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Fishways: Restoring Fish Migrations

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Sydney 2nd August, 2018

Harris Research

Recreational Fishing Trusts

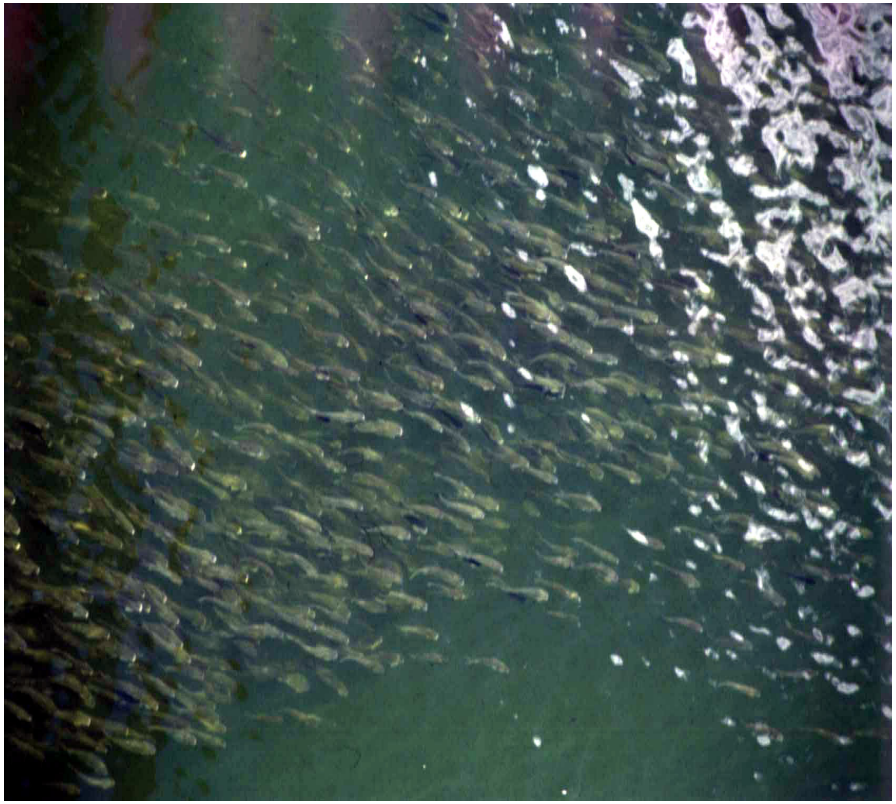
Fish migration, fish passage

- **Migration ecology** – why bother moving?
- **Examples** – coastal and inland, climbers, etc
- **Migration barriers** – physical, physiological
- **Solutions** – avoid problem, remove barrier, build fishway
- **Fishway performance** and fish rehabilitation
- **Innovation and development** – UNSW Pump Fishway

