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Evaluating oral histories for restoration ecology

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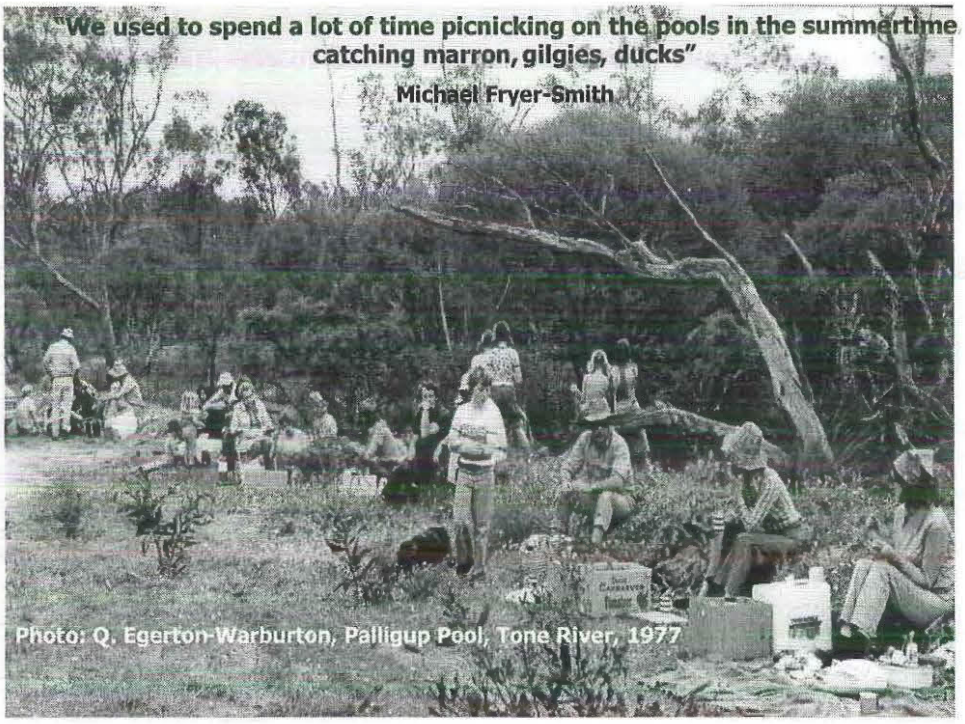

By Margaret Robertson

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USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

Abstract

Significant ecological restoration is required in the agricultural regions of south-western Australia. Environmental history, including local knowledge based on long-term observation of the biophysical environment, can help guide this process. Scientists already use local anecdotal information because other information sources are absent or too recent, yet they are often skeptical of its veracity. This study focused on whether environmental oral histories can be evaluated for factual accuracy and their capacity to be useful in the restoration process.

Some of the complexities associated with linking environmental histories with restoration ecology, and the role played by oral histories in establishing the link were reviewed. Three analytical tools were then established:

1. A set of five ecosystem attributes against which the relevancy and comprehensiveness of the oral histories could be assessed.

2. A classification of uses of historical information in the restoration process for assessing the capacity of the interviews to provide information that helps determine restoration potential, understand processes of change and assist restoration planning.

3. A triangulation process for corroborating recollections across interviews, and through the use of external data sources, in order to examine the consistency and veracity of the recollections.

These analytical tools were applied in a case study set in the degraded headwaters of the upper Tone River, south-western Australia. Purposeful sampling was used to select seven interviewees with information-rich recollections of the biophysical

condition of the river commencing prior to extensive clearing in the catchment in the late 1940s. The interview method employed broad, open questions about the ecosystem attributes to avoid pre-determining the content of the interview, and to give participants the freedom to recall what was significant about the river to them. To avoid compromising the triangulation exercises, memory aids were not used.

The deliberate non-use of specific and probing questions in the interviews probably reduced the amount and type of detailed information collected, and the capacity to determine its factual accuracy. Amending the interview method would address this issue. Nevertheless, information was collected that was relevant and potentially useful to river restoration, principally in relation to setting goals of importance to local people.

Cross-interview analysis corroborated almost 50% of selected recollections across the interviews. An exercise using the results of the cross-interview analysis and identified information sources, found that most of the statements could be corroborated, and therefore increased in evidentiary value. In another independent test of the oral histories, statements were taken from transcripts and given to scientists trained in aspects of restoration ecology. They determined that nearly two-thirds of all statements were capable of being checked for factual accuracy.

This study has demonstrated that when oral histories are collected for a particular purpose, there are techniques that can be used to extract and evaluate relevant information. By using a diversity of techniques to assess the veracity of the recollections with significant success, it has also been shown that recollections can be a valuable source of factual information.

Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education; and that to the best of my knowledge and belief this does not contain any material previously published or written by another person except where due reference is made in the text.

Signature

Date 27 April 1999

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CHAPTER ONE

1. INTRODUCTION

The use of oral histories and other anecdotal information is generally outside the norms of practice in environmental science, but may occur in the absence of any other information source. This limited use may reflect the lack of relevant training in collecting and analysing such data, but it is likely that it also reflects concerns about the veracity of anecdotal information. This is despite the fact that oral testimony is readily accepted in other fields. It is, for example, used as evidence in courts of law and in medical diagnosis.

At the heart of this distrust lies the dominance within environmental science of positivist[1] assumptions that the scientific method is the only source of 'legitimate' knowledge. Roberts and Sainty (1997:3) state "For scientists, a major drawback with anecdotal information is that it is typically not collected or stored in a structured way that conforms to normal scientific goals of hypothesis testing." A formative challenge to this narrow conception of knowledge is presented in Chapter Five. For now it is enough to argue that oral histories acquire particular value when based on long-term observation, which may extend well beyond the average period of a scientific investigation in relation to a specific area. For example, information in the oral histories collected as a part of this study provides a continuum of observation dating back to the 1920s. This predates and is continuous with the major environmental changes occurring in the focus area – an area that has attracted relatively little interest from environmental scientists to date.

diversity and stability were maximised" (Jackson et al 1995:72). According to Pickett and Parker (1994:75-6), modern ecological theory assumes that systems:

> *can (1) be open, (2) be regulated by processes arising outside their boundaries, (3) exhibit multiple equilibria or end points, (4) have multiple and probabilistic successions, (5) be subject to natural disturbance, and (6) incorporate humans and their effects.*

"Taken together, these assumptions suggest that the natural world will always be in flux from some perspective" so there is no one reference state or system that can inform restoration (Pickett and Parker 1994:75-6). This is not just because of the extent of human intervention. "A variety of pathways of change and myriad compositions of natural ecosystems" are inherent in the natural world, so to assume there is "only one ecologically legitimate or ideal system for a site is a trap" (Pickett and Parker 1994:75). The flux of nature model also means "restoration should be seen as intervention into an ongoing process rather than as a lasting patch or repair." (Pickett and Parker 1994:75) This *process*, as Pickett and Parker (1994:75) describe it, takes place in an open, dynamic system where there is no predetermined or fixed condition or end point. Instead, any one system could exhibit a variety of reference states contingent on its context - factors such as its unique history, "special spatial setting" (e.g. the nature of edges and the size, distribution and isolation of the site (White and Walker 1997:341), and current, external influences provided by the surrounding landscape. The consequence of this approach, according to Pickett and Parker (1994:76), is that restorationists have a variety of reference states to choose from:

> *Contingency establishes a whole range of systems, not just one "climax" or predisturbance state. Of course there are many ecological and societal reasons to choose certain reference states, including aesthetics, commodity production, ecosystem services, and species protection, among others. But the point is that restoration ecologists must choose, and nature provides a range of ecologically valid system states.*

The "flux of nature" view has clearly influenced perceptions of the restoration process and the role of historic, indigenous ecosystems. An early definition of restoration adopted by the Society of Ecological Restoration is:

> *the intentional alteration of a site to establish a defined indigenous, historic ecosystem. The goal of this process is to emulate the structure, functioning, diversity, and dynamics of the specified ecosystem* (Aronson et al 1993a:8).

In the Society's more recent definition of restoration, reference to establishing an historic ecosystem has been replaced with a more dynamic view. The issue has become the restoration of ecosystem processes, including persistence of species through natural recruitment and survival, functioning food webs, and abiotic processes that shape the community such as periodic floods and fires (Jackson et al 1995:72). Aronson et al (1995:2) claim to have already embraced the move away from a balance of nature approach by speaking of "'alternative steady states' drawn from the historical context of the pre-existing, indigenous ecosystem", and more recently by thinking "in terms of many equally possible ecosystem trajectories and of guiding or piloting the ecosystem under study in one direction or another."

Aronson and Le Floc'h (1996a:327) argue that an historical perspective of the ecosystems and landscapes under study is still needed to indicate ecological transformations "that have gone into the making of the contemporary landscapes in which we now set ourselves to work as restorationists." The historical background enables ecologists to ascertain whether any 'thresholds of irreversibility'[3] have been crossed in the history of the ecosystems concemed (Aronson and Le Floc'h 1996a:330). Similarly, in the context of restoration works on farmland, where

[3] The concept of "thresholds of irreversibility" refers to the presence of system thresholds that prevent the restoration of the former condition without management intervention to remove the changes that led to the threshold being crossed. Such thresholds may be crossed in a highly degraded system, such as where sedimentation or salinisation have "drastically modified surface and sub-soils". (Aronson and Le'Floch 1993:11).

hydrological, nutrient and energy cycles have been modified, Fry and Main (1993:226) state that an understanding of this historical background to the environmental impacts of farming is the key to solving current problems. A number of scientists share Clark's (1990:1) view that "managing ecosystems without any knowledge of their history may well invite future disaster." For example, Davis and Finlayson (1999:199) argue that "knowledge of the stream's pre-disturbance form and some understanding of the causal factors driving stream degradation" are essential, and "attempting stream rehabilitation without gathering the relevant historical information may ultimately lead to the failure of the project. Hobbs and Norton (1996:96) also point out that restoration efforts will be undermined unless the processes causing the degradation are identified and tackled.

While advocating the flux of nature model, Jackson et al (1995:72) observe that because the model suggests that disturbance is normal, "some might argue that restoration is never required." This issue poses another challenge: to see humans more as part of nature and their activity as yet another source of disturbance. However, it has been argued that there are limits to the capacity of nature to achieve a sustainable relationship with culture:

> *Human activity can disrupt the flux of nature itself ... - the potential for continued evolution of species, the persistence of species, and the complexity and flexibility of their interactions* (Jackson et al 1995:72).

A challenge of restoration under the flux of nature model therefore becomes restoring sustainable relationships between nature and culture. On this point, historical human use is seen as having a role. Jackson et al (1995:72) propose that:

> *"Where traditional human use, such as grazing, burning, agriculture and silviculture have shaped an ecosystem over hundreds or thousands of years ... the process of ecological restoration will include restoration of these human activities, either by encouraging traditional cultures to continue their land use practices, or, if they have been extirpated, by attempting to mimic their impacts on the landscape."*

The problem with this approach is that it relies on a "balance-of-culture" model. Culture is not static either, as Hallam (1979:104) has shown in relation to Aboriginal use of fire in south-western Australia. Moreover, traditional human use, such as hunting practices, may be unsustainable in an ecosystem that has been drastically altered in recent times. What it does suggest is that modern human use represents a threshold of disturbance that is unsustainable.

Because restoration is about the degraded present relative to the past, the two are necessarily linked. The use of "natural" or "historic" as a comparative tool – a reference state, or model, is apparent even among those who advocate a flux of nature approach. For example, Hobbs and Norton (1996:100-101) argue "the use of the term natural imposes a static perspective on restoration", yet they also observe "complete restoration of the natural system is probably an unachievable goal ... but we need to decide how close we should get", and "ecosystem restoration seeks to return some aspects of the natural ecosystem to treated areas." A consequence of the flux of nature paradigm is that there is no single, ideal, natural condition to be found in the past. However, historical (or contemporary) reference information on the natural condition continues to serve as a guide in the restoration process.

Environmental history and the restoration process

In this section I focus on the role played by environmental history in the various components of the restoration process. Later, these views are synthesised with the other material presented in the chapter, in a classification system for analysing the oral histories collected in this study.

It is apparent from the previous discussion that the restoration process can usefully draw on historical information, but this contribution is not explicit in the 'key processes in restoration' identified by Hobbs and Norton (Box 1).

Box 1

Key Processes in Restoration

1. Identify processes leading to degradation or decline.
2. Develop methods to reverse or ameliorate the degradation or decline.
3. Determine realistic goals for reestablishing species and functioning ecosystems, recognizing both the ecological limitations on restoration and the socioeconomic and cultural barriers to its implementation.
4. Develop easily observable measures of success.
5. Develop practical techniques for implementing these restoration goals at a scale commensurate with the problem.
6. Document and communicate these techniques for broader inclusion in land-use planning and management strategies.
7. Monitor key system variables, assess progress of restoration relative to the agreed-upon goals, and adjust procedures if necessary.

Source: Hobbs and Norton (1996:95)

The role of environmental history can be made clear by reconciling this list of key processes with the views of other restoration ecologists. This exercise brings together a diverse range of restoration experience. Hobbs has a botanical background and a focus on fragmented landscapes set in the WA wheatbelt. Other ecologists, whose views are outlined in this chapter, have worked in quite different settings. For example, Larsen draws on experience in river restoration in Germany, while Kershner discusses the application of watershed analysis in the North American experience of river restoration; and Aronson and Le Floch, referred to earlier, have written about restoration and rehabilitation in arid and semi arid areas in developing countries.

The historical component of the restoration process highlighted by Larsen (1996:130) which is not evident in the list of 'key processes' identified by Hobbs and Norton, is the establishment of a "model image". A model image is defined as "a description of the river as it would have appeared, had it not been subject to human activities".

Although normally unachievable through restoration, for reasons such as irreversible changes in abiotic and biotic factors, the model image "serves as a benchmark ... a description of an idealistic goal that helps to guide the planner" (Larsen 1996:130). The use of historical maps, aerial photographs, including infrared images, and contemporary reference sites are some of the sources of information required to establish the model image. Larsen (1996:131) begins the list of steps in the planning and execution of river restoration with the establishment of the model image.

In a watershed context, Kershner (1997) describes a template for decision-making about goals and objectives in restoration projects. The focus underpinning the sequence of steps outlined is identification of human-caused disturbances that might be responsible for the degraded resource, especially those compromising key processes and functions. A description of reference conditions is included as a key step in understanding and developing restoration priorities in riparian and aquatic restoration projects:

> *Identifying reference conditions is one of the most important parts of the analysis for the restoration practitioner. Reference conditions describe the history of the landscape and help us to understand what the resource conditions were in the past and what changes may have occurred and why* (Kershner 1997:18).

While noting that a system's attainment of reference conditions may be limited by current environmental factors, reference conditions are said to "play a large role in determining the range of possibilities for desired future conditions" (Kershner 1997:18). Historical surveys, old aerial photos and contemporary reference sites are listed as sources of reference information.

Kershner (1997:17,19) also describes how historical information is used to trace the development of current conditions. For example, analysis of the current condition of cutthroat trout habitat in Utah found that high-quality habitat "appeared to be in short

supply as a result of disturbance related to past logging. Historical records from the early part of this century showed that a large part of the upper watershed had been extensively logged ... during which much of the stream complexity (e.g., logs, large boulders) was removed to facilitate log drivers down the stream. Trees were removed from the riparian zone", and so on. Kershner (1997:21) observes that

> *Probably the most interesting finding from the project was the relationship between current in-channel conditions and events that happened over half a century ago. By understanding the relationships between past riparian logging practices and current volumes of coarse, woody debris in the channel, we were able to design restoration prescriptions that (1) provided short-term debris inputs and (2) recognized the long-term contribution of debris from riparian stands. We also recognized the magnitude of the restoration necessary to restore cutthroat trout habitat.*

Similarly, following an historical study of degraded streams in eastern Australia, Davis (1998:4) argues that by understanding the historical conditions of the stream and the processes that have led to their current degraded state, it is possible to devise rehabilitation actions that will prevent the degrading processes from reoccurring.

Another aspect to defining the role of environmental history in the restoration process is the type of historical information required. This includes consideration of whether information requirements are focused on ecosystem functions and ecological processes or components, such as species.

Historical information requirements of the restoration process

Hobbs and Norton (1996:100) identify six ecosystem attributes: species composition and abundance, structure, pattern, heterogeneity, function, dynamics and resilience, and argue that questions about which attributes to restore "will in large part be determined by the objectives set for the restoration." For example, a focus on restoration of productive capability of degraded land will have different needs to the restoration of nature conservation values. Pickett and Parker (1994:77) describe

modern science, including restoration, as "essentially an ongoing dialogue between a model of the world and the way the world actually works." Restoration stands out, they argue, because its "goal is to provide a working ecological system. In essence, the system that a restorationist installs is a model or theory of how such a system works, contingent on the locale and relevant ecological history" (Pickett and Parker 1994:77).

Consistent with the notion of a working ecological system is an ecosystem view or perspective. In relation to the Kissimmee River restoration project, Dahm et al (1995:225) argue that this approach "considers both the abiotic and biotic components and looks for key linkages and processes occurring among the physical, chemical, and biological elements of the overall system." The outcome of this thinking is what Koebel (1995:157) describes as a new trend in restoration:

> *Past trends in restoration evaluation have often focused on single-species responses to restoration efforts. These studies, while providing an understanding of certain life-history requirements of individual species, rarely add to our understanding of ecosystem processes and the complex web of biotic and abiotic interactions that shape and maintain biological communities.*

This position is in agreement with definitions of "ecosystem"[4] and the concept of a holistic approach to restoration:

> *The objective is to emulate a natural, self-regulating system that is integrated with the ecological landscape in which it occurs* (National Research Council 1992:18).

Similarly, Aronson et al (1993a:9) argue that restoration and rehabilitation adopt

> *the indigenous ecosystem's structure and functioning as the principal models to be followed, insofar as they can be determined or guessed. That is, they both aim at recreating autonomous or self-sustaining ecosystems, which are characterized by biotic change or succession in plant and animal communities, and the ability to repair themselves following natural or moderate human perturbations.*

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[4] "Ecosystem: a functional unit of energy transfer and nutrient cycling in a given place such as an estuary, a forest of a lake. It includes all the relationships within the biotic community, and between the biotic components of the system." (Recher et al 1986:416).

Moreover, restoration and rehabilitation must also seek to establish former paths of energy flow and biogeochemical cycling (Aronson et al 1993a:9). This emphasis on restoring ecosystem structure and function is reflected in the selection by Aronson et al (1993a; 1993b) of twenty-three "vital ecosystem attributes" (VEA), defined as "those characteristics or attributes that are correlated with and can serve as indicators of ecosystem structure and function". The choice of structure and function, as the priority ecosystem attributes on which restoration activities should focus, is also demonstrated by the goals, objectives and success criteria adopted in the Kissimmee River restoration project, discussed in more detail later.

It is worthwhile considering whether this approach to restoration ecology is consistent with the principles of ecosystem management, since these principles will subsequently be applied to restored ecosystems. According to the Ecological Society of America (1996:668), ecosystem management is "based on our best understanding of the ecological interactions and processes[5] necessary to sustain ecosystem structure and function". The primary focus of ecosystem management is described as the "sustainability of ecosystem structures and processes necessary to deliver goods and services", with the ecosystem processes said to include hydrologic flux and storage, biological productivity, biogeochemical cycling and storage, decomposition, and maintenance of biological diversity (Ecological Society of America 1996:667-8). Confusion of terms aside, there appears to be a consistent approach between the fields of restoration ecology and ecosystem management on this issue.

[5] Armstrong (1993:210) presents a "strict definition" of ecosystem functions and processes: "ecosystem functions can be defined to include nutrient cycling, hydrological cycles, soil development and primary and secondary production, while ecosystem processes consist of pollination, predation, competition, patterns of resource acquisition/utilization and regeneration." However, he notes that ecosystem function and processes are used interchangeably in the literature.

The other approach that could be taken involves restoration of components, such as a single ecosystem function or a specific species (Armstrong 1993:210). The restoration focus on the cutthroat trout, discussed earlier, is one example. Flagship species are another example of a component-based approach. Nickoll and Horwitz (in press) discuss the importance of flagship species, which are charismatic and require conservation, to foster local community involvement in restoration, benefit other species through their conservation and serve as an endpoint for restoration programmes. An argument for taking this approach, rather than a holistic, systems approach is that restoration of components is easier. An ascending hierarchy of restoration complexity extends from components, to structure, processes and functions. Functions are the most complex because they involve interactions between ecosystem components.

A recent development in a species-based approach is that advocated by Lambeck (1997). Lambeck (1997:850) notes the debate in the ecological literature about whether nature conservation planning is best served by meeting the requirements of particular species (e.g. rare or vulnerable species) or "analysis of landscape pattern[6] and process". Critics of the single species-based approach have concerns that they do not provide 'whole-landscape solutions'. However, Lambeck (1997:855) contends that questions about the pattern and ecological processes required in a fragmented landscape to achieve nature conservation objectives "cannot be answered without reference to the needs of the species in that landscape. Therefore we cannot ignore the requirements of species if we wish to define the characteristics of a landscape that will ensure their retention." He advocates a multi-species approach using a suite of species,

[6] Pattern refers to spatial attributes at the landscape level, such as habitat area or connectivity (Lambeck 1997:852).

described as "focal species"[7], selected on the basis that their individual "requirements for persistence define the attributes that must be present if that landscape is to meet the requirements of the species that occur there" Lambeck (1997:851).

Oral histories about the biophysical environment prior to and following anthropogenic change need to contain information that is relevant to the restoration process. The preceding discussion has shown that there is no single, correct approach by which relevant information can be defined – there are arguments for both holistic and component-based approaches to restoration.

In the following section, river restoration literature is reviewed as the final stage in developing a conceptual framework for the analysis of oral histories collected in this study. Where possible I have incorporated the issues discussed in the previous two sections to assist with this process.

River restoration and the use of historical information

The river restoration literature contains practical examples of the use of historical information in the river restoration process. One outstanding international example is the Florida-based Kissimmee River restoration project, described below. However, the extent to which this project can inform this study's focus on a south-western Australian river is shown to be limited.

Kissimmee River case study

The Kissimmee River restoration project involves 70 km of river channel and an area of 104 km^2 including floodplain. The river was channelised between 1962 and 1971 resulting in two-thirds of the historic floodplain being drained and a meandering 166 km long river being transformed into a 90 km-long canal. Public pressure to restore

[7] Focal species - a subset of the total pool of species in the landscape (Lambeck 1997:850).

the riverine system started before channelisation was complete and has been a persistent driving force in the development and implementation of a restoration plan. Summaries of the type of historical information being used to inform the Kissimmee River restoration process are set out below.

Goal setting: The goal of the restoration process is to restore the ecological integrity of the Kissimmee River and floodplain (Koebel 1995:155). More specifically, Dahm et al (1995:225) describe the goal as "reestablishment of pre-channelization hydrologic attributes and associated physical, chemical, and biological characteristics. Both the structure and function of the river and floodplain are to be re-created." Historical information is significant to the achievement of this goal, with "reestablishing historic hydrologic conditions, restoring the historic biological diversity and functionality, recreating the historical river/floodplain connectivity and mosaic of wetland plant communities", listed as the means by which the goal will be achieved (EPA 1997). Similarly, Dahm et al (1995:225) emphasise the importance of the historical perspective to this project:

> *When considering the outcome of restoration efforts, it is instructive to consider not merely the pre-channelization "historical" condition of the Kissimmee River and its floodplain but conditions prior to European settlement. As much as possible, the restored system should encompass those attributes of presettlement conditions that would contribute significantly to recovery of ecosystem function and plant and animal communities.*

Objectives: Reestablishment of historic river channel and floodplain habitat structure and function[8] is considered a "critical element of the ongoing effort to achieve the goal

[8] Principal attributes of habitat structure of the Kissimmee wetland are (Toth et al 1995:160): *Biotic*: vegetation characteristics, including species composition, density, and physical characteristics (physiognomy). *Abiotic*: substrate (e.g. sediment) or soil type, water depth and flow characteristics, and topography.

of restored ecological integrity of the river, and will serve as a key indicator of success for the Kissimmee River restoration project" (Toth et al 1995:160,173). Accordingly, historic and post-channelization habitat structure was determined to identify habitat divisions and as a basis for designing restoration evaluation studies (Toth et al 1995:161). Sources of historical information included pre-channelization aerial photographs, daily flow records, and clearing and snagging data.

Of the main factors and processes affecting habitat structure and requiring re-establishment, assessment of historical data revealed hydrology was the "principal determinant of the structure and dynamics of wetland plant communities" in the pre-channelized Kissimmee River ecosystem (Toth et al 1995:165.172). However, other factors such as substrates, fire, nutrient availability, grazing and other disturbances (Toth et al 1995:165,172).

Identifying and tackling degrading processes: The speed with which degradation was observed to occur following the commencement of channelization, was reflected in moves to restore the river system even before the canal was complete. The ready availability of information about the pre-channelized condition of the river provided valuable reference conditions for the identification of degrading processes, and for determining the success of a major demonstration project designed to assess the feasibility of particular restoration activities.

Success measures: Historical information will also play a significant role in the evaluation programme designed to determine restoration success. The use of pre-

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The complexity, heterogeneity, and scale of habitat structure confer habitat functionality (McCoy and Bell (1991), in Toth et al (1995)). Habitat functionality includes the provision and use of habitats by biota for growth, feeding, reproduction, and rearing of young, as well as the roles of various habitats in ecosystem processes such as biogeochemical cycling and the dynamics of energy flow." (Toth et al 1995:160). Habitat functionality also "reflects the physical, chemical, and biological components of ecosystems." (Toth et al 1995:160).

channelization data is identified as one of three ways of establishing reference conditions in order to "define realistic expectations for restoration". The data will include the physical, chemical and biological factors "that most likely contributed to the establishment, interaction, and persistence of the biological communities prior to channelization." (Koebel 1995:158). Many of the factors (or biotic and abiotic conditions and interactions) considered relevant to the restoration project, including the evaluation programme, are outline in Table 2.1. Analysis of the historic, pre-channelization condition and interactions was undertaken in relation to these factors.

Table 2.1: Analysis of the Kissimmee River's historical condition

Biological factors (biotic)	**Physical and chemical factors (abiotic)**
Taxonomic - vegetation, invertebrate, fish, waterbirds *Habitat* - river and floodplain *Functional* - river-floodplain, predator-prey, food web, competitive interactions *Structural* - vegetation, invertebrate, fish, waterbird communities *Conceptual components* - the structure of the pre-channelized biological community and the attributes of structure and function that will best elicit restoration responses by all biological communities	*Hydrology* - including stage height (e.g. overbank – floodplain flow), depth and flow characteristics (e.g. inundation frequency) *Channel geomorphology* – river form and pattern *Water chemistry* – including temperature, dissolved oxygen, dissolved organic carbon, pH, turbidity *Nutrient availability* - particulate organic matter (detritus) *River substrate and floodplain soil* *Fire, grazing and other disturbances*

Source: Koebel (1995), Dahm et al (1995:227), Toth et al (1995).

Monitoring and assessing restoration success: To measure restoration success, baseline conditions, defined as the current state of the biological communities, will be compared with "realistic expectations (reference conditions) for restoration, as well as actual conditions resulting from restoration." (Koebel 1995:158). That is, historic (and contemporary) reference conditions will be used to help determine restoration progress.

River restoration in south-western Australian

The restoration approach for rivers in south-western Western Australia contrasts markedly with the Kissimmee River restoration project. The Kissimmee project emphasises restoration of the historic hydrological condition of the river. In south-western Australia *historic* hydrological data (e.g. flood levels) is arguably much less relevant. Loss of original catchment condition associated with many river systems, such as the Upper Tone River, is now entrenched and widespread and rules out a return to the historic hydrological regime. Stream restoration measures are generally designed to take this new flow regime into account. The Water and Rivers Commission (WRC), the principal government body dealing with river restoration in Western Australia, argues that restoration activities along a stream "should conform to, and be reinforced by, the natural geomorphological processes at work in the reach" (WRC 1998b:17). This approach comes with the caution that "our catchments are in a state of flux, with changing land use, a significant declining rainfall trend and rising ground waters. All of these factors mean that the changing runoff rates of our catchments make determining natural stream form problematic in many areas" (WRC 1998b:19).

In light of this state of flux, stream restoration projects undertaken by the WRC adopt the Newbury method (Newbury and Gaboury 1993), which aims to restore the natural form suited to the reach in question. Ten steps are involved, including catchment analysis to delineate the catchment area; graphing stream profiles to identify changes in stream character; analysing flood flow information; and surveying channel geometry. Unlike the emphasis on restoring the historic hydrologic regime in the

Kissimmee River project, the Newbury method as applied in Western Australia[9], enables the river restoration process to accommodate hydrological changes resulting from landuse changes.

Ecosystem attributes for analysis of oral histories

The Kissimmee River restoration example highlighted both the uses and range of historical information required for a river restoration project of that type. However, the discussion of the situation in south-western Australia indicated the problems in applying some of these principles to our local rivers. One challenge in this study is to identify the ecosystem attributes required for gauging the usefulness of the information provided in the Tone River oral histories. In devising a list of attributes, I considered the position adopted by the WRC in relation to the Tone River and opted to go beyond its rather narrow parameters. The WRC is working with farmers in the Tone River catchment to restore water freshness to a potable level by 2030 (SSC 1998:38). Land management and use will be modified at the catchment scale (e.g. adoption of alternative pastures and agroforestry) with a view to enabling river flow to be a suitable water supply for a proposed dam downstream. In short, there is no comprehensive, ecological restoration goal established under this state-sponsored river restoration plan to assist with the identification of relevant ecosystem attributes. Indeed, one of the aims of the analysis used in this study is to examine whether the interviews could be a *source* of goals, or endpoints. Assistance with developing the criteria was provided by Rutherfurd et al (1998:16-9). In light of the strict definition of stream restoration adopted by the National Research Council (1992: 17-8), namely, to reestablish the predisturbance condition of aquatic ecosystems to the maximum

9 To date, this method has only been applied to the relatively fresh streams in higher rainfall areas of WA, such as the Swan Coastal Plain and the Northern Jarrah Forest.

extent possible, Rutherfurd et al have opted for a less ambitious approach to stream restoration in an Australian context. They argue:

> *"whilst it would be ideal to truly 'restore' our streams it is much more likely that we can return only some elements of the pre-disturbance condition. Such partial restoration should be described as 'rehabilitation'"* (Rutherfurd et al 1998:14).

In a similar vein, Raine and Gardiner (1995:5) believe "to aspire to rivers that looked like those of 200 years ago is a pipe dream in light of the cast changes that have been wrought on them and their catchments", and they urge the setting of "realistic" goals. Nevertheless, the distinction Rutherfurd et al draw between stream restoration and rehabilitation need not concern this study. First, I have already adopted the Hobbs and Norton (1996) approach of a 'spectrum of restoration ecology', and secondly, I am not setting thresholds for restoration activity in this study.

Rutherfurd et al (1998:14) identify five key elements of stream health that "stream rehabilitation must include." Beside these 'key elements', listed below, I have noted how these have been defined in this study for the purpose of evaluating the relevancy of the information in the oral histories for ecological restoration.

Key elements of stream health (Rutherfurd et al 1998:19)	**Ecosystem attributes for evaluating relevancy of Tone River oral histories**
Physical character	Riverine habitat structure
Riparian zone	Riparian vegetation
Animals	Riverine fauna
Water quality	Water quality
Water quantity	Historic information not considered a key factor in restoration of the upper Tone River

Water quantity, the fifth key element identified by Rutherfurd et al, has been disregarded for the reason that historical information about water quantity is not vital information for river restoration in a catchment undergoing major, long-term hydrological change.

Earlier it was noted that restorationists have argued for both holistic and component-based approaches to ecological restoration. The former emphasises ecosystem structure and function and ecological processes, and the latter typically involves a species-based approach. Recent ecological thinking is encouraging restorationists to employ the holistic approach at the landscape scale, and at least some ecologists (e.g. Lambeck 1997) argue that a multi-species focus is an essential component of this approach. Taking into account these views and the literature specific to river restoration, information about the following five environmental attributes is likely to be needed for any effort to restore the upper Tone River. These five environmental attributes provide the conceptual framework for coding and analysing the seven oral histories used in this case study:

1. Riparian vegetation
    a) composition: presence or absence of species or types
    b) structure: vertical layering and percentage cover or density
    c) pattern: areal extent and zonation, assessed both horizontally (across the river) and longitudinally (along the river).
2. Riverine habitat structure
    a) channel morphology (e.g. channel type, pools, riffles, bank type) and related water depth and flow
    b) mineral substrate (e.g. bedrock, rock, outcrop, gravel, sand, silt, clay)
    c) organic substrate (e.g. large woody debris, coarse to fine particulate matter)
3. Riverine fauna (aquatic fauna and fauna closely associated with the river (Lake 1995)).
    a) composition (presence or absence of species or types)
    b) abundance
    c) seasonality
    d) functional roles and use of habitat

4. Water quality:
    a) clarity
        i) turbidity/cloudiness
        ii) aquatic algal growth
        iii) colour (stain – dissolved organics)
        iv) visual depth
    b) basic physico-chemistry
        i) temperature
        ii) pH
        iii) dissolved oxygen
        iv) salinity (cumulative measure of total dissolved salts)
    c) odour
    d) water chemistry
5. Ecosystem functions and ecological processes
    a) Ecosystem functions (e.g. biogeochemical cycling, hydrological cycles, primary and secondary production and soil development)
    b) Ecosystem processes (e.g. pollination, predation, competition, patterns of resource acquisition and utilisation, regeneration and decomposition).

Table 2.2 presents a synthesis of the discussion of the uses of historical information in the restoration process and the type of historical information such uses entail.

Table 2.2: Environmental history, restoration ecology & the Tone River study

The table classifies the uses of historical information[10] in the restoration process. The classification is created from a synthesis of restorationists' views drawn from the literature presented in the preceding discussion. The third column lists examples of the type of historical information that would be needed to inform restoration of the upper Tone River.

Uses of historical information in the restoration process		How historical information fulfills this use	Examples of required historical information in the Tone River context
Reference & Change	*What is possible* Determining restoration potential of sites.	*Establishes original condition and identifies history of changes in land use and the system* Reference conditions help to determine the range of possibilities for desired future conditions. Having an historical perspective of the ecosystem under study, including (1) the historic biotic and abiotic factors and interactions, and (2) the ecological transformations that have shaped its current condition, will help to: • establish the factors and interactions that constituted a "healthy" system in the past, including the key driving factors in the system; and • indicate whether any "thresholds of irreversibility" have been crossed.	Allowing for a combination of restoration approaches: • an holistic approach focusing on ecosystem structure and function and ecological processes; and • a component, or species-based approach; the following environmental attributes are likely to be significant to the restoration of the Tone River: *Riparian vegetation* - composition, structure & pattern. *Riverine fauna* - composition, abundance & distribution, seasonality, functional roles & habitat use. *Riverine habitat structure* - channel morphology & water flow/depth, mineral & organic substrate. *Water quality* - clarity, basic physico-chemistry, water chemistry, odour. *Ecosystem functions and ecological processes*

[10] Contemporary reference sites could also meet at least some of these needs. For a discussion of the pros and cons of different forms of reference information see White and Walker (1997).

Uses of historical information in the restoration process		How historical information fulfills this use	Examples of required historical information in the Tone River context
Processes of change	*Why has change occurred* Identifying degrading and restorative processes, and developing prescriptions appropriate to achieving the desired goal.	*Establishes relationship between current condition and past events* Understanding the historical condition of the ecosystem and the processes that have led to its current condition means management/restoration practices can be devised that aim to prevent reoccurrence of the degrading processes and encourage restorative processes.	Identification of degrading and restorative processes in relation to the environmental attributes identified above.
Planning	*What needs to be done* Defining restoration goals. Setting restoration end points.	*Determines historically important biotic/ abiotic and cultural factors and interactions* Provides a model to help guide those involved in setting restoration goals. The historic ecosystem may be a source of goals. Provides measurable end points.	Identification of goals that could be significant to local people and associated end points.
Monitoring	*Is restoration working* Monitoring and evaluating success of restoration efforts relative to goals.	*Provides historic reference conditions for key system variables* A standard of comparison.	

Source: Aronson and Le Floch (1993a:10; 1995:2; 1997:330); Davis (1998:4); Ecological Society of America (1996:680); Fry and Main (1993:226); Hobbs and Norton 1996:96); Kershner (1997); Larsen (1996:130); and White and Walker (1997:338).

This chapter has outlined working definitions of restoration ecology and environmental history. It has demonstrated that historical information is an integral part of the restoration process, but its application may vary depending on the local context.

In determining the type of historical information required, it is important to note that restoration ecology is increasingly adopting a holistic approach to restoration by emphasising the restoration of the structural and functional attributes of the system. It is restoration of these attributes that provides the basis for a working and sustainable ecological system. However, more limited restoration goals also have their advantages, such as their relative simplicity and public appeal. An evaluation of usefulness of oral histories in a restoration ecology context can accommodate both the holistic and component-based approach, since they need not be mutually exclusive.

To perform the evaluation of the oral histories, two analytical tools have been developed: a classification of the uses of historical information in the restoration process and a set of ecosystem attributes relevant to river restoration.

2.2 Oral history: a review of its use and evaluation in an environmental context

This section covers a range of topics to help set the scene for future chapters. The concepts of oral history and the reliability and validity of recollections are followed by an examination of the value of environmental oral histories and a review of studies that have looked at issues of reliability and validity in environmental oral histories.

2.2.1 Defining oral history

"Oral history[11] refers to the study of the recent past by means of life histories or personal recollections, where informants speak about their own experiences" (Henige 1982:2). Oral histories are considered to be a primary source material (Starr 1984:4). As an organised activity, oral history is traced by its practitioners to 1948 when 'The Oral History Project' was launched at Columbia University, but according to Starr (1984:4), the essence of the idea "is as old as history itself", and Robertson (1996:2) describes oral history "as old as humanity". Henige (1982:3) also points out that today's oral historians[12] are "not the newest form of historian but the oldest"[13].

"Literacy and non-literacy, and therefore written and oral sources, have always co-existed to some degree", argues Henige (1982:7), at least in the Western tradition. Early Christians relied on word of mouth to receive Christian teachings because many were pre-literate (Henige 1982:8), and even today Christianity retains an oral tradition, evidenced by rituals, sermons and hymns. In non-literate cultures, oral sources remain eritical to understanding the present and reconstructing the past. Australian Aboriginal myths and rituals represent the activities of the Ancestral Beings, who created the known world and established the laws of human society. Dreamings are depicted in an oral tradition of songs and prose narratives, together with sculptures, paintings and dances. An inextrieable link exists between ownership

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[11] Oral histories are distinguished from oral traditions. Vansina (1965:20) argues oral tradition "exclusively consist of hearsay accounts", so that "eyewitness accounts, even when given orally, do not come within the sphere of tradition because they are not *reported* statements." Oral tradition is regarded as "those recollections of the past that are commonly or universally known in a given culture" and that have been handed down for at least a few generations (Henige 1982:2).

[12] According to Henige (1982:2), the term 'oral historian' "is used collectively to include anyone who seeks to learn about the past by word of mouth", i.e. through studying oral histories or oral tradition.

[13] Homer, who composed the *Iliad*, an historical epic, between 800 and 900 B.C., is nominated as perhaps "the first known oral historian" (Henige 1982:7). Other Greek historians, like Herodotus of the fifth century B.C., who "employed oral history in gathering information for his account of the Persian Wars" (Starr 1984:4), attest to the longevity of oral history.

of the myths and ownership the land to which they relate (Berndt and Berndt 1988:133-138; Sutton 1988:18). Knowledge of these myths is central to judicial and tribunal hearings of native title claims in Australian courts.

Until modern times, according to Henige (1982:7, 13), exploring the past using oral sources "was of central importance in much of the world", but their significance in Europe had declined dramatically by the seventeenth century. By this time, western historians rarely if ever consulted or collected oral data at all, priding themselves on their sole commitment to primary sources of written records and texts: "the principle that the work of writing history necessarily meant consulting these sources, and only them, can be dated from this time." (Henige 1982:13).

Hamilton (1994:12) discusses the emergence of a "battle line" between memory and history and argues for the two to again be seen as interdependent. She notes that one of the factors underpinning the tension between memory and history lies in the contest for the "dominant historical narrative", between "what is understood as collective or popular memory and the formal narrative of history that is written by professional or academic historians" (Hamilton 1994:12,13). Certainly, since the middle of the twentieth century, oral histories became the genre of "disadvantaged people who traditionally have been either ignored or misrepresented in conventional historical records", and this, according to Robertson (1996:3), is "one of the most important uses of oral histories". Thompson (1988), keen to illustrate the broader utility of oral history, describes the insights it provides across the spectrum of recent human activity - economic, political, scientific and cultural. Later I show that this list is expanding to include the use of oral historics to uncover human attitudes and behaviour towards the environment and as a source of ecological knowledge.

2.2.2 Reliability, validity and selectivity of recollections

A number of concepts are relevant to evaluating the factual accuracy of oral histories: reliability, validity and the selectivity of recollections. Discussion begins with an overview of the nature and frailties of memory.

While it is clear that "the most obvious message from the psychology of human memory is that forgetting will occur" (Baddeley 1979:25), there are numerous facets to the act of forgetting and remembering. It is claimed[14] that:

- Forgetting and memory-distortions increase over time (Baddeley 1979:25).
- Recent memories tend to be forgotten more readily than those of long ago (Gittins 1979:92).
- Forgetting is due not only to memory decay over time, but also to memory interference, such as through confusion caused by many similar incidents (Baddeley 1979:16-7).
- Memories about facts and events tend to be more reliable than memories about past beliefs and attitudes (Gittins 1979:92). A person's perspective tends to change over time, resulting in a reinterpretation of the past in terms of beliefs and attitudes held now.
- "What people remember is initially dependent on their perception and comprehension of an event or emotion", which can be affected by the person's degree of interest in what is happening (Gittins 1979:92). Or, as Baddeley (1979:25) puts it, previous assumptions and beliefs tend to influence what people remember.

