Guidelines for conservation of salt pans in Central Otago

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CONTENTS

Abstract

The Department of Conservation requested a summary of the distribution and biophysical characteristics of known Central Otago salt pans, an appraisal of the rarity of habitat and biota represented and the degree of threat to each site, and site-by-site descriptions and guidelines for conservation management.

Twenty-four salt pan sites are described and ranked. There are seven sites of major importance for biological conservation, and a further nine of moderate importance. Some adjustments in management, and monitoring of the results, are required for their protection.

The seven major sites should be formally protected. Irrigation, cultivation, direct drilling, oversowing, fertiliser application and fire should be avoided. Cattle and vehicles should be excluded, and sheep from areas with seasonally wet soils. The effects of grazing and trampling should be monitored on the seven highest ranked sites. Erosion should be monitored at the Chapman Road and Chatto Creek sites. Aggressive exotic perennial weeds should be eradicated. *Plantago coronopus*, exotic *Puccinellia* species and *Hordeum* species should be prevented from establishing where absent. Buffer zones of short sparse vegetation should be used to reduce fire risk. Soil physical and chemical properties associated with important native plant species should be determined. Detailed soil and vegetation surveys should be undertaken on the five top-ranked sites which lack them. The use of GIS should be considered for plotting existing information and recording changes. Faunal surveys should be undertaken to the same standard for all the sites. Conservation management of threatened plant species should be restricted to their present sites until plant-soil relationships are better understood. This report should be revised within five years to take account of new and improved information gained in the interim.

1. Introduction

Saline and alkaline soils are commonly known as salt pans. For the purpose of this report they are defined as sites with saline (conductivity >400 µS) or alkaline (pH >7.0) soil horizons, or supporting flora and/or fauna known to be halophytic. They formerly covered more than 40 000 ha of semi-arid land in the Maniototo basin, mid-Manuherikia Valley, and upper Clutha Valley (Raeside & Cutler 1966; Leamy & Saunders 1967; Orbell 1974). Mining, cultivation and irrigation have reduced the area of these soils to less than 100 ha. There are about 30 sites remaining in Central Otago (McIntosh *et al.* 1990, 1992). Although they have not been cultivated, all have been grazed, most have also been modified by influences such as erosion and application of fertiliser, and some by irrigation. Most are dominated by exotic plant species, and some have no native plant species at all.

Of the few native plants that are found on inland saline soils, almost all also occur in salt marsh and related communities on the coast, for example *Sarcocornia quinqueflora*, *Apium prostratum*, *Selliera* cf. *microphylla* (col.) and *Atriplex buchananii*. The exception is *Lepidium kirkii*, a small cress considered endangered (Cameron *et al*. 1993) and known only from about 200 plants at six localities in Central Otago (Allen 1992).

Most salt pans are now surrounded by non-saline agricultural land that has little or no indigenous character. However, a few are adjacent to non-saline land that still supports plant species representative of the pre-European flora. Many of these species are now absent from most of the region, and some are considered nationally threatened (Cameron *et al*. 1993). Despite modifications (e.g., by grazing and erosion), these areas are considered to be extremely important for conservation of the indigenous ecosystems of semi-arid Central Otago (e.g., Ward *et al*. 1987; Allen & McIntosh 1993, 1994).

Information on the soils and biota of salt pans is scattered through several reports and publications. These vary considerably in the detail of their records of the flora and/or fauna, the comprehensiveness of their descriptions of the vegetation and soils, and the degree to which they deal with conservation management. The present report integrates existing information on the distribution and biophysical characteristics of Central Otago salt pans. It provides a basis for assessing conservation needs and guidelines for conservation management.

The report tabulates information on the known salt pans and summarises their key characteristics, threats, and management requirements. It also provides a site-by-site inventory of salt pans, integrating the tabulated information for each site in turn.

2. Methods

1. Compile list of all known salt pans.
2. Tabulate key physical information for each site.
3. Compile lists of:
   (a) soil characteristics,
   (b) flora and plant communities,
   (c) plant species that are notable, threatened, or of restricted distribution,
   (d) invertebrate and vertebrate fauna, where information exists.
4. Rank sites in order of importance for biological conservation on the basis of representativeness, diversity, and rarity.
5. Assess immediate and potential threats.
6. Recommend immediate action, if required, for protection of threatened areas.
7. Recommend management procedures for the long-term protection of salt pans both within and outside the DoC estate.

3. Results

3.1 SALT PANS AND THEIR BIOPHYSICAL CHARACTERISTICS

The salt pans of Central Otago and their biophysical characteristics are listed in tables 1 – 4.

TABLE 1. CENTRAL OTAGO SALT PAN SITES.

SITE	REGISTER NO.	NAME	GRID REFERENCE	STATUS
1	SS1CO	Pisa Flats	NZMS 260 G41 163790	MA
2	SS4CO	Nevis Road	NZMS 260 F42 072570	B
3	SS5CO	Chapman Road	NZMS 260 G42 252435	B
4	SS6CO	Manorburn	NZMS 260 G42 239432	DoC
5	SS7CO	Springvale Junction	NZMS 260 G42 295503	B
6	SS8CO	Chatto Creek	NZMS 260 G42 360578	B
7	SS9CO	Galloway No 1	NZMS 260 G42 338496	CC
8	SS10CO	Moa Creek	NZMS 260 G42 436488	B
9	SS11CO	Patearoa	NZMS 260 H42 714390	OSC
10	SS12CO	Belmont	NZMS 260 H42 681425	CC
11	SS13CO	Wilsons Road	NZMS 260 H42 735486	B
12	SS14CO	Lindis Pass	NZMS 260 G40 338950	B
13	SS15CO	Sutton Lagoon	NZMS 260 H43 833113	B
14	SS16CO	Sutton Salt Lake	NZMS 260 H43 825106	SR
15	SS18CO	Carlowie No 2	NZMS 260 H41 626805	B
16	SS19CO	Blackstone No 2	NZMS 260 H41 595770	B
17	SS20CO	Whiteface	NZMS 260 H41 534688	B
18	SS21CO	Rockdale	NZMS 260 G42 366589	B
19	SS22CO	Dunard	NZMS 260 G42 301555	B
20	SS23CO	Blackmans	NZMS 260 G42 170457	B
21	SS24CO	Conroys	NZMS 260 G42 213406	DoC
22	SS25CO	Patricks	NZMS 260 G42 227410	B
23	SS26CO	Butchers Dam	NZMS 260 G42 234397	CA
24	-	Galloway No 2	NZMS 260 G42 349500	CC

Site numbers, Register number (McIntosh *et al.* 1990, 1992), names (after McIntosh *et al.* 1990, 1992; Galloway No 2 of Hewitt & Balks 1988, McIntosh 1989, Fagan & Pillai 1992; Manorburn = Gilberts Gully of Patrick 1989), locations and protected status (MA = informal management agreement, DoC = DoC owned, CA = Conservation Area, CC = Conservation Covenant, OSC = QE II Trust Open Space Covenant, SR = Scenic Reserve).

TABLE 2. SITE PHYSICAL CHARACTERISTICS.

SITE	AREA (ha)	ALTITUDE (m)	SLOPE (E)	ASPECT	RAINFALL (mm)
Pisa Flats	15	200	0B15	flat-E	500
Nevis Road	0.5	340	18	SE	500
Chapman Road	1	150	3	NW	350
Manorburn	4	170	0B5	NW	350
Springvale Junction	2	215	0B15	S	350
Chatto Creek	5	245	0B20	W	400
Galloway No 1	2	180	15	N	400
Moa Creek	1	455	0B10	W	455
Patearoa	20	395	0B15	N	500
Belmont	28	395	0B5	flat-E	400
Wilsons Road	1	395	0	flat	395
Lindis Pass	0.5	335	18	W	550
Sutton Lagoon	0.5	240	flat	flat	600
Sutton Salt Lake	4	240	flat	flat	600
Carlowie No 2	6	520	14	NW	500
Blackstone No 2	1	450	25	NW	500
Whiteface	5	420	12	NW	500
Rockdale	1	270	5	S	400
Dunard	0.5	330	flat	flat	400
Blackmans	1	320	0-10	flat-NW	400
Conroys	1	280	8	NW	400
Patricks	0.5	300	6	NW	400
Butchers Dam	1	300	3	NW	400
Galloway No 2	15	220	0B20	NW	400

TABLE 3. SOIL CHARACTERISTICS[1].

