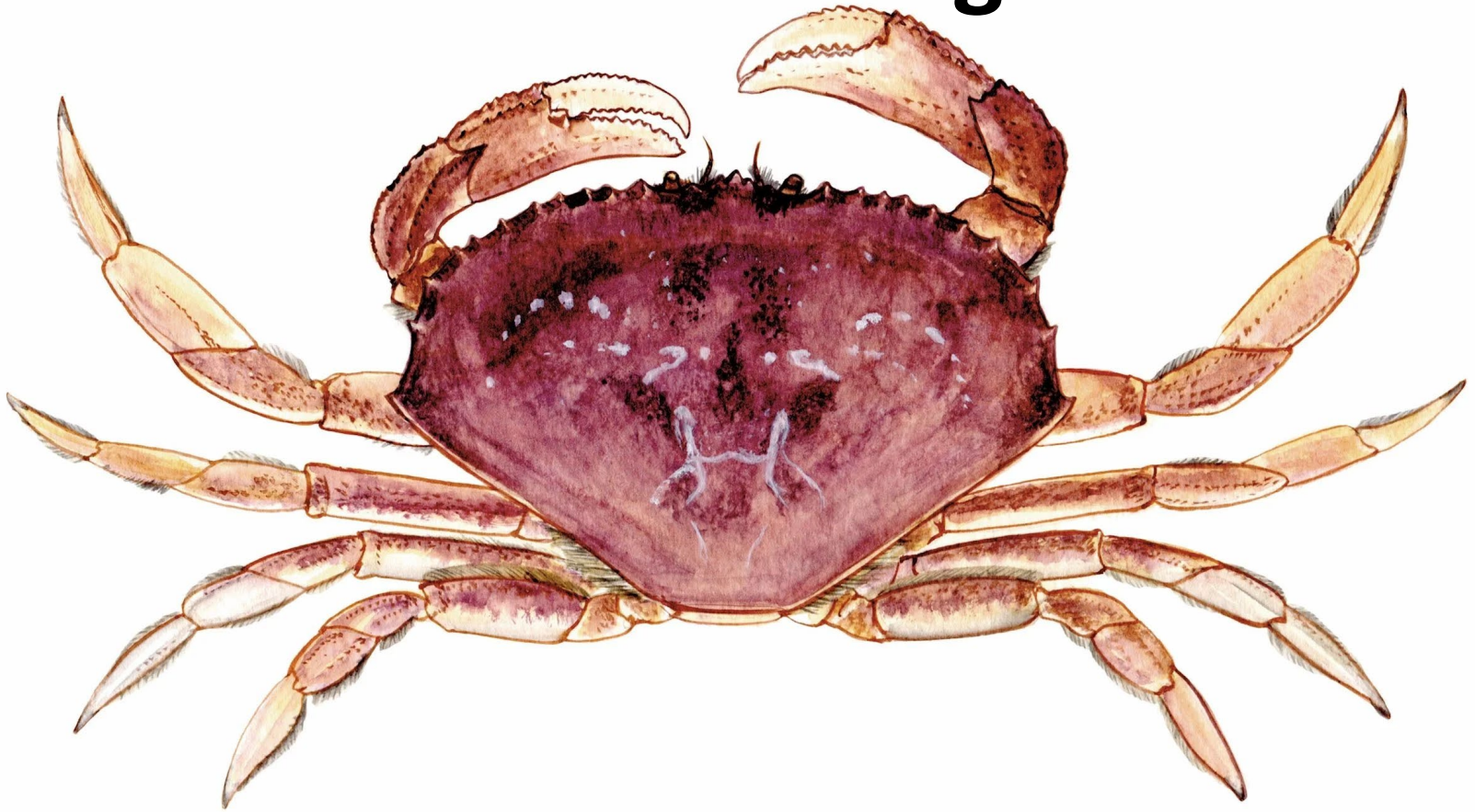
Physiological Responses of Juvenile Dungeness crab to Current and Future Ocean Change



Cooperative Institute for Marine Ecosystem and Resources Studies | Dr. Kris Bauer |26 Oct. 2026

Image from Scandposters

Dungeness crab (*Metacarcinus magister)*



Image from Arya Surowidjojo/OPB

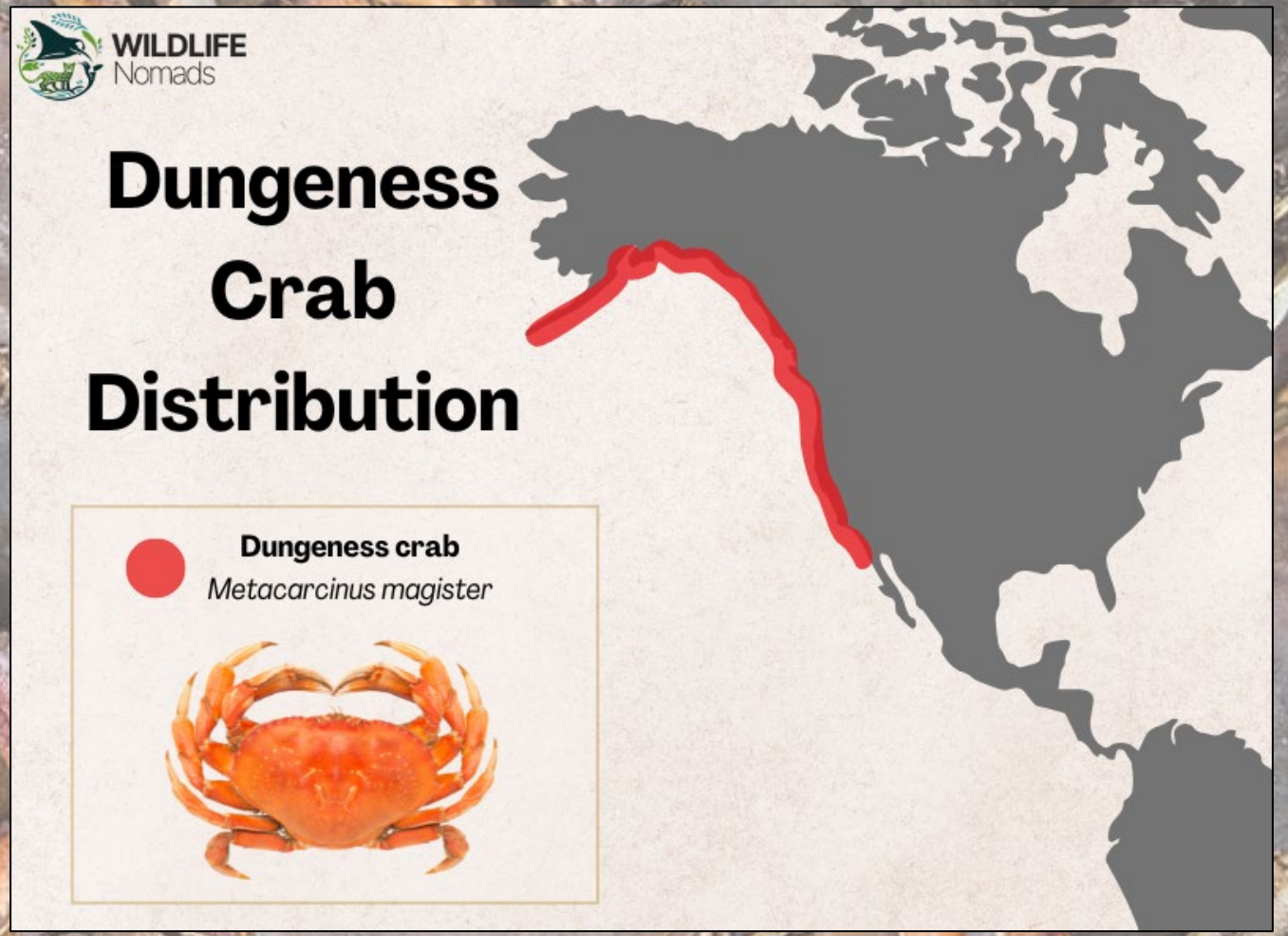


Image from Austin Trigg/NMFS



Image from Jenny Wadell/NOAA

Dungeness crab dying on Pacific Northwest coast amid low oxygen levels linked to climate change

By Isabella Breda, The Seattle Times
Published: November 7, 2022

SCIENCE | ENVIRONMENT

UW study finds Pacific Northwest waters are more susceptible to ocean acidification

By Cassie Diamond The Daily
May 21, 2026, 7 a.m.

Oct. 30, 2009

'Dead Zone' Causing a Wave of Death Off Oregon Coast

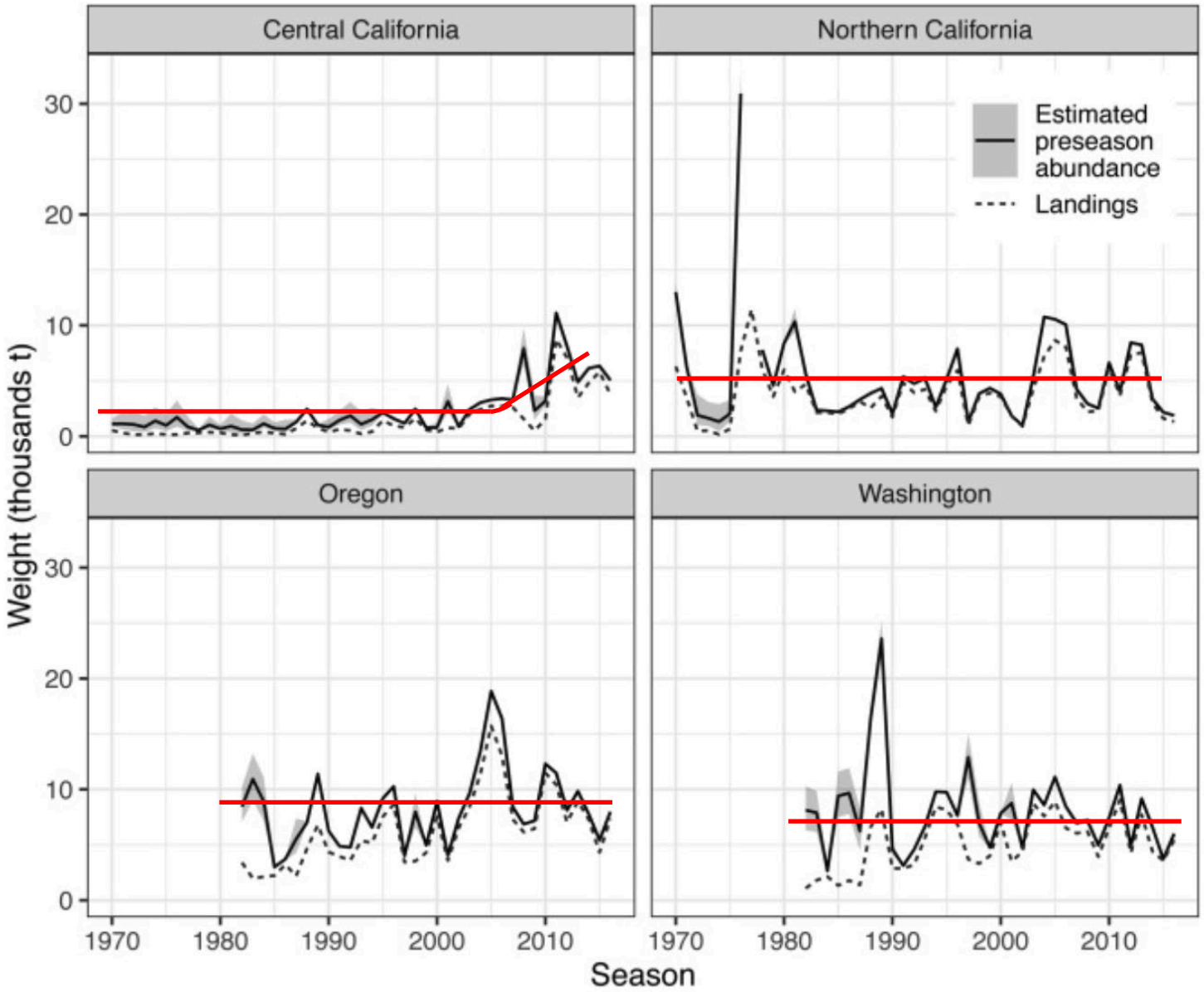
Jane Lubchenco

West Coast Dungeness Crab Stable or Increasing Even With Intensive Harvest, Research Shows

March 04, 2020

Kate Richerson et al.

High variability year to year, but relatively stable over the long term



Over the next century, will an environmental tipping point occur that could lead to collapse of the Dungeness crab fishery in the Pacific Northwest?



