Global Water Partnership

Making hydropower more sustainable: Environmental flows and other measures

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Introduction:
Water-Energy Nexus and Sustainable Hydropower

The Water & Energy Nexus and Ecosystems

- Generating energy requires water, and vice-versa
- Water management affects, and is affected by, energy planning
- Many developments in last decade:
  - **Accelerated construction of dams** for hydro, flood-control, water supply
  - **"Rush for renewables"** – hydro as "clean", low carbon solution
  - **Growing populations**; growing demands for food, water, energy

Sustainable Hydropower, what is it?

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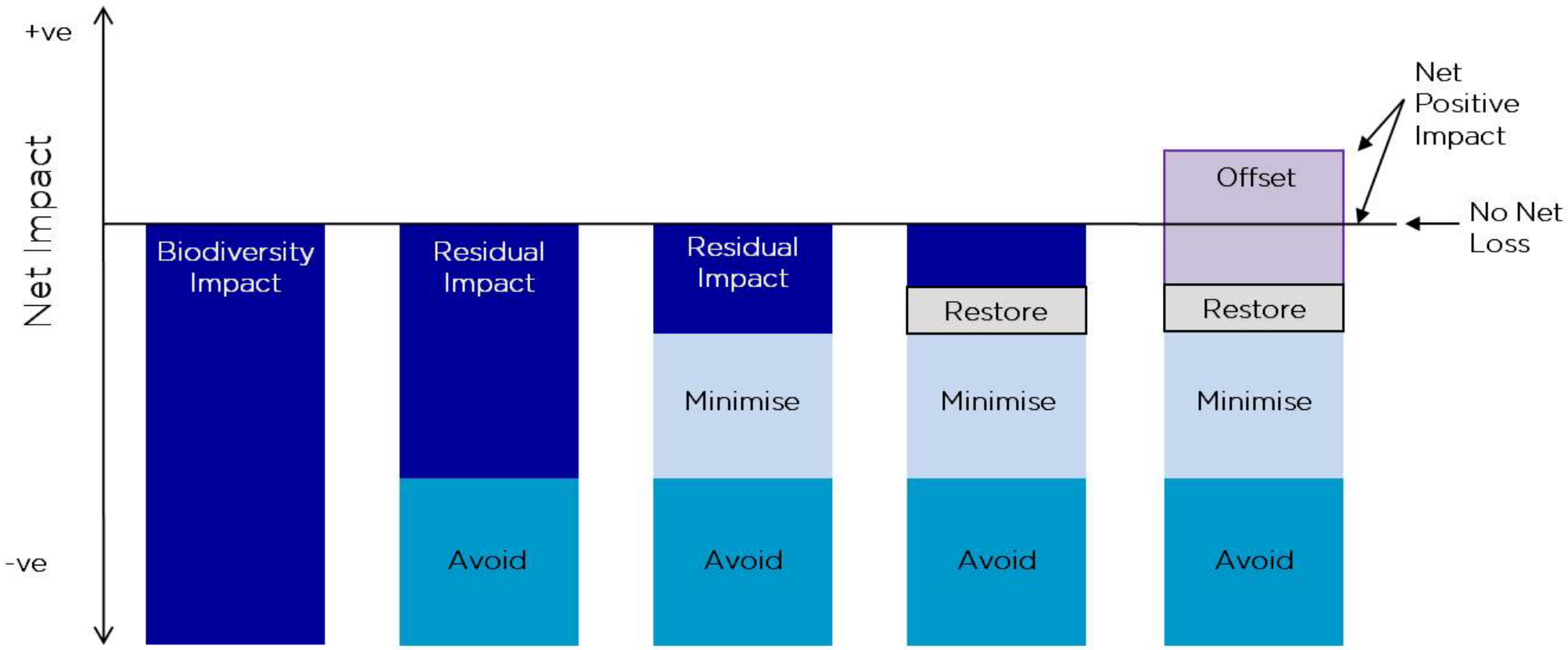
The mitigation hierarchy

Mantra:

Avoid, minimize, mitigate, and only then **compensate**!



1. A preventive approach: Avoidance of impacts and risks

1. Avoid – Why? How?

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Avoidance

= measures taken to avoid impacts from outset (e.g. siting of dams, timing of works)
= often **easiest, cheapest and most effective way** of reducing potential impacts
NB: requires **biodiversity assessment** in early stages

Scoping stage:

1. Needs assessment

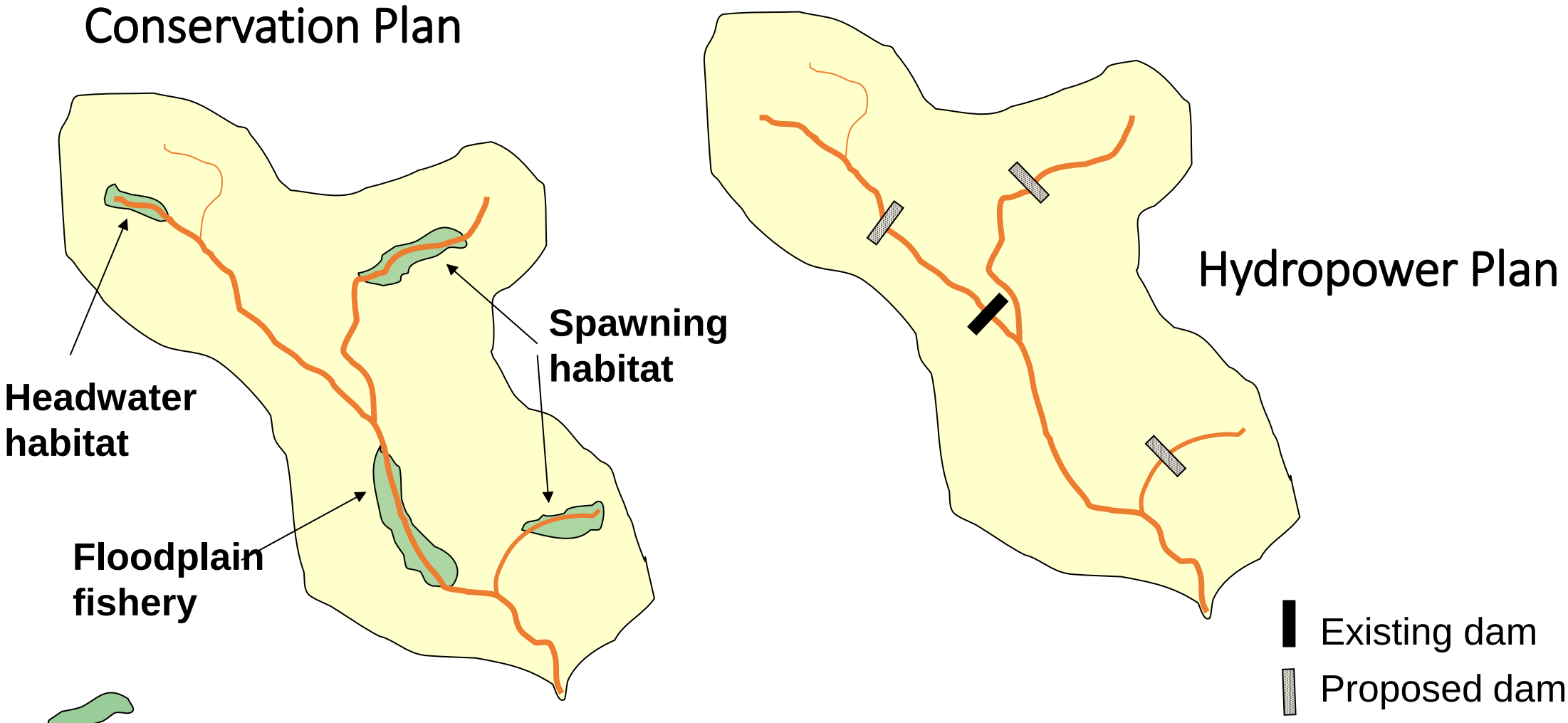
- What energy current and future needs in the country/region?
- Is there a need for additional infrastructure? What about existing dams?

