The study and management of large river ecosystems: Some points to ponder.

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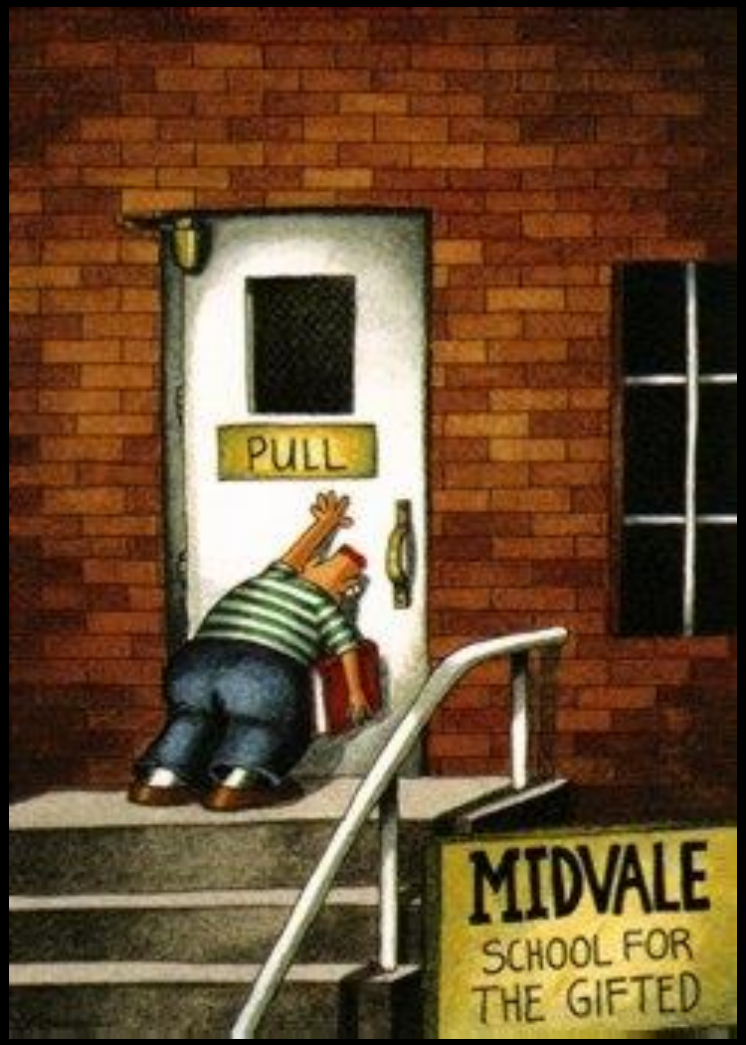
RIVERINE LANDSCAPES RESEARCH LABORATORY

SCIENCE ◇ APPLICATION ◇ MANAGEMENT

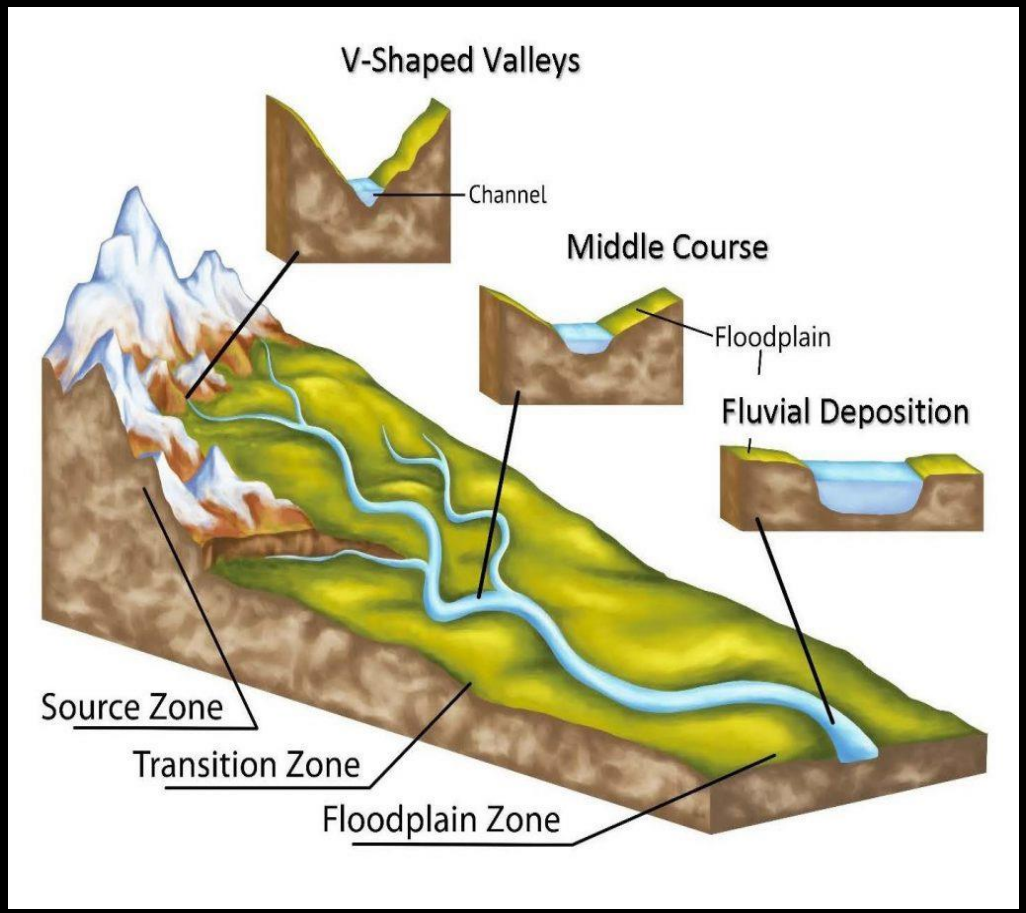
Points to ponder



1. Large river ecosystems are not just large streams.
   - Scale is important
   - Increase size = increase complexity
   - Implications for cause and effect.

