

Introductory section common to all papers

The National Carp Control Plan (NCCP) is being developed to examine and make recommendations about the feasibility of using a virus to assist in controlling common carp in Australia. The plan is to be developed by December 2019. Although focussed primarily on viral biocontrol, the NCCP will also make recommendations about the investigation and potential future use of other carp control methods.

This issues paper is one of seven prepared to summarise topics central to the NCCP's development, provide updates on emerging research results, and, where relevant, situate NCCP research within the broader context of scientific literature. Some papers within the series are intended primarily to provide background information or updates, whereas others seek stakeholder input to help shape development of the National Carp Control Plan document. An NCCP engagement report will be completed and published summarising stakeholder input.

The papers draw on results from the NCCP research program, the broader scientific literature, and stakeholder knowledge. Paper topics are:

- i. Why and how did the National Carp Control Plan originate?
- ii. What is science telling us about the potential use of the carp virus as a biological control agent for carp?
- iii. Non-target species susceptibility testing and host-switching risk in carp biocontrol
- iv. Water quality and carp biocontrol using Cyprinid herpesvirus 3 (CyHV-3)
- v. Managing water quality impacts by carcass management/clean up.
- vi. Understanding potential social and economic impacts of carp control
- vii. Genetic biocontrol and common carp (provided as final report)

Each of the papers can be read in sequence or singly. Many of the important questions and challenges associated with carp control are multidisciplinary and multifaceted, so cross-referencing between papers is used to direct readers towards more detailed discussions of a particular topic, or to Frequently Asked Questions (FAQs) on the NCCP website (<http://www.carp.gov.au/FAQ>), when necessary.

Common or European carp (*Cyprinus carpio*, referred to simply as 'carp' in these papers) are an introduced pest fish common throughout a large area of Australia. When carp are abundant, they can damage aquatic ecosystems in several ways, generating environmental, economic and social costs. Carp control initiatives in Australia are therefore based on the general premise that reducing carp numbers below the densities at which they cause environmental damage could result in improved environmental, social, and economic outcomes. While there is evidence for environmental improvements following carp control, these may not eventuate in all ecosystems, follow uniform transition pathways from the 'pre-control' to 'carp controlled' states, or be achieved without activities to address other, non-carp impacts.

Issues Paper 6. Draft 1. Understanding potential social and economic impacts of carp control

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1.0. About this paper

This paper examines the potential social and economic impacts of controlling carp in Australia. As the National Carp Control Plan (NCCP) focuses on assessing the feasibility of releasing the carp virus, this paper also focuses on the potential impacts of virus release and whether and how these impacts could be mitigated. Other carp control methods are referred to in the paper where they are relevant to understanding how impacts may differ depending on how carp control is implemented. The paper examines:

- (i) What social and economic impacts are and how they are typically assessed at different stages of project development
- (ii) The type of social and economic impact assessment (SEIA) focused on in this report: we focus on identifying how the recommendations of the NCCP could be designed to minimise negative and maximise positive impacts
- (iii) The potential social and economic impacts (positive and negative) that could result from virus release, the circumstances in which they would be likely to occur, and recommendations for actions to reduce/prevent negative impacts and increase potential for positive impacts.

The extent and nature of potential social and economic impacts of releasing the carp virus depends in large part on whether, to what extent and over what timeframe the release of the virus would result in (i) amenity impacts (e.g. fish kills, water quality) (ii) reduced water quality, biodiversity or broader environmental health, and (iii) longer term improvement in environmental health. A key focus of much of the NCCP is on assessing the extent to which these outcomes could occur and identifying whether the virus release would be feasible based on findings. As biophysical research is required to answer these questions, the socio-economic impact assessment we undertook in parallel with that research focused on identifying how rapidly and to what extent socio-economic impacts would occur if the virus had either negative impacts post-release, and positive impacts over the longer term.

If the broader investigations of the NCCP identify that virus release could be managed to prevent any significant impacts on amenity and water quality, this would reduce (and in some cases remove) potential for many of the potential social and economic impacts identified in this paper. In this paper,

the conditions under which impacts would occur are documented where possible to ensure these findings can then be combined with outcomes of assessment of the broader feasibility of virus release to more specifically identify which social and economic impacts have a higher or lower likelihood of occurring.

2.0 What is social and economic impact assessment (SEIA)?

Assessing the potential social and economic impacts of a proposed future action is challenging. This is because the type and extent of impacts experienced will depend on how well the action is designed and implemented, particularly whether specifically designed strategies are put in place to reduce risk of negative social and economic impacts. Impacts will also depend on the extent to which those experiencing impacts have the capacity to cope with and adapt to the changes it causes.

Social and economic impact assessment (SEIA) emerged in the 1960s as part of the field of environmental impact assessment, as it became apparent that many projects had social and economic as well as environmental impacts. At first, SEIA was only conducted after a decision had been made to implement a project and involved identifying who would be impacted in different ways by actions that had already been decided on. However, conducting impact assessment only after decisions were made, and without also examining existing social and economic conditions, meant that there was little scope to use this knowledge to change how the project was implemented in order to minimise negative and maximise positive social and economic impacts. In many cases, it would have been possible to reduce negative impacts had the potential for them to occur been recognised *before* decisions were made about how to implement the project. It was also common for projects to have low social acceptability when they were not designed with consideration of their potential social and economic impacts (Esteves et al. 2012, Schirmer 2018). As the field evolved, practices changed, due also to recognition that:

- **Social and economic impacts of a project begin during its development.** The period in which a project is being developed but is not yet implemented is often associated with high uncertainty about how the eventual project will impact a person or community's future. This is often associated with 'anticipatory' social and economic impacts as people, businesses and communities delay decisions about their future due to uncertainty about the nature of the proposed project, and experience psychological impacts associated with this uncertainty (Loxton et al. 2013a,b, Vanclay 2012, Walker et al. 2000). Concerns about the potential risks and impacts of a proposed action are often highest during this anticipatory period, as people identify a wide range of possible outcomes that could occur depending on whether and how the project is implemented (Loxton et al. 2013a, Schirmer 2018).
- **The processes used to develop and implement a project also have social and economic impacts.** For example, if a group is excluded from consultation processes during development of a project, they are likely to experience negative psychological impacts resulting from the exclusion, will be less likely to support the ultimate decisions made due to the lack of procedural justice they have experienced, and the ultimate design of the project is less likely to address potential for impacts on that group (Gross 2008, 2011).
- **The broader social and economic conditions households and communities are experiencing influence the social and economic impacts of a project,** and people's perceptions of those impacts (Williams and Schirmer 2012). This is typically referred to as the challenge of 'cumulative effects', in which the action being planned may interact with other events occurring at the same time (Franks et al. 2010a,b; Loxton et al. 2013b, Schirmer 2018). For

example, a business already experiencing stress will be less able to cope with a temporary shut-down of work due to effects of a project compared to one that is operating profitably.

- **Socio-economic change is not the same as socio-economic impact.** The socio-economic changes caused by a project will impact different people in differing ways, depending on their individual circumstances. Socio-economic impacts are defined as the experience of change, including how socio-economic change affects a person or community's way of life, culture, economy, business and job opportunities, community cohesion and character, health and wellbeing, personal rights, property rights, safety and security of their future, amongst others (Vanclay 2002).

This more complex understanding of social and economic impact processes has led to substantial changes in how best-practice SEIA is implemented. International guidance on best-practice SEIA recommends that SEIA begin during the process of researching and designing a potential project, and then continue through implementation of the project and monitoring of its outcomes. The goal of SEIA has also changed: instead of focusing principally on mitigating harm, SEIA focuses on proactively informing the design of programs and projects to ensure their social and economic benefits are increased as well as to minimise their negative impacts. This is more likely to result in a project that is considered socially acceptable and given a 'social licence to operate' (Vanclay et al. 2015).

SEIA is thus now viewed as an ongoing process, which should inform all stages of project development. During development of a project, SEIA focuses on identifying how to best design a project to maximise positive and minimise negative impact, rather than quantifying specific impacts; once the project is designed quantification of impacts can occur, and impacts are then monitored during implementation of the project, with this knowledge used to modify the project or implement mitigation actions as the project progresses.

3.0 SEIA methods used

The NCCP is assessing feasibility of the carp virus and making recommendations on whether and how virus release could be used as part of future carp control action. These recommendations will be drawn on to inform subsequent decisions about future investments in on-ground action to reduce carp numbers. This is a 'research and development' phase, and as such the SEIA conducted during assessment of virus feasibility focused on identifying:

- *Potential* socio-economic impacts that could occur, for whom, and under what circumstances, and
- What actions could be implemented to reduce the risk of *negative impacts* and increase potential for *positive impacts*.

Specific quantification of impacts was not undertaken, for two reasons. Firstly, at the time of this initial assessment biophysical research was continuing into the extent to which there are risks of significant loss of amenity, reduced water quality or other negative impacts in the period after virus release, and the potential for long-term positive impacts on environmental health post-virus release. Secondly, decisions about the ways carp control would occur in future had not yet been made. Quantification of social and economic impact is not possible without knowing the specific actions to be implemented, and being able to draw on available evidence regarding likely impacts on biophysical characteristics such as water quality that are likely to drive social and economic impacts.

What was possible was identification of (i) the types of groups and activities that could potentially be impacted, (ii) the scale and extent of the existing activities/groups that have potential to be

impacted, and (iii) the factors that most strongly influence the extent and nature of potential impacts. This knowledge was then drawn on to identify key recommendations for designing future carp control action to minimise negative impacts and increase positive social and economic outcomes.

First, potentially impacted groups and communities were identified, based on interviews and surveys that also examined overall public perceptions of carp control and the carp virus. Overall levels of community support for implementing carp control action were examined to understand the extent to which investment in carp control generally, and virus release specifically, is likely to be considered acceptable and supported by the broader community (Section 4.0). These initial stages identified key potential areas of socio-economic impact to be examined in more depth: potential for impacts on several specific groups was then examined in more detail (Section 5.0). Recommendations for future assessment of impacts and monitoring of impacts were then identified (Section 6). Finally, key recommendations emerging from the assessment were identified (Section 7.0).

The people and communities with potential to be impacted by carp control involving a release of the carp virus were identified using three methods.

- A review of the human activities occurring on, in and linked to waterways and waterbodies in which carp invasion has occurred, to identify the range of groups and communities potentially affected by actions to control carp.
- Review of public discussion about the proposal to release the virus, principally using searches of traditional media, social media and online discussions. This helped identify other groups with potential to be impacted by virus release or with a strong interest in carp control, even if they were not directly linked to areas experiencing carp invasion.
- Surveys of the general public identified views about both carp control and virus release (Section 4.0) and were also used to identify if any specific groups indicated high concern about potential impacts, indicating a need for further in-depth investigation.

The key groups and types of communities identified using these methods as having potential to be impacted by carp control are summarised in the list below. While not an exhaustive list, these represent the specific groups with the greatest potential to experience impacts (negative and positive):

- Traditional Owners
- Commercial carp fishers and businesses involved in processing carp
- Other commercial fishers operating in inland fisheries, or in fisheries in which carp fishers also hold licences
- Native fish aquaculture industry operating in areas experiencing carp invasion
- Tourism businesses operating in areas experiencing carp invasion
- Koi hobbyists, breeders and businesses supplying the koi sector
- Irrigators in areas experiencing carp invasion
- Other farmers and other rural residents living adjacent to areas affected by carp invasion
- Recreational fishers in areas experiencing carp invasion (including those who target carp)
- Other recreational users of areas experiencing carp invasion (ranging from those who actively use water areas such as swimmers and kayakers, to those who use park and picnic areas adjacent to water bodies invaded by carp)
- Domestic water consumers who rely on water from areas experiencing carp invasion, and
- More broadly, communities located in areas experiencing carp invasion.

