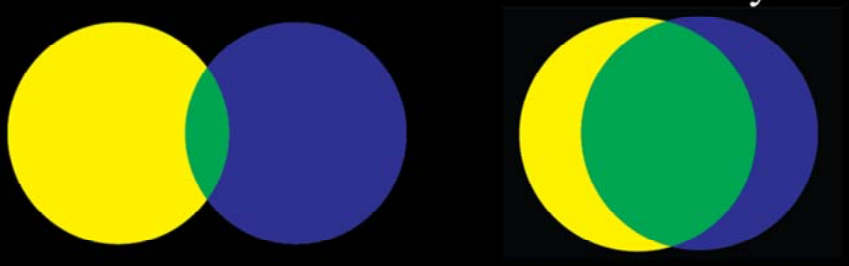
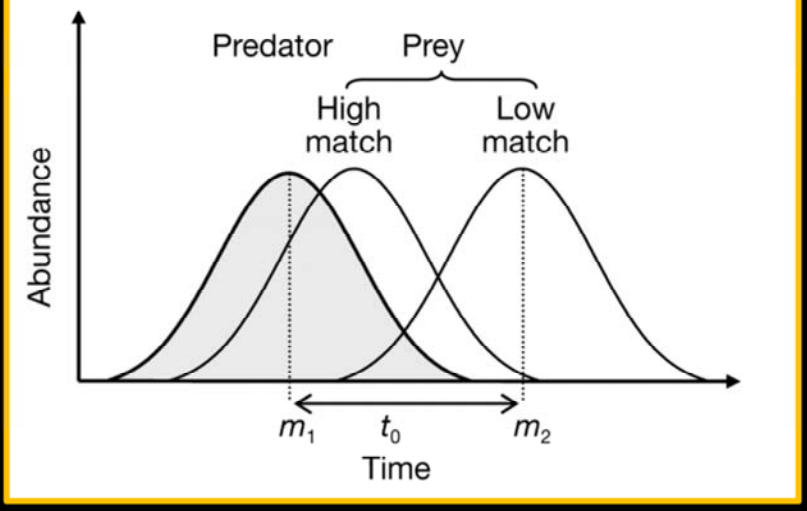
Spatial match-mismatch between juvenile walleye pollock (*Gadus chalcogrammus*) and zooplankton prey in the eastern Bering Sea may contribute to recruitment variability



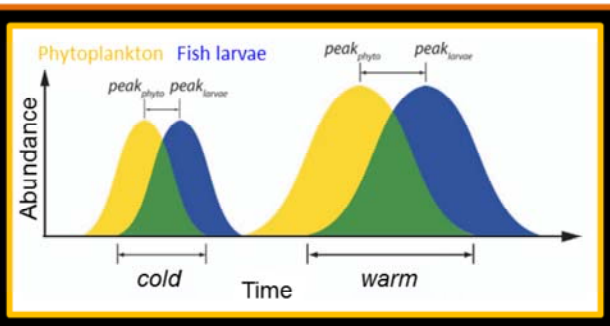
Elizabeth Calvert Siddon, Trond Kristiansen, Franz J Mueter, Kirstin K Holsman, Ron A Heintz, Edward V Farley