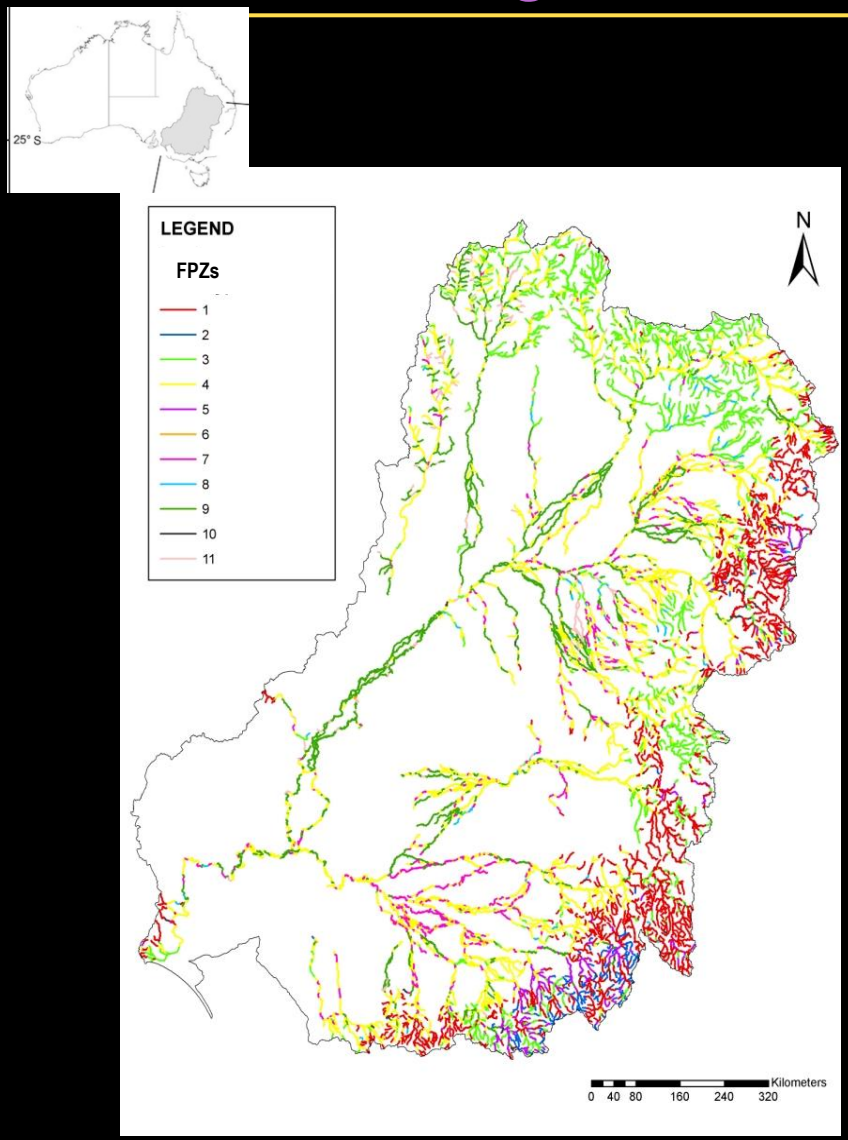
2. Large river ecosystems in the Anthropocene.
   - Resilience Thinking
   - Restoration will not push us back
   - Implications for how we study, manage and monitor.

1. Large rivers are not large streams



- Traditional models of river ecosystems:
  - Clinal change downstream in biophysical character.

