Hymenachne

Hymenachne amplexicaulis

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Australian Government

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Foreword

Hymenachne is an invasive weed with the potential to have major environmental impacts in many parts of northern Australia. Introduced as a fodder crop for cattle in the 1980s, this grass has now invaded wetlands, waterways, irrigation and drainage systems, and low-lying commercial enterprises such as sugarcane farms.

Hymenachne poses numerous economic and environmental threats to primary production, water resources, fisheries, conservation and tourism.

In this manual, hymenachne refers to the introduced species *Hymenachne amplexicaulis*, also commonly known as Olive hymenachne, and not the native species of *Hymenachne* that grows naturally in northern Australia.

The National Hymenachne Management Group recognises that we will only be able to gain some control of this weed through the combined efforts, diligence and commitment of all affected landholders, communities and all levels of government.

I recommend this manual to all landholders affected by hymenachne, and suggest that those at risk of hymenachne invasion make good use of the combined knowledge and experience contained herein.

Further, I commend all those who have been responsible, both directly and indirectly, for the production of this manual.

Nick Stipis
Chairperson
National Hymenachne Management Group

Contents

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Section 1

Hymenachne: ecology and threat

Introduction

Hymenachne (*Hymenachne amplexicaulis*) is a Weed of National Significance (WONS). It is regarded as one of Australia's worst weeds because of its invasiveness, potential for spread, and socioeconomic and environmental impacts. At the same time, however, hymenachne is valued by graziers as a source of fodder for cattle.

Hymenachne is a semi-aquatic grass, initially introduced into Australia for use as a ponded pasture in central Queensland. It was later planted in tropical wetlands in North Queensland and the Northern Territory, where it has escaped from cultivation and now seriously threatens natural wetlands, riparian zones and waterways.

Hymenachne can form dense stands that reduce plant diversity and habitat for native animals. It invades permanent water bodies and seasonally inundated wetlands. It blocks waterways, potentially causing or increasing flooding, and threatens water quality. Hymenachne blocks drainage and irrigation channels and infests crops such as sugar cane.

This manual outlines the ecology and threat of hymenachne, discusses a range of control methods, and provides planning tools to assist in weed control. It also covers the impact of ponded pasture species and provides some information on native hymenachne (*Hymenachne acutigluma*).

- Hymenachne can invade permanent water bodies or seasonally inundated wetlands

The information presented in this manual is based on a review of published information, a study of field practices, and a survey of technical experts and weed managers. In addition, the manual contains a number of case studies that give practical examples of how hymenachne is being managed or utilised in various parts of northern Australia.

Joseph Vitelli/Barbara Madigan

Ann Doak

Legal status of hymenachne in Australia

Queensland

Hymenachne is declared as a Class 2 pest under the *Land Protection (Pest and Stock Route Management) Act 2002*, which means it potentially has serious economic, environmental and social impacts. Under this legislation, landholders must take reasonable steps to keep their land free of hymenachne by controlling and, if possible, eradicating any outbreaks on their property.

Western Australia

Although hymenachne has not been found in Western Australia to date, it is a declared P1 weed under the *Agricultural and Related Resources Protection Act 1976* and all movement of plants, seed, contaminated machinery and produce is prohibited. Western Australian legislation has also declared it as a P2 weed. This means that any hymenachne found must be treated to prevent propagation, and infested areas must be managed to prevent any further spread.

Northern Territory

Hymenachne is declared as a Class B weed under the *Weeds Management Act 2001*, which means that its growth and spread must be controlled. It is also declared as a Class C weed, which prohibits its introduction into the Northern Territory.

New South Wales

On 1 March 2006, hymenachne was listed as a Class 1 weed under the *Noxious Weeds Act 1993*. This means that it poses a serious threat to primary production or the environment and is not present in the state or is present only to a limited extent. The Act also states that 'the plant must be eradicated from the land and the land must be kept free of the plant'. To date, only two small infestations of hymenachne have been detected in northern New South Wales.

Victoria

Hymenachne has been declared as a restricted weed under the *Catchment and Land Protection Act 1994*. This means that the plant cannot be sold or traded in Victoria.

South Australia

All WONS weeds, including hymenachne, are declared weeds in South Australia under the *Natural Resources Management Act 2004*. Hymenachne cannot be sold or traded in South Australia.

Joseph Vitelli/Barbara Madigan

▸ Hymenachne plants

Physical characteristics

The cultivar of *Hymenachne amplexicaulis* released in Australia in 1988 was named 'Olive' and hence some literature refers to hymenachne as Olive hymenachne. This cultivar was named after J and P Olive, the owners of Granite Vale, the property in central Queensland where hymenachne was initially planted.

Hymenachne belongs to the family Poaceae and the genus *Hymenachne*. Throughout tropical areas around the world, there are eight species of hymenachne, one of which is native to Australia. The native hymenachne (*Hymenachne acutigluma*) occurs naturally in northern Australia. More information about native hymenachne can be found on page 12.

Hymenachne is a perennial grass that grows to 2.5 m tall. It can grow above or in water with its roots in the soil. Although its stems float, they are not hollow—they contain white pith called aerenchyma. On land, erect stems can stand to 1.5 m tall, rising from stems that run along the ground. The stems of hymenachne are hairless, and produce new plants by rooting at the lower nodes. Stems buried by silt or soil easily reshoot.

Chris Gardiner

Hymenachne leaves with the characteristic leaf-clasping feature

Chris Gardiner

Flowers and seed of hymenachne

Hymenachne has bright green leaves, usually 100–450 mm long, with prominent light-coloured veins and hairy margins. The leaf base may be up to 30 mm wide and is covered with long hairs, whereas the upper part of the leaf is smoother and narrower. A key characteristic of this species is that the leaf blade is slightly heart-shaped at its base where it clasps around the stem. Hymenachne is considerably larger and more robust than para grass (*Urochloa mutica*), which is found in similar habitats.

Hymenachne flowers occur in cylindrical clusters (200–400 mm long) at the end of a spike, which may also be branched. The flower cluster is made up of numerous spikelets that are short-stalked, 3–5 mm long and lance-shaped.

Hymenachne can survive in permanently wet areas, provided these are shallow in the dry season. The plant is able to grow in water up to 2 m, but does not persist when rooted in water that is deeper than 1.2 m throughout the year. In North Queensland, hymenachne has been observed growing in water 3–4 m deep (Csurhes, Mackey & Fitzsimmons 1999).

Reproduction and spread

Hymenachne reproduces from seed and broken stem fragments. Seed germination depends on location and seasonal conditions. On land, hymenachne seed requires contact with moist soil for 48 hours before germination can take place. In northern Australia, the most likely time for germination is during the monsoon season between November and March. Seed can also survive in water and germinate when water levels recede during the dry season.

In Queensland, hymenachne generally flowers from April to June, but has also been known to flower between March and September in very wet years. Mass flowering is initiated when day length decreases to less than 12 hours. Seed set occurs from late autumn to early spring in Queensland, while flowering and seed set in the Northern Territory occurs one to two months earlier.

Hymenachne produces large numbers of viable seed, with reports indicating that a single flower head can produce over 4000 seeds. John Lyons, owner of Wambiana station near Charters Towers, has used hymenachne extensively in his ponded pastures. He notes that hymenachne has a very reliable strike from seed—around 98%—while para grass has up to only 16% viable seed. Graziers have reported good germination of hymenachne by simply throwing seeds into ponds.

Hymenachne seed germination and longevity trials are being conducted by the Queensland Department of Natural Resources, Mines and Water (NRMW) at the South Johnstone Research Station in North Queensland. Known quantities of seed are buried at depths of 0, 2 cm and 10 cm and will be retrieved at set times for up to 15 years. Initial testing in 1999 found a germination percentage of 85%, with a further 10% of seed viable but dormant. Results after four years indicated germination rates between 20% and 65%, depending on burial depth. These results show that buried seed can still have significant viability after four years. This may have implications for grazing management of hymenachne, as livestock can trample surface seeds into the soil and contribute to longer seed viability and future problems.

Other research trials by NRMW staff in Charters Towers found that when seed was placed in germination trays and watered by overhead sprinklers, germination rates were very low. However, when seed was subjected to waterlogged conditions for 48 hours, the germination rate was high, which suggests that waterlogging may be required to trigger germination.

Col Middleton

▸ Hymenachne can reproduce at the nodes

Joseph Vitelli/Barbara Madigan

▲ Hymenachne can survive in permanently wet areas

Seed is transported downstream during annual flooding and can also be spread by animals. It is thought that waterbirds, particularly magpie geese (*Anseranas semipalmata*), either spread seed in their droppings or transport seed on their bodies. Infestations of hymenachne at remote magpie geese feeding grounds not routinely visited by people support this theory. The seed of hymenachne can also be spread in mud attached to animal fur or hooves.

Graziers have contributed to the spread of hymenachne by planting seeds or stem fragments in mud, or by placing them in shallow water. Only a small piece of mature grass is required for new areas to become infested.

When hymenachne is planted on grazing land, floods and stormwater run-off can transport seed and plant fragments into public waterways, irrigation storage facilities, sugar cane crops and natural wetlands. Under natural conditions, floods can break off plant segments and carry them long distances downstream. As hymenachne is perennial, the shoots can brown off if conditions become dry and regrow during the wet season.

History of spread

Hymenachne is native to tropical regions of South and Central America. It is a serious weed in Trinidad, Florida and Surinam.

Hymenachne was first imported into Australia in the 1970s, with the aim of using it in ponded pastures too deep for para grass. Ponded pastures are used to provide food for stock during the dry season, when other sources of protein have been used. Prior to the release of hymenachne (and aleman grass), ponded pasture systems relied on native grasses and the introduced para grass. Although para grass also provides good forage for cattle, it is intolerant of water deeper than about 60 cm.

Hymenachne was approved for release in Queensland in 1988. Following its official release, the Department of Primary Industries and Fisheries (DPIF) organised several field days to promote hymenachne as a fodder plant. Landholder interest and adoption rate of ponded pastures increased rapidly, and graziers were quick to obtain vegetative material for themselves as well as colleagues in Queensland and interstate.

Hymenachne escaped cultivation within a few years of being released and, by 1997, dozens of infestations were reported in sugar-growing regions (Csurhes, Mackey & Fitzsimmons 1999). It was predominantly found in low-lying cane plantations and drainage ditches throughout the Wet Tropics region of Queensland. By 2000, the total area of infestation was estimated to be at least 1000 hectares.

Colin Wilson

▲ Pristine Beatrice Lagoon in the Northern Territory in 1986

Hymenachne has also been planted as a pasture grass in the Northern Territory along the Adelaide, Daly, Finniss and Mary river floodplains, and at Arafura Swamp in northern central Arnhem Land. It has now spread through parts of these catchments including important conservation areas such as Kakadu National Park.

▼ Beatrice Lagoon in 1995 after hymenachne invasion

Colin Wilson

Distribution and potential spread

The factors that govern hymenachne's potential distribution and abundance include climate, water depth, period of inundation, soil moisture (during dry seasons), light levels, salinity, and soil-water nutrient status. Hymenachne prefers tropical, low-lying freshwater wetlands and flood plains. It grows prolifically in wetlands that are subject to high nutrient and sediment influx from upstream agricultural land, but can also persist in less disturbed areas.

As a semi-aquatic grass, hymenachne thrives on clay soils that are inundated during the wet season but dry out to some extent in the dry season. The subsoil must remain moist during the dry season, as hymenachne can only withstand short periods without moisture. Consequently, it is found mainly in low-lying areas along the edges of permanent water.

Hymenachne can withstand prolonged inundation by growing above the water. However, it does not tolerate brackish water and does not tend to grow well in shaded areas. Since light availability is considered a primary factor limiting distribution and abundance, hymenachne is not expected to form extensive stands where native trees provide dense shade along the banks of watercourses. NRMW staff at South Johnstone are currently investigating the use of shade to suppress hymenachne.