After identifying these groups, two to three representatives of each group were interviewed, to further identify potential for impacts. Based on these interviews and the earlier assessment of potential for impact, six groups were identified with the highest potential to experience direct *negative* impacts immediately after a virus release (inland tourism industry, commercial fishers, native fish aquaculture breeders and growers, Traditional Owners, koi hobbyists and associated businesses, and recreational fishers). Some of these groups also have potential to experience longer-term positive impacts if carp control results in improved environmental health.

These six groups were examined in more depth. Between 15 and 20 representatives of each group were interviewed for all groups except Traditional Owners. A specific NCCP project was established to consult with Traditional Owners (still ongoing at the time of preparation of this report). Workshops were also held to discuss potential impacts, three with specific groups (commercial carp fishers, native fish aquaculture businesses, and koi sector representatives), and one with a diverse range of stakeholders (a multi-stakeholder workshop was held in June 2019).

In total, across the project, approximately 125 stakeholders were either interviewed or participated in a workshop, with some doing both, and a total of just over 24,000 individuals participated in surveys in which they provided their views about carp control and the carp virus (in total around 29,000 survey responses were achieved, however approximately 3,000 people participated in two or three of the surveys between 2016 and 2019 rather than only one).

4.0 Community views about carp control

Community views about carp control in general, and specifically about releasing the carp virus, were assessed through four surveys, summarised in the Table 1. All surveys collected stratified samples, meaning some groups or regions were deliberately oversampled to ensure results could be reported for that group or region. When identifying overall views of the whole population, data were weighted so findings were representative of the adult population.

Table 1 Surveys used to assess community perceptions about carp control

Timing	How were participants recruited?	Sample size	Stratification of sample
Oct-Nov 2016	A small number of questions about carp were included in the larger 2016 Regional Wellbeing Survey. This reduced risk of bias to those with an interest in carp, as questions about carp were a very small part of a much larger general survey about community and household wellbeing and liveability. Participants could complete the survey online or on a paper form.	12,081	Deliberately oversampled: <ul style="list-style-type: none"> - Rural and regional areas - Farmers - Murray-Darling Basin
Oct-Nov 2017	A panel of questions was included in the 2017 Regional Wellbeing Survey, which around	5,137	Deliberately oversampled: <ul style="list-style-type: none"> - Rural and regional areas

Timing	How were participants recruited?	Sample size	Stratification of sample
	2/5 of participants were asked to complete. Participants could complete the survey online or on a paper form.		<ul style="list-style-type: none"> - Farmers - Areas experiencing carp invasion
Dec 2017	A stand-alone survey was conducted that asked the same questions asked in the 2017 Regional Wellbeing Survey. Participants were recruited via an online panel survey provider; all completed the survey online.	1,184	Deliberately oversampled: <ul style="list-style-type: none"> - Aboriginal and Torres Strait Islander peoples - People with cultural and linguistic diversity, with a focus on those with Asian cultural background - Residents of large urban not highly sampled in Regional Wellbeing Survey
Nov-Dec 2018	Two tracking items were asked of a panel of participants in the 2018 Regional Wellbeing Survey. Participants could complete the survey online or on a paper form.	6,093	Deliberately oversampled: <ul style="list-style-type: none"> - Rural and regional areas - Farmers - Areas experiencing carp invasion
April 2019	A stand-alone survey was conducted that both tracked perceptions and identified perceptions of impact, replicating and extending 2017 survey questions. Participants were recruited via an online panel survey provider; all completed the survey online.	4,697	Used an Australia-wide random sample stratified by state and territory, and by whether person lived in capital city or other parts of state/territory.

All the surveys repeated one item with consistent wording: participants were asked to rate how acceptable they would find 'Reducing numbers of carp (a pest fish) by releasing the carp herpes virus', on a scale from 1 = very unacceptable to 7 = very acceptable with a 'don't know' option also provided. This question was asked before any information was given about carp or the carp virus, meaning responses reflect whatever level of knowledge the person had before completing the survey, and hence reflected current knowledge and perceptions without having influenced them apart from explaining that carp are a pest fish species.

Figure 1 shows responses to the 'acceptability' question, grouped based on whether the sample was focused on rural and regional areas (defined as those outside Australia's six most populated cities), or included a larger sample of people living in the 'big six' cities. It shows that there was high consistency over time: between 50% and 54% of rural and regional residents supported release of the carp virus, as did 44% to 46% of the broader population including those living in large cities. Between 16% and 17% of rural/regional residents found virus

release unacceptable, and 19% of the broader population. Around one-third of people were either unsure or answered ‘neither acceptable or unacceptable’, with these responses slightly more common amongst residents of large cities.

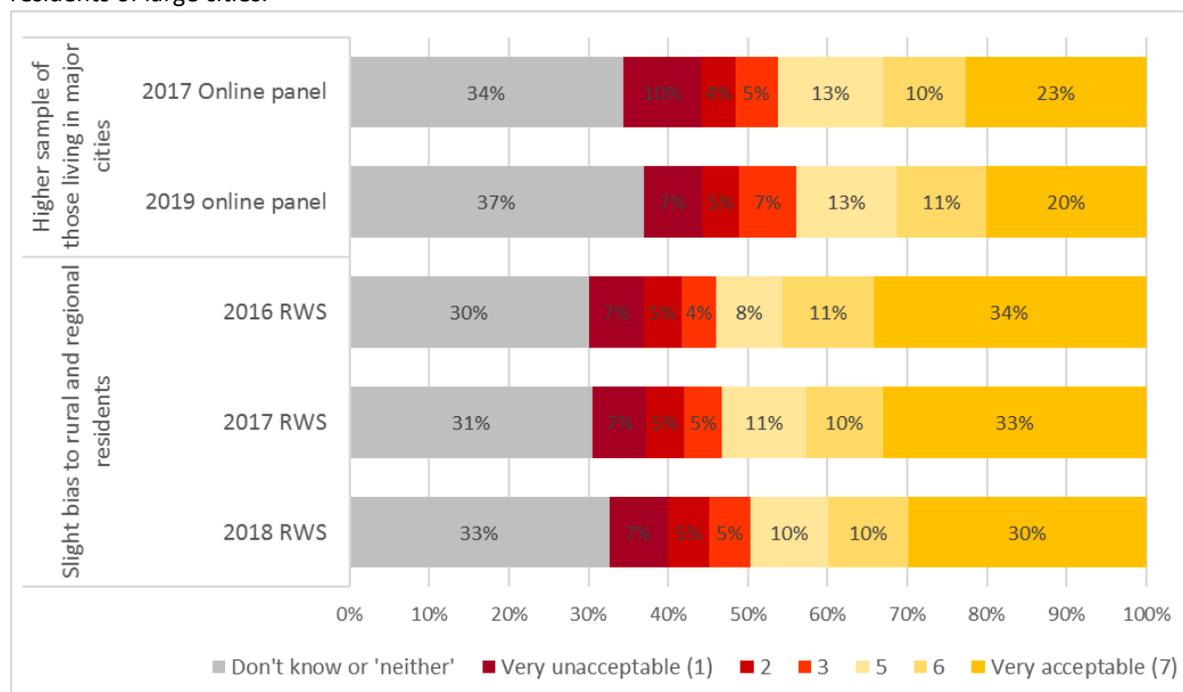


Figure 1 ‘How acceptable would you find reducing numbers of carp (a pest fish) by releasing the carp herpes virus’

These findings suggest initial positive response to the proposal to release the virus: prior to knowing the specific actions to be proposed, people were 2.5 times more likely to find virus release acceptable as unacceptable. Views around acceptability did not change significantly between 2016 and 2019. This is not unexpected, given that no major announcements about potential future actions were made beyond the initial announcement of the NCCP.

The findings also suggest high potential for attitudes around acceptability of virus release to change rapidly. People are more likely to change their views rapidly in response to new information if, prior to receiving that information, they are uncertain (don't know), ambivalent (neither acceptable or unacceptable) or have extreme views (very high acceptability or unacceptability). A large proportion of respondents were uncertain or ambivalent, and hence their views subject to change. Of those who supported use of the virus, the majority indicate the highest level of acceptability, despite having limited information about the proposed actions. This indicate low-complexity of understanding about carp and the specific details of carp control, with high strength of attitude often associated with lower complexity of understanding of that issue in multiple studies (Mylek and Schirmer 2019). Low ‘integrative complexity’ about an issue is associated with less stable attitudes and a higher likelihood of rapid attitudes shifts in response to new information or campaigns about an issue (Mylek and Schirmer 2019). This means that the survey findings suggest an overall positive disposition towards the concept of the carp virus, with high uncertainty and high potential for change in attitudes depending on the nature of carp control actions ultimately implemented.

Many factors influence levels of acceptability or ‘social licence’ for an activity. One widely acknowledged factor influencing views about acceptability of an activity is perception of the impacts of that activity; other factors are also important but for this paper perceptions of impacts are of most relevance. To examine this, two surveys (one in 2017, the second in 2019) asked about perceptions of impacts of release of the carp virus. This helped identify the impacts of highest concern, which were (from the 2019 survey):

- 63% of respondents were concerned ‘large amounts of dead carp in the water could cause water quality problems’
- 59% were concerned ‘it may not be possible to effectively clean up the dead fish’

- 59% were concerned ‘the virus may have unintended effects not predicted by scientists’
- 57% were concerned ‘the virus could be transmissible to fish or animals other than carp, despite research finding it is not’
- 49% were concerned ‘the virus could be transmissible to humans, despite research finding it is not’

Forty one percent felt short-term problems caused by virus release lasting 2-3 months were worth it if there was longer-term environmental benefit, while 24% disagreed and 35% were unsure. These findings highlight the importance of the research conducted by the NCCP, which is investigating the extent to which there are risks of impacts such as water quality problems, feasibility of clean up, and examining current knowledge about transmissibility of the virus.

In addition to overall perceptions about carp control and the carp virus, the final survey conducted in 2019 specifically assessed potential consumer responses to virus release, through asking questions designed to identify likely changes in current behaviour in relation to:

- visiting regions perceived to be affected by poor water quality or presence of a disease under circumstances where regulatory authorities had advised visiting was safe
- consuming fish caught in areas perceived to be affected by poor water quality or presence of a disease even with advice from regulatory authorities that the fish were safe to eat, and
- using other products such as pet food or fertiliser made from products harvested in these areas.

Responses to these questions supported assessment of the likely impacts of virus release on consumer perceptions and behaviour, and through this contributed to assessment of potential impacts of virus release on the tourism, recreational fishing, and inland aquaculture and commercial fishing sectors.

Survey respondents were asked how likely they would be to visit an area and undertake different activities or consume different products under three scenarios: (i) current conditions, in which the inland area often has reasonably good water quality but experiences some fish kills and poor water quality events reasonably regularly over time, (ii) an area where fish kills have occurred 50km away and which authorities say it is safe to swim and fish, and (iii) an area which had good current water quality but a 10% chance of a fish death event occurring at the time the person planned to visit (Table 2).

