Using trophically transmitted parasites to help understand the role and dynamics of small pelagic fish in the California Current

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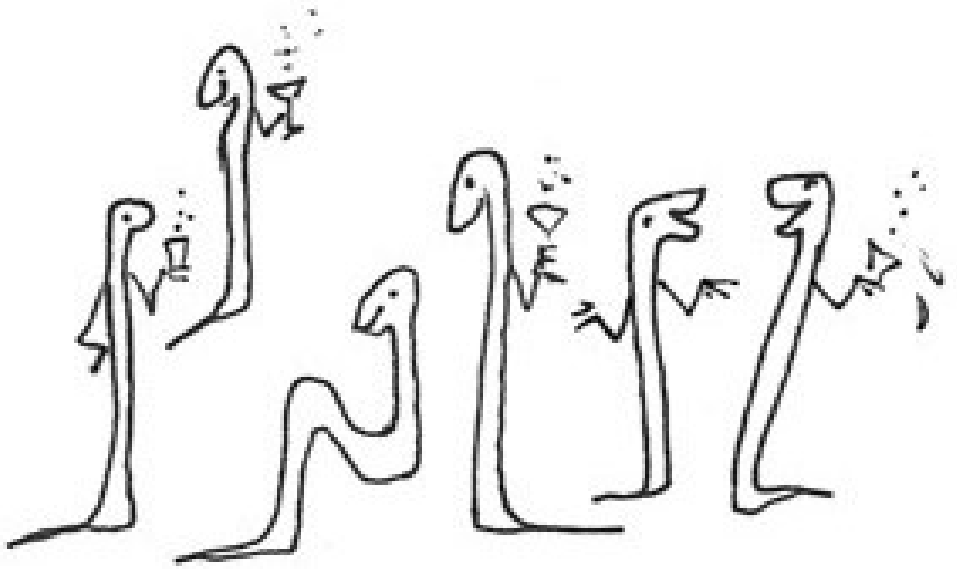
Trophically Transmitted Parasites:

Parasites that use predator prey interactions to complete their life cycles; reproducing in their final-definitive host.

Courtesy of Dr. Jen Zamon

There *are* parasites that cause severe pathology, disease, or long term cost

Not talking about those parasites today…



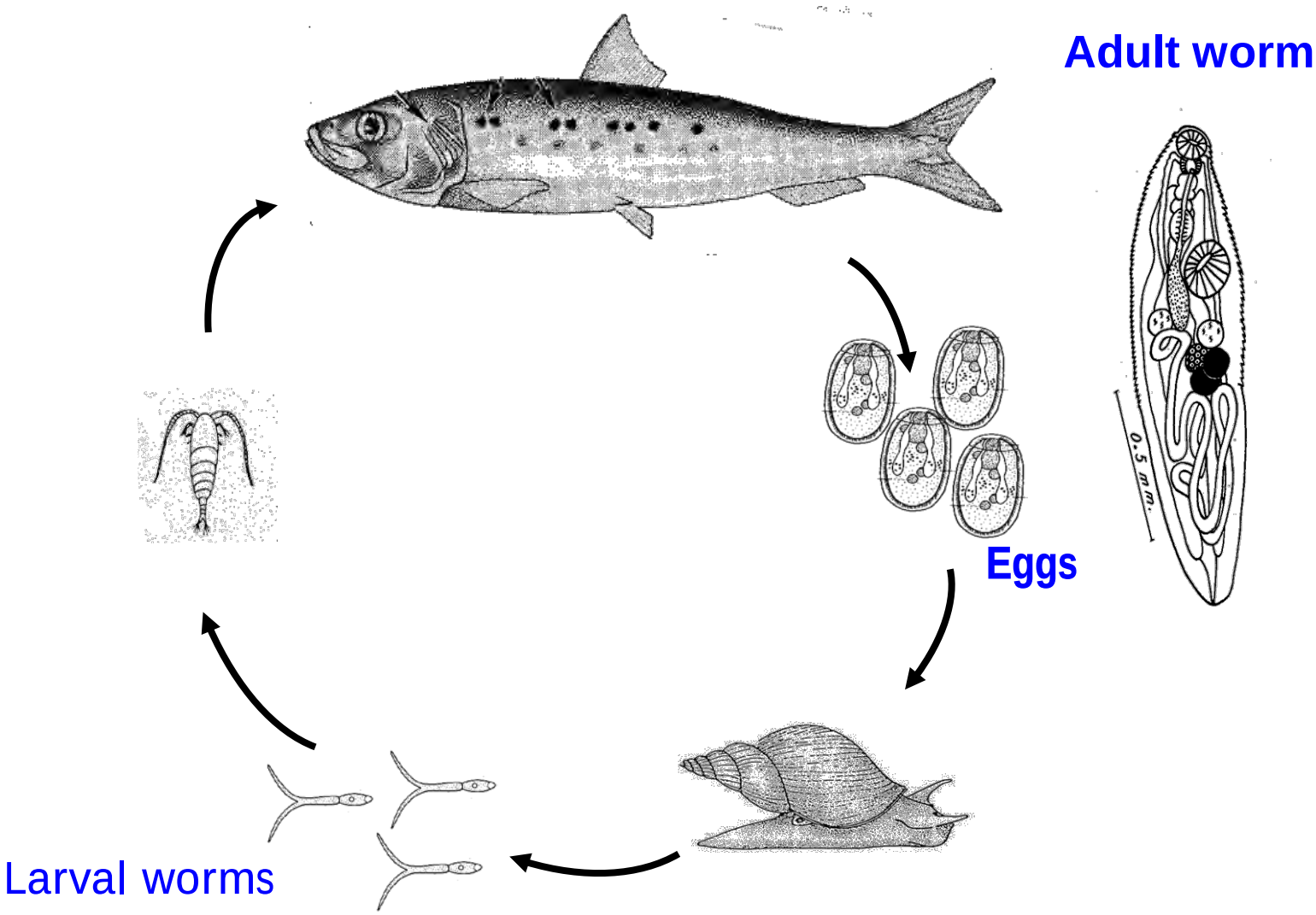
Just those that are evidence of what you have been up to…

Illustrations by Kiki Metzler
Alder Brooke Healing Arts

Objectives of this talk:

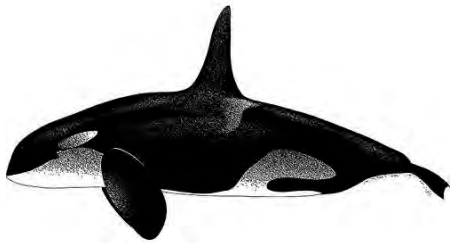
- Introduce trophically transmitted parasites
- Show how they can be used as a tool to
  - help identify prey and predators of small pelagics
  - reflect spatial variability of food web
  - help identify fish stocks or migration patterns

A Simple Trematode Life Cycle



Modified from Marcogliese (1995)

Life cycle of Nematode-*Anisakis spp.*



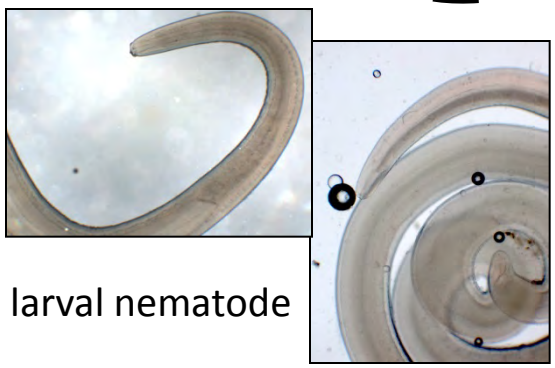
eggs are released

Paratenic Host: Predator fish

www.dfo.pac-mpo.gc.ca

First Intermediate:
Euphausia pacifica
Thysanoessa spinifera,
or other Crustaceans

Paratenic Host: Forage Fish



larval nematode

flickr.com

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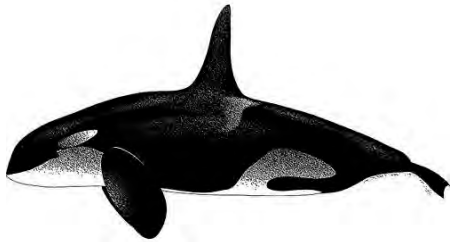

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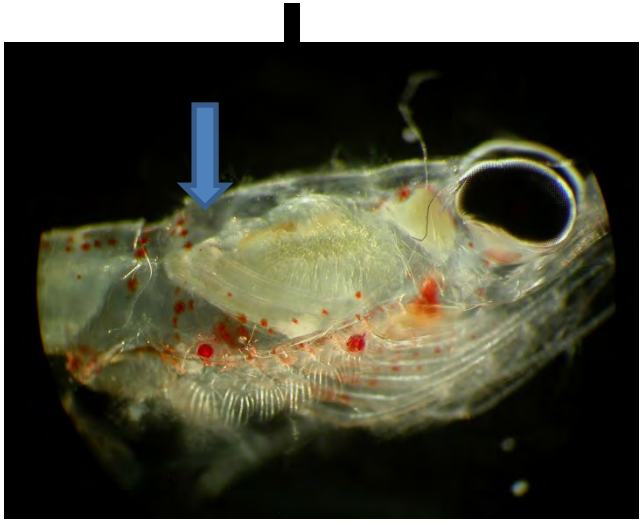