Image from Beth LaBerge/KQLED

The Juvenile Crab Research Team



Francis Chan, PhD



Samuel Gurr, PhD



Emily Branam



MacKenna Hainey



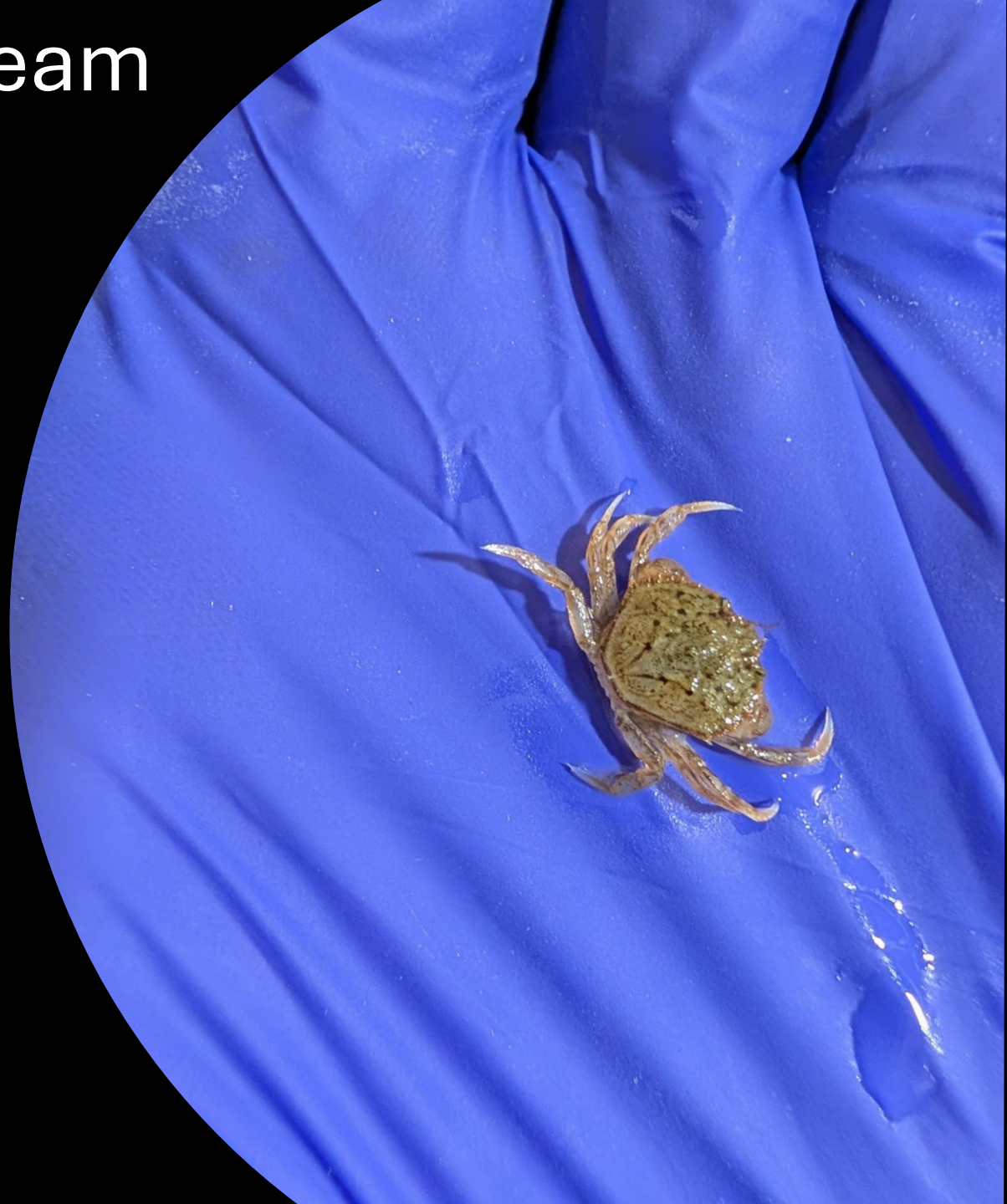
Nyazia Sajdah-Bey



Ella Dreke



Travolis Williams

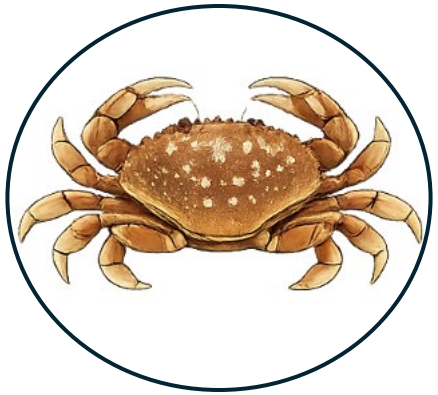


Informing Environmental Stress Tolerance

Defining physiological limits

SWINOMISH INDIAN TRIBAL COMMUNITY









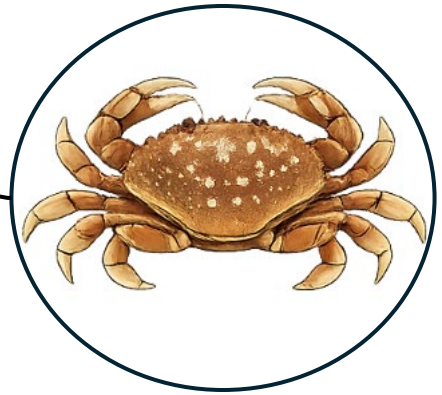
Informing Environmental Stress Tolerance

Defining physiological limits

SWINOMISH INDIAN TRIBAL COMMUNITY



What are the lower oxygen limits of *M. magister*?





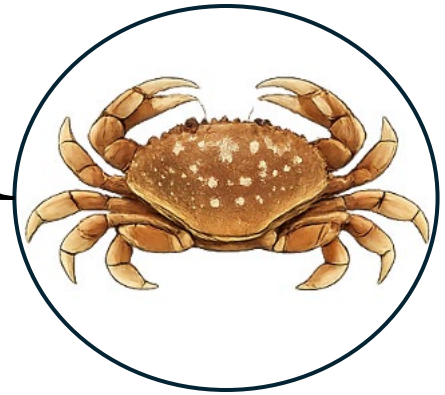


Informing Environmental Stress Tolerance

Defining physiological limits

What are the lower oxygen limits of *M. magister*?

How do these limits fluctuate with different temperatures?



SWINOMISH INDIAN TRIBAL COMMUNITY







Informing Environmental Stress Tolerance

Defining physiological limits

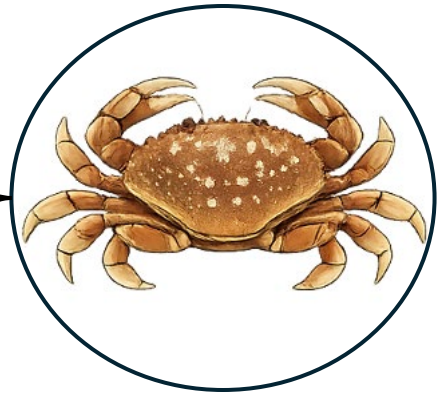
SWINOMISH INDIAN TRIBAL COMMUNITY



What are the lower oxygen limits of *M. magister*?

How do these limits fluctuate with different temperatures?

How do these limits relate to survivorship?







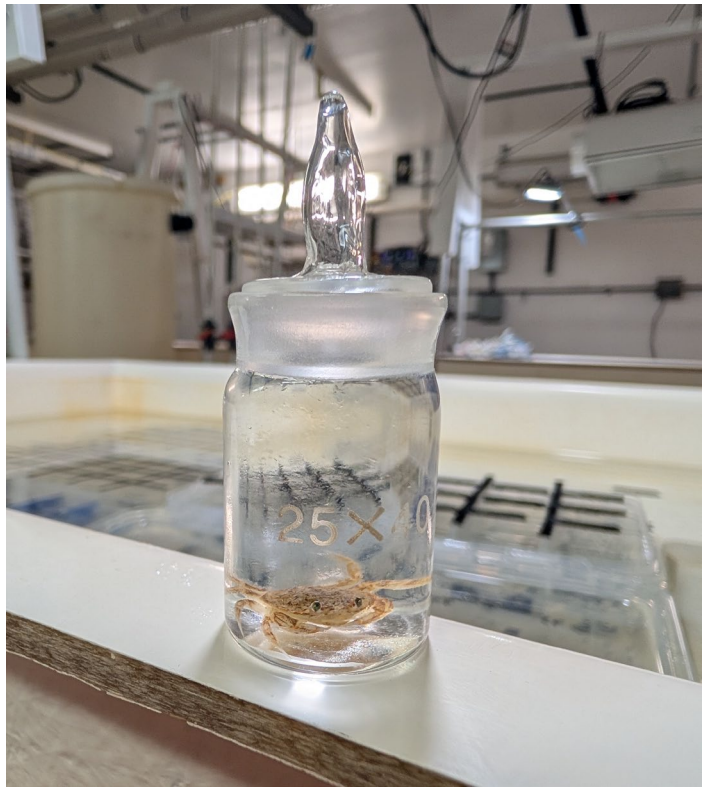
Defining lower oxygen limits of juveniles via respirometry

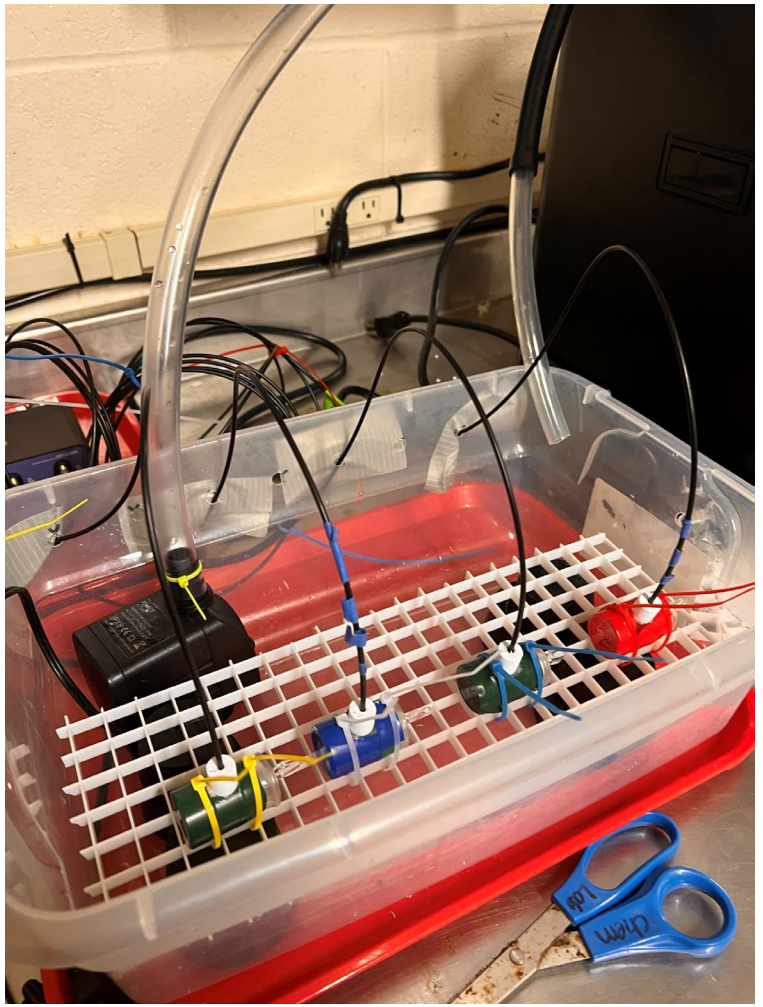


<u>Closed-system respirometry</u>

- 1st-instars were sealed in individual vials with autoclaved seawater

- Crabs were starved 48-hours prior

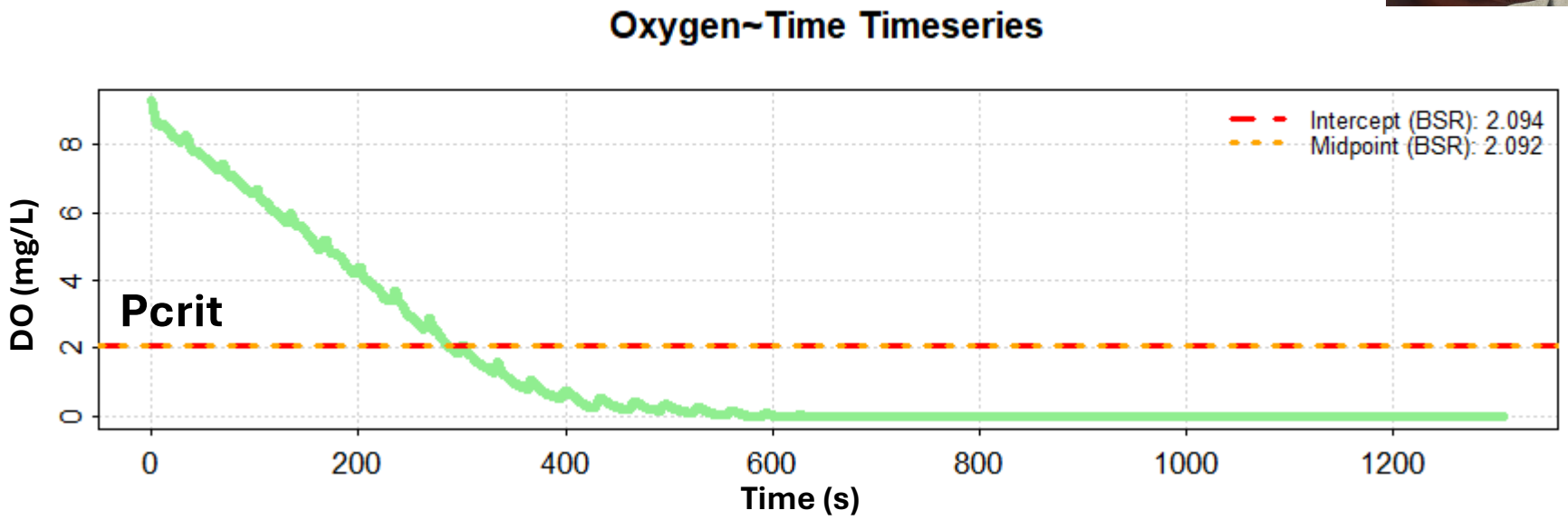


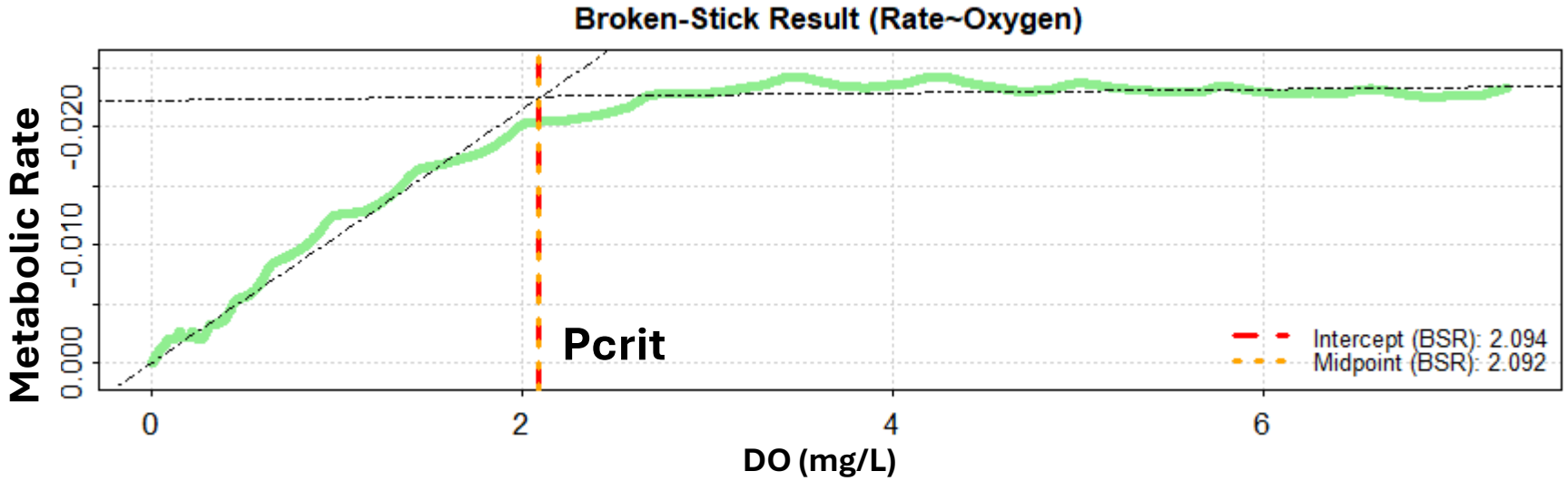


“How Low” -> Critical Oxygen Threshold (P_{crit})