Matt Buckman

▲ Hymenachne thrives in nutrient rich environments

courtesy of DPI&F

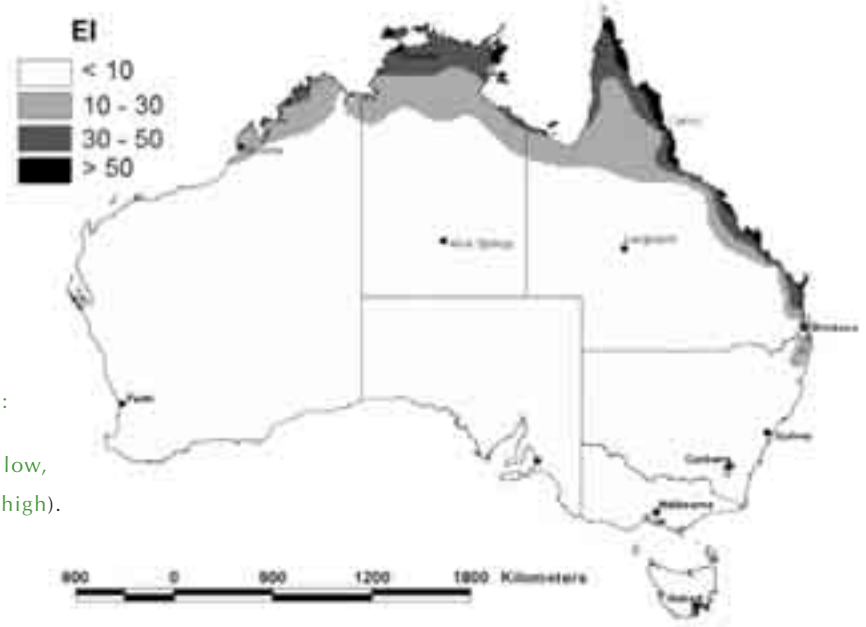
▲ Hymenachne grows prolifically in wetlands

In North, Central and South America, the range of hymenachne extends between latitudes 26°N and 28°S. Climate analysis using the CLIMEX computer-modelling package suggests that climates experienced in coastal areas of northern Australia are similar to those experienced in the plant's native range (Csurhes, Mackey & Fitzsimmons 1999). Based on its native distribution and climate, hymenachne could potentially occur in all seasonally flooded wetlands of Australia, including the Kimberley Ranges and the central coastal region of Western Australia; the Top End of the Northern Territory; most of Queensland's coastal and eastern regions; and northern New South Wales.

Hymenachne may also spread into semi-arid zones where land is flooded during the wet season and remains waterlogged during the dry season. Suitable conditions for hymenachne can be created on clay soils by irrigation channels or banks that trap overland water. Hymenachne is not likely to persist on well-drained soils.

Para grass is estimated to cover 100 000 hectares in Queensland and 40 000 hectares in the Northern Territory. This may indicate the potential distribution of hymenachne, since both species share similar habitat and climatic preferences (Csurhes, Mackey & Fitzsimmons 1999). There are, however, some major differences between the two species. Hymenachne grows taller and in deeper water than para grass, and produces dense floating mats that eventually smother other plants. In drier habitats, hymenachne is not likely to compete with para grass, which is more drought-tolerant than hymenachne.

Potential distribution of *Hymenachne amplexicaulis*



(Data is splined from a CLIMEX prediction.
EI = Ecoclimatic index:
EI < 30 potential for permanent population low,
EI > 50 potential very high).

The impacts of Hymenachne

Exotic grasses are an important weed functional group. They can have profound ecosystem impacts by altering fire regimes, changing soil properties and hydrology, and reducing biodiversity. They can also replace palatable native grasses on pastoral lands, compete with crops, and block access to public areas and amenities (van Klinken et al. 2004).

Numerous economic and environmental threats are posed by hymenachne. The environmental threat to wetlands is severe, as hymenachne can outcompete all other plant species. Environmental effects are closely tied to the economy. For example, tourism, which generates around $30 million annually in Kakadu National Park, is heavily reliant on the appeal of untouched wilderness. Similarly, the potential loss to Indigenous people of natural wildlife resources (such as fish and waterfowl) has both environmental and economic consequences.

▼ Drains adjacent to cane infested by hymenachne

Peter van Haaren

Peter van Haaren

▲ Sugarcane invaded by hymenachne (bright green in foreground of photo)

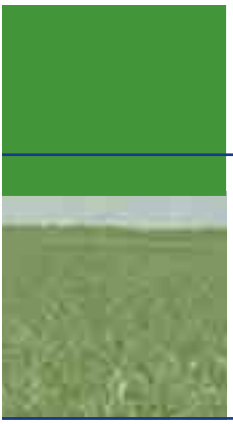
Hymenachne impacts on a number of industries, as summarised below.

Primary production

Hymenachne has invaded sugar cane crops on low-lying, poorly drained land in North Queensland. This leads to crop contamination and increased production costs. Hymenachne can smother young cane, contaminate seed cane plots and block drainage ditches, thereby causing waterlogging. Heavy infestations can cause problems harvesting cane. Floating mats of hymenachne can contribute to stock losses due to drowning.

Water resources and infrastructure

Hymenachne has already invaded irrigation water storage facilities in the Burdekin region of North Queensland. Hymenachne modifies water flow and impedes the flow of floodwater, which can increase flooding in low-lying areas.



Large stands of hymenachne can cause decreased water flow, stagnation, increased levels of organic matter, passage barriers to fish and increased levels of soil nitrogen. Hymenachne also causes the loss of native plant habitat by shading and competing with native riparian and in-stream aquatic plants.

Floating weed infestations and dieback of hymenachne during dry periods contribute large loads of organic matter to the water body. This material decomposes and consumes available oxygen, a process that has adverse impacts on water quality. The anoxic conditions that can be created beneath floating mats of hymenachne can facilitate the release of nutrients such as phosphorus from sediments, and this in turn provides a supply of nutrients for the floating weed mat.

Floating mats of hymenachne dislodge during floods, potentially damaging low bridges. The Rockhampton City Council in Queensland reports that floating rafts of hymenachne during floods have dislodged boats from their moorings, causing structural damage to boats and wharfs. Hymenachne also has the potential to drag boats under water if sufficient material gathers on the anchor lines.

Hymenachne can block the foot valves of pumps and other irrigation equipment. The presence of hymenachne—and potential herbicide applications to control it—in catchments used to collect drinking water is a matter of considerable public concern.

In contrast, hymenachne can act as a filter by trapping sediment and nutrients, thereby reducing nutrient loads from polluted catchments.

▾ Large mats of hymenachne can potentially damage bridges during flood events

Brodie Akacich

▾ Hymenachne can block the passage of fish

Joseph Vitelli/Barbara Madigan

Fisheries

The fishing industry is concerned that hymenachne can invade the natural wetlands that act as nursery areas for juvenile barramundi. Pure stands of hymenachne can modify the habitats of native invertebrates and other aquatic microfauna, consequently affecting dependent populations of native fish. Hymenachne affects water quality by preventing the infiltration of sunlight through the water column. This limits or prevents photosynthesis and oxygen production by submerged aquatic plants, which, in turn, threatens fish habitats and nursery areas.

The high-value prawn industry may also be at risk from hymenachne, as prawns breed in response to natural flood events and any disruption to natural run-off patterns can reduce their recruitment success.

Ponded pastures can impact on fish movements, with many ponds acting as fish traps. Fish swim over the banks during floods, but cannot escape when water recedes. Fishing is affected when hymenachne blocks commercial fishing nets or impedes the passage of boats.

▼ Hymenachne infestations are potential mosquito breeding areas

Joseph Vitelli/Barbara Madigan

Leonie Williams

▲ Conservation areas can be spoilt by the presence of hymenachne

Conservation and tourism

In Australia, the growth of hymenachne is unaffected by native pests and diseases, and it therefore has a competitive advantage over certain native species that dominate seasonal freshwater marshes. Hymenachne replaces native wetland plants, and this in turn affects dependent wildlife. While some native animals may adapt to utilise this weed, many will not. In either case, the natural balance is disturbed.

Hymenachne can prevent the recruitment of native trees, and exclude native grasses and sedges that provide food and nesting resources for wildlife. The loss of native birds and other wildlife, and the degradation of conservation areas, impacts on tourism and could lead to substantial losses. Hymenachne reduces aesthetic values and recreational opportunities.

In the Northern Territory, Olive hymenachne (and, to a smaller extent, native hymenachne) was used for revegetation following control of another serious weed, *Mimosa pigra*. This inadvertently led to the increased spread of hymenachne on the floodplains and in conservation areas of the Northern Territory.

Health

Public health and safety are at risk, as infested areas provide an ideal habitat for mosquito larvae. The thick mats of hymenachne prevent fish from feeding on mosquito larvae, thus allowing mosquito populations to increase. The Rockhampton City Council has expressed concerns about the increased population of two species of mosquito in the area, which is attributted to the presence of hymenachne in local waterways. Hymenachne can increase the risk of drowning, as the thick floating mats often look like firm ground.

Grazing

Hymenachne grows in deeper water than other pasture species. It remains palatable well into the dry season, providing high-protein cattle fodder. As a ponded pasture species, it helps stabilise fluctuations in productivity that occur due to seasonal variations in forage availability. In times of drought, the ponded pasture enables graziers to maintain herd sizes and helps to prevent land degradation due to overstocking. The impact of hymenachne on the central Queensland grazing industry is generally considered to be positive in contrast to its value in the Wet Tropics, where other dry season fodder is often in good supply.

The economic impacts of hymenachne are difficult to estimate. While there is probably a net gain to graziers who utilise this grass, the cost of controlling hymenachne in areas where it is undesirable is expected to far exceed the positive returns.

Native hymenachne

Hymenachne acutigluma is a native species of the genus *Hymenachne*. This perennial grass is found throughout the northern Australian wetlands, and is palatable to stock. In the late 1970s in the Northern Territory, buffalo ate so much of the native hymenachne that there was concern that it would become extinct. However, it regenerated successfully following a buffalo eradication campaign.

The native hymenachne is similar in appearance to *Hymenachne amplexicaulis* (Olive hymenachne) and is a trailing grass that roots at the lower nodes. The stems can be over 4 m long, containing 10 or more nodes. Leaves are 15–30 cm long and 2–3 cm wide. Native hymenachne does not have a stem-clasping leaf base, and can therefore easily be distinguished from Olive hymenachne.

▾ Native hymenachne growing in the Northern Territory

Colin Wilson

Colin Wilson

▲ Native hymenachne (pictured) looks similar to Olive hymenachne but lacks the leaf-clasping characteristic

Native hymenachne is dark green. The seed head consists of a spike, 8–10 cm long, which contains small seed (1–2 mm). Native hymenachne produces few viable seeds; although each seed head contains 500 florets, only 1% of these florets produce seed (Cameron 2003). Regeneration from seed is more significant in natural stands. After large floods, new seedlings can be found below the high water mark. Seed production often coincides with flooding, which prevents access to the plants and makes harvesting seeds difficult.

Native hymenachne has similar environmental requirements to Olive hymenachne but is less tolerant of cool weather, which may explain the failure of native hymenachne evaluation trials south of Mackay in Queensland.

Studies comparing growth of the two species found that native hymenachne grows more slowly, at lower temperatures and light intensities. However, at high temperatures, when light intensity is not limiting, the native hymenachne exhibited higher growth rates than the exotic species (Kibbler 1997).

Studies of both species found that they have similar adaptations to flooding:

- Stems rapidly elongate.
- Leaves rapidly senesce (die) when flooded, and submerged stems produce adventitious roots.
- Elongation results from the production of new nodes and the expansion of recently initiated internodes.

In the Northern Territory, native hymenachne is recorded in areas that are wet for 6–12 months of the year. In drier environments such as the Alice River floodplain, which is inundated for less than five months of the year, no hymenachne has been recorded.

Native hymenachne is used as dry season fodder, especially in the Northern Territory where it is more abundant than in Queensland. It has been used with other native grasses for revegetation, following mimosa (*Mimosa pigra*) control on floodplains in the Northern Territory. If the floodplain was in good condition, native grasses such as native hymenachne were found to provide productivity gains equal to any introduced species (Searle & Fell n.d.).

Like its exotic relative, native hymenachne has the ability to produce thick monospecific stands. Traditional landowners in the Northern Territory control native hymenachne through systematic burning once the vegetation becomes sufficiently dry. Regular burning of the flood plains is used to keep fuel loads down, and the removal of hymenachne promotes the growth of highly prized Indigenous food species such as water chestnuts (Russell-Smith n.d.).

Native hymenachne is difficult to propagate and has generally been overlooked for grazing, in favour of robust exotics that grow larger and faster and are more readily available. Given the detrimental impacts of Olive hymenachne, existing native hymenachne pasture must be preserved and carefully managed. The potential for expanding the use of native hymenachne in pastures instead of Olive hymenachne deserves further investigation.

Kate Charleston

Ponded pastures

Ponded pastures are defined as 'the practice developed by pastoralists to create an environment by either the construction of banks or the modification of naturally wet areas, in which fresh water is impounded or used primarily to grow suitable adapted plant species and produce fodder for grazing' (Queensland Government 2001).

