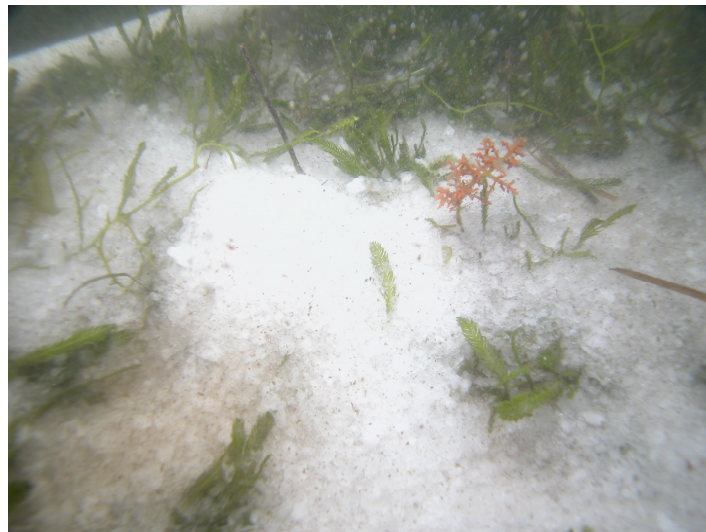


Eradicating and preventing the spread of the invasive alga *Caulerpa taxifolia* in NSW

R.G.Creese¹, A.R. Davis² and T.M.Glasby¹

¹ NSW Fisheries, Port Stephens Fisheries Centre, Private Bag 1,
Nelson Bay, NSW 2315, Australia.

² School of Biological Sciences, University of Wollongong, NSW 2522, Australia.



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TABLE OF CONTENTS

TABLE OF CONTENTS.....	I
LIST OF TABLES.....	III
LIST OF TABLES.....	III
LIST OF FIGURES.....	IV
LIST OF FIGURES.....	IV
LIST OF PLATES.....	VI
ACKNOWLEDGEMENTS.....	VII
EXECUTIVE SUMMARY.....	VIII
1. INTRODUCTION & BACKGROUND	1
1.1. Invasive <i>Caulerpa taxifolia</i>	1
1.2. <i>Caulerpa taxifolia</i> infestations in NSW.....	2
1.3. This report.....	4
2. MAPPING THE SPREAD OF CAULERPA TAXIFOLIA IN NSW	6
2.1. Field survey methods for <i>Caulerpa taxifolia</i>	6
2.1.1. Areas already affected by <i>C. taxifolia</i>	8
2.1.2. Areas likely to be affected by <i>C. taxifolia</i>	8
2.1.3. Areas considered unlikely to be affected by <i>C. taxifolia</i>	8
2.2. Creating final maps	8
2.3. Sites with <i>C. taxifolia</i>	8
2.3.1. Lake Macquarie.....	9
2.3.2. Pittwater.....	9
2.3.3. Port Jackson.....	9
2.3.4. Botany Bay.....	10
2.3.5. Port Hacking.....	10
2.3.6. Lake Conjola.....	11
2.3.7. Narrawallee Inlet.....	11
2.3.8. Burrill Lake.....	11
2.4. Temporal changes in the extent of <i>C. taxifolia</i>	12
2.5. Discussion.....	13
3. DISPERSAL, RECRUITMENT AND GROWTH OF C. TAXIFOLIA IN NSW	15
3.1. The role of fragments in contributing to spread	16
3.1.1. Spatial and temporal patterns of abundance and biomass of <i>C. taxifolia</i> fragments..	16
3.1.2. Preliminary assessment of abundance and biomass of fragments within seagrass beds	26
3.1.3. The effect of bed structure on the abundance and biomass of <i>C. taxifolia</i> fragments..	27
3.2. Persistence and growth of newly established plants	32
3.2.1. Stolon extension within and on the edge of established <i>C. taxifolia</i> beds	32
3.2.2. Growth of <i>C. taxifolia</i> into <i>Posidonia</i> seagrass beds.....	34
3.2.3. Survivorship of fragments in response to salinity.....	36
3.3. Predation on <i>C. taxifolia</i>	37
3.4. Discussion.....	38
3.4.1. Asexual Reproduction: fragmentation and stolon extension	38
4. VECTORS THAT MAY TRANSFER THE WEED TO NEW LOCATIONS WITHIN NSW.....	40
4.1. Patterns of <i>C. taxifolia</i> fragmentation.....	41
4.1.1. Results.....	42
4.2. Generation of <i>C. taxifolia</i> fragments by boat propellers.....	46
4.2.1. Methods.....	46
4.2.2. Results.....	48

