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Performance of Australia's first brushed conical fish protection screen at a large irrigation pump diversion

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The Murray-Darling Basin

- "Food bowl" of Australia
- Producing almost all of Australia's rice and cotton
- High amounts of crops, livestock, and horticulture
- ~1/3 of the annual agricultural production in the MDB is irrigated
- About 13.6 billion litres annually (Water Act 2007 – Basin Plan, 2012)

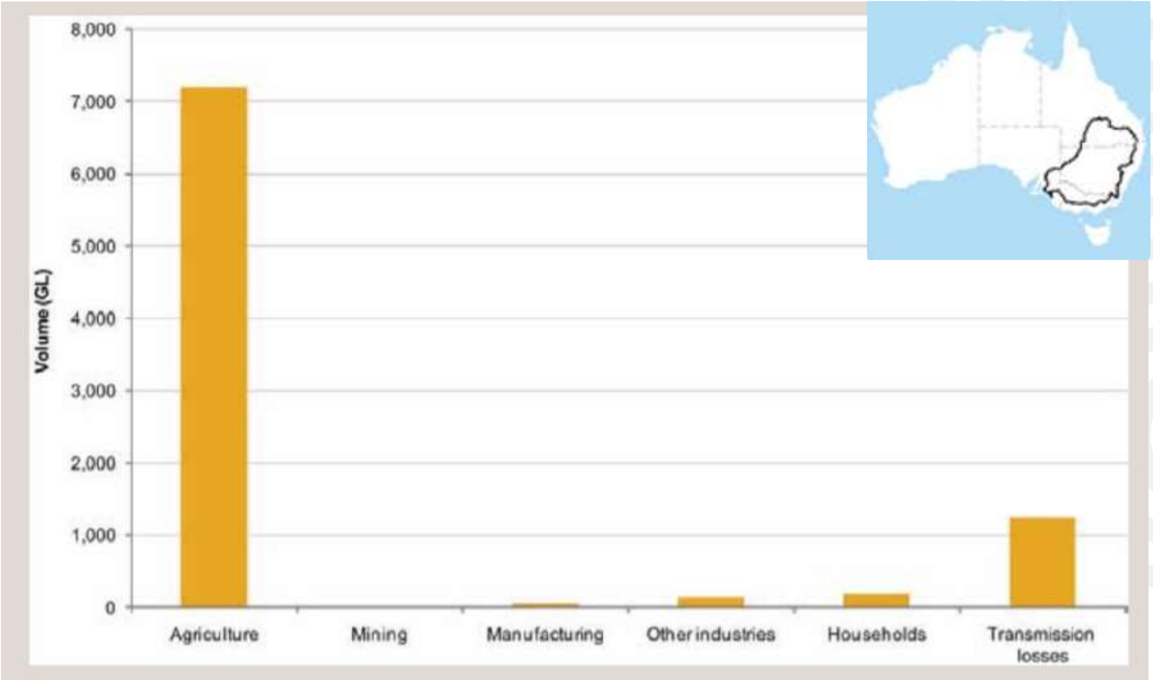
www.abc.net.au

Irrigation practice in the Murray-Darling Basin

- Gravity-fed & pump diversions
- Direct impacts on aquatic organisms and populations

Pump diversions

Gravity-fed diversions



Consumptive water use in the MDB 2005-2006 (ABS, 2008)

