Traveston Crossing Dam, Mary River, SE Qld
QWI response to reviewers report

III: Reply

Prepared by:

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For:

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November 6, 2009

1 Background

At the request of the Department of Environment, Water Heritage and the Arts, I undertook an independent review of the Traveston Crossing Dam EIS and supplementary materials in October 2008. This considered the original draft EIS and supporting documentation, issues raised during the public submission process, as well as the Supplementary Report and additional technical information[1]. The major focus of this review was on riverine species; especially the endangered Mary River cod and Mary River turtle and the vulnerable Australian Lungfish; largely because these are likely to be most affected by the proposed Dam and altered flow regimes. Two terrestrial-riparian species of concern, the Coxen's fig parrot and the Giant Barred Frog were also considered.

Since then, the proponent has released a detailed response to reviewers comments (SKM 2009)[2] and the Queensland Government Coordinator General's report evaluating the EIS was subsequently released in October 2009[3].

In this report, I have reviewed the QWI response to issues raised in my earlier report and provide the following comments.

2 Habitat restoration and mitigation of likely impacts

A major focus of the QWI response is that proposed mitigation measures (especially habitat protection and restoration) can improve the situation for endangered and vulnerable species. This is reflected in the selection of the QWI Scientific Advisors and CSIRO Expert Peer reviewers and their endorsements in the report (SKM 2009, Introduction and Appendix C). There is no question that the Scientific Advisors have experience and expertise in this area. Prof Grigg is a noted animal physiologist who has published extensively on a wide range of terrestrial and aquatic vertebrates, including some early work on the biology of lungfish. Prof Franklin is a conservation physiologist with an impressive publication record on the physiology of a range of aquatic vertebrates, including two of the turtles at risk in the Mary River. A/Prof Marc Hero is well regarded as one of Australia's leading scientists in relation to amphibian biology and species conservation, and has particular experience with the Giant Barred Frog.

I have little reason to dispute their claims of the likely success of proposed habitat protection and restoration measures (Appendix F). Indeed, as indicated in my previous report[1], such measures are required even if the dam is not constructed, given the existing threats to these species of concern. However, the QWI response gives the impression that such mitigation measures are only likely to occur **if** the dam proceeds (e.g. see p 3-35) and the endorsements of the QWI Scientific Advisors and reviewers appear to reflect that assumption. It is worth noting in this regard that the three Scientific Advisors are named as advisors for the proposed Freshwater Species Conservation Centre (Appendix G) and are likely to have a significant direct interest in the proposed research program ($28 million over 10 years) funded by QWI. I would hope that the commitment to habitat protection and restoration for these species of concern and associated funding for research is not contingent on the approval of the Traveston Crossing Dam.

Much of the proposed habitat restoration is aimed at the fringing margins of the proposed inundation area and lower reaches of adjoining tributaries (Appendix F). This includes 310 ha of riparian habitat and 52.2 km of in-stream habitat (Appendix F, Table 2-2). The Coordinator General's report[3] suggests that a commitment of at least $10 m for this activity will be required by the proponent. In my experience (see Appendix 1 in this report), in-stream and riparian rehabilitation of the scale proposed would well exceed this level of funding, especially if the ongoing cost of maintenance and monitoring is included.

[1] *http://www.environment.gov.au/epbc/notices/assessments/2006/3150/pubs/independent-expert-report-on-matters-of-nes-bunn.pdf*
[2] *http://qldwi.com.au/Default.aspx?tabid=230*
[3] *http://www.dip.qld.gov.au/traveston/*

This aside, the significant question remains as to whether such habitat protection and restoration measures can sufficiently offset the likely impacts of the proposed dam, through loss of habitat, altered flow regimes and associated changes in water quality. The Scientific Advisors and reviewers for the QWI response have much less research expertise or experience in these areas (Appendix C of the SKM report; see Appendix 1 here). In my opinion, the QWI response does not adequately address all of the substantive issues raised in the previous independent reviews or provide any new convincing information in relation to these matters.

3 Flow alteration

The impact assessment process and review by the Scientific Advisers has recommended that the most effective mitigation measure for the Mary River downstream of the dam wall is an optimised environmental flow regime (Appendix F, p 1-7). It is claimed that this will lead to improved water quality, sediment load, hydrological connectivity and seasonal flows.

