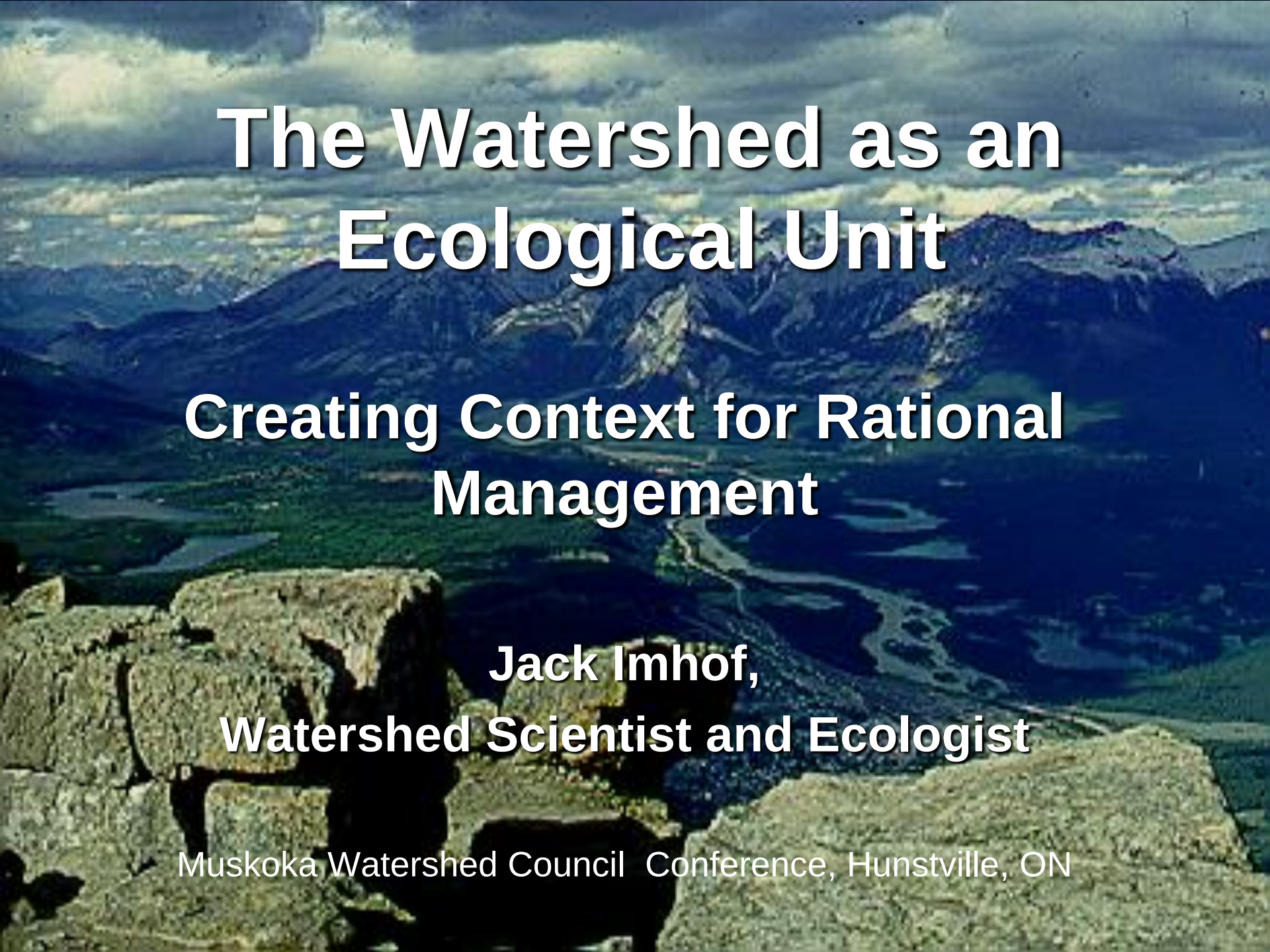


The Watershed as an Ecological Unit

Creating Context for Rational Management

Jack Imhof,
Watershed Scientist and Ecologist

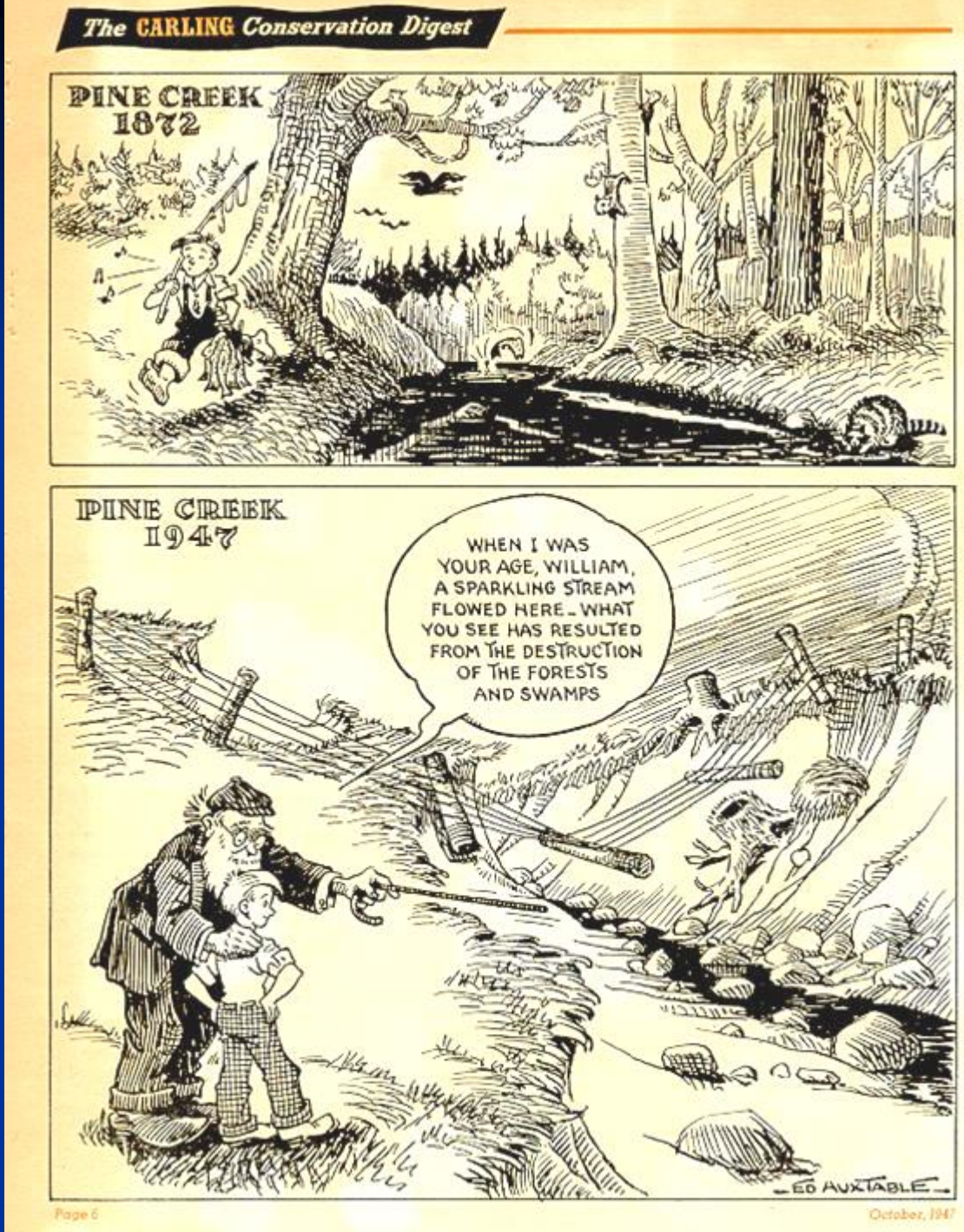
Muskoka Watershed Council Conference, Hunstville, ON

Outline

- Why Manage on a Watershed Basis?
- Watersheds as Ecological Units
- Importance of Context
- Exploring the Key elements of Sound Watershed Planning
- Need for Integrated Watershed Management
- Summary - Restoring our Natural Infrastructure and ensuring Sustainability for People and Environment

Why do we keep repeating the same mistakes?