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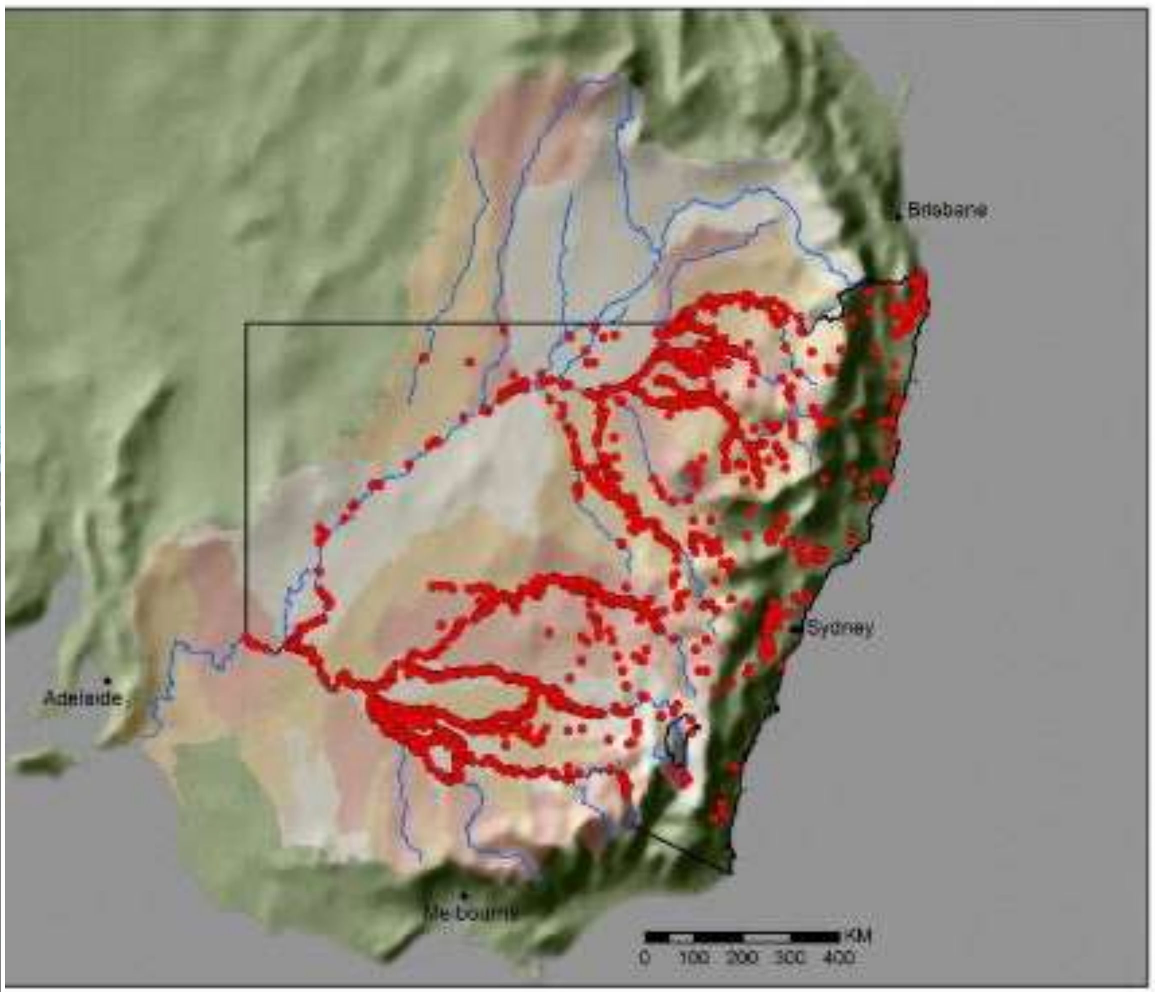
Irrigation practice in the Murray-Darling Basin - New South Wales

- NSW alone has more than 4500 irrigation pumps
- Millions to billions of native fish in 3 months each year

www.abc.net.au



C. Boys

Fish declines in the Murray-Darling Basin

- 21 rivers with at least 46 native fish species
- Endemic species
- Several threatened species
- 11 non-native fish species
- Decline of native fish abundance and diversity to 10% of pre-European settlement populations – in 2020 further declined

(Lintermans, 2013; Cottingham, 2020)

Irrigation diversions and fishes

- The majority of Australian irrigation channels have inappropriate habitat & unsuitable conditions
- Fish are more exposed to predators (including fisherman)

Irrigation diversions and fishes

- Water diversions disrupting flow-dependent fish ecological aspects (spawning, recruitment, altering habitats)
- Extraction from river systems:
  - killed directly by physical damage
  - killed indirectly through stranding
- All life stages are affected

L. Baumgartner

(e.g. King & O'Connor, 2007; Baumgartner *et al.*, 2009, Baumgartner & Boys, 2012, Boys *et al.* 2021)

