


Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission

CIAT
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REVIEW OF RESEARCH AT THE ACHOTINES LABORATORY (SAC-11-16)

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11th Meeting of the Scientific Advisory Committee La Jolla, California USA

Outline

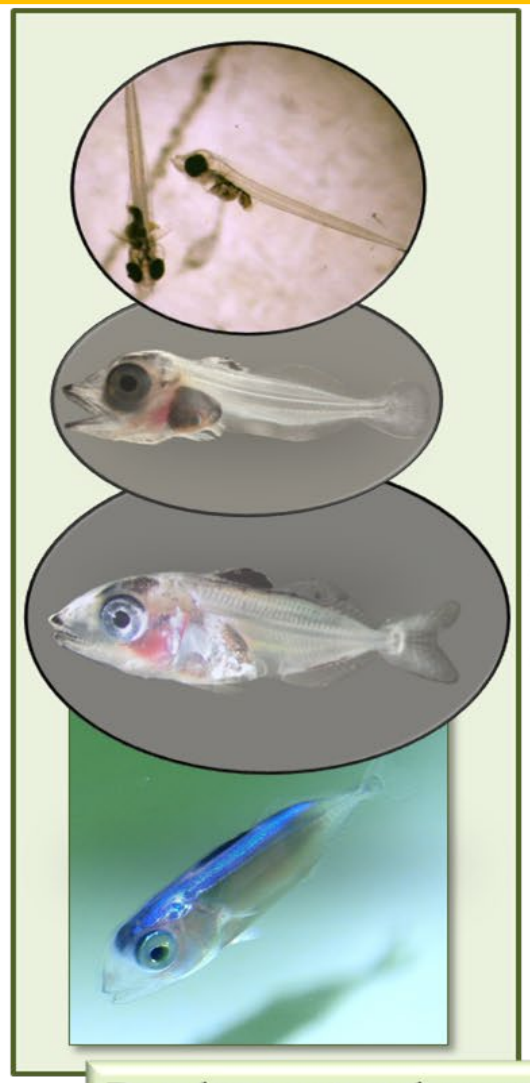
- Introductory Video – Summary of Research Program
- Current Research on Pre-Recruit Life Stages
  - Growth Studies : Larval Growth of YFT (Goal of Larval Growth Index to Forecast Recruitment)
  - Early Juvenile Studies of YFT : Growth Dynamics/ Density-Dependence In Growth From 1-6 mo of age
  - Comparative Studies of YFT and PBF Early Life Histories: Comparisons to Spawning Patterns
  - Climate Change Studies : Ocean Acidification Effects on YFT – Experimental Results & Modeling
- Bycatch Reduction Research Supported at the Achotines Laboratory
- Future Directions

