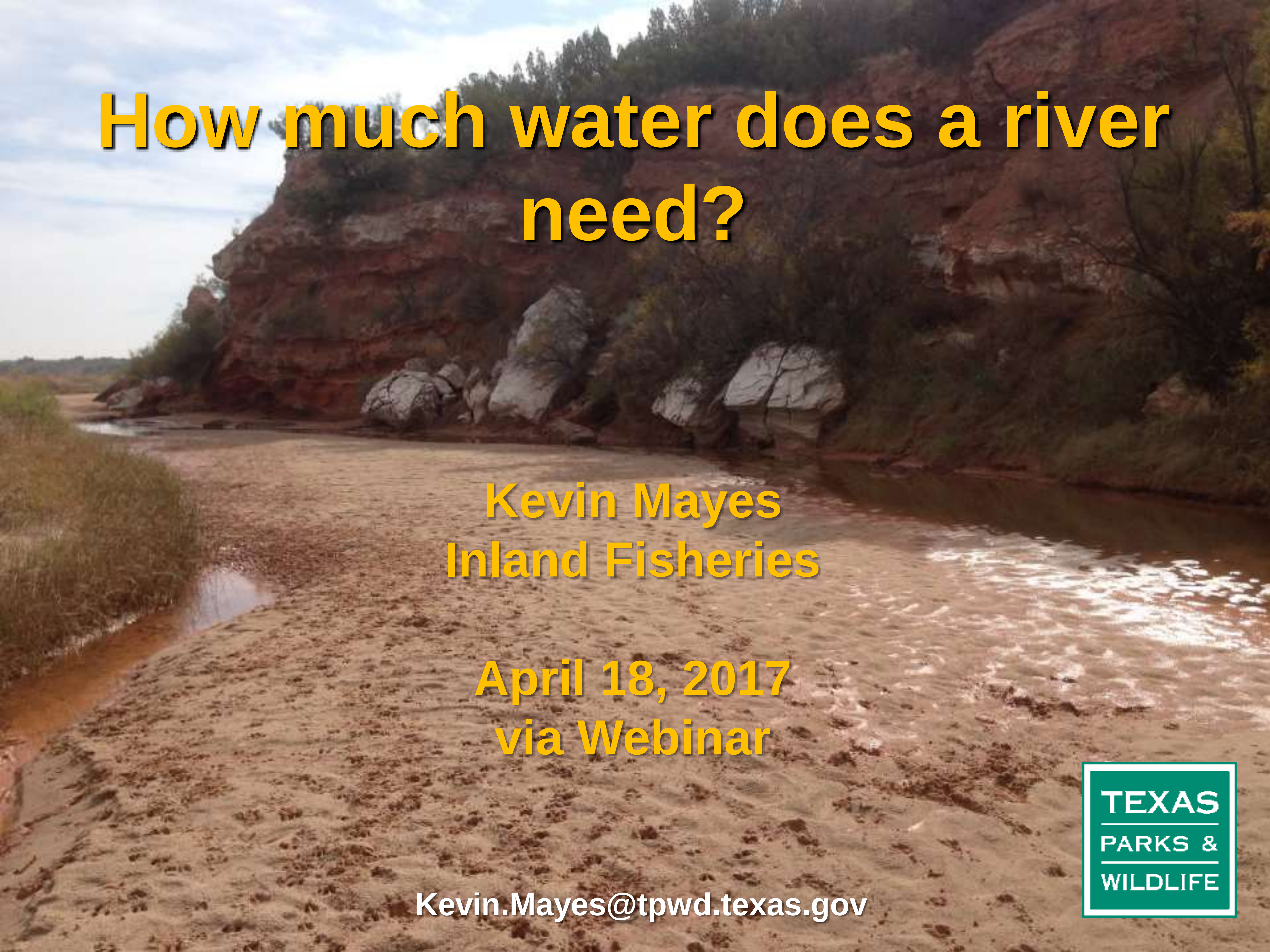
How much water does a river need?

