AMBER & Dam Removal Europe

Opening barriers in European rivers

Seminar and visit to the dam of Yecla de Yeltes

April 16 - 17, 2018 | Madrid, Spain

Flow Regulation: environmental effects in long term

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Organised by

Montes

DAM REMOVAL EUROPE

AMBER

WORLD FISH MIGRATION FOUNDATION

AEMS Ríos con vida

WORLD FISH MIGRATION DAY

Flow Regulation: Environmental Effects in the medium and long term

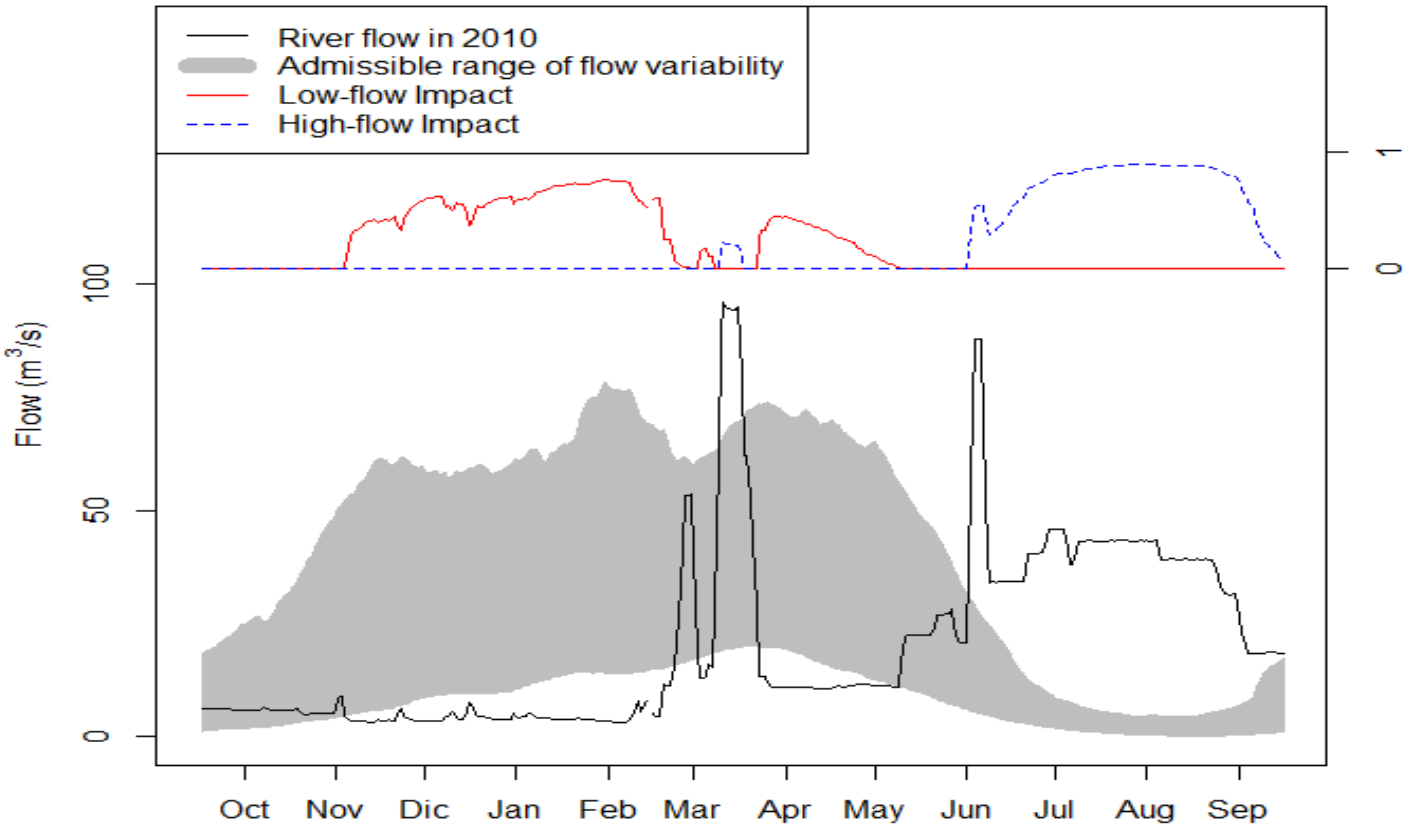
1. Types of Flow Regulation and Hydrological Impacts
2. Changes in Sediment budget
3. Bio-Geomorphic responses
4. Biological responses
5. Regulation extension & Resilience
6. Restoration & Hysteresis

1. Types of Regulation and regulation impacts

- Reservoir uses types:
  - Irrigation
  - Domestic & industrial use
  - Hydropower
- Regulation intensity:
  - Regulation Index: *Annual flow/reservoir capacity*
    - > 1: Hiper-reservoirs
- Hydrological impacts

