

# Aquatic vegetation of Chatham Island (Rekohu)

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## CONTENTS

Abstract	5
1. Introduction	6
2. Methods	6
3. Results	9
3.1 Characterisation of waterbodies	9
3.2 Aquatic vegetation	9
3.3 Aquatic fauna	11
4. Discussion	11
4.1 Current aquatic weed status	11
4.2 Native aquatic plant species in the lakes	12
4.2.1 New records for the Chatham Islands	13
4.2.2 Species of limited distribution	14
4.3 Fauna in the lakes	14
4.4 Other management issues	15
5. Recommendations	16
6. Acknowledgements	16
7. References	17
Appendix 1	
Plant species recorded in 24 waterbodies on Chatham Island	18

# Aquatic vegetation of Chatham Island (Rekohu)

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## ABSTRACT

Aquatic vegetation was surveyed on 18 lakes, four pools, Washout Creek, and Te Whanga Lagoon on Chatham Island in February 2003. All lakes surveyed were shallow, with only four exceeding 2 m depth. Underwater visibility varied from > 10 m (Lake Rangitai) to around 1.5 cm (Lake Kaikapo). Light penetration was so poor in three lakes that no aquatic vegetation was present. No problem aquatic weeds were found. The only introduced aquatic species observed were: starwort (*Callitriche stagnalis*) and purple-backed duckweed (*Spirodela punctata*) in Washout Creek; a submerged leafy rush (probably *Juncus articulatus*) in Lake Omutu; and *J. pallidus* (a species indigenous to New Zealand but not the Chatham Islands) emergent in Lakes Taia and Kairae. Management of these species is not advocated. The aquatic vegetation also comprised 23 native species, the commonest of which were: the charophyte algae *Chara globularis* (which formed substantial underwater meadows in five lakes), *Nitella hyalina* and *Lamprothamnium* sp.; the tall submerged *Myriophyllum triphyllum*; the turf species *Ruppia polycarpa*, *Lilaeopsis novae-zelandiae*, *Lepilaena bilocularis*; and tall emergent plants *Apodasmia similis* and *Eleocharis acuta*. This vegetation is species-poor compared to similar waterbodies in New Zealand. New plant records for the Chatham Islands include *Chara braunii*, *Nitella bookeri* var. *tricellularis*, *N. hyalina*, *Lamprothamnium* sp., *Ruppia megacarpa*, *Myriophyllum propinquum*, *Crassula sinclairii* and *Baumea arthrophylla*, and two undescribed taxa of the genus *Myriophyllum*. The fish and invertebrate fauna of these lakes were depauperate. The larvae of a caddisfly (Trichoptera) collected appear to be of an endemic species *Oecetis chathamensis*, a species described from a single male adult specimen. An alien snail *Physa acuta* was common in many of the surveyed lakes.

Keywords: aquatic vegetation, aquatic fauna, new plant records, Chatham Island, Rekohu, Te Whanga Lagoon.

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# 1. Introduction

A preliminary survey was made of the aquatic vegetation of Chatham Island (Rekohu or Wharekauri) during February 2003. Apparently there have been no systematic vegetation surveys of the many lakes and other waterbodies on Chatham Island, although various aquatic plants had been recorded for the Chathams in the *Flora of New Zealand* series (Wood & Mason 1977; Johnson & Brooke 1989; de Lange et al. 1999a).

The main aims of this survey were to ascertain: the current aquatic weed status; the native aquatic plant species in the main lakes; the fauna in these lakes; and immediate and longer-term management requirements (if any) to protect each lake.

# 2. Methods

The waterbodies shown in Fig. 1 and Table 1 were investigated between 24 and 28 February 2003. Eighteen of the 24 survey sites were lakes (although one near Port Hutt appeared to have been drained). Other sites sampled were four pools, Washout Creek and Te Whanga Lagoon.

