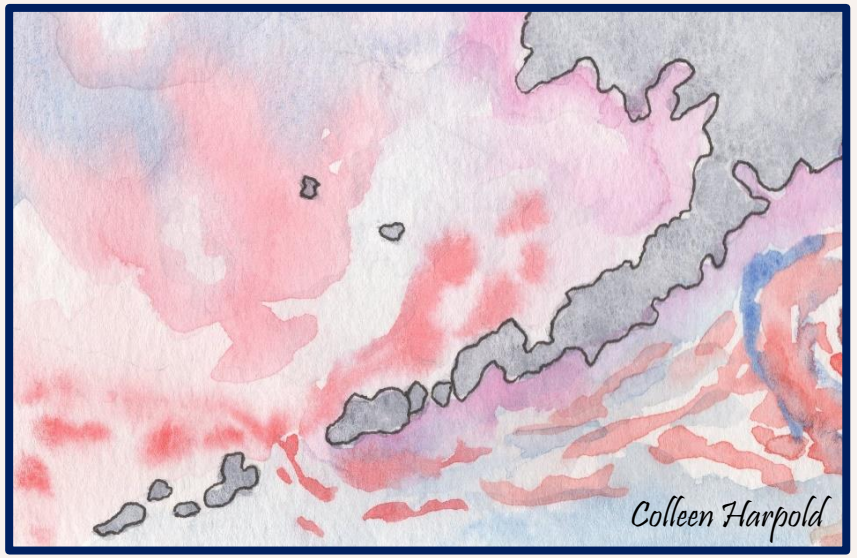
Zooplankton community and transport dynamics in Bering Canyon and Unimak Pass: Bering Sea, Alaska



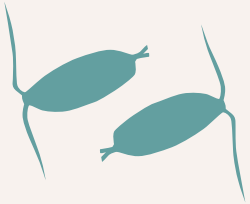


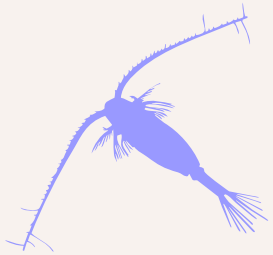
Colleen Harpold [1], David Kimmel [1]
Carol Ladd [2], Phyllis Stabeno [2]

[1] National Oceanic Atmospheric Administration: Alaska Fisheries Science Center
[2] National Oceanic Atmospheric Administration: Pacific Marine Environmental Laboratory

Bering Canyon Zooplankton

Research Questions





- What are the species composition differences between zooplankton community assemblages?
- Seasonal patterns? Geographic patterns?
- What could be influencing these patterns?
- Do zooplankton community patterns match flow patterns?

Why?

Changing Climate

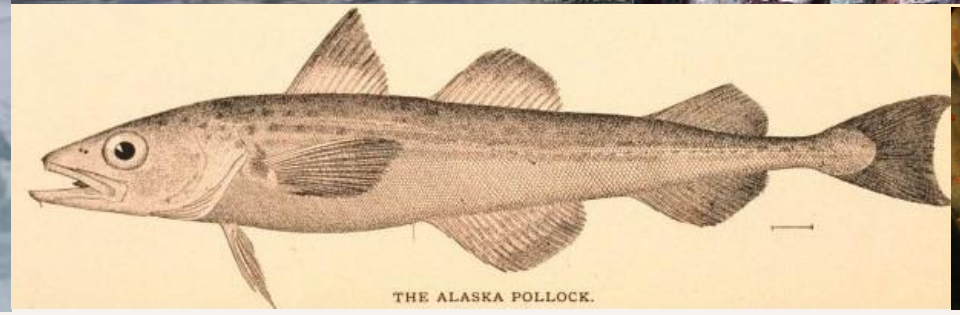


Marine Mammals



Fisheries









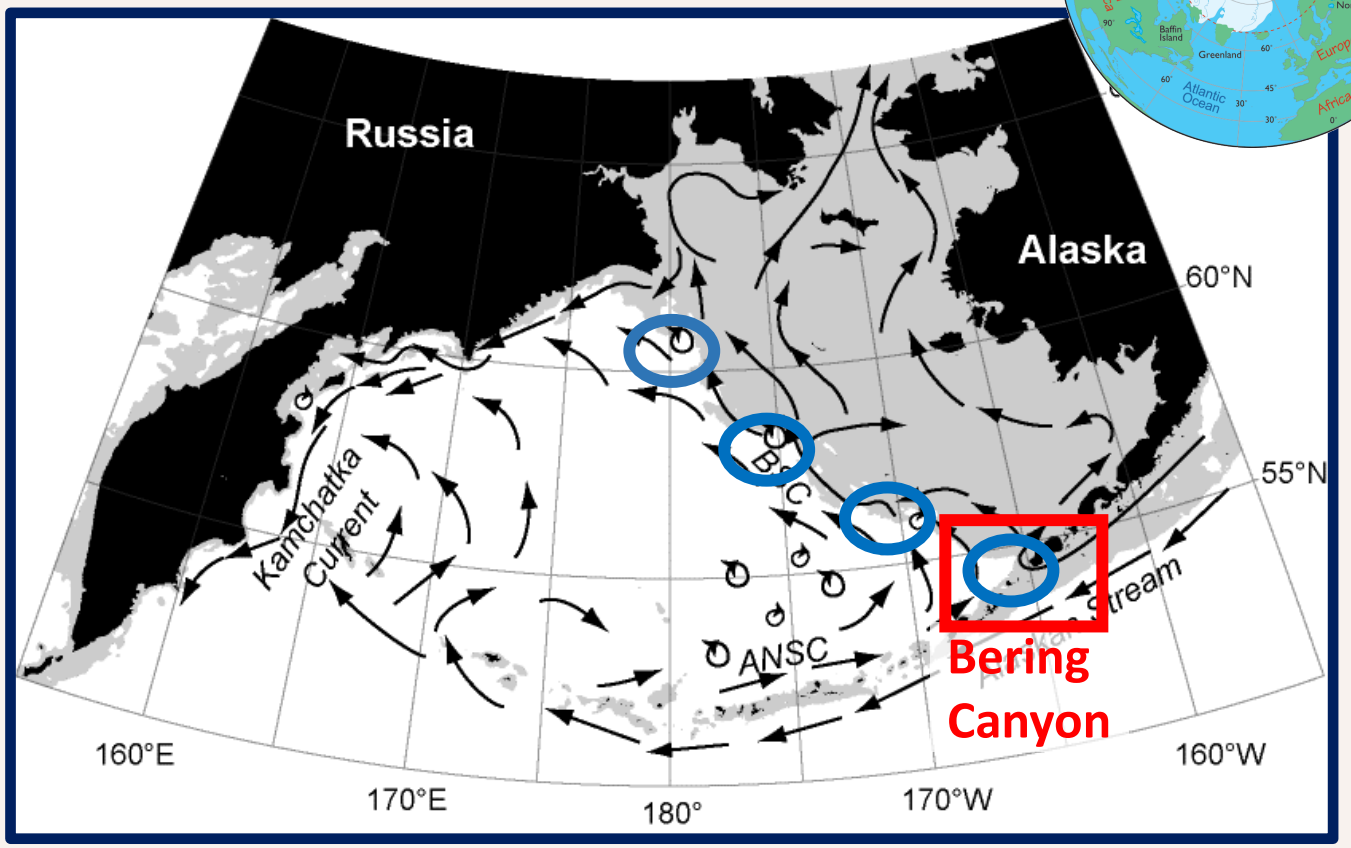




Bering Sea 101

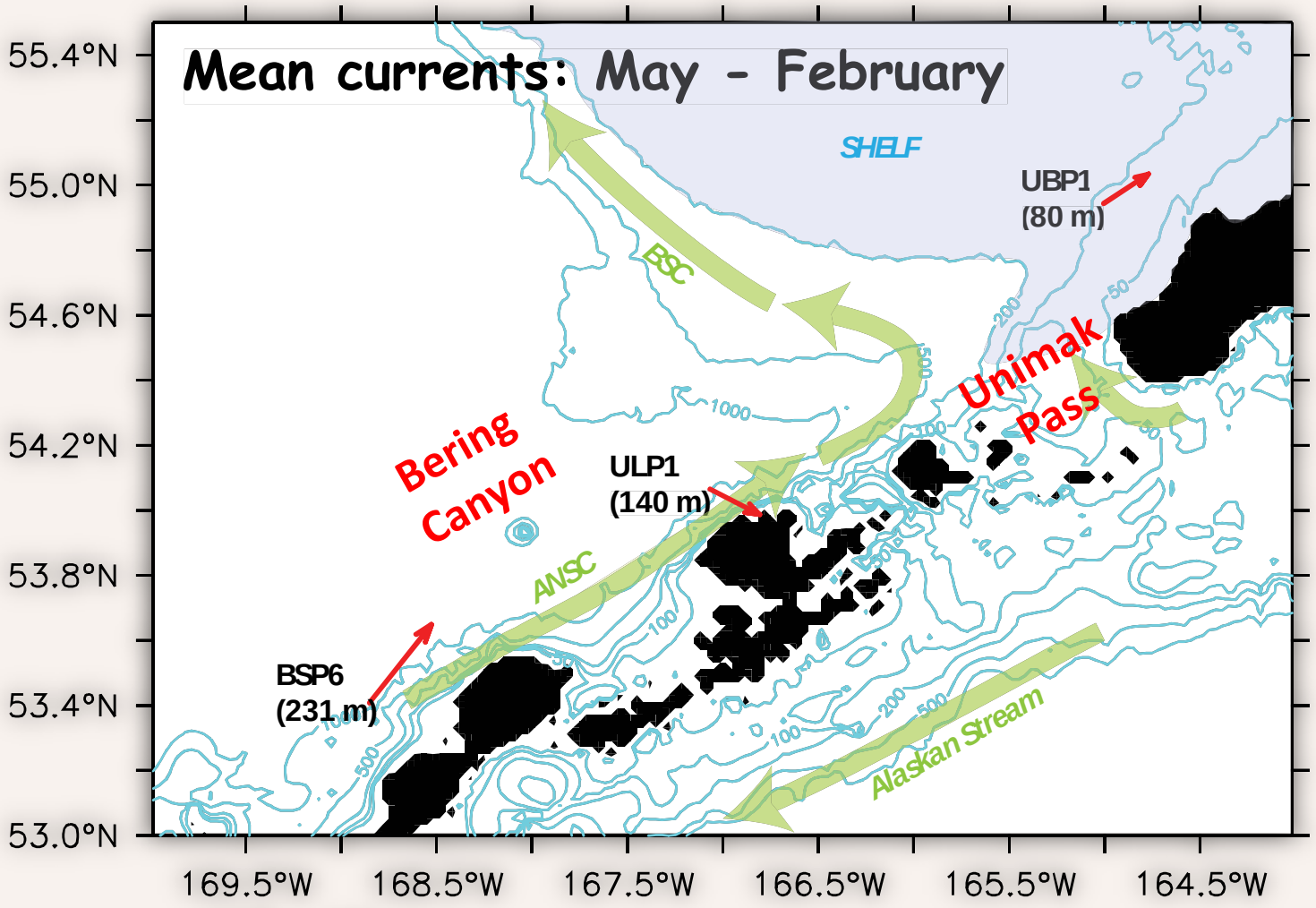


- Conduit between Arctic and Gulf of Alaska
- Wide shelf (gray)
- Canyons: Basin shelf exchange
  - Nutrients
  - open ocean plankton?



Stabeno, P.J., J.D. Schumacher, and K. Ohtani (1999)

Bering Canyon & Unimak Pass

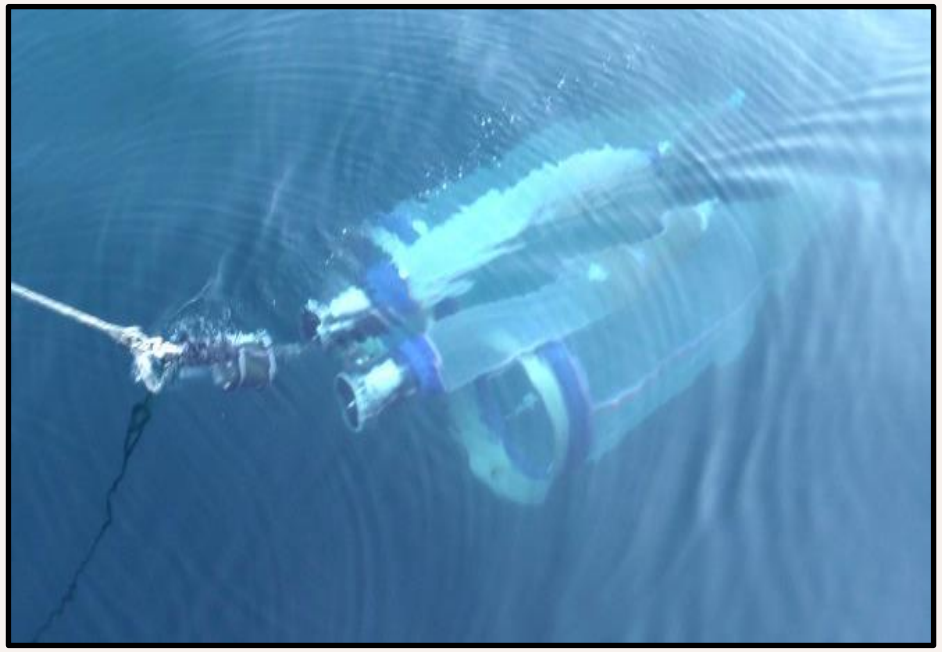


- ANSC: Aleutian North Slope Current
- BSC: Bering Slope Current
- Flow through Unimak Pass



Methods: Sampling





Spring 2014 & 2015, Fall 2014

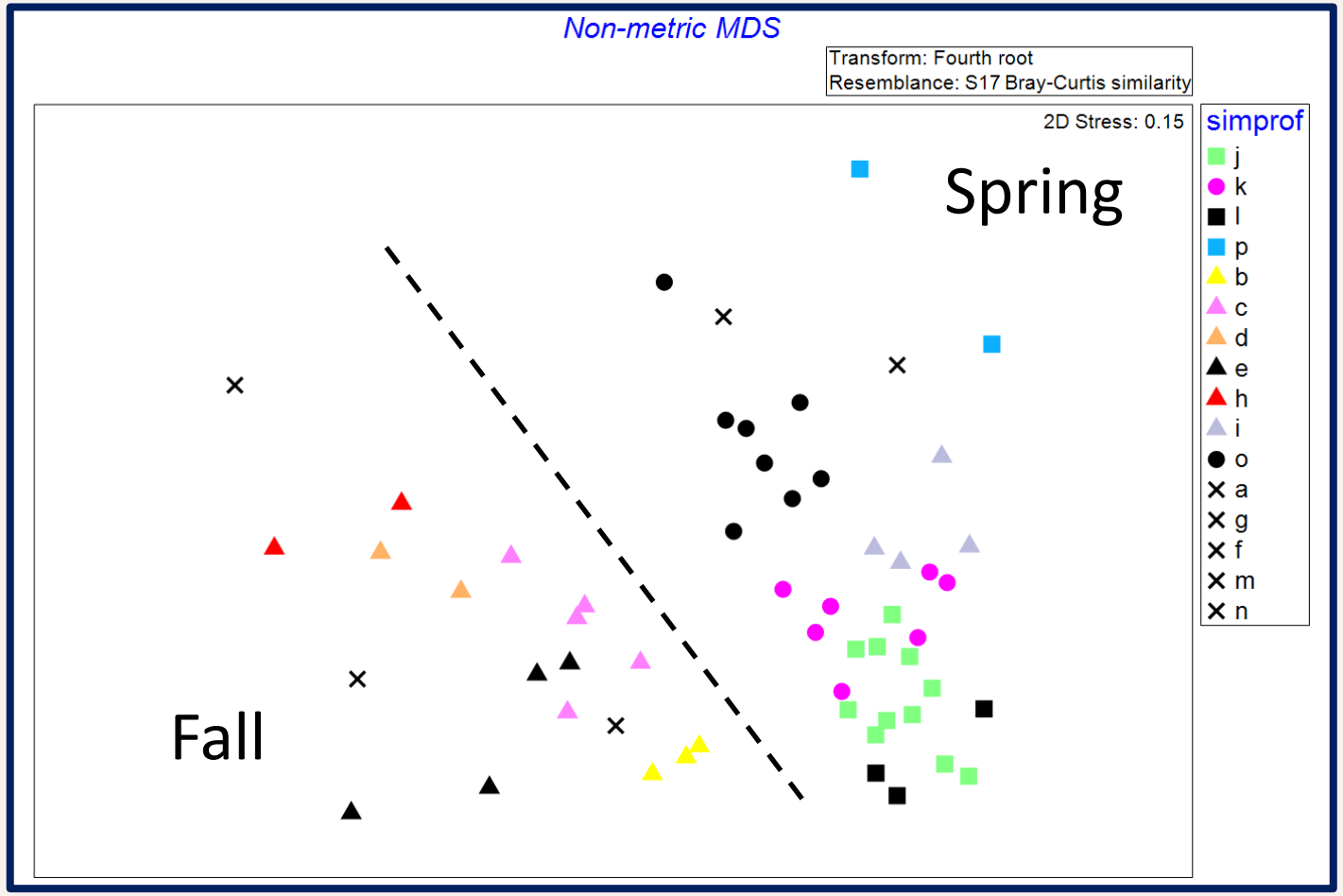
Bongo Array (153 & 505 µm mesh)

