The Guildford Floodplain Study: A Study of Resident Perceptions of Change to Flora and Fauna

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Executive Summary

The suburb of Guildford in Perth, Western Australia, is recognised nationally for its historical significance, part of which includes the floodplain environment. Recent concern over the management of the floodplain vegetation and possible impacts on biodiversity prompted this survey of residents' perceptions of change to flora and fauna of the floodplain. The aim of the survey was to provide information on flora and fauna on the Guildford floodplain. The specific objectives were to determine if there were perceived changes over time, what causal factors were perceived as effecting those changes and to determine recommendations for future management practice. The study was phenomenological and qualitative in nature to ascertain changes over time. Surveys were hand-delivered to households with properties adjoining the floodplain. Approximately one quarter of the surveys were completed. While the number of respondents was low, many of the respondents were long-time residents of Guildford and therefore the data collected is both valid and valuable.

While the survey results did not detect a clear overall perception of a change in the structure or diversity of vegetation on the total floodplain area, there was, however, a greater consistency of views expressed within zones about the impacts of management practices such as the broadscale use of herbicides and mowing. There was a clear perception of a decline in terrestrial vertebrates, most markedly of frogs, but also of bandicoots, water rats, echidnas, and tortoises. A significant outcome of this survey was a record of locations in Guildford where bandicoots and other fauna are still present. These areas will require careful management to ensure habitat is maintained and improved.

The Overarching Recommendations arising from this report are:

1. Promotion of biodiversity and habitat complexity through planting locally endemic trees, reeds and sedges and middle and understorey species.
2. Planning for 'conservation areas' as well as 'maintenance areas', with each having a distinct and separate programme of maintenance.
3. Consultation with the community about revegetation programmes and local fauna and flora issues.
4. Pre-eminence of principles of biodiversity and conservation over other planning and recreational policies.

Recommendations for improved management of the floodplain environment are consistent with the Swan River Trust's, 'Swan and Canning Rivers Foreshore Assessment and Management Plan' and other recent reports. We call on the Minister for Environment, the Minister for Planning, Department of Planning, Western Australian Planning Commission, Department of Environment and Conservation, City of Swan and the Swan River Trust, to act immediately to implement the

recommendations. Improved management of the floodplain vegetation may allow regeneration and the creation of complex habitats that will benefit the local native fauna.

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All photographs by Barbara Dundas or Harriet Mills.

The views expressed in this report are those of the authors and do not necessarily reflect those of the Guildford Association Inc.

Background to Study

The Guildford Association Inc., the local resident and ratepayer association for the Guildford community, has received regular comment from local residents about the management of the Guildford floodplains and the resultant impact on flora and fauna. Specifically, the Association has noted resident reports over recent years of loss of vegetation through spraying, mowing, lopping and the erosion of riverbanks, and the population decline of faunal species including frogs, long-necked tortoises (*Chelodina oblonga*), southern brown bandicoots (*Isoodon obesulus*), possums (*Trichosurus vulpecula*) and echidnas (*Tachyglossus aculeatus*). In response to residents' concerns, it was determined by the Association at its January 2009 meeting to conduct a study of the Guildford floodplains.

The study aimed to assess possible changes in the flora and fauna of the Guildford floodplains using the local knowledge of the residents of Guildford. Data would be generated via a survey that would collect information on perceived changes to the vegetation and fauna of the floodplain and perceived causes of those changes. The information collected would form a baseline set of data on certain key species and would contribute to forming principles for future management. This survey is important because it is the first study of its kind in Guildford, which has an unique geographic and historic place on the Swan Coastal Plain.

Structure of the Report

The report is presented in four sections – Introduction, Methods, Results and Discussion. The Introduction includes a description of the geography and history of the area, and includes a summary of policies that have affected the management of the river and floodplains, since it was felt that this has not been adequately summarised in previous reports. The discussion includes recommendations for floodplain management that are based on the main issues raised by the residents who responded to the survey.

Introduction

Site Description

i) Location

The town of Guildford is sited approximately 40 km upstream of Fremantle and 13 km east of the capital city, Perth (Fig. 1). The Swan River is generally recognised as estuarine up to the town of Guildford with brackish waters and riverine environment beyond.

However, the whole area is subject tides and tidal surges as well as seasonal shifts in salinity (Twomey and John 2001). In summer, the brackish water extends upstream beyond Guildford, but in winter, with high levels of rainfall and freshwater discharge, the brackish water is flushed into the lower estuary. The Guildford townsite area is located on acidic alluvial clays, known as Guildford Clays, which form part of the Pinjarra Plains (Australian Heritage Commission 1989). The floodplain lands are fertile and subject to seasonal inundation. The Bassendean Dunes to the west of this area represent the Pleistocene beach sands of the ancient coastline (Australian Heritage Commission 1989). The lands beyond the Swan and Helena Rivers to the south and west are comprised predominantly of this ancient sand, which is generally less fertile and supports lower canopy, woodland growth.

The town of Guildford is approximately 160 hectares in area, and is defined and limited by the Swan and Helena Rivers. Importantly, half the total area of the suburb of Guildford is floodplain (Fig. 2).

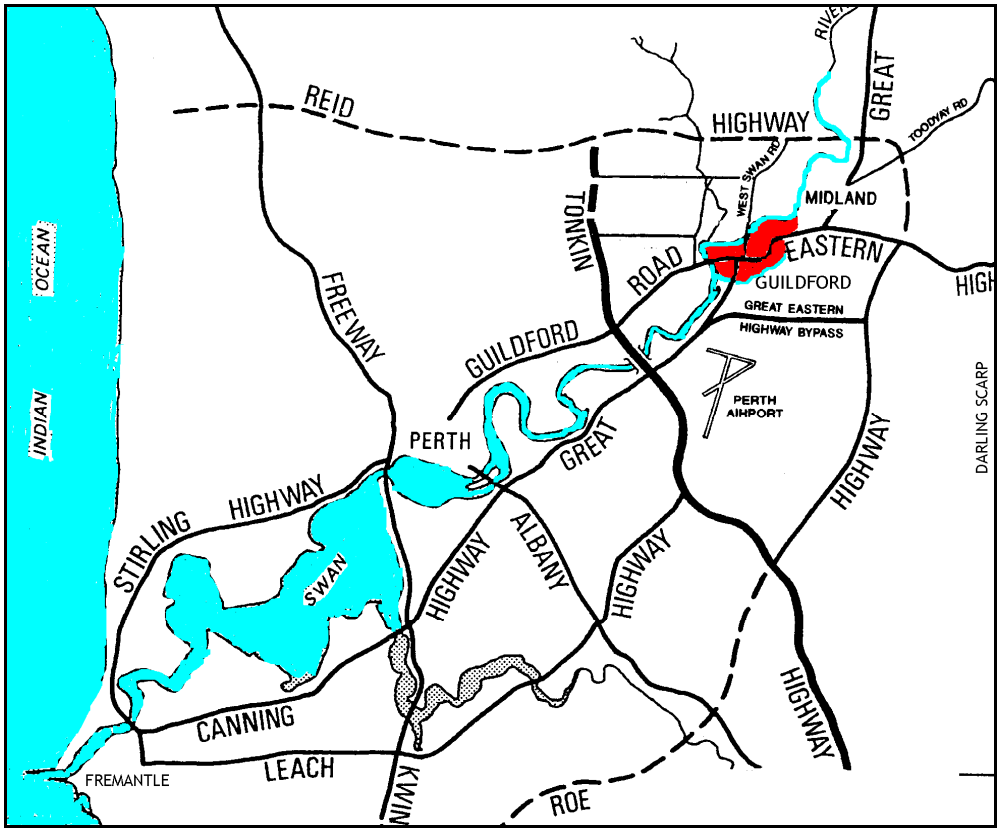

Figure 1. Location of Guildford at the confluence of the Swan and Helena Rivers, near Perth, Western Australia (Image used with permission from the City of Swan).

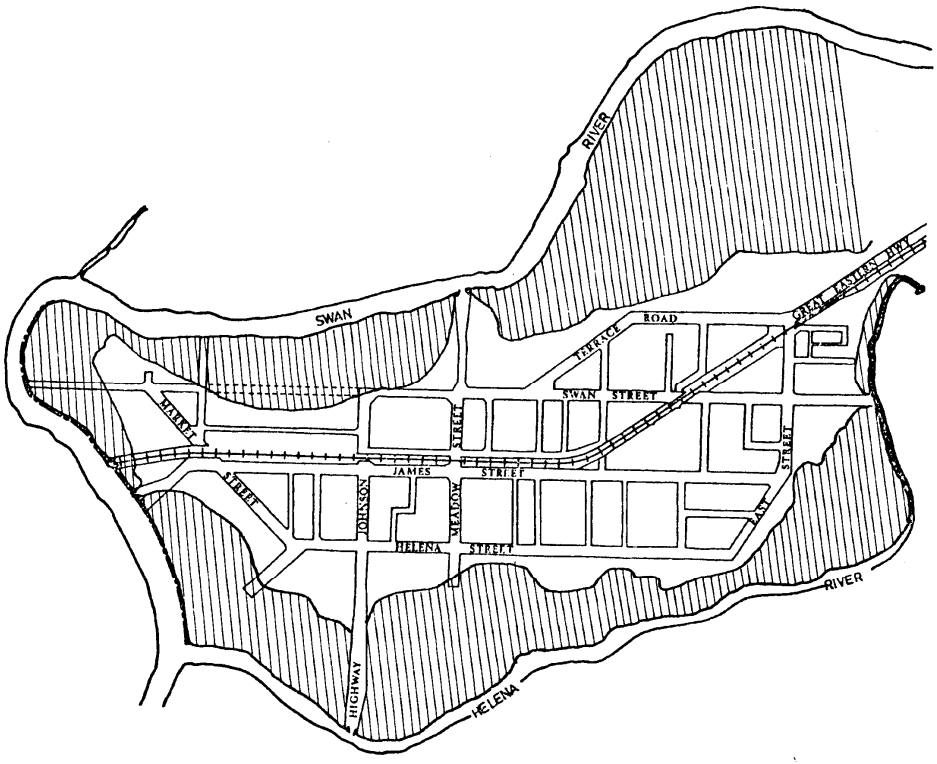

Figure 2. Map of Guildford showing the large area of floodplain (hatched)(Sourced from the Guildford Study Group Report 1981).

ii) Floodplain Vegetation

The vegetation on the Guildford floodplain has been subject to rapid change since 1829 when the area was first settled by Europeans as part of the Swan River Colony. The remnant vegetation on the floodplain suggests the area was originally well wooded with large upper canopy trees such as flooded gum (*Eucalyptus rudis)*. There is also some documentation of tuart trees (*E. gomphocephala*) or a variety there of, (*rhodoxylon* or red tuart) in a limited location in Guildford. In 1937, Henry Steedman, a plant collector, reported that only five of these unique trees remained (Cunningham 1998). It is believed these trees may have been located in an area of light loam soil possibly between Water and Turton Streets to the east of the town. There are none of these ancient tuart trees extant in Guildford today. Whilst there is some scientific debate as to whether these trees were red tuarts or not, Steedman's record of tuart in a limited area of the town is not challenged.

A study of the flora of the Swan Valley (Carter *et al.* 2000) provides a list of plant species found in clay soils, some of which may have been similar to those occurring in Guildford, but the authors note the difficulty of identifying the endemic species in an area where there is so little remaining of the flora that grew on the alluvial soils adjacent to the river. Seddon (1972) in his noted work on the Swan Coastal Plain, remarked that some of the finest stands of *E. rudis* are located near Guildford,

with heights exceeding 50 metres. Today, the only mature, indigenous, upper canopy vegetation on the floodplains around Guildford is the *E. rudis,* with the occasional wandoo (*E. wandoo)*. There are also a number of planted exotic trees including sugar gums (*E. cladocalyx*), oak (*Quercus* sp.), pine (*Pinus* sp.), and olive (*Olea europaea*), and invasive weeds such as Japanese peppers (*Shinus terebinthifolia*). Jarrah (*E. marginata*) and marri (*Corymbia calophylla*) were probably not commonly found on these clay soils, but rather on the more elevated sand and gravel areas from Midland to the hills.

Middle canopy growth has been mostly cleared, but remnants are evident on some areas of riverbank with the swamp paperbark (*Melaleuca rhapiophylla*) and sheoak trees (*Casuarina sp*) being dominant. Tea trees (probably *Melaleuca* species) were recorded in the early maps with 'tea tree swamps' around the townsite and springs at Spring Reserve (Chauncey and Snell 1842). These middle canopy trees play an important role in stabilizing riverbanks and providing habitat to macroinvertebrates, fish and birds. In Guildford the middle canopy is now largely absent, but in some areas has been replaced by weeds such as castor oil and blackberry (*Rubus fruticosus*).

The natural understorey has largely disappeared and been replaced by exotic grasses and weeds due to change of land use over 180 years, including stock grazing, recreational use and current land management practices. Weeds have replaced native shrubs, reeds, sedges and other wetland flora (Hussey *et al.* 1997). For example, arum lilies (*Zantedeschia aethiopica*), introduced by the early settlers to aid in perfume manufacture, have taken over large areas of the wetlands, as have other exotics such as marine couch grass (*Cynodon dactylon*), kikuyu (*Pennesetum clandestinum*) and soursob (*Oxalis pes-caprae*).

The loss of indigenous vegetation in Guildford is similar to the pattern seen across the Swan and Canning river systems. Indeed, the Swan River Trust, in the 2008 report 'Swan and Canning Rivers Foreshore Assessment and Management Strategy', found that 14% only of the Swan River foreshore vegetation was in good condition. The major degrading factors were identified as invasive weed species, diminished regeneration and crown death of trees and shrubs, and inadequate management. The management problems were described as a lack of delineation between areas of exotic grasses and native vegetation, allowing the exotic grasses to smother native plant species, and the mowing and trampling of vegetation which prevents the regeneration of trees, shrubs and understorey (Swan River Trust 2008).

iii) Floodplain Fauna

There are early records of fauna from the Swan Coastal Plain in general, but Guildford is rarely mentioned as a specific locality in early museum records or other reports. While information on nearby sites can be extrapolated to Guildford, the heavier soil type that is almost unique to Guildford

within the Perth metropolitan area means that any extrapolation needs to be treated with some caution. A survey of terrestrial vertebrate fauna (How and Dell 2000) found that in Perth, the only small native mammals persisting in urban areas were southern brown bandicoots (*Isoodon obesulus*), common brushtail possums (*Trichosurus vulpecula*) and (in one reserve only) honey possums (*Tarsipes rostratus*). Bandicoots were once common across the Swan Coastal Plain, but the expansion of the metropolitan area has resulted in the loss of most of the suitable habitat between Two Rocks and Mandurah. Within the existing boundaries of the metropolitan area there is less than 28% of the original bushland (Western Australian Planning Commission 1998), most of which is degraded by weed invasion, frequent fire and feral predators such as foxes and cats. These are the same threats also present on the Guildford floodplain, with the exception of frequent fire.

In Guildford, the original mammal fauna would have included the echidna (*Tachyglossus aculeatus*), Western grey kangaroo (*Macropus fulginosus*), black-gloved wallaby (*Macropus irma*), chuditch (*Dasyurus geoffroii*), common brushtail possum and southern brown bandicoot (How and Dell 2000). The chuditch was often regarded as a pest because of its habit of raiding chicken pens. A newspaper article from 1939 reports that one resident of Guildford trapped, shot or poisoned 23 'native cats' (chuditch) within a month (The West Australian 1939). 'River rats' (probably the Australian water rat, *Hydromys chrysogaster*) were recorded on the riverbanks at West Guildford (now known as Bassendean) in 1830, in the Diary of Jane Dodds (Heal 1988). Based on knowledge of the distribution of mammals in the early decades of European settlement (van Dyke and Strahan 2008), it is also likely that other smaller species were present in the Guildford area, including the numbat (*Myrmecobius fasciatus*), brush-tailed phascogale (*Phascogale tapoatafa*), mardo (*Antechinus flavipes*), bush rat (*Rattus fuscipes*), heath mouse (*Pseudomys shortridgei*) and possibly two dunnart species (*Sminthopsis crassicaudata* and *S. griseoventer*). Bats would also have been common and several species persist in the Perth metropolitan area (Taylor and Burrell 1978), including the white-striped bat (*Tadarida australis*) and Gould's wattled bat (*Chalinolobus gouldii*). Bandicoots and brushtail possums are known to persist on the Guildford floodplains and adjacent areas, as they are still sighted by some residents. Echidnas have been observed recently adjacent to Perth Airport (H. Mills pers. obs.), although no known sightings have occurred in Guildford for several years.

