Rice grass in the Derwent estuary

Update after 23 years of surveying & control works, recommendations

I. Visby, October 2017

Derwent Estuary Program

The Derwent Estuary Program Ltd. (DEP) is a regional partnership between local governments, the Tasmanian State Government, businesses, scientists, and community-based groups to restore and promote our estuary. The DEP was established in 1999 and has been nationally recognised for excellence in coordinating initiatives to reduce water pollution, conserve habitats and species, monitor river health and promote greater use and enjoyment of the foreshore. Our major sponsors include: Brighton, Clarence, Derwent Valley, Glenorchy, Hobart and Kingborough councils, the Tasmanian State Government, TasWater, Tasmanian Ports Corporation, Norske Skog Boyer, Nyrstar Hobart Smelter and Hydro Tasmania.

1 Introduction

Rice grass, (*Spartina anglica*) is a northern hemisphere intertidal saltmarsh plant that has become naturalised in Australia, and which has the potential to cause serious ecological impacts. Infestations dramatically alter the ecological and natural heritage of an estuary by impacting the distribution and habitats of native flora and fauna, including shore birds, fish, invertebrates, seagrasses and saltmarsh plants. It progressively invades the immediate and surrounding area of intertidal zones and alters sediment dynamics (DPIPWE, 2002; Strong and Ayres, 2005).

After numerous failed attempts to naturalise rice grass in Tasmania (between 1928 and 1930), it was successfully introduced across the state between the 1930s and the 1970s for its perceived benefits to coastal engineering and agriculture, as well as merely an interest as to whether this plant would grow in Australia (Boston, 1981; DPIPWE, 2002). The earliest known populations in the Derwent estuary were at Austins Ferry in 1930 (did not survive) and at Bridgewater in 1974-7 (eradicated) (Boston, 1981).

It is unclear where the current rice grass in the Derwent estuary originated from, but by the 1990s it had spread to cover approximately 1 ha (DPIPWE, 2002). The Rice Grass Advisory Group (RGAG) was formed in 1995 to provide advice and direction on the management of all rice grass-infested regions in Tasmania, and a management strategy was subsequently implemented (DPIPWE, 2002). Under the management of Parks and Wildlife Services' Derwent District Ranger John Megalos and his team, mapping and control work in the Derwent started in earnest in 1995 (Megalos, 1995). Substantial success was achieved over the following years, and by 2002 eradication became a realistic management objective (DPIPWE, 2003).

It is uncertain how much survey work took place between the years 2003-05. However, about 2006 it became clear that rice grass in the Derwent was not eradicated, and DPIPWE conducted surveys in 2007 and possibly in 2008. The Derwent Estuary Program (DEP) then took over the responsibility for planning, monitoring and implementing control works in the Derwent estuary, with the State Government providing advice and authorising the use of herbicides. The DEP has since continued annual surveying and control works, assisted by volunteers from various government agencies, local councils, NRM South, and community groups.

Despite 23 years of continued surveying and control works, rice grass persists in the Derwent estuary, though thankfully only in very low volumes. A review of the literature on the reproductive biology of rice grass (section 3) and its distribution in the Derwent estuary over the last two decades (section 2 and Appendix 10.1) has led to a change in DEP survey methodology. The new methodology involves surveying on an annual basis in areas where rice grass has been found previously, and covering the entire search region in sections on a four yearly rotational basis (Section 4).