4.3.	Generation of fragments by anchors	51
4.3.1.	Methods	51
4.3.2.	Results	51
4.4.	The ability of <i>C. taxifolia</i> to survive exposure to air.....	56
4.4.1.	Method	56
4.4.2.	Results	57
4.5.	Public awareness of boating activity as a potential vector – a preliminary study	57
4.6.	Discussion	58
5.	CONTROL TECHNIQUES FOR <i>CAULERPA TAXIFOLIA</i>	59
5.1.	Removal by hand.....	59
5.2.	Removal by diver-operated suction devices	60
5.3.	Large scale removal by commercial dredges.....	61
5.4.	Killing <i>C. taxifolia</i> by smothering	61
5.5.	Killing <i>C. taxifolia</i> with chemicals	63
5.6.	Killing <i>C. taxifolia</i> by osmotic shock	65
5.6.1.	Qualitative trials.....	66
5.6.2.	Quantitative experiments on effectiveness of salt and its colateral impact.....	67
5.6.3.	Application of salt to beds of <i>C. taxifolia</i>	71
5.6.4.	Fine tuning the use of salt as a control technique.....	74
5.7.	Discussion	76
6.	GENERAL DISCUSSION.....	77
7.	LITERATURE CITED.....	79
APPENDIX 1.....	84
APPENDIX 2.....	97
(a)	Responses of common SE Australian herbivores to three invasive <i>Caulerpa</i> spp.	98
(b)	Plant – herbivore interaction in an estuary invaded by <i>Caulerpa taxifolia</i> : Estimating the impacts of native herbivores on their food resources.....	100
(c)	Fauna associated with <i>Caulerpa</i> spp.; potential biological control of <i>C. taxifolia</i>	102
APPENDIX 3.....	104

LIST OF TABLES

Table 2.1.	Characteristics of NSW sites affected by <i>C. taxifolia</i>	12
Table 2.2.	Mapped coverage of dense and sparse <i>C. taxifolia</i> in 8 NSW estuaries, 2001-2004.	14
Table 3.1	Sampling schedule at three sites within Lake Conjola between June 2002 and August 2003... 16	
Table 3.2.	Results of ANOVAs for testing hypotheses about effects of experimental treatments on the number and/or weight of <i>C. taxifolia</i> fragments accumulated on artificial structures at Roberts Point (RP), Picnic Bay (PP) and Roberts Bay (RB).	29
Table 3.3.	Two factor ANCOVA of exposure of fragments of <i>C. taxifolia</i> to reduced salinity.....	37
Table 4.1.	Potential mechanisms for generating and transporting fragments of <i>C. taxifolia</i> and their relative importance in NSW estuaries.....	40
Table 4.2.	Results of ANOVAs and SNK tests, for testing hypotheses about patterns of distribution of abundance and/or biomass of <i>C. taxifolia</i> fragments in Lake Conjola.....	44
Table 4.3.	Results of asymmetrical ANOVAs for testing hypotheses about patterns of distribution of abundance and/or biomass of <i>C. taxifolia</i> fragments in Port Hacking.....	45
Table 4.4.	Results of asymmetrical ANOVAs for testing hypotheses about impact of boat activity on abundance and/or biomass of <i>C. taxifolia</i> fragments.	49
Table 4.5.	Results of ANOVAs for testing hypotheses about impact of boat activity at two separate depths on abundance and/or biomass of <i>C. taxifolia</i> fragments..	49
Table 4.6.	Results of ANOVAs to test for differences in biomass of <i>C. taxifolia</i> fragments removed by anchors.....	55
Table 4.7.	Results of ANOVAs to test for differences in biomass of <i>C. taxifolia</i> removed from Lake Conjola by the attachments, chain or rope, of anchors.	56
Table 4.8.	Number of small, medium and large clumps of fragments that were viable after 1 hour, 1 day and 3 days of desiccation under experimental conditions.	57
Table 5.1.	Measures to remove or kill <i>C. taxifolia</i> (other than use of salt) undertaken by NSW Fisheries in 2001-2003 at a variety of sites in NSW.....	65
Table 5.2.	Summary of salt distributed in each estuary (tonnes) to control <i>C. taxifolia</i> , December 2001 to March 2003.....	72

