Coolwater Fish Habitat in a Changing Climate

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

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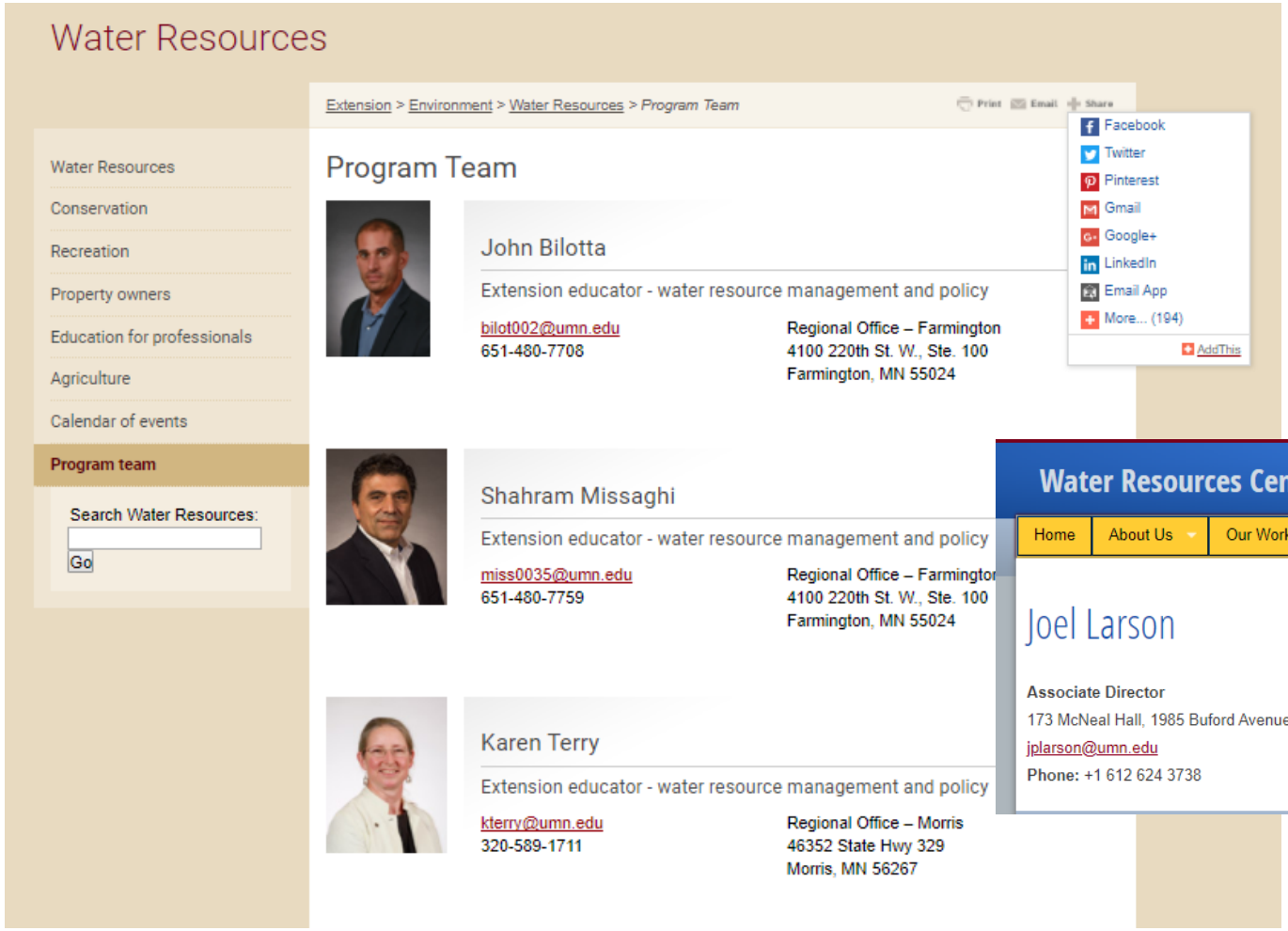
What is the UoM Extension Water Resources Team?

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

Who are the UoM Extension Water Resources Team members?

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



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

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Today's Agenda - 1st: Your expectations

Introductions

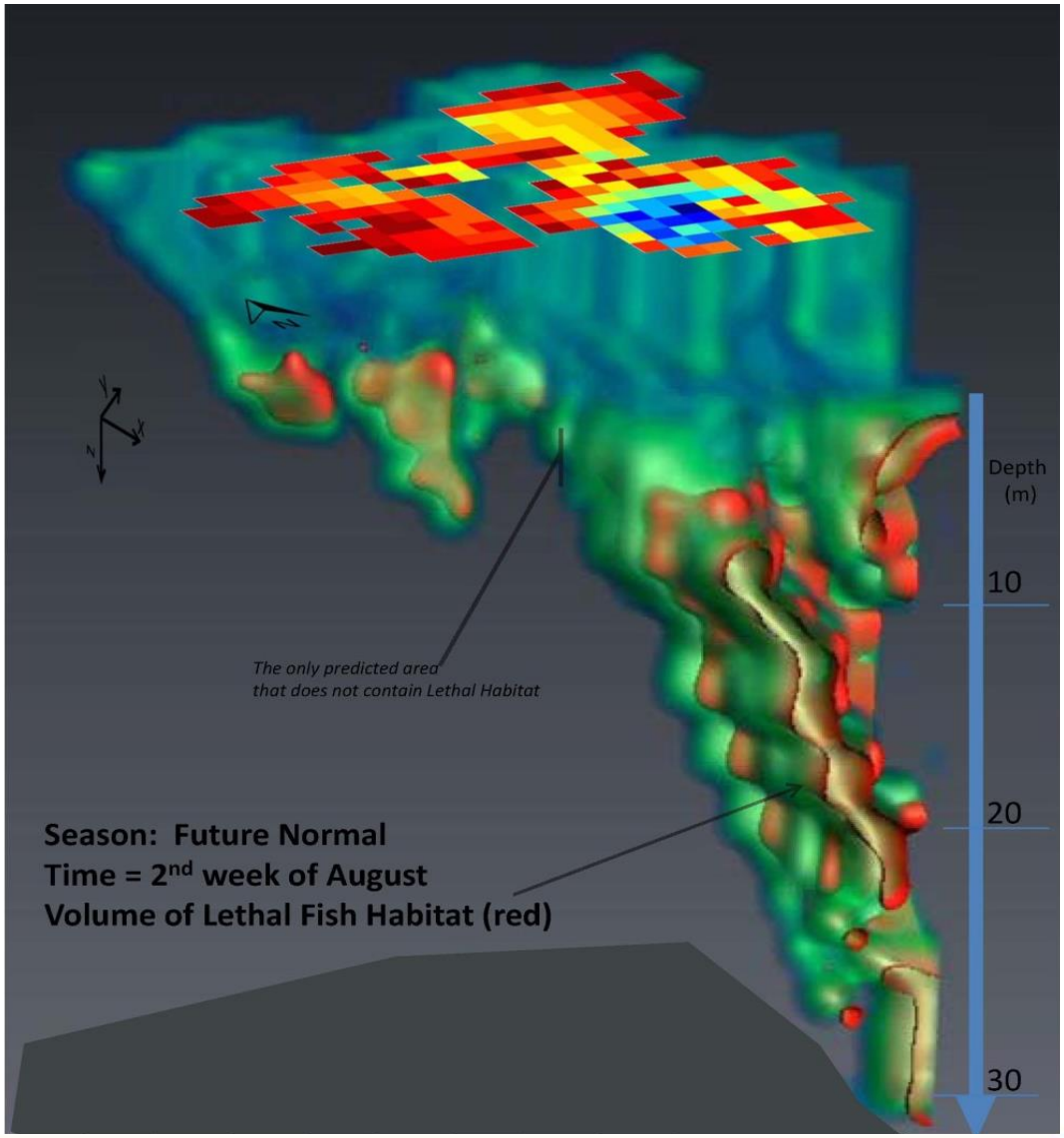
--Name

--organization, agency, location,..

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

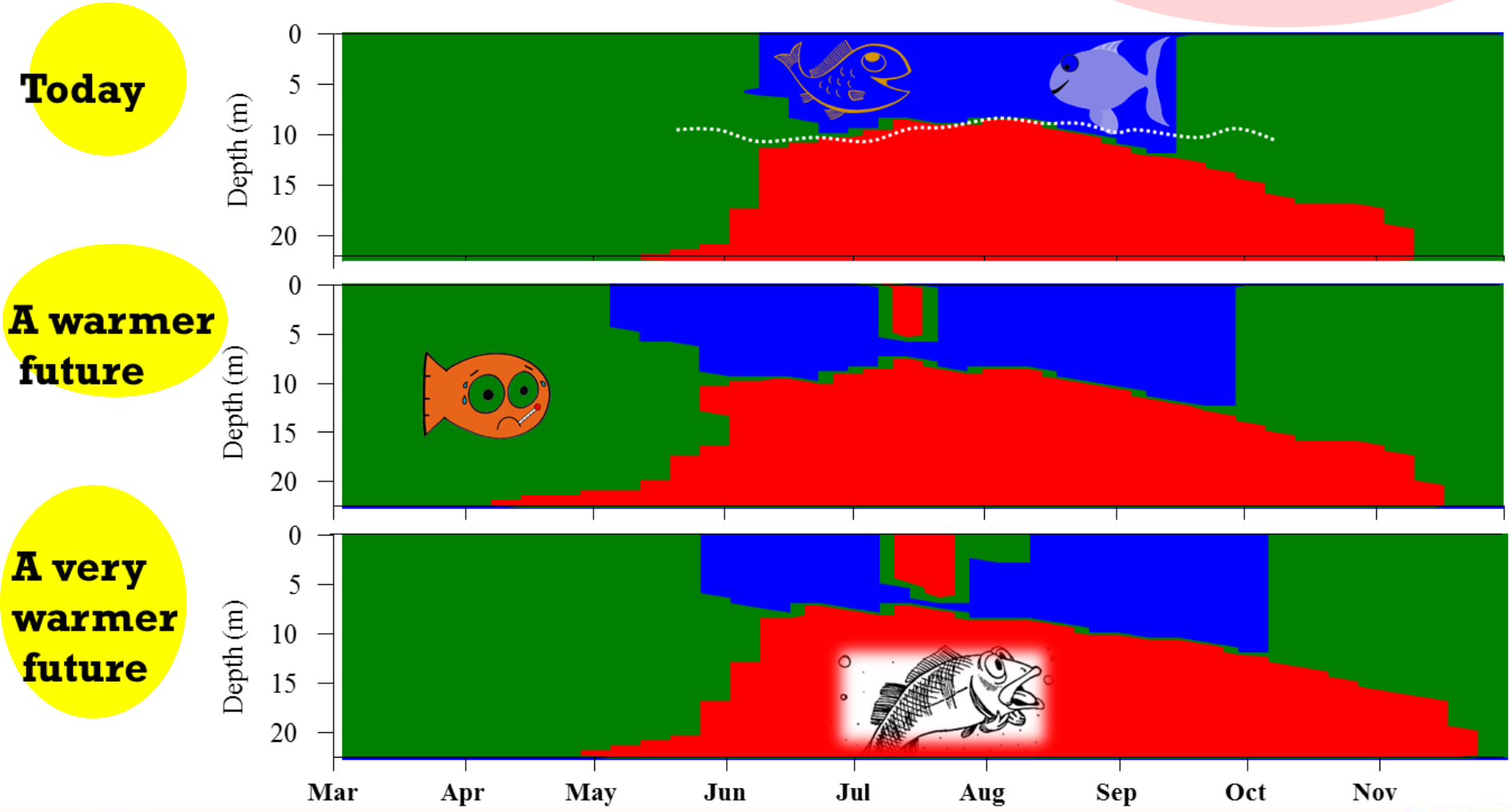
Today's Agenda - Ultimate goal

Habitat App.
to assist
decision makers



What did we learn?

Fish Habitat Response to Lake Warming



Today'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,……

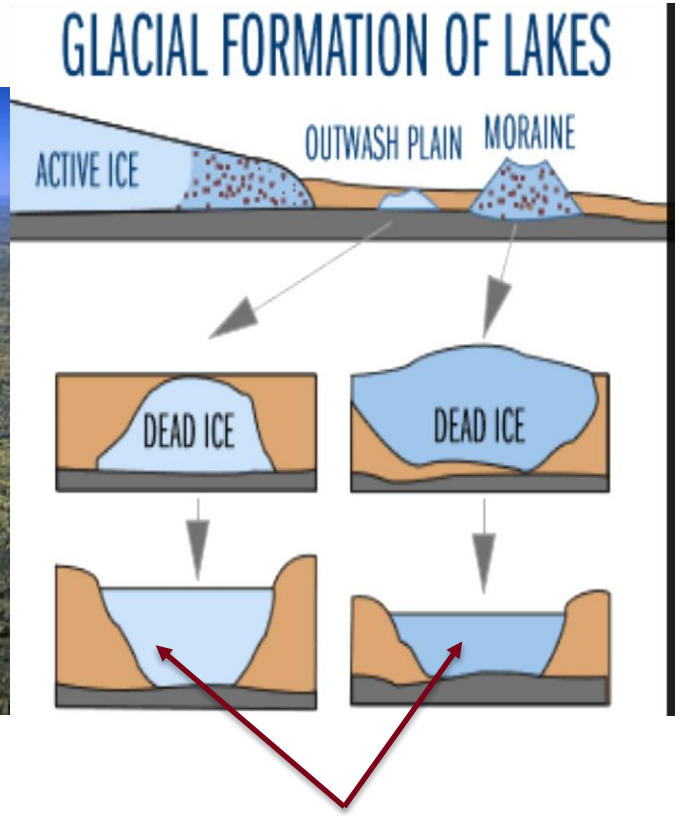
lakes are strongly influence by:

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

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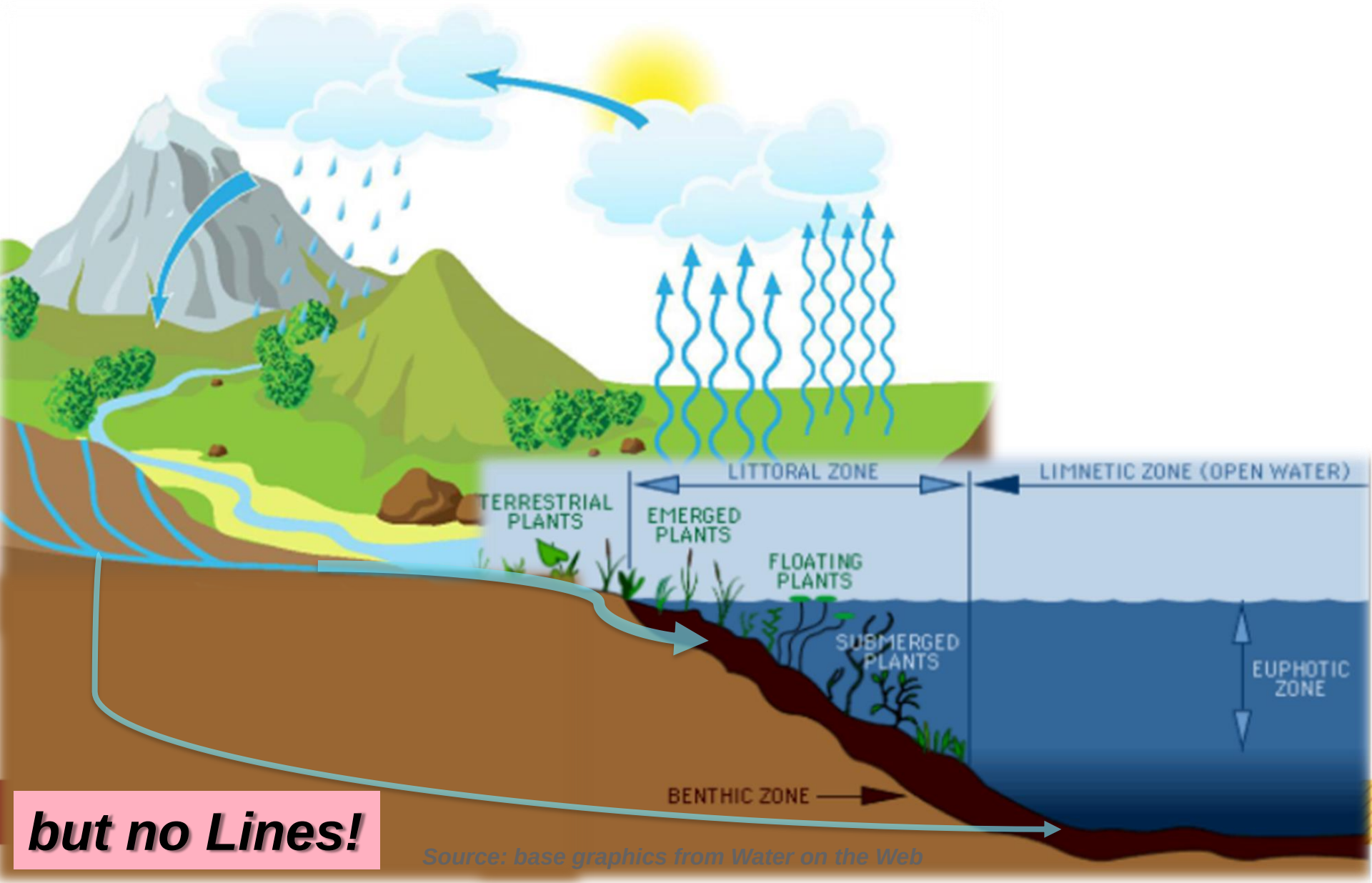
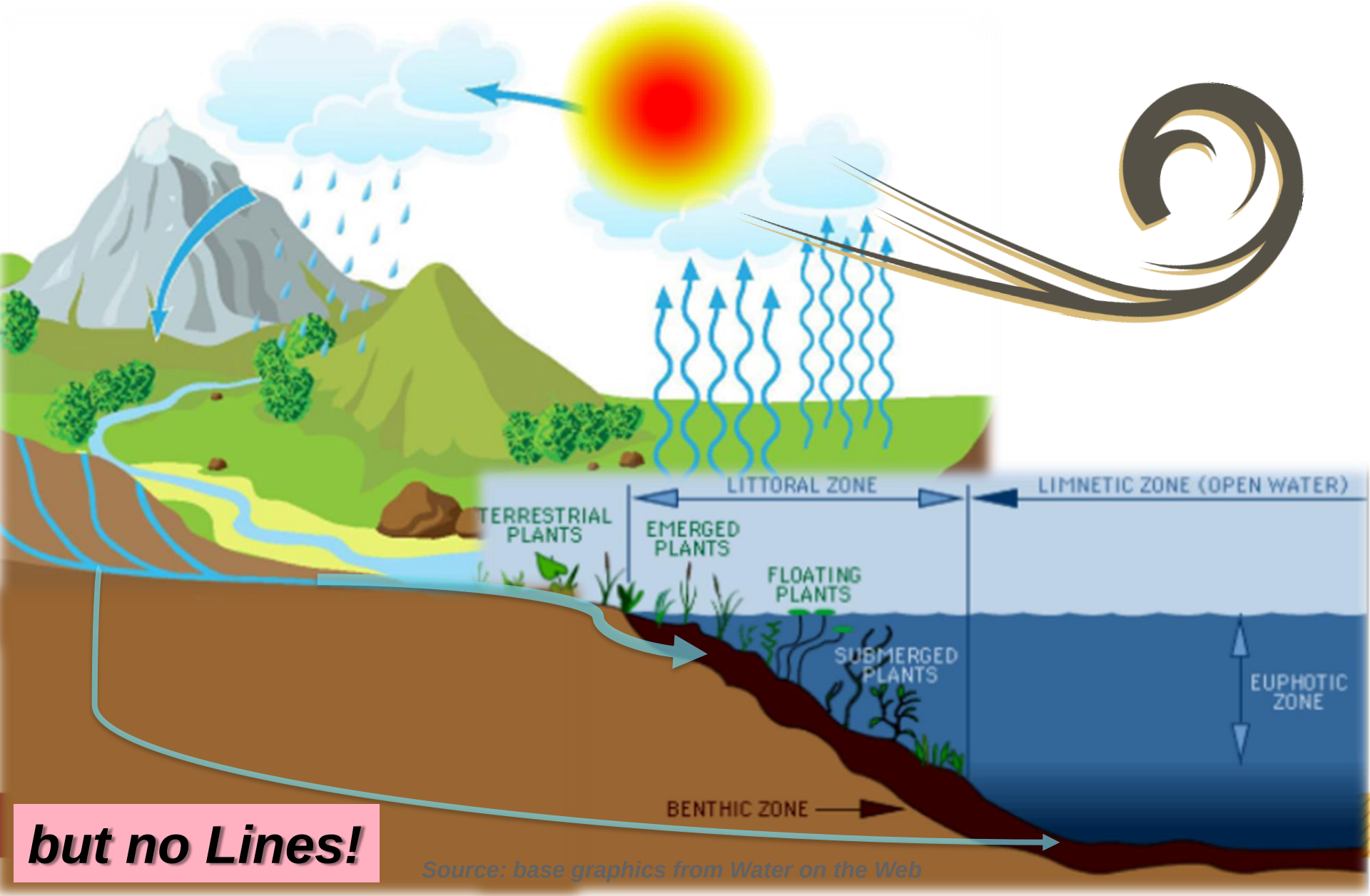
Lake system: lake & watershed



but no Lines!

Source: base graphics from Water on the Web

Lake system: lake & watershed



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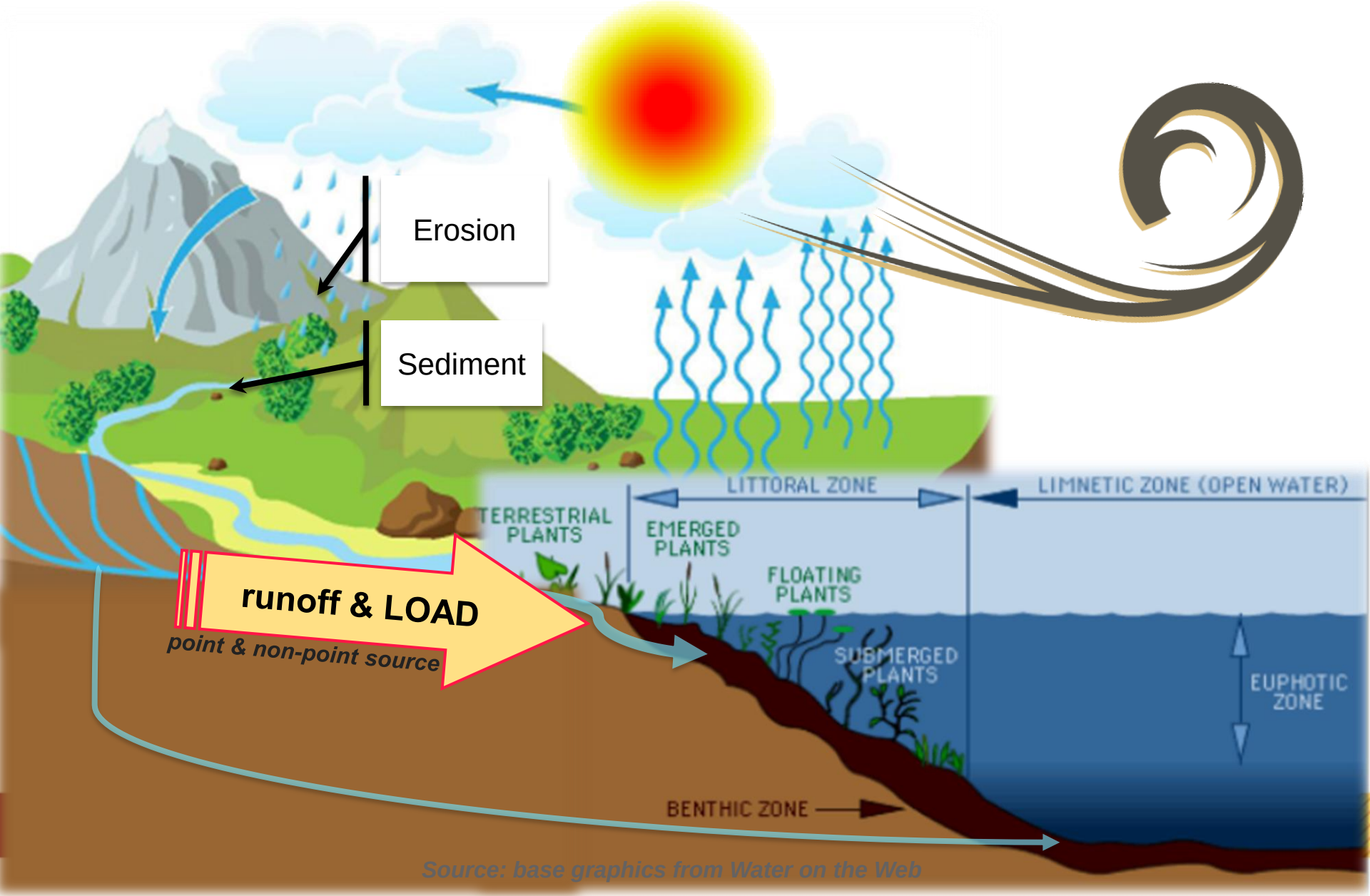
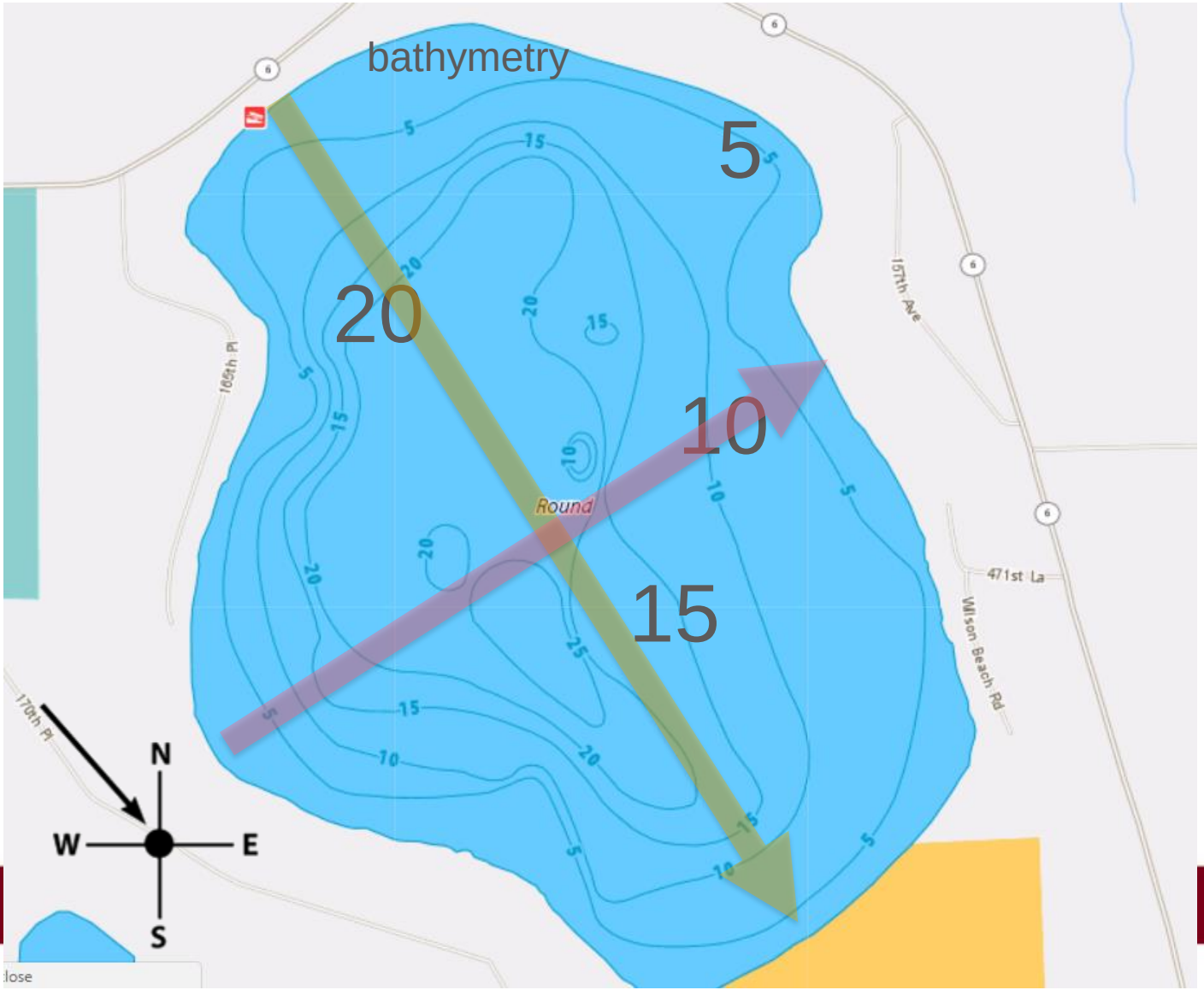
Lake system: lake & watershed



Source: base graphics from Water on the Web

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;