(Carling Conservation Digest – October 1947)



How Seriously Do Communities Take Their Watersheds?

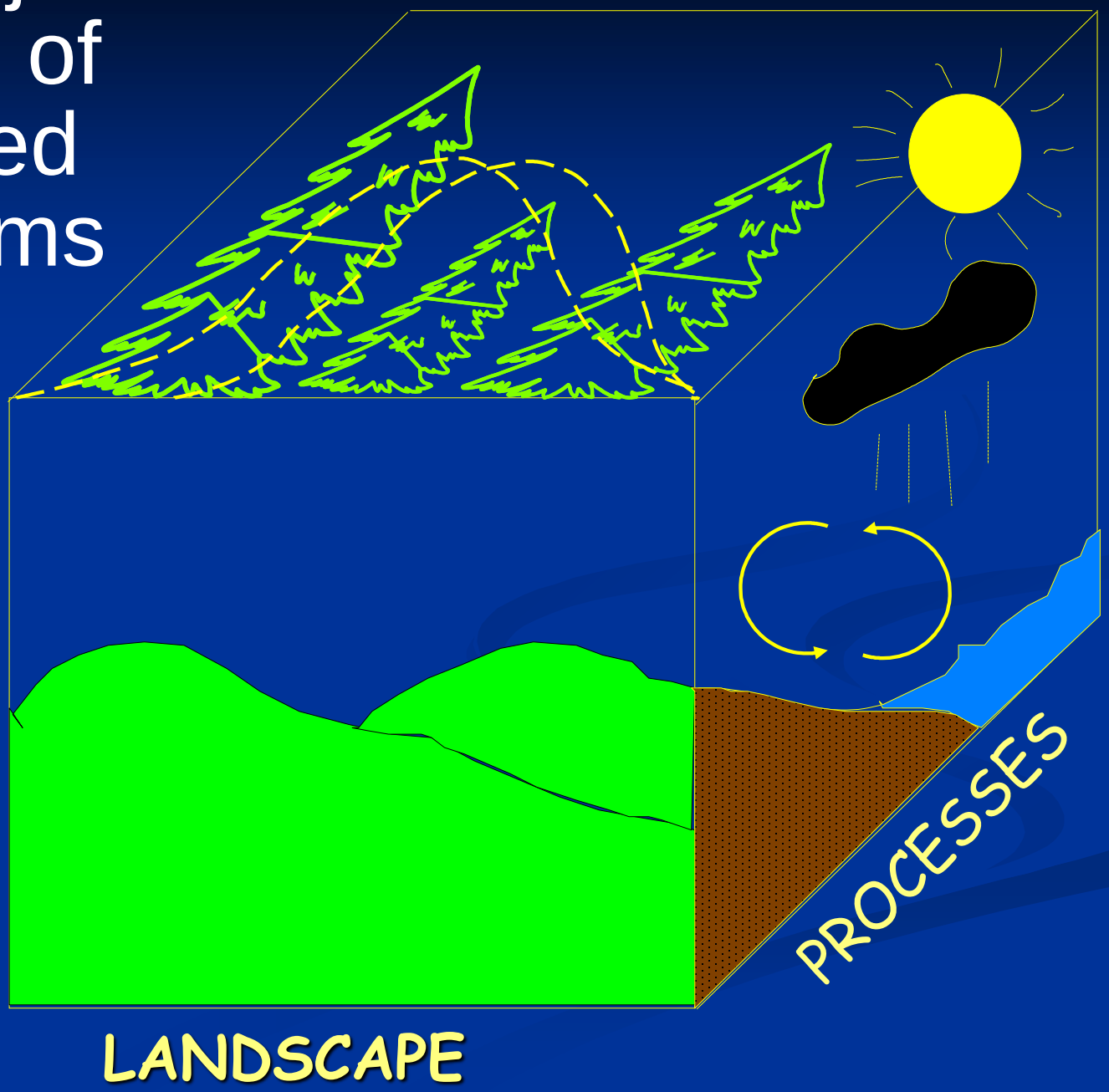
In British Columbia, they can be found….

Three Major Elements of Watershed Ecosystems

Described by:

- Composition
- Structure
- Function

Understood by the relationship between Pathways and Processes



Ecology isn't Rocket Science……

It's more complicated than that!

And we will need all of us working together to sort out managing healthier systems for everyone

Towards And Ecosystem Approach To Management

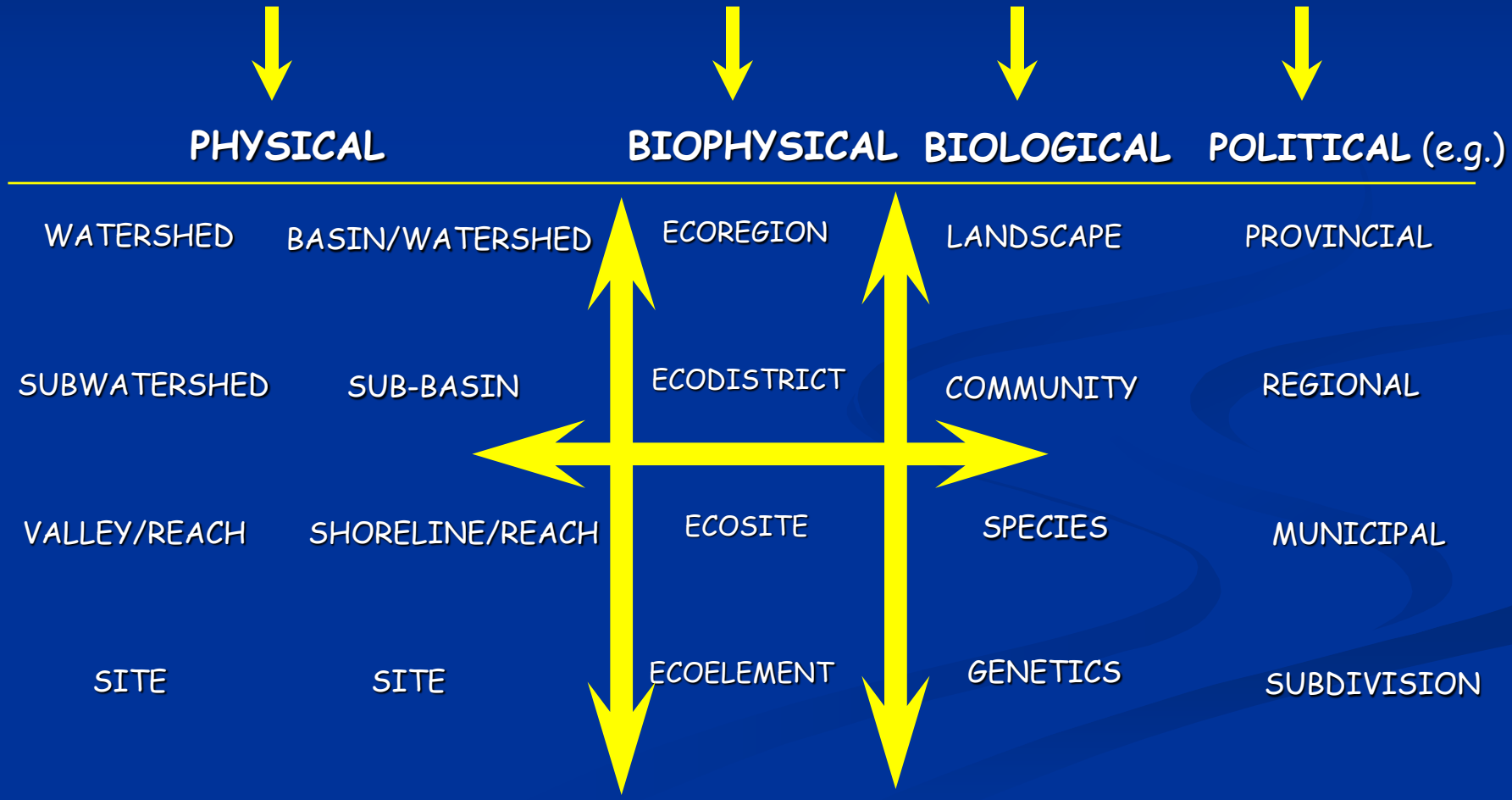
The emerging paradigm of ecological planning tells us that we must do much more than just study the parts of the watershed, its lands and waters: we need to understand how these components interact, and we need to study the whole as well

