrology)
- locations of high erosion, landslip or gullying hazard (Land Classification Classes)
- classes of ecological habitat
- best locations for streamside and wetland buffer strips
- impacts of urban development
- best locations for land effluent disposal
- long-term positive effects of tree planting or natural regeneration
- effects of land drainage
- effects of vegetation change.

RECOMMENDATIONS FOR GOOD MANAGEMENT

The optimum prescription for looking after a landscape and its wetlands is site-specific, but the underlying principles of water pathways are common to all situations. These should be applied to interpret the behaviour of water in a landscape, under both 'natural' conditions and different management regimes.

Understand your wetland landscape

- map water pathways and how they change under extreme conditions and/or get expert advice.

Use soil conservation practices

- choose crop, pasture and grazing rotations to maximize groundcover, especially during times of the year when rainfall intensity is likely to be highest. Adequate levels of groundcover are a minimum of 40% in the Western CMA and minimum 70% in the other inland CMAs
- retain crop stubble
- use soil conservation earthworks where appropriate, including graded banks and gully fill.[9]

Manage and control access points

- locate stock and vehicle access points on higher areas but not over a slope of more than 4:1.
- where livestock access to your wetland is unavoidable ensure that the access point is not shaded and is gravelled/or rocked to the water. This will minimise erosion and discourage stock from using the area as a camp or for shade.

[9] Note: such works are highly likely to require permits. Check with your local CMA

Fire

The immediate effects of fire are a residue of ash and a soil that may be temporarily impervious. The first rains that follow a fire easily transport large quantities of ash, sediment and nutrients into a watercourse. Peak flow rates may be several times higher than normal. At this stage, disturbance to the catchment's soil, by salvage logging, for example, can dramatically increase flood flows and the transport of contaminants.

In the longer term, forest regrowth can be more vigorous than the original forest and reduce dry-weather flow in watercourses significantly. For wetlands, therefore, the impacts are several: increased flows and materials in the short term and reduced inflows in the longer term.

KEY ISSUES

Impact of fire on wetlands is site and timing specific. Although some plants rely on fire to reproduce, burning too frequently or at the wrong time of year may do more harm than good.

Fire mostly has no long term impact on sedges, grasses and reeds and may be beneficial if an area is burnt infrequently with a wet soil profile. Wetland canopy trees can be killed by burning too frequently.

Image 37: The first rains that follow a fire easily transport large quantities of ash, sediment and nutrients into a watercourse. Photo NSW DPI

RECOMMENDATIONS FOR GOOD MANAGEMENT

Manage fuel loads

- manage fuel loads to manage the fire, e.g. short term or crash grazing
- control weeds.

Know your native vegetation

- incorporate biological requirements of native vegetation species when developing a fire strategy
- learn about and understand what vegetation you have on your property and how to enhance it.

Work with your neighbours and local authorities

- use local experience from other landholders or authorities
- obtain permits from relevant authorities before conducting fire management.

Altered water regime

Changes to the water regime includes too much water, as in floods or artificial watering, or too little water, such as during drought periods or unsustainable extraction.

It is best practise to try and mimic a wetland's natural wetting and drying regime in regulated areas. That means not keeping water in a wetland for longer than it would naturally be there, or draining water out of a wetland that would naturally remain wet.

CLIMATE CHANGE

Climate change is an issue that has to be addressed at every level of management. Climate change is already affecting farm viability and will continue to impact on long-term farm viability in many areas. The scientific consensus is that rising temperatures and increasing climate variability will be experienced.[10]

KEY ISSUES

Wetlands are likely to be seriously affected by climate change. Less rainfall in inland NSW means less water for inland watercourses and wetlands along and at the end of these systems. As land managers, long-term planning is needed.

RECOMMENDATIONS FOR GOOD MANAGEMENT

Allow natural flooding of the wetland

- ensure water movement to and from the wetland is not restricted, allowing the water levels to rise and fall naturally
- maintain natural connections to rivers, creeks or floodplains wherever possible.
- remove structures, such as diversion banks and channels, to allow more appropriate flow patterns
- use structures, such as regulators, to divert flows in ways that mimic natural flow patterns, particularly where natural flows to wetlands are minimal or occasionally extreme.

[10] Refer to CSIRO reports listed in Appendix 5 for more information

Plant native vegetation

- plant trees and other perennial vegetation or allow natural recruitment of the existing vegetation. Vegetation is important for carbon sequestration, the process by which carbon dioxide in the atmosphere is locked up in soils.

Maintain soil carbon

- leave virgin soils uncropped
- use no-till and stubble retention systems – burning paddocks and/or stubble in preparation for cropping releases carbon that has been sequestered in the soil into the atmosphere as carbon dioxide
- use cell ('rotational') grazing rather than set stocking. This reduces reliance on rainfall for pasture growth and helps maintain important groundcover. Refer to CSIRO reports listed in Appendix 5 for more information

Cultural heritage

Cultural values are not only limited to physical artefacts but may also include places of social and or spiritual importance. Land managers are encouraged to manage these culturally significant areas in ways that do not compromise cultural values.

