

ATHENS PROGRAM – UPM

ETSI Montes

Madrid, March 2010

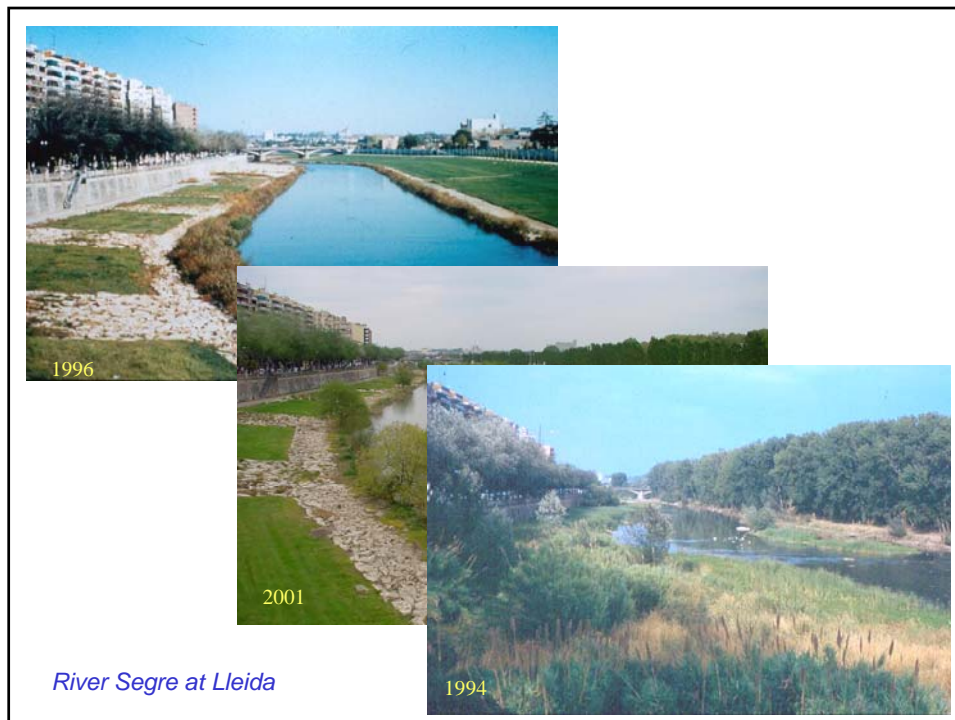
**RIVER RESTORATION:
PRINCIPLES & PRACTICES**

Diego García de Jalón

OVERVIEW

Introduction on Fluvial Ecosystems Restoration


1. Concepts on River Restoration.
2. Main pressures and impacts on rivers and starting points for restoration: Causes and problems diagnosis. Canalization. River Incision. Flow regulation.
3. Current Trends and Guidance Objectives on River Restoration.



Fluvial Restoration

- Restoration is referred to *Degraded Ecosystems*
- **Restoration:**
 - To recover ecosystem composition, structure and functioning that existed in natural conditions (self sustainable)
- **Rehabilitation:**
 - To re-establish ecosystem structure and functioning in order to maintain traditional uses (sustainable use of the resources)
- **Cosmetics or Improvement**
 - To obtain a certain structure or a composition without considering ecosystem functioning (natural garden)

Concepts in Restoration

- Does a pristine state exist? 
- ¿What is natural? Nowadays is self sustainable?
- Spatial Scale: Watershed? Hydrographic Network? River? Stream Reach?
- Relative Naturality: in a river segment where exists a balance between instream flows (water & solids) and its geomorphology.
 - Biology as an ecosystem integrity indicator that answers this physical balance

TYPES OF ACTIVITIES

RESTORATION:

To recover:

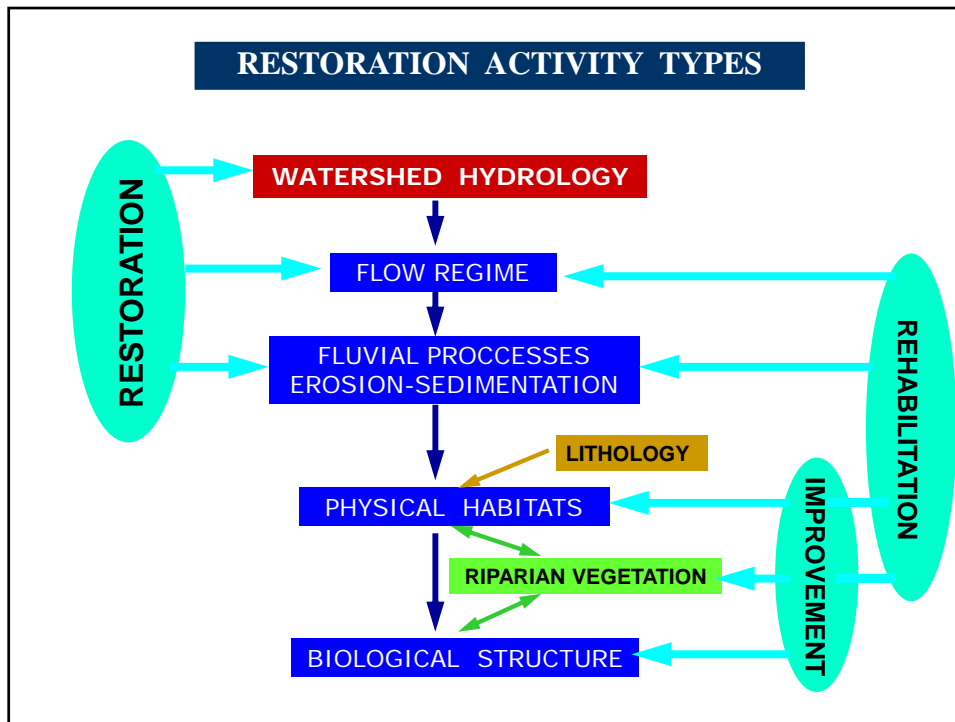
- the **natural state**,
- **Previous state** to river degradation
- Good ecological status (WFD)

REHABILITATION:

Partially Recovering natural conditions, but accepting limitations to natural functioning

IMPROVEMENT

Replace actual river structure and composition by another one, more favorable to a desired river use, improving its aesthetical values, but accepting its artificiality.



POSSIBILITIES ON RIVER RESTORATION

RESTORATION

Objetives:

- To recover fluvial processes and ecosystem functioning that existed in natural conditions

Techniques focused on:

- Natural Flow regime
- Increasing river degrees of freedom
- To Recover lateral connectivity with river margins and tributaries

Limitations:

- Requires river and watershed integral management
- Results are achieved at long term

POSSIBILITIES ON RIVER RESTORATION

REHABILITATION

Objetives:

- Partially recover fluvial processes and ecosystem functioning

Techniques focused on:

- Increasing river freedom degree
- Bio-Engineering
- Fluvial Habitat Enhancement

Bio-Engine..?

