A quarter-century of evolution in Australian stream management: trends and prospects

Kathryn Russell[1], David Reid[2], Alison Miller[3], Geoff Vietz[4], Kirstie Fryirs[5], Ian Rutherfurd[6], Apanie Wood[7], Sarah Gregor[8], Johanna Slijkerman[9], Ben Pearson[10], Jess Walker[11], Myles Coker[12]

1. School of Ecosystem and Forest Science, University of Melbourne, Burnley, VIC, 3121. Email: kathryn.russell@unimelb.edu.au

2. Department of Environment, Land, Water and Planning, State Government of Victoria, East Melbourne, VIC, 3002. Email: david.reid@delwp.vic.gov.au

3. Department for Environment and Water, State Government of South Australia, Adelaide, SA, 5000. Email: alison.miller@sa.gov.au

4. Streamology Pty Ltd / University of Melbourne, VIC, 3741, Email: geoff@streamology.com.au

5. Department of Earth and Environmental Sciences, Macquarie University, Sydney, NSW, 2109. Email: kirstie.fryirs@mq.edu.au

6. School of Earth Sciences, University of Melbourne, Carlton, VIC 3053. Email: idruth@unimelb.edu.au

7. Melbourne Water, 990 La Trobe St, Docklands, VIC 3008. Email: apanie.wood@melbournewater.com.au

8. Melbourne Water, 990 La Trobe St, Docklands, VIC 3008. Email: sarah.gregor@melbournewater.com.au

9. Water Technology, 40 Rowan St, Wangaratta, VIC 3677. Email: Johanna.slijkerman@watertech.com.au

10. Hydrobiology, 27/43 Lang Parade, Milton, Qld, 4064. Email: ben.pearson@hydrobiology.com

11. Earthwatch Institute, Suite G-06, 60 Leicester St, Carlton, VIC 3053. Email: jwalker@earthwatch.org.au

12. GHD Pty Ltd, Level 9 180 Lonsdale Street, Melbourne, VIC 3000. Email: myles.coker@ghd.com

Key Points

- Past Australian Stream Management (ASM) conference proceedings were reviewed to test hypotheses relating to progress of the industry.
- Collaboration, but not interdisciplinarity, has increased over time.
- The incorporation of social and cultural values has increased over time.
- There is no evidence of increased integration of good waterway management into policy, or that the industry has moved from a reactive to proactive/strategic approach.
- We encourage thought on the future direction of ASM and the broader industry.

Abstract

Nine Australian Stream Management (ASM) conferences, and almost 900 papers, represents an immense opportunity to reflect on the evolution of our industry. We propose four hypotheses: (1) that collaboration and interdisciplinarity have increased over time; (2) that social and cultural values of waterways have increasingly been recognised; (3) that good waterway management (incorporating scientific, social, cultural, and economic perspectives) is increasingly being integrated into policy; and (4) that we have moved from reactive to more strategic approaches to waterway management. We verified that these hypotheses aligned with the perceptions of the ASM community using a survey. We tested them with a structured review of past ASM conference proceedings papers (n = 855) from 1996 to 2018, building on previous efforts (e.g. Fryirs et al. 2013, doi.org/10.1071/MF12355). The review included author details and affiliations, interdisciplinarity, core themes, methods, consideration of policy advances, and word frequency analysis. Our analysis showed mixed support for hypothesis 1; authorship teams were increasingly large and diverse in gender and institutional representation but there was no evidence of increasing interdisciplinarity or interstate collaboration. There was little to no support for hypotheses 2, 3 and 4. These structured reflections increase understanding of how our industry has evolved and where we can be more strategic about how we shape its future.

