CHAPTER EIGHT: IMPLEMENTING RIVER REHABILITATION STRATEGIES IN BEGA CATCHMENT THAT WORK WITHIN THE RIVER STYLES FRAMEWORK

8.1. Practical uptake and extension of findings from application of the River Styles framework in Bega catchment: Some comments on adoption

Fundamental shifts in land and water management practice, and associated aesthetic/cultural values, are required if we are to reverse the process of environmental deterioration across much of the Australian continent. Moves towards sustainability require that perspectives, attitudes and actions are applied with collective commitment to 'duty of care' principles. We are ALL affected by the health of aquatic ecosystems, and the life systems they support. Building on this premise, effective communication of scientific principles is integral in the design and implementation of successful on-the-ground strategies. Application of the River Styles work provides core scientific baseline data that can assist this process, framing what can realistically be achieved in environmental terms.

Consultation processes have accompanied each step in the application of the River Styles framework in Bega Catchment (see **Table 8.1**). Collaboration with technical officers in the Bega office of DNR, river managers and various stakeholders was a core component of the adoption process. This sustained commitment to knowledge transfer and reinforcement markedly enhanced the prospects for capacity building and ownership of information that accompanied the development of a catchment-based river rehabilitation plan. Community-based workshops and field days provided opportunities for collective learning through knowledge sharing, scoping of views and determination of achievable goals within a specified timeframe. Presentations to State Government agencies and expert panels were used to highlight potential future directions for river rehabilitation based on principles of recovery enhancement. Discussions in these various fora have ensured that potential benefits and limitations of available data and understanding are fully appreciated, and the vagaries of future river responses to unforseen sets of events and/or outcomes are recognised.

Table 8.1: Application of the River Styles framework in the Bega Catchment river management process

Year	Component/Phase of research and development	Extension, discussion and communication of findings	Products on paper
1991-1995	• Various undergraduate field trips run by Gary Brierley through Macquarie University. • Honours thesis by Andrew Brooks (1994) on post-European settlement changes to the Lower Bega River, provided initial appreciation of the extent of river changes and the altered sediment budget.	1994-1995 – Development of on-the-ground support through Bega Office of DLWC. 1994-1995 - Field consultations with landowners to gain a sense of local concerns and knowledge.	Brooks (1994) Fryirs (1995) Brooks and Brierley (1997, 2000) Fryirs and Brierley (1998) Brierley and Fryirs (1998) Brierley and Murn (1995)

	• Honours thesis by Kirstie Fryirs (1995) on the Holocene evolution and post-European settlement disturbance of valley fills in upper Wolumla Creek. • River Styles applications built on work in Tuross and Cobargo catchments to the north.		
1996-1997	Research (Development and application of Stage One of River Styles framework) Successful grant applications included: • LWRRDC (now LWA) Grant MQU1	1996-1997 – extension of field consultations with landowners throughout catchment to gain a sense of local concerns and knowledge. 1996 – Parramatta and Candelo public meeting on geomorphology and river ecology, and presentation of findings from initial application of River Styles in Wolumla catchment. 1996 – Presented Wolumla river evolution story at Australia-New Zealand Geomorphology Group Conference in Cairns. 1997 – Workshop and field day to present findings from application of Stage One of the River Styles framework throughout the catchment 1997 – Presented River Styles and Wolumla work at the Integrated catchment management conference in Canberra.	Brierley et al. (1996) Cohen et al. (1996) Fryirs et al. (1996) Brierley and Fryirs (1997) Brierley and Fryirs (2000)
1998-2001	Research (Development and application of Stages Two - Four of the River Styles framework) including: • Completion of sediment budget throughout the catchment. • Assessment of the geomorphic evolution and condition of rivers throughout the catchment. • Assessment of geomorphic river recovery potential throughout the catchment. • PhD thesis completed by Kirstie Fryirs (2001) on geomorphic condition and recovery potential of rivers in Bega catchment. Successful grants included: • NHT Grant awarded to Bega Valley Shire, the Far South Coast Catchment Management Committee and NSW DLWC to support research on sediment budget. • Australian Postgraduate Award (scholarship), Macquarie University Postgraduate Research Fund, AINSE Grant and River Basin Management Society Grant	1998 – Bega book launch and field days to present findings from application of Stages Two-Four of the River Styles framework throughout Bega catchment. 1998 & 2001 - Presentation of findings of application of Stages Three and Four at 2nd (Adelaide) and 3rd (Brisbane) Stream management conferences. 1999 – Presentation of findings of application of Stages Three and Four at International Association of Geomorphologists conference in Rio de Janeiro. 2000 – Presentation of findings of application of Stage Two at Australia-New Zealand Geomorphology Group Conference in New Zealand.	Fryirs and Brierley (1998) Brierley and Fryirs, (1999) Fryirs and Brierley (1999) Brierley et al. (1999) Fryirs (1998) Fryirs (1999a, b) Fryirs (2003) Fryirs (2002) Fryirs and Brierley (2000) Fryirs and Brierley (2001) Brierley (1998) Fryirs (1998 b, c) Brierley and Fryirs (2001) Fryirs (2001)

