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The extraction and interpretation of ecological information from historical sources has been successfully applied overseas especially in England, Germany and parts of North America. For example, various studies have examined the ecological effects of changes in land-use of the English countryside.

Two distinct approaches exist, although they are not necessarily mutually exclusive. Some authors, such as Tubbs (1981), Peterken (1969), Steele and Welch (1973) and Rackham (1971, 1975, 1976) have used historical documents to complement field studies in their attempts to explain the present ecology of plant communities particularly woodlands, but also heathlands and grasslands – in terms of their land-use history. Others, such as Armstrong (1970, 1973) have seen entities such as medieval villages and eighteenth century landed estates as ecosystems, and essayed to reconstruct the flows of energy and the circulation of nutrients within them, and to indicate the structure of their species networks from historical evidence. Both approaches may require the isolation of particular periods or “time slices” from the evolution of the environment in question for more detailed study.

In Australia, Williams (1974) described the way in which human activity and settlement has moulded and changed the South Australian landscape. However, relatively few studies have given much attention to the reconstruction of ecosystems. Perhaps one notable exception is the work of Flannery (1996) which documented the ecological history of Australia, New Guinea, and New Zealand. The main focus of this historical reconstruction was the adaptation of Indigenous and non-Indigenous peoples to the environment.

Many Australian geographers have preferred to discuss the social environment, or the landscape in terms of the spatial relationships exhibited by land-use patterns. This may be partially attributable to a paucity of historical material on aspects of the physical and biological environment; the nature of the historical record in Western Australia is such that it deals mostly with property, values and the human uses of land and water (e.g. cultivation, timber cutting and obtaining water for crops, livestock and human consumption). However, some observations obtained from land records may provide a basis for deductions concerning the physical environment.

The aim of this paper is to demonstrate that, in the analysis of historical data, there is a case for an ecological viewpoint, in which
the history and ecology of a particular environment are reviewed, and an attempt is made to reconstruct the structure and dynamics of the ecosystems of the past. A study of the wetlands within, and close to, the Perth Metropolitan Region serves to illustrate how a distinctive landscape and its ecology was completely altered as the city expanded. Special attention is given to the waterbirds which are a conspicuous component of any lake or swamp community, and provide a good index of the total well-being of a wetland environment. A wetland that has a diversity of waterbirds probably represents an ecosystem that is correspondingly rich in plant species and structural diversity.

By adopting an ecological approach to the analysis of historical material, certain information may be highlighted that may not be emphasised by more orthodox historical research. Ecologists wanting to reconstruct past environments are compelled to follow a sequence of reasoning different from that of an historian or historical geographer although similar sources are often used, they may be used differently.

The concept of “ecology”, as such, was not known at first European settlement and little information is available on what the physical environment was really like, except for fragmented notes. Early naturalists were essentially taxonomists – the first systematic collections of the flora were compiled by Preiss (1838) and Diels (1906); prior to that, descriptions of the landscapes of the Swan River had been recorded by Frazer (1827) and Drummond (1829). The earliest notable records of waterbirds for the vicinity of Perth are from the visit of J. Gilbert (1839-1943), a professional taxidermist and collector, and, those contained in W. B. Alexander’s ornithological notes in Australia (unpublished documents between 1912 and 1925, now deposited in Canberra); later in 1948, D. L. Serventy published a paper on the birds of the Swan River District. Unfortunately, there is little standardisation in the manner in which the particulars are recorded or in the level of details; there are omissions and countless anomalies. When Perth was first settled, in 1829, little emphasis was given to the allocation of “public land”, for the purposes of amenity and recreation. Therefore, the early settlers made a few attempts to record the non-economic aspects of the landscape.

A range of documentary sources is now available to the researcher interested in the ecological history of wetland environments. Old maps and newspaper, explorers’ diaries, surveyors’ field-notes and various records held in the State Archives, can be used to reconstruct past ecological changes. The Perth area has only been colonized for a relatively short time, thus it is possible to trace
changes in the distribution and abundance of some species of flora and fauna over the entire period of settlement.