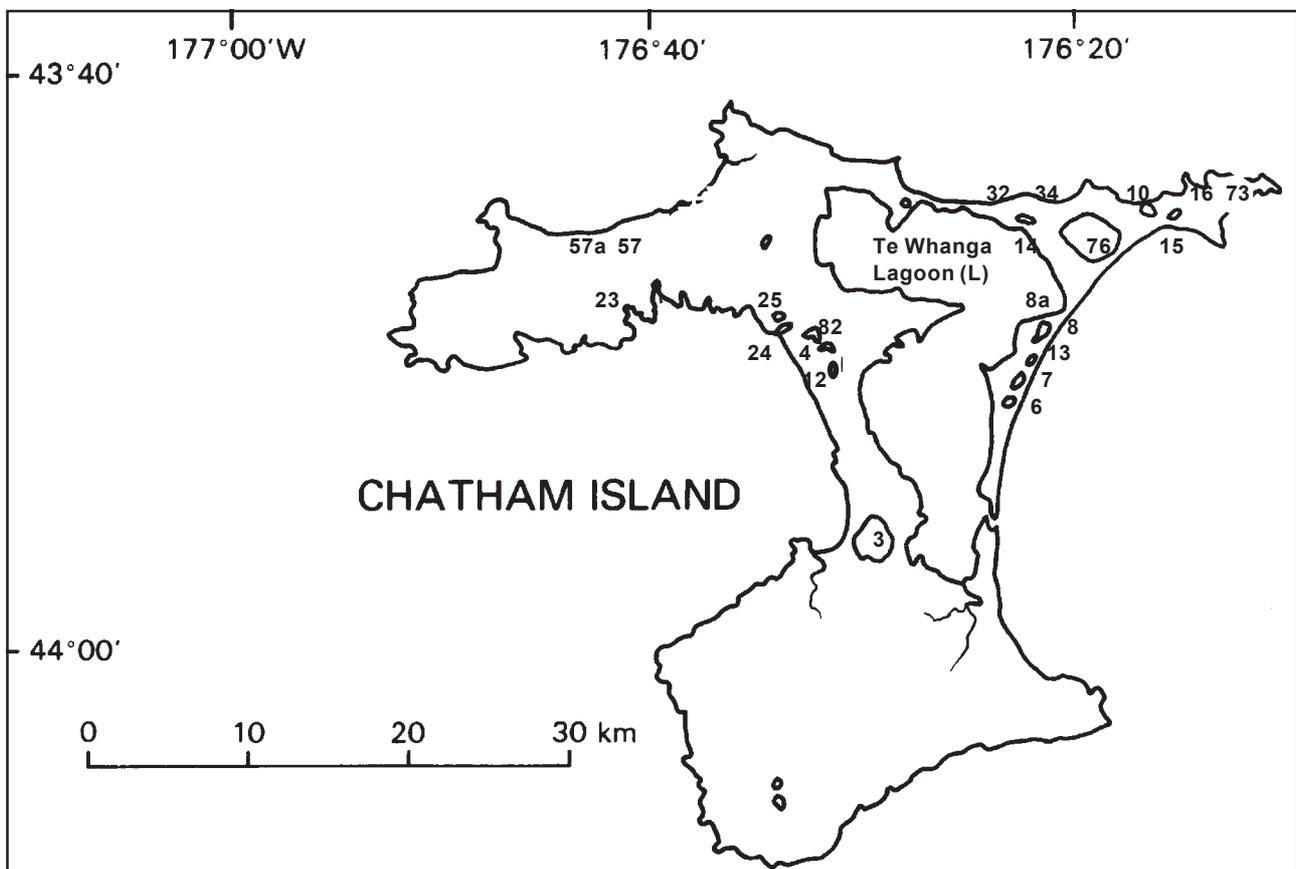


Figure 1. Map of the northern part of Chatham Island showing the locality of the lakes and other waterbodies surveyed. Numbers refer to the LINZ topo numbering system (see Table 1 for names of these waterbodies).

TABLE 1. AREA, ALTITUDE AND LOCALITY OF WATERBODIES ON CHATHAM ISLAND AND DATE OF SURVEY.

REF. NO.	WATERBODY	AREA (ha)	ALT. (m)	NZMS 260 REF. CHATHAM IS. 1	DATE, 2003
3	Lake Huro	598	0	502 565	27 Feb
4	Tennants Lake	50	21	445 696	27 Feb
6	Lake Taia	49	1	573 644	25 Feb
7	Lake Kairae	109	1	577 667	25 Feb
8	Lake Kaingarahu	75	1	599 696	25 Feb
8a	Pool off track opp. 8	< 0.5	c. 4	596 702	25 Feb
10	Lake Pateriki	129	1	657 769	26 Feb
12	Lake Marakapia	36	21	459 672	26 Feb
13	Lake Makuku	54	1	584 675	25 Feb
14	Lake Kaikapo (Wharemanu)	31	1	568 773	26 Feb
15	Lake Rotorua	25	2	670 767	26 Feb
16	Lake Te Wapu	34	3	693 790	26 Feb
23	Port Hutt lake	7	60	321 714	27 Feb
24	Te Roto	6	21	434 701	27 Feb
25	Lake Rotoparaoa	5	24	428 707	27 Feb
32	Lake Koomutu	3	0	563 777	26 Feb
34	Pool in Ocean Mail Reserve	1	0	577 780	26 Feb
57	Taoroa Pool	0.5	c. 20	306 750	27 Feb
57a	Washout Creek	-	20	299 752	27 Feb
73	Lake Omutu	2	20	703 785	26 Feb
76	Lake Rangitai	867	1	640 750	26 Feb
82	Lake opp. Tennants	1	21	448 698	27 Feb
82a	Pool between 4 & 82	< 0.5	20	446 696	27 Feb
L	Te Whanga Lagoon	-	0	450 759	26 Feb

Apart from lakes Taia, Kairae, Makuku, Kaingarahu and the Ocean Mail Reserve pool, these waterbodies were located on private land, so access was arranged prior to field investigations. To allow for the best coverage of sites over the limited time available, only one vegetation profile was investigated at each water body. Submerged and emergent vegetation was sampled by snorkel, recording plant species presence, depth range, maximum and average abundance using a modified Braun-Blanquet cover scale (1 = 1-5%, 2 = 6-25%, 3 = 26-50%, 4 = 51-75%, 5 = 76-95%, 6 = 96-100%), and maximum and average height. Vegetation profiles were sampled to below the maximum depth limit of aquatic vegetation where this was exceeded by the lake depth. Voucher material of all aquatic vegetation was collected and is deposited in the Landcare Herbarium (CHR). Total vegetation cover was recorded along with substrate type, water clarity and the presence of any aquatic invertebrates and fish. As water levels appeared to be very low at the time of the surveys, any marginal turf vegetation was also surveyed, recording each species present. Gee-minnow traps baited with Vegemite®-covered bread were placed amongst emergent vegetation (where present) for the duration of each vegetation survey to sample diurnal fish species.

