Australian Government
Department of Climate Change, Energy, the Environment and Water

Threatening Process Nomination Form 2025

This form is for nominations to amend the list of key threatening processes under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and is designed to assist in the preparation of nominations of threatening processes which are consistent with the *Environment Protection and Biodiversity Conservation Regulations 2000*.

The listing of a key threatening process under the EPBC Act is intended to prevent native species or ecological communities from becoming threatened or prevent threatened species and ecological communities from becoming more threatened.

There are a wide range of threatening processes affecting native species and ecological communities in Australia. Priority for listing will be directed to ***key*** threatening processes, those factors that most threaten biodiversity at national scale.

For a threatening process to be eligible for listing it must meet at least one of the three listing criteria. If there are insufficient data and information available to allow completion of the questions for each of the listing criteria, state this in your nomination under the relevant question.

Important notes for completing this form

- Further information to help you complete this form is provided at Attachment A. If using this form in Microsoft Word, you can jump to this information by Ctrl+clicking the hyperlinks (in blue text).
- Please complete the form as comprehensively as possible – it is important for the Threatened Species Scientific Committee to have as much information as possible to assist with the prioritisation of nominations, and the best case on which to judge a process' eligibility against the EPBC Act criteria for listing.
- Reference all information and facts, both in the text and in a reference list at the end of the form.
- The opinion of appropriate scientific experts may be cited as personal communication, with their approval, in support of your nomination. Please provide the name of the experts, their qualifications and contact details (including state agency, if relevant) in the reference list at the end of the form.
- Keep in mind the relevance of your answers to the listing criteria.
- It is particularly important that the nomination addresses the impact of the threatening process across its national extent.
- Identify any confidential material and explain the sensitivity.
- Figures, tables and maps can be included at the end of the form or prepared as separate electronic or hardcopy documents (referred to as appendices or attachments in your nomination).
- Cross-reference relevant areas of the nomination form where needed.
- Nominations that do not meet the EPBC Regulations will not proceed – see Division 7.2 of the *EPBC Regulations 2000* (www.legislation.gov.au/F2000B00190). As noted under sub-regulation 7.06(2), if information is *not* available for a particular question please state this in your answer.

Nominated key threatening process

1. NAME OF THREATENING PROCESS

Please note: there is a listed KTP '*Novel biota and their impact on biodiversity*' (http://www.environment.gov.au/cgi-bin/sprat/public/publicshowkeythreat.pl?id=20) that includes all invasive species. If this nomination is for an invasive species please contact the Department at epbcnom@dcceew.gov.au to discuss the proposed process prior to preparing a nomination.

Degradation and loss of inland aquatic ecosystems, habitats and associated biota caused by Common carp (Cyprinus carpio)

2. CRITERIA UNDER WHICH THE THREATENING PROCESS IS ELIGIBLE FOR LISTING

Please mark the boxes that apply. The process could be eligible under one or all three criteria.

✓ Criterion A	Evidence that the threatening process could cause a native species or ecological community to become eligible for listing in any category, other than conservation dependent.

✓ Criterion B	Evidence that the threatening process could cause a listed threatened species or ecological community to become eligible for listing in another category representing a higher degree of endangerment.
✓ Criterion C	Evidence that the threatening process adversely affects two or more listed threatened species (other than conservation dependent species) or two or more listed threatened ecological communities.

3. **CONSERVATION THEME**

Explain how the nomination relates to this theme. Note that nominations which do not relate to the theme will still be considered.

Conservation theme for the 2025 assessment period: '*Nominations that support the protection and recovery of species and ecological communities at risk from invasive species, disease and pathogens*'

Common carp or European carp (*Cyprinus carpio*) (hereafter 'carp') are the most widely established invasive species of freshwater megafish globally (Bernery and Bellard et al. 2022 ; Fanson and Hale et al. 2024). Furthermore, carp are considered amongst the top 100 most invasive species globally and is the third most introduced species worldwide (IUCN Global Invasive Species Database https://www.iucngisd.org/gisd/speciesname/Cyprinus+carpio). In Australia, carp occupy over 54 per cent of wetlands and 97 per cent of large rivers; including the Murray-Darling Basin (MDB) – where modelling estimates the carp biomass is estimated to be up to 90 per cent of all fish in some waters (Gehrke and Harris 2000 ; Stuart and Fanson et al. 2021). Carp have a range of significant detrimental impacts on freshwater ecosystems, including habitat modification, and decreased water quality (increased turbidity and nutrient output); competition with native species; and predation of native species (Stuart and Fanson et al. 2021 ; Fanson and Hale et al. 2024). Decreased water quality results from benthic feeding behaviour, which alters community composition and reduces the abundance of fish, invertebrates, aquatic vegetation, and potentially waterfowl (Peterson and Pearson et al. 2022). Carp are also considered to be responsible for the development and spread of the parasitic copepod, Anchor worm (*Lernaea cyprinacea*), in Australia (Zhu and Barton et al. 2020). Widespread infestations have been documented in native fish in Victoria, New South Wales (NSW), and Western Australia (Hassan and Beatty et al. 2008 ; Zhu and Barton et al. 2020). Interactions between climate change and altered water regimes also have negative effects on freshwater ecosystems which are often exacerbated by invasive species, including carp. These impacts, alongside extreme environmental tolerances and high fecundity have enabled carp to have an advantage over native fish species (Koehn and Thwaites et al. 2016 ; Peterson and Pearson et al. 2022).

4. DESCRIPTION OF THE THREATENING PROCESS

Describe the threatening process in a way that distinguishes it from any other threatening process, and how the process is a *key* threatening process. Include reference to:

a. the components of the threat (consider both biological and non-biological components),
b. the processes by which those components interact (if known).

Please provide the following information where available:

c. the area of extent of the process, including the ecosystems or landscapes the process affects,
d. the time scale or periodic/seasonal nature of the threatening process,
e. any compounding impacts from, or interactions with, other threatening processes (e.g. climate change giving an invasive species an additional advantage), and
f. the proportion of the range of native species (listed or not) that the threatening process is likely to impact.

This nomination to list carp as a key threatening process articulates the latest scientific information about the ecological impacts caused by the invasive pest species. Listing carp as a key threatening process is a critical step to addressing the problem at a nationwide scale. The application highlights the indirect effects of carp such as increased turbidity and nutrients in waterways, leading to middle-out effects: increased phytoplankton, reduced aquatic macrophytes cover, altered macroinvertebrate diversity and abundance, and degraded habitat for many threatened native species, particularly in the MDB.

Invasiveness

Carp are a major threat to aquatic systems globally and are listed as a noxious aquatic species in all states and territories in Australia, excluding the ACT and Western Australia (Koehn and Brumley et al. 2000 ; Aquatic Biosecurity & Risk Management Unit 2010 ; Queensland Parliamentary Counsel 2014 ; Fanson and Hale et al. 2024 ; PIR 2024 ; Northern Territory Government n.d. ; NRE Tasmania n.d.). Originating in Eastern Europe (the Ponto-Caspian region), central Asia and northern Vietnam, carp are a ray-finned fish that inhabit a range of freshwater and estuarine environments in over 91 countries (Koehn 2004 ; Smith 2005 ; Stuart and Fanson et al. 2021 ; Wang and Sun et al. 2024). There are three different strains of carp in Australia, European carp (*C. carpio var. communis*), mirror carp (*C. carpio var. specularis*) and leather carp (*C. carpio var. nudus*) (Smith 2005). Koi carp are also present in Australia and are coloured variants of common and mirror carp (Smith 2005).

Carp were introduced to Australia by European settlers on multiple occasions starting in the mid-1800s. Their populations stayed relatively contained until the introduction of the 'Boolara' strain in the 1960s, which spread quickly through farm dams and across south-east Australia, especially in the MDB (Koehn and Brumley et al. 2000 ; Koehn 2004). Flooding in the early 1970s facilitated the spread of carp throughout the MDB however, they were also introduced to new localities, possibly through their use as bait (Koehn and Brumley et al. 2000).

Carps' ability to become such successful invaders stems from advantageous biological traits compared to most native fish species. Carp have comprehensive environmental tolerances, they are found in water temperatures ranging from 2-40.6 °C, salinity up to 14 ppt, pH from 5.0 – 10.5 and oxygen levels as low as 7 per cent saturation at 5 °C (Koehn and Thwaites et al. 2016). Table 1 (Attachment 2) highlights carps' tolerance to degraded environments compared to native fish species (Koehn 2004). Carp demonstrate early sexual maturity, with males capable of reproducing from one year of age and females from the age of two (McDowall 1980). Females can spawn multiple times a year (typically between August and January) and are highly fecund, with larger females capable of producing approximately 1 million eggs annually (Sivakumaran and Brown et al. 2003). Carp prefer mid-latitude, slow flowing rivers and weir pools however, they are referred to as habitat generalists and can exist in rivers, wetlands, floodplains, irrigation channels and have been reported in estuaries (Gehrke and Harris 2000). Carp exhibit rapid growth and are vulnerable to few predators once they exceed 400 mm (Koehn and Thwaites et al. 2016).

Carp spawning events are stimulated by rising water temperatures and the inundation of floodplains in spring and summer (King and Humphries et al. 2003 ; Stuart and Jones 2006 ; Humphries and Brown et al. 2008). Although carp can spawn in main river channels, floodplains and wetlands provide an ideal breeding ground due to their abundance of macrophytes, and absence of predators and competition (Bajer and Sorensen 2010). The inundation of floodplains are linked to increased spawning, distribution and abundance of larval and juvenile carp (Vilizzi and Tarkan et al. 2015 ; Nazaroff 2021). Consecutive recruitment in off channel habitats aids in the increase of carp populations, this can be though multiple annual spawning events at a large variety of locations (Koehn and Thwaites et al. 2016). Annual events like these are common in areas where irrigation flows are regulated, which enable annual carp recruitment and can negatively affect the river metapopulation (Koehn and Thwaites et al. 2016). Furthermore, flooding decreases dissolved oxygen levels and increases turbidity, which has the potential to create blackwater events (Koehn and Thwaites et al. 2016). Whilst these events can prove fatal to native species, carp are more tolerant of these conditions providing them with a competitive advantage over native fish (Nazaroff 2021). Figure 1 (Attachment 2) shows the correlation between carp abundance and major flood events in Victoria (Stuart 2021).

Extent and Biomass

Research suggests that carp are found in all states and territories in Australia apart from Northen Territory and Tasmania- noting that carp were, until recently present in two lakes in Tasmania (Centre for Invasive Species Solutions 2012a). Stuart and Fanson et al. (2021) found that carp were present in 33 of 191 major river drainages in Australia, furthermore carp are estimated to occupy 17,264 km^2 of aquatic habitat area (Figure 2 – Attachment 2). Stuart and Fanson et al. (2021) also estimates that total carp numbers (for Australia) to be 199 million (95 per cent confidence interval: 106 million to 358 million) for an 'average' hydrological scenario, and 358 million (95 per cent confidence interval: 179 million to 685 million) for a 'wet' hydrological scenario. Sharp peaks in biomass of juvenile carp occurred following flooding in 2011 and 2016–2017, and again in 2022. The major floods of 2022 resulted in massive carp breeding and migration in Southeast Australia, with populations estimated at an all-time high of 375 million, with modelled data suggesting around 90 per cent of the entire biomass of fish in the MDB (Gehrke and Harris 2000 ; Stuart and Fanson et al. 2021). Despite spawning of large numbers, survival of juveniles into the adult population is highly variable and dependent on environmental conditions, nursery habitat characteristics and density-dependent factors that can strongly influence juvenile survival. Higher carp population densities do not necessarily produce more recruits, and the number of young carp surviving may decline (Koehn et al. 2000).

Estimates of biomass vary according to different data sources, temporal coverage, sampling and analysis methods. Schilling et al. (2024) found lower biomass for the NSW portion of the MDB rivers (systems <700 m elevation) but wetlands were excluded. They found a median of 57 per cent (95 percent confidence intervale: 42.5–70.4) of fish biomass at the site level, and approximately 45–66 per cent at the river catchment scale. For key NSW rivers, the median proportion of carp ranged from around 46–80 per cent. This indicated that carp can dominate total fish biomass in some rivers for short time-periods, with the likelihood of these periods following large recruitment events. At the NSW MDB scale, biomass of carp was remarkably stable across the three decades, suggesting that the carrying capacity of carp may have been reached (Schilling and Butler et al. 2024). They concluded that whilst around 20 per cent of river sites have > 90 per cent biomass carp, there are also a similar percentage of river sites that have < 10 per cent carp biomass, indicating significant areas in the NSW MDB where the protection of ecologically valuable native fish populations and habitats should be a priority (Schilling et al. 2024).

Impact Pathways

Carp, alongside some other invasive species, are labeled ecosystem engineers meaning they can dramatically reduce resource availability for a range of native species (Emery-Butcher and Beatty et al. 2020). Carp are a major factor in environmental degradation which is a direct result of adult population density in a waterway, the effect of their density is to create changes that are ecologically significant, large-scale and temporally persistent. For example, carp cause major changes in water clarity, nutrients and organic matter concentration (Gallardo and Clavero et al. 2016 ; Emery-Butcher and Beatty et al. 2020) A recent review by Stuart and Fanson et al. (2021) indicated that when carp density exceeds 250 kg/ha, a waterbody loses approximately 50 per cent of its macrophytes and macroinvertebrates. Notably, carp densities in Australia are commonly 200-400 kg/ha with some areas (particularly shallow lakes) exceeding 1800 kg/ha, which is 22.5 times higher than the lowest environmental damage threshold (Stuart and Fanson et al. 2021).

Most of the impacts from carp can be linked to their feeding behaviour. Like many other fish species, carp change their diet during their ontogeny. Carp embryos are supported by endogenous nutrition, feeding off the egg yolk. Juvenile carp (up to 10 cm) are planktivorous but preferably feed on zooplankton. With increasing size, carp increasingly include macrobenthos in their diets switching from planktivory to benthivory typically early during ontogeny. Large carp can supplement their diet with plant material (seeds and leaves), whilst large zooplankton and detritus occurs in the diet of carp in all size classes (Huser and Bajer et al. 2016).