INTRODUCTION



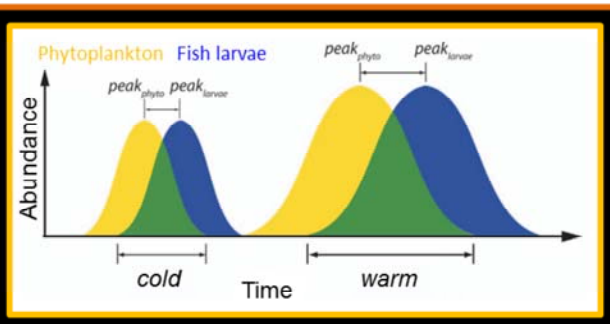
Durant et al., 2007

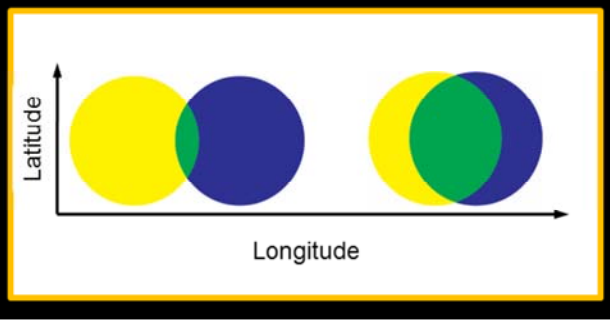
INTRODUCTION



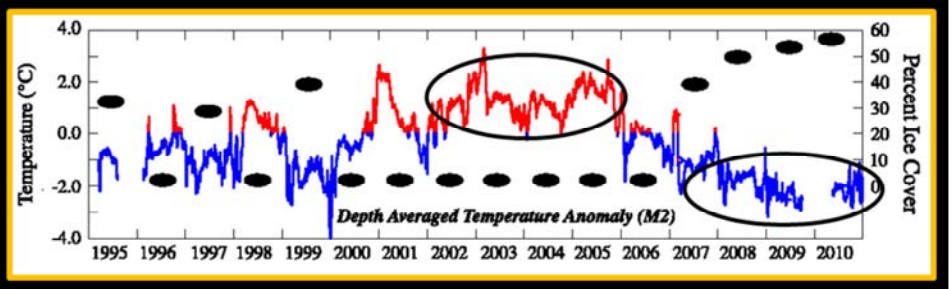
Kristiansen et al., 2011

INTRODUCTION





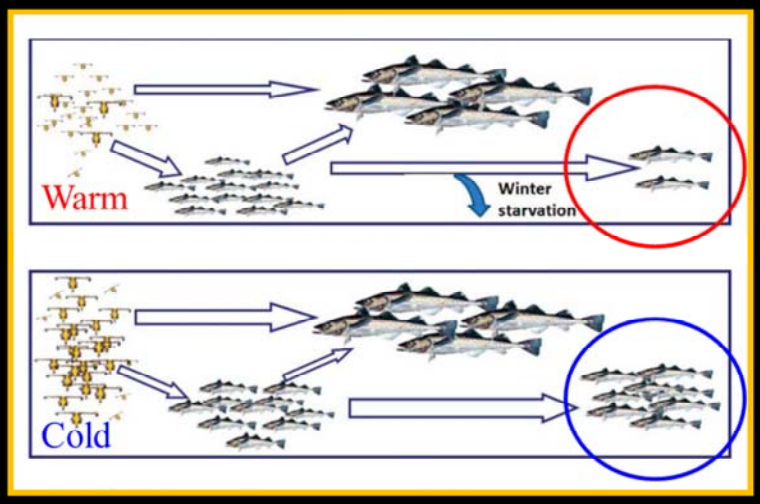
INTRODUCTION



Stabeno et al., 2012

INTRODUCTION

Oscillating Control Hypothesis



Zooplankton Age-0 Adults Age-1

Hunt et al., 2011

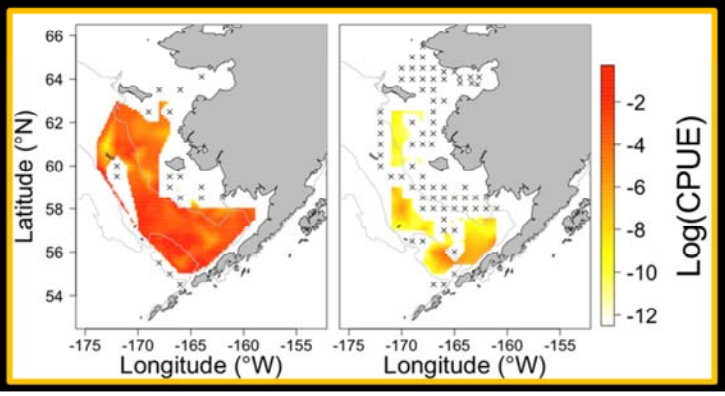
BACKGROUND: Warm-Cold differences

2005: Warm

- Age-0 pollock = 0.08 fish m^{-2}

2010: Cold

- Age-0 pollock = 0.001 fish m^{-2}



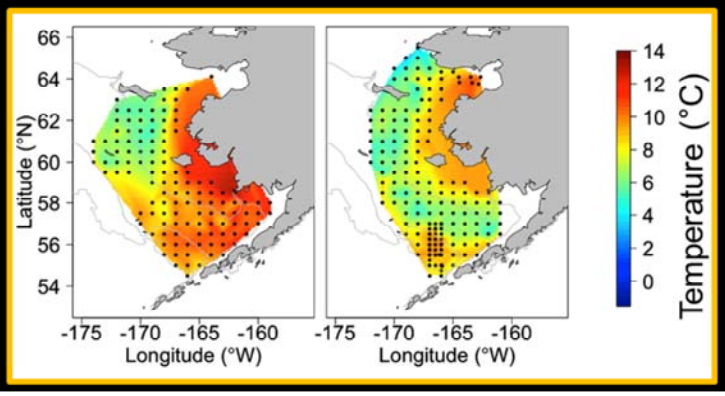
BACKGROUND: Warm-Cold differences

2005: Warm

- Age-0 pollock = 0.08 fish m^{-2}
- Water temperature
  - upper 30m: 8.8°C

2010: Cold

- Age-0 pollock = 0.001 fish m^{-2}