	to support Kirstie Fryirs PhD research and conference attendances.		
1999-present	Adoption, implementation, community ownership.	1999 – Discussions with Bega DLWC on findings from sediment budget work in the catchment. Subsequent development of the Bega sediment management plan. 1999-present - Discussions with DLWC re implementation and design of rehabilitation strategies. 1999-present - Integration of research into the Bega catchment integrative river health plan. 1999-present – Implementation of river rehabilitation strategies throughout the catchment by NSW DLWC, Bega Valley Shire, community groups and other organisations.	Brierley et al. (2002) NSW DLWC (2002) – river health plan

Inevitably it remains to be seen how changes to the pattern of thinking and associated design of river rehabilitation practices reported in this book will result in modified environmental outcomes following implementation of various components of the plan by Rivercare groups, Landcare groups and individuals. One thing is surely clear, however: lessons will only be learnt through effective monitoring and auditing programs, ensuring that the full benefits of 'learning by doing' are maximised and meaningfully transferred elsewhere. Effective engagement with adaptive management principles is also required to sustain the commitment to maintenance programs, 'tweaking the system' as we learn, and reframing our objectives as required.

In remaining sections of this concluding chapter, use of the physical template established through applications of the River Styles framework as an integrative biophysical basis for other management programs is highlighted (Section 8.2). This is followed in Section 8.3 by an appraisal of how these collective insights could be used in broader-scale applications at regional, State, and even National levels. Finally, in Section 8.4, a comment is made on the need for effective social engagement in promoting the potential benefits of this kind of work, and prospects are outlined for future research initiatives that build on the work presented here.

8.2. Maximising the potential of the River Styles framework: Moving beyond a geomorphic template for rehabilitation planning towards an integrative platform for an ecosystem approach to natural resources management

In a sense, the River Styles framework provides catchment-specific baseline information upon which broad-based management initiatives can be ***integrated***, providing a coherent platform for programs that address concerns for ***landscape futures***. Geomorphic components of landscapes (e.g. topography, lithology, sediment stores, vegetation cover, runoff relationships, etc.), their catchment-specific connections, and their sensitivity to human disturbance (and associated patterns, rates and consequences of change) present key information that guides and constrains management activities. Principles demonstrated in this book indicate that sustainable river management outcomes cannot be achieved *independent from* consideration of geomorphic insights which document the diversity, patterns and changing nature of river character and behaviour across a catchment. In no way should this be construed as saying that geomorphology provides the answer to all river management problems! However, geomorphic insights can provide a template upon which information can be organised and structured in an efficient and meaningful manner, enabling us to identify and address gaps in our primary data and understanding.

The River Styles framework synthesises local and reach-scale data into catchment-wide analyses, providing a geomorphic catchment context with which to integrate an array of biophysical data, thereby presenting a coherent physical template for management activities. The physical template developed through application of this framework in Bega Catchment has been used as a platform to add further layers of information as part of cross-disciplinary, cross-issue planning programs (see Brierley et al., 2002). Such developments mark practical steps towards realistic thinking and application of ecosystem-based approaches to natural resources management. In some ways, the River Styles framework may be viewed as the basal landscape context for such endeavours. Use of this template ensures that planners consistently take into account geomorphic behaviour and controls on that behaviour, within-catchment linkages of biophysical processes, and the evolutionary character and rate of change to river morphology.

