Swimming performance of juvenile temperate fish in response to climate change

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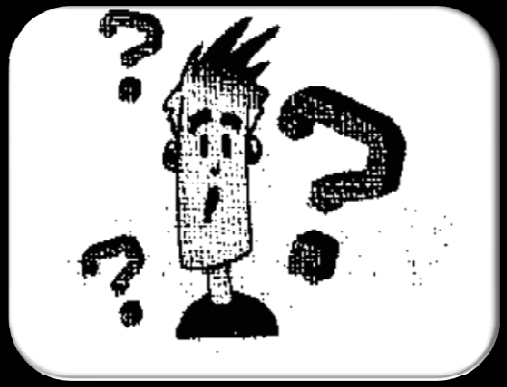
Swimming performance

- Determines the organism survival and is related to vital activities.

Prolonged swimming performance (Ucrit)

- An approach to assess the prolonged swimming performance.
- has been first invented by (Brett, 1964).
- This is the speed at which maximum sustainable oxygen uptake occurs (Gregory and Wood, 1999).
- Species specific (Hammer, 1995; Nelson and Chabot, 2011).
- Has believed to be influenced by salinity and temperature (Deslauriers and Kieffer, 2012; Yetsko and Sancho, 2015).
- Provides potential information for better understanding the organism biology and can be applied to aquaculture management systems.



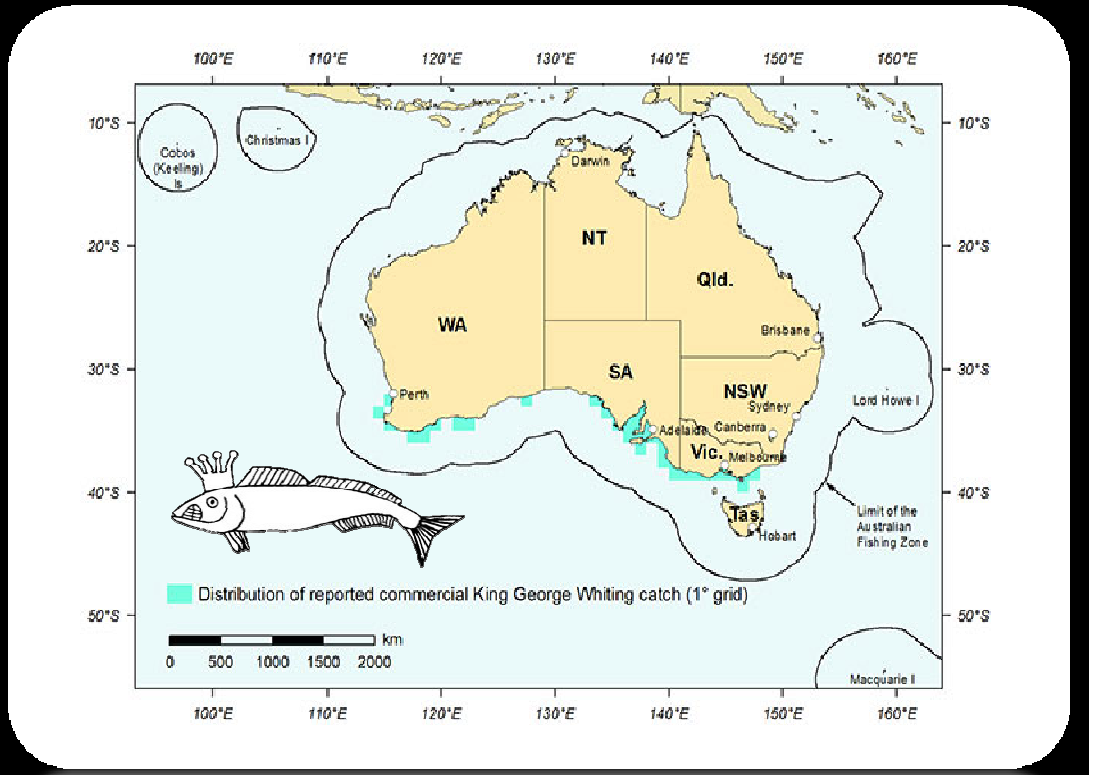
- Sustained aerobic swimming performance (Ucrit) (Temperature and salinity effects).

- Environmental variability and locomotion.

- Species performance and its tolerance limit.