Carp can exert substantial effects on ecosystem structure and function and have the potential to significantly modify communities through a variety of available pathways, they are not confined to top-down or bottom-up processes but rather produce middle-out effects. When in large numbers juvenile carp are capable of altering zooplankton communities, allowing unregulated proliferation of phytoplankton populations (Weber and Brown 2009 ; Akhurst and Jones et al. 2017) potentially increasing the risk of harmful blue-green algae blooms (Sierp and Qin et al. 2009 ; Weber and Brown 2009). During dry conditions juvenile carp may compete with small native fish for food and resources (Mazumder and Johansen et al. 2012). Adult carp are primarily omnivorous benthic feeders, syphoning food from substrata including benthic and epibenthic macroinvertebrates, fish eggs, macrophytes, insect larvae and detritus. The broad diet, large size and vast biomass of carp means they remove large stores of energy from the ecosystem making it unavailable to native species, leading to population declines (Kopf and Humphries et al. 2019). Their suction style of feeding creates the 'bottom up' effects by suspending sediments and nutrients, uprooting aquatic plants, reducing light availability, water clarity, and increasing turbidity which decreases access to suitable habitat for many native fish species (Vilizzi and Tarkan et al. 2015 ; Kaemingk and Jolley et al. 2016).

Marshall and Blessing et al. (2019) reported on the impact of carp in dryland rivers noting the main impact pathways were associated with carp feeding behaviour and by excreting nutrients, which in turn promote increased phytoplankton biomass and turbidity. Feeding and, to a lesser extent, spawning, are expected also to increase turbidity by mobilizing fine bed sediments leading to increased suspended sediment concentrations. Feeding can also reduce aquatic macrophyte and macroinvertebrate density – directly by consumption and disturbance, and indirectly by increased turbidity leading to less light availability for aquatic primary production. The indirect impacts of carp are predicted to be greater than direct (i.e., feeding on native biota) through reduced habitat availability (macrophytes), less food for native species (macroinvertebrates and possibly juvenile native fish) and elevated turbidity. Changes in turbidity leading to reduced densities of aquatic macrophytes and macroinvertebrates are also predicted to trigger cascading impacts to other elements of the ecosystem including amphibians and birds (Maceda-Veiga and López et al. 2017 ; Marshall and Blessing et al. 2019).

A large-scale field experiment conducted over two years in a terminal wetland of the lower River Murray in South Australia assessed the impact of carp on various ecological factors (Vilizzi and Thwaites et al. 2013, 2014). They found that within a year of artificial inundation, water clarity significantly declined, which was linked to subsequent reductions in the biomass and coverage of aquatic macrophytes, fluctuations in zooplankton density, and a drop in diversity of benthic invertebrates. Furthermore, there was a notable relationship between the decrease in transparency and the richness of benthic invertebrates with carp biomass, which averaged 68.0 kg per hectare, leading to a transition from a clear-water to a turbid-water condition (Vilizzi and Thwaites et al. 2014).

A similar-scale investigation at multiple lakes in the USA was undertaken by Kaemingk et al. (2017). They investigated middle out effects of carp in whole-lake observational and experimental studies across four trophic levels. Figure 3 (Attachment 2) highlights the four major carp disturbance pathways observed by Kaemingk and Jolley et al. (2016). Adult abiotic foraging yielded the strongest results and was linked to a reduction in water clarity, which can limit submerged macrophyte growth. Reduced macrophyte growth is linked to shifts in ecological stable states and zooplankton communities (Kaemingk and Jolley et al. 2016). The study noted that minimal evidence was seen for the remaining three disturbance pathways however it is possible the density of carp in the tested areas were below the critical biomass threshold which is attributed to widespread ecosystem disturbance (Kaemingk and Jolley et al. 2016). The results indicated that most trophic levels were affected by carp, highlighting strong middle-out effects likely caused by foraging activities and abiotic influence (i.e., sediment resuspension). Reduced water transparency, loss of submersed vegetation and a shift in zooplankton dynamics were the strongest effects (Kaemingk and Jolley et al. 2016). Indirect pathway effects were also seen with fish life history traits being affected. Vilizzi et al. (2013) also noted the middle-out effects of carp in their study at Brendan Park in South Australia. A study by Fanson et al. (2024) provided a working conceptual framework of the impacts from carp (see Figure 4, attachment 2). Potentially missing from this conceptual framework is the impact from transmission of disease and parasites (see *"Disease (Pathogens and parasites)"* below).

Direct

While juvenile carp feed predominantly on zooplankton, adult carp diets have been shown to be highly diverse including phytoplankton, zooplankton, open water invertebrates, macrobenthos, fish eggs, plant material and in some cases fish. Animal prey is preferred but plant matter will also be taken when abundant, with the amounts/preferences variably reported. Macroinvertebrates are an important component of adult carp diets, with a range of taxa predated (Huser and Bajer et al. 2016). It is suspected that juvenile crayfish may be predated, but there is no specific data on this in Australia (N. Whiterod 2025, pers. comm. 20 March). Carp can directly impact native fish populations through predation, including on native fish adults, eggs and juveniles, although there is limited data on predation of native species in Australia. Carp also influence ecosystems at lower trophic levels where impacts are more difficult to determine (Kloskowski 2011). In dryland rivers, the predation by carp has been linked to the extirpation of an endangered river snail (Marshall and Blessing et al. 2019 ; Wang and Sun et al. 2024). Kloskowski (2011) suggets that carp predation and related effects may be primarily responsible for animal diversity loss in invaded communities, as they may act prior to, or independent of, the ecosystem switch to a turbid phase. The consequences of carp invasion are a decrease in native biodiversity and concurrent homogenization of the fish fauna (Marr et al. 2013 cited in Vilizzi and Tarkan et al. (2015)).

In one of the earliest investigations of the impact of carp, Roberts and Chick et al. (1995) investigated the impact on water quality and aquatic ecosystems in ponds in NSW. Two experiments were conducted under high and low impact conditions, determined by stocking density and food availability. High-impact conditions resulted in significant negative effects on water quality and habitat structure, including increased turbidity, loss of plant species (specifically *Chara fibrosa* and *Vallisneria* sp.), and higher surface water temperatures. The plant loss was attributed to uprooting rather than herbivory. In low-impact conditions, the uprooting of *Vallisneria* decreased significantly (Roberts et al., 1995). Impacts on macrophytes has been reported in a number of studies including, but not limited to, Miller and Crowl (2006) ; Matsuzaki and Usio et al. (2009) ; Matsuzaki and Sasaki et al. (2013) ; Vilizzi and Thwaites et al. (2014)

A recent study by Fanson et al. (2024) used a nonlinear meta-analytic method to analyse biomass-impact relationships for eight different impact metrics and integrated the findings with a spatial model of carp biomass in Australia. The findings revealed both linear and nonlinear relationships across the various metrics. When validating the model with data from carp removal experiments, we found that it had a high prediction accuracy (within 20 per cent of the estimated values) for four of the metrics, although one metric (macrophyte recovery) was consistently underestimated by 10 to 35 per cent. Fanson et al. (2024) estimated that carp invasion in Australia has led to a reduction in macrophyte populations (median decrease of 36 per cent) and macroinvertebrates (31 per cent decrease), while increasing nitrogen levels (2 per cent), plankton biomass (7 per cent), phosphorus levels (8 per cent), and turbidity (63 per cent) concluding carp have significantly transformed Australia's aquatic environments.

Aquatic macrophytes are a key habitat component for many small-bodied native fish species, particularly wetland species. The significant loss of macrophytes (e.g., Fanson and Hale et al. (2024)) is believed to have population level impacts on some species (Lintermans 2023). Certain species of macrophytes have also been recorded as important habitat components for carp which lay their eggs on various genera including *Vallisneria*, *Myriophyllum* and also *Hydrilla (Maceda-Veiga and López et al. 2017).* Very clear direct impacts on softer annual submerged species. *Myriophyllum*, *Callitriche* and *Nitella* species would be impacted if they occur in sites with a riverine connection as carp will rapidly move into these sites when they fill so hydroperiod and dry phase are less important than the connection type (S. Wassens 2025, pers. comm. 17 March).

Indirect

As mentioned, carp primarily affect ecosystems through their feeding habits and nutrient excretion. It's believed that their excretion contributes to increased turbidity due to higher levels of phytoplankton. Their feeding behaviour, along with spawning to a lesser degree, is also anticipated to raise turbidity by disturbing fine sediments and increasing the concentration of suspended particles. This can directly decrease the populations of aquatic plants and macroinvertebrates through consumption and disturbance, and indirectly by increasing turbidity, which reduces light penetration.

While carp feeding may have direct negative effects on native fish populations, the indirect impacts are expected to be more significant, resulting from decreased habitat (due to fewer macrophytes), less food (fewer macroinvertebrates and potentially juvenile native fish) (e.g., Miller and Crowl (2006) ; Koehn and Nicol (2013)), and the detrimental effects of heightened turbidity (e.g., Matsuzaki and Usio et al. (2009) and release of nutrients from sediments (e.g., Huser and Bajer et al. (2016)) (Roberts and Chick et al. 1995 ; Miller and Crowl 2006 ; Vilizzi and Thwaites et al. 2014 ; Kowal and Badiou et al. 2022). Increased turbidity and lower macrophyte and macroinvertebrate populations can lead to further cascading effects on other components of the ecosystem, such as amphibians and birds (Marshall and Blessing et al. 2019).

Fanson and Hale et al. (2024) predicted that up to approximately 90 per cent of the macrophyte standing biomass had been lost in some areas, and turbidity increased to ~500 per cent due to carp. Fanson and Hale et al. (2024) predicted macrophytes have decreased by 41 per cent in rivers and 32 per cent in waterbodies, and turbidity increased by 74 per cent and 53 per cent for rivers and waterbodies, respectively. These results highlight major ecological changes to aquatic ecosystems across a large geographic scale spanning most of eastern Australia. Furthermore in 37 experimental studies, four of which were Australian, carp were responsible for turbidity in 91 per cent of studies, reduced invertebrates in 94 per cent, and reduced macrophytes in 96 per cent (Weber and Brown 2009). Carp increase turbidity at densities of 50-75 kg/ha, with noticeable shifts from clear to turbid waters occur when carp populations exceed densities of 200 kg/ha (Zambrano and Hinojosa 1999 ; Williams and Moss et al. 2002 ; Parkos III and Santucci et al. 2003 ; Haas and Köhler et al. 2007 ; Matsuzaki and Usio et al. 2009 ; Brown and Gilligan 2014 ; Vilizzi and Thwaites et al. 2014), with declines in macrophytes attributed to light attenuation consequently hampers aquatic primary production (Marshall and Blessing et al. 2019). Exclusion (of large bodied carp) treatments at Gunbower Forest consistently (2014-2021) resulted in higher cover of macrophytes than unfenced control plots (Bennetts et al. 2018; Bennetts 2021).

Lintermans and Lutz et al. (2024) found the most pervasive risk to threatened, near threatened and data deficient species (> 91 per cent of species affected) are the impacts of invasive and problematic native species which included carp, other established alien species and new introductions from the ornamental aquarium industry.

Investigations at two lakes in Spain showed impacts on waterbird species due to the destruction of macrophyte beds resulting in change in the waterbird community. Numbers and species richness of diving ducks were significantly reduced by carp, whilst the opposite effect was observed for piscivores such as herons. Negative impacts on herbivorous coots were particularly pronounced as well as several species of grebe. Conversely, the presence of carp led to a positive impact on herons (Maceda-Veiga and López et al. 2017).

Disease (Pathogens and parasites)

Palermo and Morgan et al. (2021) lists the symptoms of infection with *Schyzocotyle* (formerly *Bothriocephalus*) *acheilognathi* which causes the disease 'bothriocephalosis', noting the first record of the tapeworm in goldfish, koi carp and gambusia from an urban wetland in Western Australia. The Asian fish tapeworm is noted as having a higher infection rate in smaller bodied fish and has a very wide range of host species including native Australian species (Dove and Fletcher 2000). Palermo and Morgan et al. (2021) note that over a quarter of the native fishes in south-western WA are listed as threatened with many very small in size (<100 mm total length) and could be susceptible to infection (Morgan and Unmack et al. 2014). In Australia, S*. acheilognathi* has also been reported from NSW, Queensland and Victoria (Dove and Fletcher 2000).

Cumulative

Inland aquatic ecosystems are typically exposed to a multitude of spatially nested and integrated effects from local catchment activities and regional atmospheric processes, bearing significant impacts from these multiple threats. Freshwater ecosystems have a higher proportion of extinct and threatened species than terrestrial and marine systems (Dudgeon and Arthington et al. 2006 ; He and Arora et al. 2023); one of the main reasons being the presence and impacts of multiple stressors, such as altered hydrological regimes, habitat destruction, pollution, biological invasions, over exploitation and salinization, in freshwater ecosystems (Jackson and Loewen et al. 2016 ; He and Arora et al. 2023). Impacts on aquatic ecosystems and their component biota are strongly associated with altered water regimes, which many cases also provide advantages to invasive species, including carp.

Investigations into climate as an important predictor of carp population viability in European lakes indicated population viability is particularly enhanced under dry conditions and elevated temperatures (Souza and Argillier et al. 2022). Climate change is listed as a major threat to many EPBC listed species that overlap with carp. The interactive effects between climate change and the listed species will depend on the characteristics of the ecosystem and species involved (Carosi and Lorenzoni et al. 2023), but are likely to be synergistic in nature. Studies by Réalis-Doyelle and Pasquet et al. (2018) indicated that warmer water temperatures favored the early life stages of carp, and were associated with larger larvae and quicker development, these changes have the capability to reduce predators of juvenile carp and in turn increase their biomass and distribution.

Despite natural populations and ecosystems being subjected to multiple stressors, most past research has focused on single-stressor and two-stressor impact pathways, with little attention paid to higher-order interactions among three or more stressors (e.g., Tekin and Yeh et al. (2018) ; Diamant and Boyd et al. (2023)).

