The effects of early life history on recruitment and early juvenile survival of a coral reef fish in the Florida Keys

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ATMOSPHERIC SCIENCE

NOAA
CORAL REEF
CONSERVATION PROGRAM

Photo by E D'Alessandro

Complex Life Cycle

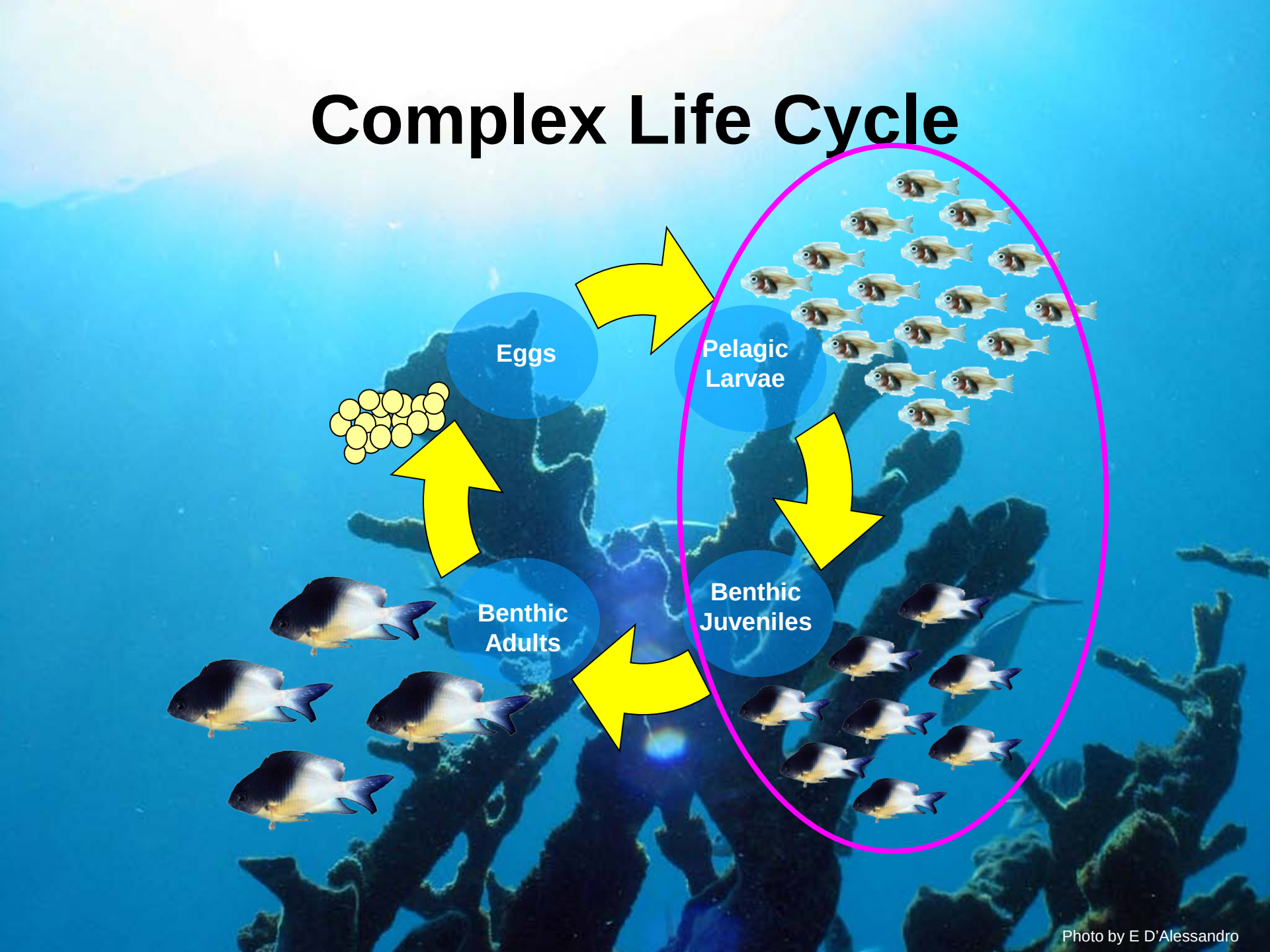


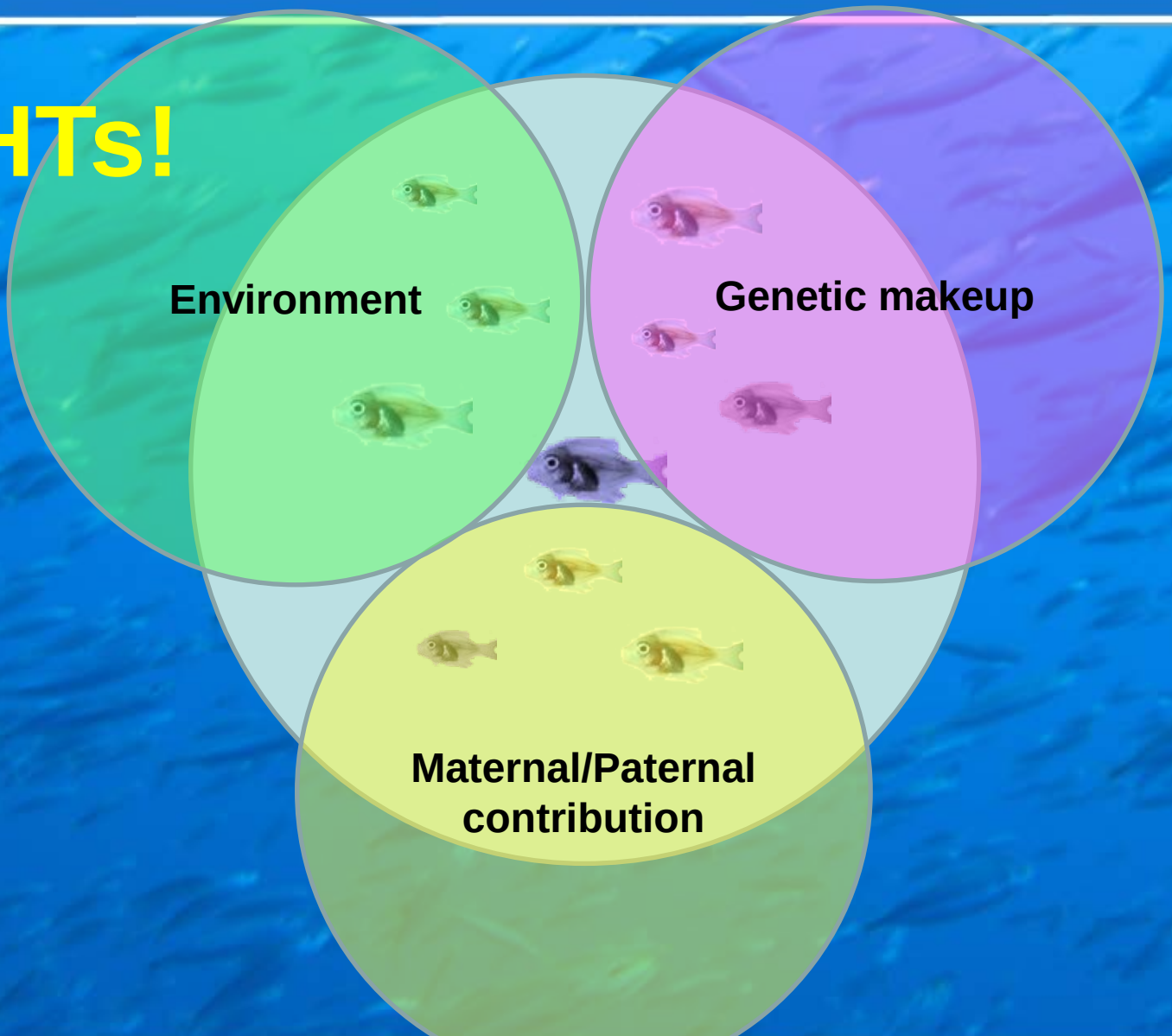
Photo by E D'Alessandro

Why the early life stages?

- High fecundity + high mortality + variation → large variation in recruitment (entry in to the juvenile population)
- Mortality not thought to be random – maybe survivors are exceptional
- Processes occurring during the early life stages can influence population dynamics

Variation in early life history traits

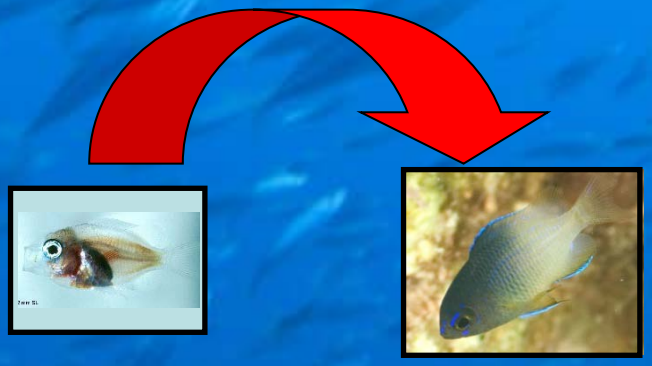
ELHTs!



Growth-mortality Hypothesis

- “Bigger is better” mechanism (Miller et al. 1988)
- “Growth-rate” mechanism (Ware 1975)
- “Stage-duration” mechanism (Houde 1987)

Carry-over effects



Dissertation Chapters

- Chapter 1: General Introduction
- Chapter 2: Temperature influences selective mortality during the early life stages of a coral reef fish
- Chapter 3: Influence of behavior on early juvenile growth and survival in a coral reef fish
- Chapter 4: Temporal and spatial patterns of early life history traits and their influence on settlement and post-settlement processes
- Chapter 5: Examining temporal patterns in genetic structure within and among cohorts of settlement-stage larvae and new recruits of a coral reef fish
- Chapter 6: Summary and conclusions

