

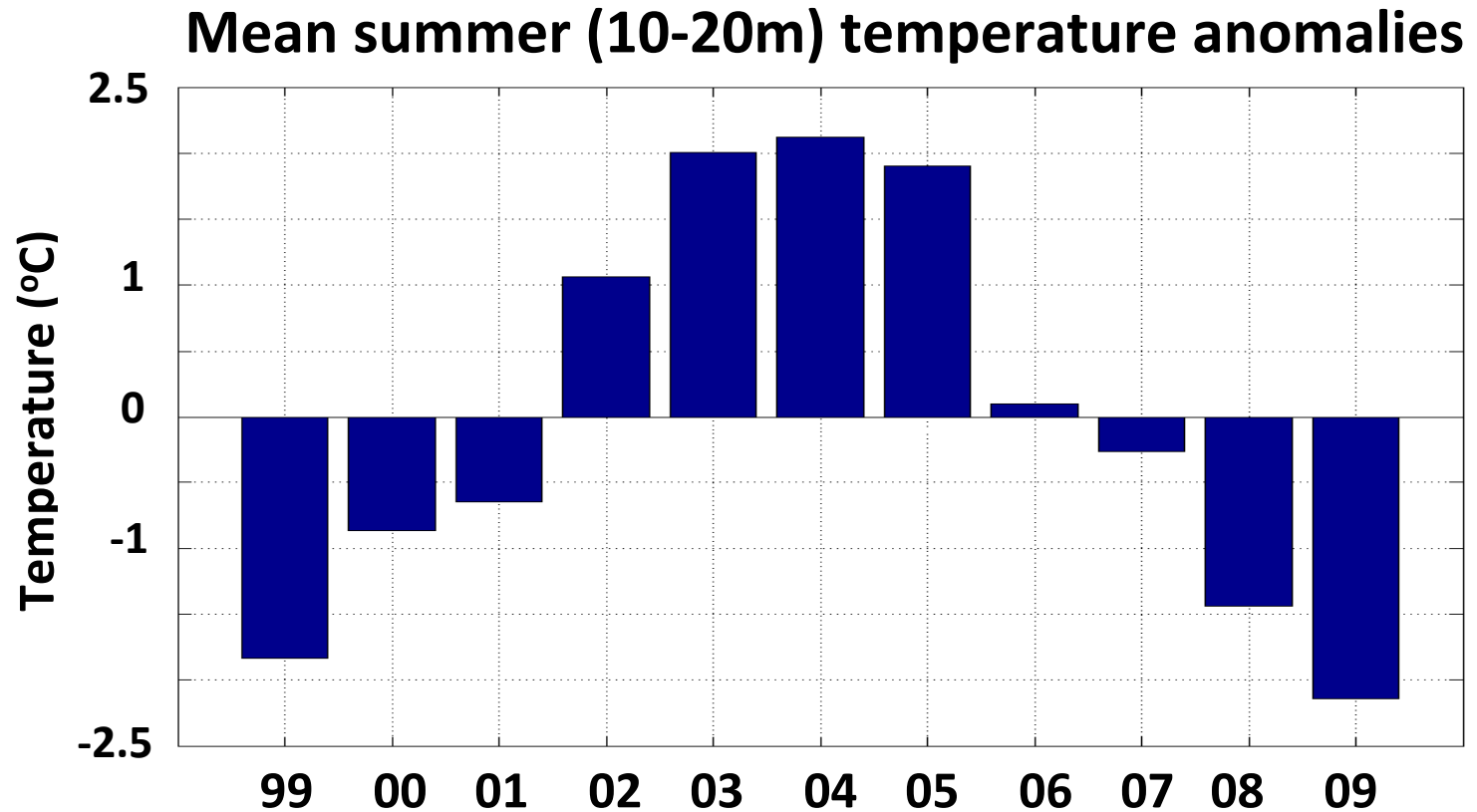
**Emergence of the Arctic hyperiid
Themisto libellula on the southeastern
Bering Sea shelf as a result of the
recent cooling and their potential
impact on pelagic food web**

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BEST-BSIERP Bering Sea Project