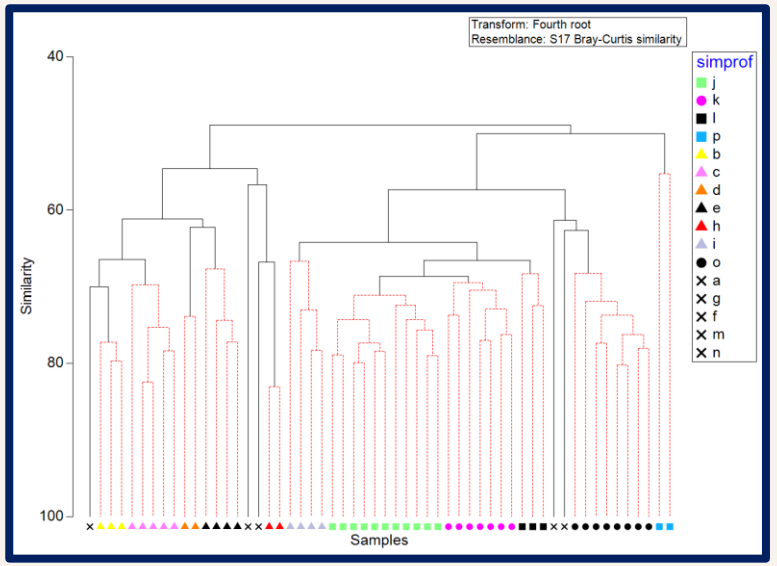
Zooplankton Community Cluster Analysis

- PRIMER: 4th root transformed abundance data
- 56 stations and 72 species
- Similarity profile routine (Simprof)
- Similarity percentage (SIMPER)
  Species differences in clusters
  (% contribution)

PRIMER-E, Clarke et al., 2014

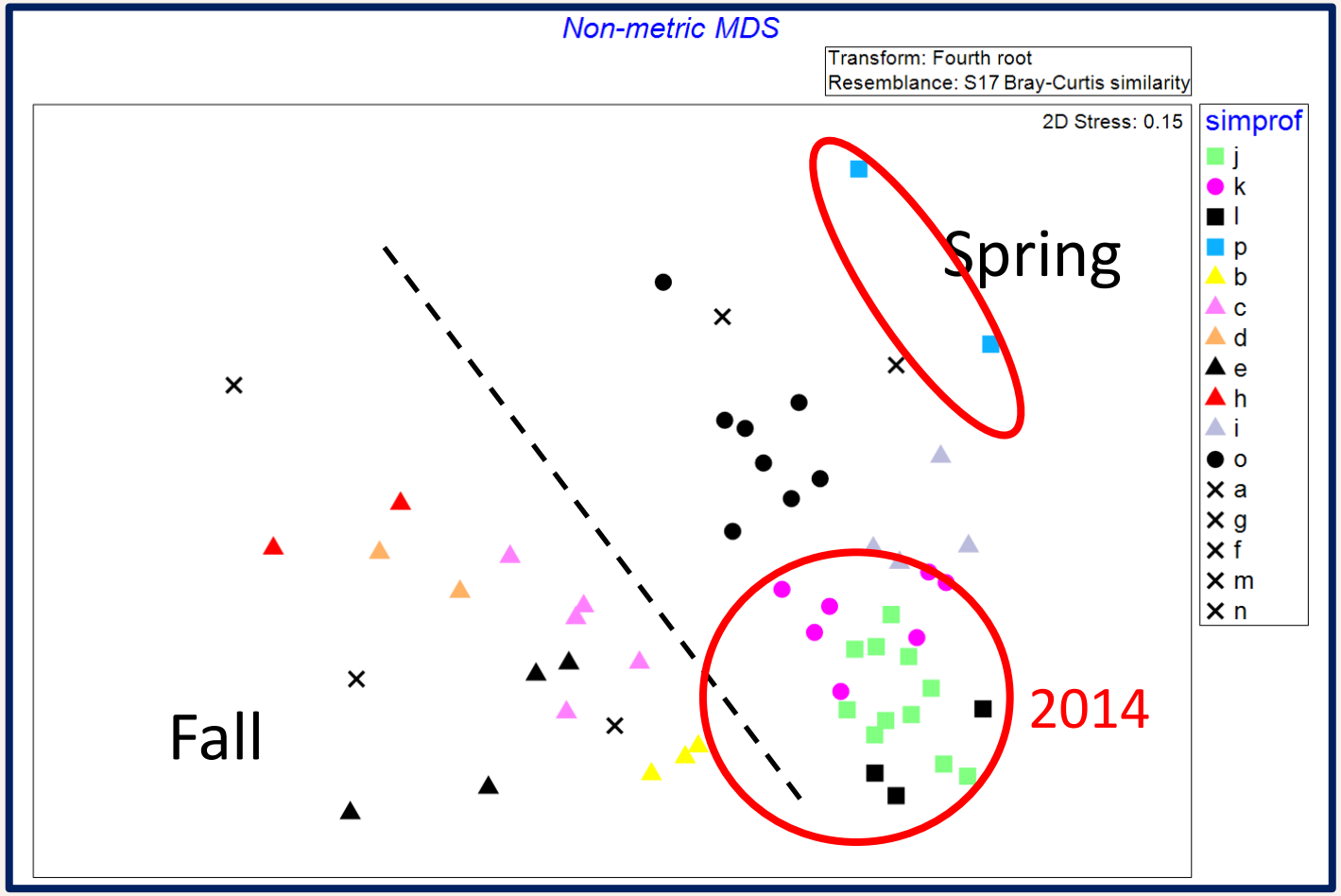
Zooplankton Community Patterns

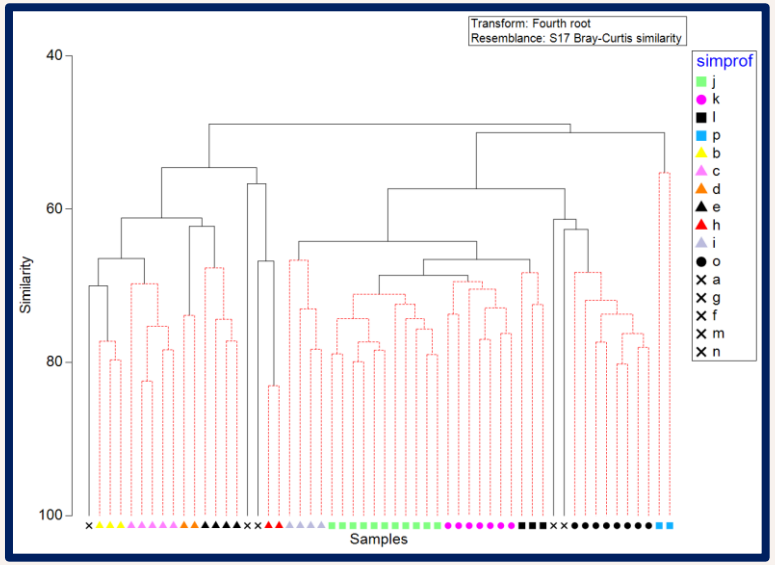




Fall 2014 (5 groups)
Spring 2014 (4 groups)
Spring 2015 (2 groups)
5 Outliers

Zooplankton Community Patterns





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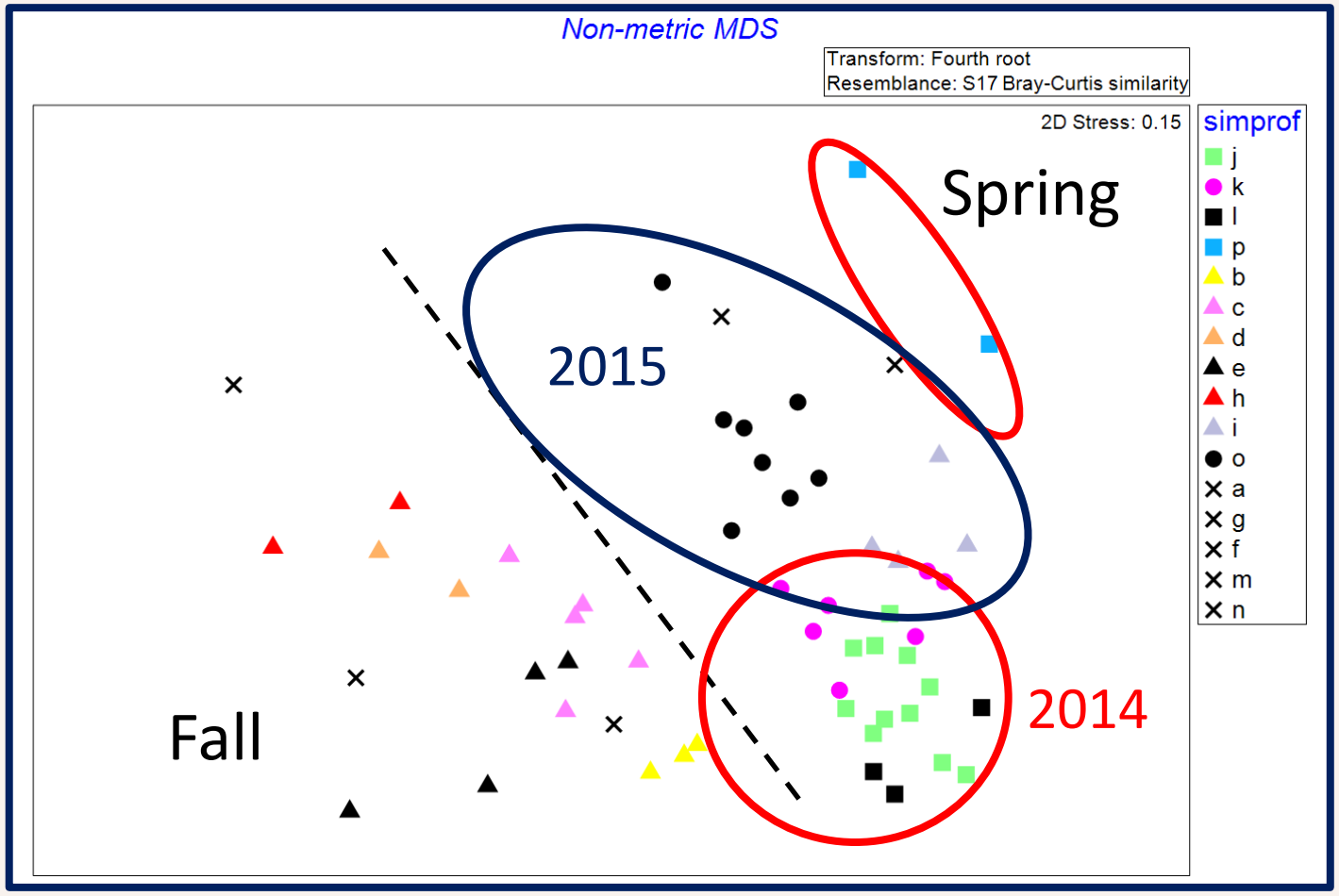
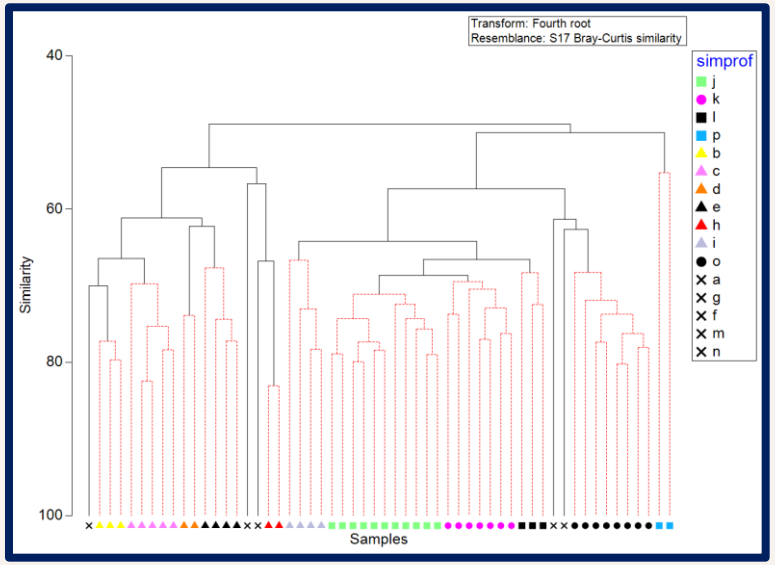
Zooplankton Community Patterns





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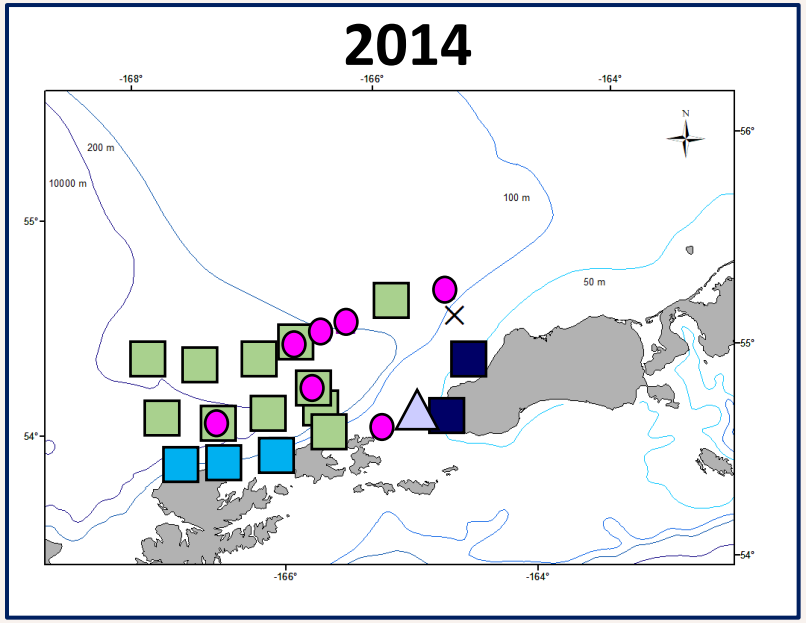
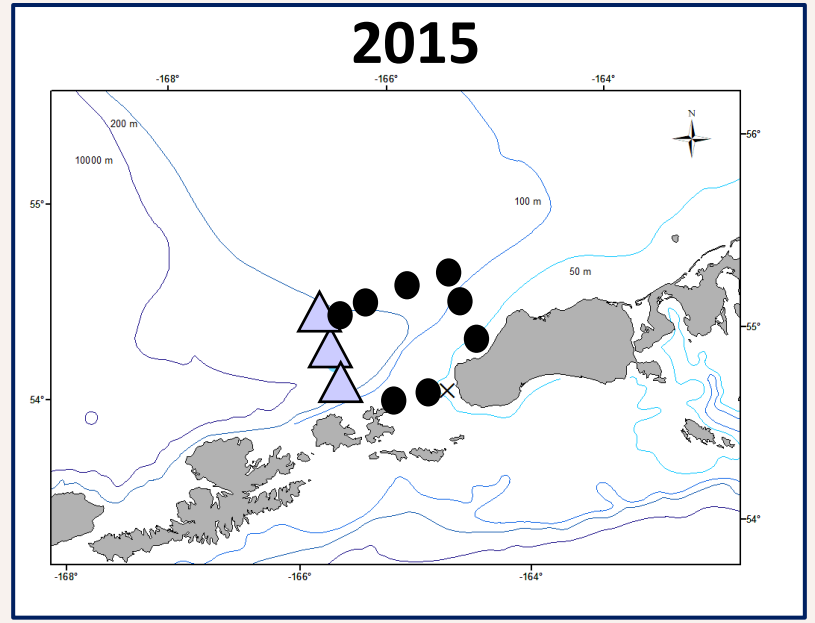
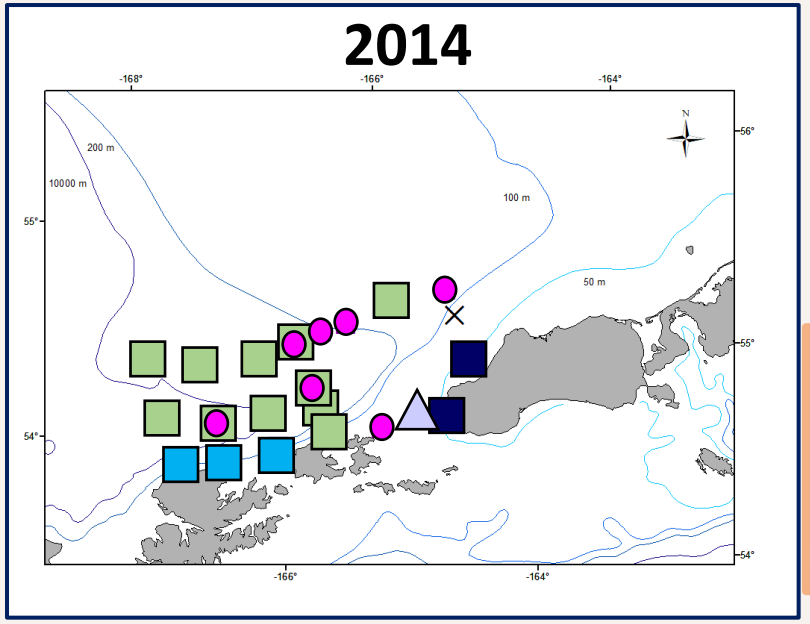
Geographic Patterns: Spring