LIST OF FIGURES

Figure 1.1.	Sites where invasive <i>C. taxifolia</i> occurs in NSW (as at May 2004).....	3
Figure 3.1.	Mean (\pm se) number of fragments per quadrat of <i>C. taxifolia</i> fragments at West Conjola, Lake Conjola between June 2002 and August 2003.....	17
Figure 3.2.	Mean (\pm se) number of fragments per quadrat of <i>C. taxifolia</i> fragments at Roberts Point, Lake Conjola between July 2002 and August 2003.....	18
Figure 3.3.	Mean (\pm se) number of fragments per quadrat of <i>C. taxifolia</i> fragments at Adder Bay, Lake Conjola between July 2002 and August 2003.....	18
Figure 3.4.	Relationships between lengths of <i>C. taxifolia</i> fragments and their wet weights at West Conjola site 1 (A) and site2 (B) and at Roberts Point site 1 (C) and site 2 (D).	20
Figure 3.5.	Relationships between total biomass of fragments and average frond height within quadrats in June/July 2002.....	21
Figure 3.6.	Relationships between total biomass of fragments and percent cover within quadrats in June/July 2002.....	22
Figure 3.7.	Size frequencies of fragments collected Before (upper) and After (lower) storm activity at Roberts Point, site 1.....	23
Figure 3.8.	Size frequencies of fragments collected Before (upper) and After (lower) storm activity at Adder Bay, site 2.	24
Figure 3.9.	Size frequencies of fragments collected Before (upper) and After (lower) storm activity at West Conjola, site 3.....	25
Figure 3.10.	Mean (\pm se) number of <i>C. taxifolia</i> fragments per quadrat within <i>Zostera</i> beds at two sites within Port Hacking in May 2003.....	27
Figure 3.11.	Mean (\pm se) number of <i>C. taxifolia</i> fragments per quadrat within 3 zones of <i>Posidonia</i> beds at two sites in Port Hacking in May 2003.	27
Figure 3.12.	Treatments (bare, mesh, 5cm fronds and 20cm fronds) used to test for the effect of bed structure on the accumulation of <i>C. taxifolia</i> fragments.....	28
Figure 3.13.	Mean (\pm se) number (A) and wet weight (B) of <i>C. taxifolia</i> fragments accumulated in each of four treatments in 3 sites at Lake Conjola between 13/01 and 12/02 2004.....	30
Figure 3.14.	Mean (\pm se) number (A) and wet weight (B) of <i>C. taxifolia</i> fragments accumulated in each of four treatments: bare, frame only, short artificial fronds (5 cm) and long artificial fronds (20 cm) in 3 sites at Lake Conjola between 10/12/2003 and 13/01/2004.....	31
Figure 3.15.	Average stolon growth (\pm se) within the interior and on the edge of established <i>C. taxifolia</i> patches at West Conjola, Lake Conjola between July 2002 and July 2003.....	33
Figure 3.16.	Average stolon growth (\pm se) within the interior and on the edge of established patches of <i>C. taxifolia</i> at Adder Bay, Lake Conjola between December 2002 and July 2003.....	33
Figure 3.17.	Diagrammatic representation of the experimental design to examine the spread of <i>C. taxifolia</i> among three zones at the boundary between the seagrass <i>Posidonia australis</i> and <i>C. taxifolia</i>	35
Figure 3.18.	Average distance (\pm se) occupied by each of three zones along transects in Gunnamatta Bay between January 2003 and February 2004.	35
Figure 3.19.	Average distance (\pm se) occupied by each of three zones along transects at Maianbar, between March 2003 and March 2004.....	36
Figure 3.20.	Average mortality (\pm se) of <i>C. taxifolia</i> fragments under three different salinity regimes (30ppt, 15ppt and 10ppt) for pulse (24hrs) and press (1 week) time periods..	37

