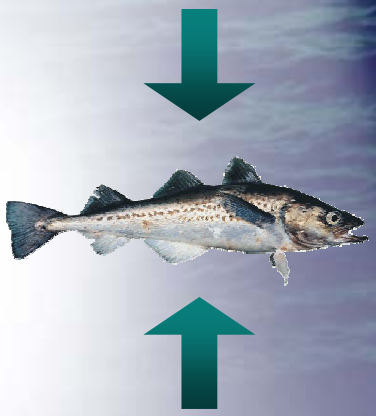
Bottom-up and top-down controls of walleye pollock in the Eastern Bering Sea



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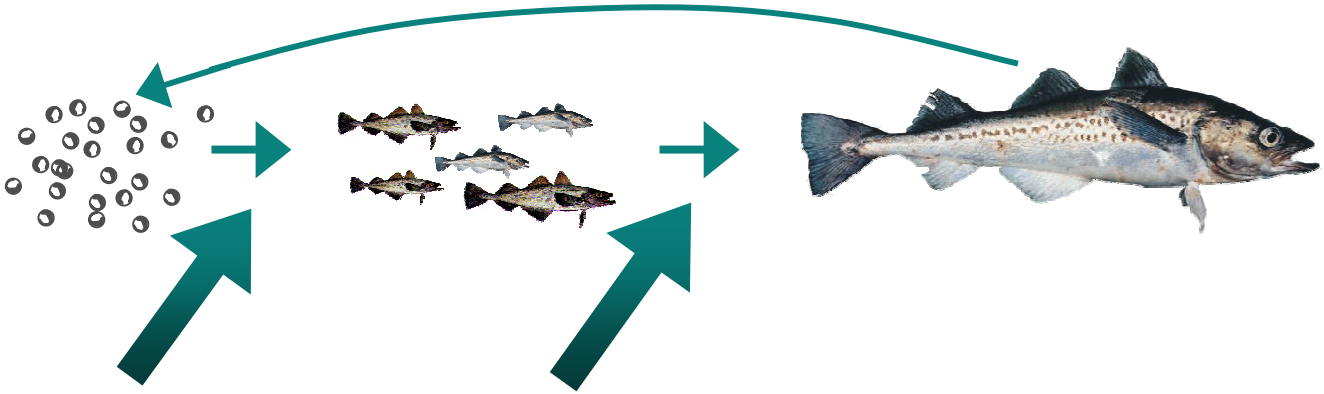
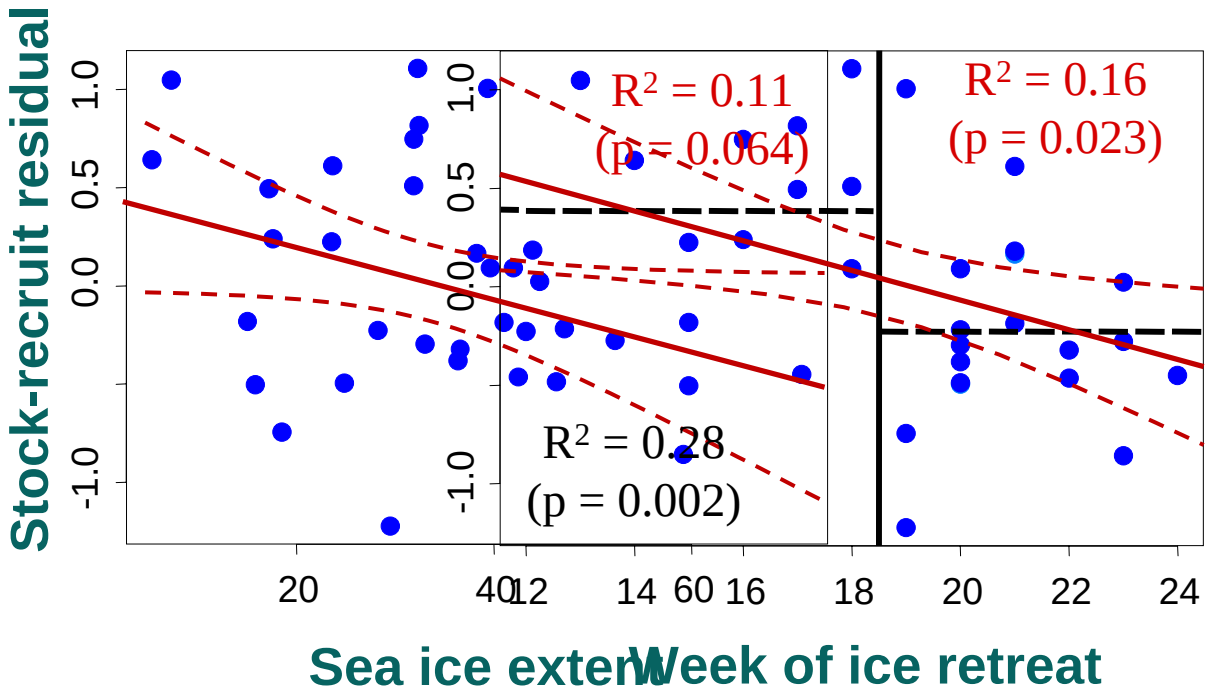
Bottom-up control

- **Recruitment limited by primary production (environmental variability)**



Ice extent / timing of retreat
Cold pool extent
Surface currents(larval transport)
Wind mixing / Stratification

