

ADDRESSING THE WICKED PROBLEM OF WATER RESOURCE MANAGEMENT: AN ECOSYSTEM SERVICES APPROACH

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INTRODUCTION

- Increasing water demand in Canterbury for irrigation
- Problem is water resources are scarce:
 - Rivers have reached maximum allocation limits while maintaining acceptable minimum river flows
- Investment in large water storage projects the **solution**?
- Water storage provides gains to farmers, but can result in losses to in-stream values
- Gains and losses lead to stakeholder disputes
- Systematic assessment required to ascertain whether this solution is **sustainable**



A SUSTAINABLE SOLUTION?

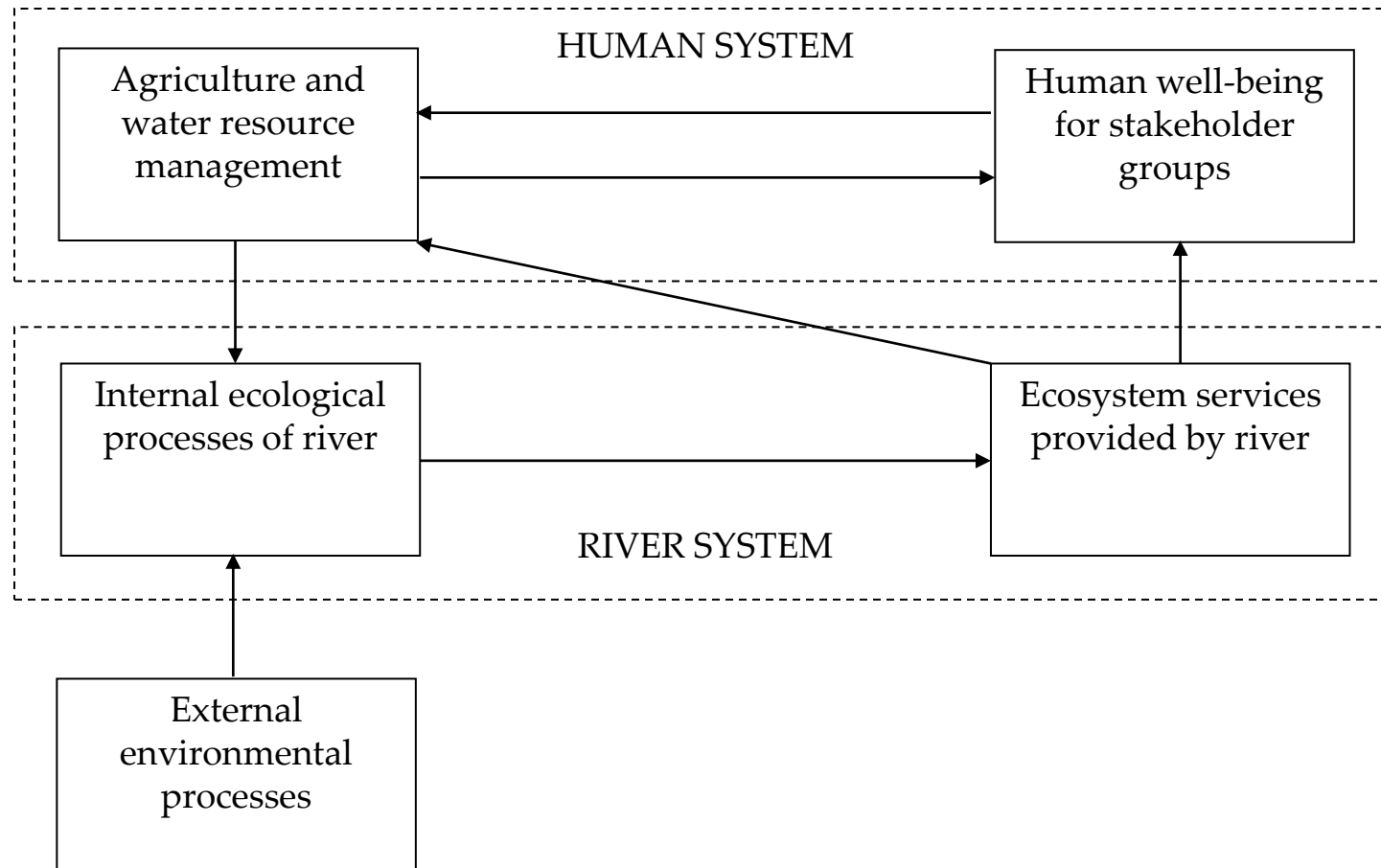


ECOSYSTEM SERVICES

- Ecosystem services:
 - Used to assess the many values from rivers
 - The collection of goods and services provided by ecosystems (*e.g.* rivers) that provide human well-being
 - Produced from ecological processes through “**complex interactions** between biotic and abiotic [factors]” (De Groot *et al.*, 2002)