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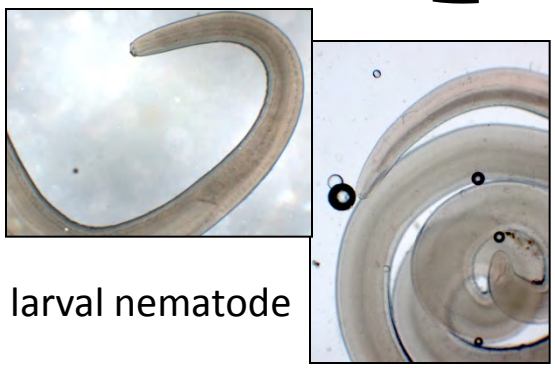

larval nematode

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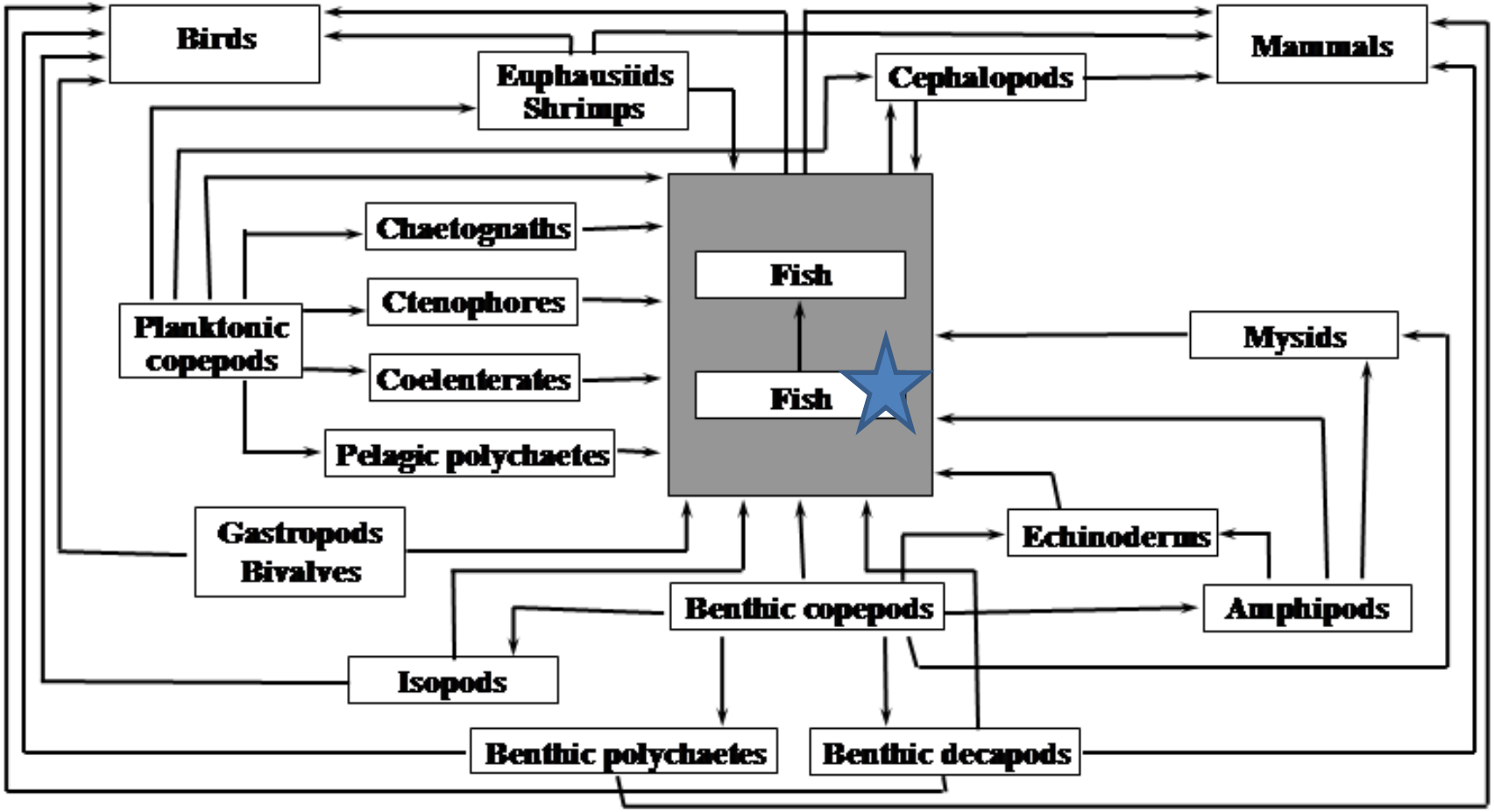
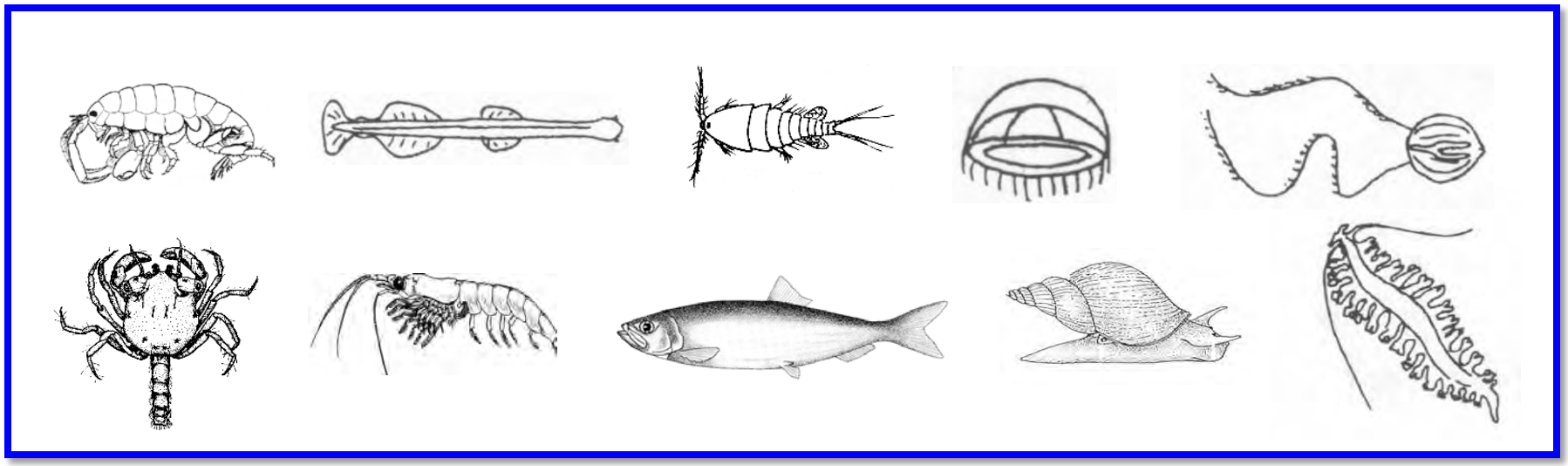
Potential transmission pathways for parasites involving marine predator-prey interactions



Marcogliese 1997, Trends in Ecology and Evolution

Examples of Intermediate Hosts of Marine Parasites

Amphipods Chaetognaths **Copepods** Cnidarians Ctenophores



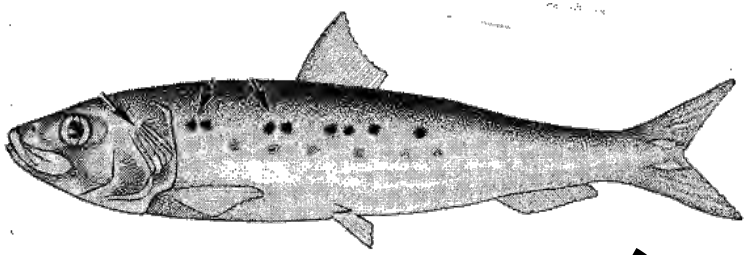
Decapods **Euphausiids** Fish **Molluscs** Polychaetes

Utility of parasites in food web studies or as biological tags for fish movement & stock structure:

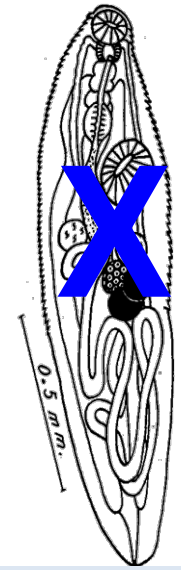
- Parasites can remain in a fish host from several months to years, extending diet history (days – yr)
- Can provide diet information even in fish with empty stomachs
- Can also provide info on predators in ecosystem
- Can use single species of parasites, multiple, or whole communities

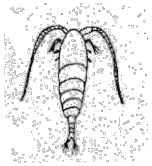
How do they work as a tag?

