TYPHA ORIENTALIS HERBICIDE EXPERIMENT

proposal for consulting services

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

Prepared by:

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1.0 Introduction

Typha Orientalis Herbicide Experiment

The Department of Conservation and Land Management require Ecoscape to design and implement an experiment to control *Typha orientalis* infestation at Forrestdale Lake. *T. orientalis* is an aggressive coloniser of wetland areas and has been present at Forrestdale Lake since the 1960's. Aerial photography shows a rapid increase in area infested, particularly in recent years. This is possibly due to reduction in water levels caused by prolonged drought and increased levels of groundwater abstraction.

The following represents Ecoscape's methods, timing and costs associated with conducting the experiment. There are two phases to the proposed experiment: The first phase will determine the most effective herbicide treatment for controlling *Typha* while the second phase will determine the most effective timing for herbicide application.

The Department may choose to proceed with the first stage only, or both stages depending on its requirements.

2.0 Key Issues

***Typha Orientalis* Herbicide Experiment**

2.1 Site specific issues

The control of *T. orientalis* at Forrestdale Lake presents some advantages and some constraints.

Constraints are:

1. The Lake forms the major part of Forrestdale Lake Nature Reserve, an A Class Reserve and RAMSAR wetland protected under the *Environmental Protection and Biodiversity Conservation Act, 1999.* Damage to native fauna and flora as a result of *Typha* control must therefore be minimised.

2. While *Typha* is the dominant species fringing the wetland, in most places it has not formed a monoculture and is interspersed with other plants, predominantly *Bolboschoenus caldwellii.* While this plant is an aggressive coloniser, most control methods will also kill this species.

There are also some aspects of the site that may facilitate appropriate control of *Typha.* These include:

1. Access. Forrestdale Lake has a dry substrate for much of the year, particularly as precipitation and groundwater levels have decreased. This may facilitate access and the methods used for control. For example in many areas four-wheel drive vehicles and quad-bikes may be used for application of herbicides. Tractor-mounted slashers may also be used.

2. Even mature stands of *Typha* at Forrestdale Lake have a relatively low height and density, possibly as a result of previous control attempts. This makes application of herbicides easier and will preclude the need for slashing prior to spraying to facilitate access.

2.2 Herbicides

2.2.1 Herbicide Types

Herbicides may be the cheapest and most effective form of control of *Typha* at Forrestdale Lake. Repeated slashing and other mechanical methods have thus far failed to eradicate *Typha* from Forrestdale Lake. This is likely to be because of the high potential for vegetative reproduction of the rhizome. Any parts of the rhizome left in the soil have the potential to resprout. For effective, long-term control the rhizome must either be removed completely or killed. The former is likely to be very time consuming, expensive and may potentially damage the Lake bed.

Due to the constraint 1 above, only herbicides registered for use in aquatic areas are likely to be accepted as a method to control *Typha*. Herbicides registered for use in wetland areas in Western Australia are (Water and Rivers Commission, 2001):

- Glyphosate (Roundup Biactive, Roundup, Rodeo, Davison Glyphosate 450)
- Flauzifop-p-butyl (Fusilade)
- Metasulfuron-methyl (Brushoff, Ally, Groper and Escort)
- Chlorsulfuron (Glean, Siege, Tackle)
- Diquat (Aquacide / Reglone)

Of these, only glyphosate appears to have been used with any success to control *Typha*. 2,2-DPA has also shown to produce good results however this has not been approved for use by the Department of Environment.

2.2.2 Penetrants

The use of a penetrant such as Pulse will enhance the uptake of the herbicide. This is important as *Typha* has a waxy cuticle on its leaves which greatly inhibits its ability to absorb herbicides, particularly Roundup Biactive, which tends to form droplets on the leaves which run off and are not absorbed. The addition of a penetrant should reduce the amount of herbicide necessary to kill the plant.

2.3 Spray Rates / concentration

Concentration of herbicides is an important variable to be tested. It is important to determine the amount of herbicide necessary to obtain an effective kill without exposing the wetland to excessive chemicals. The proposed concentrations to be tested are:

1. No Spray (control)
2. 3% concentration Roundup Biactive
3. 5% concentration Roundup Biactive
4. 1% concentration Roundup Biactive plus Pulse
5. 3% concentration Roundup Biactive plus Pulse
6. 5% concentration Roundup Biactive plus pulse

2.4 Timing

Of the variables associated with *Typha* control, timing is likely to be the most critical and has not been adequately tested in WA. Most authorities recommend spraying *Typha* from late December to late February however this is based on recommendations from other states, such as Tasmania. This timing is after both the male and female flowers have opened but before the plant has begun to senesce. The rationale behind this is that carbohydrate levels in the rhizome are at their lowest while the plant is still actively growing thereby increasing the effectiveness of the herbicide.

