Go With the Flow: Dynamics of Stream Restoration

Alison Armocida

Statewide Watershed Report Card
Professional Development

Dynamics of Stream Restoration

MARYLAND DEPARTMENT OF NATURAL RESOURCES

- Concepts in Stream Ecology
- Characteristics of a Healthy Stream
- Signs of an Unhealthy Stream
- Stream Restoration Strategies
- Steps to Restoration
- Resources

Stream Corridor

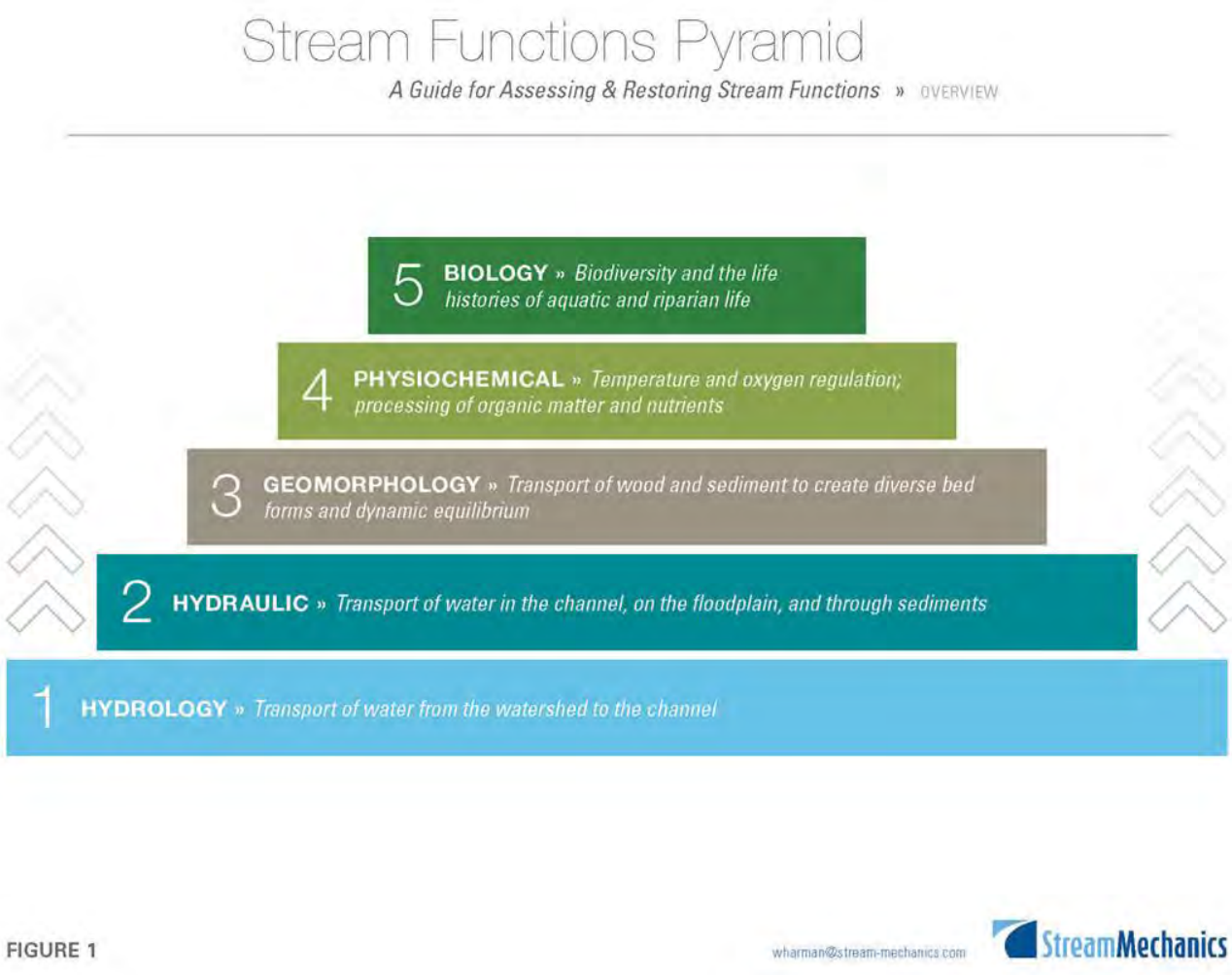
What is the function of a stream?

- Water conveyance channel
- Sediment supply and transport channel
- Habitat for biological communities

Streams are created by interactions:

- Climate
- Topography
- Geology
- Vegetation
- Biota

Functional Pyramid



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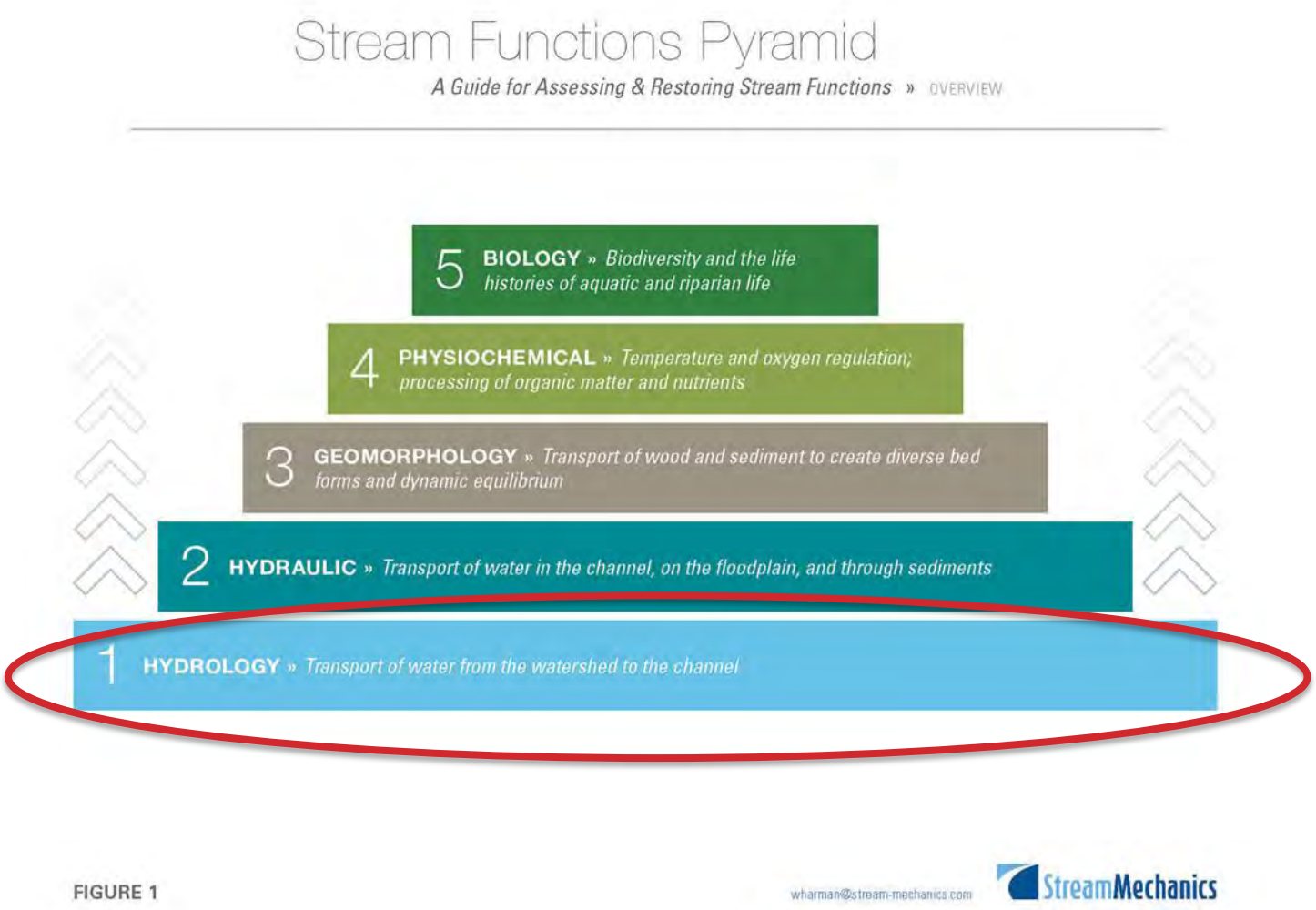
Functional Pyramid