How many stations	11	7	3	2		8	2015:3 2014:1
Symbol on map	■	●	■	■		●	△
Rank % Contribution	j	k	l	p		o	i
1	*Oithona* spp.	*Oithona spp.*	*Olthona spp.*	*Olthona spp.*		*N. flemingeri*	*N. flemingeri*
2	*N. flemingeri*	*N. flemingeri*	*N. flemingeri*	*Pseudocalanus* spp.		*Pseudocalanus* spp.	*N. cristatus*
3	*N. plumchrus*	*Metridia pacifica*	*Metridia pacifica*	*N. flemingeri*		*Olthona* spp.	*Olthona* spp.
4	*Metridia pacifica*	*Pseudocalanus* spp.	*Pseudocalanus* spp.	Barnacle larvae		*Metridia pacifica*	*N. plumchrus*
5	*Microcalanus* spp.	*N. plumchrus*	*Triconia spp.*	Paguridae		*Acartia longipes*	*Metridia pacifica*
6	*Triconia spp.*	*Microcalanus* spp.	*Microcalanus* spp.	*Metridia pacifica*		*Calanus marshallae*	*Pseudocalanus* spp.
7	*Pseudocal* spp.	*N. cristatus*	*Fritillaria* spp.	Echinoderm		*N. cristatus*	*Microcalanus* spp.
8	*N. cristatus*	Echinoderm	*Calanus marshallae*	*Microcalanus* spp.		*Microcalanus* spp.	*Eucalanus bungii*
9	*Euphausiids* (young)	*Eucalanus bungii*	*N. plumchrus*	*Calanus marshallae*		*N. plumchrus*	NF / NP CI-II
10	*Eucalanus bungii*	NF / NP CI-II	*Euphausiids* (young)	*N. cristatus*		NF / NP CI-II	*Fritillaria spp.*

Geographic Patterns: Spring



3 *Neocalanus* species

N. flemingeri *N. plumchrus* *N. cristatus*



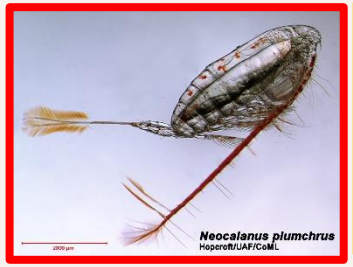
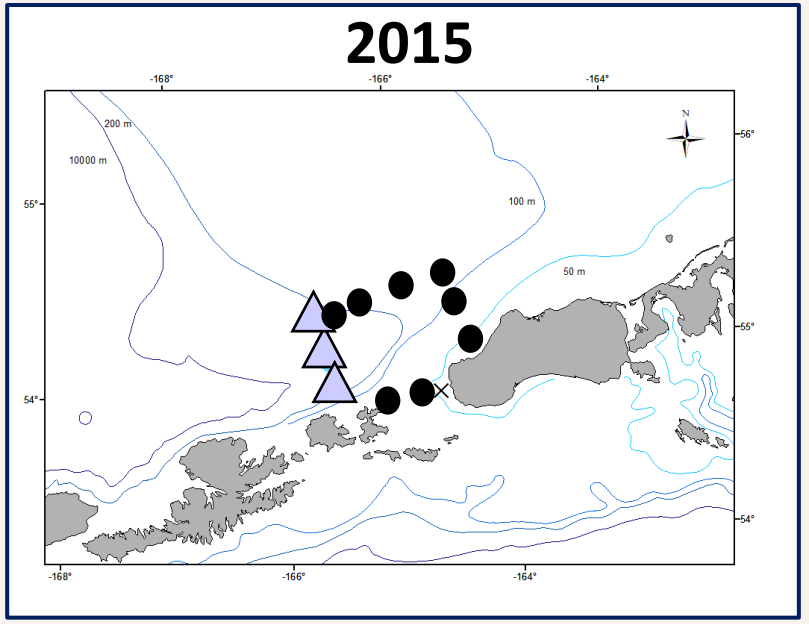


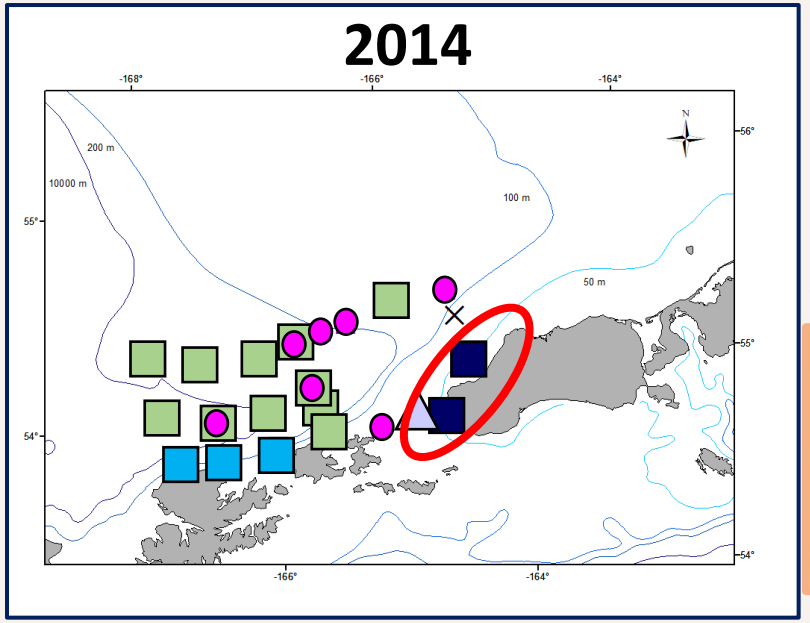


photo credit: Russ Hopcroft



How many stations	11	7	3	2		8	2015:3 2014:1
Symbol on map	■	●	■	■		●	△
Rank % Contribution	j	k	l	p		o	i
1	*Oithona* spp.	*Oithona spp.*	*OIthona spp.*	*OIthona spp.*		*N. flemingeri*	*N. flemingeri*
2	*N. flemingeri*	*N. flemingeri*	*N. flemingeri*	*Pseudocalanus* spp.		*Pseudocalanus* spp.	*N. cristatus*
3	*N. plumchrus*	*Metridia pacifica*	*Metridia pacifica*	*N. flemingeri*		*OIthona* spp.	*OIthona* spp.
4	*Metridia pacifica*	*Pseudocalanus* spp.	*Pseudocalanus* spp.	Barnacle larvae		*Metridia pacifica*	*N. plumchrus*
5	*Microcalanus* spp.	*N. plumchrus*	*Triconia spp.*	Paguridae		*Acartia longipes*	*Metridia pacifica*
6	*Triconia spp.*	*Microcalanus* spp.	*Microcalanus* spp.	*Metridia pacifica*		*Calanus marshallae*	*Pseudocalanus* spp.
7	*Pseudocal* spp.	*N. cristatus*	*Fritillaria* spp.	Echinoderm		*N. cristatus*	*Microcalanus* spp.
8	*N. cristatus*	Echinoderm	*Calanus marshallae*	*Microcalanus* spp.		*Microcalanus* spp.	*Eucalanus bungii*
9	*Euphausiids* (young)	*Eucalanus bungii*	*N. plumchrus*	*Calanus marshallae*		*N. plumchrus*	NF / NP CI-II
10	*Eucalanus bungii*	NF / NP CI-II	*Euphausiids* (young)	*N. cristatus*		NF / NP CI-II	*Fritillaria spp.*

Geographic Patterns: Spring



3 *Neocalanus* species

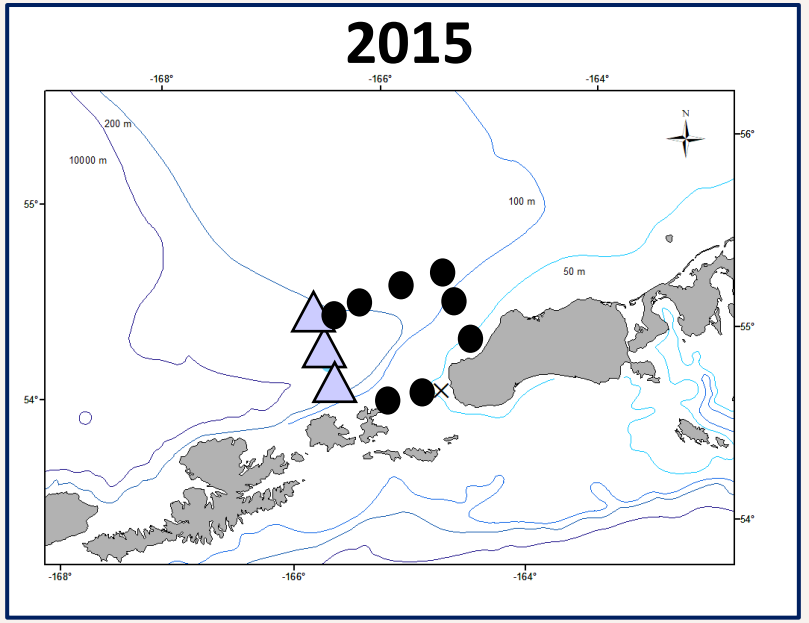
N. flemingeri *N. plumchrus* *N. cristatus*







photo credit: Russ Hopcroft



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Symbol on map	■	●	■	■	●	▲
Rank % Contribution	j	k	l	p	o	i
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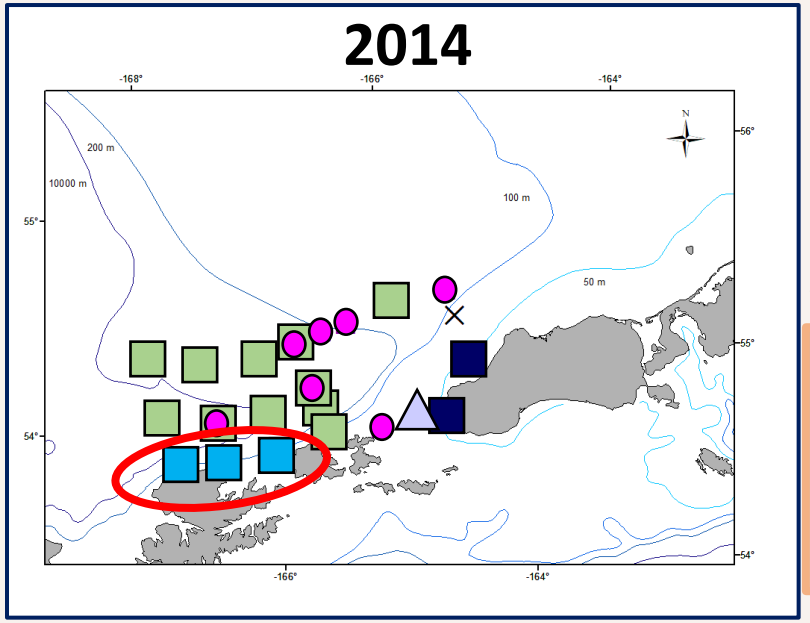
2	*N. flemingeri*	*N. flemingeri*	*N. flemingeri*	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*N. cristatus*
3	*N. plumchrus*	*Metridia pacifica*	*Metridia pacifica*	*N. flemingeri*	*OIthona* spp.	*OIthona* spp.
4	*Metridia pacifica*	*Pseudocalanus* spp.	*Pseudocalanus* spp.	Barnacle larvae	*Metridia pacifica*	*N. plumchrus*
5	*Microcalanus* spp.	*N. plumchrus*	*Triconia spp.*	Paguridae	*Acartia longipes*	*Metridia pacifica*
6	*Triconia spp.*	*Microcalanus* spp.	*Microcalanus* spp.	*Metridia pacifica*	*Calanus marshallae*	*Pseudocalanus* spp.
7	*Pseudocal* spp.	*N. cristatus*	*Fritillaria* spp.	Echinoderm	*N. cristatus*	*Microcalanus* spp.
8	*N. cristatus*	Echinoderm	*Calanus marshallae*	*Microcalanus* spp.	*Microcalanus* spp.	*Eucalanus bungii*
9	*Euphausiids* (young)	*Eucalanus bungii*	*N. plumchrus*	*Calanus marshallae*	*N. plumchrus*	NF / NP CI-II
10	*Eucalanus bungii*	NF / NP CI-II	*Euphausiids* (young)	*N. cristatus*	NF / NP CI-II	*Fritillaria spp.*

