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Fish responses to climate variation among capital-income breeders

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PICES25: Climate Variability, Climate Change and
the Reproductive Ecology of Marine Populations



Outline

Defining Capital and Income breeder

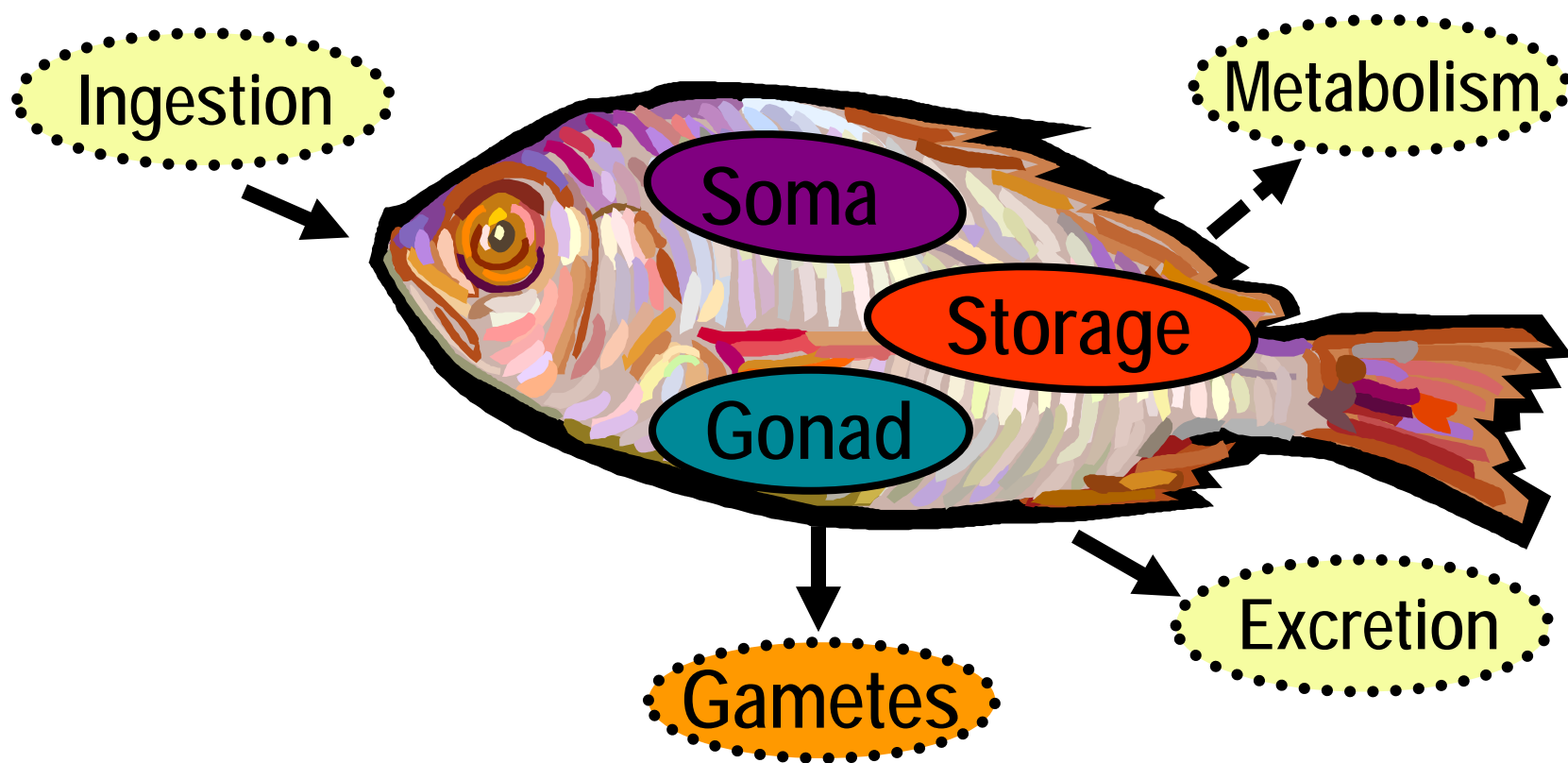
Capital breeder responses

Income breeder responses

