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Balancing hydropower, fish and human needs

Martin Mallen-Cooper

Charles Sturt University

2nd Lower Mekong Fish Passage Conference
Siem Reap, Cambodia
5-7 February 2025

Balancing hydropower, fish and human needs

1. Hydropower and fish
2. *Flowing rivers* and planning dams
3. Informed choices


Energy ⟶ Economic growth

Energy → Economic growth

Health

Education

Industry

1. Hydropower and fish

What do fish provide?

Food

Nutrition

Livelihoods

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1. Hydropower and fish

White fish

Rivers

Grey fish

Rivers

Blackfish

Wetlands

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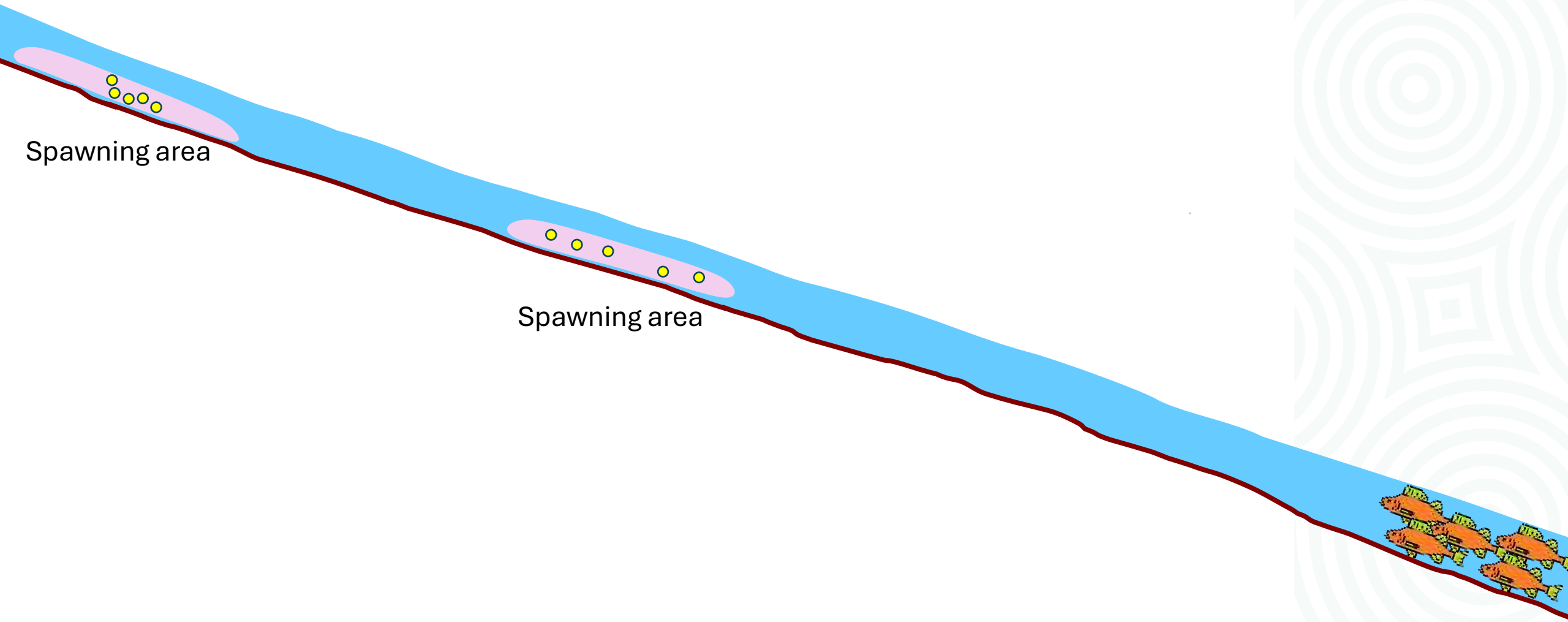
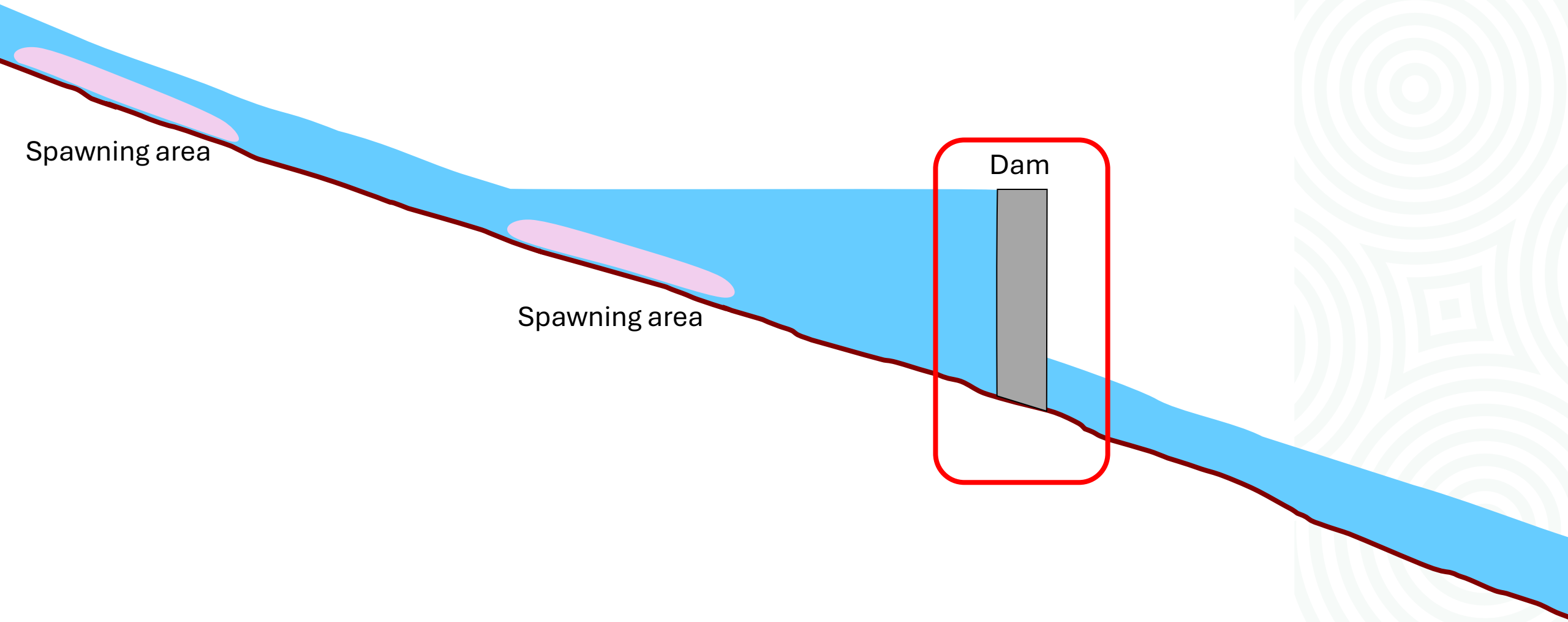
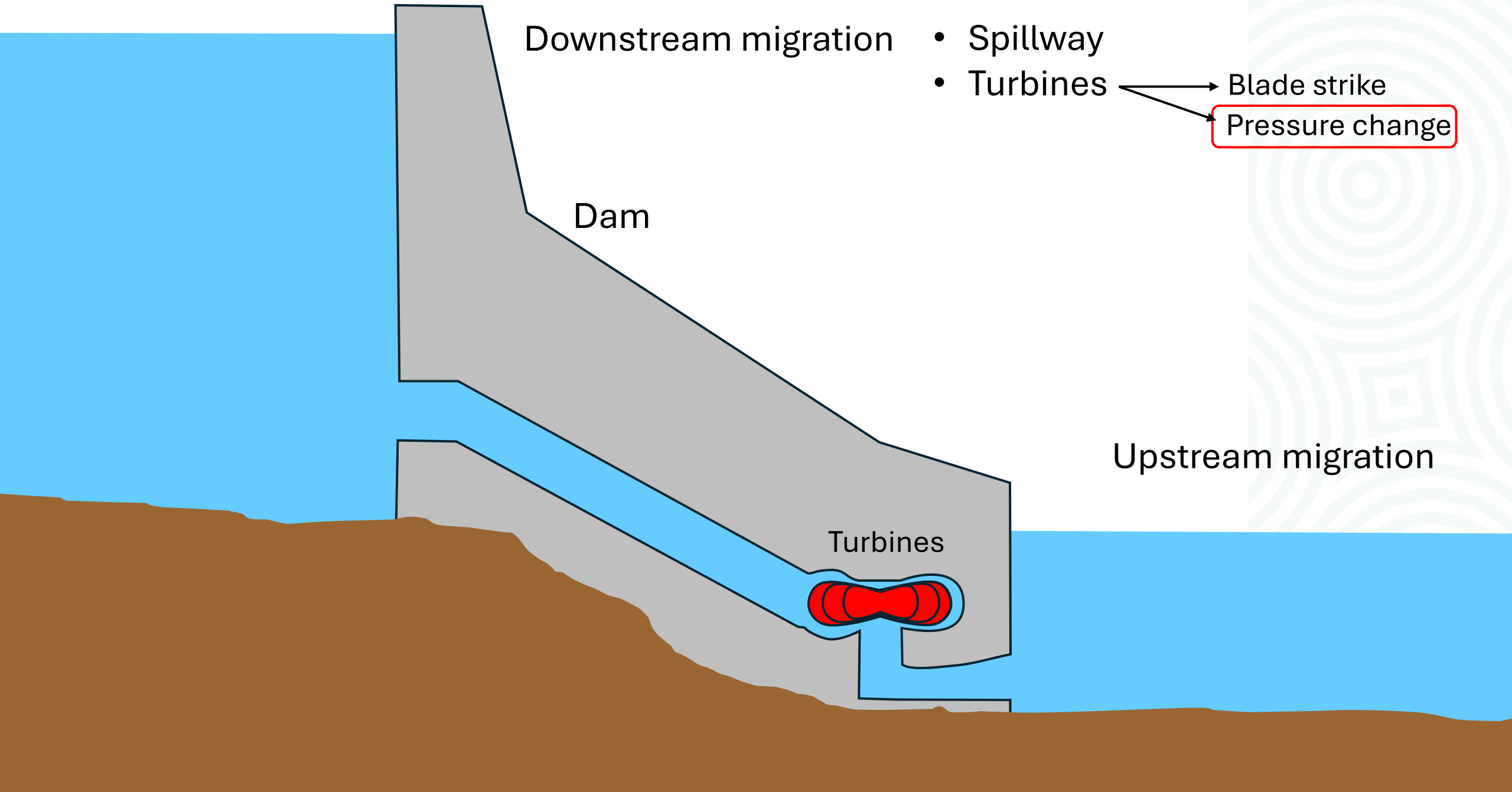
Biology – white fish (and grey fish)