Limitations:

- Results achieved at medium term
- Initial Maintenance is needed

POSSIBILITIES ON RIVER RESTORATION

IMPROVEMENT (COSMETICS)

Objetives:

- To improve actual structure (aesthetics)
- to recover singular ecosystem elements

Techniques focused on:

- Bio-Engineering
- Gardening & Landscaping

Limitations:

- Intensive maintenance



Philosophy on Fluvial Restoration

- The river as an **ecosystem**

- Water, sediments and life
- Watershed dependence



- **Understanding how the river works :**

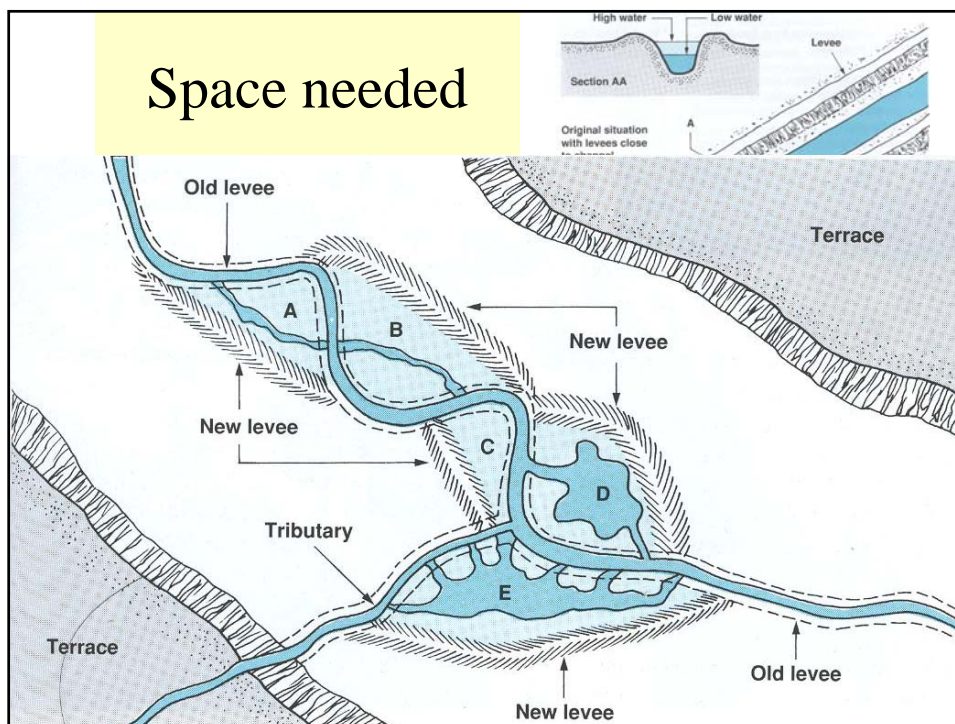
1. To Recover **geomorphological processes** and **water quality**
2. To Recover **geomorphological processes**
3. To give **space** and **time** to the river 😊
4. Promote natural **Biodiversity**
5. To design always along **with the force of the water current** ❤️

Philosophy on Fluvial Restoration



- **The river as an ecosystem**
- **Understanding how the river works**
- **Multiple sustainable uses** may be admitted by Fluvial Systems
- Restoration activities may have negative **impacts** on rivers
- **Adaptative Management**

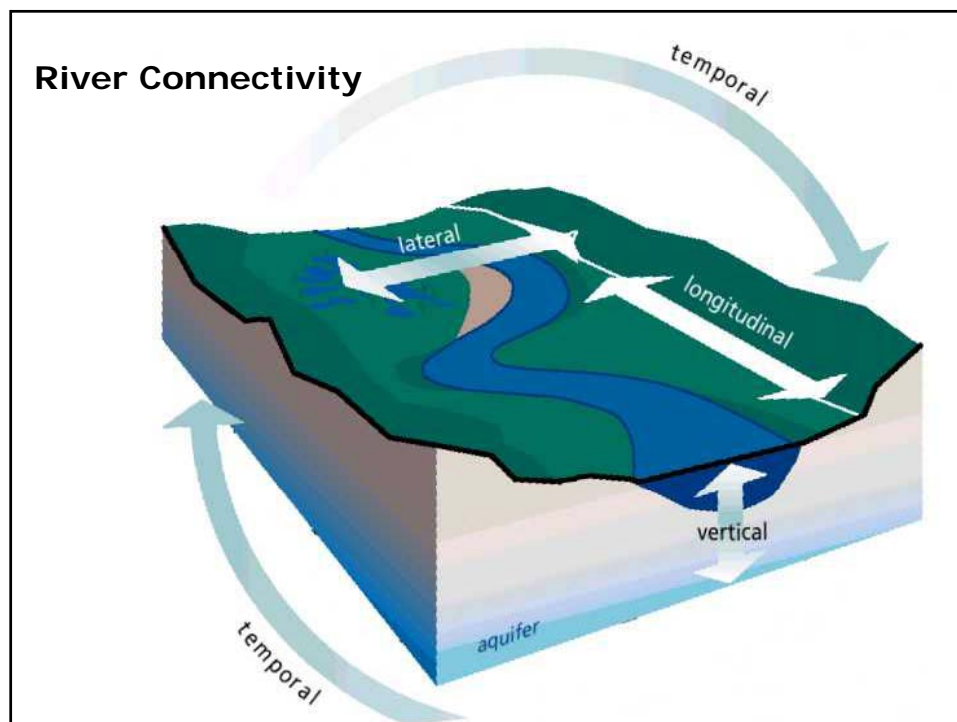
Philosophy on Fluvial Restoration synthesis

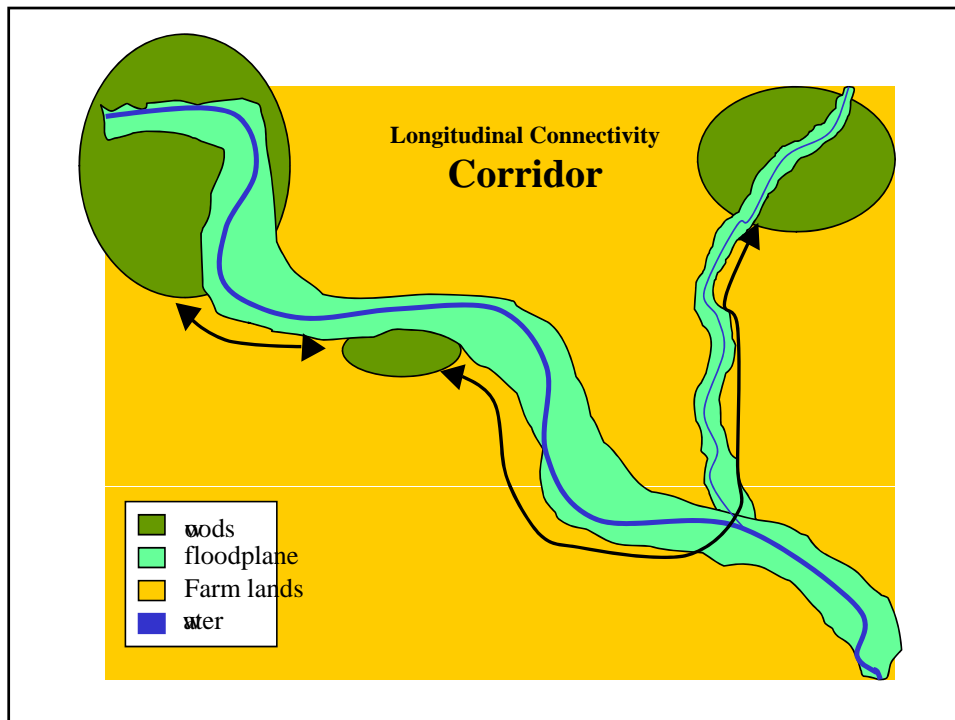
- Minimum Requirements:
 - **Water** in Quality & Quantity
 - The river needs **space**
 - Fluvial Restoration needs **time**