Ecosystem-based Management

- The ecosystem approach attempts to integrate environmental, social and economic needs.
- We define the appropriate ecosystem based upon issues to be addressed
- As applied to watershed planning, this means having concern for social and economic issues in addition to environmental issues.
- Ultimately we do not manage ecosystems per se but our interactions with ecosystems

Determination of Major Issues and Questions: Which Hierarchy is the Right One

Select Appropriate Hierarchy(ies) for Analysis

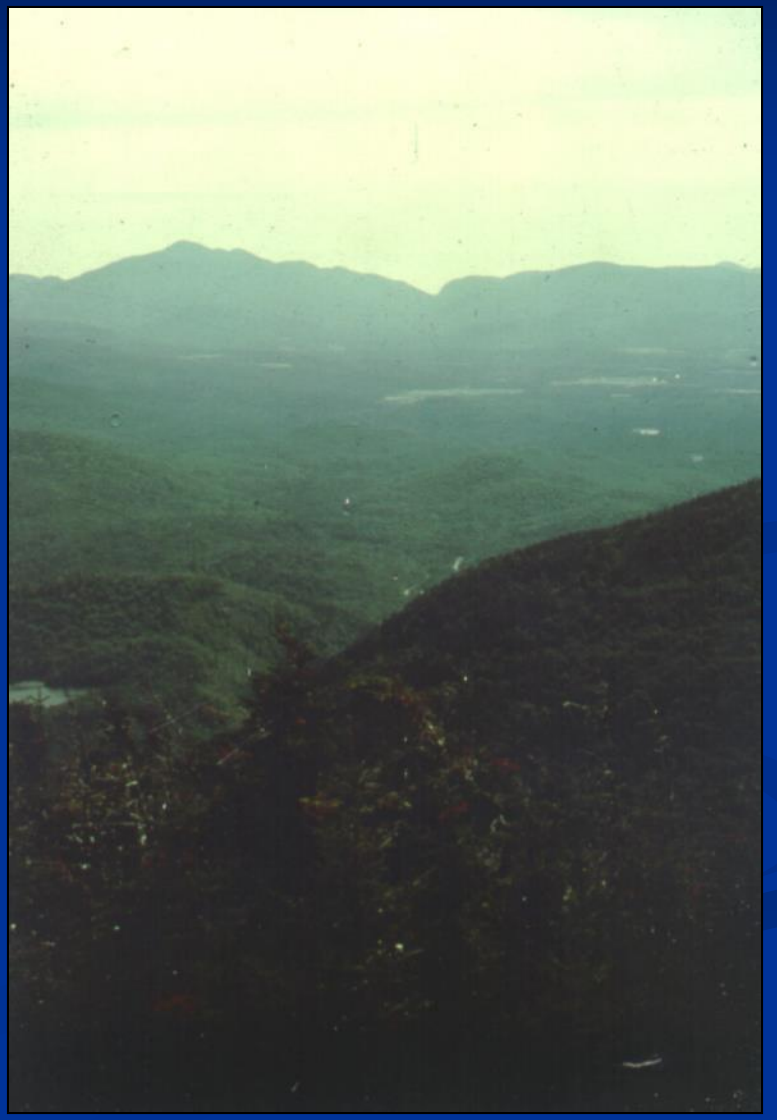


What Is A Watershed?

A Watershed is the area drained by a specific river system.

It includes both the land and water drained by the river and lake systems and in many cases includes the shallow groundwater table as well.

This is the NATURAL INFRASTRUCTURE that provides us with clean water, clean air, a healthy living environment and wholesome food



Geology Creates the Potential for the Ecology of Lakes and Streams

- The Role of Geology
  - Conditions the potential for movement of water over and through the watershed
  - Conditions the chemical make-up of the water
  - Conditions the potential for sediment composition
  - Conditions the potential various fish communities
  - Creates the opportunities for various animals and plants
- Ultimately the lake is an expression of the surrounding watershed and its health

Geology provides the rock and structure

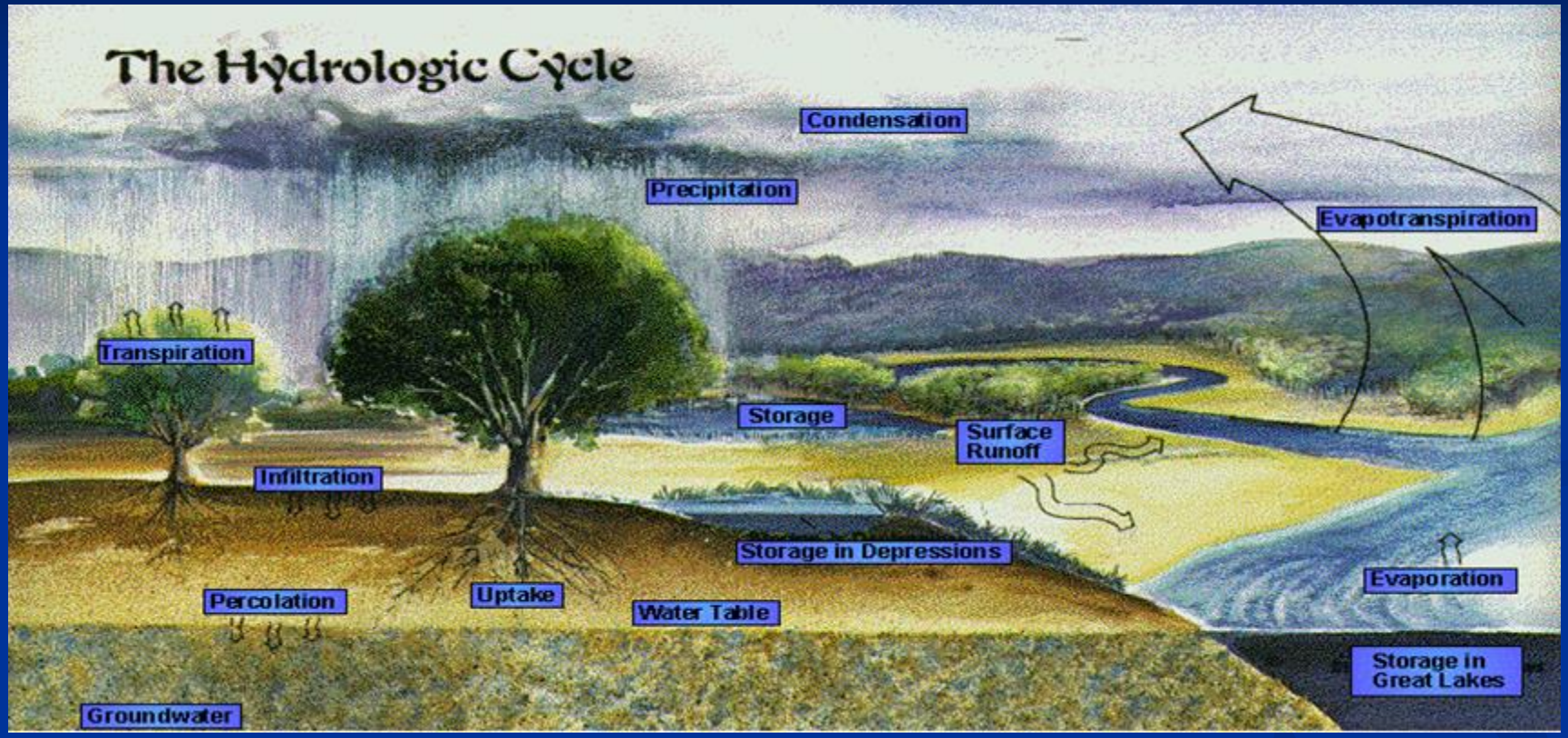
Climate creates the weather, weathering and water

