

# Benchmarking social attitudes to **river health** and **carp management** in the Lachlan River Catchment, NSW.

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# Benchmarking social attitudes to river health and carp management in the Lachlan River Catchment, NSW.

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## Executive summary

Carp, *Cyprinus carpio*, are a large freshwater fish native to Asia and considered a significant pest in Australia. The introduction of carp into Australian inland waters has raised serious concerns about the impacts the species is having on these aquatic systems and a strong interest in devising ways to manage carp populations. This paper reports on the analysis of responses from a survey conducted in the Lachlan River Catchment, NSW, which aimed to benchmark the community's perceived assessment of the health of the river, impacts of carp on that health and options for future management of carp in the river system. The research indicated that there is a general belief that the condition of the Lachlan is degraded and that the carp population is a contributing factor. There is also a perception that insufficient resources are being allocated to carp management. The survey results indicate the community will support carp management programs but that they will have certain expectations in terms of carp control and improving river features. The baseline data provides an insight into local opinions and expectations and can be a starting point for engaging the community to help manage carp in the Lachlan River Catchment.



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# Introduction

Invasive species represent one of the greatest threats to Australia's biodiversity and natural resources (Department of the Environment Sport and Territories 1996; Kingsford, Watson et al. 2009). Seventy three species of introduced vertebrate pests have been estimated to have successfully established populations in Australia (Bomford 2003); including mammals (23 species), birds (20 species), reptiles (4 species), freshwater fish (23 species) and one species of amphibian. Recent research suggests that there are actually 34 alien fish species (Lintermans 2004); some are localised to particular regions (e.g. tilapia) and others have distributions that cross jurisdictional boundaries over several states/territories (e.g. carp). Australian freshwater systems are considered particularly susceptible to invasion by pest species because of the country's harsh arid climate and geographic isolation (Lintermans 2004).

Common carp (*Cyprinus carpio*) (Figure 1) are an important food source for humans and are also a highly valued target species for recreational anglers across their native range from eastern Asia to central Europe (Panek 1987; Lin and Peter 1991; Koehn et al. 2000; Splitler 1987). However, they have been introduced to many countries and continents outside their native range and in these situations are generally perceived as a significant ecological pest (Lamarra 1975; Cooper 1987; Koehn et al. 2000). Carp have been implicated in the degradation of many Australian river systems, particularly those in the Murray–Darling Basin (Koehn et al. 2000), and have been declared a noxious species in most Australian states and territories.

In Australia to date, research aimed at investigating the attitudes of communities toward wildlife management and the control of pest species has been limited. McLeod (2004) demonstrated that as a consequence of this paucity in knowledge, current planning and policy issues are failing to adequately address relevant social issues. This lack of research to address not only social but also economic impacts has resulted in an inadequate representation of the triple-bottom-line impacts of invasive fish species, such as carp, both locally and across state and territory boundaries (West, Brown et al. 2007).

The aim of this paper is to report on the results of a project that set out to investigate the social dimensions of the impact of carp in Lachlan River Catchment waterways. The survey conducted and reported here provided an opportunity to benchmark social attitudes toward carp populations in the Lachlan River Catchment, measure the community's knowledge levels of carp control methods, determine preferences with regard to carp management procedures, and identify their goals for river health and condition.

## Background

The impacts of carp in Australia are estimated to cost approximately \$15.8 million dollars annually (McLeod 2004), of which \$2 million is spent on carp management, \$2 million on research and \$11.8 million on remediation of environmental impacts. However, it is still unclear if carp invasion represents a symptom or a cause of degraded aquatic systems. Increased incidence of blue-green algae blooms, declining native fish populations, increased turbidity in major rivers, damage to stream banks and loss of aquatic vegetation have all been attributed to carp populations (Lachner et al. 1970; Crivelli 1983; Hume et al. 1983; Fletcher et al. 1985; Newcome and Macdonald 1991; Page and Burr 1991; Wilcox and Hornbach 1991; Breukelaret et al. 1994; Faragher and Harris 1994; Gehrke and Harris 1994; Hindmarsh 1994; Roberts, Chick et al. 1995; Roberts and Ebner 1997; Koehn et al. 2000; Schiller and Harris 2001; Williams et al. 2001; Khan 2003). In most cases, the specific impacts of carp are complex and difficult to isolate from other inter-related anthropogenic changes to ecosystems (Hume et al. 1983; Gilligan and Rayner 2007) and in some cases it is likely that carp are used as a scapegoat for anthropogenic impacts of environmental mismanagement.



**Figure 1** Common carp (*Cyprinus carpio*) (Source: NSW DPI: [www.dpi.nsw.gov.au](http://www.dpi.nsw.gov.au))

The control of invasive species is a human construct affected by public opinion (Morzillo et al. 2007; Riley et al. 2002). Issues surrounding invasive species and those relating to the more generic field of wildlife management are highly emotive and often politically publicised. Addressing human dimensions of wildlife management issues is necessary to allow for local needs and capabilities to be identified and to reveal relationships and inconsistencies between these needs and capabilities. It is generally accepted that addressing human dimensions facilitates a more comprehensive understanding of key social issues governing effective wildlife management including the control of noxious pest species (Decker and Chase 1997; Stankey and Schindler 2006).



In managing invasive species, control by methods such as extermination is a sensitive public issue. The adoption of invasive species control measures requires an understanding of public attitudes toward the proposed control measures (Fraser 2006). Acceptance or rejection of control methods can relate to both moral and ethical concerns. Perceptions of uncertainty can often relate to a community's notion of risk. An increased awareness of public attitudes can help manage the potential level of conflict and identify ways in which to enhance public awareness and acceptability of specific management practices (Fitzgerald, Fitzgerald et al. 2007).

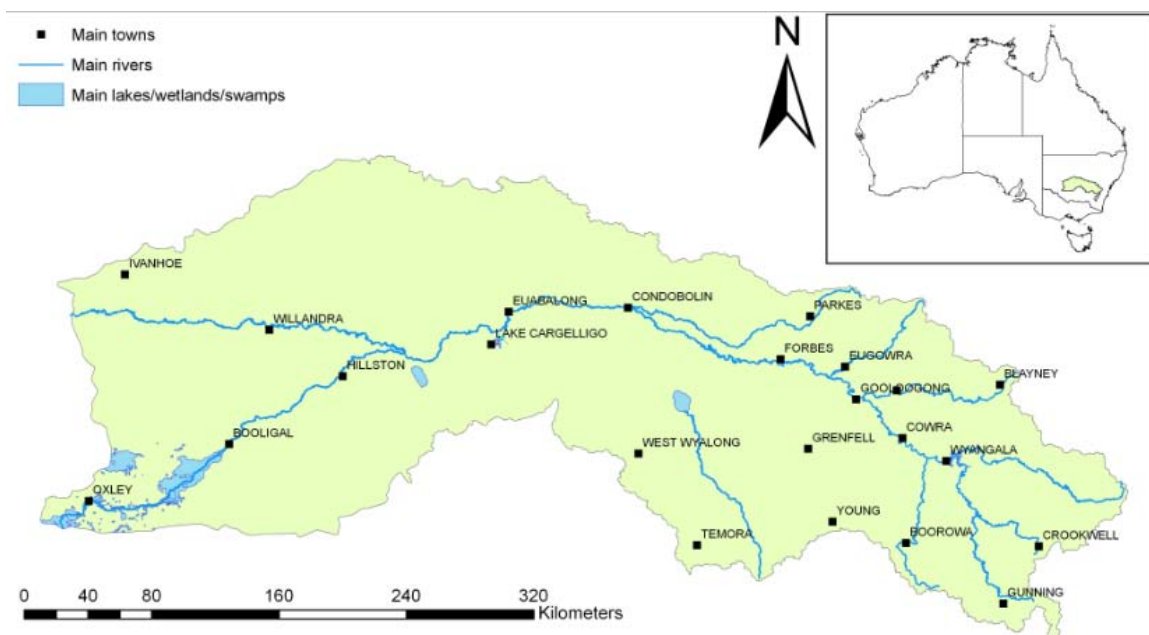
Carp are posing a significant risk to the health of the Lachlan River ecosystem in central NSW. The Murray–Darling Basin Authority's *Sustainable Rivers Audit* program recorded that the health and condition of fish in the Lachlan River Catchment was extremely poor. While fish abundance was dominated by native species, Davis et al. (2008) found that biomass was mainly alien species, and dominated by Common carp. In addition, the lowlands of the Lachlan River Catchment had the second highest abundance and biomass of carp of any of the catchment zones within the Murray–Darling Basin. The Lachlan Catchment Blueprint (Lachlan Catchment Management Authority 2003) identified the control and management of pest species as a high priority management concern for the catchment and this was confirmed when landholders identified it as a key issue in a survey conducted in 2003 (Byron, Curtis et al. 2006). To assist managers to understand social attitudes toward carp and carp management, a community survey was undertaken in the Lachlan River Catchment during 2008.

## Study area

The Lachlan River Catchment is located in central New South Wales, covering an area of approximately 84,700 km<sup>2</sup> (Figure 2) and supporting a population of more than 106,000 people. Cities and townships include Boorowa, Condobolin, Cowra, Forbes, Gunning, Ivanhoe, Oxley and Parkes. Orange and Bathurst, large centres located outside the Lachlan River Catchment, are the focal points for economic activities in the region. A number of other major centres situated outside the catchment boundary are also utilised by the Lachlan community, including Dubbo, Griffith and Goulburn.

Major economic activities in the Lachlan River Catchment include primary production, mining, manufacturing, tourism, retail and wholesale trade, property and business services, health and community services and education. Whilst the region constitutes only 10% of the area of NSW, it is estimated to produce 14% of the state's agricultural production (Lachlan Catchment Management Authority 2006). Dryland production of cereals is the dominant agricultural sector in the catchment and is often associated with lamb, cattle and wool production. Grazing-based industries that include wool, sheep meat and cattle dominate the tablelands and western plains. Other activities in the catchment include native pine milling, charcoal, red gum sleeper cuttings and brush cutting for fencing.

Mining is emerging as a contributor to the Lachlan economy with mines currently operating in North Parkes, Lake Cowal and Cadia and proposals to expand mining practices to Black Range and Mineral Hill, at Condobolin, and Bumbaldry at Grenfell (Lachlan Catchment Management Authority 2006). Tourism is based on the catchment's natural assets include hunting, fishing and camping.



