Ecosystem Function: Cyanobacteria Solutions, A Missed Opportunity?

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Ecosystem Functions: Answers and Solutions

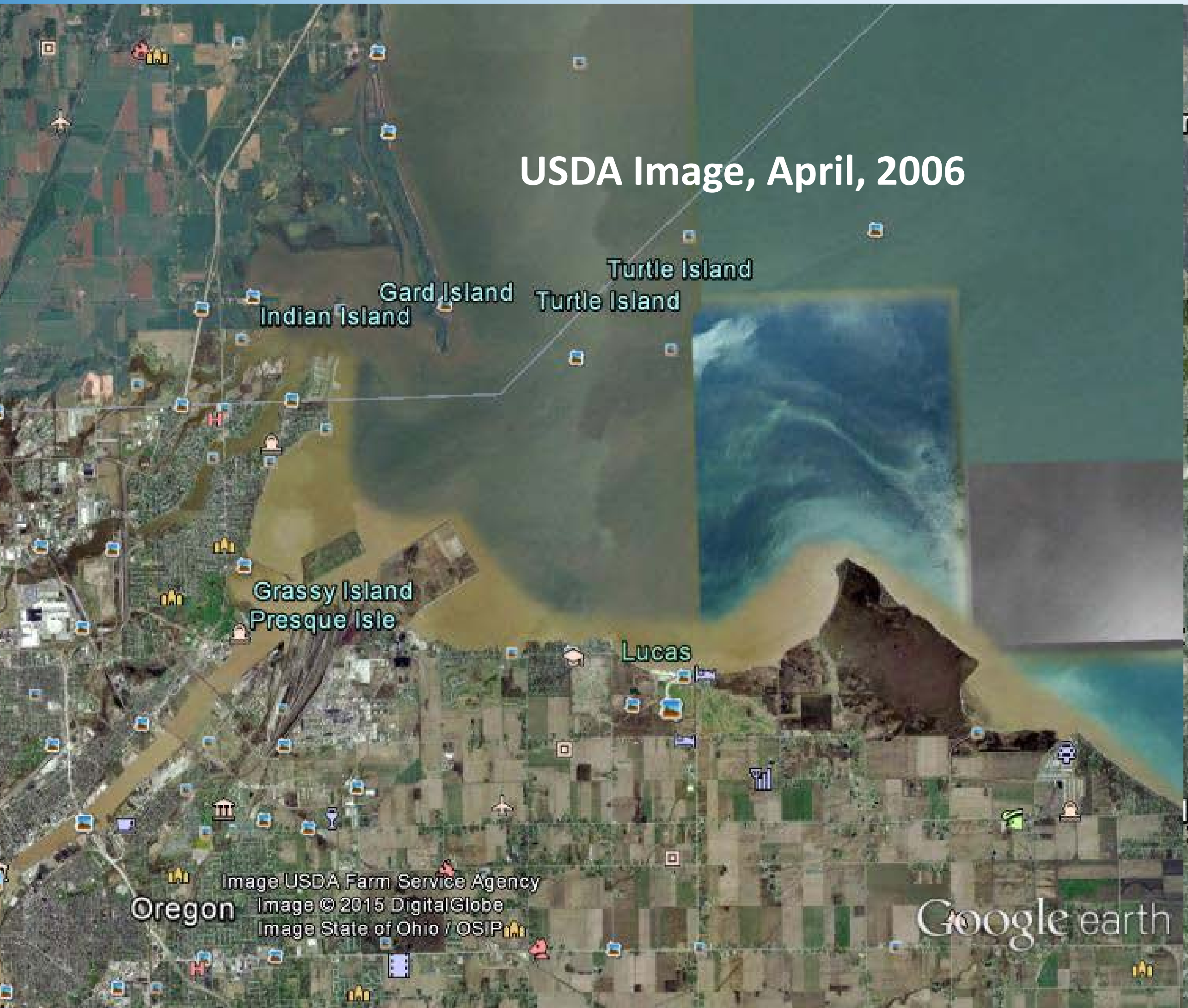
- The answer to all things environmental is “It Depends.”

- To find answers and define solutions, we need to know the problem

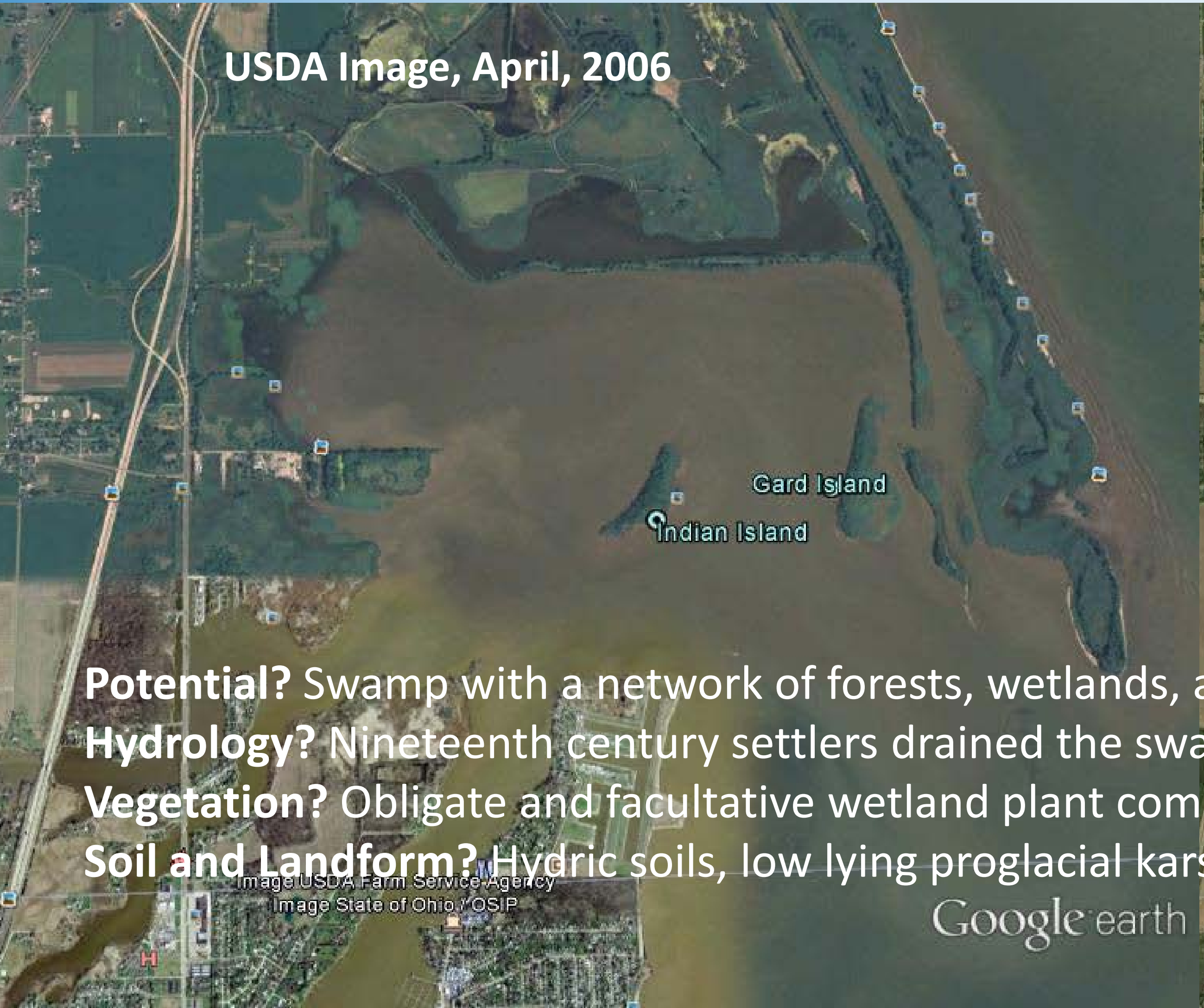
- **Solution** to **nonpoint source (NPS)** pollution is **<u>managing</u>** for **ecosystem function**.
  - Look for the cause, solve the problem not the symptom
  - Management for stream and wetland riparian functions
    - Need partners, the communities, within the watershed to solve the problem

- However, if the knee jerk reaction to a problem is using regulatory authority, than the solution will allude us (i.e., treating the symptom).
  - http://www.lakeeriewaterkeeper.org/wp-content/uploads/2012/04/lew-conf-lake-erie-hess.pdf

For example: Toledo, OH, and Lake Erie
What is the problem? Need to reduce sediment and nutrient loads to curb algal blooms (cyanobacteria)



What is the problem?
Answers and Solutions: Ecosystem Function



Potential? Swamp with a network of forests, wetlands, and grasslands
Hydrology? Nineteenth century settlers drained the swamp and converted to farmland
Vegetation? Obligate and facultative wetland plant communities (sedges, rushes, etc.)
Soil and Landform? Hydric soils, low lying proglacial karst topography

Introduction

- Drinking Water
- Ecosystem Function
- Cyanobacteria
- Case Studies
- Solutions
- Conclusion

Drinking Water

- What are we most worried about quality, quantity?
- How do we get Quality and Quantity?
- What are the sources – groundwater, surface water, treated?
- What makes New York City’s drinking water economical both in quality and quantity?

Answer can be summed up:

“Riparian functions keep water on the land longer, reduce flood and drought effects, improve water quality, enhance forage and habitats, and focus monitoring for management.” *Sherman Swanson, UNR*

Drinking Water

"Riparian functions keep water on the land longer (quantity), reduce flood and drought effects (sequesters nutrients and other pollutants, excess sediment – see Toledo, OH), improve water quality, enhance forage and habitats, and focus monitoring for management ('the' solution, which can also be written as 'focus of adaptive management')."