In addition to the mammal fauna, Guildford would have had a rich diversity of birds, reptiles, frogs and invertebrates. The invertebrate fauna remains largely undocumented. To our knowledge there has not been a survey of birds specific to the Guildford area, but there are several biological surveys of metropolitan Perth that include sites close to Guildford. For example, the Perth Biodiversity Project (2002-2006) included a survey of birds in a number of Bush Forever sites (Gole 2004). The closet site to Guildford was at Success Hill in Bassendean (Bush Forever site 305), where 74 birds were recorded including 11 that were considered 'significant'. The significant species included the brown goshawk,

Carnaby's black cockatoo, white-cheeked honeyeater, New Holland honeyeater, and several small insectivores such as the splendid fairy wren, weebill and inland thornbill (Gole 2004).

The original reptile fauna would have included numerous species that are still found across the Swan Coastal Plain. However, it should be noted that many terrestrial species from the Perth region are reported as preferring sandy soil (Bush *et al.* 1995), so it is possible that some of these species were less common in Guildford with its heavy clay soils, than in surrounding areas. Larger species would likely have included the long-necked tortoise, carpet python (*Morelia spilota*), dugite (*Pseudonaja affinis*), gwardar (*Pseudonaja nuchalis*), tiger snake (*Notechis scutatus*), bobtail lizard (*Tiliqua rugosa*), Gould's monitor (*Varanus gouldii*) and western bearded dragon (*Pogona minor*). There would also have been numerous small skinks, geckoes, legless lizards and small snakes.

The species diversity of frogs in Guildford probably has not changed greatly over the last 180 years, although the number of frogs would certainly have declined, as it has elsewhere. The species in the Guildford area are likely to include those that are common across the Swan Coastal Plain and in surrounding areas (Bush *et al.* 1995, How and Dell 2000), although again the heavy clay substrate may have an effect.

Historical Context

The town of Guildford including the floodplain area within the town and 'borrowed floodplain' (on the opposite banks of the Swan and Helena Rivers) were classified by the National Trust of Australia (WA) in 1984 and placed on the Register of the National Estate in 1987. The area was described as,

> *'a rare and comparatively intact nineteenth century town within a comparatively undisturbed topographical setting'* (RNE 1987).

The town was accorded greater recognition by the late Professor Gordon Stephenson in 1955, who noted that in a planning context;

> *'Guildford as whole should be regarded as one of the most important historic towns in Australia.'* (Stephenson and Hepburn 1955).

The inclusion of the floodplains in the definition of the historic significance at national level has not been reflected in state or local government heritage policies, or in management policies of the floodplain reserves.

i) Indigenous Associations

Prior to European settlement the rich alluvial soils of Guildford were known as *Mandoon* to the local Nyungah people, meaning place of many trees or tree thickets. The rivers formed a boundary between

two of these tribes; the *Beeloo* to the south of the Swan River and the *Mooro* to the north (Bourke 1987). The Swan/Helena wetland areas still contain many significant sites including hunting and corroboree grounds, campsites and places associated with spirits of the Dreaming and Dream Time at Success Springs, Bennett Brook and along the course of the Swan and Helena Rivers and Hazelmere Lakes. The whole of the Swan and Helena River floodplains are protected under Section 18 of the state's Aboriginal Heritage Act (1972) and relevant sections of the Environmental Protection Act (1986). The Swan Valley Nyungah Community and the Elders of the Swan River, Swan Coastal Plains and Darling Ranges, continue an ongoing involvement with river and river lands as an intrinsic part of their cultural heritage. Stories of the Dream Time as well as stories of fauna, flora and the river lands over time, are also held by the Elders.

ii) First British Settlement and Change of Land Use

Under Governor Stirling's administration, the Swan River Colony was established as a British settlement in 1829. The first three towns to be established in 1829 were Fremantle, Perth and Guildford. These early settlements caused irreversible change to the original landscape. The Guildford Town Site was created with 2-4 acre allotments (Fig. 3), to permit subsistence living by the new inhabitants (Guildford Study Group 1981).

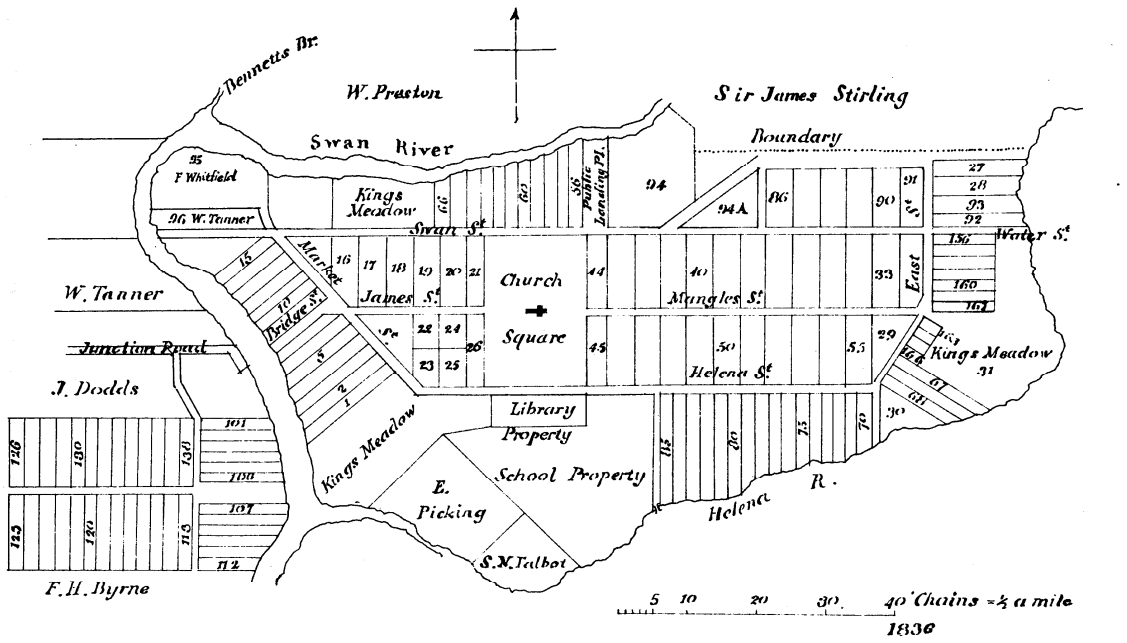

Figure 3. Town plan of Guildford from 1839 (from the Guildford Study Group Report. 1981).

The allotments fronting the river were first to be selected, as they provided both water for stock and a transport route to the towns of Perth and Fremantle downstream. The allotments were cleared quite extensively for stock, orchards, olive groves, vineyards and to reduce the ever present risk of fire. Many of the large *E. rudis* trees remained for shade or to delineate property boundaries, and olive trees were also used for this purpose. These boundary trees are still evident today on many flood fringe properties.

The South African port of Cape Town provided an important port of call for early immigrants and traders *en route* to the Swan River Colony, both for restocking of supplies for the final section of the journey and acquisition of new stock, grains and fodder. In the new Western Australian settlement, European and South African grasses and trees quickly became established e.g. Guildford grass or 'nobby grass' (*Romulea rosea*), capeweed (*Arctotheca calendula*), cape lilac trees (*Melia azedarach*) and olives. Many of these exotics acclimatised so well they became weeds. Few records were kept of the native vegetation patterns in and around Guildford in these early days, unless the plants were deemed to have particular commercial interest or were toxic to stock (Perth Gazette 1834).

In 1881 the railway from Fremantle terminated in Guildford. This was the first stage of the Eastern Railway line. Many of Guildford's central town blocks were subdivided in the next decade with the economic and population growth arising from the gold rushes (Fig. 4). This more intense development resulted in further land clearing leading to loss of upper canopy plantings in the town centre and additional clearing of the Town Meadows on the floodplain for stock grazing. Post war urban growth in the 1950s and 1960s resulted in increasing pressure to develop large blocks of land in metropolitan Perth. Guildford's relative distance from the city and limited available land protected the town and floodplain allotments from further development and encroachment (Fig. 5). Some of the large homes on river lots were developed as nursing home or mental health institutions. The presence of these institutions, to a large extent protected the river lands from subdivision, loss of vegetation and fauna for the next 30 years. There are today in Guildford and Bassendean, a number of residents who can recall the fauna, flora and changes overtime, with clarity (Porter 2009).

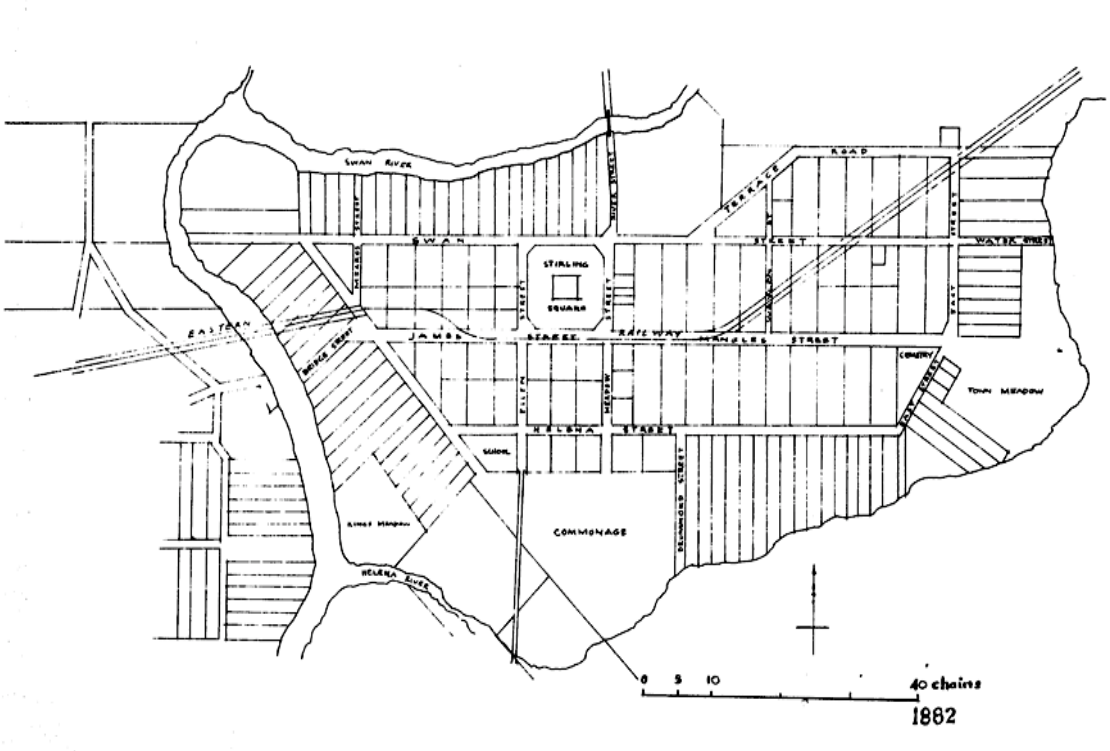

Figure 4. Map of Guildford from 1882. Shows limited change to the early town plan, with the exception of Stirling Square reduced to half its original size and some subdivision (Guildford Study Group Report 1981).

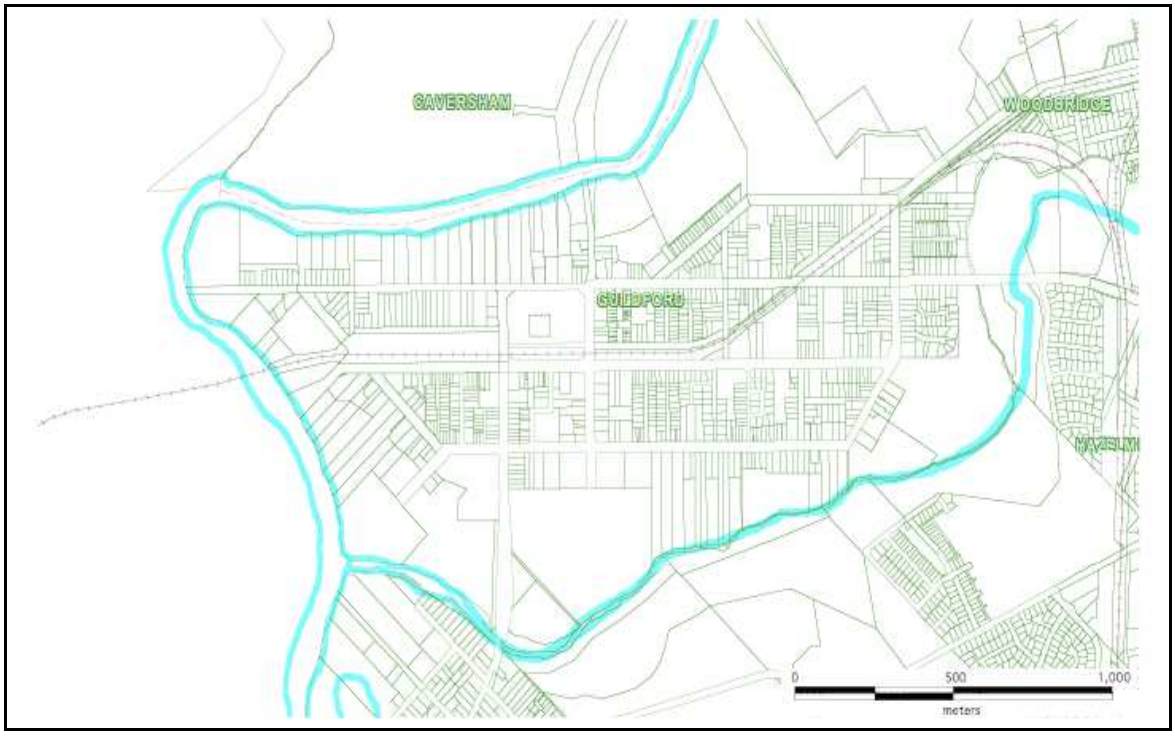

Figure 5. Guildford Town 2010 (adapted from a map copyright City of Swan and used with permission).

iii) Physical Changes to the Catchment

The blasting of the rock bar at the mouth of the Swan River at Fremantle in 1893 permitted the greater influx of seawaters into the Swan and has contributed increased tidal flux and salinity levels (Hodgkin and Hesp 1998). Records of flora and fauna changes arising from this event have not been documented, however, such changes were unlikely to have significantly affected the vegetation upstream at Guildford. The damming of the Helena River at Mundaring in 1906 and the subsequent raising of the weir wall in 1960, have contributed to greatly reduced water flow in the Helena Catchment. This factor combined with reduced rainfall has resulted in the Helena River being reduced to a trickle of water in summer. Flooding, when it occurs on the Helena River floodplains at Guildford, usually results from a backwash from the Swan River rather than high run-off from the Helena River. It is probable that the reduced water flow has had considerable impact on flora and fauna in this area. Recent change to water volume has been parallelled by changes to water quality, arising in part from increased residential and industrial development upstream of Guildford, on both the Swan and Helena Rivers. Increased nutrient run-off and salinity from the Swan/Avon and Ellen Brook catchments has also been blamed for the growing incidence of algal blooms that affect the waters of the Swan, around the Guildford area (Swan River Trust 2005).

A Summary of Government Acts and Policies Affecting Floodplain Lands

The conservation of the Swan River has been a concern of government for several decades, going back at least as early as 1943 with the establishment of the Swan River Reference Committee. Early conservation efforts were focussed on improving water quality by removing point sources of industrial pollution. This was enshrined in legislation with the Swan River Conservation Act (1958). Since then, conservation efforts have broadened to include addressing diffuse sources of pollution and river ecology. Here we summarise some of the key changes in government policy that have influenced management of the Swan River:

i) Stephenson-Hepburn Plan (1955)

The origins of planning for river parks and reserves in Guildford and the rest of the metropolitan area may be found in the Stephenson-Hepburn Plan (1955). This report sought to formalise planning along Swan River to provide protection from development and to allow public access (Stephenson and Hepburn 1955). In an open-ended statement on regional space, its definition of area and form, the report stated it:

> *'...was not subject to imposition of theoretical standards. The quantity and distribution derives largely from an examination of areas considered suitable for particular uses...*' (Stephenson and Hepburn 1955 p. 95).

This qualitative approach to determining regional reserves and their uses has resulted in a number of inconsistencies and conflicts, which have become more evident with improved technologies and

understanding of the river systems (Porter 2002). The Stephenson ideal of opening foreshores to the public contained notions of social equity, however, the resultant act of parliament (Metropolitan Region Improvement Tax 1959 W.A.), whilst providing for the purchase of reserve land, did not provide a funding structure for its maintenance and management.

ii) The Swan River Protection Act (1958)

This Act provided the initial framework for protecting the fragile Swan River system that was being extensively polluted by industry. The Metropolitan Regional Planning Authority commenced a programme of acquisition of the floodplains in 1959 for the purpose of public open space. This programme sought to form a public buffer area of all acquired properties within the floodway of the Swan, Canning and Helena Rivers. This concept of a government owned Foreshore Park was and is unique both in Australia and the world. The acquisition of such lands presents particular issues and challenges in relation to public liability, fire risk and maintenance both of riverbanks and floodway land.