Comparative approaches

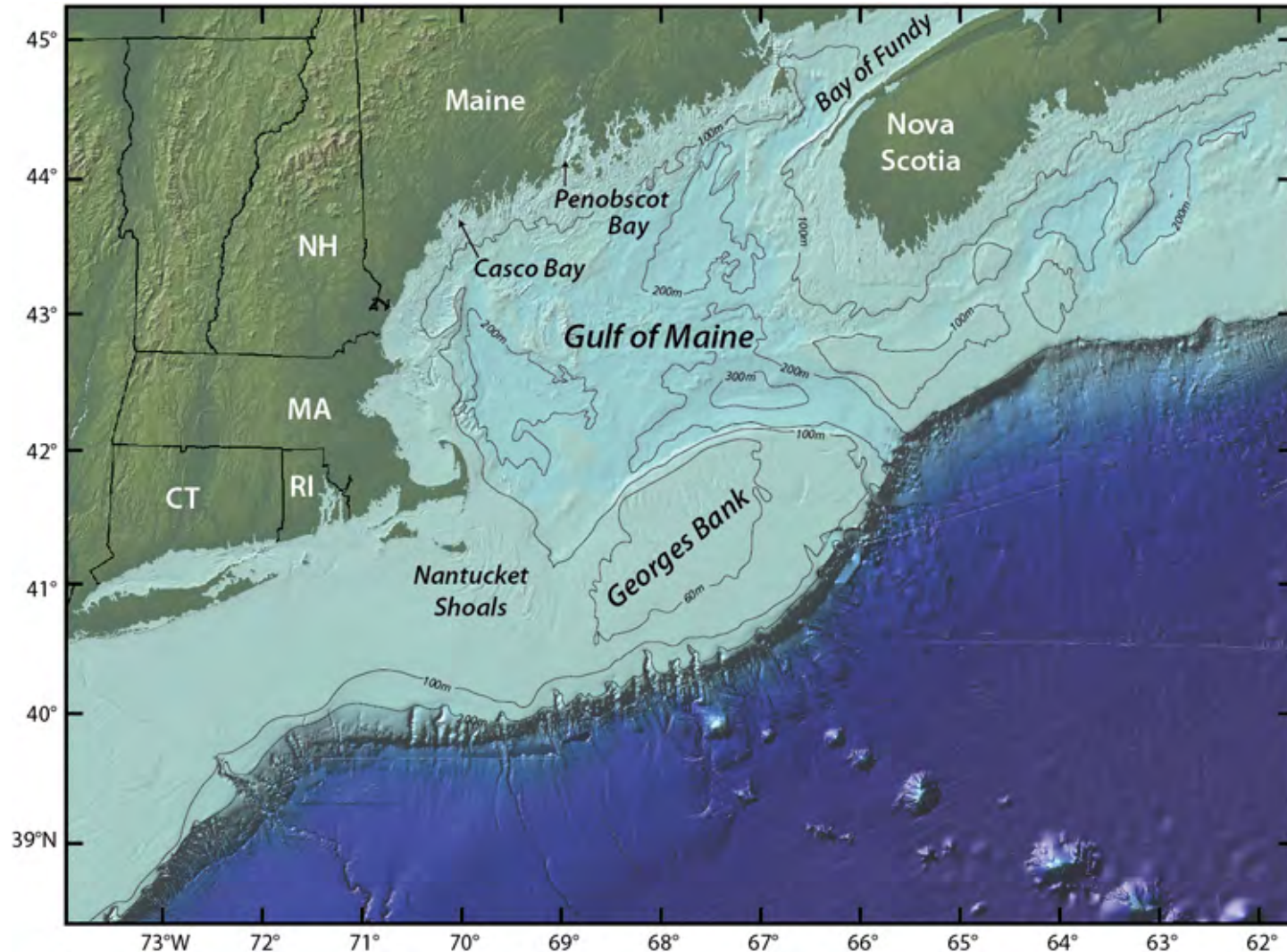
You allocate what you eat

As a ~~capital breeder~~ ~~capital breeder~~

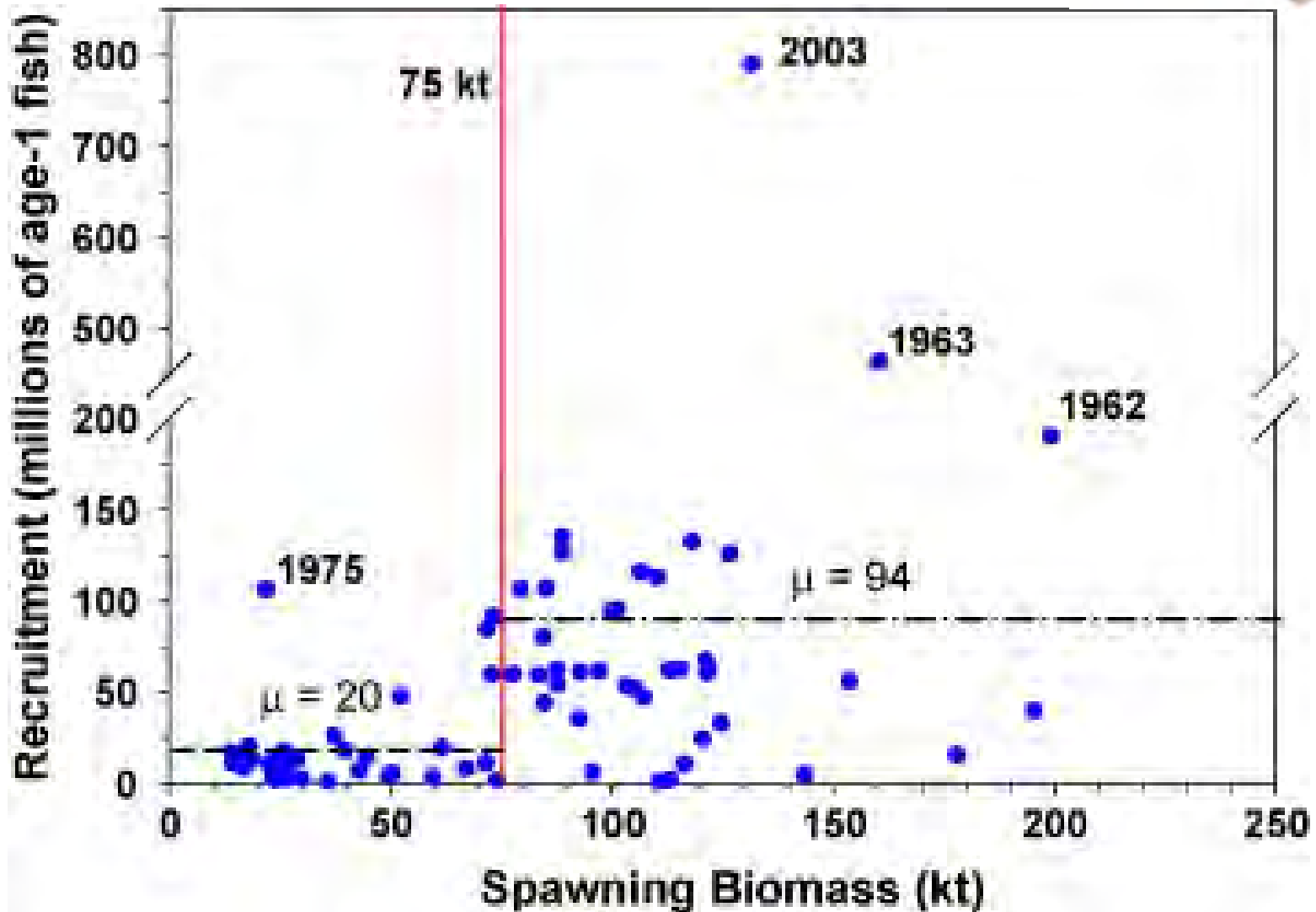


Georges Bank Haddock

A transboundary stock

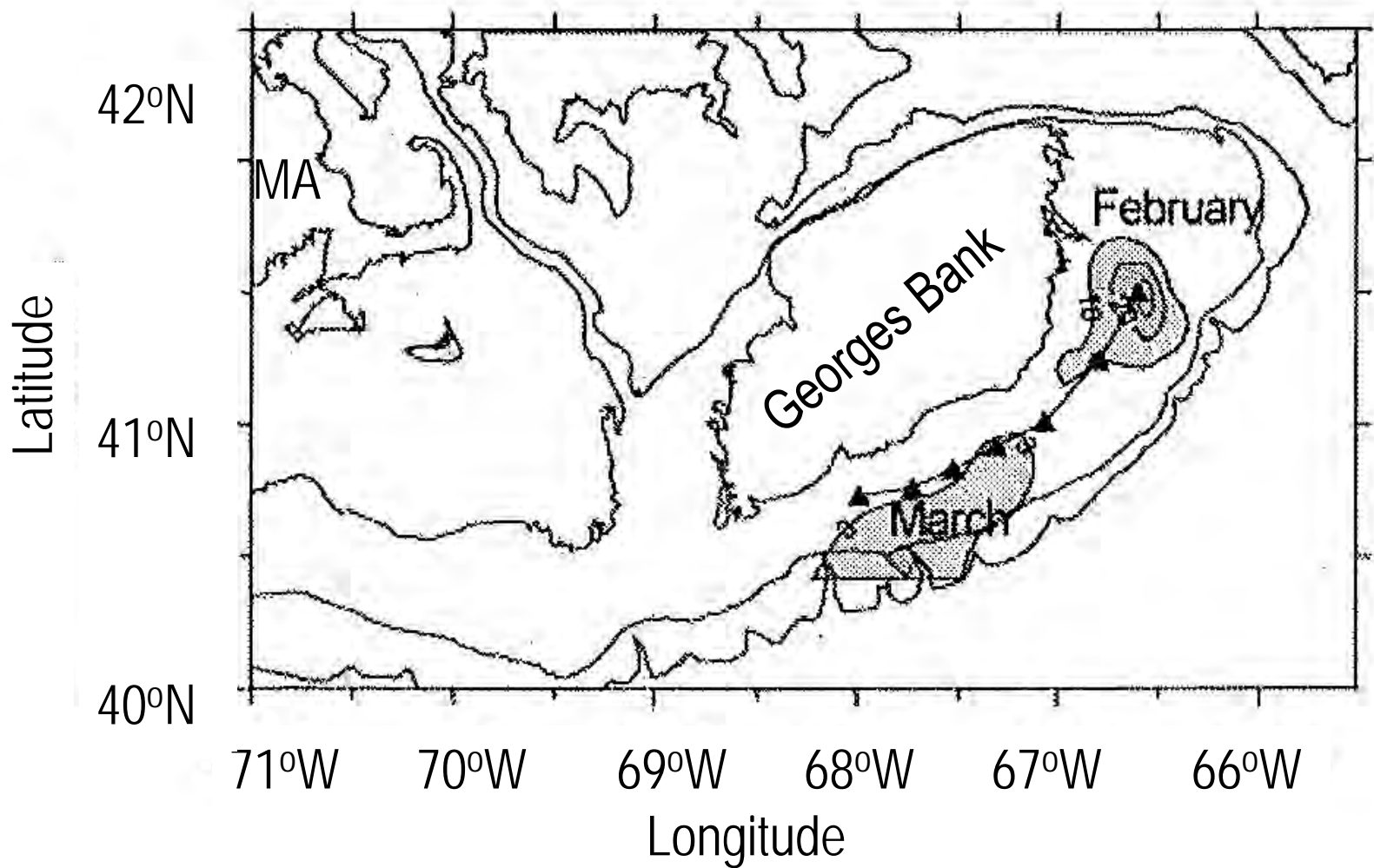


Georges Bank Haddock, stock – recruit





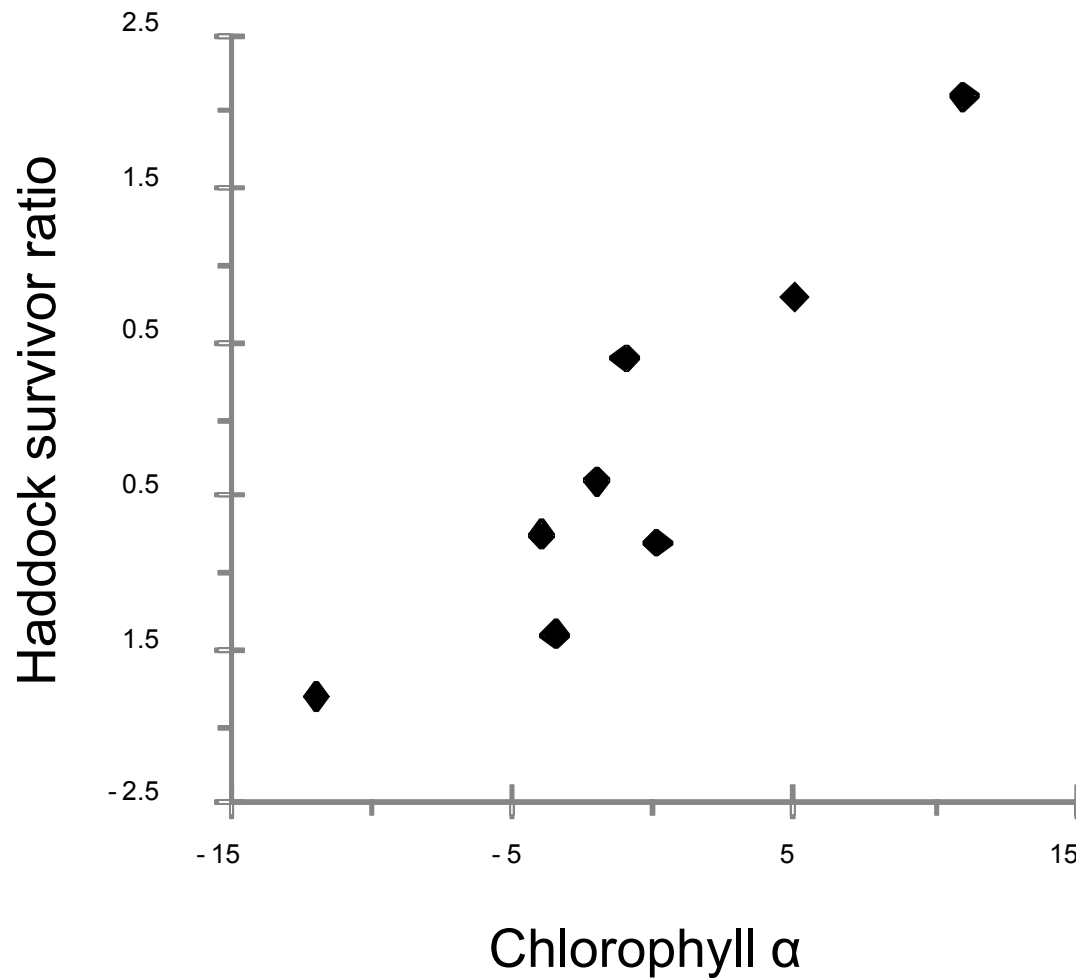
Haddock eggs and larvae drift Georges Bank gyre