Migratory adaptations – leaping

Atlantic salmon, Finn River, Ireland

Migratory adaptations – Australia

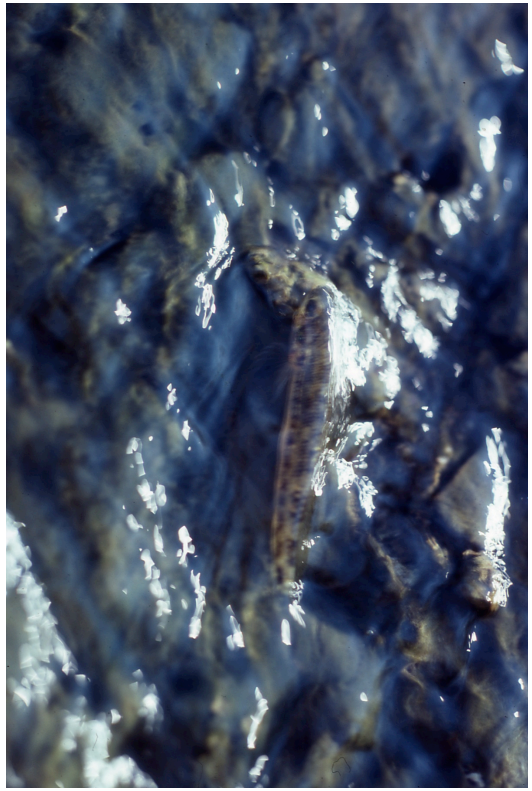


Striped mullet schooling for spawning migration

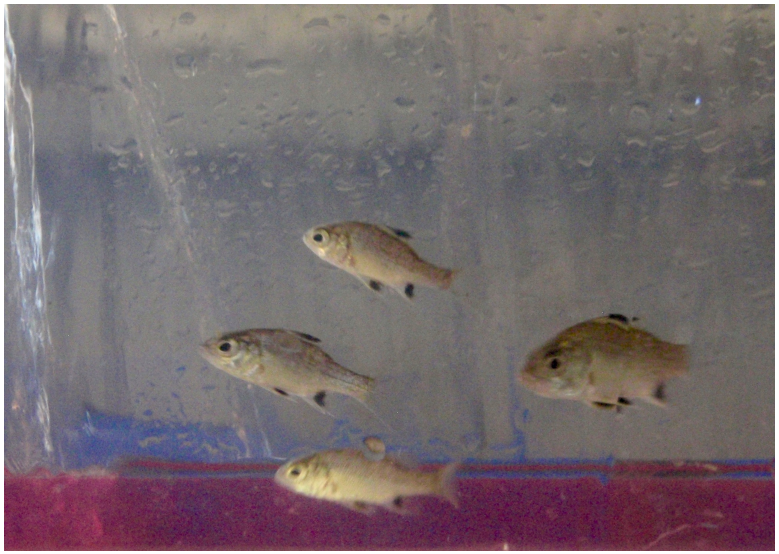
Road-running Spangled perch

Migratory adaptations – climbers etc.

Ellenborough Falls – 200m



Cox's gudgeons, Penrith Weir



Tidal gravity Circulation – bass juveniles

How many migratory fish species?

Most, probably all, freshwater fishes migrate

- **diadromous** species
  - anadromous (breed in fresh)
  - catadromous (breed in salt)
  - amphidromous (a bit of each)

- **Potamodromous** species
  - whole life cycle in freshwater

Migration ecology – why bother moving?