- Water temperature
  - upper 30m: 7.6°C



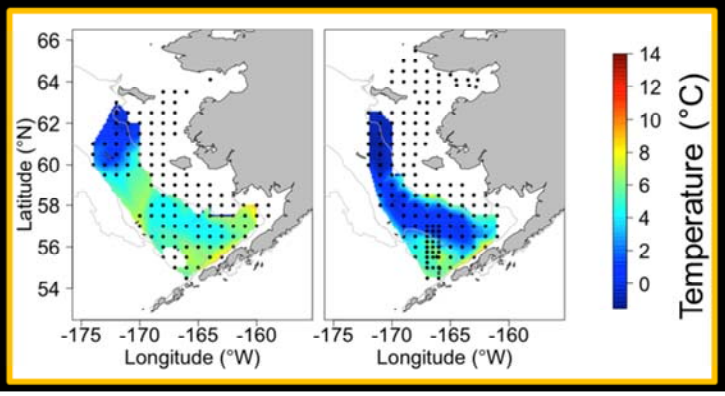
BACKGROUND: Warm-Cold differences

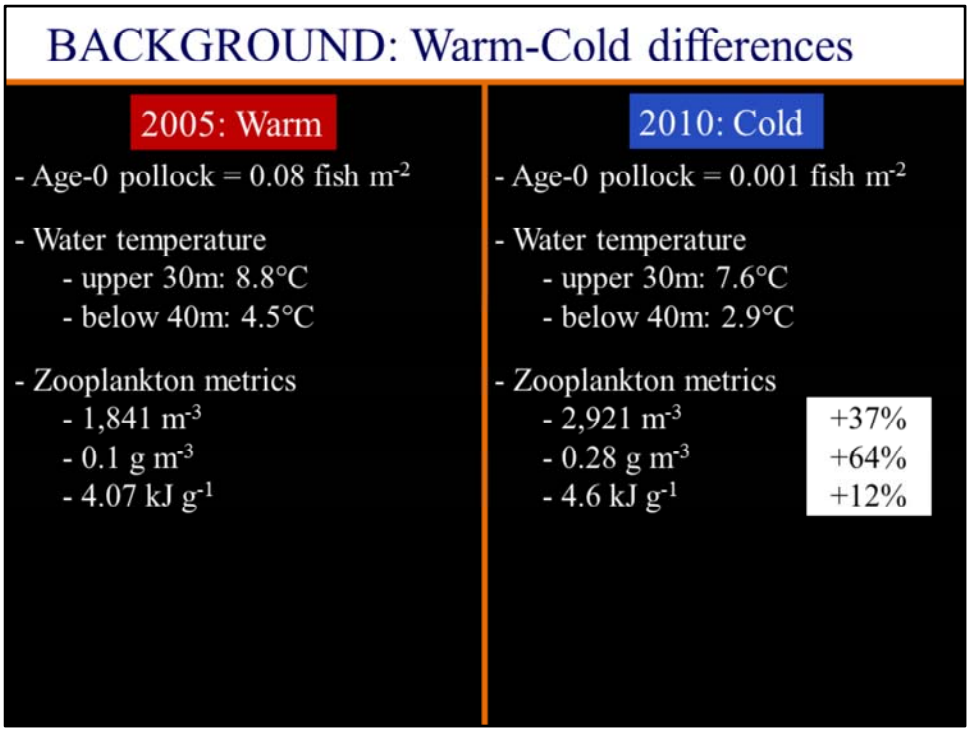
2005: Warm

- Age-0 pollock = 0.08 fish m^{-2}
- Water temperature
  - upper 30m: 8.8°C
  - below 40m: 4.5°C

2010: Cold

- Age-0 pollock = 0.001 fish m^{-2}
- Water temperature
  - upper 30m: 7.6°C
  - below 40m: 2.9°C




BACKGROUND: Warm-Cold differences
2005: Warm
- Age-0 pollock = 0.08 fish m-2
- Water temperature
- upper 30m: 8.8°C
- below 40m: 4.5°C
- Zooplankton metrics
- 1,841 m-3
- 0.1 g m-3
- 4.07 kJ g-1
2010: Cold
- Age-0 pollock = 0.001 fish m-2
- Water temperature
- upper 30m: 7.6°C
- below 40m: 2.9°C
- Zooplankton metrics
- 2,921 m-3
- 0.28 g m-3
- 4.6 kJ g-1
+37%
+64%
+12%

BACKGROUND: Warm-Cold differences

