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# A cautionary tale about the inhibitory effects of gated culverts on fish passage restoration efforts

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**Presenter Information**

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Fish Passage 2018



# Fishway research in tropical river systems

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- Fishways progressively being integrated into the design of infrastructure developments within tropical river systems
- Increasing economic investment into fishway technology underpinned by several decades of research
- Modern fishway designs
  - Pass diverse fish communities
  - Species with range of movement strategies
  - Flexible



# Other crossing structures in tropical river systems

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- Much less consideration has been given to improving the passability of other crossing structures, such as culverts
- In the Mekong River Basin, a high proportion of channels connecting main stem & floodplain habitats also incorporate culverts
- The passability of these culverts is critical since >35% of the Mekong species are migratory



Pictures: <http://my.geoview.info>



# Examples in the Mekong River Basin

- 15 fishways (including 5 in Savannakhet & 9 in Northern Laos) being constructed to allow fish to conduct lateral migrations and still access floodplain wetlands
- > 8 are being built at locations where there is a culvert & a flood regulator
  - Species need to be able pass culvert & fishway



Pictures: Lee Baumgartner and FISHBIO

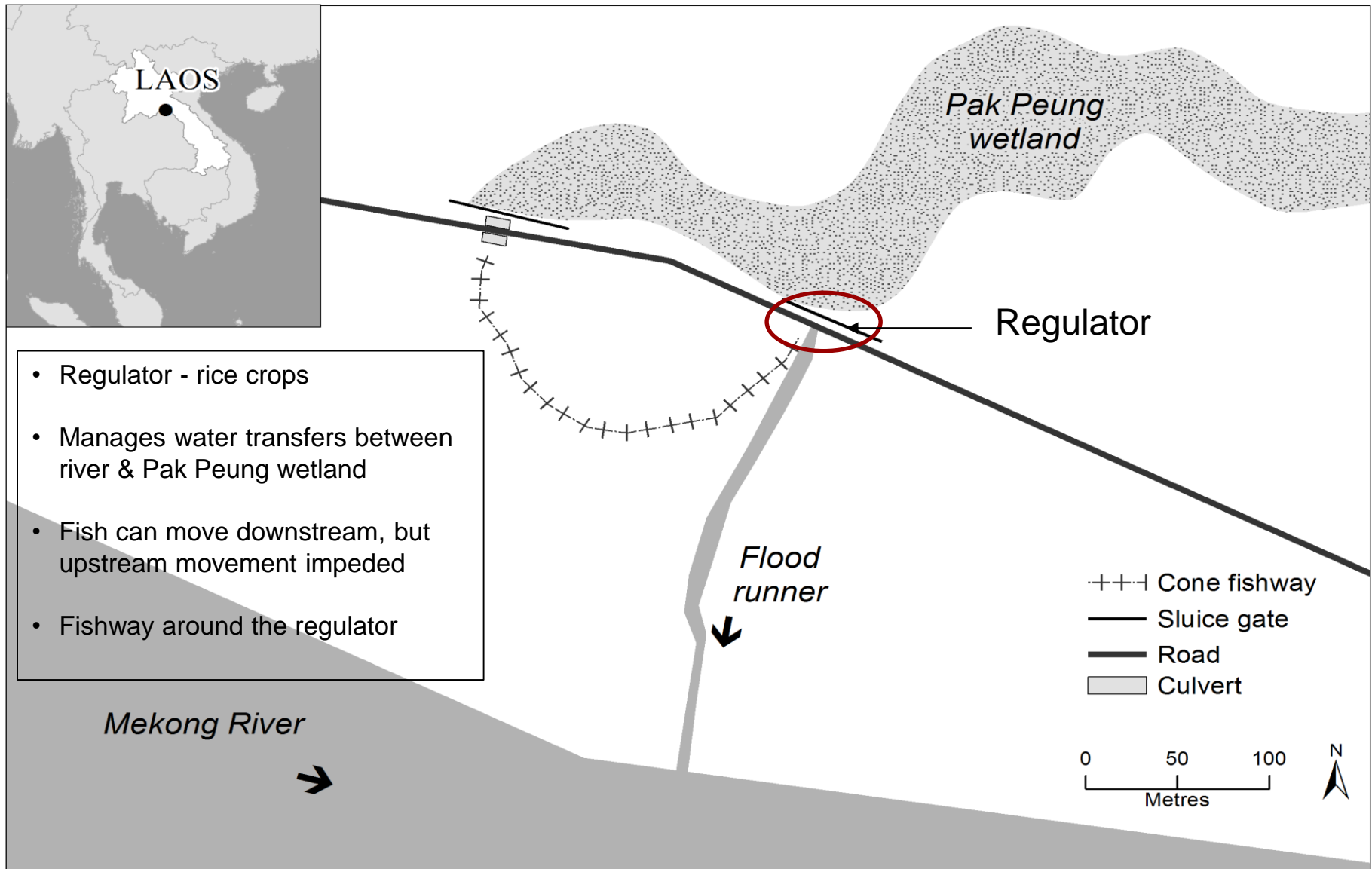
# Aim of the study

- Evaluate the passability of a fishway-culvert facility
  - Abundance, richness & composition
- Fishway built in 2012 as a demonstration site
- Fish had to swim through fishway & culvert to move Mekong → wetland