Recruitment ~ 1⁰ productivity

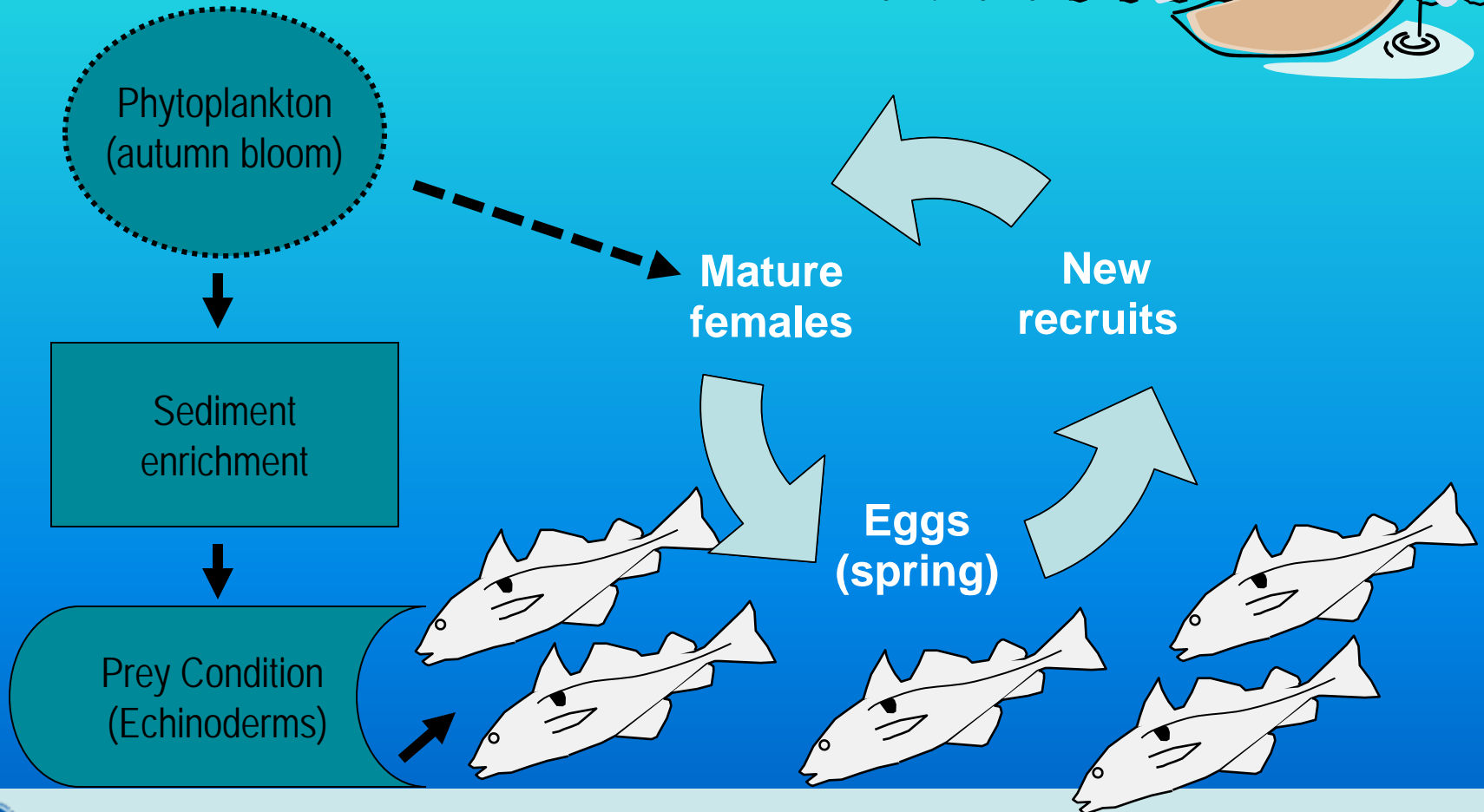


Haddock, Capital breeder





Correlation: Parental condition—autumn bloom match-mismatch hypothesis



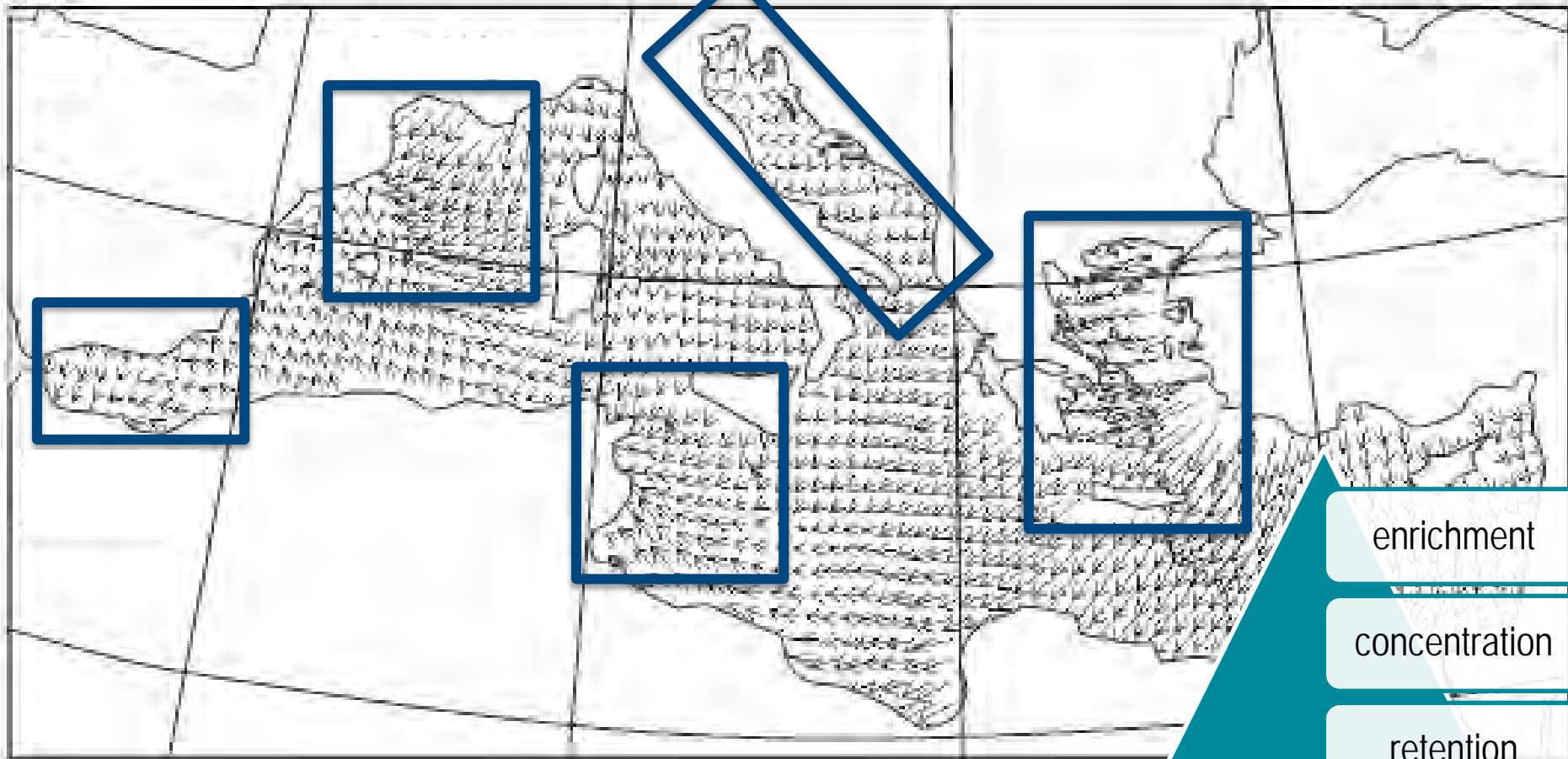
European anchovy

Mediterranean Sea (oligotrophic)