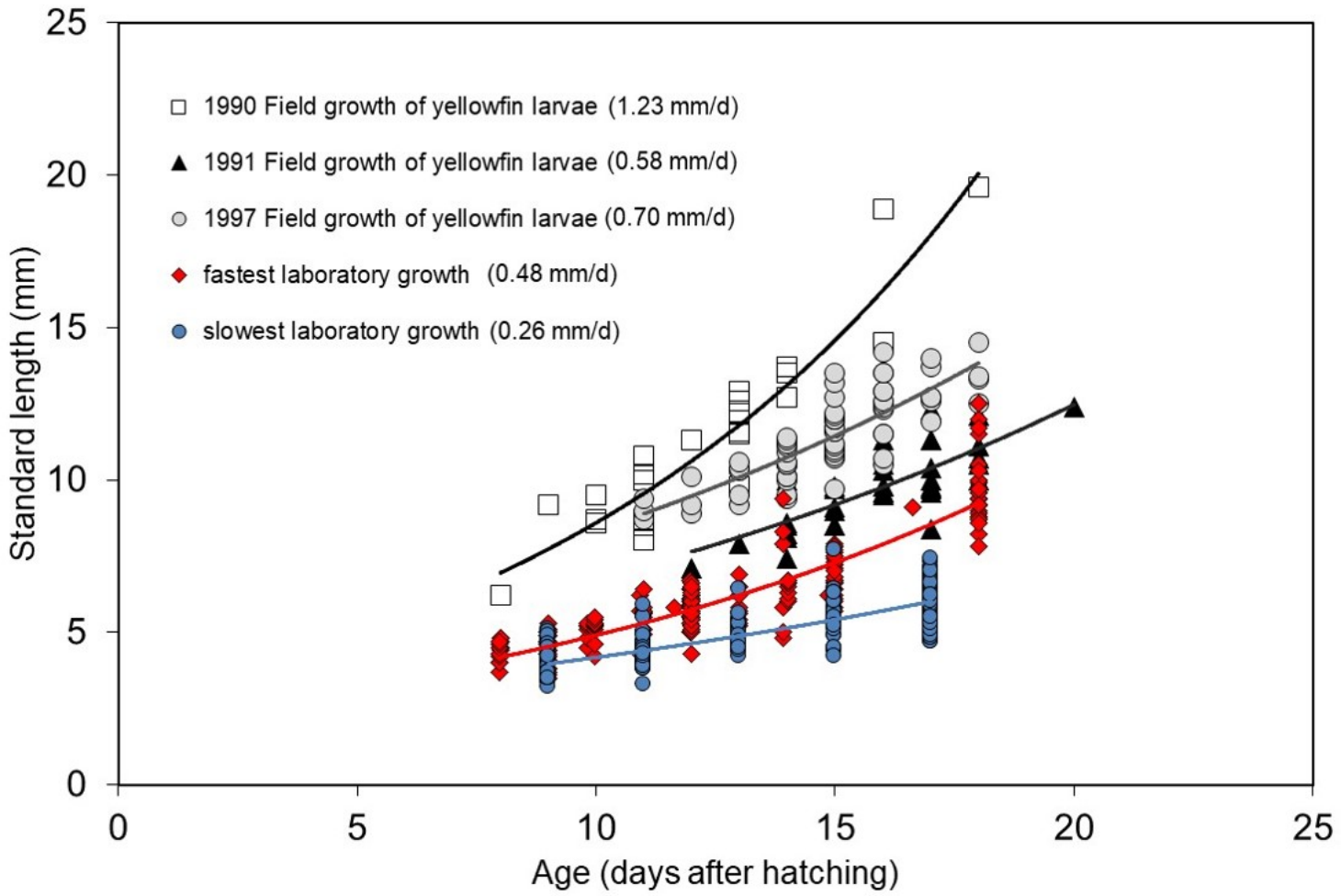
Achotines Laboratory

Click on image for video

Growth Studies

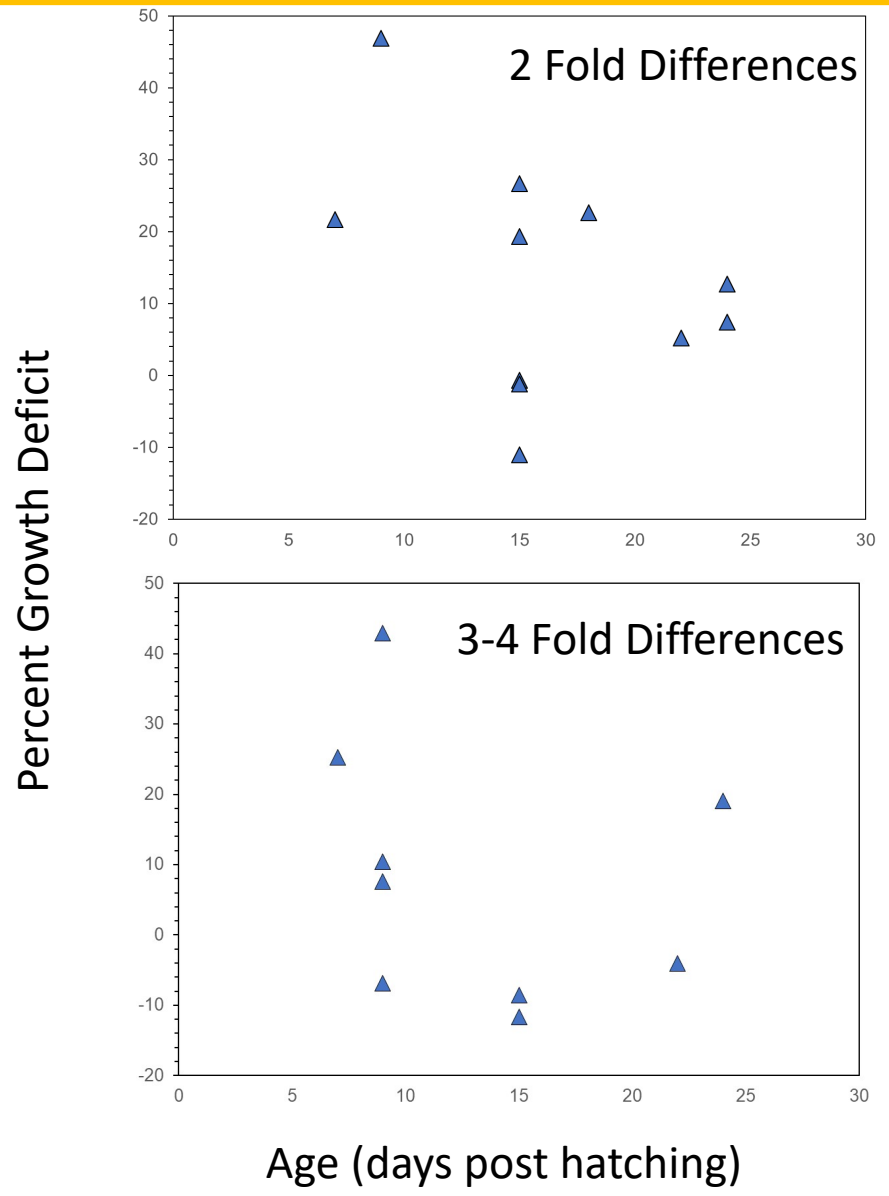
Larval Growth Index as a Predictor of YFT Recruitment?





Development and growth of yellowfin tuna larvae (photos: first feeding 4-day old larvae, 15-day old flexion larva, 25-day old transforming larva, 30-day old juvenile

Density Effects on YFT Larval Growth: Growth Deficits



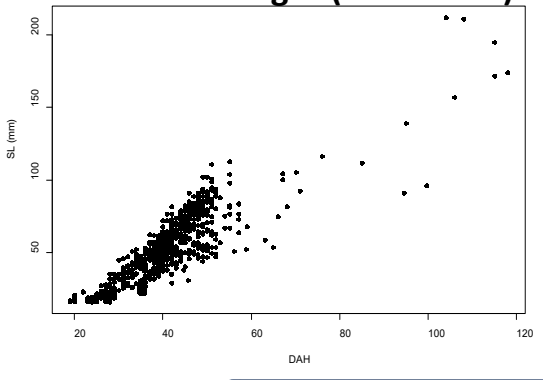
- There is an early onset of density-dependent growth in the larval stage, with daily growth deficits > 40%/day resulting from stock density increases of 2-4 x at the first-feeding stage
- The density effect on growth decreases with larval age, but it is still present at juvenile transformation
- The occurrence and magnitude of density-dependent growth during the early juvenile stage is unknown and will be studied during 2020-2021

