

Gelatinous zooplankton in Pacific Canadian Waters since 1990: trends and ecosystem implications

R. **Ian Perry**^{1,2}, Moira Galbraith², Kelly Young²

¹ Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, B.C. Canada

² Fisheries & Oceans Canada, Institute of Ocean Sciences, Sidney, BC, Canada

Ian.Perry@dfo-mpo.gc.ca



Background and Objectives

Gelatinous zooplankton in global marine systems have been:

- increasing,
- decreasing,
- undergoing oscillations with approximately a 20-yr cycle.

Objective:

Examine long-term (>25 years) patterns of gelatinous zooplankton obtained from repeated surveys since the 1990s (or earlier) in the Strait of Georgia, off the west coast of Vancouver Island (Canada), and in the Gulf of Alaska.

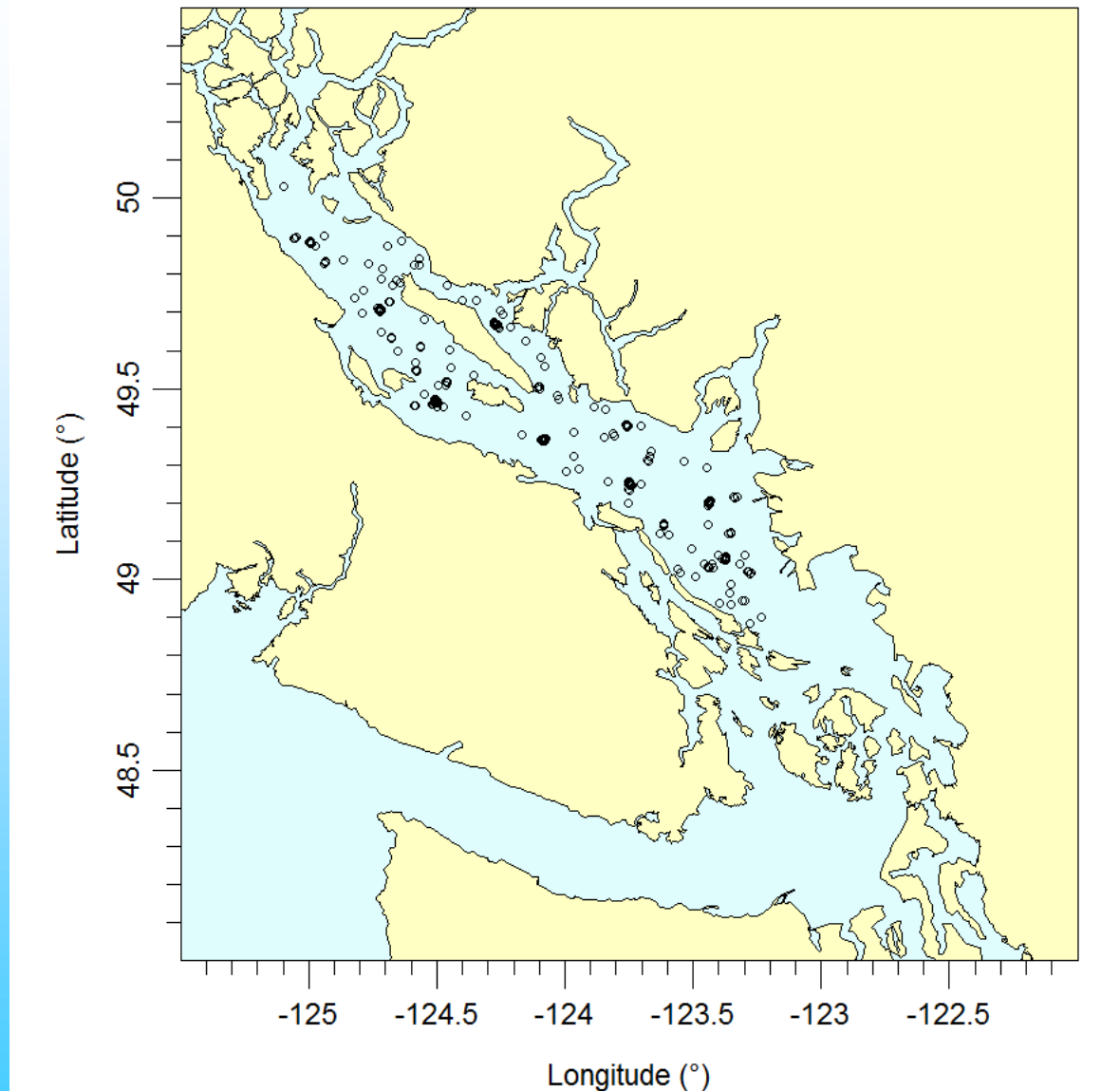
- a necessary precursor to understanding their potential “*future [ecological roles] in a more gelatinous ocean*”



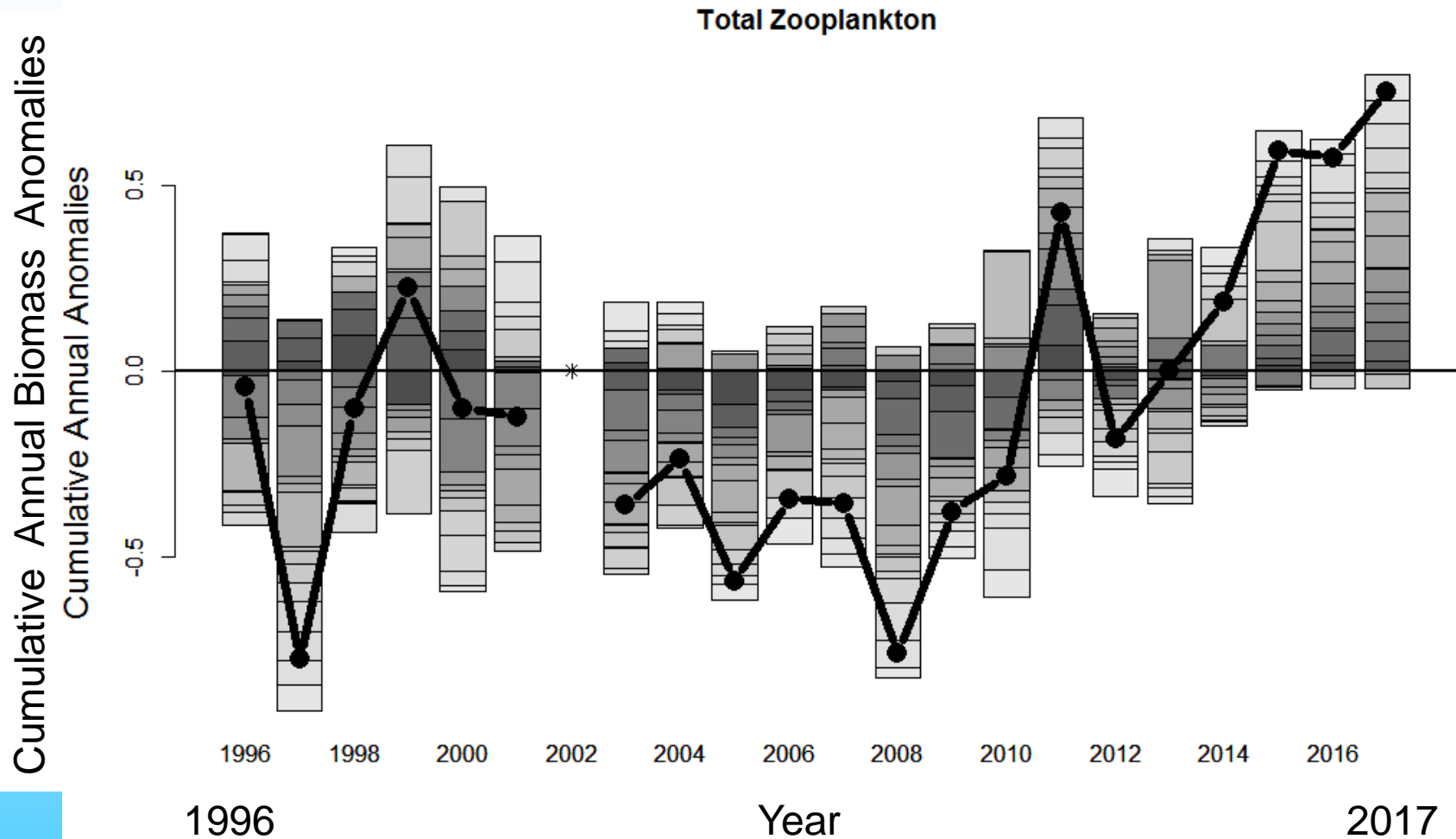
“Crunchy” (hard-bodied plankton)	“Squishy” (gelatinous plankton)	Other
Class Malacostraca (e.g. Euphausiids, Amphipods, Decapods)	Phylum Ctenophora	Phylum Chaetognatha
Class Maxillopoda (e.g. copepods)	Class Scyphozoa	Phylum Arthropoda (e.g. insects)
Class Ostracoda	Class Hydrozoa	Phylum Chordata (e.g. fish)
Class Branchiopoda (e.g. cladocera)	Order Siphonophora	Phylum Cnidaria (e.g. anemones)
Barnacles	Class Thaliacea (e.g. salps, pyrosomes, doliolids)	Phylum Echinodermata
	Class Appendicularia (e.g. larvaceans)	Phylum Mollusca (e.g. squid, octopus)
	Pteropods (e.g. Limacina, Clione)	Worms