[14] These commentators tend to draw on original studies, which are not reviewed in this study due to time constraints.

Hamilton (1994:14) comments:

> *In recent years, the frequently voiced concerns about 'inaccuracy' of memory have given way to a more sophisticated understanding that what gets remembered and how is of critical importance in the process of remembering ..*

Hoffman (1984:69) defines reliability as "the consistency with which an individual will tell the same story about the same events on a number of different occasions. Validity refers to the degree of conformity between the reports of the event and the event itself as recorded by other primary resource material such as documents, photographs, diaries, and letters." Where an informant is unreliable, the validity of the recollections "must be suspect" (Hoffman 1984:70). According to Hoffman (1984:71) one approach oral historians use to establish the reliability and validity of an interview is to give the interviewee the opportunity to resolve any inconsistencies between what they say and the printed record. This approach requires the interviewer to undertake a thorough analysis of the printed record before the interview.

Moss (1984) offers helpful insights into the evidentiary value of oral histories relative to other historical records. On a scale ranging from reality (i.e. what actually occurred) to abstraction, recollections are ranked after 'transactional records' and 'selective records' for the level of abstraction. With transactional records, such as laws, contracts, and wills, "there is no interpretive or selective process between the document and the reality it represents, beyond that inherent to the transaction itself". Selective records, while attempting to preserve and communicate events as they unfold, involve "a selective or interpretive process between the reality and the record" (Moss 1984:89-90). Selective records include minute taking, video recordings and photographic stills, which people often confuse with reality (Moss 1984:89). They differ from recollections because of their contemporary nature. Recollections are also selections, but doubly so because they are a selection of human memory, which is

itself selective. Moss (1984:90) argues that "the human observer records in his memory not exactly what is happening, but rather what his predisposition towards people and events make him capable of recording", and therefore, as with the inherent limitations of mechanical recording equipment, "there is not a truly one-to-one relationship between the reality and the record." Gittens (1979:92) acknowledges that memory is a "highly selective process", but argues "that the very process of selection in recollection provides *in itself* important historical data. In other words, *what* someone remembers can be a good indicator of what has been most important to that person over time."

In addition to the selectivity of memory, Moss (1984:91) notes that the interviewer's direct bearing on what is recalled further compounds the level of abstraction. As the level of abstraction from reality increases, the evidentiary value of the record decreases: because the evidence has been "refracted several times before he confronts it in an oral history recording", care must be taken in using recollections as evidence (Moss 1984:88). As with Hoffman, Moss (1984:98) argues that evaluating the content of oral histories includes determining if there are several sources of corroboration and, if there is variance with previous evidence, assessing why this is so.

Baddeley (1979:25) offers a psychologist's perspective, commenting that "memory is essentially a reconstructive process." This is why leading questions are considered highly problematic – they can influence the reconstruction (Baddeley 1979:25). However, there is a widely held view that all history is a reconstruction or reinterpretation of the past. In a defense of the value of oral history, Gittens (1979:93) points out "that *all* historical research is essentially a process of reconstruction, greatly influenced by present day researchers' theoretical frameworks and

preconceptions." Marwick (1981:21) also acknowledges the reconstructive nature of historical research, and Henige (1982:5) captures the essence of the argument with the observation that oral materials and written sources share "the quality of being prisms on the past rather than windows." Smith (1991:391) states that "to a large extent, oral history is not simply the reconstruction of the past but is a new construction of reality." However, he argues this is not a ground for dismissing oral histories because all historic documents are "constructions of reality", and as "scholars know ... other documents are routinely doctored, altered, falsified, or destroyed" (Smith 1991:391).

The direct communication between two people inherent in the oral history approach is claimed to achieve "a vividness which comes from being less rehearsed, less reflective and more responsive to the situation" (Roberts and Sainty 1996:ix). Thompson (1988:149) argues that oral history provides significant and sometimes unique information from the past, and because its sources are alive, offers the ability to engage in a two-way process. The study by Burbidge et al (1988) of Aboriginal knowledge of the mammals of central Australia exemplifies the advantages of the two-way process of oral history. Researchers talked to groups of old people, showing them the museum skins of mammals, asking questions and recording the information received. The data provided "... a basis for understanding the distribution, abundance and habitat of a range of mammal species in the central deserts and adjacent regions ... over the past 50-60 years" (Burbidge et al 1988:33). In short, the oral history approach has advantages that help offset the limitations of memory.

2.2.3 Oral environmental history as a guide to the cultural context of environmental change

In recent years, the publication of popular oral *environmental* histories has begun in Australia. Generally, their purpose is to tell the story of the natural environment and

anthropogenic change through the observations and experiences of local people, or to simply record human interaction with a particular place. The people themselves are an integral part of the story. These are not analytical works and they rarely set out to corroborate the information provided by interviewees. On the contrary, the intent of these collections is to honour and preserve the local perspective. This aim is evident in *Long Pools of Silence* (Rowett and Pontin 1998), described in its frontispiece as a "portrait of the lands and people of the Kalgan catchment" near Albany:

> *Interviews for Long Pools of Silence were often conducted over a cup of tea in a kitchen, sometimes with one subject, sometimes two or three when the discussion would be alive with interjections, cross-talk and mutual jogging of memories. Imagine all the interviewees brought together in a cosy farm kitchen with a hot cuppa or a cold beer to talk about their river, their land and their lives.* (Rowett and Pontin 1998:3).

Likewise, *Listening to the Lachlan* is a "book of memories" that:

> *"uncover a river as people used to know it and show experiences which are now lost. The memories come from people who lived, worked and grew up beside the river. The river was part of their lives . . .* (Roberts and Sainty 1996:ix).

Borschmann (1999:viii) describes *The People's Forest* as a collection of life stories from "people who had the good fortune to come to know the uniqueness of the Australian bush in some intimate or passionate way. I had one overriding criterion for interviewing someone: did they know the bush?"

Lane (1997) argues oral histories are inherently subjective because:

> *The features we distinguish in the landscape, the kinds of changes we observe taking place, and our attribution of causes of change, all relate somehow to who we are and what our life experiences in that place have been* (Lane 1997:203).

According to Lane (1997:204), this subjectivity, "which often makes oral history unreliable for factual accounts, makes it extremely valuable for comprehending the human impact of environmental changes, the role that local people have played in these changes and reasons for their attitudes and behaviour". She argues the coupling of local knowledge with scientific knowledge can help reveal the human context in

which environmental changes take place (Lane 1997:204). Others who have collected oral environmental histories are less ready to dismiss oral histories as sources of factual information, as shown below.

2.2.4 Oral environmental histories as sources of ecological information

A precedent for the acceptance of oral environmental histories in science is the use of indigenous knowledge based on an oral tradition. The Burbidge et al (1988) mammal study noted earlier, is one example of the recognition being given to indigenous ecological knowledge. Traditional fishers' knowledge is acclaimed in Johannes's (1981) study of the knowledge possessed by indigenous fishers of the Palau Islands. Johannes (1981:vii,148) argues that "traditional native fisherman are especially rich sources of unrecorded knowledge" and that such knowledge "can be invaluable to Western scientists as an aid in conserving natural resources." Two observations of Johannes are particularly noteworthy. First, he argues that marine science gained more new knowledge during his 16 months of fieldwork and interviews with local fishers than he had achieved using more conventional scientific techniques over a 15 year period. This was achieved through "access to a store of unrecorded knowledge gathered by highly motivated observers over a period of centuries", thus he argues indigenous fishers' knowledge "offers a short-cut to some of the basic natural history data we need in order to understand these vast and valuable resources" (Johannes 1981:x). Secondly, he points out that western science places tremendous value on data collected by members of the scientific community, "but when specialized knowledge won from the sea over centuries by formally unschooled but uniquely qualified observers – fishermen – is allowed to disappear as the westernization of their cultures proceeds, hardly anyone seems to care" (Johannes 1981:ix).

As well as demonstrating the acceptance of traditional indigenous knowledge by some scientists, these examples invite comment about the value of ecological knowledge gained over a relatively short period of time by non-indigenous people, such as farmers, having a close association with a particular place. Clearly, traditional Aboriginal Australians or the fishers of the Palau Islands have a far greater claim to a detailed ecological knowledge maintained through an oral tradition. In most cases, oral histories of farmers in south western Australia, for example, will be limited to their own experiences and observations, though they might also recall what was told to them by their parent's and grandparent's generation. Nevertheless, a number of oral history researchers claim to have recorded valuable ecological information from local, non-indigenous people who have witnessed environmental change during their lifetime. The timespan of non-indigenous people's observations is far shorter than that of traditional peoples, but it is still longer than most scientific studies:

> *Oral history provides insights into ecological change where rigorous scientific information is lacking. Its power lies in the long period for which information may be collected, more than most ecological studies can cover."* (Roberts 1999:233).

In *Listening to the Lachlan* memories are not only accepted as important accounts of people's interaction with their local environment, but as sources of ecological knowledge. Roberts and Sainty (1996:ix) argue "From these memories, we have woven an ecological history of the Lachlan River which is not readily available otherwise." They claim that:

> *Memories are not often used in ecological research. We have learnt to appreciate the collective knowledge and experience of indigenous people but have been slow to appreciate more recent memories as sources of information* (Roberts and Sainty 1996:ix).

Later, after analysing these Lachlan River oral histories, Roberts and Sainty (1997:32) argue "Using oral history, it is possible to construct, quasi-objectively, an ecological history of the Lachlan River from 1920 onwards."

Kennealy (1994:38) believes oral histories by pioneering community members from the Wanneroo wetlands near Perth are "invaluable" because they "are the only records we have of what the lakes used to be like" and they give an insight into the changes that have taken place (see also Drake and Kennealy 1995). Similarly, Sanders (1991:26) found that oral histories drawn from the life experiences and observations of farmers and other community members were a valuable source of previously unpublished information about the inland wetlands in south western Australia and the changes that have taken place since European colonisation (see Chapter 1).

The preceding discussion has shown that oral environmental histories help to explain the cultural context in which anthropogenic change occurs in the environment. Moreover, a number of scientists place value on recent memories of local people as a source of ecological information, just as other scientists like Burbidge et al (1988) and Johannes (1981) have demonstrated the value of indigenous knowledge with a long oral tradition.

In the following section I review studies where the reliability and validity of oral histories is examined. I also review the type of environmental information collected from oral sources to determine if amendments to the classification of the uses of historical data for restoration ecology are warranted (see Table 2.2).

2.2.5 Critiquing oral histories for factual accuracy and application to restoration ecology

The following review of environmental oral histories and related studies focuses on the broad interview methodology used, how the reliability and validity of the

interview material were treated, and what conclusions were drawn. Commentary about the potential usefulness of the information in a restoration ecology or environmental management context is also noted.

Numerous studies have evaluated the reliability and validity of oral sources of environmental information, including Starr (1989), Finlayson and Brizga (1995), Ebner and Roberts (1996), Ferguson and Messier (1997), Lane (1997), and Roberts and Sainty (1997). A number of these studies have also discussed the contribution that oral histories can make to environmental knowledge. The findings of Sanders (1991) and Roberts and Sainty (1997) are especially relevant in this respect.

Historical evidence, according to Starr (1989:26), is one means of broadening the database to overcome problems with the limited temporal scale of current data about gully erosion and sediment movement. The primary purpose of his study was to assess the "value of anecdotal material as a source of information on landscape changes" (Starr 1989:27). Set in Michelago Creek catchment area in NSW, interviewees were descendants of original or early European settlers in the area and almost all were lifetime residents of the area. A "casual" interview approach was adopted after earlier attempts at "direct interrogation" were abandoned "because immediate recall of landscape change proved to be too difficult" (Starr 1989:27). During conversations spaced over nine months, interruptions were avoided and questions were limited to eliciting confirmation and dating events so as to maintain the interviewee's "thought flow". Association of occurrences (e.g. erosion events) with personal events was used to establish time frames. Only information that could be validated was accepted to reconstruct a historic picture of gully erosion and sediment movement. Validation was achieved using three criteria: (1) corroboration, involving two or more people independently giving similar information; (2) physical

evidence, consisting of relics of past events (e.g. old bridge posts) which "provided both a base for recollection and substantive evidence for recalled details; and (3) reaffirmation, consisting of "repetition of details under different circumstances at later dates" (Starr 1989:27). The study concluded that anecdotal and relic information were "of value in indicating the condition of a catchment at certain times during European settlement" (Starr 1989:31).

A more recent study by Finlayson and Brizga (1995:181) compared "oral tradition" based on "popular views" "with the history of change as reconstructed from field evidence and documentary records" in relation to two river systems. They concluded that major discrepancies existed (Finlayson and Brizga 1995:181). However, their paper suffers from a profusion of terms: "oral tradition", "local folklore", "popular views", historical folklore" and "oral history", but no information is provided about the method used to acquire this information by the authors, and there is nothing to suggest that it could be called either 'oral tradition' or 'oral history' in the sense discussed in section 4.2.1.

The first case study in their analysis concerns the existence of the supposed 'Lake Salvator' in Central Queensland. They trace the origin of the 'lake' to the 1848 mapping and writings of NSW Surveyor General, Sir Thomas Mitchell, at least 12 years before settlers moved in to the area. Thirty four years later an occupation licence for an area including the 'lake' was issued. In 1889 the run boundaries were surveyed and the "the surveyor chose to reproduce the outline of the 'lake' from Mitchell's map and to name it" (Finlayson and Brizga 1995:184). However, from the surveyor's field notebook of the traverse across the 'lake', Finlayson and Brizga (1995:184) argue that it was clear that no such 'lake' existed. In studying the Queensland Lands Department file for the run, the authors claim that the file reveals

that the Department "accepted that Mitchell had stretched the facts more than a little" and that the area in question is never referred to as a lake. However, the file also contains a 1931 report from a noxious plants inspector stating the lake had been drained, and another from a government official dated 1937 that siltation had caused the lake to disappear. The authors then note:

> *It is the tenor of these later reports, which has passed down into the local folklore, and it is now widely accepted by local landholders, scientists (including government geologists) and government officials that there was a lake during Mitchell's exploration, but that it subsequently disappeared.* (Finlayson and Brizga 1995:184).

Finlayson and Brizga (1995:185) cite, as a management implication of the "false perceptions generated by Mitchell's map", the Queensland Parliament's enactment of legislation declaring the area Mitchell named Lake Salvator and an adjacent strip of land as a Watercourse Reserve. By this time a single channel had been constructed through the 'lake', draining what is actually a "swampy floodplain". The legislation stemmed from the fears of the Lands Department that "a new lessee who held only Cungelella [the run containing the 'lake'] could re-create the 'lake' and deprive the downstream leases of water, thus lowering their rental values" (Finlayson and Brizga 1995:185). This concern was evidently voiced in the reports of "some land agents" resulting in legislation to ensure it could not happen.

As the preceding summary indicates, there is no mention by Finlayson and Brizga of instances of the role played by "local folklore". Rather the impression is very much that it is official sources that have created and perpetuated the existence of the mythical 'lake', yet the authors conclude:

> *The local folklore has, in this case, been sufficiently persuasive to produce legislation, despite historical and geomorphological evidence to the contrary* (Finlayson and Brizga 1995:186).

The only insight the reader is given concerning the nature of "local folklore" is the authors' general reference to "oral tradition which includes local knowledge of specific examples of environmental change" (Finlayson and Brizga 1995:180). To present a cogent argument, these authors needed to substantiate the alleged role of "local folklore" in the 'Lake Salvator' case. As it stands, 'local folklore' is blamed for an error which based on the author's own material, resides in the very historical sources that are used to attack the oral tradition.

Similarly, in their examination of erosion along the Avon River in Victoria's Gippsland, Finlayson and Brizga (1995:186) acknowledge that "river managers as well as local lay people" shared the belief that last century the river channel changed from sinuous and narrow to seriously eroded, and yet they single out 'local folklore' as the basis for misconceptions about changes with significant management implications. For example, in referring to calculations by officers of the State Rivers and Water Supply Commission (SRWSC) as to the amount of farming land lost to bank erosion since 1890s, Finlayson and Brizga (1995:189) make an extraordinary leap of faith:

> *"However, these values were calculated on the basis of the erroneous assumption, most probably driven by popular views about channel change and widening that the Avon River ... was much narrower in 1870 than in 1936.*

This accusation regarding "popular views" is not supported elsewhere in their argument. While the authors argue that the perception of historical river erosion is due to "local folklore . . . repeated in official documents and publications", the most frequently referenced sources are government sources. Specific references to local sources consist of one farmer's 1985 seminar paper. This is compared with numerous much earlier papers and reports by an SRWSC officer which make similar and more claims, and a 1916 Parliamentary speech in which an anecdote from "a leading

auctioneer" about the river's width is recounted, followed by the statement that "similar stories have been repeated on many occasions as evidence for change" (Finlayson and Brizga (1995:187). Yet no details of these 'similar stories' are provided – who, when, where. They do not substantiate their claim that "The oral history . . . is probably so widely and uncritically accepted because it lends support to the arguments put forward by land holders who want public money spent on bank erosion affecting their land." (Finlayson and Brizga 1995:189).

Finlayson and Brizga (1995:189) have not shown that oral tradition has had a "considerable impact on both the rhetoric and practice of river management". Moreover, their claim that popular history has been more accessible and consequently more influential in river management decisions than "the less accessible history contained in documentary records and physical field evidence" is contradictory to the material they present. The sources of this popular history are rarely cited in their study, whereas the files held by the various government agencies contained erroneous reports prepared by their own officers.

In conclusion, nothing in the Finlayson and Brizga (1995) paper substantiates their claim that oral tradition is less credible than other historical sources, nor that managers have been influenced largely by "popular history of environmental change [that] contained serious inaccuracies". Even so, Lane (1997:195) comments that "their study provides a valuable cautionary tale", although she then argues that it "should not divert attention from the potential of local knowledge, used appropriately, to provide valuable information that can inform and extend professional knowledge bases in ways that other sources cannot."

In Lane's study, set in the Tumut region in NSW, local recollections were recorded about the "watercourses, weeds and climate at earlier times which were compared

with the present day environment" (Lane 1997:196). Five people who lived on properties in the region were interviewed and accompanied on site visits. Their recollections were checked against other information sources. Lane (1997:203) found that recollections of changes to watercourses "shows a reasonable degree of compliance between what science predicts and what local people have observed." Additionally, potential directions for future scientific research could be construed from the recollections in the absence of other information about particular environmental impacts (Lane 1997:203). Recollections about weeds were considered difficult to evaluate because they were suffused with antagonism towards a particular land management agency considered responsible for the spread of weeds. However, Lane (1997:203) found that in the absence of other information sources, the recollections were useful indicators of the periods of introduction and spread of weeds in the area. Recollections about climate "did not provide information that could enhance existing climate records", observes Lane (1997:203). However, her account of people's memories of climate illustrates (1) the shortcomings of the temporal scale of oral histories (e.g. an aberration such as a period of unusually heavy snow falls might become a benchmark for comparison), (2) the potential for recollections to reflect life changes rather than actual circumstances (e.g. interviewees might spend less time outside in their later years, resulting in a bias in their recollections of climatic change), and (3) informant's comments about the local situation might be influenced by external information sources (e.g. publicity about global climate change). Other issues concerning the credibility of the recollections were noted by Lane (1997:203, 199), including evidence of inconsistency within an interview, and the lack of accuracy in recalling dates "unless they relate to specific episodes in which local people were personally involved". Nevertheless, she found that the study

"indicates the potential for local knowledge to provide a greater level of detail as well as historical perspectives about how specific places have changed over time" (Lane 1997:203).

The idea of using oral evidence in historical environmental impact assessments is the focus of a paper by Showers and Malahleha (1992), and it offers another interesting perspective on the validity of local observations. Their pilot study was designed to test whether oral histories and oral evidence could be used to assess the historical environmental impact of soil conservation projects in Lesotho in southern Africa in the 1930s and 1940s. The rationale for studying historical environmental impact assessment included "the concern that most scientists and technicians operate in an ahistorical and non-social context", and the belief that:

> *people who depend on and use a landscape are intensely aware of it and make continuous and detailed observations. These observations provide a rich data base for assessing environmental conditions and changes"* (Showers and Malahleha 1992:277).

Moreover, these insights are directly relevant to ecological restoration. As discussed in section 2.1, identification of degrading processes in order to stop or ameliorate the problem, is an important part of the restoration process. This type of analysis essentially involves an 'historical environmental impact assessment'. The value attributed to local knowledge of the farmers in the Lesotho study could also have parallels with the knowledge gained by farmers in the Tone River study, since both observed the effects of a change in land use over a period of decades. Showers and Malahleha (1992:279) argue that a diverse body of international work focused on local environmental knowledge and indigenous technologies over the last 15 years has established that these knowledge systems are:

> *based on careful observation and represent a coherent paradigm of natural science information. There should, therefore, be confidence in using oral environmental data, even in the absence of confirming written documentation.*

One example of recent international work is Ferguson and Messier (1997), who focus on Inuit traditional ecological knowledge of the Arctic tundra caribou. They state "Inuit do not need written evidence to confirm the veracity of their oral knowledge and traditions, and we do not question this inherent veracity" (Ferguson and Messier 1997:22).

The study by Ebner and Roberts (1996) ranked the usefulness of four types of historical information on carp (*Cyprinus carpio* L.), including oral or aural information (e.g. anecdotal), visual (e.g. photographs), written (e.g. commercial catch records) and biological material (e.g. Museum collections). Seven criteria were used – four to elucidate the capacity of the information to provide relevant ecological information, and three to address reliability, accessibility and the effort involved in obtaining the information. Scores ranged from 0 to 5, with 5 being most productive or highest return. For three of the biological criteria and for effort, oral (anecdotal) information was ranked 3, while relatively low scores of 1 were given for reliability and one biological criterion. The reliability measure was defined "as a measure of confidence that *Cyprinus carpio* has been accurately identified" and the authors argued "the taxonomic reliability of oral information is questionable because the inteviewee may have limited taxonomic expertise", although they noted that this could easily be checked (Ebner and Roberts 1996:9, 20). "Problems associated with human error and memory" were also noted. They found that "interviews and anecdotal information have contributed to important work in Australian fish ecology and biology", but listed several points detracting from its use: "potential may not be realised; resistance and prejudice from scientists; ... no protocols exist" (Ebner and Roberts 1996:20).

The authors present two conclusions, preceded by useful discussion of a limitation with historical information such as anecdotal material:

> *In research, the difficulty in satisfactorily incorporating the old with the new is that the purpose for which the data were originally collected may not apply, creating a mis-match* (Ebner and Roberts 1996:26).

Scientific research, or research for a particular scientific project, may never have been the intent of recording the historical data. A lack of depth in informal, historical data, due for example, to collections occurring in isolation and "with an *ad hoc* timeframe" can also be problematic. Additionally, the qualitative content of oral histories presents difficulties for quantitative scientific research that relies on data suited to statistical analysis. Noting these limitations, the authors found that in the examples of historical data examined "the hardline assessment would have to be their potential usefulness is low to zero", with the exception of the commercial catch data (Ebner and Roberts 1996:26). However, they also reached another conclusion: that informal knowledge can be a useful tool in acquiring understanding and knowledge (if not exactly data) because "unstructured and temporally chaotic bits of information ... can offer firm points of knowledge in time, and are useful in refining hypotheses" (Ebner and Roberts 1996:26). Another response to the perceived limitation of oral information because of its lack of quantitative data, might be the argument put by Showers and Malahleha (1992:278) that in assessing historical environmental impacts, the need is for "detailed information about what actually occurred" and descriptive qualitative data have the potential to provide this by "[establishing] events, sequences of events and ways in which many factors interacted".

Sanders (1991) demonstrates the rich detail that can be forthcoming in oral histories[15], and the potential for drawing valuable conclusions. Sanders collected recollections,

[15] Full transcripts of the interviews are available in Battye Library, Alexander Library Building, Perth, 6000.

principally in the form of oral histories, from 17 people with memories of environmental changes in WA's wheatbelt wetlands. From the recollections she was able to reconstruct the wetland condition over a large area during the earlier part of this century, document the type and sequence of biological changes that have occurred since clearing, and identify indicator species and trends in environmental changes. Assisting managers and planners to predict the impact on wetlands of changes in land management practices was seen as one benefit of the study (Sanders 1991:26).

Her methodology included selecting informants aged over 40 years having personal recollections of the wetlands, preparing an outline for each interview, including a checklist of topics, and using reference books and map material to enable confirmation of species names and location and names of wetlands. Other information sources were used to corroborate the recollections (A. Sanders, pers. comm. 12/11/98), and it was found that certain types of information (e.g. dates and measurements) were generally not recalled accurately.

The use of corroborative material to assess the accuracy of recollections is a recurring theme in many of the examples noted in the preceding discussion. This approach is encompassed in 'triangulation theory', the topic of the next section.

2.3 Triangulation theory and its application to oral history

The principle of triangulation is drawn from navigation practice where multiple reference points enable location of an exact position (Smith 1991:485). As it has been neatly summarised by Jick (1979:602): "given the basic principles of geometry, multiple viewpoints allow for greater accuracy." Denzin's (1978:295) conception of triangulation is widely regarded as the definitive form, though earlier social scientists also advocated the use of multiple methods to enhance the validity of their work. For

example, Webb et al (1966:1) were critical of reliance on one method because "no research method is without bias" and any method such as interviews and questionnaires, "must be supplemented by methods testing the same social science variables but having *different* methodological weaknesses." Denzin (1978:295) broadened this argument to include the need for "varieties of data, investigators, and theories, as well as methodologies." Theory triangulation means "approaching data with multiple perspectives and hypotheses in mind .... pitting alternative theories against the same body of data" (Denzin 1978:297). A number of sub-types exist within the other forms of triangulation.

Miles and Huberman (1994:267) distinguish two sorts of data triangulation: data source (e.g. persons, times, places), and data type (e.g. qualitative text, recordings, quantitative). Denzin identifies two forms of methodological triangulation: "within-method" and "across-method". The former typically involves the researcher taking one method (e.g. the interview) and employing "multiple strategies within that method to examine the data" (Denzin 1978:302). However, since this approach retains the flaws that arise from using one method, Denzin (1978:302) advocates the "between-method" triangulation in which a "combination of two or more different research strategies [are used] in the study of the same empirical units" (e.g. survey interviewing, field experiments, unobtrusive methods and life histories). Jick (1979:603) draws a useful distinction between the two:

> *'Within-method' triangulation essentially involves cross-checking for internal consistency or reliability while 'between-method' triangulation tests the degree of external validity.*

Miles and Huberman (1994:279) use external validity to mean whether the conclusions of a study are "transferable to other contexts", as opposed to internal validity, which "refers to the extent to which scientific observations and

> *'Within-method' triangulation essentially involves cross-checking for internal consistency or reliability while 'between-method' triangulation tests the degree of external validity.*

Miles and Huberman (1994:279) use external validity to mean whether the conclusions of a study are "transferable to other contexts", as opposed to internal validity, which "refers to the extent to which scientific observations and measurements are authentic representations of some reality" (LeCompte and Goetz 1982:32).

In this study, triangulation has relevance at two levels. First, in terms of achieving reliability and validity in the study's results, and secondly, in addressing the study question on the reliability and validity of local recollections. In relation to the study question, reliability and validity were defined earlier in the context of evaluating recollections (section 4.2.2). In Chapter 3, I discuss how the concept of triangulation was applied to the recollections. In short, other information sources were used to corroborate the interviewee's memories of the Tone River, and interviews were examined for both internal consistency and cross-interview consistency and corroboration. This represents triangulation using both data type and data source and gives an indication of both reliability (consistency within and across interviews) and validity (two or more interviewees recalling the same thing).

Although I have defined the concepts of reliability and validity as applied by oral historians in assessing recollections (section 4.2.2), it is worthwhile briefly examining their use in evaluating the credibility of qualitative research results. The conclusion is that the use of these terms is consistent in both contexts. In the qualitative research literature, validity and reliability are distinguished on the basis that "reliability is concerned with the replicability of scientific findings, [whereas] validity is concerned with the accuracy of scientific findings" (LeCompte and Goetz 1982:32). According

to Denzin (1978:105), reliability is concerned with whether bias is present due to "idiosyncracies of the observer, a research instrument, or a subject, or by constraints of time and place." If the same result can be achieved by another researcher using the same method, then the observation is considered reliable (Denzin 1978:105; LeCompte and Goetz 1982:35). When examining the validity of findings, the issue is whether empirical reality is being accurately represented. The difficulty noted by Denzin (1978:28) is that "because each method reveals different aspects of empirical reality, multiple methods of observation must be employed" (i.e. method triangulation).

To close this section on triangulation theory, the discussion needs to return to oral histories and evaluating recollections. Miles and Huberman (1994:266) note that at its most basic "triangulation is supposed to support a finding by showing that independent measures of it agree with it, or at least, do not contradict it." They note that triangulation has "links to the *modus operandi* approach used by detectives, mechanics and general practitioners. When the detective amasses fingerprints, hair samples, alibis, and eyewitness accounts, a case is being made that presumably fits one suspect far better than others; the strategy is pattern matching, using several data sources" (Miles and Huberman 1994:267). Diagnosis of engine failure or an illness follows a similar approach, in which "the signs presumably point to the same conclusion and/or rule out other conclusions" (Miles and Huberman 1994:267).

This concept of seeking to corroborate data is not a new approach in the field of history, and more particularly, oral history, as I showed in section 2.2.5. In relation to the former, Tuchman (1981:19) writes:

> *"Bias in a primary source is to be expected. One allows for it and corrects it by reading another version. I try always to read two or more for every episode.*

Even if an event is not controversial, it will have been seen and remembered from different angles of view by different observers."

Specifically in relation to oral histories, Smith (1991:392) argues that "oral collection methods are like other methods, in their need for tests of internal consistency and external corroboration." Thompson (1988) describes a number of steps which must be taken in evaluating oral source material. The first is to assess each interview for internal consistency. The second is to cross-check oral history material with other data sources", and the final basic step is to place the interview in a wider context - a sound knowledge of the context of the interview material should enable a judgement about its authenticity to be made, "even if a specific detail is unconfirmable" Thompson (1988:240). In relation to the present study, the context would include the biogeography of the Tone River area and its land use history.

CHAPTER THREE

3. METHODOLOGY

This chapter consists of two sections relating to data collection and analysis methods. The first section covers design of and preparation for the case study, including the background on the case study area, pilot interviews, sampling strategy, and interview method and procedure, followed by discussion of the data collection process. The section on data analysis explains the approach taken to examine the usefulness of the oral histories to ecological restoration and evaluate the reliability and validity of the recollections.

3.1 Design and data collection

This is largely a qualitative study that employs a case study approach. This approach has been chosen because of its unique strength in dealing with a wide variety of evidence (Patton 1987:8). Oral histories collected from seven participants and a variety of other sources of historical evidence are used in this study.

3.1.1 Case study background

The case study is focused on the most inland and degraded parts of the Warren River catchment, represented by a 60 km length of the upper Tone River, from its headwaters in Murrin Brook, near the Jingalup townsite, extending downstream to Nymiup Pool on the Tone River proper. Interviewee's also refer to other tributaries, principally Cockatoo Creek, in the Tone's headwaters. Natural features and farm residences of the interviewee's are located on the accompanying map (Figure 3.1).

ORAL HISTORIES STUDY AREA: UPPER TONE RIVER CATCHMENT

Figure 3.1

Location of interviewee's home* and other sites referred to:

1. Fryer-Smith, M. (Keston Vale homestead)
2. Harvey, W. (Glentone homestead)
3. Jingalup School and Reserve, including golf course
4. Lee, L.P. (Mylerup Farm)
5. Lee, L.P. (Western Hills homestead - brother's house)
6. McQuire, G. (Palmyre homestead)
7. Mininiup Pool
8. Nymiup Pool
9. Owen, C. (Mininiup homestead)
10. Palligup Pool
11. Quailleup homestead
12. Robertson, G.H. (Yarrak homestead)
13. Ryall, D. (Kelvin homestead)
14. Wackelingup Pool
15. Woodenup Pool
16. Woodville homestead
17. Yandella homestead
18. Young, H. & Mathew, D. (Woodenup homestead - aunt's house)
19. Young, H. & Mathew, D. (Woodenup homestead - Hubbe house)

*some interviewee's have since moved.

Produced with the assistance of the WA Water & Rivers Commission and The Grove Secretarial Service.

While much of the Warren River and its tributaries are within the forested areas of south-western Australia, a long section of its main tributary, the Tone River, reaches into the dryer inland areas. It starts as a series of small waterways about 12 km south-west of Kojonup where the annual average rainfall is about 550 mm. Unlike the rivers on either side (the Blackwood and the Frankland) the Warren-Tone system does not tap inland salt-lake systems. However, according to Bettenay and Mulcahy (1972:362), the groundwaters present in the weathered zone of the Tone River system are "frequently saline".

For the following brief history of the study area up to the period of the earliest recollections in the oral histories (i.e. the 1920s), I have drawn on two secondary sources that describe the history of the Jingalup and Kojonup areas, Barker (c.1959) and Bignell (1971), respectively.

Expansion of the pastoral industry in the area was severely limited during the nineteenth century by the presence of 'poison' plants. The first significant settlement of the study area commenced from 1886, when a number of leases covering parts of the area were taken up. From 1886 to around 1900 considerable areas of poison 'infestation' were cleared by hand to enable bush-grazing, and smaller areas were ringbarked and cleared by work teams. Some soaks and dams were constructed, as part of the establishment of sheep grazing as the primary enterprise in the area. From around 1900 to the early 1930s there was an increase in broad-scale clearing and the use of phosphatic fertilisers, the establishment of cropping, and an increase in the resident population. Much of the Murrin Brook was settled and at least partially cleared during this period, and the small town of Jingalup was established during the 1920s. Settlement further down the study area, in the Tone River area, was generally

slower, but the first small blocks at Mobrup, about 40km south-west of Jingalup, had been taken up by 1907 (Bignell 1971:185).

Three factors determined the selection of this study area. First, major biophysical changes, largely associated with extensive clearing in the post World War II period, are within the living memory of long-term local residents. Secondly, the declaration of this area as part of a Recovery Catchment under the State Salinity Action Plan (SSC 1998:22) provides a practical backdrop for examining the extent to which local oral histories can inform the restoration process. Thirdly, as I grew up on a farm within the study area, I have a personal interest in that landscape. LeCompte and Goetz (1982:331) note that because the reliability of qualitative data depends on recognising and handling the social relationship of researcher with subjects, research reports must clearly identify the researcher's role and status within the group investigated. To enhance the reliability of this research project, I acknowledge that the interviewees are all well known to my parents, and two are reasonably familiar to me through infrequent social contact over the years. The remaining five interviewees are known to me by name only, although some may have remembered me from social occasions when I was a child in the company of my parents.

Given the study's time constraints, its biophysical focus is the stream channel and riparian zone of the upper Tone River and its tributaries. This is also a logical choice, as these waterways are a major focus of the Recovery Catchment initiative.

3.1.2 Preparation, theory and practice

All aspects of preparing for the interviews are outlined below.

Background and training

Oral history texts were consulted for interview technique (Thompson 1988; Jamieson 1992; Robertson 1996). Two workshops were also attended. The Battye Library Oral History Unit held a one day workshop to teach the basics of the oral history technique, and a river restoration workshop run by the Water and River Commission was attended for several days to gather information about the theory and practice of river restoration, as background for framing the interview questions.

Pilot interviews

Pilot interviews were an essential component of the preparation with the aim being to:

- Test the introductory letter and Statement of Disclosure and Consent Form prepared in accordance with the University's ethical requirements (see below).
- Practice explaining the project to participants, aimed at putting them at ease about the interview process and ensuring the purpose and focus of the interview was understood.
- Develop skills in oral history interviewing, including competence managing the recording equipment, note-taking and the physical arrangement of the interview.
- Test the study's interview method, principally the type, phraseology and sequence of questions.

To maximise the value of the pilot interviews it was necessary to test as far as possible the sampling strategy intended for the case study (i.e. purposeful sampling, see below). As I expected to be interviewing members of the same family, and females and males

in the case study, this was reflected in the selection of pilot interviewees. I set the minimum age at 40 years in order to capture information about the delayed effects of wide-spread clearing and increased agricultural inputs (e.g. superphosphate) in this region in the 1950s-60s.

Acting on the advice of landcare workers and river restorationists, four farmers from a similar biogeographical region to the Tone River, ranging in age from 43 to 94 yrs, were contacted and agreed to participate. The farmers, a husband and wife, and father and son, were located in the Blackwood River catchment, east of Boyup Brook and west of Duranillin. The couple lived on the Blackwood River floodplain and the father and son farmed along a minor tributary. The interviews took place over two days.

Numerous valuable lessons described in the literature were experienced first-hand. These included the negative impact of a microphone on the interviewee's confidence to speak uninhibited; the challenge of managing the physical arrangement of an interview in a house with more than one occupant and various noisy appliances; and the difficulty of juggling note-taking, maintaining eye-contact, listening, questioning, and operating the recording equipment. On the other hand, people's generous hospitality (scones and cream!) and willingness to participate were memorable.

One issue that I examined from a sampling strategy perspective was the significance of the type of interaction interviewees had with the river/stream, and the level of information they could impart. For example, whether they had played there as children, or moved to the farm as a young adult, with the priority of establishing the farm and a family. In a comparison of the interviews of the farmer who had lived adjacent to the river all his life and the farmer who moved to a farm on the tributary in his mid-twenties, the former seemed to produce richer memories. This may have also

been due to the river being a greater recreational draw-card than the tributary. Conversely, another comparison involving the married couple indicated that the later arrival of one of the interviewees to the farm did not seem to be a factor. The female interviewee had moved to the farm after marriage, but the proximity of the house to the river (approx. 150m) and the frequency of river visits for a variety of recreational activities, meant that although her memories covered a shorter period of time than her husband, who grew up there, she was able to give as detailed description of many aspects of the river and its history. Also, as both interviewees were aged over 80 yrs, their recollections included the period of major visible decline in the river system. These two interviews did highlight the difference between the naturally talkative and the more reticent interviewee. In short, no ready formula existed to apply to the selection of people to achieve the requisite level of detail. This confirmed the importance of conducting pre-interview discussions with potential interviewees for the case study.

The interview method was reviewed after the first day of pilot interviews. The use of fairly specific questions about the biophysical environment of the river/stream on their property, and reference materials (e.g. an A3 sheet of aquatic macro-invertebrate illustrations) to act as prompts and assist with species identification, was found to be problematic. The use of reference materials and specific questions, as well as follow-up questions, seemingly inhibited people's willingness to relax and recall. Moreover, interviewees appeared to feel the pressure to identify an animal from the species materials even when they were expressing uncertainty. Sanders (1991) appeared to use this approach successfully, but this may have reflected her greater zoological experience and the fact that a number of her interviewees were keen naturalists.

Two related factors contributed to a decision to change the structure of the interview: my relative inexperience as an oral historian and my relative lack of expertise in riverine ecology. The emphasis in the roles needed to change from me as 'examiner' to the interviewee as 'story-teller'. With two of the interviewees in particular, the rationale for this change in approach was clear. As farmers they had experienced and interacted with the river not as river restorationists or scientific experts, but through child's play, as well as activities such as fishing, boating, marroning parties and watering stock, and as flood escapees and keen observers. By allowing them to remember the river in their own words I was able to then examine their story for what restoration ecology might find useful. According to Patton (1990:24) open-ended questions lend themselves to this approach because the responses "permit one to understand the world as seen by the respondents . . . . without predetermining those points of view through prior selection of questionnaire categories." In light of these arguments, the interview questions were pared and worded to encourage participants to relate their observations and experience of the river.

The introductory letter and Disclosure and Consent Form were found to be satisfactory. Each interviewee was asked at the end of the interview whether they had any comments on the conduct of the interview itself, but people mostly expressed a nervous apology about their own performance rather than evaluate mine. In all, the pilot interviews were an invaluable learning experience. Thank you letters were sent to each participant.

3.1.3 Sampling strategy

Sample size and selection criteria

Due to the time constraints of the project, the number of case study interviews was initially set at four to six. The main limiting factor was the time required transcribing,

coding and analysing the interviews. The technique of purposeful sampling was used to select the interviewees. The selection was achieved using a criterion-sampling strategy to identify participants meeting pre-determined criteria of importance (Patton 1990:176). The criteria were:

1. Recommended by local community members, including other interviewees.

2. Most interviewees to be at least 60 years of age. This would ensure a sufficient number of recollections dating to the period just before the commencement of extensive clearing in the post World War II period.

3. Information-rich recollections of their experiences of the upper Tone River system dating from their childhood. The aim was to guarantee that reference conditions[16] and biophysical changes could be described.

4. Overlapping recollections of river sections, such as particular pools. The purpose of this criterion was to assist the cross-interview corroboration of the interview material.

In relation to Criterion One, my first source of recommendations was my father, who has been farming in the study area for nearly 50 years and worked closely with the local farmers as a member of the volunteer fire-brigade during the main period of extensive clearing in the upper Tone River catchment. Criterion Three involved contacting people recommended to me as potential interviewees (Criterion One) and either visiting or speaking with them by telephone to ascertain whether they would

16 Reference condition in this context refers to establishing the condition of the area at the time of the earliest available recollections. Clearly, with small-scale clearing commencing late last century this was not an undisturbed environment. Recollections of a 'pristine' river system are no longer within living memory. Discussion in Chapter Two explored the difficulty of determining reference and baseline conditions.

provide an information-rich interview. To make this assessment I asked questions about the type and extent of their interaction with the river and/or its major tributaries over their life. Based on my experiences in the pilot study, my preference was to speak with potential interviewees in person, rather than by telephone, but this was not always possible or necessary. During the selection process a list of 20 potential interviewees was identified and then reduced to nine. In the end seven oral histories were recorded and used in the study. The selection process is outlined below with the number of potential interviewees at each stage provided in square brackets:

1. A list of 20 potential interviewees was developed, consisting of eight females and 12 males. A number of other people who were said to have been ideal for the exercise had died in the previous five years or so. [20 potential interviewees].