Perhaps the core area in which principles from geomorphology have received notable uptake over the past decade or so has been in the field of ***biodiversity management***. Key themes in this work have been the re-emergence of cross-disciplinary fields such as geo-ecology and landscape ecology, renewing emphasis on landscape linkages/connections (Tockner et al., 2002). Future environmental management programs must address concerns for the linkage of aquatic and terrestrial ecosystems, developing new approaches to restoration ecology that manage for ecological health/diversity and measures of aquatic ecosystem functionality. This requires that we build on successes of environmental management programs that have targeted single species, whether birds, fish, plants, frogs, macroinvertebrates or whatever, and develop programs that operate at the ecosystem level.

Across much of the world, human endeavours have increasingly homogenised ecosystems and landscapes, modifying our sense of representativeness and connectedness. By presenting a framework that 'works with' the inherent diversity of landscape forms and processes in differing settings, the physical template developed through application of the River Styles framework enables an appropriate sense of 'naturalness' to be established. Working from this template, adopted management measures are sympathetic to local environmental needs and values. In some cases the physical structure of ecosystems is naturally simple, and these systems should be managed as such. Similarly, in many instances we cannot 'restore' river systems, so our goals must be framed in terms of the 'best that can be achieved', working towards 'created' complex adaptive (adjusting) ecosystems. Piecemeal strategies invite disaster. Recognising the fragmented, modular nature of many ecosystems and landscapes today, remaining semi-natural ecosystems must be enhanced, whenever possible, building out from scarce 'natural', 'near-pristine' or 'good condition' remnants. Conservation areas need to be identified and managed in terms of their 'uniqueness' and 'rarity' value, through river health, heritage, and wild and scenic rivers programs.

At the landscape scale, ***vegetation management programs*** provide key starting points for biodiversity management, and associated concerns for flow, sediment, nutrient/contaminant and salinity management programs. Effective targeting of replanting programs, tied to agroforestry developments, land management practices on farms, riparian vegetation and weed management programs, etc. provide tangible steps towards healthier catchments. Endeavours to attain, wherever appropriate, a continuous riparian corridor, with native vegetation dominant, are primary initial goals. Whenever practicable, fencing-off programs that minimise damage associated with stock access should be implemented, tied directly to weed management programs. The longitudinal and lateral connectivity of biophysical linkages that are sustained, enhanced or re-established through such programs should be framed in a manner that is appropriate downstream pattern of river types, their within-catchment position, and associated upstream-downstream linkages.

Flow management programs should aim to maintain, whenever possible, the vagaries of the natural hydrological cycle, including natural river and wetland functions and processes. Appropriate mixes of environmental and channel maintenance flows should be framed in context of the catchment-specific biophysical linkages. Targeted flow management strategies for ecological needs (e.g. maintenance of low flow stage refugia) must be tightly integrated with programs that address ***water quality***, ***salinity*** and ***contaminant/nutrient*** management programs. The River Styles template not only provides background information on the differing needs of individual river types, but more importantly demonstrates and explains how these reaches are linked in a catchment context.

The pattern and rate of geomorphic changes induced by human disturbance also has profound implications for the structural integrity of rivers, underpinning our efforts at ***sediment*** management along river courses. For example, river rehabilitation programs that are framed in context of geomorphic recovery notions must recognise limitations imposed by the catchment-scale sediment budget and associated patterns of sediment stores. Such insights determine the viability of programs that endeavour to release sediments from some reaches and trap them elsewhere. In many parts of Australia the effectiveness of such programs will be determined primarily in terms of alluvial sediment budget relationships, as slope sources are largely disconnected from valley floors or within-catchment sediment transfer linkage relationships are very inefficient. Elsewhere, however, slope processes are a much more important part of contemporary catchment-scale sediment budgets, and river management activities must be tightly integrated with slope management activities and associated ***soil conservation*** programs. Indeed, such issues are fundamental to water quality (turbidity) and nutrient/contaminant management programs.

Ultimately, our success in landscape- or ecosystem-scale programs in natural resources management will be determined, in large part, by the effectiveness with which we integrate these various components in coherent, holistically framed management activities.

8.3 Potential uses of the River Styles framework as a planning instrument/tool at regional, state and national scales

Baseline data are key to broad-scale thinking in environmental management programs. The nested hierarchical basis of the River Styles framework enables meaningful cross-scalar comparisons and syntheses at local, regional, state and national levels. Broad-scale syntheses of these data would provide a rich basis upon which to appraise what management goals are achievable, and where we can best achieve success given the resources that are available to us. However, considerable work remains to be completed in obtaining primary baseline information on river character and behaviour across much of the Australian continent. Such insights are fundamental in our emerging appreciation of how different types of rivers have responded to the cumulative impacts of natural and human-induced disturbance and prospects for future changes.