Table 2 Preferences for visiting inland areas and activities and consumption, under three scenarios

% of 2019 survey participants who agreed that...	Scenario 1: ‘Business as usual’ – you plan to visit an area with good current water quality, but risk of outbreak of blue-green algae or poor water quality every 3-4 years lasting 2-4 weeks causing water closure, fish deaths and smell	Scenario 2: Recent poor water quality or fish kills have occurred 50km from place you plan to visit, authorities say it is safe to fish and swim in the area you will visit	Scenario 3: You plan to visit an area with good current water quality, but a disease affecting fish in nearby areas that could cause fish deaths in the area you will be visiting, with around a 10% risk of this and no ability to predict if it will occur during your visit
I would be likely to visit an area like this during summer	45%	29%	27%
When planning to visit an area like this, I would typically book well ahead (at least a month or two ahead if not more)	46%	37%	36%
I wouldn’t risk visiting a place like this in case there was poor water quality	46%	59%	57%
I would feel safe eating fish caught from the local rivers and lakes	34%	22%	21%
I would use fertiliser products made from pest fish (e.g. carp) caught in this area	41%	35%	31%

% of 2019 survey participants who agreed that...	Scenario 1: 'Business as usual' – you plan to visit an area with good current water quality, but risk of outbreak of blue-green algae or poor water quality every 3-4 years lasting 2-4 weeks causing water closure, fish deaths and smell	Scenario 2: Recent poor water quality or fish kills have occurred 50km from place you plan to visit, authorities say it is safe to fish and swim in the area you will visit	Scenario 3: You plan to visit an area with good current water quality, but a disease affecting fish in nearby areas that could cause fish deaths in the area you will be visiting, with around a 10% risk of this and no ability to predict if it will occur during your visit
I would consider pet food safe if it was made from pest fish (e.g. carp) caught in this area	34%	27%	25%
I would feel safe swimming in this area if the local authorities say it is safe	53%	32%	31%
I would feel safe fishing in this area if local authorities say it is safe	52%	33%	29%

The findings show that many people are currently unlikely to visit inland areas and consume products from them, with only 45% likely to visit areas described as experiencing typical conditions for inland rivers in areas invaded by carp currently, 34% feeling safe consuming fish caught from these areas and 52% feeling safe fishing. Under the second and third scenarios, there was around a one-third reduction in most of the activities asked about compared to the first, with people less likely to visit, to eat fish, swim or engage in recreational fishing. There was a smaller reduction in the proportion willing to use fertiliser from these areas.

Data on hypothetical future scenarios are not accurate predictors of actual behaviour but do often indicate the direction and nature of likely change. In particular, in many cases there is an 'intention-behaviour gap' with fewer people actually behaving in ways they indicate they intend to. The findings suggest a likely initial reduction in visitation and fishing due to negative perceptions of the impacts of virus release even in areas declared to be currently safe, likely to be no greater than a decline of one-third, and likely a smaller decline than this. Although not explored in this survey, it is reasonable to assume visitation will rebound to an extent after the initial response as time passes and familiarity increases of the actual impacts of virus release (if, as assumed in this report, virus release principally results in relatively short-term impacts over limited spatial areas). If virus release led to widely publicised large fish kills or poor water quality events this may increase negative perceptions and reduction in visitation. However, if it was accompanied by few negative impacts and proactive, positive communication strategies, visitation and activities may not decline significantly, or would decline only for a short period.

Over the longer term, if reduction of carp and other actions result in improved environmental health, for example reduced water turbidity, increased native fish populations or increases in aquatic vegetation health, there is potential for growth in visitation and participation in activities explored in the survey. This is based on the assumption that some of those who do not currently visit these areas may be more interested in visiting them if environmental amenity improves.

5.0 Potential socio-economic impacts for specific groups

This section identifies potential socio-economic impacts that could occur for different groups. For each of the groups examined, the type and scale of activities that could be impacted is first identified. This is done through identifying the current scope and scale of activities relating to each group or industry and the overall trajectory for each, for example whether different sectors are growing and would be expected to continue growing under current conditions. Current conditions are identified, with a focus on identifying whether recent or current conditions have placed stress on particular groups that may reduce their capacity to implement strategies to cope with any negative impacts of future carp control activities. The potential socio-economic impacts of carp control – with

a specific focus on virus release – are then identified. For each key potential socio-economic impact, the circumstances under which it could occur, the potential scope of impact, and actions that could reduce negative impacts or increase positive impacts, are identified. When doing this, two assumptions were made. The first is that negative impacts of a virus release on amenity and/or water quality would be short-term in nature in any specific location, meaning they would usually last for a small number of weeks, and at most a small number of months (one to three). This assumption was made as it is considered unlikely a decision would be made to release the virus if short-term negative impacts are likely to occur for longer period. The second assumption was that investment in carp control would be done in a way that enabled long-term improvement in environmental health to occur in multiple locations, and that this would in turn improve aspects of amenity such as river bank vegetation, water quality (e.g. reduced turbidity), and/or native fish populations.

It is important to emphasise that these are assumptions only, and that actual social and economic impact may differ if carp control actions (i) had fewer negative impacts on amenity and water quality than assumed, or (ii) did not result in longer-term environmental health improvement.

This section focuses mostly on specific groups with the greatest potential to experience impacts, namely Traditional Owners, commercial fishers, native fish aquaculture businesses, tourism, the koi sector and recreational fishers. Less attention is given to assessing overall impacts on other groups, as it is considered less likely that significant impacts would occur. Finally, the way impacts on specific groups could potentially affect communities is examined, through both examining how (i) the potential for impacts on specific groups or sectors to have impacts at the community scale, and (ii) potential for impacts that affect a wider range of businesses and residents in communities experiencing carp invasion.

Traditional Owners

What was assessed? The summary below reflects only a limited assessment of potential impacts, based on discussions with six representatives of Indigenous Nations whose Country is affected by carp invasion, as well as discussions at a June 2019 workshop attended by two further representatives, and analysis of survey responses from 240 people identifying as Aboriginal and Torres Strait Islander in the different surveys conducted for this project. This section identifies a number of areas of potential impact but is unlikely to be comprehensive as it is based on a limited sample. At the time of preparing this report a specific NCCP project was consulting with Traditional Owners to identify key concerns, needs and opportunities in more detail.

Current conditions and future trajectory. A large number of Aboriginal Nations are affected by carp invasion. Based on data from the 2016 Australian Census of Population and Housing and mapping of carp density, at least 109,500 people who identify as Aboriginal and/or Torres Strait Islander live in areas affected to a moderate to high degree by carp invasion, with just over 50,000 living in local government areas which have high carp density in some waterways (data sources: ABS 2016; Argent 2016).

In addition to those living in carp-affected regions, many Aboriginal people living outside these regions will follow Country that is affected by carp invasion and have cultural responsibilities to care for carp-affected Country despite not currently living on that country (many people who have shifted to live elsewhere for employment regularly visit Country they follow to conduct appropriate cultural activities). Of particular relevance to understanding potential impacts of carp control is:

- **Rights:** In many regions experiencing carp invasion, Traditional Owners are seeking to increase their rights to Country in a range of ways, from Native Title Tribunal cases through to negotiation of access to important sites located on privately owned land. Ensuring respect for and protection of both current and future rights is a very high priority.
- **Cultural activities, caring for Country:** A wide range of cultural activities, including activities involving caring for Country, are undertaken in and near waterways experiencing carp invasion. These activities vary widely across Nations. There has been ongoing work in many areas to increase capacity to undertake activities on Country, and to increase engagement in cultural activities, over recent decades.
- **Culturally important sites:** Interviewees emphasised that large numbers of sites of cultural importance are located on and near waterways affected by carp invasion, many of which are not formally documented in available databases.
- **Economic enterprise:** Growing numbers of Aboriginal owned and operated businesses are operating in regions affected by carp invasion, and include business activities potentially affected by carp invasion and carp control activities, particularly for businesses involving cultural education, tourism, and some producing traditional foods.

When discussing current conditions, discussions often focused on the potential for processes of decision making about carp control to reinforce disenfranchisement of Traditional Owners, through exclusion from processes or lack of recognition of rights, or to contribute to empowerment through meaningful inclusion and recognition. They also focused on the importance of working with Traditional Owners to ensure knowledge of Country was drawn on appropriately, and the potential for future opportunities for business activity and improved health of Country. A key challenge is capacity to engage. Many representatives of different Indigenous Nations have very high demands on their time with regular requests to engage in a wide range of processes, often with little resourcing provided to compensate for time and other costs. This means appropriate resourcing is

essential to enabling effective engagement in both the NCCP and any subsequent processes. It is also critical to ensure sufficient time is provided to enable consultation within different Nations to occur, and for different Nations to come together to form shared views if they identify this as an important step. Similarly, many existing activities conducted to care for Country either receive no or little resourcing: engaging members of Indigenous Nations in monitoring or implementing carp control actions as part of caring for Country requires provision of appropriate resourcing.

Socio-economic impacts – what could happen, under what conditions, and recommended actions

Table 3 summarises potential socio-economic impacts identified, what is known about the conditions under which they would occur, and actions with potential to reduce negative impacts and increase positive impacts.

Table 3 Potential socio-economic impacts, conditions and actions – Traditional Owners

Socio-economic impact	Under what conditions would this occur?	Actions recommended to reduce negative & enable positive impact
Disempowerment through lack of involvement (negative) or empowerment through active, meaningful, appropriately resourced involvement (positive)	Negative: When Traditional Owners do not have a role in identifying terms of reference for NCCP, or are not engaged during development of recommendations Positive: When Traditional Owners have meaningful and formalised roles in making decisions and, where appropriate, implementing carp control actions, that enable fulfilment of obligations to protect and care for Country, and protection of rights	Ensure meaningful engagement can and does occur, including through providing sufficient resourcing and time for this; ensure views of Traditional Owners inform recommendations made by NCCP
Impacts on health of Country (potential for both negative and positive impacts)	Changes to the health of Country impact the wellbeing of Aboriginal people who follow that Country. Any environmental impacts of carp control activities on health of Country (positive or negative) will directly impact the wellbeing of Traditional Owners who care for that Country.	Appropriate, resourced engagement with Traditional Owners to identify how best to support health of Country when designing and implementing carp control actions. Resource Traditional Owners to enable appropriate on-Country activities to support health of country potentially affected by carp control actions.
Impact on cultural activities and culturally important sites (potential for both negative and positive impacts) (potential for both negative and positive impacts)	Negative: Important sites could be damaged when accessing waterbodies for either virus release or clean-up Negative: Cultural practices and activities disrupted due to fish kills or water quality problems Positive: Improved aquatic health enables cultural practice, activities to be maintained or increased, and enables fulfilment of some aspects of caring for Country (longer term outcome reliant on improvement in ecological health resulting from carp control)	Establish transparent and appropriate processes for identifying cultural sites and activities requiring protection. These processes should be developed with Traditional Owners and approved by them, and will include identifying resources needed to ensure sites are identified and protected when carp control occurs.
Loss of or growth in employment and income (potential for both negative	Negative: Fish kills, or water quality impacts disrupt activities of Aboriginal-owned businesses e.g. tourism or other commercial ventures	Identify Aboriginal businesses that currently depend on areas affected by carp invasion. Identify strategies for reducing potential impact on these businesses in

Socio-economic impact	Under what conditions would this occur?	Actions recommended to reduce negative & enable positive impact
and positive impacts)	<p>Negative: Aboriginal-owned businesses not able to access economic opportunities e.g. in clean-up, monitoring of waterway health, ecological restoration investment post-virus release</p> <p>Positive: Aboriginal-owned businesses able to participate in economic opportunities emerging from carp control investment. Positive: Longer-term growth in opportunities for tourism and commercial ventures, if carp control leads to improved environmental health</p>	<p>consultation with them. Ensure employment and income-earning opportunities associated with investment in carp control are available to Aboriginal businesses; provide support to enable investment in skills building or capital equipment.</p>

Commercial fishers (carp fishers, inland/estuary licence holders)

What was assessed? A total of 18 commercial carp fishers were interviewed or participated in workshops. In addition, a further three representatives of commercial fishers and three fisheries managers were either interviewed or attended a workshop. The focus of the assessment was on commercial carp fishers, however potential impacts on other commercial fishers with potential to be affected was also identified through identifying potential displacement effects if commercial carp fishers shift their fishing effort to other fisheries, and identifying potential impacts of changes in water quality or changing consumer preferences on other commercial fishers.