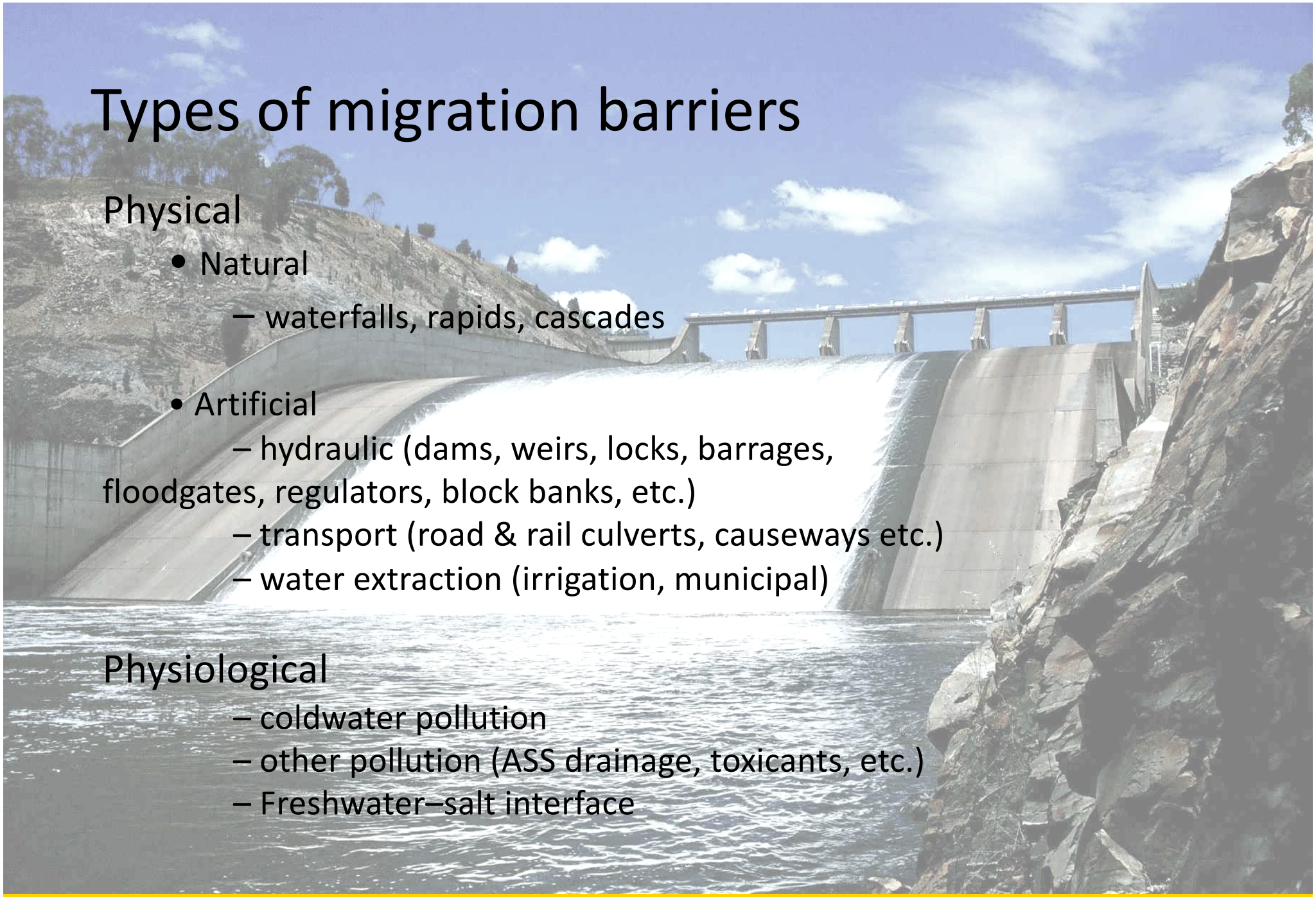
Population dynamics & viability

- reproduction, recruitment
  - – places for spawning, nursery
- growth
  - – food, space, habitat
- survival
  - –dispersal, resilience

Versus:

Costs of moving

- energetics
- mortality risks
  - – predation, starvation, disease



Types of migration barriers

Physical

- Natural
  - waterfalls, rapids, cascades
- Artificial
  - hydraulic (dams, weirs, locks, barrages, floodgates, regulators, block banks, etc.)
  - transport (road & rail culverts, causeways etc.)
  - water extraction (irrigation, municipal)

Physiological

- coldwater pollution
- other pollution (ASS drainage, toxicants, etc.)
- Freshwater–salt interface

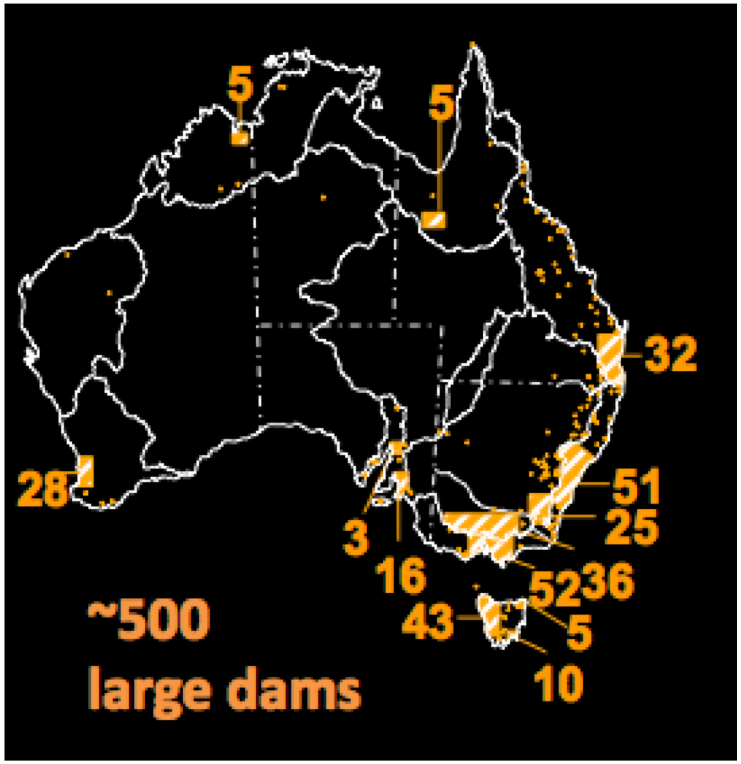
Scope of the problem:

~ 50,000 dams > 15m globally

– 500 Australian dams > 10m

~ 10,000 Murray-Darling artificial barriers

~ 10,000 NSW artificial barriers



Effects of migration barriers

- Population declines (76% global, ~ 90% in Murray-Darling)
- Local extinctions upstream of barriers
- Threatened species (30–50% Australian FW fishes)
- Reduced aquatic biodiversity
- Water-quality changes
- Reduced fisheries values
- Ecological, cultural, hydrological impacts of river impoundment

Solutions and mitigation

- Avoid the problem
- Remove the barrier
- Build a fishway

Removing barriers to fish passage

Fish need to move through a range of different habitats to complete their lifecycle. Australian Bass, for instance, move down to the estuaries and spawn during winter. Adults and juveniles then move back upstream to freshwater reaches of coastal rivers.

