Building Barriers: Saving Our Natives

Frances Charters
Masters of Engineering student
University of Canterbury

UC UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

www.hydroeco.info

Department of Conservation
Te Papa Atawhai

Species to be Protected

Upland Bully
Photo: Peter E. Smith

Taieri Flathead Galaxias
Photo: Rod Morris

Upland Longjaw Galaxias
Photo: DOC

Canterbury Mudfish
Photo: Sjaan Bowie

Köaro
Photo: Dr Paddy Ryan

Gollum Galaxias
Photo: Richard Allibone

Invasive Species

Brown Trout
Photo: Sthn Rivers Fly Fishing

Rudd
Photo: Otago Daily Times

Koi Carp
Photo: NZwaterways.co.nz

Removal of pest fish from Travis Wetland, Christchurch
Photo: CCC

Case Study: Akatore Creek

BEFORE

- 1.8 m bedrock waterfall
- Compromised in high flows

AFTER

- 2.5 m enhanced barrier
- Galaxiid popn. recovering

Photos supplied by DOC

Waterway Barriers

- Collate current knowledge
- Develop tool for recording knowledge
- Analyse
  - Understand what makes barrier effective
  - Design considerations

All photos supplied by DOC

Lake Rotopiko

Haumurana Stream

Maruia Tributary

Natural Barriers

Waterfall

Swamp

Overhangs

Others:

- Low water / dry bed
- Uninhabitable zone

Physical Built Barriers

Falls/weirs
Dams

Overhangs

Screens

Chutes
(High velocity, shallow water)

Information Package

- Review Report
- Barrier Spreadsheets
- Design Considerations Checklist
- EndNote Reference Library
- Photo Library
- Drawings Library