Philosophy on the Design of Restoration Activities

- **Spatial Heterogeneity:** The micro-relief recovery is important as enhances vegetation colonization in a mosaic pattern that promotes biodiversity 
- Always design and work **using the power of the flowing water:** 
 - We just design & suggest to the river what should be done
 - Let the river do the work
- Promote **natural fluvial landscape**
- Encourage **connectivity** (lateral, vertical & longitudinal)

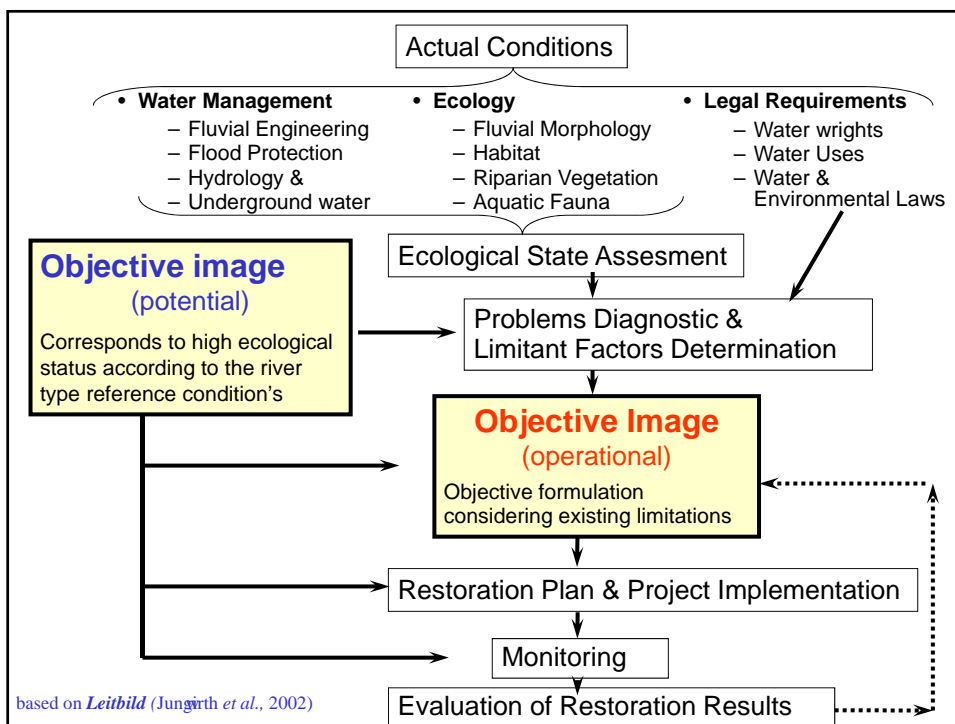
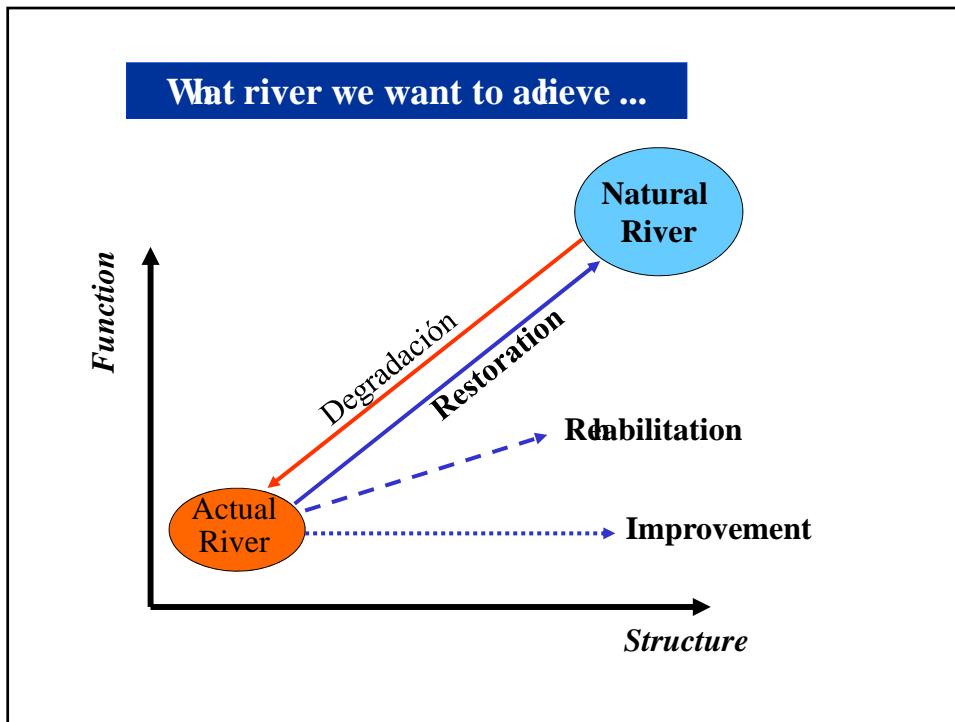




Current Trends and Guidance Objectives on River Restoration

What is River Restoration?

- A set of activities done in a river to recover its ecosystem structure and functioning in correspondence with the processes and dynamics that occur in natural conditions, or in what we establish as reference of 'high ecological status'.



1. Precise Definition of Reference Condition or Objective Image

Supported from different fields:

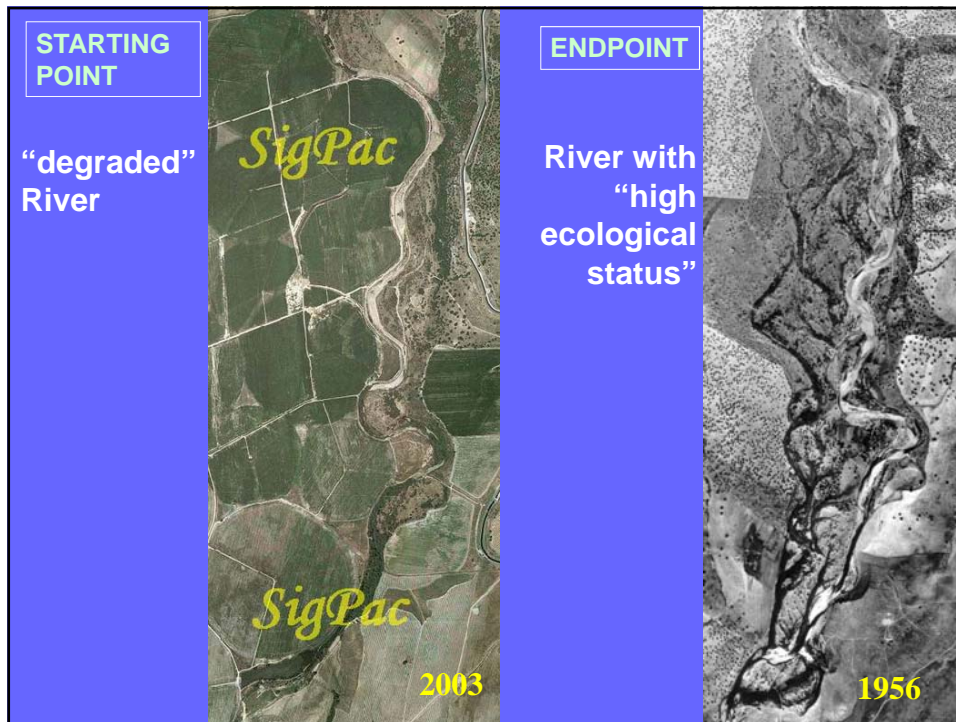
- **Scientific** (reference sites, historical data, pre-restoration sampling,.)
- **Social** (cultural change on environmental issues, and public participation)
- **Economic** (stakeholders involved & convinced to assume restoration costs)