Ice extent / timing of retreat



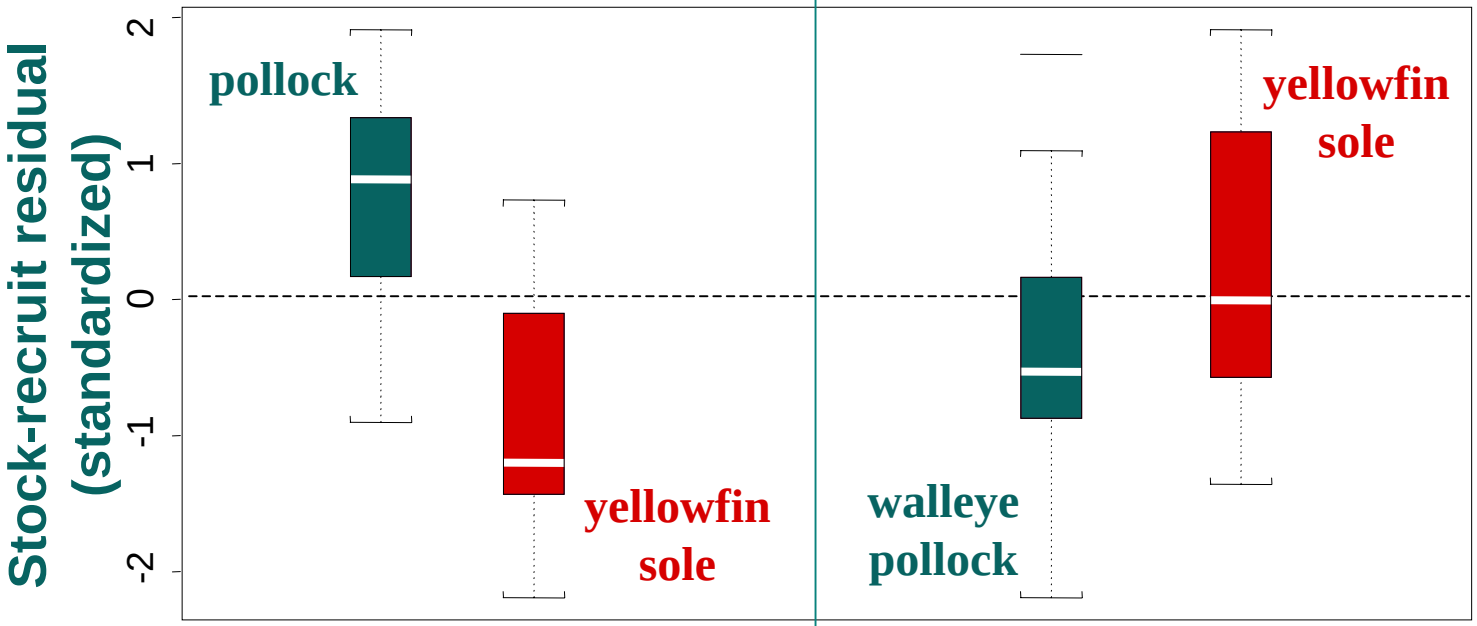
Fate of primary production

Early ice retreat

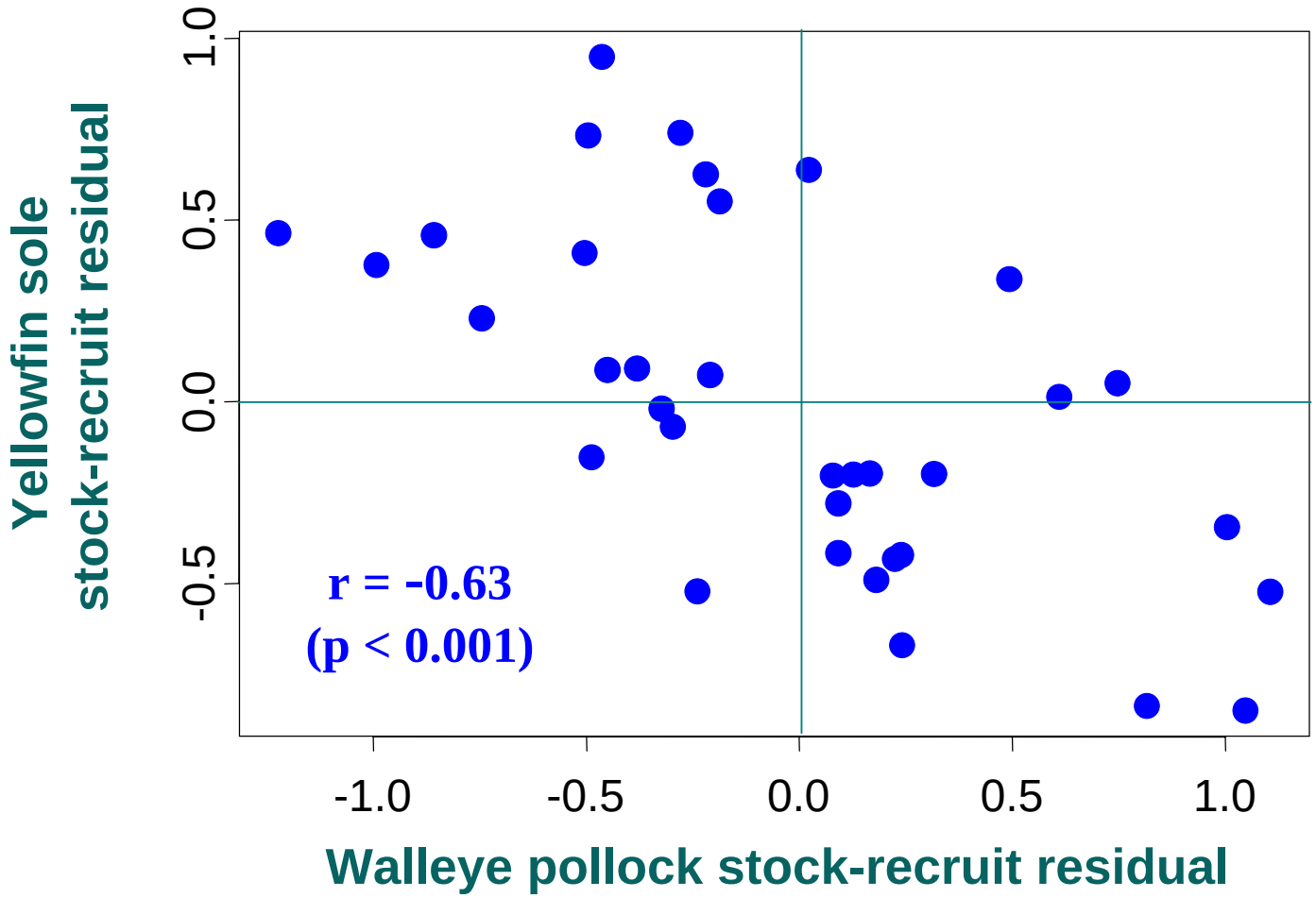
- Late bloom
- Warm SST
- High pelagic prod.

