Submission to the Independent Biodiversity Legislation Review Panel
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Introduction

As a freshwater ecologist, I focus on the conservation of freshwater biodiversity in this submission. I suggest that:

1. Freshwater biodiversity is of great importance from perspectives of both natural heritage conservation and the provision of ecosystem goods and services to society.

2. Freshwater biodiversity in NSW is under considerable threat from a wide range of causes.

3. Current statutory arrangements for the conservation and recovery of freshwater biodiversity in NSW are distributed among numerous pieces of legislation, many of which are outside the scope of the Review.

4. Assessment of the appropriateness, effectiveness and efficiency of current practice in freshwater biodiversity conservation is NSW is inadequate. Where evidence is available, it indicates varying degrees of success. Consequently, it is not possible to develop an optimal policy, planning and management approach with current knowledge.

5. Given that comprehensive Statewide monitoring of biodiversity and outcomes of management actions is unfeasible with available resources, the environmental, social and economic costs and benefits of alternative approaches should be mathematically modelled. Monitoring resources should be allocated strategically to calibrate and validate models, with emphasis on elements where model uncertainty or inaccuracy poses the greatest risks of adverse outcomes. Such an approach would enable the appropriateness, efficiency and effectiveness of biodiversity conservation to be progressively improved over time.

Importance of freshwater biodiversity

Fresh waters are disproportionally rich in biodiversity. They cover less than 1% of the global surface yet support around 6% of the Earth's species (Dudgeon et al. 2006). Freshwater biodiversity is a major component of the natural heritage that sustains and enriches human lives and experiences. Native freshwater species provide a range of goods and services to society including aquatic foods, fibres and biochemicals, aesthetic, recreational, spiritual and cultural values, processes that assimilate wastes and maintain water quality, pest control, and export of organisms that support terrestrial biodiversity and productivity (Covich et al. 2004; Dudgeon et al. 2006; Arthington et al. 2010). The global economic value of freshwater ecosystem goods and services has been placed at around $US 4 trillion (Contanza et al. 2014). It can also be argued that humans have a moral responsibility to respect freshwater (and other) species, regardless of whether they provide us with material benefits, and that not observing this duty diminishes mankind.

Freshwater biodiversity in NSW: status and threats

NSW is rich in freshwater biodiversity, including many species that are endemic to the State. However, monitoring of population trends for NSW freshwater species is extremely limited. The Eastern Australian Waterbird Survey (Kingsford & Porter 2009) provides annual population estimates for the larger diurnal waterbird species. Surveying of riverine fish and macroinvertebrates throughout NSW has declined markedly since the completion of the Sustainable Rivers Audit in the Murray-

Darling Basin in 2013. For most freshwater species, the availability of reliable and up-to-date information on conservation status and population trends depends on the interests and initiatives of individual researchers or research teams.

No freshwater species has yet been formally listed as presumed extinct in NSW but several freshwater species and ecological communities are listed as critically endangered, endangered or vulnerable. Some NSW freshwater species would very likely become extinct without the intensive species-specific programs, including captive breeding, that are currently in place (e.g. the southern corroboree frog; see McFadden et al. 2013). Molecular studies (e.g. Adams et al. 2014) are revealing increasing numbers of cryptic freshwater species in NSW, the conservation status of which needs to be determined.

Numerous factors have been identified as contributing to historical declines or posing current threats to freshwater biodiversity in NSW. They include:

- ***Climatic fluctuations and changes***. For example, during the recent Millennium Drought, broad-scale declines occurred across NSW in the distribution and frequency of occurrence of stream invertebrates adapted to cool, fast-flowing waters (Chessman 2009, 2012, in press). Long-term declines of freshwater turtles in the Murray River and its floodplain in southern NSW are also likely to be associated with climatic drying (Chessman 2011). Some post-drought recovery of aquatic and amphibious species appears to have occurred in NSW, but more so for tolerant, generalist species (e.g. Wassens et al. 2013).

  Extreme flooding and has caused mass mortality of freshwater crayfish just outside of NSW in southeastern Queensland (Furse et al. 2012), and could represent a threat to crayfish species in eastern NSW that have greatly restricted ranges. Freshwater crayfish in NSW are also vulnerable to blackwater events caused by post-drought flooding (McCarthy et al. 2014).