Geographic Patterns: Spring



3 *Neocalanus* species

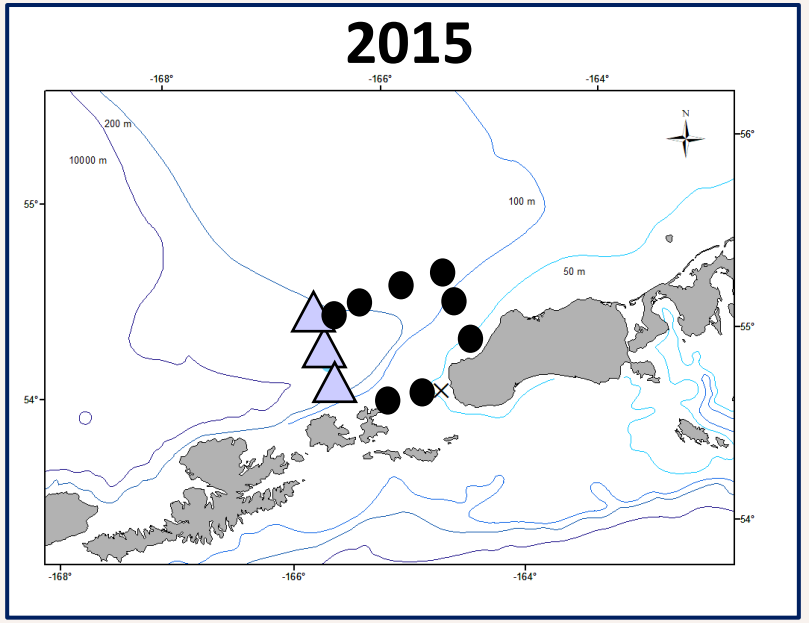
N. flemingeri *N. plumchrus* *N. cristatus*







photo credit: Russ Hopcroft



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Rank % Contribution	j	k	l	p		o	i
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2	*N. flemingeri*	*N. flemingeri*	*N. flemingeri*	*Pseudocalanus* spp.		*Pseudocalanus* spp.	*N. cristatus*
3	*N. plumchrus*	*Metridia pacifica*	*Metridia pacifica*	*N. flemingeri*		*Olthona* spp.	*Olthona* spp.
4	*Metridia pacifica*	*Pseudocalanus* spp.	*Pseudocalanus* spp.	Barnacle larvae		*Metridia pacifica*	*N. plumchrus*
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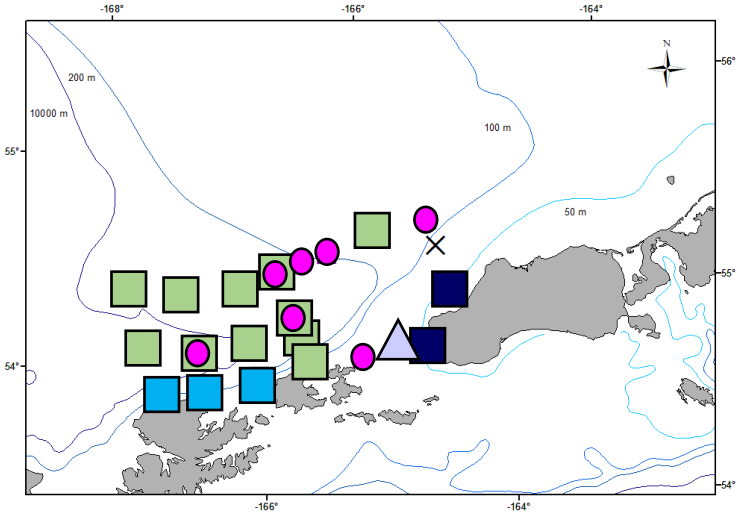
8	*N. cristatus*	Echinoderm	*Calanus marshallae*	*Microcalanus* spp.		*Microcalanus* spp.	*Eucalanus bungii*
9	*Euphausiids* (young)	*Eucalanus bungii*	*N. plumchrus*	*Calanus marshallae*		*N. plumchrus*	NF / NP CI-II
10	*Eucalanus bungii*	NF / NP CI-II	*Euphausiids* (young)	*N. cristatus*		NF / NP CI-II	*Fritillaria spp.*

Geographic Patterns: Spring

2014

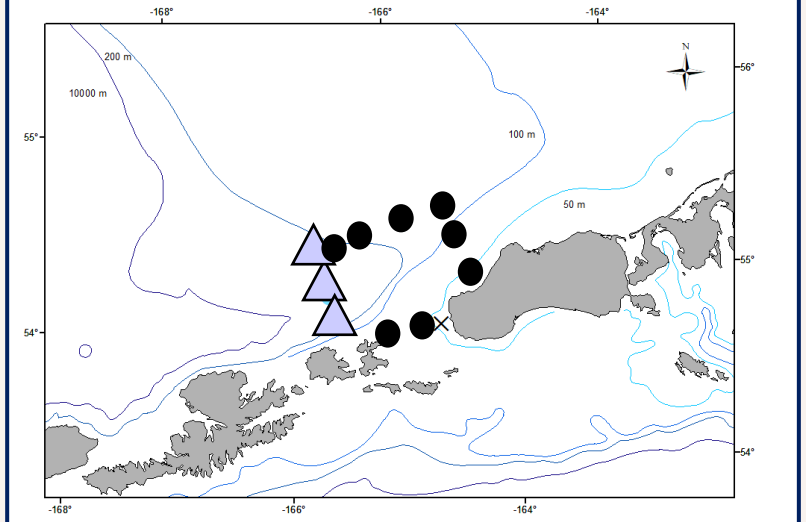


Calanus marshallae / glacialis



photo credit: Russ Hopcroft

2015



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Rank % Contribution	j	k	l	p		o	i
1	*Oithona* spp.	*Oithona spp.*	*OIthona spp.*	*OIthona spp.*		*N. flemingeri*	*N. flemingeri*
2	*N. flemingeri*	*N. flemingeri*	*N. flemingeri*	*Pseudocalanus* spp.		*Pseudocalanus* spp.	*N. cristatus*
3	*N. plumchrus*	*Metridia pacifica*	*Metridia pacifica*	*N. flemingeri*		*OIthona* spp.	*OIthona* spp.
4	*Metridia pacifica*	*Pseudocalanus* spp.	*Pseudocalanus* spp.	Barnacle larvae		*Metridia pacifica*	*N. plumchrus*
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9	*Euphausiids* (young)	*Eucalanus bungii*	*N. plumchrus*	*Calanus marshallae*		*N. plumchrus*	NF / NP CI-II
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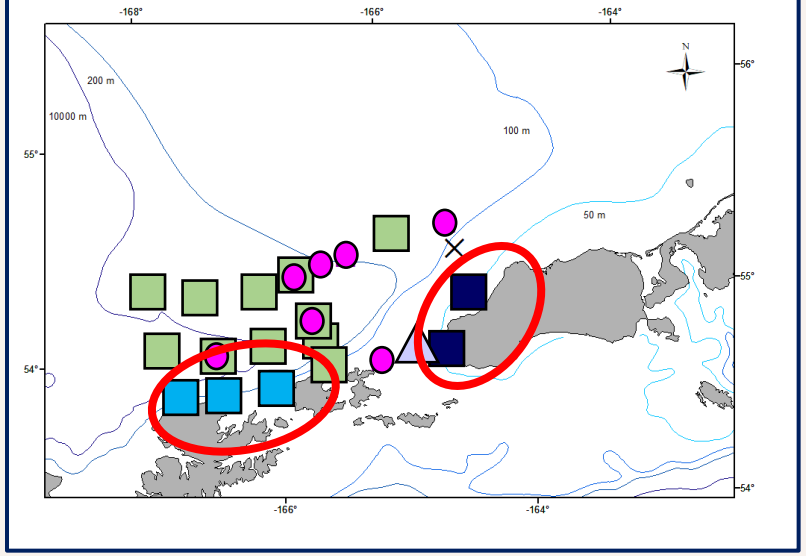
Geographic Patterns: Spring

2014

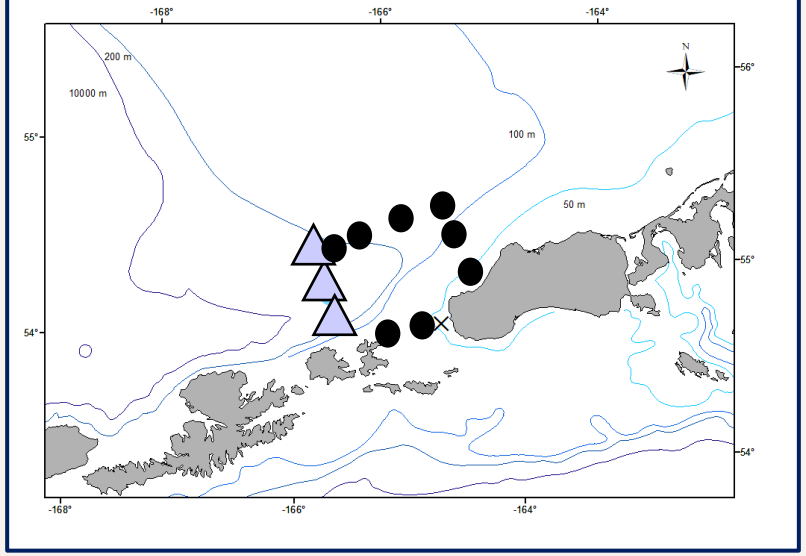


Calanus marshallae / glacialis



photo credit: Russ Hopcroft

2015



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Rank % Contribution	j	k	l	p	o	i
1	*Oithona* spp.	*Oithona spp.*	*Olthona spp.*	*Olthona spp.*	*N. flemingeri*	*N. flemingeri*
2	*N. flemingeri*	*N. flemingeri*	*N. flemingeri*	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*N. cristatus*
3	*N. plumchrus*	*Metridia pacifica*	*Metridia pacifica*	*N. flemingeri*	*Olthona* spp.	*Olthona* spp.
4	*Metridia pacifica*	*Pseudocalanus* spp.	*Pseudocalanus* spp.	Barnacle larvae	*Metridia pacifica*	*N. plumchrus*
5	*Microcalanus* spp.	*N. plumchrus*	*Triconia spp.*	Paguridae	*Acartia longipes*	*Metridia pacifica*
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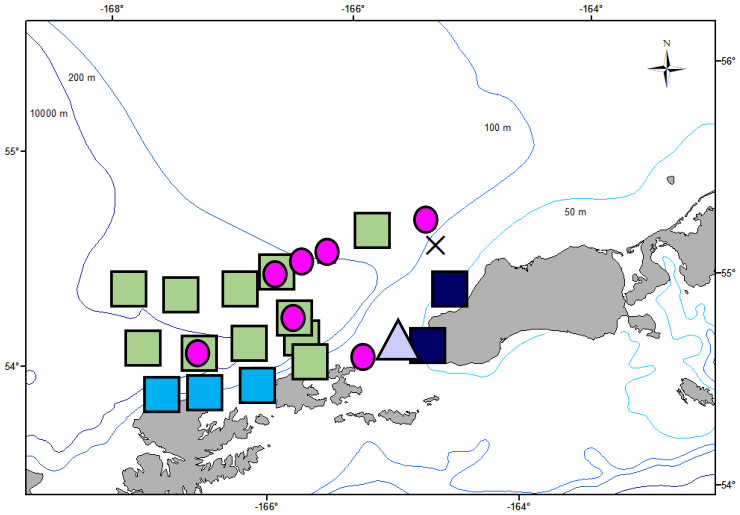
8	*N. cristatus*	Echinoderm	*Calanus marshallae*	*Microcalanus* spp.	*Microcalanus* spp.	*Eucalanus bungii*
9	*Euphausiids* (young)	*Eucalanus bungii*	*N. plumchrus*	*Calanus marshallae*	*N. plumchrus*	NF / NP CI-II
10	*Eucalanus bungii*	NF / NP CI-II	*Euphausiids* (young)	*N. cristatus*	NF / NP CI-II	*Fritillaria spp.*

Geographic Patterns: Spring

2014



Calanus marshallae / glacialis

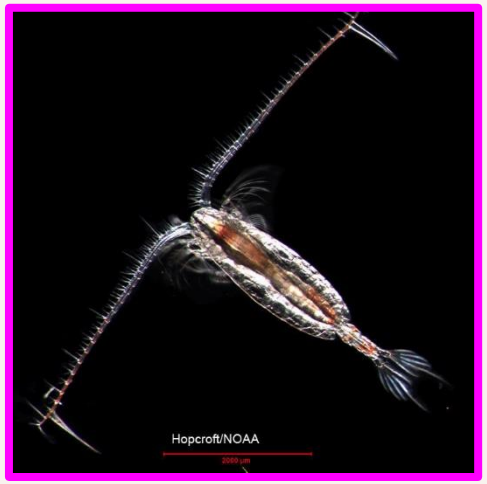
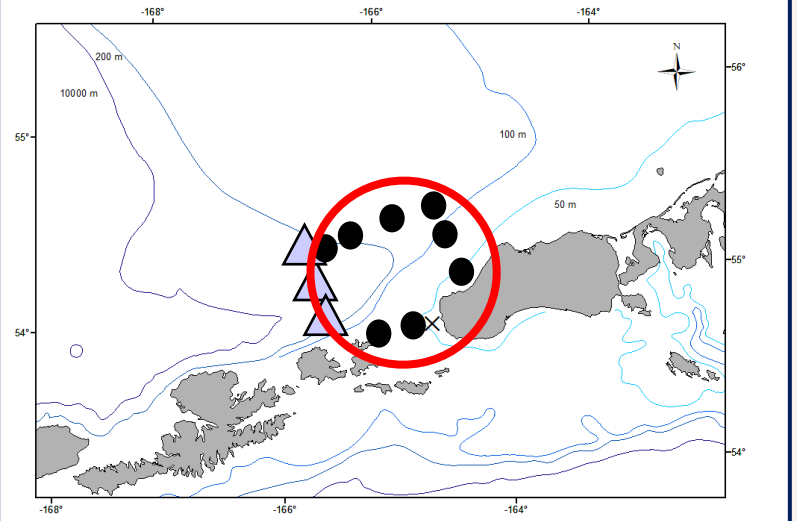


photo credit: Russ Hopcroft

2015



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Symbol on map	■	●	■	■	●	▲
Rank % Contribution	j	k	l	p	o	i
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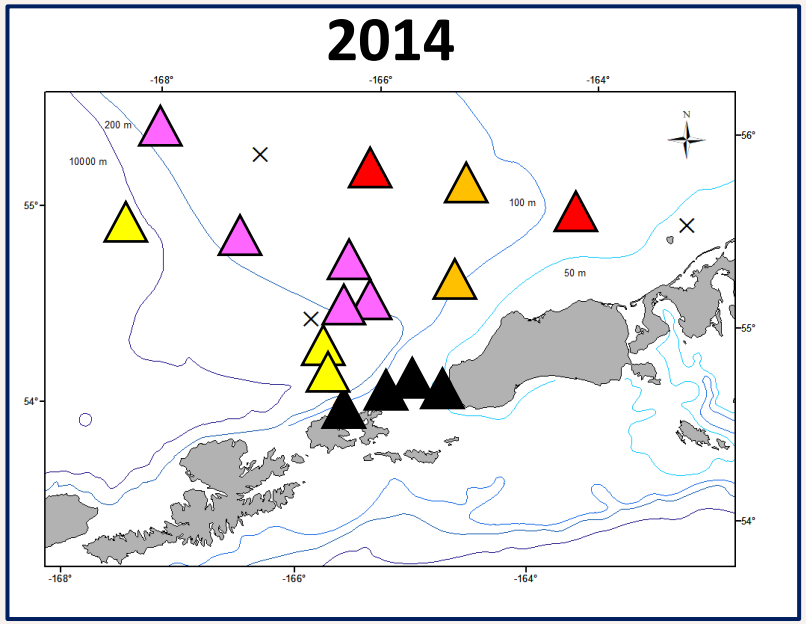
2	*N. flemingeri*	*N. flemingeri*	*N. flemingeri*	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*N. cristatus*
3	*N. plumchrus*	*Metridia pacifica*	*Metridia pacifica*	*N. flemingeri*	*OIthona* spp.	*OIthona* spp.
4	*Metridia pacifica*	*Pseudocalanus* spp.	*Pseudocalanus* spp.	Barnacle larvae	*Metridia pacifica*	*N. plumchrus*
5	*Microcalanus* spp.	*N. plumchrus*	*Triconia spp.*	Paguridae	*Acartia longipes*	*Metridia pacifica*
6	*Triconia spp.*	*Microcalanus* spp.	*Microcalanus* spp.	*Metridia pacifica*	*Calanus marshallae*	*Pseudocalanus* spp.
7	*Pseudocal* spp.	*N. cristatus*	*Fritillaria* spp.	Echinoderm	*N. cristatus*	*Microcalanus* spp.
8	*N. cristatus*	Echinoderm	*Calanus marshallae*	*Microcalanus* spp.	*Microcalanus* spp.	*Eucalanus bungii*
9	*Euphausiids* (young)	*Eucalanus bungii*	*N. plumchrus*	*Calanus marshallae*	*N. plumchrus*	NF / NP CI-II
10	*Eucalanus bungii*	NF / NP CI-II	*Euphausiids* (young)	*N. cristatus*	NF / NP CI-II	*Fritillaria spp.*