Juvenile Yellowfin Studies

2015: World-first transfer of juveniles from land based tank to sea cage

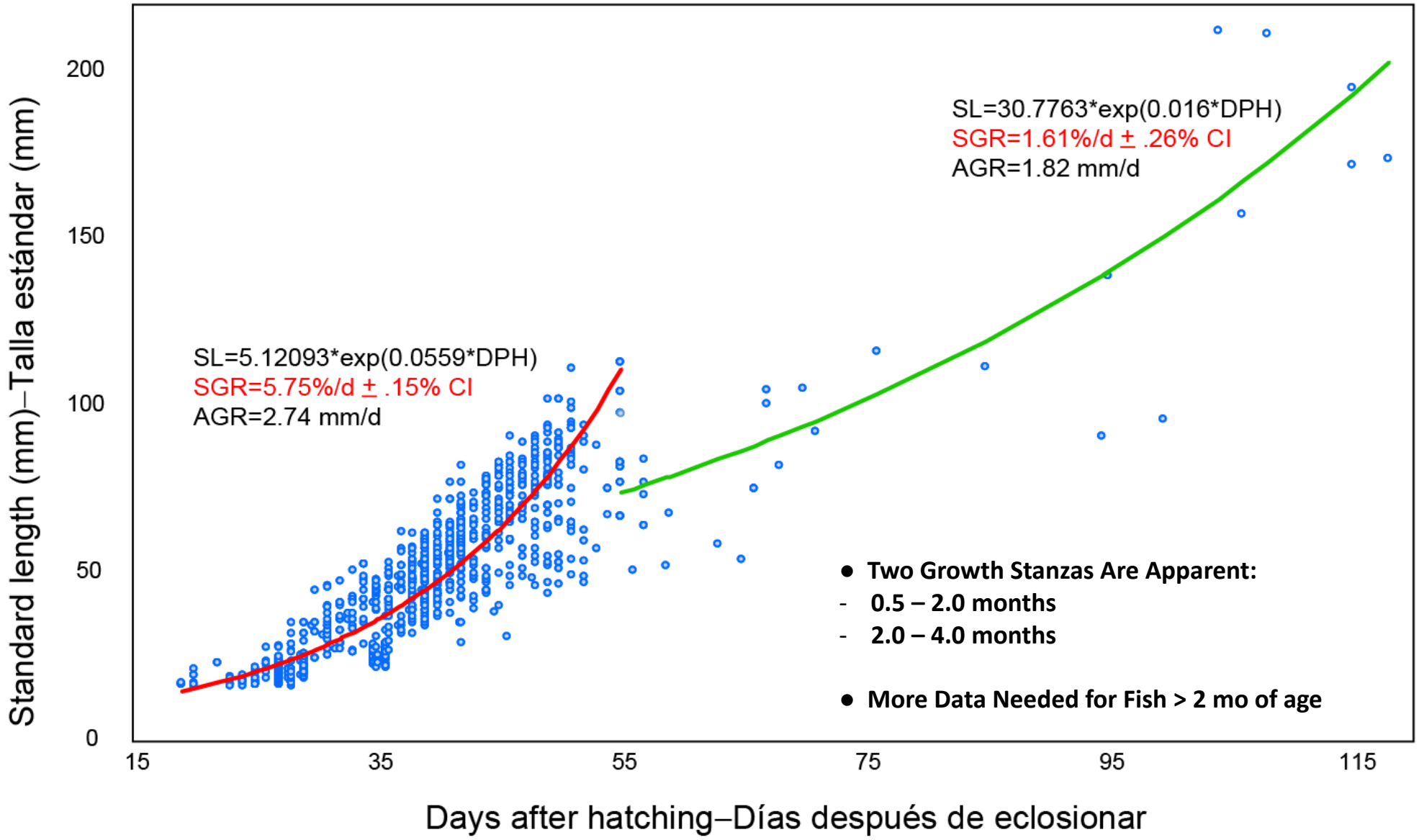
- **Collaboration with Kindai Univ**

Growth in length (0.5 – 4 mo)

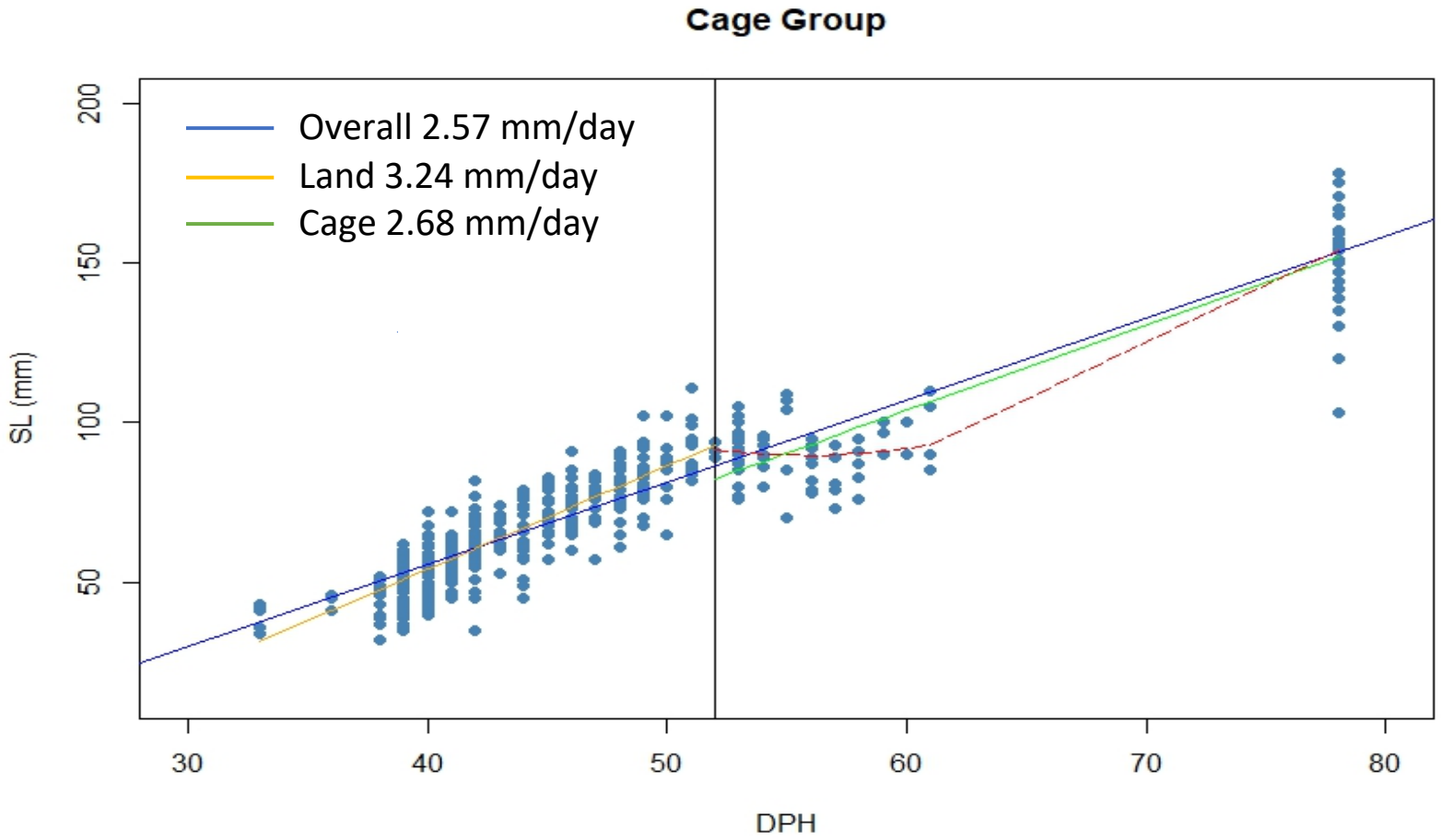


2019-2021: Studies of Density-Dependent Growth

Laboratory Growth in Length of Early-Juvenile YFT (0.5 - 4 mo of age)



YFT Early-Juvenile Growth: Landbased Tanks vs Seacage (2015)