Studies in NSW by Patrick Driver indicated that human impact is associated with higher carp biomass, in particular the effects of dams and agriculture on flow regulation (Driver and Harris et al. 1997). Changes in flow and water temperature caused by dams are detrimental to native species but have a positive association with carp, higher biomasses of carp are found in inland rivers upstream of dams and weirs as these slow flowing locations provide suitable breeding habitats (Driver and Harris et al. 1997). The MDB is considered to be one the most flow regulated riverine systems globally, water within the basin is used for irrigation, recreation, and town and water supplies (Koehn and Todd et al. 2018). This has put significant pressure on the aquatic habitat and the species that reside in it. Attempts to rehabilitate the river and the native species that rely on it are made by using environmental water allocations and environmental flows (Koehn and Todd et al. 2018). Koehn and Todd et al. (2018) reports that environmental water allocations are made to protect native fish by protecting isolated refuge wetlands, refilling weir pools and providing adequate flows through fishways, flows that provide access to off-channel wetlands and floodplains are however beneficial to carp as they provide access to ideal spawning and recruitment grounds. Based on the risk assessments of threats to EPBC listed species a simple matrix illustrating the potential interactions between carp impacts and other threats are presented (for a subset of listed species) in Table 2 (attachment 2). As discussed above, the indirect impacts attributable to carp are often more detrimental as they operate as press disturbances and are implicated in higher-order interactions (Wootton and Stouffer 2016). Empirical evidence for the relationship between carp are other threats will vary both spatially and temporally and are poorly understood.

5. INDIGENOUS CULTURAL SIGNIFICANCE

Is the threatening process known to have an impact on species or country culturally significant to Indigenous groups within Australia? If so, to which groups? Provide information on the nature of this significance if publicly available.

Since the beginning of humankind, fish and fishing have been a vital traditional and cultural component of numerous communities and societies, including Aboriginal people (Shamsi and Williams et al. 2020). For thousands of years, Indigenous communities have relied on fresh fish to provide food and employment, making it integral for community economies (Figure 5) (AIATSIS 2021). Fishing, along with a deep connection to the land is described to define Aboriginal people's sense of identity (Shamsi and Williams et al. 2020). Aboriginal people believe they reflect the environments they inhabit, with both spiritual connection, and environmental and animal health motivating their desire to limit areas from further degradation (Shamsi and Williams et al. 2020). As put by Aboriginal author, Mundrooroo, spirituality as "a oneness and an interconnectedness with all that lives and breathes, even with all that does not live or breathe" – further symbolising the geophysical beliefs in Aboriginal culture (Shamsi and Williams et al. 2020).

Aboriginal people's connection to Australian river systems is closely tied to their geophysical beliefs (Shamsi and Williams et al. 2020). For them, the care of water sites is not for individual gain, but a shared responsibility for those who live downstream (Berry and Jackson et al. 2018). The flow of water symbolises the strength of social relationships, with the health of the environment directly impacting the wellbeing of the community (Berry and Jackson et al. 2018). In Aboriginal ontologies, when water quality suffers, it reflects a breakdown in social connections, highlighting the interconnectedness between environmental health and community welfare (Berry and Jackson et al. 2018).

Australia's eastern inland river system holds a deep cultural linkage to Aboriginal people who reside in the region – this region also containing the highest abundance of carp in Australia (Hayes and Leung et al. 2014 ; Holmes and Goodall 2017). With significant impacts imposed by the pastoral industry that came with European settlement, soil compaction from hooved animals permanently altered the land, floodplains and vegetation (Holmes and Goodall 2017). Based on English law, rivers were a public right, meaning access could not be denied, and farming was limited due to accessibility (Holmes and Goodall 2017). As a result, rivers became a refuge for Aboriginal people and a way to survive. Here they lived, fished and heavily consumed river foods including fish, mussels and yabbies (Holmes and Goodall 2017). In many rivers along the MDB network, Aboriginal children detail childhoods surrounded by their grandmothers whilst their parents went to work - these childhoods filled with stories of catching fish and harvesting river birds' eggs, mussels and yabbies for dinner (Holmes and Goodall 2017). Techniques focused on fishing efficacy have been passed down for generations, including reading animal behaviour, sourcing bait, fish for consumption, and sharing the catch within kinship networks (Holmes and Goodall 2017). These lessons, encompass the practice of fishing and the cultural linkage to Indigenous Australians (Holmes and Goodall 2017). The riverbanks provided Aboriginal people a safe place they could live, and share stories of country no longer accessible (Holmes and Goodall 2017).

Among these, are stories of a native species that holds fundamental spiritual connection, the Murray cod (Deadly Story n.d. ; Murray Bridge Council n.d.). The Murray cod is detrimentally affected by carp through biological and non-biological processes and is listed as a vulnerable species under the EPBC Act 1999 (DCCEEW 2024). The Murray cod - known locally as Ponde, Pondi, Goodoo, and Burnanga, has been described in stories to have shaped the river by thrashing its head and tail along the bank as it swam away from Ngurunderi, a great hunter (Figure 6, Attachment 2) (Jarred Walker 2022). When speared, the fish was thrown back into the water in pieces, each piece representing the fish it would become (Lintermans 2023). These species including golden perch, bony bream, silver perch, Murray cod, and other native species (Lintermans 2023).

Golden perch (yellowbelly), also known locally as Dhagaay, Gagalin and Bidyin (among others) is another native species that holds cultural significance in this region, specifically when it comes to trade (Shjarn Winkle n.d.). Having been consumed for over 30,000 years, yellowbelly has provided more than just food, trade and connection to culture – but has been a key environmental cue. A river abundant in healthy Golden perch is a traditional indicator that the river is in good health (Shjarn Winkle n.d.). A study by John Koehn however shows that golden perch are particularly vulnerable to water quality issues, increased sedimentation and habitat destruction, these threats are exacerbated or created by established carp populations (Koehn 2004).

Processes leading to land degradation and nutrient pollution have had a serious impact in water quality in parts of southeaster Australia (Berry and Jackson et al. 2018). Indigenous people in the MDB aspired to maintain a level of water quality fit for consumption, a standard that has been applied for thousands of years (Berry and Jackson et al. 2018). The Ngarrindjeri nation has expressed the reasoning behind undrinkable water to be too much water diversion (construction of dams and weirs), cloudy water and pollution (Berry and Jackson et al. 2018). Suspended sediment loads are known to be the lead contributor of river degradation in the MDB, with the suspended sediments also related to high nutrient and heavy metal loads (Rutherfurd and Kenyon et al. 2020). Water diversion has also led to negative environmental consequences, including the formation of large still pools which are the perfect habitat for algae blooms and invasive fish to flourish, leaving native fish in their wake (Holmes and Goodall 2017 ; Berry and Jackson et al. 2018).

Due to their presence and reliance on the river system, Aboriginal people were some of the first to notice river changes following the expansion of carp after the 1974 floods (Holmes and Goodall 2017). Since their expansion, carp has been blamed for the disruption of river life throughout the system (Holmes and Goodall 2017). Since the introduction of carp, there has been a direct increase in suspended sediment (Rutherfurd and Kenyon et al. 2020). Prior to European settlement, the waters of the MDB were clear, and macrophytes were in abundance, which started to decline due to an increase in turbidity (Rutherfurd and Kenyon et al. 2020). A Yorta Yorta elder, Don Briggs, describes the MDB in the 1940's as "green and clear, you could see the logs in 10–15 ft in the water. Now you can't see that" (Rutherfurd and Kenyon et al. 2020). Other Traditional elders recall clearer waters before carp invaded the home of the Murray cod, eroded the banks, and altered the overall water quality (Berry and Jackson et al. 2018). Carp has the ability to alter turbidity and water quality when their densities exceed 50-75kg/ha (Holmes and Goodall 2017). These densities are, however, often exceeded in many aquatic habitats throughout the river system, prompting the conclusion that carp have almost certainly increased turbidity throughout the MDB (Holmes and Goodall 2017). Increased turbidity has a direct impact on primary productivity, resulting in food web alteration (Holmes and Goodall 2017). Ecological shifts including the growth of macrophytes in clear water, and algae domination in turbid waters have been well documented, whilst Mesocosm experiments undertaken in billabongs indicate carp can increase turbidity and algal blooms, whilst decreasing the biomass of native fish and macrophytes (Hayes and Leung et al. 2014).

Aboriginal people have attempted to abate the problem through removal techniques. In south-west Queensland, on the Moonie River near Thallon, Aboriginal rangers are working on methods to remove the pest fish from MDB (Sanders and Morris 2018). Through a new trapping program using nets, they have been able to remove up to 85 per cent of carp in small off stream billabongs (Sanders and Morris 2018). The goal of the program being able to provide "our native [fish] a really good opportunity to flourish in those small areas." (Sanders and Morris 2018). Local communities have also taken it upon themselves to organise carp musters, which aim to unite the fishing community whilst assisting conservation efforts. Don Cunningham stating the goal is simply to catch a carp, "if you catch a native, you put it back" (Holmes and Goodall 2017).

For a threatening process to be eligible for listing it must meet at least <u>one</u> of the three listing criteria. You do not need to provide details of the eligibility for all questions 6-11, however the more information you provide the more evidence is available to undertake the assessment. If there are insufficient data and information available to allow completion of the questions for each of the listing criteria, state this in your nomination under the relevant question.

Criterion A: non-EPBC Act listed species/ecological communities

6. SPECIES THAT COULD BECOME ELIGIBLE FOR LISTING AND JUSTIFICATION

Provide details and justification of non-EPBC Act listed species that, due to the impact of the threatening process, could become eligible for listing in any category, other than conservation dependent. For each species please include:

a. the scientific name, common name (if appropriate), category it could become eligible for listing in;
b. data on the current status of the species in relation to the criteria for listing;
c. specific information on how the threatening process threatens this species; and
d. information on the extent to which the threat could change the status of the species in relation to the criteria for listing.

Native Fish

There are several native fish species considered threatened, or of conservation concern at the state level that are impacted by carp and potentially could become listed nationally. It is rare that carp alone will sufficiently impact these species to solely justify listing under the EPBC Act, it is more a case of the cumulative impacts on the ecosystems as a whole which often include the effects of river regulation and water management, habitat degradation and extreme weather events such as the Millenium drought in combination with carp impacts that could lead to the species being nominated and subsequently listed.

Species: *Ambassis agassizii*
Common name: Olive perchlet, Agassiz's glassfish
Status: not yet listed under the EPBC Act

International (IUCN)	National (EPBC-listed)	SA	Vic	NSW	ACT	QLD	WA
LC	–	Prot	Ex	En	–	–	–

En = Endangered; Ex= Extinct; LC = Least Concern; Prot = Protected under SA Fisheries Management Act 2007; – = not assessed

This species is now considered extinct in Victoria (last record 1922) and South Australia (last record in 1983) (Whiterod and Zukowski et al. 2019). It was considered absent from the NSW section of the southern MDB, before it was rediscovered (after a 47-year absence) in large numbers in the Lachlan River catchment (McNeil and Wilson et al. 2008 ; Lintermans and Lutz et al. 2024). While the species has been lost to the Paroo and Warrego catchments, it has been found in the Gwydir catchment since 2010 (being absent between 1980 and 2010)(Lintermans and Lutz et al. 2024). Carp and river regulation have been suggested as the reason for declines. In NSW reduction and degradation of in stream macrophytes have been identified as contributing to declines (NSW DPI 2013). Predation on olive perchlet eggs and juveniles has also been inferred (MDB Authority 2024).

Species: *Mogurnda adspersa*
Common name: Southern purple-spotted gudgeon
Status: the MDB lineage is currently under assessment for EPBC listing – assessment due October 2025

International (IUCN)	National (EPBC-listed)	SA	Vic	NSW	ACT	QLD	WA
LC	–	Cr	Cr	En	–	–	–

Cr = Critically Endangered; En = Endangered; LC = Least Concern; – = not assessed

Historically, Southern purple-spotted gudgeon was broadly distributed across coastal areas of Queensland and NSW as well as patchily occurring in the MDB. In the southern MDB, it was once widespread and common in wetland and fringing river habitat in the Lachlan, Murrumbidgee and Murray catchments (including lower Murray) but has since experienced substantial decline. It was thought extinct in Victoria and South Australia, but was rediscovered in 1995 in Victoria, lost again, and rediscovered again in the lower Murray (2002) and in the Kerang Lakes (2019) (Lintermans and Lutz et al. 2024).

Species: *Tandanus tandanus*
Common name: Freshwater catfish
Status: not yet listed under the EPBC Act

International (IUCN)	National (EPBC-listed)	SA	Vic	NSW	ACT	QLD	WA
LC	–	En	En	En	–	–	–

En = Endangered; LC = Least concerned; – = not assessed

Carp are suspected of predation on freshwater catfish eggs, and nest disturbance (Lintermans 2023). Competition for resources such as suitable breeding ground and food (macroinvertebrates) (ARI 2024). Carp have been shown to introduced and carry parasites such as *Lernaea* species, which are known to infect freshwater catfish (Lintermans 2023).

Other Vertebrates
There is limited information on the interaction of carp with other aquatic vertebrates such as amphibians and reptiles. Amphibians are likely to be impacted in some instances, particularly egg and tadpole predation, however there are insufficient data to suggest species could become eligible for listing solely due to carp.

Species: *Ornithorhynchus anatinus*
Common name: Platypus
Status: under consideration for listing under the EPBC Act as Vulnerable

International (IUCN)	National (EPBC-listed)	SA	Vic	NSW	ACT	QLD	WA
–	–	–	Vu	–	–	–	

Vu = Vulnerable; – = not assessed

Recent calls for the listing of the platypus under the EPBC Act have been made in response to apparent population declines associated with multiple threats to their environments. Interactions with carp have not been investigated, but it is likely indirect effects caused by their feeding mechanism leading to increased sedimentation and reduced benthic food availability, may affect platypus (Bino and Kingsford et al. 2019).

Macrophytes
Macrophytes can be impacted via different pathways when carp are present, this is particularly true for those species which attach to the benthos, which carp disturb during feeding. Impacts on macrophytes can be both direct and indirect (e.g., Pietsch and Hirsch (2015) and references therein). Logically, any submergent plant species known to occur in aquatic ecosystems has the potential to be negatively affected by carp via:

- physical disturbance, e.g., carp dislodging seedlings,
- changes to water quality, e.g., increased turbidity in the water column limiting light penetration which potentially reduces germination cues and germination success,
- changes to soil consolidation, e.g., reduced submerged vegetation cover in wetlands changes the way wetland soils function which leads to ‘fluffier / flocky’ soils which has an amplifying effect on suspended sediment and turbidity in the water column; ‘fluffy/flocky’ soils also make it much harder for tiny seedlings to develop roots in soils that will stay in place; root structures of species such as *Vallisneria* or *Marsilea* may help to hold the soil together which results in firmer soil that is

easier for other plants to germinate into; similar thinking could apply to riverbanks, loss of vegetation and erosion (C. Campbell 2025, pers. comm. 13 March).

