



UNIVERSITY OF MINNESOTA EXTENSION

MAKING A DIFFERENCE IN MINNESOTA: ENVIRONMENT + FOOD & AGRICULTURE + COMMUNITIES + FAMILIES + YOUTH



Coolwater Fish Habitat in a Changing Climate

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Water Resource Team; MN Extension

4100 220th St. W., Ste. 100 | Farmington, MN 55024

**Lakeside Ballroom A | April 12-14, 2018
Breezy Point Resort in Breezy Point, MN**

What is the UoM Extension Water Resources Team?

<http://www.extension.umn.edu/environment/water>



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AGRICULTURE COMMUNITY ENVIRONMENT FAMILY FOOD GARDEN YOUTH ABOUT

Water Resources

[Extension](#) > [Environment](#) > [Water](#)



Conservation

Learn about ways to preserve and conserve water resources in Minnesota.



Education for professionals

Training and certification for water management professionals, educators and city and rural leaders.

- [Non-point Education for Municipal Officials \(NEMO\)](#)
- [Onsite sewage treatment](#)
- [Stormwater education](#)
- [Watershed education](#)



Agriculture

Topics for farmers and other ag professionals on water and the environment.

- [Ag drainage and water management](#)
- [Agricultural irrigation](#)
- [Climate and weather](#)
- [Nutrient management](#)
- [Manure management](#)



Features

- [Guardians of the waterways](#) Legacy: Summer 2017
- [Zebra Mussels and You: Spread, Impacts, and Prevention](#)
- [To Keep People from Going Thirsty](#)
- [To Chase Chemicals Down Unexpected Paths](#)

Course Calendar

Today

Wednesday, May 2	
1:00pm	Watershed Game min
Thursday, May 3	
8:00am	Watershed Game Tra
9:00am	"The Revolution of Str
Monday, May 14	
8:00am	WSG Train-the-Trainee
8:00am	Watershed Game Tra
Wednesday, May 16	
8:00am	Watershed Game Tra
8:00am	WSG Train-the-Trainee

Showing events until 6/15



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Who are the UoM Extension Water Resources Team members?

<http://www.extension.umn.edu/environment/water>

Water Resources

- Water Resources
- Conservation
- Recreation
- Property owners
- Education for professionals
- Agriculture
- Calendar of events
- Program team**


Search Water Resources:

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Program Team



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Water Resources Center

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- Our Work
- Training

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Program lead



Acknowledgement:

- ❖ Missaghi, Shahram, Miki **Hondzo**, and William **Herb**. "Prediction of lake water temperature, dissolved oxygen, and fish habitat under changing climate." *Climatic Change* 141.4 (2017): 747-757.
- ❖ **Our Extension: Applied Lake Management & Stormwater Series**
Making the connection from rain, stormwater, streams, and wetlands to lakes
Workshop:
Fundamentals of Lake Processes - Nutrient (Phosphorus) Impairment
February 22, 2018 | Farmington



Today's Agenda - 1st: Your expectations

Introductions

--Name

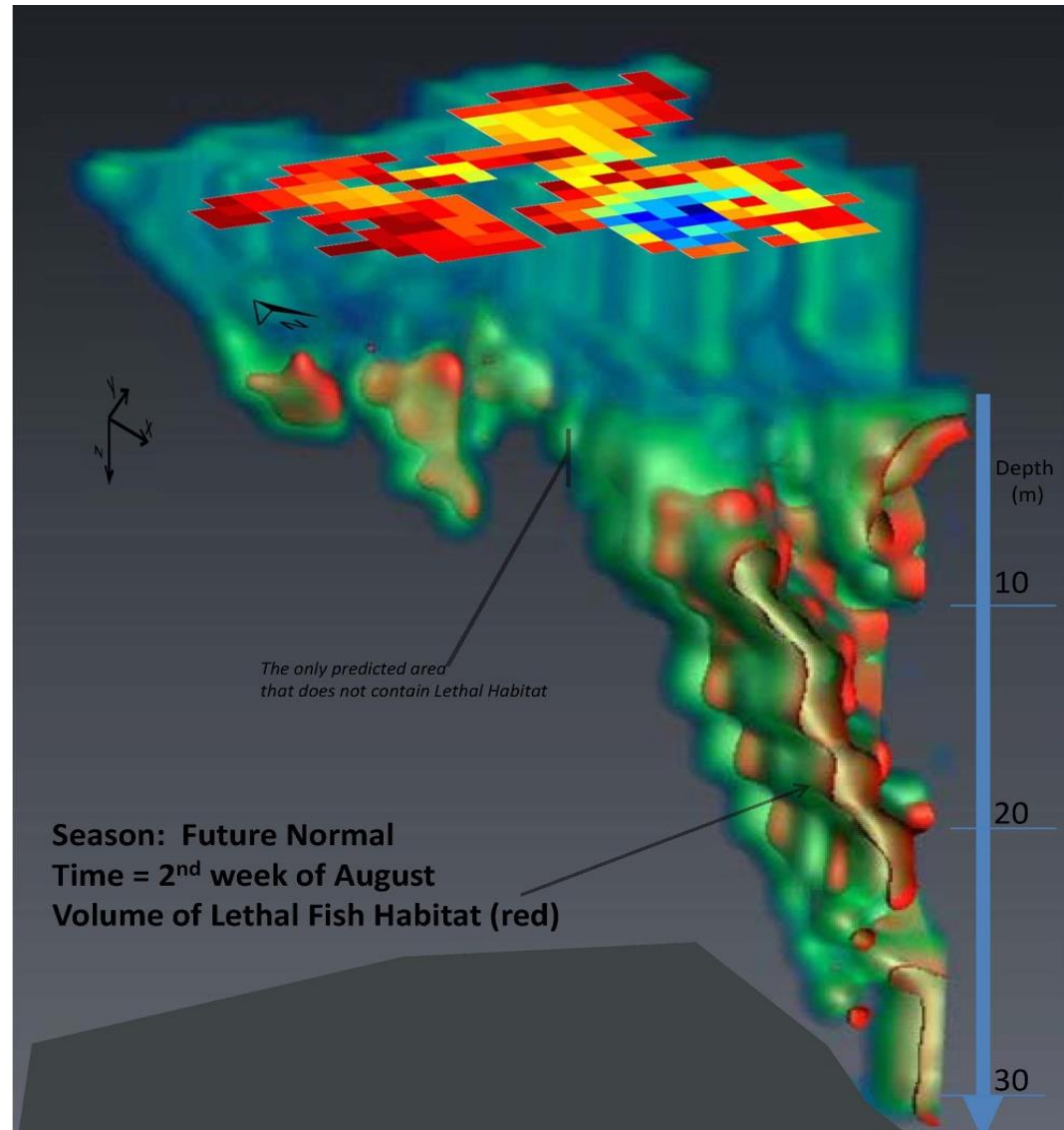
--organization, agency, location,..

--what do you expect to get out of this workshop?



Today's Agenda - Ultimate goal

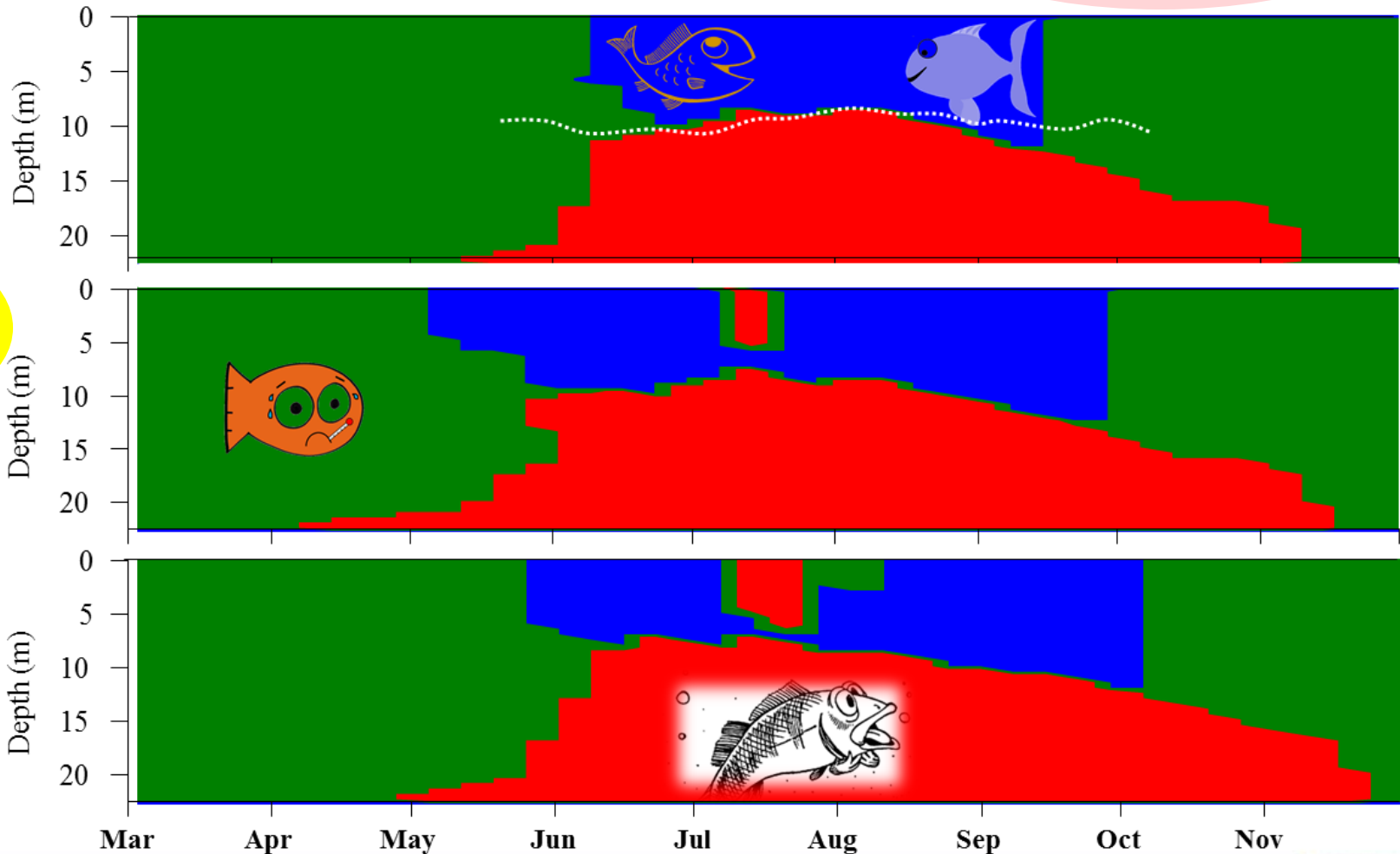
Habitat App.
to assist
decision makers



What did we learn?

Fish Habitat Response to Lake Warming

Today



A warmer future

A very warmer future



Today's Agenda:



2:45 pm

Introductions -

About the WR Team, workshop: **Agenda**, exercises

3:00 pm

Exercise I: what is a lake?

3:05 pm

Limnology (lightening) Primer

Exercise II: I know limnology

3:xx pm

What does it have to do with fish? T & DO

Why should we care about Temperature?

Temperature impact on lakes

What does research say about it?

What is the problem? Urgency?

Do we have solutions?

What can we control?

3:50 pm

Q & A; What is next and what actions to take?



Exercise I: What is a lake?

Instructions: Work individually.

Please take 2-3 minutes to answer the above question.

Reflection:

Share (~ 30 sec.) your answer



Exercise I: What is a lake? The answer!

<https://minnesotawaters.org/westbattlelake/dnr-information-faq/>

A lake is not defined by size or depth as some may suggest. **A lake may be defined as an enclosed basin filled or partly filled with water.** A lake may have an inlet and/or an outlet stream, or it may be completely enclosed (landlocked). Generally, a lake is an area of open, relatively deep water that is large enough to produce a wave-swept shore.



Exercise I: What is a lake? The answer!

<https://minnesotawaters.org/westbattlelake/dnr-information-faq/>

So, lakes can have any shape, size, volume,.....

lakes are strongly influence by:

**Physical,
Chemical, and
Biological characteristics (processes).**

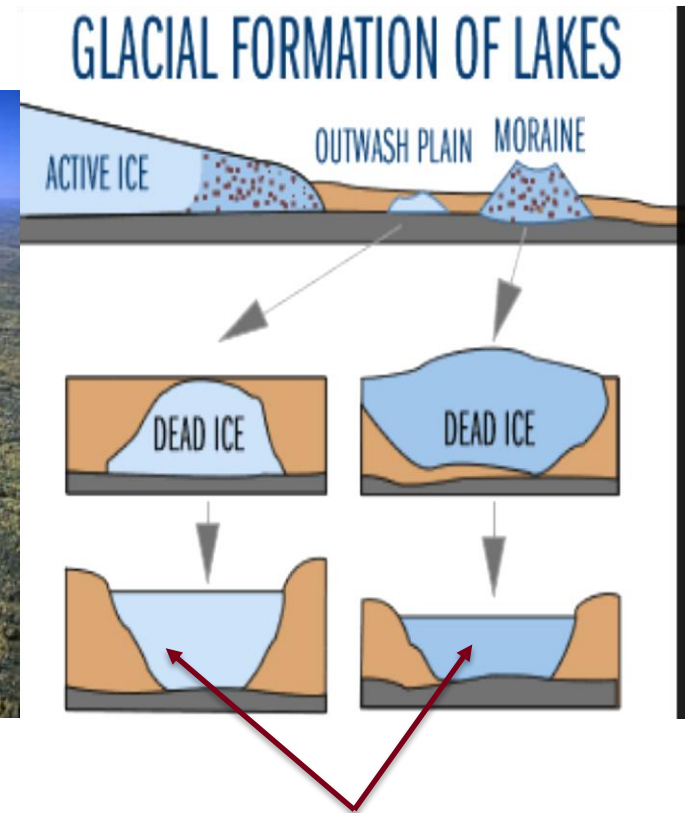
**Therefore, we need to have a solid understanding
of these processes, so we can get
to know our lakes, manage,...**



Ready for a limnology (lightening) primer?