Fish protection screens


www.wenatcheeworld.com

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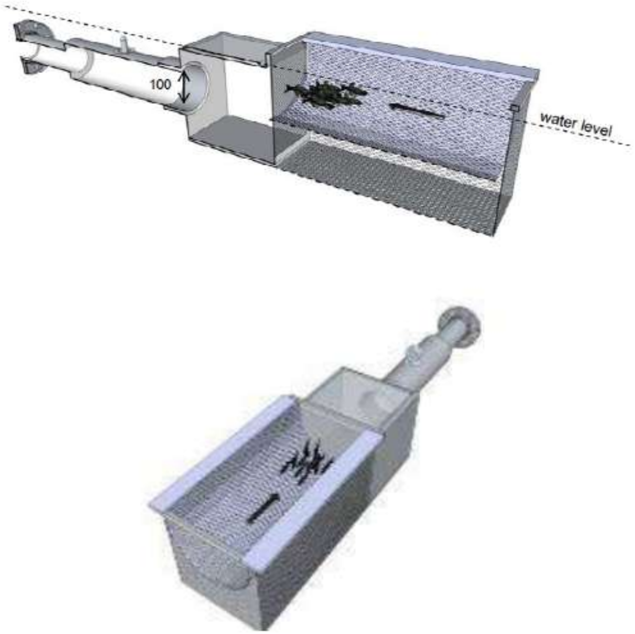
www.peekdesigns.com.au

Fish protection screens in Australia

- Development of a screen (Screen type, mesh material, mesh sizes) depends on
  - the river (flow, sediment, debris)
  - its fish community/target species
  - position and outtake type

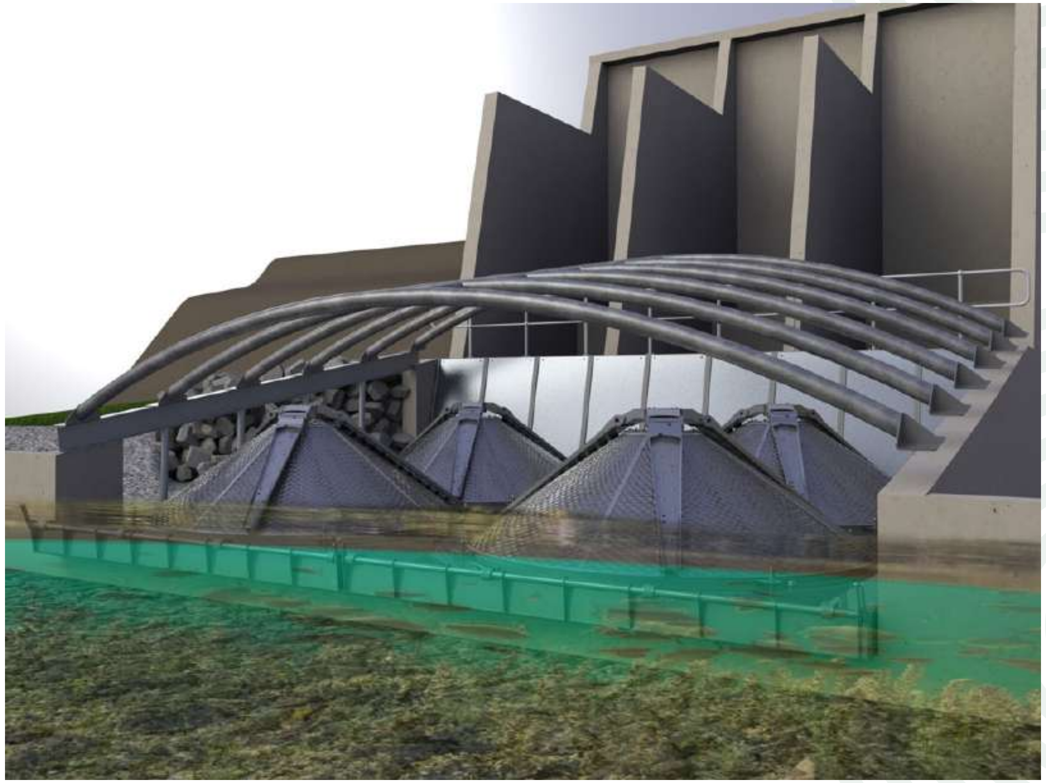
- Optimizing velocity more important than construction material



Boys *et al.* (2012)

Macquarie River cone screen at Trangie (AWMA)

The first large fish screen in NSW and "Australia's largest showcase of modern pump screening designed for fish protection”. (AWMA Water Control)