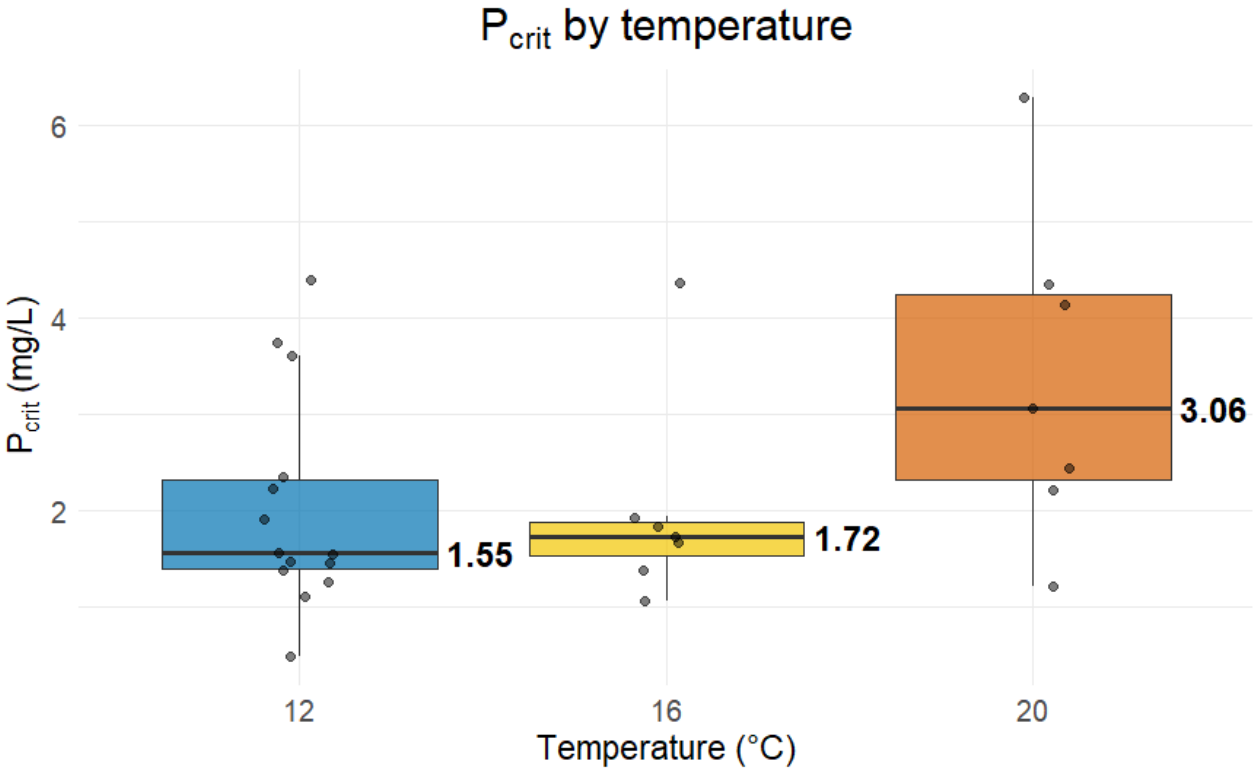
Pcrit – The level of oxygen at which an individual can no longer regulate its routine metabolic rate

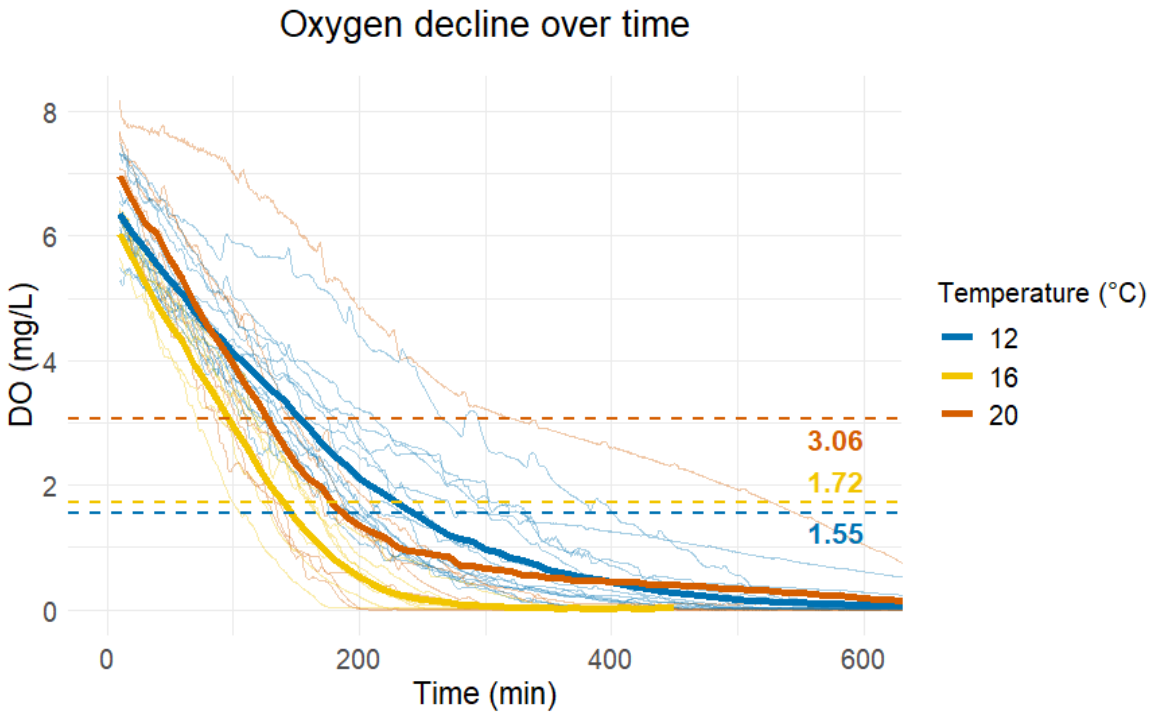






P_{crit} Results





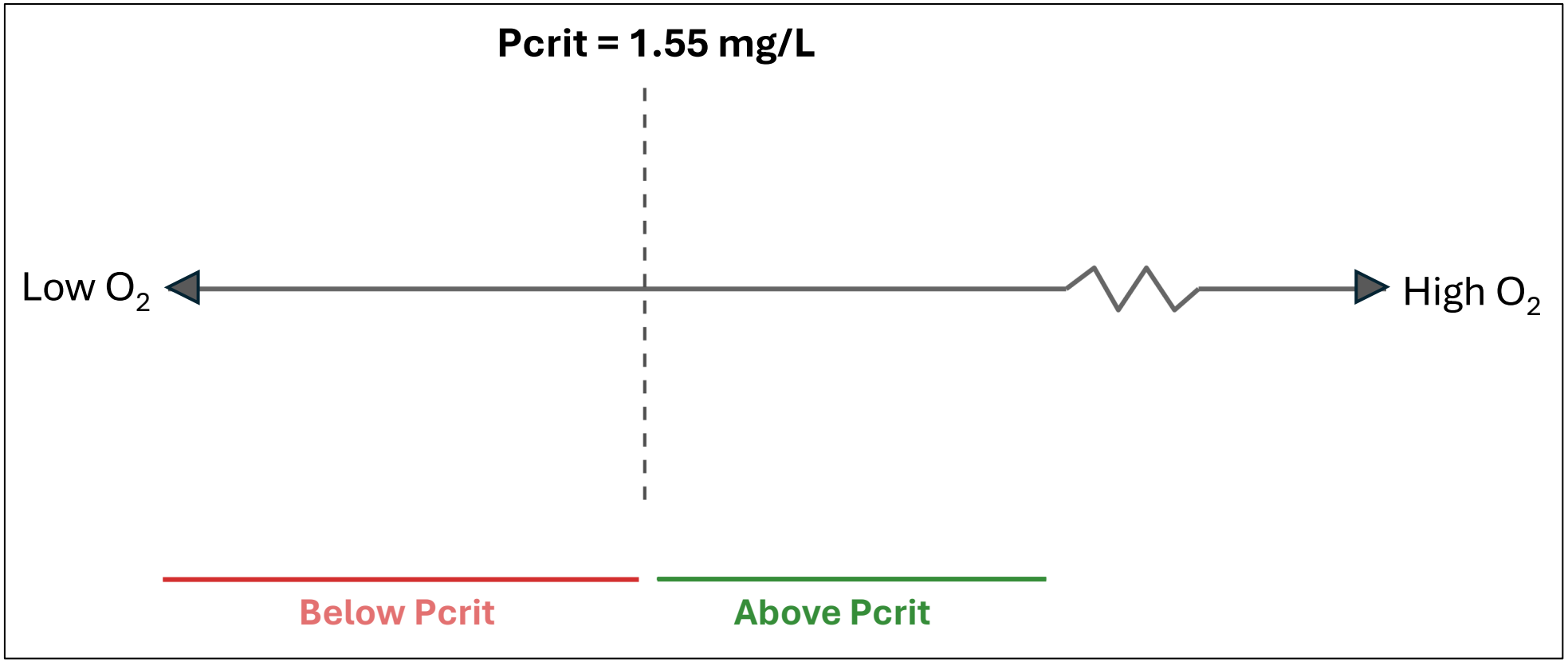
Pcrit: (Kruskal-Wallis test, H(2) = 3.96, p = 0.138)
Exploratory: 12+16 vs 20°C: (p=0.050)

How long do crabs survive in conditions near Pcrit?



Design

- Two total trials
- 3 treatments per trial: 2 hypoxic + 1 control
- Both at 12 °C
- pH conditions covaried with oxygen



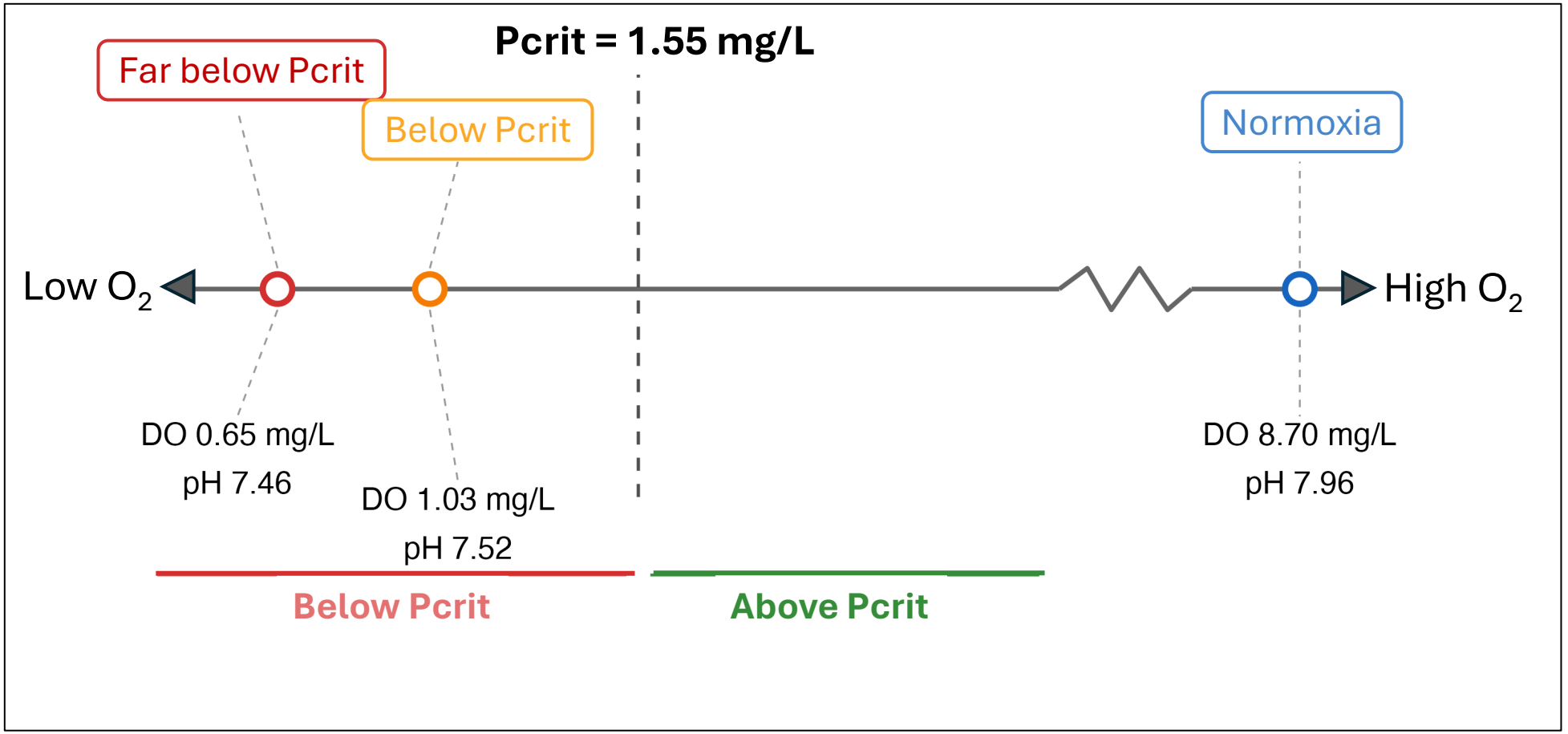
How long do crabs survive in conditions near Pcrit?

