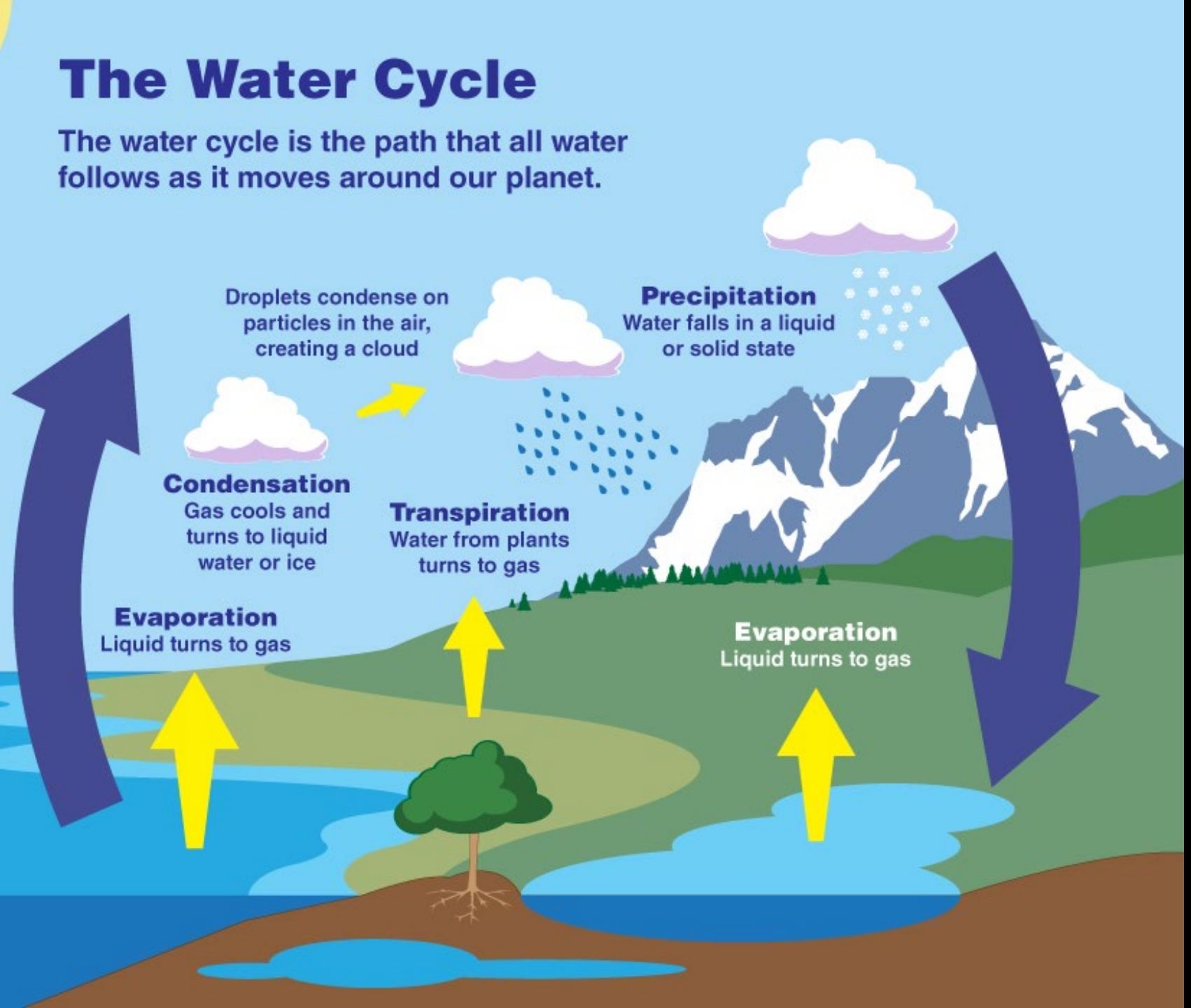
2026
VERMONT ENVIROTHON

AQUATICS TRAINING

MARCH 4, 2026
JOHN MCCANN
USFS

WHAT ARE WE COVERING TODAY?

- 🪨 Hydrologic Cycle, Topography, Landforms, and Watersheds
- 🌊 Water-Based Habitats and Processes
- 🐟 Aquatic Species Biology and Identification
- 🧪 Water Quality Basics and Monitoring
- 🌱 Land Management for Water Quality Conservation

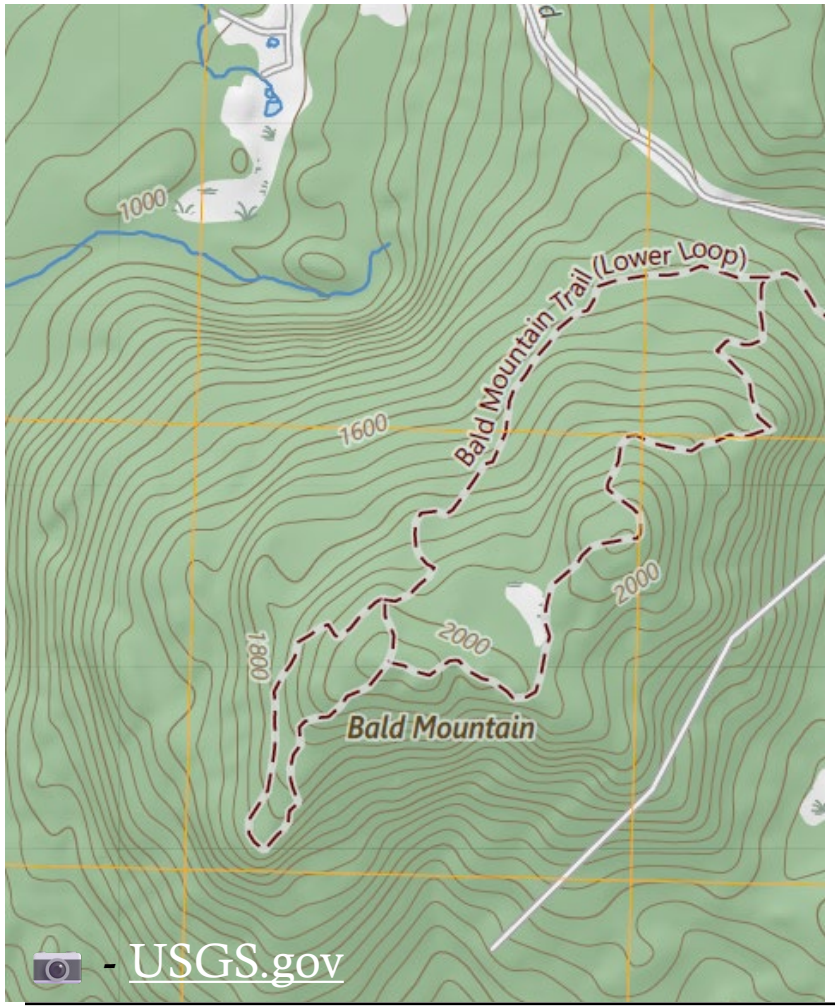


HYDROLOGIC CYCLE

- Where does the water come from?
- Where does it go?
- How does it get there?

📷 - NASA.gov

TOPOGRAPHY



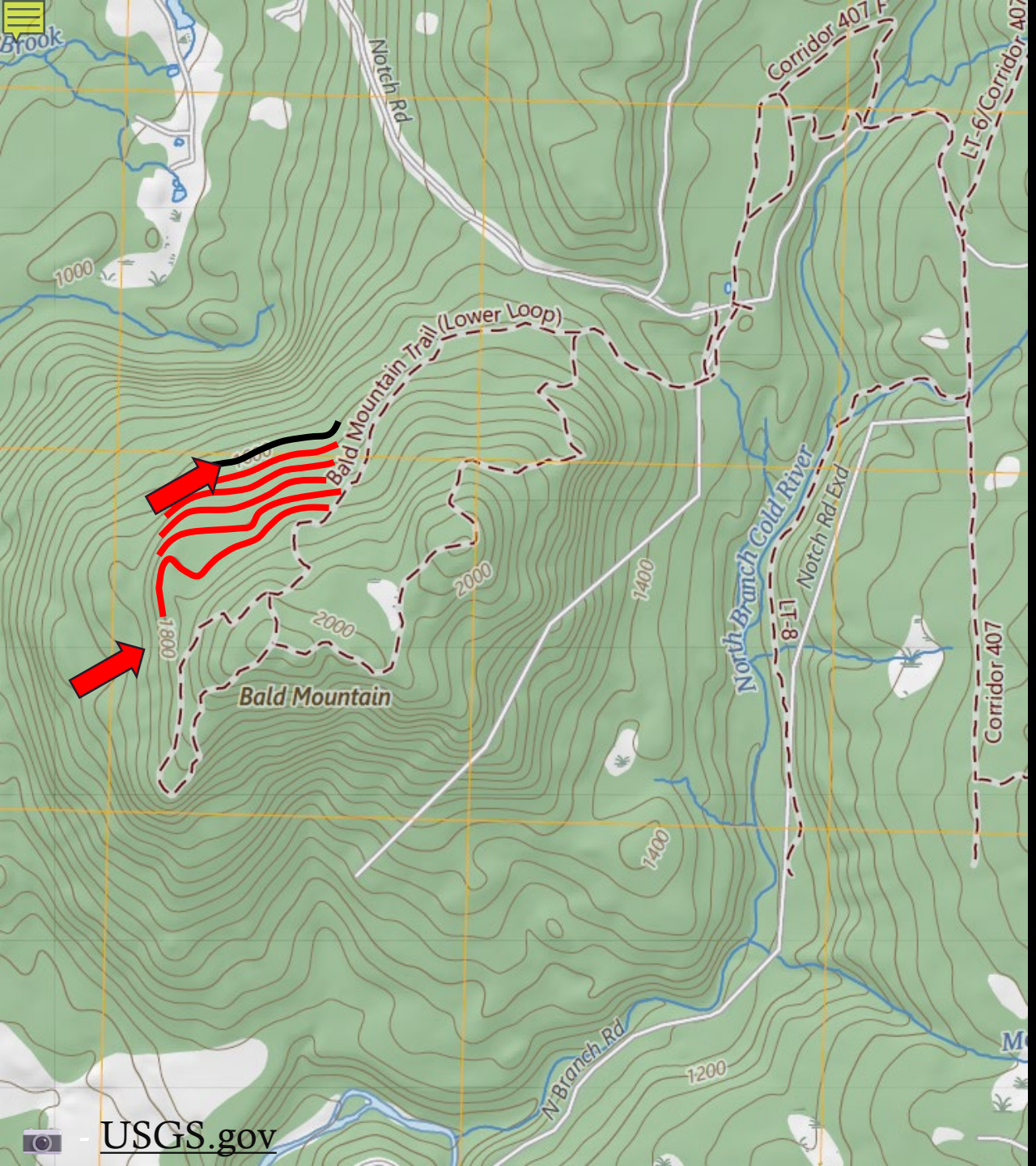
- USGS.gov

topos (n.)

"traditional literary theme," 1948, from Greek *topos*, literally "place, region, space," also "subject of a speech," a word of uncertain origin. "The broad semantic range renders etymologizing difficult" [Beekes].

-graphy

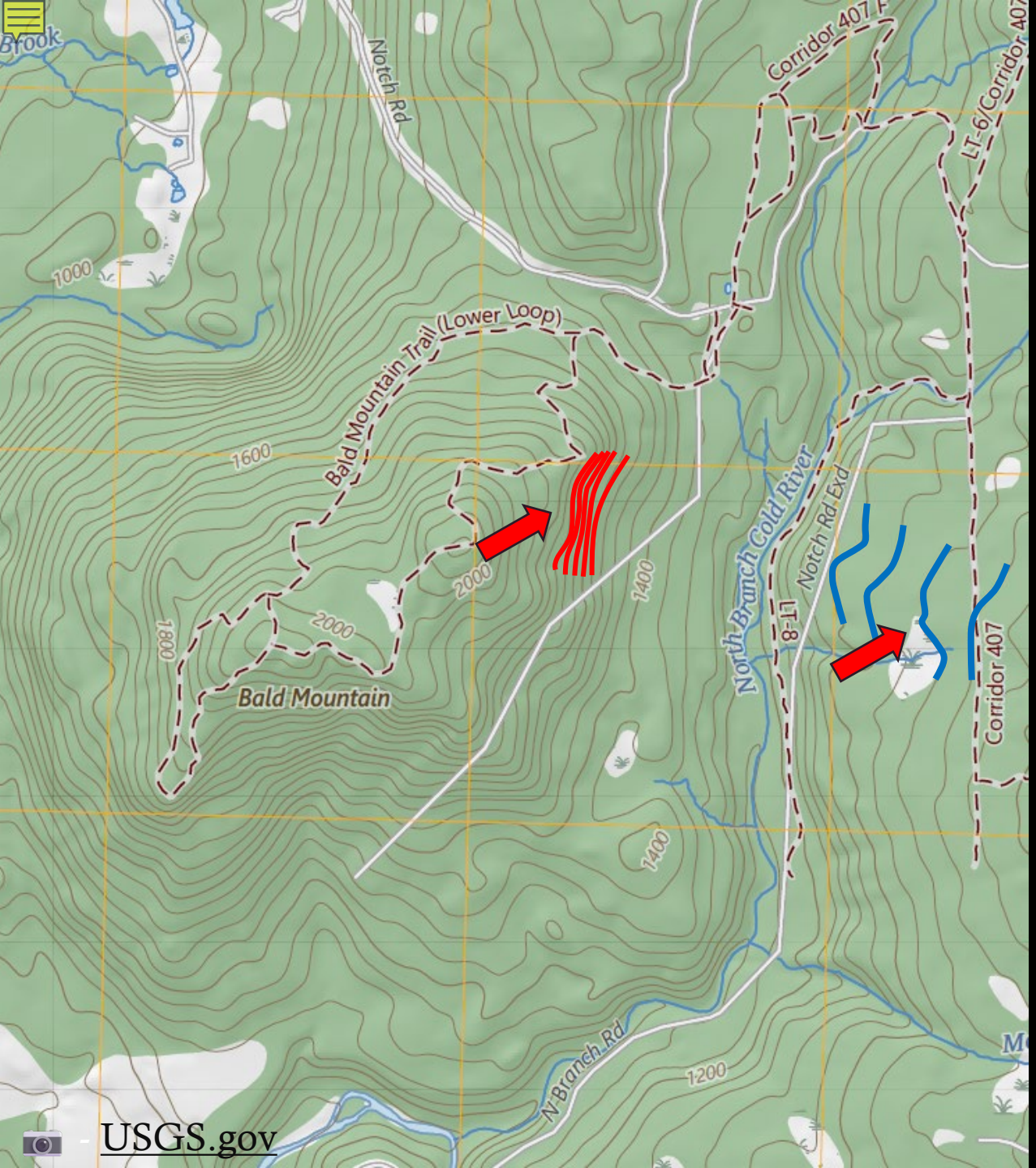
word-forming element meaning "process of writing or recording" or "a writing, recording, or description" (in modern use especially in forming names of descriptive sciences), from French or German *-graphie*, from Greek *-graphia* "description of," used in abstract nouns from *graphein* "write, express by written characters," earlier "to draw, represent by lines drawn," originally "to scrape, scratch" (on clay tablets with a stylus), from PIE root **gerbh-* "to scratch, carve" (see **carve**).



USGS.gov

HOW DOES TOPOGRAPHY INFLUENCE HYDROLOGY?

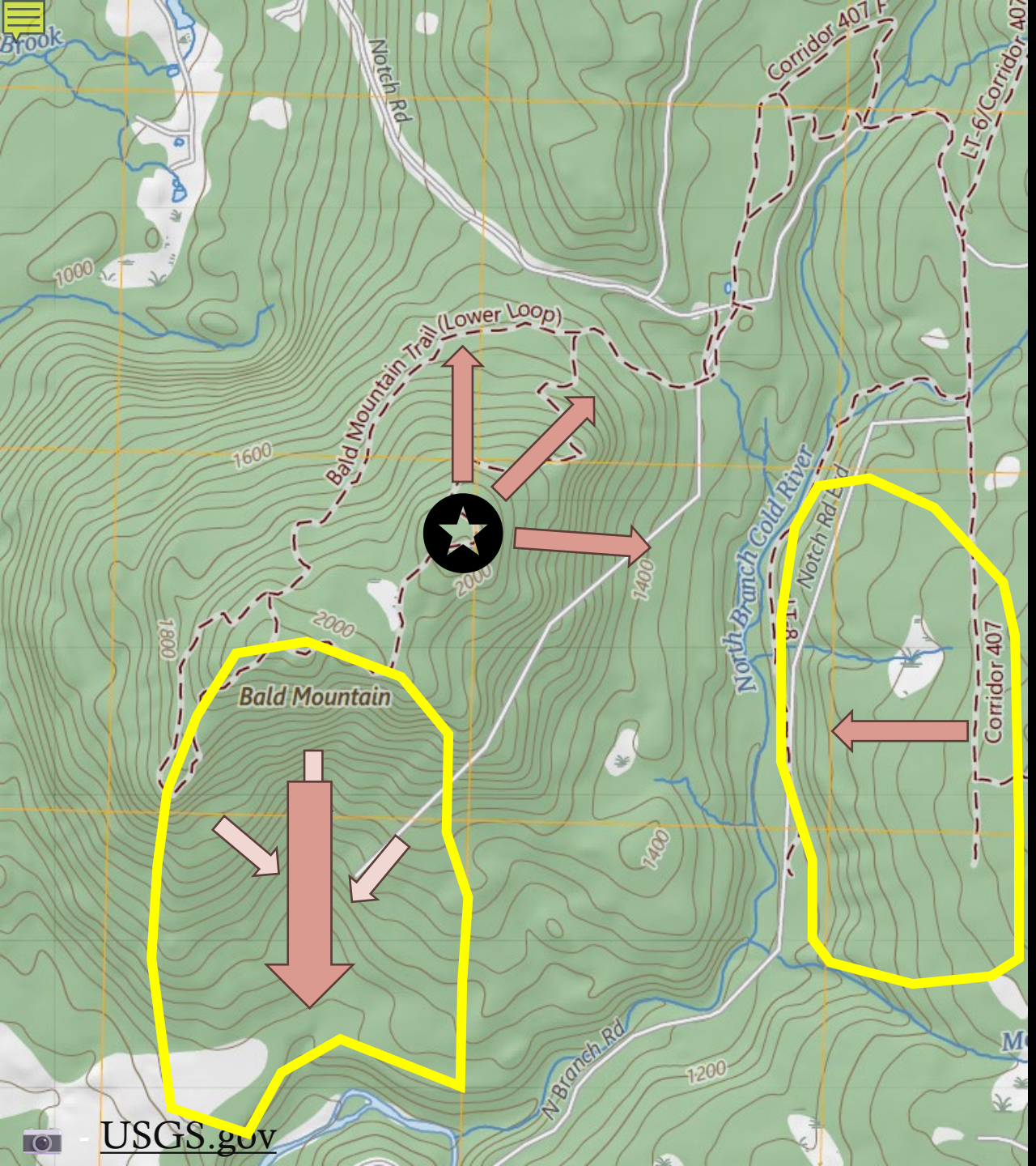
- Elevation
- Slope
- Aspect
- Flow Direction
- Flow Concentration
- Stream Order
- Landforms
- Watershed Delineation



USGS.gov

HOW DOES TOPOGRAPHY INFLUENCE HYDROLOGY?

- Elevation
- Slope
- Aspect
- Flow Direction
- Flow Concentration
- Stream Order
- Landforms
- Watershed Delineation



USGS.gov

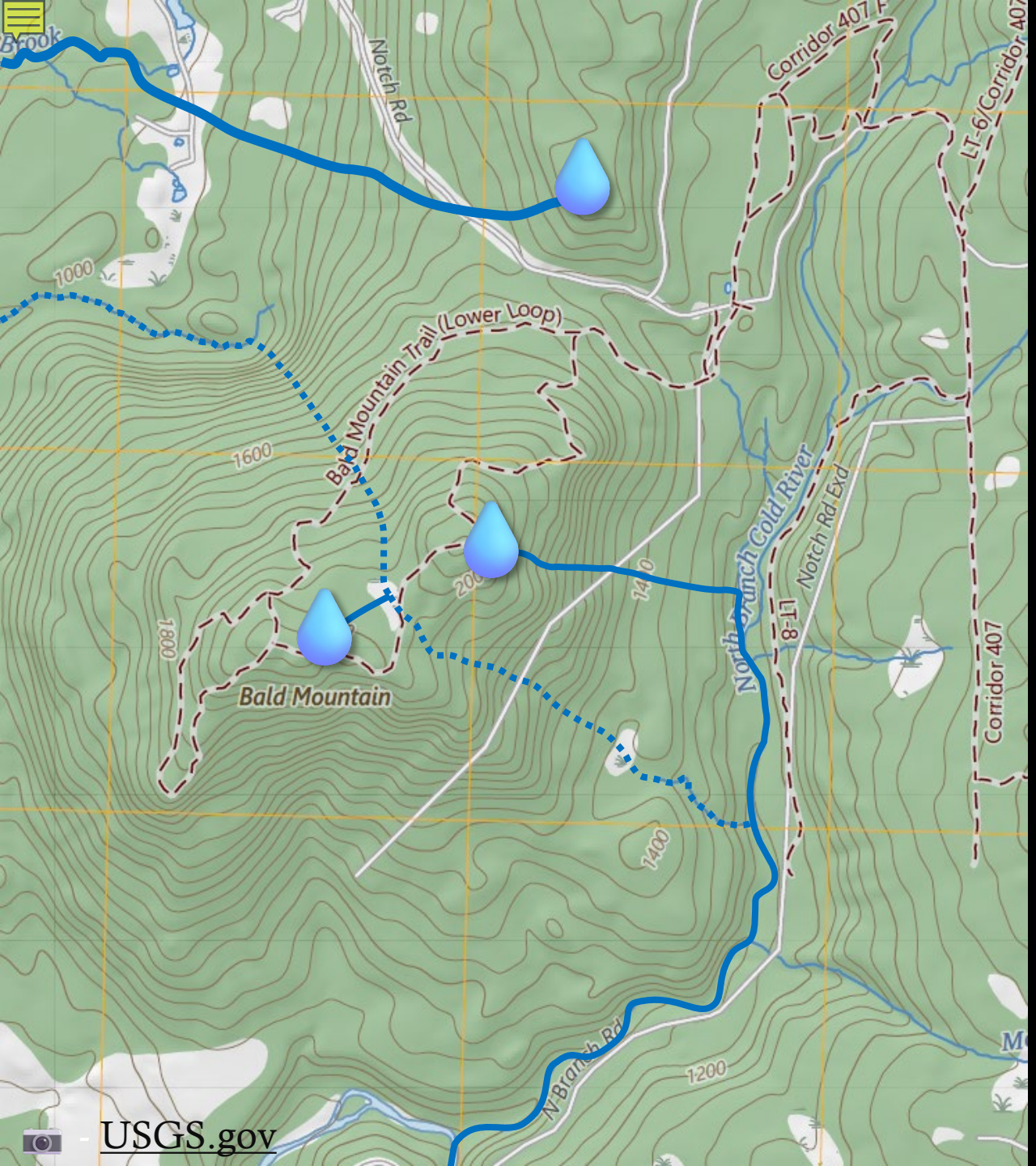
HOW DOES TOPOGRAPHY INFLUENCE HYDROLOGY?

