

# Browning and warming of Adirondack lakes limit habitat available to brook trout

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**Department of  
Environmental  
Conservation**



**Cornell  
Atkinson  
Center for  
Sustainability**



**NE CASC**

Northeast Climate Adaptation Science Center

- Warming and browning
- Implications for trout
- Trout responses
- Angler responses
- Going forward



- Warming and browning

- Implications for trout

- Trout responses

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Warming



Temperature

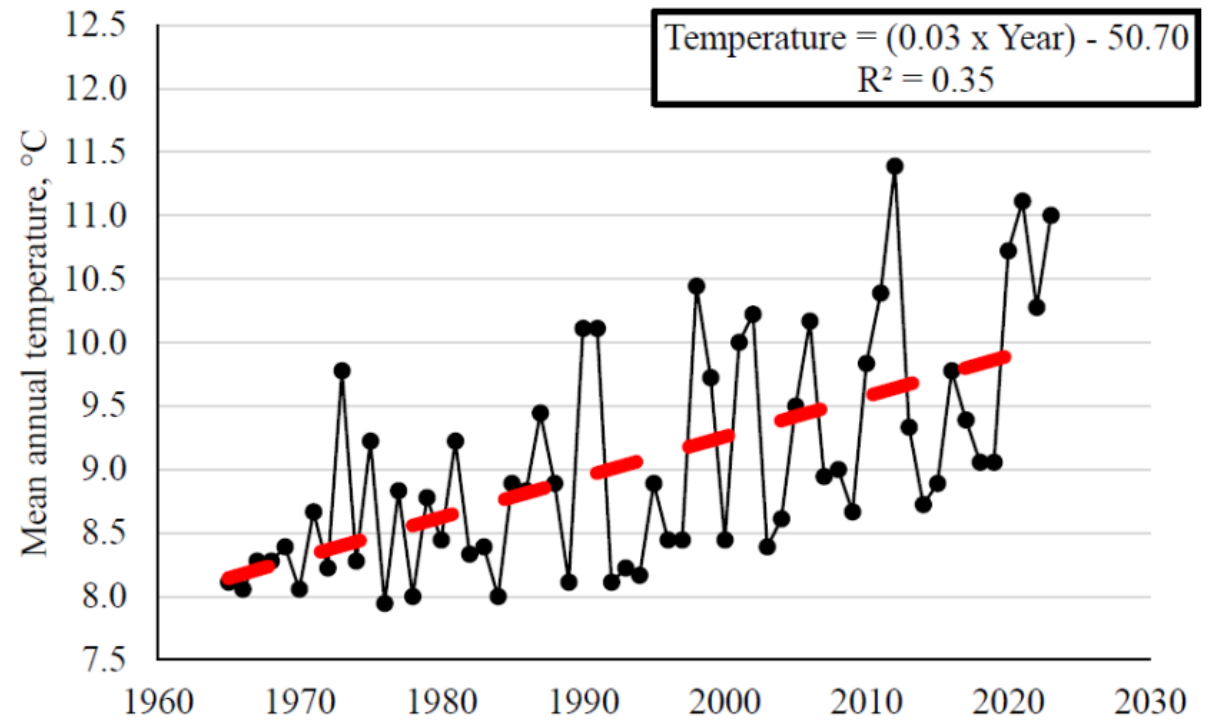
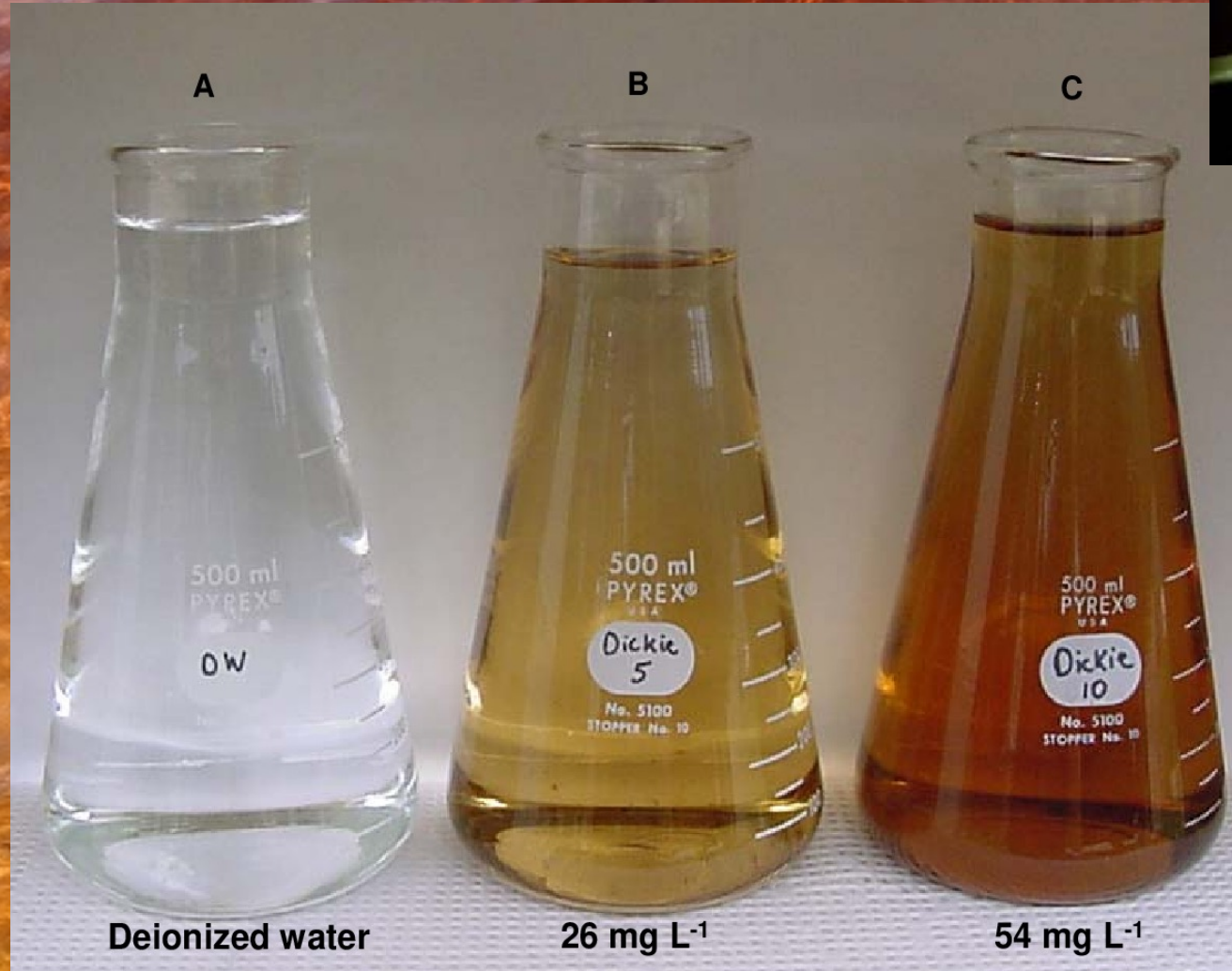


Figure 2. Mean annual temperature provided for Syracuse Hancock International Airport, New York. Downloaded from (<http://climod2.nrcc.cornell.edu/>)

# Dissolved Organic Carbon (DOC)



Deionized water

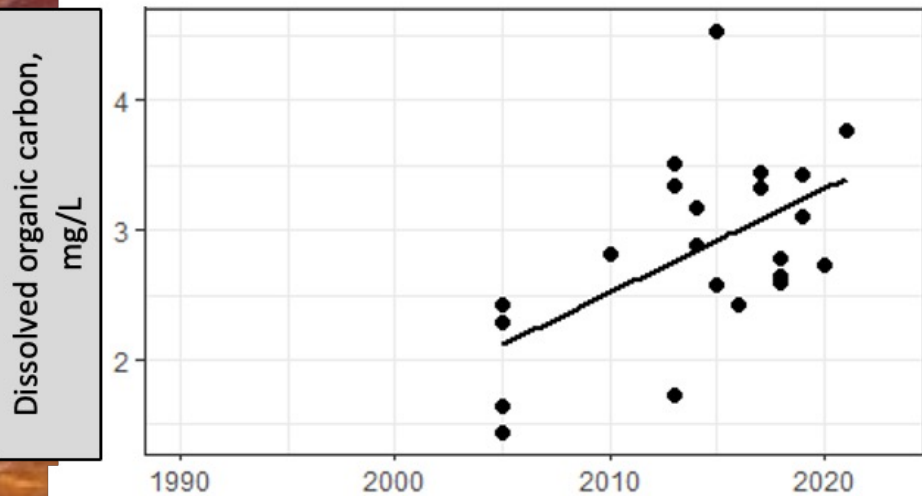
26 mg L<sup>-1</sup>

54 mg L<sup>-1</sup>

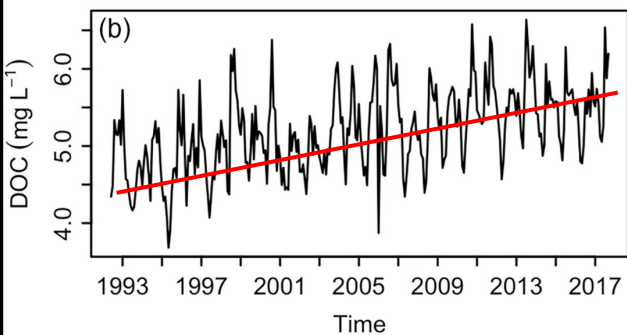
Browning



Dissolved Organic Carbon (DOC)



Dissolved organic carbon,  
mg/L



Temperature

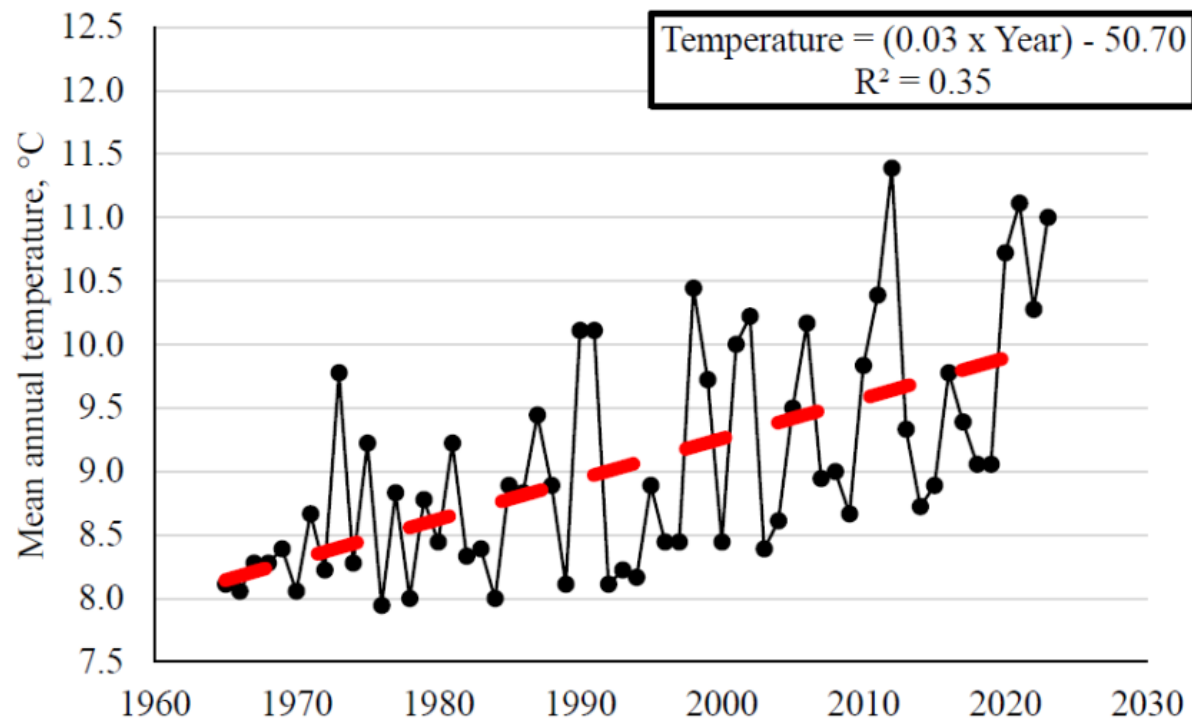


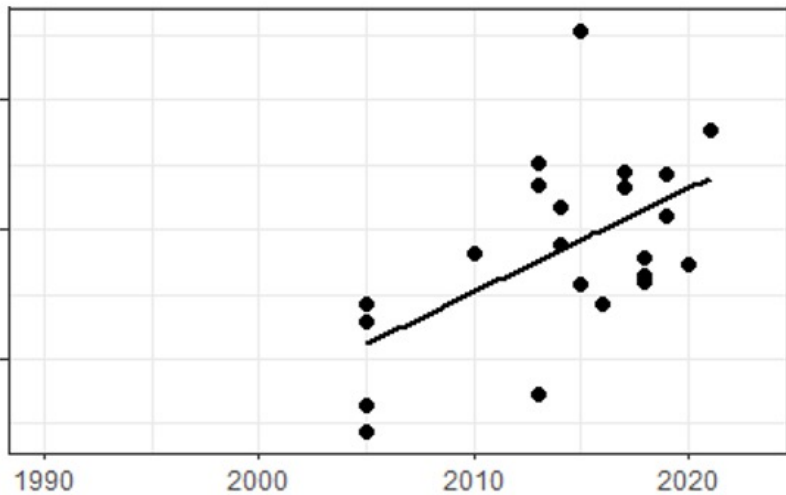
Figure 2. Mean annual temperature provided for Syracuse Hancock International Airport, New York. Downloaded from (<http://climod2.nrcc.cornell.edu/>)

Browning



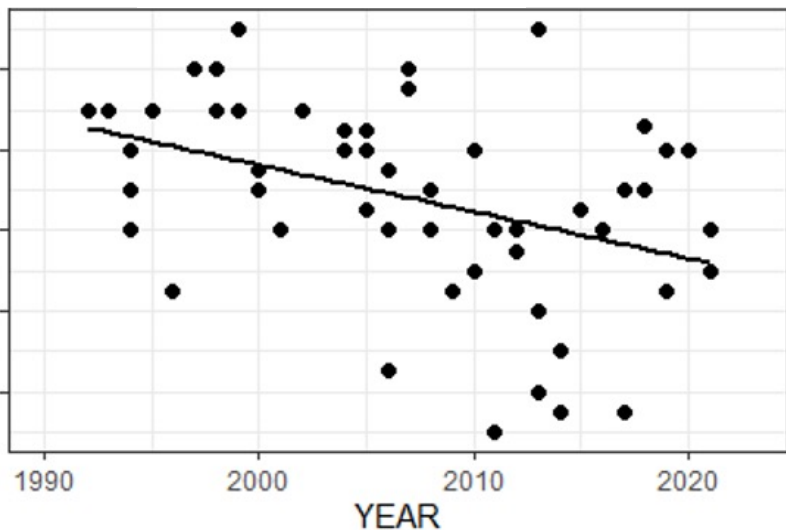
## Dissolved Organic Carbon (DOC)

