
Water quality and the community: Understanding the views, values and actions of residents of the ACT and surrounding region.

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Executive Summary

The lakes and waterways of the Australian Capital Territory (ACT) and surrounding region have multiple environmental values, contribute to an attractive landscape, provide places for recreation, and support economic activity for farmers and local businesses. The quality of the water flowing from the region's lakes and waterways affects a much larger region, and factors such as urban development, climatic variability and changing land use can all place pressure on the systems established to maintain water quality. In particular, the quality of water in the ACT's lakes is sometimes poor, a result of factors such as nutrient run-off from urban areas, and large amounts of organic matter such as leaves entering the lakes, particularly in autumn.

The ACT Basin Priority Project (ACT BPP) was established in 2014, with an objective of improving long-term water quality in the ACT and the Murrumbidgee River system, focused on six priority catchment areas within the ACT. Proposed investments including implementing infrastructure projects that follow water sensitive urban design principles, including urban wetlands¹, revegetation of riparian (river) areas, stormwater treatment systems, naturalisation of concrete lined stormwater drains, and establishment of rain gardens (bioretention systems), amongst others. The project also includes investment in community education. In 2015, the ACT and Region Catchment Management Coordination Group was established to coordinate management of catchments in the region, with an objective of supporting environmental health, including water quality. To support decision making as part of the ACT BPP and the ACT and Region Catchment Management Coordination Group, it is important to understand how residents in the region value different water-related activities and services, the types of water infrastructure they find acceptable, the types of actions they engage in that affect water quality, and where there are opportunities to encourage residents to engage in water-sensitive behaviours that improve water quality in the region.

A survey was undertaken in mid-2015 of adults living in the ACT and the surrounding local government areas (LGAs) of Cooma-Monaro, Palerang, Queanbeyan and Yass (the 'study region'). The objective of the study was to generate data to inform the design of strategies to improve water quality and to maintain and enhance the social benefits of waterways. The study was funded by the ACT BPP and supported by organisations including the ACT and Region Catchment Management Coordination Group, the ACT government, Cooma-Monaro Shire Council, Icon Water, National Capital Authority, Palerang Council, Queanbeyan City Council, South East Local Land Services and Yass Valley Council.

¹ Within the ACT, the existing Inner North Reticulation Network includes constructed urban wetlands in Lyneham, O'Connor, Dickson and Flemington Road.

Methods

A quantitative survey of adult residents of the study region was used to collect data as there was a need to quantify what proportion of the population held different views and engaged in different activities relevant to managing water quality. The study region comprised the ACT and the LGAs of Cooma-Monaro, Palerang, Queanbeyan and Yass. The survey questions were designed using an eight-step process of (i) literature review of past relevant studies, (ii) consultation with the ACT Basin Priority Project Advisory Group – Subject Experts and Academics, (iii) drafting an initial set of questions, (iv) review of questions by the ACT Basin Priority Project Advisory Group – Community, Peak and Professional Stakeholders Groups, (v) a revised draft of questions, (vi) stakeholder testing by people with an interest in water quality, (vii) pilot testing by 45 residents of the region without an interest in water quality, and (viii) formatting of the final survey. Using this process ensured survey questions were both informed by expert knowledge and tested to ensure they were understandable.

Ethics approval for the survey was granted by the University of Canberra's Human Research Ethics Committee (protocol number HREC 15-94). The survey was conducted online from July 16th to August 14th 2015. An online survey was chosen as the ACT has the highest rate of internet access in Australia, with 91% of all ACT residents having access to the internet in 2012-13, and an online survey offered greater accessibility to participants compared to phone or mail surveys. Survey participants were recruited using (i) a prize draw, with nine prizes worth a total of \$5000 offered, and (ii) mailing a flyer to every household in the study region, including people living in all kinds of dwellings. The survey was also promoted via emails, a media release, newsletters and social media.

In total, 4539 valid surveys were received from residents living within the study region. The survey responses were representative of gender, but undersampled those aged under 30 and oversampled those aged 55 to 74. There was relatively good representation of most Canberra suburbs and local government areas in the region, with some suburbs under- and over-represented in responses. Data weighting was used to correct identified biases in responses from (i) different age groups and (ii) different geographic locations. Confidence intervals were used to identify whether people living in different locations, in different types of residences, with different socio-demographic characteristics, and with different values and behaviours related to water and the environment, had significantly different views to the average for residents of the study region.

Who uses lakes and waterways and what do they do there?

Eighty per cent of the study region's residents reported spending time at one or more waterways located in the ACT, particularly Lake Burley Griffin (77%), the Murrumbidgee and Cotter River area (including Casuarina Sand, Cotter Reserve, Kambah Pool, Uriarra Crossing, Pine Island and Point Hut Crossing; 49%), Lake Ginninderra (41%) and Lake Tuggeranong (31%). Of all study region residents, 23% spent time at waterways in Palerang Council, 16% at Queanbeyan waterways, 21% at waterways in Cooma-Monaro Shire Council and 18% at waterways in Yass Council. Most of the region's smaller waterways were used principally by those who lived within easy travelling distance of the waterway.

Survey participants were asked whether they engaged in any of a number of activities when they visited waterways:

- Walking/jogging was most common around ACT's large lakes, urban ponds and constructed urban wetlands
- Picnics and barbeques were most common at the Murrumbidgee/Cotter river area and the ACT's three large lakes (Lake Burley Griffin, Lake Ginninderra and Lake Tuggeranong)
- Cycling was most common around large lakes, urban wetlands and storm drains in Canberra
- Fishing was most common in rural rivers and reservoirs
- Walking or jogging with a pet was most commonly done near stormwater drains, Lake Tuggeranong, Gungahlin Pond and Gordon Pond
- Boating (including kayaking, canoeing and yachting) was most commonly done on Lake Burrinjuck, Googong Reservoir, Lake Burley Griffin and Tantangara Reservoir
- Swimming was most common around the Murrumbidgee/Cotter river area, Lake Burrinjuck and the Goodradigbee River.