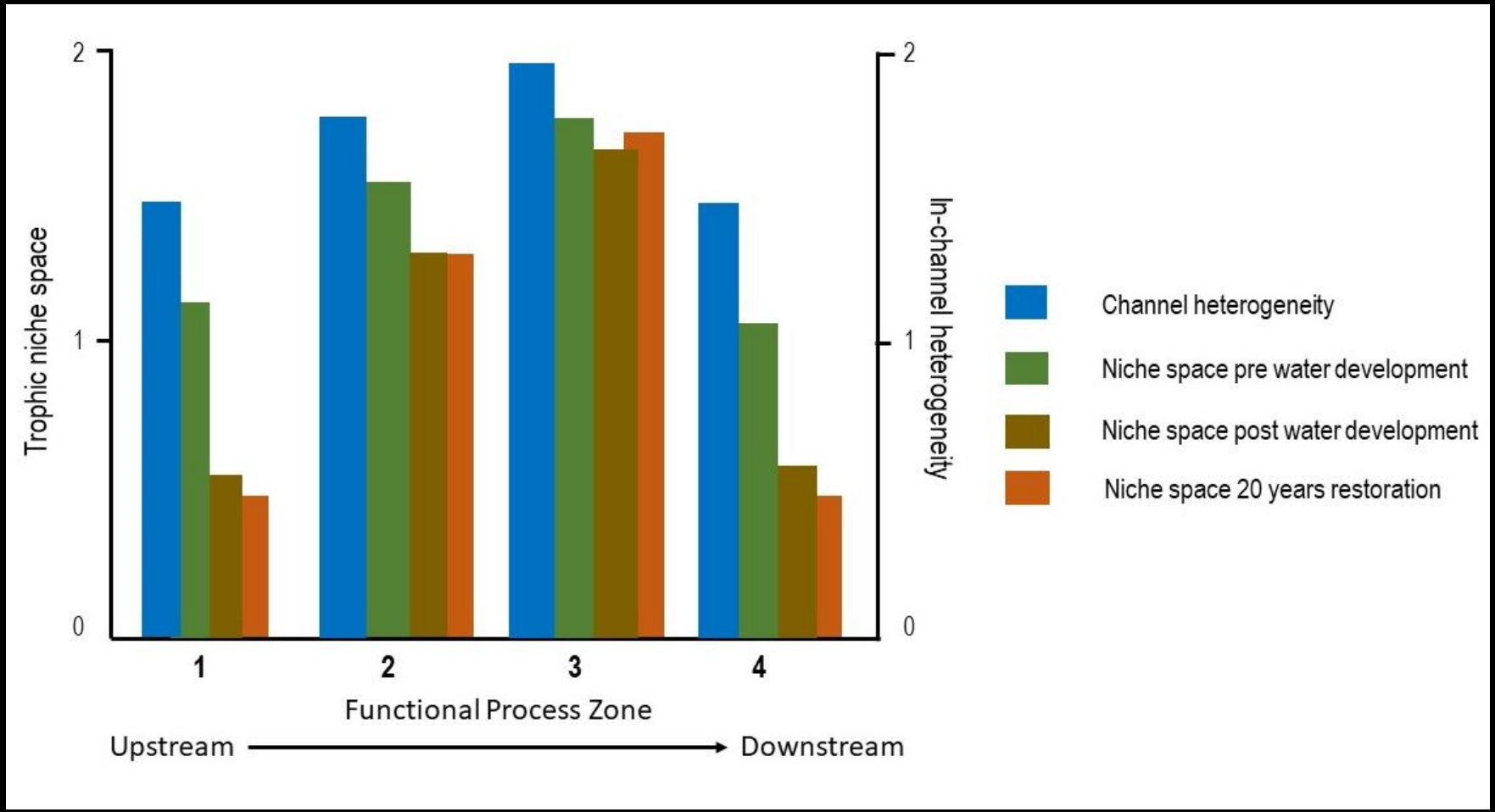
1. Large rivers are not large streams



- Do not display predictable, continuous change in biophysical character from headwaters to lowland regions.
- Functional Process Zones (FPZs) – spatially heterogenous pattern landscape mosaic.
- Each FPZ is distinct in terms of:
  - Physical character (habitat assemblage)
  - Biota
  - Riparian / floodplain vegetation
  - Ecosystem function (food webs)
  - Ecosystem services (type and use)
  - Response trajectory to disturbance.