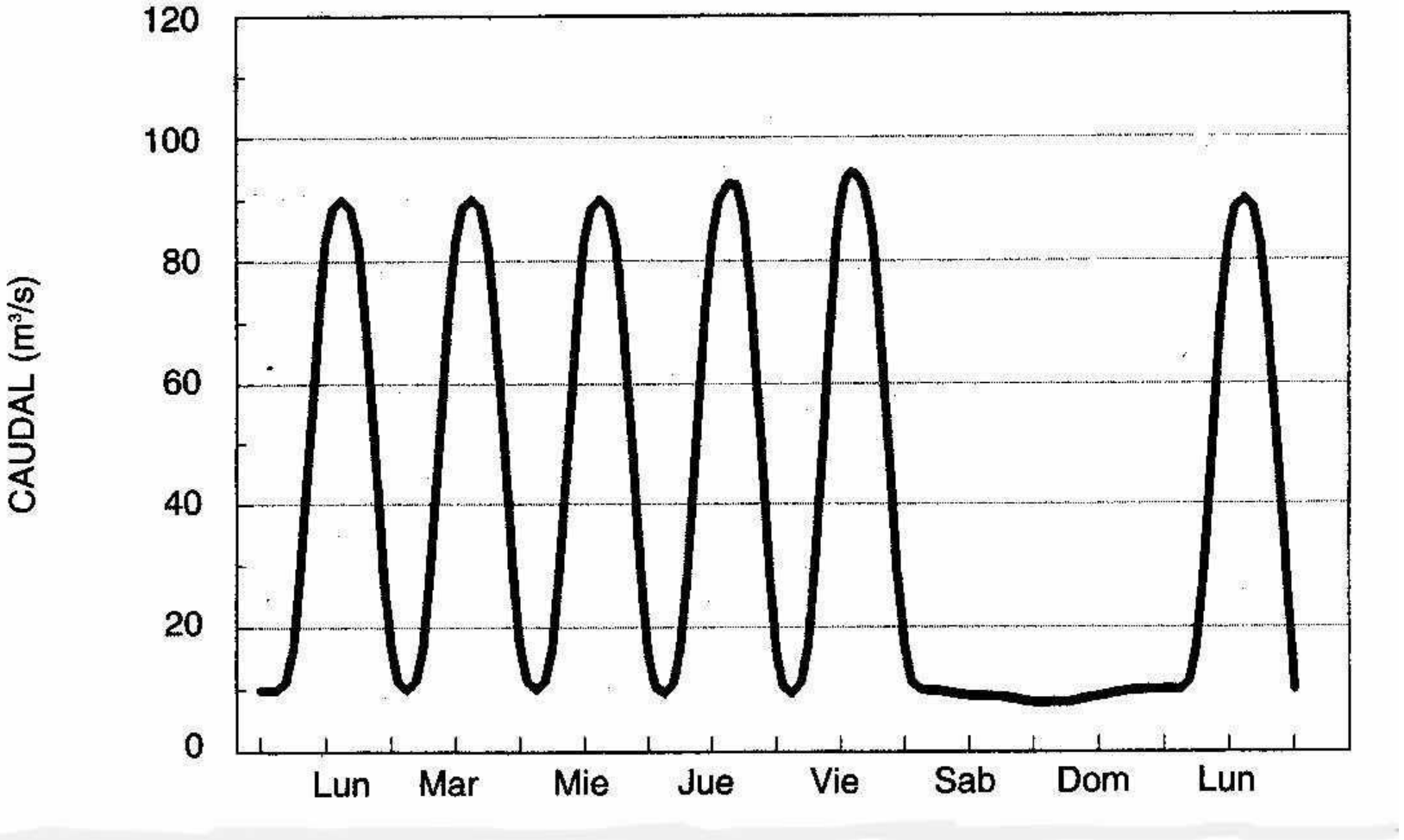
1. Regulation intensity: impacts

IMPACTS: according to how much instream flows were outside of the **'Range of Natural Variability'** along the year.

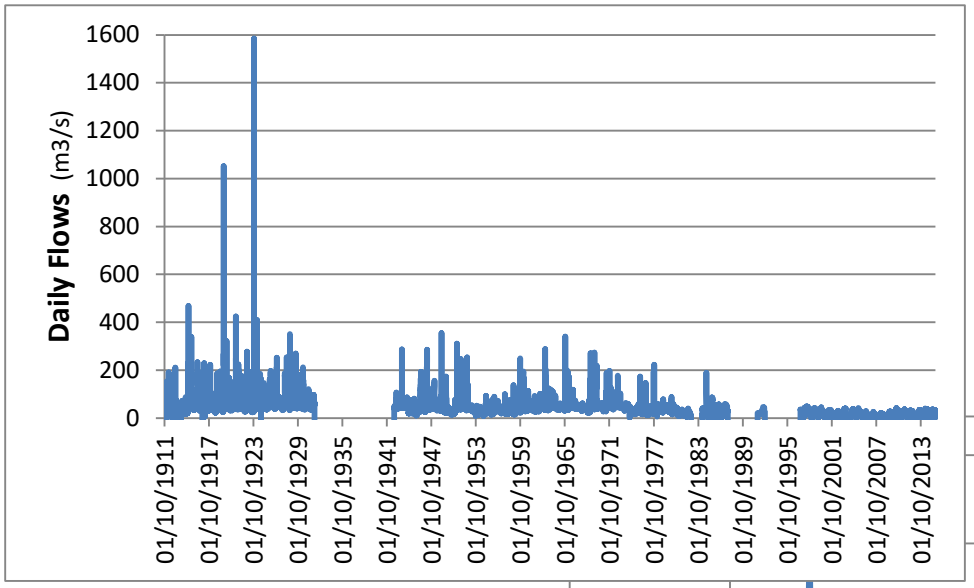


WATER for HYDROPOWER

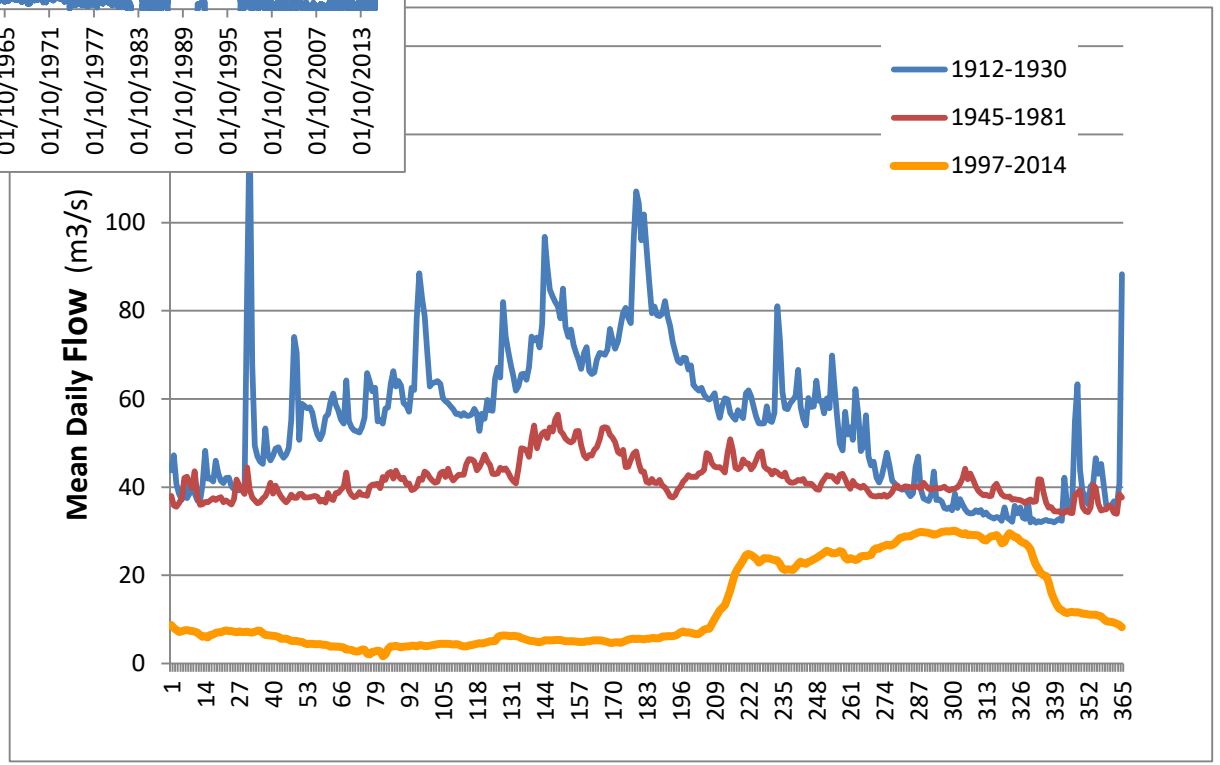
Short-term flow fluctuations



WATER for IRRIGATION



Río Jucar (Tous)