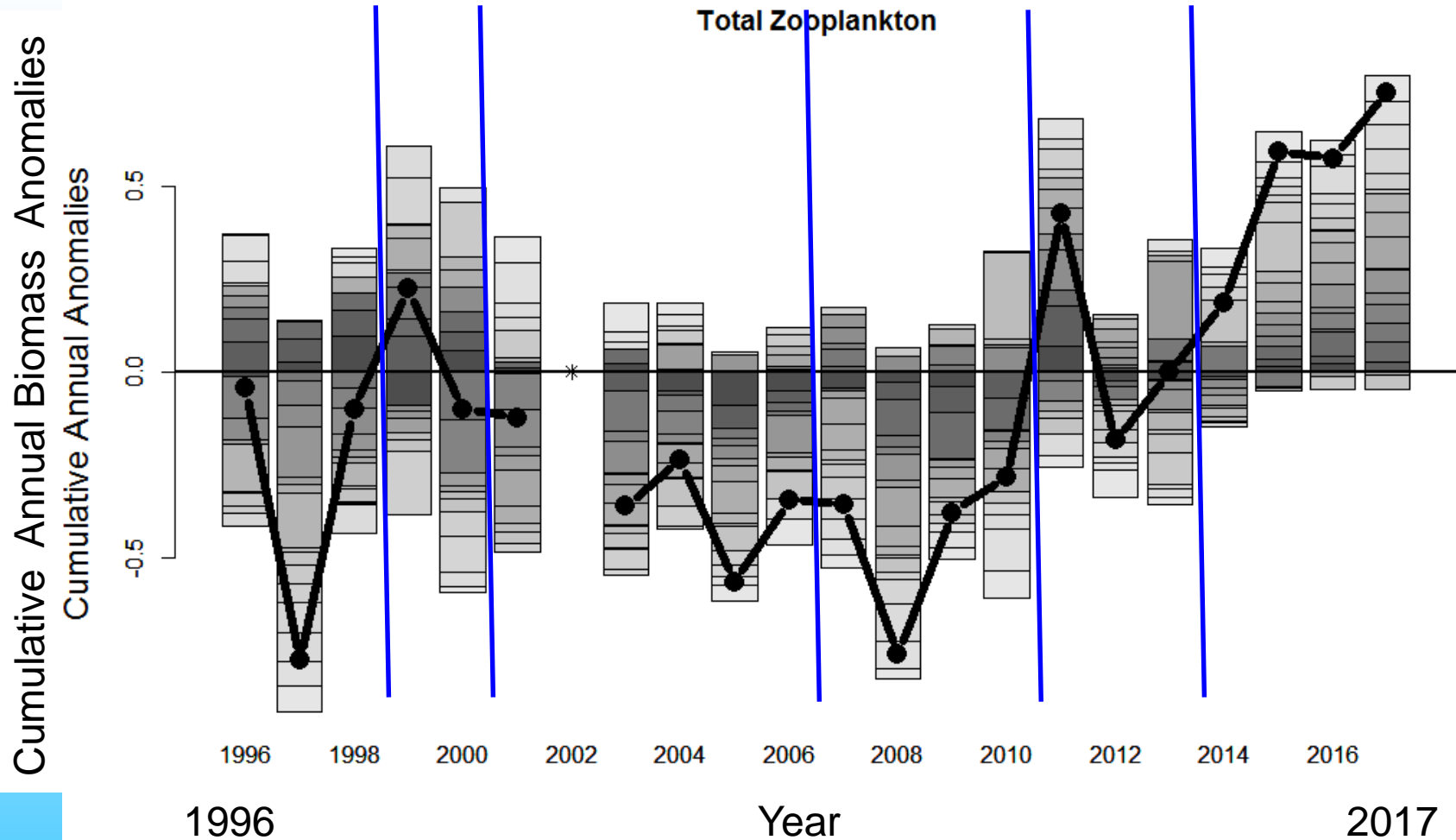
Central and Northern Strait of Georgia (Salish Sea)



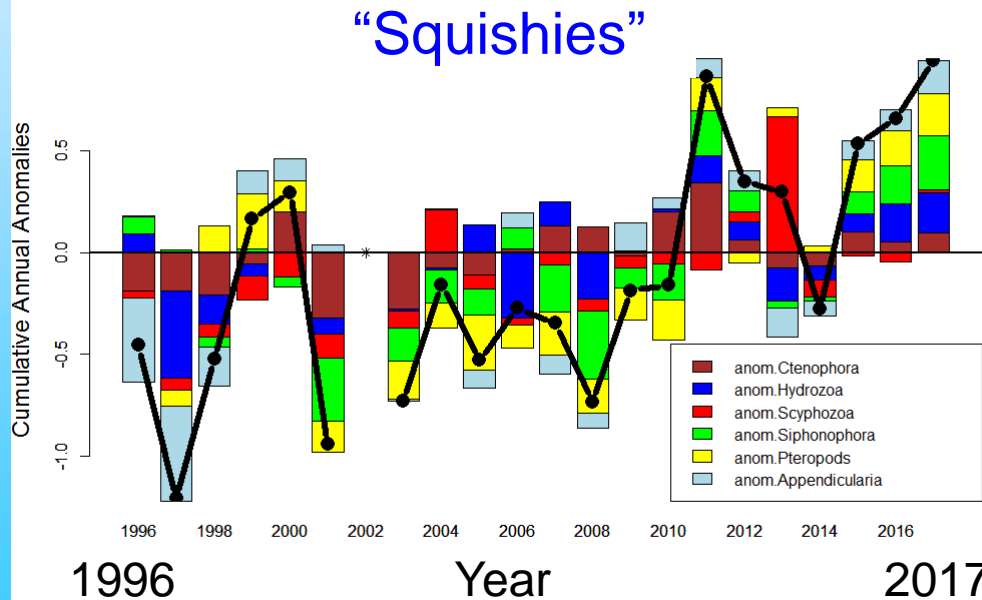
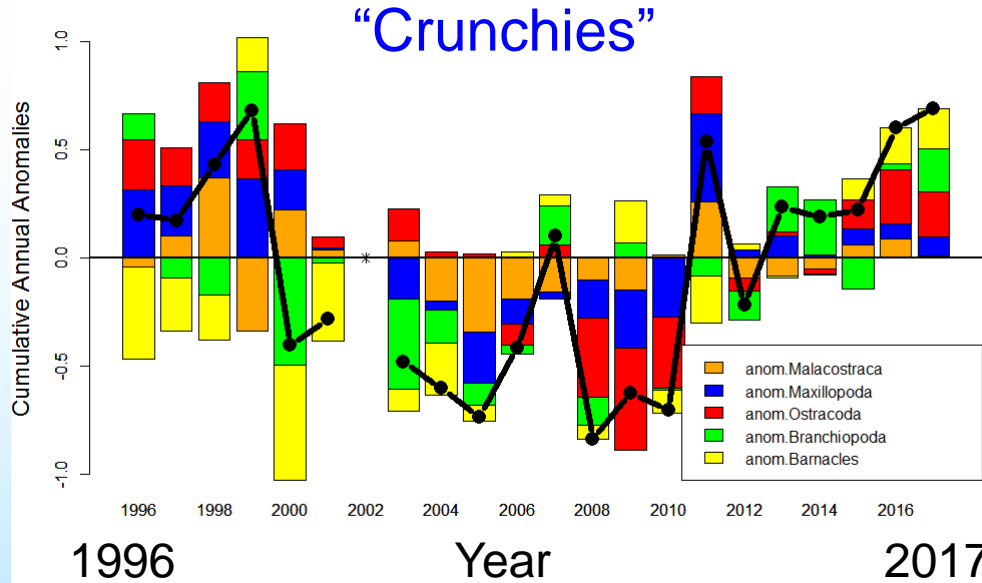
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Central and Northern Strait of Georgia (Salish Sea)



Cumulative Annual Biomass Anomalies



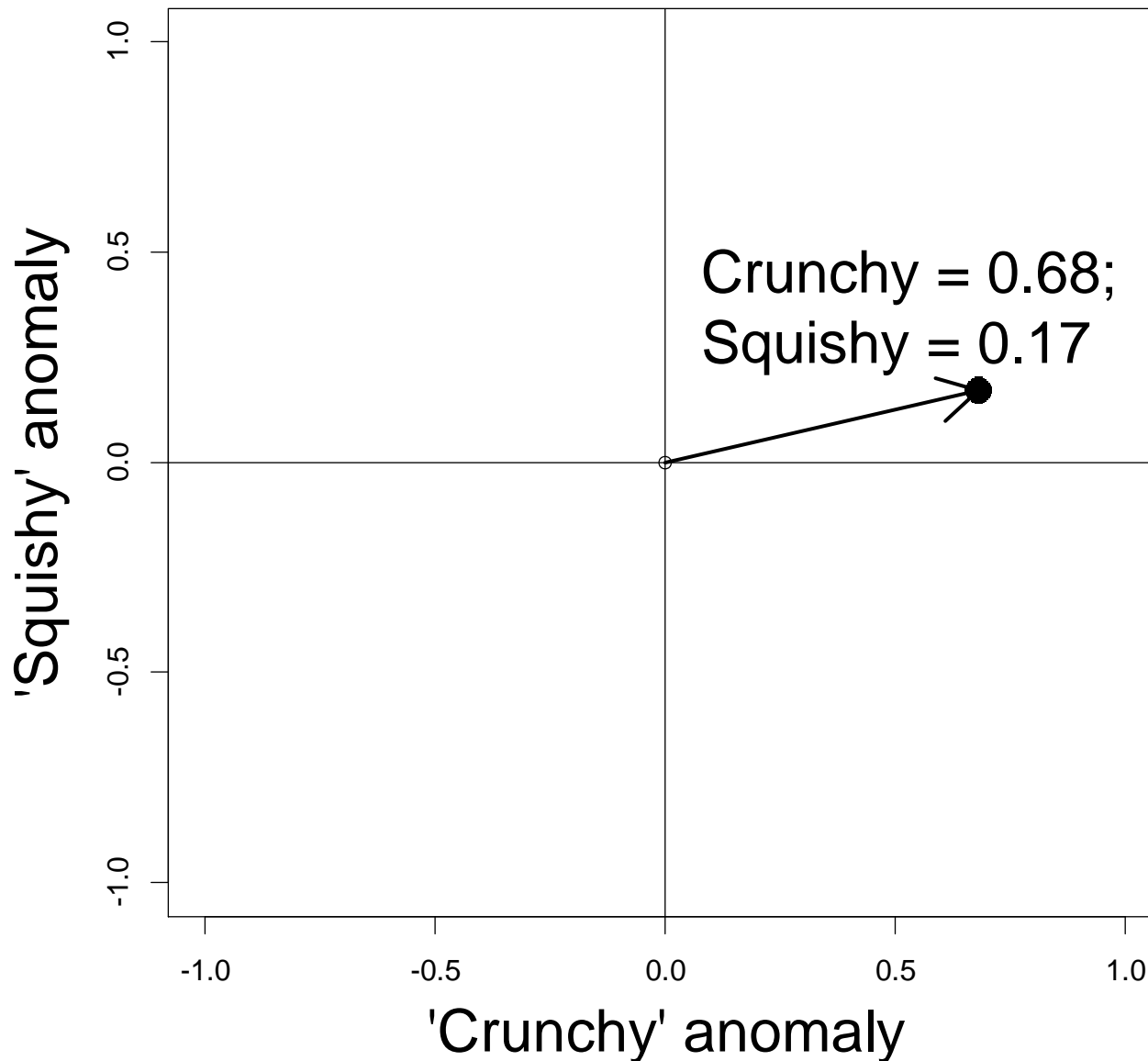
Cumulative Annual Biomass Anomalies for “Crunchy” and “Squishy” taxonomic groups