1. Large rivers are not large streams

Trophic niche space of FPZs along the Darling River, Australia



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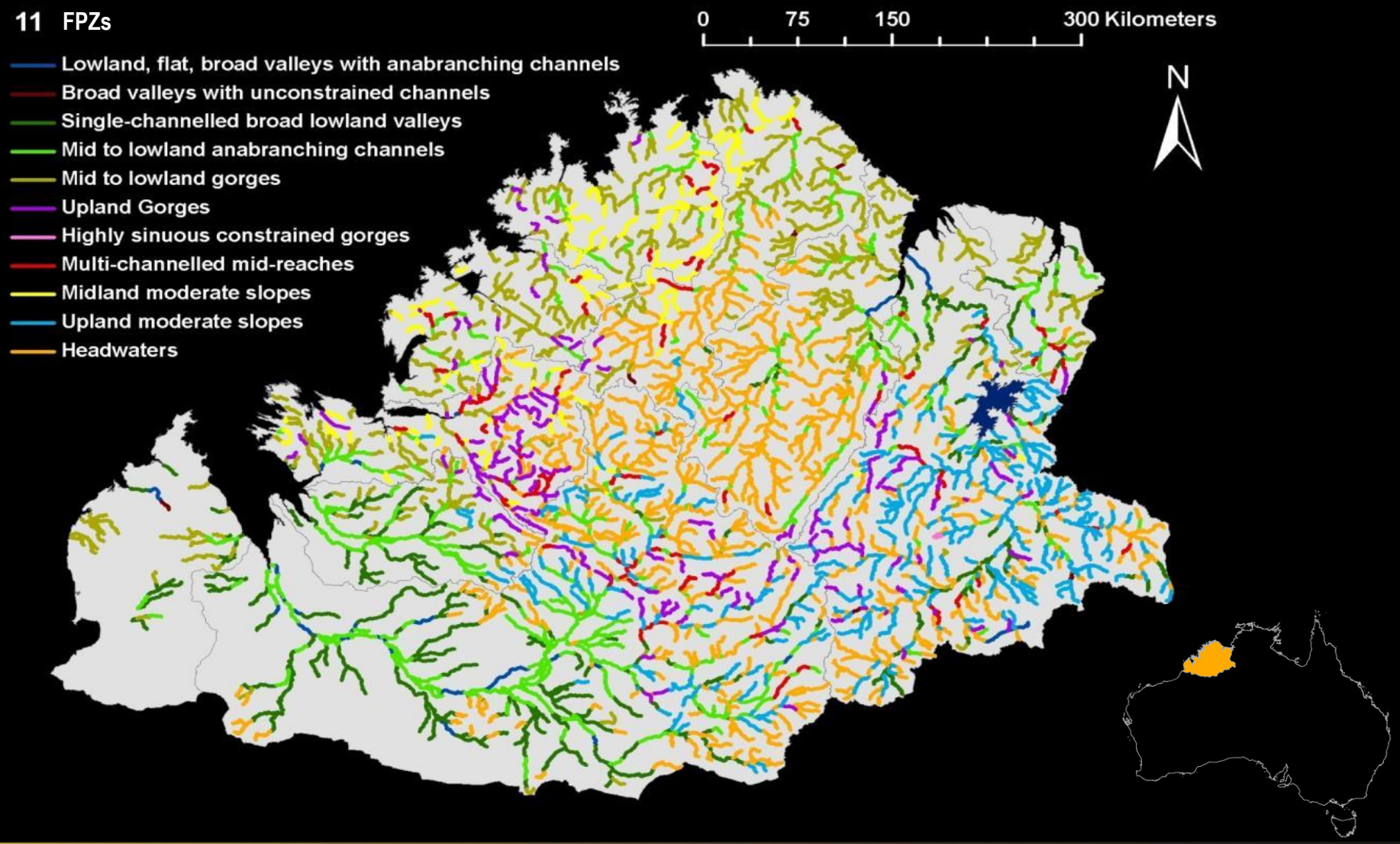

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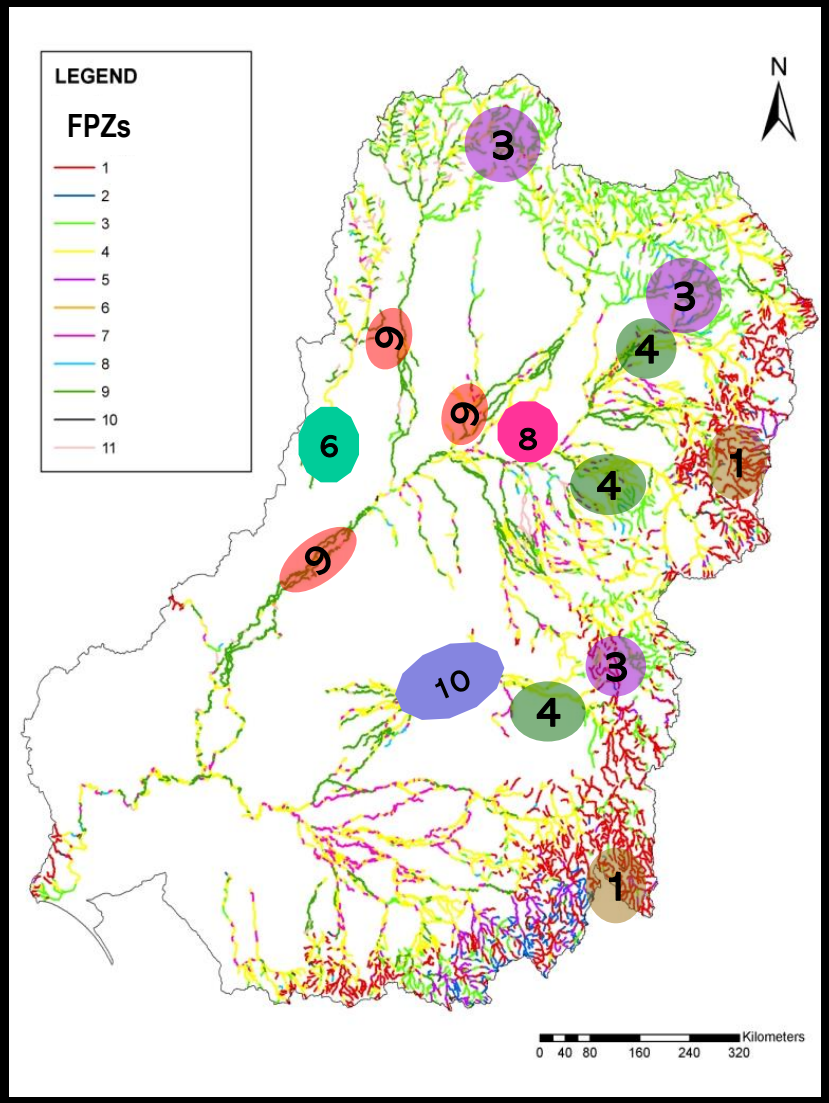


- Four abundant FPZs:
  - FPZ 1:
  - FPZ 3:
  - FPZ 4:
  - FPZ 9:

- Rare FPZs:
  - FPZ 6:
  - FPZ 8:
  - FPZ 10.

