Glenbrook Lagoon Cabomba Report 2017

Including Weed Management Plan 2017-2020

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Summary/Introduction

Cabomba caroliniana is a noxious aquatic weed listed as a Weed of National Significance in Australia. Since the early 1990's Cabomba has infested Glenbrook Lagoon in the Blue Mountains and in 2012 was covering close to 100% of the lagoon area. A viable method of controlling Cabomba became available in August 2011 when Shark Aquatic Herbicide (carfentrazone-ethyl 240 g/L) (SHARK) was registered for the control of Cabomba in closed waterbodies in Australia.

In December 2012 SHARK was applied in Glenbrook Lagoon and resulted in complete control of Cabomba across the entire lagoon. Follow-up monitoring including surface visual observations, benthic grabs, underwater video, and diver surveys did not find any evidence of Cabomba regrowth until January 2017.

In January 2017, four years after herbicide treatment, Cabomba was found regrowing in Glenbrook Lagoon in a dispersed patchy pattern and at varying depths (see Figure 3 map). Regrowth ranged from small, dense patches of Cabomba close to the surface to sparse patches or individual plants growing in deep water (between 2 – 4 metres deep). A denser concentration of Cabomba was observed in the vicinity of the North West (NW) corner of the lagoon near the stormwater inlet, most of this material was removed during 2017 hand weeding operations however a few patches remained leading into winter.

A Secondary Cabomba weed control program will be implemented over the next 3 years to continue to control Cabomba in Glenbrook Lagoon into the future. This will constitute a combination of hand weeding by divers in deep areas of the lagoon, and personnel wading shallow edges; together with strategic use of herbicide in areas where Cabomba is visible from the surface and growing in denser patches where hand weeding may become less efficient.

Secondary Cabomba weed control and monitoring requirements will be reviewed and revised on an annual basis and a new three year plan developed in 2020.

Monitoring & Weed Control

Following the application of Shark for the control of Cabomba in Glenbrook Lagoon a 3 year aquatic flora monitoring program was conducted by Australian Museum Consulting. Six post-treatment surveys between December 2012 and February 2015 found that the herbicide treatment significantly reduced the live Cabomba in Glenbrook Lagoon; however, there were impacts to non-target flora, native and non-native. Monitoring results from 2014 and 2015 detected no Cabomba in Glenbrook Lagoon (AMC, 2015). Similarly, a targeted benthic survey by ABCO Commercial Diving in March 2014 did not detect any Cabomba in the Lagoon (ABCO, 2014).

In 2015 and 2016 Cabomba was not detected in Glenbrook Lagoon during visual boat and edge surveys by the Good Bush People in December 2015; during visual, benthic rake and underwater camera surveys in April 2016 by Good Bush and council officers; or during visual edge inspections during multiple macroinvertebrate and water sampling monitoring visits by council officers. Regrowth of another weed species, Mexican Waterlily, was observed during this period.

In January 2017, four years after herbicide treatment, a single Cabomba plant was observed at the boat ramp on the southern edge of Glenbrook Lagoon during routine water sampling activities. This was followed by several visual, benthic rake and camera surveys and subsequent benthic dive surveys and manual weed control throughout the remaining growing season (see Table 1).

Table 1: 2017 Cabomba Monitoring and Weed Control Activities

Date	Monitoring Type	Comments
18 January 2017	Opportunistic Visual, BMCC	Cabomba plant seen at Boat Ramp
23 & 25 January, 15 February 2017	Canoe Surveys: visual, rake, underwater video, BMCC	Cabomba found at locations throughout the Lagoon, See map Figure 1
23 February 2017	Scuba survey, The Bush Doctor	Cabomba found at locations throughout the lagoon, See map Figure 1
13-20 March 2017	Scuba survey and hand weeding, ABCO Commercial Diving	Approx. 1 tonne of Cabomba removed by hand including roots as per Map Figure 1
29 May – 2 June 2017	Scuba survey and hand weeding, ABCO Commercial Diving	Approx. 700 kg of Cabomba removed by hand including roots as per Map Figure 2.

Between March and June 2017 approximately 1.7 tonnes of Cabomba was removed from the lagoon over two 5 day visits by a specialist dive team. Removal was by hand weeding, ensuring the entire plant including crowns and roots were removed. This material was placed in a bunded area on-shore for composting.

Observations during weed removal found the Cabomba plants were generally multi-stemmed with well-developed crowns and large root systems (Figure 1). Plants were found scattered randomly around the lagoon (Figure 3 & 4) at varying depths from 0.2 – 2+ metres. Plants occurred as single plants or in small patches up to approximately 10 m^2. Denser patches mainly occurring near the NW corner of the lagoon, a few of these patches remained leading into winter 2017.