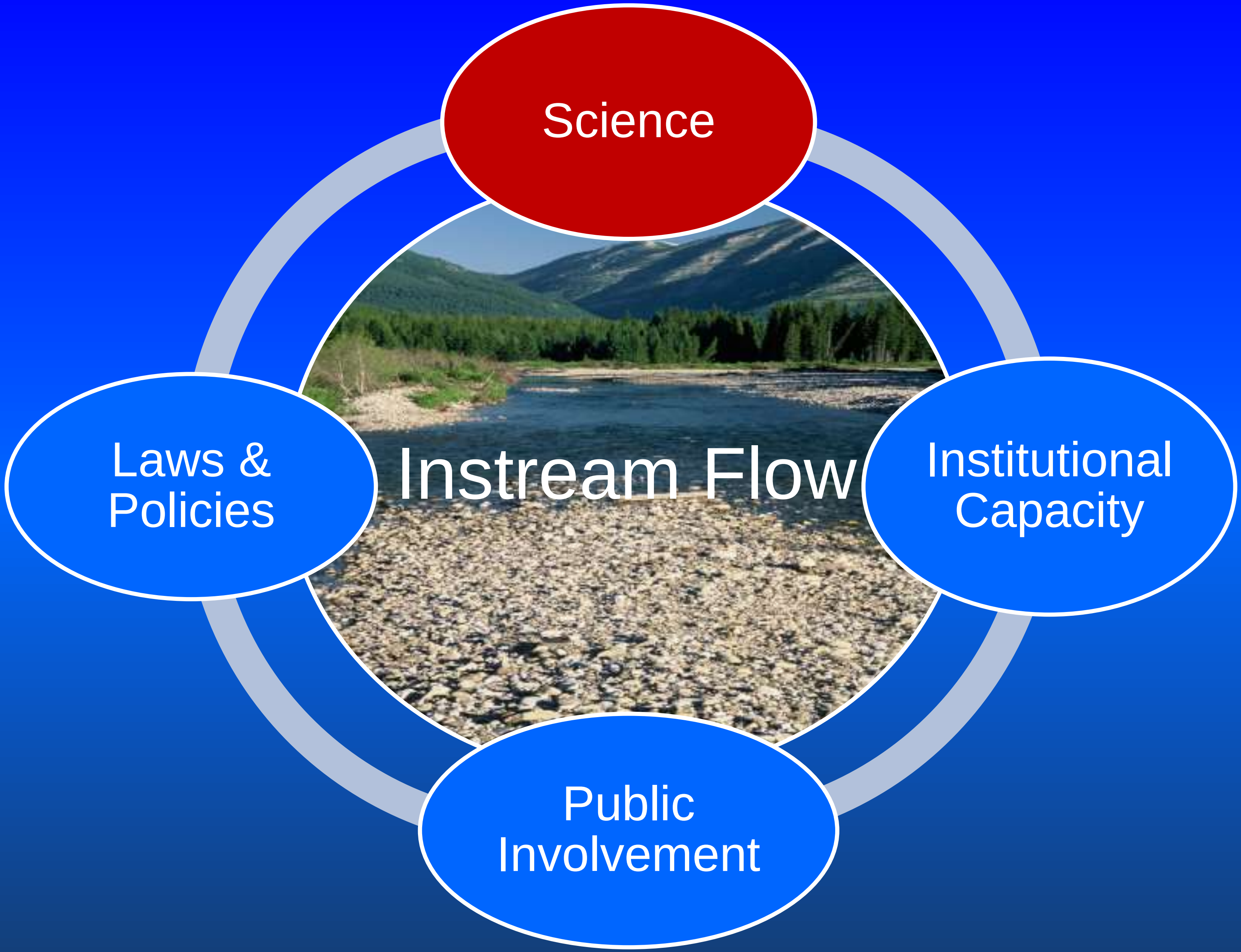


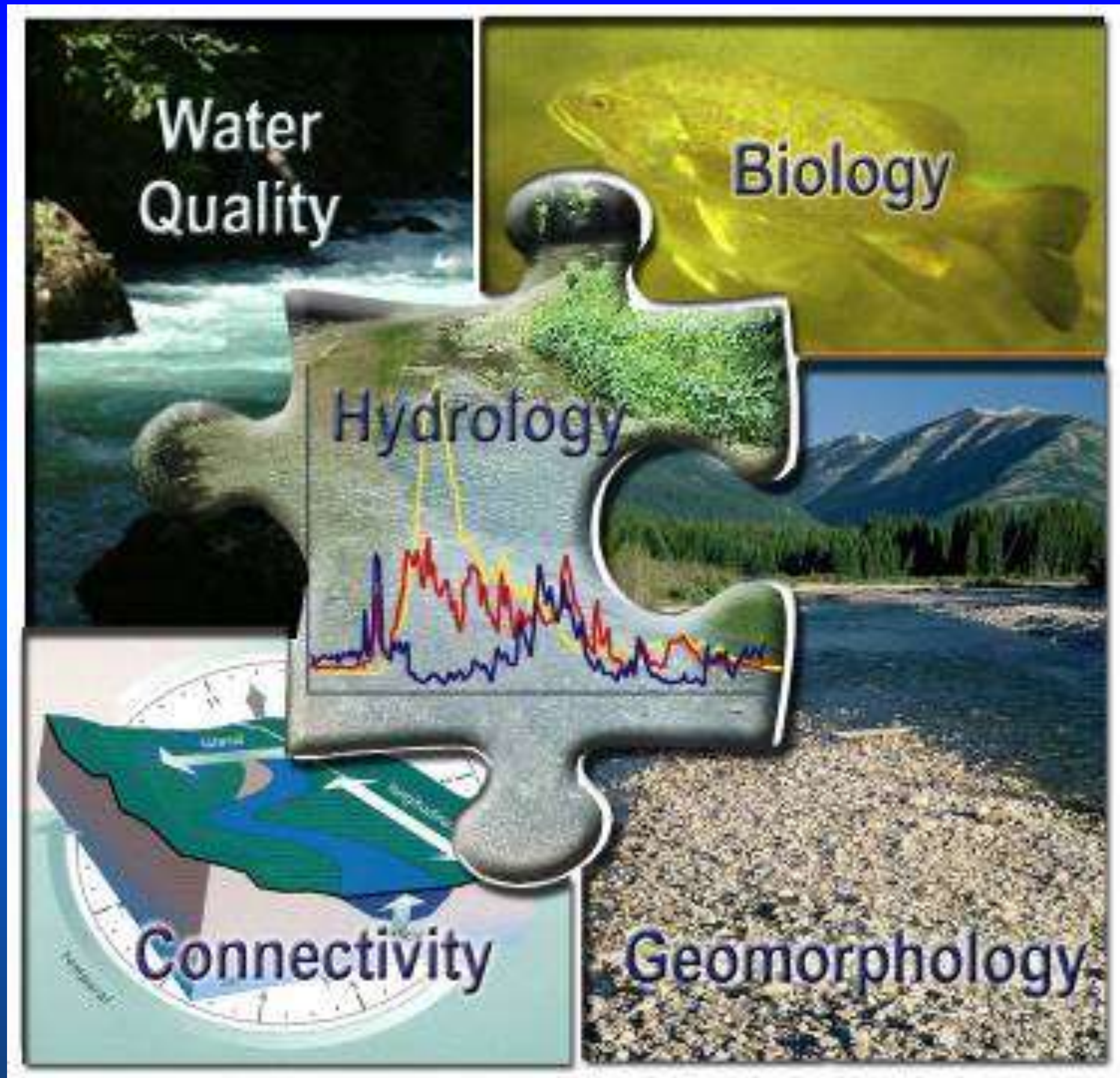
Kevin Mayes
Inland Fisheries

April 18, 2017
via Webinar

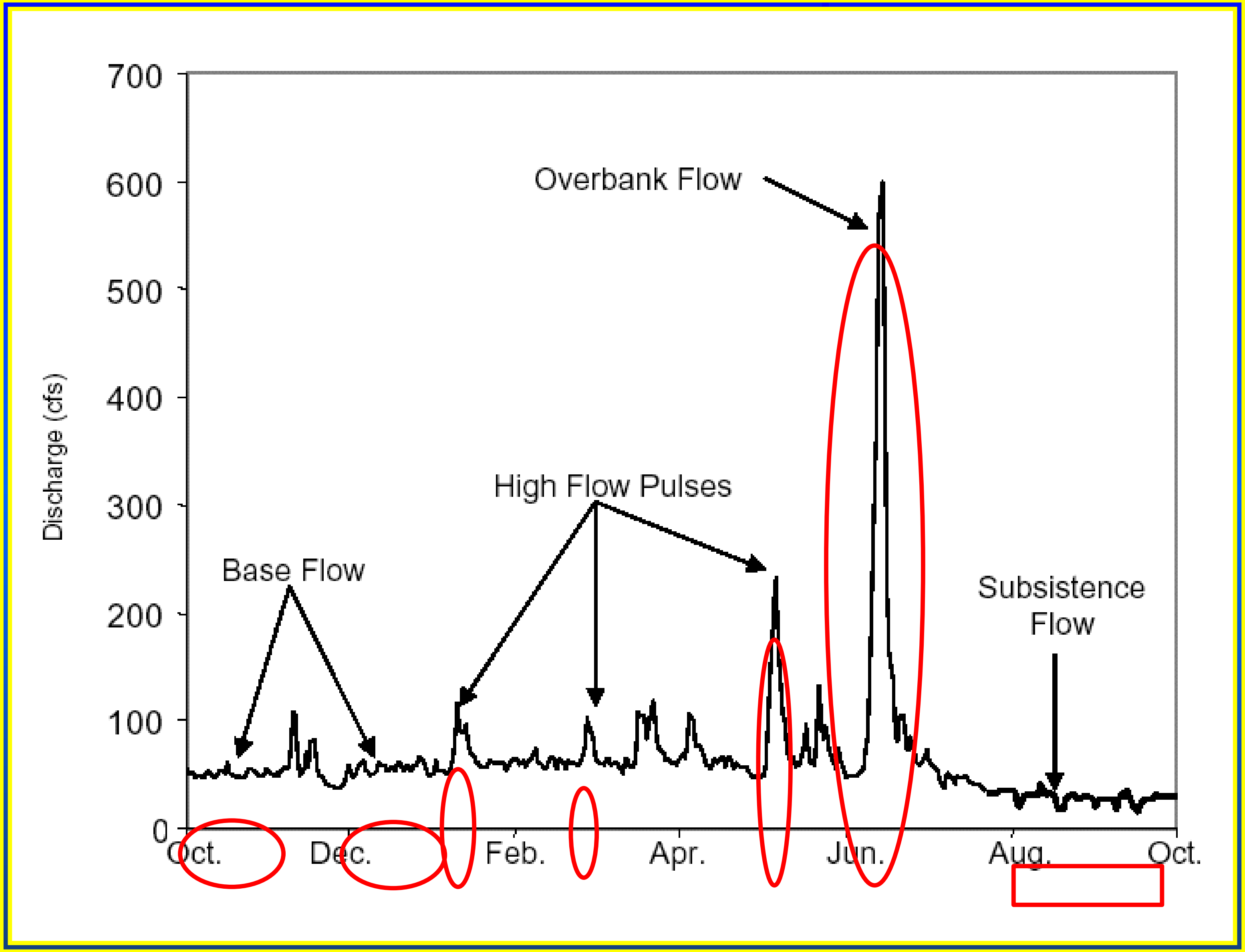
Kevin.Mayes@tpwd.texas.gov

TEXAS PARKS & WILDLIFE

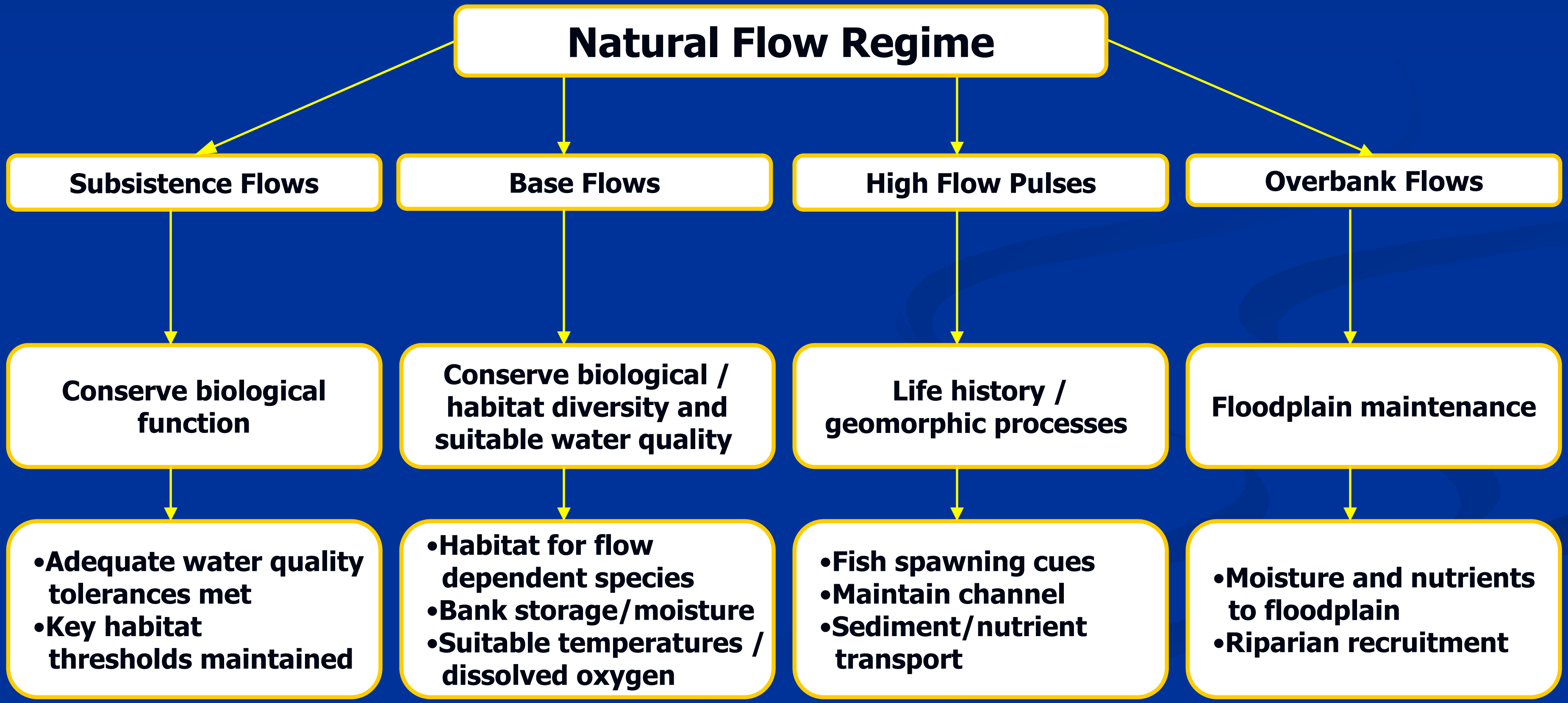

Science
Laws &
Policies
Instream Flow
Institutional
Capacity
Public
Involvement


Water
Quality
Biology
Hydrology
Connectivity
Geomorphology

Instream Flow Components



Simple Conceptual Model



Instream Flow Methods

Paradigm Shift in Instream Flow Recommendations

- 1950s-70s development of first instream flow methods yielding *single minimum flow*
- Growing recognition of role of natural flow regimes: *magnitude, duration, frequency, timing, rate of change*
- Recent shift to consideration of entire flow regime: *subsistence, base, high flow pulses, overbank*