Vegetation modifies water flow over and through the watershed

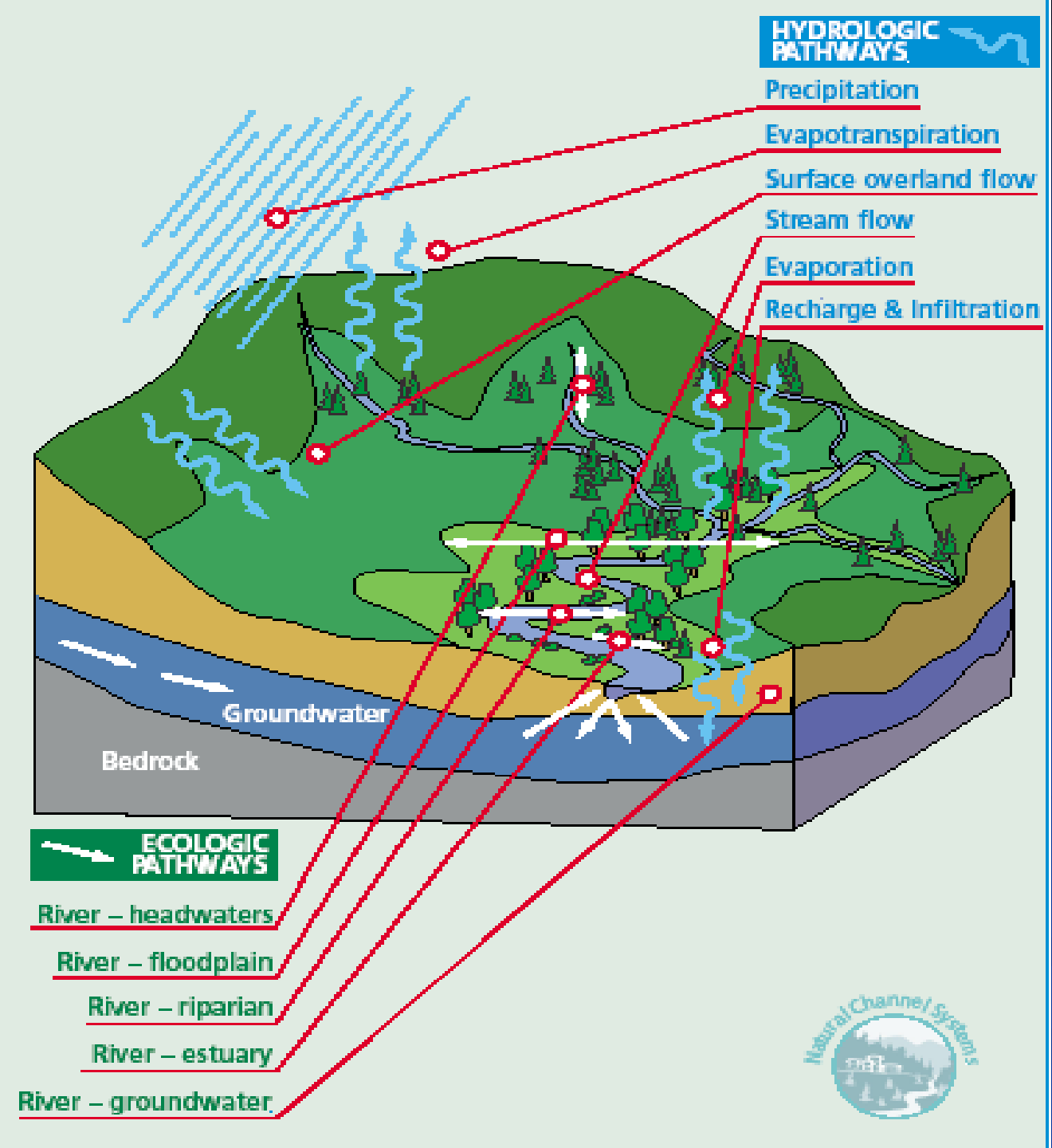
The site creates the channel form that provides habitat and stability

The valley directs and concentrates surface and groundwater

Application Of The Hydrologic Cycle



The quality and health of our watershed is controlled by the way that water, nutrients and sediments move over and through the watershed and by our interaction with these pathways.



Application of two pathways and process models to assist with integrated Watershed Planning

Impacts Of Hydrologic Pathway Disruption

- Changes in water and sediment regime and yields, resulting in:
  - Less infiltration and interflow and concurrent increases in run-off and flooding;
  - Reductions of groundwater contributing to to wetlands and baseflow in streams;
  - High flow changes (magnitude, frequency, duration and rate/timing of change);
  - Changes to geomorphology of valley and stream systems as well as floodplain/riparian and aquatic habitats;
- Impacts on built infrastructure, water quality, properties along lakes and rivers, irrigation and water supply

Impacts Of Ecologic Pathway Disruption

- Alterations in hydrology change migration patterns and routes to and from headwaters;
- Alter in-channel processes (substrate & bedload; w:d ratio, geometry, slope and planform of streams) resulting in degraded aquatic habitat and processes and built infrastructure
- Alter interactions of river and floodplains (less nutrient and sediment capture and water storage, wetland loss, changes in water quality);
- Loss of riparian zone structure and functions affecting natural system and properties along rivers

Landuse Changes Potential Consequences

- These create changes in water quality, water quantity, channel health, erosion, flooding, fish communities, etc.
- Results of these transitions on river and lake systems include:
  - Δ Nutrient Cycling
  - Δ Channel Morphology
  - Δ Change in Lake Water Storage
  - Δ In Seasonal Lake Levels
  - Δ Temperature Regime
  - Δ Habitat Conditions

