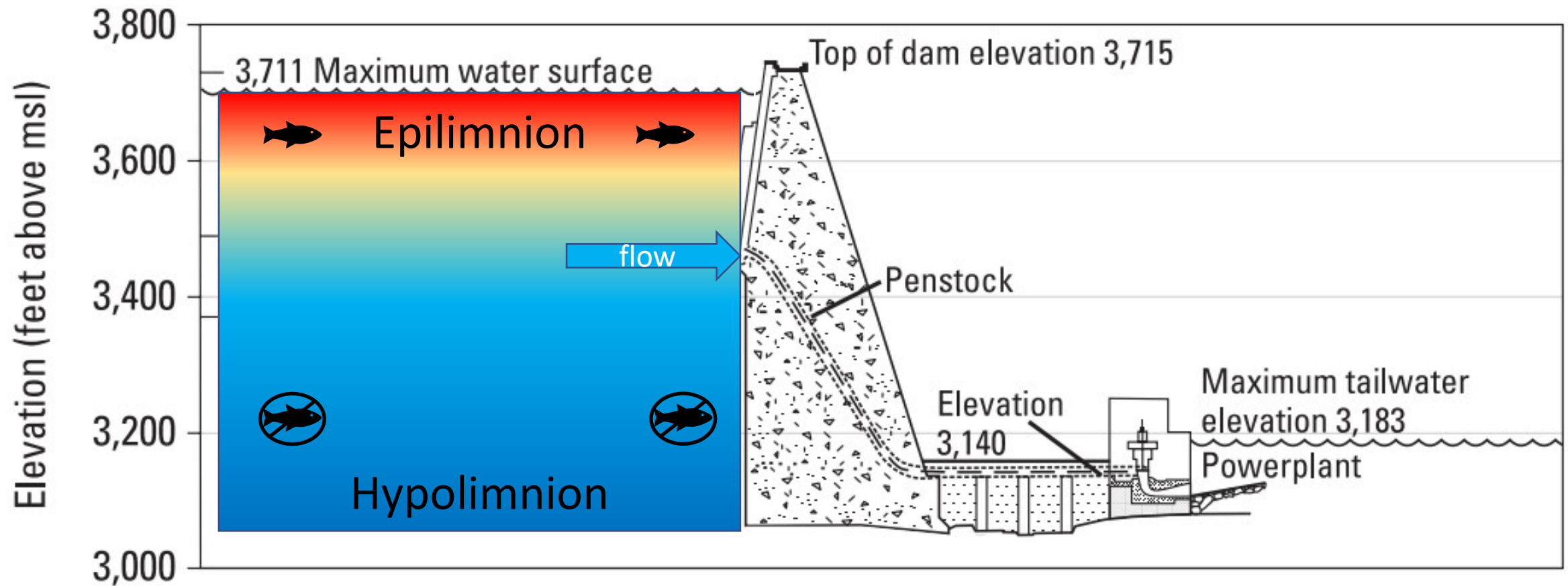


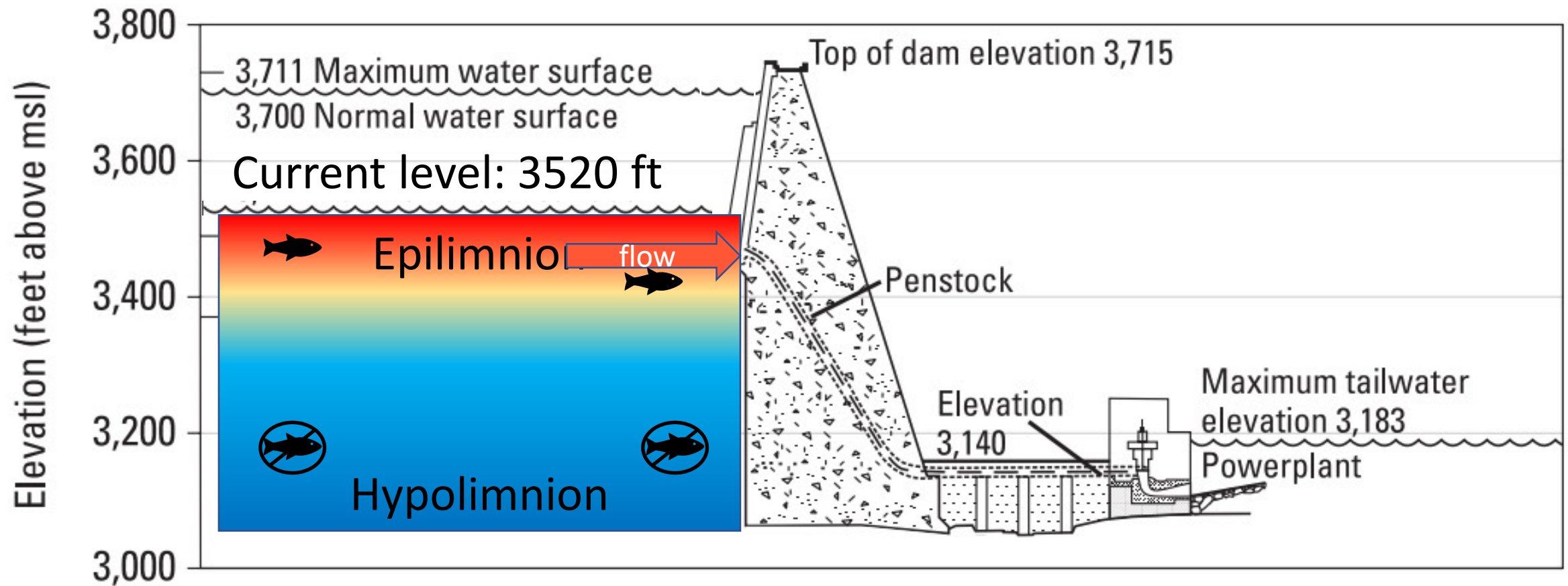
Characterizing the fish assemblage in the Lake Powell forebay and
identifying the potential for nonnative fish escapement into the Lower
Colorado River

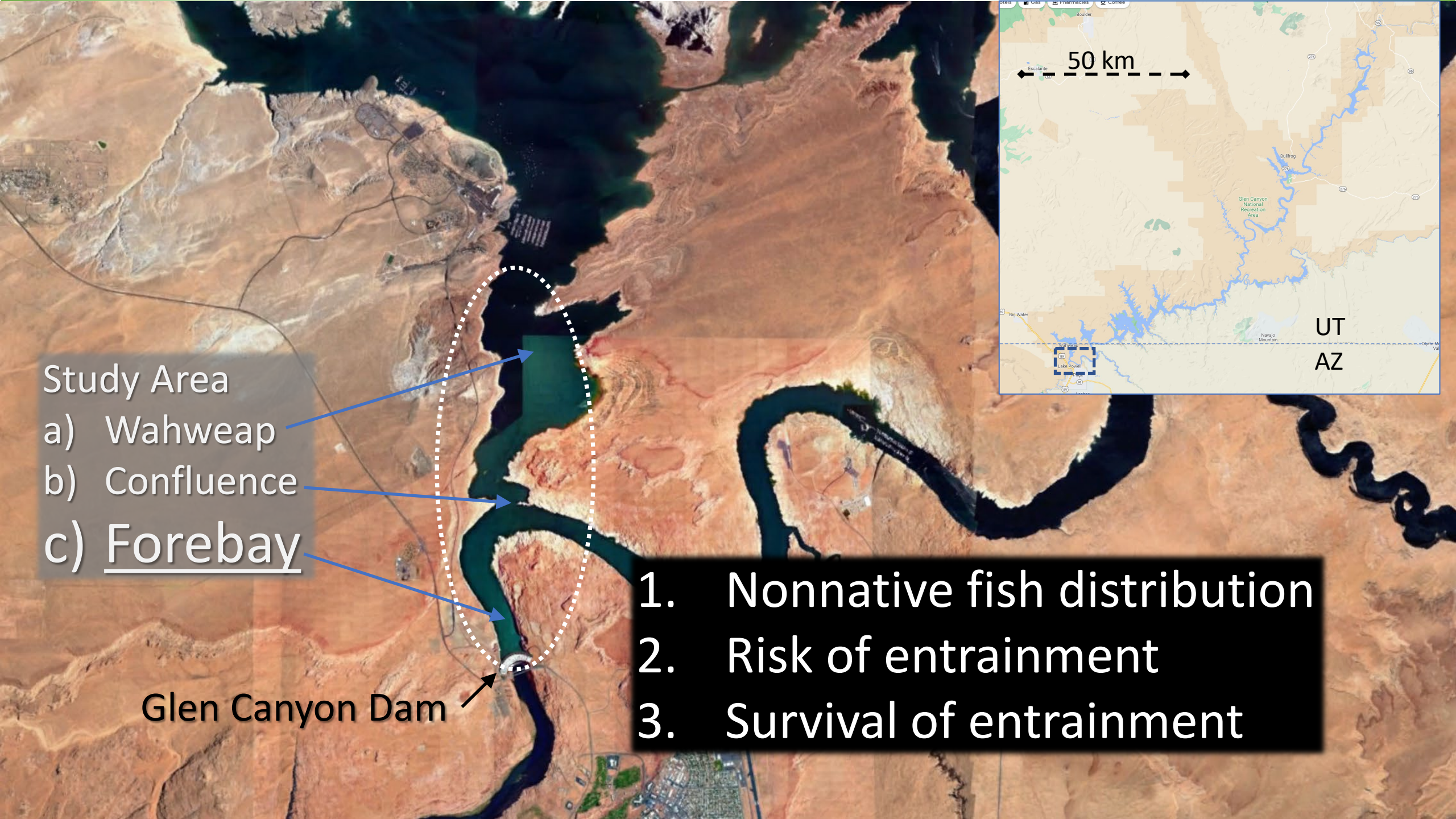
Barrett Friesen, Phaedra Budy, Casey Pennock
Utah State University

