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**Abstract:** Indigenous people demonstrably lived along rivers and around lakes and wetlands of Australia's Murray-Darling Basin in pre-European times. Water ways were, and continue to be, of major significance to the society and culture of Aboriginal peoples throughout Australia. Historically, they exploited most of the fauna - from mussels and crayfish, to fish and birds - and either ate, or used for other purposes, many species of aquatic plants. Such practices placed them in the role of environmental modifiers, a role played all human groups past and present. They built sophisticated fish traps, cut gaps in river banks to allow fish to move on to floodplains, and there is evidence that they practised a form of fish culture by creating small impoundments in which small fish could live and grow in normally ephemeral tributary streams away from predatory larger fish. Knowledge of the numbers of Aboriginal people inhabiting the riverine regions of the Murray-Darling Basin are sketchy, but at times large groups congregated for cultural reasons, facilitating fishing with extensively engineered fish traps, such as that at Brewarrina, on the Barwon River in New South Wales. At other times, densities may have been about 0.5 person per river kilometre, although this was certainly not evenly distributed and the calculation post-dated deaths from smallpox. From archaeological and anthropological evidence, aquatic fauna and flora would have constituted between about 30 and 100% of the diets of Indigenous people historically, depending on season and location. As such, Indigenous people were very much a part of the ecology of aquatic ecosystems and their effects may have been profound. Despite this, their role in influencing these ecosystems has largely been ignored by contemporary freshwater ecologists and managers. Current management practices do not seem to have considered the loss of this component of riverine ecosystems, and there is little debate about how the historical part that Indigenous people played in shaping these systems and their biota might be incorporated into management generally.

# Historical Indigenous use of aquatic resources in Australia's Murray-Darling Basin, and its implications for river management

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## ***[Bionote]***

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# **Historical Indigenous use of aquatic resources in Australia's Murray-Darling Basin, and its implications for river management**

By Paul Humphries

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## **Summary**

Indigenous people demonstrably lived along rivers and around lakes and wetlands of Australia's Murray-Darling Basin in pre-European times. Water ways were, and continue to be, of major significance to the society and culture of Aboriginal peoples throughout Australia. Historically, they exploited most of the fauna - from mussels and crayfish, to fish and birds - and either ate, or used for other purposes, many species of aquatic plants. Such practices placed them in the role of environmental modifiers, a role played all human groups past and present. They built sophisticated fish traps, cut gaps in river banks to allow fish to move on to floodplains, and there is evidence that they practised a form of fish culture by creating small impoundments in which small fish could live and grow in normally ephemeral tributary streams away from predatory larger fish. Knowledge of the numbers of Aboriginal people inhabiting the riverine regions of the Murray-Darling Basin are sketchy, but at times large groups congregated for cultural reasons, facilitating fishing with extensively engineered fish traps, such as that at Brewarrina, on the Barwon River in New South Wales. At other times, densities may have been about 0.5 person per river kilometre, although this was certainly not evenly distributed and the calculation post-dated deaths from smallpox. From archaeological and anthropological evidence, aquatic fauna and flora would have constituted between about 30 and 100% of the diets of Indigenous people historically, depending on season and location. As such, Indigenous people were very much a part of the ecology of aquatic ecosystems and their effects may have been profound. Despite this, their role in influencing these ecosystems

has largely been ignored by contemporary freshwater ecologists and managers. Current management practices do not seem to have considered the loss of this component of riverine ecosystems, and there is little debate about how the historical part that Indigenous people played in shaping these systems and their biota might be incorporated into management generally.