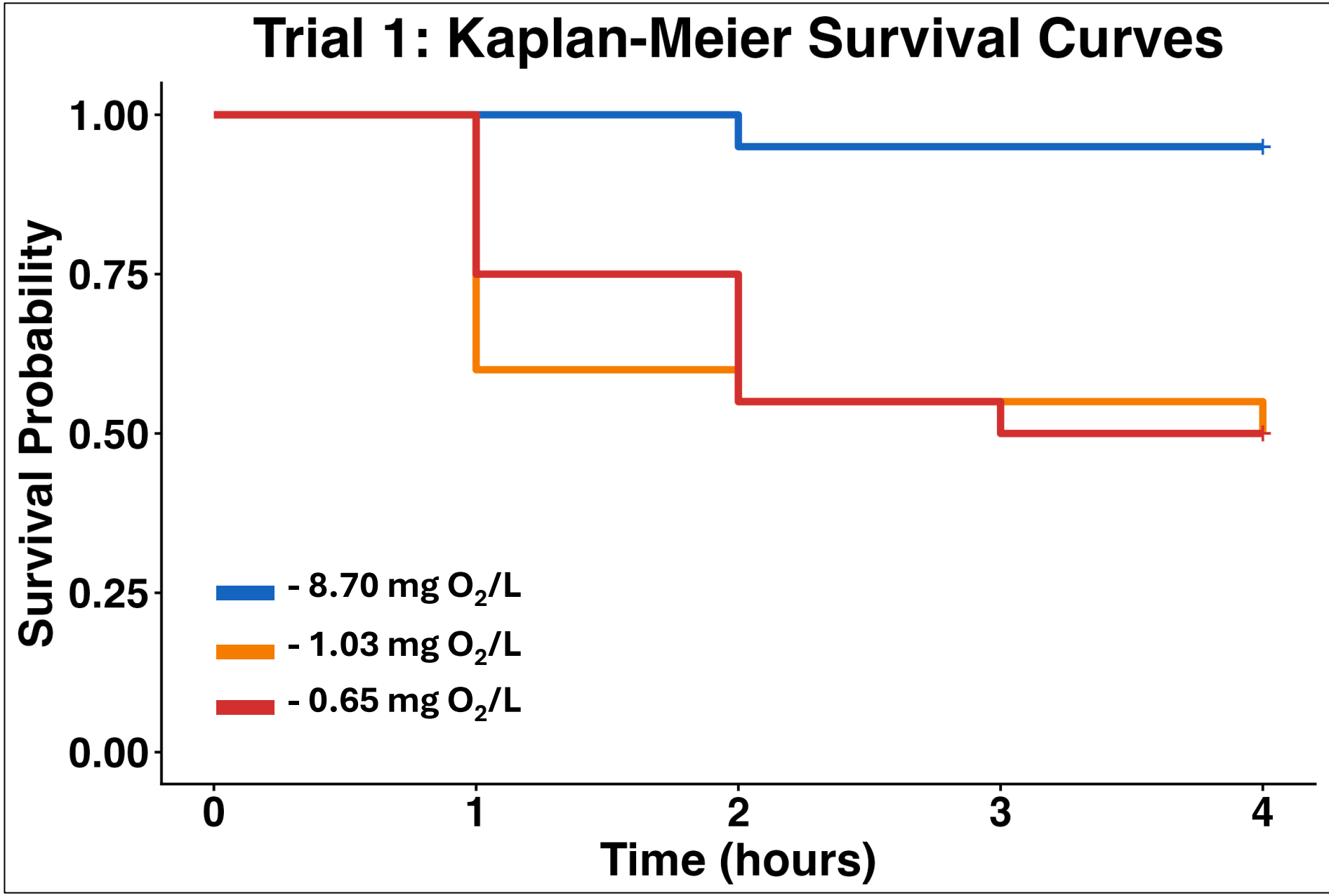


Trial 1

- Hypoxia conditions far below Pcrit





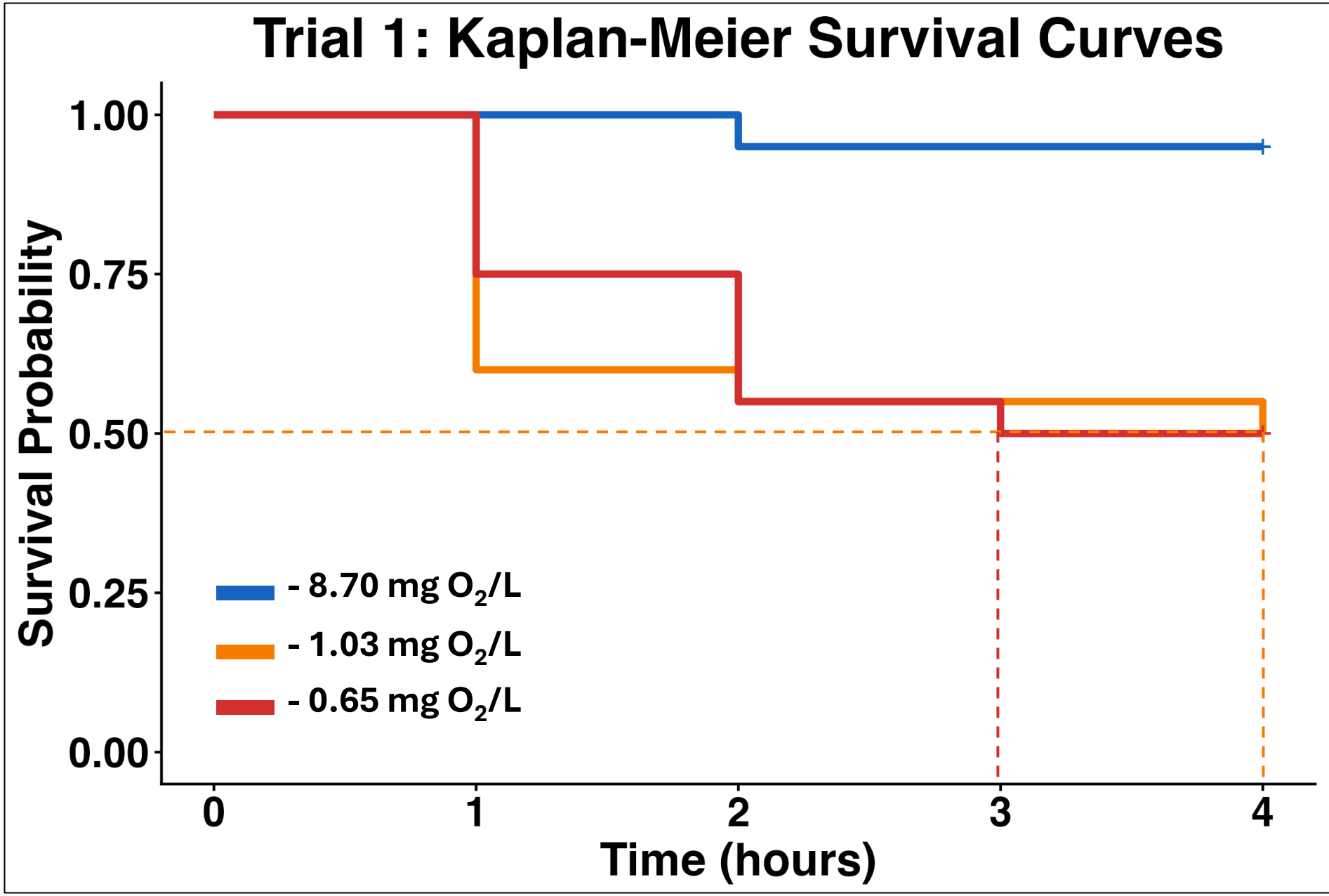

Trial 1: Kaplan-Meier Survival Curves
Survival Probability
1.00
0.75
0.50
0.25
0.00
- 8.70 mg O2/L
- 1.03 mg O2/L
- 0.65 mg O2/L
0
1
2
3
4
Time (hours)

LT50

Time at which the survival probability reaches 0.5

LT50 values

- NA
- 4 hrs
- 3 hrs



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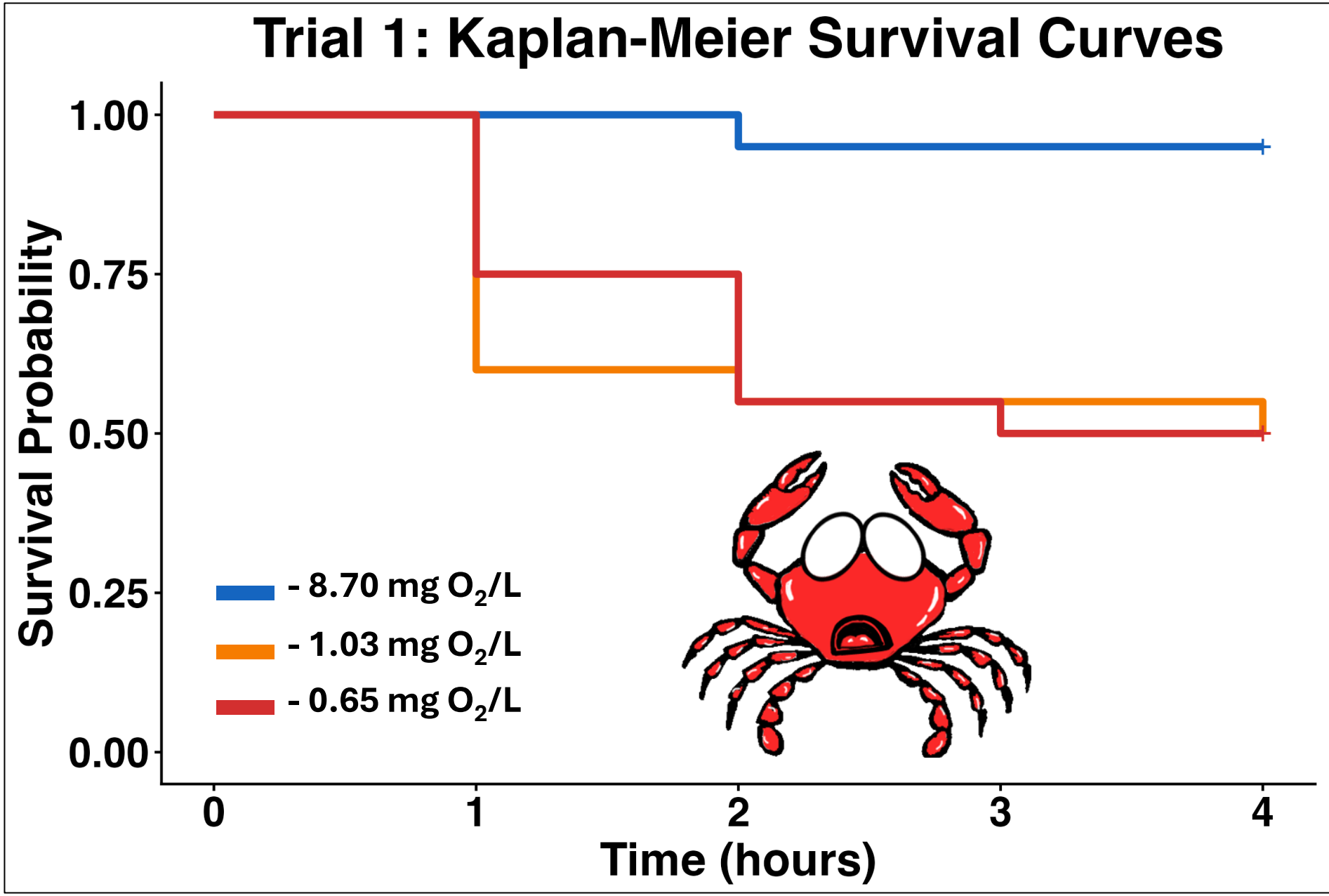
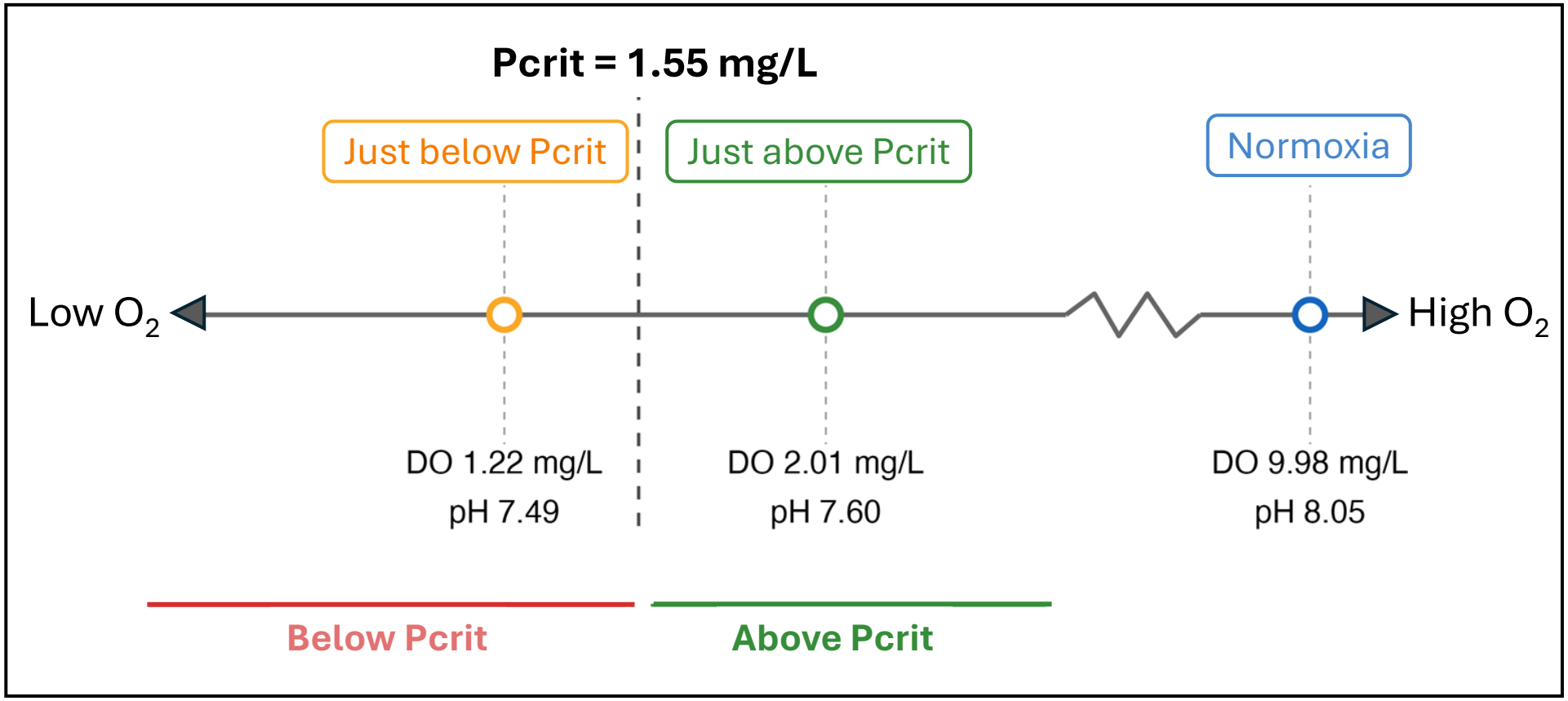


But what about at conditions closer to Pcrit?