Late ice retreat

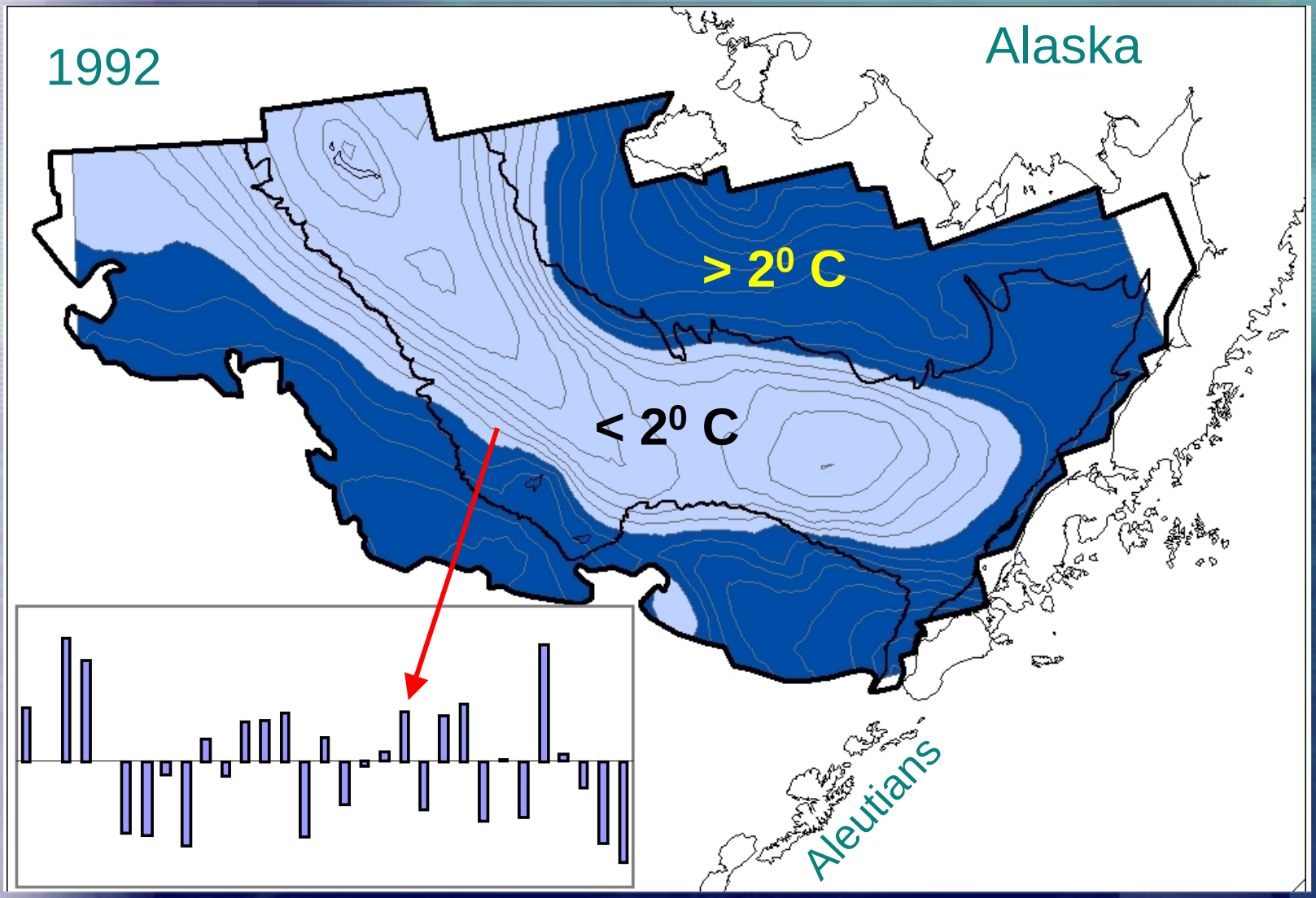
- Early (ice-edge) bloom
- Cold SST
- High benthic prod.