Modification to flow regimes downstream of the proposed dam and associated poor water quality was identified as a significant threat to Mary River Cod, Mary River Turtles and the Queensland Lungfish in my previous review[1]. The EIS[4] indicated that substantive changes would occur to low to medium flows in the river downstream of the proposed dam, which are already affected by existing entitlements during the dry season. Initial flow optimisation[5] work suggested that impacts to median flows, low flows (10-30 cm depth) and medium flows (30 cm – 1 m) could be addressed but only for the months July – October. However, this initial optimisation would not address major changes to low – medium flows during the summer and autumn months and there would still be significantly longer periods of low flow and shorter periods of medium flows downstream of the proposed dam during this period. The combination of high water temperatures, high algal and macrophyte production and high water residence time, poses a high risk of poor water quality and loss of pool habitat.

A secondary optimisation has been undertaken in the QWI response to reviewers (Appendix N) and it is claimed that this will address the issue of low and medium flows below the dam during the summer months. This may appear to be the case when the data are presented as median flows or % of simulation period (e.g. Appendix N, Figs 2-1, 2-2, Fig 4-1; Chapter 3, Tables 3-1 to 3-6; Chapter 4, Tables 4-2 to 4-7), however, the detailed daily flow simulations (Appendix N; Figs 5-1 to 5-44) still reveal long periods of zero or low flow (compared with the existing entitlement scenario) and the estimated average duration of zero flow and low flow 'spells' is much higher under the secondary optimisation compared with the preliminary optimisation or current conditions (Appendix N; Table 8-3). The standard deviations around these estimates are also high, indicating that in some years the zero flow and low flow spells would be much longer than the mean. Summary hydrological statistics (used throughout this report and the original EIS) are often uninformative for environmental flow assessments and sometimes misleading. They do not adequately capture the consequences of such variability for long-lived aquatic species such as those of concern here, where a single prolonged period of low or no flow can lead to significant mortality. Such impacts are likely below the dam and continue downstream to Fisherman's Pocket (contrary to the claim on p 3-15). Note that the photograph in Fig 4.5 (p 4-43) that has been used to illustrate low flow conditions in this discussion of downstream flow alteration is taken from the upper Mary River and does not accurately represent conditions in the channel below the proposed dam.

It also should be noted that this secondary optimisation was undertaken only for the period 1890-1999, and does not consider the implications of changed flow regimes in the catchment associated with recent and future climate, as was recommended in the reviews. The detailed simulation of the secondary optimisation also does not include the pre-development scenario –

[4] *SKM (2007). Traveston Crossing Dam Environmental Impact Statement.*
[5] *SKM (2008). Traveston Crossing Dam – DEWHA Information Request on Supplementary Report.*

only the 'existing entitlement' scenario, which may not reflect current conditions if the water is not being used. The QWI response (p3-49) that this is a matter for the Queensland DERM does not detract from the fact that the existing entitlement scenario does not meet some environmental flow objectives identified in the WRP that are relevant to the species of concern. The issue, therefore, remains that these analyses are likely to understate the risk to downstream habitats for these species.

In summary, information presented in the QWI response does not address the issues raised about decreased connectivity and poor water quality outcomes below the dam, despite that claim in Chapters 3, 4 and 6. Other possible interventions are mentioned, including flushing flows and improvements in water quality through improved landuse practices. However, the release of flushing flows with sufficient frequency to offset poor water quality downstream has not been modelled and is likely to further distort the flow regime away from the natural pattern. The scale and timing of catchment and riparian restoration planned would not be sufficient to improve water quality to the extent that nutrients are no longer limiting aquatic plant production, and the issues of poor water quality during periods of low (or no) flow still remain.

4 Suitability of the dam as habitat

Letters of endorsement from the Scientific Advisors (Appendix C) suggest that proposed habitat restoration and protection around the dam and adjoining tributaries can offset the impacts associated with inundation of important habitat for the aquatic species of concern. While this may be the case for some species of concern, several issues were raised in my previous review about the suitability of the proposed inundated area of the dam as aquatic habitat, especially in relation to the formation and persistence of aquatic macrophyte beds and the suitability of fringing riparian habitat. These issues have not been adequately addressed in the QWI response as claimed (e.g. p 4-39).