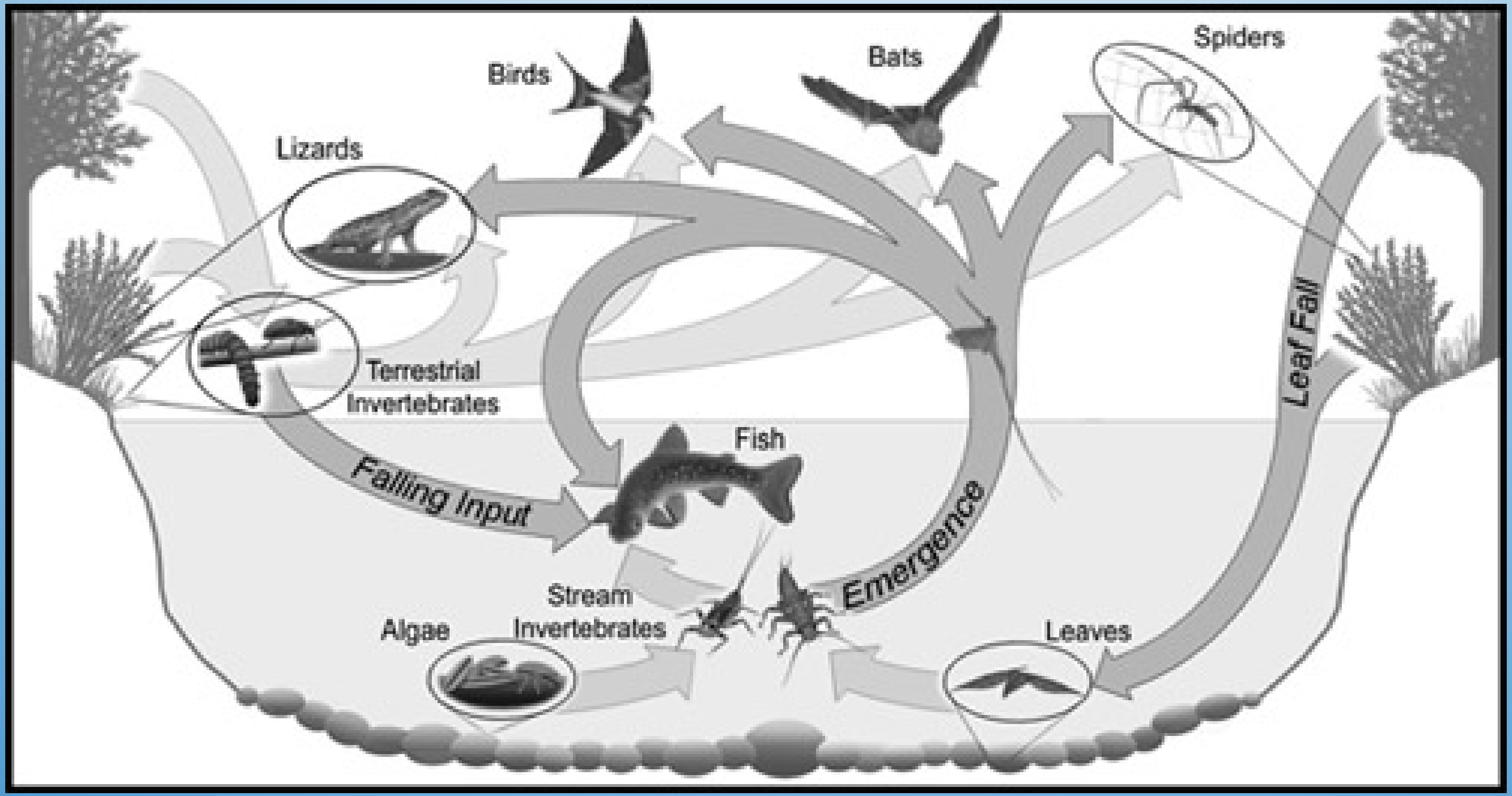
Sherman Swanson, UNR ← One smart dude

Ecosystem Function

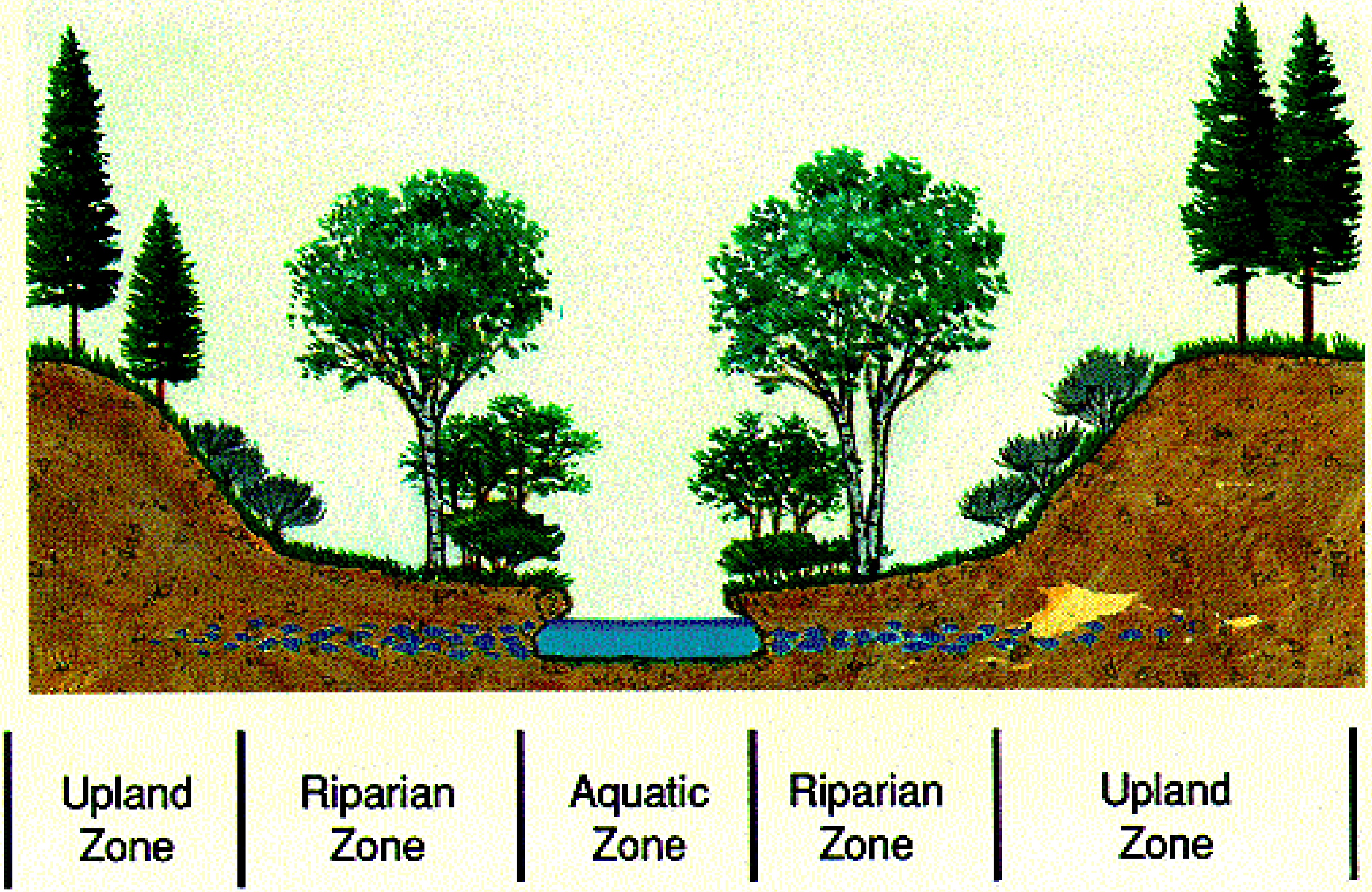
- Stream and wetland riparian function
- Proper Functioning Condition (PFC)
  - Potential
  - Indicators
    - Drivers of Ecosystem Function – Vegetation, hydrology, soil and landform
    - Response – sediment, nitrogen (N), phosphorus (P)

Stream and wetland riparian functions integrate the relationships between species, their habitats and fostering ecosystem resilience, which is critical to resilience – i.e., ensuring long-term sustainability.

These relationships are dependent on the drivers of ecological function – vegetation, hydrology, soil and landform



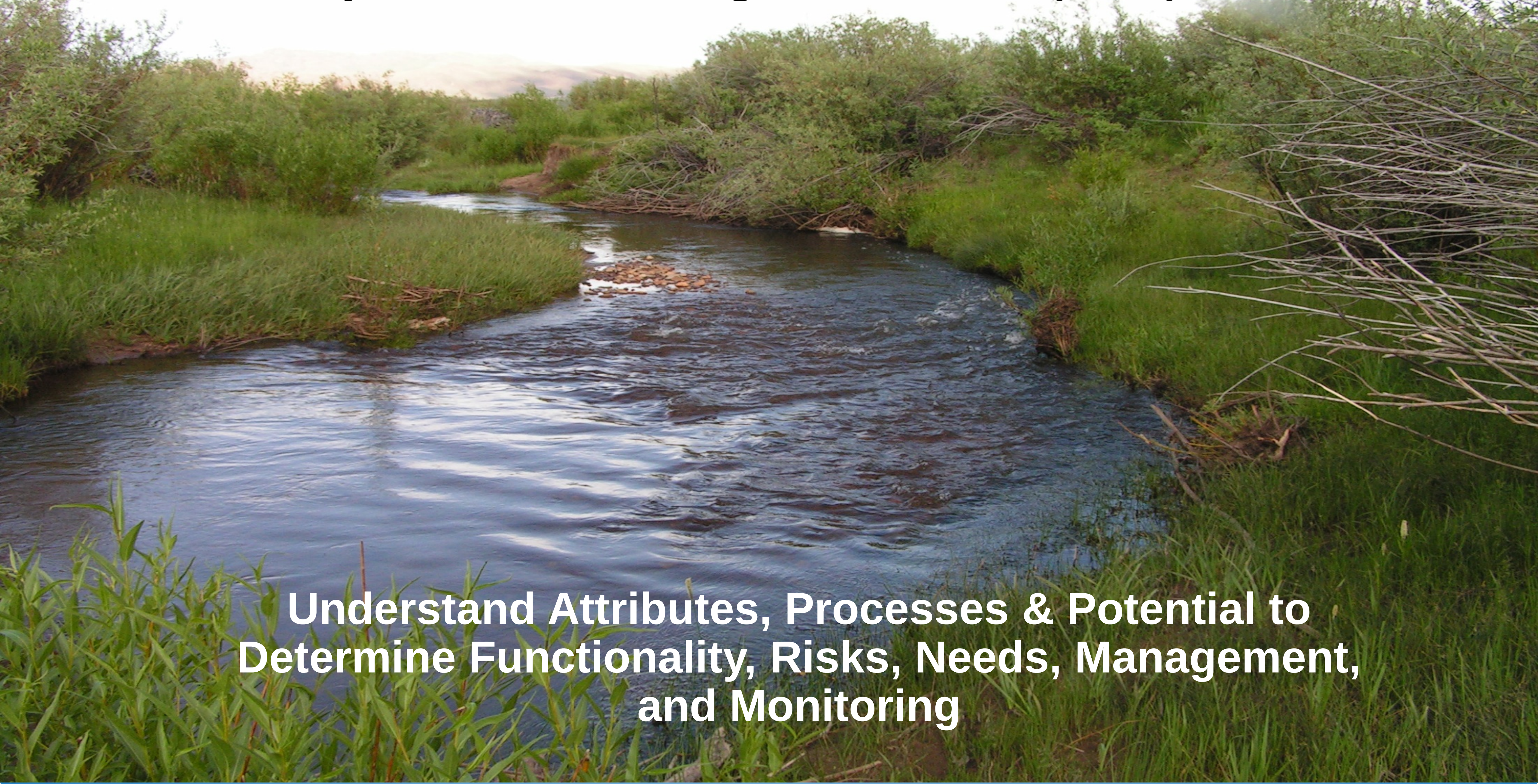
Stream food web from Nakano, et al., 1999.



