Freshwater Invertebrates of Mangarakau wetland

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The following is a brief account of what we currently know about the diversity of freshwater invertebrates in Mangarakau wetland, Tasman district, as supporting information for a community-led application for RAMSAR designation of the wetland.

Aquatic invertebrates are found in all freshwater ecosystems, including rivers, lakes and wetlands. They live on or in the bottom substrate, swim in the water column, or live on the surface of the water. There are four major groups of freshwater invertebrates:

1) **Arthropods**, including insects (e.g. mayflies, caddisflies, stoneflies, dragonflies, and true flies such as chironomid midges and blackflies), crustacea (e.g. freshwater shrimp and amphipods, as well as zooplankton such as Cladocera (Daphnia), ostracods and copepods), and aquatic mites.

2) **Molluscs**, such as snails (especially Potamopyrgus) and filter-feeding bivalves (e.g. fingernail clams (Sphaerium and Pisidium) and freshwater mussels (kakahi or Hyridella menziesi)).

3) **Oligochaetes**, typified by a number of different worm species that live in muddy streambeds.

4) **Nematodes**, which are very small, cylindrical, 'worm-like' animals with smooth cuticles.

For convenience, freshwater ecologists have arbitrarily divided aquatic invertebrates into two groups: macroinvertebrates, which are those that are large enough to be retained by a sieve with a mesh size of 500 µm, and meiofauna, which are those that pass through a 500-µm sieve but are retained on a 64-µm sieve. This latter group includes recently hatched insect larvae, microcrustacea (such as copepods, ostracods (pea shrimp) and daphnia (water fleas)), as well as animals such as nematodes.

Freshwater invertebrates play a vital role in transferring plant-based organic carbon derived from terrestrial sources (e.g. leaves or woody debris) or aquatic sources (e.g. algae or macrophytes) into animal-based organic carbon, which is then available to predators such as fish and birds. Freshwater invertebrates also have intrinsic biodiversity and ecological values. Almost all are native to New Zealand, and many are endemic (i.e. they are not found anywhere else in the world).

Summary results of a survey carried out by NIWA in 2004 are presented. Because invertebrate composition is strongly influenced by water chemistry (especially pH and nutrient concentrations), these data are also presented and discussed.

1 Methods

Invertebrate samples were collected from six open-water bodies in the Mangarakau wetland. Each water body was characterised into one of four classes:

1. Large ponds – areas of discrete open water with a size of > 10 m. These were often fringed with emergent macrophytes, but had the majority of their water surface open to the sky;

2. Small ponds - <10 m in diameter, and had discrete boundaries. They were also often completely fringed with wetland vegetation, which also often grew fairly extensively through the pond

3. Leads – characterized by less open water and dense wetland vegetation growing in the water. These consisted of either standing, or very slow moving water and often had very ill-defined margins

4. Channels - represented by wide, deep open-water areas flowing slowly through wetlands, where wetland vegetation was generally restricted to the edges of the channel

Within each water body, duplicate invertebrate samples were collected semi-quantitatively (standardised 2 minute effort) using a hand-held sweep net that was jabbed repeatedly into the water column, amongst aquatic plants, or over the substrate (see (Suren et al. 2007) for further details). The location of each sample was recorded using a Garmin® GPS. All samples were preserved immediately following collection using 100% isopropyl alcohol. Spot measurements of water chemistry (temperature, pH and conductivity) were also made at each water body in each wetland using a Horiba® multiprobe, and water samples collected and filtered (Millipore GFC filters) for nutrient analysis.

Two methods have been developed to assess wetland condition within New Zealand. The first method (Clarkson et al. 2003) is based on field observations of five specific indicators known to affect wetland condition:

1) hydrological integrity;

2) physicochemical parameters;

3) ecosystem intactness;

4) browsing predation and harvesting regimes;

5) dominance of native plants.