SITE	REFERENCE[2]	DEPTH (cm)	pH	CONDUCTIVITY (µS)	CLASSIFICATION [3]
Pisa Flats	a,b	0B0.5	7.3	240	Alkaline Immature Semiarid Soils
		0.5B22	8.5	190	plus
		22B45	8.5	160	Saline Immature Semiarid Soil
		45B50	8.6	180	inclusions
		50B70	8.0	120	
Nevis Road	b	0B15	7.1	1800	Saline Immature Semiarid Soil
		15B45	8.5	590	
		45B90	8.2	1300	
Chapman Road	b	0B10	8.6	9300	Saline Immature Semiarid Soil
		10B100	8.6	620	
Manorburn	c	0B10	5.9	B	Typic Solonetzic Semiarid Soil
		10B20	7.2	B	
		20B29	8.3	B	
		29B38	9.0	B	
		38B76	8.8	B	
Springvale Junction	b	0B1	6.8	430	Saline Immature Semiarid Soil
		1B10	8.0	2300	
		10B40	7.9	4000	
		40B90	8.1	2500	
Chatto Creek	b	0B5	6.7	680	Saline Immature Semiarid Soil
		5B10	4.5	410	
		10B30	4.0	1000	
Galloway No 1	b	0B10	7.0	1700	Saline Immature Semiarid Soil
		10B20	7.6	1980	

SITE	REFERENCE[2]	DEPTH (cm)	pH	CONDUCTIVITY (µS)	CLASSIFICATION [3]
Moa Creek (bare pan)	d	0B8 8B20 20B30 30B40	8.6 9.0 9.7 9.7	660 2770 620 250	Saline Immature Semiarid Soil
Moa Creek (under *Selliera*)	d	0B10 10B20	8.2 8.8	1500 1500	Saline Immature Semiarid Soil
Patearoa	e	0B40 40B80 80B100	9.8 9.0 7.7	1000 420 46	Saline Immature Semiarid Soil plus Alkaline Immature Semiarid Soil
Belmont	d	crust 0B6 6B15 15B50 50B90 90B100	7.5 7.8 7.8 7.9 8.1 8.1	5200 1900 1400 780 570 400	Saline Immature Semiarid Soil
Wilsons Road	b	0B20 20B40 40B70	9.4 9.3 9.5	920 1000 560	Saline Immature Semiarid Soil
Lindis Pass	b	0B20 20B50 50B70	5.6 7.0 9.5	27 82 140	Alkaline Immature Semiarid Soil
Sutton Lagoon	b	0B15 15B60 60B70 70B80	6.3 7.7 7.9 8.2	230 380 170 160	Typic Fluvial Recent Soil
Sutton Salt Lake	b	0B20 20B40	9.1 9.3	1500 1100	Saline Immature Semiarid Soil
Carlowie No 2	f	0B10 10B30 30B60 60B70	4.2 7.6 8.2 10.1	18 110 60 400	Mottled Immature Semiarid Soil
Blackstone No 2	f	0B18 18B24 24B45	6.9 8.8 9.9	70 190 180	Alkaline Immature Semiarid Soil
Whiteface	f	0B18 18B46 46B80	5.2 6.5 8.8	72 120 270	Alkaline Immature Semiarid Soil
Rockdale	f	0B10 10B40 40B55	6.0 7.8 10.0	140 500 570	Alkaline Argillic Semiarid Soil
Dunard	f	0B15 15B35 35B65 65B70	9.0 9.9 10.0 9.3	150 300 340 130	Typic Solonetzic Semiarid Soil
Blackmans	f	0B9 9B18 18B37 37B52 52B60	6.6 7.1 9.0 9.6 9.7	75 140 900 960 790	Saline Solonetzic Semiarid Soil

SITE	REFERENCE[2]	DEPTH (cm)	pH	CONDUCTIVITY (µS)	CLASSIFICATION [3]
Conroys	f	0B10	7.3	260	Saline Solonetzic Semiarid Soil
		10B37	8.4	800	
		37B52	8.6	3000	
		52B62	8.7	1600	
Patricks	f	0B18	5.7	45	Saline Argilllic Semiarid Soil
		10B25	4.9	310	
		25B60	9.0	900	
Butchers Dam	f	0B6	5.9	78	Alkaline Immature Semiarid Soil
		6B20	6.8	120	
		20B60	8.3	470	
		80B95	8.1	530	
Galloway No 2	f,g	0B3	8.3	130	Saline Immature Semiarid Soil
		3B13	8.0	390	
		13B23	9.0	1700	
		23B33	8.0	2900	

Notes:

[1]Only results for saline/alkaline soils are presented

[2]References:

a) Allen & McIntosh (1994)
b) McIntosh *et al*. (1990)
c) Soil Bureau (1968)
d) New data collected April 1995 (PDM)
e) Allen & McIntosh (1993)
f) McIntosh *et al*. (1992)
g) McIntosh (1989)

[3] Not all soils classified as Semiarid Soils in this table meet the requirement of having a weathered B horizon 10 cm or more thick, or a calcareous horizon. As no provision is made for saline or alkaline groups or subgroups in other soil orders such as Recent or Anthropic Soils, the key in the New Zealand Classification (Hewitt 1992) has not been strictly followed, and all soils with alkaline or saline horizons have been included in the Semiarid Soil order.

TABLE 4. NATIVE AND EXOTIC (*) PLANT SPECIES RESTRICTED TO SALINE SOILS (HALOPHYTES), AND SPECIES WHICH WERE RECORDED IN MCINTOSH *ET AL.* (1990, 1992), JOHNSON (1976), PARTRIDGE (1981), AND ALLEN & MCINTOSH (1993, 1994) AND ARE NOTED IN THE NEW ZEALAND THREATENED AND LOCAL PLANT LISTS (CAMERON *ET AL.* 1993). NON-HALOPHYTE EXOTIC SPECIES ARE NOT INCLUDED. COMPLETE SPECIES LISTS ARE AVAILABLE FOR SITES 1 (PISA FLATS; ALLEN & MCINTOSH 1994), 9 (PATEAROA; ALLEN & MCINTOSH 1993, JOHNSON 1976), AND 10 (BELMONT; JOHNSON 1976).

SITE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Species																								
Apium prostratum			+	+					+													+		
Atriplex buchananii	+	+	+	+	+	+	+	+	+	+								+	+	+	+	+	+	+
*Atriplex prostrata**									+															
Ceratocephalus pungens																			+				+	
Chenopodium glaucum			+											+						+				
Craspedia "Kaitorete"	+																							
*Hordeum hystrix**									+		+											+		+
Hordeum spp.*					+		+	+		+			+											
Lepidium kirkii			+			+	+		+	+	+							+				+		+
Lepidium sisymbrioides subsp. *matau*							+																	
Lepidium sisymbrioides subsp. *sisymbrioides*	+					+			+							+								
Leptinella "Clutha"	+																							
Myosurus minimus subsp. *novae-zelandiae*										+								+	+	+		+	+	
*Plantago coronopus**					+			+	+	+			+		+			+				+		+
*Puccinellia distans**									+	+	+				+							+		+
Puccinellia spp.*				+	+					+								+	+					
Puccinellia raroflorens			+			+	+	+	+											+	+	+	+	+
Puccinellia fasciculata			+			+	+	+	+											+	+	+	+	+
Puccinellia stricta			+			+		+	+	+										+		+		+
Samolus repens				+																				
Sarcocornia quinqueflora										+														
Schoenoplectus pungens									+	+														
Selliera microphylla								+	+	+			+											
*Trifolium fragiferum**									+															