**Figure 2** The Lachlan River Catchment in central NSW.

The central waterway in the catchment is the Lachlan River, which rises near Gunning in the south-east and flows approximately 1450 km to the Great Cumbung Swamp in the south-west. From here the river disperses across floodplains into wetlands and effluent creeks (New South Wales Department of Land and Water Conservation & Lachlan Catchment Management Board 2003) and occasionally, only during significant flood events, the Lachlan flows into the Murrumbidgee River. Major tributaries of the Lachlan River include the Abercrombie, Boorowa, Belubula and Crookwell Rivers and Mandagery Creek. The main dams in the Lachlan River Catchment are Wyalgala Dam, which regulates the Lachlan and Abercrombie Rivers, and Carcoar Dam, which regulates the Belubula River. There are many competing water users within the catchment including agricultural irrigators, horticulturalists, industry, extractive mining industries, recreational, stock and domestic, town water supply and aquatic habitat protection (New South Wales Department of Land and Water Conservation & Lachlan Catchment Management Board 2003).

Unfortunately for both the Lachlan valley community and the environment, the current health of the Lachlan River system has been classified as very poor (Davies et al. 2008), being the fifth worst of 23 valleys in the Murray–Darling Basin. The waterways of the lower Lachlan River have been formally recognised as an Endangered Ecological Community (EEC) under the *Fisheries Management Act 1994*. A number of key threatening processes have contributed to this situation. Six key threatening processes identified under the *Fisheries Management Act 1994* include river regulation; instream structures that alter flow regimes; the degradation of native riparian vegetation; the removal of large woody debris; recreational fishing in areas significant to threatened fish stocks; and the introduction of invasive fish species to freshwater environments.

The impact of carp on the river system is a major issue in the Lachlan River Catchment, which is home to one of the highest recorded densities of carp populations in the state of NSW and quite possibly Australia (Gilligan and Rayner 2007). Community discussion meetings held in 1998 by the NSW Department of Primary Industries and in 2003 for the Lachlan Catchment Management Authority (Byron et al. 2006) together with consultative workshops in Melbourne (Cooperative Research Centre for Pest Animal Control 2003) have highlighted concern about the health of the Lachlan River and in particular the impact of carp. This concern is also recognised in the Lachlan Catchment Blueprint (New South Wales Department of Land and Water Conservation & Lachlan Catchment Management Board 2003), which identifies the control and management of pest species as a high priority management objective.

The lower Lachlan River Catchment provides a unique opportunity for implementation of a carp control demonstration project in the Murray–Darling Basin. The lower Lachlan has a high density of carp present (Davies et al. 2008); the carp population is supported by two known and two other potential carp recruitment ‘hotspots’, each having features amenable to trialling of control options; and most importantly, the Lachlan is typically an endorheic system largely isolated from the remainder of the Murray–Darling Basin, only connecting with the Murrumbidgee River downstream during periods of exceptionally high flow (1 in 20 year floods) (Roberts and Oliver 1994). This semi-isolation means that the carp population within the lower Lachlan River Catchment is not exposed to continual immigration from carp populations in other catchments. For these reasons, a collaborative carp control demonstration program was initiated and badged as the *River Revival – Lachlan River Carp Cleanup* project. The project is a collaboration between the Lachlan Catchment Management Authority (LCMA), Invasive Animals Cooperative Research Centre (IACRC), NSW Department of Industry & Investment (I & I NSW), South Australian Research and Development Institute (SARDI), Victorian Department of Sustainability and the Environment (DSE), Kingfisher Research Pty Ltd, K. & C. Fisheries Global Pty Ltd, NSW State Water Corporation, NSW Department of Environment, Climate Change and Water and the Lachlan Catchment Community (e.g. shire councils, Indigenous groups and recreational fishing clubs). The first phase of the *River Revival* project includes benchmarking social attitudes to carp and carp management in the lower Lachlan River Catchment prior to undertaking any control efforts.

## The survey

Apart from Roberts and Sainty (1996), who presented memories from people who grew up, lived and worked on the Lachlan River, no current data sets exist that inform managers of local attitudes toward carp, carp management controls or health and condition of the waterways. To set up a baseline data set incorporating this information, quantitative research methods were used to survey the attitudes of those living in the Lachlan River Catchment. This was done using an online questionnaire, administered by the LCMA.

As this research aims to benchmark community attitudes, the survey was conducted using a self-administered attitudinal questionnaire. Attitudinal surveys (also known as affective surveys) provide valuable information relating to perceptions gained from personal experiences. Attitudinal surveys typically consist of a series of well constructed statements to which participants are asked to respond using a rating scale of agreement and disagreement (Thomas 1999). Rating scales are useful for gathering information about the degree to which a person finds something interesting or satisfying. Therefore, such scales provide information about intensity, frequency, degree of interest and degree of agreement. These scales are commonly used to measure attitudes, opinions, perceptions and beliefs. Limitations of this technique are the time taken to construct a high quality questionnaire that ensures the information needed is received and scored easily (Thomas 1999).

Self-administered questionnaires have the advantage that the stimulus is consistent for all participants and an extensive target group can be reached (Bourque 1995). For the purposes of this research the questionnaire included Likert-type scales to measure attitudes and opinions of the community in the Lachlan River Catchment. To meet the objectives of the project the questionnaire (see Appendix) was divided into the following sub-sections:

- Demographics
- Perceptions of river condition
- Perception of carp impacts on river condition
- Perception of carp removal impacts on river health
- Carp control and responsible authorities
- Attitudes to carp control efforts
- Perception of current recreational fishing opportunities.

To ensure validity and reliability across individuals and groups, a pilot study was conducted. The results of the pilot and feedback from participants were used to fine tune the questionnaire, increasing its robustness. Ethics approval for the survey was sought and gained by the Deakin University Human Ethics Committee.

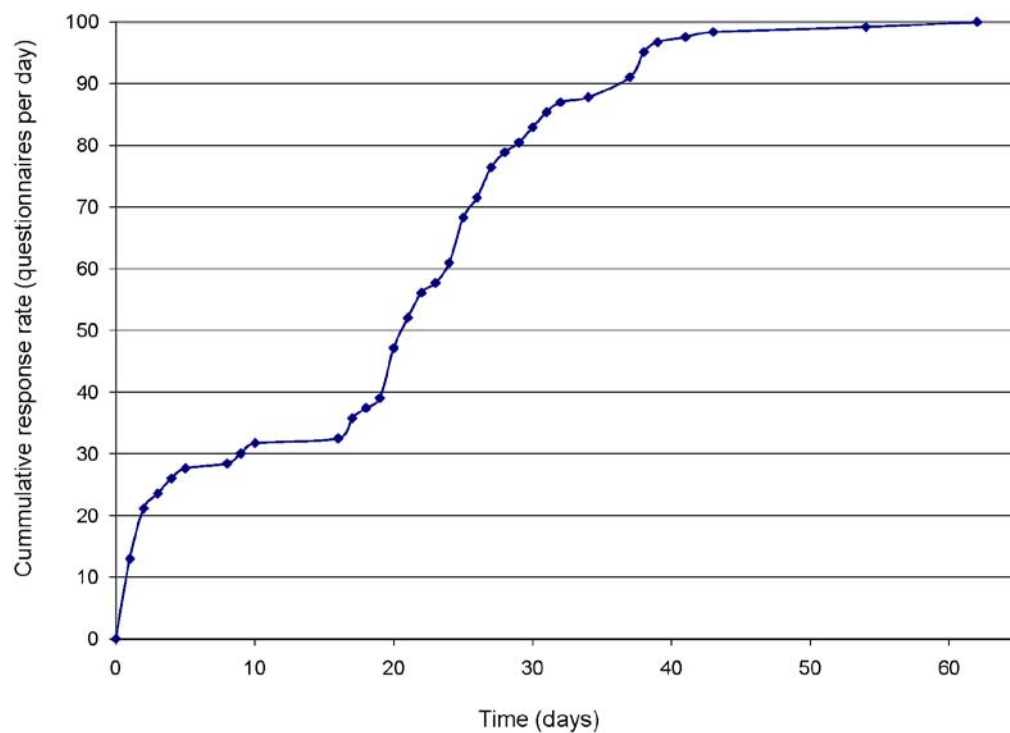
A number of advertisements placed in regional newspapers over several weeks invited members of the local community over the age of 18 years to participate in the survey. Members of the Lachlan River Catchment community who were registered on the LCMA database were

also targeted. It was a requirement that participants live in the region, have an interest in their local area, have access to email and be over the age of 18 years. This was necessary to ensure participants had a basic level of knowledge about the Lachlan River and an interest in completing the survey. Email was chosen to reduce the workload involved in administering the survey. Those interested in completing the questionnaire were encouraged to locate the questionnaire via a URL link that was emailed to them.

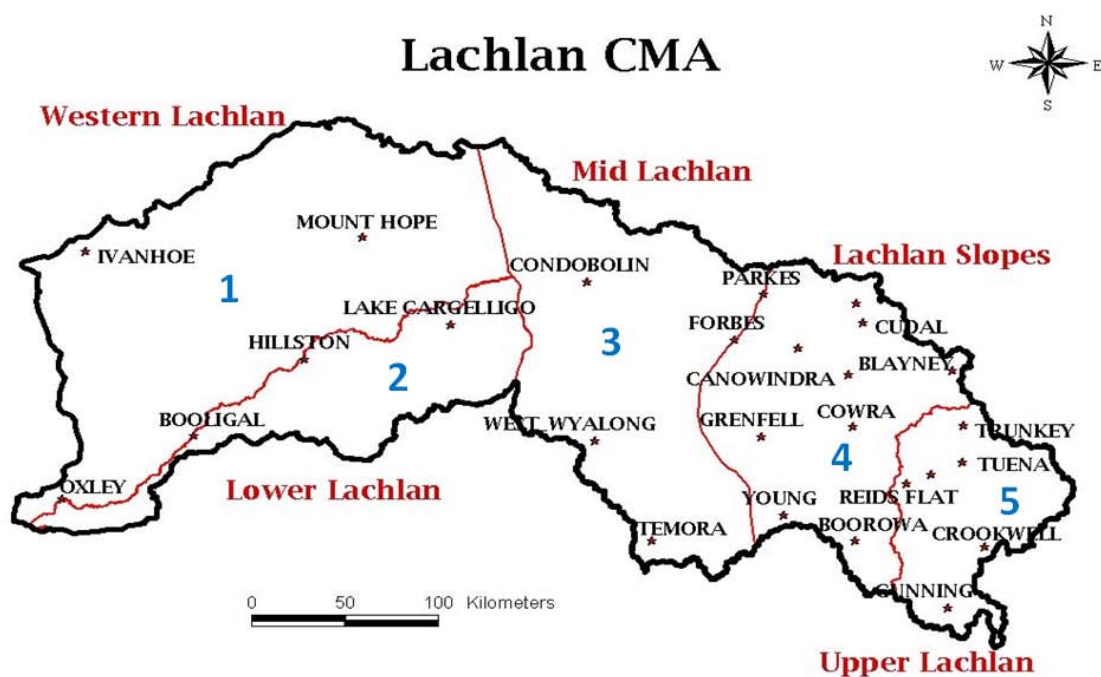
When conducting a survey such as this it is difficult to get a representative sample of the community (general public) because of various factors such as willingness to participate, access to email and language barriers. Using an online format restricted the sample to persons who had email addresses and who accessed their email regularly. As it turned out, a large proportion of respondents were recreational fishers. The results will therefore reflect the opinions of this group rather than the broader community within the Lachlan River Catchment.