Comparison With Other Species: Laboratory Growth →

Common Name	Growth Rate (mm/day)	Age range (days)	Temp range (C)	Location	Source
Atlantic Bluefin	1.62	20-108	23.5-25.5	Italy	Caggiano, et al. (2009)
Pacific Bluefin	3.2	30-120	24.5-27.5	Japan	Kindai U unpubl (2017)
Yellowfin	1.0-3.8	19-118	26-30	Panama	IATTC Data (2016)
Black Skipjack	1.0-4.8	15-167	23.7-29.1	Panama	IATTC Data (1990)

Comparative Studies of Yellowfin and Pacific Bluefin ELH

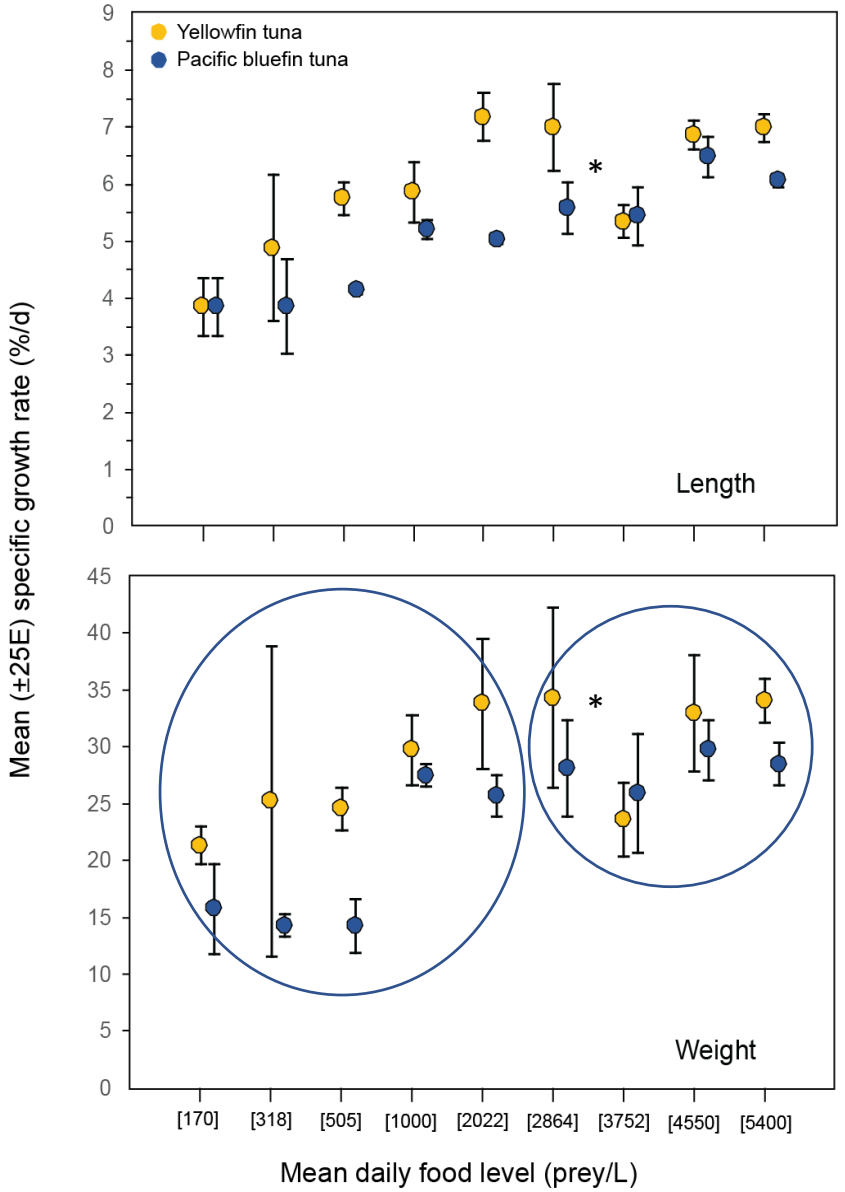
SCIENCE AND TECHNOLOGY RESEARCH PARTNERSHIP FOR SUSTAINABLE DEVELOPMENT (SATREPS)

1. Comparative growth and survival studies at multiple background prey levels
2. Comparison of larval starvation rates
3. Comparison of larval feeding dynamics and prey selectivity
4. World-first juvenile rearing and sea-cage culture of yellowfin tuna to recruitment size

Growth of Yellowfin and Pacific Bluefin Larvae at Different Food Levels

10 Days of Feeding (12 DPH)

* 6 Days of Feeding (8 DPH)



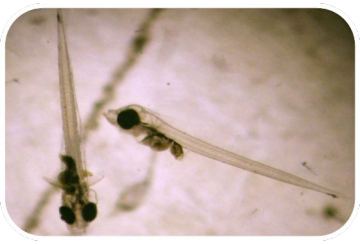
Growth In Weight (Best Index):

- Growth rate of YFT larvae consistently higher than PBF
- At prey levels < 2000/L, growth rate of YFT is statistically higher
- At prey levels > 2000/L, few statistical differences between growth rates of YFT and PBF

Comparative Larval Traits

Pacific bluefin tuna
(Thunnus orientalis)