Dissolved organic carbon,  
mg/L



## Water clarity

Secchi depth, m



## Temperature

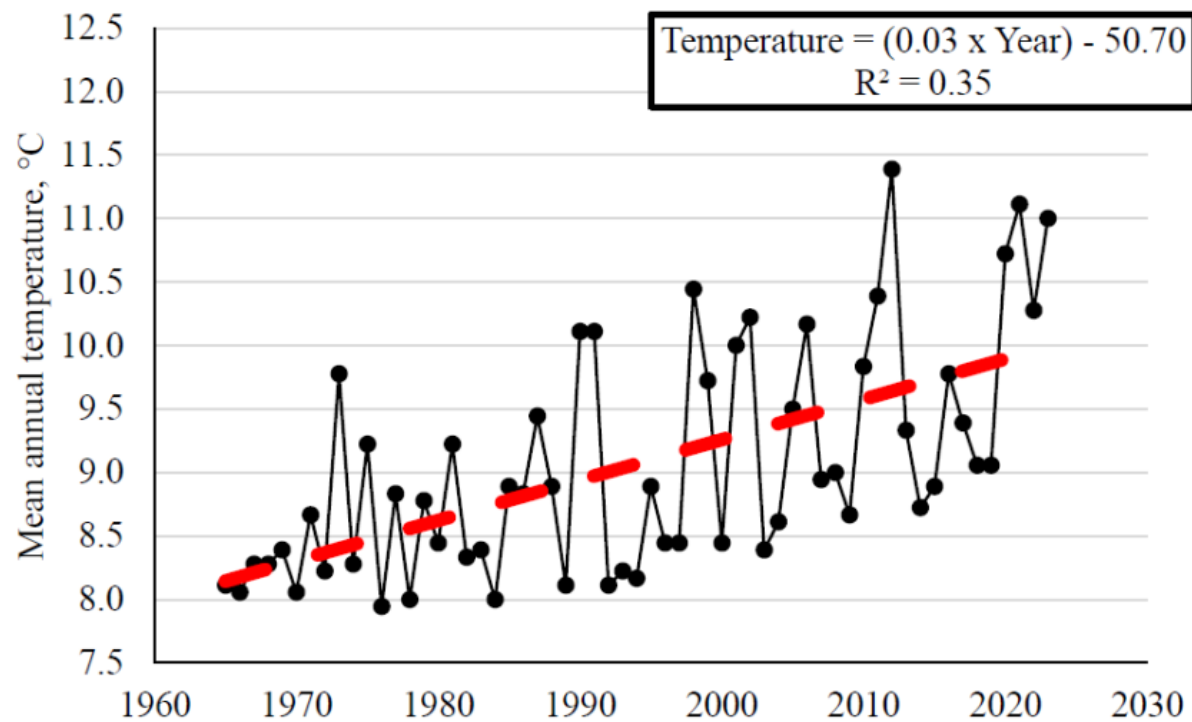
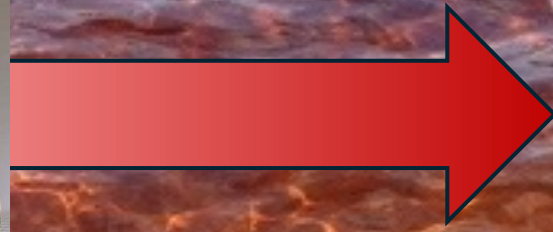
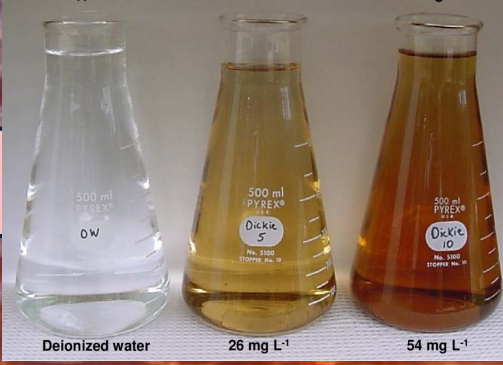


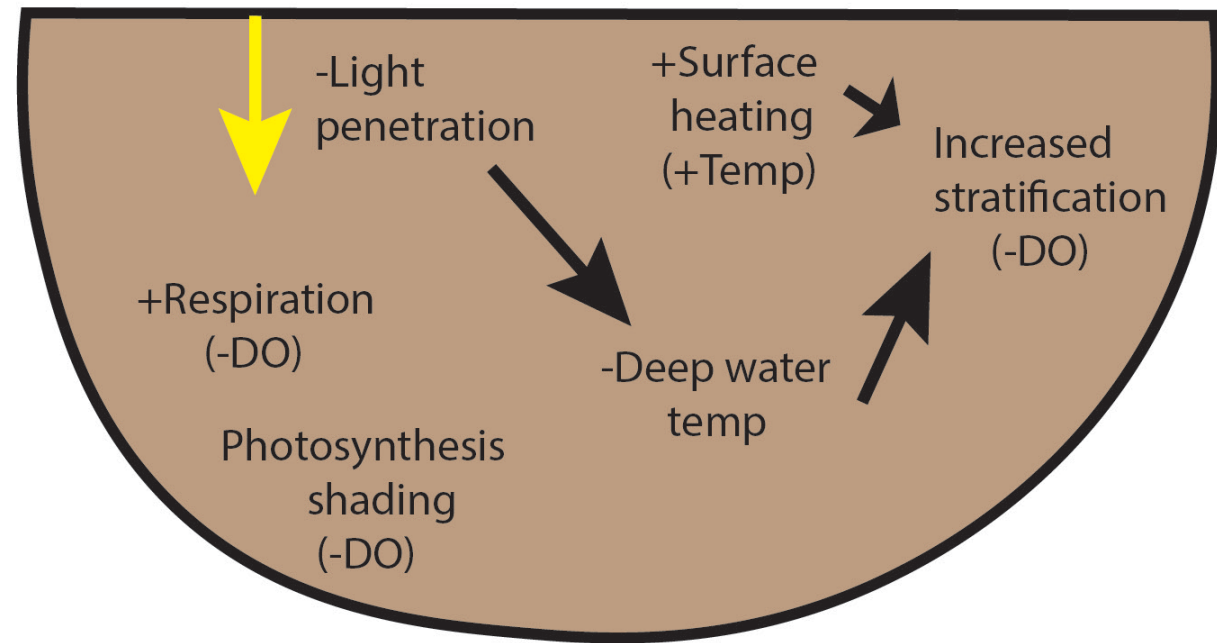
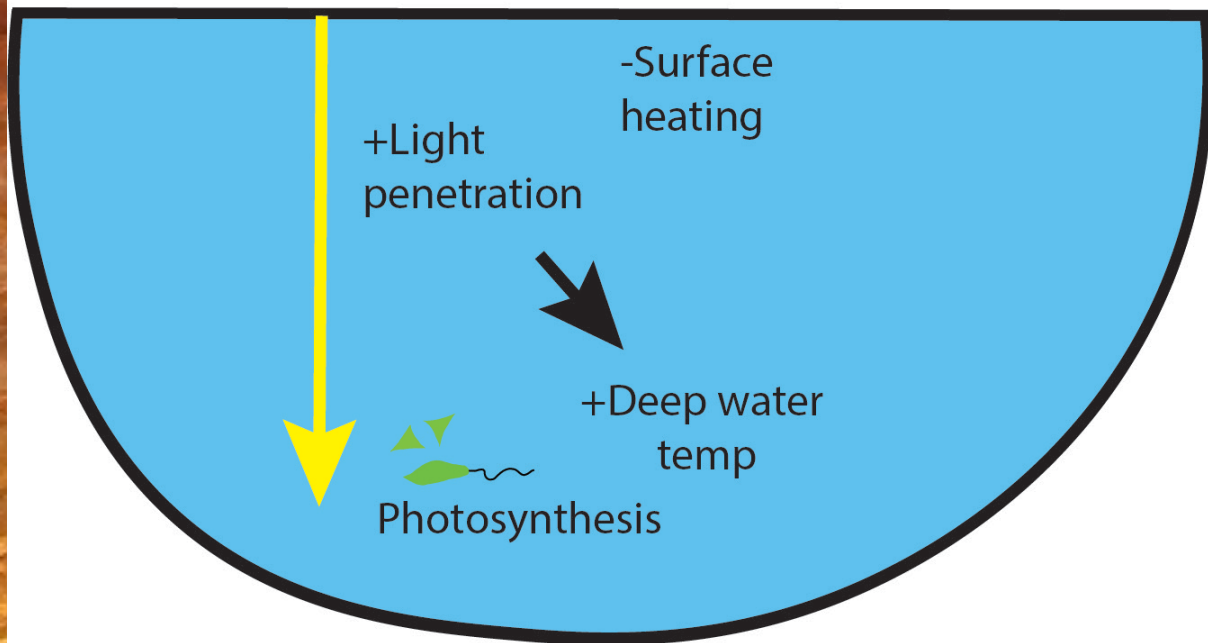
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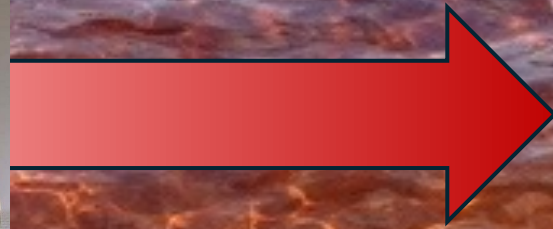
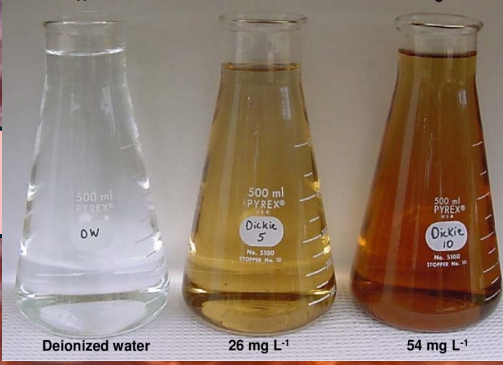




## Clear Lake

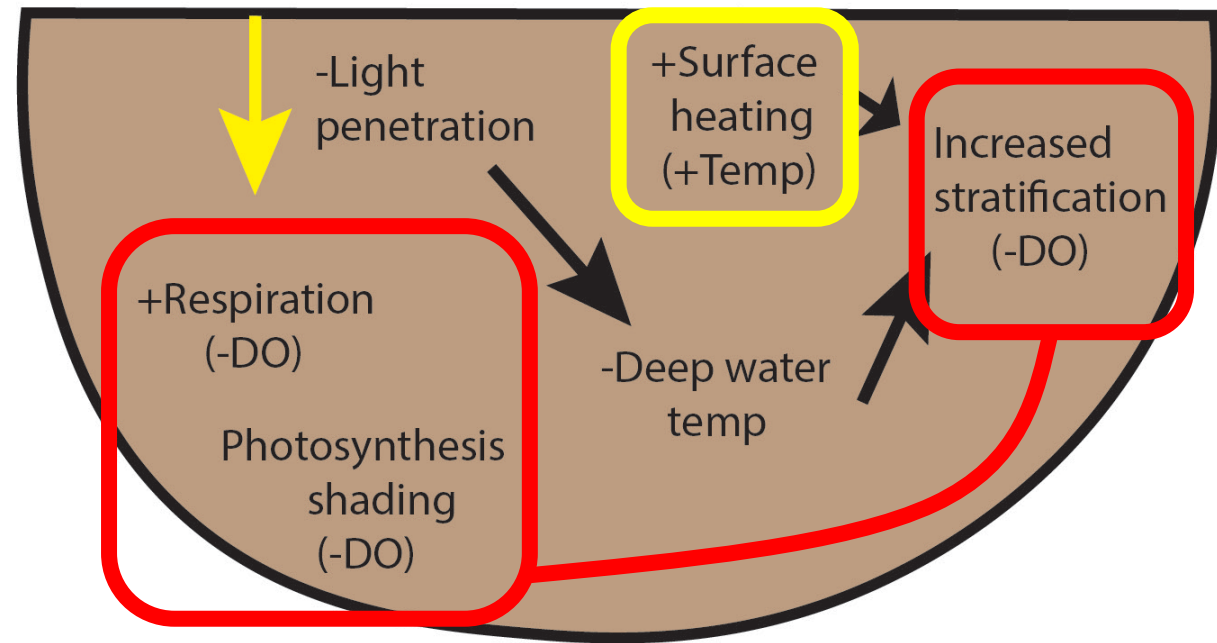
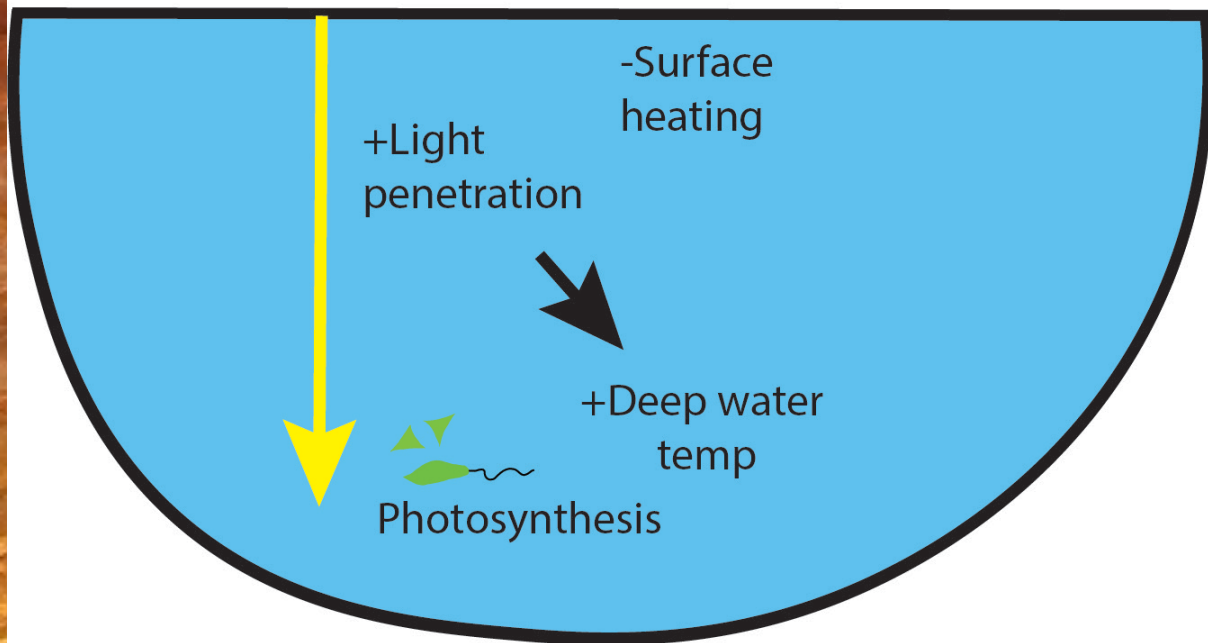
## Brown Lake





