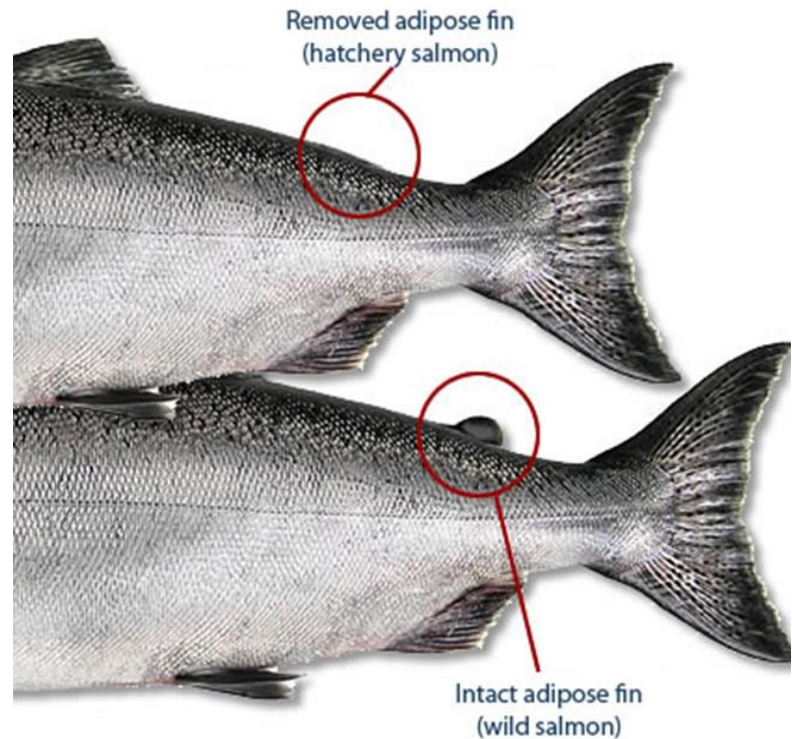


# Practical considerations for detecting density dependence in the Columbia River estuary

(It's not just about hatchery and wild salmon)



# Direct competition for prey resources

Diet overlap + limited resource = competition



From diet studies



From estimates of prey availability

## Challenges

**Challenge 1.** Need diets of other (non-salmonid) fish, too

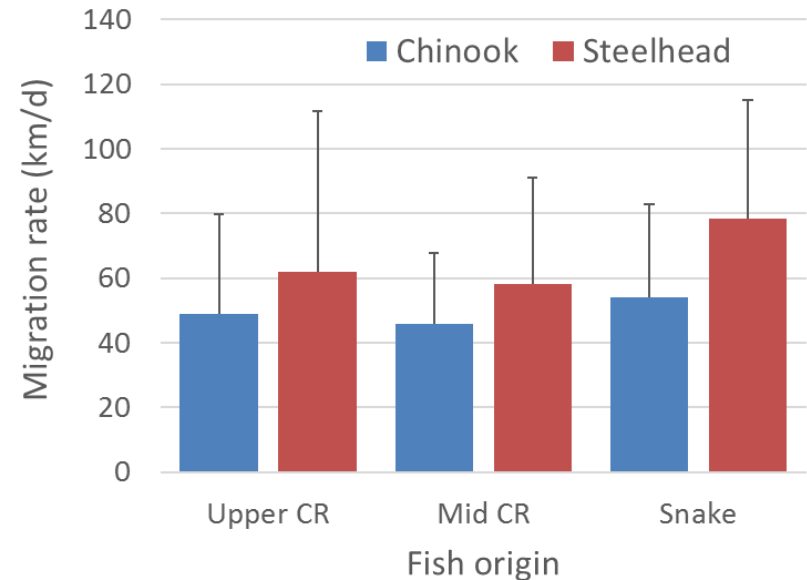
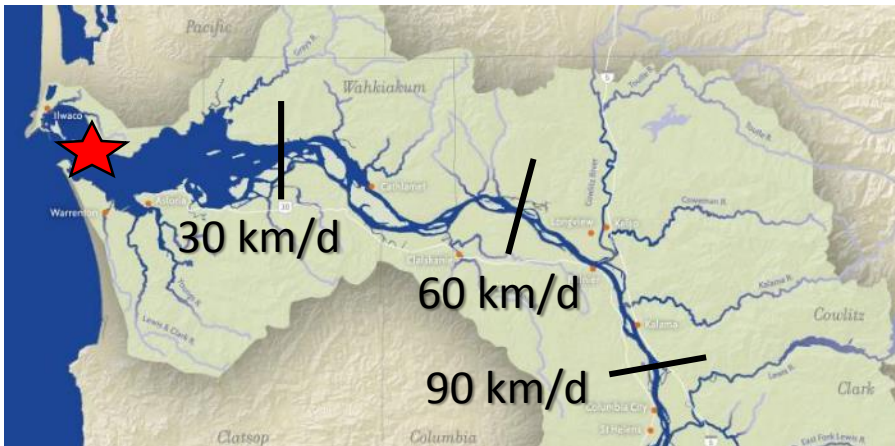
**Challenge 2.** Where to sample?  
**Challenge 3.** Prey don't stay still