1.1 Funding and management plans

Financial support for rice grass surveying and control works in the Derwent estuary is provided by a variety of sources. This has been in addition to extensive in-kind support from Department of Primary Industry, Water and Environment (DPIPWE); Glenorchy, Clarence and Brighton councils; DEP and the wider community (see list in Section 5). Summary of Australian Government funding:

- 1996: Coastcare Australia

- 1998: National Heritage Trust, Fisheries Action Program
- 2006: Natural Heritage Trust
- 2008: Coastcare Australia

Past rice grass management plans, reviews:

- 1998: Strategy for the Management of Rice Grass (*Spartina anglica*) in Tasmania, Australia, (RGAG).
- 2002: Strategy for the Management of Rice Grass (*Spartina anglica*) in Tasmania, Australia (DPIPWE, 2002).
- 2003-06: (Draft) Rice Grass Area-Based Management Plan, Derwent River Region (Coughanowr and Shepherd, 2003).
- 2006-08: Rice Grass Area-Based Management Plan, Derwent Estuary (Whitehead and Morton, 2006).
- 2009: Derwent Estuary Rice Grass Eradication Program, Review of distribution, survey areas, recent actions & recommendations (Whitehead, 2009).

2 Location of rice grass since 1995

Detailed information about rice grass surveying and control works in the Derwent estuary since 1995 is highly varied and is at times sparse and contradictive.

Table 1 lists the documented surveys and control since 1995 and includes information regarding the location and size of the infestations and other information about the surveys where known. See Appendix 10.1 for a map of all historical locations of rice grass in the Derwent. When comparing all the locations where rice grass has been located throughout the years, it becomes apparent that only very few new locations have appeared since the 1996 and 1997 surveys. These are:

- In 2006 and 2008, on the north-west side of Bilton Bay and at Dragon Point. These patches were close to the area in Bilton Bay, which in 1997 was described as “swards/meadows” of rice grass (DPIPWE, 2002).
- In summer 2008-09, at McCarthys Point, which is close to where multiple patches were previously found on the northern side of Lowestoft Bay.
- In 2013, at Old Beach (south of Duval Drive), which is a large area (~ 1 km long x 100 m wide) of thick rushes.

Rice grass has never been located north of Clarries Creek (north of Old Beach) or south of Cleburne Point (by Bowen Bridge). Since surveying began, the foreshore between Bowen Bridge and Bridgewater Bridge has been surveyed numerous times, and though rice grass can be confused with *Phragmites australis,* and can hide amongst rushes, it is unlikely that any large populations have been missed.

The wetlands above the Bridgewater Bridge are of significant conservation value, and thankfully, they still appear free of any rice grass, since the brief Bridgewater infestation in the 1970s. It is of high priority to ensure rice grass is kept out of these wetlands. Boat surveys have been conducted.

In summary, when reviewing rice grass locations in the Derwent estuary over the years, there is a clear pattern of the species almost exclusively found where they have been identified previously, or in locations close to known populations.

Table 1. Rice grass surveys and control works between 1995 and 2016.