2. Alternative options assessment

- What sound, feasible options for energy generation in the region?
- Is importing energy from elsewhere an option?
- Doing a cost-benefit analysis, incl, env. and social factors
- In case of existing dams, what options for refurbishing/retrofitting?

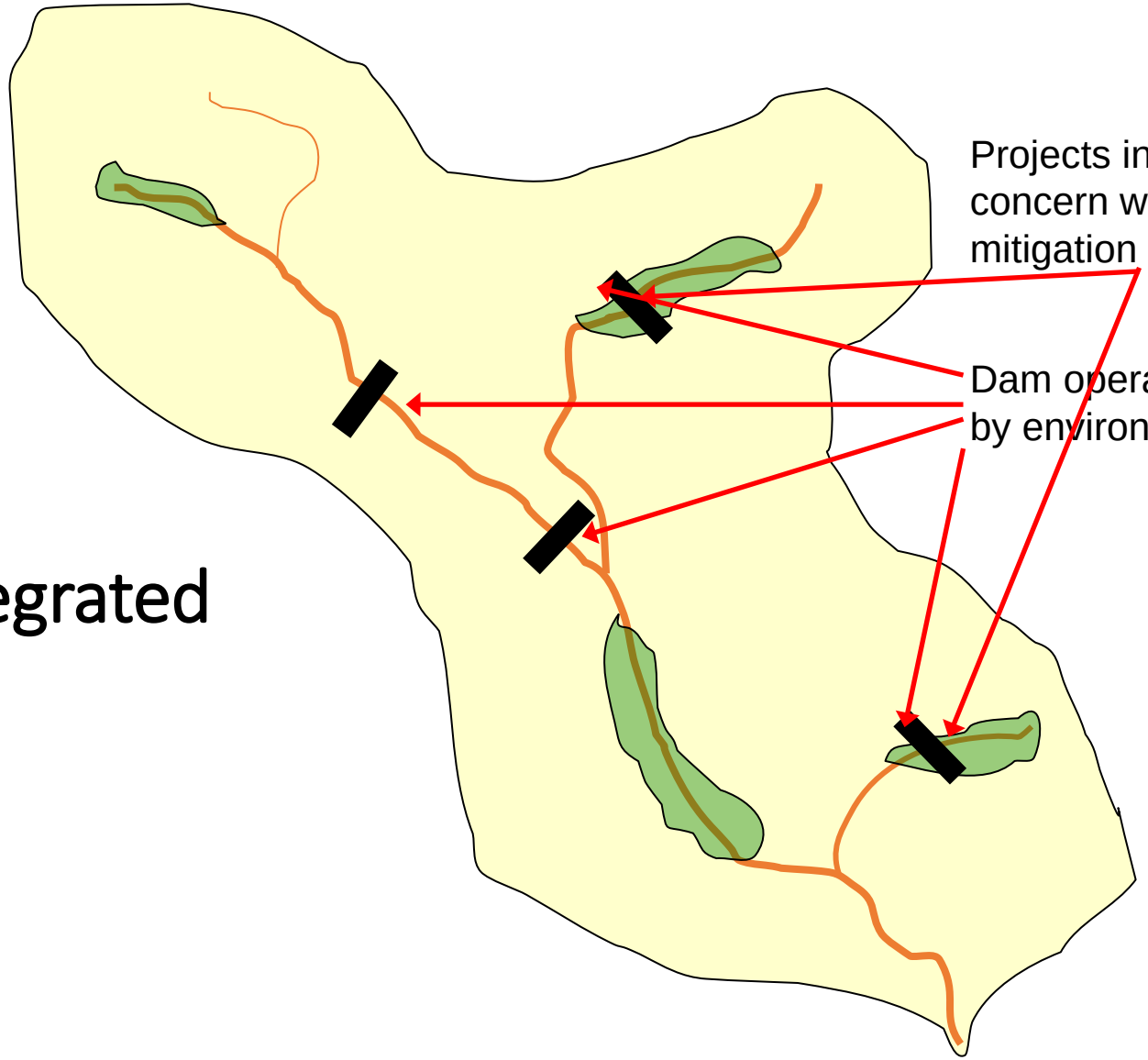
NB: Dam = large costly investment, many impacts, infrastructure to remain in place for long time !!!