Figure 4.1.	Mean (+s.e.) abundance and biomass (g dry weight) per quadrat, of <i>C. taxifolia</i> fragments sampled in Lake Conjola at three locations with high anthropogenic activity and three locations with low anthropogenic activity, on two sampling occasions, (A) 26th March 2003 and (B) 20th June 2003.	43
Figure 4.2.	Mean (+s.e.) abundance and biomass (g dry weight) per quadrat of <i>C. taxifolia</i> fragments sampled in Port Hacking at one location with high anthropogenic activity and two locations with relatively low anthropogenic activity, sampled on 20th March 2003.....	45
Figure 4.3.	Diagrammatic representation of the experimental design to examine fragmentation along a boat-impacted transect and control transects on 4 June 2003.....	46
Figure 4.4.	Diagrammatic representation of the experimental design to examine fragmentation along boat-impacted transects and control transects on 24th September.	47
Figure 4.5.	Mean (\pm s.e.) abundance and biomass (g dry weight) per 50x50cm quadrat of <i>C. taxifolia</i> fragments on one boat and two control transects before and after the impact of boat activity. Experiment was done in Lake Conjola on 4th June 2003.	48
Figure 4.6.	Mean (\pm s.e.) abundance and biomass (g dry weight) per 50x50 cm quadrat of <i>C. taxifolia</i> fragments on two boat and two control transects before and after the impact of boat activity, within two separate depth, shallow (upper) and deep (lower).....	50
Figure 4.7.	Mean (+s.e.) biomass (g dry weight) of <i>C. taxifolia</i> fragments removed from Lake Conjola on anchors. Experiments were done in Lake Conjola on 27th May 2003.....	52
Figure 4.8.	Mean (+s.e.) biomass (g dry weight) of <i>C. taxifolia</i> fragments removed from Lake Conjola on anchor attachments. Experiments were done in Lake Conjola on 27th May 2003.	53
Figure 4.9.	Mean (+s.e.) biomass (g dry weight) of <i>C. taxifolia</i> fragments removed from Lake Conjola on anchors. Experiments were done in Lake Conjola on 28th July 2003.	54
Figure 4.10.	Mean (+s.e.) biomass (g dry weight) of <i>C. taxifolia</i> fragments removed from Lake Conjola on anchor attachments. Experiments were done in Lake Conjola on 28th July 2003.....	55
Figure 5.1.	Mean number of fronds of <i>C. taxifolia</i> (a) and <i>Zostera capricorni</i> (b) in plots that were either not salted or salted at concentrations of 50, 100, 150 or 200 kg/m ²	69
Figure 5.2.	Mean number of soft sediment invertebrates (a) and infaunal taxa (b) in plots that were either not salted (close control & distant control), or salted at concentrations of 50, 100, 150 or 200 kg/m ²	70
Figure 5.3.	Estimated coverage (hectares) of <i>C. taxifolia</i> before and after complete treatment of salt in the summer of 2002-2003 at three NSW localities.	73
Figure 5.4.	Mean number of fronds (+ S.E.) of <i>C. taxifolia</i> in plots that were either not salted (controls), 'patch' salted, or covered with 50kg/m ² of salt.	75

LIST OF PLATES

Plate 1.	A comparison of native <i>C. taxifolia</i> from northern Queensland and invasive <i>C. taxifolia</i> from NSW.	1
Plate 2.	The on board mapping system developed to document the spatial extent of <i>C. taxifolia</i> infestations in NSW waterways.	7
Plate 3.	Examples of <i>C. taxifolia</i> growing in situ in NSW estuaries..	10
Plate 5.	Thallus fragment of <i>Caulerpa taxifolia</i> , indicating the frond, stolon and rhizoid section of the alga.	15
Plate 6.	Sand and rock anchors used in experiments examining the effect of anchors	51
Plate 7.	Trials in NSW to evaluate the feasibility of killing <i>C. taxifolia</i> by smothering it with various materials.	62
Plate 8.	Trials in NSW to evaluate the feasibility of killing <i>C. taxifolia</i> by spreading salt on it. Top left: navy divers assist in Careel Bay; top right: experimental 1m ² plot covered with salt; bottom left and right: deploying large quantities of salt in Lake Macquarie.	66
Plate 9.	Effectiveness of salt treatments applied to beds of <i>C. taxifolia</i> at a concentration of 50kg per m ²	74

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EXECUTIVE SUMMARY

This joint project between NSW Fisheries and the University of Wollongong had 3 objectives:

- 1 To investigate patterns of dispersal, recruitment and growth of the invasive alga *Caulerpa taxifolia* and provide information on spread within NSW estuaries
- 2 To investigate the vectors that may transfer *C. taxifolia* to new locations
- 3 To develop environmentally benign ways of removing *C. taxifolia* which might eventually lead to its elimination from whole sites or regions

The research undertaken to address these objectives provided a good understanding of the population ecology of *C. taxifolia* in NSW estuaries, allowed the evaluation of several control techniques and underpinned the development of a 'Control Plan for *Caulerpa taxifolia* in NSW' based on a preliminary assessment of risks. The control plan can be found at <http://www.fisheries.nsw.gov.au/thr/species/fn-caulerpa.htm>