## Challenge 2. Where to sample prey when fish are migrating rapidly downstream?

Migration rates for PIT-tagged juvenile Chinook and steelhead detected at dams and subsequently caught in the lower estuary.

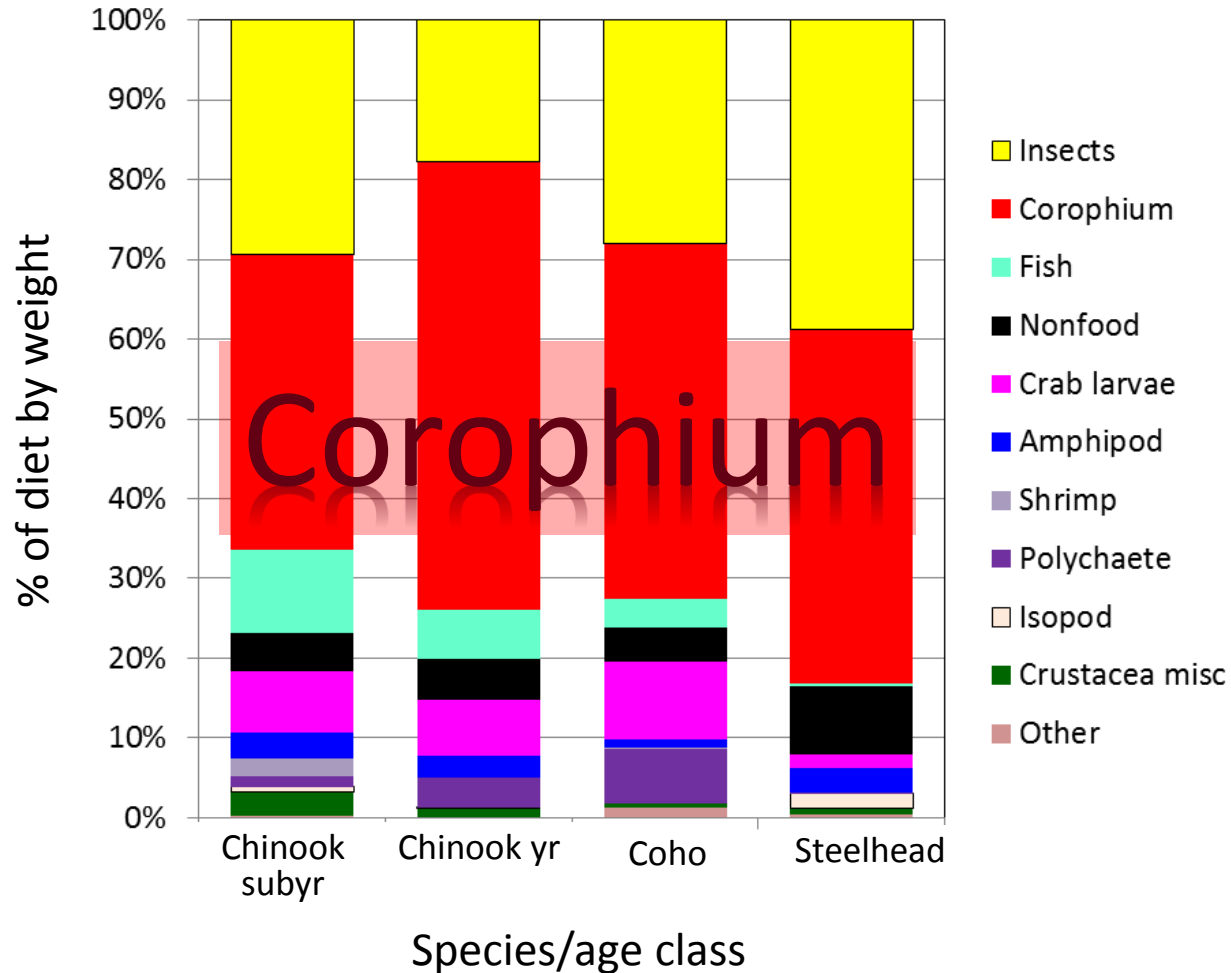
Feeding areas for fish moving at different rates and collected at the mouth