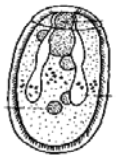
Trematode Life Cycle



Adult worm

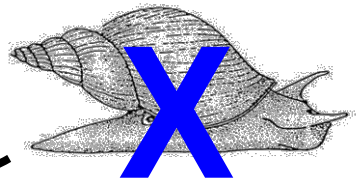


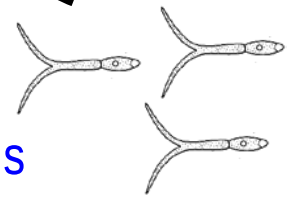




Egg

Need required hosts and habitat for parasite to occur in a location

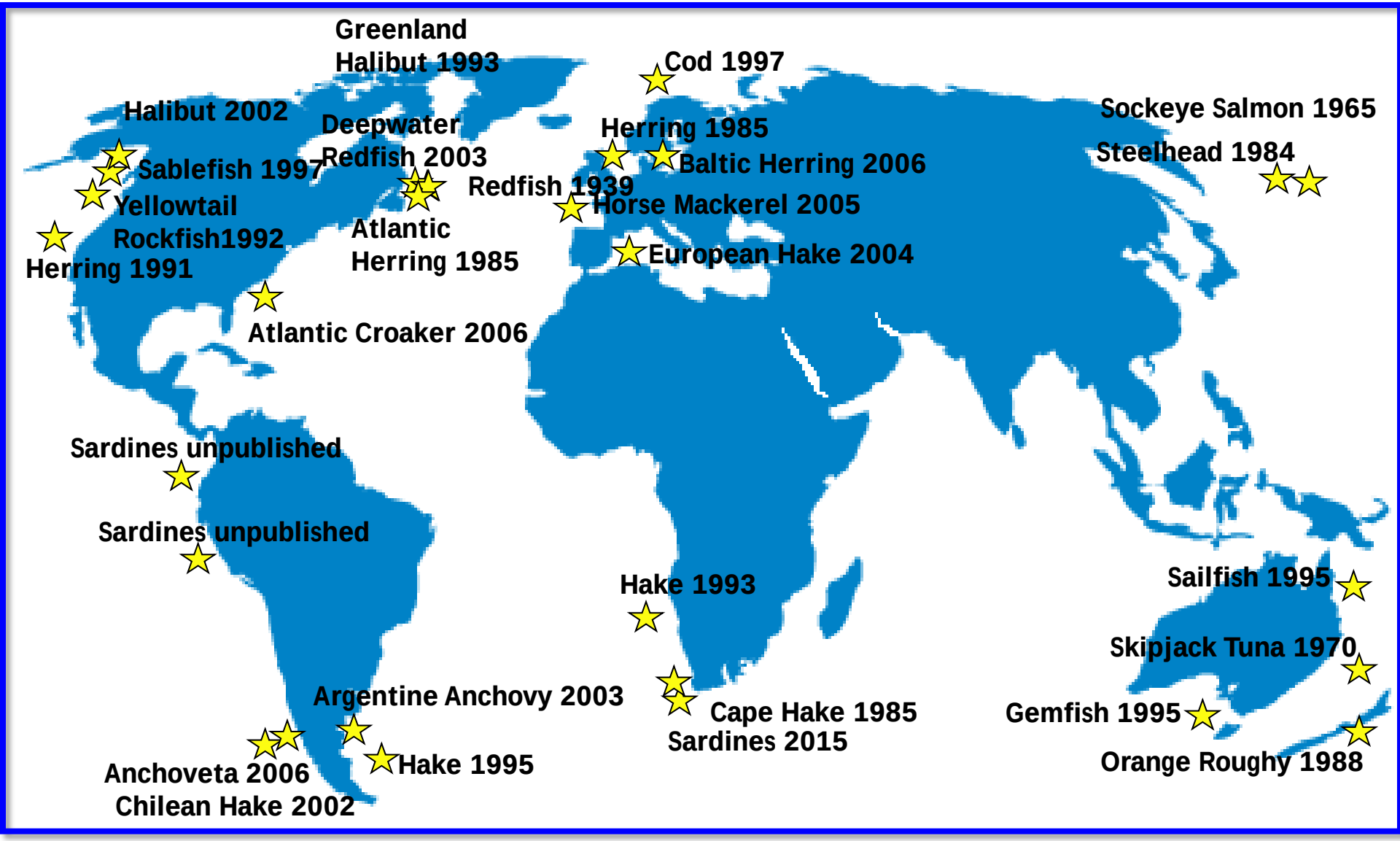




Larval worms

Modified from Marcogliese (1995)

Parasite Tag Studies Around the World: >300 studies to date



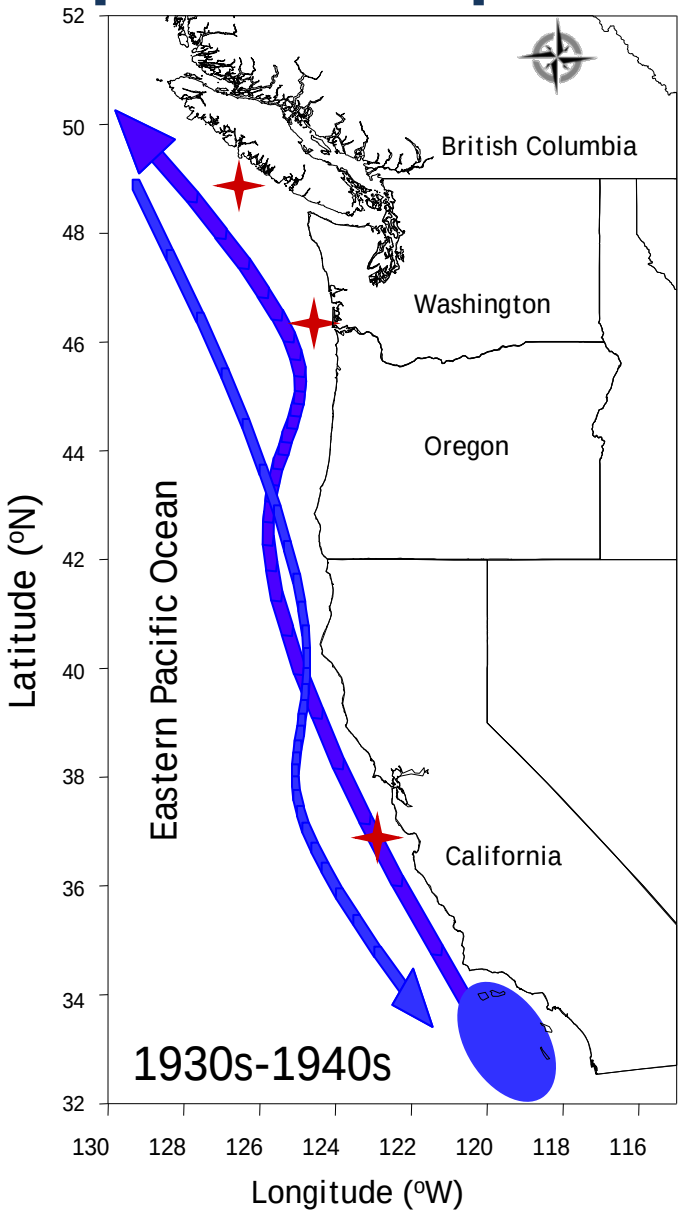
Recent Publications on Parasites as Tags in Small Pelagics

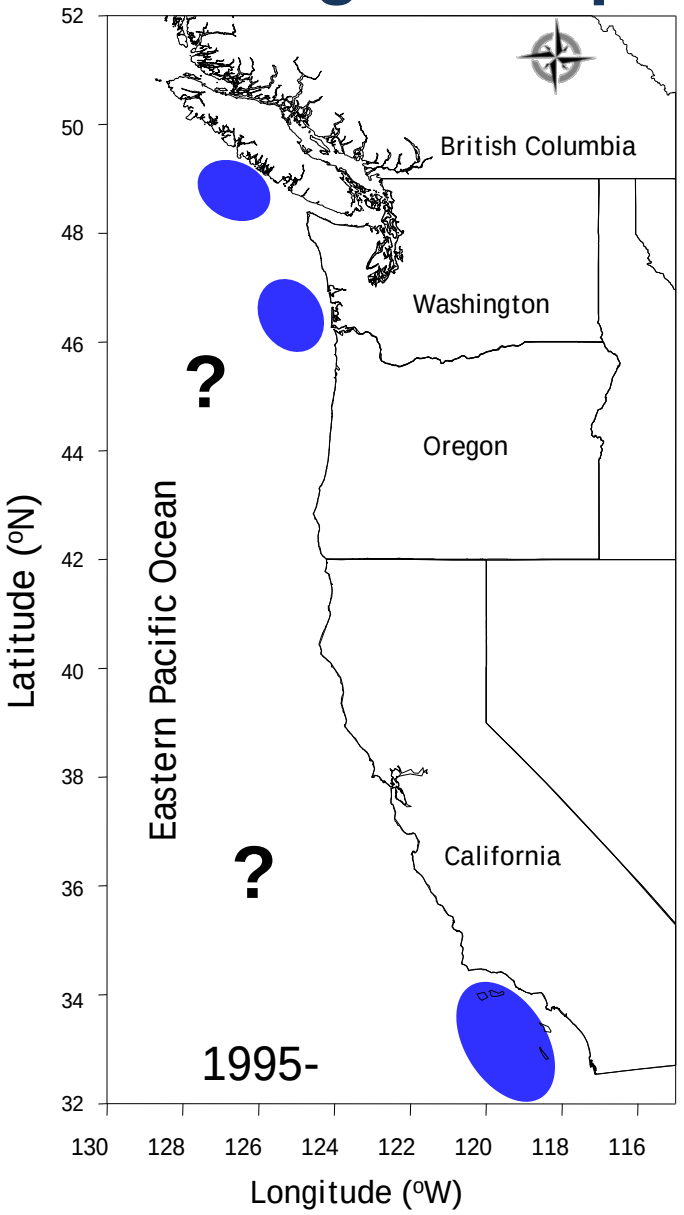
- A larval trematode in eyes, which matures in penguins, supports hypothesis of a western stock and southern stock off the coast of South Africa, with some degree of mixing (Weston et al. 2015, Van Der Lingen et al. 2015).

