Fish passage at water intake infrastructure

Fish Passage Restoration Symposium, 27th November 2013

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What is a water intake?

- Consent by consent basis
- Limited best practice/ guidance

What is the problem?

•Deterioration or loss of habitat

•Diversion into unscreened or poorly screened intakes (entrainment)

•Physical damage on poorly operating screens (impingement)

Background

- Received considerable research overseas

- Limited NZ research
  - Fish lost proportional to flow abstracted
  - Fish salvage

  Extreme example:

  - >200,000 salmon juveniles & 2,500 trout lost each season in one unscreened take
  - Significant losses of native fish

Multi-agency water intake working party

2005

Environment Canterbury convened a group

Fish & Game NEW ZEALAND

Environment Canterbury Regional Council Kaunihera Taiao ki Waitaha

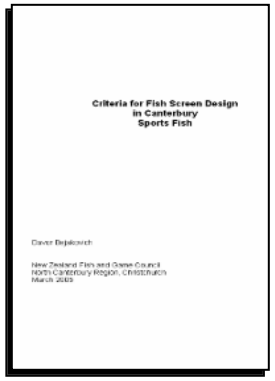
IRRIGATION NEW ZEALAND

Department of Conservation Te Papa Atawhai

Funding was gained
Used knowledge and local experience

2007

Reviews - sports and native fish
Production of the guidelines



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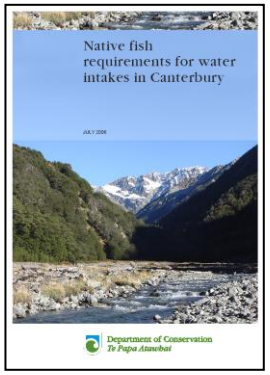
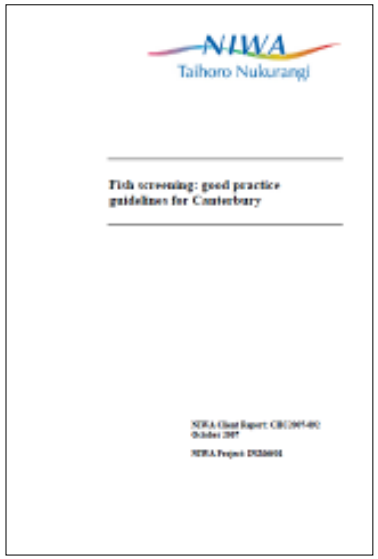


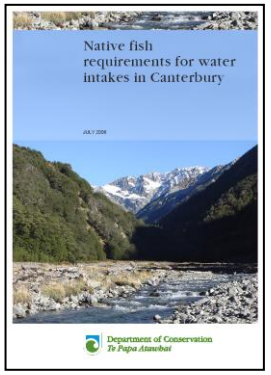


- Review
- 7 criteria
- Good practice examples

Species found in Canterbury

Biological characteristics

Size	Migration	Swimming ability
Lifecycle	Water column movement	
Habitat		



Key parameters identified that would protect freshwater fish:

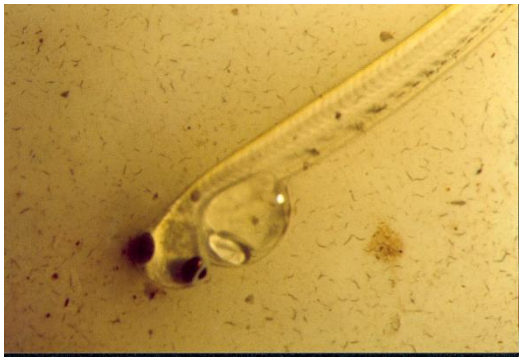
- Structure placement
- Water velocity requirements at intakes
- Effective bypass and escape routes
- Maximum screening material opening size
- Monitoring and maintenance