Trial 2

- Hypoxia conditions closer to Pcrit

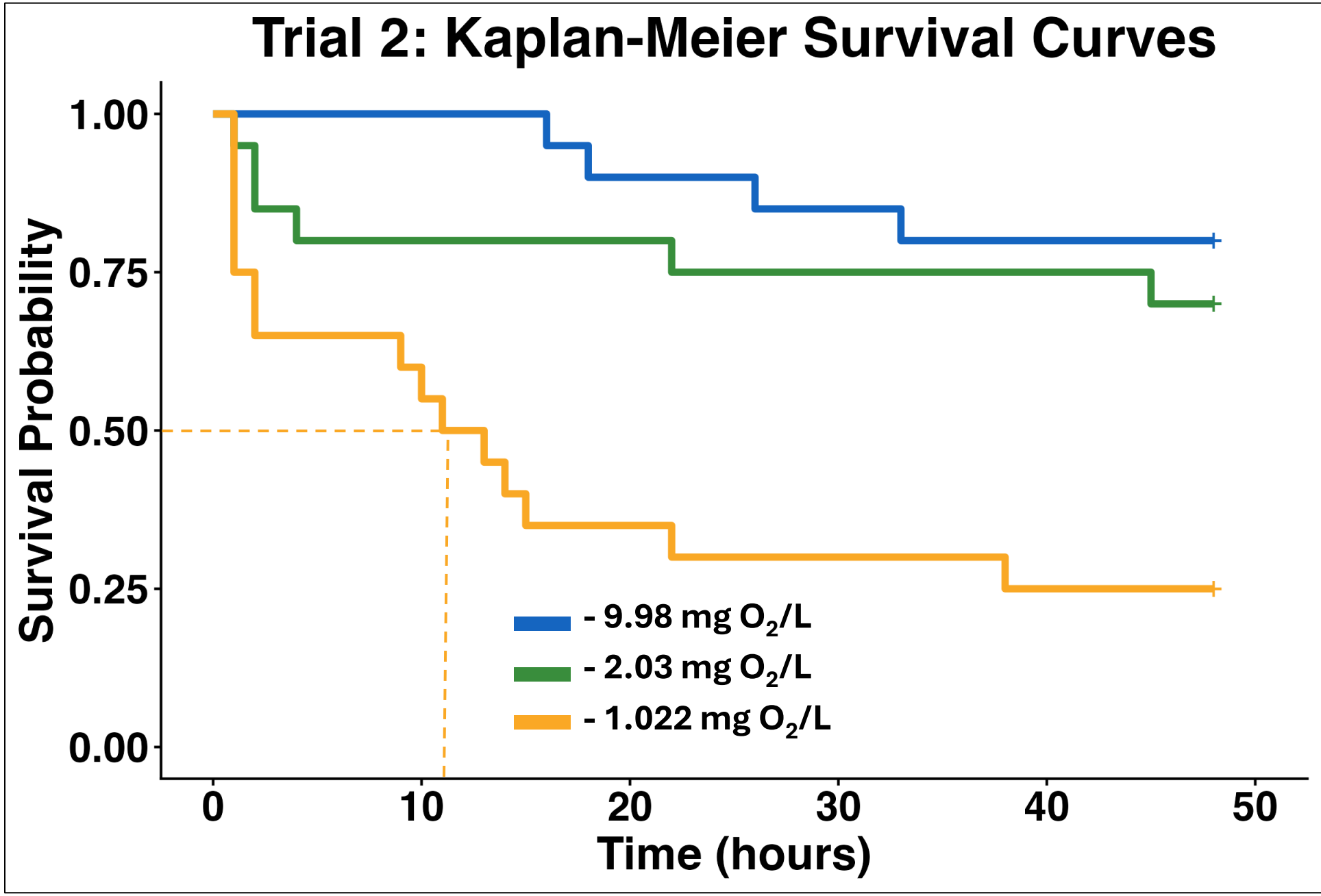


LT50

Time at which the survival probability reaches 0.5

LT50 values

- NA
- NA
- 12 hrs

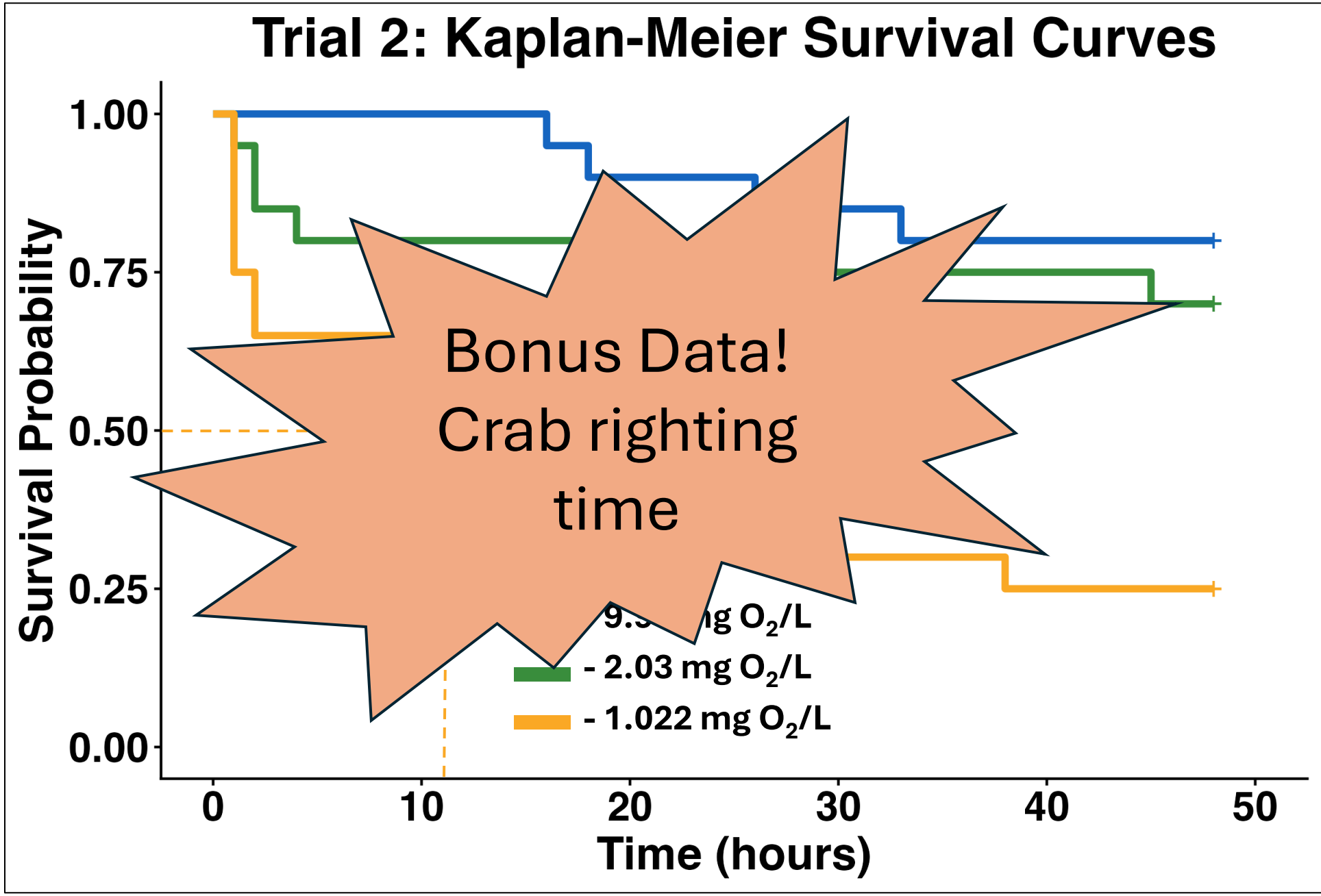


LT50

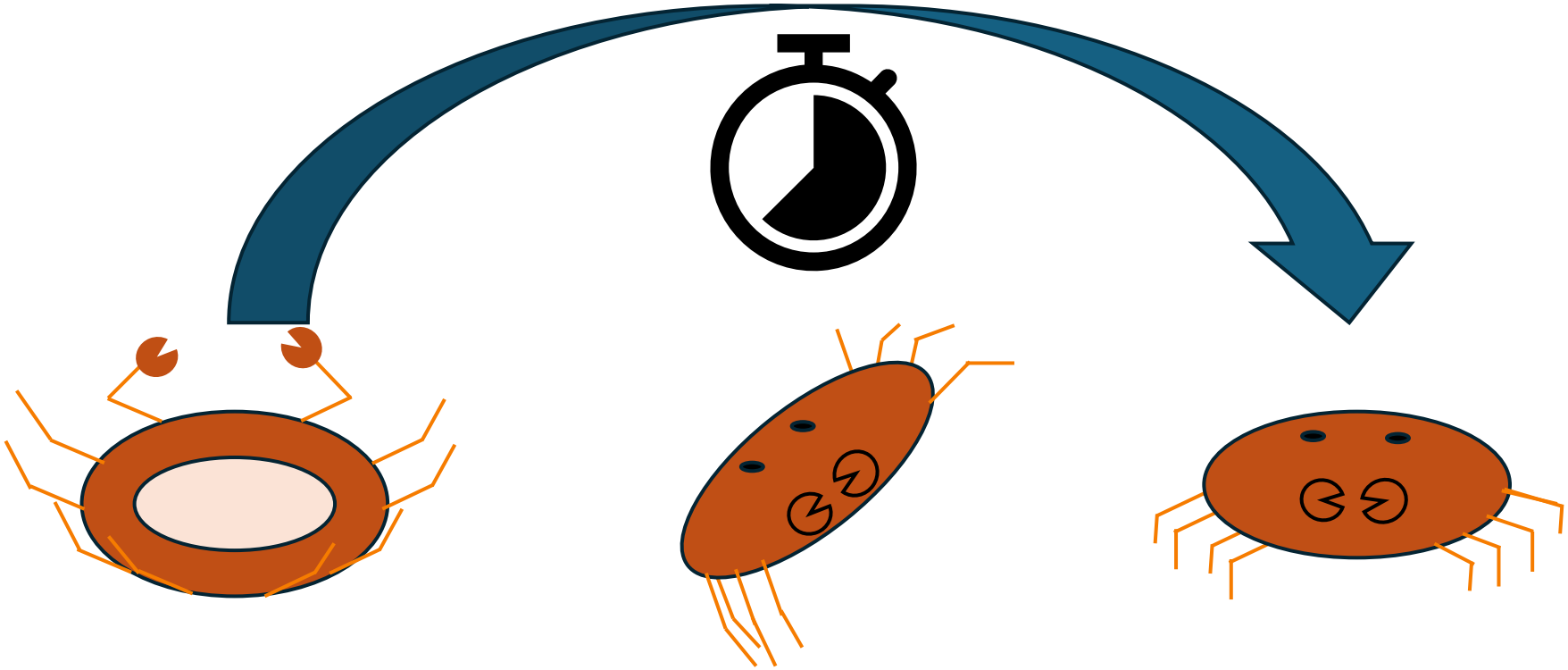
Time at which the survival probability reaches 0.5

