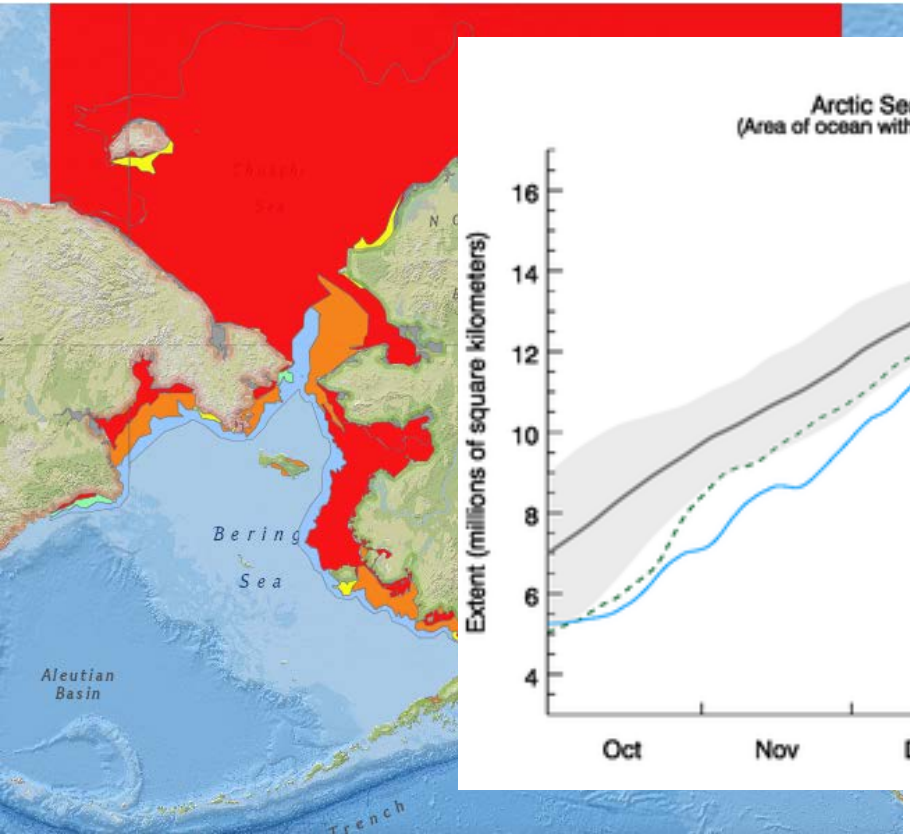
# Fish Distributions & Dynamics

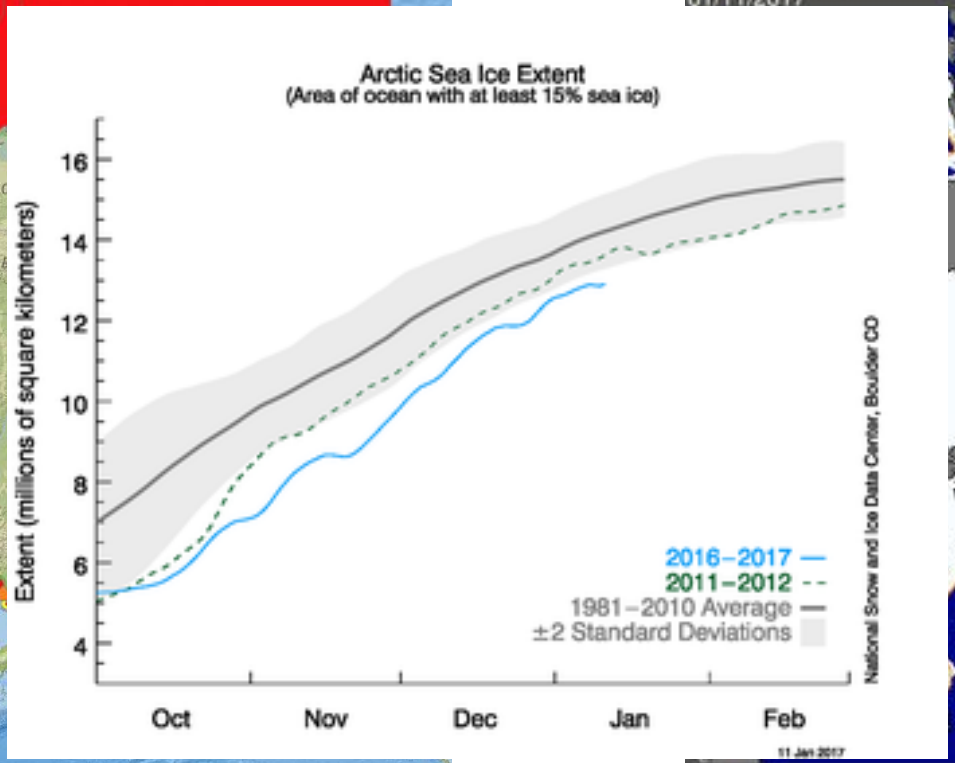
LO: systematize relative importance of physical forces on vertical and horizontal distributions of commercially important fish life history stages

