Inter-annual variation in the spring ichthyoplankton assemblages in the Strait of Georgia, 2007 – 2010

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The Strait of Georgia (SoG)

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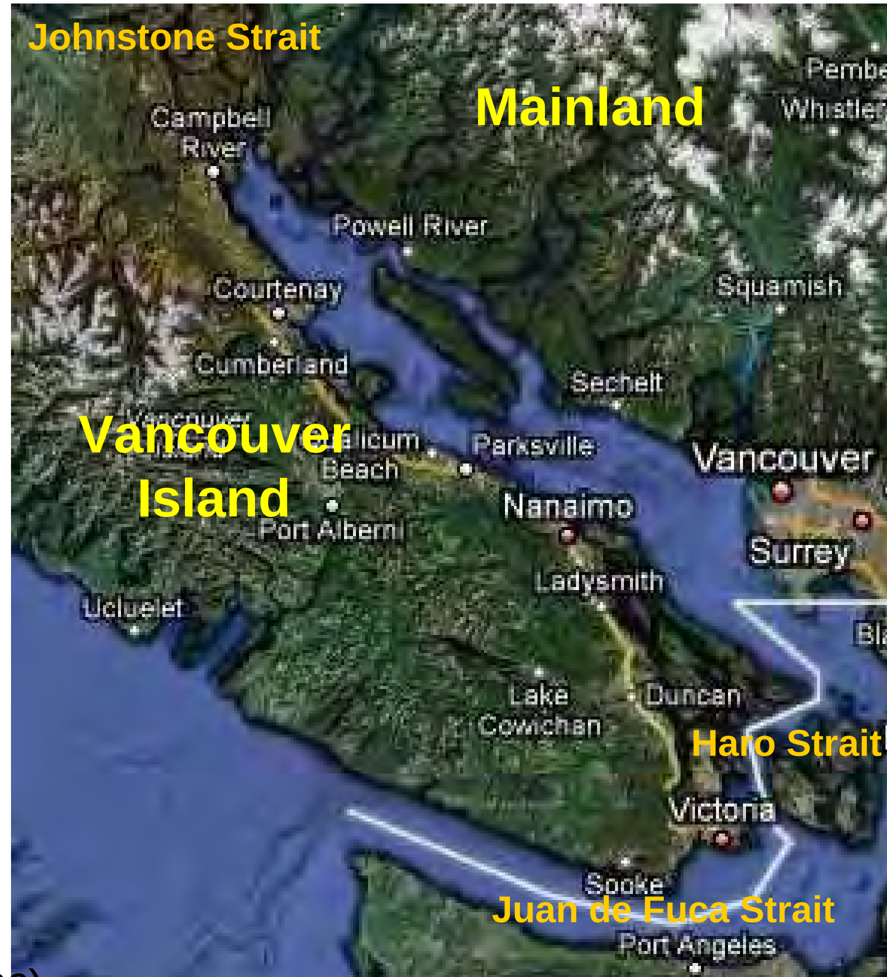
➢ **Most productive area on Canada's west coast**

- Semi-enclosed coastal basin
- Numerous islands, reefs & inlets
- Strong tidal mixing along edges & straits
- Local winds: week
- Fraser River: primary forcing of estuarine circulation

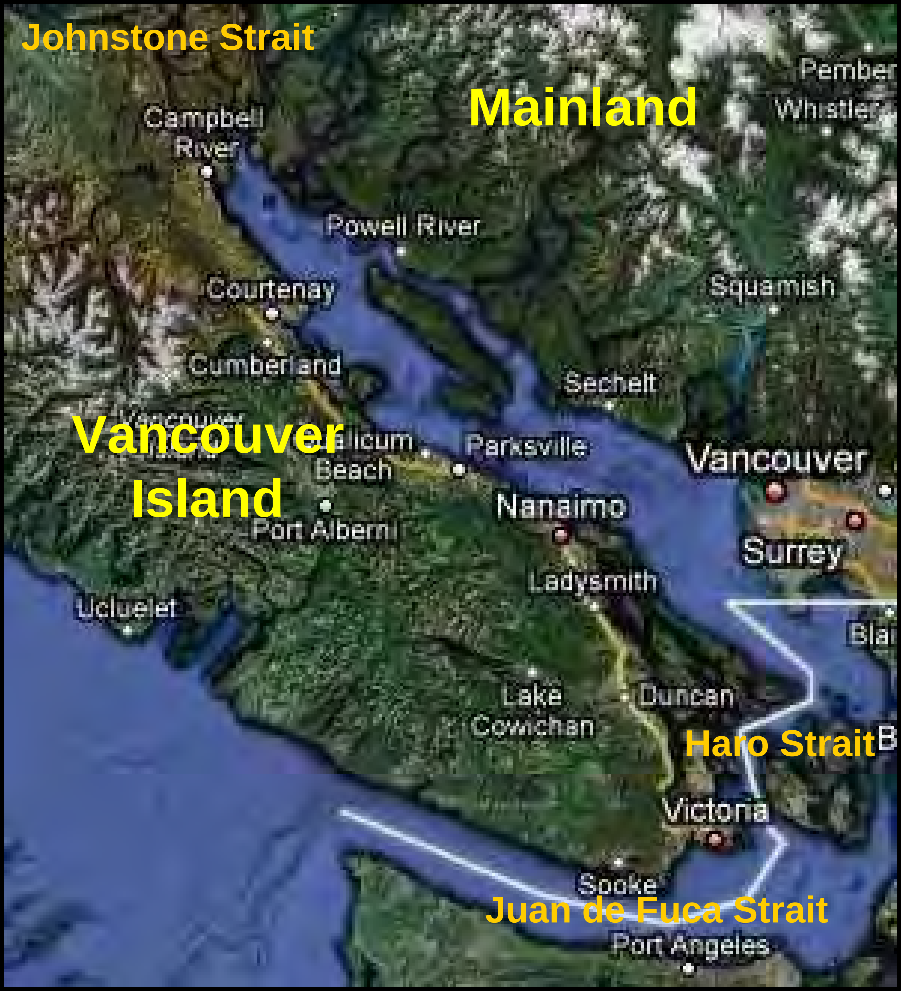


➢ **Long history of oceanographic study**

Examples:

- Estuarine circulation (*Li et al., 1999*)
- Water mass (*Masson, 2006*)
- Deep water renewal (*Masson, 2002*)
- Chlorophyll distribution (*Masson and Pena, 2009*)
- Long-term temperature trend (*Masson and Cummins, 2006*)
- Major species of Phytoplankton (*Stockner et al, 1979*)
- Major species of Zooplankton (*Parsons et al., 1970*)

The Strait of Georgia (SoG)



SoG Ichthyoplankton Surveys

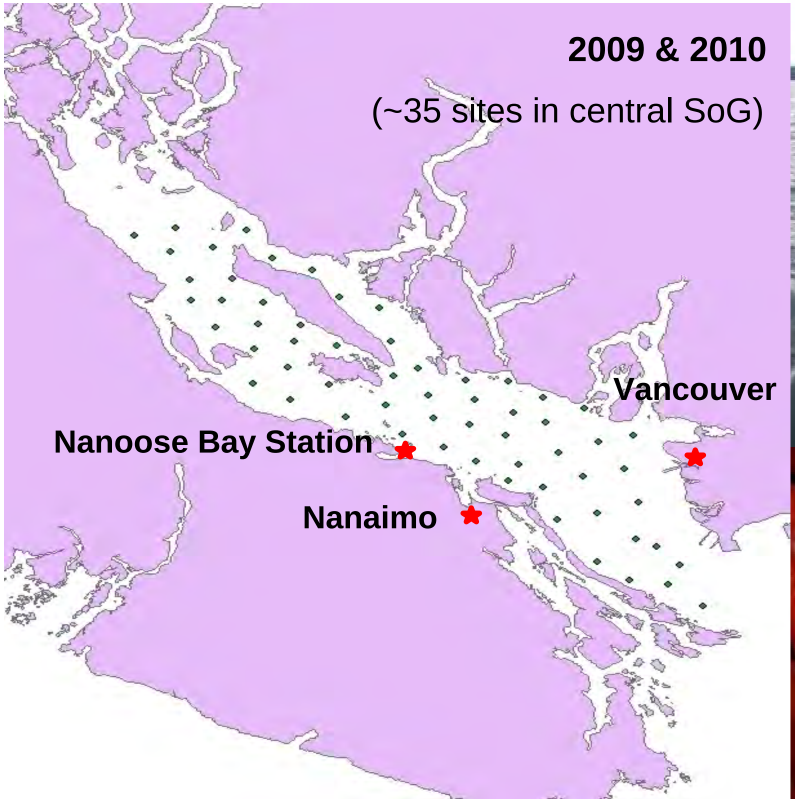
As part of the Canadian Healthy Oceans Networks (CHONe)

Ichthyoplankton Community

Quantify changes in ichthyoplankton community
&
Examine associated driving factors

Population Connectivity

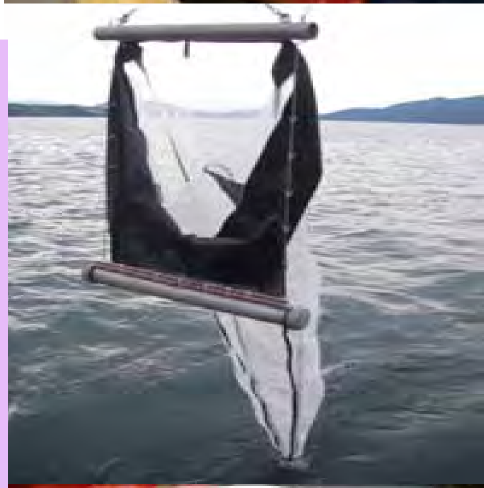
Quantify patterns of spatiotemporal variability
&
Explore dispersal pathways



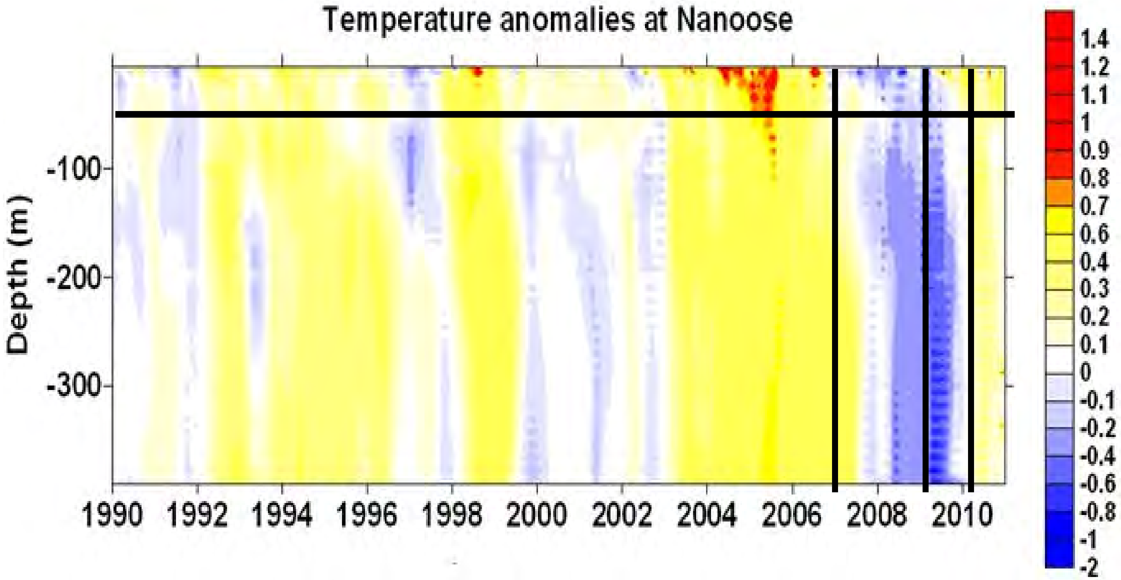
- Same time period:
  Apr, 24th – May, 1st
  (2007, 2009 & 2010)

