

Strategy for the protection of lakes and wetlands of the Swan Coastal Plain

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1. Introduction

The purpose of this paper is to clearly define the current position taken by the Environmental Protection Authority about the protection and management of lakes and wetlands on the Swan Coastal Plain. Section 2 gives the background to this position by: describing the policy framework within which this position is set (Section 2.1); defining wetlands (Section 2.2); discussing some problems of terminology (Section 2.3); and, detailing the reasons why lakes and wetlands are important and in need of protection (Section 2.4).

Section 3 begins with a summary of the five elements of the Authority's wetland protection strategy (Section 3.1) The following sub-sections give details of these elements as follows: Section 3.2 deals with the conservation reserve system; Section 3.3 describes the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992; Section 3.4 deals with the key elements of Bulletin 374; Section 3.5 describes the relationship between the Lakes EPP and Bulletin 374; and Section 3.6 describes agencies which have responsibilities (including the Environmental Protection Authority) for protecting lakes and wetlands where development is to proceed.

Section 4 describes work being carried out by other government agencies and research institutions relevant to wetland protection and management. Section 4.1 gives an overview of the work. Section 4.2 details the wetland mapping and classification work being co-ordinated by the Water Authority of Western Australia. Section 4.3 is a discussion of the relationship between this work and the Environmental Protection Authority's position on lakes and wetlands.

2. Background

2.1 Policy framework for this position paper

Since its establishment in 1971 the Environmental Protection Authority has consistently recognised the need to conserve lakes and wetlands. There are four key Bulletins that relate primarily to Environmental Protection Authority wetland policy issues:

- **Bulletin 27** - Guidelines to the conservation and management of wetlands in Western Australia;
- **Bulletin 79** - Wetlands - Guidelines for protection and management;
- **Bulletin 227** - Draft Guidelines for Wetland Conservation in the Perth Metropolitan Area; and
- **Bulletin 374** - A guide to identifying wetland management objectives in the Perth Metropolitan Area

In addition, there are the Environmental Protection Authority Systems "Red Books", which include recommendations for the reservation and protection of the Western Australia's natural environment including important wetlands, and the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992, or Lakes EPP.

The Authority's strategy for protecting lakes and wetlands has the following key elements:

- set broad principles for wetland conservation (Bulletins 27 and 79);
- identify those wetlands so important that it is necessary to ensure their on-going protection, mostly through reservation (EPA Systems "Red Books");
- develop a guide for identifying specific management objectives for the protection of those lakes and wetlands (on both private and publicly owned land) under the most pressure from development - lakes and wetlands on the Swan Coastal Plain - particularly in and near the Perth Metropolitan area (Bulletin 374);

- give statutory protection, through an Environmental Protection Policy, to an important and easily defined set of Swan Coastal Plain Lakes (Lakes EPP);
- through the environmental review process recommend that where development causes the loss of valuable wetland functions they be replaced by construction of new wetlands or rehabilitation of degraded ones; and
- identifying a clear inter-government agency process for the protection and management of the lakes and wetlands to guide decision making in areas which are the province of local and state planners.

Section 3 gives specific details of each of the above elements.

2.2 Definition of wetlands

For the purposes of this document, a wetland is defined as an area of permanent, seasonal or intermittent inundation; whether natural or otherwise; fresh, brackish or saline; static or flowing.

This paper focuses on static (lentic) wetlands which typically include lakes, swamps, marshes and dams.

This definition includes areas of land that are intermittently waterlogged and may or may not have surface water. These areas are commonly known as damplands and palusplains and are ecologically important in supporting vegetation and habitats which differ from those in other wetland types.

Excluded from this definition are areas such as flooded playing fields and roadways which typically do not support plant or animal life.

2.3 Terminology — types of wetlands

There is some confusion regarding the names used to describe the different types of wetlands on the Swan Coastal Plain, particularly lakes. The Lakes EPP defines a lake as a wetland with surface water of at least 1 000 square metres at the first of December 1991 (the first day of summer). This highly specific definition is required to meet the statutory requirements of the legally enforceable Environmental Protection Policy.

Environmental Protection Authority Bulletin 227 defines a lake as a wetland dominated by open water (rather than emergent vegetation), whether permanent, seasonal or ephemeral.