Keywords

review, progress, stream management, collaboration, social and cultural values, interdisciplinary, policy

Introduction

In 2021, at the 10th Australian Stream Management (ASM) Conference, we will celebrate 25 years since the inaugural ASM conference, held in Victoria in 1996. The nine volumes of ASM Proceedings (Table 1) provide an invaluable archive of information that can be used as an indicator of the history and evolution of river science and management in Australia over the last 25 years. The proceedings also contain a wealth of information on the demographics of the sector. In a global context, there are very few archives that can be used for such analyses. Data do not exist, have been lost, are incomplete, or are not co-located in electronic or hard copy records that can be readily analysed. Nor have the records maintained a consistency in structure over so many years that allow for trends analysis. As an industry that prides itself on adaptive management, even the act of reflecting and documenting the story provides valuable insights that can be used to consider how much has been achieved, how much there is still to achieve and how to plan and shape the future (e.g. Palmer et al. 2005; Wohl et al., 2005; Gilvear et al., 2012). It is also timely to reflect on what has not worked and whether there are any trends that have emerged that have produced unintended consequences.

The preface to the first conference suggested the intent was to increase national cooperation in stream and catchment management. In this paper, we explore whether the past ASM conferences have provided an opportunity for people from different organisations (e.g. government, consultancies, universities, community groups etc.) and locations to connect and collaborate. We also explore whether there have been increases in desirable features of collaboration, interdisciplinarity, integrated management and policy integration. We propose four hypotheses on how Australian stream management has evolved, based on our experiences as past ASM attendees and stream management professionals in research, consulting and government across Australia's three most populous states:

1. That collaboration and interdisciplinarity have increased over time in the industry
2. That social and cultural values of waterways have increasingly been recognised
3. That good waterway management (incorporating scientific, social, cultural, and economic perspectives) is increasingly being integrated into policy
4. That waterway management has moved away from reactive works to more strategic approaches

In this study, we verify these hypotheses against perceptions of the Australian stream management community through a survey, and test them against a structured review and word frequency analysis of past ASM proceedings. We update and extend the analyses conducted by Fryirs et al. (2013) for the 1ASM-6ASM to include the 7ASM-9ASM and consider whether previously identified trends have continued and whether others have emerged.

Table 1. Australian Stream Management (ASM) conference proceedings

Conference	Year	Location	No. papers	Theme	Reference
1ASM	1996	VIC - Merrijig	52	First national conference on stream management	Rutherfurd and Walker (1996)
2ASM	1999	SA - Adelaide	131	The challenge of rehabilitating Australia's streams	Rutherfurd and Bartley (1999)
3ASM	2001	QLD - Brisbane	106	The value of healthy streams	Rutherfurd et al. (2001)
4ASM	2004	TAS - Launceston	112	Linking rivers to landscapes	Rutherfurd et al. (2005)
5ASM	2007	NSW - Albury	80	Australian rivers: making a difference	Wilson et al. (2007)
6ASM	2012	ACT - Canberra	83	Managing for extremes	Grove and Rutherfurd (2012)
7ASM	2014	QLD - Townsville	85	Catchment to coast	Vietz et al. (2014)
8ASM	2016	NSW - Blue Mountains	102	Twenty years on	Vietz et al. (2016)
9ASM	2018	TAS - Hobart	104	-	Vietz and Rutherfurd (2018)

Methods

ASM community survey

We surveyed the ASM community (via the ASM and River Basin Management Society mailing lists) with two open questions regarding the trends of the past and future, specifically: a) 'Can you list two or three of the major changes you have seen in our industry over the last 25 years?'; and b) 'What do you see as areas for future work, or improvements to our knowledge over the next 25 years?'. The survey also included five questions that were answered by degree of agreement with each hypothesis, and one question on the representativeness of the conference, on a seven-point Likert-type scale (Figure 1).

Word frequency analysis

The machine learning library GROBID (2018-2021) was used to extract body text from PDFs of individual papers, which were then collated for each conference proceedings. Of the entire corpus (n = 855) a total of 43 papers (mostly from 8ASM) were omitted from the analysis due to Optical Character Recognition errors. Text cleaning was undertaken to remove common English stopwords, punctuation and numbers. To test our hypotheses, a word frequency matrix was developed for the entire corpus, from which subsets of words were selected as being an indicative reference to: collaboration; cultural, social and recreational values; policy development; and reactive or strategic approaches. Words were selected manually to ensure coherent and comprehensive word groupings were used for each topic, and to account for different spelling. If there was ambiguity in the interpretation of a word that could change its categorisation (e.g. 'community' may refer to an ecological or social community), it was not included. The count of words from each subset group was standardised against the total wordcount for each ASM to allow comparison over time. The total wordcount was used in preference to the number of papers containing a given word to give more weight to papers which focused heavily on a particular topic.