Linear regression of Squishy versus Crunchy Cumulative Anomalies:
Multiple R-squared = 0.24,
p-value = 0.02

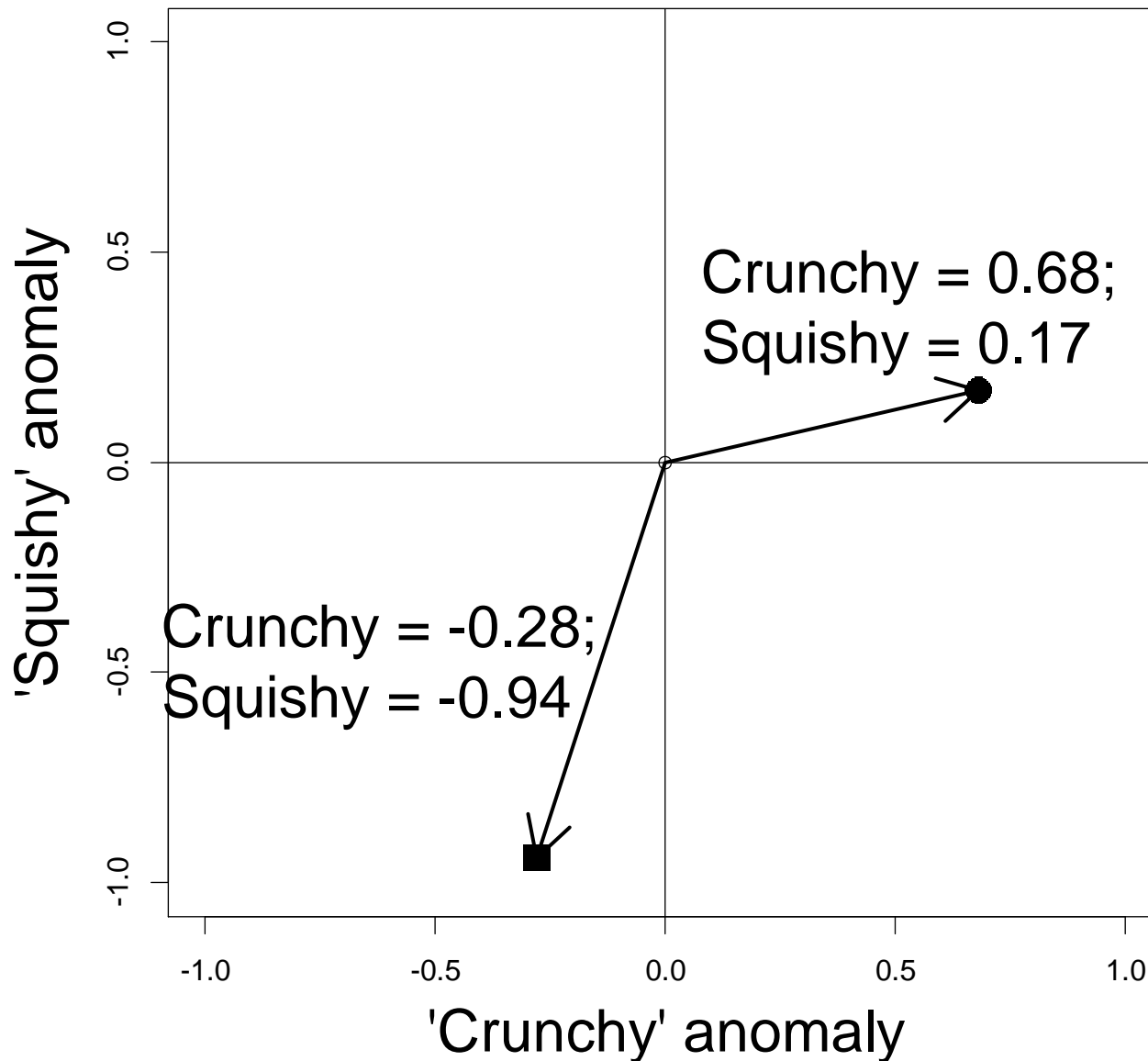
Cumulative biomass anomalies are significantly, but weakly, related