## Clear Lake

## Brown Lake



- Warming and browning

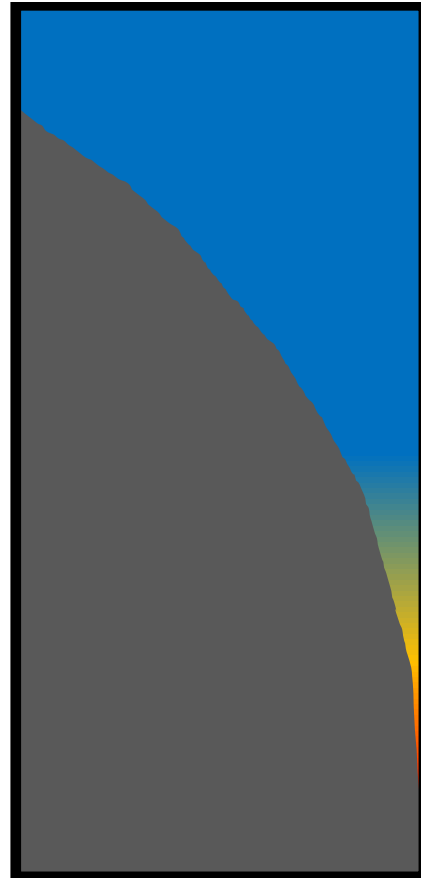
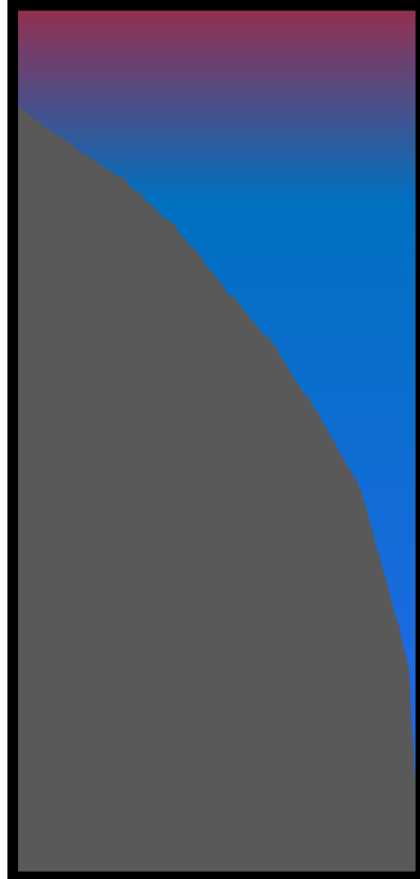
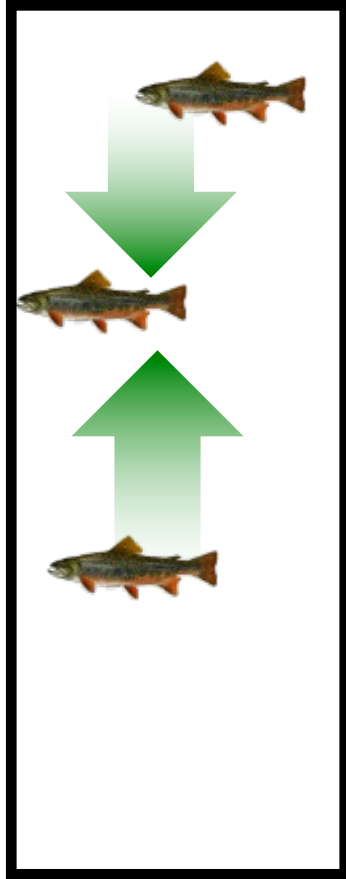
- Implications for trout

- Trout responses

- Angler responses

- Going forward





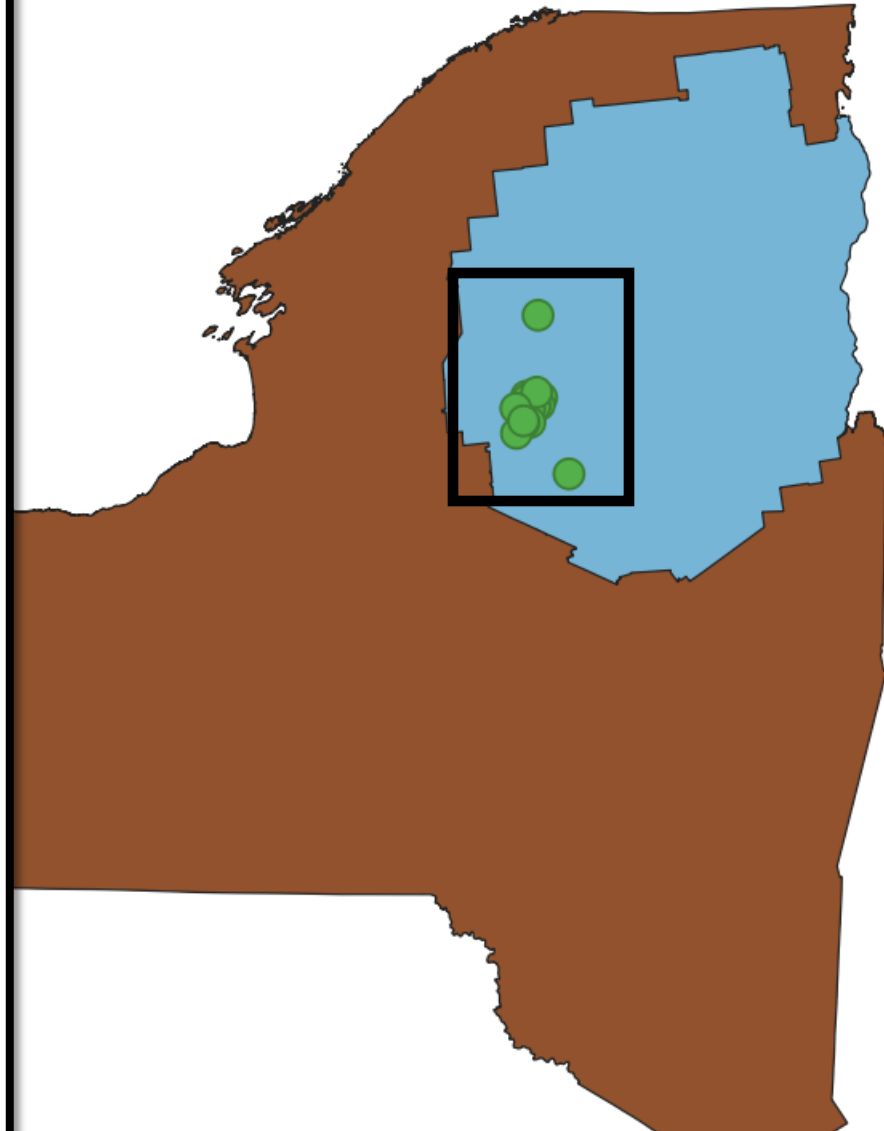
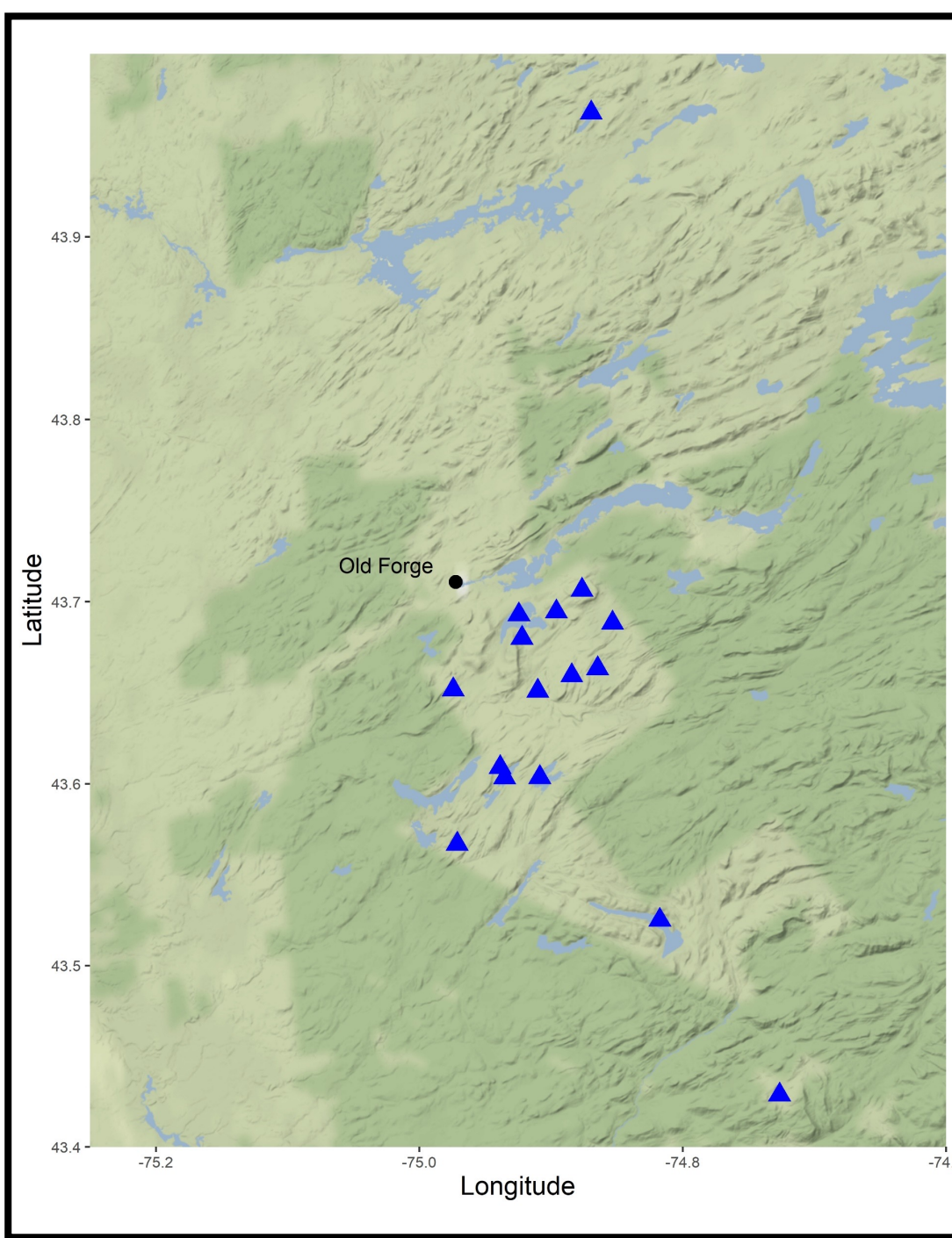
Lake surface

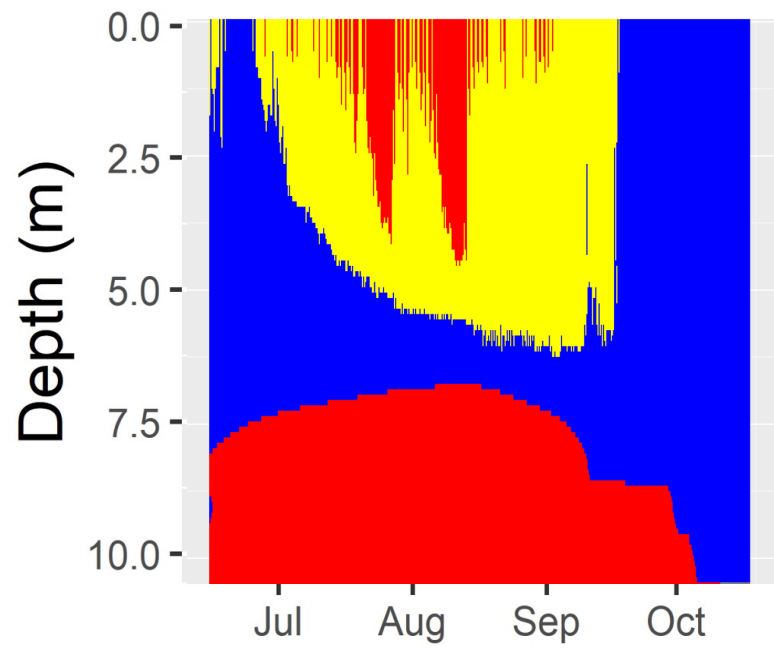
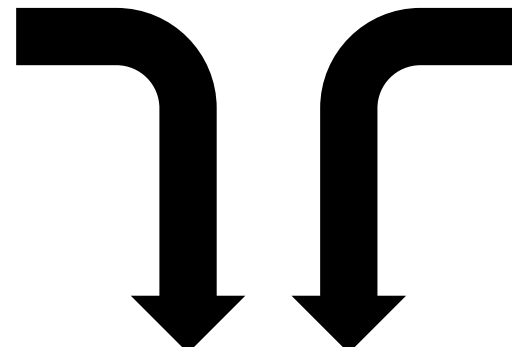
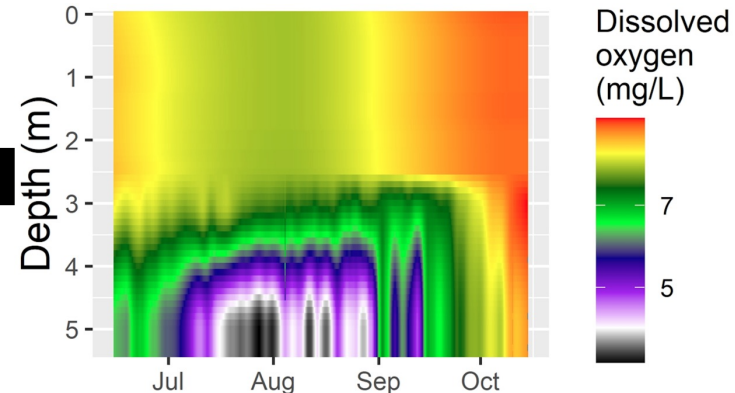
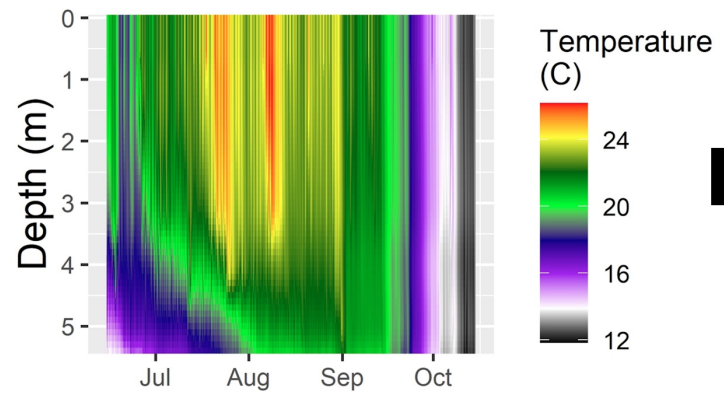
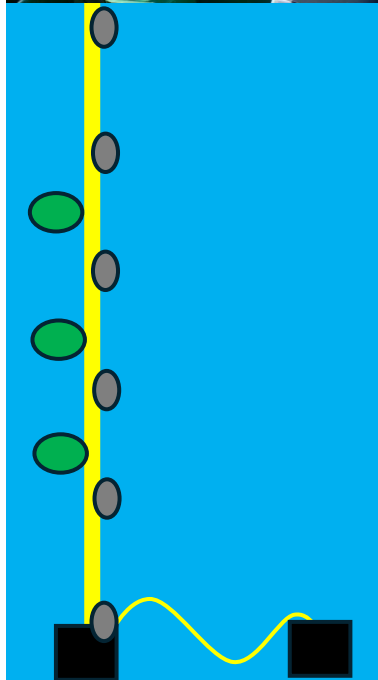
Depth