Structured review

We undertook a structured review of all papers and abstracts (n = 855) across the nine ASM conferences, building on the dataset developed by Fryirs et al. (2013) of 1ASM to 6ASM. The new data were collected by nine annotators, each of whom was assigned a portion of each conference's proceedings to reduce the likelihood of inter-annotator variability affecting trends.

For hypothesis 1 (collaboration and interdisciplinarity), we recorded the number of authors, their gender balance, affiliation categories (e.g. consultant, research, government, etc.) and locations (state/international). Author diversity is an indicator of collaboration quality (Neilsen et al., 2017), and gender, institutional and location diversity were the only dimensions of diversity we could assess from the available information. We recorded whether the paper was a cross-institutional, interstate, or international collaboration, and whether the paper was discipline-bound, cross-disciplinary (i.e. integrative science) or transdisciplinary (merging science with social, cultural, economic, management, or policy perspectives). Delegate lists for 1ASM and 9ASM were also interrogated to benchmark the diversity of authors against attendees.

For hypothesis 2 (social and cultural dimensions), we recorded the core theme of each paper using the categories defined by Fryirs et al. (2013), with the addition of a new category, 'First Nations cultural dimension'. We also recorded the occurrence of qualitative methods (e.g. surveys, interviews) in papers. For hypothesis 3 (policy advances/failings), we noted whether each paper documented knowledge-based policy advances or policy failings/limitations. Hypothesis 4 could not be tested because the concepts of 'reactive' and 'strategic' were not well-enough defined for annotators to categorise in a systematic way.

Trend detection

To test for overall trends, linear regressions were fitted between each response variable and year, and the strength and significance of the relationship was assessed. A total of 21 response variables were tested from the results of the word frequency analysis and structured review, across the four hypotheses (Table 2). To reduce the chance of false discoveries, the standard alpha level of 0.05 was corrected using the Benjamini-Hochberg procedure (Benjamini and Hochberg 1995), resulting in a significance threshold of 0.006. Therefore, any regressions with $p < 0.006$ were declared to be trends. Regressions with $0.006 < p < 0.05$ were supported by weak evidence and would require further data to confirm whether a trend exists.

Results

ASM community survey

Survey respondents (n = 40) generally agreed with all our hypotheses, and furthermore agreed that the ASM proceedings were a good representation of the state of the industry (Figure 1). Respondents were most ambivalent about whether we had moved towards more strategic approaches, and whether good waterway management was increasingly being integrated into policy. However, even in those fields, only a minority (~15%) disagreed with the statements. This indicates that our opinions and perspectives, which we have used as hypotheses, are generally shared by the ASM community.