What is a Riparian Area?

Riparian areas are the lush, well-vegetated areas immediately adjacent to streams, lakes, ponds and other bodies of water. Riparian vegetation requires the influence of surface or ground water.

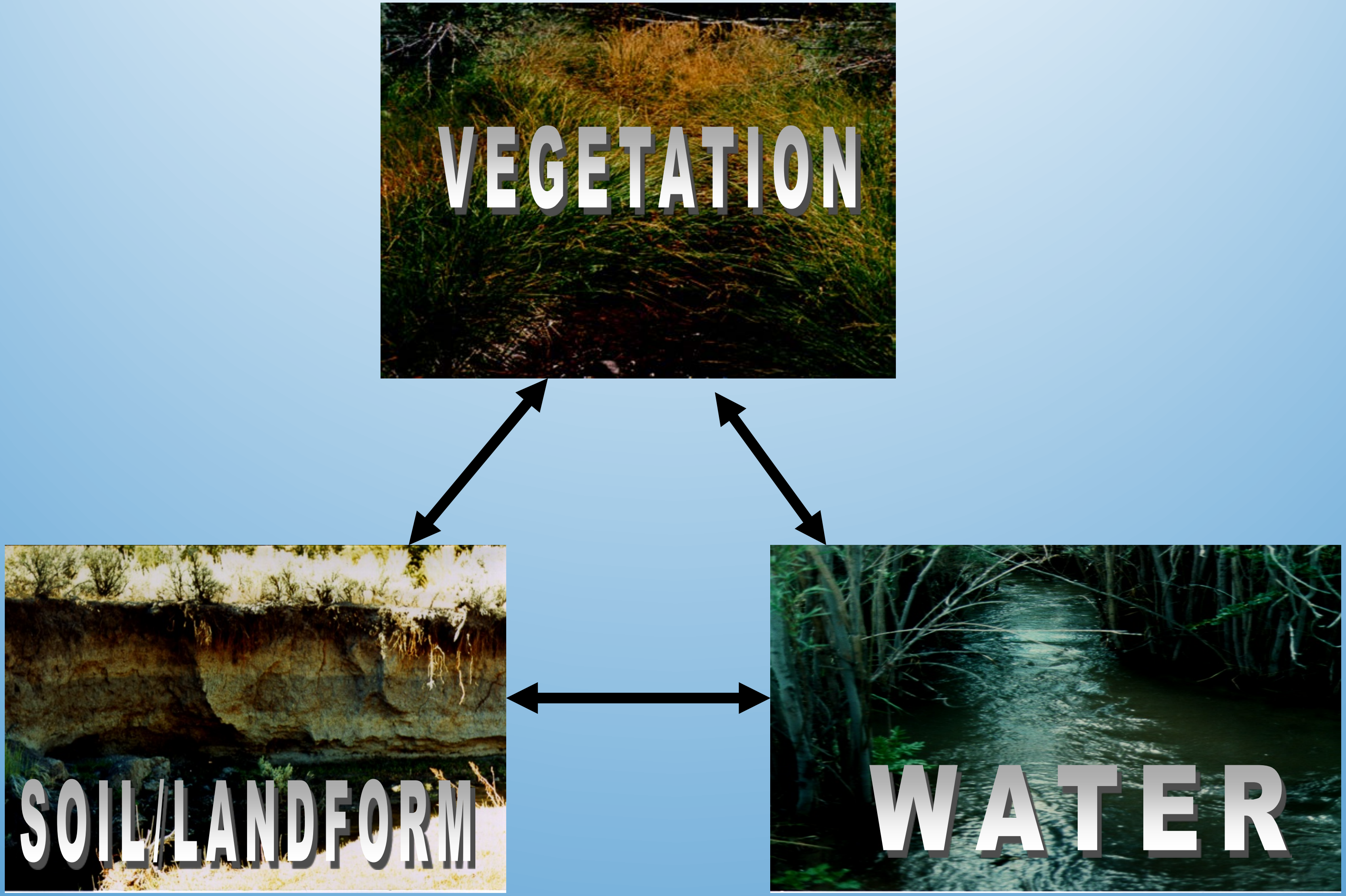
Proper Functioning Condition (PFC)



Potential

- **Highest ecological status a riparian area can attain given no political, social or economic constraints**