Recent work by C. A. Semeniuk, (Semeniuk, 1987), defined a lake as a basin wetland permanently inundated irrespective of vegetation cover.

For the purposes of this position paper, the following names will be used:

- **Policy lake** - those wetlands covered specifically by the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992;
- **wetlands - all other wetlands.**

2.4 The values of Swan Coastal Plain lakes and wetlands — defining wetland functions

Wetlands are valuable assets because they carry out a number of important processes, either ecological (biological and chemical), hydrological or social. These process can be called wetland "functions", and are described below.

Ecological

- the food webs that include plants and animals and micro-organisms;
- drought refuges for waterbirds;
- provision of summer feeding areas for trans-equatorial migratory wading birds which are the subject to international agreement (to achieve this a range of wetland types needs to be protected and controls placed on surrounding land uses);
- habitats for plants, animals or communities considered to be rare or of restricted occurrence or distribution;
- limited capacity to assimilate loads of nutrients, other pollutants, sediment and litter; and
- index of environmental quality
 - * changes in water levels;
 - * nutrient enrichment;
 - * changes in wetland vegetation.

Hydrological

- Wetlands act as compensating or retention basins during storms and hence have a flood control function. The vegetation fringing lakes and wetlands act, to a certain extent, as filters which assimilate nutrients, sediments and pollutants in surface runoff from adjoining land.

Social

- cultural and heritage
- recreation
- nature study
- education
- access to wildlife, and
- aesthetic considerations

3. The Environmental Protection Authority's wetland protection strategy

3.1 Broad framework — Bulletins 27 and 79

In 1977 the (then) Department of Conservation and Environment published 'Guidelines for the Protection and Management of Wetlands' which established the broad principles for wetland protection. These guidelines were revised in 1980 as Bulletin 79 and had two purposes:

- to provide input into the education of the broader public; and
- to help planners, developers, local authorities and land owners to ensure on-going protection of remaining lakes and wetlands.

They established important management and protection principles that are to apply to all wetlands throughout Western Australia and have been accepted by the Environmental Protection Authority through subsequent publications, including Bulletin 227. By necessity the Guidelines were general in their approach and non-statutory in their application.

3.2 Conservation reserve system

The Environmental Protection Authority considers that an adequate and representative system of reserves should be set aside for the conservation of flora, fauna and landscape. Such reserves

should be properly managed and given security commensurate with their conservation value. The integrity of such reserves should be maintained. Activities that damage the conservation values of reserves should be prohibited — regardless of whether the activities are in or outside reserves.

In 1972 the Authority initiated a study of the conservation values of Western Australia. It divided the State into 12 systems and made recommendations on conservation within each. This work led to the publication in red-covered books of recommendations for conservation reserves in WA.

The System 6 'Red Book' deals with the Perth metropolitan region and its hinterland. It differs from the other 'Red Books' in that it makes recommendations not only for public land but also private land.

The first two Red Books covering Systems 4 and 8 to 12, and 1, 2, 3 and 5 received unqualified endorsement by Government in February and October 1976 respectively. The System 7 recommendations were released in September 1981 and were accepted by Government as a guide for the establishment of conservation reserves in the Kimberley. In March 1984, the Government accepted the general principles of the System 6 Red Book and approved of the progressive implementation of the locality specific recommendations as far as possible.

The Authority considers all 'Red Book' recommended areas as potentially significant for conservation and carefully scrutinises any development which threatens their values.

The requirements of wetland conservation can extend beyond reserve or wetland boundaries. Land activities within a catchment can adversely impact on a wetland through changes in water level and water quality. This does not mean that development should not occur, or that public acquisition of private land is necessarily required. Development should proceed in a manner that protects the wetland reserve's environmental values, and is best controlled through the planning process.

3.3 The Environmental Protection Authority's statutory policy on lakes

The Environmental Protection (Swan Coastal Plain Lakes) Policy was gazetted in December 1992 and prohibits unauthorised filling, mining, drainage into or out of, and effluent discharge into lakes. This policy applies to those lakes on the Swan Coastal Plain that are shown in green on Department of Land Administration Miscellaneous Plan No 1815.

Landowners with such lakes on their property were advised during policy development of their inclusion in the policy and its implications.

Unauthorised filling, mining, drainage into or out of, and effluent discharge into these lakes can result in prosecution under Part V (Sections 49(i), 65(i) or 55(i), 58(i) of the Environmental Protection Act, 1986).

