

All cultivated varieties in Queensland belong to ssp. *glabrata* with research for better varieties commencing CSIRO at Samford in 1955. As a result of this work, the cultivars *Peru* and *El Salvador* were endorsed for release into Queensland in 1962. *Cunningham*, an intra-subspecific hybrid was released in 1976, and *Tarramba* in 1994. Researchers are now crossing sub-species *glabrata* with other Mexican species to improve psyllid resistance and cold tolerance (Hughes 1998).

But there are problems with the use of *Leucaena* as fodder. *Leucaena* contains mimosine, which breaks down into substances toxic to non-ruminants upon chewing. Cattle will show symptoms such as loss of appetite, hair loss and goitre without the addition of the bacterium *Synergistes jonesii*. This bacteria introduced by CSIRO about 15 years ago, is derived from the stomachs of cattle, sheep and goats sourced from tropical countries where animals have grazed *leucaena* for centuries and can break down mimosine to a non-toxic compound (Walton 2003).

Small landowners use *Leucaena* as a fast growing source of green nitrogen forage and green manure for organic gardens. It is promoted by Permaculture and organic gardening literature. Seeds are passed around among home gardeners (Mollison 1979) (Shelton, in Elevitch 2004).

*Leucaena* has also been used for bank stabilisation, with River Trusts preferring *Leucaena* to native species as riparian vegetation.

*Leucaena* was used as a rehabilitation species on land mined for bauxite at Weipa, and efforts have been made to utilise this *Leucaena*. Shelton and Nulik (2003) in their report on "Leucaena management in West Timor and Cape York" show that on grazing trials on mine sites rehabilitated at Weipa:-

- very good live-weight gains were possible from cattle grazing *Leucaena* thickets after mechanical treatment to make it accessible to stock,
- the *Leucaena* thickets cannot be satisfactorily eradicated by cattle grazing alone, due to high costs and
- would therefore need long-term management.

There is potential for use of *Leucaena*-grass pastures on the Weipa site as holding facilities for live cattle to be exported out of Weipa. These *Leucaena* pastures could be used to provide business opportunities and employment for traditional owners in the region. There are reports that *Leucaena* is spreading from this site, down streams and along transportation corridors, highlighting the need to manage this species even in grazed situations (S Gould pers comm.).

## Pests and diseases

There are two notable pests of *Leucaena*. Of most importance is the **Leucaena Psyllid** (*Heteropsylla cubana*), a sap sucker of the Family *Psyllidae*, which has caused considerable damage in *Leucaena* world-wide, particularly in humid areas. The psyllid is visible to the naked eye and can be found by shaking a green frond onto a dark piece of paper. The psyllids are around 0.5-1mm long and are cream to whitish in colour. There appears to be little visible effect from predation from this sap sucker but there is concern amongst *Leucaena* growers about potential loss of vigour due to psyllid attack, especially in coastal areas (Lemcke and Shotton 2007).

The **Leucaena Seed Beetle** (*Acanthoscelides macrophthalmus*, family *Bruchidae*), was first found in Townsville in May 1996 (Jones 1996), and after twelve years it is now found wherever this species is grown (Walton 2003). It is a seed predator native to Central and South America and feeds only on *Leucaena*. It is recorded that 95% or more of seed may be infested, but there is no data to confirm if seed predation due to this beetle has any effect on the weediness of the species in Queensland (Walton 2003), nor has there been any reports of Bruchid beetle predation on seed in the Mackay Whitsunday Region.

Other natural predators of legumes have been recorded on *Leucaena* in Northern Australia and will increasingly predate on *Leucaena* as the species settles into the new Australian environment.

A fungus was responsible for dieback in *Leucaena* in Northern Western Australia but this seems to be an isolated incident (Walton 2003).

## **World wide spread and weed declaration**

The first known record of the introduction of *Leucaena* worldwide was into the Philippines by the Spanish between 1565 and about 1800 (Hughes 2006). From Philippines, *Leucaena* was taken to other parts of the Pacific for use as fuel wood, and for shade protection of crops such as coffee, cocoa, pepper and vanilla (DNR&M 2004).