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Hydrology

The study of the properties of the earth's water, especially its movement in relation to land

Transport of water from watershed to stream channel

Produced by Climate and Land Use

Hydrology

Transport of water from watershed to stream channel

Climate influences on a stream:

- Stream Flow
- Groundwater storage
- Biotic community

Land Use influences on a stream:

- Soil infiltration
- Runoff volume and speed
- Pollutants

Hydrology

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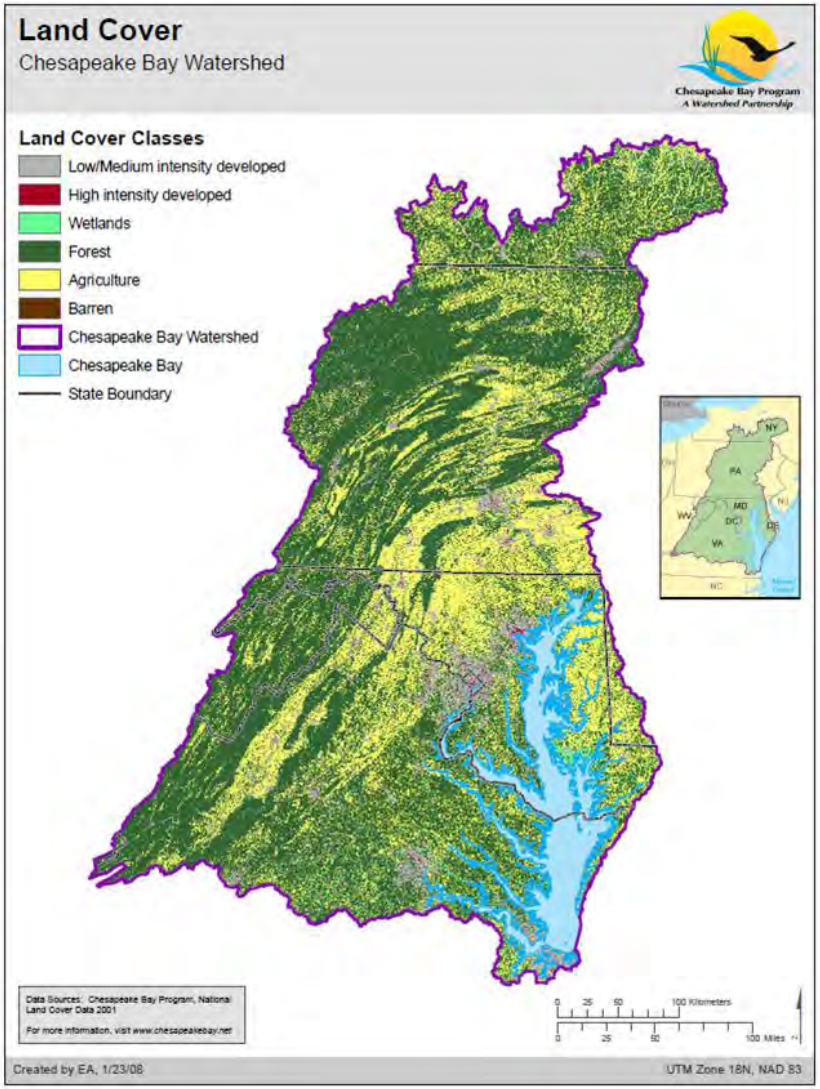