Underwater visibility, sediment type, depth limits of vegetation and comments on other lake characters (e.g. presence of algal blooms) are recorded in Table 2.

A full record of all plants seen is presented in Appendix 1, dividing plants into submerged (recording average cover class), free-floating, emergent (erect, sprawling and floating leaved) and marginal turf species.

TABLE 2. CHATHAM ISLAND LAKES AND OTHER WATERBODIES SAMPLED, RECORDING UNDERWATER VISIBILITY, SEDIMENT TYPE, MAXIMUM DEPTH SAMPLED, DEPTH LIMITS OF VEGETATION, AND COMMENTS ON OTHER LAKE CHARACTERS.

REF. NO.	WATERBODY	UNDERWATER VISIBILITY	SEDIMENT TYPE	MAX. DEPTH RECORDED (m)	DEPTH LIMIT OF VEGN (m)	COMMENTS
3	Lake Huro	0.1	sand	0.3	0.2	peat crust on margin < 0.2 m, algal bloom
4	Tennants Lake	5.0	sand	4.0	4.0	
6	Lake Taia	1.0	sand	1.0	1.0	dense organic floc 0.5-1.0 m deep
7	Lake Kairae	0.2	sand	1.0	0.1	algal bloom
8	Lake Kaingarahu	<0.1	sand	-	-	algal bloom
8a	Pool off track opp. 8	-	peat	-	-	
10	Lake Pateriki	1.0	sand	1.4	1.3	saline, peat-stained
12	Lake Marakapia	5.0	sand	2.5	2.5+	organic mud on margin
13	Lake Makuku	2.0	sand	1.0	1.0	
14	Lake Kaikapo (Wharemanu)	<0.1	peat	-	-	turbid, peat-stained Secchi est. 0.015 m
15	Lake Rotorua	0.1	mud	1.2	0.6	algal bloom
16	Lake Te Wapu	0.6	sand	0.5	0.5	brackish, peat-stained
23	Port Hutt lake	-	peat	-	-	lake drained
24	Te Roto	1.5	sand	1.5	1.3	peat-stained
25	Lake Rotoparaoa	3.5	sand	4.0	3.5	remains of algal bloom
32	Lake Koomutu	0.1	peat	-	-	peat-stained
34	Pool, Ocean Mail Reserve	>0.4	peat	0.4	0.4	
57	Taoroa Pool	0.1	peat	-	-	
73	Lake Omutu	3.0	mud	2.0	2.0	
76	Lake Rangitai	10.0	sand	1.3	1.3	
82	Lake opp. Tennants	0.2	peat	1.2	1.2	bottom lined with bryophytes
82a	Pool between 4 & 82	0.2	peat	0.1	0.1	
L	Te Whanga Lagoon	5.0	sand	1.0	1.0	saline

## 3. Results

### 3.1 CHARACTERISATION OF WATERBODIES

Of the lakes, only four (Tennants, Marakapia, Rotoparaoa and Omutu) were 2 m or deeper. The first three are all dune lakes situated on the western side of Te Whanga Lagoon, whereas Lake Omutu is a mud-bottomed lake situated to the east of Kaingaroa settlement on the northeastern peninsula (see Fig. 1, no. 73). Underwater visibility in each of these lakes exceeded 3 m. The clearest waterbody was Lake Rangitai, where the underwater visibility exceeded 10 m. This dune lake provides the water supply for Kaingaroa (A. Couchman pers. comm.). Of the remaining eight sandy-bottomed lakes, two were influenced by salinity, with Lake Pateriki approximately 50% seawater and Lake Te Wapu much less. Both have outlets to the northern coast and were tea-stained, but not turbid.

Light penetration was poor in all but two of the remaining sandy-bottomed lakes, due either to dense planktonic algal blooms (as in Lake Kairae), or in the case of Lake Te Roto due to the influence of a peat-stained inflow stream.

Lakes Rotorua and Omutu were the only lakes with muddy bottoms, and Rotorua had turbid water resulting from a planktonic algal bloom.

In all the sandy- and muddy-bottomed lakes, the water levels appeared to be much lower than normal. In many cases (e.g. Rotorua) there was a zone of exposed sand or mud which supported turf vegetation.