Biology – white fish (and grey fish)

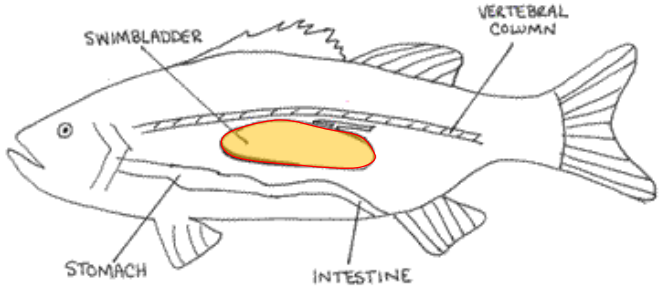



Downstream migration
• Spillway
• Turbines
Blade strike
Pressure change
Dam
Upstream migration
Turbines

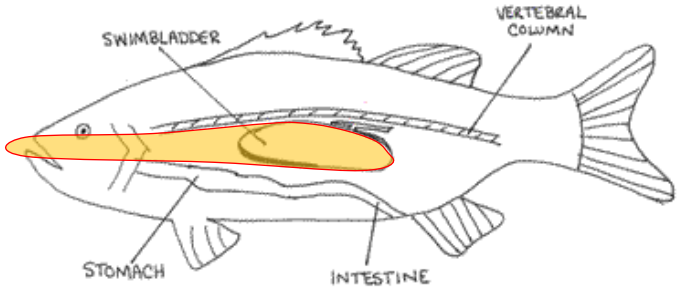
Impacts of pressure change (barotrauma)

Example: 20 m dam

Upstream



In turbine



Swim bladder approx. 3X volume

Photograph courtesy of Luiz Silva

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Impacts of pressure change (barotrauma)

Impacts vary – species

Catfishes

- can “burp” – release gas
- lower impact






Carp

- cannot “burp”
- high impact





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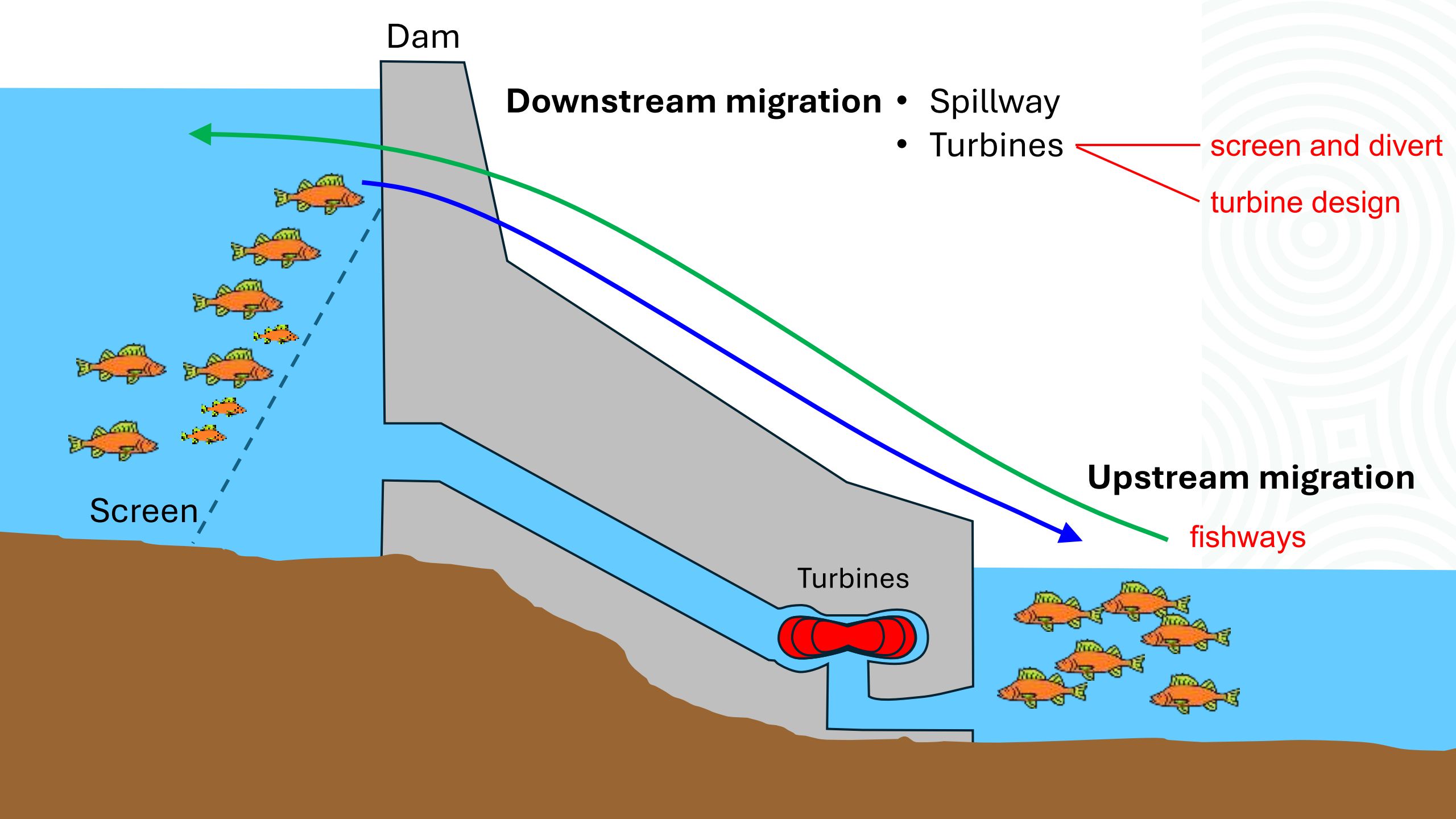
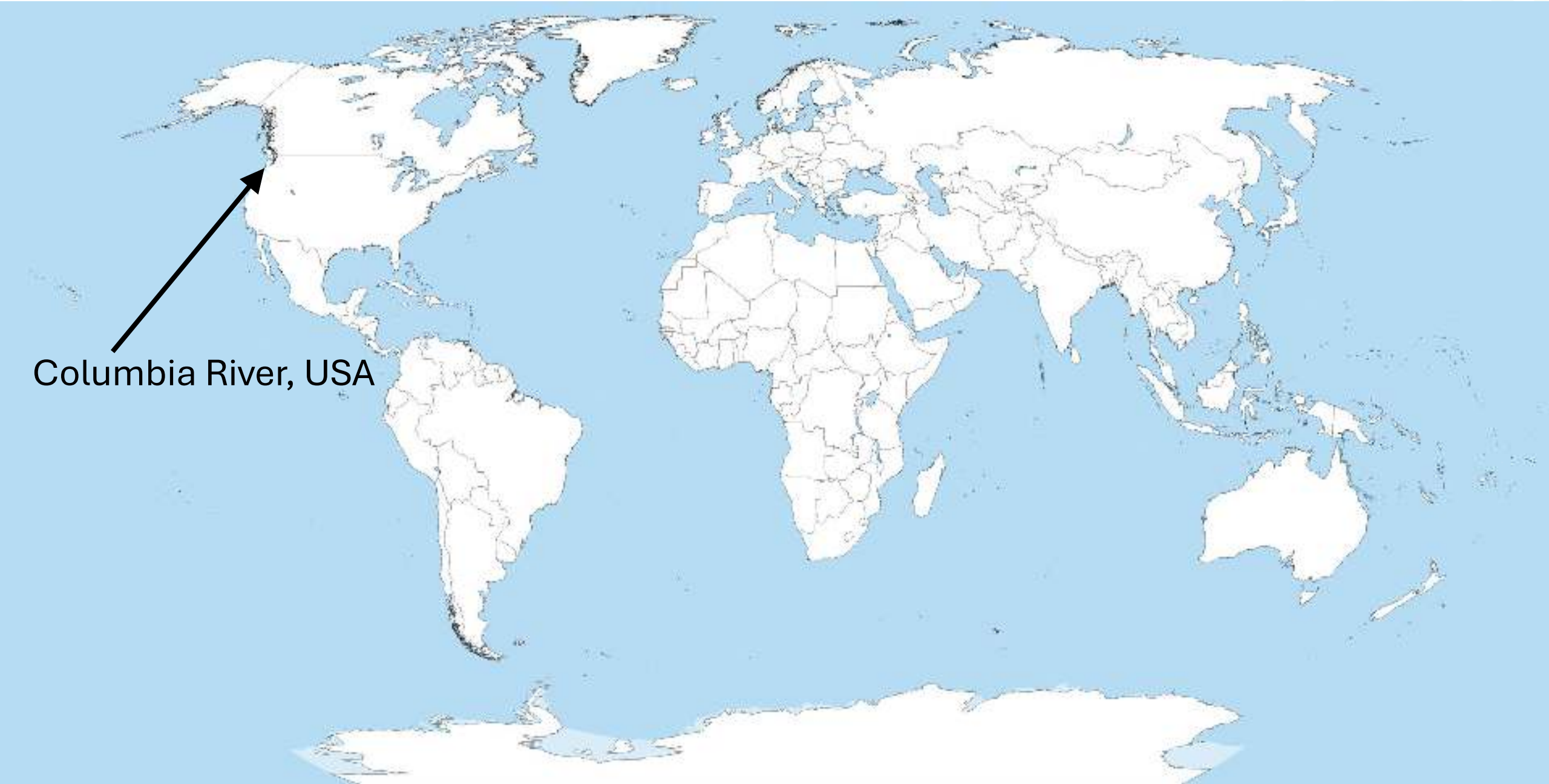