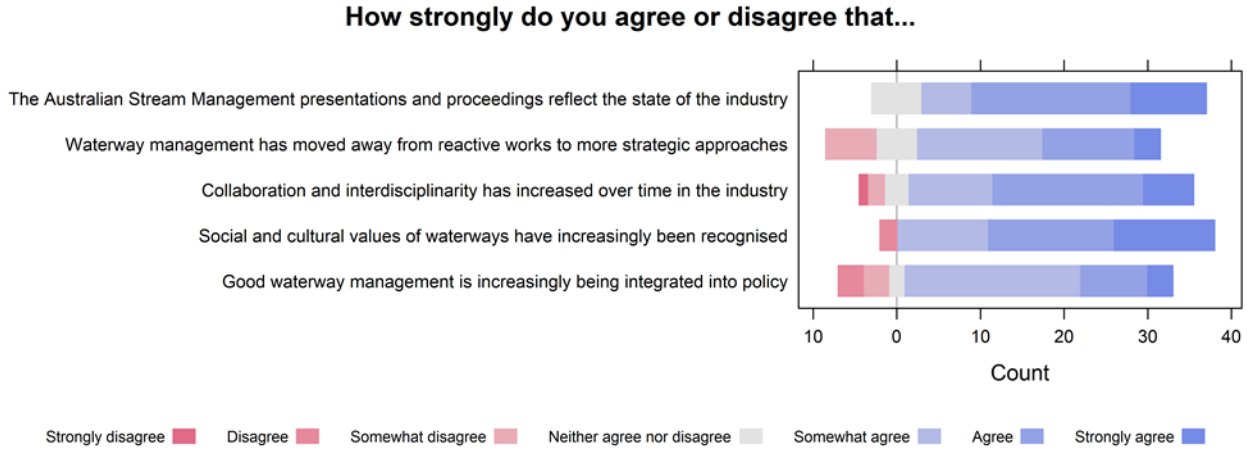

Figure 1. Survey results. There were 40 total responses including 31 from past ASM attendees, 3 from prospective attendees for 10ASM, and 6 from non-attendees.

Respondents were predominantly positive regarding collaboration and interdisciplinarity, noting "*an increase in willing partners*", "*emergence of participatory management*", "*increased community engagement*" and "*disciplines merging and working together better*". In contrast, there were comments regarding "*tokenistic public participation*" and "*progressive institutional unpickings*" of participatory management. The general consensus was summarised well by the observation "*over the past 25 years I have seen stronger integration of disciplines, and stronger links between academics and practitioners and community*".

Respondents noted increased recognition and incorporation of cultural values in waterway management, e.g. "*an increasing awareness and appreciation of just how accomplished the Traditional Owners were in respect of land and waterway management*". Yet, there were also comments indicating that such advances were very recent and still a work in progress, and that there was still a "*lack of consideration of Indigenous needs*". There was a recognition of the social services provided by riparian areas, and how they increasingly motivate waterway works and strategies, and the "*convergence of technical appraisal and social relationships building better river networking*".

There was conflicting commentary on policy changes over the years and the influence of new knowledge on policy. Some respondents cited the "establishment of CMAs" in Victoria and "*normalisation of environmental water*" and noted that "*science is slowly making its way into information works and strategies*". Others referred to "*piecemeal and sporadic nature of opportunities to participate in the profession of freshwater research, management and policy*", and a "*decline in the governance systems in place to conserve waterways*". Respondents recognised the importance of "*being effective at influencing policy and the broader community*", and specifically a need for "*inter-jurisdictional policy initiatives, techniques and shared experiences [that] will become more critical to our work and outcomes for rivers and riverine landscapes*".

The perception we have moved toward more strategic approaches was highlighted by commentary that "*we have supersized*" from working at individual locations to "*whole of system programs".* Respondents highlighted *"movement from strongly reactive interventionist approach (e.g. rocking erosion) to an approach which recognises system change and attempts to work with and plan for this change"*. This was seen as a "*Shift from problems solving... to protection/enhancement of values*" and a move towards broadly "*holistic and integrated approaches*", with a focus on the "*potential for river recovery and the key mechanisms to achieve that*".

Word frequency analysis

The proportion of words relating to collaboration showed a gradual increase over the years, almost doubling from 8 to 9ASM (Figure 2). The prevalence of words relating to cultural values (dominated by reference to individual nations and/or Aboriginal land councils) has increased since 1ASM, with a marked rise in word frequency from 7 to 8ASM. Words relating to social values also generally increased, with particular emphasis at 4 and 5ASM and then again from 7 to 9ASM. Weak statistical evidence of a positive overall trend was identified in these three word groups, i.e. collaboration, cultural and social values (Table 2). The use of policy