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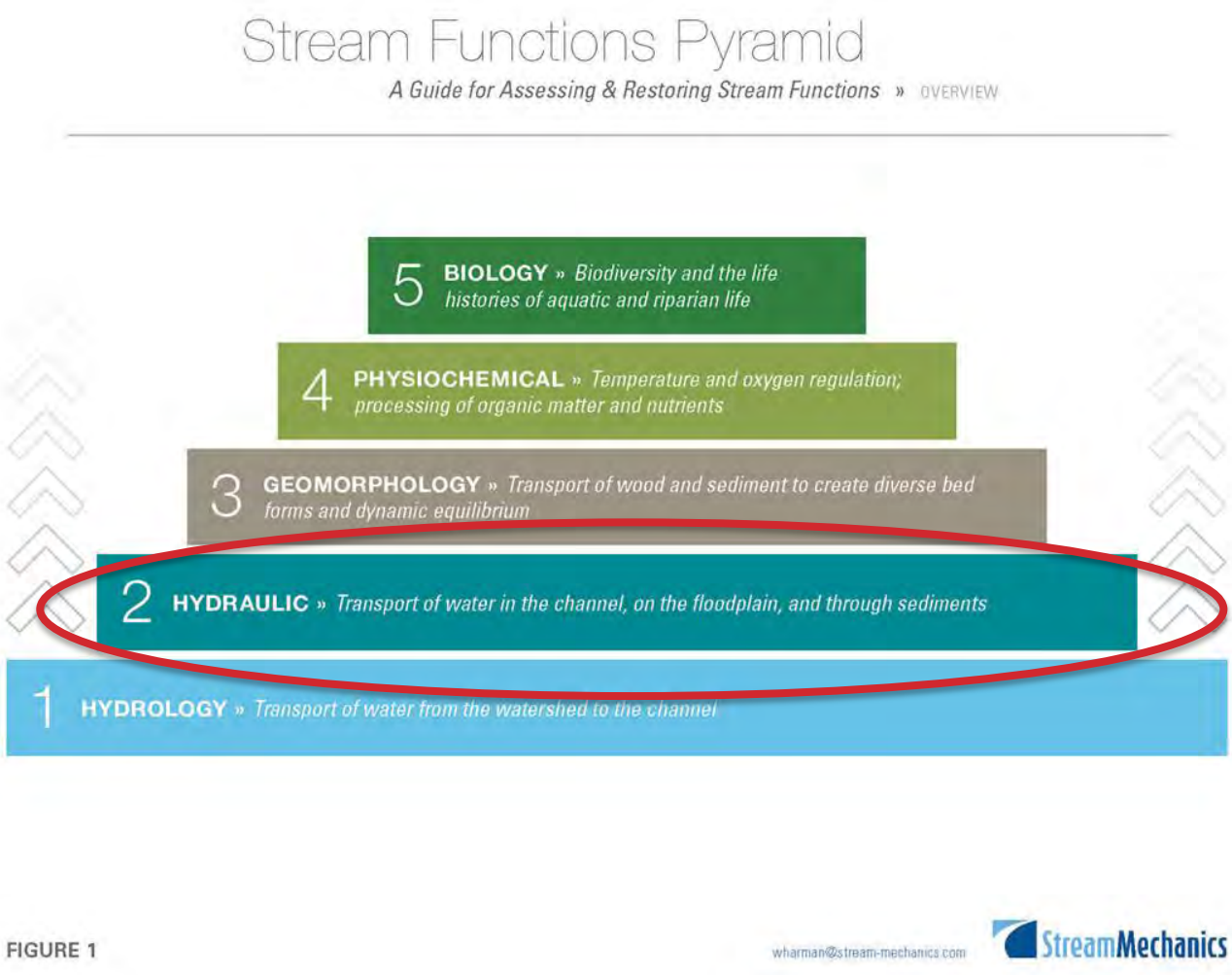

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Hydraulics

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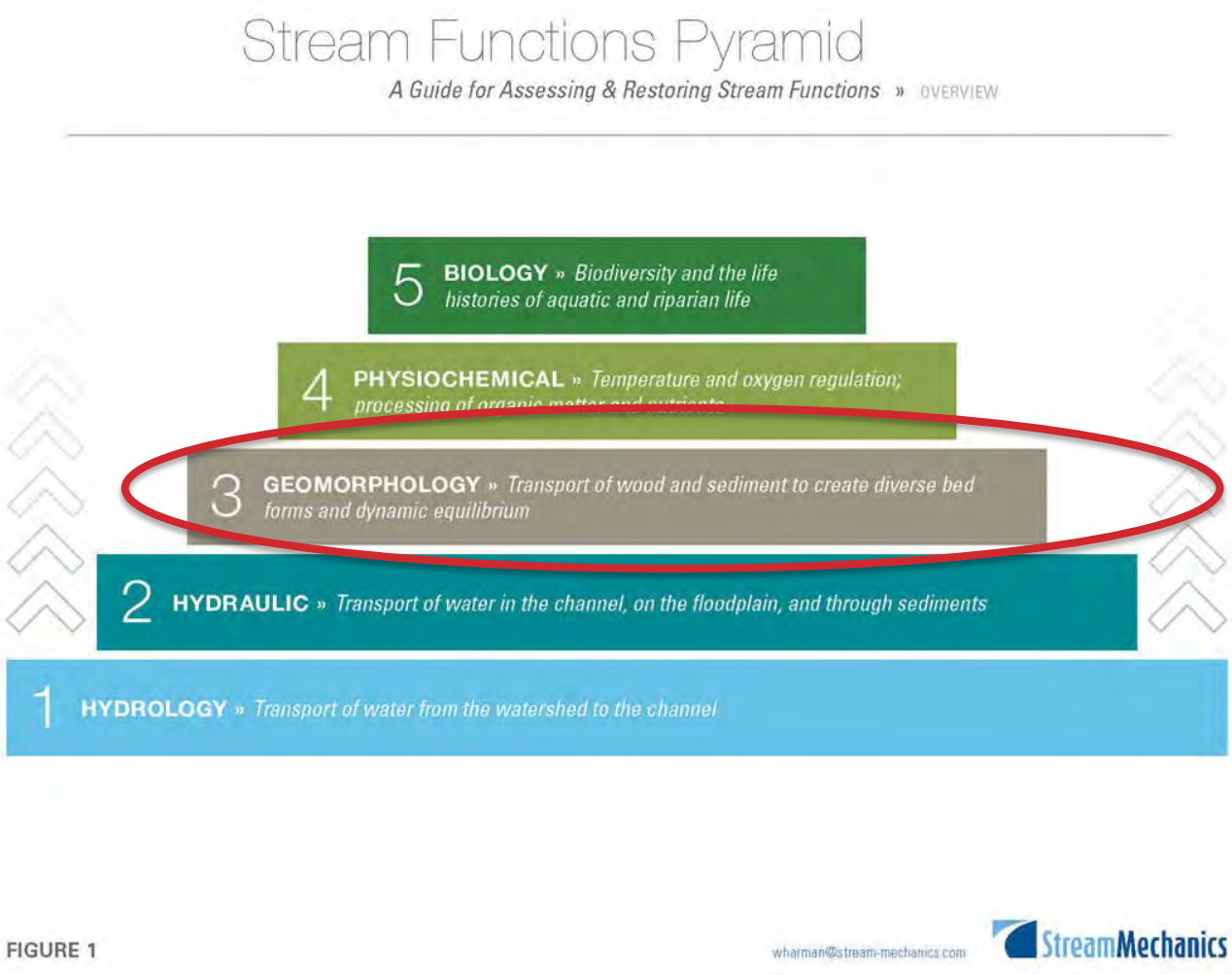
Application of the mechanical properties of liquids or fluids, covering concepts such as water flow, dam design, flow measurement, river channel behavior and erosion