Species of concern

Sports fish

Chinook salmon, brown & rainbow trout

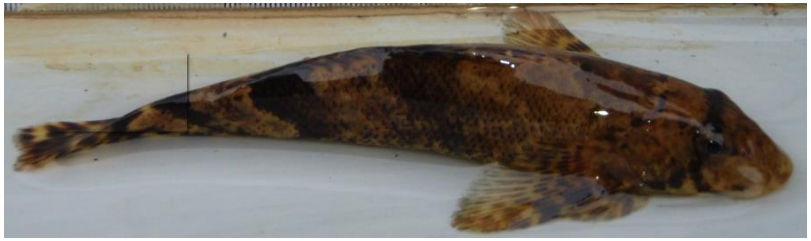
Juveniles & post spawning fish



Migration of spawning adults

Native fish

Migrating juveniles



Migrating larvae

Migrating juveniles

Threatened resident larvae & juveniles

The Criteria

- At, or as close as practical to, the point of water diversion from the main stem (Location)
- Approach velocity (<= 0.1 ms^{-1})
- Sweeping velocity =/> approach (>0.5 ms^{-1}).
- Effective escape route (bypass) ensuring fish return undamaged (connectivity).
- Max. screen material opening size of 2-3 mm
- Effective maintenance and operation

Jamieson, D., Bonnett, M, Jellyman, D & Unwin, M. 2007: Fish screening: good practice guidelines for Canterbury. NIWA Client Report CHC2007-092

Design Criteria – **Location**

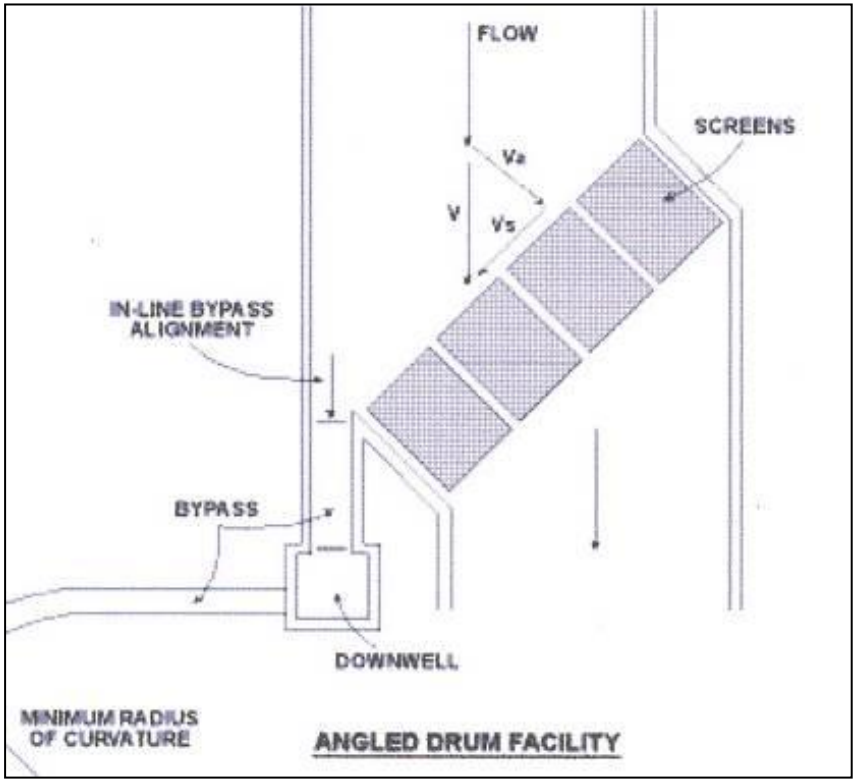
- Variety of habitats
- Species composition varies
- Some species migrate throughout freshwater catchments
- Fish use different parts of the water column at different life stages

Positioned flush with the banks of the river or as close as possible to the water intake

Design Criteria –
Approach and Sweep Velocity

- Approach velocity has to match swimming ability (sustained speed) of the weakest fish to encounter the screen.

- Sweep velocity has to be higher than approach velocity (at least twice) to minimise exposure of the fish to the screen face.