Survey participants were asked how important different recreational activities were to them. The activity most often rated as being highly important was walking with other people, rated very important by 41% of residents and as somewhat important or important by most others. This was followed by picnics/barbeques, cycling, and using playground areas, all activities considered important by 50% or more of residents. Walking a pet was important to almost half of residents. The activities least commonly reported to be important were horse riding, fishing, boating and birdwatching, largely because fewer people engaged in these activities: those that undertook them typically reported them to be important or very important to them. Those aged under 30 were less likely than older people to find most recreational activities important, with the exception of jogging. Those aged between 30 and 44 were more likely to find playgrounds, picnics and barbeques important, reflecting that many in this group have young children. Those aged 45 to 64 were more likely than others to find walking and bird watching important.

The experiences most commonly rated as important or very important by residents of the study region when they were at waterways were being outside in a pleasant area, relaxing/unwinding, spending time in nature, and seeing birds or animals. The next most important were getting exercise/being active, seeing native vegetation, being in attractive parklands and spending time with friends and family. Having access to toilets, somewhere to sit down, having time alone, having potable drinking water were considered very important by 30-34% of people.

Experience specific to particular age groups, life stages, or recreational interests, were considered important by fewer people, including accessing playground equipment, being able to go into the water, being able to commute to work away from roads, and being able to go fishing. People who regularly took action to protect water quality were more likely than those who took little action to find it important to value native vegetation, birds and animals, fishing, spending time in nature, being outside in a pleasant area, relaxing/unwinding outdoors, and exercise around waterways. Spending time around waterways was associated with higher levels of health and wellbeing. Those with poorer health placed greater importance than others on having access to amenities such as a place to sit down, toilets, and drinking water. This suggests that providing these amenities can increase the ability of those with poor health to spend time at waterways, and to experience associated benefits.

People who spent time around waterways were in general more likely than those who spent little time around waterways to take action to protect water quality, and to be concerned about the quality of the water in local waterways. This was particularly the case for those who engaged in active recreation such as swimming, cycling and boating. The links between spending time in and around water and water protective behaviour suggesting that education campaigns that help people link their observations of water quality in local waterways to their own actions can be effective.

Perceptions of water quality

A person's perceptions of the quality of the water in their local waterways can influence whether and how they use those waterways, and the actions they take to protect water quality. Poor water quality in lakes was perceived to be a problem by 59% of residents, while 36% felt poor water quality in natural rivers, streams or creeks was a problem, and 33% that poor water quality in local wetlands was a problem. Only 10% indicated that poor tap water in their house was a problem.

People living in the ACT, particularly near Lake Tuggeranong and Lake Burley Griffin, were more likely to report concerns about water quality than those living in other parts of the study region, as were those who worked in water or environment-related jobs; those who had high concerns about environmental issues; and those who cycled, swam, fished or boated near/in waterways. Those aged under 30, with little interest in water related issues, who were renting their residence or born overseas in a non-English speaking country, as well as those living in rural areas of Gungahlin, were less likely to report being concerned about water quality.

A high proportion of waterway users felt water quality was poor in Lake Tuggeranong (63%) and Lake Burley Griffin (58%). For almost all waterways, a quarter or more of waterway users indicated they did not know enough to rate how good or poor the water quality was, highlighting a lack of awareness and knowledge of water quality in local waterways even by those who spend time around them. People were more likely to feel the water quality in different waterways was poor if they were unemployed, had low levels of wellbeing, worked in a water or environment-related job, were concerned about environmental issues in general, and spent time swimming, boating or fishing in the region's waterways. People who lived in rural towns were more likely to report poor quality water in storm drains or in their home. Poor residential water quality was more commonly reported by those living in Cooma-Monaro, Palerang and Yass, and much less commonly by residents of the ACT and Queanbeyan.

People are generally considered more likely to take action to protect water quality if they are aware that water quality problems exist. However, many of those who had concerns about water quality in specific waterways were not more likely to take action to protect water quality than others, suggesting they may not link the water quality problems they are observing to the actions they themselves take. There may be potential to close this gap by helping those who are concerned about water quality in waterways to better understand how the things they do influence water quality.

Water-related knowledge and information

It is not always easy or simple to identify signs of poor water quality. Survey participants were asked whether they believed a number of things they might sometimes observe, such as cloudy water or rubbish in or near water, were indicators of poor water quality, with good water quality defined as 'healthy for plants, animals and recreational use'. The observable signs asked about included:

- *Water that smells bad*: this is considered a good indicator of poor water quality by water scientists, as it typically occurs when sediments have become anoxic
- *Algae or slime on rocks* is sometimes, but not always, a sign of poor water quality
- *Dead birds or animals, cloudy water, muddy water* and *weeds growing in water* are sometimes signs of poor water quality, but not always
- *Rubbish and littering*, while a significant issue for fish and other wildlife, typically becomes a problem for water quality only when there is a large volume of litter
- *Dead vegetation in or near water, eroding or crumbling banks, and clear water* are not always signs of poor water quality, although they can be associated with it.

Overall, residents of the ACT and surrounding LGAs had views that were relatively consistent with the advice of water scientists regarding signs of poor water quality in the region. In total, 2.5% of residents were mostly unsure of the signs of poor water quality; 18.2% often had low awareness of signs of poor water quality (meaning they often believed an indicator was not a sign of poor water quality when in reality it is); 53.1% had a relatively accurate awareness of signs of poor water quality, while just over a quarter (26.3%) were likely to 'over-attribute', meaning they often believed something to be a sign of water quality more often than it actually is. People living on rural residential properties, who spent little time recreating around water, and who did not access water-related information were least likely to recognise signs of poor water quality. Those who were in poor health, with low household income, born in a non-English speaking country, and who perceived many local water quality problems, were more likely to over-attribute signs of poor water quality.