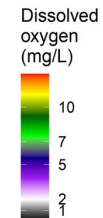
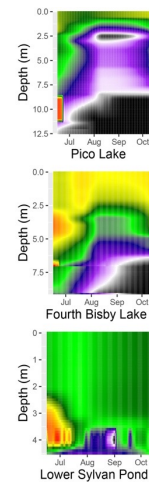
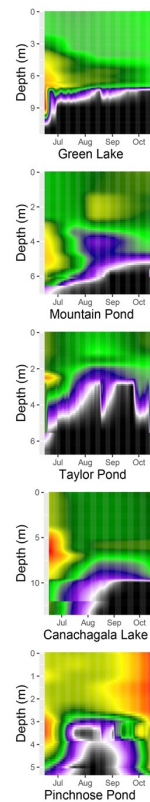
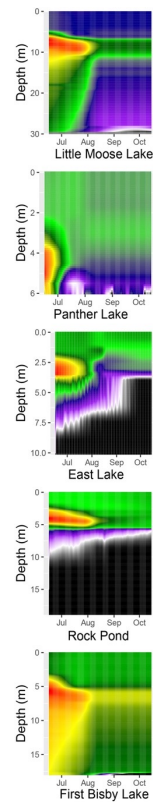
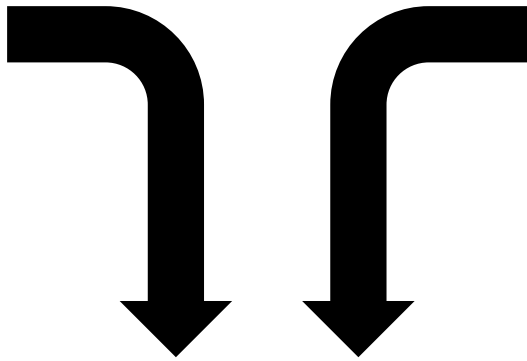
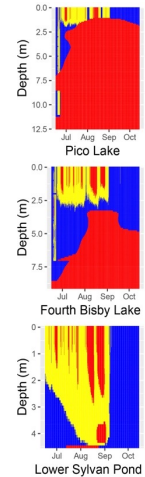
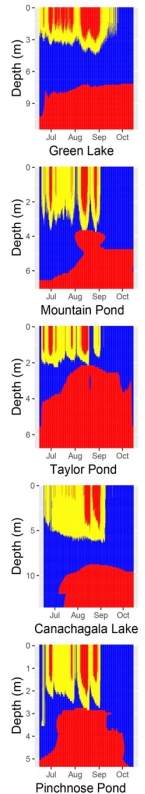
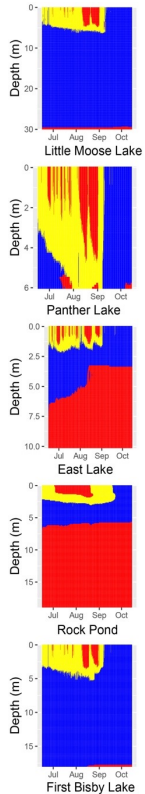
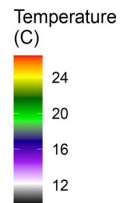
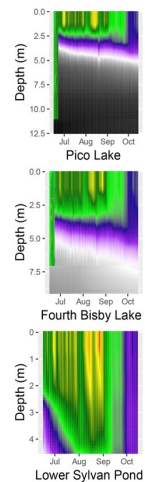
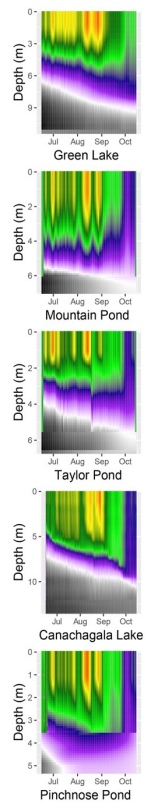
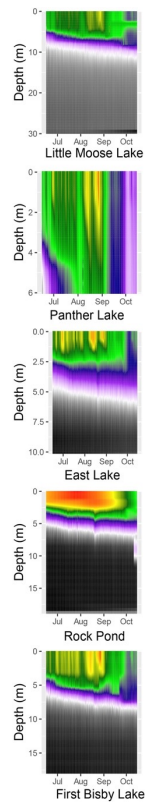
Lake Bottom

Temperature

Dissolved Oxygen



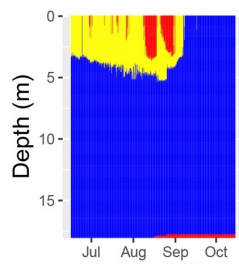
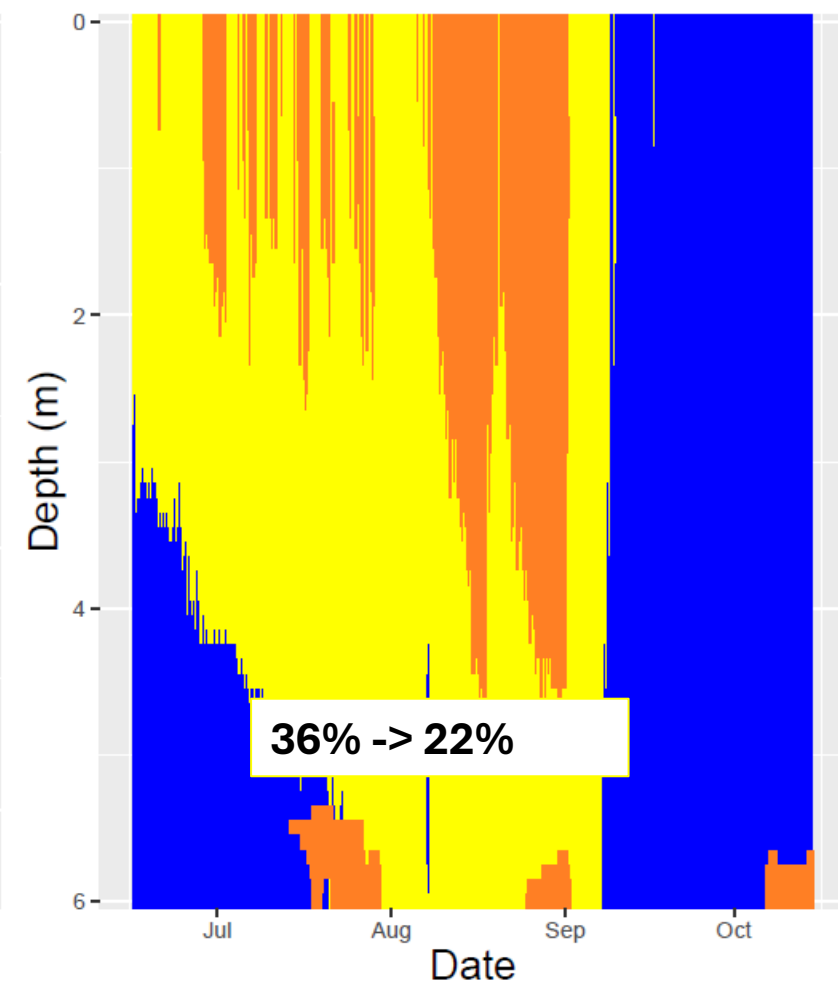
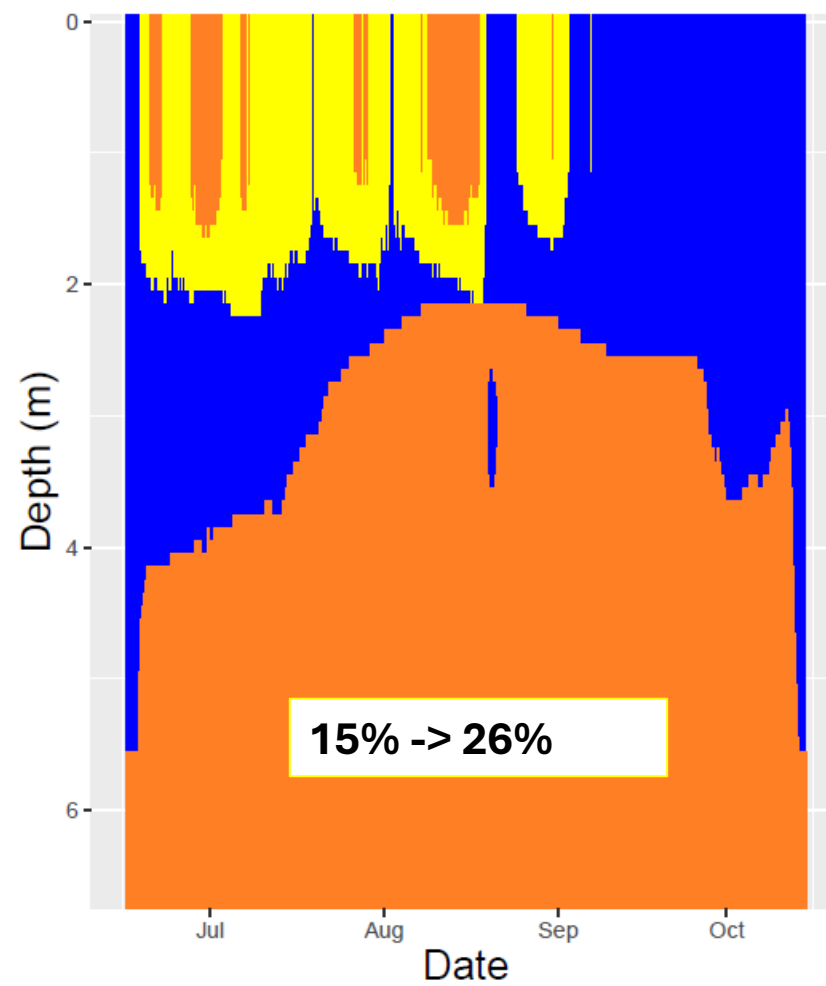
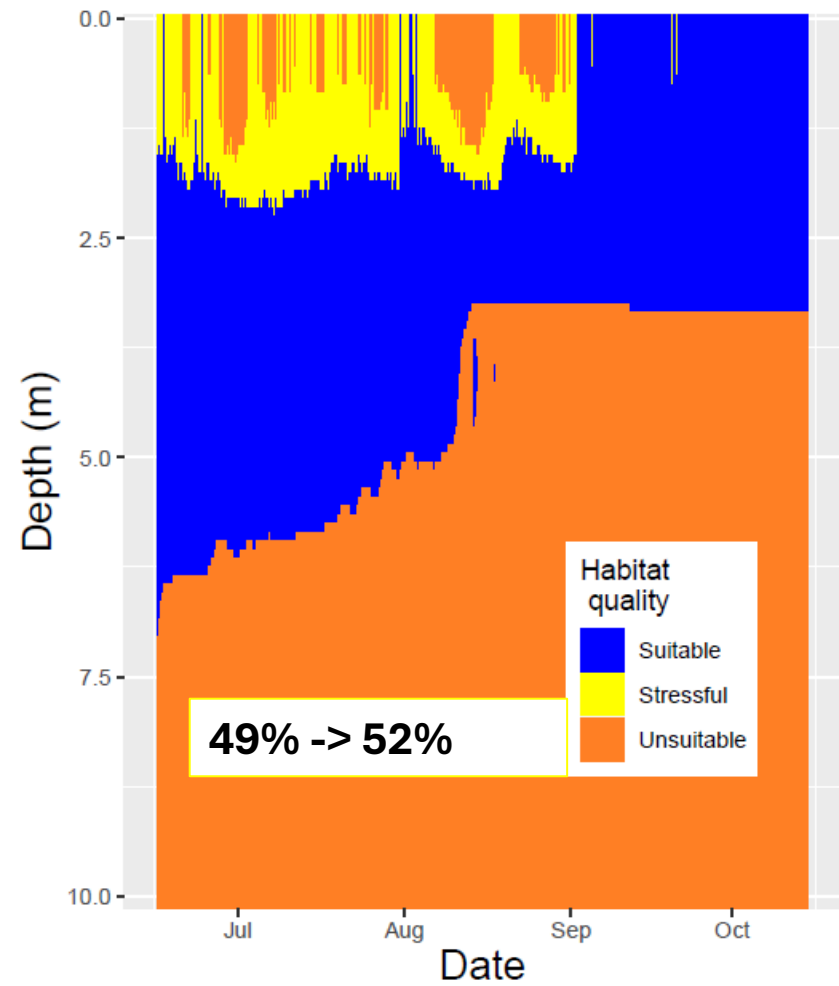




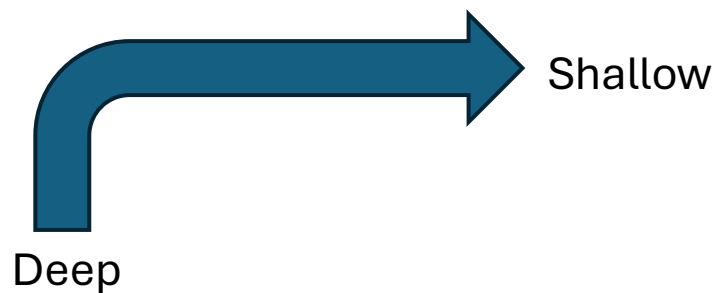
Constrained

Squeezed

Overheated (shallow)



Buffered (deep)  
 <1% -> <1%





- Warming and browning

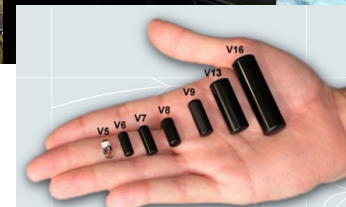
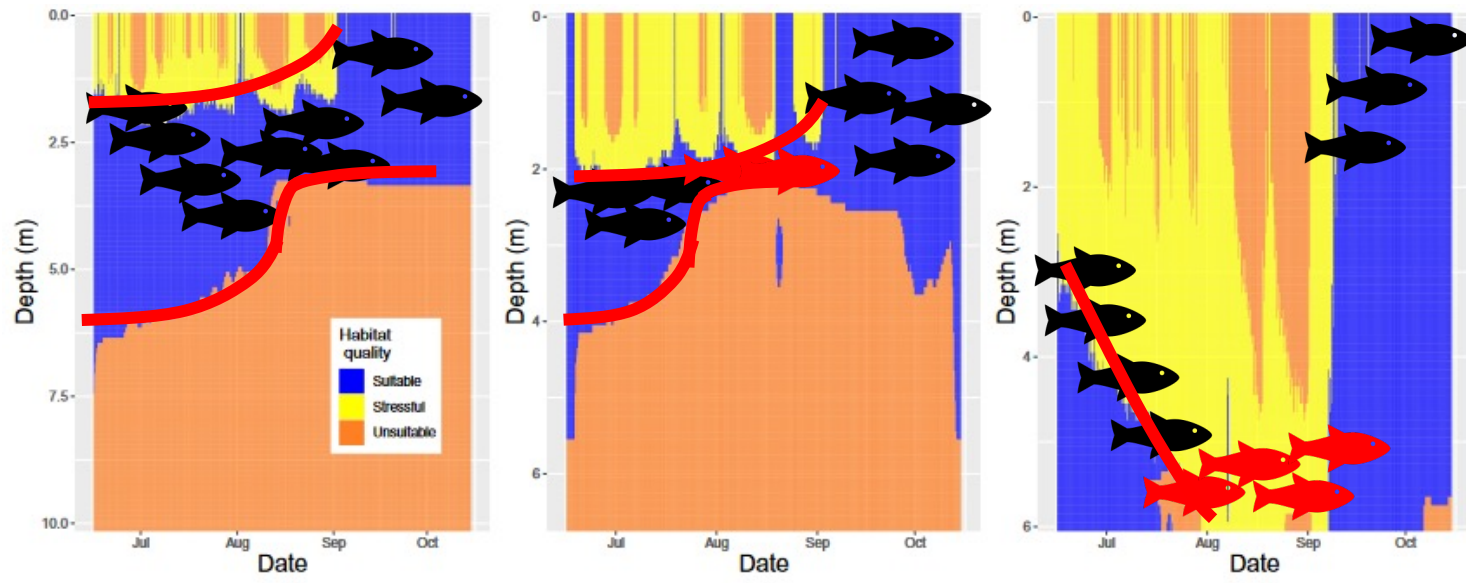
- Implications for trout