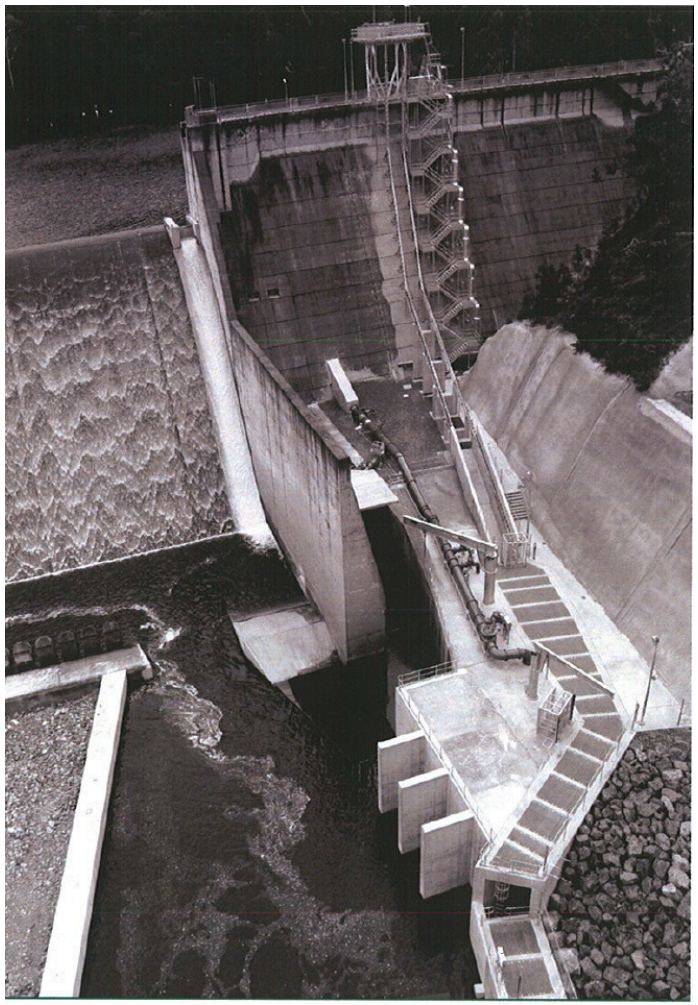
Unfortunately, these upstream migrations can be blocked by barriers such as dams, weirs and poorly designed road crossings. When caught downstream of a barrier, fish are vulnerable to predation by birds and larger fish and blocked from accessing preferred habitat.

First fishway, Penrith Weir ~ 1927

Torrumbarry fishway, 1990's

Mitigating fish-passage problems

- **Major improvements over 30+ years**
  - NSW Fisheries' research investments
  - identified problems, developed designs
  - collaboration with water agencies
- **Fishways performance**
  - ideal performance standards not yet achieved
  - challenges of Australian biota
  - engineer/biologist collaboration
  - high-level barriers are special problems
- **Fishways costs**
  - capital & operational costs too high
  - impeding widespread rehabilitation



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Funded by NSW Recreational Fishing Trusts

