The Hon. David Littleproud MP

Minister for Agriculture and Water Resources
Federal Member for Maranoa

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Senator Barry O'Sullivan
Committee Chair
Senate Rural and Regional Affairs
and Transport Legislation Committee
PO Box 6100
Parliament House
CANBERRA ACT 2600

Dear Senator O'Sullivan Barry

Thank you for your correspondence of 27 June 2018 on behalf of the Senate Rural and Regional Affairs and Transport Legislation Committee regarding concerns over the National Carp Control Plan (NCCP).

As you are aware, the NCCP is being developed by the Fisheries Research and Development Corporation (FRDC) to explore the possibility of releasing the carp virus (*Cyprinid herpesvirus* 3, CyHV-3) as a biological control agent for common carp. As part of its work to develop the NCCP, the FRDC has engaged 19 of Australia's leading universities, research institutions and expert organisations to deliver research addressing key knowledge gaps and risks, undertake consultation and engagement activities, and develop virus release and clean up approaches. This research is still ongoing and the FRDC is continuing to work to fill key knowledge gaps.

I acknowledge the concerns raised by the Committee, community members, and scientists about the manner in which the NCCP is being developed, and the current timeframe. I am aware the FRDC has proposed to extend the timeframe for developing the NCCP by 12 months to December 2019 along with further funding to support the extension, additional research and further public consultation and engagement. I agree that to ensure robust outcomes it is important to provide sufficient time to complete the NCCP. Further time will increase the likelihood of a well-developed plan that is supported by risk assessment and sufficient scrutiny of research projects through peer-review to provide confidence in the science underpinning the NCCP. My department is currently reviewing the extension request in consultation with the interdepartmental steering committee overseeing the NCCP. As part of this process the NCCP work plan will be revised along with consideration on the best way forward to develop the NCCP. I will keep you updated as this progresses.

In your letter, the Committee also raises a number of concerns requiring further scientific research and investigation. Preliminary advice from the FRDC on how these concerns are currently being addressed is enclosed. I am aware that the FRDC has been engaging with the scientists present at the Hearing on 25 June 2018, and that Dr Jonathan Marshall is a member of the NCCP Scientific Advisory Group. Notwithstanding this, I have made it clear to the FRDC that I consider stakeholder input to be a critical component to this program, and I have advised the FRDC to continue to work closely with these scientists, and the wider scientific community, to address knowledge gaps and issues. I note that an extension to the NCCP program will allow the Committee's concerns to continue to be explored by the FRDC in further detail.

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Thank you for bringing the committee's concerns to my attention. I would be pleased to discuss this matter further with you, if it would be of assistance.

Yours sincerely

DAVID LITTLEPROUD MP

Enc.

Response from the FRDC to the specific issues raised by the Committee

1.a Specificity

All available evidence, both from Australia and internationally, indicates that the carp virus (*Cyprinid herpesvirus* 3, CyHV-3) can only infect common carp (*Cyprinus carpio*), the pest species present in Australian waterways. No mortalities attributable to the carp virus have been reported in any fish species other than common carp, or in any other animal globally. A significant body of work globally, which includes a recent review of major carp mortality events caused by the virus throughout North America [1], demonstrates that even in aquatic ecosystems inhabited by a diverse range of cyprinids (fishes belonging to the same family as carp), only common carp were infected. Nonetheless, a high level of confidence in the carp virus's species specificity requires deliberate exposure of non-target species to the virus, and careful measurement of their response. The CSIRO has been conducting such trials for eight years.

The CSIRO non-target species susceptibility trials exposed 13 species of native fish, in addition to rainbow trout, birds, reptiles, amphibians, lampreys, crustaceans and mammals to the virus through intraperitoneal[2] injection and/or bathing in a solution containing the virus. There was no molecular evidence of infection by the carp virus in any of the tested non-target species. Results of the CSIRO non-target susceptibility trials have been published in the international peer-reviewed *Journal of Fish Diseases*[2].

Species-specificity is an essential precursor to the carp virus's use as a biological control agent in Australia. Reflecting this importance, and notwithstanding the peer review already undertaken on CSIRO research conducted to date, an independent review of the non-target species susceptibility research is being undertaken by a suitably-qualified veterinary pathologist. The review will make recommendations based on best-practice for research exploring specificity of viruses. Review results will be considered by the National Carp Control Plan (NCCP) Science Advisory Group when assessing the need for any further research into the carp virus's species specificity.

1.b Mutation of the virus

While all research to date indicates that the virus in its present form is species-specific, the committee has questioned whether the virus could mutate or otherwise evolve in ways that could enable infection of new host species. All viruses mutate and change over time and precisely quantifying the likelihood of the carp virus infecting new species is difficult however there are three lines of evidence that suggest this risk is extremely small.