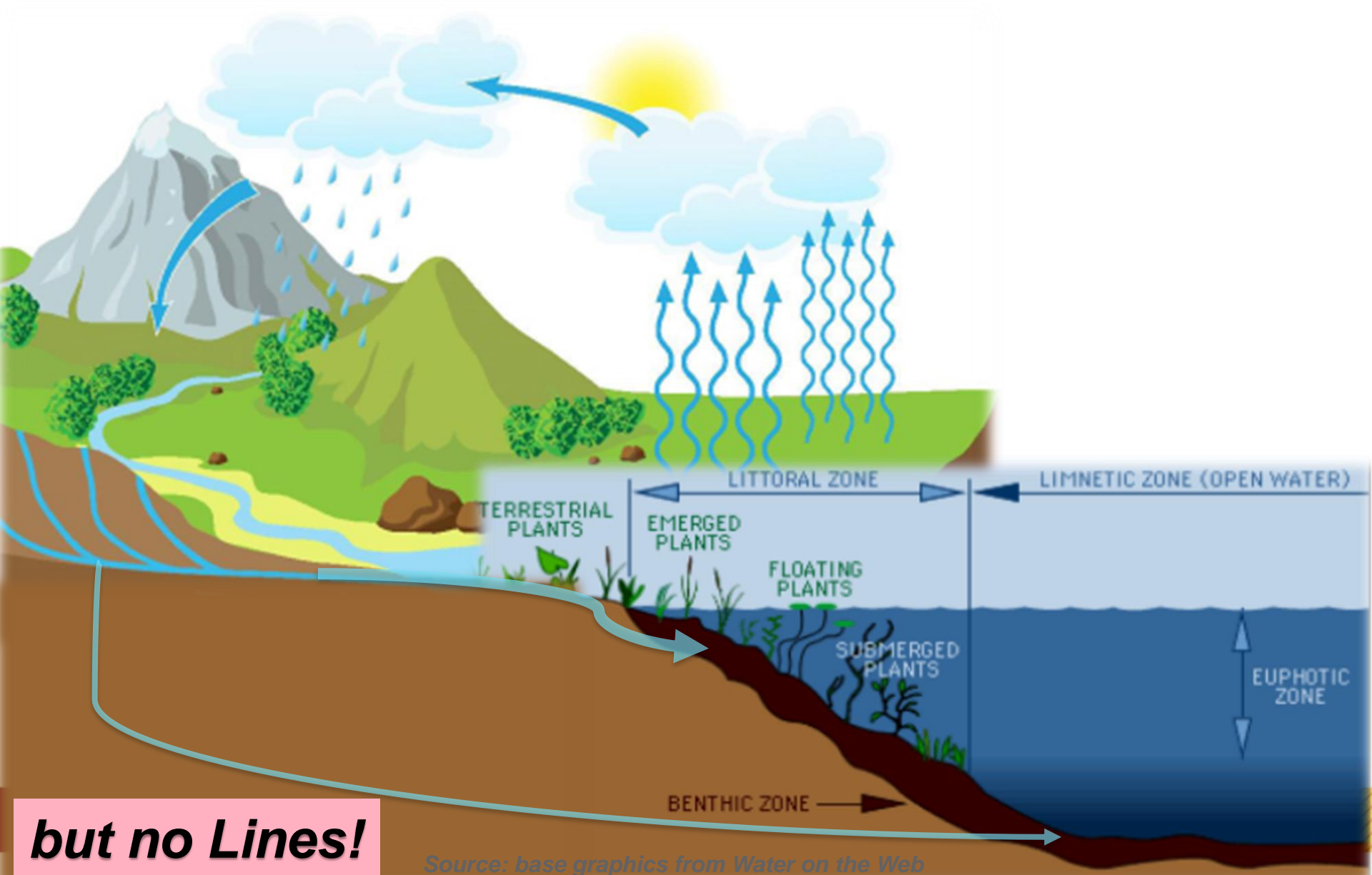
The beginning (12,000 years ago)



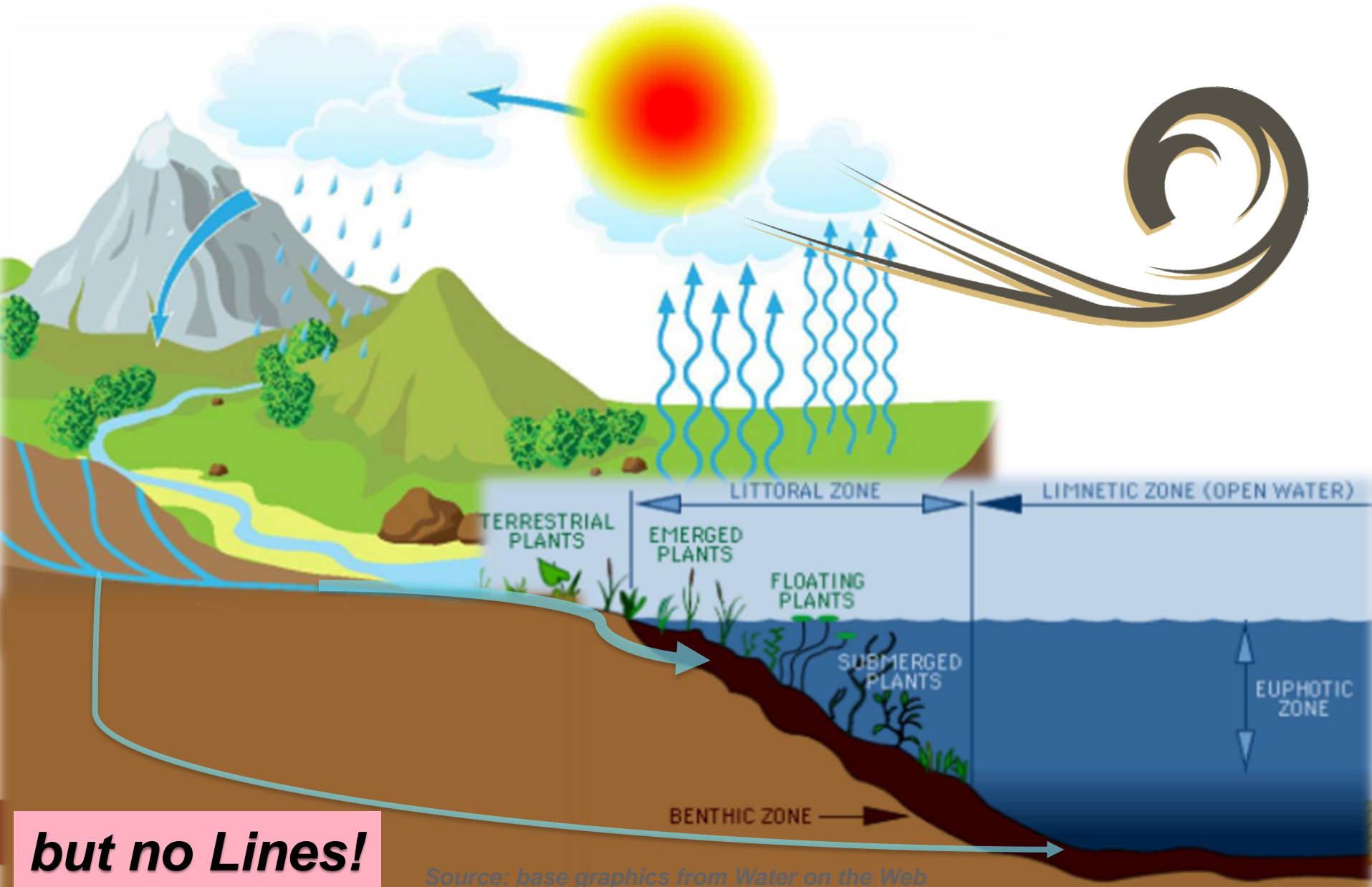
lake



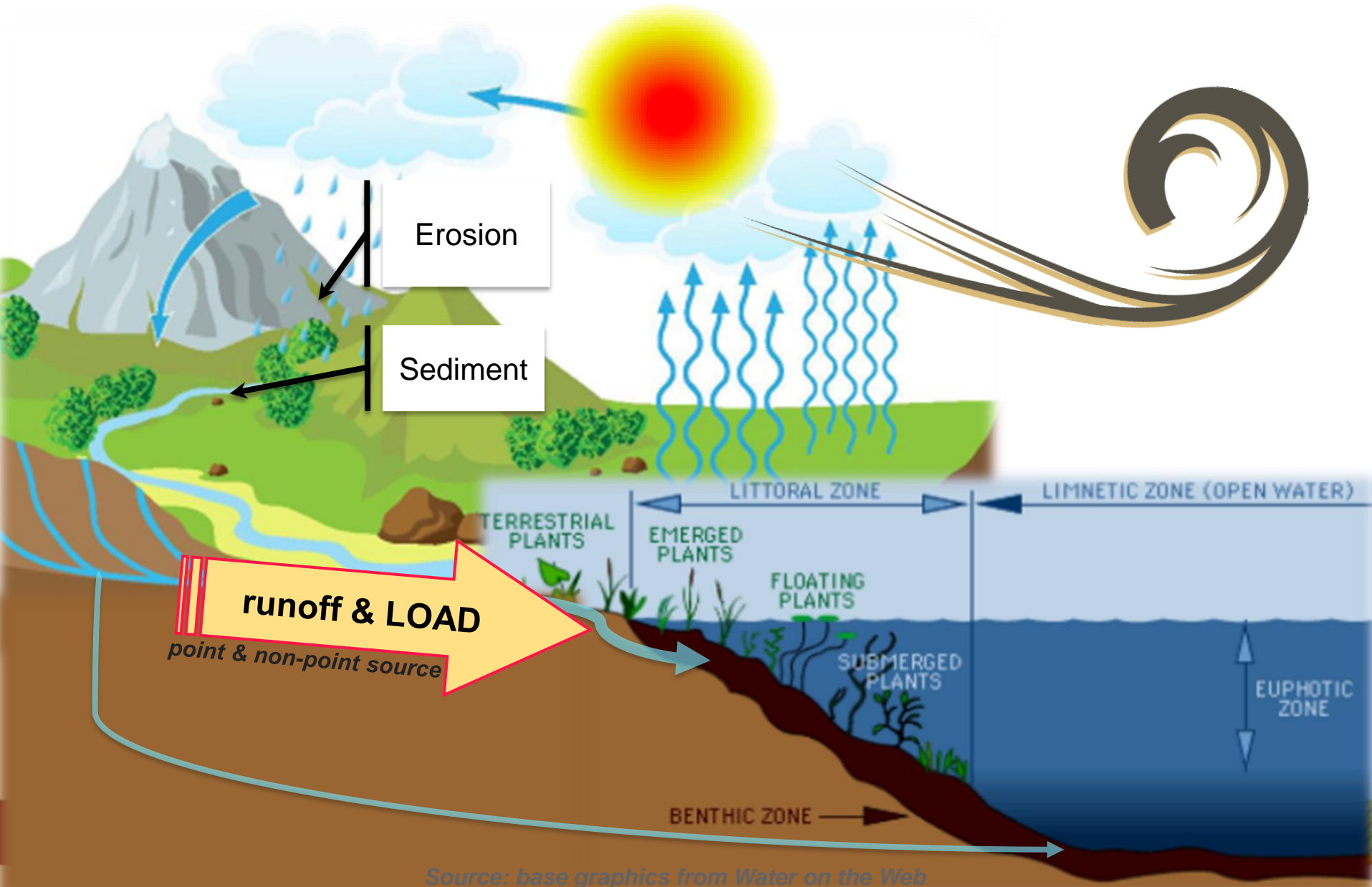
Lake system: lake & watershed



Lake system: lake & watershed



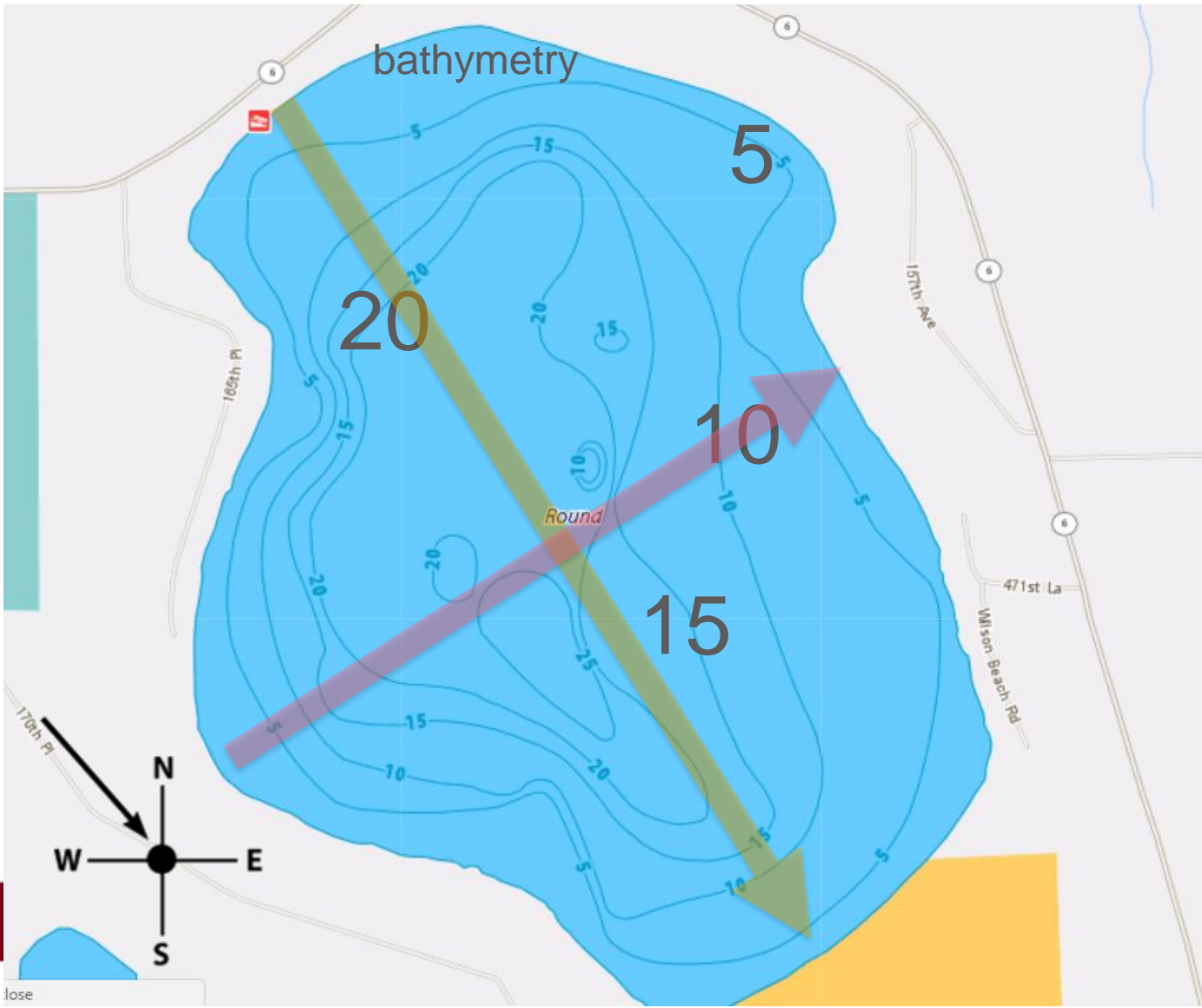
Lake system: lake & watershed



What about lakes?



Lakes: view from the top: areas, regions, zones, parts *..(name that part!)*...



Surface area (A)

Shoreline length (L)

Fetch (why does it matter?)