LT50 values

- NA
- NA
- 12 hrs

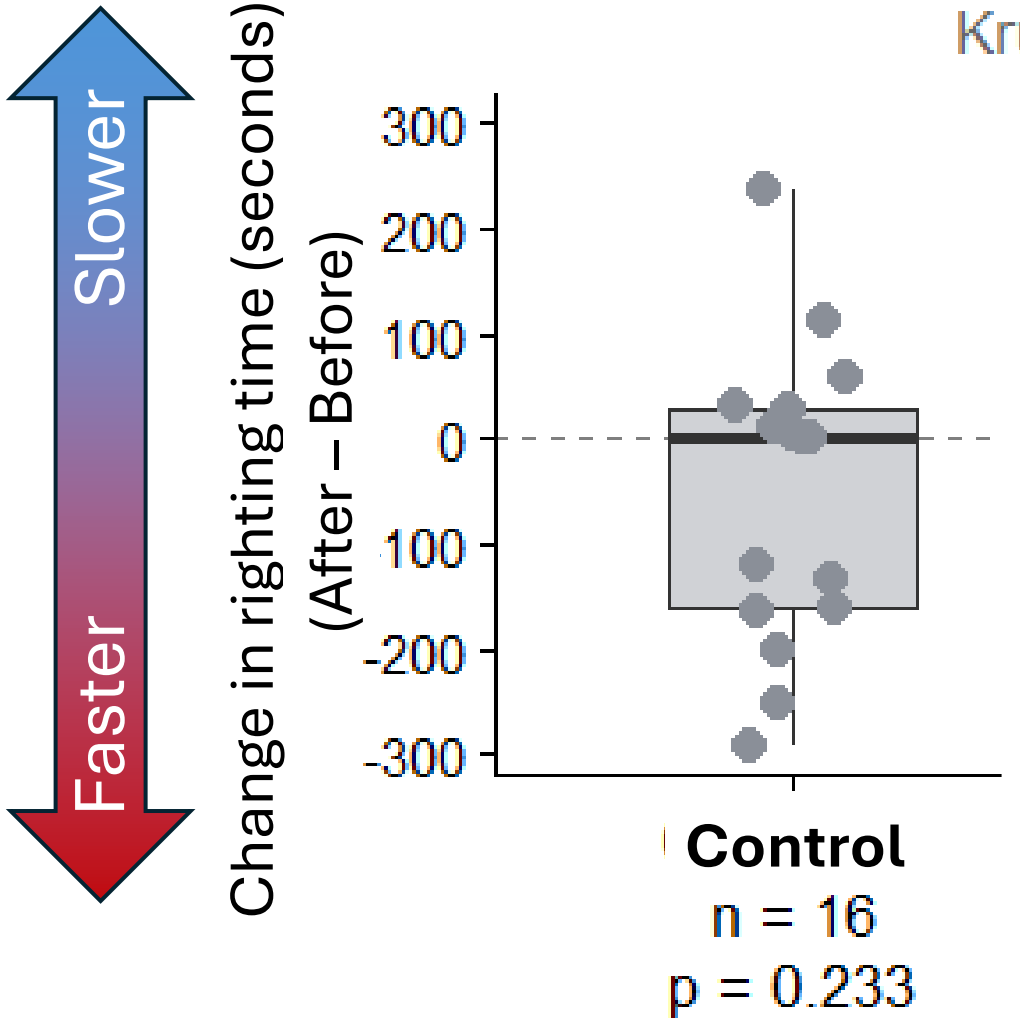


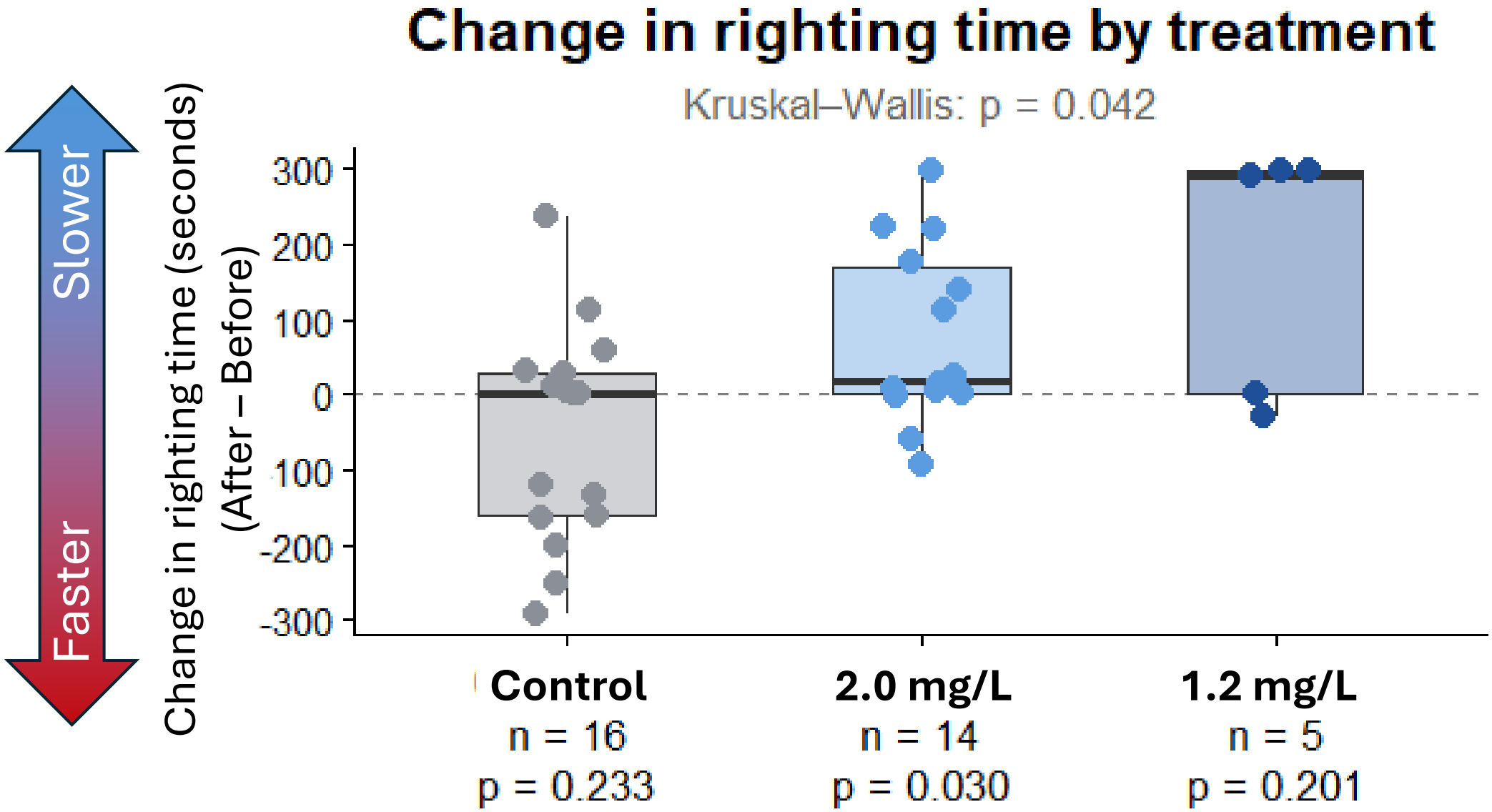
Crab righting time



Change in righting time by treatment

Kruskal–Wallis: p = 0.042



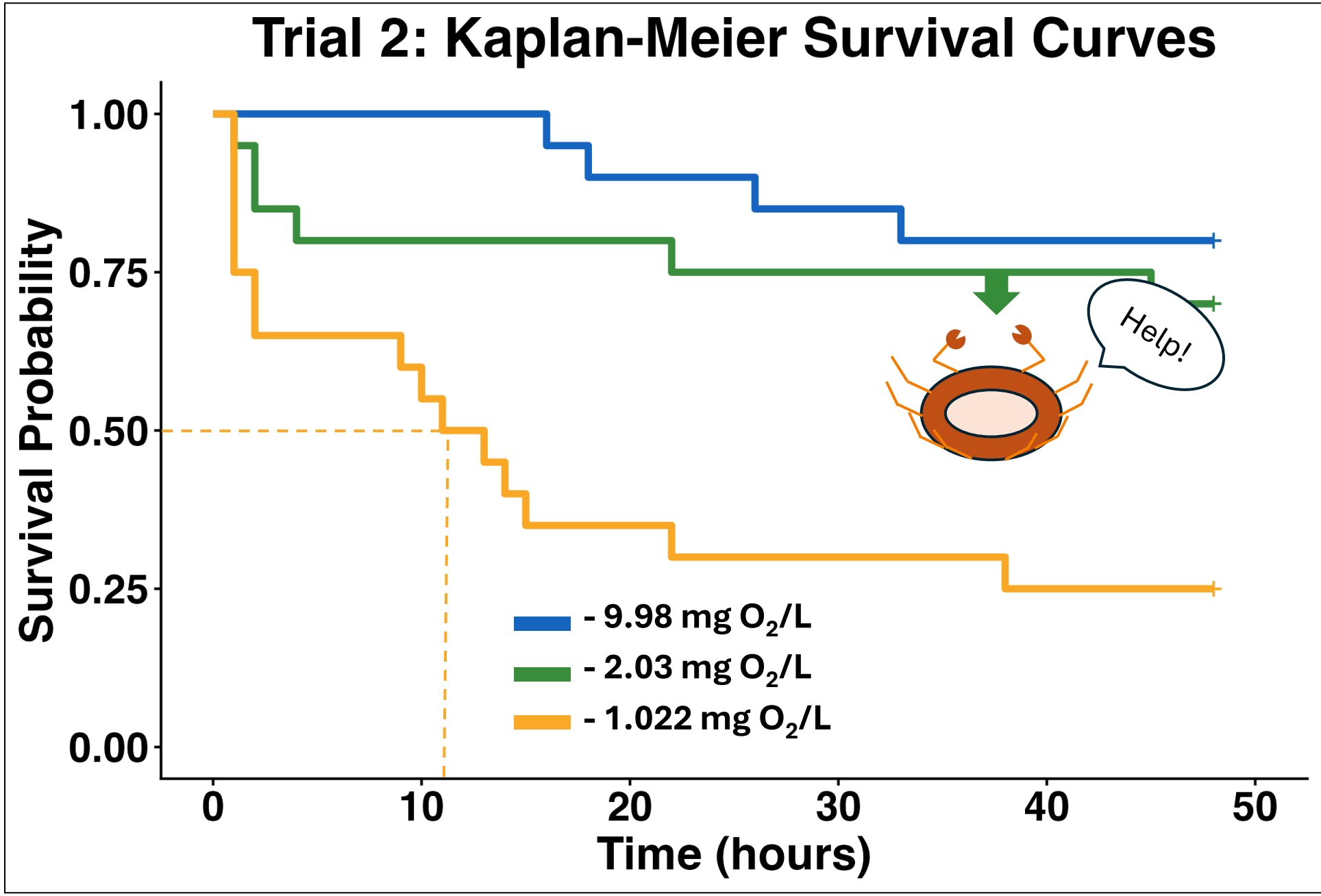

Change in righting time by treatment
Kruskal–Wallis: p = 0.042
Slower
Faster
Change in righting time (seconds)
(After – Before)
300
200
100
0
-100
-200
-300
Control
n = 16
p = 0.233
2.0 mg/L
n = 14
p = 0.030
1.2 mg/L
n = 5
p = 0.201

LT50

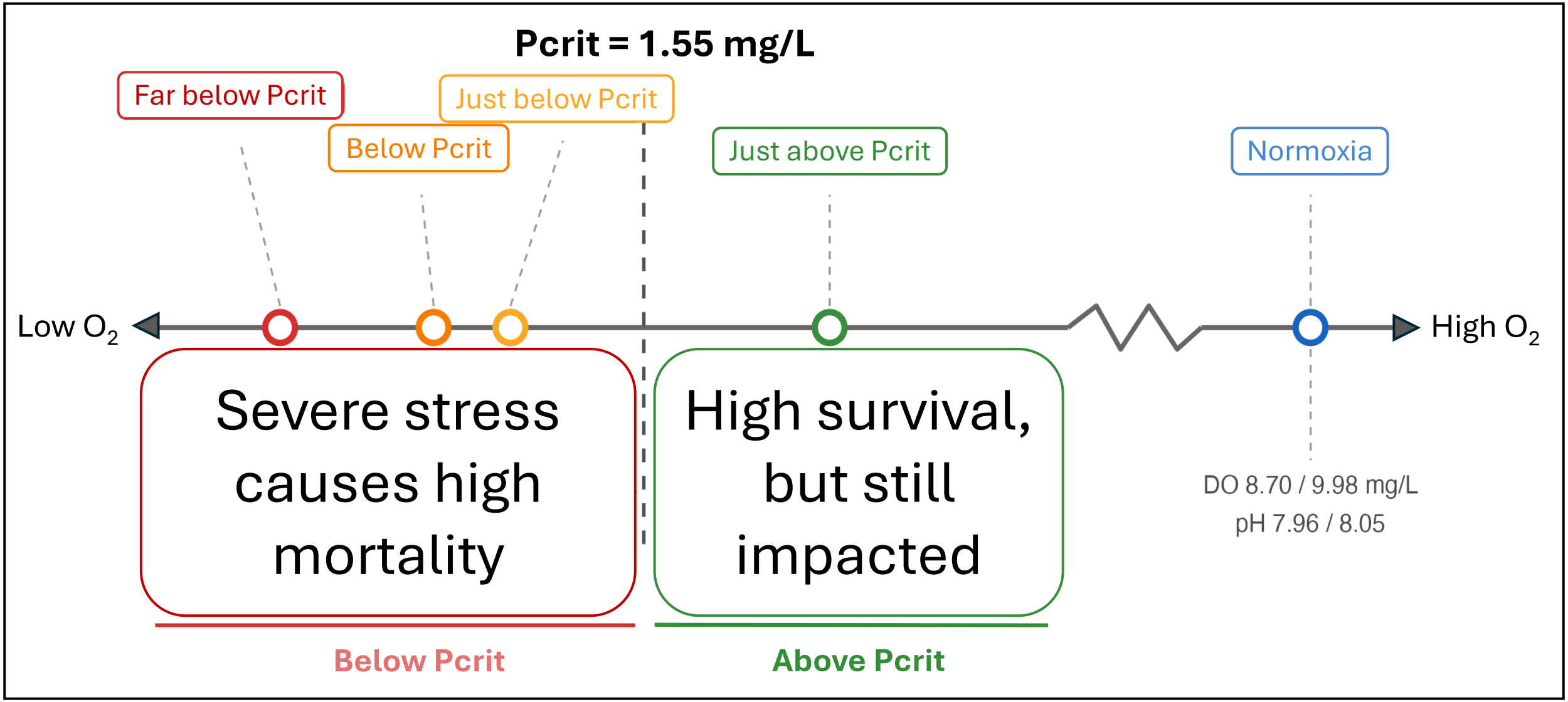
Time at which the survival probability reaches 0.5

LT50 values

- NA
- NA
- 12 hrs



Conclusions



How can we apply Pcrit to populations on the coastal shelf?

