



Aims of my talk

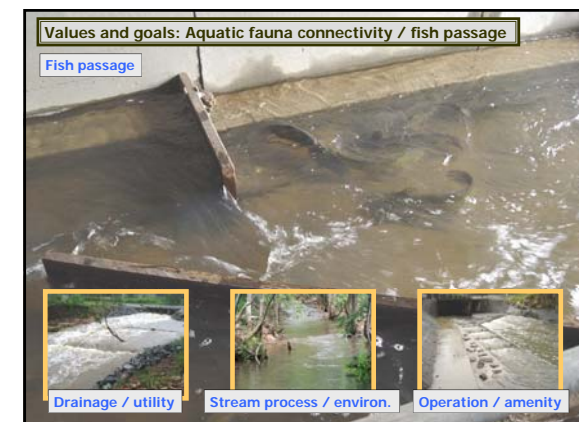
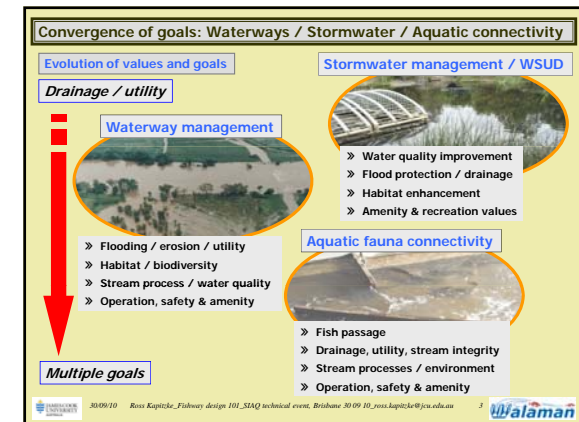
- » Place fish passage design in a stormwater context
- » Outline fish passage design concepts for waterway sites
- » Illustrate culvert fishway design applications / projects
- » Provide a leg up to *Fishway Design 101* and beyond

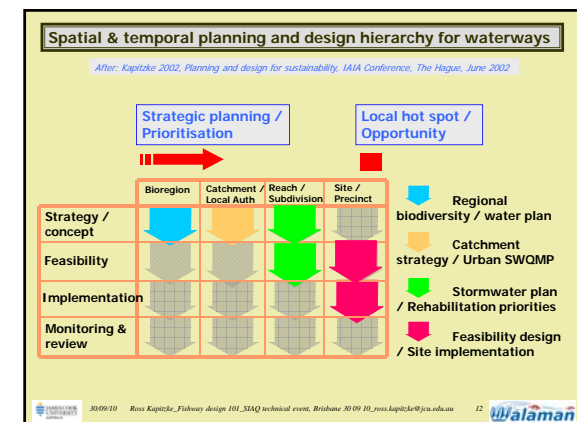
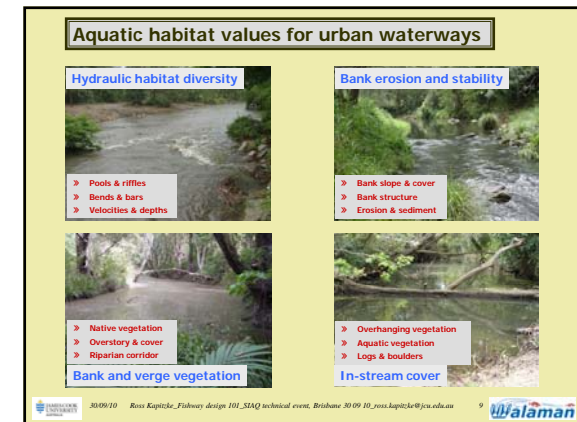
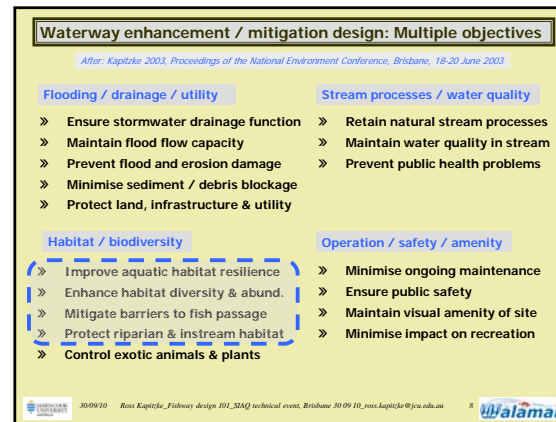
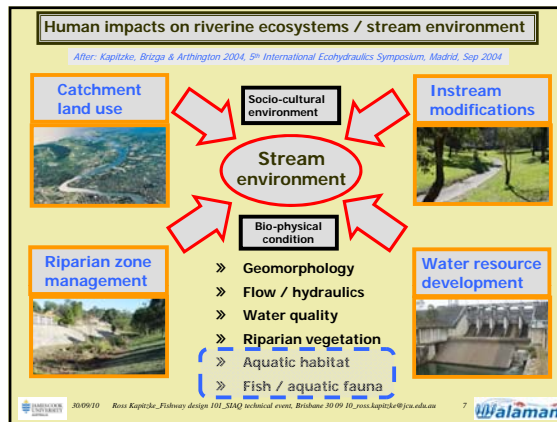
Presentation outline