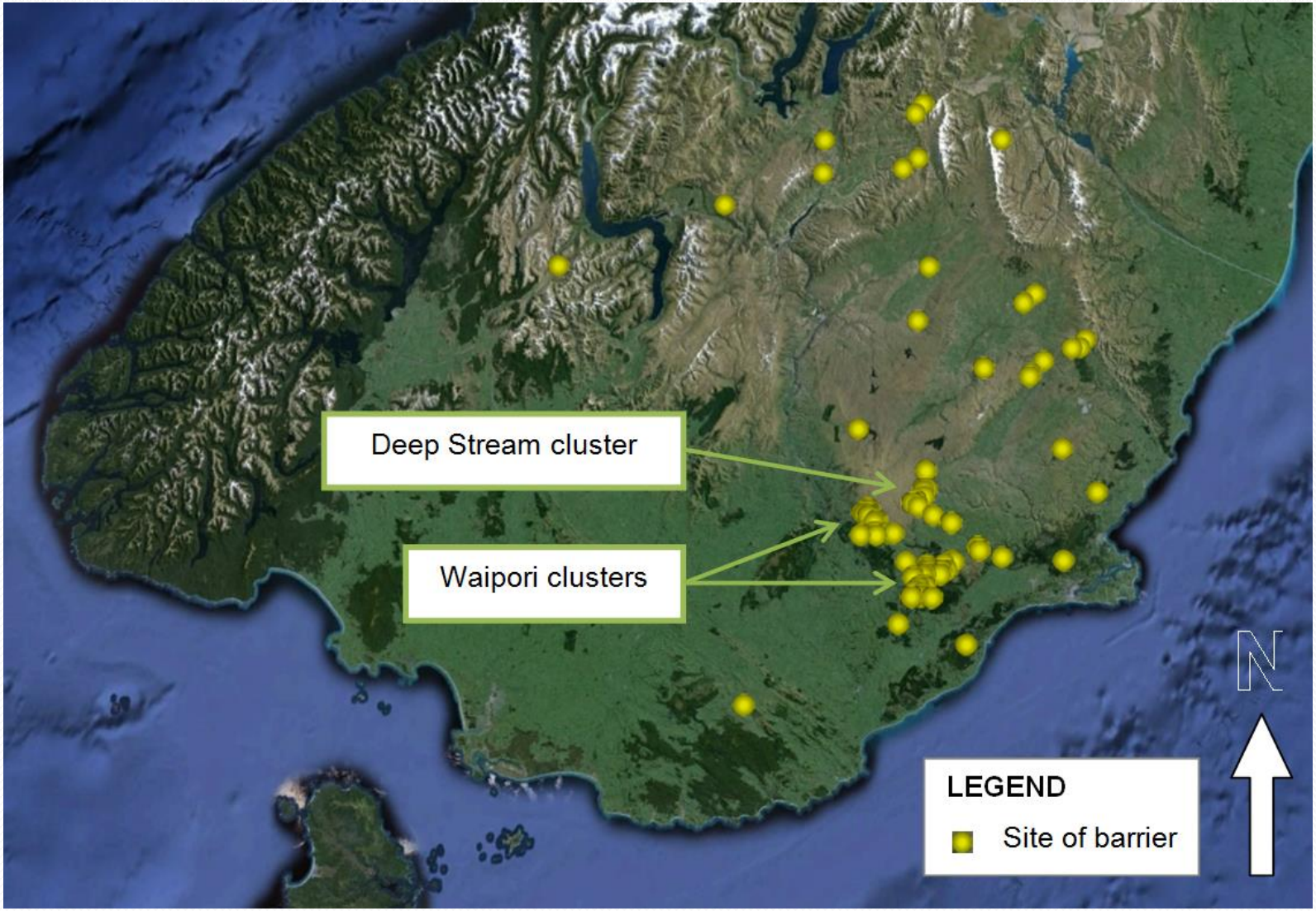
Barriers Master Spreadsheet

Summary of Barrier Information
A - Barriers Master

Barrier Name	Organisation	Region, Country (by Regional Council)	Projection	Northing	Easting	Elevation at Barrier (m asl)	Category	Waterfall	Weir	Screened	Culvert	Other	Material	Natural Barrier	Protection of upstream native fish	Protection of aquatic habitat	Prevention of movement of invasive species	Prevention of downstream movement	Prevention of upstream movement	Maintain diadromous movement
BARRIER NAME		BARRIER LOCATION					BARRIER TYPE							BARRIER OBJECTIVES						
Akatore Creek Waterfall	DOC	Otago, NZ					Natural	X					Bedrock	X					X	
Cave Stream Waterfall, Maruia catchment	DOC	West Coast, NZ					Natural	X					Bedrock	X					X	
Shingle Creek Waterfall	DOC	West Coast, NZ					Natural	X					Unspecified (likely waterfall)	X					X	
Taieri River Barriers	University of Otago	Otago, NZ					Natural	X				X	Unspecified	X						
Akatore Creek Built Barrier	DOC	Otago, NZ	NZMG	5454914	2287836	78	Physical		X				Concrete and stop logs		X				X	
Maruia Gabion Barrier	DOC	West Coast, NZ					Physical			X			Gabion		X				X	X
Orokonui Gabion Barrier	DOC	Otago, NZ				Near sea level	Physical			X			Gabion with PVC pipe running through gabion to convey main flow through barrier		X					X
Upper Waipori Barrier	DOC	Otago, NZ					Physical		X				Modification to existing V-notch weir with metal grill		X				X	
Fraser Spring Permanent Barrier	DOC	Canterbury, NZ					Physical		X				Concrete and overhanging steel plate, bypass culvert		X				X	
Fraser Spring Temporary Barrier	DOC	Canterbury, NZ					Physical			X			Pea straw bales wrapped in chicken wire		X				X	
Haldon Pastures Barrier	DOC	Canterbury, NZ					Physical		X				Concrete weir with anti-jump screen		X	X			X	
Coach Stream Barrier	Environment Canterbury	Canterbury, NZ					Physical				X		Modification of concrete apron of existing culvert, and new fish deflector		X				X	

Introduction | EndNote Library Keywords | **A - Barriers Master** | B - Non-physical Barriers | C - Natural Barrier Assessments | Natural Barriers Ranking

Otago Barrier Assessments



Otago Barrier Assessments

Effectiveness of Barrier	Barrier Type					Total
	Waterfall	Culvert	Weir	Swamp	Dry Stream Bed	
Effective	29	1	3	1	0	**34**
Not effective	5	3	1	0	0	**9**
Unspecified or unconfirmed	20	2	0	2	2	**26**
Total no. of each type	**54**	**6**	**4**	**3**	**2**	**69**

