The effects of environmental variability on growth and phenological traits of endangered Delta Smelt

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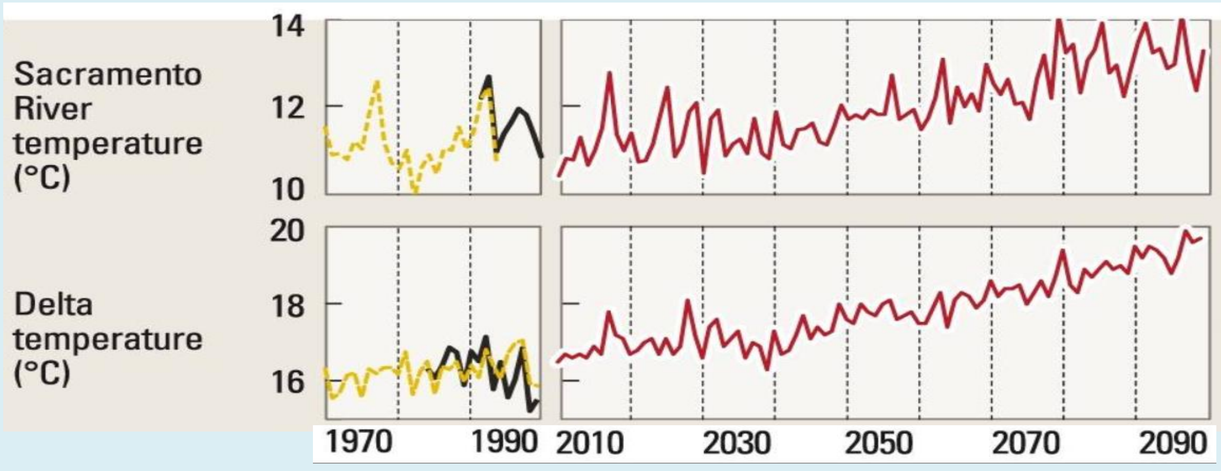

Fig. 1: Predicted change in water temperature of the Sacramento River and the Delta as a whole over the next 100 years.GFDL-A2 climate model.

Cloern et al 2011

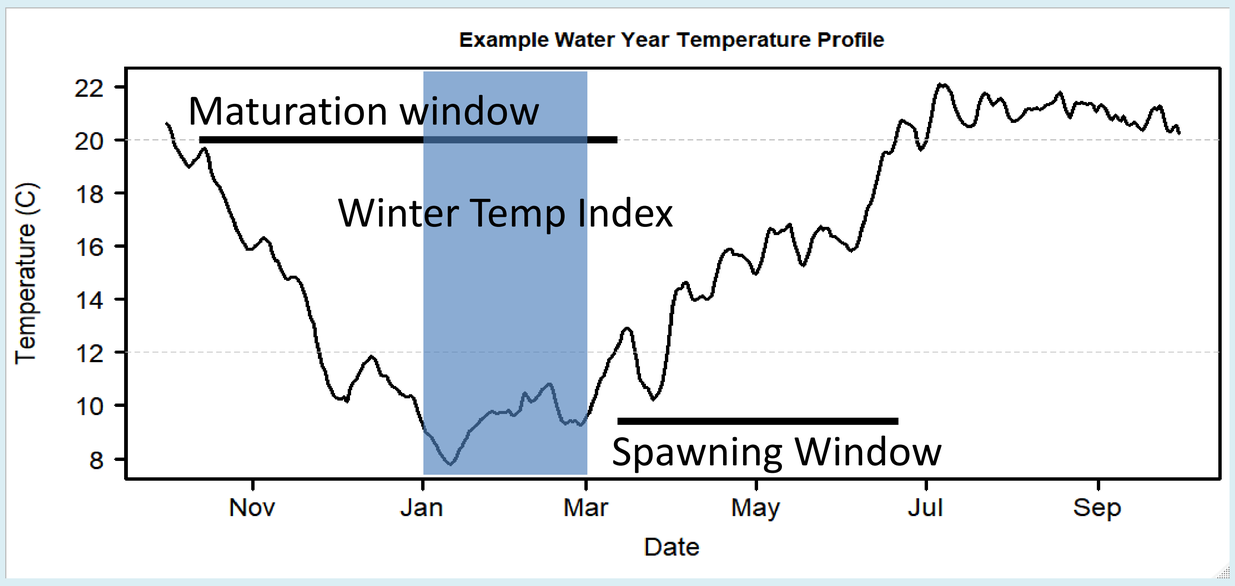

Fig 2: Maturation and Spawning windows of Delta Smelt overlaid on top of a typical annual temperature profile of the Sacramento Delta. Both are thought to be tied to the 12-20C temperature range.

Wild Delta Smelt hatch earlier and grow slower during warm conditions, corroborating laboratory studies and model predictions.

