Northern Territory Government

DEPARTMENT OF
NATURAL RESOURCES, ENVIRONMENT, THE ARTS AND SPORT

Northern Territory

Cabomba Eradication Program 2008–09 November 2009

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Northern Territory Cabomba Eradication Program 2008/09

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The information contained in this report comprises general statements based on scientific research and monitoring. The reader is advised that some of the information may be incomplete or unable to be applied in areas outside the Darwin River region. Some information may be superseded by future scientific studies, new technologies and/or industry practices.

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Front cover: Lok Landji Billabong 2009

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Cabomba caroliniana (cabomba) is a fully submerged aquatic plant native to South America. Cabomba was first recorded in Australia in 1967 and was probably introduced, and subsequently spread, through the aquarium industry trade. Since its introduction to Australia, cabomba has become widely established in various water storage facilities, farm dams and river systems in an area extending from Victoria to the Charters Towers / Townsville region in Queensland. Typical impacts of cabomba include significant reductions in biodiversity in natural ecosystems and a reduction in water quality in water storage facilities. Both of these impacts represent a significant threat to the Northern Territory.

Due to the significance of its impacts, cabomba is recognised as one of the 20 worst weed species in Australia and as such is listed as a Weed of National Significance (WoNS). Cabomba is also declared under the Northern Territory *Weeds Management Act* as a Class A weed (to be eradicated) and Class C weed (not to be introduced to the Northern Territory).

Cabomba was first recorded in the Territory in 1996, an infestation at Marlow lagoon which was successfully eradicated in 2001. Cabomba was reported at Darwin River in 2004, where survey indicated the existence of an infestation affecting an 11 km stretch of the river. The Department of Natural Resources, Environment, The Arts and Sport's (NRETAS) Weed Officers commenced integrated control efforts in November 2004 and have continued since then with a continual reduction in area being recorded. The infestation site is located within the catchment of Darwin's water supply where establishment within the dam would result in the requirement for the construction of a $40 million water treatment plant. Establishment elsewhere within the freshwater ecosystems of the Top End would have far reaching impacts on the environment.

The management program has used a combination of physical and chemical tools in addition to the declaration of quarantine (public access and movement) restrictions over the site. Control effort during 2008/09 was a total of 32 days with herbicide applied on 20 of these days directly to detected cabomba plants. The total amount of herbicide applied during this period was 29.25 litres onto plants found over a 1.8 km stretch of Lok Landji Billabong.

A supporting program monitoring native flora and fauna populations, and water quality, has been implemented within and downstream of the control area and has found no evidence of significant change in aquatic vertebrates or in water quality. No herbicide was detected within the limits of the assay technique in water samples taken downstream of treated areas.

To date the management program has reduced and maintained the cabomba population to less than 1% of the level found in 2004 and prevented the re-establishment of infestations, production of flowers and subsequent production of seed at all sites. The monitoring program implemented in parallel with control has detected no off-target impacts within the project area or in downstream marine environments.

Overall the program is on track for eradication. However, the extent of previous production of seed, and the length of viability of this seed, will determine the ultimate length of this program.

1. Introduction

Cabomba caroliniana (cabomba) is a fully submerged, aquatic plant native to South America. Cabomba was first recorded in Australia in 1967, probably introduced through the aquarium industry trade.

Since its introduction, cabomba has become established in various water storage facilities, farm dams and river systems in an area extending over the length of the east coast. Cabomba is often problematic in irrigation drains and channels where low flow rates facilitate rapid development and spread.

Nationally, cabomba has proven to be a very difficult weed to effectively manage once established because of the rate at which it grows, the plant's ability to spread rapidly and the difficulty of managing off-target impacts of control based on herbicides.

The cabomba threat

Cabomba is a fast growing plant. Growth appears to positively correlate to increasing light, high temperature and elevated nutrients. These requirements indicate that most freshwater bodies in the Top End including floodplains, backflow billabongs and water reservoirs, including Darwin River Dam, would be susceptible to cabomba infestation.

Figure 1: Cabomba infestation, Darwin River NT, November 2004. Many of the plants are in flower.

Infestations interstate and in the Northern Territory have clearly demonstrated the capacity of cabomba to reduce aquatic biodiversity and ecosystem function. Cabomba can adversely affect water quality, reduce water storage capacity of dams, block water distribution infrastructure, severely impede recreational activities, including fishing and boating and create habitat suitable for mosquito breeding.

Cabomba spreads readily. Floating stem fragments, as short as one cm, with only a pair of leaves can take root and grow into new plants. Large infestations are also able to produce vast quantities of seed. Anything that moves through the water, including fishing lures, boats, trailers, outboard motors and animals, can act as vectors for the movement of either plant fragments or seeds. The production of viable seeds seen in the Northern Territory has not occurred elsewhere in Australia.