Fraser Spring Barrier

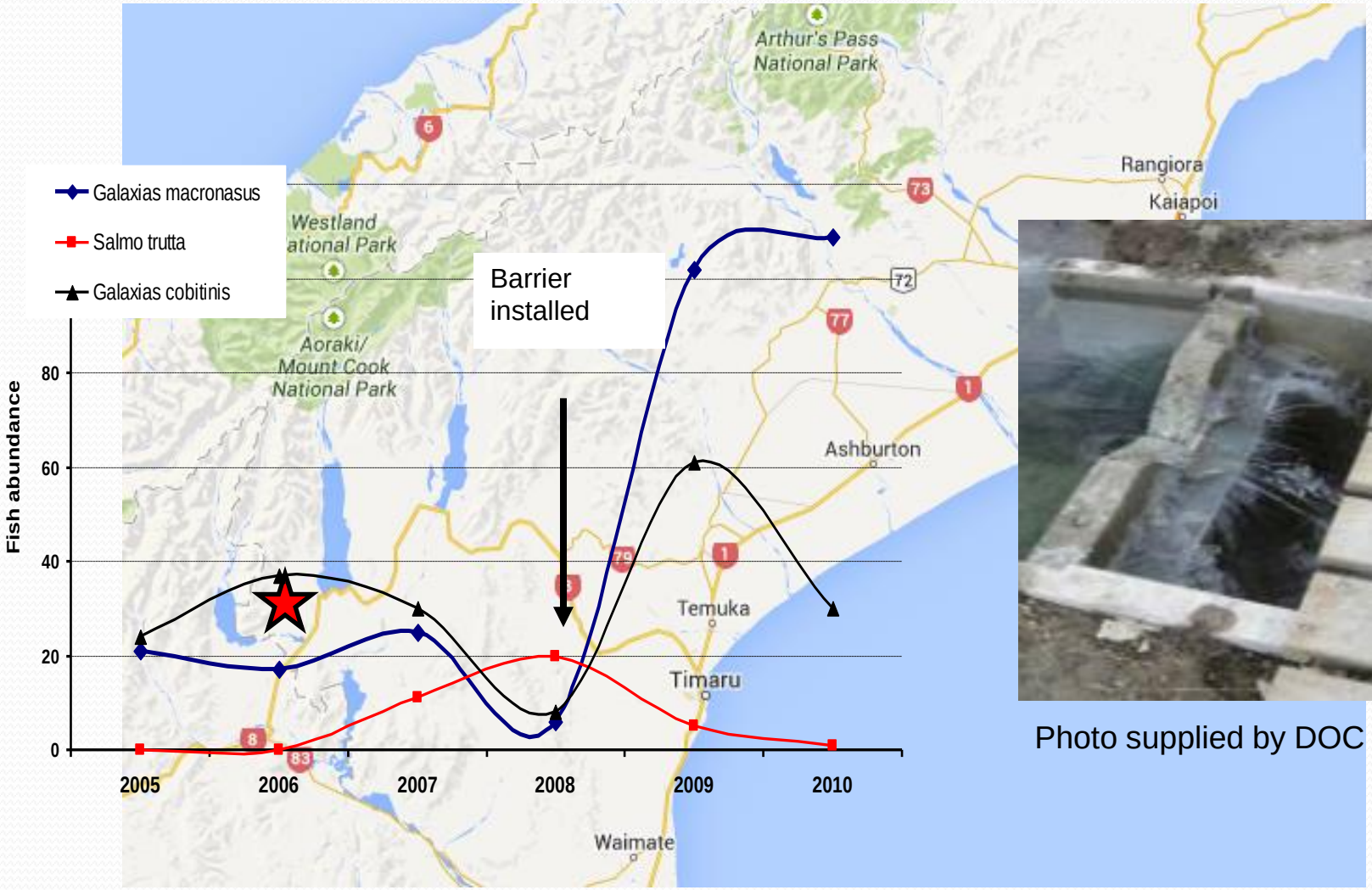


Photo supplied by DOC

What we know works:

- V-notch or similar crest profile
- Minimum fall height > 1.5 m
- Small drops (< 2.5 m) should be combined with other barrier mechanisms
- ≥ 500 mm overhangs to inhibit jumping

Examples of design considerations

All photos supplied by DOC

Hamurana Stream Barrier, Rotorua

- Protects koaro, koura
- Excludes trout
- Spring-fed stream
- Low-head weir plus overhang combination
- Allows passage for climbers

Upper Waipori Barrier, Otago

- Protects dusky galaxias
- Excludes koaro
- Enhances existing weir
- Existing V-notch weir with apron

Define barrier objectives (see Design Considerations Checkllist - Page 1)

Define the catchment characteristics

Review Waterways Barrier Database for barriers of similar characteristics (e.g. filter by objectives, stream characteristics)