Transport of water in the channel, on the floodplain, and through sediments

Mathematical models estimate physical forces of stream flow

Functional Pyramid



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Geomorphology

The study of the physical features of the surface of the earth and their relation to its geological structures

Transport of wood and sediment to create diverse bedforms and dynamic equilibrium

Physical Factors of Stream Geomorphology

- Channel Width
- Depth
- Velocity
- Discharge
- Channel Slope
- Roughness of Bed
- Sediment Load
- Sediment Type

Geomorphology

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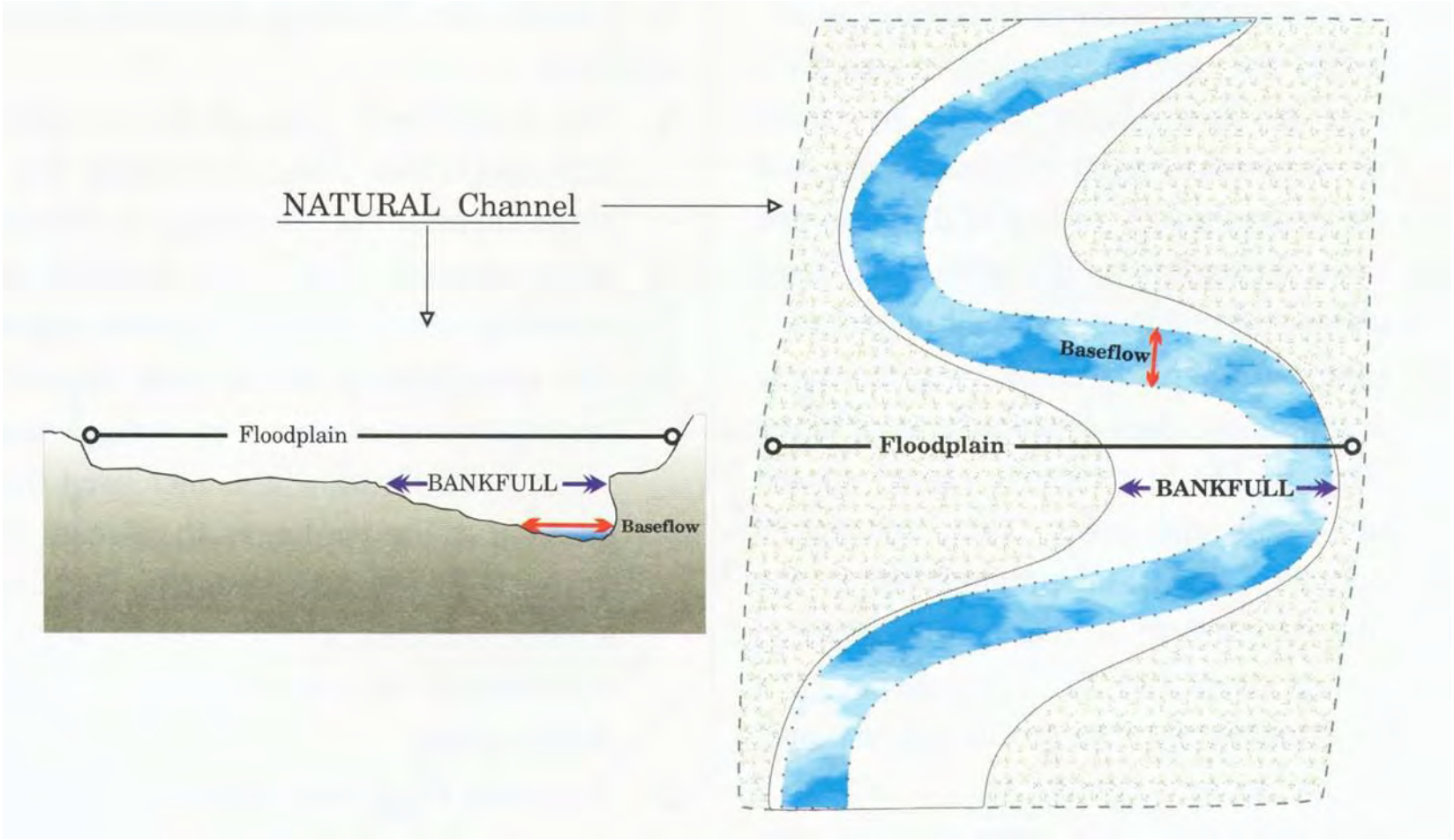

Geomorphology

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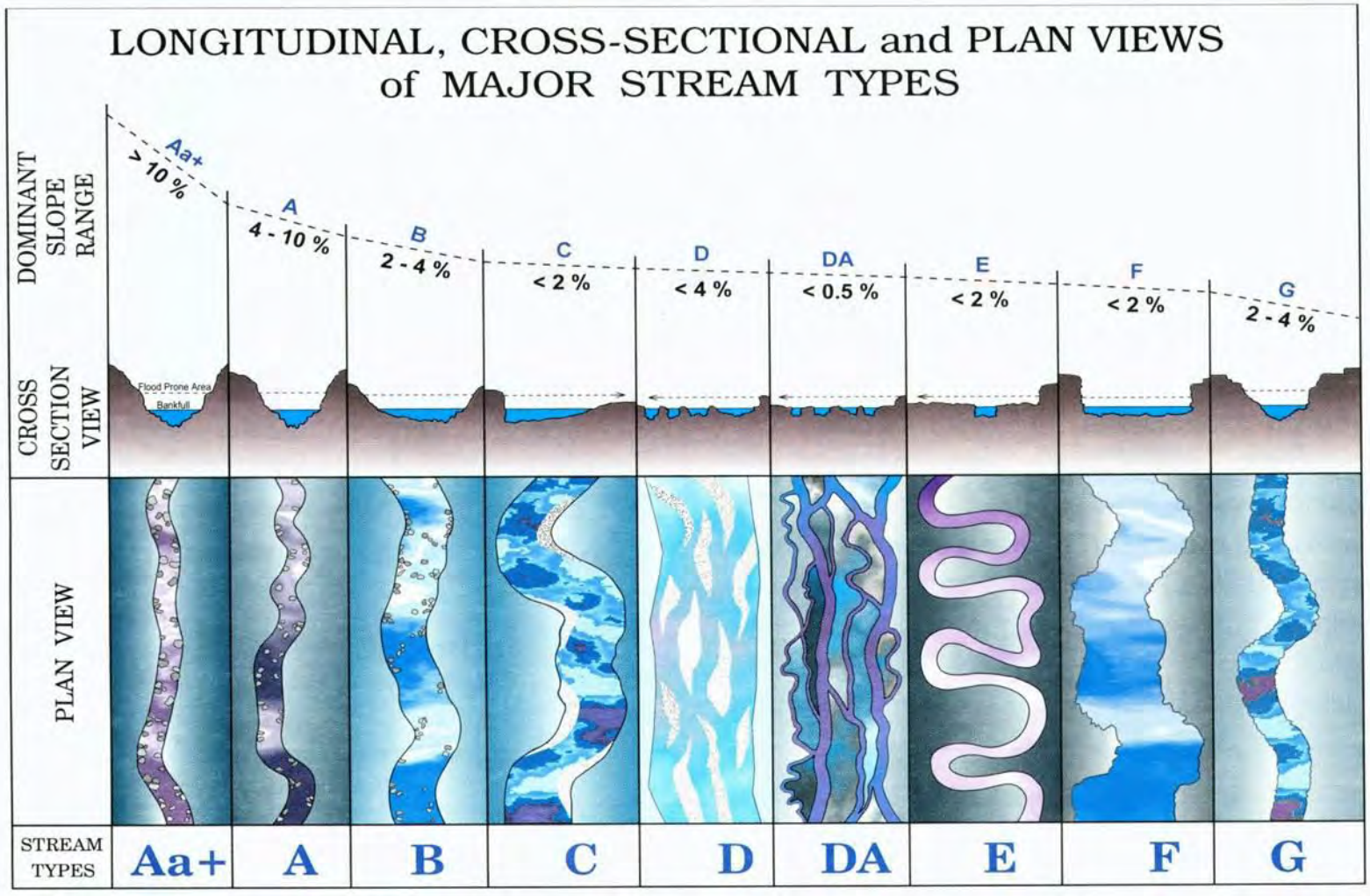