All indigenous cultural sites in NSW are protected by legislation.[11]

RECOMMENDATIONS FOR GOOD MANAGEMENT

Identify cultural values

- identify cultural values, where possible, seek expert advice
- be aware that the margins of wetlands are often where significant Aboriginal sites are located
- protect known cultural sites from farming activities.

Consult government and your local Aboriginal Land Council

- if you find an area or item that you think might be culturally important, and you are interested in finding out how to look after it for future generations, your local CMA and/or local Aboriginal Land Council will be able to help guide you.

Develop a farm or wetland management plan

- it may useful to develop a management plan for the area. Assistance can be sought from the appropriate authorities and the community.

Protect identified cultural heritage

- carry out any works that are needed for the protection of the site and continue to monitor the site.

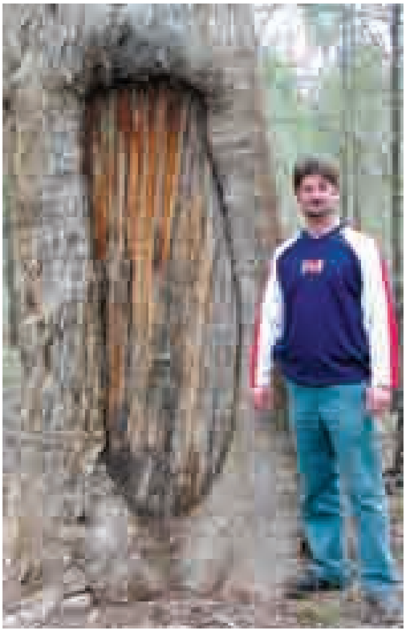


Image 38: An example of a scar tree near Gilgandra. Photo OzArkEHM.Pty.Ltd

Image 39: Examples of stone artefacts. Photo OzArkEHM.Pty.Ltd

Management goals

The purpose behind creating broad wetland management goals or a vision is to provide a guiding principle by which your wetland will be managed as part of whole farm planning.

Here are some questions to think about when working out what you want to achieve with your wetland:

- What's good about my wetland?
- What's bad about my wetland?
- How would I like it to be?
- Justification for restoring my wetland? Why am I doing it?
- What are some good things I would like to see in my wetland?
- How can I get help and from whom?
- What would I do if my assets were gone – how would I cope?

It's important to define what you would like to achieve over the short- and long-term and to be realistic about what you can achieve within particular timeframes and with the resources, both human and financial, available.

It is also critical that you understand what can legally be done within and around wetlands. A brief overview of the legal frameworks relevant to wetlands follows.

Image 40: Assistance is available to help farmers integrate wetland management into whole farm planning. Photo NSW DPI

Wetlands and the Law

LEGISLATION AND REGULATION

The law applying to wetlands is complicated as there are many areas of overlap. Wetlands bring forward many issues that are not readily addressed by regulation. As a result there can be unevenness in the application of some of these regulations.

Main Acts and their associated Regulations that apply to wetland management are provided below.

Disclaimer: The information provided below does not constitute legal advice. It is provided as a general overview only. Legal advice should be sought before any actions are taken that might affect water, soil, air, plants, animals or heritage.

Water

The *Water Management Act* 2000 controls activities in or near rivers, creeks, estuaries and lakes. A permit is needed for any earthworks in these areas.

You need to be aware that you must not dump anything in waterways or even near a waterway if there is a danger that it may pollute the water. The *Protection of the Environment (Operations) Act* 1997 imposes a general ban on polluting water without permission.

Vegetation

Management of native vegetation in NSW is guided by the *Native Vegetation Act* 2003 and its Regulations.

Western Lands

Nearly all the land and its water in the Western Division is held under Western Lands Leases granted under the *Western Lands Act* 1901.

Identifying threats

WHAT DO YOU SEE IN YOUR WETLAND?

The following table provides some links between what you see in your wetland and some issues that may need to be considered when developing your wetland management plan.