Year	Locations with rice grass	Area treated	Survey info
1995	**Western shore**: from just north of Austin's Bay to Dowsing Point. **Eastern shore**: from Ferry Point to Woodville Bay.	"vary from individual plants to swards of over 100 m^2" (Megalos, 1995).	
1996	**Western Shore:** Austins Ferry (15 m^2), Bilton Bay (465 m^2), west of Cadbury slipway (400 m^2), east of Cadbury slipway (50 m^2), south of Claremont golf course (1 m^2), Lowestoft Bay (20 m^2), Cameron Bay (70 m^2), Rosetta High School (4 m^2), slipway at Humphrey Rivulet (2 m^2), Humphrey Rivulet (25 m^2), DEC (25 m^2), Dowsing Point (6 m^2). **Eastern shore**: Jetty Rd (1 m^2), Cassidys Bay (4 m^2), Woodville Bay (20 m^2).	1108 m^2 (Megalos, 1996)	
Feb 1997	**Western shore**: from Austins Ferry to Dowsing Point, as per previous year. **Eastern shore:** most northern infestation is known at Clarries Creek and the southern most infestation known is in the shadows of the Bowen Bridge.	313 m^2 (Megalos, 1997)	
1997	Cleburne Point, around Dowsing Point and DEC, Montrose Bay High School, Cameron Bay, Lowestoft Bay/McCarthy Point, Dogshear Point, Bilton Bay, Austins Ferry jetty , Cassidy Bay, Woodville Bay	~ 0.8 - 1 ha.	**Mapping survey only** (DPIPWE, 2002)
1998	**Western shore:** from Bilton Bay to Dowsing Point. **Eastern shore**: From Clarries Creek to just below Bowen Bridge.	39.2 m^2 (Megalos, 1998)	
1998-2001		2000: ~ 1 ha. 2001: ~ 40 m^2	Annual treatment and monitoring(DPIPWE, 2002)
2002	Bilton Bay	< 1 m^2	
2003-2005			Bi-annual surveys were planned, but unsure if occurred
Mar 2006	DEC, Cameron Bay, Lowestoft Bay, Dogshear Point, Bilton Bay	~ 8 m^2	Bi-annual surveys (Mar + Dec)
2007			Surveys were conducted
2008	Rosetta High, Dogshear Point, Bilton Bay, Old Beach jetty	~ 4 m^2	Surveys were conducted
Apr, Jun 2008	None found		Kayak survey above Bridgewater Bridge + on foot survey above and below BB.
Summer 2008/09	McCarthy Point/Lowestoft Bay, Rosetta High, Dogshear Point, Old Beach jetty	~ 2 m^2	Extended survey – between Bridgewater and Tasman bridges + treatment.
Apr/May 2009	None found		Boat and foot survey above Bridgewater Bridge
Dec 2009	None found		Surveyed between Bridgewater and Bowen bridges + additional eastern shore section towards Tasman Bridge
2010	None found		A half day search of hotspots, four days of walking + a fifth boat day between Bowen and Bridgewater bridges.
Nov 2011	Bilton Bay, Dragon Point, Woodville Bay	~ 1 m^2	A half day search of hotspots, four days of walking + a fifth boat day between Bowen and Bridgewater bridges + treatment.
Nov 2012	Woodville Bay, McCarthy Point	< 1 m^2	A half day search of hotspots, four days of walking + a fifth boat day between Bowen and Bridgewater bridges + treatment.
Oct 2013	Woodville Bay, Old Beach (mid)	?	A half day search of hotspots, four days of walking + a fifth boat day between Bowen and Bridgewater bridges + treatment.
Oct 2014	None found		A half day search of hotspots, four days of walking between Bowen and Bridgewater bridges.
Dec 2015	McCarthy Point	< 1 m^2	Hot spot survey + treatment.
Spring 2016	Montrose Bay High School, Dogshear Point	< 2 m^2	Hot spot survey of known locations since 2002 + treatment.

3 Species information

In this section rice grass is referred to as *Spartina anglica* to differentiate it from related species.

3.1 Origin

Spartina anglica can be traced back to late 1800s in southern England, when the native European *S. maritima* and the introduced North American *S. alterniflora* produced a sterile hybrid *S.* x *townsendii.* A natural doubling of the chromosome complement in this sterile hybrid created a fertile, amphidiploid plant (with the genetic complements of both parent species), *S. anglica,* with the potential for increased vigour (Gray *et al.*, 1990; Thompson, 1991; Strong and Ayres, 2013), see Figure 1.