Lakes Kaikapo (not Wharemutu as recorded on the DOC database, Clifford Whaitiri pers. comm.) and Koomutu were both peat-bottomed lakes, with highly peat-stained waters; Kaikapo was also very turbid, with an estimated clarity of 1.5 cm. The lake at Port Hutt, the pools at Taoroa, near Lake Kaingarahu, Ocean Mail Reserve, and the lake on the opposite side of the road from Tennants Lake were also peaty. Between the road and this lake was a shallow pool (no. 82a), which is probably linked to the main body of the lake at normal lake levels.

Washout Creek was sampled near the road bridge. At this site, water flow was negligible.

Te Whanga Lagoon was saline, with salinity equivalent to, or slightly exceeding sea water. The substrate was sandy, with a cover of loose organic floc and encrusting algae.

### 3.2 AQUATIC VEGETATION

Aquatic vegetation was present at all of the surveyed waterbodies except Lakes Kaikapo, Koomutu, and Kaingarahu. Lakes Kaikapo and Koomutu were both highly peat-stained and were unlikely to sustain any plants, whereas Lake Kaingarahu supported a dense algal bloom on the survey date and could have supported submerged vegetation at other times.

The commonest submerged macrophytes were *Myriophyllum triphyllum* (14 sites), *Nitella hyalina* (11 sites), *Ruppia polycarpa* (10 sites) and *Chara globularis* and *Lilaeopsis novae-zelandiae* (9 sites each). The only other charophyte recorded at more than one site was *Lamprothamnium* sp. found at four sites.

In the four waterbodies where depth exceeded 2 m and also Lake Makuku, a dense charophyte meadow up to 0.5 m tall and dominated by *C. globularis* occurred below 0.5 to 1 m deep. Isolated areas dominated by *N. hyalina* and scattered plants of *M. triphyllum* were present within this zone. In shallower depths the dominant species were *R. polycarpa*, occurring in diffuse beds between 0.1 and 0.5 m. Other lakes with submerged vegetation forming considerable areas greater than 90% covers were lakes Rotorua, Pateriki and Rangitai and Te Whanga Lagoon. The vegetation of Lake Rotorua only extended to 0.6 m deep and was dominated by *N. hyalina*, with patches of dense *R. polycarpa* and *R. megacarpa*. Lake Pateriki was dominated by *Lepilaena bilocularis* with lesser amounts of both *Ruppia* spp., *Lamprothamnium* sp. and *M. triphyllum*. In water greater than 1 m deep the vegetation of Lake Rangitai was a mixed community co-dominated by *Lamprothamnium* sp. and *N. hyalina*. Te Whanga lagoon was occasionally bordered by dense beds of *R. megacarpa* to a depth of 0.5 m. In deeper water a sparse, essentially marine, assemblage of red algae including *Gracilaria chilensis* occurred.

In many lakes in water less than 0.3 m there was a turf community composed of the species described in the previous paragraph, but also including *L. novae-zelandiae*, *Myriophyllum pedunculatum* subsp. *novae-zelandiae*, *Potamogeton cheesemanii*, *Triglochin striata*, *Callitriche petriei* subsp. *chathamensis* and *Limosella australis* (*lineata*).

The following submerged species were very restricted in their distribution:

<i>Chara braunii</i>	Lake opposite Tennants
<i>Crassula sinclairii</i>	Lake Te Roto
<i>Juncus articulatus?</i>	Lake Omutu
<i>Myriophyllum propinquum</i>	Taoroa Pool, Port Hutt and lake opposite Tennants
<i>Nitella bookeri</i> var. <i>tricellularis</i>	Lake opposite Tennants

In addition to these species, the normally marginal species *Schoenus maschalinus*, *Potentilla anserinoides*, and *Ranunculus acaulis* were noted as submerged species in the shallow margins of one water body (Makuku, Ocean Mail Pool and Marakapia respectively).

Erect emergent vegetation was uncommon around the shallow margins of the surveyed waterbodies. Significant beds of emergents were recorded from Lakes Makuku, Omutu, and Te Wapu. Dominant species included *Apodasmia similis*, *Eleocharis acuta*, *Schoenoplectus pungens*, and *Baumea arthropphylla*.

The sprawling marginal species *Persicaria decipiens* and *Isolepis prolifer* were found at the peaty-substrate lakes. Floating rosettes of *Callitriche petriei* subsp. *chathamensis* were found at three sites. At Washout Creek this species grew alongside the non-indigenous *C. stagnalis*, the only record of this species from this survey. Floating-leaved forms of *Potamogeton cheesemanii* were collected at Lakes Makuku and Te Roto (inlet stream only), and the lake and pool opposite

Tennants. An emergent *Myriophyllum* species with pinnately divided emergent leaves was recorded at Washout Creek and another different *Myriophyllum* species was collected at the pool near Lake Kaingarahu. Their possible identification is discussed in Section 4.2.

Low lake levels had exposed substantial areas of shoreline of many lakes (e.g. Lake Taia). These exposed areas supported low-growing turf vegetation composed of many of the amphibious shallow-water species described earlier in this section and grading into other turf vegetation types. Common components of these turfs, not represented in the aquatic flora, included *Centella uniflora*, *Hydrocotyle novae-zelandiae/moschata?*, *Leptinella squalida*, *Lobelia anceps*, *Myriophyllum votschii*, *Pratia arenaria* and *Selliera radicans*. The full list of species is presented in Appendix 1.