Objective Image:

Natural river attributes

1. Channel Morphology
 - Cross Section
 - Longitudinal Profile
 - Plant View Sketch
2. Water Characteristics
 - In-stream Flow Regime
 - Physico-Chemical water quality
3. Interstitial Environment: substrate & sediments
4. Riparian Vegetation
5. Aquatic Life





2. Scientific knowledge of the Fluvial Ecosystem in order to evaluate its ecological status.



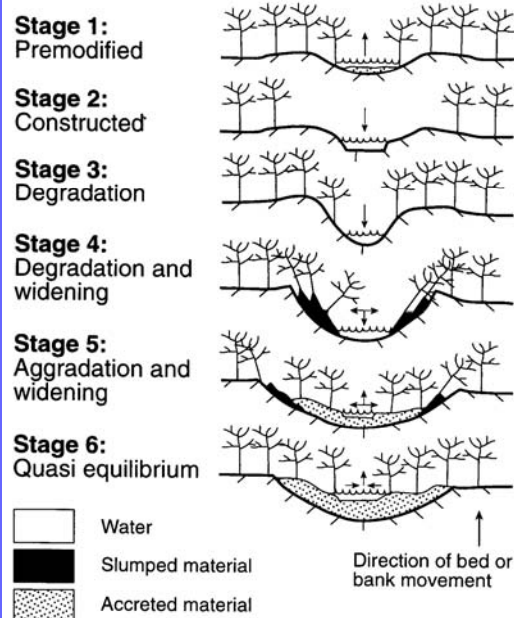
- Structure
- Functioning
- Dynamics

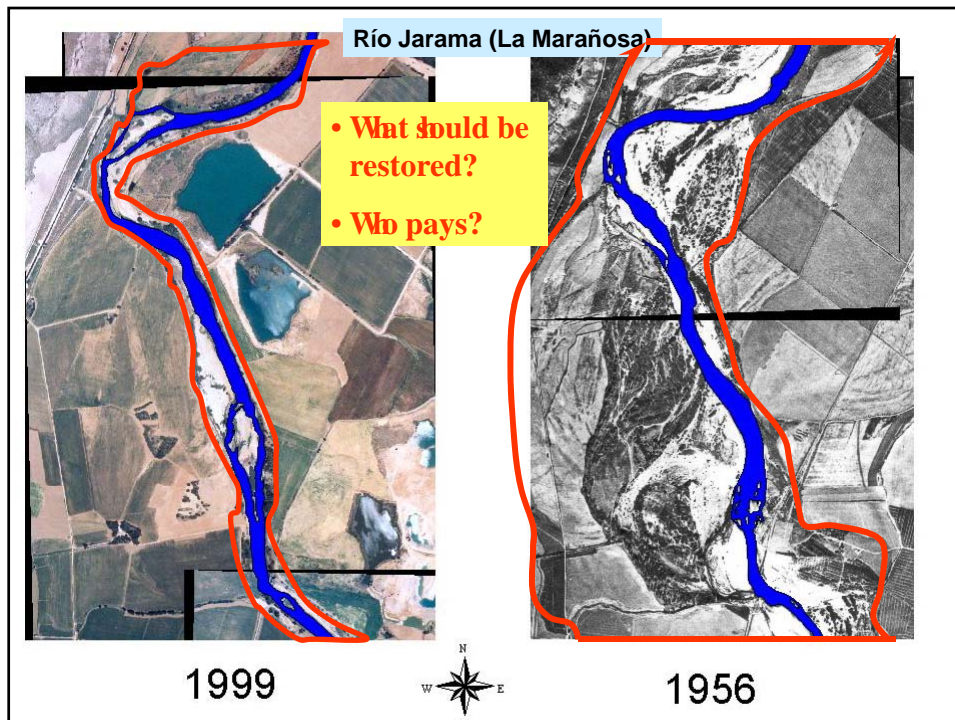
- Habitats
- Biological Communities

Current River Restoration Needs

- many river restoration projects are currently lacking a minimal scientific context, specifically (Wohl *et al.* 2004):
 - the inclusion of a solid **conceptual model** of river ecosystems
 - a clearly articulated understanding of **ecosystem processes**
 - recognition of the multiple, interacting **temporal & spatial scales of river response**
 - **long-term monitoring** of success or failure in meeting project objectives following completion

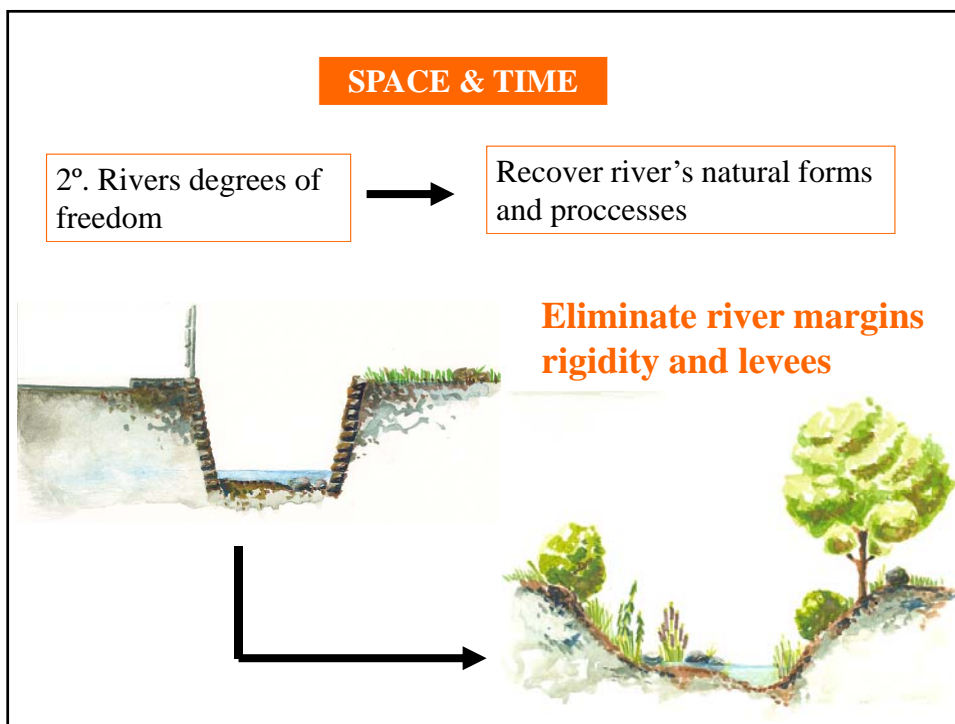
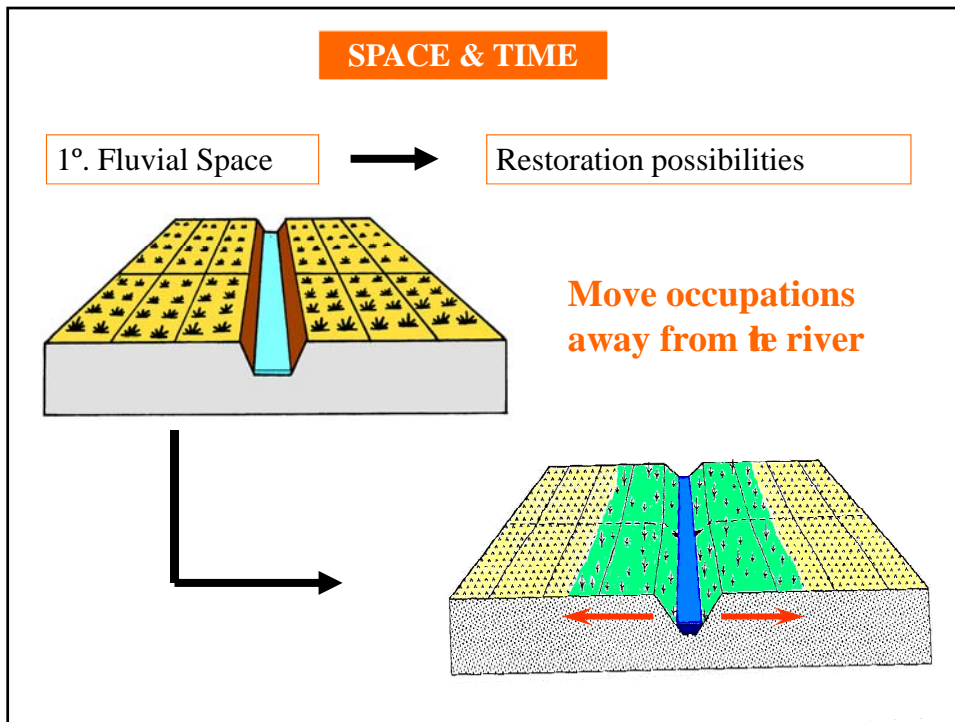
In what Stage of Degradation/Recovery the river is?