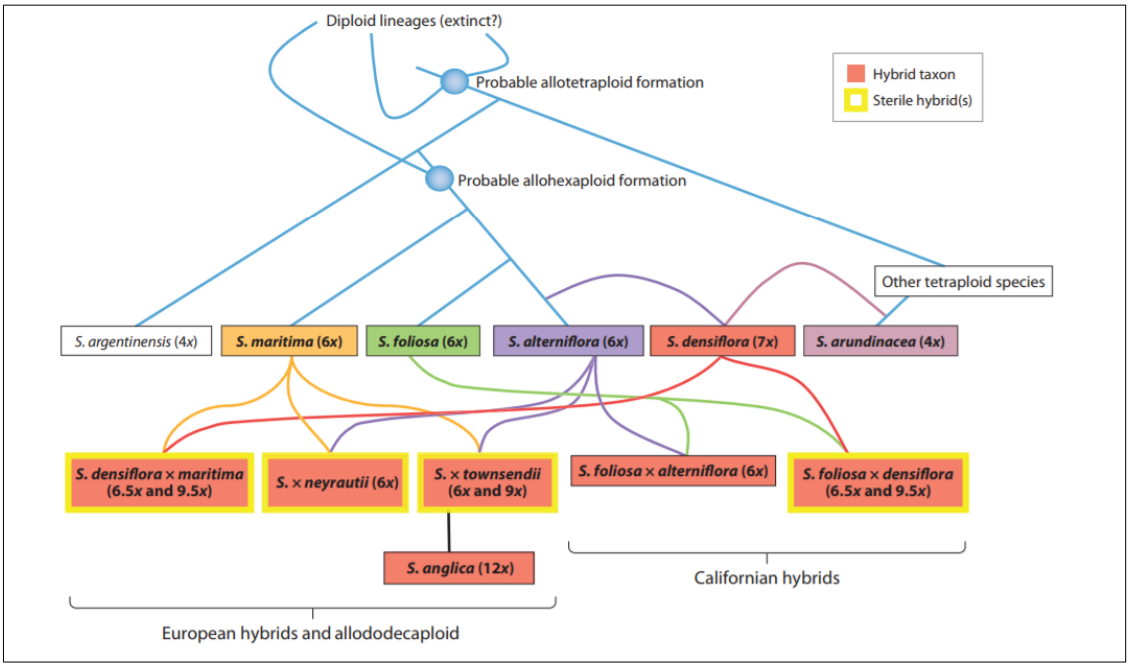


Figure 1. Genetic linage of *Spartina anglica*; taxa in bold are hybridising or hybrid taxa. Each species has color-coded lines leading to its hybrid taxa. Redrawn from Ainouche et al. (2009). (Strong and Ayres, 2013).

3.2 Pollination

Spartina anglica is wind-pollinated, and the flowers are protogynous (Thompson *et al.*, 1991; Li *et al.*, 2008); i.e. the female flower parts mature *before* the male parts. This means that in order to set viable seed, each plant mostly requires pollen to be carried on the wind from a different, earlier-flowering plant that has progressed to the later stage of having male, pollen-bearing flowers (Strong, 2002). Due to this, self-crossing is uncommon (Gray *et al.*, 1990; Li *et al.*, 2008).

In the Derwent estuary, with only very little rice grass left, these characteristics mean that there is low likelihood of successful pollination occurring.

3.3 Seeds and seed banks

Spartina anglica is known for the unpredictable, and often low, production, viability and germination of its seeds, with seed production variable both temporally and spatially, but when successful it has

the potential to set high seed numbers (Hubbard, 1970; Mullins and Marks, 1987; Marks and Mullins, 1990; Thompson, 1990; Gray *et al.*, 1991).

Multiple researchers have studied seed banks in saltmarsh pioneer species like *Spartina* spp. Zhu *et al.* (2014) suggests that seedling recruitment relies mainly on the arrival of fresh seeds, and the soil seed bank had a short-term persistence. Wolters and Bakker (2002) indicate that the majority of saltmarsh species they studied have a transient or short-term persistent seed bank, and labelled *S. anglica* as possessing "strictly transient" seedbank characteristics. Another study on seed moisture content and intolerance to drying results suggested that *S. anglica* seeds are "truly recalcitrant" (Probert and Longley, 1989), meaning sensitive to drying, and for recalcitrant seeds rapid germination is more or less obligatory (Thompson, 2000).

According to Groenendijk (1986), *S. anglica* seed viability is affected by the buried depth of the seed, with both deep and superficial positions inhibiting the seed's survival and development. Groenendijk also pointed out that seeds that do not germinate within three to six months deteriorate, and that seed growth decreases at lower levels of the marsh.