Each indicator component is scored on an objective scale from zero to five, with five representing the modified or best condition and zero representing the most degraded condition. Scores for the resultant wetland condition index (WCI) thus range from 0 – 25. The second method (Ausseil et al. 2008) was developed by combining six spatial indicators of human activities known to degrade wetland biodiversity and function, and for which nationally consistent GIS data was available. Pressure measures had been applied at three spatial units: the wetland catchment, a 30 m buffer around the wetland, and the wetland itself. The six indicators include:

1) the amount of natural vegetation cover;

2) human made impervious cover;

3) number of introduced fish;

4) percentage cover woody weeds;

5) artificial drainage;

6) nitrate leaching risk (a surrogate measure of landuse intensity).

Data on these parameters for the Mangarakau wetland were extracted from various GIS databases, and weighting functions applied to give an individual pressure measure for each indicator (Ausseil et al 2008). Resultant pressure measures are then transformed into an index of ecological integrity (IEI) ranging from 0 (totally degraded, with no remaining ecological integrity, native biodiversity or ecological function) to 1 (near pristine, no human induced impacts). Both the WCI and IEI were calculated for the entire Mangarakau wetland.

1.1 Laboratory methods

Invertebrate samples were processed according to the protocol outlined in Suren et al., (2007). Briefly, this involved washing the sample through a 300 µm sieve to remove larger animals and plant fragments, and identifying and counting all invertebrates retained on the sieve. The contents of the sieve were spread evenly across a small Bogorov tray (Winterbourn et al. 2006) and examined under a dissecting microscope (up to 40 × magnification) for invertebrates. A minimum of 400 invertebrates in each sample was identified, and the rest of the sample or subsample scanned for uncommon taxa (Duggan et al. 2003). All data were converted into percentage abundances. All invertebrates were identified to as low a taxonomic resolution as possible given the availability of taxonomic keys and the practicality of identifying small taxa such as nematodes, tardigrades and micro-crustaceans (Suren et al., 2007). Water samples were analysed for nutrients (NH4, NO3, DRP, TDP and TDN) using standard methods.

A survey of 154 wetlands throughout New Zealand enabled a comparison of the water chemistry conditions, and wetland health scores of Mangarakau to be made. The range of conditions within the Mangarakau wetland were compared to the mean water chemistry conditions of wetlands throughout New Zealand, as well as the 25th and 75th percentiles. Observed values less than the 25th percentile mean that over 75% of the wetlands surveyed have values greater than this, while observed values greater than the 75th percentile mean that 75% of wetlands have values less than this. In this way we can place particular water quality parameters found in the Mangarakau wetland into context with that from a more nationwide study.

2 Results

1.2 Physical parameters

The six sites varied in water quality (Table 1). Water pH varied the most of all measured parameters (from 5.8 to 7.2), while variation in other parameters was much less. For example, conductivity ranged by a factor of ca. 1.5 (from 79 to 125 µS/cm), total dissolved nitrogen (TDN) by a factor of 2 (from 130 to 275 mg/m^3), and total dissolved phosphorus (TDP) three-fold (from 2 to 6.5 mg/m^3). Concentrations of dissolved nitrate-N and inorganic P were low at all sites (<5 and <1 mg/m^3), respectively). The largest pool sampled (site 2) had highest pH, conductivity, TDN and TDP.

Mean water pH in the surveyed wetlands was 6.3; the 25th percentile was 5.7, and the 75th percentile was 7.0. The wide variation of water pH within Mangarakau encompasses this wide range. Values of conductivity, dissolved reactive phosphorus, TDN and TDP were all below the 25th percentile of other wetlands throughout the country, highlighting the fact that water within Mangarakau was generally unenriched. Values of ammonia (NH4) were equal to, or below the median values throughout New Zealand. As with water pH, nitrate concentrations (NO3) within Mangarakau were variable, and within the range of the 25th to 75th percentiles.