Pastoralists in northern Australia have taken advantage of natural wetland systems for grazing since the late 1800s. The construction of artificial ponds in dry land areas commenced in the 1930s in response to the perceived need for improved pastures for the pastoral industry in northern Australia. There was a widespread belief that any plant introductions that modified rangelands would always be beneficial, and little consideration was given to weed risks or environmental impacts (Grace, Gardener & Cameron 2004). The development of ponded pastures accelerated in the 1970s with the introduction of new pasture species by CSIRO and promotion in Queensland by the Department of Primary Industries and Fisheries.

The development of ponded pastures has contributed to the beef industry and community development. The large increase in cattle production in the Northern Territory has been attributed to the introduction of exotic pasture species.

◂ Ponded pastures have yielded benefits to the cattle industry

Many of the native grasses have short growing seasons and good feed is available for only a few months of the year. The introduced pastures are more digestible, produce greater biomass, remain greener for longer and are generally more productive than pastures based on native grasses. However the negative impact of these developments, through the unwanted spread of introduced pasture species, has been substantial.

Conflicts between pastoral and environmental interests are widely acknowledged in relation to exotic grass species. Hymenachne is a prime example of this conflict, where the grass has yielded significant benefits to the pastoral industry in some areas yet is an aggressive invader of natural habitats.

▾ Ponded pasture

Ann Doak

Ponded pasture species usually include introduced species. In Queensland, the introduced species are para grass (*Urochloa mutica*), aleman grass (*Echinochloa polystachya* cv. Amity) and hymenachne. All three introduced grasses are now regarded as invasive weeds in natural freshwater wetland systems and other waterways.

There is currently no legislation dealing specifically with ponded pasture development or management in Queensland. However, the Queensland Government considers that the development of ponded pastures should occur only in areas that are not:

- tidal areas
- in or adjacent to natural wetlands
- of high conservation or fish habitat value.

The development of ponded pastures should occur only where it can be demonstrated that there will be minimal and acceptable environmental impacts. Under the current ponded pastures policy, para grass, aleman grass and hymenachne will not be included in pasture mixes recommended by Queensland Government agencies. In addition, all state government agencies will use an integrated education, extension, research and regulatory approach to prevent adverse environmental impacts and to control the spread of current ponded pasture species.

Other ponded pasture grasses

Although para grass and aleman grass are not declared weeds in Australia, these grasses also pose environmental problems and are often found in conjunction with hymenachne.

Aleman grass
(*Echinochloa polystachya* cv. Amity)
Aleman grass originates from tropical and sub-tropical countries of America—from the southern United States of America (USA) to northern Argentina—where it is used for animal forage. It was first tested in Australia for use in ponded pastures in water too deep for para grass on properties in central Queensland. It was approved for general release in July 1988.

Aleman grass is a robust, vigorous, semi-aquatic grass, which produces long stems that tend to grow upright or float on the water surface. The stems of aleman grass are 10–15 mm in diameter, up to 2.5 m long and contain 7–10 nodes. The smooth and hairless leaf blades have a light blue-green colour, and are 10–25 mm wide and 200–600 mm long. The seed head is an open panicle, which is 150–250 mm long and produces seeds of 4–5 mm in length.

Aleman grass seed is believed to be sterile and the plant can only reproduce vegetatively. Each node on the stem can develop roots. It will grow in water to a depth of 3 m and is adapted to poorly drained, relatively infertile soil and seasonally flooded sites. Initial growth of aleman grass is relatively slow and it can be outcompeted by other grasses. However, this plant's ability to invade deeper water than hymenachne and potentially destroy communities of submerged or floating native plants is of concern.

Aleman grass is currently undergoing a weed risk assessment to ascertain its potential as an environmental threat. The outcome of this weed risk assessment will contibute to the decision of whether aleman grass will be declared a weed in Queensland or remain available as a forage species.

▾ Aleman grass with seed head

Arthur Cameron

▾ Aleman grass is a vigorous grass with long stems

courtesy of DPI&F

Para grass (*Urochloa mutica*)

Para grass is a native species of tropical Africa and South America, and was first introduced into Australia in 1884 to control riverbank erosion. Para grass is a coarse, vigorous, trailing perennial that produces stout runners (stems), which branch and root readily at all nodes.

The root system of para grass is shallow and fibrous. Stems can grow up to 5 m long when creeping, and stand 1 m tall when erect. Leaf blades are flat, 20 mm wide and hairy. Dense, stiff hairs can be found at the bottom of the leaf sheath (the part of the leaf around the stem). At the base of these hairs is a small ligule—a small, wart-like outgrowth that can be viewed with a hand lens.

Flowers of para grass are in a terminal panicle 200 mm long, which branches at a right angle to the stem. Spikelets are about 3.5 mm long and are often tinged purple. Flowering time depends on location. Para grass seeds are small and, despite the large quantity of seeds produced, the number of fertile seeds is low.

Para grass is considered one of the world's worst weeds and is reported as an agricultural pest in 23 crops in 34 countries, including the USA. It competes aggressively with other plants, and its fast growth, high productivity and allelopathic (production of chemicals that inhibit growth of nearby plants) abilities allow it to form a dense monoculture. Studies have shown that when para grass displaces hymenachne, it leads to a reduction in invertebrate biodiversity (Douglas & O'Connor 1999).

Mike Nicholas

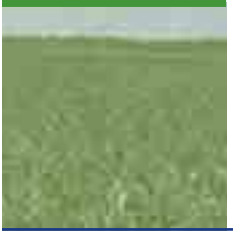
▲ Para grass can survive in shallow water

Para grass grows well under warm, moist conditions and has naturalised in many swampy areas. It will grow in any wet soil, including brackish conditions, but responds better to fertile soils. It reproduces and spreads primarily by stem fragments.

Studies in the Northern Territory have indicated that exotic grasses contribute to changes in fire regimes. The changes in fuel characteristics caused by invasion of para grass can increase the intensity of floodplain fires, particularly in drier sites, resulting in detrimental effects on native woody plants (Douglas & O'Connor 2004). Such studies demonstrate the need to control current para grass infestations and prevent further spread.

Arthur Cameron

▸ Para grass seed head and seeds



With an estimated 100 000 hectares under para grass in Queensland, elimination of this weed is unlikely. Many scientists believe that para grass has largely occupied its potential Australian range, although within this range there are still many areas with little or no para grass. Nonetheless, prevention and control of this grass remains vital. Like aleman grass, para grass is currently subject to a weed risk assessment.

Arthur Cameron

▲ Para grass is considered one of the world's worst weeds

▼ Para grass is usually found on the edge of watercourses

courtesy of Archbold Biological Station, Lake Placid, Florida

▼ Para grass can destroy waterbird breeding habitat

Eleonor Collins

Section 2

Managing Hymenachne

A national approach

To address the current and potential threats from hymenachne, a national strategy was launched in 2001 with the vision that 'the adverse impact of hymenachne is reduced to a minimum'. The strategy's four desired outcomes are to:

- prevent the spread of hymenachne
- minimise the adverse impact of hymenachne
- establish and maintain national commitment to the management of hymenachne
- ensure that this strategy does not trigger the introduction and use of additional species of non-indigenous ponded pasture species.

Historically when valuable plants are prohibited from use, proponents of those plants often search for replacements with similar attributes. There is a danger that new and potentially more aggressive pasture species could be imported or released. Such species must be subject to rigorous assessments of their potential impacts and the introduction of any ponded pasture species with weed potential must be prevented.

The national strategy is documented in the Weeds of National Significance: Hymenachne (*Hymenachne amplexicaulis*) Strategic Plan and is led by the National Hymenachne Management Group. This group comprises agency and community representatives, and is responsible for overseeing and monitoring the implementation of the national strategy.

Planning

Any control program should be planned well to ensure that the best possible results are achieved with minimal cost and effort. To do this, it is necessary to have a realistic view of how hymenachne impacts on overall property management.

Planning takes place at a number of levels, including:

- paddock to property level
- local government level—through the development of local government pest management plans
- catchment level
- regional level—through regional strategy groups.

To create a greater sense of involvement, it is helpful to involve others who are directly affected by hymenachne.

On a property level, a successful plan cannot be developed in isolation from other property operations and must be integrated into the overall property management plan. The management principles suggested here for control and local eradication of hymenachne can be applied to other weeds on a property and, ideally, strategies for management of all weeds should be included in a single plan. It is recommended that a weed control plan should have at least a 5–10 year time frame and be reviewed annually.

A range of planning processes can be adopted to develop a weed control plan. The following suggested control and eradication plan has six steps.

Leonie Williams

▲ Identify what resources are available for control

Step 1: Identify and prioritise problem areas

- The easiest way to identify problem areas is by using a map of the property. This can be a satellite image, aerial photograph or hand-drawn map. The more accurate and current it is, the easier it will be to accurately calculate control costs and to track the long-term effectiveness of control programs.
- Use separate transparent overlays when developing maps—one to indicate property improvements, one for vegetation types and natural features, and another devoted solely to weed infestations. Using different overlays can make each section of the map easier to interpret and can also be helpful when making management decisions (e.g. determining the best place to put fences).
- On the map, outline all natural features, improvements and property boundaries; then indicate areas of hymenachne (and other weeds), noting the size and density of each infestation.
- Prioritise the areas for control or eradication at the property level and at a paddock-by-paddock level, keeping in mind features outside the property such as seed sources, seed and plant dispersal routes and vulnerable areas.
- When confronted by large infestations, it may be better to control small, isolated outbreaks before managing the main infestation.
- Consider the legal and ethical responsibilities you have (e.g. the threat from hymenachne to neighbouring properties).
- Consider relevant local government, catchment or regional priorities and plans.
- To prevent infestations from spreading, focus initial control efforts on isolated outbreaks. A good rule of thumb is to start with the section that will be easiest to control and then gradually work towards the thicker patches. In the case of hymenachne, start work in the upper catchment to prevent reinfestation lower down.

▼ Focus initial control efforts on small isolated outbreaks

Ann Doak

Step 2: Determine the control options

- With a range of methods available for hymenachne control, decide which will be most appropriate in the given situation. It may be necessary to use a combination of methods to complete the job effectively.
- Identify what resources are already available or affordable, such as spray equipment, machinery and labour. This will indicate which control methods will be the most economical and beneficial.
- Decide which methods will be required at all phases of the program—initial control, follow-up and ongoing monitoring. If unsure about control methods, contact local government pest management officers for further advice.

▾ Decide on the most appropriate method of control in the given situation

Joe Vitelli/Barbara Madigan

Step 3: Develop a financial plan

- Estimate the cost of the management strategies and control options.
- Evaluate the costs of the chosen methods in relation to those of other operations currently occurring on the property to ensure that they are economically viable.
- Integrate these costs into short-term and long-term property budgets.
- Find out if there are any financial incentives available to assist with control programs.
- Consider all costs (including the hourly running costs of machinery and labour). If necessary, seek advice from local government or departmental weeds officers before committing a large amount of money.
- Take into account the cost of future control—this is frequently underestimated.

Step 4: Schedule activities

- Consider how effective various control methods will be at different times of the year and compare this with the time available for carrying them out.
- Try to integrate weed control with other property management activities (e.g. combining a routine burn with the control of hymenachne).
- Schedule all weed control activities for the year.
- Make hymenachne control a regular part of property management. When developing a plan, allow for monitoring and follow-up after the initial treatment, and ensure that follow-up occurs within three months.

Step 5: Monitor progress

- Monitoring should be an integral part of any control program. It can be used to check how well a treatment worked, to identify areas of regrowth and to find out where follow-up is required.
- Use the property map as a record of the problem before any control work has commenced.
- On the map, show any new or previously treated areas of infestation.
- Use photograph reference points to record progress. Photographs should be taken from the same location each time treatment or monitoring is carried out.
- Document control costs and resource requirements.
- Incorporate monitoring activities into the yearly timetable.

Step 6: Follow up what was started

- As no control methods for hymenachne result in 100% kill and because some seed germination and regrowth is likely, follow-up is crucial.
- From the monitoring sites, identify areas where follow-up is needed.

Helpful tips

- As there is no 'quick-fix' for weed control, developing a management plan and committing to it are essential for the long-term effectiveness of your efforts.
- Any control plan is useless without implementation. If (because of the size of the problem or lack of experience) it is difficult to start planning, seek professional advice or start planning on a smaller scale.
- While the plan must be structured, it should be flexible enough to allow for changes brought about by uncontrollable external influences such as drought, floods or fluctuating commodity prices.

The plan must be reviewed annually to assess the effectiveness and efficiency of the control options and strategies implemented.

Landholders can design individual property management plans in conjunction with their local government pest management officer. Such plans can include strategies to control the weeds, including buffer zones, containment lines and time frames in which the actions are to be carried out. This may be done in line with their local government area pest management plan.