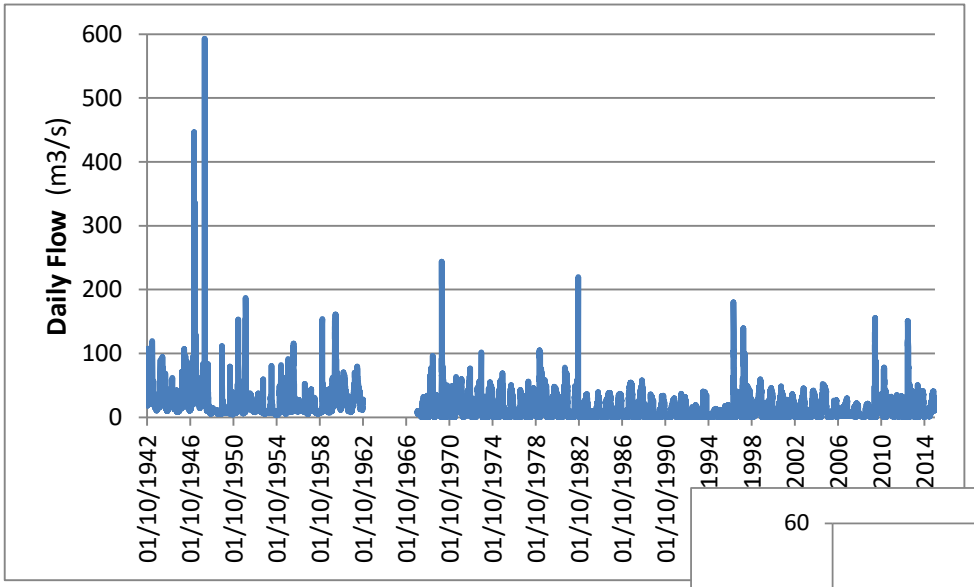


Caudales medios (m3/s)

1912-1930	1945-1981	1997-2014
55.3	41.5	12.8

Flow reduction

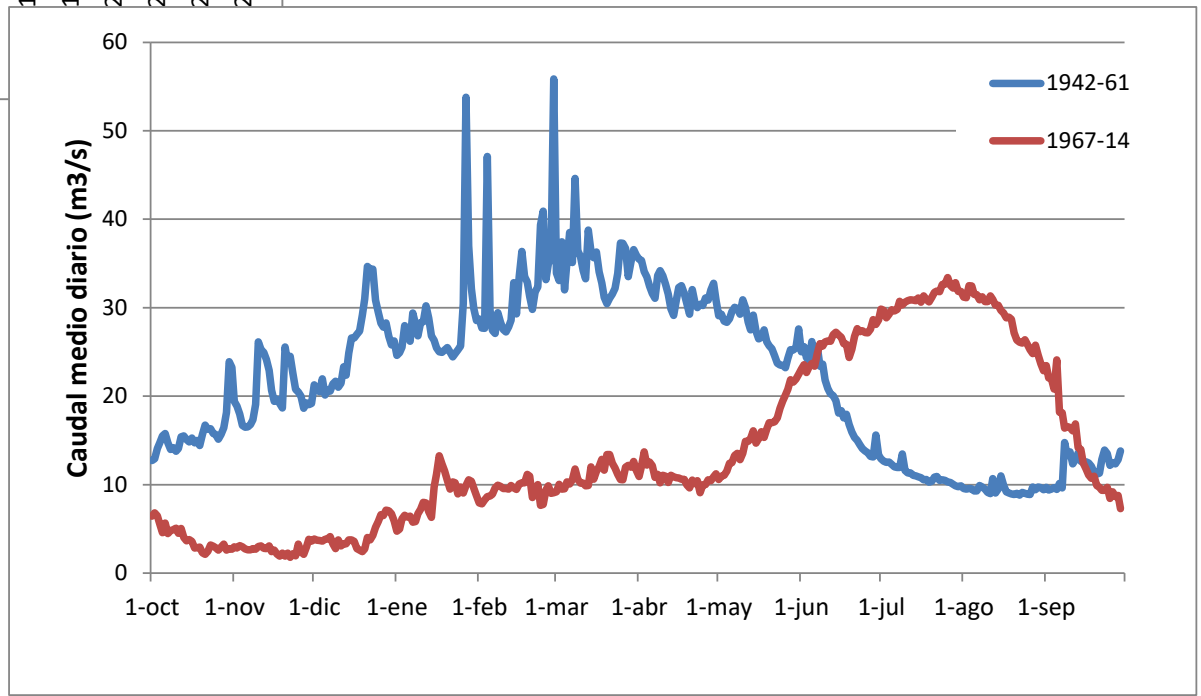
WATER for IRRIGATION



Río Genil (Iznajar)

'Mediterranean' regime toward a 'Monzonic' regime

Maximum monthly flows in summer



Caudales medios (m3/s)

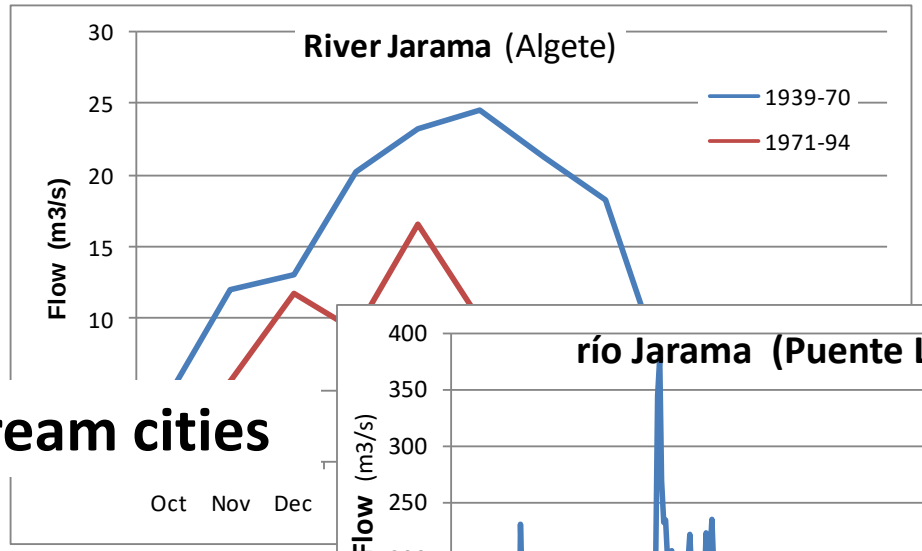
1942-61	1967-14
22.3	13.9

Flow reduction:

WATER for Domestic and Industrial uses

Water-supply Reservoirs: Changes in flow regime in a **bypass reaches**, and **downstream urban sewage** treatment plants

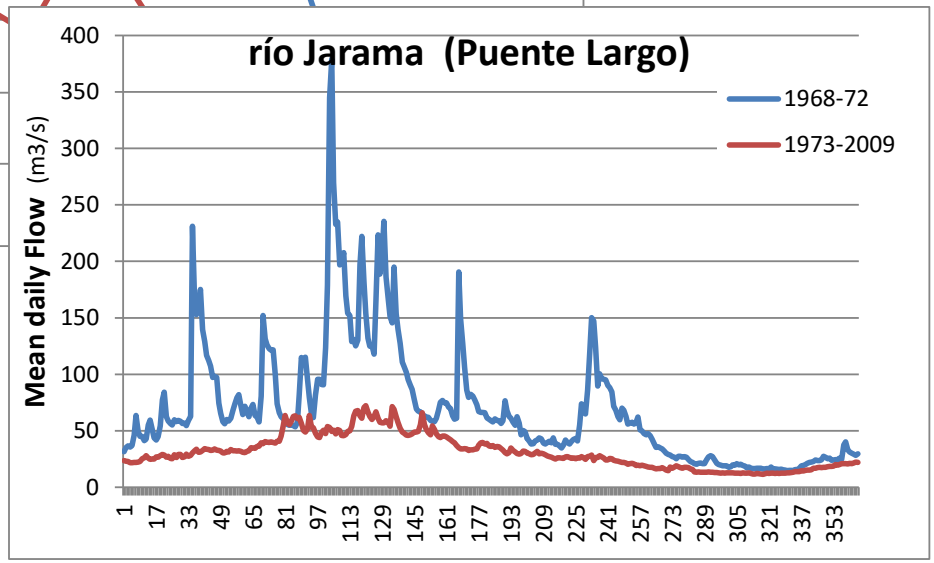
Bypass:



Qma = 12,3 m3/s

Qma = 6,4 m3/s

Dowstream cities



2. Changes in Sediment budget

Rivers have lost their sediments

- the reservoirs act as huge **sediment traps**,
- But also:
  - abandoned high lands have reduced the sediments sources,
  - gravel mining takes away the sediment left.


Barasona Reservoir


River Ebro

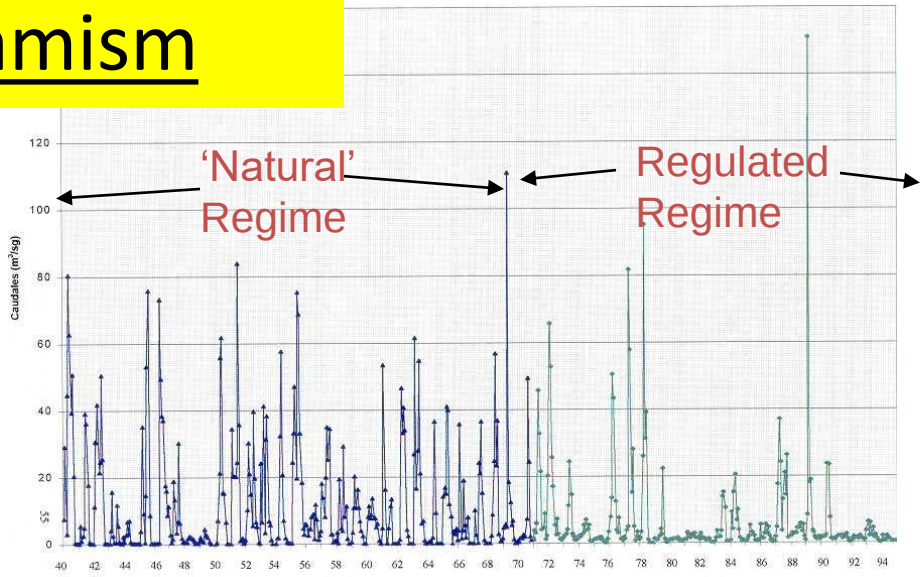
2. Changes in Sediment budget

Effects of Sediments Retention by dams

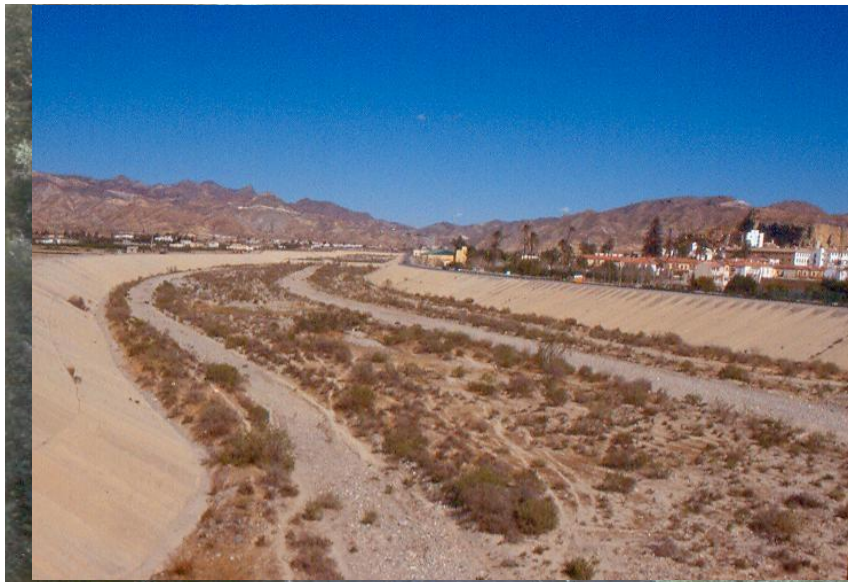
- Rivers below dams have lost all most their sediment yield
- After dam is closed, released 'hungry waters' drag sediments from bottom in a size selective process.
- Stages of **Substrate Evolution**:
  - Along years there is a '**wave**' of sediment deficit that moves downstream along the river, changing its substrate traits: caliber increase and armoring
  - Later, substrate comes to an equilibrium between the regulated flow regime and sediment input by tributaries.
  - The effects on the biota vary in space and time according to these stages of substrate change