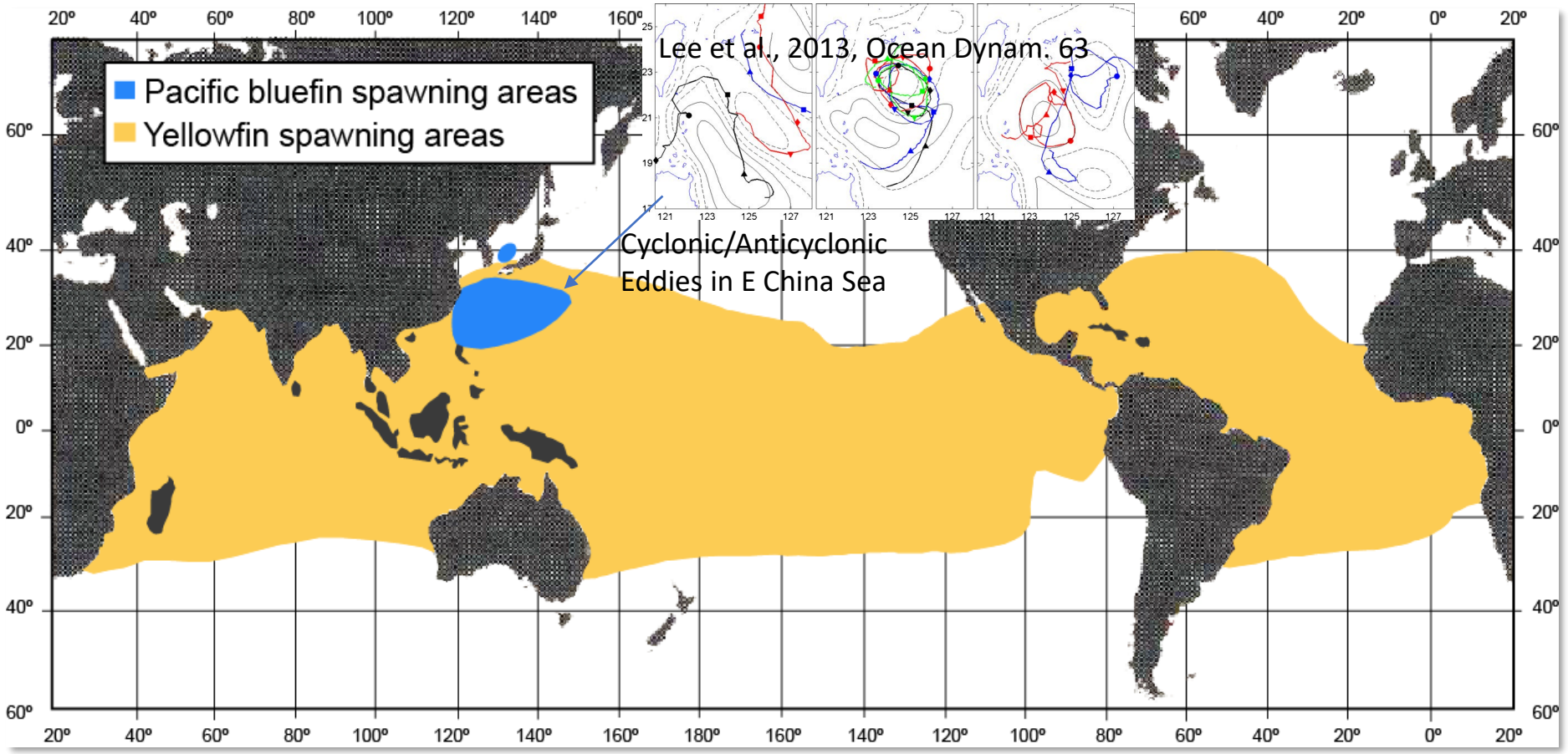
- Slightly larger at egg, yolk sac, and first-feeding larval stages
- Longer duration until starvation at the first-feeding stage at similar water temperatures
- **Slower growth and lower survival under low food conditions, require relatively high prey levels during the first week of feeding**



Yellowfin tuna
(Thunnus albacares)

- Slightly smaller at egg, yolk sac, and first-feeding larval stages
- Shorter duration until starvation at the first-feeding stage at similar water temperatures
- **Faster growth and higher survival under low food conditions, can survive under variable prey conditions during the first week of feeding**

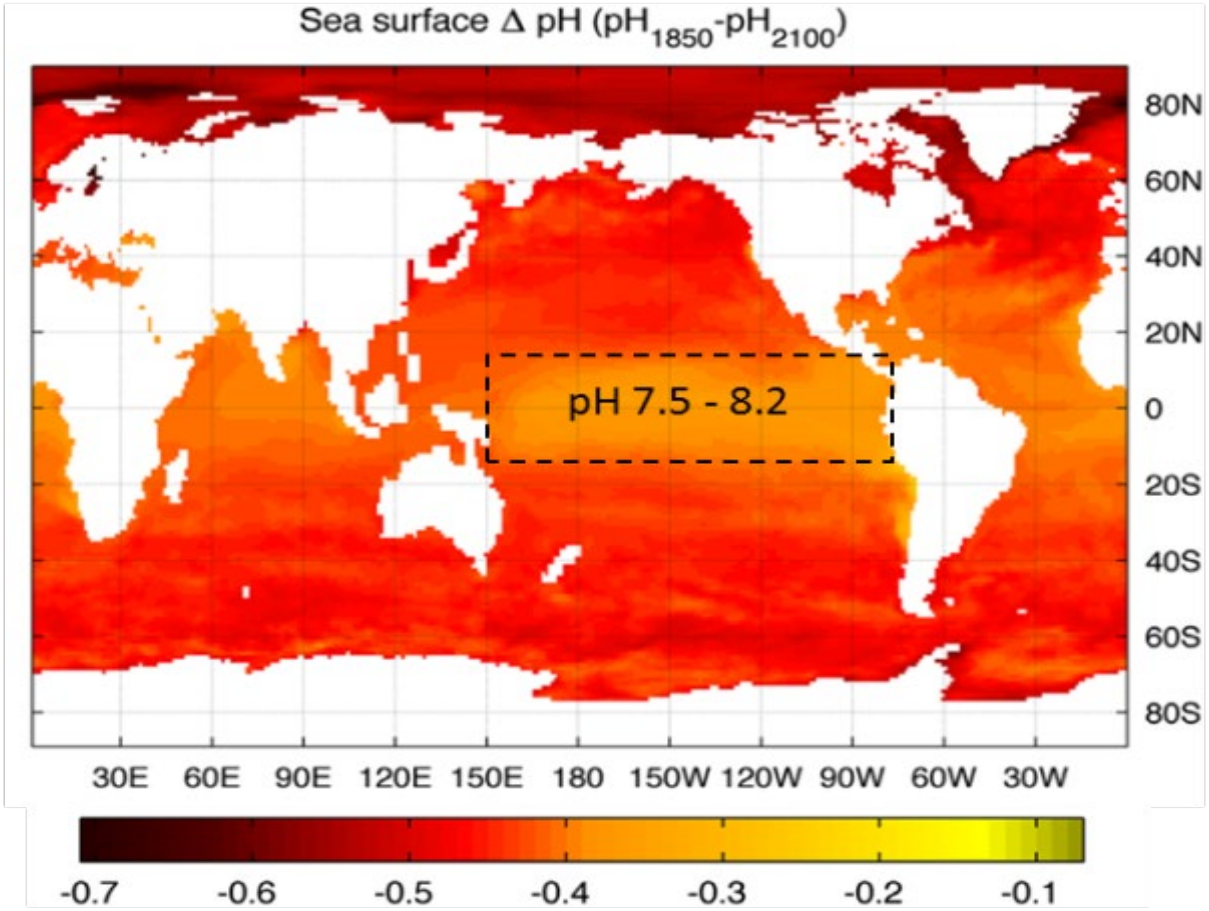
Spawning Distribution of Pacific Bluefin and Yellowfin Tunas