2. Six were spoken with in person and of these, four were selected. Two provided useful background information but did not met the criterion of information rich recollections. [4 short-listed].

3. Seven were spoken with by telephone. Of these, two were visiting family locally for a short period, and one was very busy but willing to participate. All three gave every indication that an information-rich interview would be forthcoming, as did a further three potential interviewees spoken with by telephone. The remaining candidate, a former bulldozer driver in the local area, felt that he lacked sufficient experience and knowledge of the study area to be of assistance. [6 short-listed].

4. For the following reasons none of the remaining seven potential interviewees were selected:

   a) One person was in hospital and unavailable due to illness.

b) One person lived outside the area and was not contacted due to time constraints for travel.

c) In light of the fact that 10 had been short-listed it was felt that the information base of the remaining five would not be greater than those already identified due to their younger age and/or level of contact with the river.

5. The list of ten potential interviewees was reduced to nine due to the time constraints of the project. The remaining nine (three females and six males) were interviewed. The final number of transcripts was reduced to seven by the withdrawal of one of the female interviewees, and by my decision not to use one of the remaining eight interviews[17] because it would have required extending the study area downstream. Furthermore, I was by this stage particularly conscious of the amount of time needed to transcribe the other interviews.

The final list of interviewees, together with salient biographical details, is presented in Table 3.1. The interviewees are also shown in Plate 1. The location of each interviewee's home in relation to the Tone River is shown in Figure 3.1.

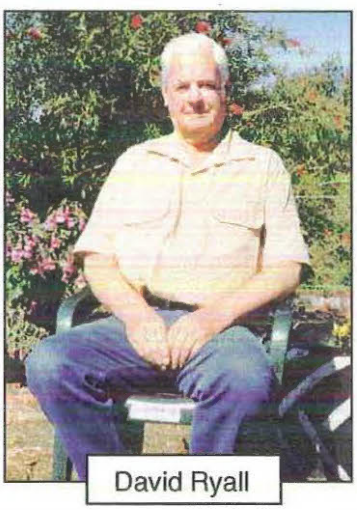
17 I had informed this participant prior to the interview that his interview might not be used in the study due to time constraints, but that it would be submitted to the Oral History Unit at the Battye Library (see below), along with the other interviews. I decided to proceed with the interview despite the uncertainty because the interviewee had extensive knowledge and experience of the river, and as he now lives in a remote centre, the opportunity would not be repeated readily. The interview played no other role in this thesis.

Table 3.1: Participant biographical details

Name	Year of birth	Farm residence (see Figure 3.1)	Period of earliest recollections	Continuous residence in upper Tone catchment
L. P. (Mick) Lee	1911 (88yr.)	Mylerup	Childhood	Yes
Christopher Owen	1934 (65yr.)	Mininiup	Childhood	Yes
Michael Fryer-Smith	1931 (68 yr.)	Keston Vale	1940s – 1950s	Yes
Diana Mathew (nee Hubbe)	1934 (65 yr.)	Woodenup	Childhood	No, but ongoing contact maintained
Helen Young (nee Hubbe)	1937 (62 yr.)	Woodenup	Childhood, 1946+	Yes
David Ryall	1929 (70 yr.)	Kelvin	Childhood	No, but retired nearby
William Harvey	1945 (54 yr.)	Glentone	Childhood	Yes

The application of the sampling strategy worked reasonably well. The major limiting factor was the time constraint of the project. Consideration was given to the issue of gender balance in the sample, and an effort was made to include males and females in the sample. However, primary importance was placed on finding participants who had a lengthy association with the river from the time it was in a relatively healthy condition to the present. It was more difficult to locate women who met this criterion because they had generally left the family farm where they grew-up when they reached adulthood, whereas the sons tended to stay on. In hindsight, the type of interaction of females and males with the river varied significantly, with the latter using the river more intensively for fishing, hunting and swimming. This factor should be taken into account in future sampling strategies.

INTERVIEWEES
from the Upper Tone

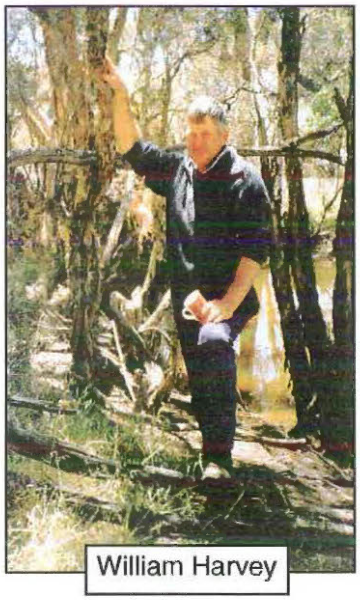


David Ryall

Chris Owen

Lawrence (Mick) Lee

Michael Fryer-Smith



William Harvey

Diana Mathew and Helen Young

Preliminary interviews

Some of the reasons for conducting a preliminary interview were raised in the discussion of the pilot interviews. First, in keeping with the sampling strategy, I did not want to commit to an interview until I had established that the person would provide an information-rich account. Robertson (1996:11) notes that a preliminary interview can be used as a screening exercise, and also provides a valuable opportunity for both interviewer and interviewee to prepare for the interview. I found the preliminary interview to be a valuable means of gauging the person's level of knowledge and interest in the topic, as well as establishing rapport. Secondly, interviewees were being asked to agree to be mentioned by name in the study and at the same time have the reliability and validity of their recollections scrutinised. Hence it was necessary to try to meet with potential interviewees to explain the introductory letter and consent form (Appendix 1). I presented a personally addressed letter with the Statement of Disclosure and Consent Form towards the end of the meeting, after I had confirmed in my own mind the suitability of the interviewee for the task. For those pre-interviews conducted by telephone, a copy of the form was faxed or posted.

An environmental oral historian (A. Sanders, pers. comm. 19/6/98) raised the problem of the interviewee providing valuable information in the preliminary interview and, knowing that the information had already been given, not providing it so readily and spontaneously in the recorded interview. I tried to minimise this problem by asking only essential questions to ascertain whether the person would provide an informative interview. The responses almost invariably included information that I would want to record and, in keeping with Robertson's recommendation (1996:11), I asked the person to raise it at the interview.

Care also had to be taken when speaking with people on a preliminary basis because it was important to not undermine the integrity of the triangulation process. This could have occurred if people had felt encouraged to consult sources of information that I would later use for corroboration. Nevertheless, it was not possible to prevent an interviewee from consulting these sources. The approach I took was to state in the introductory letter that I was interested in their recollections and that they did not need to prepare for the interview. At the same time ethical considerations required that I also make it clear that people's interviews would be examined for reliability and validity.

3.1.4 Interview method

Oral history literature, social researchers and environmental oral historians offer valuable insights into different interview methods. The Oral History Association (Robertson 1996:42) emphasises a number of points regarding interview method, including the need for:

- open-ended questions, "so that interviewees are invited to provide information, to tell a story, to give details and to keep talking"
- neutral, as opposed to leading questions, to reduce the potential for bias in the response
- follow-up questions, to avoid a superficial interview
- limiting the role of closed questions to establishing specific information such as dates.

Thompson (1988:198) discusses the spectrum of interview approach from a tightly structured and constraining questionnaire to a completely free-flowing interview.

While oral historians tend to avoid the former because they obscure rather than reveal sources of bias, which can be critical to understanding what is being said, the completely free-flowing interview "cannot exist" (Thompson 1988:199). It is considered impossible to avoid shaping what is said in an interview, just through setting up the context, explaining the purpose and asking the initial question. Lance (1984:120) also notes the questionnaire approach suffers from a lack of flexibility to accommodate "the unexpected and valuable twists and turns of an informant's memory; and ... [it] can become an obstacle to achieving the natural and spontaneous dialogue that is the aim of most oral historians."

It is apparent that oral historians seek some kind of compromise between these two extremes. Lance (1984:120) refers to lists of topics providing "useful guidelines for interviewers to work to." A similar approach was taken by Sanders (1991:2), who prepared an 'interview outline' and found that "flexibility was necessary because topics were often not covered in sequence and each person provided different information depending on their own field of knowledge and special interests."

Noting that "memory is a treacherous thing", Friedlander (1984:139) argues "the necessity for cross-examination, digging for details, and even confronting an interviewee with contradictory evidence, is critical." Similarly, Moss (1984:98) claims it "is the deliberate interview that makes oral history unique as a historical source" and therefore in evaluating the content of an interview, it is necessary to ask, "Is the interview a thorough one? Does it cover all possible relevant themes? Are all topics probed in depth for detail, amplification, and appreciation?" The rationale for this type of rigour is the need to establish the "highest standards of evidentiary value" in order to ensure that oral history "can make an important contribution to history" (Moss

1984:101). Another perspective, but with a similar emphasis on follow-up questions, is offered by Smith (1991:394):

> *"The interviewer must ask questions that [a] future audience will want answered. This means that the oral history depends heavily on probes: Who? What? When? How? Why? It depends also on numerous cues. The interviewer must juggle the innumerable facts, clues, and references that the narrator makes to add specifying dates, places, and actors. Props are essential to jarring long-term memory."*

A seemingly different approach is presented by Roberts and Sainty (1997:28) in their study of oral histories of the Lachlan River. They note that the use of specific questions, including a structured form such as a set questionnaire, is one way to obtain anecdotal information where the topic is well defined. However, Roberts and Sainty (1997:28) argue that such an approach has "an element of self-determinism":

> *Specific questions and a well-defined topic suggest that the research questions have already been framed. In contrast, an open approach was used in this project. The original intention was to construct an ecological history of the river as an extensive landscape feature, with no a priori[18] assumptions as to what information might be forthcoming. However the range of topics was potentially so wide that a prompt-list of topics, rather than questions, was used.*

Roberts and Sainty (1997:10) do not indicate the extent of follow-up questions or prompting, although they do state that points requiring clarification were noted by the interviewer and "a checklist of sub-topics ... was maintained by the interviewer as a fallback, serving as a list of prompts for direct questions." It is clear from the transcripts of interviews conducted by Sanders (1991) that her use of the 'interview outline', noted earlier, was supplemented by specific follow-up questions to achieve greater detail and clarification.

In the present study of the upper Tone River, the final interview method adopted most closely resembles the Roberts and Sainty approach of "no *a priori* assumptions". Initially a quite detailed set of questions was prepared relating to people's earliest

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18 Meaning "from the first"; knowable before experience, or independently of experience.

recollections of ecological attributes such as riparian vegetation, fauna and water quality. However, it was decided to encourage a more narrative style of interview by avoiding as far as possible asking questions of clarification and prompting interviewees, or using reference aids. This was done for the following reasons:

1. To give interviewees the opportunity to decide themselves what was significant or memorable about the river system rather than asking specific questions about attributes and issues that might be important to the restoration ecologist. This is necessary in order to ensure the value of the recollections as a source of goals and endpoints of most relevance and importance to local people, and therefore the greatest source of motivation to participate in restoration activities.

2. To maximise the potential for presentation of unexpected pieces of information through encouraging interviewees to tell their story without too much direction by the interviewer.

3. To keep the interview open to the type of information that future restoration projects may wish to draw on. We don't know now what historical information could be important in the future. While analysis of the potential usefulness of the interviews to ecological restoration in this study involves the application of a set of criteria, or ecosystem attributes, the full interview remains available for future restorationists to consult and use selectively according to a new set of criteria.

4. To avoid compromising the study's triangulation exercises through the use of reference materials (e.g. species reference books or aerial photographs) to prompt or clarify, as the same materials might be needed to corroborate what the participant said during the interview.

Additionally, the use of these materials might also be akin to a leading question. On the other hand, it can also be argued (A. Sanders pers. comm. 12/11/98) that these materials can be used in a way which minimises this risk. For example, using a bird book to help with species identification can be done by letting the participant find the species they recognise. Also, Sanders (pers. comm. 12/11/98) found that the animals described by interviewees "don't exist in the universe" – it is very hard to describe clearly even an animal that is well known. Finally, it could also be argued that there is no better time to do one instance of corroboration than during the interview as long as the interviewer has the requisite knowledge and skills to perform the corroboration 'on the spot'. My experience in this regard was dealt with in the discussion of pilot interviews above.

The approach advocated by Friedlander (1984) and Moss (1984), outlined earlier, assumes that people's recollections should be scrutinised in order to establish their legitimacy as pieces of historical information, whereas the approach taken here allows people to tell their story without being subject to cross-examination and confronted with inconsistencies, and prompts.

Open-questions with minimal follow-up and prompting therefore form the basis of the interview method adopted in this study. The approach can be described as semi-structured and focused (Sarantakos 1993:253). It seeks a balance between free and open discussion, in which I guided, rather than led and restricted the interviewee, while maintaining sufficient focus on the topic of the river system. I was seeking a series of information-rich and inter-related narratives, collected from people sharing a social and physical setting.

3.1.5 Procedure

Equipment and tape processing

A good quality tape recorder was hired from the Battye Library Oral History Unit. Efforts to maximise recording quality included using good quality, 60 minute tapes, placing a mouse pad under the microphones to reduce vibration, and testing the equipment before each interview. Tapes were labelled and spaced to leave room for an introduction to be recorded before submission to the Battye Library. A separate tape was used for each interview. The tapes were stored in a cool, dry place for protection.

Interviewing

All interviews were recorded at the interviewee's house or the house of a relative. Interviewees were generally a little nervous and keen to make a start. My first task was to set up the equipment in a quiet part of the house where interruptions would be minimal, and ask the person if they would be happy for their photograph to be taken. After a brief reminder of the purpose of the interview and giving interviewee's the opportunity to ask questions, I collected the signed Statement Disclosure and Consent Form and commenced the interview. The interviews were limited to between 40 to 50 minutes because of time needed to transcribe tapes and the desire to maximise the size of the interview sample in the time available. After the main interview was finished, I kept the equipment set up in the event that other memories came to mind. Finally, the interviewee was asked if s/he or another family member had kept a diary which might contain references to the river. I also asked if I could see any old photographs or other relevant historical documents.

Effort was made to ask similar questions across the interviews to assist with cross-interview corroboration. However, the order of questions was flexible, apart from orientation questions at the commencement of the interview. Some specific questions

were asked in recognition of an interviewee's particular association with the river (e.g. Ryall's hunting experiences along the river). A sample of the type of questions asked during the interview is shown in Box 2. A full list of questions is given in Appendix 3 and the interview transcripts[19].

Box 2

Interview questions

Interview with L.P. (Mick) Lee, 26 November 1998

- Would you please tell me your name and date of birth?
- You were born in Katanning, can you tell me where you have lived since then?
- What have been your occupations since leaving school?
- Could you tell me about the development of this farm and other farms nearby?
- What can you recall about the development of the land close to the Murrin Brook?
- As a child, what kind of things did you do down at Murrin Brook?
- What other stories can you tell me about your experiences of the Murrin Brook?
- Thinking back to your earliest memories of the Murrin Brook, can you describe what you could see?
- What was the Murrin Brook being used for in your lifetime?
- When did people stop using the Murrin Brook for watering stock?
- How would you describe the water in Murrin Brook during your early days?
- You have described what the vegetation along Murrin Brook used to look like, can you tell me what sort of changes you noticed in the vegetation over the years?
- You have mentioned before the sound of the frogs, are there other noises or sounds that you used to associate with the Murrin Brook?
- What other different animals did you use to see along or close to the river, along Murrin Brook, and also in Murrin Brook?
- You have mentioned the decline in frog numbers, are there other changes that you have noticed in the types or abundance of animals along the Murrin Brook?
- How did you feel about Murrin Brook in your early days here?
- [In response to Lee querying the previous question: Was there something about Murrin Brook that was special to you when you were a young person?]
- What are the most striking memories that you have of that part of the Murrin Brook that you're most familiar with?
- Is there anything else you would like to tell me about the early days of your experiences of Murrin Brook?
- [*In response to information provided by Lee during a rest period*: Can you tell me about some of the big old trees that used to be near the creeks on the farm? Were there big trees like that further up the valley, further up Murrin Brook?]

19 The transcripts and interview tapes are available at the Battye Library, Alexander Library Building, Perth Cultural Centre, 6000.

Some interviewees (e.g. Fryer-Smith and Mathew) also provided information about the river downstream of the study area. This information was not included in the analysis unless it also shed light on the study area.

Despite the interview method aiming to guide rather than lead the interview, a majority of interviewees found it difficult or awkward to speak at length about their memories, and asked or gestured for me to ask the next question.

Transcription process

I prepared all the transcripts personally to familiarise myself with the content for the purpose of data analysis. A transcription machine and word processor were used and each five minutes of interview took between 20 to 35 minutes to transcribe. In addition, each tape was checked three times until transcribed verbatim. Where I was still uncertain about the wording, third party assistance was sought.

Reviewing transcripts

Guidelines for editing transcripts were obtained from the Battye Library Oral History Unit (n.d.). These guidelines take a somewhat different approach to Patton (1990:379), who contends that transcripts used in qualitative research should be strictly verbatim. In the context of this study, where people are identified by name and their interviews will be lodged at the Battye Library (subject to the interviewee's consent), I found the Oral History Unit's position compelling:

> *The aim is to produce a verbatim transcript and therefore the document should be practically as spoken. However, people are inclined to think they talk as they write and are often most unhappy when their speech appears in print. Therefore a few deviations from strictly verbatim transcribing can help make the document more acceptable to informants, and save making people look like fools when they are not. The variations to strictly verbatim transcribing which follow, do not alter the historic content of the document in any way* (Battye Library Oral History Unit n.d.).

My interpretation of the Oral History Unit's guidelines, and subsequent minor adjustments to the transcripts, were included in "Notes for Interviewees Reviewing Transcripts", which I prepared and sent to the interviewees along with a cover letter and the draft transcript. On reading the transcript almost all interviewees expressed some disappointment at how they 'sounded on paper', and I anticipate their disappointment would have been greater without the use of the Oral History Unit's guidelines. The use of the guidelines included removing irrelevant false starts to sentences, reducing the level of frequent and irrelevant repetitions (e.g. 'you know' and 'sort of'), and attending to long sentences. Interviewees received a copy of the draft transcript and other material with a reply paid envelope, followed by a telephone call to answer any queries. All draft transcripts were returned and only two contained minor corrections. Changes from the original interview are shown in bold type and square brackets identify additions not on the original interview tape.

The notes on reviewing the draft transcript asked interviewees to include a note explaining the reason for making a change to the substance of the interview. The purpose of the request was to ensure I was aware of any new information that may affect the corroboration of the recollections.

Ethics

The University's Committee for the Conduct of Ethical Research granted approval for this study. In accordance with the requirements of the Committee, a Statement of Disclosure and Informed Consent Form (Appendix 1) was prepared for signature by an interviewee prior to the interview commencing. The statement alerted interviewees to two principal issues:

- Subject to an interviewee's consent, their involvement in the study would not be confidential and their name would be published in the thesis in association with their interview transcript.
- The recollections contained in the transcripts would be cross-checked with the recollections of other interviewees and other information sources.

The consent form permitted the identification of the interviewee and the publication of the interview in the thesis.

3.2 Data analysis

3.2.1 Overview

The data used in this study were the words and phrases contained in the seven oral histories. Word or text-based data analysis is typically the grist of qualitative research. The study's aim and research questions required that the recollections be interpreted, especially in light of the need to place lay observations in an ecological restoration context. Furthermore, sometimes these recollections were couched in terms that acquired relevance to the study's categories of ecosystem attributes only when an inference was drawn (e.g. white-water canoeing implied that no large woody debris obstructed the river). This qualitative (interpretive) approach was supplemented by simple descriptive statistics for a number of analyses of the interviews. A largely quantitative analysis was undertaken of the independent evaluation of the interviews by a group of scientists.

In keeping with the aims of the study – to evaluate the reliability, validity and usefulness of oral histories to restoration ecology – the following analyses were conducted:

1. Assessing the usefulness of the recollections to restoration ecology by examining the interviews for information that:

   a) Was pertinent to ecological restoration, according to the five environmental attributes identified in Table 2.2, row 1 (riparian vegetation, riverine habitat structure, riverine fauna, water quality and ecosystem functions and ecological processes). The interviewer's role in relation to the relative amount of information collected was reviewed as a part of this analysis.

   b) Meets the uses of historical information in the restoration process identified in Table 2.2, rows 1-3, respectively:

      i) establishing reference condition and change in condition to help determine restoration potential;

      ii) identifying degrading and restorative processes that need to be addressed in ecological restoration and environmental management prescriptions; and

      iii) assisting restoration planning, including setting goals and end-points.

2. Assessing the reliability of the recollections extracted under 1(a) above by checking for internal consistency in the interviews.

3. Assessing the validity, or factual accuracy, of the recollections by:

   a) Inviting four scientists with relevant expertise to evaluate the recollections to determine whether they are sufficiently clear and detailed to enable their factual basis to be investigated using other information sources.

b) Determining the extent of corroboration of the recollections across the seven interviews.

c) Performing a number of triangulation exercises using other information sources, which built on the results of 3(b) above.

These different analyses enhance the validity and reliability of the study's findings by providing a "within method" triangulation (see section 2.3). The multiple strategies employed to examine the oral histories were:

1. Data triangulation, using cross-interview analysis and triangulation exercises.

2. Independent evaluation of the interview material by scientists for its capacity to be corroborated.

3.2.2 Application of the oral histories to ecological restoration

Chapter Two, section 2.1, concluded with a classification of the uses of historical information in the restoration process, and a list of five environmental attributes that guide the type of historical information needed to fulfill these uses (see Table 2.2). This classification provided the conceptual framework for evaluating the usefulness of the oral histories.

Content analysis: five ecosystem attributes

Patton (1990:381) describes content analysis as the "process of identifying, coding, and categorizing the primary patterns in the data. This means analyzing the content of interviews and observations." In this study each interview was coded according to four of the ecosystem attributes identified in section 2.1: riparian vegetation, riverine habitat structure, riverine fauna and water quality. The coding extended to the detailed categories of each of these attributes (e.g. the composition, structure and pattern of

riparian vegetation). Pertinent recollections in the full transcript of each interview were extracted as phrases or sentences, and then tabulated and analysed using descriptive, qualitative measures and frequency data. Where possible, the context of the observations has been included. For example, with Ryall's (L.79) recollection of seeing the "odd Night Heron" I also extracted his observation that "you didn't see them because ... they only hunted at night, and they were probably something that frightened me most in my life was their night time call ... it sounded like a woman being murdered or throttled." Details of this kind – a description of the bird's call – would make triangulation more achievable, as it provides vital taxonomic clues.

As discussed in Chapter 2, the fifth attribute – ecosystem functions and ecological processes – was treated separately. Ecosystem functions and ecological processes do not lend themselves readily to being abstracted and quantified. Being the interactive aspects of complex ecosystems they require a more holistic context and appraisal. By comparison the other four attributes can be treated more easily as ecosystem components.

A questionnaire-style interview lends itself to conversion to frequency data (Roberts and Sainty 1997:28), but it does mean that the interviewee is constrained by the interviewer's phraseology, which may be unfamiliar. Opting for the open-question approach places greater onus on the interviewer to interpret the response rather than the interviewee having to interpret the question. In this study, a series of cues, mostly in relation to water quality, were used to assist with the interpretation of the recollections, including the identification of inferences about ecosystem attributes. These cues and inferences are spelt out in the qualitative analysis of the interviews in section 4.1.1.

The interviewer's role

As noted in Chapter Two, the interviewer is generally considered to play a significant role in determining the content of an oral history interview. Moss (1984:97) argues

> *Although the interviewer may seek to be objective and unobtrusive, he* [sic] *must inevitably play a dynamic role in the creation of the interview record, and the way he plays his role often determines not only the tone and character of the record produced but also the substance of the record content.*

As part of analysing the usefulness of information provided by the oral histories, consideration of the potential for bias in the record due to the influence of the interviewer is required. Bias of this type is expected to be minor in this study because the interview method was designed to give the interviewee a relatively unfettered position in the interview. To examine my influence, the interview questions that yielded information about the four environmental attributes (components) were tabulated and categorised according to my judgement (another potential source of bias!) about whether the question was referring directly or by clear inference to one or more of the environmental attributes. If no direct or clearly inferred connection could be drawn, the question was coded as "non-specific".

Application of historical information in the restoration process

The interviews were assessed for information regarding three of the uses of historical information identified in Table 2.2: determining restoration potential, identifying degrading and restorative processes, and defining restoration goals and end-points. Assessment of the relevance of the historical information to these uses incorporated the following steps:

1. Recollections extracted from the interviews for the four component-based attributes (discussed above; see Appendix 2 also) were further categorised according to:

a) Reference condition: comprising an interviewee's earliest recollections of pre-disturbance and disturbed condition. The latter was associated primarily with agricultural expansion. This information has been shown in normal type in the tables.

b) Changes in condition: interviewee's recollections of the changes in the condition of these ecosystem attributes (e.g. land and water salinisation, samphire spread). This information has been shown in italic in the tables.

Categorisation of the data in this manner permitted an assessment of the extent to which the recollections established the original condition of the riverine system and traced the history of changes in land use and the system. This assessment also considered the value of the recollections in the context of two other information sources: other documented historical records (e.g. aerial photographs, scientific records and state archives), and inference based on the present day condition (e.g. remnant riparian vegetation and soil type).

2. Instances of a perceived correlation between a degrading or restorative process and a change in the environmental attributes were identified.

3. The interviews were analysed for information that might serve as goals or end-points for restoration planning. In part the interviews can be viewed as expressions of the (former) utilitarian values of the Tone River. In the discussion of results (section 4.1.3), I draw the connection between end-points and utilitarian values.

3.2.3 Evaluating reliability and validity

Independent evaluation by scientists

An indicative and independent assessment was sought of the recollection's corroborative *potential*, relating to the four ecosystem attributes listed in Appendices 2.1 to 2.4. Given that the 'target audience' for the oral histories is the scientific community, principally restoration ecologists, part of the significance of this analysis lies in the fact that scientists with extensive, relevant expertise took the opportunity to evaluate the recollections. This analysis also strengthens the study because it involves a third party, which helps to counter bias that may result from my role as both interviewer and analyst.

The purpose of the evaluation of the recollections by scientists was to get an independent and indicative measure of the 'verifiability' of the recollections, the extent to which clarification was required before corroboration could be sought, and whether a recollection could not be evaluated because of its subjective character. In addition, the scientists were asked to classify the potential corroborative sources of information (e.g. photographic interpretation, state archives, and scientific literature).

The scientists invited to participate in the evaluation were selected on the basis of their expertise in one or more of the following scientific fields:

- restoration ecology or river restoration
- botany of the south-west region
- ecology of inland aquatic systems
- hydrology, water quality and water management of inland systems.

The scientists participating in the evaluation were Dr Peter M. Davies, Dr Richard George, Dr Richard Hobbs and Dr Luke Pen. Their identity has not been revealed in the analysis of their respective evaluations.

To perform their independent evaluation of the oral histories, the scientists were provided with two coding systems. They were asked to apply the codes to the information in the four tables of ecosystem attributes (Appendices 2.1 to 2.4) in response to the following two questions:

1. Is the recollection sufficiently clear and detailed to enable its credibility (i.e. factual basis) to be investigated using other information sources?

   Codes

   Investigation can proceed

   I The factual basis of the recollection can be investigated because its content is sufficiently clear and detailed.

   Indeterminate

   CR Clarification of the recollection is required by the interviewee. This could apply to the need for greater detail to be provided about a general recollection, or to establish the factual content of a seemingly subjective recollection.

   NI No scope for investigation because of the subjective nature of the recollection.

2. If investigation of the credibility (i.e. factual basis) of a recollection can proceed ("I"), what information sources would you use?

   Codes

   Expert and official sources of biophysical information

   EO Expert opinion. Experience and knowledge acquired by scientists and practitioners but not available in published literature. An example of the acceptance and status of (unpublished) expert opinion is the

admission of expert evidence in court through cross-examination or by affidavit. A visit to the site by an expert is included in this category.

P Palaeoecological evidence such as palaeochannels, pollen and sediments (evidence pre-dating European colonisation).

PM Aerial photographic interpretation and recent topographic mapping.

SA State archives, including explorer journals, land surveyor notebooks and sketch maps, and other historic maps.

SL Published scientific literature.

SR Scientific records and databases, including flora and fauna survey material, and hydrological, climatic, museum and herbarium records held by a range of government agencies and academic institutions (evidence since European colonisation).

Other Please specify.

Community and local sources of biophysical information

CA Community archival material, including other local oral histories, photographs, diaries, land management records of landholders (e.g. fertiliser application records), and records of community organisations (e.g. clearing and fire records of local volunteer fire brigades, and primary reference material held by local historical societies). Published local histories could be a useful secondary source of corroborative information.

Categorisation of these potential sources of corroboration was guided by a review of environmental studies employing historical information. Three major categories of "evidence relating to environmental change in river systems in post-European Australia" have been identified by Finlayson and Brizga (1995:180):

1. *An oral tradition which includes local knowledge of specific examples of environmental change;*
2. *Documentary records, ranging from written descriptions to maps, survey data and photographs;*
3. *Evidence of environmental change imprinted in the landscape itself, such as in palaeochannels, pollen and sediments.*

Further classification of Finlayson and Brizga's second category of documentary records was required for this study because it wasn't sufficiently descriptive. Guidanee was provided by Hooke and Kain (1982) and White and Walker (1997:339), as well as a number of studies of environmental change using oral evidence and other

types of historical records. For example, Beecham et al (1998:25) describe the use of sketches prepared by land surveyors over the period 1910-1938 to help determine the pre-European vegetation in the Dongolocking area, and an earlier study by Jeans (1978) also found that surveyor records dating from last century assisted the mapping of vegetation of NSW prior to European settlement. For an historical vegetation reconstruction of Tasmania's Midlands, Fensham's (1989) sources included surveyor charts and notebooks from last century, the descriptions of early traveller's, and paintings. In other studies, Eyles (1977b) used aerial photographic interpretation to help determine changes in the rate of channel incision in farmland in NSW, and also the journals of explorers and prospective settlers, surveyor records, and nineteenth century field descriptions by scientists to assess changes in drainage networks in the Southern Tablelands of NSW since 1820 (Eyles 1997a). In recent work to discover the pre-European attributes of creeks in north-east Victoria, researchers used "explorers' diaries, historical maps and field notes and land selection files" (Davis 1998:4). A study by Reznick and Baxter (1994) evaluated old field notes and museum collections as a means of reconstructing past tropical stream fish communities, and Main (1990) examined museum collections of a frog and spider species to map their former distribution, and using knowledge of their biology, to make extrapolations about what the "now modified habitats were like".

After the scientists had indicated their willingness to participate in the evaluation of the recollections, they were provided with a kit of information including the coding system set out above, a map and interviewee's biographical details, and other background material on the project.

Assessing reliability within interviews

Reliability, as applied to this study, is a measure of the consistency within an interviewee's recollections (see section 2.2.2). During the process of content analysis, including the coding, extraction and tabulating of relevant phrases, each interviewee's recollections were examined for internal consistency. The type of interview method used in this study, where there was little probing or prompting, and the absence of a follow-up interview, meant there were few opportunities to clarify and potentially resolve any inconsistencies with an interviewee.

To avoid duplication of material and discussion, I have included the results of the analysis of reliability within the results of the cross-interview analysis (see below).

Examining validity through cross-interview analysis

In the cross-interview analysis, validity refers to the degree of conformity between an interviewee's account of the biophysical environment and other interviewees' recollections of the same. The validity of these recollections has also been assessed against other information sources in the triangulation exercises. The approach taken here has been described by Vansina (1965:43) in relation to testing the "failure of memory" in oral traditions:

> *It is usually easy to evaluate the effects of failure of memory if one has at one's disposal several testimonies belonging to the same tradition. It is enough to observe the extent of variation between the various versions recorded to arrive at an accurate assessment. This applies ... also to free texts, in which the general contents can be compared.*

Recollections about reference conditions and environmental change for the designated environmental attributes were examined for corroboration across the seven interviews. The presentation of the recollections in tabular form, ordered by interviewee, river section and ecosystem attribute (see Appendices 2.1 to 2.4) assisted with the identification of conformity and inconsistencies between the interviews. From these

tables the shared characteristics of recollections from two or more different interviewees were extracted and recorded under the heading "Type of matched recollection". For example, an interviewee's recollection of "rushes and things like that along the edges" was matched with another's recollection that "the creeks were full of rushes" and a third interviewee's memory of "rushes and scrub along the river". The "Type of matched recollection" was recorded as "rushes along the edge of the watercourse". Other codes used to analyse the data for validity flowed naturally from this search for corroboration. A definition of each code is provided below.

Matched recollection - two or more recollections in different interviews shared a core characteristic.

Unmatched recollection - only one interviewee recalled a particular observation.

Inconsistent or incommensurable recollection - recollections from two or more interviewees are at odds, or due to seasonal or temporal variation, or geographical or spatial variation along the river, the recollections are incommensurable (e.g. vegetation might vary considerably between the headwaters and the river proper).

Indefinite recollection - the interviewee expressed uncertainty about the recollection.

As the final step in the cross-interview analysis, a chi-square analysis was performed with the frequency data to test the null hypothesis:

> *There is no difference between information type and the degree to which they are matched, where 'information type' includes the four quantifiable ecosystem attributes.*

According to Devore and Peck (1997:568) "it is generally agreed that use of the chi-square distribution is appropriate when the sample size is large enough that every expected cell count is a least 5." An expected cell count of at least 5 was achieved for

the two categories 'inconsistent' and 'indefinite' by combining these results with the values for the 'unmatched' category.

The purpose of the chi-square test was to examine whether the conformity of the material across the recollections was significantly related to the ecosystem attribute. Rejection of the hypothesis would have meant that validity was variable depending upon which ecosystem attribute was being recalled.

Triangulation exercises

From the discussion of triangulation theory in Chapter 2, it is apparent that the examination of internal consistency and the cross-interview analysis presented above are steps in the triangulation process. The following exercise in corroborating the recollections using other information sources concludes this process. Due to time constraints only two of the four ecosystem attributes (riparian vegetation and water quality) were selected for triangulation. The triangulation exercises built on the results of the cross-interview analysis. They were independent of the results of the scientists' evaluation, other than the latter serving as a guide to the selection of the two attributes (see Figure 4.3). Riverine fauna was not chosen because less than 50% of the recollections were considered by the scientists to be capable of investigation. Although proportionally habitat structure had slightly more potentially verifiable recollections than the riparian vegetation, it was excluded because I felt better equipped knowledge-wise to conduct the triangulation exercise of riparian vegetation.

To perform the triangulation exercises, a variety of historical documents and other information sources were consulted, informed by the categories used in the scientists' evaluation. The information in these documents was assessed against the information in three of the four categories of recollection type used in the cross-interview analysis:

matched, unmatched, and inconsistent or incommensurable. The category 'indefinite' was ignored. The other information sources were examined for information that corroborated or conflicted with the recollections.

The use of other information sources was a logical step following the cross-interview analysis. Since the recollections had already been subject to one test of their validity, a further iteration would enhance these results. The triangulation exercises were designed to be indicative (only) of the potential for corroboration. A more definitive result was not possible because an exhaustive search for corroborative material could not be expected within the time constraints of this study.

CHAPTER FOUR

4. RESULTS

There were two research questions to be addressed in the analysis. First, evaluating the usefulness of the oral histories to ecological restoration, and secondly, assessing ways of evaluating the reliability and validity of the recollections. To respond to these questions, the results of applying three analytical tools are presented: (1) content analysis, (2) the classification of the uses of historical information, and (3) triangulation theory. In addition, independent scientists have evaluated the potential verifiability of the recollections. Content analysis served as a building block for assessing the relevancy of the recollections to ecological restoration, the triangulation exercises and the scientists' evaluation.

4.1 Assessing the Usefulness of the Oral Histories to Ecological Restoration

In this section, the only analyses presented concern the first research question, evaluating the usefulness of oral histories to ecological restoration. Using a process described fully in section 3.2.2, content analysis was used to extract and tabularise phrases in the recollections associated with four of the ecosystem attributes. These tables, presented in Appendices 2 to 2.4, provided the basis for determining qualitative and quantitative measures of the relevance and comprehensiveness of the recollections to river restoration (section 4.1.1). The role of the interviewer in obtaining this information was also examined (section 4.1.2). The analysis then shifted to explore the value of oral histories to the restoration process by applying the classification of uses of historical information presented in Table 2.2 (section 4.1.3).

4.1.1 Relevance and comprehensiveness of the recollections

Qualitative measure

The following evaluation examines the extent to which the recollections provide comprehensive information that could be relevant to the restoration of the upper Tone River. The examination focuses on the type of information, and its descriptive detail, concerning both the reference condition of and baseline change in the five ecosystem attributes identified in Table 2.2. The results of this exercise are presented using qualitative, or descriptive, measures and quantitatively, using frequency data. The qualitative measures focused on the comprehensiveness of the information, such as geographical specificity, the precision of the recollection, taxa identification, and a break-down of direct versus inferential references to the ecosystem attributes.

Discussion of some of the water quality attributes is accompanied by a short justification of my interpretation of the recollections, which also help to explain the instances of multiple counting in the subsequent quantitative assessment.

Wherever phrases are extracted from the interview transcripts, a line reference is given. For example, (Mathew L.62) refers to line 62 of the Mathew's transcript.

Riparian vegetation

Components: presence/absence of species or types

Interviewees used common names and provided few of the physical characteristics needed for species identification. Nevertheless, confidence about the identification of a number of the well-known or distinctive species should be possible: yate, flooded gum, red gum, jarrah, wandoo, blackboy, and York Road and heartleaf poison. Without clarification it may not be possible to determine other species based on an interviewee's use of common names or genus, including banksia, *Melaleuca*, tea-tree,

scrub, wattle, vines, samphire, natural grasses and rushes, and the introduced *Watsonia*. The number of species mentioned appeared low relative to the likely diversity of the area.

Structure: vertical layering and percentage cover or density

Many comments conveyed an impression of the vegetation structure but used imprecise language, such as "a lot", "thick", "very prevalent", "mostly" and "large amount". Six recollections contained quantitative or descriptive detail (e.g. "huge trees about three foot in diameter ... towered to about a hundred feet" (Lee L.396), "higher than a horse" (Young L.38), "visibility limited to 20, 30 or 40 metres" (Ryall L.427)).

Pattern: areal extent and zonation

In general there was a lack of geographic specificity in the recollections. The location of tree species in relation to the riparian zone was not always clear from the recollections. It would also be difficult to map the longitudinal pattern of vegetation distribution for the length of the study area, based on the information provided, but a general description could be derived and some sections could be mapped. Some comments were imprecise (e.g. "close in", "as soon as you got away from the river", and "back from the river"), but the majority of comments relating to horizontal pattern, when read in conjunction with composition and structure, provide an image of the vegetation in a number of locations. For example:

> *most of Murrin Brook itself was covered with tea-tree and thick scrub . . . . acres and acres of it, each side of the river* (Lee L.68).
>
> *the tea-trees were very thick and lent over the top* [of the river] *like a tunnel* (Woodenup farm; Mathew L.132).
>
> *general vegetation in this area was jarrah, white gum, red gum and flooded gum back from the river, but as you get close to the watercourse, you are more confined*

to just flooded gum and wattle – large amount of wattle growing close to the river (Palligup Pool area; Fryer-Smith L.210).

Riverine habitat quality

Channel morphology and related water depth and flow

Geographical specificity was greater for this attribute, largely due to the use of pool names. Over half the recollections about reference conditions focused on pool depth and permanence over summer. Few recollections referred to bank type, but some indication of channel form was provided (e.g. "it's not a very clear course that it's in ... fairly flat country ... its more like a series of little waterways" (Owen L.276), "sometimes it was two or three miles in between really good pools" (Fryer-Smith L.197), "the river is not as defined as it was. It's spreading out over a bigger area" (Harvey L.147)). A small number of recollections of change related to erosion, flow rate and salt scalds.

Mineral substrate

A third of the total recollections for this criterion related to 'bogginess'. These recollections were usually in response to a question about what it was like crossing the brook/river. Another third of the recollections concerned change in siltation levels following clearing, and the final third mostly described the presence of rocky outcrops associated with pools. The interviews contained some useful information about the mineral substrate but not enough detail to provide an image of its overall pattern.

Organic substrate

Seven direct references were made to the presence/absence of snags, sticks, logs and fallen trees. Inferences were drawn regarding the presence/absence of large woody debris (LWD) from a further four recollections. It would be difficult to draw any

conclusions about the size or density of LWD in the riverine system on the basis of the recollections. One reference to leaf mulch as a cause of bogginess was recorded.

Riverine fauna

Components: presence/absence of species or types

The identification of some species appeared straightforward (e.g. black duck, turtles, marron and gilgies). However, it is possible that some interviewees might confuse, say, gilgies and young marron. Other recollections about fauna require further clarification (e.g. general references to frogs, minnows, snakes, ducks, and "little water beetley things" (Young L.278)). Interviewees could recall little about aquatic invertebrates, focusing most of their recollections about 'reference' species on waterbirds (19) followed by crustaceans (12), fish (10), reptiles (8), frogs (7), and leeches (1). Recollections about changes in composition related to waterbirds, including the arrival of maned geese following an increase in clearing, cropping and dams.

Abundance and distribution

Recollections about change in abundance followed a similar pattern to components, with waterbirds and crustaceans being recalled most frequently. A decline in the abundance of crustaceans and populations of original waterbird species (e.g. black duck and kingfishers) were recalled. A few observations related to change in distribution (e.g. marron moving downstream as the upper reaches became more saline (Harvey L.56), and waterbirds congregating more on the dams where the water is fresher (Harvey L.38)). A number of interviewees also described a major decline in frog numbers.