Understanding the signs of poor water quality can sometimes help people observe linkages between specific actions (e.g. spillage of chemicals or oil in waterways) and outcomes in the form of decreased water quality. However, many causes of poor water quality are not directly or easily observable. Survey participants were given a list of potential causes of poor water quality and asked if they felt each was causing water quality problems in their local region.

Residents of the study region had different perceptions to scientists about the causes of water quality problems: they were most likely to consider litter a big problem for local water quality (62% of residents), followed by blue green algal blooms (60%) and pest fish species (59%), whereas water scientists considered the highest priority problems to be organic matter in the form of leaves and grass clippings entering waterways, littering (e.g. rubbish not disposed of responsibly), erosion of stream banks, blue green algal blooms (the latter a problem in lakes only, and not in rivers), erosion from construction sites and other worksites, and high bacteria levels. Perhaps the biggest difference between residents and experts related to leaf litter and grass clippings entering the stormwater system. This issue was considered a major contributor to water quality issues by water scientists, but was considered a problem by only 38% of residents of the region.

People who lived on rural residential properties, aged under 30, who rarely accessed water-related information and had low levels of interest in water quality and environmental issues rated fewer things as being causes of poor water quality. Those who worked in water or environment related jobs, and who had a strong interest in water and environmental issues, typically identified a larger number of things as being causes of poor water quality.

Just under a quarter of survey participants reported being currently involved, or involved in the past, in Landcare, Waterwatch, Bushcare, Frogwatch or other natural resource management (NRM) or water-related groups. Most of these had been involved in the past, and were not currently involved. Participation in these groups was most common for residents of Palerang, Yass and Cooma-Monaro. People were less likely to have had involvement in these types of groups if they were younger, lived in urban areas (particularly in apartments), rarely accessed water-related information, and had low levels of concern about water and environmental issues. They were more likely to be involved if they had a university degree, worked in a water- or environment-related job, lived on a rural property, spent a lot of time gardening, and had an active interest in water and environmental issues.

Survey participants were asked (i) whether they had accessed water-related information from any of a number of sources, ranging from government agencies to family and friends; and (ii) if they had sought information about water from a source, how useful they found it. In general, people living near water, on rural properties, who spent time fishing and boating, and who had a strong interest in water and environmental issues were more likely to access information about water from all sources. Those who lived in urban areas, particularly in apartments, and who had low interest in water and environmental issues, were least likely to. Rural landholders most commonly sourced information about water from other rural landholders, with 75% doing this. Other survey participants most commonly accessed information from family and friends (61%), TV (59%), ACT Territory and Municipal Services (TAMS) (57%), the internet (57%), ABC Radio (54%), and daily newspapers (53%). Between 30% and 47% of participants accessed information about water from their local water company, NSW government agencies, National Park and conservation area managers, their local council, Local Land Services, and radio other than the ABC. Those living on rural properties or in rural towns were more likely to access information from friends and family, rural newspapers and farming related organisations compared to those living in urban areas. Those living in urban areas were more likely to access information from their local water company, and to a lesser extent from daily newspapers and TV.

When asked how *useful* different sources of information about water had been, the sources found most useful included some government agencies, particularly TAMS, which was rated as providing useful or very useful information by 56% of those who had used it. The next most useful sources of information were National Park/conservation areas managers (53%), Waterwatch (52%), the internet (51%), NRM-related groups (46% to 49%), and ABC Radio (46%). The sources of information rated least useful were radio other than ABC, rural newspapers, Facebook, TV, daily newspapers, and farming organisations, with 36% or less rating each of these useful. Other landholders, friends and family, local water companies, NSW state government agencies and local councils were considered useful by between 39% and 43% of residents.

A key challenge for reaching residents with community education campaigns is that those who take little action to protect water quality, particularly younger residents, are also those who are least likely to access water-related information from any source, suggesting a need to ensure water quality messages are delivered via media that this group do use – for example, through targeting Facebook feeds, and advertising in forums unrelated to water management.

Taking action to improve water quality

Many actions can be taken to improve the quality of water flowing through stormwater systems and into lakes, rivers and other waterways. Not all of these will be supported by all people and some will be more controversial than others. A large majority of both ACT residents and residents of Cooma-Monaro, Palerang, Queanbeyan and Yass supported the implementation of 12 types of actions asked about in the survey, indicating high levels of overall support. However, there was stronger support for some actions than others. As those who support an action slightly or moderately, rather than strongly, have a higher likelihood of ceasing to support that action if it presents impediments to their daily activities, or they become aware of concerns expressed by others about the action being implemented, actions were identified as falling into one of three categories: those that were in general *strongly supported*, *moderately supported*, or *weakly supported*:

- **Strongly supported:** Providing more drop-off points for hard rubbish; improvement of stormwater drains such as improving gross pollutant traps; more planting of vegetation along waterways; establishment of new wetland areas to help filter stormwater; and greater use of rainwater tanks. Each of these is strongly supported by 60% or more of the population, and opposed by less than 10%
- **Moderately supported:** Establishment of rain gardens, community education campaigns, increased use of mulching, and conversion of storm drains to more natural waterways were strongly supported by 51-57% of adult residents, and are likely to be relatively well accepted. However, as there was more than one in five people indicating opposition, lack of knowledge, or only weak support for each of these, they are considered less strongly supported than some others and have greater potential for opposition to occur if concerns emerge about the potential effects of these initiatives. This is particularly the case for conversion of storm drains, which was less supported than the others in this category.
- **Weakly supported:** Two actions – (i) reducing the use of fertiliser, pesticides and herbicides in suburban gardens or on rural properties, and (ii) more frequent street sweeping – were strongly supported by less than half of people, and opposed by around 10%, with the remaining 40-50% being either neutral, unsure, or weakly to moderately supporting. This indicates higher potential for these actions to have poor uptake or to become controversial.