Warm/Cold phases in the SE Bering Sea



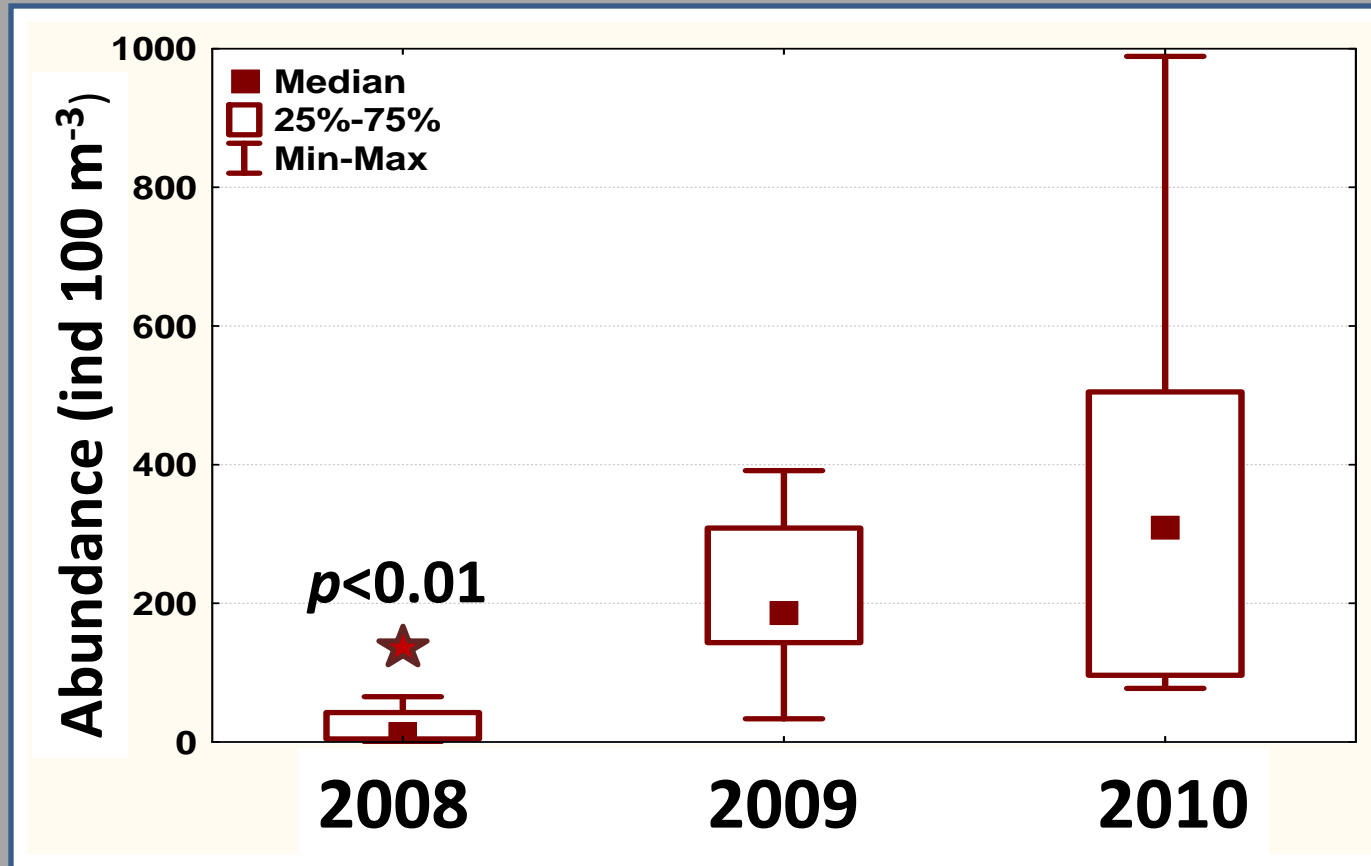
Did the recent cold phase bring any Arctic zooplankton into the SE Bering Sea?

Themisto libellula – an Arctic resident



- Large (up to 60 mm) pelagic amphipod
- Active swimmer forming dense swarms
- Voracious predator on smaller zooplankton (copepods)
- Lipid-rich prey for planktivorous predators (fish, mammals)
- An essential component of the Arctic ecosystem

T. libellula – recent interannual dynamics

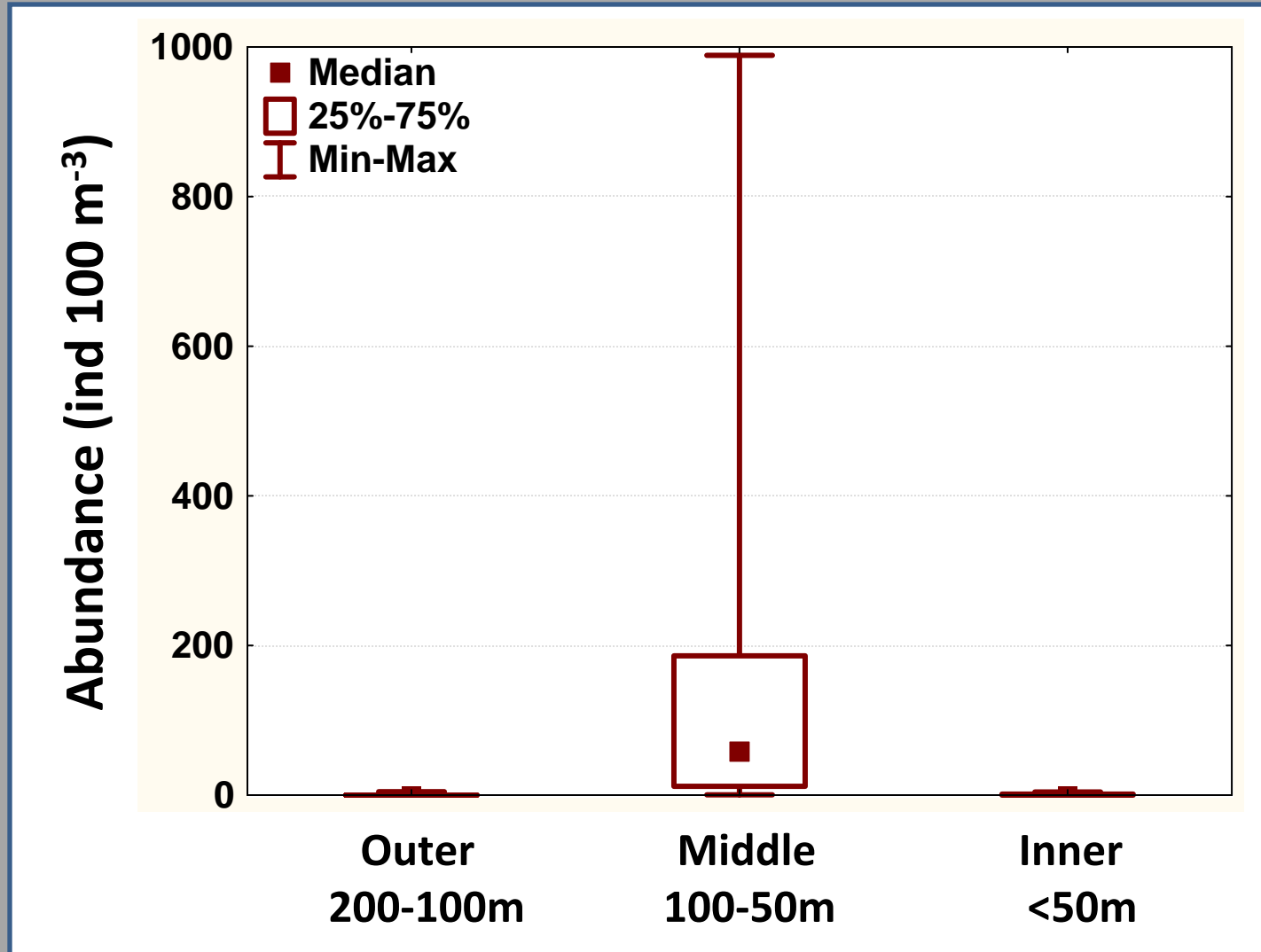


2008 < 2009 and 2010

(Tukey test on log-transformed data, $p < 0.001$)