Max width;

Max length

Littoral Area

bathymetry

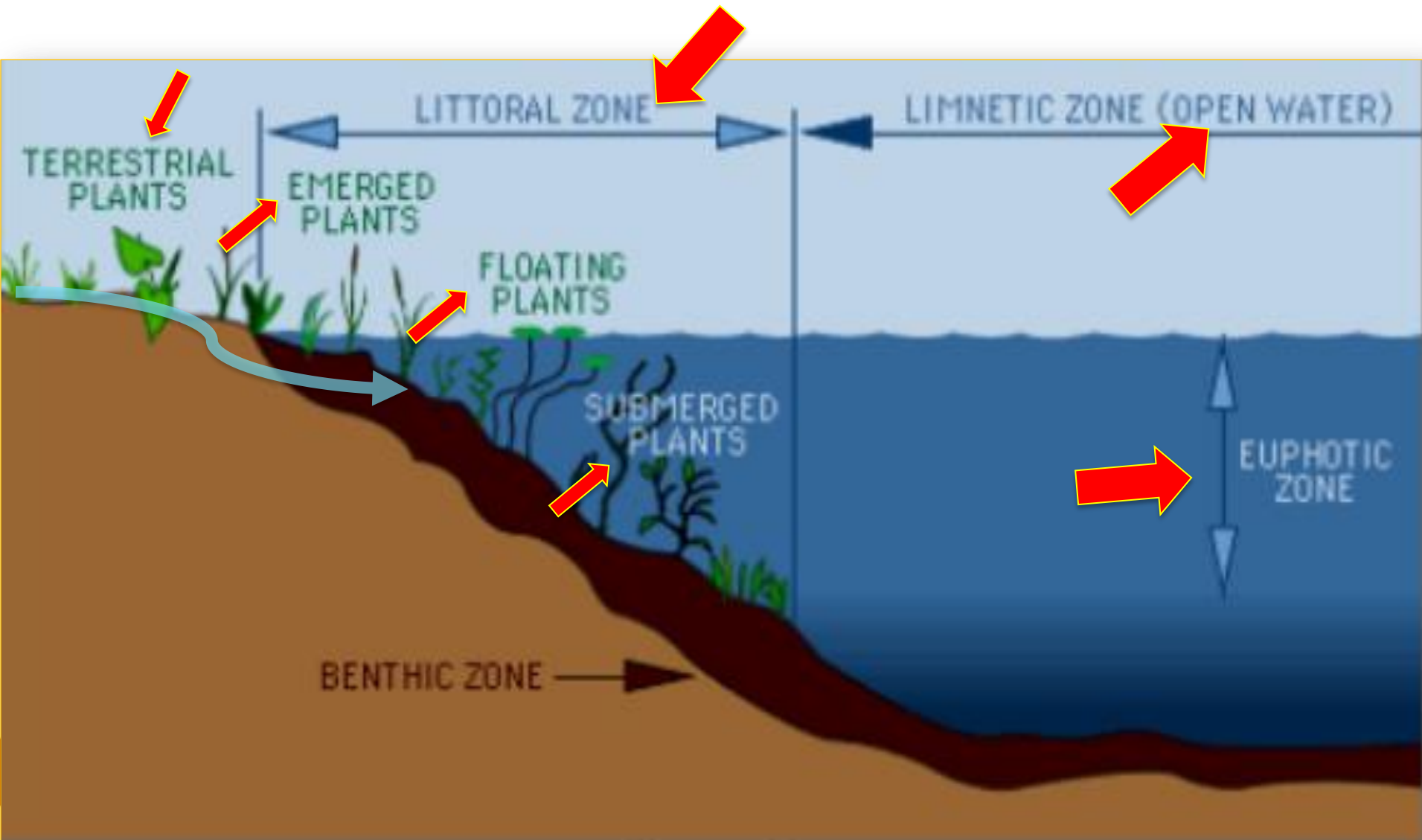
Maximum Depth

Average Depth,...

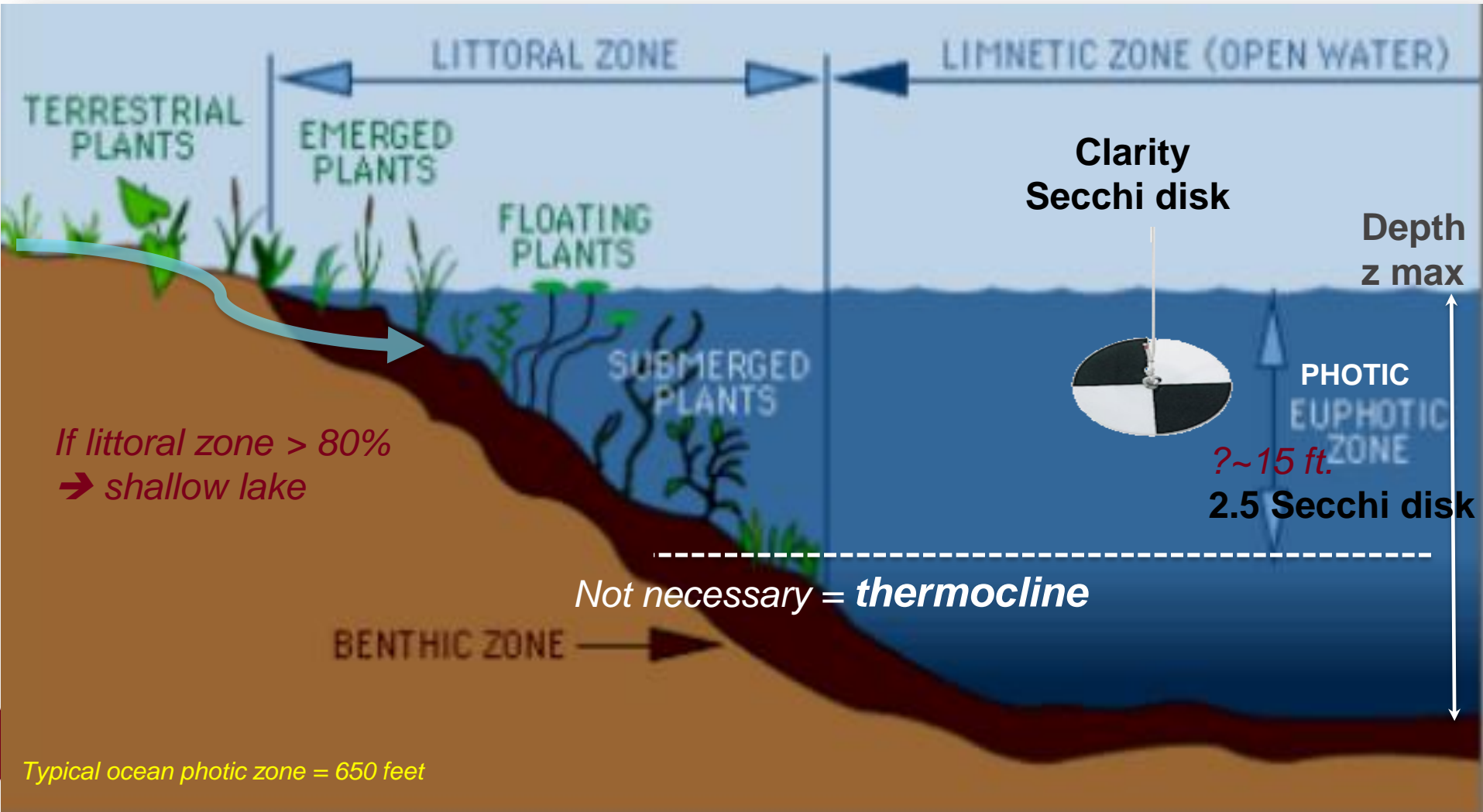
18

Lakes: view from the side:

areas, regions, zones, parts ..(*name that part!*)...



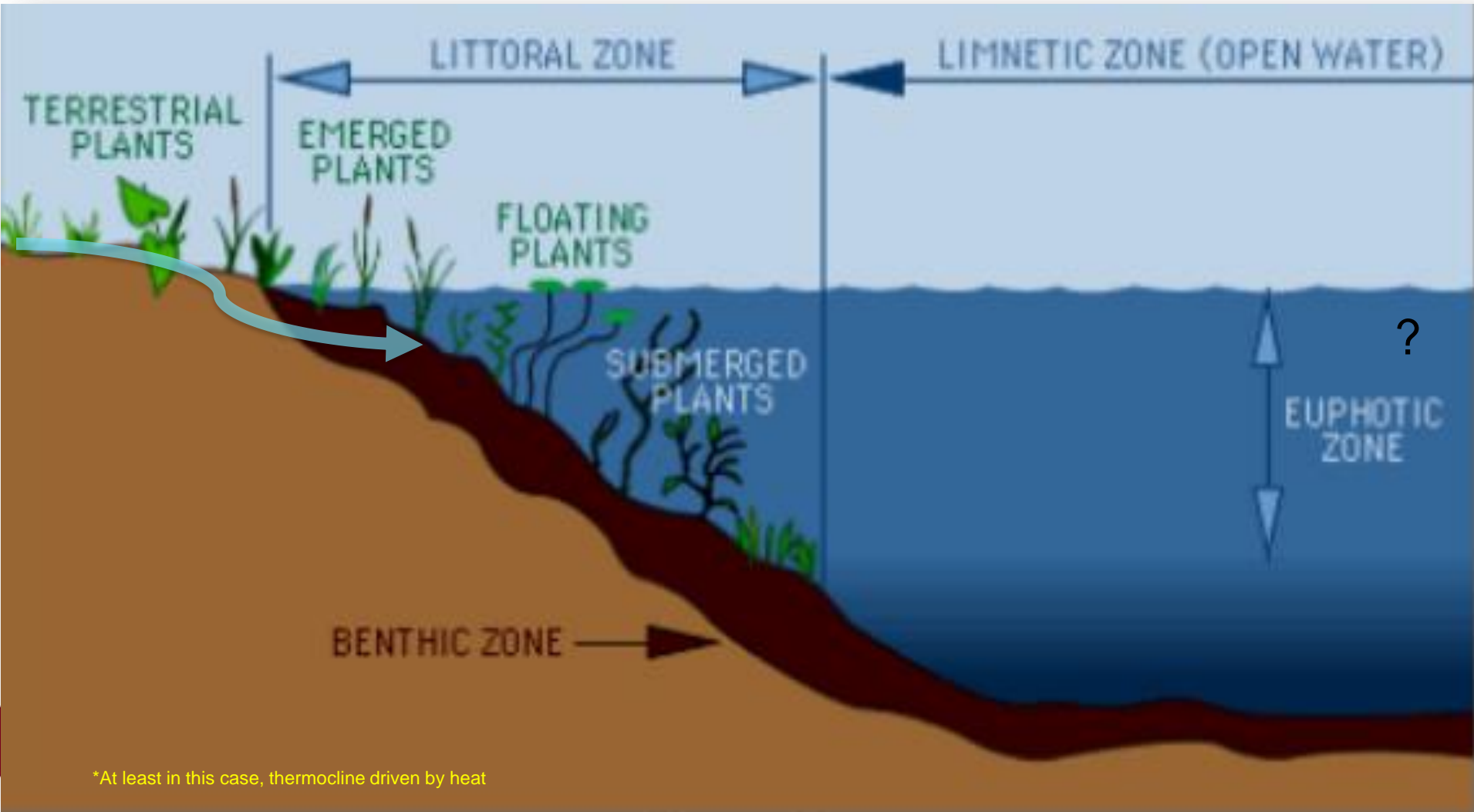
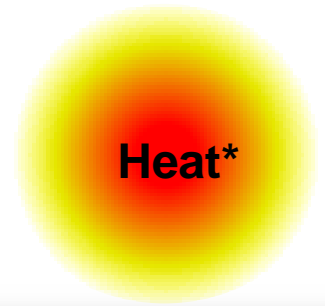
Lake system: lake ecosystems



Lake system: thermocline?

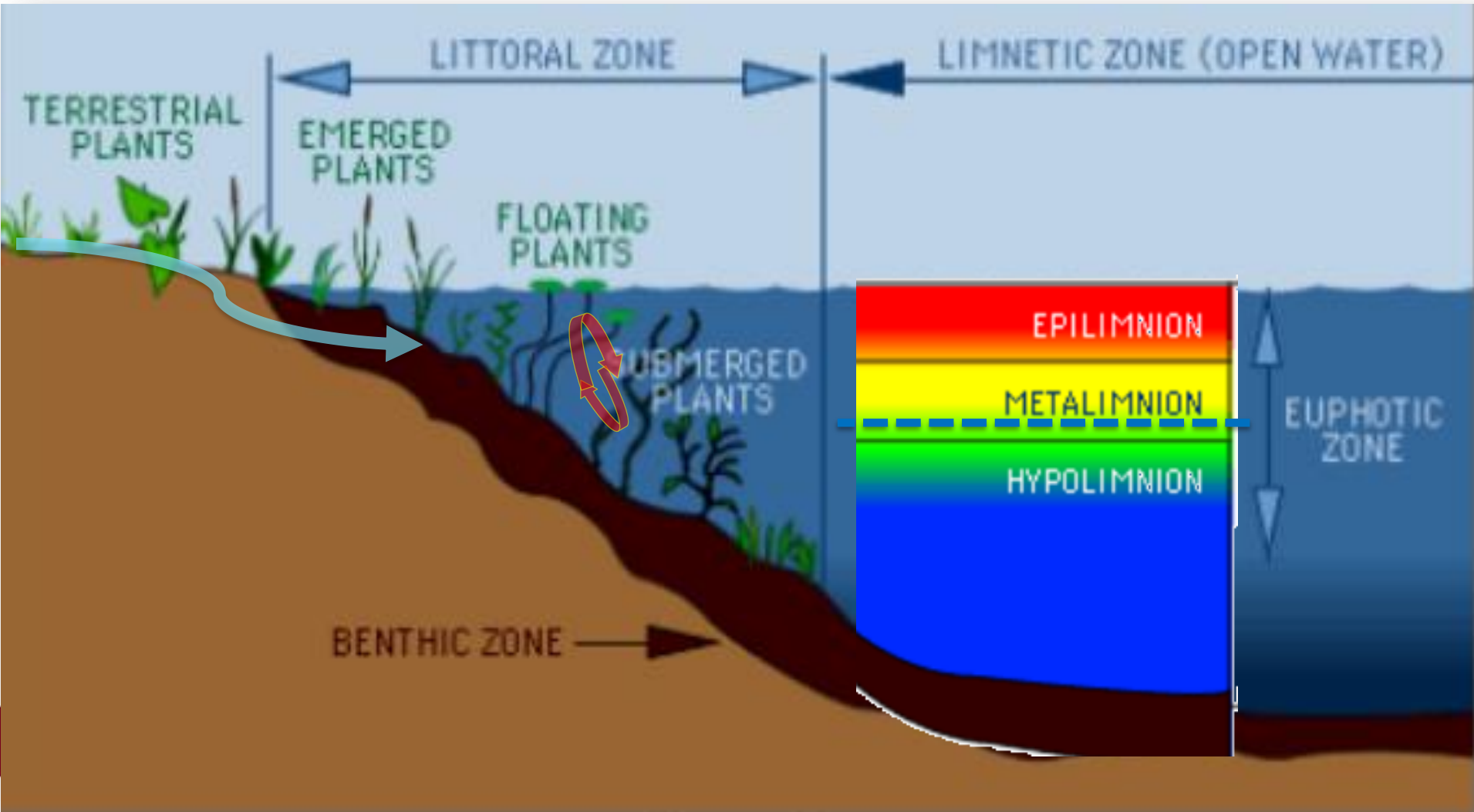
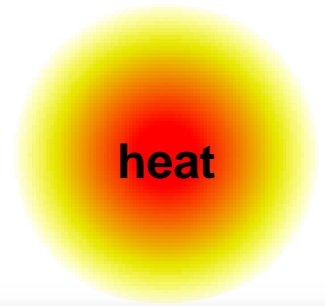


Lake system: thermocline?



