Developing ecologically meaningful metrics to advance environmental flow ecology

Group Members: Stephen Balcombe[1*], Angela Arthington[1*], Stuart Bunn[1*], Leah Beesley[2], Nick Bond[2], Justin Costelloe[3], Barbara Downes[3], Scott Hardie[4], Mark Kennard[1], Alison King[5], Christoph Matthaei[6], Jay O'Keefe[7], Jon Olley[1], Timothy Page[1], Paul Reich[2], Danielle Warfe[8], Robyn Watts[9]

Project Objectives

Environmental flow management aims to restore or conserve the ecology of river systems through the delivery of water (Figure 1). The nature of a given environmental flow will be determined by the desired management outcome, such as increased diversity and productivity of biota. The success of any environmental flow release will be determined in part by the level of knowledge of exactly what aspects of the flow regime to manipulate and the predicted response by the target biota.

At present there is a lack of quantifiable flow ecology-biotic response relationships that can be generalised across river systems (Poff and Zimmerman 2010). This is partly due to the difficulties of transferring such relationships across climatic zones (e.g. arid, temperate etc.) and river types (e.g. perennial, lowland, snow-melt etc.), but also the actual relevant flow metrics and biotic indicators that can be measured. These difficulties have been compounded by the nature of environmental flow programs that have been applied to assist river managers such as ELOHA (Poff *et al*. 2010), which necessitate the grouping of many river types and climatic regimes into smaller sets of flow classes to simplify complex relationships between flow ecology and biotic response. Such simplification clouds quantification due to the confounding nature brought about by clumping across different geographical, climatic and geomorphic gradients and the influence of a range of other environmental and man-made stressors.

The aim of this workshop was to draw knowledge from cross-disciplinary scientists with experience of different climatic regions and river types to examine whether there are identifiable biota and flow metrics that can be applied to specific regions/river types for assessing the success of environmental flows.The specific aims were to:

- Summarise flow-ecology relationships for specific regions or river types and to seek synergies across datasets to identify any universal relationships and/or universal flow metrics
- Summarise statistical methods that underlie these flow-ecology relationships
- Outline the challenges for developing flow-ecology relationships and a more rigorous scientific basis for environment flow management
- Outline the foundations for a synthesis manuscript

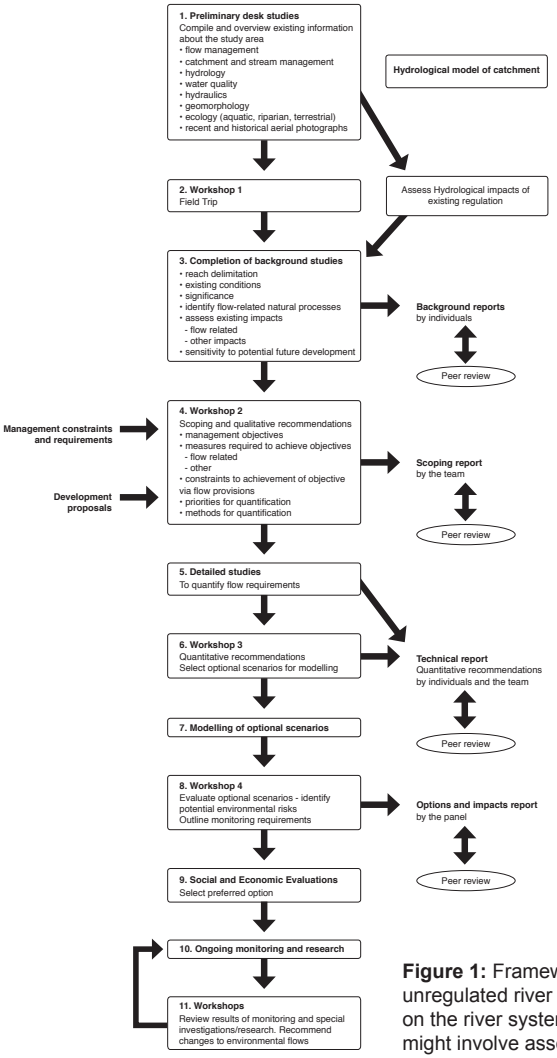

Figure 1: Framework for assessing environmental flows in regulated and unregulated river systems. Box 3 refers to the need to assess impacts on the river system other than flow regime change: this assessment might involve assessment of multiple stressors (Arthington *et al*. 1998).