- Elevation
- Slope
- Aspect
- Flow Direction
- Flow Concentration
- Stream Order
- Landforms
- Watershed Delineation

USGS.gov

HOW DOES TOPOGRAPHY INFLUENCE HYDROLOGY?

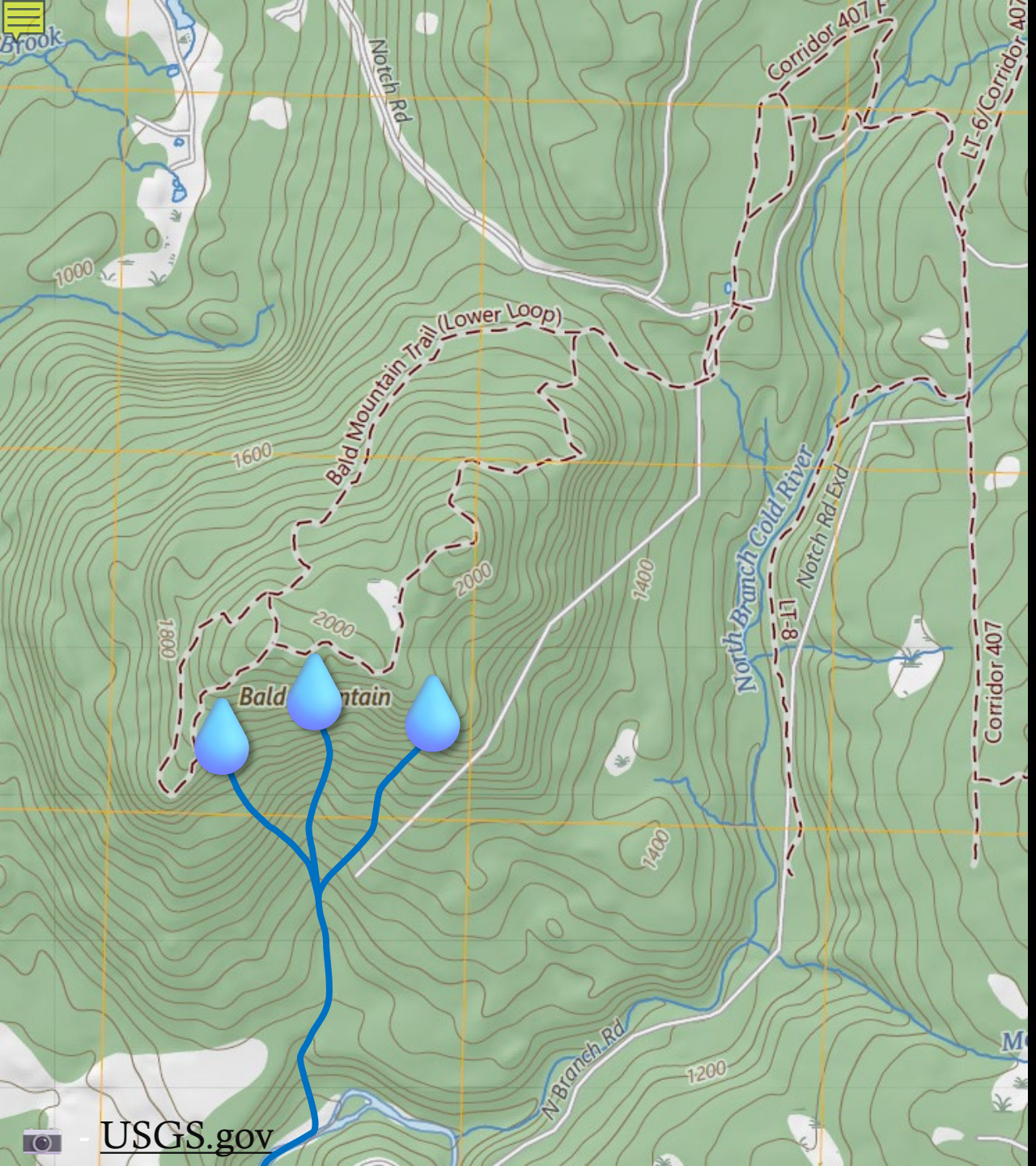
- Elevation
- Slope
- Aspect
- Flow Direction
- Flow Concentration
- Stream Order
- Landforms
- Watershed Delineation



USGS.gov

HOW DOES TOPOGRAPHY INFLUENCE HYDROLOGY?

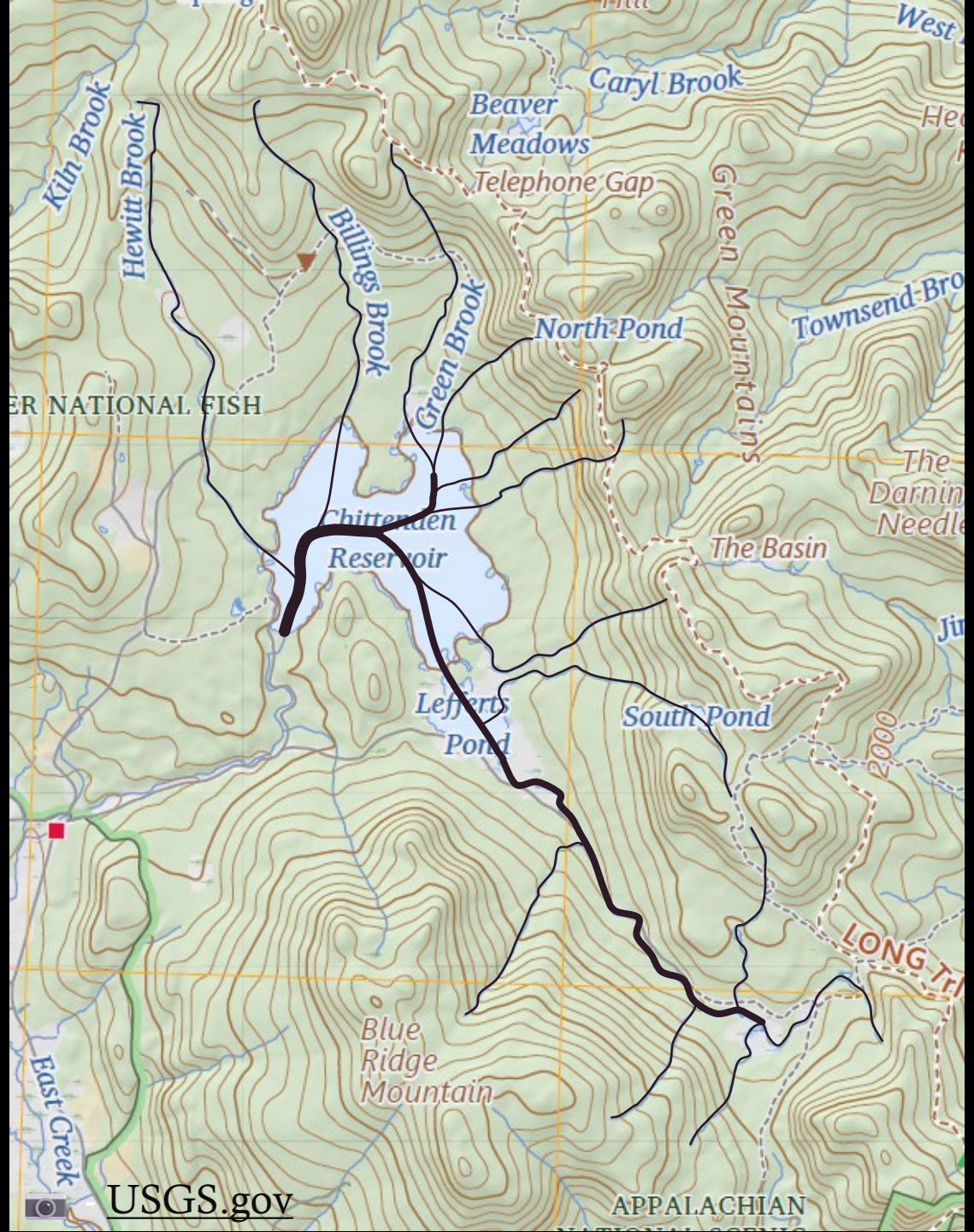
- Elevation
- Slope
- Aspect
- Flow Direction
- Flow Concentration
- Stream Order
- Landforms
- Watershed Delineation



USGS.gov

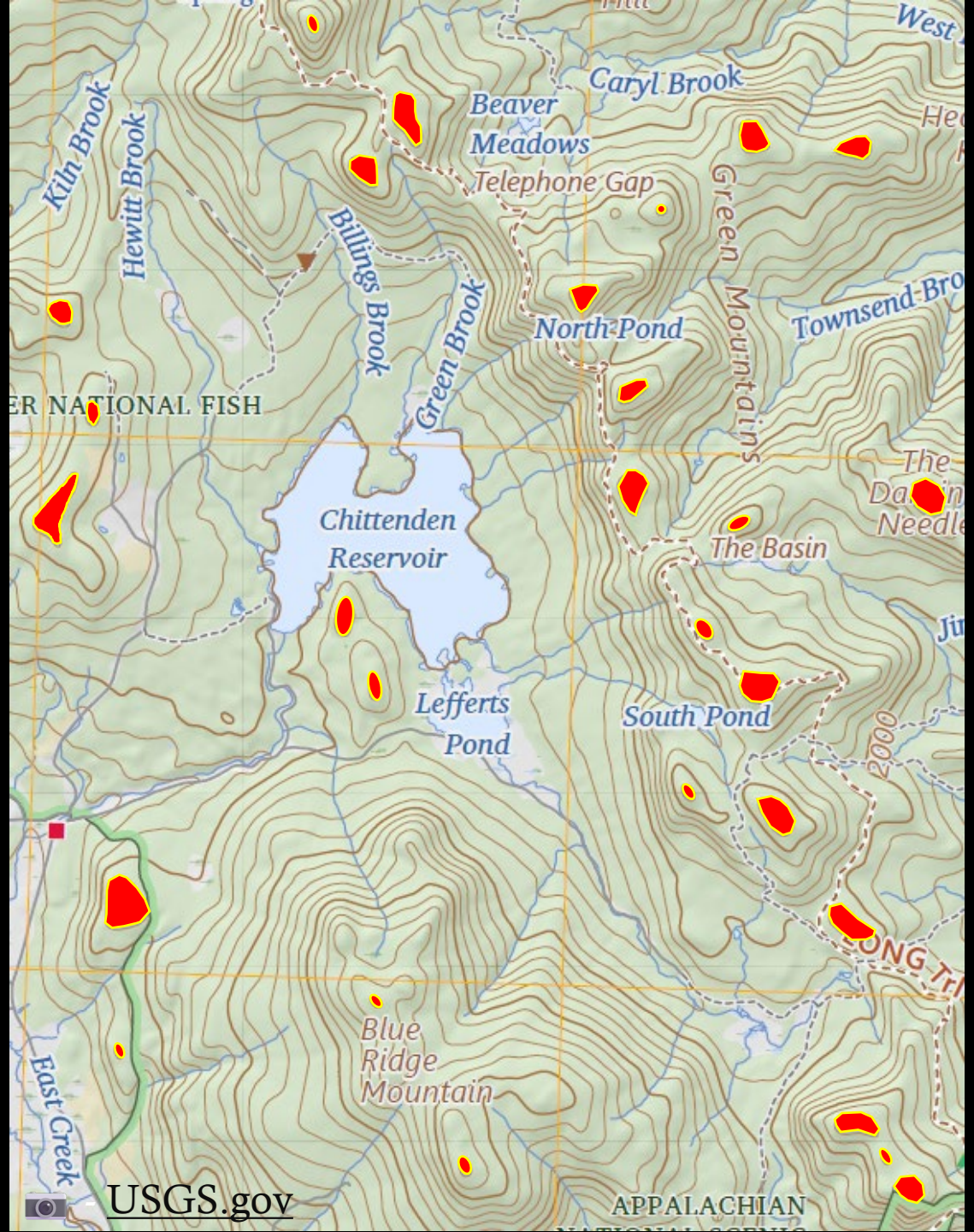
HOW DOES TOPOGRAPHY INFLUENCE HYDROLOGY?

- Elevation
- Slope
- Aspect
- Flow Direction
- Flow Concentration
- Stream Order
- Landforms
- Watershed Delineation



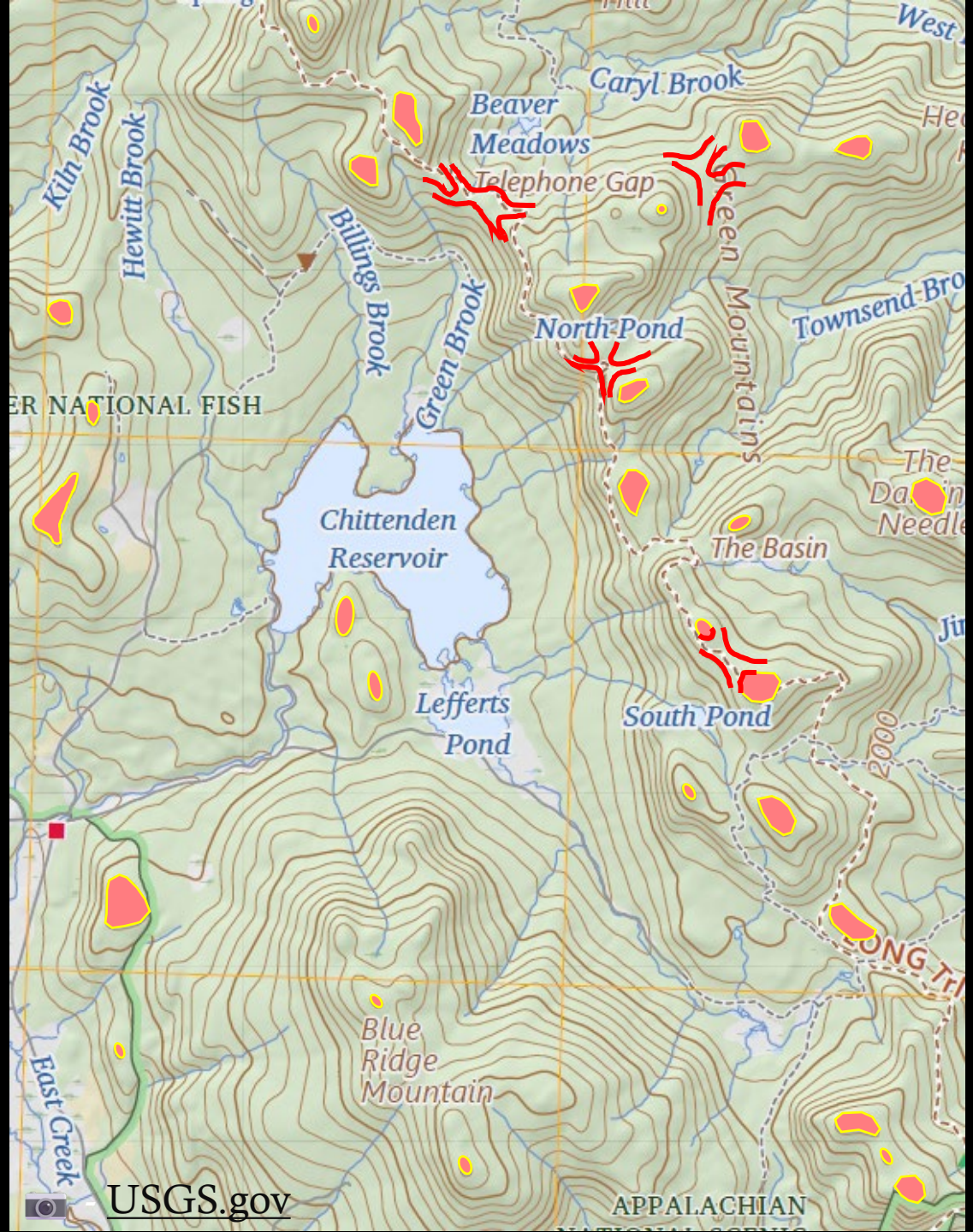
HOW DOES TOPOGRAPHY INFLUENCE HYDROLOGY?

- Elevation
- Slope
- Aspect
- Flow Direction
- Flow Concentration
- Stream Order
- Landforms
- Watershed Delineation



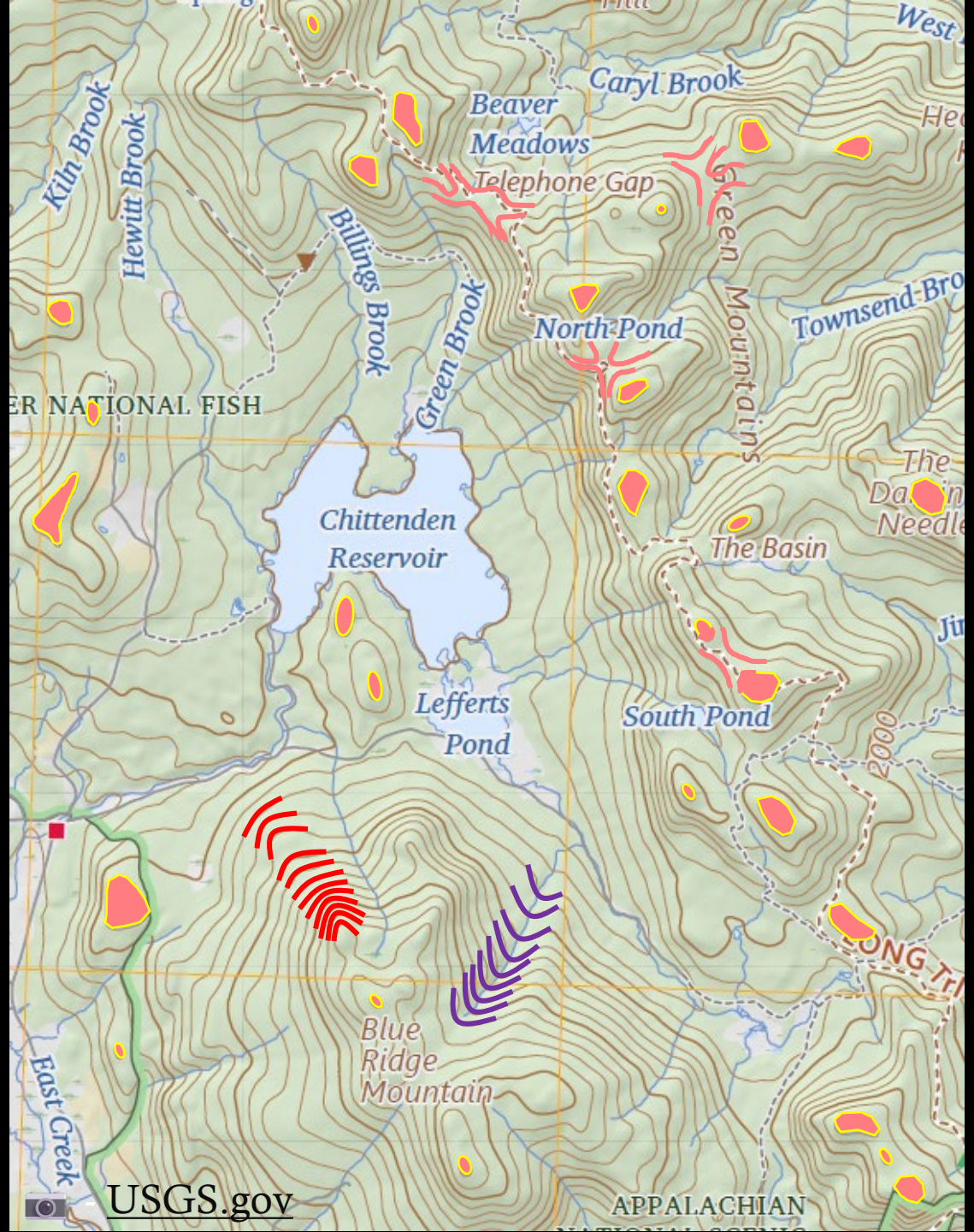
HOW DOES TOPOGRAPHY INFLUENCE HYDROLOGY?