1. Avoid – Integrated River Basin Planning



Source: TNC

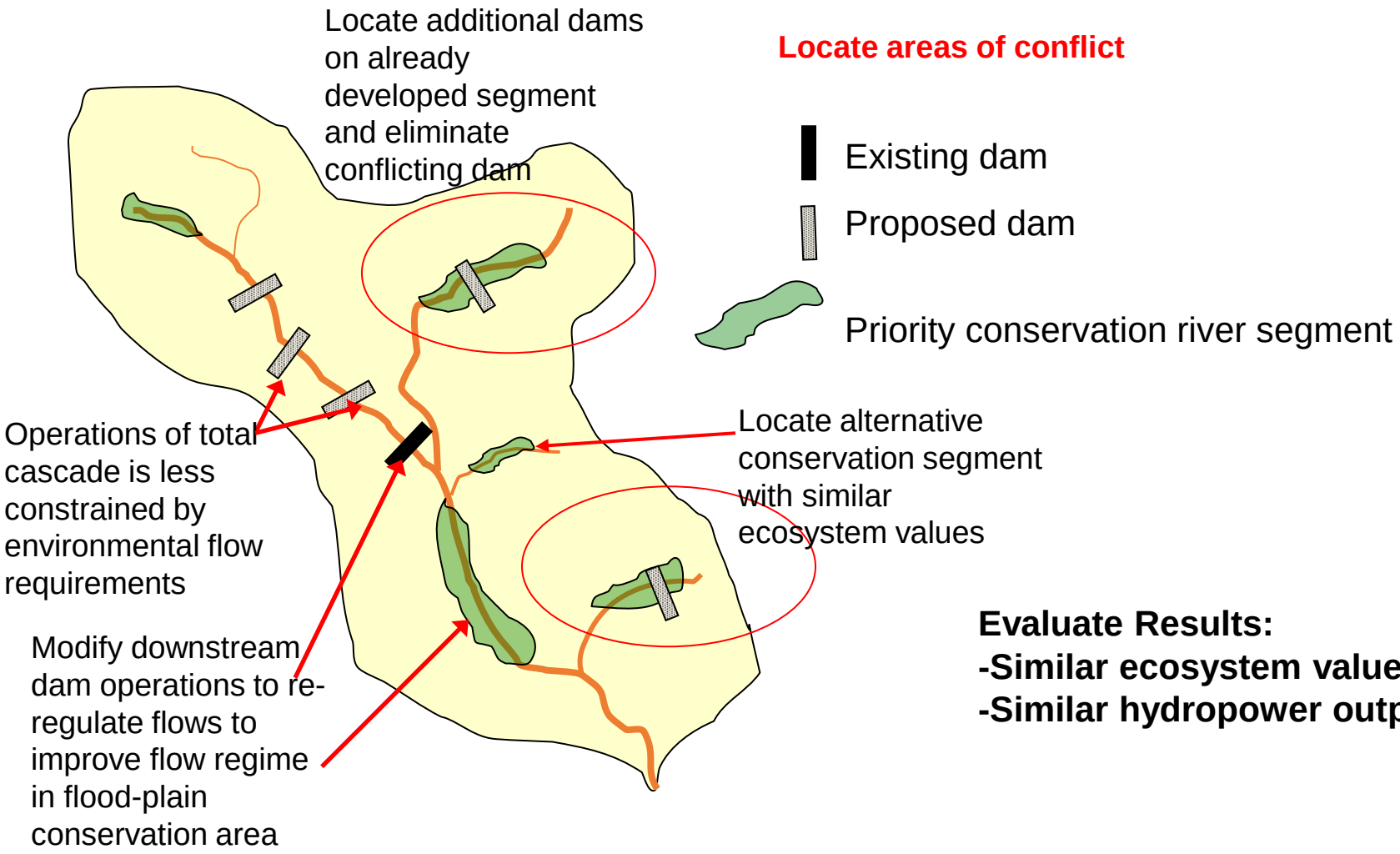
1. Avoid – Integrated River Basin Planning



Lack of integrated planning

Source: TNC

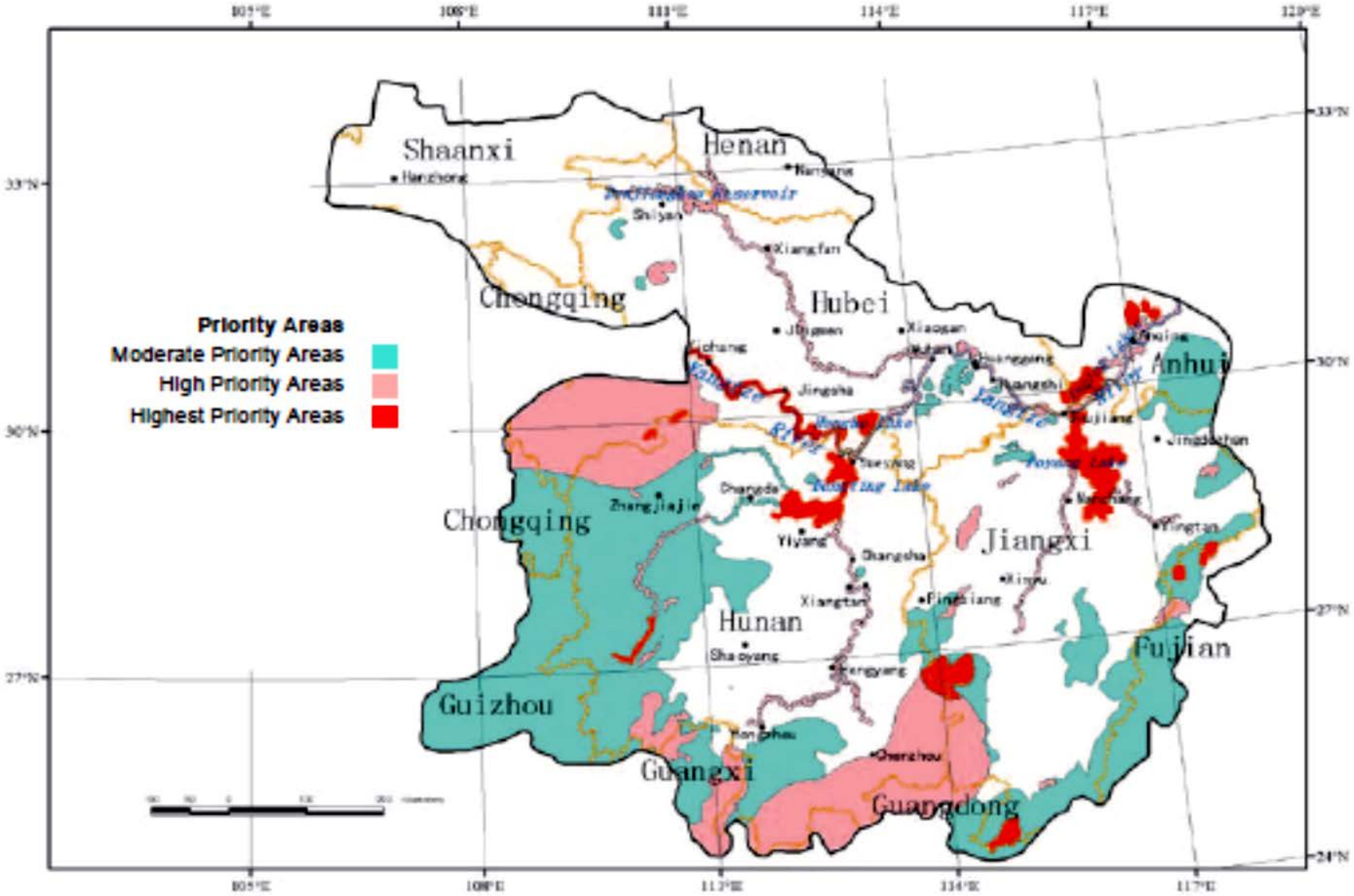
1. Avoid – Integrated River Basin Planning



Evaluate Results:
-Similar ecosystem values?
-Similar hydropower outputs?