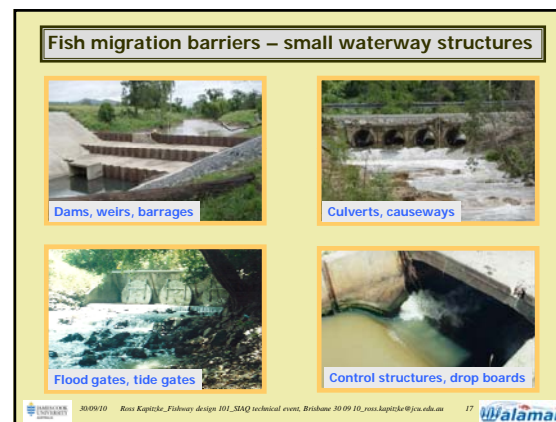
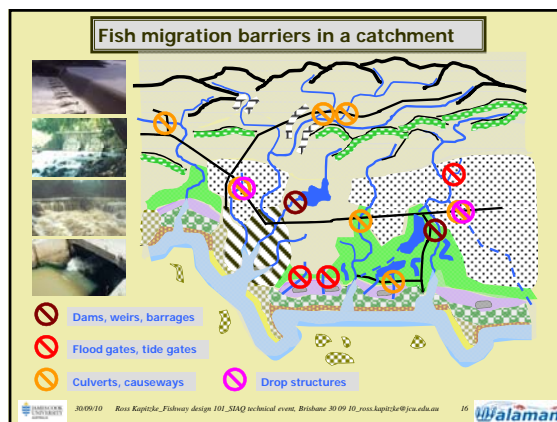
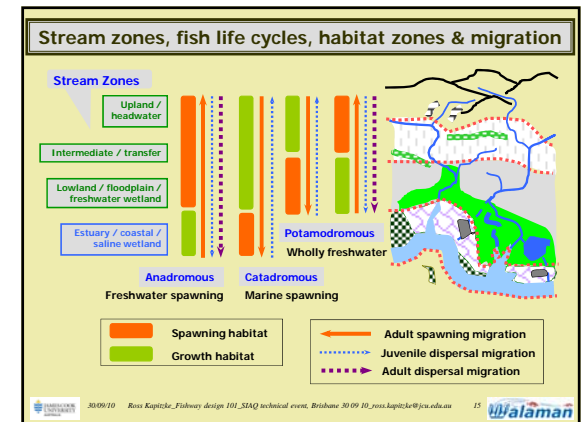
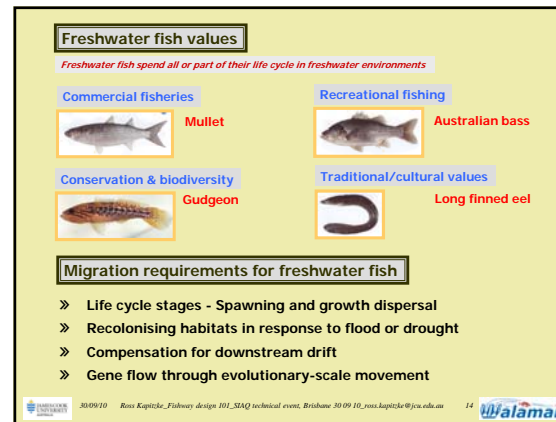
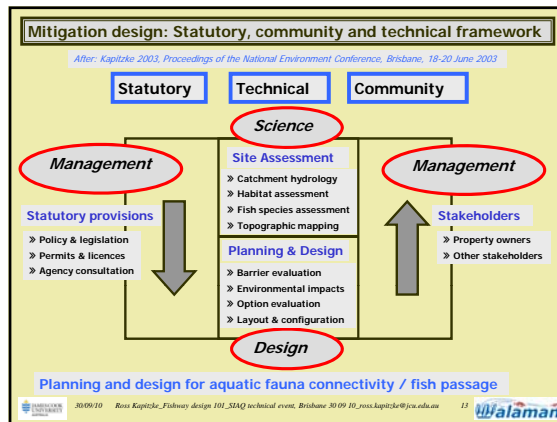
- » Waterway, stormwater and fish passage design – convergence
- » Migration barriers and multipurpose design requirements
- » Fish passage design approaches – merits and applications
- » Fish passage design and mitigation options
- » Prefabricated fishway system – design and performance
- » Fish passage planning and design – pathway for designers