European anchovy

June-July Ekman transport vectors



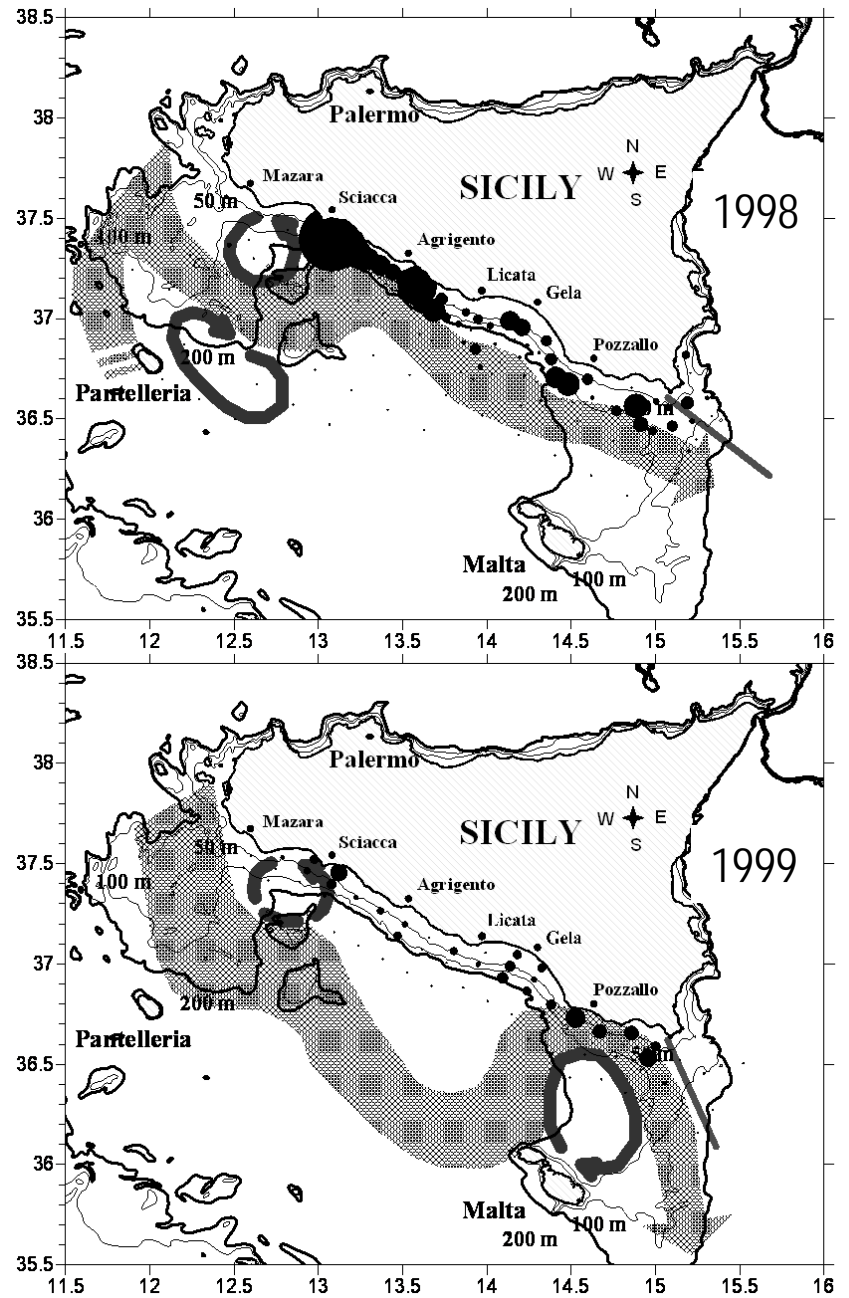
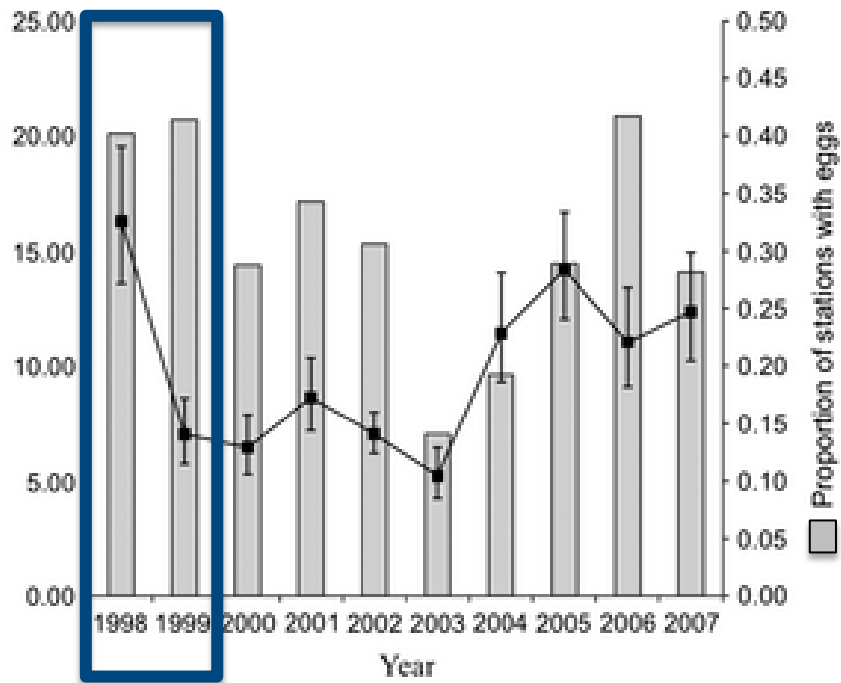
enrichment