Whilst evidence specific to individual species is lacking in most cases, advice is that softer annual submerged species belonging to *Myriophyllum*, *Callitriche* and *Nitella* would be impacted if they occur in sites with a riverine connection. Carp will rapidly move into these sites when they fill so hydroperiod and dry phase are less important than the connection type (S. Wassens 2025, pers. comm. 17 March). This observation is supported by carp exclusion trials undertaken at Gunbower Forest where higher cover of macrophytes was observed in plots where carp were excluded (Bennetts and Sims et al. 2018 ; Bennetts 2021). Robust milfoil (*Myriophyllum papillosum*) dominated exclusion plots with all four sides fenced at Little Reedy Lagoon in several treatment years, and clove-strip or water primrose (*Ludwigia peploides* subsp*. montevidensis*) was only found in exclusion plots, indicating a viable seed bank was present. Swamp lily (*Ottelia ovalifolia*) dominated exclusion plots with all four sides fenced Little Reedy Lagoon in 2015. Overall whilst changes in macrophytes at Gunbower Forest were attributed to carp impacts, they were not the only factor influencing the results – water depth, turbidity and hydroperiod were all considered to contribute to the results (Bennetts 2021).

Species: *Cycnogeton dubium*
Common name: Slender water-ribbons
Status: not yet listed under the EPBC Act

International (IUCN)	National (EPBC-listed)	SA	Vic	NSW	ACT	QLD	WA
–	–	–	En	–	–	–	

En = Endangered; – = not assessed

This species is restricted to the northern districts of Victoria within the catchment of the Murray River. The taxon is recorded within the Murray Fans, Murray Mallee, Robinvale Plains, Victorian Riverina and Wimmera bioregions. It is also found in Western Australia, Northern Territory, Queensland and NSW (Messina 2014).

C. dubium is identified as potentially susceptible to carp-induced increases in turbidity and damage by carp to the bases of emergent aquatics, such as *Baumea* spp., *Eleocharis* spp. and possibly also *Cycnogeton* spp. (DEWLP 2021)(Threatened species assessment).

Species: *Hydrilla verticillata*
Common name:
Status: not yet listed under the EPBC Act

International (IUCN)	National (EPBC-listed)	SA	Vic	NSW	ACT	QLD	WA
–	–	Rare	Vu	–	–	–	–

Vu = Vulnerable; – = not assessed

Identified as a Victorian listed species potentially impacted by carp (D. Cook 2025, pers. comm. 28 February). Mesocosm studies in China showed that carp had greater impact for the meadow forming Vallisneria than for the canopy forming Hydrilla, with no significant change in the control and treatment with common carp (Qiu and Mei et al. 2019). Qiu and Mei et al. (2019) attributed the lack of response by Hydrilla as carp's preference for Vallisneria as a food plant, and that Hydrilla has faster growth, which may offset the impacts. In addition, in the trials, the Hydrilla was less affected by the changes in light attenuation as the leaves were mostly in the surface layer.

Within the Australian footprint of carp, *Hydrilla verticillata* has a sparse and scattered distribution occurring along the Murray River in Victoria and South Australia, the northern coastal areas of NSW and a few scattered inland locations in NSW (Atlas of Living Australia data accessed 8/03/2025).

Species: *Najas tenuifolia*
Common name: Water nymph and thin leaved-naiad
Status: not yet listed under the EPBC Act

International (IUCN)	National (EPBC-listed)	SA	Vic	NSW	ACT	QLD	WA
–	–	Rare	En	–	–	–	–

En = Endangered; – = not assessed

Distribution is predominantly northern Australia, and southeastern Australia to South Australia. The southern extent of the species (NSW, Victoria and South Australia) is within the current footprint of carp and has been identified as potentially impacted (D. Cook 2025, pers. comm. 28 February).

Species: *Nymphoides crenata*
Common name: Wavy marshwort
Status: not yet listed under the EPBC Act

International (IUCN)	National (EPBC-listed)	SA	Vic	NSW	ACT	QLD	WA
–	–	Rare	En	–	–	–	–

Wavy marshwort grows on floodplains, in wetlands, irrigation channels, and occasionally in slow-flowing streams where the depth of the water is up to about 1.5 m deep (Atlas of Living Australia, accessed 22/03/2025). An amphibious species that occurs on mud and will persist on drying mud it has been recorded in carp exclusion treatment plots in Gunbower Forest (K. Bennetts 2025, pers. comm. 28 February). It is able to tolerate higher turbidities as it has floating leaves. This species is found in all Australian states, particularly along the tropical north, but is absent from southwest of WA and areas beyond the Murray River in South Australia. Within the MDB, and footprint of carp, the species is wide ranging with sparse records in the northern Basin, very few in the central parts of NSW with most records along the central Murray River in the vicinity of Barmah and Gunbower Forests.

Invertebrates - molluscs

As with macrophytes and other vertebrates, empirical data on the impacts of carp on aquatic invertebrate species in Australia are very limited. Benthic macroinvertebrates, such as molluscs, are potentially more susceptible to carp predation and are identified as an at-risk group by a number of studies (Benson and Stewart et al. 2021 ; Böhm and Dewhurst-Richman et al. 2021). Paleo investigations along the Darling-Baaka and Barwon Rivers have shown molluscs to be the most common aquatic fauna in the middens, including the river mussel (*Alathyria jacksoni*), floodplain mussel (*Velesunio ambiguous*), followed by the river snail (*Notopala*) (Balme 1990, 1995) cited in Mallen-Cooper and Zampatti (2020). McCasker and Humphries (2021) noted that seven of the 30 Australasian hyriids are currently listed as threatened either at the state, national or international levels. Most of the unlisted species are data deficient, which may be masking a broader conservation concern (McCasker and Humphries 2021).

The impacts of introduced cyprinids on freshwater bivalves are multi-faceted. Smaller native freshwater bivalves such as the native cyrenid *Corbicula australis* make an easy meal for the indiscriminate appetite of carp (Koehn 2004). Native fish that carp have displaced, such as the freshwater catfish (*Tandanus tandanus*), also feed on *C. australis* (Davis 1977). Additionally, it is possible that carp and goldfish feed on juvenile freshwater mussels and may be, in part, responsible for the apparent recruitment failure of *Alathyria jacksoni.* which is currently on the FPAL under the EPBC Act (M. Klunzinger 2025, pers. comm. 9 March).

Species: *Alathyria jacksoni*
Common name: Southern river mussel,
Status: nominated as Vulnerable in 2023 under the EPBC Act, due for assessment by October 2025 (M. Klunzinger 2025, pers. comm. 9 March)

International (IUCN)	National (EPBC-listed)	SA	Vic	NSW	ACT	QLD	WA
DD	–	–	–	Vu	–	–	–

DD = Data Deficient; Vu = Vulnerable; – = not assessed

This species is found in the MDB predominantly in slow flowing permanent lower sections of rivers in Queensland, New South Wales, and Victoria. They are not currently found in South Australia.

Freshwater mussels (Bivalvia: Unionida) have a larval stage, 'glochidia' in the Unionidae, Margaritiferidae and Hyriidae, that are usually parasitic on fishes and in rare cases amphibians or forgo parasitism (Bauer 2001). Australian freshwater mussels appear to be host fish 'generalists' with most fish species (including several introduced species) supporting the metamorphosis stage in the life history from glochidia to free-living juvenile mussels (Sheldon and McCasker et al. 2020). Once glochidia attach to their host, they undergo a stage of metamorphosis over a period of weeks to months, to emerge as juvenile freshwater mussels (Bauer 2001). Walker and Jones et al. (2014) showed that glochidia of Australian freshwater mussels of the MDB, *Velesunio ambiguus* and *Alathyria jacksoni* failed to attach to carp and Klunzinger and Beatty et al. (2012) demonstrated that goldfish were unable to serve as a host for glochidia of *Westralunio carteri*. Other studies have found carp and goldfish (*Carassius auratus*) consistently reject glochidia in several species of mussel (M. Klunzinger 2025, pers. comm. 9 March). The dominance (in terms of biomass) of carp in the MDB pose a significant threat to successful recruitment of freshwater mussel populations if they are unable to act as host species (Sheldon and McCasker et al. 2020).In the last systematic research review of the Australasian freshwater mussels (Hyriidae), Walker and Jones et al. (2014) also suggested that carp predated on juvenile freshwater mussels. Where carp have displaced much of the native fish biomass and native fish fauna (>90 per cent of fish biomass in many cases), such as in the Darling-Baaka River, this is undoubtedly reducing the reproductive success of glochidia, particularly in *A. jacksoni* where much fewer native fishes (i.e., known hosts for glochidia) are available to support their glochidia. Such is the case in a similar European scenario where the homogenisation of non-native fishes led to an excessive loss of host availability for native freshwater mussels that were unable to utilise non-native fishes as hosts (Douda and Lopes-Lima et al. 2013).

Mallen-Cooper and Zampatti (2020) report on surveys at 16 sites along 1500 km of the Darling-Baaka and Barwon River in 2019 for the river mussel *A. jacksoni* and the Darling River snail (*Notopala sublineata sublineata*) (see below). Deceased river mussels were constantly found at all 16 sites with only one site supporting live individuals. Over the 2018-2019 summer, a mass fish kill event took place in a 30 km stretch of the Lower Darling-Baaka River which resulted in hundreds of thousands to over a million dead fish (Vertessy and Barma et al. 2019), but also had significant impacts on the mussel fauna, with river mussel deaths extending from Menindee upstream for 1500 km to QLD (Mallen-Cooper and Zampatti 2020). This period included an unprecedented period of 433 days of zero flow at Bourke, the longest in the 134-year record. In addition, where water did remain in the system there was a shift from lotic to lentic conditions, which are strong drivers of ecosystem processes and determining biotic compositions. River mussel only occur in flowing systems not in lentic systems or rivers with long periods of zero flow (Mallen-Cooper and Zampatti (2020) and references therein). Interactions between carp, altered flow regimes and climate change pose a serious synergistic threat to the persistence of this species in the MDB.

Species: *Notopala hanleyi*
Common name: Hanley's River snail
Status: not yet listed under the EPBC Act

International (IUCN)	National (EPBC-listed)	SA	Vic	NSW	ACT	QLD	WA
–	–	–	–	Cr	–	–	–

Cr = Critically endangered; – = not assessed

The Hanley's river snail *Notopala hanleyi* occurs in the Murray and Murrumbidgee catchments, and is listed as Critically Endangered under the NSW *Fisheries Management Act 1994* (NSW Fisheries Scientific Committee 2016). Predation and habitat degradation caused by carp has been identified as a key threat to this species (NSW Department of Primary Industries 2007). The decline in this species and *N. sublineata* coincided with the expansion of carp into the MDB.

Species: *Notopala sublineata*
Common name: Darling River snail (MDBA lineage)
Status: not yet listed under the EPBC Act

International (IUCN)	National (EPBC-listed)	SA	Vic	NSW	ACT	QLD	WA
En	–	–	–	Cr	–	–	–

Cr = Critically endangered; En = Endangered; – = not assessed

Notopala sublineata (Murray-Darling Basin population consisting of *N.s. sublineata* and *N.s. hanleyi*) was considered ineligible for listing under the EPBC Act in 2004 (Department of Climate Change Energy the Environment and Water 2021) due to unresolved taxonomy, but was considered extinct in its natural habitat in NSW (Fisheries Scientific Committee 2016). The Darling River snail *N. sublineata,* was recently found in the lower Darling-Baaka River (Marshall and Blessing et al. 2019). Habitat degradation and predation by carp are listed as one of the main threats to the species. In 2019 recently deceased individuals were found at four sites between Tilpa and the QLD border (Mallen-Cooper and Zampatti 2020). Prior to this survey the Darling River snail was presumed extinct in the Barwon-Darling system NSW Department of Primary Industries (2007) cited in Mallen-Cooper and Zampatti (2020). All dead snails were in desiccated rocky habitats that would have been inundated under low flow conditions.

Outside of the MDB, *N. sublineata* was abundant in the Bulloo River and Cooper Creek systems where carp are absent, but it was seldom detected at sites in the MDB where carp are present (Queensland Government, unpublished data cited in Marshall and Blessing et al. (2019)). In the surveys undertaken by (Marshall and Blessing et al. 2019) no live individuals were found where carp were present, concluding carp to be clearly implicated as a likely mechanism of *N. sublineata* decline at the catchment scale and throughout the MDB.

Other invertebrates

There are no data related to other aquatic invertebrate species that may become eligible for listing under the EPBC Act. However, benthic invertebrates are both directly and indirectly impacted by carp (Fanson and Hale et al. 2024). Results are, however, variable, for example (Marshall and Blessing et al. 2019) found that general macroinvertebrate assemblages showed little to no response to the presence of carp at the catchment scale and did not reduce macroinvertebrate density or composition in the dryland rivers surveyed. This contrasts with other studies that have shown impacts (e.g., Kloskowski (2011) ; Vilizzi and Thwaites et al. (2014)). Evidence for both top down and bottom-up effects on macroinvertebrate communities exist (e.g., Matsuzaki and Usio et al. (2009) ; Huser and Bartels (2015) ; Kaemingk and Jolley et al. (2016)). Zooplankton are a key food resource for carp and are prey for juvenile to adult stages. The size and type of prey items taken is influenced by the carps' two distinct morphological features that facilitate omnivory (Huser and Bartels 2015).The branchial sieve is a filter-like structure attached to the branchial arches with the mesh size determining the prey size able to be consumed. As carp grow the mesh becomes less effective at retaining smaller sized prey, resulting in less efficient planktivory when carp reach around 30 cm. At this point there is a shift to benthivory and consumption of larger prey items is facilitated by special characteristics of the feeding apparatus such as a protusible mouth, toothless jaws and toothless palatine, and palatal and postlingual organs (Sibbing (1991) cited in (Huser and Bartels 2015)). The protusible mouth is especially well adapted to ingest large prey producing a strong suction flow able to lift attached prey with prey size limited by the gape width (Huser and Bartels 2015). Ingested food is then transported to the chewing cavity where it is then crushed between the pharyngeal jaws and the chewing pad, crushing hard materials such as seeds, molluscs and debris (Huser and Bartels

2015).