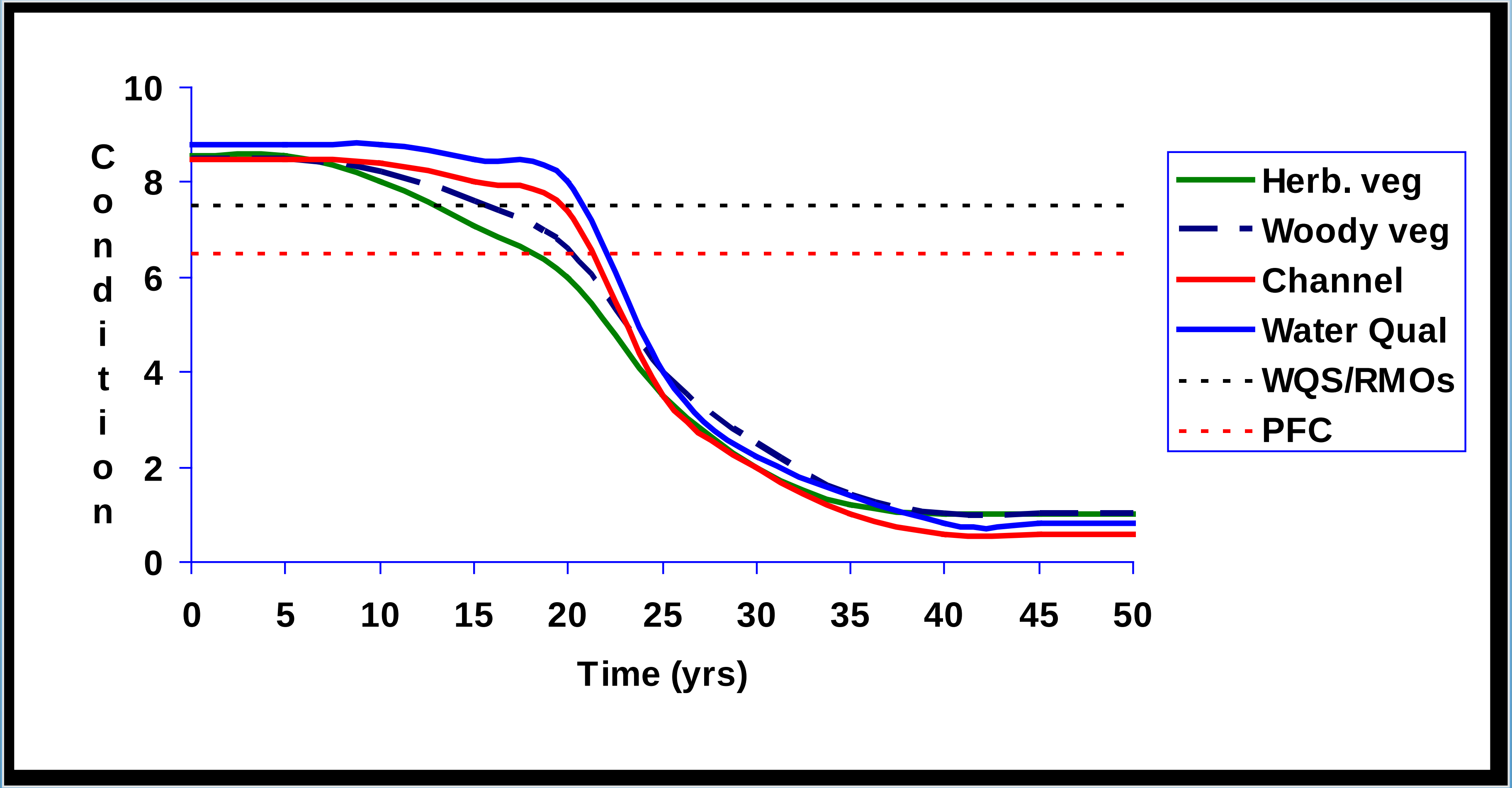
NATURAL RIPARIAN RESOURCES



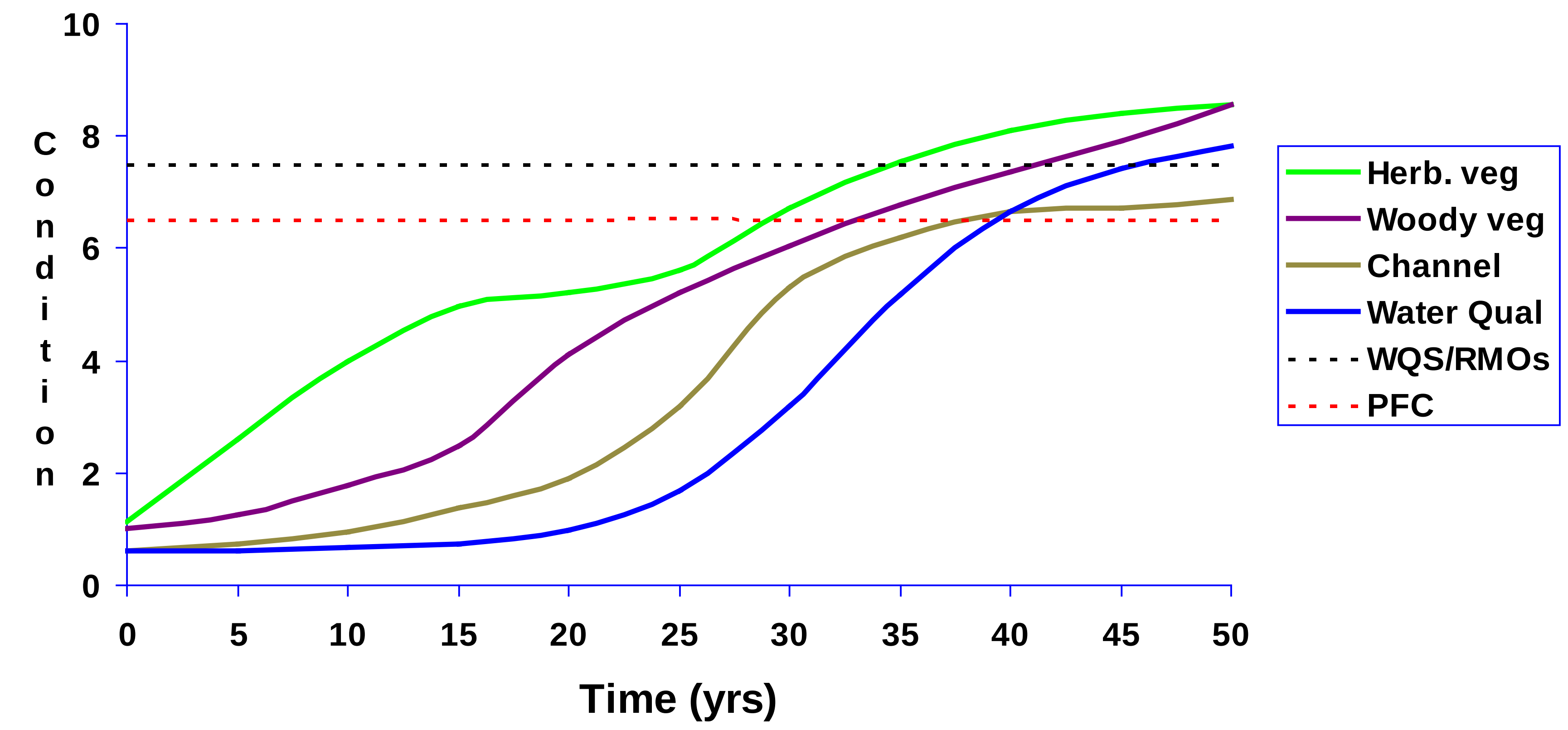
PROPER FUNCTIONING CONDITION – DEFINITION

- RIPARIAN-WETLAND areas are functioning properly when adequate vegetation, landform, or large woody debris is present to:
  - Dissipate **STREAM ENGERGY** associated with high flows
  - Filter **SEDIMENT** and **CAPTURE BED LOAD**
  - Aid **FLOODPLAIN DEVELOPMENT**
  - Improve **FLOOD WATER RETENTION** and **GROUNDWATER RECHARGE**
  - Stabilize **STREAMBANKS**

Degradation Rates



Recovery Rates



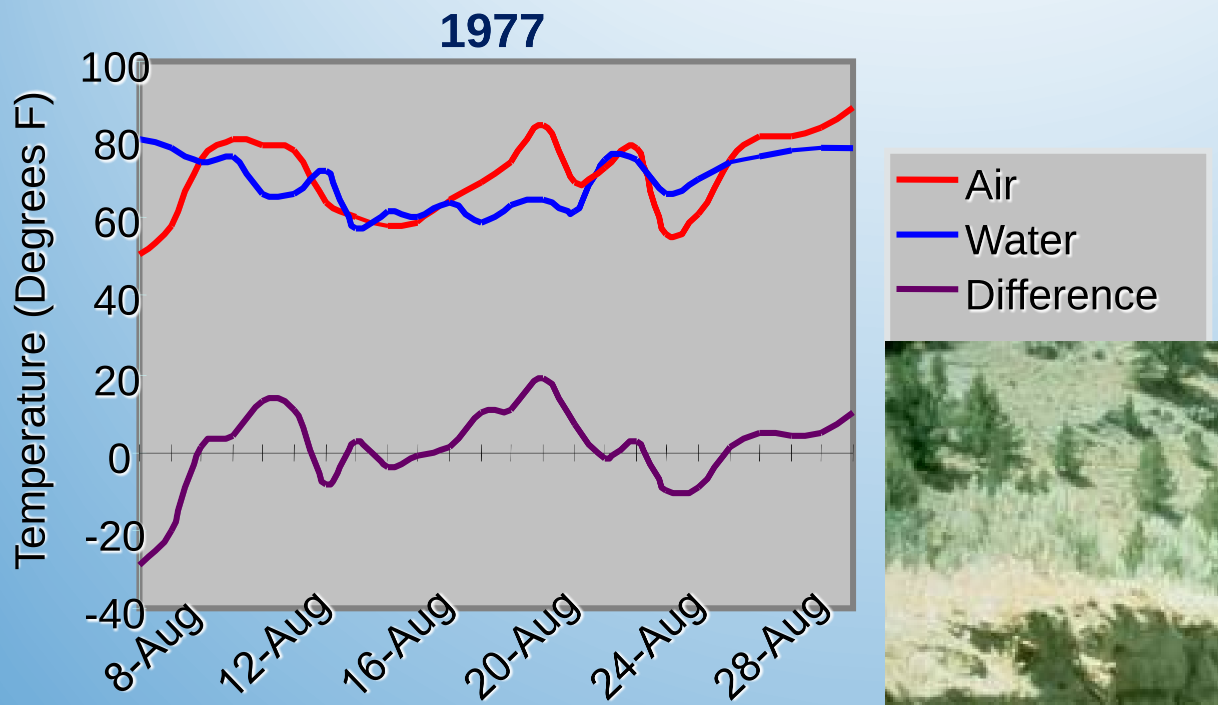
Bear Creek May 1977

19 years

Bear Creek Oct 1996

Creeks and Communities Team

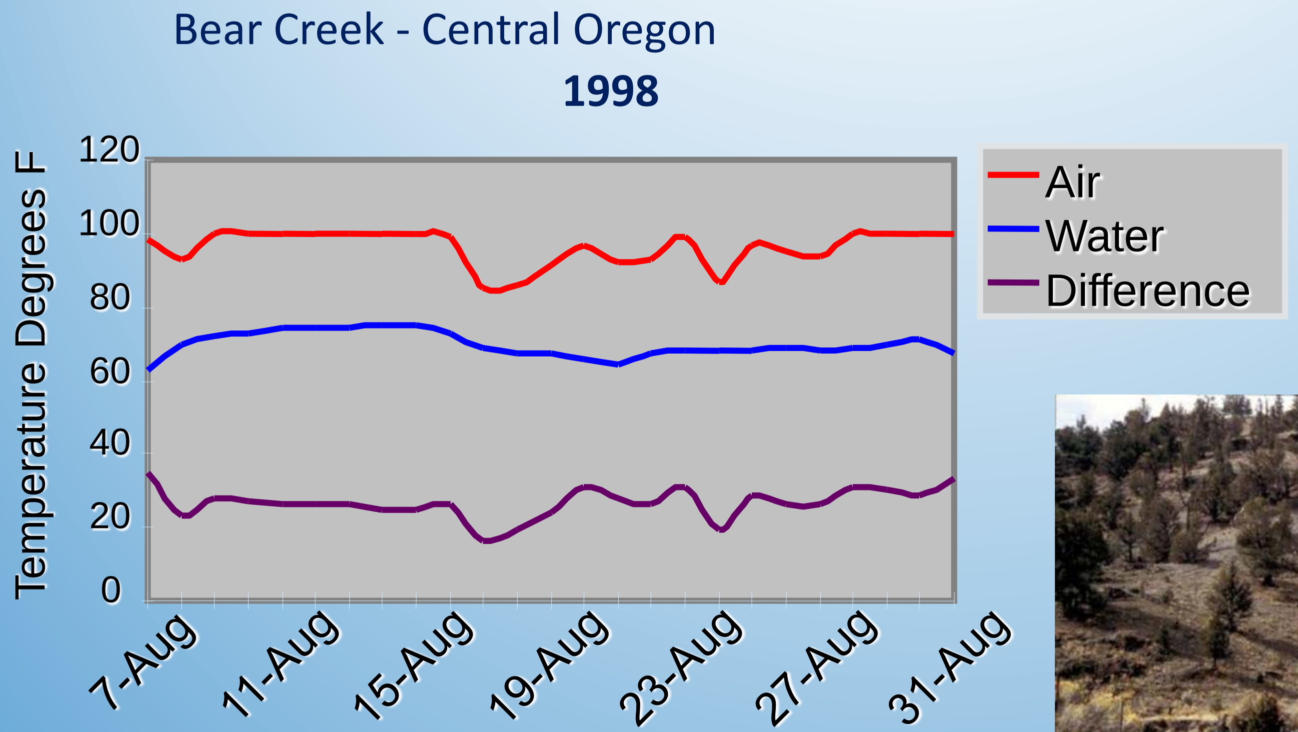
Difference in Air & Water Temperatures



Bear Creek - Central Oregon

1976

Difference in Air & Water Temperatures



Bear Creek (3.5 Miles)