ECOSYSTEM SERVICES

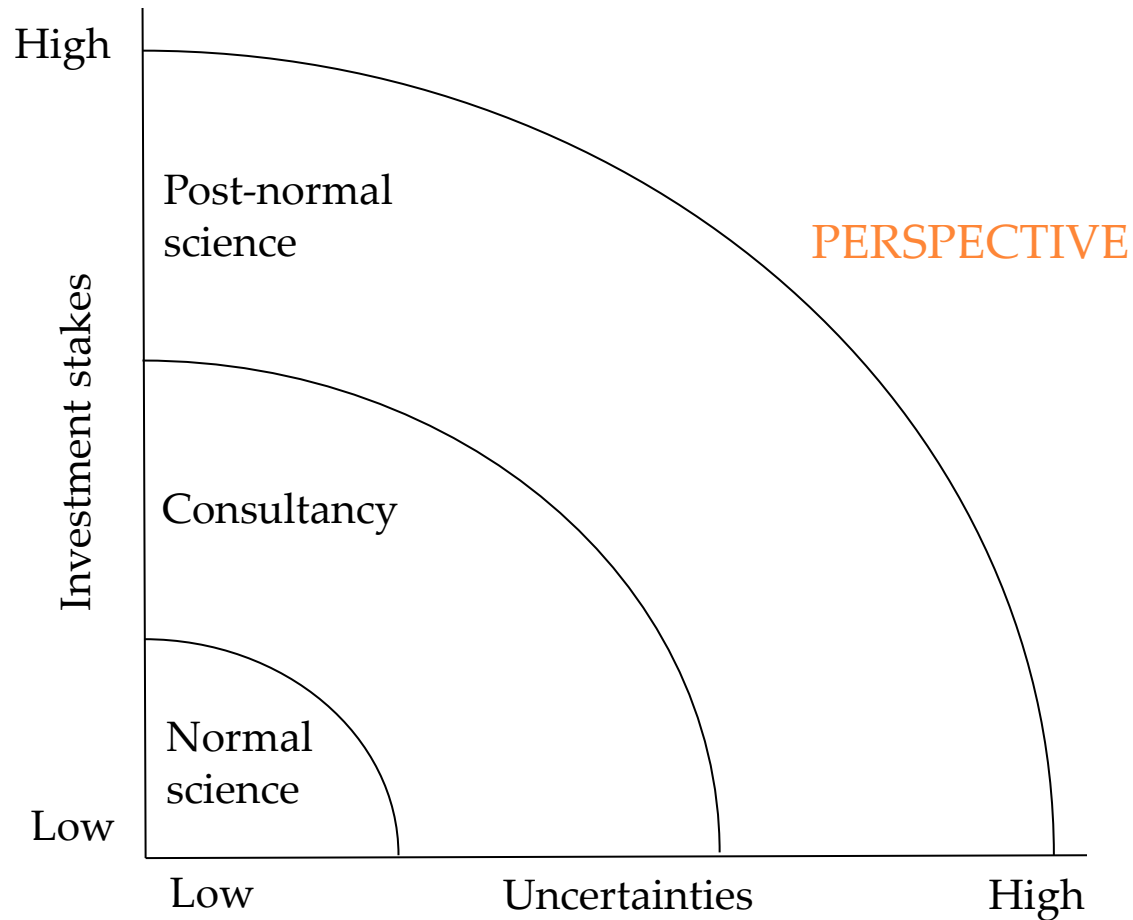


WICKED PROBLEMS

- Managing water resources in Canterbury is identified as a wicked problem (Frame & Russell, 2009)
- Wicked problems arise from:
 - Stakeholders with **conflicting** preferences
 - **Incomplete** and **contradictory** understanding of complex interactions between numerous factors
- Over-simplifying wicked problems leads to unsustainable solutions



POST-NORMAL SCIENCE



INTEGRATED MANAGEMENT

- Post-normal science recognizes the impossibility of transcending **perspective** to value-free objectivity
- Using many perspectives of 'scientists' improves objectivity towards a common 'factual' perspective
- Integration between scientists and stakeholders required
- **Integrated water resource management** provides greatest promise for sustaining ecosystem services
- Lack of research with methods that aid integration and accommodate conflict/contradiction, yet remain quantitative