**Key words:** rivers, Australia, Aboriginal people, fish, aquatic plants, food

## Introduction

Aquatic systems have been, and continue to be, important environments in the economies of indigenous peoples throughout the world (Bandler 1995a; Jackson 2005; Toussaint *et al.* 2005). Oceanic mammals, birds, fish, molluscs, crustaceans and plants have contributed to the sustainability of most societies at one time or another and have allowed many of these to prosper, expand and colonize other continents (Kurlansky 1998). For inland-dwelling peoples, rivers and lakes have served a similar function (Bandler 1995a; Hoffman 1996; Russel-Smith *et al.* 2004). The association of humans with rivers and lakes is obvious, since freshwater is indispensable to life, but the use of rivers and lakes goes far beyond simply for drinking water. Aquatic systems supply food, clothing, cooking utensils, carrying implements, ornaments and, of course, they and their fauna and flora loom large in indigenous culture and mythology (Jackson 2005).

Indigenous Australians have occupied Australia for about 50,000 years (Flood 2004; Bowler *et al.* 2003). During that time, there is good evidence that they have been associated with rivers and lakes and exploited a vast range of their resources (see Bowler *et al.* 2003; Bandler 1995a; Balme 1995; Flood 2004; Russel-Smith *et al.* 2004). Examples of early Aboriginal association with freshwater environments, include fossils (Bowler *et al.* 2003), middens (Balme 1995) and the sophisticated rock shoots and funnels of the Brewarrina Fisheries (Mathews 1903; Dargin 1976) (Figure 1). More recent examples of the association of Indigenous people with rivers and lakes, include European explorers' and anthropologists' accounts of the ubiquity of people around water bodies and the exploitation of animals, plants and minerals (see e.g. Mitchell 1839; Sturt 1882; Krefft 1865; Taplin 1879; Beveridge 1882, 1889; Mathews 1903). Virtually all rivers in the Murray-Darling Basin have evidence of Aboriginal occupation, either through the presence of middens, scar trees or artefacts.

Humans should not, however, simply be considered as exploiters of resources, but as, themselves, components of an ecosystem (Berkes *et al.*, 2000). In the case of Aboriginal Australians and freshwater ecosystems, as I will argue below, their exploitation of aquatic resources was so wide that the breadth of their impact would have likely been more significant than other species: they were not just top predators, like eagles or Murray cod (*Maccullochella peelii peelii* [Mitchell]), they used most components of the fauna and flora in one way or another.

Indigenous Australians, like indigenous peoples throughout the world (Denevan 1992; Newson 1996; Gott 2005), were also environmental modifiers. They manipulated the physical environment to aid in the collection of components of the fauna (Angas 1847; Morey 1952) including altering the physical environment to enhance the survival and growth of fish (Gilmore 1934), therefore carrying out a form of aquaculture (Bandler 1995b). Thus, the aquatic environment encountered by Europeans was not in stasis; rather it was dynamic and under the influence of, amongst other influences, the dominant humans of the time. The potential for Aboriginal people to modify aquatic environments in a substantial way through active manipulation, has received much less attention than that of terrestrial environments (see e.g. Mulvaney & Kamminga 1999). Indeed, this factor – along with the question of whether there have been any effects of their removal as primary participants in aquatic environments - is rarely discussed.

Loss of any species from an ecosystem would normally elicit concern by scientists, whether it be for its intrinsic significance or for the effects its loss would have on other components of the ecosystem. Wholesale displacement and removal of Aboriginal Australians from their land associated with rivers and lakes in inland Australia began early in European settlement history, yet aquatic scientists have lagged well behind their terrestrial counterparts in asking pertinent questions such as: “What role did Aboriginal people play in aquatic ecosystem?” and “What effect has their removal had on the biotic and abiotic components of those systems?”. These are important questions for researchers and managers trying to understand how and why freshwater ecosystems have changed, how best to restore them and what conditions ultimately are desirable. It is especially pertinent, considering Indigenous groups continue to utilise and modify the freshwater environment in many parts of Australia and want to be, and in some cases are, actively involved in the management of freshwater resources (Jackson *et al.*, 2005).