concentration

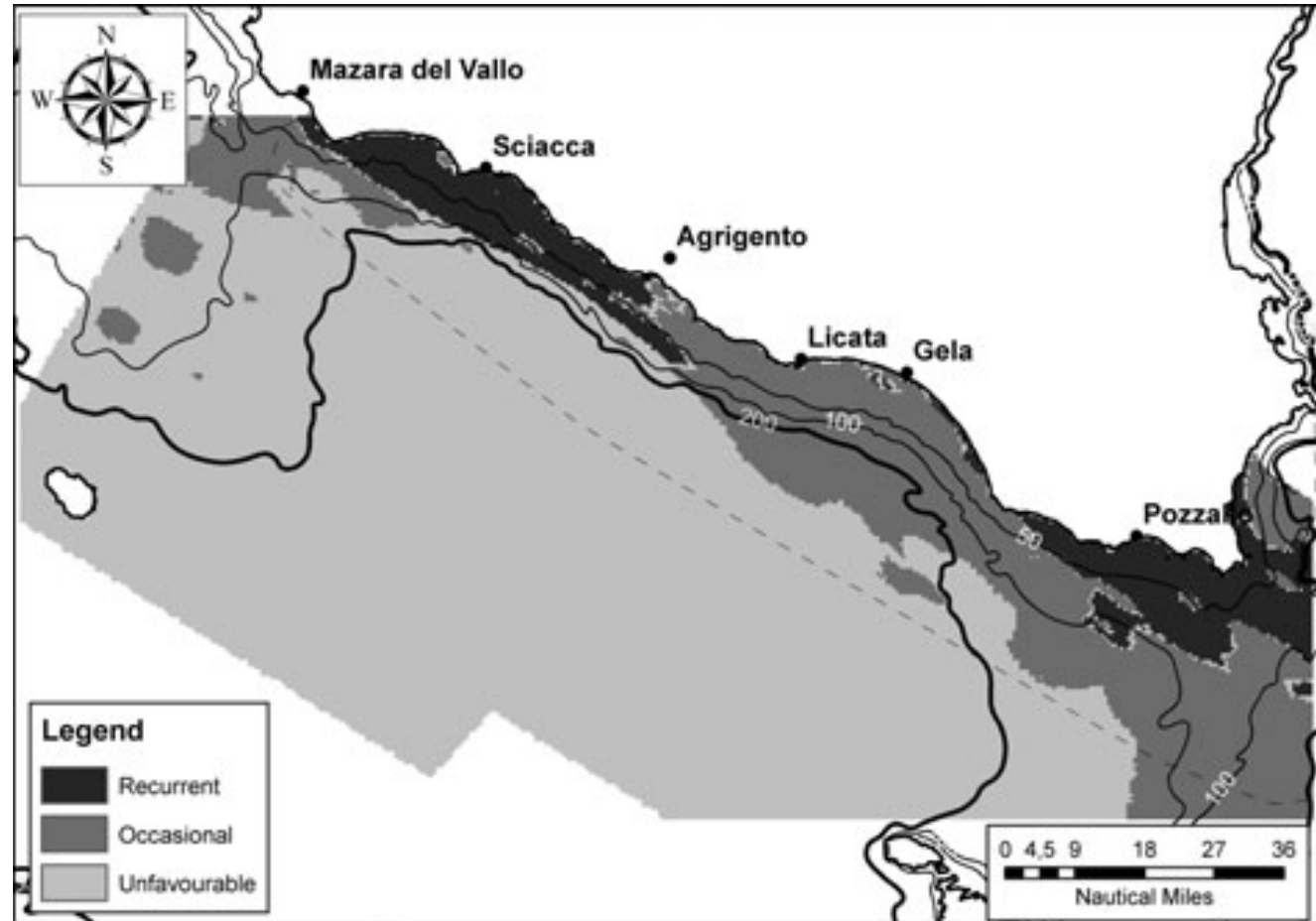
retention

European anchovy

Summer egg surveys



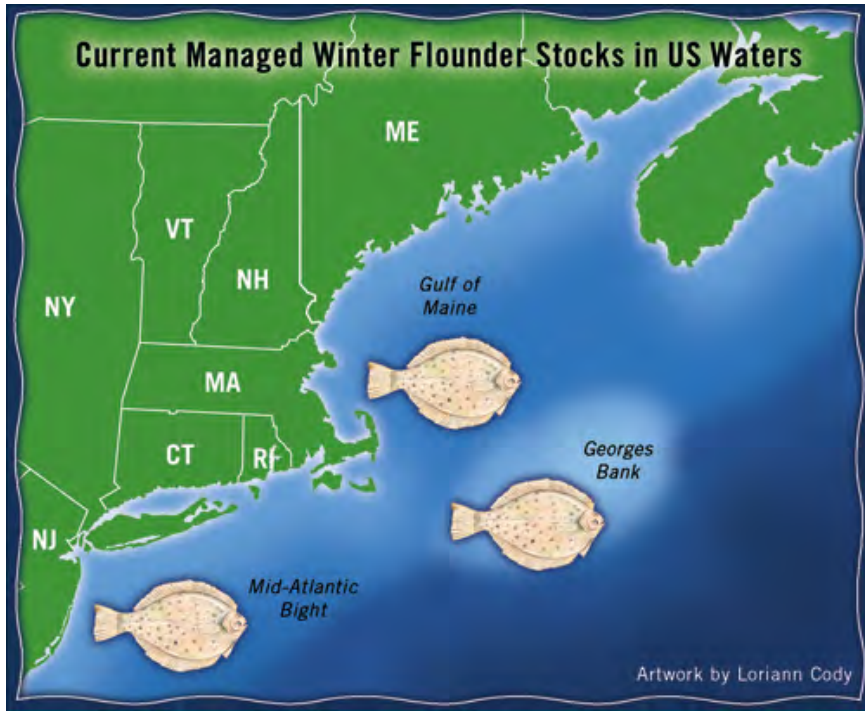
European anchovy



Spawning habitat in the Sicilian Straits



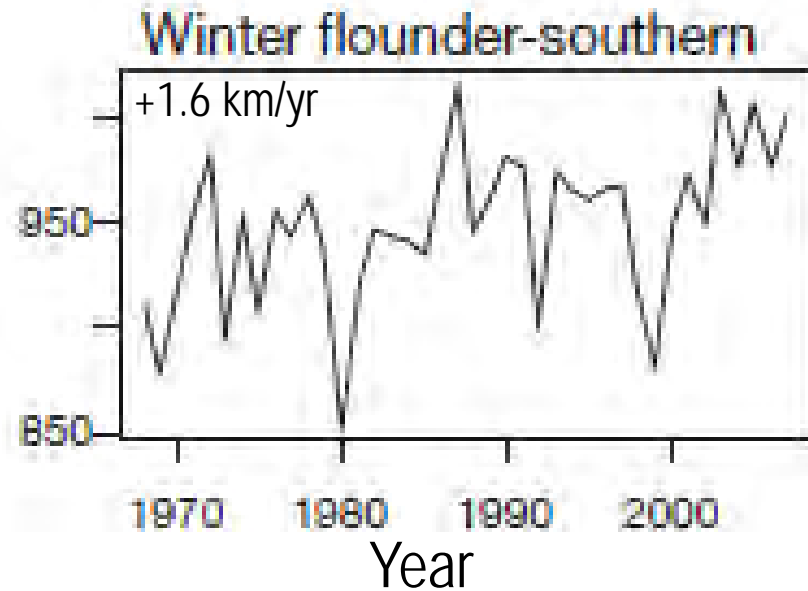
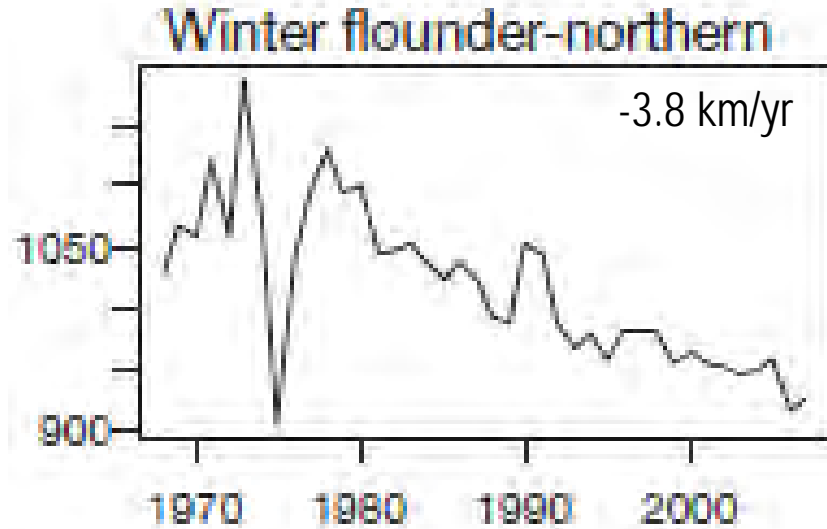
Winter flounder



Three U.S. stocks

Δ mean distribution / yr

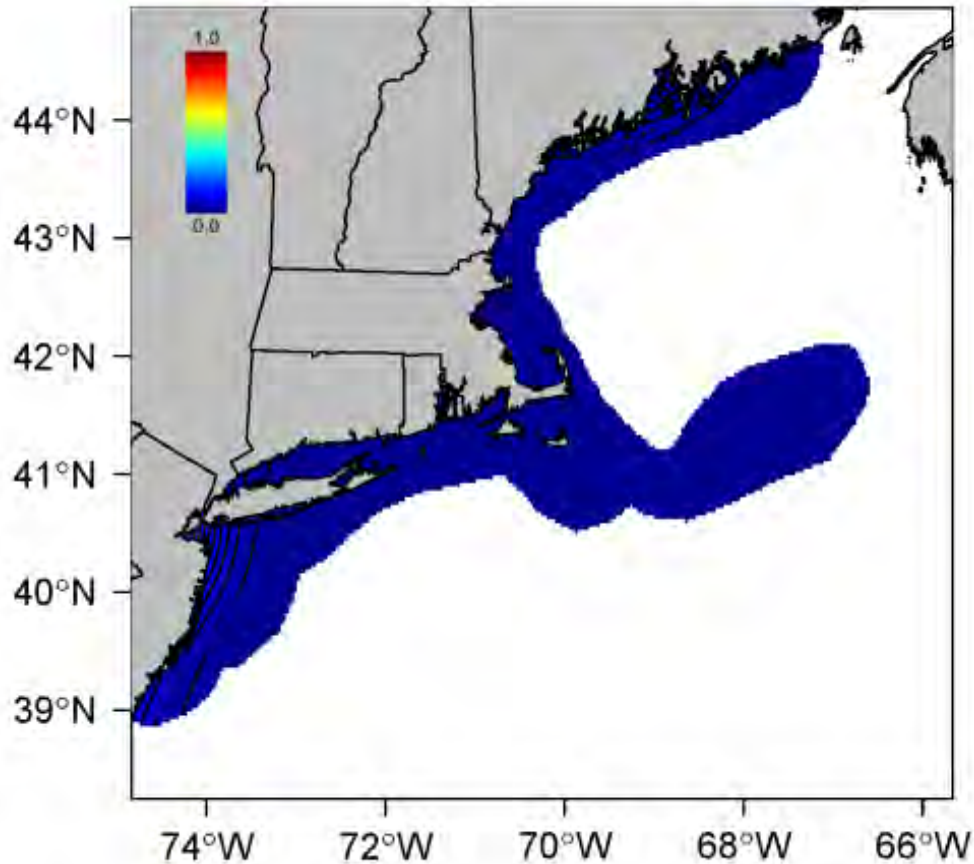
Mean center of biomass during spring survey
(km from southernmost survey point)