Regarding *S. anglica's* genetic 'ancestors', *S. maritima* show no evidence of a seed bank with all recruitment coming from seeds less than a year old (Strong and Ayres, 2005), and for *S. alterniflora* it is considered to be less than nine months, which is in agreement with that of the transient seed bank (Xiao *et al.*, 2009). Strong (2002) suggests there is no evidence that indicates a seed bank more than one year old for estuarine *Spartina* spp.

Other references that include information on the lack of a persistent seed bank in *S. anglica* include:
- IUCN's Global Invasive Species Database (2016)
- European Network on Invasive Alien Species (NOBANIS) (Nehring and Andersen, 2006)

3.4 Dispersal

Spartina spp. are powerful ecological engineers that can transform open intertidal mud to tall, dense vegetation (Strong and Ayres, 2013). *Spartina anglica* spread occurs in phases. There is an initial invasion and establishment of seedlings or vegetation fragments to produce a pioneer population of tussocks. Secondly, there is a highly aggressive asexual vegetative expansion of tussocks by radial clonal growth through ramets (an individual plant that are part of a group of plants all grown vegetatively from a single ancestor) and rhizomes, which grow in winter and put out massive shoot production when temperatures rise in spring. Spreading tussocks then fuse to form clumps that can expand into extensive meadows within a few years (Gray *et al.*, 1991; Thompson, 1991).

4 Future survey recommendations

Most years, for at least a decade, have seen yearly exhaustive 4-5 day foreshore surveys between the Bowen and Bridgewater bridges, as well as hotspot checks (inspecting sites where rice grass has intermittently been recorded in recent years) and the occasional boat survey. Given what we have learnt about rice grass pollination, seed bank characteristics and dispersal mechanisms, which matches well with the pattern of where rice grass has been appearing and re-appearing over the years in the Derwent estuary, an adjustment to survey methodology is recommended.

From spring 2017, one-day hotspot surveys will be conducted annually in all areas where rice grass has intermittently been found since 2006. Locations where rice grass has not been found *since* 2006 will be excluded from these hotspot surveys. Regular surveys of hotspots will ensure that emerging

plants (most likely from vegetative reproduction) are detected as early as possible. In addition to the hotspot surveys, the entire foreshore area between the Bowen and Bridgewater bridges will be divided into four quadrants. One of the quadrants will be surveyed annually, meaning the entire area is surveyed over a four-year period. This will ensure that propagules (most likely rhizome fragments) that have infested new areas will have only a short period of time to establish and can be effectively controlled. See Section 4.1.2 for map of the 4-yearly rotational survey plan between Bridgewater and Bowen bridges. In addition, annual surveys conducted by boat along both shorelines between Boyer and Bridgewater Bridge will be conducted, to ensure the high conservation-valued upper estuary wetlands continue to be free of rice grass.

All survey work will also provide an opportunity to monitor and manage other weed species, e.g. spiny rush (*Juncus acutus*) and African feathergrass (*Pennisetum macrourum*), as well as rubbish.

4.1 Yearly Survey Plan includes:

1. Survey hotspots in all areas not covered by the particular year's rotational foreshore survey (two people for one day in Oct/Nov).
   - **Eastern shore:** South of Duval Drive (Old Beach), Jetty Point, Woodville Bay.
   - **Western shore:** Montrose Bay High School, Lowestoft Bay, McCarthys Point, Dogshear Point (northern side), Bilton Bay, Dragon Point.

2. Survey a quarter of the shoreline between Bridgewater Bridge and Bowen Bridge (four people (two teams) for one day in Oct/Nov) – see 4-yearly rational survey map in Section 4.1.2. Extra task: take photos of any changed shoreline that is no longer conducive to rice grass + map other weed infestations and rubbish.