Dave Rosgen's Stream Classification

Geomorphology

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Stream Habitat

Geology, stream flow, and vegetation create habitat

Geology influences:

- type of soils
- stream bed sediments
- material available for erosion
- groundwater storage
- basic chemistry

Stream Habitat

Geology, stream flow, and vegetation create habitat

Stream flow influences:

- amount of wetted areas
- shape of stream channel
- velocity and depth combinations
- water quality
- food sources

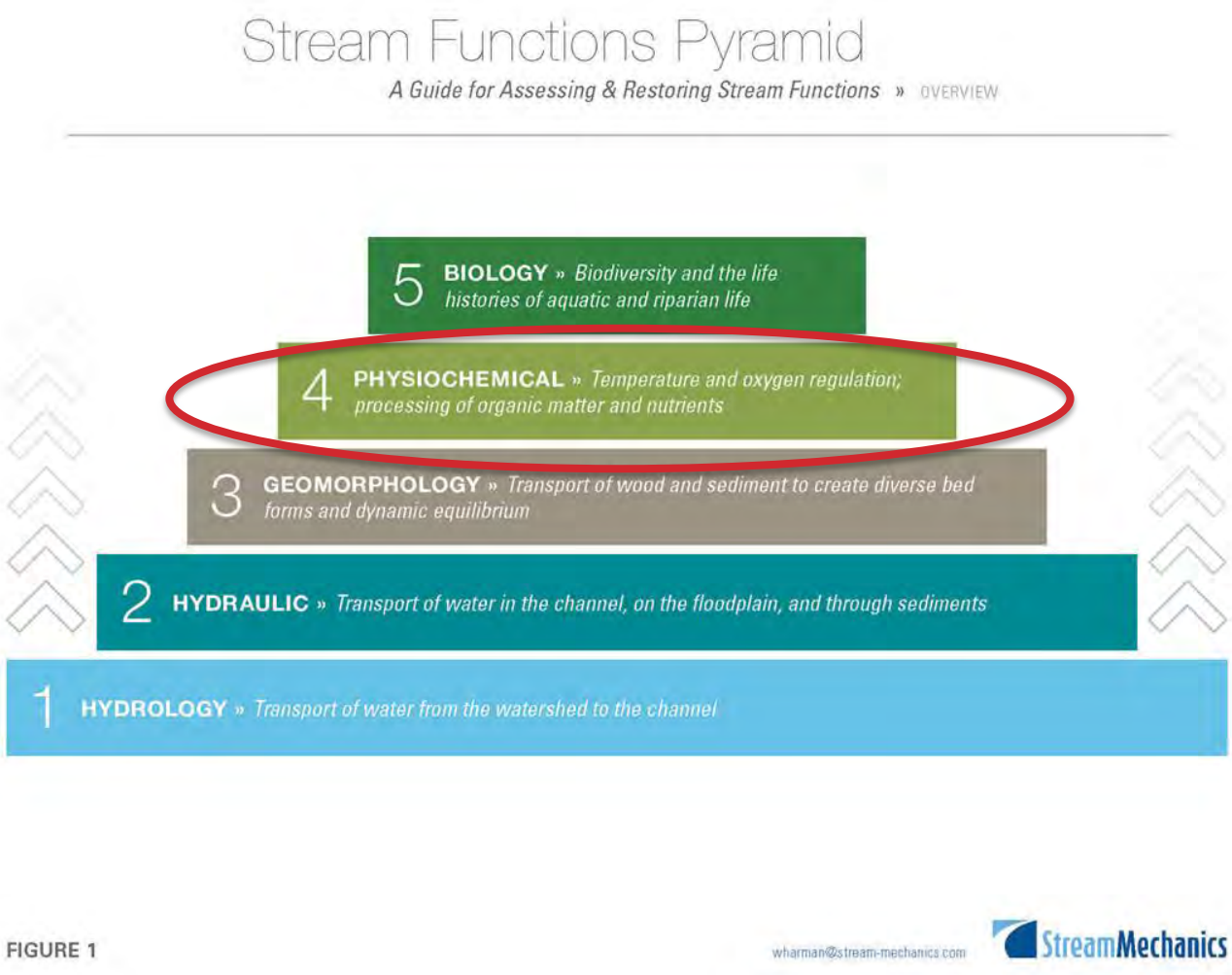
Stream Habitat

Geology, stream flow, and vegetation create habitat

Vegetation influences:

- food sources
- stream cover
- water chemistry
- pollutant mitigation

Functional Pyramid



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Stream Chemistry

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Common Pollutants

- **Pathogens**
  - Leaky sewage pipes, domestic animals
- **Pesticides and Herbicides**
  - Agricultural and urban applications
- **Excessive Nutrients**
  - Fertilizer application, leaky sewage pipes
- **Sediment**
  - Construction, agricultural fields, eroding streams
- **Heavy Metals**
  - Industrial runoff, road surfaces
- **Heat**
  - Road surfaces, industrial runoff