- Elevation
- Slope
- Aspect
- Flow Direction
- Flow Concentration
- Stream Order
- Landforms
- Watershed Delineation



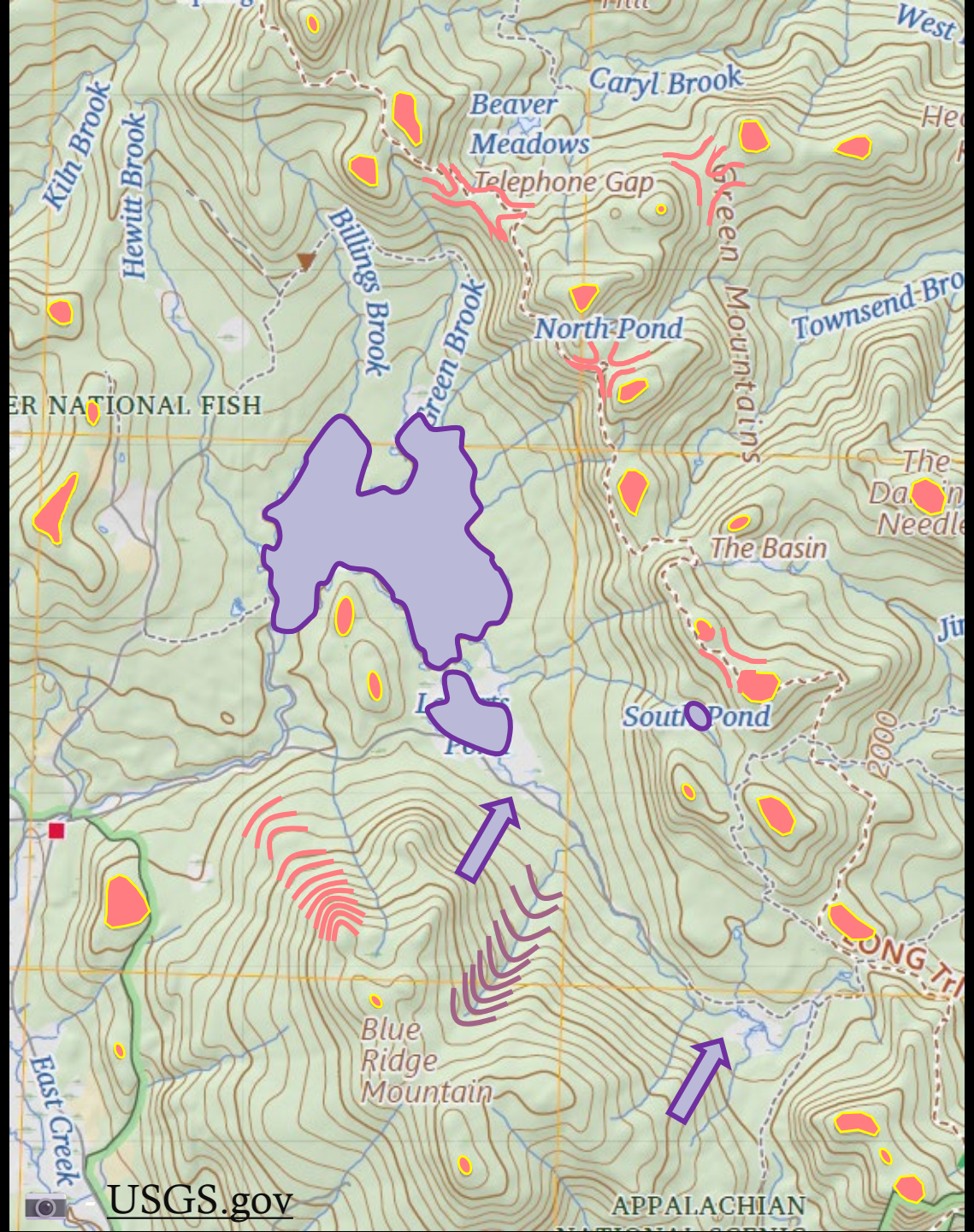
HOW DOES TOPOGRAPHY INFLUENCE HYDROLOGY?

- Elevation
- Slope
- Aspect
- Flow Direction
- Flow Concentration
- Stream Order
- Landforms
- Watershed Delineation



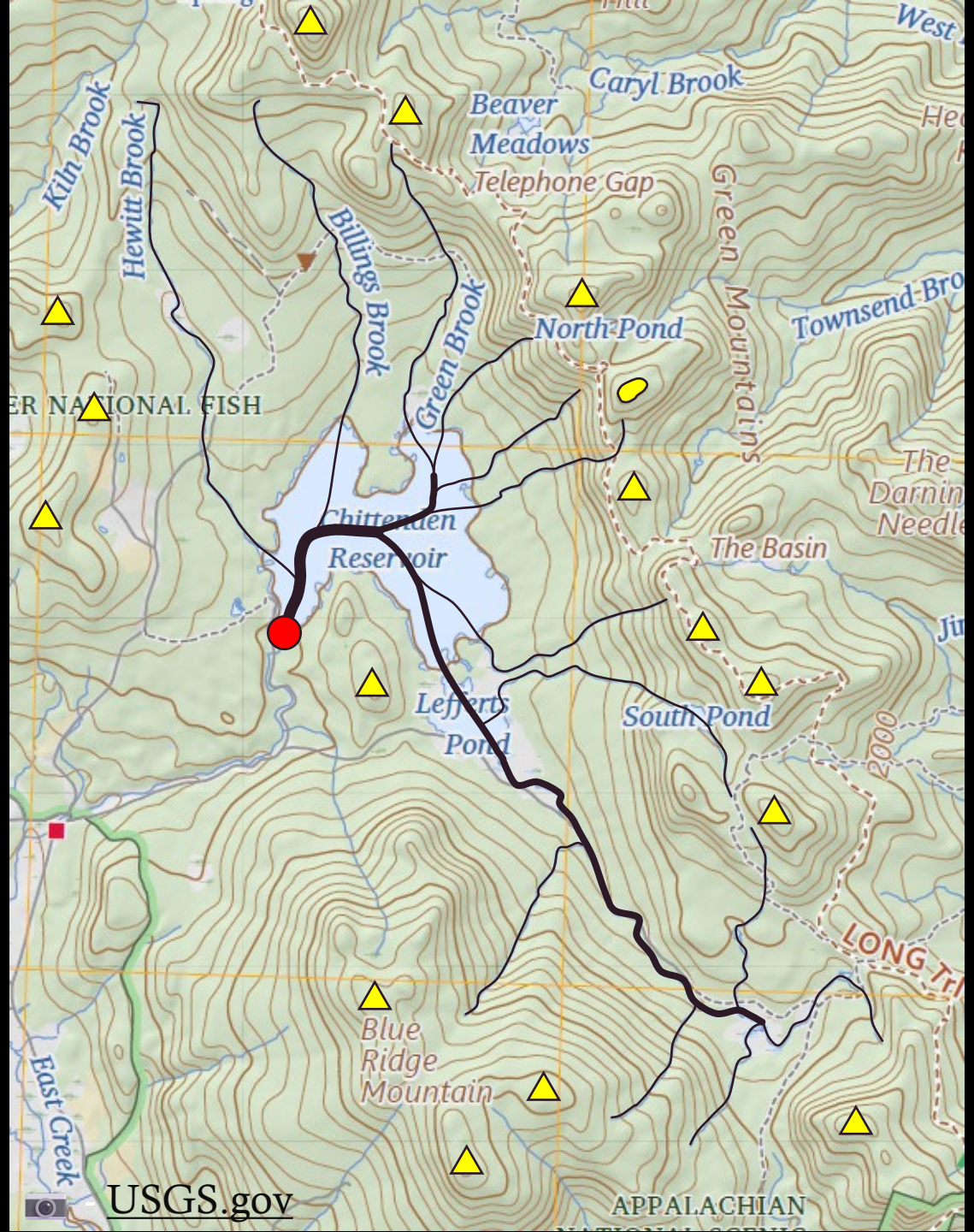
HOW DOES TOPOGRAPHY INFLUENCE HYDROLOGY?

- Elevation
- Slope
- Aspect
- Flow Direction
- Flow Concentration
- Stream Order
- Landforms
- Watershed Delineation



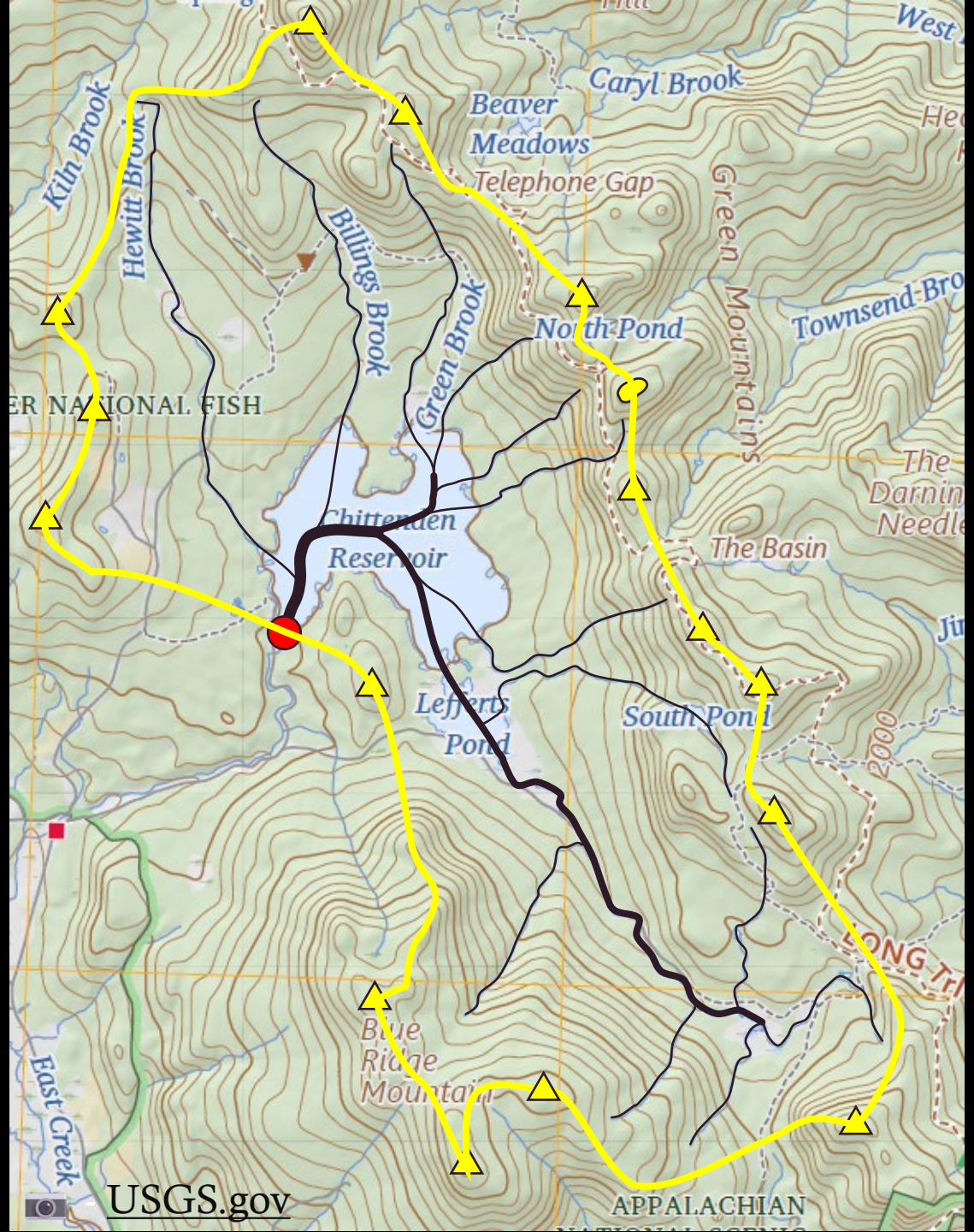
HOW DOES TOPOGRAPHY INFLUENCE HYDROLOGY?

- Elevation
- Slope
- Aspect
- Flow Direction
- Flow Concentration
- Stream Order
- Landforms
- Watershed Delineation



HOW DOES TOPOGRAPHY INFLUENCE HYDROLOGY?

- Elevation
- Slope
- Aspect
- Flow Direction
- Flow Concentration
- Stream Order
- Landforms
- Watershed Delineation



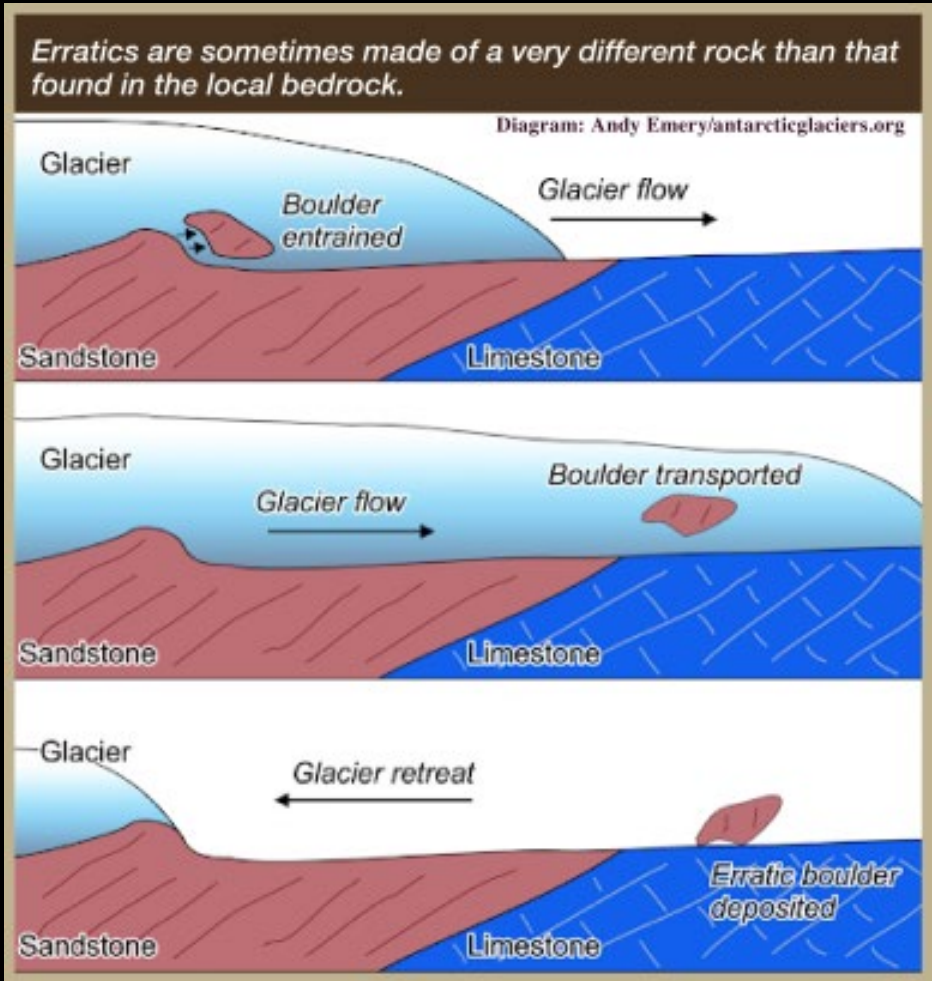
HOW DOES TOPOGRAPHY INFLUENCE HYDROLOGY?

- Elevation
- Slope
- Aspect
- Flow Direction
- Flow Concentration
- Stream Order
- Watershed Delineation

UNIQUE GLACIAL LANDFORMS

What did the glaciers take away?

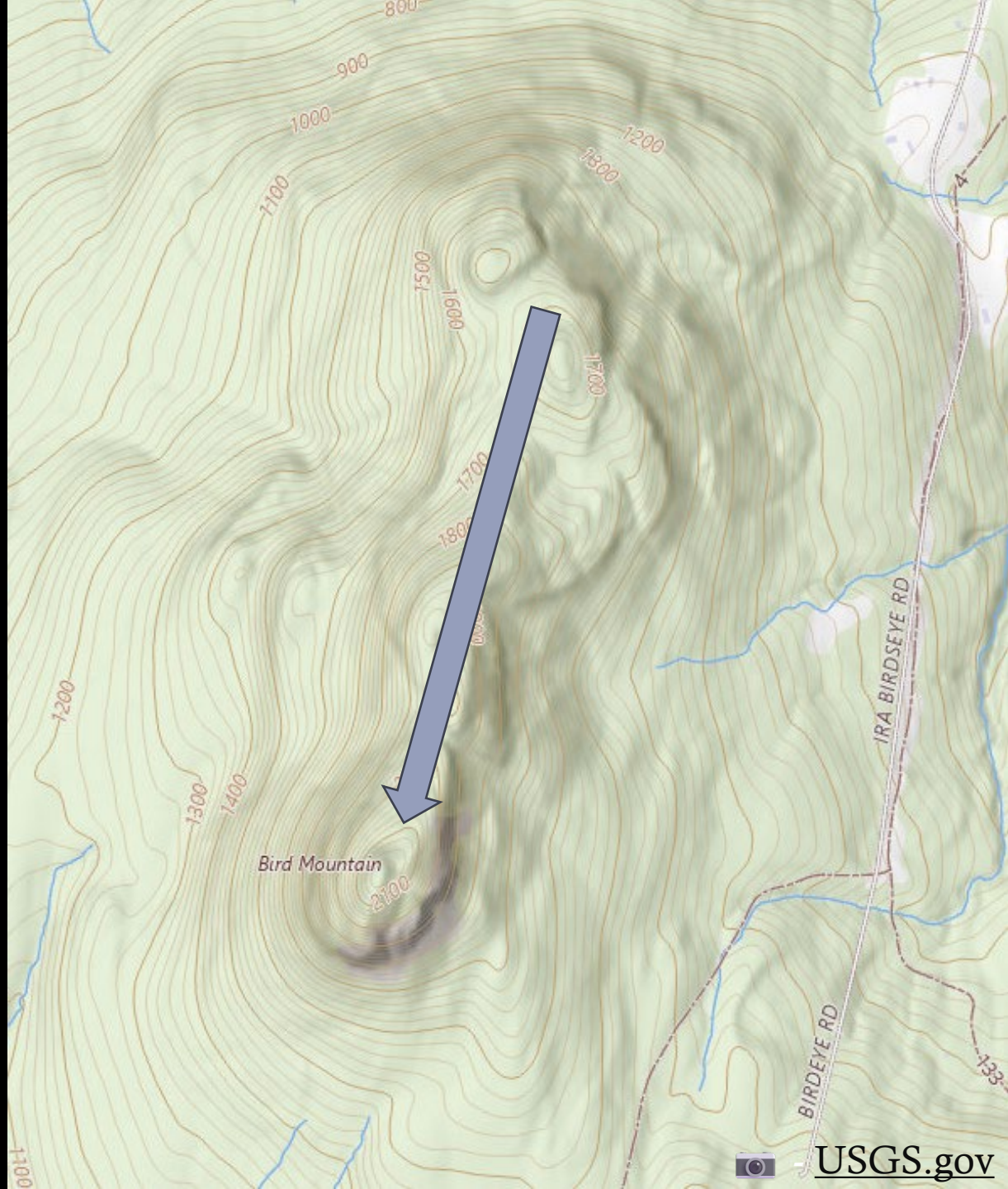
What did they leave behind?



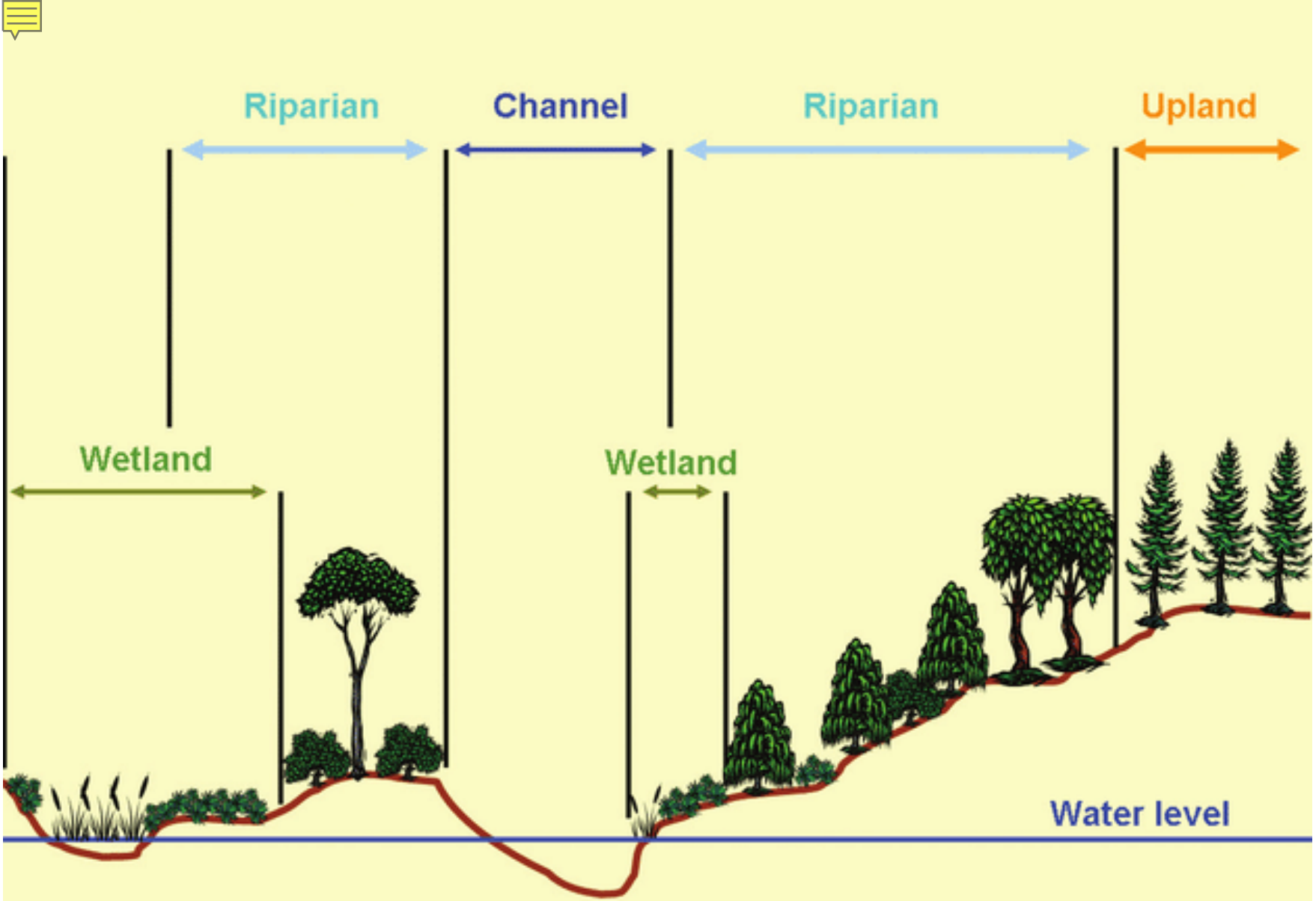
📷 - kruschnaturepreserve.org

UNIQUE GLACIAL LANDFORMS

- What did the glaciers take away?
- What did they leave behind?