www.awmawatercontrol.com.au/

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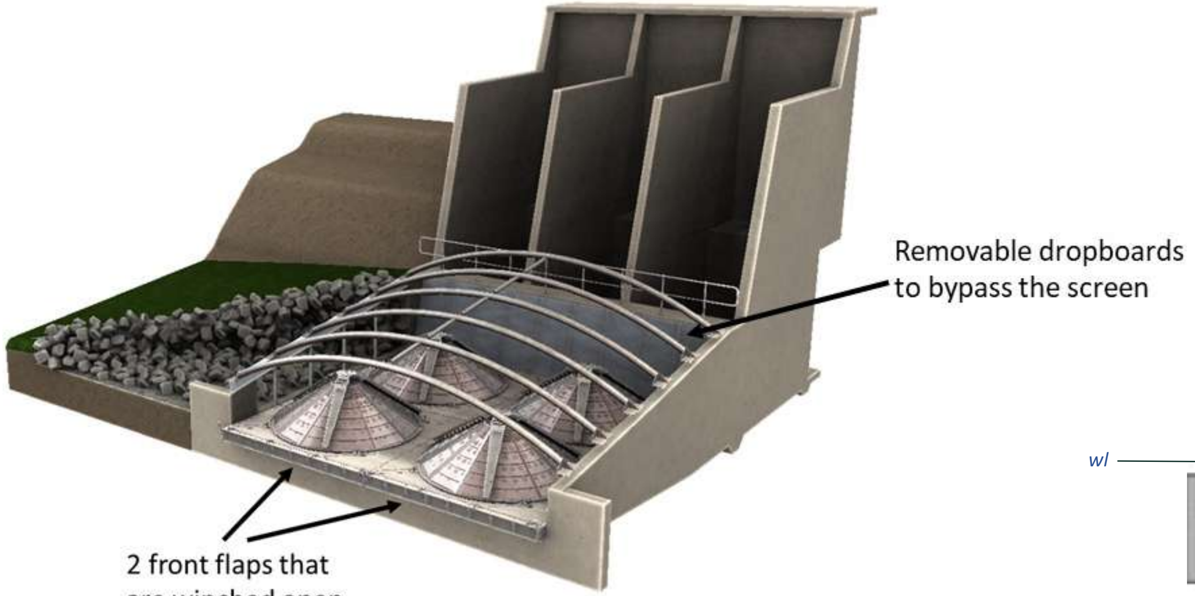
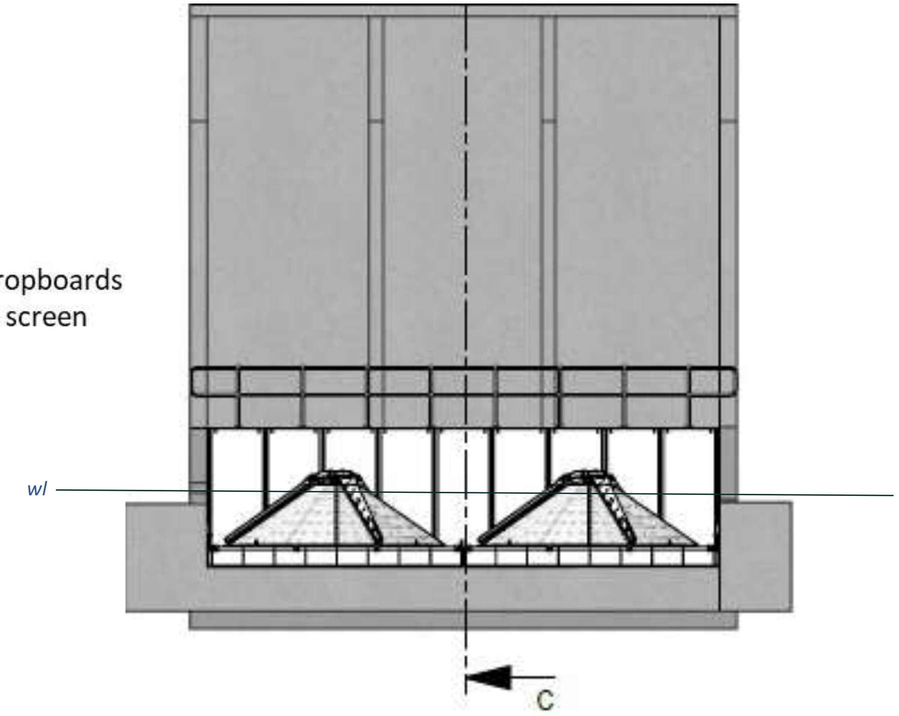
Macquarie River cone screen at Trangie (Australia, NSW)