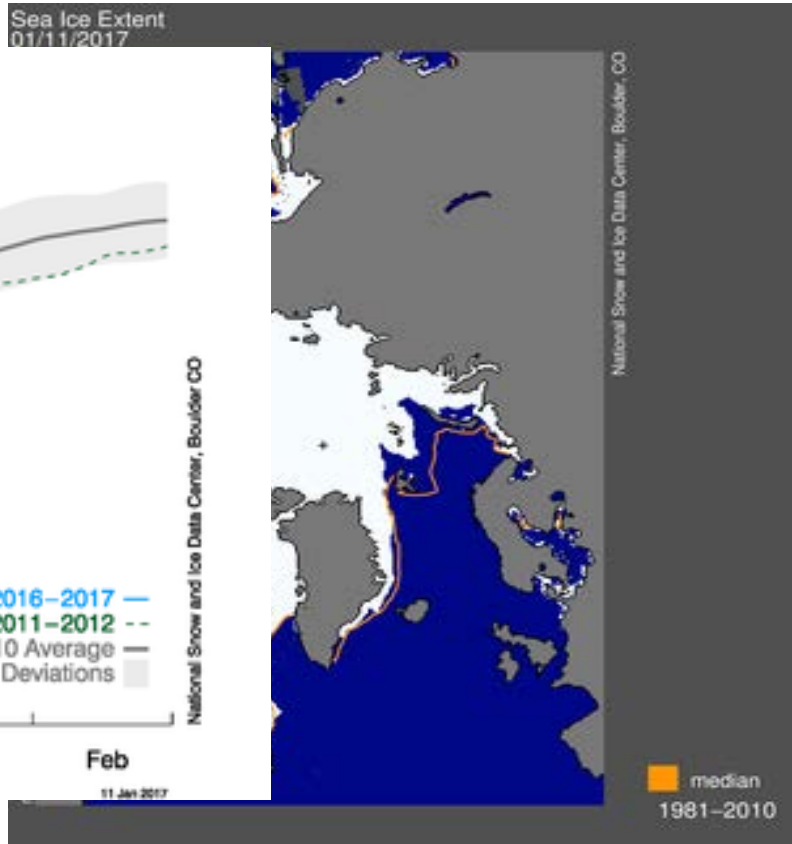
# NE Pacific Followup

What physical mechanisms are important in the Gulf of Alaska and the Bering Sea?

Can you compare and contrast physical forces that drive water circulation in the two regions?



# Stages in Scientific Research

Quantitative Pattern Description

Process Identification & Quantification

# Vertical Distributions of Fish

## Neritic (low tide to edge of continental shelf)

Pelagic (silvery fish): clupeoids, osmerids, scombrids

Demersal (brown, black, red fish): gadids, pleuronectids

## Oceanic Nekton

Epipelagic (silvery fish): scombrids, salmonids

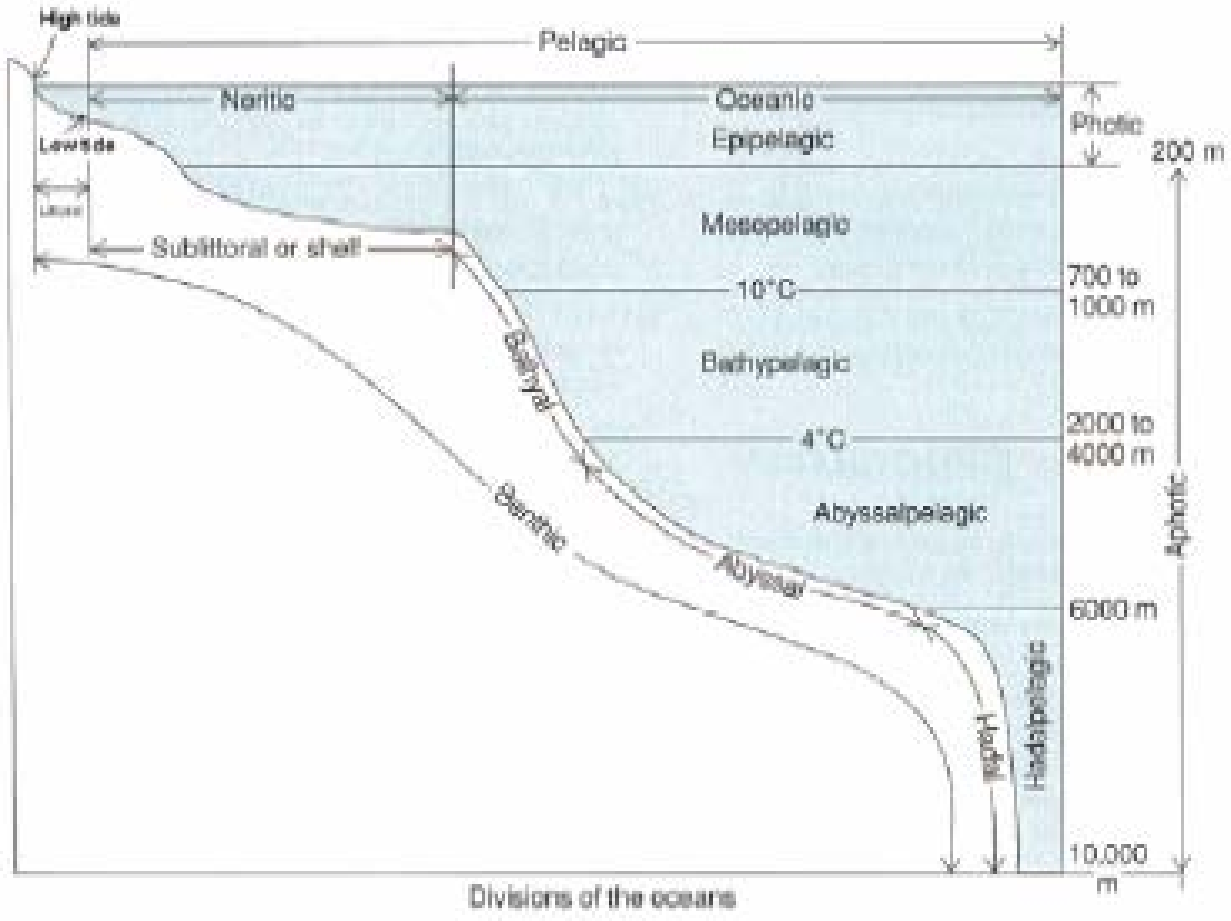
Mesopelagic (black, enlarged eyes, bioluminescent): myctophids, stomiatids

- may migrate to epipelagic at night

Bathypelagic (black without photophores): ceratids (anglerfish), saccopharyngids (gulpers and swallowers)

Abyssalpelagic (reduced or no swimbladders): macrourids (grenadiers)

# Let’s name the zones…




Hedgepeth 1957

**Epipelagic** scrombrids, salmonids

**Mesopelagic** myctophids

**Bathypelagic** ceratioidei (anglerfish)

**Abyssopelagic**

macrourids

**Hadopelagic**

(too deep for you and me to see!)