	1978	1994
Riparian Area	3.8 acres	12 acres
Bank Erosion	12,448 feet	799 feet
Water Storage	500,000 gal/mi	2,096,000 gal/mi
Production	200 lbs/acre	2000 lbs/acre

Data from C. Rasmussen (1996) and W. Elmore

Cyanobacteria - Microcystin

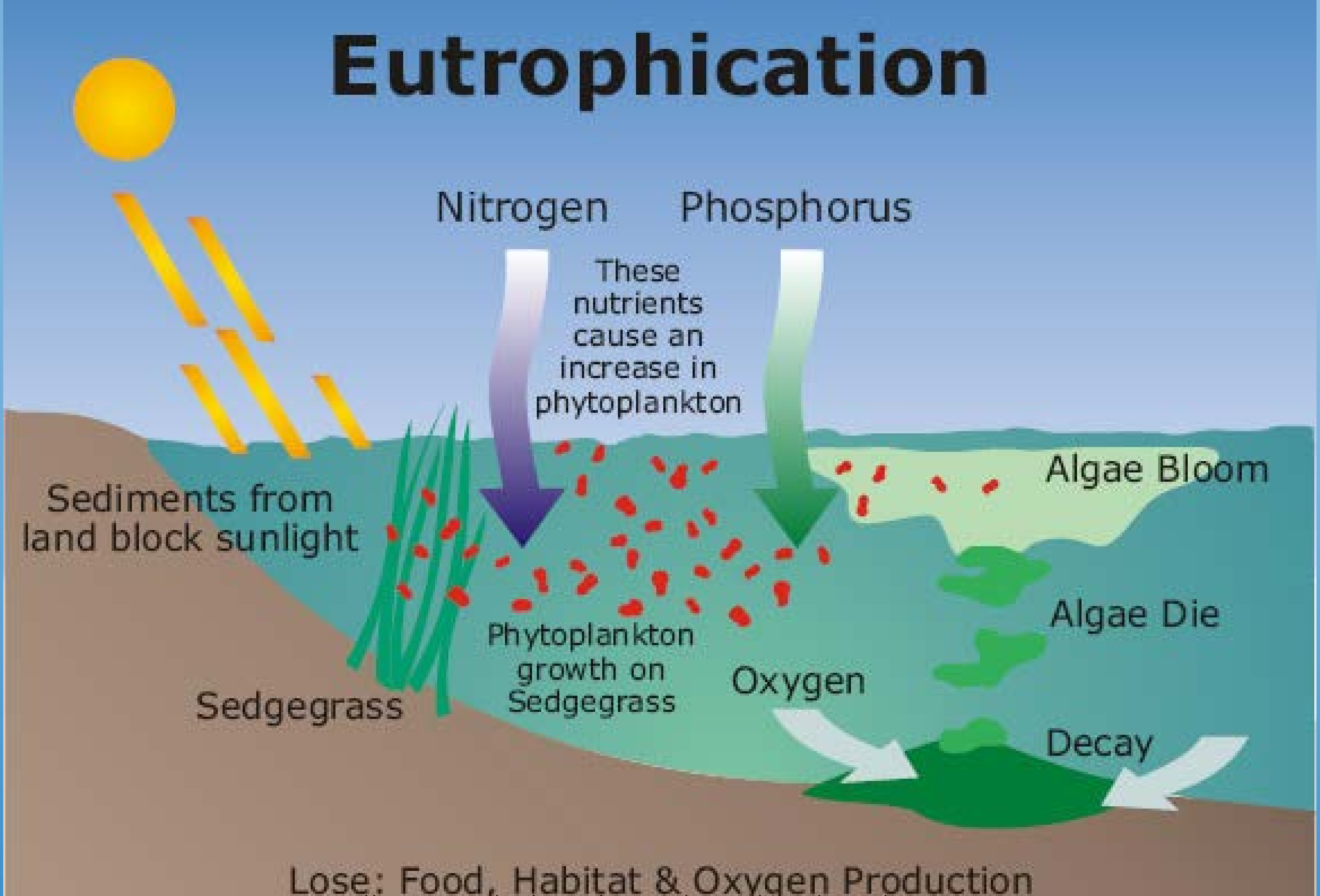
- Toxins are classified by how they affect the human:
  - Hepatotoxins affect the liver;
  - Neurotoxins affect the nervous system;
  - Dermal irritants, affect the skin.
- Dose Makes the Response – why no human deaths, but plenty of animal deaths.
- Microcystins are both hepatotoxins and dermal irritants

Dose Makes the Response

- USEPA Health Advisory for algal toxins – May 6, 2015
  - For children younger than school age, USEPA recommends drinking water values not to be exceed:
    - Micrcystin-LR – 1.6 ug/L
    - Cylindrospermopsin – 3.0 ug/L
  - For all ages, USEPA recommends drinking water values not to exceed:
    - Microcystin-LR – 0.3 ug/L
    - Cylindrospermopsin – 0.7 ug/L
- USEPA recommends:
  - Monitoring for algal blooms
  - Treating water as necessary
  - Establish advisories when concentration comes close to and/or exceed above values

Cyanobacteria: A Case Study

- Redfield Ratio atomic ratio of carbon, nitrogen and phosphorus (C:N:P = 106:16:1) found in phytoplankton
  - N:P in plankton tends to the N:P composition of seawater
  - If it’s in the water, it will be found in plant communities – primary producers
- Redfield Ratio is used to determine which nutrient is limiting for the formation of phytoplankton blooms/hypozia.
  - N:P ratio >17, P assumed limiting factor; N:P ratio <10, N assumed limiting factor; N:P ratio >10 and <17, either N or P is limiting
- Temperature
  - Blooms usually occur later in the summer
  - Pathogens - **Note: “If it’s in the water, stuff will happen.”**