  Wildfires impact on freshwater biodiversity in Australia (e.g. Verkaik et al. 2014) and increasing fire frequency and intensity could represent an emerging threat.

- ***Regulation of river flows and water extraction.*** Alteration of river flow regimes and wetland inundation has had extensive adverse impacts on aquatic biodiversity in NSW, reviewed by Walker (1985) and Kingsford (1995, 2000). Dama and weirs also interfere with migration of native freshwater fishes (Harris 1984) and alter stream temperatures with consequent effects on native fish species (Lugg & Copeland 2014).

- ***Changes to the geomorphology of river channels.*** There is evidence that streams in more natural geomorphic condition support more native species (Chessman et al. 2006), and channel change appears to have impacted adversely on freshwater mussels (Jones & Byrne 2010, 2014).

- ***Water pollution***. For example, sewage and mine discharges and agricultural and urban drainage in NSW are associated with local absence of sensitive aquatic invertebrates (Leonard et al. 1999; Sloane & Norris 2003; Besley & Chessman 2009; Wright & Burgin 2009; Tippler et al. 2012).

- ***Diseases caused by introduced pathogens and parasites.*** The introduced chytrid fungus *Batrachochytrium dendrobatidis* has been implicated in declines of many frog species in NSW and elsewhere (Berger et al. 2004; Fisher et al. 2009). Native fishes are also affected by introduced pathogens and parasites (Dove 1998; Boys et al. 2012).

- ***Predation by or competition with introduced species***. A range of evidence indicates that introduced fish such as trout, carp and gambusia have negative effect on native plants, fishes

and frogs in NSW waters (e.g. Tilzey 1976; Roberts et al. 1995; Webb & Joss 1997; Gillespie 2001; Jackson et al. 2004; Pyke 2008). Foxes impact adversely on freshwater turtle populations (Spencer & Thompson 2005). Research in South Australia (Zukowski & Walker 2009) implies that introduced freshwater snails may also be a threat to native species in NSW.

- ***Translocation of native species***. For example, aquaculture of Australian freshwater crayfish species in NSW is leading to establishment of wild populations outside of their native ranges, which threaten narrow-range endemics (Cougran & Furse 2012). Endemic freshwater turtles in NSW with narrow distributions are also under threat by release of more widespread species into waterways where they do not naturally occur (Spencer et al. 2014).

- ***Recreational and commercial fishing***. For example, fishing pressure may impact substantially on NSW populations of Murray crayfish, *Euastacus armatus* (Zukowski et al. 2013) and fishing gear can drown platypus, turtles and other vertebrates (Grant et al. 2004; Lowry et al. 2007).

Legislative arrangements

Numerous pieces of legislation, administered by several agencies, bear on freshwater biodiversity conservation in NSW. These include:

1. The Fisheries Management Act 1994 (FMA), administered by the Department of Primary Industries. The FMA applies to "fish" and "marine vegetation." "Fish" are defined in the Act (definition 5) as "marine, estuarine or freshwater fish or other aquatic animal life at any stage of their life history." Specific reference is made in definition 5 to inclusion of oysters and other aquatic molluscs, crustaceans, echinoderms, beachworms and other polychaetes. Whales, mammals, reptiles, birds and amphibians are excluded. The FMA makes no specific reference to aquatic insects.

2. The Threatened Species Conservation Act 1995 (TSCA), administered by the Office of Environment and Heritage. The TSCA applies to animals and plants but its definitions of "animal" and "plant" exclude "fish" and "marine vegetation" within the meanings of the FMA. However, Part 1, Section 5A of the TSCA provides that the ministers responsible for the two Acts may concur to:
   a. declare a species of fish to be a species of animal for the purposes of the TSCA if it is an invertebrate species that may inhabit a terrestrial environment at some stage of its biological development
   b. declare a species of marine vegetation to be a species of plant for the purposes of the TSCA if it is a species that may inhabit freshwater or a terrestrial environment at some stage of its biological development.

3. The National Parks and Wildlife Act 1974, which also defines "animals" to exclude "fish" as defined by the FMA.

4. The Environmental Planning and Assessment Act 1979.

5. The Wilderness Act 1987.

6. The Protection of the Environment Operations Act 1997, which deals with pollution and waste disposal that may impact adversely on freshwater biodiversity.