Hypoxia Sensitivity

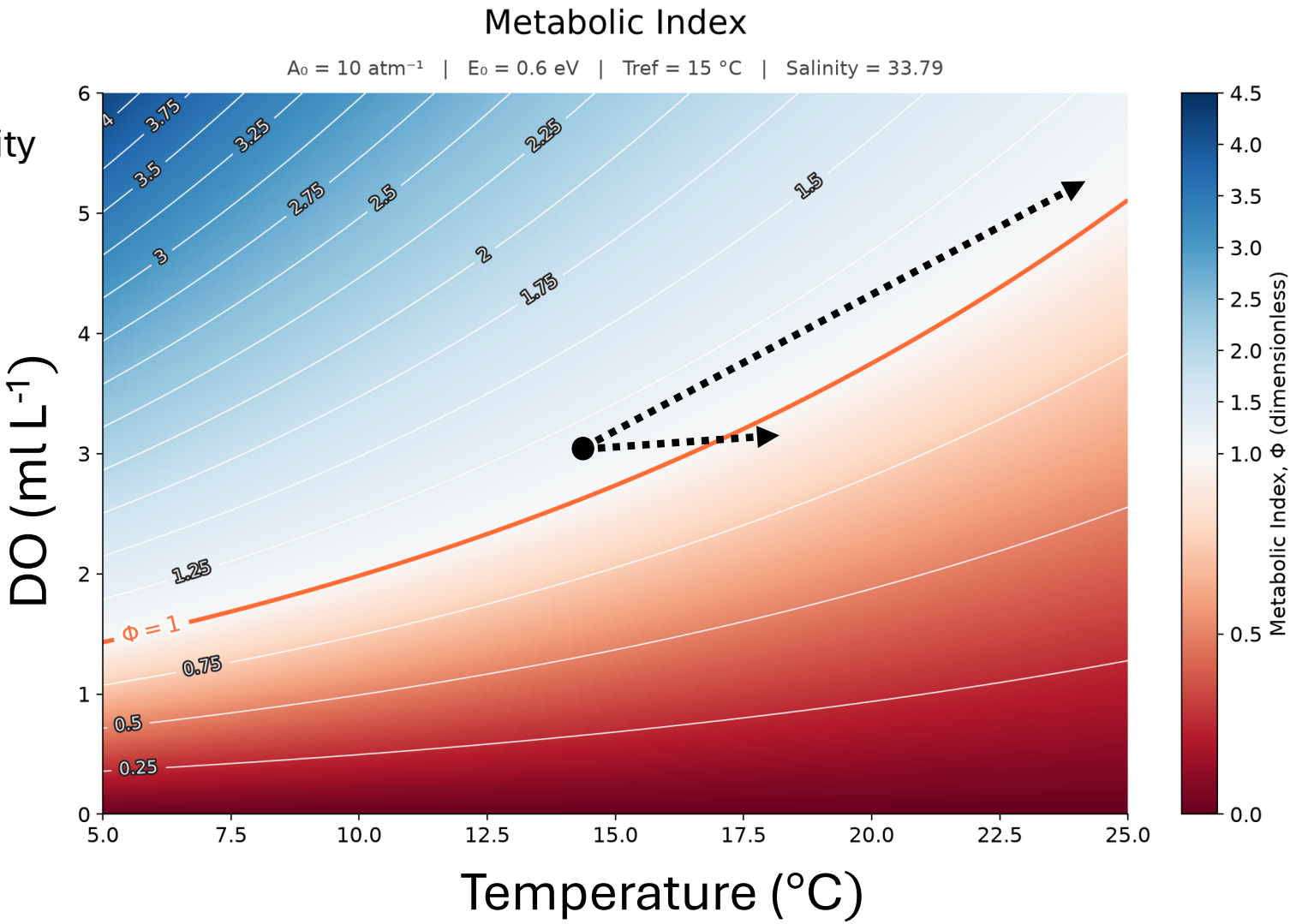
Biomass Scaling

Oxygen Supply

$$\Phi = A_0 B^n \frac{PO_2}{\exp(-E_0/k_B T)}$$

Metabolic Index

Temperature Scaling



Deutsch et al. *Science* 2015

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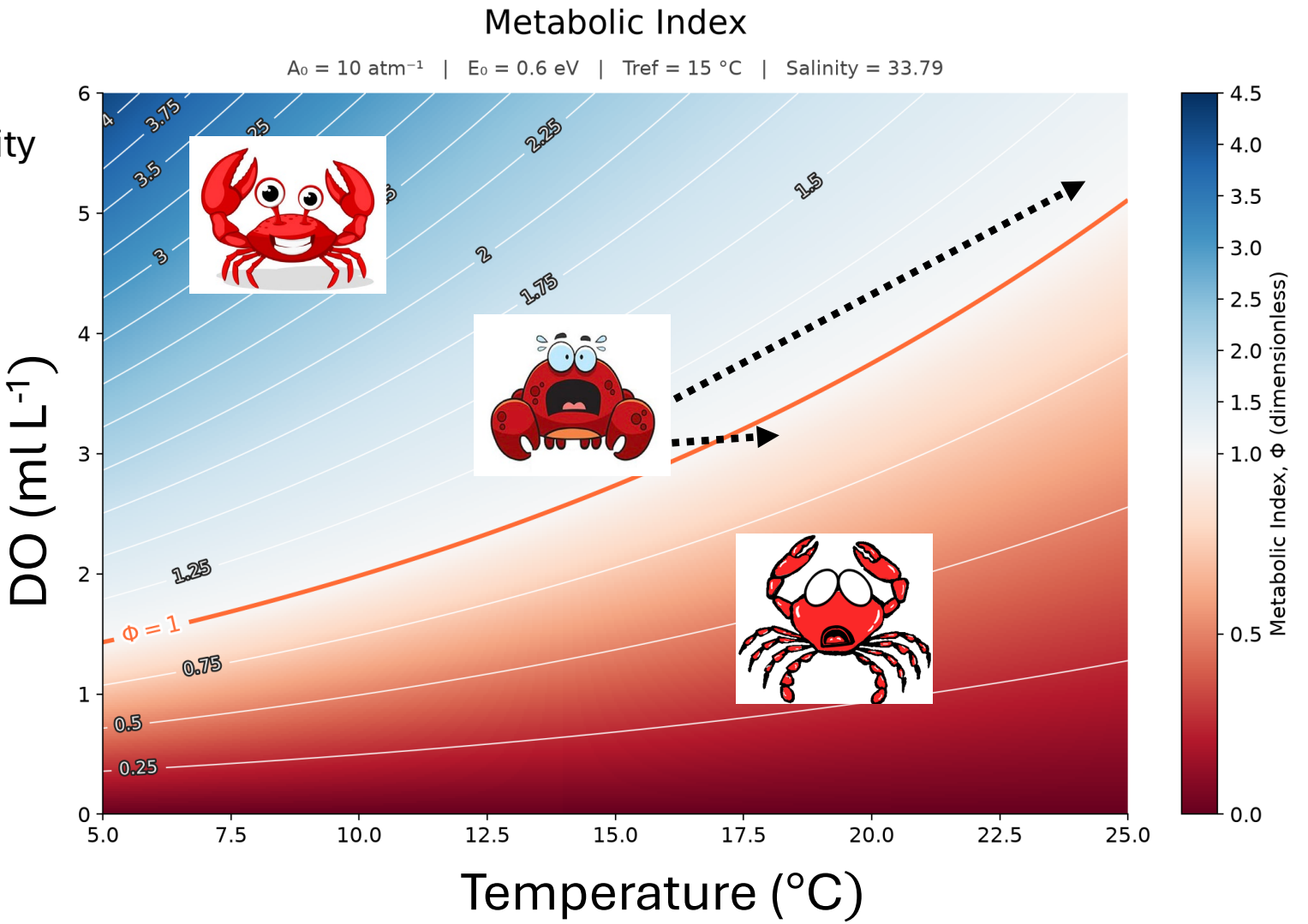
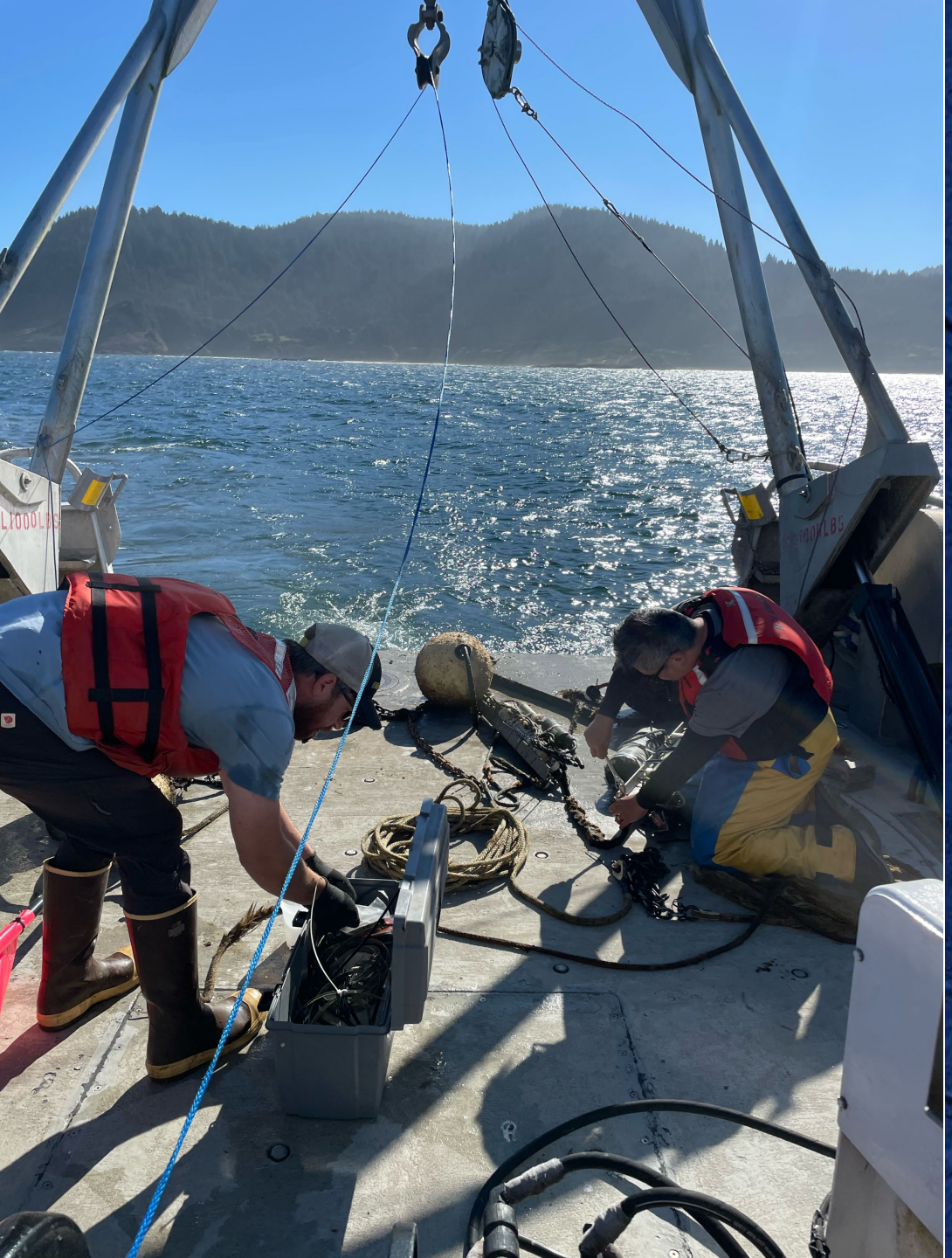
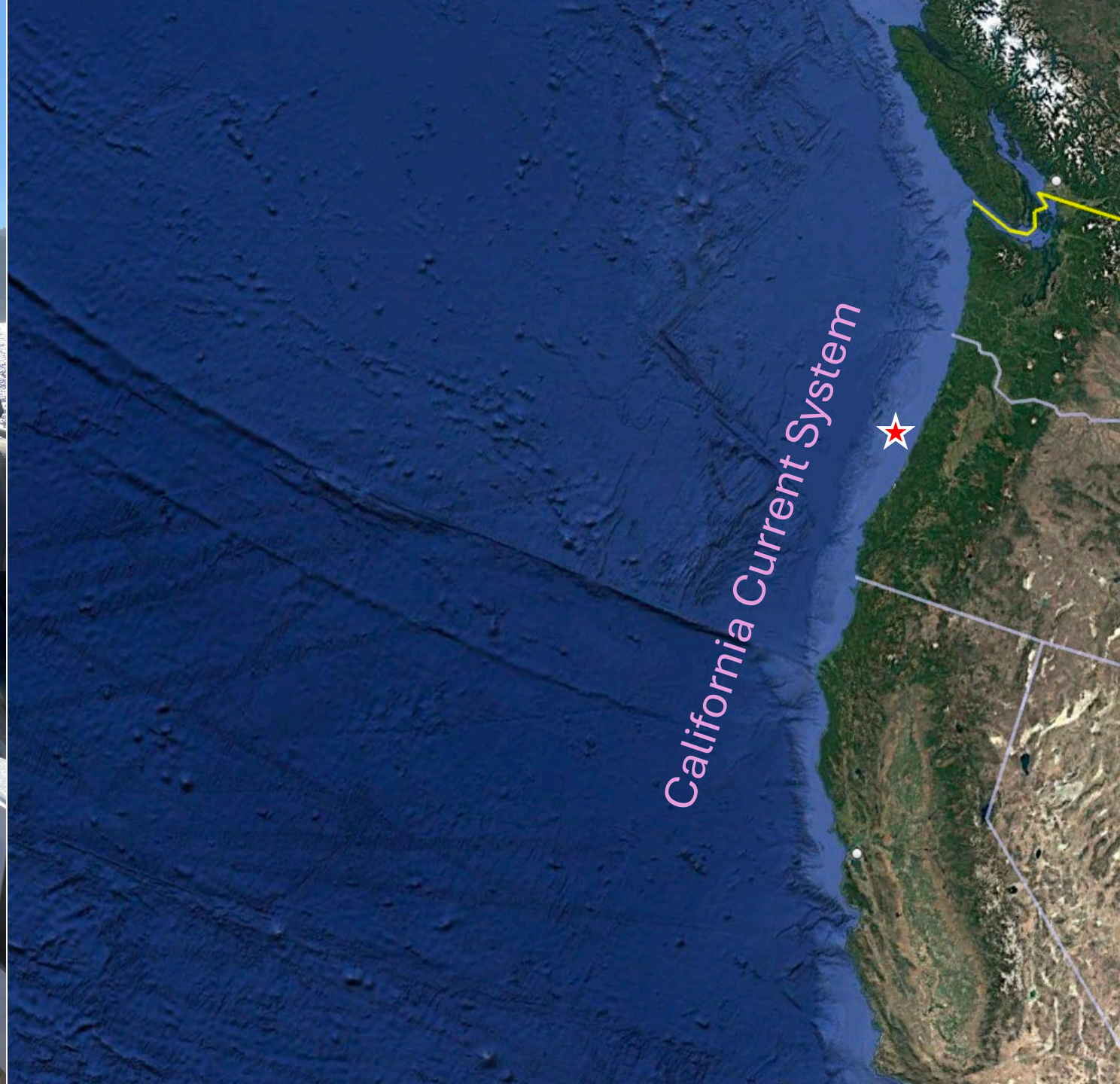
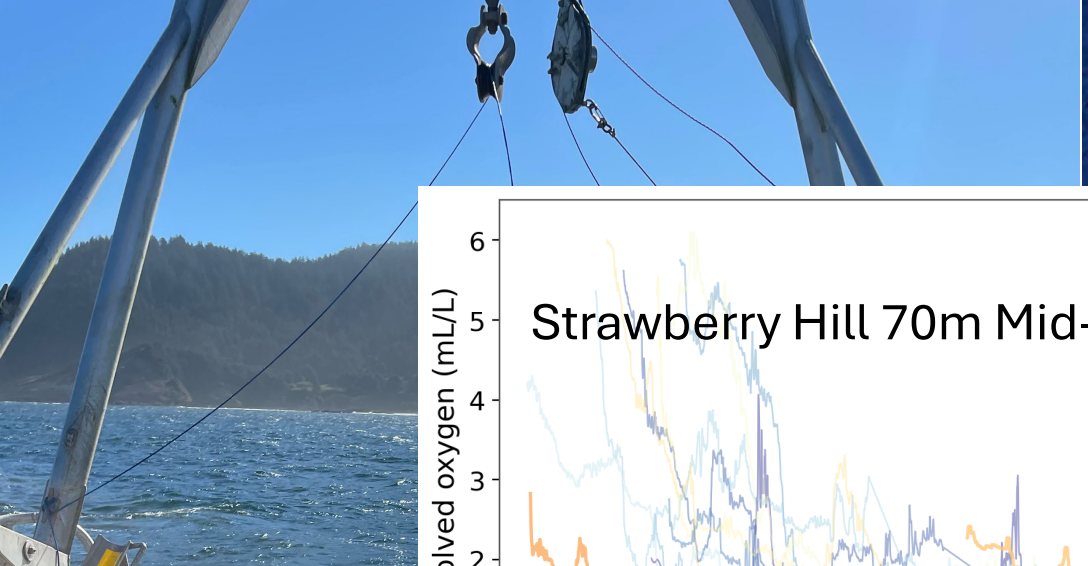
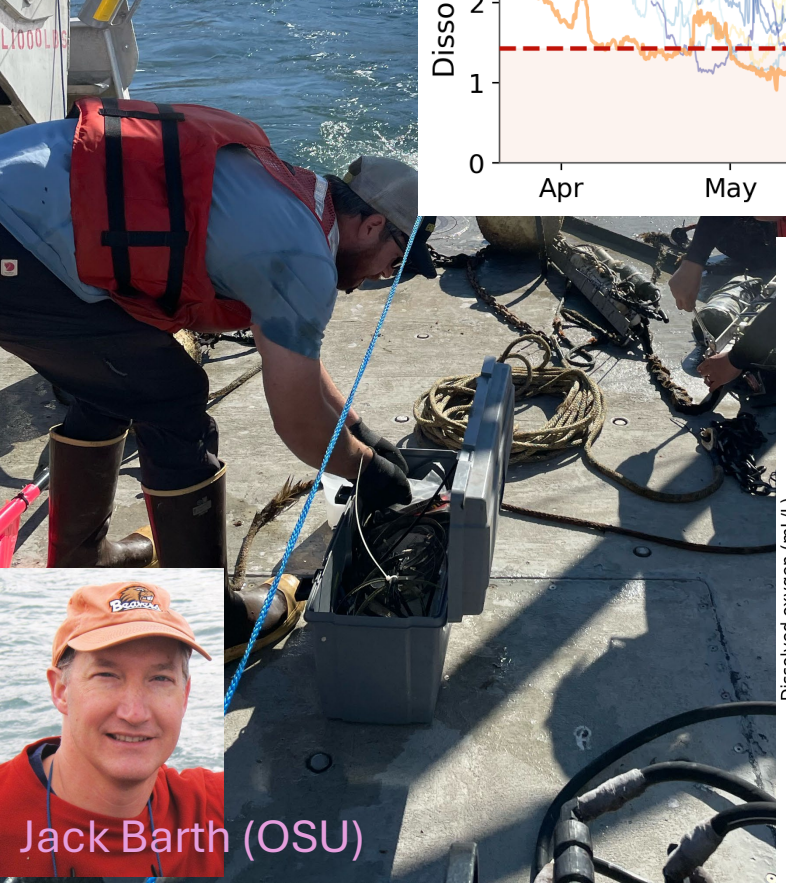