Historic conditions: withdrawal from hypolimnion when stratified



Current conditions: withdrawal from epilimnion when stratified





Study Area

a) Wahweap

b) Confluence

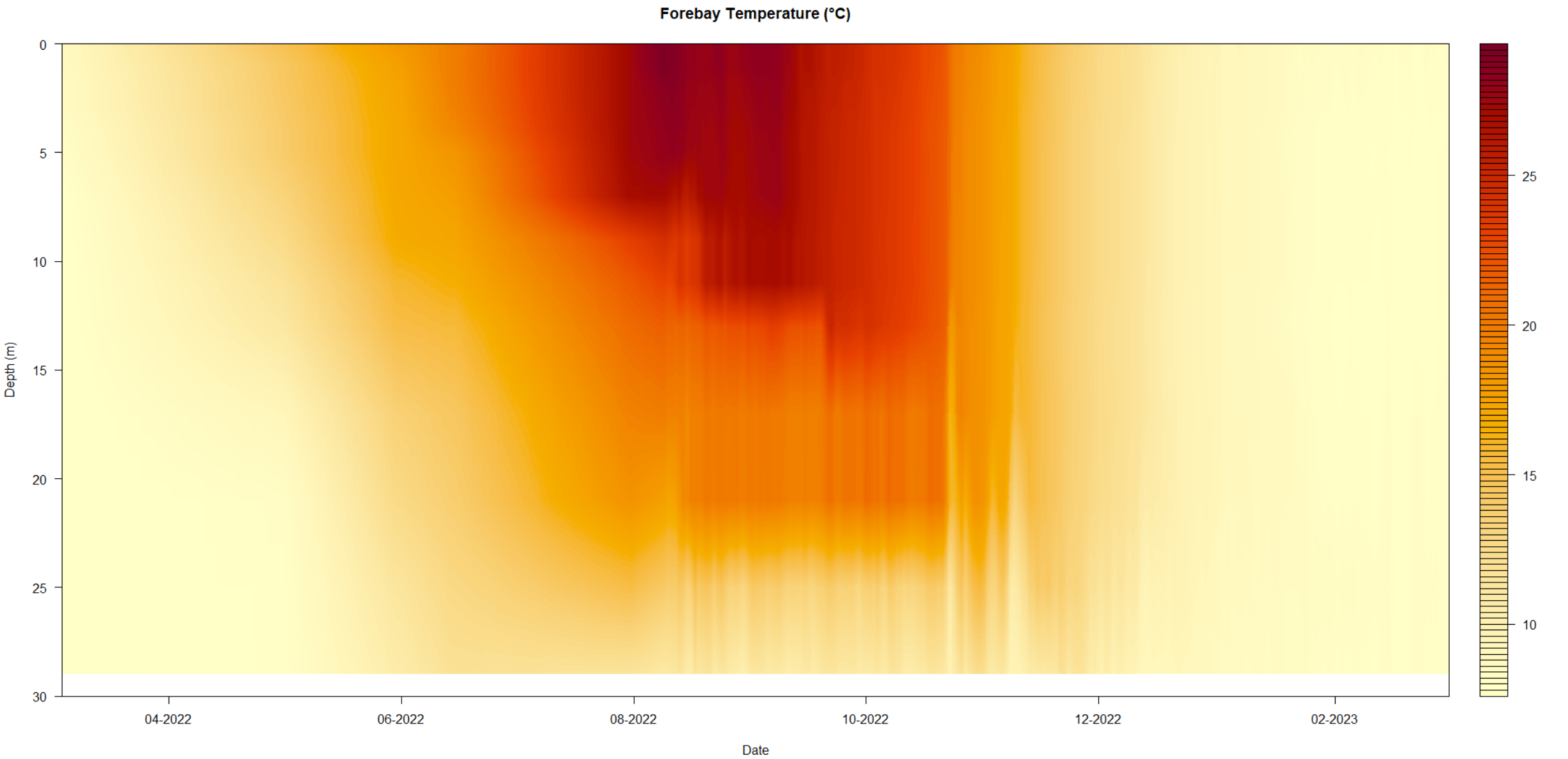
c) Forebay

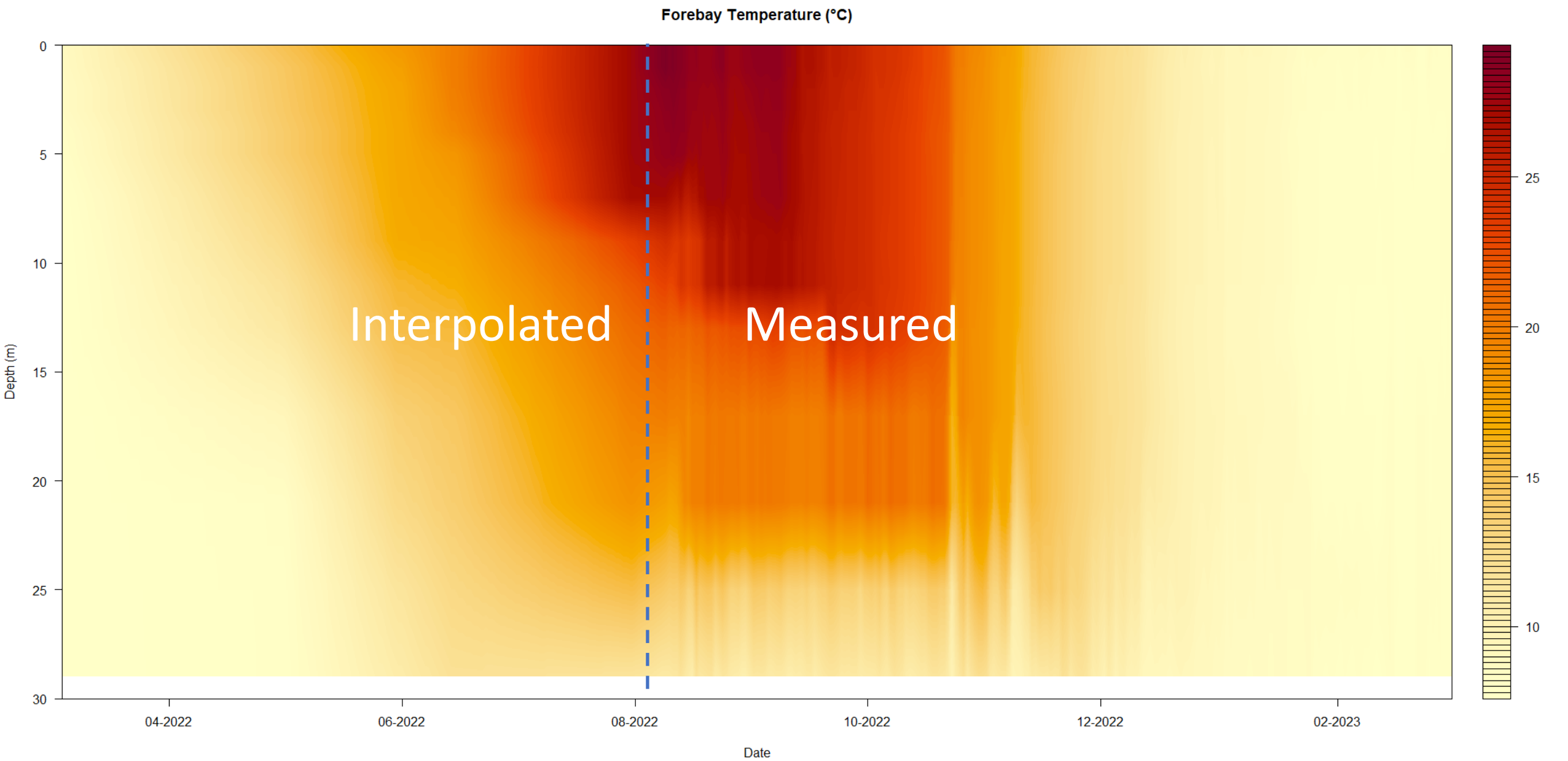
Glen Canyon Dam

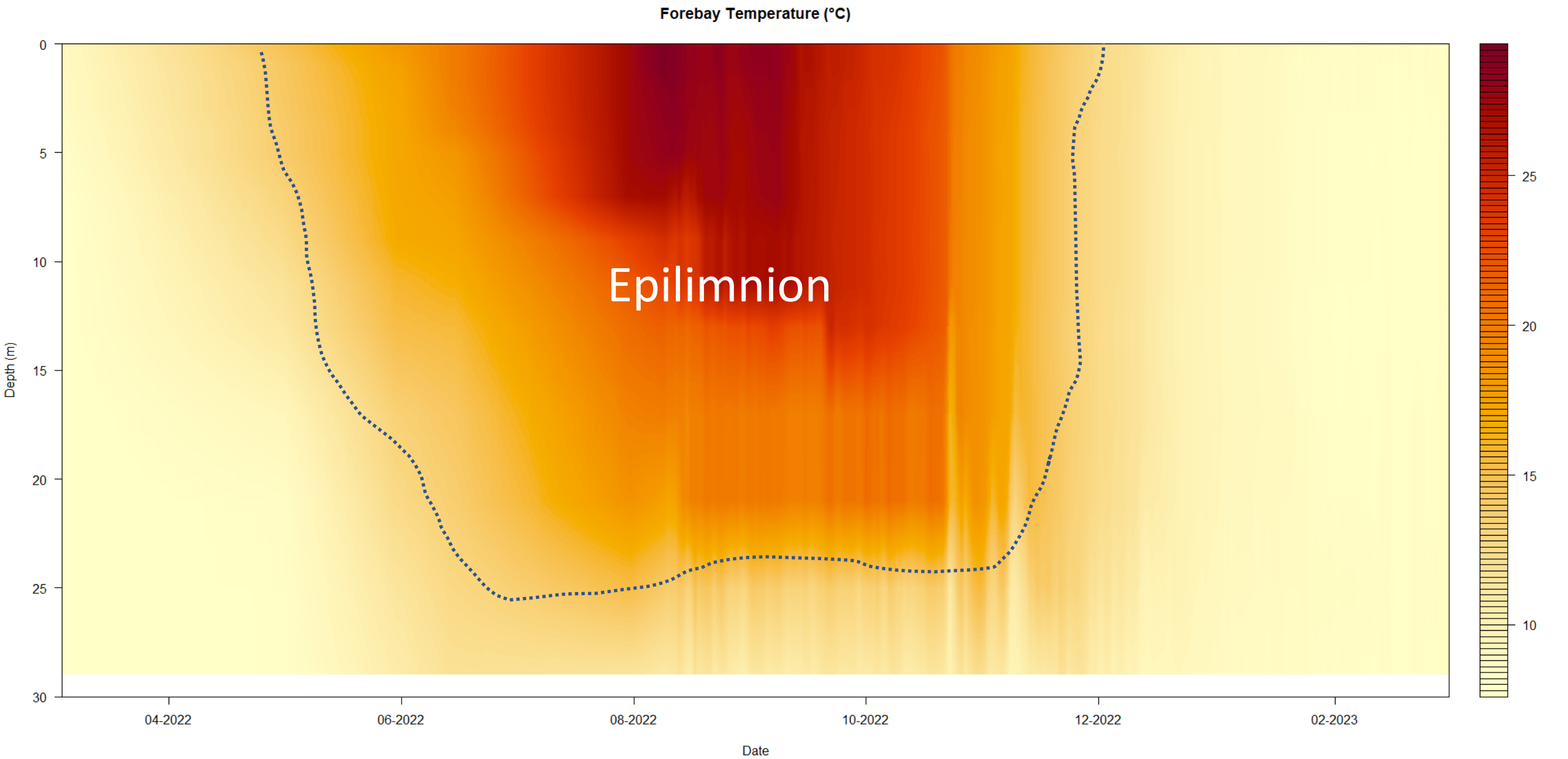
1. Nonnative fish distribution
2. Risk of entrainment
3. Survival of entrainment