For example, the Burdekin Shire Council in North Queensland has drawn up a number of pest management agreements for particular areas of the shire. The agreement is a formal contract between the landholder and shire council covering certain aspects of the management of wetlands or lagoons. This stipulates an equal share basis for

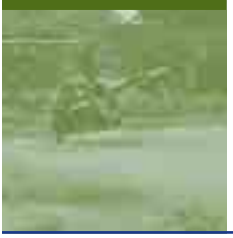
ongoing maintenance program costs and a time frame for the maintenance period. The areas specified in the agreements are generally areas adjacent to landholders' properties that have previously been treated.

An example of this is Horseshoe Lagoon, which is featured as a case study on page 56 of this manual. While the majority of these weeds have now been controlled at this site, the owners of adjacent land must continue to control weeds and maintain these wetlands.

The landholder's legal responsibility is acknowledged under the *Land Protection Act 2002*. An example of such an agreement between council and landholder can be viewed in the Appendix.

▾ Areas such as Horseshoe Lagoon will be maintained under local pest management agreements

Merv Pyott



Section 3

Toolbox for hymenachne control

Prevention of spread

The most cost-effective way of dealing with any weed is to prevent its introduction. Preventing the spread of hymenachne into catchments at risk of infestation should be a management priority. This prevention is made extremely difficult when hymenachne grows in pastures in the upper catchment, because spread by water flowing downstream can easily occur. As a general rule, upstream infestations should be treated first. Hymenachne control requires a policy of regular catchment monitoring, and the ability to eliminate any small infestations.

The clearing of native riparian vegetation, combined with increased soil and nutrient run-off from crop land—especially land used to grow sugar cane and bananas—creates an ideal habitat for a range of exotic grasses including hymenachne. Improved fertiliser and cultivation practices in cropping areas will reduce nutrient and sediment run-off.

Good hygiene practices prevent the spread of hymenachne on machinery, boats, trailers or motor vehicles. Cattle grazing on hymenachne pastures reduces biomass, but can also lead to further spread. Seeds and plant material can be transported on their hooves, or be digested and deposited elsewhere. Graziers must be aware of this potential spread and take appropriate action to avoid it. Water birds, which may spread hymenachne seed between catchments, cannot easily be managed.

▸ Water birds can spread hymenachne between catchments

Greater public awareness of the threat posed by hymenachne, the importance of its control and ways to minimise its spread will contribute to the prevention of spread of hymenachne.

▾ Cattle can spread hymenachne

Joseph Vitelli/Barbara Madigan

▾ Field days raise public awareness of the threat of hymenachne and provide information about control

Peter van Haaren

Matt Buckman

Choosing control methods

Effective control strategies for hymenachne are limited. There are significant environmental concerns and restrictions associated with the use of herbicides in aquatic environments. Human alterations to hydrology, including pondage and modifications to waterways, can compound the difficulties in hymenachne control due to increased nutrient availability.

While hymenachne populations are low, early detection and rapid response efforts increase the likelihood that control and management will be successful. Once discovered, eradication or containment of newly detected infestations is a key priority, as this is more likely to result in significant long-term savings than if weeds are allowed to proliferate.

When choosing control methods, the best approach is usually to combine different methods to suit the particular situation. Control may include chemical, mechanical, and fire, combined with appropriate land management practices.

Climate can influence the type of control undertaken. In the wet tropics of Queensland, there is a greater reliance on chemical control, as many of the areas infested with hymenachne do not dry out sufficiently to use other control methods. In the dry tropics, hymenachne can be managed through a combination of methods, which include land management practices such as grazing.

Mechanical control methods

Mechanical or physical removal will not completely eradicate hymenachne because of its ability to reproduce vegetatively from very small pieces. Mechanical harvesting to remove hymenachne and other weeds has occurred in the Burdekin Shire in North Queensland, but this requires ongoing control on a monthly basis. A number of Queensland councils have now acquired weed harvesters to regularly treat their aquatic weeds.

The success of any harvesting operation depends on the prompt and complete removal of all cut weeds. Haphazard or partial removal can increase the problem, since each remaining plant fragment has the potential to form a new weed colony. Cut plants left in the water will decay and release nutrients. This decomposition process uses oxygen, which can result in fish kills.

Weed harvesters are more effective on floating waterweeds such as water hyacinth (*Eichhornia crassipes*) and salvinia (*Salvinia molesta*) and using only this method to remove hymenachne is not cost effective. Weed harvesters can be useful in removing impenetrable floating weed mats of hymenachne from deeper water bodies where access is otherwise difficult. Harvesting of weeds provides immediate relief from unwanted plant growth and does not endanger fish life.

Kate Charleston

▲ Weed rakes are useful to clear hymenachne and para grass from irrigation channels

Merv Pyott

▼ Burdekin shire weed harvester

Another mechanical method for controlling hymenachne is the use of a weed rake. The North Burdekin and South Burdekin water boards in North Queensland employ weed rakes to clean weeds from irrigation channels.

The weed rake consists of heavy-duty steel tines mounted on the end of an excavator. The rake is more effective than a bucket, as no additional soil is removed from the channel. As demonstrated in the photo, the weed rake extends into the water and pulls all the vegetation to the bank. Once deposited on the bank, the weeds can be moved or sprayed. This method can remove large mats of hymenachne from the channels in a relatively short period of time. This method of weed removal can be used as part of an integrated approach in the control of hymenachne and para grass.

However, as with weed harvesters, it is likely that plant pieces will break off during this operation and reinfest the channel banks. To minimise reinfestation of channels, hymenachne should be moved away from the shoreline and above the flood level.

Land management

The control of hymenachne through land management practices is often achieved through a combination of methods. For instance, grazing alone will not provide effective control but a combination of grazing and fire, followed by flooding, can eliminate hymenachne from many areas. The following pages outline some of the land management actions that can assist in the control of hymenachne.

Manipulating water levels

- **Flooding** can offer some control of hymenachne when the above-ground vegetation has been removed, as it is difficult for hymenachne to keep up with rising water levels. Hymenachne can 'drown' when inundated with water, especially after being grazed down low, burnt, or reduced in height with a slasher. Any regrowth that is not killed will be weakened and is more susceptible to follow-up with herbicides.
- **Drying**, or lowering water levels, may offer some extent of hymenachne control. This practice is common in the United States of America, in ponds where drawdown occurs in the winter

months to expose weeds to harsh conditions including desiccation (drying out) and freezing (Helfrich et al. 2000). Vegetation exposed by lowering water levels should be removed, or rotting plants will contribute nutrients that promote new growth when the water level is raised. Hymenachne does not tolerate dry sites, but little research has been done on drawdown as a control method for aquatic weeds in Australia.

Grazing

In many coastal regions of North Queensland, reduced grazing—due to increased cropping—has resulted in the expansion of exotic grasses in many riparian and wetland habitats.

Controlled grazing represents a viable means of broadacre control of hymenachne in wetland and riparian zones of the dry tropics. Many of these wetlands are seasonally inundated, but dry out sufficiently in the dry season to allow cattle grazing. Grazing in the Wet Tropics is usually not an available control option, as wetlands do not dry out.

Some of the worst hymenachne infestations in the dry tropics occur in areas where the hydrology has been artificially modified by regulated flows, irrigation and damming. There is a strong relationship between hydrology and grazing hymenachne:

- Deep water provides a grazing refuge for floating mats of hymenachne.
- Sufficient dry season drawdown of wetland water levels means that hymenachne can be grazed down to very low levels.
- Drying out allows fire to be used as a complementary management tool.
- Rapid rising of water levels within a wetland basin with grazed down hymenachne margins can drown residual plants.

A number of grazing and burning trials are being conducted by Wetland Care Australia in the lower Burdekin area of North Queensland. These trials are also trying to ascertain the impacts of other aspects associated with grazing such as erosion, trampling risks, the merits of different stock types, appropriate grazing regimes, and recruitment of native vegetation.

Grazing in riparian zones can have many negative impacts, including reduced water quality due to increased nutrient loading—primarily from urine and manure—and increased turbidity due to bottom sediment disturbance and bank erosion.

▾ Grazing provides temporary control of hymenachne

Trevor Hall

Riparian grazing can also be beneficial, as it allows the removal of weed biomass and associated organic (nutrient) loading. It also creates open areas of water, which aids in oxygenation of the water column.

Where damage to banks is minimal, the positive aspects of grazing seem to outweigh the detrimental aspects. This can be seen in areas such as the Burdekin floodplain.

Grazing alone in coastal areas will not kill hymenachne, which is noted for its ability to withstand heavy grazing. While cattle can reduce the amount of hymenachne, they can also potentially spread plant segments or seed in their hooves or in mud attached to their bodies. An added risk is that hymenachne seed eaten by cattle can pass through the gut and germinate. Cattle should therefore be kept away from clean areas for several days after grazing on flowering hymenachne, to prevent further weed spread.

Dry conditions, combined with heavy grazing, have eliminated hymenachne from ponded pastures in some inland areas of the Atherton Tablelands in North Queensland (J Kernot 2005, pers. comm., December).

A research project by CSIRO and Queensland Parks and Wildlife is exploring the use of fire and grazing to control para grass in the Townsville Town Common Conservation Park. The team of scientists is examining how grazing and fire can reduce the abundance of para grass. The trial is being conducted over 72 hectares and four different treatments are being compared.

While work did not start on this project until 2004 and results are not yet conclusive, initial findings suggest that grazing, in combination with fire, is the most effective method of reducing para grass in this situation.

The project also looks at the changes in wetland vegetation and animal communities following the different treatments. The information gathered from this project will be used to develop and promote methods to restore other coastal wetlands degraded by para grass. Despite the differences between para grass and hymenachne—most notably, that hymenachne is able to grow in deeper water—some recommendations may have application for the management of hymenachne in wetlands.

Shading

Solar sheeting or solarisation—covering infestations with dark plastic—can kill small outbreaks of hymenachne. Shading by tall vegetation has also been investigated as a means of reducing the amount of plant material infesting rivers and creeks. This can offer long-term, cost-effective weed control and is considered more ecologically sound than chemical or mechanical forms of control. However, tall vegetation is not likely to become established in the seasonally inundated floodplains, and would also have its own impacts on such systems.

Shading has been investigated as a means of controlling para grass. In a study conducted in North Queensland, the biomass and height of para grass were

substantially decreased following three months under 90% shade (Bunn et al. 1998). Such data suggest that the restoration of tall native riparian vegetation can provide long-term means of controlling invasive grasses.

In the United States, shading has been trialled on water bodies by using black plastic sheeting attached to Styrofoam™ floats. These floating shades can be moved easily to different places for spot treatment of waterweeds. The black plastic raft must remain in place for at least one month to be effective (Helfrich et al. 2000).

A shading trial is currently being conducted by NRMW at Euramo, near Tully in North Queensland, to ascertain the impact of shading on hymenachne. The trial site is using artificial shade (from shade cloth) and natural shade (from vegetation) to compare this method of control with chemical control of hymenachne. Recordings from this trial include biomass samples and soil seed bank samples. The trial is being monitored annually.

▾ Fire can be a useful tool in the control of hymenachne and para grass

Mike Nicholas

Fire

Fire can be used as an additional, cost-effective means of reducing stands of hymenachne. Burning can generally only be done during the dry season when plants have dried out sufficiently to provide suitable fuel. Great care should be taken with fire, as hymenachne can create large fuel loads that promote intense, hot fires that can destroy native riparian vegetation. Reduced tree canopies following hot fires can actually promote grass growth and increase fuel levels. Fire in pure stands of hymenachne can be useful for reducing stands and may be followed up by grazing, herbicides or flooding.

Fire has been successfully used in conjunction with grazing and herbicides. In the lower Burdekin, fire is followed by grazing, just prior to the wet season. In the Northern Territory, fire was successfully used after herbicide application to reduce the bulk of hymenachne to a more manageable level. For more information, see the case study of Lambells Lagoon on page 48 of this manual.

Fire will destroy seed on the soil surface but will not destroy buried seed. The heat of the fire may even stimulate buried seed to germinate and the resulting seedlings would need to be treated by herbicide or grazing.

▾ Hymenachne seedlings after fire

Leonie Williams

courtesy of University of Florida

Ischnodemus variegatus, a potential biological control agent

Biological control

Biological control of hymenachne is currently not available in Australia. Any biological control agent for hymenachne would need to be specific for Olive hymenachne. This would ensure that there are no impacts on the native hymenachne, other grasses, or the unrelated but economically important sugar cane. To find a biological agent that will only attack exotic hymenachne will require considerable research into the pests associated with both hymenachne species.