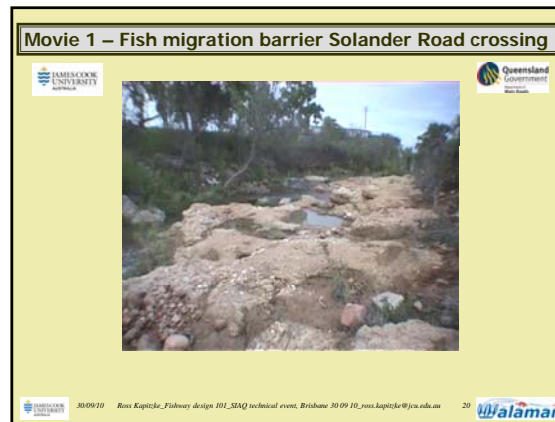
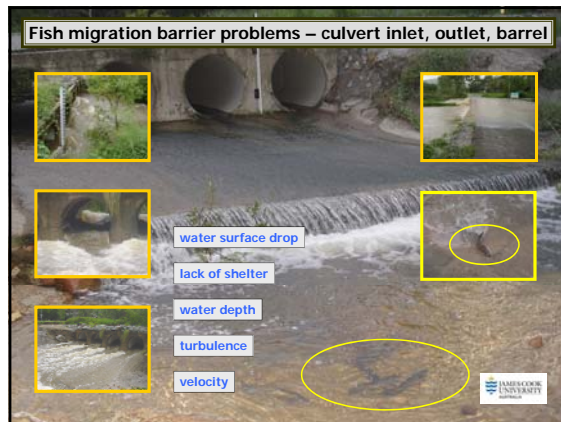
30/09/10 Ross Kapitzke_Fishway design 101_SIAQ technical event, Brisbane 30/09/10_ross.kapitzke@jcu.edu.au 2

Palaman









Establishing fish passage design for road crossings in Australia

Aquatic fauna connectivity contrasts: Northern Hemisphere & Australia

Waterway type and hydrology

- » Inter-annual flow variation
- » Seasonal flow variation
- » Perennial / intermittent flow

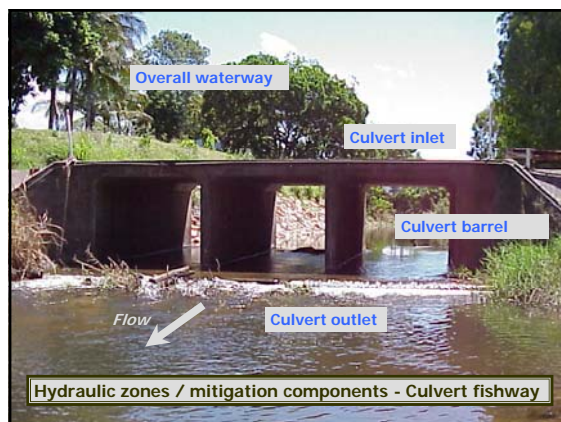
Fish species movement behaviour

- » Anadromous / Catadromous
- » Swim capability
- » Ability to jump

Waterway crossing structure type

- » Pipe culverts / box culverts
- » Single cell / multi-cell

Source: Kapitzke 2010, Culvert Fishway Planning and Design Guidelines



Fish passage mitigation measures for road-waterway crossings

Overall waterway

Culvert inlet, outlet & downstream

Culvert barrel

Arch culvert
Rock ramp
Stream simulation
Bridge
Block Ramp
Plain culvert
Apron baffles
Baffles

Fish passage design approaches for road crossings: North America

Stream simulation

- » Requires equivalent channel area
- » Requires similar substrate / bed
- » Difficult to achieve for culverts

Arch culvert

Plain culvert

- » Requires large cross section
- » Pounded water required for depth
- » Often larger than channel area

Low velocity

Hydraulic design

- » Pool type fishway suited to fish
- » Distinct hydraulic conditions
- » Applied to range of situations

Baffles / Ramps

Hybrid design

- » Difficult to configure / construct
- » Non distinct hydraulics
- » Speculative and untested

Rocks in bed

Source: Kapitzke 2002, Travelling fellowship report – Europe and North America

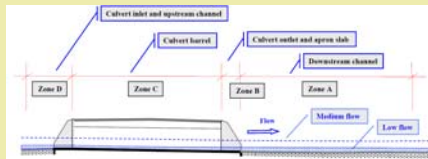
Why baffle fishways can still be used for culvert barrels



- provide flexible solutions for range of structures / conditions
- provide controlled and quantifiable hydraulic conditions.....cf. rocks in bed
- impractical to achieve prolonged swim speed conditions in plain culvert – 0.3 m/s
- effective fish passage, flow conveyance, debris and sediment clearance
- used in dedicated barrel within multiple barrel culvert facility
- sulted to new culverts (mitigation) or retrofits (remediation) – without removal

Typical hydraulic barriers at waterway crossing zones

Source: Kapitzke 2010, Culvert Fishway Planning and Design Guidelines



	Zone D	Zone C	Zone B	Zone A
High velocity	✓	✓	✓	✓
Flow depth	✓	✓	✓	✓
No shelter	✓	✓	✓	✓
Turbulence	✓	✓	✓	✓
Water drop	✓	✓	✓	✓