- YFT Larvae: Lottery Pattern of Spawning Under Variable Larval Trophic Conditions
- PBF Larvae: Discrete Spawning Areas With Possible Match to Concentrated Prey in Mesoscale Fronts and Eddies
- Poorly Studied Aspect of Spawning Dynamics: The Role of Predation Pressure on Spawning Patterns

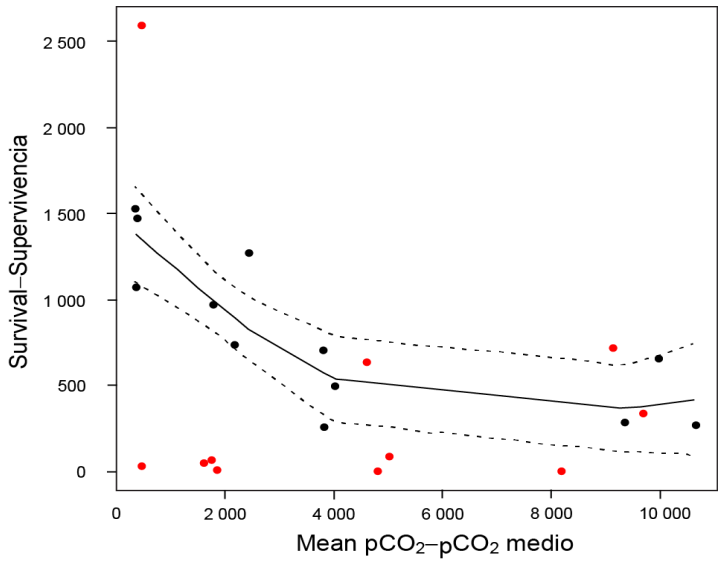
Climate Change Studies

Ocean Acidification Studies (2011 to Present)

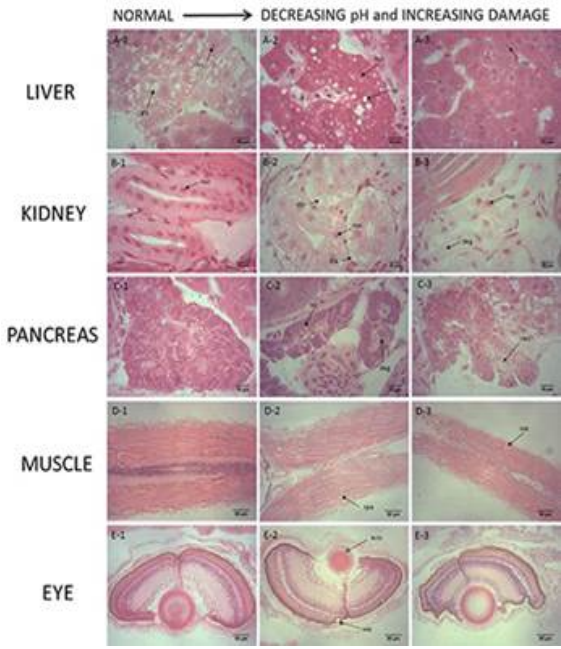


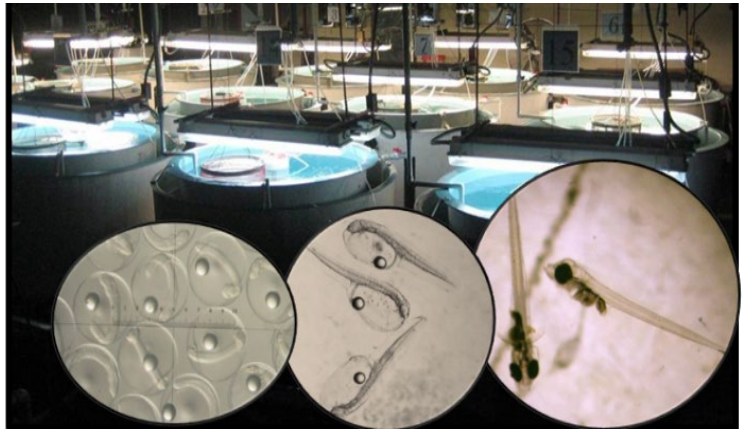
Sea surface changes in pH from 1850 to 2100