In Florida in 2000, severe damage caused by an unknown insect was noted on hymenachne plants. This insect was later identified as the blissid bug *(Ischnodemus variegatus)*. This bug is known to occur naturally in South America but was not previously recorded in Florida (Brambila & Santana 2004). The bug appears to feed and breed only on *Hymenachne amplexicaulis*, but further host-range testing is required before this is considered an option in Australia.

Damage to hymenachne by the blissid bug *(Ischnodemus variegatus)*

courtesy of University of Florida

Aquatic weeds and herbicides

Most herbicides are not registered for use in aquatic situations and their labels carry only general instructions to avoid contamination of watercourses. It is not always clear whether these products should be used on land adjoining water bodies and, if so, how far from the water they should be used.

Chemical labels must be read carefully and completely, as it is illegal to disregard label prohibitions. The risk of water becoming contaminated with herbicide, and the effects of herbicide on non-target organisms can be affected by:

- the amount of herbicide applied
- the method of application
- how mobile the herbicide is (in soil and water)
- the persistence of the herbicide
- the toxicity of the herbicide to flora and fauna
- weather conditions at the time of, or after, application.

Movement of herbicides into aquatic systems is possible via direct spray, vapour drift, surface run-off, movement of soil or movement into groundwater. This usually involves only a very small percentage of the herbicides originally applied, though this can be significant if the total amount being used in the catchment is large. Also consider that currents may carry herbicides downstream, where they can affect other ecosystems, landholders and water users.

Darryl Assenbruck

▲ Care must be taken when applying herbicide next to watercourses

When herbicides are applied in or near watercourses, the distance the herbicide needs to move—by spray drift or run-off—to reach water is much shorter. Small rises in water level can also result in the treated land being flooded. Such short-distance movement is difficult to predict, as it is influenced by weather conditions and the skill of the operator. Although the amount of herbicides used for aquatic situations is usually very small, the input of such herbicide use can still be an important source of contamination.

Indirect impacts of weed control by herbicides are more likely if the weed makes up a large component of the aquatic vegetation. Such impacts include erosion of bare banks, an increase in water temperatures after shade is removed, and the fouling of water by rotting aquatic weeds. These indirect effects can be minimised by removing weeds gradually, in conjunction with restoration of banks and bare areas.

Chemical control methods

Herbicides are an important component of integrated weed control. The advantages of using chemicals for the control of hymenachne are their flexibility, the speed of treatment and the relatively low cost. Many coastal councils in Queensland have reported that the initial expense of controlling hymenachne by chemical means can be high due to the widespread problem, but these costs reduce dramatically during the follow-up and monitoring stages.

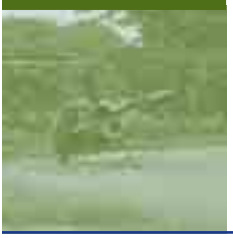
Safeguards and label information

In Australia, the Australian Pesticides and Veterinary Medicines Authority (APVMA) regulate the use of pesticides, including herbicides. Chemical products are assessed for toxicity, efficacy, environmental impact, residues, and any implications for occupational health and safety. By law, herbicides must only be used in accordance with label instructions or off-label permits.

Personal protective equipment—such as protective clothing, eye protection and respiratory protection—must be used, also in accordance with manufacturers' recommendations.

Col Middleton

◀ In aquatic situations, try to minimise the amount of herbicide entering water



Herbicides must be treated with great care. Before use:

- ensure all permit conditions are met
- read the instructions and conditions for use on the label, specifically critical comments for use in aquatic areas
- consider the possible impact on non-target vegetation and the surrounding environment.

All methods of chemical control must comply with the relevant state and local government native vegetation legislation. Causing even accidental death of native vegetation could be a breach of this legislation.

Permits

There are several herbicides used in Queensland to control hymenachne and approved for use under off-label minor use permits. Except for herbicides authorised under these permits, no products are registered for the control of hymenachne.

Off-label permits, issued by the APVMA, stipulate a number of requirements including who can use the permit, which chemicals can be used, how the chemical can be applied and any additional conditions. Permits are in force for a specific period and cannot be used once this period expires.

There are currently four valid permits for the control of hymenachne in Australia, all of which are in Queensland. Some permits can only be used in certain locations by certain persons. A condition of all permits is that the person intending to use the permit must read, or have read to them, the details and conditions of the permit.

PER7485 allows the use of glyphosate for control of hymenachne in aquatic situations This permit also allows the use of Arsenal® 250, Fusilade™ and Verdict* for the control of annual and perennial grasses, but the rates stipulated in the permit are too low for effective control of hymenachne and cannot be used close to waterways (J Vitelli 2005, pers. comm., December).

PER6961 allows the use of glyphosate for the control of hymenachne in the Mareeba area.

PER7039 contains other conditions including the monitoring and collecting of water samples that have to be submitted for testing of pH, dissolved oxygen and conductivity. Upon completion of the monitoring program, a report stating the effectiveness of the herbicide on hymenachne, as well as the results of all water testing, must be submitted to the APVMA.

PER9076 prescribes certain conditions for use, including monitoring prior to and after application at four representative sites. This includes the collection of water samples that must be submitted for testing of pH, dissolved oxygen and conductivity.

The above permits all apply to application by knapsack, handgun or boom spray. The restrictive nature of the permits may mean that a number of landholders cannot legally use any chemical for control of hymenachne. If, as a landholder, you cannot control hymenachne under any of the permits described, you can apply for a minor use permit in conjunction with the local shire.

* Trademark of Dow AgroSciences LLC

Table 1: Current off-label minor use permits for hymenachne control

Permit	Products/chemicals	Rate	Users/situations
Non-crop Areas			
PER7485 Effective 1 July 2004 to 30 June 2009	Roundup® Biactive™, Weedmaster® Duo (360 g/L glyphosate) This permit covers a number of herbicides but the herbicides above are the only ones to be used in aquatic situations.	1 L/100 L water or 10 L/ha delivered via boom	Pest control operators; employees of, or supervised by local/state governments; members of environmental groups e.g. Bush Care, Catchment Care. Spot spray in aquatic and wetland areas. Permit is not restricted to any area in Queensland.
PER6961 Effective 24 September 2003 to 30 September 2008	Roundup® Biactive™ (360 g/L glyphosate)	Max. 14 L/ha	Persons generally. For use in drainage reserves (Mareeba–Dimbulah Water Supply Scheme only).
PER7039 Effective 19 July 2004 to 30 June 2009	Verdict* 520 (502 g/L haloxyfop)	770 mL/ha delivered via knapsack, handgun or boom spray only	Restricted to trained staff of Mackay City Council, Mackay Cane Protection and Productivity Board and research staff of the Department of Natural Resources, Mines and Water. Ponded and non-flowing drainage areas and banks of flowing waterways (Mackay Shire only).
PER9076 Effective 19 January 2006 to 28 February 2007	Verdict* 520 (502 g/L haloxyfop)	770 mL/ha delivered via knapsack, handgun or boom spray only	Restricted to trained employees of the Cardwell Shire Council. Ponded and non-flowing drainage areas and banks of flowing waterways (Cardwell Shire only).

All current permits can be viewed on the APVMA website at <www.apvma.gov.au>.

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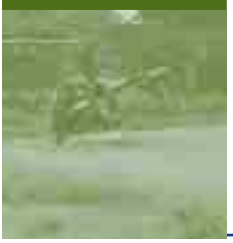

For other states, refer to the local government pest management officer or to the state agricultural or primary industries department (see Contacts on page 65).

In the past, local governments and other organisations have obtained permits for the use of helicopter application of herbicides to control hymenachne. Aerial application can be very effective where large areas of hymenachne occur or are difficult to control due to deep water or limited access. Controlling hymenachne by the aerial spraying of glyphosate has been successful in the Burdekin region of Queensland, where this weed has been controlled in several lagoons. The remaining hymenachne along the edges of the lagoons could then be controlled by chemical applications from knapsacks and handguns.

▾ Special permits are required for aerial application of herbicides

Matt Buckman

When to spray

Correctly timing chemical control can reduce seed production. Flowering trials conducted by NRMW in Charters Towers indicate that hymenachne flowering occurs once the day length drops below 12 hours. Controlling hymenachne between September and March in the Queensland tropics may reduce the number of new seeds entering the seed bank.

Effective control of hymenachne using foliar application depends on several important factors:

- Plants must be actively growing—avoid spraying when the plant is stressed.
- Plants must be sprayed to the point of run-off, wetting every leaf. Do not spray past the point of run-off.
- Spray may drift onto wetlands, natural surface waters, soil, neighbouring properties or other sensitive areas—always check weather conditions before spraying.
- Appropriate spraying equipment must be used to prevent chemical drift.
- Rain will cause herbicide run-off and reduce its effectiveness—check weather reports and do not spray if rain is expected within 48 hours after spraying.
- Treatments must be monitored and followed up.

Glyphosate is the main chemical used to control hymenachne; however, its effectiveness may be variable and could be only 50%. It is therefore very important that all sites are revisited and treated every three months. Aerial chemical application requires repeated treatments every eight weeks to control seedling germination during the early stages of the treatment program.

It is a condition of the 'minor off-label use' permit to notify the APVMA of any incidents of off-target contamination or damage associated with the foliar application of herbicides.

The cost of hymenachne control depends on the extent of the infestation, the control methods used and the degree of difficulty in getting spray equipment to infestations (site access).

▼ Riverbanks infested by hymenachne may be prone to erosion after hymenachne is controlled

Damon Sydes

Peter van Harren

▲ Regular monitoring will identify areas of seedling establishment

Monitoring and evaluation

Although the above methods to control hymenachne can achieve good results in the right situation, there is always a need for monitoring and follow-up treatment. Monitoring is an essential part of any weed control project. Sometimes plants are missed, errors in mixing or applying chemicals occur, or other unforeseen factors reduce the overall kill achieved. Some control methods, such as mechanical control, can also contribute to further infestations downstream.

Hymenachne sites should be revisited every three months. Returning to the site after initial control or follow-up work will detect any seedling establishment and identify plants that received inadequate spray coverage. All surviving and new plants require follow-up treatment to prevent them reaching maturity.

It is recommended that monitoring continue for a minimum of five years. Monitoring and regular follow-up over a longer period will result in more effective control. Careful management of funds is required to enable a monitoring and follow-up program to be implemented.

Where seedlings or juveniles of native vegetation are present within a hymenachne infestation, replanting or reseeding may not be required. In these areas, the removal of hymenachne can result in successful re-establishment of native vegetation through natural means. It is therefore important that the control methods employed have minimal impact on the native vegetation. Immediate control of hymenachne is imperative in these areas to prevent the native vegetation from being outcompeted.

Where sites are prone to erosion or further weed establishment after initial treatment, replanting using local native plant stock will assist recovery. This is particularly important along drainage lines and in agricultural areas where hymenachne may have been retained to reduce soil erosion.

▾ Researchers hope to find better herbicides for the control of hymenachne through pot trials

Peter Van Haaren

Research into chemical control methods for hymenachne

In Queensland, only 12 herbicides are registered for the control of 226 weeds that grow in or near aquatic areas (Vitelli, Madigan & Ruddle 2005). Due to the complexity of herbicide applications on aquatic weeds, the APVMA is reluctant to register any more herbicides until research data can prove that there are no detrimental effects to other aquatic organisms. Research trials have identified a number of effective herbicides for use on hymenachne, but most are unsuitable for aquatic situations.

Field experiments to determine the effect of foliar-applied herbicides on hymenachne were conducted by staff from the then Queensland Department of Natural Resources between 1997 and 2000. Experimental sites were chosen for their dense and uniform monocultures of hymenachne. At each site, all plants were sprayed to the point of run-off.

Initial trials indicated five effective herbicides and further trials were conducted to determine the lowest effective rate necessary for control of hymenachne. Parameters to determine herbicide effectiveness included mortality, biomass reduction, biomass regrowth and respray volume. Based on these parameters, the most effective herbicides were Verdict* (haloxyfop), followed by Fusilade™ (fluazifop), Arsenal® (imazapyr), Velpar® (hexazinone) and Roundup® Biactive™.

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Velpar and Arsenal are broad-spectrum herbicides and pose problems to off-target vegetation. Their application in natural wetlands would damage and kill native plants and could facilitate reinvasion of treated sites by hymenachne or other opportunistic plants. Velpar in particular has also been noted for its mobility in soil after application and, following rainfall, can move into surrounding non-target areas.

Other research into the effect of Verdict 520 herbicide (haloxyfop) in aquatic situations is nearing completion. Research identified Verdict 520 as one of the most effective herbicides for controlling hymenachne, but a major difficulty in registering haloxyfop is the lack of information available to decision makers about its effect on aquatic life.