The web-based survey ran for five weeks. Once participants received their first email with instructions for accessing the URL link, they were given three weeks to complete the questionnaire. One of the greatest disadvantages with self-administered surveys is their low response rate. In an effort to increase response rates, weekly reminders were sent. In conjunction with these reminders, a gift was offered to those who successfully completed the entire questionnaire. A total of 194 responses were received giving a response rate of 27%. Figure 3 shows the cumulative response rate over a 60-day period.

One of the objectives of this study was to analyse sub-catchment scale differences in attitudes toward river health (Figure 4) and the perceived impacts of carp on this health. However, this scale was inappropriate for the data collected. Hence to allow for the analysis of these differences at different geographical scales, postcode boundaries were adopted, which form the basis of an analysis to determine differences in attitudes across the catchment.



**Figure 3** Cumulative survey response rate.



**Figure 4** The five sub-catchments within the Lachlan River basin.

## Data analysis

Simple summary measures are used to present the proportion of respondents who indicate a particular preference. All statistical analysis was conducted using Microsoft Excel, SPSS version 14.0 for Windows (SPSS Inc, Chicago), XLStatistics version 07.08.23 and Microsoft Excel 2003. Data was managed in Microsoft Excel 2003. For assessment of differences between independent groups, where the assumptions associated with the application of parametric statistical methodologies were met, overall differences were identified using a one way analysis of variance, with subsequent post hoc analysis conducted using t-tests. Further, all variables were recoded to numerical ordinal quantities, and the Kruskal–Wallis test, the non-parametric analogue to the One Way ANOVA, was used for analysis with more than two subgroups. The analysis adjusted for tied ranks. The Mann–Whitney Mu test (analogous to the independent sample t-test) was used to assess for significant differences between two groups. The chi-square test was used to assess for differences between observed and expected frequencies. For all analyses, the critical value was set to 0.05.

Opinion-based responses were assessed for significant differences within all independent demographic measures, to determine if any factors were driving respondent opinion. For some analyses, for example, where respondents were asked to rank their preference as either being important or very important, these two response types were recoded to indicate the respondents view as being, at least, important. Other groupings were similarly recoded.

The results obtained using the questionnaire reflect a snapshot of community attitudes at the time the instrument was administered. It should be recognised that such views and values can change over time and that this study can provide a baseline for monitoring change on a temporal scale.

## Results

The questionnaire website received 328 visits, 73 partial completions and 121 completions. Of the respondents, 19% were females and 49% indicated that they belonged to a community group. The dominant occupations represented in the sample were farming (40%) and trades (19%). Seventy-five per cent of respondents classified themselves as recreational fishers. The sample was not evenly distributed across the catchment; 43% of respondents lived within 5 km of the Lachlan River and 65% visited it weekly to monthly, while 70% were from three areas: Gooloogong to Euabalong, Central Murrumbidgee and Upper Lachlan (Table 1). Opinions expressed from respondents from the areas Belabula (2), Central Macquarie (2), Hillston Murrumbidgee Junction (4), Sydney (2) and Upper Murrumbidgee (2) were removed from analysis as too few observations were present. Respondents who did not supply a postcode were also removed.

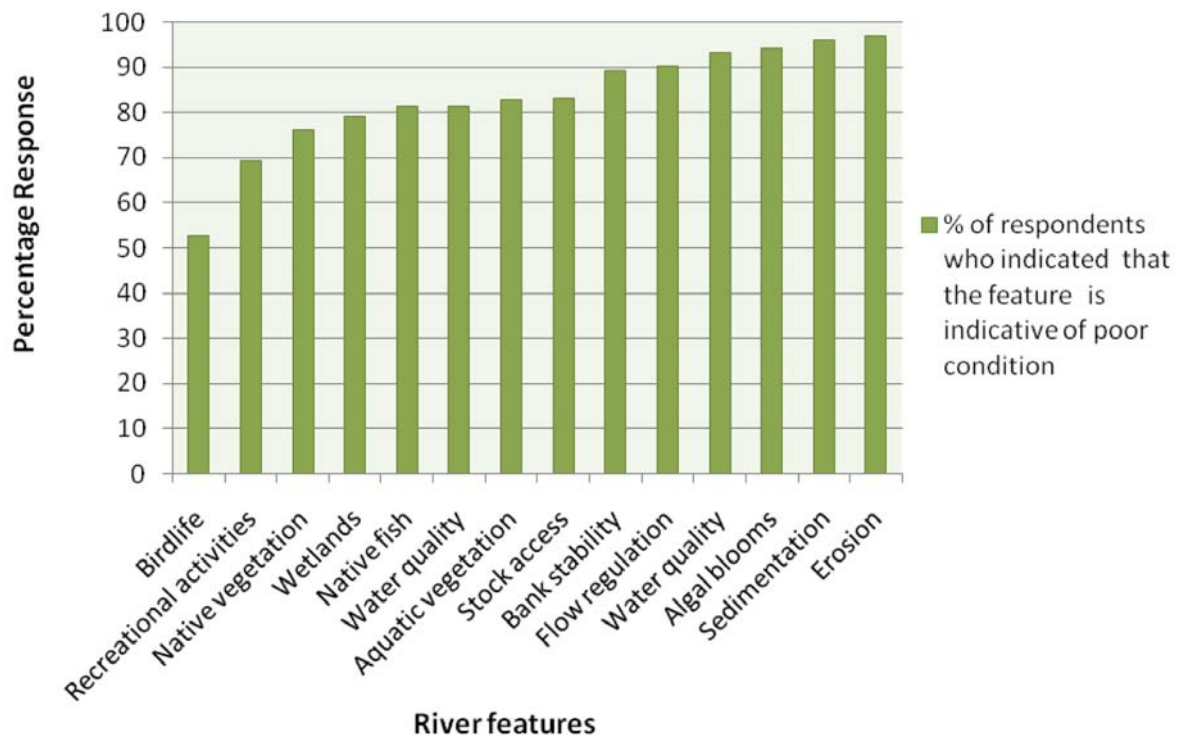
**Table 1** Frequency of responses from different geographical locations.

	Frequency
Belabula	2
Bland Creek	9
Central Macquarie	2
Central Murrumbidgee	22
Euabalong to Hillston	7
Gooloogong to Euabalong	31
Murrumbidgee Junction	4
Sydney	2
Upper Lachlan	18
Upper Macquarie	5
Upper Murrumbidgee	2
Wyangala to Gooloogong	14
<b>All</b>	<b>118</b>



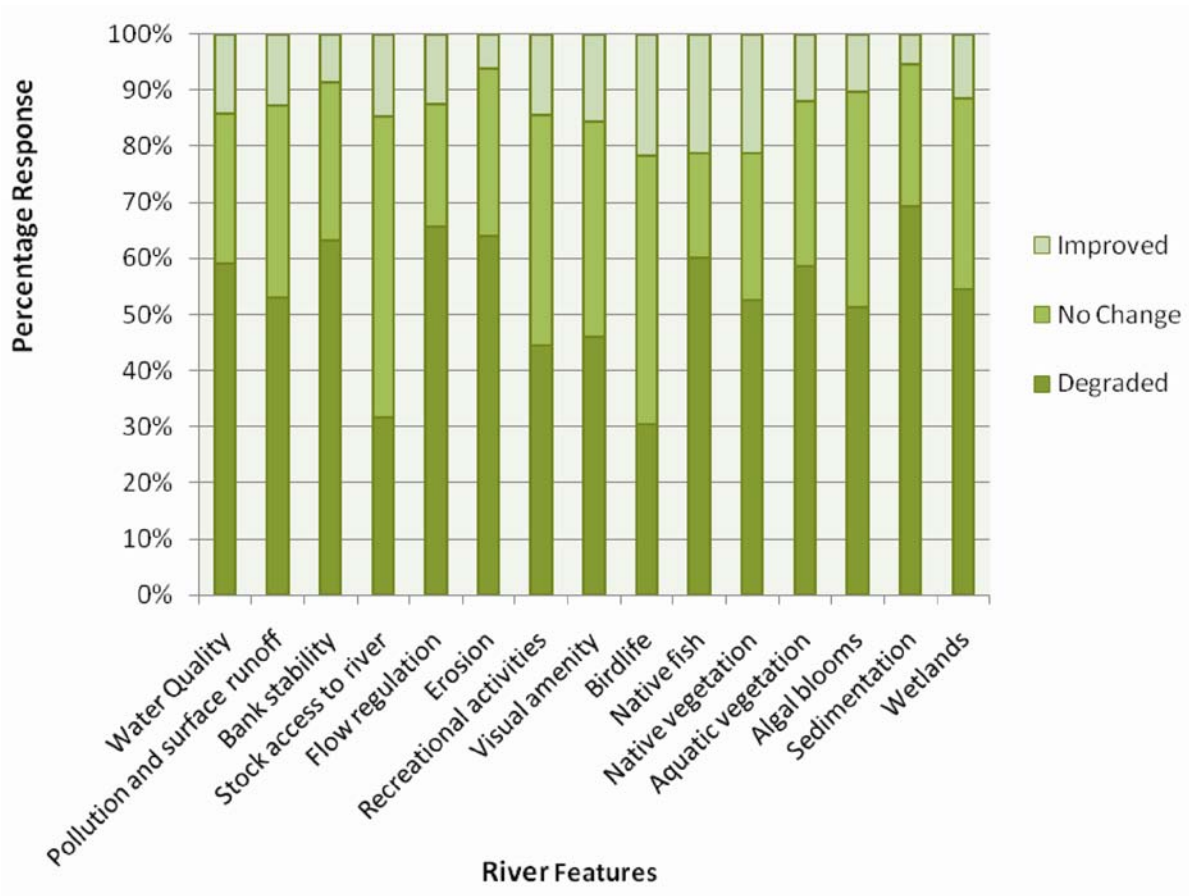
## Condition of river features

When asked about the condition of the river, 82% of respondents believed that the river is not in good condition. As shown in Figure 5 respondents identified water quality (river pollution and surface run-off), erosion, algal blooms and sedimentation as key indicators of the river's perceived poor condition. Ninety per cent of respondents indicated that they had observed change to the river during the time they had lived in the catchment. Not surprisingly, people who had lived in the catchment longer (40+ years) indicated that they had witnessed greater change than those who had only lived there a short time (0–10 years) ( $z$  2.215,  $p$ -value 0.027). It was found, however, that neither frequency of visit (chi-square 5.255,  $df$  4,  $p$ -value 0.262) nor age of the respondent (chi-square 0.505,  $df$  3,  $p$ -value 0.918) played a role in determining whether or not people were noticing changes to the river.