7. ECOLOGICAL COMMUNITIES THAT COULD BECOME ELIGIBLE FOR LISTING AND JUSTIFICATION

Provide details and justification of non-EPBC Act listed ecological communities that, due to the impact of the threatening process, could become eligible for listing in any category. For each ecological community please include:

a. the name of the ecological community (published or otherwise generally accepted), category it could become eligible for listing in;
b. data on the current status in relation to the criteria for listing;
c. specific information on how the threatening process threatens this ecological community; and
d. information on the extent to which the threat could change the status of the ecological community in relation to the criteria for listing.

State listed ecological communities that are impacted by carp include those listed below.

Community: Aquatic ecological community in the natural drainage system of the lower Murray River catchment
Status: Endangered, NSW Fisheries Act 1994 (Date effective 21-Dec-2001)

The Fisheries Scientific Committee noted carp and other invasive species as a threat to this ecological community, however little information was provided in the final determination. The threatened ecological community includes the Murray River from Hume weir downstream, the Murrumbidgee River downstream of Burrinjuck Dam, the Tumut River downstream of Blowering Dam and all their tributaries, anabranches, and effluents including Billabong Creek, Yanco Creek, Colombo Creek, and their tributaries, the Edward River and the Wakool River and their tributaries, anabranches and effluents, Frenchmans Creek, the Rufus River and Lake Victoria. Lake Victoria is also included in the nominated EPBC threatened ecological community for the River Murray and associated wetlands, floodplains and groundwater system, from the junction with the Darling River to the sea (see below).

The impacts from carp and other invasive species are listed as a key threatening process affecting this ecological community (Fisheries Scientific Committee 2001 ; NSW DPI 2007b).

Community: Aquatic ecological community in the natural drainage system of the lowland catchment of the Lachlan River
Status: Endangered, NSW Fisheries Act 1994 (Date effective 2-Dec-2005)

The Fisheries Scientific Committee noted carp and other invasive species as a threat to this ecological community The incursion of carp into the Lachlan system began in the 1960s and rapidly increased in the 1970's. Historical and anecdotal information suggests that carp had a rapid and dramatic effect on the Lachlan River and its tributaries commencing in the 1970's. Reduced numbers of yabbies (*Cherax destructor*) in most parts of the Lachlan River has been attributed in part to carp and other predatory invasive species (NSW Fisheries Scientific Committee 2005 ; NSW DPI 2006).

Community: Aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River
Status: Endangered, NSW Fisheries Act 1994 (Date effective 4-Jul-2003)

The impacts from carp and other invasive species are listed as a key threatening process affecting this ecological community, but with little detail on the actual impacts per se (NSW Fisheries Scientific Committee 2003 ; NSW DPI 2007a).

Two ecological communities are currently awaiting a Ministerial decision on listing under the EPBC Act.

Community: River Murray and associated wetlands, floodplains and groundwater systems, from the junction with the Darling River to the sea
Status: Ministerial decision is pending
Proposed conservation status: Critically Endangered

The key factors contributing to the decline of the River Murray and its eligibility for listing is the widespread decline of key species and taxonomic groups, reductions in community integrity and biodiversity of habitats, and the unlikelihood restoration processes to be effective or implemented in the short-term (TSSC 2024a).

Carp represents a major threat to the ecological community through direct, indirect and cumulative effects. They are currently the most abundant freshwater fish in the ecological community and compete with native fish for resources such as food and suitable habitat, particularly during early life-history stages (TSSC 2024a). Carp also increase turbidity and damage aquatic macrophytes and insect populations due to their benthic feeding behaviours (TSSC 2024a).

Immediate goals and high priorities listed on the draft conservation advice include reducing, excluding or eliminating carp, particularly at key sites such as Chowilla highlighting the significance of the threat (TSSC 2024a).

Community: Wetlands and inner floodplains of the Macquarie Marshes
Status: Ministerial decision is pending
Proposed conservation status: Endangered or Critically Endangered

The ecological community is found in the semi-arid and temperate northern MDB of NSW. Hydrological changes in the southern, upstream end of the Macquarie Marshes used for irrigation and floodplain harvesting has reduced inflows to sections of the Wambuul/Macquarie River (TSSC 2024b). Hydrological changes and weir pool environments create ideal conditions for carp to spawn increasing their biomass in the area (TSSC 2024b). Carp also competes with native fish for resources and uproot aquatic macrophytes creating turbidity and lowering biodiversity (TSSC 2024b).

Criterion B: Listing in a higher threat category

8. SPECIES THAT COULD BECOME ELIGIBLE FOR LISTING IN A HIGHER THREAT CATEGORY AND JUSTIFICATION

Provide details and justification of EPBC Act listed threatened species that, due to the impacts of the threatening process, could become eligible for listing in another category representing a higher degree of endangerment. For each species please include:

a. the scientific name, common name (if appropriate), category that the item is currently listed in and the category it could become eligible for listing in;
b. data on the current status of the species in relation to the criteria for listing (at least one criterion for the current listed category has been previously met);
c. specific information on how the threatening process significantly threatens this species; and
d. information on the extent to which the threat could change the status of the species in relation to the criteria for listing. This does not have to be the same criterion under which the species was previously listed.

According to experts consulted (see Section 14), there is unlikely to be no freshwater native fish undergo a status change unless there was a barrier breach and carp move into areas where the native fish fauna is relatively intact (e.g., above Copeland dam on the Gwydir River). Many of the smaller native EPBC listed native fish are found in upland environments where carp are not prevalent. In some situations, such as for sub-populations of the Southern pygmy perch, barrier breaches by carp (and redfin perch (*Perca fluviatilis*)) may have a significant impact (Pearce and Silva et al. 2018).

Species: *Nannoperca australis*
Common name: Southern pygmy perch
Status: Listed as Vulnerable under the EPBC Act (Murray-Darling Basin lineage) (Date effective 13-Apr-2021)

International (IUCN)	National (EPBC-listed)	SA	Vic	NSW	ACT	QLD	WA
NT	Vu	En	Vu	En	–	–	–

En = Endangered; NT = Near Threatened; Vu = Vulnerable; – = not assessed

Southern pygmy perch do not co-exist with carp where they are present in high abundance (Pearce 2014) cited in Todd and Koehn et al. (2017). Historically Southern pygmy perch occurred in the Southern MDB in the lower Murrumbidgee and Murray catchments (and tributaries). In 2002 it was discovered in the upper Lachlan catchment (Osborne and Lintermans 2002). Loss of habitat, non-native species interactions and the Millennium drought resulted in widely distributed sub-populations becoming fragmented, with local extirpation occurring at several localities in the middle and upland Murray catchment. At other sites sub-populations are contracting as non-native species (particularly redfin, *Perca fluviatilis*) continue to expand (Zukowski and Whiterod et al. 2021 ; Lintermans and Lutz et al. 2024). Specifically, declines in abundance and distribution are thought to be related to a loss of aquatic vegetation and habitat alteration resulting in increased predation and competition from invasive species in particular carp, redfin and Eastern gambusia (*Gambusia holbrooki*) (Pearce and Silva et al. 2018 ; Koehn and Raymond et al. 2020). This indicates the threat from non-native species as a major threat to the species.

9. **ECOLOGICAL COMMUNITIES THAT COULD BECOME ELIGIBLE FOR LISTING IN A HIGHER THREAT CATEGORY AND JUSTIFICATION**

Provide details and justification of EPBC Act listed threatened ecological communities that, due to the impacts of the threatening process, could become eligible for listing in another category representing a higher degree of endangerment. For each ecological community please include:

a. the complete title (published or otherwise generally accepted), category that the item is currently listed in and the category it could become eligible for listing in;
b. data on the current status of the ecological community in relation to the criteria for listing (at least one criterion for the current listed category has been previously met);
c. specific information on how the threatening process significantly threatens this ecological community; and
d. information on the extent to which the threat could change the status of the ecological community in relation to the criteria for listing. This does not have to be the same criterion under which the ecological community was previously listed.

No data regarding ecological communities that could become eligible for listing in a higher threat category were identified. This part of Criterion B is not met.

Criterion C: Adversely affected listed species or ecological communities

10. **SPECIES ADVERSELY IMPACTED AND JUSTIFICATION**

Provide a summary of species listed as threatened under the EPBC Act, which are considered to be adversely affected by the threatening process. For each species please include:

a. the scientific name, common name (if appropriate) and category of listing under the EPBC Act; and
b. justification for each species that is claimed to be affected adversely by the threatening process

There are currently 24 species listed on the EPBC act that are adversely impacted by the presence of carp (Table 1) These species are comprised or 13 fish species, four amphibian species, three crustacean species, two plants species, one reptile, and one mollusc, with many impacted by carp via loss of viable habitat and competition. Thirteen of the listed species have not been reviewed for over 10 years – with some listings being 25 years old. Due to the lack of monitoring of threatened species, and the widespread nature of carp impacts, evidence is limited.

Table 1. Species currently listed under the EPBC that are adversely impacted by carp and their justification. Unless stated otherwise references for impacts are the species Conservation Advice.

Species Name (Common and Scientific)	EPBC Listing	Justification of threat
Fish		
Flathead galaxias (*Galaxias rostratus*)	Critically Endangered (Date effective 05-May-2016)	• Loss of aquatic vegetation and other viable habitat due to carps benthic feeding behaviour and water quality impacts • Predation on flathead galaxias by carp
Bald carp gudgeon (*Hypseleotris gymnocephala*)	Critically Endangered (Date effective 7 Sept 2023)	• Competition for resources such as viable habitat and food
Silver perch (*Bidyanus Bidyanus*)	Endangered (Date effective 21-Dec-2013), updated to Endangered (Date effective 16 July 2024) as a nongenuine change in listing representing new information.	• Reduction of aquatic vegetation and other viable habitat due to carp benthic feeding behaviour and water quality impacts such as increased turbidity • Competition for food and other resources at both adult and juvenile life stages

Murray hardyhead (*Craterocephalus fluviatilis*)	Endangered (Date effective 10-March-2012)	• Loss and reduction of aquatic macrophytes and other viable habitat due to carp benthic feeding behaviour and water quality impacts such as increased turbidity • Predation by carp on Murray hardyhead's • Infection by the Asian fish tapeworm that was introduced and is vectored by carp
Golden galaxias (G*alaxias auratus*)	Endangered (Date effective 06-Jun-2005)	• Predation by carp on golden galaxias • Competition with carp for resources such as food and suitable habitat
Dwarf galaxias (*Galaxiella pusilla*)	Endangered (Date effective 15-Nov-2023)	• Loss and reduction of aquatic macrophytes and other viable habitat due to carp benthic feeding behaviour and water quality impacts such as increased turbidity
Trout cod (*Maccullochella macquariensis*)	Endangered (Date effective 16-Jul-2000)	• Loss and degradation of aquatic macrophytes and other viable habitat due to carp benthic feeding behaviour and water quality impacts such as increased turbidity • Decrease in plankton and aquatic invertebrates reducing viable food sources for trout cod • Infection by the tapeworm *Bothriocephalus acheilognathi* which is transmitted and vectored by carp
Macquarie perch (*Macquaria australasica*)	Endangered (Date effective 16-Jul-2000)	• Competition with carp for resources such as food and suitable habitat and predation by carp on Macquarie perch at all life stages • Carp introduced and transmit parasites such as Lernaea sp and Chilodonella cyprini, which are known to infect Macquarie perch (Lintermans 2023)
Yarra pygmy perch (*Nannoperca obscura*)	Endangered (Date effective 15-Nov-2023)	• Loss and degradation of aquatic macrophytes and other viable habitat and breeding grounds due to carp benthic feeding behaviour and water quality impacts such as increased turbidity
Murray cod (*Maccullochella peelii*)	Vulnerable (Date effective 03-Jul-2003	• Carp carry and transmit parasites such as *Lernaea sp* and Asian Tape Worms which are known to infect Murray Cod • Reduce suitable habitat by modifying waterways and increasing turbidity which reduces plankton and aquatic macrophyte abundance
Australian grayling (*Prototroctes maraena*)	Vulnerable (Date effective 16-Jul-2000)	• Carp carry and transmit parasites such as *Lernaea sp*, which are known to infect Australian Grayling
Variegated pygmy perch (*Nannoperca variegata*)	Vulnerable (Date effective 16-Jul-2000)	• Loss and degradation of aquatic macrophytes and other viable habitat and breeding grounds due to carp benthic feeding behaviour and water quality impacts such as increased turbidity (2014/15)
Southern pygmy perch-MDB (*Nannoperca australis* MDB	Vulnerable (Date effective 13-Apr-2021)	• Loss and degradation of aquatic macrophytes and other viable habitat due to carp benthic feeding

lineage)		behaviour and water quality impacts such as increased turbidity (Pearce 2014)
Reptiles		
Bellinger River saw-shelled Turtle (*Myuchelys georgesi*)	Critically Endangered (Date effective 7-Dec-2016)	• Increased sedimentation and smothering of the stream bed by carp increases turbidity and restricts macrophyte growth reducing available food sources and water quality.
Crustaceans		
Fitzroy falls spiny crayfish (*Euastacus dharawalus*)	Critically Endangered (Date effective 7-Dec-2016	• Predation on Fitzroy Falls spiny crayfish by carp
Glenelg spiny freshwater crayfish (*Euastacus bispinosus*)	Endangered (Date effective 10-Mar-2016)	• Limited information in the Conservation Advice, but carp are listed as posing a threat to the species.
Murray spiny crayfish (*Euastacus armatus*)	Vulnerable (Date effective 5-Mar-2025)	• Predation and competition for resources. • Considered likely that predation by invasive fish, including carp, may affect mortality rates of juveniles
Molluscs		
Glenelg freshwater mussel (*Hyridella glenelgensis*)	Critically Endangered (Date effective 23-Dec-2010)	• Carp predate on juvenile mussels • Loss and degradation of aquatic macrophytes and other viable habitat due to carp feeding behaviour and water quality impacts such as increased turbidity
Amphibians		
Booroolong frog (*Litoria booroolongensis*)	Endangered (Date effective 18-Dec-2007)	• Carp create in-stream sediment disturbances that fill crevices in rocky substrates used by the Booroolong frog • Carp predate on Booroolong frog eggs and larvae
Green and golden bell frog (*Litoria aurea*)	Vulnerable (Date effective 16-Jul-2000)	• Carp predate on green and golden bell frog eggs and tadpoles
Davies' tree frog (*Litoria daviesae*)	Vulnerable (Date effective 15-March-2023)	• Carp predate on Davies tree frog eggs and tadpoles • Loss and degradation of aquatic macrophytes and other viable habitat due to carp feeding behaviour and water quality impacts such as increased turbidity
Southern bell frog (*Litoria raniformis*)	Vulnerable (Date effective 16-Jul-2000)	• Carp predate on southern bell frog eggs and tadpoles • Loss and degradation of aquatic macrophytes and other viable habitat due to carp feeding behaviour and water quality impacts such as increased turbidity
Plants		
River swampy wallaby-grass *(Amphibromus flutians)*	Vulnerable (Date effective 26-Mar-2008)	• Perennial aquatic (amphibious) grass occurring in permanent to seasonally fluctuating wetlands; grows in the water column, Feeding behaviour and turbidity impacts are likely. (Direct observation - D. Cook 2025, pers. comm. 28 February)

Ridged water-milfoil *(Myriophyllum porcatum)*	Vulnerable (Date effective 16-Jul-2000)	• Carp feeding in sediment which can increase turbidity and lead to shading of aquatic macrophytes. • Foraging by adults may also be a threat to the rare *Myriophyllum* species (Goulburn Broken CMA 2012)

11. ECOLOGICAL COMMUNITIES ADVERSELY IMPACTED AND JUSTIFICATION

Provide a summary of ecological communities listed as threatened under the EPBC Act that are considered to be adversely affected by the threatening process. For each ecological community please provide:

a. the listed name of the threatened ecological community and category of listing under the EPBC Act; and
b. justification for each ecological community that is claimed to be affected adversely by the threatening process, including the severity of the impact on each species.