This paper stems from a fellowship in 2005 at the National Library of Australia, where I researched historical accounts of fish in the Murray-Darling Basin. It was during this study that I came across many references to Aboriginal use of the fauna and flora in the rivers and wetlands of the Murray-Darling Basin, the extent of which I was totally unaware. I consider that my ‘blind spot’

concerning the role that Aboriginal people played in the Murray-Darling Basin is shared by many others working in freshwater ecology. Thus, in this paper, I aim to highlight the historical association of Aboriginal people with the rivers, lakes and wetlands of the Murray-Darling Basin in pre-European times, describe their exploitation of the associated fauna and flora and the types of modification that they imposed on the biotic and abiotic environment. I then consider the replacement of Aboriginal people by Europeans as primary participants in the ecology of these rivers (specifically in terms of exploitation of fish); and, discuss (a) whether this has been considered in assessing European impacts and (b) how is it integrated into current ideas on management.

### **Aboriginal occupation of rivers and wetlands**

Aboriginal association with rivers, lakes and wetlands of the Murray-Darling Basin is proved by the existence of shell middens, which also contain many other animal remains of aquatic origin (Mulvaney & Golson 1971; Balme & Hope 1990; Balme 1995), and by the Brewarrina and other fisheries constructions (Mathews 1903; Parker 1905; Dargin 1976). Aboriginal mythology is also full of reference to rivers and fish (see e.g. Smith 1970; and Berndt *et al.* 1993; Jackson 2005; Toussaint *et al.* 2005) and Australian rivers, creeks and lakes all bore Aboriginal names when Europeans first arrived. Whilst some names were changed, many that remain bear witness to the significance of water bodies and their inhabitants to Aboriginal people.

Much more recently, written material from explorers, natural history writers, settlers, government officials, missionaries, anthropologists and newspapers, as well as paintings and early photographs all attest to the prevalence of Aboriginal people along rivers, and around lakes and wetlands. These accounts are too numerous to detail here, but a few examples will illustrate the point. Rene-Primavera Lesson, testified that the people “for the most part follow the banks of rivers and streams”, with fishing supplying “...them with their principal sustenance.” (Lesson 1824 p. 162). Charles Sturt noted the presence of scaffolding and weirs for catching fish in the Macquarie Marshes and on the Darling River and stated that the Aborigines’ main “...food is fish, of which they have great supplies in the river; still they have their seasons for hunting their emus and kangaroos.” (Sturt 1982, p. 106). Hawdon and Bonney encountered many Aborigines on the Murray River in 1838 and documented their numbers, behaviour and fishing methods:

Fish is their principle article of food and they procure it in great abundance. They also catch the Emu and different species of kangaroo, from the large-sized one, weighing 100 pounds, to the small Kangaroo rat.....The food of their women and children consists chiefly of roots of different kinds, wild Yams, freshwater muscels (sic), and the Tortoise....The men sometimes catch ducks with a net, which, as they ascend from the lagoon, come into contact with the net, and get entangled in its meshes.  
(Hawdon 1954, pp. 41-2.)

George French Angas' accounts are full of references to Aboriginal encampments along the Murray River, from Lake Alexandrina and upstream, and provide detailed descriptions of how the people lived and used the resources of the river and wetlands(Angas 1846, 1847). Peter Beveridge documented the customs of the lower Murray, Darling, Lachlan and Murrumbidgee tribes noting that: "As a rule the food of the aborigines consists of fish principally, of which, for eight months in the year they have a super-abundance; so much so indeed is their supply during those months they cannot nearly consume it all, consequently quite a moiety (sic) is absolutely wasted. To supplement the fish they have kangaroo, emu, opossum, and wallaby...." (Beveridge 1882, p. 18). He also describes the scenes during floods, when the people camped on mounds – the only dry spots - created by centuries of oven building, and feasted on fish, crayfish, water birds and eggs.