Although considerable caution must be heeded in making comparisons with other catchments, especially when extrapolating findings in a predictive sense, it is likely that similar river responses to human disturbance will be noted *for the same river type* observed along similar downstream patterns. Near

equivalent reaches are likely to have been subjected to the same types of land use pressures, and in adjacent catchments the timeframe of disturbance is likely to be roughly equivalent. For example, distinct parallels are evident in the work reported here from Bega Catchment and reports completed for adjacent river systems to the north (Dry River, Fryirs, 1998 b; Narira Creek, Brierley et al., 1999 b, Brierley and Murn, 1997). In each of these catchments, and several others on the South Coast of NSW, pronounced river responses to human disturbance have been experienced in certain sections of the landscape, especially along formerly discontinuous watercourses at the base of the escarpment (upland valley fills) and relatively short sections of laterally-unconfined river on the lowland plain. The roughly equivalent geomorphic configuration of various subcatchments has resulted in similar patterns of downstream adjustments to the structural integrity of river courses. In the instance reported here, disturbance to upland valley fills has transferred significant volumes of sediment through bedrock confined reaches down to the lowland plain and adjacent estuary.

Further regional-scale comparisons can build on the application of the River Styles framework in Bega Catchment to appraise how patterns and rates of river adjustment have varied for the same types of river, demonstrating how disturbance have been transferred through catchments, consequences for river condition and recovery, and associated biophysical implications that determine river health. When tied to other catchments in the region, such as the Clyde, Moruya, Tuross, Towamba, Genoa, etc., the South Coast office of DNR will have a comprehensive information base with which to establish regional-level priorities for management.

One of the challenging questions that needs to be addressed is whether management activities and associated funding should be equally spread across the region, or should regional-scale priorities be based on the distribution and abundance of remnants, condition of rare River Styles, selection of strategic reaches, etc. independent of their catchment-specific location? Without appropriate baseline data, many of these broad-scale decisions are, by necessity, of a reactive nature. Further baseline information would enable more strategic, proactive programs to be established.

Equivalent questions of strategic priorities and associated funding levels could be posed at State or even national levels (e.g. NHT funding). It is only with appropriate information bases and associated knowledge that informed decisions can be made for conservation programs and management of troublespots, providing an inventory of remnants on the one hand, and an explanation of stressed rivers on the other. As outlined in Section 8.2, these implications extend beyond river management *per se*, providing a physical basis for development of state-wide guidelines for holistic management of land, forests, water, riparian zones, salinity, nutrients and contaminants, etc.

As moves towards more holistic ecosystem-based approaches to natural resources management are embraced, increased emphasis will be placed on the need to develop and apply core components of adaptive management principles, reframing our approach to the implementation and maintenance of monitoring and auditing programs. To date, our record in testing the effectiveness of environmental management programs has been poorly structured, sparsely implemented, and scarcely reported. Any moves towards post-project appraisals must build upon pre-project data, requiring that commitment to such initiatives be acted upon immediately; ideally they would have been instigated some time ago. Significant questions must be addressed about the selection of *representative* monitoring sites, and what should be measured at these sites. In river terms, programs that monitor river health have placed virtual disregard for the geomorphic structure and function of river courses and associated notions of geomorphic river condition. Indeed, it is hard to build programs around such notions when appropriate information bases on geomorphic river character, behaviour and condition do not yet exist!

However difficult and whatever new challenges arise in deriving coherent information bases at catchment, regional and national scales, management options will be severely constrained without them. Sustainable environmental outcomes are far more likely to be achieved if management programs build on information that is directly pertinent to the system under investigation. The inevitable use of semi-quantitative models and associated decision support tools to predict landscape futures provide guidance as a part of foresighting exercises, but they were never designed to be used to present prescriptive sets of answers. Indeed, their authors generally recognise explicitly that they are based on flawed, non-representative data that smooth out trends such that summary findings do NOT provide an explanatory basis for management actions. Rather, they provide an indication of likely directions and potential rates of future environmental trends.

The principles presented in this book emphasise the need to come to understand your own system, recognising that the process of learning will never be complete. However imperfect the qualitative information presented through this type of work may be, it will continue to be the most grounded information that we have at hand for some considerable period into the future. We must learn to make the most of the information we have available to us.