Methods Evolution

1950s to 60s – Water quality

1970s – Hydrologic statistics

1980s – Quantitative biology models

1990s – Ecosystem processes

2000s – Holistic methods

Hydrology Methods

- Indicators of Hydrologic Alteration (IHA)
- Range of Variability Approach (RVA)
- Flow duration curves (Q_{95})
- Presumptive standard (e.g. 10% of flow can be diverted)
- HEFR (Texas)

Hydrology Model Considerations

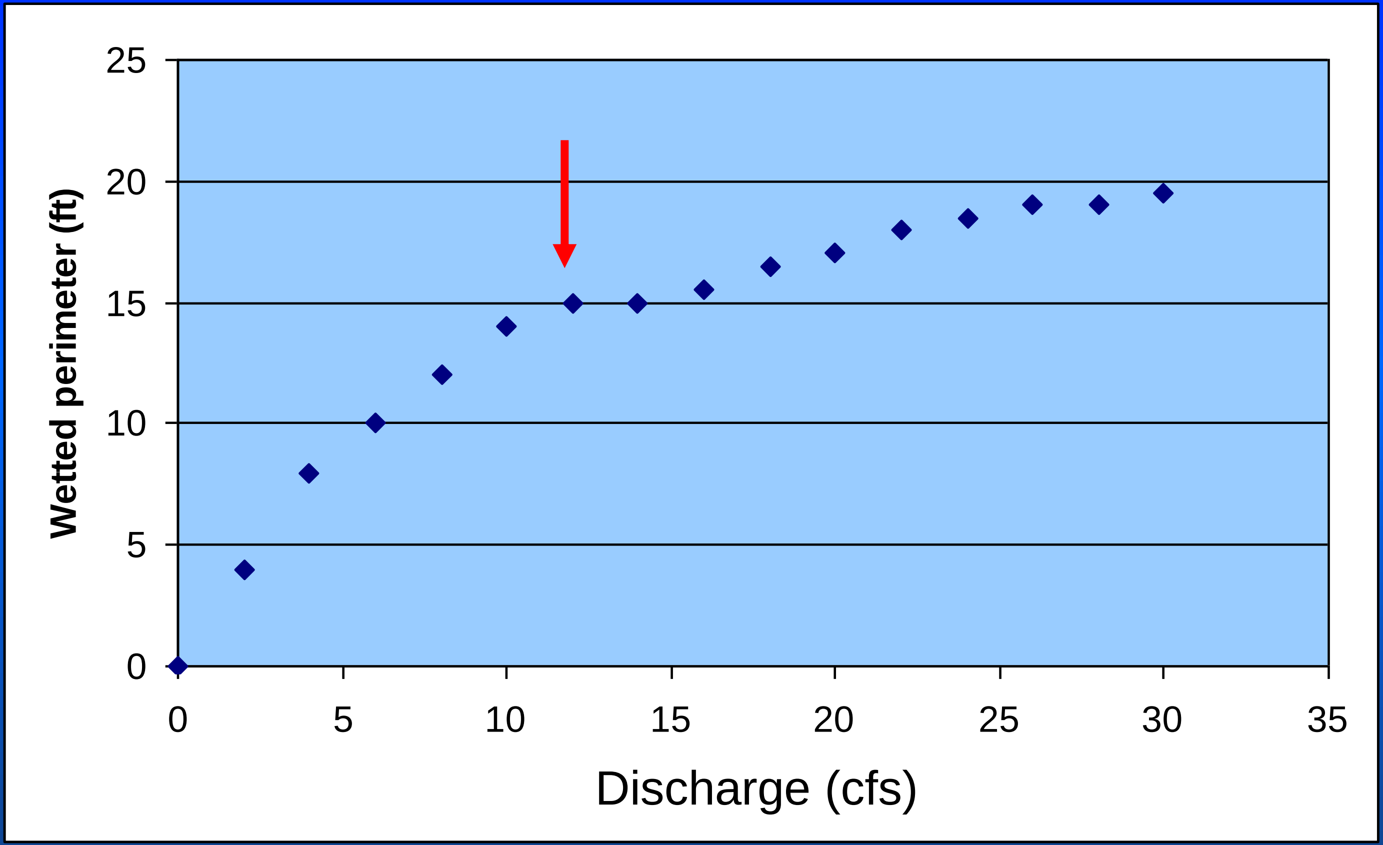
- Long history of use (for some) - acceptance
- Good for describing hydrology (planning)
- Need long-term gage data
- Low to moderate effort
- Assumes a relationship with biology
- May have different relationships with biology on different streams
- Need other tools to assess needs for other riverine elements or specific needs

Biology

- Single Transect Methods
- Tennant Method (and variations)
- Physical Habitat Simulation (PHABSIM)
- MesoHABitat SIMulator (MesoHABSIM)
- Two Dimensional Models (River 2-D)

Single Transect Methods

Single Transect Methods
(Wetted Perimeter)



Single Transect Methods

- Low to moderate effort
- Long history of use
- Only useful for setting threshold flows
- Limited ability to identify trade-offs
- Doesn’t address flow variability needs
- Need other tools to assess needs for other riverine elements

Tennant Method (1976)

Narrative Description of Flow	April to September	October to March
Flushing or maximum flow	200% from 48 to 72 hours	
Optimum range of flow	60-100%	60-100%
Outstanding habitat	60%	40%
Excellent habitat	50%	30%
Good habitat	40%	20%
Fair or degrading habitat	30%	10%
Poor or minimum habitat	10%	10%
Severe degradation	<10%	<10%

Tennant Method (1976)

- Can set threshold flows or regimes
- Need long-term gage data
- Limited ability to identify trade-offs
- Majority of challenges have been successfully defended
- Need other tools to assess needs for other riverine elements

QUICK TX DETOUR

Formed Basis of "Lyons' Method" 1979

1. Flow percentages from
Tennant or Montana Method (Tennant 1976)

2. Monthly medians from
Connecticut River Basin Method (Robinson 1969)

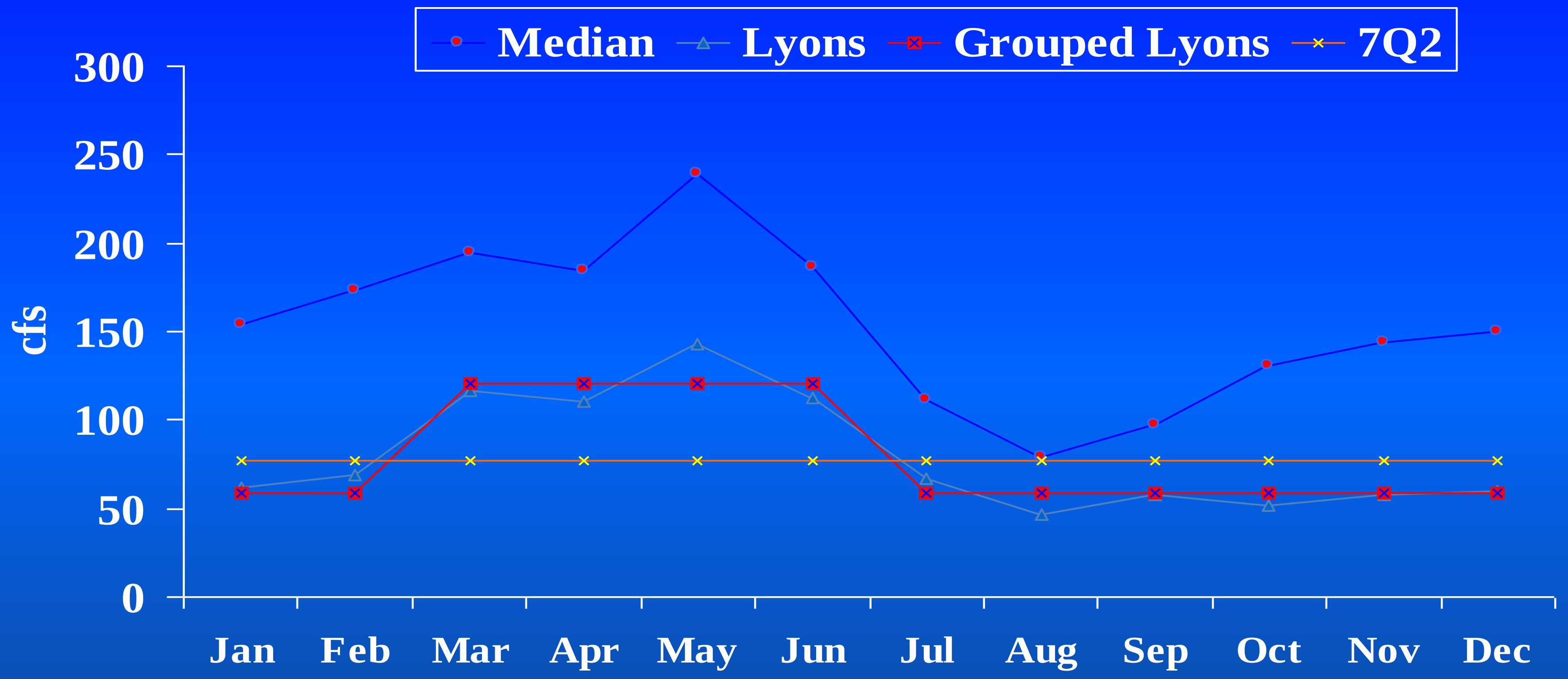
3. Adjusted Tennant's "seasons"