Chapter 2 Objectives

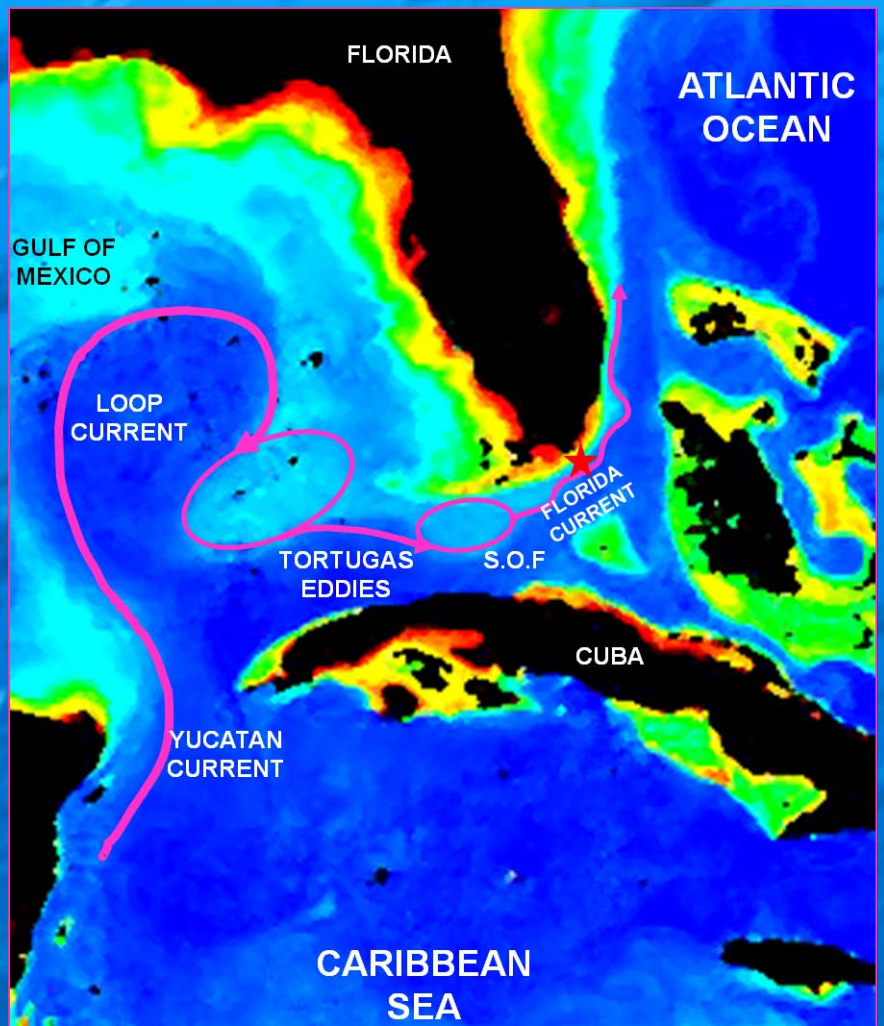
1. Identify sources of variation in growth-related ELHTs
2. Determine which ELHTs are important to early juvenile survival
3. Determine whether temperature influences selective mortality

Study Species & Site

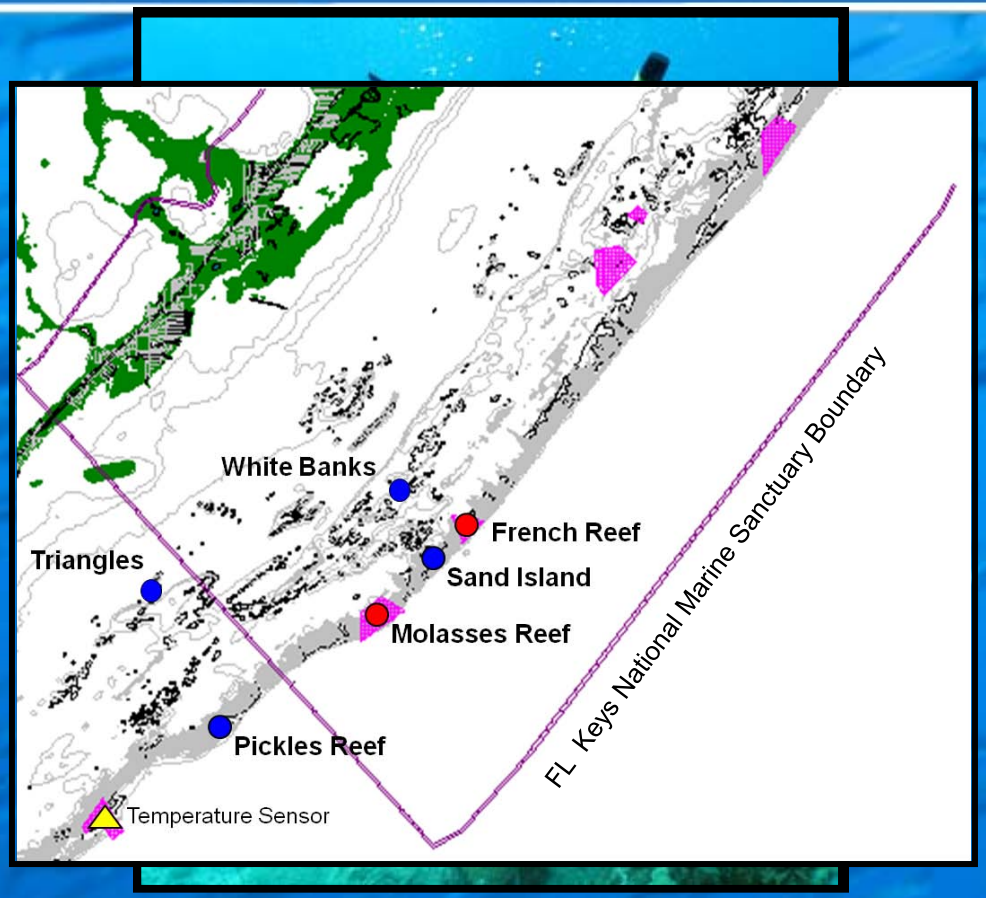
Bicolor damselfish
Stegastes partitus

- Zooplanktivorous
- Territorial juveniles and adults
- Benthic spawner
- ~ 30 d pelagic larval duration (PLD)
- Quick metamorphosis

Upper Florida Keys



Field Methods



Juvenile Age / Growth

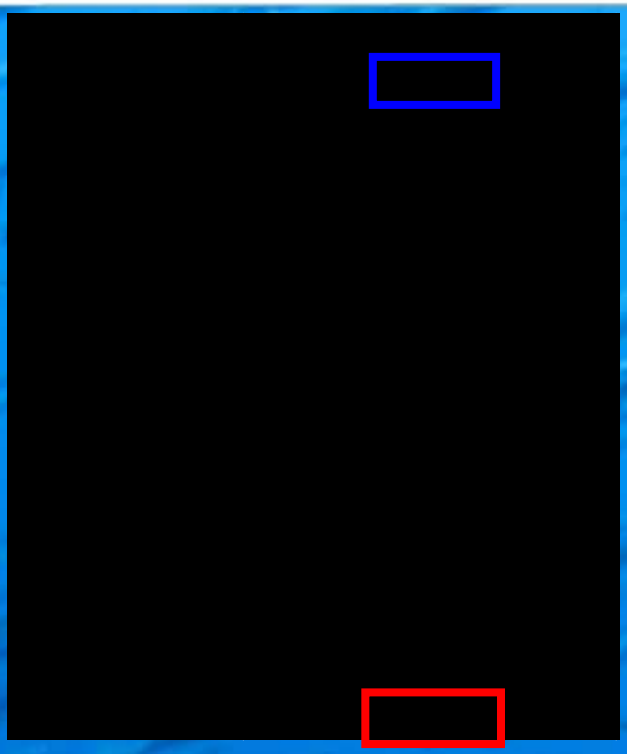
Size at
Settlement

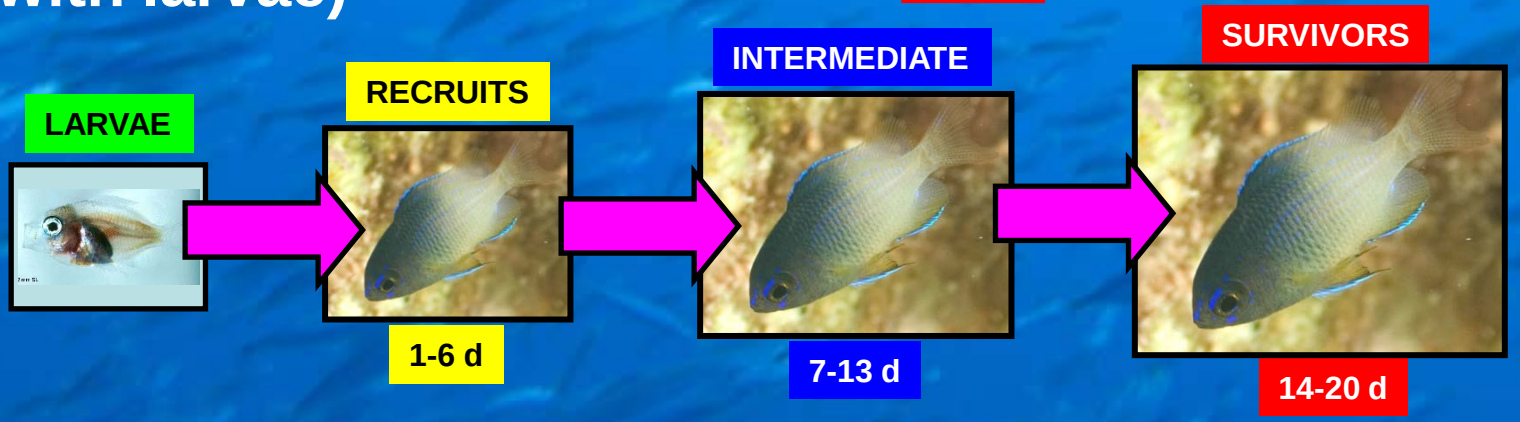
L1

PLD / Larval Growth

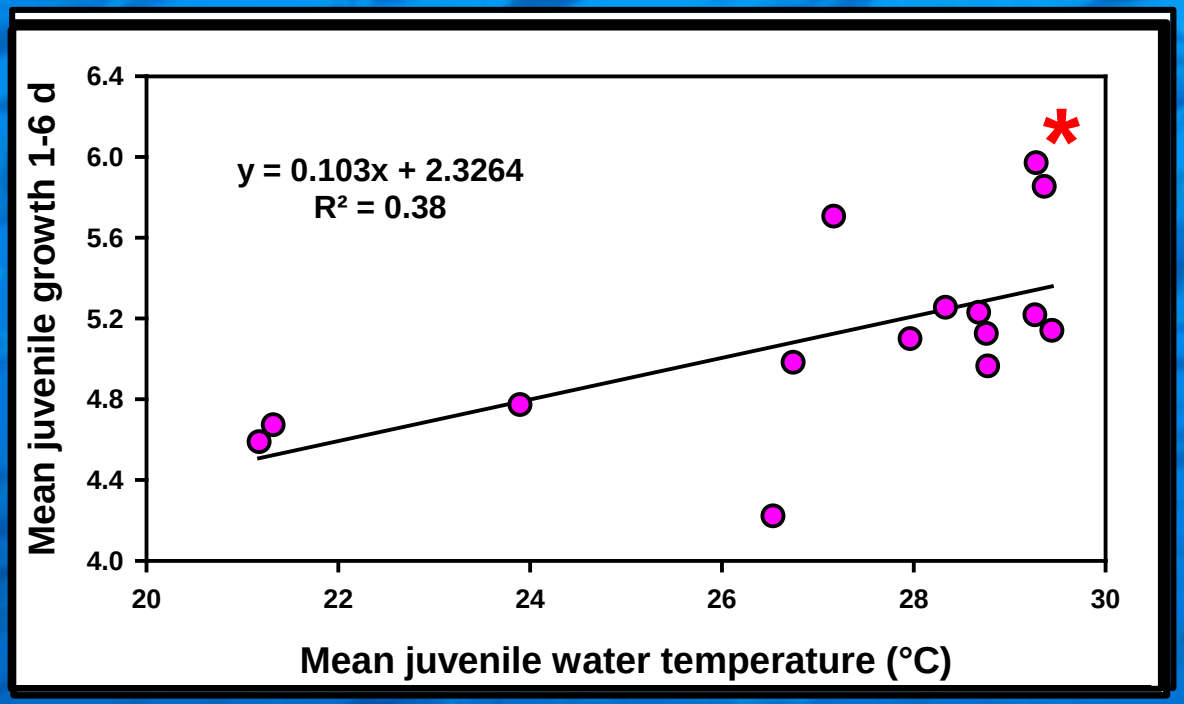
Data Analysis

- 16 cohorts
- 2000-2005
- Spanned 9 C
- 13 tracked through time
  (6 with larvae)