YFT Larval Survival vs. Acidification



Organ Damage From Acidification

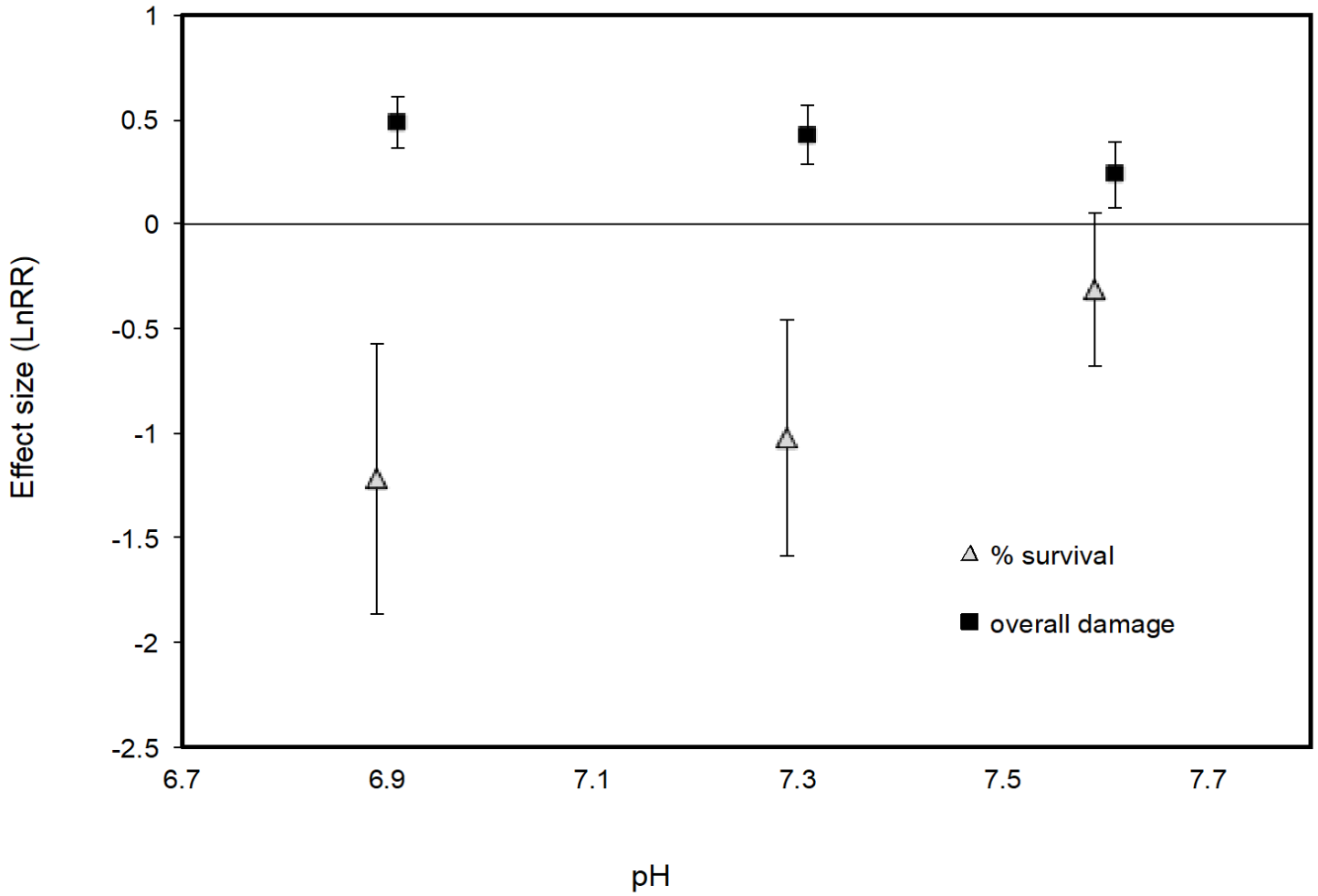




- **2015-2016: Two publications, OA effects on Survival/Growth & Organ Health**
- **2017-2020: Ongoing analysis, otoliths and genetics**

Ocean Acidification Effects on YFT Larvae: Lethal and Sub-Lethal Effects

Effect Size Analysis: Organ Damage & Larval Survival vs pH



- Significant effects are indicated if error bars do not intersect the 0 effect line

Significant Stat Level

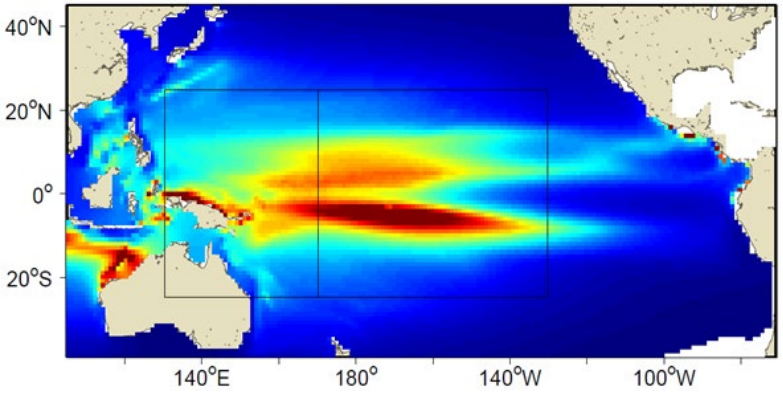
Control pH: 8.1

At pH of 7.6:

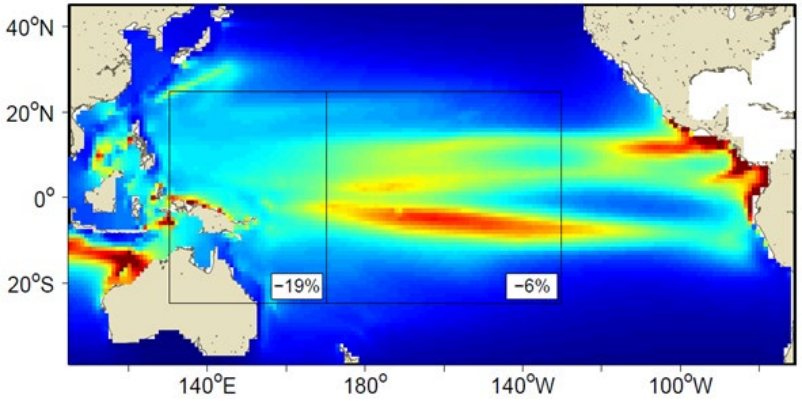
- Mean survival is not significantly reduced from control
- Overall organ damage is significantly increased from control
- Significant organ damage occurs at pH of 7.6 which is not reflected in survival data. This suggests that physiological damage within the larval population is under-represented by survival data.

Ocean Acidification and Yellowfin Distribution

Yellowfin Distribution : 2005
(Lehodey et al. 2016)

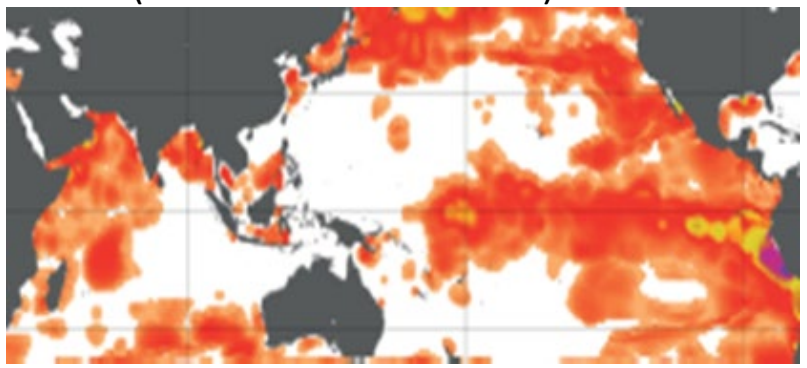


Yellowfin Distribution: 2050
(Lehodey et al. 2016)