**Figure 5** For respondents who considered the Lachlan River was not in good condition this graph shows features of the river environment and the percentage of these respondents who inferred that this feature was indicative of poor condition.

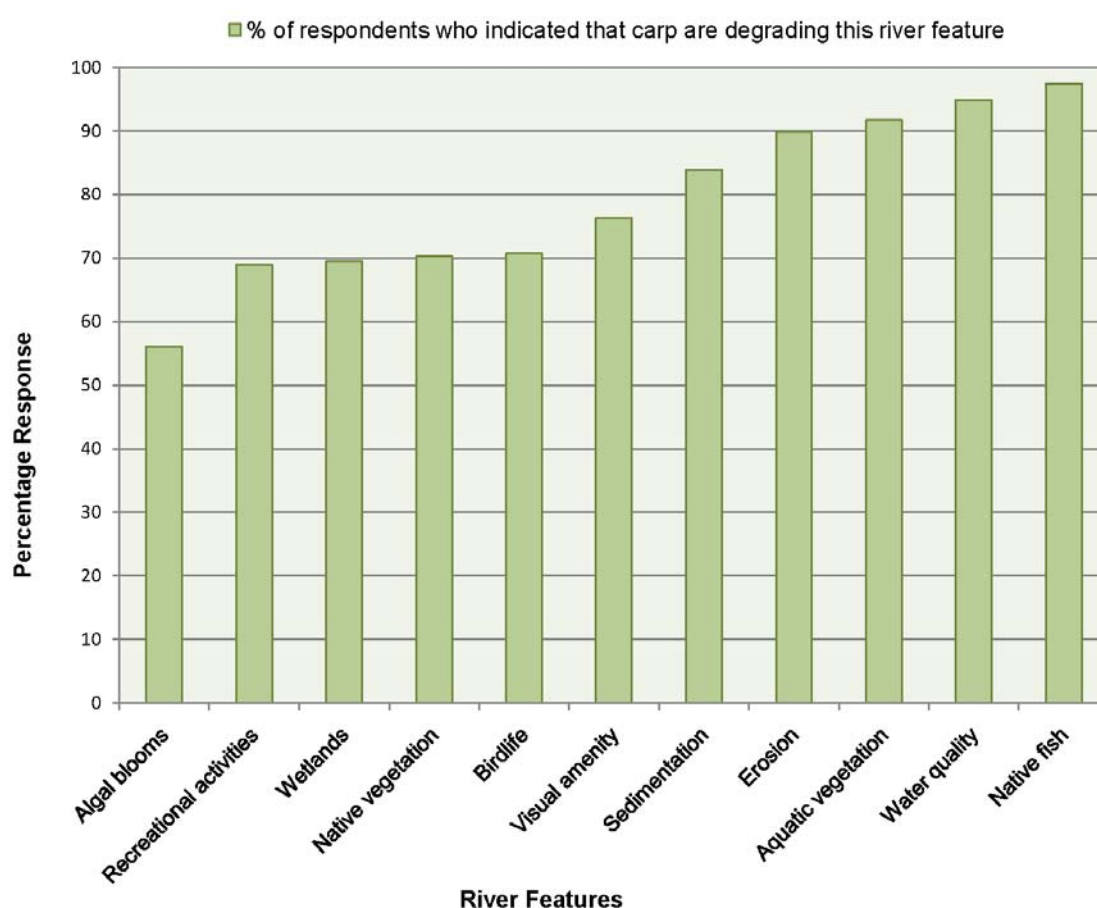
When asked if changes to river features over time had improved or degraded the Lachlan River system, it was found that significantly more respondents believed water quality (61%), bank stability (63%), flow regulation (66%), erosion (64%), native fish (60%) and sedimentation (69%) were indicators of degradation (Figure 6). On the other hand, significantly more respondents believed birdlife did not change or was improving. With regard to respondents who were farmers there were no significant differences in their opinions and the opinions of ‘other employment types’ with respect to stock access to the river and river condition (chi-square 14.706, df 11, p-value 0.196).



**Figure 6** Opinions of respondents as to whether changes to river features have improved or degraded the Lachlan River system.

## Impacts and management of carp

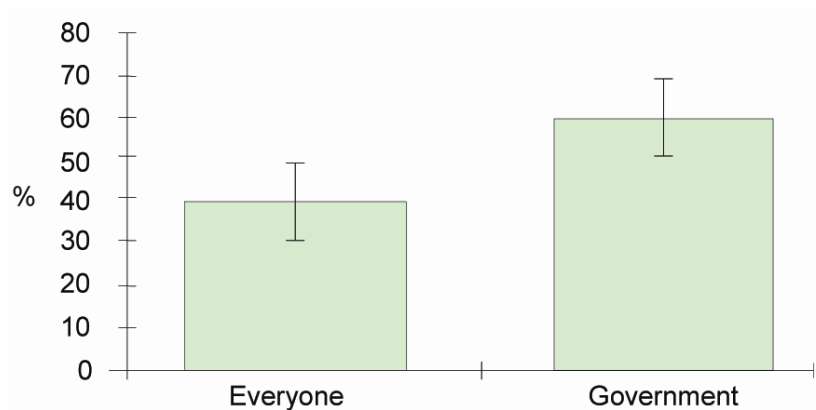
When asked to describe the impact that carp populations were having on the Lachlan River, 100% of respondents said that their impact was detrimental (72% thought their impact was very detrimental). As shown in Figure 7, for all river features listed the majority (more than 55%) of respondents felt carp were having a detrimental effect.



**Figure 7** Respondents' opinions about the impacts of carp on river features.

All of the respondents (100%) believed carp populations should be controlled in some way, with 11% indicating medium control, 38% intensive control and 51% wanting all carp removed. Only 40% of respondents indicated an awareness of the Lachlan River Revival Carp Reduction Program. Most respondents were not aware of this program and this is not surprising as the communication plan for the project is yet to be launched. However, 59% of these people (n 73) indicated an awareness of carp reduction techniques/programs in other systems.

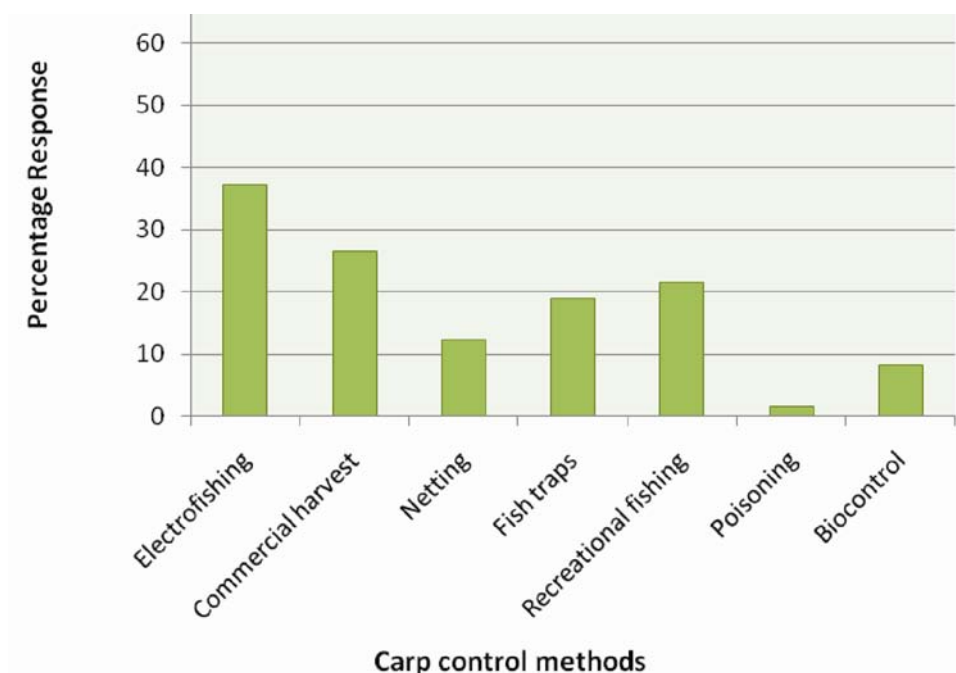
As can be seen in Figure 8 significantly more respondents (60%; n 110) indicated that the government should be solely responsible for removing carp from the Lachlan system. This was more than those who indicated everyone should share this responsibility. With regard to the resources available for carp management, 94% of respondents indicated that not enough resources were being used to manage carp in the Lachlan River.



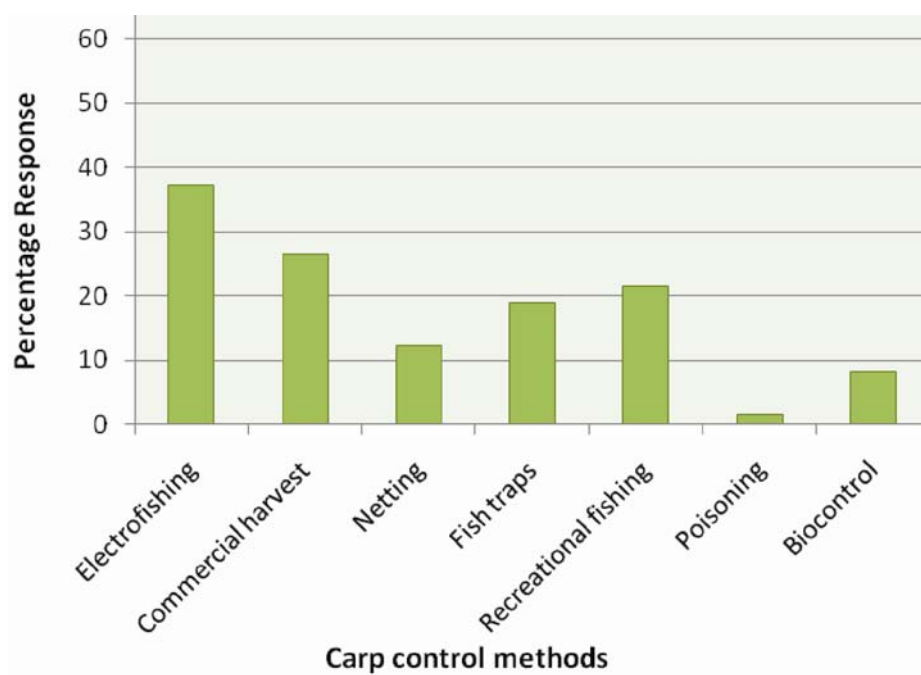
Question 18: Who do you believe is responsible for the management of carp in the Lachlan River?