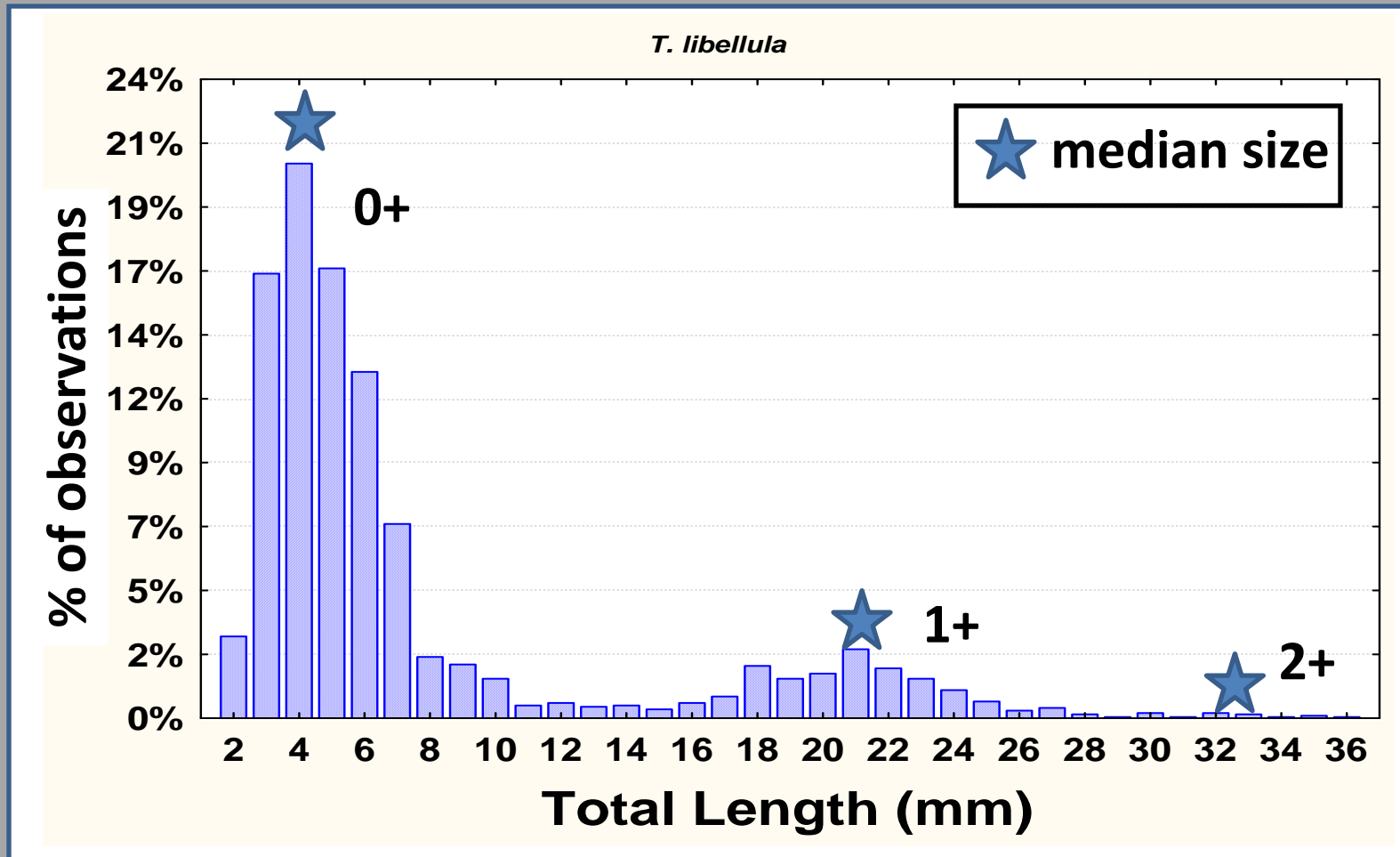
- 1 to 2 orders of magnitude increase over 2 years
- wider range in 2010 indicating greater patchiness