In Guildford most of the floodplain land has been acquired by the Western Australian Planning Commission (WAPC; formerly the Metropolitan Regional Planing Authority), part of which is divested to and under the control of the City of Swan. Approximately one third of the floodplain is under private ownership, the majority of this land falling under the ownership and control of Guildford Grammar School.

iii) Aboriginal Heritage Act (1972)

This Act was passed through the WA Parliament acknowledging the importance of the rivers and floodplains to the Aboriginal people. Section 18 of the act requires any person involved with soil disturbance or interference with identified sites to consult with the appropriate indigenous people.

iv) Eastern Corridor Report (1978) and System Six Study (1983)

Studies such as the Eastern Corridor Report (Taylor & Burrell 1978) and System Six Study (DCE 1983a and 1983b) acknowledged the difficulties of balancing idealistic and practical considerations regarding acquisition of foreshore land and public access. Burrell and Taylor (1978) recommended having some river areas accessible and some less accessible to the public. They recommended an Open Space concept for Midland with river parkland links:

> *'...very few places in the Study Area remain relatively undisturbed and retain original flora and fauna. Preservation of such areas...is critical at this time...this study will recommend the reservation of representative sections of the major habitats...of sufficient size to ensure no further species of plant or animal will become extinct through lack of early planning such area.'*

Five years later the System Six Study argued for the importance of putting land aside for conservation purposes and increasing expenditure (Department of Conservation and Environment 1983a and 1983b). The study also argued that it was not possible or desirable to bring all potential public open space into public ownership because of prohibitive costs of acquisition and management. This report argued that the *Linear Park* should be on at least one bank of the Swan River and it was important to ensure that activities in this area were based on 3 objectives;

1. To protect the riverbanks and retain remaining natural vegetation fringing the banks,
2. To provide for public access to the rivers and recreation of low impact on the environment;
3. To provide a continuous trail for pedestrians, cyclists and equestrians to move through open space.

v) Environmental Protection Act (1986)

In 1986 the EPA Act was strengthened to assist the protection of sites identified and registered under the Aboriginal Heritage Act of 1972.

vi) The Swan River Trust Act (1988)

The Swan River Trust Act (1988) established a trust to manage the Swan, Canning and Helena Rivers and their embankments. The Swan River Trust was granted statutory planning powers, but the day-to-day management falls under the varied jurisdictions of local government authorities, state government authorities including the Department of Planning and the Department of Environment and Conservation, as well as private property owners (Fig. 6). The Act addressed more diffuse sources of pollution in the rivers than the previous Act, but the complexity of the management and ownership structures has been criticised as ineffective and unwieldy (Porter 2002).

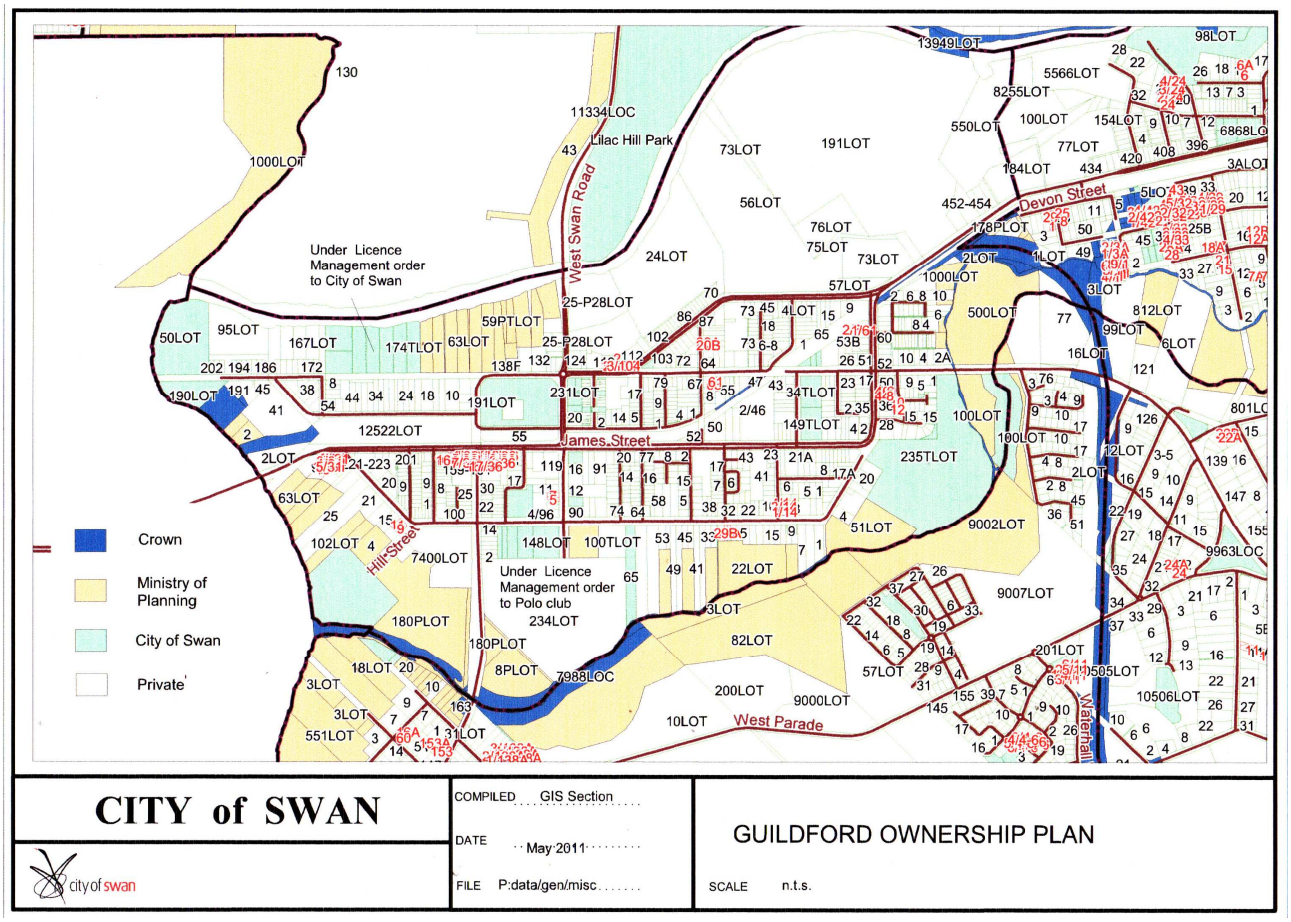

Figure 6. Land ownership and maintenance of the floodplains in Guildford (Copyright City of Swan, used with permission).

The maintenance of flood plains on the Swan, Helena and Canning Rivers is funded by the WAPC. This agency has limited resources and through necessity has to consider issues of weed control, reduction of fire risk and public liability issues as high priority. The resultant management practices have been the cause of public concern (Guildford Association Inc 2009).

vii) Metro Plan (1990)

In 1990 Metro Plan was developed as a scheme to take Perth metropolitan planning into the future (Department of Planning and Urban Development 1990). It acknowledged present and future population growth, as well as the needs and amenity of future communities. It was essentially a planning document that considered open space as an area for redevelopment including bike paths, playing fields or walk trails. It was not a document with a conservation or science focus.

Porter (2002) identified a number of concerns about river management in the middle and upper reaches of the Swan River. Foremost was lack of funding and secondly a failure to use the latest hydrological engineering and scientific methods in determining management strategies (Porter 2002).

He argued the alluvial clays of the middle and upper reaches of the Swan River required different land management strategies to the sandy regions of the lower Swan. He argued further that the Swan River Trust with its limited budget and resources is unable to fund adequate maintenance of the river and its foreshores (Porter 2002, 2010).

viii) Swan and Canning Rivers Management Act (2006)

This Act replaced the Swan River Trust Act (1988) and the Environmental Protection (Swan and Canning Rivers) Policy (Government of Western Australia 1998), with the aim of improving coordination and management of the river systems. It was developed in response to concerns about the lack of planning framework and aimed to provide strategic direction. This Act led to the creation of the Swan and Canning River Park and the River Protection Strategy. It also allowed the Swan River Trust to issue 'River Protection Notices' to the owner or occupier of land in the Swan Avon Catchment where there was a potential threat to the Swan and Canning river system. For the first time there was recognition of a need to address not only environmental values, but also social, cultural and spiritual values.

ix) Local Biodiversity Strategy – City of Swan (2005)

Guildford floodplain land vested in the City of Swan now falls within its Local Biodiversity Strategy (City of Swan 2005). The strategy document espoused many ideals for balancing recreation, land use and amenity, with conservation and biodiversity principles. The key outcomes of this strategy were to include: ensuring that biodiversity values are recognised; identifying high priority areas and making recommendations for their protection; assessing lands to prioritise management needs; and establishing incentives for private land conservation. The action plan within the report contained recommendations that were mainly for identifying and prioritising areas for management, rather than implementing any rehabilitation actions. While the intent of the document is to be applauded, its impact after more than 5 years is unclear.

x) Swan and Helena River Management Framework (2007)

This report was commissioned by the Eastern Metropolitan Regional Council (EMRC) to develop a management framework for these rivers. There were 3 premises:

1. Redevelopment would occur on the foreshores
2. Public access to all foreshores was a right
3. There was a need to upgrade facilities on the foreshores (toilets signs, bike paths).

The environmental issues appeared to be a secondary focus (EMRC 2007).

xi) Swan and Helena Rivers Management Framework - Heritage Audit and Statement of Significance (2009)

This audit of heritage and landscape components was developed for the EMRC. It noted that remnant landscape was under pressure from development and climate change, and identified four key points relating to management of natural vegetation (EMRC 2009a p.31):

1) Integrity of bushland should not be compromised by inappropriate development and motorised mowers should be excluded from areas of regeneration and rehabilitation.
2) Management should be in line with best practice principles in reserve management plans.
3) Management needs to be based on sound and accurate understanding of the ecology and functioning of the river and hinterlands.
4) Define and establish hard boundaries for bushland corridors and links to add depth to corridors to both sides of the river.

The report acknowledged that where conflicts may arise, it is necessary to,

"...take into account the natural heritage values more than aesthetic values if the health of the river is to be maintained and improved." (EMRC 2009a p. 28).

The report's 'Statement of Significance' was weak, however, because it contained no reference to the above statement of the importance of a sustainable, biodiverse, natural riverine environment.

Of the 22 recommendations more than half (12) related to future interpretation strategies and only three made recommendations related to environmental sustainability. The report has important implications for management and made statements about the importance of not compromising the integrity of bushland by inappropriate development. For example, it recommended that trails need to be on the landside, not the foreshore side of rivers. It also emphasised the importance of maintaining bushland links along the foreshore:

'In all cases, this makes the conservation and protection of remnant bushland along foreshores of the Swan and Helena rivers essential' (EMRC 2009a p. 29).

xii) Swan and Helena Rivers Regional Recreation Path - Development Plan (2009)

Released at the same time as the former report, this plan appears to have little overlap with the conservation principles identified in the Heritage Audit, noting that the principal aim was to complete the network of riverside paths in 'as short a time as possible' (EMRC 2009b p.30). The plan makes almost no reference to conservation or biodiversity principles, and it establishes a direction for paths and board walks along river foreshores and through wetlands. This seems to directly contradict the environmental statements made in the Heritage Audit document.

Contemporary Issues Impacting on the Swan and Helena River Systems

Land use changes in the upper catchment areas have had considerable impact on the waters of the Swan River in recent decades. Increased salinity arising from over clearing agricultural land and inappropriate use of fertilisers has resulted in increased salinity and nutrient levels. Algal blooms that are of increasing frequency are considered to arise from increased nutrients and the warm temperatures of summer. Industrial pollution is better regulated, however, has been problematic in the past. Residential encroachment with its pollution and fertiliser run-off, remains an issue for the waters of the Swan and Helena Rivers.

A recent report titled "A baseline study of contaminants in the Swan and Canning Catchment drainage system" by the Department of Water (2009) identified significant issues of contamination in the Swan and Helena Rivers, with the Helena River being of most concern. The Helena River sub-catchment was classed as Priority 1, with contamination by polycyclic aromatic hydrocarbons (PAHs), organochlorine (OC) pesticides, metals and potential issues with herbicides. Connel (2000) described detrimental physiological responses to PAHs in marine species, including abnormal growth and tumours, and several other studies have found similar detrimental effects (O'Conner and Huggett 1988, Farbacher *et al.* 1991). The report stated that the evidence collected for the Helena River consistently exceeded the guidelines for PAHs and warrants further investigation (Department of Water 2009).

Of all the study sites in Perth, the Helena River had the highest number of individual OC pesticides and had consistently the highest concentrations, which exceeded both low and high guidelines (Department of Water 2009). The OCs are hydrophobic, so are found typically in sediment rather than water. They are persistent in ecosystems and have half-lives ranging from months to decades. They are of considerable concern because they bioaccumulate in the food chain, particularly in species higher in the food chain such as birds of prey. While these compounds have been phased out in Australia, they are still leaching from the soil because they break down so slowly (Department of Agriculture 2005). With OC pesticides being phased out, organophosphorus (OP) pesticides are now used by local government. Whilst no OPs were detectable in the Swan or Helena Rivers at the 'reportable' levels, (Department of Water 2009), they are known to cause significant environmental harm at concentrations orders of magnitude lower than the reportable levels. This is reflected in the guidelines (ANZECC and ARMCANZ 2000) and the report, therefore, warns that 'non detect data' should be viewed with caution (Department of Water 2009).

As well as pesticides, herbicides can have significant environmental impacts. For example, the herbicides Atrizine and Simazine were detected in the Helena River (Department of Water 2009). Atrizine is a known endocrine disruptor and has adverse developmental effects in frogs (Hayes *et al*. 2002). The report also stated that the current lower limits for these herbicides 'are inadequate and there needs to be further assessment'.

Lead has been recognised as another significant contaminant in the Helena River. In fact, the only site in Perth where the high ISQG was exceeded, was in the sediments of the Helena River sub-catchment. Lead bioaccumulates and there is no known safe level for lead. The townsite of Guildford has registered contaminated sites (as defined by the Contaminated Sites Act and administered by the DEC). These sites were previously petrol stations with plumes containing lead and benzine that are being monitored. Another indicator of river health is the pH value of water. The Department of Water (2009) reported that the trigger values for acidity were exceeded by more than 20 times for the Helena River and more than 80 times for Bennett Brook. The concerns about the high pH relate to potential negative impacts on the local flora and fauna.

Increased pressure to use both the river waters and floodplains for recreational pursuits such as boating, fishing, bike riding, and walking is causing physical and environmental changes on the sensitive floodplains, through erosion, clearing, disturbance of wildlife and loss of habitat. Erosion of riverbanks is an ongoing problem and previous efforts to control erosion have been largely unsuccessful (Fig.7). Porter (2002, 2010) reported erosion of the riverbank at Fishmarket Reserve in Guildford by 9m within fifteen years, despite the previous construction of a river wall by the Swan River Management Authority. The resultant loss of fringing vegetation is of serious concern especially given the lack of regeneration or replacement. Current management that includes mowing of grassed areas (Fig. 8) and spraying riverbanks to control weeds (Fig. 9) only exacerbates the problem, while often not effectively controlling weeds. It has been noted previously that the attempted control of understorey weeds by the use of non-selective herbicides has resulted in the denuding of native middle and understorey species along the Helena River in South Guildford (Water and Rivers Commission 2001).

While mowing of certain areas is appropriate for maintaining recreational space, providing access and minimising fire risk, it is not appropriate across large areas of the floodplain (Fig. 10).
Similarly, lopping of tree limbs and removal of fallen timber is necessary in particular areas for safety and access, but since tree hollows and fallen timber are important habitat for wildlife, they must be present in some areas for wildlife to persist.

Figure 7. Severe erosion of riverbank at Fishmarket Reserve. Erosion at this site is caused mainly by boat wash, leading to loss of soil, vegetation and habitat on riverbanks. This photograph illustrates the unique property of the middle canopy river vegetation with its entwined root structure that assists bank stabilisation by binding the soil and providing microhabitat.

Figure 8. Narrow strip of fringing vegetation along the Swan River at Caversham, near Barkers Bridge. This land is managed by the WAPC. These riverbanks are vulnerable to erosion as mature vegetation is in decline and there is no opportunity for regeneration because of mowing.

Figure 9. The effects of herbicide spraying on the banks of the Helena River, on the northern side of Water Street. This land is under the management control of the WAPC. Loss of ground cover has resulted in growth of exotic new weeds.

Figure 10. Fishmarket Reserve where vegetation has been largely cleared except for the upper canopy of *E. rudis*. Regeneration of understorey and mid-storey is prevented by a maintenance programme of regular mowing.

Objectives of the Study

The aim of the study was to provide qualitative data on the flora and fauna species on the Guildford floodplains.