# Vertical Positioning By Fish

## Passive

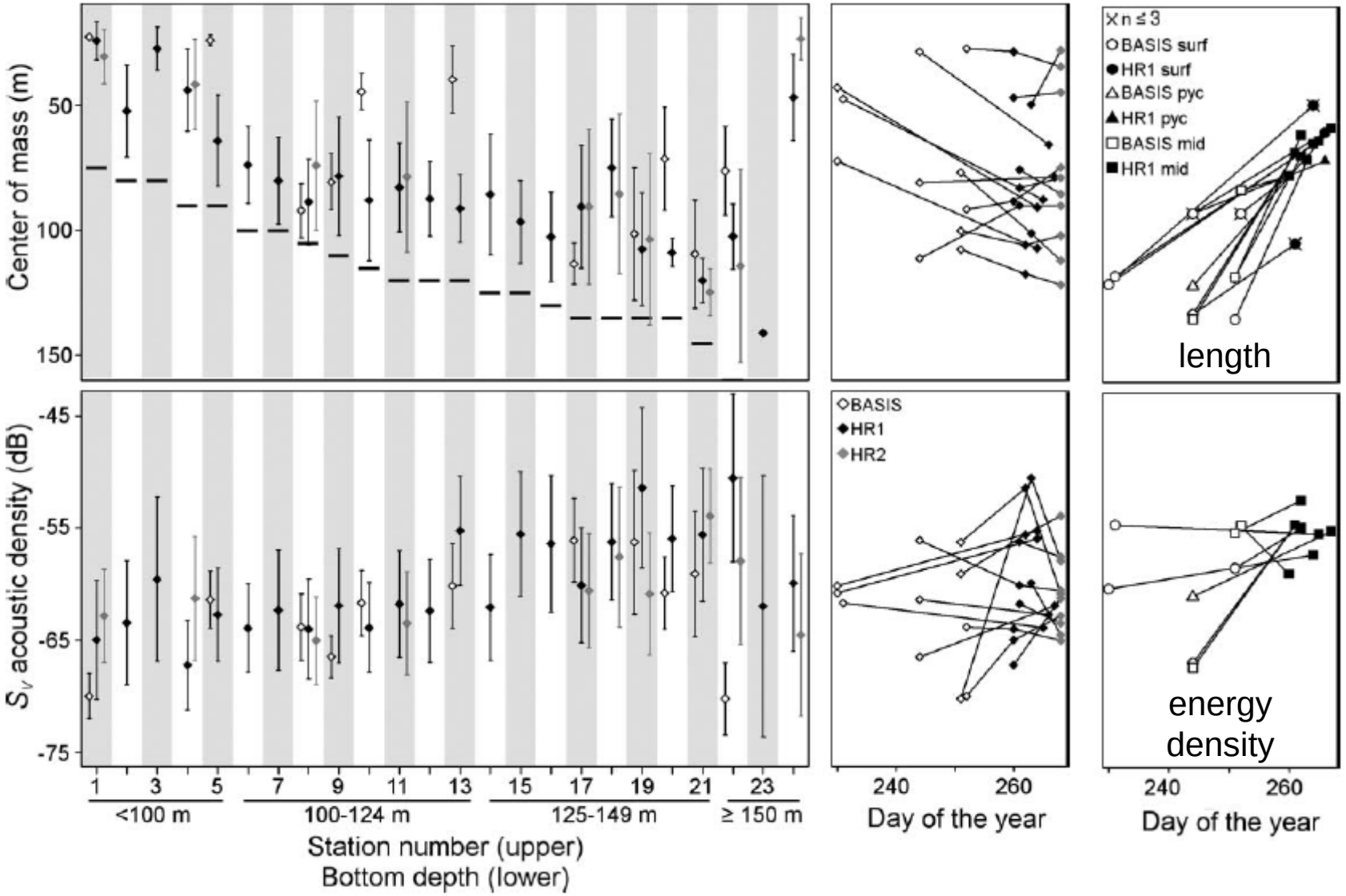
- buoyancy (fat content, specific gravity)

## Active

- hovering
- swimming adjusting tilt angle or fins
- swimbladder regulation (physiological)
- swimming to exploit or avoid currents and tides