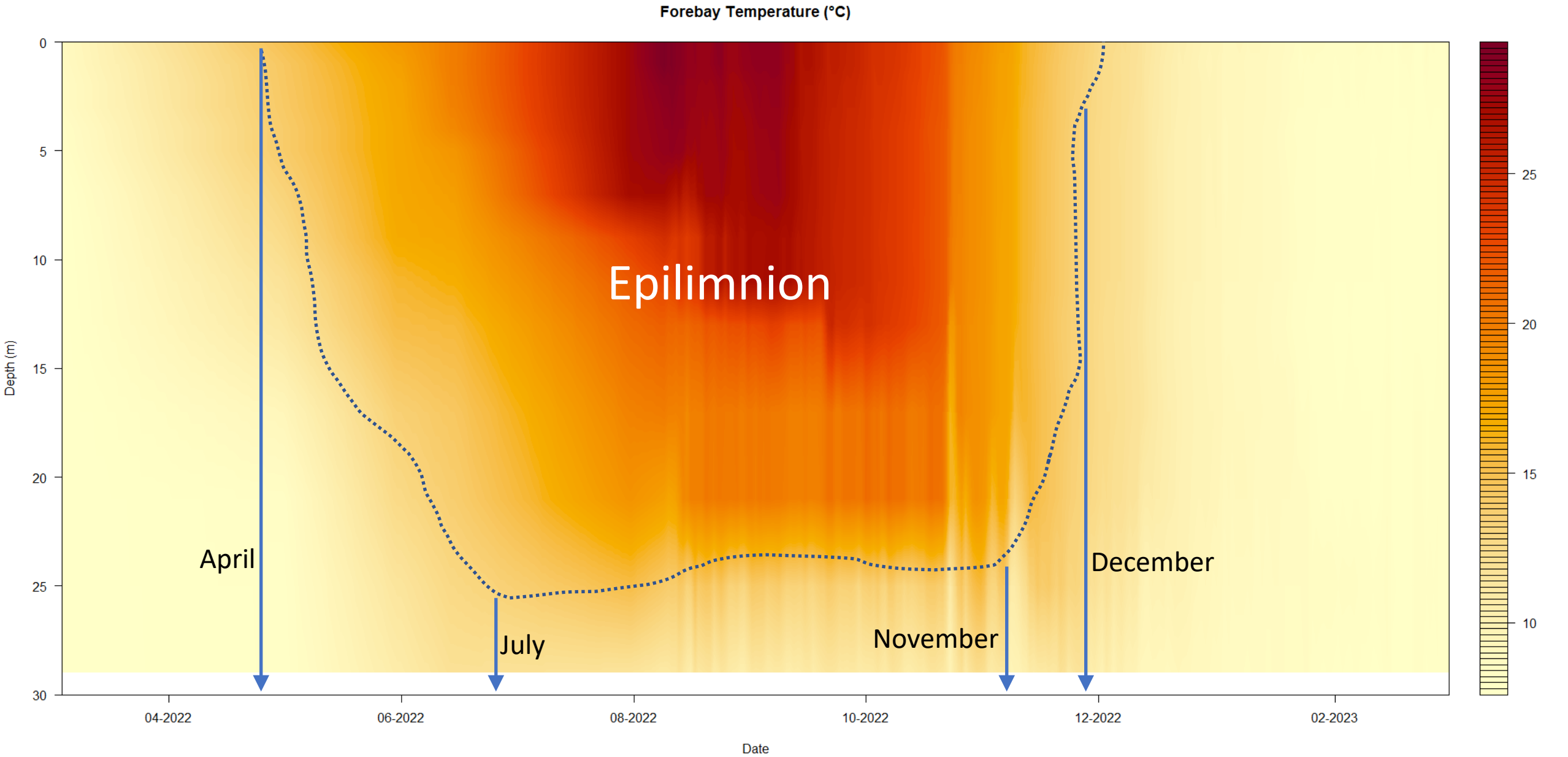
Updates to TWG

- Thermal structure of forebay
- Sampling near dam
- Sensor Fish preliminary data