To accommodate the secondary optimisation proposed in the QWI response (Appendix N, Figs 1-1 to 1-11), the range and frequency of water level drawdown will increase significantly. The analysis provided in Section 6.3.5.1 in relation to lungfish habitat suggests that, even under this scenario, extensive macrophyte beds could be maintained. However, the establishment and persistence of submerged macrophyte beds is rarely observed in storages that are used for water supply – either because water levels fluctuate beyond the tolerance range or phytoplankton blooms effectively out-compete submerged macrophytes for light and nutrients. There are numerous studies reported in the literature to support this. Given the current agricultural activity in the upper catchment and nutrient status of the water in the river, there is a high likelihood that the impoundment will develop phytoplankton blooms. The fact that nearby Lake Macdonald does not experience blooms is not convincing evidence to the contrary. The proposed level of riparian restoration will have little effect on nutrient loads to the system. Fluctuating water levels will also reduce the effectiveness of proposed protection and restoration of fringing riparian habitat.

5 Barrier effects

Little additional information has been provided in the QWI response to provide reassurance that proposed fishway and turtle passage designs will function effectively and overcome risks of fragmentation and isolation of populations, and mortality of individuals passing through. The proposed designs have not been demonstrated to work and recent concerns over the effectiveness of similar devices on other Queensland impoundments in recent years gives little confidence that these issues can be resolved. In the (likely) event that these engineering solutions are not successful, the impacts of fragmentation of populations above and below the dam can only be offset by catch and carry methods and/or captive breeding and re-stocking. While a commitment has been made for research and monitoring, no information is provided as to the likely life-time cost of such activities.

6 Remaining issues for species of concern

6.1 Mary River Cod

- I concur with the Scientific Advisers of the QWI response that without the elimination and/or active management of current threatening processes, the Mary River Cod may continue to decline in the Mary River Catchment (Chapter 3).
- As indicated above (Section 3), the downstream reduction of pool habitat and associated reduction in water quality for extended periods of time is likely to contribute to the further decline of this species. Data presented in section 3.3.1.1 do not support the claims that this issue has been addressed (p 3-14).
- Although the inundation area is "not considered to be core cod habitat" (p 3-17), this zone is dominated by deeper pools, with a high proportion of large woody debris which is known to be critical cod habitat. Restoration of the river above the dam will not offset this loss, because pools upstream tend to be short and shallow.
- The loss of habitat by inundation and downstream reduction of pool habitat and associated reduction in water quality will reduce the area occupied by the Mary River Cod, contrary to the claim in 3.3.2.1 (p 3-20). It is doubtful to say the least that areas of habitat impacted by modified flow regimes 'will potentially experience a positive impact with increases in riverine connectivity and beneficial environmental flows downstream' as claimed in 3.3.1.2 (3-17).
- Retention of vegetation and revegetation of fringing margins of the dam are unlikely to be utilised unless the dam remains at high water levels, which is even more unlikely under the Secondary optimisation (Appendix N, Figs 1-1 to 1-11).
- The report argues 'there is the potential for natural spawning to occur' in the dam, though no additional evidence is provided that cod will be able to successfully breed and recruit within the impoundment area.
- The report concedes that the utility of a fishway for cod is not well known (p 3-29) and argues that captive breeding and restocking, and if necessary 'catch and carry' can provide the same outcome. No detail is provided on the latter (in terms of logistics, cost or likely success) and little information is available on the long-term survivorship of hatchery reared fish or the proportion of hatchery versus wild fish subsequently captured.

6.2 Mary River Turtle

- Loss of eggs from nesting banks continues to be a major threat to this species and protection of nesting sites and captive breeding are undoubtedly important mitigation strategies. I concur that under a 'do-nothing' scenario, all the available data indicate that the species will continue to decline into the foreseeable future.
- The QWI response goes to some length to challenge the EIS reviewers' claim that significant populations of turtles occur within the inundation area and below the proposed dam (4.3.1.2, pp 4-12 to 4-17). However, the arguments presented are not convincing and data presented to date are still consistent with this view.
- The dam will inundate critical habitat for Mary River turtles – no additional evidence has been presented to suggest otherwise. This zone is dominated by deeper pool habitats with a high proportion of large woody debris, and includes 5 known nesting sites.
- Relocation of nesting banks is acknowledged to be an untried mitigation strategy.