Strand et al. 2005

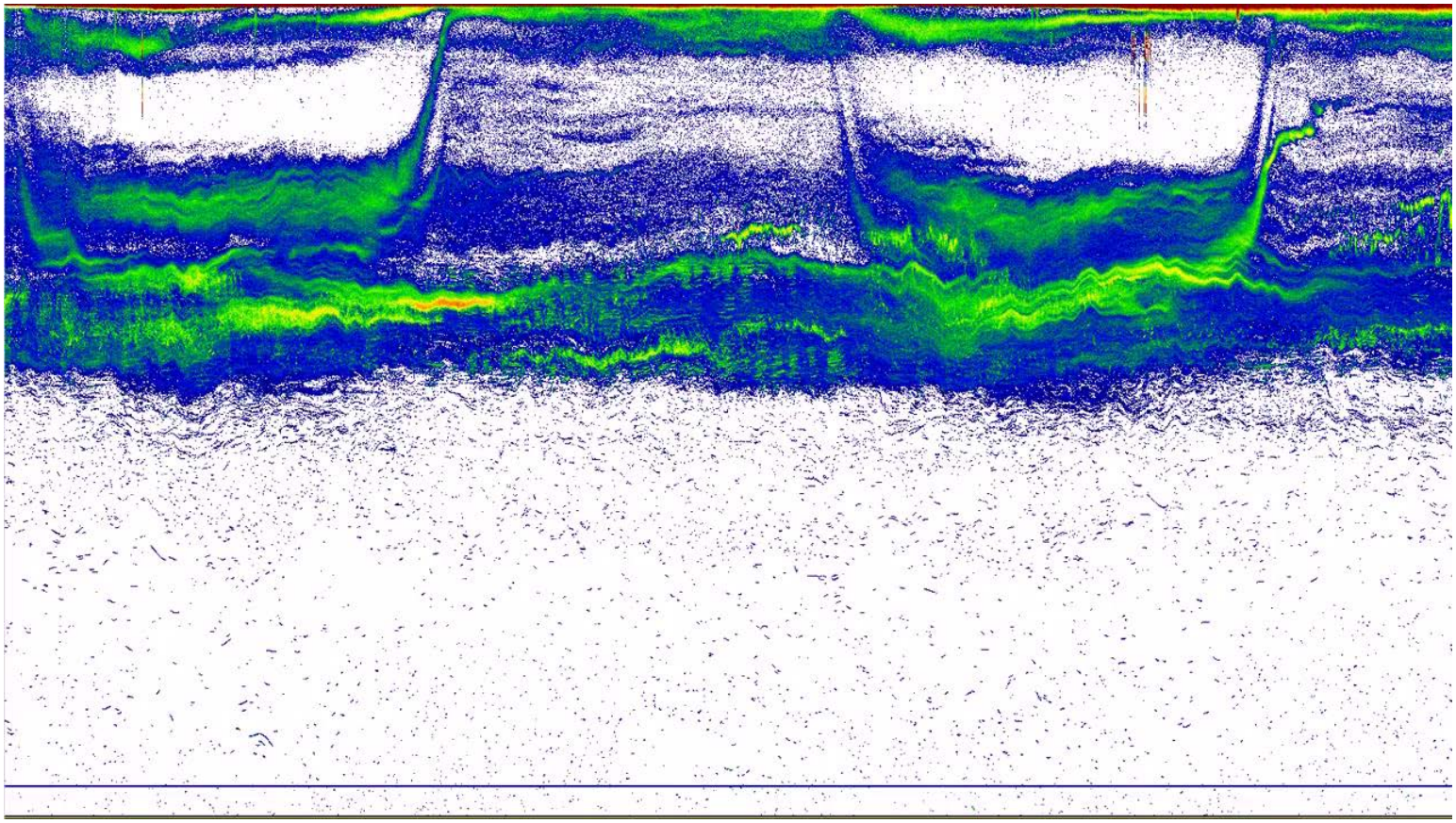
# Ontogenic Distribution Shifts




Parker-Stetter et al. 2015

# Diel Vertical Migration

Monterey Bay, Smooth Ridge
Feb. 28 – Mar. 6, 2009



# Horizontal Distributions

Topography shelf, slope, bank, open ocean

Climate Zone arctic, boreal, temperate, subtropical, tropical

Ocean and Hemisphere

Hydrographic Characteristics gyres, upwelling, fronts

Importance of Typography (Ryther 1969)

| Region | % Ocean Area | Fish Production ($\times 10^7$ t) |
|---|---|---|
| Open Ocean | 90.0 | 0.16 |
| Coastal | 9.9 | 12.0 |
| Upwelling | 0.1 | 12.0 |

# Biogeography

## Arctic ($T < 4\text{-}6^{o}$)

Atlantic – Barents and White Seas

Pacific – North of Bering Strait, Chukchi Sea, Beaufort Sea

Planktivores: herring, capelin, arctic cod

Benthic feeders: tomcod, arctic flounder

## Boreal ($4\text{-}6^{o} < T < 12^{o}$)

Atlantic – Asymmetric East – North Sea; West – Cape Cod to Newfoundland (seasonal); Temp: $5\text{-}7^{o}$ to $10\text{-}12^{o}$C

Pacific – N of $45^{o}$ Bering Sea, Gulf of Alaska (ice cover in winter); Temp: $-1.7^{o}$ to $8^{o}$C

Shelf Area: Atlantic – $14.2 \times 10^{6}$ km$^{2}$

Pacific – $10.2 \times 10^{6}$ km$^{2}$

# Biogeography cont'd

## Temperate ($12^o < T < 20^o$)

Atlantic – East: English Channel to Cape Blanco

West: Cape Hatteras to Cape Cod

Pacific – East: Puget Sound to Baja California

West: south to north Japan

- greater difference in species composition between oceans: clupeids, scombrids, scieanids

## Tropical ($T > 20^o$)

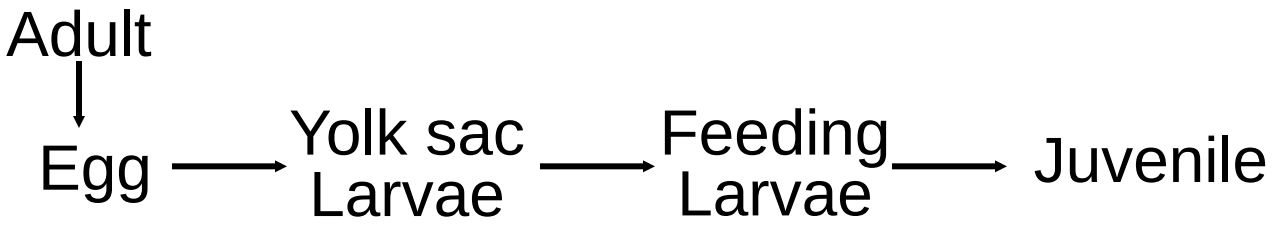
- broader on west side of oceans due to flow of equatorial currents
- great increase in species diversity: many engraulids, perciforms

# Potential Extension of Range

Chukchi & Beaufort Seas, Arctic Ocean


Walleye pollock spawning, ELH transport

# ELH Distribution Dynamics




Adult: when and where to spawn?

Egg: demersal or pelagic?

Yolk sac Larvae: go with the flow?

