Wetland Biodiversity Monitoring Program

Coyrecup Lake
Fauna and Water Chemistry Datasets

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CONTENTS

INTRODUCTION

This spreadsheet-based report is part of a series of such reports that will each comprise a Microsoft Excel workbook and a companion document summarising results of monitoring at individual wetlands. The reports provide:

1) A quality assured dataset for analysis by those with specific questions or interests.
2) Some analyses of temporal patterns in the wetland's fauna in relation to measured environmental variables.

In this report on Coyrecup Lake, spreadsheets for invertebrate, waterbird and water chemistry data collected between 1997 and 2007 are presented. They include a raw dataset and a number of spreadsheets that have taxonomy standardised for analysis within date, within the wetland or across a set of wetlands. The full report includes two files *Coyrecup to 2007 Text.pdf* (this document) and *Coyrecup 1997_2007.xlsx*

PROJECT BACKGROUND

The Western Australian Salinity Action Plan (Government of Western Australia 1996) was developed as a blue print for government action, in partnership with the community, to address the problems of landscape salinisation. The plan included strategies to manage the impact of salinity on natural (biological and physical) diversity. With respect to wetlands, the plan recognised that "changes in flora and fauna due to salinisation will be most pronounced, in the short term, in valley flats and their wetlands" and that "wetland monitoring will provide a basis for evaluating achievement of biodiversity conservation goals and will focus on both physical and biotic characteristics".

To this end, the Department of Environment and Conservation (DEC, as its predecessor CALM) was charged with the responsibility to "…monitor a sample of wetlands, and their associated flora and fauna throughout the south-west to determine long-term trends in natural diversity and provide a sound basis for corrective action."

In response, DEC's Natural Resources Management Branch and Science Division developed a wetland monitoring project (Science Project Plan 1998-018) with two components:

1. DEC (and its predecessors) had been monitoring salinity and depth in up to 100 wetlands since the 1970s (Lane and Munro 1983) and this program was revitalised as the South West Wetland Monitoring Program (SWWMP - Lane *et al.* 2009) to partially meet the requirements of the Salinity Action Plan.
2. The Wetland Biodiversity Monitoring Program commenced in 1997 to monitor waterbirds, invertebrates, flora, water chemistry and groundwater in a sub-set of SWWMP wetlands. This intensive program commenced with a pilot study of 5 wetlands (Halse *et al.* 2002) and over the course of 1998 and 1999 a further twenty wetlands were added. These wetlands were selected according to a number of criteria (listed in Cale *et al.* 2004) enabling the relatively small sample of wetlands to be representative of the wide range of wetland types occurring in the region and to make best use of pre-existing knowledge. Wetlands present in the Warden, Muir-Byenup, Toolibin and Bryde Natural Diversity Recovery Catchments were included. Coyrecup Lake was included in the program because it is an example of a secondarily salinised wetland with considerable historical data for waterbirds. The waterbird community is relatively rich for a saline wetland and is known to periodically support a high abundance of ducks.

PREVIOUS PUBLICATIONS

Several publications have arisen from this work, including a summary of the selected wetlands and of data from the first few years of monitoring (Cale *et al.* 2004), a paper on changes in biodiversity at two wetlands (Lyons *et al.* 2007) and detailed reports of results from a number of individual wetlands (Cale *et al*. 2010, Cale *et al*. 2011). In order to make results and analyses available on a more timely basis, spreadsheet-based reports will be produced for selected wetlands. These will not be as detailed as the above mentioned reports, but can be easily updated as new data becomes available.

METHODS

Each wetland in the program is sampled every second year to determine the composition of invertebrate and waterbird communities and every third year to assess the health and composition of vegetation communities. These biodiversity data are comprehensive. Invertebrates from a very broad suite of taxa are identified to species level and complete counts of waterbirds are conducted three times in a monitoring year (late winter, spring and autumn). Vegetation is monitored in set quadrats enabling the assessment of health in marked specimens of a wide range of species. To aid interpretation of biological data, data are also collected for surface water chemistry, shallow monitoring bores, and salinity of riparian soils. A detailed description of the monitoring protocol is given by Cale *et al.* (2004) and Gurner *et al.* (1999) and an analysis of the efficacy of the invertebrate sampling protocols was presented by Halse *et al.* (2000). The sampling regime is ongoing and the earliest sampled wetlands (i.e. those commenced in 1997) have now been sampled at least six times.

THE DATASETS

INVERTEBRATES

Invertebrate samples were processed to retrieve as many species as possible and specimens were identified to species level where possible. Several dipteran families (Dolichopodae, Tabanidae, Tipulidae and Muscidae) were identified to family level only and Turbellaria, Nematoda, Mestostigmata and Oribatida were not determined beyond these nominal taxa. The maturity or gender of specimens sometimes prevented identification of other specimens to species level. Within a sample these taxa do not impair the calculation of species richness for comparison between samples. However, when multiple samples (dates) are to be compared, e.g. during multivariate analyses, it is necessary to adjust species lists so that identifications at different taxonomic levels do not add spurious taxa to the analysis. This is achieved by deleting or combining taxa so as to lose as little information from the dataset as possible. For example to calculate species richness the presence of *Berosus* sp. (larvae) and adults identified as *Berosus munitipennis* in the same sample would be resolved to *Berosus* sp. by combining the two taxa.

The Invertebrate datasets presented have been adjusted at several levels to maximise the information they contain for analyses.