- Trout responses

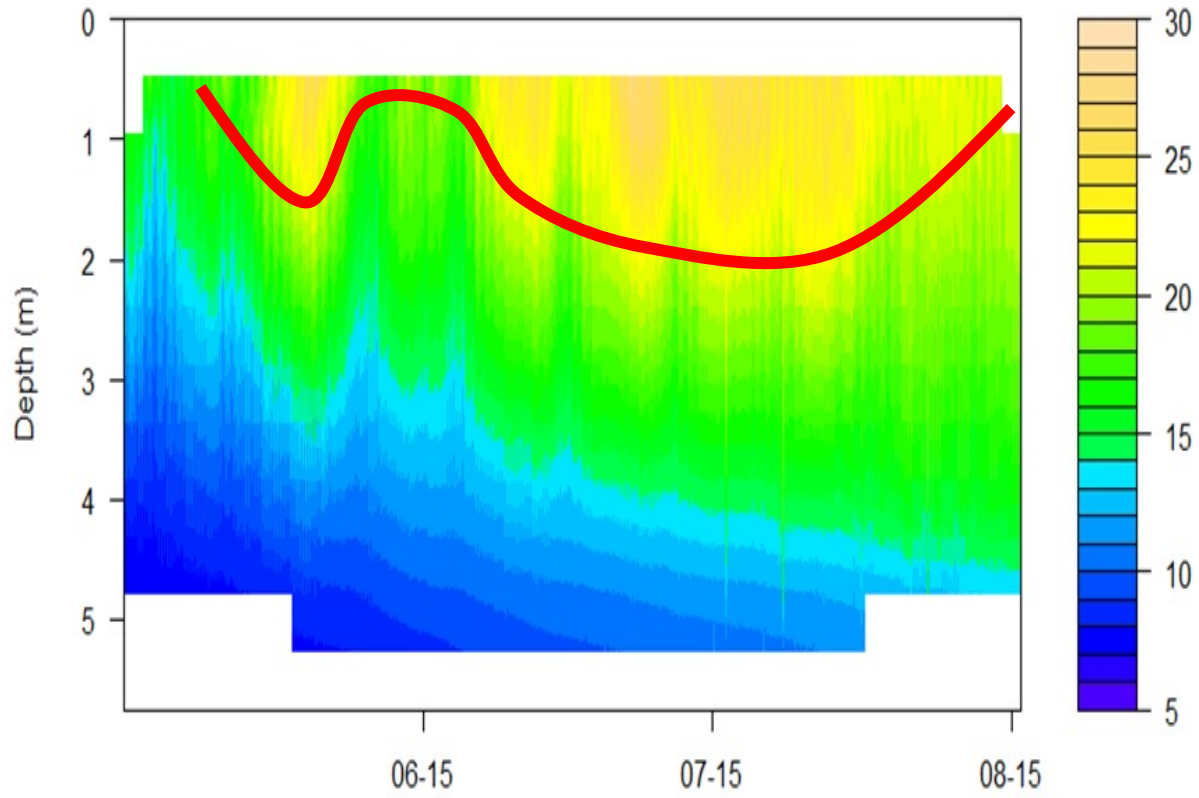
- Angler responses

- Going forward

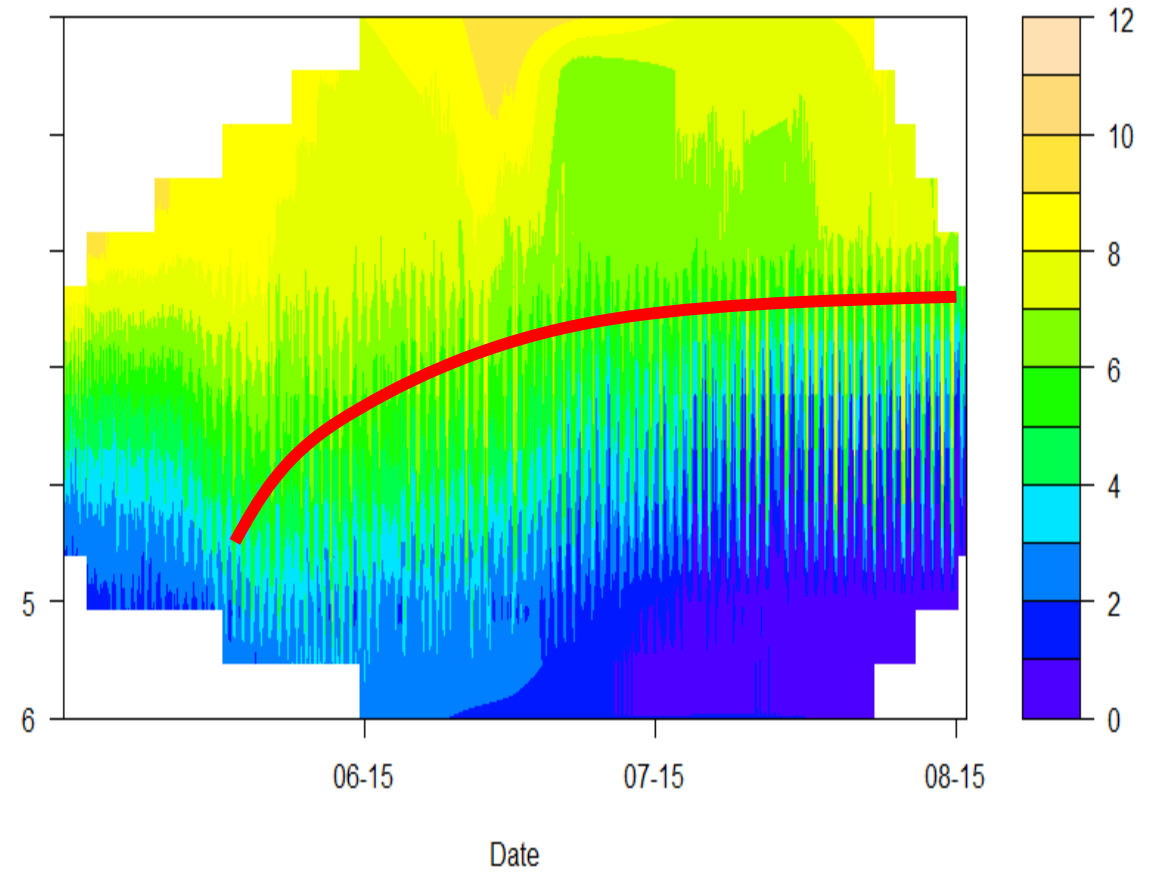




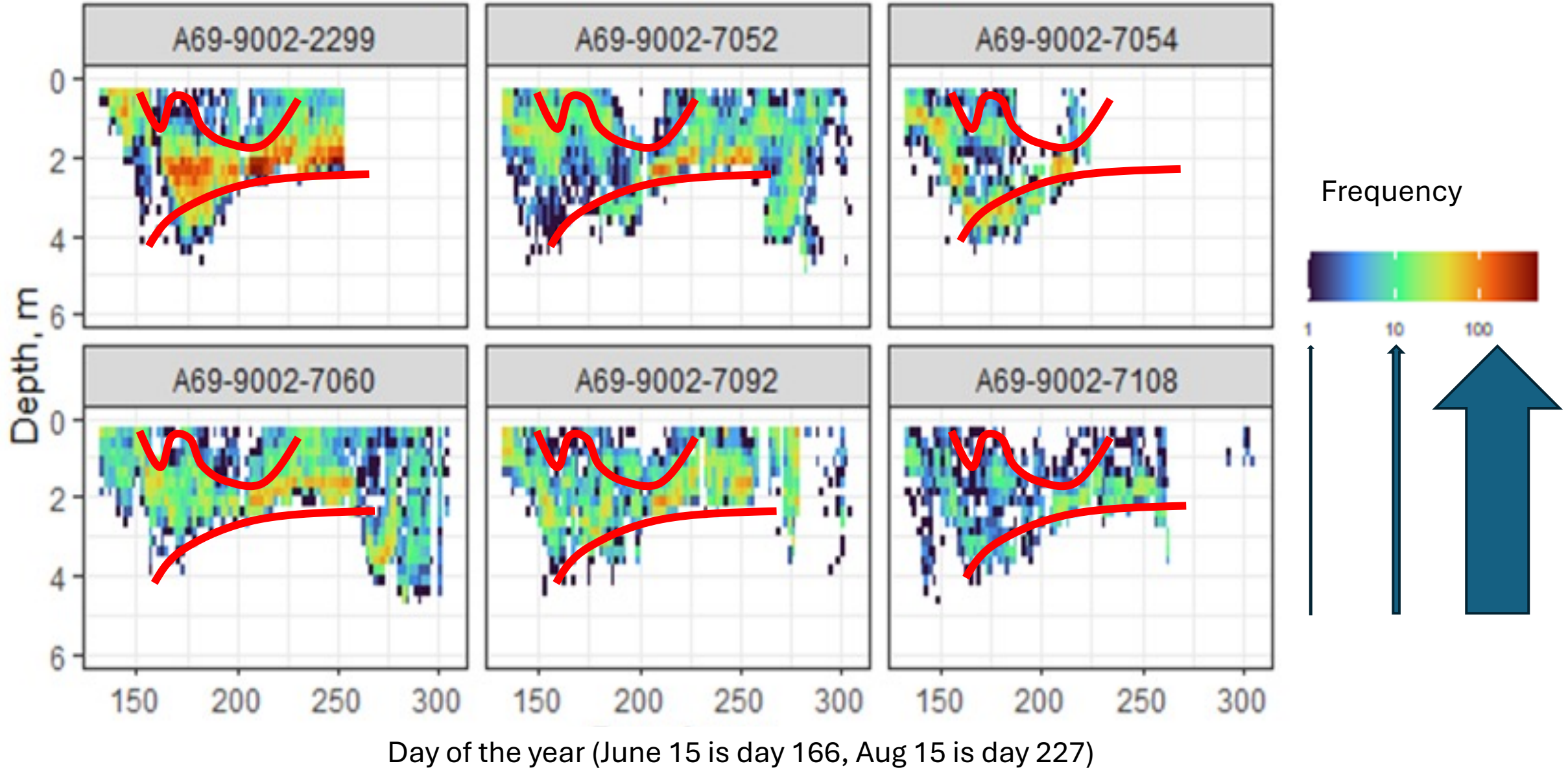
Pinchnose Pond Water Temperature (°C)



Pinchnose Pond DO mg L-1



# Pinchnose heatmap of frequency of fish at depth



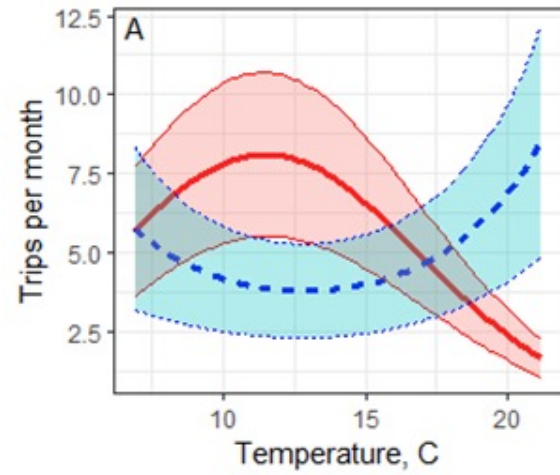
- Warming and browning
- Implications for trout
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- Angler responses
- Going forward



# Does climate change influence the distribution and success of anglers?

Shallow (4.5 m)

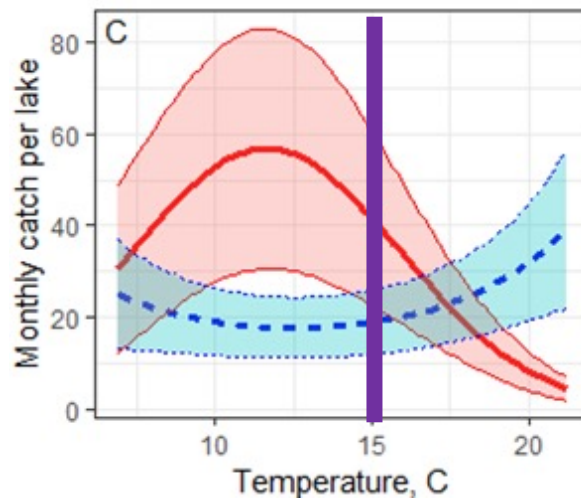
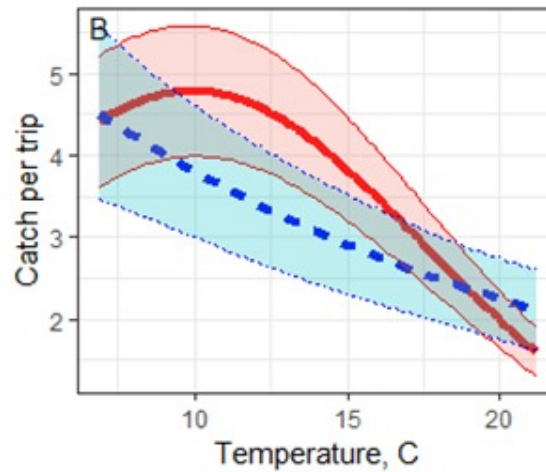
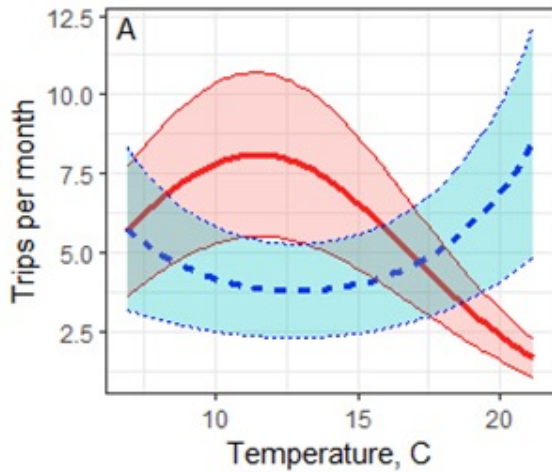
Deep (18.5 m)



# Does climate change influence the distribution and success of anglers?

Shallow (4.5 m)

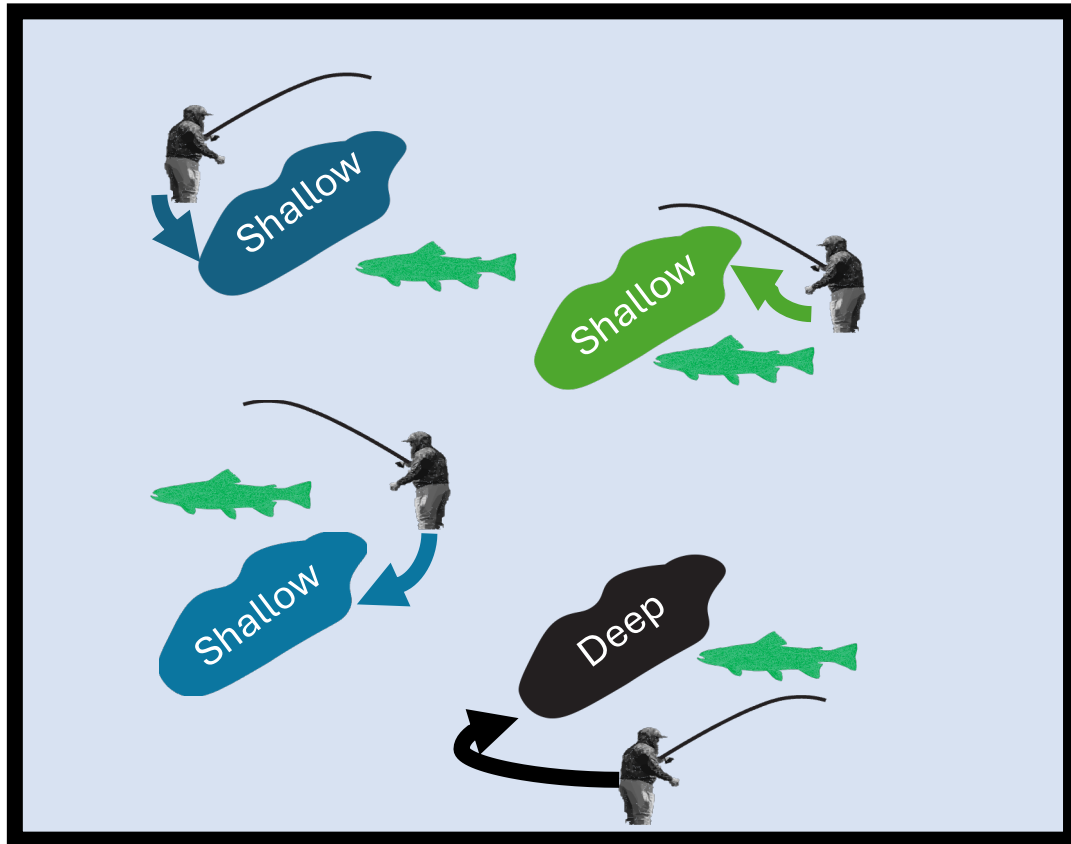
Deep (18.5 m)