Wetlands protected by this policy have the highest level of protection under the Environmental Protection Act. There is a presumption against approving developments that are likely to cause filling, mining, drainage into or out of, and effluent discharge into these lakes.

3.4 Environmental Protection Authority guidelines for management of Perth's lakes and wetlands (Bulletin 374)

In 1986 the Environmental Protection Authority released for public comment Bulletin 227 'Draft Guidelines for Wetland Conservation in the Perth Metropolitan Area'. These guidelines aimed to assist in identifying valuable attributes and ecological functions of wetlands in the vicinity of Perth on the Swan Coastal Plain; and to provide direction on establishing management priorities which would protect the conservation values, ecological functions and human use values of wetlands in the region.

Bulletin 227 included a wetland evaluation method (in the form of a questionnaire) which sought to establish the values of individual wetlands. The identified values could then be translated into a broad management framework within which a wetland should be viewed by land-uses planners and managers as well as the broader community.

Public submissions were received on the draft guidelines, and extensive field testing of the wetland evaluation method was undertaken in conjunction with the Water Authority and Murdoch University. In 1990 the guidelines were released in final form as Environmental Protection Authority Bulletin 374 'A guide to wetland management in Perth'.

The modified wetland evaluation method outlined in Bulletin 374 (called from here on as the Authority's wetland evaluation method) has now been applied to most of the wetlands from Gingin to Mandurah. This information is available in digital form from the Water Authority of Western Australia.

The Environmental Protection Authority's wetland evaluation method is based on the principle that wetlands have a number of natural and human use attributes which can be assigned a score which when added together determine the environmental value of the wetland.

A two dimensional process taking account of the natural and human use attribute scores is then applied to place the wetland into one of five management categories requiring different management priorities. These management categories:

- High conservation (category H) - These wetlands score highly on both natural and human use attributes.
- Conservation (category C) - These wetlands primarily score highly on the natural attributes scale.
- Conservation and recreation (category O - for open space) - These wetlands primarily score highly on the human use scale.
- Resource enhancement (category R) - These wetlands score moderately on both natural and human use attributes.
- Multiple use (category M) - These wetlands score poorly on both natural and human use attributes.

The Authority's wetland evaluation method is relatively simple to use and can be done using a combination of desk work (using maps and aerial photography) and limited field checks. It does not require a wetland expert to carry out the evaluation and the intent of the different management categories is readily understandable.

The evaluation method cannot be used for wetlands outside its described area, and it works better in urban areas than in rural settings. However, the principles contained in the document that all wetlands have value but different management priorities is applicable to other parts of Western Australia.

Since the publication of Bulletin 374, some further fine tuning of the evaluation method has occurred, and some minor changes to the text made. Bulletin 374 has been updated as Bulletin 686 and released at the same time as this Bulletin. This fine tuning should not greatly alter the results of the application of Bulletin 374 undertaken to date although particular care should be taken with the results for areas of extensive wetlands.

The Environmental Protection Authority has intensively promoted the use of the wetland evaluation method by metropolitan local authorities in particular so that they may make use of it planning and management of wetlands in their area, and to assist them in considering development proposals affecting wetlands. Encouragement of its use has also been made to State Government instrumentalities whose operations may affect wetlands, as well as developers and their consultants in the formulation of their development plans.

3.5 Relationship between statutory policy for lake protection and wetland management guidelines

Bulletin 686 provides a framework for the identification of management objectives for wetlands in the defined region to ensure their natural and human-use values are maintained or improved. It is an advisory document, whereas the December 1992 Swan Coastal Plain Lakes Policy ensures that any nominated lake, regardless of its wetland evaluation management category, is automatically protected from unauthorised filling, mining, changes to drainage or direct effluent discharge.

3.6 Protecting lakes and wetlands through environmental review — identifying responsibility.

The Environmental Protection Authority requires developments that have potential for significant environmental impacts to be subjected to environmental review to ensure environmental impacts are manageable.

Environmental review of development proposals that may affect wetlands is undertaken in the context of the Authority's previous statements of principle and more specific guidelines on wetland management and protection, as well as the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992.