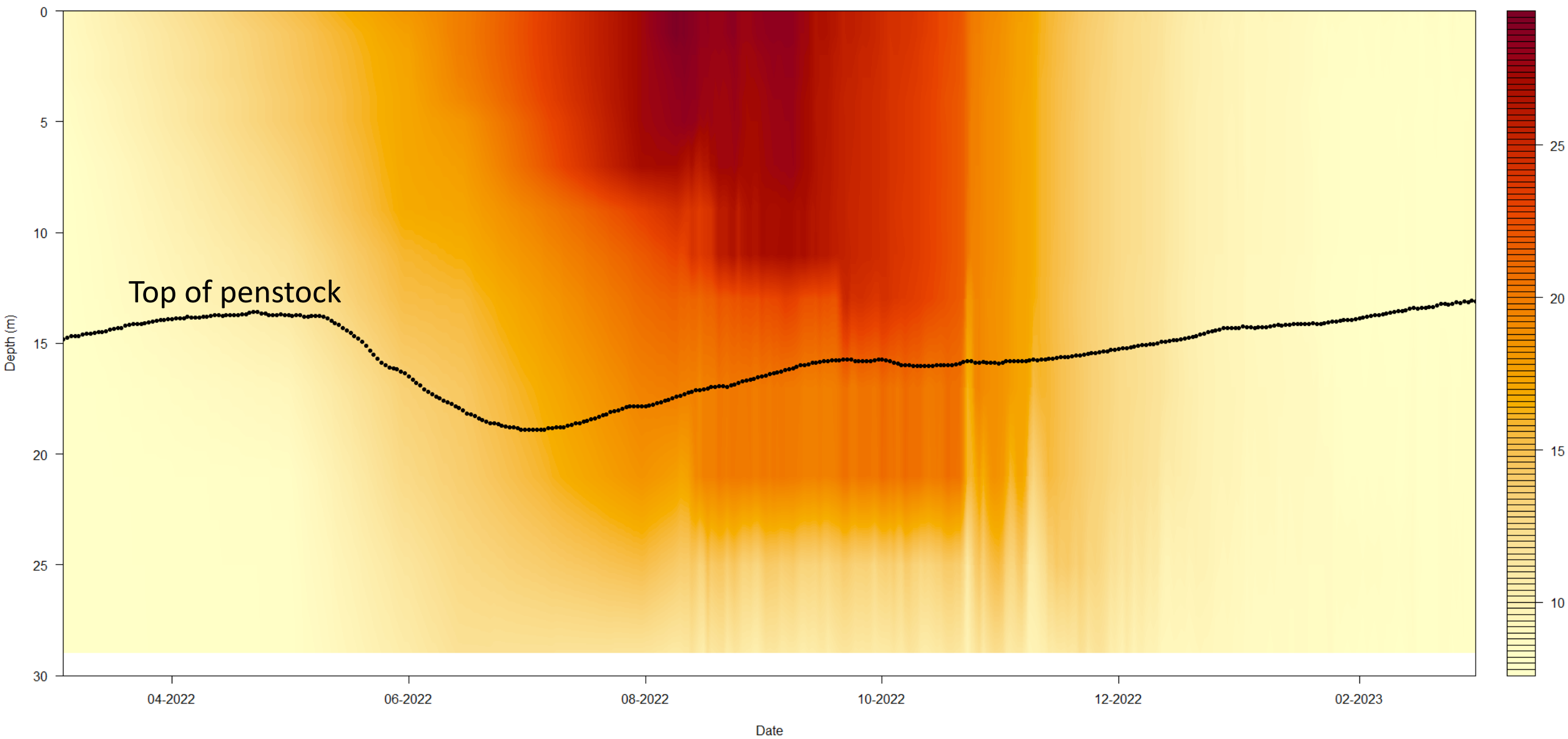




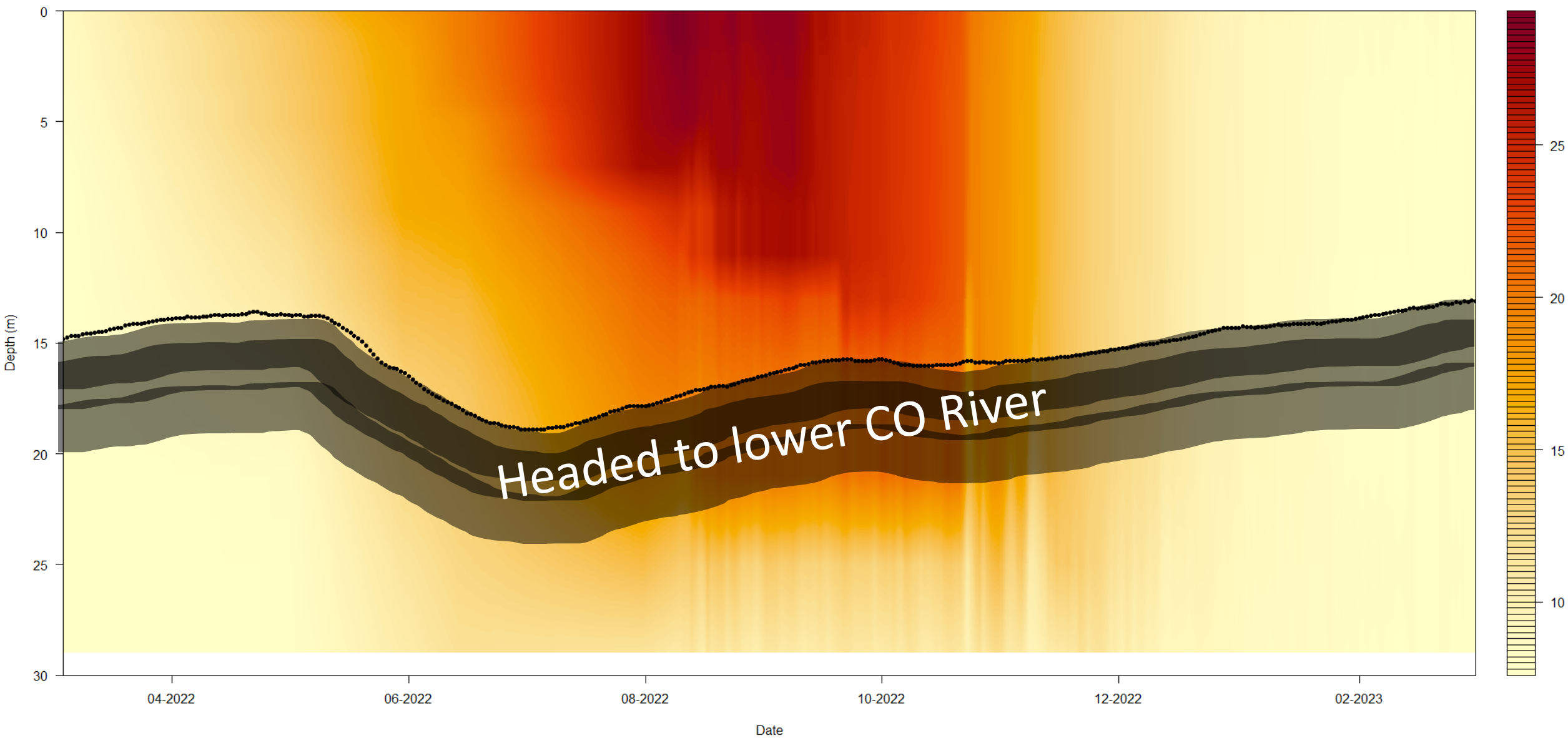




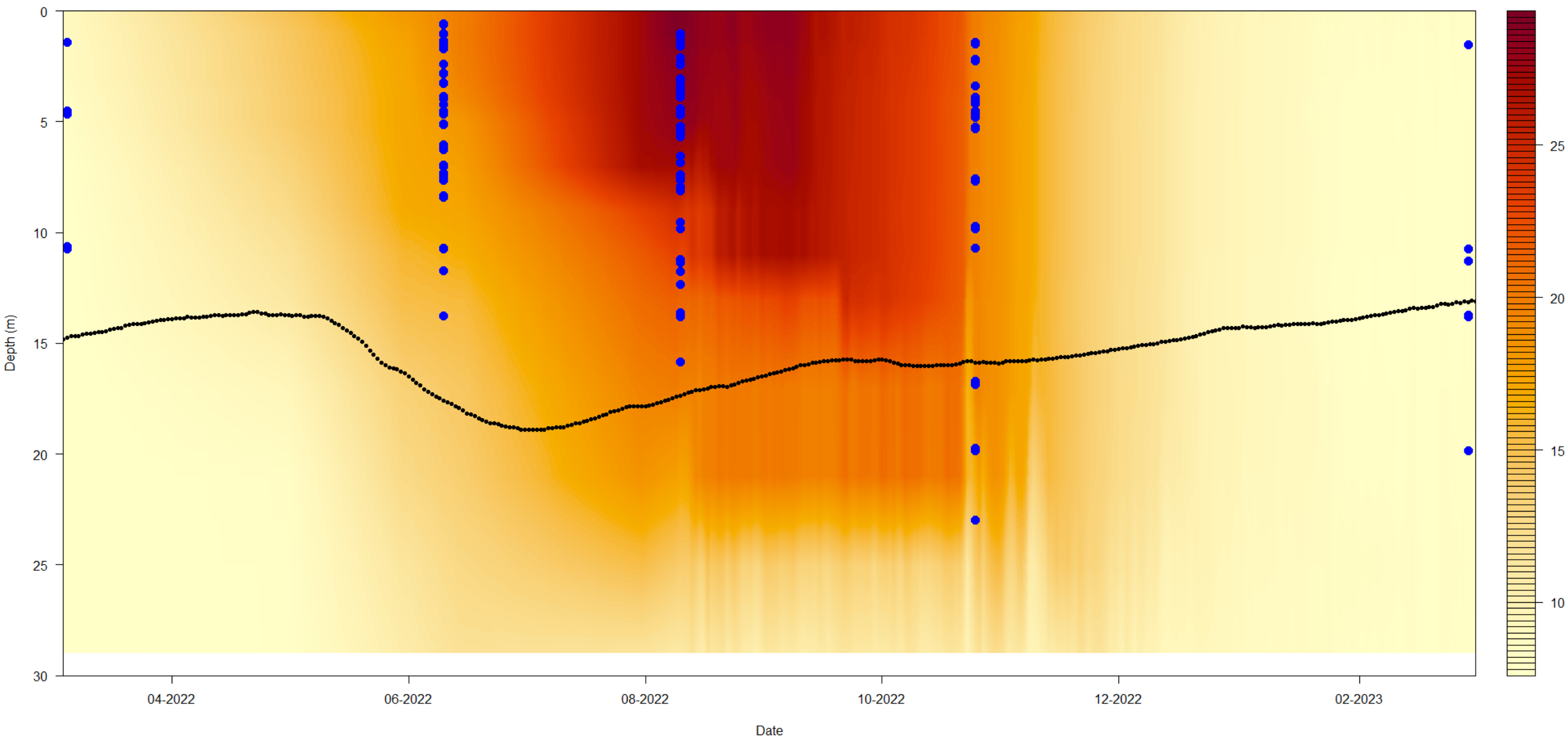
Forebay Temperature (°C) with penstock depth

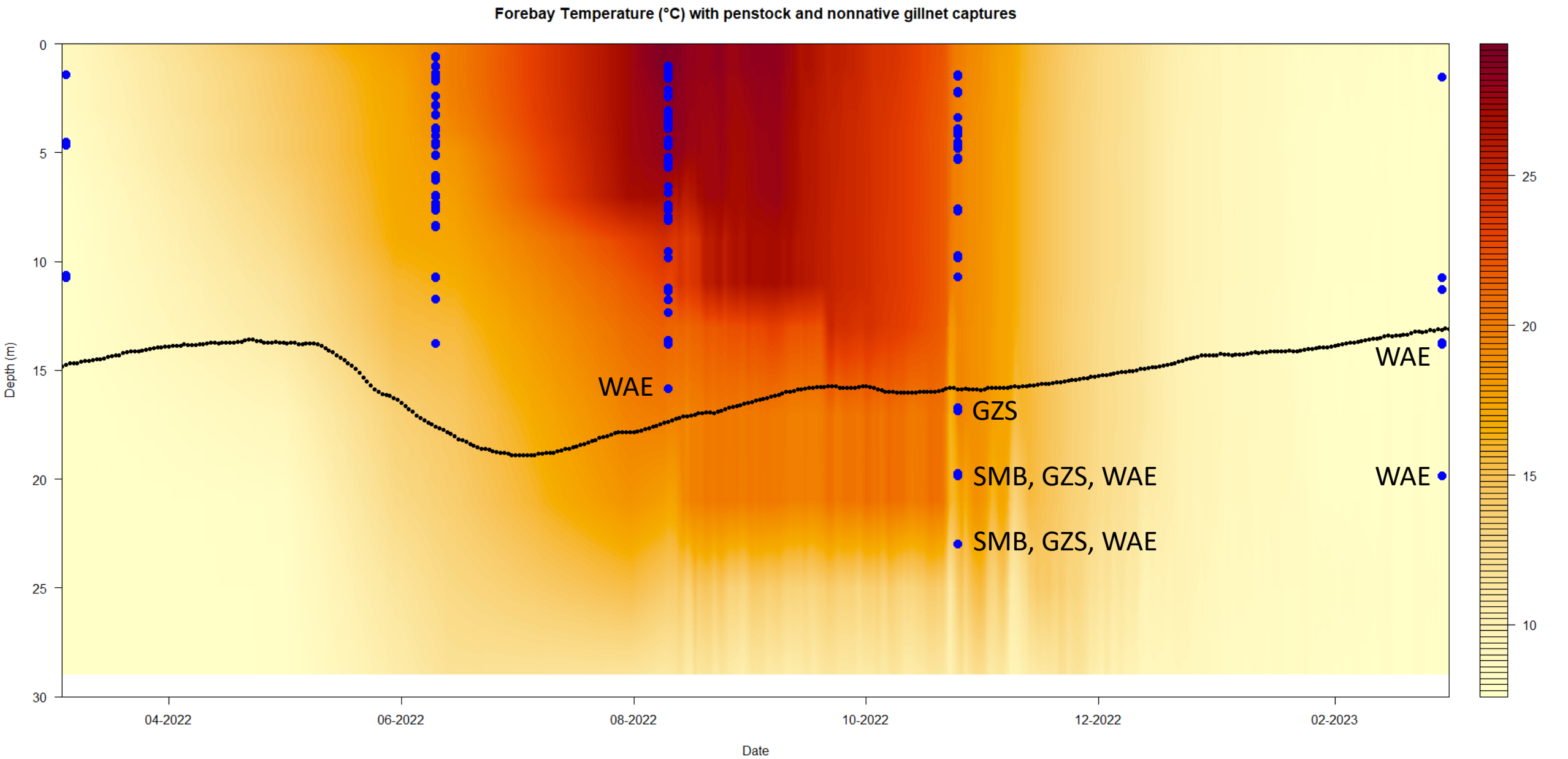


Forebay Temperature (°C) with penstock depth



Forebay Temperature (°C) with penstock and nonnative gillnet captures





Modification to sampling program: sample within chains close to dam.
Gillnets, minnow traps, larval traps throughout 2023



Question from 2022: where are entrained YoY coming from?



Shallow water habitat.
Spawning?

Possible answer: right next to the dam

BGL and GSF captured immediately adjacent to dam
Will we find spawning SMB and YoY there this summer?



Juvenile BGL & GSF

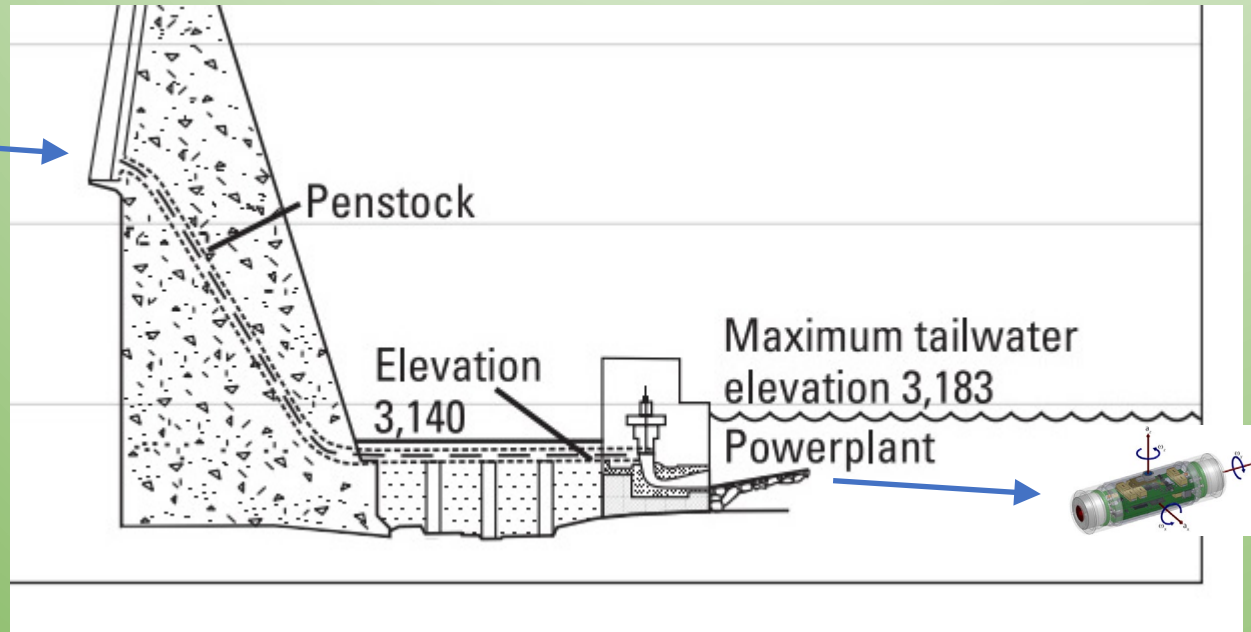
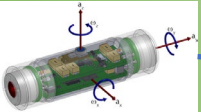