While this may be true, it is essential to trial herbicide application at different times as:

1. WA has a unique climate and Typha may not respond in the same way at this time of the year.

2. Hormonal changes during flowering may inhibit effectiveness of the herbicide
3. Plant metabolism is beginning to slow down at this time, which may reduce growth and the plants' ability to absorb the herbicide.

Spraying should be trialled at the following times:
Late October / Early November – At this time warmer weather coupled with adequate moisture should result in fast growth, numerous shoots and seedlings and subsequent increase in the uptake potential. A second treatment in *Late December / Early January* may then act to 'mop up' any survivors while carbohydrates in the rhizomes are at a low level (see Section 5.0, Draft Study Timetable).

Proposed Timing for treatments are:

1. Early February, 2004
2. Late October / Early November, 2004
3. Early January, 2005

2.5 Mechanical Control

Various forms of mechanical control have been tried at Forrestdale Lake. Slashing has been used repeatedly in an attempt to control weeds and maintain fire access tracks.

While slashing removes the aboveground biomass, it does not kill the rhizomes and so is unlikely to be effective on its own. Mechanical control can be used in conjunction with spraying in the following ways:

1. Slashing to reduce biomass and then spraying once new seedlings have emerged (it is not appropriate to spray shortly after following slashing as glyphosate relies on the plant's ability to take up the herbicide which would be significantly reduced.
2. Mowing with a weed wiper. Mowing (to achieve a clean cut) with a wiper attached to the back of the implement may act to allow intake of the herbicide into the phloem before cohesion is lost.

Slashing may also be undertaken to facilitate access to the plants so that adequate herbicide coverage is obtained. This is not necessary at Forrestdale Lake as the height and density of Typha is sufficiently low as to maintain access in many areas.

Mechanical control has not been included in the experiment; however the inclusion of mechanical control treatments in the second phase of the experiment is an option.

3.0 Method

Typha Orientalis Herbicide Experiment

3.1 General Approach

A two-phase approach is recommended. The first phase is to determine the most appropriate herbicide type and concentration to use, while the second phase will determine the most appropriate timing of herbicide application.

3.1.1 Phase 1

This Stage will compare the effectiveness of the following treatments:

1. No Spray (control)
2. 3% concentration Roundup Biactive
3. 5% concentration Roundup Biactive
4. 1% concentration Roundup Biactive plus Pulse
5. 3% concentration Roundup Biactive plus Pulse
6. 5% concentration Roundup Biactive plus Pulse

5 replications of each treatment will be undertaken

3.1.2 Phase 2

This phase will determine the most effective timing for herbicide application using the most effective spray rate from Stage 1. The treatments are outlined below.

Late Oct – Early Nov	Late Dec – Early Jan
Spray	Spray
Spray	No Spray
No Spray	Spray
No Spray	No Spray

The following task list will outline the methods and give costs for both phases. Commencement of Phase 2 will be at the discretion of the Department of Conservation and Land Management and may be undertaken as a separate contract[1].

[1] Please note that this proposal is good for a period of 90 days. Costs outlined cannot be guaranteed for engagement after this time.

3.2 Detailed Task List – Phase 1

Stage A Field Work

Task 1 Plot establishment

A total of 30, 1x10 m plots will be established at Forrestdale Lake (6 treatments, 5 replicates). The quadrats will be positioned so that they have a similar density, distribution and alignment, and will be situated near the inner margin of the infestation.

Plots will be established at least 10 metres apart to minimise spray-drift.

Task 2 Initial Counts

Initial counts will be made of the number and size class of *Typha* stems in the plots.

Task 2 Spray treatments

Plots will be sprayed according to the following treatments:

1. No Spray (control)
2. 3% concentration Roundup Biactive
3. 5% concentration Roundup Biactive
4. 1% concentration Roundup Biactive plus Pulse
5. 3% concentration Roundup Biactive plus Pulse
6. 5% concentration Roundup Biactive plus Pulse

A one metre buffer will be sprayed from the plot boundaries to ensure even coverage. Spraying will be undertaken on a still day to minimise spray-drift.

Task 3 Final Counts

Final counts will be made of the number and size class of *Typha* stems in each plot four weeks after the spray treatments have been applied. Mortality of stems will be assessed and scored.

Task 4 Rhizome assessment

Ten stems from each plot identified as 'dead' during the previous task will be removed and dissected to determine the rhizome mortality for each treatment.