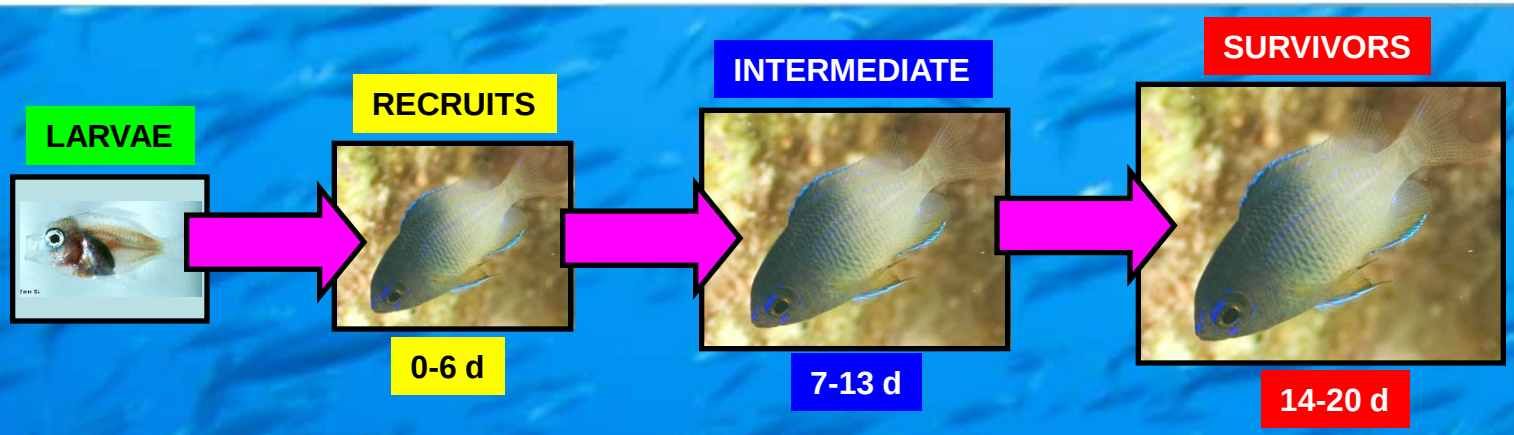


Temperature Effects on ELHTs

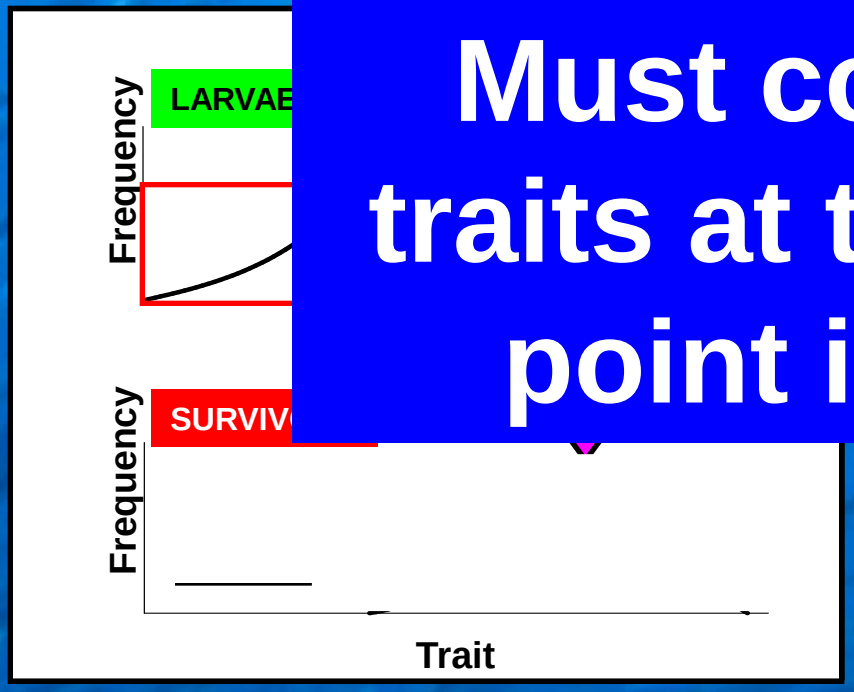


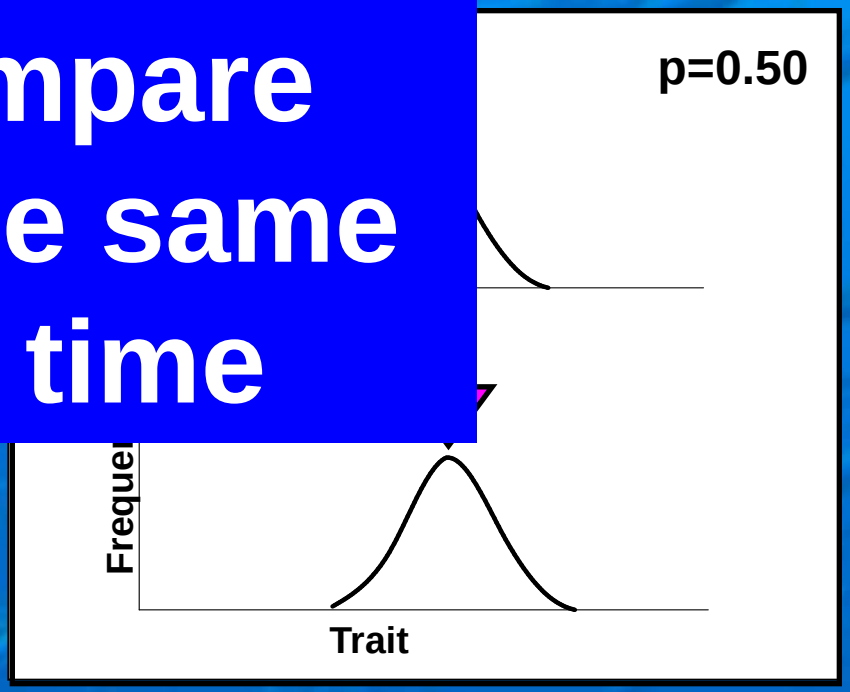
*p < 0.05, **p < 0.01, ***p < 0.001

Selective Mortality

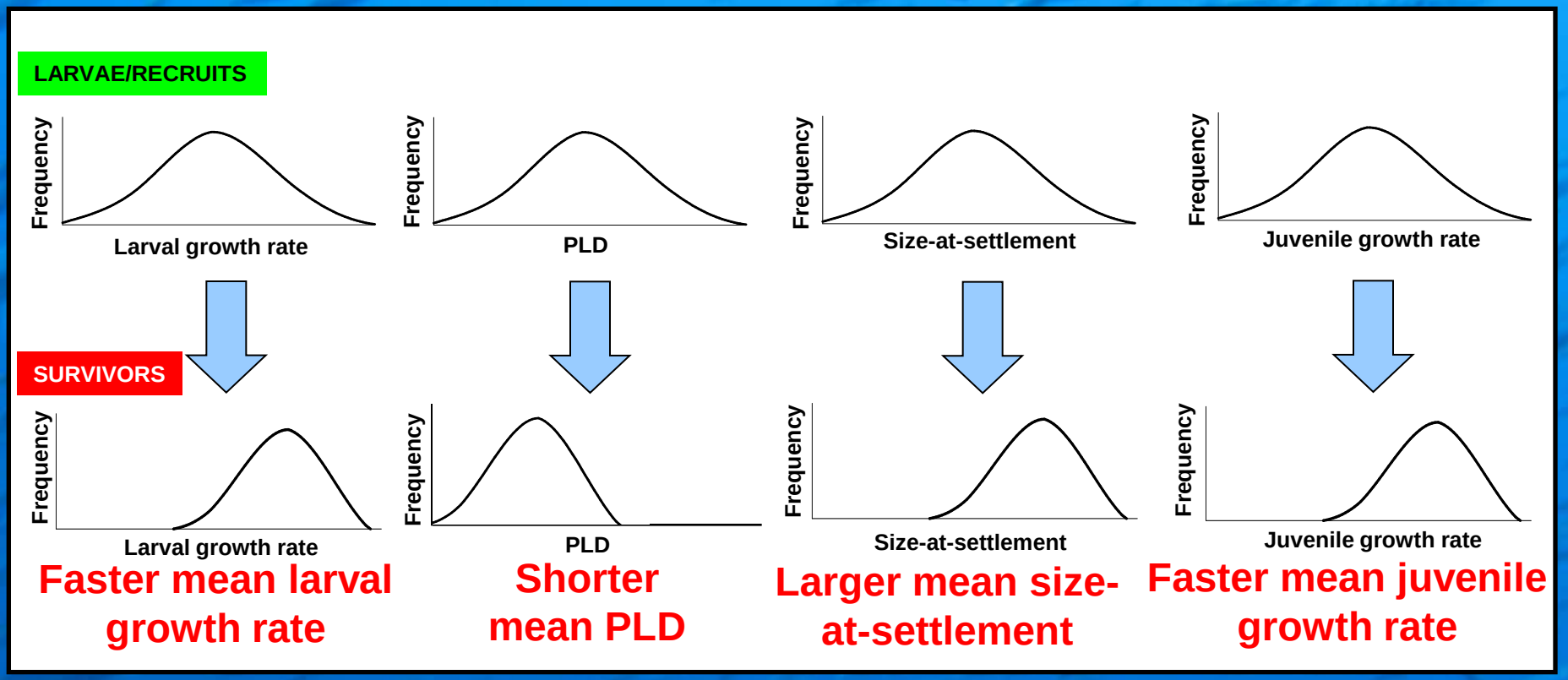


Must compare traits at the same point in time



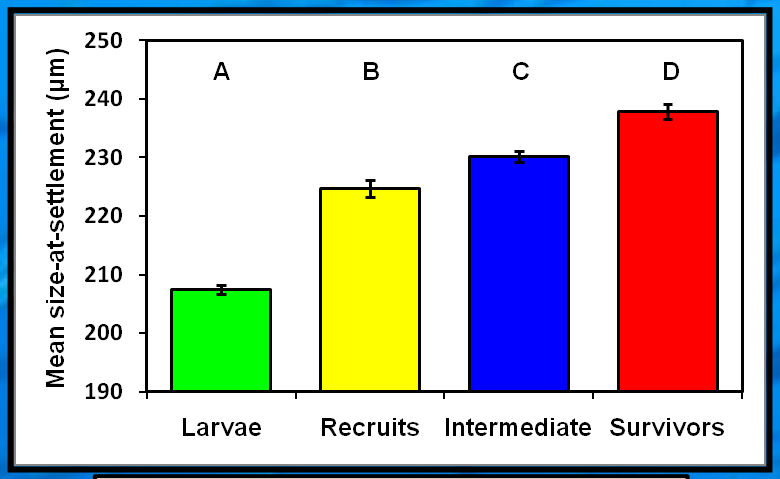


Which ELHTs are important to juvenile survival?