3. **Bio-Geomorphic Responses**

Rivers have lost their dynamism

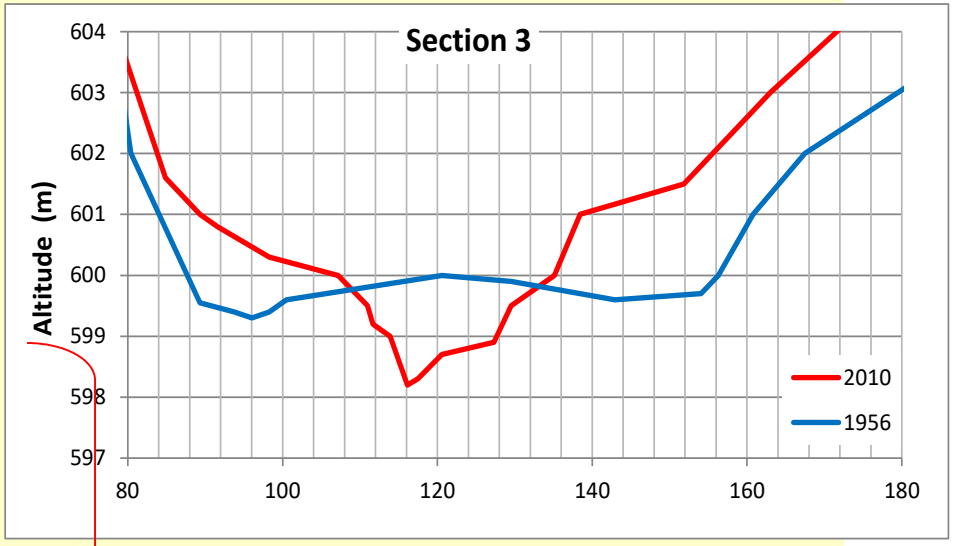


- Reservoirs laminate larger floods
- bankfull discharges become very rare,
- riparian vegetation overgrowths invading channel river margins,
- humans fix rivers by constructing levees and longitudinal dykes.



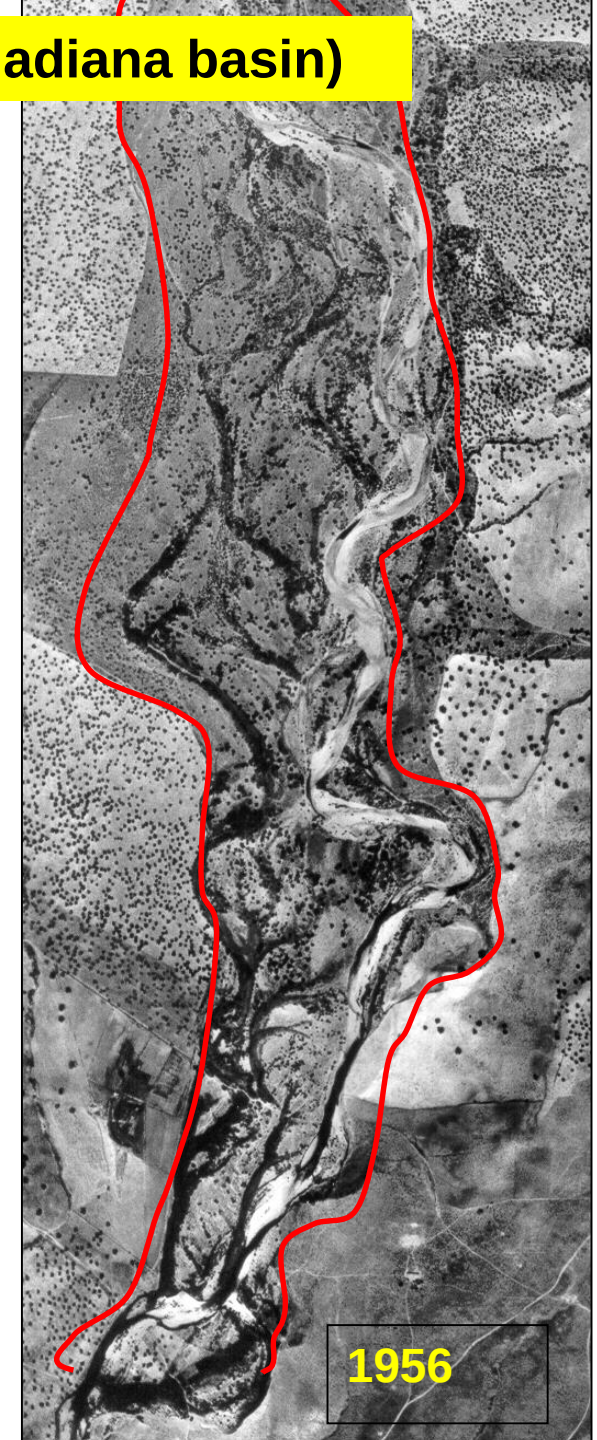
Channel Geo-morphic changes

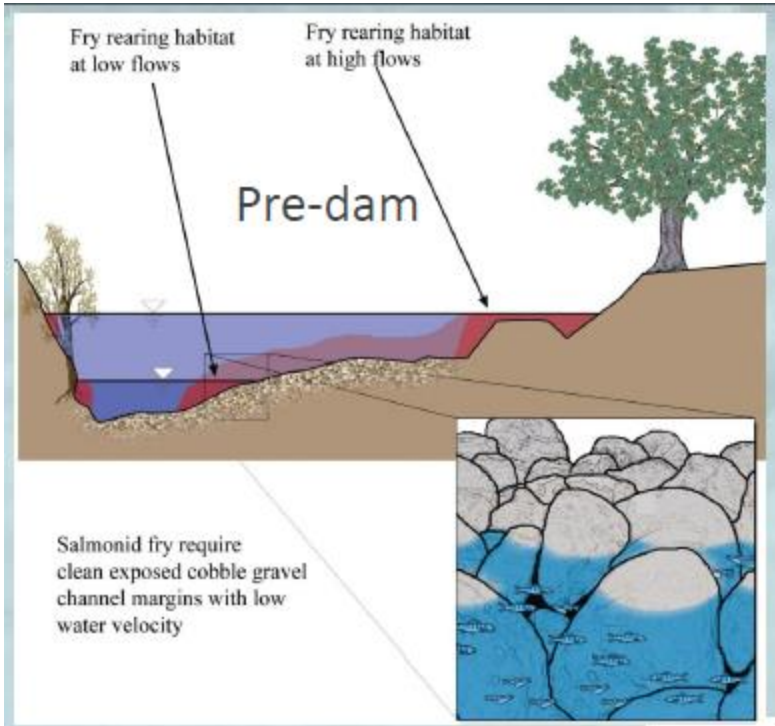
- **Alteration of erosion and sedimentation processes:**
  - **Reduction**
  - **Unbalance**
- **Incision**
- **Decrease in channel size**
- **Channel Stabilization**



The river Bonsai concept

The evolution of river Ruecas (Guadiana basin)