Figure 1: Images of Cabomba growing in Glenbrook Lagoon between January and June 2017

In addition to Cabomba weed control in 2017, control of re-growing weed waterlily was undertaken by council officers using glyphosate 360g/L.

Figure 2: 2017 Mexican Waterlily re-growth and control

Other observations of note during monitoring surveys include the return of native species such as Bladderwort (*Utricularia sp*.), and healthy growth of *Eleocharis sphacelata* rushes that were impacted by the herbicide treatment four years ago.

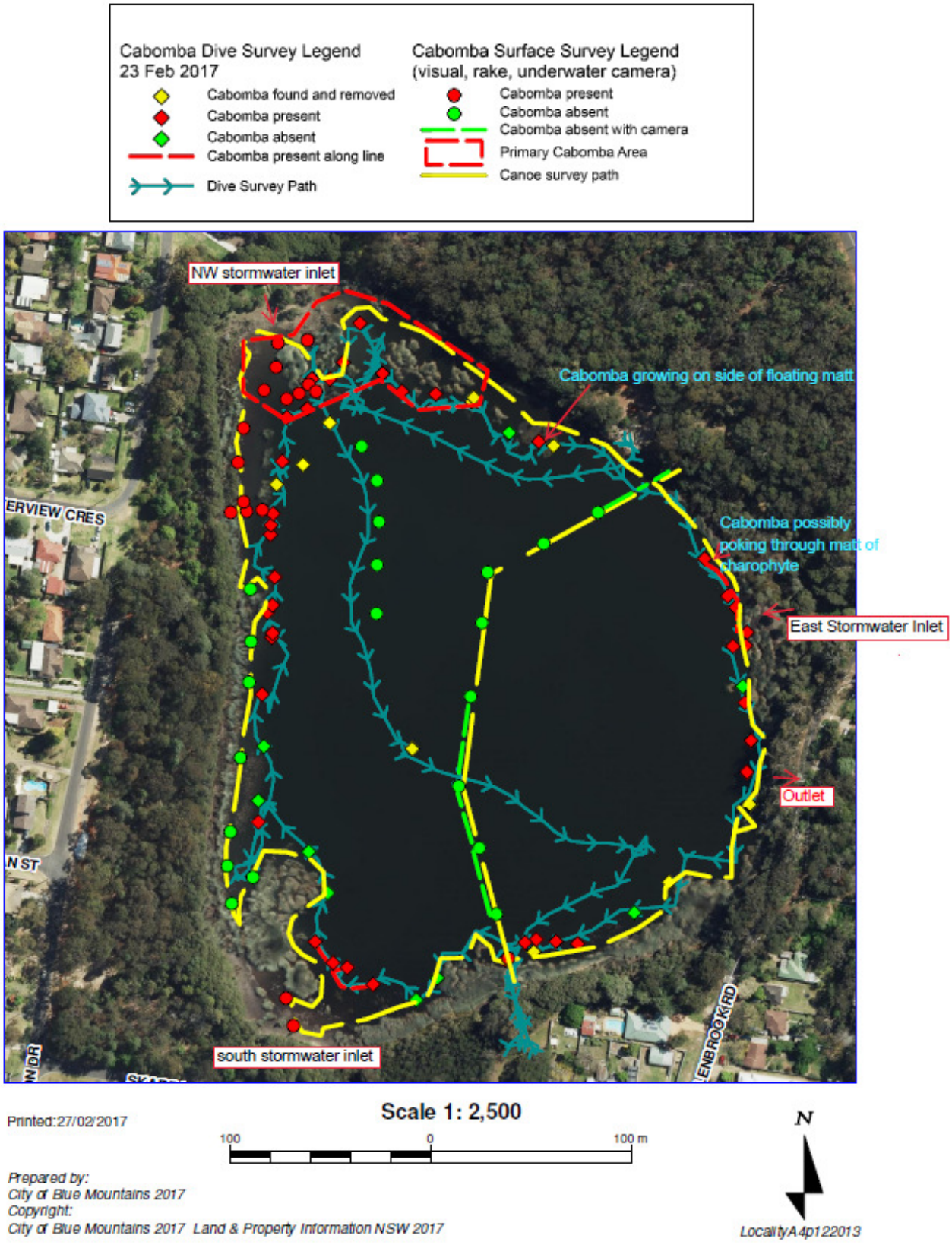

Figure 3: Glenbrook Lagoon Cabomba Weed Survey, February 2017

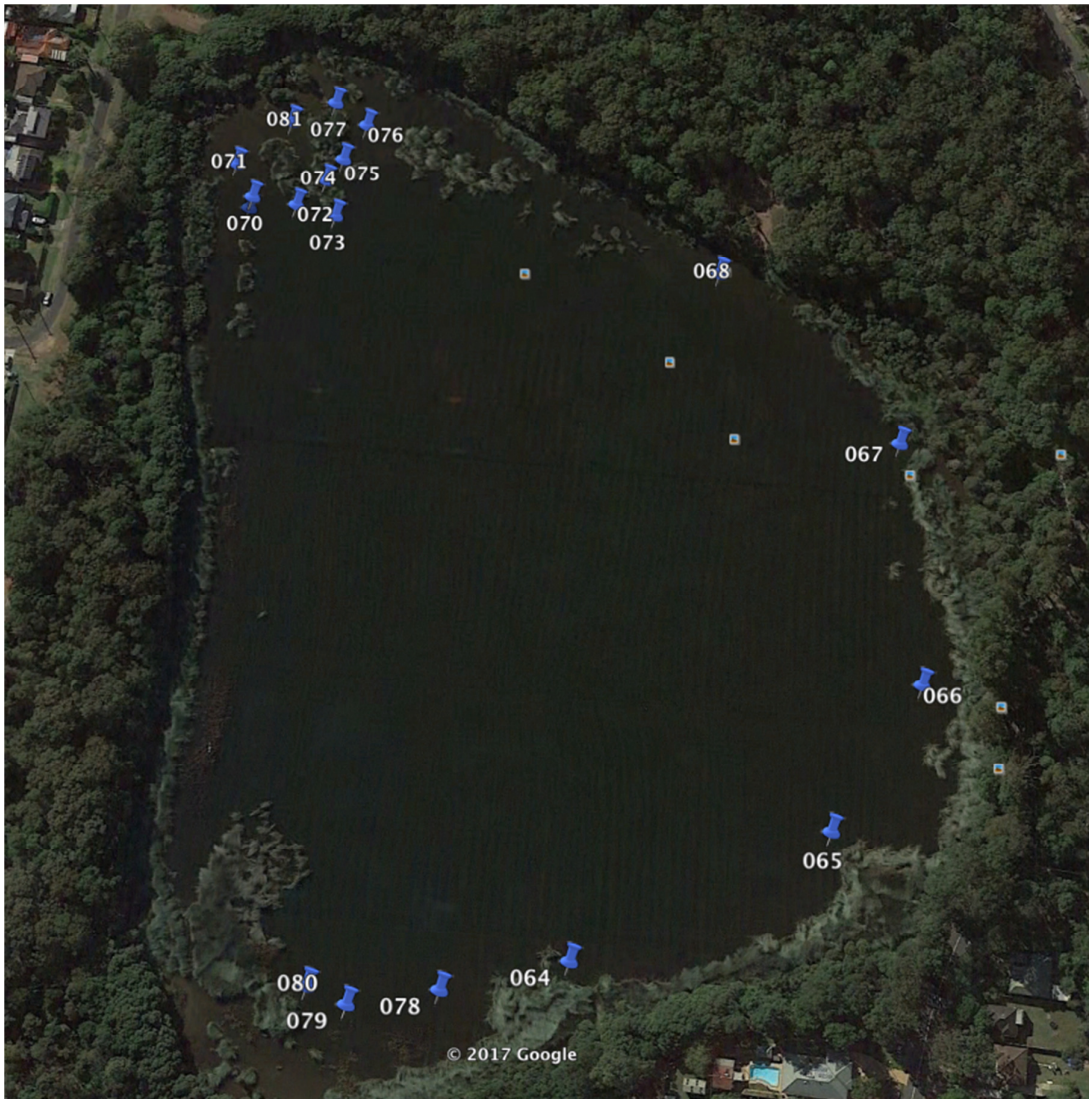

Figure 4: Map of ABCO Dive survey and Weed Removal, June 2017 (weed remaining at 072-076)

Secondary Cabomba Weed Control Plan (2017-2020)

Background

Cabomba caroliniana is a noxious aquatic weed listed as a Weed of National Significance in Australia. Since the early 1990's Cabomba has infested Glenbrook Lagoon in the Blue Mountains and in 2012 was covering close to 100% of the lagoon area. A viable method of controlling Cabomba became available in August 2011 when Shark Aquatic Herbicide (carfentrazone-ethyl 240 g/L) (SHARK) was registered for the control of Cabomba in closed waterbodies in Australia.

In December 2012 SHARK was applied in Glenbrook Lagoon as part of a Primary Cabomba Weed Control Program and resulted in complete control of Cabomba across the entire lagoon. Follow-up monitoring including surface visual observations, benthic grabs, underwater video, and diver surveys did not find any evidence of Cabomba regrowth until January 2017.