The Authority does not assess all developments which are likely to impact on every wetland, recognising that other agencies have a role to play in wetland protection. Those most concerned are the departments of Planning and Urban Development and Conservation and Land Management and the Water Authority of Western Australia. Local authorities and the community are also involved in reaching decisions about the best use of remaining wetlands.

Impacts on wetlands fall into two major categories: direct impacts through filling, mining, draining or polluting; and indirect impacts where loss of native vegetation or contamination of groundwater in the catchment could affect wetland water quality and water levels.

The Authority uses environmental review to protect wetlands against impacts as follows:

- proposals which may result in filling, draining, mining or polluting of lakes nominated for protection in the Environmental Protection (Swan Coastal Plain Lakes) Policy gazetted in December 1992;
- representative wetland areas recommended for protection in the System 6 and other 'Red Book' reports, other conservation reserves, areas recommended for reservation by the Department of Conservation and Land Management, and regional open space set aside for conservation;
- wetlands with rare vegetation communities not adequately represented in reserves, or rare flora and fauna (and their habitats); and
- wetlands recognised by international agreement because of their importance primarily for waterbirds and their habitats.

The Policy Lakes of the Swan Coastal Plain have the highest level of protection through the Environmental Protection Policy.

The Authority expects that the planning agencies will manage developments that are likely to have indirect impacts on these wetlands. Advice can be provided to planning agencies on these matters so that they can be incorporated in broader land-use planning and management proposals.

Generally, proposals affecting wetlands in categories other than those listed are not subject to the Environmental Protection Authority environmental review process, but the Authority works in the knowledge that agencies and proponents recognise that wetlands have special values in assessing possible uses.

To assist this process, the Authority provides general advice on use and management of these areas and generic guidelines are in preparation.

The Environmental Protection Authority also continues to disseminate information to agencies which make decisions affecting wetlands, particularly local authorities.

The Environmental Protection Authority also works in the knowledge that, in assessing the impacts of proposed developments, planning and management agencies will ensure proponents provide information about the impacts on wetlands, including measures to minimise their environmental effect.

4. Current initiatives and future work

4.1 Overview

There have been increasing efforts in the past 20 years to protect wetlands. Much more is known about the requirements and movements of wildlife populations and our knowledge of how aquatic ecosystems work is improving. With the increase in knowledge has come greater appreciation of the value of wetlands and a better understanding of how they can be better managed to conserve their ecological, hydrological and social functions.

In 1990, the Environmental Protection Authority, in conjunction with the Water Authority of Western Australia, released Bulletin 266 called "Jenny Arnold's Perth Wetlands Resource Book". This was a six volume report written by the late Dr Jenny Arnold providing resource information about the wetlands of the Perth Metropolitan Region.

The Environmental Protection Authority, the Water Authority and the Land and Water Resources Research and Development Corporation (formerly the Australian Water Resources Advisory Council) have integrated and co-ordinated wetland research and since 1987 have funded five wetland research projects:

- Wetland classification based on the quality of the water and the animal communities;
- The effects of altered water levels on wetland plants;
- An assessment of the value of different types of wetlands for waterbirds;
- Interactions between wetlands and groundwater; and
- Effects of seasonal drying and nutrient enrichment of the wetland invertebrates.

The aims of each of these studies are listed in Appendix 1.

Additionally the wetlands of the Perth region have been mapped using a wetland classification system designed by C. A. Semeniuk. In a joint project the V & C Semeniuk Research Group, the Water Authority and the Department of Land Administration have refined wetland boundary definition and classification.

The findings of the research projects will be published in a seven-volume edition, expected in September 1993. The results will be integrated into a report that will be useful for wetland managers.

To further assist local authorities and other agencies with an interest and role to play in looking after wetlands on the Swan Coastal Plain the Environmental Protection Authority and the Water Authority are preparing wetland 'atlases' showing the boundaries of environmental protection policy lakes, wetland evaluation management categories, System 6 recommendation areas and the wetlands mapped by the Semeniuks. These atlases will be distributed to local authorities in the Perth metropolitan region in 1993.

In December 1992 the State Government, through the Integrated Catchment Management Coordinating Group and the Department of Conservation and Land Management, released a draft "Wetland Conservation Policy for Western Australia" for public comment. Officers from the Authority provided input to the draft. The final policy has not been released.