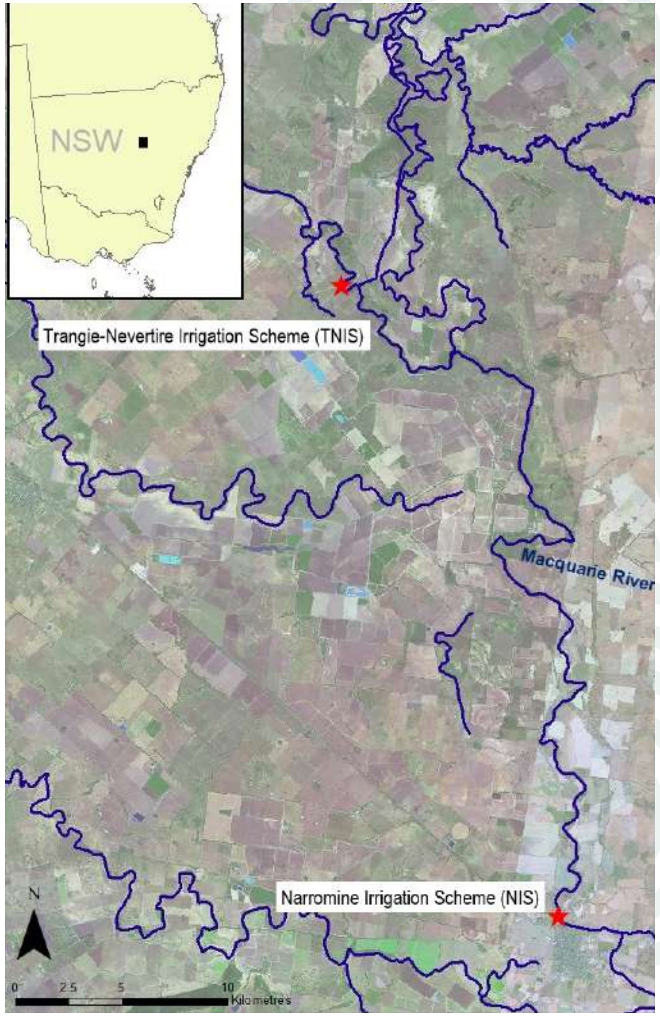




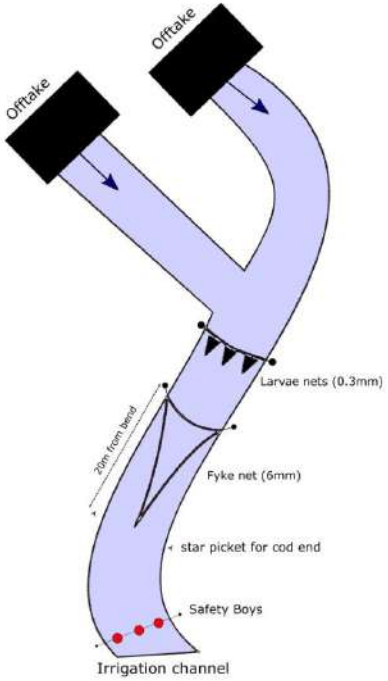
www.awmawatercontrol.com.au/

Unscreened reference Site: Narromine (NIS)

- Eight electric pumps
- Combined maximum pumping capacity of about 1000 ML/Day
- During sampling ~112 ML/day



Irrigation channel sampling



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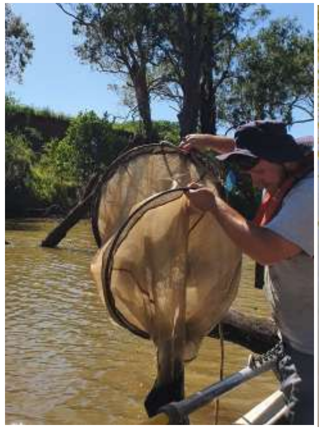
River surveys