Methods

The workshop was structured around group discussions of background readings and presentations by participants, followed by discussions and synthesis in key focus groups to further explore specific sections for the intended manuscript.

On Day 1 each of the attendees provided examples of biota-flow ecology relationships in different river types and regions. These examples provided specific information on quantitative relationships in unregulated rivers, and/or regulated rivers and/or regulated rivers with environmental flow management.

Day 2 started with the recognition that there were a number of confounding factors inhibiting our ability to find evidence for a suite of biota and flow metrics that could be widely applied across regions or river types. The main confounding factor was the influence of differing multiple stressors (e.g. catchment land use, alien species) across most regions and rivers.

The workshop then focused upon discussing where and when it is appropriate to use environmental flows for the rehabilitation of flow-altered rivers.

The remainder of the meeting was dedicated to smaller focus groups to develop the basic structure of the manuscript with some initial text for each of the major sections. These discussions and knowledge reviews resulted in the expansion of our thinking into two possible manuscripts for development post-workshop. It is intended to submit both manuscripts early in 2013 with work continuing out-of-session.

PARTICIPANT'S INSTITUTIONS

[1]Australian Rivers Institute, Griffith University; [2]Victorian Dept. of Sustainability & Environment; [3]University of Melbourne; [4]Tasmanian Dept. of Primary Industries, Parks, Water & Environment; [5]Charles Darwin University; [6]University of Otago; [7]Rhodes University; [8]University of Western Australia; [9]Charles Sturt University.

Major Findings

The provision of environmental flows is without doubt an essential prerequisite for maintaining the ecological health of a river, even where other environmental factors may be limiting (Bunn and Arthington 2002; Bunn *et al*. 2010; Poff *et al*. 2010). However, the likelihood of achieving beneficial ecological outcomes from environmental flows will depend on two sets of factors: (1) the types and degrees of flow regime alteration and the potential for flow restoration and their spatial/temporal scales, and (2) the complexity and scale of other stressors on the river system (i.e. the multiple stressor context).

This workshop group has

(i) Developed a conceptual framework to capture a continuum of possibilities that may influence the likelihood of ecological success from provision of environmental flows in multiple-stressor contexts (for similar framework see Figure 1)

(ii) Identified four categories of river settings and examples of environmental flow programs that are suited to these categories based upon this conceptual framework

(iii) Outlined some potential monitoring designs with appropriate indicators that are likely to detect measureable responses to environmental flows (i.e. cost-effectiveness) within multiple-stressor contexts

(iv) Outlined the management utility of the conceptual framework

(v) Identified knowledge gaps and research priorities to advance the science, monitoring and decision-making surrounding environmental flows in multiple-stressor contexts.

These five findings are currently being worked into the first of the following two manuscripts that we aim to submit in early 2013.

Key papers or products

Paper 1: Environmental flows in rivers with multiple stressor syndromes: what can we expect to achieve? (in prep.).

Paper 2: Risks and opportunities from artificial watering as a means of achieving environmental flow objectives (in prep.)

How will this affect Australian ecosystem science and management?

There have been many studies on flow-ecology relationships over recent years, but there are still only a limited number of examples of large scale environmental watering actions around the world (Arthington 2012; LeQuesne *et al*. 2011). Australia is at the frontier of delivering environmental water (large scale restoration programs) and is at a critical stage in river management where governments are considering implementing large-scale monitoring programs to assess responses to environmental-watering, such as in the Murray Darling Basin.

The outcomes of this workshop and subsequent peer-reviewed manuscripts will bring together ideas from fundamental and restoration ecology, flow-ecology relationships, and water allocation strategies to provide robust links between freshwater science and the management of environmental flows. Furthermore, it will provide some cautionary principles for the delivery mechanisms of environmental water (e.g. via engineered structures rather than natural overbank flows) and the likelihood of achieving strong responses for riverine biota based upon their ecological needs.

Above: Sampling aquatic fauna with fyke nets.

Above: Environmental Flows ACEAS workshop.

References and citations

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