Source: TNC

1. Avoid – Prioritisation of Conservation Areas



2. Minimisation and Mitigation of adverse impacts and risks

2. Minimize/Mitigate – How?

The right dam in the right place operated in the right way...

- dam design (structure, equipment)
- dam operations

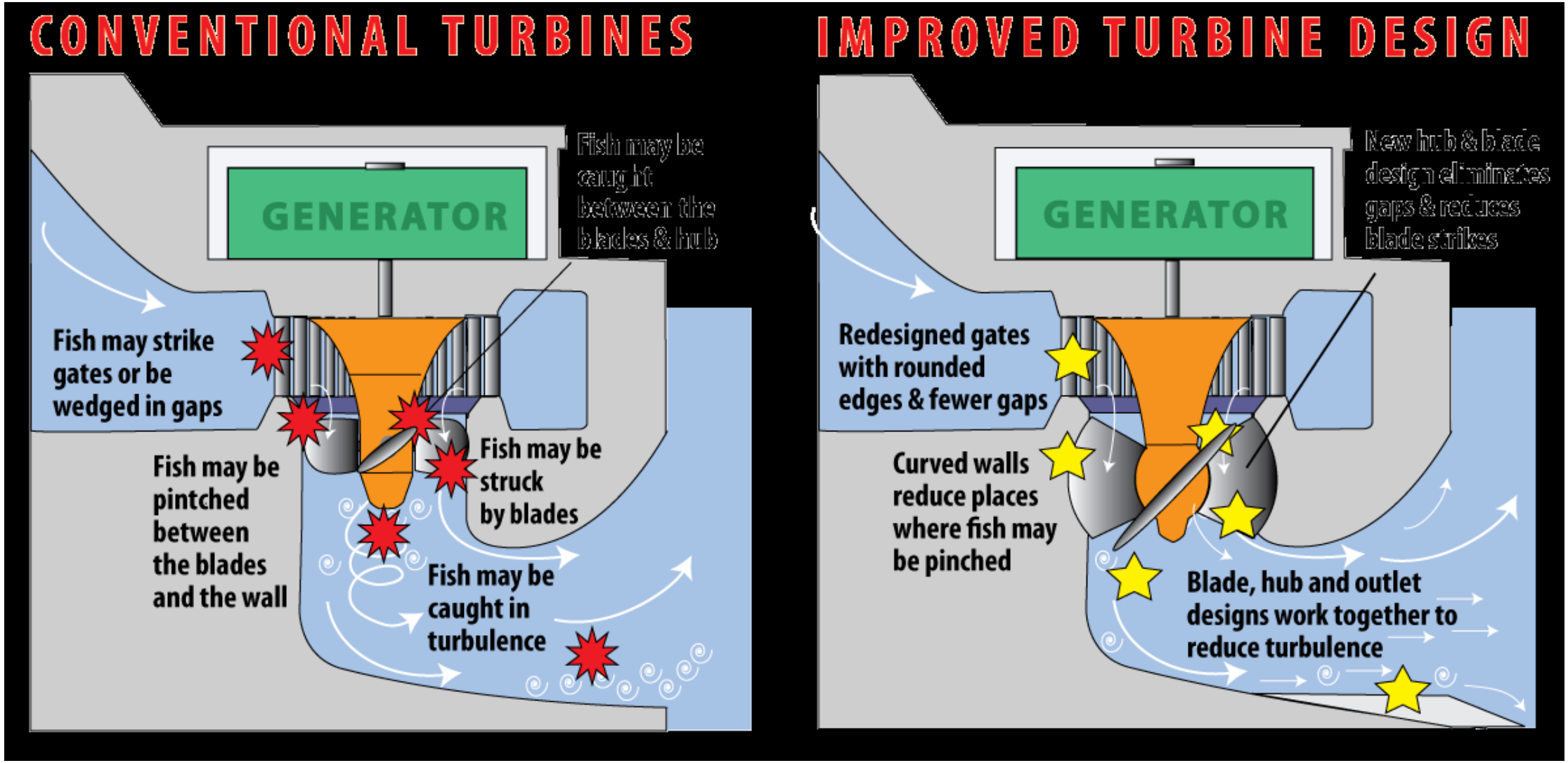
Minimisation = measures taken to reduce duration, intensity and/or extent of impacts that cannot be completely avoided. Effective minimisation can eliminate some negative impacts.