Consequences of Change to Fish and Biota

- Δ Channel Morphology
  - Less complexity for species specialists and for all life stages of top-level predators within Trophic system
  - Higher levels of fines in substrate, reducing habitat complexity and reducing link to hyporheic zone
  - Less complexity reducing mixing and affecting DO

- Δ Habitat Conditions
  - Pool:riffle sequencing reduced, leading to lower habitat complexity, less LWD, less undercut banks and specialized habitat areas
  - Reproductive zones may be limited or affected by high fines

Consequences of Change to Fish and Biota

- Δ Lake Storage and Seasonal Levels
  - Alteration in Spawning habitat
  - Alteration in Juvenile and Rearing habitat
- Temperature Regime
  - Less shading allows for increased temperature extremes, allowing for increased production and constraints on some species
- Δ Nutrient Cycling
  - High levels of P and N driving excess production
  - Less complexity allowing for higher production of lower trophic levels
  - Higher cycling with less retention in higher trophic levels

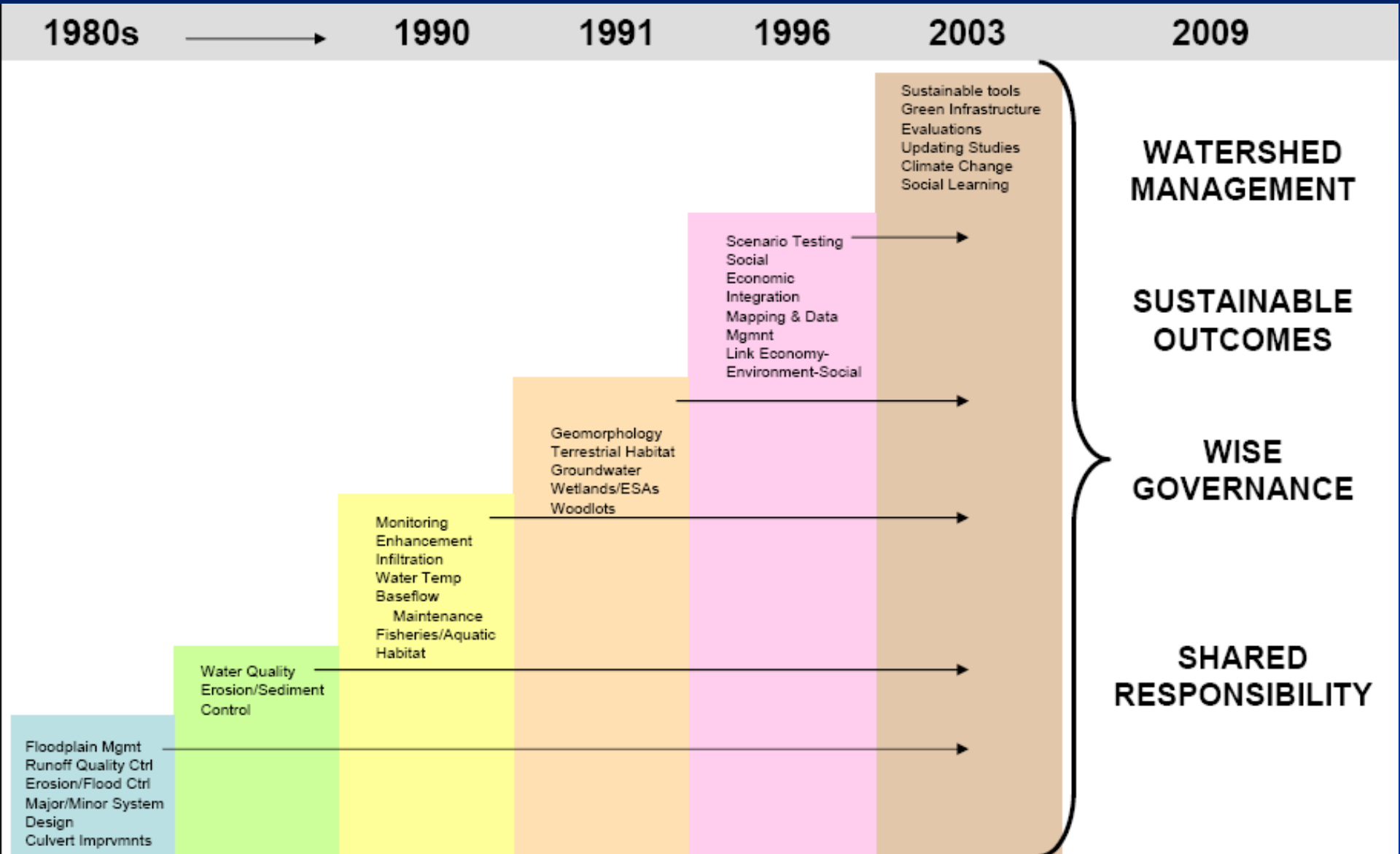
Development Of Integrative Approaches

- Linking Watersheds to Aquatic Habitat
- Developing integrative understanding of Watershed and connected Lake Basin form and functioning
- Developing integrative planning and design tools
- Linking knowledge to social learning

Things are Complicated

Complex problems often have easy to understand WRONG answers

EVOLVING COMPLEXITY….The Questions keep increasing!