Geographic Patterns: Fall



How many stations	3	3	2	4	2
Symbol on map	▲	▲	▲	▲	▲
Rank % Contribution	b	c	d	e	h
1	*Oithona* spp.	*Oithon* a spp.	*Oithona* spp.	*Pseudocalanus* spp.	*Oithona* spp.
2	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*Oithona* spp.	*Limacina helicina*
3	*Microcalanus* spp.	*Microcalanus* spp.	*Limacina helicina*	*Calanus marshallae*	*Calanus marshallae*
4	*Metridia pacifica*	*Metridia pacifica*	*Calanus marshallae*	*Oikopleura* spp.	*Pseudocalanus* spp.
5	*Limacina helicina*	*Calanus marshallae*	*Acartia longiremis*	*Limacina helicina*	Bivalve larvae
6	*Acartia longiremis*	*Acartia longiremis*	*Microcalanus* spp.	*Acartia longiremis*	*Acartia longiremis*
7	*Oncea* spp.	*N. plumchrus*	*N. plumchrus*	Bivalve larvae	*Eucalanus bungii*
8	*Triconia* spp.	*Limacina helicina*	*Centropages* spp.	*Metridia pacifica*	Echinoderm
9	Ostracoda	*Themisto pacifica*	*Metridia pacifica*	Echinoderm	*Parasagitta elegans*
10	*Fritillaria* spp.	Gastropoda	*Eucalanus bungii*	Gastropoda	Euphausiids (young)

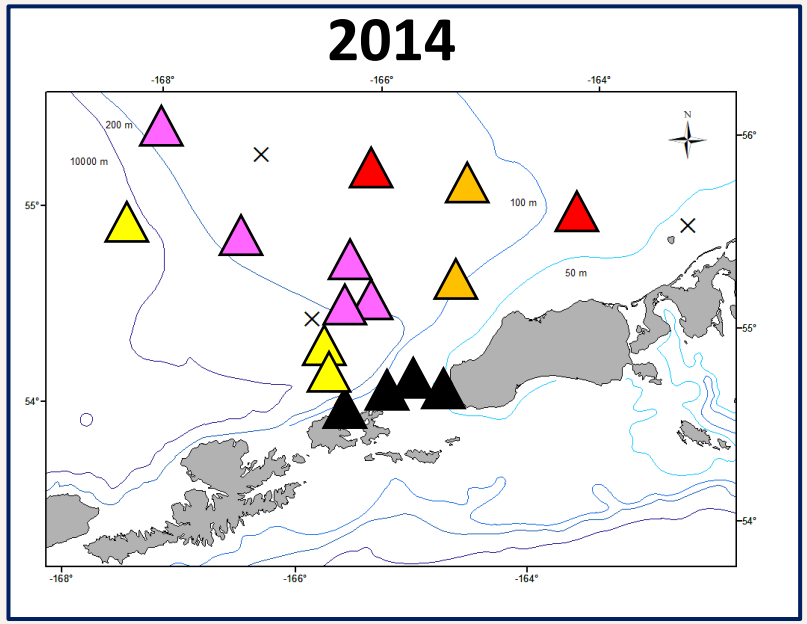
Geographic Patterns: Fall

3 *Neocalanus* species

N. flemingeri *N. plumchrus* *N. cristatus*



photo credit: Russ Hopcroft



How many stations	3	3	2	4	2
Symbol on map	▲	▲	▲	▲	▲
Rank % Contribution	b	c	d	e	h
1	*Oithona* spp.	*Oithon* a spp.	*Oithona* spp.	*Pseudocalanus* spp.	*Oithona* spp.
2	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*Oithona* spp.	*Limacina helicina*
3	*Microcalanus* spp.	*Microcalanus* spp.	*Limacina helicina*	*Calanus marshallae*	*Calanus marshallae*
4	*Metridia pacifica*	*Metridia pacifica*	*Calanus marshallae*	*Oikopleura* spp.	*Pseudocalanus* spp.
5	*Limacina helicina*	*Calanus marshallae*	*Acartia longiremis*	*Limacina helicina*	Bivalve larvae
6	*Acartia longiremis*	*Acartia longiremis*	*Microcalanus* spp.	*Acartia longiremis*	*Acartia longiremis*
7	*Oncea* spp.	*N. plumchrus*	*N. plumchrus*	Bivalve larvae	*Eucalanus bungii*
8	*Triconia* spp.	*Limacina helicina*	*Centropages* spp.	*Metridia pacifica*	Echinoderm
9	Ostracoda	*Themisto pacifica*	*Metridia pacifica*	Echinoderm	*Parasagitta elegans*
10	*Fritillaria* spp.	Gastropoda	*Eucalanus bungii*	Gastropoda	Euphausiids (young)

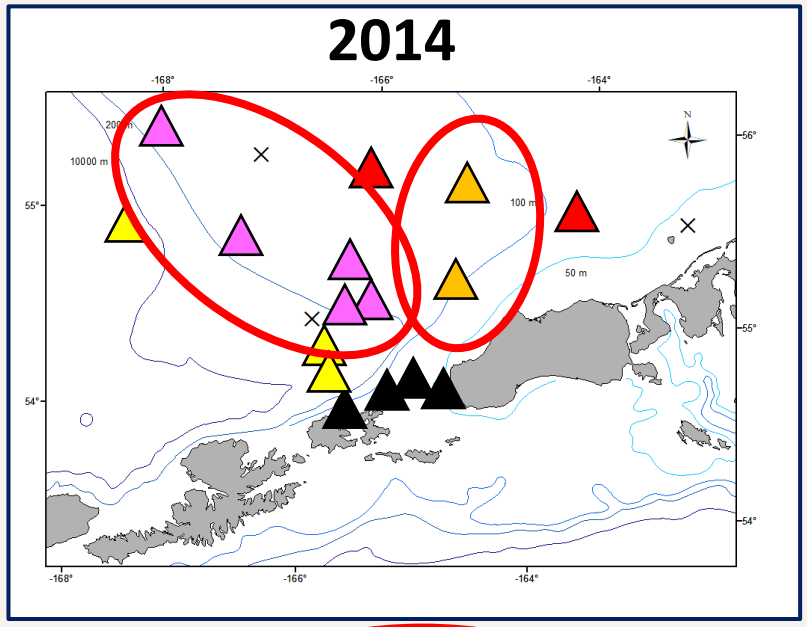
Geographic Patterns: Fall

3 *Neocalanus* species

N. flemingeri *N. plumchrus* *N. cristatus*



photo credit: Russ Hopcroft



How many stations	3	3	2	4	2
Symbol on map	▲	▲	▲	▲	▲
Rank % Contribution	b	c	d	e	h
1	*Oithona* spp.	*Oithona* spp.	*Oithona* spp.	*Pseudocalanus* spp.	*Oithona* spp.
2	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*Oithona* spp.	*Limacina helicina*
3	*Microcalanus* spp.	*Microcalanus* spp.	*Limacina helicina*	*Calanus marshallae*	*Calanus marshallae*
4	*Metridia pacifica*	*Metridia pacifica*	*Calanus marshallae*	*Oikopleura* spp.	*Pseudocalanus* spp.
5	*Limacina helicina*	*Calanus marshallae*	*Acartia longiremis*	*Limacina helicina*	Bivalve larvae
6	*Acartia longiremis*	*Acartia longiremis*	*Microcalanus* spp.	*Acartia longiremis*	*Acartia longiremis*
7	*Oncea* spp.	*N. plumchrus*	*N. plumchrus*	Bivalve larvae	*Eucalanus bungii*
8	*Triconia* spp.	*Limacina helicina*	*Centropages* spp.	*Metridia pacifica*	Echinoderm
9	Ostracoda	*Themisto pacifica*	*Metridia pacifica*	Echinoderm	*Parasagitta elegans*
10	*Fritillaria* spp.	Gastropoda	*Eucalanus bungii*	Gastropoda	Euphausiids (young)

Geographic Patterns: Fall

Calanus marshallae / glacialis

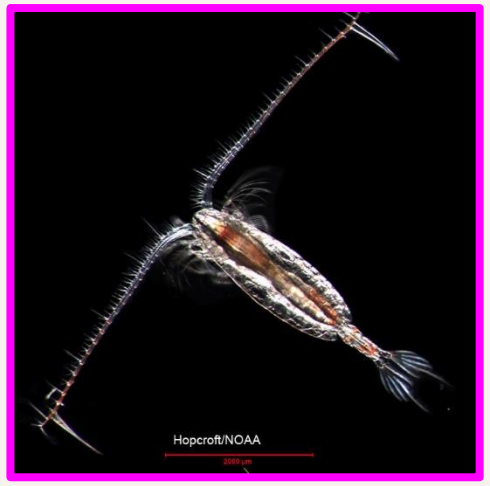
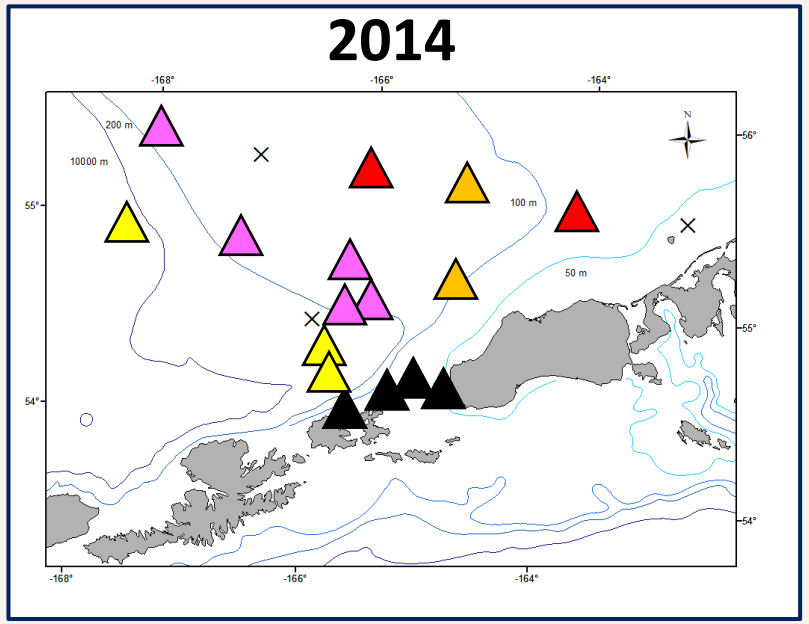


photo credit: Russ Hopcroft



How many stations	3	3	2	4	2
Symbol on map	▲	▲	▲	▲	▲
Rank % Contribution	b	c	d	e	h
1	*Oithona* spp.	*Oithon* a spp.	*Oithona* spp.	*Pseudocalanus* spp.	*Oithona* spp.
2	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*Oithona* spp.	*Limacina helicina*
3	*Microcalanus* spp.	*Microcalanus* spp.	*Limacina helicina*	*Calanus marshallae*	*Calanus marshallae*
4	*Metridia pacifica*	*Metridia pacifica*	*Calanus marshallae*	*Oikopleura* spp.	*Pseudocalanus* spp.
5	*Limacina helicina*	*Calanus marshallae*	*Acartia longiremis*	*Limacina helicina*	Bivalve larvae
6	*Acartia longiremis*	*Acartia longiremis*	*Microcalanus* spp.	*Acartia longiremis*	*Acartia longiremis*
7	*Oncea* spp.	*N. plumchrus*	*N. plumchrus*	Bivalve larvae	*Eucalanus bungii*
8	*Triconia* spp.	*Limacina helicina*	*Centropages* spp.	*Metridia pacifica*	Echinoderm
9	Ostracoda	*Themisto pacifica*	*Metridia pacifica*	Echinoderm	*Parasagitta elegans*
10	*Fritillaria* spp.	Gastropoda	*Eucalanus bungii*	Gastropoda	Euphausiids (young)

Geographic Patterns: Fall

Calanus marshallae / glacialis

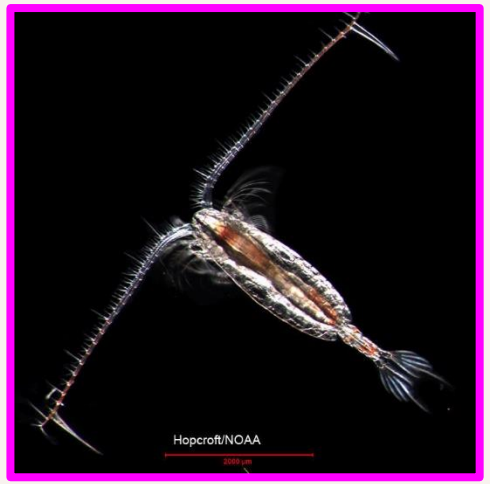
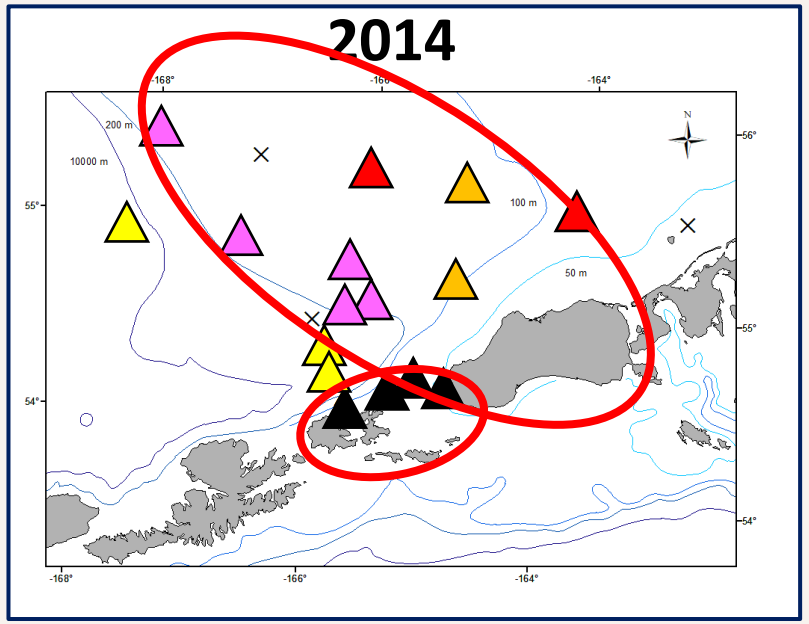


photo credit: Russ Hopcroft



How many stations	3	3	2	4	2
Symbol on map	▲	▲	▲	▲	▲
Rank % Contribution	b	c	d	e	h
1	*Oithona* spp.	*Oithon* a spp.	*Oithona* spp.	*Pseudocalanus* spp.	*Oithona* spp.
2	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*Oithona* spp.	*Limacina helicina*
3	*Microcalanus* spp.	*Microcalanus* spp.	*Limacina helicina*	*Calanus marshallae*	*Calanus marshallae*
4	*Metridia pacifica*	*Metridia pacifica*	*Calanus marshallae*	*Oikopleura* spp.	*Pseudocalanus* spp.
5	*Limacina helicina*	*Calanus marshallae*	*Acartia longiremis*	*Limacina helicina*	Bivalve larvae
6	*Acartia longiremis*	*Acartia longiremis*	*Microcalanus* spp.	*Acartia longiremis*	*Acartia longiremis*
7	*Oncea* spp.	*N. plumchrus*	*N. plumchrus*	Bivalve larvae	*Eucalanus bungii*
8	*Triconia* spp.	*Limacina helicina*	*Centropages* spp.	*Metridia pacifica*	Echinoderm
9	Ostracoda	*Themisto pacifica*	*Metridia pacifica*	Echinoderm	*Parasagitta elegans*
10	*Fritillaria* spp.	Gastropoda	*Eucalanus bungii*	Gastropoda	Euphausiids (young)