First, the carp virus uses deoxyribose nucleic acid (DNA) to replicate its genetic material. DNA replication is an inherently stable biochemical process, and DNA viruses consequently mutate at a much lower rate than viruses that replicate using ribose nucleic acid (RNA). RNA viruses include many of those that mutate and result in new infectious strains such as the common cold and influenza, and those that have moved between animal and human hosts (e.g. Ebola virus, West Nile virus). Whilst DNA viruses can mutate, these mutations are less likely to result in an evolutionary change which would lead to the infection of a new host species[4,5].

Second, the carp virus has the largest genome in the viral family to which it belongs (Alloherpesviridae). Viruses with large, complex genomes are more stable, and are considered less likely to infect new host species than those with smaller, simpler genomes.

Third, the movement of a virus between species generally only occurs between closely-related species. Carp belong to the taxonomic order Cypriniformes. Australia has no native cyprinid species. In evolutionary terms, catfish, which belong to the taxonomic order Siluriformes, are the group of Australian native fishes most closely related to carp, with the two groups diverging from a common ancestor tens to hundreds of millions of years ago. Two native Australian catfish species have been tested for susceptibility to the carp virus. No molecular evidence of virus replication was found for either species.

2. *Water-quality and clean-up issues resulting from dead carp*

Research projects to assess risks to water quality, and developing appropriate responses, are central to the NCCP research program and operational planning. The NCCP's suite of water-quality research projects are underpinned by a major carp biomass estimation project. Understanding the total tonnage of carp present in Australian aquatic ecosystems, and the manner in which this biomass is distributed across different habitat types, is an essential precursor to water quality research for two reasons. First, biomass estimates provide insights into the potential magnitude of clean-up operations. Equally importantly, high carp densities are almost certainly one of the key pre-requisites for effective transmission of the virus between carp. Therefore, identifying the relative distribution of carp biomass across the Australian landscape is an important input to the epidemiological modelling.

In turn, epidemiological modelling will provide insights into likely patterns of viral transmission and subsequent mortality in Australian carp populations, accounting for factors such as carp density, immune status, and river flow conditions. Thus, epidemiological modelling will seek to predict the magnitude, timing, and location of major carp mortality events if the virus is released.

Research under the program's water quality theme also seek to address specific outcomes of decaying carp on a range of water quality parameters. Linked projects are using field experiments and modelling to investigate the effects of varying dead carp concentrations on dissolved oxygen levels and the prevalence of harmful blue-green algae (cyanobacteria).These projects extend beyond quantifying the extent of these issues on water quality to the investigation of potential mitigation measures.

In addition, ongoing research is investigating the impacts of dead carp on water quality parameters including dissolved oxygen, harmful bacterial levels, and odour and taint in water-supply reservoirs. A project in which the NCCP is co-investing will shortly begin to assess water-treatment implications of carp mortalities.

The NCCP's Operations Working Group (OWG) is assessing and planning the logistical requirements for clean-up. The OWG's early deliberations draw on a global review of fish-kill clean-up methods, and has since expanded to include a range of workshops involving stakeholders, local authorities, and experts in logistics and emergency response. The most recent workshop look at assessing engineering solutions that could facilitate clean-up. The NCCP Policy Advisory Group (PAG) also plays a central role in mapping the legislative implications of clean-up activities.

Finally, an NCCP research project is exploring options for the use of harvested carp biomass through a variety of fertiliser and fish-meal products. Carp utilisation research includes active collaboration with commercial animal-waster processors, many of whom have indicated that they consider there are commercial opportunities in processing dead carp if the virus is released.

3. *Secondary infections*

The NCCP research program would potentially benefit from a targeted project or projects assessing risks associated with secondary infections. The NCCP water quality research projects described above are important as secondary infections are partly the product of poor water quality. In particular, the committee's letter mentions *Clostridium botulinum*, the bacterium that produces the neurotoxin botulinum. *Clostridium botulinum* is anaerobic, capable of surviving only in environments from which oxygen is absent. One of the key aims of the NCCP's water quality research is investigating clean-up and river management options that maintain dissolved oxygen levels. Additionally, the NCCP's quantitative risk assessment project is explicitly considering degradation of water quality to an extent enabling botulism. Systematic interviews with subject-matter experts under the risk assessment process will assist in clearly-defining the risk of botulism following carp mortalities including risks to livestock, native species and human health. Similarly, research projects conducted in collaboration with water treatment authorities (as described under question 2) include the measurement of bacterial loads.