**Figure 8** Perceptions of who should be responsible for carp management.

As shown in Figure 9 only a small percentage of respondents indicated that they were aware of carp control methods being applied in the Lachlan River Catchment. The method most recognised was electrofishing. On average, people indicated no knowledge of the overall effectiveness of any control programs (Figure 10). However, significantly more people believed that fishing competitions were marginally more effective than any other method. Note that only 22% of respondents indicated awareness of this control method, and yet 43% considered it to be, at least, marginally effective. When participants were asked *What methods you would use to remove carp?*, a large variety of different methods were identified (Table 2). However, most people (41%) would accept any method available to remove carp from the system.

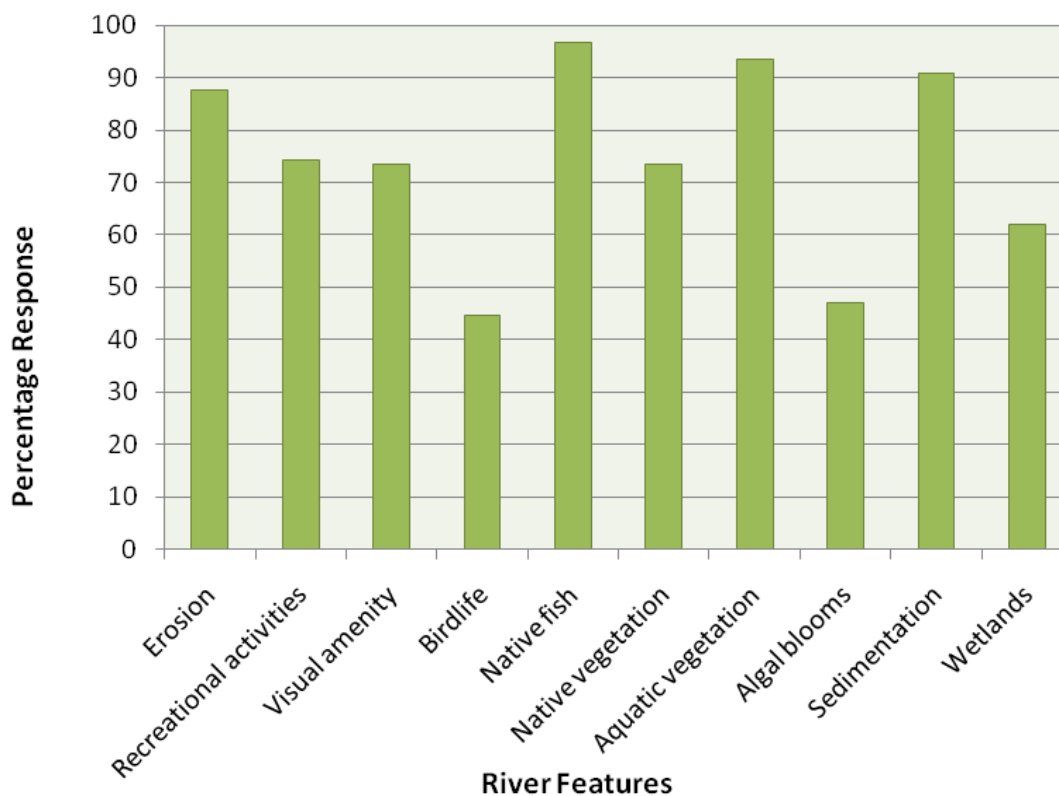


**Figure 9** Awareness of carp control methods.



**Figure 10** Perceptions of the effectiveness of carp control methods.

Ninety-six per cent of people believed that at least some positive change would result if all carp were removed from the river system. The percentage of respondents indicating specific features would improve if carp were removed is presented in Figure 11.



**Figure 11** The percentage of respondents who thought removal of carp would be a positive change for river features.

## Recreational fishing and carp catch

Three quarters (75%) of respondents indicated that they fished at some stage during any given year. Those who fished most commonly did so on a monthly basis (52%). The various baits used are presented in Table 2. As well as those listed in the table, two anglers identified using trolling and spinner baits.

**Table 2** Methods participants would employ to control carp.

<b>Method you would use</b>	<b>%</b>	<b>N</b>
All methods available	41.3	45
Commercial harvest	2.8	3
Recreational harvest	6.4	7
Non-destructive methods	11.0	12
Restock with natives	0.9	1
Bio-control	13.8	15
Fish traps	0.9	1
Electrofishing	3.7	4
Poisoning	0.9	1
Bounty	4.6	5
Government	0.9	1
Electrofishing & Bio-control	1.8	2
Electrofishing & Commercial harvest	1.8	2
Electrofishing & Netting	1.8	2
Netting	0.9	1
Netting & Commercial harvest	0.9	1
Not poisoning	1.8	2
Fishing	0.9	1
Traps	1.8	2
Recreational harvest & Bio-control	0.9	1

**Table 3** Types of baits used by anglers in the Lachlan River Catchment.

<b>Bait type</b>	<b>% who use this bait</b>
Dead bait	36.4
Live bait	58.7
Soft plastics	28.9
Hard body lures	49.6
Fly rod	5.0

Only 7% of anglers indicated that they never catch carp. Those who did catch carp were most likely to dispose of the fish by killing and leaving on the land. Other methods were also identified but used by a much smaller proportion of respondents (Table 3). It was found that no one puts the carp back in the river alive, although some people did not indicate how they disposed of them. From the data collected it was not clear whether carp used for bait were used dead or alive.

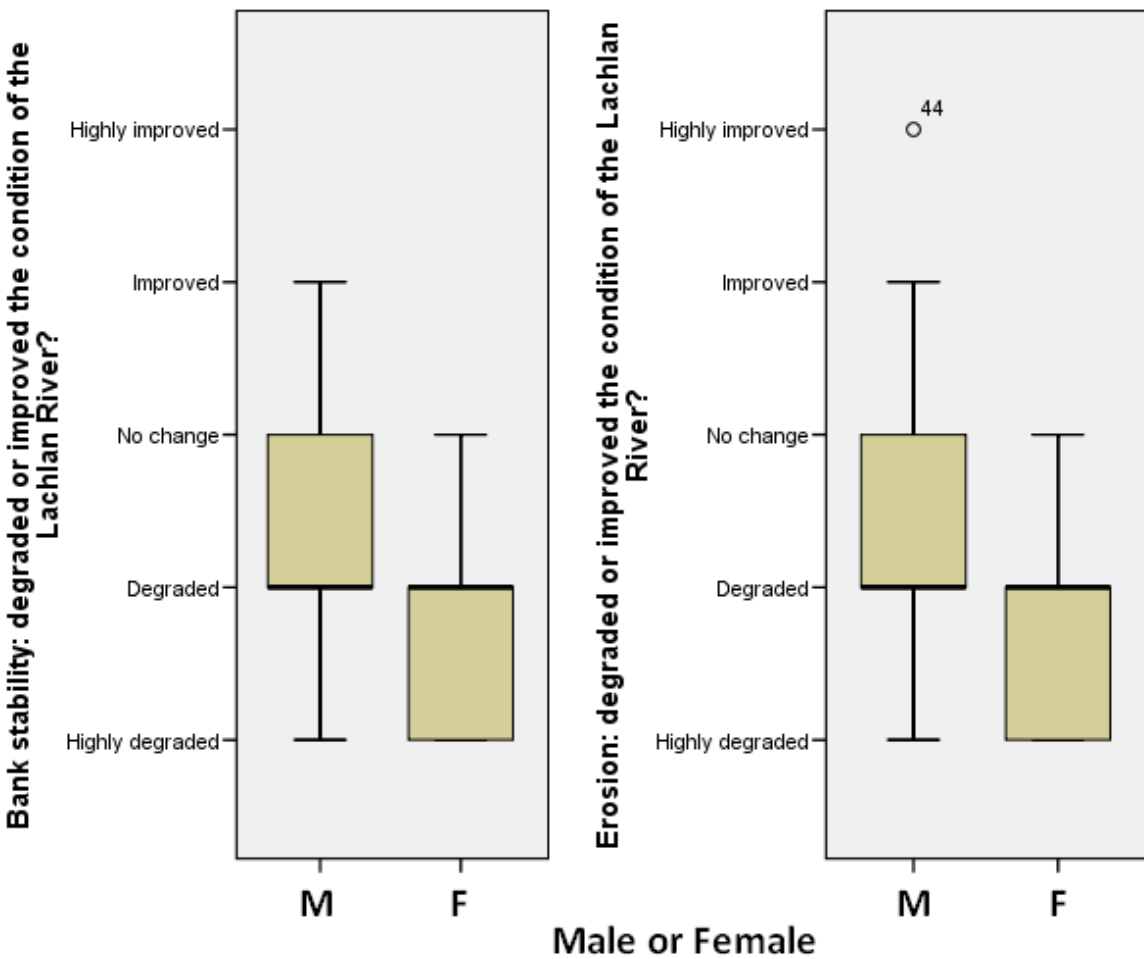
**Table 4** Methods used by anglers to dispose of carp.