Current conditions and future trajectory. There are around 44 commercial carp fishers in Australia who have active permits to fish for carp (this was current as of 2018 and will fluctuate over time). Many of these also have other commercial fishing licences or permits, or engage in commercial aquaculture. Dependence on income earned from carp fishing varies, with most commercial carp fishers having a relatively small proportion of household income derived from carp fishing. A core group of fishers (7-10) have businesses and household incomes with significant reliance in income from carp harvest. Many of this group report strong market interest in expanding harvest of carp for a range of products, particularly from export markets. A further 10-15 licence holders rarely actively use their carp harvesting permit/licence either currently or historically, while the remainder do actively utilise their carp harvest licence/permit, but income from carp harvest constitutes a relatively small proportion of total household income.

Current commercial use of carp in Australia ranges from sale of carp products for human consumption, to production of pet food, and production of products such as fertiliser and leather. Internationally a wide range of products are made from carp, including salted roe, gefilte fish, a range of processed fish food products for humans and animals (including fishmeal for use in aquaculture), and fertiliser (liquid and pellet).

Commercial carp fishers have been limited in their ability to expand carp harvesting in Australia due to a range of factors, including regulatory constraints that cause difficulty achieving reliable harvest volumes to supply markets (affecting some but not all fishers), difficulty achieving permission to fish and access sites where carp are aggregating in a timely fashion, and lack of coordinated cross-jurisdictional strategies to support commercial live harvest. Views varied about the potential for expanding markets for products derived from commercial harvest of carp: many felt there was high potential, particularly in international markets, as they had significant demand from prospective customers. Others felt the potential to expand domestic or international markets was limited by the

relatively higher costs of harvesting carp in Australia compared to growing them in aquaculture operations internationally. Several reported a highly constrained operating environment and having experienced multiple past changes to fisheries licences and permits that have created stress and reduced their ability to cope with further change.

Socio-economic impacts – what could happen, under what conditions, and recommended actions

Table 4 summarises potential socio-economic impacts identified, what is known about the conditions under which they would occur, and actions with potential to reduce negative impacts and increase positive impacts.

Table 4 Potential socio-economic impacts, conditions and actions – commercial fishers

Socio-economic impacts	Under what conditions would this occur?	Actions recommended to reduce negative & enable positive impact
Uncertainty about the future resulting in psychological distress, stress, mental health impacts	Already occurring: The announcement of the NCCP and resultant extended period of assessment has created distress and uncertainty for commercial fishers with adverse impacts on mental health, particularly for those living in households with a high proportion of their livelihood dependent on commercial carp harvest. Depending on the timing and nature of future decisions, this may continue.	Provide a clear timeline for decision making to help enable planning for the future. Provide regular communication about progress.
Reduced opportunities	Several commercial fishers felt that the proposal to release the virus was significantly reducing opportunities for their businesses, and to use their knowledge to achieve effective control of carp. In particular, several wanted formal trials of live carp harvest that drew on their knowledge to produce hard data on the effect of well-designed live harvest on carp volumes.	Ensure carp fishers knowledge is acknowledged, respected, and drawn on where possible. Identify potential to co-design research that draws on this knowledge.
Inability to invest in or sell business	Already occurring: Many carp fishers are unable to actively invest in their business due to uncertainty about the future affecting market interest, access to finance and ability to make decisions; while the future of carp fishing is uncertain there is a lack of interested buyers for carp fishing businesses.	As above, and also provide clear advice and communication to markets and financial institutions if requested to do so by fishers.
Difficulty or inability obtaining or servicing finance	Already occurring: See above; some fishers have reported inability to access finance and concern from their financial institutions about their future ability to service existing debt if a virus release affects viability of their business	As above
Loss of market access	Already occurring: Some current customers of carp fishers have withdrawn previously expressed interest in expanding volume purchased. Overall, fishers report lower interest from prospective customers and markets. Depending on the decisions made about virus release, this may continue after carp control actions are initiated. In particular, market access may be reduced through (i) domestic or international consumers being unwilling to consume products they perceive to be affected by a virus (even if it is not), or (ii) domestic or	Provide support to maintain current markets and to build demand in alternative markets, in collaboration with fishers. Develop appropriate campaigns to maintain consumer confidence in consumption of safe carp harvest. Provide clear advice to fishers on potential impacts on market access from regulatory requirements. If regulatory requirements will reduce or close

Socio-economic impacts	Under what conditions would this occur?	Actions recommended to reduce negative & enable positive impact
	export regulatory constraints imposed on transport or sale of harvested carp due to the presence of the carp virus in the waterbodies in which carp were harvested (it is unclear whether this would occur or what form it would take).	some markets, provide support to businesses impacted by this change in circumstances to assist transition.
Increased business costs	Business costs may increase if there is a need for businesses to test for virus presence in harvested carp, implement new practices to reduce risk of virus transmission, or if volume of carp harvested reduces. The latter is not considered a high risk due to the expectation that while the virus would reduce carp numbers to a lower level, fishable aggregations of carp would still occur.	Identify costs of adhering to any regulatory requirements applying due to potential presence of virus. Support cost reduction where appropriate e.g. through investment in developing low-cost methods for detecting virus presence.
Opportunities: - for regulatory change to better support live harvest of carp - to include live fishing as part of carp control	While not a focus of the NCCP, several fishers requested a carp control plan include recommendations to develop and implement a more enabling regulatory environment for live carp harvest, that enables maximum use of this as a method for reducing carp populations. This could provide positive impacts for businesses and may mitigate some negative impacts, depending on how it was designed.	Establish cross-jurisdictional group to identify and implement appropriate regulatory reform to enable fishers to better contribute to reducing carp populations through live fishing. Trial live harvest methods and assess their potential contribution to carp population reduction.
Impact on public reputation (negative or positive)	If a large-scale carp kill results in problems such as loss of amenity (e.g. smell, presence of rotting fish), poor water quality or other negative impacts, commercial fishers are concerned they may be blamed as they are often the public 'face' of carp fishing. This is particularly the case if fishers become involved in clean-up activities.	Ensure clear communication about who is responsible for actions that cause carp kills and how to contact relevant authorities. Have a plan to ensure safety of those involved in clean-up activities.
Impacts of reduction in or loss of business	There is potential for a relatively small number of carp fishers (<10) fishers to lose business viability if the virus is released. This would have significant negative social and economic impacts for these fishing households.	Provide assistance for those fishers whose livelihood is threatened, to support transition to new business activities or employment.

Potential impacts on other commercial fishers. There is potential for some impacts to occur that affect commercial fishers other than carp fishers if the virus is released. This could occur if one or more of the following resulted from virus release:

- Restrictions were placed on sale of goods harvested from waters the virus could be present in. This could affect any commercial fishers operating in waters in which the virus could be present, predominantly those fishing in inland freshwater areas and estuary areas.
- Restrictions were placed on sale of goods harvested using carp bait or other bait that may have been exposed to the virus, due to concerns about potential for presence of virus particles on harvested produce. This could affect rock lobster fishers.
- Consumers reduced demand for produce they perceive to have potential to have come into contact with the virus (irrespective of whether produce is safe)
- Those who fish in fisheries that current commercial carp fishers might increase effort in as a response to reduced carp harvesting activity. This could then increase competition in the commercial fisheries to which effort has shifted, with varying impacts depending on the fishery involved and the type of management mechanisms in place.

If any of these occurred, they would result in similar types of impacts to those listed in the above table being experienced by these broader groups of fishers.

Reducing risk of these impacts can be assisted through:

- Communication campaigns that reduce risk of negative perceptions about consuming produced harvested from areas the virus has been released in. With multiple examples of the large fish harvest (carp and non-carp) from virus-affected areas in other countries, there is a large body of evidence to draw on regarding safety that can be used to support communication strategies.
- Clear advice on any regulatory changes resulting from presence of the virus.
- Monitoring whether fishers are shifting effort into other fisheries, and providing support that does not actively increase activities that might then displace other fishing effort.

Native fish aquaculture businesses

What was assessed? A total of 12 operators of native fish aquaculture businesses were interviewed or participated in workshops. The focus of the assessment was on potential impacts of virus release on those aquaculture businesses operating in freshwater and estuary areas in which carp invasion has occurred, and where virus release could occur. Originally a survey of businesses was planned. However, this was not undertaken on the advice of those currently in the sector, as rapid growth in the sector meant data were likely to be out of date by the time decisions about carp control were made, and therefore unlikely to have high relevance. Instead, investment was directed to assessing likely consumer perceptions of consuming aquaculture products if the carp virus was released in the regions in which they were produced.

Current conditions and future trajectory. Inland native fish aquaculture is a relatively small component of the aquaculture industry in Australia – inland freshwater species account for around 6.4 per cent of Australia's aquaculture by value (ABARES 2017), although onshore aquaculture accounted for around 28% of total aquaculture employment recorded in the 2016 Census (some onshore aquaculture involves saltwater species). However, parts of the native fish aquaculture industry have grown rapidly in recent years. For example, Murray cod aquaculture production in NSW grew by 212 per cent between 2013-14 and 2017-18, from 85.3 tonnes to 265.9 tonnes. The total market value for Murray cod produced in NSW increased over this same period from \$1.44 million to \$4.89 million (represented in nominal terms) (NSW DPI n.d.).

Freshwater native fish aquaculture operators supply fingerlings for restocking of natural waterways and impoundments for both biodiversity restoration and recreational fishing purposes. They also supply fingerlings and fry for growing on in domestic or overseas operations. Some operators also grow stock into table fish size for both domestic and export markets. Fish consumption markets are highly sensitive to any change in product quality: in particular, Australian producers exporting to other countries typically rely for business viability on receiving price premiums based on their 'clean and green' image.

Despite significant growth over the last decade, the sector is also experiencing several constraints to growth, particularly complex regulatory conditions and restocking program requirements and a lack of public investment in research and development (both of these issues are also identified in the National Aquaculture Strategy). This results in challenging conditions under which not all potential markets are profitable: for example, several businesses stopped participating in the NSW restocking program in recent years due to concerns about legal liability and high transaction costs that meant

they could not achieve a positive return; meanwhile the Victorian government restocking program, was described as positive and supportive of industry viability. Limited industry coordination has also been identified as impacting capacity for representation and advocacy, also potentially constraining growth of the industry.