Dam
Downstream migration
• Spillway
• Turbines
screen and divert
turbine design
Upstream migration
fishways
Screen
Turbines

Experience of migratory fish and hydropower in other countries



Experience of migratory fish and hydropower in other countries

USA, Columbia River (Williams 2008)

USD $7 billion - fish passage/hatcheries
- multiple dams over 30 years
- upstream passage
- downstream passage

90% decline in salmon

What decline in fish is acceptable in the Mekong?
10%? 20%? 30%?

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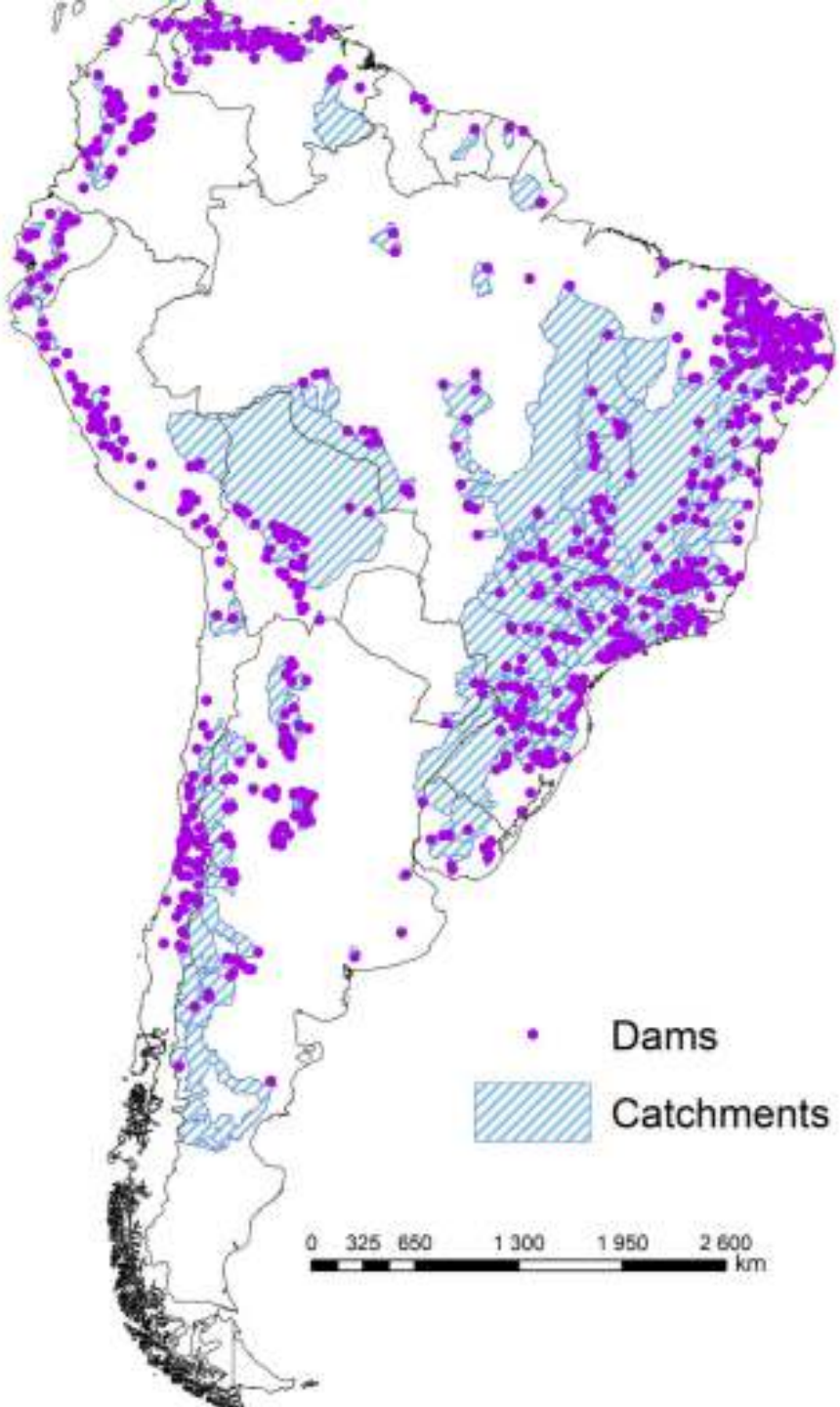
Experience of migratory fish and hydropower in other countries



- Many hydropower dams
- Many fishways
- No migratory fish populations maintained by any fishway at a high dam
- **<u>but</u>**, some migratory fish populations are maintained between dams, if there is enough **<u>flowing river</u>**

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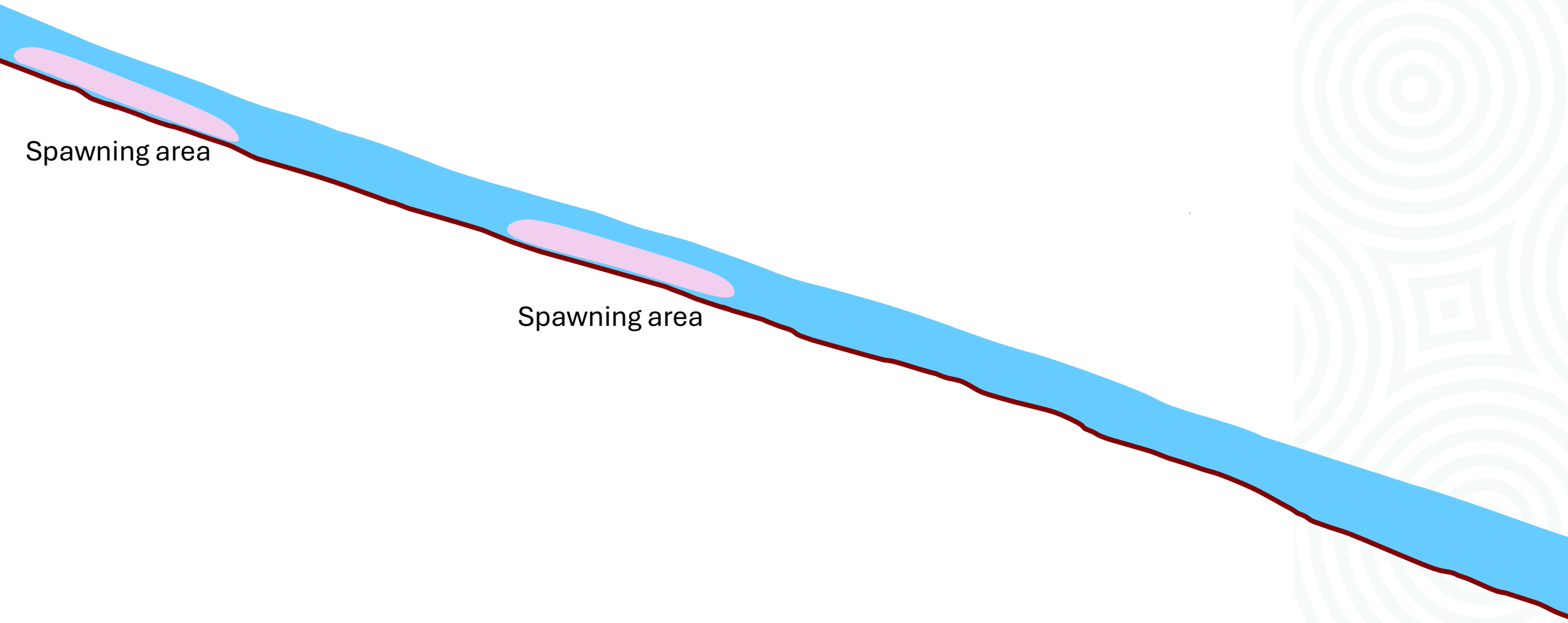
2. *Flowing rivers* and planning dams

Biology – white fish (and grey fish)