2005: Warm

- Age-0 pollock = 0.08 fish m^{-2}
- Water temperature
  - upper 30m: 8.8°C
  - below 40m: 4.5°C
- Zooplankton metrics
  - 1,841 m^{-3}
  - 0.1 g m^{-3}
  - 4.07 kJ g^{-1}
- Age-0 pollock diet:
  - 39% small copepods
    (Acartia, Pseudocalanus)
  - 0% large copepods

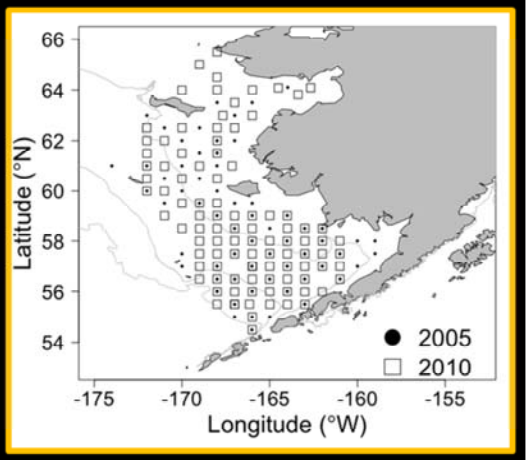
2010: Cold

- Age-0 pollock = 0.001 fish m^{-2}
- Water temperature
  - upper 30m: 7.6°C
  - below 40m: 2.9°C
- Zooplankton metrics
  - 2,921 m^{-3} +37%
  - 0.28 g m^{-3} +64%
  - 4.6 kJ g^{-1} +12%
- Age-0 pollock diet:
  - 0% small copepods
  - 25% large copepods
    (Calanus)

GOALS

1) Identify growth 'hot spots' based on prey and temperature conditions

2) Examine spatial overlap of pollock with growth 'hot spots' in a warm and a cold year