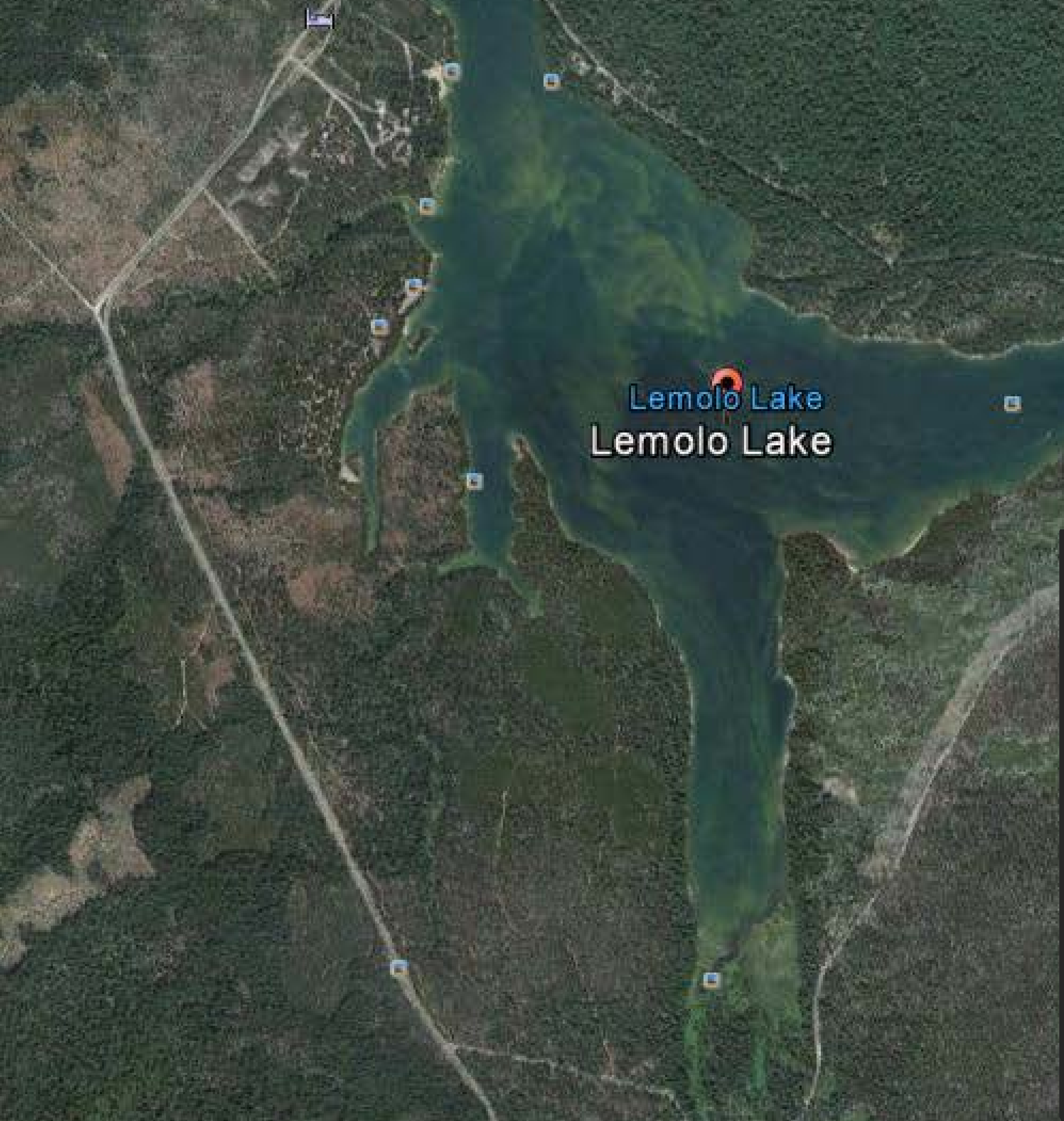


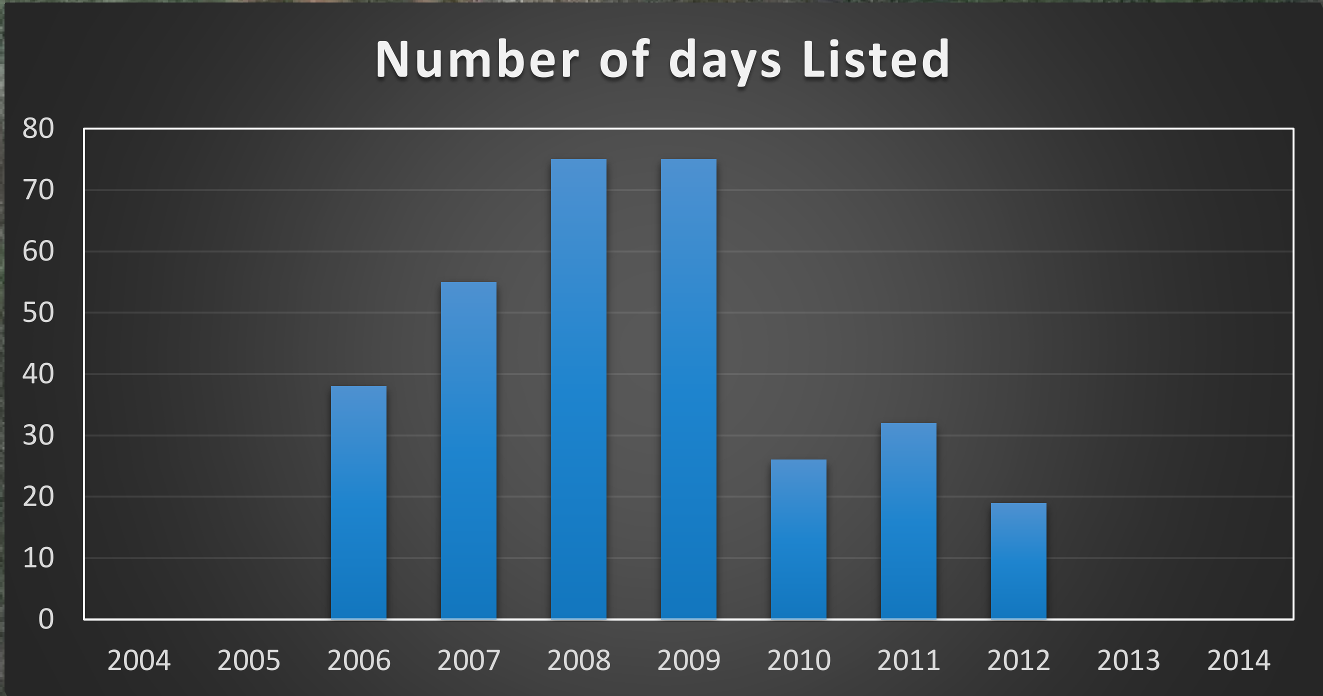
http://lincoln.ne.gov/city/pworks/watrshed/educate/fertiliz/images/eutroph.jpg


Lemolo Lake
USDA Image – July 6, 2014
Case Study 1.
Diamond and Lemolo lakes
Diamond Lake
Mount Bailey
Diamond Lake
Mount Thielsen
Image USDA Farm Service Agency
Google earth