Pictures: Lee Baumgartner

# Study area: Pak Peung village, Laos

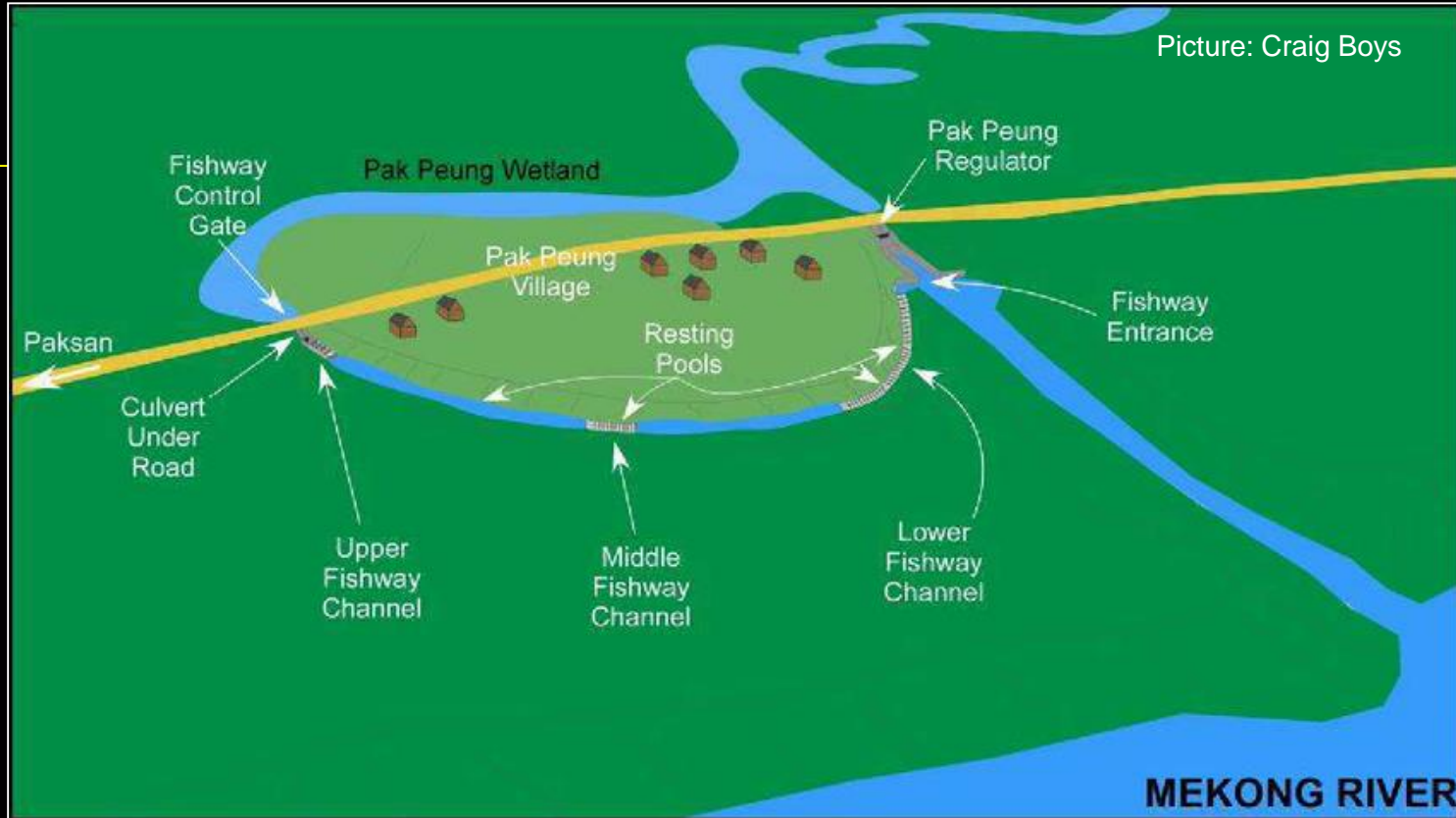




# Description of the fishway

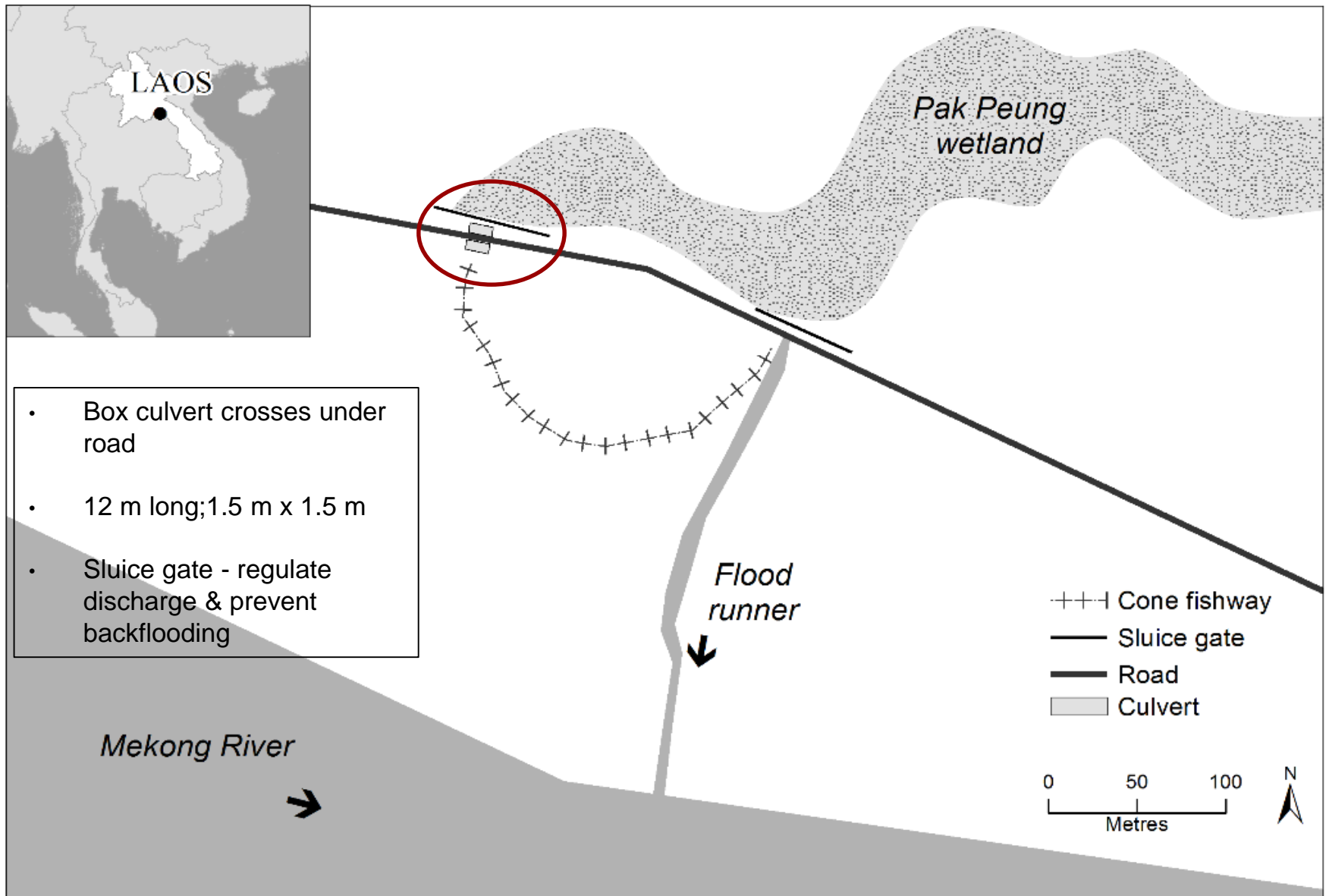


Slot velocity 1.33 m/s & pool turbulence 50 W/m<sup>3</sup> when operating at depth of 800 mm



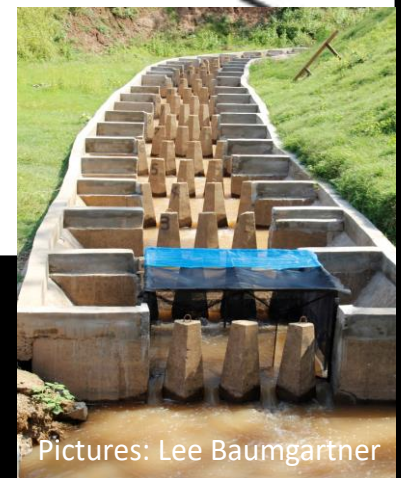
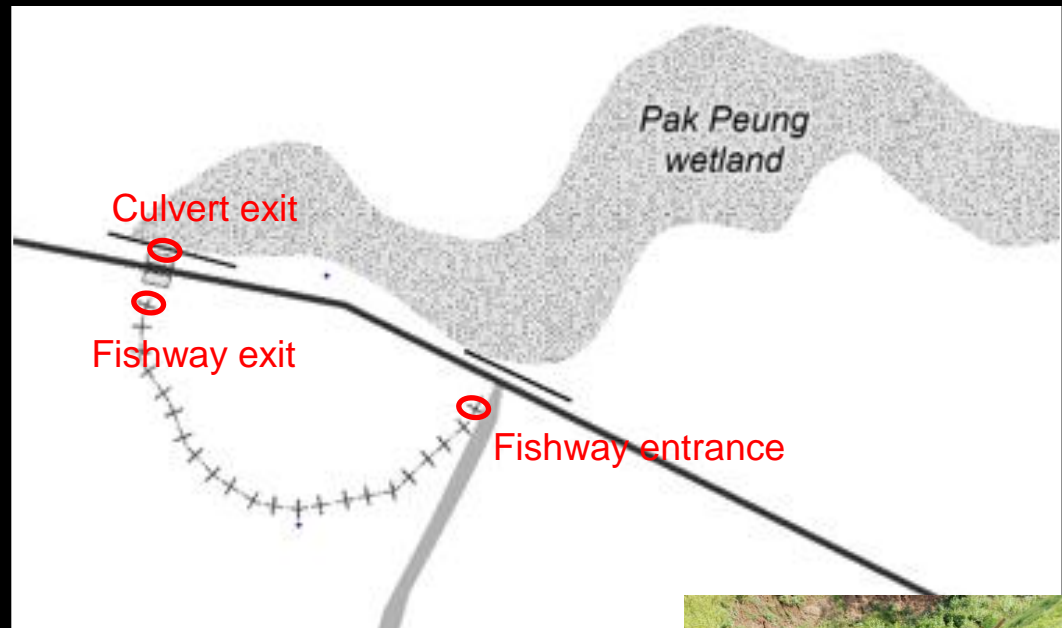
- Concrete cone design: forty-five 1.0 m–high concrete cone baffles - tapered slots
- Slots in each baffle offset (turbulence): 2 baffle arrangements – 3 full slots & 2 full /2 half
- Pool with sloping sides and flat bottom between each baffle; 0.09 m differential head between pools
- Fishway - 3 sections, 2 long resting pools