USGS.gov



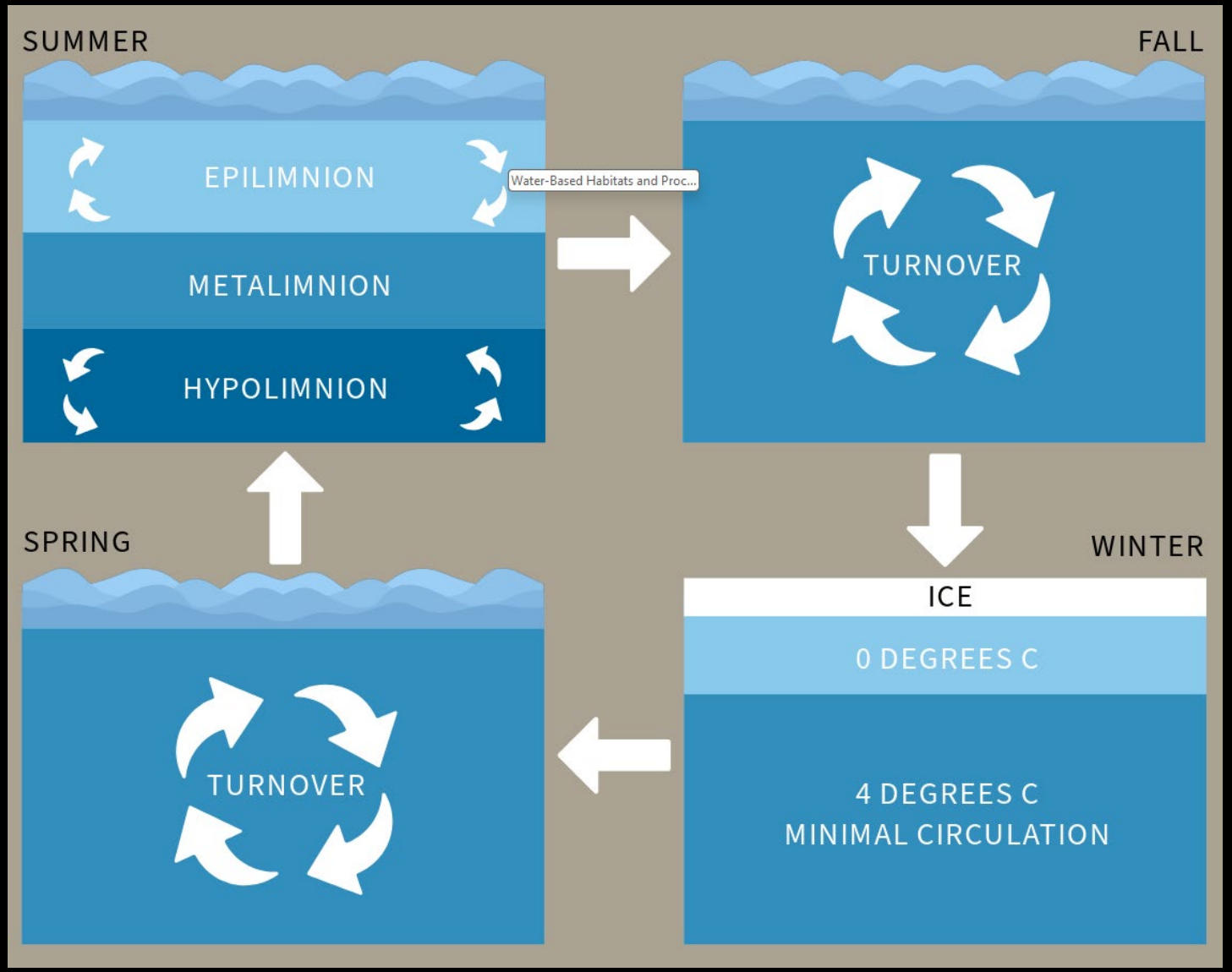
- researchgate.net

WATER-BASED HABITATS AND PROCESSES

- Lacustrine
- Riverine
- Wetland
- Riparian

TEMPERATURE STRATIFICATION IN LAKES

- What does it mean?
- How does it happen?
- When does it change?

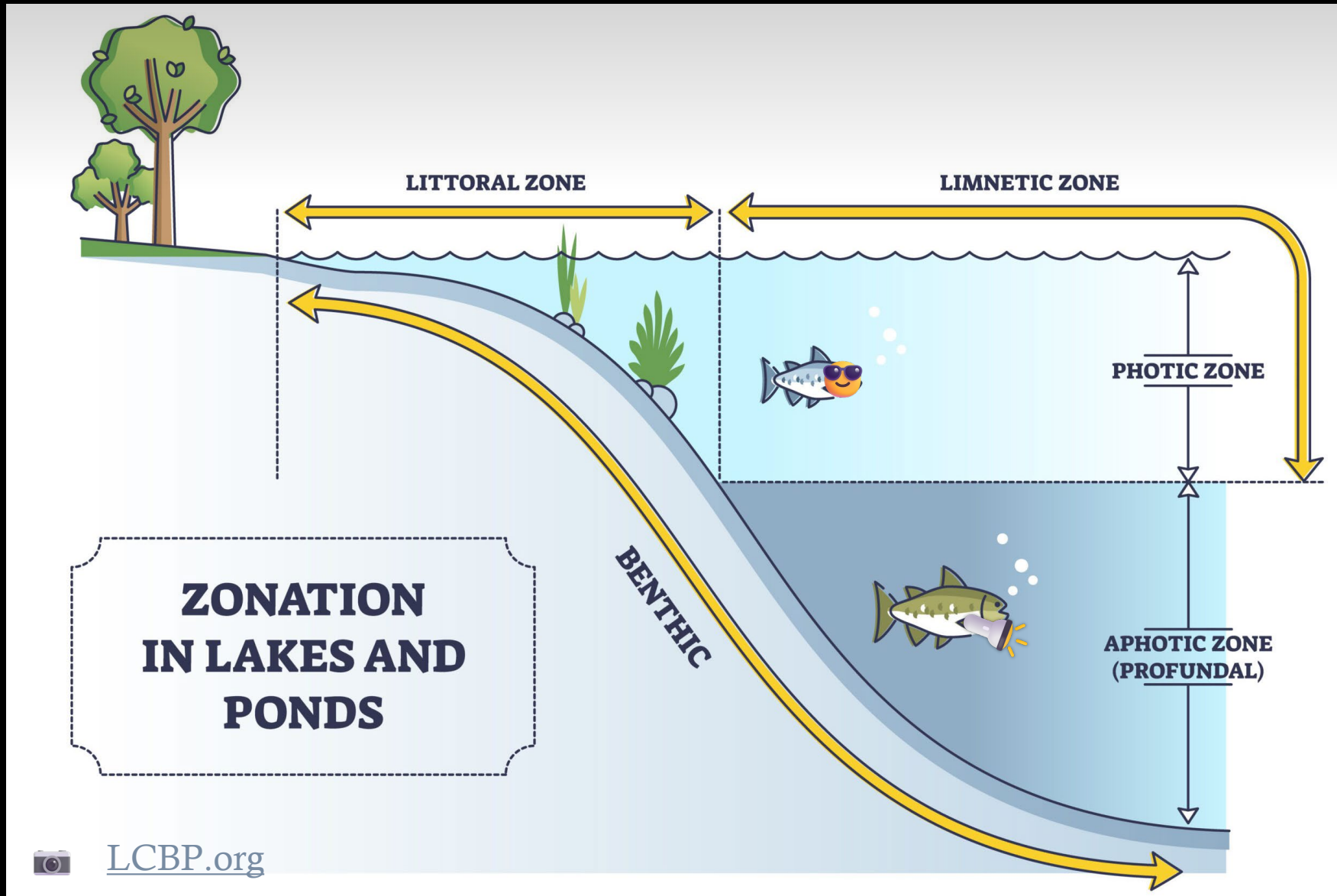


📷 - LCBP.org

LIGHT BRINGS LIFE TO LAKES

What are photic zones?

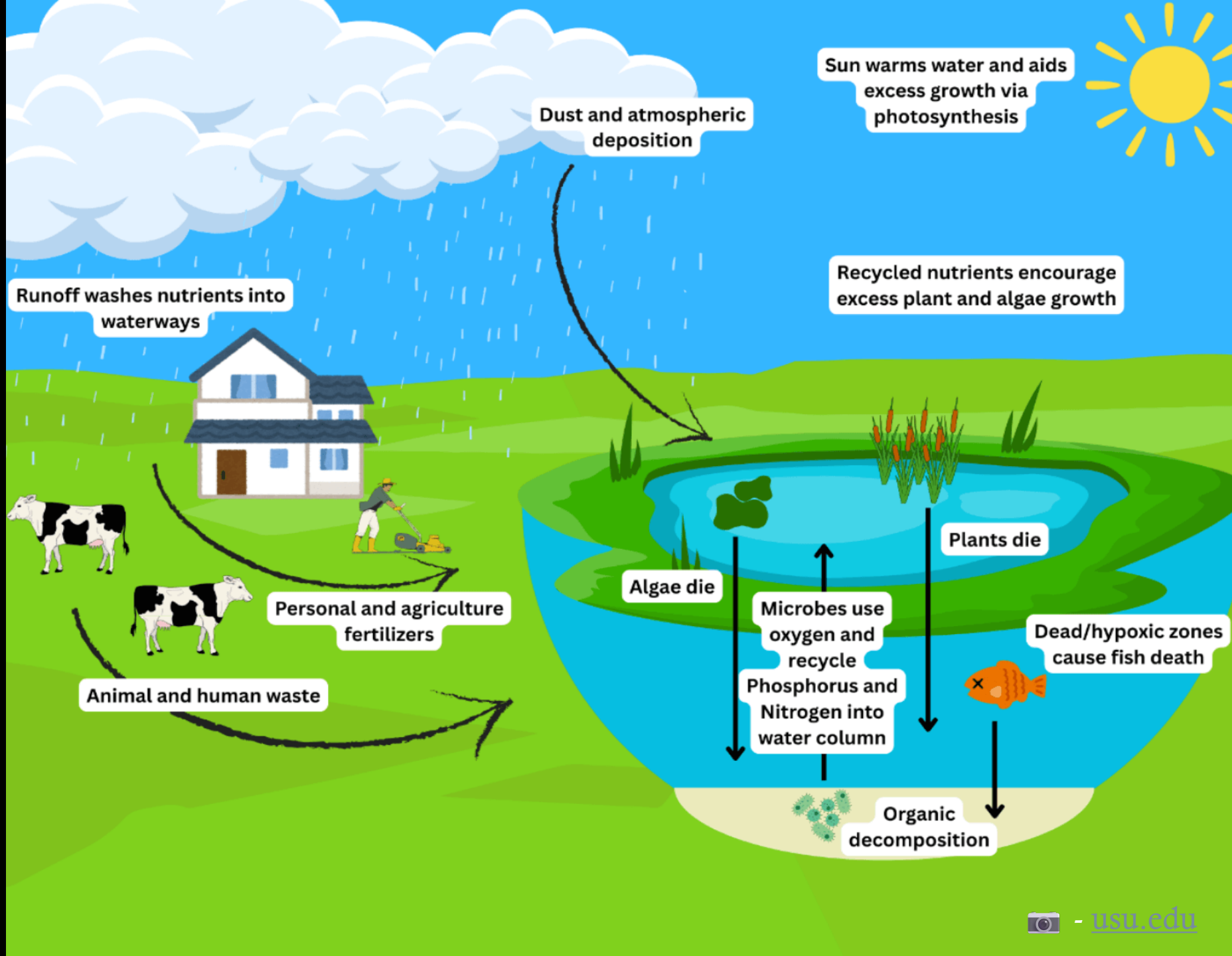
Why do they matter?



LCBP.org

TROPHIC STATE AND TRANSITION

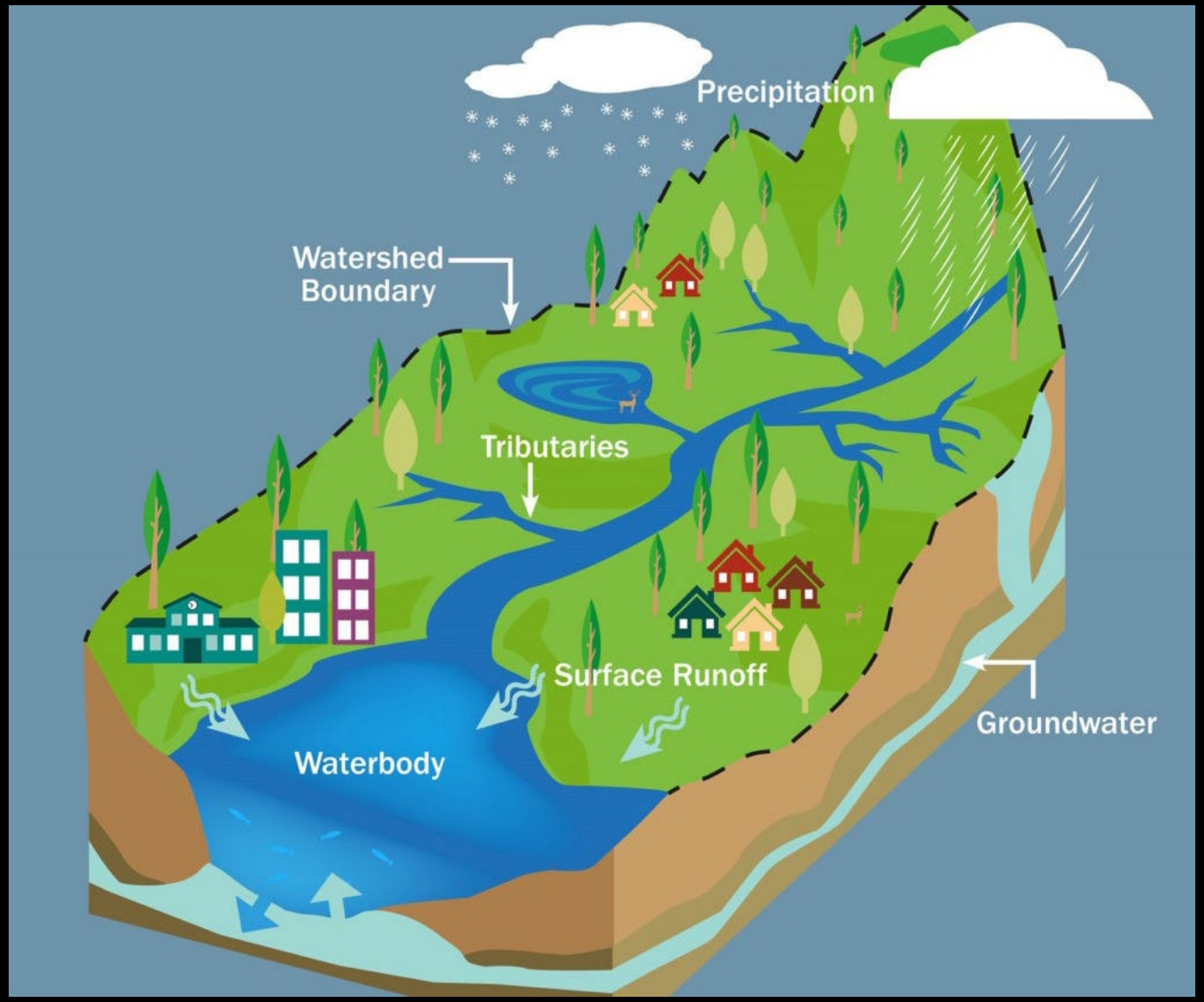
Can lakes get old and die?



- usu.edu

RIVER HYDROLOGY

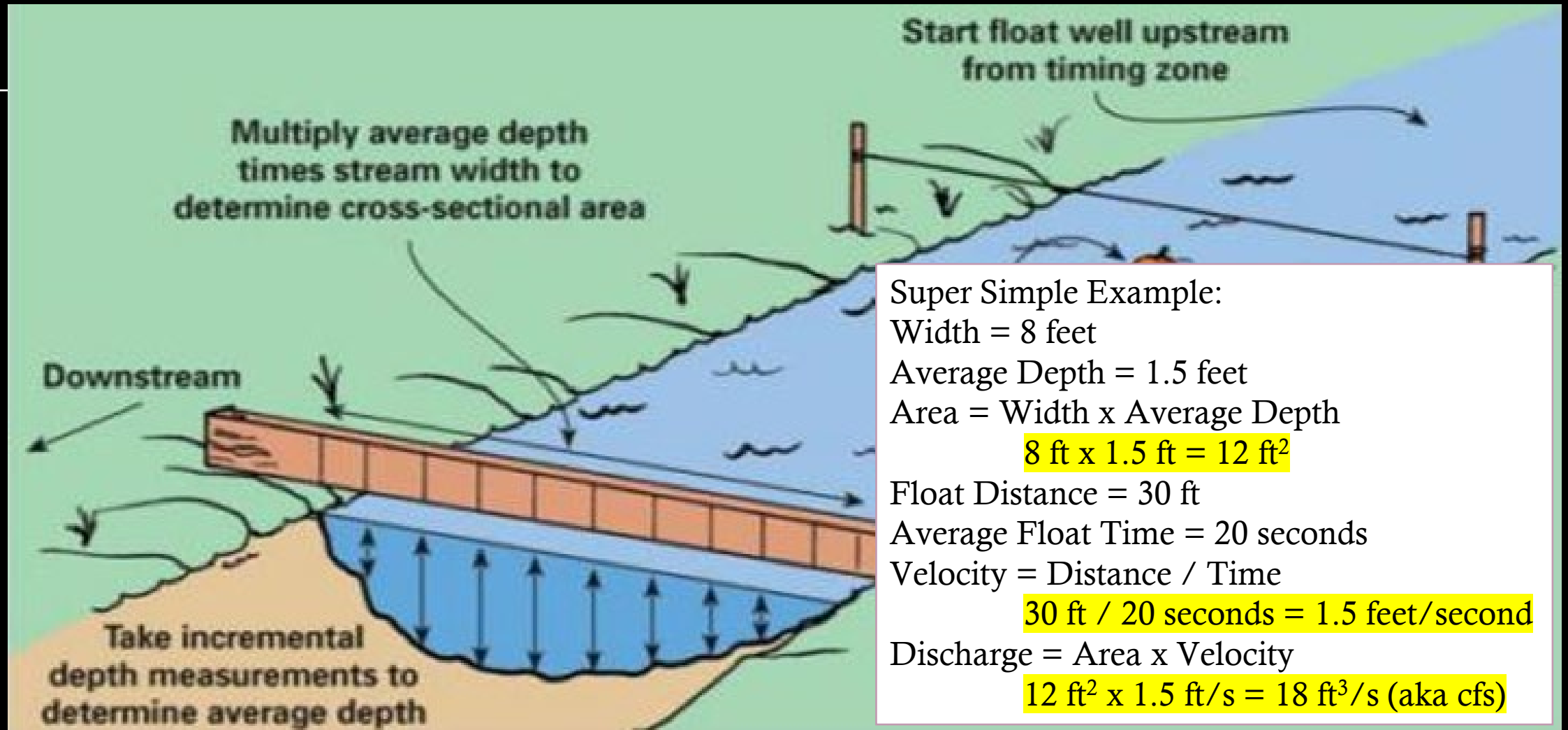
- How much water is there? And when?
- How do we measure flow?
- When are the high and low flows?
- Unusual flows.



📷 - noaa.gov

RIVER HYDROLOGY

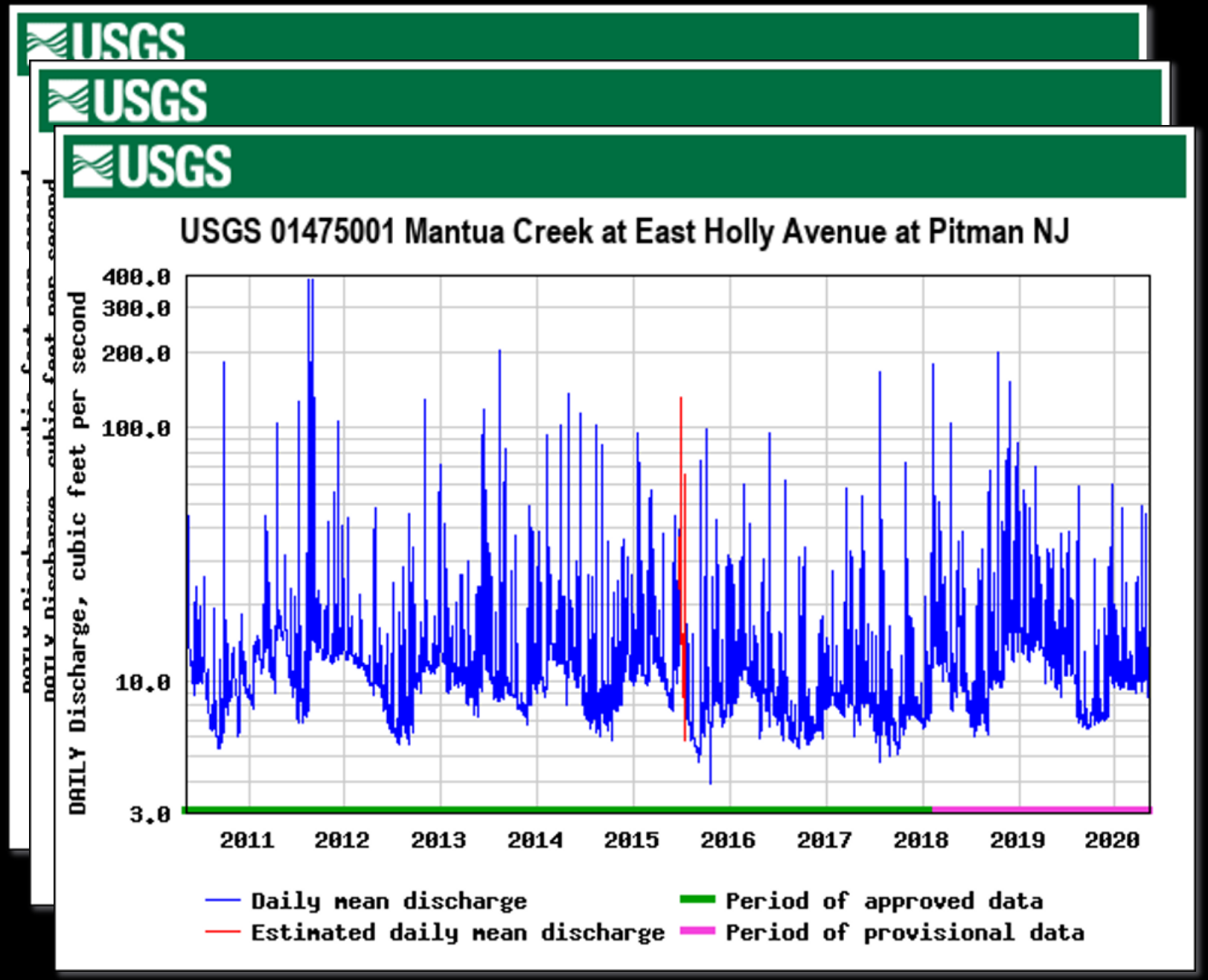
- How much water is there?
- How do we measure flow?
- When are the high and low flows?
- Unusual flows.



Super Simple Example:
Width = 8 feet
Average Depth = 1.5 feet
Area = Width x Average Depth
8 ft x 1.5 ft = 12 ft^2
Float Distance = 30 ft
Average Float Time = 20 seconds
Velocity = Distance / Time
30 ft / 20 seconds = 1.5 feet/second
Discharge = Area x Velocity
12 ft^2 x 1.5 ft/s = 18 ft^3/s (aka cfs)

RIVER HYDROLOGY

- How much water is there?
- How do we measure flow?
- When are the high and low flows?
- Unusual flows.