T. libellula spatial distribution in 2008-2010



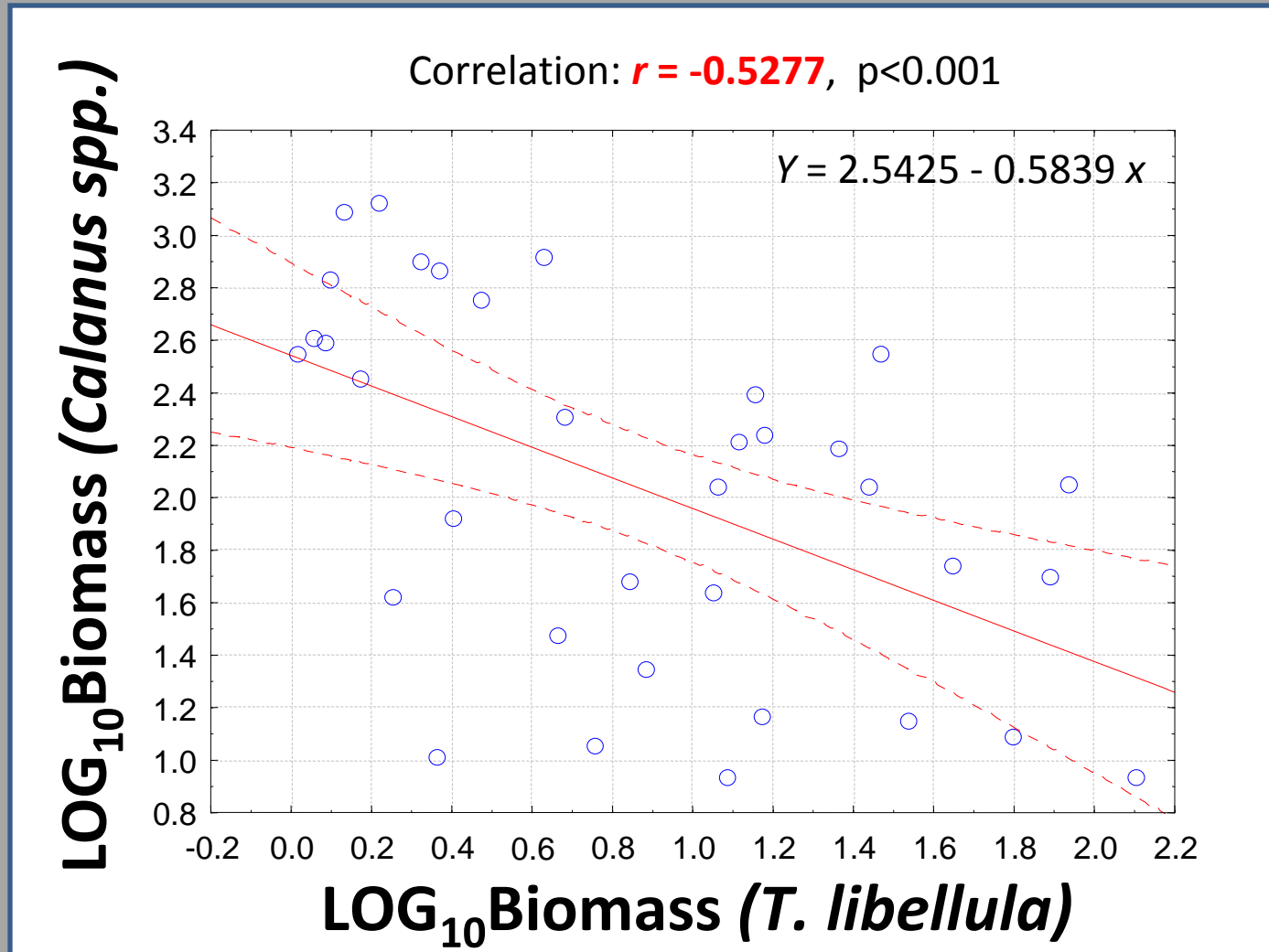
- occurred only in the Middle Domain
- no difference between N and SE sub-regions

T. libellula population status in early summer 2010



- Three distinct cohorts (multi-year life span)
- Well-established population reproducing in spring
- Lack of larger specimens

Down the trophic chain: Potential impact on copepods



- stomachs contained *Calanus* spp. fragments
- significant negative correlation suggests predation

Potential impact on copepods

Calculation:

- *T. libellula* Daily Ingestion Rates (DIR) for *Calanus* in Gulf of St. Lawrence: 3.4 - 4.02 % of body DW d⁻¹ (Marion et al 2008)

$$\text{Impact} = \frac{\text{DIR} * T.\text{libellula}_{\text{Biomass}}(\text{DW } m^{-3})}{\text{Calanus}_{\text{Biomass}}(\text{DW } m^{-3})}$$

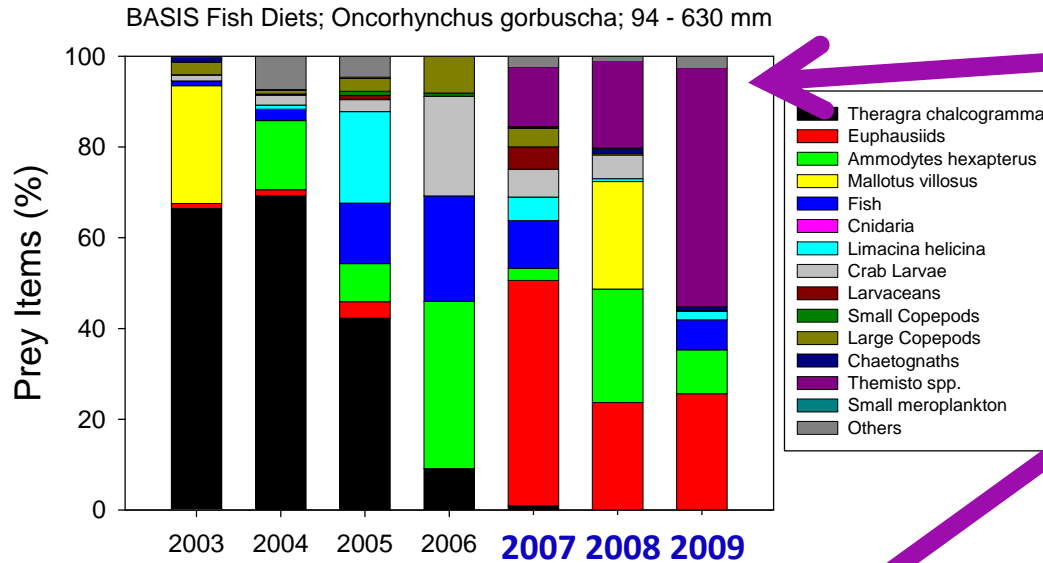
Estimate:

1.77 – 4.6 % of *Calanus* standing stock day⁻¹
in early summer 2010

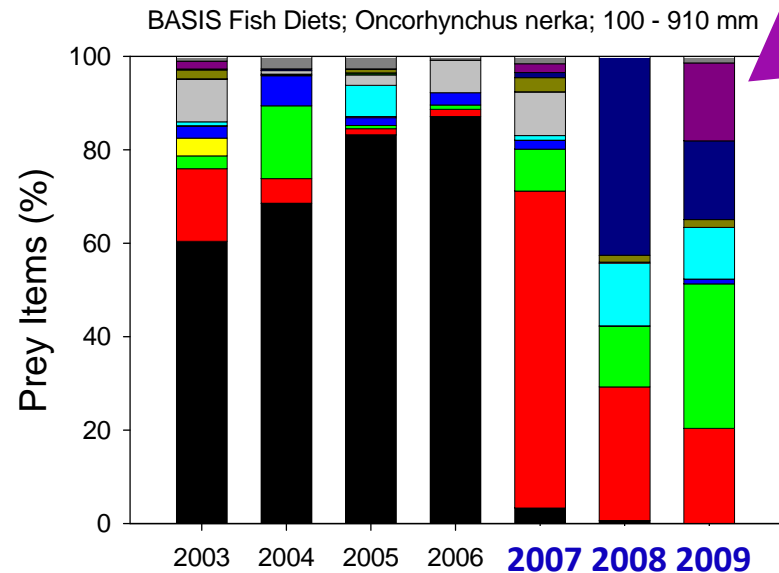
- may indirectly impact 0-class pollock via competition for food

Up the trophic chain: juvenile salmon diets

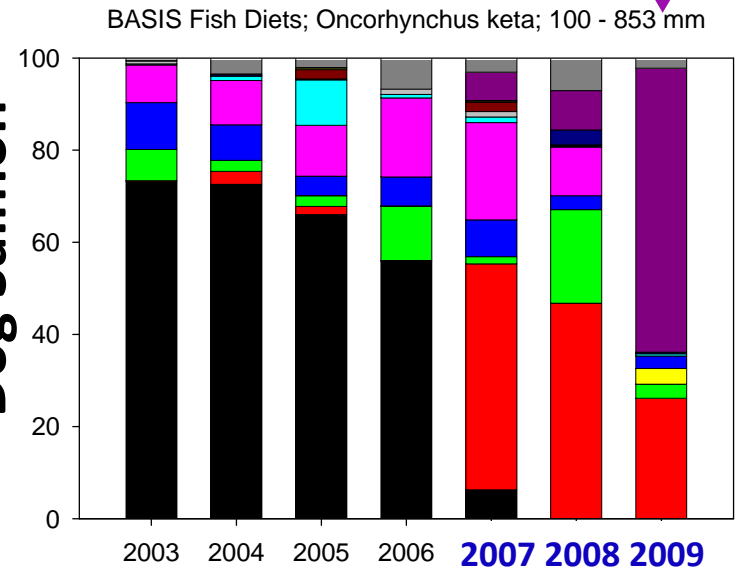
Pink Salmon



Red Salmon



Dog Salmon

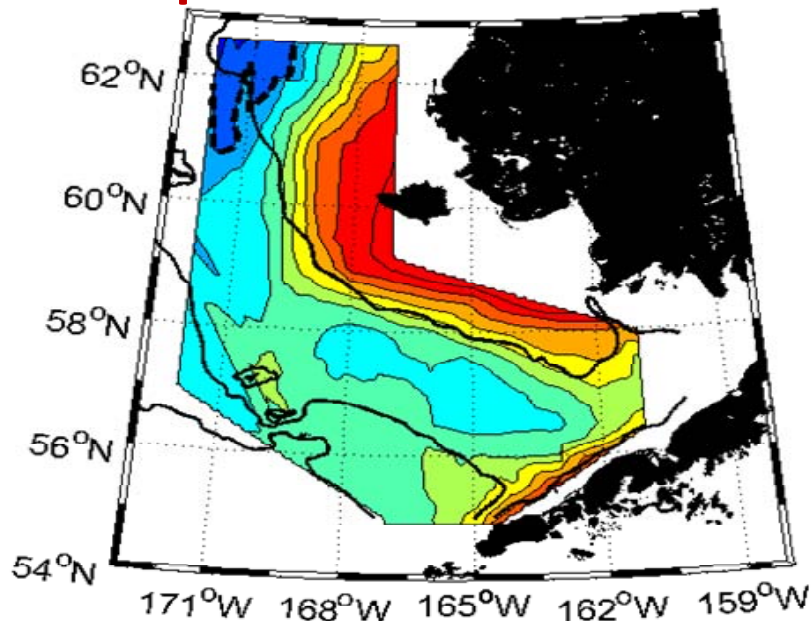


What factors contribute to *T. libellula* success?

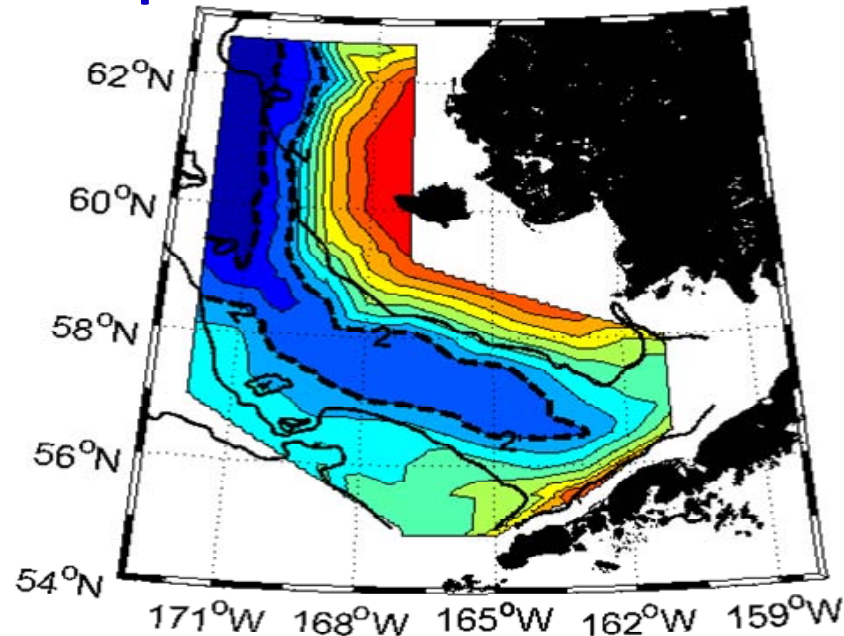
- **Water Temperature**
- **Food Availability**