### 3.3 AQUATIC FAUNA

Only two species of freshwater fish were sampled or seen during the survey period. Common smelt (*Retropinna retropinna*) were recorded from Lakes Taia, Makuku, Marakapia, Rotoparaoa, and Tennants. One 500 mm eel, probably a shortfinned eel (*Anguilla australis*), was seen in Lake Omutu.

Invertebrates were found in all of the vegetated waterbodies sampled, including backswimmers (*Anisops* sp.), aquatic moth caterpillars (*Hygraula* sp.), and a Leptocerid caddisfly larva with a turquoise blue abdomen. This is likely to be *Oecetis chatbamensis* (see Section 4.3). In many of the lakes, especially Tennants, most plants of *M. triphyllum* and occasionally *R. polycarpa* were defoliated, presumably by *Hygraula* sp., as cases of this caterpillar were found in great abundance, although most were apparently empty. The tubes of chironomid larvae were abundant in Lake Te Roto but no living animal could be found. Two snails, the indigenous *Potamopyrgus antipodarum* and the alien *Physa acuta*, were common in all but the peat- and saline-influenced waters.

## 4. Discussion

### 4.1 CURRENT AQUATIC WEED STATUS

None of the problem aquatic weed species listed by Walls (2002) or the Pest Plant Manual (Protect New Zealand 2002) were seen in the waterbodies surveyed. The only alien aquatic species noted were starwort (*Callitriche stagnalis*), purple-backed duckweed (*Spirodela punctata*), and a submerged rush, probably *Juncus articulatus*. None of these species is particularly problematic and *J. articulatus* is well established in wet modified areas and lake marginal turf on Chatham Island. *S. punctata* is reported as present on the Chatham Islands by Johnson & Brooke (1989). The collection of *C. stagnalis* is the first known record of this species on the Chathams, but it may have been

introduced from New Zealand via waterfowl rather than human activities (see Section 4.2).

Two indigenous New Zealand aquatic plants which are regarded as introduced to the Chatham Islands are *Juncus pallidus* and *Typha orientalis*. *J. pallidus* was the dominant marginal species around Lake Taia and was also seen at Lake Kairae. *T. orientalis* was not seen during this survey.

The introduction of problem aquatic weeds and pest fish to the Chatham Islands, either for ornamental purposes or in an attempt to naturalise them, would have to be deliberate. No ornamental ponds were evident in Waitangi, Te One, or Kaingaroa, but the presence of any such pond or aquarium on the Chatham Islands warrants investigation. The unique status of the biota of these islands is well publicised, both through information leaflets on the aeroplane entering the Chathams and also the booklet produced by DOC (Walls 2002). The lack of any major problem weeds in the lakes of the Chatham Islands adds to the conservation value of this area. There are no regions within the North and South Islands of New Zealand that have this status.

#### 4.2 NATIVE AQUATIC PLANT SPECIES IN THE LAKES

The aquatic vegetation of the Chatham Islands is depauperate compared to the New Zealand flora. For example, Table 3 compares the number of indigenous species found in the current survey with those reported from a recent survey of Northland lakes (Champion et al. 2002), one of the few areas of New Zealand with many waterbodies still unimpacted by weed species.

TABLE 3. COMPARISON OF THE NUMBER OF AQUATIC SPECIES RECORDED IN NORTHLAND AND CHATHAM ISLAND.

	NORTHLAND	CHATHAM ISLAND
Charophyte spp.	8	5
Tall vascular spp.	7	4
Turf spp.	14	7
Tall emergent spp.	14	7

The reduced number of species reflects the isolated nature of the Chatham Islands from New Zealand and the limited opportunities for introduction by natural means. Species absent here, but which commonly dominate the indigenous floras of similar waterbodies in New Zealand include *Chara australis* (= *corallina*), *C. fibrosa*, *Nitella* aff. *cristata*, *N. leptostachys*, *Potamogeton ochreatus*, and the turf species *Elatine gratioloides* and three species of *Glossostigma* (two are recorded by de Lange et al. 1999a, but were surprisingly absent from the areas surveyed). The tall emergent species that often dominate lake margins in New Zealand *Eleocharis sphacelata*, *Schoenoplectus tabernaemontani* (recorded by de Lange et al. 1999a) and *Typha orientalis* (recorded as naturalised by Johnson & Brooke 1989 and de Lange et al. 1999a) were also absent from the surveyed sites.

#### 4.2.1 New records for the Chatham Islands

##### **Charophytes**

*Chara braunii*, *Nitella hookeri* var. *tricellularis*, *N. hyalina* and *Lamprothamnium* sp.

The first two of these species are restricted to one site, whereas *N. hyalina* is the most widespread of the charophytes. The *Lamprothamnium* sp. found in four lakes on this survey is not *L. papulosum* (previously thought to comprise all New Zealand material, Wood & Mason 1977), but is likely to be either *L. macropogon* or *L. succinctum*. Other New Zealand collections of *Lamprothamnium papulosum* are likely to be one of these two species. The charophyte is typically found in saline habitats, but where salinity is low the dactyls of this taxa are typically inflated, as seen with material from Lakes Huro and Makuku.