Strongly supported actions are unlikely to become controversial, and are likely to be supported even in the absence of information dissemination explaining the purpose of the action and why it is being taken. Moderately supported actions require good communication about their rationale and benefits to be more strongly supported. In the absence of this information, there is potential for opposition to develop. There is high potential for weakly supported actions to be controversial in the absence of a dialogue with the general public regarding their relative costs and benefits that puts a strong case for their implementation. In general, younger people, men, and those who were less concerned about water quality, water conservation, or environmental health in general, were less likely to support most options.

Water management at home and in the garden

Water quality in the ACT and surrounding region is influenced by many factors, including the way people manage water in their homes and gardens. Survey participants were asked a series of questions about their management of drains, gardening, and watering.

Management of drains

Survey participants were asked whether any of a number of materials went down the drains inside their house. Almost all people reported putting detergent and cleaning agents in their drains regularly, as expected. Other common materials entering drains were cooking oil (52% of people), food scraps (49%), wipes labelled as 'flushable' (24%), cosmetics other than soap, shampoo etc. (17%), medications (14%), and paint (13%). Only 4% of residents reported putting wipes not labelled as flushable into their drains. The types of people who reported putting different materials into their inside drains varied. For example, the use of wipes labelled as 'flushable' was more commonly reported by men, those aged under 30, renters, those born in non-English speaking countries, people with severe health problems, Gungahlin residents, and those with low concern about environmental issues in general. Cooking oil was more commonly put down drains by people aged under 45, particularly those with children or living in a group house, by those born in non-English speaking countries, by those living in apartments, renters, Inner South residents, and by those studying or working full-time. Paint was more commonly put down the drain by those aged 30-44, with mortgages, and living with a partner and children, and by those with higher household income.

Survey participants who indicated they had a front or back garden area were asked what went down the tap drains outside their home, irrespective of whether they were personally responsible for the material entering the drain. The most common materials entering tap drains outside the home were soil/dirt washing into the drain due to rain (68% of people), soil/dirt washing in due to actions of residents such as cleaning and watering (54%), leaves (45%), and detergents/cleaning agents (42%). Fifteen percent or less reported fertiliser, chemicals, grass cuttings or oil or paint entering these drains. Some people were more likely than others to report materials entering drains outside their house. Soil washing into drains was more commonly reported by women, those aged under 30, those who spent little time gardening, and those who took few actions to conserve water. Leaves were more commonly reported to go into outside drains by those aged under 30, renters, apartment dwellers, residents of the East Belconnen, Inner South and Inner North parts of the ACT (areas with many deciduous trees), those who spent no time gardening and those who took little action to conserve water or protect water quality. Oil/paint was more commonly reported to enter outside drains by those aged under 30, with low household income, living in apartments, and those who took little action to conserve water.

All survey participants were asked what went down the kerbside stormwater drains outside their home. The most common materials were soil/dirt washing into the drain during rain (77%), leaves (76%), soil/dirt washed in by actions of the household such as cleaning and watering (47%), and grass cuttings (32%). Fewer reported detergent/cleaning agents (23%), fertiliser (16%), chemicals (13%) or oil or paint (12%). Soil washing into drains during rain was more commonly reported by women, low income households, Inner North residents, and people living near lakes/ponds, as well as those with high concern about environmental issues and those who swam in waterways. Soil being washed into drains when hosing or watering was more commonly reported by women, renters, and Weston Creek/Lower Molonglo residents. Grass cuttings washing into drains was more

commonly reported by those aged under 30, living in group houses, with poorer wellbeing, Yass residents, those who swam in waterways, and those who took little action to conserve water or protect water quality. Leaves washing into drains were more commonly reported by those with low household income, living in rural towns, apartments, renters, those living close to stormwater drains, Weston Creek/Lower Molonglo residents, and those who swam in or picnicked near water.

Gardening

The way people manage their garden can affect the quality of watering flowing into the stormwater system: to give just a few examples, large piles of leaves or grass clippings left near stormwater drains can then blow or wash into that drain and contribute to poor water quality; exposed soil may wash into drains, contributing to siltation of waterways; and the use of mulch can slow down water flow and reduce the amount of material and nutrients washing into drains, helping protect water quality.

Most people who had a garden felt positively about it: 69% agreed or strongly agreed that they enjoy gardening, while only 17% disagreed with this statement. However, fewer were able to spend a lot of time in the garden: 48% agreed that they spend a lot of time gardening, while 35% disagreed.

Survey participants who had gardens were asked how they managed their leaves and clippings. Most residents with gardens reported that they sometimes or regularly mulched their garden beds (86%), raked up leaves without using a leaf blower (80%), and composted leaves/clippings on their property (73%). Many also left leaf litter where it fell (50% did this sometimes, and 20% regularly), left grass clippings on their lawn (51%), took greenwaste to the tip (50%), or used a leaf blower (39%). Very few reported that they raked or blew leaves or grass clippings into the street (7%).

Raking up leaves without using a leaf blower was more commonly done by those aged over 45, particularly retired people, by Inner South residents, and by those who gardened frequently and who had strong interest in water and environmental issues. Leaf blowers were more commonly used by people with poor health, with lower formal education, and aged 65 and older, and by people living in the Inner South and Tuggeranong. Raking/blowing leaves and clippings onto the street was more commonly done by people living in apartments, those born in non-English speaking countries, and Inner North and Inner South residents. People were more likely to leave leaf litter where it fell if they lived in a group house, had a university degree, worked in a water or environment related job, often accessed water-related information, had a strong interest in water/environmental issues, were aged 30 to 44, had poorer wellbeing, lived on a rural property, or spent little time gardening. Grass clippings were more commonly left on the lawn by those living in group houses, those who worked in water or environment related jobs, lived on rural properties or in rural towns, Outer North residents, and those who spent time fishing, swimming or boating.