It was determined that with its limited resources, the Guildford Association would conduct a study of perceptions of change to establish a baseline of data. The study would be based on residents' perception of changes to flora and fauna over time. This information could provide a basis for future research by students or staff from universities or for guiding management decisions by government agencies. The specific objectives of this study were to:

i) Record residents' perceptions of changes to the flora and fauna on the Guildford floodplains.

ii) Record perceptions of possible causes of such changes.

iii) Develop principles for management of the Guildford floodplains.

Methods

A phenomenological approach was selected as the means of studying changes to Guildford flora and fauna over time. Perceptions of change were the only possible means of documenting an historical event or series of historical events, in the absence of any other quantitative data.

The Survey

An initial interview was held with several elderly residents in Guildford to determine the nature of fauna and flora that had been or was still evident in the floodplain lands around the town. These flora and fauna species were to be used as indicators of change. The lists were also discussed with staff from the University of Western Australia and Curtin University to ensure they encompassed the most sensitive species that could be used as important indicators of change.

Surveys were hand-delivered to households abutting the floodplains of Guildford, between 17-30 April 2009 with a letter explaining the purpose of the survey and information on how to return the survey to the local library (and contact details for the investigators to arrange collection if that was more convenient). Where possible, the surveys were delivered directly to a householder by knocking on doors and explaining the purpose of the study. If the house was unoccupied the survey was left in the letterbox.

It was decided to use the household as the unit of study. Whilst households could not be homogenous in number, background or many other variables, they were felt to be the best unit of study to provide a group of people who shared the same address but who had a variety of experiences and information on the floodplain area. Length of stay in the town and residence were the only two variables recorded that could be controlled.

The questions included closed and open-ended questions to derive maximum information from responding households. Closed questions, where the possible responses are limited to one-word answers or a range of pre-selected options, were used to give standardised data (Foddy 1995). As some properties extended to the floodplain and others abutted regional reserves it was determined to duplicate all questions for both private property and reserves. It was anticipated that changes in flora and fauna might be identified in these two areas and that the open-ended questions may give some explanation for such variance and change.

Survey Structure

The Survey was divided into 6 sections with specific focus areas (Appendix A):

Section 1 - provided the demographic data on households including length of stay in residence and the Guildford area.

Section 2 - examined perceived changes to flora. Respondents were asked to comment on 3 tiers of vegetation (upper, middle canopy and the herbaceous layer). Comments were also sought on exotic/introduced vegetation and reasons for changes.

Section 3 - examined perceived changes to fauna. The list of fauna provided was not comprehensive but rather included species that could be easily identified and best act as indicators of change. The selected fauna included snakes, long-necked tortoises, frogs, echidna, bandicoots, brushtail possums, water rats and introduced species.

Section 4 - asked questions about bird species and possible factors affecting population change.

Section 5 - this section examined key invertebrates that were sensitive to environmental change.

Section 6 - an open-ended question to gather any additional comments in relation to any of the above sections.

All sections were divided into two discrete question areas relating to changes on the householder's property and a selected reserve.

Survey Area

The town of Guildford is clearly limited and defined by its riverine boundaries, providing a well defined and manageable study area. The town was divided into 5 discrete zones for this study based on physical boundaries including, rivers, major roads and crown reserves (Table 1 and Fig. 11). Historically the town has had four areas of 'commonage' defined as such due to their flood-prone nature. These commonage areas were central to four of the five zones. The fifth selected zone fell outside the original town plan and is now in the ownership of Guildford Grammar School. This land is unique along the Swan/Helena river system in that it is not zoned a Regional Parks and Recreation Reserve, however, it contains approximately one quarter of the town's total river frontage and around one third of the floodplain land.

Table 1. Description of survey zones.

Zone	Area
1	Swan River floodplain from Fish Market Reserve to Stirling Square, including properties on Market St, Swan St, Meares St, Victoria St, Johnson St and Swan St
2	Swan River floodplain from Barkers Bridge to Guildford Grammar, including properties on Meadow St, Swan St and Terrace Rd
3	Helena River floodplain east of East Street including properties on Martha St, Almond St, Turton St, Water St, Claymore Close, Gum Grove, and East St
4	Helena River floodplain from East Street to the Helena River Bridge on Johnson St, including properties on East St, Helena St and Johnson St
5	Helena and Swan River floodplain from Helena River Bridge to Guildford Road Bridge, including properties on Hill St and Market St

The reserves that were nominated by residents included:
Zone 1: Kings Meadow north of Swan St; Fishmarket Reserve.
Zone 2: Kings Meadow west of Meadow St; Kings Meadow at south end of Meadow St; Fishmarket Reserve.
Zone 3: Near Olive Grove Estate; Waterhall Estate floodplain; Helena River near Water St.
Zone 4: Polo ground; Helena River foreshore along Helena St; Helena River near East St.
Zone 5: Kings Meadow near Hill St; Floodplain near Bridge St.

Data was compiled and responses summarised for each zone as the percentage of the total respondents for each zone who selected that response. Overall results were the means of the percentages for each zone. Locations of fauna were mapped as approximate locations within reserves, with the accuracy dependent on the amount of information provided.

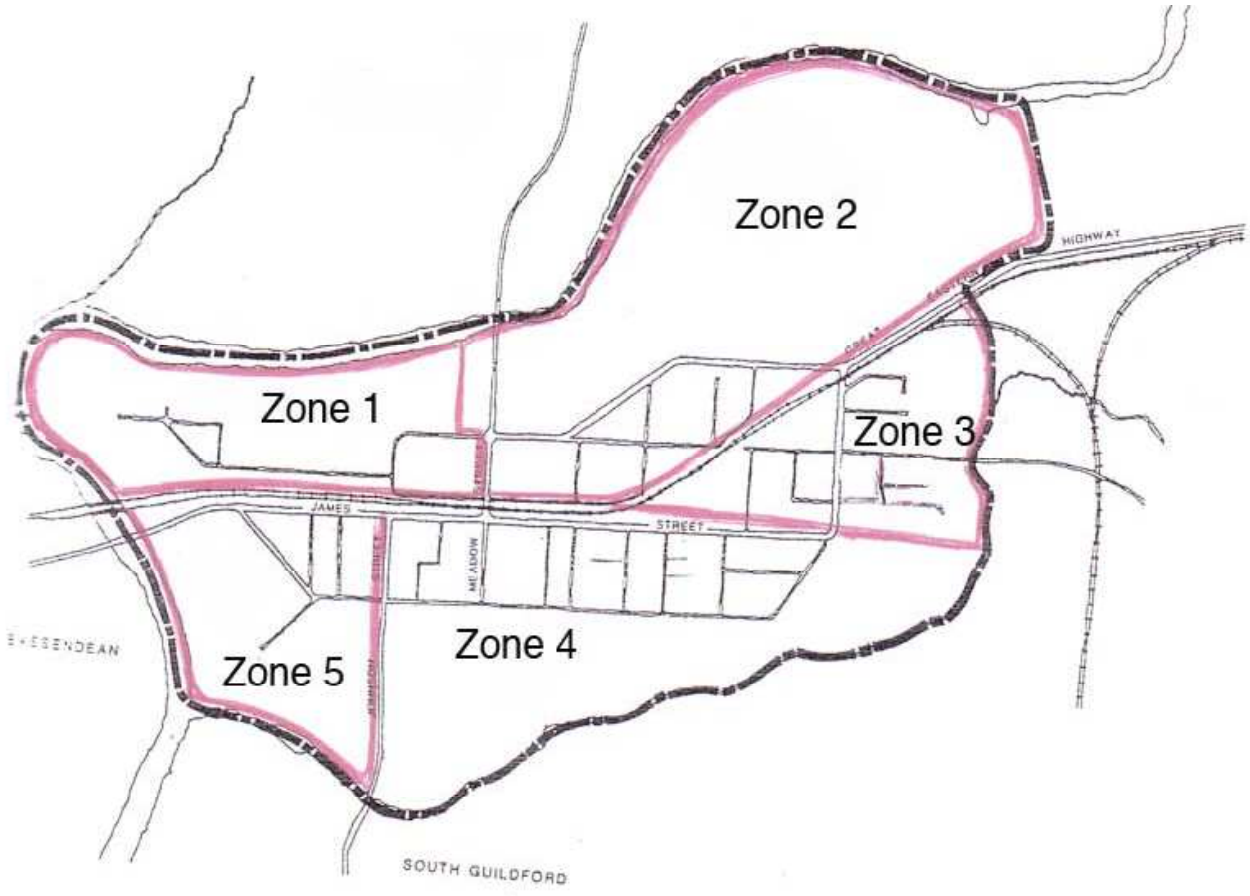

Figure 11. Map of 5 zones that were used to group survey responses.

Results

A total of 120 surveys were distributed and 30 were returned, thus the response rate was 25%. The qualitative nature of the study, combined with the low response rate, did not lend to detailed statistical analysis. The data could show possible trends and possible causality only. The results did, however, identify specific areas of fauna populations in the Guildford floodplains.

The average length of time living in Guildford by the longest residing member of the household was greater than 10 years with 22 of the 30 households including a resident who had lived in Guildford for at least 10 years. Only two households had a longest resident who had lived in Guildford for less than two years.

On residents' own properties there was little change observed to the overall structure of the vegetation or the plant species (Tables 2 and 3). On reserves, weeds were observed to have decreased, probably as a result of the use of mowing and herbicides by local government contractors, but reeds were also perceived to have decreased (Table 4).

Table 2. Perceived changes to vegetation on own property by zone.

Zone	% Noticed change to structure	% Noticed change to species
1 (n=7)	43	43
2 (n=4)	75	25
3 (n=4)	25	50
4 (n=9)	44	56
5 (n=6)	67	50
Zones combined	50	47

Table 3. Perceived changes to vegetation on own property – all zones combined.

	No change %	Increased %	Decreased %	Unsure %	No response %
Trees	33	17	10	0	50
Shrubs	27	17	13	0	43
Reeds	37	3	10	3	47
Weeds & Exotics	50	30	10	3	7

Table 4. Perceived changes to vegetation on reserve – all zones combined.

	No change %	Increased %	Decreased %	Unsure %	No response %
Trees	13	30	23	7	27
Shrubs	30	13	27	7	23
Reeds	23	10	30	10	27
Weeds & Exotics	17	17	36	10	20

The amount of shrubs on reserves seemed to be perceived as declining in Zones 3, 4 and 5 along the Helena River, but most respondents in Zones 1 and 2 had not perceived a change (Fig. 12). Note that there were few respondents in Zones 1 or 2 who answered this question (Question 2.16, Appendix A) because most had not perceived an overall change to the vegetation on the nominated reserve.

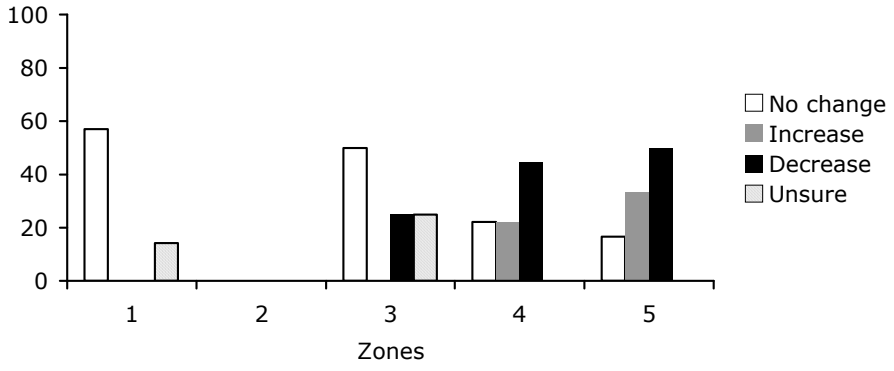

Figure 12. Perceived changes in the number of shrubs on reserves in each zone.

Of the four native mammal species that were included in the survey, all four species had been observed by at least some residents on their own properties. Introduced mammals, snakes, tortoises and frogs were also all recorded by at least some residents. The majority of respondents reported no change in abundance of possums, introduced mammals, or snakes on their properties (Table 5). There was a general trend of a decrease reported for bandicoots, water rats, echidnas, tortoises and frogs, with the clearest response being for the perceived decline in long-necked tortoises and frogs. All but one respondent had observed frogs on their properties and 60% reported a decrease in frogs (Table 5).

The changes observed by residents on their own properties were very similar to what was observed in the reserves (Table 5), however there were some minor differences that are worth noting. On reserves, the abundance of most fauna was perceived as having not changed or to have decreased, or residents were not sure. Introduced mammals and snakes were the only two groups that a small number of residents thought had increased (Table 6). This was in contrast to residents' own properties, where at

least some households reported an increase not only in introduced mammals and snakes, but also possums, water rats, and frogs (Table 5).

Table 5. Perception of change in abundance of terrestrial vertebrate fauna on respondents' own property adjoining the Guildford floodplain.

Species	% Response				No. households
	Increased	No change	Decreased	Unsure	observed
Southern brown bandicoot	0	0	16.7	3.3	7
Common brushtail possum	6.7	23.3	16.7	6.7	17
Water rat	3.3	6.7	10.0	0	6
Echidna	0	0	10.0	3.3	5
Introduced mammals	6.7	26.7	20.0	6.7	20
Snakes	13.3	26.7	13.3	20.0	23
Long-necked tortoise	0	0	20.0	10.0	9
Frogs	6.7	16.7	60.0	6.7	29

Table 6. Perception of change in abundance of terrestrial vertebrate fauna on local reserves on the Guildford floodplain.

Species	% Response				No. households
	Increased	No change	Decreased	Unsure	observed
Southern brown bandicoot	0	0	10.0	3.3	4
Common brushtail possum	0	6.7	0	6.7	4
Water rat	0	3.3	6.7	16.7	8
Echidna	0	0	3.3	3.3	2
Introduced mammals	3.3	13.3	13.3	10.0	13
Snakes	3.3	6.7	10.0	20.0	12
Long-necked tortoise	0	6.7	23.3	6.7	11
Frogs	0	13.3	40.0	3.3	18

From the survey, we were able to identify the specific location of certain fauna within the Guildford floodplains. The distribution of some fauna species appeared to be uneven with respondents from within a zone consistently reporting either the presence or absence of a particular species. For example, bandicoots were identified by several households within Zones 3, 4 and 5 along the Helena River and the section of the Swan River below the Guildford Road Bridge, but there were no reports from Zones 1 or 2 (Fig. 14). Possums and long-necked tortoises were observed across Guildford.

Possums were reported in all zones and tortoises were in all zones except Zone 2. There were 5 reports of echidnas in Guildford, and they were from different areas of the Swan and Helena floodplain, but all were of single sightings.

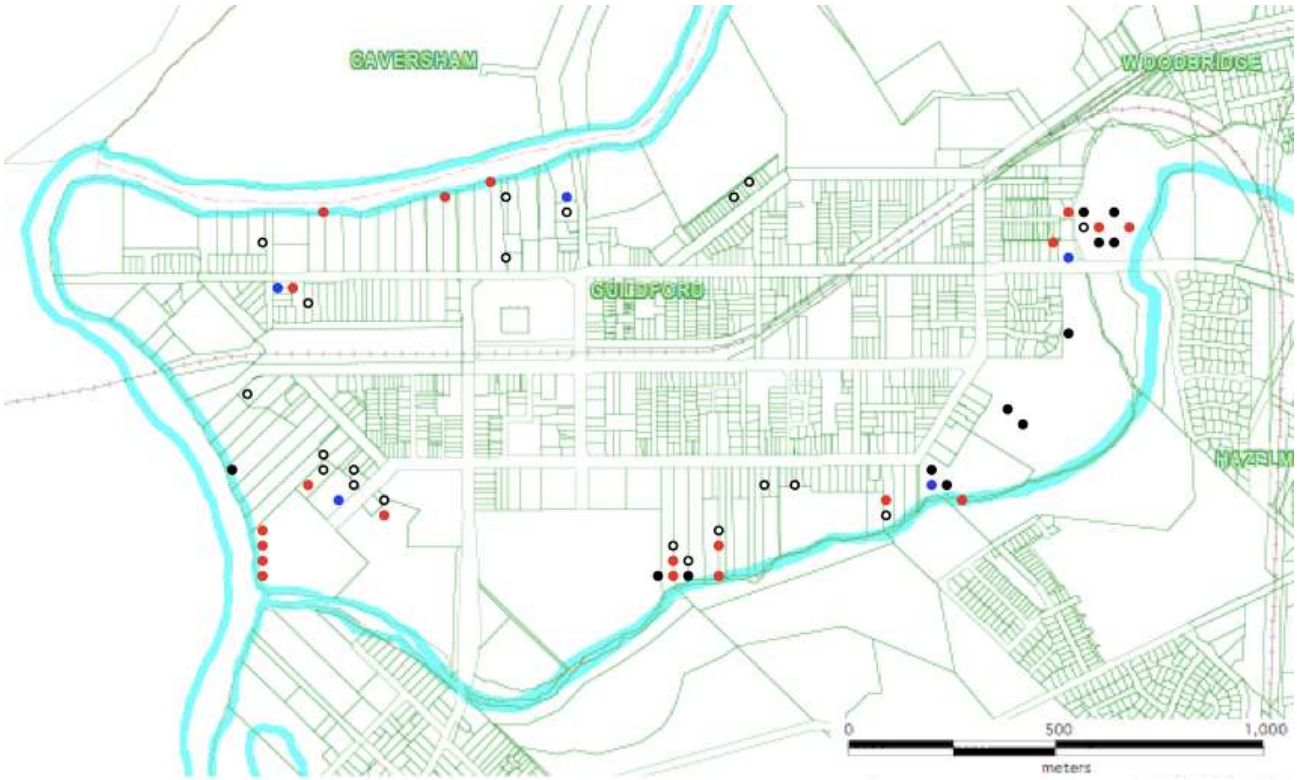

Figure 14. Locations of fauna reported by residents in the survey. Bandicoots (black dots), brushtail possums (black open circles), echidna (blue dots) and long-necked tortoises (red dots) (Adapted from a map provided by the City of Swan and used with permission).