APPROACH

1) Bioenergetics Model

- Wisconsin-type
- Predator and prey energy density
- Consumption parameter = 1

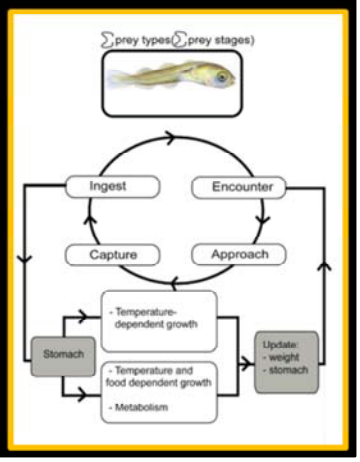
➡ Maximum growth
(Growth potential)

Growth = Consumption
- Respiration
- Waste

2) Individual-based Model

- Mechanistic feeding component
- Size-based - Vertical behavior

➡ "Realized" growth

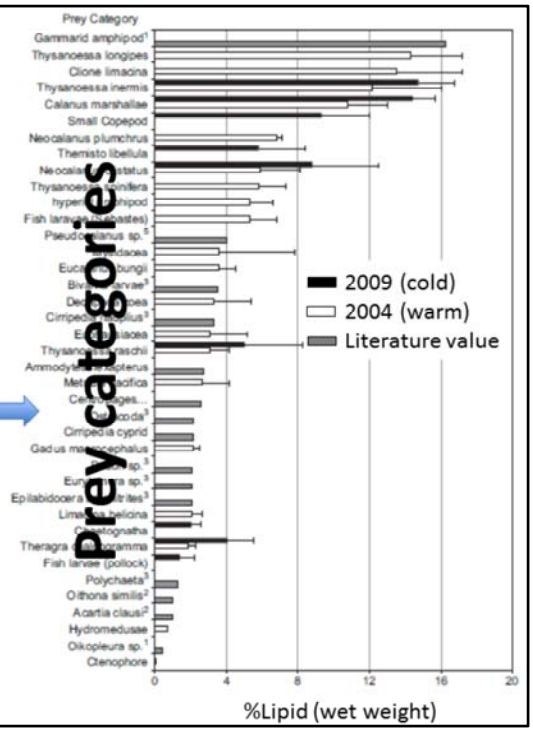


APPROACH

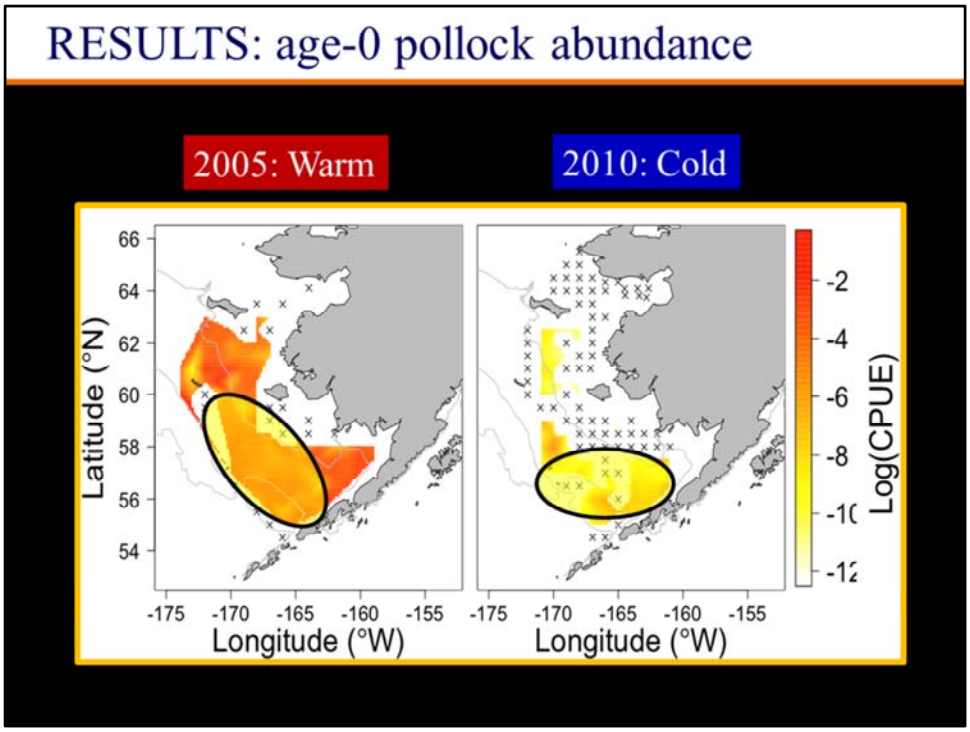
Need average energy density by station and year:

- Taxon-specific energy density based on % lipid
- Compute biomass-weighted average energy density across all taxa

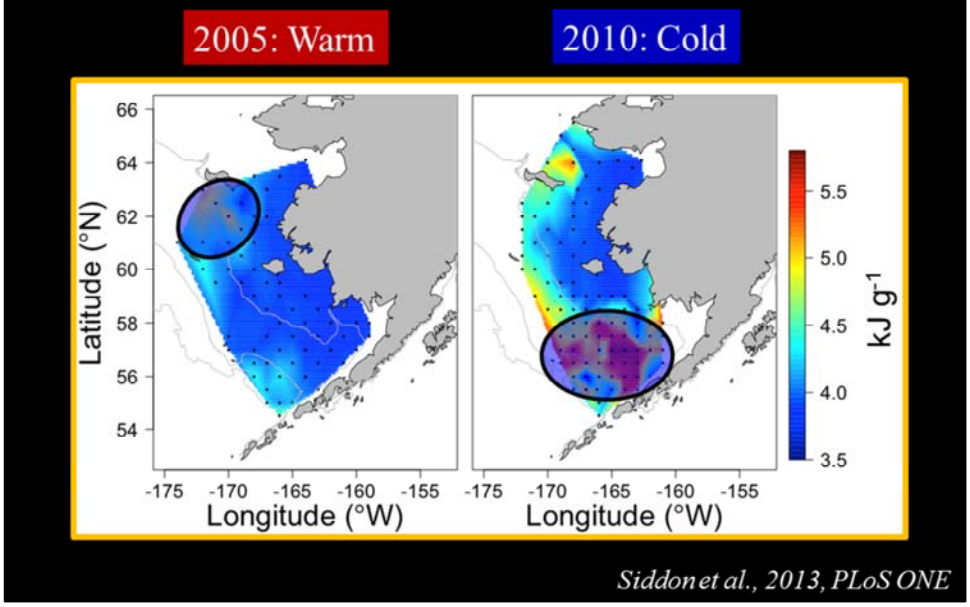
Heintz et al 2013 DSR II



RESULTS: age-0 pollock abundance

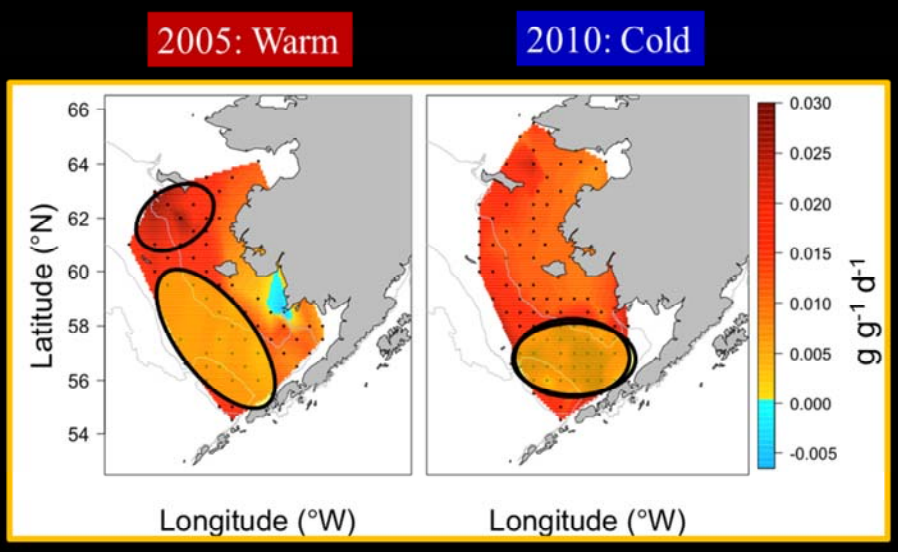