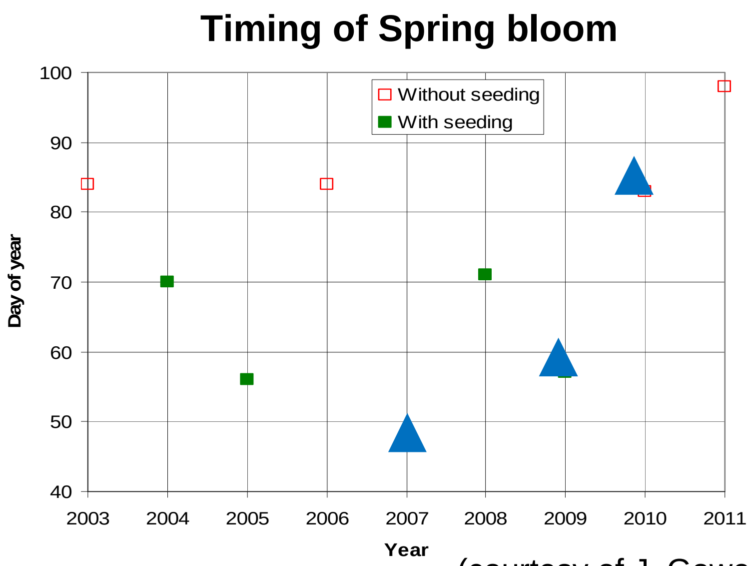
- Field procedure:
  $1m^2$ Tucker trawl
  1mm mesh size
  top 0-50m
  15min @ 1m/s

- Lab process:
  Sort, Identify, Measure

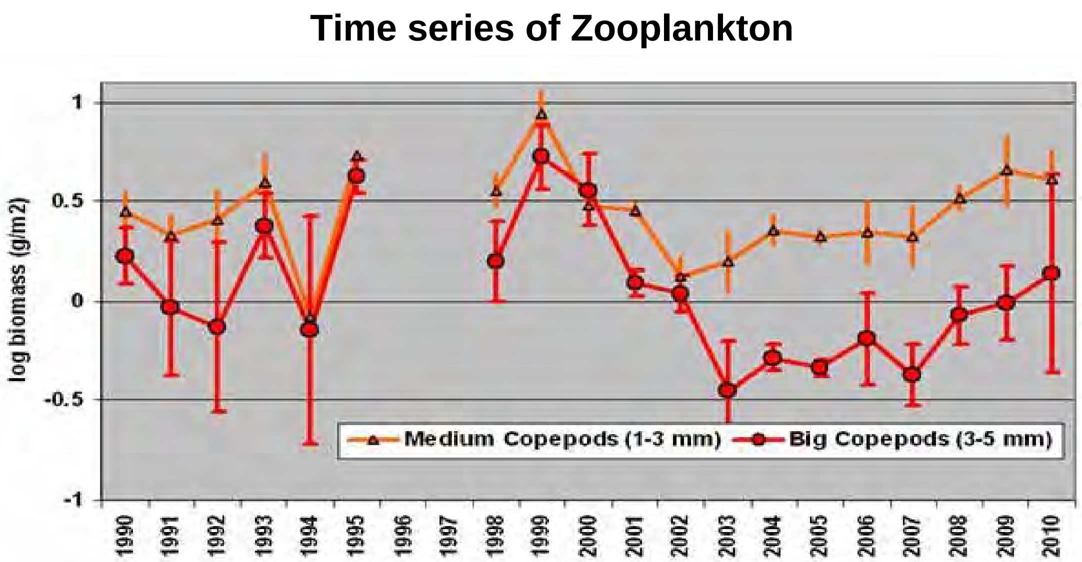


How is the SoG environment changing?