3. Boat survey between Norske Skog at Sorell Creek and Bridgewater Bridge (two people for two days), map rice grass, spiny rush, karamu, and other significant weeds and rubbish.

4.1.1 Yearly Survey Plan (2017-2020) – Plan & method to be reviewed in 2020.

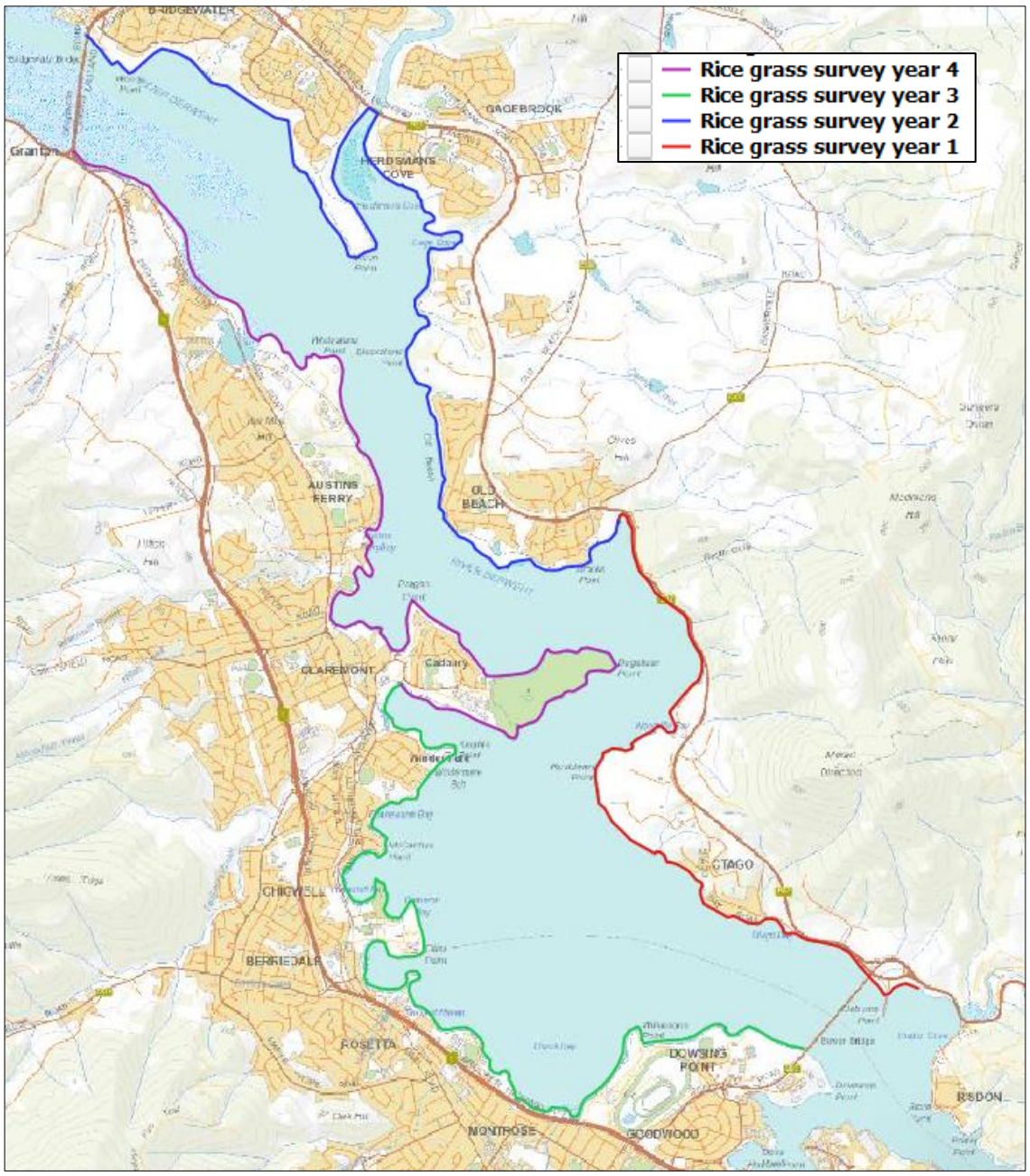
	Survey time	1-day foreshore survey zones* (4 people)	1-day hotspot survey** (2 People)	2-day boat survey above Bridgewater (2 people)	Primary stakeholders***	Extra tasks
Year 1 (2017)	Oct – Nov	Zone 1: DEP + NRM S + P&W + Herbarium	DEP + GCC	DEP	Clarence Council, DEP	Survey other weeds, rubbish, problems, photos
Year 2 (2018)	Oct – Nov	Zone 2: DEP + ?	DEP + GCC	DEP	Clarence, Brighton councils, DEP	Survey other weeds, rubbish, problems, photos
Year 3 (2019)	Oct – Nov	Zone 3: DEP + ?	DEP + GCC	DEP	Glenorchy Council, DEP	Survey other weeds, rubbish, problems, photos
Year 4 (2020)	Oct – Nov	Zone 4: DEP + ?	DEP + GCC	DEP	Glenorchy Council, DEP	Survey other weeds, rubbish, problems, photos