Seasonality

The appearance of "little tiddler fish" in a "heavy winter", and the arrival of migratory "grey ducks" in response to change were recalled by Lee (L.85, 358). Both recollections suggest a seasonal response to environmental conditions.

Functional roles and use of habitat

The nesting habitat of black duck (Ryall L.52), the habitat requirements of marron over summer (Fryer-Smith L.123), the burrowing habits of gilgies (Lee L.176), and predation/competition between turtles and marron, and gilgies and marron (Fryer-Smith L.131, 155), were noted in the recollections. These observations might be useful to restorationists seeking to understand the habitat requirements of some species and some aspects of species interactions and trophic structure, but they are not comprehensive.

Water quality

Turbidity/cloudiness

Four interviewees described the river water as clear in their early recollections. The two recollections about change in appearance were relatively imprecise: "brackish looking look" (L.Young L.75) and "it's not the crystal clear . . . waterway it used to be" (Harvey L.440).

Aquatic algal growth

There was no indication of algal growth in the early recollections. Harvey (L.30, 193) refers to the water becoming a "murky green colour" and "stagnant and putrid" in more recent times, which suggests algal growth.

Colour

In early recollections the water was described as clear and "tea-coloured" (Mathew L.127) and clear and "dark brown" (Young L.72). Both interviewees mentioned the prevalence of thick tea-tree along the river, and other interviewees recalled trees hanging over the river, which would act as an eventual source of dissolved organic material, and give rise to tannin-stained water.

Visual depth

Only one interviewee referred specifically to being able to see through the water to the river bed (Mathew L.174).

Temperature

"Deep water and very cool" and "the water was icy cold once you were down about four or five feet ... and the water would remain cold right throughout summer", was how Fryer-Smith described the water temperature of two pools (L.122, 169). This last recollection indicates thermal stratification in deeper pools, namely the existence of a thermocline, which is evidenced by a rapid change in temperature with depth (Lee et al 1978:902).

As noted above, a number of interviewees recalled trees/tea-tree hanging over or shading the river, which would have had a cooling effect on the water. A reference to the loss of riparian vegetation, and two recollections that suggest algal growth ("murky green colour" and "putrid") are included as recollections relating to temperature change.

pH

Two references (Mathew L.127; Young L.72) to a brown stain in the water were inferentially treated as indicators of the presence of organic acids. No other recollections could be used to infer the pH of the water.

Dissolved oxygen

The three recollections of change recorded above under temperature provide some indication of oxygen levels. First, stratification of water bodies indicates the presence of a thermocline, which acts as a barrier between the mixing of warmer, less dense surface waters, and the cooler, denser bottom waters, preventing the replenishment of the latter's dissolved oxygen supplies (Lee et al 1978:902). Secondly, the recollections of a change in colour and odour indicate the presence of algae. The evidence of algal decomposition ("putrid" smell) suggests further oxygen depletion of the pools' bottom waters (the hypolimnion). Lee et al (1978:902) explain that algae that have grown in the surface waters (the epilimnion), "settle and decompose in the hypolimnion, resulting in the reduction of the dissolved oxygen concentration in the bottom waters." Thirdly, it can be inferred from recollections of the loss of riparian vegetation, and consequently its shading effect, that oxygen levels would have been affected, since dissolved oxygen concentrations tend to decrease as temperature increases (Allan 1995:24). Finally, most interviewees recalled the river contracting to permanent pools over summer, providing therefore, little opportunity for water flow and related turbulence to offset these processes of de-oxygenation, such as breaking up the thermal stratification.

Salinity

All interviewees made references to freshness/salinity and the increase in salinity levels over time. No quantitative details were provided, but an indication of the early and more recent salinity levels can be ascertained from references to the uses of the water (e.g. human consumption, and watering pigs, horses, sheep and the garden) and what was growing adjacent to the watercourse (e.g. clover). All these indicators have a documented total dissolved salts (TDS) tolerance range. Some recollections tied the change to specific time periods, but others were general statements about changes since extensive clearing after the Second World War, making it more difficult to identify a temporal trend.

Odour

Only one interviewee commented on odour. The river water has become "putrid" according to Harvey (L.30), inferring some change in odour.

Water chemistry

Very little information about water chemistry could be inferred from the recollections. Two interviewees recalled washing fertiliser bags in the river each year as children (Mathew L.85; Young L.90). This activity would have introduced chemicals, principally phosphorus, into the water. Lee (L.45) provided the only other recollection concerning the use of phosphatic fertilisers in the catchment, noting that its use increased after the Second World War. Agricultural fertiliser use in catchments is a well-known source of nutrient enrichment in watercourses (e.g. Hodgkin and Hamilton 1993:95).

Ecosystem functions and ecological processes

It might be argued that any one of these observations is a description of part of an ecosystem function or ecological process. For instance, the recollections about water salinity noted above, are also comments about hydrogeochemical cycling, and recollections about water flow are indicators of the hydrological cycle. There was also mention of regeneration of riparian vegetation, which is an ecological process. Examples of these types of recollections are:

- changes in salinity levels, evidenced by the eventual rejection of the river water for stock use, decline of species types and abundance, death of reeds and other riparian vegetation and the spread of samphire;
- the river contracting to permanent pools over summer (Owen L.35; Mathew L.123; Fryer-Smith L.197), and the rate of flow increasing following clearing (Owen L.148; Ryall L.131); and
- observations of the regeneration of certain species following fencing-off the river to exclude stock (Lee L.241, 255; Young L.204).

The examples of regeneration could be of particular interest to restorationists because riparian vegetation is critical to re-establishing a healthy riverine system. The same value may not be attached to the recollections of the hydrogeochemical and hydrological cycling. These functions are already relatively well understood in relation to south-western rivers, and therefore may be of little added benefit from a restoration point of view, at least at the level of detail provided in the recollections.

Quantitative measure

To arrive at a quantitative measure of the relevancy of the recollections to river restoration, I used the tables developed during content analysis (Appendices 2.1 to 2.4)

to count the frequency of recollection phrases for the components of each of the four ecosystem attributes (e.g. water quality recollections were counted at the level of turbidity, colour, pH, algal growth and so on). This exercise was done across the seven interviews.

Multiple counting of the statements in the tables occurred when a recollection contained both reference information and ecological change information within the one statement (e.g. "people used to water their sheep on them [the pools], whereas today most of it would be too salty"), or when a recollection contained inferences about two or more of the ecosystem attributes. All instances of multiple counting are set out in Table 4.1. A phrase was only counted more than once when it provided meaningful information about more than one attribute. For example "today the water is ... a murky green colour" yields a number of important inferences (see Table 4.1 below), whereas a reference to the water being "clear" was counted as a reference condition for turbidity/cloudiness only. While "clear" water could also be considered as a reference condition for the absence of algal growth, it was considered that this approach would increase the quantity of data without necessarily enhancing its value.

Table 4.1: Multip' ..ferences concerning ecosystem attributes

Note: Italicised phrases refer to changed conditions.

Riverine habitat structure	**Ecosystem attribute**	**Reference or changed condition**
"... it was quite boggy in those pools ... I suppose with a lot of leaf mulch and that sort of thing" (Young L.110).	Organic substratum Mineral substratum	Reference Reference
"It used to be a bit of white water rafting ... it was just a watercourse ... we were on this little sealed canoe ... and it used to fairly belt down there" (Harvey L.168).	Channel morphology and water flow Organic substratum (i.e. inferred large woody debris not obstructing watercourse)	Reference Reference
Water quality	**Ecosystem attribute**	**Reference or changed condition**
"The water was clear .... *Today the water is ... a murky green colour in most of the pools*" (Fryer-Smith L.193).	Turbidity/cloudiness Turbidity/cloudiness Algal growth Dissolved oxygen Temperature Colour	Reference Change Change Change Change Change
"... back in the '50s ... The water was absolutely clear ... *but you see it now and it's stagnant and putrid*" (Harvey L.30).	Turbidity/cloudiness Turbidity/cloudiness Algal growth Dissolved oxygen Temperature Odour	Reference Change Change Change Change Change

A quantitative measure of the extent to which the recollections provided information about the ecosystem attributes is provided in Figure 4.1. The graph represents frequency data for the individual components of four of the five ecosystem attributes. Three relative values are shown:

1. The difference between the number of recollections about (a) reference condition and (b) change in condition, for each ecosystem attribute.

2. The difference between the total number of individual recollections for each of the four groupings of ecosystem attributes: riparian vegetation, riverine habitat quality,

riverine fauna and water quality. To assist with this assessment, total numbers are provided below.

3. The difference between the number of recollections recorded across all the attributes.

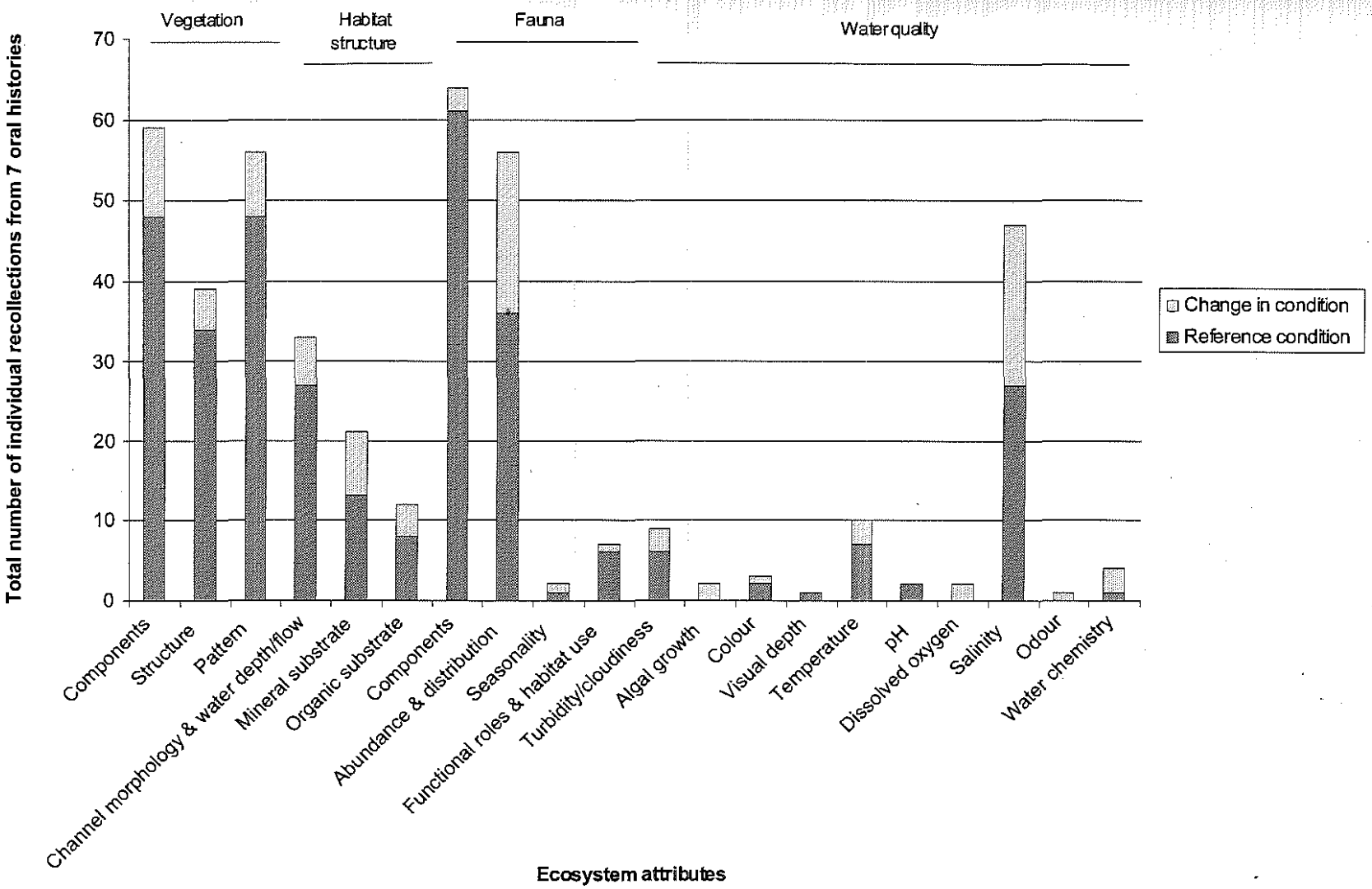

Figure 4.1. Frequency data for ecosystem attributes referred to in the seven oral histories

There are three corresponding points to draw from Figure 4.1 regarding the identification of recollections that were relevant to the ecosystem attributes:

1. Most of the recollections contained information relating to interviewee's earliest recollections, i.e. reference conditions, (328 phrases), rather than changes in condition (102 phrases). This may reflect the fact that interviewees spent less time at the river as they got older and as the river declined. Most of the records of change related to observations of increased water salinity and its perceived impact on riparian vegetation and fauna. It is not possible to determine the extent to which this emphasis in the recollections has been influenced by publicity about salinisation in more recent years.

2. The highest number of recollections related to riparian vegetation (154 phrases) followed by riverine fauna (129 phrases), water quality (81 phrases), and riverine habitat structure (66 phrases). One likely explanation for this result is that people are more attuned to certain types of plants and animals than, say, channel form or mineral substrate.

3. Faunal and vegetation components (species or types) were the most frequently mentioned attributes, followed closely by vegetation pattern, and faunal abundance and distribution, and then salinity levels and vegetation structure. All other individual water quality attributes recorded fewer numbers of recollections than any other single attribute from another category. Indeed, once the count for salinity is taken out of the water quality recollections, the total count for water quality components is reduced to 34 phrases. This last result suggests that information about components such as pH, water chemistry and dissolved oxygen

will only be forthcoming through the formulation of appropriate questions. Roberts and Sainty (1997:10) made a similar finding in their oral history study:

> *Concepts such as water quality were difficult to discuss without directly introducing the topic. In this respect, the interviewer gradually developed a list of related questions: Do you filter your water? Do you get much problem with the foot valves on your pump? Has it always been like that?*

In summary, the recollections contain information that is certainly relevant to restoration ecology, according to the ecosystem attributes used, but overall they do not provide a detailed account of the reference condition or changes in condition of the riverine system. For the purposes of ecological restoration, specific limitations of the data include a lack of detail or comprehensiveness, imprecise language (e.g. use of subjective terms for quantitative concepts, such as size and amount), and the general lack of both geographic and temporal specificity (i.e. where and when did the observation take place).

A further measure of the value of the recollections depends to some extent on whether similar information is available in other historical sources. My research indicates that:

1. Early land surveyor records for the area indicate, in varying degrees of detail, the components and pattern of riparian vegetation at the scale of individual location numbers (i.e. parcels of land assigned a lease or title), which equate roughly to the early farm boundaries in the area. This information tends to be more geographically specific and therefore of more use in determining the overall pattern of riparian vegetation along the study area. However, it lacks the detail of vegetation structure, and some components (e.g. reeds) provided in the recollections.

2. Aerial photographs for the study area began in 1943 (Commonwealth) for the Murrin Brook area and 1956 (now Department of Land Administration) for the lower reaches. Apart from Lee's recollections, which begin in the Murrin Brook area in the 1920s, the aerial photographs overlap with the recollections of the interviewees. The photographs are relevant to a number of the ecosystem attributes, including riparian vegetation, channel morphology and mineral substrate, but on-the-ground knowledge of historical conditions, of the type provided in the oral histories, improves the accuracy of interpretation.

3. There are no systematic water quality records for the upper Tone. Salinity and flow records, based on spot sampling, are available for 1977-1979 for the study area.[20] (Collins, P. and Barrett, D.F. 1980). A permanent monitoring site was established in 1978 on the middle Tone, some 25 kms below the study area (J. Garbutt, Water and Rivers Commission, pers. comm. 8/3/99). The oral histories are therefore an irreplaceable source of historical information about the water quality of the upper Tone, particularly when augmented by the occasional reference to water quality in land surveyor records and published local histories.

4. While individual scientists may hold records, it appears that fauna records for the upper Tone are patchy and generally quite recent. Morrissy (1978) surveyed marron in the Tone River. The WA Museum database contains only two fauna (reptile) records for the study area in its database (print-out dated 18/12/98), but considerably more for a search area with a radius of 50km. The CALM office responsible for managing some of the small reserves on the Tone River has no fauna records prior to the early 1980s (M. Graham, pers. comm. 7/4/99). The only

20 Earlier records (c.1940s) were collected towards the lower end of the Warren River system.

significant fauna survey of the reserves in the area was commissioned as recently as 1985 (Ninox 1985). The riverine fauna recollections in the oral histories are therefore of significant value in light of the paucity of other historical fauna records for the upper Tone.

To conclude, the oral histories provide a range of information that is not available from any other source uncovered in this study. It may be possible to infer a certain amount about the past biophysical condition of the upper Tone from records of similar riverine systems in the south-west, but a higher degree of site specificity is provided by the oral histories.

In light of the qualitative and quantitative evaluation of aspects of the oral histories, it is necessary to examine the extent to which the oral histories in this study were influenced by the content of the interviewer's questions.

4.1.2 Examining the interviewer's role

A measure of the potential influence of the interviewer over the type of information provided by interviewees is shown in Figure 4.2. Values were calculated by coding the questions according to whether they contained (1) non-specific, or (2) direct or indirect 'prompts' concerning the ecosystem attributes (see Appendix 3). There are two main findings to note:

1. Questions that were directly or by clear inference related to the four ecosystem attributes were about even in number.

2. Non-specific questions that yielded information about one or more of the four ecosystem attributes were more than twice the number of the highest category of question that did contain a direct or indirect 'prompt' concerning an attribute.

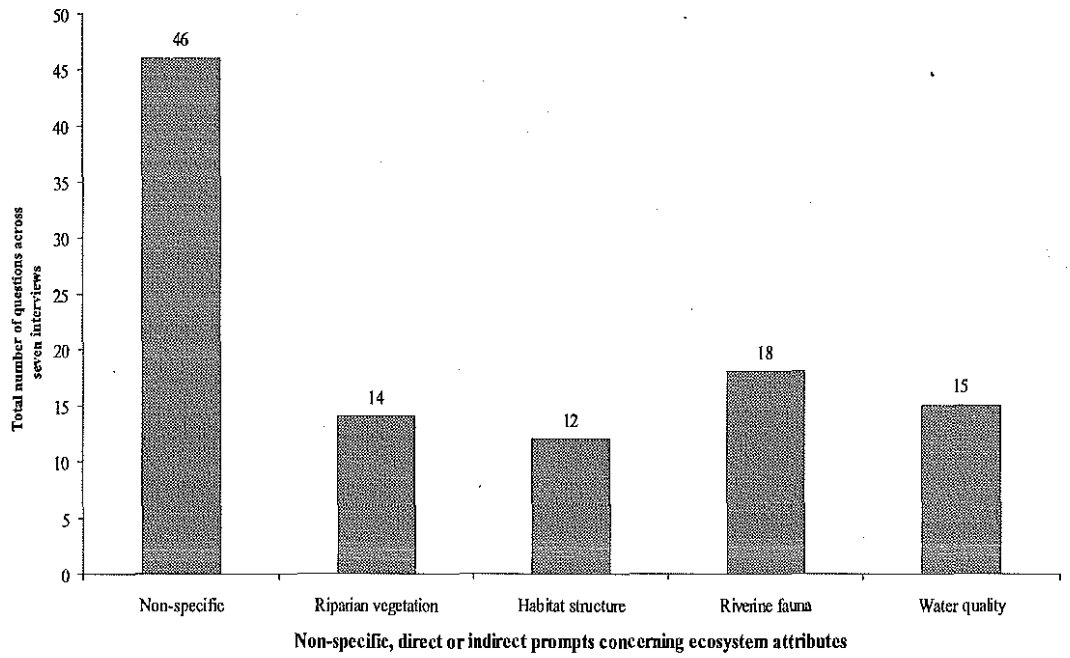

Figure 4.2: Analysis of the content of interviewer's questions from seven oral histories

Furthermore, noting the relatively high number of salinity-related recollections within the water quality category in Figure 4.1 (i.e. 47 out of 80 recollections or 58%), examination of the interviewer's questions shows that only four (or 27%) salinity-related questions were asked out of a total of 15 questions about water quality. It could be concluded then that the interviewer's role was not primarily responsible for the relatively high number of salinity-related recollections.

The results suggest that the interviewer's role, by virtue of the relatively large number of non-specific questions and the more or less even number of attribute-related questions, has not had a marked influence over the relative amounts of information provided by interviewees.

A number of points need to be considered when reviewing the results. First, some questions appear to have little or no relationship to any of the four environmental attributes yet they resulted in recollections that were relevant. Secondly, the context of the question (i.e. the interviewee's recollections that preceded it) is missing, although it is available in the full transcript[21]. Finally, the nature of the question did not necessarily result in the interviewee's response being limited or even relevant to that ecosystem attribute (e.g. a question about fauna might also prompt a recollection about water quality and vegetation, such as Harvey L.65).

This concludes the assessment of the comprehensiveness and relevancy of the information in the recollections against five ecosystem attributes chosen for their importance to river restoration. In the next section the analysis focuses on the extent to which the recollections could inform the restoration process.

4.1.3 Assessing the value of oral histories in the restoration process

In this analysis three uses of historical information in the restoration process, identified in Table 2.2, are applied to the oral histories. In doing so, the utility value of oral histories can be assessed. Some of the discussion that follows draws on the results presented in section 4.1.1.

Determining restoration potential

The first type of historical use outlined in Table 2.2 requires establishing the reference condition, based on interviewee's earliest recollections, and changes in that condition, to help determine restoration potential. The question examined here is the extent to which the oral histories provide (1) a reconstruction of the historical biotic and abiotic factors and interactions; and (2) an understanding of the ecological transformations

[21] Available at the Battye Library, Alexander Library Building, Perth Cultural Centre, 6000.

that have shaped its current condition. The purpose of this information is to help establish the factors and interactions that constituted a 'healthy' system in the past and indicate whether any "thresholds of irreversibility" have been crossed.

Building on the description of the recollections in the section 4.1.1, and further close readings of the transcripts, the value of and limitations in the data in relation to the two measures are described below:

1. Establishing a reference condition for the system is difficult due to the extent of changes that had taken place in the catchment prior to most of the interviewee's earliest recollections. This is particularly the case for the Murrin Brook area, where agricultural land use started late last century. Nevertheless, Lee, born in 1911, described parts of the brook in a relatively undisturbed condition:

   Most of Murrin Brook itself was covered with tea-tree and thick scrub. It grew very well because the Murrin Brook was all fresh water and a lot of scrub grew, acres and acres of it, each side of the river and a lot of that didn't get cleared until many years later (Lee L.67).

   Likewise, Fryer-Smith and Harvey were familiar with river stretches further downstream that were developed for agriculture at a later stage. Another factor to bear in mind regarding establishing a reference condition is that while the 1943 Commonwealth photographs of the Murrin Brook show quite extensive clearing in the vicinity of the brook, it is possible that considerable regrowth of tea-tree and some other species occurred during the remaining war years and prior to the period of intensive clearing by bulldozer. Consequently, some interviewees born in the 1930s (e.g. Mathew and Young) may in fact be recalling regrowth in some areas.

2. Another difficulty in establishing the reference condition for the study area is that little information was provided on historical biological interactions, such as

functional roles and habitat use. It is therefore difficult on the basis of the interviews alone to establish the factors and interactions that constituted a 'healthy' Tone River system in the past. This result contrasts with Roberts and Sainty (1997:32), who found that 45 oral histories about the Lachlan River enabled a "reconstructed ecological history":

The main value of this ecological reconstruction in relation to carp impact, is that it certainly describes the Lachlan River before carp, and in a 'total' way which could not have been done otherwise.

Likewise, on the strength of 17 interviews, Sanders (1991:26) states that she was able to reconstruct the condition of the wheatbelt wetlands during the earlier part of this century. Three reasons for the difference in comprehensiveness between the Tone River oral histories and the other studies are interview method, the number of interviews, and the 'information-richness' of the interviewees. The number of Tone River interviews were limited to seven due to time constraints, and it is clear from viewing Sanders' transcripts that her interview method was far more probing and specific (transcripts of the Roberts and Sainty study have not been viewed). Also, Sanders' (1991:2) interviewees included people "known to have an interest in wetlands", and the choice of study areas reflected the availability of such people, whereas I selected my study area and then set about locating local people who had the most information-rich recollections. In this respect the sampling strategy used by Roberts and Sainty (1997:10) seems to resemble the Tone River project.

Roberts and Sainty (1997:32) found that "oral history was probably most useful for conspicuous or distinctive species, rather than small or cryptic ones." To an extent this was also the case for the Tone River interviews. Aquatic macroinvertebrates (apart from crustaceans) were rarely mentioned. It seems that people recalled species that were a source of enjoyment, either through hunting and fishing, or

memorable due to conspicuous visual and/or audible characteristics (e.g. the sound of a large flock of waterbirds taking off or the evening chorus of frog calls).

Some abiotic components of the riverine system received little attention in the interviews, including important aspects of habitat structure (e.g. bank type and channel form), while others, such as constituents of water quality (e.g. pH, dissolved oxygen and water chemistry) could only be inferred. The lack of recollections about aspects of water quality is not surprising in light of the interview method, including the general nature of most of the questions.

3. The bulk of the interviewee's perceptions of ecological transformations stemmed from changes in the hydrogeochemical cycle caused by the clearing of native vegetation in the catchment (and its replacement with shallow-rooted annual plants). Interviewee's recollections of these changes included a marked increase in water salinity and the appearance of salt scalds, siltation of the river (e.g. loss of pool depth), the appearance of erosion channels and a faster rate of water flow. Interviewee's perceptions of the increase in salinity levels involved a spectrum of the ecosystem attributes examined in this study, principally changes in the abundance and distribution of faunal species, the impact on riparian vegetation such as reeds, and unsuitability of the water for stock use. A number of the ecological transformations described are well documented in the scientific literature (e.g. Hobbs 1993). These recollections may not offer any new insights to assist restoration at the level of detail provided in the interviews. More specific dating of recollections is one example of the need for greater specificity in the oral histories.

Other recollections of ecological transformations, such as the cause of the decline in species type and abundance tend to be less understood. With more in-depth interviewing it may be possible to gather valuable new information on these changes, especially in light of the relative absence of existing ecological studies in the area. A precedent for the expansion of ecological knowledge through oral histories is the study by Roberts and Sainty (1997:32), who found oral histories yielded valuable new information on plants in the Lachlan River that had disappeared from the Lachlan and comparable rivers prior to any research being undertaken.

The usefulness of oral histories in explaining ecological transformations is, however, constrained by the fact that at best they can indicate a strong correlation, not a cause and effect relationship, which requires a more rigorous evidentiary process, i.e. hypothesis testing (Roberts and Sainty 1997:32).

To conclude, there are a number of limitations in the oral histories that prevent a reconstruction of the historical condition of the study area. Moreover, the opportunity to do this reconstruction through oral histories is narrowing rapidly as the availability of people of sufficient age now (say, >85 yrs in the Murrin Brook area and >50 yrs in the lower reaches of the study area) to recall the pre-agricultural condition of the area will inevitably decline. Recalled biophysical changes are focused on the hydro-geochemical consequences of clearing. Some aspects of these changes are understood to require major management inputs to reverse or ameliorate the impacts (e.g. to lower water salinity levels to approximate past condition). In this sense the oral histories not only reiterate the fact that 'thresholds of irreversibility' have been crossed in the upper Tone River system, which is probably already widely recognised, but they provide a

reference point for that past condition in terms of a guide to former salinity levels, and some of the biotic factors and interactions that could exist under those conditions[22].

Understanding processes of change

Another use of historical information in the restoration process requires the identification of degrading and restorative processes (see Table 2.2). From the discussion so far it is clear that a number of degrading processes were identified by the interviewees, principally the direct and indirect effects of clearing for agriculture. Most interviewee's earliest recollections also included references to the presence of foxes, and rabbits, especially during the rabbit plague years (e.g. Ryall L.242; Mathew L.295, 331). However, only a few recollections delved into their impact on the river system. One interviewee (Owen L.200) suggested that the foxes preyed on birds nesting in the "rushes" along the river. Ryall noted the black duck nested in the rushes along the tributaries, and Lee (L.350) recalled a decline in their abundance, which he attributed to water salinity. Predation may have been one factor, but the decline in reed beds following increased salinisation (Ryall L.54) was likely to be another. Owen (L.202) also suggested that rabbits had damaged the sandy banks of the river (presumably through constructing warrens), while Ryall (L.337) didn't recall the rabbits causing much damage to vegetation along the river as "they came out on the clearings to feed at night". Two other introduced species were recalled: the presence of red fin perch in the upper Tone between at least the 1940s and 1950s, and the recent appearance of a *Watsonia* weed species.

Superphosphate use was noted by a few interviewees, but only Lee (L.44) describes how it was not used to any great extent until "many years . . . after the Big Depression

22 There may have been other factors (e.g. dissolved oxygen levels) that were equally or more important (e.g. see Morrissy 1978).

from the 1930s to 1940." Young (L.85) and Mathew (L.90) describe how as children they washed super bags in a river pool every year. Water quality changes associated with superphosphate use can only be inferred from two interviewee's recollections of the water changing from clear to a "murky green colour" (Fryer-Smith L.189) and becoming "stagnant and putrid" (Harvey L.30). Stock faeces and crop stubble are other likely sources of nutrient enrichment that were not mentioned in the interviews.

Use of other farm chemicals (e.g. pesticides, herbicides and fungicides) were not mentioned in any interview and yet their use has almost certainly been an integral part of the agricultural system in the catchment for many years. Fire received very little attention in the interviews, but Ryall (L.170) commented that he attended many "clearing fires" in the Tone area.

Grazing within the riparian zone was noted by a number of interviewees in their earliest recollections (e.g. Lee L.71; Mathew L.52), and there were frequent references to the river being used for watering stock. No impacts were described by the interviewees, but damage to bank structure and riparian vegetation almost certainly occurred. A number of interviewees recalled the vigorous regrowth following the fencing of salt-affected areas and other parts of the river to keep stock out (Lee L.230; Young L.204). I referred earlier to the potential value of these observations in the context of 'thresholds of irreversibility' because they suggest that simply excluding stock from the riparian zone can result in a degree of revegetation.

In short, identification and description of degrading processes in the interviews is rather thin, with the exception of clearing and associated hyrdrogeochemical changes, but the limitations of this information were noted previously. The interviewees' perception is that impacts were principally the result of clearing.

Assisting restoration planning

Defining restoration goals and setting end-points is the last use of historical information in the restoration process to be considered in this study. The approach taken is to identify goals and end-points in the oral histories that could be significant to local people.

The need for local people's participation in land management and the restoration process is being recognised in the scientific literature. Nickoll and Horwitz (in press) state "river restoration cannot be successful, let alone initiated, without the understanding and commitment of people who live around the river." Similarly, Hobbs et al (1993:236) argue "it is clear that conservation objectives are more likely to be met if the people living on, and adjacent to, conservation areas have some input into planning and are given responsibility for management." They argue traditional management has tended to ignore the interactions between different landscape segments (e.g. remnant vegetation and agricultural land), and the involvement of local communities is essential to achieve integrated management of fragmented landscapes. This logic applies to the Tone River, which is flowing through a predominantly agricultural landscape with the occasional river reserve. The restoration of the river environment will largely depend on the adjoining agricultural lands being managed in a sympathetic, if not supportive, manner, so the involvement of local farmers is essential.

The interview method was designed to generate a narrative style to enable the interview to be read as a statement of what aspects of the river environment were or

are important to the local people, and to help identify goals and end-points[23] that would be significant to them.

A striking result of the interviews was the extent to which interviewee's recollections of how they felt about the upper Tone River and its tributaries varied according to the level and type of interaction they had with the river. Those interviewees, all male, for whom the river was a major recreational focus had the most to say about its significance to them.

In response to a question about what the river meant to him as a young person, Owen (L.223) responded:

> *It wasn't exactly the seaside but it was getting close . . . especially as it's such a baby river, it wasn't as if we had an eastern river to look at . . . it was very much our river really, because it was such a local thing.*

Fryer-Smith (L.139) remembers "we used to spend a lot of time picnicking on the pools in the summer time, catching marron, gilgies, ducks", and although it "was a long, hot walk coming home in the evening" it was usually made worthwhile "with a bag of marron and some wild ducks". Asked how he felt about the river in his early days, he responded:

> *I used to look forward to it. It was a lot of fun. I mean there wasn't local sports available, through lack of people and lack of good roads in those days, so going to the river on a weekend and fishing and shooting was an enjoyable occupation and was carried out by a lot of young people my age. You could spend a good day at the river, even if it was a very hot day you could still always swim and then you'd generally go down in the morning and come home in the cool of the evening. It was a fairly long walk to the river but we always felt it was worthwhile.* (Fryer-Smith L.309).

As a child, Harvey used Wackelingup Pool below his house as a swimming pool:

> *I was at the end of the school bus run, we were the last cleared farm in the Kojonup Shire . . . sou'-west of us you'd be bush from here to the coast. . . . So we were in the frontier country, really, back in the '50s and the river was a bit of a*

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23 For the purpose of this paper, restoration goals are statements of intent and end-points are measurable indicators of recovery success.

> *centre of attraction in the summer . . . . This particular pool just below the house has got a huge granite rock protruding over it about three or four metres, on the edge of it, and we used to do bombies off it and swim and throw things. The water was absolutely clear, you'd jump in it* (Harvey L.25).

The river was a focal point for other activities too:

> *We used to swim there, we'd fish there, we'd canoe on it. You'd get your marron, you'd do everything there. If you had kids or friends to stay, well, right oh, we're off down the river. You'd either shoot a duck, or catch a duck – we had duck traps.* (Harvey L.409).

Another recollection also expresses the importance of the river wildlife as a recreational resource:

> *Apart from the birdlife on the river, I mean we used to catch fish. There was red perch. You could go down there and in this big pool, we wouldn't catch a fish straight away but we'd never come home without one – they were pretty plentiful. The little minnows, it was crawling with minnows . . . and we used to catch them and use them for bait to catch these fish. Put old sheepskins, too, in the river and you'd pull them out on a bit of string and they'd have a couple of turtles on them, you know, eating the fat. And then of course there was the marron. There was absolutely heaps of marron* (Harvey L.47).

Most of the utilitarian values of the river described above – picnicking, swimming, marroning, fishing and hunting – are considered by the interviewees to have been lost in their lifetime. Of course, it is not possible to say whether these values would be important to the next or subsequent generation of farmers in the area, especially in light of greater mobility and alternative recreational interests. However, the recollections presented above do provide one source of restoration goals that would be significant to at least some of the local people living and farming in the area at present.

Milner (1996:207) lists a range of possible biotic and abiotic end-points, including those involving a comparison with pre-disturbance conditions, such as species richness and water quality. I see no reason why cultural, symbolic or utilitarian values could not be considered along with ecological measures of recovery success, given that the potential for conflict can be managed. If we accept that the involvement of local

people is critical to the success of the restoration process, then there is real benefit in finding out what matters to them and devising appropriate goals and end-points. A similar rationale is advocated by Nickoll and Horwitz (in press) in their case study of the use of marron as a flagship species in the restoration of the Blackwood River system:

> *Using flagship species to provide a tangible endpoint, and to make clear the local or regional benefits from the restoration work, should be considered integral to restoration planning.*

In this vein, interviewees also expressed regret over the loss of abundant frog and duck populations along the river. It is likely that the return of any one of the species mentioned (above) would be considered a suitable end-point from the local community's perspective[24], although Milner (1996:207) notes that from a scientific perspective "biotic recovery is examined principally at the community level". Abiotic end-points signalling the return of other utilitarian values, such as suitability for swimming, would, on the basis of the interviews (see discussion in 4.1.1) include the recovery of clear, potable water and sufficient pool depth.

The value of the recollections to the restoration process has been shown to be variable across the three types of historical uses, with the greatest contribution coming from the defining of restoration goals and end-points.

4.2 Evaluating the Reliability and Validity of the Oral Histories

In relation to the second study question, three main analyses are presented: an independent evaluation of the recollections by scientists, cross-interview analysis and triangulation exercises.

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24 Of course, reintroduction of the perch may be problematic because it is not an endemic species.

4.2.1 Scientists' evaluation

Four scientists were asked to evaluate the recollections contained in Appendices 2.1 to 2.4 for their *potential* to be corroborated using other information sources. The tables (also used in the analysis of relevancy and comprehensiveness, section 4.1.1.) consisted of phrases extracted from the transcripts in accordance with the four ecosystem attributes, riparian vegetation, riverine habitat structure, riverine fauna and water quality. The three codes used by the scientists for the evaluation: 'investigate ' (I), 'no scope for investigation' (NI), and 'clarification required' (CR), were defined in Chapter 3. Of the four scientists invited to participate in the evaluation, three evaluated all four tables, and the fourth scientist elected to evaluate the two tables – water quality and riverine habitat structure – that most suited his field of expertise.

Concerning the water quality table, one scientist commented that "the recollections of quality are usually accurate", and although he "agreed with all the [interviewees'] comments", he stated it is "very hard to quantify the validity in a scientific way" because our measurements are very modern (pers. comm. 22/2/99). In light of this last comment I sought clarification of his use of the code "no scope for investigation" (NI). His response indicates he would have, and in some cases did apply the NI code to a number of the recollections on the grounds that due to the length of elapsed time and the extent of change, the validity of the recollections cannot be quantified (e.g. we will never know what the TDS level was in the 1920s). However, he largely opted for a combination of 'Investigate' (I) and 'Expert Opinion' (EO), meaning expert opinion would be required to "judge the merit – value – authenticity of the [recollection] as a piece of scientific evidence" (pers. comm. 2/3/99). He also argued that more dates are required in the recollections to make this task more achievable.

It could be argued that the code 'No scope for investigation' should have gone beyond subjective recollections to include the perceived absence of any other information sources that could be used for corroboration. On the other hand, that would require second-guessing the outcome of the investigation of potential corroborative sources, of which a scientist or any other person is unlikely to be fully cognizant. This argument might appear less persuasive where a scientist is seeking to quantify the recollection (e.g. a comment that clover used to grow alongside the creek suggests a maximum total dissolved salts (TDS) at the time), and there are no early measurements that verify the recollection, but other qualitative information may be available that is consistent with the recollection.

The scientists' evaluation assesses the type of information in the recollections in the sense that it might, or might not be verifiable. It is a measure of the potential value of the recollections because it shows whether the validity of the recollections is capable of being examined. If the evaluation showed that the bulk of the recollections required clarification or could not be investigated because of their subjective content, their perceived usefulness would be diminished among restoration ecologists seeking factual information on the historical ecology of the river. The coding allocated by the scientists is tabulated in Appendices 2.1 to 2.4 and aggregated in Appendix 4. The results of the evaluation presented in Figures 4.3 and 4.4 enable the following conclusions to be drawn.

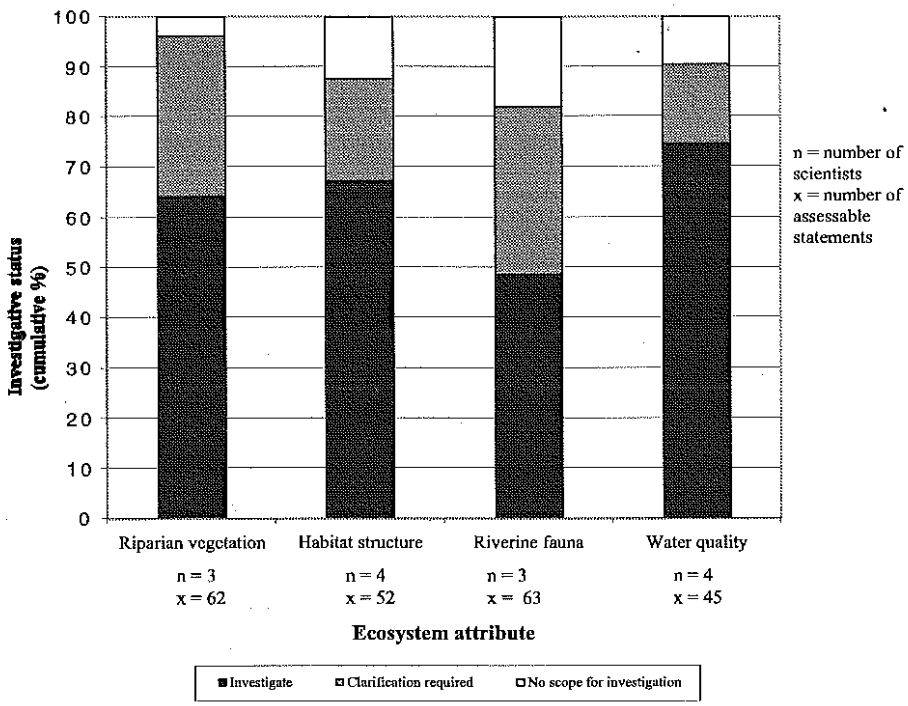


Figure 4.3: Scientists' evaluation of the potential for the validity of recollections to be ascertained by corroboration with other information sources. Cumulative percentage (y-axis) is the sum of the total number of assessed statements converted to a percentage.

The scientists found that between 48 and 75 percent of recollections were sufficiently clear and detailed to enable their validity to be determined, with recollections concerning riverine fauna, receiving the 'lowest' score. Recollections requiring clarification by interviewees received the next highest number of records. When this outcome is combined with the results for the investigate category, the lowest cumulative percentage value for an ecosystem attribute was 82% for riverine fauna. In other words, less than a fifth of the recollections for any one attribute were at the outset considered to be without a verifiable factual basis.