Sensor fish deployed: March 2023

Deployed Sensor Fish through dam to measure conditions of passage

- Pressure
- Acceleration
- 17 trials completed

Sensor Fish



Turbine



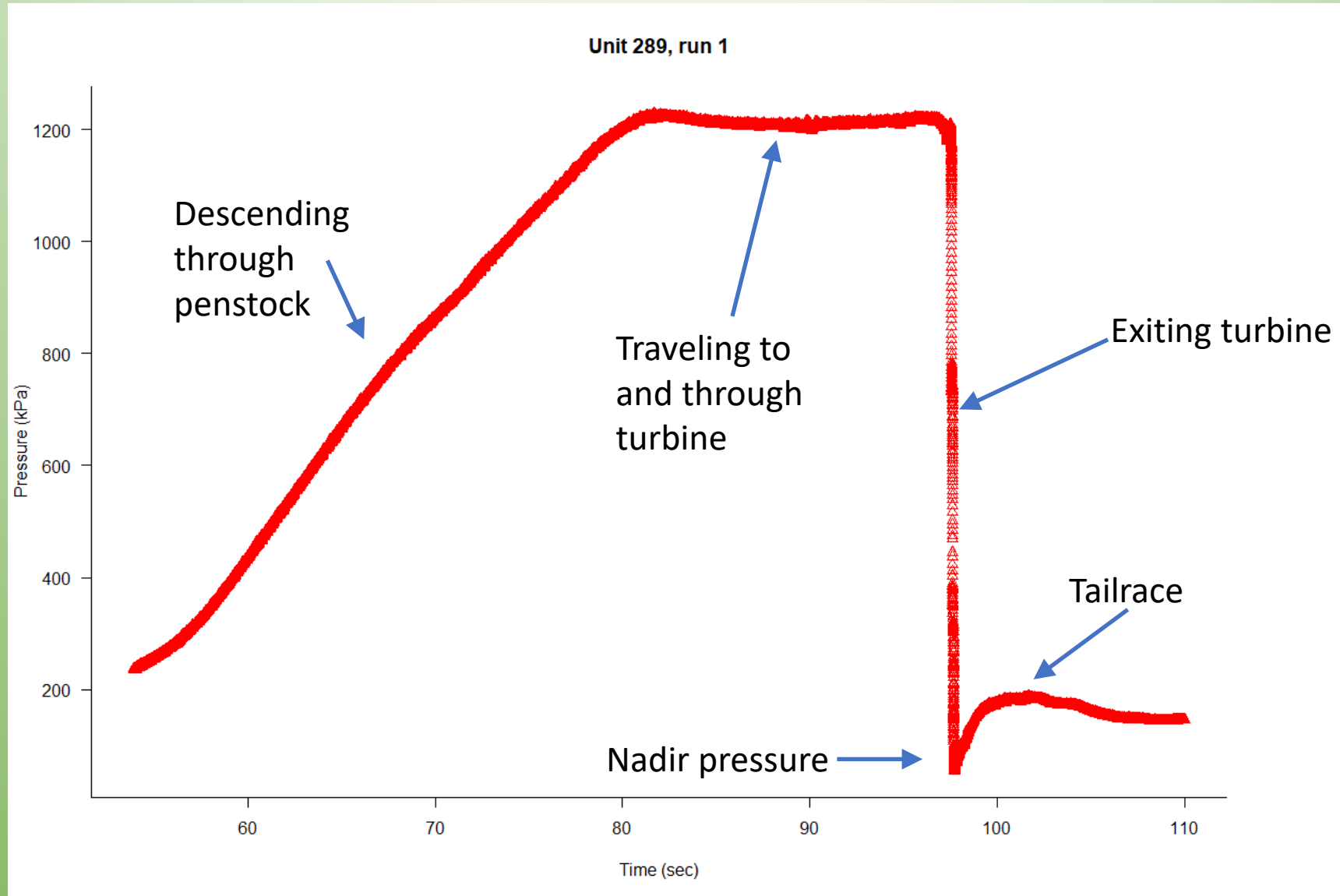
Sensor fish deployed: March 2023

Sources of immediate and delayed mortality

- Turbine blade strike
- Injury due to abrasion
- Gas bladder rupture
- Gas bubble disease
- Embolism
- Hemorrhage
- Exophthalmia