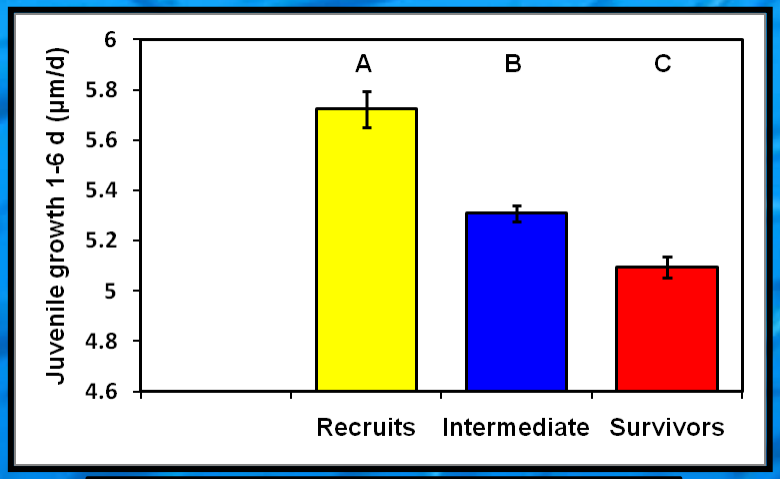


Selective Mortality

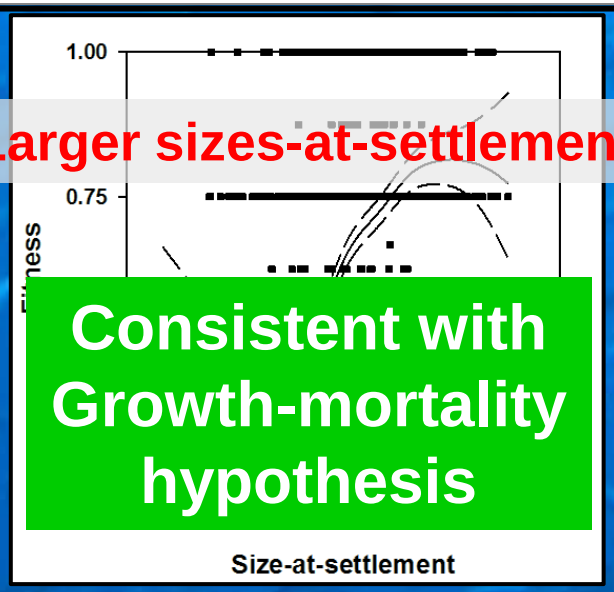
Size-at-settlement



Early juvenile growth

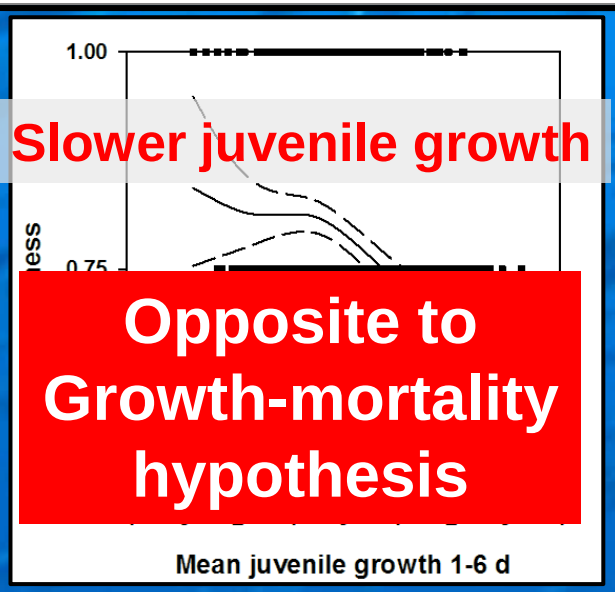


Larger sizes-at-settlement



Consistent with Growth-mortality hypothesis

Slower juvenile growth

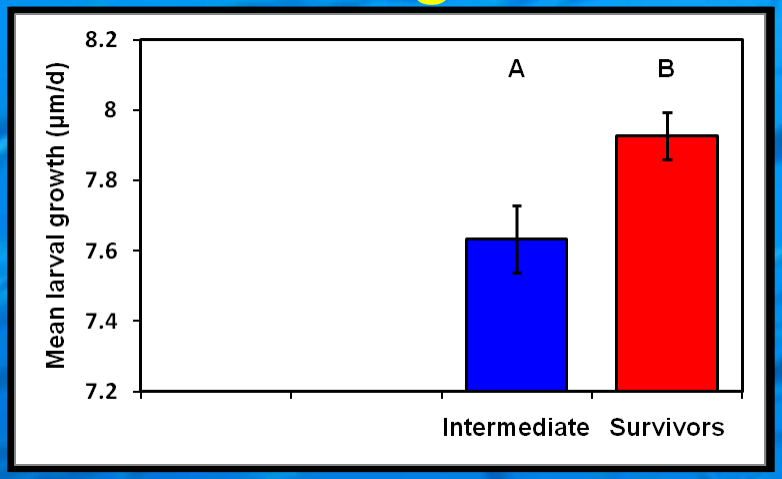


Opposite to Growth-mortality hypothesis

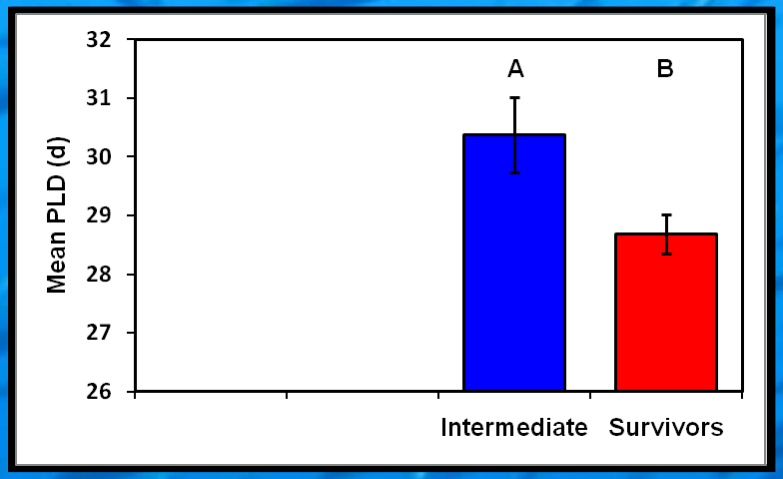
$p \leq 0.001$

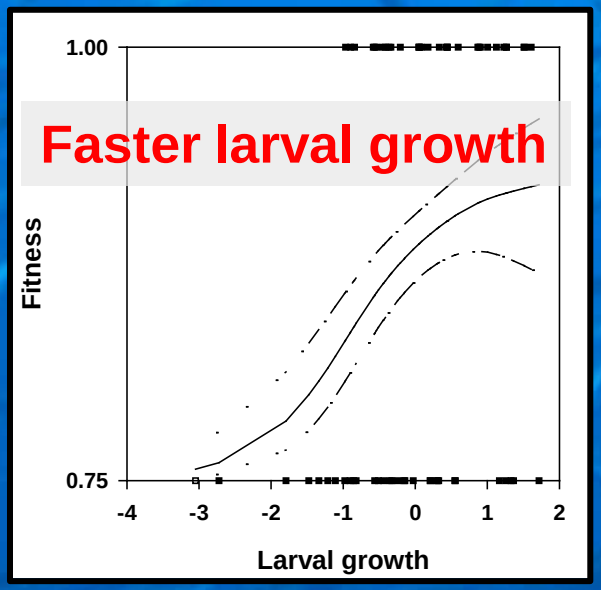
Selective Mortality: Winter

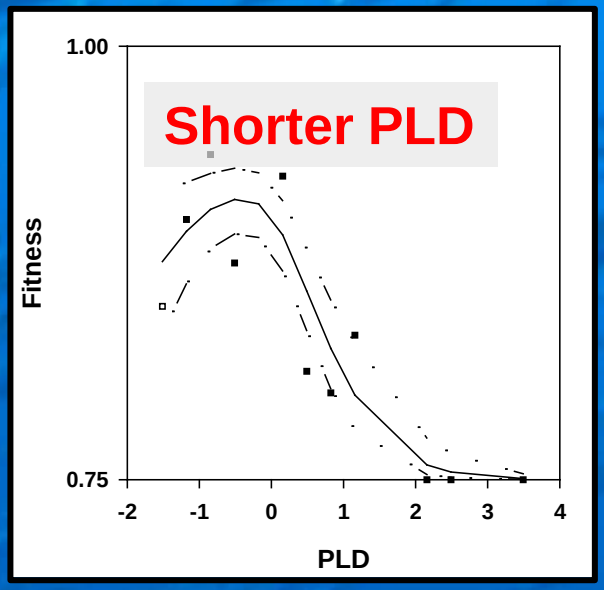
Larval growth



PLD



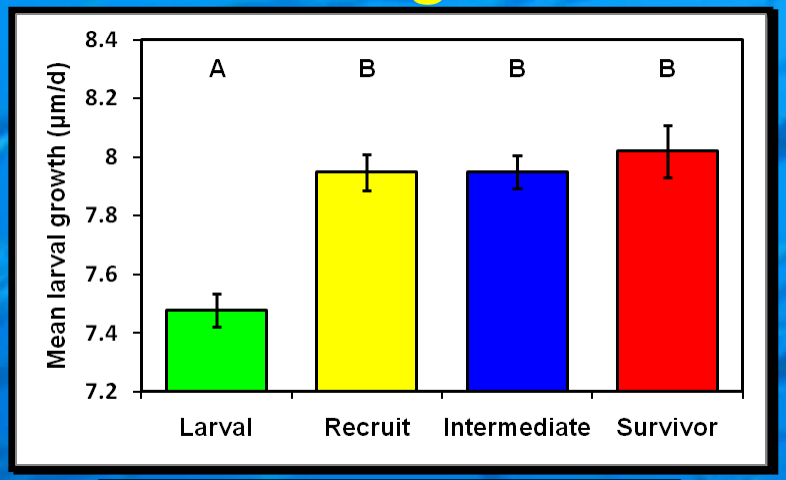




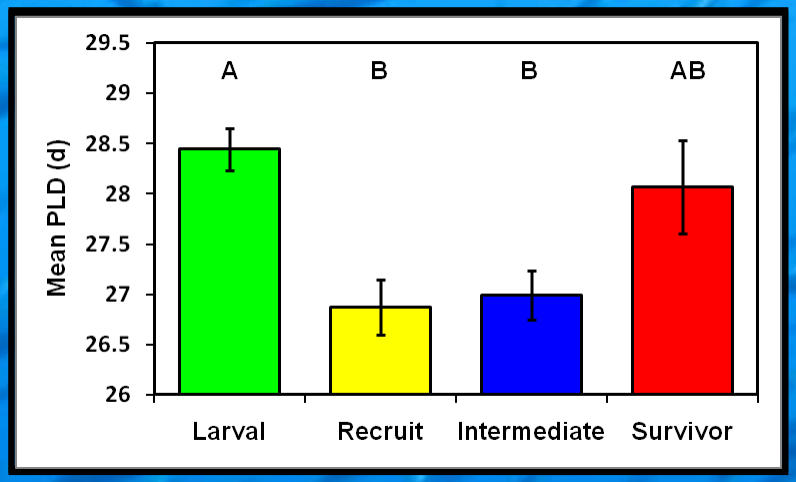
$p \leq 0.05$

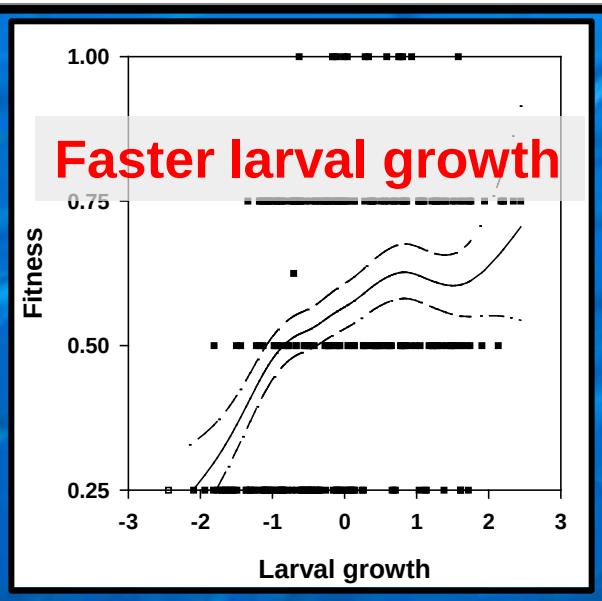
Selective Mortality: Spring

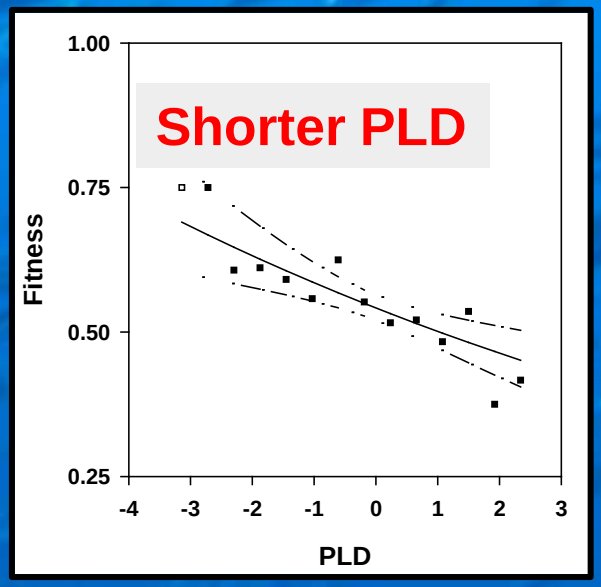
Larval growth



PLD



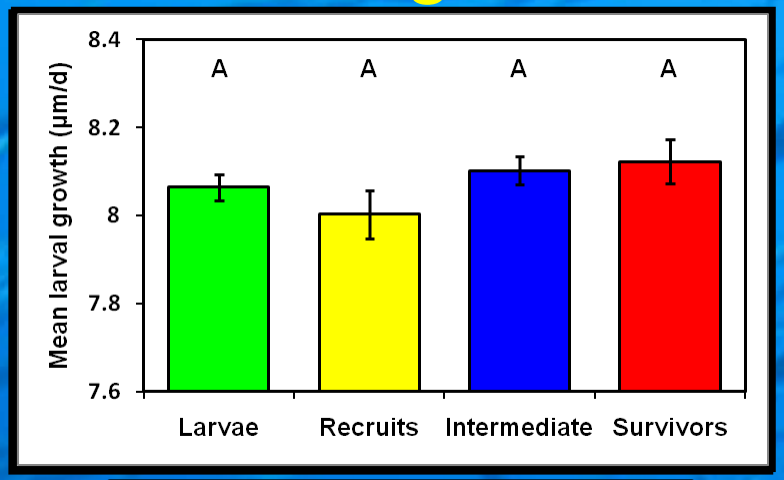


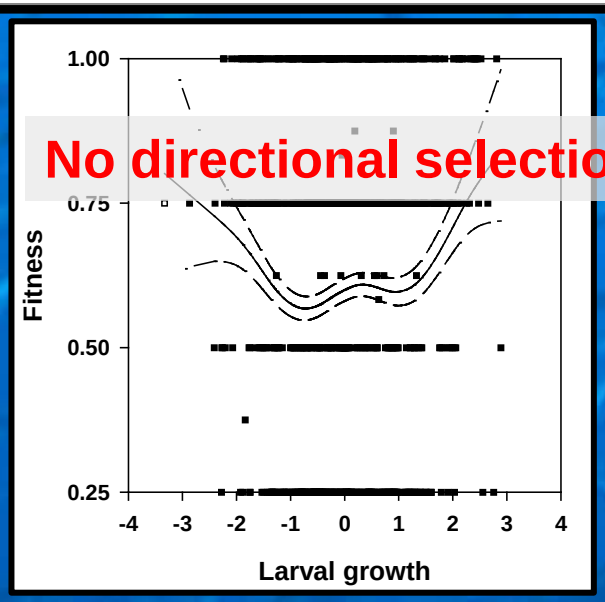


$p \leq 0.001$