# Description of the culvert



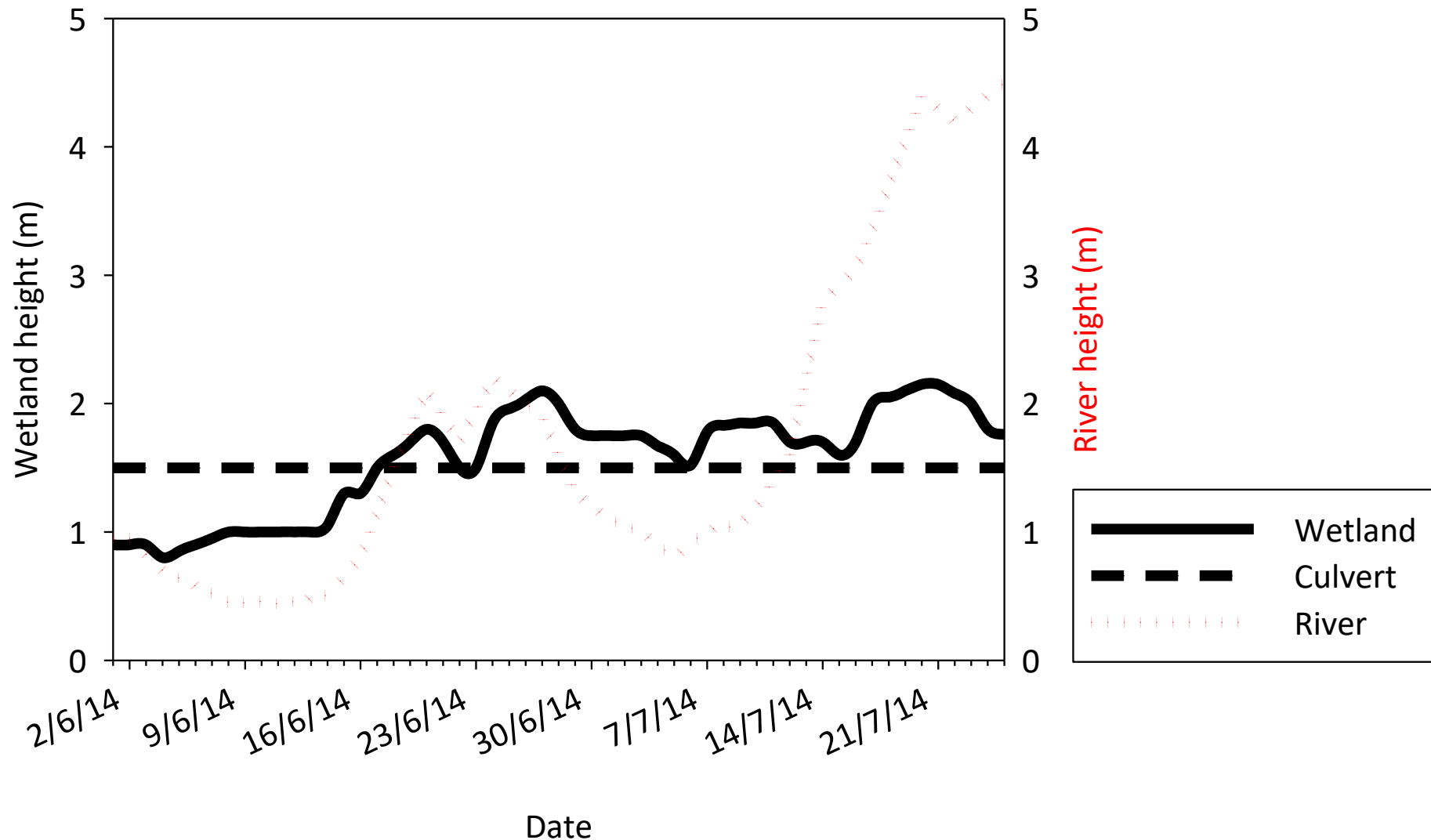
# Experimental design

- Fish passage - 3 locations
  - 'fishway entrance'
  - 'fishway exit'
  - 'culvert exit'
- Fish samples collected - large fish trap (32 mm mesh cone design, 1.5 m high × 1.5 m wide × 1.3 m long m long) facing downstream
- 25 blocks beginning of wet season 2014
  - Water levels within wetland & Mekong were steadily increasing