Sensor fish deployed: March 2023

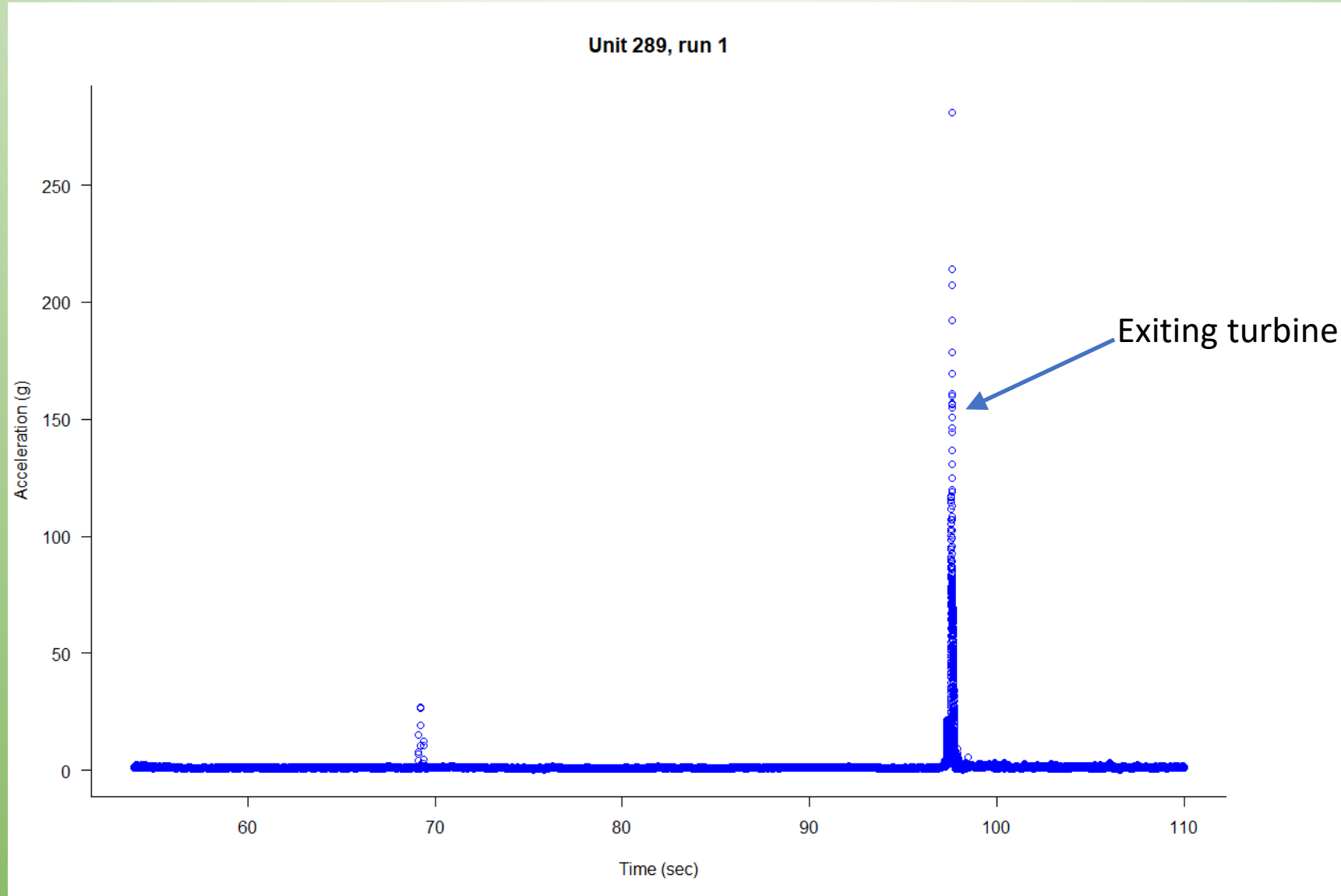
Typical pressure curve



Preliminary data

Sensor fish deployed: March 2023

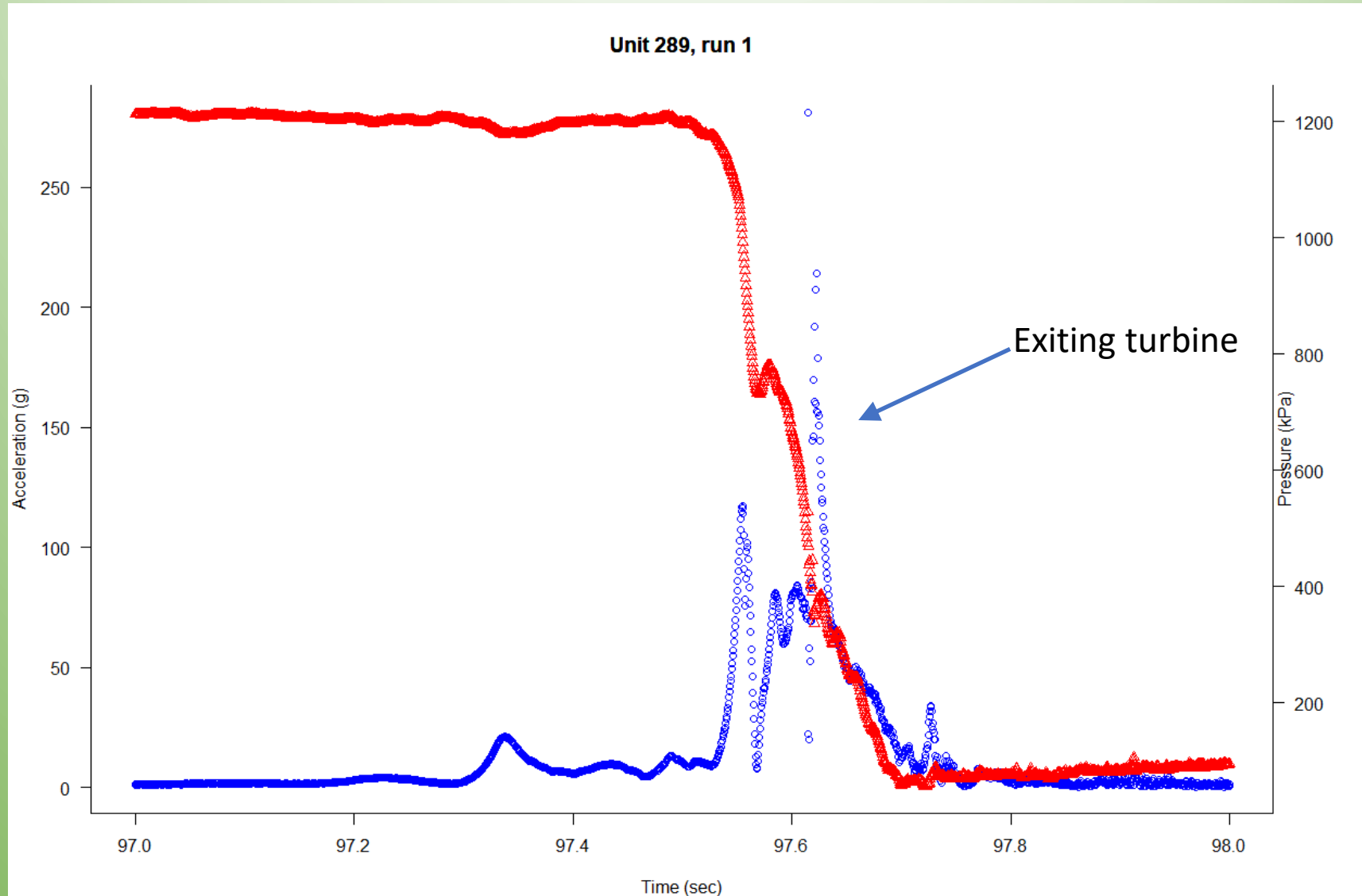
Typical acceleration curve



Preliminary data

Sensor fish deployed: March 2023

One second of action



Preliminary data

Sensor fish deployed: March 2023

Initial findings:

- No evidence of turbine strikes
- Acclimation pressure dependent upon depth of penstock (water level)
- Gas bladder rupture likely
- Embolism, hemorrhage, exophthalmia possible due to gas bladder rupture
- Gas bubble disease unlikely (short time period, low dissolved gas)

Sensor fish deployed: March 2023

Initial findings:

- No evidence of turbine strikes
- Acclimation pressure dependent upon depth of penstock
- Gas bladder rupture likely
- Embolism, hemorrhage, exophthalmia possible due to gas bladder rupture
- Gas bubble disease unlikely (short time period, low dissolved gas in forebay)

Injury/mortality appear linked to change in pressures – no significant effects from turbine passage per se

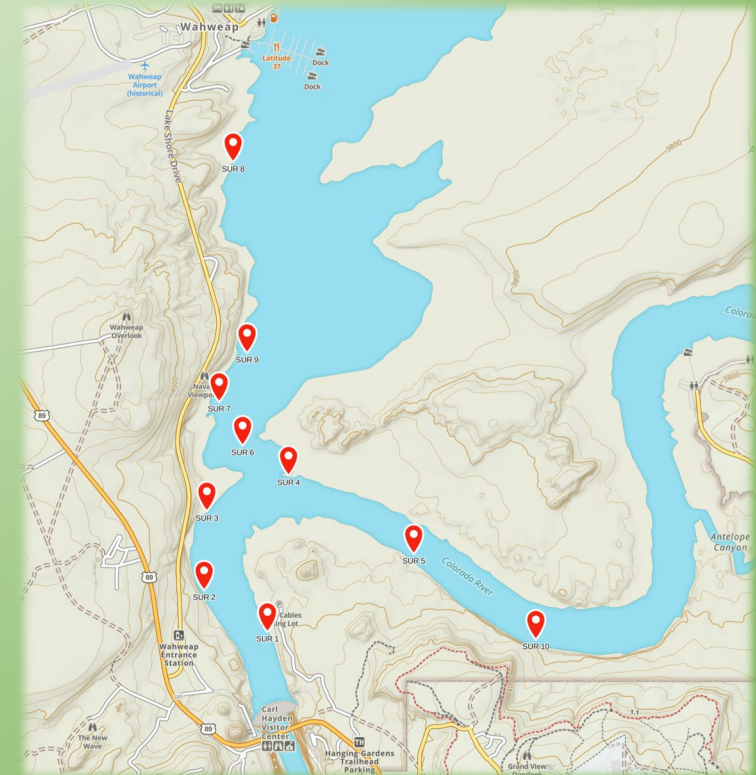
Sensor fish deployed: March 2023

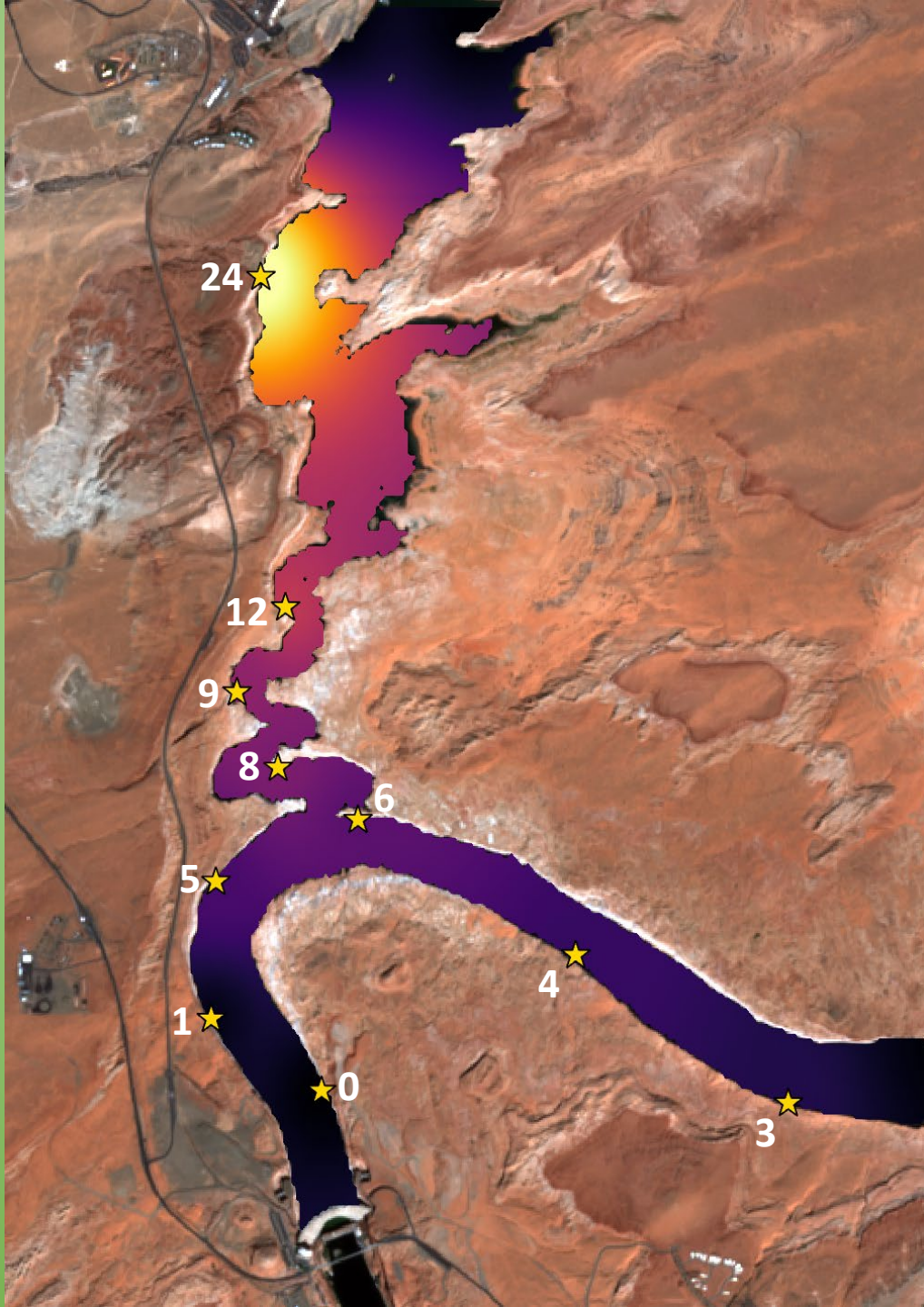
Boyle's Law

- $P_1V_1=P_2V_2$
- Assume $V_1 = 1$
- Acclimation pressure at penstock intake = $P_1 = 237$ kPa
- Median nadir pressure = $P_2 = 36$ kPa (atmospheric = 98 kPa)
- $V_2 = 237(1)/36 = 6.6$ (gas bladder expands 6.6x)
- From literature:
 - Gas bladder rupture at 2-4x expansion
 - 84% mortality (for Chinook Salmon)
 - Physostomous vs physoclistous
 - Life stage implication

Acoustic telemetry

- Movement
- Depth
- 30 fish implanted with ultrasonic transmitters October 2022
 - 20 Smallmouth Bass
 - 10 Channel Catfish