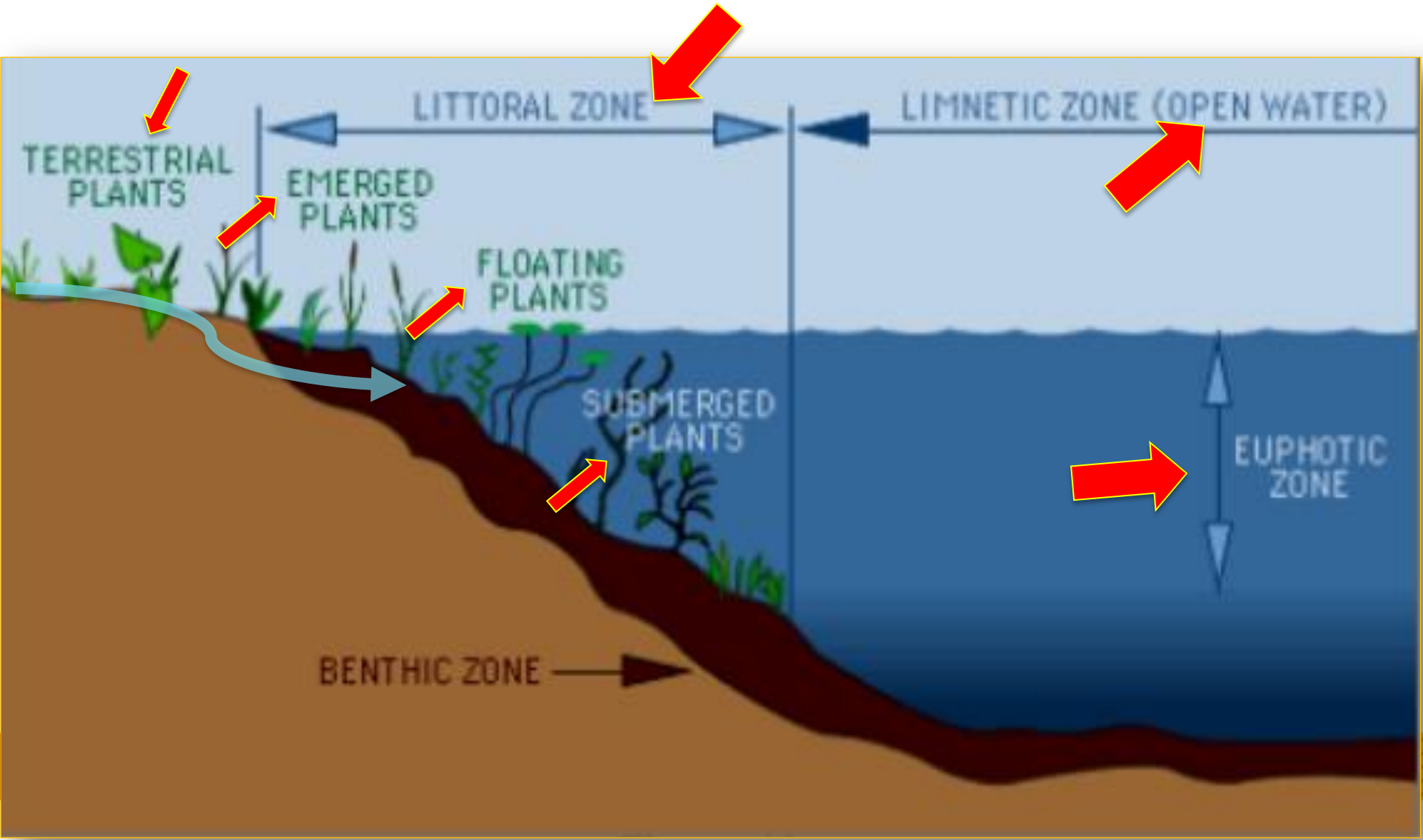
Max length

Littoral Area
bathymetry

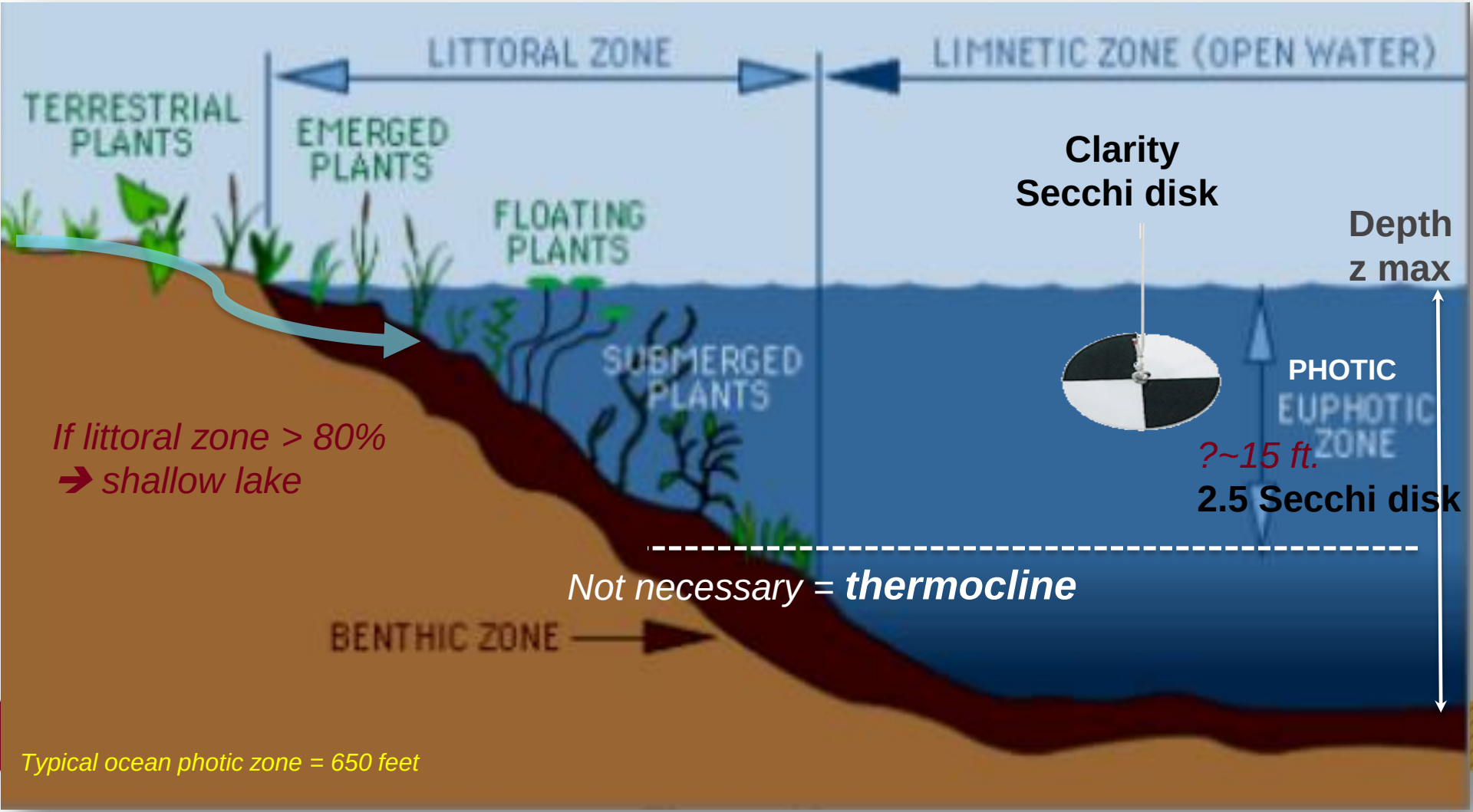
Maximum Depth

Average Depth,..

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



Lake system: lake ecosystems



Lake system: thermocline?

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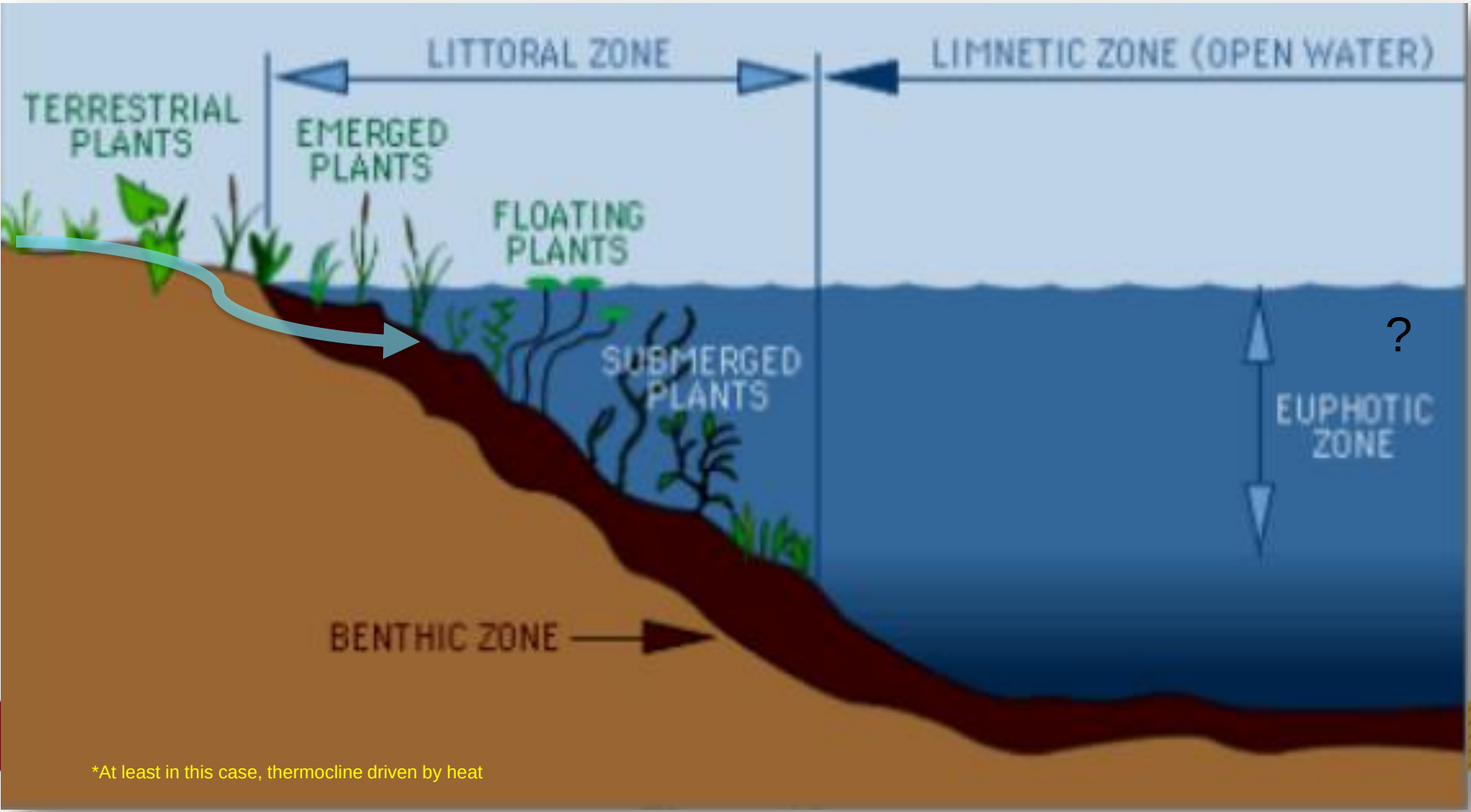
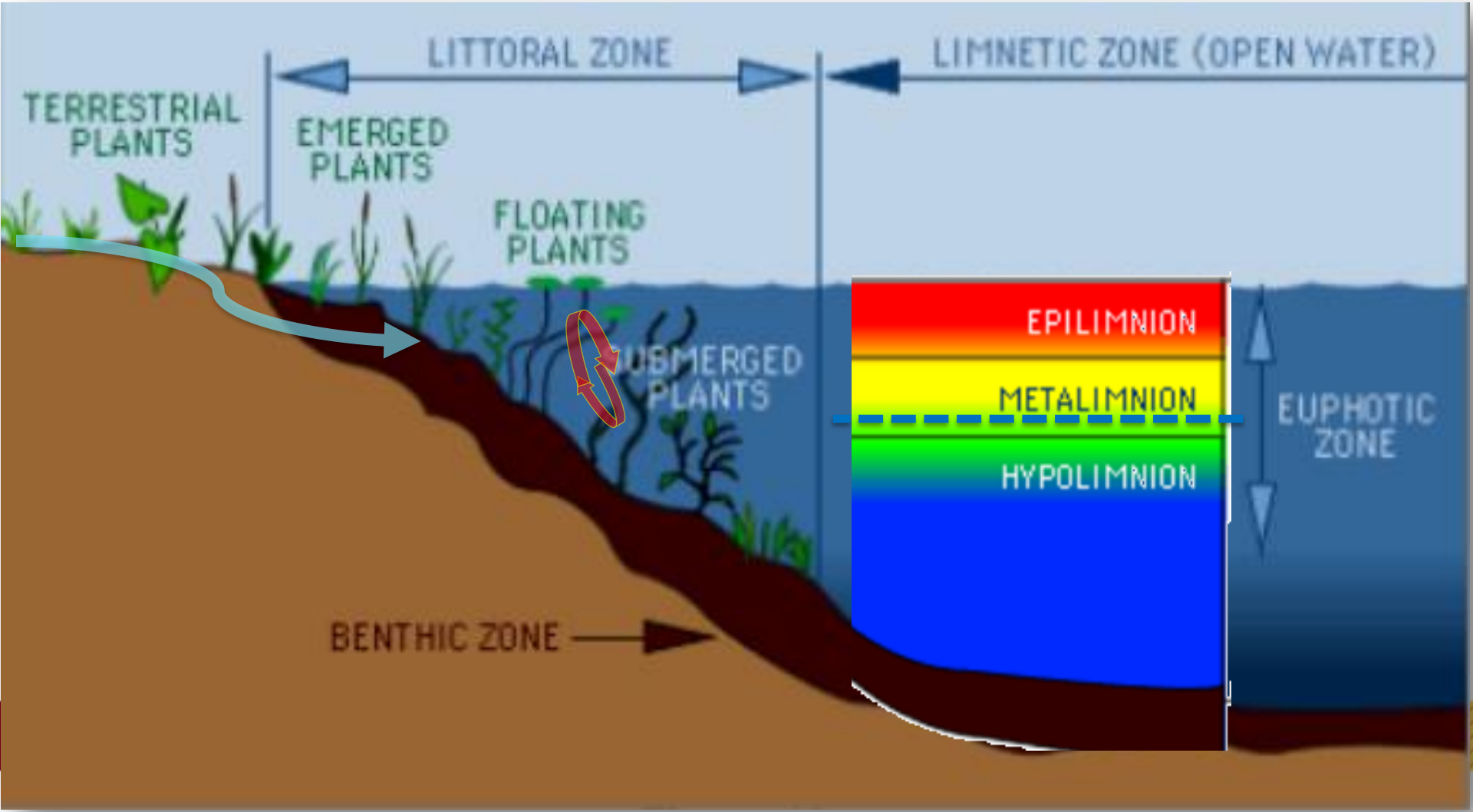


Lake system: thermocline?