- Review case studies section of report for similar examples
- Photo library is available if unsure of what barrier options might look like
- Drawings library is available to show construction details of similar barriers
- Reference sources are available in the EndNote Library

Review this report's conclusions for lessons learnt and improvements identified from previous experience

CONTINUE TO CONCEPTUAL DESIGN OF BARRIER

WATERWAY BARRIERS INFORMATION

- **Waterway Barriers Review Report**
- **Waterway Barriers Database**
- **Waterway Barriers Design Review Checklist**
  Table 1: Basis of Design
- **Waterway Barriers Design Review Checklist**
  Table 2: Design Considerations
- **EndNote Library**
- **Photo Library**
- **Drawing Library**

Summary of Progress

- ☑ Desk-top study and literature review
- ☑ Spreadsheet tool to capture knowledge
- ☑ Information package available to those designing barriers

- Lab testing of design criteria
- Maintain feedback into these ‘live documents’

Contacts

Sjaan Bowie

sjaanbowie@doc.govt.nz

Freshwater Technical Advisor

Dave West

dwest@doc.govt.nz

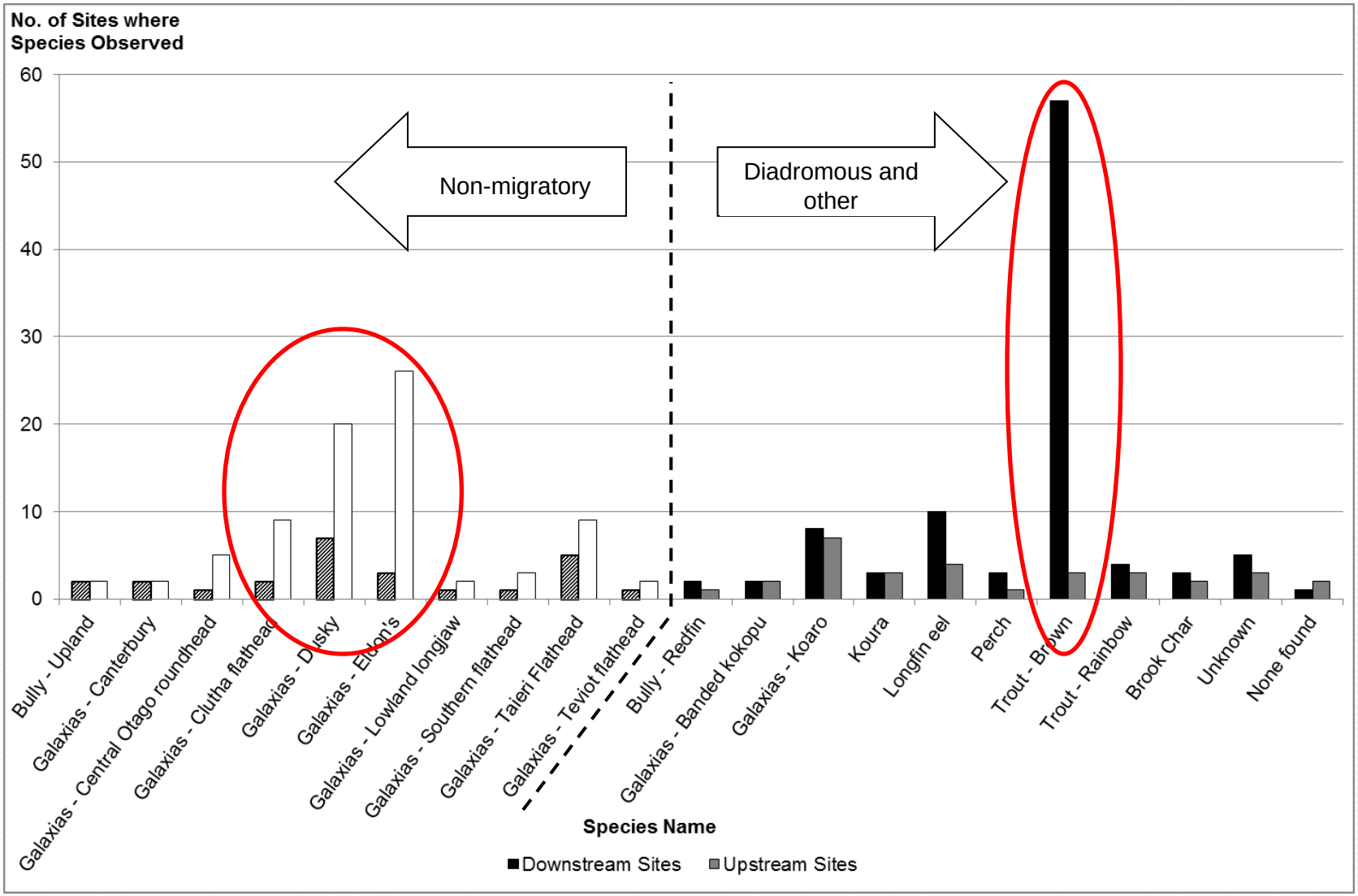
Freshwater Science Advisor

Department of Conservation

Science and Capability, Freshwater Team

Questions?

Species' response to barriers



Waterway Barriers - Design Review

DESIGN CONSIDERATIONS

This spreadsheet provides a checklist of factors that should be considered in the design of a physical built waterway barrier.
Also included is a checklist of hydrological field data, which, if it can be obtained, will help focus the design decisions and reduce the risk of the barrier not performing as expected.

Waterway Hydrology

	Define the design flood that the barrier is required to pass without being compromised	*Need to ensure barrier will not be compromised at higher flows, through undermining of barrier, overturning, scour and washout of the abutments*
	Define expected flood characteristics at this design flood: stream flow, stage height, flow paths in vicinity of barrier, level of debris	
	Is barrier location in hydrologically stable reach?	*Minimises the effects of the barrier on the sediment transportation within the stream, i.e. a hydrologically stable reach will not alter its profile, aggrade or degrade over time*
	What is the expected profile of the upstream backwater, i.e. how much ponding is expected upstream of barrier and what area will this cover?	*This can be positive in terms of providing addiitonal upstream pool habitats, or can be negative due to desired riffle habitat being drowned out, stagnation of water (reduced DO levels), raising of localised groundwater table (in neighbouring land) and flooding of dry land.* *Consider if barrier is at outlet of lake, then will raising effect of water level create an alternative outlet at another low point along the lake edge?*