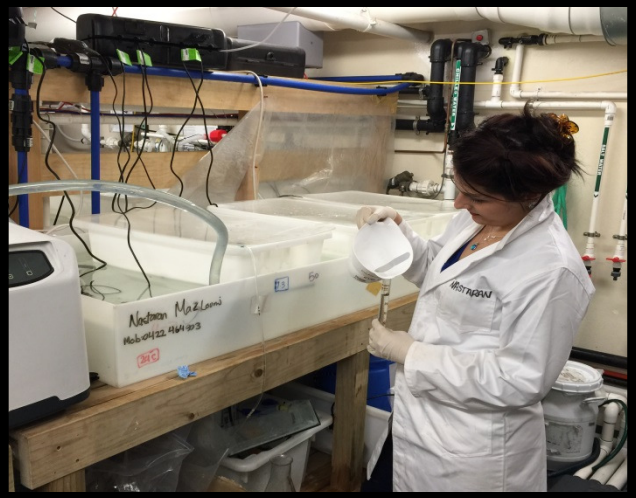
King George whiting

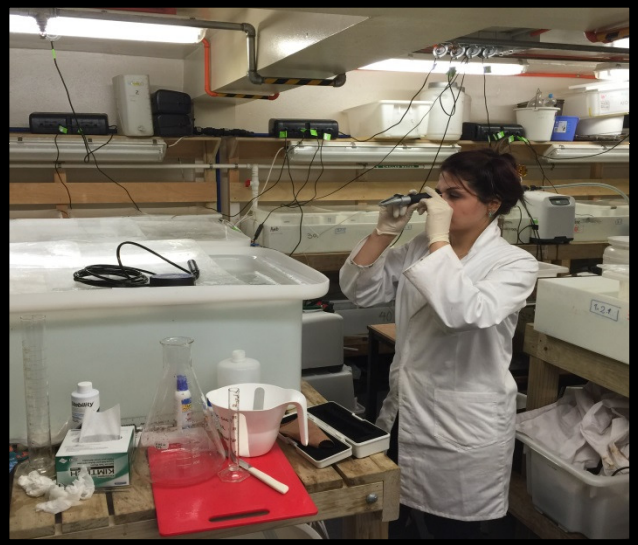
- The most commercial and recreational fish of Southern Australia.
- Longevity: 22 years
- Maximum size: 590mm (total length).
- Maturity: 3-4 years, 300-350mm (total length).



http://www.fish.gov.au/

Fish collection
(Port Vincent on the east coast of York Peninsula, South Australia (34°46′0″S ,137°51′0″E))





Fish maintenance
(Aquarium room, The University of Adelaide)