2. Minimize/Mitigate – How?

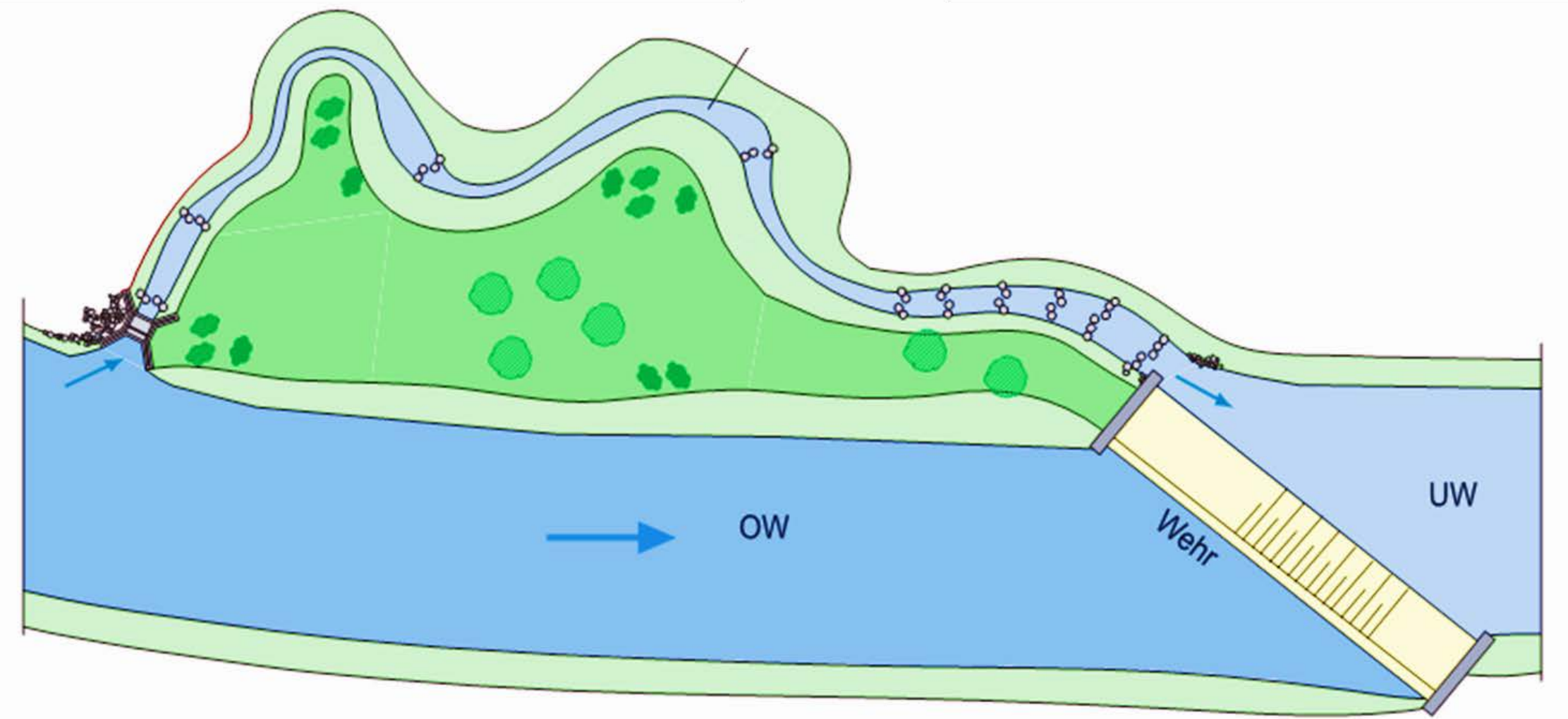
Dam Design: Structure and equipment

- Use **best available techniques** and **state-of-the-art technology**
- Build **fish passages/ladders**
- **Enhance/enlargen water-release structures** for e-flows (e.g. Jindabyne Dam in Australia)
- Add **bypass tunnels and bottom outlets** to allow sediment transport
- Install **fish-friendly turbines** to reduce mortality
- Install **special water intake towers** for variable water temperature (e.g. Berg River dam, South Africa)

2. Minimize/Mitigate – Fish-friendly equipment



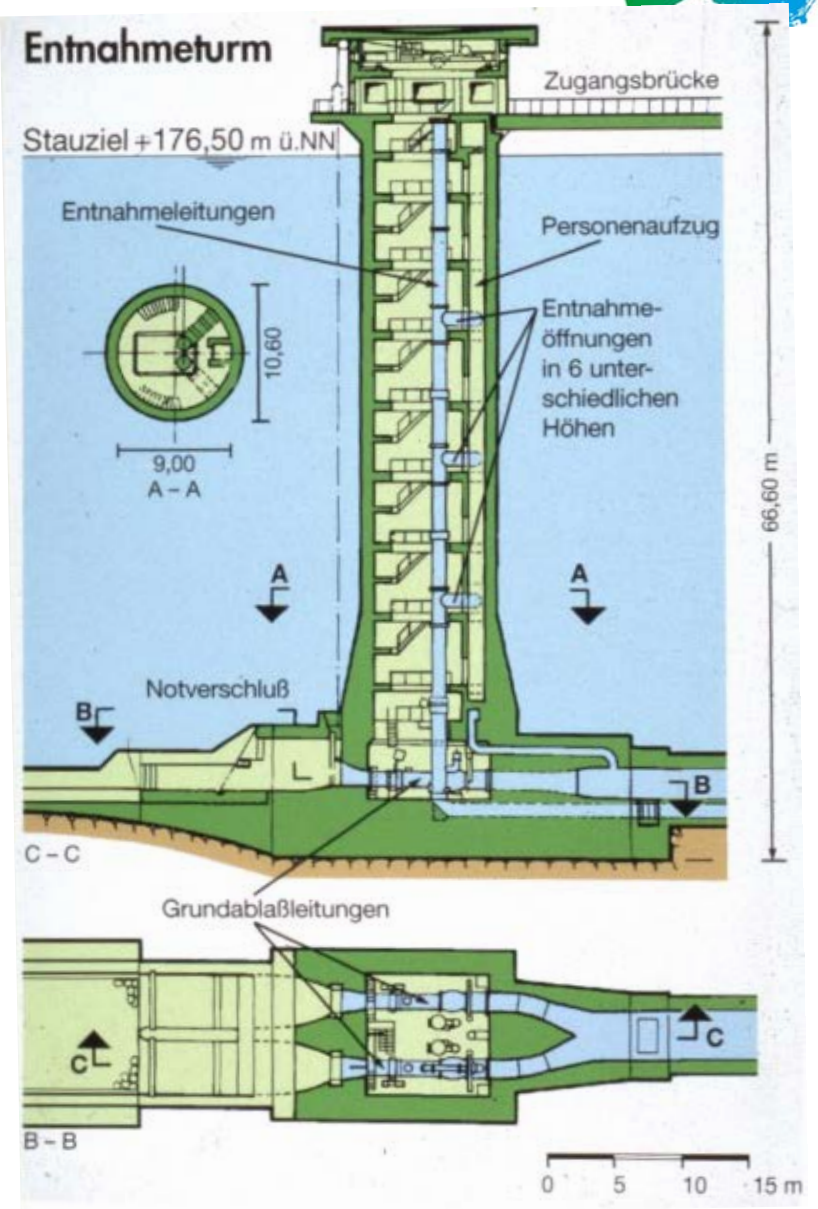
2. Minimize/Mitigate – Fish passages



2. Minimize/Mitigate – Water Intake Tower

water intake (drinking water)

bottom outlet



Intake tower
for level-specific water withdrawl

2. Minimize/Mitigate – How?

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Dam Operations

- **Apply best practices/standards**, incl. for dam safety (e.g. IFI safeguards, etc.)
- **Design and implement e-flows** (volume, timing, temperature, sediments)
- Facilitate and **coordinate for multi-purpose use** and IWRM
- **Build capacity** of plant managers and staff
- **Consider the changing climate** and impacts on dam operations!