3.2 PLANT COMMUNITIES

Plant community descriptions are available for some sites as follows:

Site 1: Pisa Flats (Ward *et al.* 1987; Allen & McIntosh 1994)

Communities of non-saline soils (numbered after Allen & McIntosh 1994, which contains full descriptions):

1. *Raoulia australis/Hypochoeris radicata* herbfield
2. *Convolvulus verecundus/Vittadinia australis* herbfield
3. *Raoulia australis/Scleranthus biflorus/Myosotis uniflora* herbfield
4. *Raoulia australis/R. monroi* herbfield

5b. *Poa cita/Poa pratensis* grassland

5c. *Poa pratensis/Lolium perenne* grassland

6. *Carmichaelia petriei/Raoulia australis* shrub herbfield

Communities of saline soils:

5a. *Atriplex buchananii* salt pan: salt pans with crusted silty soils (Alkaline Immature Semiarid Soils and Saline Immature Semiarid Soils) of the highest pH and conductivity carry few plants, including the salt-tolerant grass *Hordeum hystrix* and clover *Trifolium fragiferum*, and are characterised by *Atriplex buchananii*.

Site 8: Moa Creek (Partridge 1976, 1981; Johnson 1976; McIntosh 1989)

Salty soils (Saline Immature Semiarid Soils) support *Atriplex buchananii*, *Plantago coronopus*, *Selliera microphylla* and *Puccinellia stricta*, and where salts are washed out onto non-saline soils less tolerant species such as *Hordeum hystrix* are found.

Site 9: Patearoa (Partridge 1976, 1981; Johnson 1976; Allen & McIntosh 1993)

Communities of low pH, low conductivity soils (see Allen & McIntosh 1993 for full descriptions):

1. Short tussock grassland with *Hieracium pilosella*, *Anthoxanthum odoratum*, *Agrostis capillaris*, *Melicytus alpinus*, *Poa colensoi*, *Festuca novae-zelandiae*.
2. Depleted herbfield/shrubland with *Vittadinia australis*, *Raoulia australis*, *Carmichaelia monroi*.
3. Grassland/herbfield with *Rumex acetosella*, *Poa maniototo*, *Raoulia hookeri*, *Elymus* sp. and exotic annual herbs.
4. Exotic perennial grassland/herbfield with *Trifolium dubium*, *T. repens*, *Poa pratensis*, *Stellaria gracilenta*, *Cerastium* sp.

Communities of permanently moist or wet soils of near-neutral pH and low salinity:

5. Sedgeland/rushland with *Carex coriacea*, *Juncus* spp., *Glyceria fluitans*.

Communities of soils with relatively high pH and conductivity:

6. Salt meadow on slightly salty moist areas (Alkaline Immature Semiarid Soils and Mottled Orthic Recent Soils; including old meander) with *Schoenoplectus pungens, Hordeum jubatum*, *Rumex crispus*, *Agrostis stolonifera*, *Trifolium fragiferum*, *Apium prostratum*, *Selliera microphylla.*
7. Salt grassland/herbfield on dry salt pan (Saline Immature Semiarid Soils) with *Hordeum hystrix*, *Puccinellia* spp., *Plantago coronopus*, *Atriplex buchananii*.

Site 10: Belmont (Partridge 1976, 1981; Johnson 1976)

Hollows which remain from old oxbows (Saline Immature Semiarid Soils) contain zones of *Schoenoplectus pungens/Poa pratensis*, *Agrostis stolonifera/Hordeum jubatum* and *Puccinellia distans*. Adjacent bare salty soil carries *Sarcocornia quinqueflora*.

Site 11: Wilsons Road (Partridge 1976, 1981)

Scattered pans (Saline Immature Semiarid Soils) support sparse vegetation with salt-tolerant species including *Hordeum hystrix* and *Puccinellia distans*. *Lepidium kirkii* has been recorded here in an area of *Poa cita* tussocks.

Site 24: Galloway No 2 (Partridge 1976, 1981; Johnson 1976; Fagan & Pillai 1992)

Saline patches (Saline Immature Semiarid Soils) on a gently sloping fan carry *Plantago coronopus*, *Puccinellia distans* and *Hordeum hystrix*, with *Atriplex buchananii* growing alone on bare soil with a salty efflorescence. *Lepidium kirkii* was recorded here by McIntosh (1989) and Fagan & Pillai (1992).

3.3 VERTEBRATE AND INVERTEBRATE FAUNA

All sites are grazed by rabbits, most by sheep, and some by cattle. The vertebrate fauna has not been formally recorded, but the sites are accessible to all the common mammal, bird and reptile species of the region. Banded dotterel and white-fronted tern have been recorded at site 1, Pisa Flats (McIntosh *et al*. 1990).

Invertebrate faunal information is available mainly for moths (after Patrick 1989, 1994; McIntosh *et al*. 1990, 1992; and additional records from B.H. Patrick, pers. comm.).

TABLE 5. INVERTEBRATE SPECIES RECORDED AT EACH SITE.

SITE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Species																								
Arctesthes catapyrrha								+	+					+								+		
Athrips zophochalca							+																	+
Capua semiferana	+		+					+	+											+	+	+		+
Crocydopora cinigerella									+											+		+		+
Dichromodes sp. nov.	+																					+		
Eudonia atmogramma																						+		
Eudonia gyrotoma	+																							
Eudonia sabulosella			+						+					+						+	+	+		+
Eudonia leptalea			+		+				+					+						+		+		+
Eurythecta zelaea	+		+	+			+	+	+	+	+			+			+	+	+	+	+	+	+	+
Heliothis sp. nov.							+															+		
Hierodoris frigida																						+		
Kiwaia pharetria																								
Kiwaia thyraula			+		+	+	+	+												+	+	+	+	
Loxostege sp. nov.	+		+	+	+	+	+		+											+	+	+	+	+
Lycaena boldenarum									+					+										
Orocrambus corruptus	+		+		+		+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+
Oxythecta austrina	+					+																+		+
Paranotoreas brephosata			+	+					+													+		
Paranotoreas fulva	+		+	+	+	+	+	+	+	+	+							+			+	+	+	+
Phaeosaces sp. nov.									+	+												+		
Phylacodes cauta												+		+	+									
Scoparia exilis			+				+													+		+		+
Scopula rubraria				+	+		+		+													+		+
Scoriodyta suttonensis									+													+		
Scythris triatma									+		+													
Sporophylla oenospora									+													+		
Stenoptilia celidota	+								+													+		
Zizina oxleyi									+													+		+
grasshoppers:																								
Sigaus campestris									+															
Sigaus minutus							+																	

3.4 RANK FOR BIOLOGICAL CONSERVATION VALUE

For most sites, biophysical, particularly invertebrate, information is incomplete. It is possible, however, to assess/compare the importance of sites for biological conservation using other criteria: the rarity and diversity of their biota and soils; and the degree to which they represent the hypothetical natural state of the pre-European landscape.

Scoring took into account the whole site encompassing the salt pan, so sites with salt pans in a relatively unmodified landscape were given a higher score than those surrounded by highly modified land. Table 6 summarises the sites assessed and their importance for biological conservation.

TABLE 6. SITES RANKED FOR THEIR IMPORTANCE FOR BIOLOGICAL CONSERVATION ON THE BASIS OF AREA (1 = 1–4 ha, 2 = 5–10 ha, 3 = >10 ha), RELATIVE REPRESENTATIVENESS (THE EXTENT TO WHICH THEY REPRESENT THE POSTULATED 1840 CONDITION; REP; 0–3), DIVERSITY (DIV; 0–3) AND RARITY (RAR; 0–3) OF BIOTA AND SOILS. 1 = HIGHEST OVERALL RANK.