	Is there possibility of the barrier being drowned out due to downstream obstruction or flooding?	*Consider the barrier's proximity to other obstruction features*
	What is the expected reduction in water flow downstream of barrier?	*May cause degradation of habitat during low flow periods*
	Define the cross-sectional profile of the stream at barrier site	*How does the waterway behave at different flow levels? What physical features need to accounted for in the design of the barrier abutments and base?*
	What is the expected sediment load in the stream?	*Settling out of sediment in upstream pool created by barrier will need to be managed in the long term. Also, consider whether silt or coarser sediments filling in gaps in barrier surfaces could creating issues (e.g. increased splash zone allowing climbers more access, smoother surfaces (changing surface texture))*
	How will expected hydrological changes affect the wider community balance, including macrophytes?	*Invasion of macrophytes, for example, could be detrimental to the species to be protected*
	Include in the design criteria any expected future change in hydrological regime	*Designing for the future. Historical data provides a baseline but expected future changes must also be incorporated into the design criteria.*

Species to be Protected

	Do they need to be able to climb past barrier as part of their migratory lifecycle?	*These factors contribute to design choices for overhang details and upstream face slope (affecting upstream pooling and riffle habitat)*
	Availability of habitat that species require	
	Interchange/connectivity needed to maintain healthy population	*Consider whether isolation of species may contriubte to inbreeding effects or decline in numbers*

Design considerations include

Location and reach profile	Response to varying flows	Upstream effects
Downstream effects	Sediment	Erosion protection
Dimensions and crest profile	Foundations and connections	Habitat health

Other Built Barriers

Effectiveness of Barrier	Barrier Type				Total
	Weir	Screened Barrier (includes gabions)	Culverts	Other	
Effective	5	3	1	1	**10**
Not effective	1	2	0	0	**3**
Unspecified or unconfirmed	11	4	2	2	**19**
Total no. of each type	**17**	**9**	**3**	**3**	**32**

Design considerations include:

Construction Enabling Works

- Temporary diversion
- Clearance of vegetation
- Bank reshaping, bunding
- Sediment control

Commissioning

Shaw Creek Barrier, VIC, Australia
Photo: Tarmo Raadik, 2012

Before:

After:

Non-physical Built Barriers

- Air bubble curtains
- Acoustic
- Electric
- Light
- Chemicals

Hydrological focus = Physical barriers