4. Flows "validated" on two sites downstream of Guadalupe River

Lyons' Method
Percentage of Monthly Median

Oct – Feb	Mar – Sept
40%	60%

Instream Flow Recommendations using Lyons Method and 7Q2 flows



Lyons Method

121 cfs for Mar-Jun

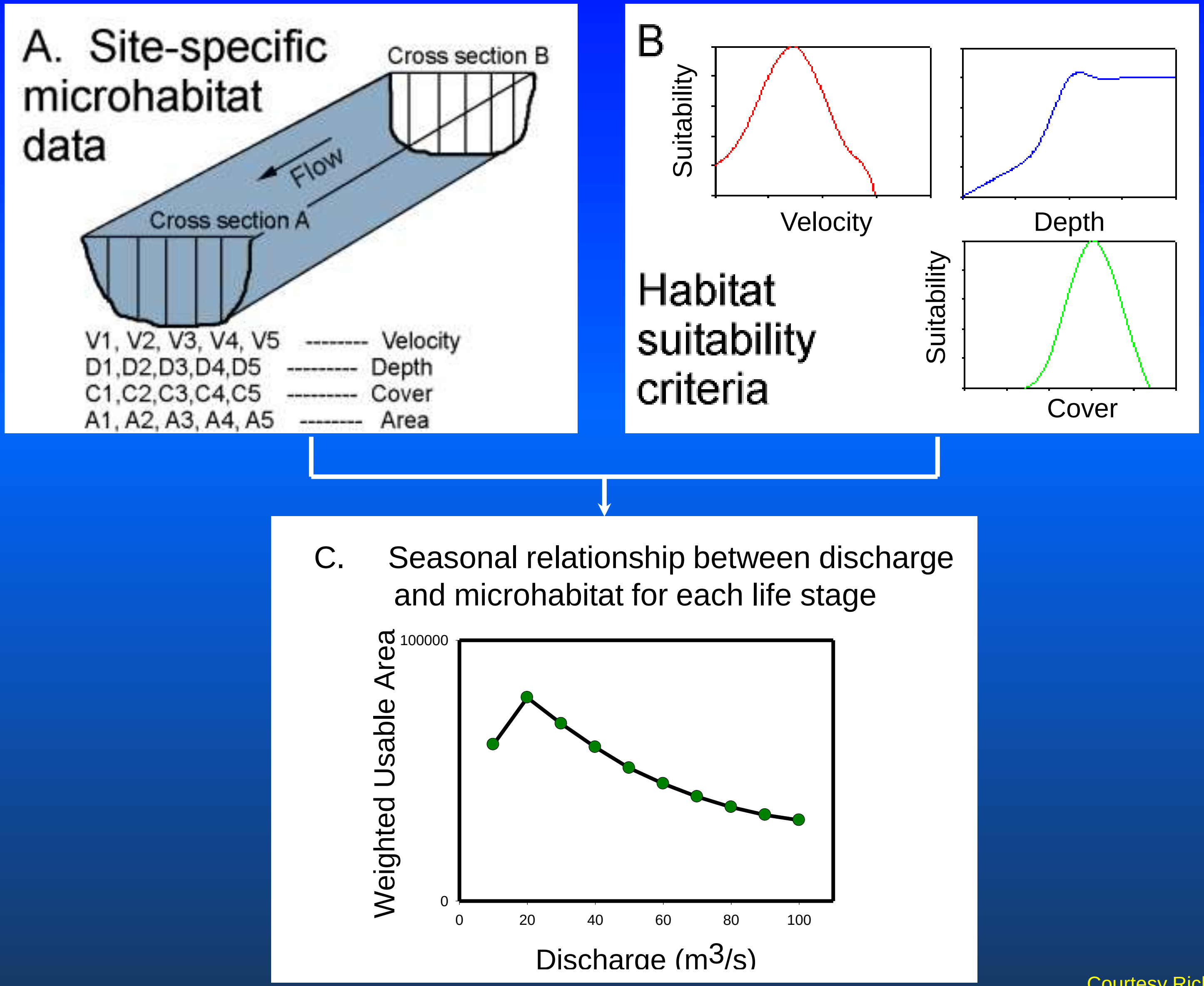
59 cfs for Jul-Feb

Lyons Method + 7Q2

121 cfs for Mar-Jun

77 cfs for Jul-Feb

Physical Habitat Simulation (PHABSIM)