	BIOTA				SOILS			TOTAL SCORE	RANK
SITE	AREA	REP	DIV	RAR	REP	DIV	RAR		
Pisa Flats	3	3	3	3	3	3	2	20	1
Nevis Road	1	1	1	1	1	0	1	6	10
Chapman Road	2	2	2	3	3	0	2	14	3
Manorburn	2	1	1	2	3	0	3	12	5
Springvale Junction	1	1	1	1	1	0	2	7	9
Chatto Creek	2	2	2	3	1	0	1	11	6
Galloway No. 1	1	2	2	3	3	2	2	15	2
Moa Creek	1	1	2	2	2	2	2	12	5
Patearoa	3	3	3	3	3	3	2	20	1
Belmont	3	2	2	3	2	0	2	15	2
Wilsons Road	1	0	1	1	2	1	2	7	9
Lindis Pass	1	0	0	0	1	0	2	4	11
Sutton Lagoon	1	1	1	1	1	1	1	7	9
Sutton Salt Lake	1	2	1	1	2	2	2	11	6
Carlowie No. 2	2	2	2	1	2	2	2	13	4
Blackstone No. 2	1	2	1	1	2	2	2	11	6
Whiteface	2	1	0	0	1	1	2	7	9
Rockdale	1	1	2	2	3	2	2	13	4
Dunard	1	1	1	2	2	2	3	12	5
Blackmans	1	2	2	2	2	2	3	14	3
Conroys	1	1	1	1	1	1	3	9	8
Patricks	1	2	2	2	1	2	2	12	5
Butchers Dam	1	1	1	1	2	2	2	10	7
Galloway No. 2	3	2	2	1	3	1	2	14	3

The top-ranked sites are Pisa Flats, Patearoa, Belmont, Galloway No. 1, Chapman Road, Blackmans and Galloway No. 2, with scores of 14 or more and ranking 3 or higher. A further nine sites with scores of 11 or more and ranking 6 or higher are of moderate importance.

3.5 IMMEDIATE AND POTENTIAL THREATS

Most immediate threats to salt pan areas are out of the land occupier's control. For example, recent damage to the protected area at site 7 (Galloway No. 1) resulted from a fire started to control roadside vegetation, and from spoil deposited by an excavator operator clearing the adjacent irrigation channel. A further threat came from the establishment of the weed stonecrop (*Sedum acre*) which arrived at the adjacent roadside in spoil dumped there from another part of the district.

Several sites are threatened by wind and water erosion. The effects of agricultural management such as irrigation, cultivation, oversowing and seed drilling are irreversible.

The native flora at most sites is small, and constantly under threat of displacement by exotic species. Table 7 summarises the threats to identified salt pan areas.

TABLE 7. IMMEDIATE (I) AND POTENTIAL (P) THREATS TO EACH SITE.

	RANK	ROAD	DUMP	FIRE	EROS	IRRN	CULT	FERT	SEED	WEED	GRAZ
Pisa Flats	1	-	-	-	-	p	p	p	p	p	-
Nevis Road	10	-	-	-	p	-	-	p	p	p	p
Chapman Road	3	-	-	-	p	p	p	p	p	-	p
Manorburn	5	-	-	-	p	-	-	-	-	-	-
Springvale Junction	9	p	p	-	i	-	-	-	-	p	p
Chatto Creek	6	-	-	p	i	-	p	p	p	i	p
Galloway No. 1	2	-	p	p	-	-	-	p	p	p	-
Moa Creek	5	-	-	-	-	p	p	p	p	p	p
Patearoa	1	-	-	p	-	p	-	p	p	p	-
Belmont	2	-	-	p	-	-	-	p	p	p	i
Wilsons Road	9	-	-	-	-	i	i	p	p	p	i
Lindis Pass	11	-	-	-	-	-	p	p	p	-	-
Sutton Lagoon	9	-	-	p	-	-	-	p	p	p	p
Sutton Salt Lake	6	-	-	-	-	-	-	p	-	-	-
Carlowie No. 2	4	-	-	p	p	-	-	p	p	p	p
Blackstone No. 2	6	-	-	-	p	-	-	p	p	p	p
Whiteface	9	-	-	-	i	-	-	p	p	p	i
Rockdale	4	-	-	-	-	p	p	p	p	-	p
Dunard	5	-	-	-	-	-	-	p	p	p	p
Blackmans	3	-	-	-	-	-	-	-	p	-	-
Conroys	8	p	-	-	p	-	-	p	p	-	-
Patricks	5	-	-	-	-	-	-	-	-	p	-
Butchers Dam	7	-	-	-	-	-	-	-	-	p	-
Galloway No. 2	3	-	-	-	-	-	-	-	-	-	p

Road = roadworks; dump = dumping of excavated spoil or rubbish; eros = natural wind or water erosion; irrn = direct or incidental irrigation; cult = cultivation; seed = deliberate or incidental oversowing, or direct drilling; fert = deliberate or incidental fertiliser application; weed = invasion by exotic plant species, including those deliberately planted; graz = stock effects, including grazing, trampling, tracking and nutrient transfer.

3.6 SUMMARISED DESCRIPTIONS OF SALT PANS

Site 1: Pisa Flats

NZMS 260 G41 163790
area 15 ha
altitude 200 m
slope 0–15E
aspect flat–E
rainfall 500 mm
informal management agreement

- Soils present:

  Typic Immature Semiarid Soils, acid brown phase
  Typic Immature Semiarid Soils
  Typic Orthic Recent Soils
  Saline Immature Semiarid Soils
  Alkaline Immature Semiarid Soils
  Acid Fluvial Recent Soils

- Halophyte, threatened or unusual flora:

  Atriplex buchananii, *Craspedia* "Kaitorete", *Leptinella* "Clutha", *Lepidium sisymbrioides* subsp. *sisymbrioides*

- Important invertebrate fauna:

  Capua semiferana, *Dichromodes* sp. nov., *Eudonia gyrotoma*, *Eurythecta zelaea*, *Heliothis* sp. nov., *Loxostege* sp. nov., *Orocrambus corruptus*, *Oxythecta austrina*, *Paranotoreas fulva*, *Stenoptila celidota*

- Rank for conservation: 1

- Threats:

  irrigation, cultivation, fertiliser, oversowing, weeds; no immediate threats

- Other information

  This site was ranked as a Soil Site of International Importance by Arand *et al.* (1991)

- References:

  Allen & McIntosh (1994); Arand *et al.* (1991); McIntosh *et al.* (1990); Patrick (1989); Ward *et al.* (1987)

Site 2: Nevis Road

NZMS 260 F42 072570
area 0.5 ha
altitude 340 m
slope 18E
aspect SE
rainfall 500 mm
no protection

- Soils present:

  Saline Immature Semiarid Soil

- Halophyte, threatened or unusual flora:

  Atriplex buchananii

- Important invertebrate fauna:

  nil

- Rank for conservation: 10

- Threats:

  erosion, fertiliser, oversowing, weeds, grazing; no immediate threats

- References:

  McIntosh *et al*. (1992)

Site 3: Chapman Road

NZMS 260 G42 252435
area 1 ha
altitude 150 m
slope 3E
aspect NW
rainfall 350 mm
no protection

- Soils present:

  Saline Immature Semiarid Soil

- Halophyte, threatened or unusual flora:

  Apium prostratum, *Atriplex buchananii*, *Chenopodium glaucum*, *Lepidium kirkii*, *Myosurus minimus* subsp. *novae-zelandiae*, *Puccinellia raroflorens*, **Puccinellia fasciculata*, *Puccinellia stricta*

- Important invertebrate fauna:

  Capua semiferana, *Eudonia sabulosella*, *Eudonia leptalea*, *Eurythecta zelaea*, *Kiwaia thyraula*, *Loxostege* sp. nov., *Orocrambus corruptus*, *Paranotoreas brephosata*, *Paranotoreas fulva*, *Scoparia exilis*

- Rank for conservation: 3

- Threats:

  erosion, irrigation, fertiliser, cultivation, oversowing/direct drilling, grazing; no immediate threats