	Approach Velocity	Sweep Velocity
Native fish - general	**<0.3ms-1**	**>0.5ms-1**
Native fish – important spawning or migration pathway	**≤0.1ms-1**	
Sports fish	**0.12ms-1**	**>0.24ms-1**

Approach velocity of <0.1 ms^{-1}

Sweep velocity of >0.5 ms^{-1}

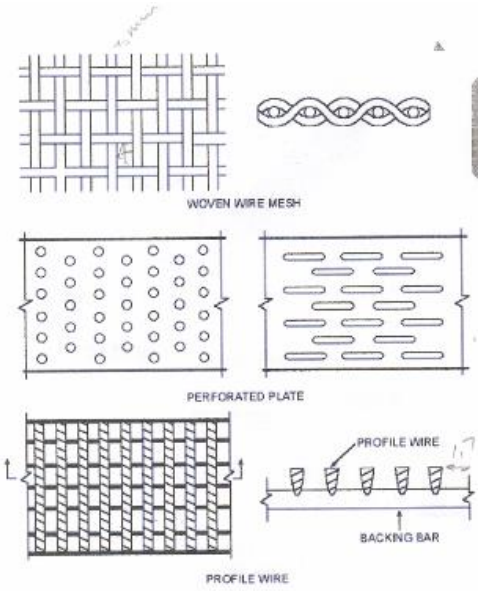
Design Criteria – **Bypass and Connectivity**

- Bypass entrance easy to find
- Downstream end of the intake, ideally in the cleft formed by the screen & bank
- Excluded fish need unimpeded passage/diversion back to the mainstem

Design Criteria –
Screen Material Opening size

	Minimum fish size
Native fish	3-20mm
Sports fish	25-30mm

GROUP	MESH SIZE (MM)	PROFILE BAR	PERFORATED PLATE
Native larval fish	0.3		
Whitebait (banded kokopu, inanga), common bully, shrimp	2.0		
Canterbury mudfish	2.0		
Glass eels/elvers	1.5		
Eels (adults)	20-25		
Sports fish	3	2	3.2



2-3 mm best

Design Criteria – **Maintenance and Monitoring**

- Regular
- 24 hours a day - fish are moving within waterways at all times.

Monitoring Outcomes

- Effectiveness of the screen system in preventing fish entrainment
- No.’s of fish impinged/ entrainment during peak migration periods
- Ensuring unimpeded fish passage

2008

- **Public meetings**

2010-now

- **$ for field trials**
- **Trials currently being undertaken**

Sustainable Farming Fund
Ministry of Agriculture and Forestry
Te Manatū Ahuwhenua, Ngāherehere