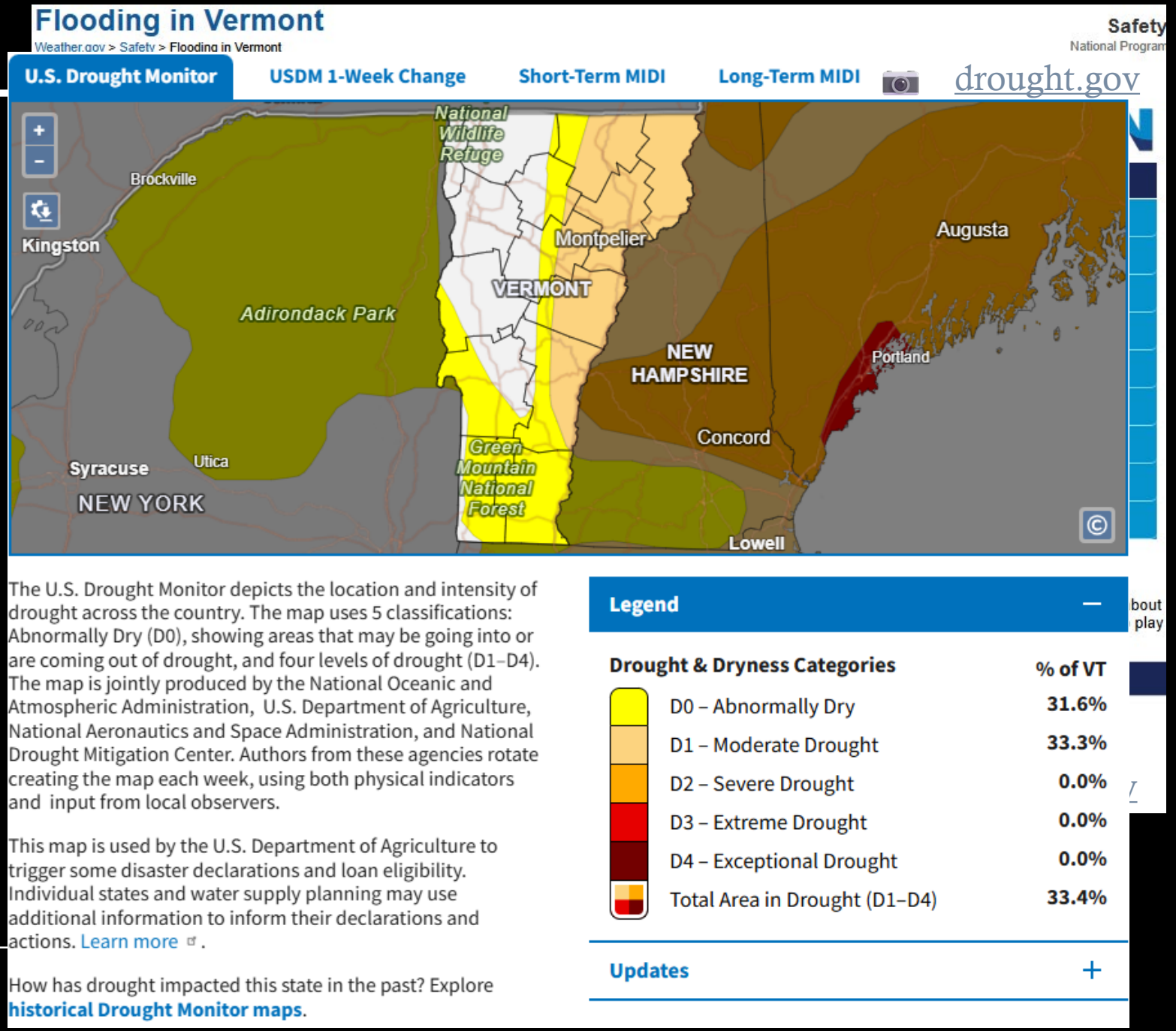
RIVER HYDROLOGY

How much water is there?

How do we measure flow?

When are the high and low flows?

Unusual flows.

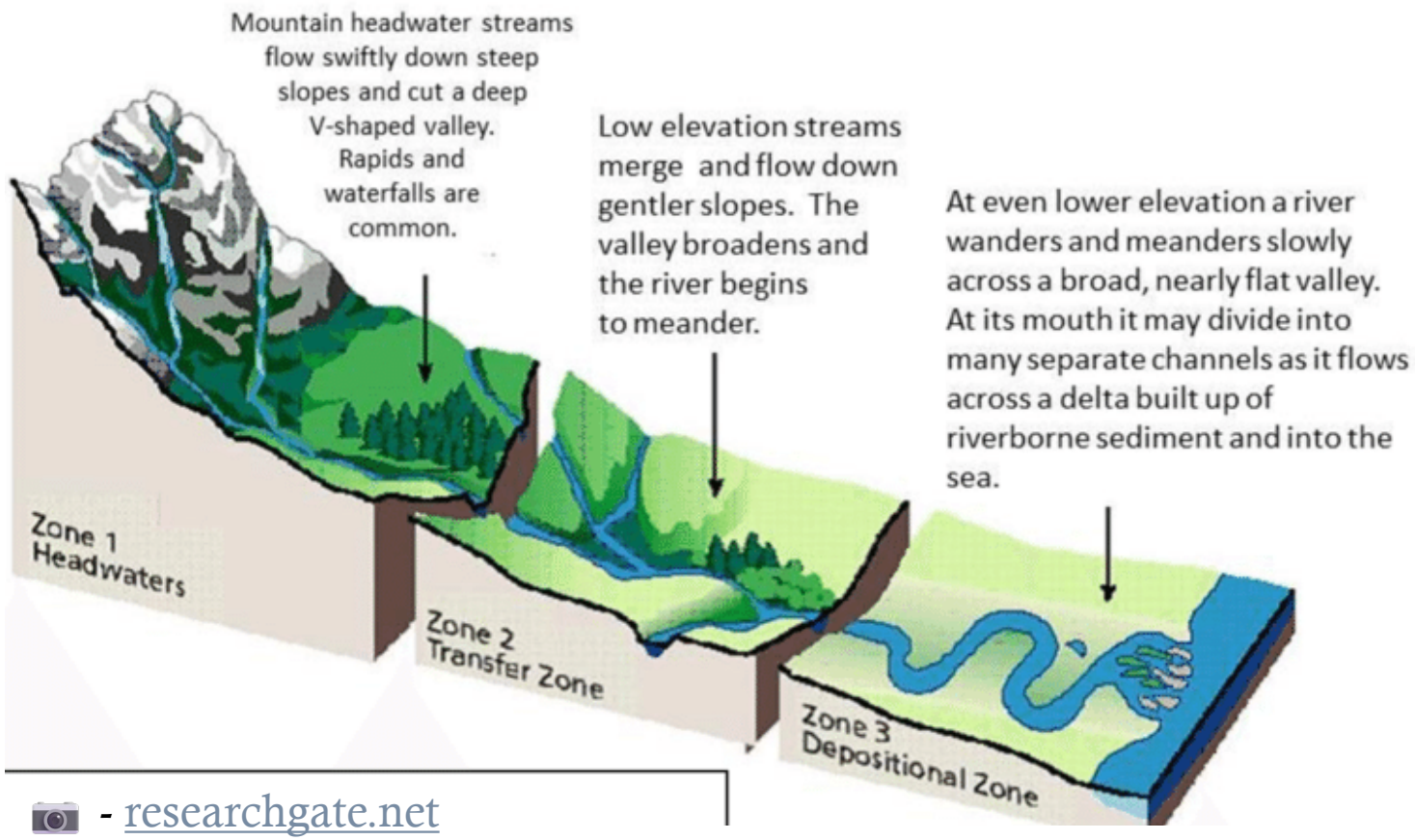


RIVER MORPHOLOGY AND CHANGE

Sediment

Floodplains

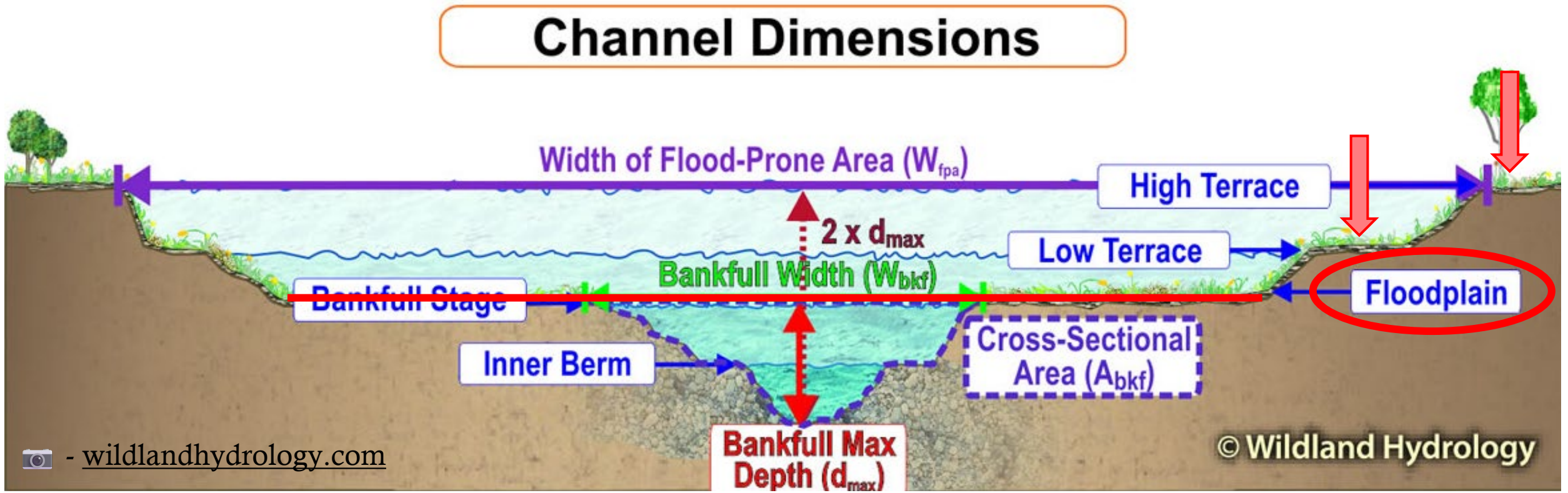
The Perpetual Balancing Act



📷 - researchgate.net

RIVER MORPHOLOGY AND CHANGE

- Sediment
- Floodplains
- The Perpetual Balancing Act



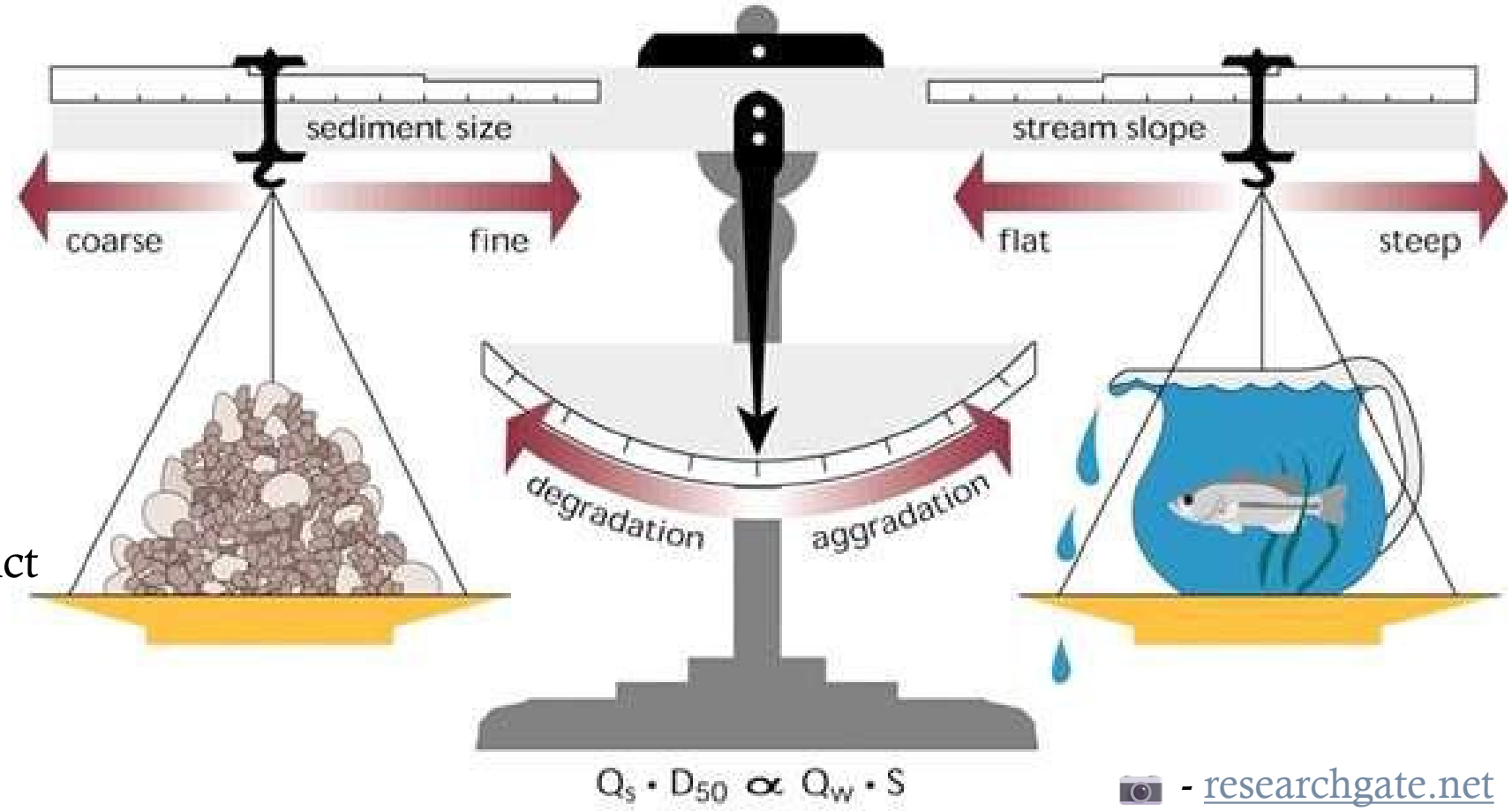
- wildlandhydrology.com

RIVER MORPHOLOGY AND CHANGE

Sediment

Floodplains

The Perpetual Balancing Act



- researchgate.net

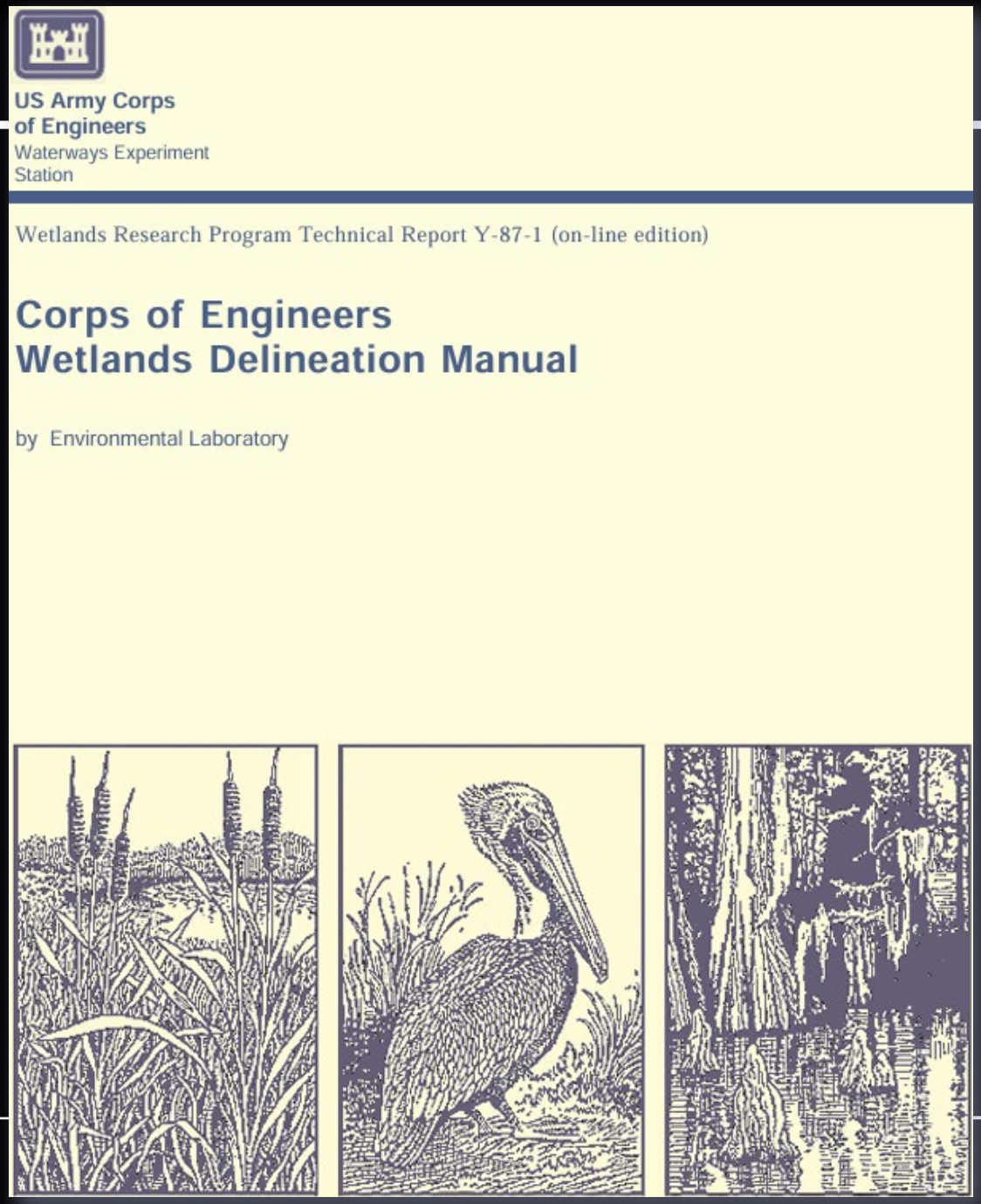
WETLANDS

What are they?

Beaver influence.

Values.

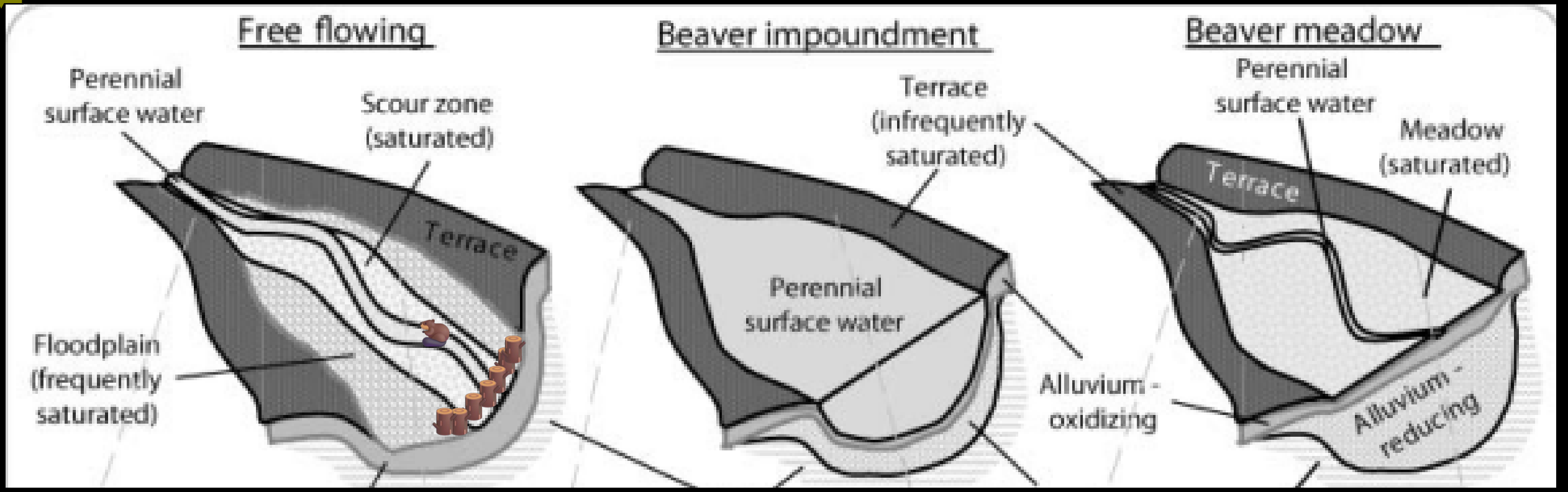
WETLAND DELINEATION



VERNAL POOLS

- Unique hydrology
- Temporary
- Critical for some amphibians

📷 - vtfishandwildlife.com



BEAVERS!

- Nature's engineers.
- Sometimes stable, sometimes cyclical.