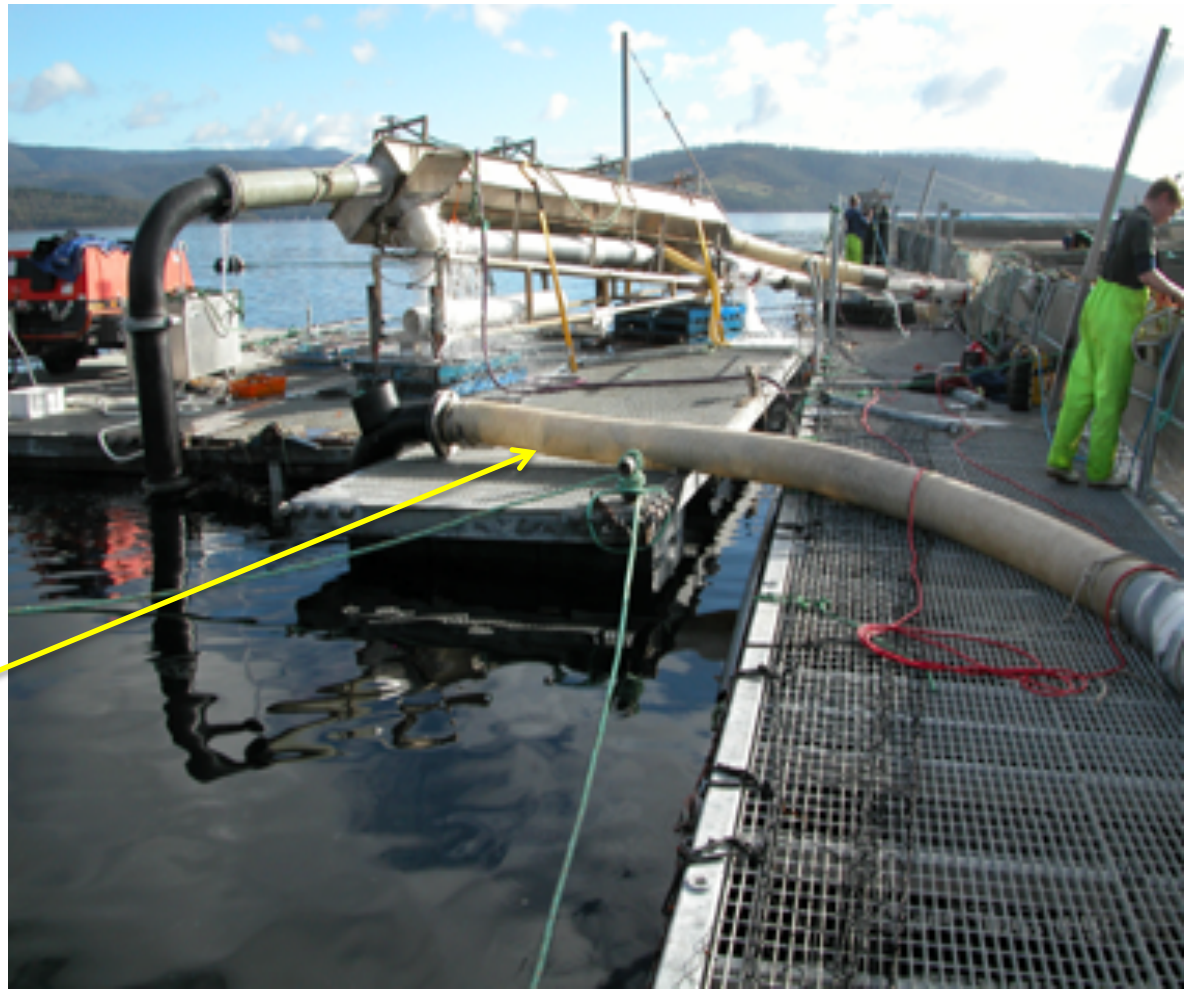
Pump Fishway Principles & Objectives

- Design a better, cheaper upstream fishway
- Optimize all passage stages – **attraction, entry, passage, refuge**
- Combine fishways & aquaculture methods
- Reservoir's hydraulic head provides flow & independent energy

Commercial Fish Pump in Operation

Tassal Salmon Farm, Bruny Island, Tasmania

- Airlift pump relocating & grading Atlantic salmon
- 10,000 fish, 2–4kg moved without injury through 200mm pipe in 3 hours
- 2–4 kg Atlantic salmon passing through pipe



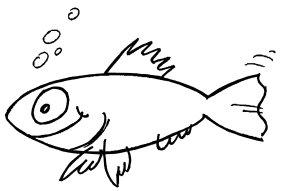
Pump Fishway Features

- Combines four technologies:
  - Fish passage, aquaculture transfer, hydro energy, novel hydraulic pumping
- Compact, light-weight, modular construction
  - Floating –> independent of tailwater variation?
  - Barge-mounted & re-positioned –> optimal attraction?
  - Removable before floods?
- Constant operation, short cycling period
- Energy-independent
- Simple
- Proof-of-concept established

Expected Pump Fishway Benefits

- Less limited by fish physiology & behaviour
- Versatile, adaptable to sites >~2m
- Low capital and operating costs
- Energy independent
- All critical fishway functions effective:
  - attraction, entry, passage, refuge

Harris Research



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