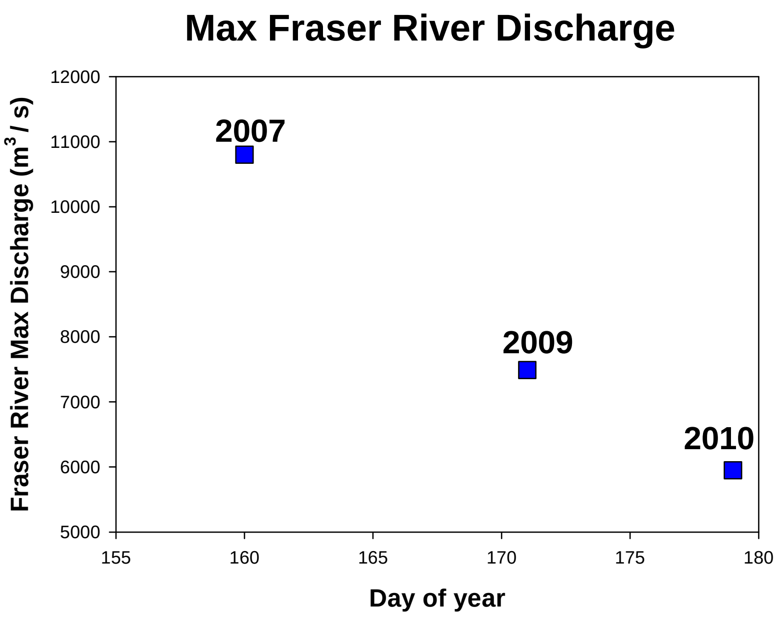




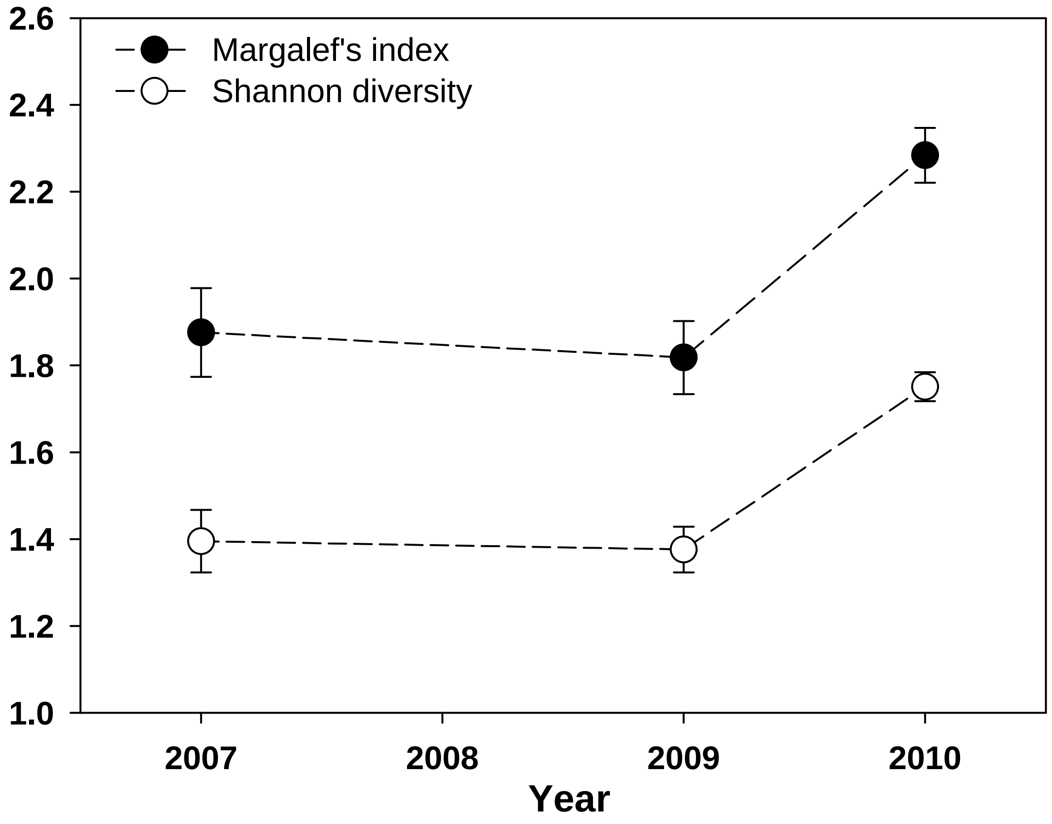
(courtesy of J. Gower)



(courtesy of D. Mackas)



Changes in species diversity & richness ?



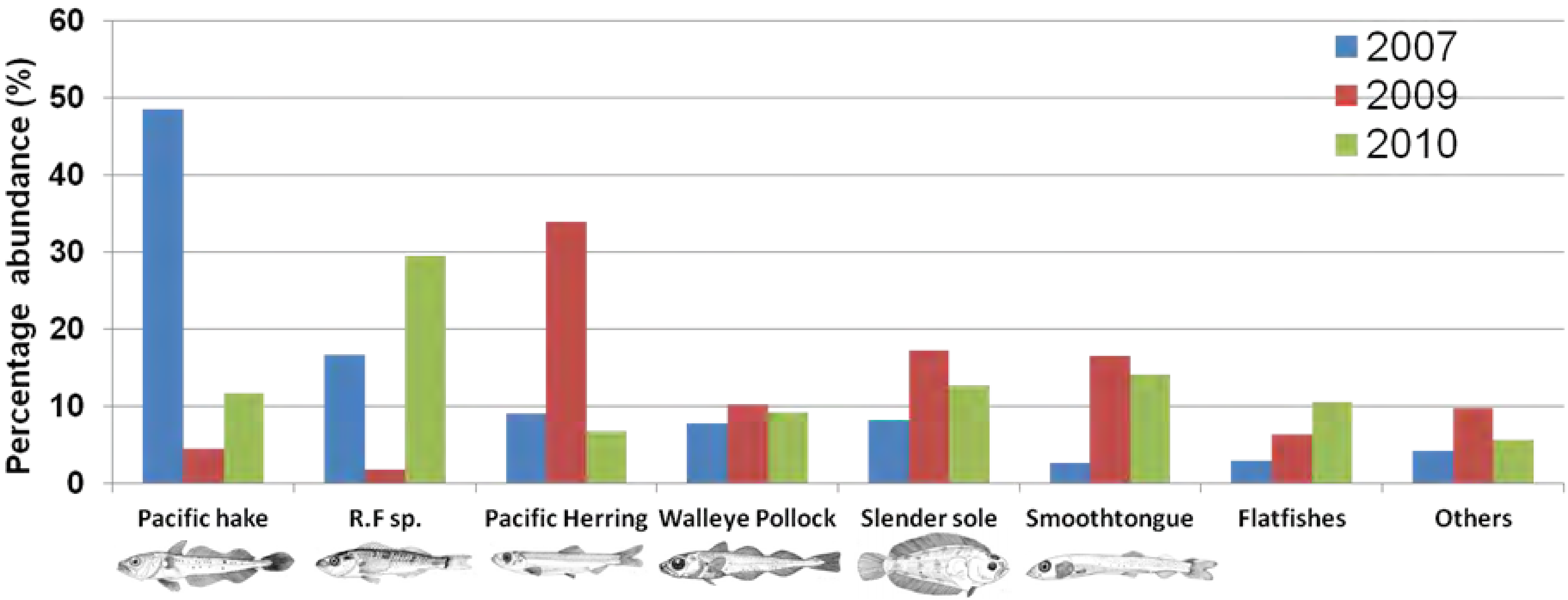
- ❖ Shannon-Wiener diversity index / Margalef's index — Same trend: 2007 = 2009 < 2010
- ❖ Abrupt increase from 2009 to 2010

Changes in community composition?

➢ **Most abundant fish species and groups:**

Pacific herring, Pacific hake, Walleye pollock, Northern smoothtongue, Slender sole, Rockfishes, Flatfishes ➡ 2007: 95.77% / 2009: 90.21% / 2010: 94.41% } of total larval abundance

➢ **Composition (late Apr): very different among sampling years**



Changes in community composition?