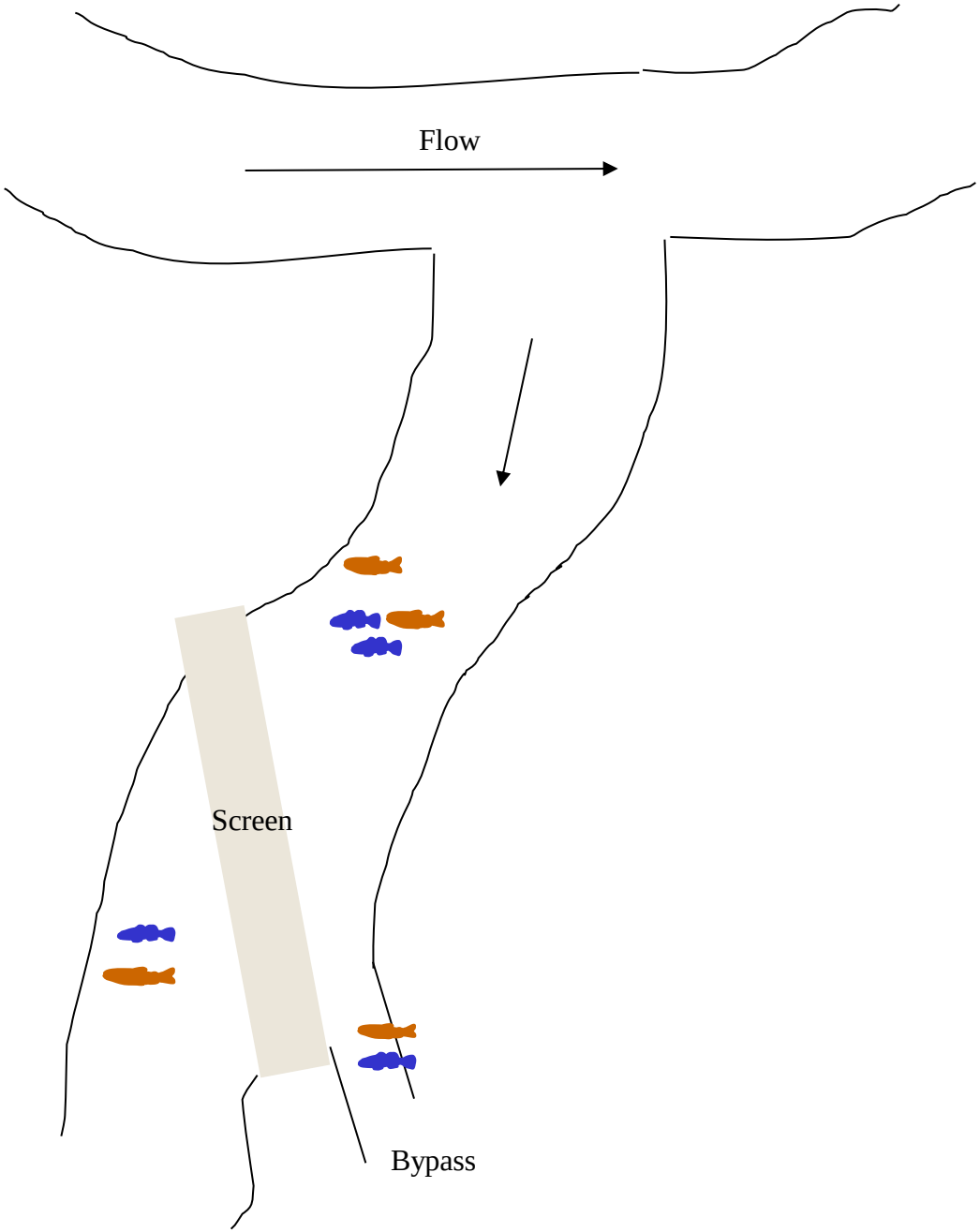
Key Outputs

- **Update of NIWA guidelines**
- **Check list to monitor effectiveness of intakes using the 7 criteria**

Trials

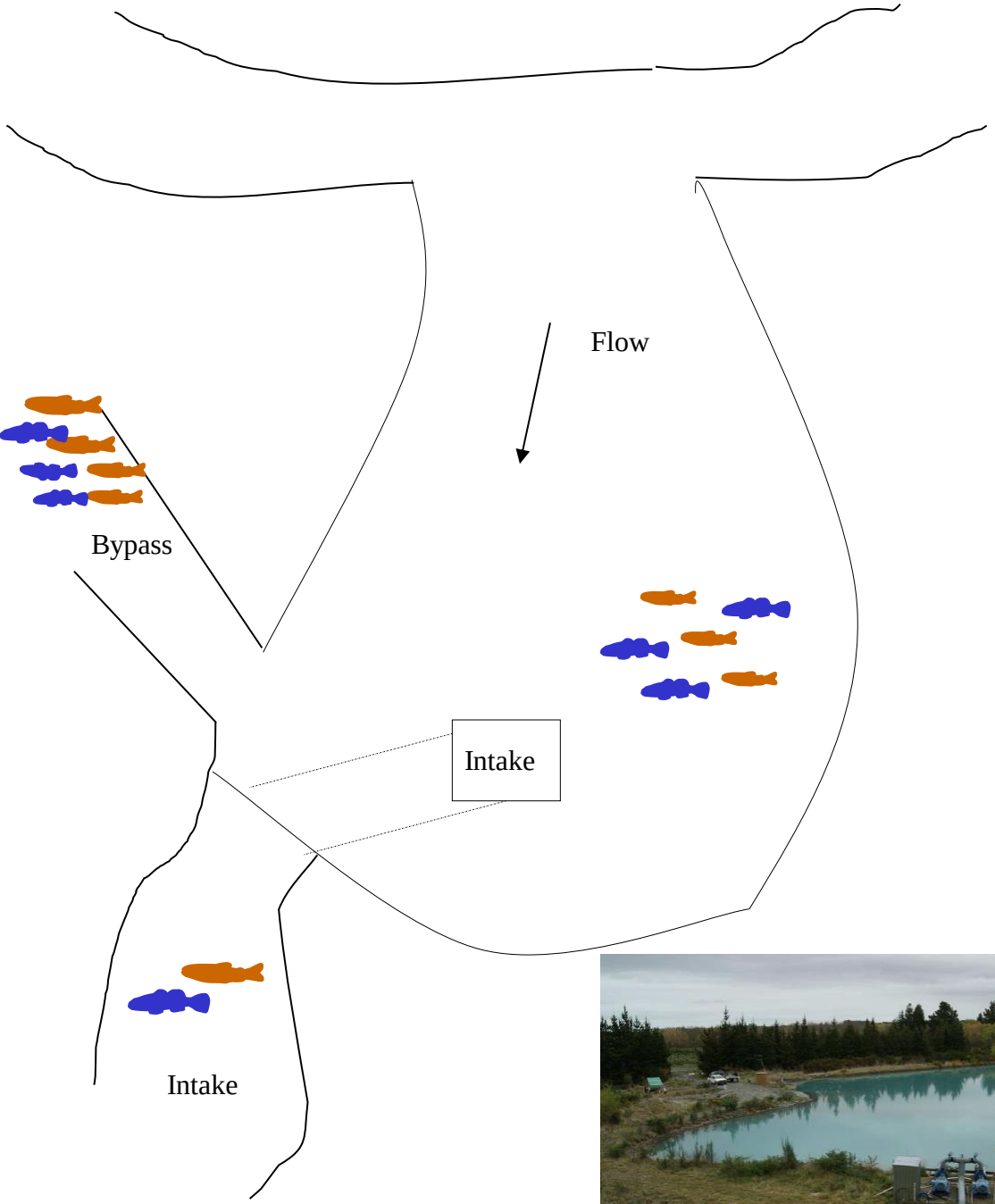
- No water intake meets all 7 criteria
- Pre-fish intake and bypass
- Release fish (salmon and trout)