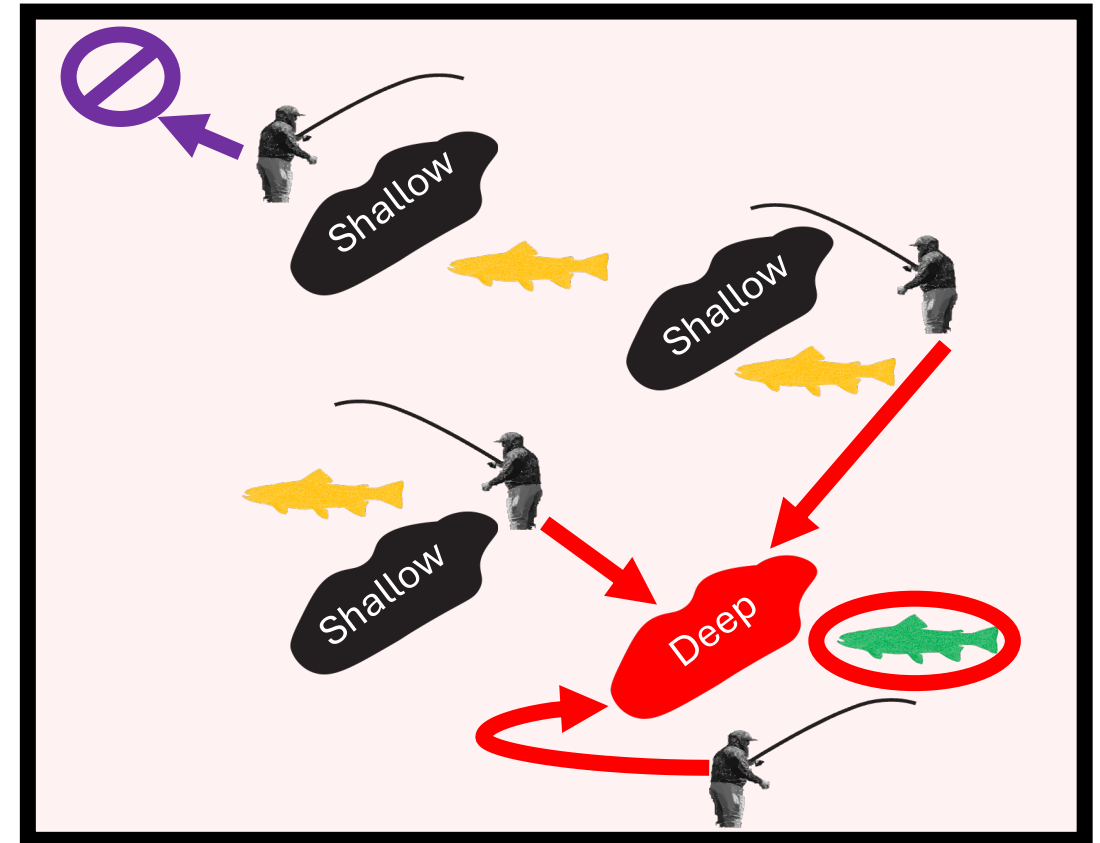
***“Climate resilient cold-water fisheries” will be increasingly difficult to manage because fish are either directly stressed by climate change or indirectly stressed by increased angler encounters.***

# Does climate change influence the distribution and success of anglers?

*Cool*



*Warm*



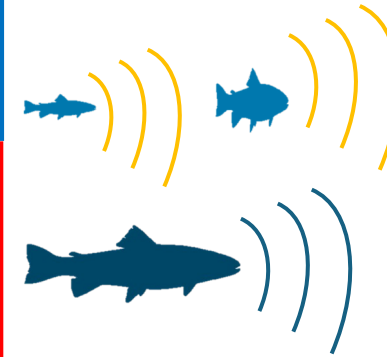
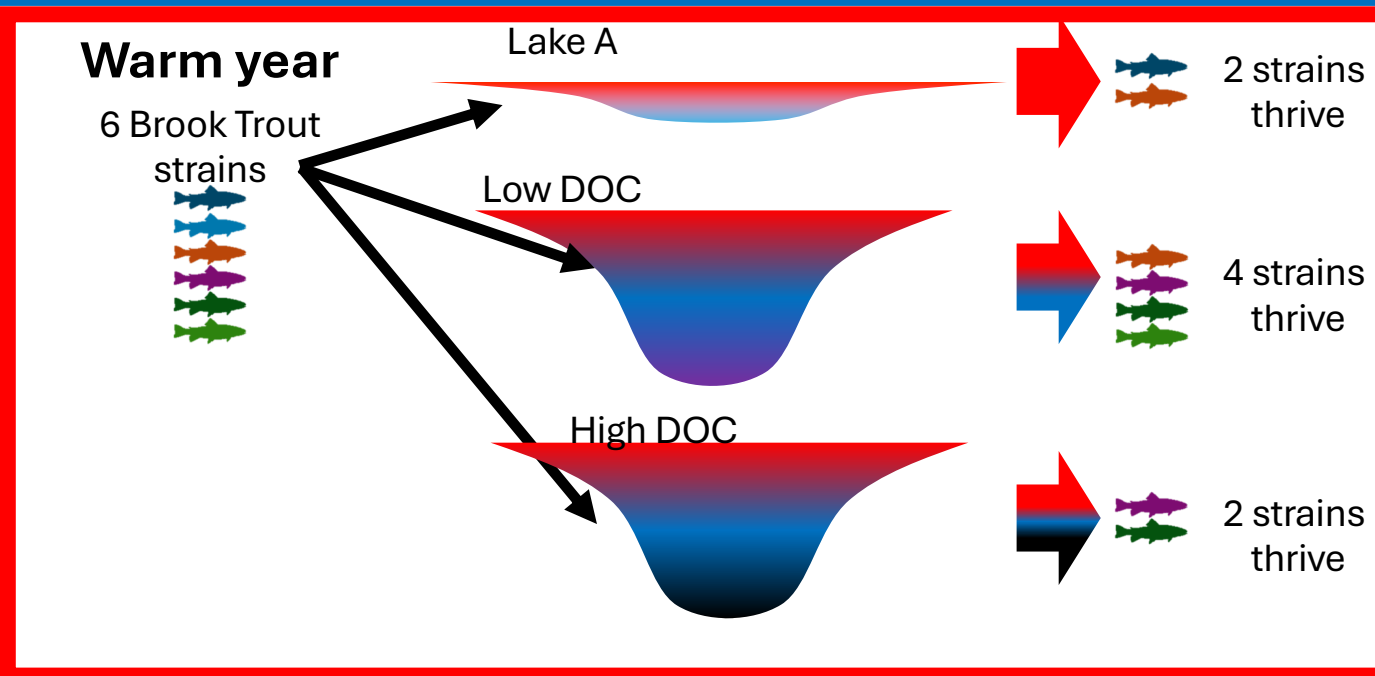
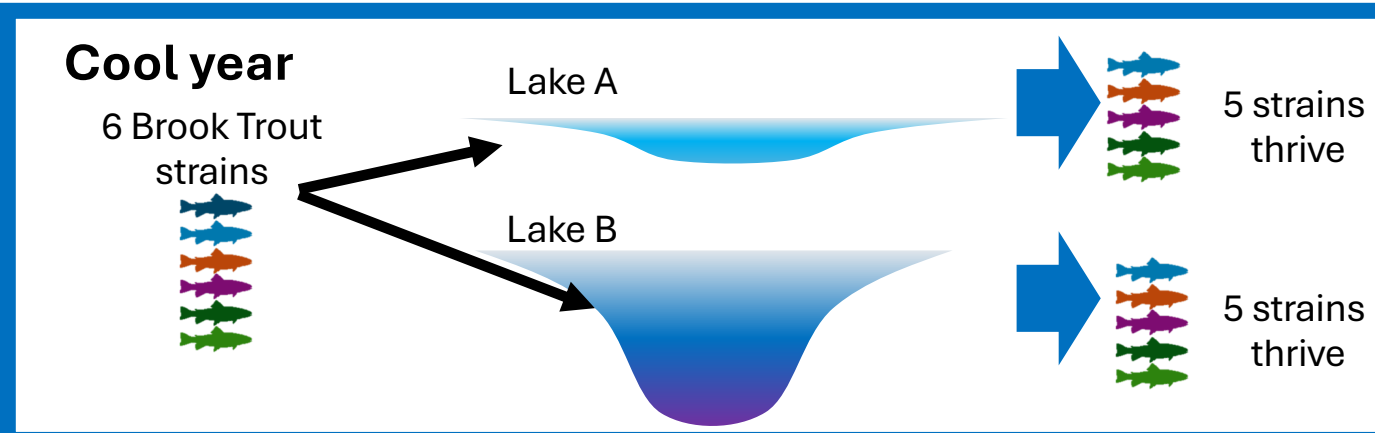
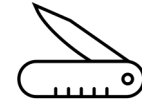
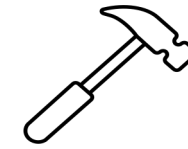


- Warming and browning
- Implications for trout
- Trout responses
- Angler responses
- Going forward





# Develop Tools (Climate Adaptive Stocking)



Department of  
Environmental  
Conservation

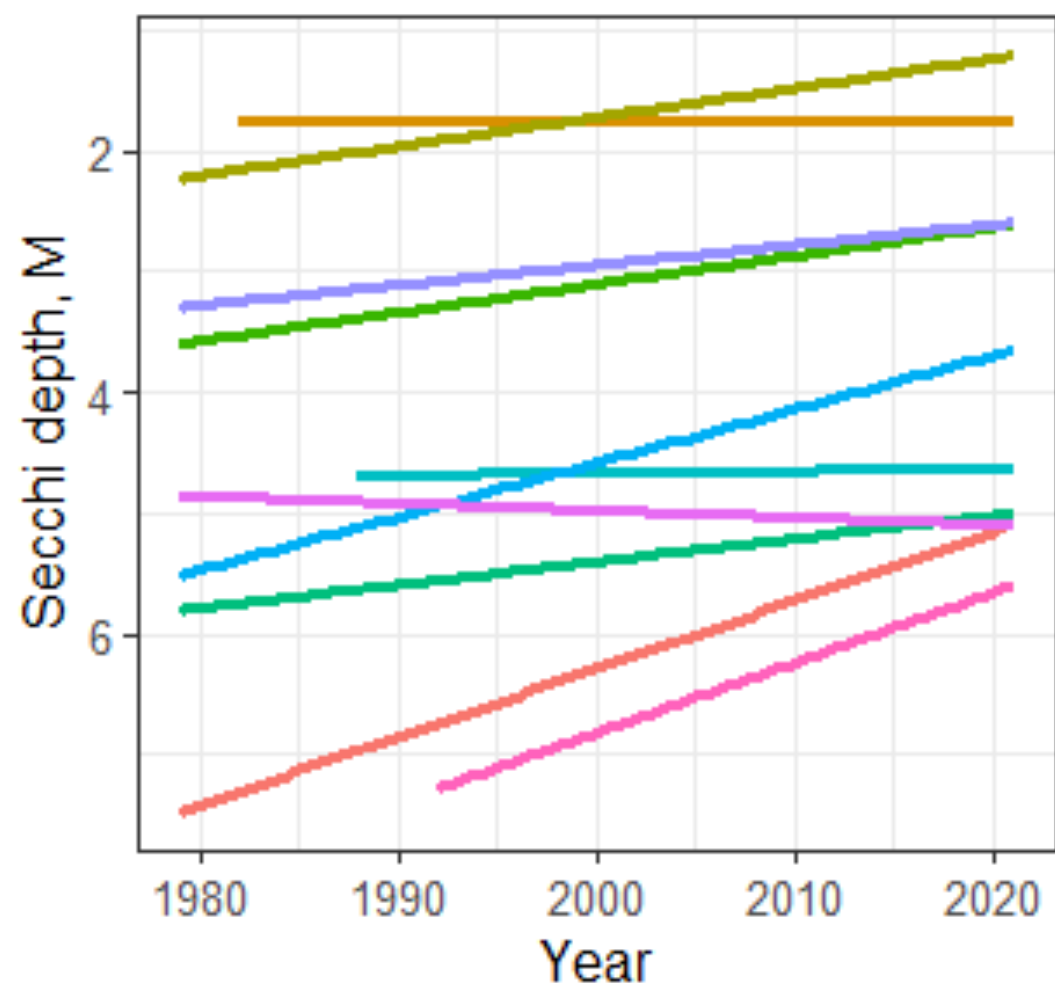
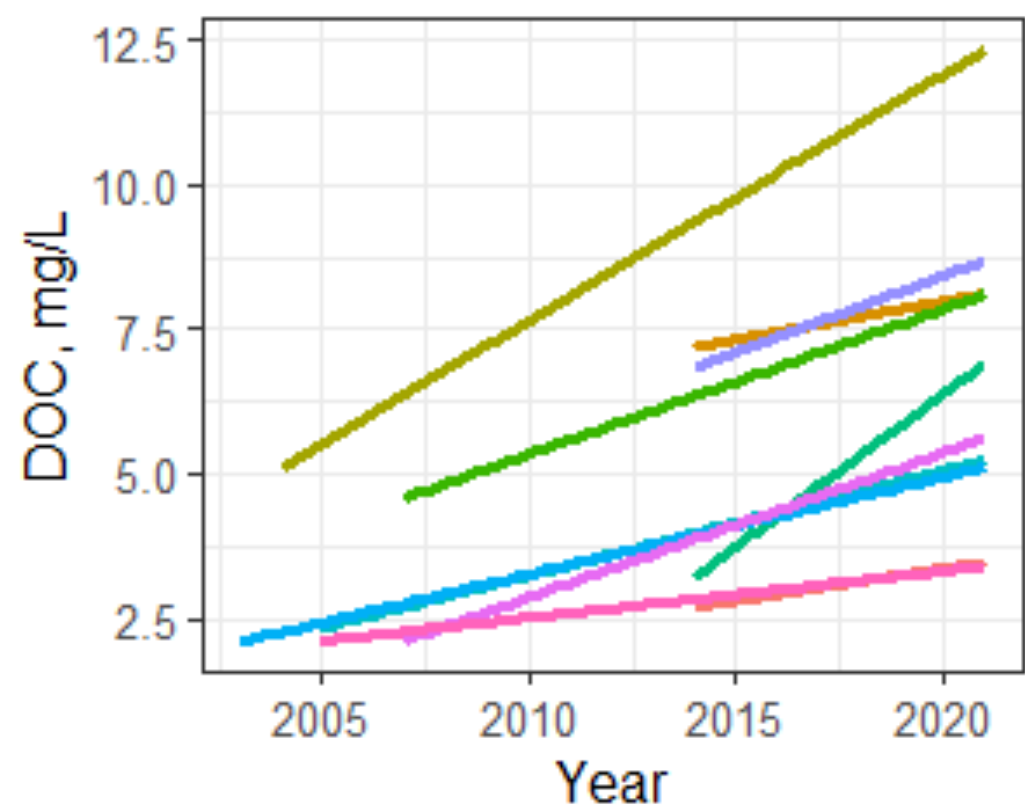
- Warming and browning
  - *Browning will exacerbate warming*
- Implications for trout
  - *Habitat is being reduced*
- Trout responses
  - *Trout shift habitat with conditions*
- Angler responses
  - *Angler behavior shifts*
- Going forward
  - *Thoughtful management and evaluating new tools*

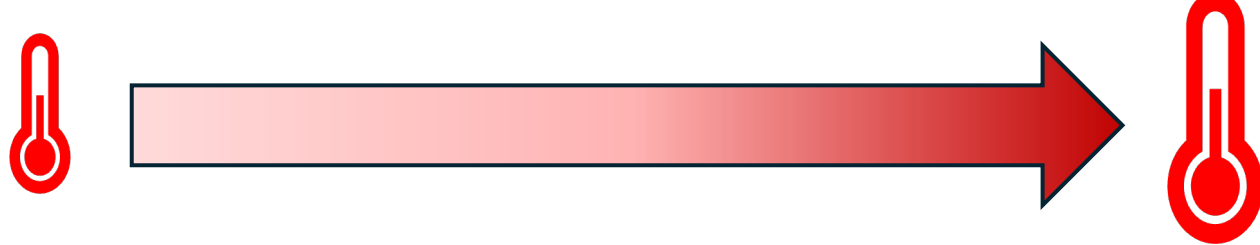


# Questions

A close-up photograph of a rainbow trout, likely a steelhead, resting on a bed of ice. The fish's body is covered in numerous yellow spots and several red spots. The scales are visible, and the fish's fins are partially visible. The background is a textured, light-colored surface, possibly a fishing net or a piece of fabric.