- References:

  McIntosh *et al*. (1990)

Site 4: Manorburn

NZMS 260 G42 239432
area 4 ha
altitude 170 m
slope 0–5E
aspect NW
rainfall 350 mm
DoC owned, gazettal pending as Scientific Reserve

- Soils present:

  Typic Solonetzic Semiarid Soil

- Halophyte, threatened or unusual flora:

  Apium prostratum, *Atriplex buchananii*, *Puccinellia* spp., *Samolus repens*

- Important invertebrate fauna:

  Eurythecta zelaea, *Loxostege* sp., *Paranotoreas brephosata*, *Paranotoreas fulva*, *Scopula rubraria*

- Rank for conservation: 5

- Threats:

  erosion (natural and motorcycle tracks); no immediate threats

- References:

  McIntosh *et al*. (1990); Patrick (1989; referred to as Gilberts Gully)

Site 5: Springvale Junction

NZMS 260 G42 295503
area 2 ha
altitude 215 m
slope 0–15E
aspect S
rainfall 350 mm
no protection

- Soils present:

  Saline Immature Semiarid Soil

- Halophyte, threatened or unusual flora:

  Atriplex buchananii, **Hordeum* spp., **Plantago coronopus*, **Puccinellia* spp.

- Important invertebrate fauna:

  Eudonia leptalea, *Kiwaia thyraula*, *Loxostege* sp. nov., *Orocrambus corruptus*, *Paranotoreas fulva*, *Scopula rubraria*

- Rank for conservation: 9

- Threats:

  roadworks, dumping, erosion, weeds, grazing; erosion is an immediate threat

- References:

  Hewitt & Balks (1988); McIntosh *et al*. (1990); Patrick (1989)

Site 6: Chatto Creek

NZMS 260 G42 360578
area 5 ha
altitude 245 m
slope 0–20E
aspect W
rainfall 400 mm
no protection

- Soils present:

  Saline Immature Semiarid Soil

- Halophyte, threatened or unusual flora:

  Atriplex buchananii, *Lepidium kirkii*, *Lepidium sisymbrioides* subsp. *sisymbrioides*, *Puccinellia raroflorens*, **Puccinellia fasciculata*, *Puccinellia stricta*

- Important invertebrate fauna:

  Kiwaia thyraula, *Loxostege* sp. nov., *Oxythecta austrina*, *Paranotoreas fulva*

- Rank for conservation: 6

- Threats:

  fire, erosion, cultivation (for trial plantings), fertiliser (for trial plantings), oversowing/direct drilling, weeds (including planted halophyte forage shrubs), grazing; erosion and weeds (escapes from cultivation) are immediate threats

- References:

  McIntosh *et al*. (1990); Patrick (1989)

Site 7: Galloway No. 1

NZMS 260 G42 338496
area 2 ha
altitude 180 m
slope 15E
aspect N
rainfall 400 mm
Conservation Covenant

- Soils present:

  Saline Immature Semiarid Soil

- Halophyte, threatened or unusual flora:

  Atriplex buchananii, **Hordeum* spp., *Lepidium kirkii*, *Lepidium sisymbrioides* subsp. *matau*, *Puccinellia raroflorens*, **Puccinellia fasciculata*

- Important invertebrate fauna:

  Athrips zophochalca, *Eurythecta zelaea*, *Heliothis* sp. nov., *Kiwaia thyraula*, *Loxostege* sp. nov., *Orocrambus corruptus*, *Paranotoreas fulva*, *Scoparia exilis*, *Scopula rubraria*, *Sigaus minutus*

- Rank for conservation: 2

- Threats:

  dumping, fire, fertiliser, oversowing/direct drilling, weeds; no immediate threats

- References:

  Allen (1992); Fagan & Pillai (1992); Hewitt & Balks (1988); McIntosh *et al.* (1990); Patrick (1989)

Site 8: Moa Creek

NZMS 260 G42 436488
area 1 ha
altitude 455 m
slope 2E
aspect W
rainfall 455 mm
no protection

- Soils present:

  Saline Immature Semiarid Soil

- Halophyte, threatened or unusual flora:

  Atriplex buchananii, **Hordeum* spp., **Plantago coronopus*, *Puccinellia* raroflorens, *Puccinellia fasciculata*, *Puccinellia stricta*, *Selliera microphylla*

- Important invertebrate fauna:

  Arctesthes catapyrrha, *Capua semiferana*, *Eurythecta zelaea*, *Kiwaia thyraula*, *Orocrambus corruptus*, *Paranotoreas fulva*

- Rank for conservation: 5

- Threats:

  cultivation, irrigation, fertiliser, oversowing/direct drilling, weeds, grazing; no immediate threats

- References:

  Fagan & Pillai (1992); McIntosh *et al*. (1990); Partridge (1976, 1981); Patrick (1989; referred to as Crawford Hills Road)

Site 9: Patearoa

NZMS 260 H42 714390
area 20 ha
altitude 395 m
slope 0–15E
aspect N
rainfall 500 mm
QEII Open Space Covenant over part

- Soils present:

  Typic Immature Semiarid Soil
  Typic Orthic Recent Soil
  Saline Immature Semiarid Soil
  Alkaline Immature Semiarid Soil
  Typic Orthic Gley Soil
  Peaty Orthic Gley Soil

  Note: pH values were determined in the field, and are likely to be low compared with the laboratory determinations from similar soils at the other sites (McIntosh 1993).

- Halophyte, threatened or unusual flora:

  Apium prostratum, *Atriplex buchananii*, **Atriplex prostrata*, **Hordeum hystrix*, *Lepidium kirkii*, *Lepidium sisymbrioides* subsp. *sisymbrioides*, *Myosurus minimus* subsp. *novae-zelandiae*, **Plantago coronopus*, *Puccinellia raroflorens*, **Puccinellia distans*, **Puccinellia fasciculata*, *Puccinellia stricta*, *Schoenoplectus pungens*, *Selliera microphylla*, **Trifolium fragiferum*

- Important invertebrate fauna:

  Arctesthes catapyrrha, *Capua semiferana*, *Crocydopora cinigerella*, *Eudonia sabulosella*, *Eudonia leptalea*, *Eurythecta zelaea*, *Loxostege* sp. nov., *Lycaena bolderanum*, *Orocrambus corruptus*, *Paranotoreas brephosata, Paranotoreas fulva*, *Phaeosaces* sp. nov., *Scopula rubraria*, *Scoriodyta suttonensis*, *Scythris triatma*, *Sporophylla oenospora*, *Stenoptilia celidota*, *Zizina oxleyi*, *Sigaus campestris*

- Rank for conservation: 1

- Threats:

  fire, irrigation, fertiliser, oversowing, weeds; no immediate threats

- Other information:

  Ranked as a Soil Site of International Importance by Arand *et al.* (1991)

- References:

  Allen & McIntosh (1993); Arand *et al.* (1991); Johnson (1976); McIntosh *et al.* (1990); Partridge (1976, 1981); Patrick (1989)

Site 10: Belmont

NZMS 260 H42 681425
area 28 ha
altitude 395 m
slope 0–5E
aspect E
rainfall 400 mm
Conservation Covenant

- Soils present:

  Saline Immature Semiarid Soil

- Halophyte, threatened or unusual flora:

  Atriplex buchananii, *Hordeum* spp., *Lepidium kirkii*, **Plantago coronopus*, **Puccinellia distans*, *Puccinellia stricta*, *Sarcocornia quinqueflora*, *Schoenoplectus pungens*, *Selliera microphylla*

- Important invertebrate fauna:

  Eurythecta zelaea, *Orocrambus corruptus*, *Paranotoreas fulva*

- Rank for conservation: 2

- Threats:

  fire, fertiliser, oversowing/direct drilling, weeds, grazing (trampling); trampling is a current threat to the structural integrity of the moist soils of the seasonal ponds

- References:

  Hewitt & Balks (1988); Johnson (1976); Partridge (1976, 1981); McIntosh *et al*. (1990), Patrick (1989)

Site 11: Wilsons Road

NZMS 260 H42 735486
area 1 ha
altitude 395 m
slope 0–5E
aspect flat
rainfall 395 mm
no protection

- Soils present:

  Saline Immature Semiarid Soil

- Halophyte, threatened or unusual flora:

  **Hordeum hystrix*, *Lepidium kirkii* (no recent record), **Puccinellia distans*

- Important invertebrate fauna:

  Eurythecta zelaea, *Orocrambus corruptus*, *Paranotoreas fulva*, *Scythris triatma*

- Rank for conservation: 9

- Threats:

  irrigation, cultivation, fertiliser, oversowing/direct drilling, weeds, grazing; drainage, irrigation, cultivation and grazing are immediate threats

- References:

  McIntosh *et al*. (1990); Partridge (1976, 1981)

Site 12: Lindis Pass

NZMS 260 G40 338950
area <1 ha
altitude 335 m
slope 18E
aspect W
rainfall 550 mm
no protection

- Soils present:

  Alkaline Immature Semiarid Soil

- Halophyte, threatened or unusual flora:

  nil

- Important invertebrate fauna:

  Orocrambus corruptus, *Phylacodes cauta*

- Rank for conservation: 11

- Threats:

  erosion, fertiliser, oversowing, weeds; no immediate threats

- References:

  McIntosh *et al*. (1990)

Site 13: Sutton Lagoon

NZMS 260 H43 833113
area 0.5 ha
altitude 240 m
slope flat
aspect flat
rainfall 600 mm
no protection

- Soils present:

  Typic Fluvial Recent Soil

- Halophyte, threatened or unusual flora:

  **Hordeum* spp., *Schoenoplectus pungens*, *Selliera microphylla*

- Important invertebrate fauna:

  nil

- Rank for conservation: 9

- Threats:

  drainage, fertiliser, oversowing, weeds; no immediate threats

- References:

  McIntosh *et al*. (1990)

Site 14: Sutton Salt Lake

NZMS 260 H43 825106
area 4 ha
altitude 240 m
slope flat
aspect flat
rainfall 600 mm
Scenic Reserve

- Soils present:

  Saline Immature Semiarid Soil

- Halophyte, threatened or unusual flora:

  Chenopodium glaucum, *Apium prostratum*

- Important invertebrate fauna:

  Arctesthes catapyrrha, *Eudonia sabulosella*, *Eudonia leptalea*, *Eurythecta zelaea*, *Lycaena boldenarum*, *Orocrambus corruptus*, *Phylacodes cauta*

- Rank for conservation: 6

- Threats:

  drainage, fertiliser, oversowing, weeds; no immediate threats

- Other information:

  Ranked as a Soil Site of International Importance by Arand *et al*. (1991)

- References:

  Arand *et al*. (1991); McIntosh *et al*. (1990); Patrick (1989)

Site 15: Carlowie No. 2

NZMS 260 H41 626805
area 6 ha
altitude 520 m
slope 14E
aspect NW
rainfall 500 mm
no protection

- Soils present:

  Mottled Immature Semiarid Soil

- Halophyte, threatened or unusual flora:

  **Plantago coronopus*, **Puccinellia distans*

- Important invertebrate fauna:

  Orocrambus corruptus, *Phylacodes cauta*

- Rank for conservation: 4

- Threats:

  fire, erosion, fertiliser, oversowing, weeds, grazing; no immediate threats

- References:

  McIntosh *et al*. (1992)

Site 16: Blackstone No. 2

NZMS 260 H41 595770
area 1 ha
altitude 450 m
slope 25E
aspect NW
rainfall 500 mm
no protection

- Soils present:

  Alkaline Immature Semiarid Soil

- Halophyte, threatened or unusual flora:

  Lepidium sisymbrioides subsp. *sisymbrioides*

- Important invertebrate fauna:

  Orocrambus corruptus

- Rank for conservation: 6

- Threats:

  erosion, fertiliser, oversowing, weeds, grazing (tracking); no immediate threats

- References:

  McIntosh *et al*. (1992)

Site 17: Whiteface

NZMS 260 H41 534688
area 5 ha
altitude 420 m
slope 12E
aspect NW
rainfall 500 mm
no protection

- Soils present:

  Alkaline Immature Semiarid Soil

- Halophyte, threatened or unusual flora:

  nil

- Important invertebrate fauna:

  Eurythecta zelaea, *Orocrambus corruptus*

- Rank for conservation: 9

- Threats:

  erosion, fertiliser, oversowing, weeds, grazing (tracking); erosion, much resulting from stock tracks, is an immediate threat

- References:

  McIntosh *et al*. (1992)

Site 18: Rockdale

NZMS 260 G42 366589
area 1 ha
altitude 270 m
slope 5E
aspect S
rainfall 400 mm
no protection

- Soils present:

  Alkaline Argillic Semiarid Soil

- Halophyte, threatened or unusual flora:

  Atriplex buchananii, *Lepidium kirkii*, *Myosurus minimus* subsp. *novae-zelandiae*, **Plantago coronopus*, **Puccinellia* spp.

- Important invertebrate fauna:

  Eurythecta zelaea, *Orocrambus corruptus*, *Paranotoreas fulva*

- Rank for conservation: 4

- Threats:

  irrigation, cultivation, fertiliser, oversowing/direct drilling, grazing; no immediate threats

- References:

  McIntosh *et al*. (1992)

Site 19: Dunard

NZMS 260 G42 301555
area 0.5 ha
altitude 330 m
slope flat
aspect flat
rainfall 400 mm
no protection

- Soils present:

  Typic Solonetzic Semiarid Soil

- Halophyte, threatened or unusual flora:

  Atriplex buchananii, *Ceratocephalus pungens*, *Myosurus minimus* subsp. *novae-zelandiae*, **Puccinellia* spp.

- Important invertebrate fauna:

  Eurythecta zelaea, *Orocrambus corruptus*

- Rank for conservation: 5

- Threats:

  fertiliser, oversowing, weeds, grazing; no immediate threats

- References:

  McIntosh *et al*. (1992)

Site 20: Blackmans

NZMS 260 G42 170457
area 1 ha
altitude 320 m
slope 0–10E
aspect flat–NW
rainfall 400 mm
no protection

- Soils present:

  Saline Solonetzic Semiarid Soil

- Halophyte, threatened or unusual flora:

  Atriplex buchananii, *Chenopodium glaucum*, *Myosurus minimus* subsp. *novae-zelandiae*, *Puccinellia raroflorens*, **Puccinellia fasciculata*, *Puccinellia stricta*

- Important invertebrate fauna:

  Capua semiferana, *Crocydopora cinigerella*, *Eudonia leptalea*, *Eudonia sabulosella*, *Eurythecta zelaea*, *Kiwaia thyraula*, *Loxostege* sp. nov., *Orocrambus corruptus*, *Scoparia exilis*

- Rank for conservation: 3

- Threats:

  fertiliser, oversowing; no immediate threats

- References:

  McIntosh *et al*. (1992)

Site 21: Conroys

NZMS 260 G42 213406
area 1 ha
altitude 280 m
slope 8E
aspect NW
rainfall 400 mm
DoC owned - reservoir marginal strip

- Soils present:

  Saline Solonetzic Semiarid Soil

- Halophyte, threatened or unusual flora:

  Atriplex buchananii, **Puccinellia* spp.

- Important invertebrate fauna:

  Capua semiferana, *Eudonia sabulosella*, *Eurythecta zelaea*, *Kiwaia thyraula*, *Loxostege* sp. nov., *Orocrambus corruptus*, *Paranotoreas fulva*

- Rank for conservation: 8

- Threats:

  roadworks, erosion, fertiliser, oversowing; no immediate threats

- References:

  McIntosh *et al*. (1992)

Site 22: Patricks

NZMS 260 G42 227410
area 0.5 ha
altitude 300 m
slope 6E
aspect NW
rainfall 400 mm
no protection

- Soils present:

  Saline Argillic Semiarid Soil

- Halophyte, threatened or unusual flora:

  Atriplex buchananii, *Myosurus minimus* subsp. *novae-zelandiae*, *Puccinellia* spp.