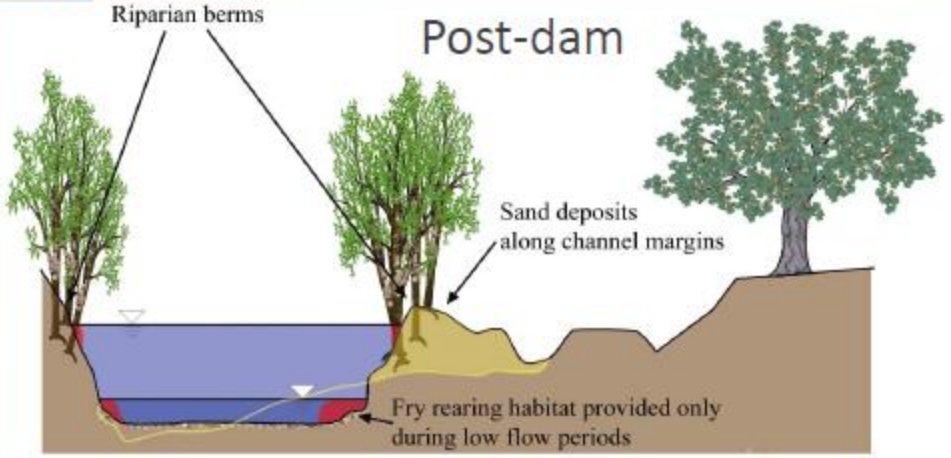




Impacts of modified channel morphology on salmonid habitat

Trinity River, California

images courtesy S. McBain

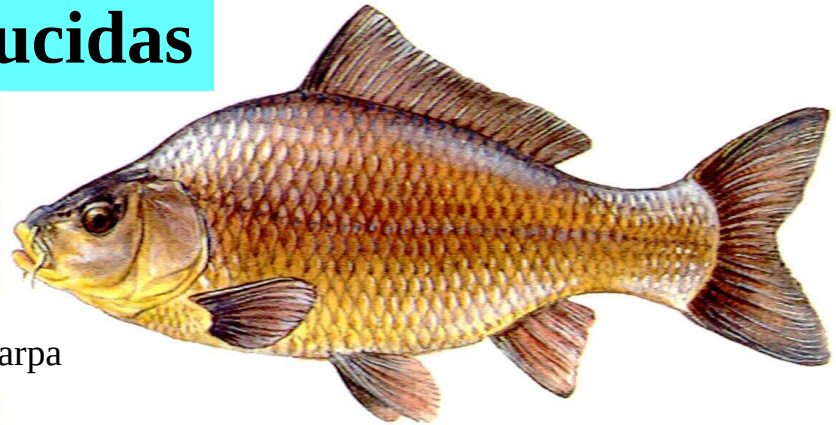


4. Biological responses
Efectos en las Comunidades Acuáticas

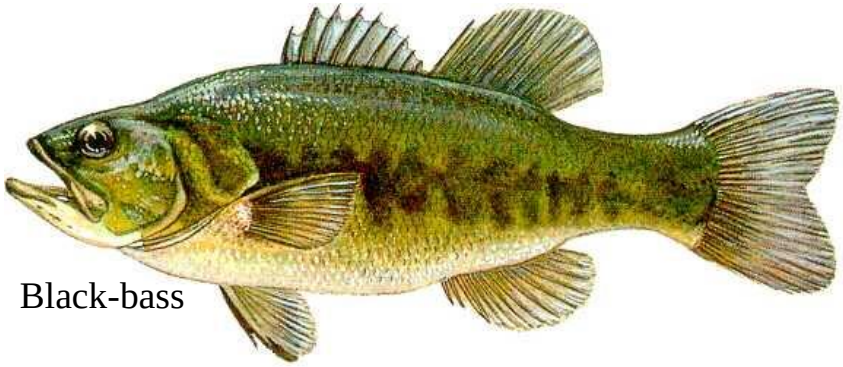
- **Fragmentación de poblaciones**
- **Interferencia del embalse como habitat nuevo**
- **Modificación del hábitat fluvial:**
  - **Perdida de su torrencialidad**
  - **Condiciones mas predecibles**
- **Muchas especies autóctonas están poco adaptadas, pero no todas!**
- **Invasión de especies introducidas leniticas**