Fishway component types for culverts and open channels

After: Kapitzke 2010, Culvert Fishway Planning and Design Guidelines

Baffle fishways for box culverts

- » Offset baffle fishway
- » Corner "EL" baffle fishway



Baffle fishways for pipe culverts

- » Offset baffle fishway
- » Corner "Quad" baffle fishway



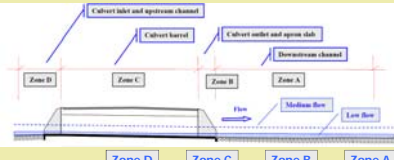
Ramp fishways for drops / channels

- » Rock ramp / cascade fishway
- » Block ramp fishway



Application of fishway components in hydraulic zones

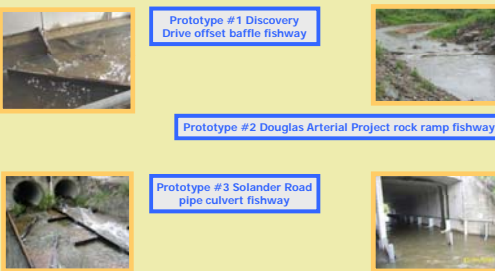
After: Kapitzke 2010, Culvert Fishway Planning and Design Guidelines



	Zone D	Zone C	Zone B	Zone A
Offset baffle - box	✓	✓	✓	
Corner "EL" baffle	✓	✓	✓	
Offset baffle - pipe		✓		
Corner "Quad" baffle		✓		
Rock ramp / cascade	✓			✓
Block ramp			✓	✓

Prototype fishway design, development and testing

University Creek, Townsville, north Queensland, Australia

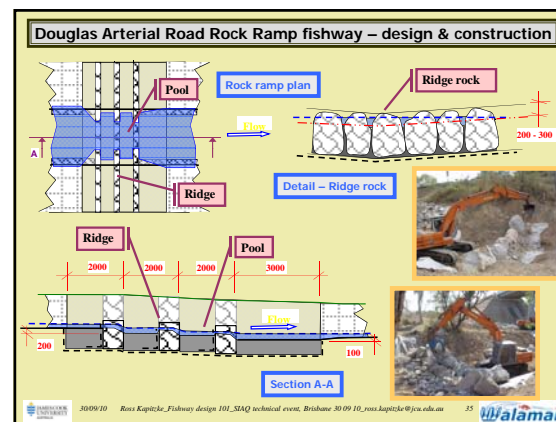
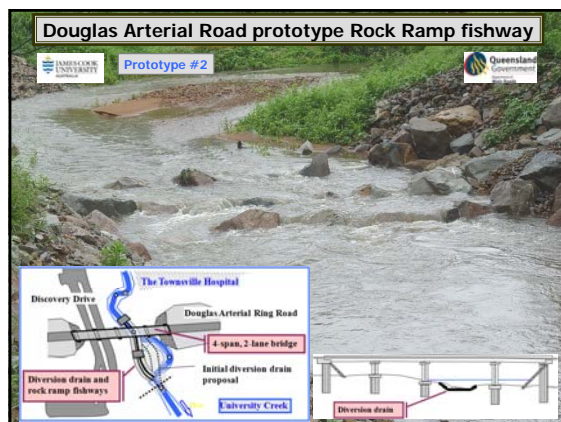
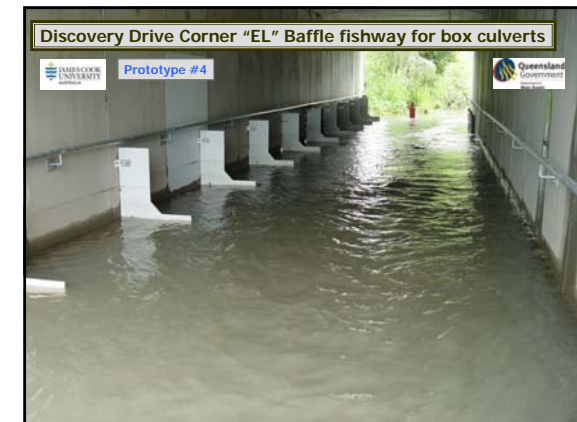
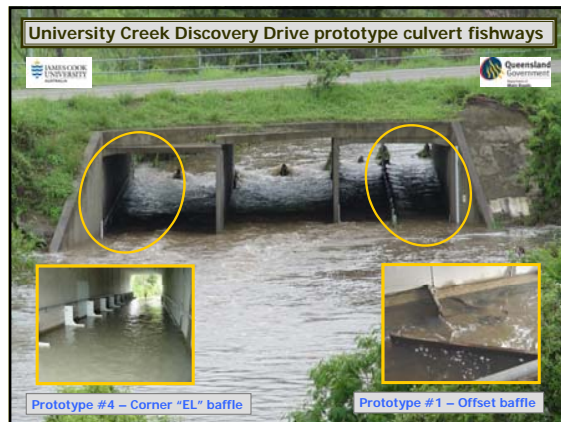