This result is also reflected in Figure 4.4. Only 11% of all recollections assessed by the scientists were considered to have no scope for an examination of their validity. Nearly two-thirds of the recollections were considered to be sufficiently clear and detailed to permit their validity to be scrutinised using other information sources.

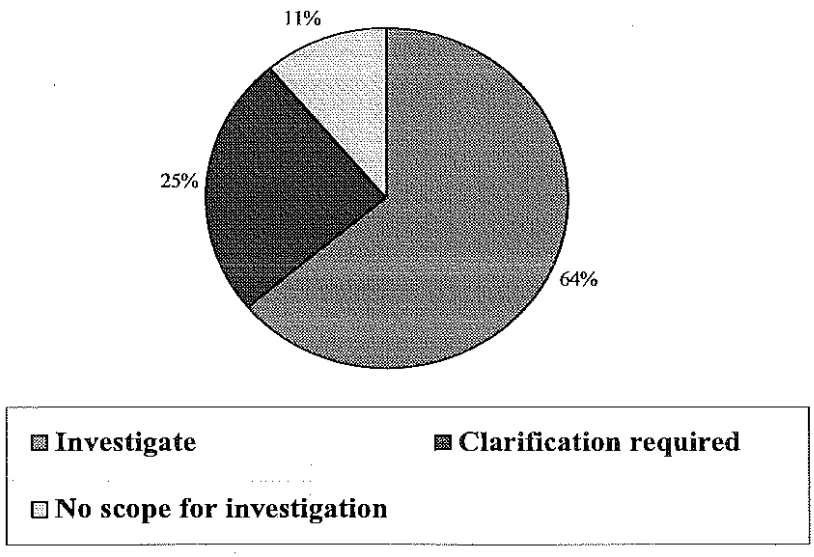


Figure 4.4: Recollections coded by the scientists, expressed as cumulative percentages. Cumulative percentage has been calculated by summing the total number of assessed statements across all four ecosystem attributes for all four scientists, and converting them to a percentage.

Figures 4.5 and 4.6 demonstrate that the codes were not applied uniformly by the different scientists to the recollections in each of the tables (Appendices 2.1 to 2.4). Figure 4.5 outlines the level of conformity in the coding done by three of the four scientists, and Figure 4.6 reflects the results of coding by all four scientists. Several important points about the scientists' treatment of the data were revealed.

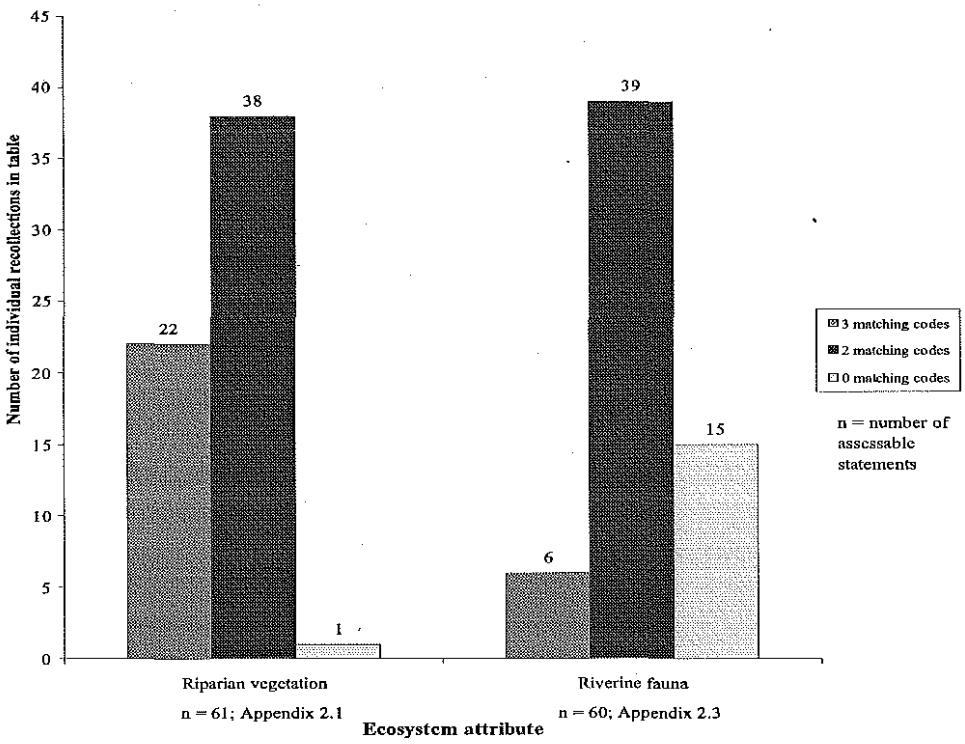
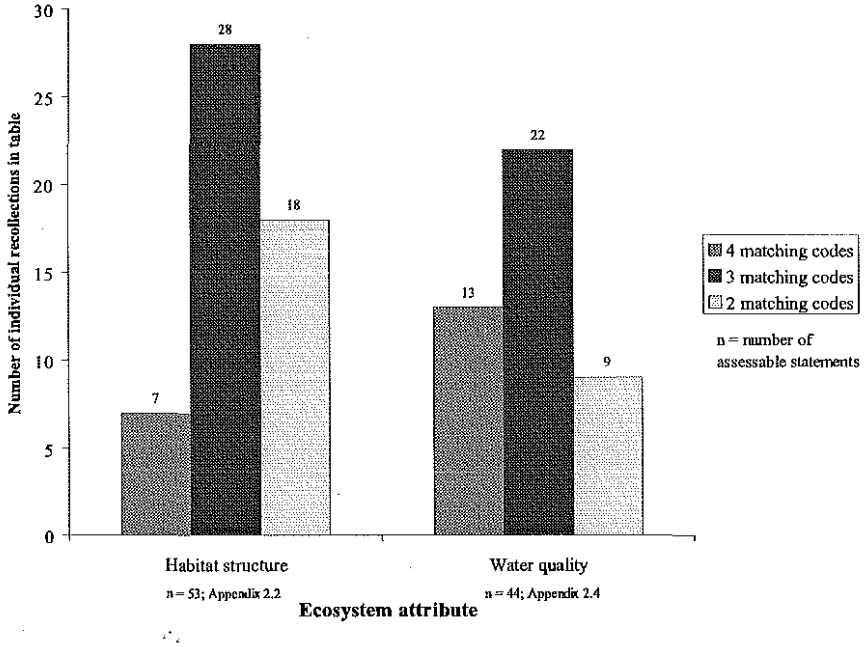


Figure 4.5: Measure of conformity in coding used by three scientists in their evaluation of the potential to corroborate the factual accuracy of the riparian vegetation and riverine fauna recollections. The lowest level of conformity possible was '0 matching codes' as there were three scientists and three codes.

Figure 4.6: Measure of conformity in coding used by four scientists evaluating the potential of the recollections to be corroborated. The lowest level of conformity possible was '2 matching codes' as there were three codes and four scientists.



For all four of the ecosystem attribute tables the most frequent result was one less than the maximum number of matches (i.e. 3 out of 4) or (2 out of 3). Further analysis shows that one scientist who evaluated all four tables of data, frequently took a different position to the other scientists. For example, in the water quality table, the one scientist[25] took a different position in 100% of the cases where three out of four of the other scientists agreed on the coding. This figure was reduced to over 90% for two of the tables and reached its lowest level at 62% in the riverine fauna table. The scientist clearly interpreted the codes or the recollections in a different way to the other scientists. Returning to the example of the water quality table, all instances of disagreement involved the one scientist using the code 'no scope to investigate', whereas the other three selected 'the code 'investigate'. This suggests a more cautious approach to the potential verifiability of the recollections.

The table of recollections about riparian vegetation (Appendix 2.1) recorded the highest degree of consistency in the coding used by the scientists. This may be explained by the relative clarity of these recollections and greater confidence on the part of the scientists in the recollections because interviewees were generally describing an actual biophysical feature (i.e. a plant) rather than a perceived interaction or change (e.g. the water flowing faster since clearing in the catchment).

The highest levels of inconsistency in the coding were recorded for habitat structure (34% of 53 assessable statements received only 2 out of 4 possible matching codes), followed by riverine fauna (25% of 60 assessable statements recorded no matching codes). While I cannot discern a pattern in the coding based on the type of

25 The scientist is identified as S3 in the data tables in Appendix 4.

recollection, these results are not surprising. These two tables contained substantial numbers of recollections based on interpretation of environmental change. In addition, the scientists may have been unsure about species identification based on the content of the recollections in the fauna table.

The same tabular data evaluated by the scientists were used in the cross-interview analysis to examine internal consistency and corroboration across the interviews.

4.2.2 Cross-interview analysis

The data in Appendices 2.1 to 2.4 were evaluated principally for (1) matching (or corroborative) and (2) inconsistent or incommensurable recollections. Unmatched and indefinite recollections were also identified. Achieving a match required looking for recollections with information in common across two or more of the interviews. The matched recollections are listed in Tables 4.2 to 4.5, while recollections belonging in the other categories (e.g. unmatched) are outlined in the text. A statistical summary is presented in Figure 4.7, at the end of this section. For further explanation of the cross-interview analysis method and a definition of the terms "matched", "unmatched", "inconsistent or incommensurable" and "indefinite", see Chapter 3. An explanation of how data (i.e. interviewee's words and phrases) have been treated in this analysis is provided below.

Some recollections have been coded two or three times. For example, Fryer-Smith's (L.211) recollection that "... close to the watercourse, you are more confined to just flooded gum and wattle" was matched separately with other interviewee's memories of either flooded gum or wattle. In addition, since no other interviewee recalled the vegetation association of "flooded gum and wattle", it was recorded as "unmatched".

Unless stated specifically in the following analysis, the approximate date of an interviewee's earliest recollections can be gauged from Table 3.1. Where possible, the geographical location or distribution of biophysical attributes within the study area has been included in the analysis, e.g. the presence of marron in particular pools. Where specific information of this type is not available an indication of the position of the recollection is usually provided in Appendices 2.1 to 2.4, which locate the interviewee's recollections by river section.

In two instances, relating to habitat structure and riverine fauna, a number of recollections have been grouped as indicators of a change in baseline condition. Each grouping was recorded as one match. In addition, each individual recollection within the grouping was also recorded as 'unmatched' or 'matched', depending on whether there were recollections that matched the specifics of the recollection. For example, the local extinction of fish life is included in a group of recollections about changes in riverine fauna due to the effects of clearing, which is counted as a match. However, no other interviewee mentioned this specific point, so it has also been recorded as unmatched (see last entry in Table 4.4).

Recollections based on explicitly secondary, or hearsay, sources of information are not included in the analysis. There are two known instances in the interviews where an interviewee recalled something they had been told by another person.

Where possible, comment on plausible reasons for non-matching recollections are provided. It is important to note that an unmatched recollection cannot be assumed to have no factual basis.

Corroboration of riparian vegetation recollections

Matched recollections

Specific matched recollections are presented in Table 4.2. This is followed by discussion of the overall pattern of historic riparian vegetation in the study area, as suggested by the matched recollections.

Table 4.2: Matched recollections for riparian vegetation.

Note: Italicised phrases refer to changed conditions.

Type of matched recollection	Match references
Extensive areas of thick tea-tree scrub along Murrin Brook and other tributaries in the upper reaches of the Tone River.	Lee (L.68, 70, 109, 149); Mathew (L.68, 132); Young (L.38, 57, 137, 305, 308); Ryall (L.48).
Blue gum/flooded gum trees/areas close in to the watercourses, including Murrin Brook and the Tone River.	Lee (L.149); Owen (L.118); Ryall (L.36); Mathew (L.68); Fryer-Smith (L.97, 126, 212); Harvey (L.197).
Presence of a variety of other tree species (red gum, wandoo, jarrah) in the vicinity of the river and brook (see discussion below).	Lee (L.149); Owen (L.118); Fryer-Smith (L.211, 126); Harvey (L.199).
Wattle close to the river.	Lee (L.154); Ryall (L.421); Fryer-Smith (L.210).
Yate in flat areas along the watercourse.	Owen (L.281); Harvey (L.191).
On Woodenup farm a lot of banksias grew on an area of sandy soil along the river to the west of the old homestead.	Mathew (L.69); Young (L.602).
Paperbark downstream of where the tributaries joined to become the Tone.	Ryall (L.47); Harvey (L.71, 196).
Natural grasses/ grassland areas along the river.	Fryer-Smith (L.19); Harvey (L.71).
Rushes along the edge of the watercourse.	Owen (L.201); Mathew (L.80); Ryall (L.53); Fryer-Smith (L.22), Harvey (L.38).
Relative tolerance of blue gum to increase in salinity levels.	Lee (L.241, 412); Ryall (L.375).
Death of tea-tree with increase in salinity levels.	Lee (L.110); Ryall (L.374).
Tree death and appearance of samphire near watercourses following clearing and rising salinity levels.	Mathew (L.230); Young (L.214).

Ryall spent time along the tributaries, including Cockatoo Creek in the headwaters of the Tone, as well as further down the river. His insights, in conjunction with the other

matched recollections, help to present an overall pattern of the riparian vegetation for the study area. Ryall (L.425) recalled that:

> *... further down the Tone from my area [the tributaries] it was much easier walking, where the river got a little bigger, the bush was not as thick, but up where the tributaries joined it, places there, they were quite thick with various shrubs and poison and blackboys. Visibility was pretty limited in places to maybe only 20, 30 or 40 metres.*

This recollection of the transition in the structure of the vegetation between the headwaters and the lower reaches of the study area, is consistent with the emphasis on extensive areas of thick tea-tree scrub by interviewees when recalling Murrin Brook, and the absence of any mention of tea-tree by Fryer-Smith and Harvey, who were familiar with the Tone River some distance downstream. Similarly, recollections of natural grasses along the river is confined to Fryer-Smith (L.19) and Harvey (L.71), which is consistent with Ryall's description of the country becoming more open further down the Tone River.

Unmatched recollections

The presence of sheoak (Lee L.108), patches of quandong (Lee L.151), vines (Owen L.115), and "thick tangly stuff" (Young L.65) along the river, were unmatched recollections. In terms of vegetation associations, Fryer-Smith (L.211) was alone in noting that in the upper Tone River area (see Map) "... close to the watercourse, you are more confined to just flooded gum and wattle", and Harvey's (L.191) recollection that "... the vegetation was really varied here" [Glentone farm area], wasn't matched specifically by Fryer-Smith, who spent time in the area.

Unmatched recollections relating to disturbance included the specific observation that "white gums are the worst affected with the salt " (Lee L.244), and the absence of *Watsonia* along the river until recently (Young L.242).

Inconsistent or incommensurable recollections

There is not consistency among the recollections concerning the proximity of jarrah, wandoo and red gum to the river:

- "a bit further away where the ground became a bit less waterlogged during the winter" (Lee, L.149).
- "wandoos and all these other trees right through the creek as well." [Murrin Brook, near Jingalup] (Owen, L.282).
- "grew right up to the river bank" (Owen, L.118).
- "back from the river" (Fryer-Smith, L.211).
- "a lot of overhanging trees, red gums and flooded gums" (in relation to Wackelingup Pool) (Fryer-Smith, L.126).
- "scattered along the river" (Harvey L.199).

However, all these recollections could be correct given the potential for variability in vegetation structure and pattern along a 60 km river stretch from its headwaters in Murrin Brook to the more substantial reaches of the Tone River.

Similarly, with accounts of the location of poison plants in relation to the river, a potential inconsistency may just reflect regional variability. Lee (L.130, 156) recalled poison plants to be "prevalent as soon as you got away from the river" and "... many areas close to the river were just not selected because nobody wanted them on account of the poison, too low-lying country". Mathew (L.51), referring to the Woodenup Pool area and surrounding bush, remembered sheep used to graze "all through there because there was no poison", although poison did occur elsewhere on the farm (e.g. L.274).

There is an apparent inconsistency between the observation of the loss of tea-tree following increasing salinity (see Table 4.2), and its regeneration following stock proofing of saline watercourses (Lee L.255), which may be due to the presence of more than one 'tea-tree' species. Young's (L.62) recollection of two species of *Melaleuca* (i.e, tea-tree and "one they call wild thyme") along Murrin Brook, and also Mathew's (L.68, 127) reference to both "tea-tree scrub" and "thick *Melaleucas*" along the river, support this contention. On the other hand, Young (L.204) uses both the terms tea-tree and *Melaleuca* to refer to regeneration after fencing stock from the river. In this instance, clarification of the species referred to is required from the interviewees.

Corroboration of riverine habitat structure recollections

Riverine habitat structure was the most complex set of recollections to analyse for cross-interview corroboration. The recollections tended to contain more subjective and imprecise language, making it difficult to distinguish between a match or inconsistency, particularly in relation to pool depth and permanence.

Table 4.3: Matched recollections for riverine habitat structure.

Note: Italicised phrases refer to changed conditions

Type of matched recollection	Match references
Presence of a braided channel in some areas in the upper reaches (see discussion below)	Owen (L.276); Mathew (L.373).
Little evidence of erosion or "bare sandy patches" in early recollections	Owen (L.41, 283); Mathew (L.81).
Early recollections of boggy areas not far from the river	Mathew (L.177); Young (L.114).
Parts of the river were boggy, but it was relatively easy to cross in summer	Mathew (L.370); Young – refers specifically to the pools being boggy (L.101, 109, 118); Fryer-Smith (L.197).
Presence of pools along the brook and river, which were shallower in the upper reaches relative to those downstream	See discussion below
The river contracted over summer to a number of permanent pools (see discussion below)	Owen (L.35); Mathew (L.123); Young (L.54); Fryer-Smith (L.197).

Rocks were associated with a number of pools (see also Owen (L.186) regarding "rocky areas")	Young (L.88); Fryer-Smith (L.42, 121, 126); Harvey (L.33).
A number of geomorphological changes occurred following extensive clearing	See discussion below
Siltation of the river and pools occurred in the last 20 or 30 years, evidenced by loss of water depth and appearance of bare sand in the river	Owen (L.41, 60, 234, 283); Harvey (L.137, 147).
Flow rate has increased in the upper reaches since clearing	Owen (L.148); Ryall (L.131).

Discussion of various matched recollections

Channel morphology

In referring to the "fairly flat country" that Murrin Brook runs through near Jingalup, Owen (L.276) recalls that it was "not a very clear course ... more like a series of little waterways ... and a lot of scrub and trees growing right through the creek". Similarly, downstream, Mathew (L.373) remembers "lots of places it was a very wide river, with lots of little courses flowing through the tea tree". There is an inconsistency between this statement and another recollection in which she states "it wasn't ever a very wide creek, except where the bigger pools were, you'd scarcely give it the name of a river really ... but as it got down a bit it got bigger." (Mathew L.132). However, there is potentially an underlying logic to Mathew's two recollections: the main channel of the creek/river was not very wide, until you got further downstream, and in places upstream many little courses formed though the tea-tree. I have ignored the inconsistency within Mathew's interview on the basis that it is matter of semantics, and recorded a match between her account of the braided channel and Owen's (L.276) recollection.

Pool depth and permanence

The recollections concerning pool depth demonstrate the difficulty of interpreting imprecise and subjective language (e.g. "big", "deep", "real pools"), especially for the

purpose of corroboration. The recollections about pool depth are set out below, beginning in Middle Murrin Brook and extending downstream to Nymiup Pool:

- "the pools ... at this part of the Tone [middle Murrin Brook] anyway, are not big pools – you could swim in them but you could sort of put your feet on the bottom pretty much." (Owen L.75). Relative to the Beaufort River, "we only run to sort of baby pools really" (Owen L.238).
- "there were quite a lot of not very big pools." (Mathew L.123).
- "nice big pools here and there." (Mathew L.42).
- "there were quite deep pools in a lot of places" (Young L.53).
- "I never saw many ... what I'd call real pools. There was some places where there was a reasonable amount of water, but only approximately eight to ten metres across and fairly shallow." (Ryall L.110).
- "Odd ones [pools] were quite deep." Ryall (L.110).
- Wackelingup Pool was large and "particularly deep water" (Fryer-Smith L.121).
- Wackelingup Pool "was 17 or 18 foot deep ... used to jump off this three or four metre rock" (Harvey L.139).
- Nymiup Pool had "deep, cool water" (Fryer-Smith L.126).

Together these recollections present an imprecise but coherent picture of pool dimensions in the channel. Pools were present along the length of the river and they were shallower in the upper reaches (e.g. Owen L.75) relative to those situated downstream (e.g. Harvey L.139), where the river became a bigger watercourse.

Over summer, according to the interviewees, Murrin Brook and the Tone River contracted to permanent pools (Owen L.35; Mathew L.123; Young L.54; Fryer-Smith L.197). Both Mathew (L.47) and Young (L.54) recall Woodenup Pool as permanent, and Harvey (L.32), and Fryer-Smith (L.123) remember keenly the summer activities in Wackelingup Pool, such as swimming and marroning.

As well as the subjectivity and imprecision of language mentioned earlier, precision with recollections of this type is difficult because of the need to account for seasonal and temporal variation (e.g. fluctuations of water levels between wet and dry years), and geographical or spatial variation (e.g. the changing character of the river as it becomes a larger watercourse downstream). Nevertheless, as noted earlier, a match is recorded for pool depth and permanence.

Geomorphological changes

Siltation of the river is noted in Table 4.3, but other recollections, while unmatched in themselves and therefore in need of corroboration, support the contention that the river has undergone significant geomorphological change since the early recollections of most the interviewees, i.e. since the Second World War when extensive clearing occurred:

- appearance of salt scalds (Owen L.60)
- formation of erosion channels (Mathew L.238)
- a "very boggy and slushy" river bed in winter, "especially after it had gone salty" (Mathew L.370).

A match has therefore been recorded for this small group of recollections about geomorphological change following clearing.

Unmatched recollections

Individually the three recollections of geomorphological change, noted above, were not matched. No other interviewee made a comment in support of Young's (L.114) perception that the country near the river "was a lot boggier then". Further downstream, Fryer-Smith (L.22) was the only one to describe clayey, lightly vegetated floodplain areas.

A number of recollections about the brook/river bed were unmatched. Lee's (L.178) recollection of "very flat crossings" along the Murrin Brook "where horses and carts used to go across in the early days" was not matched. Nor was Mathew's (L.175) specific memory of the river bed being "fairly firm" and not "terribly muddy" near the house, or Owen's (L.328) more recent observation that "... when it came to the actual river bed, most fire fighting vehicles were not able to cross the river." Harvey's (L.147, 168, 304) recollections of "... the river being ... a real defined bit of flowing water", and a subsequent build up of woody debris, including fallen trees, since childhood (L.139, 145, 170, 439), were also unmatched. More detailed information was needed to draw a match from these memories, although they indicate support for the matched recollection that siltation of the watercourse has occurred in more recent times (see Table 4.3).

Inconsistent or incommensurable recollections

Presence of large woody debris

Fryer-Smith (L.103, 165) recalls swimming in the pools was dangerous on account of "underground logs and snags". Mathew (L.171) also comments that her parents "... didn't like us swimming in the creek because there were snags". On the other hand, Harvey (L.144, 438) remembers in relation to Wackelingup Pool: "when we were kids ... there was no sticks, nothing in it at all", and "... it was a clean, quite a clean river

bed.". Other recollections indicate there were sections of the river that were free from fallen trees during the youth of some of the interviewees. Young (L.67, 112) remembers the fun of swimming her horse across the flooding river "... in any sort of place that we could swim through with the current wafting us down." And Harvey (L.168) gives an account of "white-water" canoeing a section of the river on his farm, suggesting that there were few obstacles in the race for the bridge. Once again, the potential for variability in the character of the river, such as following flood events, and the need for greater detail in the recollections, are plausible explanations for the lack of a clear picture of the former abundance of large woody debris.

Corroboration of riverine fauna recollections

Matched and related unmatched recollections are listed in Table 4.4, followed by a listing of other unmatched, inconsistent and indefinite recollections.

Table 4.4: Matched and related unmatched recollections for riverine fauna

Note: Italicised phrases refer to changed conditions.

Type of matched recollection & matched reference	Related unmatched recollections
Presence of black duck. Lee (L.350); Ryall (L.52).	Ryall (L.54) recalls black duck adjusting to the decline in nesting habitat (rushes) by nesting in trees.
High abundance of ducks. Fryer-Smith (L.224), Mathew (L.196); Harvey (L.38, 41).	
Decline in abundance of duck along the watercourses. Ryall (L.146); Harvey (L.38, 41).	Lee (L.355) refers specifically to decline in abundance of black duck.
Proliferation of wood duck/maned geese due to increased clearing, cropping and farm dams. Mathew (L.306); Ryall (L.147).	Ryall (L.148) also recalls the arrival of maned geese. Fryer-Smith (L.81) remembers a lot of maned geese but says nothing about their arrival or population increase. Lee (L.357) recalls the arrival of the grey duck.
Presence of a small number of cranes. Lee (L.359); Mathew (L.197); Ryall (L.78, 350).	
Presence of shags. Mathew (L.198); Ryall (L.78, 350).	

Type of matched recollection & matched reference	Related unmatched recollections
Disappearance of kingfishers. Mathew (L.109); Young (L.240).	Both Mathew (L.109) and Young (L.240) recall that there used to be kingfishers, but Mathew's recollection appears to be based on information provided by her mother, rather than a direct observation. Hence Young's recollection is recorded as unmatched.
Presence of turtles. Young (L.86); Ryall (L.76); Fryer-Smith (L.131, L.35); Harvey (L.52).	
Presence of snakes*. Fryer-Smith (L.88); Harvey (L.371).	
Dramatic decline in abundance of frogs. Lee (L.88); Young (L.85); Harvey (L.368).	Lee (L.89) refers specifically to decline in cat frog population.
High populations of bullfrogs. Lee (L.93); Young (L.276).	Lee (L.93) remembers the decline of bullfrog populations.
Presence of significant numbers of perch in various river pools. Fryer-Smith (L.16, 35); Harvey (L.47).	Fryer-Smith (L.16) recalls perch at Woodenup farm pools (Young and Mathew, who lived at Woodenup, make no mention of perch).
Presence of minnows. Lee refers to "little tiddler fish" (L.85); Mathew (L.89); Young (L.279); Ryall (L.76); Harvey (L.49).	
Presence of gilgies. Lee (L.176); Owen (L.83); Mathew (L.84); Young (L.89); Ryall (L.77); Fryer-Smith (L.139; 368).	The following recollections are listed here because they are not mutually exclusive, and nor do they corroborate each other: Ryall (L.78) remembers gilgies in the "fresher parts of it". Fryer-Smith (L.157) observed that "gilgies will live in much more brackish water than marron". Mathew notes the decline of gilgies due to increasing brackishness (L.84).
Presence of gilgies as far upstream as Woodenup farm. Fryer-Smith (L.368); Mathew (L.84); Young (L.89).	
Presence of marron. Owen (L.83); Fryer-Smith (L.139, 368); Ryall (L.101); Harvey (L.56).	Fryer-Smith (L.155) recalls that gilgies and marron tended to occupy different pools.
Presence of marron at Wackelingup Pool. Fryer-Smith (L.123); Harvey (L.56).	
Perception of marron population as plentiful, at least in some pools. Fryer-Smith (L.35, 154); Harvey (L.56).	
Decline in abundance of marron. Ryall (L.108); Fryer-Smith (L.158); Harvey (L.56).	Fryer-Smith (L.158) recalls that "marron virtually survived only in the better pools that remained reasonably fresh."

Type of matched recollection & matched reference	Related unmatched recollections
Presence of mosquitoes. Mathew (L.174); Young (L.294); Harvey (L.418).	
Specific changes in riverine fauna (many noted above) attributed to effects of clearing, principally rising salinity levels and availability of grain and dams. Lee (decline of black duck L.355; decline in frogs L.93). Mathew (population increase grain-eating ducks L.306; decline in gilgies L.84**). Young (loss of turtles, L.87). Ryall (decline of ducks on watercourse, L.146; arrival of maned geese, L.147). Fryer-Smith (extinction of fish life, L.238**; snakes and lizards no longer water at the river, L.89**; contraction of marron range, L.158). Harvey (transition of waterbirds to farm dams, L.41**).	

* Fryer-Smith recalls seeing a "large number of snake tracks" running to the water's edge. Harvey (L.371) recalls "a lot of snakes".

** Recollections that are unmatched individually. These are counted individually as "unmatched" and once as a part of a matched grouping.

Other unmatched recollections

The following recollections were also unmatched: the presence of storks (Harvey L.41), the occasional stilt (Mathew L.197) and Night Heron (Ryall L.78), and "little water beetley things" (Young L.278); as well as the presence of a lot of lizard tracks on the river bank (Fryer-Smith L.88); dragonflies (Young L.278); and leeches (Fryer-Smith L.191); and the observation that mosquitoes have become more prevalent, perhaps in response to more brackish water (Young L.294).

Inconsistent or incommensurable recollections

Turtles

Recollections concerning turtles indicate the difficulty of distinguishing between inconsistencies and incommensurability across interviews, in light of the heterogeneity

of a river system. Owen (L.287), whose recollections focus on the Middle Murrin Brook area, has never seen a turtle "in this river"; Lee, also with a focus on the Middle Murrin Brook area, makes no reference to turtles, whereas interviewees further downstream (see Table 4.4) recall seeing them. A plausible explanation might be that turtle's range did not extend to the Middle Murrin Brook.

Young (L.87) has not seen turtles for years and thinks it is too brackish for them, whereas Fryer-Smith (L.133) states "today you'll still find turtles in the fairly salty pools." Both the stated absence and presence of the turtles may be explained by relatively lower salinity levels in the lower reaches of the study area, where Fryer-Smith spent most of his time. In fact, Fryer-Smith's recollections also ranged to pools in the Tone Bridge area, i.e. downstream of the study area, and it may be to these pools that his reference to surviving turtles is pointing.

Gilgies

Both Mathew and Young give accounts of washing super bags in the river and pulling out the bags with gilgies attached, yet Mathew's (L.89) recollection of gilgies as "little tiny ones mostly" is at odds with Young's memory of "big black gilgies".

Indefinite recollections

Only two of the selected recollections fell within this category: Lee's (L.175) statement that "People used to catch ... probably a few marron here and there" and Mathew's recollection of "Frogs, I suppose" (L.90).

Corroboration of water quality recollections

Assessing the water quality recollections involved the difficult task of determining whether there were was a consistent theme across the recollections concerning salinity levels. A discussion of this point follows the table of matched recollections.

Table 4.5: Matched recollections for water quality

Note: italicised phrases refer to changed conditions.

Type of matched recollection	Matched references
Up to about the 1940s the water was potable with low-level brackishness, which increased over summer and over time.	See discussion below.
Water suitable for stock within living memory	Lee (L.38); Owen (L.36); Fryer-Smith (L.261, 374); Mathew (L.346), Young (L.135, 253).
Early recollections of clear water	Fryer-Smith (L.189); Mathew (L.80, 127, 174); Young (L.72); Harvey (L.30, 440).
The water was tea-coloured/ stained brown	Mathew (L.127); Young (L.253, 135).
The river was shaded [inference: cooling effect]	Owen (L.113); Mathew (L.132, 174), Fryer-Smith (L.97, 126).
A connection between clearing and salinisation of the river was observed	See discussion below.
A connection between increased salinity levels and decline in species abundance was observed.	Lee (L.355) – black ducks; Lee (L.93) – frogs; Mathew (L.84) – gilgies; Young (L.87) – turtles; Fryer-Smith (L.158, 238) – fish and marron.
Water clarity has declined	Young (L.75); Fryer-Smith (L.193); Harvey (L.30).

Comments on matched recollections

Reference salinity levels

Two interviewees (Fryer-Smith L.8, 35, 43, 66, 189; Ryall L.52) recall the water being fresh and make no mention of brackishness. Fryer-Smith's (L.8) recollection is dated to the early 1940s, and Ryall's reference to the headwaters of the catchment fits about the same time period. Young's (L.611) recollection of the use of a well very near the river as the original water supply for the old Woodenup homestead [circa 1919 to no later than 1945] adds support to the view that the river water was potable up to the 1940s. Young (L611) suggests this was perhaps because the water supply had gone brackish, however, it may have been due or contributed to by pollution risk (e.g. a septic system).

Other interviewees recall that the water was always a little brackish:

- Lee (L.206) and Owen (L.170) recall the water being "quite drinkable" [≤1000mg/L (R. George, pers. comm., 26/2/99)] with low-level brackishness in the upper reaches of the Tone River. Lee dates his recollection to the early 1920s, while Owen's recollection dates to his first contact with the river, which would have been in the 1940s.

- Mathew (L.374) remembers the water "not being brackish, except at the end of the "hottest, driest summers" when she was "very little". Mathew (L.374) also states it was never drunk at the Hubbe house at Woodenup because "it was always a bit on the brackish side", especially in summer, when as a small child, it was "too brackish even to pour on the garden" (circa early 1940s). There appears to be an inconsistency between these two statements.

  Young (L.267), Mathew's younger sister, also recalls that the water was not used on the garden, and that it was "brackish-ish in summer. it wasn't completely fresh." (L.132). Fryer-Smith's (L.366) recollection that the water was "very fresh" at Woodenup in the 1940s and 1950s is inconsistent with the recollections of the Hubbe sisters, who lived at Woodenup. However, it too supports the contention that the quality of the water was much higher within living memory than it is at present.

Other, largely unmatched, recollections which support this contention are listed below:

- Clover [<495 mg/L TDS; Agriculture WA 1990] grew right to the edge of Murrin Brook near Jingalup where now it is bare, salty ground – inferred 1940s-1950s (Fryer-Smith L.342).

- Horses were able to drink the water "without a great deal of worry" during a ride down the Tone River in 1946/47 (Mathew L.164).

- A large number of tracks of native cats, lizards, snakes and foxes ran to the water's edge in the 1940s-1950s; "... today you don't see that happening. They tend to go more to farm dams where the water is fresher" (Fryer-Smith L.227, 88).

- Dams sunk in the watercourses of the Tone catchment have been abandoned for the purpose of stock water (Fryer-Smith L.299; Mathew L.78; Young L.472).

- In drought years, the river was a major source of stock water (Fryer-Smith L.261).

- Pigs were watered [<4500mg/L TDS; Agriculture WA, 1988] from the river – *circa* early 1940s (Harvey L.326).

- River water was suitable for the garden at Glentone until about the 1960s (Harvey L.340).

These recollections are relative, not absolute, statements of water quality given the variability across seasons and change over time. Water flow in the Tone River is seasonal. Salt concentrations will increase in summer as the water level is reduced to a series of pools and evaporation occurs. The context of an interviewee's earliest recollection is also relative to the present. Since the interviewee's earliest recollections, levels are considered to have increased greatly. For example, the river water is no longer suitable for stock, except perhaps in winter or further down the Tone River (Lee L.190; Mathew L.217; Fryer-Smith L.322). Therefore, the river water may have been fresh in the past relative to its present condition. Another factor to be considered is that quite a lot of clearing had already taken place in the upper Tone

catchment by the 1940s, so a change in water quality may already have been underway, as suggested by Lee (L.190; 255).

On the whole, these recollections support at least a lowest common denominator view of salinity levels in the upper Tone River up to about the 1940s: that the water was potable with low-level brackishness, which increased over summer and over time. I have chosen to view the "lowest common denominator" for salinity levels as a "matched" recollection because the recollections support the position that there has been a significant change in the quality of the water from the time of interviewees' earliest recollections to more recent times, and this is an important piece of corroboration. This discussion has highlighted the fact that the recollections do not provide a specific reference point in relation to water quality at the time of the interviewees' earliest recollections.

Increasing salinity levels

Recollections of increasing salt loads in the Tone River and its tributaries refer to a number of time periods. Lee (L.190; 255), born in 1911, recalls that Murrin Brook started to go salt in "about the mid-1920s", citing the creek near the Jingalup Reserve and golf course (see Figure 3.1) as the first area to go salt following ring-barking in the late nineteenth century. Mathew (L.217), born in 1934, recalls the change starting "... after 1948, right into the '50s and beyond". A close reading of the transcript suggests that Mathew's recollections also reflect the effects of clearing in the Katanning area, where she was attending boarding school until about 1950. Ryall (L.162), born in 1929, also places the change "probably in the 1950s". Owen (L.159), the same age as Mathew, cites the '60s and '70s as the period when they realised there was a problem with salt "breaking out on the hillsides" and the salt "going up the creeks". Similarly,

Young (L.472), Fryer-Smith (L.255) and Harvey (L.350) all recall the increase in salinity dating to about the 1960s. The common thread in almost all the interviews is the perception that there was a connection between the extensive clearing that took place following the arrival of the bulldozer after the Second World War, and an increase in salinity of the river and land (Lee L.73, 110; Mathew L.207; Young L.470; L.378; Ryall L.162; Fryer-Smith L.253; Harvey L.230, 350). Young recalls "... more salt and less vegetation was really the difference between the 1940s and the 1970s." A match has been recorded for this common feature of the interviews, i.e. the connection between extensive clearing and salinisation.

Unmatched recollections

Three of Lee's (L.210) recollections were unmatched across the interviews: seeing an oily film for the first time on the pools near Jingalup in the 1920s (L.210) (presumably caused by iron bacteria associated with groundwater discharge (R. George, pers. comm. 26/2/99)); Murrin Brook starting to go salty in the mid-1920s (L.190), and his memory of the site of the first area to go salty in the Jingalup area (L.194). Fryer-Smith's specific recollection of cool/cold water in pools (L.122, 126, 169), and Mathew's (L.131) memory of the salt appearing for the first time on the bank as the water levels dropped in summer, were also unmatched.

Inconsistent or incommensurable recollections

Two instances of inconsistent recollections, concerning salinity levels in the river at Woodenup farm, were noted in the discussion above.

Indefinite recollection

One indefinite recollection was recorded concerning a well located near the Tone River becoming unusable, "presumably because it had gone brackish" (Young L.611).

Cross-interview corroboration statistics

The results of the preceding discussion are quantitatively summarised in Figure 4.7.

Using the chi-squared test it was found that no significant difference exists between information type (ecosystem attributes) and the degree to which they are matched ($X^2 = 0.936$, d.f. = 3, $p > 0.05$). Therefore the null hypothesis is accepted.

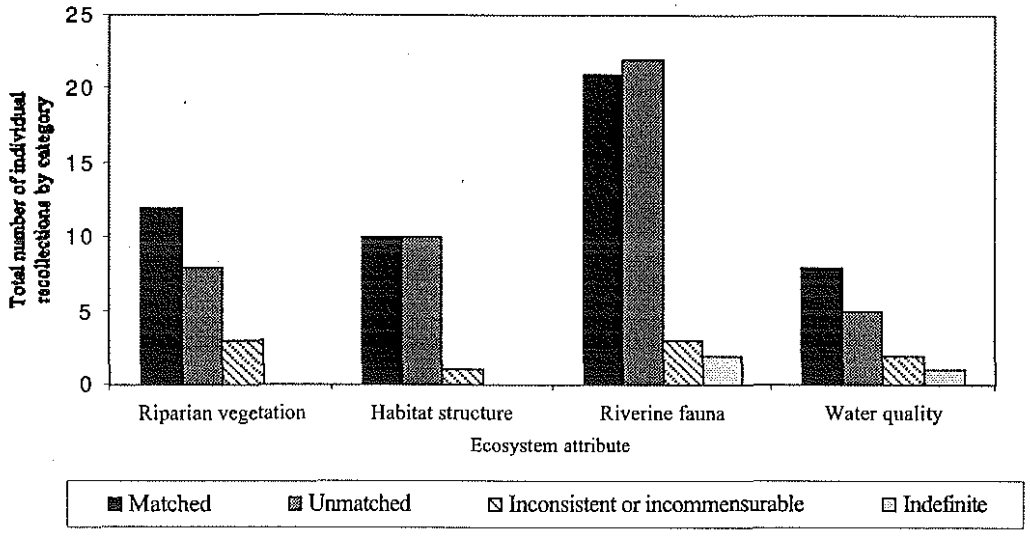


Figure 4.7: A cross-interview assessment of the validity of the recollections according to four categories.

Reflecting on the preceding corroboration statistics it is evident that:

1. The difference between the number of matched recollections and the combined value of the other categories is relatively constant across the environmental attributes.

2. Almost 50% of the total number of records across the credibility categories (n=108) were in the matched category, followed closely by unmatched.

3. Inconsistent or incommensurable recollections were identified across the four environmental attributes, but in low numbers, representing only 8% of the total of 108 records across the credibility categories. An even smaller number of indefinite recollections were identified across the environmental attributes.

With respect to the qualitative analysis of the recollections, which gave rise to the preceding statistics, several points stand out. First, a number of limitations in the recollections help to explain the fact that nearly 50% of the total number of records (n = 103) is made up of unmatched and inconsistent or incommensurable recollections. I have noted previously that interpretation of the recollections is limited or constrained by:

- spatial, temporal and seasonal variation
- the need for greater detail in the recollections to assist with establishing dates, locations, dimensions, species and the environmental variations noted above
- subjective and imprecise language (e.g. concepts like "deep" and "wide").

Recognising these limitations, or constraints, is of crucial significance to the results of this study. By seeking clarification from the interviewees in the form of more detailed and exact information it is likely that these constraints can be alleviated significantly. Therefore, the measure of validity and reliability revealed here in the cross-interview analysis cannot be considered conclusive.

These limitations have a further consequence. They tend to result in a 'loss' of information in order to achieve a match across the different interviews. A match often requires the recollections to be pared to a minimum because detail provided by one

interviewee (e.g. the common name and type of a call of a frog species and dramatic change in its abundance, Lee L.88) is not matched by detail in another (e.g. dramatic decline in abundance of frogs only, Harvey L.368). The match is described as 'dramatic decline in abundance of frogs', and the information about the type of frog is recorded as unmatched. This unmatched information might be valuable and needs to be corroborated using other information sources if possible.

The results of the cross-interview analysis provided the data for the triangulation exercises.