Yellowfin sole and walleye pollock

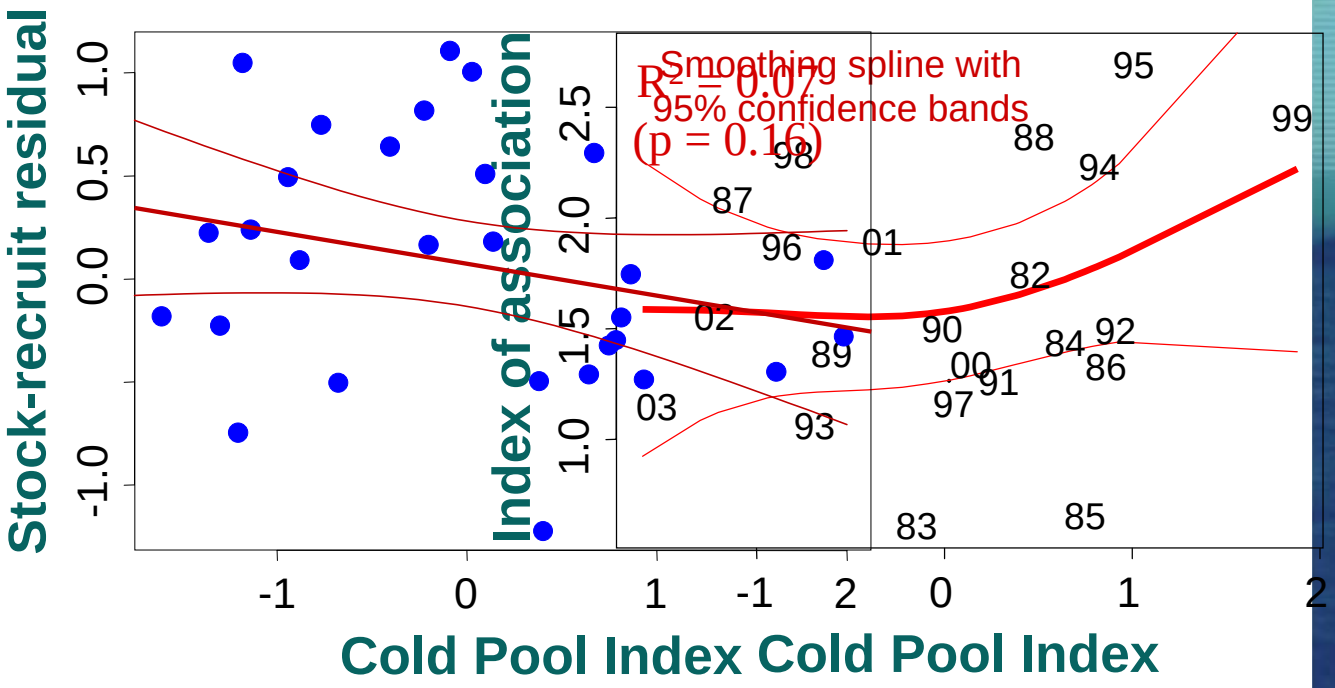


Cold Pool extent

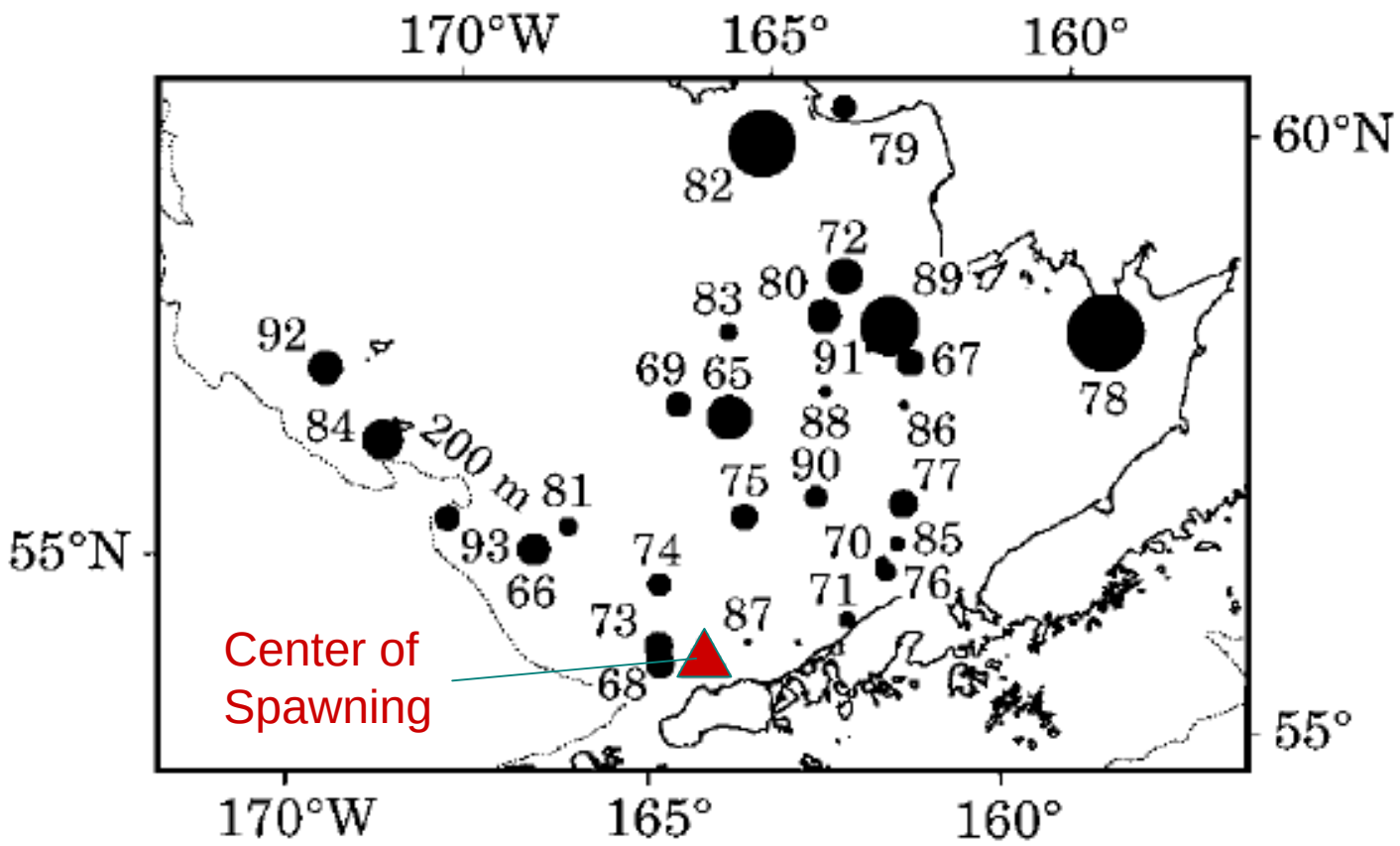


Cold Pool extent

Index of association modified and updated from Wespestad et al. (2000)