**The various sources of data, and problems in their interpretation**

The way in which wetlands were recorded by early settlers vividly illustrates the problems with which these people were confronted. Inaccuracies in the data are often due to an observer’s subjectivity or lack of experience in a new environment. Ignorance of the peculiarities of the Australian environment was a major problem faced by many Europeans who tried to record or evaluate it. For this reason, the degree to which an area was familiar or unfamiliar to the investigator needs to be considered. Stirling and Frazer, during their reconnaissance of the Swan River in March 1827, tended to concentrate on those elements which they were most familiar with or those which otherwise claimed their attention, and neglected those which were alien (Cameron, 1975). This inability to understand or identify with Australian landscapes was to persist until adaptation to the environment had increased by the second and third generations of colonial born. The reversal of the seasons, an unfamiliar climate and the strange flora and fauna were foreign to Europeans’ experience, as were the discontinuous chains of shallow interdunal lakes and swamps.

Frequently, first impressions coloured the choice of names and the nature of the report. For this reason, the timing of the investigations introduced a major bias due to seasonal variation. Prior to European settlement, the Dutch arrived in 1696 at the height of summer, to find that the Swan River was extremely saline and that there was a general shortage of fresh water (Cameron, 1975). In contrast, when the first fleet arrived after storms in May 1829, they found a surplus of water as abundant rains had already affected the lakes and swamps.

The attitudes and preconceptions of particular observers, are apparent throughout the historical records. Historically, the attitude towards Western Australian wetland areas has been mostly unfavourable; early settlers found lakes in their new surroundings quite unfamiliar and hardly worthy of preservation. Such is the account given by an early visitor to the colony:

"At home, a lake is known only as a sheet of water which seldom or ever is dried up, and it is naturally associated in one’s mind with pleasant and picturesque scenery, but here it is quite different... there is an air of desolation about these lakes which strikes the spectator at once... It is complete still life without one point of interest in it, as far as striking scenery
goes, and totally different from anything I ever saw outside of Australia.”

*(The Swan River News, August 11, 1847, p. 161)*

A collection of old maps arranged in chronological order reveals the sequence of settlement and progressive sub-division of the landscape. Locations of former and existing lakes can be identified and changes in their outline recorded. The impact of drainage and reclamation has seen the disappearance of seventy-five percent of the wetlands of the Swan Coastal Plain, representing approximately 200,000 hectares of lost habitat (Riggert, 1966; Bekle, 1981; Bekle and Gentilli, 1993). Old maps are often useful, as they may allow the contraction or expansion of an area of wetlands to be traced through the years; early maps of the Perth townsite show many lakes and swamps of which there are now few or no surface traces. They serve to illustrate the irreversible damage caused to almost an entire complex of wetlands by drainage and reclamation as the city expanded.

The reconstruction of 1829, in Bekle and Gentilli (1993), shows the position of many of the former wetlands which occupied shallow depressions north of Perth townsite. A multiplicity of names appear for these lakes and swamps. Many are known after the original owner or user, such as Lake Kingsford which was named after Samuel Kingsford, who in 1833, erected a water mill driven by water he derived from the lake. For some other wetlands, there is uncertainty in the most popular identification of names (e.g. Stone’s Lake, also known as Tea-tree Lake, Lotus Paddock, and now Perth Oval). The area of these wetlands varied significantly between winter and summer, therefore if a comparison is to be made with later maps the dates of survey must be established.