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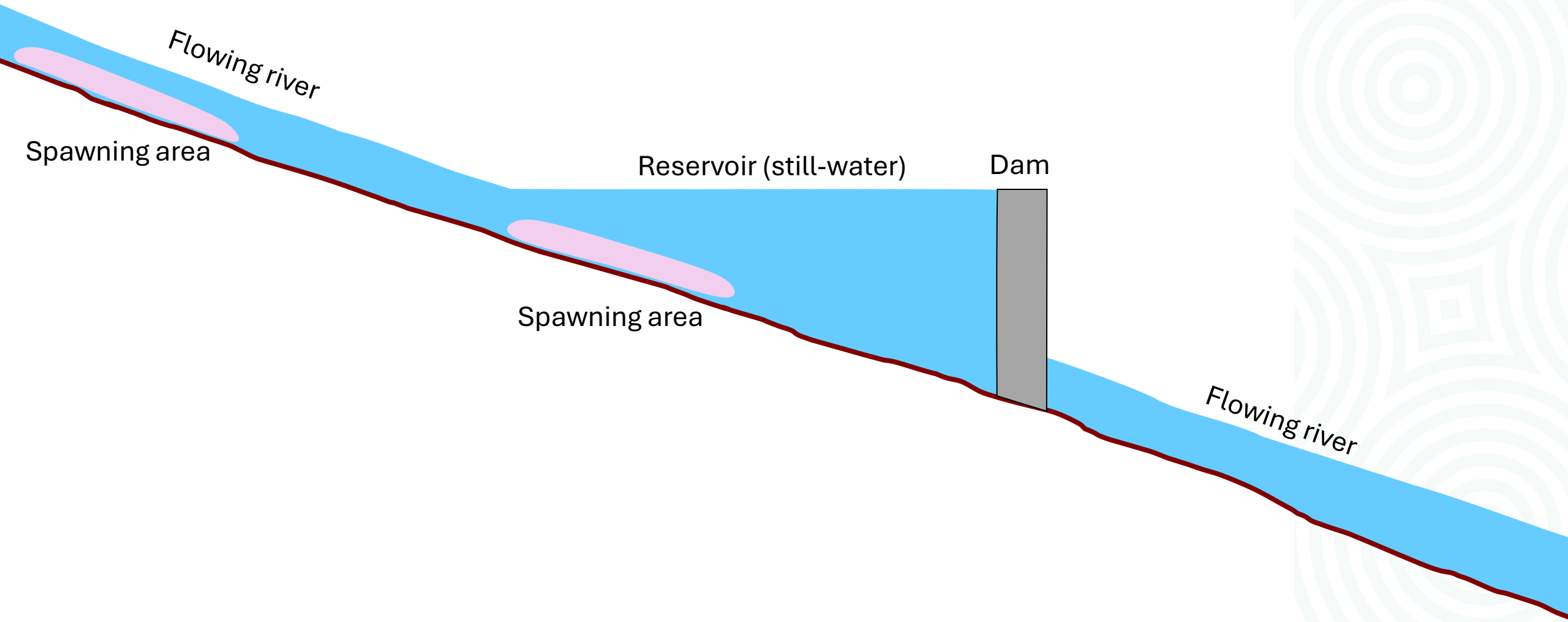


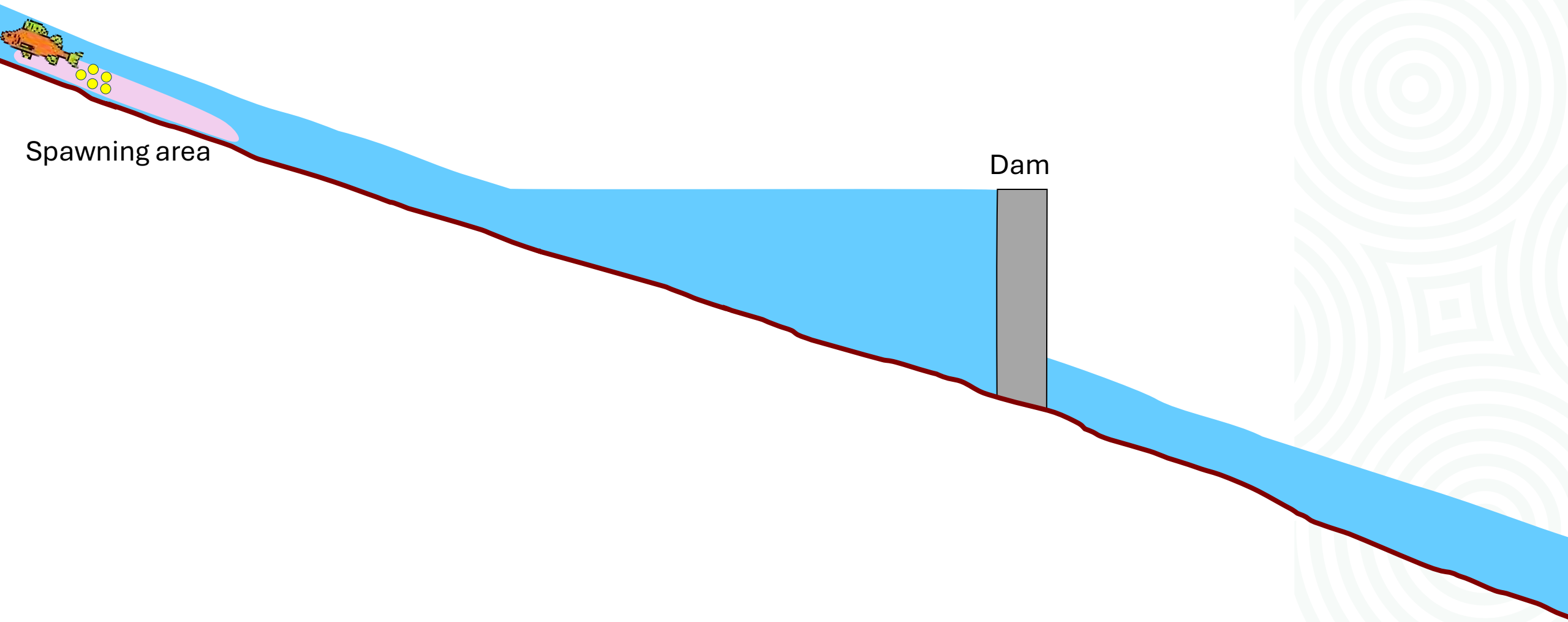
Flowing river:

Spawning areas

Different habitat:

fish, mussels, snails

Biology – white fish (and grey fish)



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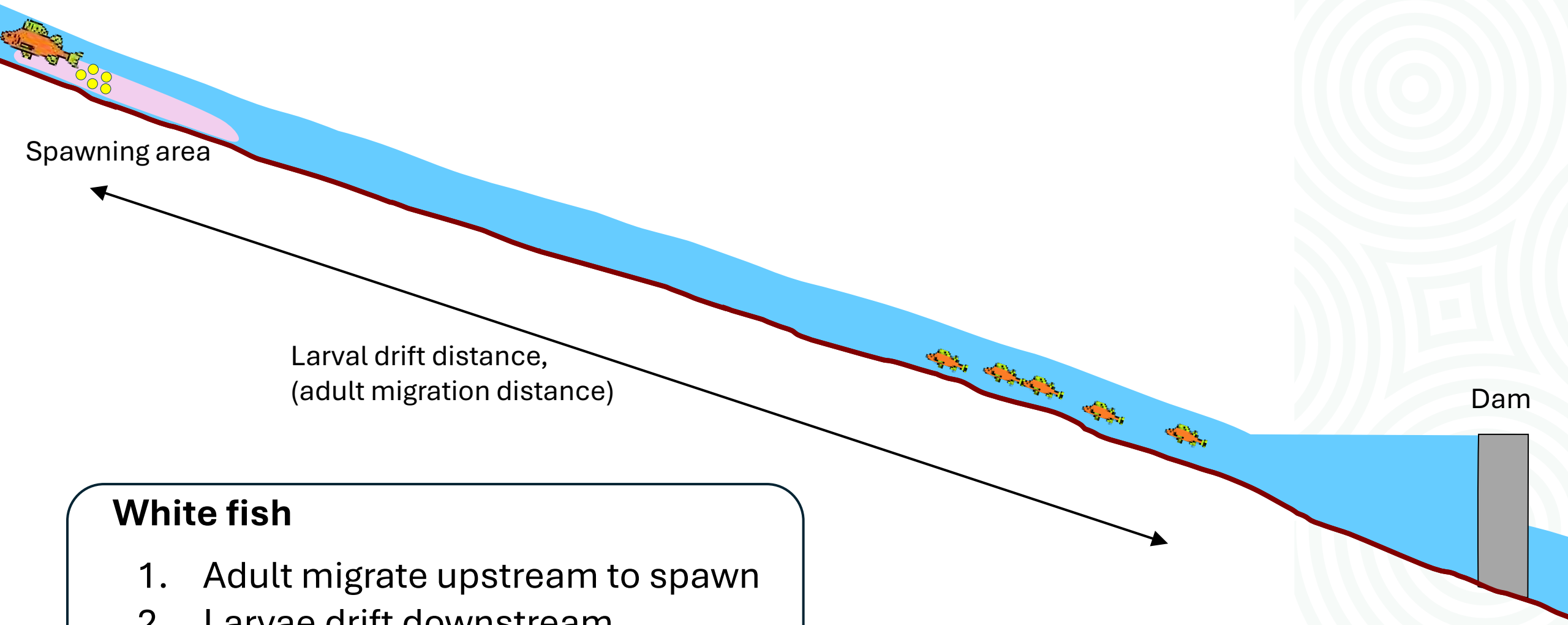