RESULTS: prey energy



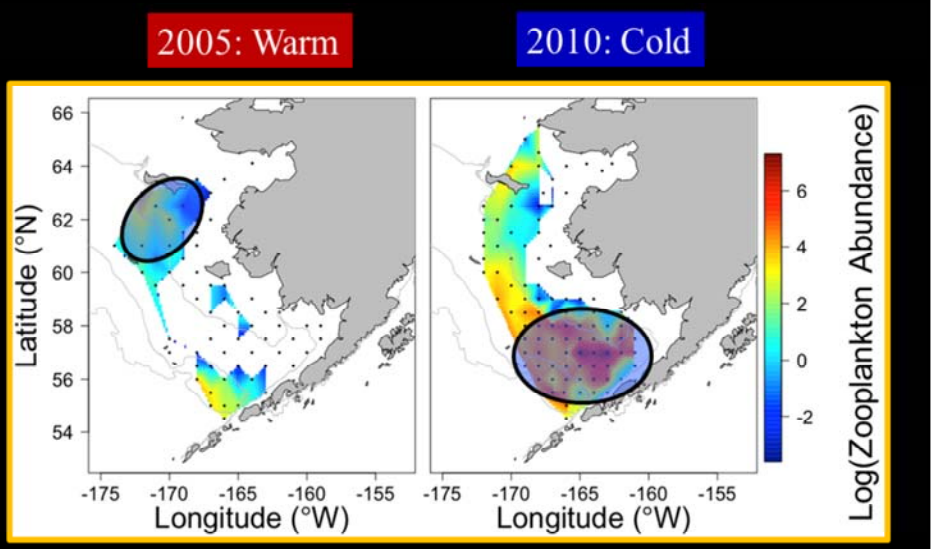
Siddon et al., 2013, PLoS ONE

RESULTS: bioenergetics model



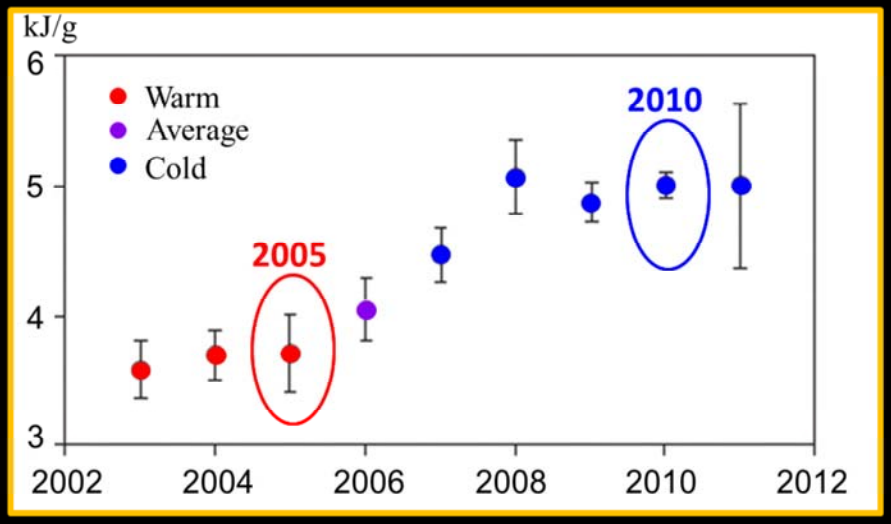
Siddon et al., 2013, PLoS ONE

RESULTS: optimal prey size (IBM)