- Boat electrofishing
- Seine
- Bait traps
- Larval drift nets



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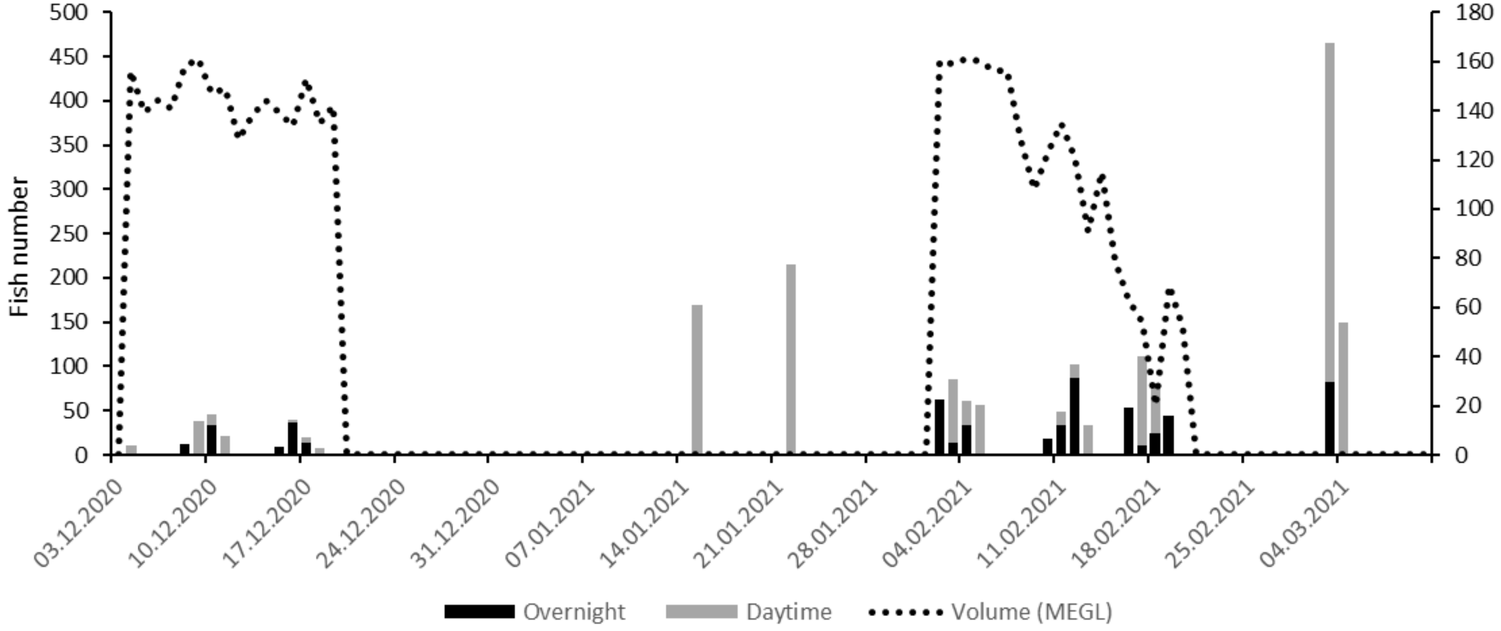
Results – NIS 2020/21 (unscreened)

- 1959 fish of eleven species
- 0.43 fish per ML (Fyke)
- 3.2 larvae per ML (Larval drift nets)
- No difference for night/day sampling



*including clearances when pumps off using electrofishing and seine netting

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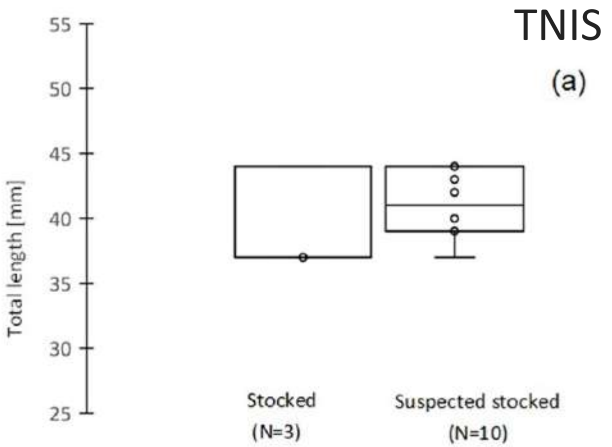
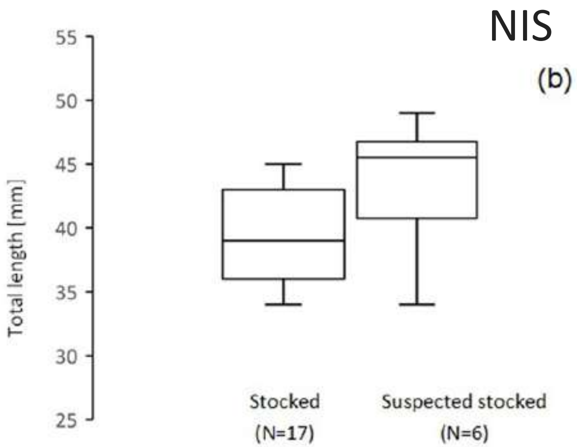
Results – TNIS 2020/21 (partially screened)

- 294 individuals (150 in larval nets) of eight fish species
- 0.04 fish per ML (Fyke)
- Screened data biased
- General low entrainment rates (Flap slot?)