Especies introducidas

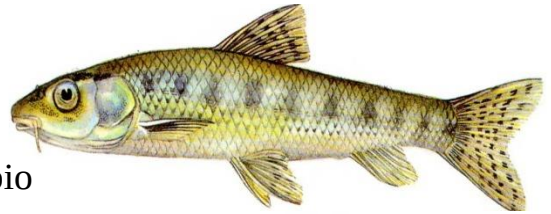
carpin



carpa

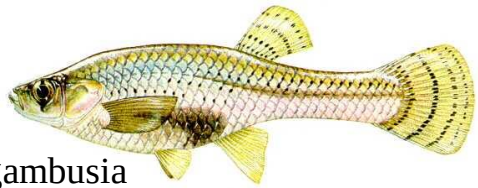


Black-bass

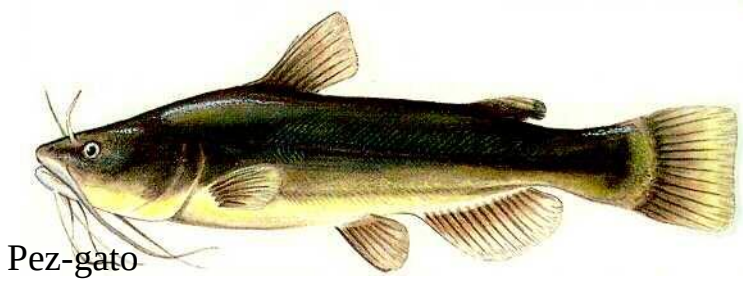


gobio

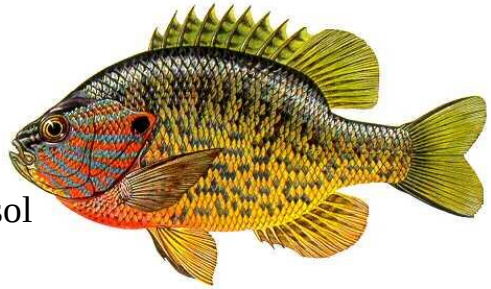
lucio



gambusia



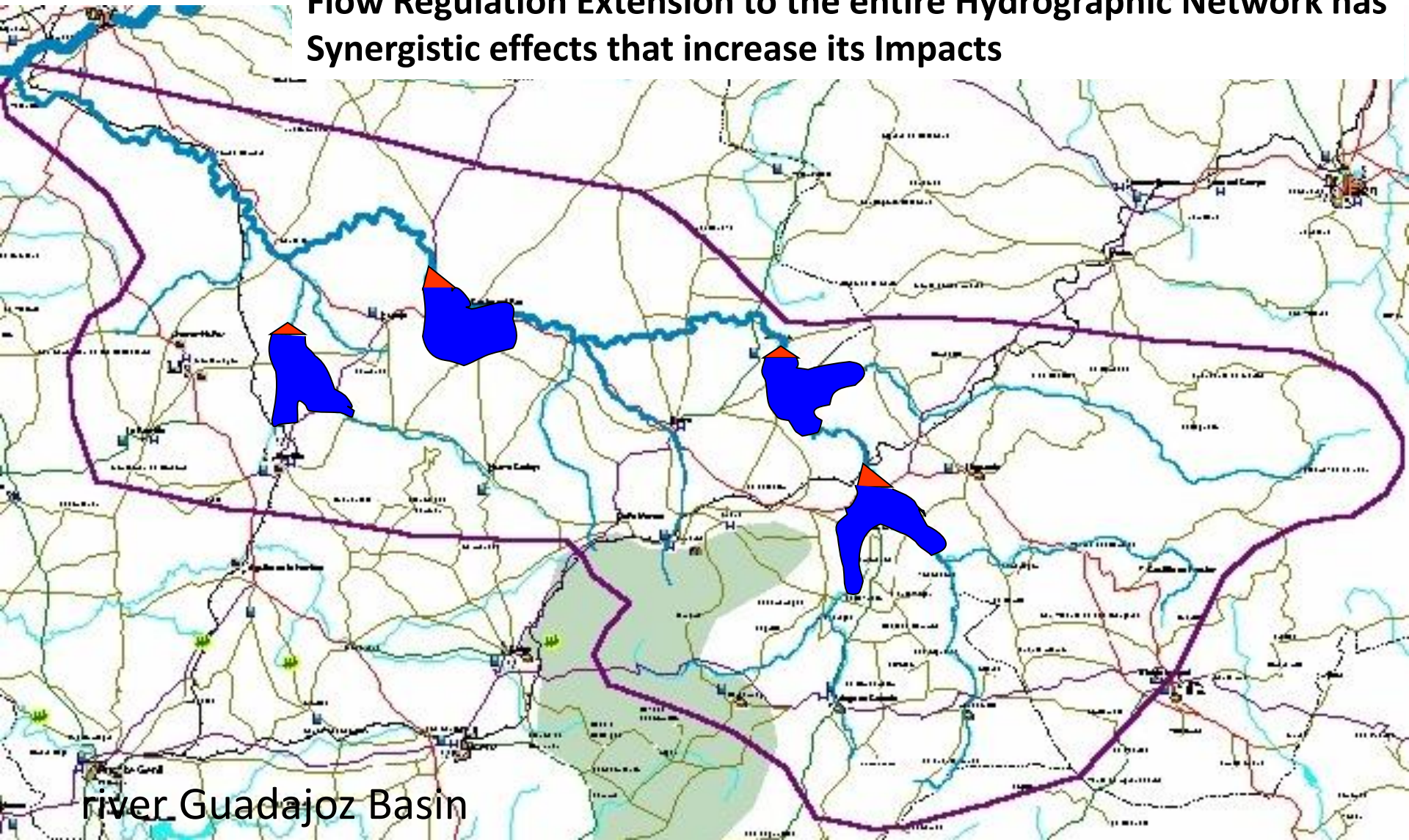
Pez-gato



Pez-sol

4. Flow Regulation Extension & Resilience

Flow Regulation Extension to the entire Hydrographic Network has Synergistic effects that increase its Impacts



river Guadajoz Basin

4. Flow Regulation Extension & Resilience

- Ecological **Resilience** is the property of an ecological system that determines the persistence of **relationships within the system** (Holling, 1973)

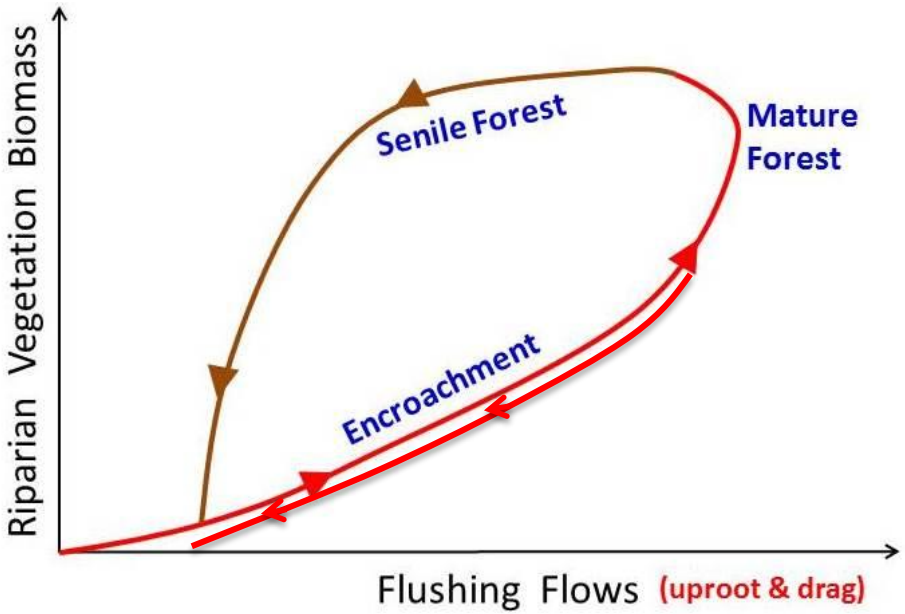
- Dams are physical **barriers** that prevent the migration of fishes, and the arrival of seeds, plant sprouts upstream, as well as the drift of benthic invertebrates.

- Numerous dams in the same river and its tributaries **fragment** the river ecosystem and disconnect its communities, making it difficult to recover from disturbances.