- Spatial variability of four parasite taxa suggests two discrete stocks of the round sardinella, *Sardinella aurita,* off the coast of Tunisia (Feki et al., J. Helminthology 2016)

Pacific Sardine in California Current system returned to the Pacific Northwest and Canada in late 1990s…

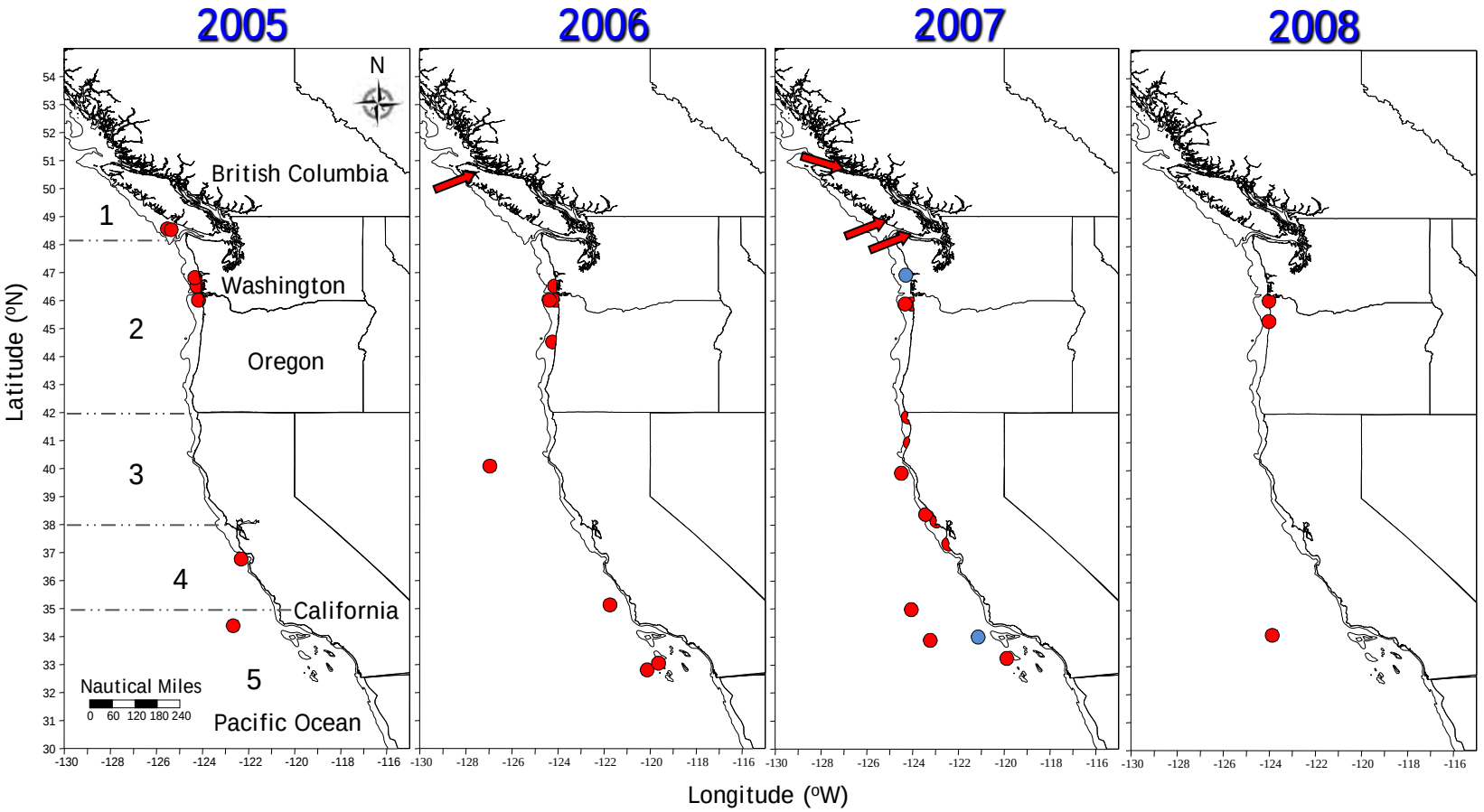
Were the Pacific sardines from the recent expansion repeating the old migration pattern ?





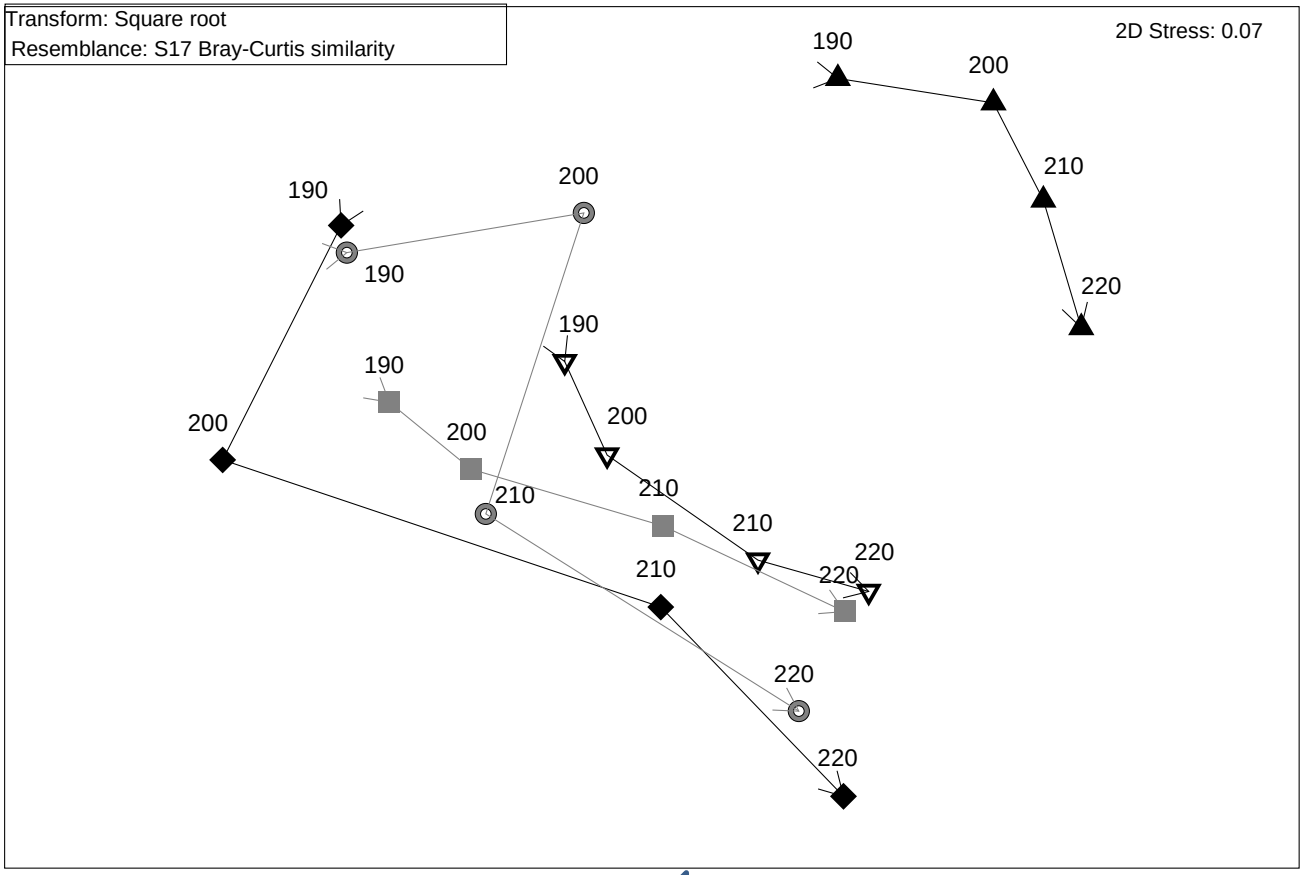
Sampling Locations

Pacific sardine (n = 1491) and northern Anchovy (n = 168)



N = 272 N = 473 N = 662 N = 99

Parasite communities of Pacific sardine were different by size and region



- British Columbia
- Washington-Oregon
- Central California
- Northern California
- Southern California

Small size class < 200mm SL

Largest size class > 220mm

2-way PERMANOVA: both region and size significant in main effects model $p < 0.01$