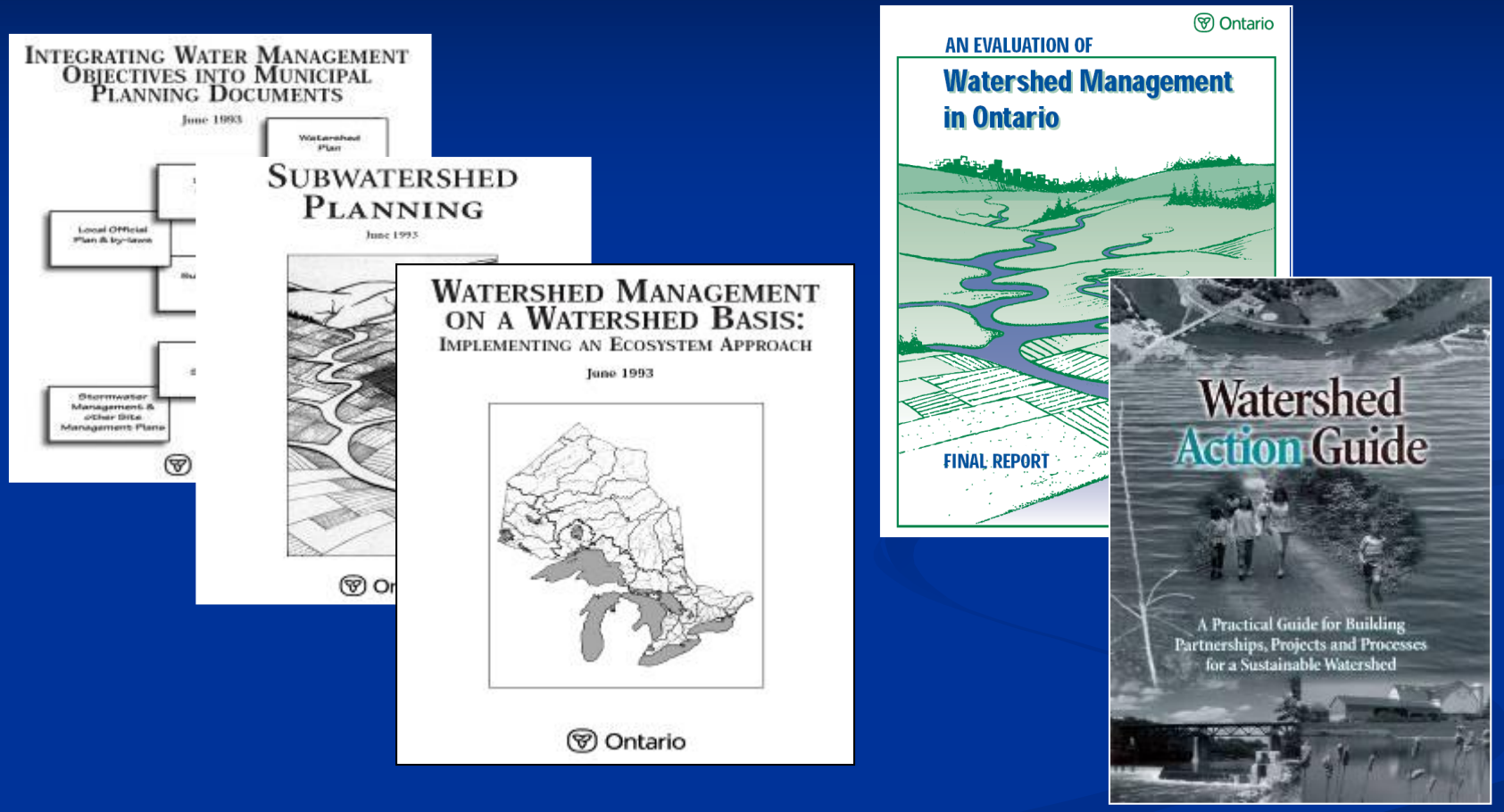
Management and Planning Need

- We need to create contextual planning and management approaches and tools linked to an understanding of:
  - Form and Function;
  - Cause:Effect, Cause:Response relationships
  - Consequences of various management outcomes (which trajectory do we want?)
  - The full breadth of what is possible through various management options

Integrated Watershed Management

- Process of managing human activities and natural resources in a defined ecological unit.
- Accounts for spatial and temporal landscape scales.
- Links all landscape together through network of interconnected streams and lakes.
- Strives for: sustainable use, careful development, restoration and protection of functional features.
- Recognizes complexity and multiplicity of issues and helps determine multiple outcomes.
- Integrates scientific components.
- Identifies agency and stakeholder responsibilities.
- Strives for social learning and an engaged community.

Example of Recent Past: Watershed Management 1990's in Ontario



From Master Drainage Plans to "Community-driven, voluntarily-led and locally implemented" to comprehensive basin strategies (from Messervey and Boyd 2008)

Putting Integration Into Watershed Management

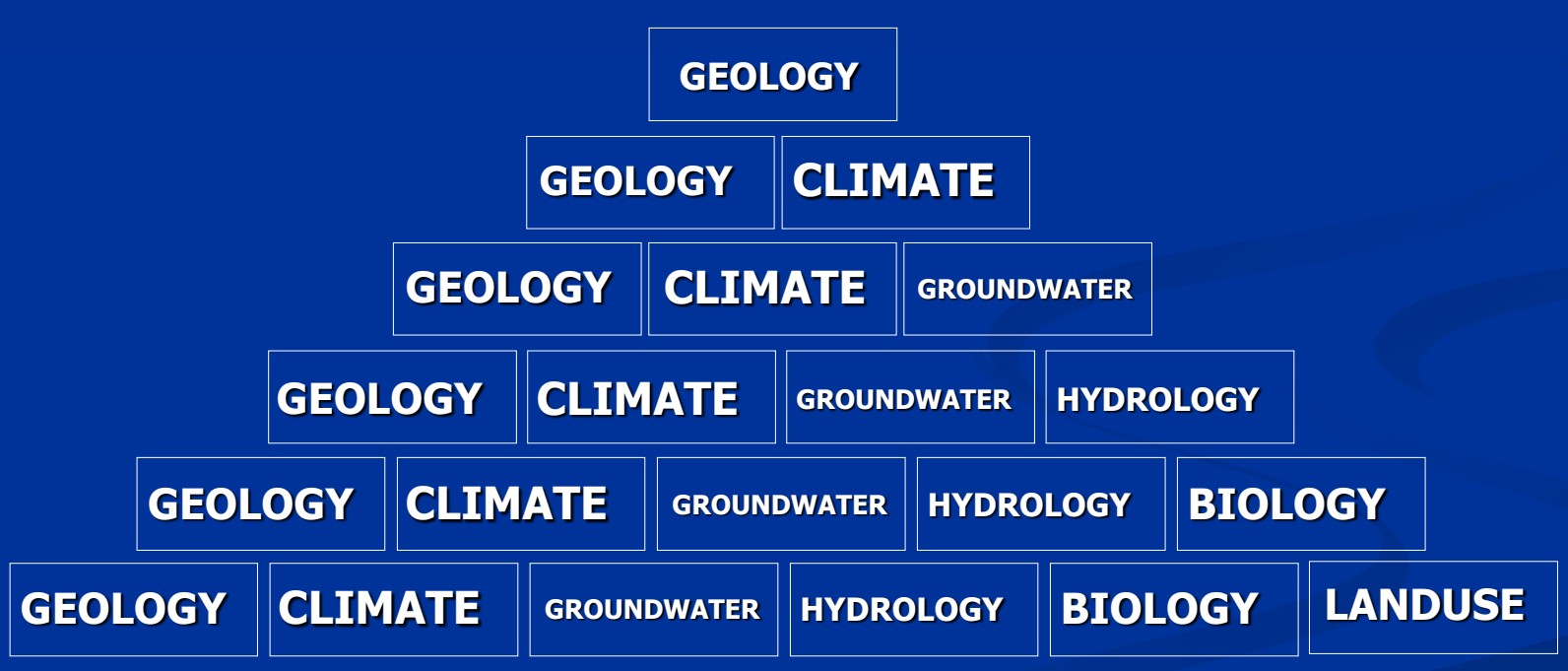
- **Context is Everything** (eg. Spatial, temporal, policy)
- Helps identify locations and causes of problems
- Integrates understanding of the watershed and helps to prioritize conflicting policy and legislation
- Creates a science-based, transparent process open to scrutiny and discussion
- Ensures that implementation projects Treat the Causes of System dysfunction, not their Effects

Integrating What?

- Integrating the processes
  - *Defining the technical and analytical approaches to linking the science*
  - *Creating Enabling Policies and Legislation*
- Integrating the disciplines and mandates
  - *Creating a common scientific and policy view*
  - *Creating institutional arrangements and a common vision*
- Integrating our view of the watershed
  - *Social learning*
  - *Community engagement and leadership*
  - *Integrating jurisdictional responsibilities*

Technical Approach:
Building Block Approach

Sequential networked model selection



A vertical integration procedure for the selection of watershed sub-models.

Integrating The Disciplines Through Structuring Information

- State of the Science
  - Science – *scientific understanding*
  - Knowledge Base – *widely understood and shared*
  - Current Practices – *applied science available*
  - Information – *interpreted understanding of data*
  - Data – *observations and measurements*
- Application of the Science
  - Characterization – *define structure, composition, function and known interrelationships*
  - Prediction – *ability to identify future responses to change*
  - Issue Resolution – *ability to use information to establish relative risks of various choices*
  - Communication – *ability to disseminate knowledge*
  - Monitoring – *ability to monitor and understand and relate changes to actions*

Summary Of Key IWM Tools

- Creating tools to help integration of disciplines and understanding
  - Water Budget Tool
  - Phosphorus Modeling and Nutrient Input Models
  - Seamless surface water:groundwater model
  - Governance Structure and Community-based Involvement
  - Enabling legislation, policy and technical guidelines
    - Moving from a regulatory environment to an **ENABLING** environment
    - Moving from regulatory to **OUTCOME** based management

Linking To The Community

"TRUE PROTECTION AND RESTORATION OF NATURAL ENVIRONMENTS WILL NOT OCCUR UNTIL WE ENGAGE THOSE WITH WHOM WE WOULD NOT NORMALLY ASSOCIATE."