Stage B Analysis

Analysis of Variance (ANOVA) of mortality will be used to test the following hypotheses:

- $H_0$1 There is no significant difference in mortality of Typha with no treatment (control)
- $H_0$2 There is no significant difference in stem mortality of Typha after application of 3% concentration Roundup Biactive
- $H_0$3 There is no significant difference in stem mortality of Typha after application of 5% concentration Roundup Biactive
- $H_0$4 There is no significant difference in mortality of Typha after application of 1% concentration Roundup Biactive plus Pulse
- $H_0$4 There is no significant difference in mortality of Typha after application of 3% concentration Roundup Biactive plus Pulse

- $H_0 4$ There is no significant difference in mortality of Typha after application of 5% concentration Roundup Biactive plus Pulse

Mortality of stems and rhizomes for each treatment will also be compared using analysis of variance.

Stage C Report

A report will be prepared discussing the major results and recommendations for Typha control and management. Recommendations will also be made for future phases of the project.

3.3 Detailed Task List – Phase 2

Stage A Field Work

Task 1 Plot establishment

A total of 20, 1x10 m plots will be established at Forrestdale Lake (6 treatments, 5 replicates). The quadrats will be positioned so that they have a similar density, distribution and alignment, and will be situated near the inner margin of the infestation.

Plots will be established at least 10 metres apart to minimise spray-drift.

Plot locations will be marked using a handheld GPS to locate a permanent stake in the north-east corner.

Task 2 Initial Counts

Initial counts will be made of the number and size class of *Typha* stems in the plots.

Task 3 Spray treatments

Plots will be sprayed according to the following treatments using the most successful treatment from Phase 1:

Late Oct – Early Nov	Late Dec – Early Jan
Spray	Spray
Spray	No Spray
No Spray	Spray
No Spray	No Spray

Task 4 Final Counts

Final counts will be made of the number and size class of *Typha* stems in each plot four weeks after the spray event. Mortality of stems will be assessed and scored.

Task 5 Rhizome assessment

Ten stems from each plot identified as 'dead' during the previous task will be removed and dissected to determine the rhizome mortality for each treatment.

Stage B Analysis

Task 1 Data Entry

This task allows time to enter the data into an excel spreadsheet

Task 2 Analysis

Analysis of Variance (ANOVA) of mortality will be used to test the following hypotheses:

- $H_0$1 There is no significant difference in mortality of Typha with no treatments (control)
- $H_0$2 There is no significant difference in stem mortality of Typha after a single treatment in Late October / early November
- $H_0$3 There is no significant difference in stem mortality of Typha after a single treatment in Late December / early January
- $H_0$4 There is no significant difference in stem mortality of Typha after treatment in Late October / early November and a subsequent treatment in Late December / early January

Mortality of stems and rhizomes for each treatment will also be compared using analysis of variance and significance tested using t tests.

Stage C Report

A report will be prepared discussing the major results from both phases and will include recommendations for Typha control and management.

4.0 Study Cost Estimates

***Typha Orientalis* Herbicide Experiment**

The costs of the study have been estimated in accordance with the tasks listed in the previous section.

4.1 Cost Estimate – Phase 1

Stage A Field Work	
Task 1 Plot establishment	$770.00
Task 2 Initial Counts	$385.00
Task 3 Spray treatments	$1,000.00
Task 4 Final Counts	$385.00
Task 5 Rhizome assessment	$275.00
Stage B Analysis	
Task 1 Data Entry	$280.00
Task 2 Analysis	$490.00
Stage C Report	$1,120.00
Project Management	$560.00
Travel	$330.00
Total	$5,595.00
Total plus GST	$6,154.50

4.2 Cost Estimate – Phase 2

Stage A Field Work	
Task 1 Plot establishment	$550.00
Task 2 Initial Counts	$275.00
Task 3 Spray treatments	$1,000.00
Task 4 Final Counts	$275.00
Task 5 Rhizome assessment	$165.00
Stage B Analysis	
Task 1 Data Entry	$200.00
Task 2 Analysis	$490.00
Stage C Report	$1,120.00
Project Management	$560.00
Travel	$330.00
Total	$4,965.00
Total plus GST	$5,461.50

4.3 Hourly Chargeout Rates

The costs of the study are based on the following hourly chargeout rates:

Abe Francis, Environmental Scientist	$ 70.00
Tom Ralph, Field Assistant	$ 40.00
Administration	$ 35.00

4.4 Proposed Payment Schedule

Payment to be made upon completion Phase 1.