Siddon et al., 2013, PLoS ONE

RESULTS: observed pollock condition



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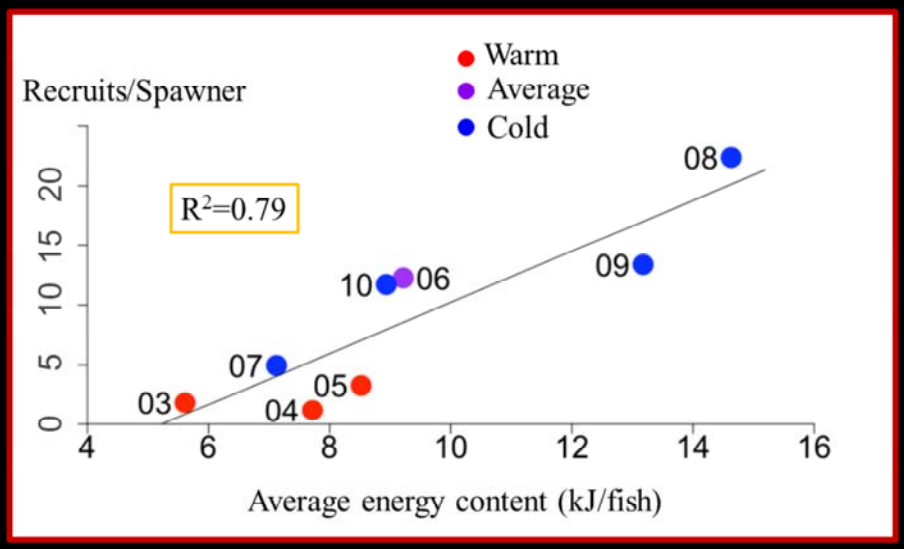
RESULTS: Pollock recruitment response



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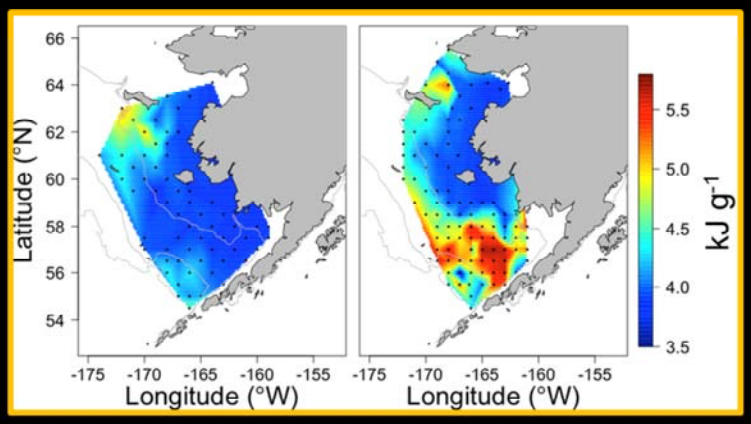
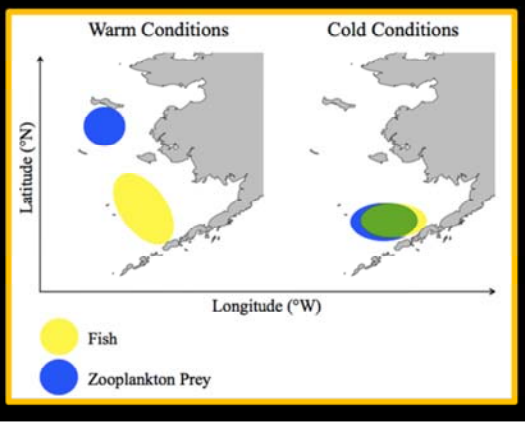
CONCLUSIONS

1) Spatial patterns in prey and temperature lead to growth 'hot spots'; survival may depend on the overlap of fish and 'hot spots'.



CONCLUSIONS

1) Spatial patterns lead to growth 'hot spots'
2) Spatial mismatch in 2005 associated with poor recruitment; greater overlap in 2010 associated with improved recruitment.



Siddon et al., 2013
PLoS ONE