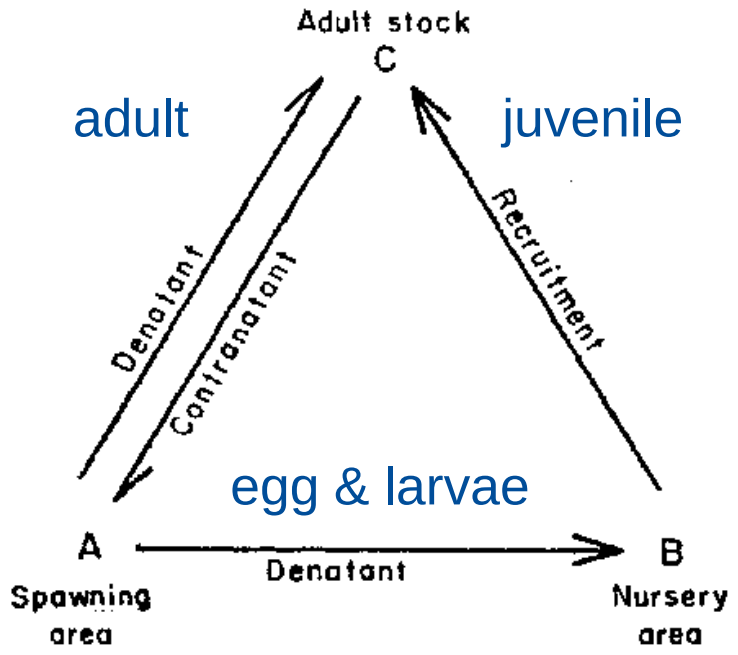
Feeding Larvae: need to feed, vertical for horizontal

Juvenile: postflexion means nekton, where to settle?

Flexion: end of spinal column bends up for caudal fin development

# Harden Jones's Triangle

feeding grounds

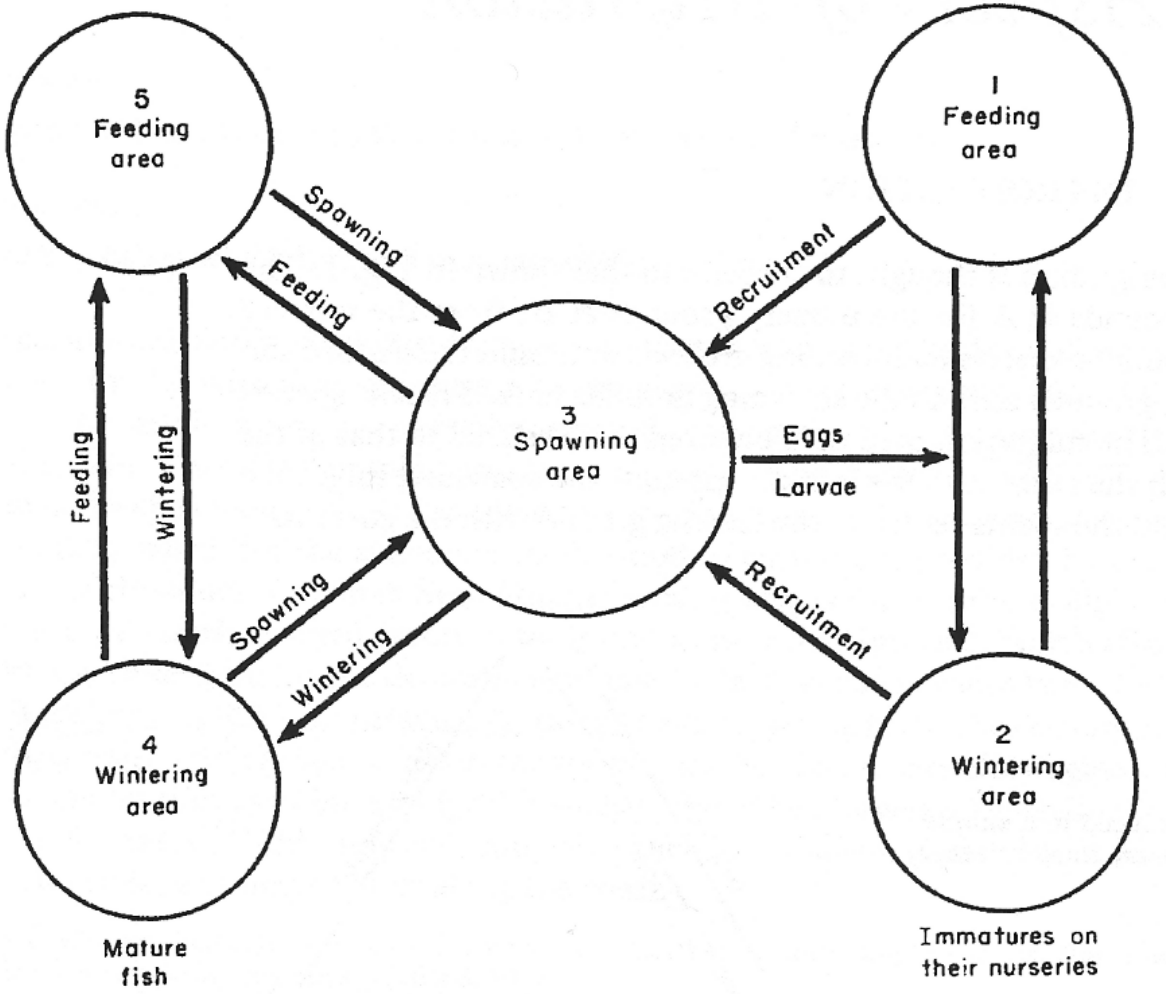



upstream

downstream

Harden Jones 1968

# Harden Jones's Triangle




- not all movements for all species or life stages
- overwintering may not exist
- feeding and spawning grounds may coincide