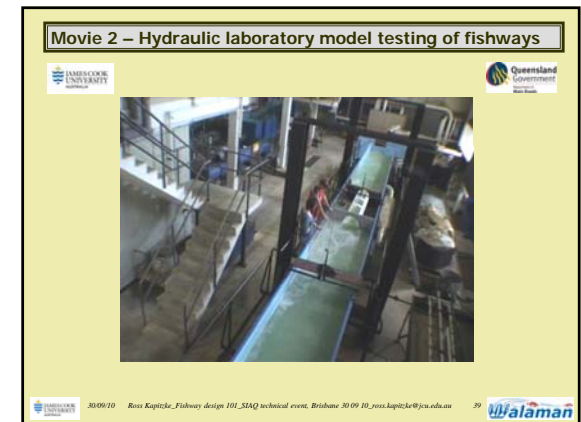
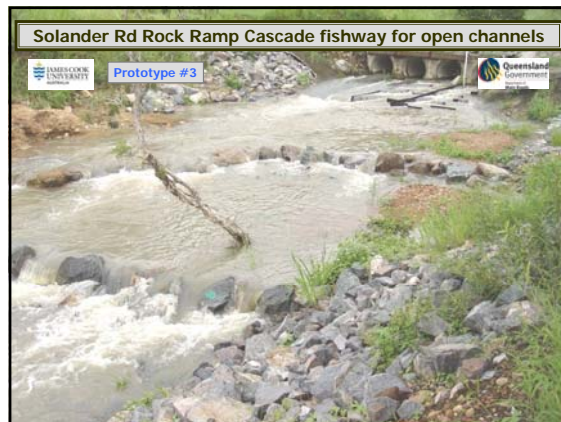
- Prototype #1 Discovery Drive offset baffle fishway
- Prototype #2 Douglas Arterial Project rock ramp fishway
- Prototype #3 Solander Road pipe culvert fishway
- Prototype #4 Discovery Drive corner baffle fishway

University Ck fish community – 13 native species observed in 2003



- Long-finned eel
- Black catfish
- Agassiz's glassfish
- Spangled perch
- Hyrtl's tandan
- Barred Grunter
- Empire gudgeon
- Purple spotted gudgeon
- Eastern rainbowfish





University Creek Solander Road – Prototype culvert fishway

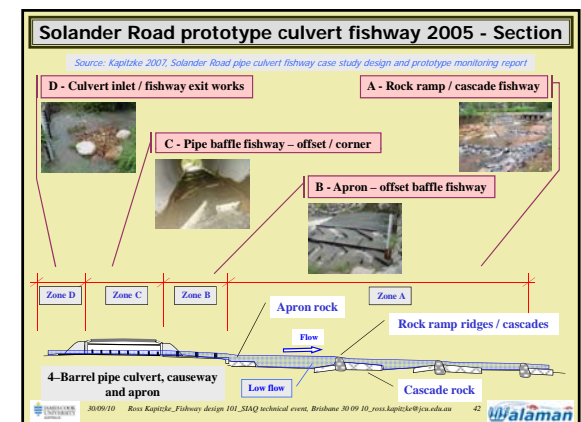
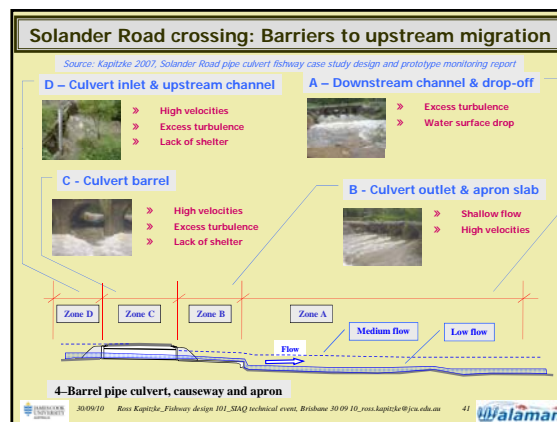
James Cook University | Queensland Government | Prototype #3