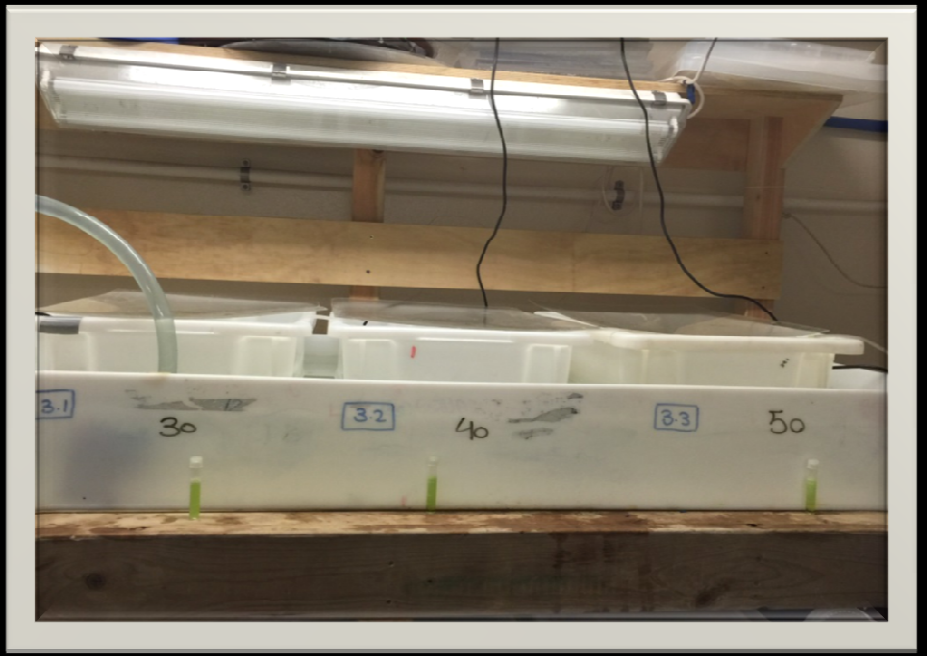
Experimental Design

Replicate tanks

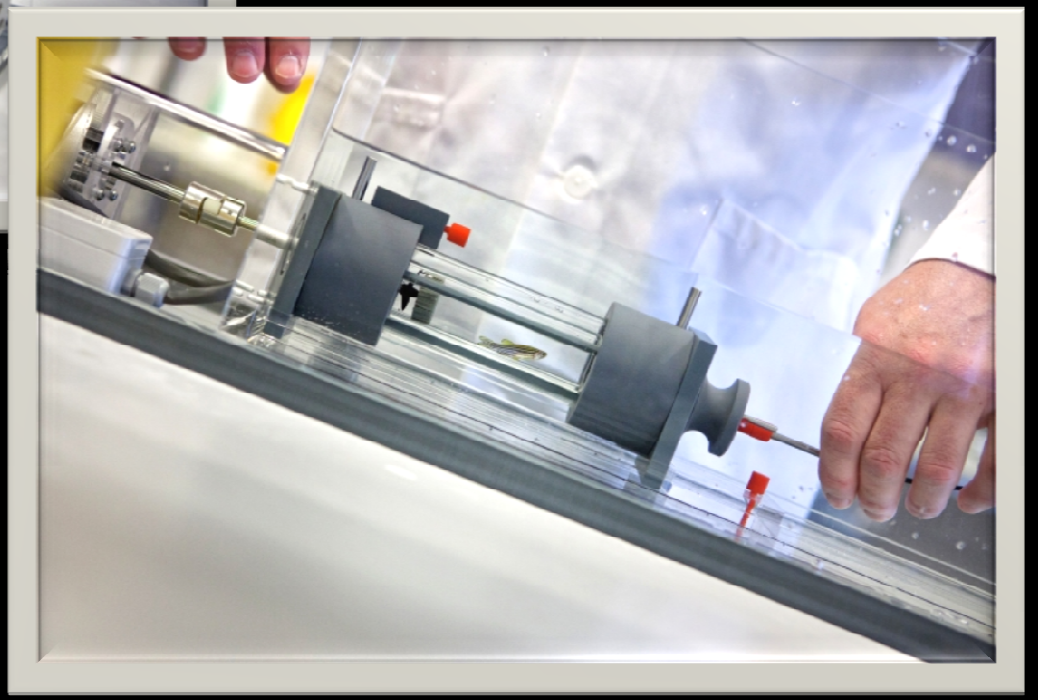
16°C	16°C	19°C	19°C	22°C	22°C	25°C	25°C
30‰	30‰	30‰	30‰	30‰	30‰	30‰	30‰
40‰	40‰	40‰	40‰	40‰	40‰	40‰	40‰

Swimming performance

- Fish were left for a minimum of 3 weeks in holding tanks to acclimate to the new condition.
- Temperature and salinity, as well as ammonia and nitrite levels in seawater were monitored on a daily basis using an electronic water quality unit (YSI Sonde, 556 MPS) and ammonia and nitrite test kits.
- Half of the seawater in tanks was exchanged every other day, ensuring that the ammonia level in the water never exceeded 0.25ppm.



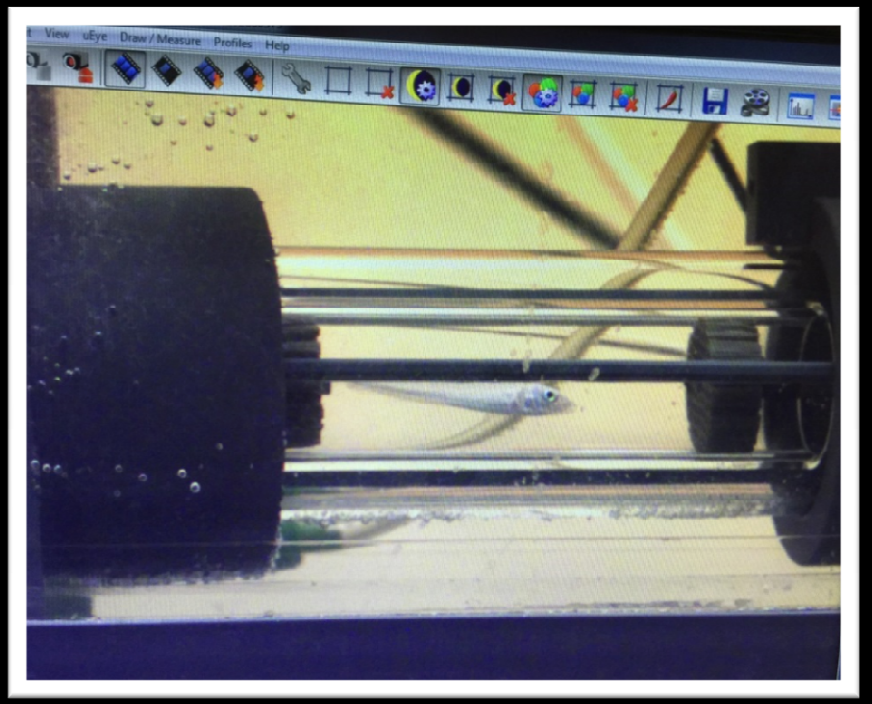
Swim chamber respirometer (170ml), Loligo Systems, Copenhagen, Denmark.