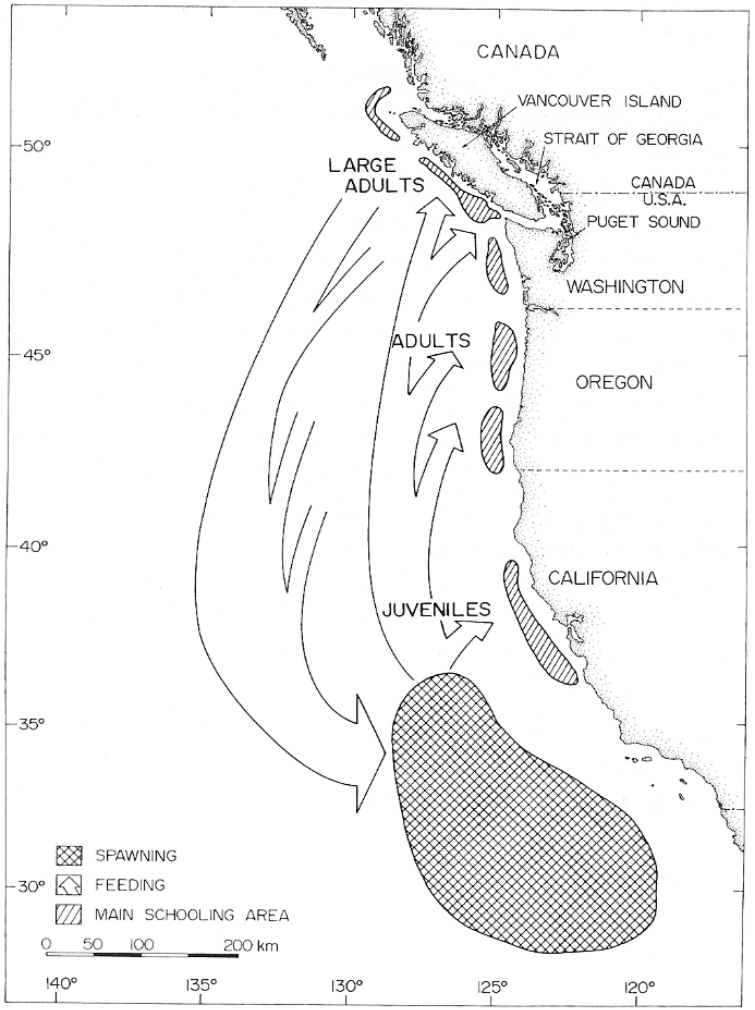
Harden Jones 1968

# Why Migrate?

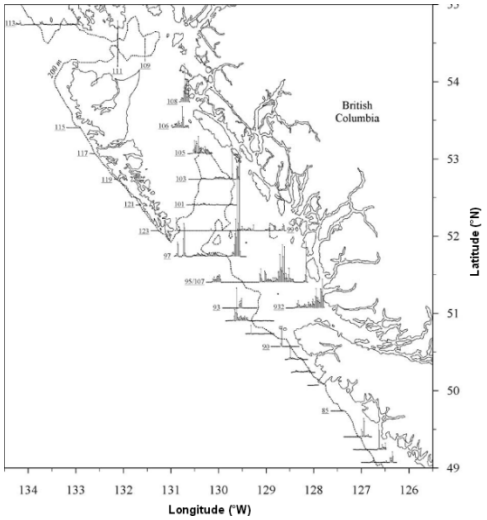
- adaptation toward sustaining abundance: not enough food in spawning or nursery grounds to sustain adult and ELH populations (different diets: mouth gape size)
- adults go to spawning grounds with potential to survive and reproduce
- spawning upstream of favorable environmental conditions (Match-Mismatch in time and space Cushing)