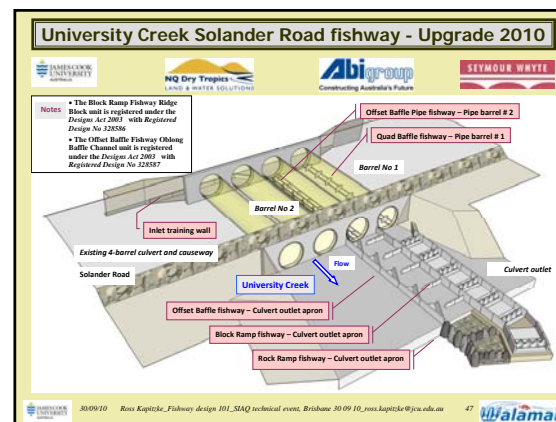
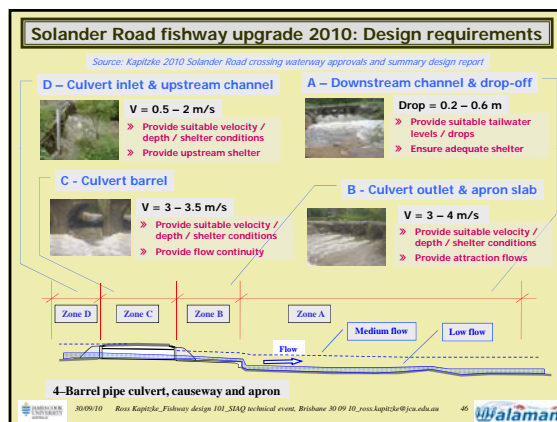
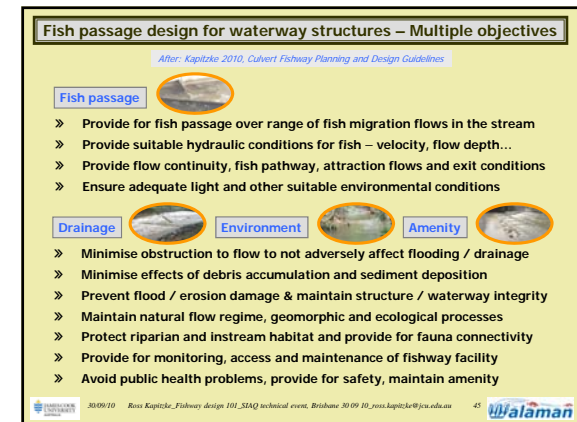
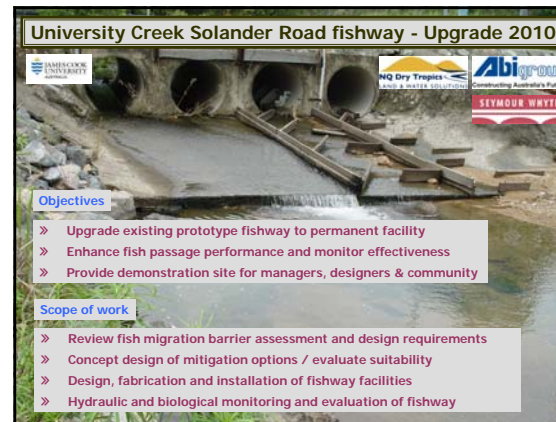
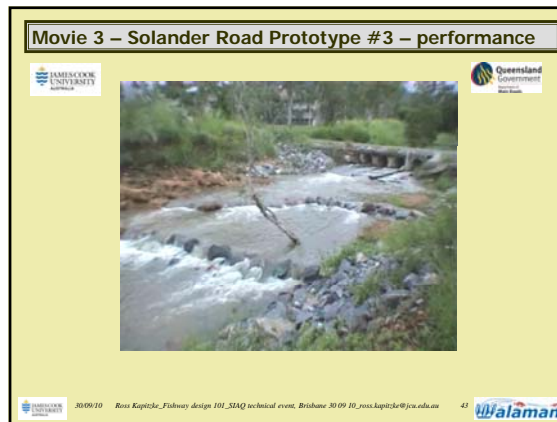
Objectives

- » Provide fish passage and remediate degraded waterway crossing
- » Establish prototype fishway for pipe culvert and causeway
- » Provide demonstration site for managers, designers & community

Scope of work

- » Aquatic habitat and connectivity assessment for University Creek
- » Fish migration barrier assessment and evaluation of mitigation options
- » Design, fabrication and installation of prototype fishway facilities
- » Hydraulic and biological monitoring and evaluation of fishways





Fish passage design flow conditions – Tully Murray floodplain

Low flow

- » Flow depth < ~ 0.5 m
- » Inundating channel bed

Medium flow

- » 0.5 m < flow depth < ~ 1.5 m
- » Below low flow channel bench

High flow

- » 1.5 m < flow depth
- » Upper channel / overbank flow



Tully Murray fish community and nominal swim speeds

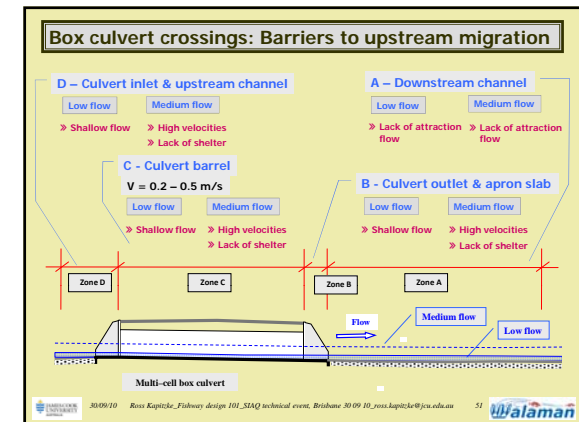
Source: Kapitzke 2007, Bruce Highway Corduray Creek to Tully fish passage road corridor scale assessment

Native freshwater species

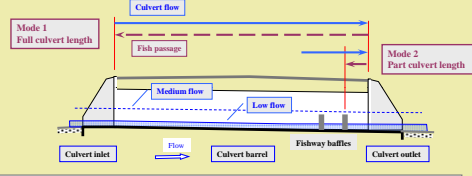
- Catadromous – 14 species ..eels, barramundi, jungle perch, goby
- Potamodromous – 33 species .. catfish, gudgeon, glass perch, blue eye
- Amphidromous – 11 species .. garfish, mangrove jack, mullet

Nominal swim speeds

Fish size range	Prolonged speed (20 sec to 200 min duration)	Burst speed (5 to 20 sec duration)
ATS – Adult upstream spawning migration		
Medium size fish species (adults 15 cm + 25 cm)	0.45 m/s to 0.75 m/s	0.9 m/s to 1.5 m/s
Small size fish species (adults < 10 cm)	0.25 m/s	0.5 m/s
JUD – Juvenile upstream dispersal migration		
Medium – large size fish species (juveniles to 30 cm)	0.3 m/s to 1.0 m/s	up to 1.4 m/s
Small size fish species (juveniles to 10 cm)	0.1 m/s to 0.3 m/s	0.2 m/s to 0.6 m/s