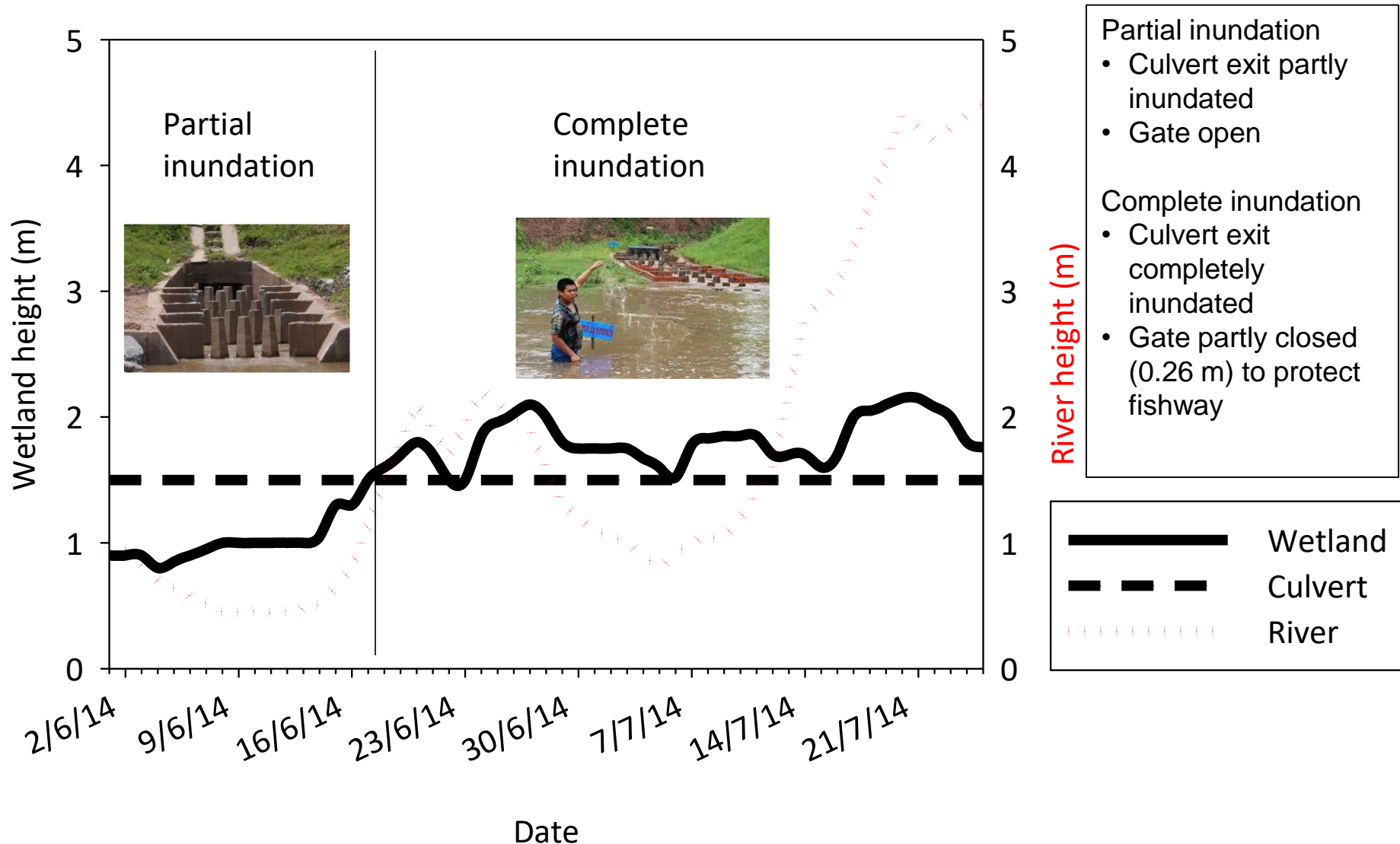
Pictures: Lee Baumgartner

# Wetland and river water levels





# Two distinct hydrological periods



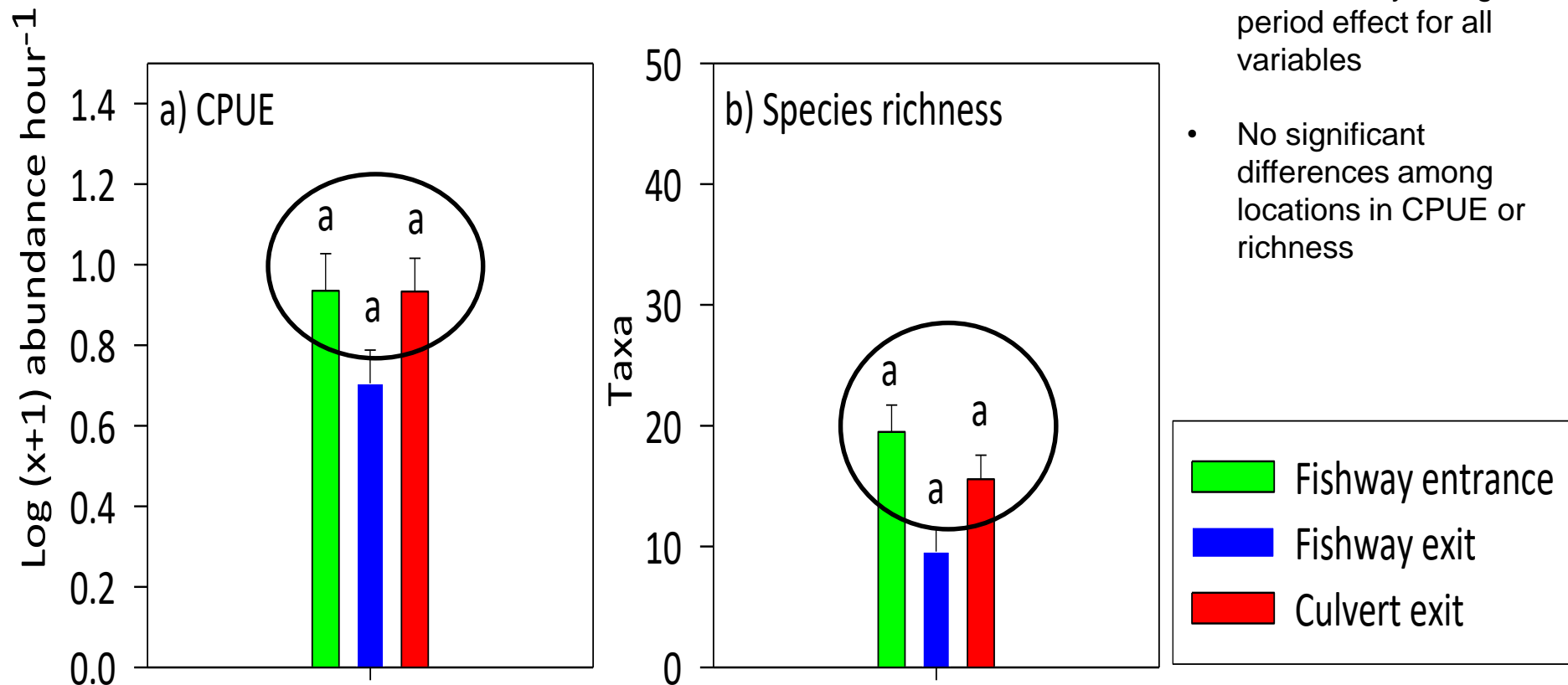
# Sampling protocols and data analysis

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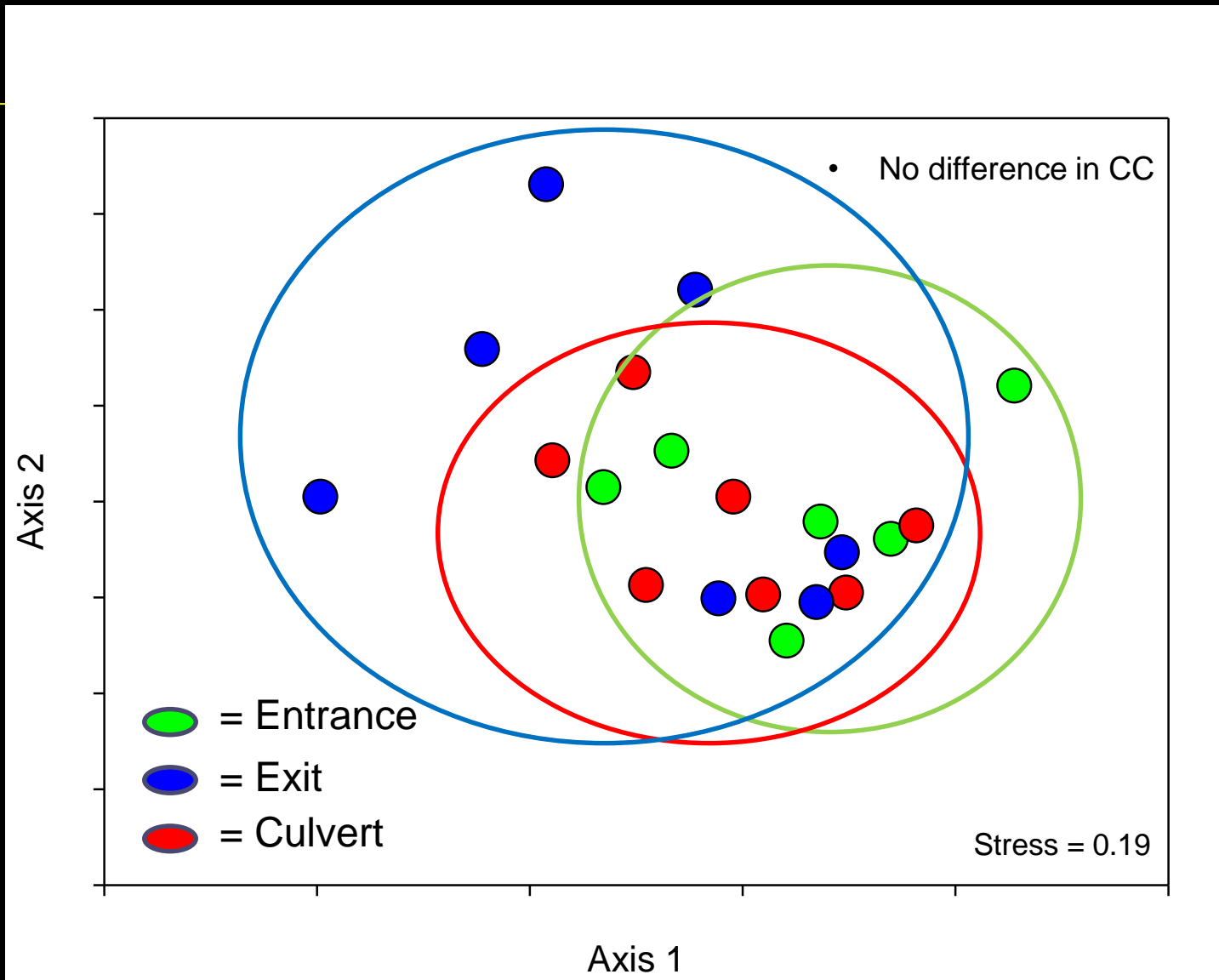