2. Minimize/Mitigate – Environmental Flows

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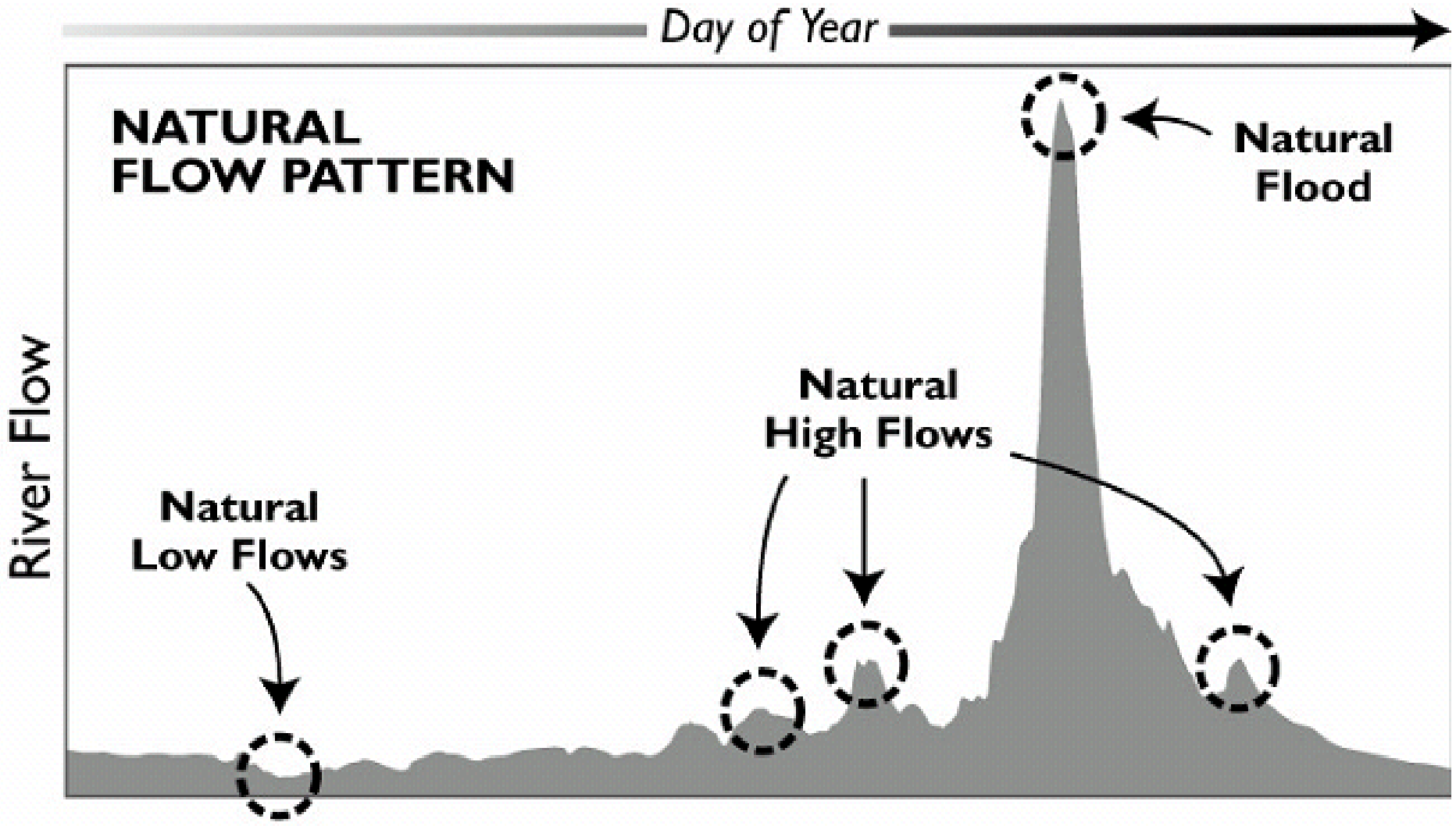
"Environmental flows"
≠ natural flows
= quantity, timing, and quality of water flows
required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems.

Basic Approaches to setting Eflow Standards

- Minimum flow thresholds
  - Annual or seasonal minimum flow levels to not be undercut
- Variation percentage of natural flow
  - Bands of allowable alterations from the natural flow regime (sustainability boundaries)
- Systematic construction of a modified flow regime
  - Specification of flow elements representing well defined features of the flow regime intended to achieve particular ecological, geomorphological, water quality, social or other objectives in the modified system

2. Minimize/Mitigate – Environmental Flows



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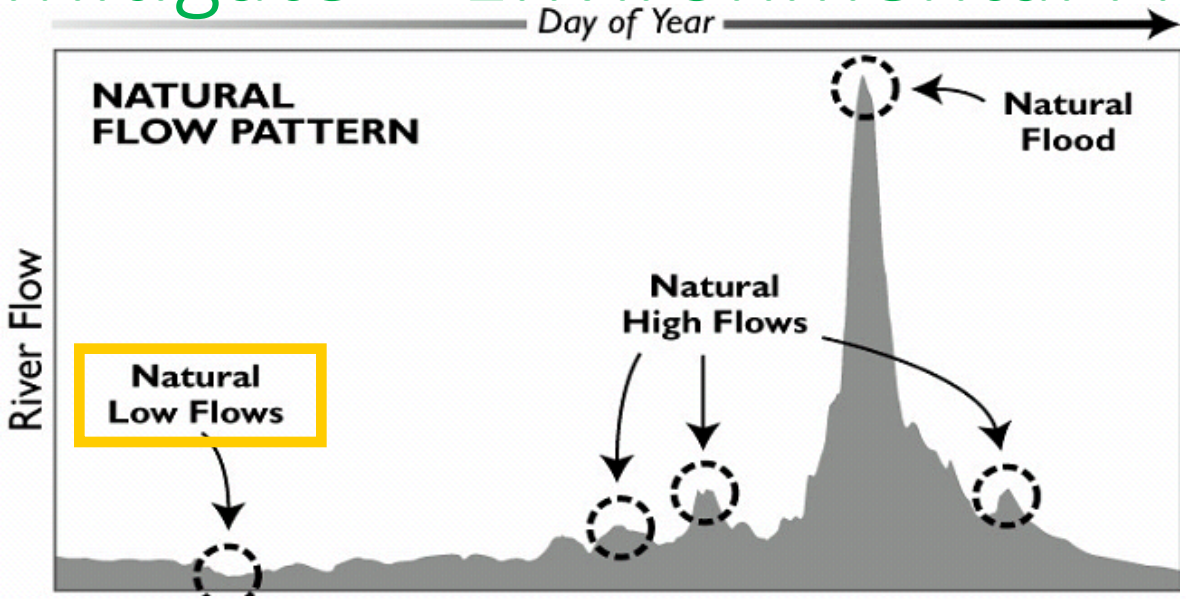
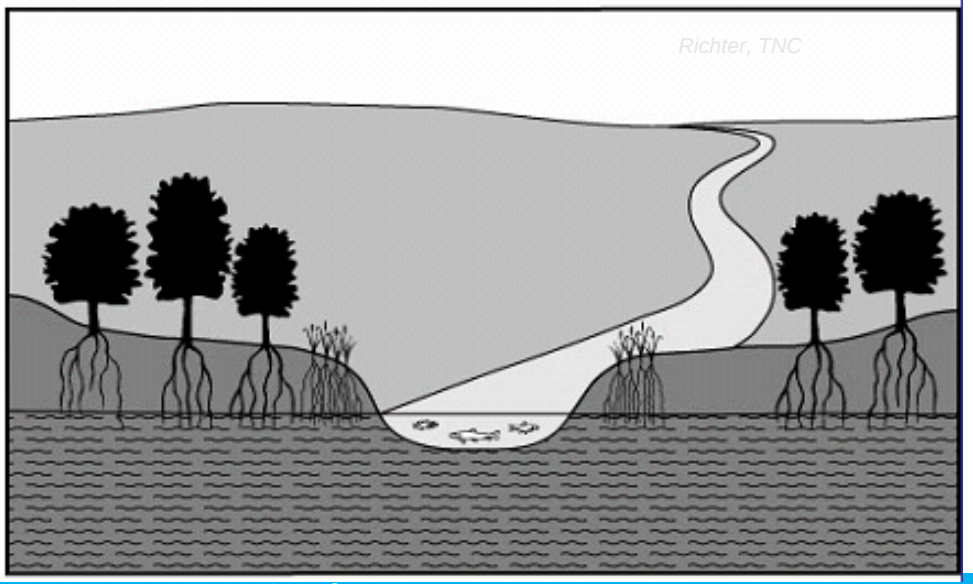