Reiterating statements made earlier, catchment-specific applications of the River Styles framework are NOT intended to provide a prescriptive blueprint for broader, regional-scale applications. By definition, any management operation framed around some sense of a 'norm' negates the presence and significance of unique attributes of ecosystems – the very attributes that we seek to maintain or enhance in biodiversity management programs! As such, there is considerable danger in uncritical application of broadly-based decision-support tools that fail to appreciate the diversity and uniqueness

of 'natural' systems. Without suitable catchment-specific information, it is impossible to develop coherent environmental management projects, realistically framing what can be achieved in a manner that maximises the potential benefits from the utilisation of on-the-ground (community-based) support.

8.4 Broader implications of this work: Science, social engagement and future research agendas

Information presented in previous sections of this chapter indicates that the scientific basis for river management in Australia remains very patchy, with excellent discipline-bound information at local scales but relatively little by way of coherent inter-disciplinary thinking at broader scales. Perhaps of greater concern is the lack of appreciation of the limitations and dangers of extrapolation between scales: scaling-up is not a linear, deterministic process! The principles developed and applied in this book provide guidance on how information bases for environmental decision-making can be established within a landscape context at an array of inter-related scales. Significant gaps in our baseline information on geomorphic river character, behaviour and condition have been emphasised, and associated implications in the development of holistic, ecosystem-based environmental management programs have been outlined.

Regardless of complexities, uncertainties and inherent limitations in our understanding, management is ongoing, and we have to make the most of the information that we have available to us now. Observing tenets of the precautionary principle is surely warranted. In this concluding section of the book, the changing nature of environmental science and strategies to maximise the effectiveness of information use are outlined, focussing on social engagement and knowledge transfer. Finally, various questions for further research enquiry are presented.

Given the relatively small number of researchers in Australia, and the enormous breadth of environmental concerns to be addressed, it is scarcely surprising that enormous gaps remain both in our scientific understanding and in the use/uptake/extension of the knowledge we have gained. However, the authors of this book feel that problems are not simply issues of scale, funding and communication – we also feel that there is significant potential for researchers to reframe their practice, and become more effective in their work. Among the notable failings or limitations in much of the research on aquatic ecosystems in Australia has been an overemphasis on discipline-bound local-scale enquiry. This concern is not only manifest in terms of research design, with undue emphasis on linear, deterministic approaches to cause-and-effect experimentation, but it is also reflected in the nature of undergraduate training and lack of real-world practice in environmental management. Undue emphasis on simplified laboratory-style cause-and-effect relationships that bear little resemblance to the

complexity of interactions that is evident in real world situations is not an adequate basis for training. Ironically, the complexity that we seemingly avoid in much of our research design could be viewed as the very lifeblood of adaptive ecosystems. Although the practical considerations in this situation are self-evident (i.e. PhD students must complete their research in a limited time), an additional critical limitation in this approach to research is our limited capacity to scale-up findings in a meaningful way. Inevitably this reservation is compounded by the limited cross-disciplinary nature of the research design. To address these concerns, research projects must be constructed in a way that recognises scaling relationships explicitly. Similar conclusions can be drawn about the operational role of environmental management agencies.

Moving beyond some of the limitations and failures of scientific enquiry, the second area of scientific practice that requires further consideration is the communication, use and uptake of information, and how our 'best available understanding' is translated across into environmental management practice. Considerable gains have been made with this regard over the past decade. Of particular note here is the key role of agencies such as Land and Water Australia and Co-operative Research Centres, who have worked at the interface between researchers and managers. Increasing use of knowledge brokers has facilitated far greater uptake of scientific information. In addition, a whole suite of practical research tools have been developed. Key examples with this regard include the Australian Stream Rehabilitation Manual (Rutherfurd et al., 2001) and proceedings from the Australian Stream Management Conferences. Increasingly our research is better targeted to the needs of end users.

One of the difficulties faced by researchers in Australia is an emerging credibility gap among practitioners in environmental management. There are multiple components to this credibility gap:

1. Scientific understanding is forever changing and often appears to be contradictory. A clash of cultures is evident, as local communities tend to favour the 'security of traditional values', while scientists relish the prospect of changes in our understanding bringing about revolutionary changes in knowledge and approach (paradigm shifts), recognising with certainty that our understanding will change and actively promoting this process (this, after all, is what research is about).
2. Differing perspectives from discipline-bound researchers not only emphasise differing components of ecosystems, often at differing scales, but recommendations from their research often lack a coherent cross-disciplinary overview. As such, guidance for on-the-ground practice seemingly reflects the latest set of findings from researchers in that area. If another research group comes into the area, their findings are often inconsistent with the first group. This in itself is not a problem. Indeed, it is probably healthy. However, to the end users, confusion may reign unless a more coherent overview is presented that places these various findings in context.