*** See foreshore survey zones below in Section 4.1.2 ; participation to be determined yearly.**

**** Hotspot survey areas listed above. Glenorchy participation recommended as mostly in the Glenorchy area.**

***** Other stakeholders include DPIPWE, NRM South, P&W, and all three councils every year.**

4.1.2 4-yearly rotational survey map between Bridgewater and Bowen bridges.



5 Sourcing survey participants

Over the years, numerous people have participated in rice grass surveys. They have come from a range of organisations, such as Southern Coast Care Association of Tasmania, Environmental Protection Agency, Inland Fishery Services, University of Tasmania, NRM South, Threatened Plants Tasmania (Wildcare), Understorey Network, local councils, and state government agencies, including Parks & Wildlife Services.

Given the restrictions with using volunteers (paperwork, insurance) it is preferred to find willing helpers from DPIPWE, local councils and NRM South. This has the significant added benefit of providing networking opportunities with people who have their own interest in the Derwent estuary. The contribution by these organisations in allocating staff and other resources towards this program is greatly acknowledged.

6 Chemical treatment

Over the years control of rice grass in the Derwent estuary has been an integrated technique of physical removal and subsequent spraying with herbicide (Fusilade Forte®), which required an off-label permit from the Australian Pesticides and Veterinary Medicines Authority (APVMA). This product was initially selected as the best herbicide for broad scale spraying. When the rice grass infestation in the Derwent significantly decreased and only spot spraying was required, glyphosate was the better choice. In recent years, Glyphosate Bioactive (13 mL/L) has been used. As per suggestion by a weed contractor (in 2016) it is now recommended that any future work also include a surfactant e.g. Protec Plus produced by Grevillia Ag.

Despite rice grass only appearing in small patches in recent years, and some years not at all, physical removal on its own is rarely recommended, due to the aggressive nature of the rhizomes. Experienced contractors will make this final decision in any given year.

7 Acknowledgements

Many thanks to Matthew Baker, Curator (Weed Taxonomy) Tasmanian Herbarium; Adam Muyt, Environment Officer Glenorchy City Council; Alastair Morton, Principal Policy Officer Department of State Growth; and to Prof Mendelssohn, Department of Oceanography and Coastal Science, Louisiana State University for extremely useful comments and suggestions.

8 Further information

Additional information about current and past surveying, locations of rice grass, participants etc. can be obtained from the Derwent Estuary Program Ltd. derwent@environment.tas.gov.au.