Geographic Patterns: Fall

Calanus marshallae

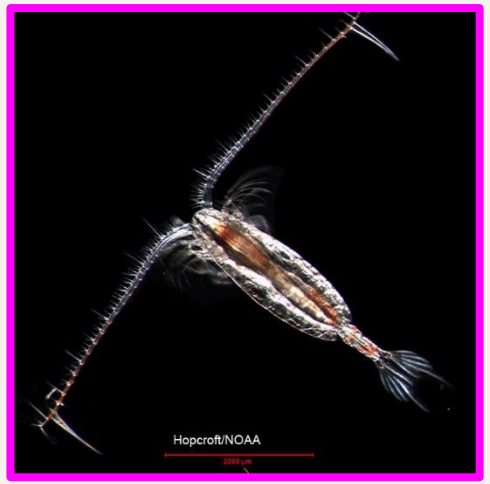
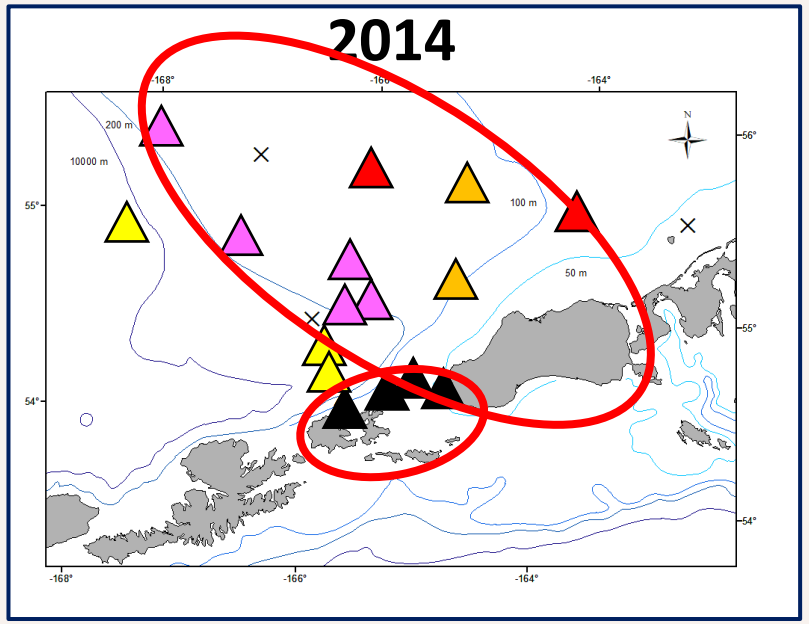
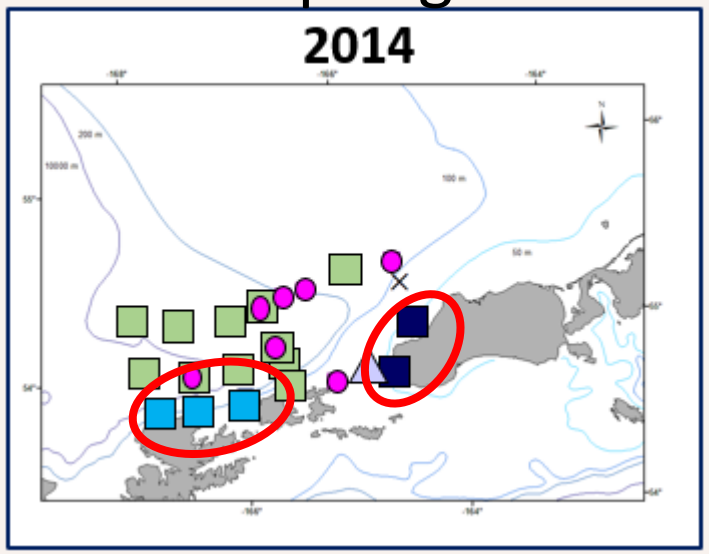


photo credit: Russ Hopcroft



Spring

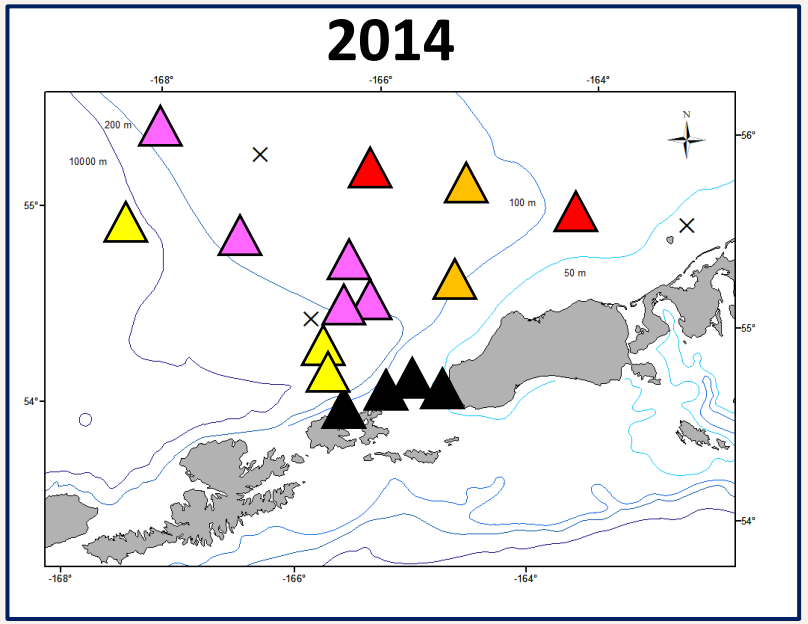


How many stations	3	3	2	4	2
Symbol on map	▲	▲	▲	▲	▲
Rank % Contribution	b	c	d	e	h
1	*Oithona* spp.	*Oithon* a spp.	*Oithona* spp.	*Pseudocalanus* spp.	*Oithona* spp.
2	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*Oithona* spp.	*Limacina helicina*
3	*Microcalanus* spp.	*Microcalanus* spp.	*Limacina helicina*	*Calanus marshallae*	*Calanus marshallae*
4	*Metridia pacifica*	*Metridia pacifica*	*Calanus marshallae*	*Oikopleura* spp.	*Pseudocalanus* spp.
5	*Limacina helicina*	*Calanus marshallae*	*Acartia longiremis*	*Limacina helicina*	Bivalve larvae
6	*Acartia longiremis*	*Acartia longiremis*	*Microcalanus* spp.	*Acartia longiremis*	*Acartia longiremis*
7	*Oncea* spp.	*N. plumchrus*	*N. plumchrus*	Bivalve larvae	*Eucalanus bungii*
8	*Triconia* spp.	*Limacina helicina*	*Centropages* spp.	*Metridia pacifica*	Echinoderm
9	Ostracoda	*Themisto pacifica*	*Metridia pacifica*	Echinoderm	*Parasagitta elegans*
10	*Fritillaria* spp.	Gastropoda	*Eucalanus bungii*	Gastropoda	Euphausiids (young)

Geographic Patterns: Fall

Limacina helicina

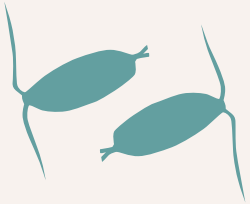




Absent from top 10 species in Spring

How many stations	3	3	2	4	2
Symbol on map	▲	▲	▲	▲	▲
Rank % Contribution	b	c	d	e	h
1	*Oithona* spp.	*Oithon* a spp.	*Oithona* spp.	*Pseudocalanus* spp.	*Oithona* spp.
2	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*Pseudocalanus* spp.	*Oithona* spp.	*Limacina helicina*
3	*Microcalanus* spp.	*Microcalanus* spp.	*Limacina helicina*	*Calanus marshallae*	*Calanus marshallae*
4	*Metridia pacifica*	*Metridia pacifica*	*Calanus marshallae*	*Oikopleura* spp.	*Pseudocalanus* spp.
5	*Limacina helicina*	*Calanus marshallae*	*Acartia longiremis*	*Limacina helicina*	Bivalve larvae
6	*Acartia longiremis*	*Acartia longiremis*	*Microcalanus* spp.	*Acartia longiremis*	*Acartia longiremis*
7	*Oncea* spp.	*N. plumchrus*	*N. plumchrus*	Bivalve larvae	*Eucalanus bungii*
8	*Triconia* spp.	*Limacina helicina*	*Centropages* spp.	*Metridia pacifica*	Echinoderm
9	Ostracoda	*Themisto pacifica*	*Metridia pacifica*	Echinoderm	*Parasagitta elegans*
10	*Fritillaria* spp.	Gastropoda	*Eucalanus bungii*	Gastropoda	Euphausiids (young)

Seasonal Patterns? Geographic Patterns?

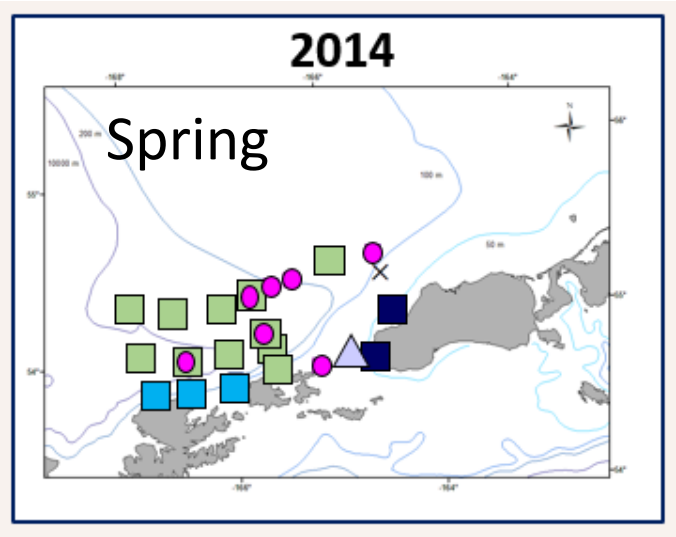


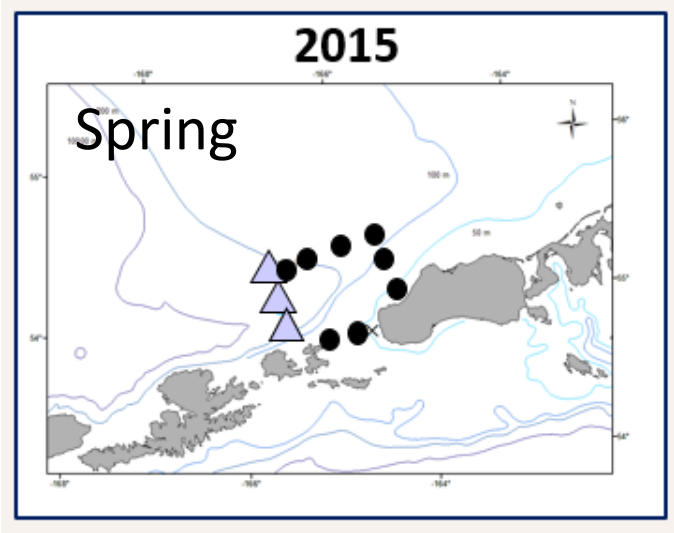


- *Neoalanus plumchrus* remained in fall which was a surprise due to life history
- *Calanus marshallae / glacialis* high % contribution inshore in Spring and on the shelf in Fall
- *Limacina helicina* (pteropod) high % contribution in Fall throughout study area

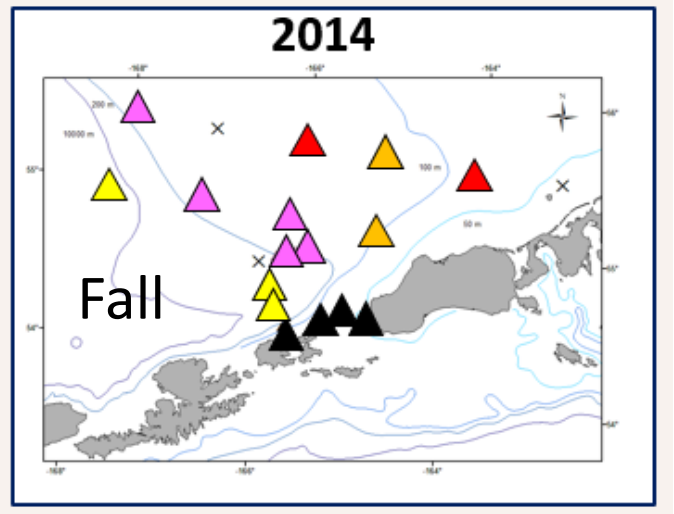
Flow Patterns?

ANSC = Aleutian North Slope Current





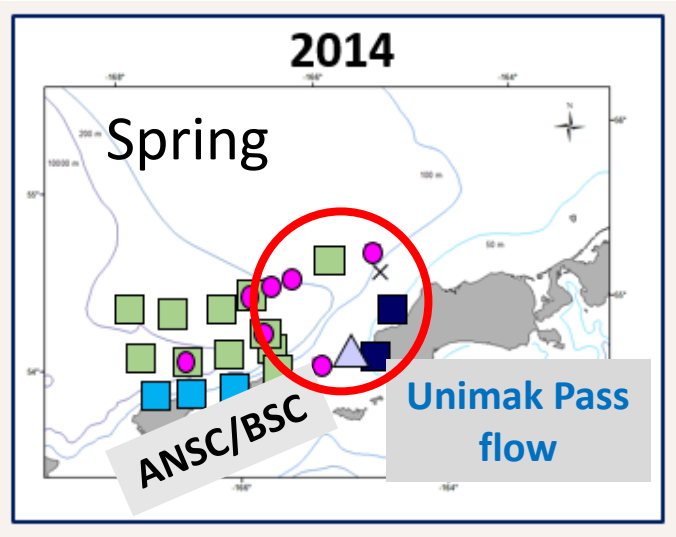
BSC = Bering Slope Current

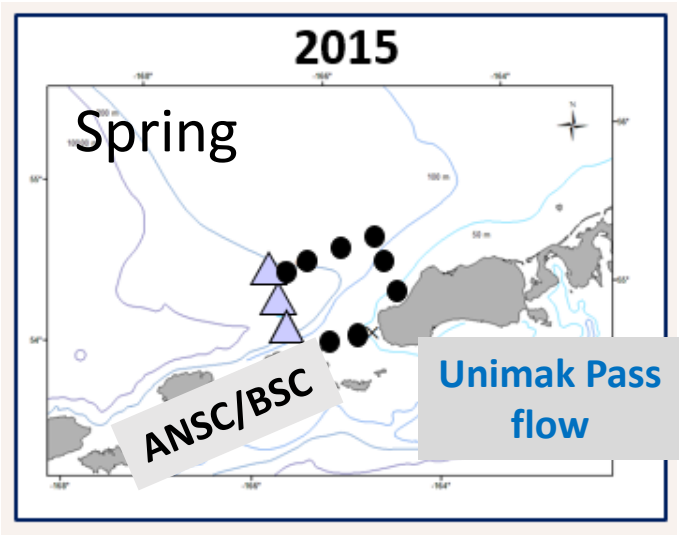


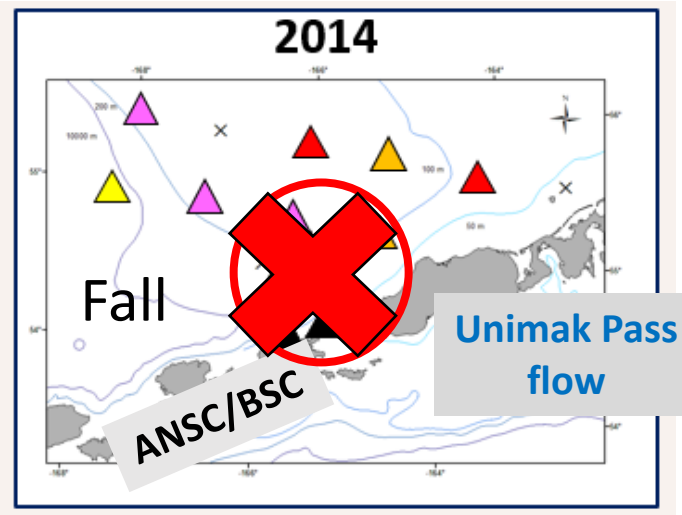
Flow Patterns?