Spatial variation in maturity rates



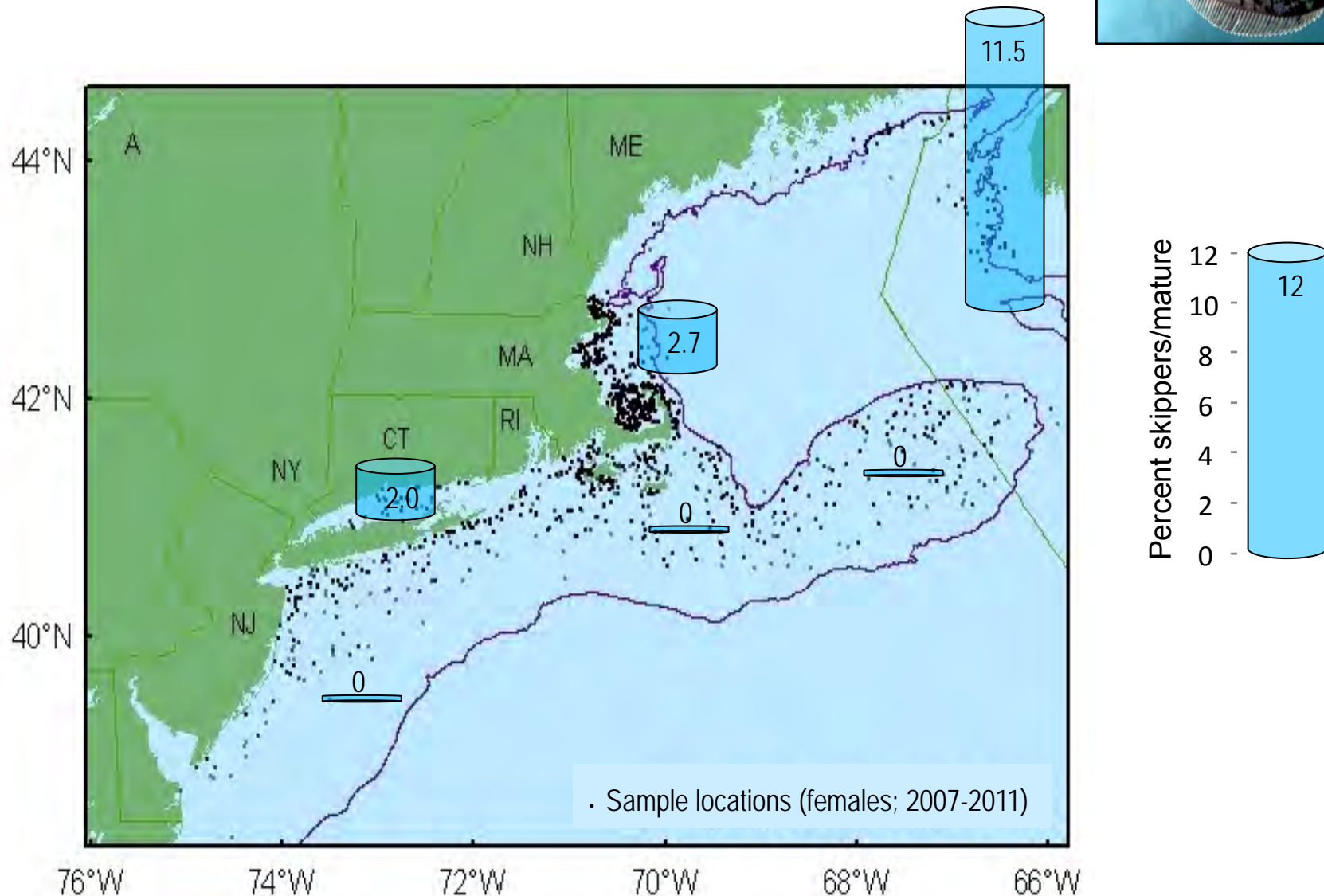
Probability of maturity at age 1



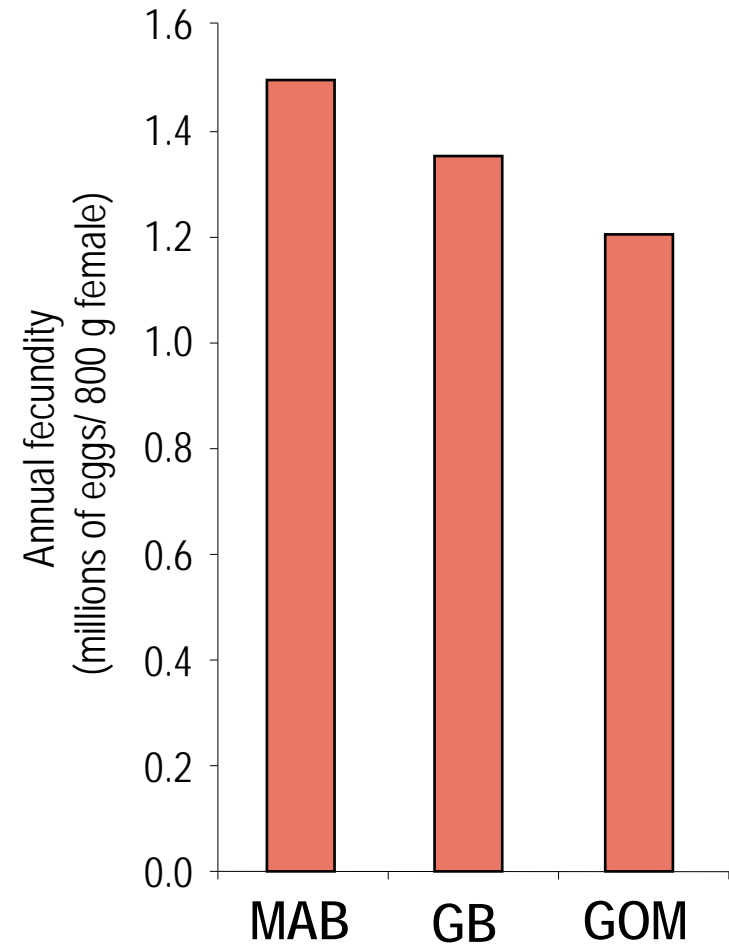
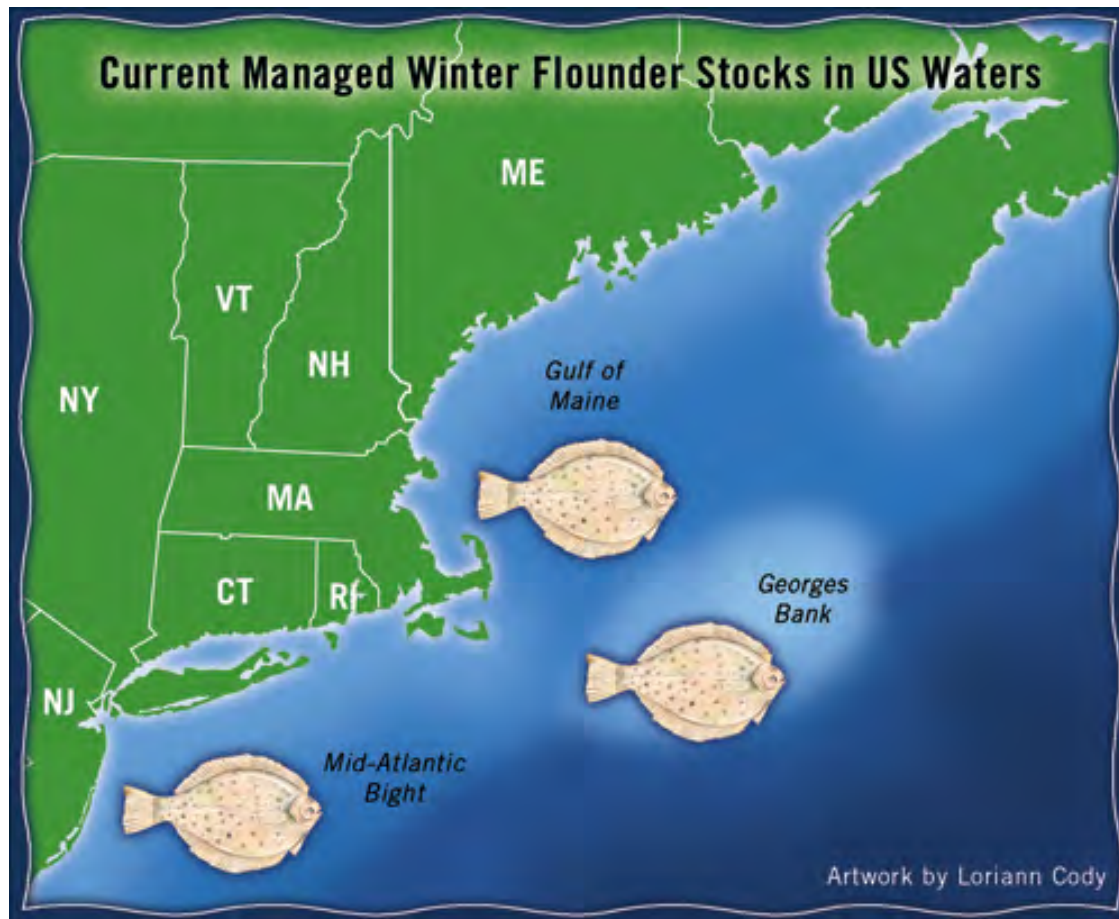
Generalized Additive Model
of spatial variation in female
winter flounder maturity
(movie)

Megan Winton (NOAA HAIP funded)

Spatial variation in skip spawning rates

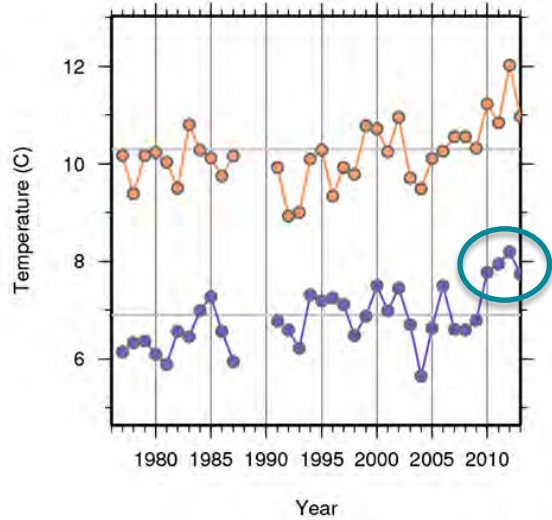


Spatial variation in annual fecundity

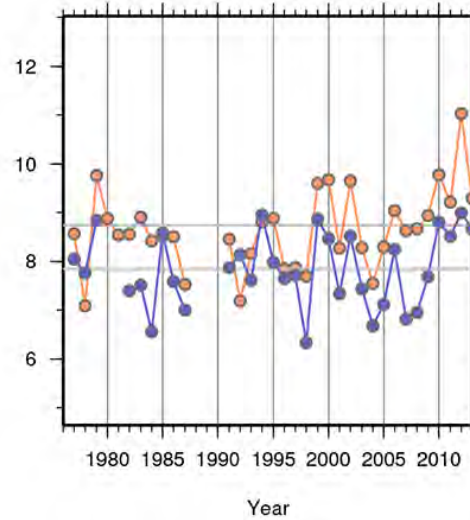


Moving in place?