To date, *C. taxifolia* has been found in 9 separate locations. All are estuaries or sheltered embayments and the seaweed has not yet been found on exposed coasts. It occurs in water 0.5–10 metres deep. *C. taxifolia* is capable of growing extremely quickly; stolons can extend by up to 13 mm per day in optimal conditions. Vegetative growth is the primary means by which the alga has invaded these NSW waterways, covering over a total of 4–8 km² by mid 2004. *C. taxifolia* reproduces asexually through a process of fragmentation, dispersal and eventual anchoring of drifting fragments which are negatively buoyant and move across the seafloor in bottom currents. Large numbers of fragments were found within existing beds of *C. taxifolia*, and experiments showed that they could be trapped within seagrass beds or other structures on the seafloor. Once trapped, even small fragments can attach to the seafloor and grow into new plants. Infestations of *C. taxifolia* in NSW range from sparse distributions of scattered runners to dense beds 40 cm thick. Several other marine organisms may occur within beds of *C. taxifolia*, but most herbivorous species avoid eating it. Only two species of opisthobranch molluscs appear to readily feed on it.

A boat-mounted mapping system was developed to document the extent and spread of *C. taxifolia* in NSW waterways. A procedure whereby all known infestations are comprehensively mapped twice a year, in mid summer and in mid winter, has now been implemented. This mapping has accurately documented the continued spread of *C. taxifolia* in most of the estuaries where it occurred at the start of the project. Large-scale die-offs, however, occur in shallow water (0.5–2 m) in most waterways in NSW during winter and this was particularly evident after heavy rainfall. This die-back may be a consequence of decreased temperature, decreased salinity, increased turbidity or some combination of these.

There are several natural vectors that aid the fragmentation and translocation of *C. taxifolia*; storms, and the increased wave action associated with them, were found to be particularly important. These vectors become increasingly significant as the amount of *C. taxifolia* at a site expands, and they probably overshadow human-mediated vectors when infestations cover large areas such as in Lake Conjola and Botany Bay. Commercial activities on waterways infested by *C. taxifolia* such as commercial fishing, aquaculture, dredging or the building/maintenance of foreshore structures such as wharves, jetties or boat ramps can potentially cause increased fragmentation. Most such activities are now banned or strictly controlled at sites with *C. taxifolia*. Many human leisure activities may also generate, trap and transport fragments of *C. taxifolia*, including passive pursuits such as swimming, diving and more active pursuits such as boating, water skiing, anchoring or recreational fishing. These were investigated in an Honours project at the University of Wollongong and the results reproduced here. Abundances of fragments were higher in areas of human use, and experiments showed that boat anchors, in particular, were readily able to remove significant amounts of the seaweed from beds of *C. taxifolia*. Additional

experiments showed that fragments caught this way could survive for 1-2 days out of water in conditions that mimicked the anchor well on a small boat and might constitute a major risk for transferral to other waterways.

Removing *C. taxifolia* by either hand-picking or using underwater suction devices was found to be effective for very small patches at shallow sites with sandy bottoms and good underwater visibility. Many of the infested waterways in NSW, however, are muddy and often turbid, making detection of all plants difficult and increasing the risk of accidentally releasing fragments. A scoping exercise was done for using a commercial dredging vessel to remove large areas of the seaweed, but the logistics proved too difficult. Experiments with various types of smothering materials, particularly jute matting, were also reasonably effective at killing most *C. taxifolia* in small-scale trials. Their use for areas larger than a few hundred square metres, however, created more difficulties than they provided solutions.

The use of osmotic shock showed the most promise in preliminary trials. The addition of a layer of salt directly onto the plants killed them within hours. Trials using salt delivered from a specially designed punt were very successful at scales of several hundred square metres, but results of larger scale salting were mixed. For example, single applications of salt to numerous outbreaks at one location resulted in the apparent removal of almost 5200 m² of *C. taxifolia*, whereas repeated salting of a 3000 m² infestation at another site led to a considerable reduction in the density of *C. taxifolia*, but no overall change to the extent of the infestation. Salt rapidly dissolves in seawater and therefore has little residual impact on the marine environment. Although salt may kill other marine organisms directly covered by it, experiments showed that the seagrass, *Zostera marina*, and invertebrate infauna which often co-occur with *C. taxifolia*, recover after 6 months if salt is applied at 50 kg salt per square metre. The use of this salting technique has now been adopted as a major component of the NSW *Caulerpa* Control Plan for the targeted control of new outbreaks or high risk infestations.

Because there is now more *C. taxifolia* in NSW waterways than can be effectively treated with salt, eradication does not seem feasible at this time. It is hoped, however, that the control procedures outlined in this report and in the NSW *Caulerpa* Control Plan will prevent the spread of the alga to locations where it is not currently found. A better understanding of the biology and patch dynamics of *C. taxifolia* will also assist in minimizing its impact on native biodiversity and the sustainable use of marine resources in NSW estuaries.