Selective Mortality: Summer

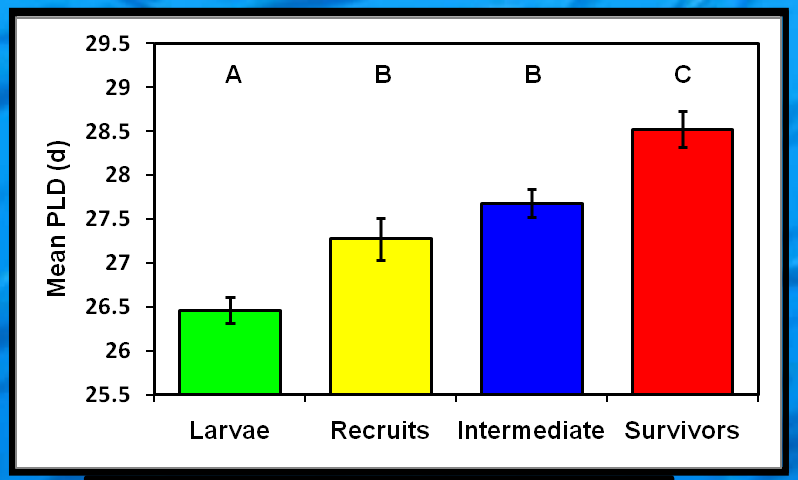
Larval growth

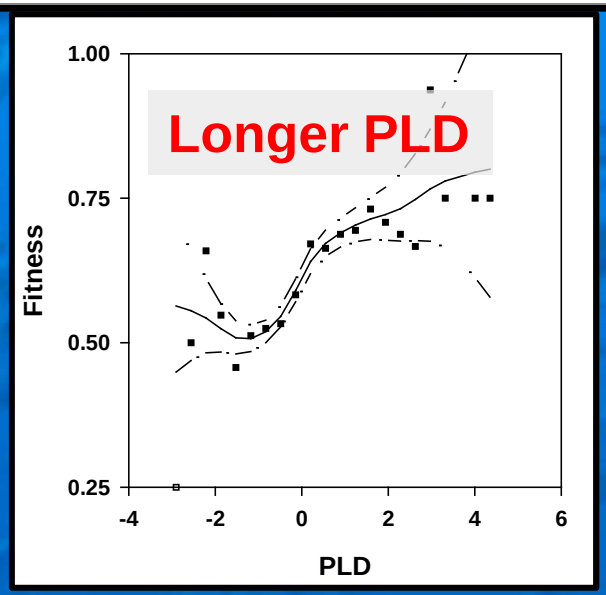




p = 0.276

PLD





p ≤ 0.001

Temperature mediates selective mortality

Cooler Water Temps

- Slow larval growth
- Long PLDs

Warmer Water Temps

- Fast larval growth
- Short PLDs

Selective mortality processes act to remove individuals with slow larval growth and extreme PLDs (too short or too long)

Chapter 2: Conclusions

- **Temperature influences ELHTs**
- **Temperature influences selective mortality acting on larval growth & PLD:**
  - **Winter & Spring: survivors have faster larval growth & shorter PLDs**
  - **Summer: no directional selection against larval growth; shorter PLDs selected against**
- **Selective mortality processes consistently act on some traits such that survivors have:**
  - **Larger sizes-at-settlement**
  - **Slower early juvenile growth**