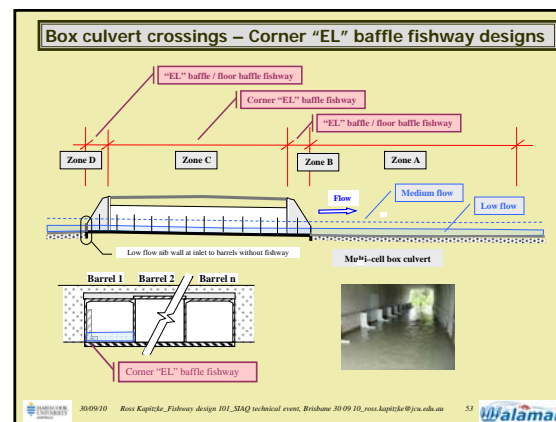
Velocity barriers – Fish swim modes and swim speeds



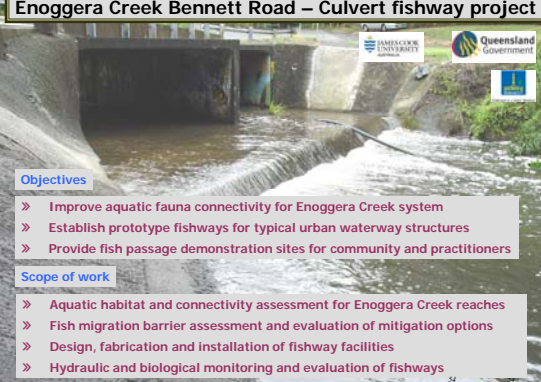
Required swim speed for fish to negotiate culvert – full or partial length

Culvert velocity	Mode 1 – full length (15 m)	Mode 2 – baffles (@ 2 m)	
	Prolonged speed	Burst speed	Prolonged / burst speed
0.3 m/s	~ 0.3 m/s	1.05 m/s	~ 0.3 m/s
0.6 m/s	~ 0.6 m/s	1.35 m/s	~ 0.6 m/s
0.9 m/s	~ 0.9 m/s	1.65 m/s	~ 0.9 m/s

Prolonged speed – maintained for 20 sec to 200 min Burst speed – maintained for 5 to 20 sec



Enoggera Creek Bennett Road – Culvert fishway project

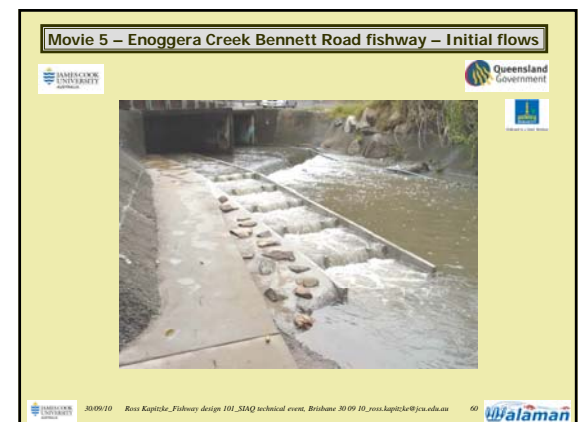
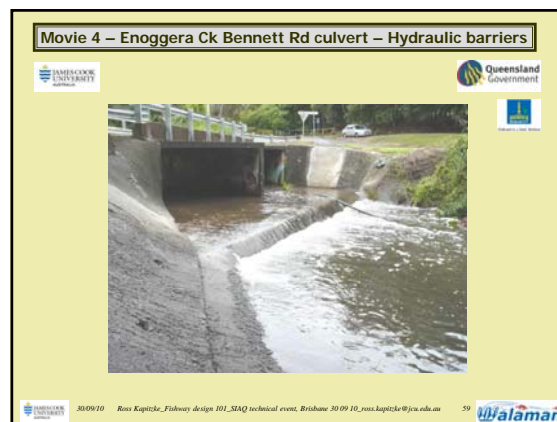
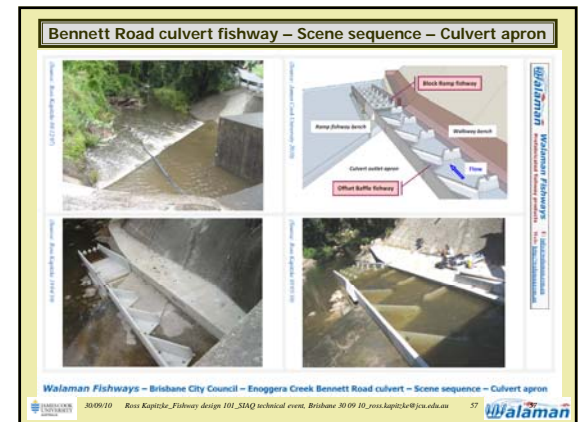
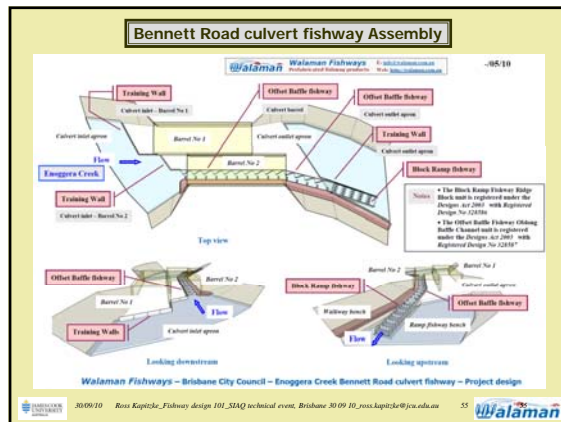