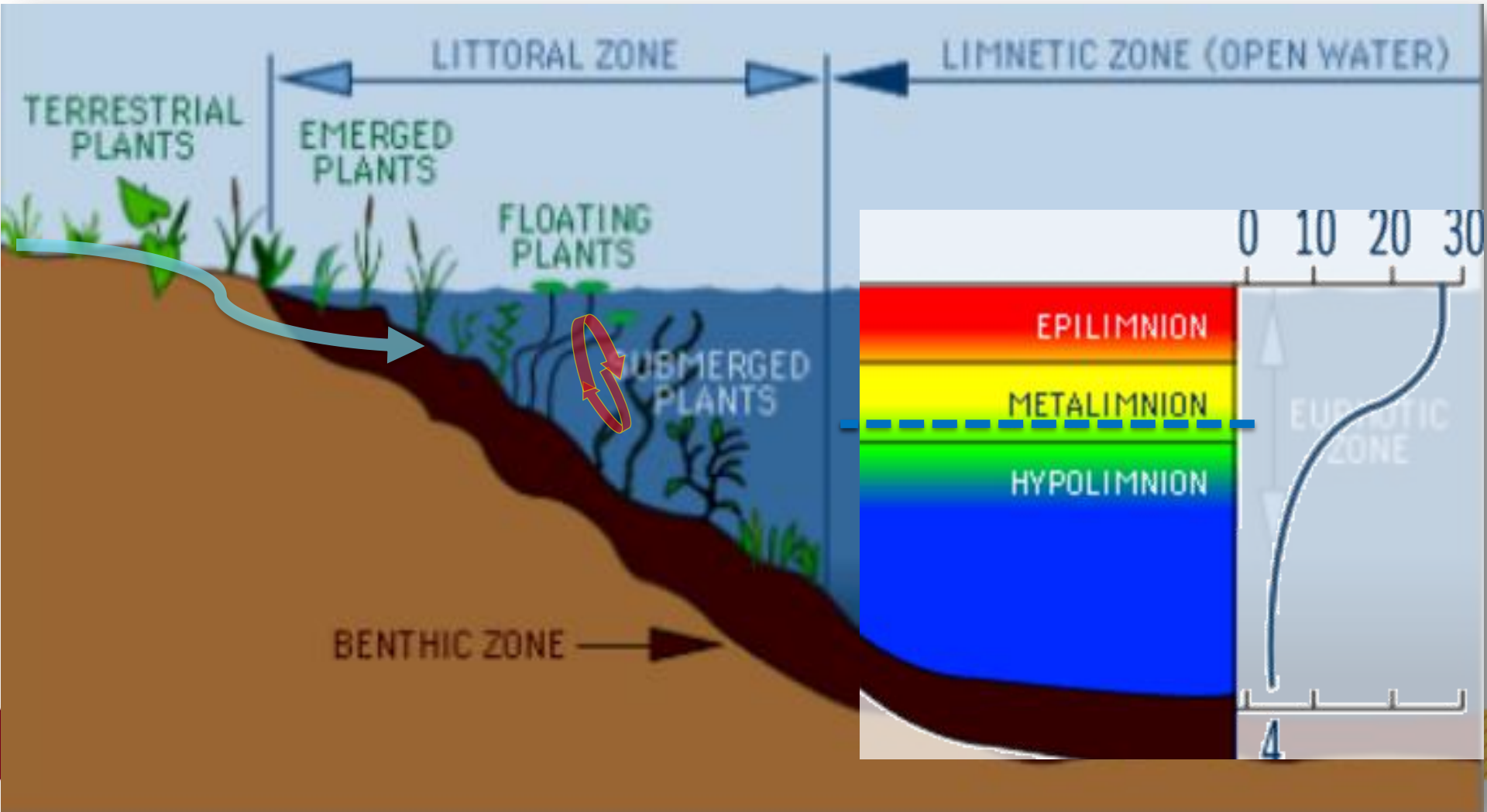
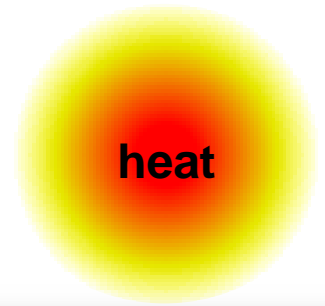
*At least in this case, thermocline driven by heat

Lake system: thermocline?

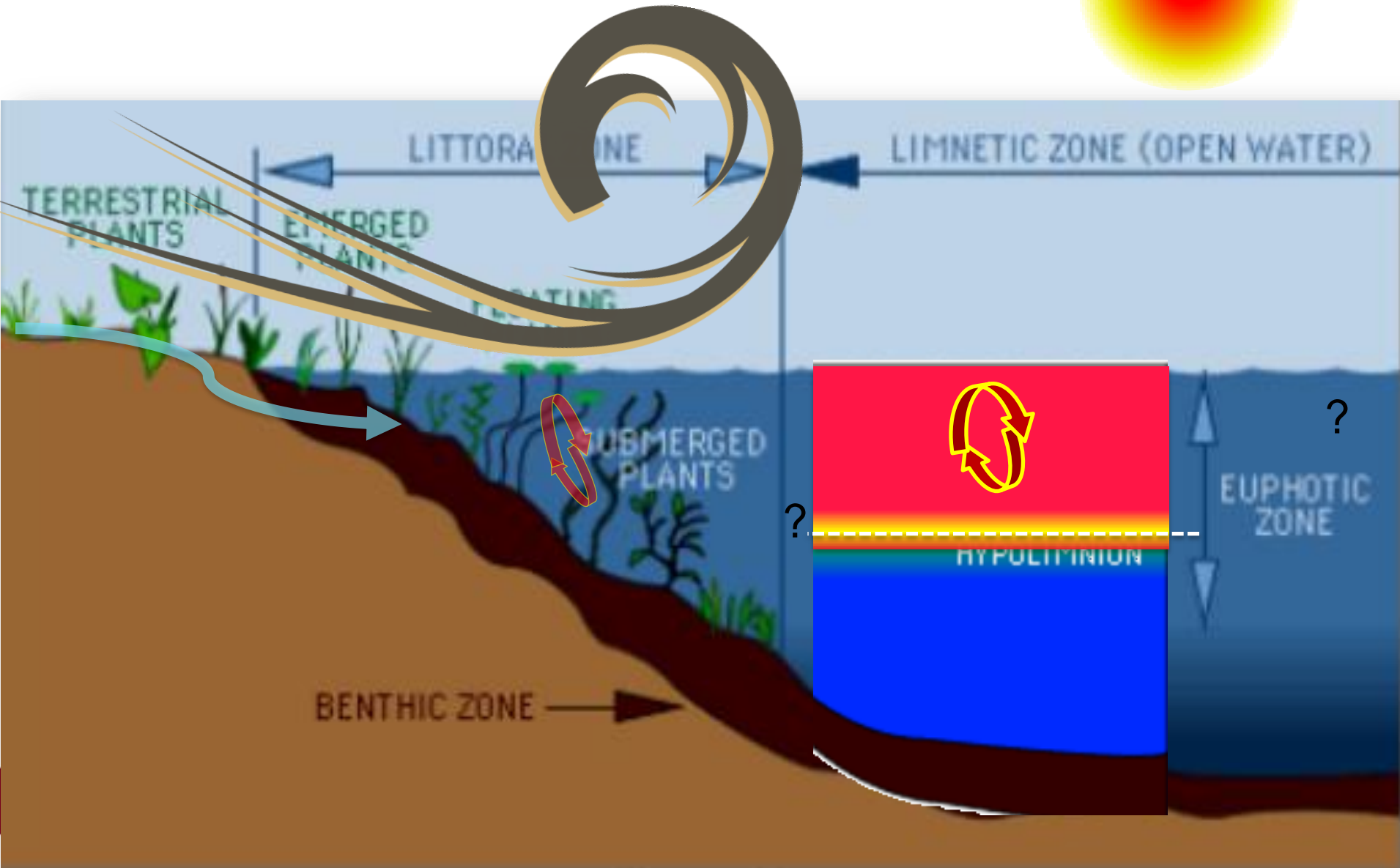
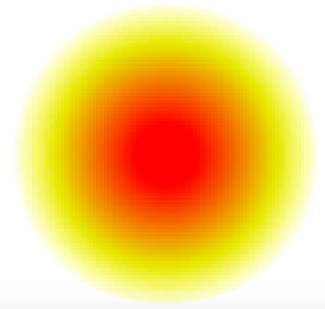


Lake system: thermocline?

Temperature

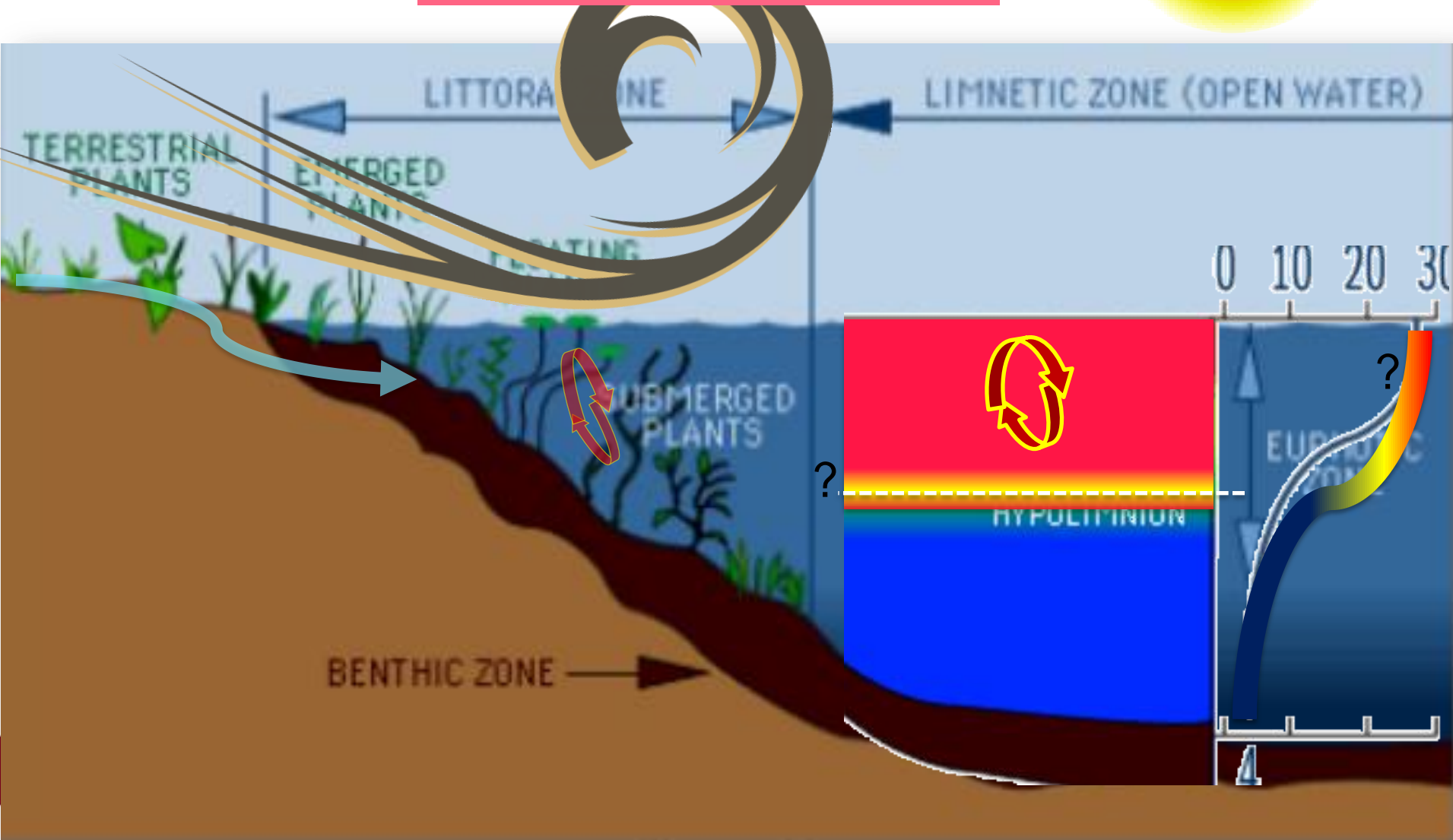
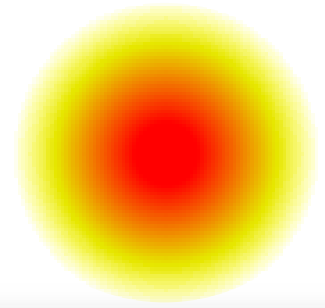


Lake system: lake processes



Lake system: lake processes

thermal structure



Lake system: thermal structure

So what does it have to do with fish?

Let's do a quiz first!