Chapter 3 Objectives

1. Determine whether size-at-settlement and early juvenile growth are linked via behavior.

2. Determine if these relationships underlie patterns of survivorship.

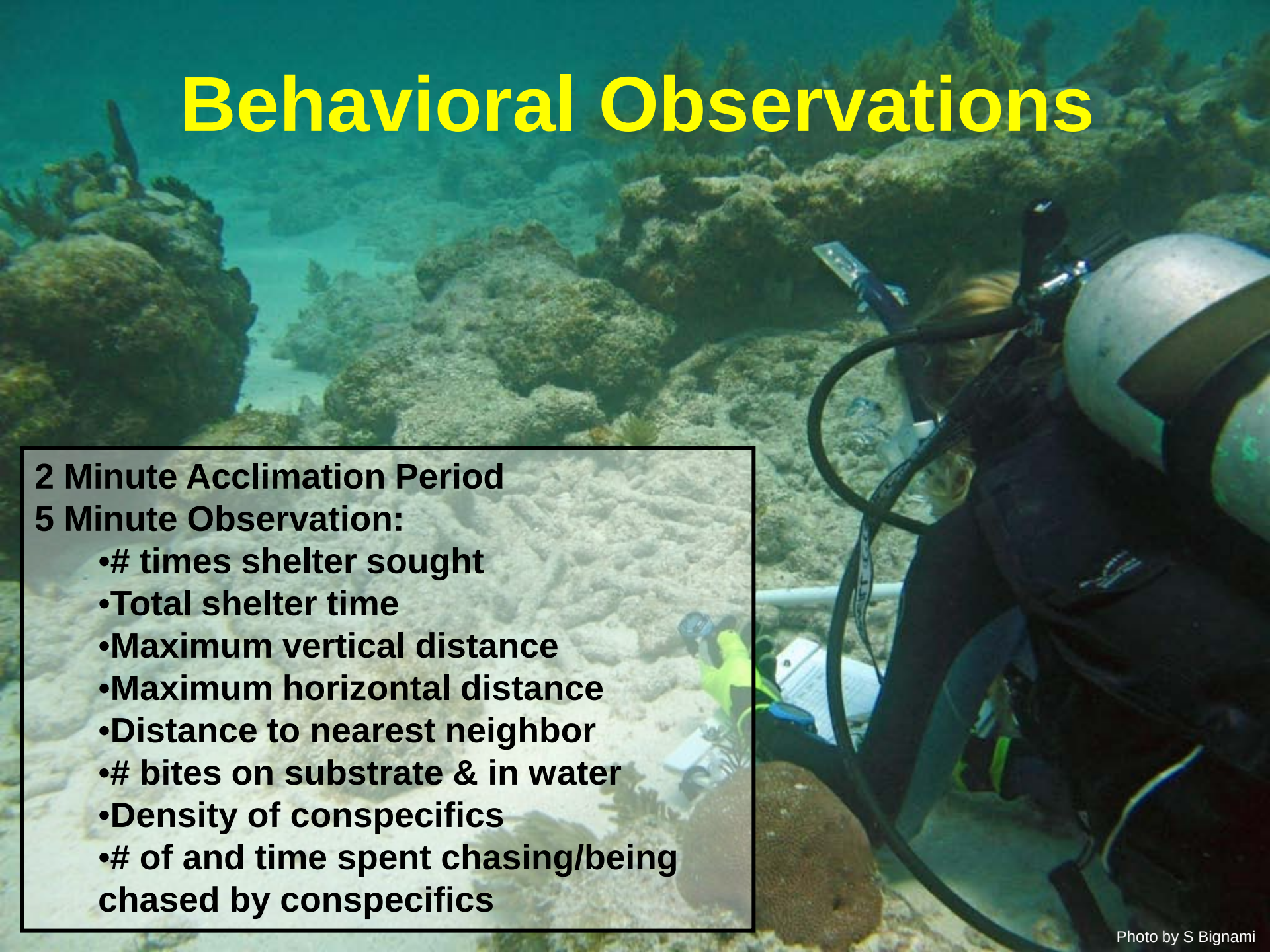
H_{A1}: Sheltering Hypothesis

JUVENILE GROWTH < JUVENILE GROWTH

H_{A2}: Activity Hypothesis

JUVENILE GROWTH < JUVENILE GROWTH

Behavioral Observations



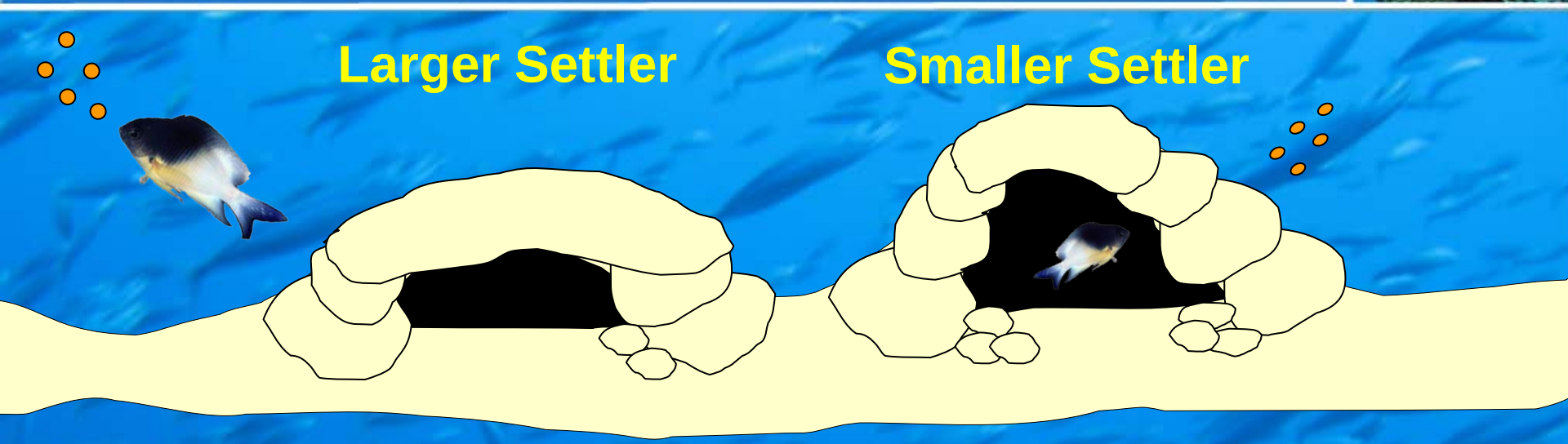
2 Minute Acclimation Period

5 Minute Observation:

- **# times shelter sought**
- **Total shelter time**
- **Maximum vertical distance**
- **Maximum horizontal distance**
- **Distance to nearest neighbor**
- **# bites on substrate & in water**
- **Density of conspecifics**
- **# of and time spent chasing/being chased by conspecifics**

Photo by S Bignami

Chapter 3 Conclusions



- Spend less time shelte
- Trave
- Have with c
- Had f
- Expe
- Grow more slowly

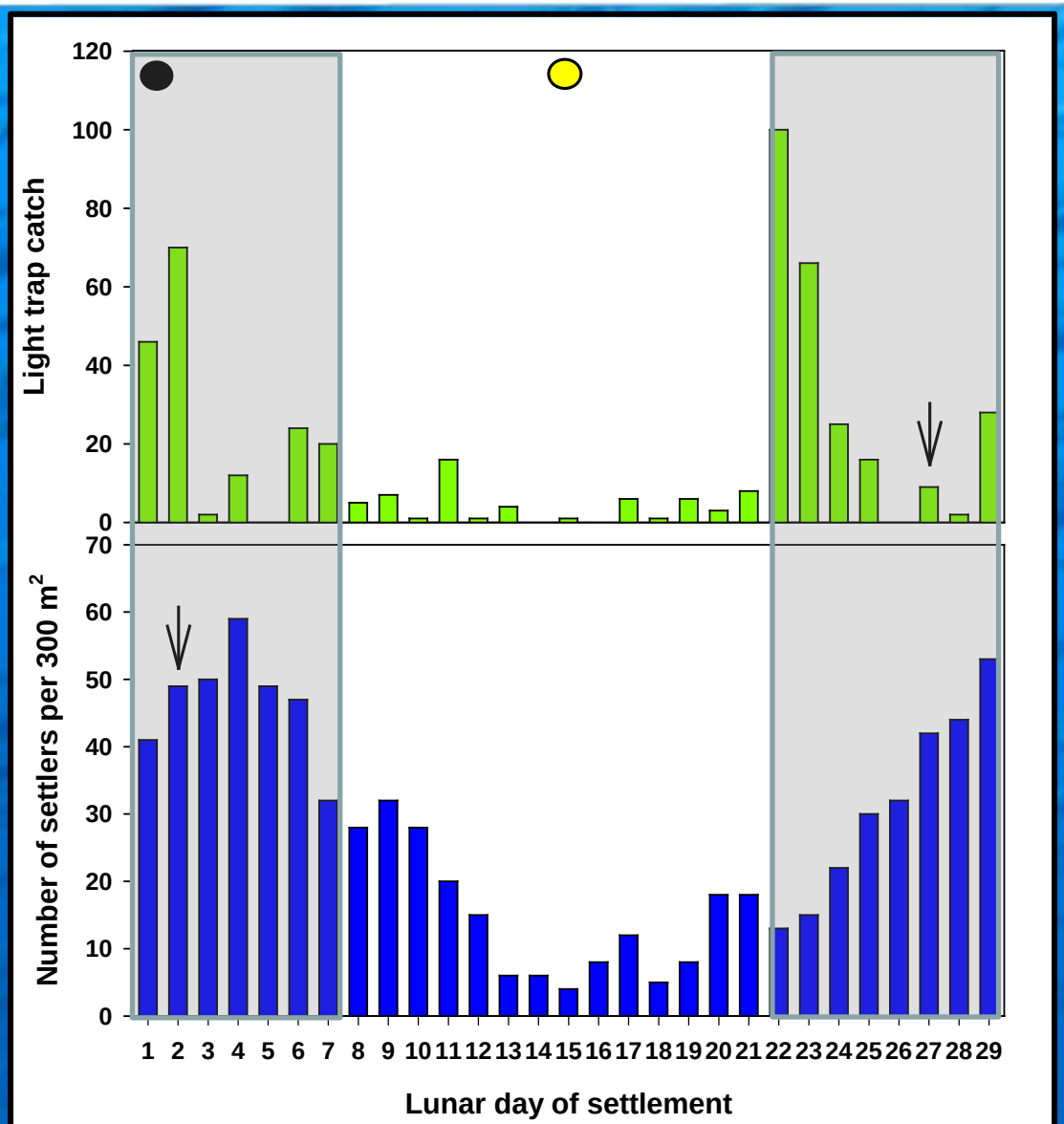
- Spend more time
- lter
- tions
- e speeds
- y
- Grow faster

Relationship between size-at-settlement, juvenile growth and survival is behaviorally mediated

Chapter 4 Objectives

1. Examine temporal and spatial patterns in recruitment over multiple scales
2. Determine if ELHTs vary with timing or location of settlement/recruitment
3. If so, determine if variation in settlement conditions & ELHTs influences selective mortality processes