4.2.3 Triangulation exercises

The purpose of the triangulation exercises was to ascertain whether the corroboration achieved in the cross-interview analysis could be strengthened using other information sources, and whether corroborative sources could be found for the unmatched recollections. An attempt was also made to resolve the placement of some recollections in the inconsistent or incommensurable category. The two ecosystem attributes selected for the exercise were riparian vegetation and water quality.

Sources used

A list of the types of materials consulted during the triangulation exercises is provided below. The groupings of materials reflect the categories also used in the scientists' evaluation.

1. Aerial photographs, commencing with the earliest run undertaken by the Commonwealth Department of Defence in 1943 (Dinninup Run 8, scale 1:23270), followed by State Government photography taken in July 1961 (Dinninup Run 10) for the Murrin Brook area, and March 1962 (Balbanup Run 3) for the lower section of the study area.

2. State archives, including:

   a) 'Land Tax – Classification and Valuation Forms' consisting of sketch maps and notations held by the Valuer General's Office for individual location numbers along the Tone River. An example of the form is provided in Plate 2. The forms cover the period 1911 to 1939 for the Murrin Brook and Tone River sections, and include comment on vegetation patterns and soil types. Dates are frequently shown as *circa* because some sketch maps and notations appear to have been prepared or amended by different people, warranting some caution over the document date.

   b) 'Classification and Valuation Forms' consisting of former Department of Lands and Survey's land surveyor sketch maps and notations held by the Department of Agriculture (formerly held by the Department of Land Administration) for individual location numbers along the upper Tone River section of the study area. An example of the form is provided in Plate 3. Only forms covering this section could be found (i.e. no records were located upstream of and including Woodenup farm). These contain similar classes of information to the Valuer General Office 'Land Tax – Classification and Valuation Forms', and also contain information on "prospects and manner of obtaining water". Dates are recorded as per the forms held by the Valuer General's Office.

   c) Explorer journals held by the Battye Library relating to expeditions passing close to the Jingalup area, including those of Stirling (1835, 1837), Nairn-Cross (1840), Hillman (1837, 1838), Bannister (1831) and Roe (1835). These are located in the *Exploration Diaries* Volumes 1 to 6. It appears that there were

no traverses of the study area, but numerous visits to nearby rivers, principally the Balgarup and the Gordon, were noted.

3. Published scientific literature: relating to vegetation (Beard 1980), water quality records (Schofield et al 1988; Davies and Bari 1995), assessment of river condition (Pen 1997), specific riverine fauna studies (Morrissy 1978), and other relevant environmental histories (Sanders 1991). Both Schofield et al and Davies and Bari are essentially analyses of the extensive database now held by the Water and Rivers Commission, but also incorporate references to published scientific papers and specific experimental works on water quality change. The water quality information was useful in establishing general trends in salinity levels for the Warren-Tone system.

4. Scientific records and databases. No search was done of Herbarium databases because it was felt that the emphasis in the corroboration process was on the pattern of vegetation, and single taxonomic records from specific locations were unlikely to be of corroborative value.

5. Community archival material:

   a) Three published Kojonup histories (Bignell 1971, 1991, 1997).

   b) An unpublished thesis of the history of Jingalup (Barker , c.1959).

Plate 2. Sample of "Land Tax – Classification and Valuation Form" held by the Valuer General's Office. The form depicts broad vegetation associations along the Tone River at Location Number 7541, south of Woodenup Pool. The sketch map is drawn at a scale of "20 chains to the inch". The form is dated 22 July 1921.

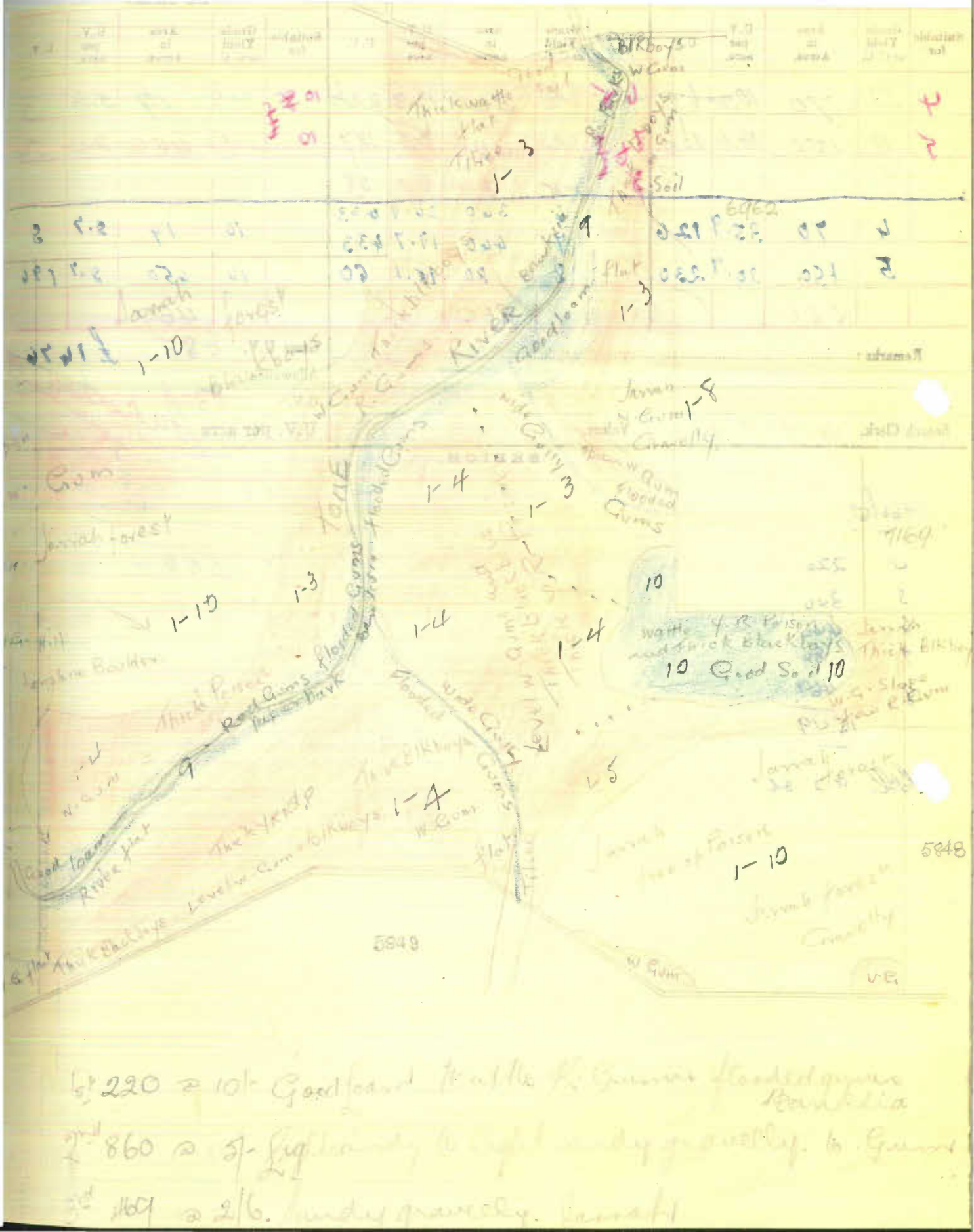
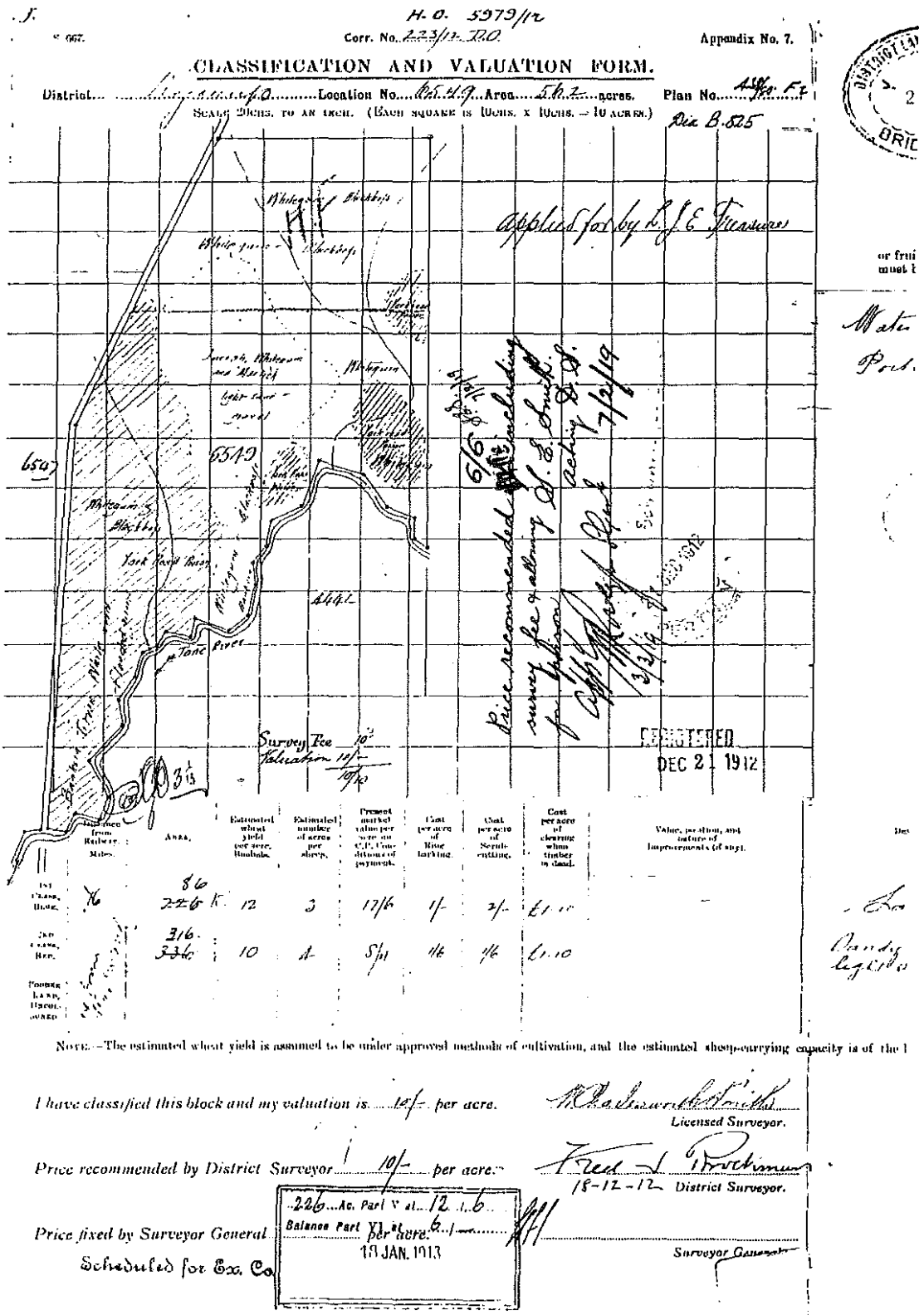


Plate 3. Sample of "Classification and Valuation Form" held by the Department of Agriculture (formerly held by the Department of Lands and Surveys). The form depicts broad vegetation associations along the Tone River at Location 6459, adjacent to Wackelingup Pool. The sketch map is drawn at a scale of "20 chains to the inch". The form is dated 18 December 1912.



H.O. 5979/12

Corr. No. 223/12 T.O.

Appendix No. 7.

CLASSIFICATION AND VALUATION FORM.

District... Location No... Area... acres. Plan No...

Scale 20chs. to an inch. (Each square is 10chs. x 10chs. = 10 acres.)

Dis. B. 525

Applied for by L.J.E. Treasure

Water Pool.

6540

6543

Tone River

Survey Fee 10/-

Valuation 10/-

10/-

REGISTERED DEC 21 1912

Distance from Railway. Miles.	Area.	Estimated wheat yield per acre. Bushels.	Estimated number of acres per sheep.	Present market value per acre on C.I.F. Conditions of payment.	Cost per acre of Rabbit barring.	Cost per acre of Scrub-cutting.	Cost per acre of clearing when timber is dead.	Value, per acre, and nature of Improvements (if any).
1st Class, Blue.	86 226 K.	12	3	17/6	1/-	2/-	£1.10	
2nd Class, Red.	316 336	10	4	8/11	1/6	1/6	£1.10	Sandy light loam
Poorer Land, Brown, mixed								

Note.—The estimated wheat yield is assumed to be under approved methods of cultivation, and the estimated sheep-carrying capacity is of the l

I have classified this block and my valuation is 10/- *per acre.* H. Charles Stewart Smith
Licensed Surveyor.

Price recommended by District Surveyor 10/- *per acre.* Fred L. Hutchinson
18-12-12 *District Surveyor.*

Price fixed by Surveyor General 226 Ac. Part V at 12/6
Balance Part VI at 6/-
18 JAN. 1913

Scheduled for Exc. Co.

Surveyor General

Gaps in sources of other historical records

Water quality records were available from the Water and Rivers Commission for the Tone River but they were too recent (commencing in 1978) to be used to corroborate the recollections (see 4.1.1 for further discussion of this point).

A search of the Battye Library photographic collection located some good general shots of the Murrin Brook area but nothing that assisted with triangulation. Personal diaries and photographs of the river were sought from interviewees and other local people recommended to me. Very few useful black and white photographs were available. Ryall's father, who farmed about 10 km from the Tone River, kept a diary but it appeared not to contain any entries about the river. A small number of other diaries tracked unrelated events. Young and Mathew's father kept a diary but it was burnt in a bushfire in 1963.

Abbreviations used

The following abbreviations have been used to assist with the presentation of material:

- VGO: original sketch maps held by the Valuer General's Office. The number recorded immediately after 'VGO' is the location number of the land area.
- DLS: original sketch maps prepared for the Department of Lands and Surveys. The number recorded immediately after 'DLS' is the location number of the surveyed land area.

Results of triangulation exercises

The results of the triangulation exercises are presented in Tables 4.6 and 4.7. The information within the tables is arranged in sequence commencing in the headwaters and extending downstream. Whether the type of matched recollection has been corroborated ("C") or not corroborated ("NC"), is recorded in the third column.

Attempts to corroborate unmatched recollections are discussed in the text. The results of the exercises are quantitatively summarised in Table 4.8.

Table 4.6: Triangulation of recollections matched during cross-interview analysis: riparian vegetation

Type of matched recollection from cross-interview analysis	Potential source of corroboration	Corrobor-ative status
Extensive areas of thick tea-tree scrub along Murrin Brook and other tributaries in the upper reaches of the Tone River.	Quite large flats containing vegetation consistent with tea-tree are evident in: • a 1km x 50m wide band along Cockatoo Creek on the 1943 Cwlth aerial photo (Dinninup Run 8, 30526). These same areas are marked as "scrubby" on VGO6070 (c.1919) and DLS6865 (c.1912) • an area along Murrin Brook east of Woodenup Rd on a Cwlth aerial photo (Dinninup Run 8, 30522), which was also consistent with a tea-tree/paper-bark area on VGO4295 (c.1925). • an area just west of the Jingalup townsite, including the Mininiup Pool area, appeared to be tea-tree on a Cwlth aerial photo (Dinninup Run 8, 30515-16) and was consistent with VGO6613 (c.1911) sketch map marked with "scrubby ti-tree". Note: Interpretation was difficult owing to the relatively poor quality of the 1943 photos. Additionally, Beard's (1980:17) classification of the "Jingalup System", which covers part of the Murrin Brook area, states that "major creeks are lined by *E.rudis, Melaleuca cuticularis* and *M. viminea*".	C
Blue gum/flooded gum trees/areas close in to the watercourses, including Murrin Brook and the Tone River.	A narrow band of trees lining considerable sections of the main watercourses is evident in 1943 Cwlth aerial photos (Dinninup Run, e.g. 30522) and the 1962 DOLA aerial photos (Balbanup Run 3). Flooded gum is marked along Murrin Brook on VGO4295 (c.1925), and its tributaries (VGO6048 c.1921). Sketch map notations of flooded gum along the Tone River include VGO7541 (c.1921), south of Woodenup farm; DLS6549 (c.1912) on Harvey's farm; and DLS6553 (c.1922) near Nymiup Pool. Tributaries of the Tone are also marked flooded gum on DLS6548 (c.1922) and DLS6755 (c.1912). Beard's (1980:17) classification of the "Jingalup System", which covers part of the Murrin Brook area, states that "*E.rudis* occurs along minor drainage. Major creeks are lined by *E.rudis, Melaleuca cuticularis* and *M. viminea*". (Note: blue gum/flooded gum = *E.rudis*).	C

Presence of a variety of other tree species (red gum, wandoo, jarrah) in the vicinity of the brook and river.	A narrow band of trees lining considerable sections of the main watercourses is evident in 1943 Cwlth aerial photos (Dinninup Run, e.g. 30522) and 1962 DOLA aerial photos (Balbanup Run 3). White gum is shown along Murrin Brook near Jingalup on VGO6946 (1924). A short distance downstream, jarrah, red gum and white gum are shown to occur adjacent to the river flat of "scrubby ti-tree" (VGO6613, c.1911) Red gum is marked along the river about 3 km downstream of Woodenup Pool on VGO7541 (1921). "Red gum" is marked adjacent to the river on Harvey's farm DLS6547 (c.1939), now location 8751. Interestingly, the notation on an earlier sketch map (c.1912) for the same location reads "whitegum, jarrah, blackboys' adjacent to the river. "Odd jarrah" about half way between Wackelingup and Nymiup Pools is noted on the VGO6553 (1956) sketch map, (probably drawn with the assistance of aerial photography). Red gum and white gum are marked adjacent to the river on DLS6553, 6545 & 6548 (c.1922), in the vicinity of Nymiup Pool.	C
Wattle close to the brook and river.	Beard (1980:17) commented that there were three common wattles in the Jingalup System, including jam wattle (*Acacia acuminata*). A quite extensive area of "jam wattle" is noted downstream from Mininiup Pool on VGO6432 (1919). 'Thick wattle flat & ti-tree" is noted on VGO7541 (c.1924), about 2.5 km downstream of Woodenup Pool; wattle is marked adjacent to the Tone River just north of Palligup Pool on DLS6755 (c. 1913); and also on DLS6553 (c.1922), near Nymiup Pool.	C
Yate in flat areas along the watercourse.	Presence of yate is noted in the middle Murrin Brook area (VGO6946, 1924) and at the other end of the study area on "swampy, level to flat clayey soil", near Nymiup Pool (VGO6653 1956, probably drawn with the assistance of an aerial photo).	C
On Woodenup farm a lot of banksias grew on an area of sandy soil along the river to the west of the old homestead.	No corroborative records were found specific to Woodenup farm, but banksia was noted about 2.5 km downstream on VGO7541 (c.1924), and in a number of other downstream locations.	C

Paperbark downstream of where the tributaries joined to become the Tone.	Paperbark are recorded along the river on VGO7541 (c.1924), about 3 km south of Woodenup Pool. Note: paperbark also recorded upstream along Murrin Brook VGO4295 (1925).	**C**
Natural grasses/ grassland areas along the river.	No other records located.	**NC**
Rushes along the edge of the watercourse.	No other records located.	**NC**
Relative tolerance of blue gum to increase in salinity levels.	No other records located.	**NC**
Death of tea-tree with increase in salinity levels.	An extensive area of healthy tea-tree is evident along Cockatoo Creek in a 1943 Cwlth aerial photo (Dinninup Run 8, no. 30526), and this shows as a bare, saline area by 1995 DOLA aerial photo (Dinninup Run). However, the vegetation may also have been cleared, burnt and/or grazed.	**NC**
Tree death and appearance of samphire near watercourses following clearing and rising salinity levels.	A number of oral histories in Sanders (1991:22) commented on samphire colonising and increasing around lakes in the wheatbelt area during this century, a region where extensive clearing has occurred.	**C**

Attempted corroboration of recollections unmatched in cross-interview analysis

There is reference to sheoak along Murrin Brook near Jingalup (VGO6946, c.1924), which supports Lee's (L.108) recollection of sheoak in the area. Furthermore, in Beard's (1980:17) description of the Jingalup system he includes *Casuarina huegeliana* as one of the small trees likely to be present.

In the following discussion, one of the two related recollections is corroborated. Fryer-Smith (L.211) observed that in the upper Tone River area "... close to the watercourse, you are more confined to just flooded gum and wattle". As shown in the table above, flooded gum and wattle were clearly present along the river. However, the VGO and DLS mapping supports a more varied vegetation adjacent to the rivers, with the presence of various eucalypt species, banksia, York Road poison, blackboys, and paperbark. This corroborates Harvey's (L.191) recollection that "... the vegetation was really varied" along the river (Glentone farm area). Nonetheless, the land surveyors may well have been more concerned about recording vegetation on the arable land back from the river, rather than on the immediate water's edge. Additionally, it is difficult to determine the boundary of the riparian zone from the surveyor records and the interviews. For the purpose of this analysis, I have treated Harvey's recollection as corroborated but not Fryer-Smith's.

No corroboration was available for the remaining six of the eight previously unmatched recollections.

Investigation of inconsistent or incommensurable recollections

The VGO and DLS records corroborate the variability in the proximity of jarrah, wandoo and red gum to the river provided in the interviews.

The prevalence of poison plants in the vicinity of the river/brook is well established in other historical sources, such as the VGO and DLS records. Lee's (L.130, 156) recollection of poison near the river/brook is corroborated by VGO6613 (c.1911) and VGO6946 (1924). Mathew (L.51) referred to the absence of poison in the vicinity of Woodenup Pool area. This is supported by VGO4295 (1925) which makes no mention of poison plants on the land immediately around Woodenup Pool. However, the same mapping makes no mention of poison elsewhere on the property, yet Mathew (L.51) recalls its occurrence elsewhere on the farm. I have treated Lee's recollection as corroborated, but not Mathew's.

No progress could be made on the remaining inconsistent recollection without clarification from the interviewee.

Material not in the oral histories

It appears poison plants and blackboys were quite abundant close to the river in the upper Tone section of the study area, yet neither Harvey nor Fryer-Smith mentions their presence along the river. York Road poison and blackboys are marked north of Palligup Pool on DLS6755 (c.1912), on the other side of the river DLS6280 (1918), and also along the river on Harvey's farm (VGO6547 c.1913; now location number 8751). It is possible that the poison was eradicated prior to the period Harvey and Fryer-Smith are recalling. Banksia were only mentioned in relation to the Tone River on Woodenup farm, but their presence is noted on a number of sketch maps down river (e.g. upstream of Palligup Pool (DLS8007, c.1923); in the vicinity of Wackelingup Pool (DLS6549, c.1912); and about half way between Wackelingup and Nymiup Pools (VGO6553, 1956).

Table 4.7: Triangulation of recollections matched during cross-interview analysis: water quality

Type of matched recollection from cross-interview analysis	Potential source of corroboration	Corrob-orative status
Up to about the 1940s the water was potable with low-level brackishness, which increased over summer and over time. [Fresh (potable) water is defined as <500 mg/L TDS; 500 – 1000 mg/L is considered marginal and may be acceptable drinking water based on taste (WRC 1998a)].	Indications that the water was potable are given by the following historical sources and reports: • "they established large vegetable plots along the edge of the Murrin Brook" on location 4447 (Barker c.1959:17), which includes Mininiup Pool. Although this suggests the stream water was used for irrigation, it may have been a winter garden, situated along the Murrin because of the soil. An indication of the salinity levels are given by the range of tolerance of many vegetables to total salts in irrigation water, which is 495 to 1485 mg/L (Agriculture WA 1990). • "Pools on the river may be relied on generally till about Christmas time" (DLS6280 (c.1918), north of Palligup Pool). • "water could be obtained from ... River" (DLS6549 (c.1912), incorporating Wackelingup Pool) • "some fair water holes along the river" (DLS6566 (1919), just east of Wackelingup Pool). The fact that the water could be brackish over summer is noted as long ago as 1921. In relation to DLS6553 it is stated "the river ... has permanent water which is brackish towards end of summer." Pen (1997:62) states "it is likely that the upper reaches of the Warren . . . were always at least marginally fresh ... but have become more saline as a result of land clearing in low rainfall areas (<700mm)". Increases in "brackishness" (salinity) over time have been well documented. The overall average annual salinity for the Warren-Tone River is recorded as increasing by 15 mg/l/yr between 1940 and 1988 (Schofield et al 1988:35,49) based on a monitoring site in the lower reaches of the Warren-Tone Catchment. In the Warren River "the rate of stream salinity rose markedly after 1955", Schofield et al (1988:4). A 1995 study confirmed that for salt concentration "the Tone River has an increasing trend of 53 mgL^{-1} TSS", and "there is an increasing trend of annual salt load for the Tone River" (Davies and Bari 1995:29).	C

Water suitable for stock within living memory	*In 1891 a 40 foot deep well was sunk on (what is now) Fares Pty Ltd farm lands on the northern side of Murrin Brook, near Jingalup: "... the water is now affected by salt seepage [but] in the drought year of 1940, thousands of gallons were carted from the well, which would draw about 1,200 gallons per day ... to water stock on their property" (Barker c.1959:11; no reference provided).* "I think about 1935 ... there was no stock water left on the farm. I spent many months shepherding sheep along the Tone River. This was not a great hardship as the water was fresh". (Walter Furniss quoted in Bignell 1997:118; Furniss was probably referring to the section of the Tone closest to his farm, which was south of Nymiup Pool).	C
Early recollections of clear water	No turbidity records for the Tone River prior to the late 1970s.	NC
The water used to be tea-coloured/stained brown	No water quality records for the Tone River prior to the late 1970s.	NC
The river was shaded [inference: cooling effect]	Aerial photographs (e.g. 1962 Balbanup Run 3, No 5063 (DOLA)) indicate a narrow band of quite dense cover along the river. Some river sections and larger pools (e.g. Wackelingup Pool) are visible (i.e. not fully shaded), other sections are obscured by vegetation, particularly in areas where the land adjacent to the riparian zone is uncleared.	C
A connection between clearing and salinisation of the river was observed	"Agricultural clearing almost invariably results in increased stream salinity in the south-west" (Schofield et al 1988:32). The overall average annual salinity for the Warren-Tone River has been documented as increasing by 15 mg/l/yr since 1940 (Schofield et al 1988:35,49). In the Warren River "the rate of stream salinity rose markedly after 1955", which is consistent with the second major phase of clearing in the catchment identified by the interviewees, and described by Schofield et al (1988:4).	C

A connection between increased salinity levels and decline in species abundance was observed.	• Lee (L.355) attributes the decline in black duck to increased salinisation. Saunders and Ingram (1995:48) state that salinisation resulting in loss of suitable habitat is one reason for the decline in abundance of the black duck. • Young (L.87) thinks tortoises have declined due to salinity. According to Pen (1997:106), "tortoises appear to be at risk from salinisation . . . but are still present in river pools . . . that exhibit considerable degradation". This is consistent with Fryer-Smith (L.131) who comments "today you'll still find turtles in the fairly salty pools." Young's observations are from further upstream, where salinity levels are probably higher. • Lee (L.93) refers to a massive decline in frog populations due to rising salinity. Pen (1997:106) states "most [frog] species are sensitive to changes in salinity . . . . The probable impact of salinisation on frogs bas not been documented." Main (1990:400) concurs. Of course, frog decline has been noted globally, and other possible factors in their decline include agricultural chemical use (Tyler 1994:161). • Fryer-Smith (L.238) stated that salinity caused the virtual extinction of fish life (referred to elsewhere by Fryer-Smith as "perch") in the river. From oral histories of wheatbelt wetlands, Sanders (1991:24) found "the disappearance of fish from wetlands ... coincided with increased salinity." Redfin perch (*Perca fluviatilis)* is one of the species mentioned. Pen (1997:106) claims that the introduced redfin perch has declined "probably as a consequence of salinisation and low oxygen levels." • Mathew (L.84) attributes the loss of gilgies in a pool on Woodenup farm to rising salinity, and Fryer-Smith (L. 60) infers higher salinity levels in the upper reaches of the Tone have been detrimental to marron. Using oral histories of various rivers in the wheatbelt Sanders (1991:25) found "it appears that crustaceans [gilgies and marron] disappeared from 10 to 20 years after the onset of salinisation was first noticed." No corroborative scientific sources have been identified for gilgies, whereas some work has been done on marron. Morrissy (1978:7) notes in relation to marron that "the decline has been associated usually with the obviously increasing salinity of inland rivers following clearing and agricultural development." He states, however, that "there is no positive evidence that high salinities *per se* were responsible alone for the documented decline in inland stocks of marron" and concludes that marron stocks have "retreated" down the rivers "because of oxygen depletion produced by summer eutrophication" (Morrissy 1978:5,14).	**NC**
Water clarity declined	No water quality records for the Tone River prior to the late 1970s.	

Attempted corroboration of recollections unmatched in cross-interview analysis

No corroborative sources for the five unmatched recollections were found.

Investigation of inconsistent/ incommensurable recollections

The one inconsistent recollection concerning salinity levels at Woodenup farm could not be resolved.

Summary and conclusions

The results of the triangulation exercises are set out in Table 4.8. Seven of the 12 matched recollections from the cross-interview analysis of the riparian vegetation were corroborated, along with four recollections from the unmatched and inconsistent or incommensurable categories. Half of the water quality recollections matched in the cross-interview analysis were corroborated, but no progress was made with respect to the unmatched, inconsistent or incommensurable recollections.

Table 4.8: Results of triangulation exercises

	Corroborated	Not corroborated*
Riparian vegetation**	11	13
Water quality	4	10
Total	**15**	**23**

* Includes previously unmatched and inconsistent or incommensurable recollections. Indefinite recollections are not included.

** Note: the increase in the number of riparian vegetation records (n=24) compared with results of cross-interview analysis (n=23) in Table 4.2 reflects an instance where the corroboration of one recollection within an inconsistent record was achieved, resulting in two records.

The triangulation exercises were aimed at determining whether information from the oral histories could be corroborated for validity (i.e. factual accuracy) using other information sources. The conclusions are:

1. In most cases any inability to corroborate the recollections generated by the cross-interview analysis was due to the lack of corroborative material. To the extent that such material was found, the recollections were almost all found to be valid. The one exception is discussed under point 2, below.

   Two limitations of this result need to be born in mind. First, in the research time available I cannot claim to have exhausted all possible sources of corroboration, and some of this 'missing' material might conflict with some of the corroborated recollections. Secondly, in the course of doing the cross-interview analysis, matched recollections were pared to core shared information, and important detail of dates and geographical locations often had to be discarded. This widened the gap between the temporal and spatial scale of the recollections and the corroborative material. Corroborative sources, including the aerial photographs and the records of the Valuer General's Office and the Department of Lands and Surveys, were already at a finer temporal and spatial resolution than the original recollections – many of the recollections did not specify dates or locations with precision, whereas this information was usually specified or readily apparent in the other sources.

2. The lack of corroboration of the interviewee's perceived connection between decline in species population and increasing salinity, was generally not a case of conflicting information but inconclusive science to substantiate the claim.

   While there was scientific support for some of the individual recollections (e.g. in relation to the decline in black duck numbers), generally it was not conclusive. For example, it was noted that frogs are sensitive to changes in salinity but the probable impact has not been documented (Pen 1997:106). Salinity is considered by one

interviewee to be the reason for the decline in abundance and distribution of marron, but the principal cause is likely to be other factors (Morrissy 1978).

Roberts and Sainty (1997:32), who found that "the reconstructed ecological history can only be a correlation, rather than hypothesis testing for cause and effect", have noted the issue. Their oral history study of the Lachlan River in NSW concludes:

The ecological impact of carp cannot be confirmed by the oral history process. A strong correlation is evident ... between the arrival of carp and changes in water quality and loss in plants; correlation alone is inadequate .... The procedure for complete confirmation requires first identifying the mechanisms, then testing in the field, and finally confirming the relevance in an appropriate scaling-up procedure.

Sanders (1991) accepts that oral histories of the wheatbelt wetlands have established at least a strong correlation between salinity and various biological impacts. Two examples from her study illustrate this point: "Frogs have also disappeared since the increase in salinity levels in the wetlands" and "using oral histories ... it appears that crustaceans disappeared from ten to 20 years after the onset of salinisation was first noticed" (Sanders 1991:25).

In addressing the effects of environmental change, the Tone River oral histories do lend support to the perceived correlation between events noted in other studies (e.g. Sanders 1991), but they cannot be definitive.

3. In the triangulation of riparian vegetation it was noted that some detail, relating to poison plants and banksia, was provided in sources such as the VGO and DLS records that were absent in the oral histories. This highlights an issue that needs to be born in mind in triangulation. The sources of information come from different time periods, which may produce complications. Lee's recollections began in about 1920, at least 20 years before most of the other interviewees. The VGO and DLS records generally coincide with Lee's earliest recollections, but predate the

other interviewees. The commencement of aerial photographs, on the other hand, coincides with the earliest recollections of a number of the interviewees. Since degrading and restorative processes are always at work, comparison of data across different time periods must be treated with caution.

In this Chapter the oral histories have been evaluated for their capacity to inform ecological restoration and provide reliable and valid information. The analytical tools developed in Chapter Two were augmented by an assessment of the role of the interviewer's questions and an independent evaluation of the recollections by a group of independent scientists. The implications of this analysis and the role of interview method are discussed below.

CHAPTER FIVE

5. DISCUSSION

This project explored the value of environmental oral histories for ecological restoration and their legitimacy as a source of factual information. The aims and associated research questions focused on whether environmental oral histories can be evaluated for factual accuracy and their capacity to be useful in the restoration process, using a number of analytical tools. Three analytical tools were developed in Chapter Two to provide for the evaluation of the transcripts. These tools drew on four main bodies of literature: restoration ecology, environmental history, oral history and qualitative research theory.

The study's first research question required assessing the relevancy and comprehensiveness of the interviews against a set of ecosystem attributes pertaining to river restoration, and evaluating the usefulness of the recollections to the restoration process according to three uses of historical information identified in the restoration ecology literature. In response to the second research question, recollections extracted from the interviews were subjected to an independent evaluation by scientists, and to cross-interview analysis, before being corroborated against other information sources to assess their reliability and validity.

5.1 Interview method

Interview method was discussed in Chapter Three. During the analysis it became apparent that the results were constrained by the use of broad, open questions. I therefore begin this discussion by addressing whether the interview method enabled the study's aims to be achieved. The interview method may have reduced the potential for the oral histories to provide data that would be of value to restoration and have the

capacity to be examined for factual accuracy. On the other hand, there are sound reasons for pursuing the approach used and it could be regarded as a successful outcome as a first phase of an interview process. There is support in the sociological literature on participant observation for the notion that volunteered rather than directed statements have a higher evidentiary value because they have been made independently of the observer (Becker 1958:655). According to Becker (1958:655), volunteered statements are:

> *likely to reflect the observer's preoccupations and possible biases less than one which is made in response to some action of the observer, for the observer's very question may direct the informant into giving an answer which might never occur to him otherwise.*

A parallel can be drawn between the role of the participant observer and my role as interviewer. I showed in the analysis of the interviewer's role that I had not had a marked influence over the relative amounts of information provided by the interviewees.

Another argument for the chosen interview method is the value attached to local people's stories about the biophysical environment in which they live. It was useful to give interviewees the freedom to focus on what is important to and understood by them. This information may have special value as 'unsolicited' sources of restoration goals and endpoints revealed through interviewee's stories about the river. Popper and Popper (1996:18) describe the importance of stories in a regional planning context:

> *Stories ... highlight a region's distinctive, valuable features, defining what is worth protecting.*

Popper and Popper (1996:18) have drawn on published stories about regional ecosystems to mount their case, arguing that "writers often first distill the spirit of a region." In the context of my study area, which is now an uncharismatic physical

setting for an 'outsider' to consider using as the focus of picture hook or a published narrative, oral histories can be the medium for local people to tell their stories.

Earlier I noted that the interview method might have reduced the potential for the oral histories to provide information that would be of value to restoration, and have the capacity to be examined for factual accuracy. I have shown in Chapter Four that if detailed biophysical information is needed to inform the restoration process, specific questions and some probing questions are necessary to establish dates and geographical locations of observations, to clarify imprecise language (e.g. concerning size or depth), and to make identification of species more feasible. Moreover, information about a range of ecosystem attributes might be overlooked unless actively sought in the interview or a follow-up interview (e.g. information about water quality components and biological interactions).

The deliberate non-use of specific questions, probing and prompting meant that interviewee's observations and experiences were not fully explored, and therefore the measure of reliability and validity obtained for the upper Tone is inconclusive in a number of respects. First, in their evaluations the scientists may have found more of the recollections potentially verifiable if the interviews had contained more specific information. Secondly, there may have been fewer unmatched recollections in the cross-interview analysis if the generalities had been reduced – it may also have been less difficult to perform the analysis because the common aspects and differences across the interviews would have been more apparent. Thirdly, with respect to the triangulation exercises, there may not have been such a difference between the relatively fine resolution of the temporal and spatial information provided by other sources and the relatively coarse information contained in the recollections.

The interview method also meant that I did not explore the full depth of the interviewee's recollections of the biophysical environment and therefore the assessment of their usefulness may understate the potential for oral histories to inform the restoration process. Compared with the results of other studies (e.g. Roberts and Sainty 1997), I did not achieve the same level of ecological reconstruction of a 'pre-disturbance' environment. The smaller number of interviews may also have contributed to this result.

5.2 The usefulness of the oral histories to ecological restoration

The analyses of the recollections against a set of ecosystem attributes demonstrated information relevant to river restoration was obtained, but it generally lacked comprehensiveness and there were gaps. The results of applying the classification of historical uses (Table 2.2) showed the recollections were probably most significant for one of the three uses - setting goals for restoration. Information about degrading processes was generally limited to the perceived environmental impacts of clearing, in particular those associated with rising salinity levels. Most of this information was not at a level of detail that goes beyond existing knowledge of degrading processes in south-western rivers. It is also impossible to dissociate the information provided from the emphasis in the media and elsewhere on salinisation as a land degradation problem. However, the recollections of natural revegetation processes indicate an area where oral histories might be of significant value. These are less likely to have been influenced by external information sources, and the process may be more readily observed than a number of the degrading processes identified in the interviews (e.g. increasing water salinity levels). Moreover, ecological restoration is not only interested in the why, how and when of degrading processes, but also in the restorative

processes that come in to play. More emphasis could be placed on collecting recollections about the latter. Since in most cases, there are fewer local people surviving who have witnessed the degradation associated with the early period of clearing in south-western Australia, a focus on environmental response (resilience and resistance[26]) to degrading processes opens up the potential for a whole new group of younger people to be involved.

The recollections of the massive decline in frog numbers indicate the potential for oral histories to also provide information about significant and poorly understood ecological interactions. While the level of detail provided in the frog-related recollections was quite thin, which further questioning may have augmented, it appears that it was still important information. There is little or no documentation of changes in abundance of frogs in this state (A. Sanders and G. Harold, Moloch Fauna Consultants, pers. comm. 14/4/99).

The results reveal that the recollections provide other unique and therefore irreplaceable sources of historical information. The recollections of changes in water quality are one example where other documented records of the water quality for the upper Tone, prior to the late 1970s, are virtually non-existent, whereas Lee's recollections date back to the 1920s and many of the other interviewees from the 1940s. Moreover, while other historical sources of information, such as the land surveyor forms, provide valuable information about vegetation associations, the recollections give a more holistic image. For example, the presence of tea-tree along the river is noted on several land surveyor forms and is visible in the aerial photos, but

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26 Aronson et al (1993a:11) define resiliency as an ecosystem's ability to return to a former successional trajectory after being degraded or deflected by outside disturbances. Resistance is defined by the same authors as "an ecosystem's inertia in the face of change" (Aronson et al 1993:11).

the recollections tell us more about the structure of the vegetation. For example, the interviewee's recalled that "it was higher than a horse" (Young L.38), and "there were funny little areas that you had to get off your horse and pull the brute through behind you, because the tea-tree was just too thick" (Young L.56). Mathew (L.32) recalls that "the tea-trees were very thick and lent over the top like a tunnel". Other instances of the richness of the description include, Harvey's (L.140) recollections about Wackelingup Pool prior to the river silting up:

> *Certainly I know this pool that we used to swim in below the house, I can remember we were putting a rope down, when we were kids, and it was 17 or 18 foot deep, the river. Used to jump off this three or four metre rock. . . . I'd say it's less than half its depth now.*

This type of information is not provided in any of the other historical records that I viewed in relation to the upper Tone River.

5.3 The veracity of the recollections

With all the constraints noted above, analysis of the reliability and validity of the recollections show that almost two-thirds were considered by the scientists to be sufficiently clear and detailed to be potentially verifiable. According to the cross-interview analysis, almost 50% of the total number of records across the four categories of reliability and validity were in the matched category, followed closely by unmatched recollections. Inconsistent or incommensurate recollections were identified but in low numbers. The results of the triangulation exercises showed that to the extent that other corroborative material was found, almost all recollections could be found to be valid, although some had a greater level of corroboration. These results indicate that environmental oral histories can provide information consistent with other data sources.

Although I did not have time to undertake a full triangulation of the riverine fauna table (Appendix 2.3), the information collected from other sources corroborates a number of the recollections (e.g. the presence of turtles, marron, perch and minnows). There is one instance of where it does not - the identification of a bird species by Ryall (L.78). Based on the description of its call, it appears that the bird was incorrectly identified (A. Sanders pers. comm. 13/2/99). The cross-interview analysis of the ecosystem attributes also revealed a few instances where there was a fairly clear conflict between interviewee's statements. In short, although I have not found many instances where there was clearly a conflict across interviews or between the recollections and another information source, there were some.