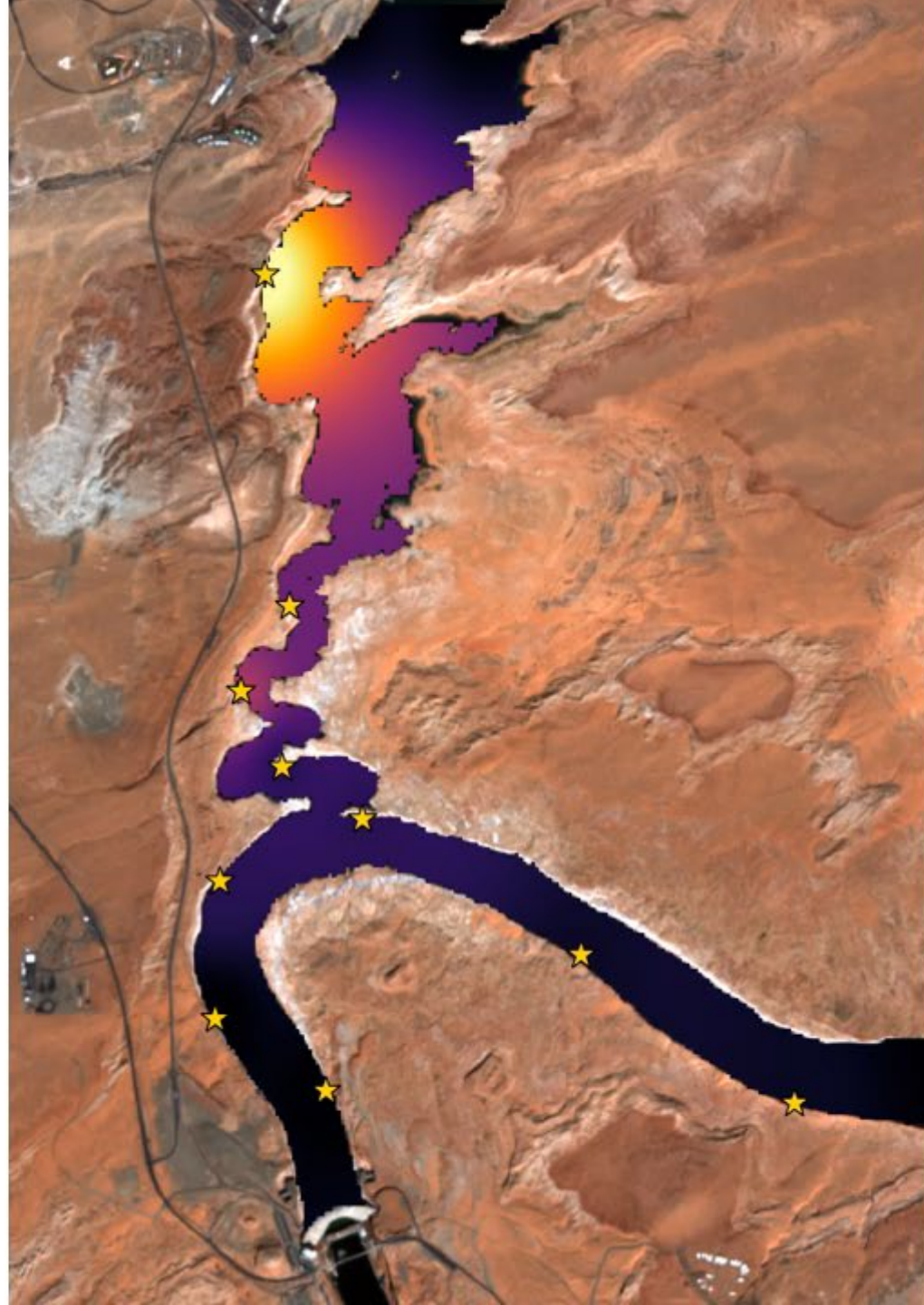
Acoustic telemetry

Where have the 30 fish traveled?

Unique fish detections higher near Wahweap, zero detected at dam

Expectation: fish will move into forebay as water warms and epilimnion forms

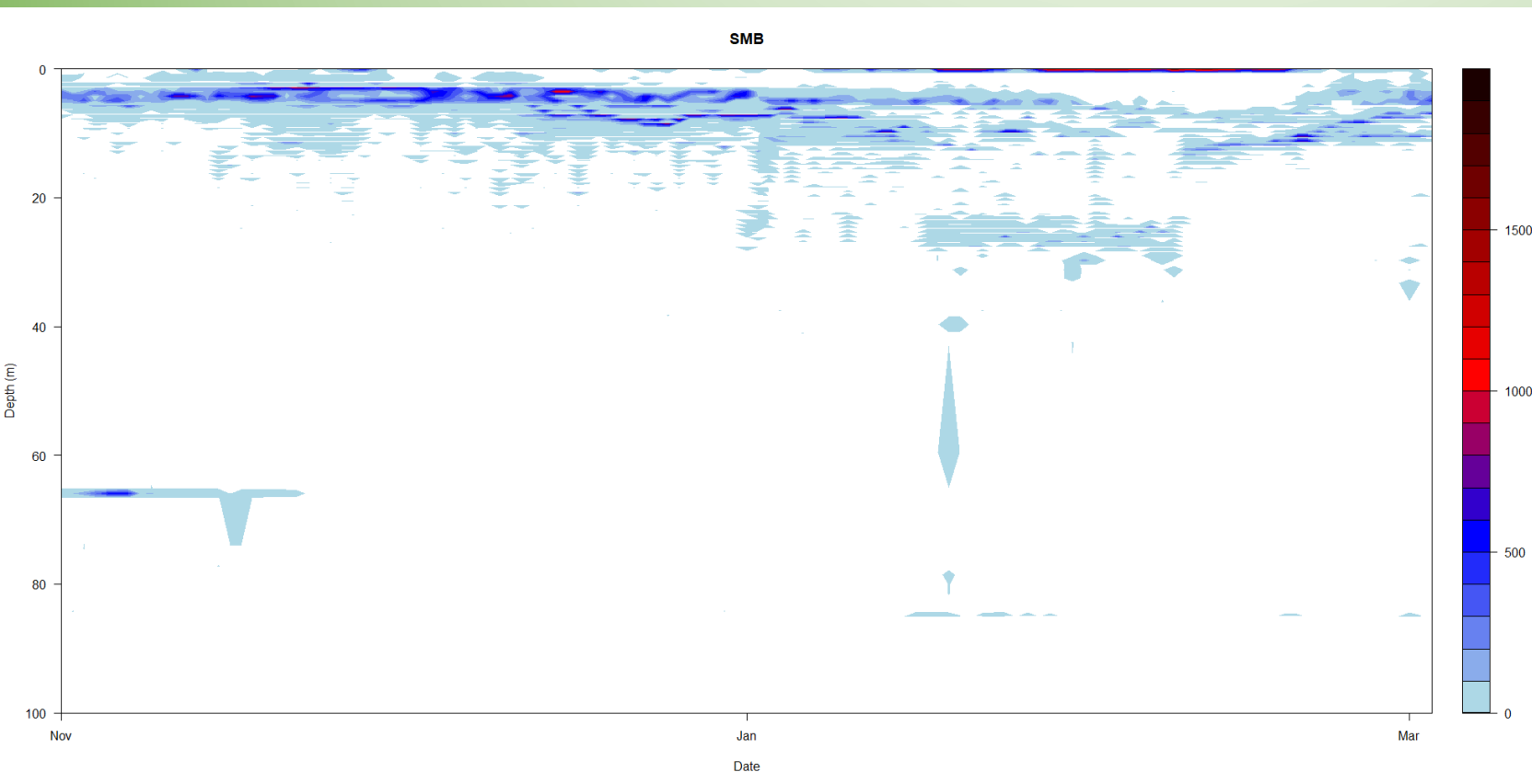
11-7-22



Acoustic telemetry

Smallmouth Bass (20 fish implanted)

$n = 230,000$



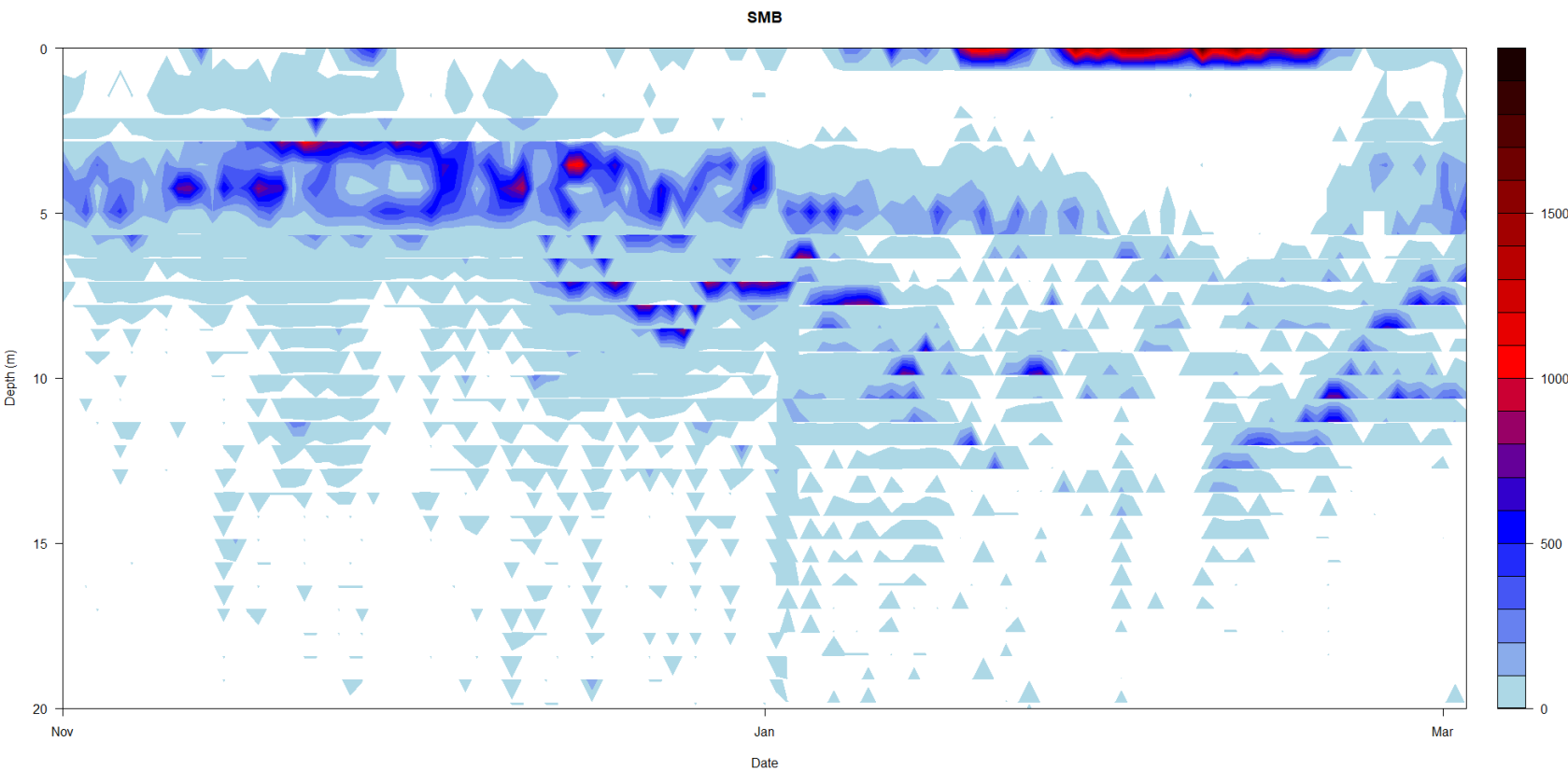
What depths?