- Experimental block: all 3 locations were sampled for five-hour periods over 2 days
- Fish identified, weighed & measured
- Examined influence of 'location' & 'hydrological period' on:
  - Abundance (CPUE)
  - Species richness
  - Community composition



# Period of partial inundation: CPUE and richness

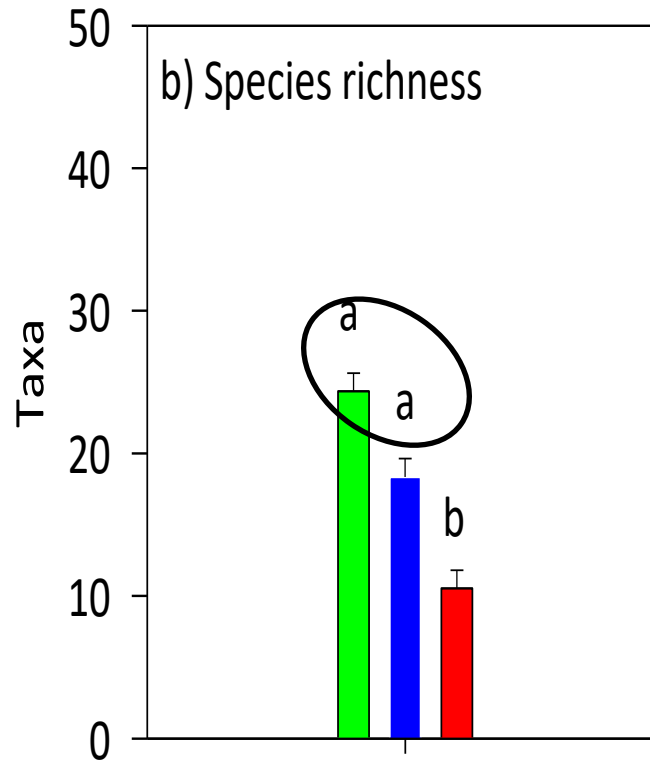
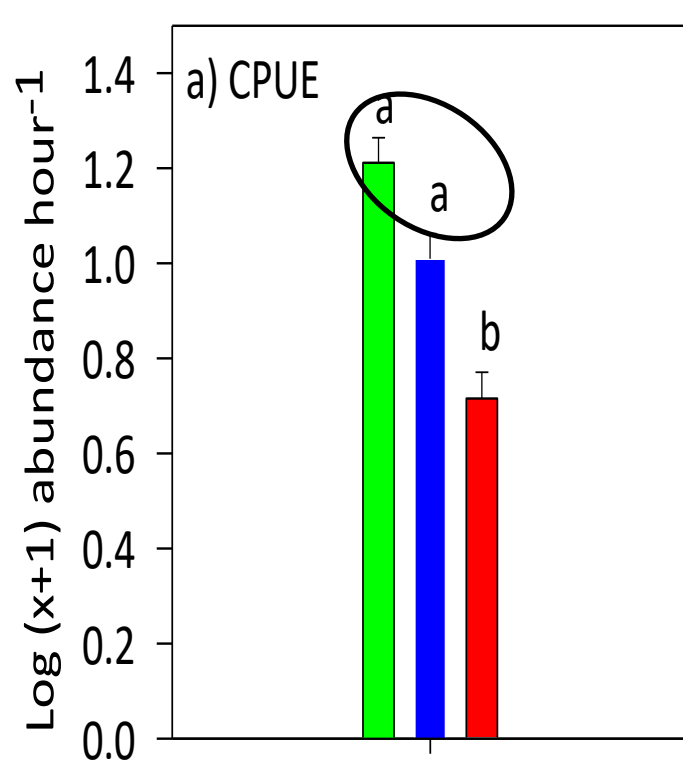