4.2 Water Authority co-ordinated wetland mapping and classification systems

The Water Authority has recently mapped wetlands of the Perth region from Wedge Island to Dunsborough. These maps show the original wetland resource of Perth, about two thirds of which has been lost through filling and draining. A broadsheet of Perth's wetland resource has been printed by the Water Authority, and is available also in digital form from the Water Authority.

Preliminary management objectives for 2000 of Perth's remaining wetlands have been determined using Environmental Protection Authority Bulletin 374 based on the Water Authority of Western Australia mapping. This has been co-ordinated by the Water Authority with advice from the Gnangara Mound Technical Advisory Group and the Western Australia Water Resources Council. Evaluations were carried out over four years by environmental science students at Murdoch University, Environmental Protection Authority staff and by consultants Joan Payne, Jan Rodda and Garry Middle. The Environmental Protection Authority and the Water Authority are soon to publish a broadsheet which depicts the management categories for these 2000 wetlands and the location of the Swan Coastal Plain Policy Lakes. The Water Authority also has the information on the wetland management categories available in digital form.

4.3 The relationship between the Water Authority work and the Environmental Protection Authority's wetland protection strategy

The Environmental Protection Authority recognises that the work on wetland mapping co-ordinated by the Water Authority is an important initiative in protecting the lakes and wetlands of the Swan Coastal Plain. However, some problems have arisen in the subsequent application of the Authority's wetland evaluation method for the "extensive" wetland areas found mainly on the east of the Coastal Plain (on the Pinjarra Plain and in the inter-dunal swales of the Bassendean Dunal System).

The evaluation method allocates a single management category to each wetland. This works well for wetlands with well defined boundaries, but has been found to be inappropriate for the extensive wetlands.

These wetlands can be very large, covering tens of square kilometres. The Pinjarra Plain is arguably one large wetland covering hundreds of square kilometres. There are sections of many of these extensive wetlands which have been severely degraded, through a combination of clearing of native vegetation and draining, to allow for agricultural activities. These degraded areas have few if any wetland ecological or social functions, although they may have some hydrological function in that water may be present at or near the surface for some of the year.

Rather than allocate a single management category to each extensive wetland, it is more appropriate that these wetlands are sub-divided into homogeneous units based on vegetation cover and a separate management category given to each unit.

The units that are severely degraded with only hydrological functions will be allocated management category M through the Bulletin 686 process. Where development is proposed to take place in these areas, the key issue is the management of the water and the associated off-site impacts.

The work by the Water Authority in applying the Authority's wetland evaluation method to these extensive wetlands should be seen as a preliminary allocation of management categories. Detailed fieldwork will enable appropriate management categories to be allocated to the various units, and appropriate management objectives identified.

5. Summary

The Environmental Protection Authority has had a long-term interest in wetlands and has taken and will continue to take the following key initiatives to seek their protection and management.

- Setting of broad principles for wetland protection through Bulletins 27 and 79;
- Legal protection of lakes through the Environmental Protection (Swan Coastal Plain Lakes) Policy;
- Identification of wetlands of conservation significance which should become part of the reserve system through the 'Red Books';
- Formulation and application of Bulletin 686 (including its questionnaire) to assist people in identifying management objectives for wetlands on the Swan Coastal Plain (the updated Bulletin 374);
- Dissemination of wetlands' atlases to local authorities to assist in the protection and management of these areas (to be completed in 1993);
- Contribution to wetlands research to improve our knowledge about how wetlands work and the implications of this information for management (to be completed by September 1993); and
- Using environmental review to protect important wetlands where development is proposed.

This Strategy represents the Environmental Protection Authority's current position, and has evolved through the Authority's long history of working for wetland protection. The Authority may decide that, as new initiatives are implemented, the Strategy may have to be revised to reflect the effectiveness of these programmes. The effectiveness of new initiatives and this Strategy will be reviewed in 12 months time, and a revised strategy released should the Authority consider this is required.

6. Reference

Semeniuk, C. A. (1987). Wetlands of the Darling System - A geomorphic approach to habitat classification. *J. Roy. W.A.*, **69**, 95-112.

7. Glossary of terms

The definitions given here are as they relate to wetlands and their useage in this Bulletin.