Courtesy Rick Anderson, CDOW

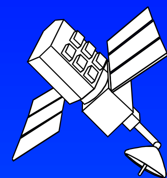
2-Dimensional Physical Habitat Models

flow

Courtesy Rick Anderson, CDOW

High-tech field equipment

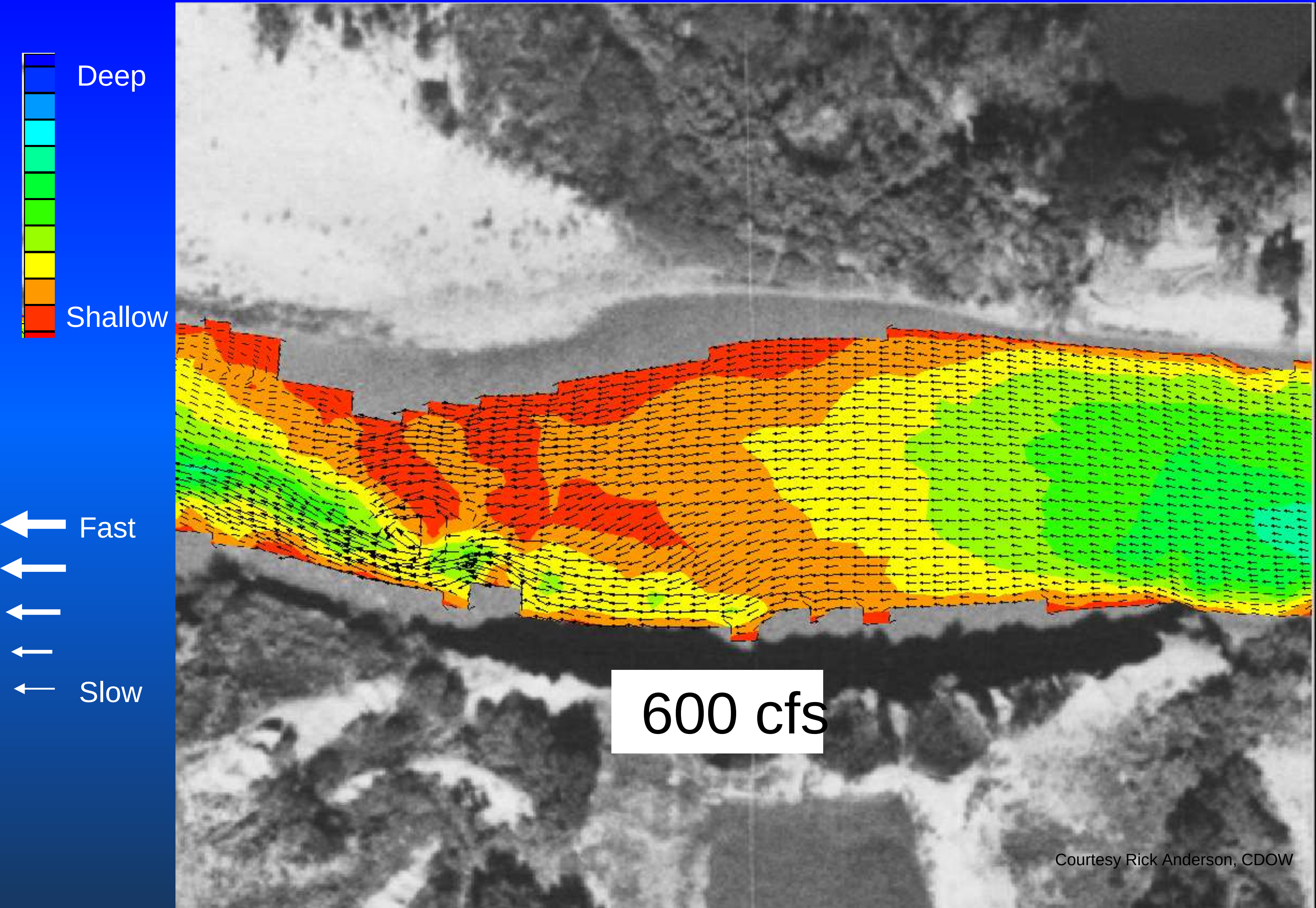
RTK-GPS & ADP/sonar



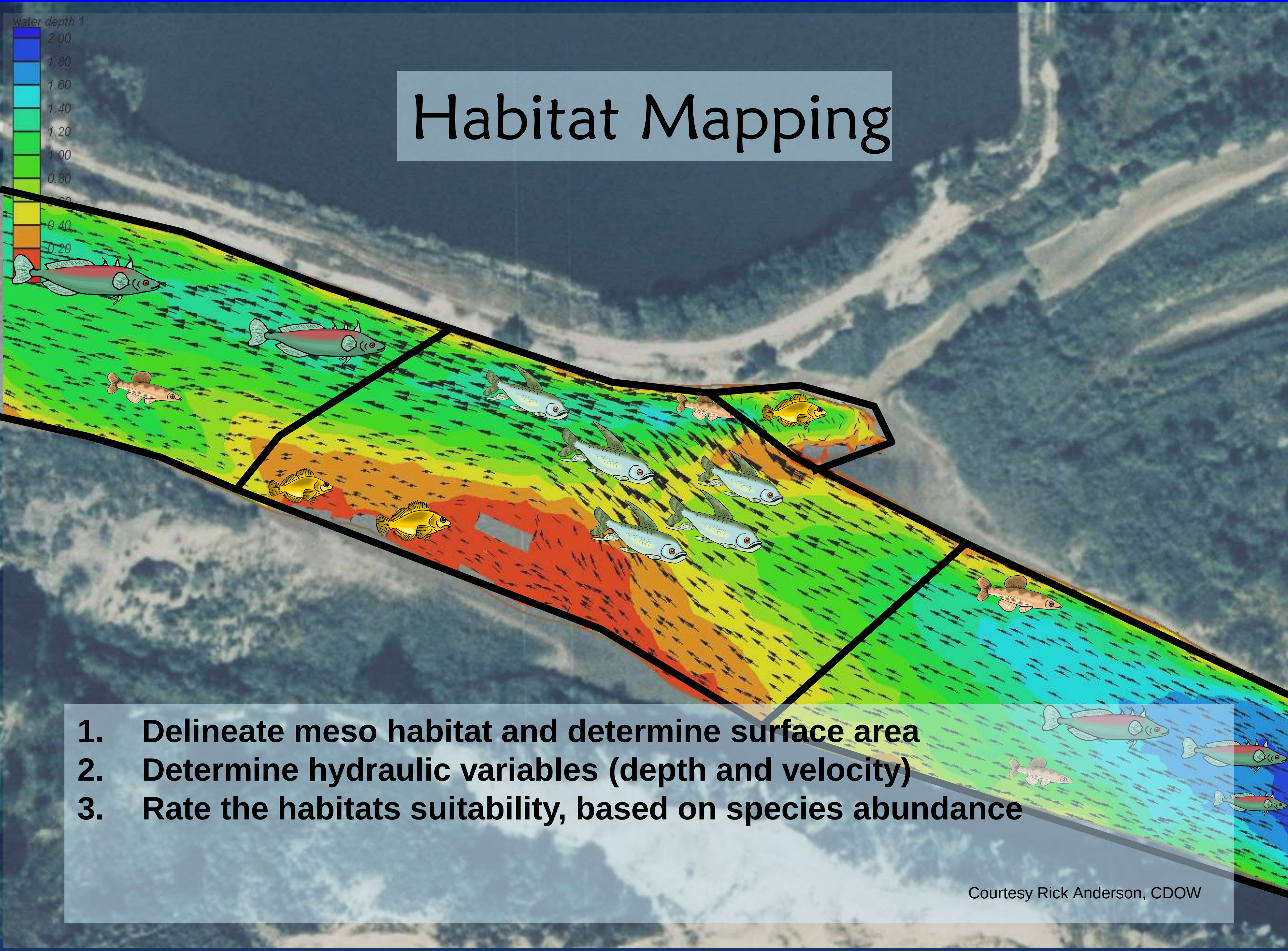
GPS & ADP/Sonar Survey

Courtesy Rick Anderson, CDOW

2-D modeling simulates river hydraulics for a flow range



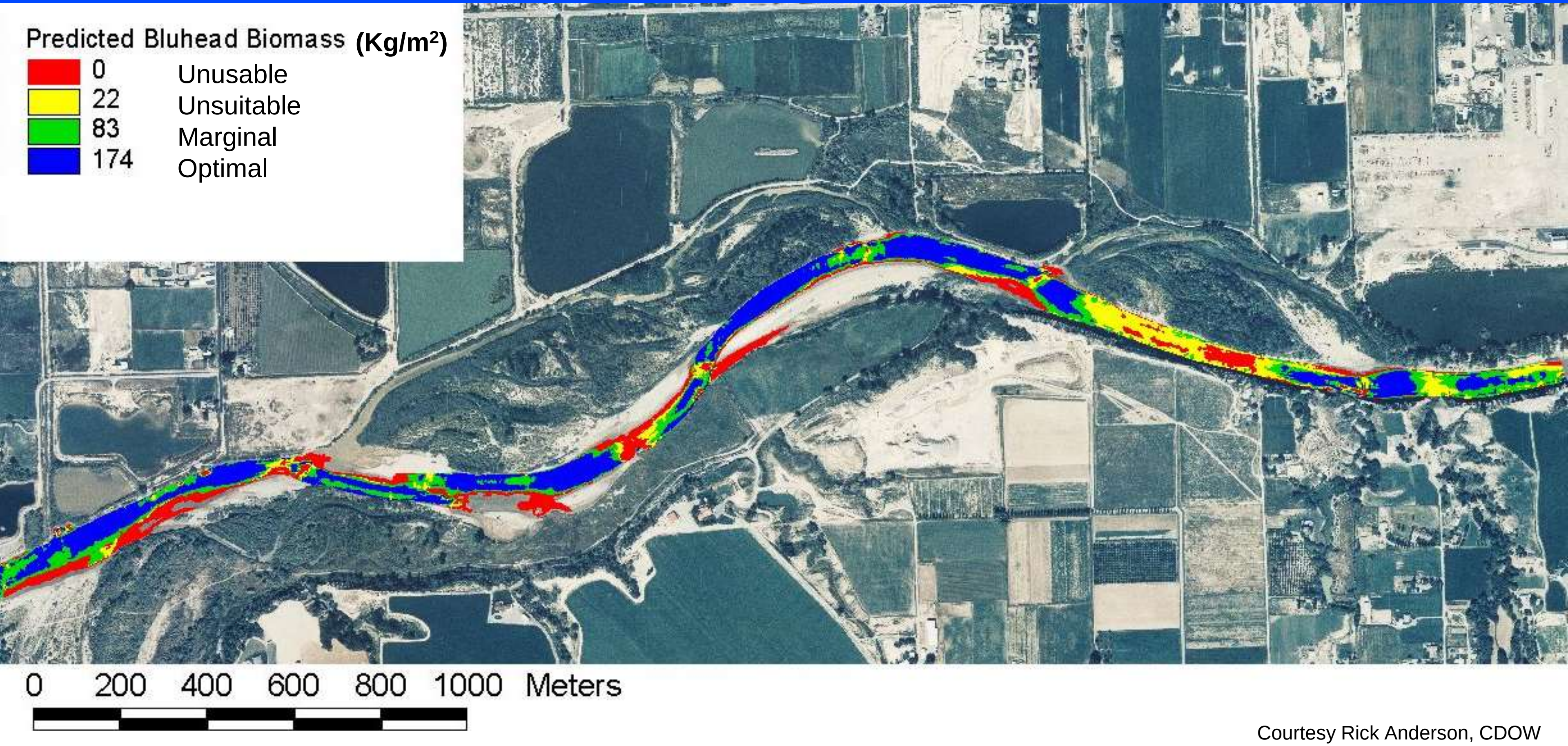
Habitat Mapping



1. Delineate meso habitat and determine surface area
2. Determine hydraulic variables (depth and velocity)
3. Rate the habitats suitability, based on species abundance

Courtesy Rick Anderson, CDOW

Habitat Suitability



Courtesy Rick Anderson, CDOW

Geomorphology

- Channel maintenance in gravel-bed streams
- Flushing flow
  - empirical
  - office-based
- Geomorphic classifications (Rosgen)
- HEC-6 and HEC-RAS

Geomorphology Model Considerations

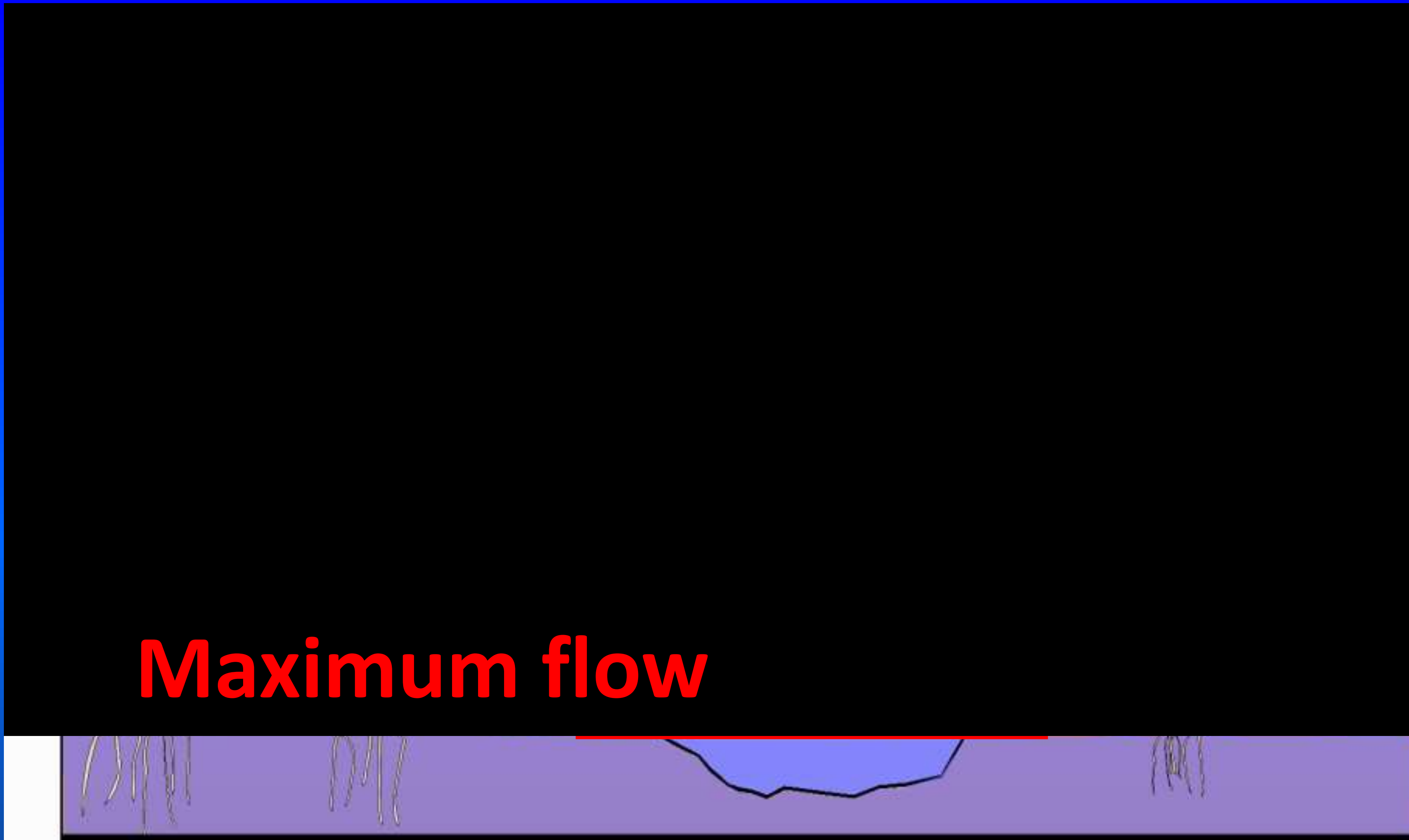
- Usually have broad confidence intervals
- Address long-term physical habitat (not tied to one species)
- Need to specify timing, duration, ramping
- Need other tools to assess needs for other riverine elements

Water Quality

- Stream System Temperature (SSTEMP)
- Stream Network Temperature (SNTEMP)
- QUAL2E (and K)
- 7Q10

Water Quality

- Addressed long before water quantity
- Don’t address intra- or inter-annually variable flows or processes
- Don’t directly identify trade-offs with biology
- Need other tools to assess needs for other riverine elements and processes



Water quality models typically relate to minimum flows . . .