Note that two ecological communities that are impacted by carp are currently awaiting a Ministerial decision on their being listed and so have been placed under Criterion A. If approved for listing, they will fall within Criterion C.

Community: Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community
Status: Listed as Endangered (Date effective 25-Oct-2018)

Carp are highly fecund and opportunistic species that can inhabit brackish water, they compete with native fish for resources, destroy aquatic macrophytes and reduce water quality through their benthic feeding behaviours which can lead to the erosion and collapse of riverbanks. They are currently distributed in low numbers across the Glenelg River and Thompsons Creek (TSSC 2018).

Threat Abatement

12. THREAT ABATEMENT

Describe what actions could be taken to abate the threatening process. Link these to the components of the threatening process as described in question 4.

A variety of investigations and methods have been trialed to reduce the carp population in Australia, but none have been independently successful in the long-term, wide scale reduction of carp to date. The use of integrated pest management utilises a multi-tiered approach that incorporates prevention, early detection measures, monitoring, and containment or control tools to help aid in the reduction of carp biomass (Brown and Gilligan 2014). A summary of techniques that have been used for carp control in Australia are provided below.

Electrofishing
Electrofishing is considered to be the most successful tool for carp removal in Australia to date (Norris and Hutchison et al. 2014). Electrofishing is a versatile tool that can be used in a range of habitat types and conditions and has minimal effects on native fish. It is most effective when used in clear shallow waters that have low conductivity, portable barriers and pre-feeding can also be used to increase effectiveness (Norris and Hutchison et al. 2014). Research by Andrew Norris found that water quality parameters heavily influenced the efficiency of electrofishing, in waters with extremely high or low conductivities the size of the effective stunning field was reduced and lower densities of carp were captured (Norris and Hutchison et al. 2014). Electrofishing can be successful at a local level but has a high capital cost and is labour intensive, it also doesn't prevent reinfestation in an open and connected system (Norris and Hutchison et al. 2014). Recent electrofishing operations conducted in Lake Toolondo and Lake Wendouree to reduce the carp populations cost $25,000 and $17,500, respectively.

Water level manipulation
Manipulating the water level is a technique that has been used to help reduce carp numbers and spawning activities (Norris and Hutchison et al. 2014). It aims to eradicate carp by removing their water source, or concentrating the population by reducing a water source and using other removal methods to finish the eradication (Norris and Hutchison et al. 2014). This method is viable for all life-stages as it can be used to cut off access to viable breeding grounds or to desiccate eggs once they have been laid (Norris and Hutchison et al. 2014). This method

can have drastic impacts on non-target species if they are not removed from the area prior to draining, it is also only viable in areas where water levels can be safely manipulated (Norris and Hutchison et al. 2014).

This technique has been successful in Pilby Creek in South Australia where the wetland area was drained and 1,200 carp were removed, a carp screen and control drain were installed to prevent reinvasion (Norris and Hutchison et al. 2014). This project cost $103,500 and was successful in eradicating carp in the area for five years (Norris and Hutchison et al. 2014).

Carp traps

Several versions of carp traps have been developed for carp removal, they can be portable and moved to high density locations as needed (FRDC 2022a). These designs are typically accompanied by fyke nets or food dispenser to attract carp, carp traps can capture 300-400 carp per set however their effectiveness has not been evaluated (Sanders and Morris 2018). Permanent carp traps are typically set along carp migration pathways, they are designed to exploit carps' migratory instincts and behaviours and reduce spawning opportunities (FRDC 2022a). The most successful permanent carp trap is installed at Lock 1 in the Murray River, over the 10 year trial 723 tonnes of carp were captured with only two native fish (Stuart and Conallin 2018). However successful this technique is it is not a viable option for nationwide carp control due to the population size and range of carp.

Daughterless carp

The use of daughterless carp has been assessed in Australia by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). It involves the alteration of genes so modified carp only produce male offspring (Centre for Invasive Species Solutions 2012b). The 'female lethal' gene can be passed down with the idea being the population will eventually be entirely male (Centre for Invasive Species Solutions 2012b). CSIRO has tested this gene in zebrafish and found that it reduces egg production by 70-90 per cent (Centre for Invasive Species Solutions 2012b). The effectiveness would be dependent on multiple factors such as heritability; fitness of modified fish; size of carp population at time of release; and number of modified fish released, furthermore noticeable effects on the carp population could take a century to be apparent due to carp's long lifespans (FRDC 2022d).

Commercial fishing

Commercial fishing for carp is permitted in some Australian jurisdictions and can assist in reducing carp numbers in some waterbodies. Carp have been harvested in relatively small numbers for human consumption, fertiliser and fishing bait. However, commercial fishing is generally considered non-viable for reducing the carp numbers at a population scale due to the relatively high capital and operating costs e.g., (labour intensive, extensive travel costs & processing costs) compared to the relatively low domestic market demand and price for carp.

Other physical methods

Physical removal alone is insufficient in lowering carp numbers to a sustainable level at a national scale. Other techniques that have been utilised for carp reduction include, exclusion screens and the use of carp separation cages, physical removal in the form of recreational fishing, fish downs, commercial fishing (long lining), netting (e.g., pound, drag, gill, splash and seine), a range of traps (e.g., bait, hopper and migratory) and chemicals such as Rotenone however, this technique requires a permit and poses a large risk to native fish if not used appropriately (Centre for Invasive Species Solutions 2014 ; Norris and Hutchison et al. 2014). A technique called Judas carp (transmitter carp) has also been trialed, this entails the implantation of a radio-transmitter into male carp, which are then tracked into high aggregation areas where other removal methods are utilised, this method has proved to be a successful component in Tasmania's eradication of carp however is unviable on a national scale due to the labour and resource intensity required (Patil and Purser et al. 2014).

To further aid in reducing carp numbers, it is prohibited to return them live to waterways in Victoria, South Australia and Queensland (Queensland Parliamentary Counsel 2014 ; PIR 2023 ; VFA n.d.).

Cyprinid herpesvirus 3

Cyprinid herpesvirus 3 (hereafter *'carp virus'*) is a waterborne double-stranded DNA virus which is the causative agent of the fatal koi herpes virus disease (KHVD) in carp and koi variations and hybrids (Bavarsad and Abed-Elmdoost et al. 2024). The carp virus was first discovered in Germany and Israeli aquaculture facilities in the 1990's, today the carp virus is found in 38 countries. However, it is not currently present in Australia (Samsing and Hopf et al. 2021). The carp virus is species specific and highly contagious and causes one off mass mortality in carp, koi and hybrid species with juvenile carp demonstrating higher mortality rates (Bavarsad and Abed-Elmdoost et al. 2024). The carp virus spreads through direct fish-to-fish contact and is most successful when water temperatures are between 18°–28°C and carp are in dense aggregations (demonstrated in spawning season) (Centre for Invasive Species Solutions n.d.). Symptoms of disease in carp typically appear within 7-14 days with mortality following a few days after, carp that survive remained infected for their lifetime and are capable of spreading the virus when stressors are present (Centre for Invasive Species Solutions n.d.). The carp virus has never been utilised as a biocontrol, but its potential has prompted the Australian government to explore its feasibility as a biocontrol agent in Australia.

A Tasmanian case study

Carp were first discovered in Tasmania in the mid 1970's and then again in 1980, these populations were small and contained and were eradicated using a rotenone treatment (Yick and Wisniewski et al. 2021). In 1995 electrofishing surveys confirmed that carp were established in Lake Cresent and Lake Sorell (Yick and Wisniewski et al. 2021). These lakes are home to many endemic fauna including the *Austropyrgus* sp., and *Galaxias auratus* which are listed under the EPBC Act 1999 (Yick and Wisniewski et al. 2021). The Inland Fisheries Service established a Carp Management Program in 1995 in an effort to control and localise the carp population (Yick and Wisniewski et al. 2021). Multiple techniques were used to eradicate carp in the lakes, including the use of carp screens, gill nets electrofishing, seine nets, transmitter carp, fyke nets, containment screens and lake closures (Figure 7). 28 years later, in 2023 carp were announced as functionally eradicated by the Inland Fisheries Service, this effort removed 49,301 carp and cost the state $400,000 annually (Diggle and Day et al. 2004 ; Inland Fisheries Service 2023).

13. DEVELOPMENT OF THREAT ABATEMENT PLAN OR AN ALTERNATIVE

Would the development and implementation of a threat abatement plan be a feasible, effective and efficient way to abate the process? If so, describe how the threat abatement actions describes in Q12 could be included in a threat abatement plan.

Describe any alternative coordinating documents or measures that may assist in abating the threatening process, either separate from or in conjunction with a threat abatement plan.

Long-term carp management and reduction has the potential to benefit aquatic ecosystems, improve water clarity and increase the abundance of native aquatic flora and fauna (FRDC 2022b).

In 2016, the Australian Government invested $10.37 million to assess the feasibility of using the carp virus as a biocontrol agent to control Australian carp populations. The Fisheries Research & Development Corporation (FRDC) led the research and undertook extensive consultation, investigations and targeted research creating one of the most "comprehensive and coordinated assessments of a biological control strategy for aquatic environments ever undertaken globally" (FRDC 2022c). The NCCP was published in 2022, alongside 19 research papers and five planning investigations (FRDC 2022b ; DAFF 2024). In 2024 the Federal government announced a further $3 million in research funding to address the remaining information gaps (VFA 2024). The outcomes developed in the NCCP will be used to inform Federal legislative approval processes under the EPBC Act 1999, Biological Control Act 1984, Biosecurity Act 2015, Water Act 2007 and Agriculture and Veterinary Chemicals Codes Act 1994 (VFA 2024). If approved for release by the Federal government, state jurisdictions will play a key role in implementing the virus's release where further consultation and approval processes will be required (VFA 2024). Figure 8 outlines the 2 phase roadmap released by the Department of Agriculture, Forestry and Fisheries in 2024 (VFA 2024).

The key findings of the NCCP are listed below

If successful, the carp virus could reduce carp populations by 40-60 per cent (DAFF 2024)
Modelling conducted under the NCCP indicate that the carp virus has the potential to reduce carp populations by 40-60 per cent with 80 per cent reductions possibly occurring in less resilient populations (FRDC 2022b). These modelling outcomes were informed by peer-reviewed science and where viable tested in laboratories (FRDC 2022b). Further testing on Australia's carp population structure and interactions between the carp virus and carp varieties in a natural and semi natural setting were recommended to further refine the understanding of the carp virus mortality rates (FRDC 2022b).

Integrated approaches may be useful in further reducing the impact of carp (DAFF 2024)
Carps large biomass and interconnected nature of the population makes carp highly resilient to control methods, due to this control techniques are unlikely to be successful if used in isolation (FRDC 2022b). Findings by the NCCP found that the carp virus is likely to be the most successful when a portion of the total carp present are removed prior to deployment, this method would also reduce the risk to negative environmental outcomes such as black water events (FRDC 2022b). Methods the NCCP recommended include genetic control technologies and physical removal, physical removal is the most accessible however the NCCP suggest that genetic control could provide longer term benefits to suppressing the carp population (FRDC 2022b).

The release of the virus would most likely cause an initial major outbreak followed by ongoing seasonal outbreaks that continue to suppress the carp population (DAFF 2024)
The deployment of the carp virus aims to achieve widescale reduction of suppression of Australian carp population for the medium and long-term (5-10 years), this will be achieved by an initial reduction followed by ongoing suppression (FRDC 2022b). The success of the carp virus is dependent on a range of factors including favorable water temperature, recurrence of infections, carp aggregations to sufficiently transmit the virus and the portion of the sub-population that become infected (FRDC 2022b). These factors indicate that spring and summer is the optional time to release the virus to ensure maximum success, as the water temperature cools the carp virus becomes latent within carp, experiments conducted under the NCCP indicate that latent carp can become active as water temperatures rise continuing the spread of the virus into the future (FRDC 2022b).

Even with the extensive research that has been conducted, there are some remaining uncertainties about the carp virus's feasibility in Australia (FRDC 2022b). The key concerns are transmissibility and water quality impacts. The World Organisation for Animal Health state that carp and carp hybrids are currently the only species that are susceptible to infection by the carp virus. Furthermore, research conducted by CSIRO concluded that the carp virus will not infect humans or any mammal, they also found no evidence of the carp virus infecting Australian aquatic organisms (FRDC 2022b). Water quality impacts are unlikely, but depend on dead carp densities and their distribution in waterways, higher densities pose a greater risk to water quality (FRDC 2022b). These risks are lowered when carp numbers are reduced prior to the release of the virus (FRDC 2022b). Research on non-target species susceptibility, carp virus latency and recrudescence, methods for large-scale production, storage, and transport of the carp virus and validating epidemiological modelling with real data are some examples of further research the NCCP has suggested (FRDC 2022b).