A total 12 parasite taxa was recovered

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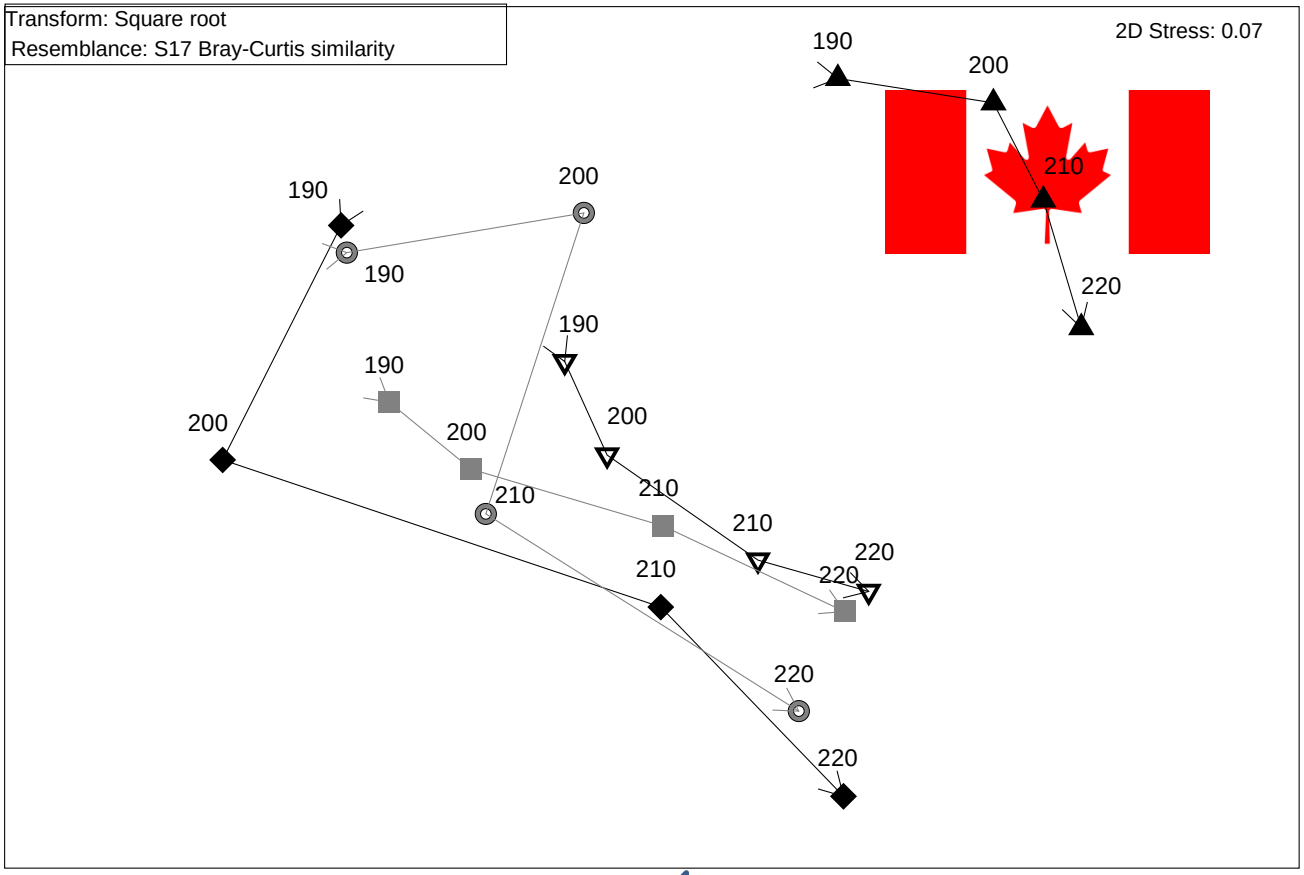

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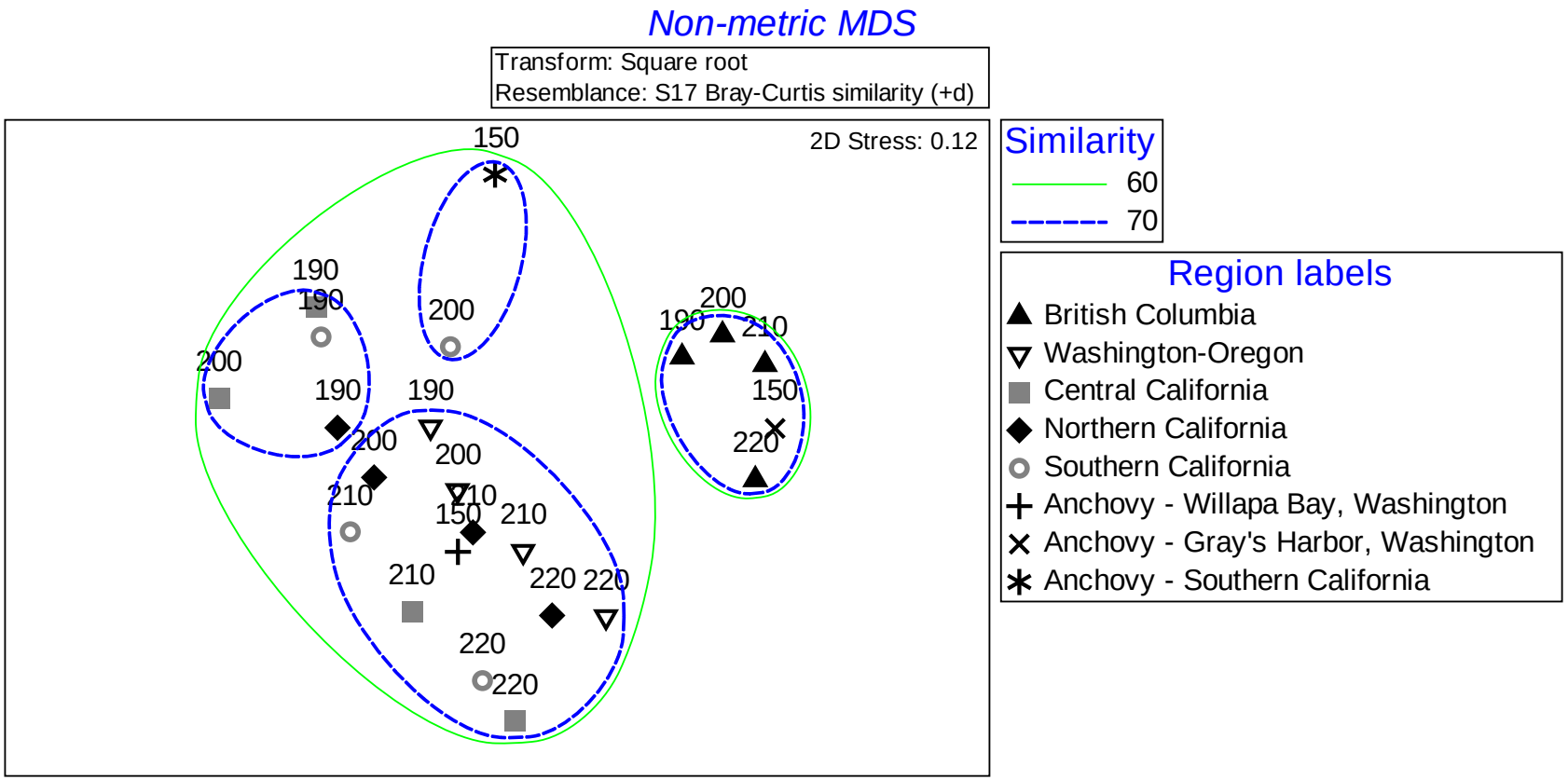
Northern Anchovy from different locations were different from each other, representing local food web