Stocked Murray cod





Site	Sampled total [No]	0- 24 h after stocking event [No]	24- 72 h after stocking event [No]	DNA analysed [No]	Known stocked fish (one or two parents identified) [No]	Suspected stocked without DNA correlation [No]	Proportion tested/DNA identified stocked fish [%]
TNIS	18	11	3	13	3	10	23.1
NIS	30	27	2	23	17	6	73.9

Eel-tailed catfish (*Tandanus tandanus*)

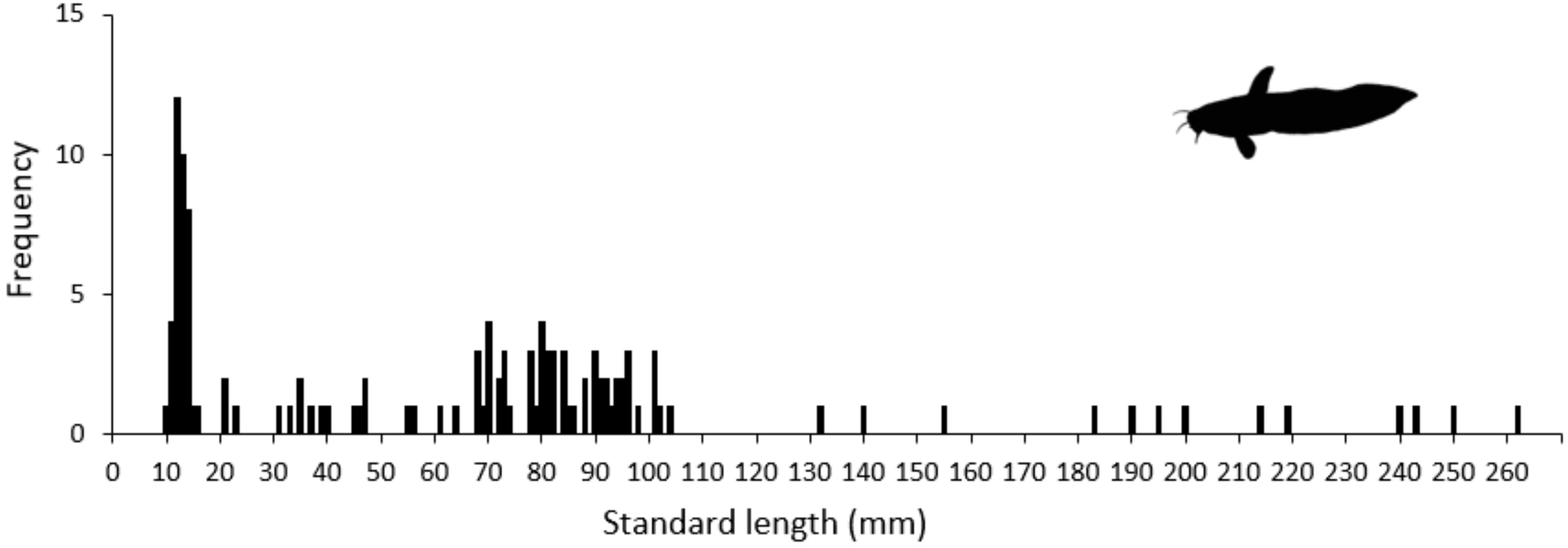


Figure 6: Length distribution of all measured entrained Eel-tailed catfish (*Tandanus tandanus*), sampled in the partially screened-unscreened treatment in TNIS (N=124) 2020/21

Results – TNIS 2022 unscreened

- 1641 individuals of six species
- 0.9 Fish per ML (Fykes)
- Catch was dominated (96.6%) by Flathead gudgeon (*Philypnodon grandiceps*)
- Significantly higher entrainment rates during night sampling (1.4 fish/ML) than day sampling (0.1 fish/ML) (Wilcoxon, P=<0.001)

Results - TNIS 2023 screened

- 67 individuals of 6 species
- 0.03 fish per ML (Fykes)
- 96.67% less fish per ML than 2022 (unscreened)
- Fish mean lengths were significantly larger compared to completely unscreened treatment (Wilcoxon, p=<0.001)
- Two species not sampled in the channel before
- No stocked Murray Cod (Despite stocking taking place during sampling)