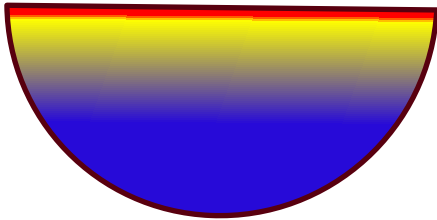
Lake system: thermal structure

Quiz – Matching:

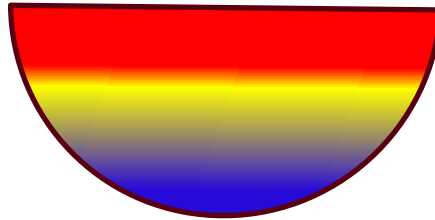
a. April

b. November

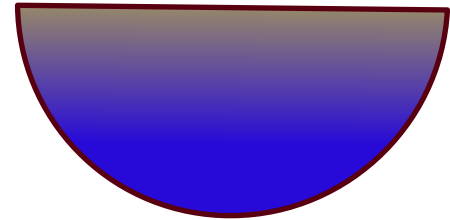
c. August



1



2

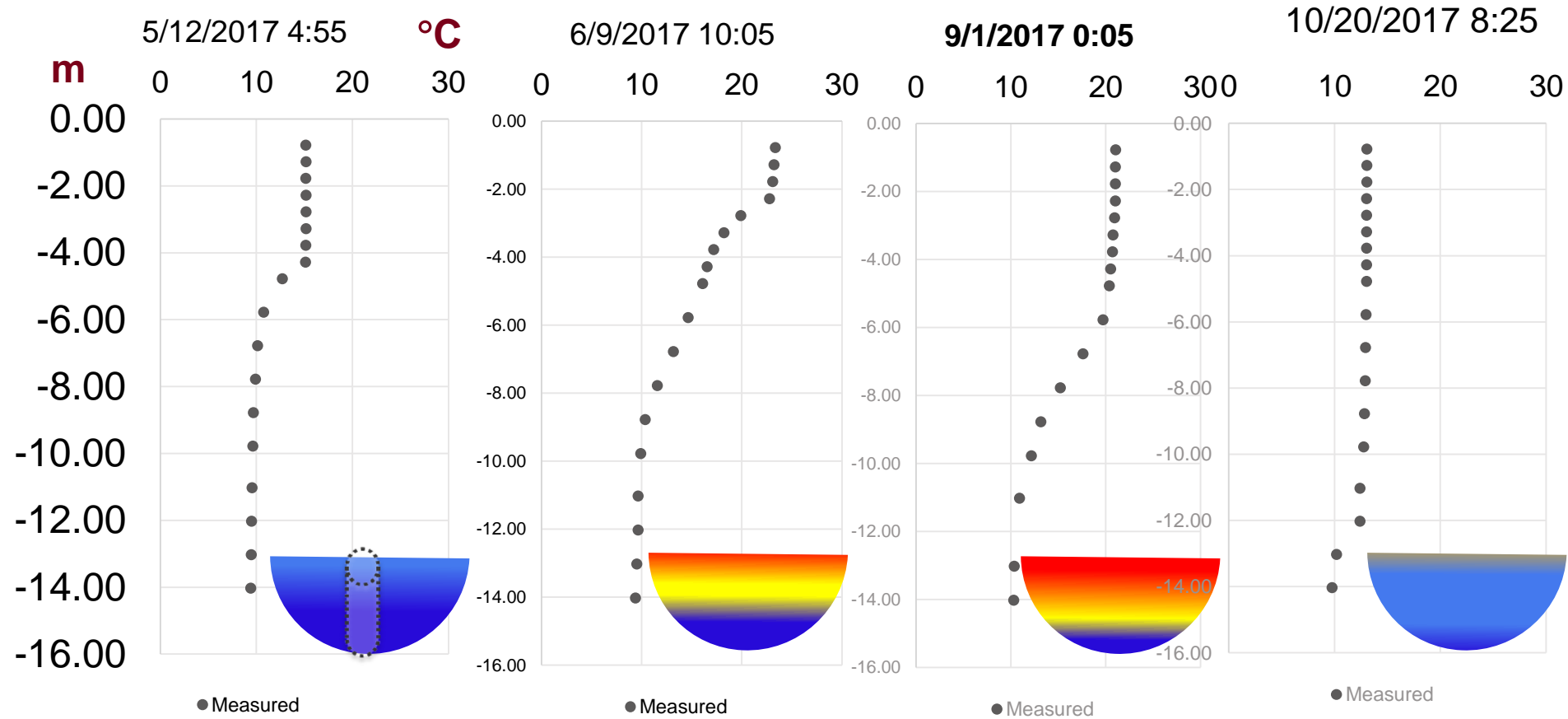


3

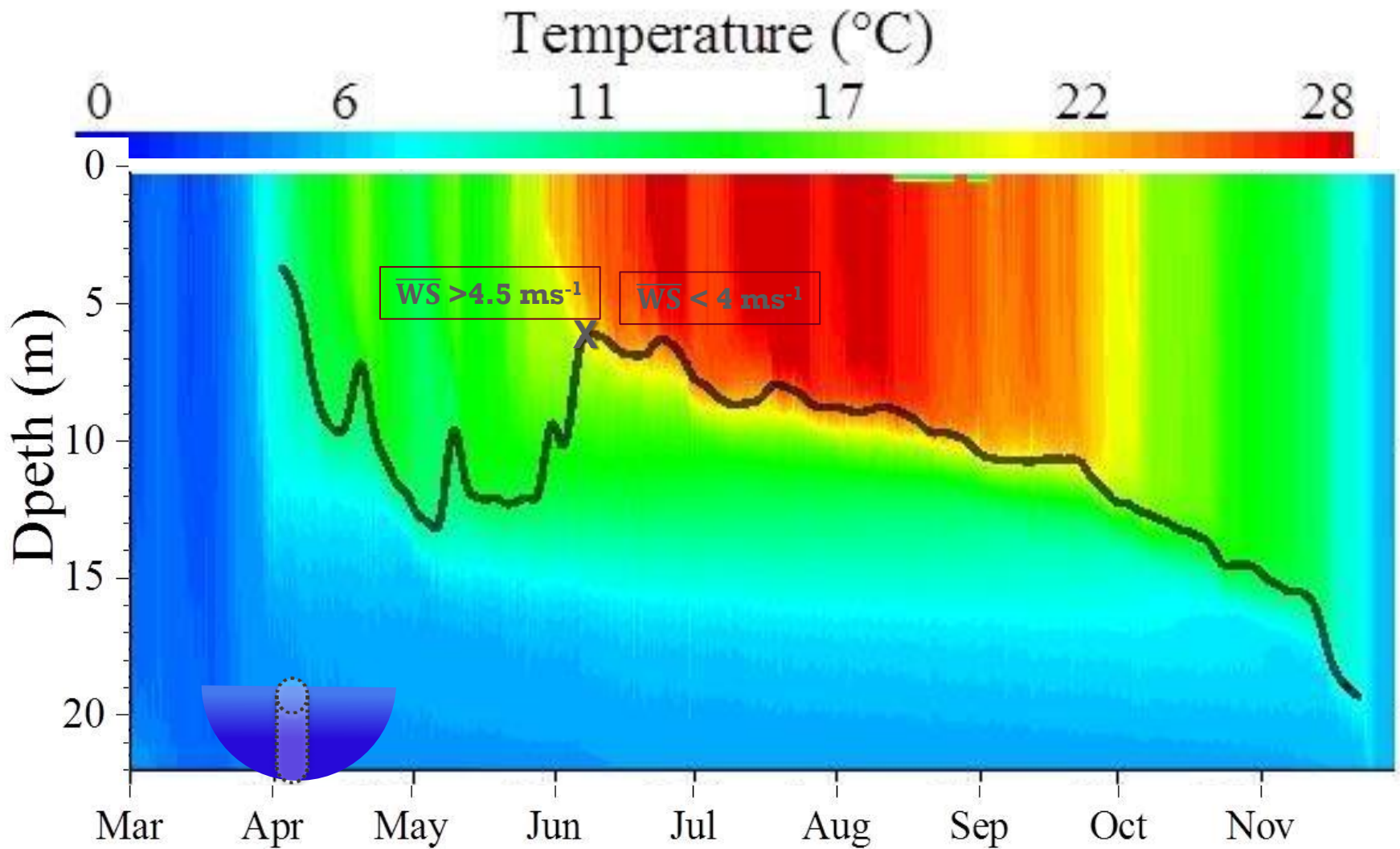


Lake system: thermal structure

T profiles (2017, S.C. Lake).



Lake system: thermal structure



Lake system: thermal structure

So what does it have to do with fish?

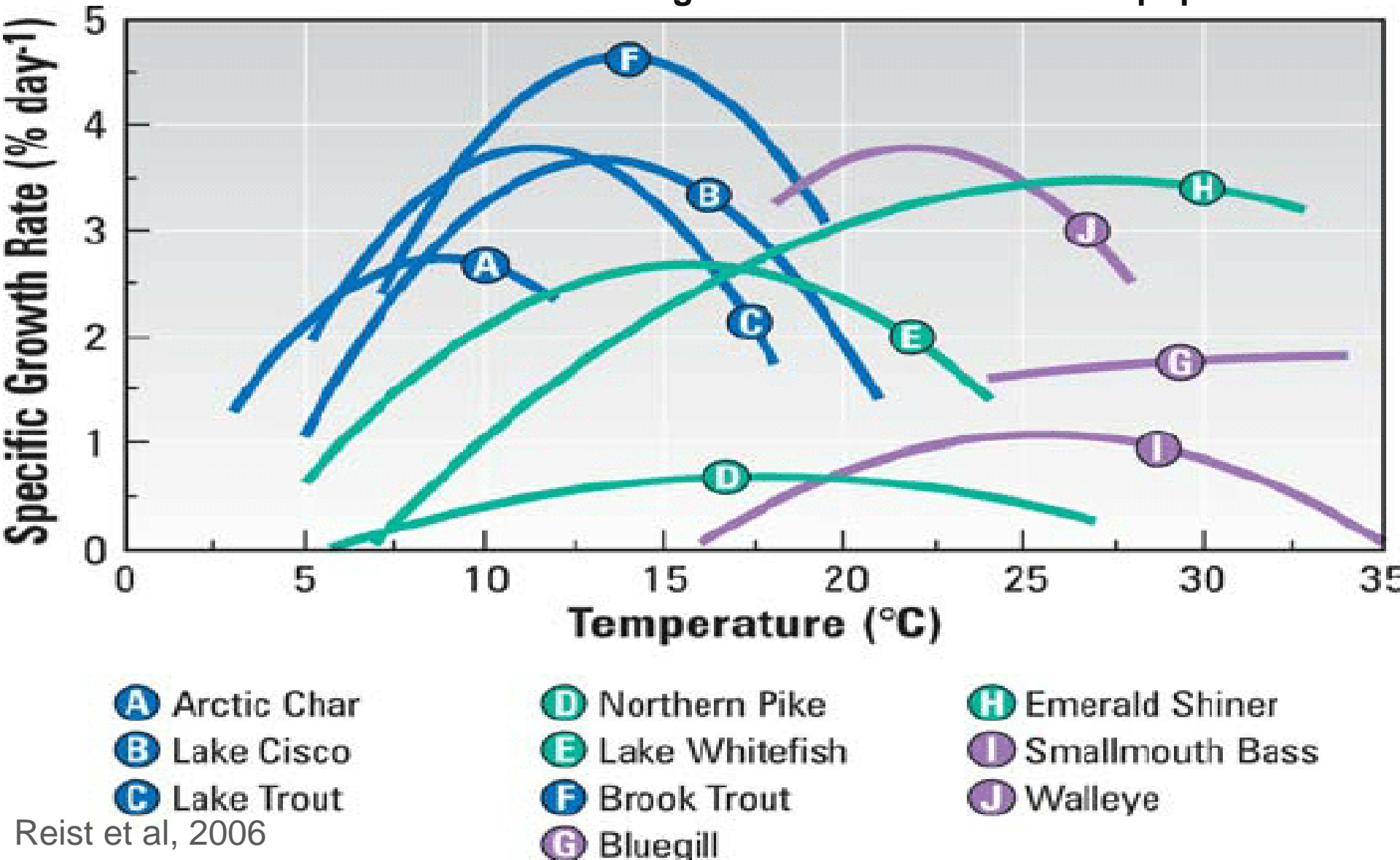


Temperature drives biology



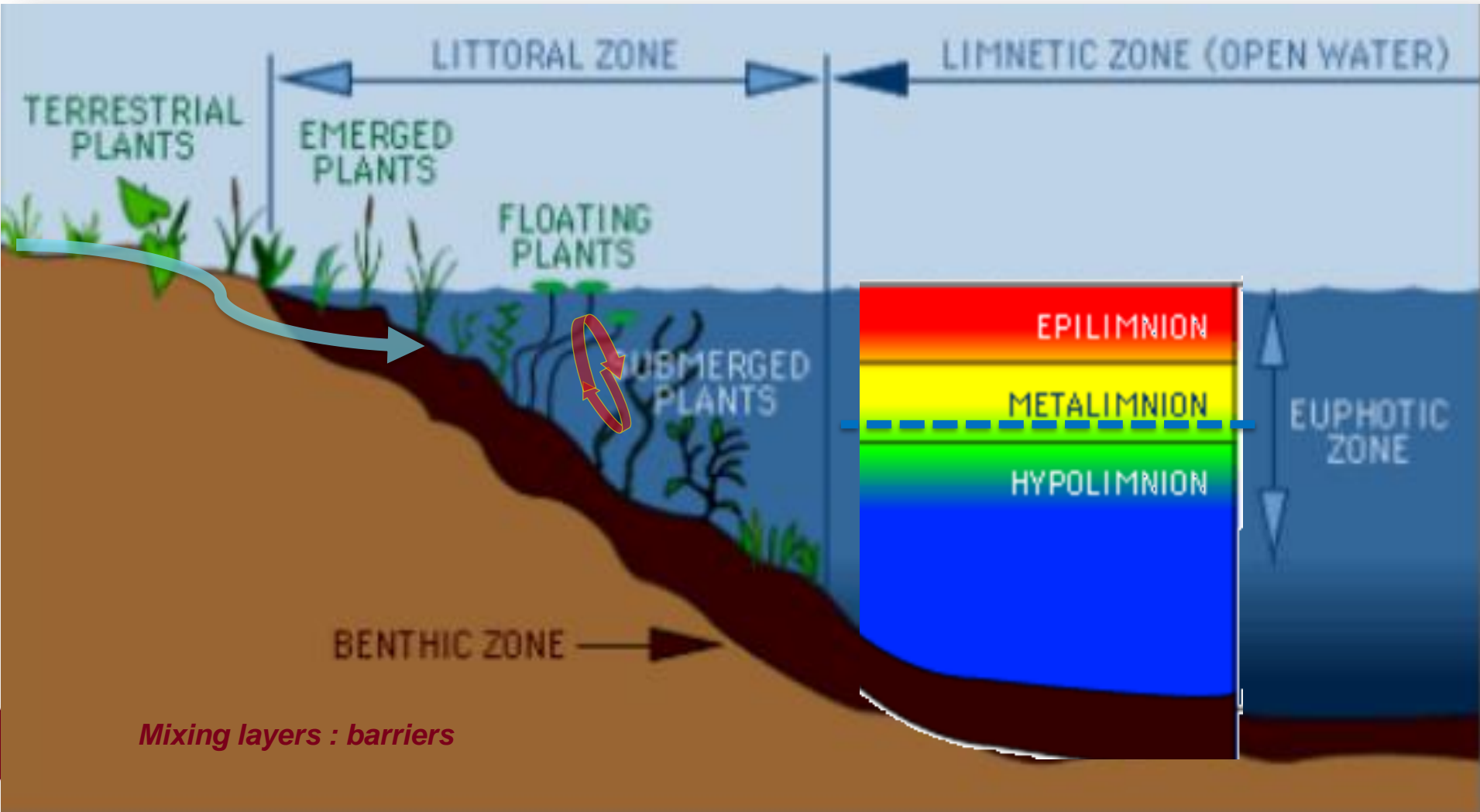
Temperature → fish growth rate

“General effects of climate change on Arctic fishes and fish populations”