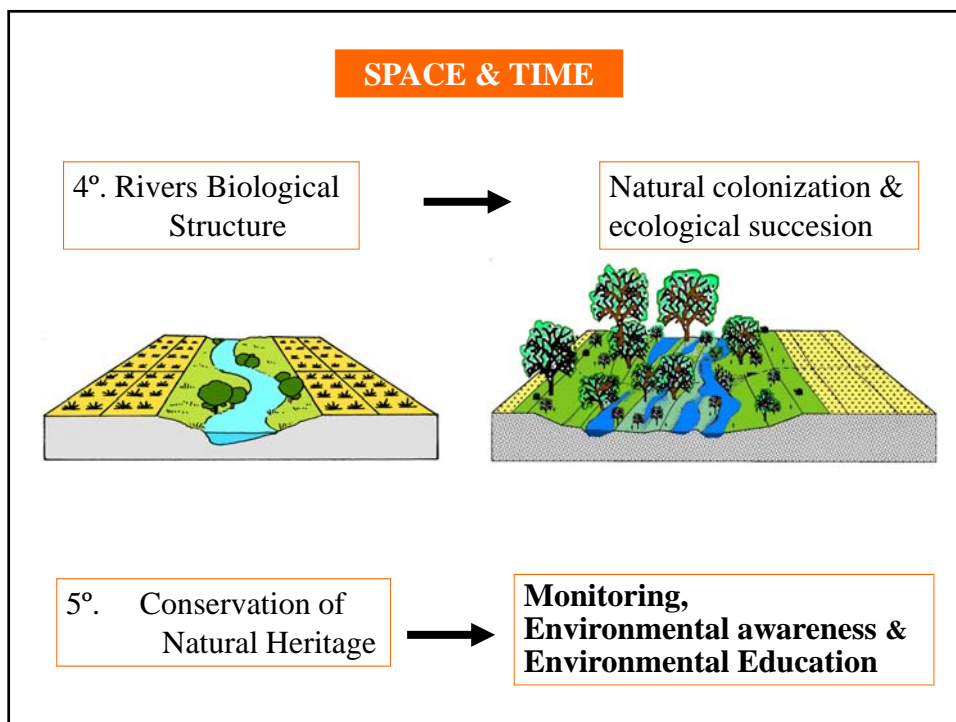
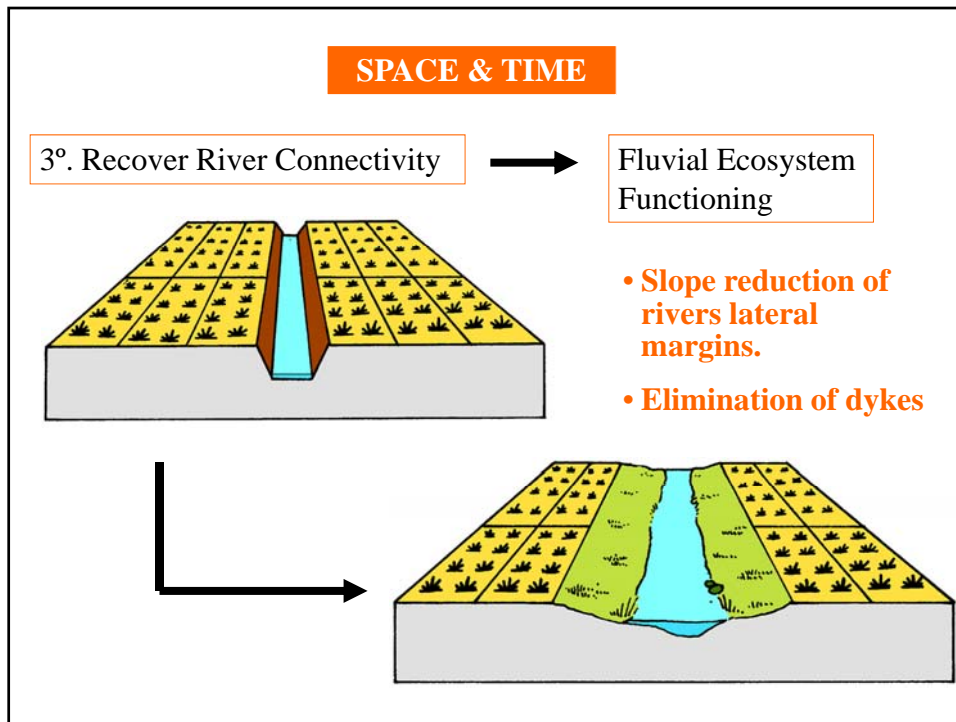




How do we Restore?

- A **learning-by-doing** approach may be a prerequisite for effective management of complex river ecosystems.
- Design restoration activities at appropriate scales and plan to be conducted adaptively
- develop **scientific guidelines** for how best to restore adaptively or over what timescale adaptive management should be applied.
- Effective restoration science must continue to be explicitly grounded in interdisciplinary research and understanding.
- We must acquire **assessment tools**: better models, use adequate indicators of ecological status and processes





How do we know we have Restored the River?

Five Criteria (*Palmer et al., 2005*):

Standards for ecologically successful river restoration

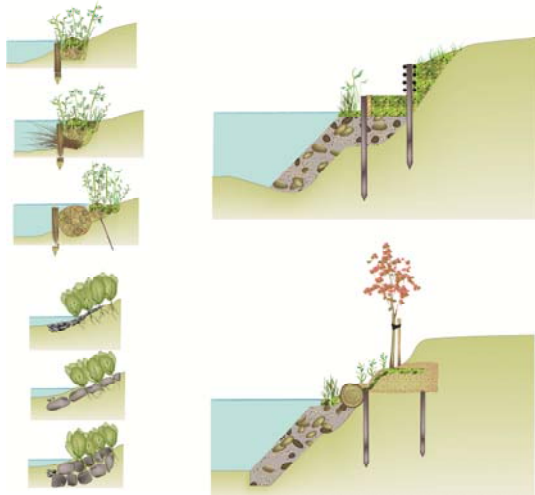
1. A **Guiding Image** has been identified *a priori*
2. **Improvement of River ecological** conditions has been measured
3. **Sustainability** and resilience
4. During Restoration activities no lasting, neither **irreparable harm, has been** caused.
5. A complete **ecological assessment** has been carried out.