The following is a chronological list of events pertaining to the spread of *Leucaena* both in Australia and in the Pacific from Walton 2003.

- During the nineteenth century, it was taken to Hawaii, Fiji, northern Australia, India, East and West Africa, and islands of the Caribbean
- Present in the Philippines in 1825
- Recorded in New Caledonia in 1855
- Hawaii in 1864
- Marquesas Islands prior to 1893
- First recorded in Australia at the end of the 19th century, imported from New Guinea or Fiji
- By 1920 it was naturalised in northern Australia
- First plants collected in Queensland were from Herbert River (1921), Mourilyan (1923) and Brisbane (1924)
- Planted in the Brisbane City Botanic Gardens in 1932
- Infestations at Macknade on the Herbert River, and at Bowen in 1937
- *Leucaena* introduced to more Pacific Islands to rehabilitate damage caused by American and Japanese Armed Forces 1946
- Naturalised populations at Bald Hills (Brisbane) and Darwin in the 1950s



Photo 4 Hillside in Guam infested with *Leucaena* (Photo by Greg Calvert)



Photo 5 Hillsides infested with *Leucaena* in Noumea (Photo by Greg Calvert)

*Leucaena* is among the 32 land plants in the **Pacific Island Ecosystems at Risk (PIER)** list of the world's 100 worst invasive species, and is ranked 45th. The following table is the Risk Assessment score of *Leucaena* and some common weeds prepared for Australia and Pacific Islands

SPECIES	COMMON NAME	PIER RISK RATING	QLD DECLARED (CLASS)
<i>Dalbergia sissoo</i>	Penny-leaf Tree	21	N
<i>Lantana camara</i>	Lantana	21	III
<i>Prosopis juliflora</i>	Mesquite	19	II
<i>Schinus terebinthifolius</i>	Brazilian Pepper	19	III
<i>Macfadyena unguis-cati</i>	Cat's-claw Creeper	17	II
<b><i>Leucaena leucocephala</i></b>	<b>Leucaena</b>	<b>15</b>	<b>N</b>
<i>Spathodea campanulata</i>	African Tulip Tree	14	III
<i>Thunbergia grandiflora</i>	Blue Trumpet Vine	13	II
<i>Ziziphus mauritiana</i>	Chinee Apple	12	III
<i>Thevetia peruviana</i>	Yellow Oleander	9	III
<i>Tecoma stans</i>	Yellow Bells,	8	III
<i>Nerium oleander</i>	Oleander	6	N
<i>Haematoxylum campechianum</i>	Logwood	8	N

Table 3 Pacific Island Weed Risk Comparisons. Compiled from information from <http://www.hear.org/pier/scientificnames/scinameh.htm>

## Australian Spread and Weed Status

The following are excerpts and examples from Walton (2003) and others describing the current distribution of Weedy *Leucaena* in Australia

- In Western Australia, *Leucaena* can be found near creeks wetlands and disturbed sites in Halls Creek, Kununurra, Broome, and Derby, Cockatoo Island, Christmas and Coolan Islands.
- In the Northern Territory, *Leucaena* is the most abundant woody weed. It can be found in and around many coastal communities including Darwin, Nhulunbuy, Yirrkala and Howard Island. It has spread to the catchments of the Adelaide, Blyth, Buckingham, Daly, East Alligator, Finnis, Liverpool and Moyle rivers.
- It is the major weed on Department of Defence lands around Darwin, and is considered a longer-term problem due to the seed bank.
- Locals report it is present on Norfolk Island but not yet invasive.
- *Leucaena* is reported to be spreading in riparian areas in the Northern Rivers region of NSW, including along the Clarence River in Grafton.
- Werren (1999), ranked *Leucaena* with Pond Apple as the 2 weed species that pose the greatest risks to natural systems of the Wet Tropics Bioregion.
- In the McNeill Local Government Review of Queensland (no mention of date), weedy *Leucaena* was reported to be found in 79 of the 83 Shires, with 18 considering it a pest plant in their Pest Management Plans, (Walton 2003).
- Eighteen shires responding to the McNeill Survey noted that the *Leucaena* infestations were less than 10 years old, which suggests either spread from the planted cultivars or spread from older weedy stands.
- Eleven councils reported that *Leucaena* was growing in undisturbed natural habits. A subsequent visit was not carried out to investigate exactly where.
- That a number of *Leucaena* infestations in and near larger population centres of Brisbane, Rockhampton and Townsville includes plants of both subspecies.
- *Leucaena* is ranked as 41<sup>st</sup> of the 200 Environmental Weeds in SE Queensland.