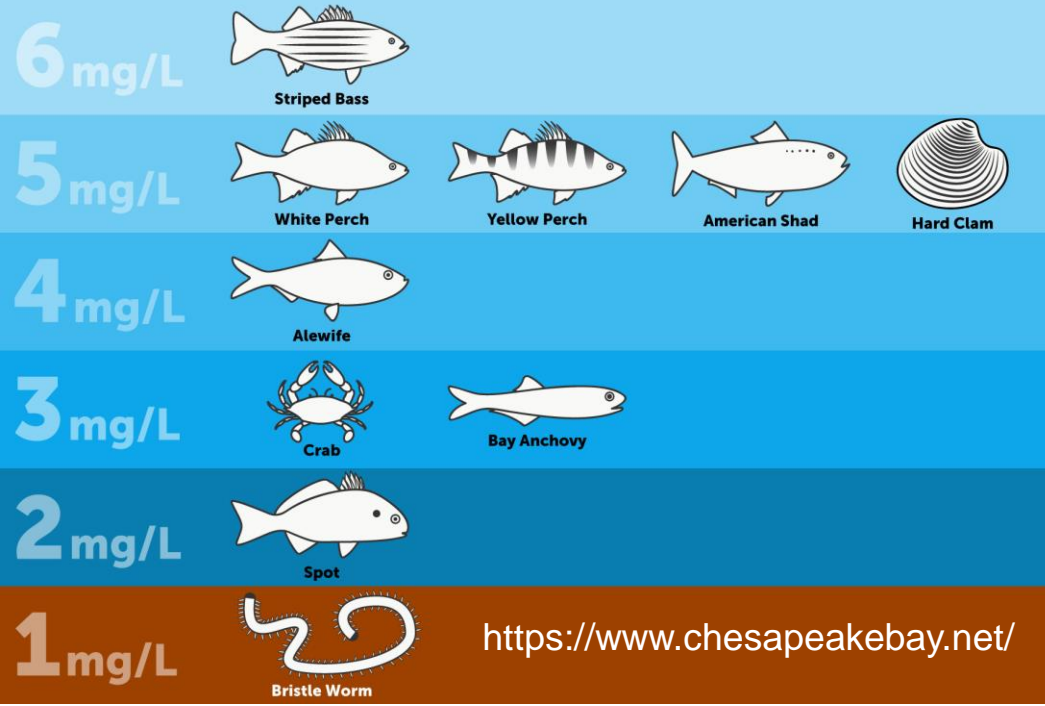
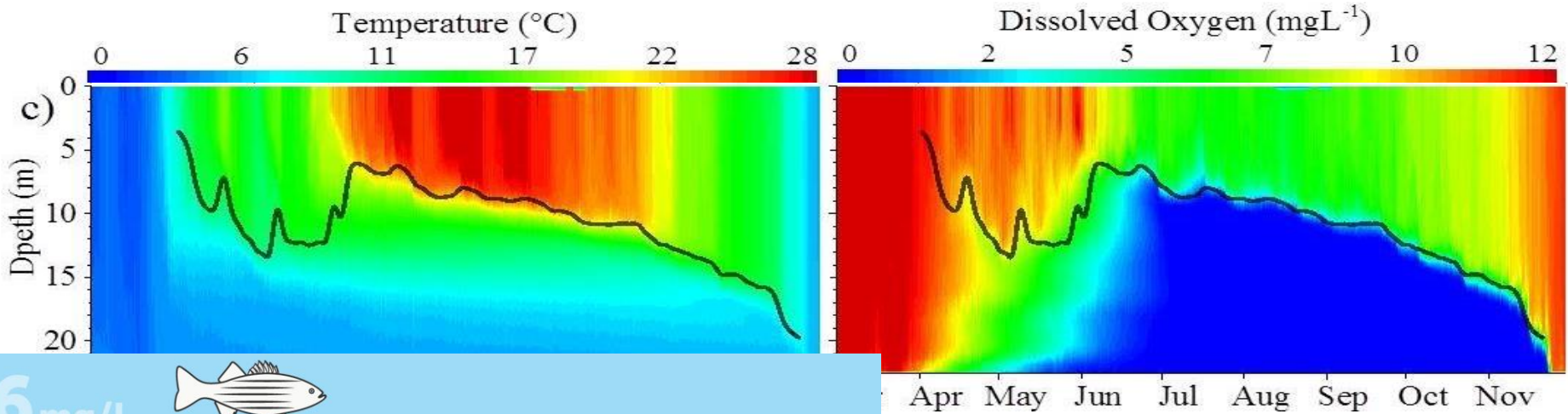


Thermal structure, stratification, DO distribution

heat



Thermal structure, stratification, DO distribution

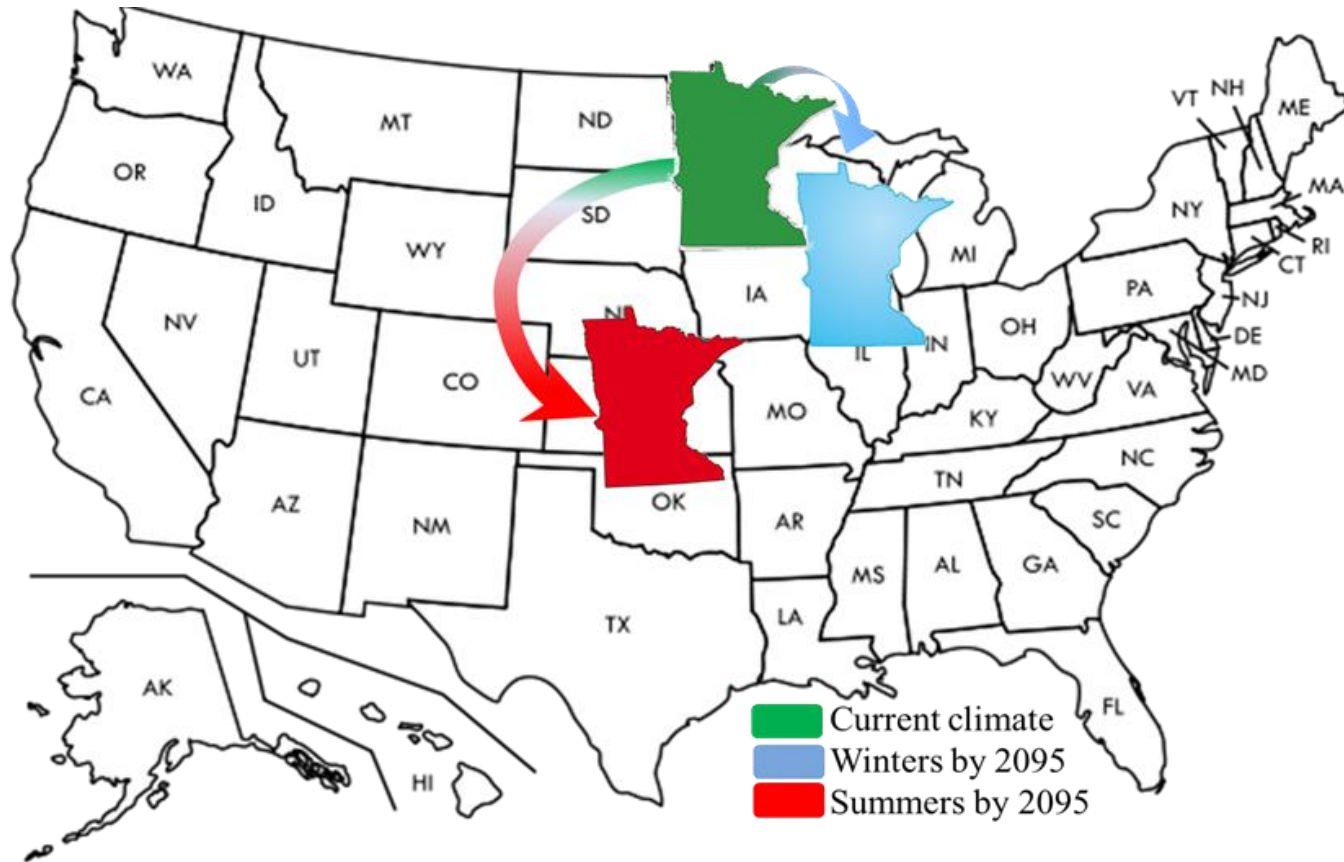


Salmon need oxygen rich water

<https://www.epa.gov/national-aquatic-resource-surveys/indicators-dissolved-oxygen>

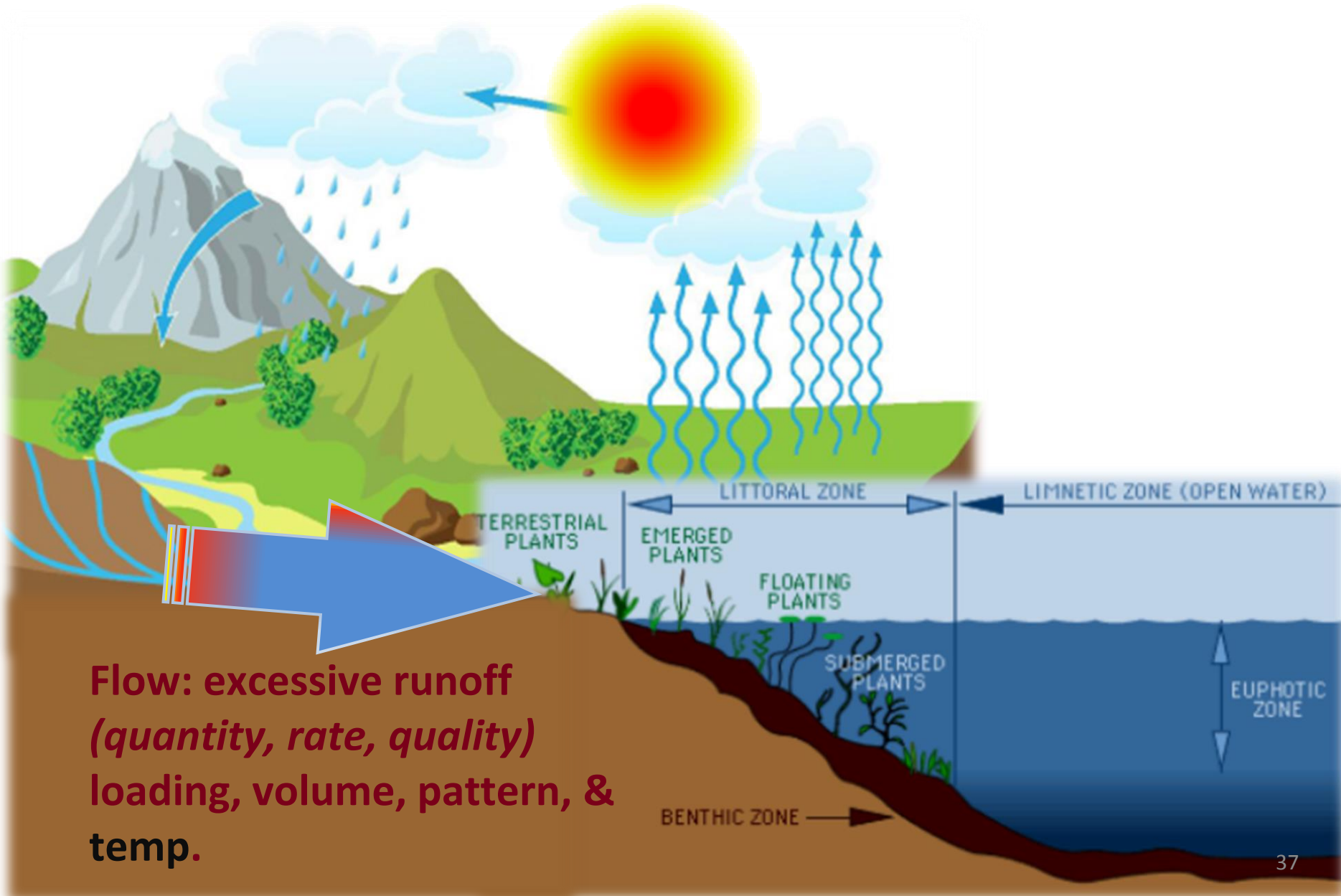
<https://www.chesapeakebay.net/>

So, what is the issue? Urgency?

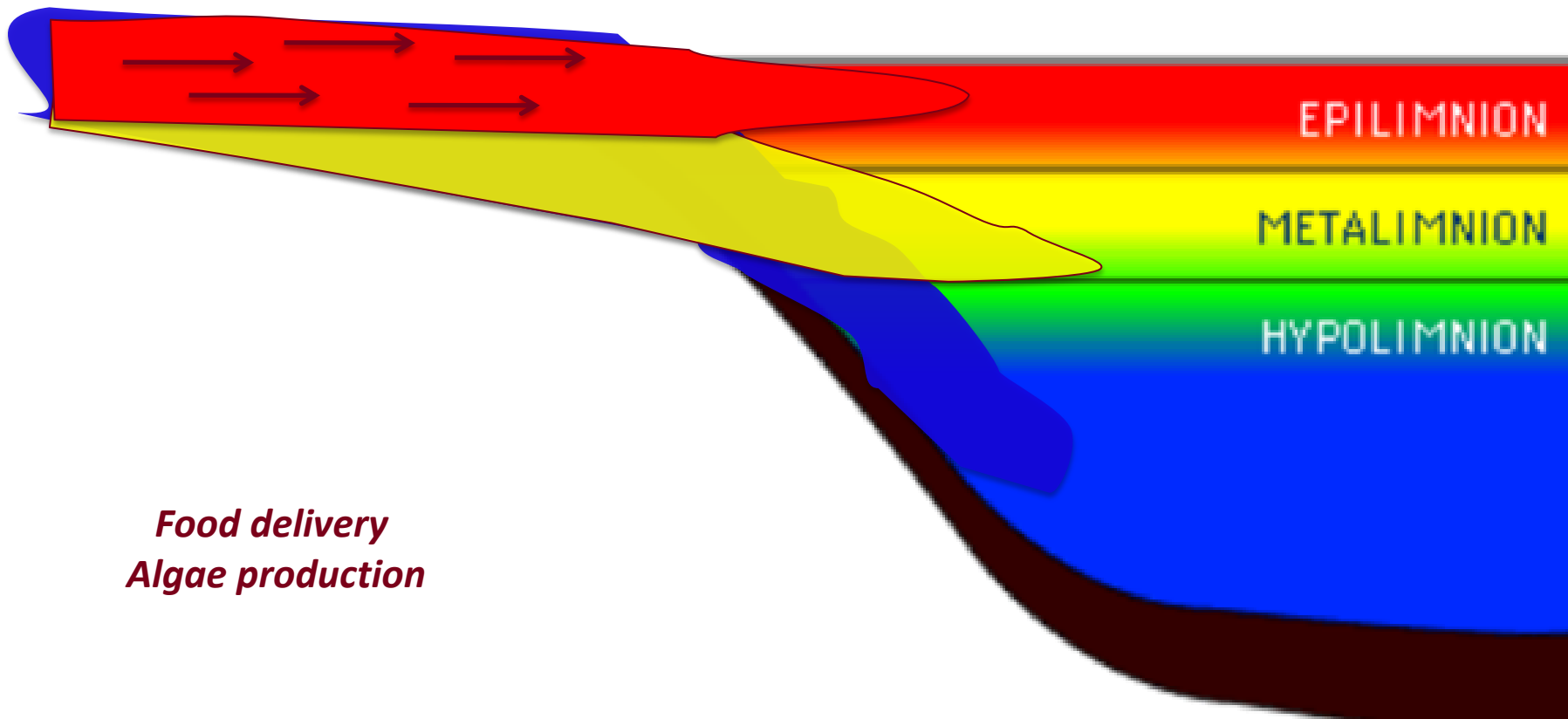


Q: What will happen to the T & DO
under a changing climate?