Connectivity Methods

- Habitat/hydraulic models can address longitudinal connectivity (e.g. min. depth for passage)
- Some groundwater models address vertical connectivity
- Estuary methods
  - Salinity-based inflow method
- Floodplain inundation assessments

Connectivity

- Specify which of 4 dimensions you're using (lateral, vertical, longitudinal, time)
- Identify which elements are of interest (organisms, chemistry, bedload, energy)
- Specify time and duration when needed
- Need other tools to assess needs for other riverine elements and processes

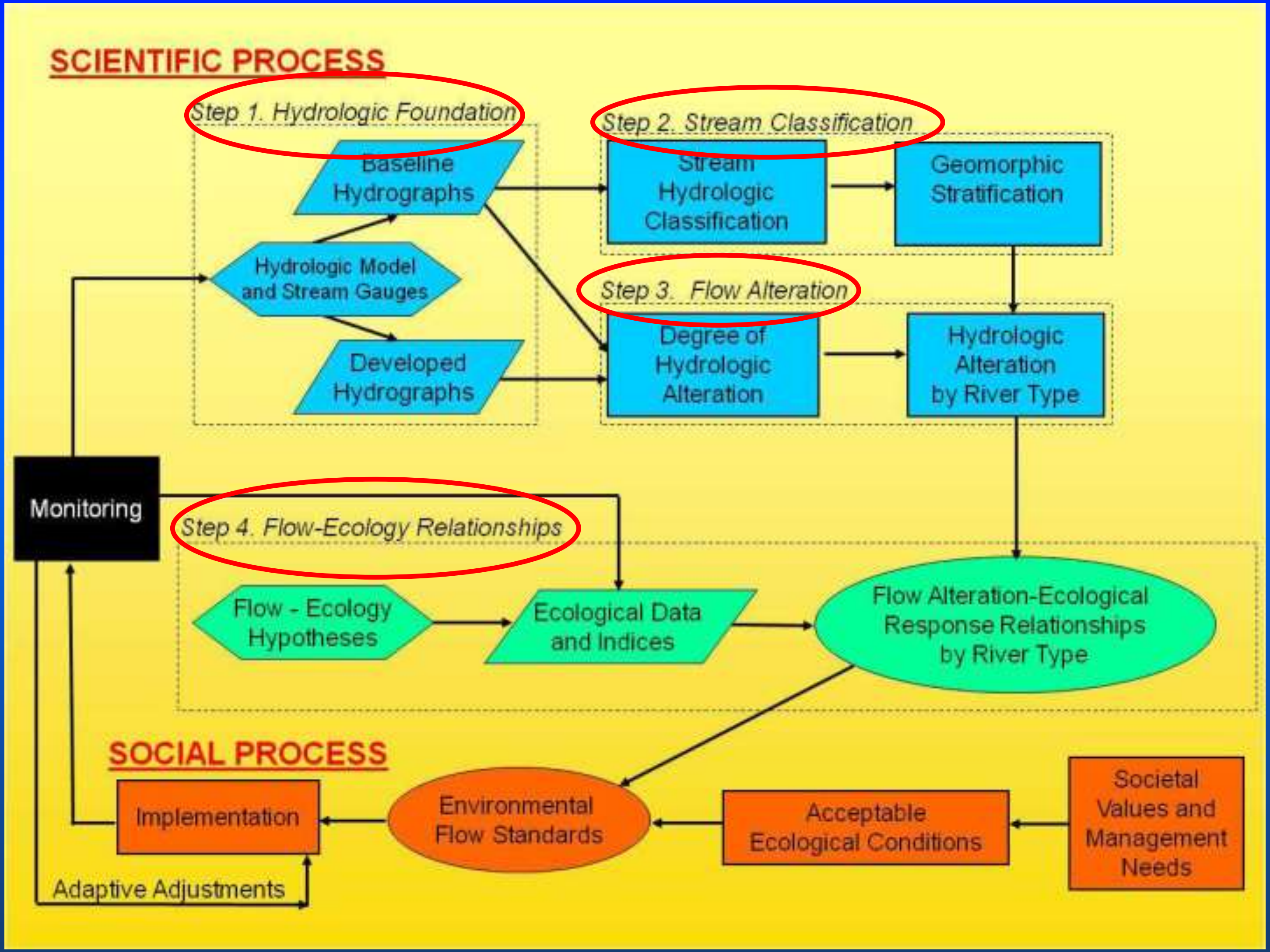
Holistic Methodologies

- Downstream Response to Imposed **Flow** Transformation (DRIFT)
- Ecological Limits of Hydrologic Alteration (ELOHA)
- Bayesian Decision Models
- Demonstration Flow Assessment (DFA)

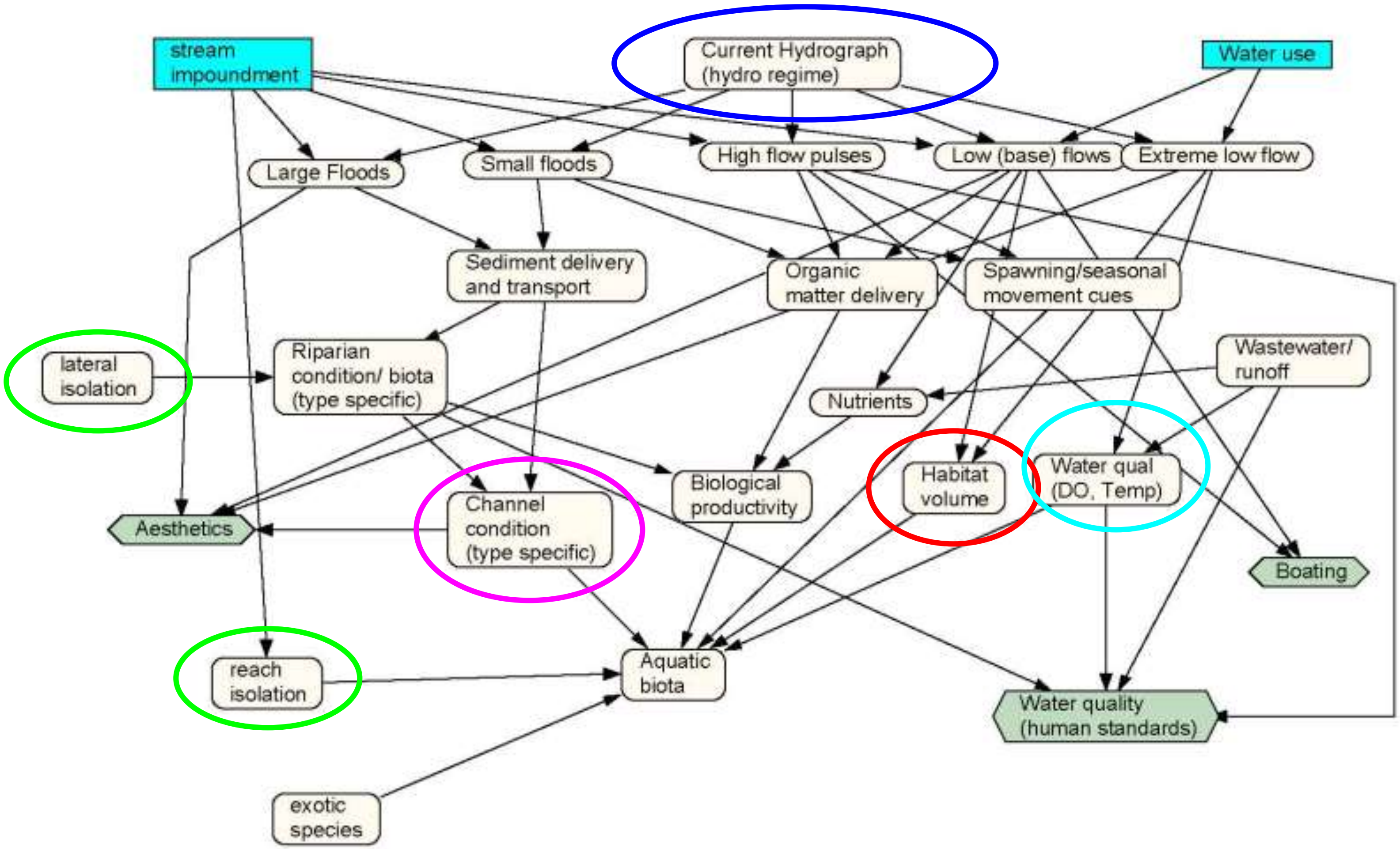
Ecological Limits of Hydrologic Alteration (ELOHA)