Dr. Stephen Born,

University of Wisconsin/Madison,

River Rendezvous 1997, Kitchener, Ontario

Developing An Engaging Plan: Linking People To The Process

- The process is about both people and the resource;
- Focus is established by core sociological, ecological and management principles;
- Context is established by understanding the relationships between the land/waterscape, people and natural systems;
- Since people will implement the plan, it MUST be the people's plan, not the agencies plan
- Plan can show EVERYONE how things and decisions link together

FUNDAMENTAL SHIFTS NEEDED

- A shift to a broader strategic approach to managing the environment (as compared to the more traditional regulated and reactive approach) where implementation is shared across jurisdictional agencies.

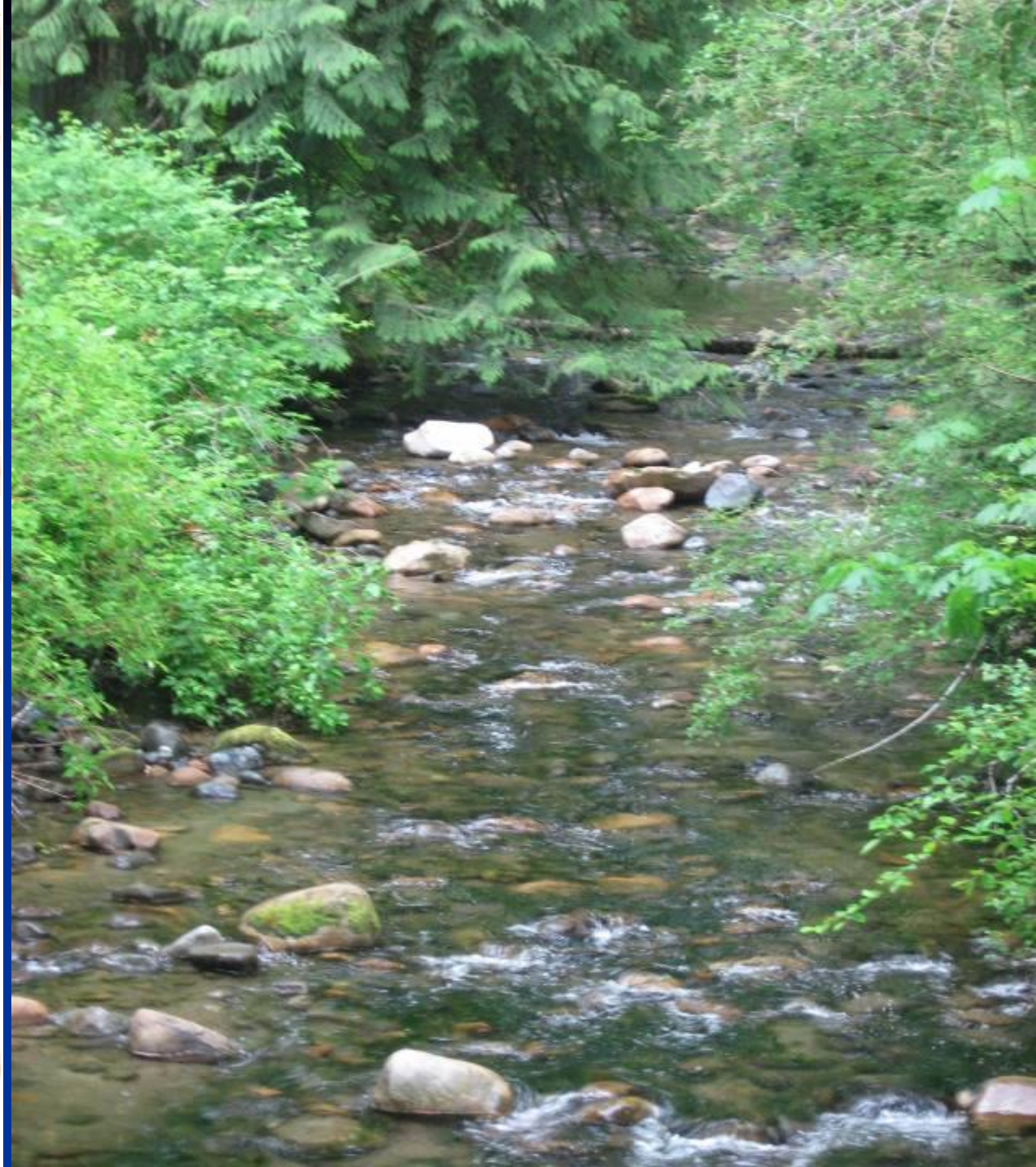
- A shift towards continuous improvement in environmental performance.

- A shift to a "place-based" approach using boundaries that make environmental sense and which facilitate a cross-media, cumulative approach.

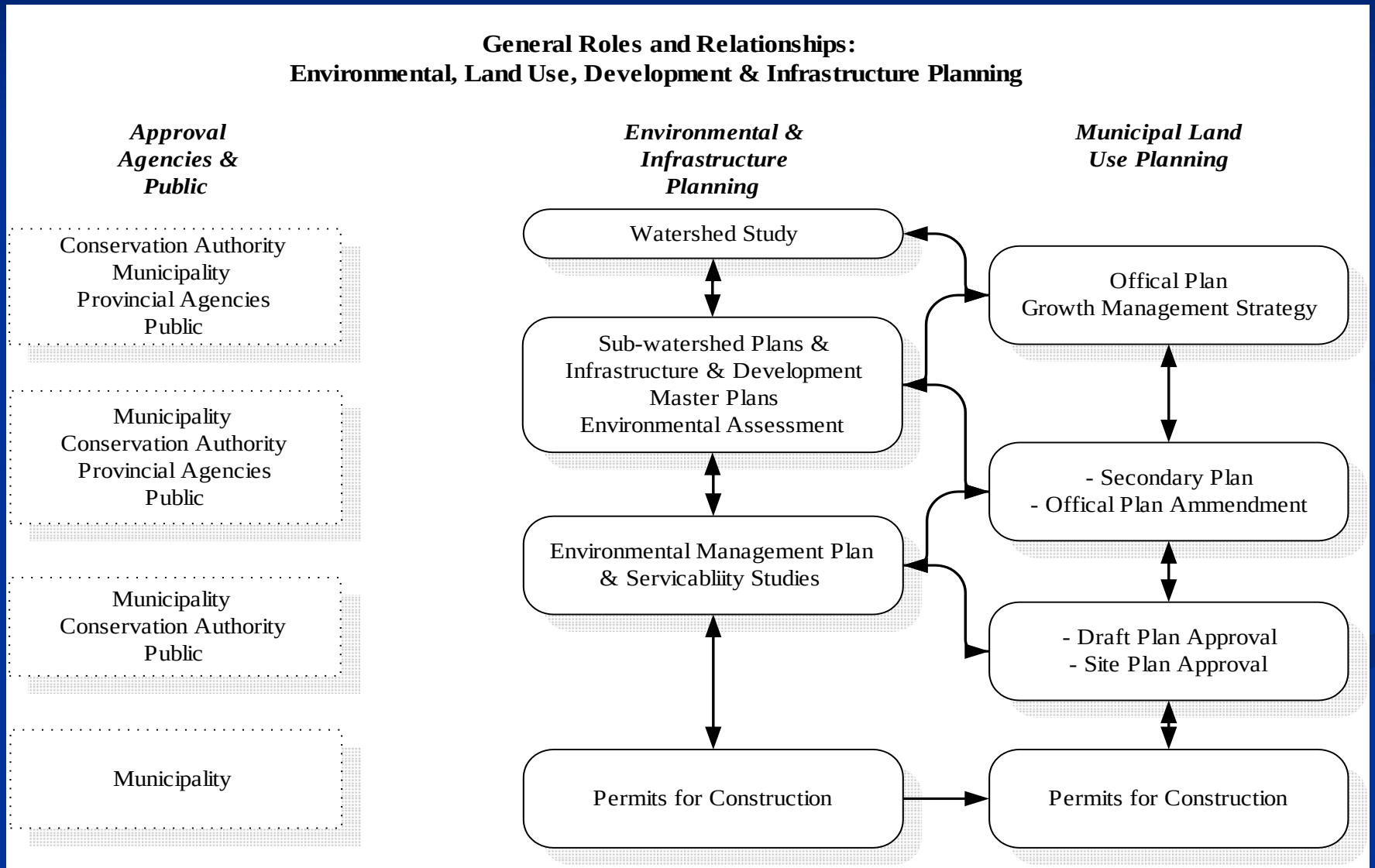
- A shift towards a comprehensive, more flexible set of regulatory and non-regulatory tools and incentives (e.g., best management practices) instead of a more traditional "command and control" approach.