<b>Disposal method</b>	<b>% of people who use this method</b>
Kill and leave on land	72.7
Kill and take home	9.1
Return to river dead	3.3
Use as bait	8.3



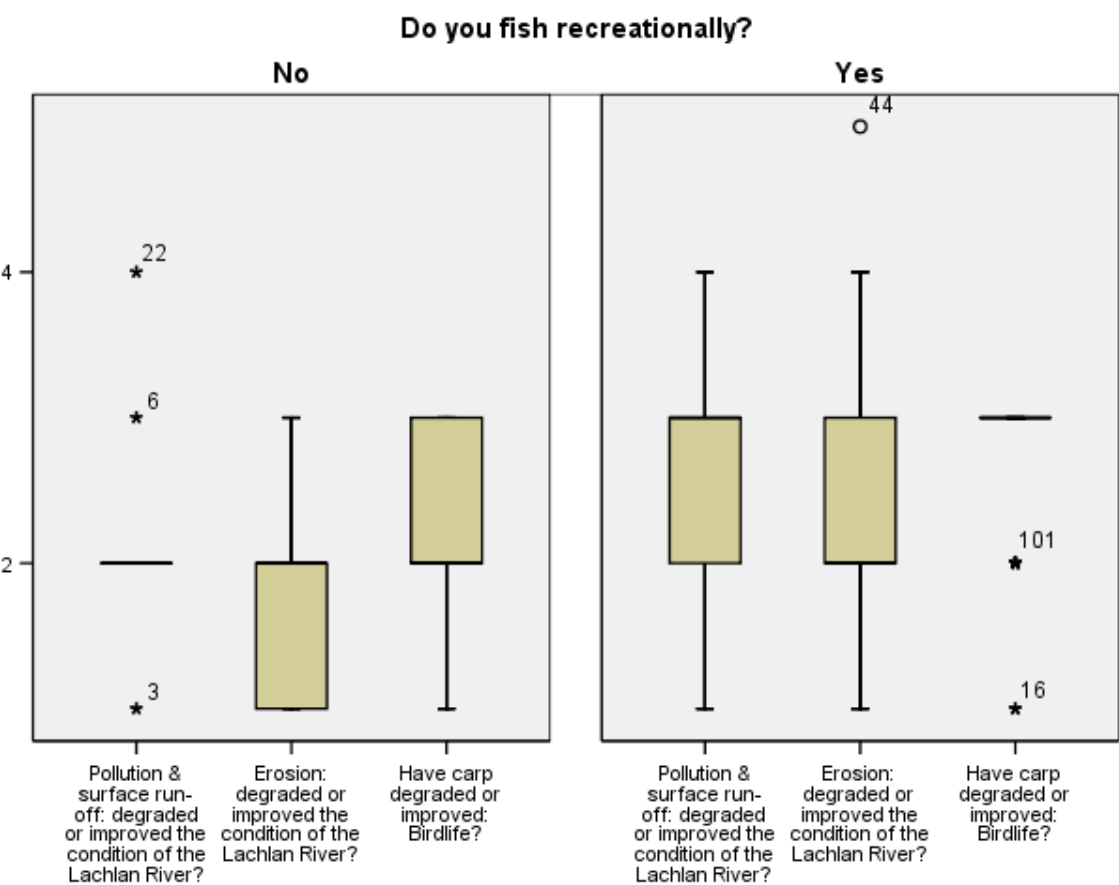
# Demographics and responses

Occupation type was not found to be causing any difference in the opinions expressed by respondents. For most responses it was found that gender was not driving differences in opinion apart from whether or not bank stability and erosion degraded or improved the condition of the Lachlan River (Figure 12). Females were more likely to consider that bank stability and erosion have degraded the condition of the Lachlan River. (Bank stability U 569.5, z -3.62, p-value 0.000 and erosion U 609.5, z -3.31, p-value 0.001).



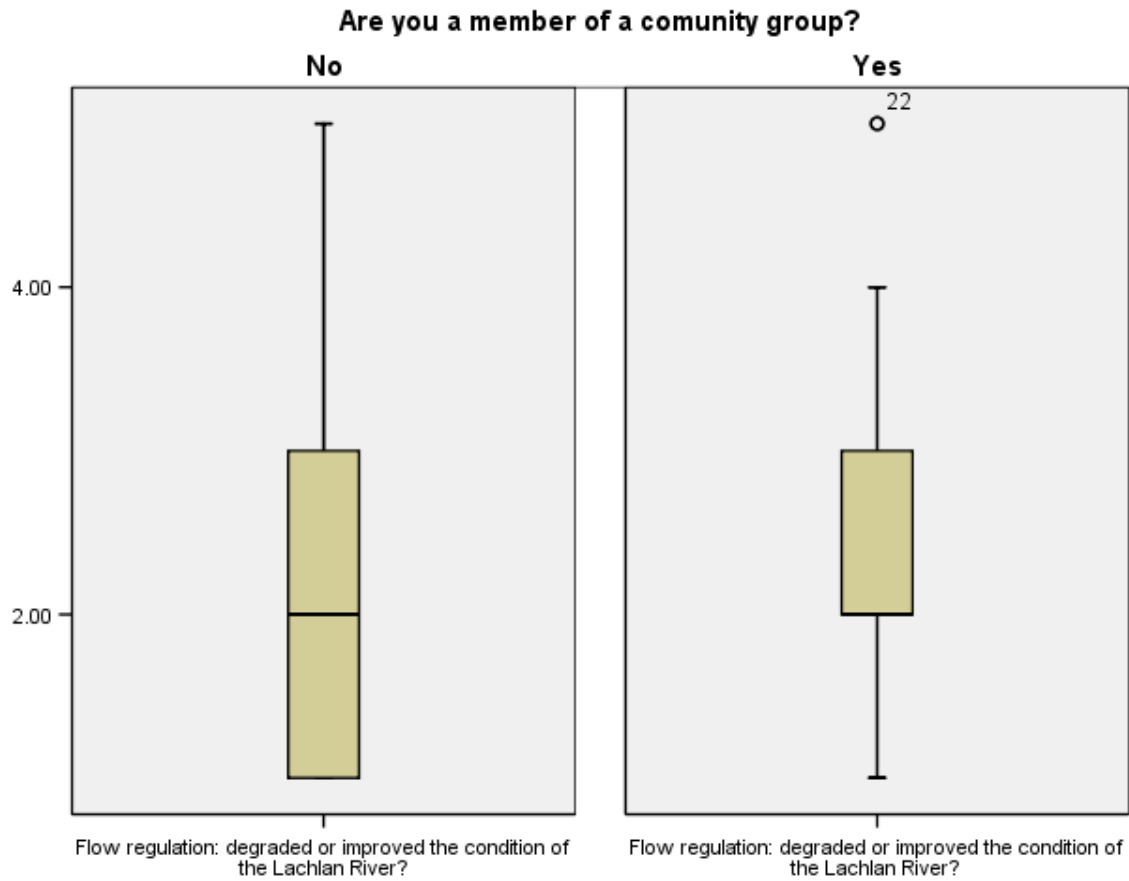
**Figure 12** Is gender driving difference of opinion? Differences in opinion about bank stability were detected (U 569.5, z -3.62, p-value 0.000 and erosion U 609.5, z -3.31, p-value 0.001).

Compared to respondents who did not fish, respondents who indicated that they do fish in the area were significantly more concerned about the factors of water quality, surface runoff and erosion as indicators of the degrading condition of the Lachlan River (U 738.0, 901.5 and 556.0, z -2.764, -2.576 and 556.0, p-value 0.006, 0.010 and 0.002 respectively). People who did not fish were also more likely to think that the presence of carp degraded birdlife (Figure 13).



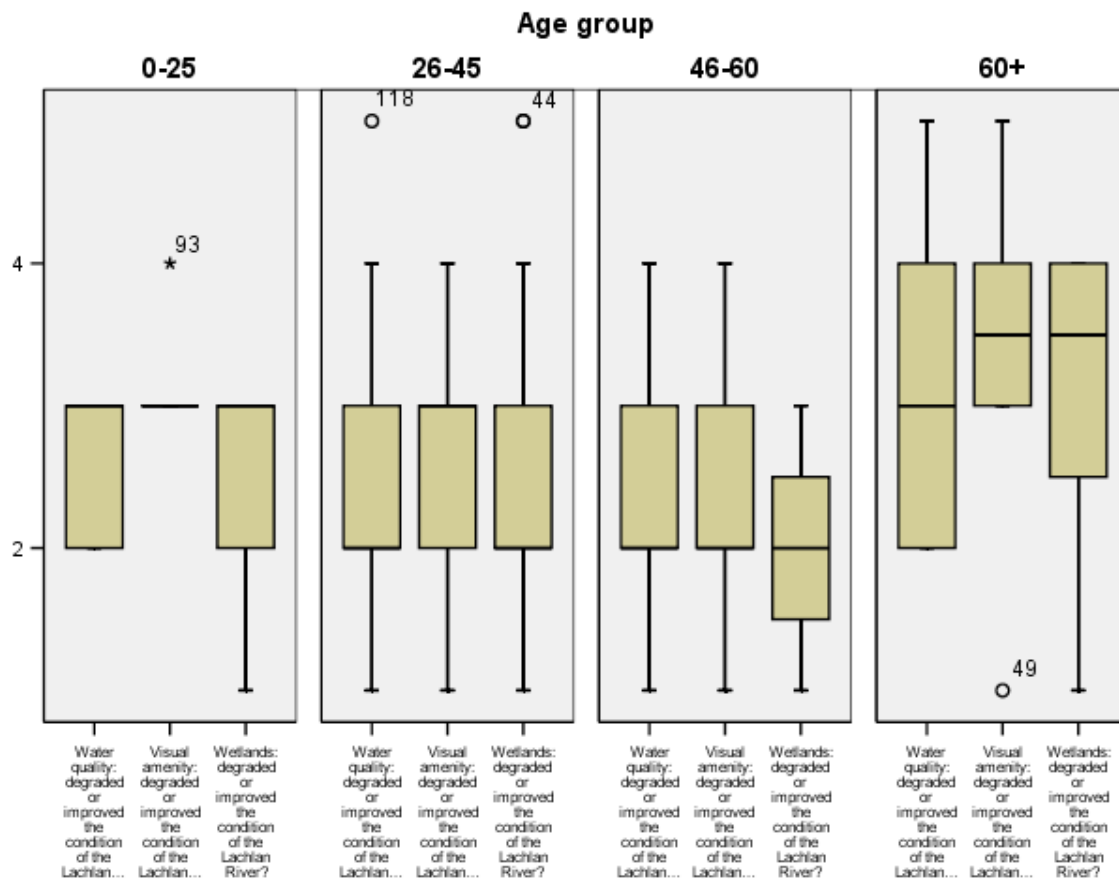
**Figure 13** Does whether or not people fish affect their opinion on characteristics of the Lachlan River? Significant differences detected in pollution and surface runoff, erosion and birdlife. U 738.0, 901.5 and 556.0, z -2.764, -2.576 and 556.0, p-value 0.006, 0.010 and 0.002 respectively.

On average, those people who belonged to a community group believed that flow regulation was causing 'no change' to river condition (U 1284.5,  $z = -2.028$ , p-value 0.043). However, those not belonging to a community group were more likely to think that flow regulation was degrading the condition of the Lachlan River.