OBSERVED	POSSIBLE CAUSE
Acid soils	• altered water regime • salinity (big factor for acid soils in wetlands) • drought
Algal bloom	• excess nutrients entering the wetland • altered water regime
Contamination	• chemical contamination (herbicides, pesticides, fertilisers) • stock effluent from intensive stock areas (piggery, dairy, beef feedlot or stock camps) • stock effluent associated with stock use of the wetland for grazing and/or water
Decline in birds, fish, frogs and other wildlife	• loss of suitable habitat (for example, tree hollows for nesting, food trees, reeds, permanent water or flowing water) • increase in contaminants, either sediment or pollutants (including excess nutrients, salinity)
Decline in soil structure	• inappropriate cultivation • grazing • constant wetting (of non-permanent/ephemeral wetlands)
Erosion	• over grazing • drought • minimal or insufficient ground cover • no buffer zone to protect wetland edges and vegetation • wave action from water eroding banks
Monosulfidic black ooze	• exposure of acid sulfate soils • altered water regime

OBSERVED	POSSIBLE CAUSE
Pugging	• grazing when wet • cattle disturb soil much more than sheep/goats • presence of pigs (pigs root up the soil)
Salinity	• altered water regime • loss of native vegetation (i.e. deep rooted perennials)
Vegetation decline or degradation	• overgrazing • grazing at inappropriate times of year (for example, during seed set) • cultivation • interruption of natural cycles of wetting and drying • weed infestation
Weed infestation	• loss of native vegetation and/or groundcover • inappropriate grazing • inappropriate cropping • inappropriate wetting and drying cycles

Figure 6: Links between what's observed in the wetland and possible causes and issues.

HOW DO YOU USE YOUR WETLAND?

How you use your wetland can have specific impacts on wetland health. The uses are not necessarily wrong – but it is important to be aware of potential impacts and how to manage them. The table below provides some links between uses and potential impacts.

USE	POSSIBLE NEGATIVE IMPACTS
Grazing	• pugging of soil (cattle disturb soil much more than sheep) • erosion caused by stock and vehicle tracks • defecation in and around the water leading to excess nutrients • damage to vegetation in and around the wetland • weed invasion • reduced production from poor quality wetland water
Lakebed cropping	• over cultivation • degradation of soil structure • salinity • altered water regime • weeds • excess nutrient from fertilisers entering wetland areas • spray drift into wetland areas
Timber harvesting	• loss of biodiversity • loss of animal/bird habitat • altered water regime
Tracks and access	• spread of weeds • stock access leading to nutrients, pugging, erosion • degradation of fish habitat
Water extraction	• over extraction leading to loss of plant and aquatic species • insufficient ground cover • contribution to erosion • altered water regime stops wetland normal processes • development of acid soils • salinity • combined effects contributing to weed infestation

Figure 7: Links between uses of wetland and possible issues.

Finding help

There are organisations in NSW that help with wetland management ideas, on-ground actions and funding assistance. More information about the organisations and the assistance they can offer is provided in Appendix 4.

GOVERNMENT ORGANISATIONS

For up-to-date contact details: www.directory.nsw.gov.au

NSW Department of Primary Industries

Web: www.dpi.nsw.gov.au
Ph: 1800 808 095
Em: nsw.agriculture@dpi.nsw.gov.au
Post: NSW DPI, Locked Bag 21, Orange NSW 2800

Department of Environment and Climate Change

Web: www.environment.nsw.gov.au
Info: Environment information and publications requests 131 555

Department of Water and Energy

Web: www.dwe.nsw.gov.au
Ph: 02 8281 7777 Algal Information Line: 1800 999 457
Post: GPO Box 3889 Sydney NSW 2001

Catchment Management Authorities

There are thirteen Catchment Management Authorities (CMAs) in New South Wales, eight of which are located within the Murray Darling Basin and are associated with the 'Wetlands on Farms' project: namely Western, Lower Murray Darling, Murray, Murrumbidgee, Lachlan, Central West, Namoi and Border Rivers-Gwydir Catchment Management Authorities.
Web: www.cma.nsw.gov.au

BORDER RIVERS/GWYDIR Ph: 02 6721 9810 Em: brg@cma.nsw.gov.au	**CENTRAL WEST** Ph: 02 6840 7800 Em: cw@cma.nsw.gov.au
NAMOI Ph: 02 6742 9220 Em: namoi@cma.nsw.gov.au	**LACHLAN** Ph: 02 6851 9500 Em: lachlan@cma.nsw.gov.au
MURRUMBIDGEE Ph: 02 6932 3232 Em: murrumbidgee@cma.nsw.gov.au	**WESTERN** Ph: 1800 032 101 (free call) Freecall: 1800 032 101 Em: western@cma.nsw.gov.au
LOWER MURRAY DARLING Ph: 03 5021 9460 Em: lmd@cma.nsw.gov.au	**MURRAY** Ph: 03 5880 1400 Em: murray@cma.nsw.gov.au

Non-Government organisations

Wetland Care Australia (WCA)
Web: www.wetlandcare.com.au
Ph: 02 6681 6169
Em: ballina@wetlandcare.com.au

Greening Australia
Web: www.greeningaustralia.com
Ph: 02 9560 9144
Em: info@ga.org.au

Murray Wetlands Working Group (MWWG)
Web: www.mwwg.org.au
Ph: 02 6051 2223

Appendices

The appendices contained on the CD contain background and detail on the topics and issues discussed, as well as suggestions for further reading.

Recommendations for managing

wetlands on farms

in inland NSW

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