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Results

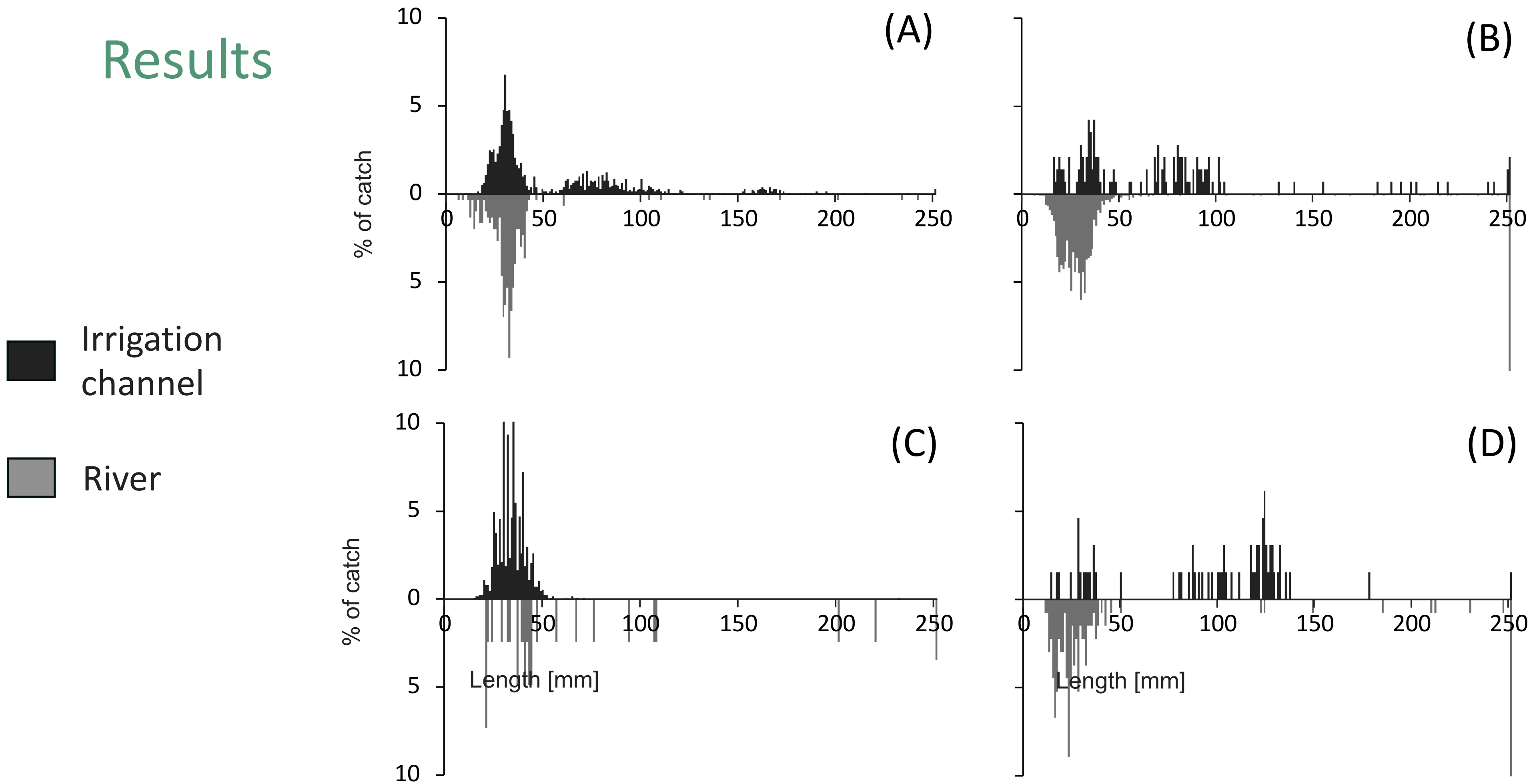

Figure: Length frequency distribution of sampled fish from 0 to >250mm in the irrigation channels (top, black) and the related river sites (bottom, grey) in (A) NIS, (B) TNIS 2020/21 (partially screened-unscreened), (C) TNIS 2022 (unscreened) and (D) TNIS 2023 (screened).

How did the larger fish get in the channel?

How did the larger fish get in the channel?

Conclusion

- Unscreened: Entrainment of different fish species in all life stages
- Screened: Results imply significant reduction of entrainment
- Efficient tool to protect native species
- Stocking improvement
- Further research: early life stages (larvae, eggs) & large scale effects
- Radom block design unsuitable
- River flows need to be considered

Acknowledgements

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  - Field assistance & support: Karen Arnold, Andrew Bruce, Anthony Fowler, Patrick Martin, Chris Keogh, Michael Rodgers, Jerome Stocks, Justin Stanger, Patrick McSweeney,
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All literature and picture sources used in this presentation on request (jbretzel@csu.edu.au)