Later maps disclose more detail, as illustrated by the survey plans of 1845 and 1903, which indicates that urban settlement has been extended to encroach on the lakes area (cf. Bekle, 1981; Bekle and Gentilli, 1993). Some wetlands, including Lake Kingsford, have been omitted from later surveys, possibly in anticipation of their eventual drainage and infilling. Additional information obtained from old newspapers, however, reveals that Lake Kingsford was still in existence. Reports from such (old) newspapers (e.g. *The Swan River News, The Inquirer*) have a tendency to record either the negative aspects or sensational occurrences, such as the heavy rains during the winter of 1847, which caused Lake Kingsford to flood parts of the Perth townsite: “In Murray, and all the streets in its rear, the water had risen so much as to compel the inhabitants to quit and seek for drier homes” (*Inquirer*, August 11, 1847, p. 2). When dealing with this material it is easy to overlook unpublished, but equally significant events, such as the gradual reclamation of a lake for market gardens. Flooding may be also caused by human
action – the same amount of water would rise to a higher level after a lake cavity has been partially filled.

The writings and diaries of early explorers offer descriptions of many lakes, which were frequently used as campsites. In the journals of Lt. (later Sir) George Grey, recording excursions made during 1838 into the country north of Perth, are references to the character of the landscape and the abundance of waterbirds. The waterfowl at Loch McNess, provided a plentiful source of food for the expedition:

“We were sitting on a gently rising ground, which sloped away gradually to a picturesque lake, surrounded by wooded hills... we could distinctly see the large flocks of wildfowl, as they passed over our heads, and then splashed into the water, darkening and agitating its silvery surface; in front of us blazed a cheerful fire round which were the dark forms of the natives, busily engaged in roasting duck for us.”

(Grey (1841, I, pp. 296-297).

This entry was recorded in December, and it provides both an accurate seasonal description of the landscape and an instant report on the waterfowl population. However, the value of such observations may only be valid for a very short space of time, such was the speed with which Australian wildlife reacted to changes in the environment. Any reports of the abundance of birdlife, must be treated with caution; sudden unseasonable rainfall may disperse summer concentrations of waterbirds, leaving a false impression of low numbers for the total population.

Unlike the Aborigines, whose intimate knowledge and experience of the land enabled them to live by the seasons, British settlers were accustomed to surpluses of water – rather than aridity. Events recorded as extraordinary, such as the seasonal drying of a lake, may be a regular phenomenon. The regular re-occurrence of drought in Western Australia, becomes apparent when lake water-levels are regularly monitored.

During a dry spell in 1963, Lake Thomson had gone dry for the first time in the memory of the local residents: “Several years ago about three thousand fingerling trout had been placed in the lake, apparently in the belief that it would never completely dry up” (West Australian, March 9, 1961). After a very dry period from 1975 to 1977, the water-level of nearby Bibra Lake was similarly lowered.

Coverage of different areas may also vary; a contrast exists between those lakes further from the settlement, which have been described in great detail by early explorers (e.g. Grey, 1841) and lakes located in the vicinity of Perth, which were largely taken for granted. When around the turn of the century unsettled land close
to Perth became scarce, settlers went to the interdunal lakes and swamps of the Swan Coastal Plain (e.g. Lake Joondalup and Bibra Lake). Two conflicting attitudes existed, whereas wetlands close to Perth were regarded as an impediment to development, lakes further away were viewed rather differently. Due to the harshness of the sand dune country where the soils were of no great fertility, wetlands were regarded as a valuable resource. Lakes provided both fresh water and rich peat soils along their margins. Unfortunately, this resulted in considerable clearing of vegetation around these lakes, particularly the reed beds, and more recently, in fertilisers posing a serious threat to water quality.

Surveyors’ field-notes generally gave a one-sided representation of the landscape. They provide an economic interpretation of the land, either regarding the availability of good grass for pasture – this may, however, also imply that suitable feed exists for native animals – or the location of fresh water for livestock. Surveys of various locations near lakes, however, allow at least a partial reconstruction of the landscape. The zonation of vegetation, slope of the terrain and distinctive landmarks, such as limestone outcrops, are described with varying degrees of detail and accuracy, depending upon interests, attitudes and competence of the surveyor. The initial objective of surveying land was to facilitate its use by settlers. This tended to make the surveyor’s examination partial and selective. Unpleasant features of the landscape or land described initially as poor, might be overlooked in later surveys. The early work both of government surveyors and those operating independently, was supervised by the office of the Surveyor-General.