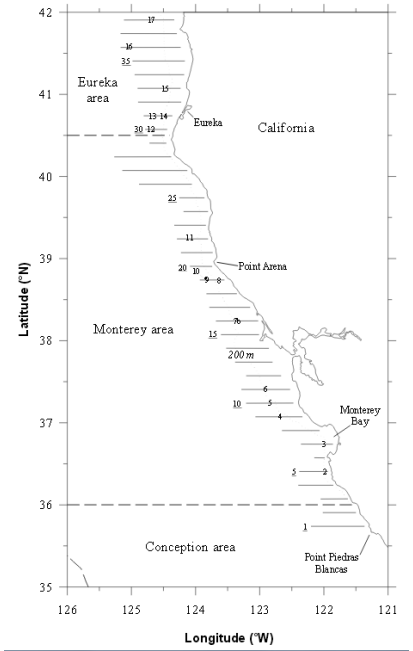
Harden Jones 1968

# Pacific Hake Bi-Annual Cycle

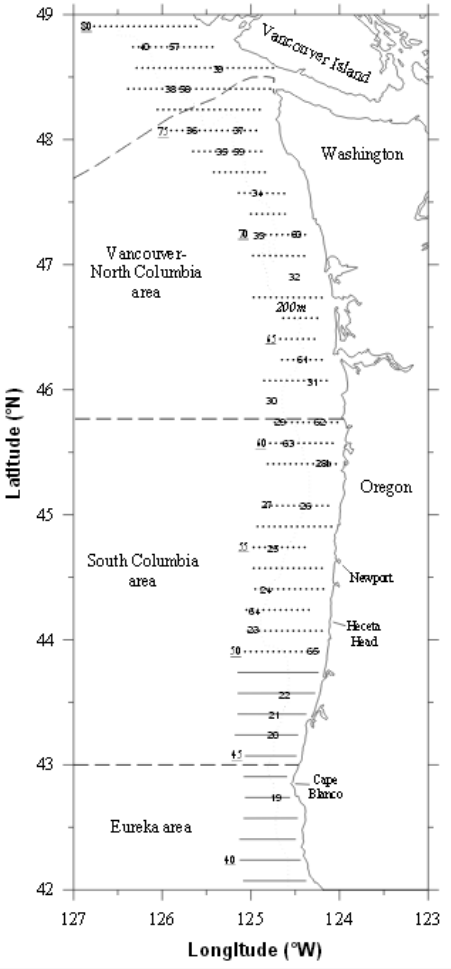



Bailey et al. 1982

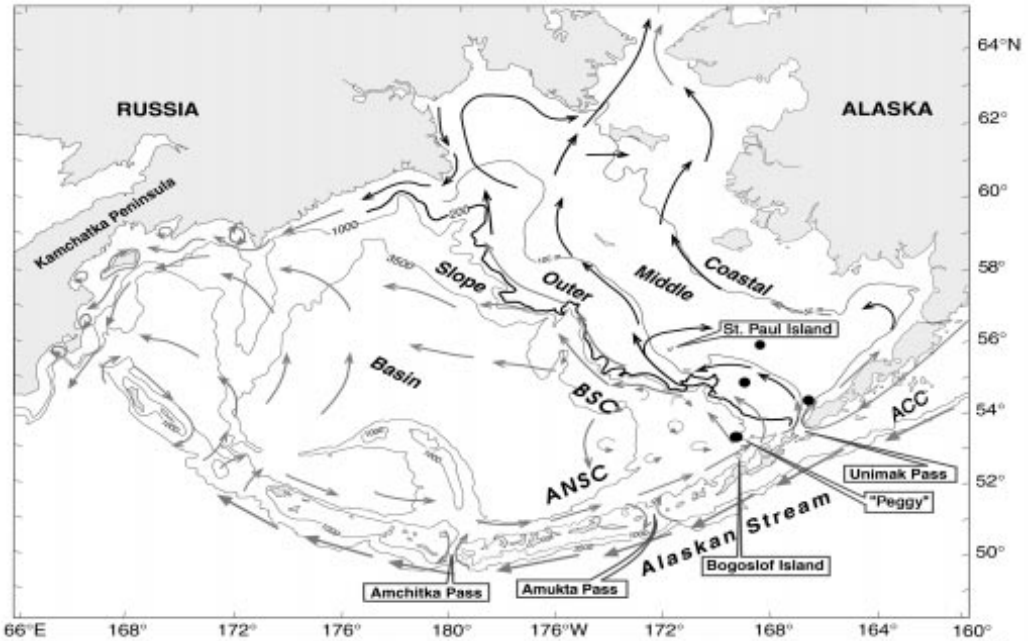


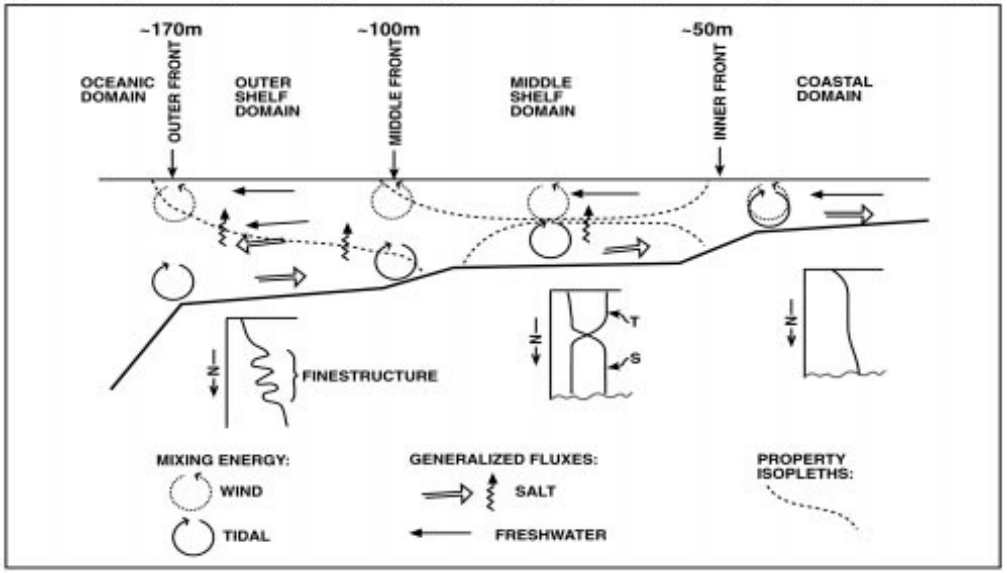




2005 Acoustic Survey



# Walleye Pollock in NE Pacific




ACC – Alaska Coastal Current

ANSC – Aleutian North Slope Current

BSC – Bering Slope Current

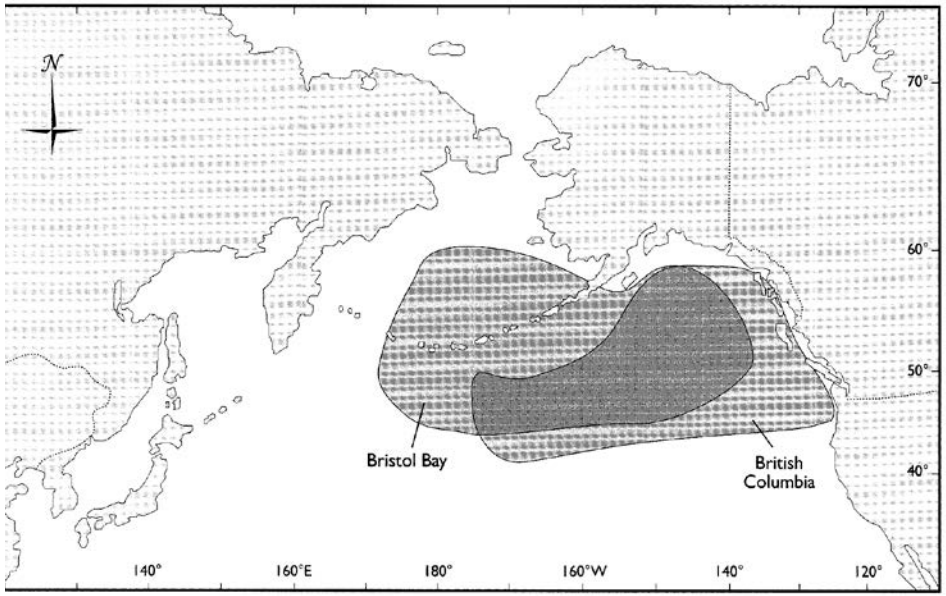
Given these horizontal and vertical flow regimes, where would you go to feed and spawn?

How many walleye pollock stocks would you predict in the Bering Sea?