Assessment of the numbers of Aboriginal people associated with rivers, lakes and wetlands is problematic for many reasons. Lawrence (1971) makes the point that numbers were very much dependent on season and location, and density estimates are necessarily vague. However, he quotes one person per 52 km<sup>2</sup> and one person per 8 km<sup>2</sup> in riverine areas (from Bonney 1883 and Curr 1886) and Eyre (1845) estimated that in the lower Murray, there was a permanent population of about 3-4 people per mile of river, which would mean about 0.5 people per km. The last estimate is comparable with that of coastal densities (Lawrence 1971; Lourandos 1980), and is about the same as has been estimated for populations of Ecuadorian Indians living in inter-fluvial forest prior to 1492 (Newson 1996). Population size estimates dating from post-settlement times, however, would be considerably lower than prior to the two major epidemics of smallpox (Campbell 2002). Larger congregations of people undoubtedly occurred at times to take advantage of a seasonal abundance of fish and other resources and to strengthen important relationships (Mathews 1903; Gilmore 1934). Sturt noted 600 people at Lake Victoria in the early 1830s (Sturt 1982), but he also mentioned about 70 permanent huts at Brewarrina, each capable of holding a dozen or more people, although this does not mean that they were occupied all the time. There were also accounts

of 5,000 or more people at Brewarrina, Bourke, Wilcannia and Menindie (Mitchell 1839; Gilmore 1934), although these numbers may be exaggerated.

### **Exploitation of aquatic resources**

Historically, Aboriginal people harvested most moderate to large faunal species in the rivers, lakes and wetlands of the Murray-Darling Basin. They not only had names for the individual species of fish – large and small - but even for different life stages of some of the larger species (Blandowski 1857). There are numerous first-hand accounts of fishing practices (see e.g. Eyre 1845), of catching birds in nets (Fountain & Ward 1907), of gathering huge numbers of bird eggs (Beveridge 1882), of fishing for crayfish by women (Wyndham 1890) and collecting mussels using the toes (Mitchell 1839; Sturt 1982). Anthropological work done in the late 1930s and early 1940s, documented the culture, economy and hunting and fishing practices of the Ngarrindjeri of the Lower Murray and its lakes (Berndt *et al.* 1993). These people captured and ate a large range of fish and other aquatic fauna and flora.

Methods for catching aquatic fauna were many and varied (Lawrence 1971). Fish were speared from the bank, within the water or from canoes (Eyre 1845; Angas 1847); nets were strung right across smaller rivers to catch birds disturbed by members of the hunting party downstream (Beveridge 1889; Morey 1952); brush weirs were constructed to trap fish that had swum on to floodplains during high flows (Angas 1847; Kirby 1895; Gilmore 1934); rock chutes – such as at Brewarrina – funnelled fish to places that they could be speared easily (Mathews 1903; Dargin 1976); poison or tannins from plants were introduced into the water to bring fish to the surface (Lawrence 1971); and, hooks were used to catch large fish (Gerritsen 2001).

Aquatic plants were also eaten in large quantities. The main species consumed was cumbungi (*Typha* sp.) (Gott 1999). Indeed, Gott argues that this species could lay claim to being a staple food for Aborigines in southern Australia. The main part of this plant eaten was the fibrous rhizome, but young shoots and young flowers were also consumed (Beveridge 1882; Morey 1952; Lawrence 1971; Gott 1999). Other aquatic plants were also eaten or used in other ways (see below), and include *Juncus* spp, *Phragmites australis* [Cav.], Ribbon Weed (*Triglochin* and/or *Vallisneria*) and Nardoo (*Marsilea drummondii* [A. Braun]) (Stone 1911). Reports suggest that *Typha* and other plants were eaten all year round, but that spring and early summer, when floods had receded and starch was greatest in the rhizomes, was the best time for harvesting (Gott 1999).