- Links hydrological alteration (IHA) with ecology
  - Requires good hydrological data
  - Requires information about ecological processes

Ecological Limits of Hydrologic Alteration (ELOHA)



Bayesian Decision Models



Demonstration Flow Assessment


Empirical Methods

Adaptive management is a process

Establish Objectives

Implement Management

Monitor Effectiveness

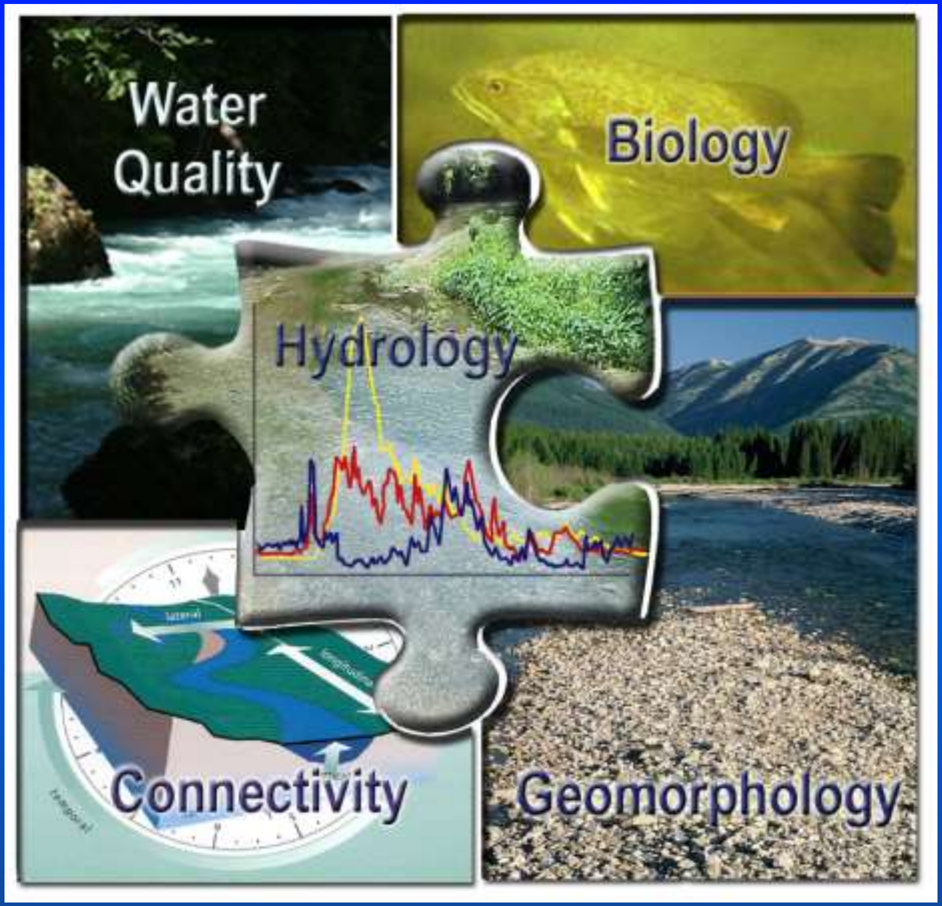
Evaluate Results

Revise Management

Adaptive management requires:

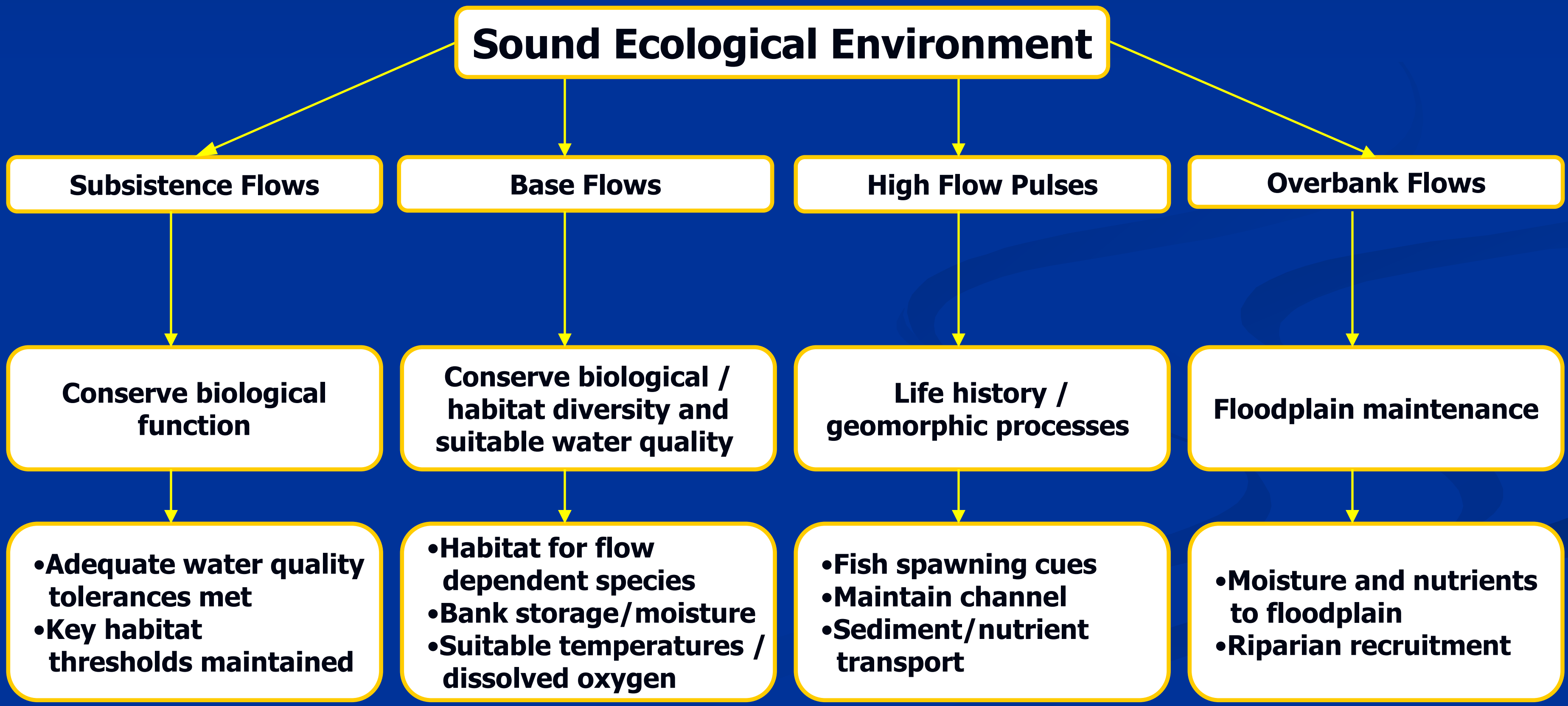
- Long-term commitment of all parties to a common (defined) goal,
- A clear definition of what success looks like (dynamic vs. static; habitat vs. population)
- Extensive monitoring before and after implementation of a flow prescription
- Ability and resources (formal commitment, water & money) to implement new strategies when information shows the need.