Napp et al. 2000

# Sockeye Salmon (Anadromous)

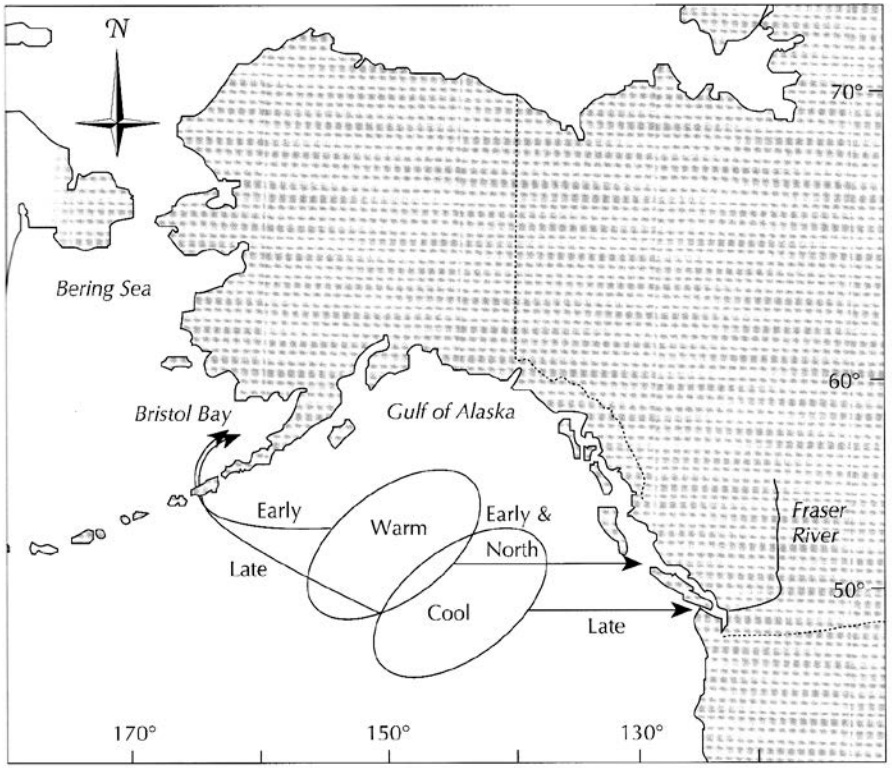
## Oceanic Range (tag returns)




migration timing – temperature link

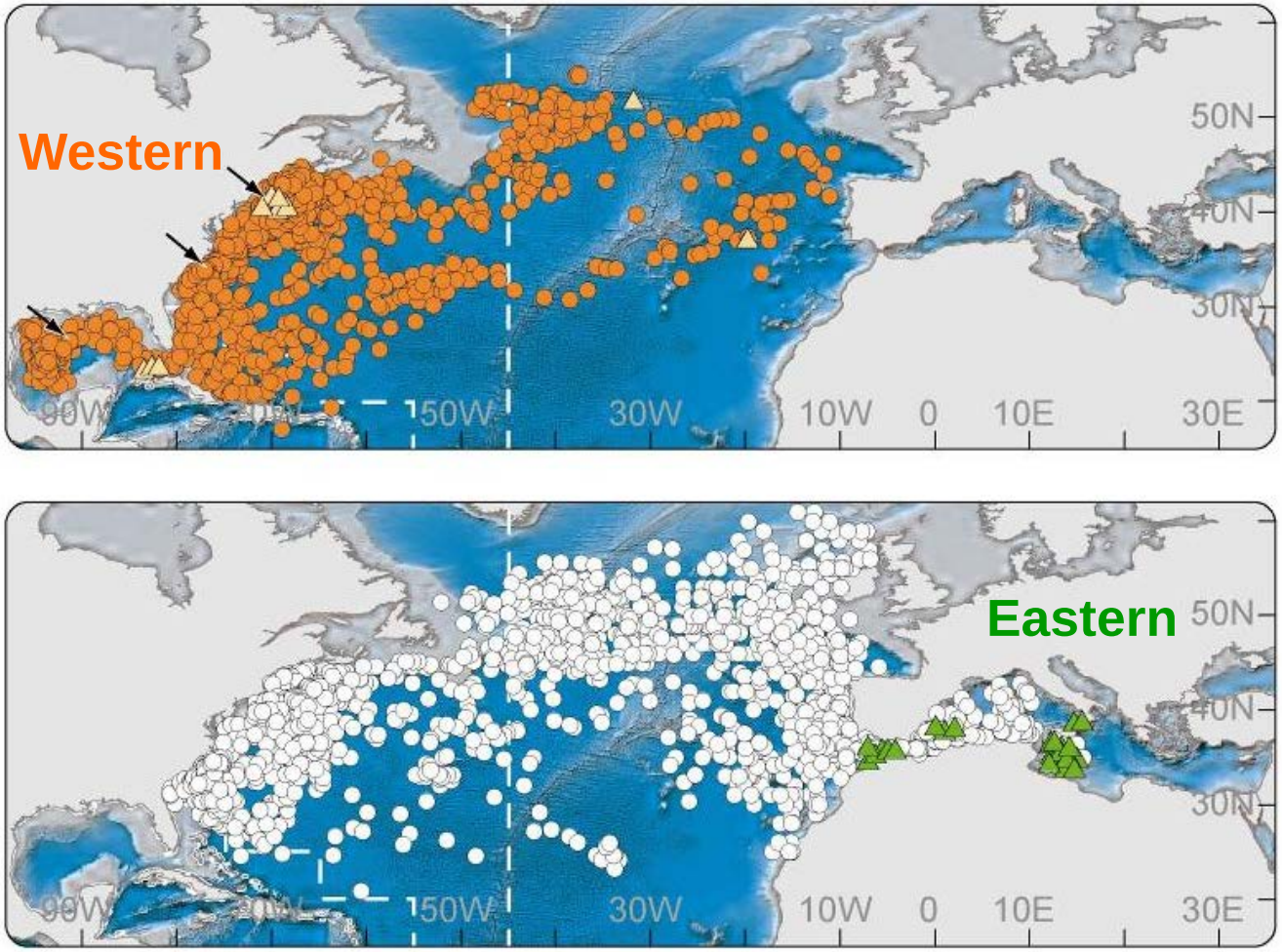
warm winter, further north (Bristol earlier)

## Bio-Phys Coupling




Blackbourn 1987

# Bluefin Tuna (mega nekton)




- tagged Bluefin tuna
- link Atlantic & Mediterranean
- common feeding grounds, separate spawning grounds
- dashed line separates management zones

Block et al. 2005