Aquatic plants and animals contributed to Aboriginal economies much more than just as food. The roots and stems of various plants were chewed and the fibre used to construct bags and nets. Nets were highly prized, as they took a long time to make and were mostly made from aquatic plants (Angas 1847; Taplin 1879; Beveridge 1882, 1889; Fraser 1892; Fountain & Ward 1907; Morey 1952; Gott 1999). Mitchell noted that the nets: “..... are very well worked, much resembling our own in structure, and they are made of the wild flax, which grows in tufts near the river...” (Mitchell 1839, p. 305). Several types of nets were made, including bag nets to ensnare large fish, drag or seine nets for small fish and crayfish, and even larger nets, as mentioned above, for catching birds. Light spears were made from reeds, which were used to catch fish (Beveridge 1889; Fraser 1892). Plant and animal parts, particularly crayfish antennae and fish bones, were also used for decoration (Angas 1847; Beveridge 1882; Stone 1911). There were also reports of people anointing their bodies with fat taken from Murray cod for decoration or insulation (Beveridge 1882). The bark of River Redgums (*Eucalyptus camaldulensis* Dehnh.), was cut to make canoes, shields and carrying devices.

Few studies have attempted to determine the relative importance of food derived from the freshwater environment for Aborigines in relatively recent pre-European times. A stable isotope study of bones from Roonka Flat, near Blanchetown, however, has suggested that 40-50% of dietary protein was of terrestrial herbivore origin, 10-15% of terrestrial carnivore origin and 30-40% from freshwater fish and shellfish (Pate 2000). Balme (1995), in a comprehensive analysis of 216 open midden sites along the Darling River and associated lakes in western New South Wales, showed that mussels were the most common item in remains. Fish - mostly golden perch (*Maccullochella* sp.), river catfish (*Tandanus tandanus* Mitchell) - and the yabby (*Cherax destructor* Clark) were also common, with mammals and reptiles apparently being less so. More studies of the diet of pre-European Aboriginal people, especially using stable isotope analysis, are possible and desirable.

### **Modification of the biotic and abiotic environment**

Considering that riverine regions were more heavily populated than the arid zones of Australia (Lawrence 1971), that the diversity of types of animals and plants exploited by Indigenous people prior to European intervention was high and that fishing, gathering and harvesting were widespread, it is worth asking what impact these practices had on the flora and fauna of river systems. In relation to quantities of resources harvested, at low population densities (e.g. 0.5 people per river km), the pressure on rivers would likely have been relatively slight. Most people, however, lived in

bands, which would have meant greater intensity of exploitation for a given stretch of river. When large congregations took place, intensity of exploitation could have been very high, with thousands of fish extracted if the festivals lasted even a few days (Mathews 1903; Dargin 1976). But the more long-term impact on the aquatic resources would have related to the selection processes that Aborigines employed in their harvesting. Fisheries research has shown that targeting particular species, if harvesting intensity is sufficient, will have cascading effects through the food web (Jackson *et al.* 2001; Frank *et al.* 2005). Selecting particular size classes of a species will tend to affect population dynamics and influence the evolution of that species. However, the relative influences on the fauna of consistent, low-intensity fishing for the majority of the time (which may have been broader in terms of species selection) versus 'pulsed', high-intensity fishing (which may have been highly selective for particular species) is unknown and warrants consideration.

To elucidate selection of aquatic species or size ranges, appropriate analyses of Murray-Darling Basin middens would be a fruitful area of research. Such analyses are **currently** virtually non-existent (see, however, Balme 1995). The nature of the geographic distribution of fishing effort by Aboriginal people (i.e. whether fishing pressure was evenly distributed along rivers or limited to popular and productive sites) would also provide insight into likely effects on the fauna. In addition, knowledge of the cultural rules of the Aboriginal people, in relation to aquatic animals and plants, would provide insight into how or whether moderation of harvesting practices prevented resources from being exhausted.

Direct extraction of plants and animals was one type of modification of the environment, but Aboriginal people also modified their environment to enhance the capture of food and, in some cases, to enhance the production of food. An example already mentioned is the rock fisheries at Brewarrina, but there were, it seems, many more of these in the Darling River and tributaries (Gilmore 1934; Dargin 1976). Their presence in different areas of the Murray-Darling Basin may testify to the periodic congregations of large groups and the associated intense harvesting. These rock constructions would have altered water currents locally, changing the hydraulic environment for riverine biota, enhancing conditions for some organisms, whilst making conditions less conducive for others. River morphology may also have been affected by the fishing structures, as high flows were deflected off rock walls. Certainly the structures were sufficiently obstructive to river flow and to the movement of water craft, for some of them to be removed by entrepreneurs wanting to open up rivers to river transport (Dargin 1976). Harvesting of aquatic plants for net and basket making may also have altered the morphology of rivers (aquatic plants play an important role in the local

hydraulic environment) and may have altered the available habitat for fish, water birds and invertebrates. In other instances, harvesting may have encouraged re-sprouting, enhanced growth and/or increased the area of some species of plants.