ANSC = Aleutian North Slope Current

BSC = Bering Slope Current



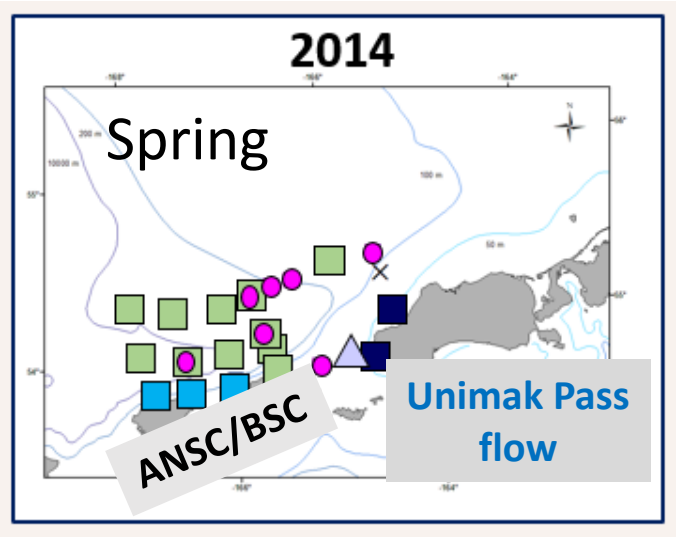


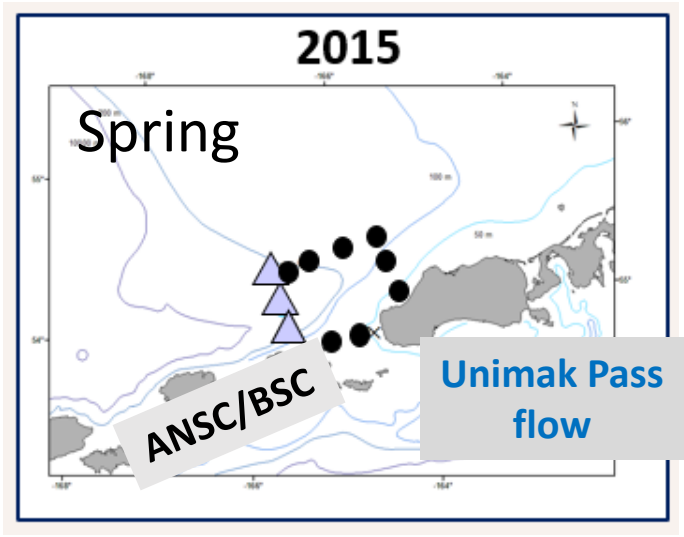


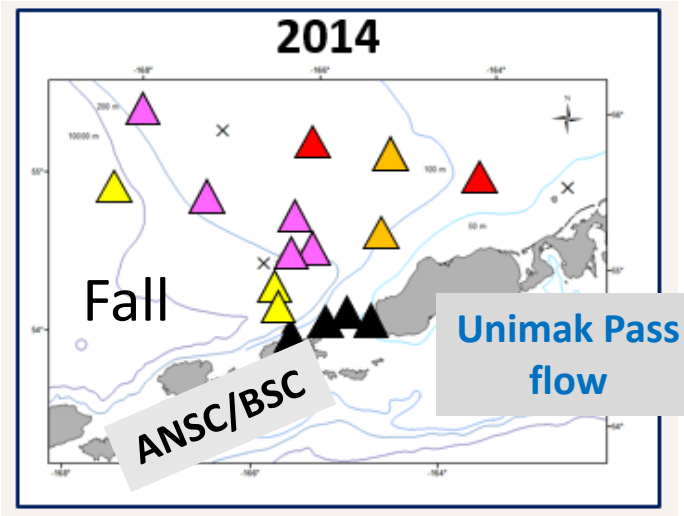
Temperature & Salinity?

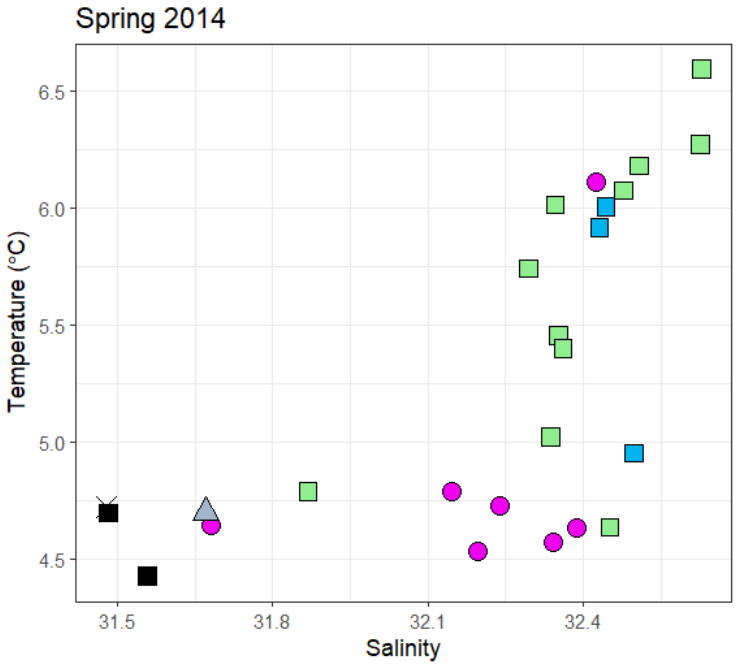
ANSC = Aleutian North Slope Current

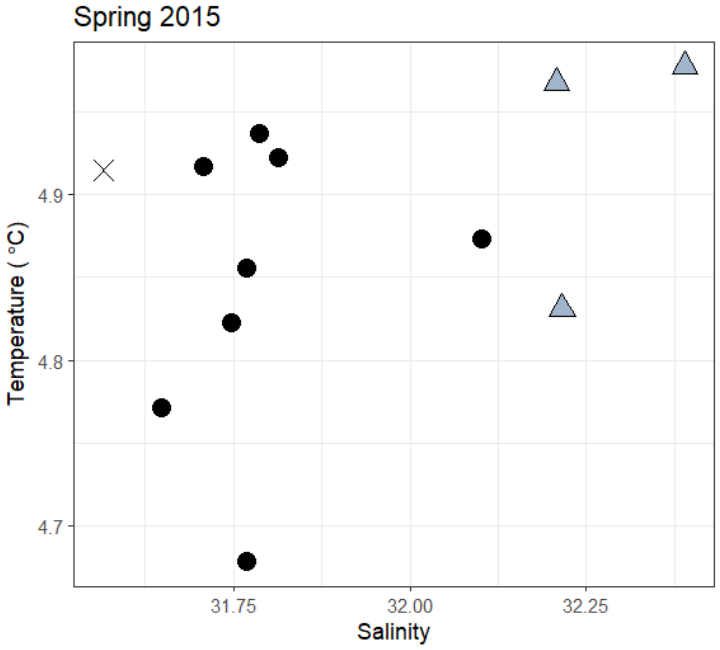
BSC = Bering Slope Current

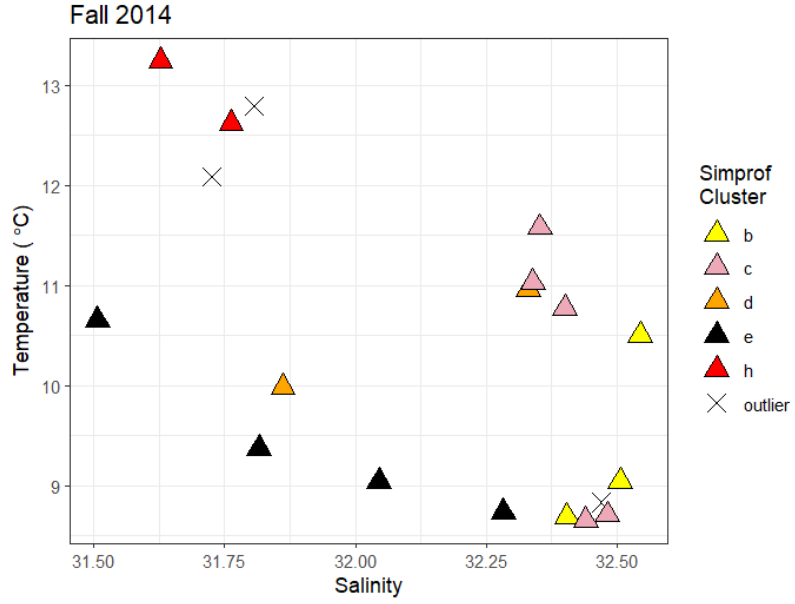










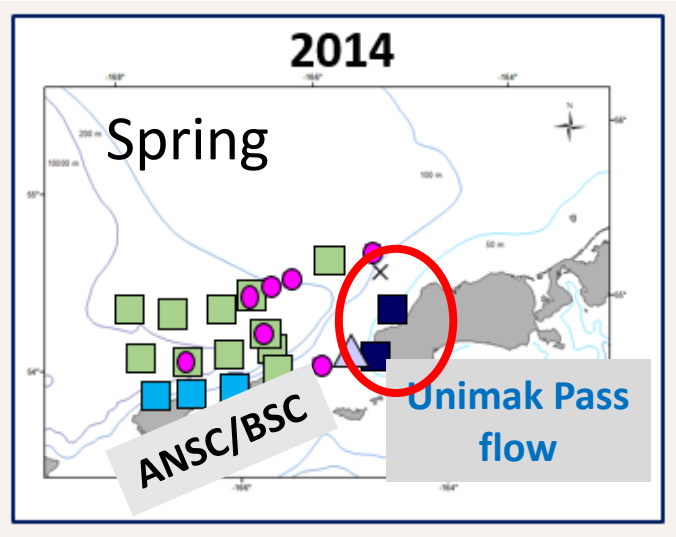


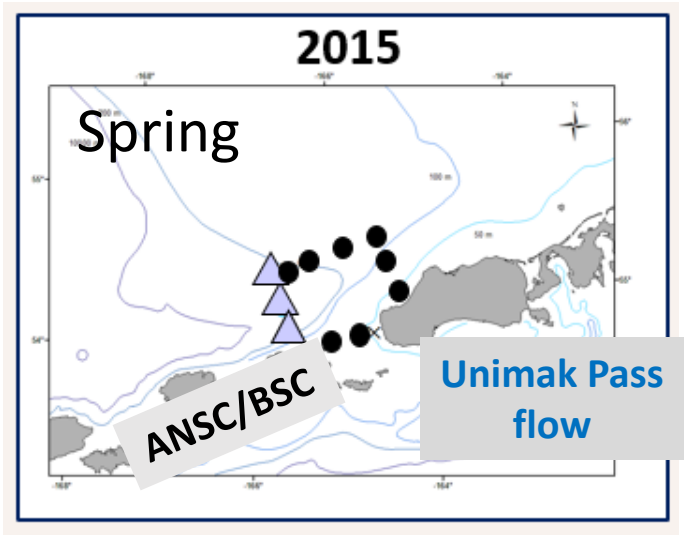
Temperature and salinity are different scales

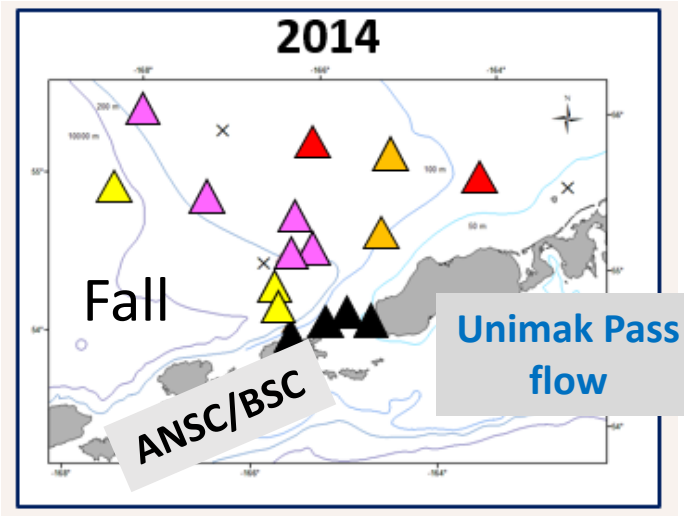
Temperature & Salinity?

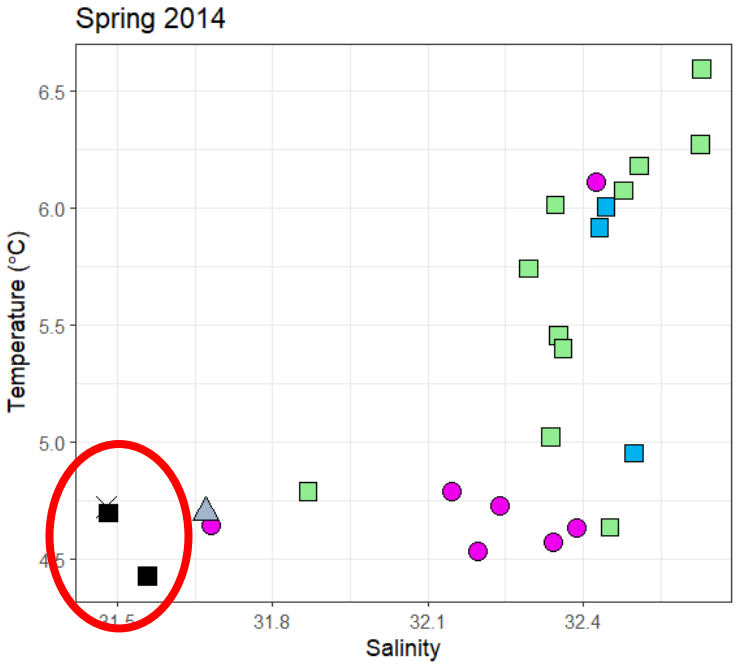
ANSC = Aleutian North Slope Current

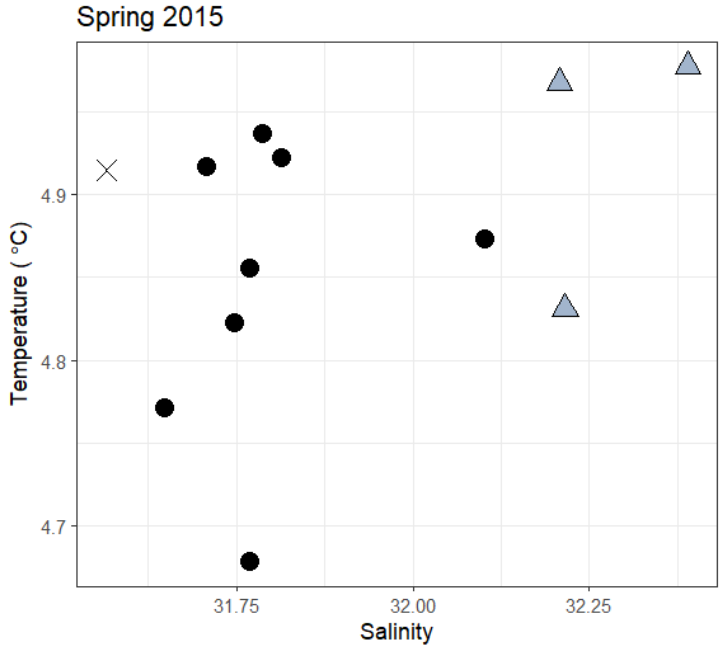
BSC = Bering Slope Current

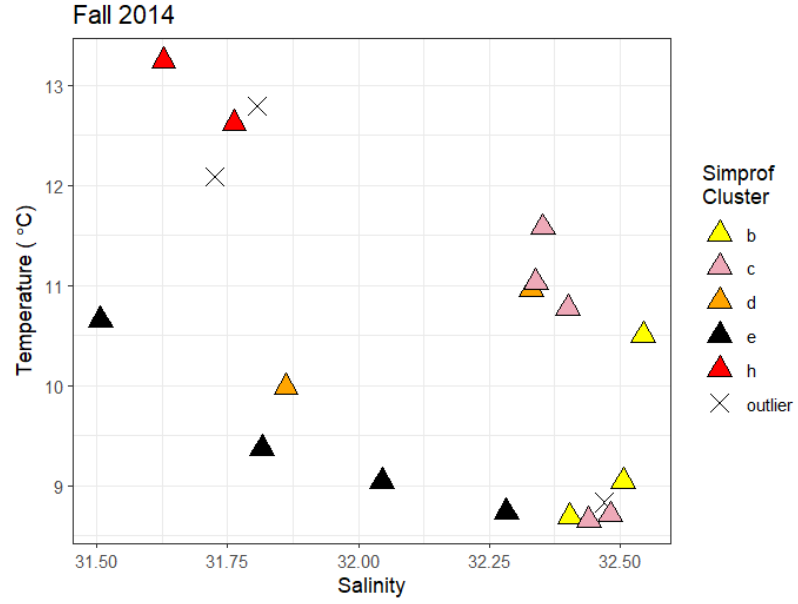










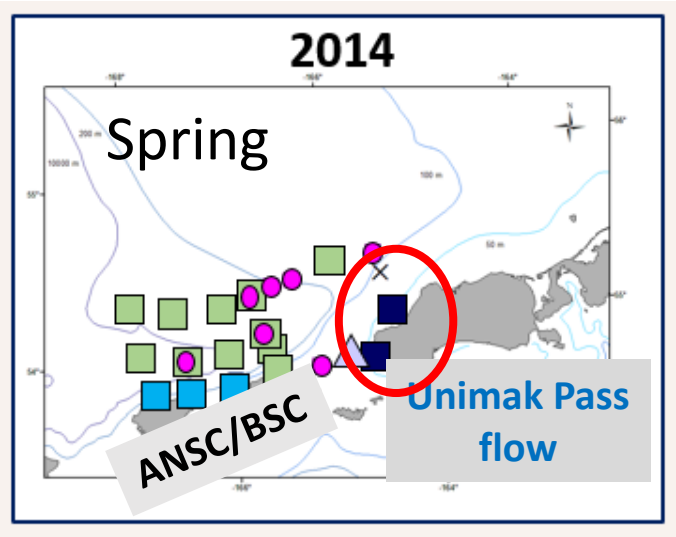


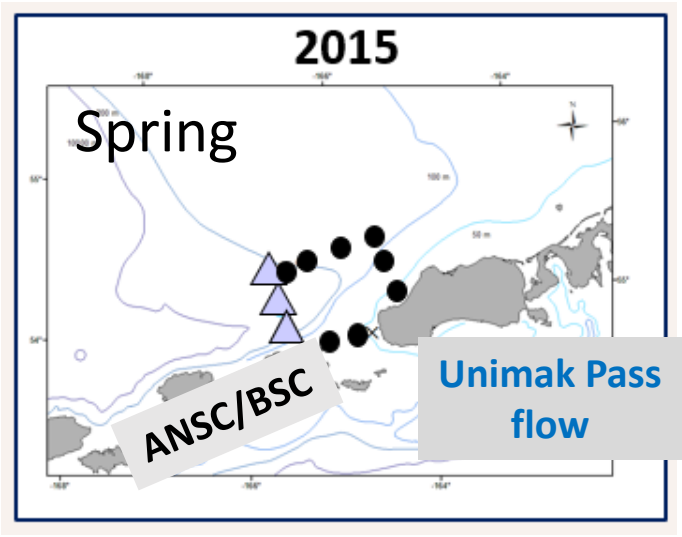
Temperature and salinity are different scales