# Period of partial inundation: community composition





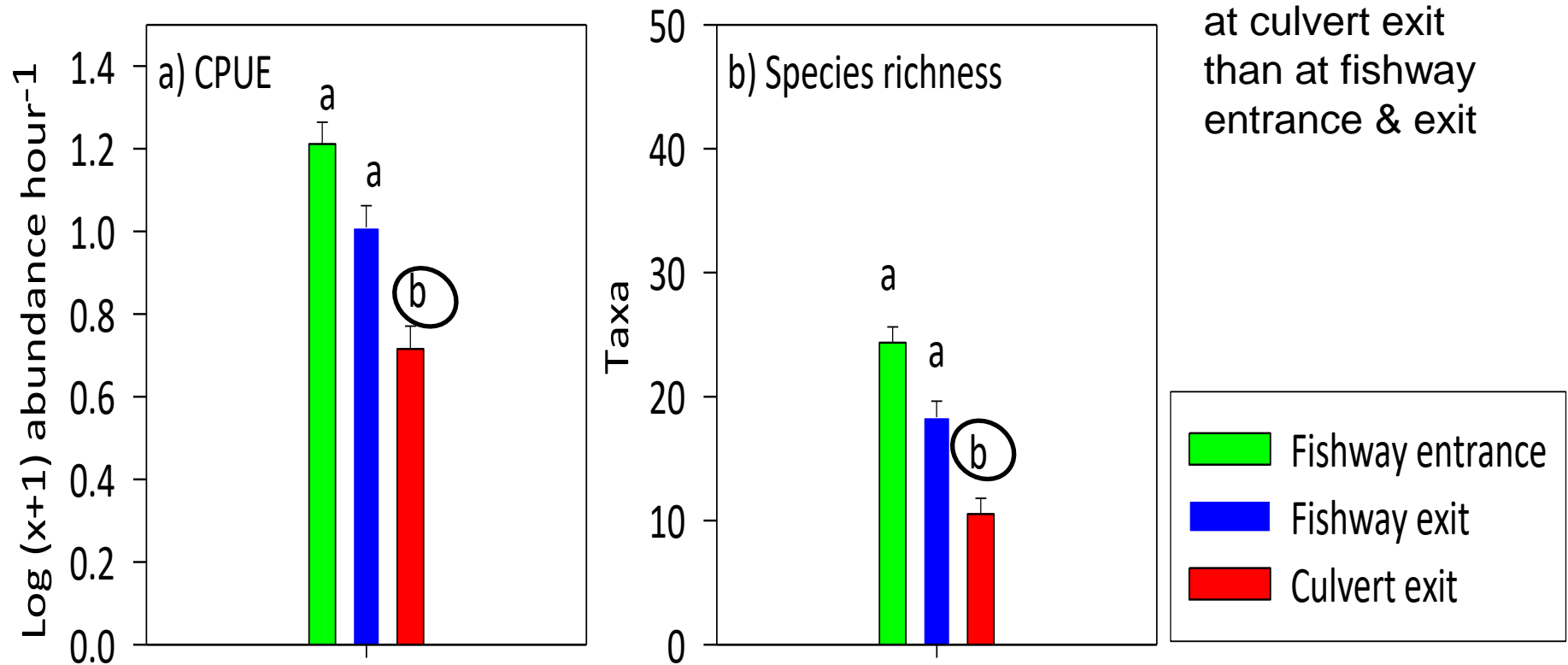
# Period of complete inundation: CPUE and richness