In some areas this situation has resulted in a crisis of confidence among community and stakeholder representatives, with significant disillusionment with scientists/researchers and their unintelligible set of publications, perceived bias and lack of coherence among expert groups/panels, and cynical disregard for the findings of consulting groups whose reports inevitably endeavour to sustain their own business interests.

3. Top-down, expert-framed approaches to environmental management have limited credibility, as their track-record is far from impressive and there have been too many failings through lack of engagement with the communities of concern. Unless communities are engaged in the process, they will always look to blame someone else whenever things go awry – whether this is the local management agency, the expert consultant, or the local/state/national government. Communities have realised that they cannot wait for governments to fix problems. Indeed, even when guidance is provided, there is considerable distrust on what is said, and whether what is offered will actually be delivered. In many instances an equal level of concern is held for researchers and notional 'experts', who are good at proffering guidance and indicating how much we don't know, and how much more we actually need to know before we actually can do anything effective about it.

In Australia we have developed a number of environmental initiatives that merge research and managerial perspectives with community values/attitudes as part of participatory approaches to environmental management. Shared engagement and commitment not only promote an increased capacity to maintain environmental initiatives, they also provide a basis to collectively learn from ongoing adjustments over time. Through this, collective responses to successes and failures can be orchestrated, enabling us to strategically modify our practices through an experimental framework that promotes sustained learning.

In order to make the most of the information and insight that are available to us, we need to work and learn together in an adaptive management framework, with mutual respect among managers, stakeholders/community representatives, researchers, and others involved in the processes, implementation and auditing of environmental management. Core components of such frameworks include the development of appropriate communication skills/tools that integrate local knowledge with scientific understanding and sustained commitment to extension/technical officers who act as key pivotal players in the knowledge transfer process. Through primary (targeted) research and meaningful auditing programs that enable us to learn lessons from our successes and mistakes, our information and knowledge bases are forever changing and updated.

One of the outcomes from this potential (or seeming) impasse is the difficulty in developing coherent perspectives on the future. Without a meaningful sense of what is achievable, we cannot propose realistic visions for management programs, framing what we seek to achieve over a definable timeframe. Such considerations are critical in our endeavours to move forwards within a testing, auditing and learning approach to ecosystem management. Coherent and holistic frameworks for environmental planning are absolutely vital if we are to maximise the benefits of expensive 'action' and implementation programs such as the Natural Heritage Trust. It is only with effective, visionary and coherent planning processes, tied to collective engagement and will for implementation processes, that meaningful strategies for river repair will be achieved. Lessons from the past that have not been heeded include the need for meaningful auditing programs. Hopefully next time around, our collective mutual commitment to a process of learning will be recognised and acted upon, such that progressive knowledge gain is achieved and environmental benefits are maximised.

This concluding section of the book is not intended to be a foreteller of doom and gloom; far from it. Throughout the book we have noted the considerable advances in our understanding and management of rivers that have been gained over the past decade or so. Recognition of the concerns highlighted above is a key initial step towards their rectification! Of particular note with this regard are the following issues addressed in this book:

1. ***Landscapes as integrators***. Landscape-scale enquiry is increasingly seen as the most appropriate basis for management programs that operate within an ecosystem approach to natural resources management. Principles from geomorphology are increasingly recognised and used as the basis to develop integrative biophysical templates, using differing components of landscapes and their connections within catchments as platforms for holistic planning, implementation and monitoring in environmental management. The River Styles framework provides some critical steps in working towards this landscape-scale approach, such as:
    a. the nested-hierarchical nature of the framework (emphasising linkages among scales),
    b. appreciation of the diversity of river forms and processes in differing settings
    c. separation of river character and behaviour from assessments of their condition and trajectory of change,
    d. recognition of the need to 'work with change', emphasising catchment-specific responses to human and natural disturbance, and associated patterns/rates of change of biophysical linkages, and
    e. the need for predictions of likely landscape futures to be framed in a catchment-specific manner, emphasising what is realistically achievable for that catchment.
2. ***Communities as implementers***. Adaptive management and participatory approaches have become core underpinnings of environmental management practice in Australia. This is a

fundamental and lasting legacy of the Green movement of the 1960's and 1970's followed by the Decade of Landcare in the 1990's. Collective engagement in the environmental management process has made Australia a world leader in river rehabilitation practice.