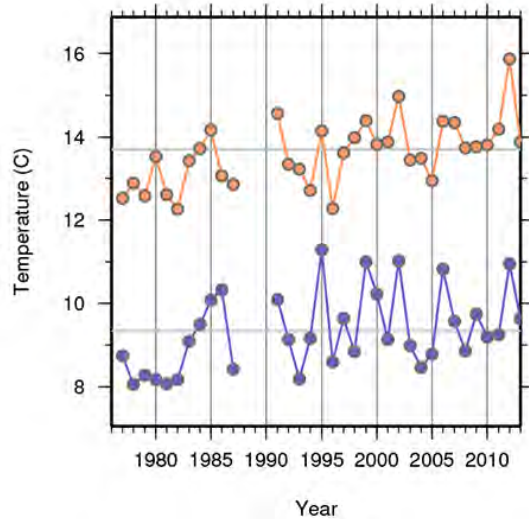
(a) Western Gulf of Maine



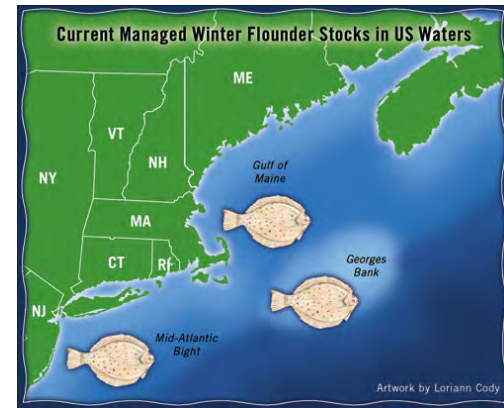
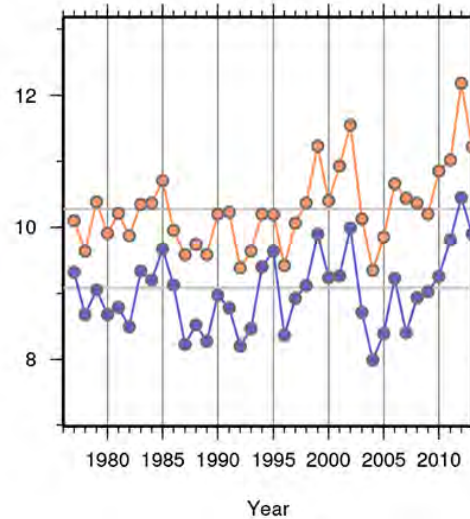
(b) Eastern Gulf of Maine