White fish

1. Adult migrate upstream to spawn
2. Larvae drift downstream
3. Need *flowing rivers* for larval drift

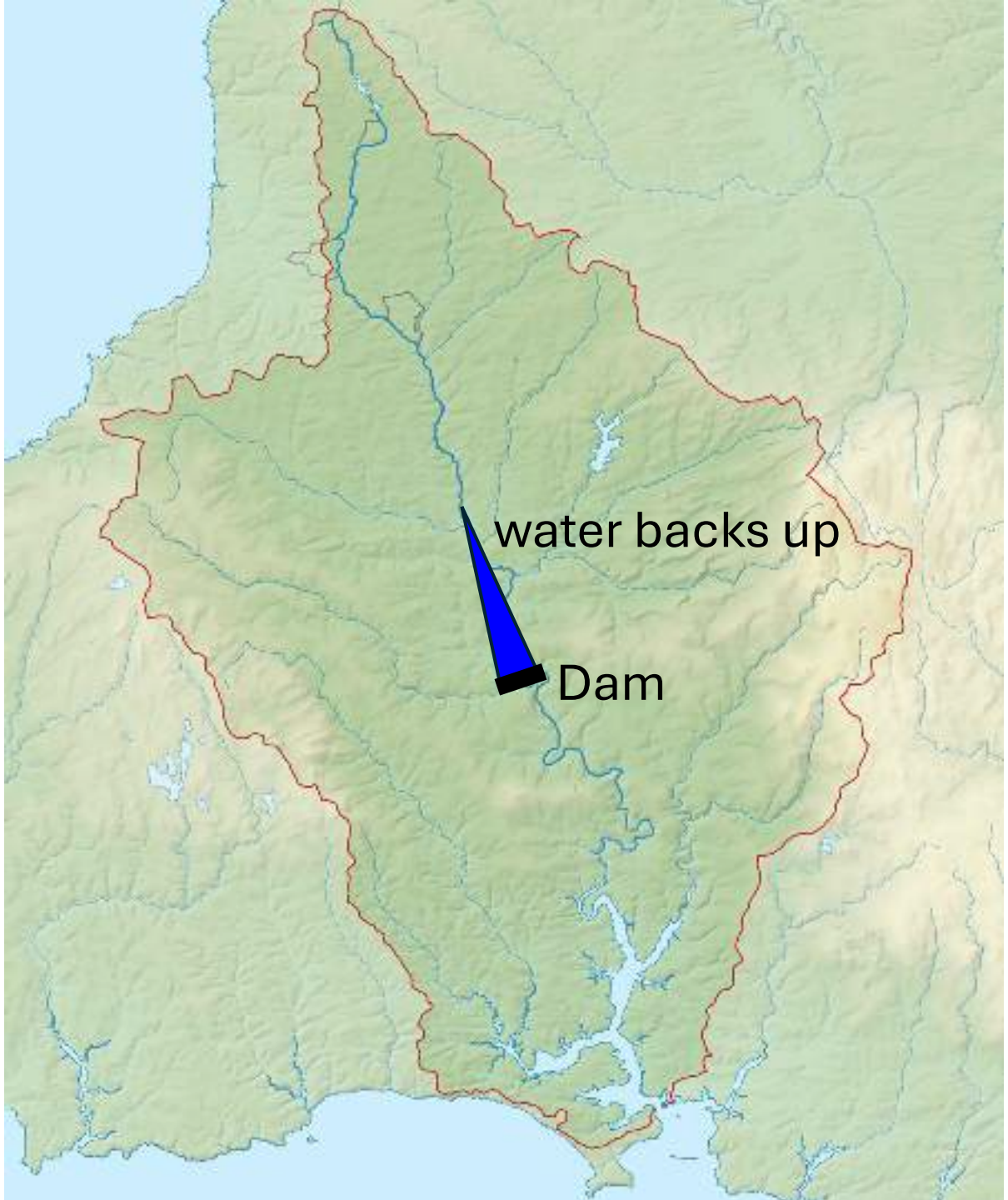
2 exercises

1. You are a developer:
   - hydropower engineer
   - hydropower planner

2. You are a senior Government employee:
   - planner
   - fish scientist
   - social scientist

Exercise 1.

- You are a developer:
  - hydropower engineer
  - hydropower planner
- Want to build 4 dams
- Where to place them?



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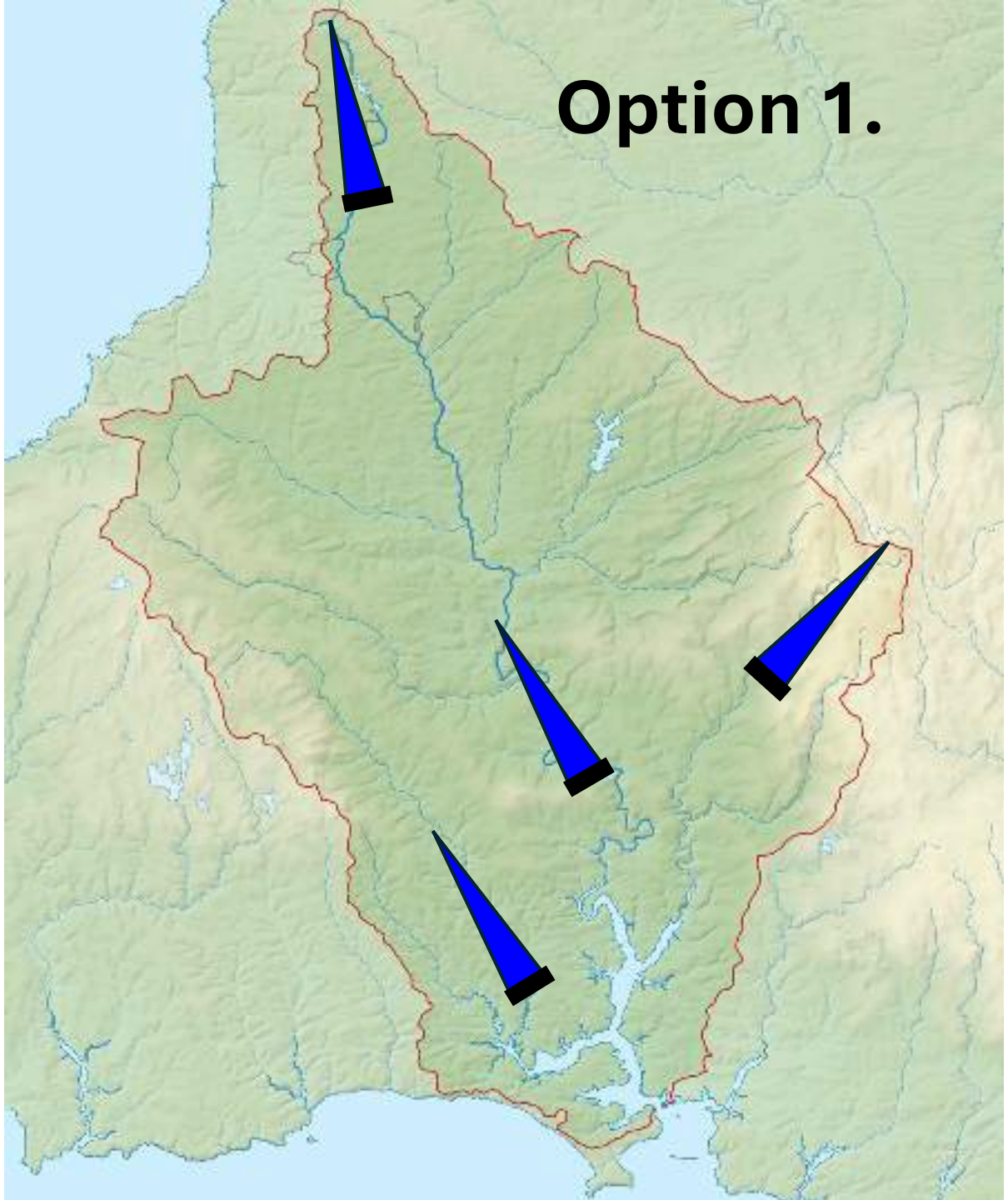