A laboratory-based haloxyfop study indicated chemical presence in all aquatic species tested, but levels were low and no organism deaths were attributed to herbicide toxicity. Under field conditions, herbicide concentrations were lower than in the controlled environment and current field studies in three North Queensland sites should validate and further quantify residue levels. Data from such research will contribute to the registration of haloxyfop and assist in establishing withholding periods for this product.

Peter van Haaren

▲ Field-based trials will allow researchers to assess the effectiveness of herbicides on hymenachne

Conclusion

Despite the range of control methods outlined above, the eradication of hymenachne from northern Australia is not considered feasible due to the plant's resilience, its extensive distribution, the lack of effective chemical control options, and the reluctance of graziers to destroy a valuable pasture. Through carefully planned control and management activities, working in conjunction with neighbours and across catchments, hymenachne can be contained and its impacts can be minimised.

Bruce Cook

▲ Always try to control hymenachne before flowering and seed set

Joseph Vitelli/Barbara Madigan

▲ Hymenachne can out-compete native vegetation

▼ Hymenachne can invade water storage areas

Peter van Haaren

Peter van Haaren

Section 4

Case studies

The following case studies highlight the problem of hymenachne in both Queensland and the Northern Territory. They include accounts of various control methods and the successes and challenges faced in different situations.

One case study features a research project with some surprising findings about the impact of hymenachne control in aquatic areas. It contains essential information for all land managers who control hymenachne along waterways.

The need for strong collaboration between various sectors of the community and government, especially when large infested areas require control, is highlighted in two of the case studies. Early intervention and persistence in controlling hymenachne has reduced the weed to a manageable level for a grower and a North Queensland council.

The case studies also emphasise the need to integrate the various control options to manage hymenachne.

A case study with a grazier explains the importance of hymenachne to the cattle industry, especially in the drier regions of northern Australia. Control of hymenachne in these areas could have a major impact on the profitability of cattle production.

The case studies are the result of consultation with people who have been closely involved with hymenachne and who have generously donated their time and photographs for this publication.

Early intervention has reduced the hymenachne problem in the Cairns region

Background

Hymenachne in the shire of Cairns is believed to be the result of planting done by landholders in the 1990s. The plant spread from grazing lands into wet areas, including drains and creeks, and was also found along the major rivers and tributaries of the region. Hymenachne increased rapidly in both distribution and density in the Cairns region.

After numerous sightings of the weed, the Cairns City Council declared hymenachne a noxious weed in 2000 under the *Local Government Act 1993*. At this time, hymenachne was still being promoted and seed was commercially available. Although hymenachne was only beginning to be recognised as a pest, immediate

management was essential, as the benefits of control at this early stage would prevent any costs associated with future management.

Controlling hymenachne

Initial control of hymenachne was done by council staff, in cooperation with local landholders who had infestations on their land. All the hymenachne in the Cairns region was controlled by chemical means, including Arsenal® and glyphosate. Glyphosate was the only chemical that could be used in wet areas and along waterways. Council staff found that while glyphosate provided some control, it was not very effective on thick mats of hymenachne, as the chemical did not penetrate and control the bottom layers of the weed. Poor chemical control required many follow-up applications.

▼ Hymenachne in the Cairns region was spread by seed and vegetative parts

Greg Cooper

Darryl Assenbruck

▲ Many hymenachne infestations could only be accessed by boat

Many of the hymenachne infestations were not accessible from land and had to be reached by boat. Cairns City Council staff frequently used canoes, punts or small boats to access the weed from the river. These operations required good boating skills, as it was often difficult to manoeuvre the boat in running water. Most of the spraying was carried out during the dry season, but weed control also occurred during the wetter months where site access was possible.

Funding from National Heritage Trust obtained in 2001 was used to control hymenachne along the Wyvuri swamp esplanade of Frenchmans Creek in Babinda. The funding was also used to survey and map this region.

Cairns City Council has received no other funding for the control of hymenachne but continues to control this weed as part of their pest control program. This includes continually monitoring the areas already sprayed, and surveying and controlling further infestations. Monitoring activities include travelling the full length of the main rivers at least twice per year to look for further infestations of hymenachne.

Obstacles

In 2000 and 2001, landholders in the Cairns region continued planting of hymenachne, which further increased the spread of the weed. Many landholders did not control hymenachne on their properties unless the weed impacted on their farming enterprises, such as by invading cane land. While the council controlled hymenachne from esplanades along rivers, landholders with river access did not practise weed control and hymenachne reinvaded previously controlled sites.

Flooding of rivers and creeks in the wet season contributed to the spread of hymenachne. While floodwaters washed some hymenachne out to sea, where it perished, flooding also led to new infestations in low-lying areas. Access to many of these areas remains difficult, except by boat.

Despite the obstacles, the council believed that they had much of this weed under control by early 2005. However, infestations found in areas not subject to flooding suggested further spread of hymenachne by waterfowl. Weed dissemination by birds is highly unpredictable and makes the mapping of hymenachne much more difficult.

The longevity of the seed also means that follow-up control must continue for an extended time period. The current chemical control options remain limited and require continued follow-up applications to control hymenachne.

Darryl Assenbruck

▲ If left unchecked and untreated, hymenachne could 'choke' the river system

Public awareness

A large public meeting about hymenachne infestations in the Mulgrave River system was held in 2005, to raise greater awareness of the problem among landholders and the public. The Mulgrave River near Gordonvale has numerous islands that have created many smaller streams, each of which could potentially contain hymenachne. If left unchecked and untreated, the weed could 'choke' the river system by growing across the whole of the river. The public meeting also served to facilitate right of access through private properties adjacent to the river for the purpose of weed control.

Containment and management

New infestations are still being found, but the Cairns City Council has a good knowledge of where the weed occurs and has the experience to manage and contain infestations. There is significantly less hymenachne in this shire than in other shires in the Wet Tropics regions of North Queensland. This can be attributed to early intervention and continual survey and control. While the council does not believe that they will completely eradicate this weed, they are successfully managing hymenachne in the Cairns region.

Canegrower has spent thousands on hymenachne control

Background

In 1985, Nick Stipis bought his first sugar cane farm near Euramo, a small town situated in the Cardwell Shire on the coast of North Queensland. Between 1989 and 1994, he bought four cattle properties in the Murray Upper area to expand his canegrowing enterprise. These cattle properties contained hymenachne in numerous low spots where it had survived during drier years. All of Nick's farms are situated on the Tully–Murray floodplain, an area between the Tully and Murray rivers prone to severe flooding during very wet years.

Nick first found hymenachne in his sugar cane in 1998. He was not familiar with the species and he called on the Tully Cane Productivity Services for plant identification. This organisation frequently helps growers with pest and weed problems in cane, but they did not recognise the grass either. The plant was finally identified by local government officers as *Hymenachne amplexicaulis*.

The Cardwell Shire Council not only knew of this weed, but had been concerned about it since 1993. They first found it in the Murray Upper region while this area was being opened up for cane production. Hymenachne had been extensively planted by graziers in the late 1980s, but much of the grass had not survived the dry years following planting. However, hymenachne flourished in low-lying areas, lagoons and drains and was being spread further by floods and waterfowl. The Cardwell Shire Council estimates that some 3000 hectares are currently infested by hymenachne in the region.

Impact of hymenachne

Nick observed the aggressive nature of hymenachne first-hand when it was found growing in one of his sugarcane crops. Hymenachne can grow faster and taller than cane, and will decrease productivity through direct competition. Hymenachne even persisted between cane rows in low light intensity. When not competing with cane, it was able to set seed and spread further into the paddock.

One 4.5 hectare paddock of cane was so badly contaminated by the hymenachne that Nick did not send this cane to the sugar mill. Instead, the area was burnt in an attempt to rid the paddock of hymenachne. Burning was followed by slashing, aerial and on-ground herbicide spraying, and cultivation. The paddock was left fallow for four years to eliminate all hymenachne from the block. Nick was not prepared to replant cane in an area that contained any hymenachne. The cost of controlling hymenachne and the resulting loss of income from this block cost Nick in excess of $30 000.

Control measures and cost

While Nick does most of the weed control on his land, he has also been assisted by Cardwell Shire Council staff. The council supplied him with herbicides, as well as equipment such as a Quikspray® unit.

Nick has removed hymenachne by both chemical and manual means. He often removes seed heads manually and marks

▼ Hymenachne flourishes in low-lying areas in the Cardwell shire

Darryl Assenbruck

Peter van Haaren

▲ Nick's sugarcane was badly contaminated by hymenachne

the remaining plant for follow-up. Isolated hymenachne plants have frequently been dug out of cane paddocks. Nick has also closed in a number of drains on his properties to prevent the spread of hymenachne via these drains. He has even gone to dangerous lengths to manually remove hymenachne from the bottom of wetlands—using a rope for a quick escape from lagoon-dwelling crocodiles.

Nick uses the herbicide Fusilade™ on hymenachne in all non-aquatic areas. He has found this to be the most effective chemical for hymenachne control, and is willing to pay the extra cost for this herbicide to achieve a good kill. He adds canola oil to the herbicide for better chemical absorption. Nick has also used the herbicide Gramoxone® to burn off the seed heads of hymenachne.

The Cardwell Shire Council used Verdict* (with Uptake* or canola oil) for the control of hymenachne in all aquatic areas on Nick's farm. The council has a permit (PER9076) for the use of Verdict*, and

reports much better control when using this herbicide compared to glyphosate. While Roundup® Biactive™ (glyphosate) provides some control of hymenachne, the Cardwell Shire Council reports that its non-selective range has resulted in damage to non-target species. Verdict* is a grass-selective herbicide and does not damage other vegetation, including native sedges.

From 1999 to 2005, Nick monitored and controlled hymenachne on all his properties at least four times per year. This cost him about $8000 per year, in chemicals, man hours and equipment, though costs have reduced each year as less hymenachne needs to be controlled.

* Trademark of Dow AgroSciences LLC

Local government role

The Cardwell Shire Council has been proactive in the control of hymenachne. All landholders whose land borders on areas treated by the council are informed of these activities, and are urged to control hymenachne on their properties to prevent reinfestation. The council sent letters to all landholders adjacent to Nick's properties recommending that they address the hymenachne problem. The council's Quikspray unit is available to all landholders for use on hymenachne and, with a 150 m extension hose, most infestations along banks and drains can be reached.

Conclusions

After seven years of hard work and significant expenses, Nick feels that he is achieving success against hymenachne. He has now controlled hymenachne on all his properties, but says he must remain vigilant to prevent reinfestation.

'I have beaten it and now have a farm with one less weed,' Nick said.

▾ The Cardwell Shire Council has been proactive in controlling hymenachne and has assisted many landholders such as Nick

Darryl Assenbruck

Government and Landcare working together

Eradicating hymenachne from an annual lagoon in the Northern Territory

Background

The area known as Lambells Lagoon is located near the Arnhem highway, approximately 50 km south-east of Darwin. Lambells Lagoon, the wetland of Ewart Road, has progressively been invaded by hymenachne. The weed had covered most of the lagoon by 2004, to the detriment of many native water plants and animals.

How did the weed spread?

It is not clear how hymenachne came to be in the lagoon, but there are several means by which it could have spread. Hymenachne is grown on a nearby research farm where it is utilised as a ponded pasture. The research farm, though situated on the Adelaide River floodplain, is not linked to the lagoon system. The presence of a hymenachne source on this farm, however, may have provided material for spread to the lagoon by either buffalo or by magpie geese.

Humans may also have assisted in the spread of hymenachne, as many people hunt near the lagoon. Seed or plant material, transported on quad bikes, motorcycles, boats or vehicles, could have contributed to the spread of hymenachne. Two other lagoons, located within the same drainage system during the wet season and in close proximity to Lambells Lagoon, are not visited by humans and are free of hymenachne.

Planning

The local Landcare group were the first to report hymenachne growing in the lagoon. In August 2004, the invasive weed was positively identified as *Hymenachne amplexicaulis* by Northern Territory Government staff. The Landcare group, concerned by the widespread infestation of hymenachne, wanted to restore the area to its natural state. The group was prepared to maintain the site if the initial weed density could be reduced to a manageable quantity.

The eradication of hymenachne from Lambells Lagoon required careful planning. The planning process involved the local Landcare group, staff from the Department of Natural Resources, Environment and the Arts (NRETA) and staff from the Pastoral Management Branch of the Department of Primary Industries, Fisheries and Mines (DPIFM).