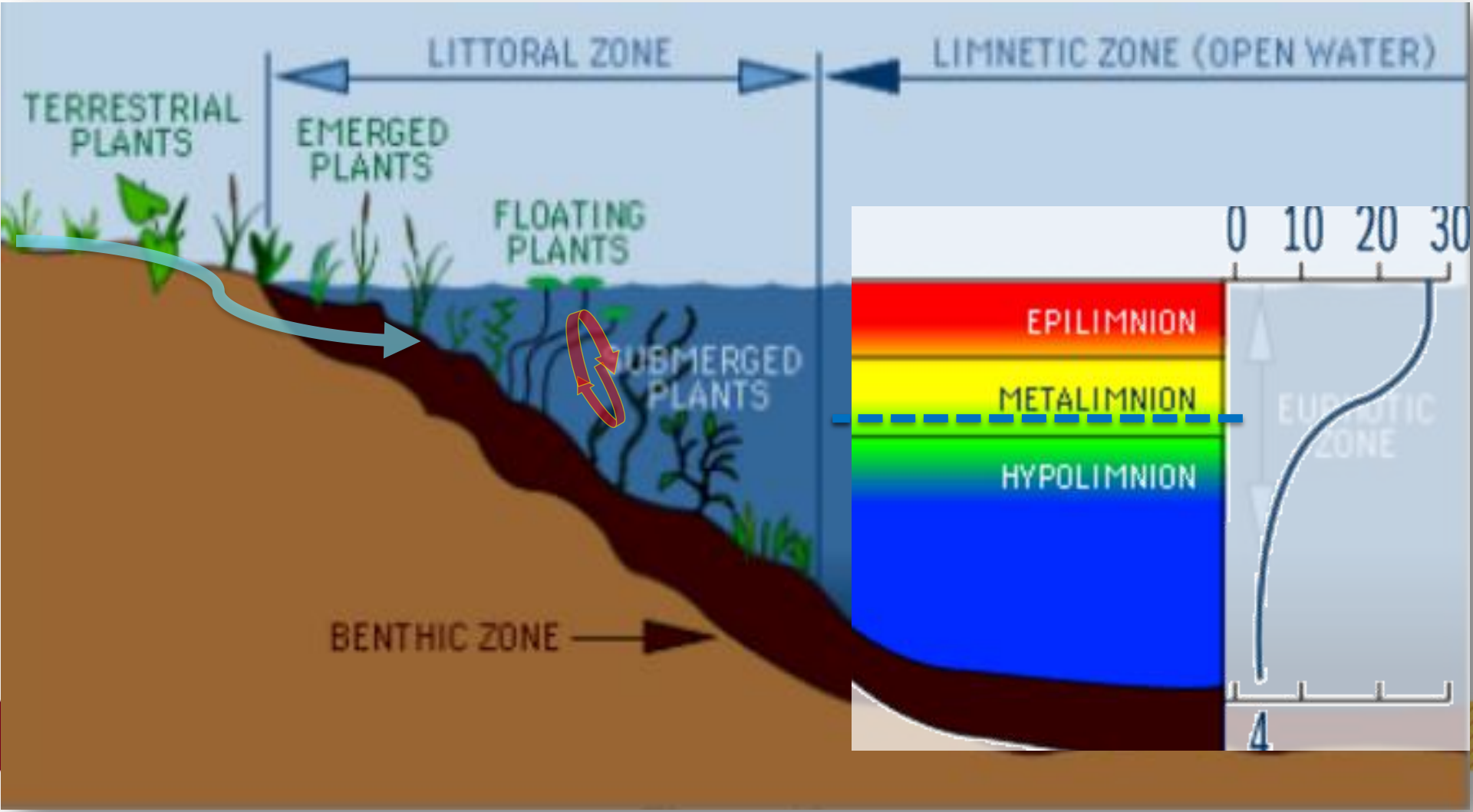
heat



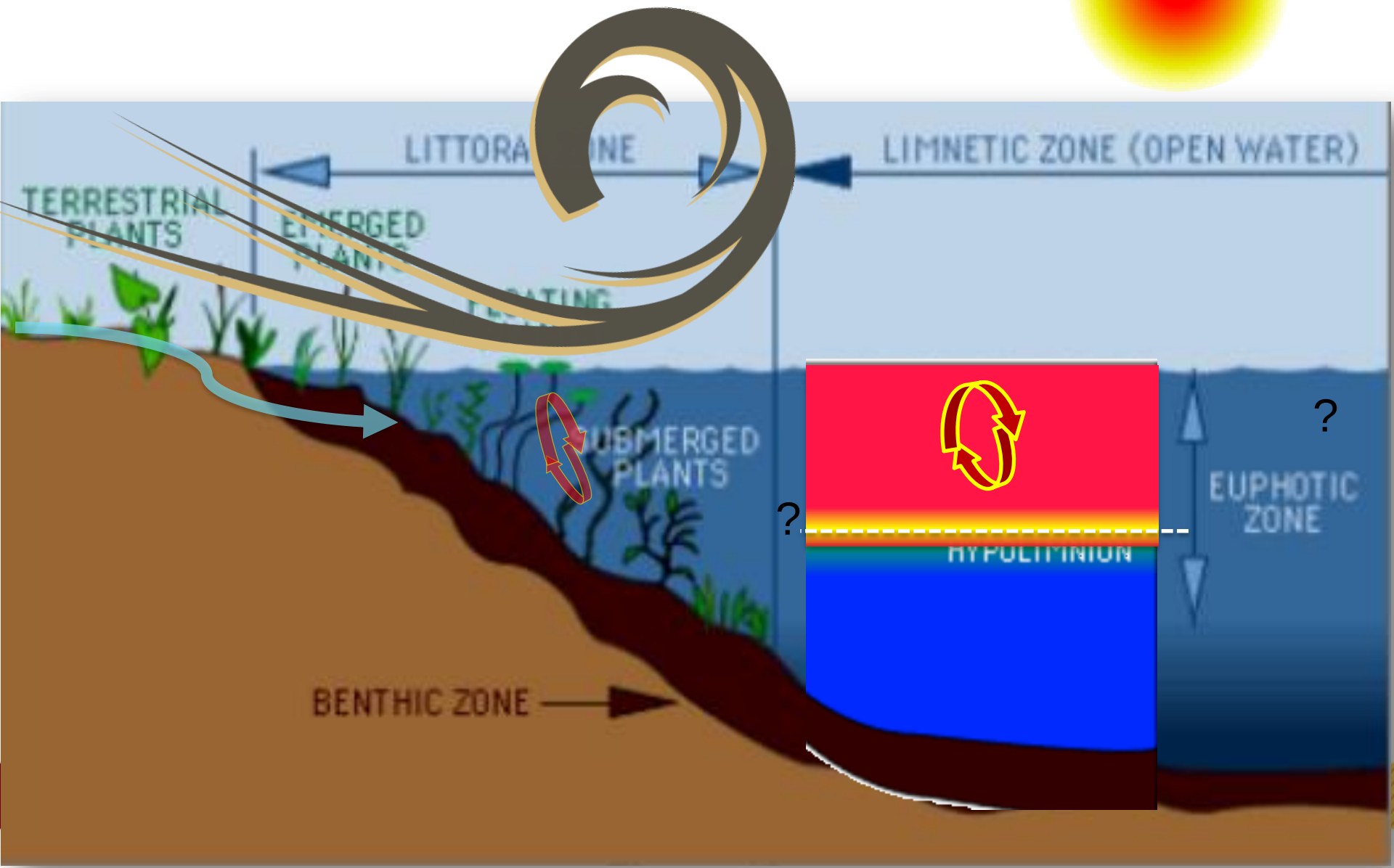
Lake system: thermocline?

Temperature

heat

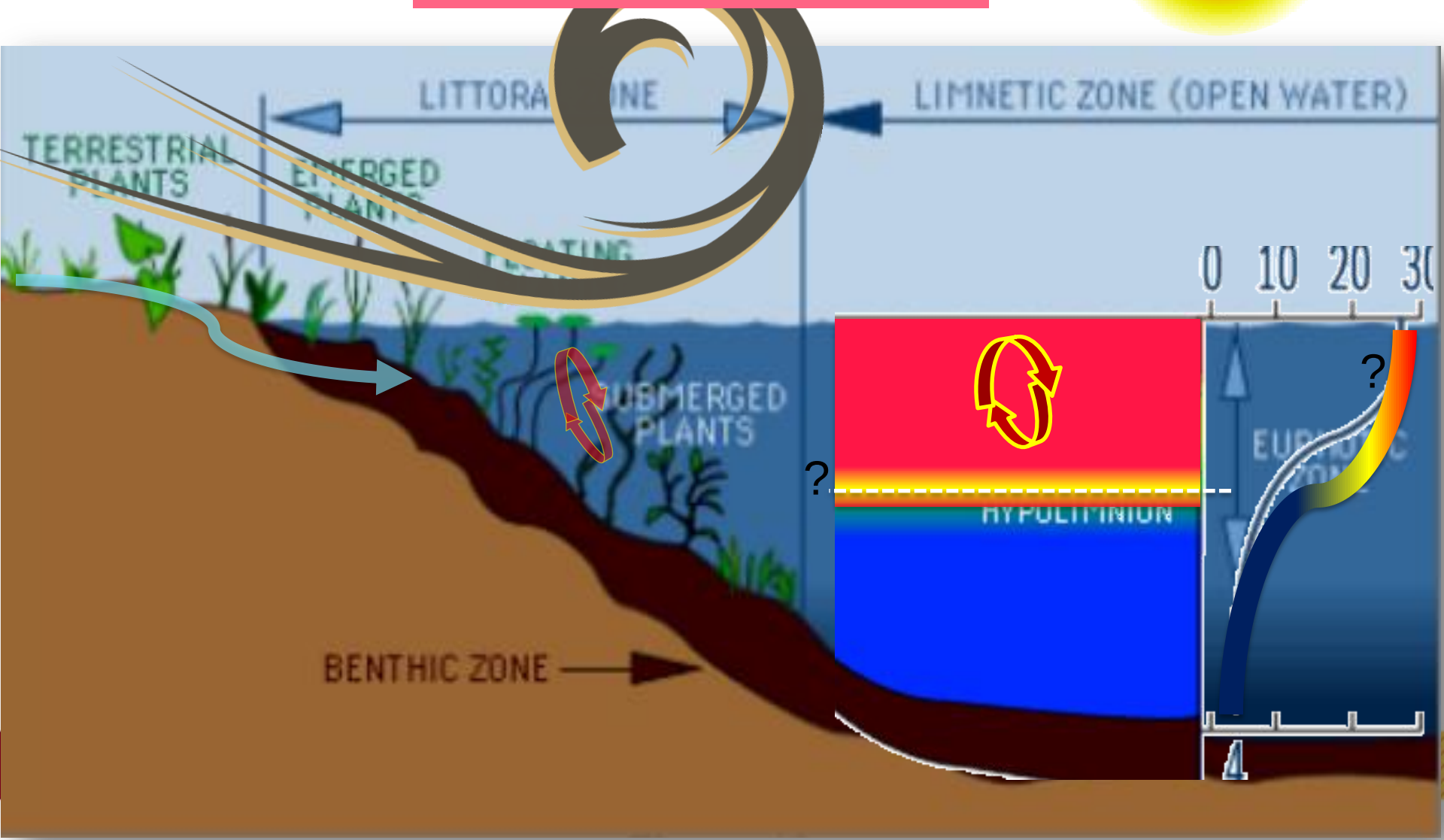


Lake system: lake processes



Lake system: lake processes

thermal structure



Lake system: thermal structure

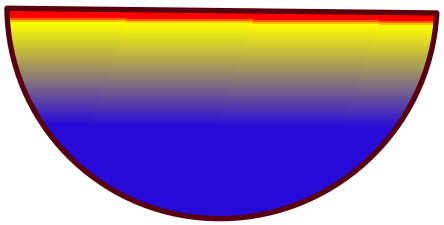
So what does it have to do with fish?

Let's do a quiz first!

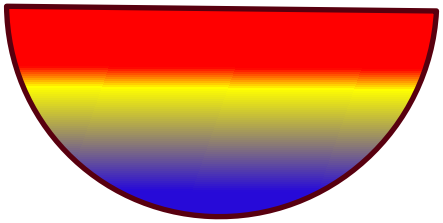
Lake system: thermal structure

Quiz – Matching:

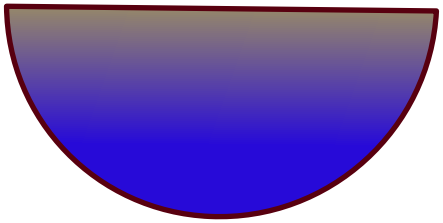
a. April **b. November** **c. August**



1



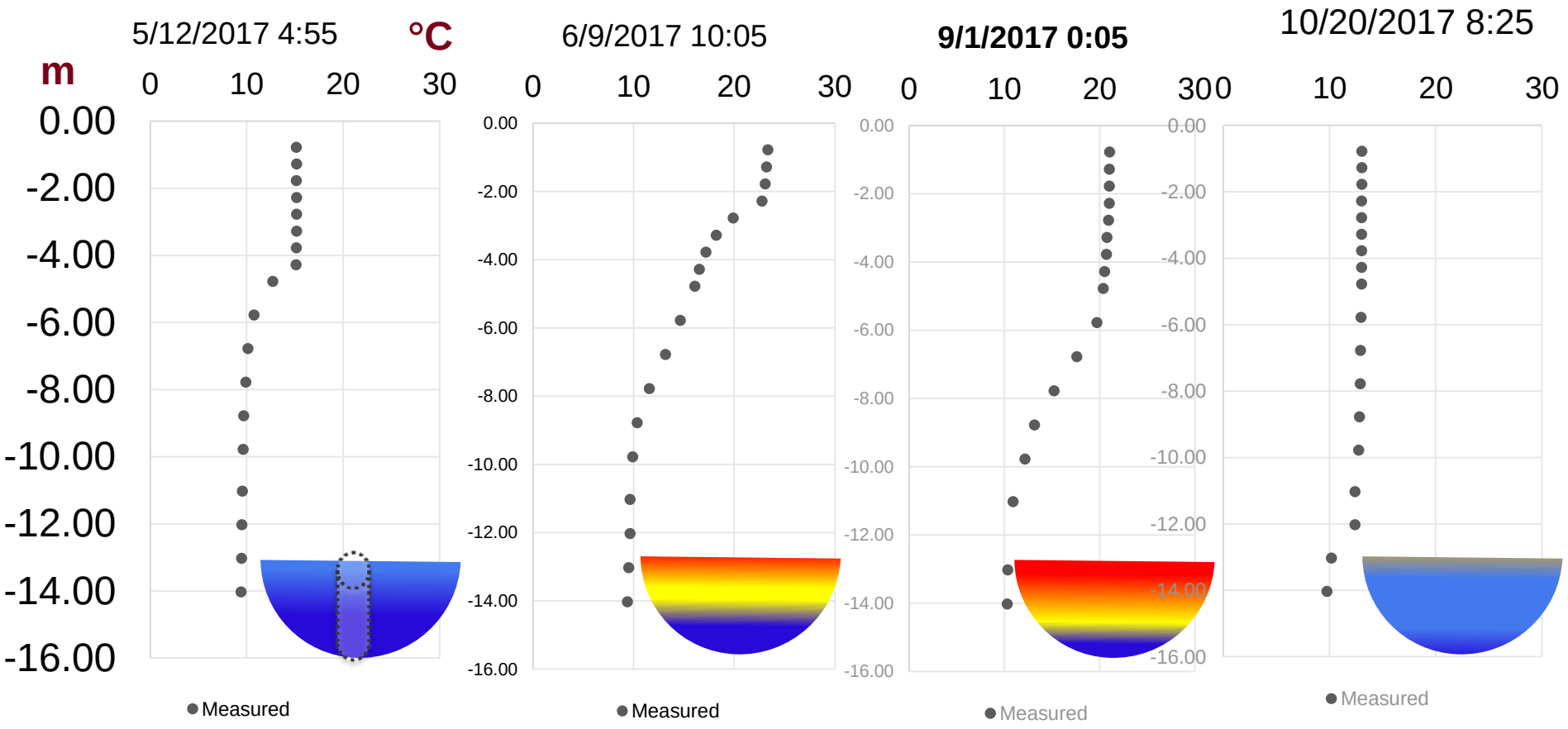
2



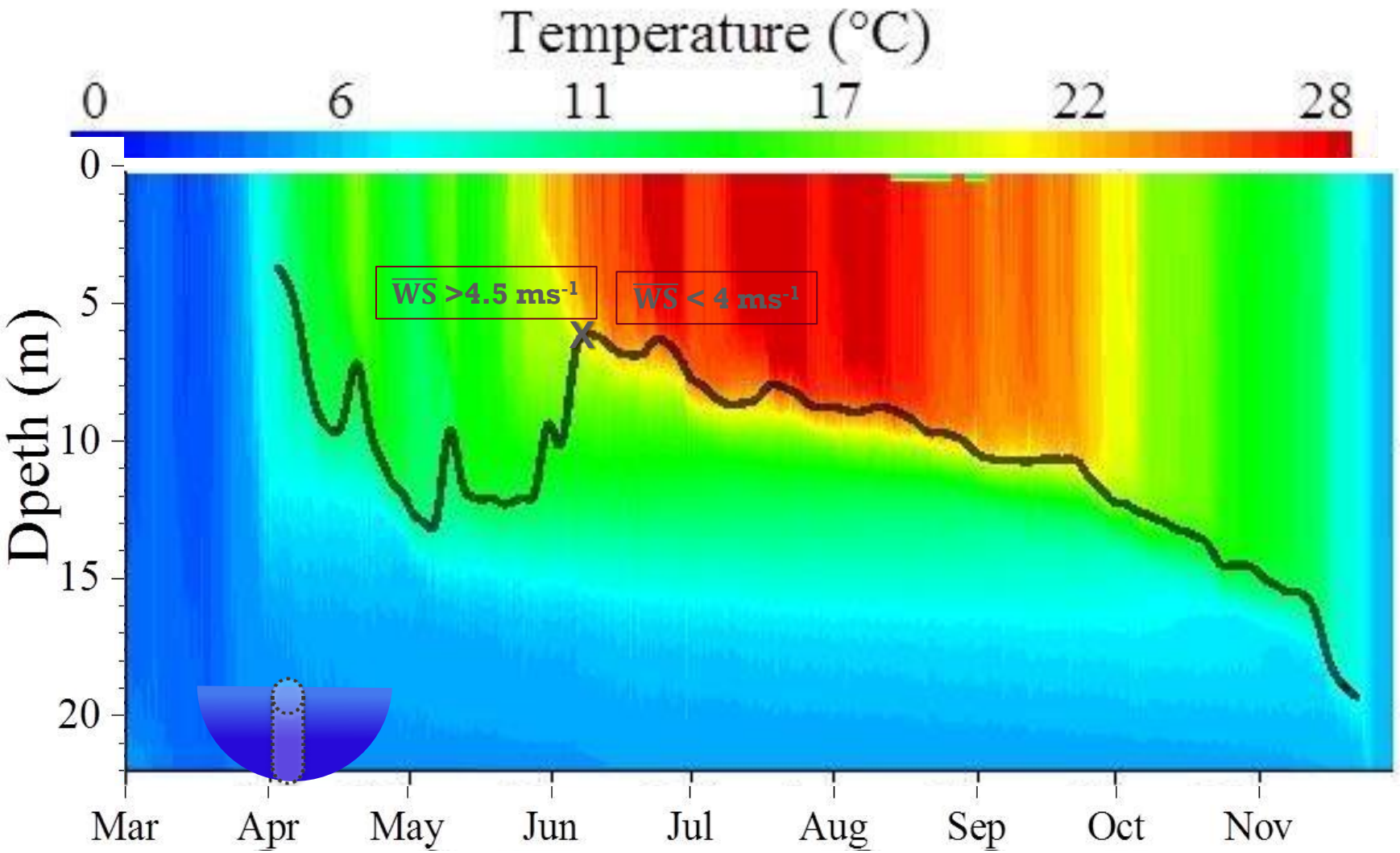
3

Lake system: thermal structure

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



Lake system: thermal structure



Lake system: thermal structure

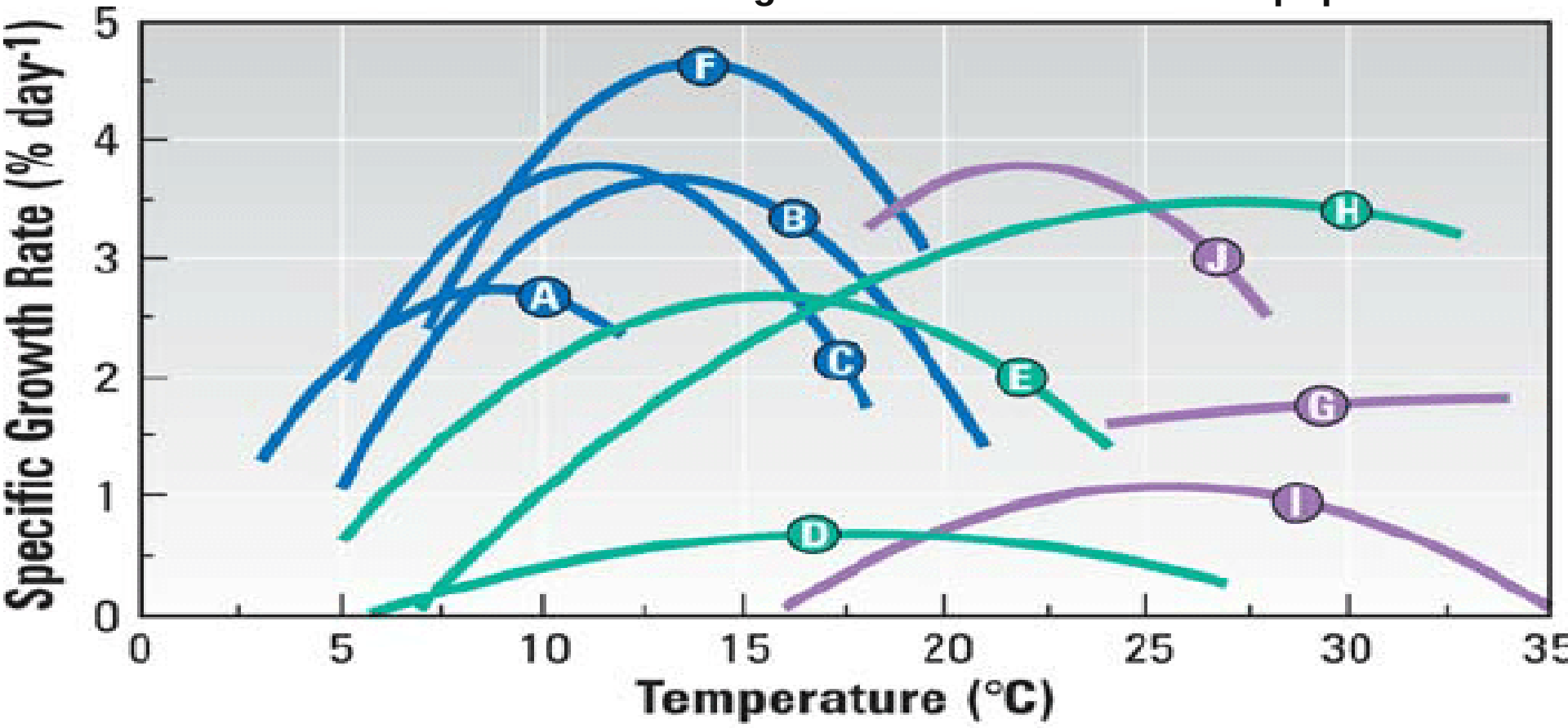
So what does it have to do with fish?

Temperature drives biology

Reist et al, 2006

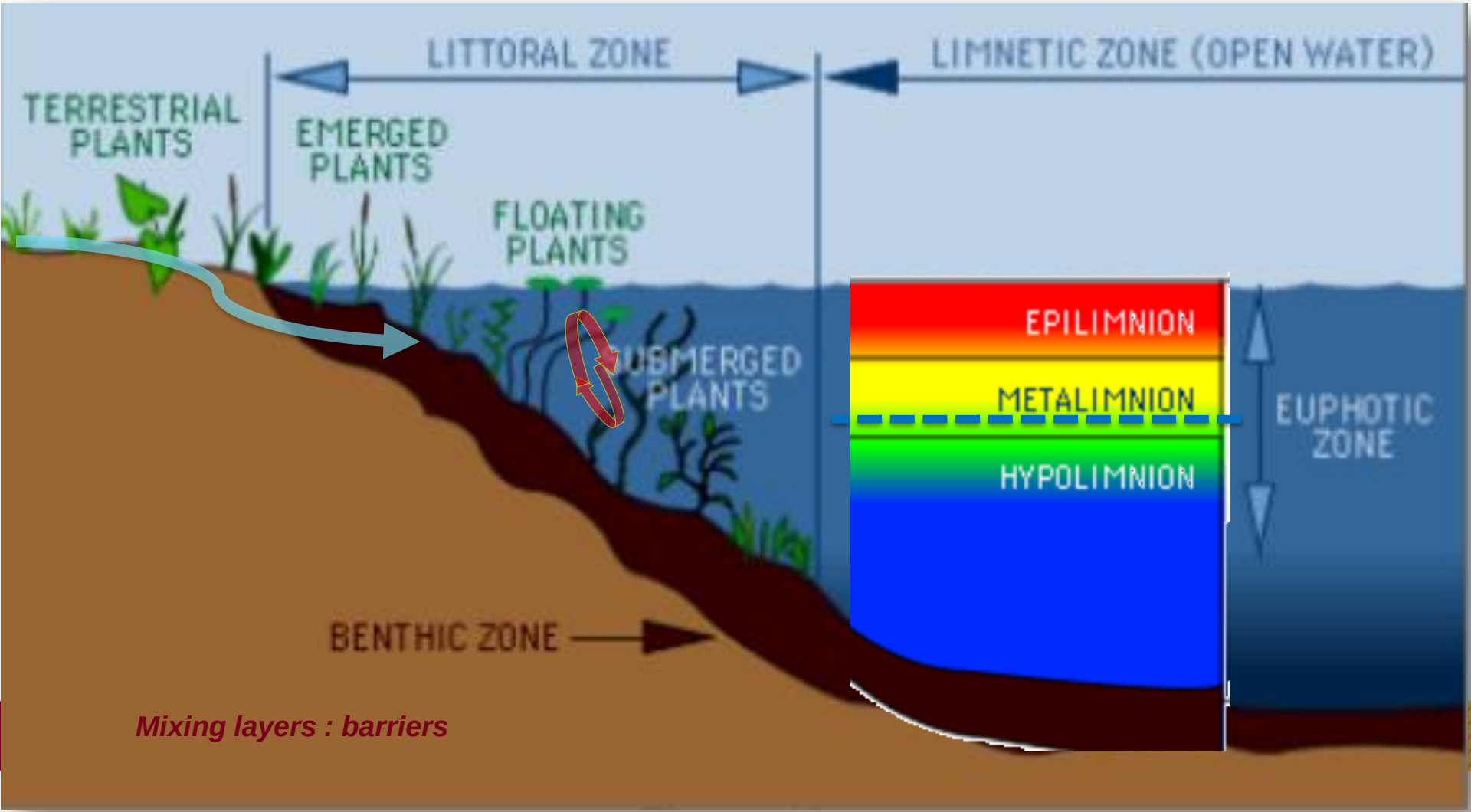
Temperature → fish growth rate

"General effects of climate change on Arctic fishes and fish populations"