- The velocity of the water was calibrated using a digital flow tracking system before starting the swim test

http://www.loligosystems.com/

- Fish were fastened for 48h before starting the test
- Fish were rested for a minimum of 10h in the chamber to rest.



Swim test

- **Increasing water velocity by 0.3 BLs-1 every 60 minutes until fatigue.**
- **Ucrit was interpolated from the final steps of swimming (Brett, 1964)**

$$U_{crit} = U + (t/t_i \times U_i)$$

U = Last speed expressed in BLs^{-1}

U_i = The velocity increment expressed in cm/s^{-1}

t = The time fish swum in the final velocity increment

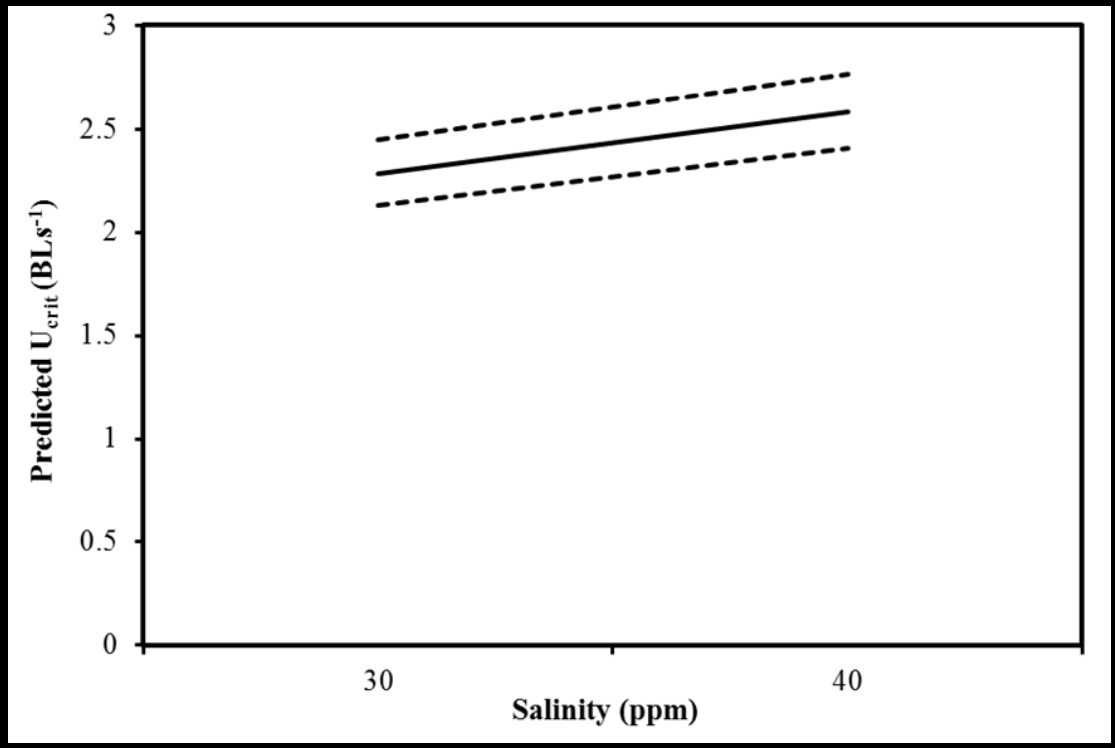
t_i = The set time interval for each velocity increment (60 min)