##### **Tall vascular species**

*Ruppia megacarpa*, *Myriophyllum propinquum* and possible new *Myriophyllum* taxa.

*R. megacarpa* was the dominant macrophyte on the margin of Te Whanga Lagoon, also occurring in Lakes Pateriki and Rotorua. *M. propinquum* was reported from the Chathams by Johnson & Brooke (1989), but not by de Lange et al. (1999a). Submerged and emergent forms of this species were collected from Taoroa Pool, the drained Port Hutt lake and the lake opposite Tennants Lake. Two emergent milfoils with pinnate emergent leaves were collected from Washout Creek and the pool near Lake Kaingarahu. The Washout Creek plants (collection no. CH57A04) had the floral characters of *M. triphyllum* (short hairy stigmas, lanceolate bracteoles) but lacked the almost entire ovate leaves typical of emergent *M. triphyllum* (e.g. collection no. CH1510, Lake Rotorua). The Kaingarahu pool plant (collection no. CH08A02) had slightly more dissected leaves than the Washout Creek specimen. Although the bracteoles were lanceolate (a character of *M. triphyllum*) the stigmas were plumose (possibly a character of *M. robustum*). This latter species, a nationally endangered endemic New Zealand plant (de Lange et al. 1999b), has not been recorded from the Chatham Islands. Submerged plants of *M. triphyllum* were found in the saline waters of Lake Pateriki, an unusual habitat for this species.

##### **Turf and emergent species**

*Crassula sinclairii* and *Baumea arthrophylla*

*C. sinclairii* was collected from Lake Te Roto. de Lange et al. (1999a) report a collection of the similar *C. bunua* (AK 229937). *B. arthrophylla*, collected from Lakes Makuku and Omutu, is distinguished from *B. rubiginosa* (collected at the lake opposite Tennants Lake) by the white nuts and the more slender flowerhead.

##### **Other species**

Other species of interest included *Isolepis inundata* collected from the marginal turf of Lake Makuku and a large-leaved *Hydrocotyle*. *I. inundata* was reportedly collected by Jane in 1997, but this specimen was subsequently determined as *I. habra* (de Lange et al. 1999a). Fertile material of *Hydrocotyle*

was collected from marginal turf adjacent to Lake Kairae (collection no. CH0710). Fruit of this species were apparently closer to *H. moschata* than *H. novae-zelandiae* (D. Burnett pers. comm.)

#### 4.2.2 Species of limited distribution

Several macrophytes were far more restricted in range than would be predicted based on available habitat, including *Chara braunii*, *Crassula sinclairii*, *Myriophyllum propinquum*, and *Nitella bookeri* var. *tricellularis*. Similarly other species reported by de Lange et al. (1999a), including *Schoenoplectus tabernaemontani*, *Lemna minor*, *Potamogeton pectinatus*, *Glossostigma elatinooides*, and *G. submersum* (recorded as *G. diandrum*), were not seen in this survey. There appears to be a new wave of introduction of indigenous New Zealand plants to the Chatham Islands and this may result from the relatively recent invasion of black swans (*Cygnus atratus*) and possibly other waterfowl migrating between New Zealand and the Chatham Islands.

### 4.3 FAUNA IN THE LAKES

The following records exist in the NIWA Freshwater Fish Database from a 1989 survey (Table 4). In addition to smelt and shortfinned eels reported in the current report, species collected in these lakes were longfinned eel (*Anguilla dieffenbeckii*), inanga (*Galaxias maculata*) and Crans bully (*Gobiomorphus buttoni*). Washout Creek had a larger fish fauna with both eel species, inanga, banded kokopu (*Galaxias fasciatus*) and koaro (*Galaxias brevipinnis*).

TABLE 4. NUMBER AND/OR ABUNDANCE OF FISH SAMPLED FROM LAKES IN THE CURRENT SURVEY.

Taken from the NIWA Freshwater Fish Database. Species are coded by the first three letters of genus and species name (e.g. Ret ret = *Retropinna retropinna*)

	Ang die	Ang aus	Gal mac	Gob hut	Ret ret	NONE
Lake Kaingarahū						0
Lake Makuku					abundant	
Lake Marakapia						0
Lake Pateriki					abundant	
Lake Rangitai						0
Lake Te Wapu			1		abundant	
Lake Huro				rare	abundant	
Lake Huro	2	5		3	58	
Lake Huro tributary	common	1				
Tennants Lake					common	

The low abundance of fish species encountered on the current survey may be an artefact of the sampling techniques used, i.e. gee-minnow trapping in shallow water for diurnal species, and underwater observation. Overnight traps would target nocturnal species such as bullies (*Gobiomorphus* spp.) and kokopu species (*Galaxias* spp.), and other fishing techniques (e.g. fyke nets) would target other species like eels. Nets set in or at the bottom depth limit of

submerged macrophyte beds would sample benthic fish in this habitat, and sampling of tributaries would target species moving in or out of the lakes on a daily basis.