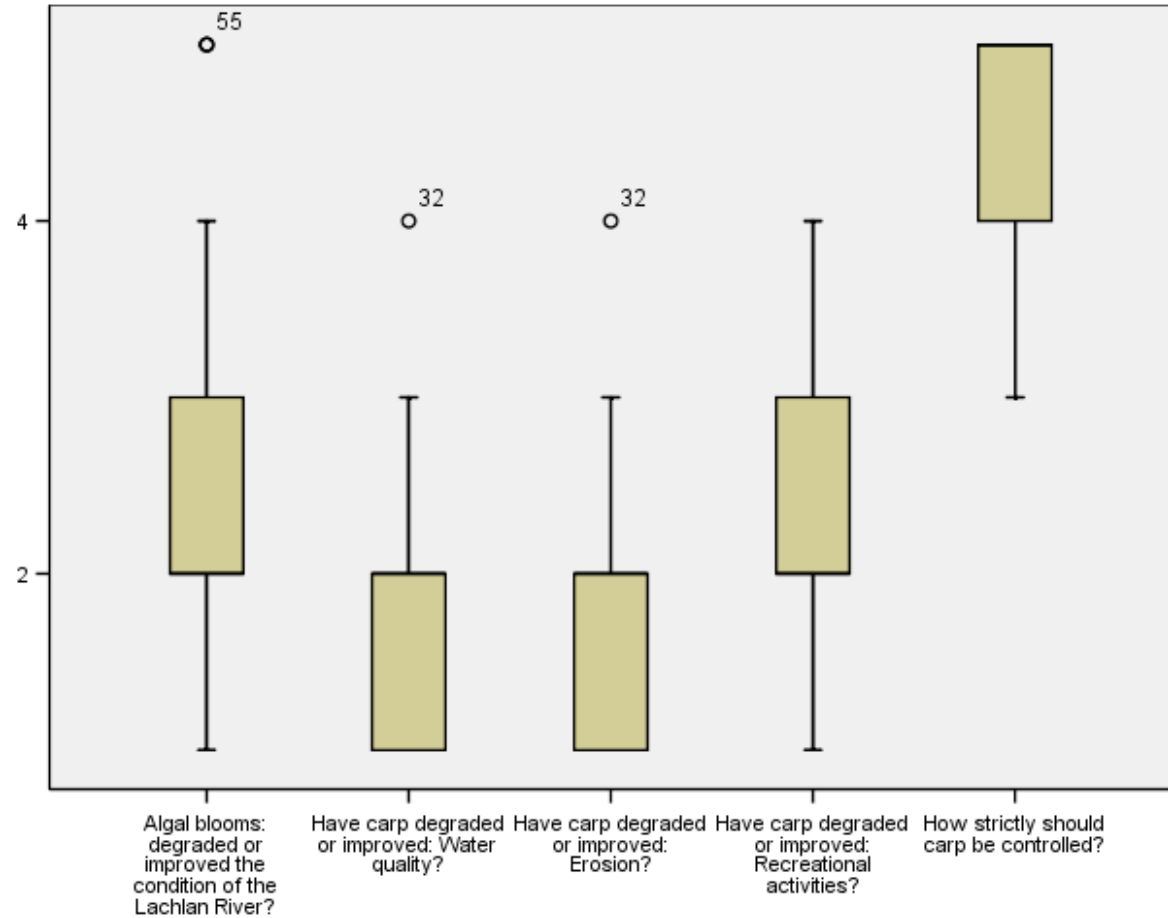
**Figure 14** Does being a member of a community group alter people's opinion? Significant difference detected in flow regulation. Mann–Whitney 1284.5,  $z = -2.028$ , p-value 0.043.

Although no particular age group indicated that, on average, things were improving, there was a trend of an increasing expression of concern as age of respondent decreased. That is, younger people were more likely see these features as degraded (Figure 15).



**Figure 15** Is age influencing people's opinion? Significant differences detected in opinion on water quality, visual amenity and wetlands (chi-square 7.936, 14.574 and 11.020, df 3, p-value 0.047, 0.002 and 0.012 respectively).

The distance that respondents live from the river does not appear to affect their opinion on carp management. Not surprisingly, however, those people who indicated that they thought the river was not in good condition were also those people who indicated its *features* were, at least, degraded. However, no difference of opinion was detected for the features of ‘algal blooms’, ‘carp degrading the water quality’, ‘carp degrading recreational activities’ and in ‘how strictly carp should be controlled’. Figure 16 shows boxplots of views of level of degradation of particular features of the Lachlan River through carp. This part of the analysis also confirms that respondents have generally been consistent in their responses. That is, people who indicated that they thought the system was not in good condition in this question are also the same people who categorised degradation of features of the river elsewhere in the survey.



**Figure 16** Views of level of degradation of particular features of the Lachlan River through carp.

Apart from opinions on river condition (chi-square 18.01, df 6, p-value 0.006) there was no significant difference in the opinions of respondents from the different geographical locations across the catchment. Of the 106 responses, 18% indicated that the river was in overall good condition. This response was pronounced in the Gooloogong to Euabalong region, with 39% of respondents in that region indicating they thought an overall, good condition was apparent. However, in the regions of Upper Lachlan, Upper Macquarie and Wyangala to Gooloogong, of the 37 responses (in those regions only) not one respondent indicated that they thought the Lachlan was in good condition, with all respondents (100%) indicating the river is not in good condition.

**Table 5** Numbers of respondents from different geographical and their opinions on whether the river was overall in good condition or not.

	<b>All</b>	<b>No</b>	<b>Yes</b>
All	106	87	19
Bland Creek	9	8	1
Central Murrumbidgee	22	18	4
Euabalong to Hilston	7	5	2
Gooloogong to Euabalong	31	19	12
Upper Lachlan	18	18	0
Upper Macquarie	5	5	0
Wyangala to Gooloogong	14	14	0

## Discussion

Local people are often keenly aware of the changes that have taken place around their communities, and such knowledge can augment the knowledge possessed by scientists and managers (Stankey and Schindler 2006). Those who lived in the Lachlan River Catchment or have frequently used the waterways have insights into historical changes in the condition of local water bodies and into the spatial extent, densities and disturbances that have been created by carp populations (Roberts and Sainty 1996). This local knowledge is important for developing plans to manage the waterways, yet such information is often overlooked by those preparing management plans. Management strategies developed using a combination of local and other knowledge sources will be better informed and are more likely to be supported by the local community (Steinmetz, Chutipong et al. 2006).

In the Lachlan River Catchment the majority (82%) of respondents believed that the Lachlan River is in poor condition. The key indicators of this perception were water quality, erosion, algal blooms and sedimentation. These beliefs are supported elsewhere by the fact that the Lachlan River is categorised as degraded due to the combined effects of erosion, nutrients, salinity, pollutants, turbidity and thermal pollution (NSW Department of Environment and Climate Change 2006). Residents of the Lachlan River Catchment can provide authorities with a good guide to the quality of the river and how quality parameters might have changed over time.

The memories recorded in *Listening to the Lachlan* (Roberts and Sainty 1996) support the view that the introduction of carp in the 1960s has been detrimental to the condition of the river. Respondents in this study believed that carp were responsible for the degradation of various river features. More than 90% of respondents thought that carp were having a detrimental effect on native fish, water quality and aquatic vegetation, while more than 70% thought carp were degrading birdlife, and visual amenity through sedimentation and erosion. All of these features attributed to carp were also listed as being the primary indicators that the river was in poor condition. Therefore, the community gave a clear indication that they perceived that carp were detrimental to the health of the Lachlan River.

This view is also supported by the *Future Directions for Research into Carp* (Carp Control Coordination Group 2000a), which showed that the Australian community and in particular those of the Murray–Darling Basin believe that carp have had a detrimental impact on the aquatic environment. The detrimental impacts identified in this report include resource degradation, reduced water quality, bank erosion and decreases in native fish populations. It has been acknowledged by the Lachlan River community that land and water use practices have also had a detrimental impact on the region's natural resources and in particular the Lachlan River environment (Byron, Curtis et al. 2006).

All of the respondents believed that carp populations need to be controlled, with the majority wanting them totally eradicated from the system. Total eradication, however, is not really a viable option and suitable control measures must be developed and implemented to ensure

negative impacts are minimised (Koehn 2004). It is important that the community understands the barriers to total eradication of carp populations, so that they do not have too high an expectation as to what a control program's outcomes are likely to achieve. There is also a belief that when carp populations are reduced there will be improvements in erosion, native fish populations, aquatic vegetation and sedimentation. If carp control programs are successful, then improvements in these river features may be something that the community will expect to observe. Again, managers need to be prepared to deal with community expectations.

Governments across Australia have provided resources for assisting in carp control programs. In 1996, the first national level task force (National Carp Task Force) was established by the Murray Darling Association to coordinate control of carp populations (Murray Darling Association 2009). In recognition of the threat posed by pest fish species other than carp, this group was renamed in 2002 the National Carp and Pest Fish Task Force (NCPFTF). In 2000, as part of the forthcoming Murray Darling 2001 Fish Rehab Program, the Carp Control Coordination Group (CCCG) was established (Barrett 2002). The principal role of each of these bodies is to guide national, state and local government and the community in the management and control of carp and other pest species. In 2000, the CCCG prepared the National Management Strategy for Carp Control 2000–2005, which provides direction for the management and control of carp in Australia.

The majority of respondents believed that the government should be responsible for the control of carp populations and that not enough resources have been invested in the control of carp in the Lachlan River. Most were not aware of the Lachlan River Revival Carp Reduction Program, which is not unusual as the communication strategy for this project has not yet been put in place. As 60% were unaware of this program, and as 100% of people believed that carp were having a detrimental effect on the system, it would be very unusual to find that people thought that sufficient resources had been allocated to the problem of carp. As well as government resources, it should also be recognised that there are likely to be further untapped resources within the local community (e.g. knowledge and capacity), in which the community or individual community members may be willing to invest, once they have a better understanding of the program. A local *Lachlan River Revival – Lachlan River Carp Cleanup* program 'champion' may be a possible method for helping to promote the project.

Carp are present in rivers and lakes that are essentially in the public domain. A program champion could help the community enhance their sense of ownership of the river and its environs, which could lead to a vested interest in the control of carp populations and rehabilitation of affected waterways. A champion can provide a connect between scientists, managers and the community, allowing opportunities to communicate learning and increase the stock of information – support for the carp reduction program will build along with the general understanding of carp management (Stankey and Schindler 2006).

Wells (2003) has noted that governments are much more likely to achieve results through effective partnerships rather than just regulation and administration. However, our research has highlighted that whilst views are changing, the community still predominantly believes that the government is solely responsible for management of carp populations.



A number of strategies to control carp populations have been proposed, developed, modelled and/or tested, including options for physical removal, biological control, habitat modification and chemical control (Roberts and Tilzey 1997). Strategies currently showing potential for effective carp control include the 'Judas fish' approach, as used in the Tasmania carp Management Program (Diggle et al. 2004), Williams' Carp Separation Cage technology for fishways (Stuart et al. 2003; Stuart et al. 2006), Koi herpes virus (Hedrick et al. 2000; Hartman et al. 2004), carp pox disease (Hedrick et al. 2000) or the development of 'Daughterless Carp Gene Technology' (Thresher and Bax 2003).

Within the Lachlan River Catchment community however, there is little awareness of the different types of control methods available. Yet the use a combination of available control methods was supported by the majority of respondents in this study. The community might have strong views on methods of control (e.g. from a moral standpoint) and management authorities charged with controlling carp would be well advised to work closely with the community in gaining acceptance of control strategies.