As a result of these issues and associated costs, management programs in most Australian jurisdictions target impact reduction rather than eradication. However in the Northern Territory eradication of cabomba remains a priority. This is due to its continued limited range, its enormous potential range, and the scope for extensive environmental, social and economic impacts. This could include the possible infestation of Darwin River Dam with cabomba which would require a drinking water supply treatment facility being built.

2. The approach to cabomba management in the NT

The Northern Territory Cabomba Eradication Program operates with the intent of achieving eradication without off-target impacts and to prevent any further introduction of the species to the Northern Territory. In order to do this a number of key objectives must be achieved. These are:

- Cabomba is not re-introduced into the Northern Territory.
- No new infestations are identified.
- The spread of any recorded populations of cabomba into new areas is prevented.
- The re-establishment of cabomba at any recorded site is prevented through timely management activity.
- Seed production at any recorded site is prevented through timely management activity.
- There are no negative off-target environmental or economic impacts as a result of the implementation of the management program.

In 2008/09 a major focus of the program was the requirement that all known sites of infestation and adjoining areas be visited and monitored for plants on at least 25 occasions. All plants detected were to be treated promptly with an approved herbicide, with special effort being made to complete treatment before flowering can occur. The Department of Natural Resources, Environment, The Arts and Sport was to maintain a public awareness program throughout the reporting period and promptly respond to any enquiries received.

In addition to survey and control the Department was also required to continue the implementation of monitoring programs during the 2008/09 reporting period in an effort to provide an early warning system that detects, and prevents further unintended off-target damage. These programs monitor for the effects of herbicide application on aquatic macroinvertebrates and allows for the provision of an indication of the presence of 2,4-D-n-butyl ester in both freshwater and saline ecosystems upstream and downstream of active control sites.

Control methods

A number of options are available for the control of cabomba including physical removal, shading, water level manipulation, biological control and herbicides. Of these options, herbicide remains the only viable option in the Northern Territory for a number of reasons.

- Physical removal is not a viable option in the Northern Territory due to the potential presence of saltwater crocodiles at the site and the fact that any plant fragment missed could result in the re-establishment of an infestation.
- Shading does not provide a viable option given that growth could occur at any location within the project area and maintaining effective establishment of shade structures for any number of small sites is inefficient.
- Biological control is not an option given there are currently no suitable agents currently available in Australia for release against the target species.
- Water level manipulation provides an effective management tool in sites such as man-made dams. The manipulation of water levels however within the confines of Darwin River is impossible due to the presence of numerous springs feeding the river throughout the Dry season.
- Currently there are no herbicides registered for use in the control of cabomba in Australia. Previous experience in the Northern Territory gained at Marlow Lagoon however, demonstrated 2,4–D n-butyl ester provides effective control. Given this experience, and the success of control within the Darwin River project area using this product since November 2004, NRETAS applied to the Australian Pesticide and Veterinary Medicine Authority (APVMA) for an *off-label* permit to continue with the use of this herbicide in the 2008/09 reporting period.

Chemical control of cabomba in the NT

Given earlier experience and success, continued use of 2,4-D-n-butyl ester remained the preferred and, in the view of agency personnel, the only viable management option. NRETAS was successful in its application for an off-label permit to continue use of this herbicide during 2008/09.

The permit for use of 2,4-D-n-butyl ester stipulates spot application directly into cabomba infestations. This provides the dual benefits of minimal herbicide use and a specifically targeted application.

The required amount of herbicide is mixed with diatomaceous earth in a 100 lt spray tank on a boat (see Table 1 below). This mixture is then pumped directly onto submerged plants via hand held wands with nozzles submerged during application. This method of application facilitates targeted application and minimal herbicide use and minimises the risk of subsequent spread and off-target impacts. Herbicide is applied during the Dry season when water is clear and water flow is minimal. A high degree of sub-surface visibility is essential for targeted application and minimal flow means the herbicide will remain in the required area for sufficient time to control target plants. Preferentially the herbicide is applied prior to flowering in order to prevent any seed production.

Table 1: Effective dilution and application of 2,4-D-n-butyl ester to Darwin River

Target herbicide concentration: 10,000 g of 2, 4–D n-butyl ester per megalitre of water.

Product chemical concentration : 800g active (2, 4–D n-butyl ester) per litre of raw product**.**

Label requirement: 12.5 L product + 5 kg diatomaceous earth mixed per 200 L water to be applied to a megalitre of water.