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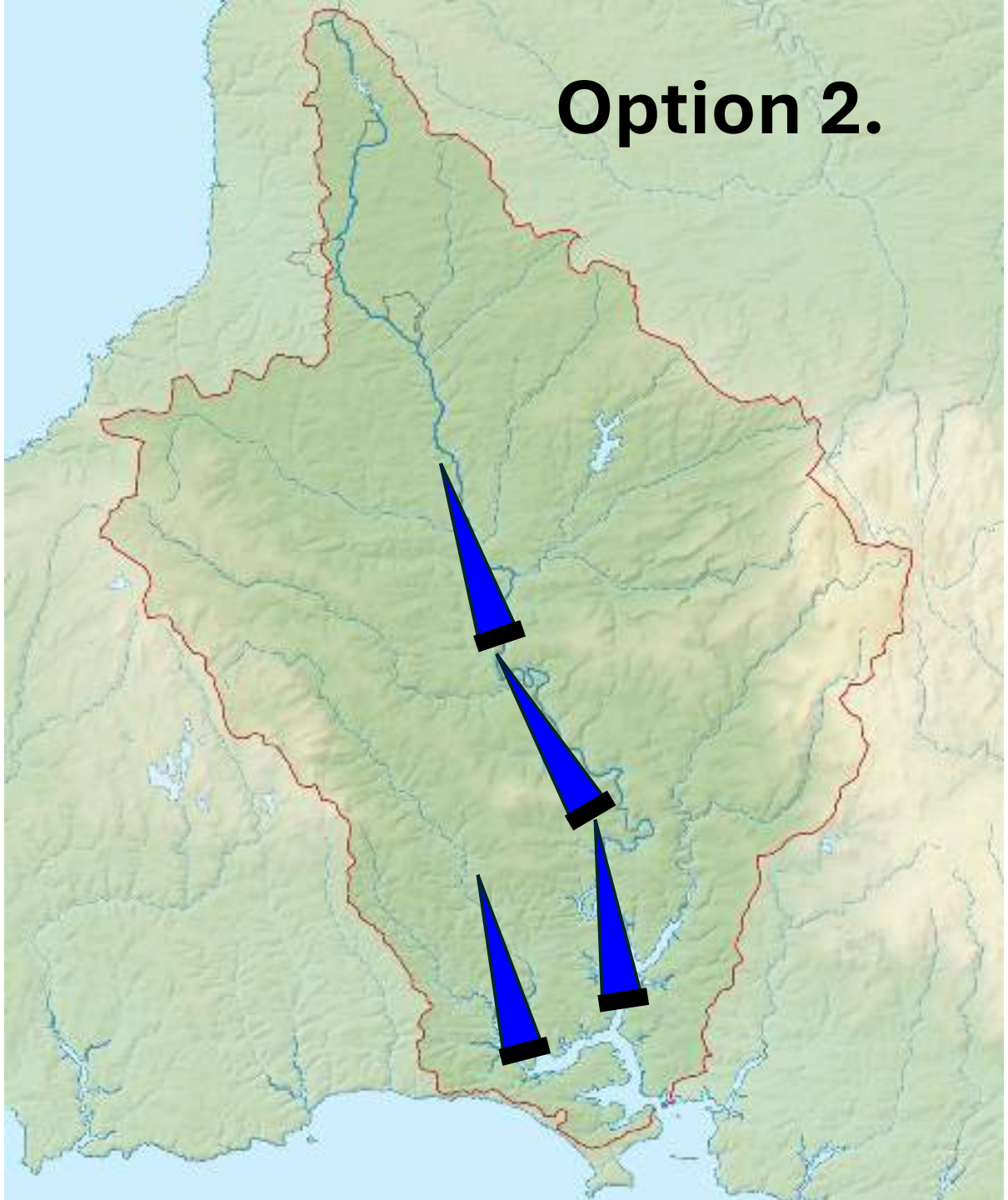

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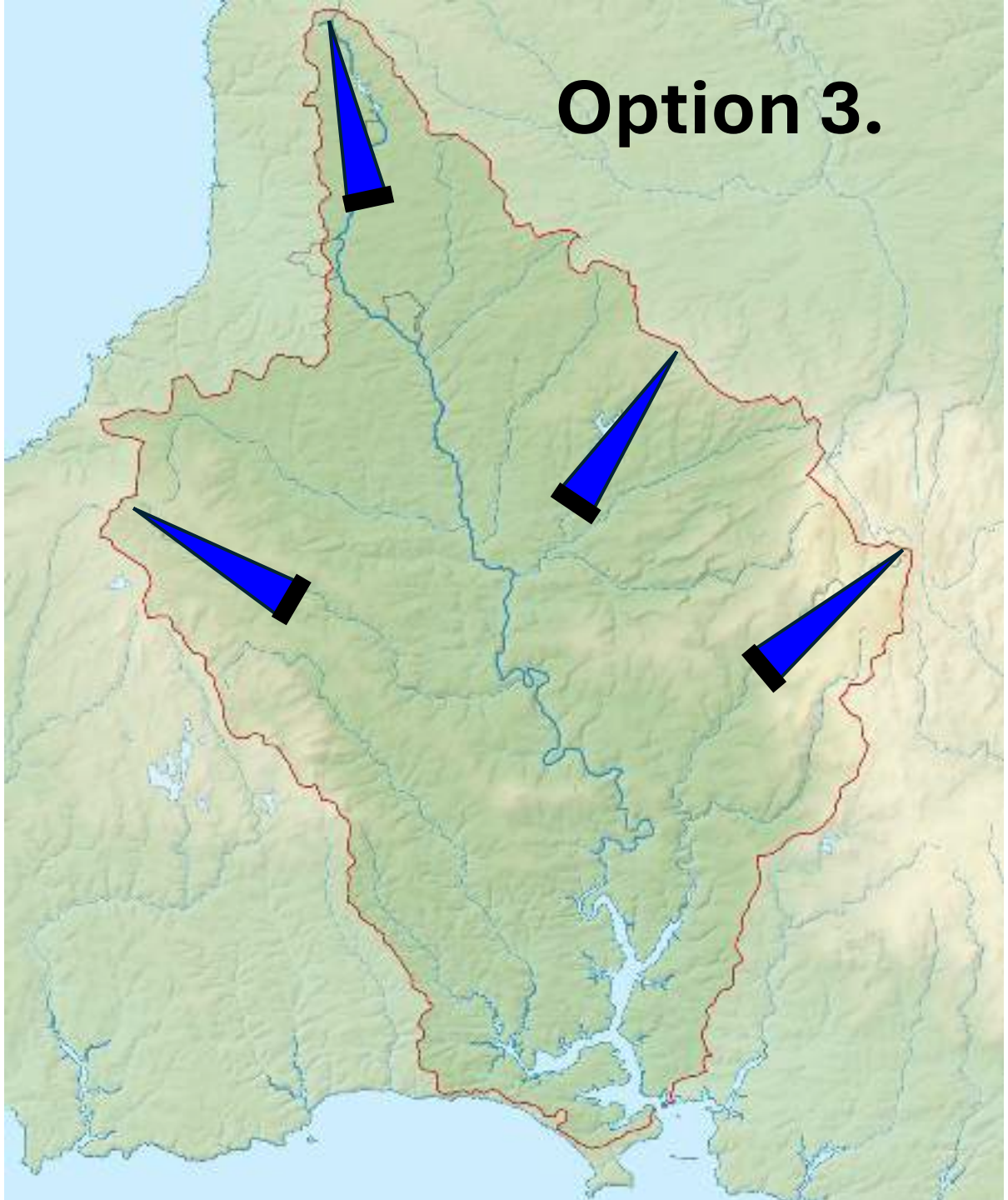

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Exercise 2.

You are a senior Government employee:

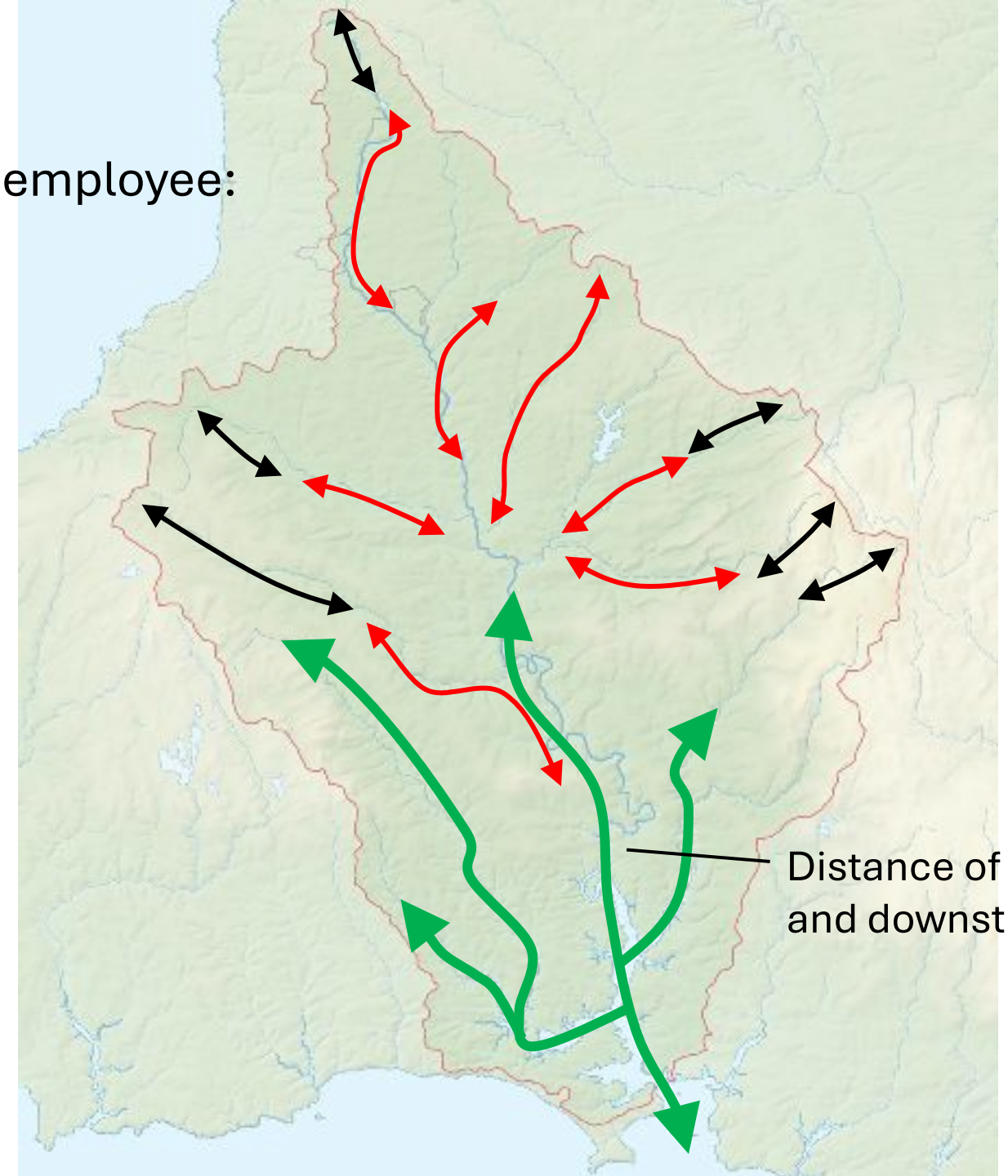
- planner
- fish scientist
- social scientist

Fish Migration

Major fishery

Moderate fishery

Local fishery



Distance of upstream migration and downstream larval drift

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Exercise 2.