Most respondents had not observed a change in the numbers of snakes on their properties, and were unsure about any change on the reserves. The two species that were noted by respondents were dugites and tiger snakes.

Frogs are not usually observed, but the characteristic calls of male frogs means their presence is easily detected and the species can often be identified with some accuracy. The frog species noted by respondents were motorbike frogs (also referred to as green tree frogs, *Litoria moorei*), moaning frogs (*Heleioporus eyrie*), slender tree frogs (*Litoria adelaidensis*), western banjo frogs (*Limnodynastes dorsalis*), turtle frogs (*Myobatrachus gouldii*), 'quacking frogs' (probably *Crinea georgiana*) and 'sand frogs' (probably *Heleioporus psammophilus*).

The clearest perception of change for birds was the large increase in Australian ravens, where over 48% of respondents reported an increase on their own property. The birds that were perceived to have

decreased most were sacred kingfishers, ringneck parrots (Twenty-eights) and galahs (Table 7). Perceptions of changes for birds on respondents' own properties were similar to on the reserves.

Table 7. Perception of change in abundance of birds on own property- all zones.

Species	Observed %	Increased %	No change %	Decreased %	Unsure %
Pacific black duck	27.6	3.4	13.8	3.4	10.3
Wood duck	65.5	10.3	24.1	10.3	13.8
Great egret	27.6	0.0	6.9	10.3	13.8
Sacred ibis	48.3	13.8	13.8	6.9	6.9
Sacred kingfisher	58.6	0.0	24.1	24.1	10.3
Butcher bird	62.1	10.3	34.5	3.4	13.8
Willy wag tail	96.6	17.2	48.3	13.8	6.9
Honeyeaters	72.4	0.0	44.8	6.9	13.8
Wattlebird	65.5	10.3	31.0	10.3	10.3
Silver eye	58.6	0.0	34.5	10.3	10.3
Mudlark	93.1	17.2	44.8	10.3	10.3
Australian raven	86.2	48.3	17.2	6.9	20.7
Tawny frogmouth	20.7	0.0	13.8	3.4	13.8
Southern boobook	31.0	0.0	10.3	3.4	13.8
Ringneck parrot	89.7	6.9	31.0	37.9	10.3
Galah	82.8	13.8	20.7	27.6	13.8
Black cockatoo	58.6	17.2	10.3	20.7	6.9
Kookaburra	86.2	17.2	37.9	10.3	10.3
Corella	82.8	24.1	24.1	27.6	10.3
Rainbow lorikeet	69.0	24.1	13.8	20.7	10.3

Additional bird species that were not listed in the survey but were noted by respondents included Australian magpies, pigeons, doves, grey teal ducks, red capped parrots, barn owls, shelducks, spoonbills, yellow breasted shelducks, white faced herons, striated pardalotes, spotted pardalotes, wrens, bronzewing pigeons, brown honey eaters, singing honey eaters, red wattle birds, western wattle birds, night herons, nankeen kestrels, robins, and thornbills. Other species that were noted by residents as having once occurred in Guildford but that have disappeared included fairy wrens, scrub wrens, reed warblers, wedgetail eagles, and owlet night jars.

Most respondents did not make observations about the numbers of invertebrates, although there were several comments about exotic European honeybees occupying tree hollows, and the large number of mosquitoes that were a nuisance. One respondent commented that the loss of *Acacia saligna* in Drummond St and the polo fields has resulted in the loss of cossid moths and another mentioned that monarch butterflies had almost disappeared since there was a program to remove cotton bush.

Discussion

While the response rate was low, this is not unusual for a written survey. Recent research into response rates for surveys has revealed that low response rates are not necessarily linked to poorer accuracy (Visser *et al.* 1996). For example, Holbrook *et al.* (2005) investigated whether lower response rates are associated with less unweighted demographic representativeness of a sample and ultimately found that surveys with much lower response rates were only minimally less accurate. In our survey, most respondents were from households containing at least one resident who had lived in Guildford for 10 or more years, thereby possibly having greater knowledge and experience of the local flora and fauna and a clearer perception of change. If a similar study were to be conducted in future, a greater response may possibly be achieved through direct interview rather than a postal survey.

Vegetation

Perceptions of changes in vegetation varied between the zones. Around half of all respondents noticed a change in the species and structure of vegetation on their properties, but the various plants were reported as both decreasing and increasing. This apparent contradiction could be due to a number of factors influencing changes in vegetation. For example, several respondents reported an increase in trees and shrubs on their properties due to their own planting of natives and weed removal, while others noted a loss of native shrubs, which they attributed to competition with weeds. The diversity of perceptions could also be due in part to the low sample size and to the slow growth rate of many plant species, making it difficult for people to notice changes within the time they had resided in Guildford (on average around 10 years).

On the reserves, some residents noted a loss of small shrubs, but others reported an increase in shrubs as a result of planting activities, for example by community groups and the local primary school. Along the Helena River there was a greater number of reports of a decline in the number of shrubs on reserves. Based on the comments, this was due at least in part to the widening of the path along the southern bank, adjacent to the Waterhall Estate (Fig. 15). There were some positive reports of control of weeds by government contractors. However, many respondents were concerned about a lack of biodiversity and the negative impacts caused by mowing and spraying (Table 8).

There have been areas of replanting over the last ten years by the WAPC and community groups in all zones, however, in many places planting has been predominantly limited to upper storey species such as *E. rudis.* In two discrete areas (in Zones 4 and 5) plantings on the opposite bank to Guildford (adjacent to Waterhall Estate) have included mid-storey species such as *Casuarina* and *Melaleuca* (Fig. 16). In the last two years there also has been limited planting of herbaceous understorey in Zone 5 of sedges and reeds in the billabong in the recreation reserve. These activities are very positive, but more planting of understorey is required on the Guildford side of the Helena River and on all

riverbanks. In addition, soil stabilising species such as *Casuarina* and *Melaleuca* are needed, especially along the banks of the Swan River.

Several respondents were concerned about the loss of structural complexity, along with mowing, herbicide spraying and clearing of fallen debris, which were perceived as contributing to the loss of habitat. This is summarised in a comment by one respondent from Zone 5, who wrote, "On the reserve I loathe the patches of dead and denuded ground and the constant lopping of healthy tree limbs. It is a reserve, not a manicured park. It is losing its character and bird breeding areas." Another respondent from Zone 4 noted that the clearing and spraying on river banks had resulted in erosion to banks and had reduced habitat and protection for wildlife, and that there were now less water birds, tortoises and frogs in her area. It is possible that part of the 'clearing and spraying' noted by this resident was in preparation for a revegetation programme that later took place. If this was the case, it highlights the importance of communicating with local residents. Those residents in Zone 4 and 5 along the Helena River were the most critical of government management of the floodplains and were those who noted most changes to flora.

Mowing of grassed areas is undertaken to reduce fire risk and for aesthetic reasons, but it also has the consequence of suppressing native plant species and removing habitat for wildlife. In a study of the effects of mowing in a small bushland reserve in western Sydney, James (1994) observed a threefold increase in the number of native plant species after just one year of a reduced mowing regime. While mowing is necessary in certain areas, most residents were concerned about the effects on biodiversity. An alternative approach to the current practice would be to set aside areas for conservation that were not mowed (or not frequently mowed), to create habitat and allow natural regeneration. This strategy has already been recommended by The Swan River Trust (2008).

Erosion of riverbanks was another common concern, particularly in relation to the subsequent collapse of large old trees and the loss of fringing vegetation and habitat. In an effort to reduce the effects of shoreline erosion, the speed limit was recently reduced from 8 knots to 5 knots on the Upper Swan River (Department of Transport 2011). While this is a positive step, the new speed limit will need to be enforced for it to be effective. Even then, it will not completely alleviate the erosion and more needs to be done in terms of structural solutions and replanting to stabilise banks.

Residents were supportive of the removal of weed species such as wild olives, castor oils, blackberry and arum lilies. However, there was general concern about the broadscale use of herbicides. One respondent commented on the loss of native grasses by "…well-intentioned but poorly supervised Round-up spraying by government people". There was also concern about the removal of woody weeds resulting in a reduced area of habitat for fauna. Gole (2004), reporting on the management

issues for birds, pointed out that removal of woody weeds should be carefully staged to ensure that sufficient thick, low vegetation remains as habitat (Fig. 17).

There was also concern about the loss of historic plantings. Guildford has several examples of exotic species that constitute historic plantings, rather than being weeds, and thus require protection (Fig. 18). For example, a respondent from Zone 4 noted the "…avenue of elegant palms from the old Rose Hill - Helena Bridge site (to the home) has been largely and unjustifiably destroyed". This is in reference to an avenue of palms that was planted circa 1900 and lined the driveway leading from Helena Street in Guildford to Rose Hill, the property of Matthew Padbury. It is understood that this removal was undertaken by the developers of the new housing estate and with the approval of the City of Swan, who have no register or listing of significant trees. Another resident mentioned the removal of large old pine trees in the same area, which used to be used by black cockatoos.

The City of Swan is currently planning a register of historic plantings in Guildford, however, it is unlikely to include areas outside the historic precinct and therefore significant plantings such as the avenue of palms in South Guildford (the borrowed banks) would not be included.

Figure 15. Area of floodplain on the southern side of the Helena River cleared for bike path and walk trail.

Figure 16. Planting of mixed upper-storey and mid-storey species on the southern bank of the Helena River, near Waterhall Estate, South Guildford.

Figure 17. Private property along the banks of the Helena River in 2009, with fallen debris creating complex habitat (but note also the heavy infestation of weeds such as arum lilies).

Figure 18. Historically significant Manetti roses killed by herbicide spraying. While the removal of exotic weed species is generally good practice, Guildford has many culturally significant plantings of species, such as these roses, that do not pose an environmental threat and should be protected.

One of the weeds that is being removed by spraying on the Guildford floodplains is the bulrush (*Typha orientalis*), which is documented as a weed that was introduced from the eastern states (Hussey *et al.* 1997). It is similar in appearance to the endemic bulrush *T. domingensis*.

Recently, members of the Swan Valley Nyungah Community, on behalf of the Traditional Owners of the Swan River, Swan Coastal Plains and Darling Ranges, have expressed concern over spraying operations aimed at eradicating *T. orientalis* from the lower Helena River, stating their belief that it is an endemic species and that there were always two species of bulrush present in the area (see Appendix B). There is an early collection by Preiss of *T. orientalis* from 1839, described as being, "…in swampy places at the base of Mt Eliza, Perth" (Australian Virtual Herbarium), possibly supporting an endemic southwest distribution. Most other evidence points to *T. orientalis* being introduced. Its distribution and abundance have increased due to European human-related disturbance, grazing, and eutrophication of wetlands. If left unmanaged it behaves as a weed and may have serious environmental impacts including increased fire risk and out-competing native species. Conversely, *Typha* species, both exotic and endemic, provide good habitat for waterbirds, frogs, tortoises and mammals. Given the lack of clarity of its status as either an indigenous plant or a weed, it seems necessary to further investigate this issue.

If *T. orientalis* is confirmed to be a weed in south west Western Australia, its removal should be carefully staged alongside revegetation programs so that important habitat is not lost. In the recent past, spaying to remove *T. orientalis* has also removed *T. domingensis* and other small plants, resulting in a loss of habitat. Within our study area, *T. orientalis* was cleared from a billabong in Zone 5 and one resident noted, "…constant spraying of pesticides has denuded the area of shrubs and grasses and created a barren wasteland. Billabongs are now scummy ponds with virtually no sign of healthy bird or frog life". This resident also noted, "…after the first concentrated spraying ~ 3 years ago (2006) I had two dead bronzewings and three dead doves in my garden". The billabong area has been replanted with shrubs and reeds over the last 3 years, but it will be at least several years before the understorey provides dense cover for wildlife.

While respondents added many additional observations and comments about vegetation in the space provided on the survey, most of the concerns could be grouped as relating to impacts of mowing, herbicide spraying, erosion, increased urbanisation (including new pathways and increased presence of humans and domestic animals near the foreshores), impacts of exotic plants and animals, and the drying climate (Table 8).

One factor that may contribute to the perceived problems of poor management on the floodplains is the disparate ownership of these lands (Fig. 6). The floodplain may be managed by the WAPC or City of Swan, through their employees or contractors, or it may be managed privately by individuals or organisations. Responsibilities for the management any given land is often unclear to residents.

This has led to problems with communication. It should also be noted that the indigenous community has expressed dissatisfaction with the level of consultation (Appendix B). It is a legal requirement to consult and seek approval from the local indigenous people at the planning stage for any revegetation, fire control or maintenance work and this requirement must be fulfilled.

Guildford Grammar School was not included in the survey as it is privately-owned land without public access. It comprises approximately 20% of the total floodplain area. No residents selected Guildford Grammar land as a reserve and therefore no data was collected on the flora or fauna of this land. It is planned to approach Guildford Grammar School to complete a post survey questionnaire to extend our database.

Mammals

There were important patterns that emerged from the survey questions on fauna. For example, bandicoots were reported as having been observed on several householders' own properties in Zones 3, 4 and 5, adjoining the banks of the Helena River, but not by any residents in Zones 1 or 2, adjoining the floodplain of the Swan River, and only in reserves from Zone 3. This may be because there is

better vegetation cover and reduced public access along this section of the Helena River compared with the borrowed floodplain on the southern banks of the Helena River and those on the Swan River. Bandicoots are one of few terrestrial mammals persisting in metropolitan Perth. The Western Australian sub-species of the southern brown bandicoot (*Isoodon obsesulus fusciventer*) is classified as 'lower risk' (near threatened) on the IUCN Red List, and as Priority 4 on Western Australia's Wildlife Conservation Act, but they are still vulnerable to local extinction through loss of habitat – particularly the loss of the dense lower stratum, which is important protection from predation by foxes and cats (Paull 2008). One respondent from Zone 4 reported that they had witnessed a cat attacking a bandicoot on their property. Stricter legislation around cat ownership including compulsory registration and sterilisation may have beneficial outcomes for bandicoots.

Bandicoots will use open, weedy and degraded areas for foraging, but they require dense vegetation as refugia – whether this vegetation is native or exotic. The structure of the habitat is often more important than the species composition (Garden *et al.* 2007). In Victoria and Tasmania, the eastern barred bandicoot (*Perameles gunnii*) survives in agricultural areas partly because of habitat provided by weed species such as blackberry, which protects them from predation (Mallick *et al.* 1997), and it is recognised that removal of such weeds may be damaging unless cover is replaced with suitable native species. It is concerning that most residents who had observed bandicoots in Guildford perceived that their numbers had decreased. Removal of woody weeds must be staged so that sufficient thick low vegetation remains for species such as bandicoots, while also protecting habitat for other species such as birds (Gole 2004).

The observations of water rats by several households, both on their own properties and on reserves, is of particular interest as there is little known about the current distribution of this species within the Perth metropolitan area. The native water rat is easily distinguished from introduced rats such as the black rat (*Rattus rattus*) because of its larger size, dark brown pelage, white tipped tail and webbed hind feet (Olsen 2008). However, it is possible that some respondents may have misidentified this species and therefore a follow-up biological survey using live-trapping or camera traps to target water rats would be extremely useful. The fact that several sightings have been recorded in the Guildford area suggests that the species probably is indeed present and one respondent commented, "…there seems to be plenty all along the Swan and Helena". Water rats are considered an indicator of water and habitat quality (Valentine 2009, Smart *et al.* in press) and they have been linked to the persistence of important wetland ecosystems. Thus their presence on the Guildford floodplains would be an encouraging sign and should be taken into consideration for future management of the floodplains.

Common brushtail possums appeared to have a patchy distribution in Guildford with sightings in all zones, but most from Zones 4 and 5. All six respondents from Zone 5 reported seeing possums on their own properties. This species has adapted well to urban living and in some areas are considered a

pest because of damage caused to ceilings and garden plants. Since none of the respondents noted any problems with possums, it is likely that in Guildford possums are using hollows in large *E. rudis* trees along the river's edge.