- As discussed above (Section 3), issues related to flow alteration below proposed dam and associated poor water quality have not been adequately addressed. Even under the secondary optimisation, the downstream flow regime cannot mitigate significant water quality problems in pool habitats (particularly during summer/autumn) that will increase the incidence of extreme dissolved oxygen depletion and risk to turtles (especially juveniles). It is very unlikely that flow release strategy for the Project could indeed enhance the quality of habitat downstream, as claimed (p 4-39), through the maintenance and or increase of flows for the purpose of water quality and movement.
- Several approaches are proposed to counter the effects of the dam wall, including a 'fishway design which explicitly takes account of the needs of turtles, intake tower screen design that prevents turtles entering the system, non-destructive acoustic or electric barriers to keep turtles away from the spillway gates' and a barrier design that prevents turtles entering downstream release areas where they might be injured by high flow velocities. However, no detail is provided of their design or additional evidence presented of their known effectiveness.
- The White-throated snapping turtle (*Elseya albagula*) (also assessed as a high priority for conservation management by the Queensland EPA's 2006 Back on Track prioritisation framework) is likely to be affected in similar ways to the Mary River Turtle.

6.3 Giant (Southern) Barred Frog

- It is acknowledged (p 5-12) that the Project will result in a loss of a small number of individuals within the lower reaches of Coonoon Gibber, Skyring, Happy Jack and Belli Creeks due to inundation of habitat. While capture and translocation is proposed, it is also acknowledged that there may be loss of individuals translocated due to attempts to return to their capture site.
- Because local populations persist under current fragmented conditions (with limited habitat connectivity) at these sites, it is assumed that impacts of the dam on fragmentation are not expected to be significant. These populations have only relatively recently been fragmented (in evolutionary terms) and the long-term implications are unclear.
- Under present conditions, isolated populations may be connected only through larval dispersal, noting that adult movement between populations is unlikely. This could be determined through a study of population genetic structure and such work would need to be done to assess the implications of the dam on fragmentation of populations.
- The report acknowledges that translocation of individuals poses an unknown risk and that about half of the reported attempts for other species have been unsuccessful. Research on this would need to be undertaken before the dam is approved – rather as an ongoing activity as proposed.
- The project will affect up to 215.17 ha of remnant riparian vegetation which provides potential habitat for the Giant Barred Frog and approximately 50.88 ha is considered to be critical habitat.
- Rehabilitation of riparian habitat along tributaries upstream of the FSL is proposed 'progressively over time' and it is suggested that 'essential frog habitat requirements, including understorey vegetation and leaf litter, would establish in the short term'. There is still a risk that the species will decline in population due to loss of critical habitat in the short to medium term while rehabilitated riparian areas upstream of the inundation area become established.
- I note that previously proposed control measures for invasive weeds (including cattle grazing) that may have impacted on frog populations are no longer being considered.

6.4 Coxen's Fig Parrot

- The fact that Coxen's Fig-Parrot was not detected during the field surveys and there are no recent records of the species from within the inundation area or nearby areas, is not evidence that the species no longer occurs in the region (p 7-2), nor does it diminish the importance of its forest habitat and fig trees.
- The project will result in clearing and/or inundation of vegetation that contains fig trees and the loss of 10% of the total of 277 'paddock trees' in the region. The proposed revegetation is unlikely to offset this loss of both fig trees and associated RE 12.3.1 vegetation in the short- to medium-term.