In the Lachlan River Catchment, efforts to increase current knowledge include a research program that aims to apply an integrated approach to carp control. The approach will be to first significantly reduce carp populations and then to install barriers to prevent further spread and outbreak of future populations (Carp Control Coordination Group 2000b). To reduce the likelihood of conflict resulting from the use of particular methods of carp control it would be wise to ensure that the community has a better awareness of the methods available and those likely to be used.

Tourism based on natural resources in the Lachlan River focuses predominantly on fishing. To reduce the likelihood that anglers will catch carp population controls will be required. Anglers involved in this study expressed support for using recreational fishing events to help control carp and they felt that this is an effective carp reduction mechanism. Such recreational fishing events could also be used as a means to promote good disposal methods for carp that are being caught.

Addressing the social issues related to carp control requires the development and implementation of communication and education programs (Carp Control Coordination Group 2000b). The end goal of these programs is public assistance in the implementation of control programs, ownership of the issues surrounding carp control, raising awareness of pest species and natural resource management, and the dispelling of myths associated with the impact of carp and their control.

## Conclusion

Given that the community within the Lachlan River Catchment perceives that the condition of the river is degraded and that carp are in some way responsible for this, it is important that people are aware that through the *Lachlan River Revival – Lachlan River Carp Cleanup* program resources are being allocated to control the carp population in the waterways of the Lachlan River. There is a need for greater communication with the community to inform them of the project aims and expected outcomes, to provide them with a better understanding of carp control methods, to determine what the community or community members might be willing and able to invest in a carp control program, and to ensure that managers have an understanding of the community's expectations so that these can be managed to enhance the acceptance of the project and its outcomes. The *River Revival – Lachlan River Carp Cleanup* program is a step in the right direction for carp management not only in the Lachlan River Catchment but also for management at a national level.

The results of this survey suggest that the community will be supportive of carp management programs but will have certain expectations about what the outcomes should be for improving river conditions. The baseline data provided in this report uncovers some of these opinions and expectations and can be a starting point for engaging the community and the resources they could provide to help control carp in their river system.

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## **Appendix:**

### Community attitudes survey







## Community attitudes survey

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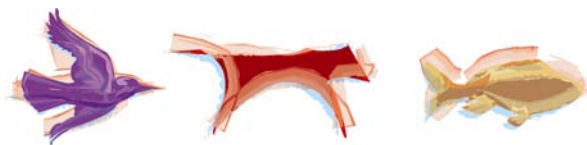
*Thank you for taking part in the NSW Department of Primary Industries survey designed to gauge community attitudes towards river health and carp management in the Lachlan River Catchment. This project is a collaboration between the Lachlan Catchment Management Authority (LCMA), Invasive Animals Cooperative Research Centre (IA CRC), NSW Department of Primary Industries (NSW DPI) and the South Australian Research and Development Institute (SARDI). As part of this project, this survey has been designed to help us identify the community's goals for river health and its perceptions of the effectiveness and implications of current carp control measures in the Lachlan River.*

**Your participation is greatly appreciated.**

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**NSW DEPARTMENT OF PRIMARY INDUSTRIES**



**Invasive Animals CRC**





## Section 1: Condition of the Lachlan River

1 Can you please list your postcode?

\_\_\_\_\_

2 How many kilometres from the Lachlan River would you estimate you live?

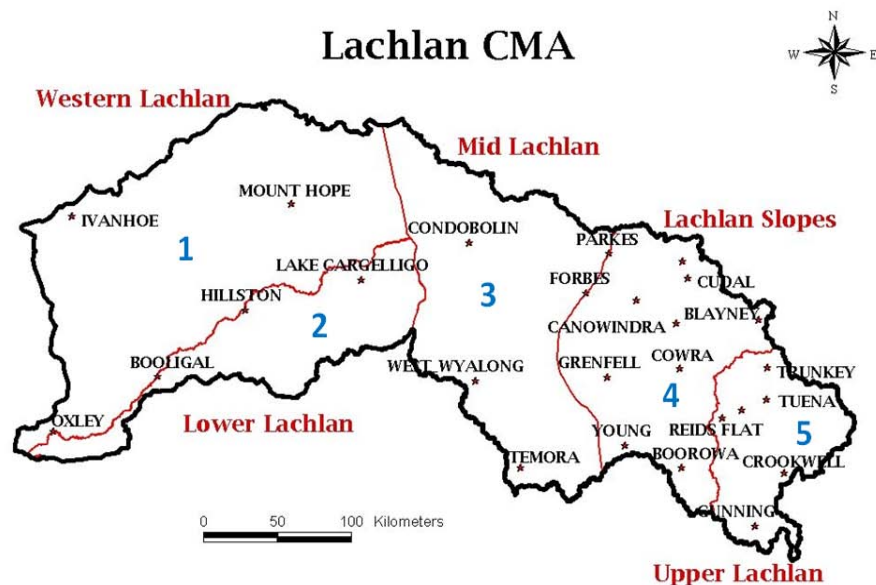
- ☐ 0–5  
☐ 6–25  
☐ 26–50  
☐ 51–100  
☐ 100+

3 How many years have you lived in the Lachlan River Catchment area?

- ☐ 0–10  
☐ 11–20  
☐ 21–30  
☐ 31–40  
☐ 40+

4 How often do you visit the Lachlan River?

- ☐ Never  
☐ Daily  
☐ Weekly  
☐ Monthly  
☐ Yearly



- 5 On the previous map please identify the number/s that correspond with the areas of the Lachlan River you visit and list them below.

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Other, please specify:

---

- 6 How do you use the Lachlan River environment?

- ☐ Water activities (e.g. swimming and boating)
  - ☐ Fishing
  - ☐ Irrigation
  - ☐ Water supply
  - ☐ Camping
  - ☐ Hiking/walking
  - ☐ Picnicking
  - ☐ Other, please specify:
- 

- 7 Do you agree with the following statement:  
'Overall the Lachlan River is in good condition?'

☐ Yes ☐ No

- 8 If you answered **YES** to the above question, which features of the Lachlan River suggest that it is in good condition?

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If you answered **NO** to the above question, which features of the Lachlan River suggest that it is not in good condition?

- ☐ Water quality (e.g. pollution and surface run-off)
  - ☐ Stock access to river
  - ☐ Bank stability
  - ☐ Flow regulation
  - ☐ Erosion
  - ☐ Recreational activities
  - ☐ Visual amenity
  - ☐ Birdlife
  - ☐ Native fish
  - ☐ Native vegetation
  - ☐ Aquatic vegetation
  - ☐ Algal blooms
  - ☐ Sedimentation
  - ☐ Wetlands
  - ☐ Other, please specify:
-

- 9 Have you noticed any changes during the time you have been visiting the Lachlan River?
- ☐ Yes ☐ No

- 10 On a scale of 1–5 do you think changes to the following river features have degraded or improved the condition of the Lachlan River?

River features	Highly degraded	Degraded	No change	Improved	Highly improved	Unknown
	1	2	3	4	5	6
Water quality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Stock access to river	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bank stability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Flow regulation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Erosion	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Recreational activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Visual amenity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Birdlife	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Native fish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Native vegetation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Aquatic vegetation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Algal blooms	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sedimentation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wetlands	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## Section 2: Carp and their impact on the Lachlan River

- 11 The density of carp in the Lachlan River has been described as the highest for any river system in New South Wales and quite probably Australia. How would you describe the impact of carp on the Lachlan River?
- ☐ Very beneficial
- ☐ Beneficial
- ☐ No impact
- ☐ Detrimental
- ☐ Very detrimental
- ☐ Unknown

- 12 For each of the following river features please indicate on a scale of 1–5 whether you feel carp have degraded or improved the condition of the Lachlan River.

River features	Highly degraded	Degraded	No change	Improved	Highly improved	Unknown
	1	2	3	4	5	6
Water quality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Stock access to river	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bank stability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Flow regulation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Erosion	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Recreational activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Visual amenity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Birdlife	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Native fish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Native vegetation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Aquatic vegetation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Algal blooms	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sedimentation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wetlands	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- 13 Do you feel carp populations in the Lachlan River should be controlled?

☐ Yes ☐ No

- 14 If yes, please indicate below how strictly you feel the carp populations in the Lachlan River should be controlled?

- ☐ No control  
☐ Minimal control  
☐ Medium control  
☐ Intensive control  
☐ Removal of all carp  
☐ Unknown

- 15 Are you aware of the Lachlan River Revival Carp Reduction Program?

☐ Yes ☐ No

- 16 Are you aware of any other programs to control carp populations in the Lachlan River?

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17 Who do you believe is responsible for the management of carp in the Lachlan River?

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18 Do you believe there are enough resources currently invested in managing carp populations in the Lachlan River?

☐ Yes ☐ No

19 The following is a list of carp control methods currently used by government agencies to manage carp. Please indicate if you are aware of any of these methods being used in the Lachlan River.

- ☐ Electrofishing
  - ☐ Commercial harvest
  - ☐ Netting
  - ☐ Fish traps
  - ☐ Recreational harvest (e.g. fishing competitions)
  - ☐ Poisoning
  - ☐ Bio-control (e.g. daughterless carp gene therapy)
  - ☐ Other, please specify:
- 

20 Please rate how effective you believe these carp control methods have been.

Carp control methods	Very effective	Effective	Marginal	Not at all effective	Unknown
	1	2	3	4	5
Electrofishing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Commercial harvest	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Netting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fish traps	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Poisoning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Recreational harvest (e.g. fishing competitions)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bio-control (e.g. daughterless carp gene therapy)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

[illegible]



## Section 3: Recreational fishing in the Lachlan River

23 Do you use the Lachlan River for recreational fishing?

- ☐ Yes ☐ No

24 How often do you fish?

- ☐ Daily  
☐ Weekly  
☐ Monthly  
☐ Yearly

25 What method of fishing do you use?

- ☐ Dead bait  
☐ Live bait  
☐ Soft plastics  
☐ Hard-bodied lures  
☐ Fly-fishing

26 Do you catch carp when you fish?

- ☐ Yes ☐ No

27 How often do you catch carp?

- ☐ Always  
☐ Most fishing attempts  
☐ Half of the time  
☐ Occasionally  
☐ Never

28 What do you do with the carp when you catch them?

- ☐ Return to river live  
☐ Take home live  
☐ Use as bait  
☐ Kill and take home  
☐ Kill and return to river  
☐ Kill and dispose on land  
☐ Other, please specify:
-

## Section 4: Demographics

29 What is your gender?

☐ Male ☐ Female

30 What is your age?

☐ 0–25  
☐ 26–45  
☐ 46–60  
☐ 60+

31 What is your main occupation?

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32 Are you a member of or involved in any community groups?

☐ Yes ☐ No

33 Can you please list these groups?

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**Thank you for completing this survey.**