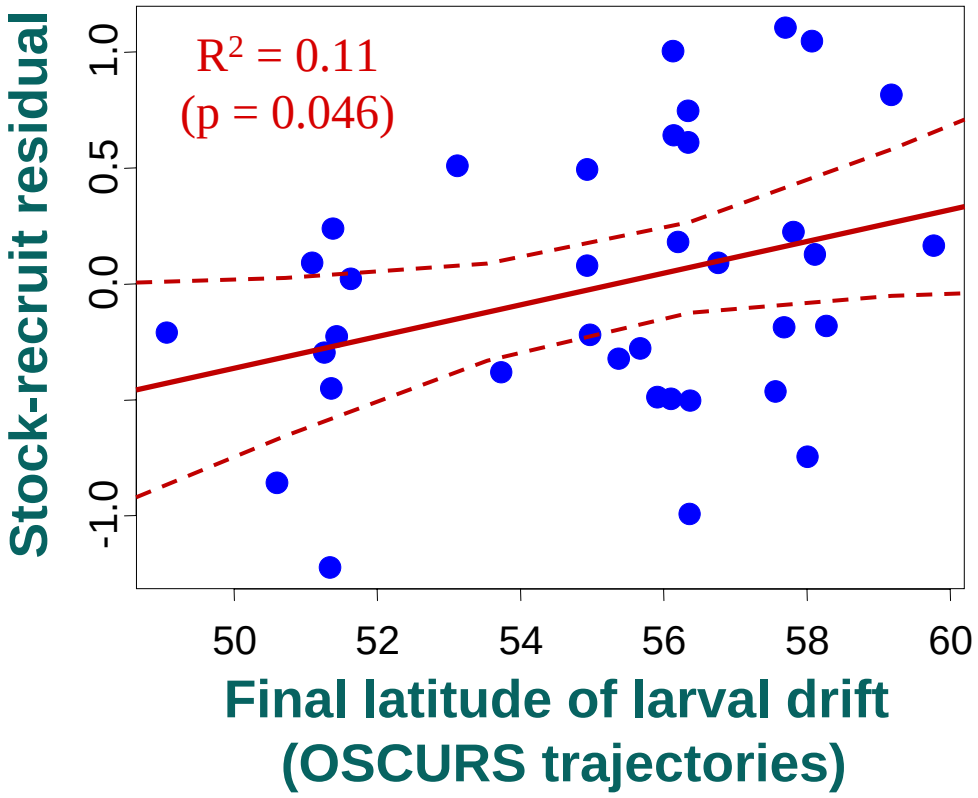


Surface transport



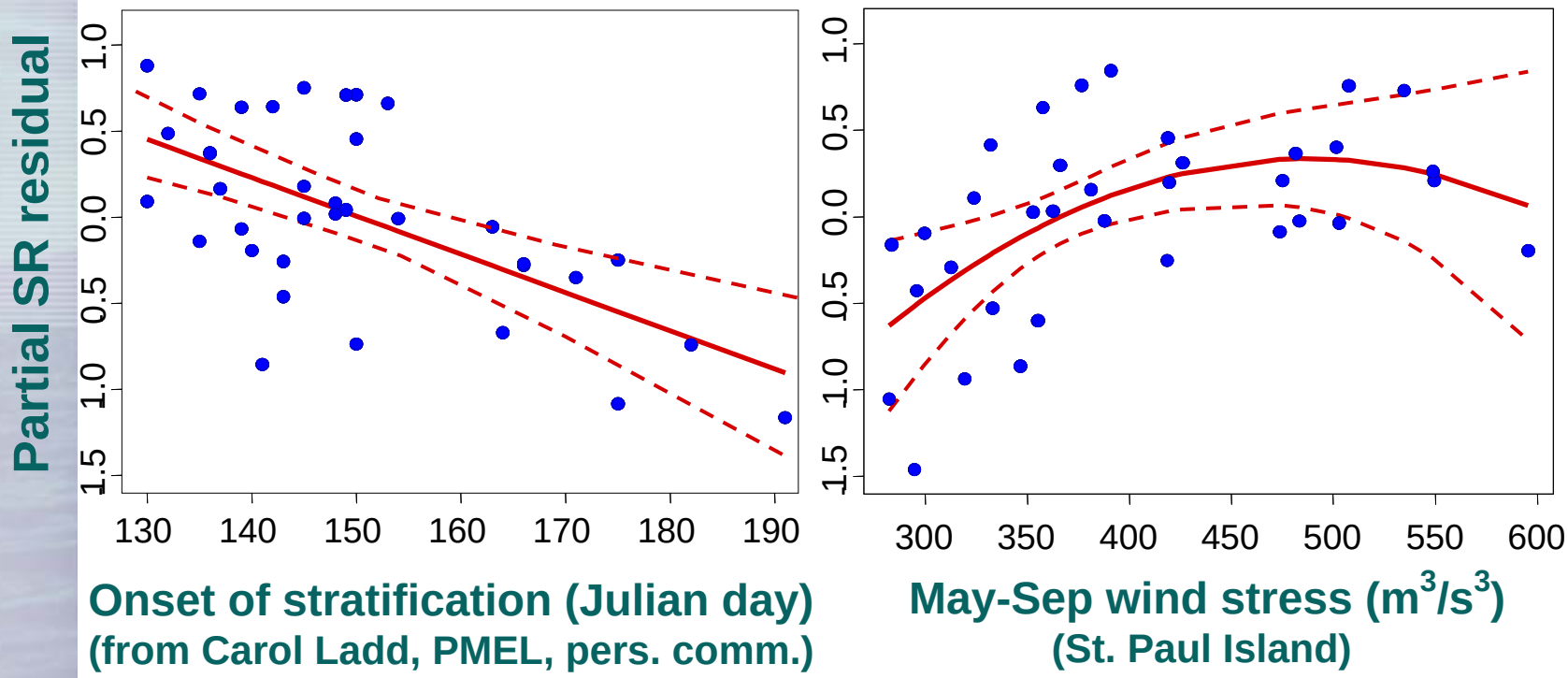
From: Wespestad et al. (2000). ICES J. Mar. Sci 57:272-278

Surface transport



Summer stratification

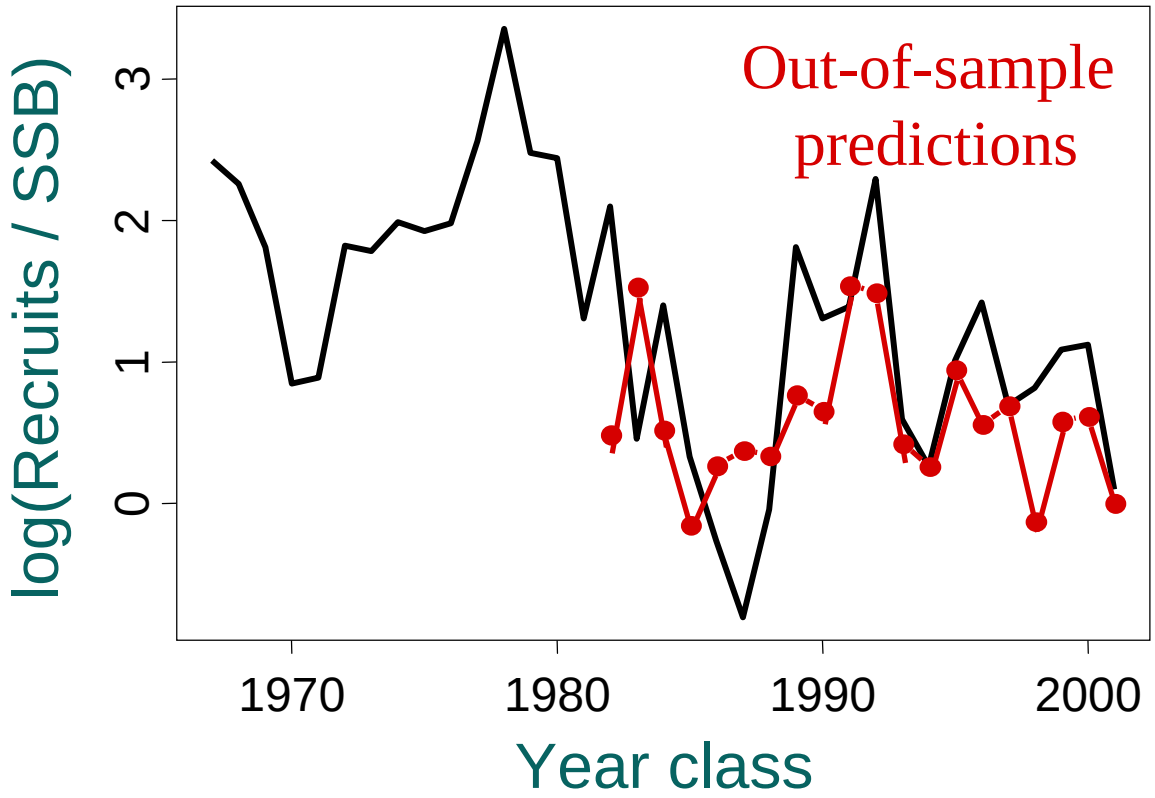
$R^2 = 0.38$, $p = 0.002$



Summer conditions <u>best</u> explained past variability in survival rates of walleye pollock