A purpose of this study was to examine whether environmental oral histories can be evaluated for consistency and factual accuracy. The study has shown that triangulation of the interviews using cross-interview analysis and corroboration by external information sources can be used to gain a measure of the consistency and accuracy of the information. The triangulation exercises also showed that other corroborative information is not always available, which is potentially an indication of the value of the recollections as a unique source of biophysical information. In this situation, the cross-interview analysis serves as a measure of verifiability, but it is not possible to know the extent to which the interviews are independent of each other. Other's perceptions or a collective view of the local biophysical environment may influence interviewees who are members of the same local community.

5.4 Other perspectives on oral histories

There are other ways of thinking about the reliability and validity of oral histories. These include seeing environment oral histories as stories about how people interact

with and perceive the environment. Another perspective is provided by the accumulation of local knowledge based on continuous first-hand observation, which cannot be measured against traditional scientific data sources.

According to Popper and Popper (1996:18):

> *Many planners see cultural regionalism as irrelevant because its storytelling relies on fuzzy devices like symbols and metaphor. They prefer the hard-edged certitude of regulatory regionalism: legal authorization, mapped boundaries, delineated districts, precise rules, and above all an enforcing agency.*
>
> *But the idea of creating regions by telling stories suggests the possibilities for soft-edged planning. Soft-edged planning is more inclusive and less technical, and it allows more people to take part.*

The attitude of "many planners" as described by Popper and Popper, is analogous to the views of some restoration ecologists. To qualify as a successful science, Bradshaw (1993:72) suggests restoration ecology must distance itself from non-scientific approaches by adhering to "six cardinal points", including a "preparedness to carry out proper experiments to test ideas", and "that the successful restoration ecologist has, above all, to be a good scientist. One must have the appropriate background and a logical mind." This position was challenged by Higgs (1994:145):

> *The brilliance of ecological restoration thus far has been a fusion of practical and theoretical knowledge and a convivial and unique mingling of amateurs and professionals within the larger environmental movement . . . . The insights of scientific research should be integrated with other ways of understanding ecological restoration and not remain a separate province. We must combat the notion that the best way of accomplishing ecological restoration is with an elite corps of restoration scientists who feed information to armies of willing supplicants.*

This call for the meaningful involvement of non-scientists in restoration is comparable to giving landholders involved in landcare on their own property, a real role in informing and guiding the restoration process within the broader and integrated 'fragmented landscape'. One obvious approach is to recognise their accumulated local knowledge of the biophysical environment based on many years of observation. Wynn

(1997) presents an excellent example of the potential for this approach. He critiques the natural history writings of a New Zealand pastoralist, W.H. Guthrie-Smith[27], and argues that they provide a remarkable "microgeographical perspective ... that is so vital to understanding the often intricate and incremental processes of environmental transformations." According to Wynn (1997:427), Guthrie-Smith's writing is "based on half a lifetime of acute observation and an unflagging interest in nature" with a primary focus on a detailed description of the arrival of weeds and introduced fauna on his 20 000 ha North Island pastoral station:

> *Throughout the last decades of the nineteenth century, Guthrie-Smith delighted in the close observation of his local area, enlisting the assistance of his shepherds to alert him to changes in the environment of his run* (Wynn 1997:430).

Wynn (1997:438) presents a number of arguments for the significance of Guthrie-Smith's work. First, the processes of weed and faunal invasions described by Guthrie-Smith represent a detailed "environmental impact statement" at a very localised scale, which was mirrored across a much broader area of the North Island. Secondly, Guthrie-Smith's "curiosity about, fascination with, and fondness for this place led him, ultimately, to reflect not only upon its transformation but also upon his role in the process of environmental change." The significance of this last point, according to Wynn (1997:438), stems from the fact that it requires "engagement with questions about how humans have used, and interpreted their interactions with, nature."

This last point is similar to Lane's (1997:204) observation, noted in Chapter Two, that oral histories are valuable expressions of local knowledge about the role of humans in environmental change. Martin and Lockie (1997:76, 80) support this view and argue, in the context of total catchment management, for local knowledge and experience to

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27 These writings are contained in W.H. Guthrie-Smith (1921), Tutira: The Story of a New Zealand Sheep Station.

be considered a 'legitimate' source of information because scientific data collection, typically focused on the biophysical environment, ignores the role of "human motivations and pressures", providing "little understanding of the relationship between land use, management practices and land degradation." Moreover, they argue that all information, "whether 'raw data' or localised perspectives from farmers" is always influenced by "the particular institutional circumstances of its collection and interpretation" (Martin and Lockie 1993:81). This "requires the different types of information to be placed in interaction (that is, to be compared, contrasted and cross-checked)" and provides a greater diversity of information for land management (Martin and Lockie 1993:81). They suggest that local knowledge is not a less credible source of information, and also offers another perspective. Unprompted, some of the interviewees (e.g. Harvey L.353, 464) in this study commented on the "human motivations and pressures" that underpinned various land management decisions and indicated an awareness of their impact on the river.

The restoration ecology literature and the conservation biology literature emphasise the importance of viewing humans and their effects as a part of ecological systems. According to Pickett and Parker (1994:75), modern ecological theory assumes that systems "incorporate humans and their effects". Meffe and Carroll (1994:16) state that one of the guiding principles of conservation biology is that "the human presence must be included in conservation planning". What are the implications of these principles for local knowledge and its expression through oral histories? Within the context of this study there are two.

First, accepting local knowledge as a legitimate source of ecological information recognises local people's role and place in that ecological system, which will have benefits for the successful implementation of restorative measures.

Secondly, if humans are a part of ecological systems then a person's knowledge and perceptions of the system with which they interact acquires a certain status or meaning and cannot be viewed simply in terms of reliability and validity. The perception and experience is a part of the interaction, and it has inherent properties (e.g. as a statement of sense of place) irrespective of whether the phenomenon (e.g. a fire or flood event) existed in that environment as an external reality. Watson (1969:10) argues that:

> *The geography of any place results from how we see it as much as from what may be seen there. Not all geography derives from the earth itself; some of it springs from our* ***idea*** *of the earth. This geography within the mind can at times be the effective geography to which men* (sic) *adjust and thus be more important than the supposedly real geography of the earth.*

Watson (1969:26) concludes that:

> *In all cases, illusions about the environment have powerful effect* (sic) *upon how the environment is used, and thus the subject we call geography should pay at least as much attention to climate of the mind as to the climate, to the morphology of thought as to geomorphology, that is to metal processes and patterns. The place of perception is critical to the perception of place. Increasingly we must write the geography of countries in terms of the country of the mind.*

The principle of incorporating humans in ecological systems has a number of important implications for restoration ecology. According to Watson's argument, people's "mental image" of a place has significant ramifications for that environment. The "mental image" revealed in environmental oral histories could help inform ecological restoration. In addition, the cultural, symbolic or utilitarian values expressed in people's recollections indicate the type of restoration goals and end-points that might motivate local people to participate in ecological restoration.

Several of the points raised above point to the difficulty of defining what is meant by factual accuracy. Thompson (1988:240) offers a useful approach to the problem:

> *where there are discrepancies between written and oral evidence, it does not follow that one account is necessarily more reliable than another. The interview may reveal the truth behind the official record. Or the divergence may represent two perfectly valid accounts from different standpoints, which together provide vital clues towards the true interpretation. Very often, indeed, while oral evidence which can be directly confirmed proves to be of merely illustrative value, it is fresh but unconfirmed evidence which points the way towards a new interpretation. Indeed, much oral evidence, springing from direct personal experience ... is valuable precisely because it could come from no other source. It is inherently unique. Of course its authenticity can be weighed. It cannot be confirmed, but it can be judged.*

As demonstrated in the discussion in Chapter Two, there are precedents for scientists regarding local knowledge based on long and detailed observation as legitimate and valuable information. Wynn (1997:430) argues that "he has no reason to doubt the thoroughness and accuracy" of Guthrie-Smith's written account. Other scientists have acknowledged the veracity of oral forms of local knowledge. Showers and Mandela (1992:279) maintain that local environmental knowledge "based on careful observation" and from "people who use and depend on a landscape" can be used with confidence. Similarly, fishers who are "good observers" are "incredibly reliable" sources of information about fish ecology (as distinct from catch information) according to a fisheries scientist with experience in this field (J. Prince, pers. comm. 19/2/99). Indeed, it is argued that "it is not possible to do fisheries research in this country without using fisher knowledge" (J. Prince, pers. comm. 19/2/99). The Tone River farmers also use and depend on the landscape, although their life and livelihood is generally more bound up with production systems than with the natural systems that they have displaced. Nevertheless, the oral histories tapped the observations that spanned over half a century and, in Lee's case, considerably longer. In some of the

interviews, especially Harvey, there is also a reflective aspect of the role played by the farmers in the biophysical decline of the river.

To conclude, this study has demonstrated that when oral histories with a specific focus are collected from local people who have a long association with an area, then there are techniques that can be used to extract and evaluate relevant information. By using a diversity of techniques to assess the veracity of the recollections, with significant success, it has also been shown that recollections can be a valuable source of factual information.

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Appendix 1: Statement of Disclosure and Consent Form

Dear

Student research project: oral histories of local waterways

Thank you for agreeing to give an interview about the environmental history of the upper Tone River and its tributaries with which you are familiar. The purpose of this letter is to confirm our interview will take place at your house at .
This letter also provides you with further information about the project and a form that needs to be signed by you prior to the interview. By signing the form you agree that the interview may be published as a part of the study. You will also be giving consent to being identified by name in the study.

Purpose of the research project

The memories of local people are an important source of historical information about changes that have taken place in their local environment since clearing for agriculture. The aim of this study is to examine the extent to which these recollections can be evaluated and used to assist landcare efforts and the restoration of the local environment, such as waterways. To do this, the project will address two research questions:

1. Can the credibility of local oral histories be assessed through cross-checking memories with other information sources?
2. To what extent can local oral histories about environmental change contribute to landcare efforts and the restoration of the local environment?

Benefits of the project

The project is an acknowledgment that you are a valuable source of information about your local environment. It is hoped that your memories will contribute to the wellbeing of the local environment and community by helping to define future landcare and environmental restoration goals in relation to the upper Tone River and its tributaries.

At a more general level, there is a vast store of information about the natural environment and environmental change in the collective memories of local communities, and the two research questions posed in this study will help to establish the legitimacy and usefulness of this type of information.

Interview structure and time involved

Although I will ask you questions during the interview, I will guide rather than direct the interview. It is important that you feel free in how you answer the questions and to offer other insights that might not arise in answer to my questions. Since I am interested in your own recollections of the upper Tone River and its tributaries, there is no need for you to do any preparation for the interview.

The interview will take approximately one hour and will be tape-recorded. A copy of the transcript of your interview will be returned to you as soon as possible for you to review and correct. Subject to your consent, a copy of the tape and transcript will be lodged with the Battye Library in Perth within nine months of the completion of the project for use by other researchers and as a permanent record of your recollections of the area.

I am available to answer any queries you may have. My telephone numbers are (08) 9384 3793 (h) or (08) 9400 5058 (university). My postal address is c/- Centre for Ecosystem Management, School of Natural Sciences, Edith Cowan University, 100 Joondalup Drive, Joondalup WA 6027.

I hope you will enjoy being a part of the project.

Yours sincerely

Margaret Robertson
Research student

Statement of Disclosure and Informed Consent

(To be read and signed by the interviewee)

Project title

Environmental history for ecological restoration: evaluating local recollections of landscape condition and ecological change.

A review of possible risks to, or concerns of, interviewees

1. **Subject to your consent, your involvement in the study will not be confidential and your name will be published in the thesis in association with your interview transcript.** This approach is considered desirable because the significance and credibility of your recollections depend to an extent on making clear the length and nature of your association with a particular geographical area. This level of detail makes it difficult to achieve anonymity for interviewees.

2. **The recollections provided by you during the interview may be cross-checked with the recollections of other interviewees and other information sources. Discrepancies may be discussed in the thesis.**

3. During the interview, you may recall that environmental change occurred as a likely consequence of your or your family's land management actions. This project is concerned with understanding the process and apparent causes of environmental change without apportioning blame.

4. In considering how recollections might help with restoration of the local environment, this project will work at a theoretical level. There is no expectation that farmers will undertake landcare or environmental restoration activities in the course of, or as a direct consequence of, this project.

Giving your consent

I ..... have read the information above and any questions I have asked have been answered to my satisfaction.

I agree to participate in this activity, realising I may withdraw at any time.

I agree that the research data gathered for this study may be published and that I will be identified.

Interviewee ..... Date .....

Research student ..... Date .....

Seeking clarification

Any questions you have concerning this project can be directed to Margaret Robertson (research student) of the School of Natural Sciences at Edith Cowan University on (08) 9384 3793 (h) or (08) 9400 5058.

Appendix 2: Codes Used in Appendices 2.1 to 2.4

For 'potential information sources' See section 3.2.3

For 'investigative status' See section 3.2.3

For coding of 'ecosystem attributes' See table below

Coding system for ecosystem attributes

Riparian vegetation	**Attribute coding**
Composition	Co
Structure	St
Pattern	Pa
Riverine habitat structure	**Attribute coding**
Channel morphology	Ch
Mineral substrate	Mi
Organic substrate	Or
Ecosystem functions	Ec
Riverine fauna	**Attribute coding**
Composition	Co
Abundance and distribution	Ab
Seasonality	Se
Function roles and habitat use	Fu
Water quality	**Attribute coding**
Turbidity	Tu
Algal growth	Al
Colour and stain	Cs
Visual depth	Vi
Temperature	Te
pH	pH
Dissolved oxygen	Di
Salinity	Sa
Odour	Od
Water chemistry	Wa

Reference condition (r)
Changed condition (c)

Appendix 2.1: Local recollections of riparian vegetation: ecosystem attributes, and investigative status and sources

NB: Normal type = earliest recollection. *Italics* = subsequent change in condition.

River section	Interviewee	Composition (presence or absence of species or types)	Structure (vertical layering & percentage cover or density)	Pattern (areal extent & zonation)	Ecosystem attributes	Investigative status	Potential information sources
Middle Murrin Brook	M. Lee	"Tea-tree or blue gums" (L.149).	"Mostly" (L.149).	"Close in to the Brook" (L.149).	Co (r) St (r) Pa (r)	I I I	EO,SA,CA EO,SA,SR,PM EO,SR
		"White gum, red gum" (L.149).		"... a b.. further away where the ground became a bit less waterlogged during the winter" (L.149).	Co (r) Pa (r)	I I I	EO,SA,SR,CA EO,SA,SR,PM EO,SR
		"Quandongs" (L.151). *"...none of those left anymore* (L.153).		"... some areas would be patches of quandongs ... they used to grow ... away from the watercourse" (L.153).	Co (r) Pa (r) Co (c)	I I I	EO,SA,SR,CA EO,SA,SR,PM EO,SR
		"Wattles" (L.154).		"very close to the rivers" (L.154)	Co (r) Pa (r)	I I I	SA,SR,CA SA,EO,SR,PM EO,SR
		"Tea-tree and scrub" (L.68; 109)	"thick" (L.68).	Covered most of Murrin Brook (L.68). "... acres and acres each side of the river" (L.70). "... nearly all along the whole area of the river, for several miles in this area, where we live." (L.109) [Mylerup, near Jingalup].	Co (r) St (r) Pa (r)	I I I	EO,PM,SA,CA SA,EO,SR,PM EO,SR
		"virgin bush trees and scrub" (L.131).	"too many" to see "the lay of the land" (L.131).		Co (r) St (r)	CR CR CR	EO,SA,SR,PM
		"When it became alkaline ... most of that [tea-tree] scrub disappeared and some people just chopped it" (L.110).			Co (C)	CR I CR	EO,P,PM,SA
		"Sheoak" (L.108).		"along the river" (L.108).	Co (r) Pa (r)	I I I	EO,SA,CA SA,SR EO,SR

River section	Interviewee	Composition (presence or absence of species or types)	Structure (vertical layering & percentage cover or density)	Pattern (areal extent & zonation)	Ecosystem attributes	Investigative status	Potential information sources
		"York Road poison" and "heart leaf" poison (L.156)	"very prevalent" (L.156).	"...as soon as you got away from the river." (L.156).	Co (r) St (r) Pa (r)	I I I	EO,SA,SR,CA SA,SR EO,SR
		"Poison" (L.216)	"less" (L.216).	"in the little tributaries leading into the Murrin." (L.216).	Co (r) St (r) Pa (r)	I CR I	SA,CA SA,SR EO,SR
		White gums. "They've been dead for 70 or 80 years" (L.396).	"A lot of huge trees about three foot in diameter ... towered to about a hundred feet high." (L.396).	"... in some of the creeks" (L.397).	Co (r) St (r) Pa (r)	I CR I	EO,PM,SA,SR,CA SA,SR,PM EO,SR
		"White gums are the worst affected with the salt." (L.244).			Co (c)	I I I	EO SA,SR,SL EO,SR
		"... the blue gum creeks weren't anywhere near as affected with salt." (L.412)			Co (c)	I I I	EO SA,SR,SL EO,SR
		In fenced-off, salt-affected areas "... where there's blue gums they are the first ones to come up as a rule" (L.241).			Co (r)	I I I	EO,SL,CA SA,SR,SL EO,SR
		"reclaimed itself": tea-tree, salt-water cooch (L.255). [See also L.110].	*"covered over"* (L.266).	Early to mid-1920s: an area of about five or six hectares in the creek below Mylerup "... used to be just glistening with salt ... the people in the district used to have picnics and play cricket there for quite a few years ... they used to have Jingalup sports there with horses" (L.255).	Co (c) St (c) Pa (r)	I CR I	EO,PM,CA SA,SR,PM EO,SR
	H. Young	Tea-tree scrub (L.305).	"Thick" (L.305)	The "brook itself" and a "... very wide" area (L.308): "... almost right up to the edge of the road where the school was." (L.305). [Observed during school years (1946-1950)].	Co (r) St (r) Pa (r)	I CR I	EO,PM,CA PM,SR,SA EO,SR
		"Melaleuca ... the one they call wild thyme" (L.63).	"Really thick" (L.62).	"... around by Jingalup, all that area now that's cleared below the school" (L.61).	Co (r) St (r) Pa (r)	I CR I	EO,SA,SR,CA PM,SR,SA EO,SR
			"Thick tangly stuff" (L.65).	"... around by Jingalup, all that area now that's cleared below the school" (L.61).	St (r) Pa (r)	CR NI CR	

River section	Interviewee	Composition (presence or absence of species or types)	Structure (vertical layering & percentage cover or density)	Pattern (areal extent & zonation)	Ecosystem attributes	Investigative status	Potential information sources
	C. Owen	"Scrub" (L.279).	"A lot". (L.279) " ... because of all the undergrowth, it was quite difficult to get in and across and even get much of a look at it." (L.280).	"... growing right through the creek" [Murrin Brook, near Jingalup; observed during school years] (L.279).	Co (r) St (r) Pa (r)	CR CR CR	SA,CA,SR
		Yate (L.281)	"A lot" (L.281).	"right through the creek"; "It's sort of fairly flat country" (L.277) [Murrin Brook, near Jingalup] (L.282).	Co (r) St (r) Pa (r)	I CR I	EO,PM,SA,SR,CA SA,CA,SR EO,SR
		Wandoos "and all these other trees" (L.282).		"right through the creek"; "Its sort of fairly flat country" [Murrin Brook, near Jingalup] (L.282).	Co (r) Pa (r)	I CR I	EO,PM,SA,SR,CA SA,SR,CA EO,SR
Lower Murrin Brook – Upper Tone River	C. Owen	Wandoo, red gum, jarrah, blue gum and yate (L.118).		"... grew right up to the river bank." (L.119). "... all the trees ... hung over the rivers in those days." (L.113).	Co (r) Pa (r)	I I I	EO,SA,SR,CA SA,SL,SR EO,SR
		Vines (L.115).		*Not seen "in the farming parts of the river anymore."* (L.115).	Co (r) Pa (c)	CR NI CR	
		Scrub (L.134).	"A lot" (L.134).		Co (r) St (r)	CR NI CR	
		Rushes (L.201).		"... any of the birds that were nesting on the rivers, on the rushes ..." (L.201).	Co (r) Pa (r)	I NI I	EO,SR,CA EO,SR
			"... there was very little sand showing, they were much more covered with vegetation." (L.41).	*"... the pools in those days"* (L.41).	St (c) Pa (c)	I CR	PM,SA,CA PM,SA

River section	Interviewee	Composition (presence or absence of species or types)	Structure (vertical layering & percentage cover or density)	Pattern (areal extent & zonation)	Ecosystem attributes	Investigative status	Potential information sources
	D.Mathew	"Melaleucas" (L.127)	"Thick" (L.127).	"all down it" (L.128).	Co (r) St (r) Pa (r)	I CR I	EO,PM,SA,SR,CA PM,SA EO,SR
		"Tea-tree scrub" and flooded gums (L.68).	"Mostly" (L.68).	"Along the river" (L.68).	Co (r) St (r) Pa (r)	I CR I	EO,PM,SA,SR,CA PM,SA EO,SR
		"Tea-tree" (L.132).	"... very thick and lent over the top like a tunnel." (L.132).	"... lent over the top like a tunnel." (L.132).	Co (r) St (r) Pa (r)	I CR I	EO,PM,SA,SR,CA PM,SA EO,SR
		"Banksias" (L.69).	"A lot" (L. 72).s	"along the river" through a "fairly large tract of very sandy soil" on Woodenup farm to the west (L.69).	Co (r) St (r) Pa (r)	I CR I	EO,SA,SR,CA PM,SA,SR EO,SR
		Absence of poison (L.51).		Woodenup Pool area (L.46).	Co (r) St (r) Pa (r)	I CR I	SA,CA PM,SA,SR EO,SR
		"rushes and things like that" (L.80).	"Lots" (L.80).	"along the edges" (L.81).	Co (r) St (r) Pa (r)	I CR I	EO,SR,CA PM,SA,SR EO,SR
		"samphire stuff" (L.230). "Flooded gums and white gums" (L.236).	*Death of trees; spread of samphire.* (L.235).	*"... used to be hardly any of that, and as the river went more and more salt it spread up, the samphire stuff grew a lot more ... great boggy, salty marshlands covered with this heathy stuff"* (L.231).	Co (r) St (c) Pa (c) Co (r)	I I I	EO,PM,SA,CA,P PM,SR,SL,CA EO,SR
	H. Young	"Tea-tree" (L.38).	"Terrific amount ... higher than a horse, so that you were pushing your way through it" (L.38). When riding along the river around age ten or 11 had to dismount in some places and pull the horse through due to the thickness (L.57).	"... all along the edge" (L.38).	Co (r) St (r) Pa (r)	I CR I	EO,PM,SA,CA PM,SR,SL EO,SR
		"Tea-tree"	"Very thick" (L.137).	Cockatoo Creek area (L.136).	Co (r) St (r) Pa (r)	I CR I	EO,PM,SA,CA SA,SR EO,SR
		"Banksias" (L.600; L.58). "Banksias" (L.602).	"lots and lots" (L.601). "big old ones" (L.602).	Along the river, west of the old Woodenup homestead (L.601). "... along the edge of the Woodenup Pool ... all the way along on that sandy area there", on the low lying south-side [observed from about age 10] (L.602).	Co (r) St (r) Pa (r) Co (r) St (r) Pa (r)	I CR I I CR I	EO,SA,SR,CA SA,SR EO,SR EO,SA,SR,CA SA,SR EO,SR

River section	Interviewee	Composition (presence or absence of species or types)	Structure (vertical layering & percentage cover or density)	Pattern (areal extent & zonation)	Ecosystem attributes	Investigative status	Potential information sources
		Tree death and appearance of samphire following clearing (L.214).	Formerly "quite thick" vegetation (L.214).	Tributary along the south side of the farm (L.214).	Co (c) St (r) Pa (r)	I I I	EO,PM,SR,CA,P P,PM,SA EO,SR
			A difference between the 1940s and 1970s was that since the 1940s "there was so much less vegetation" (L.471; 477).	*"...along the edges of it [the river]"* (L.471).	St (c) Pa (c)	CR CR	SA,SR,PM
		The tea-tree/Melaleuca "has come back" (L.204).	*"A lot"* (L.206).	*Since fencing the main part of the river through Woodenup in the 1970s* (L.204).	Co (c) St (c) Pa (c)	I CR I	EO,PM,CA SA,SR,PM EO,SR
		Absence of watsonia until "a few years ago" (L.242).		*A long the river.* (L.242).	Co (c) Pa (c)	I I I	P,CA SL,SR,PM EO,SR
	D. Ryall	"Blue gum country" (L.36).	"quite often" (L.37).	Upper reaches of the Tone, including Cockatoo and Smiths Creeks area. "... near the watercourses, within a 100 metres or so, was quite often blue gum country." (L.36).	Co (r) St (r) Pa (r) Pa (r)	I CR I	EO,PM,SA,SR,CA PM,SA,SR EO,SR
		"... rushes, what we call grass trees" (L.53). *"But with the advent of clearing the rushes disappeared"* (L.54).	"full of" (L.53).	The creeks "... right at the very headwaters of the catchment" (L.52).	Co (r) St (r) Pa (r) Co (c)	CR CR I	PM,SA,SR,SL EO,SR
		"paperbark" (L.48).		"... when it became a river after the tributaries was when you got into the paperbark along the river, (L.47).	Co (r) Pa (r)	I CR I	SA,EO,PM,SR,CA SA,SR EO,SR
		"tea-tree" (L.48).	"quite extensive ... areas" (L.49). "One place I remember, as a boy, there was numerous numbers of tammar wallaby" (L.49). [Inference: density].	"... when it became a river after the tributaries was when you got into the paperbark along the river, whereas up higher up it was tea-tree and quite extensive tea-tree areas along the creek in places." (L.47).	Co (r) St (r) Pa (r) St (r)	I CR I	EO,PM,SR,CA SA,SR EO,SR
		"various shrubs and poison and blackboys" (L.427).	"Visibility was pretty limited in places to maybe only 20, 30 or 40 metres." (L.427).	"... up where the tributaries [e.g. Cockatoo Creek] joined it [the Tone]" (L.426).	Co (r) St (r) Pa (r)	CR CR I	SA,SR,CA EO,SR

River section	Interviewee	Composition (presence or absence of species or types)	Structure (vertical layering & percentage cover or density)	Pattern (areal extent & zonation)	Ecosystem attributes	Investigative status	Potential information sources
		"bush"	"... much easier walking ... not as thick" (L.425).	"... further down the Tone from my area [tributaries] it was much easier walking, where the river got a little bigger" (L.424).	Co (r) St (r) Pa (r)	CR NI CR	
		"The only trees that seem to be able to withstand the salt is the native blue gum, which is the best equipped to my knowledge, outside of paperbark." (L.375).			Co (c)	I I I	EO,SL SL,SA,SR EO,SR
		"The tea-tree can't handle salt. I have seen all that disappear in large quantities" (L.374).		*Changes to vegetation were noticed "probably in the '50s after the clearing increased rapidly"* (L.162).	Co (c) Pa (c)	I I I	EO,SL SL,SA,SR EO,SR
Upper Tone River	M. Fryer-Smith	"jarrah, white gum, red gum and flooded gum" (L.211).		"...back from the river" (L.211).	Co (r) Pa (r)	I I I	EO,PM,SA,SR,CA SL,SA,SR EO,SR
		"flooded gum and wattle" (L.212).	"large amount" (of wattle) (L.212).	"... close to the watercourse, you are more confined to just flooded gum and wattle" (L.211).	Co (r) St (r) Pa (r)	I I I	SA,SR,CA SL,SA,SR EO,SR
		"flooded gums" (L.97).	"... a lot of shade from overhanging branches of flooded gums" (L.97).	Along the pools (L.97).	Co (r) St (r) Pa (r)		
		"red gums and flooded gums" (L.126).	"a lot of overhanging trees" (L.126).	Wackelingup Pool (L.126).	Co (r) St (r) Pa (r)		
				If you walk down the watercourse now you ... have to get back a 100 metres from the water before you get into good, healthy wattle. There's a lot of wattle along where the Palligup Pool ... a lot of wattle back a 100 or 200 metres from the edge of the river today, but in the '40s to '50s that wattle grew quite close to the water's edge" (L.210).	Pa (c)	I I I	CA SA,SR,CA,EO EO,SR
		"... perennial grasses, and natural grasses" (L.19).		"... on the edge of the river ... natural grasses would grow right to the water's edge then" (L.19).	Co (r) Pa (r)	CR CR CR	SA,SR

River section	Interviewee	Composition (presence or absence of species nr types)	Structure (vertical layering & percentage cover or density)	Pattern (areal extent & zonation)	Ecosystem attributes	Investigative status	Potential information sources
		"various types of rushes" (L.22).		The floodplain ... in some sections it's clay and doesn't contain much vegetation, apart from various types of rushes"(L.20).	Co (r) Pa (r)	CR NI I	EO,SA
	W. Harvey			"... the vegetation was really varied here" [Glentone farm area] (L.191)	Pa (r)	CR NI CR	
		"yate" (L.191).		"flats along the river ... they seem to be pretty prone to going salt, the clay is obviously pretty close to the surface there." (L.192) "That was sort of harsh, harsh-type country" (L.195).	Co (r) Pa (r)	I CR I	EO,PM,SA,SR,CA SA,SR EO,SR
		"paperbark" (L.196).	"a lot" (L.196) "... that's where the open grassland was more ... you had the spaced out vegetation and these paperbarks" (L.196).	"... in the swampy areas" (L.196).	Co (r) St (r) Pa (r) St (r)	I CR I	EO,PM,SA,SR,CA SA,SR,EO,CA EO,SR
		"flooded gum" (L.197).		"... areas along the river" (L.197).	Co (r) St (r) Pa (r)	I CR I	EO,PM,CA PM,SA,SR EO,SR
		"white gum, red gum and jarrah" (L.199).	"scattered" (L.199).	"... along the river" (L.199).	Co (r) St (r) Pa (r)	I CR I	EO,SA,SR,CA SA,SR,PM EO,SR
				"... this particular place along the river where there was bits of grassland, it wasn't all bush - on one side of the river there's usually a steep side, and the other side flattens out, it changes as you go down the river, and also one side of the river is usually a bit heavier country than the other side, so on these flatter areas, where there was more grass ..." (L.71).	Pa (r)	CR CR I	SA,SR,EO,CA EO,SR
		"rushes and scrub" (L.38).		"... along the river" (L.38).	Co (r) Pa (r)	CR CR I	PM,SA,SR EO,RS

Appendix 2.2
Local recollections of riverine habitat structure:
ecosystem attributes, and investigative status and sources
NB: Normal type = earliest recollection. *Italics* = subsequent change in condition.

River section	Interviewee	Water depth, flow and channel morphology (with reference to organic and mineral substrata)	Ecosystem attributes	Investigative status	Potential information sources
Middle Murrin Brook	M. Lee	In summer, pools on Murrin Brook "eventually dried out, or got some thunderstorms to fill them up a bit." (L.39).	Ch (r) Ec (r)	I I I I	CA EO,SA,CA PM,SL,SA,SR EO
		"... were very flat crossings where horses and carts used to go across in the early days" (L.178).	Ch (r)	I I CR I	CA CA SA,EO P
	C.Owen	"Well, near Jingalup, the Murrin Brook, it's not a very clear course that it's in. It's sort of fairly flat country. So you have probably more than one channel in a lot of it, and that means there's not many pools there, it's more like a series of little waterways, and they're quite small, and a lot of scrub and trees growing right through the creek" (L.276). [Response to a question about memories of the Murrin Brook from school days at Jingalup].	Ch (r)	CR I CR I	EO,PM,SA,CA EO,SA EO,PO
		"At that time, in the river itself, I don't think you would ever have seen much bare sand or bare patches in the actual river itself." (L.283). *"Whereas I think these will have developed in the last 20 or 30 years."* (L.283).	Mi (r) Mi (c)	I I CR I CR	EO,CA CA PM P,EO PM
		"... most of it [Murrin Brook, near Jingalup] is quite different to what it was ... . There are salt scalds there now and quite big areas of silt, sort of washed out." (L.60).	Mi (c)	I I I I	EO,CA PM,SA,CA PM EO,P
		"We often used to use salt patches on the river's edges to help us fight the fire". "... when it came to the actual river bed, most fire fighting vehicles were not able to cross the river." (L.328).	Ch (c) Ch (c)	I I CR CR CR	EO,CA CA PM,SA PM,CA
		"... we used to ride down there a bit and look at it, and it always seemed a very quiet little ... not much of a river at all really. But there was always pools there. Most of the summer the pools were there" (L.35).	Ch (r)	I I CR I	CA PM,CA PM EO
		"... the pools ... at this part of the Tone anyway, are not big pools - you could swim in them [e.g. Mininiup Pool] but you could sort of put your feet on the bottom pretty much." (L.75). Relative to the Beaufort River, "we only run to sort of baby pools really." (L.238).	Ch (r)	I I NI I	CA PM,CA EO
		"The pools in those days - there was very little sand showing, they were much more covered with vegetation." (L.41). *"I think the [Mininiup] pool is pretty-well silted up now ... but I haven't seen it for a few years"* (L.49).	Mi (c) Mi (c)	I I I CR I CR	EO,CA PM,CA EO PM P
		"... there's certainly a lot less [pools], I think, than there were." (L.234).	Ch (c) Ec (c)	I I CR I	CA PM,CA PM PM,P
		"... it would have made a bit of a sound where it goes through rocky areas - it would have been babbling along pretty well, but on most of it you wouldn't have heard anything." (L.186).	Mi (r)	CR NI NI I	EO,P
		"As the country further up has been cleared, the water has certainly come down more quickly." (L.148).	Ch (c)	CR I NI I	EO,SL EO

River section	Interviewee	Water depth, flow and channel morphology (with reference to organic and mineral substrata)	Ecosystem attributes	Investigative status	Potential information sources
Lower Murrin Brook – Upper Tone River	D. Mathews	"It wasn't ever a very wide creek, except where the bigger pools were, you'd scarcely give it the name of a river really ... but as it got down a bit it got bigger." (L.132).	Ch (r)	I NI CR NI	EO,CA PM,SA,SR
		"Lots of places it was a very wide river, with lots of little courses flowing through the tea-tree" (L.373).	Ch (r)	I I CR NI	EO,CA PM PM
		"... there were lots of rushes and things like that growing along the edges. There was not a lot of erosion as I can remember" (L.81). *"... the creeks gradually got more and more degraded. Erosion, especially when there was heavy rain in the early winter, you'd get great eroded channels running down into the main creek"* (L.238).	Ch (r) Ch (c)	I I NI I CR I	EO,CA EO,PM,CA EO PM,SA EO
		"Very boggy away from the edges a bit`1. The horses used to nearly go mad, because they hated getting bogged" (L.177).	Mi (r)	I I NI I	EO,CA CA,PM,EO EO
		"In winter, especially after it had gone salty, it would be very boggy and slushy ... but you could easily find places if you followed the kangaroo tracks through the tea-tree, it was easy enough to get across in the summer." (L.370)	Mi (c)	I I CR I	EO,CA CA EO EO
		"... they were only winter creeks and so was the Tone River mostly, it didn't run all through the year, even when it was really wet. It just made nice big pools here and there." (L.42).	Ch (r) Ec (r)	I I CR I	EO,CA EO,SA,SR,CA EO,PM EO
		"... the water used to flow along quite quickly when it was in the winter ... But as the summer came the pools would dry up" (L.128).	Ch (r) Ec (r)	I I CR I	EO,CA SR,CA PM,EO EO
		"... there were quite a lot of not very big pools. Woodenup Pool was the biggest one, and there was a fairly large one near the old Woodenup homestead ... I suppose a couple of feet of water in it all through the year" (L.123).	Ch (r) Ec (r)	I I CR I	EO,CA CA,PM SA,SR PM, P,EO
		Woodenup Pool was a "permanent pool" (L. 47).	Ch (r) Ec (r)	I I I I	CA CA,PM SL,SR,SA EO
		"They didn't like us swimming in the creek because there were snags" (L.171). [Inference: large woody debris present].	Or (r)	I I I I	EO,CA CA SA EO
		"It ... wasn't terribly muddy, it was a fairly firm bottom, the bits we used to paddle [in] near the house." (L.175).	Mi (r)	I I NI I	EO,A CA EO,P
	H. Young	"There were big stretches where we couldn't get through because it was also quite boggy in a lot of those pools ... so you did actually have to pick the bits between the pools where it got a bit shallower and where it was a bit thinner." (L.109).	Ch (r) Mi (r)	I I CR I	EO,CA CA SA,SR EO,P
		"I can remember [as "a small child"] going across one pool ... and getting the horse bogged right up to its belly" (L.118).	Mi (r)	I I NI I	CA CA EO,P
		"I think the country was a lot boggier then too, for riding in. I suppose it's a while since I've ridden horses around the farm, but we used to get bogged quite a lot getting down to the river" (L.114).	Mi (c) Ec (c)	I I NI I	CA CA EO
		"... in summer it was okay [to cross] because the pools were quite shallowish and you could find bits in between the pools to get through and we had [on/near Woodenup] ... maybe ten or a dozen places that we could always get through in the summer but not in the winter time, they were too deep. Gee, would it have been as many as that, may not have been as many as that." (L.101).	Ch (r) Ec (r)	I I CR	CA CA

River section	Interviewee	Water depth, flow and channel morphology (with reference to organic and mineral substrata)	Ecosystem attributes	Investigative status	Potential information sources
		"... there were quite deep pools in a lot of places" (L.53).	Ch (r)	I I CR I	CA CA SA,SR EO,P
		"... even in the summer there seemed to always be a trickle of water going down there past the old homestead" (L.83).	Ch (r) Ec (r)	I I I I	CA EO,SA,SR,CA SA,SR EO
		"The Woodenup Pool that was a permanent pool ... and there were permanent pools by the house." (L.54).	Ch (r)	I I I I	CA PM,CA,SA SA,SR EO
		"... the floods were fun ... I used to go down the river and swim across it [on horseback] in any sort of place that we could swim through with the current wafting us down" (L.67). [Inference: absence of large woody debris, at least in some river sections].	Or (r)	I NI CR CR	CA SA,SR
		"In the winter time when it was in flood you could sort of sweep along ... level with the tops of the tea-trees" (L.112). [Inference: absence of large woody debris, at least in some river sections].	Or (r)	I NI CR NI	CA SA,SR
		"... it was also quite boggy a lot of those pools ... I suppose with a lot of leaf mulch and that sort of thing." (L.110). [Inference: organic substrata].	Mi (r) Or (r)	I I NI NI	CA CA
		"... pool in the rocks just behind the shearing shed" (L.88).	Mi (r)	I NI NI NI	
	D. Ryall	*"Oh, the main change [to the river] is the onset of salt, brought on by clearing, and it certainly did change in that context, because once the rushes died out and the salt came in, the water ran much faster, where in the early days it used to be held up by rushes and the undergrowth and it moved much slower."* (L.131).	Ch (e)	I I CR I	EO,CA EO,P,SR,CA SA,SR,EO EO
Upper Tone River	D. Ryall	"... I never saw many real ... what I'd call real pools. There was some places where there was a reasonable amount of water, but only approximately eight to ten metres across and fairly shallow. Odd ones were quite deep, but some of them would be 70 or 80 metres long, when the river was easing down in the summer." (L.110).	Ch (r)	I I I I	CA PM,CA,SA SA,SR EO
	M. Fryer-Smith	"The floodplain in some ... sections it's clay and doesn't contain much vegetation, apart from various types of rushes, and some areas where it goes out like that [concave], and the water would lie there all the winter on clayey floodplain, therefore there wasn't very much vegetation." (L.22).	Ch (r)	I NI I I	CA SA,SR,PM EO
		Wackelingup Pool: "A large pool with high granite rocks on the west side. It was particularly deep water" (L.121).	Ch (r) Mi (r)	I I CR I	CA,PM EO,CA,SA SA,SR,PM EO
		Nymiup Pool: "... a similar pool [to Wackelingup Pool] with granite rocks on the west side and deep, cool water". (L.126).	Ch (r) Mi (r)	I I CR I	CA,PM EO,SA,CA SA,SR,PM EO,P
		Nymiup Pool: "... that was a pool with large granite rocks" (L.42).	Mi (r)	I I CR I	CA,PM EO,CA,SA SA,SR,PM
		"In winter it was very difficult to cross [the river], extremely difficult, unless there was a specific area where there was a hard, rocky base. Summer time was relatively easy to cross because the river dried up to a series of permanent pools ... the mud would be sometimes sticky, boggy mud. But sometimes it was two or three miles in between really good pools, numerous small pools, just little holes, but the good permanent pools, as I have mentioned, they were there all the summer." (L.197).	Ch (r) Mi (r)	I I CR I	CA EO,PM,SA,CA SA,SR,EO EO
		"Swimming in the pools was always a very dangerous occupation because of underground logs" (L.103).	Or (r)	I I CR I	CA CA SR,SA EO
		"... swimming in the pool you had to be very careful because of underground snags and logs" (L.165).	Or (r)	I I CR I	CA CA SR,SA EO

River section	Interviewee	Water depth, flow and channel morphology (with reference to organic and mineral substrata)	Ecosystem attributes	Investigative status	Potential information sources
	W. Harvey	"... the river being sort of 'a river', a real defined bit of flowing water, was something that probably stood out." (L.304).	Ch (r)	CR I NI I	EO,PM,SA,CA,SR EO
		"... the river has silted up" (L.137).	Mi (c)	CR I CR I	EO,PM,SA,CA PM EO,P
		Wackelingup Pool: "... has got a big granite rock protruding over it about three or four metres, on the edge of it, and we used to do bombies off it and swim" (L.33).	Ch (r) Mi (r)	I I	PM,CA EO,CA
		"... we were putting a rope down, when we were kids, and it was 17 or 18 foot deep, the river. Used to jump off this three or four metre rock" (L.139).	Ch (r)	I I I	CA SA,SR,PM EO
		"I'd say it's less than half its depth now. That's symptomatic of the river all the way through ... it's just clogged up ... the river is not as defined as it was. It's ... spreading out over a bigger area." (L.147).	Mi (c)	I CR I	CA,PM SA,SR,PM EO,P
		"... the water course, as I remember it, was quite open ... we didn't have to sneak through trees and things" (L.290).	Ch (r)	I NI CR I	CA,PM SA,SR PM
		[Canoeing the river with his brother as a child. Their mother would pick them up at the bridge "about a mile down the road".] "... we'd get on the canoe here probably about a mile and try and beat her down there. It used to be a bit of white water rafting ... it was just a watercourse ... we were on this little sealed canoe ... and it used to fairly belt down there" (L.168).	Or (r) Ch (r)	I NI CR I	CA SA,SR PM
		"... you couldn't get through there for the trees and what-not now" (L.170). [Inference: increase in large woody debris].	Or (c)	CR	SA,SR,PM
		"... it was a clean, quite a clean river bed." (L. 438).	Or (r)	I NI NI I	CA EO
		"When we were kids ... there was no sticks, nothing in it at all" (L.144).		CR	SA,SR,PM
		That's something you notice now - it's full of debris ... it's not the ... uninterrupted waterway it used to be." (L.439).	Or (c)	I I CR I	CA SA,SR EO
		The whole thing is "bunging right up" through trees falling into the river and vegetation loss from the banks. (L.139).	Or (c)	I I CR I	CA,PM SA,SR EO
		"... it's so full of rubbish now, debris and trees" (L.145).	Or (c)	I NI CR I	CA,PM SA,SR EO

Appendix 2.3: Local recollections of riverine fauna: ecosystem attributes, and investigative status and sources

NB: Normal type = earliest recollection. *Italics* = subsequent change in condition.