1. Large rivers are not large streams

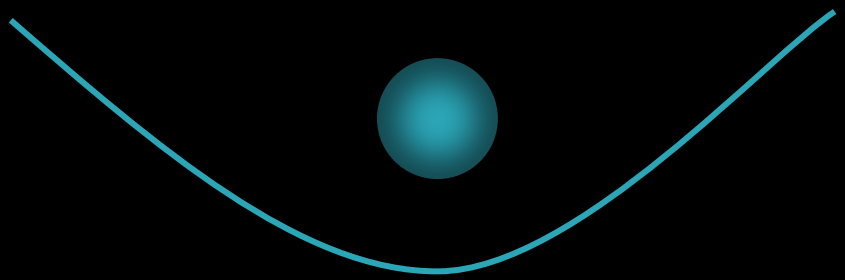
Implications:

- Complex landscapes – series patches (FPZs), varying connections between patches.
- Each FPZ has unique set of influencers and sensitivity.
- Each FPZ response to disturbance(s) is unique.
- Outcomes, indicators and what you monitor will vary between FPZs.
- Need to understand the entire riverine landscape mosaic.

2. Large rivers in the Anthropocene

- Anthropocene – human domination of the environment.
- Anthropocene Rivers are different to their natural cousins - they are novel.
- Implications for the study and management of Anthropocene.
- View through a ‘Resilience’ lens.

2. Large rivers in the Anthropocene



- Ball & Cup model of resilience.
- Thresholds and Tipping Points.
- Fast and slow variables.
- FPZs have different Tipping points and fast and slow variables.

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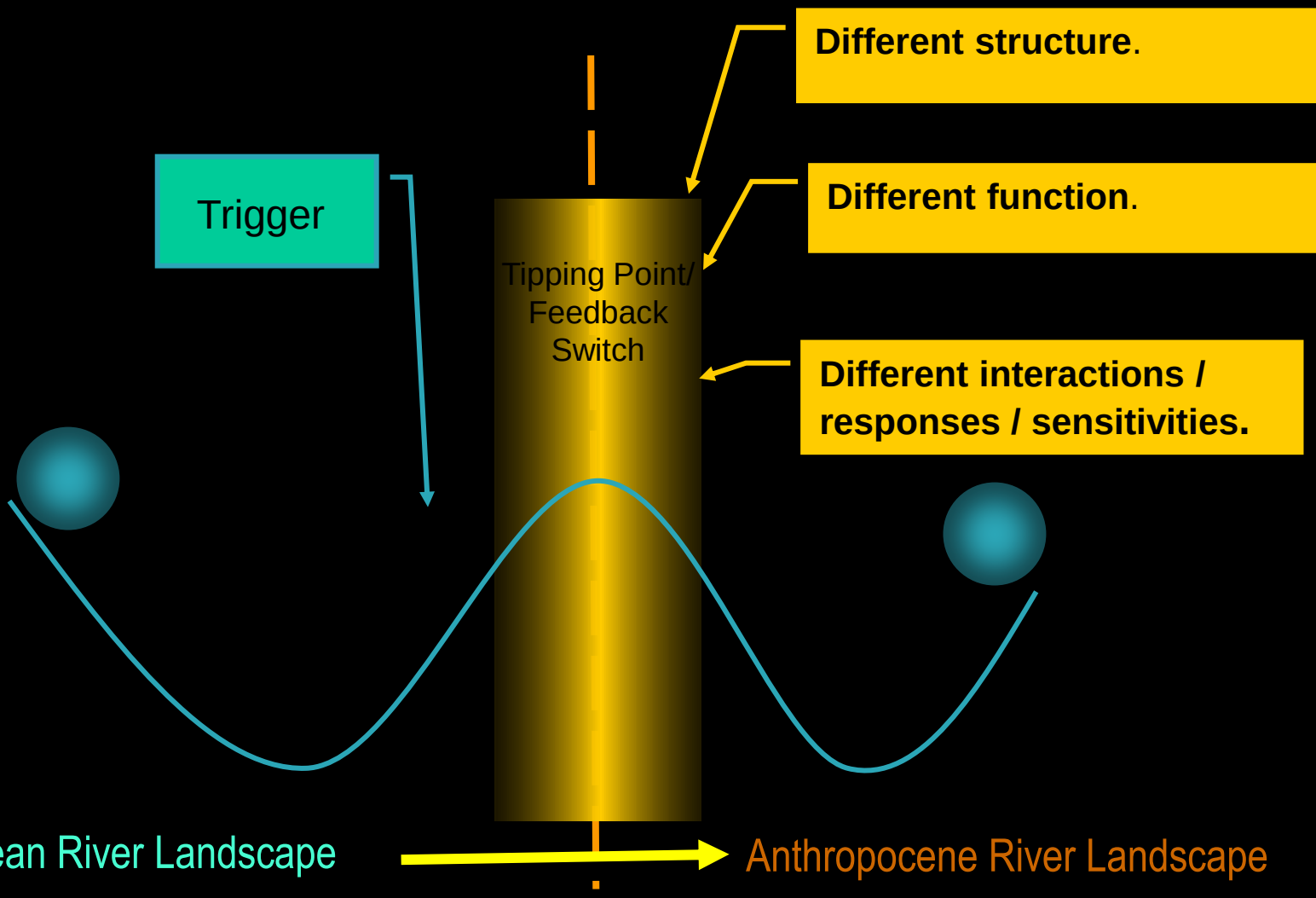