Deutsch et al. *Science* 2015

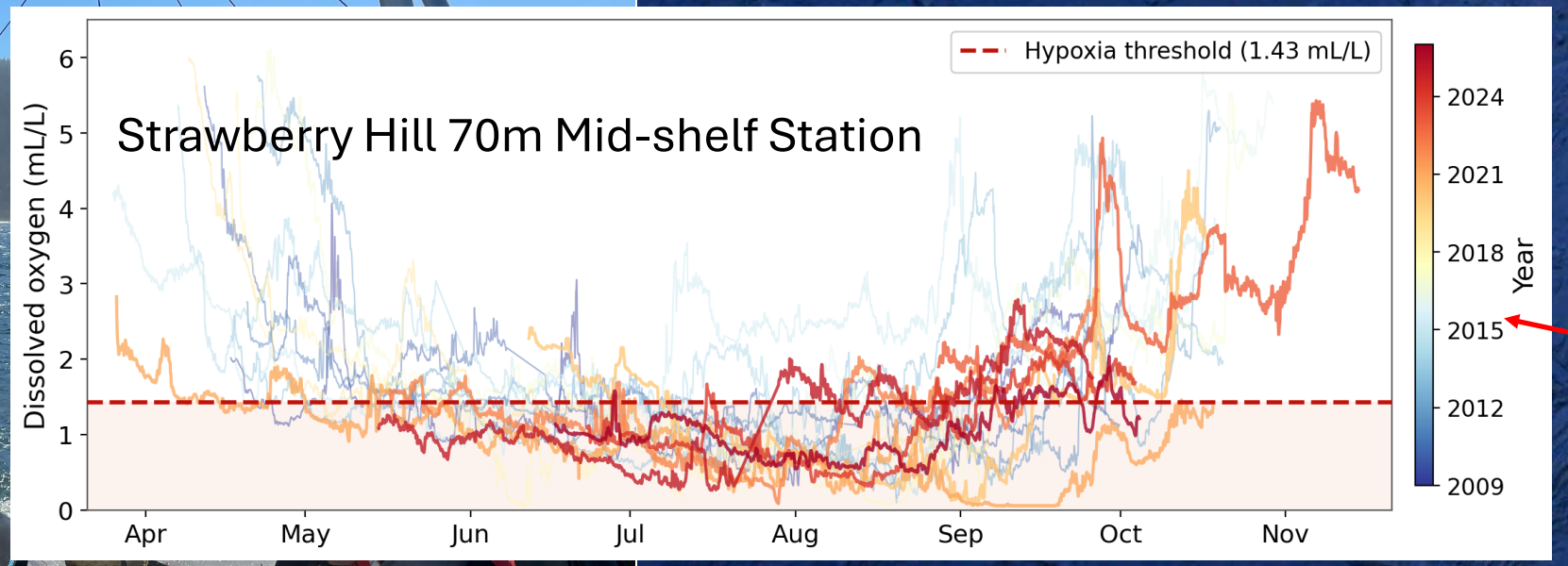


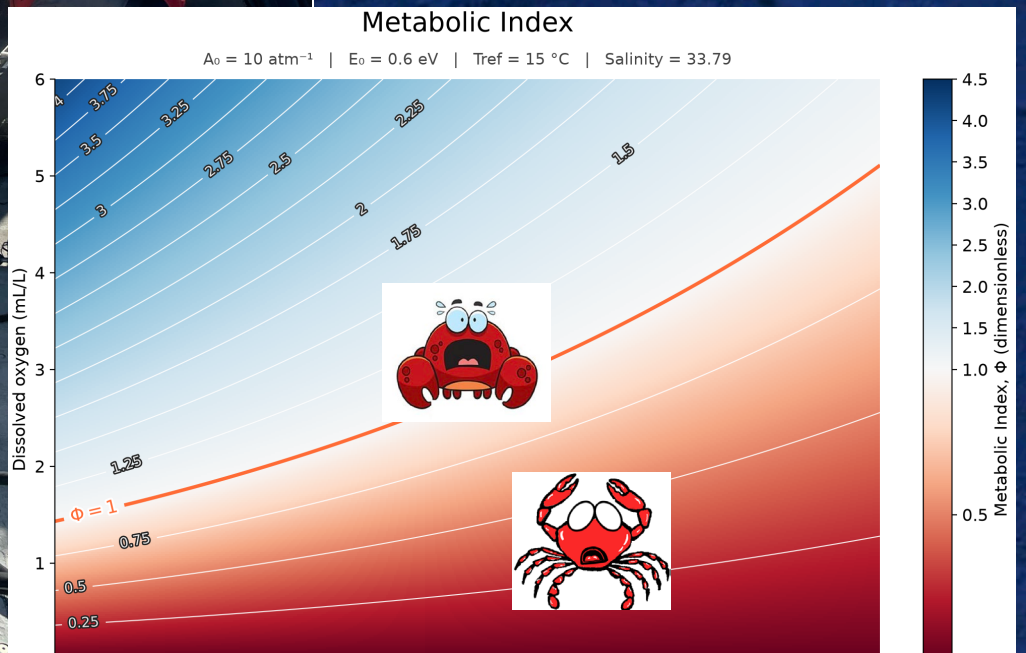

California Current System



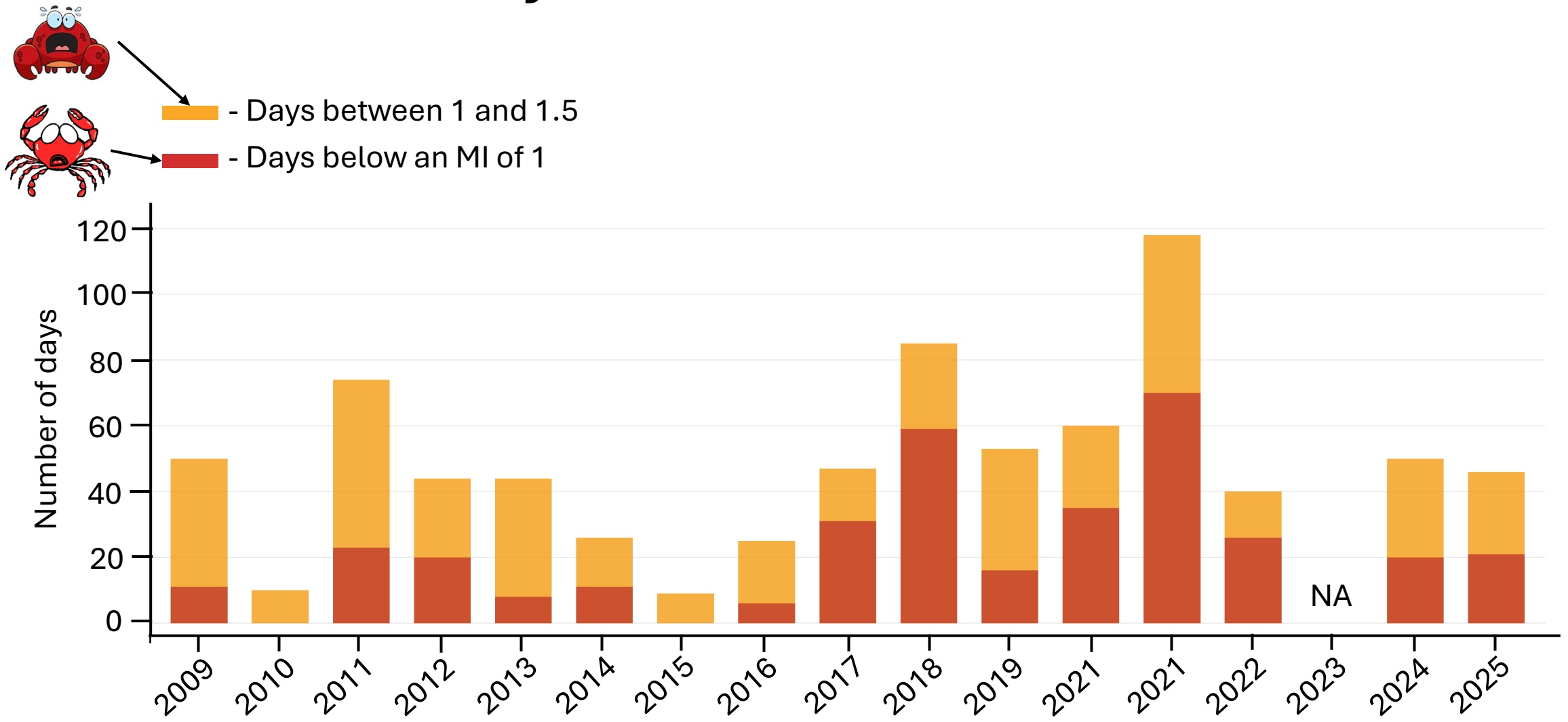


Jack Barth (OSU)





Number of days near or below MI of 1 at SH70



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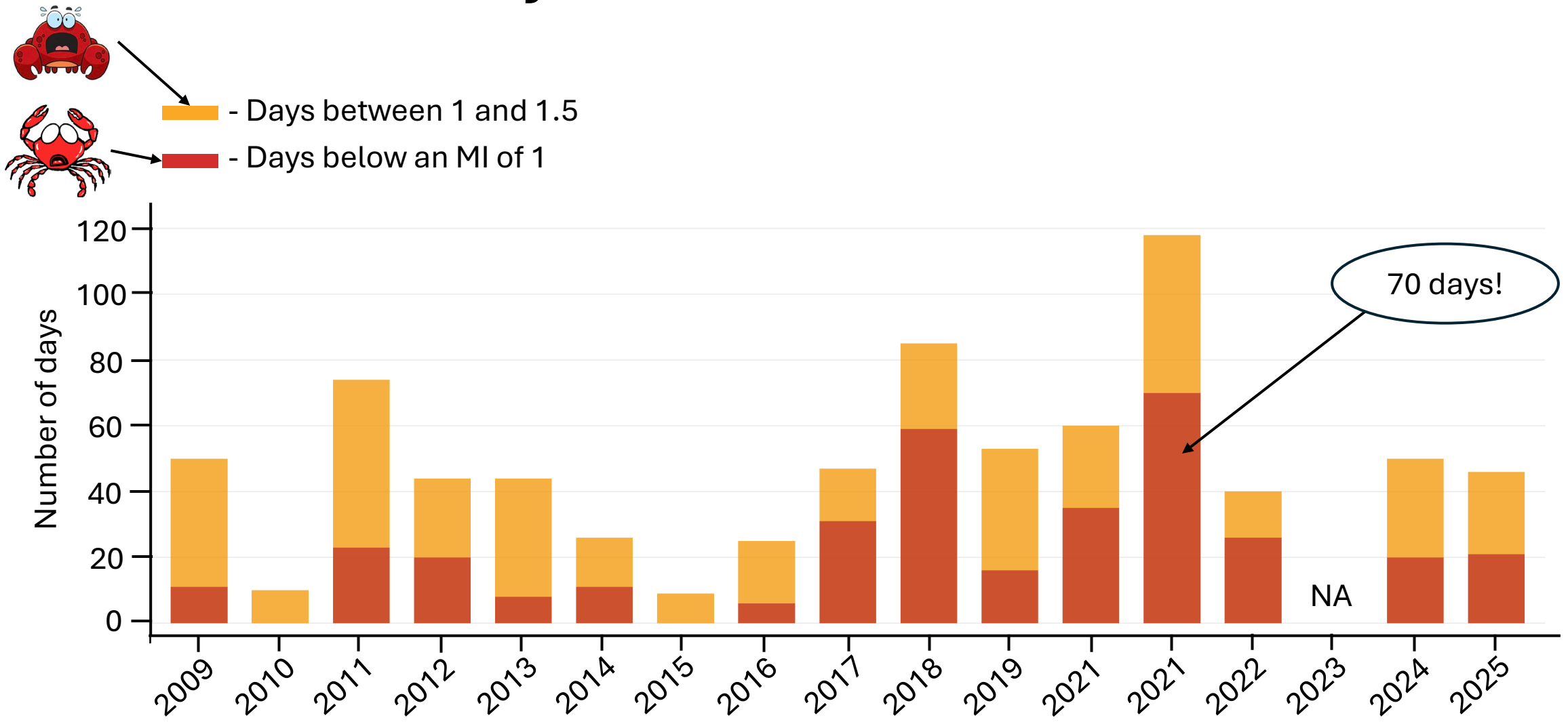

Over the next century, will an environmental tipping point occur that could lead to collapse of the Dungeness crab fishery in the Pacific Northwest?



Image from Beth LaBerge/KQLED

Over the next century, will an environmental tipping point occur that could lead to collapse of the Dungeness crab fishery in the Pacific Northwest?

Conclusions

- Crabs have a relatively high threshold to hypoxia, but are still exposed to extreme stress
- Years with intense upwelling may be the most environmentally stressful

Next steps

- Better understanding the impacts of low pH conditions on hypoxia tolerance
- Molecular effects of severe stress exposure

Image from Beth LaBerge/KQLED

Integrated multi-stressor observations, modeling, and experiments to inform management in the Northern California Current (Project NA22NOS4780171)



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