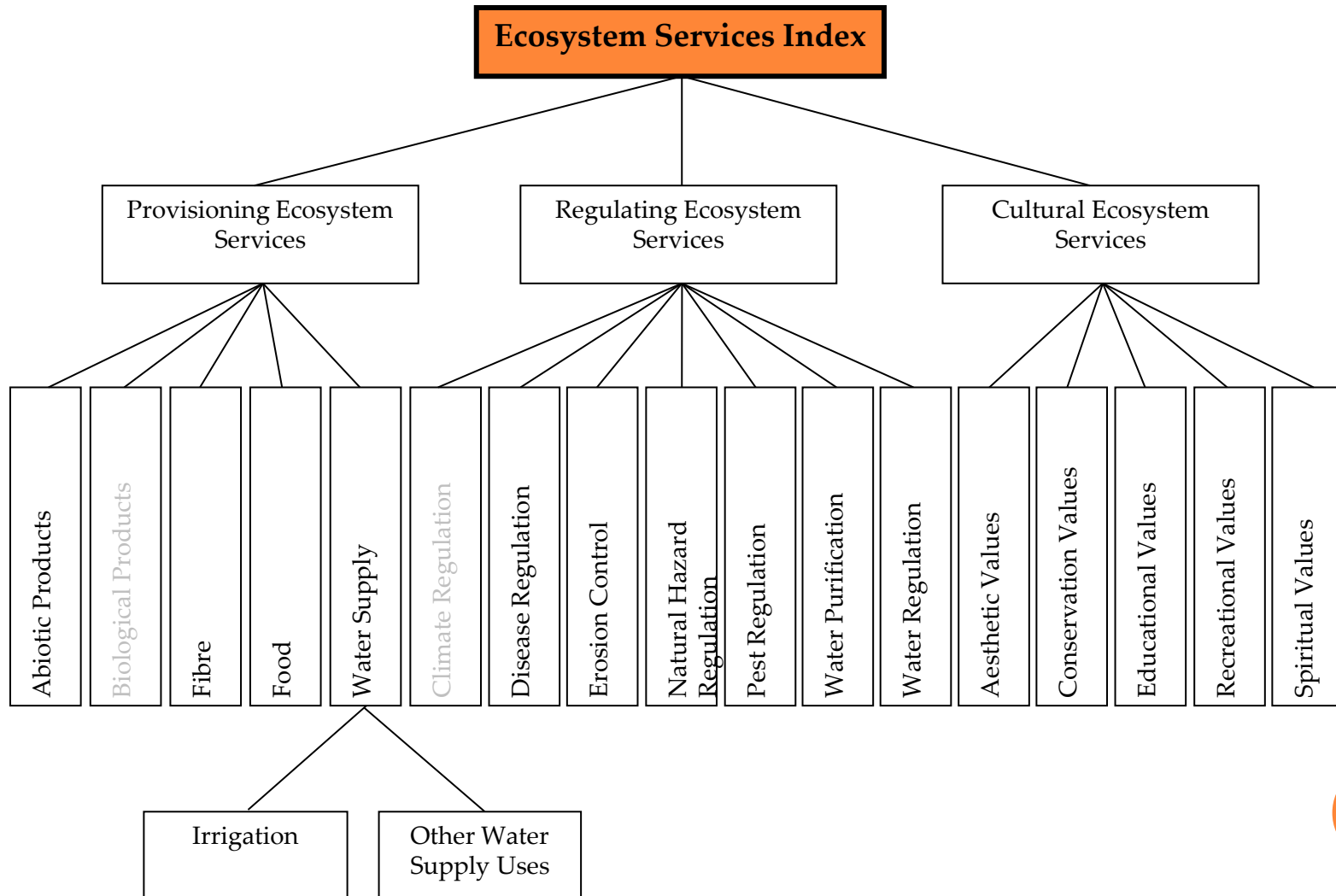


ECOSYSTEM SERVICES INDEX

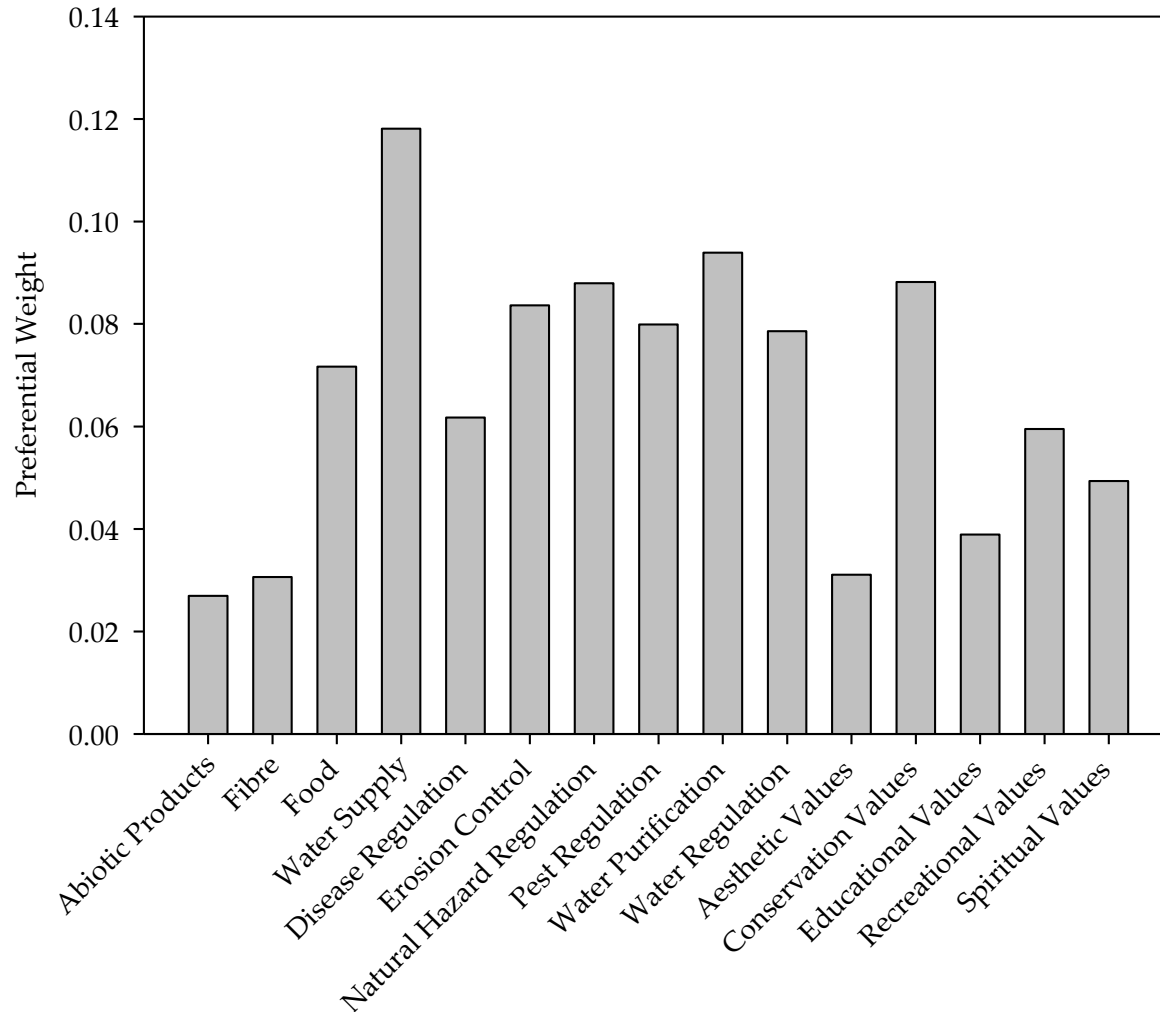
- Missing markets for ecosystem services leave them undervalued
- Problem usually tackled with non-market valuation
 - But, these methods can be costly and time-consuming
- Despite difficulty monetizing ecosystem services, Boyd and Banzhaf (2007) recognize the need for “standardized units of account to measure the value of ecosystem services”
- Fortunately, ecosystem services can be assessed by a utility index; $ESI = \sum w_n s_n$