Composting was more commonly done by those aged over 45, by people with a strong interest in water and environmental issues, by residents living on rural properties or in the Yarralumla Creek priority catchment, and by those who spent a lot of time gardening, and who spent time swimming or boating. Mulching garden beds was more commonly reported by those aged 45 and older, with high household income, retired, living on rural properties, who spent a lot of time gardening and who had a strong interest in water and environmental issues. Taking garden waste to green waste facilities was more common for those with mortgages and Tuggeranong residents.

Fertiliser and pesticides can be washed from gardens into the stormwater system. The extent to which this occurs depends on how often they are used, how much is used, and whether they are used in close proximity to heavy rain events during which there is greater potential for run-off into the stormwater system. Just over half (51%) of study region residents said they sometimes or regularly applied fertiliser in their garden immediately before or during rain, while 38% reported applying fertiliser when it was dry or there had been little rain. Pesticides were applied predominantly when it was dry or there had been little rain (34%), and rarely when it was either about to rain or raining (9%). Applying fertiliser during dry conditions was more commonly reported by those who did not actively conserve water (who were more likely to water in fertiliser using a hose or watering system), and by those who often accessed water-related information. Fertilising before or during rain was more commonly done by older people, those living on rural properties, those who took action to conserve water, and those who spent a lot of time gardening, as well as Woden Valley and Yarralumla Creek priority catchment residents. Using pesticides in dry weather was more commonly reported by older people, men, those living on rural residential properties, and those with lower levels of concern about environmental issues in general. Use of pesticides in proximity to rain events was more commonly reported by those born in non-English speaking countries, and by those who took few actions to protect water quality.

Watering and management of water run-off

Residents were asked about how they water their garden. Watering the garden using a hose was more common than any other method of watering, with 85% of people with a garden reporting doing this sometimes or regularly. Most washed their car at home, and just over half watered their gardens using sprinklers or drippers. Under half (43%) sometimes used a hose to clean their windows or driveways. Just over one-third (35%) watered their garden using tank water, while 32% used grey water. There is substantial scope for change in some watering practices, with 21% of those who didn't water their garden using drippers stating that they would like to, while 38% of those who didn't use a rainwater tank wanted to install one, and 32% of those who didn't use grey water on their garden indicating that they would like to.

When asked about the frequency with which they water their garden, just over half of residents with a garden reported that they watered occasionally or regularly in summer, and rarely the rest of the year. Thirty four per cent reported they almost never watered their garden. Fifteen per cent reported watering so much it substantially increased their water bill, and 12% reported that they watered their garden regularly through most of the year. Around half watered some parts of their garden but not others. One third (34%) watered both their garden beds and lawn area.

Forty three per cent of residents had some landscaping or garden features that reduced water run-off, 50% had a watering system other than hand held hosing, and 36% had a rainwater tank connected to their roof. For those who had watering systems, most were fed from mains water supplies (78%) and only 26% from a water tank; most used drippers or weeper hoses (81%), while 46% used low-flow sprinklers, and only 17% used high-flow sprinklers. Of those who had a water tank, 85% used it to water their garden, 66% had a pump connected to it, and 26% used the tank for household water.

Rainwater tanks were more common for rural property residents and those who took a lot of action to conserve water, as well as those who spent a lot of time gardening. They were least commonly located at the residences of younger people, renters, those living in townhouses or apartments, those living in the Outer North (Dickson/Downer/Watson) and Tuggeranong, those who never/rarely accessed water-related information, and those who rarely spent time gardening or took action to conserve water. Watering systems were most commonly installed by those who had high household income, rural property residents, those living in Yass and the Inner South and those who spent a lot of time gardening. They were less commonly installed at the residences of younger people, renters, those with lower household income, those with lower levels of formal education, those who took no/little action to conserve water use, and Outer North residents. Landscaping to reduce run-off was more common for older people, rural property residents, Palerang residents, and those who spent a lot of time gardening; and less commonly for young people, unemployed people, those with lower wellbeing, renters, apartment dwellers, Outer North residents, those who spent little time gardening, and those with few concerns or actions related to water quality, water conservation or environmental issues more generally.

Nature strip management

Stormwater drains are often located adjacent to nature strips. As such, the materials left on nature strips, and the way nature strips are managed, can have a large influence on the types of materials that enter the stormwater system and therefore the water quality. Participants were asked about the type of nature strip they had. Just over half had a nature strip with no walking path (54%), while 31% had a nature strip separated from their front yard by a walking path, and 20% had a walking path directly next to the road. Three quarters of nature strips were reported to have trees or shrubs on them, 61% had grass, 36% had a paved or concreted area, 36% a gravel area, and 31% bare patches of earth. Trees/shrubs were more common in the Inner North and Inner South. Grass was more commonly reported by young people living in rental houses, and those living in rural towns, as well as by those living in the Inner and Outer North and Inner South regions. Paving was more commonly reported by renters, townhouse residents, young people, and by those born in a non-English speaking country. Gravel on the nature strip was more common for those living in Palerang, Yass, Gungahlin, and the Lake Tuggeranong priority catchment area. Bare earth was most common for young people, renters, those living in townhouses, those on lower incomes, and those living in Cooma-Monaro.

When asked how they managed their nature strip, 56% of residents reported raking leaves from their nature strip sometimes or regularly, 21% left lawn clippings on the nature strip sometimes or regularly, 16% used a leaf blower to blow leaves from the nature strip (indicating that of the 39% who used a leaf blower, most did not use it on their nature strip), 9% used fertiliser on their nature strip, and 10% used pesticides on their nature strip. This suggests that increasing the practice of raking leaves away from nature strips has potential to reduce the volume of leaf litter entering the stormwater system.