- Important invertebrate fauna:

  Arctesthes catapyrrha, *Capua semiferana*, *Crocydopora cinigerella*, *Dichromodes* sp. nov., *Eudonia atmogramma*, *Eudonia sabulosella*, *Eudonia leptalia*, *Eurythecta zelaea*, *Heliothis* sp. nov., *Hierodoris frigida*, *Kiwaia thyraula*, *Loxostege* sp. nov., *Orocrambus corruptus*, *Oxythecta austrina*, *Paranotoreas brephosata*, *Paranotoreas fulva*, *Phaeosaces* sp. nov., *Scoparia exilis*, *Scopula rubraria*, *Scoriodyta suttonensis*, *Sporophylla oenospora*, *Stenoptilia celidota*, *Zizina oxleyi*

- Rank for conservation: 5

- Threats:

  weeds; no immediate threats

- References:

  McIntosh *et al*. (1992)

Site 23: Butchers Dam

NZMS 260 G42 234397
area 1 ha
altitude 300 m
slope 3E
aspect NW
rainfall 400 mm
Conservation Area

- Soils present:

  Alkaline Immature Semiarid Soil

- Halophyte, threatened or unusual flora:

  Atriplex buchananii, *Myosurus minimus* subsp. *novae-zelandiae*

- IMPORTANT invertebrate fauna:

  Eurythecta zelaea, *Kiwaia thyraula*, *Loxostege* sp. nov., *Orocrambus corruptus*, *Paranotoreas fulva*

- Rank for conservation: 7

- Threats:

  weeds

- References:

  McIntosh *et al*. (1992)

Site 24: Galloway No. 2

NZMS 260 G42 349500
area 15 ha
altitude 220 m
slope 0–20E
aspect NW
rainfall 400 mm
Conservation Covenant

- Soils present:

  Saline Immature Semiarid Soil

- Halophyte, threatened or unusual flora:

  Atriplex buchananii, **Hordeum hystrix*, **Plantago coronopus*, *Puccinellia raroflorens*, **Puccinellia distans*, *Lepidium kirkii*

- Important invertebrate fauna:

  Athrips zophochalca, *Capua semiferana*, *Crocydopora cinigerella*, *Eudonia leptalea*, *Eudonia sabulosella*, *Eurythecta zelaea*, *Loxostege* sp. nov., *Orocrambus corruptus*, *Oxythecta austrina*, *Paranotoreas fulva*, *Scoparia exilis*, *Scopula rubraria*, *Zizina oxleyi*

- Rank for conservation: 3

- Threats:

  grazing; no immediate threats

- References:

  Fagan & Pillai (1992); Hewitt & Balks (1988); McIntosh (1989); Patrick (1989)

4. Discussion and conclusions

4.1 IMMEDIATE ACTION REQUIRED TO PROTECT THREATENED AREAS

The only high-ranked site immediately threatened with damage is Belmont, where the soft soil surface of the seasonal ponds has been churned by stock trampling. No stock were present in early April 1995, but the presence of lush herbage at that time may indicate an intention to winter graze. If possible, grazing should be avoided when the soil surface is moist and soft, or stock should be excluded from the pond areas.

Naturalisation of exotic halophytic forage plant species planted at the Chatto Creek site is of concern, especially if they have the ability to spread to other sites. Any species that have successfully established seedlings should be removed. The question of whether "soil conservation" plantings or experiments are appropriate in this area of high natural values requires attention.

Erosion from intense downpours is a threat at Chatto Creek and the much lower-ranked Springvale Junction and Whiteface sites. However, this is a natural process and probably beyond artificial control.

4.2. MANAGEMENT PROCEDURES FOR LONG-TERM PROTECTION OF SALT PANS

Protection requires management of both the soils and the vegetation, and extends beyond the boundaries of the salt pans into a surrounding buffer zone. Given the high conservation value of non-saline soils and their vegetation at some of the sites, management of these habitats must also be considered.

4.2.1 Soil management

Salinity and pH gradients are primarily controlled by soil water, so a first consideration of management is to prevent alteration of the natural water regime. Both direct irrigation, and runoff and changed water tables resulting from irrigation adjacent to sites, should be avoided.

The distribution of salinity and pH through the profile determines to a large extent the biophysical characteristics of a site. Disturbance by cultivation, direct drilling, or stock trampling should be avoided because it alters soil structure and the water regime, resulting in changes in pH and salinity distribution with subsequent profound effects on the biota.

Natural erosion results in the redistribution of soil material at all salt pan sites with sloping terrain, and as such is not of concern. However, at sites where erosion has been exacerbated by activities such as gold mining and motorcycling, there is some risk of loss of halophyte habitat. Erosion should be monitored at least at the important Manorburn, Galloway No. 1 and Galloway No. 2 sites with a view to preventative action if conservation values are threatened.

4.2.2 Vegetation management

The first priority for conservation of the flora and vegetation is maintenance of soil chemistry and physical properties as outlined in 5.2.1 above. Avoidance or mitigation of the effects of pasture management practices should follow. The deliberate or incidental sowing of seed of exotic grass and legume species must be avoided, especially on relatively acid and salt-free soils where such species are likely to persist to the detriment of the native flora and vegetation. Aggressive weeds are few in this environment, and mainly limited to acid and salt-free soils. Where practicable, exotic shrub weeds such as briar should be controlled, along with perennial herbaceous weeds, such as Californian thistle and mouse-eared hawkweed, as these have the potential to displace native species.

Plantago coronopus, two *Puccinellia* species and *Hordeum* species are widespread and well-established exotic halophytic weeds which occupy habitat consequently denied to native species. Control or eradication is unlikely to be practicable except over small areas because it is difficult to avoid damaging native halophytes. Nevertheless, sites where the exotic species are absent should be monitored, and control undertaken (if this is practicable) where invasion occurs. Where native species are threatened with local extinction, or where it is deemed desirable to introduce them to a site from which they are absent, then control or eradication of exotic halophytes will be necessary.

Grazing by sheep and rabbits does not appear to threaten the vegetation of salt pans and adjacent acid or salt-free soils, and may be beneficial by reducing competition from exotic pasture species and weeds. However, sheep trampling changes soil properties, at least in moist areas, and may affect the distribution of halophytes. Monitoring of vegetation in exclosures would determine if grazing and trampling effects are significant. Cattle should be excluded from salt pan areas because of the severe effects of their trampling on both soils and vegetation.

The vegetation of salt pans is insufficiently dense to carry fire but, as a the recent fire at the Galloway No. 1 site demonstrated, the vegetation of adjacent soils is vulnerable. Grazing reduces fire risk so, where possible, a buffer zone of short, sparse vegetation should be maintained by this or other means at the boundaries of salt pans and associated significant vegetation of acid or salt-free soils.

The apparently erratic distribution of native halophytes and other threatened plant species between and within sites suggests that each species has very particular site requirements; this is certainly true of coastal halophytes, which segregate mainly along salinity gradients (Partridge & Wilson 1987, 1988). The efficiency of species management would be increased considerably by a systematic study at a range of sites of physical and chemical soil properties associated with each species. The results of such a study would facilitate introductions of threatened species such as *Lepidium kirkii* and *Lepidium sisymbrioides* subsp. *matau* to new sites (Allen 1992) as part of species recovery plans, as well as providing insurance against unexpected habitat loss for the less threatened species.

4.2.3 Monitoring

Monitoring of changes is at present *ad hoc* and unsystematic, depending on occasional observations by DoC staff and scientists. GIS technology offers a means of recording changes in a systematic way which can be used for site management. We recommend that a trial monitoring system be established using GIS to record soils and vegetation data and future changes at the Pisa Flats site, where the terrain is highly suitable for grid survey and systematic recording.