**Challenge 3:** The amphipod *Americorophium* is a key prey species in the Columbia estuary but doesn't sit still



# *Americorophium* is an important prey for juvenile salmon in the Columbia River estuary



It is also important prey for other estuarine fishes

Prey items

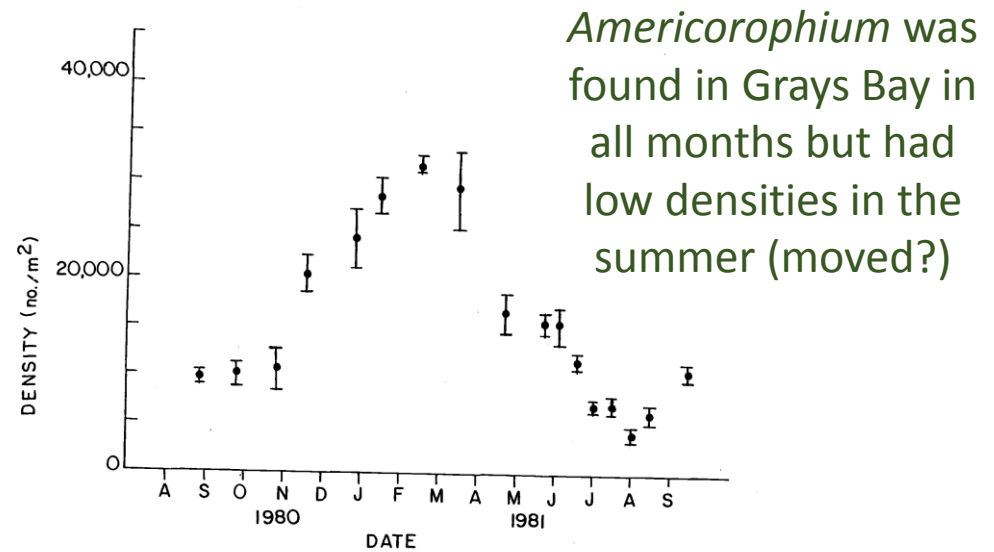
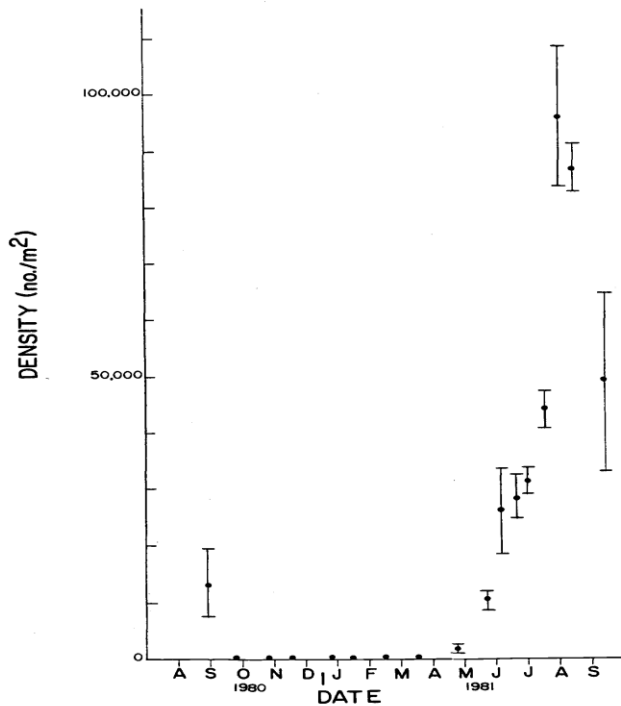
- Phytoplankton
- Plant material
- Turbellaria
- Polychaeta
- Corbicula manilensis*
- Macoma balthica*
- Ostracoda
- Daphnia* spp.
- Bosmina* spp.
- Calanoida
- Cyclopoida
- Harpacticoida
- Mysidacea
- Neomysis integer*
- Corophium salmonis*
- Corophium spiniorme*
- Zogammarus* spp.
- Euhaustrorius estuaris*
- Crab megalops
- Diptera adult
- Diptera larvae
- Heleidae larvae
- Chironomid larvae
- Chironomid pupae
- Coleoptera adult
- Trichoptera larvae
- Hymenoptera adult
- Homoptera adult
- Arachnid
- Sand lance
- Digested fish