Term/word	definition
Attribute	Characteristic used to describe a wetland - eg size, diversity and depth of water.
Dampland	A basin wetland where the soil is seasonally waterlogged.
Episodic wetlands	Wetland with surface water for a period of time but not every year.
Extensive wetland	Large seasonally waterlogged wetlands found on the east of the Swan Coastal Plain, found typically on the Pinjarra Plain and the Bassendean Dunal system.
Function	Ecological (biological and chemical), hydrological or social process carried out by a wetland - eg food web and flood control.
Gazetted rare species	Species Gazetted Endangered under the Wildlife Conservation Act.

Hydrological function	Wetland processes that are related to water only - flood control, and drainage
Lake (as used in EPA Bulletin 227)	A wetland dominated by open water (rather than emergent vegetation), whether permanent, seasonal or ephemeral.
Lake (Semeniuk, 1987)	A basin wetland permanently inundated irrespective of vegetation cover.
Lentic wetland	Wetland where the water is stationary - a lake or swamp.
Lotic wetland	Wetland where the water is moving - streams and rivers.
Palusplain	A wetland typically flat rather than in a basin where the soil is seasonally waterlogged - typical of the Pinjarra Plain.
Pinjarra Plain	Poorly drained flat area stretching from the foot of the Scarp to the Bassendean dunes consisting of clay sediments mixed with sand.
Policy/EPP lake	A Swan Coastal Plain wetland with surface water of at least 1 000 square metres at the first of December 1991 (the first day of summer) protected by the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992.
Rare species	Species not gazetted under the Wildlife Conservation Act, but listed on the Department of Conservation and Land Management's Reserve List.
Seasonal wetlands	Wetland with surface water for only part of the year.
Sumpland	A basin wetland seasonally inundated irrespective of vegetation cover.
Swamp	A wetland dominated by emergent vegetation (rather than open water), whether permanent, seasonal or ephemeral.
Value	The importance of a wetland as expressed in terms of its functions.
Wetland	An area of permanent, seasonal or intermittent inundation, whether natural or otherwise; fresh, brackish or saline; static or flowing.

Appendix 1

Current wetland research projects

The Water Authority of Western Australia, the Environmental Protection Authority and the Land and Water Resources Research and Development Corporation have been instrumental in integrating and co-ordinating wetland research and have funded five wetland research projects. These are:

i) Wetland classification based on the quality of the water and the animal communities

Aims:

- To classify the different types of wetlands in the Perth area,
- To determine relationships between invertebrate communities and the quality of the water,
- To design a monitoring programme, and
- To determine water quality standards and specific management strategies for the urban wetlands.

Undertaken by Dr Ron Rosich at the Water Authority, and Dr Jenny Davis and Dr Stuart Bradley at Murdoch University.

ii) The effects of altered water levels on wetland plants

Aims:

- To study the effects of changing water levels on the survival of individual species of common wetland plants,
- To study the effects of changing water levels on the composition of wetland plant communities, and
- To develop a model which will help predict the effects of changing water levels.

Undertaken by Prof Arthur McComb and Dr Ray Froend at Murdoch university.

ii) An assessment of the value of different types of wetlands for waterbirds

Aims:

- To find out which waterbirds use different types of wetlands, in what sort of numbers and at what time of year,
- To identify what makes a wetland good or bad for waterbirds,
- To predict the effect of changes in a wetland, especially water depth, on its use by waterbirds, and
- To determine how often birds move between different types of wetlands.

Undertaken by Dr Stuart Halse and Dr Andrew Storey at the Department of Conservation and Land Management, and by Mr Rodney Vervest of the Royal Australasian Ornithologists Union.

iv) Interactions between the wetlands and the groundwater

Aims:

- To understand how groundwater moves into and out of wetlands,
- To define the zone upstream of a wetland which supplies groundwater to the

wetland,

- To test predictions about interactions between wetlands and the groundwater by measuring concentrations of chemical tracers in and around wetlands, and
- To develop computer models for studying groundwater flow in and around wetlands.

Undertaken by Dr Lloyd Townley and Dr Jeffrey Turner at the CSIRO Division of Water Resources.

v) Effects of seasonal drying and nutrient enrichment on the wetland invertebrates

Aims:

- To study how seasonal drying affects the wetland invertebrates,
- To find out how nutrient enrichment affects the invertebrates,
- To discover when the invertebrates need water in the wetlands and for how long,
- To determine how the invertebrates survive when the wetlands are dry.