📷 - uconn.edu

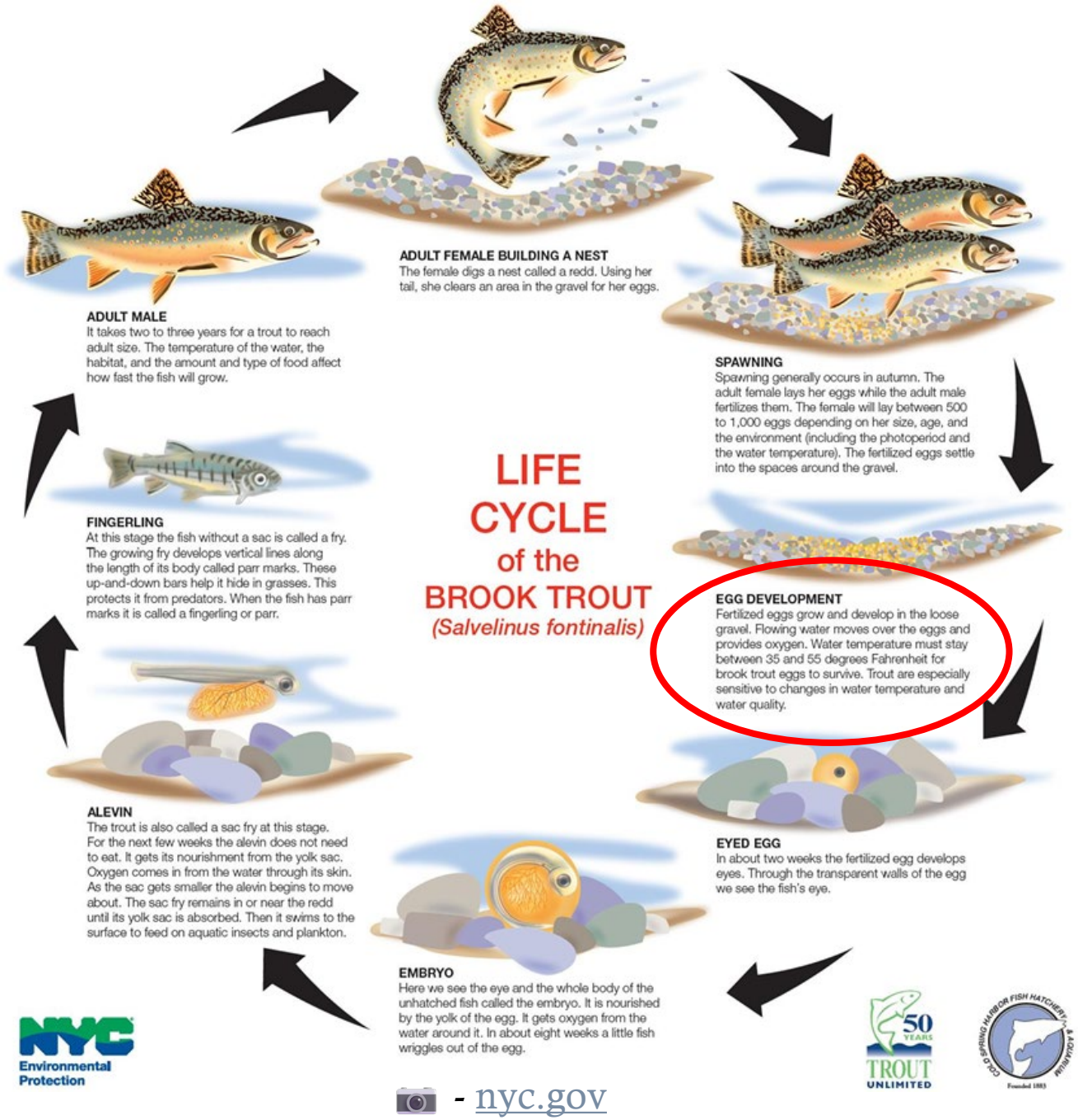
WETLAND ECOSYSTEM SERVICES

- Provisioning (🛒 🚰)
- Regulating (🧅 🌡️ 🌊 🧯)
- Supporting (🌳 🫎 🦢 🐟)
- Cultural (🚣 🎧 🔭 📷 🛖)

AQUATIC SPECIES BIOLOGY AND IDENTIFICATION

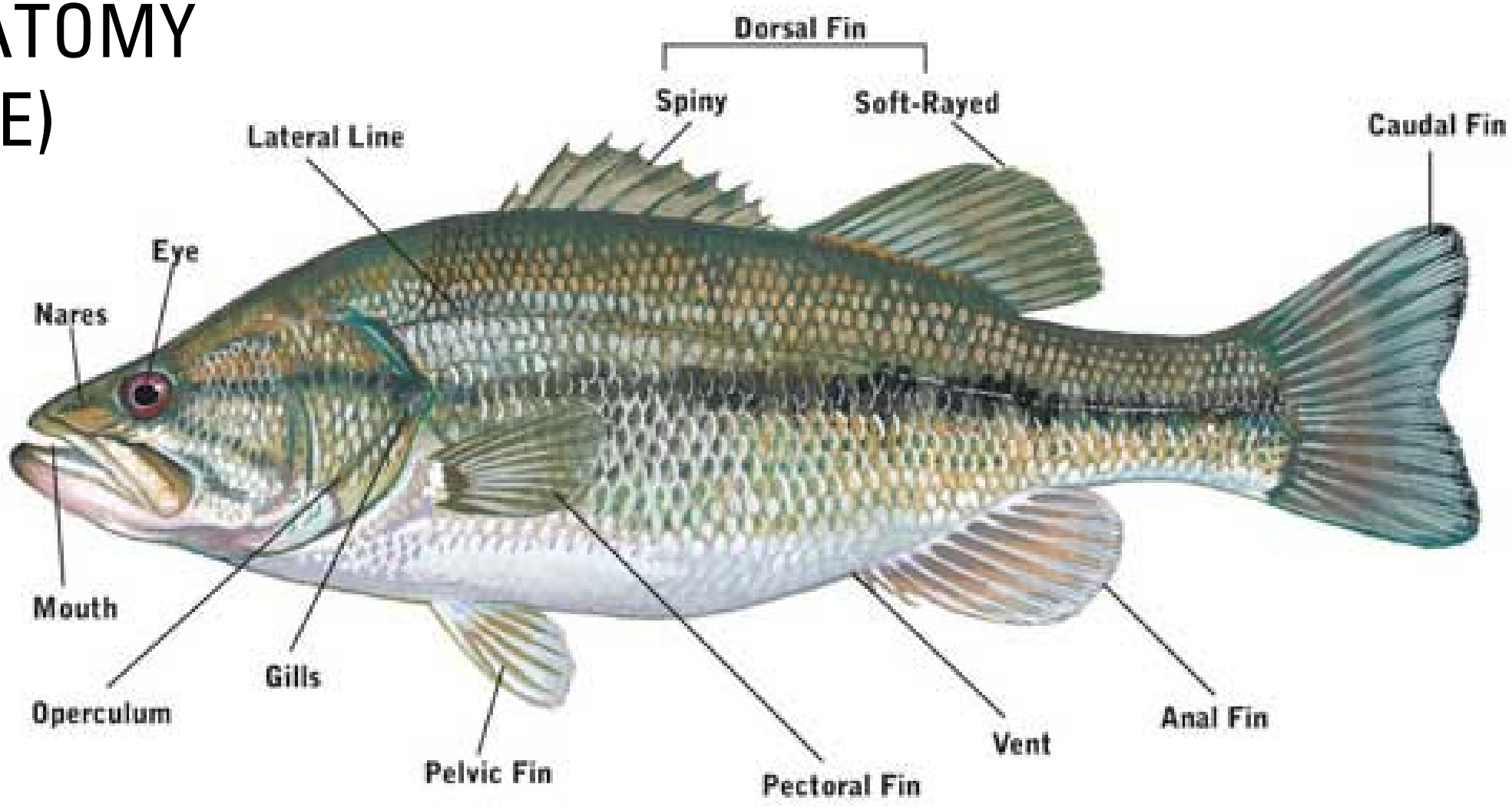
- Fish
- Amphibians
- Bugs
- Plants
- Food Web
- Invasives

FISH LIFE CYCLE (EXAMPLE)



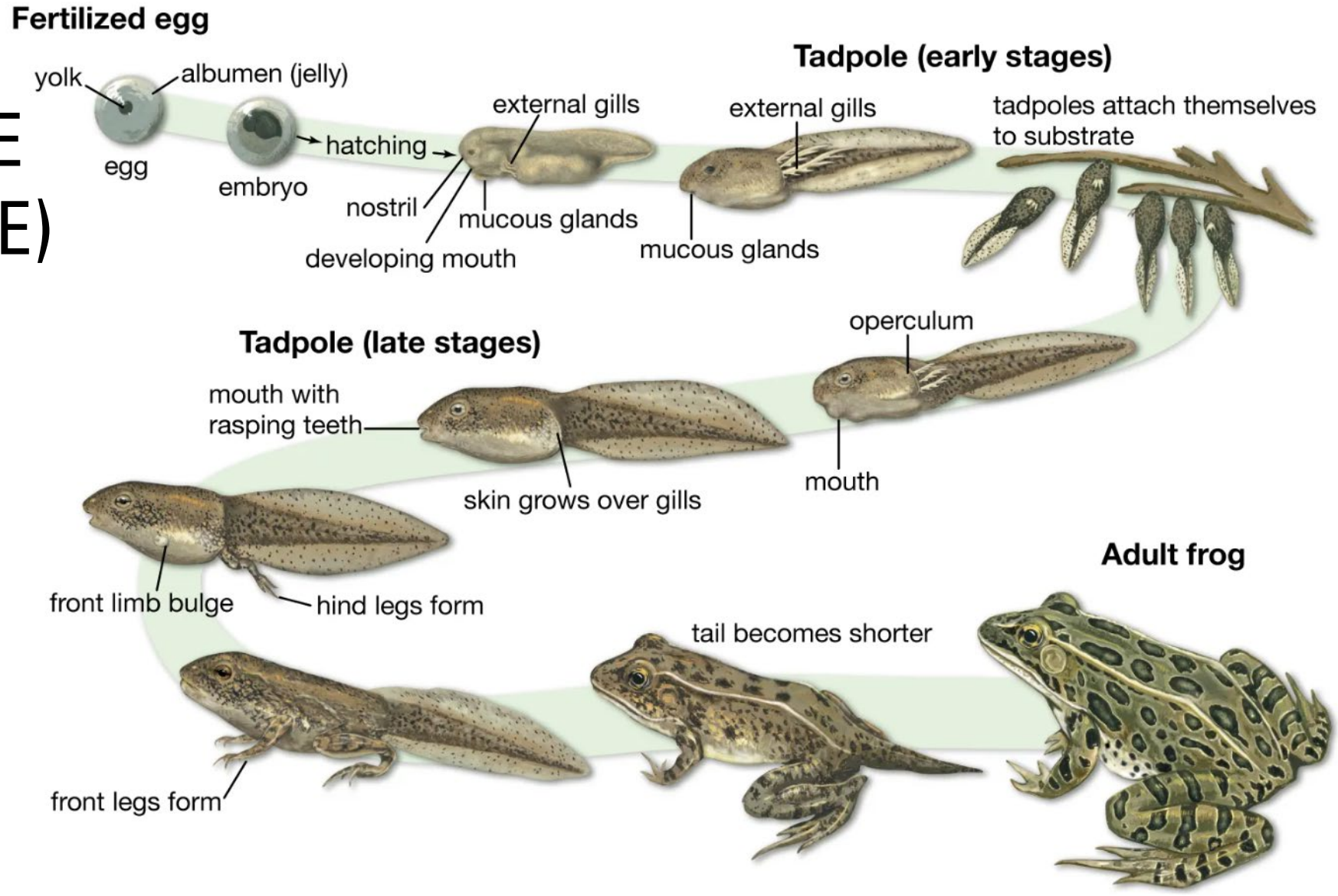
- nyc.gov

FISH ANATOMY (EXAMPLE)

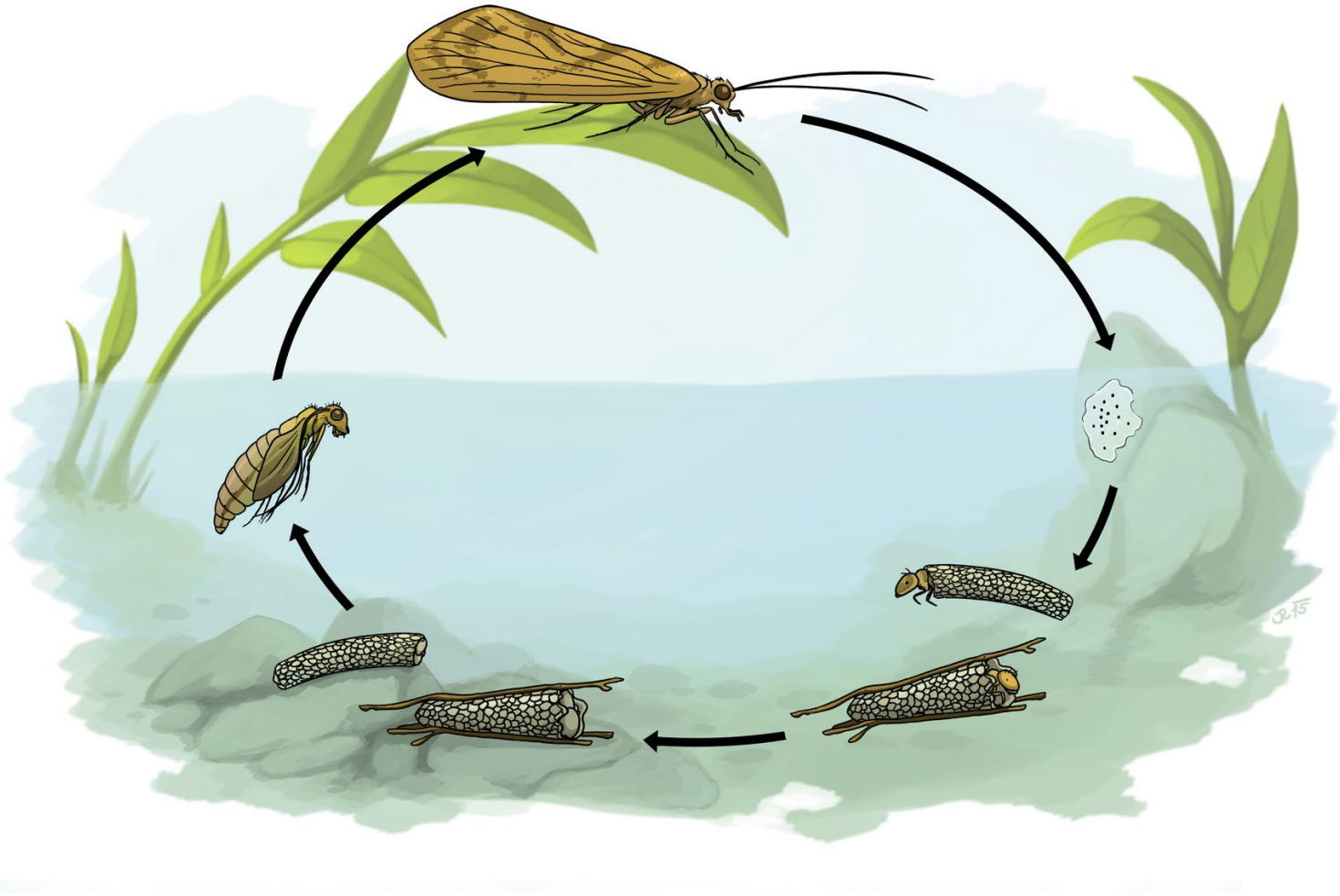


📷 - dnr.sc.gov

AMPHIBIAN LIFE CYCLE (EXAMPLE)



📷 - britannica.com



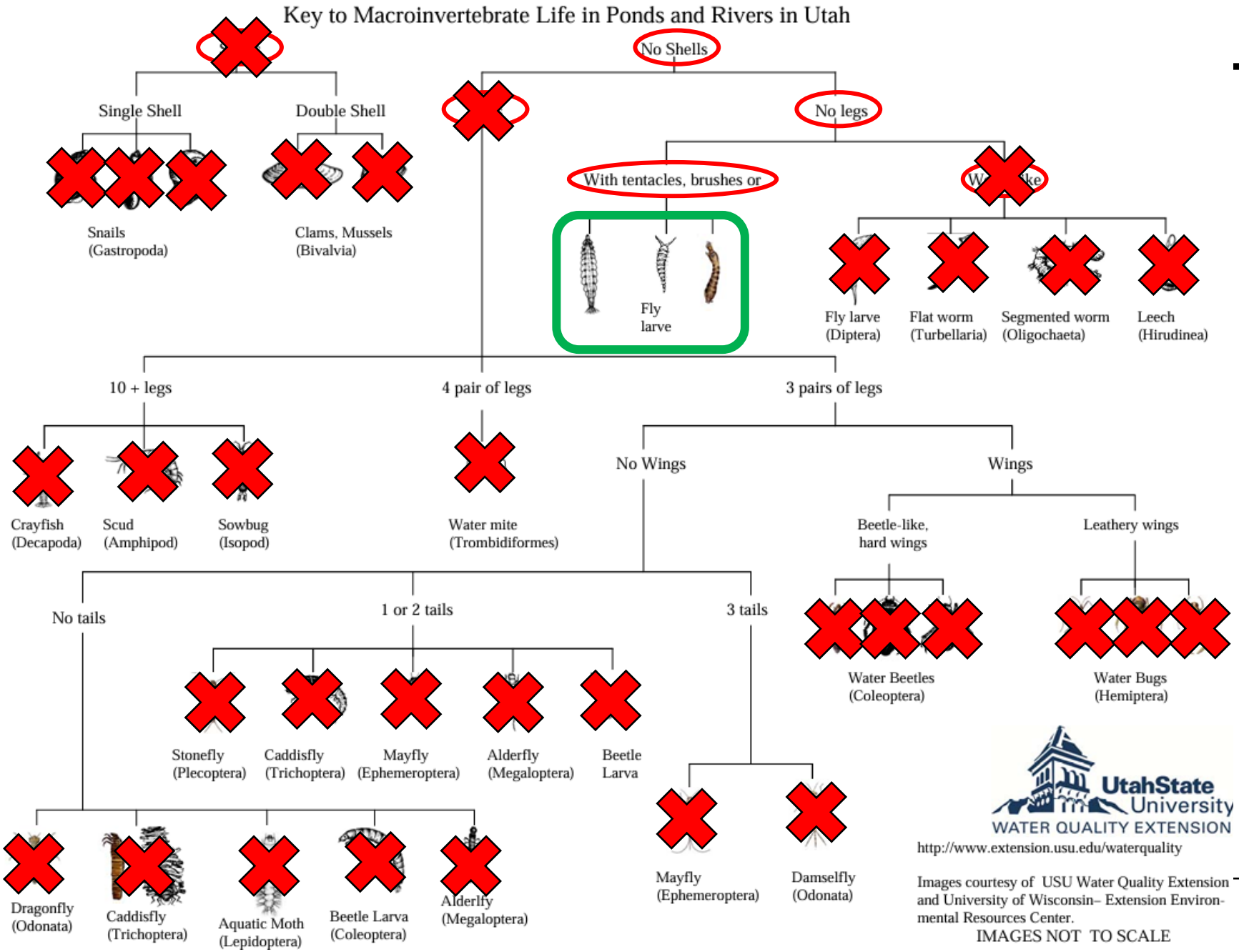
- jrtracey.artstation.com

MACROINVERTEBRATES

Life Cycle (Example)

Identification

Water Quality



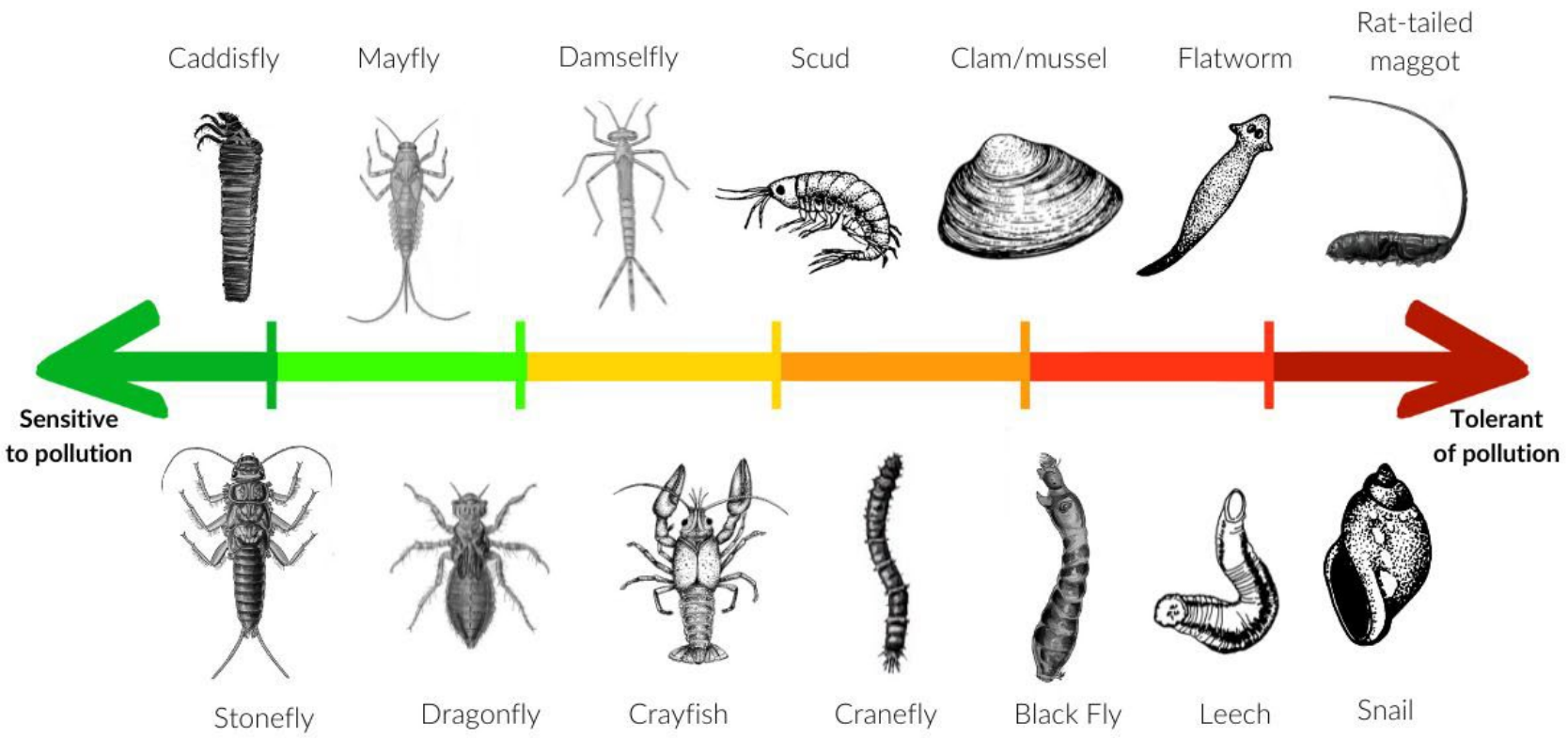
MACROINVERTEBRATES

Life Cycle (Example)

Identification

Water Quality

MACROINVERTEBRATES



Life Cycle (Example)

Identification

Water Quality

📷 - usu.edu

AQUATIC PLANTS (EXAMPLES)