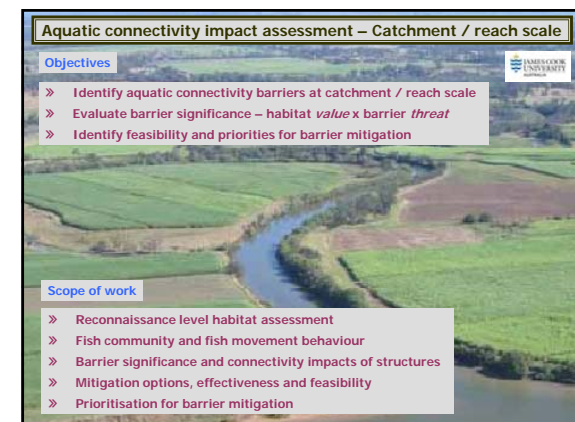
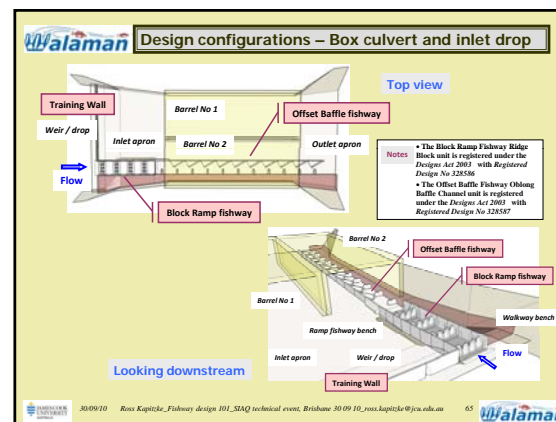
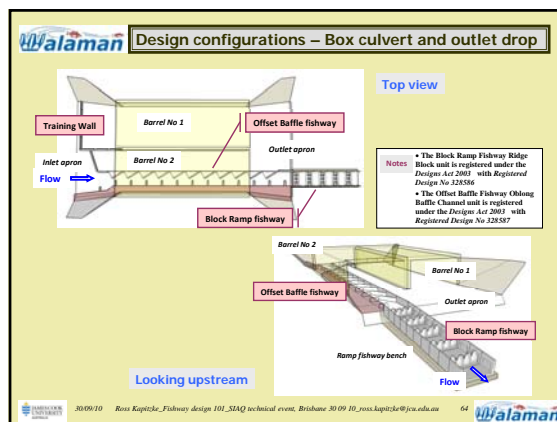
Objectives

- » Improve aquatic fauna connectivity for Enoggera Creek system
- » Establish prototype fishways for typical urban waterway structures
- » Provide fish passage demonstration sites for community and practitioners

Scope of work

- » Aquatic habitat and connectivity assessment for Enoggera Creek reaches
- » Fish migration barrier assessment and evaluation of mitigation options
- » Design, fabrication and installation of fishway facilities
- » Hydraulic and biological monitoring and evaluation of fishways





Fish passage planning and design – Road corridor scale

Objectives

- » Identify fish movement corridor crossings of road corridor
- » Establish aquatic connectivity goals and design characteristics
- » Identify priority waterway crossings for fish passage (& integrated fauna)

Scope of work

- » Waterway character and fish habitat assessment
- » Fish species, fish movement behaviour and characteristics for design
- » Fish movement corridor locations and classification
- » Fish passage goals and prioritisation of corridor crossings
- » Mitigation design options for type crossings (and integrated fauna)
- » Optimising waterway crossing type and configuration



Fish passage planning and design – Site scale


Objectives

- » Identify fish migration barriers at waterway structure
- » Establish fish passage and multipurpose design requirements
- » Define and evaluate fish passage (and integrated fauna) facility for site

Scope of work

- » Fish habitat, fish movement behaviour and characteristics for design
- » Fish passage barrier evaluation – hydraulic zones
- » Objectives, criteria and constraints for fish passage design
- » Fish passage options and evaluation for multipurpose requirements
- » Design configuration of fish passage (and integrated fauna) facility

Retrofit or new: Remediation of barriers at existing structures; Mitigation design for new structures



Aquatic fauna connectivity – the bright star of barrier mitigation

Comparative benefits of aquatic and terrestrial fauna connectivity

- » 99 % of waterways are retained in the landscape
- » many waterways are significant fish movement corridors
- » high connectivity effectiveness is possible for fish at crossings
- » effective mitigation design is a relatively low cost solution
- » mitigation design can be achieved for retrofit or new structures