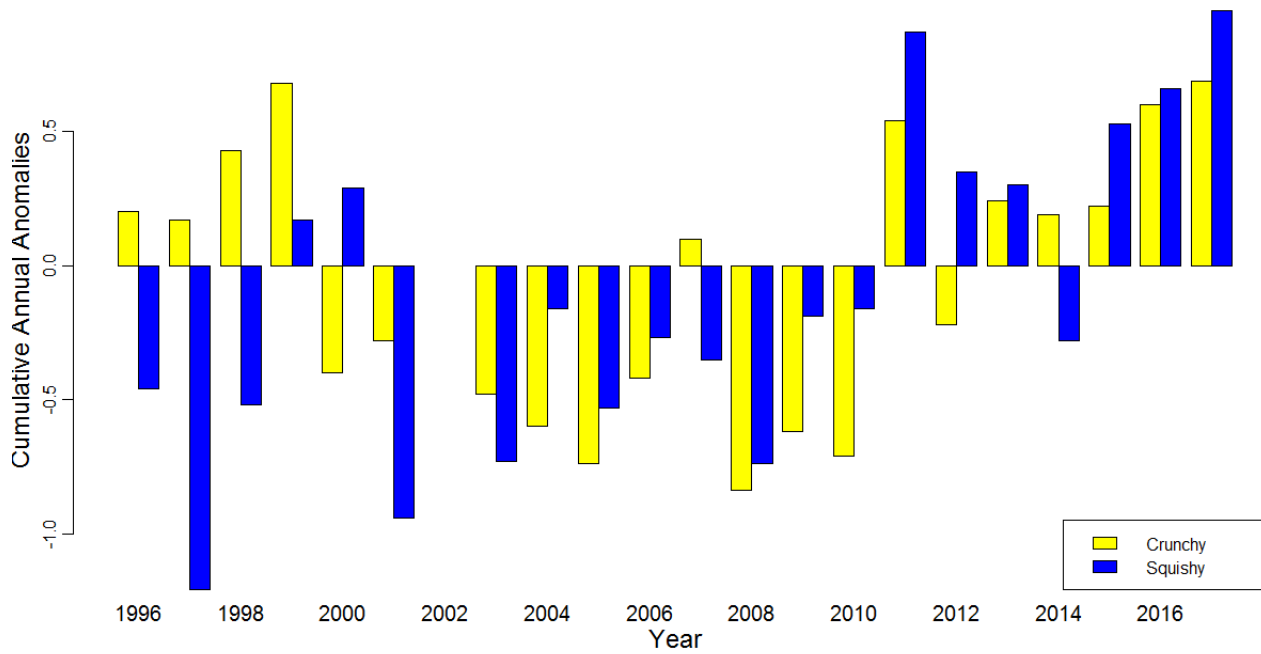


Development of a “Crunchy : Squishy” index

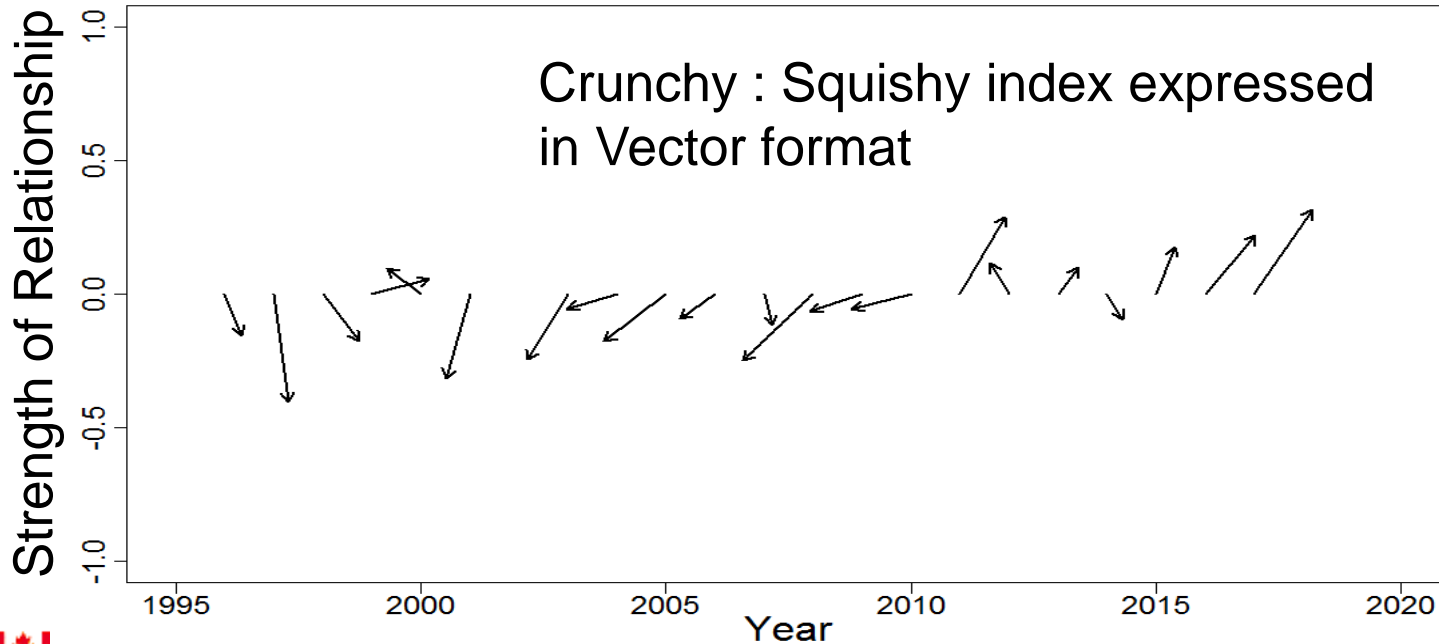


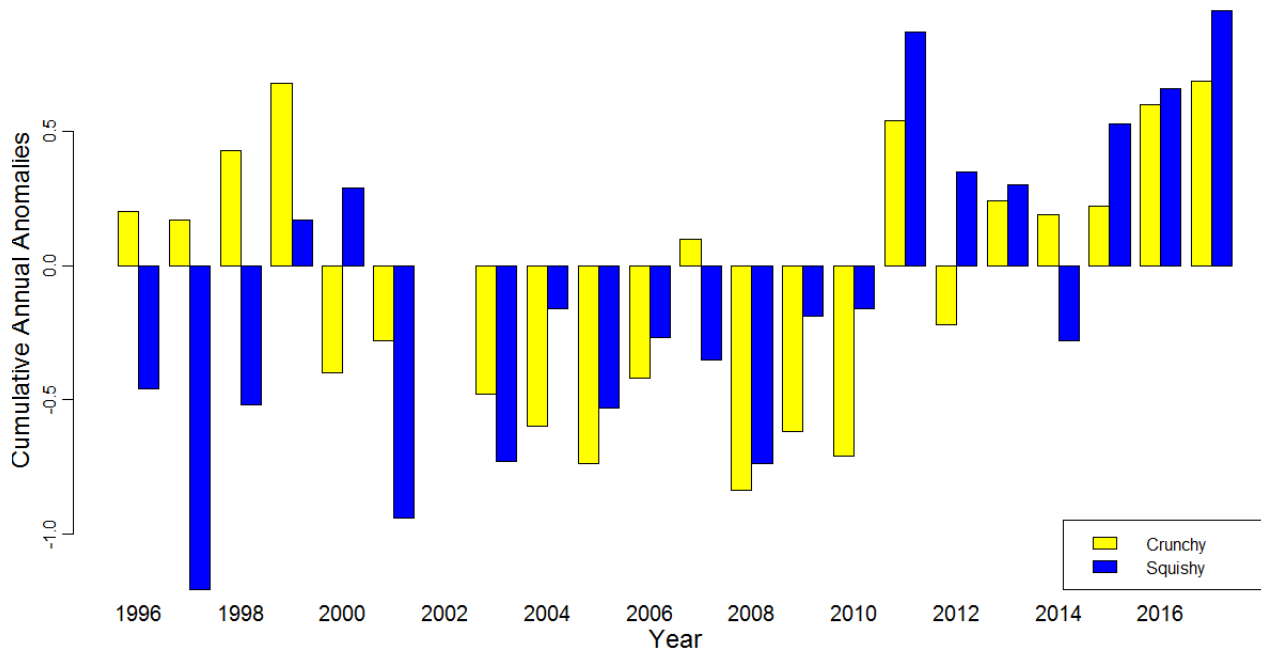
Development of a “Crunchy : Squishy” index



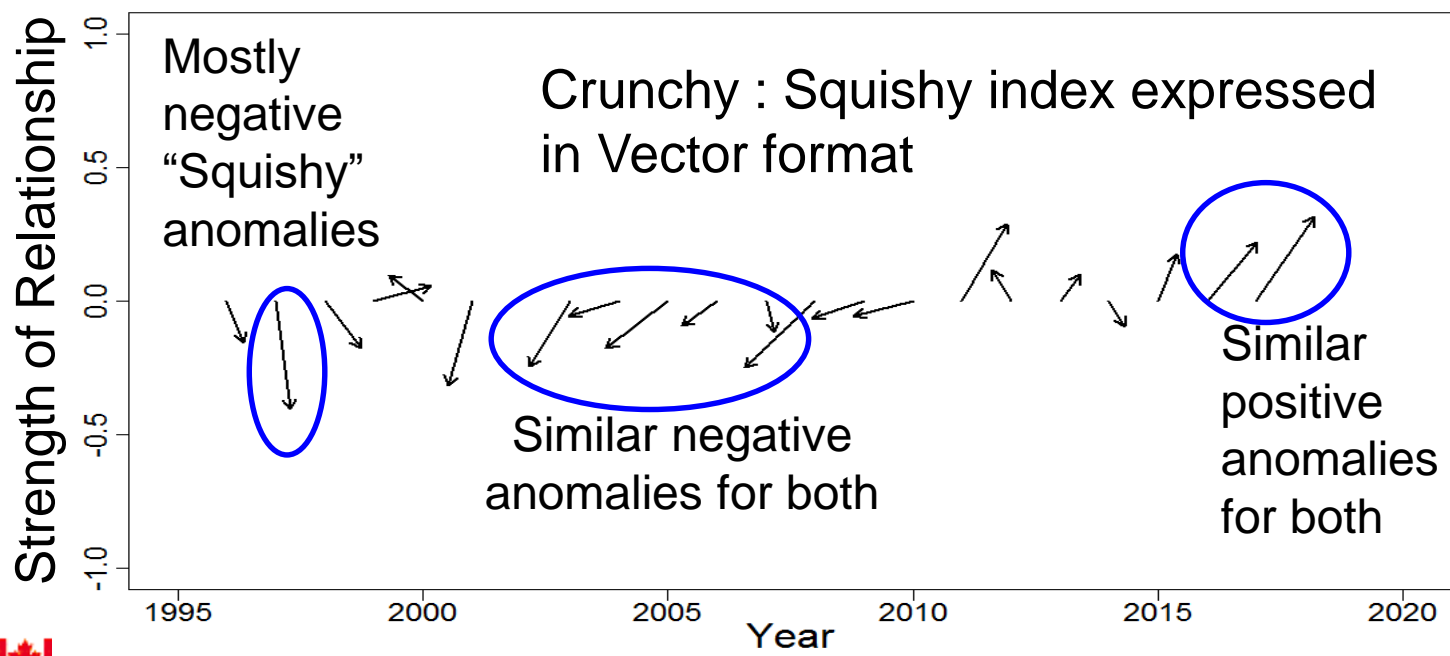


Cumulative Annual Biomass Anomalies for "Crunchies" and "Squishies"