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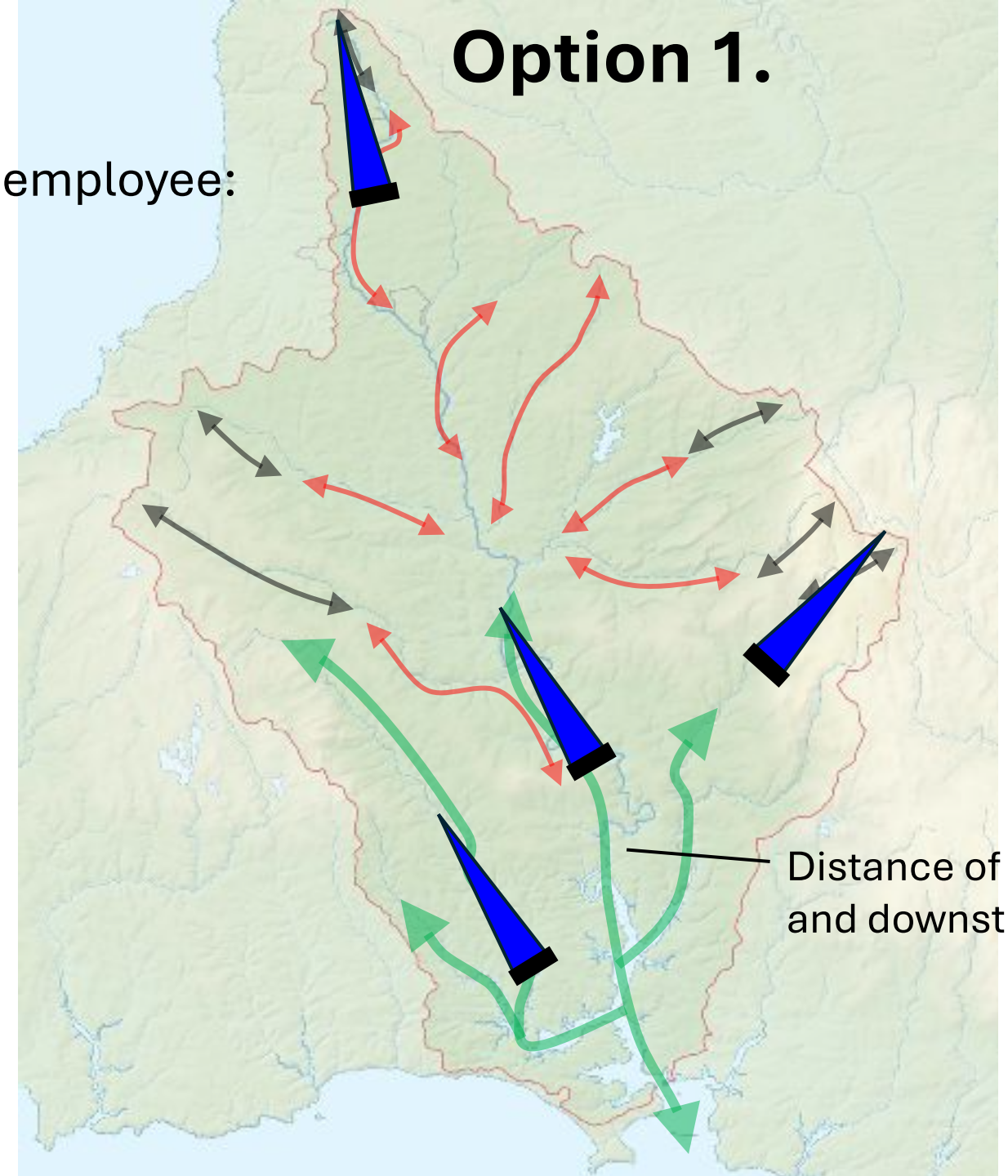
Fish Migration

Major fishery

Moderate fishery

Local fishery

Option 1.



Distance of upstream migration and downstream larval drift

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Exercise 2.

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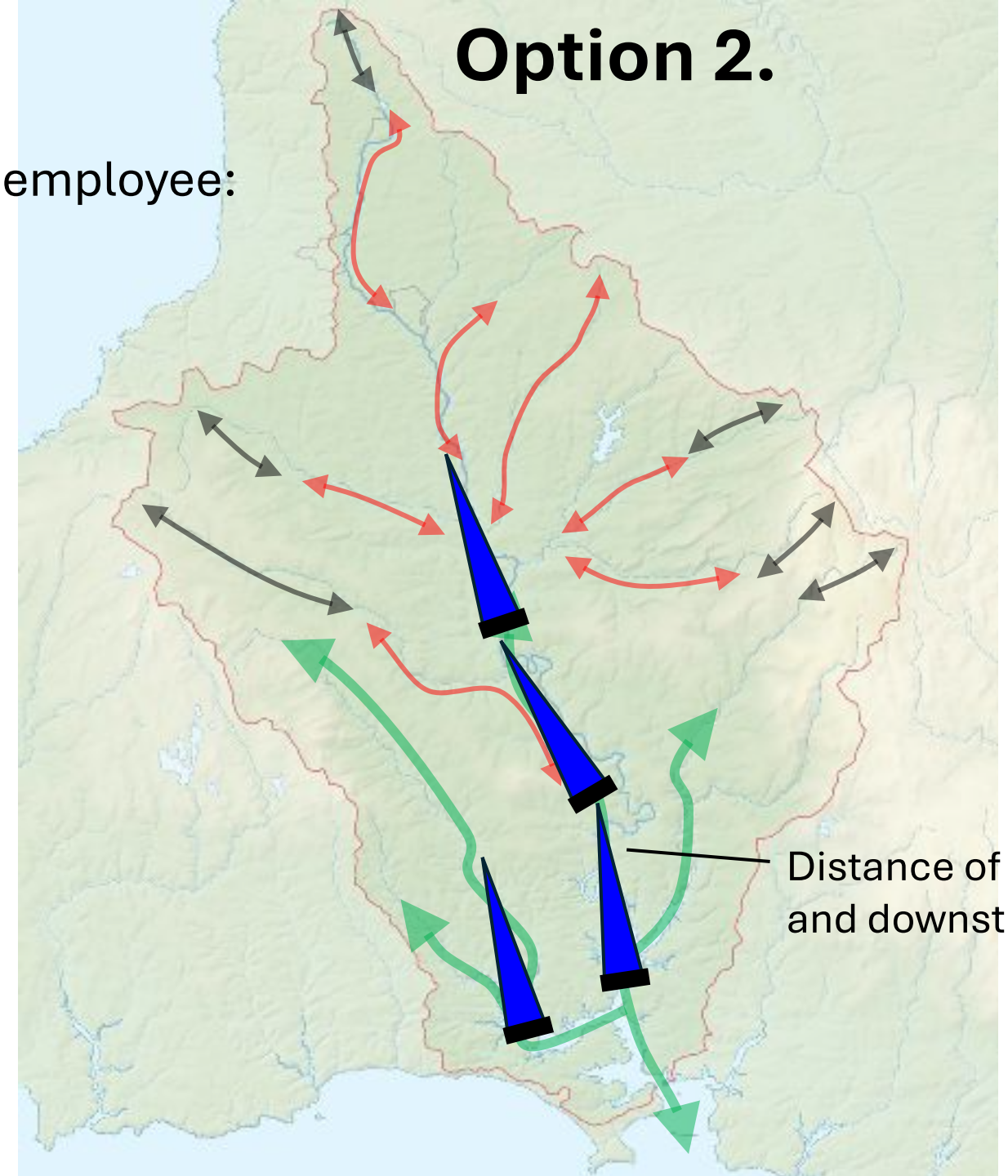
Moderate fishery