There were reports that Aboriginal people cut gaps about one metre wide into the banks of rivers, allowing fish to move into wetlands and billabongs (Kirby 1895). The main aim of this, according to Kirby, was to allow easier capture of fish. But it would also have provided enhanced fish access to floodplain wetlands and billabongs at times other than high floods. A more dramatic example of modification of the aquatic environment has been given by Mary Gilmore, who lived, as a child in the 1870s, near Wagga Wagga, on the Murrumbidgee River. She describes the use and ubiquity of fish 'balks' and traps in tributaries of the main rivers (rock traps like at Brewarrina tended to be more common in the large rivers) to allow fish to move upstream, but to hold them and the water back when the flow in the streams, mostly ephemeral, subsided (Gilmore 1934). Gilmore claims that "...the conservation of fish in streams depended on them [balks]; and that (as the aborigines taught) without them the great fish would devour the smaller varieties and the end would be loss – a loss that the years since have proved fact." (Gilmore 1934, p. 194); and that the once highly abundant balks were destroyed by settlers or replaced with permanent, and much larger dams. She also argues that the use of these balks, together with the transport of fish (using hollow logs, baskets and 'coolamons') resulted in the presence of fish in places which would not normally be expected to hold fish and gave rise to early settler's theories about fish falling with rain. The death and displacement of the Aborigines, Gilmore asserts, resulted in the loss of fish, as there: "...were no sanctuaried (sic) areas; no close (sic) season for breeding; no selection in netting fish; and, as I said before, the seventy pounders ate the smaller fish, and the once plentiful breeding diminished." (Gilmore 1934, p. 195).

### **Removal of Aboriginal fishing practices and replacement by early commercial fishing practices.**

While many Aboriginal people remain in the districts and continue to have relationships with rivers and their biota, between the late 1830s to the mid 1870s a large number of Murray-Darling Aboriginal people were displaced, forcibly removed to missions or died as a result of settlement of the productive river districts (see e.g. Matthews 1873, 1893; Curr 1893; Barwick 1971; Jenkin 1979; Robinson 2000). Thus, in a relatively short space of time, Aboriginal people had gone from playing a major role in the ecology of rivers, wetlands and lakes, to playing a very minor role (Curr 1893;

Robinson 2000). They were, however, replaced by Europeans who related to the rivers and their biota quite differently.

European commercial fishing of Murray cod and other species in the Murray River began in 1859 near Echuca, supplying fish to local towns, the goldfields and later to Adelaide, Sydney and Melbourne (Dannevig 1903; Dakin and Kesteven 1938; Rowland 1989). Aborigines were recruited to help in this enterprise. Fishing was intense and widespread. The fishers typically used 'bag nets' or gill nets (sometimes as long as 200 m) and often strung them right across rivers, and it was common "...to not lose sight of one net before you would see another" (Royal Commission on Fisheries, 1894-96, p. 29). These nets captured virtually all fish of sufficient size that encountered them and were used extensively in the breeding grounds of the Moira Lakes, in which it was "...just one mass of nets that are termed gill nets, and it is impossible for the fish to get out of the lakes into the river" (Royal Commission on Fisheries, 1894-96 p. 29). The commercial fishing industry, as documented in commissions of the time, articles in newspapers and later analyses, was intense, exhaustive, took fish regardless of size and age and ignored spawning times and nursery habitats (Argus 1863a, 1864; Macleay 1880; Royal Commission on Fisheries 1894-96; Dannevig 1903; Dakin and Kesteven 1938; Rowland 1989). There was no evidence that any 'moderation' of fishing practices occurred that took into account the habitat or breeding requirements of the fish, nor that there was any concept of sustainability. It took only four years before concerns were expressed at the state of the fish in the river (Argus 1863a, 1864), and Royal Commissions into the state of NSW fisheries highlighted major concerns about the sustainability of the fish stocks and lack of effective fishing regulations (Royal Commission on Fisheries 1894-96). It appears that in only a few decades, the rivers went from supplying Aboriginal people with a bountiful resource to one which was severely depleted.