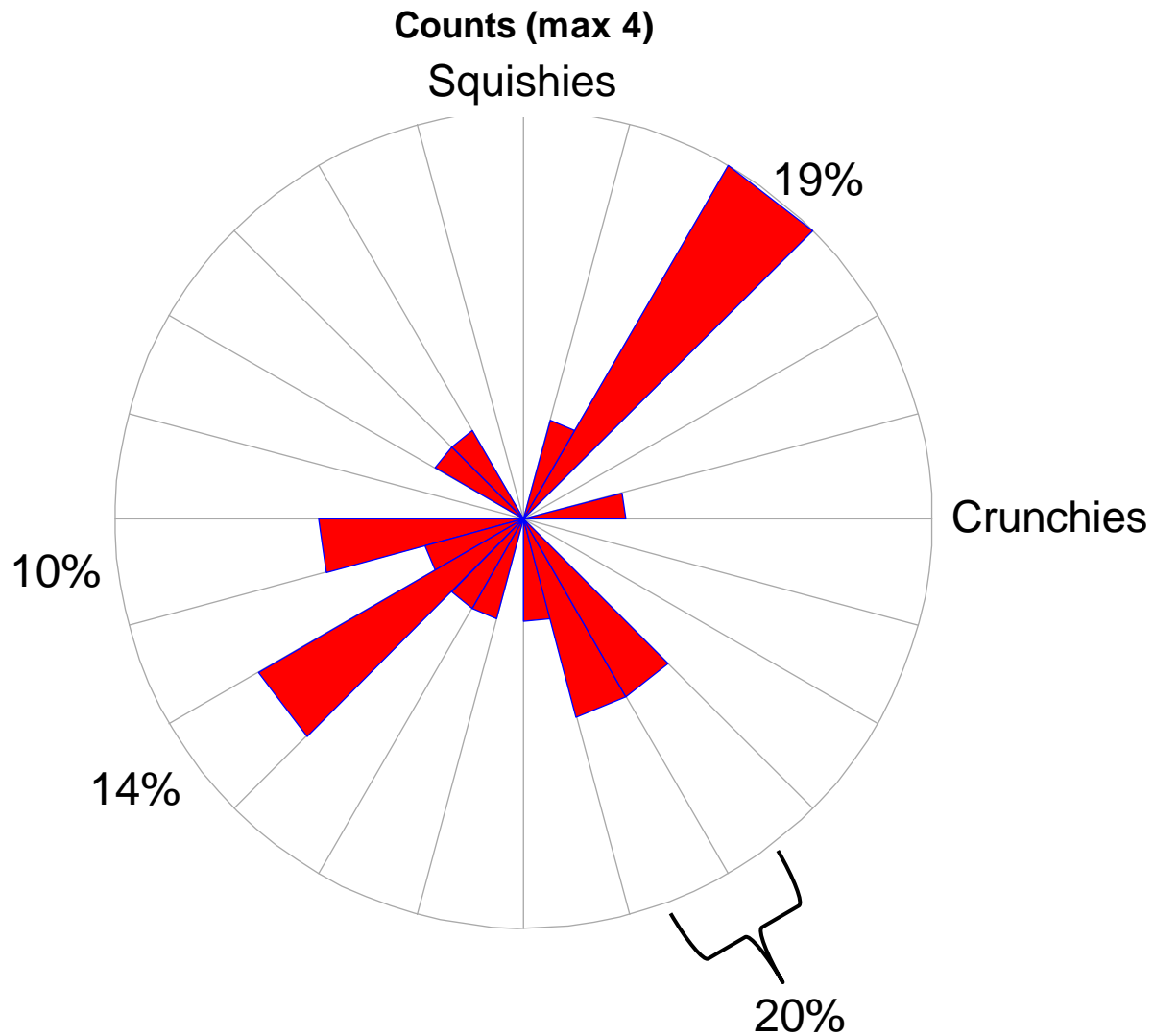




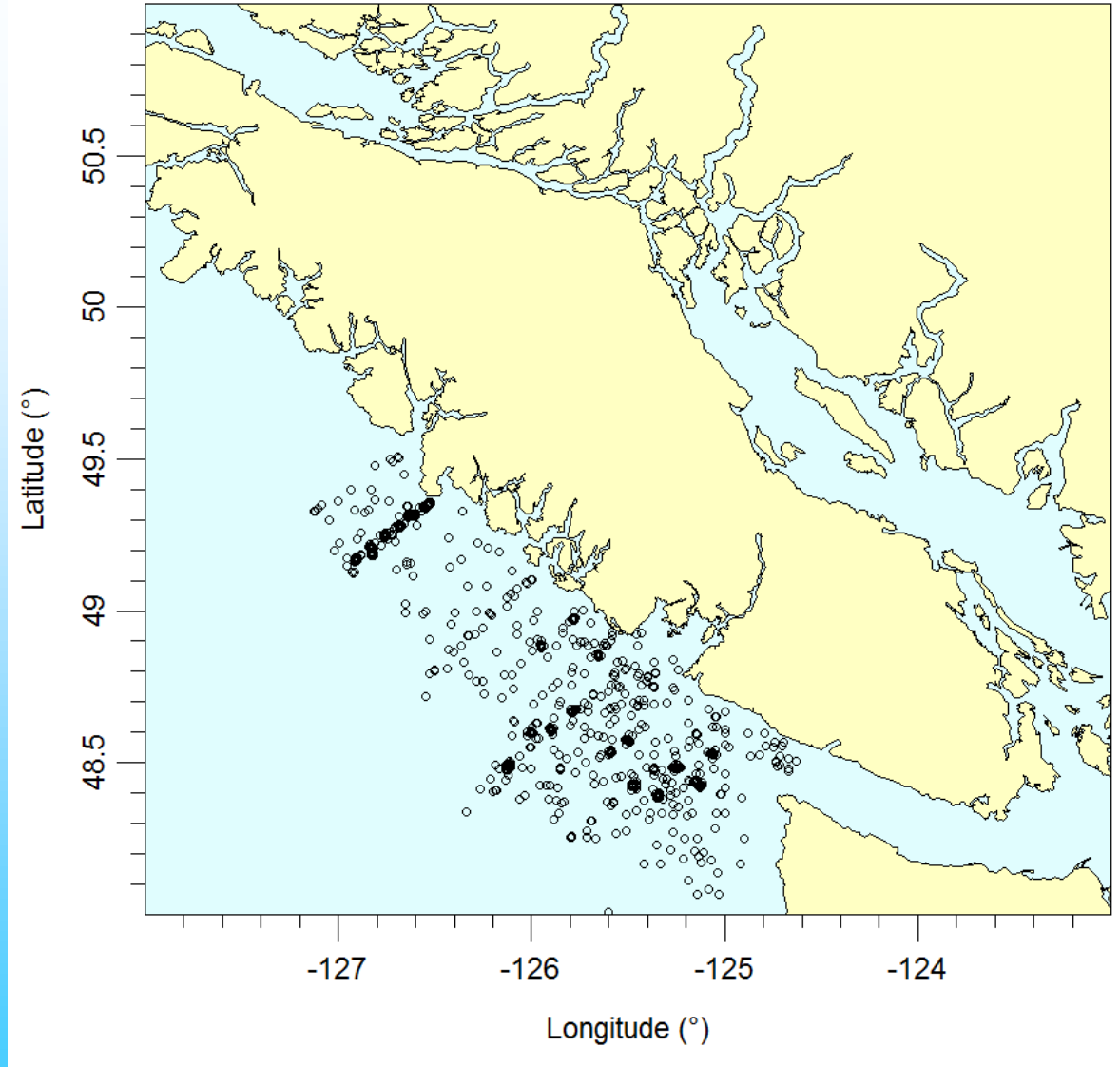
Cumulative Annual Biomass Anomalies for "Crunchies" and "Squishies"



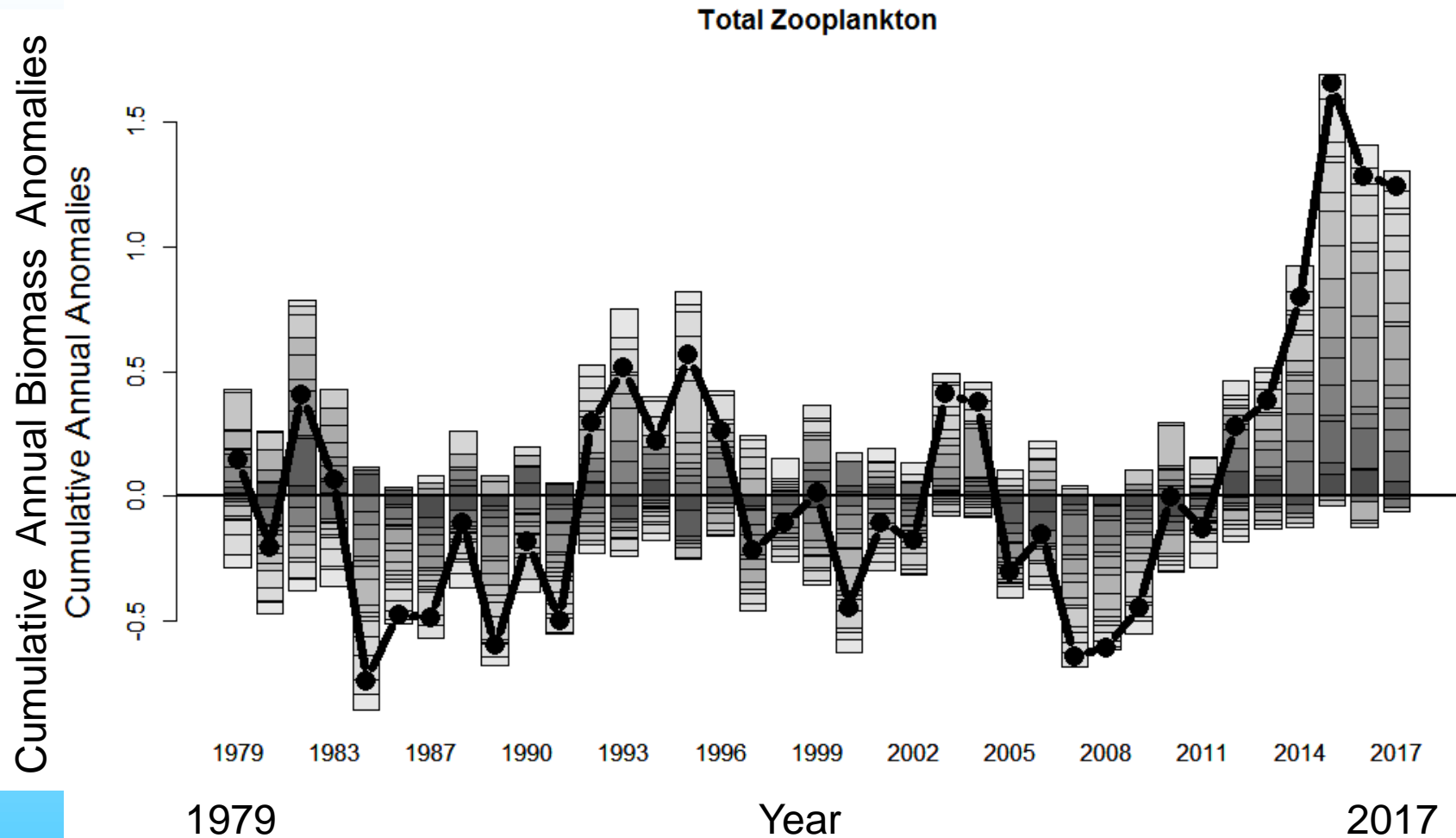
Wind Rose Plot of “Crunchy : Squishy” Vectors



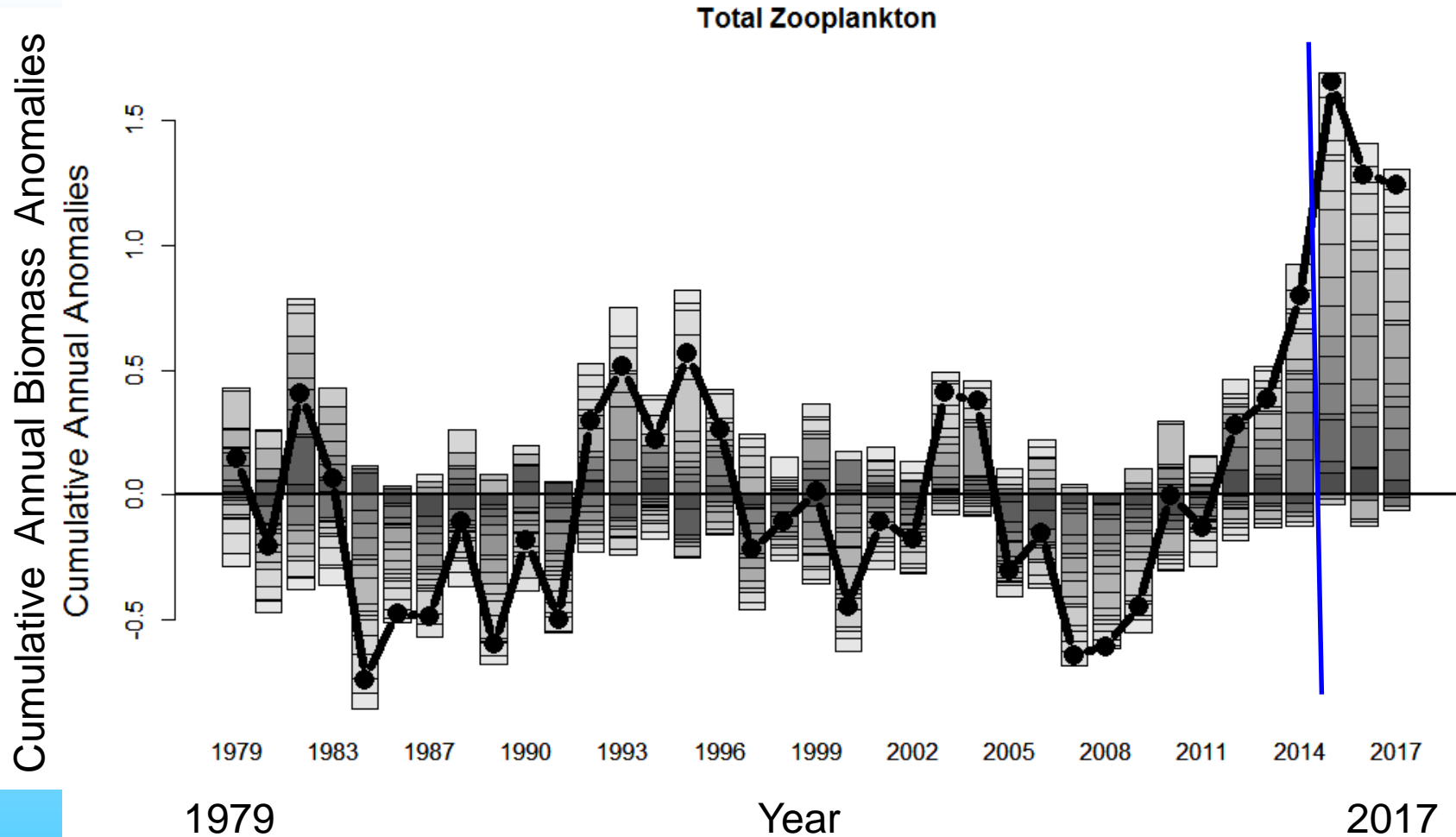
southern West Coast Vancouver Island continental shelf