(c) Middle-Atlantic Bight



(d) Georges Banks



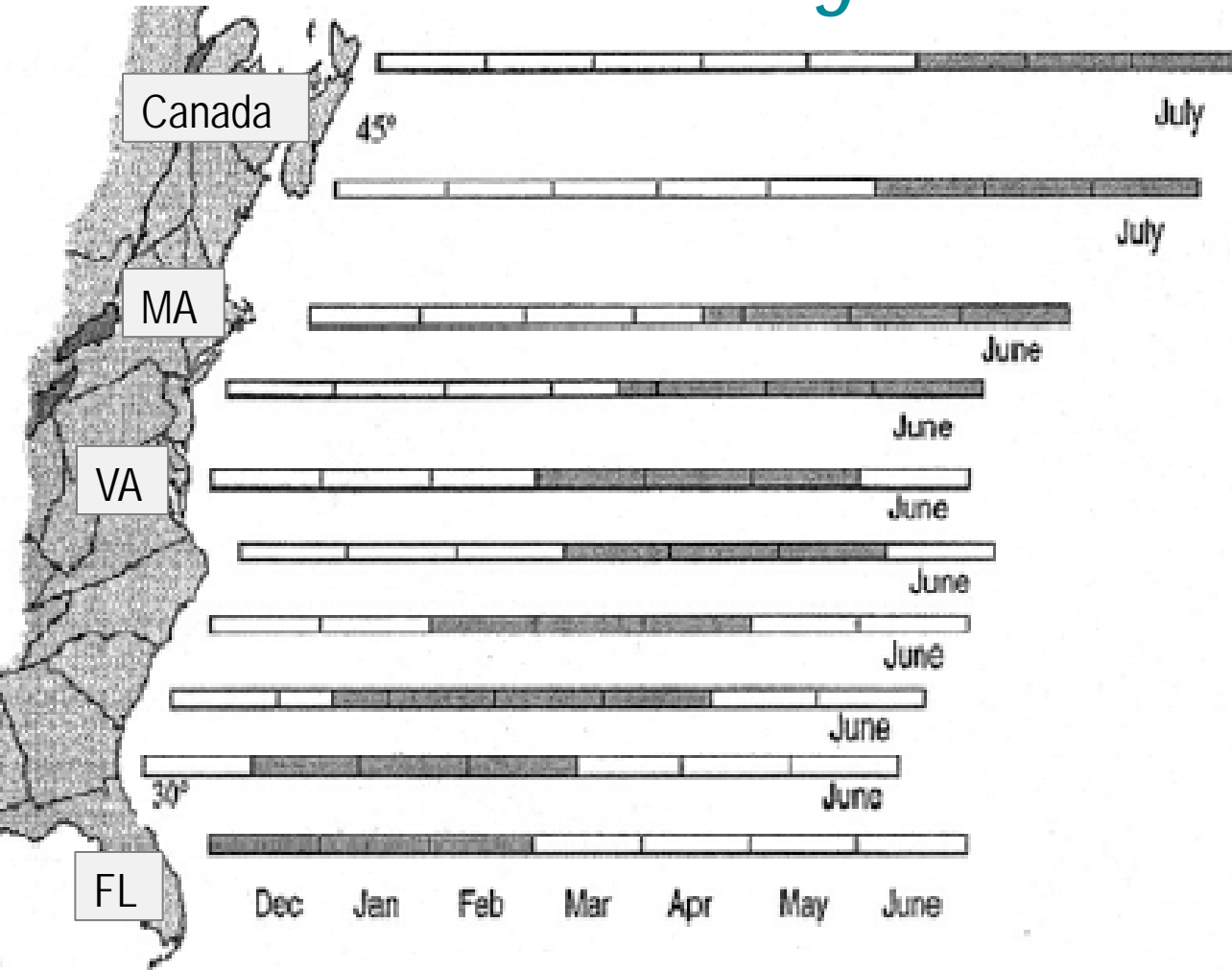
Temperature

- Surface
- Bottom

American shad life history varies across its range



American shad,
Alosa sapidissima

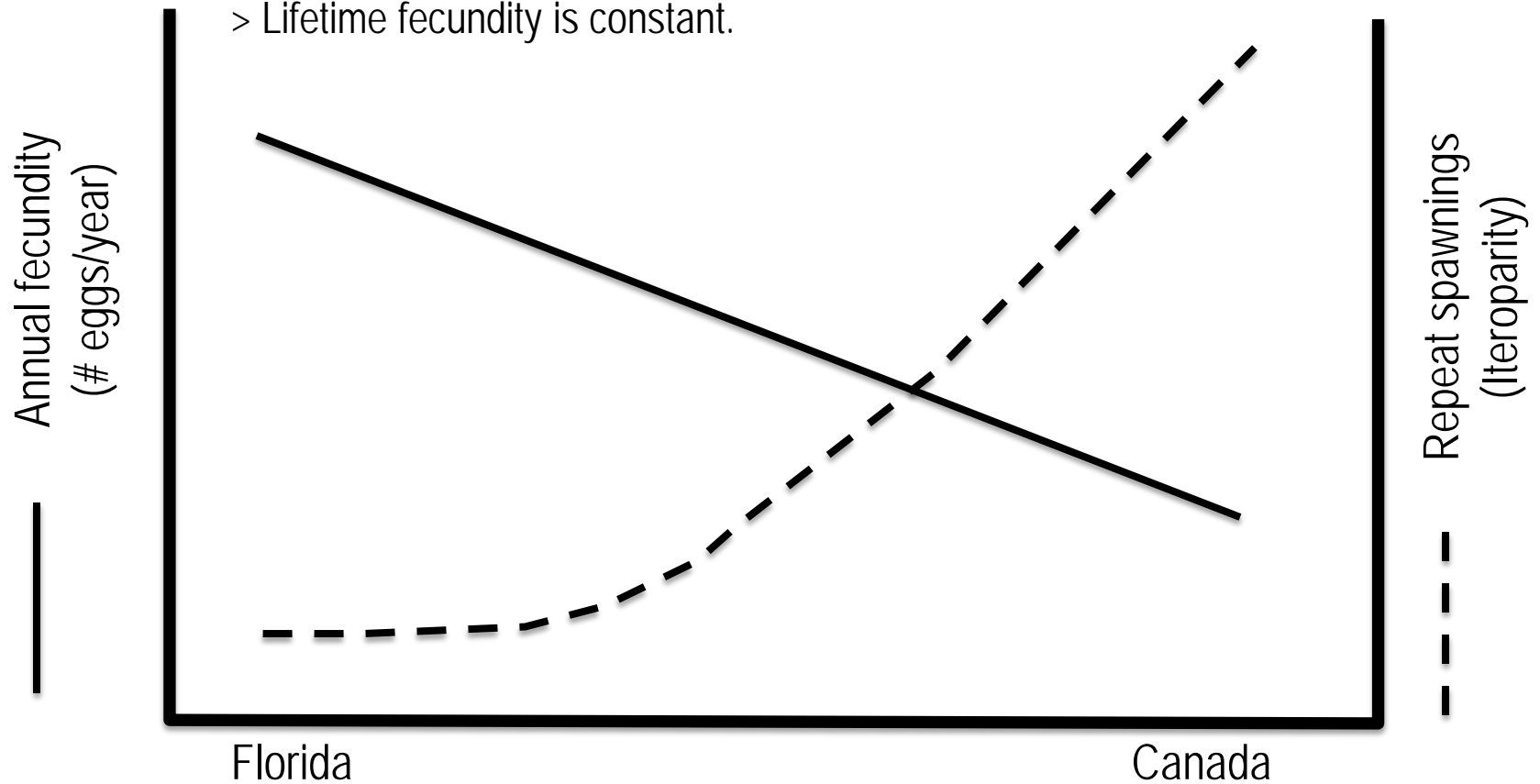


Filled boxes depict spawning period by latitude

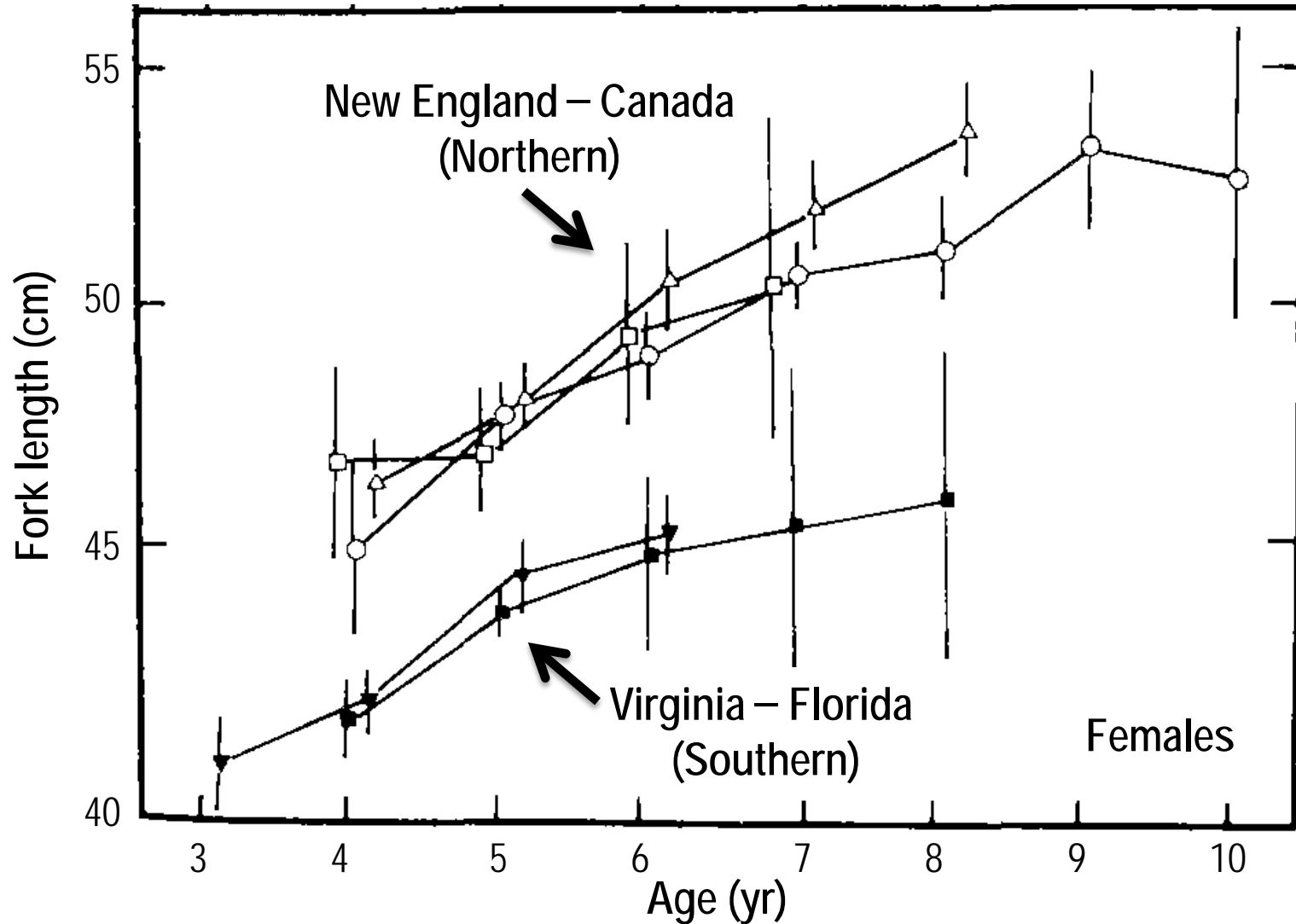
Adaptive significance of life history variation



Annual fecundity declines with latitude.
Repeat spawning increases with latitude.
> Lifetime fecundity is constant.



Size at age decreases with latitude





Take homes

Egg production ~ acquired & allocated energy

McBride et al. (2015) Fish & Fisheries, DOI: 10.1111/faf.12043

Spatial & temporal scales of egg production will vary
between capital (annual) and income (daily) breeders

Intra-specific, between population, comparisons inform predictions of
how existing populations will respond to climate change

ICES Annual Science Conference 2017 theme session:

**Patterns, sources, and consequences of intraspecific variation in responses of
marine fauna to environmental stressors**

Organizers: Christopher Chambers, Hannes Baumann, Guðrún Marteinsdóttir,
and Richard S. McBride

September, 2017, Broward County Convention Center, Fort Lauderdale, Florida, USA.



Energy acquisition and allocation to egg production in relation to fish reproductive strategies

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Abstract

Oogenesis in fishes follows a universal plan; yet, due to differences in the synchrony and rate of egg development, spawning frequency varies from daily to once in a lifetime. Some species spawn multiple times during different seasons (i.e. **capital breeding**) throughout a prolonged spawning season, allocating energy directly to reproduction (i.e. **income breeding**). Capital breeders tend to ovulate all at once and are more likely to be distributed at boreal latitudes. Income breeding allows small fish to overcome allometric constraints on egg production. Income breeders can recover more quickly when good-feeding conditions are re-established, which is a benefit to adults regarding bet-hedging spawning strategies. **Many species exhibit mixed capital- and income-breeding patterns.** An individual's position along this capital–income continuum may shift with ontogeny or in relation to environmental conditions, so breeding

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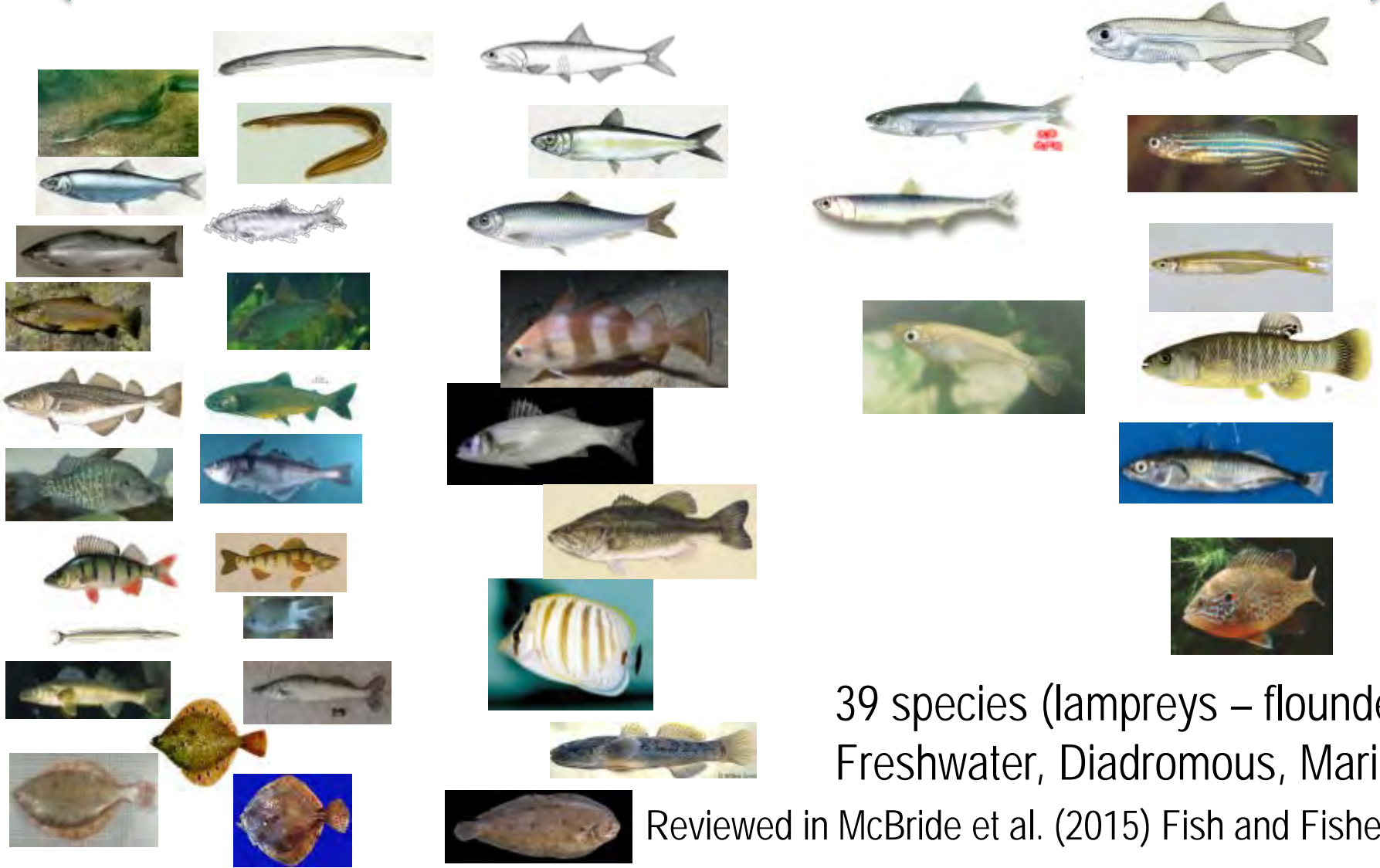


Capital

Capital-Income

Income-Capital

Income



39 species (lampreys – flounders)
Freshwater, Diadromous, Marine

Reviewed in McBride et al. (2015) Fish and Fisheries.

Acknowledgements

NOAA's MARVLS (Maturity Assessment, Reproductive Variability, and Life Strategies) working group.

Northwest Atlantic Fishery Organization working group on reproductive potential.

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Fish Reproduction and Fisheries (FRESH).**