BIO-ENGINEERING

Bio-Engine..?

Soft-Techniques used to fix and stabilize river banks and to improve aesthetic values of the urban rivers

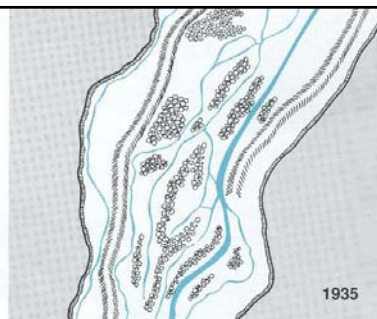


- Systems to rigidize the channel (**green canalization**)
- Source of exotic invading species
- Initial state little persistent
- High cost of implantation
- Necessity of maintenance
- Visible results in the short term
- Appropriate only in certain circumstances

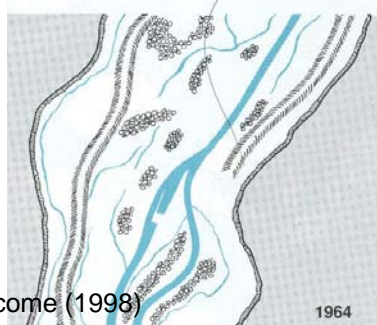
Evolución del Rhine



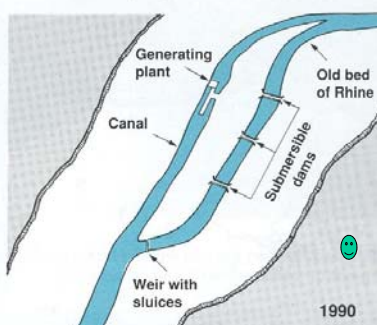
Extensively anastomosed channel, floodplain and floodable hardwood forest



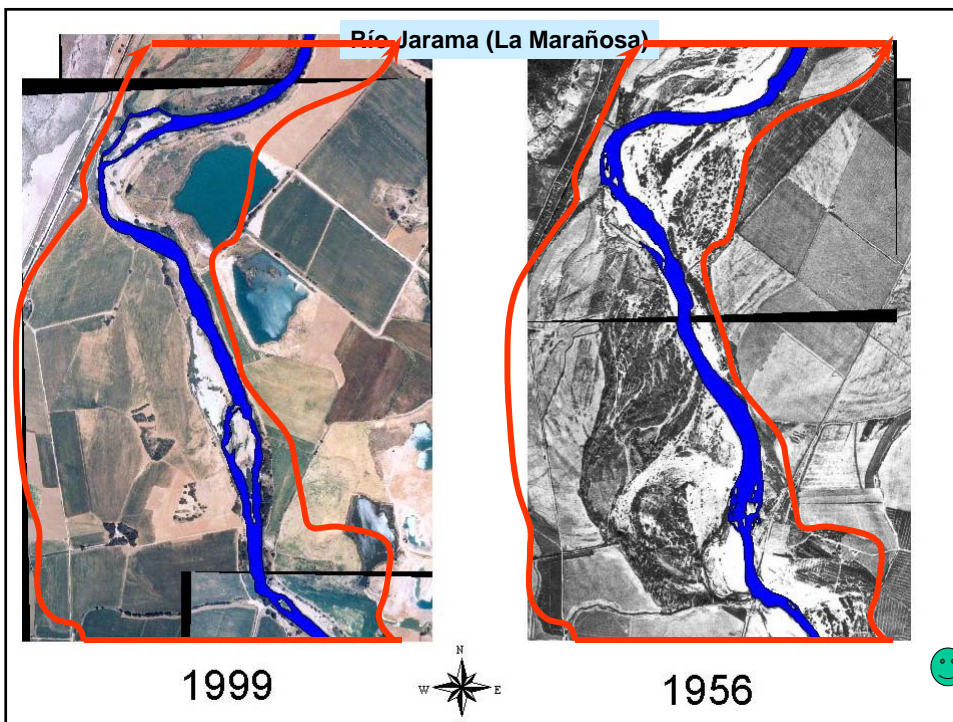
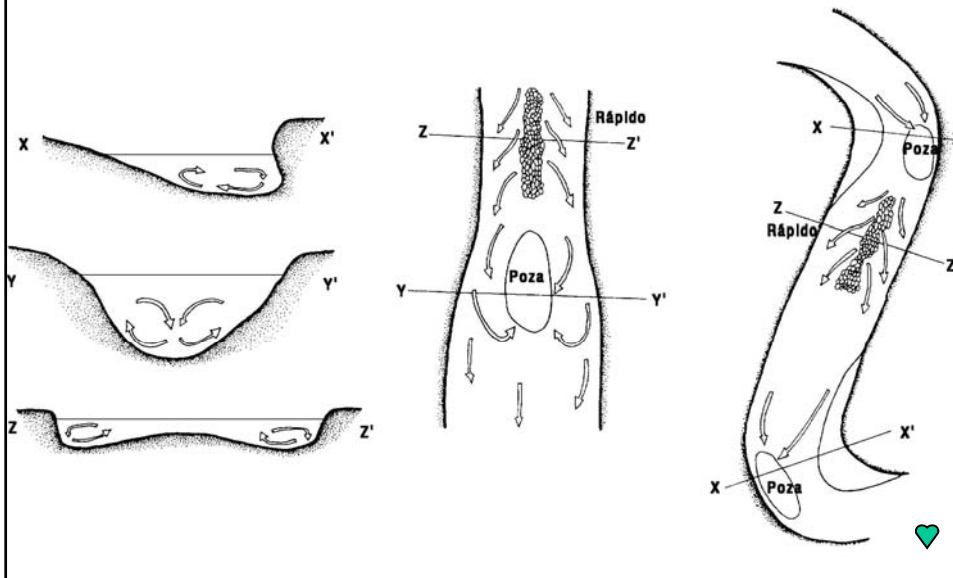
Channel with set-back levees to allow retention of flood forest and channel complexity