The following table from Walton, (2003), is a summary of the action and priority of *Leucaena* from Shires in Queensland, based on Shire Pest Management Plans.

Shire	Current actions and priority
Barcoo	Recently added to the plan, which aims to prevent establishment of this species along the shire's river systems.
Burdekin	Considered an unsightly weed of roadsides and disturbed areas in the urban areas of the shire. Local government is considering local declaration—P2 (all the shire); P4 (in beef production areas to stop spread).
Calliope	Listed as a minor weed problem. The plan requires monitoring and control of known infestations.
Cairns	Listed in the plan as a 'very dangerous' threat to conservation, but it is a medium priority.
Charters Towers	Listed as a growing environmental weed that requires mapping and control on council roads and reserves. There are isolated plants throughout the town.
Cook	<i>Leucaena leucocephala</i> is ranked as a dangerous threat to natural areas (strategic importance 2). Council considers that the plant should be contained or prevented from spreading. In order to meet its goal, Cook Shire Council will remove any leucaena on its property; educate landholders not to use the species as fodder; request DPI to stop recommending the species and instead recommend native alternatives; request Comalco to remove the material in regeneration areas and, in the interim, ensure no seed is contained in fodder sent to local properties; and request NR&M to investigate biological control for leucaena. Council locally declared <i>ssp. leucocephala</i> in 2002.
Flinders	Monitoring of leucaena in the shire is required. Not a problem yet, but there is concern due to problems in nearby local government areas.
Gladstone	A target species in city environs over the 2001–02 control season.
Hinchinbrook	Infestations are to be monitored; the species is common and widespread.
Ipswich	Classed as a high priority environmental weed; action taken on infestations in riparian areas and parks and reserves, when found.
Longreach	Noted leucaena spread from the town in drainage lines leading to the Thomson River. Council will support the eradication of this weed from all areas in the shire other than where approved by council. Council will support the Longreach Landcare Group in conducting Weedbuster days to assist town residents to remove leucaena. Council may approve plantings of commercial forage varieties of leucaena for animal production. Plantings should be consistent with the Code of Practice established by the Leucaena Grower's Network, and no closer than 200 metres from a watercourse. The species is not mulched to reduce spread.
Mareeba	Is to be controlled on council land.
Mackay	Listed in plan as an environmental weed; there is estimated to be 50–100 ha of <i>Leucaena leucocephala ssp. leucocephala</i> in the shire.
McKinlay	Not yet present in the shire; actions are listed to prevent introduction or spread.
Mount Isa	Is declared under a local law, outside of its use for fodder. Leucaena is an urban weed of disturbed areas in the city.
Noosa	A low priority environmental weed.
Rockhampton	Is declared under a local law requiring the containment of infestations to prevent spread by using treatments such as buffer strips.
Thuringowa	Leucaena is classed as a critical weed in conservation areas and waterways, and a moderate threat to recreation areas and state lands. Scattered plants occur along most creeks and drainage lines. Ross River at Sander Beach and drains in the shire are infested. An infestation near a government research station has been treated, as it was spreading on the roadside and creek. The species is also grown in gardens throughout the town. Actions listed include reduction of populations and removal of isolated populations.

Table 4 The control activity on and priority given to *Leucaena* by local government in Queensland (reproduced from Walton 2003).

## Potential Distribution

### Sub-species *leucocephala*

Climatically, *Leucaena* prefers the annual rainfall of 30 inches in summer, the dry winter period of less than 4 months, and where the mean winter temperature of no less than 11.5°C, (Walton 2003). Scientists interested in promoting planted *Leucaena* as a crop predict 144,000 sq miles (373,000km<sup>2</sup>), in Queensland and 158,000 sq miles, (393,000km<sup>2</sup>) in other states suitable for the growing of *Leucaena*. One can only assume that it will grow there as a Weedy *Leucaena* as well. Other estimates of amount 30,000-50,000km<sup>2</sup> are probably more realistic. Current limits to distribution such as psyllid attack in humid areas, drought and frost tolerance are being selected for and will increase this range in the future.