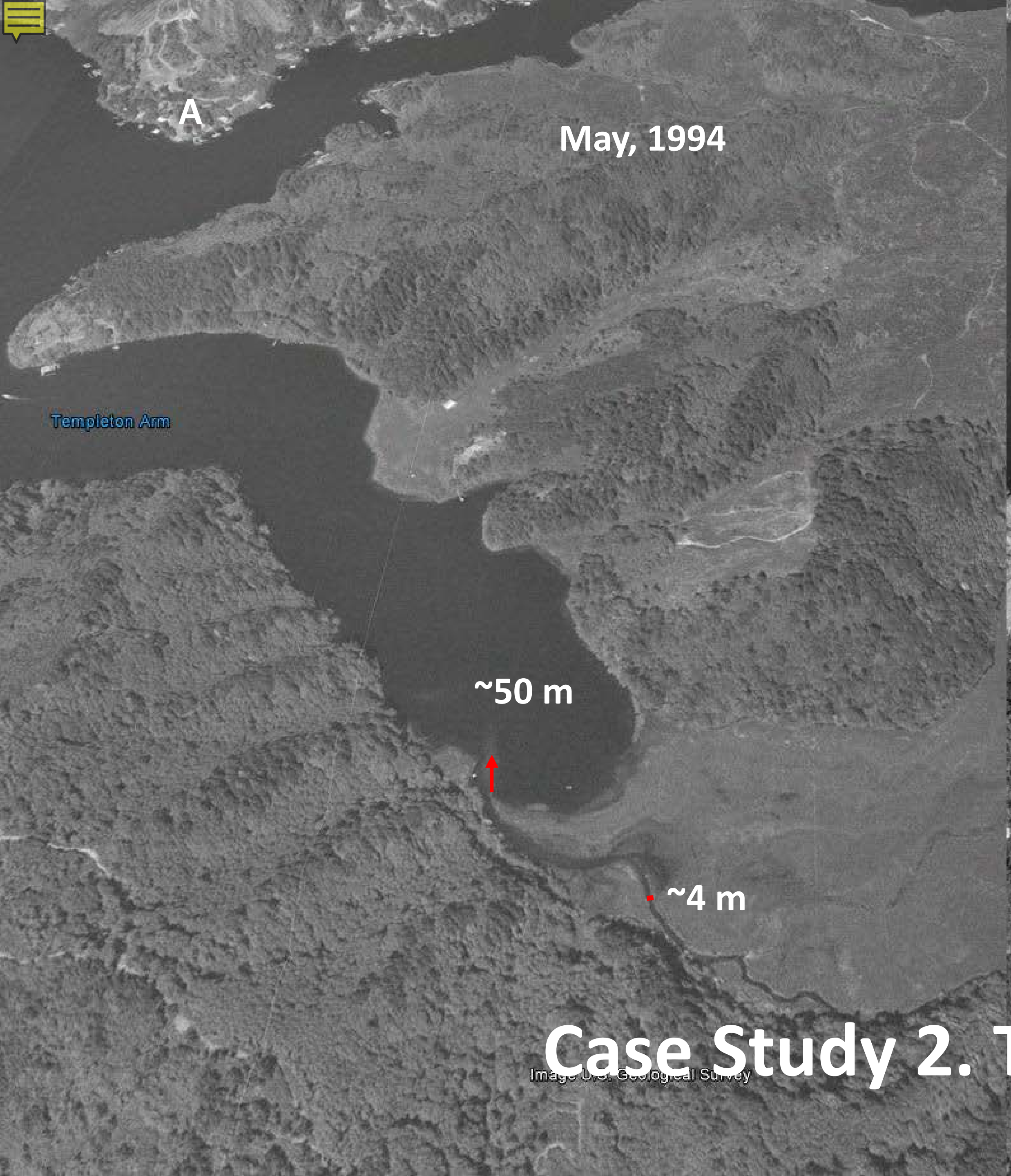
Case Study 1. Diamond and Lemolo lakes

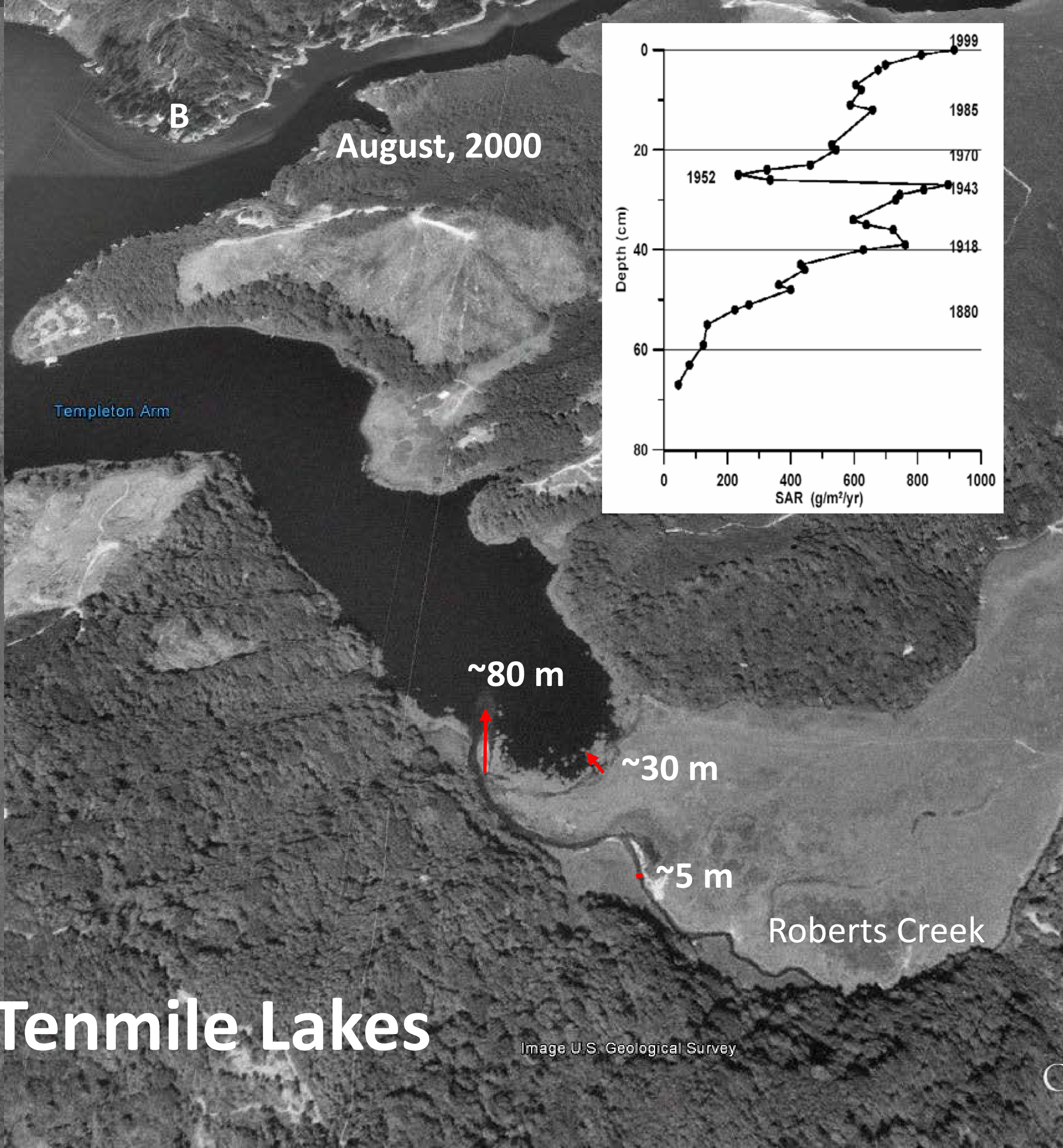
USDA Image, August 11, 2012





Case Study 2. Tenmile Lakes





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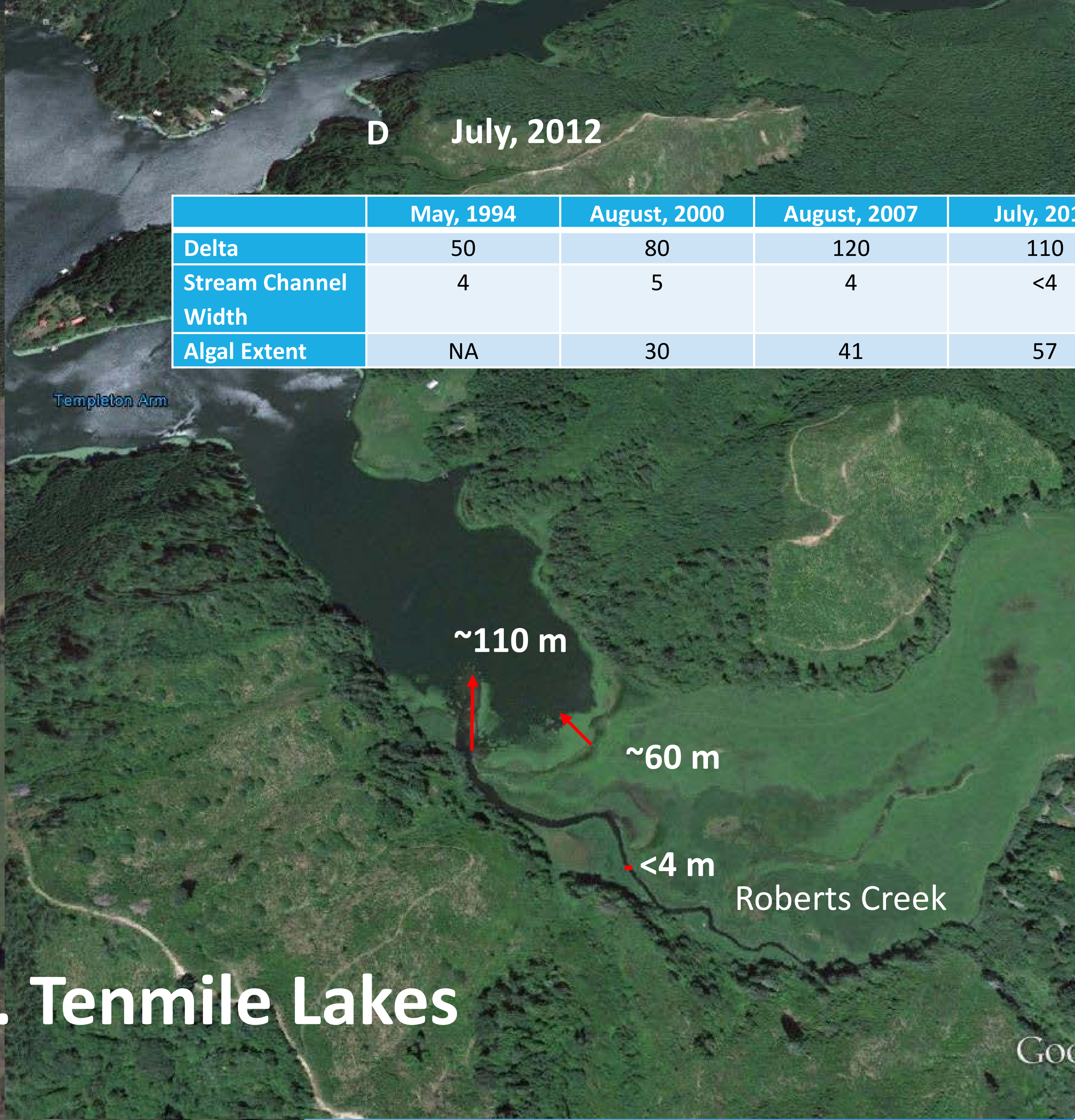
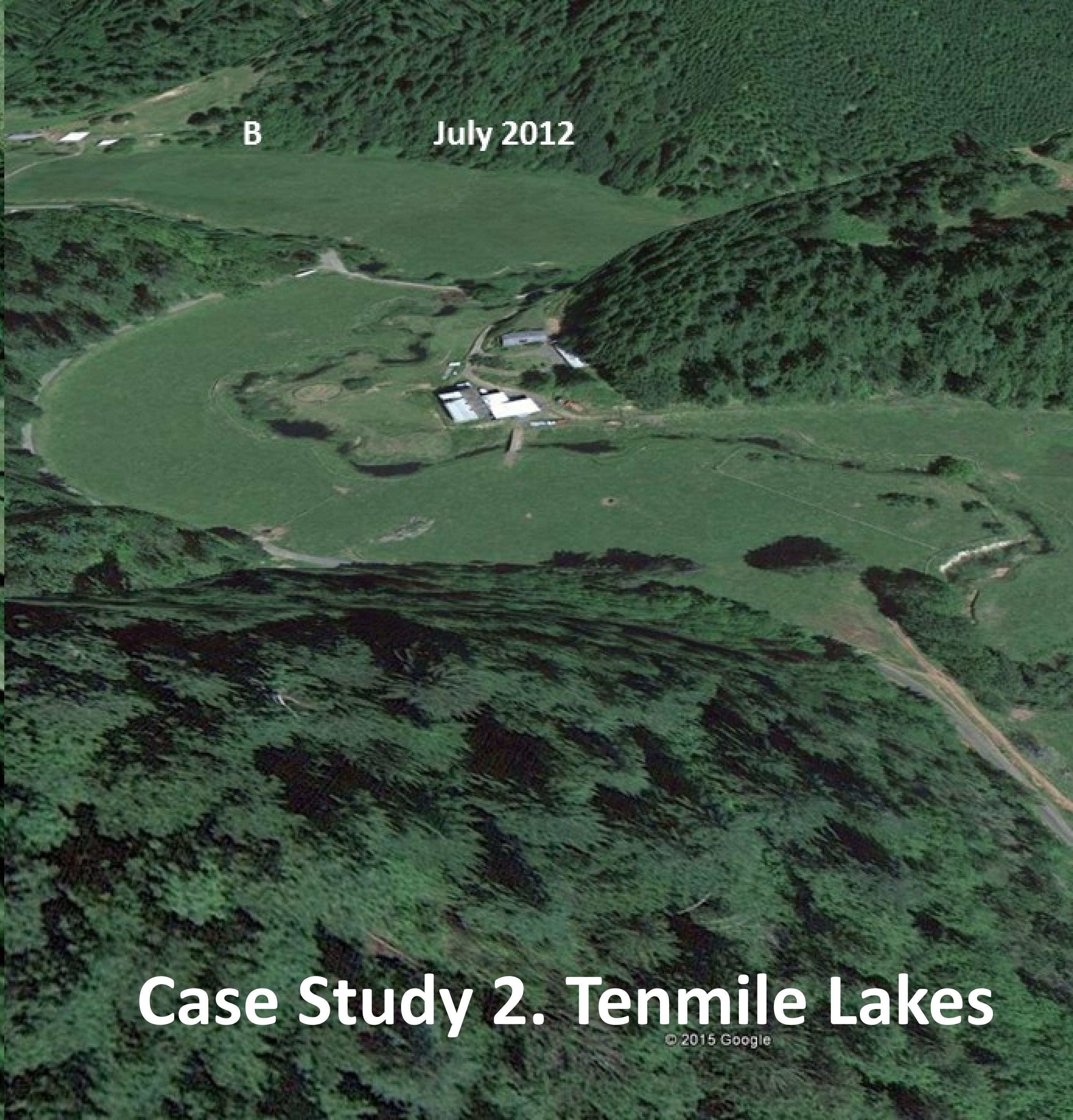
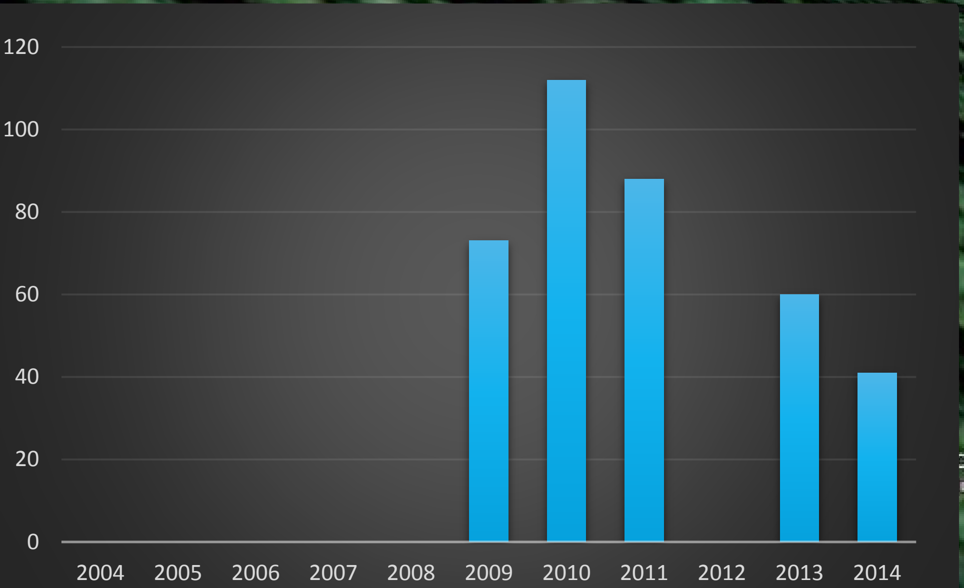