3. ***Adoption of adaptive management principles and practices***. Application of the River Styles framework enables greater *accountability* in environmental management practice, as this broad-scale information base presents an opportunity to establish a clearer sense of what we are trying to achieve. This enhances the application of adaptive management principles, increasing our capacity to respond to 'new' situations by taking into account changing social, economic, environmental (e.g. climatic) and cultural values in the decision-making process, promoting principles of openness and transparency. It is far easier to be *flexible* in management responses when working within a proactive, rather than a reactive, context. Management strategies that worked for a particular problem in the past may not be appropriate in the system today, as the system may now operate under an altered set of circumstances – the functionality of the system may well have changed, yielding differing responses to the same set of inputs!

Finally, the principles demonstrated in this book, and lessons learnt in application of these principles in reframing perspectives in river management programs, have highlighted several key issues that we feel need to be addressed if we are to move towards adoptions of more sustainable environmental practices. Critical questions that we feel need to be addressed include:

- How do we develop coherent biophysical templates that enable managers, stakeholders and the community at large to gain an understanding of the forms, processes and interactions in complex adaptive systems that are forever adjusting? How do we develop practical strategies to deal realistically with complexity and uncertainty?
- What steps can we take to develop holistic broad-scale environmental management programs that build directly on the 'natural' diversity of landscape forms and processes and associated patterns and rates of biophysical linkages?
- How do we assess the likelihood that geomorphological adjustments will bring about the desired ecosystem responses?
- How do we quantify notions such as landscape sensitivity and recovery to provide a better framework with which to predict landscape futures and guide what we seek to achieve in environmental management programs?
- Can we develop sets of guidelines that determine the reliability of interpretations and inferences in extrapolating local-scale findings to broader-scale of enquiry? What steps can we take to maximise the potential benefits, and highlight the underlying limitations, of Decision Support Tools?

- How do we develop sustainable agricultural, ecotourist, aquacultural and forestry systems that reduce the risk of salinity/pollution and improve the physical habitat of river systems and associated wetlands for wildlife?
- What social, institutional and environmental educational arrangements will most readily facilitate the adoption of best available knowledge within an adaptive framework? How do we ensure that moves beyond the planning stage through to implementation are achieved? What steps do we need to set in place to achieve these prospective developments? How do we develop, implement and maintain monitoring and auditing programs that will enable us to respond (adapt) and achieve (i.e. learn by doing)?
- How do we improve professionalism in environmental management practice in Australia? Should we adopt certification or accreditation programs?

In conclusion, we've come a long way in reframing approaches to environmental management in Australia over the past two decades. A sustained commitment to patience, persistence and resilience is required to further advances made in this process of change. One of the fundamental lessons learnt by the authors in the development and application of the River Styles framework, and something that we were advised of initially but never truly appreciated, was the observation that "change in natural resource management does not occur overnight". Endeavouring to be patient was challenging indeed, with significant frustrations along the way. Without sustained commitment and determination, considerable support (of multiple forms), and significant doses of good fortune at the right time (especially in terms of securing funds), the ultimate outcomes would not have been achieved.

In Australia today, many of the drivers of change in furthering the development of participatory approaches to environmental management are being driven from the bottom up. As a consequence, managers, researchers, and notional experts must be prepared to adjust their perspectives and their practice in light of these changes. Hopefully the River Styles framework provides a set of tools that is well equipped to facilitate various components of information delivery and use that can underpin successes in this socially transitional process. The way of thinking outlined in this book goes beyond mere description of the types of rivers that are evident in the landscape, how they work, and their catchment-specific patterns of connections. Core insights are also provided into geomorphic river condition, explaining why reaches are the way they are, and the potential for recovery is appraised through assessment of catchment linkages. Collective ownership of these forms of catchment-specific information, and advances in our understanding gained through mutual reinforcement of ideas, provide a basis to develop strategic environmental management programs that have a commonly-agreed purpose and direction. Collective visions and agreement on priorities, practices and actions required to

achieve the vision will hopefully result in collective engagement with outcomes … whether successful or otherwise … such that responses and future programs take heed of the lessons learnt.

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