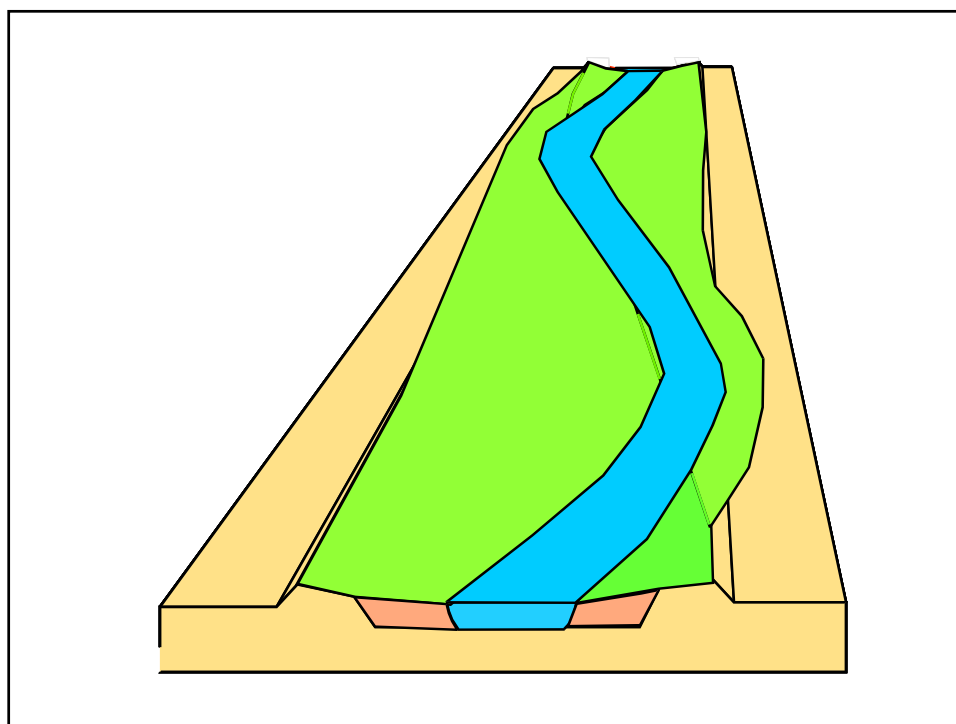
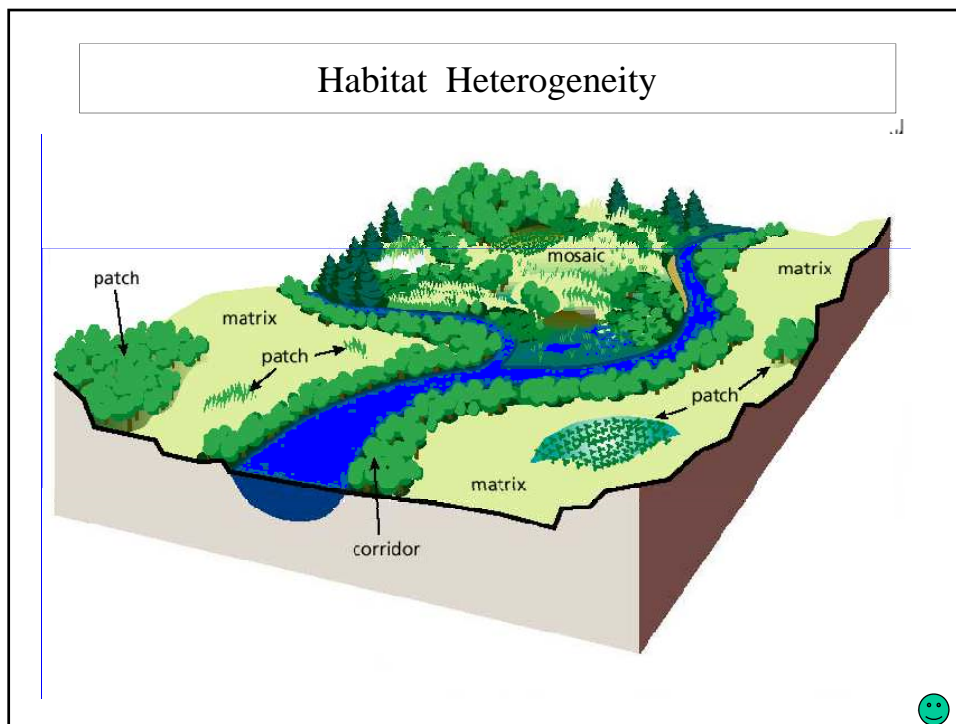


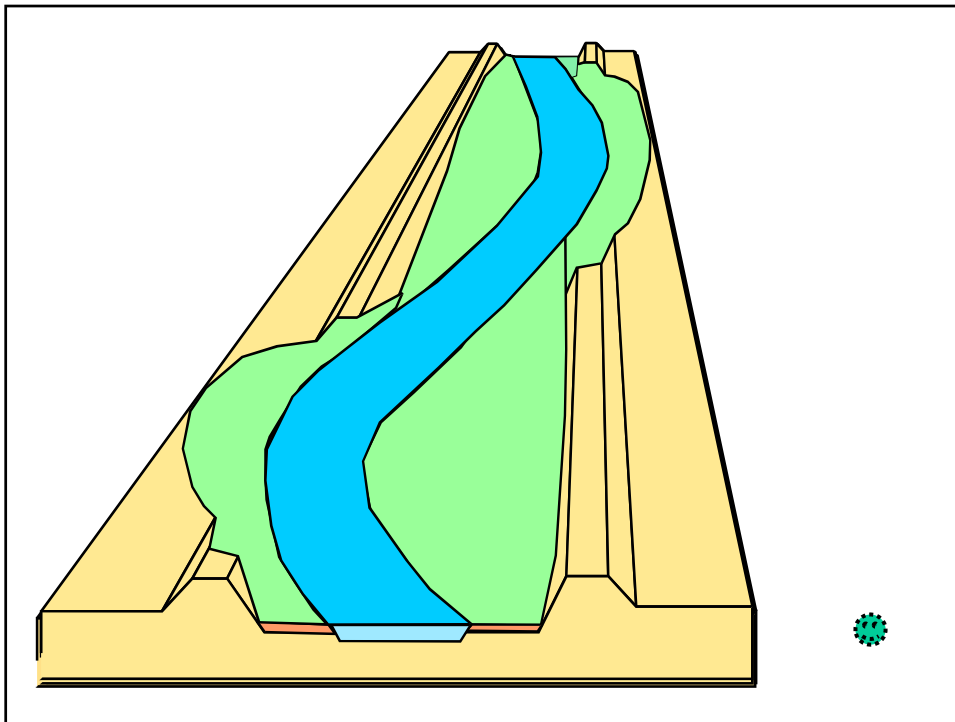
Cowx & Welton (1998)



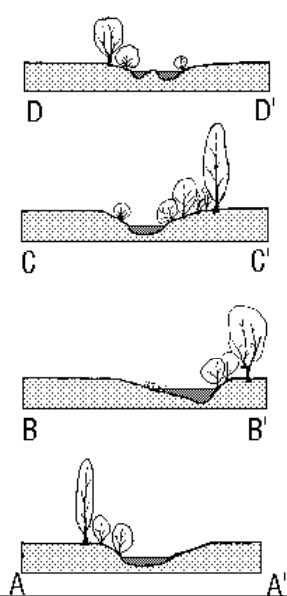
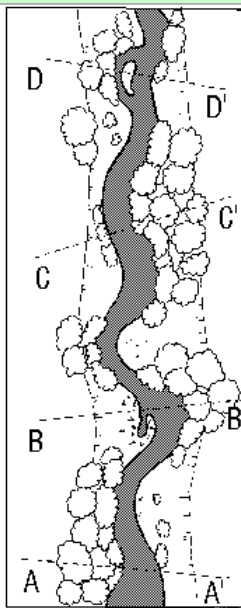
Channel morphology as a consequence of fluvial erosion-sedimentation processes





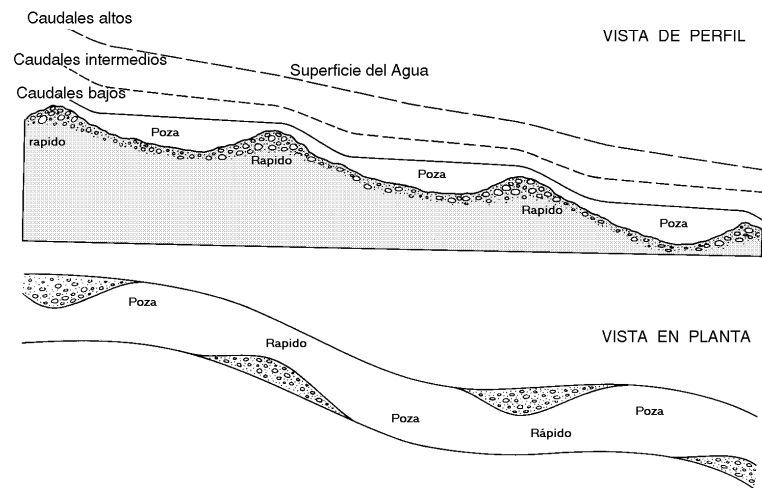


Plant View & Cross Sections



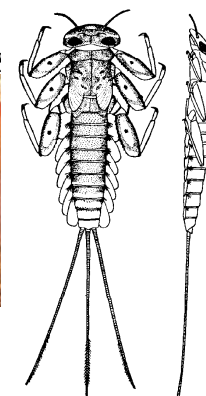
Natural Sape:
 Asymmetric and irregular sections, link to the channel laid out and to the pool-riffle sequences.