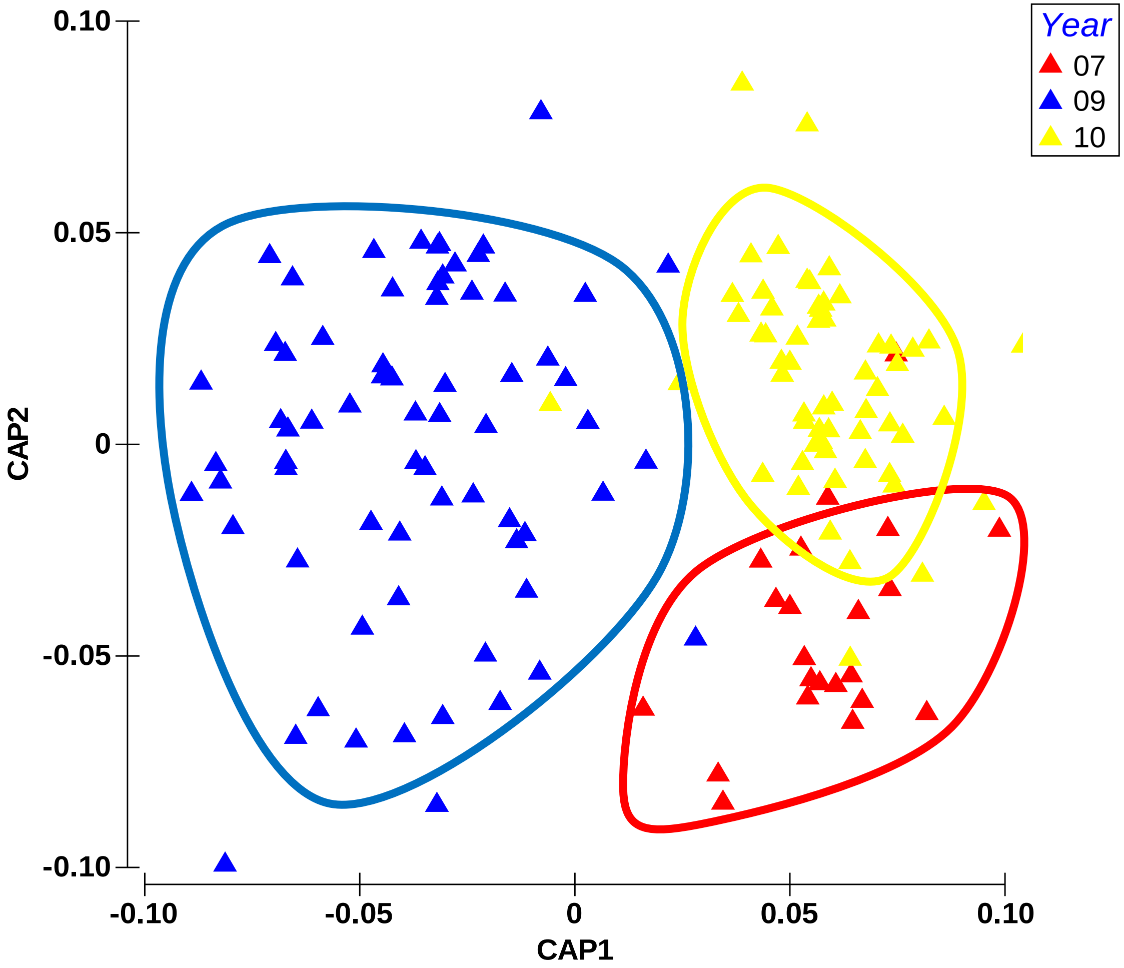
- **Method:**

  Canonical analysis of principal coordinates on the Station-based multivariate data

- **Species composition:**

  3 clusters

  PERMANOVA: P = 0.0001



Changes in community composition?

- **Method:**

  Canonical analysis of principal coordinates on the station based multivariate data