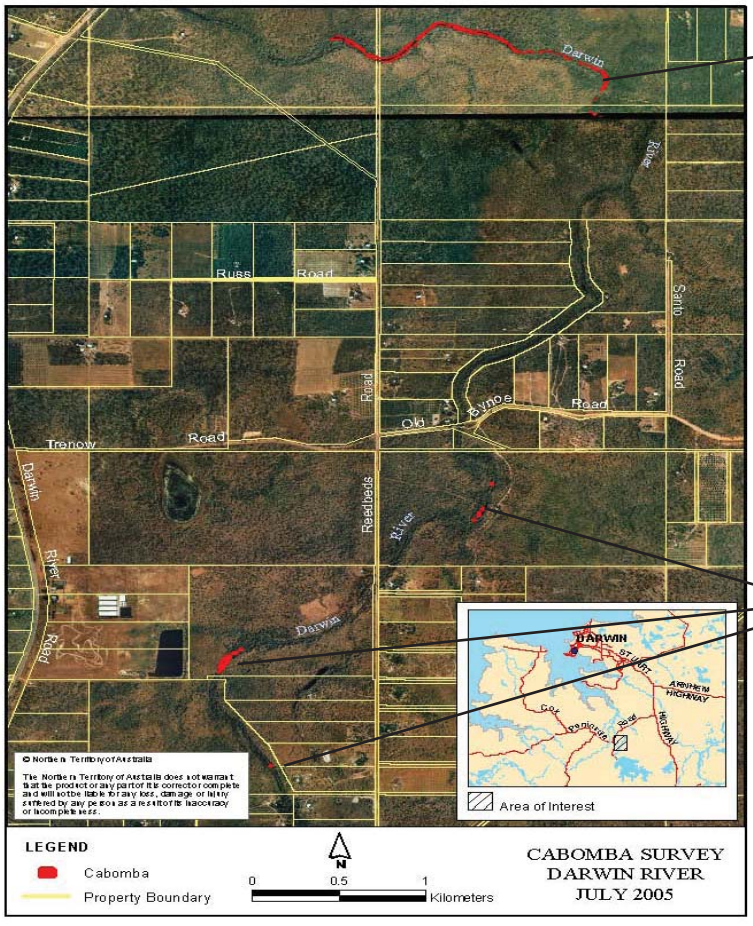
1 megalitre = 1,000,000 litres of water. (This is calculated through a combination of water depth and surface area).

Label requirement is 10,000 g of product per megalitre of water = 1 g per 100 litres of water.

1 g per 100 litres of water =10 mg per litre of water.

Actual herbicide application is calculated considering water depth, width of spray boom, number of spray nozzles, speed of boat and pump rate (litre/min).

Thresholds have been established for detection of the active constituent of the herbicide in connected waters at which reduction in use or cessation of use would be required (see Monitoring Program below).



Lok Landji Billabong: All 2008/09 cabomba found at this site.

Activity at these sites limited to monthly survey during 2008/09

Map 1: 2008–09 survey and control sites, Darwin River NT.

3. Monitoring program

Cabomba distribution and abundance

Cabomba survey was conducted during the 2008/09 Dry season at all previously active sites at Lok Landji Billabong on a weekly basis and along the other upstream sites along Darwin River on a monthly basis. All accessible segments of the river were visited by boat and two experienced observers scanned for the presence of cabomba plants. Effort involved was approximately 300 hours.

In addition, an aerial survey of the Darwin River Dam was also carried out in July 2009. Aerial survey was necessary to avoid risks of introducing pests to the Dam on boats or other equipment.