Socio-economic impacts – what could happen, under what conditions, and recommended actions

Many of the potential impacts described for commercial fishers were also reported by the native fish aquaculture sector. However, anticipatory impacts experienced by those involved in native fish aquaculture were typically much less acute than those experienced by commercial carp fishers. Similar to commercial carp fishers, many of the potential impacts related to potential for regulatory constraints or for negative market perceptions. Many in this sector – principally those supplying restocking programs – also saw potential for positive opportunities for this sector from carp control, depending on whether restocking was invested in as part of encouraging improved environmental health after a reduction in carp numbers.

These businesses identified both positive and negative potential future impacts, with potential to increase supplies for restocking but also for reduced market demand, especially for domestic and export table fish markets. For positive impacts to occur forward planning is required, to enable sufficient investment across the industry to meet any increase demand for restocking, as well as for regulatory reform and biosecurity measures to be planned and implemented.

Table 5 summarises potential socio-economic impacts identified, what is known about the conditions under which they would occur, and actions with potential to reduce negative impacts and increase positive impacts.

Table 5 Potential socio-economic impacts, conditions and actions – native fish aquaculture businesses

Socio-economic impacts	Under what conditions would this occur?	Actions recommended to reduce negative & enable positive impact
Uncertainty about future of business (negative)	Already occurring: While many businesses have been unaffected by announcement of the NCCP, most are uncertain about the future – for some this has led to delaying decisions about business investment until there is greater certainty about future carp control action. Others have not changed their investment activity, with expansion in the sector overall during the period of the NCCP.	Provide a clear timeline for decision making to help enable planning for the future. Provide regular communication about progress.
Increased business costs (negative)	Business costs may increase if there is a need for businesses to test for virus presence in fingerlings being transported to other locations (domestic or in other countries), or for businesses to implement specific biosecurity measures to ensure virus free water (for example using specific techniques to ensure no presence of virus in water or on produce).	Identify regulatory implications. Provide clear guidance on required processes for businesses. Assist businesses through actions such as investing in developing low-cost processes for meeting any additional regulatory requirements.
Loss of market access due to either negative perceptions and/ or regulatory barriers (negative)	Market access may be reduced through (i) domestic or international consumers being unwilling to consume product they perceive to be affected by a virus (even if it is not), or (ii) domestic or export regulatory constraints imposed on transport or sale of produce harvested in waters in which the carp virus may be present. This is particularly a concern in	Develop appropriate campaigns to maintain consumer confidence in consumption of produce: this has high potential to offset any decline in consumption related to negative perceptions of produce grown in

Socio-economic impacts	Under what conditions would this occur?	Actions recommended to reduce negative & enable positive impact
	relation to export markets, where some businesses reported a high likelihood of reduced market interest if any factor was perceived to affect the 'clean, green' image of Australian produce. In Australia, research on consumer perceptions identified a likely initial reduction in willingness to consume table fish grown in areas perceived to have potential to be affected by the virus. However, it also identified that overall low awareness of these products meant investment in marketing campaigns would likely result in net growth in demand for produce through increasing overall awareness in products, despite some consumers being unwilling to consume produce from areas perceived as virus-affected.	areas in which the carp virus would be released. Invest in marketing and diplomatic strategies into export markets to reduce risk of impacts. Provide clear advice to fishers on potential impacts on market access from regulatory requirements. If regulatory requirements will reduce or close some markets, provide support to businesses impacted by this change in circumstances.
Opportunity for expanded business opportunities (positive)	Those businesses that supply restocking programs could have expanded demand for their produce, if restocking is increased after carp control actions are implemented. However, for businesses to be able to benefit from this, they need sufficient lead time and clarity about the type of restocking to be done, as there is typically a long lead time to undertake any expansion of business operations or ramp up production of particular species and grow them to a specified size.	Make decisions about restocking early and ensure sufficient lead time to ensure businesses can supply. Use appropriate programs and processes to contract businesses for restocking, ensuring regulatory conditions are clear and businesses are given an appropriate operating environment.
Opportunity to address existing regulatory constraints (positive)	While not an objective of the NCCP or carp control, similar to carp fishers, some involved in the native fish aquaculture sector felt that including work to reduce regulatory complexity in their sector could assist them in engaging in restocking activities, and more broadly could support maintenance and growth of the sector.	Review current regulatory system and key constraint areas; invest in reform to streamline and reduce costs of regulation for businesses.
Impacts of reduction in or loss of business	There is potential for some businesses to experience loss of business viability. This would occur under specific circumstances: if an unpredicted water quality event resulting from virus release caused large loss of stock; if regulatory constraints substantially reduced markets or increased business costs to a point of non-viability; or if there was a large negative impact on consumer perceptions resulting in large loss of markets. The actions listed above are recommended to reduce the risk of substantial loss of business activity.	Provide assistance for those whose business activities are reduced, to support transition to new business activities or employment.

Tourism industry

What was assessed?

A total of 24 people were interviewed, including individual tourism business operators and representatives of state and regional tourism organisations and peak industry groups. The focus of the assessment was on potential impacts of virus release on tourism businesses operating in

freshwater and estuary areas in which carp invasion has occurred. An online survey of 69 tourism businesses in these areas was also conducted, to better identify how businesses had coped with past water-related events such as blue-green algae outbreaks and low-water events, and identify potential impact mitigation strategies.

Current conditions and future trajectory

Many tourism businesses operating in freshwater inland regions, particularly those reliant on close contact with rivers, lakes and wetlands (e.g. houseboat operators, fishing guides, nature-based or adventure tourism, and accommodation with water frontage), need to cope with reductions in tourist visitation resulting from poor water quality and changed water flow events. All business operators who participated in interviews, workshops or the survey had experienced one or more of these events, including many experiencing very low water levels in 2019 due to low water inflows in much of eastern Australia. For some, these past experiences have increased adaptive capacity with the development of regional or local government support in the form of communication materials, business assistance and support to assist the industry to recover. For others, the events have created significant stress that has impacted on capital reserves and financial viability and reduced their capacity to cope with subsequent events. The past experiences of water quality or flow events will have increased the capacity of some businesses to cope with potential impacts of carp control and reduced the capacity of others. They have also resulted in development of processes and materials by the tourism sector that provide important examples to draw on when developing any strategies for supporting tourism businesses as part of the Plan.

Socio-economic impacts – what could happen, under what conditions, and recommended actions

A key issue for the tourism industry is that socio-economic impacts don't result only from *actual* occurrence of issues such as a decline in water quality or fish kills occurring; they also result from consumers believing these are affecting an area (even if they are not), or fearing they might occur in an area and as a result choosing to visit an alternative destination instead. Interviewees described a large gap between consumer perceptions of a water-related event and what is being experienced on the ground. This perception gap can be driven by the way events are represented in the media, with 'worst case' images often feeding negative perceptions and driving downturn in visitation. Most reported that after a significant water event, tourist visitation can take months to years to recover. This has implications for the capacity of a business to cope with subsequent events or down-turns.

Table 6 summarises potential socio-economic impacts identified, what is known about the conditions under which they would occur, and actions with potential to reduce negative impacts and increase positive impacts.

Table 6 Potential socio-economic impacts, conditions and actions – tourism industry

Socio-economic impacts	Under what conditions would this occur?	Actions recommended to reduce negative & enable positive impact
Uncertainty about the future causing frustration and some delay of business investment	This is already occurring across the sector to an extent. Many have reported feeling in 'limbo' in making short to medium term business investment decisions because of the uncertainty about short-to medium terms water quality impacts of virus release and potential for business down-turn. However, few reported significant impacts on investment decisions to date. Most wanted greater certainty about what carp control	Provide a clear timeline for decision making to help enable planning for the future. Provide regular communication about progress.

Socio-economic impacts	Under what conditions would this occur?	Actions recommended to reduce negative & enable positive impact
	would happen in future and when, so they could prepare for any potential impacts.	
Increased tourism business opportunities over the longer term	This is already occurring across the sector. In many cases, tourist operators in freshwater inland areas are closely connected economically, socially and emotionally to the natural environment. The proposal for national coordination of control carp has been experienced positively by many in the sector as they hope carp control will increase tourism opportunities in the long-term through improving water quality and native fish populations.	Coordinate carp control actions with investments in environmental recovery being made by others, and ensure appropriate investment in achieving improved environmental health. Invest in communications to raise public awareness of long-term improvements in environmental health, if they occur, in order to support visitation. Ideally, invest in citizen involvement in actions to improve environmental health after reductions in carp populations, with these programs supporting visitation after virus release when visitation is most likely to decrease.
Impacts of virus release on amenity – actual	Businesses are likely to experience downturn in visitation in areas in which virus release results in a reduction in amenity in the form of fish deaths or poor water quality. Downturn in visitation has been associated with all past negative water quality and fish kill events, and particularly affects businesses dependent directly on water-based activities such as houseboat businesses. Forward bookings often decline when a potential loss of amenity in future has been identified.	Ensure tourism industry are actively involved in each local area in determining priorities for clean-up to reduce potential impacts on tourism businesses. Invest in communication to ensure tourists are aware when an area has recovered after an impact on amenity, and to clearly communicate risk of low amenity for a future booking. Support tourism industry to develop approaches to building confidence in tourism bookings, such as implementing refund schemes if an area is affected by a fish kill when a visitor planned to visit. Ideally, invest in citizen involvement in actions to improve environmental health after virus release, with these programs supporting recovery of visitation after decline related to virus release.
Impacts of virus release on amenity – perceived	Most businesses felt that the greatest impact would result from tourist perceptions of reduced amenity extending beyond actual impact on amenity. In past events, businesses reported that downturn in visitations typically extended into areas unaffected by poor water quality or fish kills, and extended for long periods of time after there was no longer an amenity issue, due to tourists having negative perceptions driven by media coverage that gave the impression of more widespread amenity impacts than were actually occurring. This led to longer-term downturn than would have occurred had tourists had an accurate understanding of amenity impacts.	Ensure carp control investment includes sufficient investment in high-quality, proactive and well-coordinated communication to the public, including to tourists, that actively involves the tourism industry. Ensure communications are clear and do not create negative perceptions that reduce visitation to areas not affected by issues such as fish kills or water quality problems.

Socio-economic impacts	Under what conditions would this occur?	Actions recommended to reduce negative & enable positive impact
Impacts of short-term business downturn	It is likely that short-term reductions in visitation will occur in association with virus release, with survey results presented earlier in this report supporting this. Most businesses can cope with a short reduction in visitation lasting no more than one or two months, however if this is accompanied by other events also causing downturn (e.g. drought or a flood), some businesses will experience significant negative impacts and have to reduce employment and turn to measures such as drawing on financial reserves to cope.	Actively track impacts on tourism visitation and identify areas where short-term impacts from virus release are adding to other existing negative impacts. Consider provision of support in these areas. Ensure clean-up activities source accommodation, food and other resources from local businesses where possible to offset some effects of downturn in visitation.
Impacts of long-term business downturn	If long-term reduction in visitation occurs, many businesses would find it difficult to cope, and reduction in tourism employment and closure of some businesses is likely to result, with flow-on impacts to communities with reliance on tourism employment (see 'overall community impacts' section).	Implements measures listed earlier in this table to reduce risk of long-term downturn in visitation. Monitor length of impacts on visitation. If long-term reduction in visitation occurs, consider providing active support for affected tourism businesses.