The calculated wetland condition index score (WCI) of the Mangarakau wetland (18.7) was very similar to the national average of the 154 wetlands surveyed (18.4). This score was lower than that derived by Bev Clarkson in an earlier survey (21.25), and may have reflected the impact of a fire that had occurred prior to our latter survey. In addition, some of the differences may be the result of different interpretations by observers, and the slightly different focus. Thus our assessment of harvesting levels also focused on potential harvesting of ducks and fish, whereas Bev’s focus was predominantly on terrestrial plants.

Despite our relatively low score of the WCI, the calculated index of ecological integrity (0.885) was much higher than the national average (0.442), and indeed higher than the 75th percentile. Examination of the ranked IEI data showed that the Mangarakau wetland was ranked 124 out of the 136 wetlands for which we had scores for. The 12 wetlands which ranked higher than Mangarakau included four wetlands from the west coast (Bullock Creek, Cascade Plateau wetland, Shearer Swamp, and Nikau wetland), two wetlands each from the Auckland region (Kaitoke and Whatipu), Southland region (LakeRakatau and TransitBay), and Stewart Island (Mason Bay and Ruggedy Flats). Based on these results, the Mangarakau wetland appears to be of high to very high ecological value.

Table 1. Locations and water chemistry details for six sites in the Mangarakau wetland sampled for algae and invertebrates in 2005. Nutrient concentrations are given in ppb (mg/m3). See text for explanations of abbreviations.

Site	Water type	Easting	Northing	pH	Cond (µS/cm)	Temp (°C)	NO3-N	NH4-N	TDN	DRP	TDP
1	Large pond	2466270	6062270	6.95	104	16.0	2.4	15.3	249	0.9	4.7
2	Large pond	2466080	6062330	7.23	125	17.8	3.6	10.0	275	0.8	6.5
3	Lead	2466280	6062090	5.95	81	20.3	3.2	8.0	130	0.9	2.0
4	Small pond	2466200	6061970	6.21	79	17.9	4.5	5.6	176	0.3	2.3
5	Lead	2466190	6062150	5.83	84	17.1	3.8	8.2	235	0.2	4.0
6	Channel	2466690	6062530	6.01	113	10.3	3.5	8.0	183	0.5	3.0

1.3 Invertebrate communities

Fifty-two invertebrate taxa were identified (Table 2). The most common invertebrates were nematodes (representing 27% of the total density), the common snail *Potamopyrgus antipodarum* (9.2%), Ostracods (8.5%), two types of chironomid (non-biting) midges (*Tanytarsus* [5.7%] and Orthocladiinae [4.6%]), aquatic mites (4.4%) and Cyclopoid crustacean (4%). Thirty-two taxa were regarded as being uncommon, with total relative abundances of < 1%. The most widespread taxa were aquatic mites, the amphipod *Paracorophium*, ceratopogonid (biting) and chironomid midges, oligochaetes, nematodes, the damselfly *Xanthocnemis zelandicus*, and micro-crustacea (cuclopoid copepods, ostracods), which were found in all the water bodies sampled. Other taxa such as mosquito larvae, the freshwater shrimp *Paratya curvirostris*, and the predatory free-living Hydrobiosid caddisflies were found at only one of the sampling sites.

Table 2. List of invertebrate taxa identified from samples taken from 6 sites in Mangarakau wetland, showing their average percentage abundance, and the number of sites within the wetland where these animals were collected from.