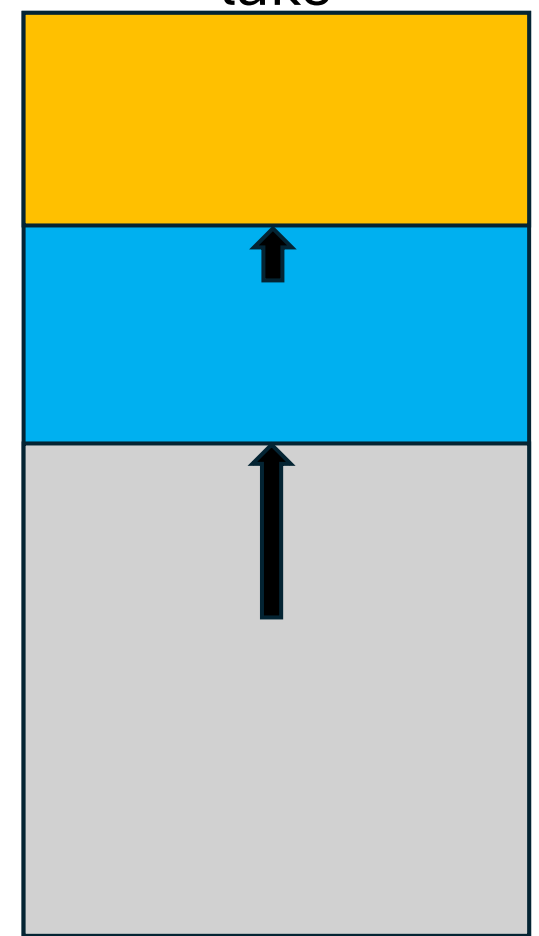
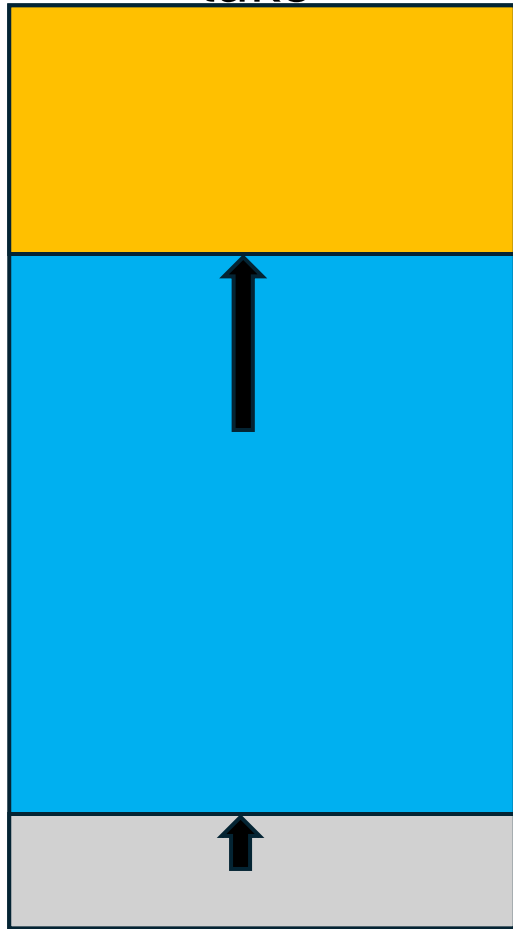
**Tommy Detmer**  
**([Thomas.m.detmer@gmail.com](mailto:Thomas.m.detmer@gmail.com))**