The following map is a crude prediction from Walton based on the above climatic figures.

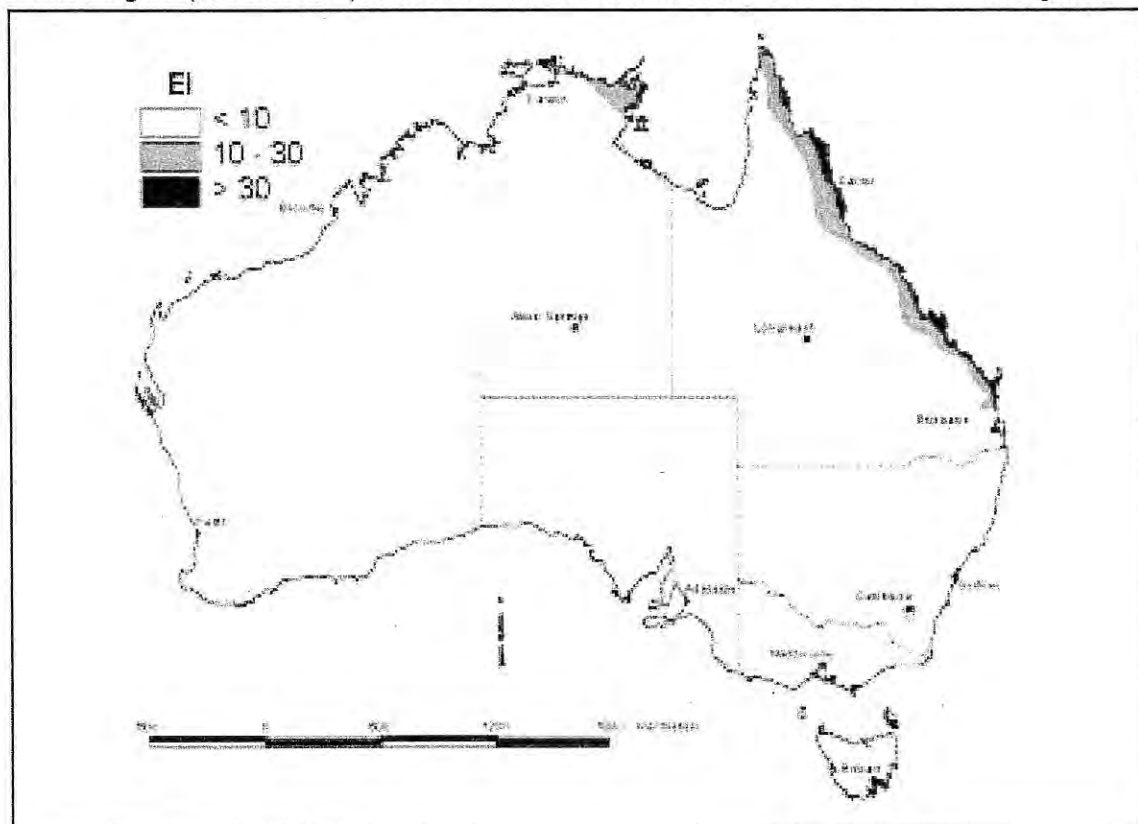


Figure 1 Potential distribution of *Leucaena leucocephala* ssp. *leucocephala*. (Data is splined from a CLIMEX prediction. EI = Ecoclimatic index: EI<10 potential for permanent population low, EI>30 potential very high).(Reproduced from Walton 2003)

One would suggest that this is an indication only as literature suggests there is potential for Weedy *Leucaena* spread into the riparian vegetation of all rivers flowing north of the tropic if disturbed, and many ephemeral wetlands in the seasonally dry tropics on Northern Australia, most of which have disturbance by feral pigs.

### Sub-species *glabrata*

There is documented history of the international spread and use of the sub species *glabrata*. The following are excerpts from Walton relating to its spread and distribution as a fodder crop.