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Habitats	Prey items	Species	Notes
Upper pelagic	+	American shad (36)	Juv. salmon
	+	Subyearling chinook (94)	
Upper pelagic	+	Yearling chinook (105)	Peamouth stickleback
	+	Coho (87)	
Upper pelagic	+	Steelhead (37)	Peamouth stickleback
	+	Peamouth (31)	
Upper pelagic	+	3-Spine stickleback (13)	Peamouth stickleback
	+	American shad (26)	
Lower pelagic	+	Pacific herring (63)	Juv. salmon
	+	Northern anchovy (19)	
Lower pelagic	+	Subyearling chinook (70)	Juv. salmon
	+	Yearling chinook (38)	
Lower pelagic	+	Coho (31)	Predators
	+	Steelhead (33)	
Lower pelagic	+	Surf smelt (12)	Predators
	+	Longfin smelt (47)	
Lower pelagic	+	Shiner perch (16)	Predators
	+	No Identifiable Food Items	
Upper intertidal	+	Subyearling chinook (25)	Juv. salmon
	+	Starry flounder (17)	Starry flounder
Lower intertidal	+	Subyearling chinook (61)	Juv. salmon
	+	Surf smelt (10)	Juv. salmon
Lower intertidal	+	3-Spine stickleback (20)	Shiner perch
	+	Shiner perch (26)	Sculpin
Lower intertidal	+	Staghorn sculpin (16)	Starry flounder
	+	Starry flounder (46)	Starry flounder

The only study (in 1980/81) of *Americorophium* showed it moved around in the Columbia estuary. Need to understand its movements and dynamics to estimate abundance.

*Americorophium* only present at Desdemona Sands during summer, but at very high densities.



*Americorophium* was found in Grays Bay in all months but had low densities in the summer (moved?)





# How to study density dependence in the CR estuary?

## Ongoing work

- Better understanding of prey dynamics and abundance
  - *Americorophium* dynamics in lower estuary (*could be greatly expanded*)
  - Prey (insect) production & export from wetlands (*could be expanded*)
- Diets of juvenile salmon migrating from BON to mouth
- Diets & consumption rates of juvenile salmon in wetland habitats

## Could be done

- Modeling to determine size of potential effects, including:
  - Estimated prey consumption by different guilds of fish (eat common prey)
  - Biomass to support consumption at range of rates
  - Environmental factors influencing prey availability & consumption
  - Putting it all together to identify potential bottlenecks
- Diets and abundance of likely non-salmonid competitors
- Once we know more (about prey, competitors), putting it all together





## Summary

- Estuarine (and ocean) environments are extremely dynamic, from daily tides to seasonal freshets
- Fish (and their prey) respond to dynamic environments in a variety of way that are generally poorly understood.
- Documentation of density dependence is complicated in systems like the Columbia. It requires:
  - Diet information from likely predators, which may be rapidly migrating (salmon) or numerous (other fishes)
  - Abundance information for key prey (which also move)
- Need focused studies to understand predator/prey dynamics and therefore opportunities for density dependence.

# Hatchery-wild origins (2)

I was going to keep this as an extra slide, if we need to make the points that

- 1) Its hard to tell which fish are truly wild
- 2) Wild sample sizes are so low its hard to do anything with them.

Species/ age class	Clip rates (%)	% hatchery	% wild
Yearling Chinook	91	95.5	4.5
Subyr. Chinook	76	83.6	16.4
Coho	75	94.8	5.2
Steelhead	78	91.7	8.3