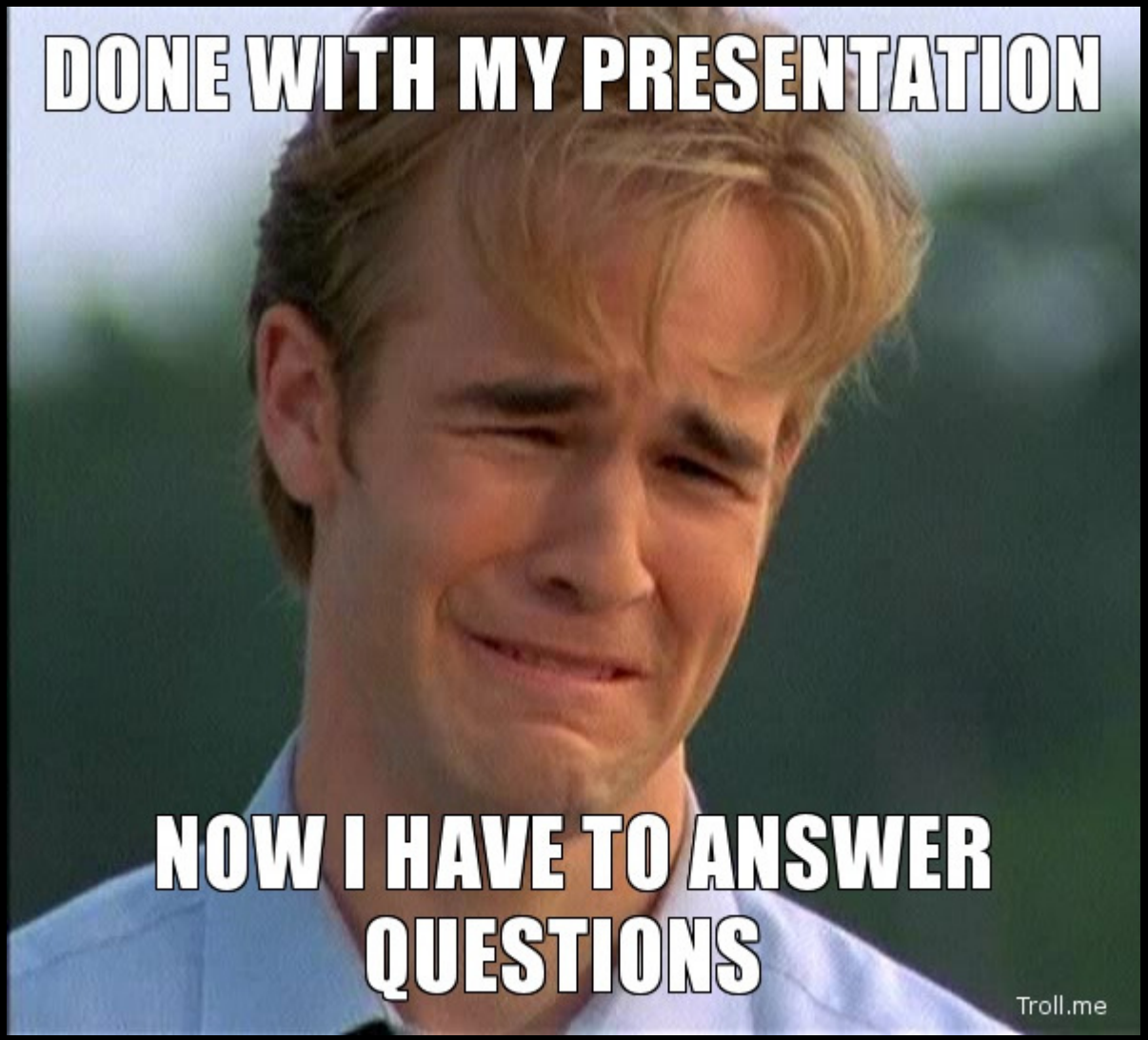
Statistical analysis
General linear mixed effect models (GLMM, lme function in R) (Pinheiro and Bates, 2000)

Mixed modelling approach

- Separate GLMMs
- Stepwise forward procedure with the optimal model at each step selected based on lowest Akaike information criterion corrected for small sample size (AICc) (Burnham and Anderson, 2002)
- Random term: replicate tanks
  Fixed terms: temperature, salinity and their interaction
- Best supported model was (salinity), AICc: -8.26

Random effects:	Estimate	Std.Error	t.value
Intercept	0.00	0.00	
	0.03	0.19	
Fixed effects:	Variance	Std.Dev	
Intercept	0.82	0.03	23.38
Salinity 40	0.12	0.04	2.46




DONE WITH MY PRESENTATION
NOW I HAVE TO ANSWER QUESTIONS
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