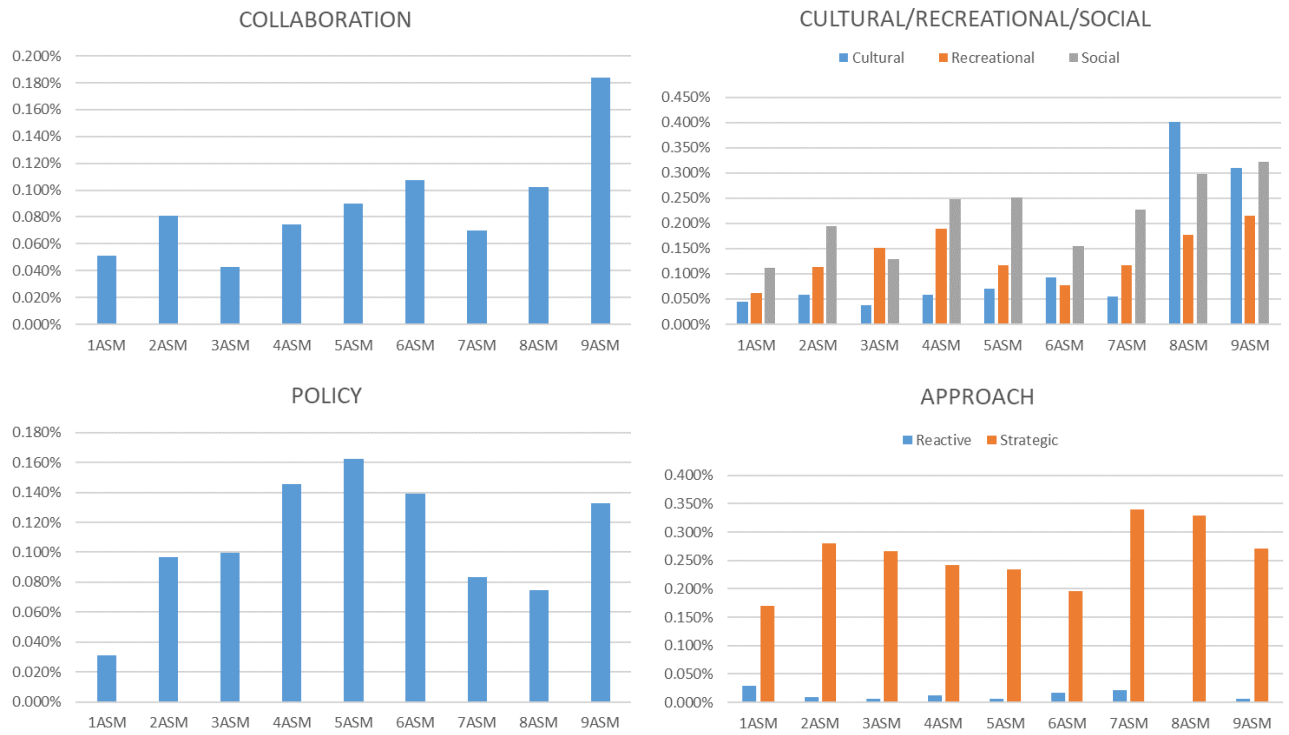

Figure 2. Results of word frequency analysis, representing proportional frequency of subset word groups (collaboration, cultural, recreational, social, policy, reactive and strategic) in ASM proceedings from 1ASM (1996) to 9ASM (2018).

terminology greatly increased after 1ASM but there was no overall trend. Likewise, there was no trend in reactive or strategic approaches, although strategic lexicon was used much more frequently than reactive terminology. Therefore, the word frequency analysis weakly supports hypothesis 1, that collaboration across the industry has increased, and hypothesis 2, that social and cultural values of waterways are being increasingly recognised, but does not support hypothesis 3 or 4. We note that the use of policy lexicon does not necessarily imply the development or integration of knowledge from the industry into policy or good stream management. Similarly, words representative of 'reactive' or 'strategic' may also be insufficient to represent our approach. These hypotheses may be better tested with more niche word group searches.

Structured review

Authorship teams increased in size and in some measures of diversity over the proceedings (Figure 3, Table 2). At 1ASM, papers had two authors on average, authorship teams were on average 18% women, and 24% of first authors were women. By 9ASM, on average, papers were authored by teams of 3-4, of which 37% were women, but still only 26% of first authors were women. Lead authorship by women peaked at around 45% at 5ASM but declined at subsequent conferences. Representation of women in authorship at 9ASM in 2018 was approximately consistent with attendance at the conference (38% of delegates were women).

Cross-institution collaboration became more common, increasing from 31% of papers at 1ASM to 51% of papers at 9ASM (Figure 3, Table 2). Interstate and international collaboration remained uncommon (around 10-20% and 1-5% of papers respectively). First authors at early ASMs mostly had research affiliations, but the contribution of consultants increased rapidly after 4ASM, while the contribution of researchers diminished. At 1ASM, researchers made up only 24% of delegates but 50% of first authors. By 9ASM, delegate and first author affiliations were more balanced. First authors were mostly from Victoria, and the representation of Victorian first authors increased over time. Around 25% of first authors were from New South Wales and 15% were from Queensland, with the remainder a diminishing minority from other states and overseas.