Research: climate change & watershed



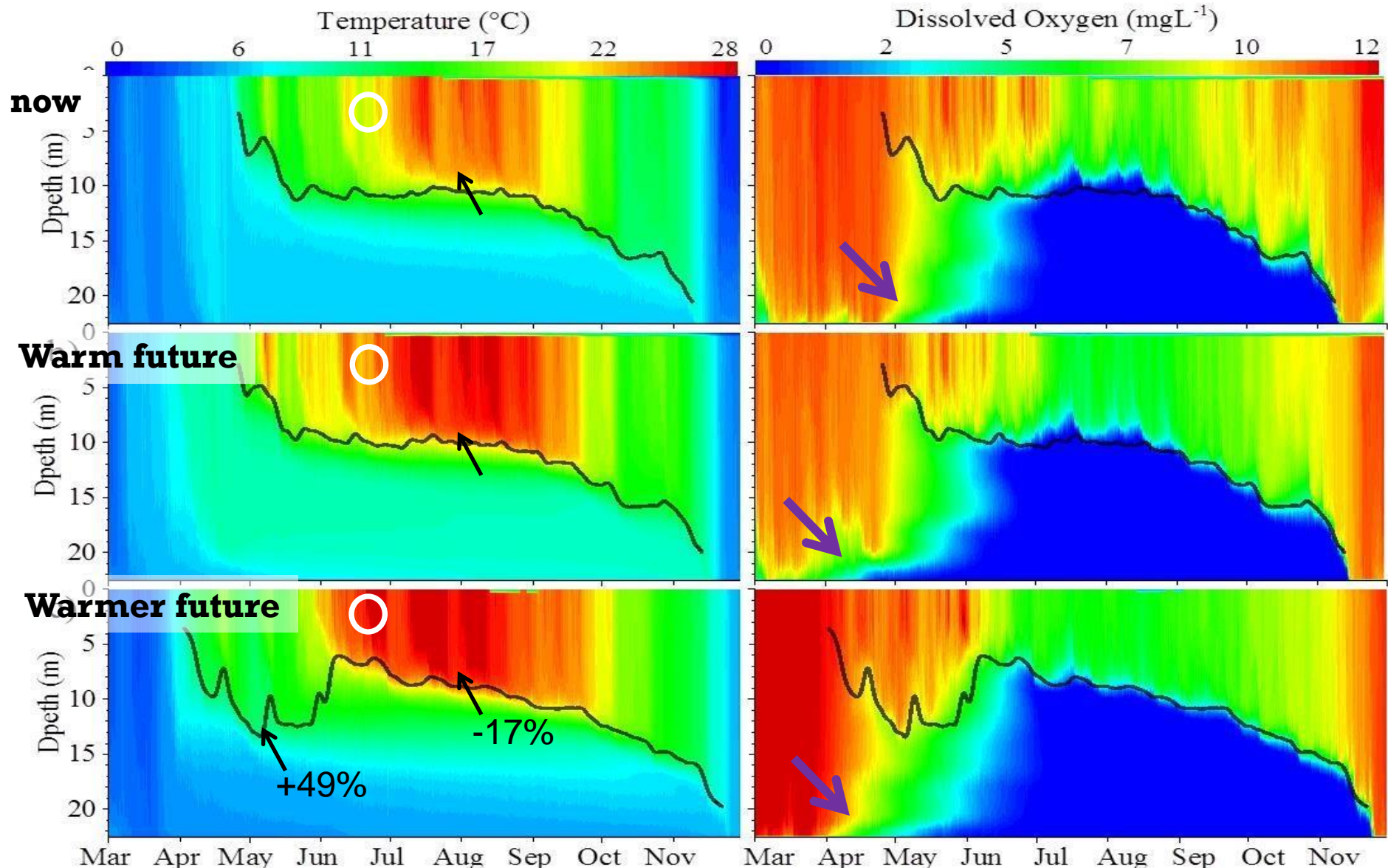
Research: temperature & stream flow



Missaghi & Hondzo, 2010

Research: changes in T & DO → fish habitat

Missaghi et al., 2017



Research: evaluating coolwater fish habitat

Habitat Criteria

Good Growth (GG)

Restricted Growth (RG)

Lethal (L)

Conditions

$(16.3 < T < 28.2)$ AND $(DO > 3)$

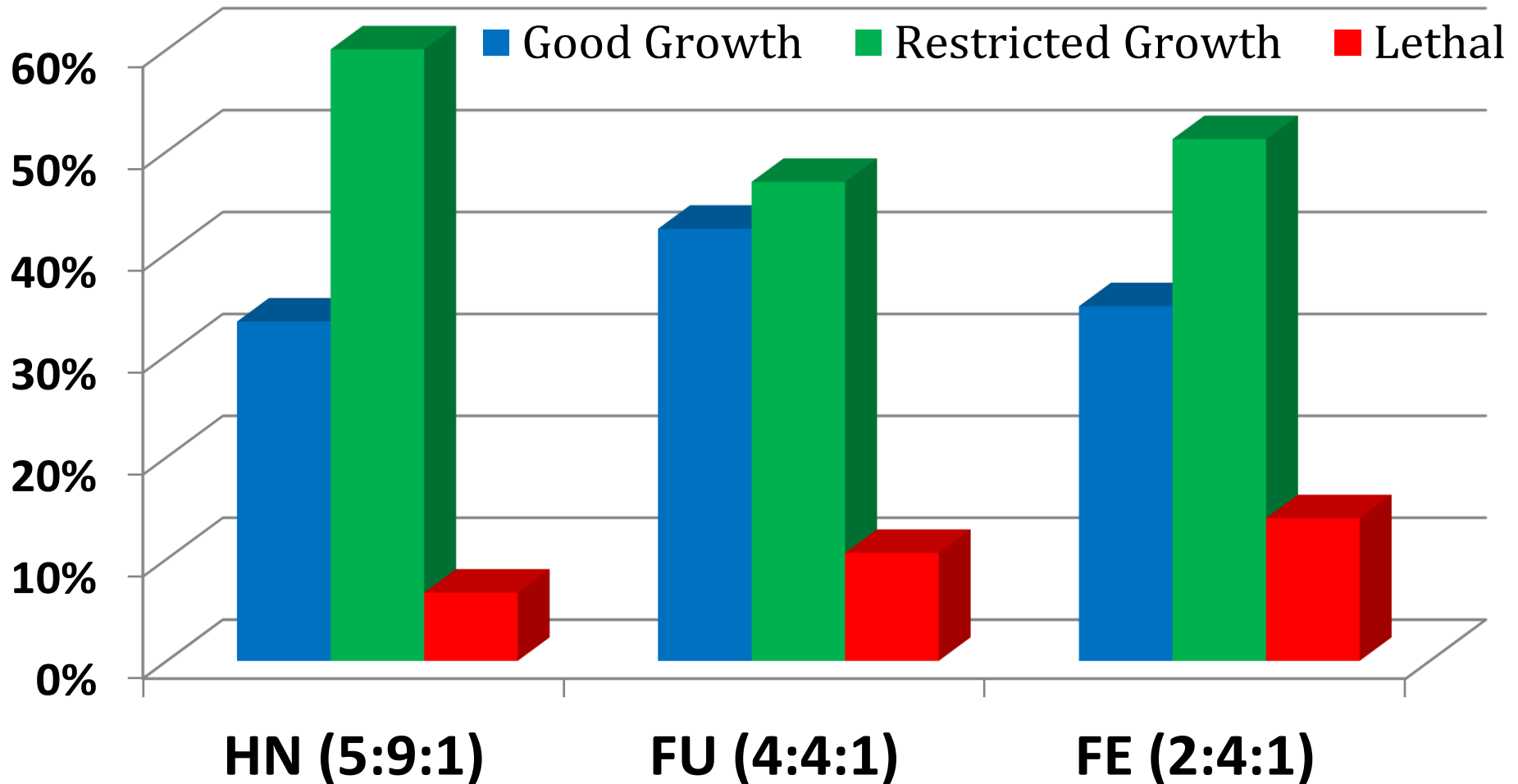
**$(28.2 < T < 30.4)$ OR
 $(T < 16.3 \text{ AND } DO > 3)$**

$(T > 30.4)$ OR $(DO < 3)$

Results — Coolwater Fish Habitat --- T and DO

Missaghi et al., 2017

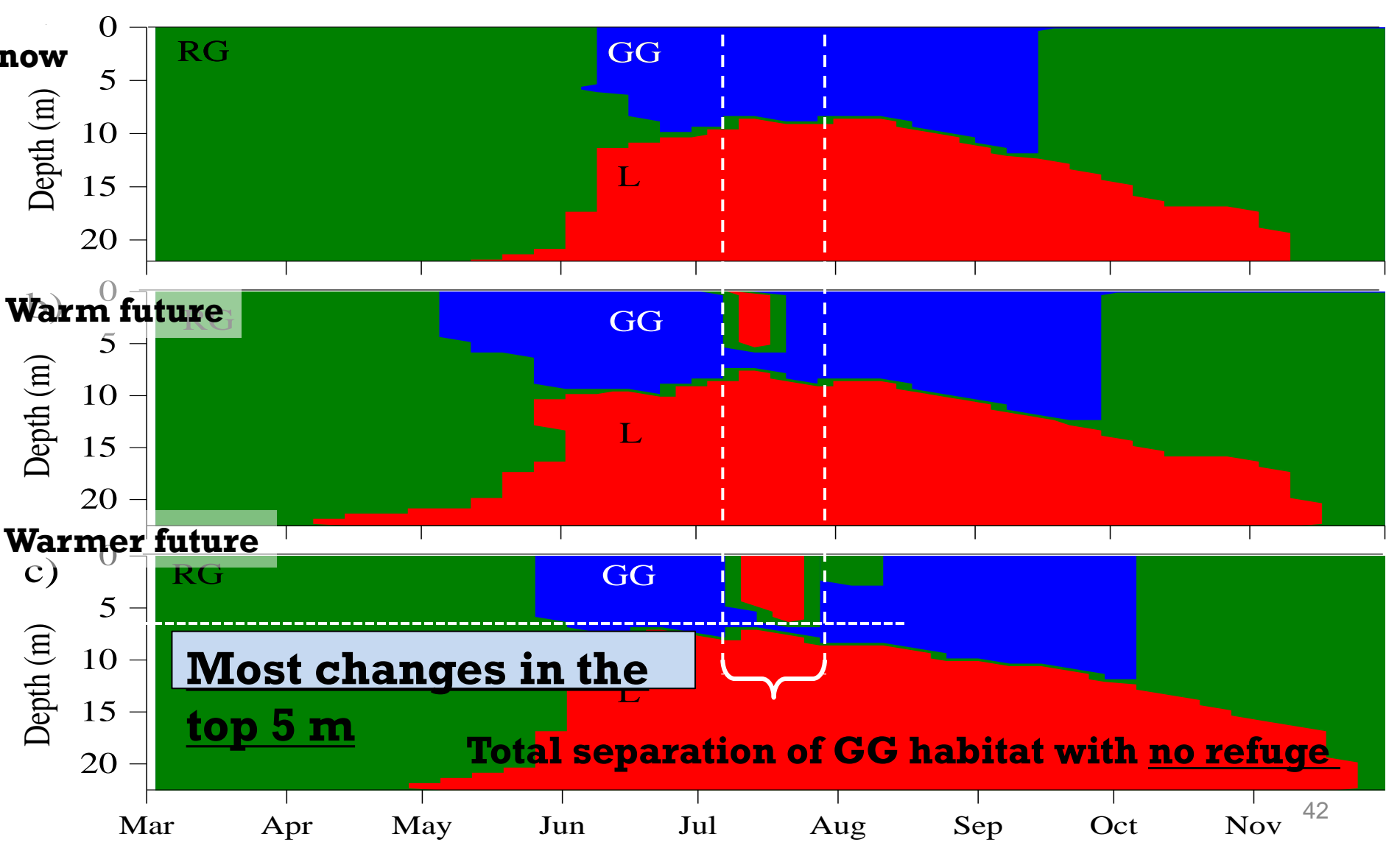
Fish habitat as a % of the total lake volume



Note ratios

Results: Coolwater fish habitat spatial & temporal evaluation

Deepest point of the study area (West Upper Bay)



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Do we have solutions?

What can we control?

3:50 pm

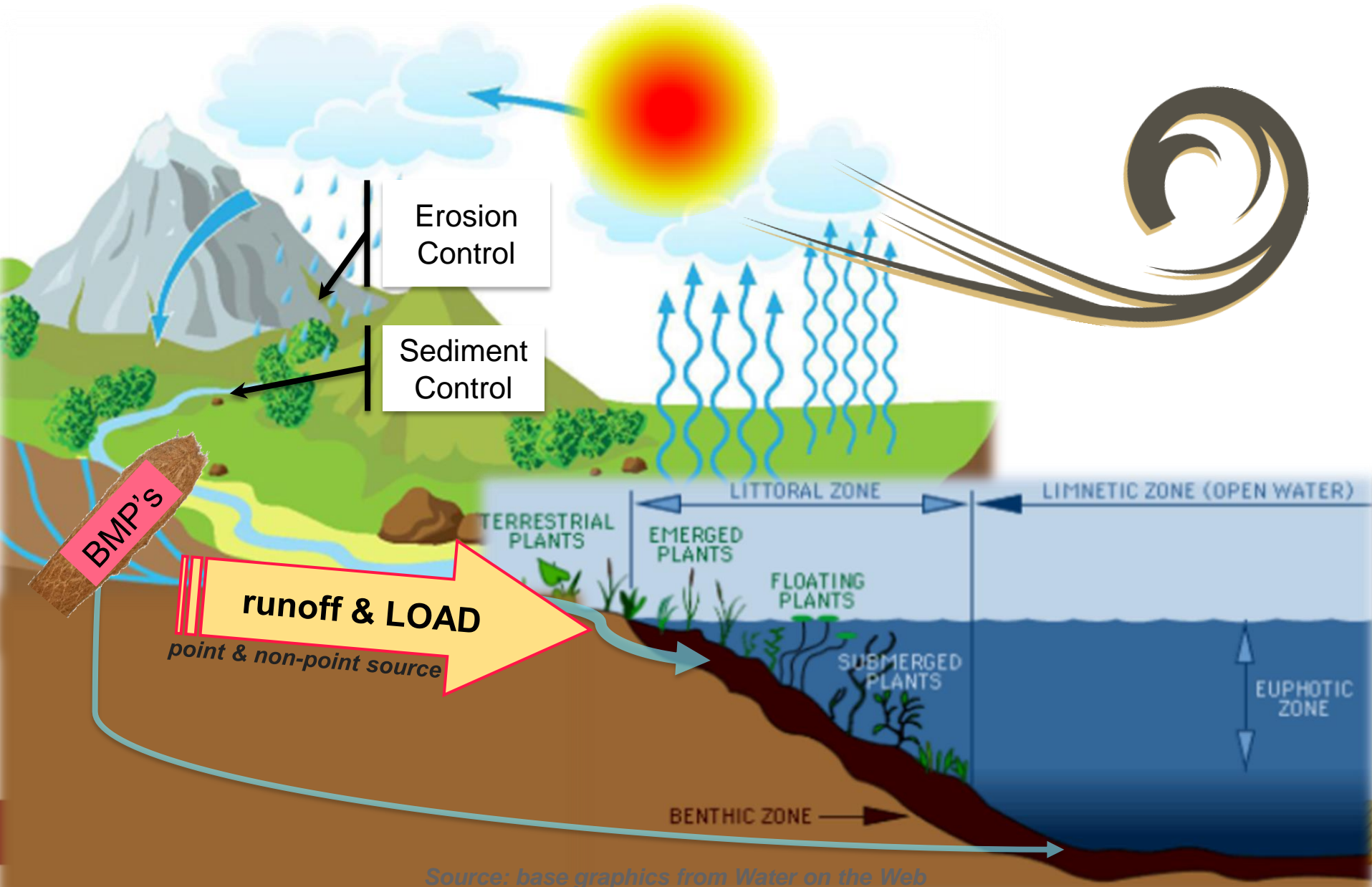
Q & A; What is next and what actions to take?