Natural Low Flow

- Fish have adequate oxygen and can move up- or downstream to feed
- Riparian vegetation sustained by shallow ground water table
- Insects feed on organic material carried downstream
- Birds supported by healthy riparian vegetation and aquatic prey



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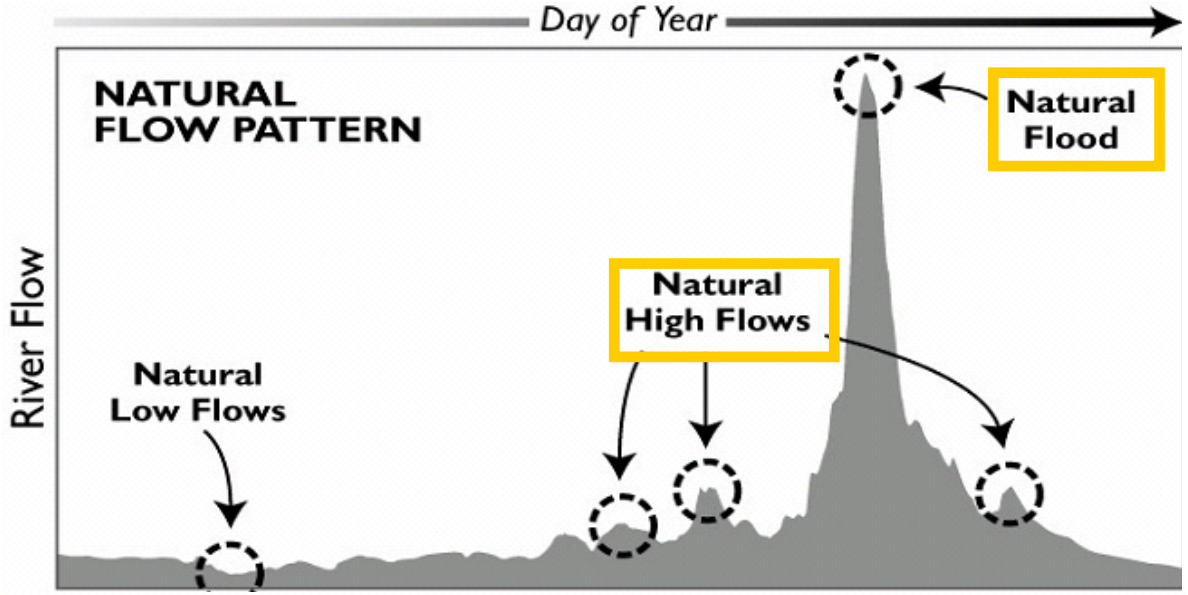
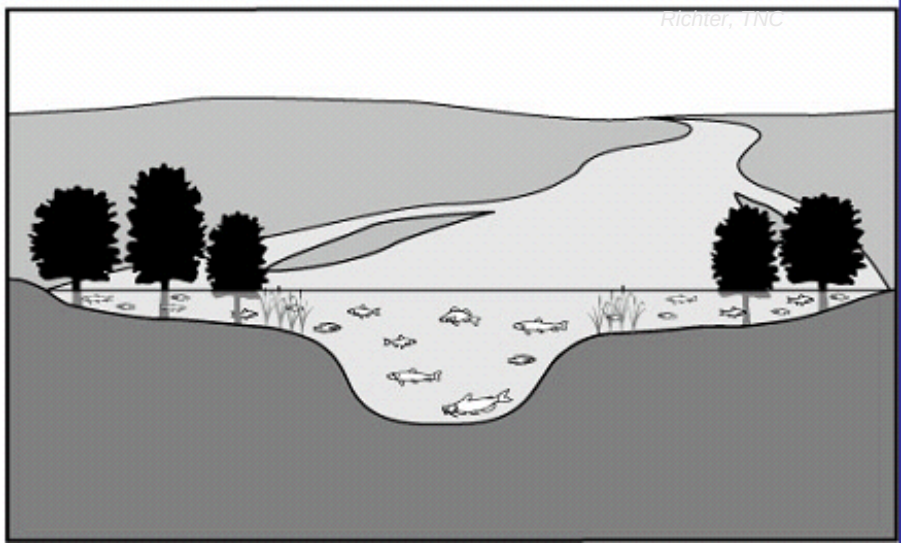


Natural Flood

- Fish are able to feed and spawn in floodplain areas
- Riparian plant seeds germinate on flood-deposited sediments
- Insects emerge from water to complete their lifecycle
- Wading birds and waterfowl feed on fish and plants in shallow flooded areas