1) Invertebrate richness: adjustments in this sheet are aimed at achieving the best count of total richness on each date. Consequently, only differences of determination between sub-sites on the same date are modified.
2) Invertebrate occurrence: adjustments are aimed at ensuring consistent determination of taxon identity across sampling dates and to remove species which are not obligate aquatic species (i.e. at best semi-aquatic). This dataset is most appropriate for multivariate analyses of samples from the wetland over time.
3) Invertebrate Community Structure: corrections in this sheet have been made to match taxa between the monitored wetland and a series of 'marker wetlands' which have been sampled with the same protocol and are representative of particular wetland types (see Cale *et al*. 2004). This dataset is derived in order to present a brief analysis of community data in relation to diversity elsewhere in the Wheatbelt.

WATER BIRDS

The water bird datasets presented have not been adjusted for taxonomic resolution except to remove "un-identified species". Un-identified species may be suitable for inclusion in calculations of species richness, but because they are often seen briefly or poorly it cannot be discounted that they are individuals of species properly identified later in a survey.

1) Waterbird Occurrence: lists species abundance for individual surveys and species occurrence by monitoring year (i.e. consecutive late winter (LW), spring (Sp) and autumn (Au) surveys; see Cale *et al*. 2004).
2) Waterbird richness: presents species richness by category, i.e. total, breeding and guild
3) Waterbird Community Structure: lists the presence or absence of species by monitoring year for the monitored wetland and for five marker wetlands.

WATER CHEMISTRY

Two spreadsheets are presented for water chemistry

1) Water Chemistry: data as measured (including units).
2) Environmental Variables: data from Water Chemistry which has been transformed to approach normal. Ionic variables were converted to milli-equivalents. All variables were examined individually and transformed (by log or square root) as required to give the best approximation of a normal distribution. Variables with two or fewer value levels or with grossly skewed distributions were removed from the dataset. Where single data points were missing from a variable the datum was imputed to be the median of the remaining data. Where data were missing for more than one sampling date no imputation of values was performed.

ANALYSES AND STATISTICS

Pinder *et al*. (2004) classified Wheatbelt invertebrates into a number of assemblages (groups of taxa which co-occur in wetlands with similar physicochemical characteristics). Waterbird guilds are based on a broad food category (animal or vegetable) and foraging technique. These guilds were developed by Halse (1987) and modified by Cale *et al*. (2004). These assemblages and guilds are used to characterise changes in invertebrate and waterbird communities through time.

Constrained ordinations were performed in R (R Development Core Team 2009) using function rda() from the vegan package (version 1.15, Oksanen et al. 2009). This analysis investigates relationships between community composition and environmental variables. Both response (species presence/absence) and predictor (environmental) matrices were centred. Abundance data were transformed using the Helliger transformation (Legendre & Legendre 1998). A simple model using only spring depth, pH and chlorophyll concentration and late winter Ec are presented. Function anova()(Oksanen *et al*. 2009) was used to separately test the significance of axes and terms for the resulting ordination. Vectors for statistically significant terms ($p < 0.5$) are displayed in red, terms displayed in black are not significant and are only included for descriptive purposes.

Ordination by non-metric multidimensional scaling (n-mds) was performed in R (R Development Core Team 2009) using function metaMDS() from the vegan package (Oksanen *et al*. 2009), presence/absence data and the Bray-Curtis dissimilarity measure.

SUMMARY OF RESULTS

The analyses presented in the spreadsheets indicate that:

1) Invertebrate species richness was correlated with depth (positive) and salinity (negative) and varied within the range 9-50 taxa according to the extent of lake filling.
2) Invertebrate species diversity was dominated by species of micro-crustacea in most years. These taxa are generally salinity tolerant and probably resident as propagules retained in the wetland. In contrast insects have a greater capacity to opportunistically colonise the wetland but are less tolerant of saline conditions. While dipterans (fly larvae) were always present, other insects were only recorded when salinity was less than 60 mS/cm (45 g/L). Insect diversity increased substantially when salinity was greatly reduced in the flooding event of 2005.
3) While invertebrate species richness and community structure have varied over the monitoring period, there has been no consistent directional change. Flooding in 2005 resulted in reduced salinity and coincided with higher species richness and a substantial shift in invertebrate community structure. The shift in community structure was characterised by addition of species of micro-crustacea and insects of both dipteran and non dipteran families. A small number of frequently occurring halobiont micro-crustacea were not found during 2005. This shift was short-term, with 2007 samples having a community structure similar to years prior to 2005.
4) Invertebrate community structure varied across two significant environmental gradients; depth and pH. Samples collected at the shallow end of the depth gradient include mostly halobiont species while at the deep end more insects including beetles and dragonflies are collected. The effects of the pH gradient are confounded by depth since the most alkaline conditions (1997 and 1999) occurred at intermediate depths. However, some species of ostracod and copepod were more abundant at higher pH and species richness tended to be lower at lower pH.
5) A total of 29 species of waterbird have been recorded on Coyrecup Lake. Eight of these species have been recorded only once but a core group of species i.e. Australian shelduck, grey teal, black swan, banded-stilt, red-capped plover and silver gull are present during most surveys and in most years.
6) Comparison of waterbird community structure over the monitored period indicates that, while species composition is variable, there is no directional trend that would suggest an ongoing change in the waterbird community using Coyrecup Lake. Species richness declines and guild structure simplifies as the wetland dries and in dry years compared to wet years. At low water levels small waders are a major component of waterbird diversity as a result of expanded exposed beach and shallow feeding habitat, while dabblers are a major component on most surveys.
7) In most years waterbird community structure resembles that of other moderately saline wetlands, but when flooding reduced salinity in 2005 the waterbird community changed to resemble that occurring in brackish wetlands such as Lake Toolibin. The absence of most small wader species and the addition of diving and shore feeding species accounts for the observed changes in community structure.
8) Water chemistry data do not indicate any trend of rising salinity, however nutrient concentrations in early 2005 and 2007 suggest an influx of nutrients during the 2005

flooding of the wetland. The seasonal decline of these nutrients may indicate their assimilation into biological communities, sediments or both.

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