Extensive research identified suitable control options, with stage one of the control program commencing in October 2004. The control of hymenachne was a collaborative effort between government agencies and Landcare.

▾ Hymenachne covered most of Lambells Lagoon in 2004

Leonie Williams

Controlling hymenachne

Hymenachne was first sprayed with Weedmaster® Duo (glyphosate 360 g/L at 1 L per 100 L water), which took two operators three hours to cover the entire area. Boom sprays and a vehicle-mounted spray tank were used in this operation.

Within three weeks of application, the hymenachne was dying off and much of its height had collapsed. The hymenachne was left for another month, and was then burnt to remove the bulk of dead matter and provide access for follow-up control.

Burning was followed with another chemical application of Roundup® Biactive™ (glyphosate 360 g/L at 1 L per 100 L water) to control emerging seedlings. The follow-up control took much less time and herbicide, with two operators taking only one hour to spray the same area.

The lagoon refilled over the wet season with only a few isolated islands of hymenachne surviving. Free-floating hymenachne was removed by boat, with operators using scoop nets and weed bags. By April 2005, many of the native aquatic species previously displaced by hymenachne had recovered in the lagoon.

Impacts on aquatic ecology

Before any control measures were carried out, government agencies and Landcare conducted a general survey of the lagoon. The group used a macroinvertebrate sampling sheet (for more information see the Waterwatch website at <www.waterwatch.org.au/publications/module3/macroinvertebrates.html>) to determine the type of macroinvertebrates present, which gave a general idea of the health of the lagoon. This activity clearly demonstrated the adverse effects hymenachne had on aquatic life in the lagoon and highlighted the reason for eradicating hymenachne from this area.

The same study was repeated after all the methods to control hymenachne were carried out. This time the study found that the number of species in and around the lagoon had markedly increased. This suggested that the timing and application of all methods undertaken by the group, including the use of herbicides registered for waterway use, had little or no residual effects on native aquatic species. It also demonstrated the impact hymenachne can have on the ecology of aquatic areas, and how quickly the affected area recovers once this weed is removed.

▾ Hymenachne was sprayed with Weedmaster® Duo

Leonie Williams

Leonie Williams

▴ Three weeks after herbicide application, much of the grass had died off

Successful outcomes

In less than one year, the original weed infestation was reduced to three contained islands. This left a manageable area to be controlled during the following dry season. The local Landcare group will continue to monitor and control the hymenachne at Lambells Lagoon.

This case study illustrates how a problem weed can be controlled through the successful collaboration of government and community. It also demonstrates that integrated weed control, using herbicides, fire and manual control, can achieve the desired outcomes.

▾ In less than one year hymenachne was drastically reduced to a level that could be managed

Leonie Williams

Does chemical control of hymenachne affect water quality?

Findings from a research project in Mackay, Queensland

Introduction

A collaborative research trial in the freshwater Sandringham Lagoon Wetland was conducted over a six-month period in 2003–04. The study was designed around the needs of sugarcane growers and land managers, and focused on developing best management practices for the chemical eradication of hymenachne at farm scale.

Sandringham Lagoon is situated approximately 15 km south of the city of Mackay. This small coastal lagoon is long and narrow, and, while it makes up only about 11 hectares, it is approximately 8 km in length. The lagoon flows directly into Sandringham Bay, which forms part of the South Pacific Ocean. Average rainfall in this region is approximately 1600 mm per year.

Collaborators in this project included the Department of Natural Resources, Mines and Water, CANEGROWERS (Queensland Cane Growers' Council), the Pioneer Integrated Catchment Management Association, the Mackay Area Productivity Services and the Mackay City Council.

Project aims

This study aimed to determine how much hymenachne could be successfully controlled during a spray event without causing adverse impacts on water quality.

Sites and control methods

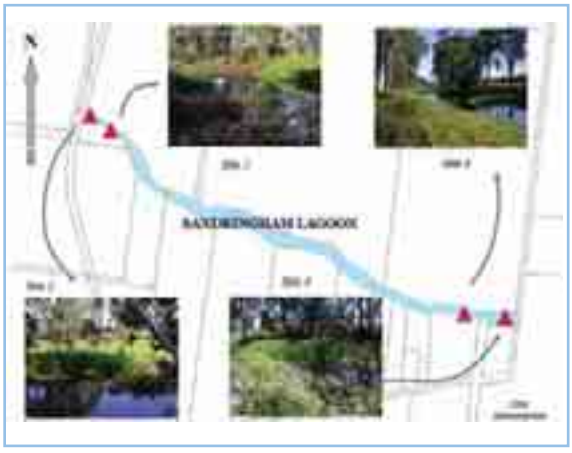
Land managers generally control hymenachne with a 'blanket' spray of the whole infested area. This project, however, was designed to spray only a percentage of the weed at the given site instead of aiming for total coverage. This was achieved as follows:

- Site 1 was not sprayed and was referred to as the control site.
- At Site 2, 25% of the site was sprayed. For each chemical application, only 25% of the hymenachne covering that site was actually sprayed. Follow-up spraying of regrowth occurred in the same percentage where necessary—the same principle was followed at Sites 3 and 4. Site 2 was sprayed a total of eight times.
- At Site 3, 33% of the weed was sprayed. The chemical was applied a total of six times.
- At Site 4, 50% of the weed was sprayed and the chemical was applied four times.

The herbicide used was Monsanto's Roundup® Biactive™ (360g/L glyphosate). Spraying and monitoring occurred in the wet season from October 2003 to March 2004.

Monitoring water quality

Water quality sampling was conducted at all four sites, and measurements of dissolved oxygen, pH, electrical conductivity and temperature were taken. Apart from the four experimental sites, water quality testing was done at a site that had 100% hymenachne cover.



▲ Location of the four test sites

▼ Controlling large areas of hymenachne next to water can have detrimental impacts on water quality

Peter van Haaren

Dissolved oxygen is deemed the critical parameter in aquatic environments and is vital to life in the aquatic ecosystem. The expected daily trends for dissolved oxygen were observed at all sites prior to spraying, but these levels changed after the sites were treated. Two weeks after spraying, the dissolved oxygen levels at these sites had decreased markedly. This is because decomposition processes consume oxygen and the larger the organic load, the more oxygen is required to decompose this matter. Dissolved oxygen levels continued to decline, and the impact of hymenachne death typically took one month to fully register.

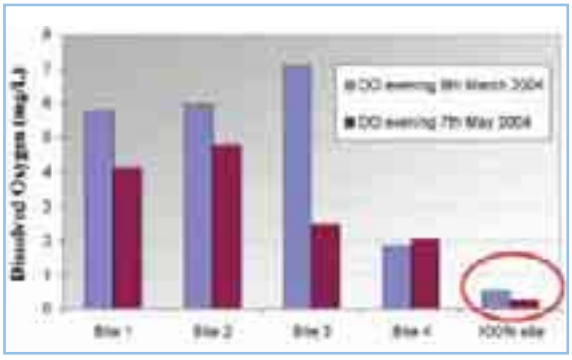
The greatest impact on dissolved oxygen occurred at Site 4, where the largest percentage of hymenachne was controlled. Although a large amount of hymenachne was killed, the decomposing matter consumed dissolved oxygen and depleted water quality.

The smallest impact on dissolved oxygen was at Site 2, where the least amount of hymenachne was treated. Because less hymenachne was treated, the impacts of decomposing material on water quality were minimised. Controlling large hymenachne infestations with this strategy is not likely to be economical, however, as the remaining hymenachne plants can regrow quickly.

The most effective hymenachne control in Sandringham Lagoon occurred at Site 3, where 33% of the hymenachne was sprayed. This maximised the amount of hymenachne killed, but minimised the loss of dissolved oxygen.

It is also interesting to note that the site with 100% hymenachne cover had lower dissolved oxygen readings than the lowest levels recorded in the treated sites. This suggests that the 'do nothing' approach is not effective in managing this weed, and contributes to further degradation of aquatic ecosystems. There was a noticeable loss of biodiversity at this site, and the low dissolved oxygen levels contributed to the loss of fish and native invertebrates. The physical clogging of the wetland also resulted in the loss of roosting and feeding areas for birds.

Other water quality parameters tested showed little adverse affect on the aquatic ecosystem. Water temperature showed no discernable relationship with the death of hymenachne. Electrical conductivity results were broadly similar throughout the testing and had no impact on aquatic life. Tests proved that pH levels were all within acceptable limits and correlated to natural cycles. The death of large areas of hymenachne caused some shift in pH due to the release of organic acids, but this shift was low and not expected to harm aquatic life in the lagoon.



▲ Levels of dissolved oxygen at each site before and after treatment

Key outcomes

The study of hymenachne eradication within Sandringham Lagoon provided evidence and conclusions that can be applied to other freshwater bodies in the region. Best management practices should be guided by four conclusions:

- The 'do nothing' approach is not an effective management system for hymenachne.
- The best practice is to spray hymenachne when there is no water. If there is water present, the death of large quantities of hymenachne will result in a decrease of dissolved oxygen. Where 50% of the site was sprayed (Site 4) dissolved oxygen levels only started to recover after four months. A staggered spraying regime, between three and four months, will limit the drop in dissolved oxygen.
- For small infestations of hymenachne, the most effective spraying regime is to spray one quarter of the weed each month, for four months. This will result in effective weed kill and limit the drop in dissolved oxygen.
- In areas where hymenachne has infested 40–50% of the total area, the best approach is to spray a third of the infestation every month over a three-month period.

This case study is a summary of an unpublished report by Edward Oldmeadow and Cassandra Chopping titled 'Towards a farm scale best management practice for the eradication of the noxious weed *Hymenachne amplexicaulis* in Sandringham Lagoon, Mackay, Queensland'.

The value of hymenachne to the grazier

Background

Wambiana, owned and managed by John and Ronda Lyons, is a 23 200 hectare property near Charters Towers in North Queensland. This breeding and fattening property has been owned and operated by the Lyons family since 1912. The property runs 3000 head of cattle in an average season. Rainfall in the area averages 625 mm per year, but can vary significantly.

The Lyons family, like many graziers in northern Australia, have searched for ways of overcoming the effects of the annual dry. Cattle lose weight in the dry season when native pastures lack quality, even in years of average rainfall. The system of ponded pastures allows the storage of run-off water to produce fodder in the dry season, which reduces the annual protein drought experienced by graziers between May and December.

Ponded pastures

Ponded pastures were established on Wambiana in the mid 1980s. The first system of ponds contained para grass, but although this plant was useful, it had limitations. Para grass grew well in water up to 30 cm deep, but this only accounted for 20% of the ponded area and left the other 80% wasted.

John Lyons first saw hymenachne at Granite Vale, the property of Joe Olive, at Marlborough during a field day in May 1987. John was impressed by the plant's ability to grow in deeper water and obtained some hymenachne runners for planting on his property.

Planting hymenachne

The first runners of hymenachne were planted on Wambiana in a small dam near the house. The family also established a nursery to produce runners for replanting in the larger ponds.

Initial establishment of hymenachne from runners was an outstanding success as a result of favourable seasonal conditions. The clear pond water also allowed good sun penetration, which accelerated plant growth.

To improve planting efficiency, the Lyons family designed and constructed a planting machine pulled by a four-wheel motorbike. This proved very successful, and the plans for this machine have been distributed as far as Darwin.

The area under hymenachne on Wambiana fluctuates between 38 and 78 hectares, depending on the season. All the hymenachne is grown in a ponded pasture system and it grows well year-round, provided there is enough moisture. Other grasses in the ponded system include native couch grass, aleman grass and para grass, with the latter dominating the shallow water and edges of the pond.

The advantages of hymenachne

Hymenachne produces twice the bulk of para grass or aleman grass on Wambiana. This has resulted in the improved carrying capacity of one beast per hectare for six months of the year. This is not only five times better than results from native grasses, but hymenachne also provides quality feed to grow cattle in the dry season.

In years with sufficient rainfall to provide run-off into the ponds, the Lyons' can increase their stocking rate. John said, 'I have not found anything to match the carrying capacity or advantages of the ponded system, provided you have the country and climate to suit.' The ponds still work in years of low rainfall, but to a reduced capacity.

Wambiana's ponded pastures are designed to overcome weight loss of weaners, and hymenachne is a cheap and highly successful weaner feed. The need to purchase molasses or protein meal, which can be a weakness in animal production, is alleviated by the use of ponded pastures.

Managing spread of hymenachne

John said that there is a possibility that hymenachne could spread along waterways, but he has seen no evidence of it spreading from his property. John is aware that birds and ducks can spread the seed and he has seen hymenachne at isolated waterholes and dams. However, he says these infestations never survive due to dry weather and heavy grazing by cattle.