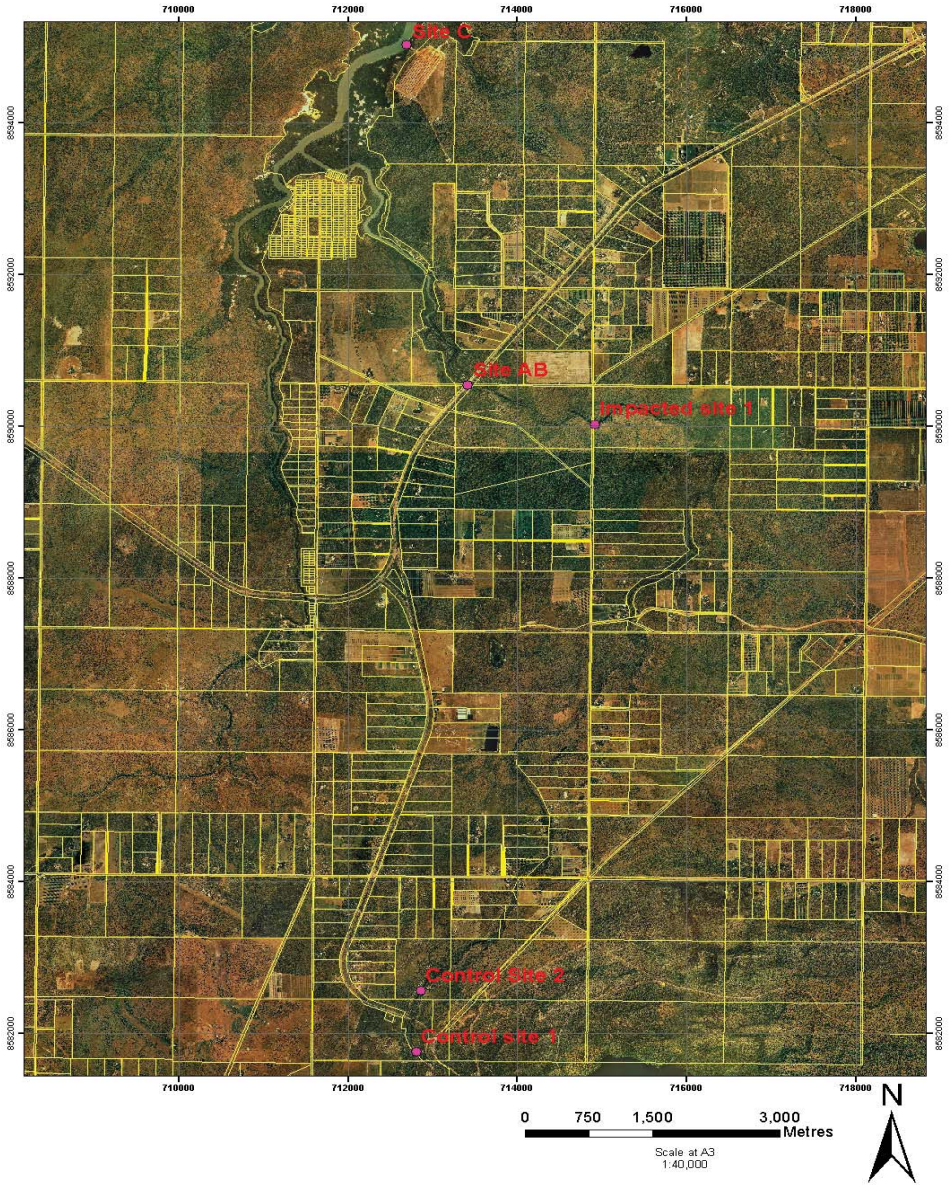
Off-target impacts

The continued use of herbicide within the Darwin River project site required that a program monitoring potential off-target impacts also be continued during 2008/09. This monitoring program provides an early warning system and if necessary, allows a management response adaptation to occur to protect the important public values and uses of the Darwin River environment.

In 2008/09 monitoring included:

- surface water quality assessments included testing for 2,4-D-n-butyl ester, and dissolved oxygen; and
- macroinvertebrate monitoring as biological indicators of river health.

Figure 2: Key identification points relating to Cabomba caroliniana: include pairs of opposite leaves growing along stems; and small emergent flowers.



Map 2: 2008/09 Water Quality and Biological Monitoring sites on Darwin River NT. Control Sites 1 and 2 are upstream of treated areas, and Sites AB and C are downstream.

Water quality monitoring

Surface water samples were collected from two sites, identified as Sites AB and C, for analysis of the herbicide 2,4-D-n-butyl ester. Site locations are described below and shown in Map 2 above.

- Site AB is in the lower freshwater reach of Darwin River downstream of all infestations of cabomba and hence of areas treated with herbicide; and
- Site C is downstream of the Darwin-Blackmore Rivers confluence adjacent to the intake for an aquaculture operation.

The number of water quality sites were rationalised as a consequence of the limited extent of cabomba in 2008 and the lack of 2,4-D-n-butyl ester detection in previous years in addition to the reduced herbicide application.

This is a result of the achievements in cabomba eradication and management over previous years. Two additional sites would be monitored if herbicide was detected at Site AB and the monitoring regime and response to the detection of the 2,4-D-n-butyl ester would follow an 'Adaptive assessment approach'.

It was predetermined that if the concentration of 2,4-D-n-butyl ester exceeded a 'trigger value' concentration of 1.0 mg/L at Site AB, action would immediately be taken to prevent any further increase (e.g. reduce volumes or cease application) or spread to downstream areas. Action would also be taken if herbicide was detected at Site C.

Analyses of water samples were carried out at the Northern Territory Department of Regional Development, Primary Industries, Fisheries and Resources laboratory, Berrimah, where the detection limit or minimum detectable concentration was 0.02 mg/L for the herbicide 2,4-D-n-butyl ester.

Volumes of herbicide being applied would be reassessed if sampling at Site AB recorded concentrations of 2,4-D-n-butyl ester > 1 mg/L , or if 2,4-D-n-butyl ester was detected at any concentration at Site C.

Physical parameters of temperature, pH, Dissolved Oxygen (as mg/L and % saturation) and Electrical Conductivity (EC) were also recorded at each site using a Hydrolab multi-parameter probe. Turbidity was measured at the surface of each site using a Hach 2100P turbidity meter. Water quality was assessed against regional water quality objectives for aquatic ecosystem protection (Fortune, 2009). These objectives provide a performance benchmark for maintaining beneficial uses declared under the Northern Territory *Water Act*.