6.5 Queensland Lungfish

- It is claimed that the inundation area is not critical habitat (pp 6-24, 6-40) and represents only 4% of the total potential habitat in the catchment. However, the QWI response does not address the fact that nearly 40% of the core habitat for lungfish in its native distribution (Mary and Burnett Rivers) is already currently impounded. Furthermore, the inundation zone (36.5 km) represents about one fifth of the main channel habitat for lungfish within the Mary River and is dominated by deeper pools, with a high proportion of large woody debris which is known to be important lungfish habitat.
- While lungfish are known to occupy dams, there is still little evidence that populations are self sustaining in the long-term. The additional anecdotal evidence provided in the QWI report does not challenge this view. Given the longevity of this species, the presence of populations of large (old) individuals (e.g. in the Brisbane River) cannot be assumed as evidence that dams impounded systems can support "substantial populations of the species" (p 6-24).
- The QWI response includes an analysis of the <u>median</u> area of macrophytes that will be available under the secondary optimisation (6.3.5.1). Even if we assume that macrophyte beds can establish (see 4 above), and if we assume that lungfish will spawn within macrophyte beds in impoundments (no additional evidence has been provided), it is misleading to say that 86-88% of macrophytes available for egg laying are predicted to survive for the 30 days egg cycle. While the total area of predicted cover may not be predicted to change dramatically over a 30 day period, significant littoral areas with macrophytes will still be exposed during drawdown. If a lungfish spawned in the littoral margins then it is highly likely that their eggs would be exposed during this period.
- The *Secondary Optimisation* has not demonstrated the Project's ability to improve flow conditions downstream of the dam for lungfish as claimed (p 6-40). Long-lived species such as lungfish with sporadic recruitment are likely to be particularly vulnerable to the effects of low (or no) flow and associated poor water quality, even if they only do occur infrequently. The use of median statistics to suggest that, under the *Secondary Optimisation* scenario, low flows during the lungfish breeding months will be '*barely affected'* (Table 6-1) is misleading.
- In summary, no additional evidence is provided to counter the view that the loss of habitat (especially for spawning and recruitment) from inundation and the downstream alteration of flows and associated reduction in water quality will reduce the area occupied by the Queensland lungfish to the extent that the species is likely to decline.
- As indicated above, no additional information is presented on the proposed design of the fishway or evidence presented of their known effectiveness, other than a set of guiding principles. It is suggested (p 6-47) that "the general design process will involve a series of design workshops between stakeholders to review and agree to concept designs, management plans and modelling". The apparent lack of success of the fishway other storages leaves little confidence that this can be achieved. Similarly, mortality from entrapment and the spillway are ongoing concerns, as evidenced by recent reports of lungfish deaths at North Pine and Somerset Dams (not mentioned in the report).

7 Concluding remarks

It is important that the freshwater conservation issues raised here in relation to the Traveston Crossing Dam are not only considered from a regional and national perspective but also in the international context. In this regard, it is sobering to note:

- Although surface freshwater habitats contain only around 0.01% of the world's water and cover only about 0.8% of the Earth's surface, they support 9.5% of all described animal species (~40% of fish diversity and ~30% vertebrate diversity)[6].
- The Millenium Ecosystem Assessment (2005) has highlighted that population declines in freshwater are twice that of terrestrial and marine systems[7].
- 10,000-20,000 freshwater species are currently extinct or imperiled[8].
- In intensively developed regions, more than one-third of the species in some freshwater taxa are threatened[9]**.**

From a national perspective, recent work by Kennard *et al*.[10] on systematic conservation planning of eastern Australian rivers to maintain bioregional variation in fish biodiversity, emphasises the importance of the Mary River catchment, irrespective of cost-weightings based on factors such as catchment area, level of catchment disturbance or presence of exotic species.

It is clear that several species of concern in the Mary River are also threatened by factors other than those directly associated with the construction and operation of the Traveston Crossing Dam. These include stock access and trampling of stream banks, degradation of riparian zones, channel erosion, and direct predation. Urgent action is required to address these other threatening processes.

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[6] Dudgeon *et al*. (2006). Freshwater biodiversity: Importance, threats, status and conservation challenges. *Biol. Rev.* **81**: 163-82; Balian *et al*. (2008). The freshwater animal diversity assessment: An overview of the results. *Hydrobiol.* **595**: 627-37.

[7] Ricciardin & Rasmussen (1999). Extinction rates of North American freshwater fauna. *Cons. Biol.* **13**: 220-2.

[8] Strayer & Dudgeon (2009). Freshwater biodiversity conservation: Recent progress and future challenges. *J. Nth Am. Benth. Soc.* in press.

[9] Kottelat & Freyhof (2007). *Handbook of European Freshwater Fishes*. Jelks *et al*. (2008). Conservation status of imperiled North American freshwater and diadromous fishes. *Fisheries **33**: 372-407*

[10] Kennard *et al*. (in prep.). Systematic conservation planning of eastern Australian rivers to maintain bioregional variation in fish biodiversity. *Ecological Applications*

Appendix 1: Brief biographical details – Prof Stuart Bunn

Professor Bunn has an international reputation for research on the ecology and management of aquatic ecosystems, with a focus on energy and nutrient flux and the structure of aquatic food webs. At the same time, he has maintained an active interest in the science to underpin environmental flow assessment, and in the development of tools to assess aquatic ecosystem health and guidelines for riparian management.

His research has resulted in over 180 research and technical publications, most of which are refereed journal papers, book chapters and conference proceedings. His journal publications receive over 300 citations per year and he has an ISI citation '***h***' statistic of 28.

These include over 20 journal articles on river health and general ecology of streams in the Mary River catchment, as well as several highly-cited papers on environmental flows. The latter is the outcome of his work with the Scientific Committee for Water Research (International Council of Science), and more recently the Global Water System Project.