Table 2. Trends in variables associated with hypotheses. p-values of < 0.006 were considered significant; p-values of 0.006-0.05 are reported as providing weak evidence of a trend.

Variable	Trend	p-value	level of support
Hypothesis 1: Collaboration and interdisciplinarity			
Cross-institution collaboration	+0.9% per year	0.002	significant
Mean % women on authorship teams	+0.6% per year	0.002	significant
Mean number of authors	+0.05 per year	0.009	weak evidence
Word frequency: collaboration	+0.004% per year	0.03	weak evidence
Cross-disciplinary focus	-0.7% per year	0.04	weak evidence
Transdisciplinary focus	no trend		
Interstate collaboration	no trend		
International collaboration	no trend		
Hypothesis 2: Social and cultural dimensions			
Core theme: First Nations cultural dimension	+0.08% per year	0.02	weak evidence
Qualitative methods	+0.5% per year	0.02	weak evidence
Word frequency: social	+0.007% per year	0.02	weak evidence
Word frequency: cultural	+0.012% per year	0.03	weak evidence
Core theme: education	-0.2% per year	0.03	weak evidence
Core theme: economics	no trend		
Core theme: social dimension	no trend		
Word frequency: recreational	no trend		
Hypothesis 3: Policy advances/failings			
Documents incorporation of new/better knowledge into policy	no trend		
Documents policy failing/limitation	no trend		
Word frequency: policy	no trend		
Hypothesis 4: Reactive vs strategic			
Word frequency: reactive	no trend		
Word frequency: strategic	no trend		

Figure 3. Results of structured review including average number of authors, gender balance of authors, collaboration types, affiliation types and locations, interdisciplinarity, core themes, and policy advances/failings documented in ASM proceedings from 1ASM (1996) to 9ASM (2018).

Interdisciplinarity did not appear to increase over the proceedings (Figure 3, Table 2). Most studies were discipline-bound, particularly at 1ASM and 6 to 8ASM. Cross-disciplinary studies decreased after 4ASM and only represented around a quarter of studies at 5 to 9ASM. Transdisciplinary studies were a minority (around 20% of studies). There was some indication of transdisciplinary studies increasing since 7ASM as discipline-bound studies decreased. Around 70% of studies focused on science (mainly abiotic science), while around 15% focused on managerial, institutional and governance arrangements. Around 10% focused on the social

dimension of river management, while a very small but growing minority (2% at 9ASM) focused on First Nations cultural values. A minority of papers documented policy failings/limitations (~5%) or advances (~15%) and there was no trend in either.

Discussion

The ASM community agreed with our hypotheses, based on shared perceptions that collaboration and interdisciplinarity have increased, that social and cultural dimensions are increasingly being integrated into stream management, that new and better knowledge is being incorporated into policy, and that management responses have become more strategic. However, the proceedings provided mixed support for those hypotheses. Authorship teams became larger and more diverse, and there was some indication that collaboration increased between institutions but not between states. International collaboration and representation at the ASMs remained very low. There was no evidence that interdisciplinarity increased. Rather, cross-disciplinarity appeared to decrease in the mid-2000s. There was no overall trend in transdisciplinarity, but a hint of an increase over the last few conferences, reaching around one-third of papers at 9ASM. There was some evidence that social dimensions of stream management were being discussed more over time, and that qualitative methods (common in social research) are becoming more common. First Nations cultural dimensions were discussed in a small but growing minority of papers. There was no evidence of increased discussion of policy (either failings or successes) over time, nor was there any evidence of a shift from reactive to strategic stream management approaches.