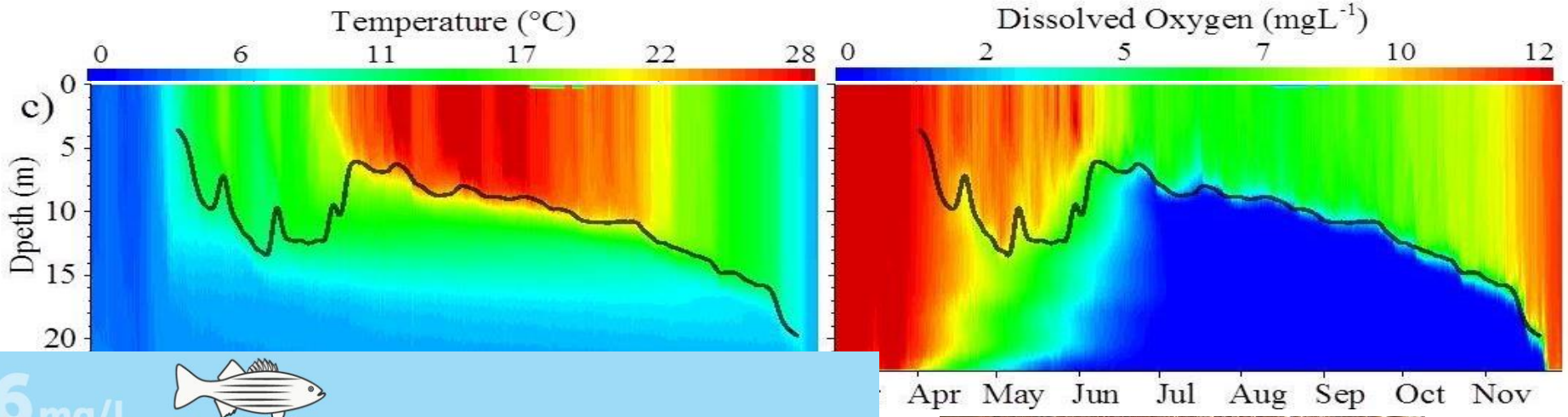


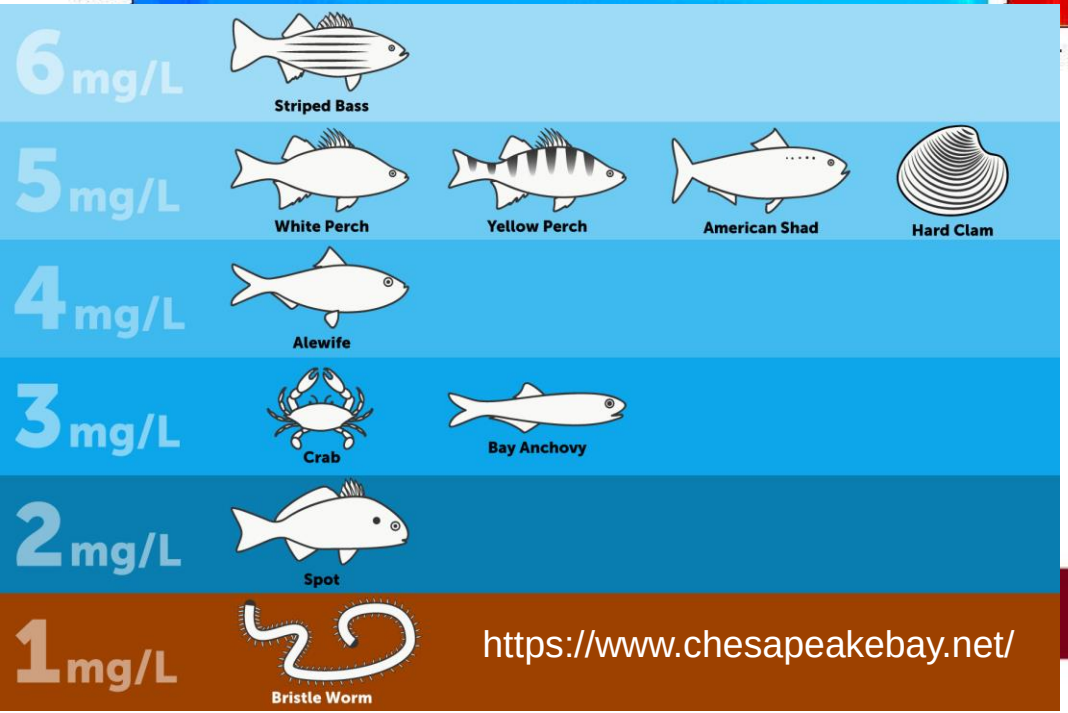
Reist et al, 2006

Thermal structure, stratification, DO distribution



Thermal structure, stratification, DO distribution



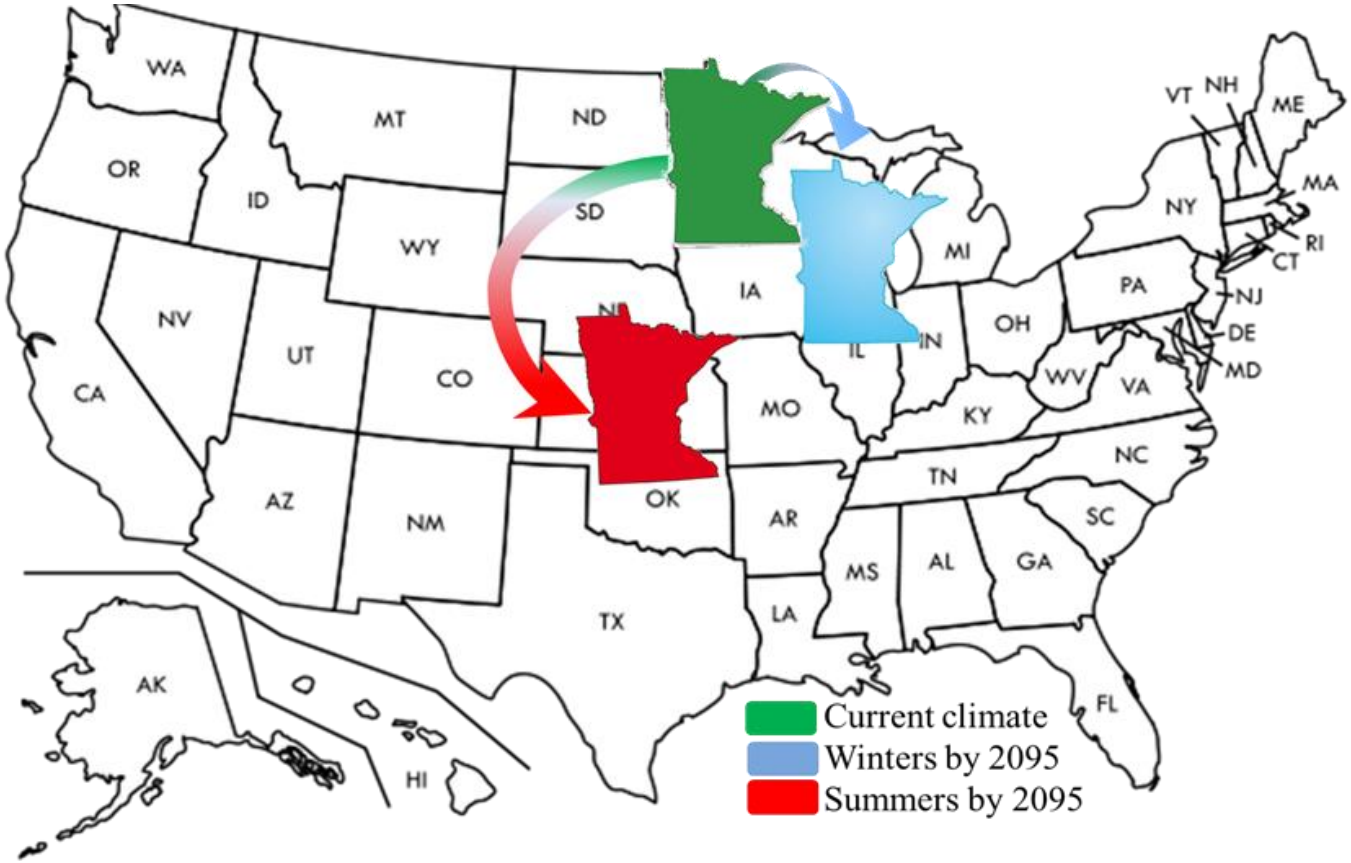


https://www.chesapeakebay.net/

Salmon need oxygen rich water

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

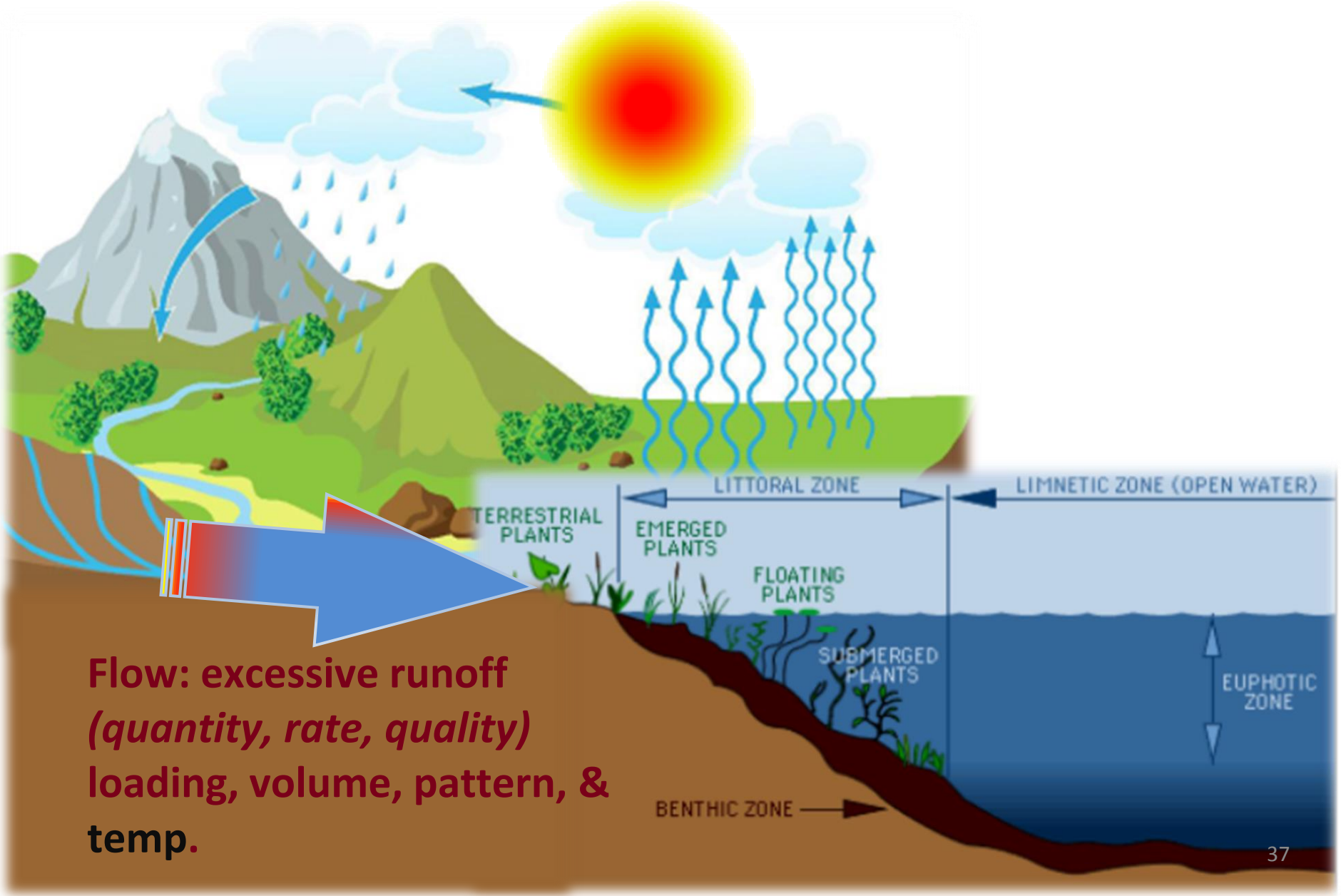
So, what is the issue? **Urgency?**



Q: What will happen to the <u>T & DO</u>

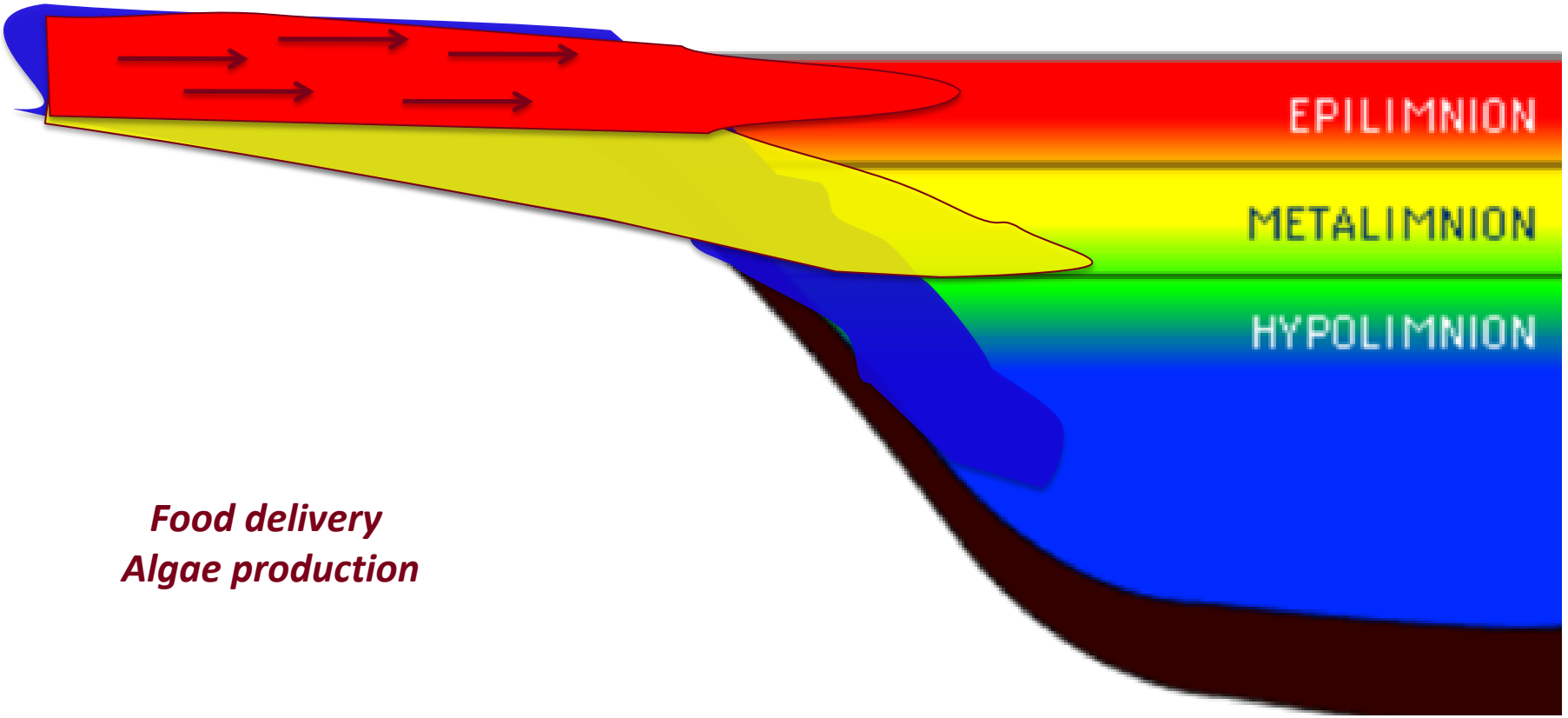
under a changing climate?