Stream Chemistry

- **Point Sources**
  - Defined by section 502(14) of the Clean Water Act as
    - any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel… from which pollutants are or may be discharged
  - This term does not include agricultural water discharges

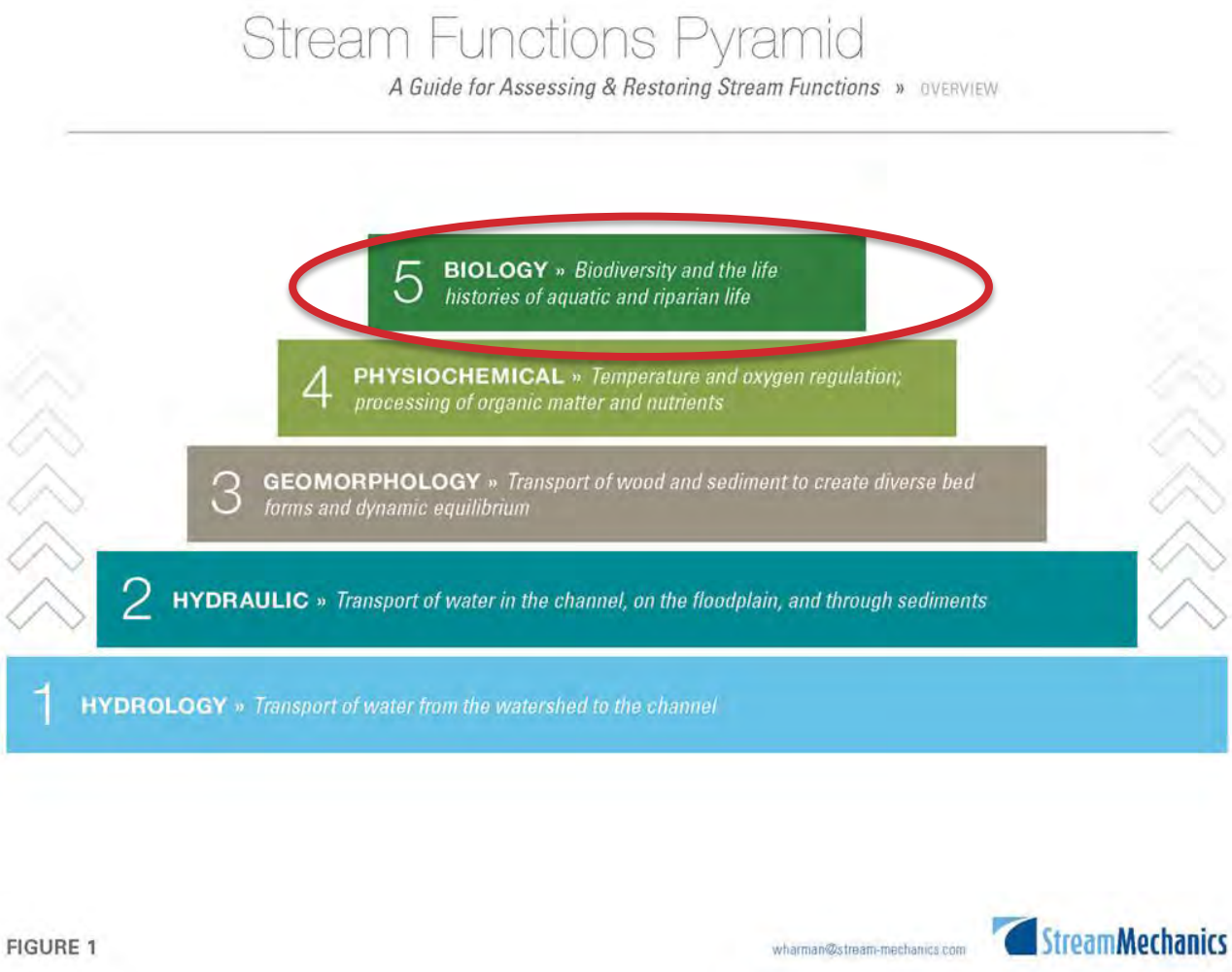
- **Non-point Sources**
  - Any source of water pollution that does not meet the above definition of "point source“
  - Non-point source pollution is picked up from many diffuse areas and carried into streams by water moving over the land (rainfall, snowmelt, etc)

Stream Chemistry

Total Maximum Daily Loads

- A TMDL is a "pollution budget" that sets the maximum amount of a pollutant allowed in impaired waters
  - Impaired waters are defined by section 303(d) of the Clean Water Act
  - Used as a planning tool to implement pollutant reductions to one or more pollutant sources
- Chesapeake Bay's TMDLs were set in 2010 by EPA
  - Limits on Nitrogen, Phosphorous, and Sediment
  - All states in the watershed are working towards meeting these goals by 2025

Functional Pyramid



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Stream Biology

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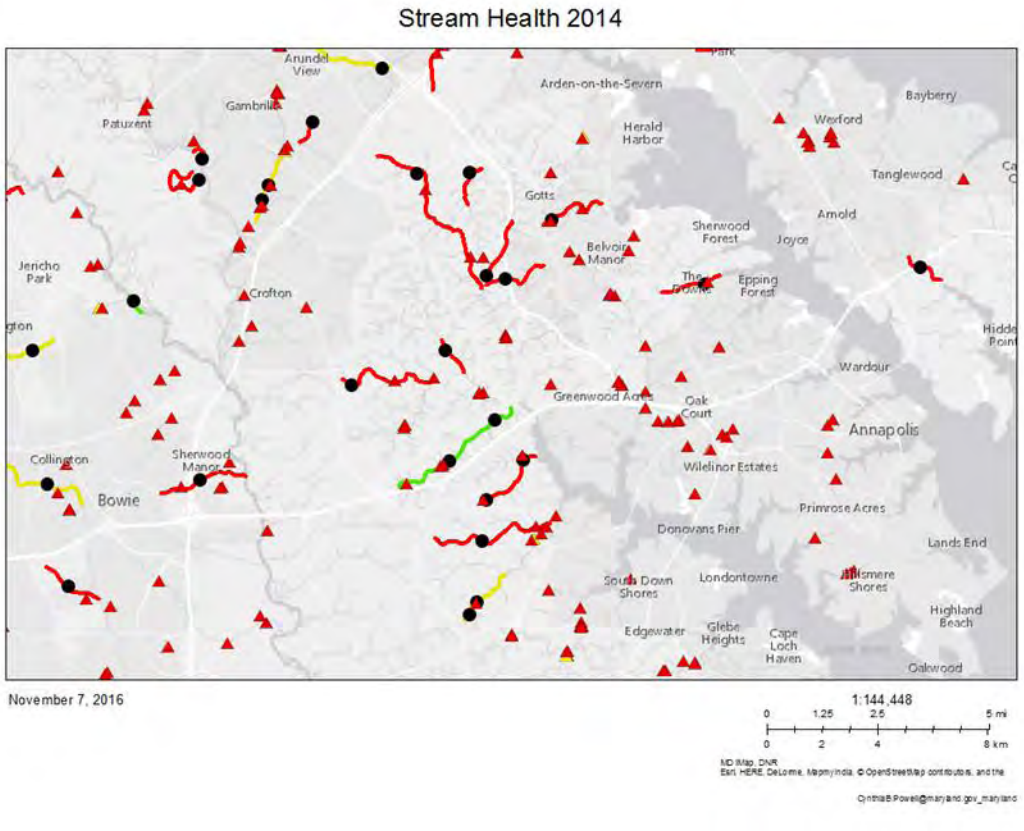
Index of Biological Integrity (IBI)