Recreational fishers

What was assessed? A total of 27 recreational fishers were interviewed and/or participated in workshops held as part of the project. In addition, surveys examining community attitudes to carp control included large samples of recreational fishers (more than 1,500 recreational fishers participated across the different survey), and specifically identified those that fished in areas more likely to be experiencing carp invasion. This enabled specific examination of views of recreational fishers about the potential impacts of release of the virus, and of carp control more broadly, using survey data.

Current conditions and future trajectory. Freshwater recreational fishing is a key driver of visitation to many inland areas, and estuary fishing is also common. The data on recreational fishing suggest that many who fish in carp-affected areas will also spend time fishing in oceans and other areas where carp invasion is not an issue. Across Australia, as of 2000 there were an estimated 3.36 million Australians aged five or over who went fishing at least once a year. These 3.36 million fishers spend 20.6 million days fishing between May 2000 and April 2001, in 23.2 million separate fishing events. Just under 20% of recreational fishing effort at that time occurred in freshwater dams and rivers across the country, with an estimated 2.7 million fishing events (fishing trips) in freshwater rivers and 1.9 million fishing events in freshwater lakes or dams (Henry and Lyle 2003). These figures will be updated in 2020 with the release of new figures from the 2019-20 National Recreational Fishing Survey; it is expected there has been some decline in recreational fishing participation, but that participation remains in the millions across Australia.

Within the recreational fishing sector, a relatively small number of fishers specifically focus on carp fishing (coarse fishing, defined as fishing involving targeting a fish considered undesirable for consumption or game fishing). Recreational fishing is a significant driver contributing to tourism revenue in inland areas, and changes in fishing conditions are one factor that contributes to changing visitor numbers.

Recreational fishers have been highly engaged in discussions about carp control and in actions to raise awareness of carp invasion, for example through conducting regular ‘carpmuster’ competitions in which fishers seek to catch as many carp as possible from a given area on the competition day, with prizes given for categories such as largest carp caught.

Socio-economic impacts – what could happen, under what conditions, and recommended actions

Recreational fishers were more likely to feel virus release, and carp control more broadly, would have a positive impact on the recreational fishing sector, with fewer identifying potential negative impacts. Their main focus when discussing carp control was on ensuring positive impacts on environmental health from carp control actions, with improvements in recreational fishing considered a beneficial side effect of achieving overall improvement in health of waterways and waterbodies currently affected by carp invasion. The key concerns expressed by recreational fishers typically focused on (i) whether there was sufficient evidence that virus release would be safe for other fish species, both in terms of virus transmission and water quality impacts, (ii) whether carp populations would be reduced long-term or would rebound over time, and (iii) what co-investment was needed in actions other than reducing carp numbers in order to increase likelihood of improvement in environmental health after any reduction in carp populations. Potential impacts on recreational fishers were usually raised as secondary considerations after first examining these issues.

Table 7 summarises potential socio-economic impacts identified, what is known about the conditions under which they would occur, and actions with potential to reduce negative impacts and increase positive impacts.

Table 7 Potential socio-economic impacts, conditions and actions – recreational fishers

Socio-economic impacts	Under what conditions would this occur?	Actions recommended to reduce negative & enable positive impact
Increased fishing success and enjoyment for fishers (positive impacts)	Many recreational fishers supported release of the virus as they felt this could lead to long-term improvement in recreational fishing conditions through improved environmental health, increased native fish stocks, and reduction in unwanted catch of carp. Many felt this would result in increased benefits of recreational fishing in the form of enjoyment and wellbeing.	Coordinate carp control actions with investments in environmental recovery being made by others, and ensure appropriate investment in achieving improved environmental health. Identify opportunities for recreational fisher engagement in programs involving in implementing and monitoring carp control, and programs seeking to improve environmental health. This also has potential to offset negative impacts of any short-term inability to fish in specific areas through encouraging long-term engagement of fishers in a range of activities.
Increased revenue for fishing-related businesses (positive impacts)	Some felt that improved environmental conditions had potential to increase recreational fishing effort (increased numbers of fishing trips to areas previously affected by carp by larger numbers of fishers). If this occurred, it would positively impact on tourism revenue and revenue for recreational fishing businesses. This impact would occur if carp reduction led to improvement in environmental health, and supported growth in numbers of native fish.	
Opportunities for recreational fisher involvement (positive impact)	Many recreational fishers wanted to have opportunities to have a role in carp control, through actions such as assisting with monitoring carp numbers in citizen science projects, assisting with clean-up, and assisting with actions to	

Socio-economic impacts	Under what conditions would this occur?	Actions recommended to reduce negative & enable positive impact
	increase likelihood of environmental recovery. These were considered to	
Reduction in carp numbers for coarse fishers (potentially negative impact)	Some coarse fishers were concerned they might lose access to a species that is relatively easy to target, with carp acting as a good species to catch for people with little experience in fishing, and being specifically targeted in some specialised programs such as programs supporting people with disabilities to fish. Not all felt this was a concern, given there were expected to be carp available after virus release albeit in smaller numbers, and some felt it would be possible to identify other ways to achieve similar outcomes for fishers who needed easily targeted species.	Engage coarse fishers in citizen science projects tracking change in carp population. Invest in identifying alternative fishing opportunities to carp that can be used by groups who currently target carp.
Reduced fishing opportunities and/or fishing activity (negative impact)	This impact would occur if virus release led to water quality problems or other issues that then reduced fishing opportunities for native fish in some areas. This was usually considered likely to be a short-term impact immediately after virus release affected carp in a given area, which most felt would have relatively limited impact on recreational fishers. Some were concerned about potential for longer-term reductions. There is also potential for fishers to reduce fishing activity in areas where the virus has been released due to perceptions that it is unsafe to be in contact with waters or fish in these areas. Survey results presented earlier did suggest a likely initial reduction of up to 1/3 of fishing effort in areas perceived to have reduced amenity or risk of it, with many people choosing to fish elsewhere. This may recover reasonably rapidly unless there are ongoing negative perceptions that extend beyond the period in which there are impacts on fishing opportunities and amenity.	In addition to actions listed above, invest in communication to ensure accurate understanding of safety of fishing, of being in contact with water in areas where virus is released, and of consuming catch.
Significant reduction in business activity for some recreational fishing suppliers or guide businesses (negative impact)	This impact is considered unlikely to occur to an extent where it causes significant harm to businesses. Significant impact on businesses would only occur if virus release led to inability to fish in a relatively large area for a relatively long period of time (several months), longer than the typical impacts of existing events such as blue-green algae outbreaks, which these businesses have already established mechanisms to cope with.	Investing in the actions above is likely to reduce risk of this to a low level.

Koi hobbyists, breeders and supply businesses

What was assessed? A total of 34 people involved in the koi industry, including koi breeders, koi keepers, vets and those involved with koi associations were interviewed or participated in workshops. Two international koi associations were contacted and discussed impacts of virus outbreaks on koi hobbyists in (i) Japan and (ii) Malaysia, to provide an understanding of typical

responses to virus outbreak in those countries. Five people considering starting to keep koi, recruited to participate in the study at the 2019 Sydney koi show, were asked whether and how the potential for future release of the virus would affect their decisions about entering the hobby. A further 154 current koi keepers and 308 people who had in the past kept koi or lived in a household where a person kept koi, were surveyed as part of collecting broader data on community attitudes, enabling an understanding of views of koi hobbyists about carp control and the carp virus. These were identified as part of broader samples of the overall community, and hence many of those who had a knowledge of koi were people who had kept koi in the past and fewer kept them currently.

Current conditions and future trajectory Koi keeping is a relatively small hobby in Australia, with koi able to be kept legally as pets in the states of New South Wales and Western Australia and in the Australian Capital Territory, and not in other parts of Australia. It is difficult to estimate the total size of koi keeping as a hobby in Australia, or its total economic value. In surveys of the general community conducted for this project, around one in one hundred people indicated either currently keeping koi or having done so in the past, with around one in two hundred indicating currently keeping koi in their household. Given that koi keeping often occurs as a household activity, this suggests that somewhere between one in every 300 people and one in every 200 households has a current association with keeping koi: this suggests between 40,000 and 78,000 people across Australia live in households where koi are kept as pets. For most, koi are relatively substitutable for other fish species, but for enthusiastic koi hobbyists this is not the case, with at least 2,000 highly enthusiastic koi hobbyists being members of koi societies in Australia, and the number of 'keen' hobbyists who would find it difficult to switch to keeping other species likely to be substantially higher than these 2,000 members. Based on an estimate of annual spending of \$600 by smaller hobbyists and \$3,000 by enthusiastic hobbyists (many of whom in reality spend significantly more than this on the hobby), the industry conservatively general annual expenditure of \$20 to \$52 million Australia-wide in the form of koi keeping costs (power, fish food, maintenance of water quality etc), purchase of new fish, and spending on equipment such as koi ponds, water pumps etc.

Similar to other countries in which koi are a cultural tradition, many people engaged in koi keeping in Australia spend years and decades breeding specific lines of koi for particular characteristics. With relatively small numbers of koi breeding businesses in Australia, and a ban on importing koi from other countries, the domestic hobby is reliant on Australian breeders. Social interaction is a core part of the culture of koi keeping, with koi enthusiasts often visiting each other's ponds and reporting strong positive social outcomes from the koi hobby resulting from this.

Socio-economic impacts – what could happen, under what conditions, and recommended actions

Many people interviewed from the koi sector preferred to discuss their concerns about the use of the virus more generally, particularly concerns about potential for virus mutation and water quality impacts that would have an impact on a range of species. It was typically only after discussing these concerns that they were willing to talk about potential impacts on koi keeping and associated businesses in Australia. The impacts listed below are specifically related to the impacts of a decision to release the carp virus: other carp control methods were not considered likely to cause any meaningful impact for the koi sector.

Table 8 summarises potential socio-economic impacts identified, what is known about the conditions under which they would occur, and actions with potential to reduce negative impacts and increase positive impacts.