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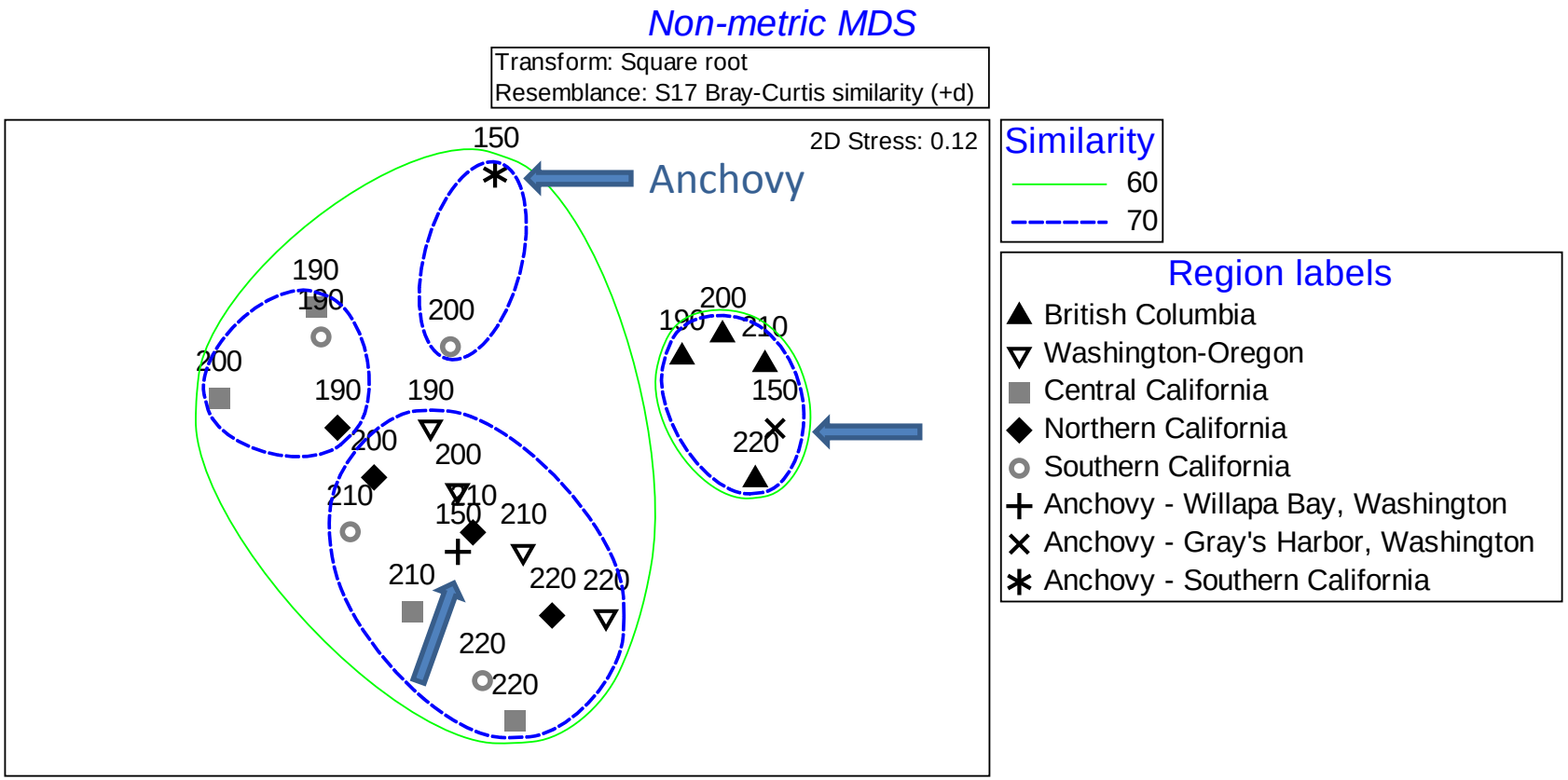
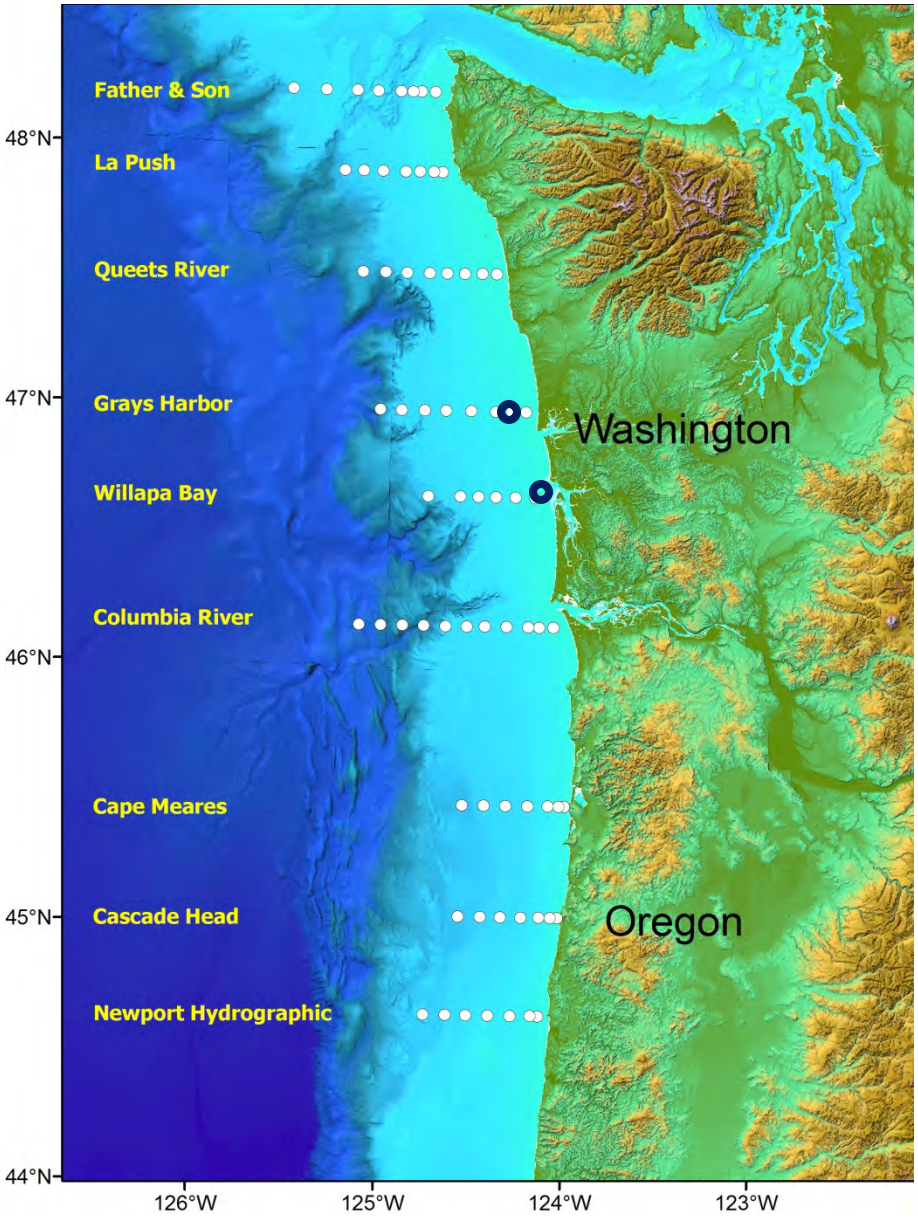
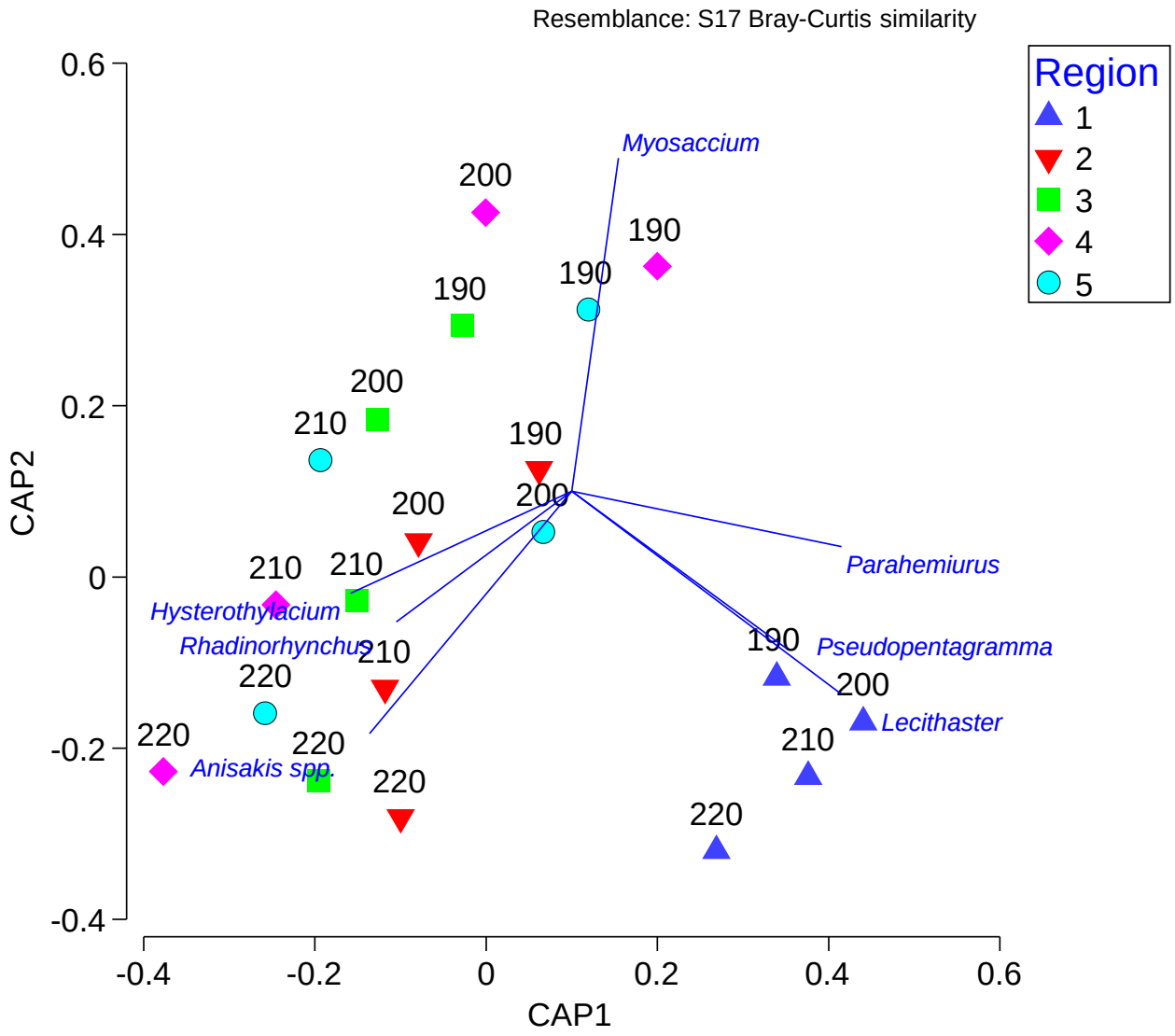


A total 6 parasite taxa was recovered from northern anchovy

northern Anchovy collected at two stations off Washington had very different parasite communities