- **Species composition:**

  3 clusters

  PERMANOVA: P = 0.0001

- **Dominant species (late-Apr) shift:**

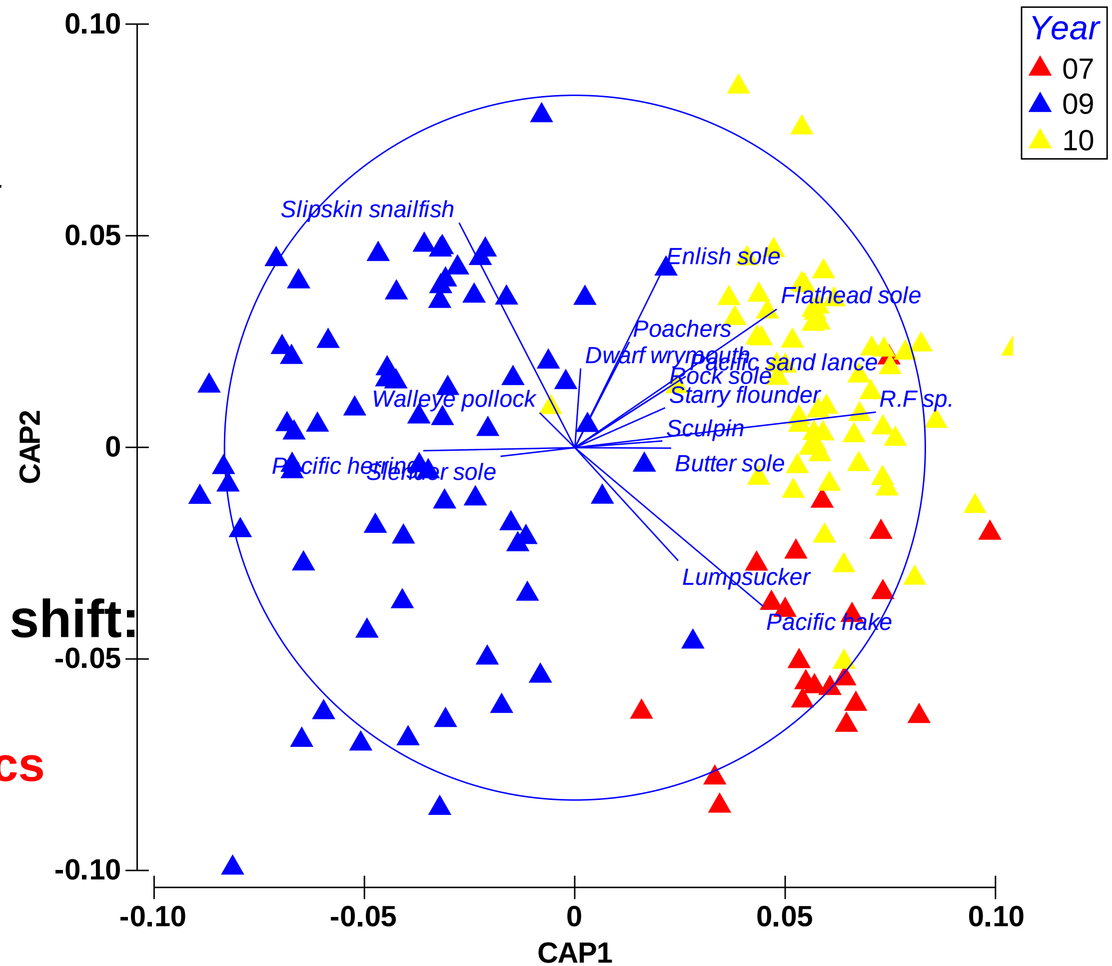
  2007: Pacific hake

  2009: Pacific herring
  Walleye pollock

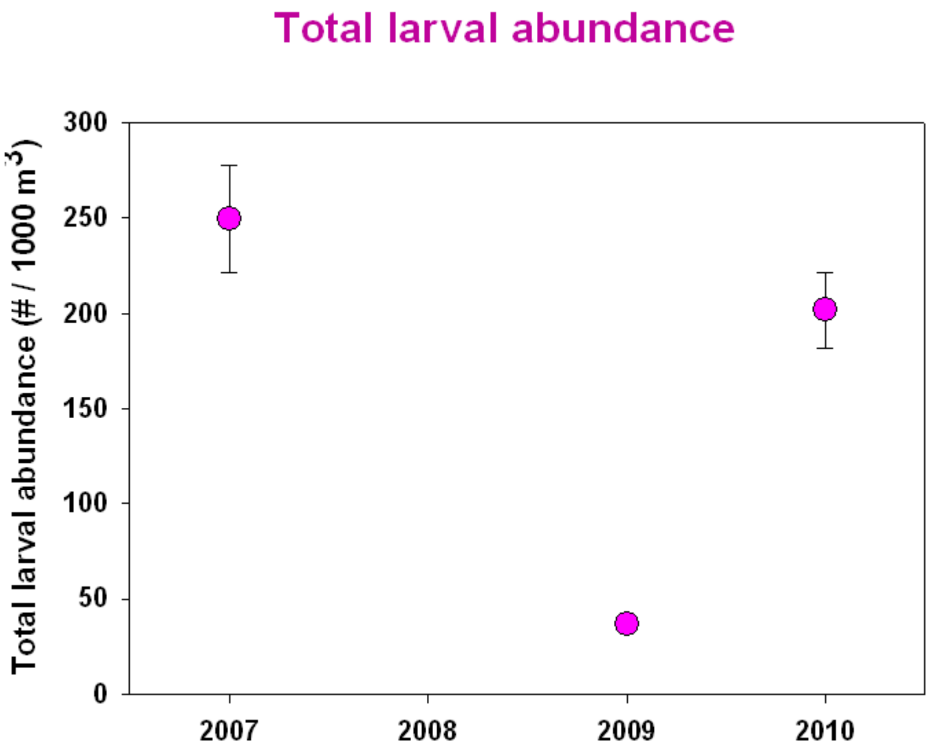
  2010: Rockfish sp.
  Flatfishes

Pelagics

Demersals



How did larval abundance change?