River section	Interviewee	Composition (species and abundance), ecological processes and ecosystem functions	Ecosystem attributes	Investigative status	Potential information sources
Middle Murrin Brook	M. Lee	"People used to go shooting ducks, black ducks. Used to be quite a few of those on the river, in the pools" (L.350).	Co (r) Ab (r)	NI CR I	EO,SR EO,SR
		"...once it turns salt I don't think they spent too much time on the salt water then ... don't see many black ducks now" (L.355).	Ab (c)	CR	EO,SR
		"... quite a few of the grey ducks but they're migratory ... they weren't here in the early days." (L.358).	Co (c) Se (c)	NI CR I	EO,SR EO,SR
		"... there were a few cranes around in the early days." (L.359).	Co (r) Ab (r)	NI CR I	SA,SR,EO EO,SR
		"In the nights in the winter there used to be an awful lot of frogs ... creek was full of cat frogs ... there must have been literally thousands of them and the night would just scream with these cat frogs ... just thousands of them ... all over the rivers and creeks and flat areas, where the water was." (L.88).	Co (r) Ab (r)	I I I	EO,SR,CA SA,SR,CA EO,SR
		"But over the years they have disappeared on account of the salt. Hardly ever hear them now" (L.93).	Ab (c)	I	SA,SR,CA
		Now you hear "just the occasional bullfrog" (L.93)	Co (r) Ab (r)	I I	EO,SR,CA EO,SR
		"... but when I was much younger, any amount of bullfrogs croaking every night." (L.93).	Ab (c)	CR	SA,SR,CA
		"... when the heavy winter was on ... sometimes see little tiddler fish floating down the river." (L.85).	Co (r) Se (r) Fu (r)	NI NI CR	
		"People used to catch gilgies ... when the water dried up, the gilgies just buried under the ground and stayed there until the rain came next year." (L.176).	Co (r) Fu (r)	I CR I	EO,SR,CA SA,SR,CA EO,SR
		"People used to catch ... probably a few marron here and there" (L.175).	Co (r) Ab (r)	I CR I	SA,SL,SR EO,SR
Lower-Murrin Brook – Upper Tone River	C. Owen	Never seen a tortoise "in this river" (L.287).	Co (r)	NI CR I	SA,SL,SR EO,SR
		"There certainly would have been things like gilgies and marron - they were there." (L.83).	Co (r)	NI CR I	SA,SL,SR EO,SR
	M.Fryer-Smith	"... any amount of perch ... right up as far north as probably the property that used to belong to Caw and Hubbe [Woodenup farm] ... Because I know that fish were caught there in the early '40s." (L.16).	Co (r) Ab (r)	I I I	CA SA,SR,CA EO,SR

River section	Interviewee	Composition (species and abundance), ecological processes and ecosystem functions	Ecosystem attributes	Investigative status	Potential information sources
		"... we'd have picnics on the river [at Woodenup farm] ... and they would catch marron and gilgies" (L.368).	Co (r)	I CR I	CA SA,SR,CA EO,SR
	D. Mathew	"... there used to be a lot of kingfishers there evidently, Mum said they used to come into the [open rainwater] tanks" (L.109). "But I haven't seen a kingfisher that I can remember for years on the place" *(L.109).*	Co (r) Ab (r) Ab (c)	I CR I	EO,SR SA,SR EO,SR
		"There was always a lot of birds and ducks" (L.196). *"I think a lot more ducks came too as there was more clearing and more dams and more grain for them – grain-eating ducks, they certainly proliferated, especially the wood ducks"* (L.306).	Co (r) Ab (r) Ab (c) Co (c)	NI CR I	SA,SR EO,SR
		" ... a few cranes" (L.197).	Co (r) Ab (r)	NI CR I	SA,SR,CA EO,SR
		"The odd shag" (L.198).	Co (r) Ab (r)	NI CR I	SA,SR EO,SR
		"... very occasionally a stilt would appear" and visit the dams quite close to the river (L.197).	Co (r) Ab (r)	NI CR I	SA,SR EO,SR
		"Frogs, I suppose" (L.90).		NI NI CR	
		"There were always minnows – little minnow things, they are still there" (L.89).	Co (r)	I NI CR	EO,SR,CA
		"... we used to catch gilgies actually in the creek ... we used to soak the super bags in the creek ... and every year when we pulled the super bags up there would always be gilgies, clinging to the bags. Little tiny ones mostly" (L.84). *"... and then they gradually went as the water became more and more brackish"* (L.84).	Co (r) Ab (c)	I CR I	EO,SR,CA EO,SR
		"... mosquitoes." (L.174).	Co (r)	NI NI CR	
	H. Young	"We used to have kingfishers a long there too" (L.240). *... Haven't seen a kingfisher for years either."* (L.240).	Co (r) Ab (r)	I CR CR I	EO,SR EO,SA,CA CA EO,SR
		"... there were ... little inland, I suppose they were long-necked tortoises, they wouldn't have been the short-necked ones would they, they were there ...they lived in the pool in the rocks just behind the shearing shed there, little tiny tortoises. (L.86). *"I haven't seen them for years now ... I think it's far too brackish for them"* (L.87).	Co (r) Ab (c)	I I I	EO,SR,CA SR,SL EO,SR
		"Tadpoles we used to catch" (L.278).	Co (r)	I CR I	EO,CS,SR SA,SR EO,SR
		"... there certainly were a lot of frogs of various sorts" (L.275).	Co (r) Ab (r)	CR I	SA,SR EO,SR
		"... a lot of bullfrogs, or the ones that we think of as bullfrogs, make that sort of booming sound. There were a lot of those." (L.276).	Co (r) Ab (r)	I I I	EO,CA,SR SA,SR,SL EO,SR

River section	Interviewee	Composition (species and abundance), ecological processes and ecosystem functions	Ecosystem attributes	Investigative status	Potential information sources
		"... there were a lot of frogs, *which there aren't now of course*" (L.85).	Ab (c)	I CR I	EO,SR,CA SA,SR EO,SR
		"A lot of ... minnows" (L.85); "little minnowy fish were always there" (L.279).	Co (r) Ab (r)	I CR CR	EO,SR,CA SA,SR
		"... there were lots of gilgies ... We used to wash our super bags in the river every year ... and there was quite a deep pool so you could drop them [bags] over the edge and they were always covered in gilgies when we'd pull them up about four or five days later ... . Big black gilgies." (L.89).	Co (r) Ab (r)	I CR I	EO,SR,CA SA,SR,SL EO,SR
		"Lots of dragonflies" (L.278).	Co (r) Ab (r)	I CR I	SR,CA SA,SR,SL EO,SR
		"The little water beetley things were always there" (L.278).	Co (r)	NI NI CR	
		"I don't think there were nearly as many mosquitoes then ... as there are now." (L.294).	Co (r) Ab (c)	NI NI I	 EO,SR
	D. Ryall	"... right at the very headwaters of the catchment the creeks were all fresh those days and full of rushes, what we called grass trees and it was good cover for the black duck – it used to nest along the rushes those days. (L.52).	Co (r) Fu (r)	NI CR I	 SA,SR,SL EO,SR,CA
		"But with the advent of the clearing the rushes disappeared and the [black] ducks had to take to nesting in trees, which they seemed to be able to accommodate." (L.54).	Fu (c)	NI CR I	 SA,SR EO,SR,CA
		"... plenty of birdlife - shags and cranes" (L.78). "Always shags or cormorants along the river, a few ... cranes ... but you didn't see many of them." (L.350).	Co (r) Ab (r)	NI CR I	 SA,SR EO,SR
		"I did see the odd Night Heron, which didn't appear very often, or you didn't see them because the daytime they slept all the time and only hunted at night, and they were probably something that frightened me most in my life was their night time call ... it sounded like a woman being murdered or throttled." (L.78).	Co (r)	NI I I	 SR,SA,SR EO,SR
		"One difference we did notice with the advent of clearing, the ducks along the water courses thinned out (L.146*).* *"... but the Maned Geese came in, and they became quite prolific with the advent of cropping and clearing."* (L.147).	Co (r) Ab (c) Co (c) Ab (c)	I CR I I	CA SA,SR EO,SR SA,SR,SL
		"... I remember ... the freshwater turtle" (L.76).	Co (r)	I I CR	EO,SR,CA SA,SL,SR
		"... I remember ... minnows - there were no other fish that I was aware of." (L.76).	Co (r)	I CR CR	EO,SR,CA SA,SR
		"... what we call gilgies in the fresher parts of it" (L.77).	Co (r)	NI CR I	 SA,SR EO,SR
Upper Tone River	D. Ryall	*"I went down several times [marroning], but when it was too late, the marron were already disappearing, and I caught very few"* (L.101). "... but I remember as a boy, Mr Ward going down and getting quite reasonable catches below William Harvey's" (L.103).	Co (r) Ab (c) Ab (r)	I CR I CR	EO,SR,CA SA,SL,SR EO,SR SA,SR

River section	Interviewee	Composition (species and abundance), ecological processes and ecosystem functions	Ecosystem attributes	Investigative status	Potential information sources
	M. Fryer-Smith	"... a lot of birds in the area, in the times that I visited, which was the early '40s right up to the late '50s. Large amount of ducks and geese." (L.224).	Co (r) Ab (r)	I CR CR	CA SL,SR
		"... a lot of ... Maned Geese" (L.81).	Co (r) Ab (r)	I I I	CA SL,SR,SA EO,SR
		"... you generally boiled it [river water] because of the amount of fish in the water" (L.190).	Co (r) Ab (r)	NI NI CR	
		"... *fish life is now practically extinct ... because of salinity*" (L.238).	Co (r) Ab (c)	I CR CR	EO,SR,CA SA,SL,SR
		"Turtles were one of the main enemy of the marron, and in fact, as the water became more saline, the turtles survived in the saline water and so depleted the stocks of marron" (L.131). "Today you'll still find turtles in the fairly salty pools." (L.133).	Co (r) Fu (r) Ab (e)	NI CR I I	 SL,SR,SA EO,SR SL,SR
		"Large number of snakes' and lizards' tracks would run to the water's edge" (L.88). "... *today you don't see that happening. They tend to go more to farm dams where the water is fresher.*" (L.89).	Co (r) Ab (e)	I CR I CR	EO,SR,CA EO,SR EO,SR SR,SA
		"We used to spend a lot of time picnicking on the pools, in the summer time, catching marron, gilgies" (L.139). "...catching ... ducks" (L.139; 154).	Co (r) Co (r)	I CR I 	CA,SR CR,SA EO,SR,CA
		Using a copper wire snare "... you could catch quite a lot of marron." (L.147). "Walking home after a day at the river "usually with a bag of marron" (L.154).	Ab (r)	I CR I	CA,SR SA,SR,SL EO,SR,CA
		"... in a pool where there was marron, generally there were not any gilgies. ... So you tended to find gilgies in one pool and marron in another pool ... and gilgies will live in much more brackish water than marron" (L.155). *"So the marron virtually survived only in the better pools that remained reasonably fresh."* (L.158).	Co (r) Fu (r) Ab (c)	NI I I I	 SL,SA,SR EO,SR SL,SA,SR
		"... there was a lot of leeches in the water" (L.191).	Co (r) Ab (r)	I CR I	EO,SR,CA SA,SR EO,SR
		Palligup Pool: "In the early '40s to '50s that pool was particularly fresh and contained large amounts of marron" (L.35). "... contained large amounts of ... turtles" (L.35). "... contained large amounts of ... perch ... natives used to camp there and do quite a bit of fishing." (L.35).	Co (r) Ab (r) Co (r) Ab (r) C0 (r) Ab (r)	I CR CR I CR	EO,SA,SR,CA SA,SL SA,SL EO,SR SA,SL
		Wackelingup Pool: "It was particularly deep water and very cool and therefore enabled marron to live throughout the summer period in that pool." (L.123).	Co (r) Fu (r)	I CR I	CA SA,SR,SL EO,SR
		Nymiup Pool: "I used to go fishing there" (L.40).	Co (r)	NI CR	

River section	Interviewee	Composition (species and abundance), ecological processes and ecosystem functions	Ecosystem attributes	Investigative status	Potential information sources
	W. Harvey	"The bird life certainly, that was just prolific" (L.303).	Co (r) Ab (r)	NI CR CR	EO,SA,SL,SR
		"I can remember the habitat along the river was ... rushes and scrub, and there was birds flying off the water everywhere." (L.38). *"Well the birds, they seem to have gone ... they seem to more congregate on the dams now."* (L.38).	Co (r) Ab (r) Ab (c)	NI CR CR NI	EO,SA,SR
		"There was storks and ducks and if you walk along it, 50 metres ahead of you you'd hear birds taking off everywhere" (L.41). *"... you don't hear that now."* (L.41).	Co (r) Ab (r) Ab (c)	NI NI I NI	EO,SR
		"Put old sheepskins, too, in the river and you'd pull them out on a bit of string and they'd have a couple of turtles on them" (L.52).	Co (r) Ab (r)	I CR I	CA,SR SA,SR,SL EO,SR
		"Frogs and snakes – there were a lot of snakes too" (L.371).	Co (r) Ab (r)	I CR I	EO,SR,CA SA,SL,SR EO,SR
		"Frogs were absolutely incessant all night ... there was heaps of different frogs apparently and you could hear all these different noises." (L.368). *"... but the thing that's really missing, that we used to hear all night, were the frogs ... they're long gone"* (L.368).	Co (r) Ab (r) Ab (c)	I CR I CR	EO,SR,CA SA,SL,SR EO,SR SA,SL,SR
		"... we used to catch fish. There was red perch ... in this big pool, we wouldn't catch a fish straight away but we'd never come home without one - they were pretty plentiful." (L.47).	Co (r) Ab (r)	I CR I	CA SL,SA,SR EO,SR
		"The little minnows, it was crawling with minnows - they are not the little insecty things you see, these are ... 60-70 millimetres long ... we used to catch them and use them for bait to catch these fish." (L.49).	Co (r) Ab (r)	I CR I	EO,SR,CA SL,SA,SR EO,SR
		"There was absolutely heaps of marron" (L.56). *"... as the marron died out farther upstream, our area and our pools were noted for probably having the marron in the area ..., for most recent times ... the marron and all those things that were formerly up in the upper reaches of the river, have gradually drifted down and now you've got to go quite a long way down the river to get that sort of wildlife."* (L.56).	Co (r) Ab (r) Ab (c)	I CR I	EO,SR,CA SL,SA,SR EO,SR
		" ... the reason they brought them [rabbits] here was because the mozzies are always thick along the river. (L.418).			

Appendix 2.4: Local recollections of water quality: ecosystem attributes, and investigative status and sources

NB: Normal type = earliest recollection. *Italics* = subsequent change in condition.

River section	Interviewee	Potability, clarity, basic phyrio-chemistry and odour	Ecosystem attributes status	Investigative	Potential information sources
Middle Murrin Brook	M. Lee	Murrin Brook "was quite fresh. Potable water anyway, quite fresh. ... in 1920 or '23 it would be quite drinkable water most of it, just in odd pools probably here and there it was a bit brackish." (L.206).	Sa (r)	I I I I	EO,SA,SR,CA SR,SI. EO,SR SA,EO
		"When I was going to school there [Jingalup] ... we saw our first oily looking film on top of the pools of water ... It had the ... colours of the rainbow, in there. (L.210).	Wc (r)	NI NI CR I	 EO,SA
		In the early days of farming, prior to sinking larger dams with bulldozers, "some farmers near the Murrin Brook could use the pools ... to water their stock (L.38).	Sa (r)	I I I I	EO,SA,SR,CA SR,SI. EO,SR EO,SA
		As the area of cleared land gradually increased, rising salt "interfered with the pools of water on the river that farmers used to use for their sheep and some of that became much too salty for stock", except perhaps during the winter, when the water was flowing. (L.73).	Sa (c)	I I I I	EO,SA,SR,CA SR,SI.,EO,CA EO,SR EO,SA
		Murrin Brook started to go salt "... oh, I suppose about the mid-1920s ... it seemed to break out in salt patches in certain areas" (L.190)	Sa (c)	I I I I	EO,SR,CA SR,CA EO,SR,CA EO,SA
		"All that Jingalup Reserve down there where the golf course is, it must have been rung-barked ... in perhaps the 1880s or ... early '90s ... and that was the about the first area to go salt, just around this area, that I can remember. Then the salt went right back up past ... McQuire's place [Palmyre]." (L.194).	Sa (c)	I CR I I	PM,CA CA,EO CA EO,SA
	M. Fryer-Smith	Crossing over the upper reaches of the Tone River "... when I was young, [it] was fresh with clover growing right to the water's edge." (L.342).	Sa (r	I CR I I	EO,SA,CA CA CA EO,SA
Lower Murrin Brook - Upper Tone River	C. Owen	"Oh, I dare say it always had a bit of salt in it, but ... certainly when we first went to those rivers there was very, very little. You could certainly drink it quite easily." (L.170).	Sa (r)	I CR I I	EO,SA,CA,SR SR,CA CA EO,SA
		"People used to water their sheep on them [the pools], *whereas today most of it would be too salty"* (L.36).	Sa (r)	I I I I	CA,SA,EO,SR CA,SA CA EO
		"... we've had this salt breaking out on the hillsides ... That would have happened in the '60s and '70s ... it seemed to happen quite suddenly in those years, and we realised it ... I can remember saying to my father, that this salt seemed to be going up the creeks" (L.162).	Sa (c)	I CR I I	EO,SR,CA EO,SR,CA,PM CA,PM,SR EO,PM,SA
		"... all the trees ... hung over the rivers in those days." (L.113). [Inference: shade and cooling effect on water].	Te (r)	I NI I I	PM,CA CA EO,SR

River section	Interviewee	Potability, clarity, basic physio-chemistry and odour	Ecosystem attributes	Investigative status	Potential information sources
	M.Fryer-Smith	"We used to visit the Hubbe farm [Woodenup] in the '40s and '50s ... The water was very fresh there" (L.366). "... the water there was good" (L.352).	Sa (r)	I CR I I	EO,SA,SR,CA EO,SR,CA,PM CA EO,SR
		"... the Hubbe's used to use the water in the river for their stock and also in dry summers they would cart water from a pool not far from the house and that water was used for their stock." (L.374).	Sa (r)	I I I I	SA,CA CA,SR CA EO,SR
	D. Mathew	"... they never drank it at the house. It was always a bit on the brackish side ... In the summer it was usually too brackish even to pour on the gardens when I was a small child ... but the stock did drink it." (L.346).	Sa (r)	I CR I I	EO,SA,CA CA,EO CA EO,SR
		"... when I was very little I can remember it not being brackish, except at the end of "hottest, driest summers". (L.82).	Sa (r)	I CR I I	EO,SA,SR,CA CA,EO EO,SR CA
		During a ride down the Tone River in 1946/7 "... the horses were able to drink the water without a great deal of worry." (L.164).	Sa (r)	I CR I I	SA,CA CA,EO EO CA
		"But as the summer came the pools would dry up, and as the salt came up ... you could see it shining on the banks as the water went down, *(L.129).* "... but to start with it wasn't like that, it was just as dry creeks go, but there was no salt coming up" *(L.131).*	Sa (r) Sa (c)	NI CR I I	PM,EO,SR CA EO,SR
		"It was, I suppose, after 1948, right into the '50s and beyond, that it started changing quite quickly and the water got so that the stock wouldn't drink it" (L.217).	Sa (c)	I I I I	CA,SR SR,PM,CA CA,PM EO,SR,PM
		"... *before it went salty* it [Woodenup Pool] was a ... clear, tea colour" (L.127).	Cs (r) pH (r)	I I I I	CA PM,SR CA EO,SR
		"... we used to paddle ... you could see the bottom, the water was nice and clear mostly" (L.174; 80).	Vi (r) Tu (r)	I NI I	CA CA
		"... the tea-trees were very thick and lent over the top like a tunnel." (L.132). [Inference: shade and cooling effect on water].	Te (r)	I CR I I	PM,CA PM,SA EO CA
		"... we used to paddle. It was shady and cool" (L.174).	Te (r)	NI NI I	 CA
	H. Young	"... it was used for stock water. It was brackish-ish in the summer, it wasn't completely fresh. In the winter-time, yes, it was certainly good stock water. In the summer time it was used ... there were pools that were fresh and there were also little soaks in the creeks that they had excavated ... that were good ... well, yes, probably good for wethers ... not so good for ewes, I guess." (L.253).	Sa (r)	I CR I NI	SA,CA SR,PM,SA CA
		"The stock ... used to drink the river, it was good stock water then." (L.135).	Sa (r)	I CR NI I	SA,CA SR,PM,SA CA
		"... they didn't ever use the water for the garden [Hubbe house - Woodenup]. I don't ever remember that they pumped water for the garden" (L.267).	Sa (r)	I CR I NI	EO,SA,CA EO CA

River section	Interviewee	Potability, clarity, basic physio-chemistry and odour	Ecosystem attributes	Investigative status	Potential information sources
		"The original water supply at the old Woodenup house where the Caws lived, was a well. The house was right down on the edge of the river, probably only about ten yards, 15 yards to their house fence from the river. The [well] ... was just sort of outside the fence, close to the river. I'm not quite sure when they stopped using it, but by the time when we came back from Katanning at the end of 1945, it had been filled in then ... *presumably because it had gone brackish* ... But it certainly was their house supply for a good many years from when they first started there" [the property was purchased in 1919]. (L.611).	Sa (r)	I CR I I	EO,SA,CA SA,CA,EO CA EO
		"The dams that were down on the ... there's one particularly that went salt ... I think it would probably have been the early 1960s". (L.472).	Sa (c)	I CR I I	EO,SR,SA,CA SA,CA,EO CA,PM EO,PM
		During floods "I used to do down the river and swim across it ... it was quite clear the river, I suppose, it was a sort of a dark brown, but it was clear ... it was a really clear, swirling thing." (L.72). *"... not that brackish looking look it's got today"* (L.75).	Tu (r) Cs (r) pH (r)	I NI I CR	CA CA
	D. Ryall	"... right at the very headwaters of the catchment the creeks were all fresh those days" (L.52).	Sa (r)	I CR I I	EO,SR,SA,CA SA,CA,SR CA EO
Upper Tone River	M.Fryer-Smith	" ... you'd find a lot of marks of foxes and native cats drinking at the water ... the whole edge of the bank used to be covered in marks of snakes, lizards, foxes etc." (L.227). "Large number of snakes' and lizards' tracks would run to the water's edge" (L.88). *"... today you don't see that happening. They tend to go more to farm dams where the water is fresher."* (L.88).	Sa (r) Sa (c)	I NI NI I	EO,SL CA,SR
		"In the early '40s ... the river was very fresh in those days" (L.8). The water "was perfectly drinkable, although you generally boiled it because of the amount of fish in the water, but it was very drinkable" (L.189). "... in my childhood the water was used largely for stock." In dry seasons water was carted from permanent river pools to augment supplies from small farm dams that would go dry. "In one or two bad drought years in this area, practically all the water was carted from the Tone River for stock in this area where we live." (L.261).	Sa (r) Sa (r) Sa (r)	I I CR I CR CR CR	EO EO,SR,SA,CA CA,EO,SA CA CA,EO,SA CA,EO,SA
		"In the '60s when a large amount of clearing was conducted in the Tone River catchment area ... [the] water became more saline". (L.255).	Sa (c)	I I I I	EO,PM,SA EO,SR,SA,CA,SL PM,SA,SR CA,SR,PM
		"... today we can't use the water for anything, very few places are suitable for stock until you get further south from this property" (L.322).	Sa (c)	I I I I	EO,PM,SA EO,SR SL,SA CA,SR
		"Originally the creeks and watercourses feeding into the Tone were sound, fresh water" (L.66). *"... but today that is not the case."* (L.66). *"Dams that were sunk on this property many years ago were put in a watercourse to catch water, and now those dams have been filled in and new dams have been sunk on the hillsides and the water for the watercourse carried by contour drains to the dams, because most water courses in this area are now salty"* (L.299).	Sa (r) Sa (c) Sa (c)	I I CR I I I	EO,PM,SA EO,SR,SA,CA,SL CA,SR,EO SA,SR SA,SR
		"In the early '40s to '50s that [Pallinup] pool was particularly fresh." (L.35). "I can remember natives who used to work in the area - used to camp on that river simply because it was a good water supply." (L.37).	Sa (r) Sa (r)	I I I I	EO SA,CA SR,SA,EO CA

River section	Interviewee	Potability, clarity, basic physio-chemistry and odour	Ecosystem attributes	Investigative status	Potential information sources
		Nymiup Pool: "... particularly good, fresh water" (L.43).	Sa (r)	I I I I	EO SA,CA SR,SA CA
		"The water was fairly clear ... it was clear" (L.189).	Tu (r)	I I NI	EO CA
		Today the water is ... a murky green colour in most of the pools." (L.193).	Tu (c) pH (r) Al (c) Di (c) Te (c)	I I	CA SR
		Wackelingup Pool: "It was particularly deep water and very cool" (L.122).	Te (r)	I I NI I	EO,P CA CA
		Nymiup Pool: "... deep, cool water with a lot of overhanging trees, red gums and flooded gums" (L.126).	Te (c)	I I CR	EO,P CA,PM PM,SR
		"The water was always very, very cold even on extreme hot days, the water was icy cold once you were down about four or five feet, and the water would remain cold right throughout summer." (L.169).	Te (c)	I I NI I	EO CA CA
		"One thing that was noticeable with the pools in those days, there would be a lot of shade from overhanging branches of flooded gums" (L.97).	Te (c)	I I CR I	EO CA,PM PM CA,SR,PM
		"... which today is not evident because the salinity has killed the vegetation alongside those pools" (L.98).	Te (c)	I	PM,SR
		"... therefore the temperature of the water is higher now than it used to be." (L.104).		CR	EO
		"... therefore they are far more exposed to the sun, which creates further salt encroachment on the banks." (L.99).		CR	EO
	W. Harvey	"When my father first came here [early 1940s] there wasn't any clearing and ... they went in to pig farming". Six hundred pigs were kept down along the river in summer months because "they didn't like the hot weather" (L.326) and "the water was good and it was a nice, cool environment for them." (L.330). [Inference: a measure of salinity level].	Sa (r)	I I CR I	EO,SA CA PM,SA,SR CA
		"... early on we pumped water. We used the river to water the garden, *but that sort of got knocked on the head as the salinity in the water went up."* (L.340).	Sa (r) Sa (c)	I I I I	SR SR,CA SA,SR CA
		The water became unusable for the garden in the '60s (L.350).		I	SA,SR
		[A drought experience dating to 1940-41 told to Harvey by a farmer who lived near the river not far from Harvey's property]. "Of course a drought really stood out as a drought because the dams were small [in those days] and they didn't have water storage for the animals, and for the houses, and this chap telling me that they carted water in petrol tins from the river, making their tea and drinking it". By April-May 1941, when the river had stopped running, they were experiencing health problems (e.g. diarrhoea) through using the stagnant water. (L.96).	Sa (r)	I I NI I	EO CA CA
		"... you couldn't drink it in a good year now ... but these guys lived on it, made their tea" (L.103).		CR	EO,SL,SR
		""... back in the '50s ... The water was absolutely clear ... *but you see it now and it's stagnant and putrid"* (L.30).	Tu (c) Tu (r) Al (r) Di (c) Te (c)	I I CR I	EO CA EO,SL,SR CA
		"That's something you really notice now ... it's not the crystal clear ... waterway it used to be." (L.440).	Tu (c) Tu (r)	CR	EO,SL,SR

Note:

Following the scientists' independent evaluation, further analysis of the interviews revealed additional information. This information has been added to the frequency data shown in Figure 4.1:

- Two changes in water chemistry "Wa (c)" recalled by Young (L.90) and Mathew (L.85)
- Six changes in salinity "Sa (c)" recalled by Lee (L.355,93), Young (L.87), Mathew (L.84), and Fryer-Smith (L.158,238)

Appendix 3: Assessment of the content of interviewer's question by ecosystem attribute type and condition

Interviewer's questions	Attribute type	Reference/ change
M. Lee		
Could you tell me about the development of this farm and other farms nearby? (L.24).	Non-specific	Non-specific
What can you recall about the development of the land close to the Murrin Brook? (L.64)	Non-specific	Non-specific
As a child, what kinds of things did you do down at the Murrin Brook? (L.81)	Non-specific	Reference
What other stories can you tell me about your experiences of the Murrin Brook? (L.104)	Non-specific	Non-specific
Thinking back to your earliest memories of the Murrin Brook, can you describe what you could see? Well, if you were standing close to the Murrin Brook, just describe what the vegetation was like that you could see [second question provided as clarification] (L.146)	Vegetation	Reference
What was the Murrin Brook being used for in your lifetime? (L.171)	Water quality	Non-specific
When did people stop using the Murrin Brook for watering stock? (L.188)	Water quality	Change
How would you describe the water in the Murrin Brook during your early days? (L.203)	Water quality	Reference
You have described what the vegetation along Murrin Brook used to look like, can you tell me what sort of changes you noticed in the vegetation over the years? (L.221)	Vegetation	Change
What other different animals did you use to see along or close to the river, along Murrin Brook, and also in Murrin Brook? (L.289)	Fauna	Reference
Was there something about Murrin Brook that was special to you when you were a young person? (L.340)	Non-specific	Reference
Can you tell me about some of the big old trees that there used to be near the creeks on the farm? (L.393)	Vegetation	Reference

C. Owen		
Can you tell me what memories you have of the Tone River from when you were a child? (L.32)	Non-specific	Reference
Can you tell me a bit more about the sorts of things you used to do when you were down there, and who you used to go down to the river with? (L.53)	Non-specific	Reference
When you did go swimming there, what sorts of things did you see in the water? (L.79)	Non-specific	Reference
Can you tell me anything more about the bird life you used to see? (L.89)	Fauna	Reference
Do you remember, with the people you used to go down to the river with, what sorts of things did you all do together down there? (L.99).	Non-specific	Reference
When you were in the river, what vegetation could you see? (L.111)	Vegetation	Reference
What about when you moved away from the river a little bit, and maybe a bit more out on to the floodplain - what was the vegetation like there? (L.127)	Vegetation	Reference
When did you start to notice changes to the river itself? (L.142)	Habitat structure Water quality	Change
What other changes did you observe? (L.156)	Non-specific	Change
What was the appearance and taste of the water that you can remember when you first started visiting the river? (L.167)	Water quality	Reference
What sounds do you associate with the Murrin Brook or the Tone River, perhaps when you were young and going down there? (L.183)	Fauna Habitat structure (e.g. riffles)	Reference
Can you tell me anything more about wildlife that you've seen down along the Murrin Brook or the Tone? You have mentioned the native cat. (L.193)	Fauna	Non-specific
So, if your grandchildren now were to ask you what you remember most about that river, or the look of it or something, what would you say to them? (L.229)	Non-specific	Reference

If we can just go back to your memories of what it was like when you went down to the Murrin Brook from school, from the Jingalup School, can you just paint a picture for me of what that bit of the Murrin Brook used to look like? (L.272)	Non-specific	Reference
Have you ever fought any fires down along the Murrin Brook or the upper Tone? (L.323)	Non-specific	Non-specific
D. Ryall		
How far south down the Tone River would you have been to? (L.28)	Non-specific	Non-specific
What else can you tell me about the river when you first used to go down there hunting?	Non-specific	Reference
Can you paint a picture of when you were close to the river what it looked like? (L.58)	Non-specific	Non-specific
Can you remember what was in, what wildlife or animals were in the water, in the river? (L.73)	Fauna	Reference
Thinking back to when you used to go down to the Tone, can you remember what sorts of things people used to use the river for? (L.98)	Non-specific	Reference
Can you describe the pools that you might have seen along the Tone River? (L.107)	Habitat structure	Non-specific
What changes have you noticed in the river? (L.129)	Non-specific	Change
Any changes to the wildlife, animal life? (L.144)	Fauna	Change
Can you tell me a bit more about the actual changes you've observed with the vegetation along the river? (L.152)	Vegetation	Change
When did you notice these changes starting to happen? (L.160)	Vegetation	Change
What was it like walking down the river? What would you have seen as you were on a hunting trip walking down beside the river? (L.344)	Non-specific	Non-specific
How would you like to see it [the river] in the future? (L.360).	Non-specific	Change
How easy was it to walk along the river? (L.417)	Vegetation	Non-specific

D. Mathew		
Can you tell me when you were growing up which sections of the Tone River or the Murrin Brook that you were most familiar with? (L.27)	Non-specific	Reference
Can you tell me ... can you paint a picture of what the Tone River used to look like as you remember it from when you were a child? (L.56)	Non-specific	Reference
When you were down close to the river, can you tell me a bit more about what the river looked like and whether there were any pools along it? (L.120)	Non specific Habitat structure	Reference
On your ride down to Lake Muir can you tell me more about the sort of vegetation along the river itself? (L.147)	Vegetation	Reference
Back on your farm, say around Woodenup, if you were just swimming in the pool, what sort of things do you remember about that environment, what was it like? (L. 167)	Non-specific	Non-specific
Can you tell me about the types of noises or sounds that you associated with that river environment? (L.182)	Fauna Habitat structure	Non-specific
You have mentioned a number of changes that you observed, mostly to do with salt, can you tell me a bit more about the changes that you observed and when you observed those changes taking place? (L.203)	Non-specific Water quality	Change
Were there any other changes that you can remember observing, perhaps when you came back from school or in later years when you would come back and visit the farm? (L.245)	Non-specific	Change
Do you remember anything about the history of the clearing further up the catchment, so further up Murrin Brook, I suppose? (L.267)	Non-specific	Non-specific
Earlier on you mentioned some of the introduced species, can you tell me anything about when you remember those arriving?	Fauna	Change

H. Young		
Can you tell me where you went to school? (L.8)	Non specific	Non-specific
You have talked about trying to cross the river, can you tell me a bit more about that, what it was like in summer and winter? (L.98)	Habitat structure	Non-specific
Can you tell me more about the kinds of uses that people made of the river and the river water? (L.250)	Water quality	Non-specific
Can you remember anything more about any other animals that used to live in the water? (L.272)	Fauna	Reference
What other noises did you associate with the river, perhaps in the evening?	Fauna	Non-specific
You mentioned earlier that you went to school at Jingalup, can you tell me about the Murrin Brook near Jingalup? (L.302)	Non-specific	Reference
Did any of the kids from school used to go down to the Murrin Brook to play, as far as you know? (L.344)	Non-specific	Reference
So, when you got to Jingalup, can you tell me a bit more about what the bush around there used to look like and that little tributary you mentioned that you used to go swimming in - can you describe that a little bit more? That sort of area? (L.410)	Vegetation	Reference
So, having gone back to the farm to manage it or run it in the 1970s, what were the big contrasts with what you remember it being like when you were small?	Non-specific	Change
How did you feel about the river when you growing up on the farm? (L.509)	Non-specific	Reference
Is there anything else that you would like to tell me about the Tone or Murrin Brook? (L.593)	Non-specific	Non-specific
M. Fryer-Smith		
Can you describe for me the sections, or perhaps the pools, along the Tone River and its tributaries that you are most familiar with, so perhaps put some names and so forth on those areas?	Habitat structure	Non-specific

Can you tell me from your earliest recollections of the wildlife you used to see along the Tone, what sort of animals can you recall?	Fauna	Reference
What about ... you've described the pools that you have visited in the past, can you take me to some of those pools in a sense and paint more of a picture of what they used to look like, and what the experience was like of swimming there or fishing there?	Habitat structure Water quality Fauna Vegetation	Reference
Can you tell me a bit more about the pools that you used to visit, I think you mentioned two on William Harvey's property?	Habitat structure Water quality	Reference
You mentioned before that people used to go down to some of the pools for picnics, can you tell me anything more about that?	Non-specific	Reference
Any other memories about the sorts of activities you did down there?	Non-specific	Reference
I think you mentioned you did go swimming in there and you mentioned that there were snags and things, can you tell me a bit more about when you were in the pool, what it was like?	Habitat structure Water quality	Reference
How would you describe the appearance and taste of the water when you first used to go down to the river?	Water quality	Reference
What was it like trying to cross the river in summer and in winter?	Habitat structure	Non-specific
Thinking about the whole of the river that you're familiar with, say north of William Harvey's, can you give me a more general description of what the vegetation was like, perhaps also a bit further back from the river?	Vegetation	Reference
What sounds or noises do you associate with the Tone River, perhaps from being there in the evenings?	Fauna	Non-specific
Can you tell me about the changes that you've observed along the Tone River since you first started visiting it?	Non-specific	Change
Is there anything else about the changes over time that you've observed? Approximately when some of those changes may have taken place?	Non-specific	Change
Can you tell me more about what the river used to be used for, perhaps going also back to your childhood and then thinking into more recent times?	Water quality Fauna	Reference and change
Can you tell me about the history of land development on the farm - on Keston Vale, your farm, but also what you know about the development further up in the catchment?	Non-specific	Change

Is there something about the river that's special to you now?	Non-specific	Change
Is there anything else that you would like to tell me about the history of the river or your experiences?	Non-specific	Non-specific
Did you spend much time in that area [Murrin Brook near Jingalup] when you were young?	Non-specific	Reference
You mentioned that you used to visit the Hubbe farm, could you tell me a bit more about the river and the wildlife that you used to see there?	Fauna Non-specific	Reference
W. Harvey		
Could you please tell me you name and date of birth? [Harvey commenced his recollections of the river from this question]	Non-specific	Non-specific
Ok. So, were there any other animals that you remember seeing along the river?	Fauna	Reference
Any other animals that you can recall?	Fauna	Reference
How have the pools changed - you have mentioned you had four pools on the farm?	Water quality Habitat structure	Change
You mentioned before some of the things you used to do down there when you were a child, have you got any other memories or experiences you've had down the river?	Non-specific	Reference
Can you tell me anything else about the vegetation along the river and a bit away from the river as well, if you were describing what it used to look like to someone?	Vegetation	Reference
You were mentioning the different types of vegetation you had seen along the river, can you tell me how that has changed over time, when you think it started to change?	Vegetation	Change
With the house so close to the river, was it used for any other purposes, as far as the house was concerned?	Water quality	Non-specific
When do you think the water would have become unusable for the garden here?	Water quality	Change
You were mentioning earlier about the sorts of noises you could hear, sounds of the bush when you were in the river, what about at night time - what could you hear down at the river at night time?	Fauna	Non-specific
How would you compare your experiences of the river when you were growing up to what your kids experienced when they were growing up on this farm?	Non-specific	Change
When you went swimming in the river, did you see anything in particular in the water?	Non-specific	Reference

Appendix 4: Results of Scientists' Evaluation of Four Ecosystem Attributes (see Appendices 2.1 to 2.4)

Riparian vegetation

Respondent	Investigate	Clarification required	No scope for investigation	Total
S1	47	15	-	62
S2	51	9	-	60
S3	20	35	7	62
Actual	**118**	**59**	**7**	**184**
%	**64.1**	**32.1**	**3.8**	**100**

Number of respondents = 3

Minimum number of responses expected = 62

S2 gave no answer to two questions

Habitat structure

Respondent	Investigate	Clarification required	No scope for investigation	Total
S1	43	-	10	53
S2	49	5	-	54
S3	10	37	12	59
S4	46	3	5	54
Actual	**148**	**45**	**27**	**220**
%	**67.3**	**20.4**	**12.3**	**100**

Number of respondents = 4

Minimum number of responses expected = 52. A number of cells contained more than one recollection.

S4 gave no answer to one question

Riverine fauna

Respondent	Investigate	Clarification required	No scope for investigation	Total
S1	36	-	26	62
S2	49	14	-	63
S3	12	53	10	75
Actual	**97**	**67**	**36**	**200**
Total	**48.5**	**33.5**	**18.0**	**100**

Number of respondents = 3

Minimum number of responses expected (a number of cells contained more than one recollection) = 63

S1 gave no answer to one question

Water quality

Respondent	Investigate	Clarification required	No scope for investigation	Total
S1	42	-	4	**46**
S2	44	1	-	**45**
S3	18	28	11	**57**
S4	40	2	3	**45**
Actual	**144**	**31**	**18**	**193**
%	**74.6**	**16.1**	**9.3**	**100**

Number of respondents = 4

Minimum number of responses expected (a number of cells contained more than one recollection) = 45

S4 gave no answer to two questions