The invertebrate fauna of the waterbodies sampled appeared to be depauperate compared to similar waterbodies in New Zealand. Common New Zealand animals like koura (*Paranephrops* spp.) and freshwater mussels (*Hyridella* spp.) were absent.

Of interest was the non-indigenous snail *Physa acuta*. This species was widespread in many of the lakes (as is the case in New Zealand), but it is likely that this species was introduced to the Chathams naturally, via waterfowl.

The long-horned caddis (Leptocerid) larva with the turquoise blue abdomen, is almost certainly *Oecetis chathamensis* Tillyard, a species apparently endemic to the Chatham Islands. This species was described from a single male adult caught at the Ngaio in 1924 (Tillyard 1925). The larvae collected vary from the two other described species *O. unicolor* and *O. iti*, which have white and pale cream abdomens respectively (Cowley 1978).

#### 4.4 OTHER MANAGEMENT ISSUES

Apart from the lakes on the eastern shore of Te Whanga Lagoon and the pool in Ocean Mail Reserve, all other sites are in private ownership. None of the lakes is protected from grazing livestock, especially cattle, which have well documented deleterious impacts on lake health and vegetation (e.g. Tanner 1992). These include:

- consumption of marginal vegetation often resulting in the loss of the emergent zone, or displacing it to water deeper than 1 m,
- pugging, compaction, erosion and resuspension of lakeshore sediments,
- nutrient and bacterial addition by faeces and urine.

The removal of marginal vegetation also increases the likelihood of wind and wave action causing more sediment resuspension leading to increasing water turbidity. Impacts of cattle were evident by hoof prints and faeces surrounding the lakes, but also the lack of tall emergent or marginal vegetation apart from fenced-off areas (e.g. Lakes Rotorua and Te Wapu). Nutrient addition through direct contributions of livestock, and the removal of marginal and emergent vegetation, which provides a nutrient filtering role, are likely to contribute to the planktonic algal blooms resulting in poor water clarity. The shallow nature of these waterbodies makes them particularly prone to this eutrophication.

The destruction of the lake near Port Hutt through drainage also illustrates how vulnerable such shallow waterbodies are to water removal.

## 5. Recommendations

The authors recommend that DOC should:

- Undertake a vegetation survey of remaining fresh waterbodies on Chatham Island, especially the lakes of the southern tableland (e.g. Lake Rakiura). These should be complemented by surveys of fish, invertebrates, and water quality.
- Carry out taxonomic studies on the *Myriophyllum triphyllum*-like plants to determine their identity and also conservation status.
- Maintain the high level of awareness of the threat posed by alien invasive species. Determine the possible presence of ornamental ponds or aquaria on the Chatham Islands and if relevant identify their contents.
- Promote the value of these waterbodies as unique and close to pristine habitat. Advocate the exclusion of livestock from waterbodies on the island, and the prevention of further drainage of them. Identify landowners willing to fence off lakes with good water clarity and continue to keep stock out of the reserve on the eastern shore of Te Whanga Lagoon.

## 6. Acknowledgements

We thank John Sawyer (Wellington Conservancy, DOC) for organising, providing maps and lake co-ordinates, and, with Peter de Lange (Science & Research Unit, DOC), for conceiving the field visit resulting in this report. On Chatham Island we received great assistance from Adrian Couchman (who identified land owners and also navigated on day one of fieldwork), Maria Pascoe (who organised vehicles, food, etc.), Amanda Baird (for information on the Chatham's flora), and the field staff, who made the trip very enjoyable and rewarding. Thanks also to the many landowners who consented to our requests to access lakes through their properties.

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# Appendix 1

## PLANT SPECIES RECORDED IN 24 WATER-BODIES ON CHATHAM ISLAND

Numbers refer to modified Blaun-Blanquet cover class (1 = 1-5%, 2 = 6-25%, 3 = 26-50%, 4 = 51-75%, 5 = 76-95%, 6 = 96-100%). \* Indicates plants alien to the Chatham Islands. § Plants found in tributary stream. For lake codes refer to Table 1.

	3	4	6	7	8	8a	10	12	13	14	15	16	23	24	25	32	34	57	57a	73	76	82	82a	L	
<b>Submerged</b>																									
<i>Callitriche petriei</i> subsp. <i>chathamensis</i>														1	+		1	+					+	+	
<i>Chara braunii</i>																							+		
<i>Chara globularis</i>	1	3						6	+		1			1	6					5	1				
<i>Crassula sinclairii</i>														1											
<i>Fissidens</i> sp.																							+		
<i>Gracilaria chilensis</i>																									1
<i>Juncus articulatus</i> *																					1?				
<i>Lamprothamnium</i> sp.	1						1		+													3			
<i>Lepilaena bilocularis</i>	1						4		+			1		1								1			
<i>Lilaeopsis novae-zelandiae</i>		2	+					3	+		1										1	1	+	+	
<i>Limosella lineata</i>	1		+																		1				
<i>Myriophyllum pedunculatum</i> subsp. <i>novae-zelandiae</i>	1		+							+											2				
<i>Myriophyllum propinquum</i>													+						+					+	
<i>Myriophyllum triphyllum</i>	1	1	+	1			1	1	+		1				1		1	+			1	1	+		
<i>Nitella hookeri</i> var. <i>tricellularis</i>																							+	+	
<i>Nitella hyalina</i>	2	2	+					2	+		2			1	2						3	3	+		
<i>Potamogeton cheesemanii</i>									+					+	+		1					1	+	+	
<i>Potentilla anserinoides</i>																	1								
<i>Ranunculus acaulis</i>								1																	
<i>Ruppia megacarpa</i>							1				1														4
<i>Ruppia polycarpa</i>	1	1					2	1	+		2	2			1						1	1			
<i>Schoenus maschalinus</i>									+																
<i>Sphagnum</i> sp.													+												
<i>Triglochin striata</i>								1	+									2			1		+	+	