Upright

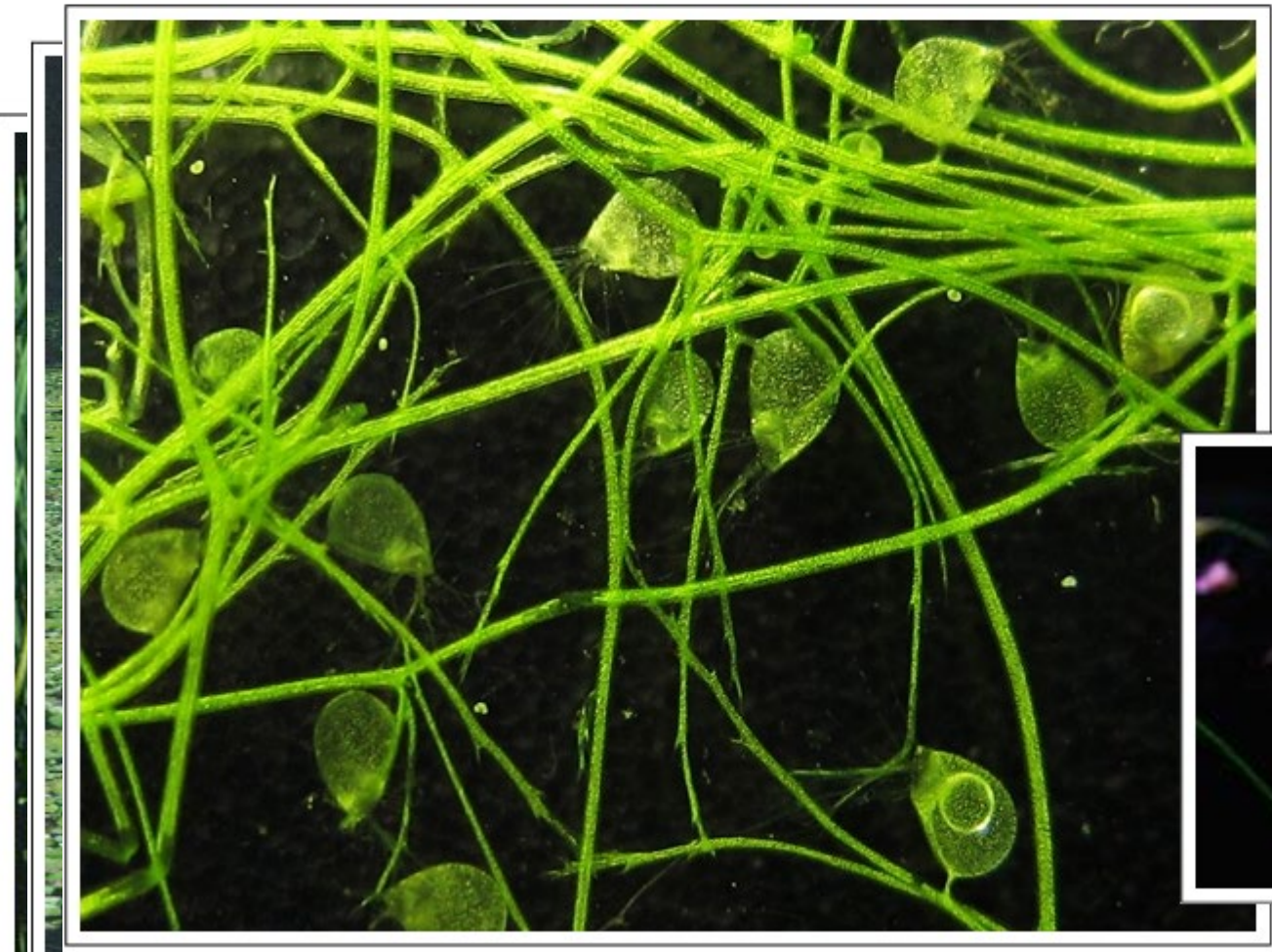
Anchored

Free-floating

Utricularia gibba

(u-TRICK-u-LAIR-ee-a GIB-ba)

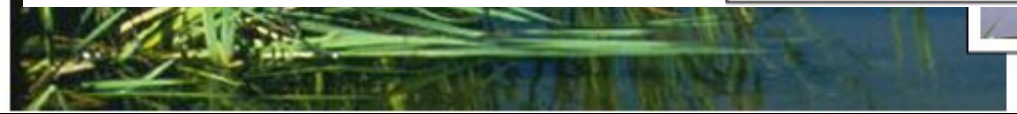
Humped Bladderwort



Bladderworts are carnivorous plants that capture and digest aquatic insects and animals by means of small bladder like traps.

Photos from http://www.aquarium-kosmos.de/

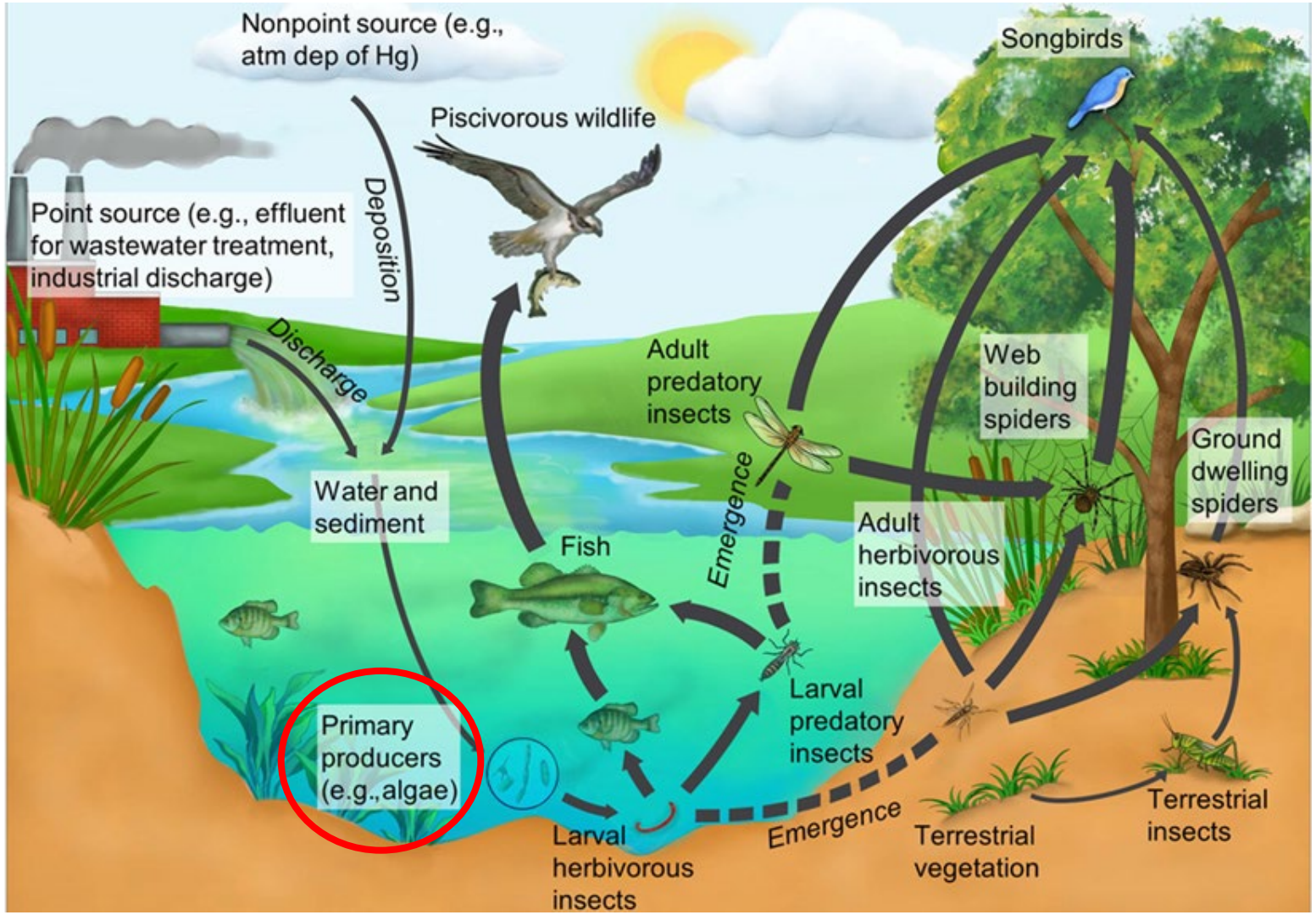
Vermont DEC Staff Photos



Mike Haddock 2004
http://www.lib.ksu.edu/wildflower/broadcattail.html

- vtinvasives.org

AQUATIC FOOD WEB



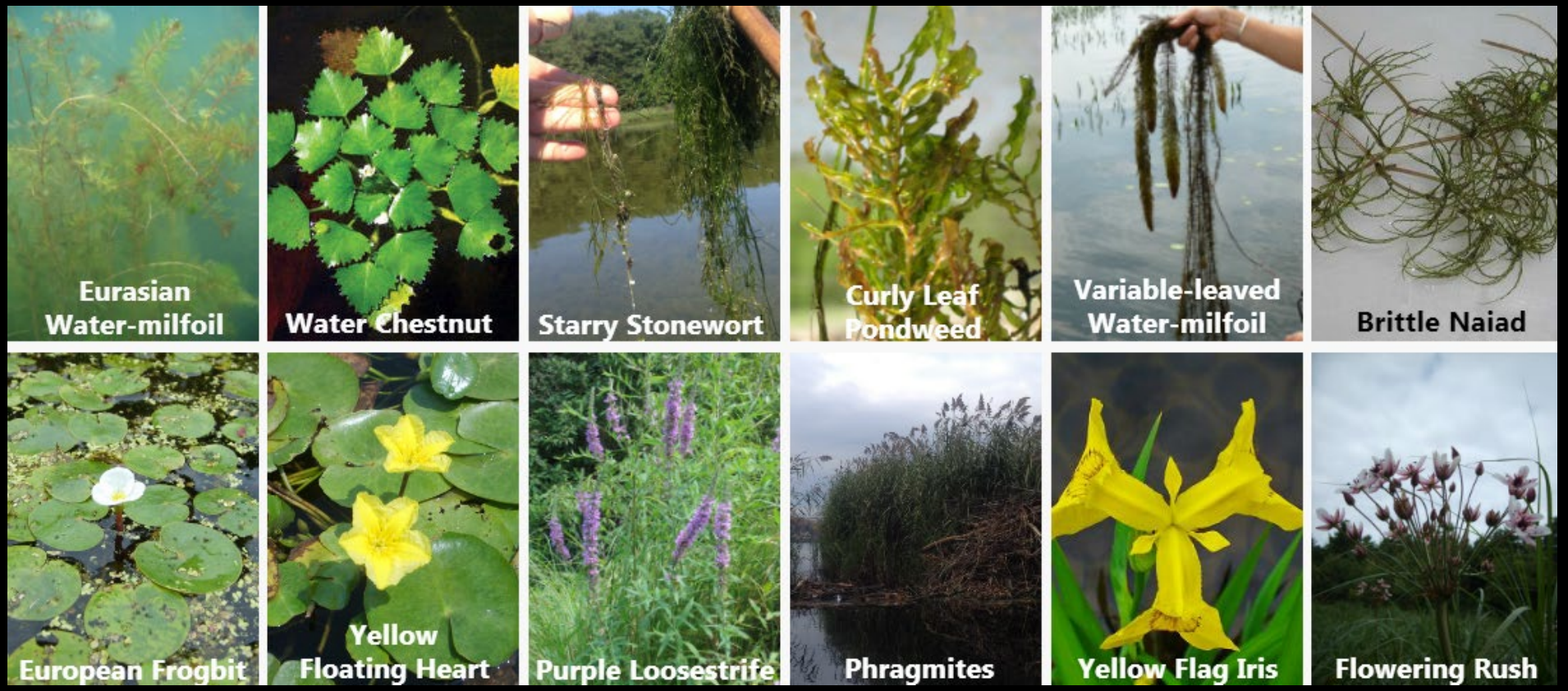
- usgs.gov

AQUATIC INVASIVE SPECIES IN VERMONT

Plants

Vertebrates

Invertebrates



📷 - dec.vermont.gov

AQUATIC INVASIVE SPECIES IN VERMONT

Plants

Vertebrates

Invertebrates

📷 - dec.vermont.gov

AQUATIC INVASIVE SPECIES IN VERMONT

Plants

Vertebrates

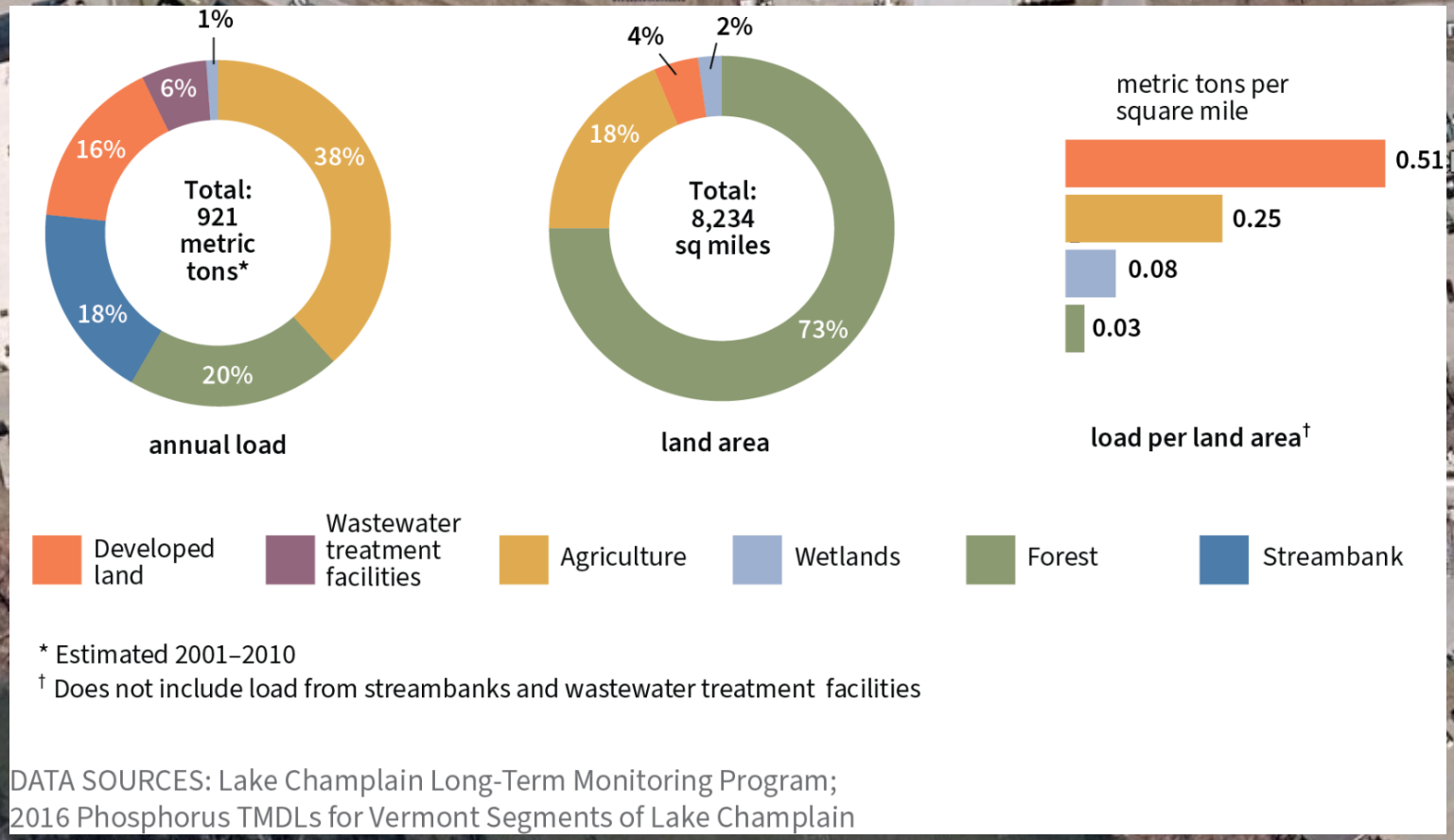
Invertebrates

📷 - dec.vermont.gov

WATER QUALITY BASICS AND MONITORING

- ~~Source Type~~ (Scratch that. You're basically doing this for your current issue.)
- Examples
- Monitoring
- Water Quality Classifications

- craftsbury.com



WATER QUALITY CONCERNS IN VT

- Nutrients
- Pathogens
- Anthropogenic Compounds
- Salinity/ Chlorides
- Thermal
- Sediment

📷 - maps.google.com

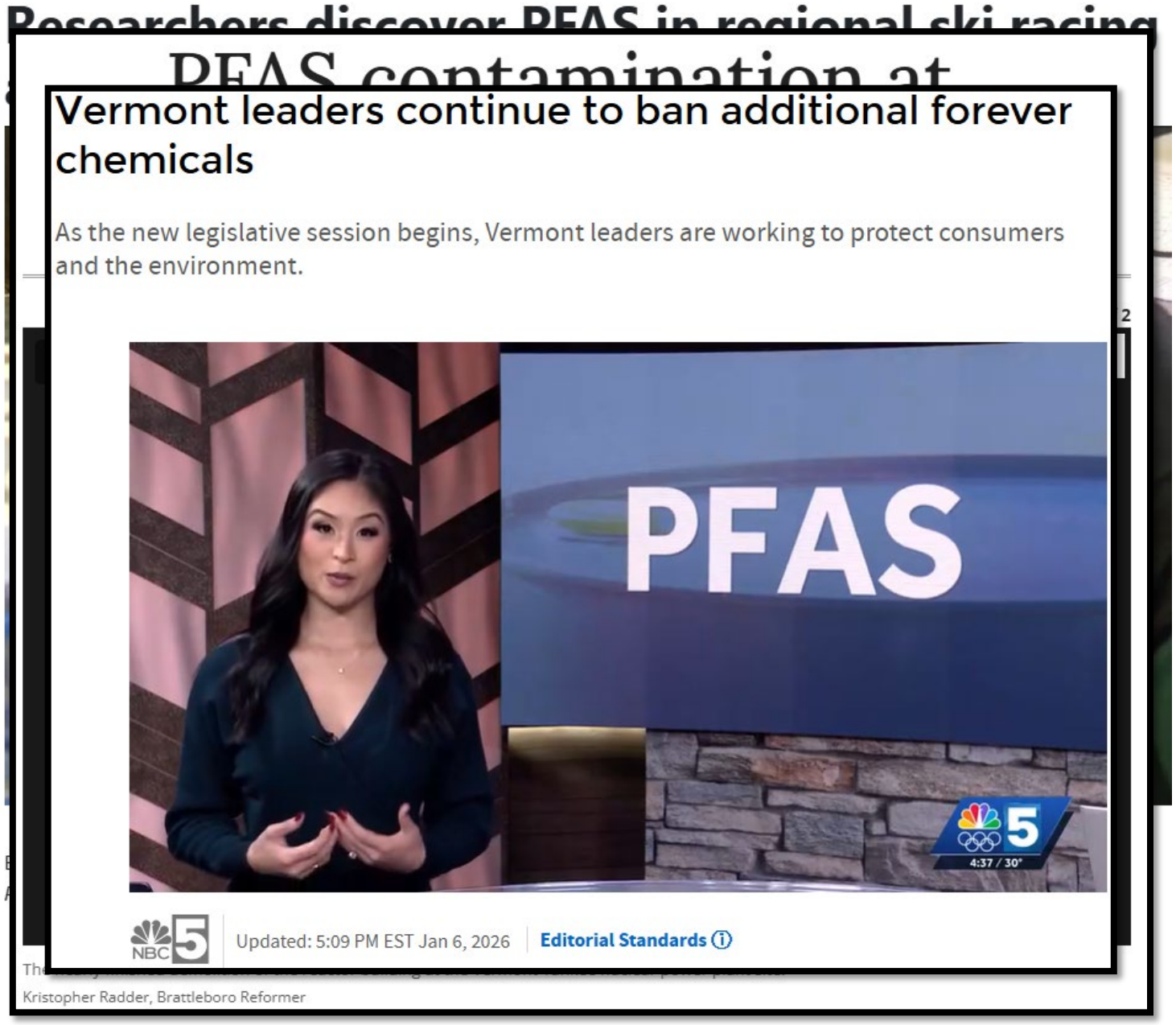
WATER QUALITY CONCERNS IN VT

- Nutrients
- Pathogens
- Anthropogenic Compounds
- Salinity/ Chlorides
- Thermal
- Sediment

📷 - maps.google.com

WATER QUALITY CONCERNS IN VT

- Nutrients
- Pathogens
- Anthropogenic Compounds
- Salinity/ Chlorides
- Thermal
- Sediment



WATER QUALITY CONCERNS IN VT

- Nutrients
- Pathogens
- Anthropogenic Compounds
- Salinity/ Chlorides
- Thermal
- Sediment

WATER QUALITY CONCERNS IN VT

- Nutrients
- Pathogens
- Anthropogenic Compounds
- Salinity/ Chlorides
- Thermal
- Sediment

📷 - maps.google.com

WATER QUALITY CONCERNS IN VT

- Nutrients
- Pathogens
- Anthropogenic Compounds
- Salinity/ Chlorides
- Thermal
- Sediment

📷 - vermontpublic.org

WATER QUALITY MONITORING

Chemical/ Physical

- Temperature 🌡️
- pH 🍋
- Turbidity 🌫️
- Chemical Concentrations 🧪
- Stage/ Discharge 🌊

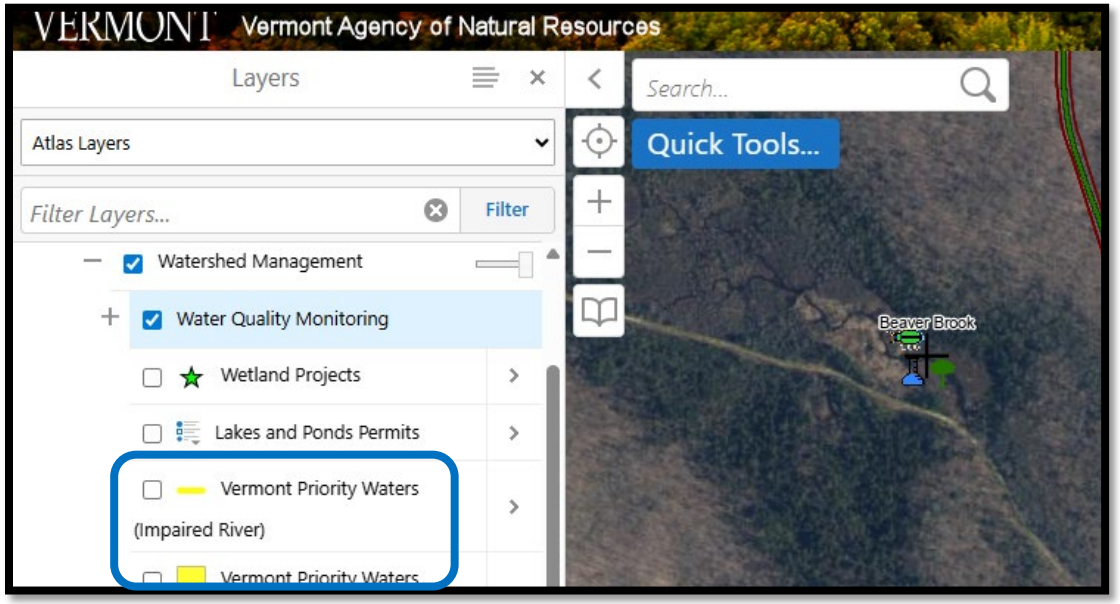
Biological

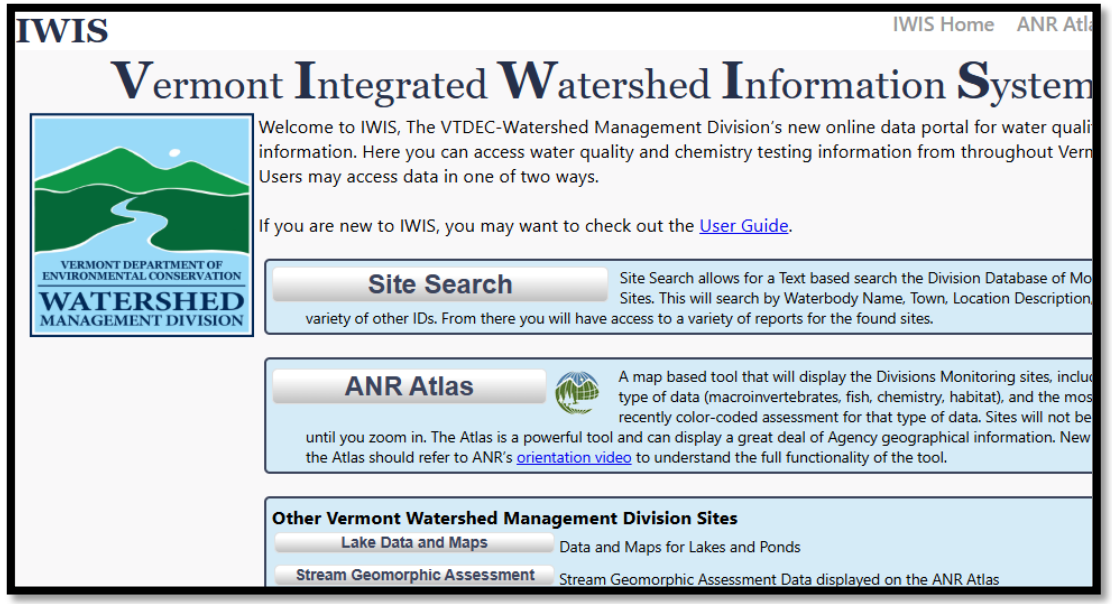
- Habitat 🏞️
- Fish Populations 🐟
- Macroinvertebrate Populations 🪳

How often do we need to measure to tell a complete story?