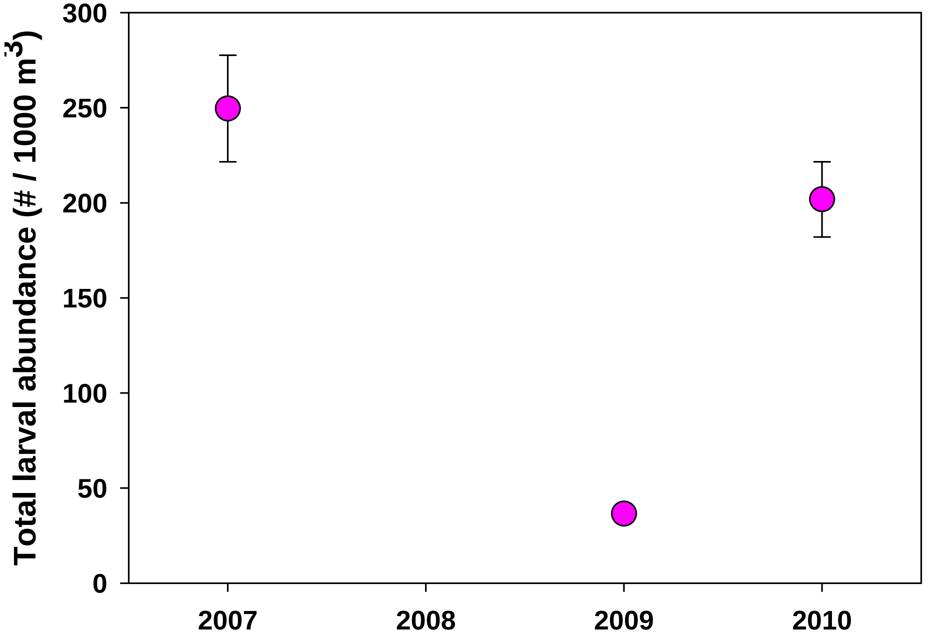


❖ Total larval abundance: 2009 < 2007 = 2010

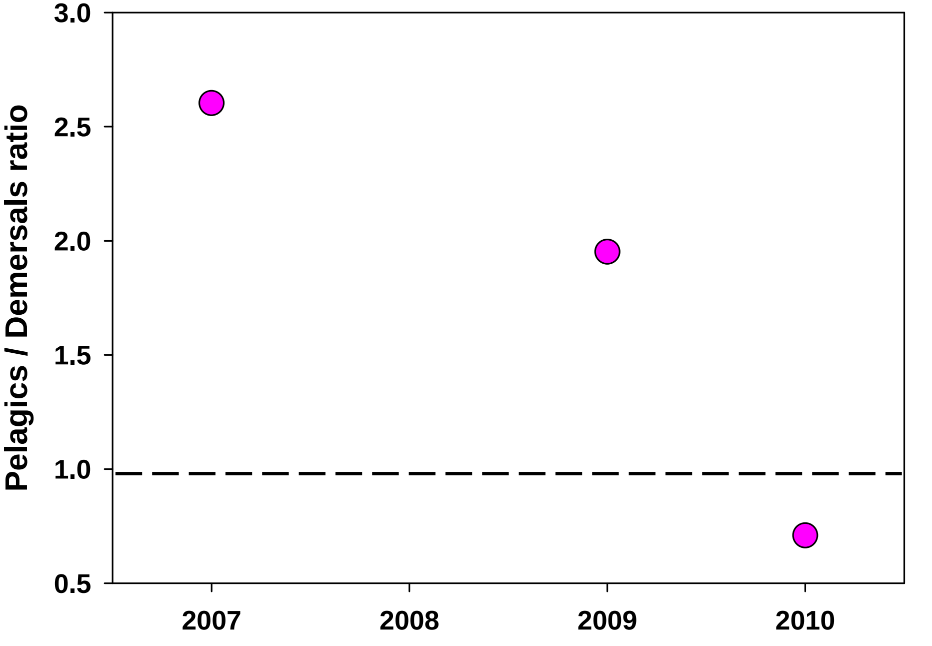
❖ Very low abundance in 2009

How did larval abundance change?

Total larval abundance

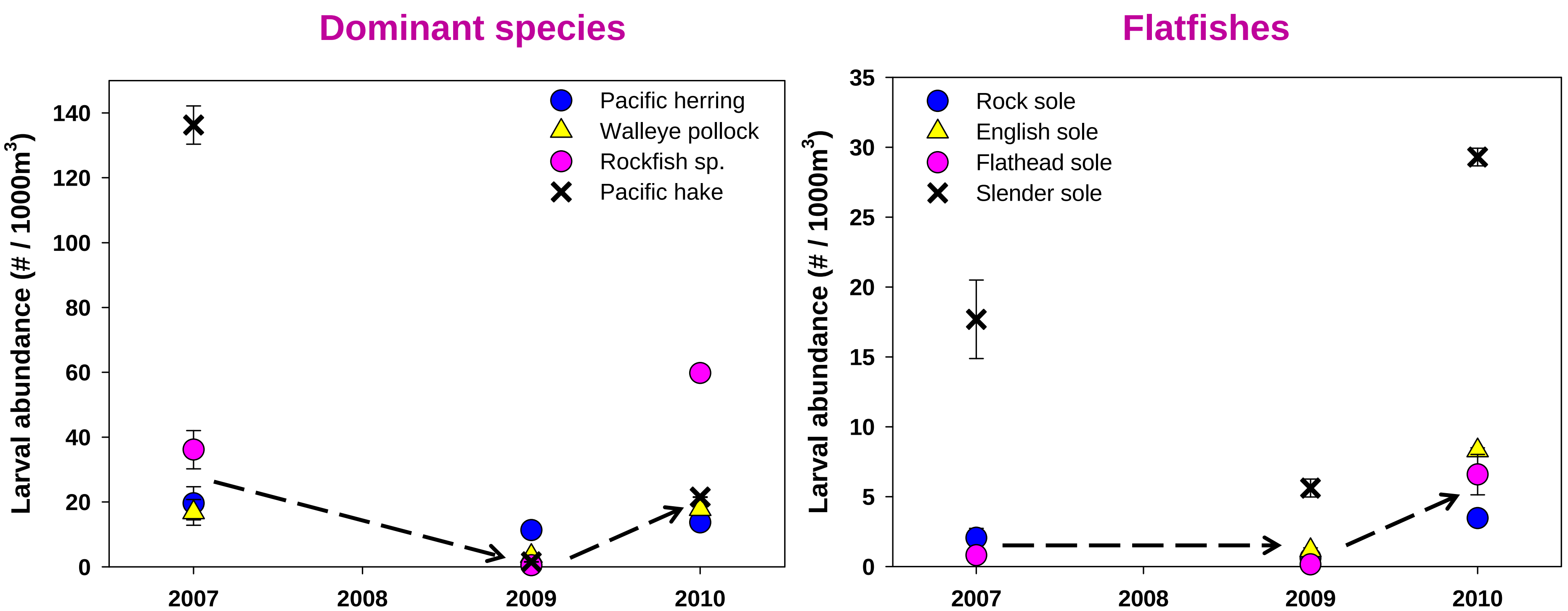


Pelagics / Demersals abundance ratio



- ❖ Total larval abundance: 2009 < 2007 = 2010
- ❖ Very low abundance in 2009
- ❖ Pelagics / Demersals ratio: decreasing

How did larval abundance change?