- A shift to an approach based on shared responsibility with the regulated community, NGOs, the public and the scientific/technical community, and transparent sharing of information with the public.

Taken from: Executive Resource Group, 2001. Managing the Environment: A review of best practices. Prepared for the Secretary of Cabinet.



Need to create a seamless relationship between contextual understanding and traditional planning processes



Outcomes - Restoring A Watershed's Natural Infrastructure

- In most cases, unrealistic to think that we can return systems to historical conditions;
- The key is to try to return the landscape and its land:water linkages to a healthy, **functional** state for people and environment
- We need an integrative understanding to accomplish this.
- We need **OUTCOME** based approaches to Implement it with our partners and communities
- We do NOT need continued piece-meal approaches

Watershed Plans As Experiments

- Watershed Plans are not forever, but need to be updated
- Most IWM Plans are our best educated guesses, based on best info and science
- IWM plan can be considered an experiment
- Monitoring implementation and outcomes becomes part of the tracking the plans recommendations and how well they fulfill the goals and objectives of the plan
- This knowledge and information is then rolled back into the review and update of the IWM plan

Integrated Watershed Management: Setting Context for linking Agendas and Mandates

Forest Management

Biodiversity Conservation

Federal Fisheries Act & Fish Habitat Management

Erosion Management

Water Quality/Quantity Management

Agricultural Irrigation and production

Shoreline Management

Natural Hazards Management

Source Water Protection

Aquatic Ecosystems Management

Groundwater Surface water Interactions

Regional Land Use Planning & Management

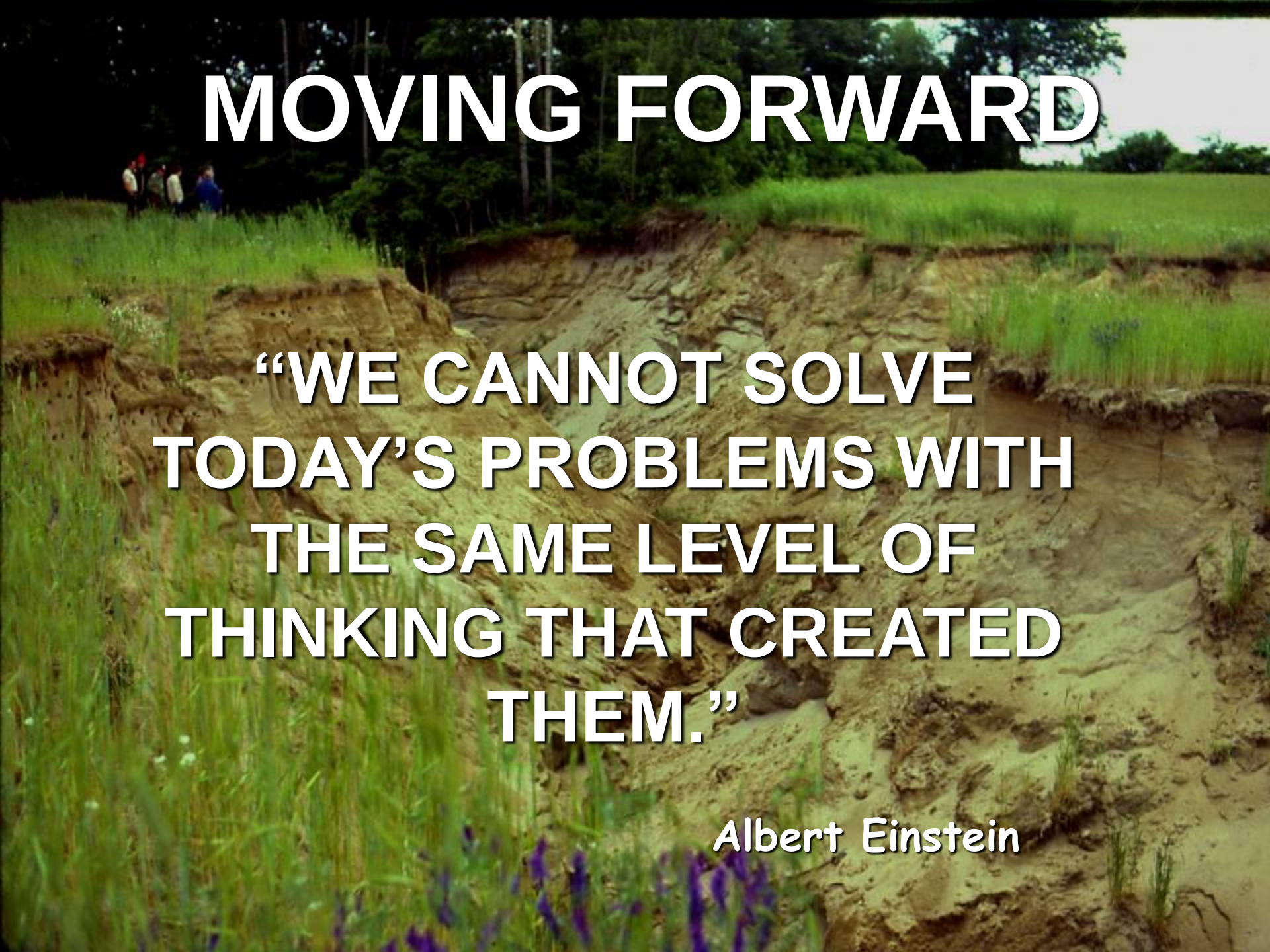
Growth Management

Lake Development

Natural Infrastructure

Natural Heritage Systems

Water Quality Management


MOVING FORWARD
“WE CANNOT SOLVE TODAY’S PROBLEMS WITH THE SAME LEVEL OF THINKING THAT CREATED THEM.”
Albert Einstein