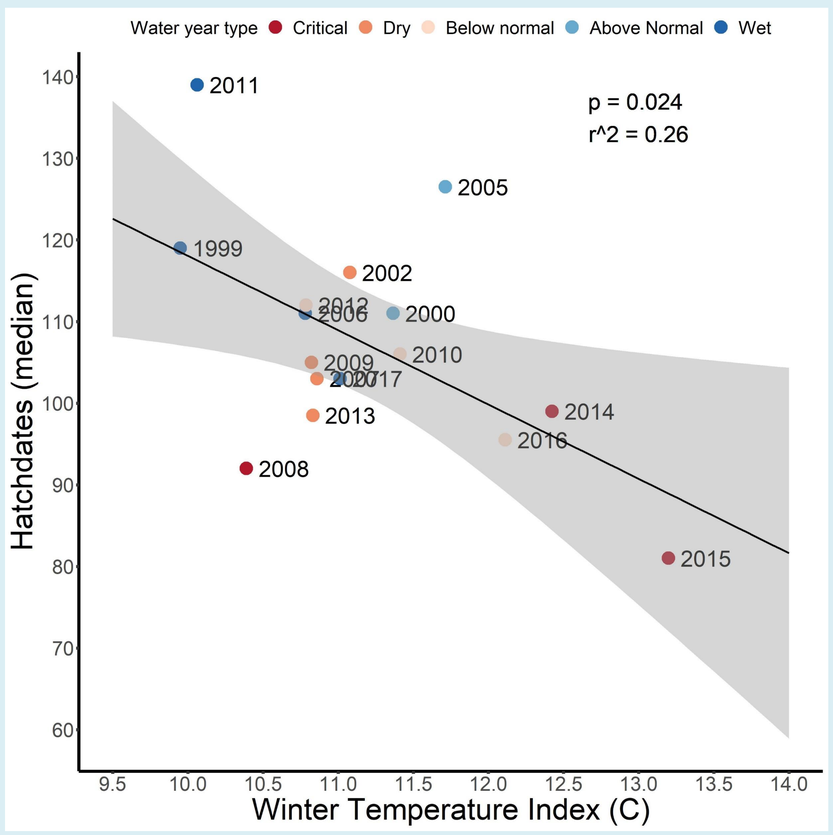

Fig. 3: Mean hatch date by year in relation to Winter Temperature Index. Colors represent water year type from Critical to Wet. 1999 to 2017.

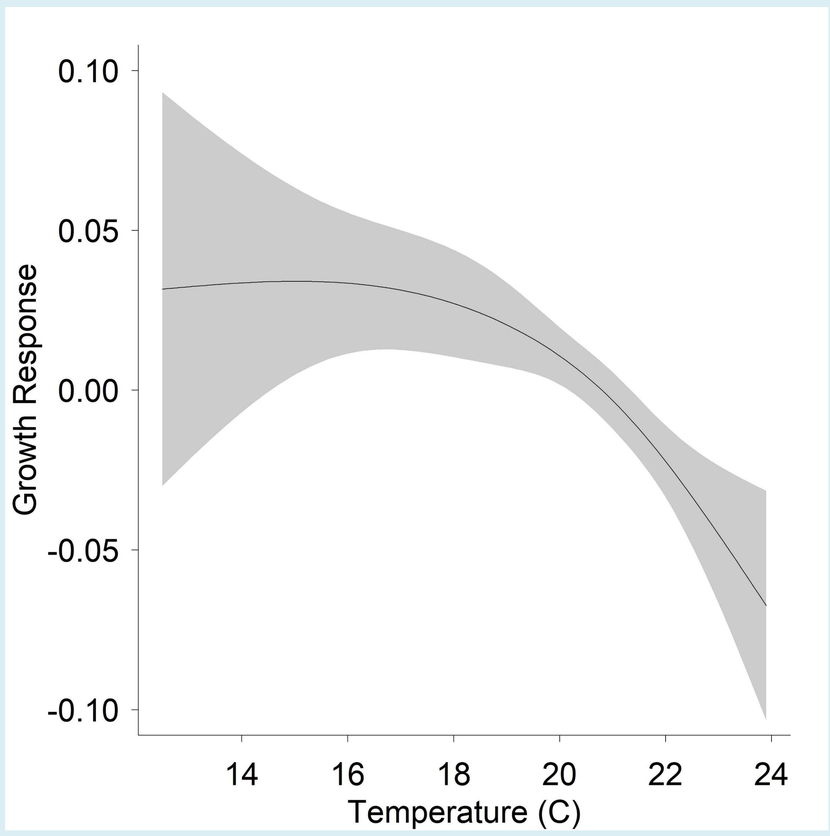

Fig. 4: Temperature at time of capture was used to model recent growth, as measured by the otolith increments at the edge of the otolith (last 14 days). Fish in the model were from 2011 through 2018 in August through December.

Introduction

Global and regional climate models predict warming temperatures over the next century.

Laboratory studies indicate that timing of Delta Smelt spawning/hatching is related to temperature. As a result, climate change may shift hatch dates by ~5 days/decade or up to 50 days by 2100.

We examined how the correlation between hatch dates and annual winter temperature index over the past 20 years correlated with the Winter Temperature Index to ask the question: do field observations corroborate laboratory tests.

Methods

- Delta Smelt were aged and hatch date was back-calculated from age and capture date.
- Climate models predict that the Delta will warm considerably over the next 100 years. (**Fig 1).**
- Spawning and hatching in Delta Smelt are thought to be connected to the 15-20C temperature range. (**Fig 2)**
- Otolith increments were used to calculate recent growth and compared to Temperature at time of capture in order to model growth response. (Fig. 4)

Results/Discussion

- We examined Delta Smelt hatch date distributions for 20 years of wild caught Delta Smelt and compared shifts in hatch date distribution to laboratory results.
- Our findings demonstrate that wild Delta Smelt hatch distributions shift in response to winter temperature index at approximately the same rate as observed in lab studies , approximately 10 days/degree C **(Fig 3).**
- Additionally, as water temperatures warm, we expect reduced somatic growth, which could impact fecundity in a warming delta (Fig. 4)
- This supports the hypotheses that Delta Smelt hatching windows will move earlier in response to increasing delta temperatures.
- It's possible that at some point, the ability of Delta Smelt to spawn earlier in the year will be exhausted. If both maturation window and spawning/hatching windows are being compressed as temperatures increase, total egg production rates may suffer. Additionally, if spawning is forced to occur in non-optimal temperatures, hatch rate could similarly decrease. Reduced egg production plus decreased hatch rates could be disastrous for the remaining population.

Acknowledgements

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References

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