Leaf raking on the nature strip was more common for older people, those living in the Inner North, Inner South and Woden, those who spent a lot of time gardening, those who took a lot of action to conserve water, and those who had higher levels of concern about environmental issues. Using a leaf blower on the nature strip was more common for those living in townhouses, born in non-English speaking countries, living in the Inner South and in the Lake Tuggeranong priority catchment area. The high use of both raking and leaf blowing in the Inner South likely reflects the relatively high amount of deciduous trees in this region, which results in a higher need to remove leaves in general.

In general, older people and those who lived in houses were more likely to feel they (not the government) were responsible for their nature strip and that it was important it looks presentable. Those who rented, lived in townhouses, had poor health, were born in non-English speaking countries, Gungahlin residents and those who spent little time gardening were more likely to feel the government was responsible for managing their nature strip. The groups least likely to manage their nature strip were young people, renters, townhouse residents, residents living in the Outer North (Downer/Dickson/Watson), those who spent no time gardening, those who accessed little water-related information, and those with low engagement in water issues.

Barriers to changing garden management

A number of actions can be taken to improve the quality of water that flows from urban gardens and outdoor areas into the stormwater system, particularly actions that reduce the materials entering stormwater drains and which slow the flow of water into drains. For example, composting materials at home or taking leaves and clippings to green waste facilities can reduce the amount of leaves and grass clippings that enter stormwater drains; installing a rainwater tank can reduce the velocity and volume of water entering stormwater systems after rain events; mulching garden beds and appropriate landscaping of the garden can help rain absorb into garden beds and reduce run-off; and maintaining vegetation cover in gardens can reduce the amount and velocity of water run off as well as the amount of soil entering stormwater systems. However, not everyone is able to easily implement all these actions. Survey participants were asked whether they experienced any of a number of barriers to implementation of these actions:

- **Composting:** For those who did not compost but wished to (11% of residents), the most common barriers were lacking the tools/equipment to compost (44%), composting being a low priority (35%), lacking space for composting (26%), and lack of knowledge (25%). For those who didn't compost and had no plans to do so (16% of residents), the largest barrier reported was that composting was a low priority (21%), a lack of tools/equipment (17%), and a lack of time to compost (14%).
- **Taking leaves and clippings to green waste facilities:** For those who didn't do this but wished to (4% of residents), the most common barrier was lacking a trailer or car suitable for transporting green waste (70%), followed by taking this action being a low priority (34%). Those who did this (49% of residents) sometimes also commonly reported lack of a trailer or suitable car as a barrier to doing it (32%).
- **Installing rainwater tanks:** The biggest barrier to installing a rainwater tank, for those didn't have a tank who wished to, was the installation cost (67%), lacking space for a tank (21%) and installing a water tank being a low priority (21%). Cost was the most commonly reported barrier for all groups, including those who already had a water tank.

- Mulching garden beds: For those who did not mulch (14% of residents with gardens), the most common barrier to mulching was that it was a low priority compared to other things. Of those who wanted to mulch but were not doing it, 23% reported they lacked the equipment needed, and 20% that they had no need to mulch. Those who didn't plan to mulch often also reported having no need to (30%). Lack of knowledge was rarely a barrier.
- Landscaping gardens to reduce water flow: 54% of residents had not done this at their residence. Of these, 29% reported cost being a barrier, followed by a lack of knowledge (22%), and landscaping being a low priority (19%).
- Maintaining vegetation cover in the garden: Few people felt there were barriers to maintaining vegetation cover in their garden. Cost (15%), low priority (12%) and lack of time (10%) were the most commonly reported barriers.

Scope for changing home and garden management

Most people living in the study region take care to minimise the volume of inappropriate materials entering drains inside and outside their home. However, a large proportion did report that soil/dirt, leaves, and grass cuttings entered drains outside their home and/or kerbside storm drains. This suggests potential to achieve water quality improvements through encouraging residents to reduce these volumes.

Managing water quality on rural properties

A small number of survey questions were specific to the management of water quality on rural properties. Only a small proportion of respondents to the survey lived on rural properties: a total of 190 lived on rural residential properties (defined as a rural property used principally for residential purposes with no or very little commercial activity occurring on it), and a further 99 lived on properties used predominantly for agriculture. On most rural properties (97%), water supply came wholly or partly from a water tank. Only 8.5% reported that some or all of their water supply came from mains water supply, while 17% sourced some or all of their water from bores, dams or rivers.

Grass cover was the main land cover for most rural properties, followed by trees and shrubs. Very few reported having areas of bare earth and dirt. Those managing agricultural properties typically reported a larger proportion of their land having grass cover, and less having vegetation cover, compared to those who had rural residential properties. Smaller rural properties (<11 ha) typically had a smaller proportion of land covered with vegetation compared to those that were larger than 11 ha. Younger rural property residents were more likely than older residents to report that they had areas of bare earth on their property, and generally reported a smaller area of the property being covered with trees and shrubs. The large majority of rural property residents felt that living on a rural property and the associated lifestyle was important to them. Most also felt it was important to maintain good groundcover and to increase the diversity of plants and animals on their property. Just under half (46%) felt it was important to keep their property tidy, while 37% disagreed.

Rural property residents were asked whether they had ever participated in a number of activities that can help protect water quality on rural properties:

- Planting vegetation in riparian areas: Approximately 55% had already done this or planned to do so in the future, while 25% said this was not applicable to them, and just under 20% stated they had never done this and didn't plan to. Those who managed agricultural properties were more likely than those on rural residential properties to do this
- Off-stream watering points for stock: This had been done by most agricultural property landholders, but few rural residential landholders
- Fencing of riparian areas: This was more common on agricultural and large properties, and less common on rural residential and smaller properties. Younger rural landholders were less likely to have done this in the past, but more likely to be planning to do it in future
- Managing stock to maximise ground vegetation cover and use of flexible fencing for grazing: These two practices were much more commonly done by those on agricultural properties with stock than by those on rural residential properties who had stock
- Use of contour management: 57% of rural residential landholders, and 35% of agricultural property landholders, stated that using contour management was not applicable for them or that they did not plan to do it. This suggests that, particularly amongst rural residential landholders, there is some lack of awareness of the use of contour management as a strategy for managing water flow across the property
- Stabilising eroded areas and fencing out erosion gullies: Agricultural landholders were more likely to have implemented these actions than rural residential landholders. Those aged under 50 were least likely have either done these actions or to be planning to. Many landholders felt these actions were not necessary on their property.