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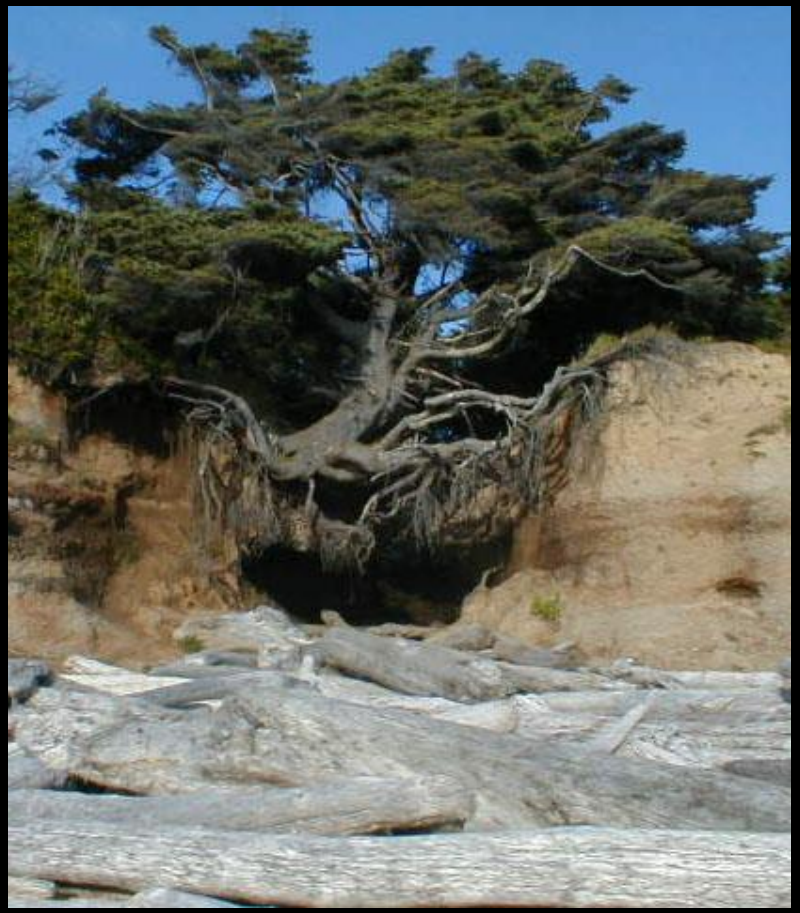

Multiple Lines of Evidence:

- Climate
- Land use (management)
- Hydrology (surface flow and groundwater)
- Sediment regimes
- Floodplain and channel morphology
- Aquatic community composition /interactions/responses
- Vegetation composition/responses
- Ecosystem responses to restoration efforts.

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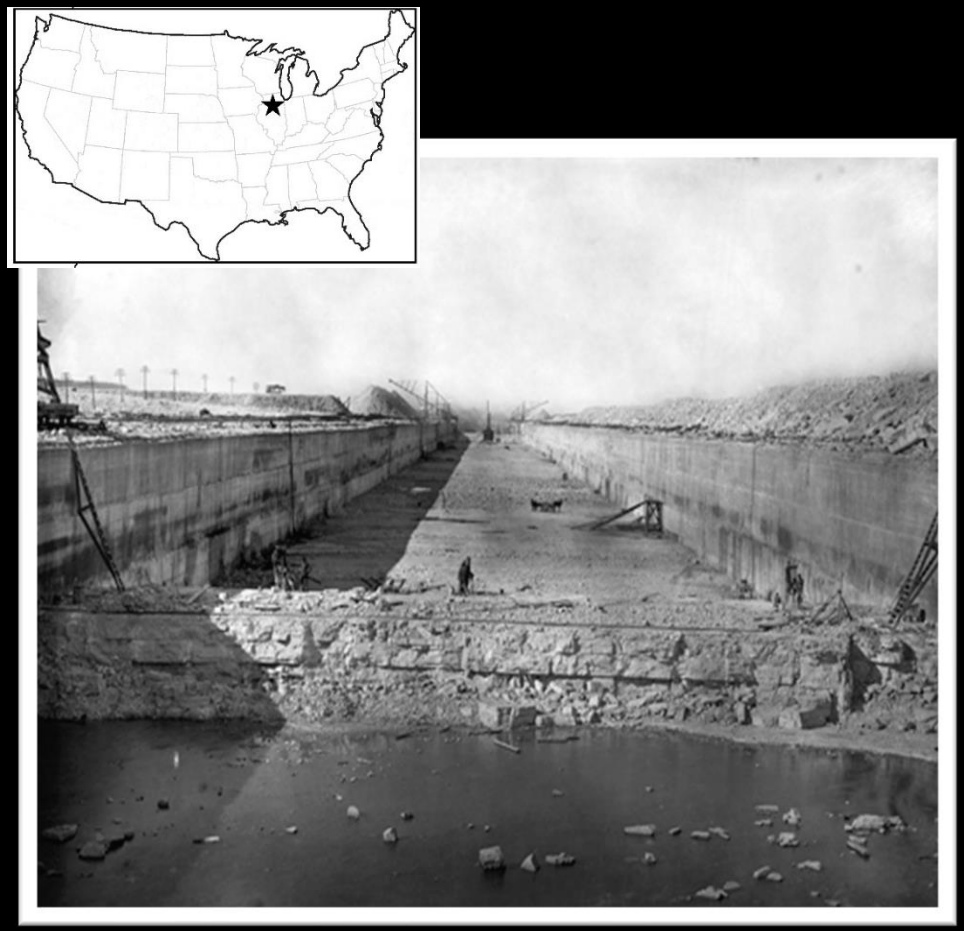