Among other surveying instructions issued, probably the most significant was the provision in respect of nomenclature. All known names of lakes, were to be noted down and wherever “euphonious Native names” could be ascertained they were to be retained (Tyman, 1976). The Aborigines, always closely associated with the land, had given many lakes distinctive names. An impression of how they were using the wetlands and the surrounding countryside at the time of European contact, or how the lakes fitted into their patterns of traditional land-use, may sometimes be gained from the original titles; the following interpretation is given for Lake Yangebup. The name “Yangebup” (first recorded by the surveyor F. F. Monaghan in 1888) may be derived from “Yanget” or “Yanjidi”, the Aboriginal names for the edible root of a species of bulrush (Typha orientalis). Grey (1841, II, 294) recorded that “the natives must be admitted to bestow a sort of cultivation upon this root, as they frequently burn the leaves of the plant in the dry seasons, in order to improve it”. It is likely the Aborigines visited Lake Yangebup in summer, as it became sufficiently shallow for the reeds to be burnt, and the aquatic life to be harvested. A number of other
lakes also have Aboriginal names ending in “up” (e.g. Lake Joondalup, Lake Jandabup); this denotes a camping place.

Aboriginal names were to be accurately recorded and special care taken to discover their correct pronunciation. However, problems of linguistics are frequently encountered during the interpretation of Aboriginal words. The Aborigines had no written language, consequently Aboriginal words are spelt in various ways of different authors (e.g. documented forms of the spelling of the Aboriginal name for Bibra Lake are “Wallubup”, “Walliabup”, “Walyerbup” and “Walyubup”). A ‘Descriptive Vocabulary’, giving the meanings of many Aboriginal words was compiled by G. F. Moore in 1842, however, interpretation is still difficult due to inconsistencies arising through the existence of a large number of different dialects.

It is inevitable that individuals drawn from a variety of cultural and environmental backgrounds, would inject diverse forms of literary expression into their accounts. The incorrect or ambiguous identification of wildlife, and plant species (e.g. using ‘home’ or European names) is a problem; the early surveyors commonly referred to jarrah (Eucalyptus marginata) as “mahogany.” Also, some naturalists only record unusual species or those of particular interest to themselves, and commonly occurring birds (e.g. Black Duck (Anas superciliosa) may be overlooked. In contrast to the above, some documents are easier to interpret. Various historical documents obtained from the State Archives (e.g. records and correspondence from the offices of the Surveyor-General and Colonial Secretary) provide details of the decision-making process that led to events, such as the construction of drainage channels. Similarly, technical reports (e.g. those of a Public Works’ engineer) are precise and open to little misinterpretation.

Aerial photography reveals more than a map often does, but maximum benefit is obtained from both when the two data sources are studied side by side. From the 1940s onwards oblique and vertical aerial photographs are available. They can be often used to reconstruct, with considerable accuracy, recent changes in plant communities and land-use. One such example is provided by the spread of the bulrush (Typha orientalis), a pioneer species, which colonises disturbed lake margins at the expense of native sedges: this spread, in Lakes Joondalup, Neerabup and Claremont can be documented using photographs taken between 1950 and 1970.

**Fieldwork in relation to eco-historical sources**

But a study of maps and old documents, however scholarly, can reveal only an incomplete picture (Armstrong, 1975). Field observations can supply information both of ecological and historical value, by providing a link between historical documents and the
contemporary landscape; Hoskins, (1967) wrote of the value gained from fieldwork:

There is no opposition between fieldwork and documents... behind a good deal of work in the field are documents that help to throw more light on what is being studied; and behind a good many documents lies much valuable fieldwork if only the unimaginative 'researcher' had the wit to see it.