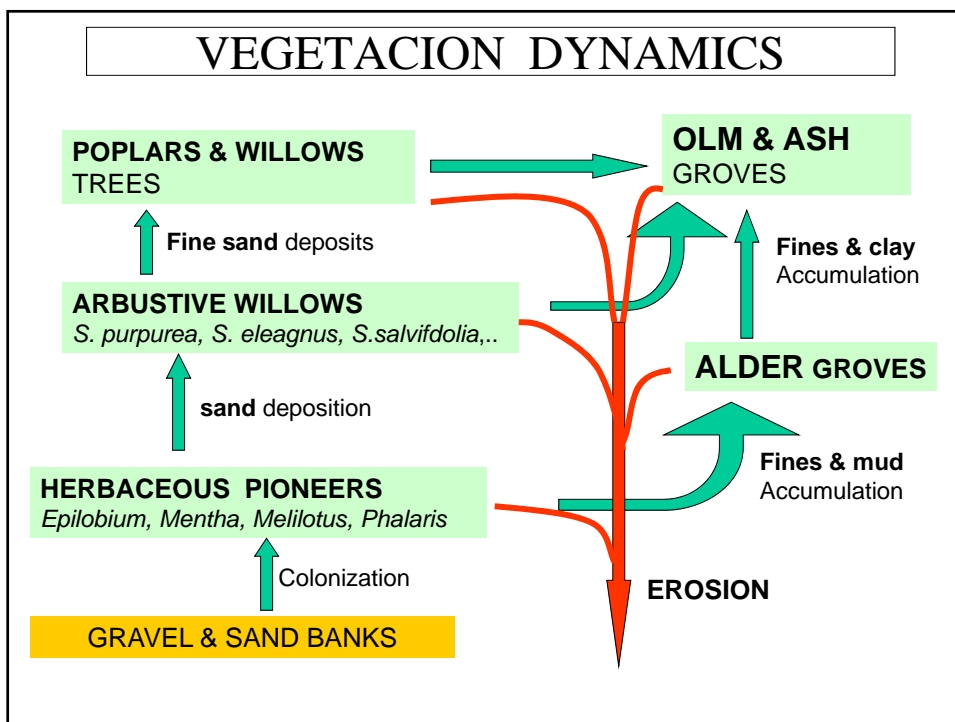
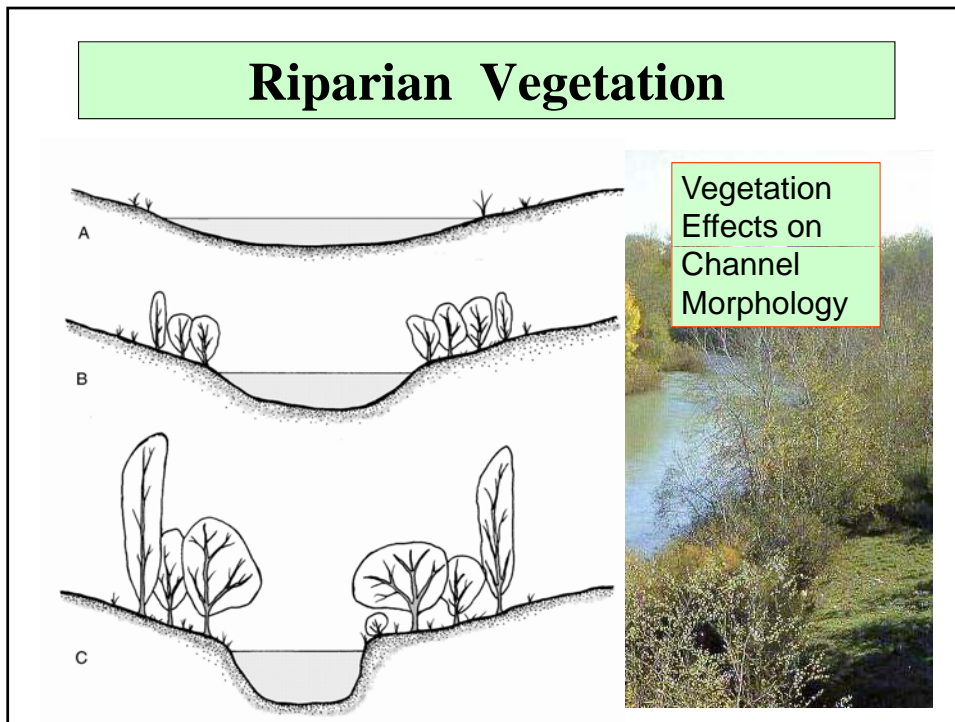
Longitudinal Profile



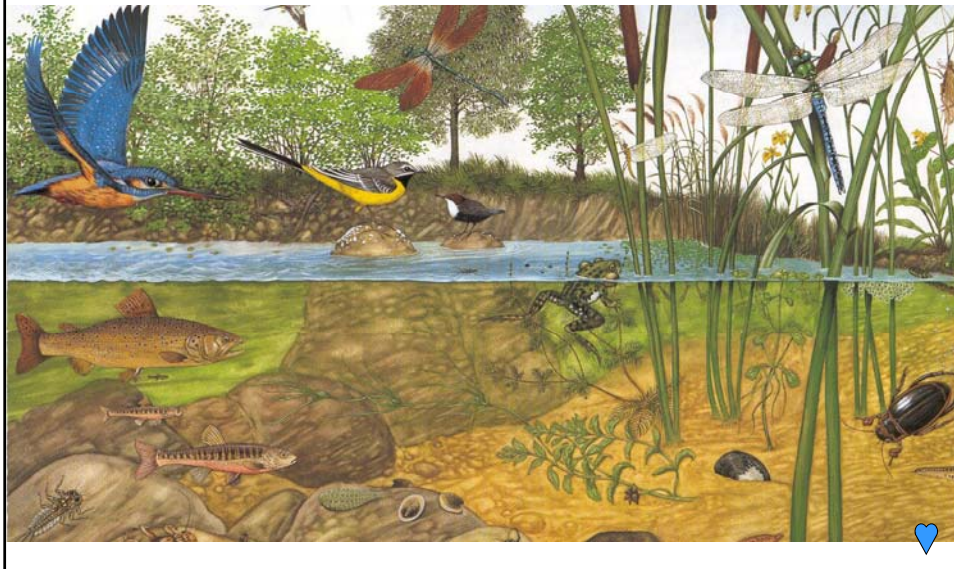
Interstitial Environment

- **Vital refuge** for fluvial communities
 - Larval Development
 - Macro benthic Habitat
- **Bottom Substrate traits**
 - Mean Diameter
 - Porosity
 - Fine sediments





Aquatic Communities



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