Clear lake

Brown lake

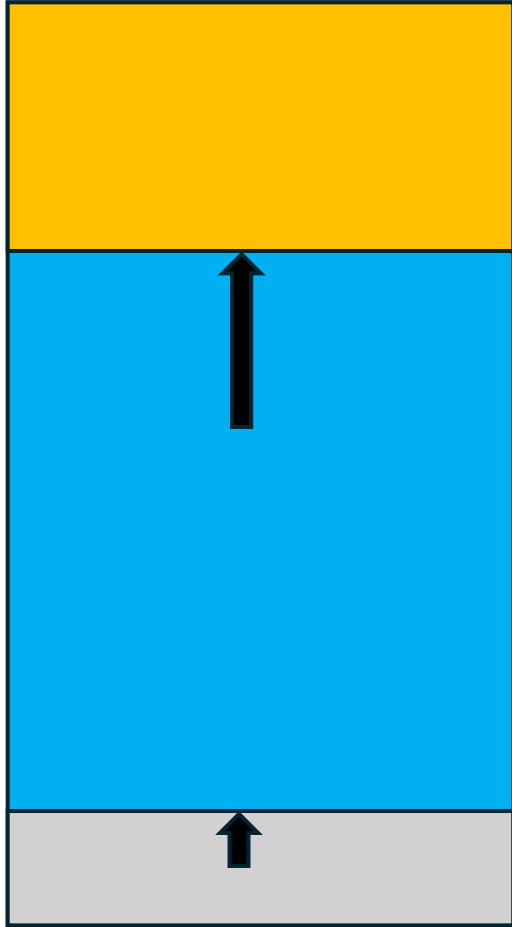


Cool water expansion

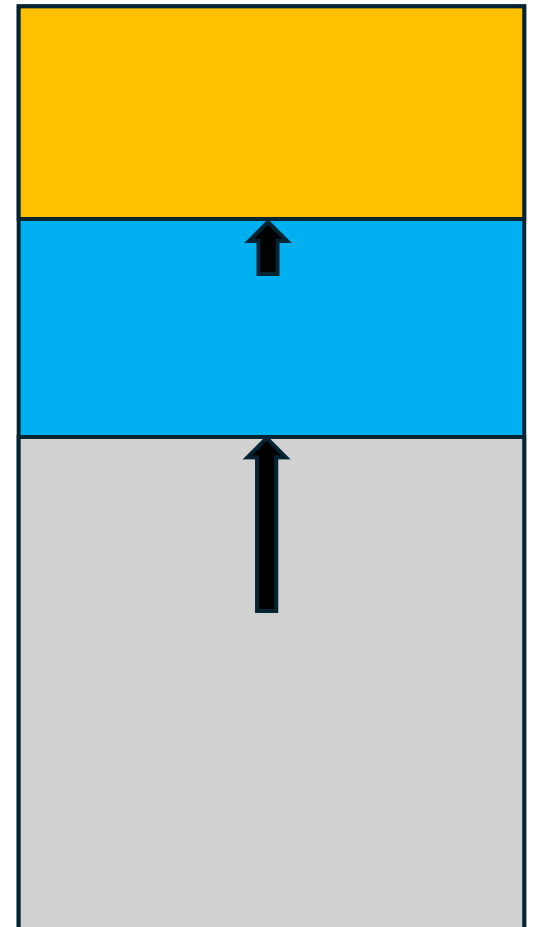
Low oxygen expansion

■ Warm      ■ Cool      ■ Low oxygen

Clear lake



Brown lake



Cool water expansion

Low oxygen expansion

■ Warm

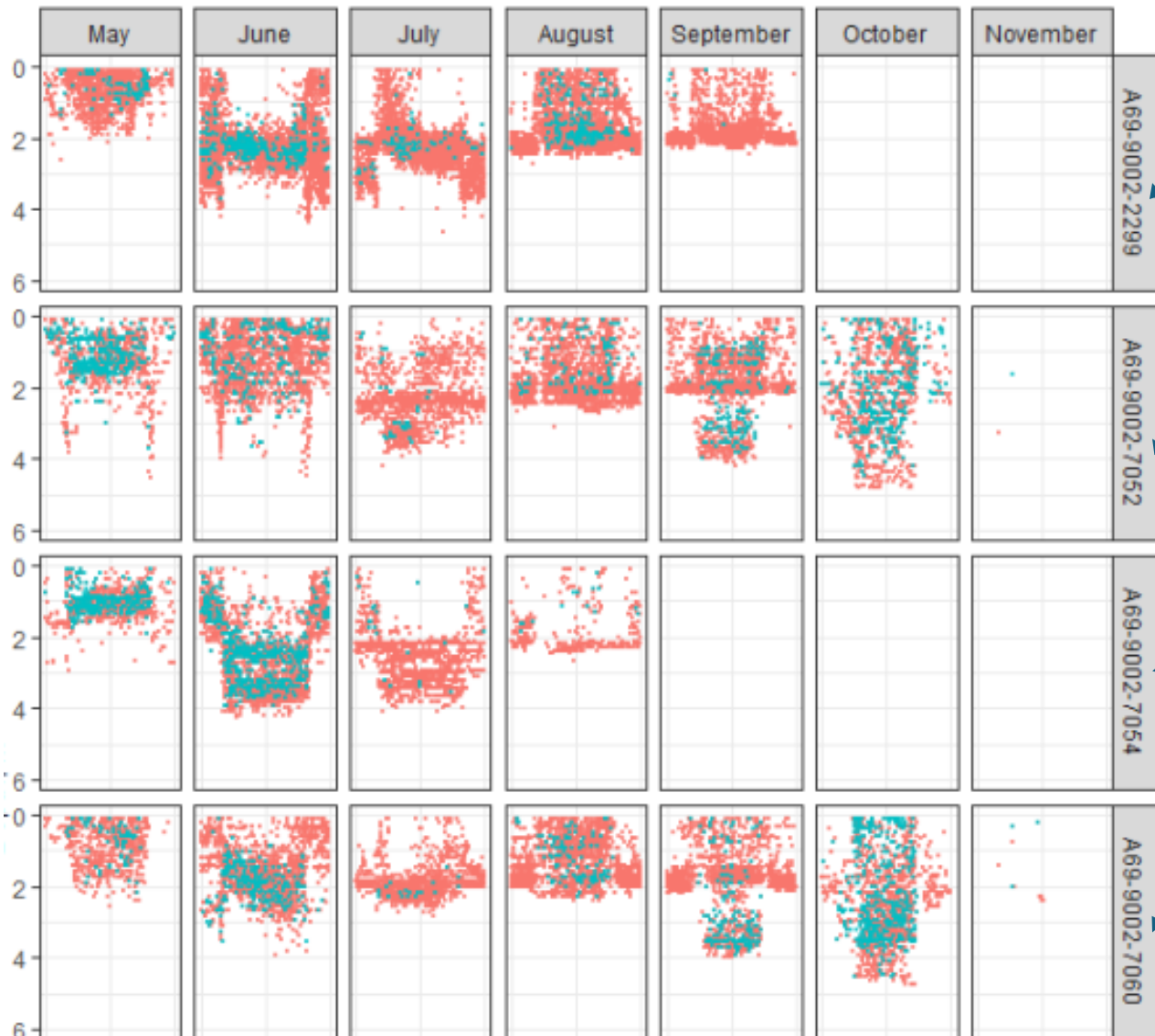
■ Cool

■ Low oxygen

Month

# Pinchnose Pond brook trout with acoustic telemetry tags

Depth, m



Individual fish

Location in lake



Time, midnight to midnight



Month

# Pinchnose Pond brook trout with acoustic telemetry tags

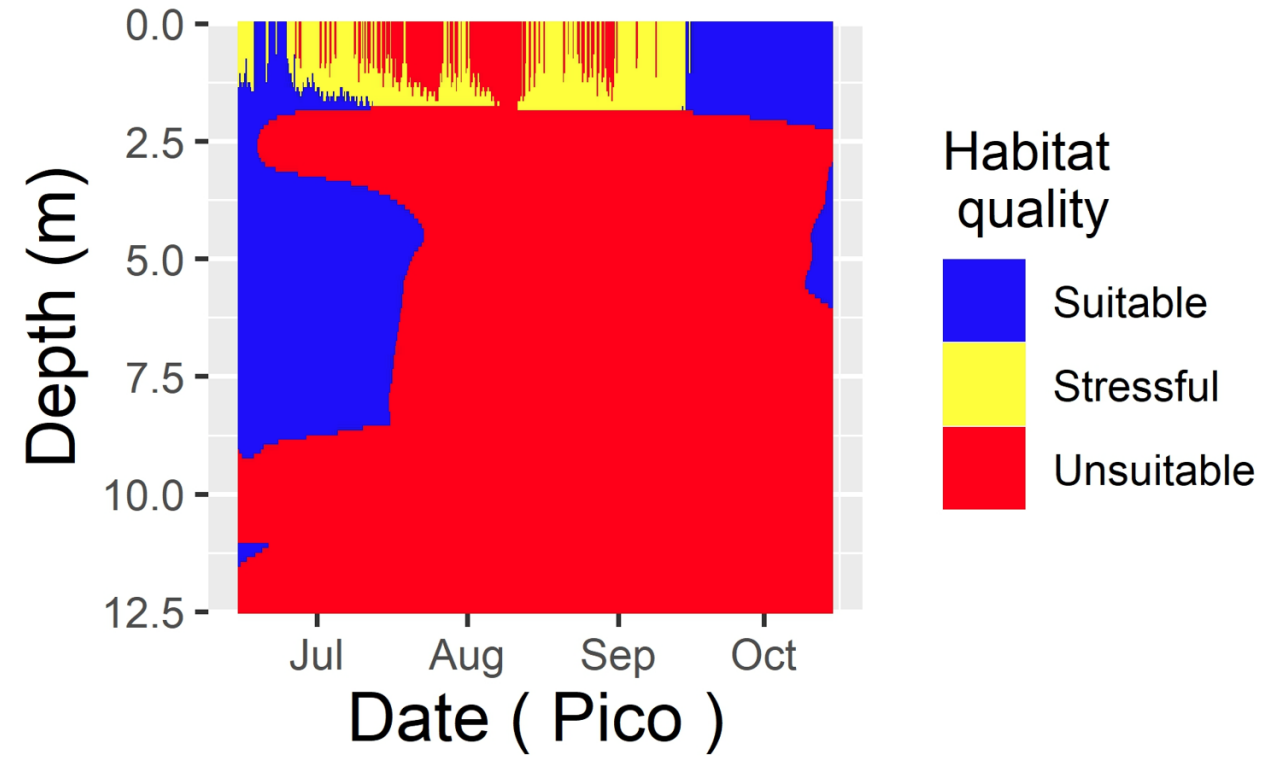
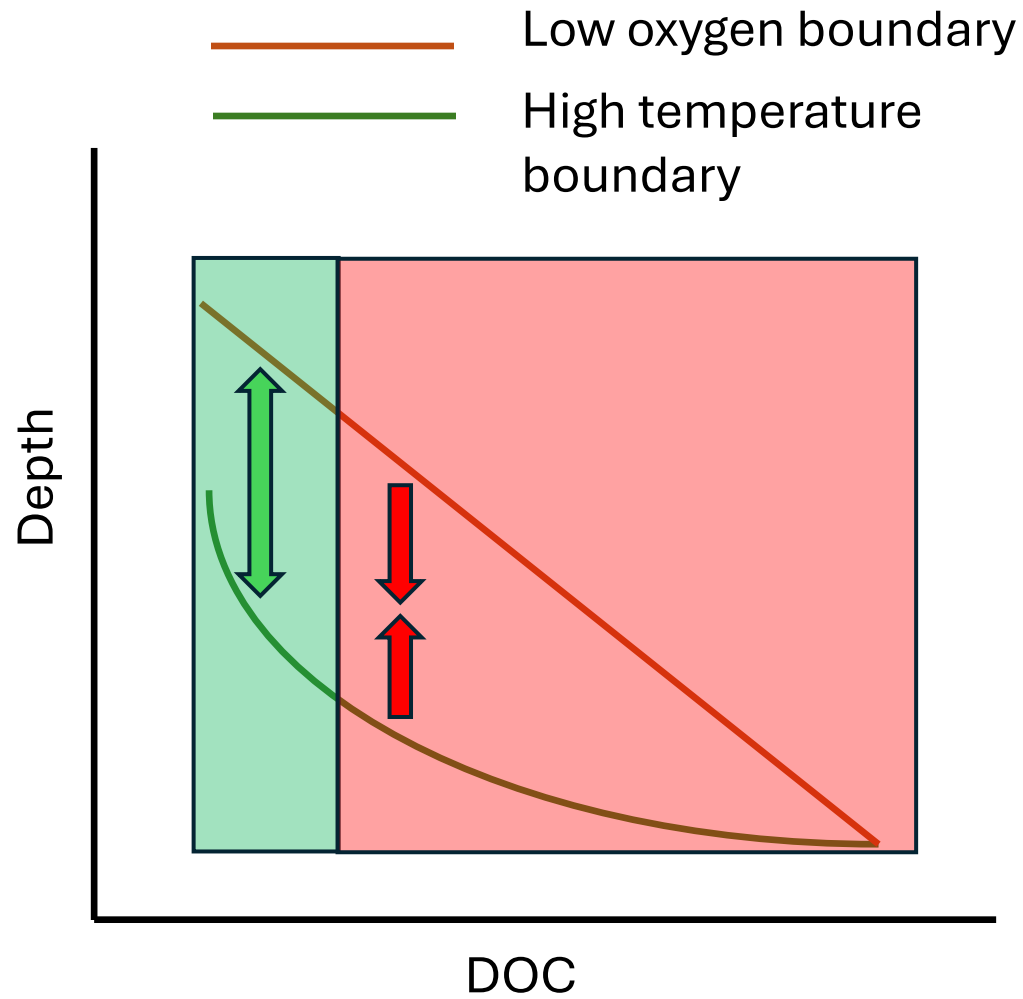
Depth, m

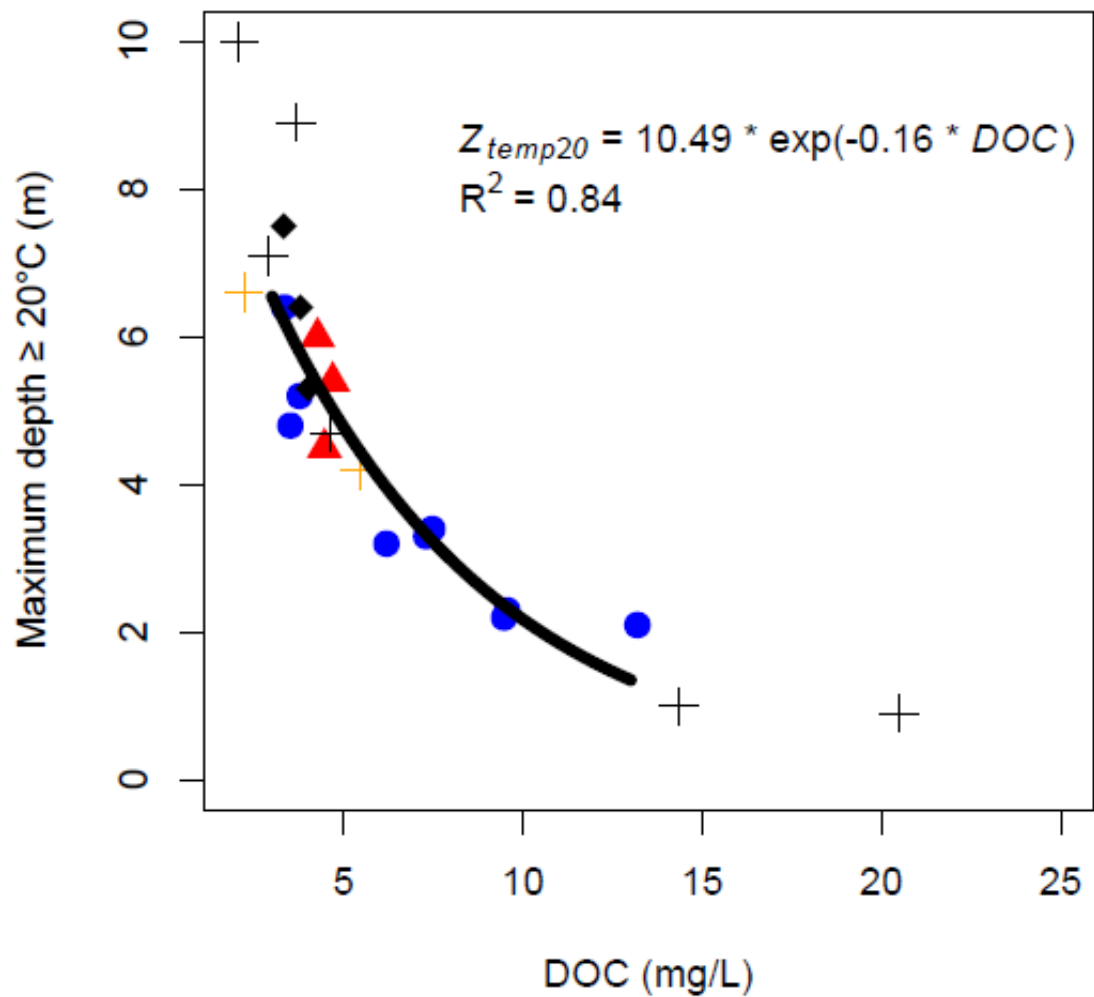


Time, midnight to midnight

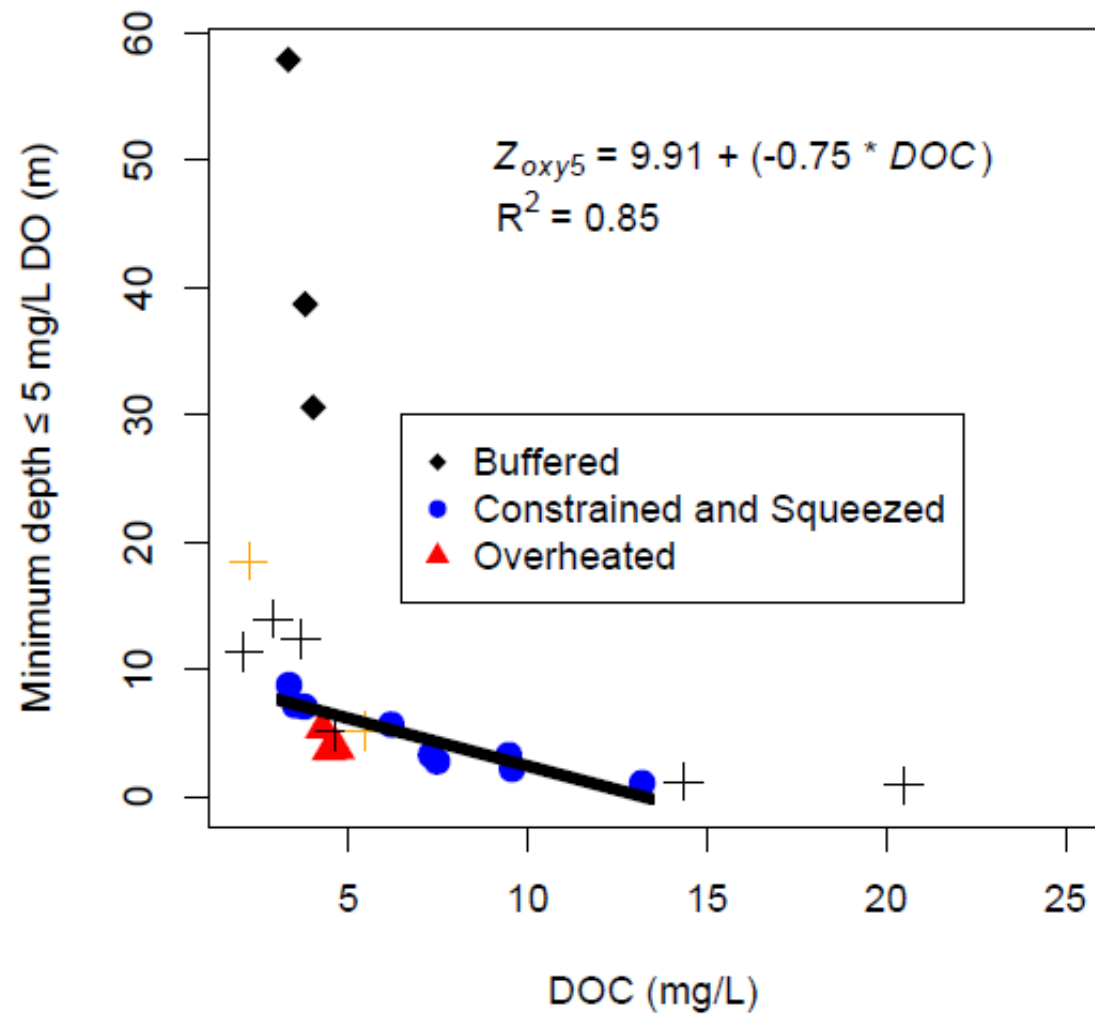
Location in lake



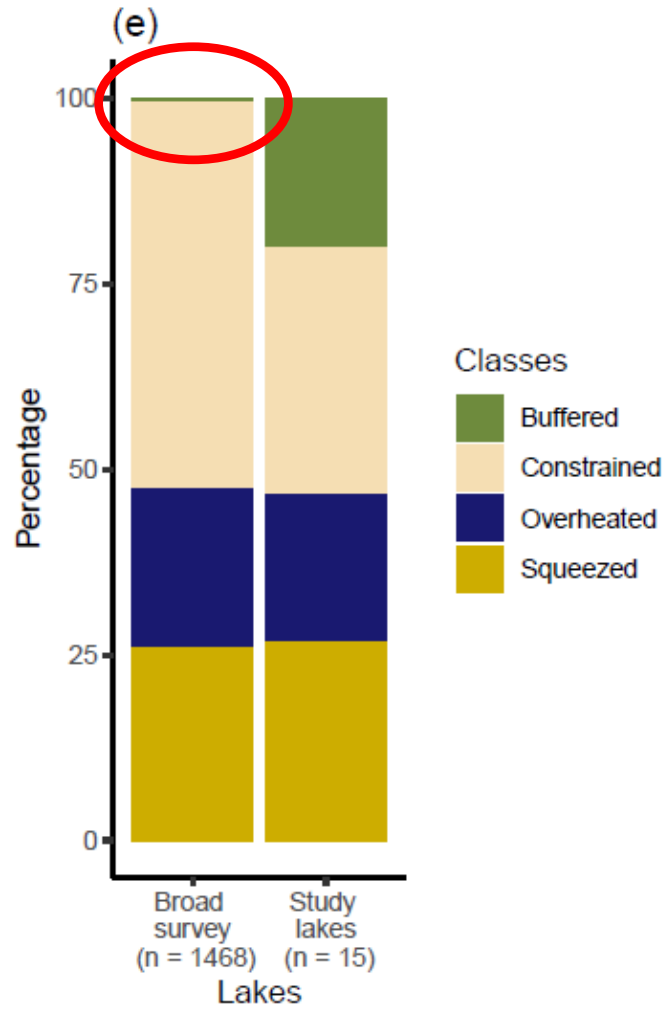
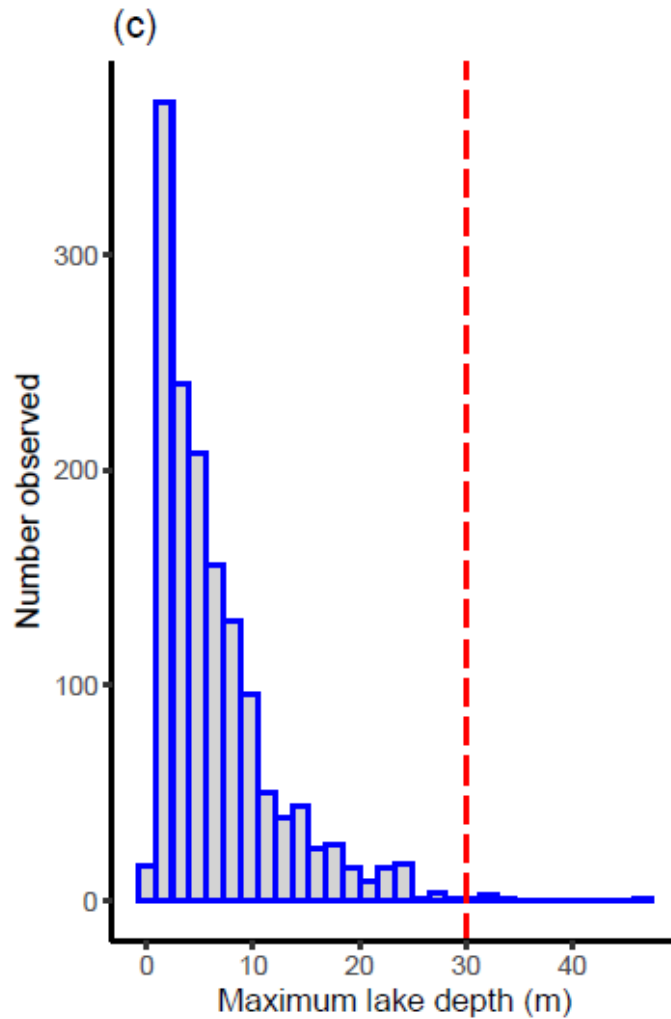




Higher DOC means higher temperatures shallower



Higher DOC means higher temperatures shallower depths with limited oxygen



Very few buffered lakes

Since 1980s low DOC  
constrained: 23.4 -> 4.8%