Beneath the ground, Paleosols provide evidence of long term climatic changes affecting the lakes. Darker layers are evidence of wetter periods, which would have extended the area of known lakes and swamps, and also created additional wetland areas. On the surface, marl deposits and peaty bogs are indicative of areas which were once either lakes or swamps. Similarly, stands of dead trees testify to a recent rise in water level. Summer drying of lakes is a regular feature of the Perth environment, to which many aquatic or semi-aquatic plants have adapted. Trees such as Flooded Gums (*Eucalyptus rudis*) and paperbarks (*Melaleuca*) which are unable to withstand permanent flooding, are found beyond the sedges around the rim of many urban lakes. Permanent flooding has killed the paperbarks (*Melaleuca rhaphiophylla*) at Lake Claremont (formerly known as Butlers’ Swamp); judging from their girth, the trees are approximately eighty years old. Also, old submerged fencelines, such as those at Lake Joondalup, indicate a lower water-level and grazing during the past.

**Conceptual problems associated with the understanding of the dynamics of contemporary wetland ecosystems**

Care must be taken in the ecological interpretation of historical material. The investigation of a wetland environment as a dynamic, functioning system requires the approaches and skills of the ecologist, as well as the historian. For the successful application of this approach, a knowledge both of the historical material and ecosystem structure and dynamics is essential. Proper assessment of the sources is equally important when dealing with descriptions of the natural environment. The interpretation of aerial photographs, the scrutiny of legal documents and old maps, and field studies are complementary to one another (Armstrong, 1975).

It is important to be able to recognise wetland ecosystems as a network of ecological relationships. Wetlands are known as the home for a multitude of different waterbirds, from tiny waders such as Dotterels, to the majestic Black Swans. Different habitats, which may be associated with certain species of waterbirds, will advance or retreat as the level of the lake moves from high to low water. The abundance of many of the aquatic plants and animals which form the food of waterbirds is closely tied to seasonal fluctuations in
water-level. Seasonality is an integral part of a wetland environment in Western Australia. Seasonal climatic fluctuation including rainfall, temperature and evaporation, produces constant change in aquatic environments. They provide the basis for annual fluctuations in water depth, resulting in a continual succession in plant and waterbird species composition. Newly exposed mudflats yield a wide range of insects and crustaceans and the relatively high light penetration in the shallows, encourages prolific growth of aquatic plants.

Flood, suitable nesting materials, shelter or roosting facilities and other linkages have a spatial expression; one habitat may be connected with another, nearby or far away. Examples of various scales can be quoted. Within the south-west there are regular seasonal movements of waterbirds, related to the availability of water and wetland habitat. During winter and spring, when wetlands are most extensive, many species disperse throughout the smaller, more secluded areas to breed. With the advent of summer and the drying out of many of these waterbodies, most birds move to the permanent coastal wetlands. Local movements also occur; Ibis and other colonially roosting birds, while residing at the lake during the hours of darkness, may move daily to nearby wetlands in search of food. In 1952, when very low rainfall was recorded in the north of the state, a number of different species moved south from the Kimberley Division and became permanently established in the south-west (e.g. White Ibis *Threskiornis molucca*). This led to an increase in bird variety in the Perth area, emphasising the fact that no ecological system is self-contained. Birds are essentially mobile, and populations of waterfowl on the coastal lakes vary from one season to the next. Certain species of Australian waterfowl are nomadic. Under conditions of widespread drought, the movement of Grey Teal (*Anas gibberifrons*) may span the continent.

Birds banded in the south-west have been recovered in all States. Therefore, before conclusions can be made from bird records, the weakness of the data need to be established; the time of year and prevailing climatic conditions should be stated. Rather similar long-distance relationships exist between an international complex of wetland habitats. There are the trans-equatorial migrants – birds that breed in Northern Hemisphere countries and migrate to the south-west each year (e.g. the Sandpipers and some other waders). The natural complexity of many of these wetland communities, together with the system by which contrasting communities are locked together, probably contributes to the overall stability of these ecosystems.