4. *Efficacy of the virus as a method of biocontrol*

International examples, supported by Australian lab trials, demonstrate that under optimal conditions the virus can result in high mortality levels in carp. The CSIRO researchers are currently conducting epidemiological modelling that considers how various factors – including temperature and carp behaviour - are likely to influence virus transmission and overall effectiveness, Additional research is proposed to investigate transmission pathways in more detail. It is important to note however that like all biological control agents, the carp virus is not a silver bullet and is unlikely to completely eradicate carp. An integrated management program, using other control methods to complement the virus release, would need to be considered to maximise success. Furthermore, carp virus biology, particularly in a new environment, is complex. Consequently, while the epidemiological modelling will greatly improve understanding of the virus's likely impacts on Australian carp populations, it will not provide complete understanding. In particular, knowledge gaps exist regarding: the capacity of carp to change their behaviour and seek out different water temperatures to reduce mortality (a behaviour noted in international lab trials but not extended to field observations); potential changes to the carp virus's virulence (i.e. capacity to kill carp) under highly-variable temperature regimes; and detailed understanding of the host and environmental factors (and their potential interactions) leading to infection, disease, and mortality in carp following exposure to the virus.

The committee also raised questions regarding the presence of innate resistance to the carp virus (developed through several mechanisms), or its rapid acquisition by Australian carp populations. The CSIRO researchers have exposed numerous carp to the virus during various experiments, and high mortality rates have ensued under optimal conditions. However, these carp were from geographically-restricted areas, and the research was not specifically searching for resistant individuals. Therefore, resistant carp populations could exist in Australia. Research to identify resistant populations has been proposed under the NCCP, but has not commenced. Development of resistance to the virus over time is possible, but is not currently the subject of current NCCP research. The Scientific Advisory Group (SAG) has concluded that the most practical approach to addressing the issue of resistance is to aim for an integrated carp control plan, in which the virus is used to provide an initial population reduction, with a range of other control measures then used to complement the virus and capitalise on reduced carp abundance. Subsequent use of genetic methods to skew the ratio of males and females in remaining carp populations to a single sex is one potentially valuable component of a long term, integrated approach. Sequentially releasing more virulent strains of the virus, as has been done with rabbit calicivirus, is also a potential response to emerging resistance in Australian carp populations. There is merit in modelling the interaction between the carp virus and other carp control methods that may be deployed as part of any integrated strategy, to determine optimal timing, sequencing, and gather important information on how the control methods interact. Though due to budget and time constraints, this is not currently the subject of NCCP research.

5. *Extent of the problem of carp and benefits of carp control to native fish.*

Australian rivers experience many environmental pressures, of which carp are one. Carp have become the dominant freshwater fish in south-east Australia, making up a significant proportion of fish biomass in many areas including the Murray-Darling Basin. Over approximately the last four decades, freshwater ecologists both in Australia and internationally have debated whether carp are a primary cause or a symptom of environmental degradation. Disentangling carp impacts from other sources of environmental stress can be difficult, for two main reasons. First, carp thrive in rivers that are already degraded, and tend to intensify the impacts resulting from other pressures. Second, the broad-scale nature of carp impacts means that large-scale, multi-year experiments – rare in ecology – are often required to understand them.

Despite these difficulties, increased research on carp impacts through the 1990s has provided evidence that carp really do damage river ecosystems. This research included systematic reviews and meta-analyses, which combine and analyse data from all available studies on a particular topic, as well as large-scale experiments. These studies, which reviewed both Australian and international research, show that carp muddy waters, increase nutrient levels (thereby promoting blue-green algae blooms), and reduce abundance of water plants (macrophytes), invertebrates (e.g. aquatic insects and

crustaceans), and some fish species. For example, one meta-analysis found that carp increased water turbidity (muddiness) in 91% of surveyed studies, reduced invertebrates in 94% of surveyed studies, and reduced macrophytes in 96% of surveyed studies. A more recent meta-analysis[6,7] supported these results, finding strong evidence for carp impacts on all the same ecosystem components.

Direct links between carp abundance and the impacts described above will not exist in all Australian aquatic ecosystems. Carp now occupy a very large proportion of southeastern Australia, encompassing numerous habitat types, land management practices, soil types, and historical management practices. Therefore, to say that controlling carp will result in uniform improvements in aquatic habitat across the species' Australian range is unrealistic. In some locations, poor water quality may be driven primarily by factors other than carp. However, the research evidence described above, and, on balance, broad-scale, long-term carp suppression will likely provide real environmental benefits. Research undertaken through the NCCP is systematically investigating the manner in which carp control may may benefit aquatic ecosystems and rural and regional communities. Crucially, these benefits will be significantly enhanced if carp control is accompanied by ecological restoration programs designed to improve aquatic habitat and rebuild native fish populations. Such initiatives are strongly supported by those working on the NCCP.

References

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2. Intraperitoneal injection is the injection of a substance into the body cavity.

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