- 1953/54, CSIRO in Queensland introduced a range of material from Mexico, Central America and Hawaii.
- Cultivars *Peru* and *El Salvador* released in northern Australia in 1962
- First planted in the Burnett region in the 1960s

- Cunningham variety released in 1976.
- Tarramba variety released in 1994.
- By 1990 16,000ha was planted in central Queensland
- Increased to 40,000–50,000ha in 1996
- 150,000ha in 2006
- The area of *Leucaena leucocephala* ssp. *glabrata* in Queensland was estimated by the Leucaena Network to be approaching over 200,000ha in 2009.

Growers report that most grazed sub-species *glabrata* plots have not spread (Shelton et al. 2001). At Meadowbank Station near Herberton, after 37 years, no seedlings have grown outside a fenced plot.

Jones and Jones (1996) provided sightings of the spread from planted sub-species *glabrata* in Queensland, and Shelton et al (2001), recorded thickening of stands of planted varieties over many years both inside and outside the fence. Cassandra Chopping, past LPO from Mackay Region, reported sub-species *glabrata* individuals spreading to streams and creeks from trial sites around Broadsound and Sarina.

Weedy *Leucaena* can be seen growing on roadsides and gullies outside plantations in the Central Queensland Highlands, and infestations around the towns of Moranbah and Dysart, not far from Planted *Leucaena* (M. Lane, 2010).

Shelton et al (2001), also report cultivated varieties growing in “a steep and eroded drainage line within the government research station in Gayndah and along roads away from the station.”

Walton (2003), noted seedling on roadsides or in disturbed sites outside planted paddocks near Rockhampton, Emerald, Rolleston (Bauhinia), Esk and Townsville prior to 2001.

New varieties bred for psyllid resistance and tolerance to cold may extend the existing range both north and south and increase weediness.

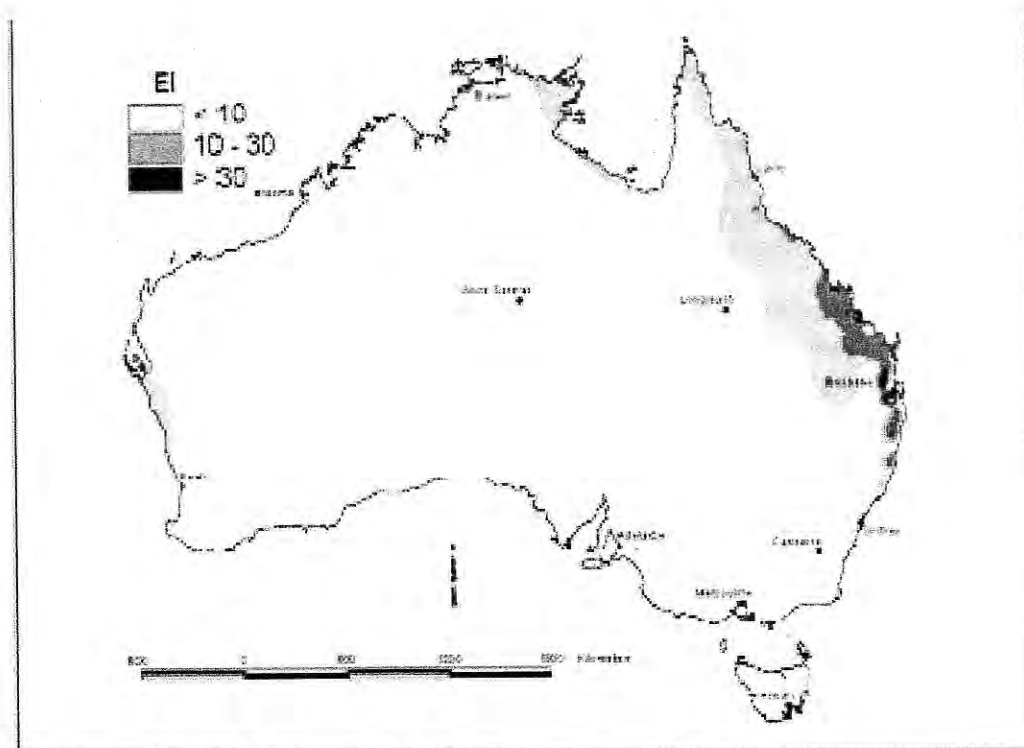


Figure 2 Potential distribution of *Leucaena leucocephala* ssp. *glabrata*.