4.3 POTENTIAL FOR RESTORATION TO LIKELY 1840 CONDITION

The potential for restoration to their likely 1840 condition is very low for all sites because of the overwhelming dominance of exotic pasture and weed species. Nevertheless, at least at the seven highest-ranked sites, there is scope for experimental manipulation of the vegetation on a small scale this would allow a better understanding of pre-European plant-soil relationships, and thus the potential local and regional distribution of plant species associated with salt pans and their adjacent habitat.

4.4 POTENTIAL AS SITES FOR RECOVERY PROGRAMMES

Until systematic study of plant-soil relationships is undertaken (see 4.2.2 above), the potential use of sites for recovery programmes for threatened plant species is difficult to determine. Recovery programmes should concentrate on the sites which presently support threatened species until the potential of other sites is understood. This is particularly true where species are confined to one or two sites, for example *Lepidium sisymbrioides* subsp. *matau* at Galloway No. 1 and *Leptinella* "Clutha" at Pisa Flats. At present, the transplanting of species between sites should be avoided or, if absolutely necessary for species conservation, should be followed with intensive monitoring to ensure that the transplanted species do not threaten the ecological stability of the new site.

5. Recommendations

Unless otherwise stated, the following recommendations apply to all sites ranked 6 or higher for their importance for biological conservation in Table 6.

- Formal protection should be negotiated for the Pisa Flats, Chapman Road and Blackmans sites. Protection for the Pisa Flats site is most urgent as, together with the Patearoa site (already protected), this site is the most highly ranked and is classified as a Soil Site of International Importance.

- The terms of the Conservation Covenant for the Belmont site should be discussed with the landowner and, if necessary, revised so that damage by stock trampling is limited.
- Irrigation, cultivation, direct drilling, oversowing, fertiliser application and fire should be avoided.
- Cattle and vehicles should be excluded.
- Sheep should be excluded from the parts of sites which have seasonally wet soils.
- A monitoring programme using exclosures should be established to assess the effects of grazing and trampling on at least the seven highest ranked sites.
- A GIS-based monitoring system should be trialled at the Pisa Flats site.
- Erosion should be formally monitored at the Chapman Road, Galloway No. 1 and Galloway No. 2 sites, and occasionally assessed at the other sites with sloping terrain.
- Briar and aggressive exotic perennial herbaceous weeds, especially mouse-eared hawkweed and Californian thistle, should be eradicated wherever practicable.
- Sites lacking any of the exotic halophyte species, but especially *Plantago coronopus*, *Puccinellia* species and *Hordeum* species, should be monitored to prevent invasion.
- A buffer zone of short, sparse vegetation should be maintained at each site to reduce the risk of fire.
- A systematic survey should be carried out of physical and chemical soil properties associated with native halophytic and non-halophytic plant species (Table 4).
- Soil and vegetation surveys as detailed as those carried out at the Pisa Flats and Patearoa sites should be undertaken on at least the other five top-ranked sites.
- Fauna, particularly Lepidoptera, surveys should undertaken to the same standard for all the sites.
- Conservation management of threatened plant species should be restricted to their present sites until plant-soil relationships are better understood.
- This report should be revised within five years to take account of new and improved information gained in the interim.

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7. References

Allen, R.B. 1992. Recovery plan for indigenous saline soil *Lepidium* species. DSIR Land Resources Contract Report 92/18. Unpublished report for the Department of Conservation, DSIR Land Resources, Dunedin.

Allen, R.B., McIntosh, P.D. 1993. Saline soils and plant communities and their management, Patearoa, Central Otago. Landcare Research Contract Report LC9293/48 for the Department of Conservation. Landcare Research NZ Ltd, Dunedin.

Allen, R.B., McIntosh, P.D. 1994. Saline soils and plant communities and their management, Pisa Flats, Central Otago. Landcare Research Contract Report LC9394/131 for the Department of Conservation. Landcare Research NZ Ltd, Dunedin.

Arand, J., Basher, L., McIntosh, P.D., Heads, M. 1991. Inventory of New Zealand Soil Sites of International, National and Regional Importance. Part 1 – South Island and southern offshore islands. 1st Edition. *N.Z. Society of Soil Science occasional publication 1.*

Cameron, E.K., de Lange, P.J., Given, D.R., Johnson, P.N., Ogle, C.C. 1993. New Zealand Botanical Society threatened and local plant lists (1993 revision). *New Zealand Botanical Society newsletter* 32, 14–28.

Fagan, B., Pillai, D. 1992. Manorburn Ecological District. Survey report for the Protected Natural Areas Programme. Department of Conservation, Wellington.

Hewitt, A.E., Balks, M.R. 1988. Review of some halophyte habitats, Central Otago. N.Z. *Soil Bureau Contract Report 88/07*. New Zealand Soil Bureau, DSIR, Dunedin.

Johnson, P.N. 1976. Central Otago salt pan vegetation. Unpublished report, DSIR Botany Division, Dunedin.

Leamy, M.L., Saunders, W.M.H. 1967. Soils and land use in the upper Clutha Valley, Otago. *N.Z. Soil Bureau bulletin 28*. New Zealand Soil Bureau, DSIR, Wellington.

McIntosh, P.D. 1989. Proposed soil-vegetation reference sites on the east Otago uplands: soil characteristics. *Division of Land and Soil Sciences Technical Record DN1*. DSIR, Dunedin.

McIntosh, P.D. 1993. Field pH measurements for soil classification. *Soil news* 41, p. 72.

McIntosh, P.D., Beecroft, F.G., Patrick, B.H. 1990. Register of saline soil sites in North and Central Otago, Vol. 1. *Division of Land and Soil Sciences Technical Record DN5*. DSIR, Dunedin.

McIntosh, P.D., Beecroft, F.G., Patrick, B.H. 1992. Register of saline soil sites in North and Central Otago, Vol. 2. *DSIR Land Resources Technical Record 82*. DSIR Land Resources, Lower Hutt.

New Zealand Soil Bureau 1968. Soils of New Zealand. Part 3. *N.Z. Soil Bureau Bulletin* 26 (3). DSIR, Wellington.

Orbell, G.E. 1974. Soils and land use of mid-Manuherikia Valley, Central Otago, New Zealand. *N.Z. Soil Bureau bulletin* 36. New Zealand Soil Bureau, DSIR, Wellington.

Partridge, T.R. 1976. Additional information on salt-pan vegetation, Central Otago. Unpublished report, DSIR Botany Division, Dunedin.

Partridge, T.R. 1981. Rare and endangered habitats of New Zealand: inland saline habitats. Unpublished report, DSIR Botany Division, Christchurch.

Partridge, T.R., Wilson, J.B. 1987. Salt tolerance of salt marsh plants of Otago, New Zealand. *New Zealand journal of botany* 25, 559–566.

Partridge, T.R., Wilson, J.B. 1988. The use of field transplants in determining environmental tolerance in salt marshes of Otago, New Zealand. *New Zealand Journal of Botany* 26, 183–192.

Patrick, B.H. 1989. The Lepidoptera of Central Otago salt-pans. Scientific Series No. 3, Department of Conservation, Dunedin.

Patrick, B.H. 1994. Valley floor Lepidoptera of Central Otago. *Otago Conservancy Miscellaneous Series No. 19*, Department of Conservation, Dunedin.

Raeside, J.D., Cutler, E.J.B. 1966. Soils and related irrigation problems of part of Maniototo Plains, Otago. *N.Z. Soil Bureau bulletin 23*. New Zealand Soil Bureau, DSIR, Wellington.

Ward, C.M., Bruce, D.L., Rance, B.D., Roozen D.A. 1987. Lindis, Pisa and Dunstan Ecological Districts. Draft survey report for the Protected Natural Areas Programme. Department of Lands and Survey.