- Common measurement to assess the health of a biological community
  - Unit-less score to compare different water bodies
  - Indicate the presence of long-term stressors
  - Cannot determine source of impairment
- Metrics
  - Number of species
  - Functional Feeding Groups
  - Pollution Sensitivity
  - Proportion of introduced species

Stream Biology

Index of Biological Integrity (IBI)

Maryland Biological Stream Survey has sampled stream biota throughout the state since 1993



Characteristics of a Healthy Stream

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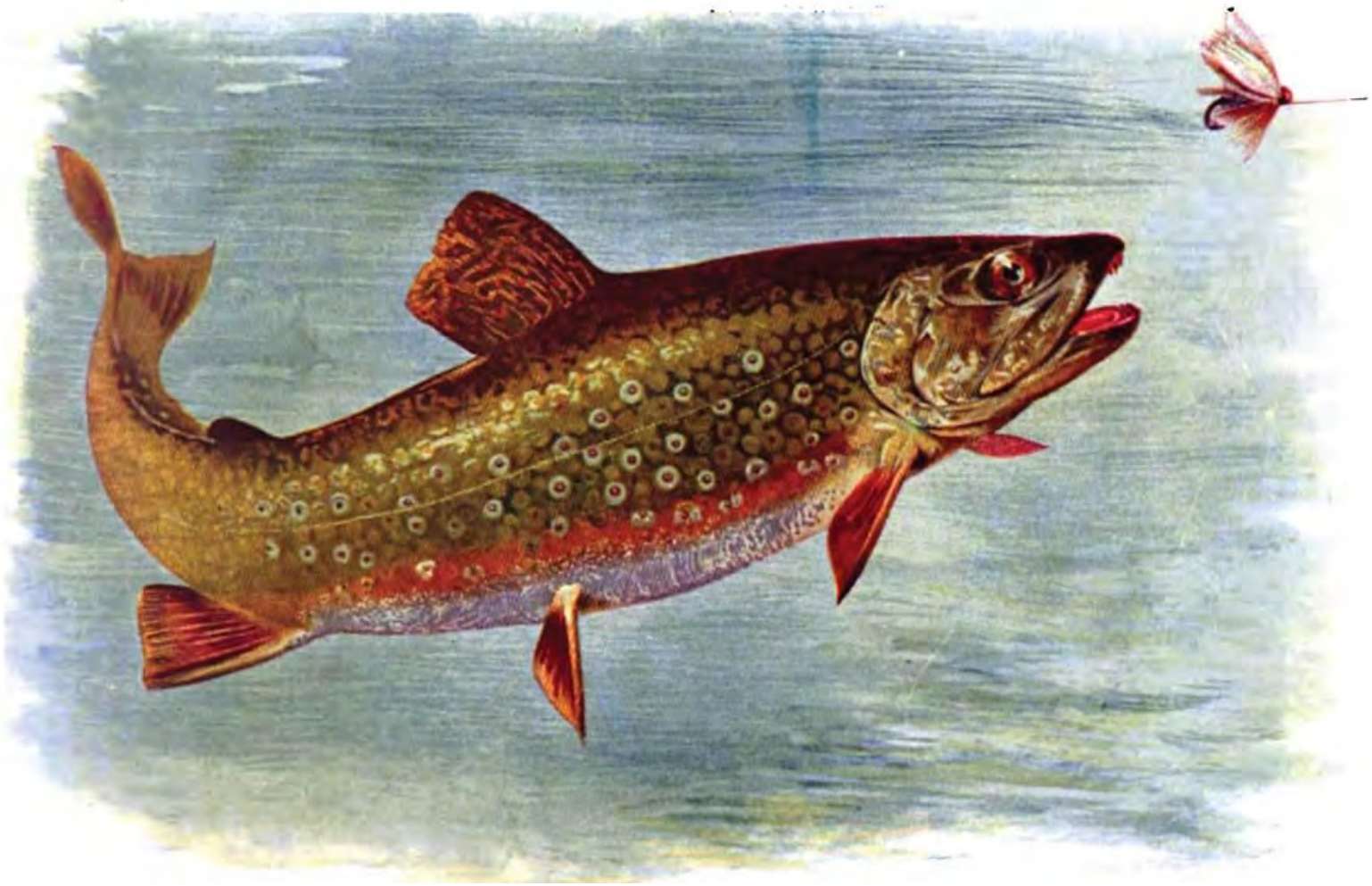

Characteristics of a Healthy Stream

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"Good" Hydrology: Stream Connected to Floodplain

Characteristics of a Healthy Stream

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"Good" Hydrology: Little Erosion or Deposition

Characteristics of a Healthy Stream

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"Good" Hydrology: Large Riparian Buffer