Local fishery



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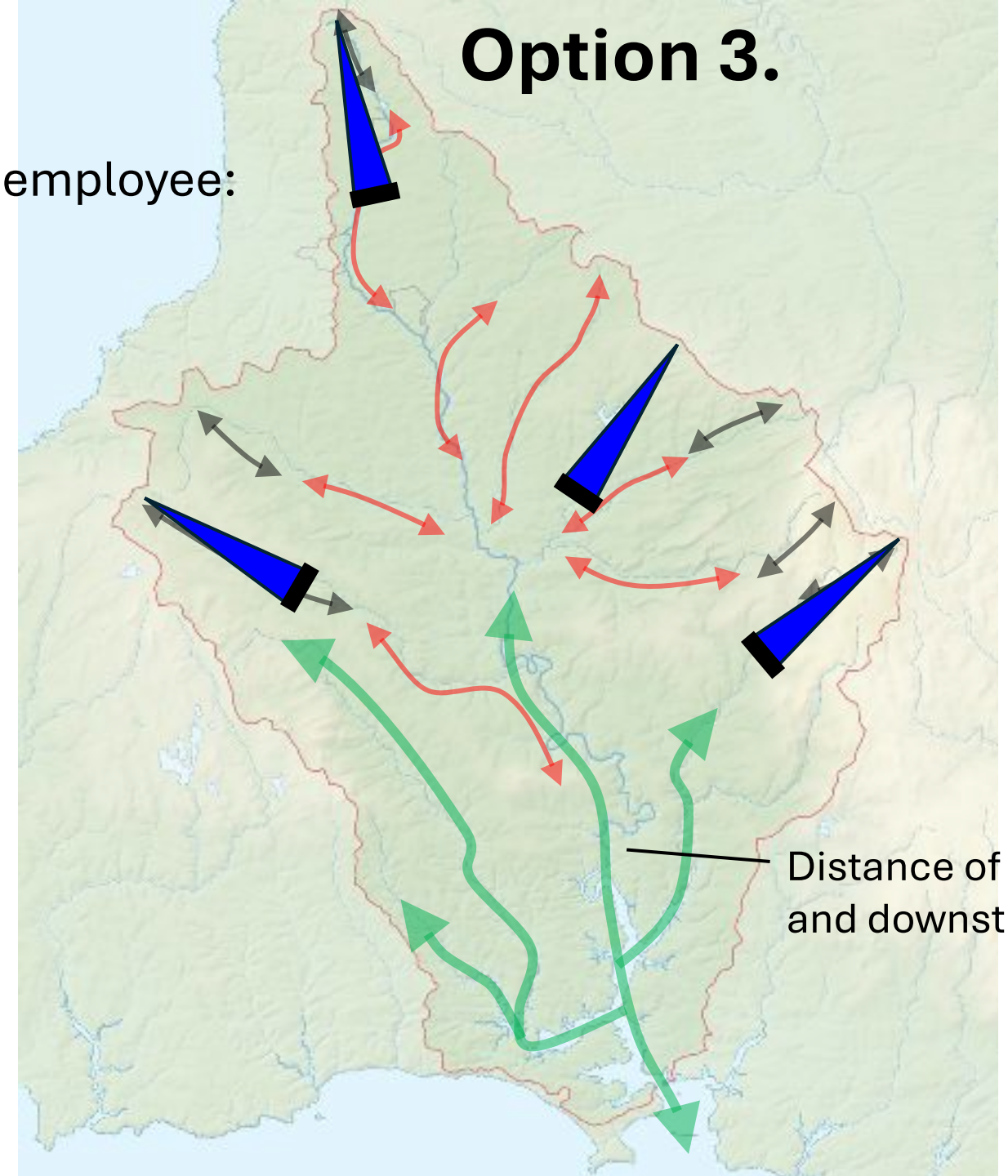
Fish Migration

Major fishery

Moderate fishery

Local fishery

Option 3.



Distance of upstream migration and downstream larval drift

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3. Informed choices

a) Strategic sites to balance fish, people, hydropower

b) Build - Operate – Transfer

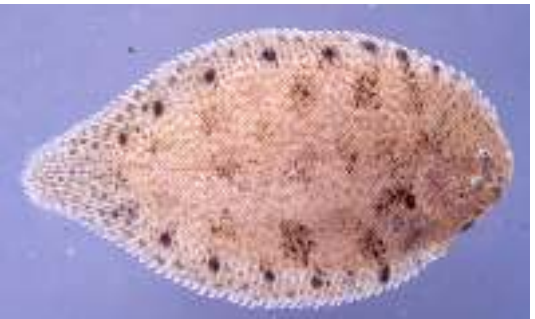
c) Greenhouse gases & energy sources

b) Build – Operate – Transfer (BOT)

Built and paid by developer

Operate by developer (e.g. 25 years) to pay for the dam, and make a profit

Transfer back to public sector



b) Build – Operate – Transfer (BOT)

- The developer is a business
- Your government has the power in negotiations
    - negotiations fail? another developer would step in

b) Build – Operate – Transfer (BOT)

- Concession periods (20-50 years)

  - some impacts on fish and sediment may take decades to happen

  - export energy market in 20-50 years?
  - solar, wind **and batteries**
  - energy economist

- Risk for your country – own the risks in 20 years, and difficult to export the energy

3. Informed choices

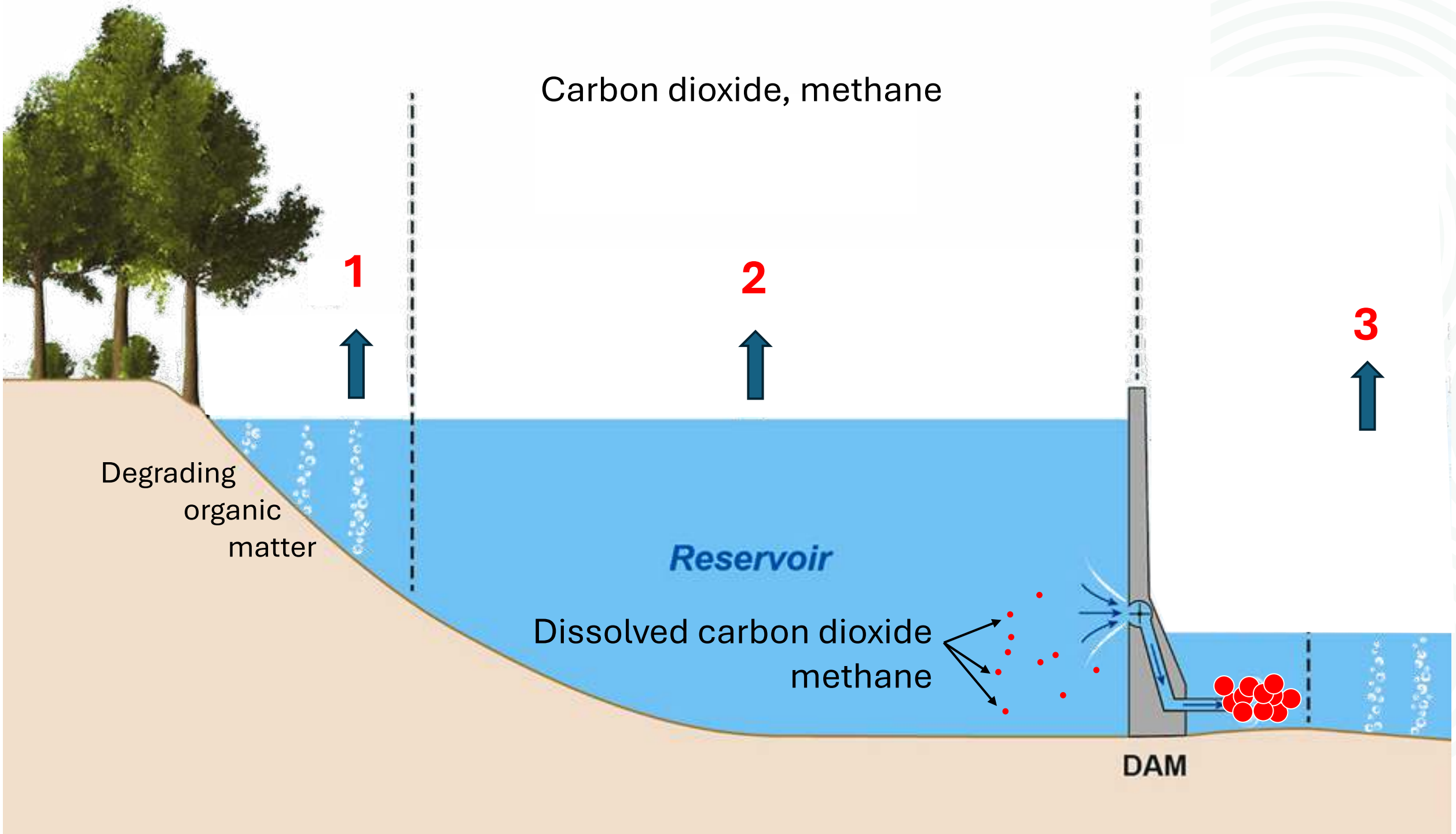
a) Strategic sites to balance fish, people, hydropower

b) Build - Operate – Transfer

c) Greenhouse gases & energy sources

c) Greenhouse gases

- Hydropower is renewable (if there are no droughts)
- Hydropower produces greenhouse gases


Carbon dioxide, methane
1
2
3
Degrading
organic
matter
Reservoir
Dissolved carbon dioxide
methane
DAM

How significant are greenhouse gas emissions from hydropower?

Hydropower: 1 billion tonnes per year

Fossil fuels: 37 billion tonnes per year

Methane has 80 times the impact of carbon dioxide on global warming

Hydropower: 18 million tonnes per year

Fossil fuels: 173 million tonnes per year

Soued *et al*. (2022) Reservoir CO_2 and CH_4 emissions and their climate impact over the period 1900 – 2060. *Nature Geoscience* **15**, 700–705.

3. Informed choices

a) Strategic sites to balance fish, people, hydropower

b) Build - Operate – Transfer

c) Greenhouse gases & energy sources

Solar and wind

Cambodia - solar

Battambang Solar Farm 73.9 MW

Asian Development Bank study:

Cambodia energy potential

6,500 MW wind

8,100 MW solar

} No impacts on fish, less greenhouse gases

10,000 MW hydropower

Business Case: $$$ invested / $$$ Megawatts

Need to include cost of impacts on fish and people (food, nutrition, livelihoods)

Then you can make an informed choice for your country

Conclusions

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Low-level fishways

Conclusions

1. Dam placement can minimise fish and social impacts - make it your choice

2. If migratory fish are important – leave *flowing river* reserves, not only fishways

3. Large hydropower in large rivers, will likely lead to major declines in migratory fish (e.g. 60-90%)

4. Comparing renewable energy sources, consider benefits/impacts on fish & people

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អរគុណ!

ขอบคุณ!

ຂອບໃຈ!

Terima kasih!

Thank you!

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Gulbali Institute
Agriculture Water Environment

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