Rural landholders were asked if they experienced any of a number of barriers to (i) investing in fencing riparian areas, or (ii) revegetating streambanks or riparian areas on their property. For those who had agricultural properties, the biggest barriers to fencing riparian areas were the cost of installation and management, and difficulty installing watering points for stock that had previously had direct access to the now fenced waterway. For rural residential property owners, the most common responses were that they did not have a need to do this, and for those who did feel it was needed, the costs involved, low priority and lack of time were the most common barriers. When different age groups were compared, younger rural landholders were more likely than older landholders to feel they needed to do this, but were much more likely to identify barriers of cost of installation, lack of time, and cost of managing watering points as barriers to fencing riparian areas.

More than a third of rural property owners felt there were no barriers to revegetating streambank and riparian areas on their properties, while just under 30% felt they had no need to do any revegetation on their property. For those who did experience barriers, the most common issues were cost and low priority (particularly for those on agricultural properties). Similar to fencing riparian areas, younger landholders (those aged under 50) were more likely to feel they needed to revegetate streambank/riparian areas, but also more likely to report experiencing barriers to doing so including high cost, lack of expert advice, and having other higher priorities. These results suggest a particular need to focus on encouraging uptake of water-sensitive land management practices by those living on rural residential properties, and in particular by younger landholders.

Fishing

One common recreational activity undertaken in the region's lakes and waterways is fishing. While the principal objective of this study was not to examine recreational fishing, a small number of additional questions were asked of fishers in order to better understand their views.

Just over half of residents of the study region had fished in some point but not in the last two years, while 19% had never fished, and only 25% had fished in the last two years. Of this 25%, most fished only once or twice a year, and fewer fished more often. People were less likely to have ever participated in fishing if they never/rarely accessed water related information, spent no time gardening, or were born overseas in non-English speaking countries. Those who lived in Cooma-Monaro and those who spent time boating were significantly more likely than others to fish monthly or more often. In the last 12 months, the majority of the region's fishers had fished both in the ACT and in the ocean while 18-28% had fished in Cooma-Monaro, Yass, Queanbeyan or Palerang. Within the ACT, the most common places fished were Lake Burley Griffin, the Murrumbidgee River, Googong Dam (located in NSW but frequented by many ACT fishers), and the Cotter River.

Survey participants were asked whether they targeted particular fish species within the ACT during the past 12 months. There was little difference in species targeted, with Redfin targeted slightly more often than other carp, trout, Golden Perch or Murray Cod. All species were more commonly targeted by those in lower income households and those who were unemployed, likely reflecting that these groups may fish more regularly and target more species overall. Murray Cod and Golden Perch were most commonly caught and released, while trout and redfin were just as likely to be caught and eaten as caught and released. Caught carp was predominantly disposed of without eating it.

The most important reasons for fishing included spending time in the outdoors, relaxing or unwinding, spending time with family, and spending time with friends. Only 5.6% of fishers were part of a fishing club.

Fishers were asked whether they would support or oppose a variety of protection measures if they were implemented in the ACT. The majority of survey participants supported all proposed protection measures, although there was less support for a total close to all fishing in the Murrumbidgee during Murray Cod breeding season or using only barbless hooks when fishing for trout in the Cotter River.

Most fishers were moderately to highly satisfied with their fishing over all. Within the ACT, they were most satisfied with their access to lakes and rivers for fishing, and overall accessibility of fishing areas. They were least satisfied with the current investment in improvement of freshwater habitats, the availability of fish stocks, and the number of stocked lakes in the ACT.

Discussion

Many actions can help improve the quality of water entering the stormwater system. These include major investments in water infrastructure, such as those proposed as part of the ACT Basin Priority Project. Most residents support improving stormwater infrastructure using principles of water sensitive urban design, as long as it does not cause significant disruptions or negative impacts for residents. In addition to these types of infrastructure investments, changes in how residents manage their homes and gardens such as better managing organic matters, establishing rain gardens and increased use of composting and mulching, can contribute to improving water quality in the region.

The survey results suggest potential to achieve change through encouraging residents to reduce the volume of leaves, grass clippings and other garden waste entering stormwater drains; reduce the amount of soil entering drains; and reduce the amount of fertiliser entering drains.

Perhaps the area where there is greatest scope for achieving change is in reducing the volume of leaf litter, grass clippings and other garden cuttings that enters storm drains, given the large contribution this organic matter makes to poor water quality in the region's lakes and the relatively low awareness of this issue. Achieving this change requires asking residents to spend more time removing leaf litter and grass clippings from areas where these materials are likely to enter storm drains, particularly nature strips and to a lesser extent areas of front yards near storm drains. They then need to have the capacity to manage the leaves/clippings that have been removed from these areas, for example by composting them, or transporting them to green waste facilities. For those who are active gardeners with the time and means to manage garden clippings easily, achieving change can be as simple as raising awareness of the need to reduce the volume of leaves and clippings entering drains. For other people, particularly younger people, renters, and those on lower incomes, there is a need to both increase awareness and to provide practical advice on low cost options for managing leaves and clippings. For those living in apartments and townhouses, achieving change likely requires providing easy options for managing garden clippings that do not require on-site composting in small courtyards.

Reducing the amount of soil entering stormwater drains requires more than raising awareness: many people are already aware of the issue. This suggests a need to focus on providing advice on simple, low cost options for reducing soil washing into drains. Many of these actions, such as better use of mulching, require investment of time and effort in gardening. These actions are likely to be readily undertaken by those who already spend a lot of time gardening: however, those who most commonly reported having areas of bare earth in their gardens were young people and those who rented rather than owned their residence; these groups also invested the least time in gardening, and were less likely to be interested in water and environment-related issues. Achieving change amongst this group requires targeting education campaigns beyond traditional sources of water-related information, as this group typically accesses little to no water-related information.