Temperature: bottom water on the middle shelf in summer

Warm phase 2002-2005



Cold phase 2006-2009



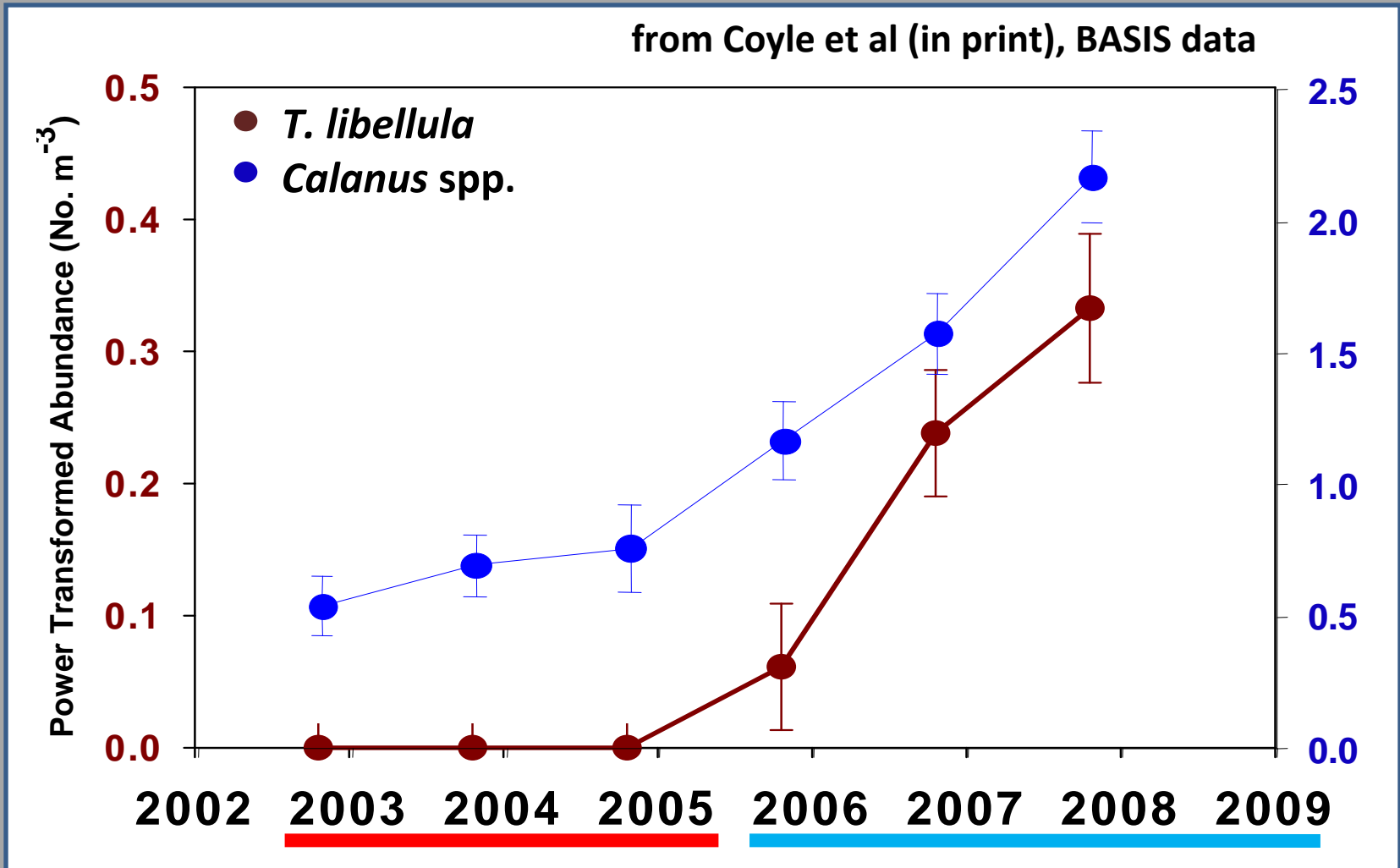
Correlations ($p < 0.05$) relating temperature to populations of large zooplankton

Taxa	T above pycnocline	T below pycnocline
<i>Calanus marshallae</i>	-0.33	-0.48
<i>Themisto libellula</i>	-0.34	-0.44

Dual benefit from the cold layer:

- **Retreat from heat during summer**
- **Better overwintering due to slow metabolic rates and long-lasting lipid storages**