7. The Water Management Act 2000, which inter alia aims to "protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality."

8. The Nature Conservation Trust Act 2001.

9. The Native Vegetation Act 2003, which has provisions for conservation of freshwater plants but excludes marine vegetation as defined by the FMA.

10. The Local Land Services Act 2013.

Effectiveness of current arrangements

Insufficient scientific information exists to adequately assess the outcomes of current legislation, policy and management for freshwater biodiversity in NSW. For example, in its recent review of Water Sharing Plans prepared and implemented under the Water Management Act, the Natural Resources Commission was unable to assess the extent of the plans' contribution to Statewide targets for aquatic ecosystems and biodiversity conservation (NRC 2013). Lintermans (2013) noted difficulties in evaluating success of numerous recovery actions for threatened freshwater fishes undertaken in NSW and elsewhere.

Positive small-scale, short-term responses of native freshwater species to environmental water allocations have been reported in NSW (e.g. Alexander et al. 2008; King et al. 2009; Spencer & Wassens 2010), although in other cases responses have been limited (e.g. Rolls & Wilson 2010) and some perverse outcomes such as increases of alien pest fishes have been reported (e.g. King et al. 2010). Some local successes have also been reported from river restoration activities (e.g. Watson 2009) but as elsewhere in Australia, assessment of ecological outcomes of river restoration in NSW is rare (Fryirs et al. 2013). Impacts of point-source water pollution on freshwater species have been alleviated in some cases (e.g. Besley & Chessman 2008) but not in others (e.g. Belmer et al. 2014). Little information appears to be available on effectiveness of efforts to reduce diffuse pollution of NSW waterways.

Little information also appears to be available on the effectiveness of biodiversity offsets for freshwater species in NSW. However, Pickett et al. (2013) suggested that offset requirements for green and golden bell frogs (*Litoria aurea*) were high.

Potential to improve legislation and practice

Considering the information and evidence summarised above, I suggest that:

1. The various pieces of legislation that relate to freshwater biodiversity conservation set appropriate goals for maintaining and enhancing the values that freshwater biodiversity provides.

2. However, the diversity of legislation addressing freshwater biodiversity conservation in different contexts and with different emphases creates a considerable challenge for achieving an integrated, strategic and cost-effective approach.

3. The partitioning of freshwater biodiversity between the FMA and other Acts raises some specific issues:
    a. The FMA and other Acts define animals, fish and plants in ways that are contrary to the normal meanings of the words and likely to be confusing.
    b. Some species require ministerial decisions to decide which Act applies to them.
    c. Having threatened species dealt with under two Acts with different ministers and administering agencies has led to some duplication of effort. Two scientific committees have been established to assess applications for listing, one under each Act. Different species of Odonata (dragonflies and damselflies) have been listed under each Act. Separate listings of

threatening processes have been created, both of which include anthropogenic climate change, native vegetation clearing or degradation, removal of dead wood, alteration of natural flow regimes and introduced fish species.

4. Improving efficiency and effectiveness of freshwater biodiversity conservation, while having regard to other public policy goals, is constrained by the following factors:
   a. Inadequate information on the costs and benefits of procedures and actions currently in place.
   b. Severely limited resources for freshwater biodiversity monitoring and performance assessment of management actions.
   c. Lack of technology for effective broad-scale control of alien species that pose great threats and impediments to freshwater biodiversity conservation in NSW, such as chytrid fungus, gambusia and common carp.
   d. Challenges in balancing the adverse impacts of trout on native biodiversity with their value for recreational fishing.
   e. Uncertainty regarding future impacts of climate change.

5. While it may be possible to streamline and consolidate existing legislation and procedures, it is not possible to develop an optimal approach with current knowledge.

6. Given that comprehensive Statewide monitoring of biodiversity and outcomes of management actions is unfeasible with current resources and fiscal constraints on government, the environmental, social, and economic costs and benefits of alternative approaches should be mathematically modelled. Available monitoring resources should be allocated strategically to calibrate and validate models, with emphasis on instances where model uncertainty or inaccuracy poses the greatest risks of adverse outcomes. Such an approach would enable the appropriateness, efficiency and effectiveness of biodiversity conservation to be progressively improved over time. If additional resources can be invested, this improvement would proceed more rapidly with consequently greater environmental, social and economic benefits.

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