Table 8 Potential socio-economic impacts, conditions and actions – koi hobbyists, breeders and supply businesses

Socio-economic impacts	Under what conditions would this occur?	Actions recommended to reduce negative & enable positive impact
Uncertainty about the future resulting in psychological distress, stress, mental health impacts (negative impact)	Already occurring: This is principally occurring for koi breeding businesses and koi associations, due to uncertainty about ability to continue successful koi breeding and koi shows in future if the virus was released. While koi shows have continued as usual during the anticipatory period, some decline in auction sales of koi was observed after the initial announcement of the NCCP, followed by a rebound, and some breeding businesses reported delaying new investment until the future was more certain. Most breeders did not report a decline in demand, but did have many customers expressing uncertainty about their likelihood of staying in koi keeping if the virus was released. To a lesser extent, this has caused some impacts for koi hobbyists, with some reporting delaying investment in new koi or equipment for koi keeping, and a small number of people interviewed	Provide a clear timeline for decision making to help enable planning for the future. Provide regular communication about progress. Provide clear advice on conditions under which the virus could be transmitted to koi and measures to reduce risk for breeders, sellers and hobbyists.
Higher day-to-day business costs (negative impact)	Introduction of biosecurity measures to reduce spread of the virus amongst koi populations has a high likelihood of increasing costs for koi breeders and sellers. The extent of impact depends on the cost of effective biosecurity measures.	Invest in identification of appropriate biosecurity measures and in reducing costs where feasible for breeders, sellers and koi keepers. Establish clarity around regulations regarding transportation and sale of koi if the virus is released.
Higher koi keeping costs (negative impact)	Koi keepers may incur higher koi keeping costs if they need to introduce biosecurity measures to reduce risk of their koi being exposed to the carp virus. An increase in costs is likely to lead to some hobbyists ceasing koi keeping; the proportion who stop keeping koi will vary depending on the extent of higher costs as well as complexity of implementing biosecurity measures.	
Reduced social interaction (negative impact)	Internationally, koi associations report that virus outbreaks have led to long-term reduction in the amount of social visits between koi hobbyists and breeders, due to the need for increased biosecurity. Sharp reductions in social interaction were reported during outbreaks, followed by some recovery but not to previous levels. Reduced showing of koi at koi shows was also reported, although internationally koi shows have generally continued successfully in countries affected by the virus, albeit experiencing substantial decline in numbers of koi shown during any period when virus outbreak has occurred.	Identify how to ensure safe social interactions continue, and clearly communicate this, to reduce impact.
Psychological and financial impacts of loss of koi - hobbyists (negative impact)	Koi hobbyists are often highly psychologically attached to their pets, similar to other animal owners. Loss of koi due to the virus, or having to destroy koi known to have been exposed to the virus, has significant negative psychological impacts, causing high distress. Several koi hobbyists interviewed described that they felt they could not remain in the hobby if their current koi – often bred over long periods – had to be destroyed due to the virus, due to both the psychological and financial impact of the loss.	Clear communication of biosecurity options and their likely effectiveness. Assist koi industry to implement phone support for hobbyists and breeders to increase use of appropriate biosecurity measures, and to refer those experiencing distress to appropriate services.

Socio-economic impacts	Under what conditions would this occur?	Actions recommended to reduce negative & enable positive impact
Psychological and financial impacts of loss of koi – businesses (negative impact)	Koi breeders are typically highly psychologically attached to koi breeding and their koi, as well as financially dependent on koi, with many (but not all) breeders relying on koi breeding for a large part of their income. Loss of koi due to virus outbreak would result in loss of business for many breeders, due to the financial costs and time required to rebuild suitable breeding stock.	As above, and provide support for koi breeders to diversify businesses beyond koi, to reduce total impact. This support could take a range of forms, from low interest loans to direct grants or hosting seminars and workshops to build business ideas.
Overall impact on koi keeping in Australia in longer term (negative to stable)	Many interviewees felt that overall, koi keeping would reduce in size as a hobby in Australia if the carp virus is released. This would result from reduced interest in entering a hobby where the pet may catch a lethal virus, and existing hobbyists not remaining in the hobby if they lost their pets. Internationally, there is a lack of clear evidence about total impacts on the number of people keeping koi, although as the hobby is not as significant in Australia as a cultural tradition, it is likely Australian hobbyists would have a higher likelihood of exiting the hobby than those in other countries with strong cultural traditions of koi keeping.	The actions listed above are designed to retain engagement in koi keeping as a hobby.

Other groups and organisations

Other groups with potential to be impacted by carp control actions were not examined in detail due as in general representatives of these groups felt there was either little to no risk of significant direct impacts for them, felt that impacts would not require specific action to address, or felt confident that impacts would be readily able to be addressed. In addition, some identified that the only impacts they were concerned about were ones that would be caused by issues such as reduced water quality, which were being assessed as part of the NCCP's biophysical research – if these were highly likely to occur, it was considered likely the virus would be deemed not feasible to release. Given this, only a brief identification of potential impacts was undertaken for these groups, reported below.

What was assessed? A total of 23 people representing local government, water supply managers, farmers, irrigators, and recreational users of areas invaded by carp other than fishers, were either interviewed or attended the June 2019 workshop.

Socio-economic impacts – what could happen, under what conditions, and recommended actions

The table below summarises potential impacts identified, perceived risk of these occurring, and actions to reduce risk of negative impacts and increase potential for positive impact.

Table 9 summarises potential socio-economic impacts identified, what is known about the conditions under which they would occur, and actions with potential to reduce negative impacts and increase positive impacts.

Table 9 Potential socio-economic impacts – other groups and organisations

Group/organisation	Potential impacts identified	Actions recommended to reduce negative & enable positive impact
Local government	Relatively few felt there was significant likelihood of major impact at a community wide-scale, but most were concerned about amenity impacts for residents and tourists in particular. Key issues were potential for (i) loss of local amenity in short term, (ii) growth in local amenity in long term, (iii) local government to be asked to bear costs of clean-up and rehabilitating sites, (iv) uncertainty about whether local governments would be appropriately resourced to undertake these roles.	Ensure roles of local government are clear, ensure local government can lead identification of sites of local significance for prioritising in clean-up, and sufficiently resource any actions local government needs to assist with such as signage for closure of areas, clean-up and disposal of dead carp.
Water supply managers – stock and domestic	For this group, the key concern was whether release of the virus would result in water quality problems or higher incidence of blue-green algae, or diseases associated with high organic matter, particularly botulism or salmonellosis, that could affect human or stock health. However, all interviewed felt confident these risks could be managed appropriately, with processes already in place enabling successful management of similar incidents when they occur. The greatest remaining concern was that of perceptions: water managers felt that even if water was safe, there was a risk that negative perceptions would lead to unwillingness to use domestic or stock water for periods of time.	Ensure processes already used to address short periods of poor water quality will be ‘fit for purpose’ to use to address any water quality problems arising from carp kills. Invest sufficiently in communication campaigns enabling an understanding of water quality impacts and safety of use of water.
Water supply managers - irrigation water managers	In addition to the topics described above, irrigation water managers need to address risk of irrigation intakes being affected by dead fish, which in some circumstances have potential to block intake pipes. All interviewed felt this could be readily managed using existing techniques such as barrages around intake pipes to ensure fish bodies did not block intakes.	Ensure allocation of resources to enable rapid deployment of appropriate methods to reduce risk of dead carp blocking intakes, and ability to rapidly respond if blockage occurs.
Farmers – dryland and irrigators	All types of farmers were typically more supportive of the potential release of the carp virus than the broader population. Most did not feel virus release would have significant negative impacts for farmers, although potential for short-term water quality and amenity issues were identified with interviewees feeling these would not be significant for the majority of farmers. Several felt long-term improvement in environmental	Clear communication ahead of time about virus release plans, and ongoing rapid communication about observations of dead carp and water quality post-release. Provide ‘real time’ information can provide both reassurance where there are few or no problems, and opportunity for rapid response when there are.

Group/ organisation	Potential impacts identified	Actions recommended to reduce negative & enable positive impact
	health had potential to have benefits for farmers, in the form of better water quality long-term in particular. See also below.	Where clean-up activities may cause damage to a crop or pasture (e.g. loss due to vehicles driving over these areas), consider potential to provide resources for farmers to address this damage in return for access.
Rural landholders bordering waterways/ waterbodies (including farmers)	Access across rural properties for clean-up of dead fish was raised as a potential impact for this group, with landholders wanting clear and appropriate procedures to reduce risk of damage to their land and water in any processes involving accessing waterways from their land. Amenity impacts were also a concern, with many wanting forewarning of likely amenity impacts so they could take action to respond to these ahead of time.	Clear processes for communicating with all rural landholders about access to their land or waterways for clean-up activities, with farming organisations involved in establishing appropriate processes.
Recreational users other than fishers	Recreational users of waterways, waterbodies and adjacent areas such as parks may be impacted by short-term reduction in amenity and closure of some areas for use if there are high volumes of dead fish or loss of water quality. In the long-term they may be impacted positively by increased amenity if improved environmental health results from reduction in carp populations.	

Overall community impacts

A large number of people live in communities located on or near waterways where carp invasion has occurred. Using spatial data from the 2016 State of the Environment on spatial location of carp invasion and different densities, overlaid with data on human population from the 2016 Census of Population and Housing, just under 8.4 million Australians live in a local government area (LGA) in which waterways and waterbodies have a moderate to high density of carp, and of these just under 5.3 million live in an LGA in which part or all of the waterways and waterbodies have experienced high levels of carp invasion. Many of these are residents of Melbourne and parts of Sydney, as well as those living in the rural and regional areas in which carp invasion has occurred.

These communities have potential to be affected by carp control programs. This would occur principally through (i) flow-on effects of impacts on the specific groups and business sectors described previously in this report, (ii) direct amenity impacts, with potential for shorter term negative amenity impacts after virus release, and longer-term positive amenity impacts if reduction of carp population led to long-term improvement in health of rivers, lakes and wetlands. Short term negative impacts could occur specifically during periods of large carp kills both in the communities where carp are initially affected by the virus, and in any downstream communities affected by large volumes of dead fish floating downstream or poor-quality water flowing downstream.

The first type of impact – the flow-on impacts on communities from impacts on specific groups such as tourism businesses or native fish aquaculture - will be significant only where a community has relatively high dependence on employment generated by those specific groups. In other words, while the individual impacts remain important to consider, if those directly affected make up a very small proportion of the community and its economic activity there is unlikely to be significant impact for the broader community or economy. In other cases, those impacted may represent a significant

proportion of local economic activity or population, and the impacts they experience flow-on to affect other businesses and people in the community to a significant extent.

There is no clear or set ‘threshold’ when an impact can be said to be large enough to have potential to noticeably impact an entire community or economy, beyond the people directly affected. To assess potential for this, data from Tourism Research Australia and from the 2016 Census of Population and Housing were overlaid with spatial data on carp invasion from the 2016 State of the Environment Report. This was used to identify the number of local government areas in which more than 10% of jobs depend directly on industries with potential to be affected by carp control actions, particularly release of the carp virus if it occurs. The threshold of 10% was chosen as it is unlikely that a majority of the jobs in a sector would be lost due to carp control actions, and hence this represents a very conservative threshold. It is likely that in most cases, a community meeting this threshold will not experience significant negative impacts if appropriate communications strategies are implemented to ensure only a small proportion of total employment dependent on fishing, aquaculture or tourism would be affected by carp control actions, and only for limited periods of time. A total of 58 LGAs located outside major city areas were identified as meeting these criteria and hence having potential to be impacted. However, several included in this list are likely to have a significant proportion of tourism businesses that are not highly dependent on freshwater areas¹.

Table 10 summarises potential socio-economic impacts identified, what is known about the conditions under which they would occur, and actions with potential to reduce negative impacts and increase positive impacts.

Table 10: Potential socio-economic impacts – overall community impacts

Socio-economic impacts	Under what conditions would this occur?	Actions recommended to reduce negative & enable positive impact
Downturn in employment in a local community	Likely to only occur where (i) tourism, recreational fishing, commercial freshwater/estuary fishing, and/or freshwater aquaculture contribute significantly to local employment <i>and</i> (ii) one or more of these groups is impacted substantially by virus release for an extended period of time leading to job losses. Highest risk of this occurring would be if negative misperceptions resulted in loss of visitor numbers for tourism industry for an extended period of time, rather than being contained to actual impacts of carp virus release.	Implement actions recommended elsewhere in this report to reduce risk of jobs being lost. In particular, have proactive communications strategy to maintain visitation for tourism, the main industry where loss of jobs could cause significant impacts at community scale.