MULTI-CRITERIA ANALYSIS



PREFERENTIAL WEIGHTS



CONFLICT

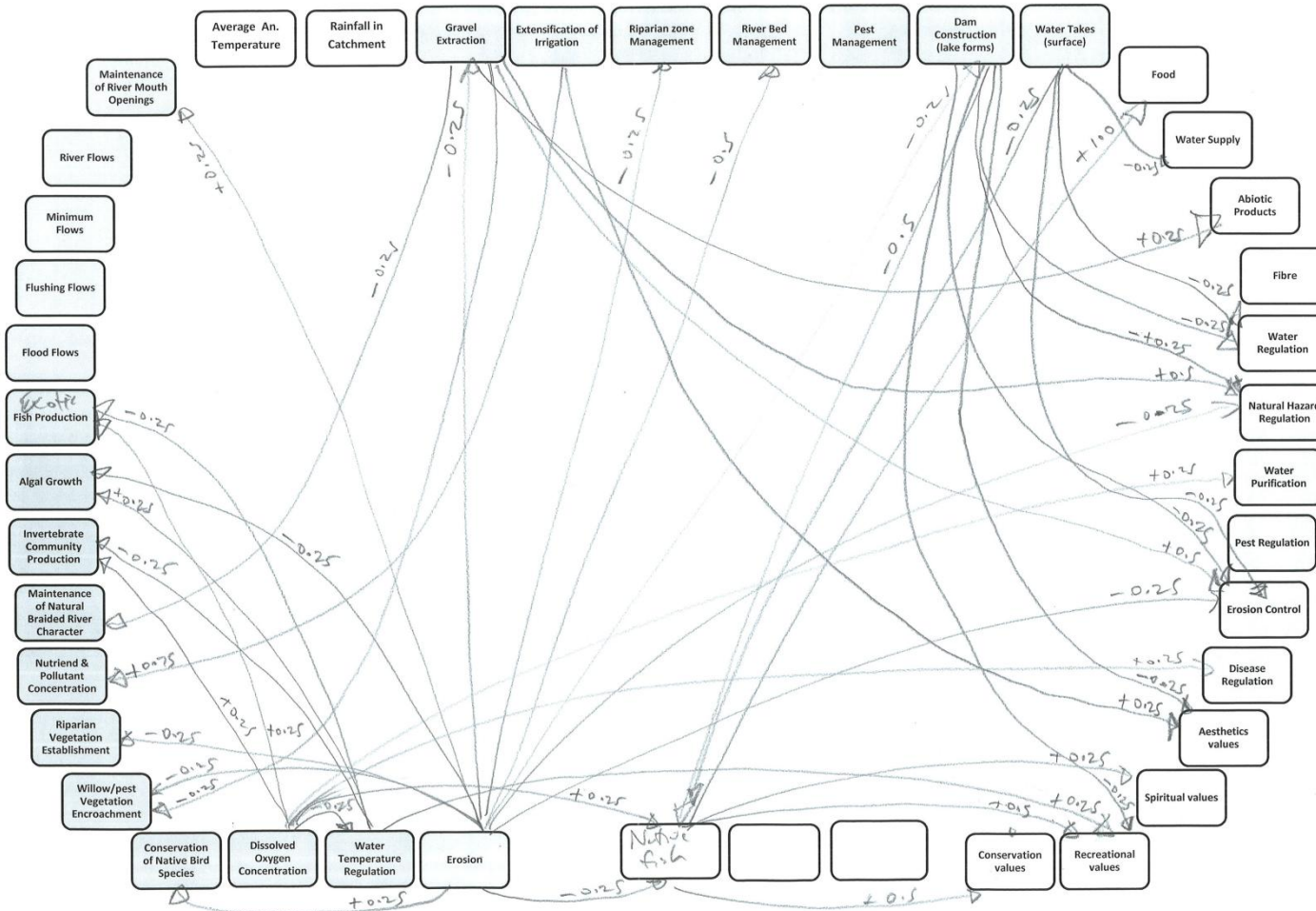
- Stakeholder representatives placed into 4 groups:
 - Steering Group
 - Water Consumers Group
 - Water Conservators Group
 - Government Group
- Non-parametric statistical tests to be used to assess potential conflicts in preferential weights

Friedman's <i>Q</i> statistic	37.622
Significance	<0.001
<i>N</i>	6



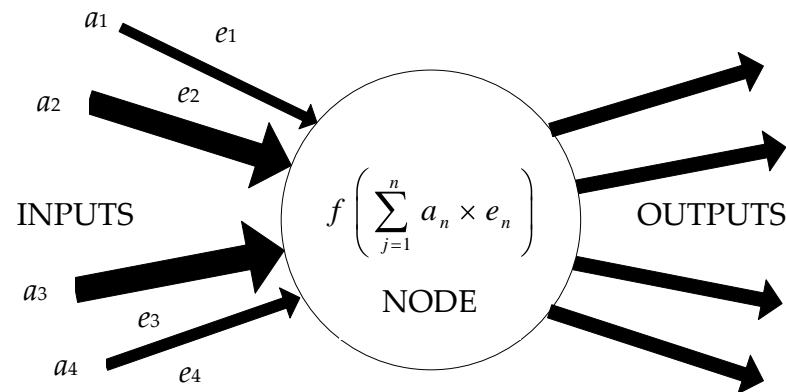
GRAPHS & CONTRADICTION

Kan ©



GRAPH ANALYSIS & UTILITY SCORES

- Graph analysis with and without water storage project:
 - **Static** graph analysis indicates utility scores by centrality index
 - Centrality: $L_i = id(C_i) + od(C_i)$
 - **Dynamic** graph analysis indicates utility scores by simulated activation values



SUSTAINABILITY

- **Weak sustainability:**
 - Indicated by non-declining ecosystem services index with water storage project
- **Strong sustainability:**
 - “... minimum quantity of ecosystem processes ... required to maintain a well-functioning ecosystem” (Fisher *et al.*, 2009)
 - Indicated by targets met with water storage project
 - *e.g.* native fish population shows no decrease (CWMS, 2010)
 - Lexicographic method applied for assessment



CONCLUSION

- Novel approach to address the wicked problem of water resource management
- Indicates conflicts in preferences and contradictions in understanding to aid integration
- Systematic assessment will indicate the sustainability of rivers impacted by water storage projects