No differences in CPUE & richness between fishway entrance & exit

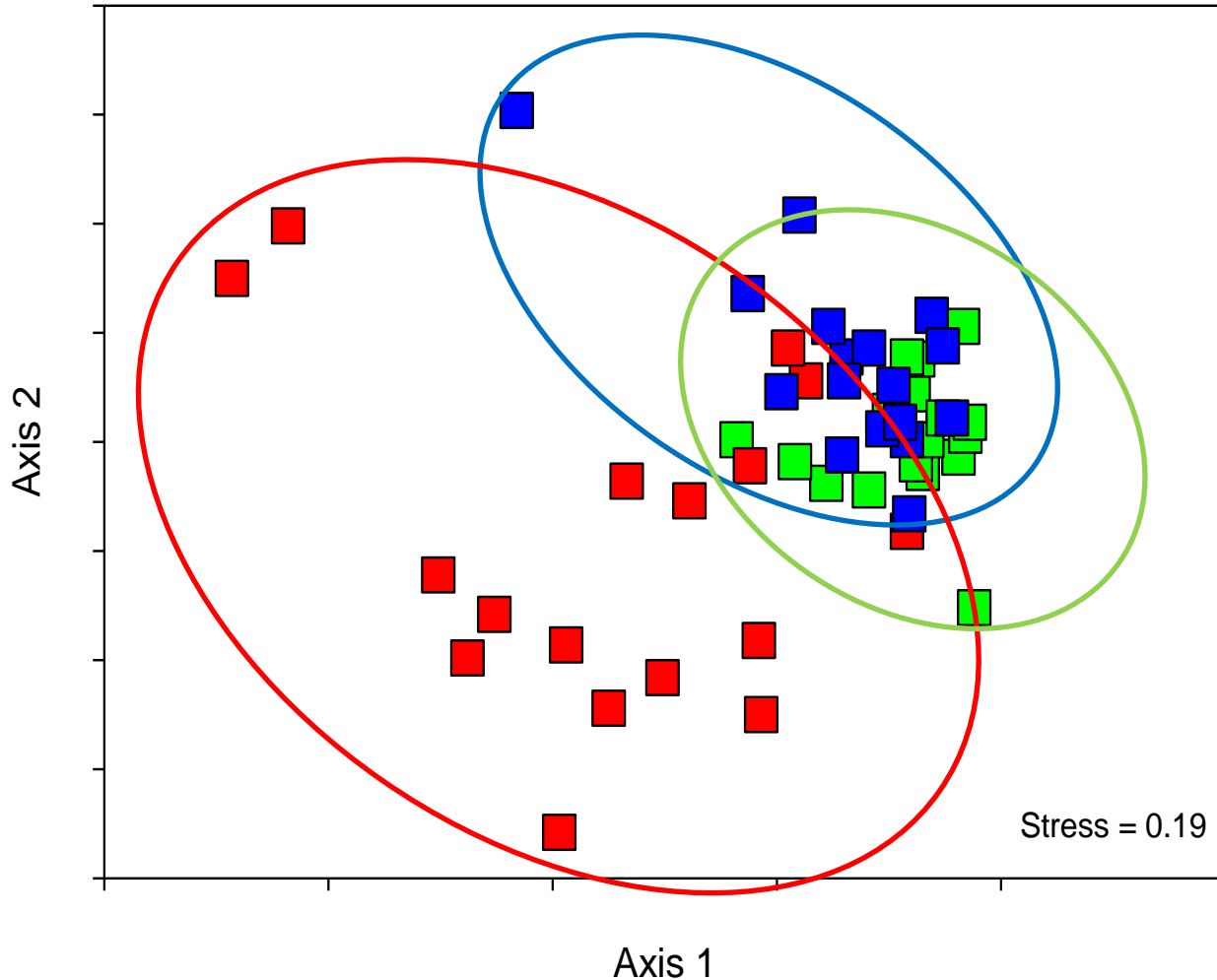
Fishway entrance  
Fishway exit  
Culvert exit

## Period of complete inundation: CPUE and richness



# Period of complete inundation: community composition

CC at culvert differed significantly



*Parambassis siamensis*



- Many small-bodied species prevalent at fishway entrance & exit, but rare/absent at culvert



*Probarbus jullieni*

- Other species populations present at all locations, but missing smaller size classes at culvert exit

■ = Entrance

■ = Exit

■ = Culvert

# Discussion: Period of partial inundation

- Fishway-culvert worked effectively in passing LMB fish
  - While wetland water levels remained below the height of the culvert
  - Culvert exit gate fully open





# Discussion: Period of complete inundation

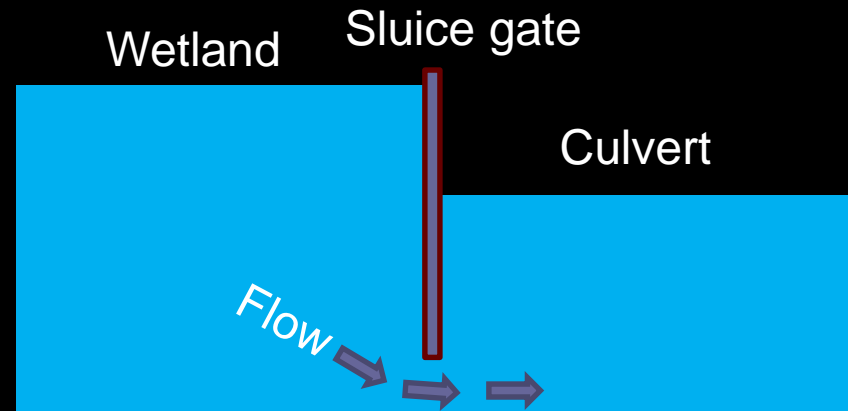
- Once rising wetland water levels surpassed height of culvert & gate had to be partly closed (to protect fishway)
  - Culvert became impassable
- Small-bodied (< 10 cm) species & small size classes of species not reaching the culvert exit



# High velocities and low light during complete inundation

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- Inhibitory effect of culvert on fish passage during complete inundation → velocity barrier
  - Partial closure of gate + increased headwater levels = high flow under gate
- Small fish need low velocities to ascend culverts
  - Lesser burst swimming abilities than large fish
- Low light availability may have also played a role in impeding fish passage through culvert
  - Predator-prey movement response
  - Stress response



# Management implications

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- Critical first step in demonstrating potential inhibitory effects of gated box culverts on fishways
- Next step: *in situ* or laboratory experiments to confirm which specific hydraulic attributes responsible
- Such research is crucial
  - Culvert internal hydraulics can be optimised
  - Engineering/operational solutions



# Potential solutions

Type	Option	Pak Peung
Engineering	Existing culverts could be replaced with units possessing larger cross-sectional areas that can handle increased head differential & reduce flow velocity	
Engineering	Fishways could be modified (or replaced) to cater for greater water level ranges	Extra fishway section upstream of culvert – greater water level range & velocity control
Operational	Maintaining headwater levels within a range that enables both the culvert & fishway to function effectively	Managed with this objective in mind



# Acknowledgements

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Pictures: Jo Millar