Flat plate screen



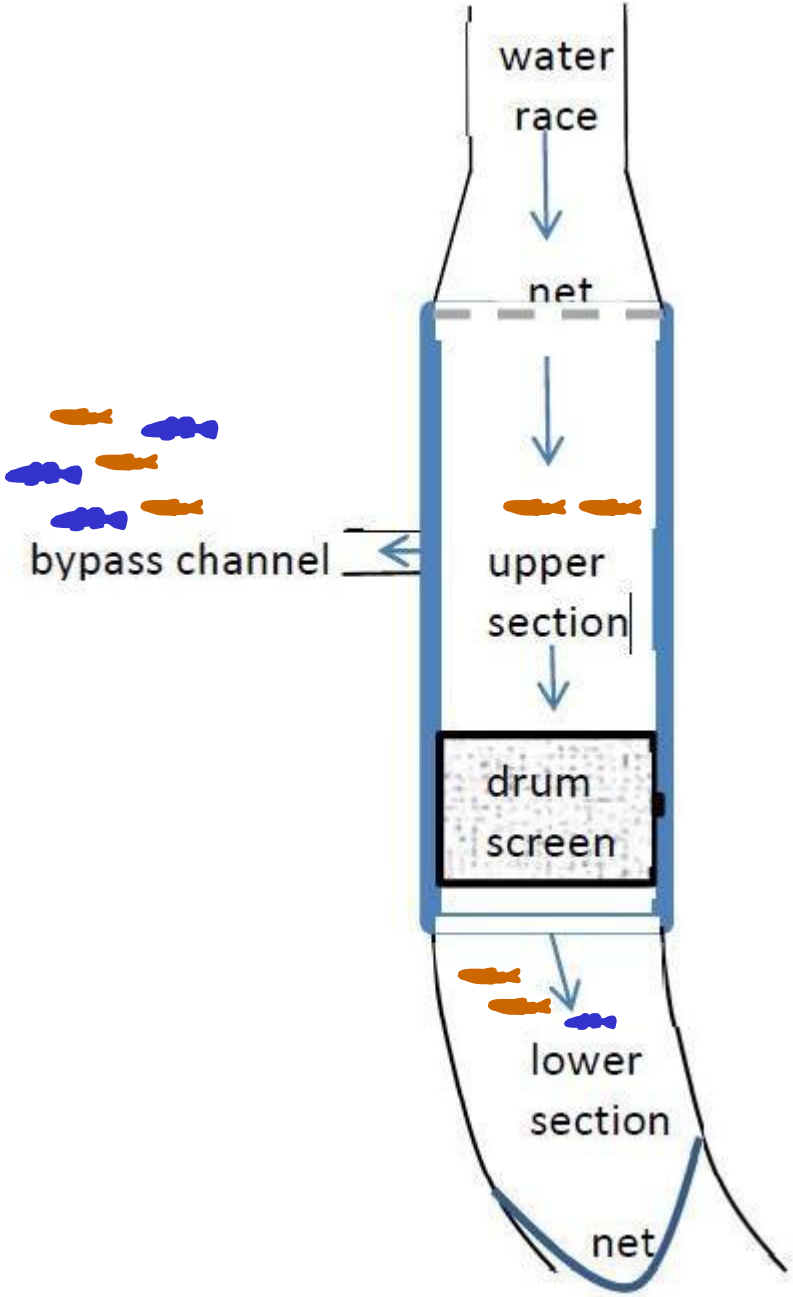
Criteria	Criteria present	Result
Location	Y	👌
Approach velocity	Y	👍
Sweep velocity	Y	👎
Bypass	Y	👍
Connectivity	Y	👍
Screen material opening size	Y	👎
Maintenance and Operation	Y	👎