Research: climate change & watershed



Flow: excessive runoff
(quantity, rate, quality)
loading, volume, pattern, &
temp.

Research: temperature & stream flow

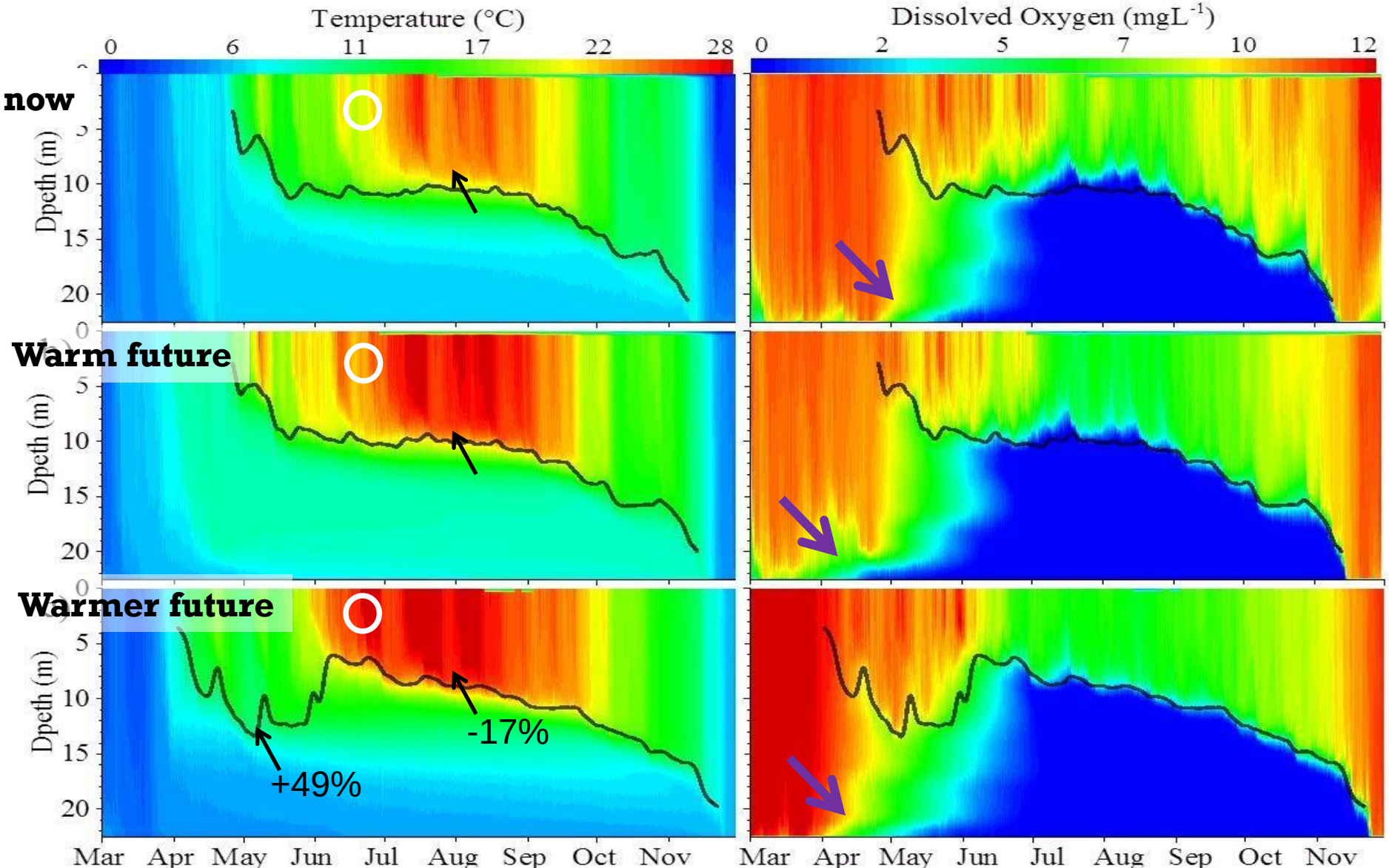


Food delivery
Algae production

Missaghi & Hondzo, 2010

Research: changes in T & DO ➔ fish habitat

Missaghi et al., 2017



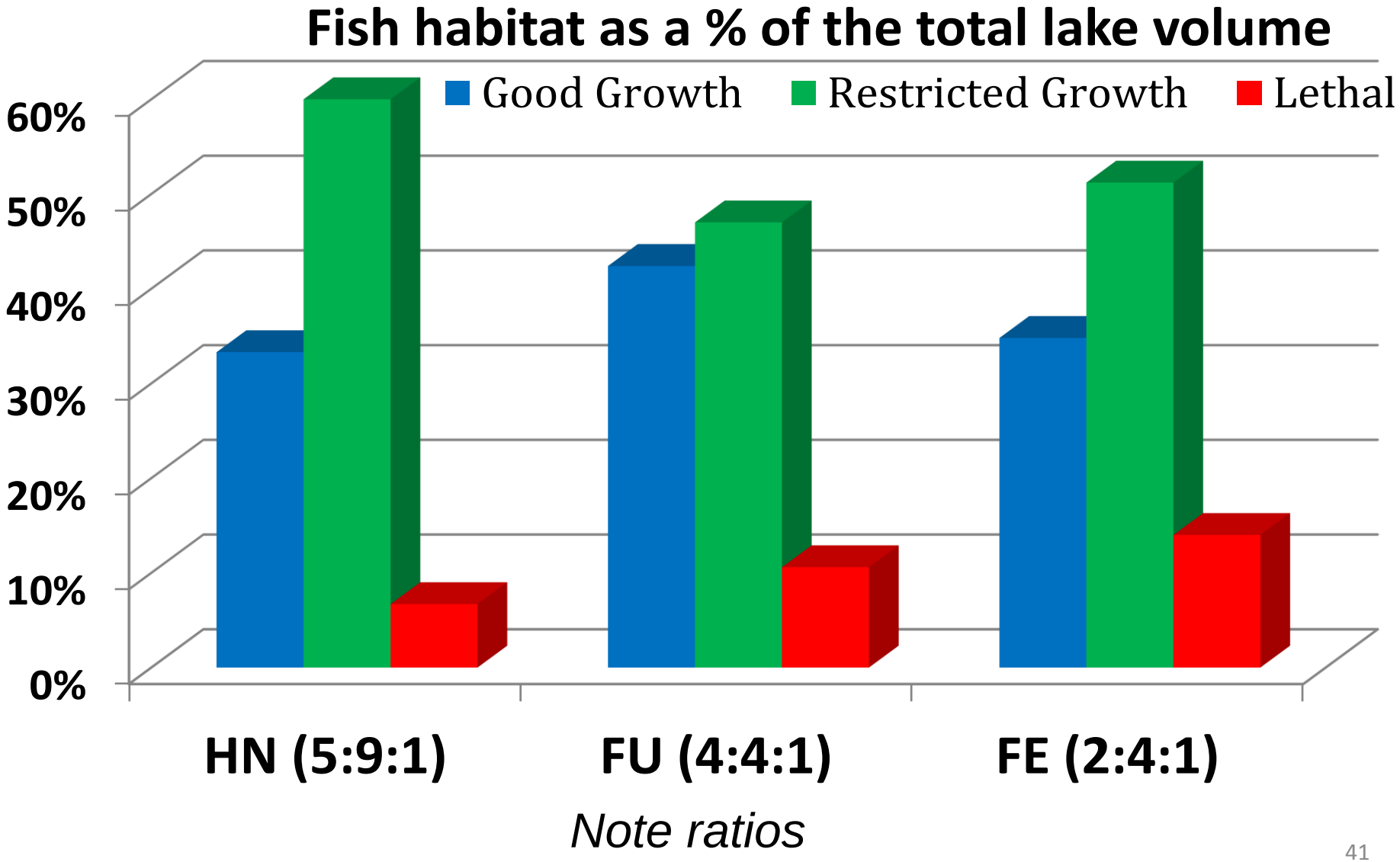
Research: evaluating coolwater fish habitat

Habitat Criteria	Conditions
Good Growth (GG)	(16.3 < T < 28.2) AND (DO > 3)
Restricted Growth (RG)	(28.2 <T < 30.4) OR (T< 16.3 AND DO > 3)
Lethal (L)	(T > 30.4) OR (DO < 3)

Work by Prof. H. Stefan Research Group (Stefan et al., 2001)

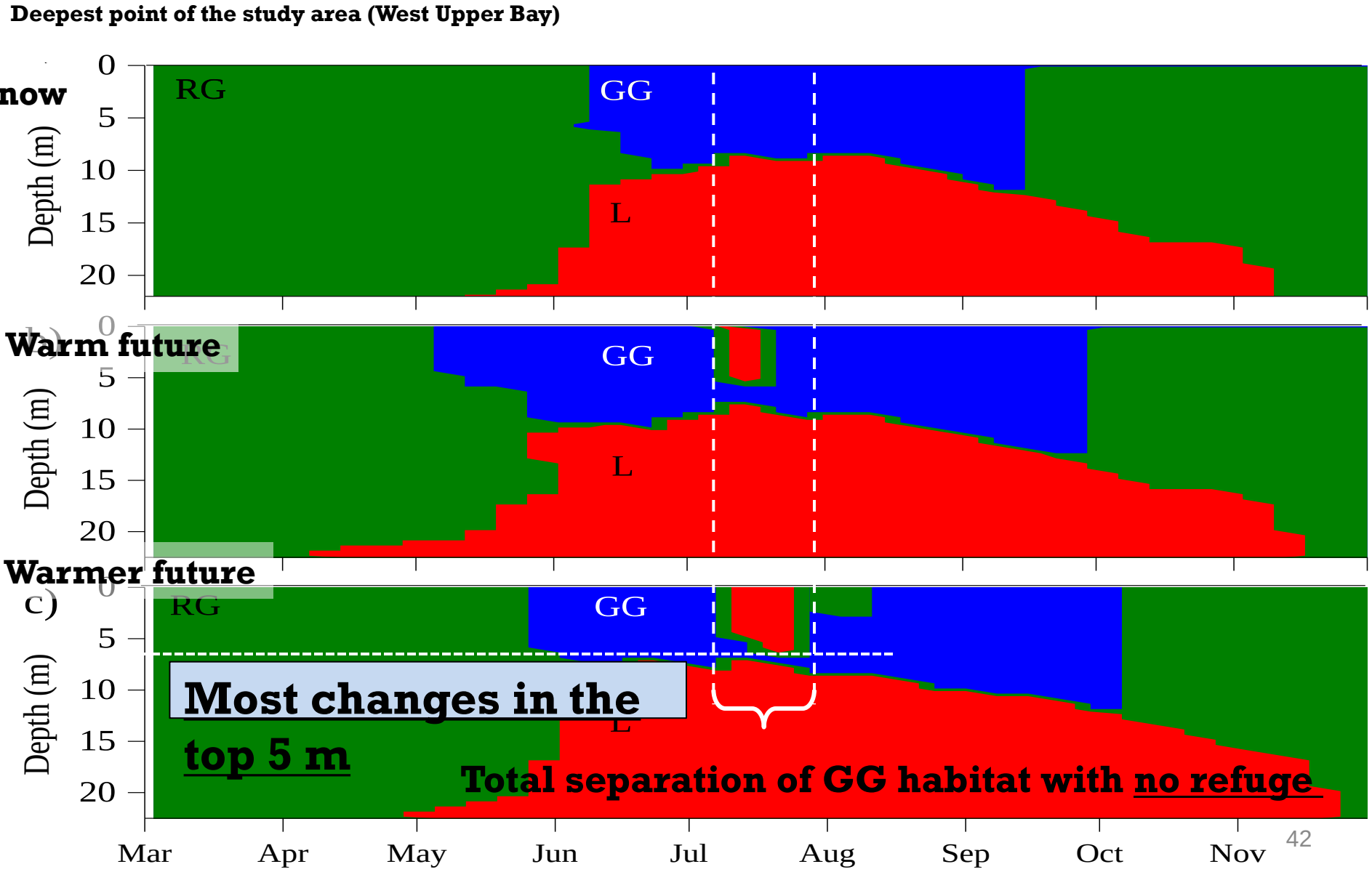
Results – Coolwater Fish Habitat --- T and DO

Missaghi et al., 2017



Note ratios

Results: Coolwater fish habitat **spatial** & **temporal** evaluation



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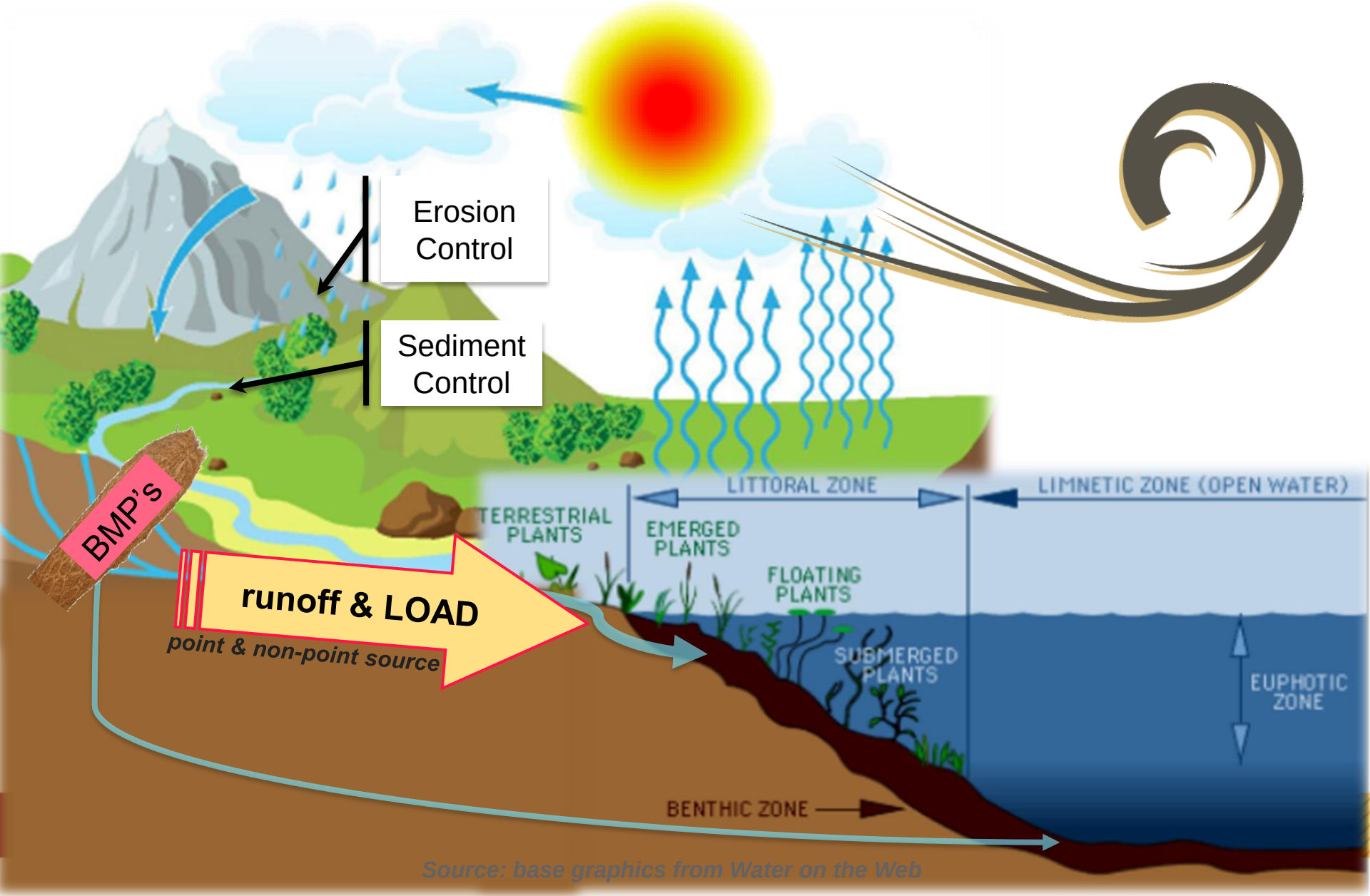
3:xx pm	**What does it have to do with fish? T & DO** **Why should we care about Temperature?** **Temperature impact on lakes** **What does research say about it?**
	What is the problem? Urgency? **Do we have solutions?** **What can we control?**
3:50 pm	**Q & A; What is next and what actions to take?**