Characteristics of a Healthy Stream

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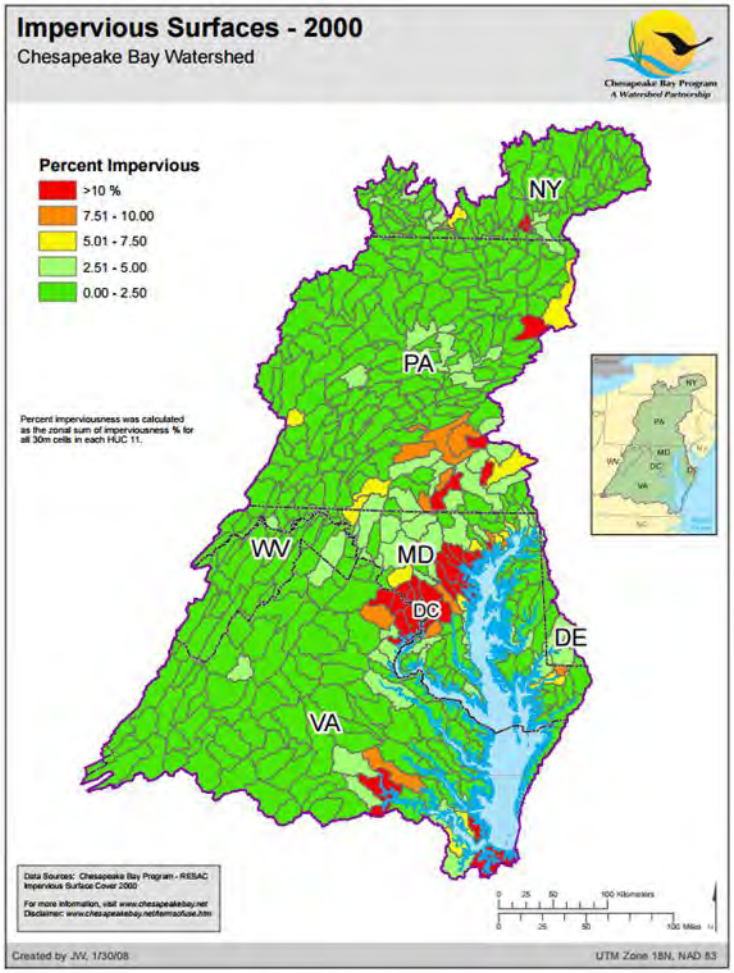
"Good" Hydrology: Low Percent Impervious Surface



Characteristics of a Healthy Stream

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"Good" Habitat: Variety of In-Stream Surfaces

Characteristics of a Healthy Stream

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"Good" Habitat: Places to hide

Characteristics of a Healthy Stream

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"Good" Habitat: Variety of Food Sources

Characteristics of a Healthy Stream

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"Good" Habitat: Appropriate chemistry

Signs of an Unhealthy Stream

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Signs of an Unhealthy Stream

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Incised Channel

- Stream is disconnected from its floodplain
- Storm flows are concentrated in channel
- No nutrient processing occurs in floodplain

Signs of an Unhealthy Stream

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Incised Channel

Signs of an Unhealthy Stream

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Evidence of Significant Erosion

- High velocity of water is damaging the channel
- Sediments can impair downstream waters
- Streams may not recover without intervention

Signs of an Unhealthy Stream

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Evidence of Significant Erosion

Signs of an Unhealthy Stream

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Little or no Riparian Buffer

- Banks are not protected from erosion by roots
- Overland flow into the stream is not mitigated
- Limited food and shade source

Signs of an Unhealthy Stream

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Little or no Riparian Buffer

Signs of an Unhealthy Stream

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Other Physical Indicators

- Large depositional features
- Cloudy or discolored water
- High algal composition

Signs of an Unhealthy Stream

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Pipe Outfalls

- Stormwater outfalls are concentrated and can create unstable channels prone to erosion
- Untreated water can contain many pollutants
- Outfalls of unknown origin may be in violation of pollutant discharge regulations

Signs of an Unhealthy Stream

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Pipe Outfalls

Signs of an Unhealthy Stream

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In- and Near- Stream Trash

- Hazardous to many animals
- May contain chemicals and pollutants
- Create blockages in streams

Signs of an Unhealthy Stream

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In- and Near- Stream Trash

Signs of an Unhealthy Stream

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Dams

- Create barriers to fish migration
- Trap sediments behind the structure; if the dam fails, it can release large amount of sediments and pollutants at once
- Outlet can cause erosion downstream

Stream Restoration

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"Manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former degraded aquatic habitat."

Goals of restoration vary by project

- Generally try to restore the natural function of a system by creating a stable stream channel connected to its floodplain

Restoration Strategies

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Restore Floodplain Connection

- Addresses incised channels
- Allows water to flow onto floodplain
- Slows energy of water to reduce erosion
- Creates wetland complexes
- Creates conditions for nutrient processing

- Techniques:
  - remove surrounding sediments
  - fill in channel to raise stream bed

Restoration Strategies

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Stabilize Channel

- Prevent Erosion
- Maintain appropriate bed habitat

- Techniques:
  - Create stable, meandering stream with physics
    - Utilize flow data to estimate energy in system
    - Design stream to distribute energy over wide area
    - Variety of in-stream structures to direct flow
  - Armor banks with stone only in confined areas

Restoration Strategies

Restore Riparian Buffer

- Roots hold and stabilize sediments in channel
- Vegetation filters nutrients from overland flow
- Trees provide shade and food for biota

- Techniques:
  - Plant native vegetation as landowner allows

Success??

- Goals of project MUST match stream's potential
  - "If you build it, they will come" is not always true
  - Upstream and downstream conditions may prevent chemical or biological recovery
  - Biological recovery can take >5 years to achieve

- Stream monitoring is generally focused on stability of the built structures
- Pooled Monitoring effort is studying water quality and biological improvements

Steps to Restoration

- Support and Funding
  - Watershed Assistance Collaborative
    - provides services and technical assistance to communities to advance restoration activities and projects
  - Riverkeepers
    - Local non-profit groups that work with communities to protect and restore watershed resources
  - Local Governments
  - MD DNR

Steps to Restoration

- Design Project
  - Done by experienced stream restoration and engineering firms
  - Survey area, run models, draft plans appropriate to the site and goals of project

- Permitting
  - Army Corps of Engineers
  - Maryland Department of Environment
  - Local Permits

Steps to Restoration

- Construction!
  - Amount of time depends on complexity

Steps to Restoration

- Post-restoration Monitoring
  - Permits require monitoring for stability of structures
  - Additional monitoring of water quality and biological response is voluntary

Stream Restoration

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Resources

- Maryland Stream Health Website
  - http://dnr.maryland.gov/streams/Pages/streamhealth/default.aspx
- Watershed Assistance Collaborative
  - http://dnr.maryland.gov/ccs/Pages/healthy_waters/wac.aspx
- Waterkeeper Alliance
  - http://www. http://waterkeeper.org/
- DNR's Habitat Restoration and Conservation Division
  - Alison Armocida, alison.armocida@maryland.gov