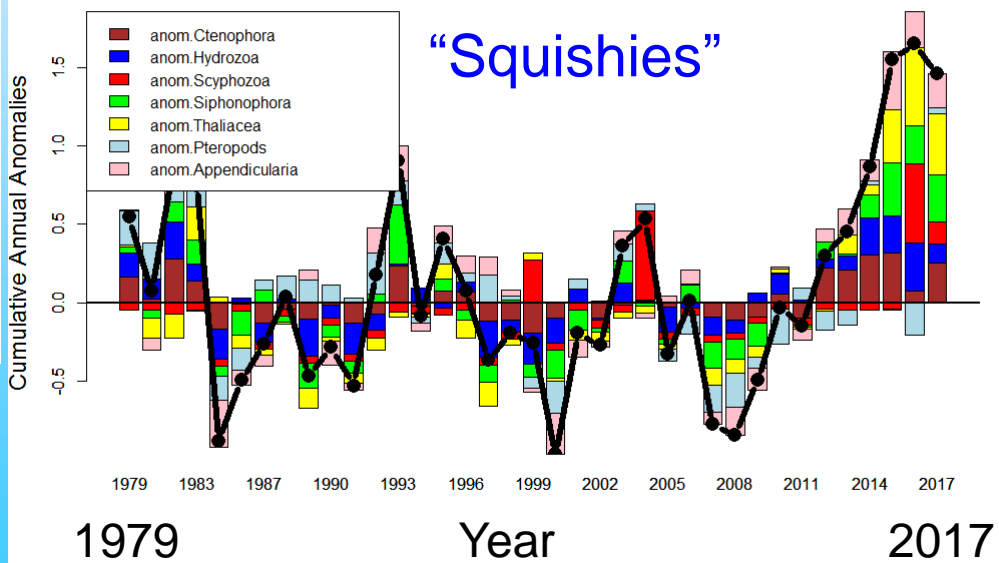
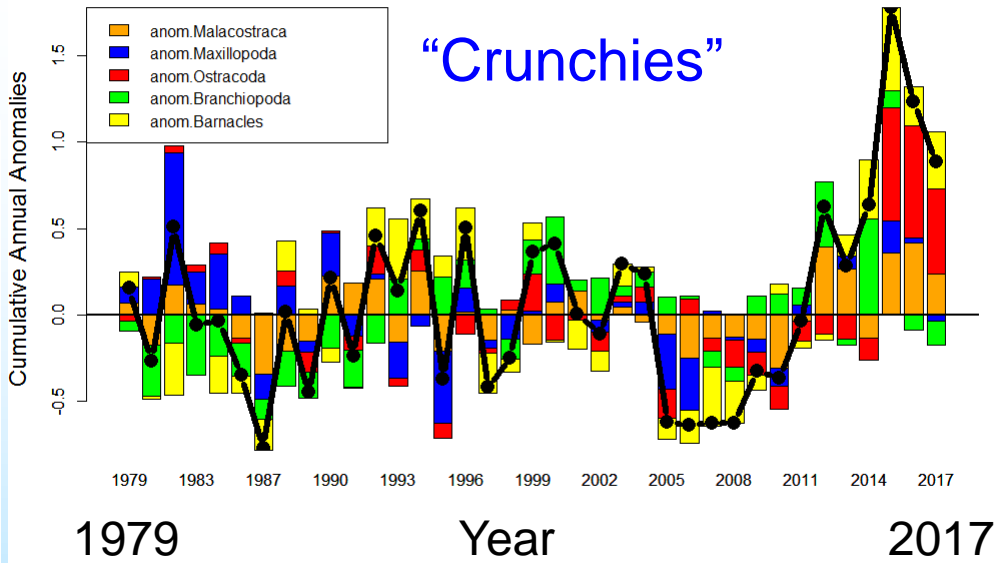
southern West Coast Vancouver Island continental shelf



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Cumulative Annual Biomass Anomalies



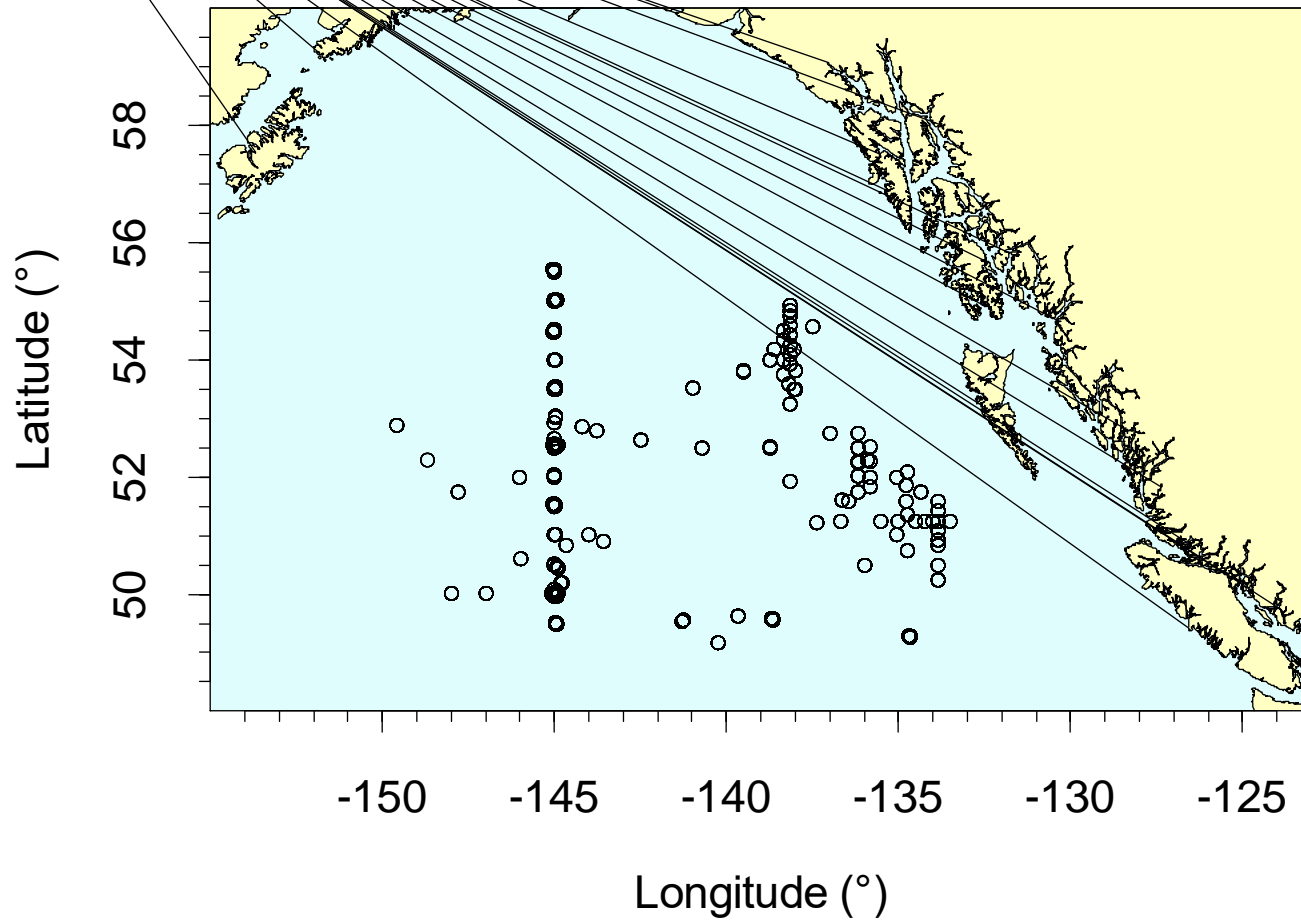
Cumulative Annual Biomass Anomalies for “Crunchy” and “Squishy” taxonomic groups

Linear regression of Squishy versus Crunchy Cumulative Anomalies: Multiple R-squared = 0.50, p-value << 0.01