5.0 Draft Study Timetable

***Typha Orientalis* Herbicide Experiment**

5.1 Phase 1

STAGE	FEBRUARY				MARCH				APRIL			
Stage A												
Stage B												
Stage C												

5.2 Phase 2

STAGE	NOVEMBER				DECEMBER				JANUARY				FEBRUARY			
Stage A																
Stage B																
Stage C																

6.0 Project Team

Typha Orientalis Herbicide Experiment

Abe Francis, Environmental Scientist BSc (Hons)

Abe is an environmental scientist with a background in botany and zoology with honours in ecology. He is currently studying towards a Master of Science in Natural Resource Management. His interests are primarily in the areas of land rehabilitation and natural resource management. His areas of expertise include Environmental Impact Assessment, Management Plans, Environmental Risk Assessment, experimental design and GIS-based multi-criteria analysis. He has also undertaken flora and biological surveys at numerous locations including the Darling Ranges, the Swan Coastal Plain, Margaret River the Gascoyne and the Pilbara. Abe is highly experienced in project management and field techniques as well as data analysis, flora identification and report writing.

7.0 Capability

***Typha Orientalis* Herbicide Experiment**

7.1 Relevant Experience

Arum Lily Herbicide Experiment - Year 4

Client: Department of Defence

This experiment was the culmination of four years of herbicide treatments on Arum Lily quadrats on Garden Island. Nine treatments were applied involving spraying Glean alone or mixed with 2,4-D Amine, in consecutive years or in alternate years. Final year analysis involved assessing aboveground numbers to compare with previous years' assessments. Excavation of arum lilies to determine below ground numbers total biomass was also carried out with comparisons made between different treatments and size classes. The results conclusively showed that a combination of 2,4-D amine and Glean applied over alternate years produced the most cost-effective results. The report was also published as part of a series of working papers on Arum Lily Control on Garden Island.

Assessment of the Environmental Impact of Runnelling in the Peel Inlet and Harvey Estuary: Phase One, 2002

Client: Health Department of Western Australia

As part of an on-going mosquito control programme, the Western Australian Department of Health proposed installing runnels in saltmarsh breeding areas in the Peel Inlet and Harvey Estuary, Western Australia. Runnels lessen the need for high-intensity chemical control programmes, and decrease related adverse ecological impacts. Following an environmental assessment of the proposed runnelling sites by Ecoscape, we developed and undertook a monitoring programme to assess the impacts of runnelling in Phase One sites. Physical (surface and ground water table height, pan area, distribution and height), chemical (surface and ground water conductivity and pH) and ecological (vegetation composition and abundance, tree stress, invertebrates, fish and water birds) factors were included in the programme. Due to the highly dynamic nature of saltmarsh ecosystems, sites were monitored seasonally and comparisons were made between treatment (runnel) and non-treatment (reference) sites. No significant differences between the runnel and reference sites were observed.

Preparation of an Environmental Weed Strategy for Western Australia

Client: Department of Conservation and Land Management

Ecoscape, as lead consultant in a consortium of specialists, prepared the Environmental Weed Strategy for Western Australia which determined the list of 1350 environmental weeds and developed a criteria which rated these weeds according to their impacts on biodiversity. The report also examined management strategies, control methods and the involvement of government, private and community groups in weed management. A relational database using Access 97 was prepared as part of the strategy - known as 'weedBase'. A major component of the project was the

establishment of an interactive weeds database website. The website provides a resource for identification of weed species, an accurate picture of their distribution, information on spread, environmental impacts and appropriate control methods.

State Weed Plan and Weed Action Plan

Client: Department of Agriculture

A State Weed Plan Steering Committee, comprised of government agencies, industry and community group representatives, was established to oversee the preparation of a State Weed Plan and Weed Action Plan. Ecoscape worked in conjunction with Farm Information Services to prepare the Weed Plan and Action Plan which will ensure a coordinated approach to the management of weeds occurring throughout Western Australia.

7.2 Insurance

Workers Compensation

Insurer: Zurich Australia Insurance Ltd
Policy No: 542769787GWC
Cover: $50 000 000
Renewal Date: 30th April 2004

Motor Vehicle

Insurer: Lumley General Insurance Ltd
Renewal Date: 30th April 2004
Legal Liability Cover: $20 000 000

Public Liability

Insurer: Zurich Australia Insurance Ltd
Policy No: 54B100286GLG
Cover: $10 000 000 - any one occurrence
Renewal Date: 31st January 2004

Professional Indemnity

Insurer: Royal and Sun Alliance
Policy No: F101032
Cover: $2 000 000 – any one claim and $2 000 000 in the aggregate any one policy period
Renewal Date: 31st October 2004