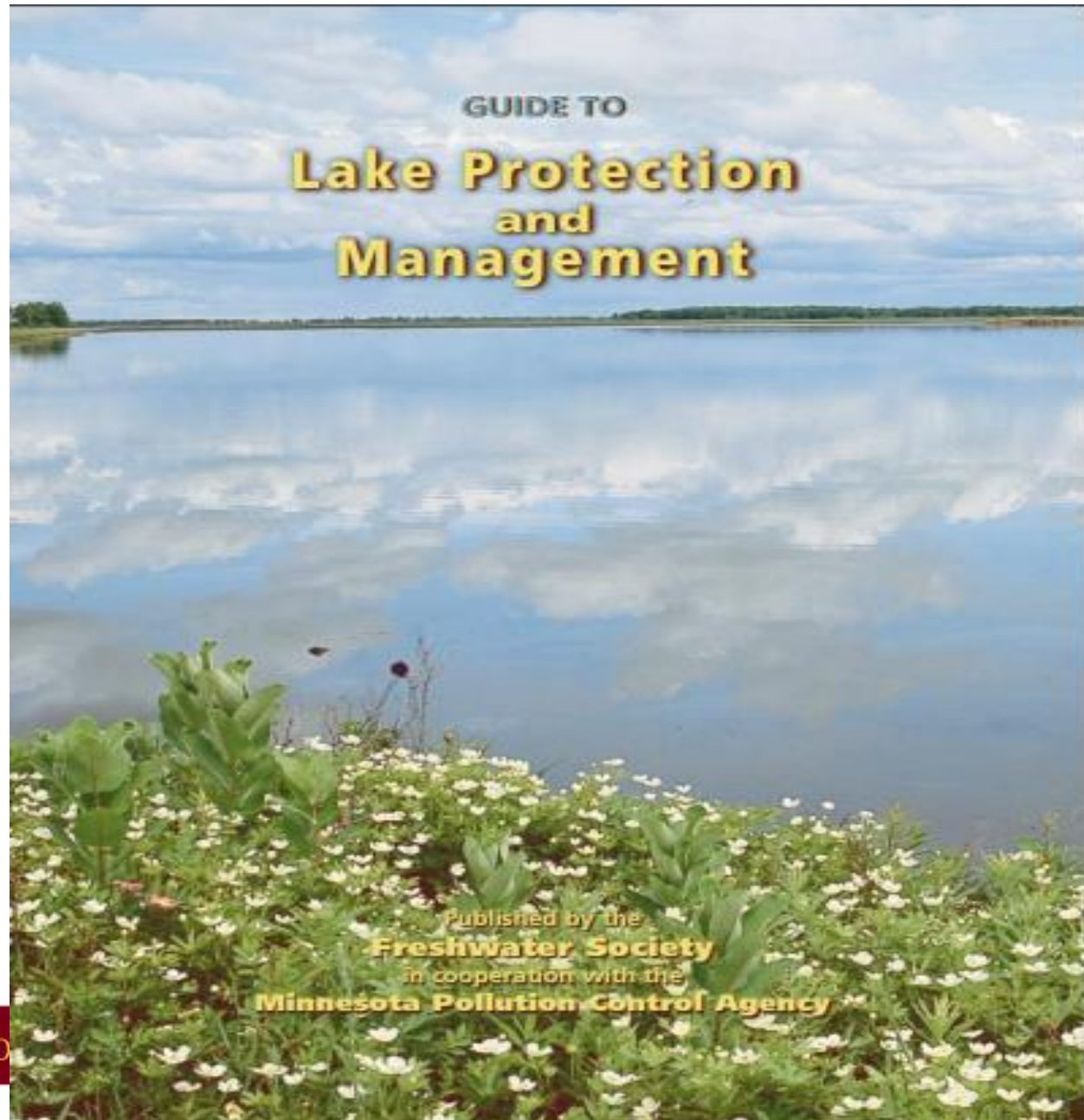
Do we have solutions?
What can we control?



Do we have solutions: watershed management

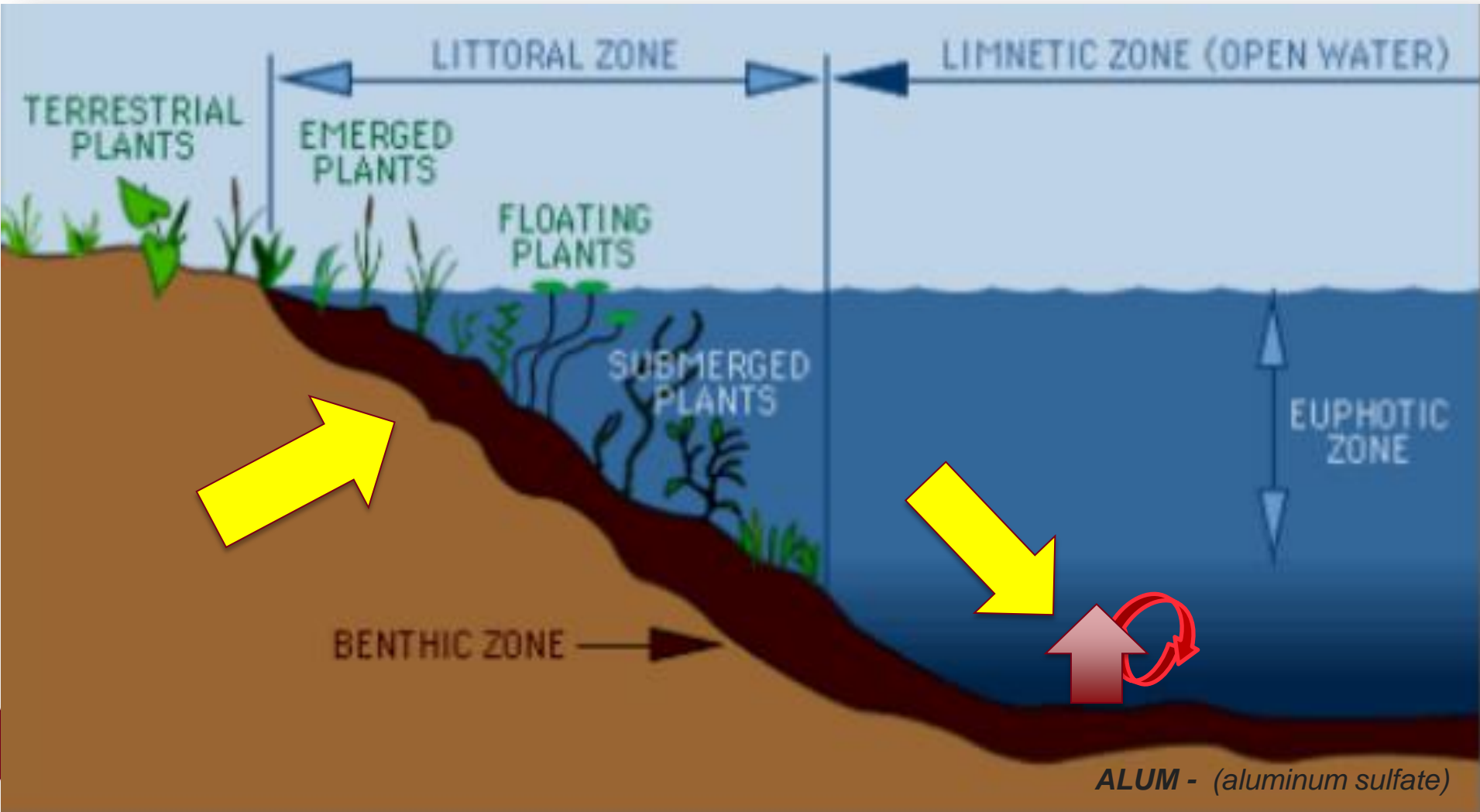


Do we have solutions: inflake management



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Do we have solutions: inflake management



We have solutions:

Chemical

Algal toxins, nutrient control, plant control, fish control, alum treatment, herbicide,.....



Physical



Aeration and circulation, Dilution and flushing, On-shore treatment techniques, drawdown, harvesting, bottom sealing, & shading (dye).....

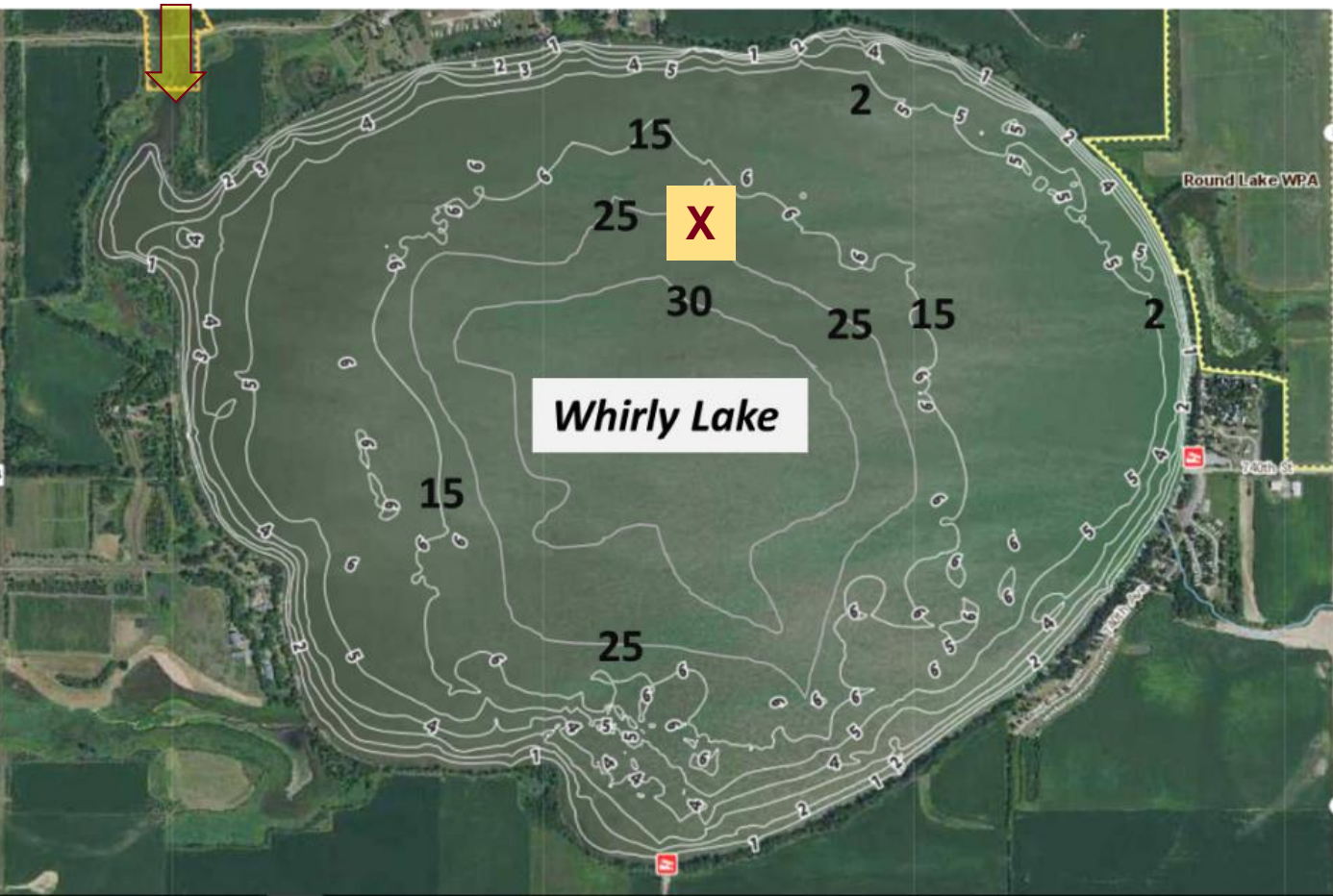


Biological



Exercise II: *Work in teams of 3. Take 7-10 Min.; Max. depth = 30'; Optic zone: 15';*

1. Identify the littoral zone, is there anything missing in this area? How would the XXXX (the missing thing) help with water temperature?
2. Can you draw the lake thermal structure (from top to the bottom of the water column) in a typical month of April and August at the location marked with X? How about the DO levels?
3. Theoretically, on a typical day in August, why wouldn't we see walleye at 30 feet deep? Where can they find refuge?
4. If we had groundwater seeping in (discharge) and acted as a coldwater refugia (a place for fish to go and get away from the warm water); then at what depth would it be an ideal location?



Additional reading / resources:

HOW COLD IS COLD ENOUGH? STREAM TEMPERATURES OF MINNESOTA'S NORTH SHORE STREAMS TODAY AND IN THE FUTURE

http://www.lrcd.org/uploads/1/6/4/0/16405852/johnson_cold_water.pdf

Relationship between stream temperature, thermal refugia and rainbow trout *Oncorhynchus mykiss* abundance in arid-land streams in the northwestern United States. [J. L. Ebersole](#); [W. J. Liss](#) ; [C. A. Frissell](#)

First published: 20 December 2001; <https://doi.org/10.1034/j.1600-0633.2001.100101.x>

Simulations of Cisco Fish Habitat in Minnesota Lakes under Future Climate Scenarios

The cold-water climate shield: delineating refugia for preserving salmonid fishes through the 21st century DANIEL J. ISAAK 1 , MICHAEL K. YOUNG 2 , DAVID E. NAGEL 1 , DONA L. HORAN 1 and MATTHEW C. GROCE 1 1 Rocky Mountain Research Station, U.S. Forest Service, 322 E. Front St. Suite 401, Boise, ID 83702, USA, 2 Rocky Mountain Research Station, U.S. Forest Service, 800 East Beckwith Avenue, Missoula, MT 59801, USA





Thank you!
Q & A

Action!

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in a Changing Climate***

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