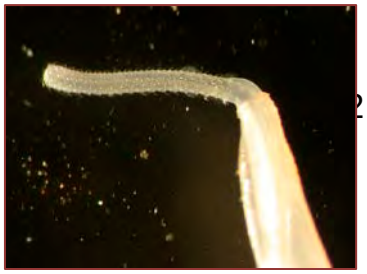


Canonical analysis of principal coordinates (CAP) with vector overlays of parasite species

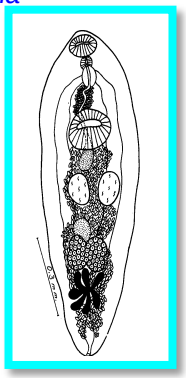


Canonical analysis of principal coordinates (CAP) with vector overlays of parasite species

nematodes and acanthocephalan



trematodes



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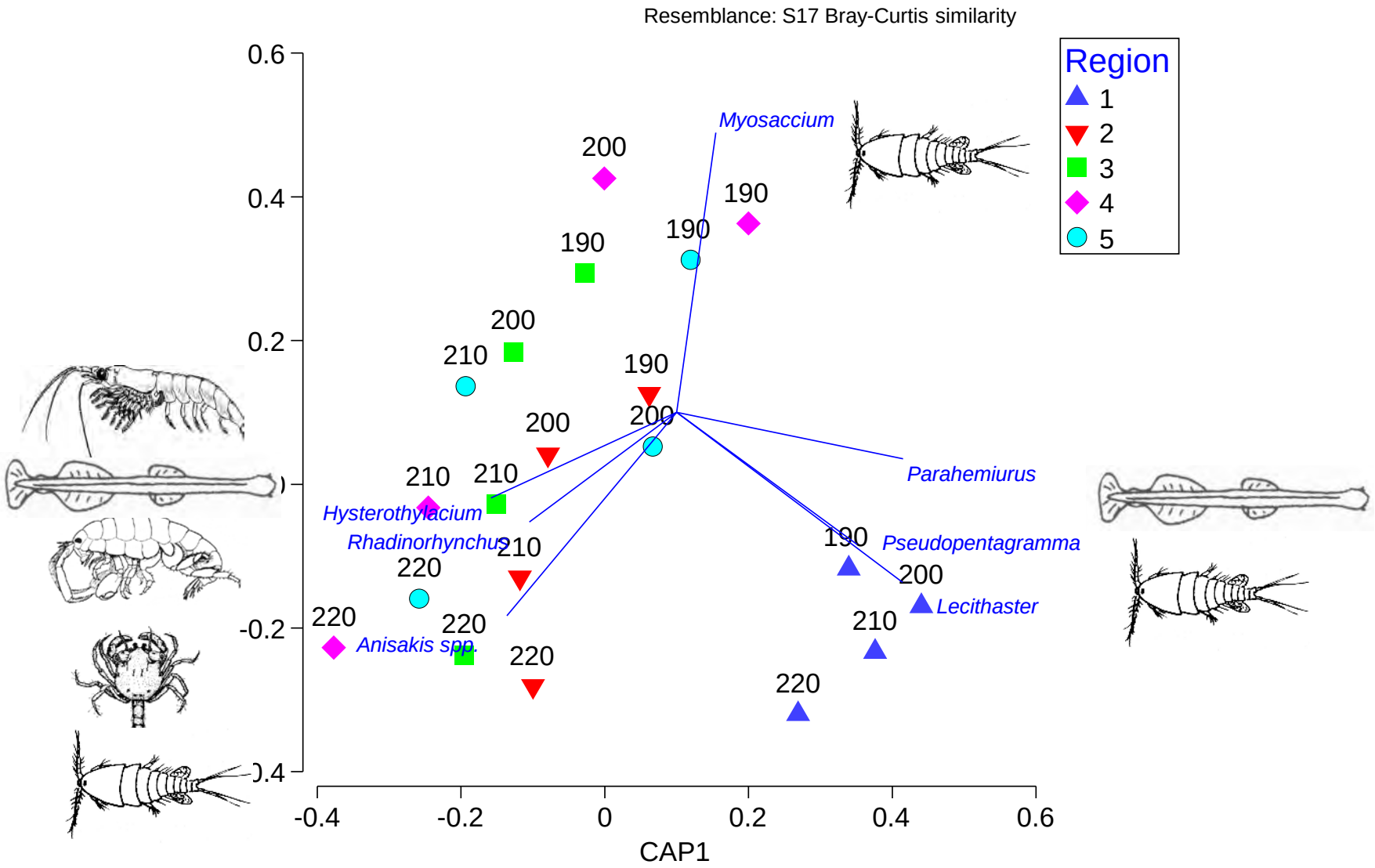
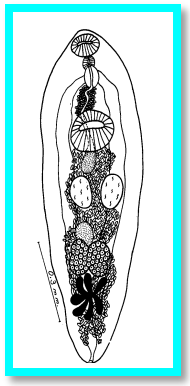
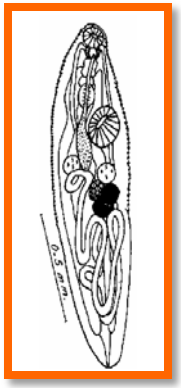


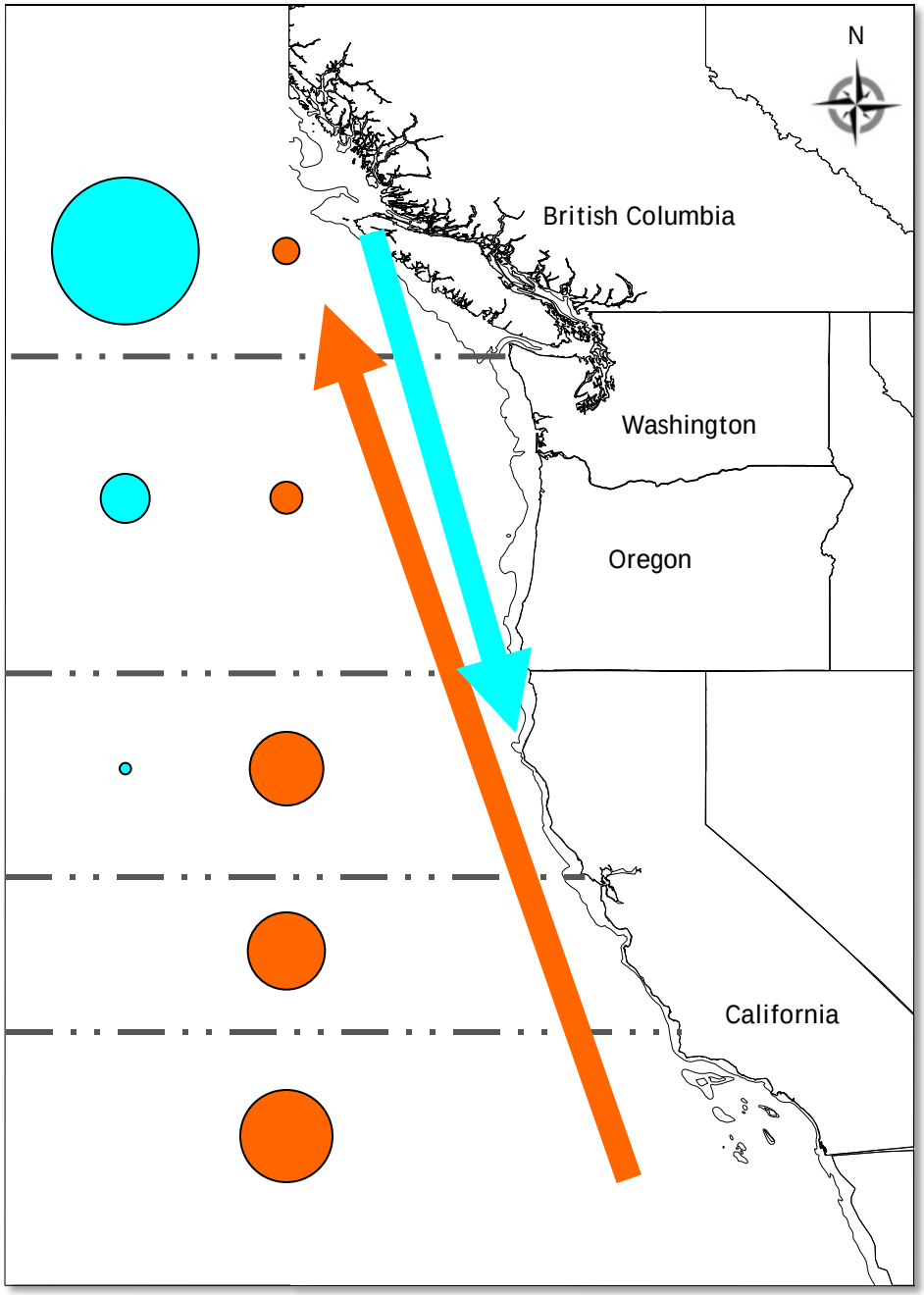
Distribution of the trematodes *Lecithaster gibbosus* and *Myosaccium ecaude* suggest that Pacific sardine from BC were not returning to S. California spawning grounds

Mean abundance / region

Lecithaster ***Myosaccium***

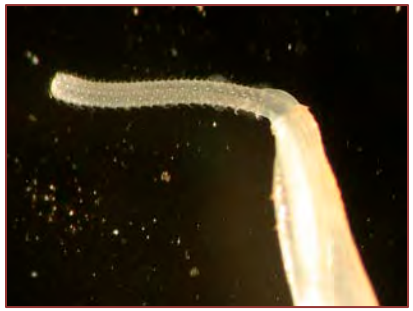






In addition:

The acanthocephalan is an offshore species. It's absence in large sardine off BC suggests those fish remained on the shelf, not making an offshore migration.