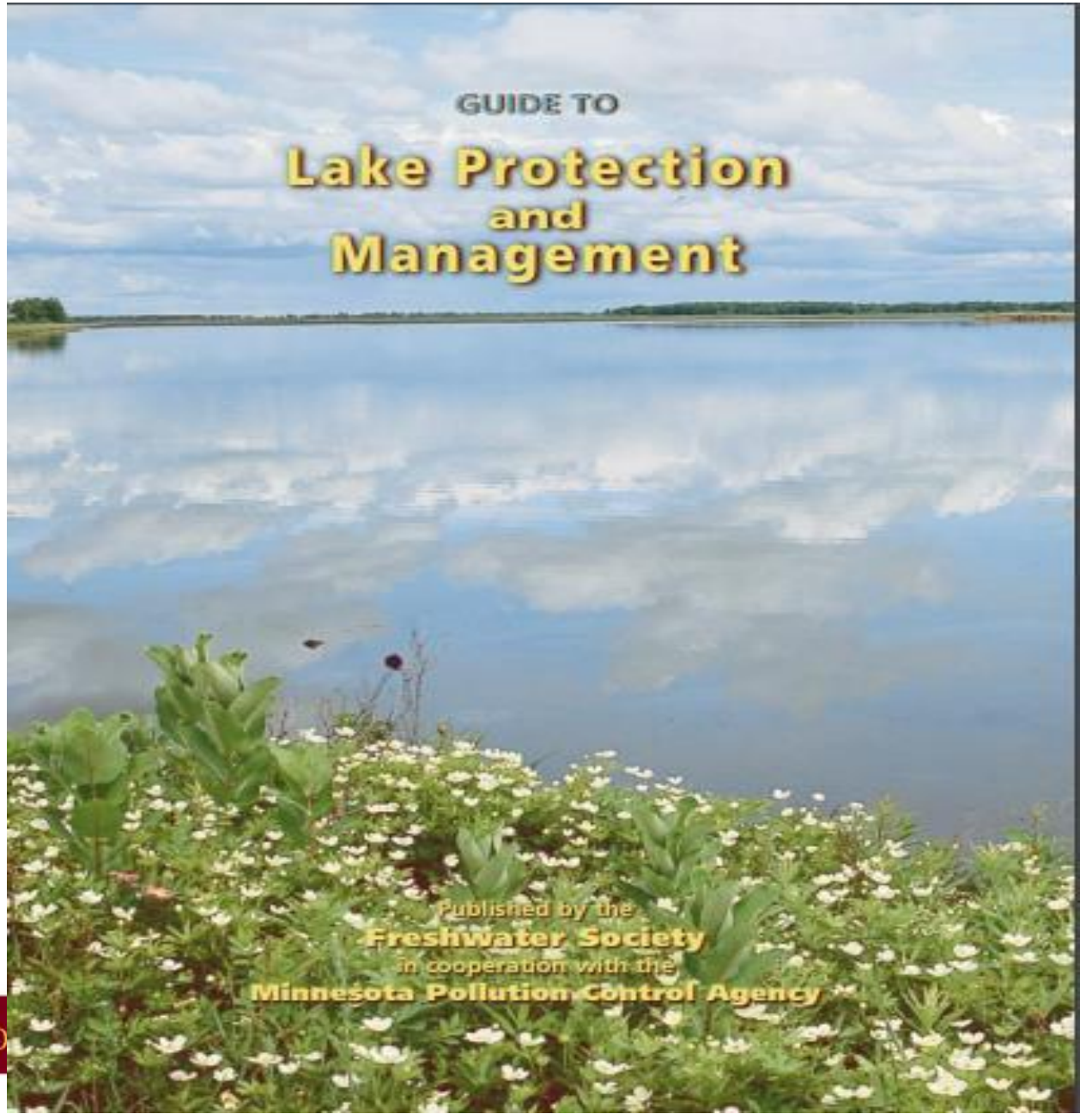
Do we have solutions?
What can we control?

Do we have solutions: watershed management

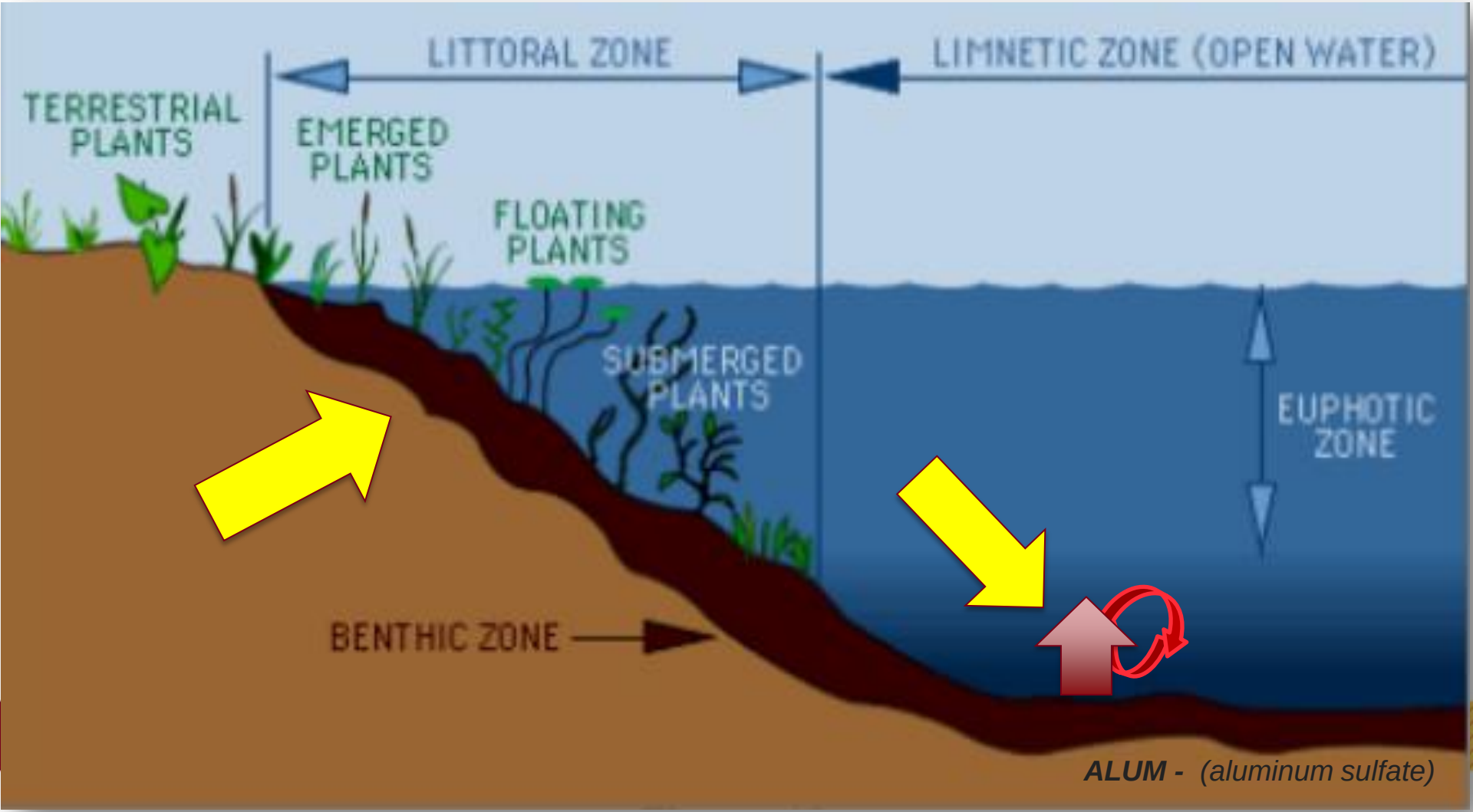


Source: base graphics from Water on the Web

Do we have solutions: inlake management



Do we have solutions: inlake management



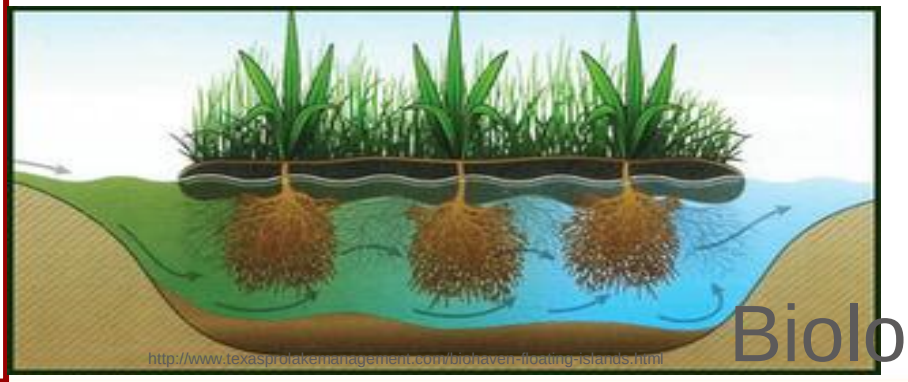
We have solutions:

Chemical

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

Physical

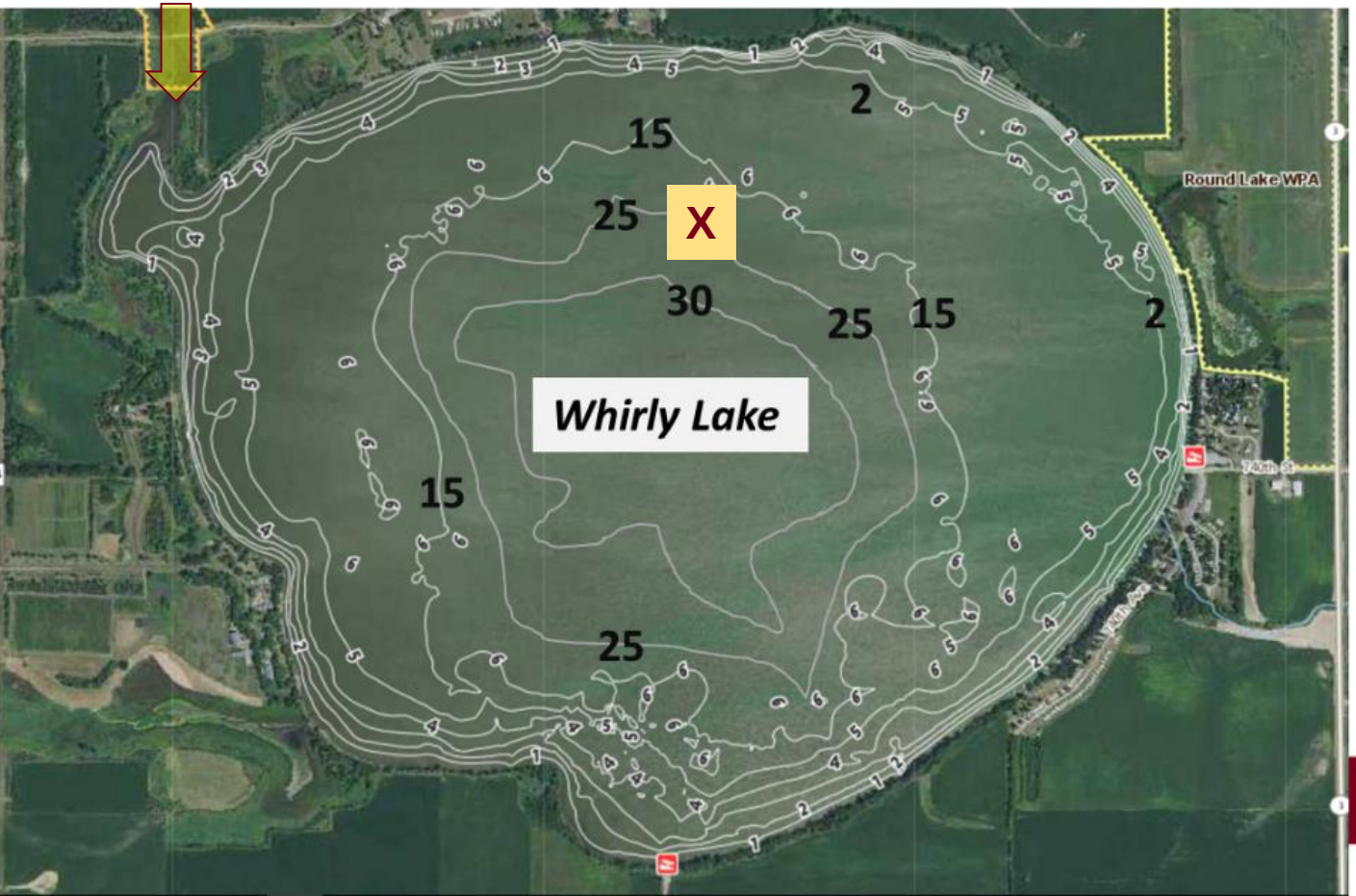
Aeration and circulation, Dilution and flushing, On-shore treatment techniques, drawdown, harvesting, bottom sealing, & shading (dye).....



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. GROCE1 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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