Dissolved oxygen is a measure of the amount of oxygen in the water and varies with physical and chemical conditions. It is critical for aquatic organisms to survive. Low dissolved oxygen can occur as a consequence of decomposing plant matter with anoxic conditions associated with fish kill events and impacts to other sensitive aquatic fauna.

Turbidity is a measure of water clarity. Material suspended in the water column can inhibit light available for photosynthesis. Light environment in the water column can have bearing on ecosystem productivity.

Electrical conductivity measures the dissolved solids, usually salts in the water profile. Plant and animal growth can be inhibited if too high. However many species have specific tolerances for conductivity.

The indicator of pH is a measure of how alkaline or acidic the water is. This parameter is particularly important to biological and other chemical processes.

Macroinvertebrate monitoring

To evaluate the impact of the herbicide application on the river's health after the wet season, the macroinvertebrate community was monitored in the early Dry season at site DW47 upstream of the impacted site of Lok Landji Billabong before the application of the herbicide. This site has remained a regular monitoring site since 2002.

Due to the continuing reduction in the extent of cabomba since 2004 (see results below), sampling was rationalised and undertaken at two control sites (CON1 and CON2) and the one impacted site, Lok Landji Billabong (IMP1). The analysis of this monitoring was undertaken using the AUSRIVAS methodology as previous applied (Lamche 2007). The results of monitoring for the years 2007 and 2008 are reported in the following section.

Macroinvertebrate sampling was carried out in June and October 2008 according to the Darwin Daly region AUSRIVAS manual (Lamche 2007). Briefly, one operator disturbed the edge habitat with a rake while a second person collected the sample from the disturbed substrate and adjacent water column using a sweep net. Abiotic parameters were measured in situ and water samples collected and analysed in the laboratory.

The invertebrate samples were sorted and identified in the laboratory and analysed using the 'Darwin Daly region-early Dry season–edge habitat–family level AUSRIVAS model'. Results were calculated as OE50 score, displaying the number of Observed to the number of Expected or predicted taxa if the site was similar to reference condition. The OE50 score is assigned to a band, which enables easy interpretation of the results (Table 2 below).

Table 2: The bands provided through AUSRIVAS

Band	Description	Interpretation
X	More biologically diverse than reference	More families found than expected. Potential biodiversity "hot-spot" or mild organic enrichment. Continuous irrigation flow in a normally intermittent stream.
A	Similar to reference	Expected number of families within the range found at 80% of the reference sites.
B	Significantly impaired	Potential impact either on water and/or habitat quality resulting in a loss of families.
C	Severely impaired	Many fewer families than expected. Loss of families from substantial impairment of expected biota caused by water and/or habitat quality.
D	Extremely Impaired	Few of the expected families and only the hardy, pollution tolerant families remain. Severe impairment.

4. Results

Cabomba distribution and abundance

During the Dry season periods of 2008/09 reporting period a full survey of all previously affected areas of the Darwin River was conducted by NRETAS Weeds Officers. These surveys resulted in no cabomba being found at any time in any of the suitable sites located upstream of Lok Landji Billabong which has been the case since the 2005/06 reporting period.

In contrast to this, cabomba was found to have germinated at a number of sites located on Lok Landji Billabong during suitable periods of the 2008/09 reporting period – these are times when river flow rates and water clarity are suitable for the growth of submerged aquatic plants.

All infestations recorded during the 2008/09 reporting period on Lok Landji Billabong, with the exception of one, were found at "known" sites that have remained active since the initial commencement of treatment in November 2004. These infestations were all small and appeared to be the result of viable seed germinating on site and not the result of "vegetative" establishment.

An aerial survey of suitable habitats in Darwin River Dam was also conducted in June 2009 which again resulted in no cabomba being recorded there. This survey is conducted on an annual basis.

Chemical control program

During the 2008/09 survey and control program all cabomba plants found were immediately treated with 2,4-D-n-butyl ester and diatomaceous earth as per the APVMA permit requirements. On all occasions, plants recorded on site had not reached maturity prior to treatment and as a result it is expected that no viable seed had been added to seed populations existing in the project area.

Herbicide treatments were found to be effective on all occasions as follow up inspections (1 week later) found all plants to be dead on site. On no occasion was herbicide treatment found to be ineffective against the target plant.

Cabomba was detected only at Lok Landji Billabong and at no other previously recorded sites resulting in the need to apply herbicides only at this site. Table 3 provides details of the dates of herbicide application and the amount of herbicide applied during the 2008/09 reporting period to Lok Landji Billabong.