Best overall model: Retrospective analysis

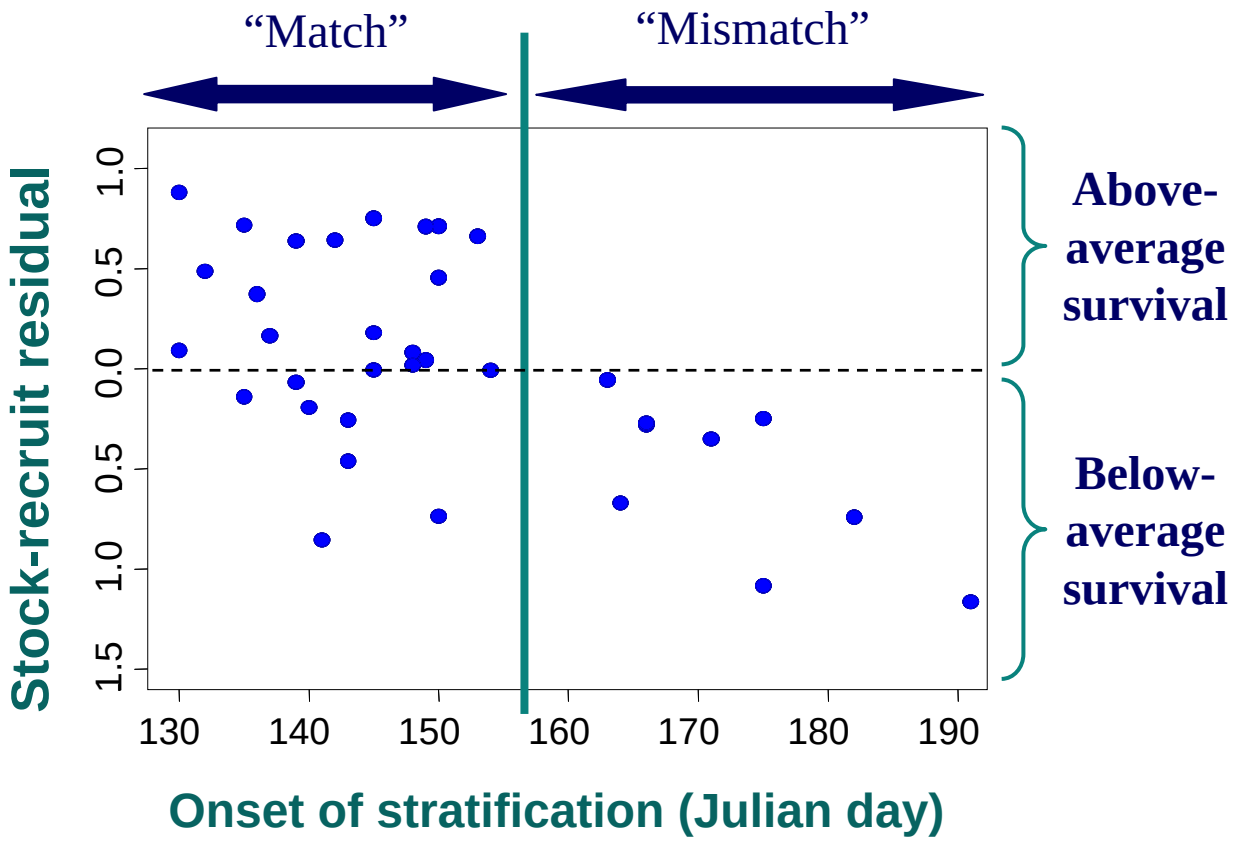
$$\log(R_t/S_t) = b_0 + b_1 * \mathrm{SSB}_{t-2} + b_2 * \mathrm{Strat}_{t-1} + b_3 * (Wind_{t-1})^2 + b_4 * Lat_{t-2} + \varepsilon_\tau$$



Summary: Bottom-up controls

- Ice extent / timing of ice retreat √
  - Fate of primary production √
  - Oscillating Control Hypothesis ?
- ~~Cold pool extent~~
  - ~~Cold pool hypothesis~~
- Surface transport √
  - ~~Larval transport hypothesis~~
- Summer stratification / wind mixing √
  - New hypothesis?

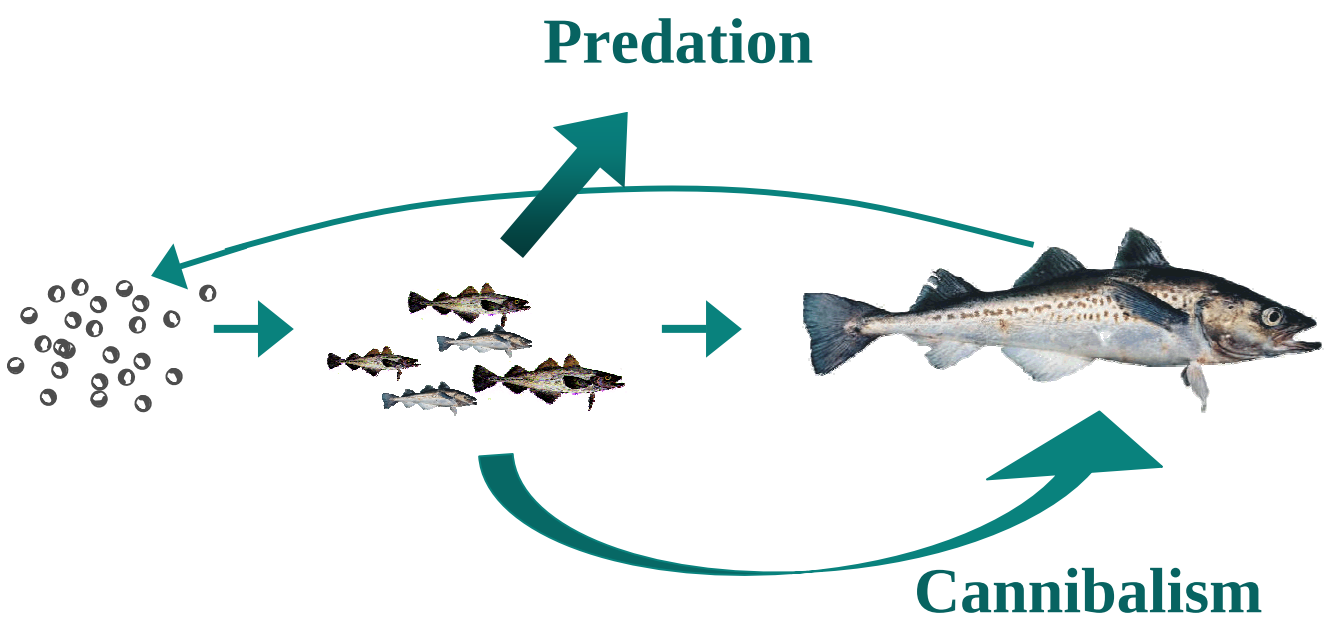
Match / mismatch hypothesis



Stratification index from Carol Ladd (pers. comm.)