*What might have been the ecological effects of the removal of Aboriginal people and their replacement by Europeans in the riverine environment?*

The following is necessarily speculative, since data do not exist on many aspects of Indigenous and European exploitation of aquatic resources in general, and fish in particular. But it is, I think, worthwhile constructing hypotheses relating to the changing influences and pressures on the fauna and flora of the rivers and wetlands of the Murray-Darling Basin, so that future research has some basis on which to work.

Aboriginal people, as I have described, had lived in the Murray-Darling Basin, exploiting aquatic resources for tens of thousands of years. By definition, this demonstrates that sustainable exploitation occurred. To some extent this is likely to be due to relatively small populations of people; but if evidence from explorers and early anthropological workers can be relied upon, this may also be partly due to cultural rules, taboos and accumulated knowledge ; (see e.g. Krefft 1865; Beveridge 1882; Berndt 1993). Many cases exist of indigenous peoples from around the world modifying their hunting and fishing practices to avoid the decline of important resources (Berkes *et al.* 2000). It is logical, therefore, to conclude that Aboriginal peoples in the Murray-Darling Basin would have been aware of their own potential impact on aquatic flora and fauna and may have modified their management to ensure it did not result in resource decline. Despite our relatively poor knowledge of densities of Indigenous people along rivers and of levels of exploitation, there appears to be enough documentary evidence to suggest that the substituted fishing practices of the early settler commercial fishing industry was immediately qualitatively different and became, in only a few years, quantitatively much greater than those previously employed.

The significance of the above analysis is not merely to note that European commercial fishing had a greater impact on fish populations compared with previous Aboriginal impacts. More importantly, it is to draw attention to potential for the *absence* of Aboriginal impacts and management practices to have a bearing on subsequent fish populations; particularly in the very early period after Aboriginal displacement. This in turn may have implications for our understanding of what may have been 'baseline' populations in the Murray-Darling Basin and raises questions about whether we are considering the full range of river management options in our planning for the future.

To detail one hypothesis, for example, it is possible that before commercial fishing took off, highly palatable species such as Murray cod, river catfish, golden perch and silver perch ([\*Bidyanus bidyanus\*](#) Mitchell) may have bloomed as fishing pressure on these species eased with declines in Indigenous populations. If this bloom occurred it may have resulted in reductions in the prey of these larger fish: i.e small-bodied species such as gudgeons, Australian smelt (*Retropinna semoni* [Weber]), rainbowfish juveniles of larger fish, and crayfish and mussels. Were this the case, cascading effects are likely to have occurred right through the food web. An alternative hypothesis might be that, if Aboriginal use of barks and fish culture practices had played a significant part in maintaining abundant populations of various fish species, as Gilmore and others have suggested, then it is possible that numbers of those species could have, instead, declined following Aboriginal population decline.

Testing these hypotheses would be very difficult, due to our lack of knowledge of past abundances, distributions and assemblage composition of fish in the Murray-Darling Basin. Only about half of the Murray-Darling Basin species had been described by the time commercial fishing started and about a quarter were still to be described when large-scale river regulation operations took off. **Until** such research is conducted, it is reasonable to suggest that scientists need to acknowledge uncertainty not only about estimates of population and assemblage structure but also about which species even existed during this period of rapid change. Nonetheless, such questions need to be asked, and any possible cross disciplinary research facilitated to gain insight into how fish assemblages and populations responded to such dramatic changes in exploitation by humans.