Table 3: Herbicide usage date and amount 2008/09 reporting period, Darwin River

Date	9/7/08	16/7/08	23/7/08	30/7/08	8/8/08	15/8/08	23/8/08	31/8/08
Amount used	3.5 lt	0.5 lt	0.5 lt	0.5 lt	0.5 lt	1.5 lt	2.5 lt	2.0 lt

Date	Sept	3/10/08	10/10/08	17/10/08	21/10/08	Nov 08	Dec 08	14/4/09
Amount used	Nil	3.0 lt	3.0 lt	0.5 lt	1.5 lt	Nil	Nil	2.0 lt

Date	24/4/09	1/5/09	8/5/09	15/5/09	29/5/09	9/6/09
Amount used	0.25 lt	0.5 lt	0.75 lt	1.5 lt	5.25 lt	Nil

Impacts monitoring program

Water quality monitoring

Physical chemical parameters were found to be within the recommendations for the Darwin Region Water Quality Objectives (Fortune, 2009). Electrical Conductivity (EC), Turbidity and Dissolved Oxygen varied considerably (Table 4) and are typically a result of tidal influences, freshwater runoff or altered flows.

The herbicide 2,4-D-n-butyl ester was detected on one occasion at the Darwin River monitoring site AB in the 2008 year (13/06/2008: sample registered 0.04mg/L). In this case a follow up sample was carried out within 24 hours. However the second sample was unable to detect any chemical presence above 0.02 mg/L. This departure was not regarded as a threat to the aquatic ecosystems as the sample remained well below the trigger value of 1 mg/L. Since this time and during this reporting period there has been no detectable herbicide found at Darwin River monitoring site AB or downstream at Site C on the Blackmore River during sampling.

Long-term monitoring site assessment (macroinvertebrates)

The results of the AUSRIVAS analysis using the family level model are presented in Table 4 and compared to the preceding years for historical site DW47 upstream of Lok Landji Billabong. Although there is some variability on the OE50 score over the years, there is no observable trend and the scores are classed as Band A throughout the monitoring period (refer to table 2 for AUSRIVAS bands).

Table 4: Regular AUSRIVAS monitoring data for the site DW47 within the control area; Darwin Daly region-early Dry season–edge habitat–family level AUSRIVAS model

	2002	2003	2004	2005	2006	2007
OE50	1.10	0.87	Not sampled	1.00	1.11	0.99
Band	A	A		A	A	A

Note: 2008 data to be modelled – no departure from previous years is expected. Results for the post treatment site at Impact site 1 (DW63) are more relevant to condition.

Table 5: Water quality monitoring schedule, physical water quality parameters and results for Darwin River sites July 2008-December 2009.

Date sampled	G code	Sample code	2,4-D (mg/L) detection limit 0.02	Turbidity (NTU's)	pH	EC (us/cm)	DO (mg/L)	Temp ° C	DO % saturation (calculation)
04/07/2008	G8155644	AB008	<0.02	n/a	7.35	18347	5.06	24	60.11
11/07/2008	G8155644	AB 009	<0.02	n/a	n/a	n/a	n/a	n/a	n/a
11/07/2008	G8155646	C005	<0.02	n/a	n/a	n/a	n/a	n/a	n/a
18/07/2008	G8155644	AB009	<0.02	2.02	7.41	1978	6.27	23.3	73.51
24/07/2008	G8155644	AB010	<0.02	1.99	7.76	3203	7.21	25.11	87.43
24/07/2008	G8155646	COO6	<0.02	28	7.28	56752	5.41	30.39	72.05
08/08/2008	G8155644	AB013	<0.02	n/a	n/a	n/a	n/a	n/a	0.00
08/08/2008	G8155646	C008	<0.02	n/a	n/a	n/a	n/a	n/a	0.00
15/08/2008	G8155644	AB014	<0.02	n/a	7.65	1322	7.92	21.9	90.41
22/08/2008	G8155644	AB015	<0.02	n/a	6.87	25759	5.4	24.67	64.95
22/08/2008	G8155646	C009	<0.02	n/a	7.19	63914	5.8	24.77	69.89
28/08/2008	G8155644	AB016	<0.02	2.21	7.31	1581	6.66	25.39	81.18
05/09/2008	G8155644	AB017	<0.02	3.1	7.12	27458	4.43	27.41	56.00
05/09/2008	G8155646	C10	<0.02	16.7	7.28	40802	6.22	28.22	79.77
12/09/2008	G8155644	AB018	<0.02	n/a	7.79	2489	6.74	29.71	88.72
19/09/2008	G8155644	AB019	<0.02	n/a	7.32	26365	4.27	29.32	55.83
19/09/2008	G8155646	C011	<0.02	n/a	n/a	n/a	n/a	n/a	n/a
28/09/2008	G8155644	AB020	<0.02	3.78	7.65	34433	n/a	28.47	n/a
03/10/2008	G8155644	AB021	<0.02	n/a	7.3	25973	5.17	29.85	68.22
03/10/2008	G8155646	C013	<0.02	n/a	7.56	57107	4.8	30.3	63.83
10/10/2008	G8155644	AB022	<0.02	3.89	7.98	3674	5.43	28.06	69.44
17/10/2008	G8155644	AB023	<0.02	n/a	n/a	n/a	n/a	n/a	n/a
17/10/2008	G8155646	C014	<0.02	n/a	n/a	n/a	n/a	n/a	n/a
24/10/2008	G8155644	AB024	<0.02	n/a	n/a	n/a	n/a	n/a	n/a
31/10/2008	G8155644	AB025	<0.02	13.1	7.22	21950	4.32	30.62	57.77
07/11/2008	G8155644	AB026	<0.02	5.29	n/a	n/a	n/a	n/a	n/a
14/11/2008	G8155644	AB027	<0.02	9.69	7.36	17990	5.02	31.24	67.84
17/11/2008	G8155646	C016	<0.02	33.5	7.56	57255	5.41	31.12	72.96
21/11/2008	G8155644	AB028	<0.02	6.78	7.78	1061	5.44	30.03	72.01
28/11/2008	G8155644	AB029	<0.02	7.61	7.58	3185	5.56	30.87	74.66
28/11/2008	G8155646	C017	<0.02	96.9	7.38	30.5	7.08	30.01	93.68
05/12/2008	G8155644	AB030	<0.02	5.84	7.17	1.71	5.29	30.8	70.95
12/12/2008	G8155644	AB031	<0.02	9.5	7.21	0.341	5.04	29.11	65.65
19/12/2008	G8155644	AB032	<0.02	38.2	6.83	490	6.35	27.2	79.97
19/12/2008	G8155646	C018	<0.02	23.2	6.9	10680	6.03	27.55	76.42