Many people used fertiliser in their gardens, and the relatively weak support for reducing fertiliser use suggests that instead of seeking to achieve this, a more effective approach may be to seek to reduce the use of fertiliser at times where there is a high risk of fertiliser being washed into storm drains: immediately before or during rain events. A large proportion of gardeners, particularly those who prioritised conserving water, applied fertiliser before anticipated rain rather than during dry periods when it would need to be watered in. There is potential to nudge behaviour so that fertiliser is not applied when larger/heavier rain is expected. This would not require substantial change in behaviour, but could reduce flushes of nutrients entering the stormwater system.

There is less scope to achieve change through increasing use of rainwater tanks, due to the high level of existing uptake, and the fact that key barriers to doing this are cost and lack of space. Similarly, achieving better garden landscaping requires greater intervention in the form of providing advice or subsidising costs. Rain gardens are a popular but relatively unknown concept for many residents, and as such would a comprehensive campaign to both raise awareness and build knowledge and competence in establishing them would be needed to achieve any substantial uptake.

Six key groups were identified in the report, who may need to be reached in different ways to achieve behaviour change.

Young renters with no interest in water: Typically aged under 30, are studying while working part-time, renting and often living in a group house, this group spends little time around waterways, and rarely access water-related information. This group was more likely to report managing their garden in ways that contribute to poor water quality, and were less aware of water quality problems than others. This group has a significant impact on water quality via their actions, with 30% of all occupied private dwellings in the ACT being rented in 2011, including 20.6% of detached houses. Reaching this group with community education campaigns is challenging given their low awareness of water quality issues, low level of interest in engaging with these issues, and the higher number of barriers they report to changing their behaviour compared to other groups. To be effective, campaigns would need to be entertaining and connect to non-water related aspects of the lives of this group. Traditional sources of water information are unlikely to be effective, and use of social media more likely to reach this group.

Young and middle aged people who are physically active around water: This group are typically aged in their 30s, 40s or early 50s, live in a wide range of residences, often have a mortgage and children, and are working full-time or part-time. They typically have less free time than other groups. They do have a strong interest in water related issues due to spending time being physically active around water, particularly through cycling, walking, jogging, swimming or in some cases boating and fishing. This group has a strong interest in water and environmental issues, but many lack awareness of some of the causes of poor water quality. Raising awareness of specific issues such as impacts of organic matter entering drains is likely to result in some behaviour change; however, this is a group already often engaging in actions that are protective of water quality, limiting the total size of changes able to be achieved. Nevertheless, the low cost of engaging with this group, and their regular use of water-related information from multiple sources and of waterways, makes them one of the most effective to focus on.

Young and middle aged people who are not physically active around water: While this group often spend time at playgrounds, and picnic/barbeque near water, they less commonly take part in physically active recreational pursuits around water than the group above, and has less interest in, and awareness of, water quality issues compared to their more physically active counterparts. They do, however, often participate in gardening, and have higher interest in and awareness of water and environmental issues than the 'young renters' group. They are also much more likely than the 'young renters' group to be living in a house or townhouse with a garden, and hence to have potential to reduce the volume of leaf litter/ clippings entering the stormwater system through changing their actions. This group is somewhat less likely to access water-related information compared to those who are more physically active around water. However, they do access information from government agencies such as TAMS, water providers, and are likely to see information provided as locations near water such as playgrounds and picnic areas.

Older residents who own their home: This group are older residents, retired or self-employed, typically living in a house with a partner and no children, and often in areas of the ACT with larger garden sizes. This group often spend time gardening, and have a strong interest in water and environment related issues. Those in good health spend time walking, birdwatching and recreating around water. This group is likely to change their behaviour in response to community education campaigns, with the exception of those who are in poor health and with lower household income, who find it more difficult to implement many of the actions examined in this study. However, the extent of behaviour change that is possible is limited as this group is already relatively well engaged in protecting water quality.

Rural residential property owners: People living on smaller rural residential properties are less likely than those on larger and agricultural properties to have undertaken actions such as fencing and revegetating riparian areas, and those with stock are less likely than their agricultural/larger property counterparts to manage grazing using methods that promote retention of groundcover. This group are highly interested in water and environmental issues, and often obtain information from NRM organisations, suggesting high potential to achieve increased investment by this group in some of these actions.

Younger rural property owners –those aged under 50 – were less likely than older rural property owners to have invested in activities such as fencing riparian areas and erosion gullies, and more likely to report experiencing barriers to doing so. Providing additional support to these younger rural property owners may help achieve improved water quality.

Conclusions

The results of this study suggest that well targeted and conceived community education campaigns have good potential to contribute to improving water quality in the study region, particularly through seeking to reduce the volume of leaf litter and garden clippings entering stormwater drains in urban areas, and through helping those rural property owners who are less likely to be taking some actions that protect water quality to implement them on their properties. To a somewhat lesser extent, due to their smaller overall impact on water quality in the region, campaigns seeking to reduce soil and fertiliser entering drains have potential to achieve change.

Any community education campaign will need to trade off investing in (i) achieving change from those groups with low interest and awareness – particularly younger people and renters, and those who spend less time around water – versus (ii) achieving change by those residents who already have high interest and awareness, but who also are more likely to be already engaging in some behaviours protective of water quality. The first option is more difficult, as achieving behaviour change from groups with low interest and awareness requires significantly more effort compared to achieving change amongst people who already have a reasonably high level of awareness and interest. The second option may be more successful as many of those with high awareness and interest still have potential to substantially reduce the extent to which they contribute to organic material and fertilisers entering the stormwater system.