5. Restoration & Hysteresis

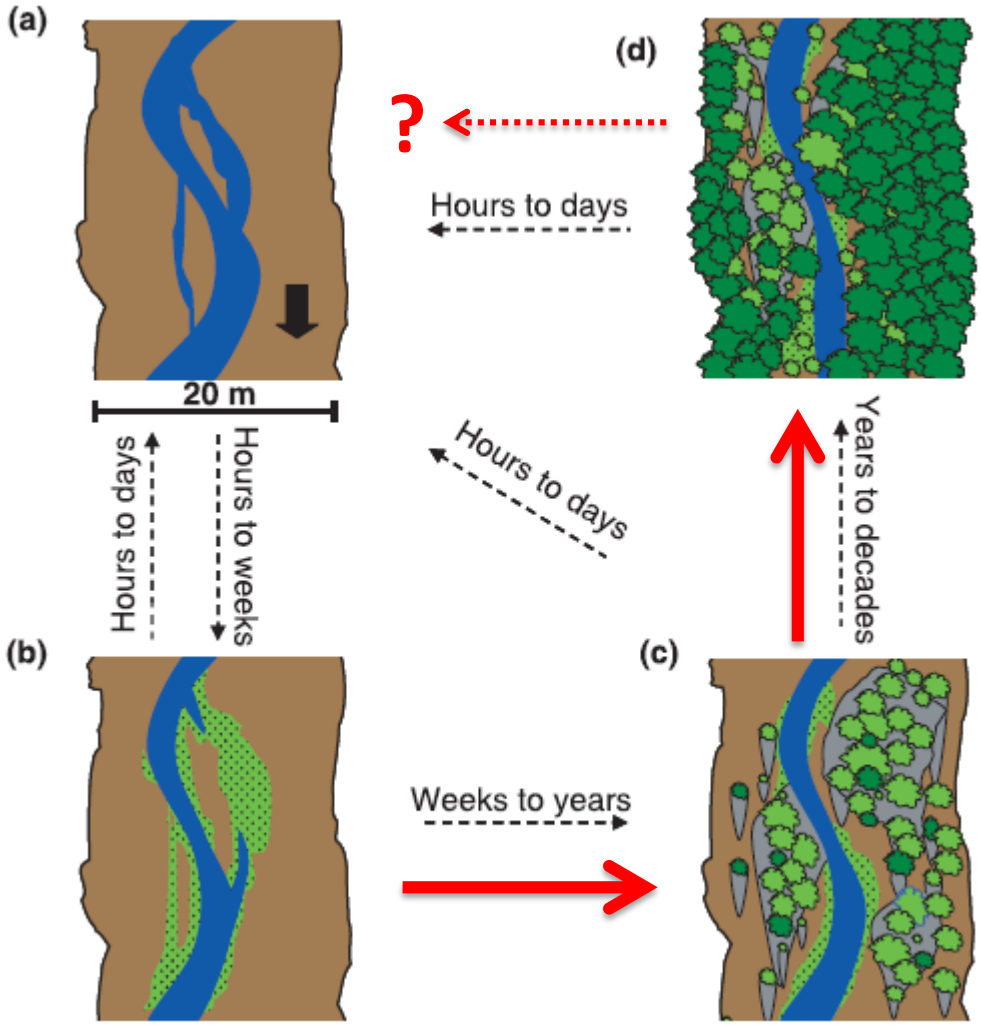
- **Hysteresis** is the time-based dependence of a system's output on present and past inputs. Represents an asymmetrical process.

- Regulated flows often promote **vegetation encroachment** in river channel
- Once **mature forest** stands are stablished, it is anchored by sediment accumulation and development of a dense root system.
- Setting E-flows, neither Flushing Flows is often not enough.
- Alternatives?



5. Restoration & Hysteresis

Effects of Riparian Vegetation Hysteresis



b &c: niche construction sequence induced by pioneer plants (encroachment)

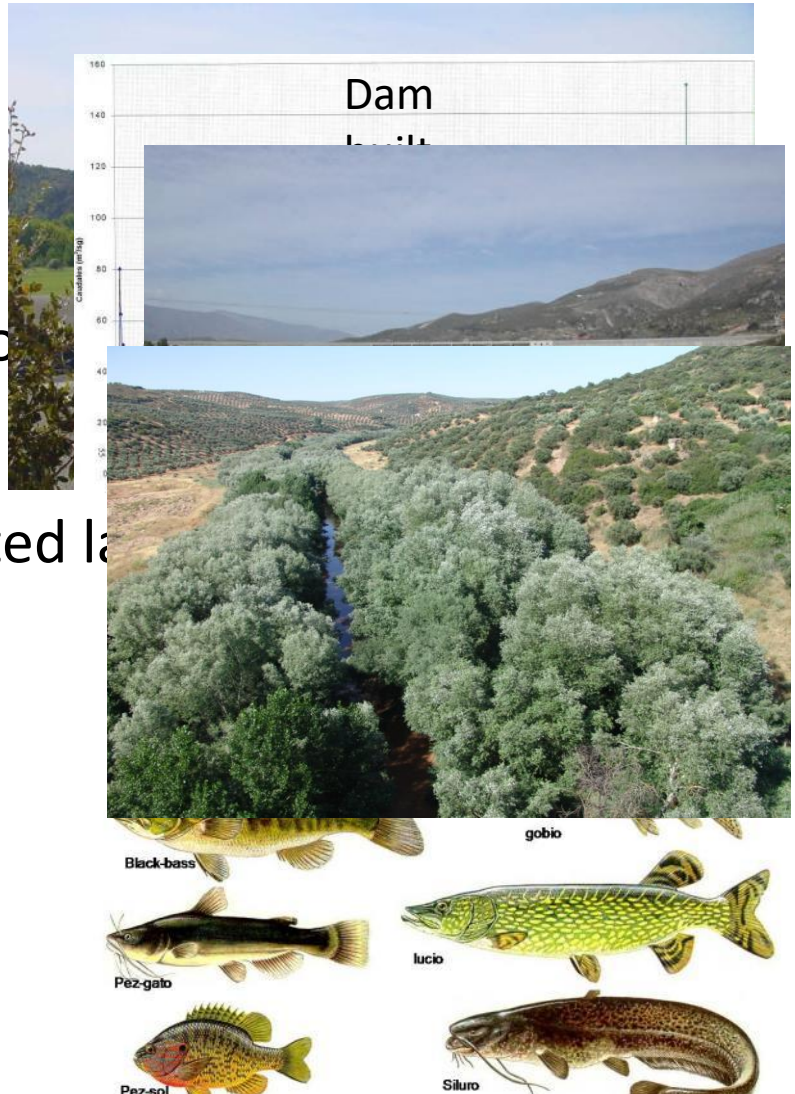
d: succession into a mature riparian forest

Corenblit *et al*. 2009

CONCLUSIONS

The river Bonsai concept: Mediterranean regulated rivers

- Rivers have lost sediments
- Rivers have lost their dynamism
- Rivers have been fragmented and lo
  their longitudinal connectivity
- Rivers are narrower and disconnected la
- The rivers are immobilized by an overgrown riparian vegetation
- Rivers have reduced their native biodiversity
- Rivers have been invaded by introduced species



CONCLUSIONS

Conclusion: We must adopt a new E-Flows template

HABITAT IMPROVEMENT

Potential E-Flows actions

1. Hydrologic regime
2. Sediment Transport regime
3. Woody Debris dynamics

MORPHOLOGICAL CHANGE

Bonsai rivers need:

Complementary measures

- Removing mature Riparian Forest
- Eliminating/Reducing Barriers
- Direct Morphological reconstruction


Thank you for
your attention