Impacted and control site assessment

As a consequence of the limited extent of cabomba only three sites were sampled in 2008 in addition to the longer term site established upstream (DW47). The three sites sampled were (Map 2):

Control site 1

- located on the Darwin River 470 metres upstream of the Darwin River Road causeway.

Control site 2

- located 370 metres downstream of the Darwin River Road causeway.

Control site 3

- Impacted site 1 is located at the Reedbeds Road crossing.

Two analytical approaches were adopted in 2008. Firstly, the Darwin-Daly genus level AUSRIVAS model was used to generate condition scores (OE50 scores). Secondly, ordination methods were used to compare the composition of macroinvertebrate communities of test sites and those of monitoring sites throughout the Darwin region in the early Dry season of 2007 (Dostine 2009).

Results of AUSRIVAS modelling (Table 6) suggest that the macroinvertebrate communities of impacted and control sites are equivalent to reference condition, and there is no evidence of significant ecological impairment.

Table 6: Results of AUSRIVAS modelling of macroinvertebrate community structure at 10 sites in Darwin region streams.

Site code	Site name	Sample date	OE50	Band
DW37	Peel Creek, u/s road crossing	11-May-07	0.96	A
DW31	Berry Creek, u/s road crossing	14-May-07	0.82	B
DW26	Bee's Creek at Horne Road Crossing	16-May-07	0.9	A
DW40	Elizabeth River, u/s gauging station	16-May-07	0.66	B
DW21	Rapid Creek, u/s v-weir	17-May-07	0.41	C
DW23	Mitchell Creek, d/s Lambrick Ave drain	18-May-07	0.64	B
DW47	Darwin River, d/s Old Bynoe Road Crossing	06-Jun-07	0.99	A
DW57	Darwin River, Control site 1*	28 Oct 08	0.99	A
DW58	Darwin River, Control site 2*	28 Oct 08	1.07	A
DW63	Darwin River, Impact site 1*	28 Oct 08	0.86	A

(*) Darwin River sites assessed in conjunction with the Cabomba eradication program

The results of MDS ordination present an equivalent description of site similarities, with some separation of the three Darwin sites from other sites (Figure 3). There is no clear gradient of disturbance in the ordination space (Dostine 2009).