Cumulative biomass anomalies are significantly, and strongly, related



Gulf of Alaska

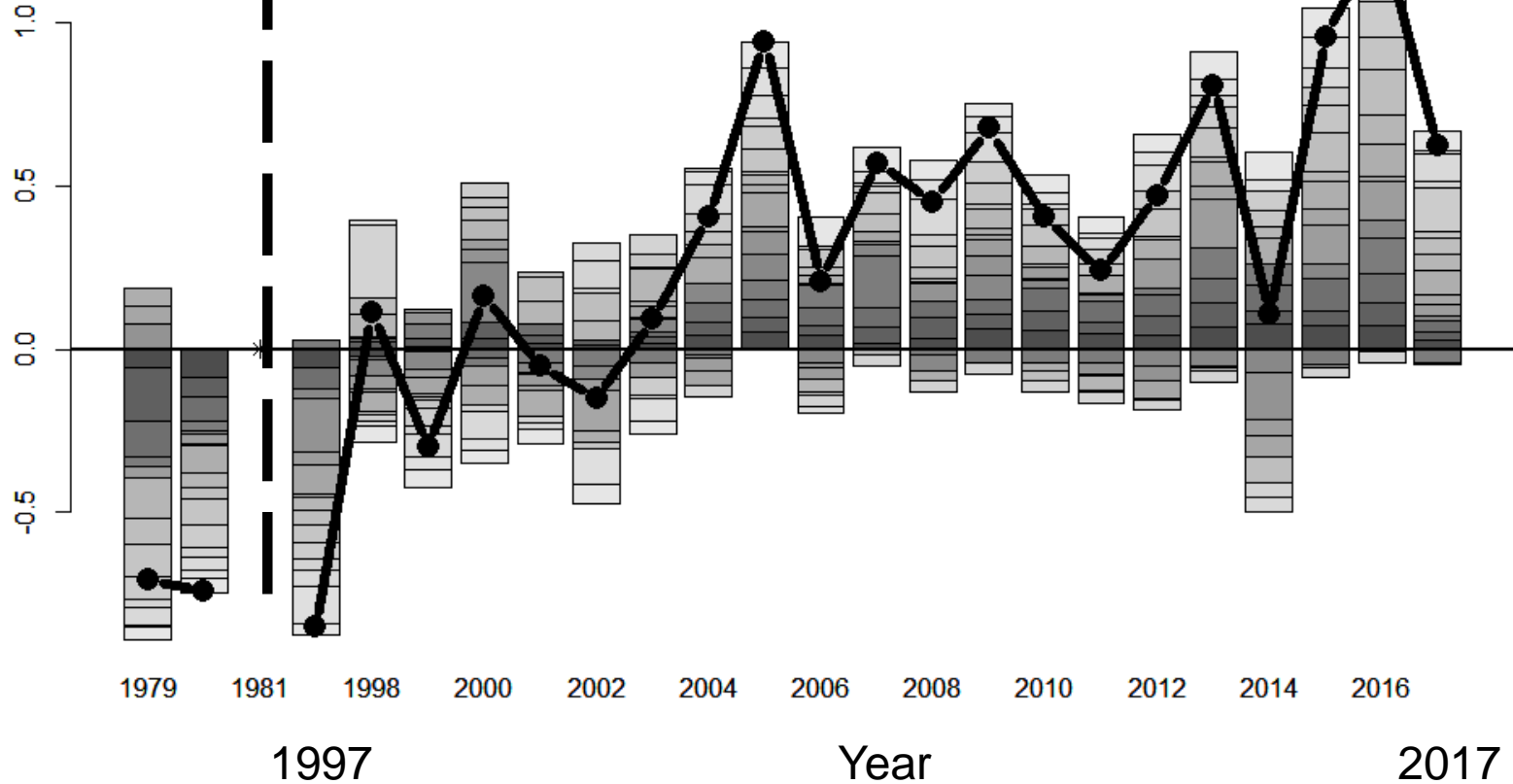


Gulf of Alaska

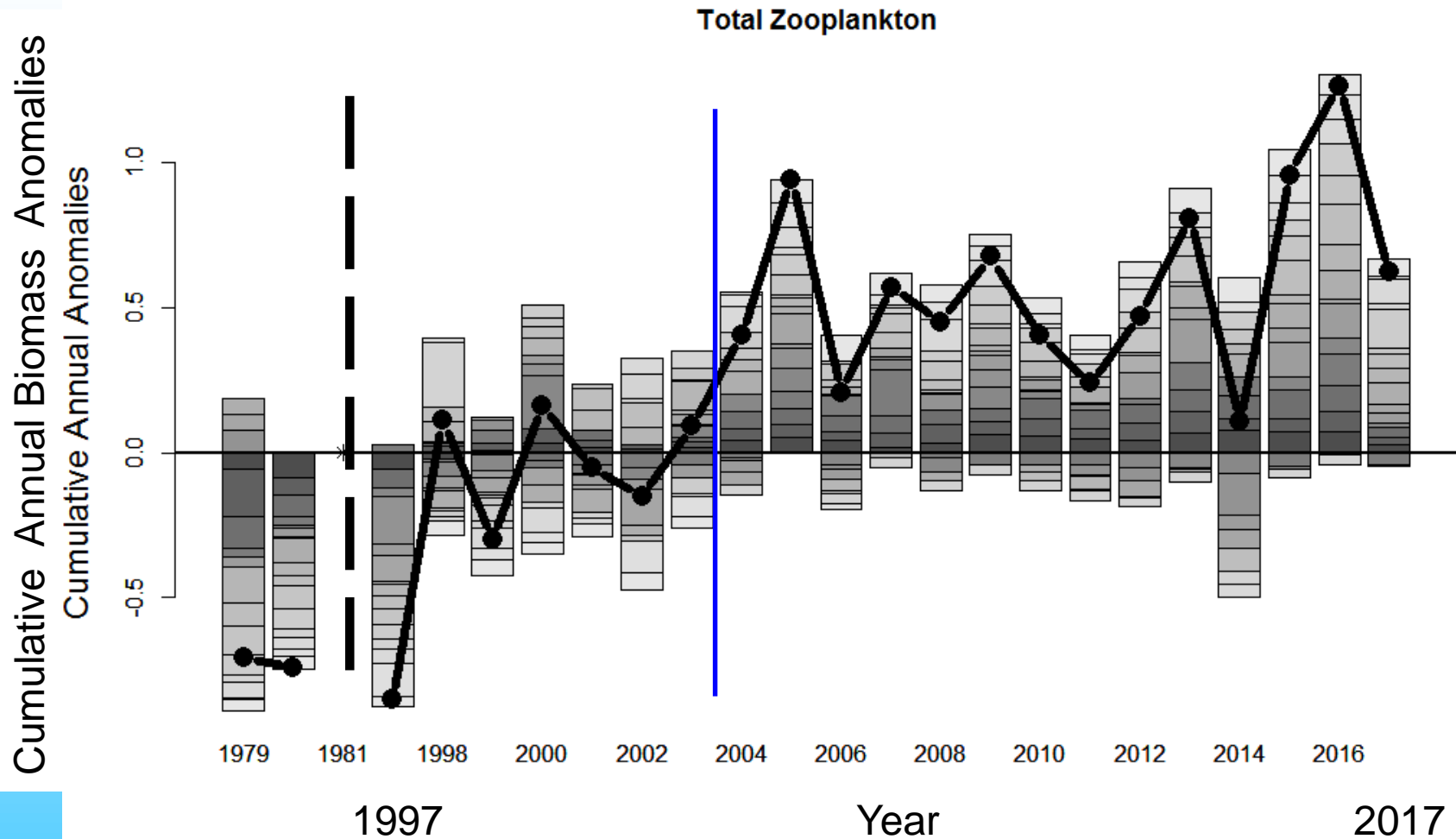
Cumulative Annual Biomass Anomalies

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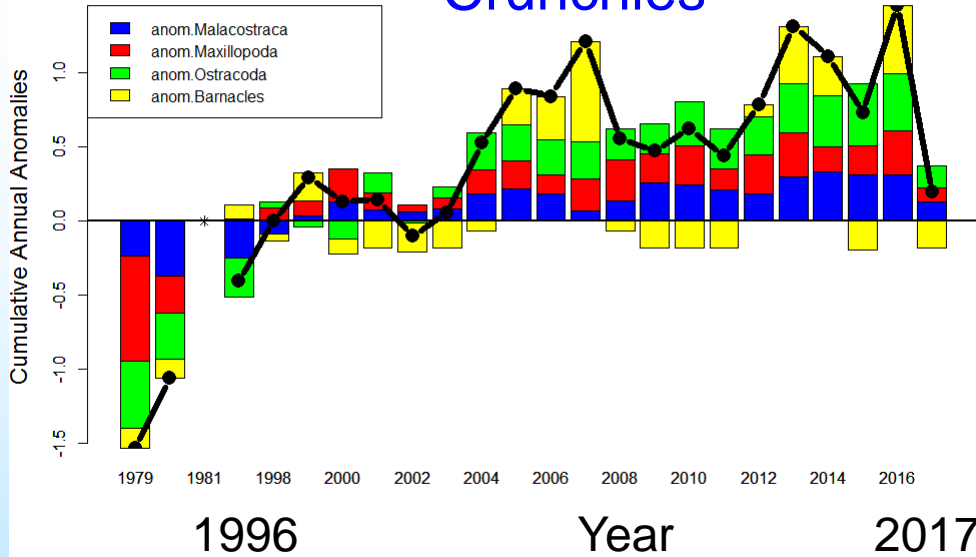
Total Zooplankton



Gulf of Alaska

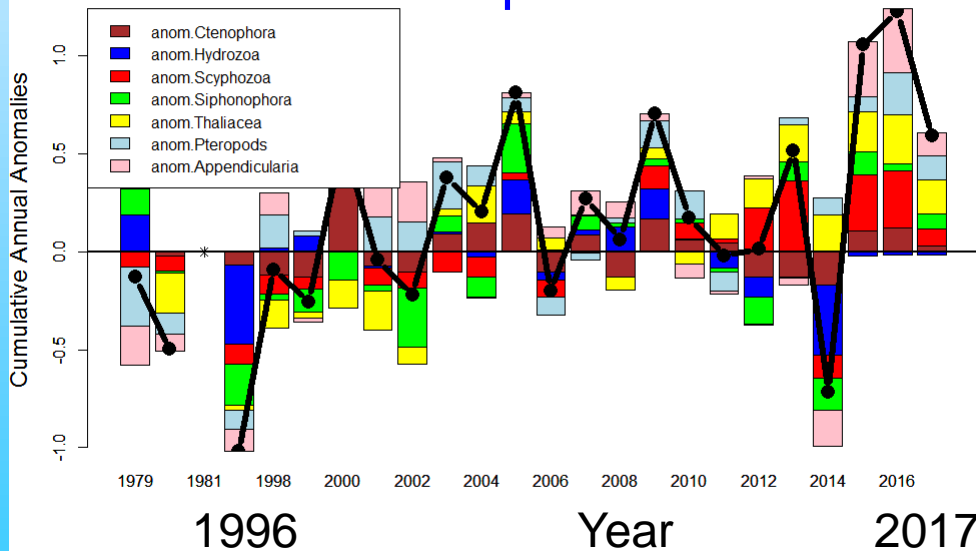


“Crunchies”



Cumulative Annual Biomass Anomalies for “Crunchy” and “Squishy” taxonomic groups

“Squishies”