There are many ways in which man has destroyed whole ecosystems composed of plants and animals, and simplified others. It was usually the shallower lakes and wetlands that were completely
reclaimed, while only the margins of deeper, permanent lakes could be economically modified. Early sub-divisions near wetlands, show some property boundaries as extending into a lake or swamp, this implies that the holder of the land is entitled to encroach on the wetland, altering both the shape of the shoreline and the extent of open water. The margins are the most biologically productive part of a lake, and also the most important for waterbirds, providing, as they do, nesting, roosting and feeding habitats. The most significant functions of the wetland are destroyed, once the surrounding paperbarks and reeds have been removed.

It is by no means certain that an event has the same effects now as a similar occurrence had in the early years of European settlement. The environmental consequences of drought upon lakes in the Perth Metropolitan Region are different today from those of dry periods in the nineteenth century because of certain aspects of the physical environment that have altered. Lake Monger, once surrounded by stands of paperbark trees, and containing high reeds and rushes, became almost dry by the close of early summer; the following description was given by an early settler:

The only place where I saw any water was just in the centre, where a small stagnant pool of about a hundred yards in circumference, appeared fast evaporating like the steam from a shallow vessel of boiling water”

(The Swan River News, 1847).

Today the lake has been modified to a steep-sided, artificially maintained, open-water area, surrounded by cultivated lawns. Also, the water chemistry of most urban lakes has been changed by alterations in the pattern of agriculture, particularly the application of artificial fertilizers. Before the 1880s, Perth depended for water supplies upon wells and springs, which drew water from the same source as the lakes. Wetlands are now richer in nutrients. In times of droughts water-levels in some lakes may be similar to those recorded in the past, but now when severe overcrowding results from a large influx of displaced birds, they are affected by blue-green algae, botulism, foul water and may die from starvation.

Statements regarding the effects of the alteration of wetland habitat on bird populations, are comparatively few. Fluctuations in the total population of waterbirds as a result of climate, for instance high mortality and lack of breeding success during a period of drought, are the normal order of things; only the surplus are removed and recovery is dependent upon the return of favourable conditions. But when several pressures (e.g. habitat destruction and change, increased eutrophication and disease (botulism) deplete breeding stocks, recovery may be impeded. Ecological changes in lake habitats have led to serious wildlife disturbance, but caution must
be exercised when drawing any more detailed conclusions. Basic ecological principles remain unchanged but the biology of certain species may alter through time. Certain species of waterbirds, such as the Freckled Duck (*Stictonetta naevosa*) and Black Bittern (*Dupetor flavicollis*) have been reduced in their range and numbers, while other birds like the Black Swan (*Cygnus atratus*) or Coot (*Fulica atra*) have adapted splendidly to urbanised environments.

The future of wetland areas is dependent upon the attitudes of the society. There is a growing concern for the environment and enthusiasm for conservation, which is highlighted by a steady increase in the number of wetlands incorporated into reserves and recent public involvement where amenity is concerned (e.g. the formation of private conservation groups, such as Habitat Herdsman). But at the same time there is increased demand for recreation areas and pressure from land developers – lake surrounds have become popular sites for residential developments. A broad diversity of habitats is essential in supporting the many different types of waterbirds. Sound management and careful planning are required to ensure the continued effectiveness of wetlands as wildlife sanctuaries.

**Conclusion**

Descriptive accounts and other records obtained from historical documents, can be recognised as useful indicators of past environmental conditions in landscape studies; the evidence is often hidden or neglected but retrievable. Modern geographers and ecologists concerned with the “total environment” can benefit being able to reconstruct the complex of inter-related changes that influenced an ecosystem in the past. Historical material may provide information on the former status of certain species of wildlife and the productivity of different ecosystems; this technique has applications for environmental management and cross-disciplinary research focussed on human interactions with landscape.

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