Invertebrate group	Taxa	Percentage abundance	No. of sites found
Odonata	*Aesha brevistyla*	0.15	3
	Anisoptera	0.39	5
	Austrolestes colensonis	0.85	5
	Procordulia smithii	0.18	4
	Xanthocnemis zelandicus	2.96	6
Hemiptera	*Anisops assimilis*	0.09	2
	Corixidae	0.83	5
	Diaprepocoris zealandiae	1.15	4
	Microvelia sp.	0.92	5
	Sigara sp	0.13	2
Trichoptera	Hydrobiosidae	0.13	1
	Hydroptilidae	1.28	6
	Oxyethira albeceps	1.13	5
	Paroxyethira hendersoni	0.94	4
	Triplectides spp.	0.09	2
Lepidoptera	*Hygraula nitens*	0.04	1
Coleoptera	Dytiscidae	0.09	2
	Hydrophilidae	0.04	1
Diptera	Ceratopogonidae	3.76	6
	Chironomidae	0.41	5
	Chironominae spp.	0.30	2
	Chironomus zealandicus	1.64	2
	Corynoneura	0.22	4
	Culicidae	0.04	1
	Limonia nigrescens	0.04	1
	Orthocladiinae	4.68	6
	Parachironomus	0.26	3

	Podonominae	0.46	5
	Tanypodinae	2.20	6
	Tanytarsus sp.	5.75	6
Collembola		0.09	2
Crustacea	Chydoridae	1.05	6
	Cyclopoida	4.02	6
	Daphniidae	3.09	3
	Harpacticoida	1.96	5
	Ilyocryptidae	0.25	3
	Ostracoda - all Ostracods	8.52	6
	Ostracoda - all Ostracods	0.04	1
	Paracorophium	3.54	6
	Paratya curvirostris	0.04	1
	Tenagomysis chiltoni	0.13	2
Acarina		4.45	6
Bivalvia	Sphaeriidae	0.37	3
Gastropoda	*Ferrissia neozelandica*	0.28	2
	Lymnaea	0.49	4
	Potamopyrgus antipodarum	9.22	4
Oligochaeta		3.62	6
Hirudinae		0.07	1
Platyhelminthes	Rhabdocoel	0.16	3
Nematoda		26.63	6
Hydra		0.73	3
Tardigrada		0.04	1

The common taxa found at Mangarakau were also the most common taxa in other wetlands throughout New Zealand (Table 3), suggesting that the fauna of wetlands throughout New Zealand is dominated by core taxa that are tolerant of environmental conditions in these habitats. Such conditions would include the presence of large quantities of organic matter on the bottom of wetlands that may lead to low oxygen levels, particularly during the night or during summer times when water temperature is high.

Table 3. List of the 15 most common invertebrate taxa from the Mangarakau wetland, and from wetlands throughout New Zealand showing their average percentage abundance. Note the similarity of the common taxa between Mangarakau and other New Zealand wetlands.

Mangarakau wetland		New Zealand wetlands	
Taxa	Percentage abundance	Taxa	Percentage abundance
Nematoda	26.63	*Potamopyrgus antipodarum*	19.62
Potamopyrgus antipodarum	9.22	Cyclopoida	9.92
Ostracoda	8.52	Oligochaeta	9.08

Tanytarsus sp.	5.75	*Tanytarsus* sp.	9.03
Orthocladiinae	4.68	Nematoda	6.47
Acarina	4.45	Daphniidae	5.92
Cyclopoida	4.02	*Xanthocnemis* sp	5.69
Ceratopogonidae	3.76	Ostracoda	4.25
Oligochaeta	3.62	Orthocladiinae	2.71
Paracorophium	3.54	Tanypodinae	2.34
Daphniidae	3.09	Ceratopogonidae	2.11
Xanthocnemis sp	2.96	Acarina	2.06
Tanypodinae	2.20	Ilyocryptidae	1.87
Harpacticoida	1.96	Harpacticoida	1.56
Chironomus zealandicus	1.64	*Austrolestes colensonis*	1.43

Commentary

Investigations of invertebrate communities of wetlands throughout New Zealand show that the fauna is dominated by chironomid midges, aquatic mites, microcrustacea (copepods and ostracods), nematodes, oligochaetes and the snail *Potamopyrgus*. This fauna is very similar to that found in other biogeographic regions (e.g. Australia (Robson & Clay 2005); USA (Whiles & Goldowitz 2005); Europe (Oertli et al. 2002; Nicolet et al. 2004)). Despite the predominance of non-insect groups (crustacea, nematodes, oligochaetes and snails) in the wetlands, aquatic insects were the most diverse class, with 93 taxa recognised. However, the diversity of the non-insect groups was likely under-represented, reflecting the absence of appropriate taxonomic identification guides that would have allowed these groups to have been identified to the same level as the aquatic insects.