Cabomba Regrowth 2017

In January 2017, four years after herbicide treatment, Cabomba was found regrowing in Glenbrook Lagoon in a dispersed patchy pattern and at varying depths (see Figure 3 map). Regrowth ranged from small, dense patches of Cabomba close to the surface to sparse patches or individual plants growing in deep water (between 2 – 4 metres deep). A denser concentration of Cabomba was observed in the vicinity of the North West (NW) corner of the lagoon near the stormwater inlet, most of this material was removed during 2017 hand weeding operations however a few patches remained leading into winter.

Between January and March 2017 Cabomba showed very vigorous growth with patches expanding outward and to the surface very quickly over this optimum growing season. Observations during weed removal found the Cabomba plants were generally multi-stemmed with well-developed crowns and large root systems. It is likely Cabomba has regrown from mature crowns that were not killed during the 2012 herbicide treatment. The crowns will have remained buried in a thick layer of organic sediment on the bottom of the lagoon supressing and preventing crowns from shooting until recently (silt depths in 2014 were 1.5-2+ metres deep).

Later in the season during May-June 2017 weed control operations some young plants were observed with small root systems starting to establish along the shallow edges of the NW corner. This is likely due to fragments from mature plants developing roots from nodes rather than from existing crowns. The fragments may have occurred naturally as part of Cabomba's natural dispersal strategies or could have come from previous hand weeding operations and highlights the importance of taking care when hand weeding to remove all plant material and avoid fragmentation.

Cabomba Detection

Surface visibility for detecting Cabomba in Glenbrook Lagoon is generally limited to between 0.5 to 1 meter deep, making detection of regrowth in deeper areas only practically possible using scuba divers. Underwater cameras and benthic drags (with rake) are of limited use as comprehensive weed location methods. Waiting for plants to reach the surface for detection is possible, however would provide an undesirable opportunity for Cabomba to spread widely. As such, we feel that the use of scuba divers will be an important tool in the ongoing control of Cabomba, both for detection and removal of the weed.

Cabomba Control

In 2012 when Cabomba covered close to 100% of Glenbrook Lagoon, herbicide treatment was a practical and effective way of managing this weed infestation.

In 2017, with a highly dispersed pattern of regrowth and difficulty detecting Cabomba locations from the surface herbicides have become less practical to use. A broad scale application of herbicide across the lagoon to pick up the scattered regrowth would be wasteful and expensive (and against label directions). However, there are still opportunities for using herbicide in the ongoing control of Cabomba, particularly in shallower locations where weeds can be easily seen and treated from the surface, such as the NW corner where denser patches are being found in water depths less than 1 metre.

In water depths greater than 1 metre where regrowth is patchy, hand weeding by scuba divers has been an effective control method. Where cabomba re-growth was denser this method became less efficient with divers becoming bogged down in areas such as the NW corner reducing overall lagoon coverage in the available time and budget.

Ongoing control of Cabomba in Glenbrook Lagoon over the next 3 years will include a combination of herbicide treatments in shallow areas with dense patches growing near the surface; scuba diver hand weeding in deeper water (> 1 m); and wading hand weeding along shallow edges (<0.5 m deep), to continue to work toward complete eradication of Cabomba from Glenbrook Lagoon.

Inspections and weed control will occur at several times across the growing season to respond quickly to new growth and minimise the opportunity for Cabomba to spread widely across the lagoon. The use of divers needs to be balanced against cost and the schedule below has been developed with the aim of providing thorough coverage over the growing season. Results of each dive visit should be reviewed closely and additional dive weeks added if felt necessary to prevent greater expense in the future.

Cabomba Weed Control Schedule 2017/18

Following is a Cabomba weed management schedule for the 2017/18 growing season. This schedule will continue for at least another 2 seasons (2018/19 and 2019/20), with ongoing review and revision as required.

Table 2: Cabomba Weed Control Schedule 2017/18

Time period	Activity	Comments
October 2017	Surface boat and wader survey and spot herbicide application to accessible Cabomba patches (< 1 metre depth)	Subject to growth phase of Cabomba at the time. Weed should be actively growing prior to applying herbicide. Hand weeding around lagoon edges
November/December 2017	Scuba survey and hand weeding	Focusing on areas >1 metre depth. Mark any large patches with buoys for later herbicide treatment.
January 2018, February 2018 & May 2018	Surface boat and wader survey and spot herbicide application to accessible Cabomba patches	Twice during vigorous growth period. Once at end of growing season.
April 2018	Second scuba survey and hand weeding toward end of growing season.	Focusing on areas >1 metre depth. Potentially mark any large patches for herbicide treatment.
April 2018	Evaluate & Review	Review outcomes of surveys and plan for future needs
2017/18	Estimated Budget	2 x dive contractor weeks; 4 days boat/wader survey/ herbicide

References & Recommended Reading

AM Consulting (2015). *Glenbrook Lagoon Cabomba Weed Control Monitoring Program – 2015.* Report prepared for Blue Mountains City Council by Australian Museum Consulting.

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