¹ Excluding those known to not depend highly on freshwater areas for tourism activity, the LGAs with potential to be impacted identified were Hay (NSW), Alpine (Vic), Mansfield (Vic), Snowy Monaro Regional (NSW), East Gippsland (Vic), Federation (NSW), Hepburn (Vic), Inverell (NSW), Goondiwindi (QLD), Renmark Paringa (SA), Snowy Valleys (NSW), Albury (NSW), Horsham (Vic), Campaspe (Vic), Moree Plains (NSW), Berri and Barmera (SA), Mildura (Vic), Edward River (NSW), Murray River (NSW), Greater Shepparton (Vic), Northern Grampians (Vic), Berrigan (NSW), Central Goldfields (Vic), Mount Alexander (Vic), Benalla (Vic), Swan Hill (Vic), Hilltops (NSW), Indigo (Vic), Wellington (Vic), Murrindindi (Vic), Yankalilla (SA), Tweed (NSW), Loxton Waikerie (SA), Moira (Vic), Narrabri (NSW), Alexandrina (SA), The Coorong (SA), Wangaratta (Vic), Barossa (SA), Warrumbungle Shire (NSW), Ararat (Vic), Macedon Ranges (Vic), Gunnedah (NSW), Mount Barker (SA), Wodonga (Vic) and Murray Bridge (SA). This is not an exhaustive list, as carp populations can vary and other regions may be impacted depending on timing of carp control and spatial distribution of carp populations at the time as well as water flow conditions.

Socio-economic impacts	Under what conditions would this occur?	Actions recommended to reduce negative & enable positive impact
Increase in employment associated with improved environmental health	This has potential to occur if reduced carp populations are achieved and this is followed by improvement in environmental health. It would occur predominantly in communities where there is potential for increased visitation for recreational fishing, tourism, and freshwater or estuary related recreational activities that could benefit from improvements in aspects of environmental health such as native fish populations, riverbank vegetation or turbidity of water.	Ensure investment in carp control is accompanied by other measures to improve long-term environmental health. Develop communications strategies to increase knowledge of changes in ecosystems and encourage increased visitation.
Reduced amenity for residents	This has potential to occur if carp control actions result in large amounts of dead carp or reduced water quality and associated impacts of that reduced water quality. The extent of impact in different communities will range. Impacts on amenity could occur in the form of reduced access to recreational areas for a period of time, smell and visual impacts of fish kills and poor water quality. Some amenity impacts can occur via perceptions of safety: data on community perceptions suggests there is a risk of negative perceptions such as fear of the virus being transmissible to humans causing fear or distress and hence reduced liveability for local residents.	Ensure clear communication prior to carp control actions that prepares residents for potential impacts on amenity and reduces risk of misperceptions about potential impacts (e.g. transmissibility to humans). Provide ongoing communication during periods of carp kills or poor water quality, to ensure communities have best possible information about progress and likely length of effects of impacts on amenity. Involve residents in assisting with reporting on aggregations of dead carp or water quality concerns and ensure feedback is provided to those reporting concerns on actions taken.
Increased amenity for residents	This has potential to occur if reduced carp populations are achieved and this is followed by improvement in environmental health. If this occurs, it can increase wellbeing of residents through improved amenity of outdoor areas and increased recreation in those areas.	Ensure investment in carp control is accompanied by other measures to improve long-term environmental health.

6.0 Future SEIA, monitoring and evaluation

The positive and negative impacts identified in this document are *potential* impacts: whether they occur, and to what degree, depends on the ultimate decisions made about the design and implementation of future actions to reduce carp populations. The actions proposed in this report are recommended to reduce incidence and extent of negative impacts, and increase potential for positive impacts on key groups and on communities in which carp invasion has occurred. However, implementing some of these actions would require further quantification of current activity in areas such as the tourism, commercial fishing and native fish aquaculture sectors. As implementation of carp control may take some time to occur, a current assessment of size of these sectors should take place once timing of likely carp control actions is known. This is particularly important for sectors where activities have been changing rapidly, such as the rapidly growing native fish aquaculture industry, which if current trajectories continue will continue growing significantly in size year-on-year.

It is therefore recommended that once decisions are made about design of future carp control programs, a specific assessment of the size of the sectors that may be affected is undertaken. By this time an accurate set of data on recreational fishing activity in areas affected by carp will also be available through the National Recreational Fishing Survey which is being conducted through 2019 and 2020. This will enable a more accurate assessment of the number of businesses and people potentially affected in the short-term and long-term, and design of investment in the types of strategies recommended in this report.

Ideally, future carp control programs should identify specific points in time at which social and economic impacts will be evaluated, and include scope to adapt the design of the program to respond to and address any unexpected impacts that are identified from this ongoing monitoring and evaluation. This can help to ensure future carp control is both designed to address known likely impacts, and can respond to impacts that were not predicted or assessed as unlikely if they emerge.

For this to occur, monitoring needs to occur with sufficient frequency to enable timely response to the emergence of unexpected types or extent of social and economic impacts. Most social and economic impacts will emerge as a consequence of four factors: (i) reduced amenity due to carp kill, (ii) reduced water quality, (iii) impacts of clean-up efforts and of fish kill or water quality on sites with high cultural and recreational values, and (iv) perceptions of both safety of visiting and using areas where virus release has occurred, and of consuming produce from these areas.

For the first two areas, monitoring should focus on rapid consultation with communities in which reduced amenity or water quality impacts occur, to identify whether these impacts are approaching thresholds where they cause significant social and economic impacts, as well as monitoring how rapidly local businesses recover from these events to identify if any further action may be needed to support recovery. This consultation requires appropriate resourcing to ensure it does not present high burden for those asked to participate in it.

For the third, there is a need to design carp control to have active involvement of groups including Traditional Owners, tourism businesses/peak organisations, so they can proactively identify sites requiring protection and reduce the risk of negative impacts. This will also assist in reducing impacts of (i) and (ii) discussed above. It is preferable to focus investment on 'pre-monitoring and action to prevent impact' rather than monitoring impacts post-release. Active involvement before and during carp control will better enable prevention of impacts compared to monitoring after implementation of control actions have occurred. To address the fourth area requires engagement and monitoring of community perceptions about safety. This should be done intensively in initial stages of carp control. If the virus is released, we recommend monitoring every 6-8 weeks in the 4-6 months prior to virus release as this is when anticipatory impacts will occur and many perceptions will be formed, and every 6-8 weeks immediately after virus release implementation. Beyond the first six months of virus release, it is likely that monitoring can be reduced in frequency, to once every six months, as perceptions are likely to form and 'solidify' in the initial period prior to and just after implementation of a carp control program.

Intensive monitoring at the frequency recommended should be explicitly used to inform investment in communication strategies that focus on building an accurate understanding of safety of visiting areas in which carp control is occurring, and of consuming produce harvested in those areas. As perceptions are commonly formed based on distribution of messages in traditional and social media that cross large geographic areas, monitoring should focus on a sample of (i) people living in areas experiencing carp invasion and (ii) people living in other areas who may visit areas experiencing carp invasion, for example for tourism. We do not recommend monitoring aims to specifically identify

views of people living in different individual communities, as evidence to date suggests perceptions will be formed at a broader scale and be relatively consistent across different communities. This means sample sizes do not need to be large, and monitoring of perceptions can be done effectively using samples of 1,000 to 2,000 people nationwide.

To complement the community surveys, we recommend implementing (i) an email address, website and free-call phone number that community members can use to report social and economic impacts they believe may be occurring in their community, and (ii) regular update surveys of local government, tourism, native fish aquaculture, commercial carp fishing, koi and recreational fishers. The latter involves conducting a brief email or online survey comprised of 5-10 questions with a sample of these groups on a monthly basis to gauge any emerging issues. This again enables rapid tracking of potential impacts and response to them, including response to address inaccurate perceptions and prevent rapid spread of inaccurate perceptions, as well as investment to mitigate negative impacts where appropriate.

7.0 Recommendations and conclusions

While there is potential for negative social and economic impacts from a release of the carp virus, this potential can be minimised through implementation of key strategies designed to reduce impacts. This report assumes that virus release would only occur if there is low risk of long-term negative impacts on local amenity: if this is the case, investment in the following can act to reduce potential social and economic impacts from short-term reductions in amenity related to water quality and fish kills:

- **Active involvement** of Traditional Owners, tourism sector, native fish aquaculture, local government, recreational fishers, water managers, farmers and other relevant stakeholders in prioritisation of clean-up areas and ensuring safe and appropriate access to areas for clean-up. This can ensure clean-up activities are prioritised in areas with the greatest risk of social and economic impact, while also ensuring clean-up activities do not themselves create impacts through damaging sites of cultural, recreational or commercial significance. This requires resourcing involvement of these groups, and establishing clear governance of processes of allocating clean-up resources.
- **Active monitoring and communication** with potentially impacted businesses and local government areas prior to, during and after virus release, ensuring sectors such as tourism have access to the information they need to put in place strategies to reduce impacts. This ideally would include 'real time' mapping of any areas affected by poor water quality or dead carp to enable residents, tourists and businesses to accurately understand actual areas affected and reduce risk of people perceived areas to be impacted when they are not. This requires specific allocation of sufficient resources to enable effective monitoring and communication. Real-time monitoring enables early identification of emerging impacts and implementation of action to reduce their extent.
- Invest in **proactive communication strategies** to reduce risk of longer-term reduction in visitation of areas or reduced consumption of some products as a result of negative perceptions. As part of this, ensure existing learnings from the tourism sector about managing communication during negative water events are drawn on when communicating about carp control actions more generally.
- Identify **regulatory implications** of virus release for commercial carp fishing, commercial fishing, recreational fishing and aquaculture in areas where virus release will occur, as well as for transport and sale of koi. Assess impacts in terms of market access, business costs and

labour time of these regulatory impacts. Develop strategies to assist affected businesses adapt to changes.

- Ensure carp control is accompanied by **long-term investment in complementary measures to improve environmental health** a reduction in carp populations. Almost all potential positive social and economic impacts will occur only if carp reduction results in improvement in environmental health and associated amenity such as improved fishing opportunities, clearer water or better vegetated riverbanks, for example.
- **Provide opportunities for involvement** of those potentially impacted to be involved in carp control and environmental recovery activities after a reduction in carp activities. This can include engagement in citizen science activities for recreational fishers and tourists, such as monitoring of areas, and commercial opportunities for engagement in clean-up activities, supporting clean-up activities, and supporting environmental recovery measures such as restocking of native fish, for commercial fishers, tourism businesses and aquaculture businesses.
- **Acknowledge impacts** on those who experience them. Impacts are more damaging psychologically when not recognised and acknowledged, and recognising impacts assists people to process and adapt to impacts. This includes acknowledging the anticipatory impacts occurring during the NCCP and further anticipatory impacts likely to occur prior to any decisions on the nature of future carp control actions. It also includes acknowledging both short-term and long-term impacts resulting from future carp control actions. While assessment suggests relatively small numbers of businesses are likely to experience long-term impacts, there is potential for some to experience significant impacts. Putting in place a support program that can be applied for by those who demonstrate significant long-term impacts is therefore important for those who do experience extended large-scale impacts. Providing support in the form of phone counselling and potentially short-term financial assistance such as low-interest loans could assist those experiencing short-term impacts on business revenue, particularly if they are experiencing cumulative impacts (see below).
- **Identify cumulative impacts**, meaning identify where carp control actions may combine with other unrelated stresses being experienced by a sector to potentially cause a ‘tipping point’ for business viability or a person’s wellbeing. Put in place support resources such as liaison officers who can assist impacted people and businesses to access existing services that can provide support.

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