Top-down control

- **Recruitment limited by predation from top-predators**



Top-down control: Consumption of walleye pollock

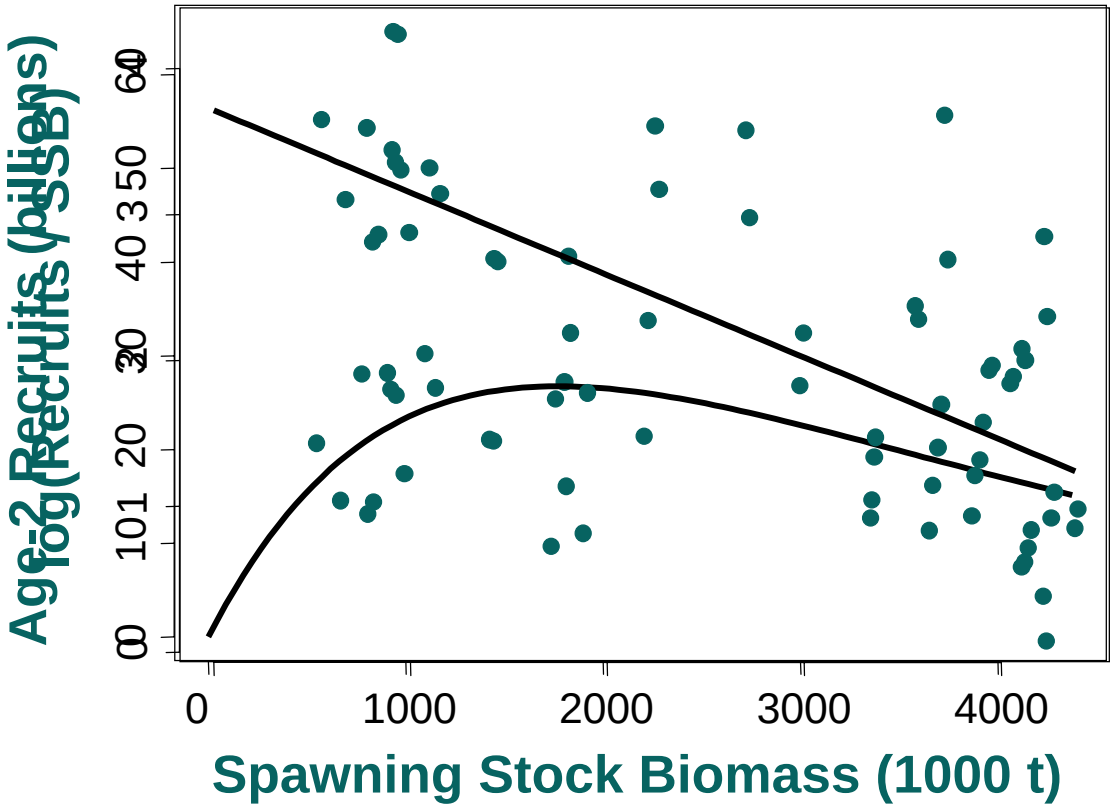
- Total consumption of walleye pollock as high as 3.5 million t

  (Livingston & Lang 1996)
- Model estimates based on diet composition
  - ~40% of juvenile production (age 0-1) consumed by adult pollock (age 2+)
  - ~5% of the diet of age 2+ pollock consists of age 0-1 pollock

  (Kerim Aydin, pers. comm.)

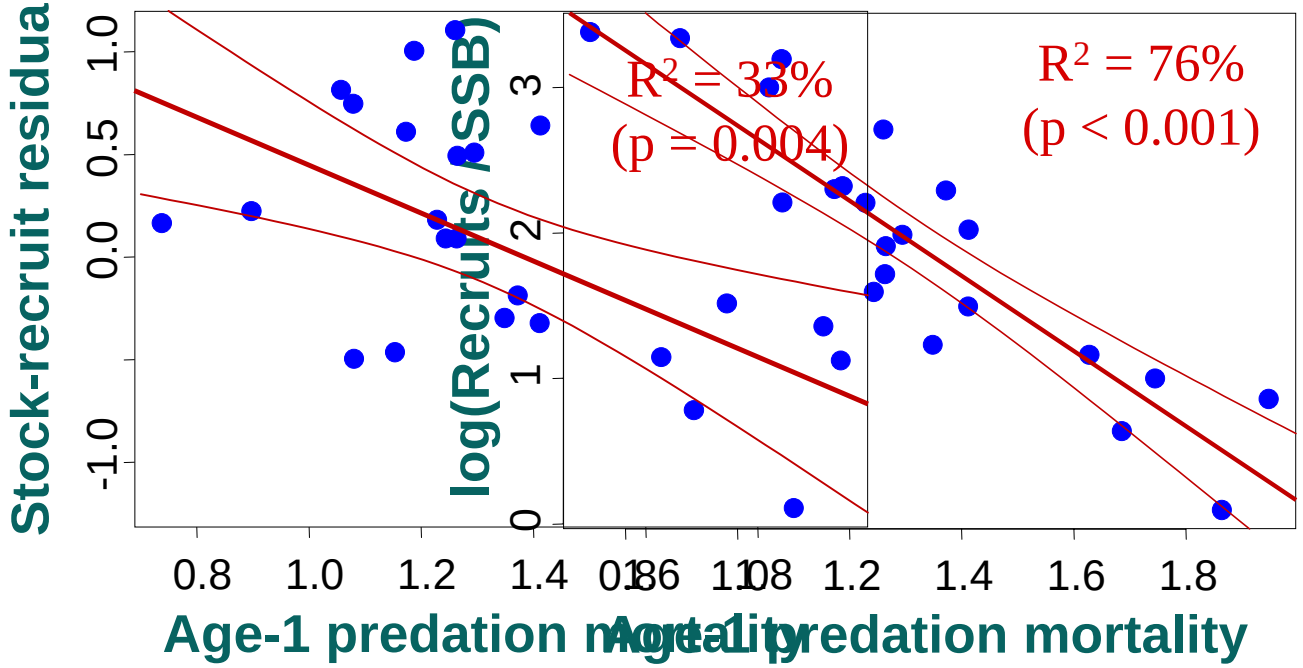
Cannibalism: Stock-recruit relationship

- **Strong density-dependence in spawner-recruit relationship**



Predation mortality

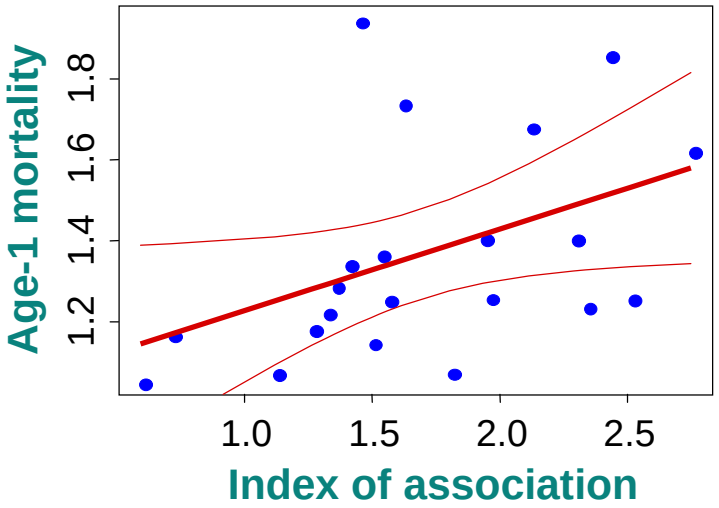
- **Predation mortality accounts for 33% of remaining variability in log-survival (1979-2001)**
- **Or as much as 76% of total variability in log-survival**



Predation estimates from Jurado-Molina and Livingston (pers. comm.)