### **How has the role of Aboriginal people and their removal been considered in current ideas on management?**

Current management strategies for Murray-Darling Basin rivers in general have pre-European conditions as targets for restoration (MDBC 2003a, 2003b). The goal of the Murray-Darling Basin Commission Native Fish Strategy is to “..rehabilitate native fish communities in the Murray-Darling Basin to 60 per cent or better of their estimated pre-European settlement levels after 50 years of implementation” (MDBC, 2003, p. i). It is currently estimated from “...research, fishing records, Indigenous history and anecdotal evidence” (MDBC 2003a, p. 6) that fish communities are at 10% of pre-European levels. I believe that, whilst there may be implicit recognition within the Murray-Darling Basin Commission strategies that the conditions that Europeans first encountered in the rivers may have been the result of thousands of years of Aboriginal involvement, this needs to be made explicit. We – freshwater ecologists and managers – should acknowledge that these ecosystems were not static, and that in 1788 they were at one point in a trajectory leading from the past into the future. Despite considerable discussion in the last few decades (see e.g. Rolls 1981; Beck 1997; Kay 1998; Brook and Bowman 2002, 2004), Gott (2005) argues that only relatively recently have terrestrial botanists moved away from the fallacy of Australian landscapes being ‘pristine’ prior to European intervention. It seems that those of us working in freshwater systems have shared a similar misconception. We should acknowledged that the choice of a pre-European ‘benchmark’ is, at the end of the day, arbitrary.

That aquatic communities were probably more sustainable in pre-European times (i.e. that populations and species were less prone to extinction than they are now) is a reasonable conclusion

since there are now so many more stresses and threats on rivers than 200 years ago. So, perhaps it is logical to use the pre-European condition – assuming we can determine what that was - as the target for restoration. However, the role of Indigenous people in megafaunal extinctions in Australia has been the subject of debate for some time, and, while the jury is still out on its extent (see e.g. Burney & Flannery 2005; Wroe & Field 2006), it is not unreasonable to suppose that extinctions of freshwater fauna may have also taken place because of over-exploitation by Indigenous people. This has not been investigated as far as I know and again reinforces the need for studies that examine the structure of fish faunas over time, pre- and post-European involvement. An analysis of resource selectivity by both groups would also shed considerable light on the issue.

Indigenous issues are mentioned in some documents associated with the Living Murray Program - which aims to protect and improve the health of the River Murray - and other programs within the Murray-Darling Basin. While there are some references to using historical and Indigenous information to gain insight into fish population dynamics, amongst other things, in most cases references concern Indigenous communities being involved in decision-making processes, and the spiritual and cultural significance of rivers and their biota to these groups (Morgan *et al.* 2004). Whilst clearly, displacement of large numbers of Aboriginal people from rivers is not a current threat to fish communities – it happened mostly more than 100 years ago - there needs to be some debate relating to how this may have affected fish and whether there is a need to include historical Indigenous exploitation modification or management practices in current management strategies, as they are in some terrestrial environments in northern Australia.

Many indigenous peoples around the world have had sophisticated methods for ensuring the sustainability of their natural resources, and Berkes *et al.* (2000) argue cogently that there are important lessons that contemporary managers can learn from this indigenous ecological knowledge. Whilst we may never have a complete understanding of the exact historical role of Indigenous people in our riverine ecosystems, acknowledging their influence and asking the right questions related to their practices may give greater substance to our attempts at management and restoration.

In summary, we, as freshwater ecologists and managers, have largely ignored the role that Indigenous people have played in the ecology of freshwater ecosystems in the Murray-Darling Basin prior to European settlement. This has been compounded by not considering their removal, and replacement by Europeans, as primary participants from these systems as a potential major change, admittedly one that occurred some time ago. I believe this highlights a 'blind spot' in our thinking

and, at least for ecologists, but not necessarily managers, a disregard of history as providing context to our work.

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