The Illinois River USA:

- 1900 - Chicago Sanitary and Ship Canal.
- Biological dead for 500 km downstream as result of poor water quality.
- Major restoration efforts 1948 and 1972; and in 1982 water quality restored to pre 1900 levels.
- Ecosystem structure (fish diversity), function (food webs), interactions (fish growth) did not return to pre 1900 levels.

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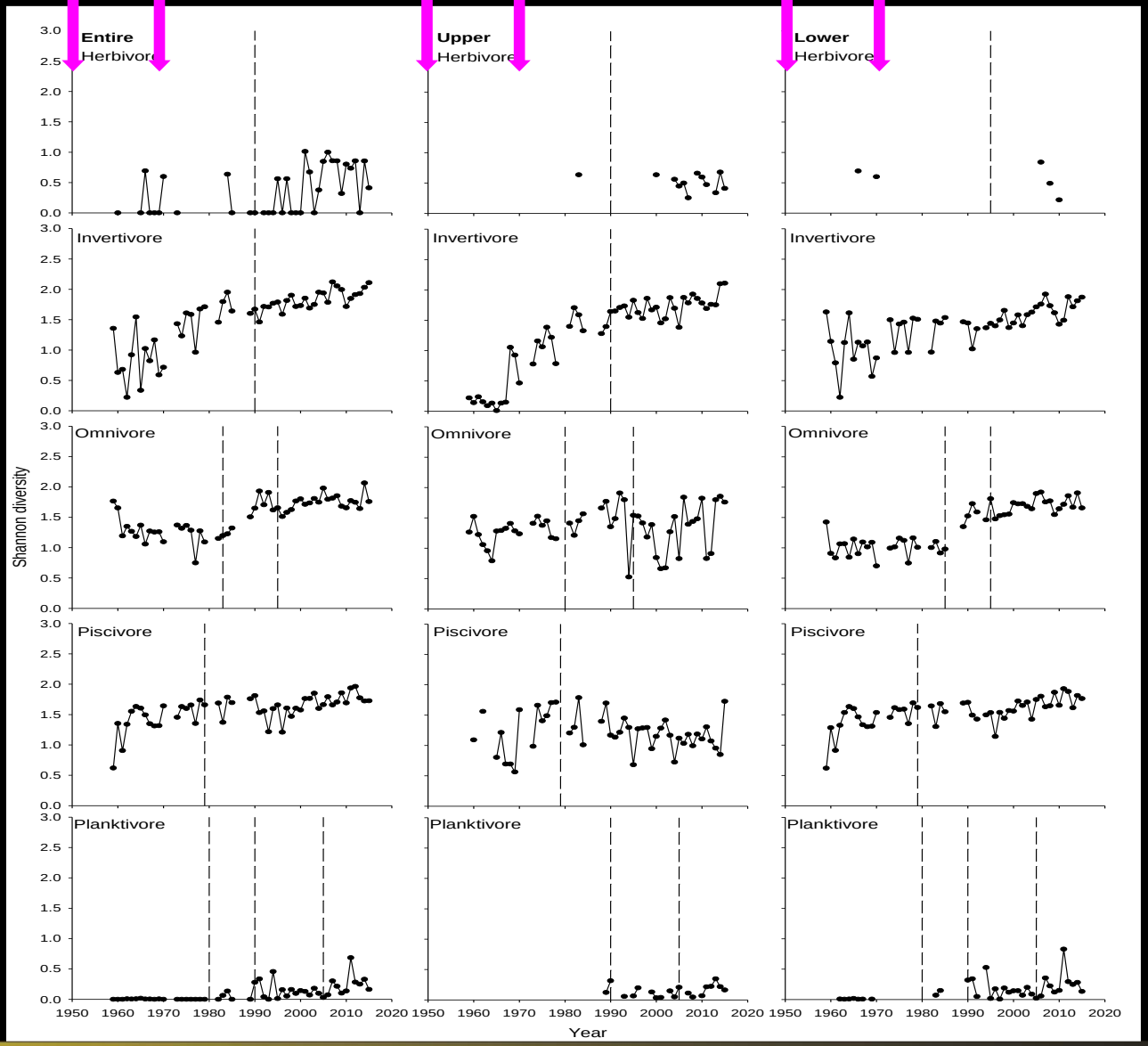