	3	4	6	7	8	8a	10	12	13	14	15	16	23	24	25	32	34	57	57a	73	76	82	82a	L				
<b>Free-floating</b>																												
<i>Spirodela punctata</i> *																				+								
<b>Emergent</b>																												
<i>Apodasmia similis</i>				+			+		+		+	6									+	+	+					
<i>Baumea arthrophylla</i>									+												4							
<i>Baumea rubiginosa</i>																							+					
<i>Callitriche petriei</i> subsp. <i>chathamensis</i>							+												+		+							
<i>Callitriche stagnalis</i> *																					+							
<i>Centella uniflora</i>																									1			
<i>Dichondra repens</i>																									+			
<i>Eleocharis acuta</i>				+	+		+			+	+		+	+	+						+	+		5		+		
<i>Gunnera monoica</i>																									+			
<i>Isolepis nodosa</i>								+							+										+			
<i>Isolepis prolifer</i>														+											+	+		
<i>Juncus kraussii</i> var. <i>australiensis</i>								+																	2	+		
<i>Juncus pallidus</i> *				+	+																							
<i>Myriophyllum triphyllum</i>																										+		
<i>Myriophyllum</i> sp.								+																				
<i>Nasturtium officinale</i> *																										+		
<i>Persicaria decipiens</i>																										+	+	
<i>Potamogeton cheesemani</i>										+					+	+										1	+	+
<i>Ranunculus amphitrichus</i>										+																+	+	
<i>Schoenoplectus pungens</i>																2										+		

	3	4	6	7	8	8a	10	12	13	14	15	16	23	24	25	32	34	57	57a	73	76	82	82a	L
<b>Marginal turf</b>																								
<i>Acaena novae-zelandiae</i>							+																	
<i>Ammophila arenaria</i> *							+																	
<i>Anagallis arvensis</i> *							+																	
<i>Apium prostratum</i> var. <i>denticulata</i>				+																				
<i>Callitriche petriei</i> subsp. <i>chathamensis</i>	+		+								+								+					
<i>Centella uniflora</i>			+	+					+				+											
<i>Cotula coronopifolia</i>			+				+																	
<i>Epilobium billardioreanum</i>				+					+															
<i>Gunnera monoica</i>																							+	
<i>Holcus lanatus</i> *				+																				
<i>Hydrocotyle novae-zelandiae</i> ?			+	+					+															
<i>Isolepis distigmata</i>																							+	
<i>Isolepis inundata</i>									+															
<i>Juncus articulatus</i> *			+	+					+															
<i>Juncus bufonius</i> *	+			+																				
<i>Lachnagrostis billardierei</i>				+																				
<i>Lachnagrostis filiformis</i>			+																					
<i>Leptinella squalida</i>			+	+			+		+															
<i>Lilaeopsis novae-zelandiae</i>	+		+	+			+		+		+				+									
<i>Lobelia anceps</i>	+			+			+		+				+											
<i>Limosella lineata</i>	+		+												+									
<i>Mentha spicata</i> *	+																						+	
<i>Myosotis laxa</i> var. <i>caespitosa</i> *	+																							
<i>Myriophyllum pedunculatum</i> subsp. <i>novae-zelandiae</i>			+	+					+		+		+						+					
<i>Myriophyllum propinquum</i>															+								+	
<i>Myriophyllum triphyllum</i>			+	+							+													
<i>Myriophyllum votschii</i>			+					+			+													
<i>Plantago coronopus</i> *				+																				
<i>Potamogeton cheesemanii</i>											+							+					+	
<i>Potentilla anserinoides</i>	+		+	+					+									+						
<i>Pratia arenaria</i>			+	+			+						+											
<i>Prunella vulgaris</i> *				+																				
<i>Pseudognaphalium luteoalbum</i>				+											+									
<i>Ranunculus acaulis</i>							+	+																
<i>Ranunculus amphitrichus</i>			+	+																		+	+	
<i>Ranunculus reflexus</i>				+																				
<i>Rorippa palustris</i>	+																							
<i>Sagina procumbens</i> *				+																				
<i>Selliera radicans</i>				+					+				+						+					
<i>Triglochin striata</i>	+		+	+					+		+		+						+					
<i>Trifolium dubium</i> *			+	+																				