There is no best method

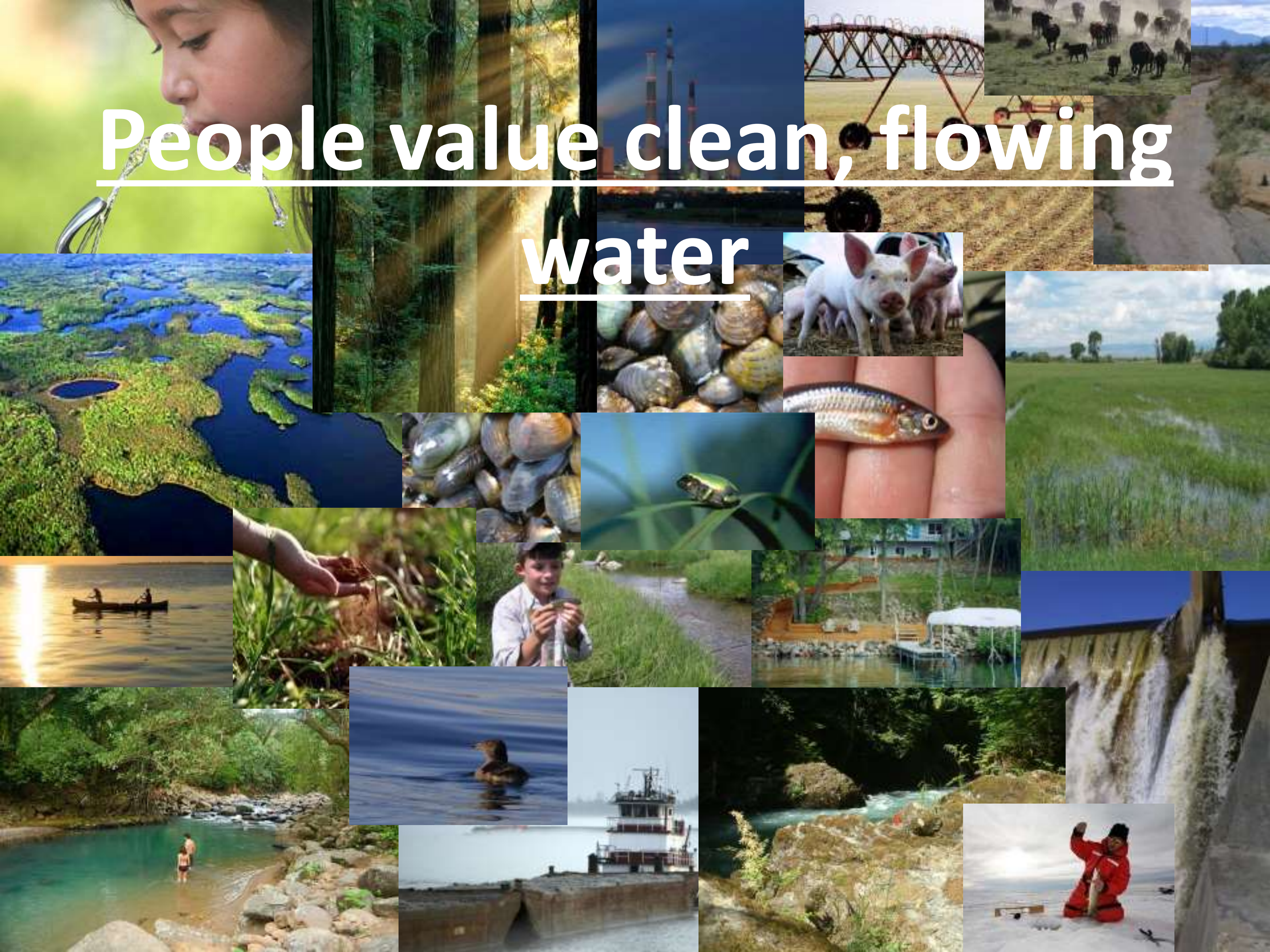


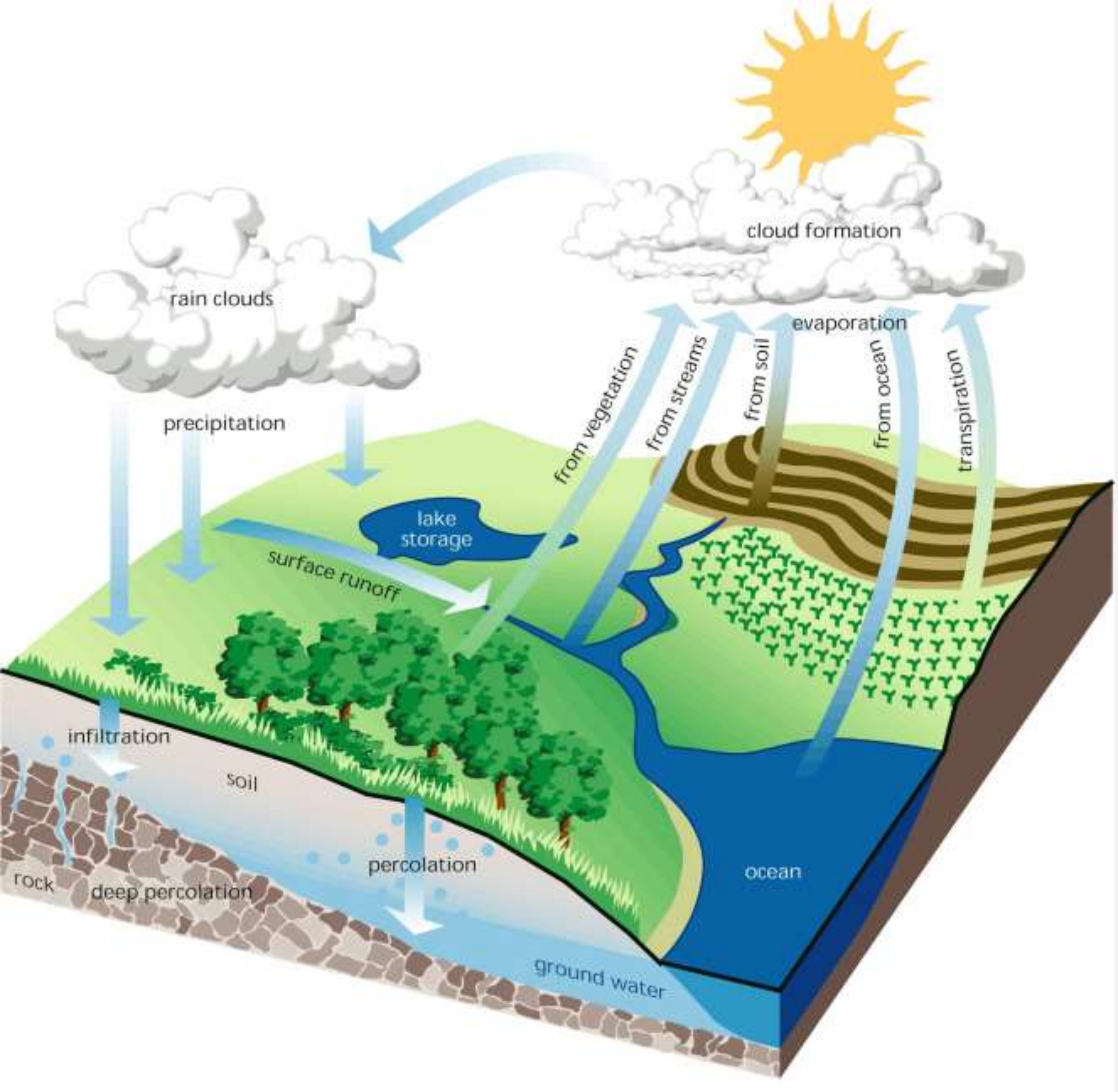
Long-term persistence of organisms comes from long-term persistence of habitat and habitat processes

Natural Flow Regimes



People value clean, flowing water



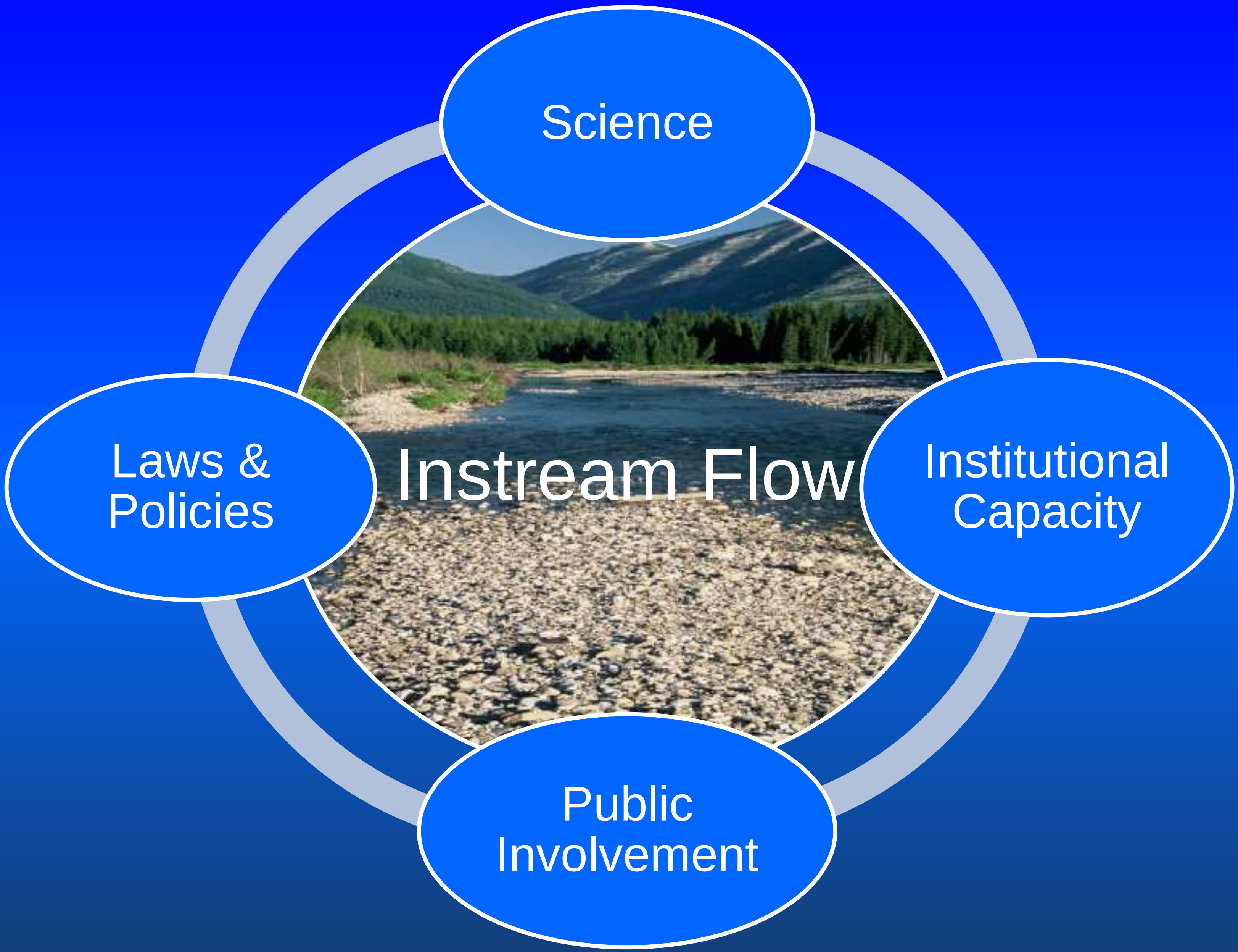


The land and water . . . and people are intimately connected.

"When you pull on one string in nature, you find it is connected to everything else"

John Muir


Healthy
Ecosystems
Benefit Humans


Science
Laws &
Policies
Instream Flow
Institutional
Capacity
Public
Involvement

Resources

http://www.instreamflowcouncil.org/
https://www.facebook.com/TexasRiversStreams
http://www.twdb.texas.gov/surfacewater/flows/instream/
http://tpwd.texas.gov/landwater/water/conservation/fwresources/instream.phtml
http://tpwd.texas.gov/landwater/water/conservation/freshwater_inflow/
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