Several of the extracted variables were reasonably objective (author affiliations, gender balance, word frequency), but others were subjective (e.g., interdisciplinarity, core themes, policy failings/advances). Therefore, the data quality varied, and was generally better for the variables related to collaboration than other aspects. We minimised the effect of annotator bias by assigning multiple annotators to each conference and multiple conferences to each annotator. We also compared the results from subjective assessments to the results of the word frequency analysis. The subjective assessment of core themes did not pick up a trend in social-focused work, while the word frequency analysis picked up some evidence of a trend, suggesting that we may be writing more about social aspects without them coming through as obvious core themes. The word frequency results were consistent with the structured review results on collaboration and cultural values trends, as well as the lack of trend in discussion of policy.

The ASM community provided commentary which contextualises some of these findings. While respondents were primarily positive about collaboration and transdisciplinary approaches, some noted that public participation tends to be tokenistic, and that genuine participatory management has been eroded by institutions. Comments also suggested that there is too much focus on ‘what we do’, but not ‘how we do it’, an essential element of transdisciplinary work. This suggests that our industry and the ASM conference needs to increase emphasis on how we can work better together. However, the consensus was that stronger integration of disciplines, and stronger links between academics and practitioners and community have emerged. This was reflected in decreased dominance by researchers, with authors from consultancies becoming more prevalent over time and government maintaining a strong presence. Authorship relative to attendance was skewed towards technocratic experts at 1ASM: researcher delegates were much more likely to author a paper than non-researcher delegates. This suggests that the conference initially focused on one-way information flow from experts to managers and policy-makers, and perhaps missed opportunities for practical and place-based knowledge-sharing and feedback from practitioners to researchers. By 9ASM, delegate and first author affiliations were more balanced, indicating that all affiliation groups that attended were contributing and sharing knowledge. While the conference is still male dominated in both attendance and authorship, representation of women is consistent with industry benchmarks (e.g., women make up 30% of the qualified environmental/agricultural science workforce; Professionals Australia, 2018).

The ASM community provided an overarching commentary that there was an increasing recognition of social and cultural values in waterway management. However, a minority also recognised that consideration of Indigenous culture is still fledging in our industry, and genuine integration of First Nations knowledge and values is still some way off. Respondents also noted that policy and governance advances have been piecemeal and sporadic. It would appear a more structured approach to how those in the industry could contribute to or influence various layers of policy is required. Respondents offered many comments about how our industry has become more strategic (e.g., working at whole of system scales, moving away from patching symptoms and towards protection and enhancement, and working with recovery trajectories), despite no evidence in the proceedings of that trend.

The intent of the first ASM was to increase national cooperation in stream and catchment management. It is not clear from subsequent proceedings if that intent was maintained but there is no evidence of increasing interstate collaboration from the data. The conference has consistently been dominated by delegates from the eastern states and representation of central and western states has declined over time. Naturally, industry members must choose between competing conferences and must justify the costs of conference travel. Nonetheless, the ASM was seen as valuable by its in-group, particularly the role it plays in individual professional development and sharing achievements and lessons when there is an opportunity to attend. Therefore, it appears worthwhile to explore opportunities to increase participation from central and western states and overall representativeness of ASM.

Conclusions and prospects

Based on the reviews, analysis and commentary we see a number of opportunities for ASM to play a bigger role in shaping the future of stream and catchment management in Australia. We put forward nine questions for consideration by the ASM leadership and community in developing strategic plans for the future:

1. How might we collaboratively and inclusively set a shared vision for ASM and the future role the conference plays in shaping stream and catchment management in Australia?
2. How might we foster a more diverse community of practice at ASM, particularly with regard to gender representation, representation of First Nations people, and participation from underrepresented states?
3. How might we better include, consider and respect Traditional Owner knowledge as a fundamental aspect of waterway management.
4. How might we connect ASM to global contexts and learnings from elsewhere in the world?
5. How might we enable and encourage more transdisciplinary collaboration through ASM to better integrate different types of knowledge to address emerging challenges and opportunities?
6. How might we influence the translation of knowledge into policy through ASM?
7. How might we explore better ways of working, including the integration of disciplines and organisations (e.g. academics, practitioners and community) through ASM?
8. How might we communicate the progress we are making, document our mistakes/failures and the changes we want to see, to a wider audience in order to grow the impact of ASM?
9. How might we continually reflect on and evaluate our progress towards our shared vision and goals for ASM?

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