Infiltration gallery



Criteria	Criteria present	Result
Location	**Y**	👍
Approach velocity	N	
Sweep velocity	N	
Bypass	**Y**	👍
Connectivity	**Y**	👍
Screen material opening size	Y	Gravel
Maintenance and Operation	Y	👌

Rotary Drum



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Bypass	Y	👍
Connectivity	Y	👎
Screen material opening size	Y	👎
Maintenance and Operation	Y	?

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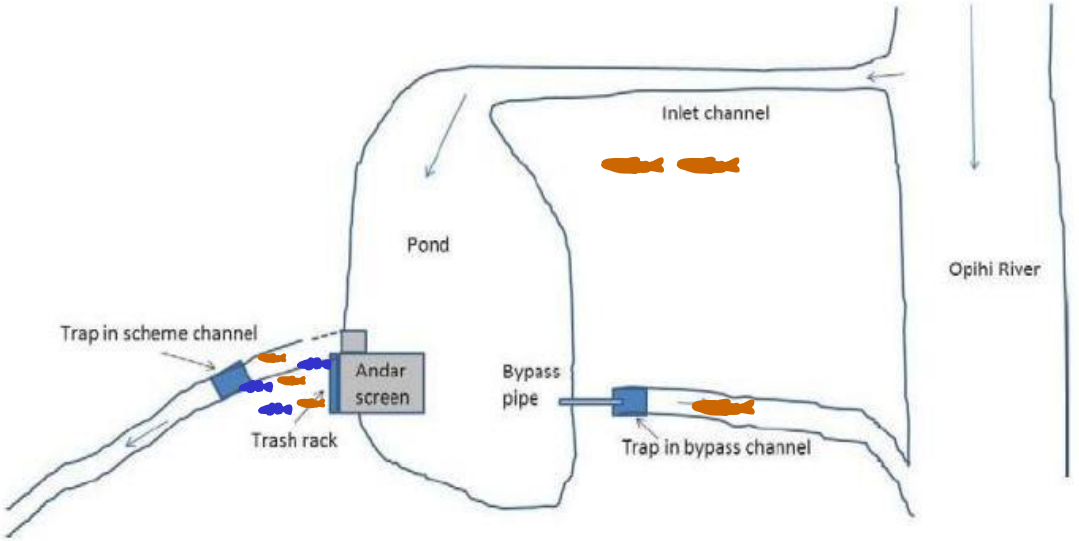