- Date range: Nov 1 to Mar 5
- Most detections <10 m

Acoustic telemetry

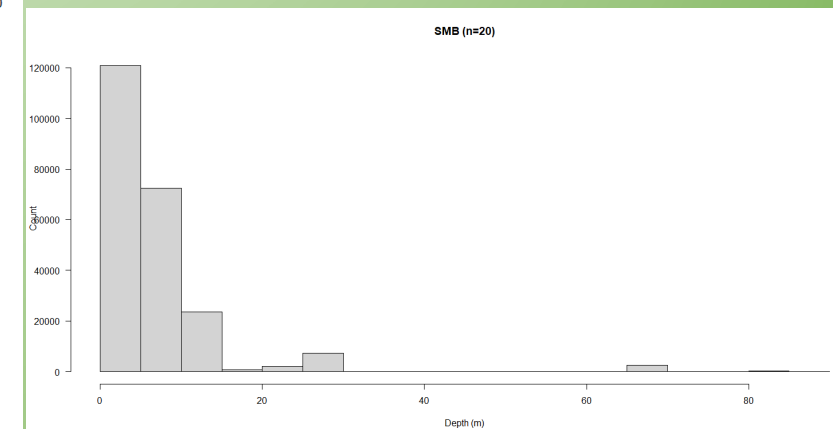
Smallmouth Bass (20 fish implanted)

Depth: 0 – 10 m



What depths?

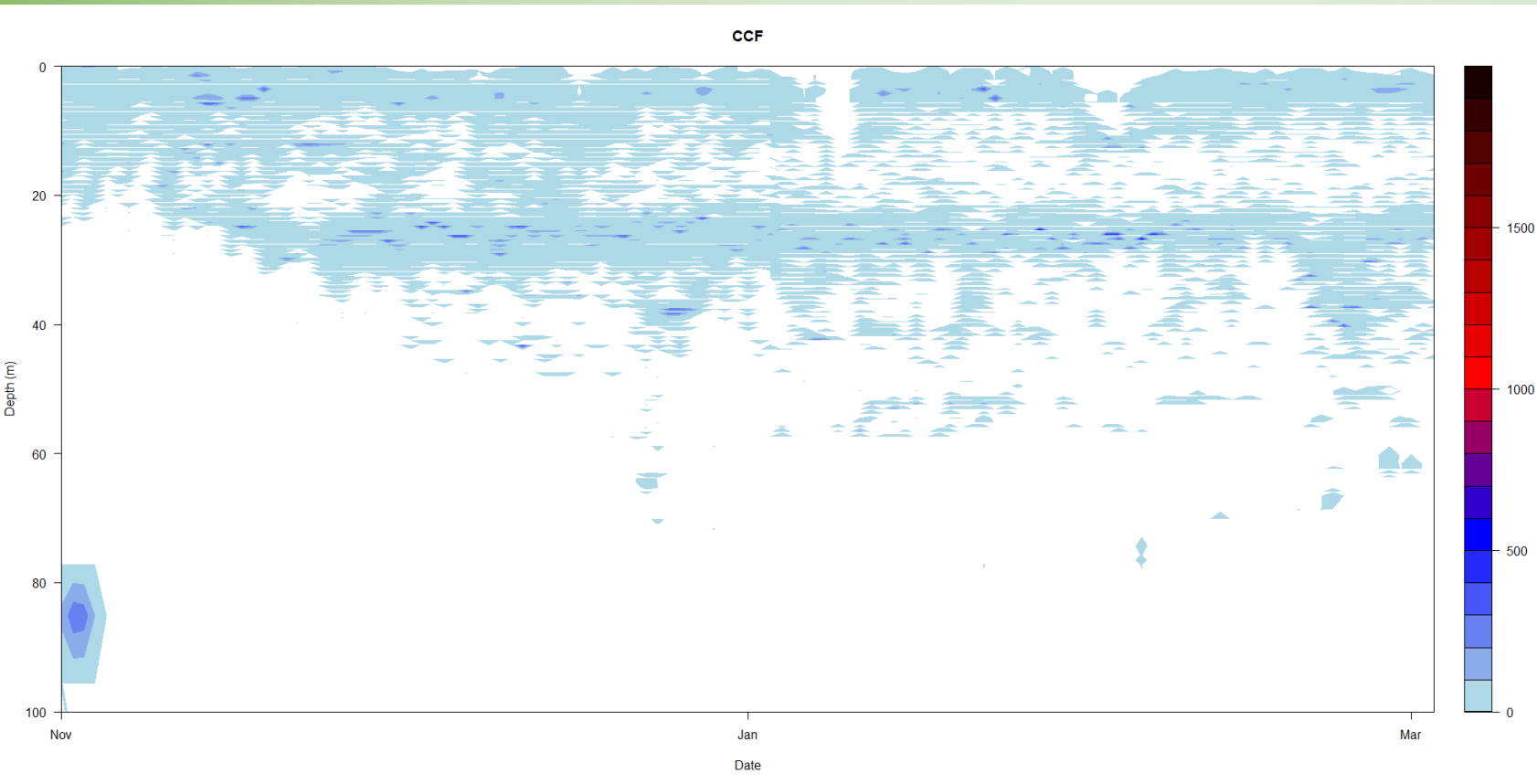
- Date range: Nov 1 to Mar 5
- Most detections <10 m



Acoustic telemetry

Channel Catfish (10 fish implanted)

$n = 160,000$



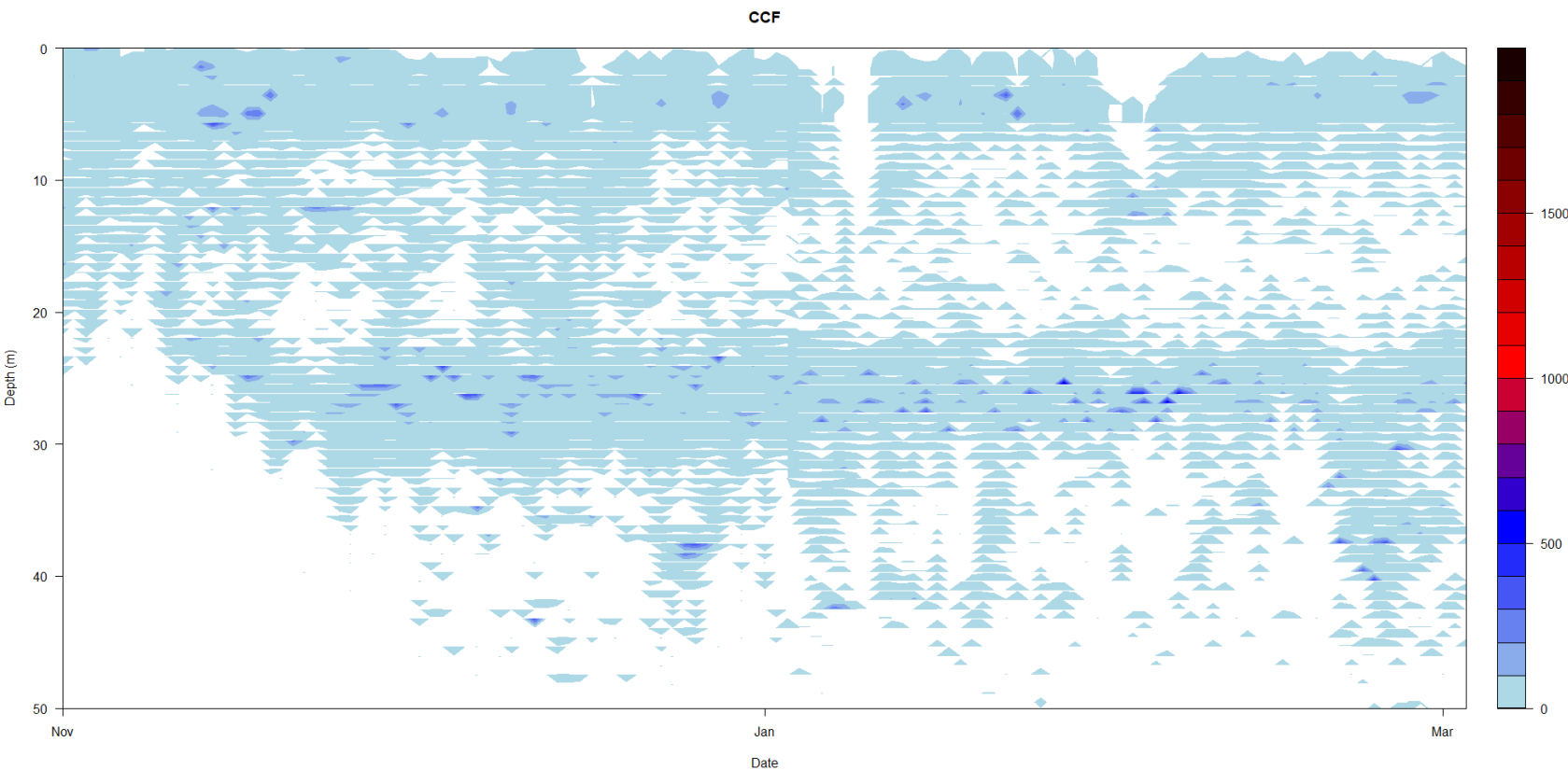
What depths?

- Date range: Nov 1 to Mar 5
- Most detections <50 m

Acoustic telemetry

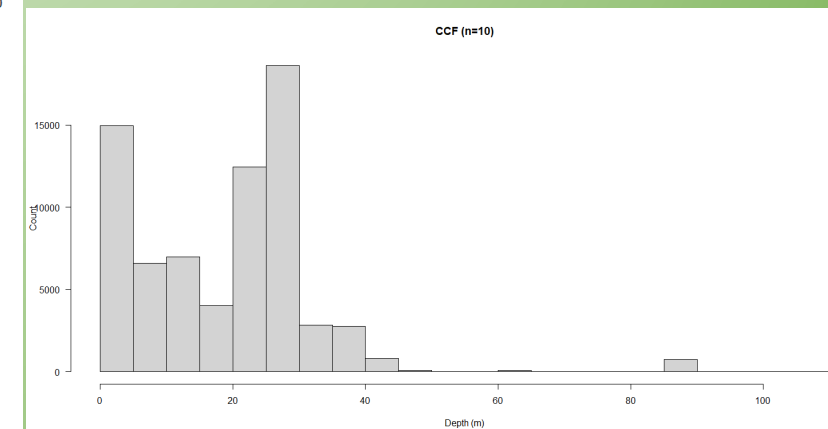
Channel Catfish (10 fish implanted)

Depth: 0 – 50 m



What depths?

- Date range: Nov 1 to Mar 5
- Most detections <50 m



Relative Probability of Entrainment (PoE)

Probability of presence at depth given:

- Season (stratification)
- Water temp
- Location
- Species

Work on model database setup has begun, exact form of model TBD

Acknowledgments

Bureau of Reclamation

- Kato Miyagishima
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Arnold

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Utah Cooperative Fish
Life Research Unit