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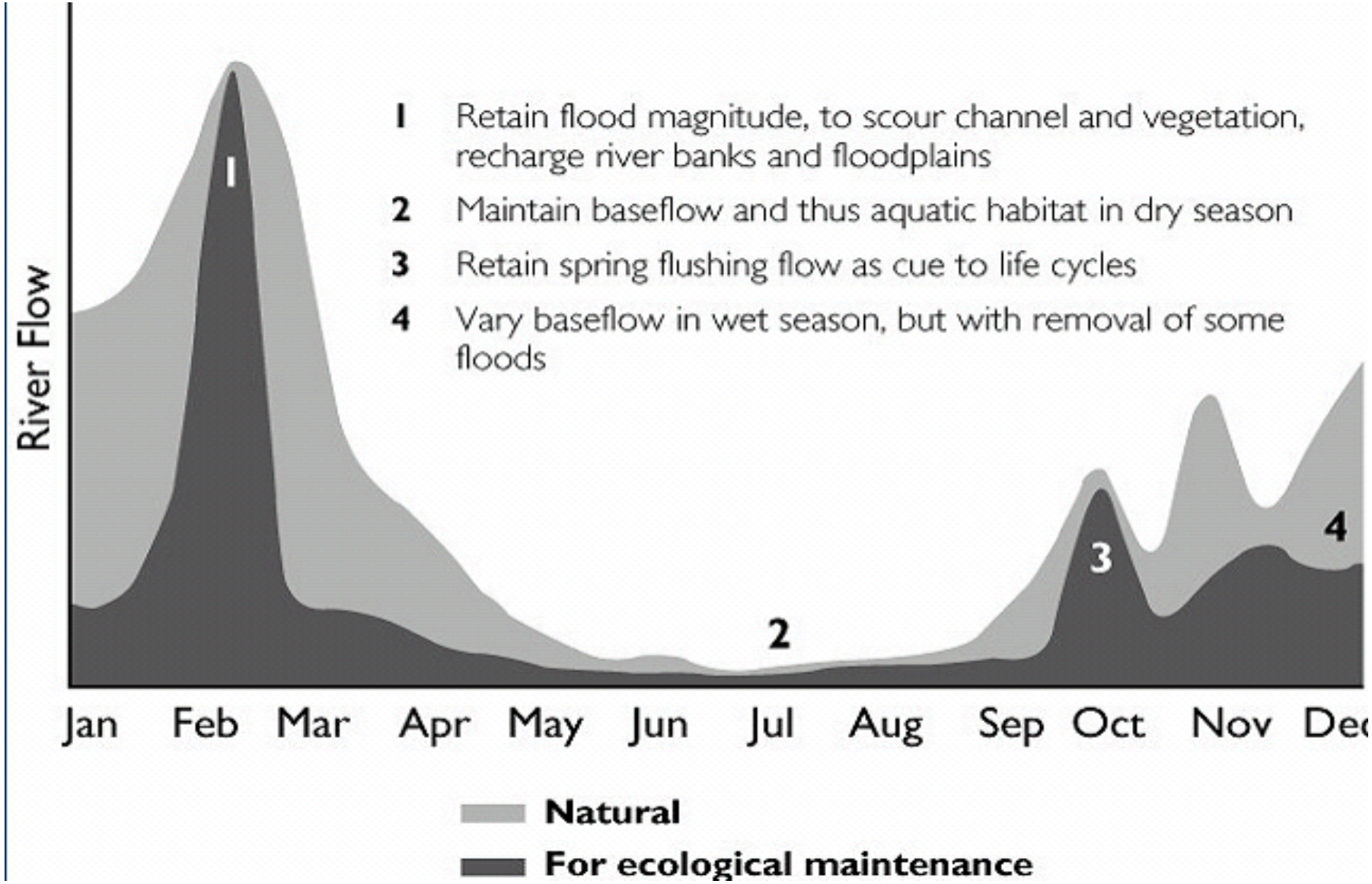

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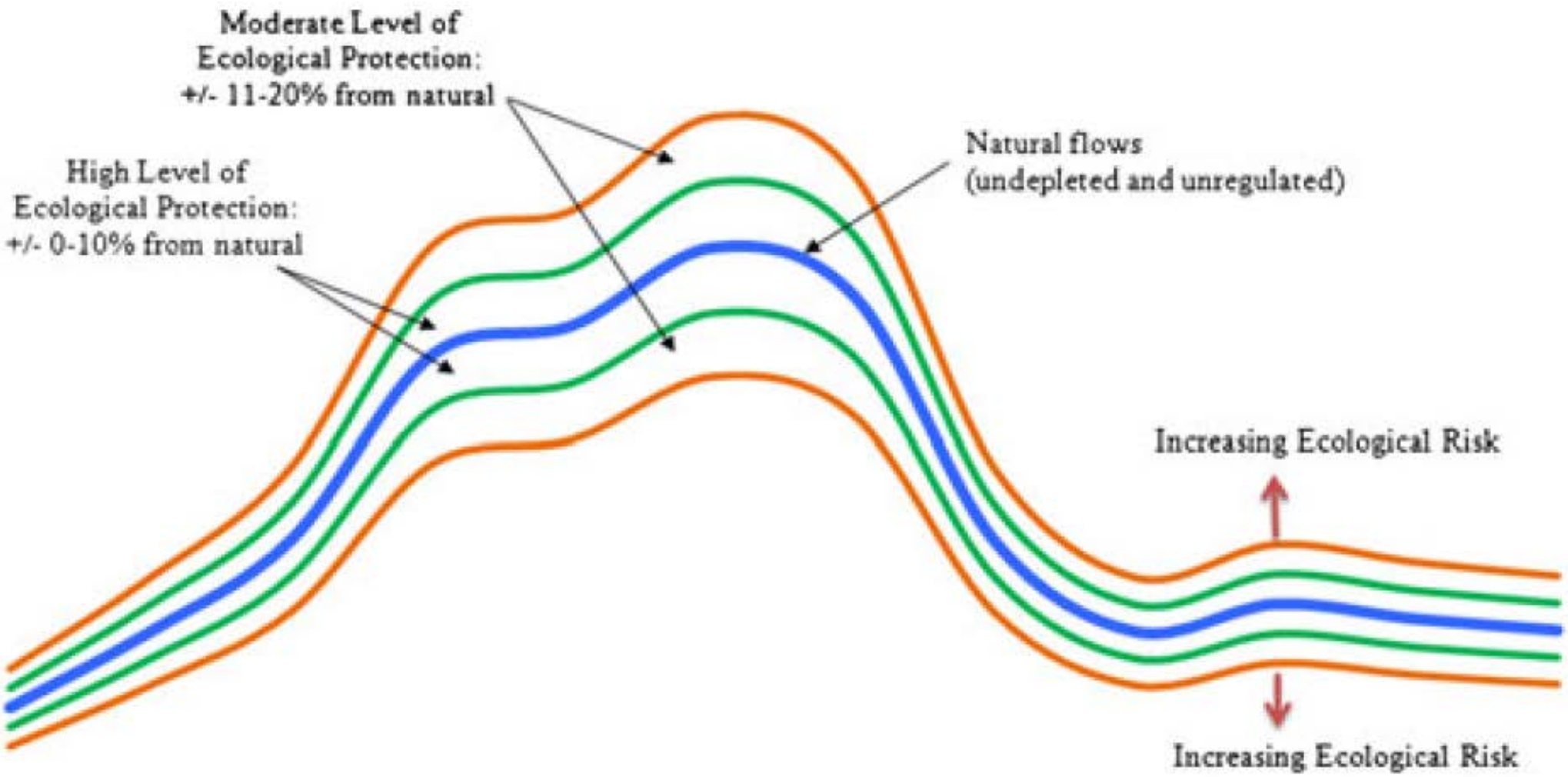

2. Minimize/Mitigate – Environmental Flows

Environmental Flow Implementation – Key Steps:

1. **Fully engage stakeholders** in every aspect of e-flow assessment and decision-making.
2. Identify **opportunities for e-flow integration** at a regional scale.
3. **Define e-flow needs** using a holistic approach, utilizing the best available knowledge and tools
4. Assess e-flow needs **before designing the dam's structural features** (***'form follows function'*** concept).
5. For **existing dams**, seek to integrate e-flow needs and implement opportunistically.
6. Be clear about desired outcomes and necessary measures, and **monitor outcomes and re-adjust** during implementation.

Thank you for your attention!

For further info, please contact:
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or visit: **www.gwp.org**