Occasional sightings of echidnas by residents were recorded with one resident noting a sighting from 32 years ago and another from around 20 years ago. The last sighting of an echidna was from 2007 in Zone 5, following clearing of logs and herbaceous growth from the adjacent government reserve. This relatively recent sighting was welcome news as it had long been thought that echidnas may have been locally extinct on the Guildford floodplains. One echidna that had been run over and killed was observed in November 2010 by one of the authors (HM) 4 km south of Guildford on the Great Eastern Highway Bypass. Whilst there have been no known sightings of echidnas in Guildford for four years, this is evidence that a population persists quite close to the town, probably in remnant vegetation surrounding Perth Airport. Adult echidnas have few predators and across their range are considered common (Augee 2008). They are, however, rarely found in the metropolitan area. The distribution may be influenced by the availability of suitable nest sites, which include thick bushes, hollow logs and piles of debris (Augee 2008) and food availability (termites). On the Guildford floodplains, most of the understorey has been removed, therefore reducing suitable nesting sites.

Issues of public liability, including fire risk and public hazard, determine the West Australian Planning Commission's management policies on the floodplains. Accordingly, logs, long grass and dense understorey is removed from the floodplain and spraying and mowing are used as key management strategies. Future management practices must permit the retention of logs and regeneration of the understorey in certain management areas, if echidnas and other fauna are to persist in this area.

Reptiles

This survey did not detect any perception that the number of snakes had decreased, either on residents' own properties or on floodplain reserves in Guildford, however, very few species were observed. This is consistent with other reports (Storr *et al.* 1978) suggesting that urbanisation and agricultural development have not caused extinctions of reptile species, but that very few species persist in such areas. The two snake species that were recorded were dugites (*Pseudonaja affinis*) and the western tiger snake (*Notechis scutatus*), both species that are common still on the Swan Coastal Plain. Guildford has been noted to be the southern boundary for the Gwarda (*Pseudonaja nuchalis*), however, none were reported. Most snakes reported by Guildford residents to local snake catchers have been dugites, however at least one gwardar has been reported and removed in recent years (pers. comm. Russell Oldham). It is possible that residents failed to identify a particular snake species. Snakes can be difficult to identify correctly because colouration and markings can vary even within a species and environment (e.g. dugites vary in colour from pale yellow to black; Bush *et al.* 1995). The mixed results for the reporting of changes to snake numbers may be due to the fact that snakes can be

attracted to food sources, such as mice around aviaries or chicken coops, resulting in some residents reporting an increase in sightings near their homes. A small number of residents (4) noted an increase in snakes around their house, which they felt was related to loss of natural habitat on the floodplain. While certain snake species (e.g. dugites) have remained common in highly disturbed habitats such as in agricultural areas, they still need cover. A study of fauna in urban remnants in Brisbane found that reptiles were most strongly associated with areas with termite mounds and where there was fallen woody material (Garden *et al.* 2007). On the Guildford floodplains, important habitat can be preserved by ensuring there are adequate areas where fallen timber is retained, and mowing and use of herbicides is excluded. Such maintenances practices will enhance food sources and habitat for snakes and other fauna.

Long-necked tortoises were observed to have possibly decreased both on residents' own properties and on the reserves. The comments showed clearly that residents were concerned about the recent impacts of disturbance and predation of tortoises by dogs, cats and foxes, particularly in Zone 4 (Table 7). These impacts were felt to have arisen from the new residential developments and increased pedestrian use of walkways along the riverbanks. Over the last 15 years the southern side of the Helena River adjacent to Zone 4 has changed from a rural landscape with dense understorey along the riverbanks to residential and public recreational land use with clearing of floodplain vegetation for footpaths and playing spaces. Adult tortoises can be predated by foxes and dogs, while eggs and hatchlings can be predated by foxes, dogs, cats, rats, and even native bandicoots and ravens. Mowing can kill tortoises directly, but on the other hand, small hatchlings can perish when they become tangled in long grass (Bush *et al.* 1995), such as kikuyu, which is present across the Guildford floodplains. A resident in Zone 1 who had lived there for more than 10 years commented that tortoises no longer moved from the billabong on the reserve north of Swan Street into her garden to lay eggs, as they had done for many years previously.

Tortoises vary widely in their tolerance to urbanisation, with some species surviving well in seemingly unsuitable habitat (Rees *et al.* 2009), but long-term persistence is likely to depend on water quality, the availability and access of suitable nesting sites and protection from predators. Continued disturbance of habitat and loss through spraying and mowing riverbanks will therefore jeopardise the persistence of this species in the Guildford area. The Guildford floodplains have the potential to continue to provide habitat for long-necked tortoises, especially given that there is good connection between the rivers and nesting sites. Many other areas of the Swan River have adjacent roads that dissect habitat and result in large numbers of road kills. Therefore we recommend that there are areas set aside for the exclusion of mowing and herbicide spraying. Also, that dogs are kept on leashes in designated conservation areas and additional areas are designated as dog exercise areas.

One resident in Zone 4 noted the recent loss of bobtail lizards (*Tiliqua rugosa*) on the floodplain, which they attributed to domestic cats. Despite lizards not being included in the survey, several residents used the space for comments to note a decline. Given that data were not collected specifically on lizards in this survey, it is difficult to determine the extent of any change, but it would be expected that Guildford is similar to other areas on the Swan Coastal Plain where the majority of reptile species retain viable populations, even in small remnants of native vegetation (How and Dell 2000). Thus a decline may indicate a loss of suitable habitat. Certainly it is known that large lizards such as bobtails can be injured by mowers and can be killed by dogs. Smaller species such as the marbled gecko (*Phyllodactylus marmoratus*) are common in backyards throughout the older suburbs of Perth, but there is some concern that newer residential developments may not contain suitable habitat (Bush *et al.* 2007). Some other species are quite cryptic and therefore their status is unknown. These species include small and litter-dwelling species such as Burton's legless lizards (*Lialis burtonis*) and the south-western cool skink (*Bassiana trilineata*).

Frogs

The clearest pattern in all of the data was the decline in the number of frogs on both properties and reserves. Most respondents noticed a decline in frogs although a small number noted an increase on their own properties where they had maintained natural wetlands or had constructed ponds. There was also one resident in Zone 5 who noted an increase in overall frog numbers, but a decrease in species diversity. This resident noted that moaning frogs (*Heleioporus eyrie)* have replaced the western banjo frog (*Limnodynastes dorsalis*), slender tree frog (*Litoria adelaidensis*), motorbike frog (*Litoria moorei*), turtle frog (*Myobatrachus gouldii*) and 'quacking frog' (probably *Crinea georgiana*). While some frogs have calls that are easily identified by non-experts, a formal biological survey would be required to confirm the list of species that are present in the area.

The decline in frogs on the Guildford floodplains is similar to that reported elsewhere in Australia and, indeed, worldwide (Skerratt *et al.* 2007). The broad decline has been attributed to a loss of habitat and also to the chytrid fungus, which is known to be present in frogs on the Swan Coastal Plain (Berger *et al.* 1999). Other factors implicated in the global decline of amphibians include the impacts of herbicides used for weed control and insecticides used for controlling mosquitoes. For example, it has been established that spraying of glyphosphate for weed control causes death of tadpoles and gender and developmental change in frogs, and has been argued to be a contributing factor in the decline of the frog populations (Relyea 2005, Jones *et al.* 2010, Hayes *et al* 2002). The Aboriginal Elders have spoken out strongly against the spraying of herbicides and pesticides on their sacred river and flood plain lands (SVNC 2011). The above concerns and environmental costs need to be evaluated against costs of steam spraying or mulching prior to considering any programme of spraying.

Birds

The data for birds was mixed across species, but a few species were perceived to have declined more than others. Interestingly, of the listed species in the surveys, those most noted to have declined were relatively large species – the sacred kingfisher, ringneck parrot and galah. It is likely that these species were noted because they are easily recognised by most residents. The decline in the parrots could be attributable to competition for nest hollows with introduced species, and the sacred kingfisher to lack of food sources or decline in suitable nesting sites.

A decline in bird species is consistent with recent reports identifying a general decline in ground feeding insectivores (Paton and O'Connor 2010), and other species that depend on dense vegetation and connectivity in the landscape. The increase in Australian ravens noticed by Guildford residents was consistent with other reports for the Perth metropolitan area (Stewart 1997). Ravens are large, noisy and conspicuous, and are recognised as a damage-causing species in rural and urban areas (Department of Environment and Conservation 2009), so it is no surprise that this species was particularly noted.

The species list in the survey included common and easily identifiable birds in an attempt to obtain reliable data. However, these birds are also generally the species that have good populations on the Swan Coastal Plain and it is possible that the data were biased because we did not include the smaller insectivore species such as thornbills and wrens that are known to have declined (Gole 2004). Most of the additional comments noting other species that had declined referred to these types of small birds. The two owls, the southern boobook and tawny frogmouth, were observed least often. This is unsurprising considering that they are nocturnal, although the southern boobook has an easily recognised call and is heard regularly in Guildford (H Mills pers. obs.).

As part of the Perth Biodiversity Project, surveys of birds were carried out in the Perth metropolitan area. The report pointed out that many birds require networks of adequately conserved and appropriately managed remnants of vegetation in order to survive (Gole 2004). While some species are relatively mobile and were possibly migratory or seasonal visitors, other species are sedentary and management of these species can be complex requiring maintenance of both quality of the bushland and links. Some species are able to survive within the Perth metropolitan area in disturbed habitats or small patches of bushland. Others, however, are entirely dependent on having large and continuous bushland habitat that is ecologically intact containing endemic species with multiple layers of structure. A survey site at Success Hill in Bassendean had one of the highest numbers of bird species recorded for the whole project, suggesting it is important habitat for both water birds and bush birds and probably forms an important corridor for bush birds along the Swan River. Given the close proximity to Guildford it is likely that the floodplain vegetation in Guildford could similarly function as important habitat, although the current lack of understorey would compromise the quality of the habitat.

The large number of introduced birds was noted as a concern by several residents (Table 8). Two species of corella, the little corella (*Cacatua sanguinea*) and the eastern long-billed corella (*Cacatua tenuirostris*), are present in Guildford and throughout the Perth metropolitan area, where they are considered a pest. The little corella is found across Australia and has increased in number since European settlement, although the birds in Perth are thought to have established from aviary escapes. Eastern long-billed corellas are found in eastern Australia and the populations in Perth were certainly introduced by aviary escape. It is interesting to note that it was probably another species in this area at the time of European settlement, Muir's corella (*Cacatua pastinator pastinator*, a sub-species of the western long-billed corella). White cockatoos were reported by George Fletcher Moore in his personal memoirs on the Guildford /Swan districts in the 1830s (Moore 1978). This species was originally found through the south west of Western Australia, as far north as the Swan and Avon Rivers, but it has now declined to a single population around Lake Muir near Manjimup (Johnstone and Storr 1998). Rainbow lorikeets are another pest species introduced from the eastern states, as are kookaburras. Kookaburras were first released in Western Australia close to Guildford by Charles Harper in 1895 or 1896 at his home, Woodbridge House (The West Australian, 1934), and they have since become a serious ecological pest.

Invertebrates

Two residents made special note of the large number of tree hollows occupied by European honeybees, which exclude the use of those hollows by native birds (Table 7). Introduced bees are recognised as a threatening process to fauna, although the environmental impacts of feral bees are not yet well understood (Paton 1996). The Department of Environment and Conservation is developing a Feral Bee Control Strategy for Western Australia and some local councils in the Perth metropolitan area also have programmes to remove hives from reserves (e.g. City of Melville).

Table 8. Issues of concern for residents included as comments noted on the survey.

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Broadscale mowing removing small replanted trees preventing regeneration	1				
Mowing and spraying results in loss of habitat	1		2	1	3
Loss of reeds on river banks	2			1	2
Predation of fauna by domestic cats, feral cats, dogs and foxes	3		3	8	3
Large numbers of exotic birds	1			1	1
Loss of nesting hollows for native fauna	1		1	1	2
River bank erosion and subsequent collapse of trees	2		1	1	1
Increase in weeds and silt choking creeklines	1		1		
Clearing of vegetation to create new pathways - loss of habitat and wildlife disturbance				1	
Introduced bees occupying tree hollows	1			1	1
Lack of rainfall causing drier conditions	1			1	1
Lack of management since land not tenanted	1				
Nuisance 4WD activity	1				
Effect on fauna of chemical spraying to control mosquitoes	1				
Increased kookaburras predating on small native birds, reptiles and frogs	1				1
Exotic weeds e.g. Patterson's curse, bamboo, couch, kikuyu		1	1	3	1
Increased numbers of mosquitoes		2		1	
Pollution caused by housing development			1		
Falling water tables, and lack of flooding affecting vegetation			2	2	
Run-off from agriculture and roads polluting river			1	1	
Use of herbicides affecting frogs			1	2	

Disturbance of tortoises and birds by people, trail bikes and dogs on footpaths			1	2	3
Increase in domestic stock causing reduction and alteration of habitat				1	
Removal of domestic grazing stock (sheep) caused increase in weeds				1	
Loss of indigenous grasses by weed spraying and mowing				1	1
Poor management of weeds on government-owned land				1	
Loss of *Acacia saligna* has resulted in loss of Cossid moths				1	
Surfactants in water causing decline of frogs				1	
Failure of authorities to discourage or limit cat ownership				1	
Erosion following weed removal by DPI				1	
Loss of reeds and erosion from construction of path south of Helena River				2	
Increase in ravens which are aggressive				1	
Removal of dead limbs of trees resulting in loss of tree hollows for fauna					2
Urbanisation of area					1
Herbicide spraying causing deaths of bronze wings and doves					1
Mowing killing tortoises					1
Rubbish in bush reserves					1
Lack of public toilets					1
Loss of jetties					1

Management Recommendations

Biodiversity on the floodplains is dependant upon an understanding of the complex inter-relationship of flora and fauna. It is encouraging to note that management practices on the floodplains in Guildford have started to improve in recent years. There has been some very positive collaboration with community groups, which has resulted in improved weed management and recent plantings of understorey species in some areas of the Guildford floodplains. However, as the results of our survey showed, many residents are dissatisfied with management and there is still much that needs to be improved.

The Overarching Recommendations arising from this report are:

1. Promotion of biodiversity and habitat complexity through planting locally endemic trees, reeds and sedges and middle and understorey species.
2. Planning for 'conservation areas' as well as' maintenance areas', with each having a distinct and separate programme of maintenance.
3. Consultation with the community about revegetation programmes and about local fauna and flora issues.
4. Pre-eminence of principles of biodiversity and conservation over other planning and recreational policies.

These four Overarching Recommendations are expanded below:

1. Promotion of biodiversity and habitat complexity through planting locally endemic trees, reeds and sedges and middle and understorey species.

1.1. Fringing vegetation along riverbanks should be widened where possible by revegetation programmes and by allowing natural regeneration, to ensure riparian vegetation persists and existing mature trees are replaced.

1.2. Where weed control is required, alternatives to herbicide spraying should be investigated and used wherever possible. Alternatives may include steam spraying, mulching, or hand weeding.

1.3. Phased clearing of small areas in preparation for revegetation or fire management is preferable over the current practice of clearing and spraying large areas. It is important to ensure that there is adequate vegetative cover for fauna.

1.4. Riverbank vegetation must be protected from boat erosion, by enforcing the 5 knot speed limit for boats in the upper reaches of the Swan River. Bank erosion is causing substantial loss to the fringing vegetation and habitat.

1.5. Community and/or school plantings and maintenance programmes for the floodplain would provide educational opportunities and create awareness.

2. Planning for 'conservation areas' as well as 'maintenance areas' each with a distinct and appropriate plan of maintenance

2.1. Areas of replanting or areas containing significant remnant vegetation should be identified as 'conservation areas'. These areas should be distinct from 'maintenance areas' that include recreation areas, playground areas, access roads and paths, firebreaks, etc.

2.2. Within the 'conservation areas', broadscale mowing and broadscale spraying of herbicides on the floodplains should cease to allow natural regeneration of vegetation. Mowing should be limited to specific 'maintenance areas' and should not occur near foreshores nor in 'conservation areas'.

2.3. In 'conservation areas', upper storey species, particularly *Eucalyptus rudis,* should be permitted to mature and lose limbs through natural processes. The resultant hollows provide nesting sites for native fauna. Fallen tree limbs should remain on the ground to contribute to bushland habitat where appropriate. 'Conservation areas' should require minimal management and should act as bushland corridors.

2.4. There needs to be resolution of the conflict of opinion as to whether *Typha orientalis* is an indigenous species or an exotic weed. If necessary, a genetic study should be undertaken to resolve this issue. In the interim period a conservative approach to management of wetlands should be adopted and *Typha orientalis* should not be removed or sprayed.