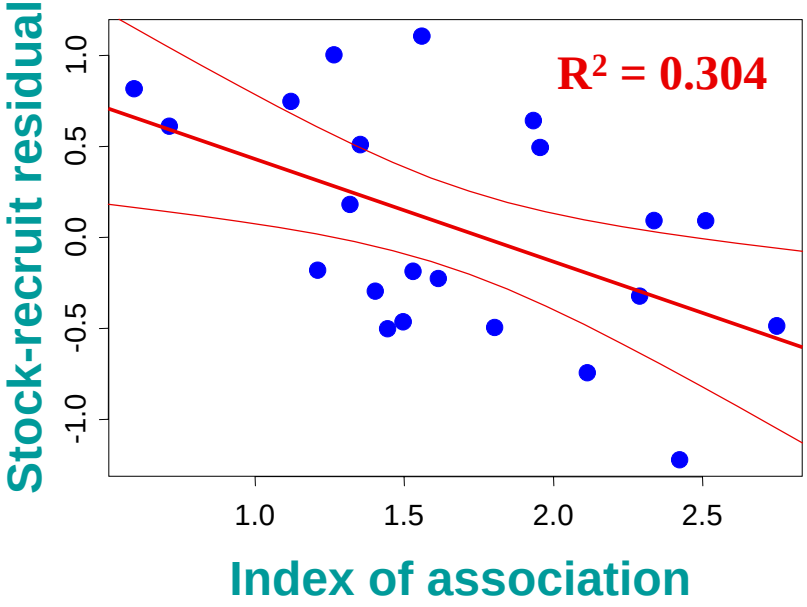
Top-down control

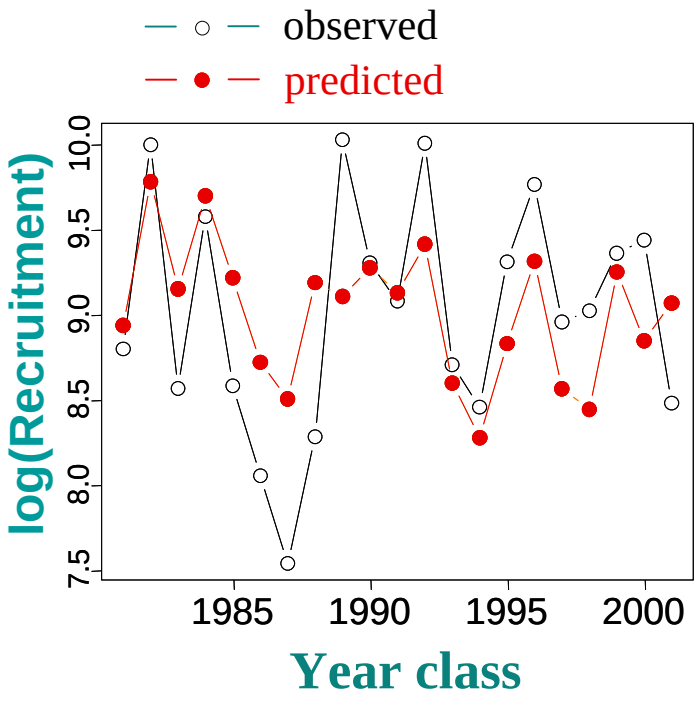
- **Predation mortality depends on**
  - **Abundance of predators**
    - Primarily adult pollock
  - **Availability of juveniles to predators**
    - Spatial overlap: horizontal / vertical



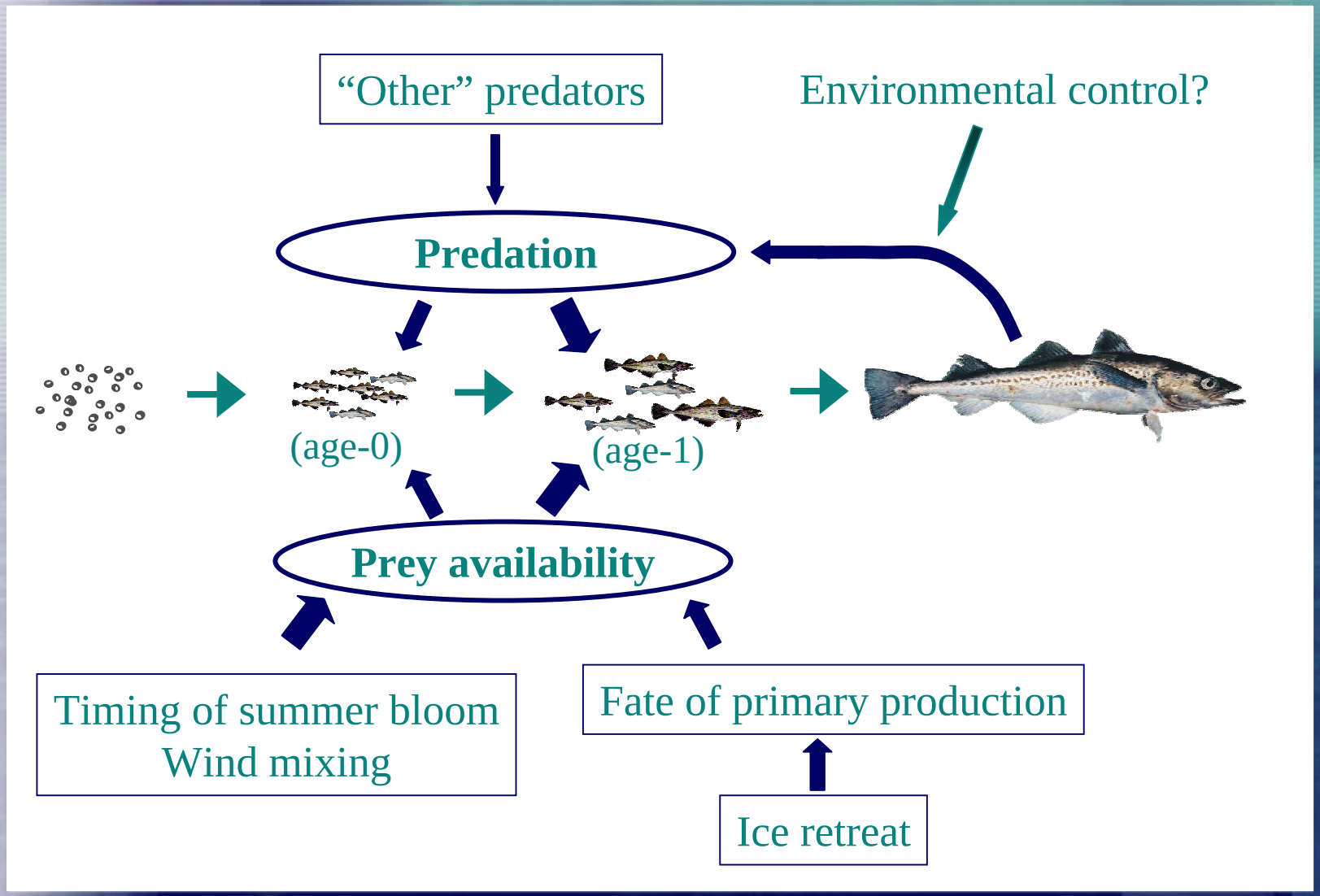
Top-down control

- **Index of spatial association as predictor of log-survival and recruitment**





Bottom-up and top-down controls



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Pat Livingston, AFSC