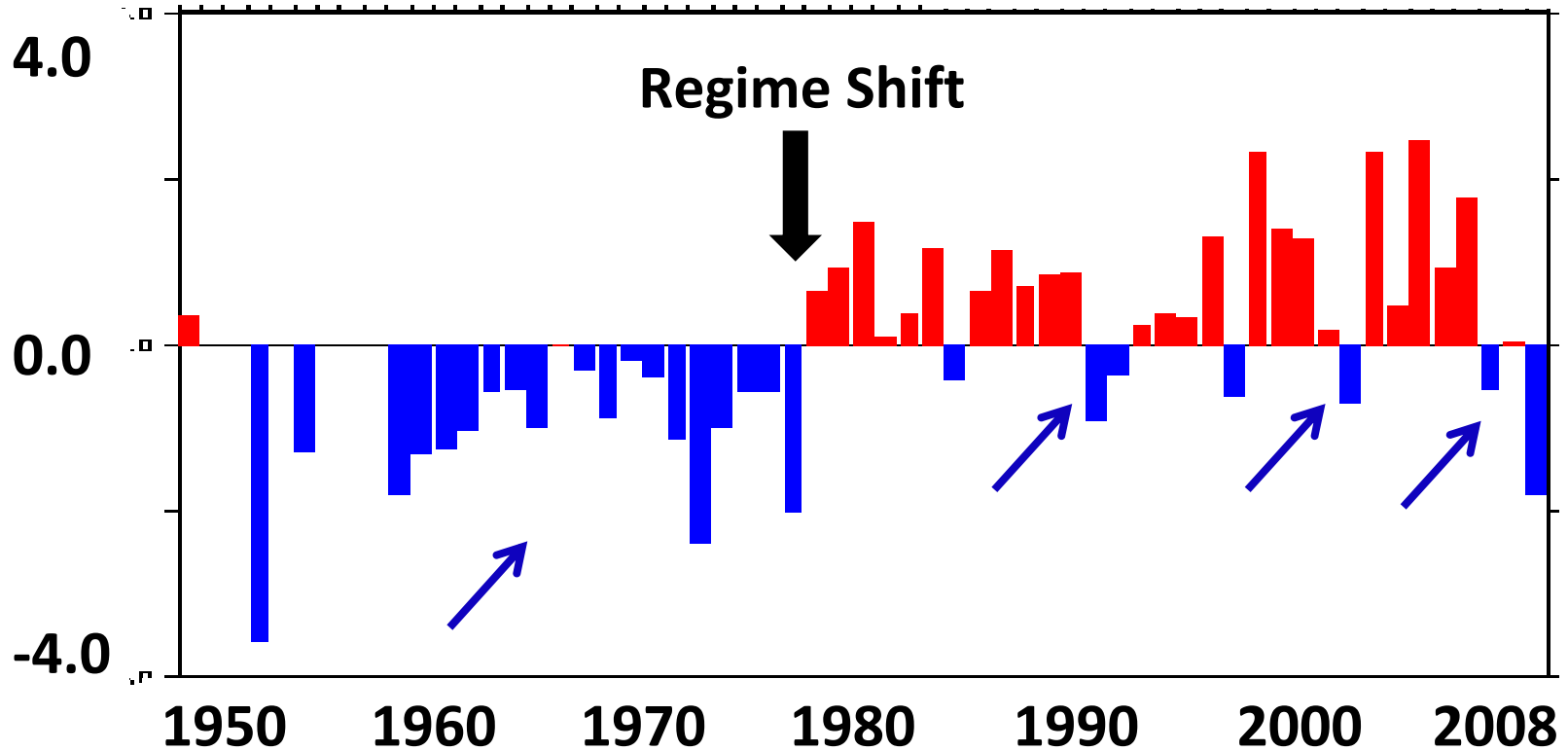
Prey fields: *Themisto* vs *Calanus* in fall



- Steady increase of both *T. libellula* and *Calanus* spp. abundance as the cooling intensified
- No apparent shortage of food until 2008

Look into the past:

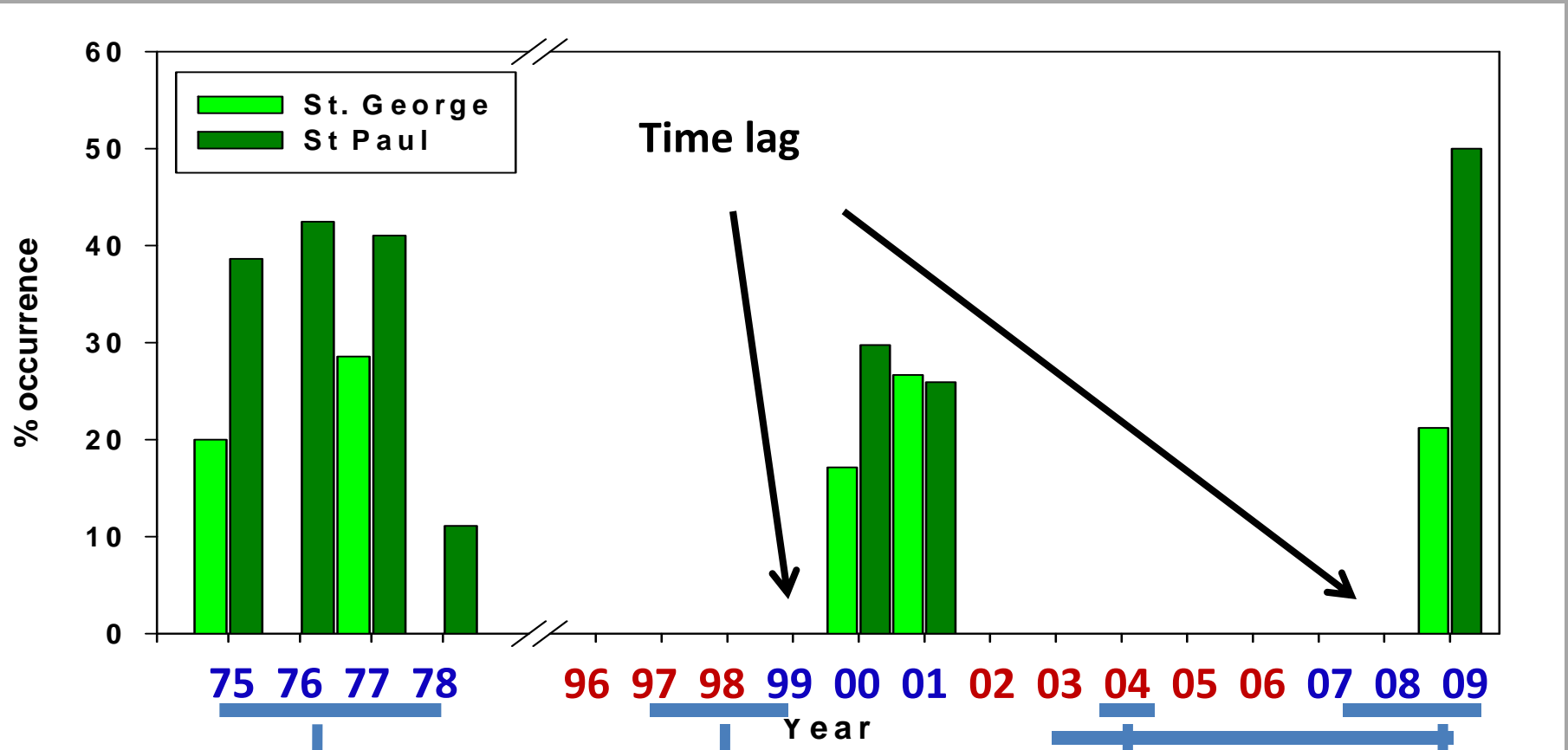
Winter SST Anomalies in the SE Bering Sea