Further research

Long-term benefits to native flora and fauna

The NCCP covers a broad range of research including but not limited to carp biomass, socio-economic impact, virus transmissibility and deployment strategies. All the research completed and ongoing will aid in making an informed decision of release of the carp virus in Australia. A possible gap in research is the predicted benefits to induvial species due to reduced carp biomass. Although the NCCP has published papers surrounding the predicted ecosystem response to carp control, little research has been done on long-term ecosystem and species recovery (Nichols and Gawne et al. 2019).

The following case studies demonstrate how carp removal is beneficial to native flora and fauna.

Research by Cahoon (1953) explored the effects removing >72,500kg of carp from Lake Mattamuskeet, North Carolina. Notable observations were seen in water clarity which improved from 15cm of visibility to 121cm of visibility over four years, this increase saw various macrophytes reestablished and in turn reduced shoreline damage (Cahoon 1953). Creel census surveys also established that the take of game fish by recreational fishers increased by 75 per cent as compared to pre carp removal, Cahoon (1953) suggests that this is due to increased suitable spawning ground as a result of increased water clarity and macrophyte abundance.

A study by Johnson (2013) on macrophyte restoration following carp removal in 2010 indicated that by removing carp, 80 per cent of the Upper Clam Lake in Wisconsin restored its macrophyte coverage, in particular the increased abundance of northern wild rice. It was noted that due to the riverbed damage sustained by carp restoration and replantation efforts were required to help reestablish the macrophyte population (Johnson 2013)

An Australian example is the removal of rainbow trout (*Oncorhynchus mykiss)* from a section of Lees creek, Victoria in an attempt to recover the native mountain galaxias (*Galaxias olidus*) (Lintermans 2000). Results found four years following the eradication of the non-native trout, mountain galaxias had recolonised and successful breeding programs had been established (Lintermans 2000). It is important to note that the mountain galaxias did not reestablish downstream where trout populations still occur, suggesting that the species recovery is a direct response to the absence of rainbow trout (Lintermans 2000).

Clean up efforts and water quality impacts

If the carp virus was to be released the mortality rate of carp would vary depending on a range of conditions including density and temperature, Kopf and Boutier et al. (2019) suggests that a mortality rate of just 10 per cent in warmer months can result in high concentrations of dead carp. Carcass decomposition is linked to localised cases of hypoxia or anoxia and the increase of cyanobacteria blooms and in some cases botulism (Kopf and Boutier et al. 2019). The likelihood and severity of complications increases with warmer water temperatures which are required for the effective use of the carp virus (Kopf and Boutier et al. 2019). Native fish kills particularly in the MDB caused by hypoxia is increasingly common especially once dissolved oxygen concentrations drop below 2–3 mg/L, in addition wetlands, water holes and shallow lake ecosystems where carp are known to spawn are increasingly more vulnerable to hypoxia events (Kopf and Boutier et al. 2019). The concerns of the cleanup operation stem from the complexity of the MBD and associated wetlands. There is approximately 5.7 million hectares of wetlands and 16 Ramsar wetlands of international importance protected under the EPBC Act 1999, these wetlands are home to a variety of threatened fauna (waterbirds, frogs, turtles, fishes etc.) that use these habitats to breed simultaneously with carp (Kopf and Boutier et al. 2019). The NCCP have acknowledged these concerns and risks and have completed research into the predicted severity and outcomes, it is believed that the mortality events will be manageable and localised (FRDC 2022a).

The presence of carp in Australia's waterways represents a significant threat to native species and the ecosystems they inhabit. Current management strategies have proven to be ineffective, resource-intensive, and unsustainable, while comprehensive research conducted by the NCCP remains at an impasse. As a result, this invasive species continues to proliferate, further degrading ecosystems, habitats, and the biodiversity they support. Listing carp as a Key Threatening Process would enable a more focused and coordinated approach to mitigating the impacts on both known species and communities (Criterion A, B, and C), as well as those we may not yet fully understand due to gaps in up-to-date threatened species monitoring data. While listing threatened species is critical, the effectiveness of individual management plans diminishes if the underlying threats are not addressed. The listing of "Degradation and loss of inland aquatic ecosystems, habitats, and associated biota caused by Common carp (Cyprinus carpio)" would not only enhance mitigation efforts aimed at controlling carp populations but also reduce both direct and indirect impacts currently posed by this invasive species. his, in turn, will decrease the resources required for species and community recovery, enabling more efficient and sustainable conservation outcomes.

The NCCP document can be found here.

Reviewers and Further Information

14. **REVIEWER(S)**

Has this nomination been reviewed? Have relevant experts been consulted on this nomination? If so, please include their names and current professional positions.

Reviewers

- Dr Rhonda Butcher, Principal Consultant, Waters Edge Consulting
- Associate Professor Ivor Stuart, River Management and Fisheries, Charles Sturt University
- Dr Taylor Hunt, Freshwater Fisheries Manager, Victorian Fisheries Authority
- Anthony Hurst (retired), former Assistant Commissioner, NSW Health Rivers Commission; Former Director, Wild Harvest Fisheries, NSW Fisheries; Former Executive Director, Fisheries Victoria

Experts Consulted

- Associate Professor Jason Nicol, Plant Ecology Sub-program Leader, SARDI, Adelaide, South Australia.
- Associate Professor Mark Lintermans, Freshwater Fisheries Ecology and Management, University of Canberra.
- Associate Professor Paul Humphries, Environmental Sciences, Charles Sturt University
- Associate Professor Stephen Beatty, Director - Centre for Sustainable Aquatic Ecosystems, Harry Butler Institute, Murdoch University.
- Chris Bird, Senior Technical Officer, Aquatic Biosecurity, Sustainability and Biosecurity, Department of Primary Industries and Regional Development, Perth, Western Australia.
- Damien Cook, Director, Restoration Ecologist, Wetlands Revival Trust, Victoria.
- Dr Adrian Pinder, Program Leader Ecosystem Science, Biodiversity and Conservation Science, Department of Biodiversity, Conservation and Attractions, Perth, Western Australia.
- Dr Cherie Campbell, Senior Policy Officer – Native Vegetation, Riverine Ecology, Science Acquisition, Basin Science and Knowledge
- Dr Hugh Jones, Senior Environmental Water Planner at NSW Department of Planning, Industry and Environment, Sydney, NSW.
- Dr John Koehn, Adjunct Professor, Gulbali Research Institute, Charles Sturt University.
- Dr Kate Bennetts, Vegetation Ecologist, Fire, Flood, and Flora, Victoria.
- Dr Michael Klunzinger, Adjunct Research Fellow, Australian Rivers Institute, Griffith University.
- Dr Nicole McGaster, Freshwater Ecologist Research Fellow, Gulbali Research Institute, Charles Sturt University.
- Dr Nick Whiterod, Science Program Manager at the Coorong, Lower Lakes and Murray Mouth (CLLMM) Research Centre
- Dr Peter Unmack, Research Fellow, Institute for Applied Ecology, University of Canberra.
- Dr Samantha Bridgwood, Senior Research Scientist, Aquatic Pest Biosecurity, Biosecurity and Emergency Response, Department of Primary Industries and Regional Development, Perth, Western Australia.
- Jason Higham, Manager, Conservation and Threatened Species Unit, National Parks & Wildlife Service, Department for Environment and Water, Adelaide, South Australia.
- Keith Ward, TLM Barmah project manager, Goulburn Broken CMA, Victoria.
- Professor Skye Wassens, Professor in Ecology, Leader Murrumbidgee Monitoring Evaluation and Research Program, School of Agricultural, Environmental and Veterinary Sciences, Charles Sturt University.
- Tim Storer, Manager River Science - Principal Scientist (Aquatic Ecology), Department of Water and Environmental Regulation, Perth, Western Australia.

15. **MAJOR STUDIES**

Identify major studies that might assist in the assessment of the nominated threatening process.

Assessing impacts of a notorious invader (common carp *Cyprinus carpio*) on Australia's aquatic ecosystems: Coupling abundance-impact relationships with a spatial biomass model
Continental threat: How many common carp (*Cyprinus carpio*) are there in Australia?
Contribution of invasive carp (Cyprinus carpio) to fish biomass in rivers of the Murray–Darling Basin, Australia
Impacts of Carp in Wetlands
https://pestsmart.org.au/wp-content/uploads/sites/3/2020/06/Norris_carp_removal_techniques.pdf

16. **FURTHER INFORMATION**

Identify relevant studies or management documentation that might relate to the species (e.g. research projects, national park management plans, recovery plans, conservation plans, threat abatement plans, etc.).

National Carp Control Plan
National Carp Control Plan – Further studies
Threat Abatement Guidelines for the Key Threatening Process 'Novel biota and their impact on biodiversity'
Flora and Fauna Guarantee Act 1988, Action Statement- Introduction of live fish into waters within Victorian river catchments
The Murray–Darling Rivers First Nations - DCCEEW – First Nations animation

17. IMAGES OF THE THREATENING PROCESS

Please include or attach images of the threatening process and/or its impacts on native species and ecological communities if available.

Please refer to attachment 1

18. IMAGE CONSENT STATEMENT

The Department is seeking permission to use the image(s) provided with the nomination. The Department may choose to use the image in a variety of ways including (but not limited to) printed and online content, social media and press releases. The owner of the image will be attributed if the image is used.

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19. REFERENCE LIST

Please list key references/documentation you have referred to in your nomination.

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20. **APPENDIX**

Please place here any figures, tables or maps that you have referred to within your nomination. Alternatively, you can provide them as an attachment.

Please refer to attachment 2.

Nominator's details

Note: Your details are subject to the provision of the *Privacy Act 1988* and will not be divulged to third parties if advice regarding the nomination is sought from such parties.

21. TITLE

Mr.

22. FULL NAME

Anthony Forster

23. ORGANISATION OR COMPANY NAME (IF APPLICABLE)

Victorian Fisheries Authority

24. CONTACT DETAILS

Email: Anthony.Forster@vfa.vic.gov.au

Information sharing and usage

If your nomination is progressed for prioritisation and assessment, most of the information you include in this nomination will be considered by the department, the Threatened Species Scientific Committee, the Indigenous Advisory Committee, state and territory government agencies and scientific committees, relevant external experts, and the Minister, for potential inclusion in a public-facing conservation planning document. Only three types of information will be handled differently:

- First Nations expert knowledge: the department encourages the inclusion of First Nations expert knowledge and consideration of culturally significant information where appropriate when preparing a nomination.
    - If this material is included in your nomination, please identify any confidential or culturally sensitive information, describe any sensitivities you are aware of, and indicate whether it can be shared with the parties identified above, for potential inclusion in a public-facing conservation planning document.
    - Any sensitive information you identify will be held and marked as sensitive by the department, and will not be shared with the parties identified above or included in public documentation without your consent.
- Personal information: your details as nominator may be provided to state and territory government agencies and scientific committees, as well as the Commonwealth's Threatened Species Scientific Committee and Indigenous Advisory Committee, as part of their collaboration on national threatened species assessments. However, your details will not be shared with external experts or the public without your express permission.
- Other confidential information: if you identify other confidential information in your nomination, please explain its sensitivity. It will be held and marked as sensitive by the department, and will not be shared with external experts or the public without your express permission.

25. **DECLARATION**

I declare that, to the best of my knowledge, the information in this nomination and its attachments is true and correct. I understand that any unreferenced material within this nomination will be cited as 'personal communication' (i.e. referenced in my name).

Signed:

Date: 31/03/2025

Prior to lodging your nomination

In order for received nominations to be eligible for consideration by the Threatened Species Scientific Committee for inclusion on the Finalised Priority Assessment List, nominations must contain all information required by Division 7.2 of the *Environment Protection and Biodiversity Conservation Regulations 2000* (the Regulations) https://www.legislation.gov.au/Series/F2000B00190.

If the required information is not available to be provided in the nomination because of a lack of scientific data or analysis it, is a requirement of the Regulations that the nomination includes an explicitly statement that the data are not available for that question.

Please check that your nomination contains the required information prior to submission.

How to lodge your nomination

Completed nominations may be lodged either:

1. **by email to:** epbcnom@dcceew.gov.au**, or**
2. by mail to: The Director
   Species Listing, Information and Policy Section
   Protected Species and Ecological Communities Branch
   Department of Climate Change, Energy, the Environment and Water
   GPO Box 3090
   CANBERRA ACT 2601

*** If submitting by mail, please include an electronic copy on a memory stick.**

NOMINATIONS CLOSE AT 5PM ON 31 MARCH 2025.

Where did you find out about nominating items?

The Committee would appreciate your feedback regarding how you found out about the nomination process. Your feedback will ensure that future calls for nominations can be advertised appropriately.