2.5. Planning of 'conservation areas' and 'maintenance areas' should allow for public nodal access to the river foreshore for viewing areas, picnic areas, etc. rather than full river access.

2.6. Conservation areas may need to be designated and blocked from public access with bollards to avoid future public liability issues.

3. Consultation with the community about revegetation programmes and about local fauna and flora issues.

3.1. It must be recognised that all areas of the Swan and Helena River floodplains fall under Section 18 of the Aboriginal Heritage Act and require consultation with local Aboriginal People prior to removal of

vegetation or land disturbance. The local Nyungar people have a wealth of knowledge that can assist planning and other floodplain work.

3.2. Management of the floodplains is likely to be most successful when the local community is consulted and has an opportunity to contribute ideas and to be involved. An involved community will also be more informed and respectful of the work undertaken. Several residents indicated on their surveys that they are willing and keen to be involved in revegetation and other conservation activities.

4. Pre-eminence of principles of biodiversity and conservation over other planning and recreational policies.

4.1. Planning and management programmes at local and state government levels need to recognise the importance of natural bushland and give environmental considerations a priority in decision-making and policy.

4.2. 'Conservation areas' need to be identified prior to the planning and establishment of 'maintenance areas' including bike paths, picnic areas, etc.

4.3. Bike paths and walk trails should have nodal foreshore access rather than continuous riverside access. Paths must avoid sensitive wetlands and foreshore areas and pass around conservation areas and mature trees. As recommended in the Eastern Metropolitan Regional Council's, Environmental and Heritage Audit Development Plan (2009), the location of the paths should have due regard to heritage and conservation issues.

4.4. Dogs may need to be restrained on a leash near designated 'conservation areas' and additional areas need to be set aside as designated dog exercise areas.

4.5. Exotic vegetation in Guildford needs to assessed for cultural heritage significance, as the townsite contains certain plantings with scarcity and heritage values (e.g. sugar gums, oak trees, fruit trees, olive trees, vines, roses, etc) in the townsite and river floodplains. These plantings are often rare, have historical and cultural significance and can be indicative of archaeological and other sites. It is recommended that the managers/owners of these lands develop a comprehensive inventory of significant plantings so they can be protected.

4.6. Pesticide spraying should be avoided on the floodplain and areas of public recreation. Chemical control of mosquitoes, if necessary, should only use relatively non-toxic substances such as the larvacides *Bacillus thuringiensis israelensis* (Bti) granules and s-methoprene briquets, as used by the City of South Perth in 2010-2011 (City of South Perth 2010). Fogging of adult mosquitoes should not occur because the chemicals

are not specific to mosquitoes. Any spraying programme needs to be informed of current research and adopt best public health and environmental standards.

4.7. There should be ongoing documentation and research on the flora and fauna in Guildford. Such research may be scientific or may include stories from indigenous and local people.

A positive management strategy would allocate conservation areas of the floodplain to resident groups or school children for 'adoption' – this could involve managing the allocated area for weed removal (regular and long-term maintenance) and planting of native trees, understorey and reeds. Weed control in mulched areas would need regular maintenance due to the natural spread of weeds from surrounding areas via wind, water, birds. This 'grass roots' approach has a great potential for success and already a number of residents indicated in the survey that they would be willing to participate (or increase current levels of participation) in rehabilitation of their local floodplain reserve. It should also be noted that many of these residents are actively involved in informed and appropriate management of their properties.

Conclusion

The Guildford floodplains are a wonderful asset to the town of Guildford and to the Perth metropolitan area. Other than their use for grazing purposes and limited recreation, the floodplains have historically escaped pressures of development resulting in relatively large areas have been retained in their semi-natural state, while surrounding areas have become urbanised. However, in recent years the biodiversity of the river and floodplains as well as riverine health have been noticeably declining. There is a wealth of local knowledge amongst the Guildford community, and the local indigenous people. Successful management practice should seek to utilize local information and local resources.

Most floodplain management strategies to-date, have tended to omit mapping of flora, fauna and historic or culturally significant sites prior to commencing clearing, spraying or planning bike trails. The challenge now for the Guildford community and for government agencies is to use current knowledge and best management practices to reflect the stated biodiversity policies.

It is notable that the recommendations in this report are strikingly similar to many of those recommended previously by other agencies, such as by the Water and Rivers Commission (2001) and the Swan River Trust (2008). This would suggest that the recommendations of these previous reports have either not yet been adopted, or have yet be translated into 'on-ground' practices.

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There are encouraging signs in recent policies for management of Perth's river systems. Collaborative efforts among government and land care groups, such as the 'C21 Discover Your Rivers' campaign are positive. It is now well recognised that issues of water quality and other environmental attributes of the river need to be

addressed in the long term at the scale of the whole river catchment. There is now a need to actively translate policies into action. Within the context of the catchment, problems need to be tackled step-by-step. The Guildford floodplains are only a small part of the Swan and Helena river systems, but improving management of this one small area will no doubt have flow on effects downstream and provide a positive example to other communities.

The conclusions of this report suggest that the current maintenance practices are not ideal. There is a need to embrace a new paradigm of active restoration of the floodplain landscape. We therefore call on the Minister for Environment, the Minister for Planning, Department of Planning, Western Australian Planning Commission, Department of Environment and Conservation, City of Swan and the Swan River Trust, to adopt the recommendations presented here and to begin implementation immediately.

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Appendix A

Copy of the Survey

THE GUILDFORD ASSOCIATION
HISTORIC GUILDFORD - FIRST SETTLED IN 1829
P.O. Box 115, Guildford 6935 Western Australia

SURVEY OF RESIDENT PERCEPTIONS OF CHANGES TO FLORA & FAUNA IN THE FLOODPLAIN LANDS IN GUILDFORD WA.

8th April 2009

Dear Householder,

The Guildford Association Inc., your resident and ratepayer body, is conducting a survey of resident perceptions of changes to flora and fauna in the riverine (floodplain) lands of Guildford. This is a preliminary study to provide background information for the second stage - a planned collaborative study with tertiary institutions.

There has been ongoing concern in the Guildford community about management practices of the riverine reserves and possible changes to flora and fauna. This study seeks to identify those changes observed by residents living adjacent to these riverine areas.

The survey may take half an hour of your time, or longer if you wish to discuss with other family members. Please answer every question, even if it is circling Don't Know or Unsure.
This survey consists of 11 pages. Please check that you have responded on all pages.

The respondents are described as **household** - permitting a range of individuals in a family unit to discuss and contribute information.

Respondents are asked to describe changes to **Flora** (trees, shrubs, flowers, weeds) and **Fauna** (reptiles, mammals, birds, insects, etc) on their property and if they wish, a nearby property such as a reserve or public place on the floodplains. It is important that these locations can be clearly identified.

The Association will compile a report that will ensure privacy and confidentiality of individual household responses. Accordingly, personal details such as addresses will be coded and used by the researchers to locate patterns of responses and sightings. The information obtained will be used for future research and Guildford Association purposes.

Your survey sheets should be returned to the box in the Guildford Library by 30 April 2009. Please ring if you need the survey form to be collected.

If you have any questions or concerns please contact Harriet on 6488 1978 or Barbara on 9279 7057.

Your assistance is greatly appreciated.

Yours sincerely,

Barbara Dundas
(for the Guildford Association Inc)

Survey of Resident Perceptions
of Changes to the Flora and Fauna of the Guildford Floodplains.

1. Household Information

1.1 Name of Household…….

1.2 Number of people in Household……..

1.3 Address……..

……..

1.4 Contact Telephone Number……

Please circle the appropriate responses below

1.5 Period of residence in Guildford (longest residing member of the Household)
less than 2 years 2-5 years 6-10 years more than 10 years

1.6 Period of residence in this property (longest residing member of the Household)
less than 2 years 2-5 years 6-10 years more than 10 years

1.7 Do any members of the household walk around the floodplain areas of Guildford?
daily weekly monthly irregularly do not walk there

In the following parts of the survey you will be asked to identify perceived changes on **Your Property** and in a nearby area such as **Reserve or park land.**

1.8 Could you name the **Selected Reserve** and nearest streets to that reserve, that will be included in your answers?

1.9 Reserve / Place name……

1.10 Nearest Street(s)……

Survey of Resident Perceptions of Change to Flora

You will be asked to describe any changes you have noticed to populations of flora (vegetation) both on **Your Property** and on the **Selected Reserve**.

Please circle the most accurate response – remember you can discuss your responses with other members of your household

2. Changes to Flora on the Floodplains

*Vegetation Changes to **Your Property***

2.1 Have you noticed any changes to the **structure** (height, density or distribution) of vegetation (trees, shrubs, wildflowers or weeds) on **Your Property** over time? Yes No

2.2 Have you noticed changes to **types or species** of vegetation on **Your Property** over time? Yes No

If you answered **Yes** to either of the above please proceed to Q 2.3 - 2.8.
If you answered **No** proceed to Q 2.9

2.3 Have you noticed changes to the number of trees on **Your Property**?
no change increase in trees loss of trees unsure

2.4 Can you further describe these changes to the trees? (Species, health, vigour, exotics etc)
……
……
……

2.5 Have you noticed changes to the number of shrubs on **Your Property**?
no change increase in shrubs loss of shrubs unsure

2.6 Can you further describe changes to the shrubs on **Your Property**? (Species, health, vigour,weeds etc)
……
……
……

2.7 Have you noticed a change in rushes or reeds on **Your Property**?
no change increase in reeds loss of reeds unsure

2.8 Can you further describe the changes to the rushes or reeds on your property?
……
……
……
……

2.9 Have you noticed changes to weeds or other exotic / non indigenous plants (e.g. arum lilies, blackberries, bullrushes, deciduous trees etc) on **Your Property**?
no change increase in weeds loss of weeds unsure

2.10 Can you describe the changes to weeds and introduced trees etc on **Your Property**? (species, health or vigour of weeds.)

……
……
……
……

2.11 Thinking about any changes to vegetation you may have noticed on **Your Property**, what do you consider the most likely reasons for those changes?

……
……
……
……

Vegetation changes to the *Selected Reserve*

2.12 Have you noticed any changes to the **structure** (height, density or distribution) of vegetation (trees, shrubs, wildflowers or weeds) on the **Selected Reserve** over time? Yes No

2.13 Have you noticed changes in the **type or species** of vegetation on the **Selected Reserve** over time?

Yes No

If you answered **Yes** to either of the above please proceed to Q 2.14 - 2.22.
If you answered **No** proceed to Section 3 on Fauna

2.14 Have you noticed changes to the number of trees on the **Selected Reserve**?

no change increase in trees loss of trees unsure

2.15 Can you further describe these changes to the trees? (Species, health, vigour etc)

……
……
……
……

2.16 Have you noticed changes to the number of shrubs on the **Selected Reserve**?

no change increase in shrubs loss of shrubs unsure

2.17 Can you further describe the changes to the shrubs on the **Selected Reserve**? (Species, health, vigour etc)

……
……
……
……

2.18 Have you noticed a change in the reeds or rushes on the **Selected Reserve?**

no change increase in reeds loss of reeds unsure

2.19 Can you describe the changes to the reeds/rushes? (Species, health, vigour etc)

……
……
……
……..

2.20 Have you noticed changes to weeds or other exotic / non indigenous plants (e.g. arum lilies, blackberries, bullrushes, deciduous trees etc) on the **Selected Reserve?**

no change increase in weeds loss of weeds unsure

2.21 Can you describe the changes to weeds and introduced trees etc on the **Selected Reserve**? (Species, health, vigour etc)

……
……
……
……

2.22 Thinking about any changes to vegetation you may have noticed on the **Selected Reserve**, what do you consider the most likely reasons for those changes?

……
……
……
……
……

Survey of Resident Perceptions of Change to Fauna

You will be asked to describe any changes you have noticed to populations of fauna (animals) including reptiles, amphibians, mammals, birds and invertebrates

Please circle your response.

3. REPTILES- SNAKES

3.1 Have you ever noticed snakes on **Your Property**? Yes No

If you answered **Yes** to Q 3.1 proceed to Q 3.2. If you answered **No** go to Q 3.4.

3.2 Have you noticed any changes to snake populations on **Your Property**?

no change increase in numbers a decline in numbers unsure

If you noticed a change please go to Q 3.3. Otherwise go to Q 3.4.

3.3. On Your Property have you noticed the change in the last

12 months 1- 2 years 2-5 years 6-10 years more than 10 years.

Other (please specify)……..

3.4 Have you ever noticed snakes on the **Selected Reserve**? Yes No

If you answered **Yes** to 3.4 proceed to Q 3.5. If you answered **No** go to Section 4.

3.5. Have you noticed changes to the snake populations on the **Selected Reserve**?

no change increase in numbers a decline in numbers unsure

If you noticed a change please go to Q 3.6. Otherwise go to Q 3.7.

3.6. On the **Selected Reserve** have you noticed change in the last

12 months 1- 2 years 2-5 years 6-10 years more than 10 years.
Other (please specify)……..

3.7. Do you have any comments that you could add about why you think the population of **snakes** has changed/not changed in both or either of these areas?
……
……
……

3.8. Please provide information on particular snake species if you have been able to identify these species on **Your Property or Selected Reserve.**
……
……

4 REPTILES- LONG NECKED TORTOISE

4.1 Have you ever noticed long-necked tortoises on **Your Property**? Yes No

If you answered **Yes** to Q 4.1 proceed to Q 4.2. If you answered **No** go to Q 4.4.

4.2 Have you noticed any changes to long-necked tortoise populations on **Your Property**?
no change increase in numbers a decline in numbers unsure

If you noticed a change please go to Q 4.3. Otherwise go to Q 4.4.

4.3. On **Your Property** have you noticed the change in the last
12 months 1- 2 years 2-5 years 6-10 years more than 10 years.
Other (please specify)……..

4.4 Have you ever noticed long-necked tortoises on the **Selected Reserve?** Yes No

If you answered **Yes** to 4.4 proceed to Q 4.5. If you answered **No** go to Section 5.

4.5. Have you noticed changes to the long-necked tortoise populations on the **Selected Reserve?**
no change increase in numbers a decline in numbers unsure

If you noticed a change please go to Q 4.6. Otherwise go to Q 4.7.

4.6. On the **Selected Reserve** have you noticed change in the last
12 months 1- 2 years 2-5 years 6-10 years more than 10 years.
Other (please specify)……..

4.7. Do you have any comments that you could add about why you think the population of **long-necked tortoises** has changed/not changed in **either or both** these areas?
……
……
……

5. AMPHIBIANS-FROGS (please circle the most appropriate answer).

5.1. Have you noticed frogs on **Your Property**? Yes No

Note this may include sightings of adult frogs or tadpoles or hearing frog calls

If you answered **Yes** to Q 5.1 proceed to Q 5.2. If you answered **No** go to Q 5.4.

5.2 Have you noticed any changes to frog populations on **Your Property**?
no change increase in numbers a decline in numbers unsure

If you noticed a change please go to Q 5.3. Otherwise go to Q 5.4.

5.3. On **Your Property** have you noticed the change in the last
12 months 1- 2 years 2-5 years 6-10 years more than 10 years.
Other (please specify)……..

5.4 Have you ever noticed frogs on the **Selected Reserve**? Yes No
Note this may include sightings of adult frogs or tadpoles or hearing frog calls

If you answered **Yes** to 5.4 proceed to Q 5.5. If you answered **No** go to Section 6.

5.5. Have you noticed changes to the frog populations on the **Selected Reserve**?
no change increase in numbers a decline in numbers unsure

If you noticed a change please go to Q 5.6. Otherwise go to Q 5.7.

5.6. On the **Selected Reserve** have you noticed change in the last
12 months 1- 2 years 2-5 years 6-10 years more than 10 years.
Other (please specify)……..

5.7. Do you have any comments that you could add about why you think the population of **frogs** has changed/not changed in **either or both** of these areas?
……
……
……

5.8. Please provide information on particular frog species if you have been able to identify species.
……
……
…….

6. MAMMALS-ECHIDNA (please circle the most appropriate answer).

6.1. Have you ever noticed echidna on **Your Property**? Yes No

If you answered **Yes** to Q 6.1 proceed to Q 6.2. If you answered **No** go to Q 6.4.

6.2 Have you noticed any changes to echidna populations on **Your Property**?
no change increase in numbers a decline in numbers unsure

If you noticed a change please go to Q 6.3. Otherwise go to Q 6.4.

6.3. On **Your Property** have you noticed the change in the last
12 months 1- 2 years 2-5 years 6-10 years more than 10 years.

Other (please specify)……..

6.4 Have you ever noticed echidna on the **Selected Reserve**? Yes No

If you answered **Yes** to 6.4 proceed to Q 6.5. If you answered **No** go to Section 7.

6.5. Have you noticed changes to the echidna population on the **Selected Reserve**?
no change increase in numbers a decline in numbers unsure

If you noticed a change please go to Q 6.6. Otherwise go to Q 6.7.