Walleye pollock
Pacific hake
Rockfish sp.
} 2009 < 2007 & 2010

Pacific herring 2007 = 2009 = 2010

2009: lowest in abundance

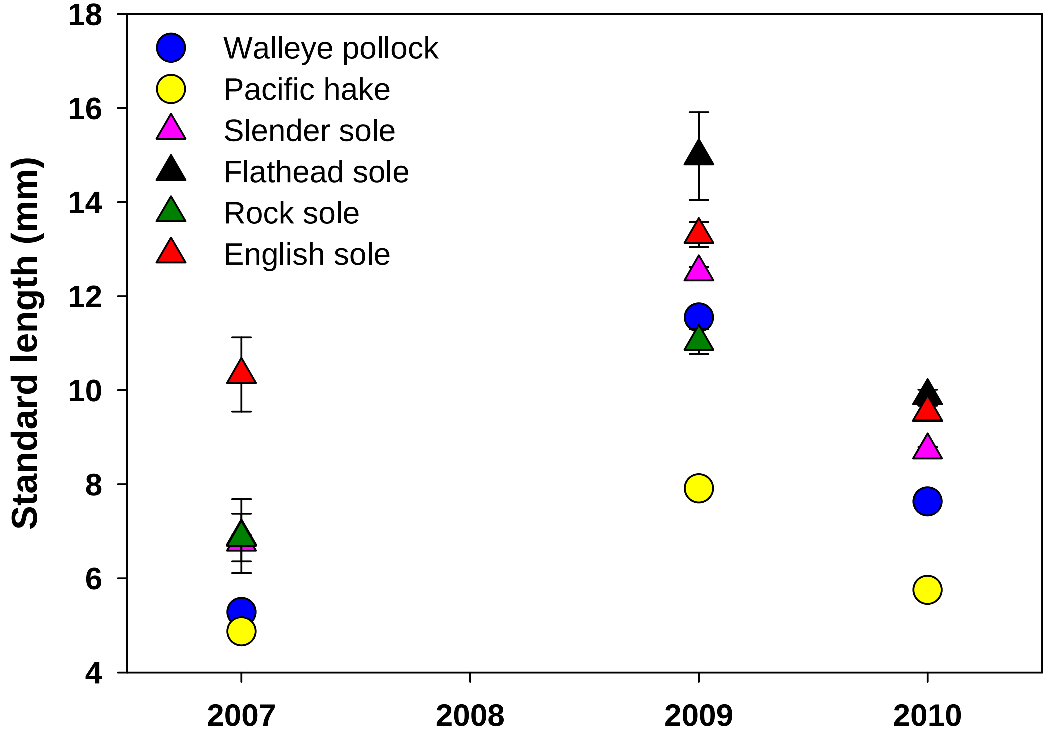
Rock sole
English sole
Flathead sole
} 2007 = 2009 < 2010

Slender sole 2009 < 2007 = 2010

2009: lowest; 2010: highest

Poor year in 2009 for a lot species + Dramatic increase in 2010

Changes in mean standard length?



- Consistent trend in standard length:
  - Pacific hake, Walleye pollock, Flatfishes — 2009 > 2010 > 2007, consistently
- 2007: Poor zoop year — Low growth rate
- 2009: Low larval abundance, big in size

  Evidence of early spring in 2009

⇒ Fish spawned early? Larvae hatched early?

Changes in Phenology? – Pacific hake

- **Examine the otolith**

  Read the rings

  Age the larvae

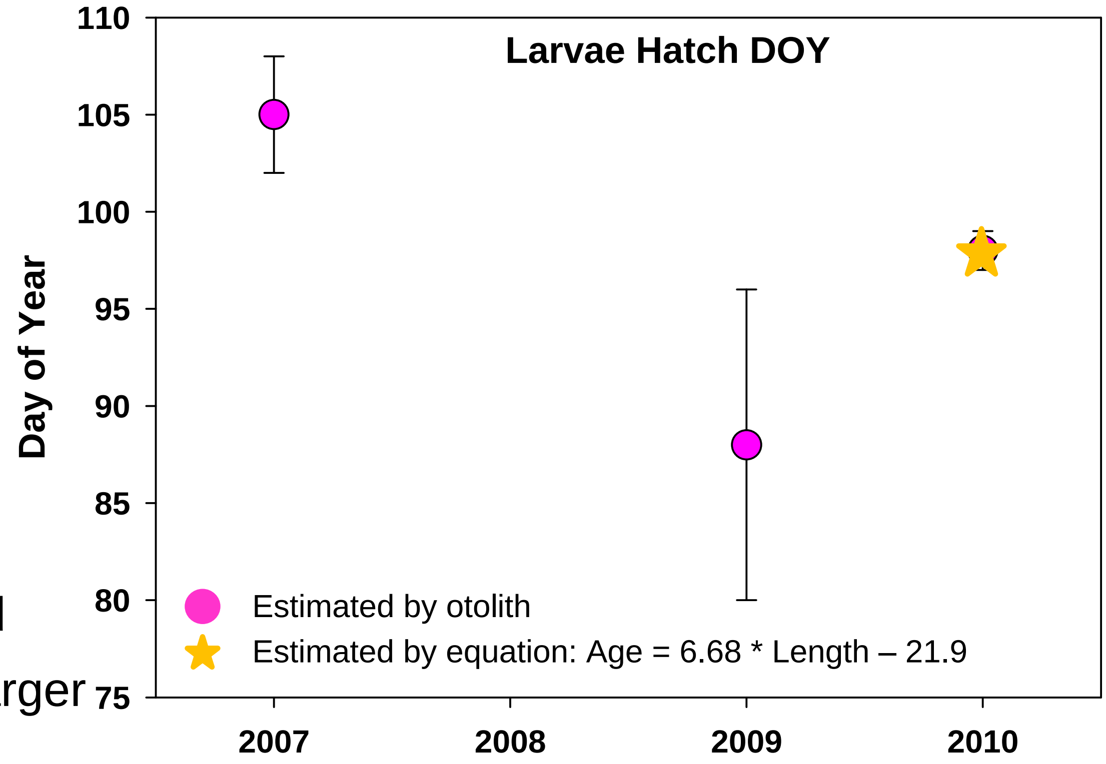
  Back-calculate hatch date

- **In 2009:**

  Hatched early

  Cold environment, good food

  Late Apr: less abundant & larger



	2007	2009	2010
Mean hatch DOY	105	88	98
Range of hatch DOY	101-108	81-98	97-99
Larval abundance	Highest	Lowest	Intermediate
Larval size	Smallest	Largest	Intermediate

Summary

	2007	2009	2010
Temperature	Warm phase	Cold phase	Intermediate
Spring bloom time	Feb 14	Feb 25	Mar 23
FR max discharge (m3/s)	Jun 09 (10800)	Jun 20 (7490)	Jun 28 (5950)
Zooplankton biomass	Poor	Good	Good

Diversity & Richness	2007 = 2009 < 2010		
Pelagic/Demersal dominance	Pelagics	Pelagics	Demersals
Larval fish abundance	High	Poor	High
Larval fish standard length	Smallest	Largest	Intermediate
Timing	Probably spawning / hatch earlier in 2009		

- **Large inter-annual variability between 2009 and 2010**
- **Follow up question: specific driving mechanisms??**