Hymenachne is not likely to become a weed because 'the harsh, dry environment and its appeal to cattle do the managing for us', John said.

The future

John recognises that hymenachne is a problem weed on the coast, but, in his environment, it is a valuable grass and an asset to animal production.

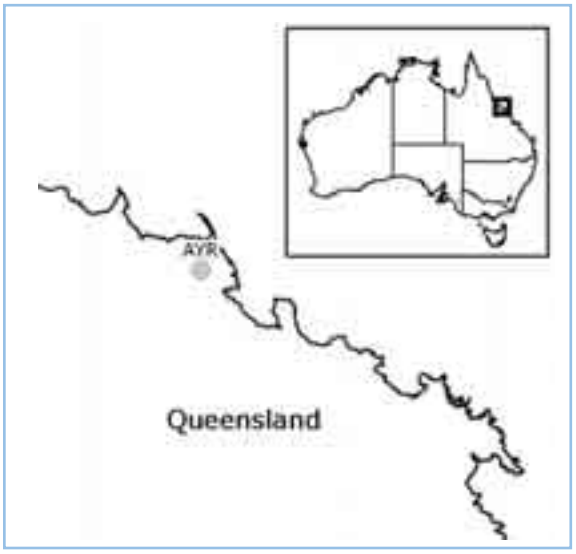
If hymenachne was no longer available as a pasture grass, the Lyons family would have to rely on aleman grass or let native water grasses take their place in the ponded pasture. Neither are preferred options, nor will they provide the benefits that hymenachne does to cattle production on Wambiana.

John believes that the loss of hymenachne would remove a cheap, natural supplement that grows automatically in favourable years. Replacing hymenachne with expensive supplements would increase running costs, and 50% of the capital investment of $50 000 to create the pond system would also be lost.

Please Note
This manual does not endorse the use of hymenachne. Hymenachne is a declared weed.
Refer to page 3 for your State/Territory legislation

Controlling hymenachne in Horseshoe and Pink Lily lagoons

A collaborative project in North Queensland



Background

Horseshoe Lagoon is an important fish-breeding and fauna conservation site of around 102 hectares. Pink Lily Lagoon, also noted as a fish-breeding site, comprises 90 hectares. Both wetlands provide a habitat for native and migratory birds as well as many ground-dwelling frogs and reptiles. The wetlands are fringed by cane farms and grazing lands, and are situated in close proximity to the small sugar town of Giru in the Burdekin Shire.

Hymenachne is still utilised as cattle feed by graziers in the Burdekin region. It is believed that its spread to the wetlands was aided by waterfowl and other native birds. Three years of above average wet seasons in the late 1990s caused an alarming expansion of hymenachne within these lagoons.

Collaboration and planning

Following a successful bid by the Burdekin Shire Council for Australian Government funding in September 2001, a management committee was formed to coordinate hymenachne control for the lagoons. This committee comprised landholders, representatives of government agencies, local sugar mills, SunWater, irrigators and fish restockers.

The management committee provided information about the sites before hymenachne had invaded the wetlands, including survey maps showing the estimated boundaries of the lagoons. Large areas of open water had existed in 1995. The committee used this information to determine how much weed control would be necessary to return the lagoons to their original conditions.

Before treatment occurred, the extent of the weed infestation was determined and photographed, and three permanent photograph points were established. Aerial photographs and Geographical Information System (GIS) mapping of the sites provided benchmarks for future monitoring and evaluation.

The committee liaised with landholders, including traditional owners, in the development of plans to control hymenachne in the lagoons. All landholders strongly supported the control of hymenachne in these wetlands.

Control

In April 2002, work commenced with on-ground and aerial spraying of lagoons and adjoining areas. An aerial spray permit for the use of Roundup® Biactive™ was obtained from the APVMA. Aerial application, which was expensive, was only used in areas impossible to reach by conventional vehicles or watercraft.

An excavator was used initially to provide access to the lagoons for the spray equipment. Infestations along the banks were removed and channel banks were formed to allow access for on-ground operators and monitoring personnel. Land-based treatment of hymenachne was limited and dangerous, as it was often difficult to see where the land ended and the water began.

The herbicide used for all chemical control operations was Roundup Biactive (glyphosate 360 g/L) at a maximum rate of 14 L/ha, which provided consistent results in the order of 90% control of hymenachne eradication.

Manual removal of hymenachne made up a significant part of the control program. Weed harvesters and weed rakes were able to remove large sections of hymenachne and create areas of open water in the lagoons. More isolated areas of hymenachne that surrounded the open water were then treated with herbicide applications from a boat.

Hymenachne was found growing on floating mats of water hyacinth. These mats varied in size from several plants to about 800 m^2, and would move from one end of the lagoon to the other with the prevailing winds. The Burdekin Shire Council used their weed harvester to push large rafts of hymenachne and water hyacinth to the edges of the lagoon. An excavator, mounted with a weed rake, moved these weeds from the water onto the banks.

Rather than burning or disposing of the weed matter, a landholder incorporated this green waste into his cane paddocks prior to planting. By the time he planted his sugarcane, much of the material had decomposed. The addition of this green manure greatly improved soil fertility and resulted in the grower obtaining double his average yields for sugarcane the following year.

▾ The lagoons were infested by hymenachne and other aquatic weeds

Merv Pyott

Merv Pyott

▲ Large areas of hymenachne were removed by excavator and weed harvester

Follow-up and monitoring

All infestations required regular follow-up control and monitoring. The permanent photograph points showed the progress made by the control operation. Monitoring consisted of visiting sites, where infested and successfully controlled areas were recorded. Quarterly boat surveys and half-yearly aerial photographs also assisted with this process.

Monitoring has helped identify new threats. Reinfestation of hymenachne from surrounding waterways by wildlife and floods was identified as an ongoing threat in this area. Evidence of the cabomba weed (*Cabomba caroliniana*) in the lagoons was also a potential problem due to an increase in open water.

The monitoring process of the lagoons and surrounding areas has continued since this project was completed.

Promoting the benefits

The benefits of control were promoted to local land managers to encourage follow-up control of hymenachne. Regular meetings with landholders kept them informed of chemical use, control costs, recording requirements, and results from site visits and monitoring. Management committee minutes, Waterwatch information and fish surveys were also discussed during meetings with landholders.

The Burdekin Shire Council provided herbicide subsidies to landholders who demonstrated an ongoing commitment to the eradication of hymenachne in the lagoons. Close collaboration with landholders has raised the awareness of the environmental impacts of hymenachne and has underlined the need for control.

The region-wide value of the control project was presented to the community at local

▼ The Burdekin Shire weed harvester removes hymenachne and water hyacinth

Merv Pyott

shows, agricultural field days, and through local media and signage. The Burdekin Shire Council also obtained an interactive touch-screen computer that informs the public of the threat of hymenachne and the control measures undertaken in the shire.

Benefits and future work

The removal of large areas of hymenachne from the lagoon had broad biodiversity benefits in the region, such as:

- improved water quality
- an increase in fish populations
- recolonisation of native plants and wildlife
- reinstatement of the native food chain.

This two-year project promoted the environmental benefits of hymenachne control to the broader community, and also provided an excellent example for other areas with similar problems. Landholders were actively involved in controlling hymenachne, and many will continue to do so as participants of the lagoons' maintenance group.

Although large areas of hymenachne have been removed from these lagoons, the eradication of aquatic weeds remains an ongoing task. Other land management strategies, such as fencing, grazing and replanting of riparian vegetation, have now been included in ongoing plans to eradicate

▾ Control of hymenachne created large areas of open water which led to improved water quality and an increase in fish populations

Merv Pyott

courtesy of NRMW

▲ Hymenachne (dark green) invading a water storage area

Joe Vitelli/Barbara Madigan

▲ Hymenachne reduces aesthetic values and recreational opportunities

Section 5

Further information

Enquiries about declared weeds should first be referred to your relevant local government, shire council or state government department.

Hymenachne information sheets can be obtained from the following agencies.

Table 2: General contact details

Organisation/department	Contact details
Department of Natural Resources, Mines and Water (Queensland)	Phone: 1800 803 788 Website: www.nrm.qld.gov.au
Weeds Australia	Website: www.weeds.org.au
Cooperative Research Centre for Australian Weed Management	Phone: 08 8303 6590 Email: crcweeds@adelaide.edu.au Website: www.weeds.crc.org.au

Table 4: State and territory contact details

Organisation/department	Contact details
New South Wales	
Department of Agriculture	Phone: 02 6391 3100 Email: dpi.nsw@dpi.nsw.gov.au Website: www.dpi.nsw.gov.au
Department of Infrastructure, Planning and Natural Resources	Phone: 02 9762 8044 Email: information@dipnr.nsw.gov.au Website: www.dipnr.nsw.gov.au
Northern Territory	
Department of Natural Resources, Environment and the Arts	Phone: 08 8999 2020 Email: weedinfo.nreta@nt.gov.au Website: www.nt.gov.au/nreta
Parks and Wildlife (for information on prohibited entrants)	Phone: 08 8999 5511 Website: www.nt.gov.au/ipe/pwcnt
Queensland	
Department of Natural Resources, Mines and Water	Phone: 1800 803 788 Website: www.nrm.qld.gov.au
South Australia	
Department of Primary Industries and Resources	Phone: 08 8226 0222 Website: www.pir.sa.gov.au
Tasmania	
Department of Primary Industries, Water and Environment	Phone: 1300 368 550 Website: www.tas.gov.au
Victoria	
Department of Primary Industries	Phone: 136 186 Email: customer.service@dpi.vic.gov.au Website: www.dpi.vic.gov.au
Western Australia	
Department of Agriculture	Phone: 08 9368 3333 Email: enquiries@agric.wa.gov.au Website: www.agric.wa.gov.au

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Appendix 1

BURDEKIN SHIRE COUNCIL
PEST MANAGEMENT AGREEMENT
DRAFT Ver 2

Burdekin Shire Council

Name of land Holder: _____

Name of Property: _____

Lot on Plan: _____

Parish: _____ County: _____

Postal Address: _____

_____

Contact Phone Numbers: _____ (Home)

_____ (Mobile)

_____ (Fax)

_____ (Email Address)

AGREEMENT BETWEEN THE LANDHOLDER AND BURDEKIN SHIRE COUNCIL REGARDING THE ONGOING MAINTENANCE OF FLOATING DECLARED AQUATIC WEEDS IN HEALY'S LAGOON.

I, _____ of _____,
agree to participate in the Control of Declared Aquatic Weeds on my property for the three (3) year period from 1 st February 2005 to 31 st January 2008 on the following basis:

I acknowledge that I have a legal responsibility under the Land Protection Act 2003 to control Declared Weeds on my property as described above.

I give a commitment to participate in the Healy's Lagoon Maintenance group.

As part of this group, I commit to contribute on an equal share basis to the ongoing maintenance program cost for the control of aquatic weeds in Healy's Lagoon for a trial period of 3 years.

I acknowledge my commitment to this debt and that the Burdekin Shire Council will forward twice yearly, an account (June & December) for the cost of the required works.

I hereby give my authority to the projects spraying contractor to enter my land for the purpose of aquatic weed control.

I acknowledge that the maintenance contract will be based on the following criteria.-

- The period of the maintenance trial will be a 3 yr period;
- Maintenance will comprise of spraying of the floating Aquatic weeds with an intervention level of 1.5 metre from the water line;
- A maximum of 4 spraying events will be undertaken any one-calendar year.

I provide this commitment on the understanding that: -

- Sunwater have committed to pay for the initial 12 months of ongoing maintenance spraying (i.e. minimum of four (4) spray treatments.)

- The Burdekin Shire Council with funding from the Burdekin Dry Tropics Board PAP No2 will undertake the initial clearing of the lagoon between Woodstock road and the Bruce Highway.
- The Burdekin Shire Council will provide 50% subsidy towards the cost of herbicide to undertake the maintenance.
- Sunwater will project manage the spraying contractor with technical support being provided by Burdekin Shire Council.
- The Burdekin Shire Council will undertake financial administration of the project.
- That 6 months before the end of the trial I will participate in discussions to establish a longer-term maintenance agreement.

Should either myself or any other of the Healy's Group seek to withdraw or fail to contribute toward the cost of the ongoing maintenance of Healy's Lagoon, that it is the expectation of the group, that the Burdekin Shire Council will undertake legal action under the Lands Protection Act to require ongoing maintenance of floating Aquatic weeds in Healy's Lagoon by that party.

..../...../2005

(Signature of Landholder) (Date)

..../...../2005

(Signature of Authorised Officer) (Date)

Signature of Landholder _____ Date

Signature of Authorised Officer_____ Date