Associated Topics of Study:
- **Ocean warming**
- **Oxygen depletion**

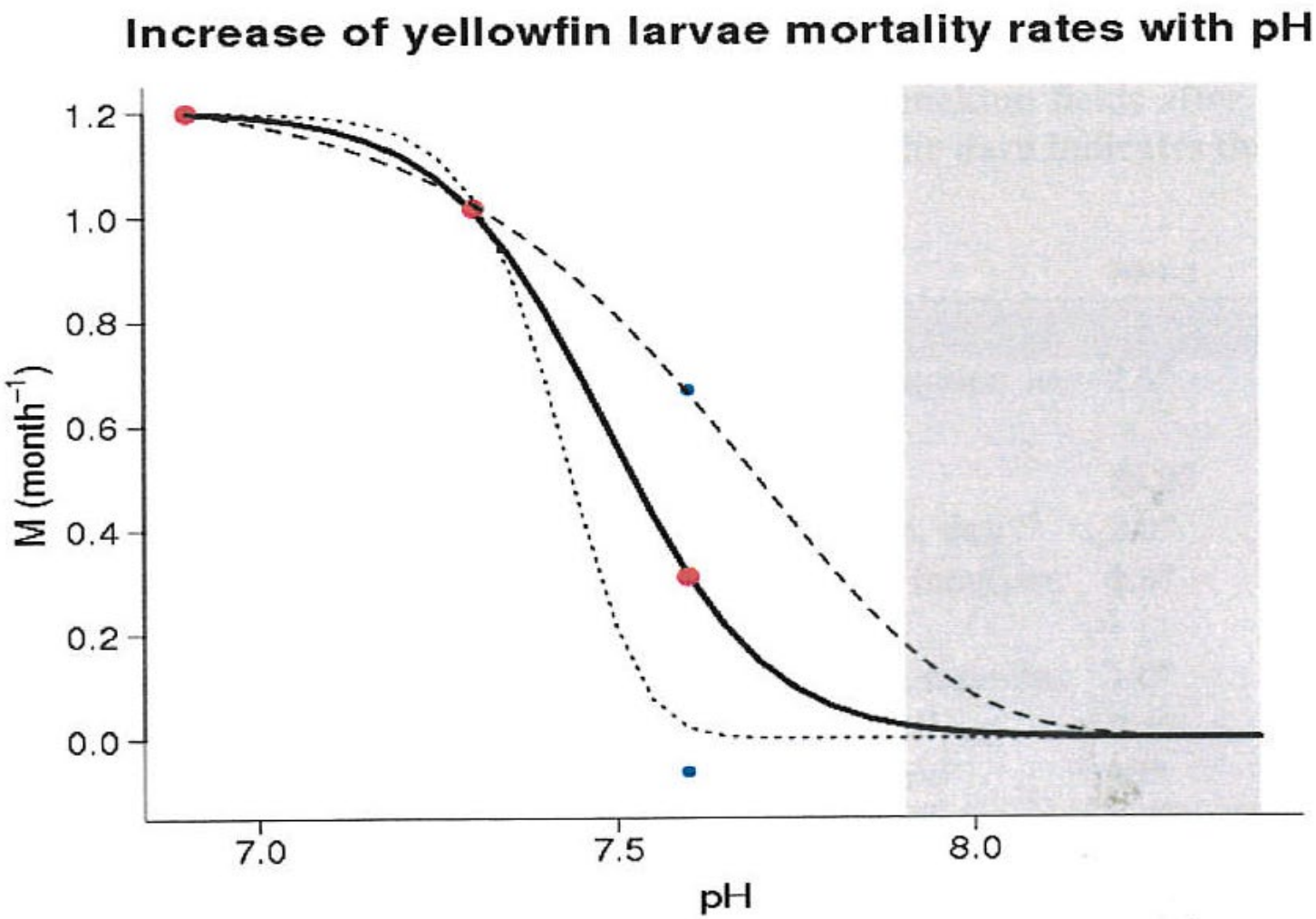
Ocean Acidification Hotspots : 2050 – 2100 (McNeil and Sasse 2016)



- SEAPODYM predicts eastward shift in yellowfin distribution due to ocean warming and productivity shifts
- This eastward shift by yellowfin puts distribution into regions more influenced by ocean acidification

- SEAPODYM Predictions of Yellowfin Distributions in Pacific from 2005-2050 (Top)
- Prediction of Ocean Acidification Hotspots in the Pacific from 2050-2100 (Bottom)

Effects of Ocean Acidification on YFT Larval Mortality

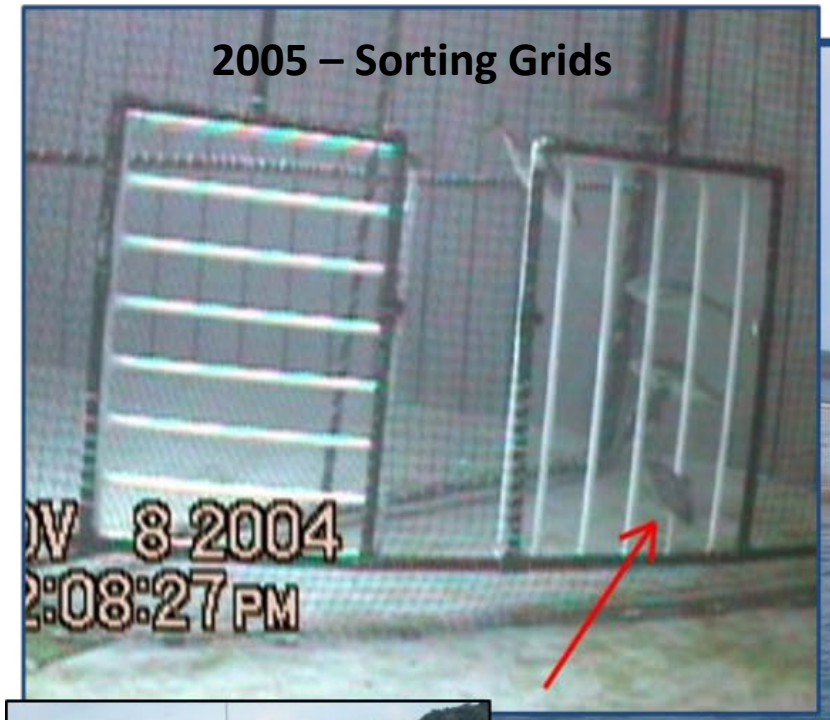


From: Lehodey et al. 2017. WCPFC-SC13-2017/EB-WP-01 and Senina et al., 2018. Final Report CI-3, Common Oceans ABNJ Program

Key Questions From the Research:

- Can YFT adults adapt to increased acidification? Unknown
- Are resistant traits heritable? Unknown
- Is there a threshold pH level that could influence YFT recruitment?
  pH 7.6 -7.5?
- How does ocean warming interact with ocean acidification? TBD

Research on Reducing Bycatch – Achotines Laboratory



- 2016 – Acoustic Trials on YFT by ISSF
- 2020-21 – New Phase of Acoustic Trials by Drs. G. Moreno and G. Boyra

Future Directions: A Long-Term Plan for Research at the Achotines Laboratory

- A long-term plan to strengthen and diversify research is under development
- Components of the plan include:
  - Identification of areas of research to be expanded and diversified
  - Improvements in infrastructure and identification of new sources of funding
  - Staff internal review and external review of the plan and research programs of the Laboratory
  - A focus on strengthening links among pre-recruit research, stock assessment and management
  - Development of a program of great return value to the IATTC and the goals of Antigua Convention