WHERE CAN YOU FIND WATER QUALITY DATA?

- VT ANR Atlas: https://anrmaps.vermont.gov/websites/anra5/
- Vermont Integrated Watershed Information System: https://anrweb.vt.gov/DEC/IWIS/





HOW DO WE PROTECT AQUATIC HABITAT?

Prevention

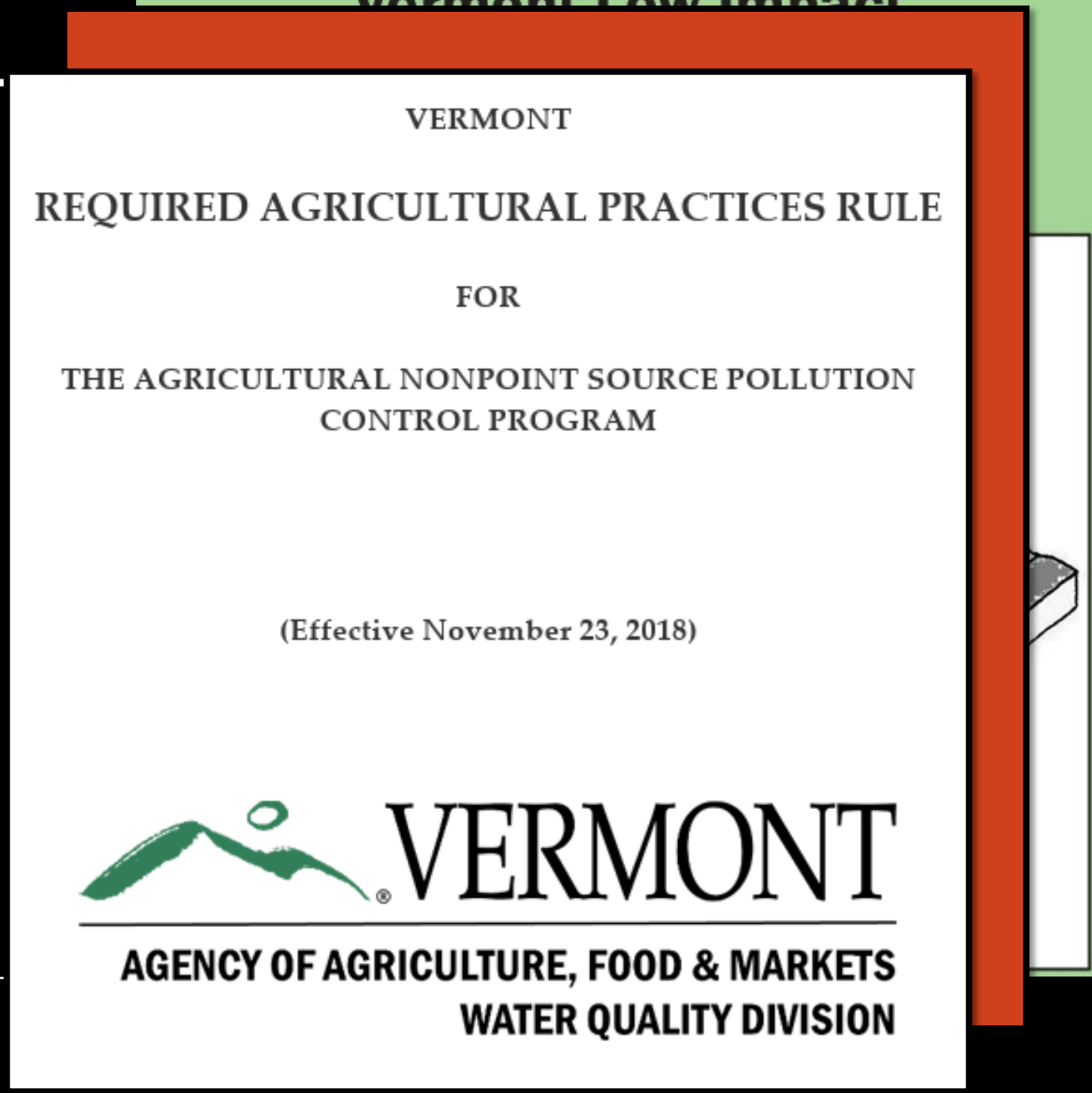
Vs.

Restoration

PREVENTION

System understanding and careful planning are key.

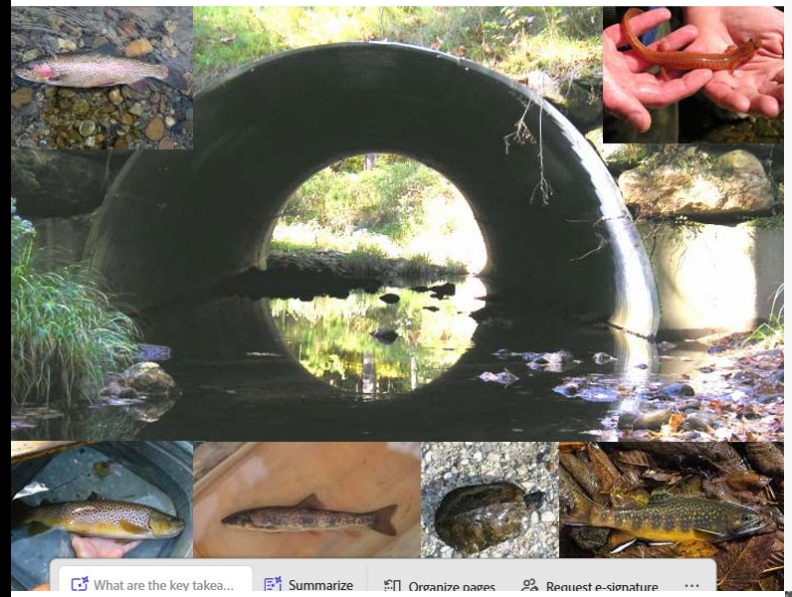
Luckily, smart people have done a lot of the work for us.



Putting best available science to work improving habitat, watershed function, and water quality.

RESTORATION

Guidelines for the Design of Stream/Road Crossings for Passage of Aquatic Organisms in Vermont



Watershed Planners

- Marie Caduto - Springfield
  Marie.Caduto@vermont.gov
  802-490-6142
- Angie Allen - Rutland
  Angie.Allen@vermont.gov
  802-490-9081
- Keith Fritschie - Montpelier
  Keith.Fritschie@vermont.gov
  802-490-6176
- Ben Copans - St. Johnsbury
  Ben.Copans@vermont.gov
  802-490-6143
- Karen Bates - Essex
  Karen.Bates@vermont.gov
  802-490-6144

What are the key takea... | Summarize | Organize pages | Request e-signature | ...

AGRICULTURE

Agriculture

- Conservation practices that reduce sources of pollution from farm production areas and farm fields.

DEVELOPED LANDS

Developed Lands--Stormwater

- Practices that reduce or treat polluted stormwater runoff from developed lands, such as parking lots, sidewalks, and rooftops.

ROADS

Developed Lands--Roads

- Stormwater and roadside erosion control practices that prevent erosion and treat road-related sources of pollution.

WASTEWATER

Wastewater

- Improvements to municipal wastewater infrastructure that decrease pollution from municipal wastewater systems through treatment upgrades, combined sewer overflow (CSO) abatement, and refurbishment of aging infrastructure.

NATURAL RESOURCES

Natural Resource Restoration

- Restoration of "natural infrastructure" functions that prevent and abate pollution. Natural infrastructure includes: floodplains, river channels, lakeshores, wetlands, and forest lands.

CLEAN WATER FUNDS PROJECT PLAN

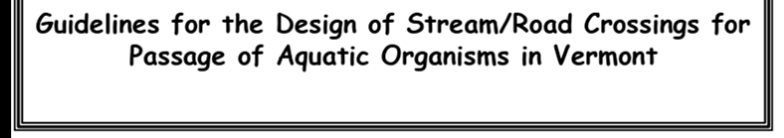
VERMONT

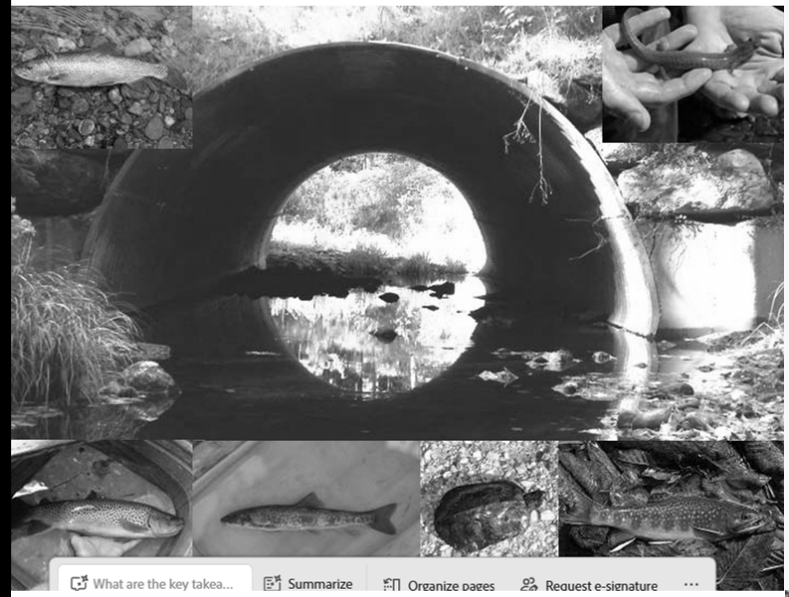
Deerfield River & Lower Connecticut River Tactical Basin Plan

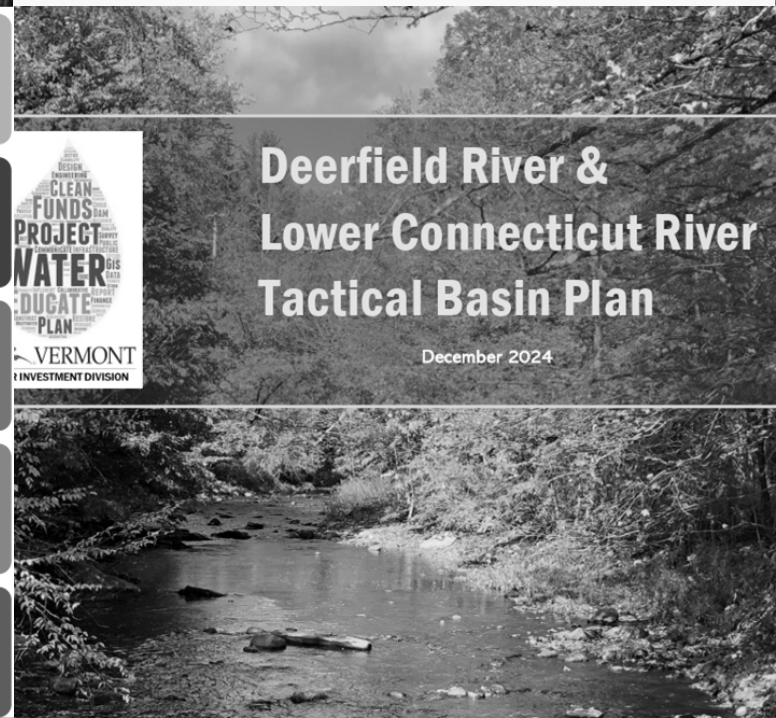
December 2024

Putting best available science to work improving habitat, watershed function, and water quality.

RESTORATION

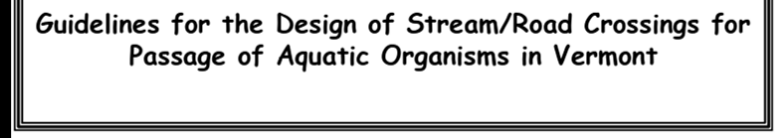


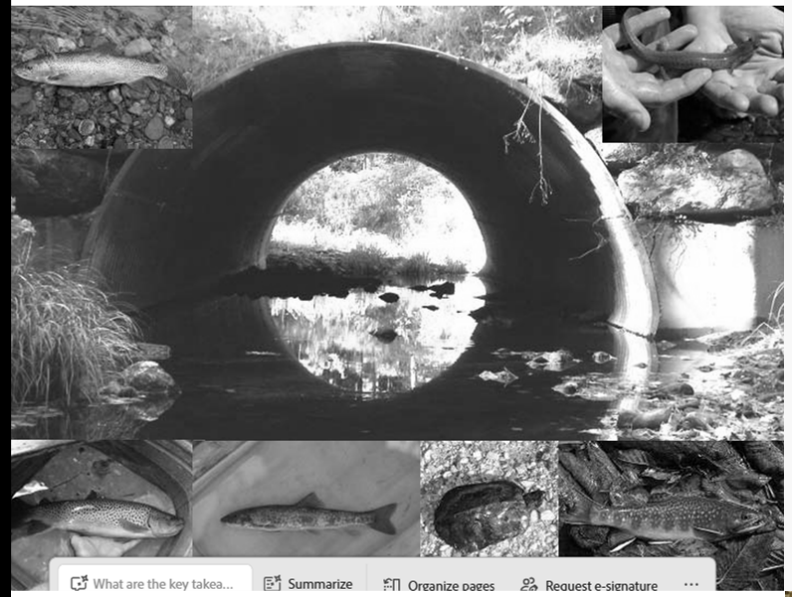


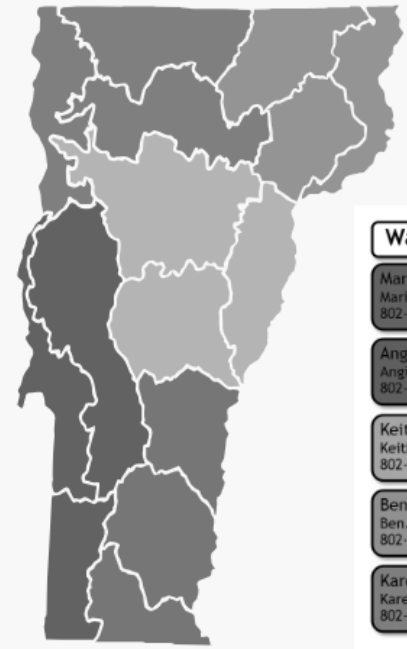


Putting best available science to work improving habitat, watershed function, and water quality.

RESTORATION

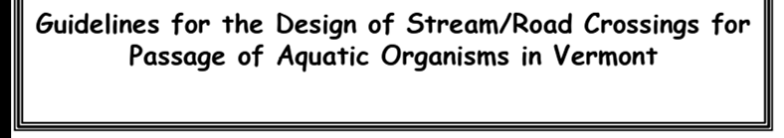


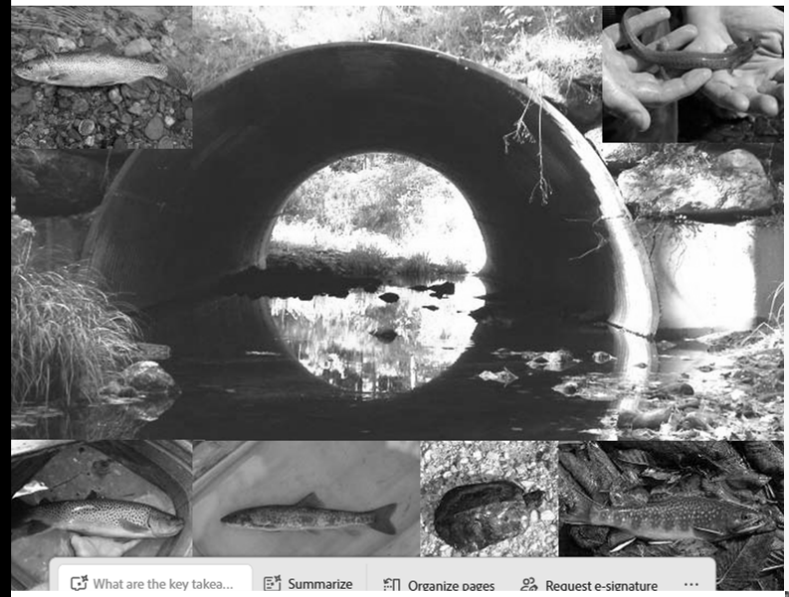


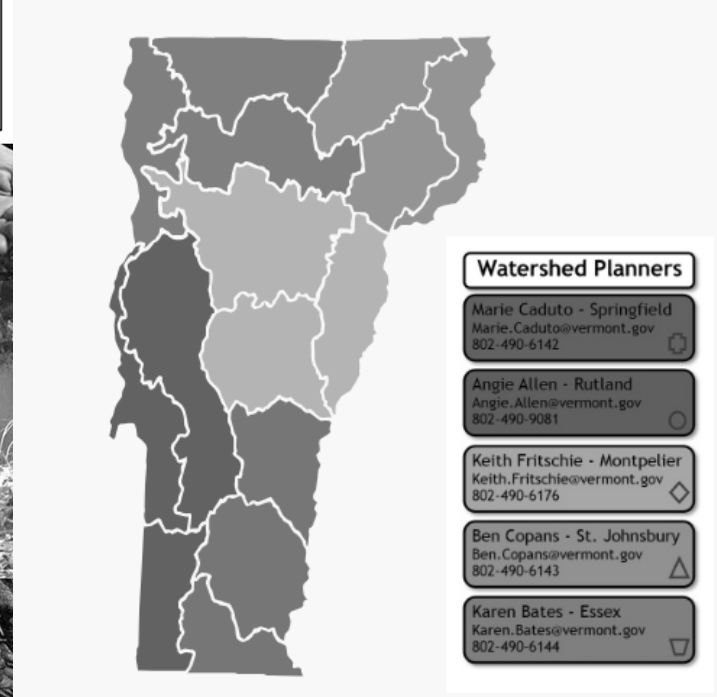


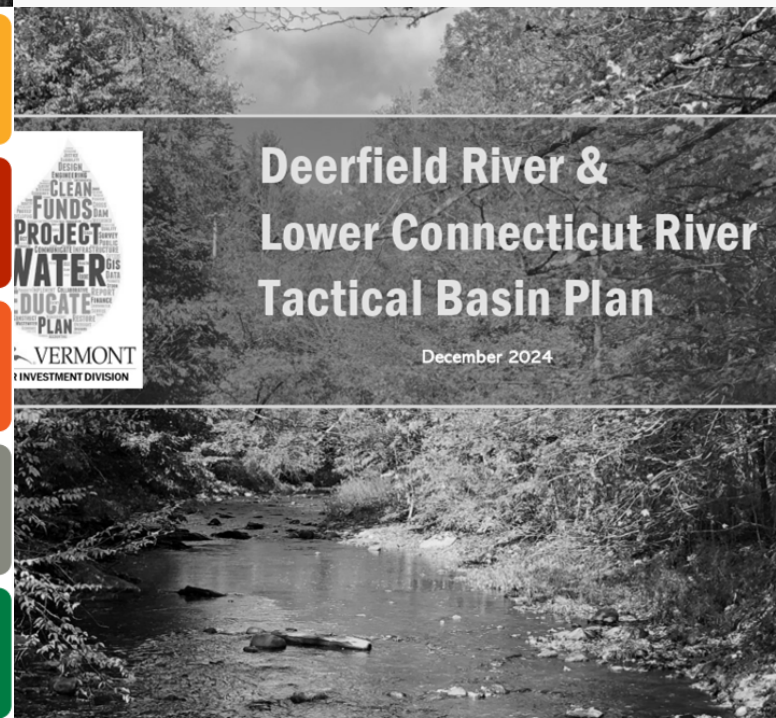
Putting best available science to work improving habitat, watershed function, and water quality.

RESTORATION









THANK YOU

John McCann
Watershed Program Manager
US Forest Service, Green Mountain
& Finger Lakes National Forests
john.mccann@usda.gov