A recent advance in freshwater ecology:

Biodiversity and ecosystem function in tropical rivers

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Tropical Rivers and Coastal Knowledge

My career history

- 88 Honours at Monash University
  - Species-Area Relationships (Sam Lake)
- 89-90 ABC TV Natural History Unit
- 91-99 PhD at Monash University
  - Effects of fire on stream communities: CSIRO's Kapalga Fire Experiment (Sam Lake)
- 95-06 Lecturer/Senior Lecturer at CDU
  - Floodplain weeds, Riparian grazing, Env. flows
  - Trophic interactions, Top-down control
  - TRaCK consortium
- 07 Director, TRaCK Research Hub

What sort of ecology interests me?

- Theoretical ecology
- Management relevance
- Community/Ecosystem level
- Tropical streams and rivers

Loss of a harvested fish species disrupts Carbon flow in a diverse tropical river

(2006) Taylor, B. W., Flecker, A.S. and Hall, R. O. *Science* **313**:833-836

Biodiversity & ecosystem function

- Impacts of biodiversity loss
- Long-running and contentious debate
  - Elton (1927) "Diversity begets stability"
  - Ives and Carpenter (2007) "Diversity is just one factor"

- Unresolved, but some consensus (Lareau *et al*. 2005 *Science*)
  - Some minimum number of species required under constant conditions
  - More species at lower trophic levels imparts a degree of insurance
  - Changing environments

Biodiversity & ecosystem function

- "Rudimentary understanding" (Schindler 2007, Ives and Carpenter 2007)
- Largely based on simple, experimental terrestrial systems (Hooper *et al*. 2005 *Ecol. Monogr*.)
- Poor understanding of:
  - species-rich natural systems (Srivastava *et al.* 2005 *Annual Review Ecol. Evol. Syst*.)
  - which species have a significant impact (Lareau *et al.* 2005)
  - freshwater systems (Lareua *et al*. 2005)

Loss of fish biodiversity

- Fish are the most species rich vertebrates
- Harvesting is a major cause of species loss (Allan *et al.* 2005 BioScience)

- Tropical fish fauna particularly diverse but increasingly under threat from overharvesting (Winemiller 2005)

- Limited understanding of the ecosystem consequences of speceis loss (Wantzen *et al*. 2006 JNABS, McIntyre *et al* 2007 *PNAS*)

Prochilodus mariae

Photo: Brad Taylor

Prochilodus mariae

Photo: Bob Hall

Harvesting *Prochilodus mariae*

B. W. Taylor et al., Science 313, 833 -836 (2006)

Photo: Bob Hall

Prochilodus mariae feeding and feeding scars on rock

B. W. Taylor et al., Science 313, 833 -836 (2006)

Prochilodus: an “ecosystem engineer”

- Small-scale cage experiments ($4m^2$)
- Reduces benthic particulate matter (Flecker 1996 *Ecology*)
- Changes benthos from diatoms and bacteria to N-fixing cayanobacteria (Flecker 1996 *Ecology*)
- Switch system to primary production independent of N-limitation (Flecker *et al.* 2002 *Ecology*)
- But….only small-scale, short-term experiments

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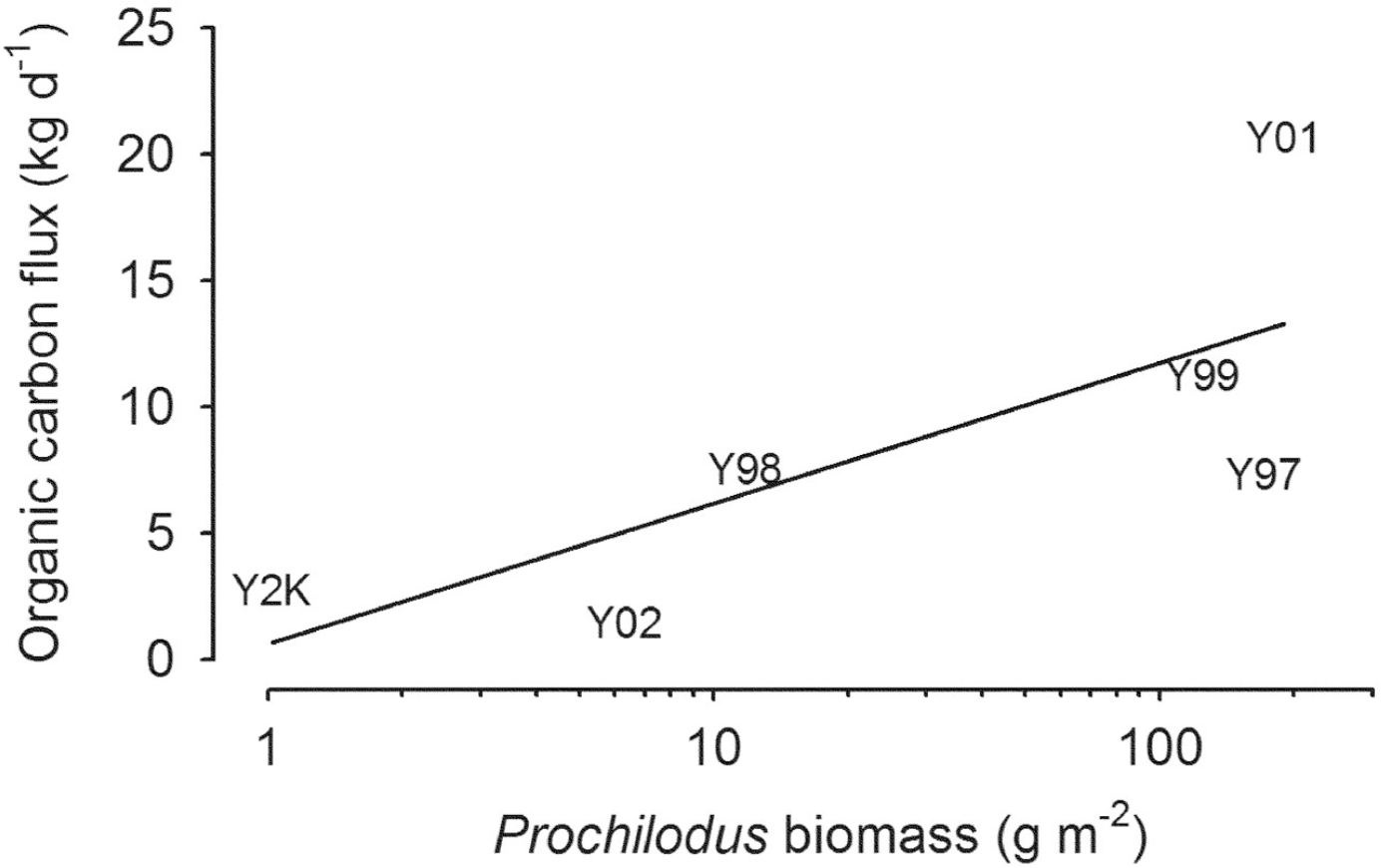
Photo: Bob Hall

Fig. 1. Interannual variation in organic carbon flux



B. W. Taylor et al., Science 313, 833 -836 (2006)

Fig. 2. Photographs of the split-stream removal experiment

B. W. Taylor et al., Science 313, 833 -836 (2006)

Fig. 3. Ecosystem properties in the treatment and reference area of the split-stream experiment before and after removal of P. mariae B. W. Taylor et al., Science 313, 833 -836 (2006)

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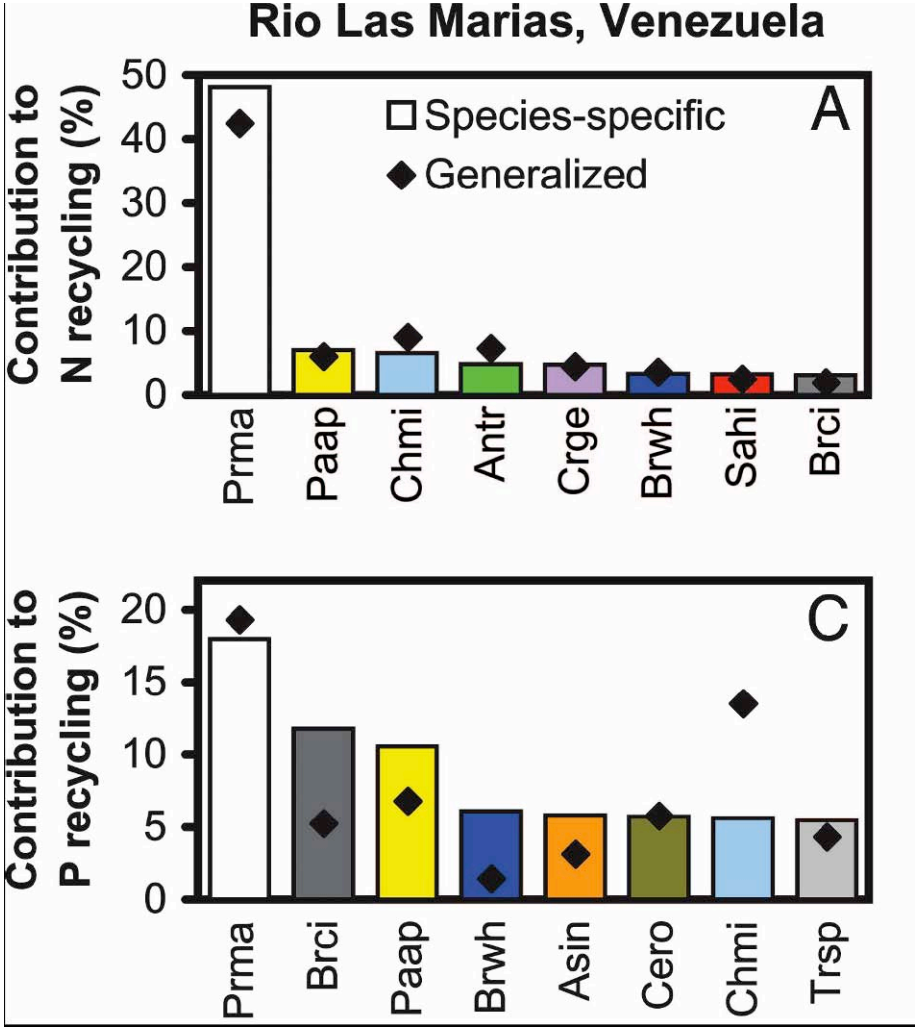
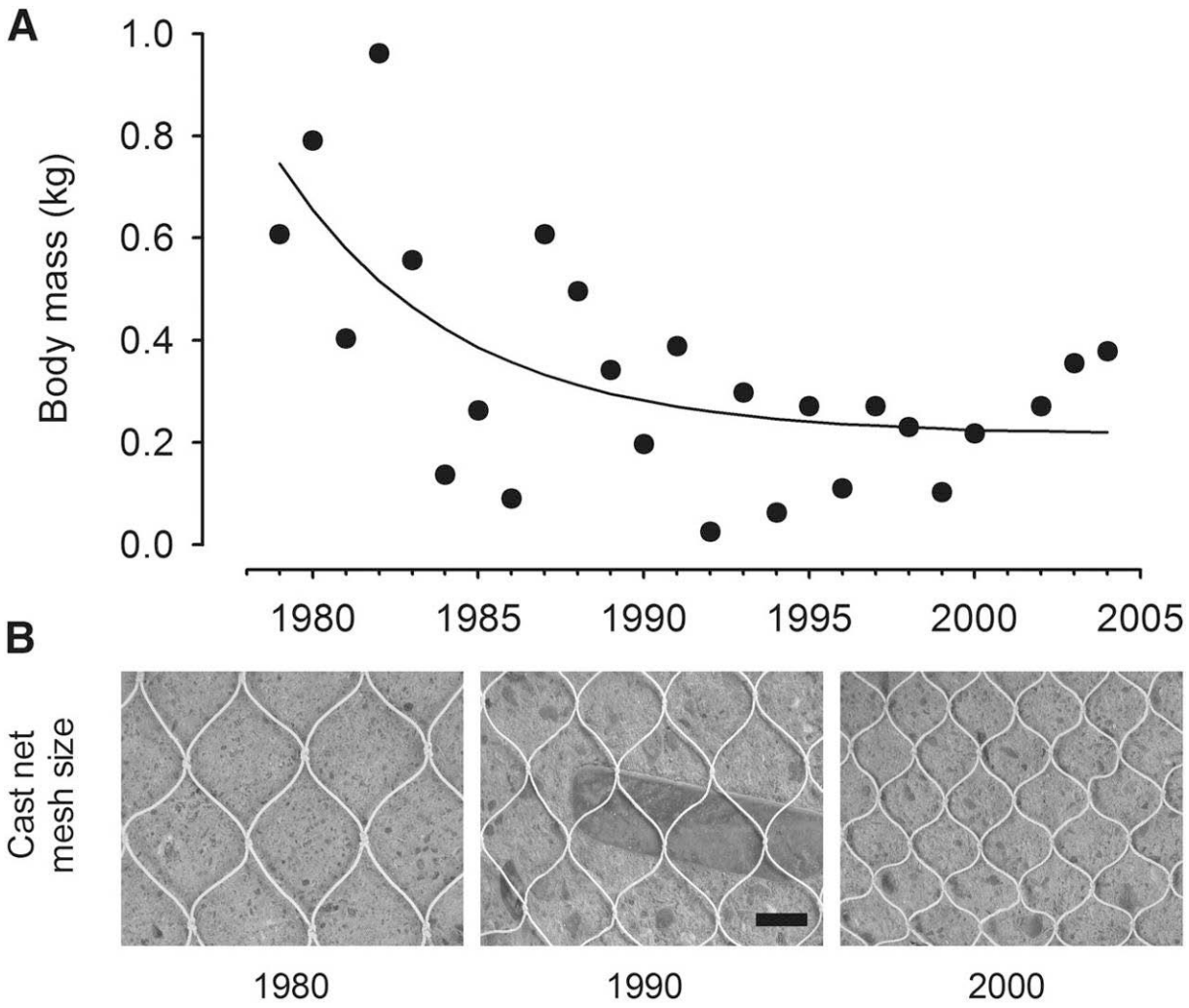
Contribution of Prochilodus (Prma) to nutrient recycling



McIntyre, P.B., Jones, L.E., Flecker, A.S. and Vanni, M. J. (2007) *Proceedings of the National Academy of Sciences* **104**: 4461-4466

Fig. 4. Time trends of body mass for the migratory fish P. mariae



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River ecology & management

- Prochilodus reduces spatial and temporal variability in organic carbon flow and nutrient recycling
- Single species results in a more constant supply of energy and materials at a critical time
- Shows potential ecosystem ramifications of species loss

Biodiversity & ecosystem function

- More species = degree of insurance

- Naturally diverse freshwater community (>80 species in 3km)
- But….low functional redundancy for fundamental processes (synthesis & degradation of carbon, recycling of nutrients)

- No evidence of compensation in other systems where Prochilodus permanently lost (Barbanio Duque *et al.* 1998 *Env. Biol. Fishes*)

Future research

- Need to identify ***which*** species rather than just ***how many*** (Schindler 2007 *PNAS*)
- Selective experimental removals of species most likely to be threatened by human activity (Taylor *et al*. 2006 *Science*)
- Likely to vary with different perturbations so may require study of each ecosystem on a case-by-case basis (Ives and Carpenter 2007 *Science*)
- Preserve as much diversity as possible!