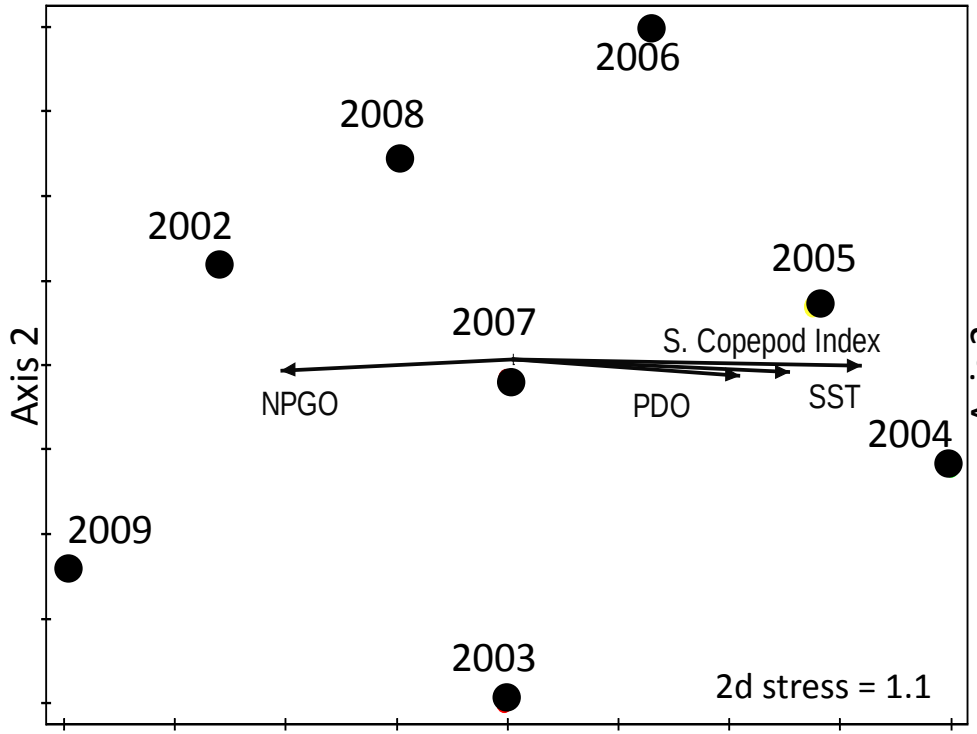
Fishdisease.net

The greater abundance of larval *Anisakis* spp. in large sardine off California suggests greater exposure to marine mammal final hosts.

Parasite Composition Can Vary Interannually & Reflect Dynamics of Ocean Conditions

Parasite Communities of Juvenile salmon

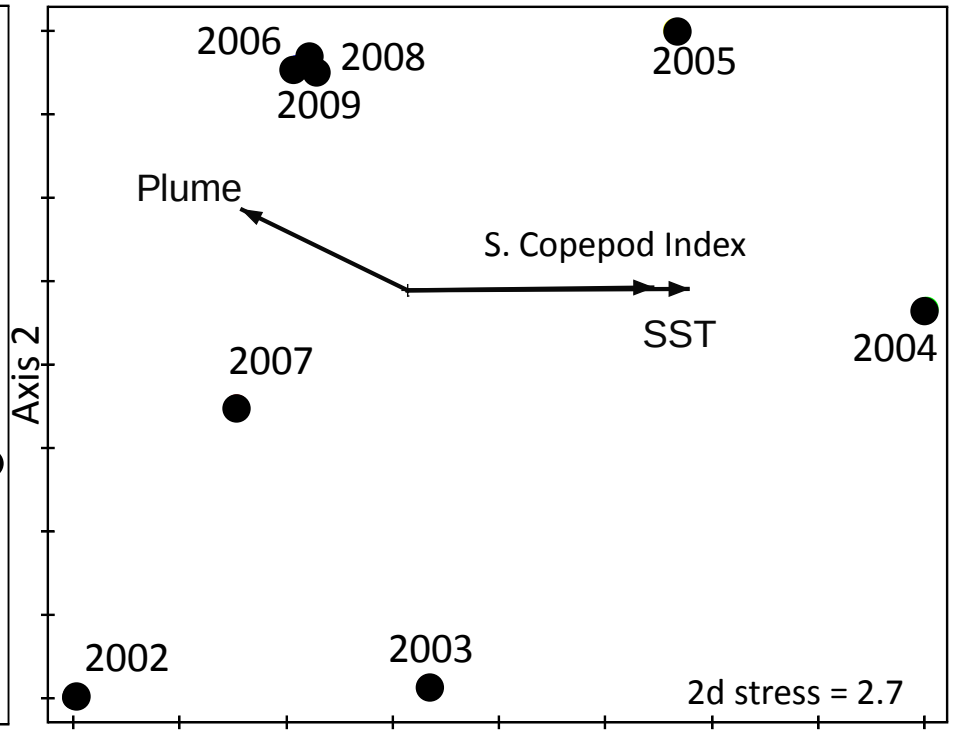
Chinook salmon



Axis 1=64% of variance

MRPP for Year, P<0.05

Coho salmon



Axis 1=52% of variance

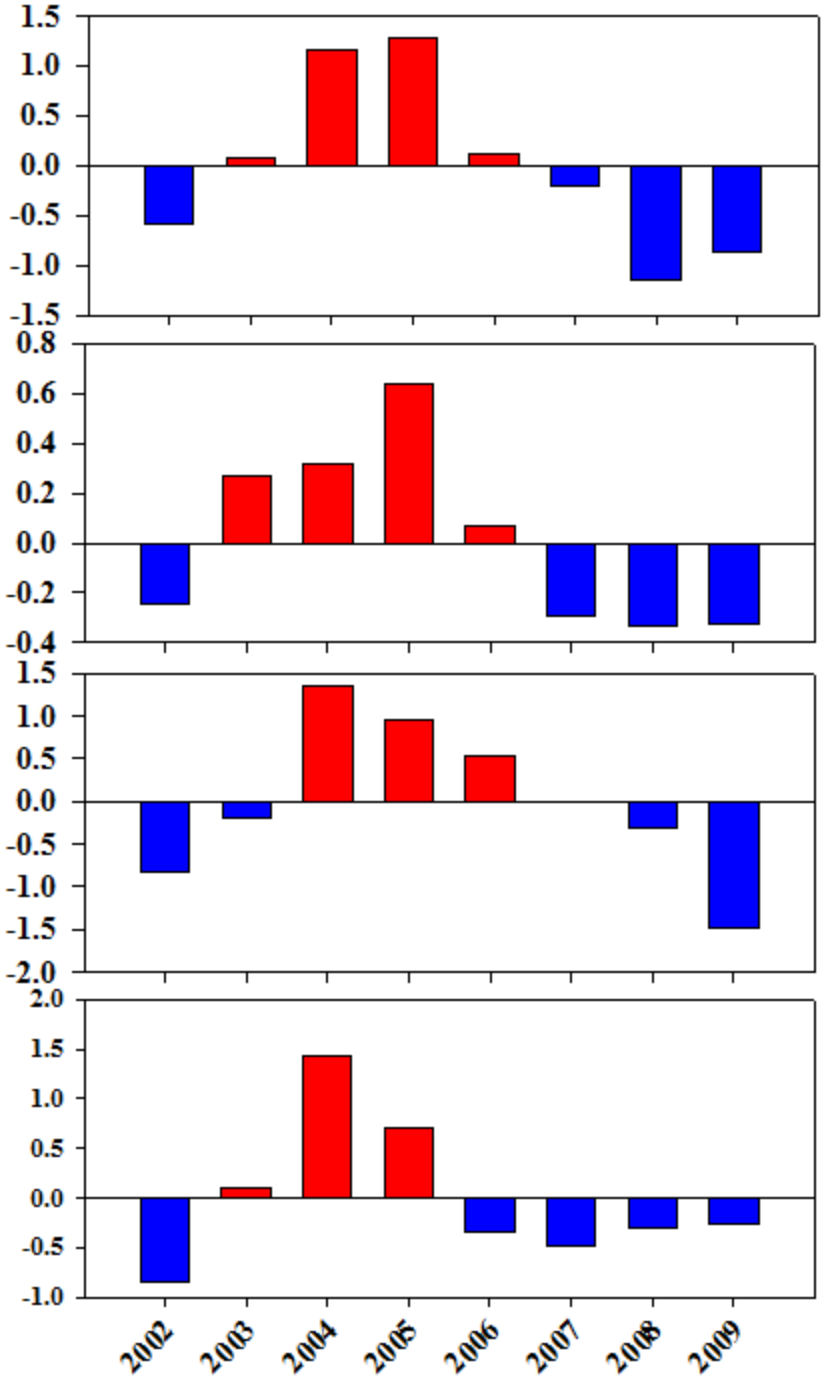
MRPP for Year, P<0.05

Sea-surface Temperature

Copepod Community Index

UCR summer/fall CR Chinook Salmon Parasite Community Index

Coho Salmon Parasite Community Index



Thank you

Tusen takk

Gracias

Merci

どうもありがとうございます

Danke sehr