Undertaken by Dr Jenny Davis and Ms Shirley Balla at Murdoch University.

Appendix 2

Bibliography

Bibliography

1. Policy related

Policy area	Report/Bulletin
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Drylands and wetlands, South-west	Environmental Guidance for Land Use and Developments in Southern Western Australia. Environmental Protection Authority, March 1988. Bulletin 319.
Drylands and wetlands, State-wide	Guidance Notes from Environmental Protection Authority reports 1971-1992, Western Australia. May 1992. Bulletin 625.
Groundwater & wetlands, Swan Coastal Plain	Protection of the Groundwater, Wetlands and Associated Ecosystems of the Swan Coastal Plain. A public discussion paper. (Bulletin number not printed on report). July 1990. Bulletin 437.
Wetlands and roadworks	Roadworks and Wetlands in the Perth Metropolitan Region : Recommendations for conflict resolution. A Report by Department of Conservation and Environment, October 1985. Bulletin 233.
Wetlands and roadworks	The impact of Proposed roads on wetlands in the Perth Metropolitan Region. Department of Conservation and Environment, October 1985. Bulletin 232.
Wetlands, Perth area	A Guide to Identifying Wetland Management Objectives in the Perth Metropolitan Area. Report by the Environmental Protection Authority. December 1990. Bulletin 374.
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Wetlands, Statewide	Guidelines to the Conservation and Management of Wetlands in Western Australia. Department of Conservation and Environment, July 1977. Bulletin 27.
Wetlands, Statewide	Wetlands guidelines for Protection and Management (Revised Edition). Department of Conservation and Environment, February 1980. Bulletin 79.
Wetlands, Statewide	Environmental Protection Authority (1974), Statement of Wetland Conservation, Department of Conservation and Environment. 1p.
Wetlands, Statewide	Environmental Protection Authority (1974), Conservation Reserves for Western Australia, Department of Conservation and Environment, Bulletin 3, Perth, Western Australia.
Wetlands, Statewide	Environmental Protection Authority (1975), Conservation Reserves for Western Australia, Department of Conservation and Environment, Bulletin 8, Perth, Western Australia.

2. Research and Technical reports

Research area	Report/Bulletin
Albany Harbours	An overview of environmental problems in Princess Royal Harbour and Oyster Harbour, Albany, with a discussion of management options. Environmental Protection Authority, June 1987. Technical Series 16.
Albany Harbours	Decline of seagrass beds in Princess Royal Harbour and Oyster Harbour, Albany Western Australia. Environmental Protection Authority, May 1987. Technical Series 15.
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Albany Harbours	Distribution of seagrasses in Princess Royal Harbour and Oyster Harbour on the southern coast of Western Australia. Department of Conservation and Environment, May 1986. Technical Series 1.
Albany Harbours	Water quality and seagrass biomass, productivity and epiphyte load in Princess Royal Harbour, Oyster Harbour and King George Sound. Environmental Protection Authority, April 1991. Technical Series 39.
Gauging stations and streams	The Effects of Gauging Station Control Structures on Native Fish Migration in Freshwater Streams of South West Australia. Environmental Protection Authority, May 1987. Bulletin 282.
Herbicides and streams	The Results of Monitoring the Department of Conservation and Land Managements Program of applying Granulated Herbicides by Helicopter. A report to the Environmental Protection Authority. June 1990. Bulletin 435.
Local Government and wetlands	Planning Management for Wetland Conservation. 15 June 1989. A Conference: Wetlands in Crisis. What can Local Government do? Conference papers. February 1989. Bulletin 372.
Mosquito and/or midges	A means of identifying common mosquitoes of the Perth Metropolitan area. Irving-Bell and Liehne, Revised by Andrew Blair. Department of Conservation and Environment, September 1978. Bulletin 42.
Mosquito and/or midges	Control of Mosquitoes and Non-Biting Midges in Perth and Outer urban areas. A Blair. Department of Conservation and Environment, November 1979. Bulletin 66.
Mosquito and/or midges	Evaluation of Sumilarv for Midge Control. Cities of Perth and Cockburn. Report and recommendations of the Environmental Protection Authority. November 1990. Bulletin 465.
Mosquito and/or midges	Mosquito Investigation No. 2, Shire of Wanneroo. Department of Conservation and Environment, August 1978. Bulletin 36.
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