(Data is splined from a CLIMEX prediction. EI = Ecoclimatic index: EI<10 potential for permanent population low, EI>30 potential very high). Reproduced from Walton 2003

## **Local situation**

The Invasive Species Specialist Group (ISSG) Database "Ecology of *Leucaena leucocephala*" states that *Leucaena* "is a weed of open, often coastal or riverine habitats, semi-natural, and other disturbed or unused sites and occasionally in agricultural land". In the Mackay Whitsunday region Weedy *Leucaena* has mainly spread along transportation corridors throughout newly developed suburbs and along drainage lines. Much of the seed probably came as contaminants in sand sourced from Don River, where it was reportedly planted by the Don River Improvement Trust in the 1960s.

In fertile areas of suburban Cannonvale and Airlie Beach it has formed thickets up to 8m in height in drains, parks, footpaths and unused land where it has overhung gardens and has established such a seed bank that it out-competes lawns and vegetable gardens. There was Weedy *Leucaena* found in 26 of the 47 Council owned reserves throughout the Airlie Beach Cannonvale area, (Hardy and Alden 2006).

A study in 2002 mapped 33 sites of Weedy *Leucaena* infestations in the Cannonvale /Airlie/ Shute Harbour region. A 2005/06 drive-by survey identified 189 known locations where *Leucaena* was growing throughout the Shire, 89 of these are in the area surveyed and controlled during 2002/03. Of the areas controlled there were no remaining mature trees but there were seedlings or suckers present. These seedlings themselves carried seed pods. This highlights the need to carry out follow up control on all known sites for the life of the seed in the soil.

Earthworks connected with the recent Pinnacles development on the hillside above Airlie Town has spread *Leucaena* throughout that suburb where it has become a nuisance in landscaping and gardens and has infested Airlie Creek down to the sea. It has also heavily infested Campbell Creek in Jubilee Pocket, the next valley to the south.

The Land Management Officer for the Whitsunday Council received many complaints regarding *Leucaena* from property owners, and requests for assistance with its control; most were complaints about the seeds and seedlings coming into private property from neighbouring private or Council land. Although *Leucaena* can be controlled by repeated application of chemical, the frequency and cost of control is beyond the physical and financial capabilities of many landowners. With the spread of *Leucaena* on both private and public land, Councils have an obligation to be proactive in its control.

*Leucaena* has established itself on the high tide mark directly above mangroves on the rocky and rubble shore lines between Shute Harbour and Airlie Beach. It is present on the rocky headlands of Gloucester, Abel Point, Mandalay and Shute Harbour. Midge Point, Finlayson Point at Seaforth, Shoal Point, Eimeo and Dolphin Heads, Slade Point, Hay Point, Armstrong's Beach and Freshwater Point and down to Clareview.

*Leucaena* is present at almost every recent bridge and culvert construction site and bulk material dump site along the Main Roads north, south and west and is being continually spread along the road by mowing and maintenance activities. *Leucaena* has also spread down gullies and streams from those Main Roads culverts and is in most of the coastal creek systems down-stream from the Bruce Highway.

*Leucaena* is also on most major arterial roads, from the top of the valley on Eungella Range, along the Peak Downs Highway over Eton range into the Upper Isaacs Catchment. Seaforth Road, Habana Road, Homebush, Marian Hampton Rd and Kungurry Gap have thickets of



Leucaena as has many of the roads around Sarina and up over Sarina Range (refer map below).

Pioneer River banks from Mirani down are heavily infested, originating from bank stabilisation plantings opposite to the town, and sand is still being removed from among Leucaena thickets in the Pioneer River behind Canelands in the city of Mackay.

Proserpine River at the junction of Happy Valley Creek had a small infestation 5 years ago, as was a patch at Spruce's Crossing and further downstream. There is a large thicket on the sand banks and channels in the O'Connell River, and thickets south on the poor country surrounding St Lawrence.