	May, 1994	August, 2000	August, 2007	July, 201
Delta	50	80	120	110
Stream Channel Width	4	5	4	<4
Algal Extent	NA	30	41	57





Case Study 2. Tenmile Lakes

Solutions: Immediate – Management Response

<u>Environmental Risk - Break the pathway</u>

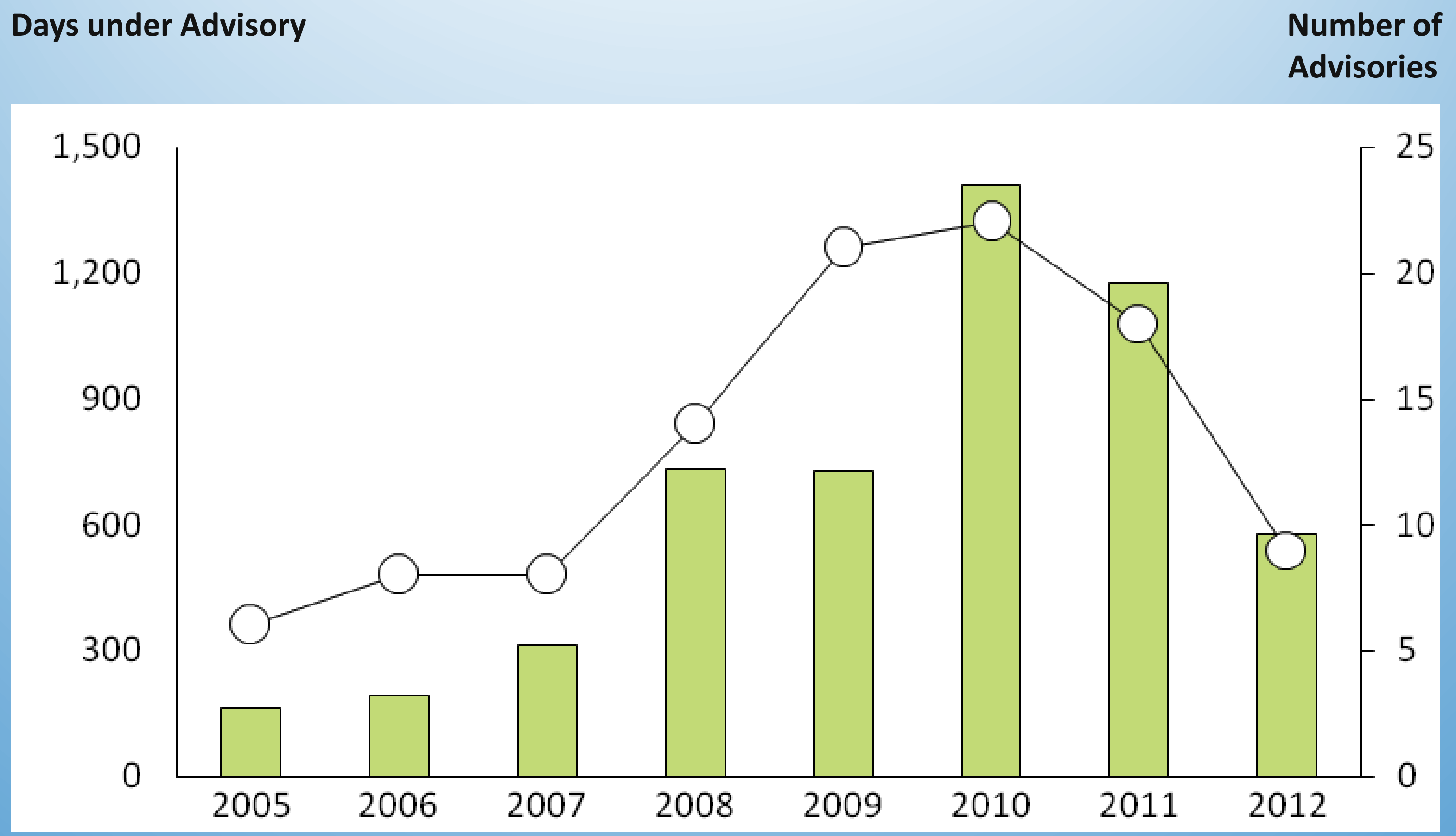
- Cyanobacteria Microcystin, Toledo, Ohio
  - Provide water

- Uranium, Yerington, Nevada, Anaconda Mine,
  - Provide water

- However, this is unsustainable

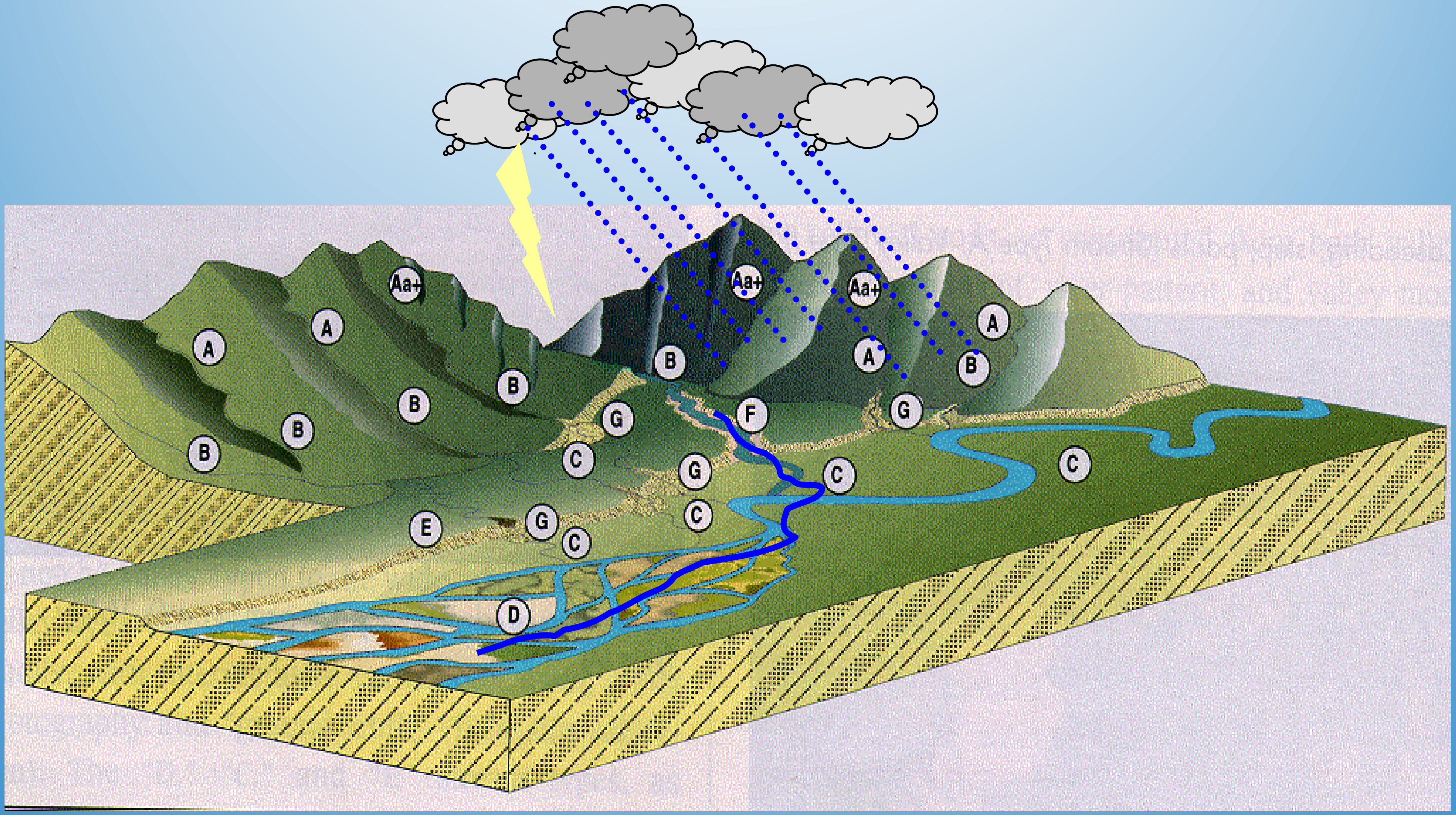
Short Term – Management Response

State of Oregon DEQ Number of HAB Advisories and Days Under Advisory By Year



This is unsustainable as well. Why? Response (lagging) indicators. What do we need? Drivers of physical processes.

Long-Term Management - Watersheds that capture, store & safely release water



Cooperative riparian Stewardship
Creeks and Communities Team

Long Term Management

- Potential is based upon a concept of dynamic equilibrium within an ecosystem corresponding to measures of the physical setting
  - i.e., vegetation, hydrology, soil and landform

- Lakes, reservoirs, rivers and wetlands are complex ecosystems.
  - For example - Lemolo Lake and Diamond Lake, Oregon

- Risk to an ecosystem is contingent on the ability of that ecological system to achieve its functional state, or proper functioning condition, given that it has an anthropogenic use.
  - For example – Toledo River, Ohio

- Nature is not static but adjusts and adapts to climatic and anthropogenic stresses
  - For example - Tenmile Lakes, Oregon

- A functional and resilient ecosystem is sustainable.

COOPERATIVE riparian STEWARDSHIP
Creeks and Communities Team

Conclusions

- **Solutions**
  1. Think Management
     - Manage the ecosystem for functions
     - A proper functioning condition watershed will provide resilience and sustainable goods and services
  2. Think Long-term Management
     - Solve the problem before it becomes a problem
- **Indicators**
  - Drivers of Ecosystem Function – leading indicators
    - Vegetation, hydrology, soil and landform
  - Response indicators (e.g., water quality) are lagging
    - may not respond in time to make a decision
- **Proper functioning condition (PFC)**
  - A way of brining communities together
  - Integrating science in collaborative decision making