6.6. On the **Selected Reserve** have you noticed change in the last
12 months 1- 2 years 2-5 years 6-10 years more than 10 years.
Other (please specify)……..

6.7. Do you have any comments that you could add about why you think the population of **echidna** has changed/not changed in **either or both** these areas?
……
……
……
……
……

7. MAMMALS–QUENDA (South Brown Bandicoot)
(please circle the most appropriate answer).

7.1. Have you ever noticed quenda on **Your Property**? Yes No

If you answered **Yes** to Q 7.1 proceed to Q 7.2. If you answered **No** go to Q 7.4.

7.2 Have you noticed any changes to quenda populations on **Your Property**?
no change increase in numbers a decline in numbers unsure

If you noticed a change please go to Q 7.3. Otherwise go to Q 7.4.

7.3. On **Your Property** have you noticed the change in the last
12 months 1- 2 years 2-5 years 6-10 years more than 10 years.
Other (please specify)……..

7.4 Have you ever noticed quenda on the **Selected Reserve**? Yes No

If you answered **Yes** to 7.4 proceed to Q 7.5. If you answered **No** go to Section 8.

7.5. Have you noticed changes to the quenda population on the **Selected Reserve**?
no change increase in numbers a decline in numbers unsure

If you noticed a change please go to Q 7.6. Otherwise go to Q 7.7.

7.6. On the **Selected Reserve** have you noticed change in the last

12 months 1- 2 years 2-5 years 6-10 years more than 10 years.
Other (please specify)……..

7.7. Do you have any comments that you could add about why you think the population of **quenda** has changed/not changed in **either or both** these areas?

……
……
……

8. MAMMALS-BRUSHTAIL POSSUM (please circle the most appropriate answer).

8.1. Have you ever noticed possums on **Your Property**? Yes No

If you answered **Yes** to Q 8.1 proceed to Q 8.2. If you answered **No** go to Q 8.4.

8.2 Have you noticed any changes to possum populations on **Your Property**?
no change increase in numbers a decline in numbers unsure

If you noticed a change please go to Q 8.3. Otherwise go to Q 8.4.

8.3. On **Your Property** have you noticed the change in the last
12 months 1- 2 years 2-5 years 6-10 years more than 10 years.
Other (please specify)……..

8.4 Have you ever noticed possums on the **Selected Reserve**? Yes No

If you answered **Yes** to 8.4 proceed to Q 8.5. If you answered **No** go to Section 9.

8.5. Have you noticed changes to the possum population on the **Selected Reserve**?
no change increase in numbers a decline in numbers unsure

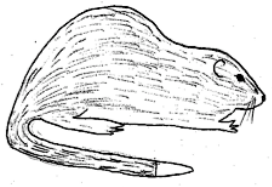
If you noticed a change please go to Q 8.6. Otherwise go to Q 8.7.

8.6. On the **Selected Reserve** have you noticed change in the last
12 months 1- 2 years 2-5 years 6-10 years more than 10 years.
Other (please specify)……..

8.7. Do you have any comments that you could add about why you think the population of **possums** has changed/not changed in **either or both** these areas?

……
……
……

9. MAMMALS-WATER RAT
(please circle the most appropriate answer).



9.1. Have you ever seen a water rat on **Your Property**? Yes No

If you answered **Yes** to Q 9.1 proceed to Q 9.2. If you answered **No** go to Q 9.4.

9.2 Have you noticed any changes to water rat populations on **Your Property**?
no change increase in numbers a decline in numbers unsure

If you noticed a change please go to Q 9.3. Otherwise go to Q 9.4.

9.3. On **Your Property** have you noticed the change in the last
12 months 1- 2 years 2-5 years 6-10 years more than 10 years.
Other (please specify)……..

9.4 Have you ever noticed water rats on the **Selected Reserve**? Yes No

If you answered **Yes** to 9.4 proceed to Q 9.5. If you answered **No** go to Section 10.

9.5. Have you noticed changes to the water rat population on the **Selected Reserve**?
no change increase in numbers a decline in numbers unsure

If you noticed a change please go to Q 9.6. Otherwise go to Q 9.7.

9.6. On the **Selected Reserve** have you noticed change in the last
12 months 1- 2 years 2-5 years 6-10 years more than 10 years.
Other (please specify)……..

9.7. Do you have any comments that you could add about why you think the population of **water rats** has changed/not changed in **either or both of** these areas?
……
……
……
……
……

10. **<u>INTRODUCED MAMMALS–FOX, RABBIT, FERAL CAT</u>** (please circle the most appropriate answer).

10.1.Have you ever seen introduced mammals on **Your Property**? Yes No

If you answered **Yes** to Q 10.1 proceed to Q 10.2. If you answered **No** go to Q 10.4.

10.2 Have you noticed any changes to introduced mammal populations on **Your Property**?
no change increase in numbers a decline in numbers unsure

If you noticed a change please go to Q 10.3. Otherwise go to Q 10.4.

10.3. On **Your Property** have you noticed the change in the last
12 months 1- 2 years 2-5 years 6-10 years more than 10 years.
Other (please specify)……..

10.4 Have you ever noticed introduced mammals on the **Selected Reserve**? Yes No

If you answered **Yes** to 10.4 proceed to Q 10.5. If you answered **No** go to Section 11.

10.5. Have you noticed changes to the introduced mammal population on the **Selected Reserve**?
no change increase in numbers a decline in numbers unsure

If you noticed a change please go to Q 10.6. Otherwise go to Q 10.7.

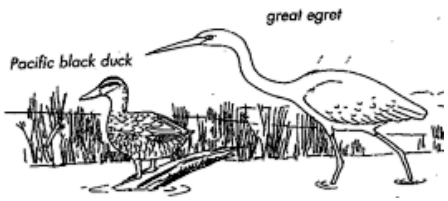
10.6. On the **Selected Reserve** have you noticed change in the last
12 months 1- 2 years 2-5 years 6-10 years more than 10 years.
Other (please specify)……..

10.7. Do you have any comments that you could add about why you think the population of **introduced mammals** has changed/not changed in **either or both** these areas?
……
……
……

11a. BIRDS – Please answer for birds seen on Your Property

Bird species	**Tick if seen on Your Property**	**For those species you ticked, indicate whether you think there has been any change to the population size**				**If you think there has been a change, over what time period has this happened?**				
		Increased	No change	Decreased	Not sure	Less than 12 months	1-2 years	2-5 years	5-10 years	More than 10 years
Pacific black duck										
Wood duck										
Great egret										
Sacred ibis										
Sacred kingfisher										
Butcher bird										
Willy wag tail										
Honey eaters										
Wattlebird										
Silver eye										
Mudlark/Magpie lark										
Australian raven										
Tawny frogmouth										
Southern boobook										
28 parrot (ringneck)										
Galah										
Black cockatoo										
Kookaburra										
Corella										
Rainbow lorikeet										

Further comments……
……
……



11b. BIRDS – Please answer for birds seen on the Selected Reserve

Bird species	**Tick if seen on the Reserve**	**For those species you ticked, indicate whether you think there has been any change to the population size**				**If you think there has been a change, over what time period has this happened?**				
		Increased	No change	Decreased	Not sure	Less than 12 months	1-2 years	2-5 years	5-10 years	More than 10 years
Pacific black duck										
Wood duck										
Great egret										
Sacred ibis										
Sacred kingfisher										
Butcher bird										
Willy wag tail										
Honey eaters										
Wattlebird										
Silver eye										
Mudlark/Magpie lark										
Australian raven										
Tawny frogmouth										
Southern boobook										
28 parrot (ringneck)										
Galah										
Black cockatoo										
Kookaburra										
Corella										
Rainbow lorikeet										

Further comments……
……
……

12a. INVERTEBRATES - Please answer for invertebrates seen on Your Property

Invertebrate	**Tick if seen on Your Property**	**For those species you ticked, indicate whether you think there has been any change to the population size**				**If you think there has been a change, over what time period has this happened?**				
		Increased	No change	Decreased	Not sure	Less than 12 months	1-2 years	2-5 years	5-10 years	More than 10 years
Dragon flies										
Feather horn beetle										
European honey bee										
Ladybirds										
Butterflies										

Further comments……
……
……
……
……

Feather horn beetle

12b. INVERTEBRATES - Please answer for invertebrates seen on the Selected Reserve

Invertebrate	**Tick if seen on the reserve**	**For those species you ticked, indicate whether you think there has been any change to the population size**				**If you think there has been a change, over what time period has this happened?**				
		Increased	No change	Decreased	Not sure	Less than 12 months	1-2 years	2-5 years	5-10 years	More than 10 years
Dragon flies										
Featherhorn beetle										
European honey bee										
Ladybirds										
Butterflies										

Further comments……
……
……
……
……

Please feel free to write additional observations or comments on this page.

END OF SURVEY

Thank you for your time

Please remember to return your completed survey to the Guildford Library by 30th April or telephone Barbara (92797057) or Harriet (64881978) to arrange collection.

Appendix B

Letter from the Swan Valley Nyungah Community

To Guildford Association, and Barbara and Ben

At least one of us will be attending the Meeting concerning the Guildford Floodplain Study - and Swan and Helena River at 7.30 pm tonight.

The Swan River and Helena River and all rivers and waterways and their surroundings are Sacred to us.

This includes the whole area of the Floodplains. No floodplains or the Rivers themselves should ever be disturbed or damaged or cleared. They are Nature's Gift to us. We are of the Land but the whitefella government doesn't recognise us or our Sacredness and our Spiritual Beliefs in the Rivers and Waterways and the Land itself and all it contains.

Yanjeb and the Rivers and Spraying of Herbicides

We, the Nyungar Elders of the Swan River and Swan Coastal Plains, who are the Swan River People, and who are the only Native Title Applicants for the area on behalf of the Nyungar People of the Swan River, are putting into writing our concerns about what we call **Yanjeb**, which applies to **the two bullrushes** in and around the Floodplains and the Helena River and the Swan River and the Canning River and many other Creeks, Rivers and Wetlands.

We always have opposed the spraying of any of the bullrushes, and any herbicide spraying whatsoever.

We have always eaten the roots of the two bullrushes.

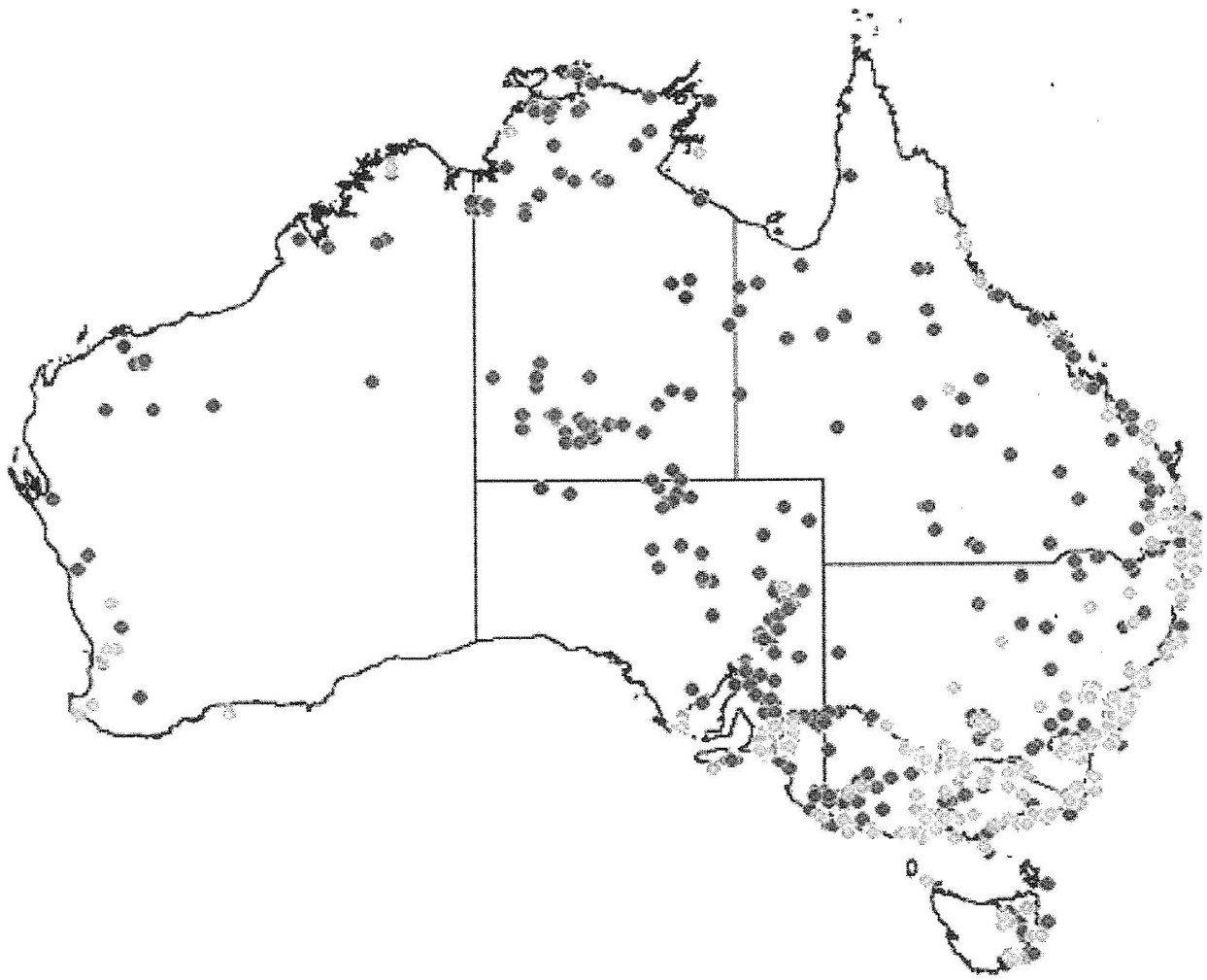
We believe both Bull-rushes were here in our Land since the Beginning of Time.

We are aware that the Whitefella thinks the bigger Bullrush doesn't come from our Land. We are aware the Swan River Trust has been trying to destroy the big Bullrush in the Rivers by herbicide spraying, saying it doesn't come from here. We have informed them this is not correct. To our knowledge, the two Bullrushes belong together in our rivers and waterways.

Yanjeb/Floodplains/BoatRamp 17.5.11

We are sending you evidence coming from the whitefella which shows that both bull-rushes come from here.

1. the enclosed map showing where the two bullrushes grow in Australia



Typha distribution map (generated by the Australian Virtual Herbarium) for orientalis (green dots) and domingensis (red dots).

Yanjeb/Floodplains/BoatRamp 17.5.11

2. the words of George Grey - 1841 - see top of page 292

and

Boerhaavia—two species.
Typha—two species.
Orchis—several species.

Some of these are in season in every period of the year, and the natives regulate their visits to the different districts accordingly. Those plants which grow in a stiff soil cannot be dug up by their implements without great difficulty in the heat of the dry season, but those which grow in a loose sandy soil can be obtained at all times. The natives have, however, a law that no plant bearing seeds is to be dug up after it has flowered; they then call them (for example) the mother of *Bohn*, the mother of *Mud-ja*, &c.; and so strict are they in their observance of this rule, that I have never seen a native violate it, unless requested by an European, and even then they betray a great dislike to do so.

The abundance of these roots varies, of course, with the nature of the soil, &c. but when there is a scarcity of any one of them, this is amply provided for by the abundance of others. In the Province of Victoria, as already stated, I have seen tracts of land several square miles in extent, so thickly studded with holes, where the natives had been digging up yams (*Dioscorea*), that it was difficult to walk across it. Again, in the sandy desert country which surrounds, for many miles, the town of Perth, in Western Australia, the different species of *Hæmadorum* are very plentiful.

It is generally considered the province of women to dig roots, and for this purpose they carry a long,

pointed stick, which is held in the right hand, and driven firmly into the ground, where it is shaken, so as to loosen the earth, which is scooped up and thrown out with the fingers of the left hand, and in this manner they dig with great rapidity. But the labour, in proportion to the amount obtained, is great. To get a yam about half an inch in circumference and a foot in length, they have to dig a hole above a foot square and two feet in depth; a considerable portion of the time of the women and children is, therefore, passed in this employment. If the men are absent upon any expedition, the females are left in charge of one who is old or sick; and in traversing the bush you often stumble on a large party of them, scattered about in the forest, digging roots, and collecting the different species of fungus.

The roots are eaten raw, or roasted in the fire; in either case they are, most of them, very good,—some have the taste of a mild onion, and others have almost the taste and appearance of a small English potato, but of these only a single root is attached to each plant: the *nuene* has rather an acid taste, and when eaten alone is said, by the natives, to cause dysentery; they never use it, in the southern districts, without pounding it between two stones, and sprinkling over it a few pinches of an earth which they consider extremely good and nutritious; they then pound the mould and root together into a paste, and swallow it as a *bonne bouche*, the noxious qualities of the plant being destroyed by the earth.