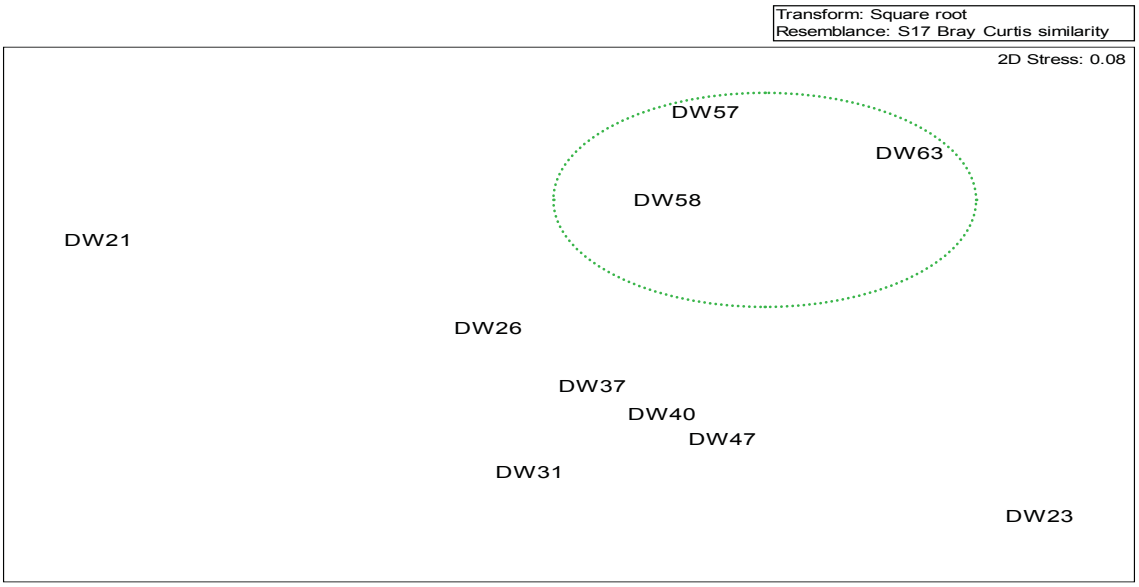


Figure 3. MDS ordination of macroinvertebrate community structure at seven sites in the Darwin streams sampled in early Dry 2007, and 3 sites on Darwin River sampled in late Dry 2008. DW57 and DW58 = upstream sites; DW63 = impacted site.

5. Discussion

The level of cabomba infestation in the Northern Territory continues to decrease as is evidenced by the level of herbicide usage over the period from 2005/06 through to the current 2008/09 reporting period. Over this time the average level of herbicide use per treatment visit has dropped from 23.5 litres per visit in 05/06, to 14.8 litres per visit in 06/07, to 4.08 litres per visit in 07/08, to the current level of 1.14 litres per visit in the 08/09 reporting period.

In addition to this, cabomba has not re-appeared at any site upstream of Lok Landji Billabong since the 2005/06 reporting period.

These trends, both herbicide requirements and apparent exhaustion of viable seed at most sites, support the notion that the program is effectively moving toward ultimate eradication.

Biological monitoring of the effects of herbicide application for the control of cabomba provided no evidence of substantial impairment of the ecological health of treated sites. Indices of macroinvertebrate community health at impacted sites were equivalent to reference conditions in each of four separate assessments.

Water quality findings suggest that the treatment of cabomba has had no discernable impact. Events of low dissolved oxygen appear to be typically associated with changing flow conditions and tidal influences at the monitoring sites and are characteristically short-term. Typically DO levels below 30% saturation can have an impact on fish and other aquatic fauna and these conditions were not observed during the sampling period.

Minimal volumes of herbicide were applied during the monitoring period. This factor coupled with continuous flows maintained by Darwin River Dam and the rapid break down of 2,4-D appear to result in negligible if any impact on the receiving aquatic environment. However it could reasonably be expected that localised short term impacts to water quality are possible within the reach of direct herbicide application.

6. Conclusion

An effective weed eradication program is the result of a number of things including prevention of introduction, community awareness, early detection and action, spread prevention, prevention of seed production, prevention of establishment, the availability of management tools that minimise off-target damage risk, and a targeted research program that supports all aspects of the program as required. As a result of this an integrated weed management program targeting eradication has a number of objectives that must be achieved in order for success to occur.

During the 2008/09 reporting period all objectives of the Northern Territory Cabomba Eradication Program were met, with success being measured through the following observations:

No new infestations in the NT were identified

The delivery of an Education and Awareness Program, while resulting in a number of reports of potential new infestations, again revealed no infestations in the Northern Territory during 2008/09.

The spread of populations of Cabomba into new areas was prevented

Prevention of spread from known sites of infestation was achieved through the continued implementation of quarantine restrictions in the project area and also through immediate active management of all sites where germination was detected.

Re-establishment at existing sites was prevented through management activity

Throughout the 2008/09 reporting period, all recorded infestations were actively managed using 2,4-D-n-butyl ester and diatomaceous earth. This activity resulted in all plants being effectively treated immediately upon detection and the subsequent prevention of any further growth or more importantly, seed production.

Seed production at known infested sites was prevented through the implementation of weekly survey and subsequent treatment

The prevention of any seed production is an absolute priority for this eradication program.

The implementation of weekly survey and control activities prevented any opportunity for seed production and/or subsequent transfer of seed into unaffected areas.

Monitoring programs did not indicate negative off-target environmental or economic impacts as a result of the implementation of the management program

The assessments failed to detect any discernable differences between macroinvertebrate indices of impacted sites and those of spatial and temporal control sites, and concluded that there were no significant impacts on these communities (and thus the ecological health of the Darwin River) following eradication measures for cabomba.

Continued vigilance with respect to monitoring and surveillance remains an essential requirement for long term eradication. The issue of viable seed also remains a challenge in the Northern Territory.

Figure 4: Previously heavily infested site on Darwin River NT (Figure 1 shows this site in November 2004)

7. References

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