In addition to this scientific research, Prof Bunn has been a member of several technical panels aimed at identifying environmental flow needs for rivers in Queensland and he is very familiar with the WRP process and the flow modelling that underpins it. He has also worked on environmental flow issues in North America and more recently in China.

He is also an author on several technical reports on environmental flow methods, and guidelines for stream and riparian rehabilitation and protection (the latter, in part, is based on his research in the Mary River catchment). Prof Bunn developed and led the ecological component of Land and Water Australia's successful R&D program on Riparian Lands from 1994-99 and was also actively involved in research undertaken in Phase 2 of the Program (2001-06).

Prof Bunn has been invited to give over 15 keynote or plenary talks (at international and national meetings) on environmental flows and over 30 on river health and riparian management, and has co-taught several field courses in stream habitats and hydrology – including two in the Mary River catchment.

In 2007, he was awarded the Australian Society for Limnology medal in recognition of his "outstanding contribution to research and management of Australia's inland waters". He was appointed as a National Water Commissioner in 2008 and has previously served as a Director of Land and Water Australia.

A brief CV is attached:

Summary Curriculum Vitae

Professor Stuart E. Bunn

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Qualifications: BSc Hons *(West Aust.)* 1980; PhD *(West Aust)* 1985

Recent Employment History

2008- present	Commissioner, National Water Commission
1999- present	Professor in Ecology, Griffith University
1999-2002	Director, Land and Water Australia

Research Experience and Interests

- river and riparian ecology and aquatic food webs;
- aquatic ecosystem health assessment;
- environmental flow allocations.

Recent Roles and Responsibilities

- Deputy Director, Tropical Rivers and Coastal Knowledge program (www.track.gov.au)
- Steering Committee, Global Water System Project (www.gwsp.org)
- Chair, Scientific Advisory Panel, Lake Eyre Basin Ministerial Council;
- Chief Ecologist eWater Cooperative Research Centre;
- President, Australian Society for Limnology (2006–08);
- Deputy Chair, Scientific Expert Panel, SEQ Healthy Waterways Partnership;
- Water Champion, Earth Dialogues Meeting, Brisbane 2006;
- Executive Committee, North American Benthological Society (2003-06);
- Director, Centre for Riverine Landscapes, Griffith University (GU) (2003-06);
- Research Director, Cooperative Research Centre for Freshwater Ecology, 2003-05;

Major Grants Received

Over $20 million in collaborative R&D funding, including grants from CRCs (Catchment Hydrology, Freshwater Ecology), the Australian Research Council (Discovery, RIEF and Linkage), Land and Water Australia, SEQ Healthy Waterways Partnership, Department of Environment and Water Australia and Griffith University.

Consultancies

Over 30 environmental consultancies with industry and government agencies including:

- environmental flow assessments
- environmental assessments of mining on river systems
- river and riparian restoration
- development of aquatic ecosystem health monitoring programs.

Awards

- Australian Society for Limnology Medal, 2008
- Healthy Waterways Science Award, 2001
- Queensland Landcare Research Award, 1997

Publications

16 book chapters, 95 journal articles and over 80 other technical publications and reports. Over 300 citations per year (ISI Web of Knowledge), h score = 28, average citations per paper > 25.

Oral presentations

Over 50 invited conference and workshop papers, 40 conference papers and 80 invited lectures and seminars. Recent presentations include:

- "Maximising environmental outcomes in water planning" (*Environmental Water Allocation Forum, Canberra, 29 May 2009*).
- "Optimising investments in riparian rehabilitation and protection to improve the health of waterways" (*Plenary address – Vegetation Futures Conference, Toowoomba, Queensland, 20 October, 2008*).
- "Integration of science and monitoring of river ecosystem health to identify potential causal factors of degradation and guide investments in catchment protection and rehabilitation" (Keynote address – *Freshwater Biological Association, Inaugural Freshwater Biology Summit on Multiple Stressors in Freshwater Ecosystems, Windermere, UK, Sept 1-4, 2008*)
- "Threats to Australia's Freshwater Biodiversity" (Plenary address – Biodiversity Extinction Crisis Conference, Society for Conservation Biology, Sydney, Australia, July 11, 2007)
- "Influence of flow on aquatic biodiversity and ecosystem health in rivers". *ESSP, Global Environmental Change Conference*, Beijing, China, 9-12 November, 2006.

Selected publications

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