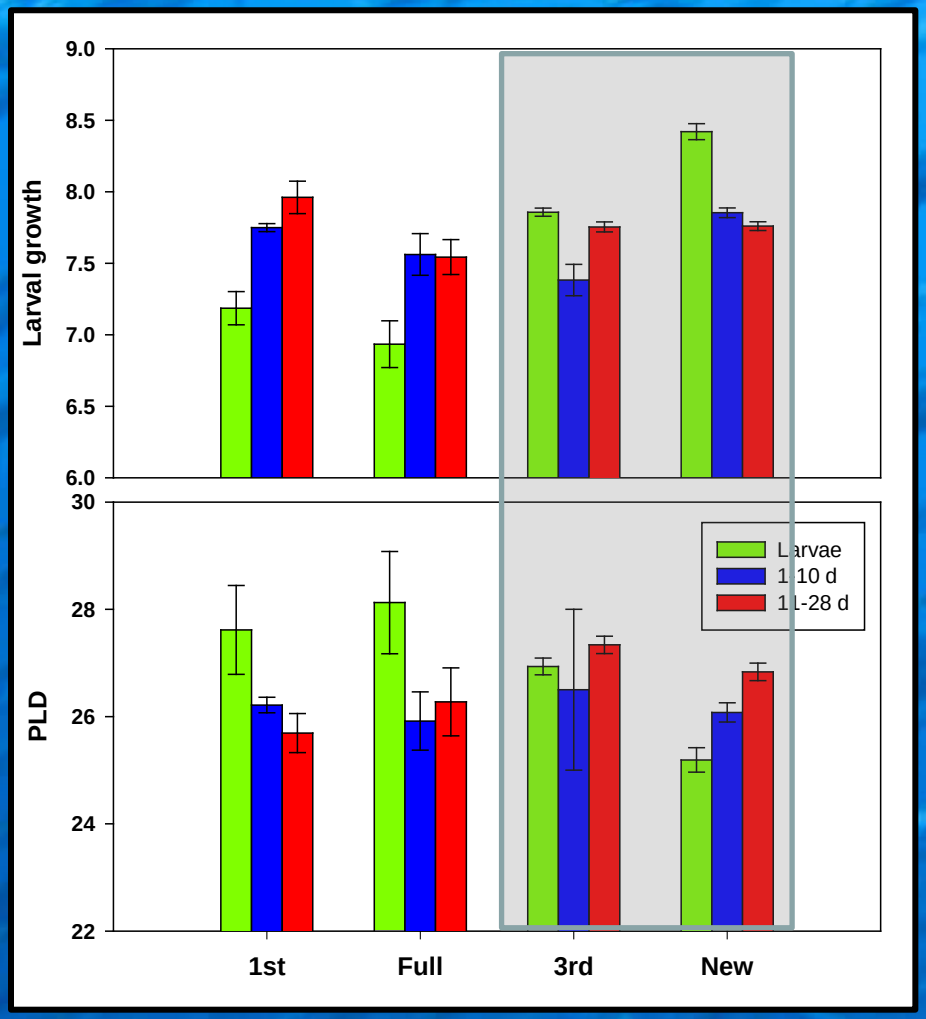
Lunar Day of Settlement

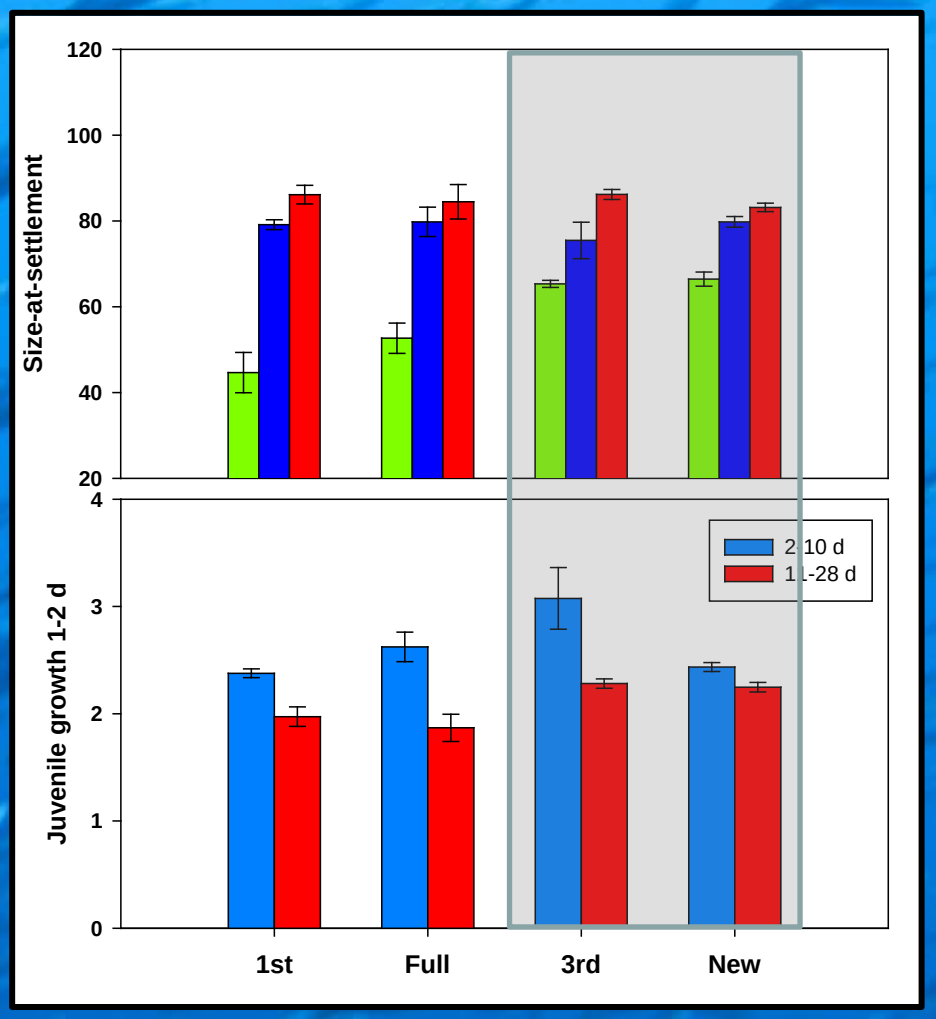


Larvae

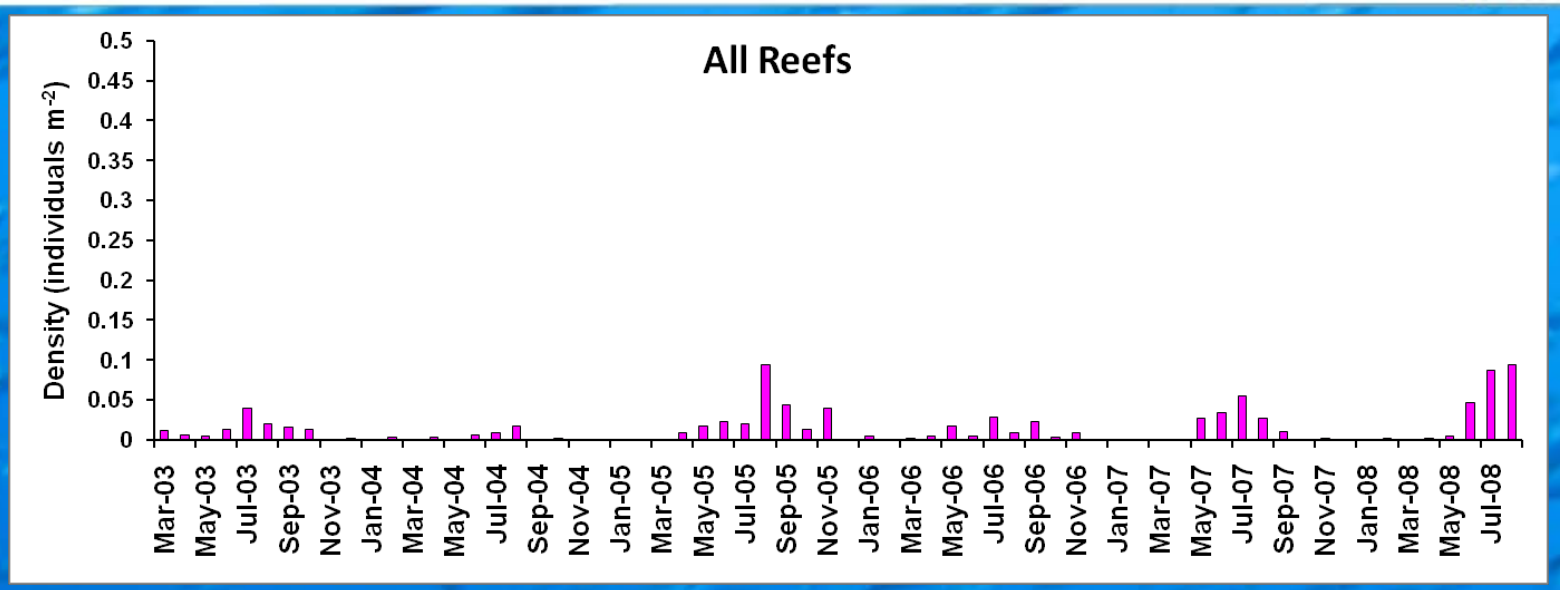
Recruits

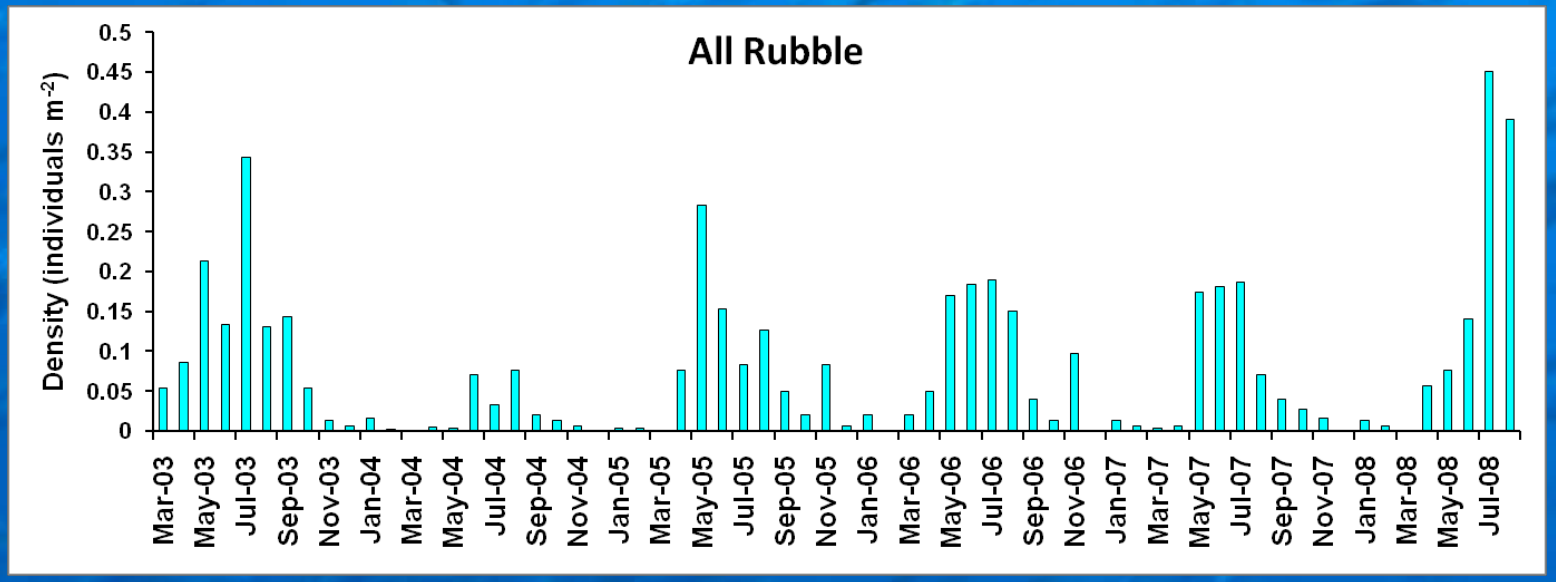
ELHTs by Lunar Phase



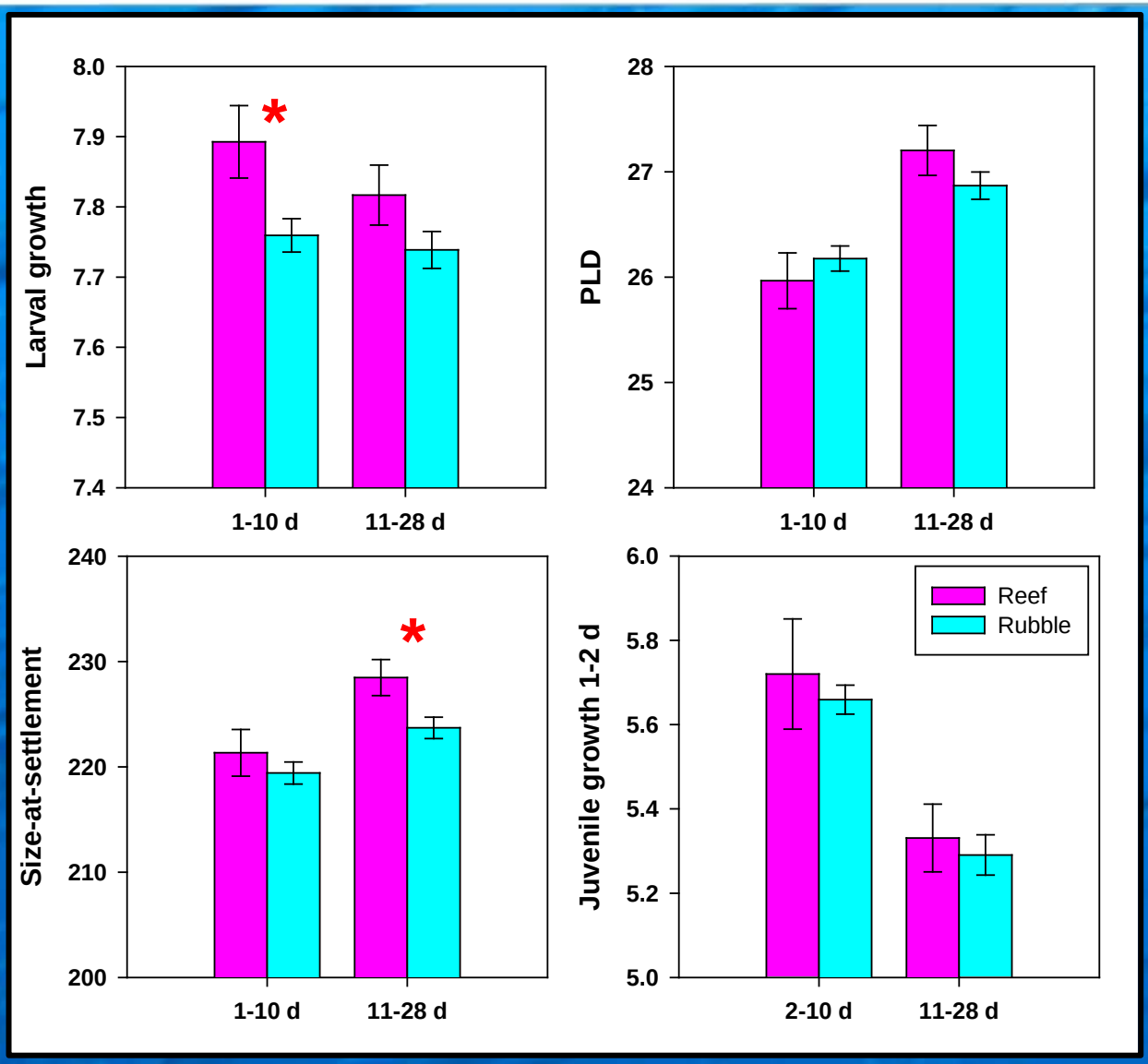


Recruitment to Reef vs Rubble Habitat

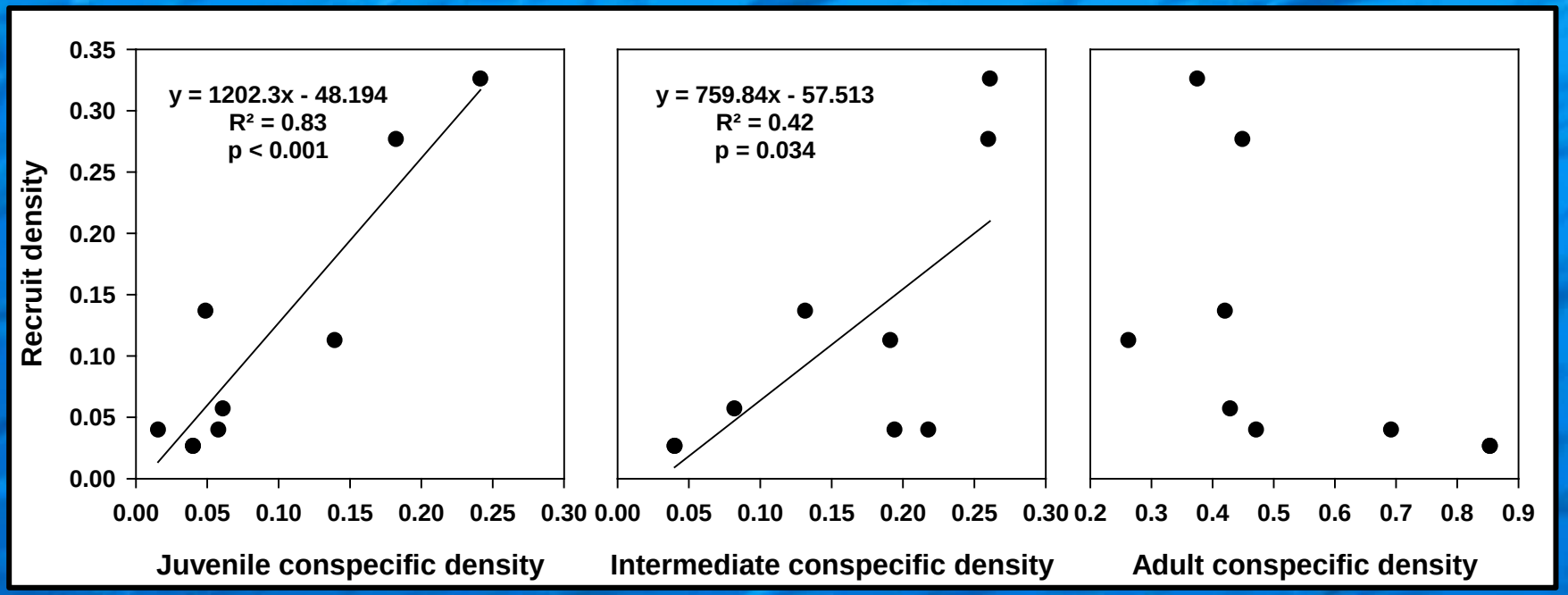




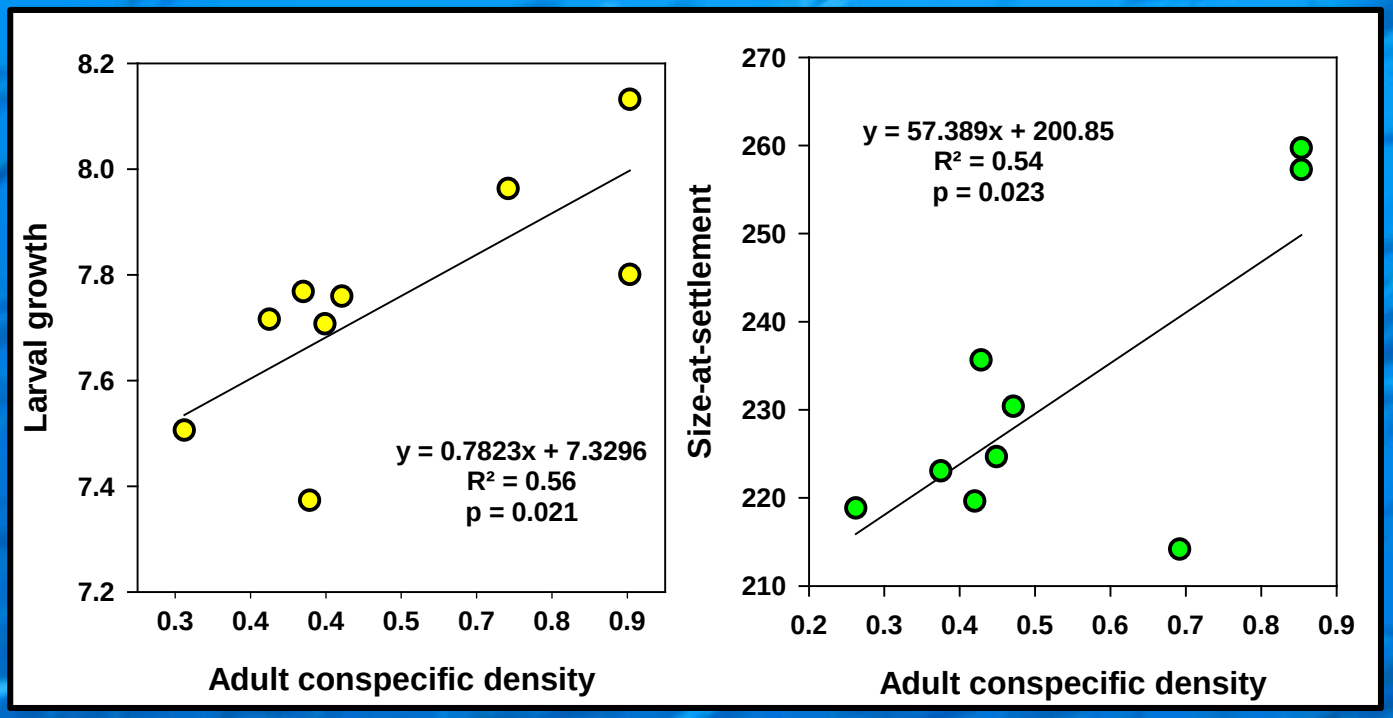
ELHTs by Habitat



Recruitment vs. Conspecific Density



ELHTs vs. Adult Conspecific Density



$p < 0.05$

Overall Conclusions

- Environmental factors varying temporally and spatially influence quality of *S. partitus* juveniles and the selective mortality processes they experience
- For some ELHTs (size-at-settlement & juvenile growth), selective mortality processes consistently remove least favorable traits and the relationship between the two is behaviorally-mediated
- For other ELHTs (larval growth & PLD), patterns in selective mortality vary depending on initial composition of traits and settlement conditions
- Post-settlement mortality maintains some patterns of larval supply, but others are obscured
- These processes shape juvenile demography and have the potential to influence adult dynamics

Acknowledgements

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