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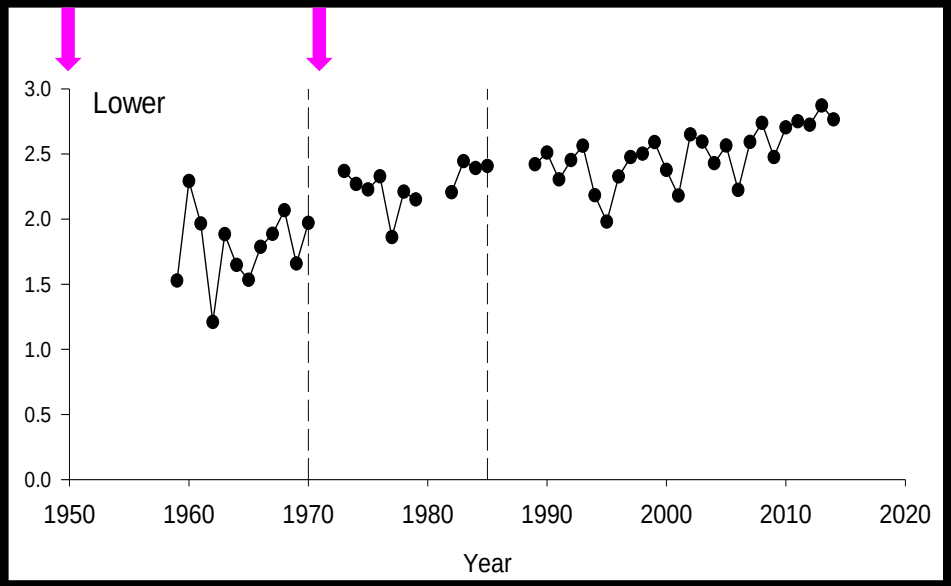
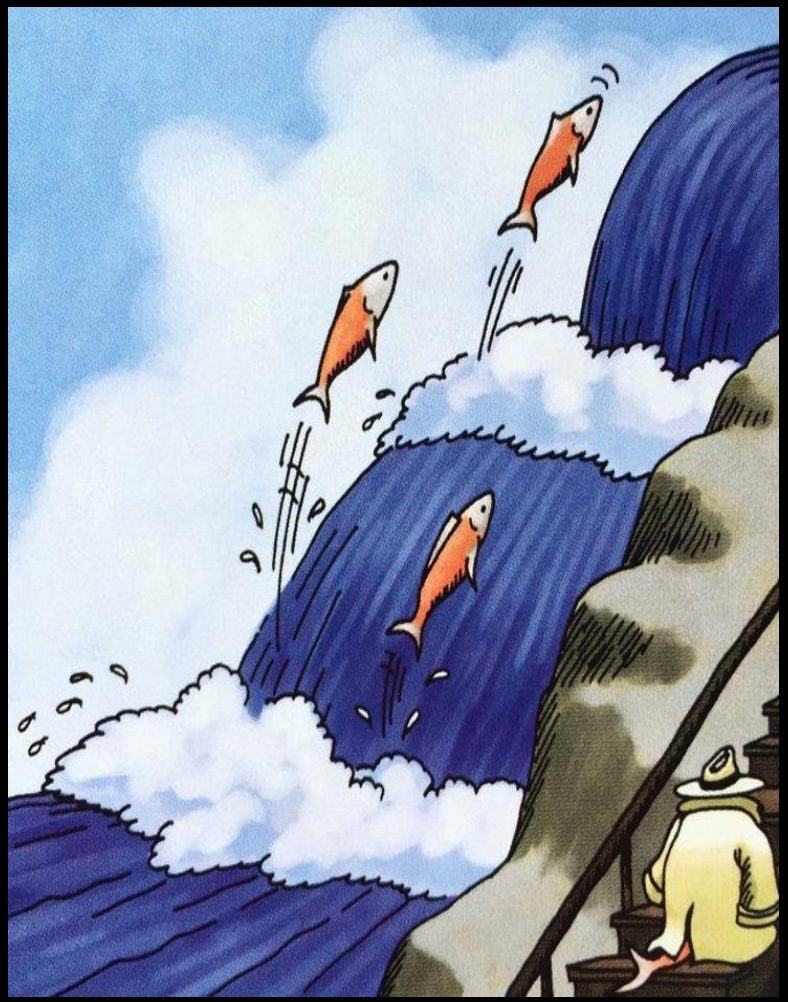


The Illinois River USA:

- Fish diversity poor despite excellent water quality.
- Fish response trajectories differ between feeding guild and location along the river (FPZ)
- Response trajectories are *Novel*

2. Large rivers in the Anthropocene



Implications:

- Cannot restore back:
  - ecosystem targets / outcomes cannot be achieved.
- Managing for the future:
  - to prevent further flips.
- Increased focus on slow variables:
  - not just water quality ??
- Targets / outcomes / indicators specific for FPZs.

Points to Ponder

Context:

- Large river ecosystems in the Anthropocene:
  - complex adaptive systems requiring different approaches to their study and management
  - avoid further system flips – resilience thinking.

Response:

- Increased scale of focus
  - river network
  - complexity, heterogeneity and variability.
- Zone specific management.
- Improved focus on outcome, indicators and monitoring.