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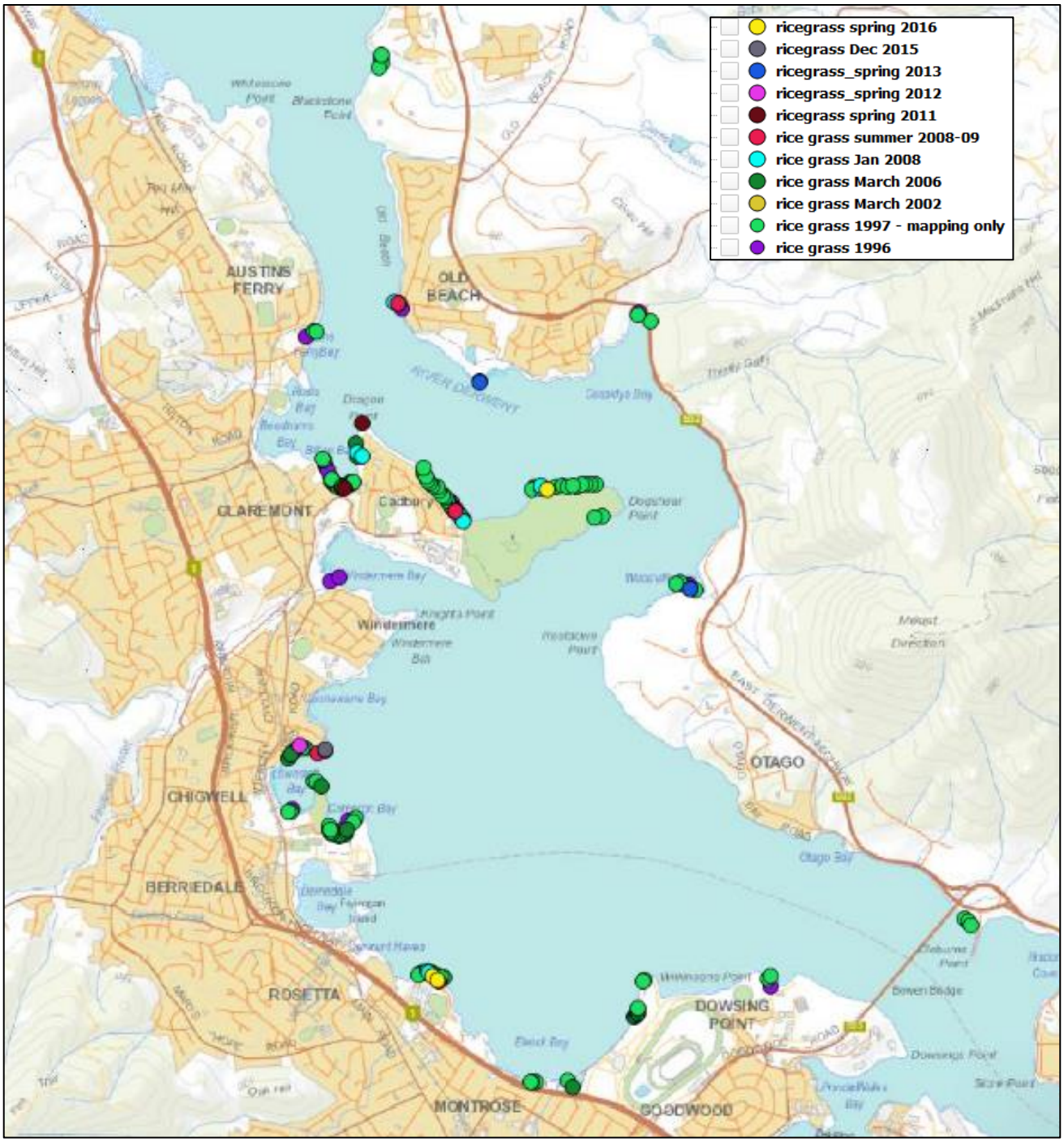
10 Appendix

10.1 Location of rice grass and treatment in the Derwent since 1997*



*** Exact position for all locations are uncertain for late 1990s.**