The invertebrate fauna of the Mangarakau wetland appears to be typical to that of other wetlands throughout New Zealand. As far as we are aware, no taxa collected had particular conservation interest, or restricted distributions. However this comment needs to be tempered by the fact that many tax could not be identified to genera or species. Many of the common invertebrates found in Mangarakau belong to the meiofauna, or small animals < 500 µm in size. Although these animals are small, they are important in their own right from a biodiversity perspective: indeed many types of copepods, ostracods and nematodes may only be found in New Zealand. Meiofauna can also be found at very high densities within aquatic environments, as evidenced by their commonness in the Mangarakau wetland. They may consequently contribute significantly to organic carbon turnover and energy transfer within wetlands (O'Doherty 1985; Strayer & Likens 1986; Palmer 1992). Unlike aquatic insects, which have mobile adult phases, members of the meiofauna do not emerge from the aquatic environment, and so all carbon that has been taken up by the animals remains within a particular wetland. Finally, members of the meiofauna, such as microcrustacea, are also often important components in the diets of small larval fish (McDowall 1990).

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Appendix 1: Mangarakau Wetland Record and Plot Sheets from New Zealand Wetland Database

WETLAND RECORD SHEET

Wetland name: Mangarakau Wetland **Date:** March 2006

Region: Nelson-Marlborough **GPS/Grid Ref.: 6 sampling locations**

Sample	NZMS easting	NZMS Northing
1	2466270	6062270
2	2466080	6062330
3	2466280	6062090
4	2466200	6061970
5	2466190	6062150
6	2466690	6062530

Altitude: 15 m asl **No. of plots sampled:** 6

Classification: I System	**IA Subsystem**	**II Wetland Class**	**IIA Wetland Form**
Palustrine	Permanent	Swamp	Basin

Field team: Brian Sorrell, Alastair Suren, Rob Smith, Dona Sutherland

3. Indicator	**Indicator components**	**3 Specify and Comment**	**4 core 0– 5[1]**	**5 ean score**
Change in hydrological integrity	Impact of manmade structures	Some roads adjoining wetland. A few tracks and old drains within wetland	4	4
	Water table depth	Still intact except perhaps for very margins	4	
	Dryland plant invasion	Only on very margins	4	
Change in physico-chemical parameters	Fire damage	Signs of recent fire in some areas	3	3.66
	Degree of sedimentation/erosion	Localised signs of sedimentation in drains	4	
	Nutrient levels	Probably slightly elevated near farmland, and as a result of the fire	4	
	Von Post index	Not applicable (swamp)	-	
Change in ecosystem intactness	Loss in area of original wetland	Probably about one third lost downstream	3.5	3.5
	Connectivity barriers	Still mainly intact; indigenous catchment surrounded by farmland. Some culverts may represent fish passage barriers	3.5	
Change in browsing, predation & harvesting regimes	Damage by domestic or feral animals	Some grazing observed; probably some feral animals present	3.5	3.83
	Introduced predator impacts on wildlife	None observed but likely to be some	4	
	Harvesting levels	Small amount of cultural harvest (flax) and for sphagnum has been recorded. May be duck hunting and eeling or whitebaiting	4	
Change in dominance of native plants	Introduced plant canopy cover	Mainly on margins (e.g., gorse), esp adjacent farmland (west). Occasional exotics in wetland.	4	3.75
	Introduced plant understorey cover	Mainly on margins. Occasional exotics within wetland	3.5	
Total wetland condition index /25				18.74

[1] Assign degree of modification as follows: 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme