Jun 19th, 11:10 AM - 11:30 AM

Fishway design in the temperate S. Hemisphere

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Centre for Agroecology, Water & Resilience

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Fish Passage 2017, Corvallis, Orgeon

Martin Wilkes (Coventry U.)
Evelyn Habit & Oscar Link (U. Concepción); Luiz Silva (UFSJ)
Angus Webb (U. Melbourne); Lee Baumgartner (Charles Sturt U.)
Craig Boys (NSW Dept. Primary Industries/Charles Sturt U.);
Justin O'Connor, Matthew Jones & Ivor Stuart (Arthur Rylah Institute)

EXCELLENCE WITH IMPACT

Coventry University

Knowledge Exchange for Efficient Passage of Fish in the Southern Hemisphere (KEEPFISH)

Martin Wilkes (Coventry U.); Kim Aarestrup & Niels Jepsen (DTU-Aqua); Bernd Ettmer (HSM); Paul Franklin & Cindy Baker (NIWA); Evelyn Habit & Oscar Link (U. Concepción); Paul Kemp (U. Southampton); Paulo Pompeu (UFLA); Luiz Silva (UFSJ); Angus Webb (U. Melbourne)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 690857.

EXCELLENCE WITH IMPACT

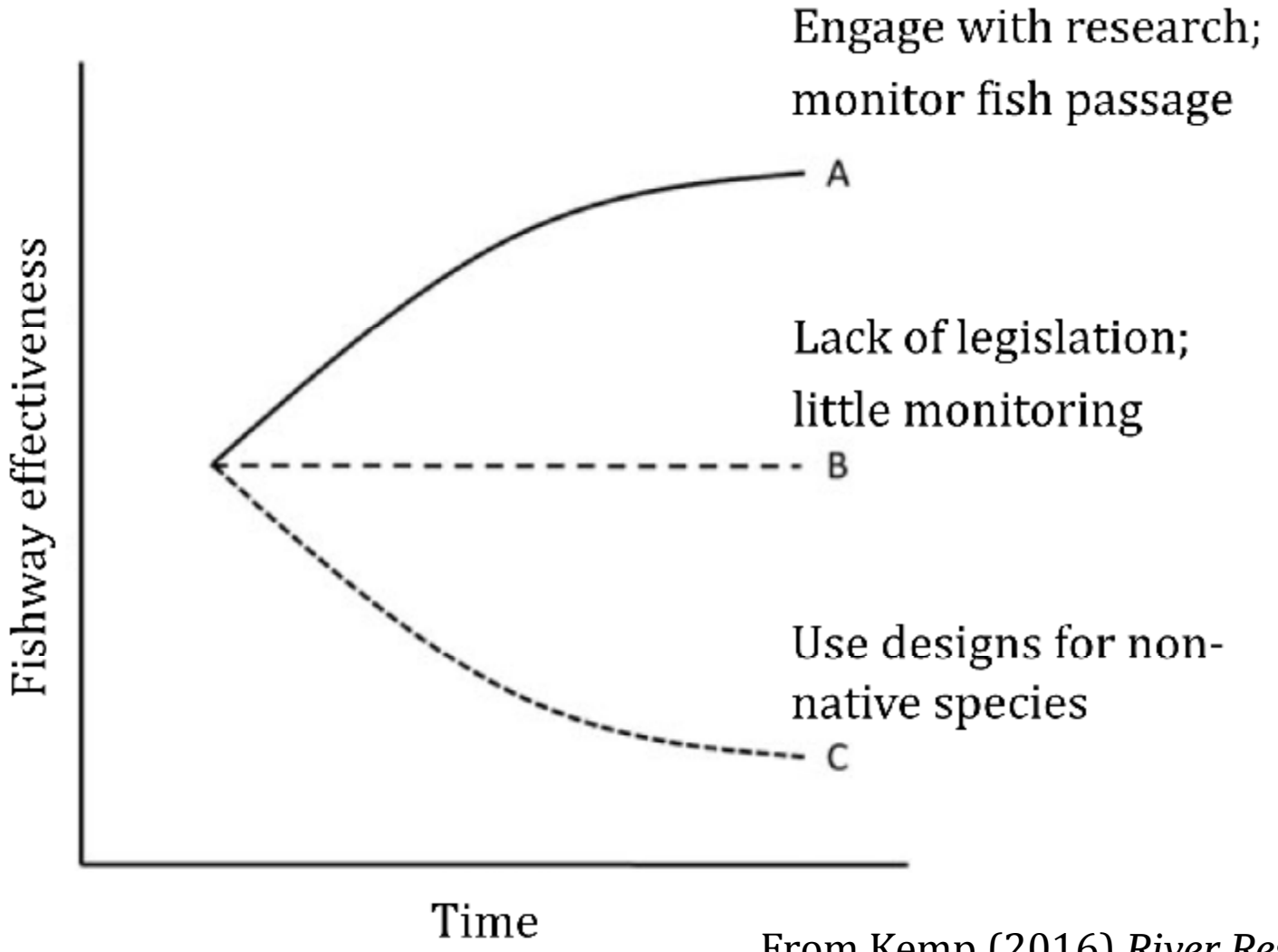
Fish passage in the Southern Hemisphere Network (FISH-Net)

Outline

- Global trends in fishway effectiveness
- The (neglected) temperate Southern Hemisphere
- A new approach to fishway design criteria:
  - Upstream fishway design for “migratory” species
  - Mortality during downstream passage
- Applications to hydropower planning, design and monitoring

Global trends in fishway effectiveness

Global trends in fishway effectiveness



From Kemp (2016) *River Res. Appl.*

Global trends in fishway effectiveness

RIVER RESEARCH AND APPLICATIONS

River Res. Applic. (2016)

Published online in Wiley Online Library

FISH and FISHERIES

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ELSEVIER

The development of fish passage research in a historical context

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SS

ARTICLE INFO

ABSTRACT

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FA

Title: Structures assisting the migrations of non-salmonid fish: Latin America...

Español

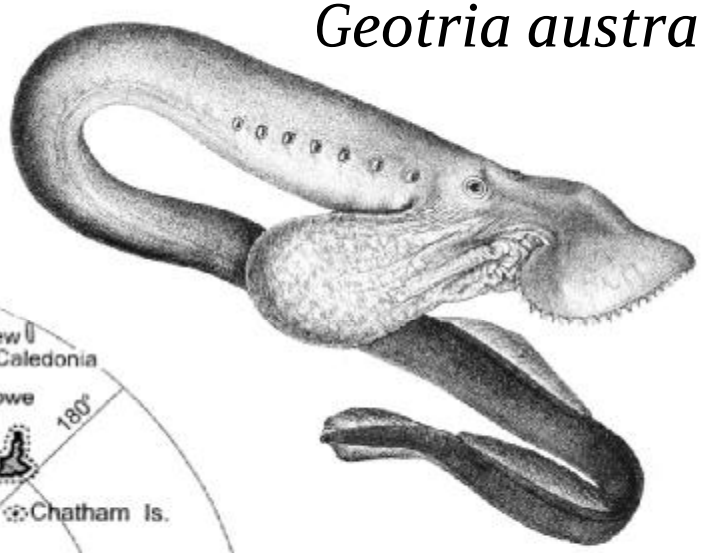
More details

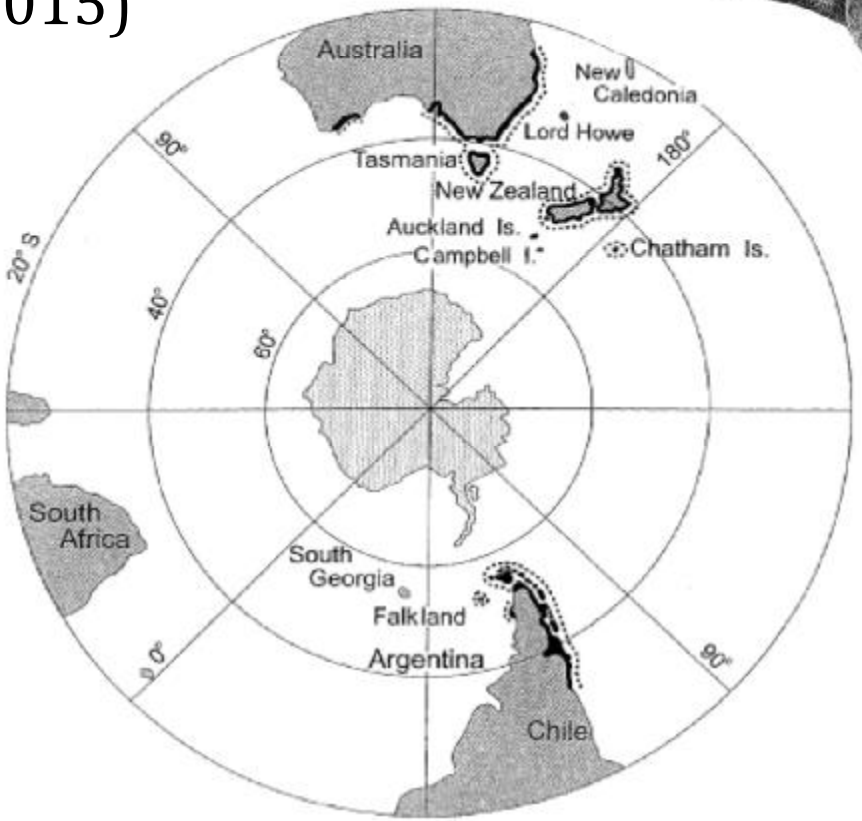
The temperate Southern Hemisphere

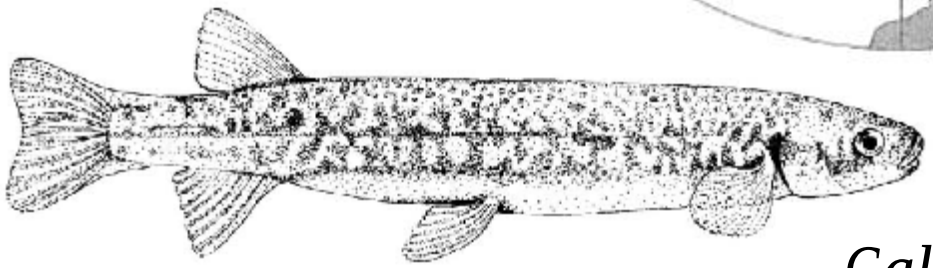
Fish fauna

“Non-sport” fish <150 mm
(Link & Habit, 2015)

Geotria australis







Galaxias maculatus

Chilean freshwater species

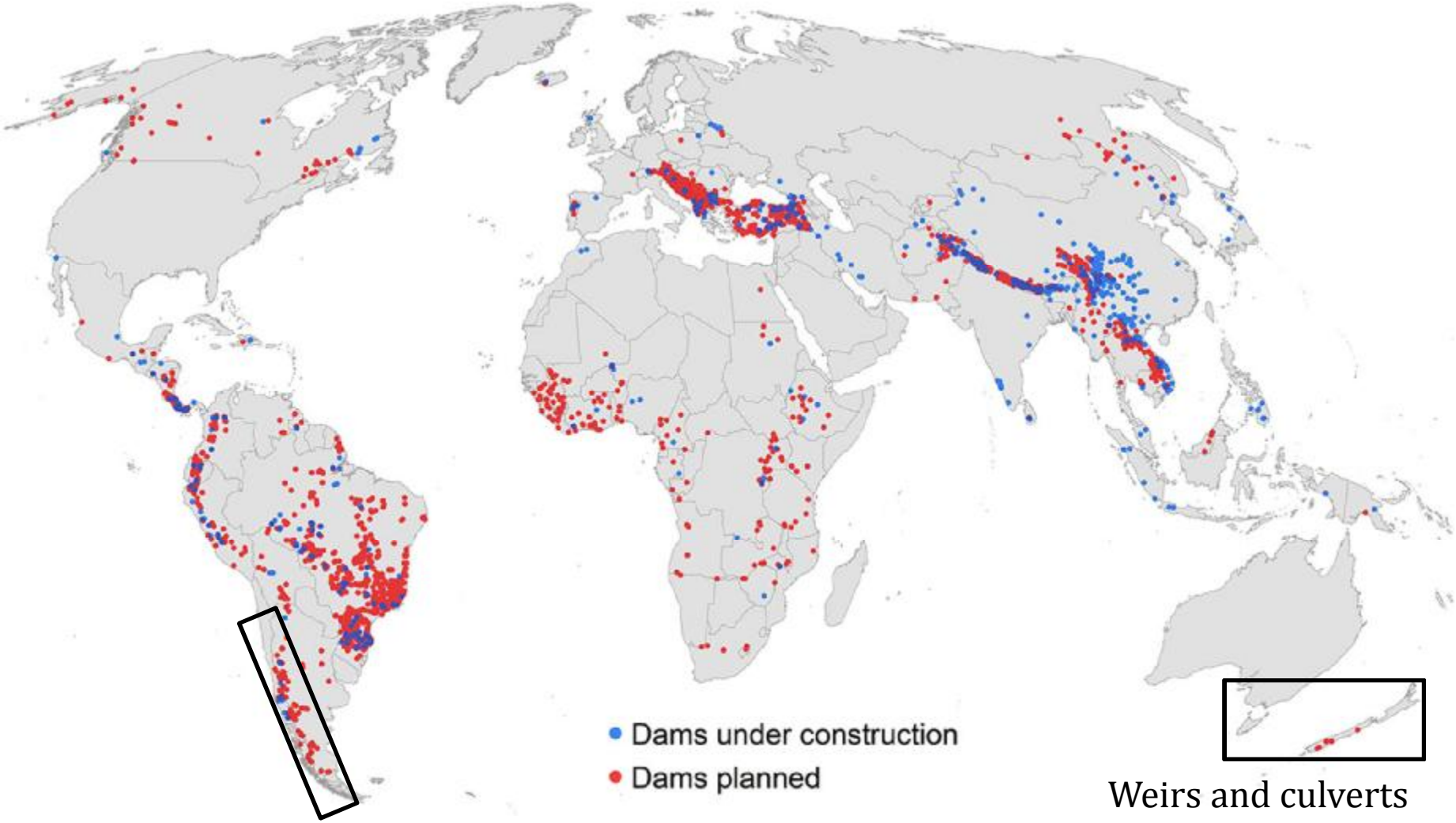
Wilkes et al. (in prep.)

Order	Family	Species	Conservation status	Life-history
Petromyzontiforms	Geotridae	*Geotria australis*	Vulnerable	Anadromous
	Mordaciidae	***Mordacia lapicida***	Endangered	Anadromous
Characiforms	Characidae	***Cheirodon pisciculus***	Vulnerable	Resident
		Cheirodon galusdae	Vulnerable	Resident
		Cheirodon kiliani	Endangered	Resident
		Cheirodon australe	Vulnerable	Resident
Siluriforms	Nematogenyidae	***Nematogenys inermis***	Endangered	Resident
	Trichomycteridae	***Bullockia maldonadoi***	Endangered	Resident
		Trichomycterus areolatus	Vulnerable	Resident
		Trichomycterus chiltoni	Endangered	Resident
	Diplomystidae	***Diplomystes chilensis***	Endangered	Resident
		Diplomystes nahuelbutaensis	Endangered	Resident
		Diplomystes camposensis	Endangered	Resident
		Diplomystes incognitus	Not classified	Resident
Galaxiforms	Galaxiidae	*Galaxias maculatus*	Vulnerable	Catadromous*
		Galaxias globiceps	Endangered	Resident
		Galaxias platei	Least concern	Resident
		Brachygalaxias bullocki	Vulnerable	Resident
		Aplochiton zebra	Endangered	Resident
		Aplochiton marinus	Endangered	Marine-estuarine
		Aplochiton taeniatus	Endangered	Catadromous**
Artheriniforms	Artherinopsidae	***Basilichthys microlepidotus***	Vulnerable	Resident
		Odontesthes mauleanum	Vulnerable	Resident
		Odontesthes brevianalis	Vulnerable	Resident - Estuarine
Perciforms	Percichthyidae	*Percichthys trucha*	Near threatened	Resident
		Percichthys melanops	Vulnerable	Resident
	Perciliidae	***Percilia irwini***	Endangered	Resident
		Percilia gillissi	Endangered	Resident
Mugiliforms	Mugilidae	*Mugil cephalus*	Least concern	Catadromous

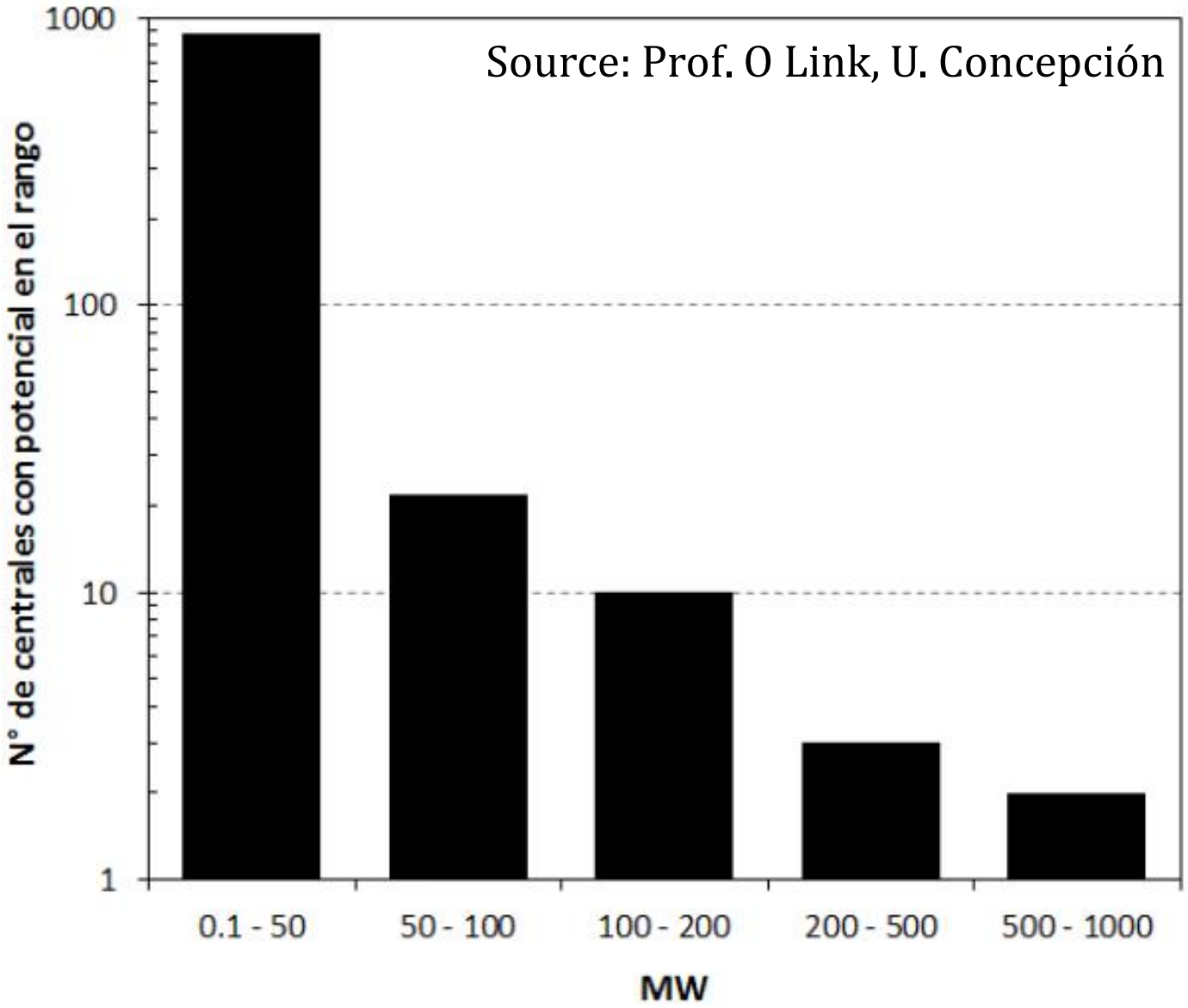
Adapted from Link & Habit (2015) *Rev. Environ. Sci. Biotechnol.* 14 (1) 9-21.

Hydropower pressure

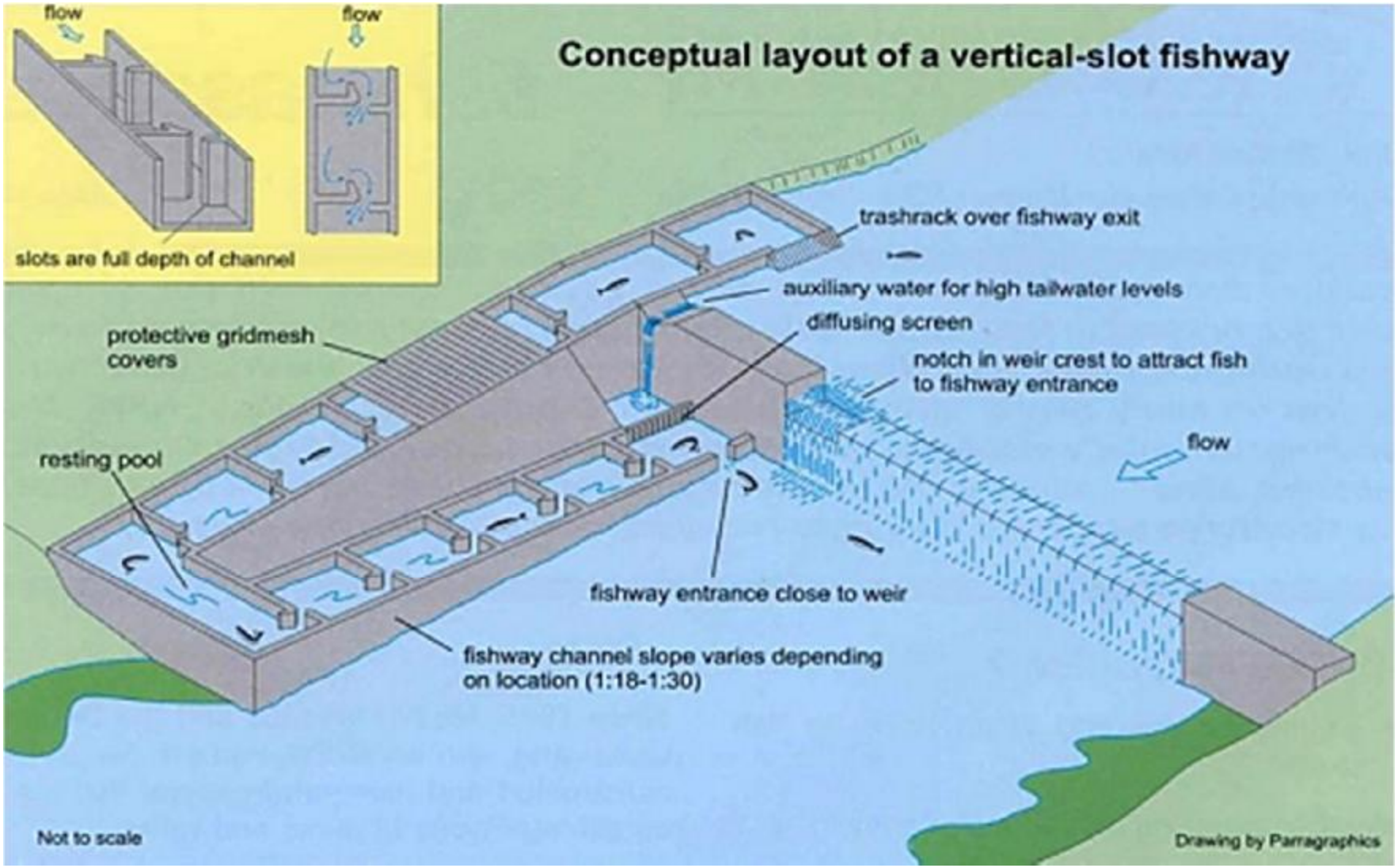
Zarfl et al. (2015) *Aquat. Sci.* 77 (1) 161-170.



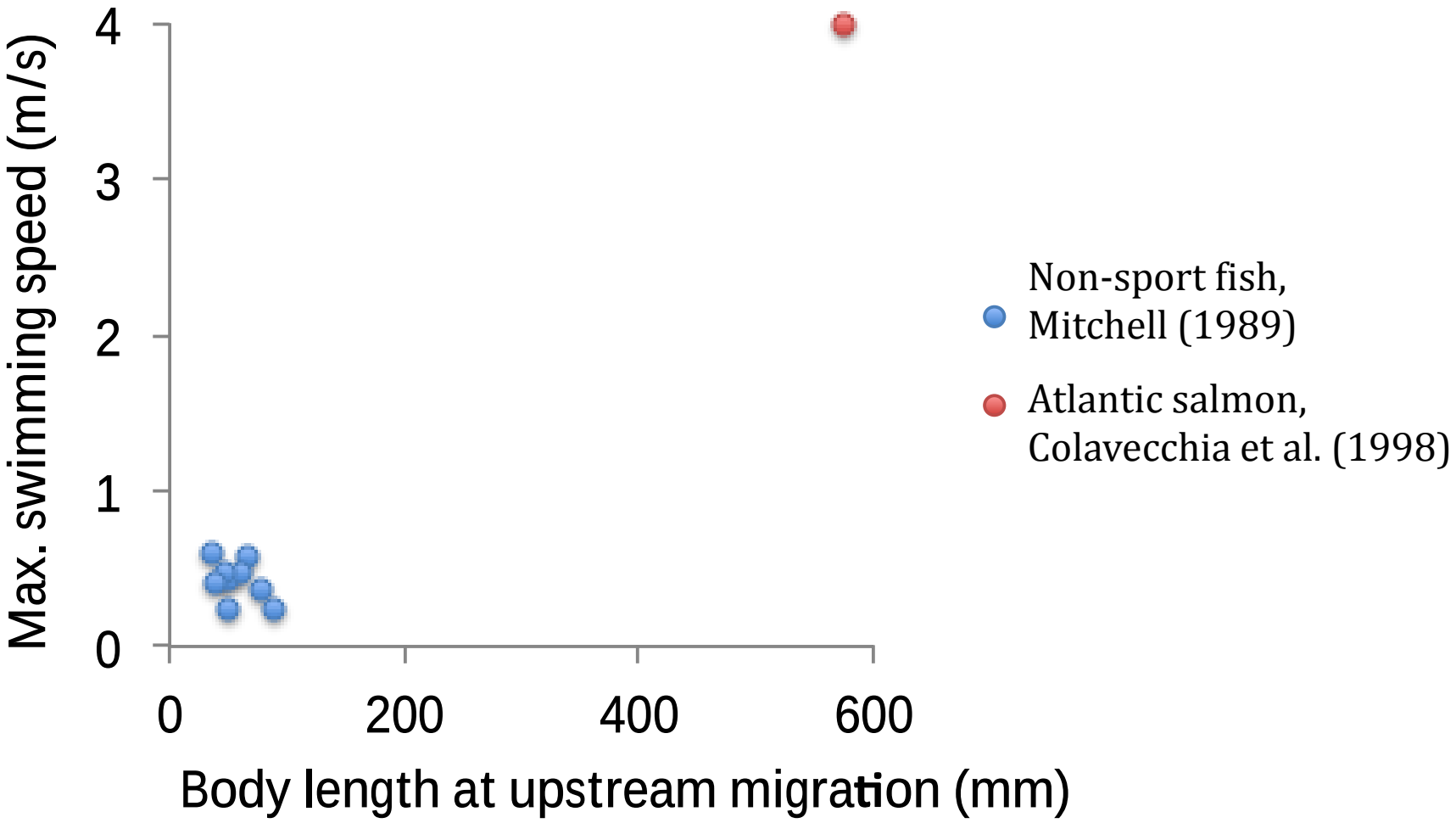
Rapid hydropower development in Chile



Fishways as mitigation



”Non-sport” fish



A new approach to fishway design criteria

Design criteria

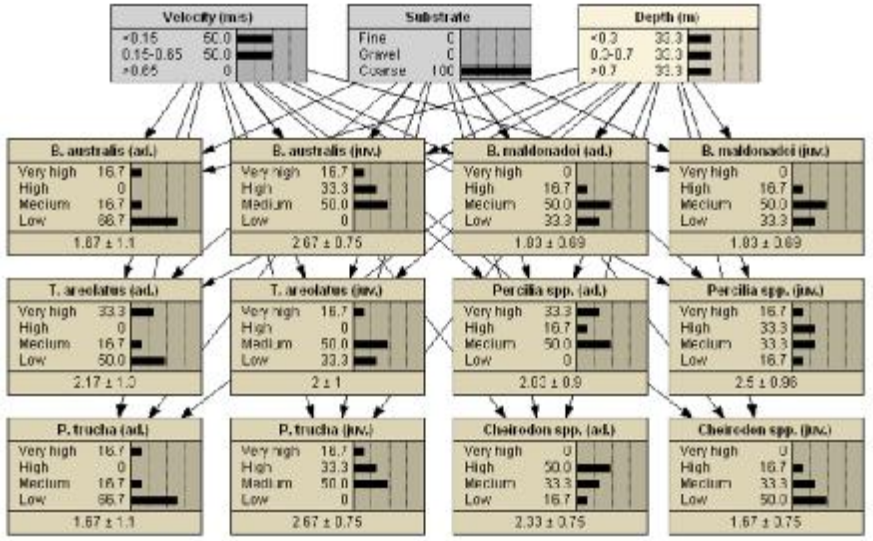
- Approach:
  - Systematic evidence review (Eco Evidence)

Design criteria

- Approach:
  - Systematic evidence review (Eco Evidence)
  - Expert elicitation workshops

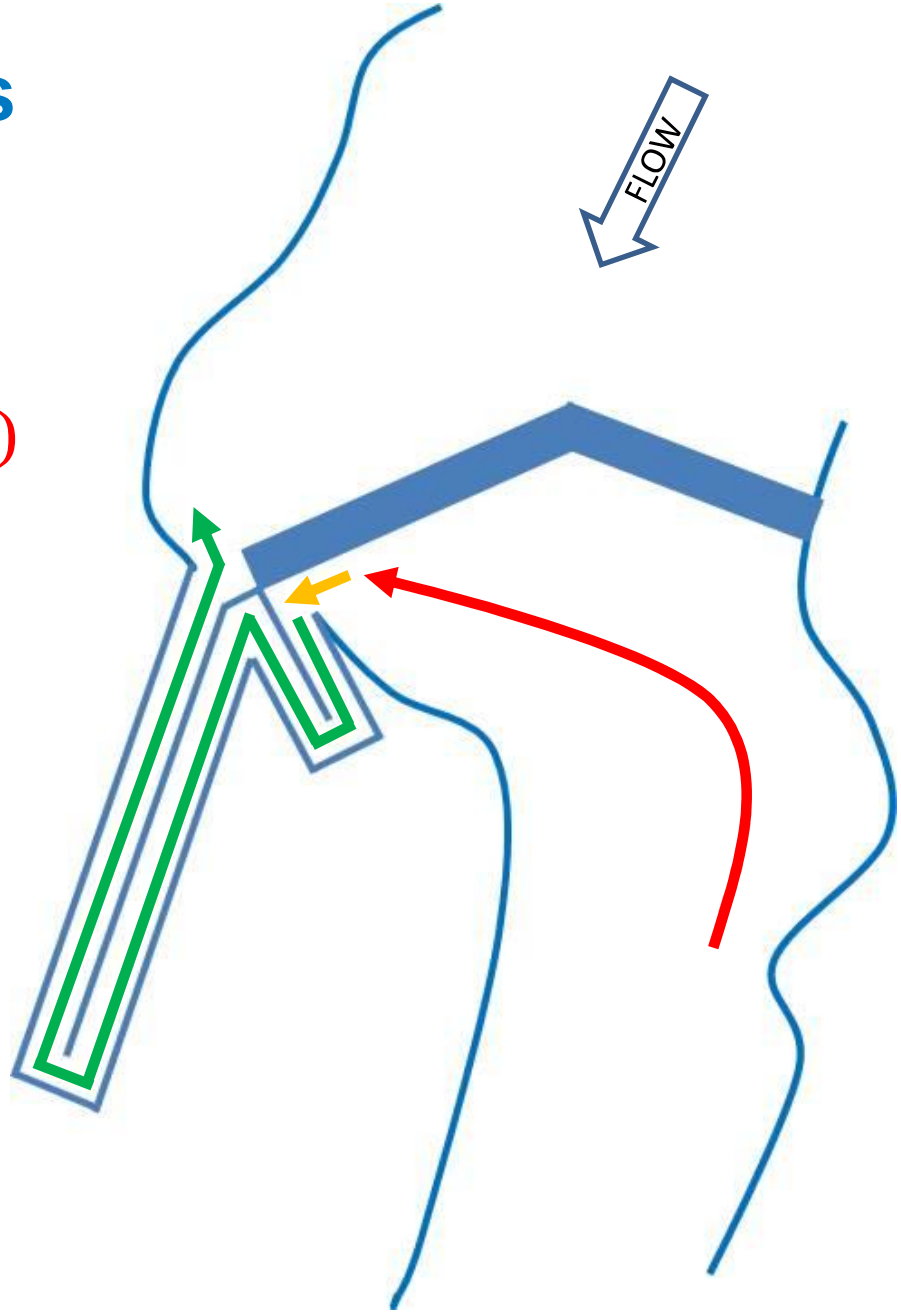
Design criteria

- Approach:
  - Systematic evidence review (Eco Evidence)
  - Expert elicitation workshops
  - Bayesian Networks



Fishway effectiveness
Definitions

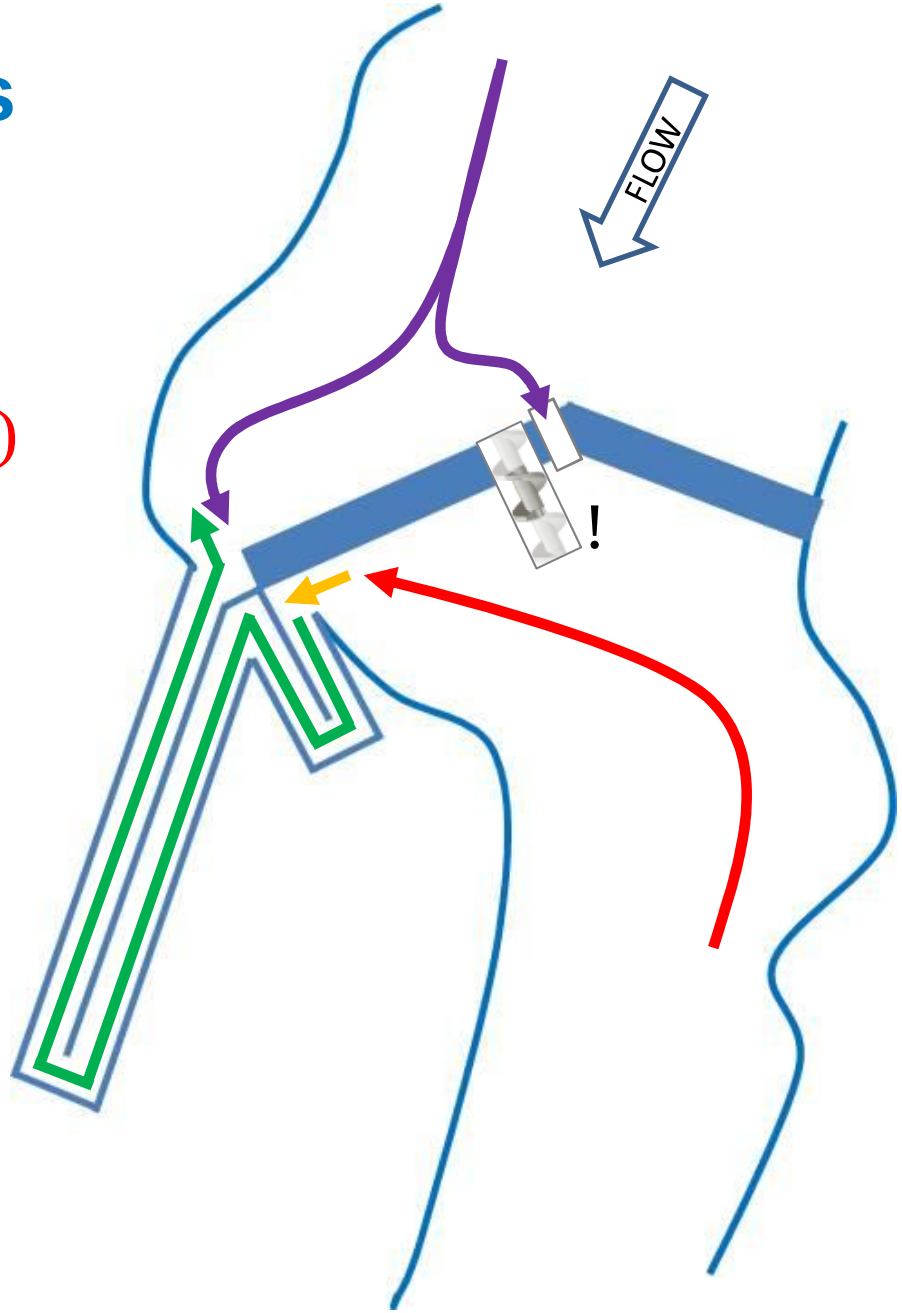
- Attraction efficiency (%)
- Entrance efficiency (%)
- Passage efficiency (%)



Kemp & O'Hanley (2010)

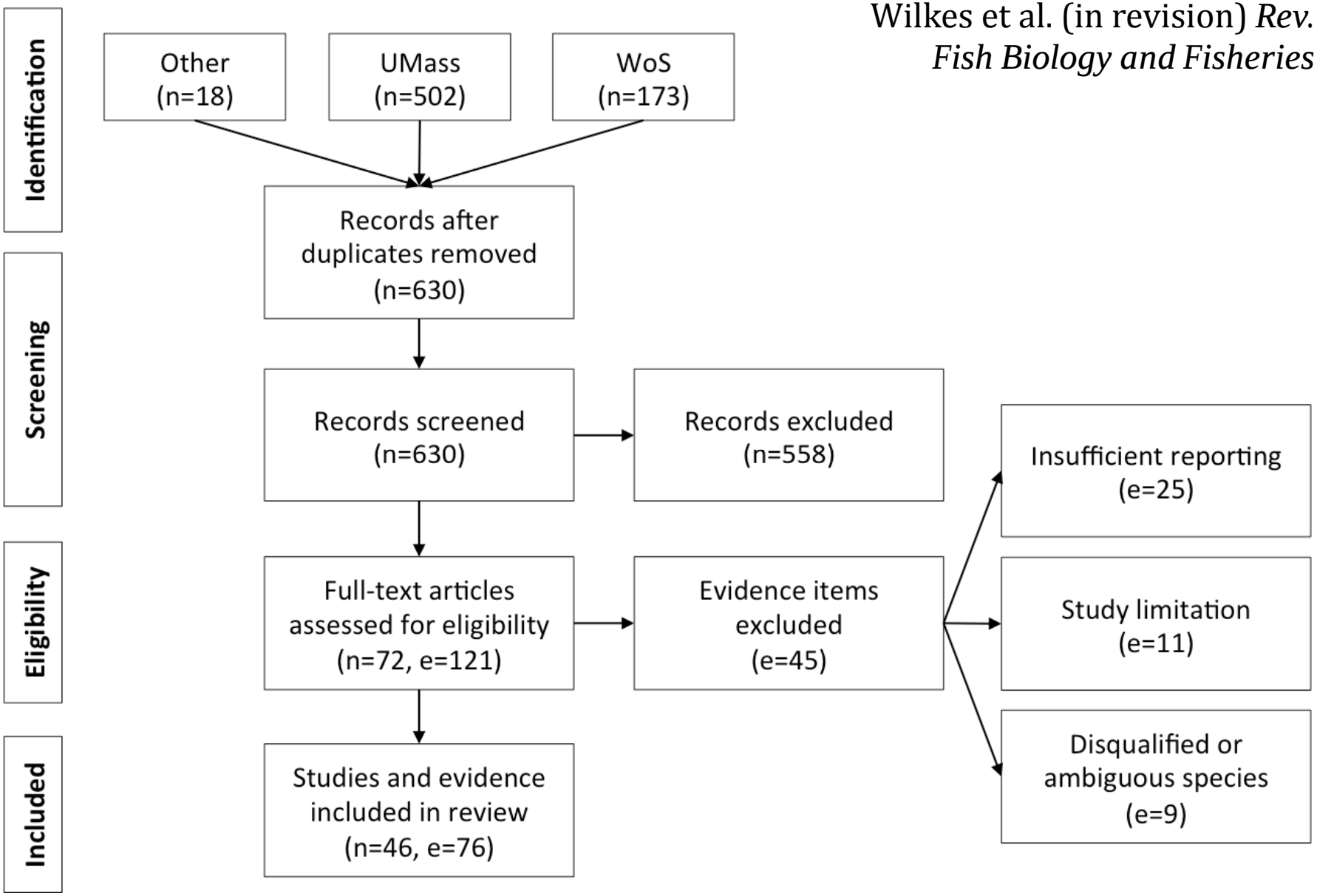
Fishway effectiveness
Definitions

- Attraction efficiency (%)
- Entrance efficiency (%)
- Passage efficiency (%)
- Guidance efficiency (%)
- Turbine entrainment (% mortality)
  - Pressure
  - Fluid shear
  - Blade strike



Systematic evidence review

Wilkes et al. (in revision) *Rev. Fish Biology and Fisheries*



Systematic evidence review

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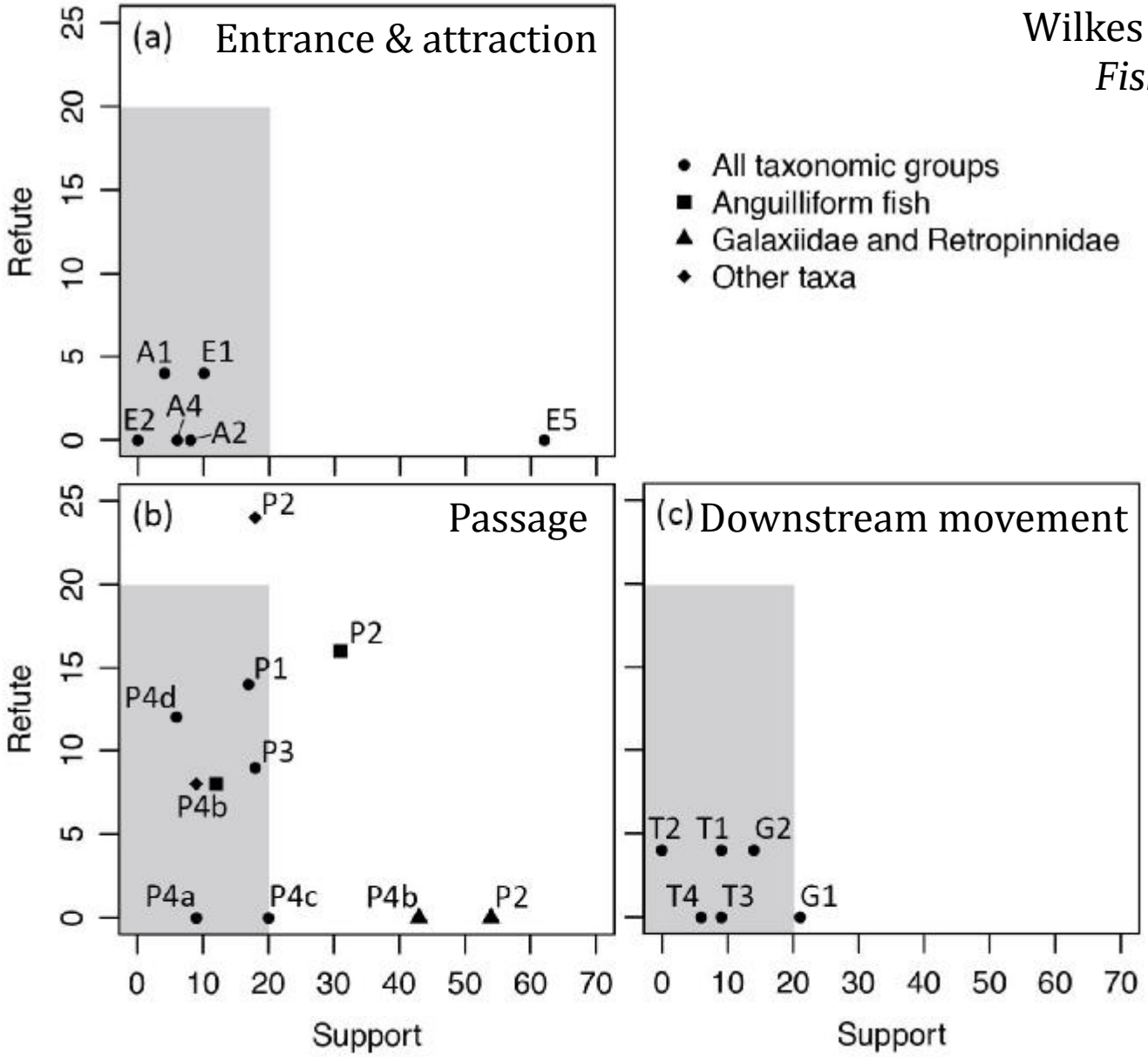

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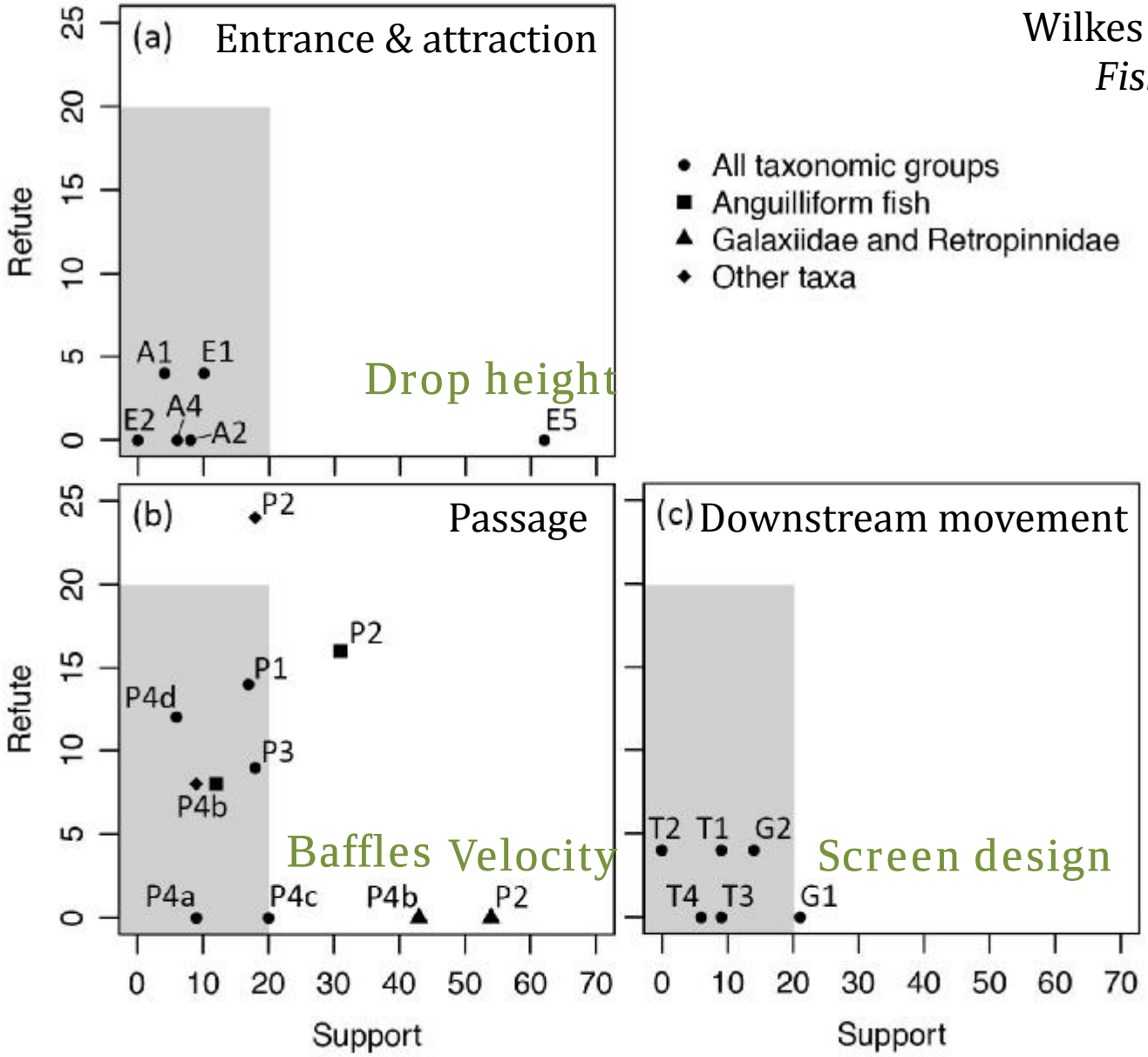

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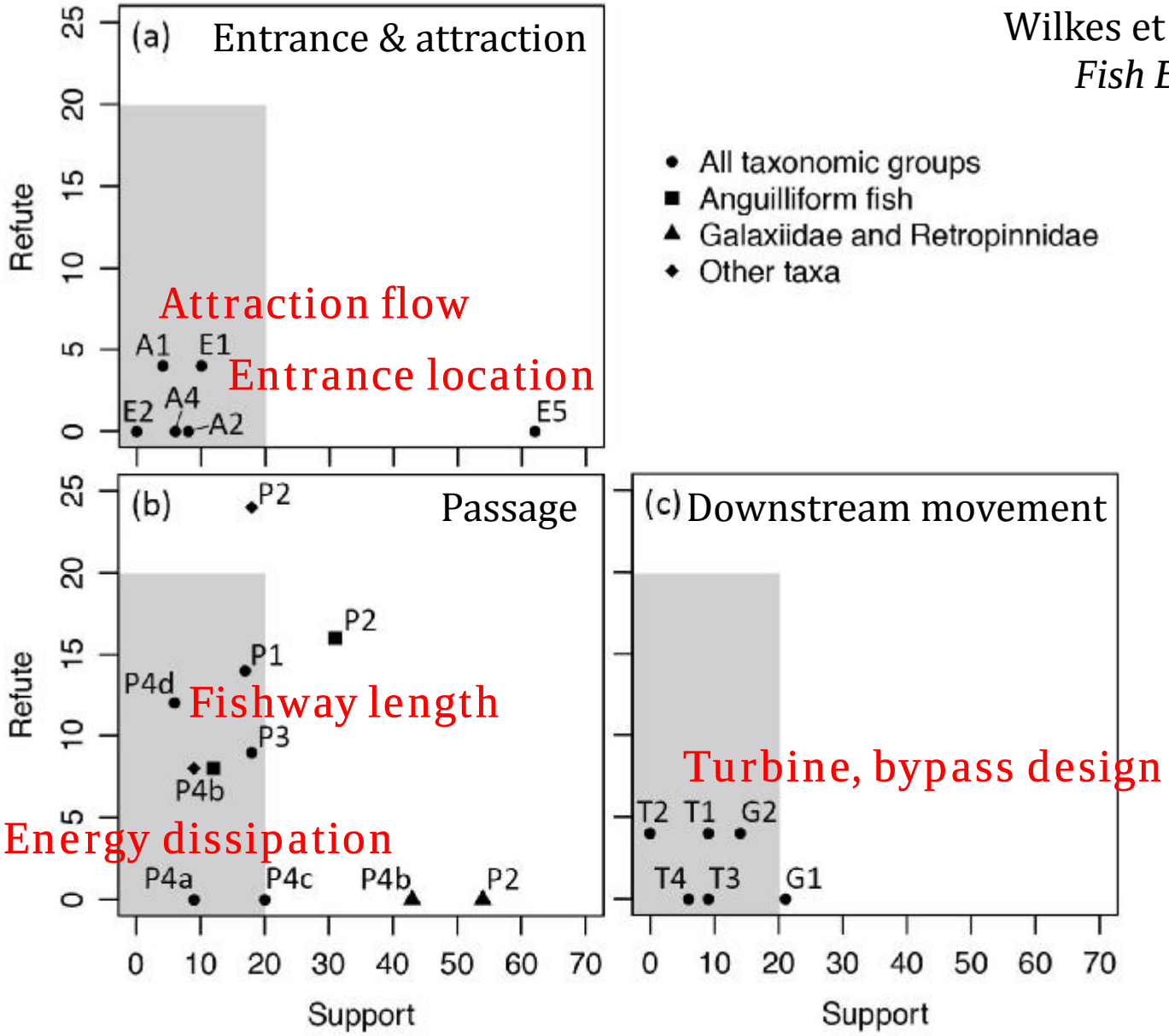
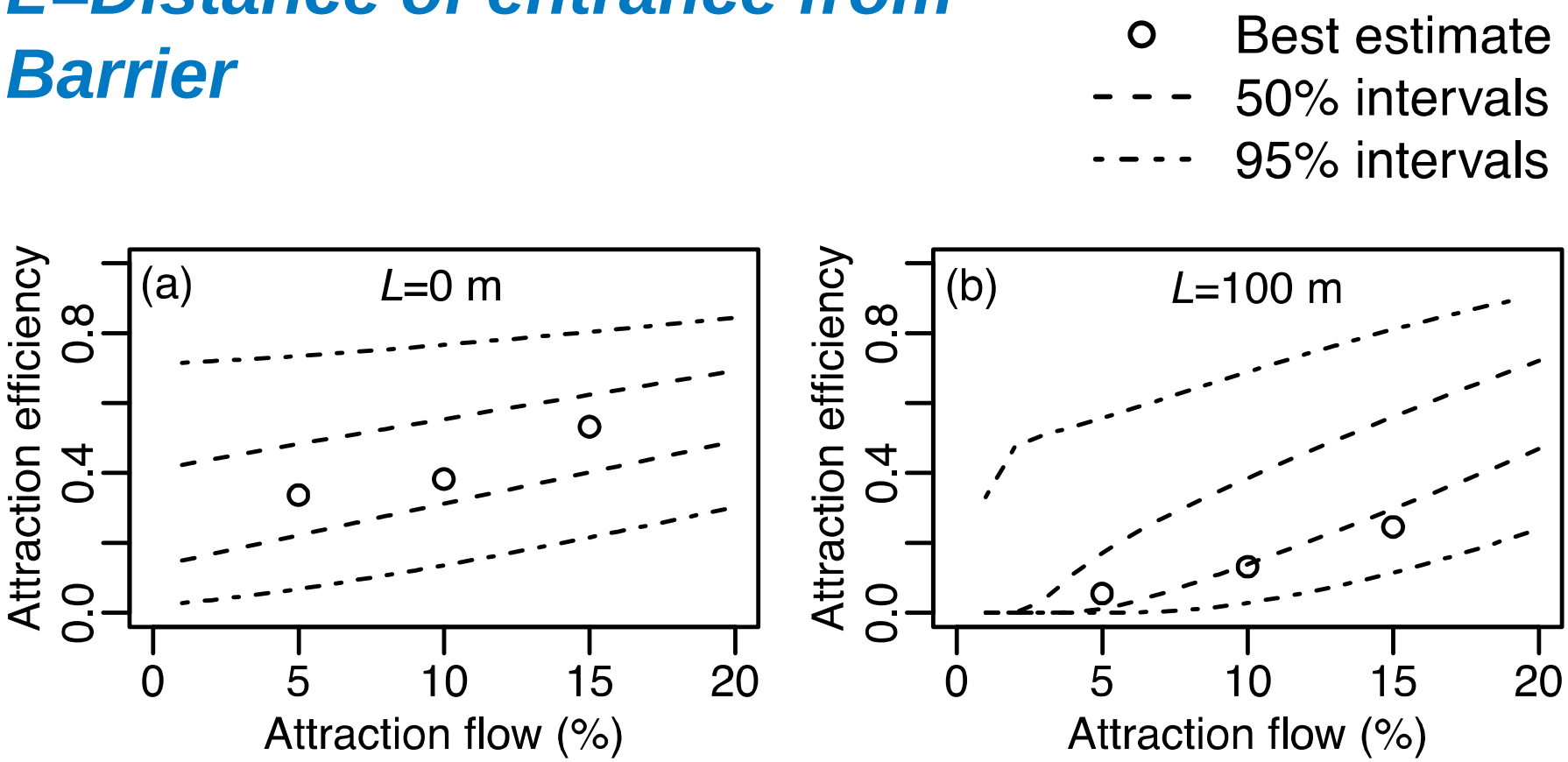


Systematic evidence review

- Key findings:
  - Not enough empirical evidence
  - Attraction of fish and downstream movement neglected
  - Incomplete monitoring data and insufficient reporting
  - Need to combine little evidence with expert knowledge and numerical modelling

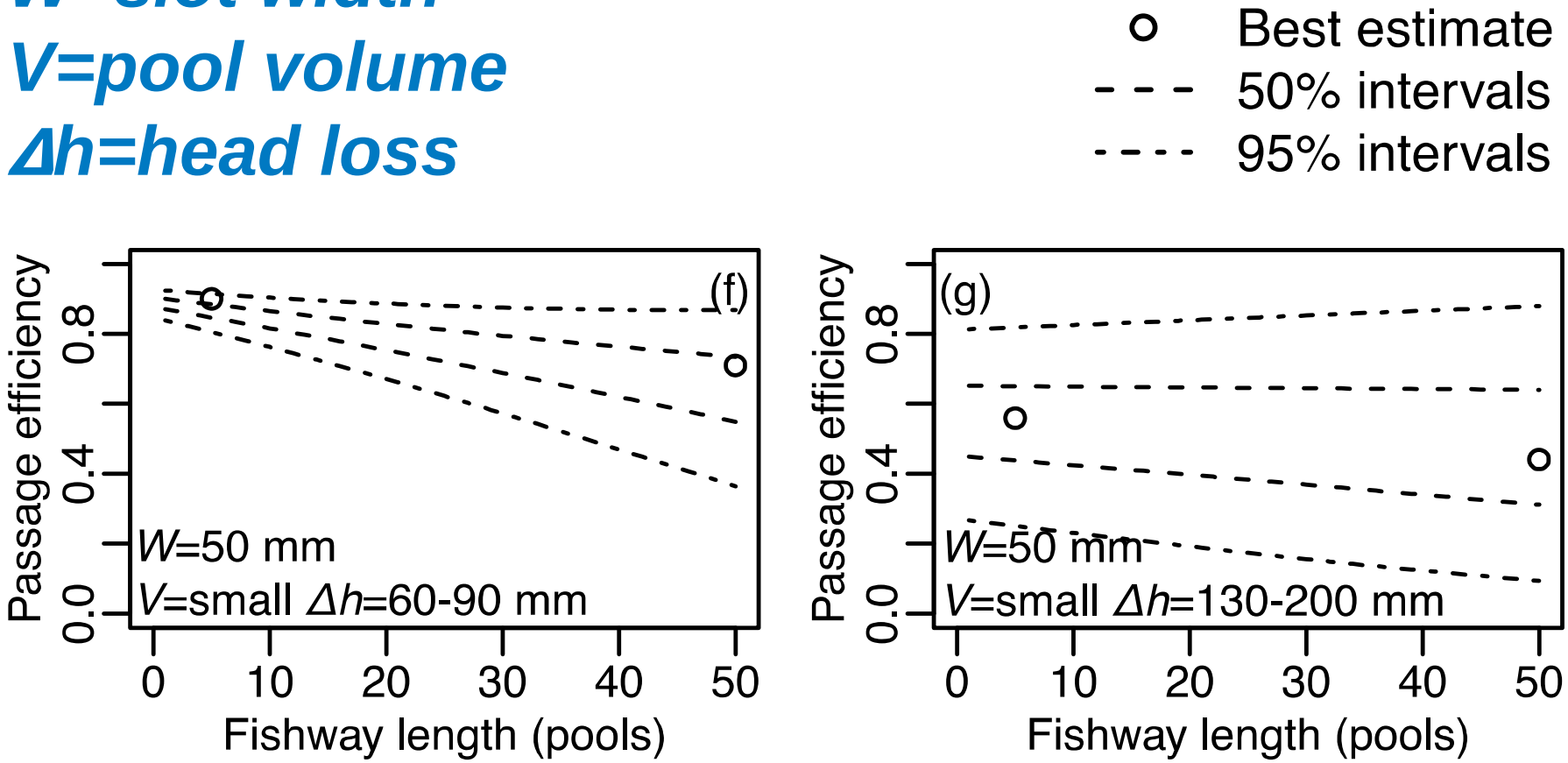
Bayesian networks: Upstream passage

L=Distance of entrance from Barrier

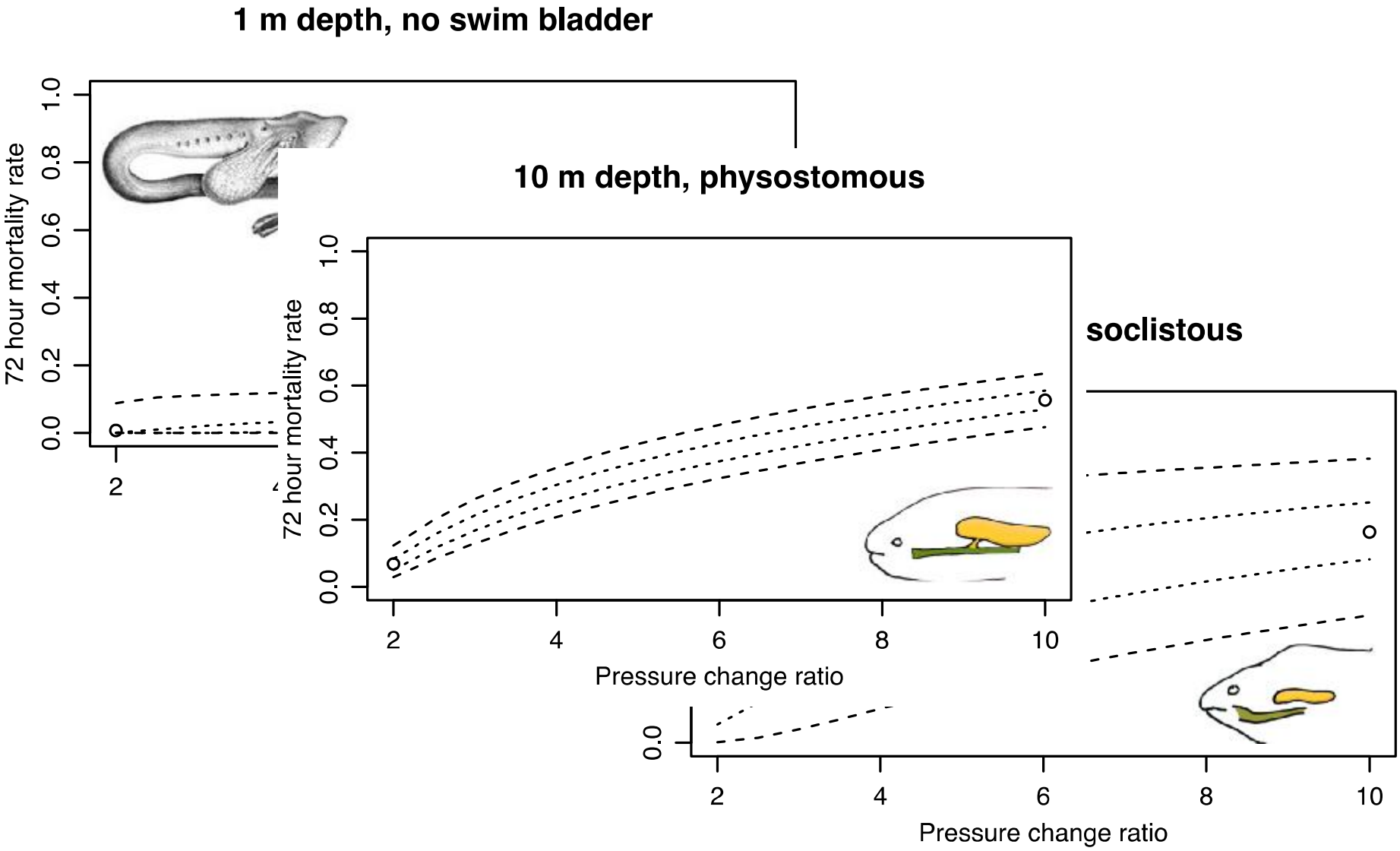


Bayesian networks: Upstream passage

W=slot width
V=pool volume
Δh=head loss

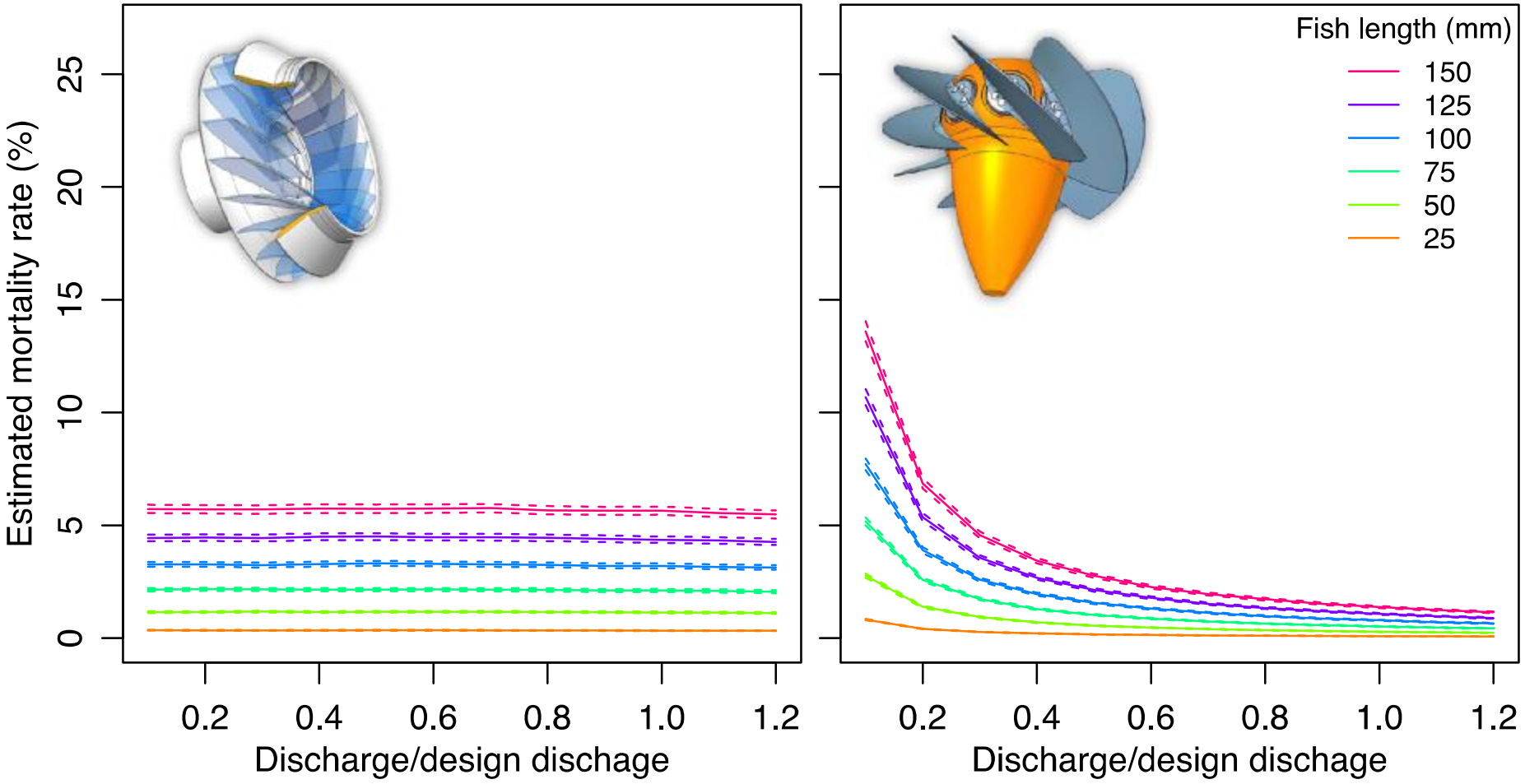


Bayesian networks: Downstream passage *Pressure*

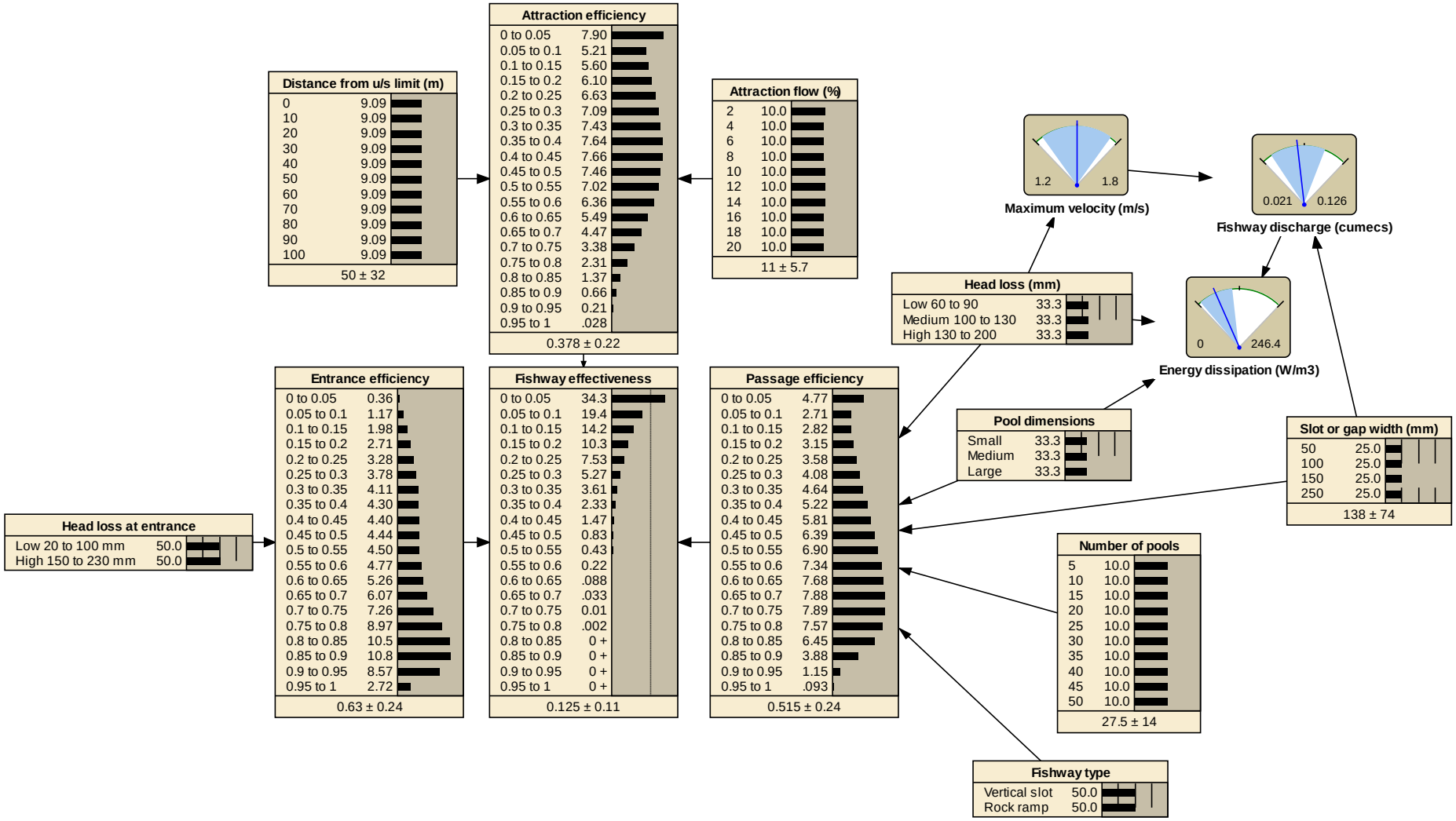


Bayesian networks: Downstream passage
Blade strike

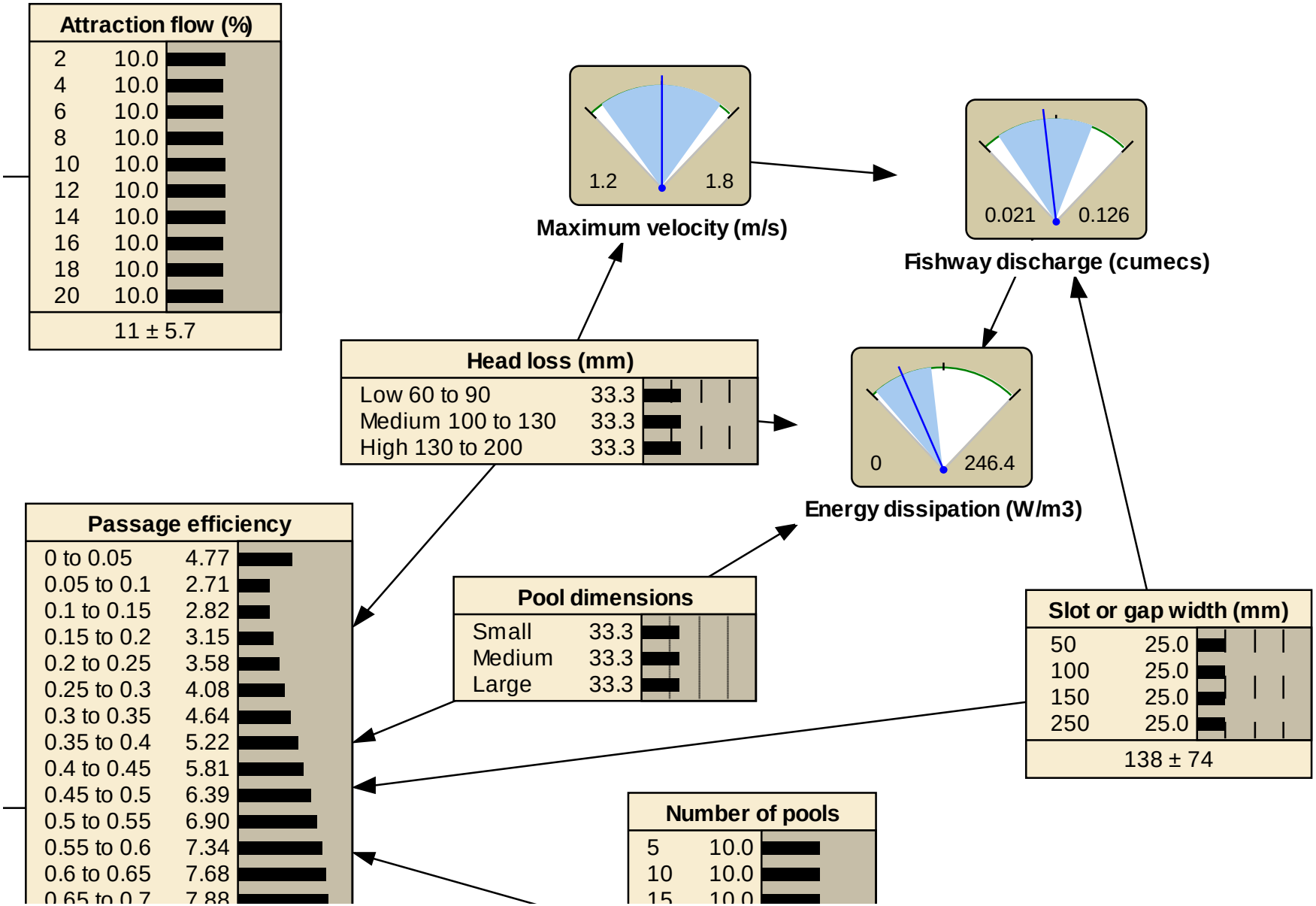
Francis turbine (Ferguson et al., 2008) **Kaplan turbine (Deng et al., 2007)**



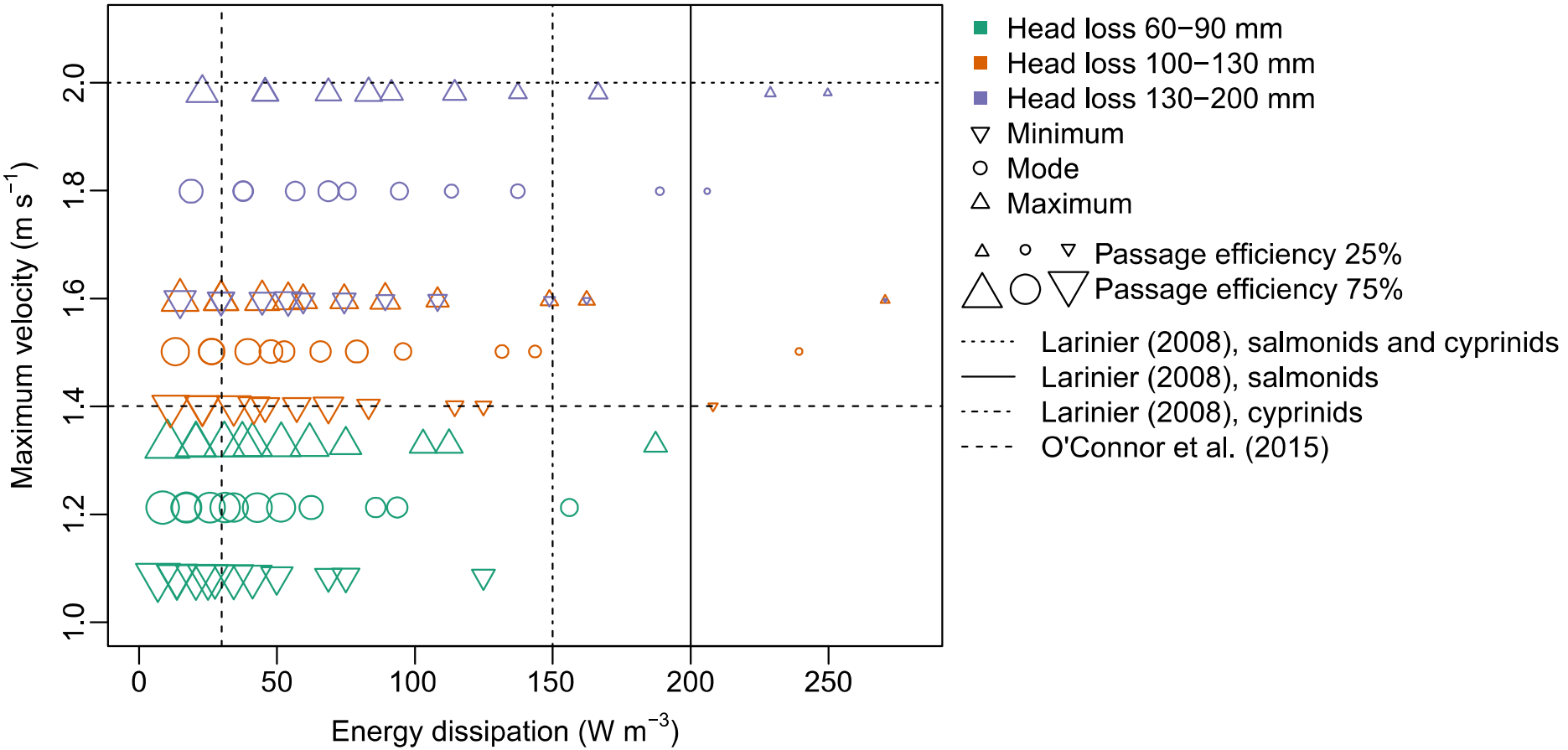
Upstream fishway design



Upstream fishway design

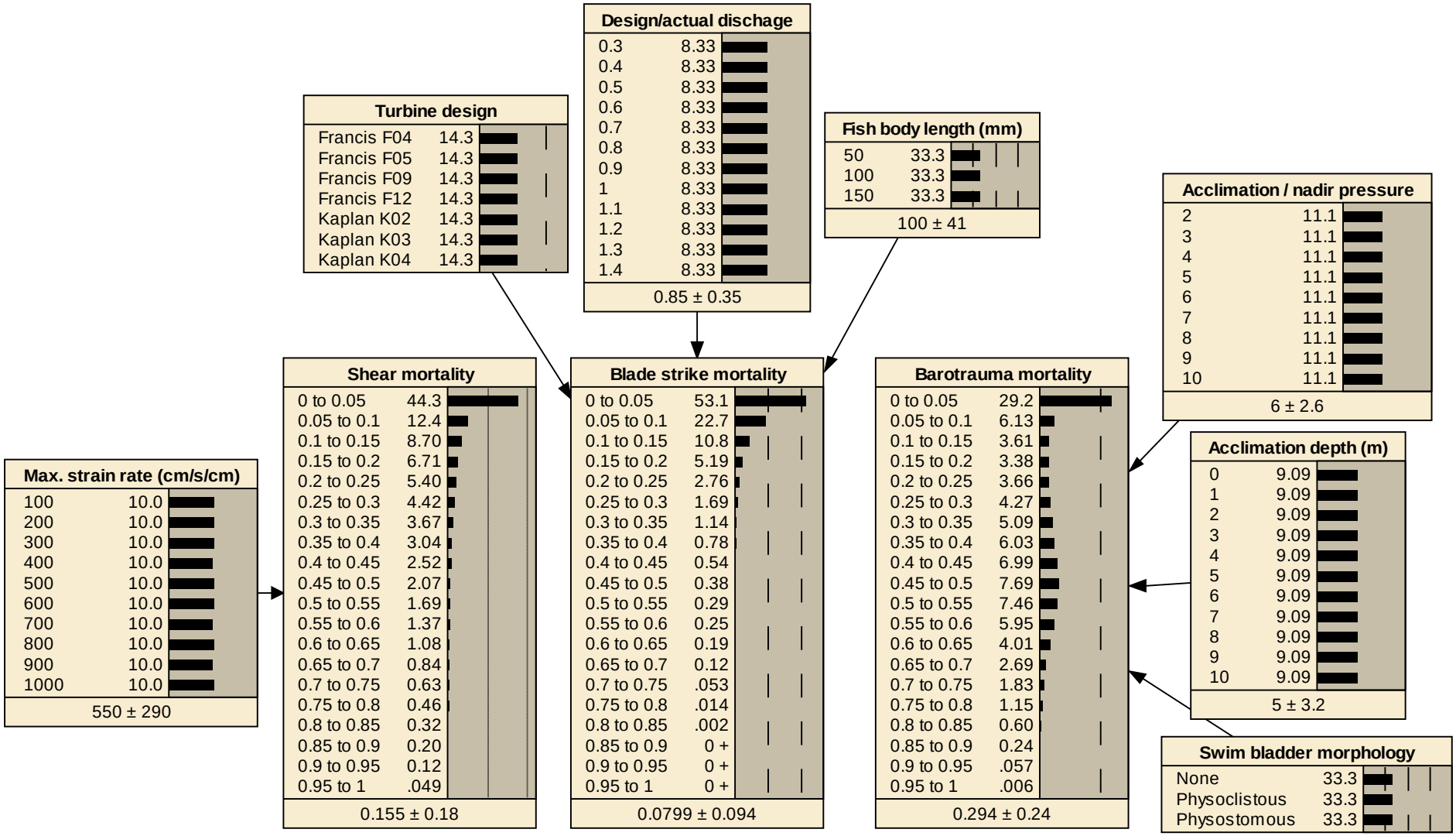


Upstream fishway design criteria

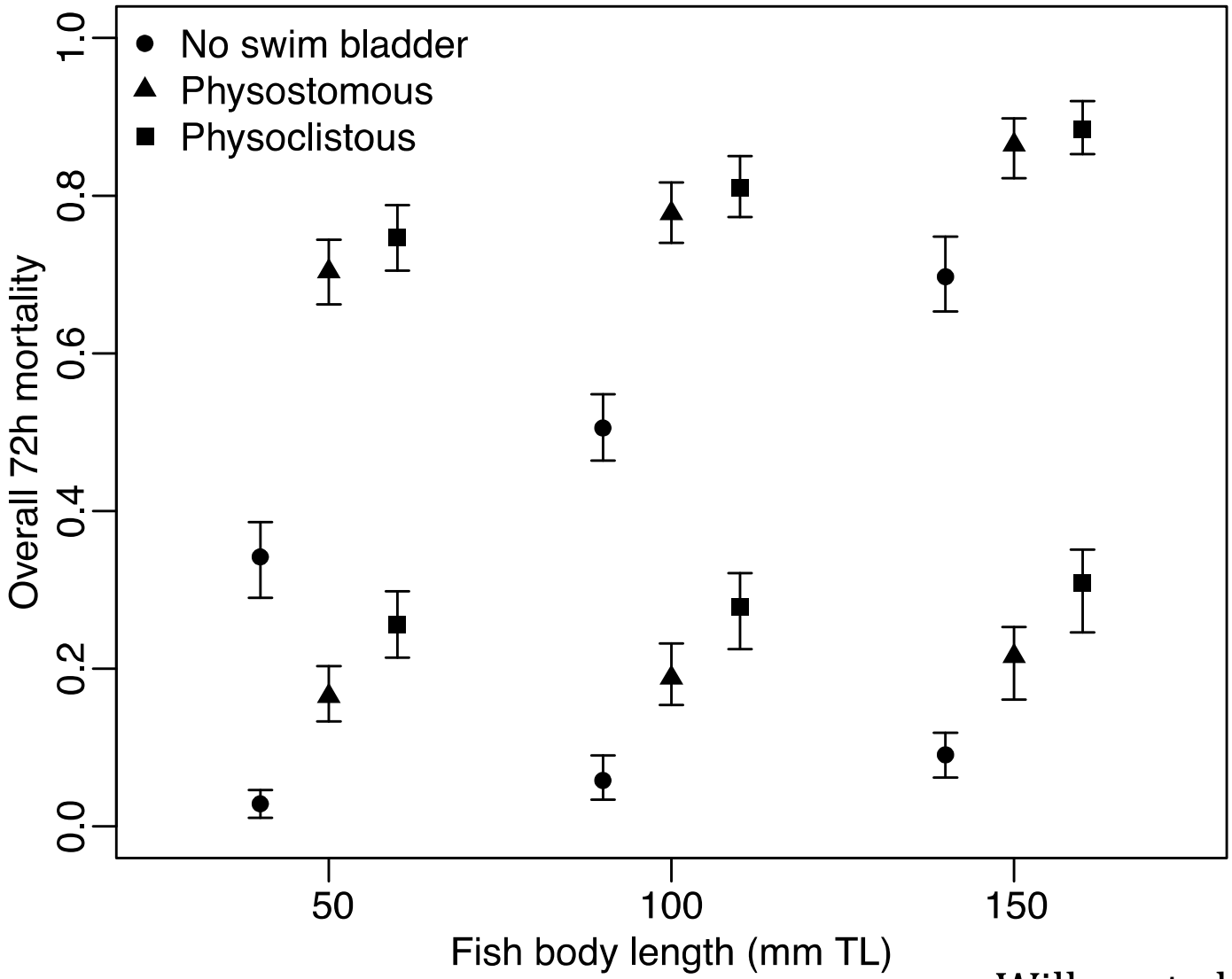


Wilkes et al. (in prep.)

Mortality during downstream passage



Mortality during downstream passage



Wilkes et al. (in prep.)

Bayesian networks

- Key findings:
  - N. Hemisphere criteria an order of magnitude too high
  - Attraction flow, turbine design and pressure most sensitive design parameters
  - Solutions could be near 0% or near 100% effective, depending on design
  - Local extinction, decline in fisheries and ecosystem services expected without sensitive planning and design

Applications to hydropower planning, design and monitoring

Applications

- Predict impact of barrier for planning and EIA
- Design fishways for any target species or group
- Set targets for fish screens and bypasses
- Trade-offs between cost, hydraulic & biological performance
- Prior probabilities for basic fish passage research

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WORLD FISH MIGRATION DAY