Please tick

☐ **Department website**

☐ *The Australian* newspaper

☐ word of mouth

☐ Social media? if so which ………………………………………………………………

☐ Journal/society/organisation web site or email? if so which one………………………………………………………………

☐ web search

☐ Other……………………………………………………………………………………

17. Images of the Key Threatening Process

Carp Abundance

Figure 1. Carp caught in Torrumbarry weir – Photo credit Dave Anderson

Figure 2. A frenzy of carp pictured near the Macquarie Marshes – Photo credit https://www.abc.net.au/news/rural/2011-03-03/carp-in-macquarie-at-carinda/6189164

Carp removal efforts

Figure 3. Shepparton Council electro fishing efforts – photo credit Greater Shepparton City Council

Carp eggs

Figure 4- Carp eggs – photo credit Keith Bell

Figure 5 Carp eggs – photo credit Keith Bell

Carp environmental impacts

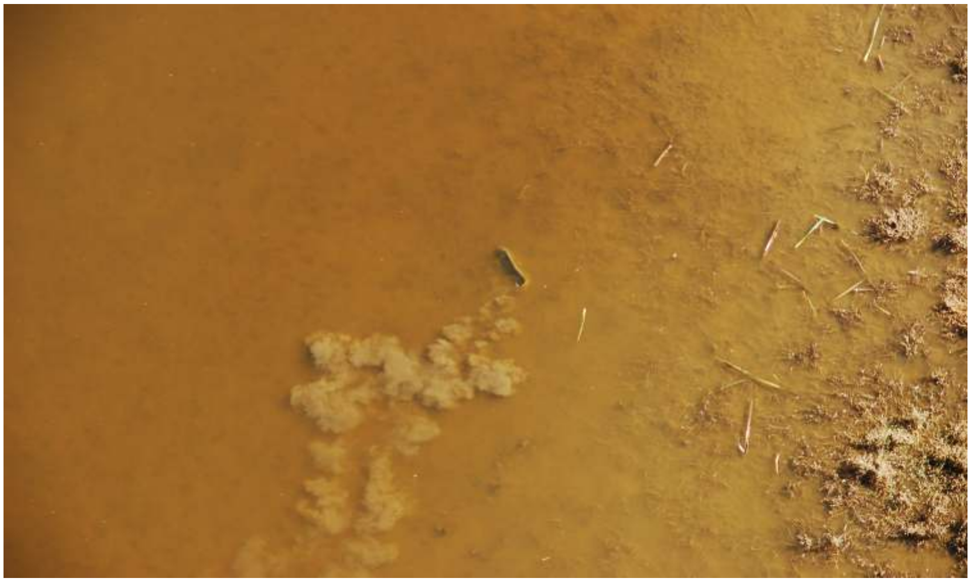

Figure 6. Aerial view of carp in the Lachlan River, NSW – photo credit FRDC

Figure 7. Carp feeding creating turbidity in the Namoi River, NSW – photo credit FRDC

Figure 8. Effects of carp foraging behaviour on riverbeds – photo credit: Ivor Stuart

20. Appendix

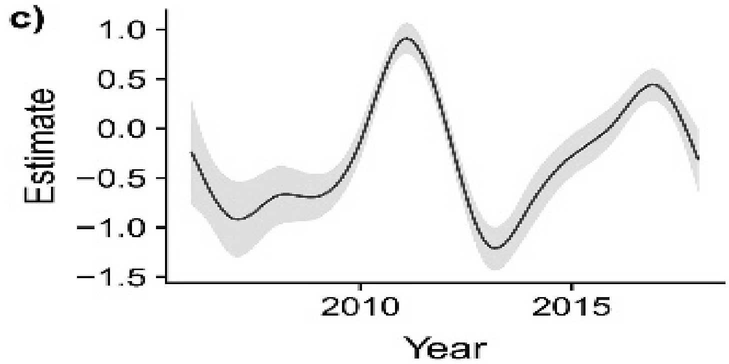

Figure 1. The graph demonstrates juvenile carp biomass throughout time, the peaks in biomass align with major flood events seen in Victoria. The graph shows a fitted relationship with 95 per cent creditable interval and standardised by the mean (Stuart and et al. 2021)

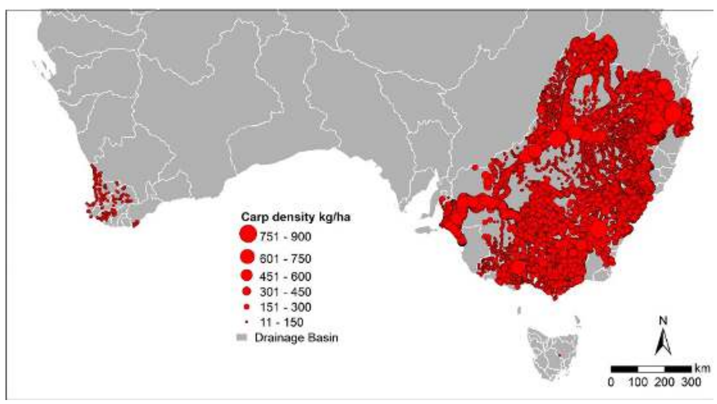

Figure 2. Distribution and *predicted* density of carp in Australia (Stuart 2021)

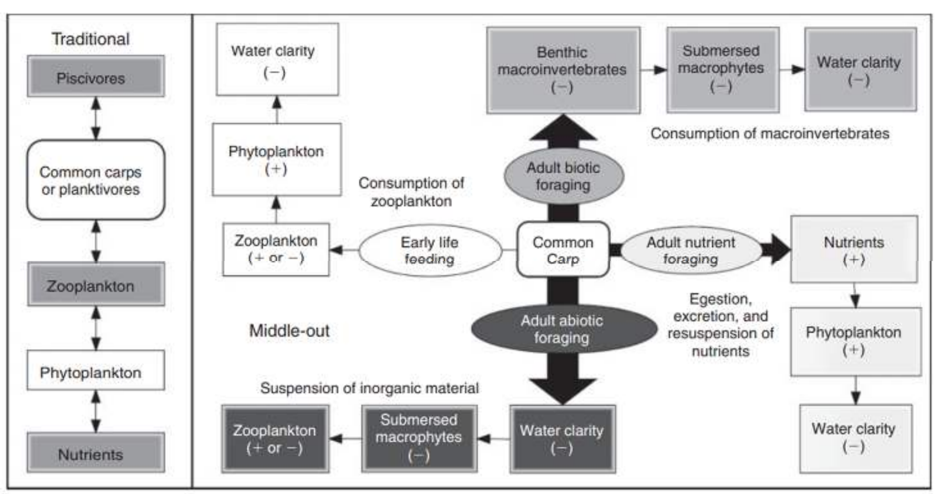

Figure 3. Trophic effects of carp in a traditional (bottom-up and town-down; left) and middle out (right) framework. A middle-out approach highlights (1) four potential common carp disturbance pathways; (2) direction and trophic position of the pathways; and (3) magnitude (larger arrow width reflecting a larger disturbance from carp) and potential effect of disturbance (negative sign indicates a decrease; positive sign indicates an increase). Ovals represent the immediate activity and behaviour or process of common carp disturbance (Kaemingk and Jolley et al. 2016).

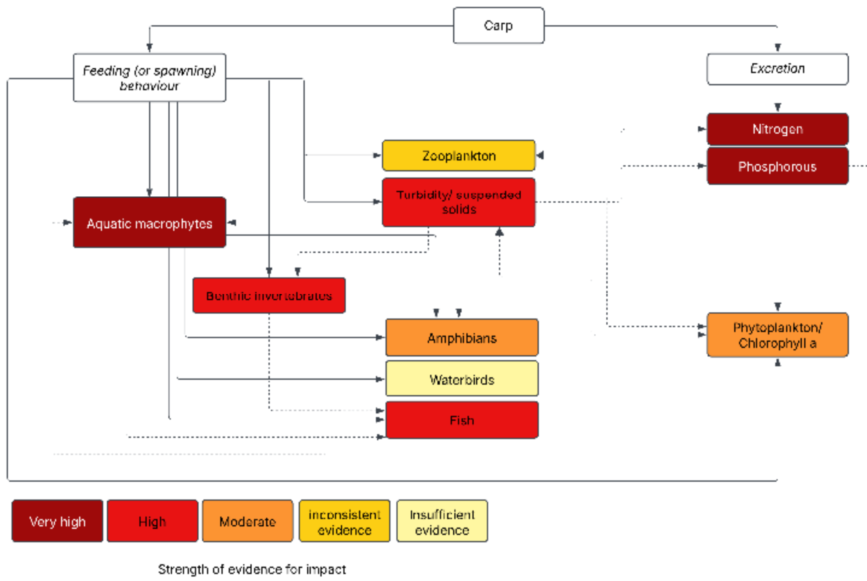

Figure 4. Conceptual model (updated from Koehn and Brumley et al. (2000)) of the effects of carp on freshwater ecosystems. Relative strength of evidence for impacts for each component is based on a total outcome score computed from the sum of weights of conclusions based on the location of experiments. Note that nitrogen and phosphorus are part of "nutrients," and amphibians, waterfowl and fish of the "other native fauna" grouping in Koehn and Brumley et al. (2000) original model. Solid lines indicate direct impacts, dotted lines indirect impacts (modified from Vilizzi and Tarkan et al. (2015)).

Figure 5. Illustration by Sonny Green that depicts the indigenous importance of Australian waterways and rivers (Green n.d.)

Figure 6. Illustration of the story of Ponde and the creation of the Murray River (Moggridge 2023)

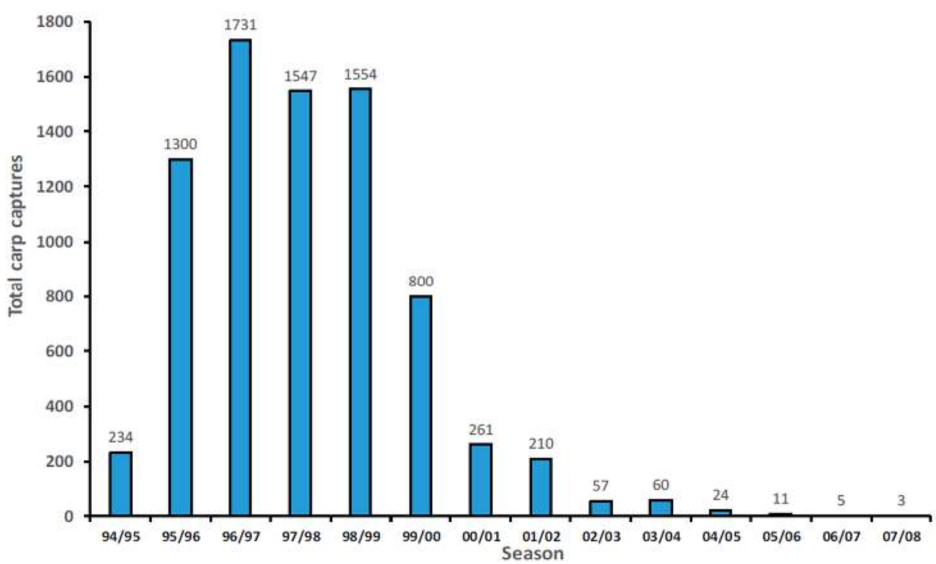

Figure 7. The total number of carp caught in Lake Crescent from 1995 to 2007 (Yick and Wisniewski et al. 2021)

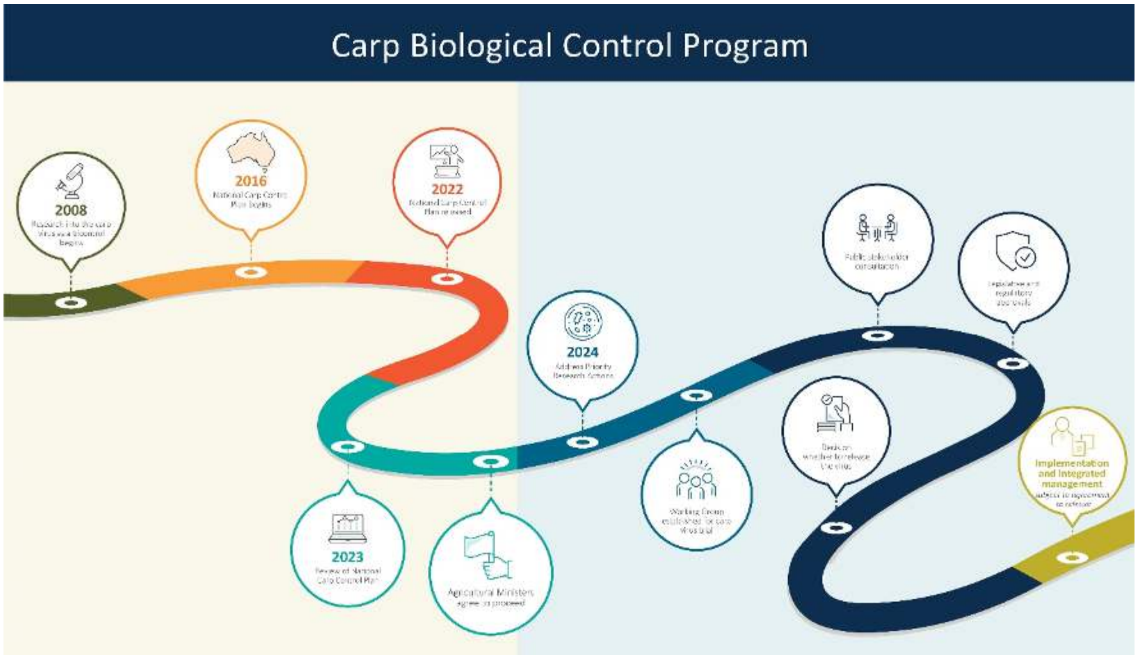

Figure 8. Figure 1. NCCP roadmap to a decision (VFA 2024).

Table 1. Assessment of the potential effects of existing threats in the Murray-Darling Basin on carp and native species (Koehn 2004).

	Species						
Threat	C	MC	TC	GP	SP	MP	CF
Habitat destruction	1	3	3	2	2	2	3
Water quality	1	2	2	3	3	2	2
Harvesting	1	3	3	2	2	2	2
Barriers	2	2	1	2	2	2	1
Water temperature	1	3	2	2	2	2	2
Altered flows	1	3	2	2	2	2	2
Sedimentation	1	2	2	2	2	2	2
Introduced species	1	2	2	1	1	2	2
Stocking/genetics	1	2	1	2	2	1	1
Total	10	22	18	16	18	17	17

Effect scores: 1, low; 2, moderate; 3, high.
C, carp; MC, Murray cod; TC, Trout cod; GP, Golden perch; SP, Silver perch; MP, Macquarie perch; CF, catfish.

Table 2. Carp attributed impacts and potential interacting threats identified from Conservation Advice for a subset of EPBC listed species. Orange = high risk and Red = very high risk as per threat matrix in each species Conservation Advice.

	Carp attributed impacts	Potential interacting threats
Murray cod	Parasite vectors; habitat degradation	Altered hydrology, sedimentation, increased drought, removal of woody debris
Silver perch	Competition, habitat degradation, parasite vectors	Altered hydrology, increased drought
Trout cod	Competition, predation and habitat modification	Altered hydrology, sedimentation, increased drought, removal of woody debris
Variegated pygmy perch	Vegetation impacts	Groundwater changes, increased temp and extreme events
Bellinger River saw-shelled turtle	Increased sedimentation and turbidity, vegetation impacts	-
Southern bell frog	Predation, vegetation impacts, increased turbidity	Disease, altered hydrology, increased drought
Yarra pygmy perch	Competition, vegetation impact, habitat impacts	Altered hydrology, increased temp and extreme events, decreased water quality from stock

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