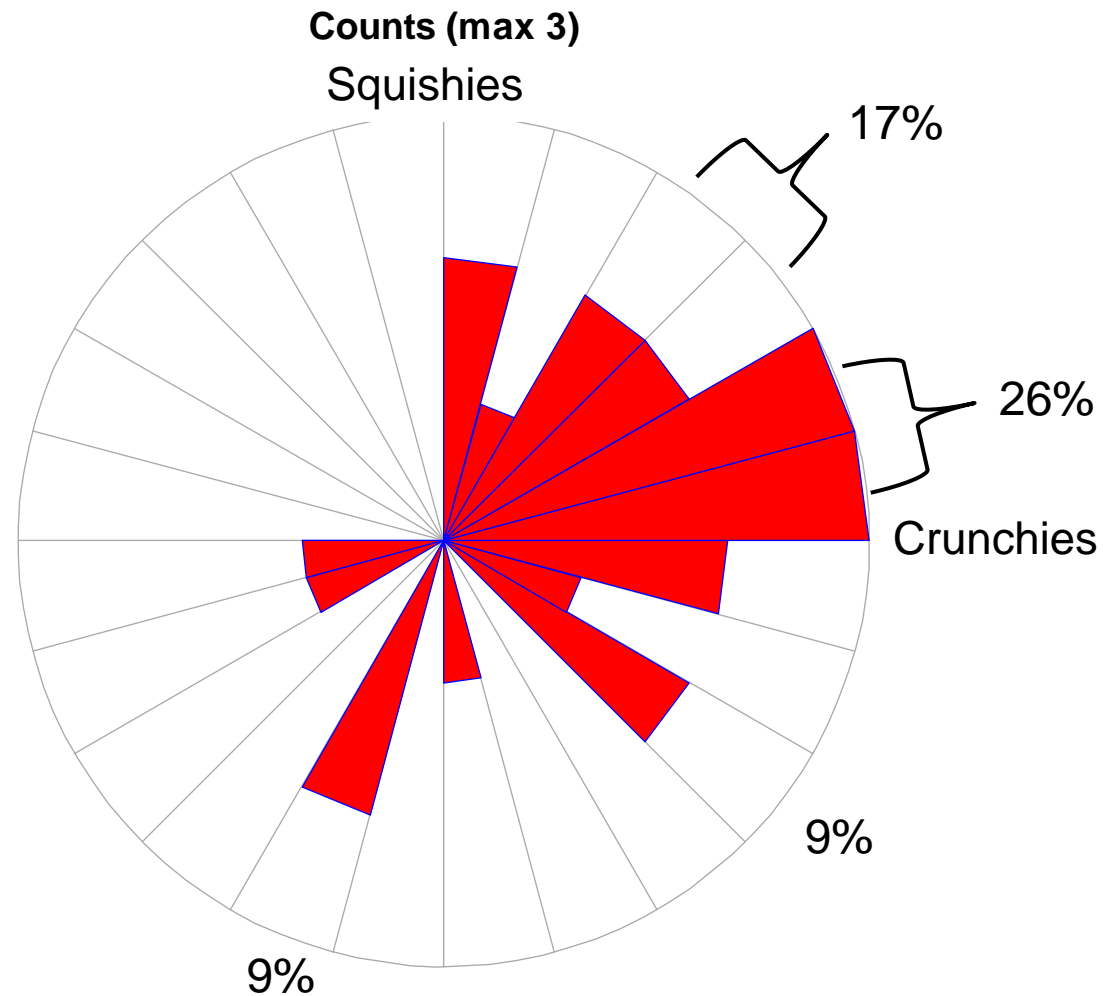


Linear regression of Squishy versus Crunchy Cumulative Anomalies:
Multiple R-squared = 0.21,
p-value = 0.03

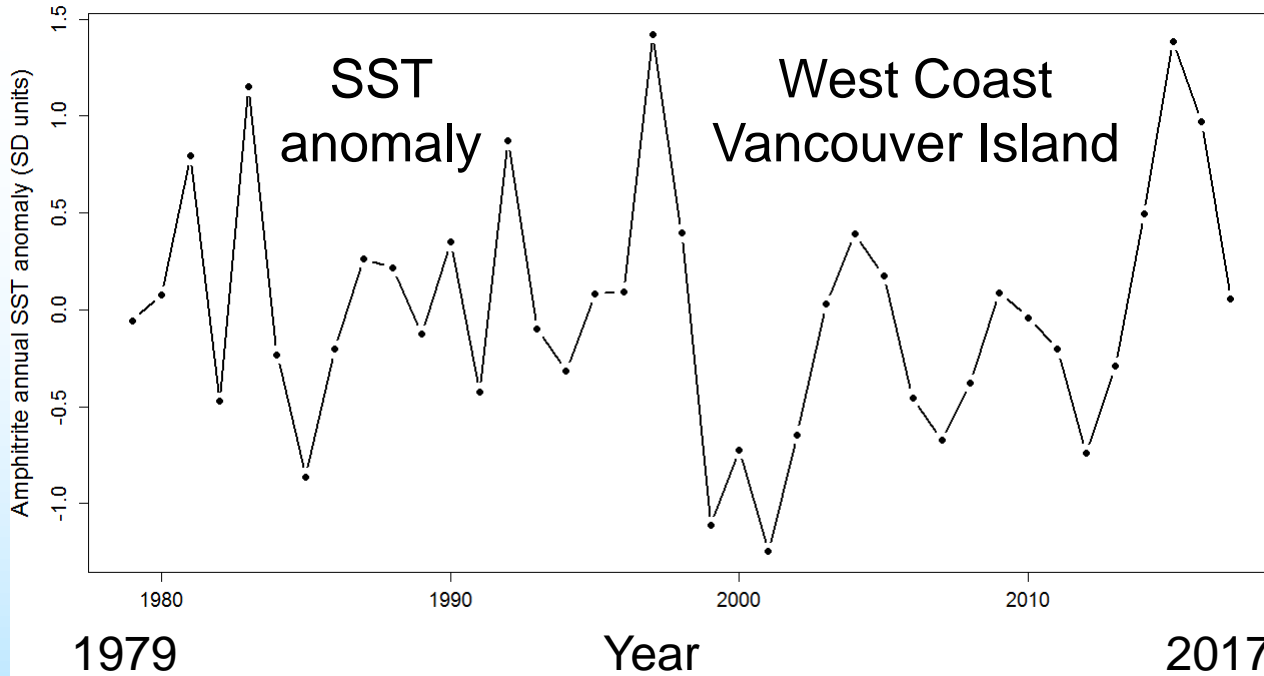
Cumulative biomass anomalies are significantly, but weakly, related



Wind Rose Plot of “Crunchy : Squishy” Vectors



Amphitrite SST Anomaly

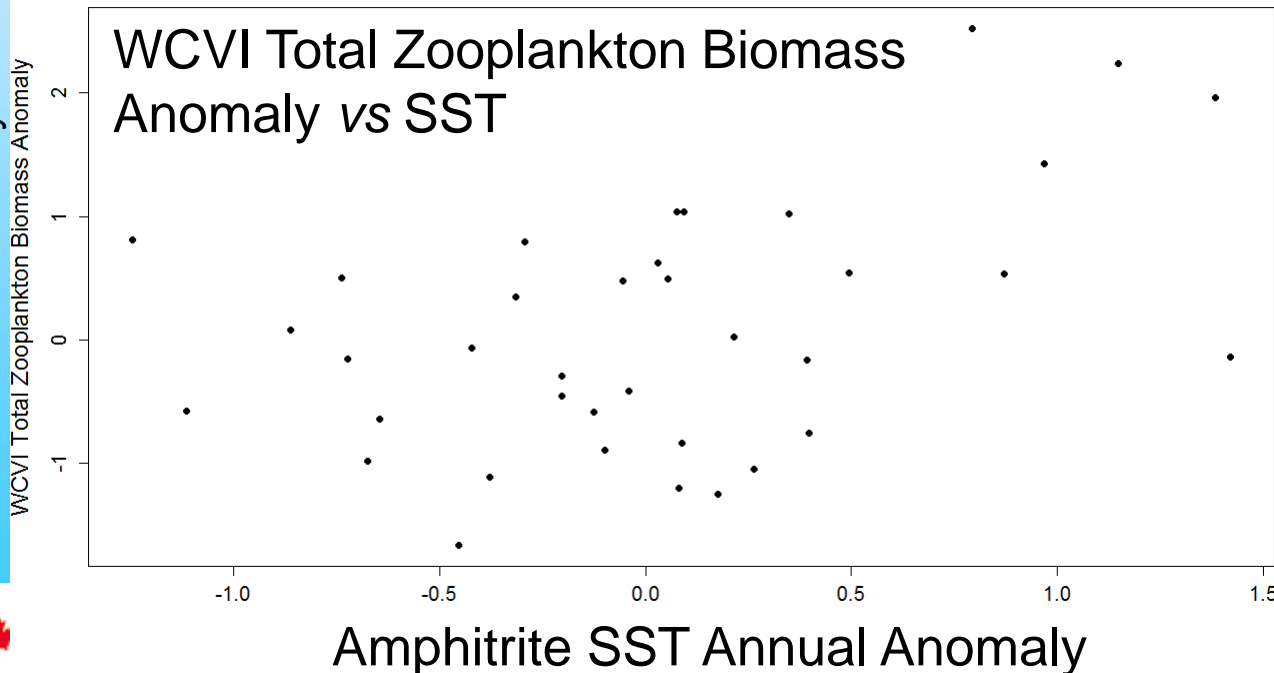


Is sea temperature contributing to these results?

Linear regression:
West Coast Vancouver Island total zooplankton biomass Cumulative Anomaly Index *versus* annual SST anomalies at Amphitrite Point:
R-squared = 0.20,
p-value = 0.01

For WCVI: Yes

WCVI Total Zooplankton Biomass Anomaly



Summary (1)

Comparisons among Strait of Georgia, West Coast Vancouver Island southern continental shelf, and Gulf of Alaska show that:

Interannual patterns of biomass anomalies of high-level taxonomic categories (hard-bodied zooplankton “Crunchies”; gelatinous zooplankton “Squishies”) are weakly positively correlated over the period 1990s to 2010s.

Biomass anomalies are most strongly synchronised:

- 1) on the West Coast of Vancouver Island (38% of years have strongly positive or negative anomalies for both “Crunchies” and “Squishies”);
 - 2) the Strait of Georgia (33% of years have positive or negative anomalies for both “Crunchies” and “Squishies”).
- In Gulf of Alaska, biomass anomalies are dominated (42%) by positive anomalies of hard-bodied taxa (Crunchies).



Summary (2)

Comparisons among Strait of Georgia, West Coast Vancouver Island continental shelf, and Gulf of Alaska show that:

Biomass anomalies for most high-level taxonomic categories have been **high and positive since about 2013-2014**

Sea temperature is a significant (single) contributor to these patterns only for the West Coast of Vancouver Island

Conclude that:

Ecosystem consequences of gelatinous plankton should be examined for **specific taxonomic groups** (e.g. 'surprises') rather than for total gelatinous plankton.



West Coast Vancouver Island Shelf: Salps, Dolilolids, Pyrosomes Thaliacea