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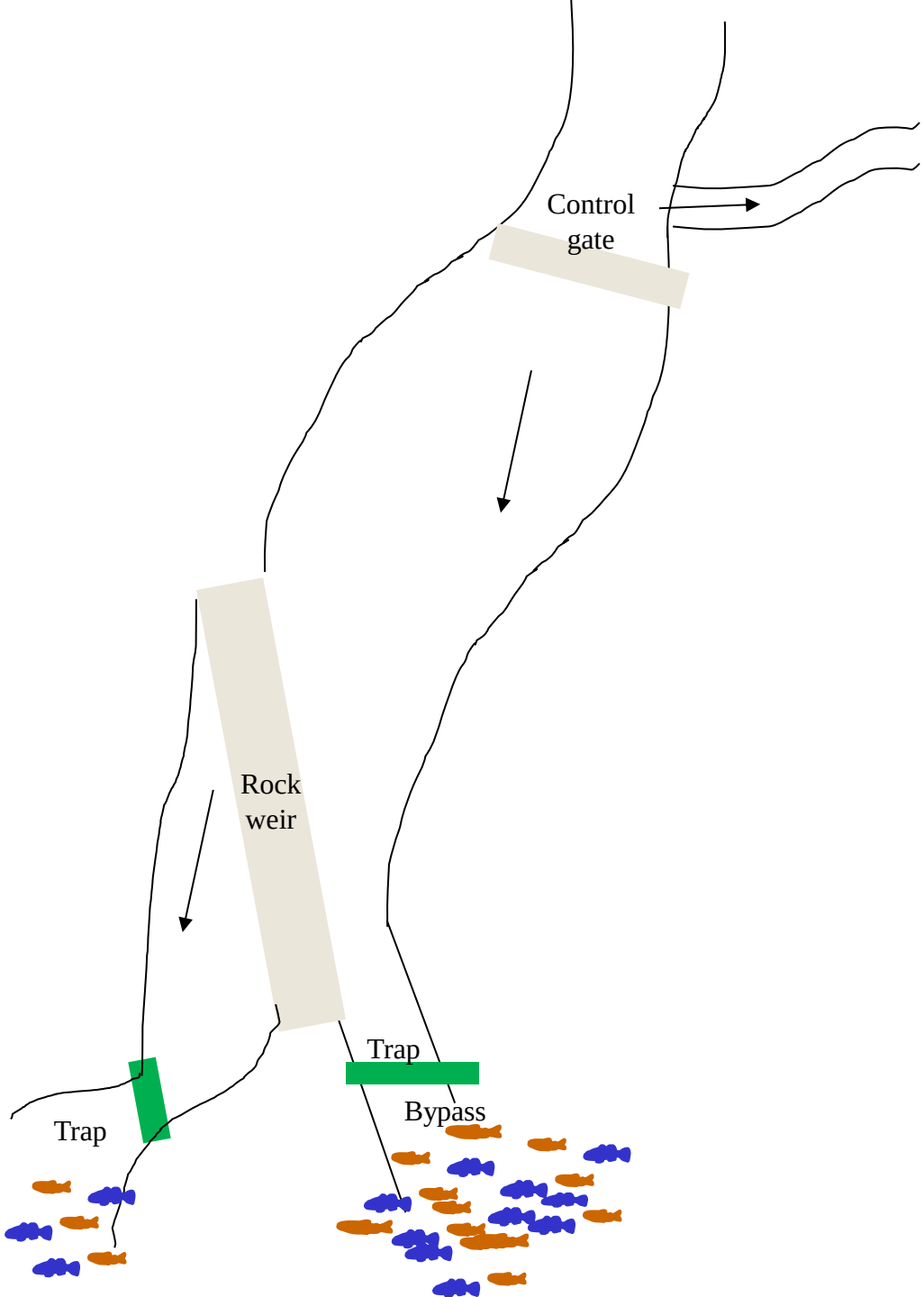
Bypass	Y	👎
Connectivity	N	👎
Screen material opening size	Y	👍
Maintenance and Operation	Y	👌

Rock Groyne Intake/ Permeable Weirs



Criteria	Criteria present	Result
Location	Y	👍
Approach velocity	Y	?
Sweep velocity	Y	👍
Bypass	Y	👍
Connectivity	Y	?
Screen material opening size	Y	?
Maintenance and Operation	Y	👍

Summary

- Know the values of the area
- Consider 7 key design criteria
- Water intakes can be designed to protect fish

http://www.irrigationnz.co.nz/irrigators/fish-screens/

Acknowledgements

• Sustainable Farming Fund
•Water Intake/Screening group (Irrigation NZ, ECan and Fish & Game)
•NIWA

Department of Conservation
Te Papa Atawhai