PMEL Data Archive: <http://www.beringclimate.noaa.gov/data/>

Did *T. libellula* occurred on the SE shelf during the past cooling events?

T. libellula in Least Auklet diets on Pribilofs (data courtesy of H. Renner USFWS)



75 76 77 78

96 97 98 99 00 01 02 03 04 05 06 07 08 09

Year

BLM/NOAA
PROBES

Inner Front

Pribs Study

BASIS

BEST

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N

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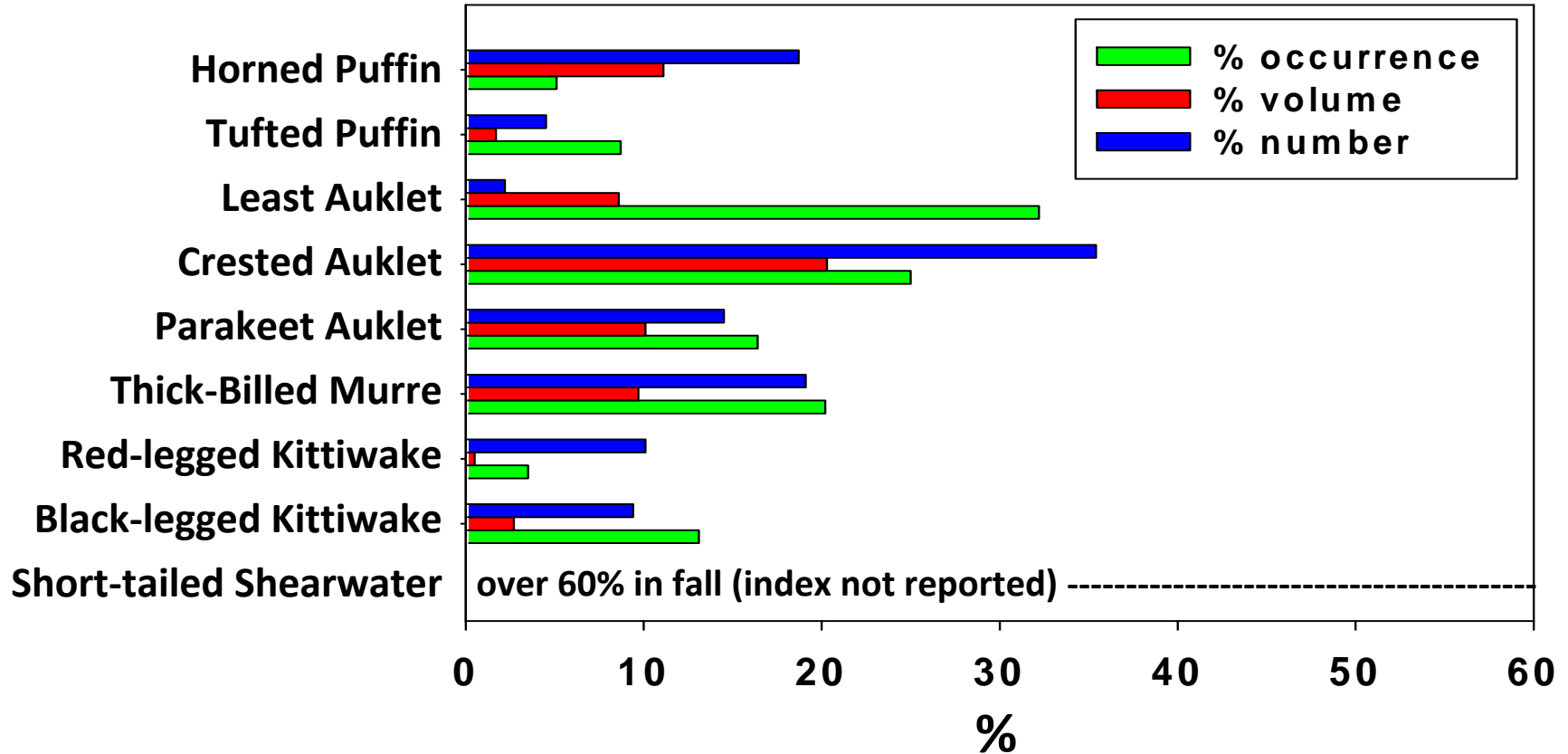
Y

Y

Zoop
collections

How important was *T. libellula* in the 70th?

Seabird diets Pribilof Islands, 1975-78



from Hunt et al 1981 (modified)

- A major prey for planktivorous birds - indicates high abundance
- A common prey for piscivorous birds - indicates large sizes

Summary

- Orders of magnitude increase in *T. libellula* abundance on the SE shelf during the recent cold phase
- Occurred only on the middle shelf where the cold pool and numerous prey were observed
- Occurred during past cooling events
- Need **a sequence** of cold years to build up the stock (due to multi-year lifespan)
- Becomes a key element in the trophic chain acting both as a predator for copepods and a prey for apex consumers