Leucaena is not mentioned in the Whitsunday Pest Management Plan 2004–2008, despite the Whitsunday Rivers Integrated Catchment Management Association (WRICMA), making considerable effort to recruit a Green Corps team for its control in 2002. The Pest Management Officer for the Whitsunday Shire Council and other staff also spent considerable time and resources controlling Leucaena in this area in 2003. This has been on-going.

Of these areas controlled, there were no remaining mature trees but most had a thicket of 1-2 year old seedlings on the same spot. These seedlings themselves carried seed pods. This highlights the need to carry out follow up control on all known sites for the life of the seed in the soil (Alden and Hardy 2006).

Weedy Leucaena is listed as an Environmental Weed in the Mackay Whitsunday Natural Resource Management Plan 2005, and in the Mackay Whitsunday Regional Pest Management Strategy 2008 -2013.

## **Potential Further Spread**

Leucaena growing in a grazed paddock will be cropped up to the reach height of cattle, sometimes standing on back legs. Any seedling germinating in a grazed paddock will be eaten, so that stops effective spread in regularly grazed land. There is, however, high potential for it to spread outside the fence where it will not be grazed, or if seeds in dung are dropped into a waterway and floated downstream. There is also a risk of spread when moving stock which may have viable seeds in their stomach. Leucaena growing under constant mowing or agriculture will not survive if the mowing or cultivation is more regular than four months. So this effectively prevents Leucaena from establishing on agricultural or regularly managed land.

Leucaena is only found in areas of abandoned or poorly managed land. Locally, Leucaena thickets can be seen along both sides of the Main Road and most arterial roads impacting on the scenic values of the region, down most of the river systems, along estuary banks and increasingly spreading throughout suburbia. Without action Leucaena will become the most obvious vegetation in this region surpassed only by sugar cane.

Without control there will be thickets along the foreshore between Cannonvale and Mandalay, and Shute Harbour, seriously impacting on the ocean views for which the Whitsunday Region is well known.

## Local Environmental Impacts of the Weed

As an Environmental Weed, *Leucaena* does not invade undisturbed bushland. It inhabits disturbed land, and fills newly created empty niches. The concentrations and longevity of the seed enables *Leucaena* to form a thicket that will out-compete any establishing vegetation and prevent any other species re-colonising.

*Leucaena* does not invade native forests and will not colonise undisturbed land, (Walton 2003), but will invade the managed edges of forests and thickets. It will colonise both un-slashed and slashed grassy areas, and flourishes in the current management of our transportation corridors.

In our natural system, the niche now most at risk of invasion by *Leucaena* would be that of RE 8.1.4, 8.1.5, Littoral forests containing *Hibiscus tiliaceus*, *Thespesia populneoides* and *Vitex trifolia*, on muddy rubble filled shorelines behind mangroves. Slightly landward would be various wattles and shrubs such as Cocky Apple (*Planchonia careya*), and Red Ash (*Alphitonia excelsa*), which are slow growing compared to *Leucaena* and will not compete.

It will spread into bushland if there is previous disturbance and reduced canopy; slower if there is abundant Guinea grass cover.

*Leucaena* is a pest if present in revegetation and rehabilitation sites as it is the most abundant and the fastest growing plant.

## Legislative Status

*Leucaena* is not declared as a weed in any state in Australia including Queensland.

Without state declaration there are currently no resources allocated for, or legal requirement that, *Leucaena* be controlled, unless local government has listed it under local law. Attempts to declare *Leucaena leucocephala* spp *leucocephala* as a pest under Local Law #13 in the Whitsunday Shire 3 years ago were not successful.

## Mapping

Mackay Regional Pest Management Group has facilitated a community mapping exercise to establish the extent of Weedy *Leucaena* throughout the region. The resultant map, presented below, shows infestations along all major roads with only a small proportion off the roads system. This could be a function of the methods of data gathering, (incidental reporting of infestations while driving along the roads), but may not be far from the truth, given the known methods of seed dispersal, and the previously mentioned limits to spread.

Further incidental sightings and reportings may fill in any gaps between current known sightings.