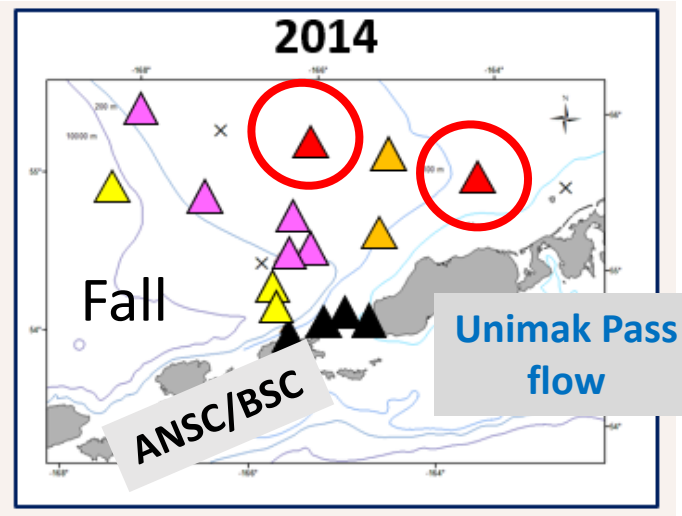
Temperature & Salinity?

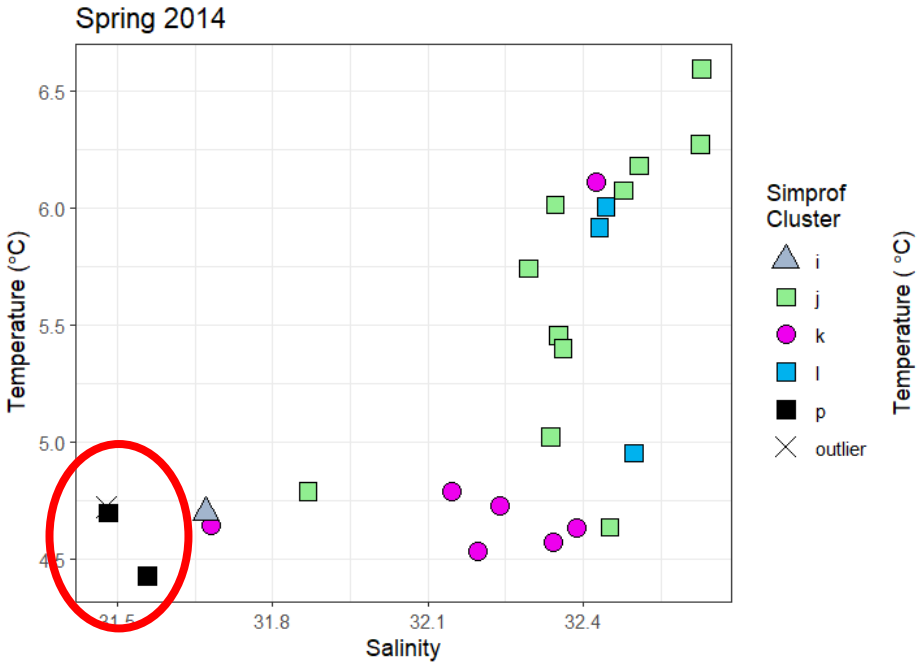
ANSC = Aleutian North Slope Current

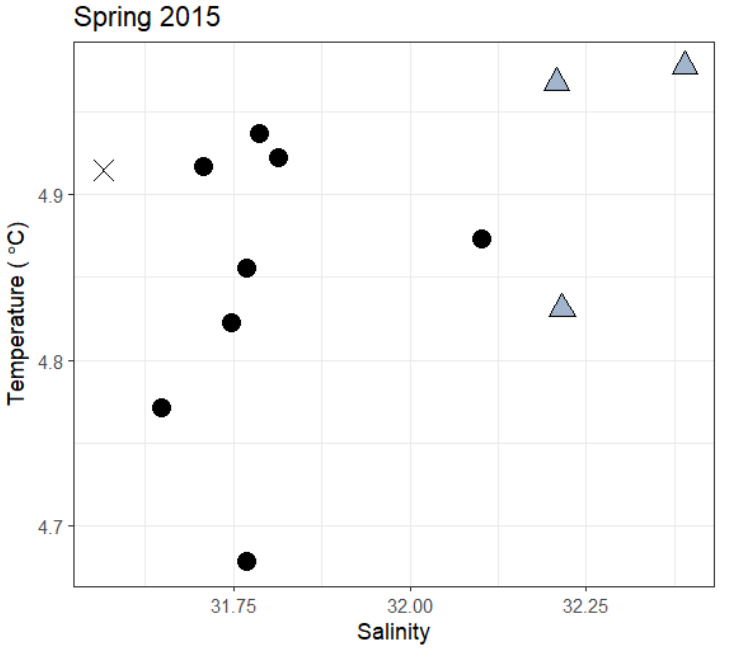
BSC = Bering Slope Current

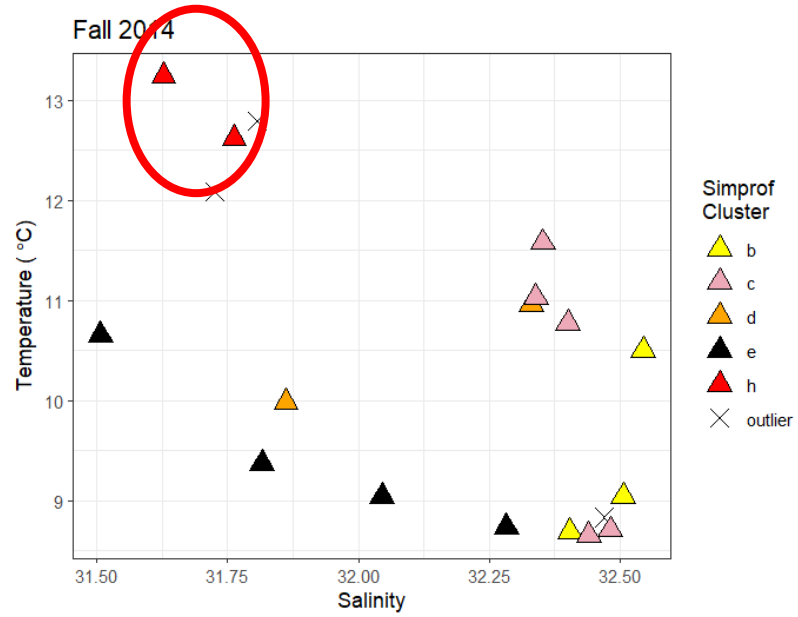




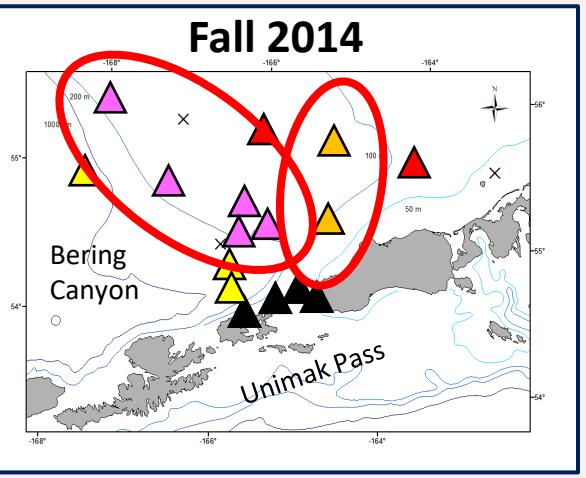








Temperature and salinity are different scales



Neocalanus plumchrus
Stage Composition

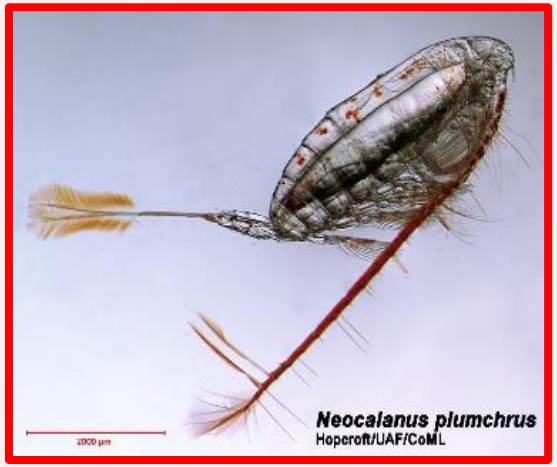
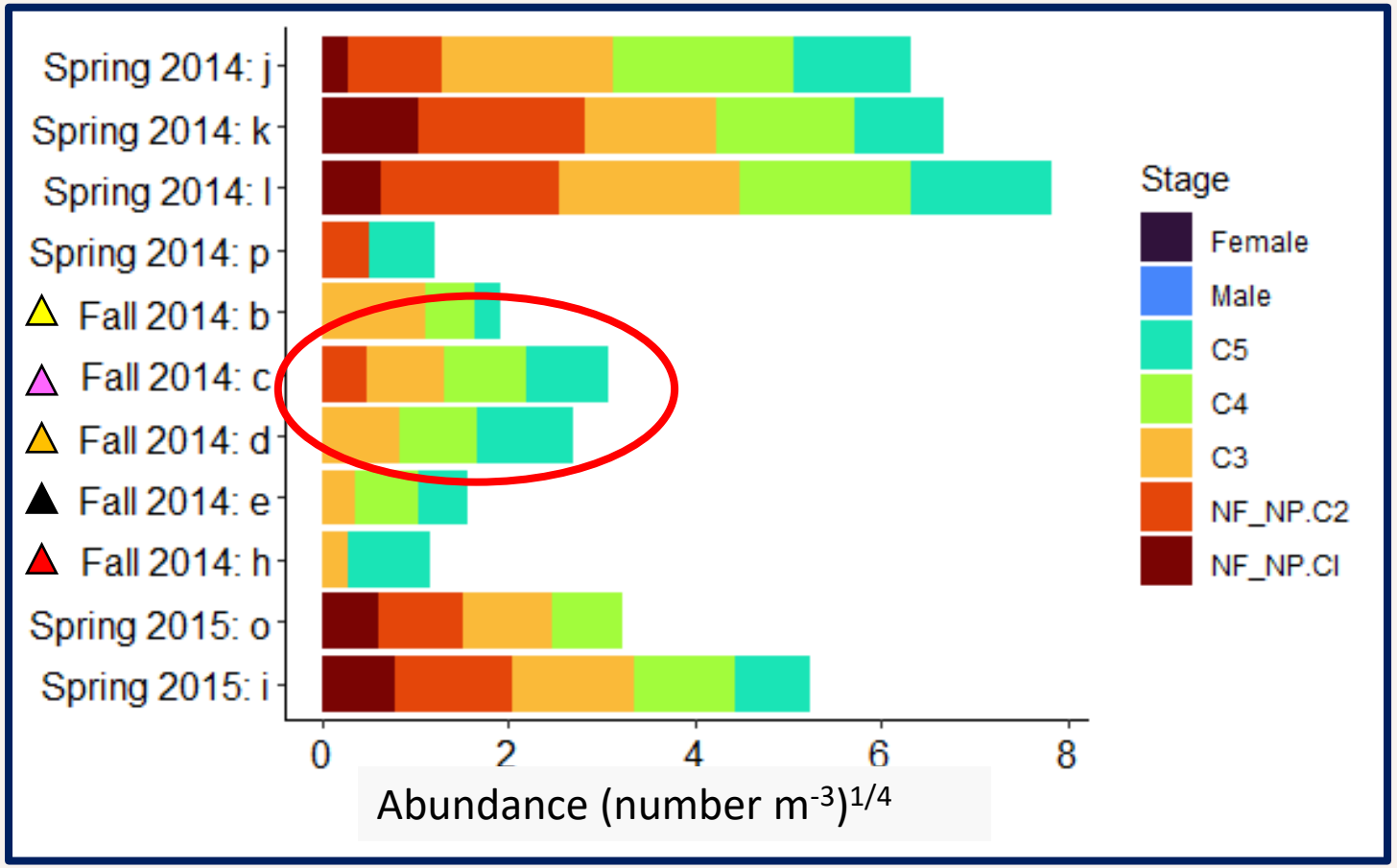
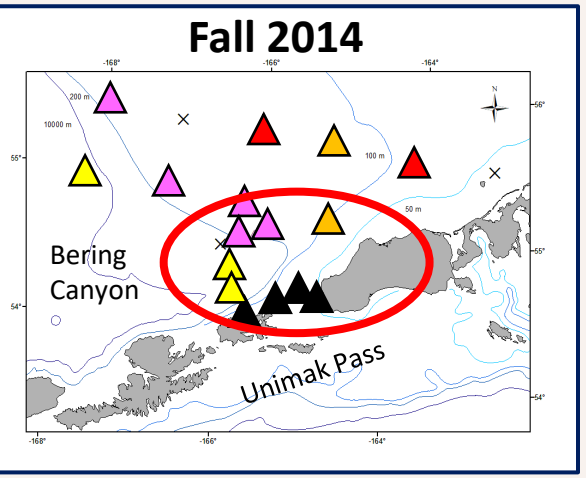


photo credit: Russ Hopcroft





Neocalanus plumchrus
Stage Composition

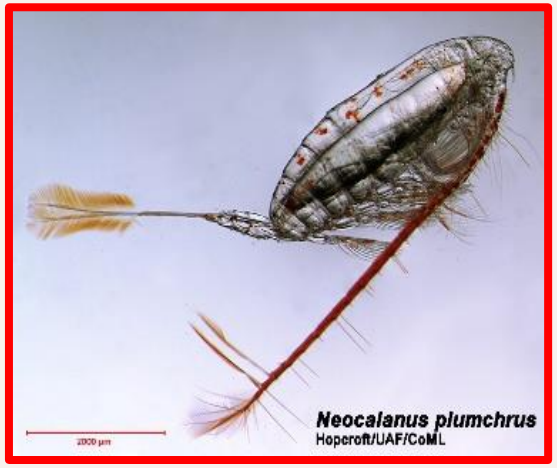
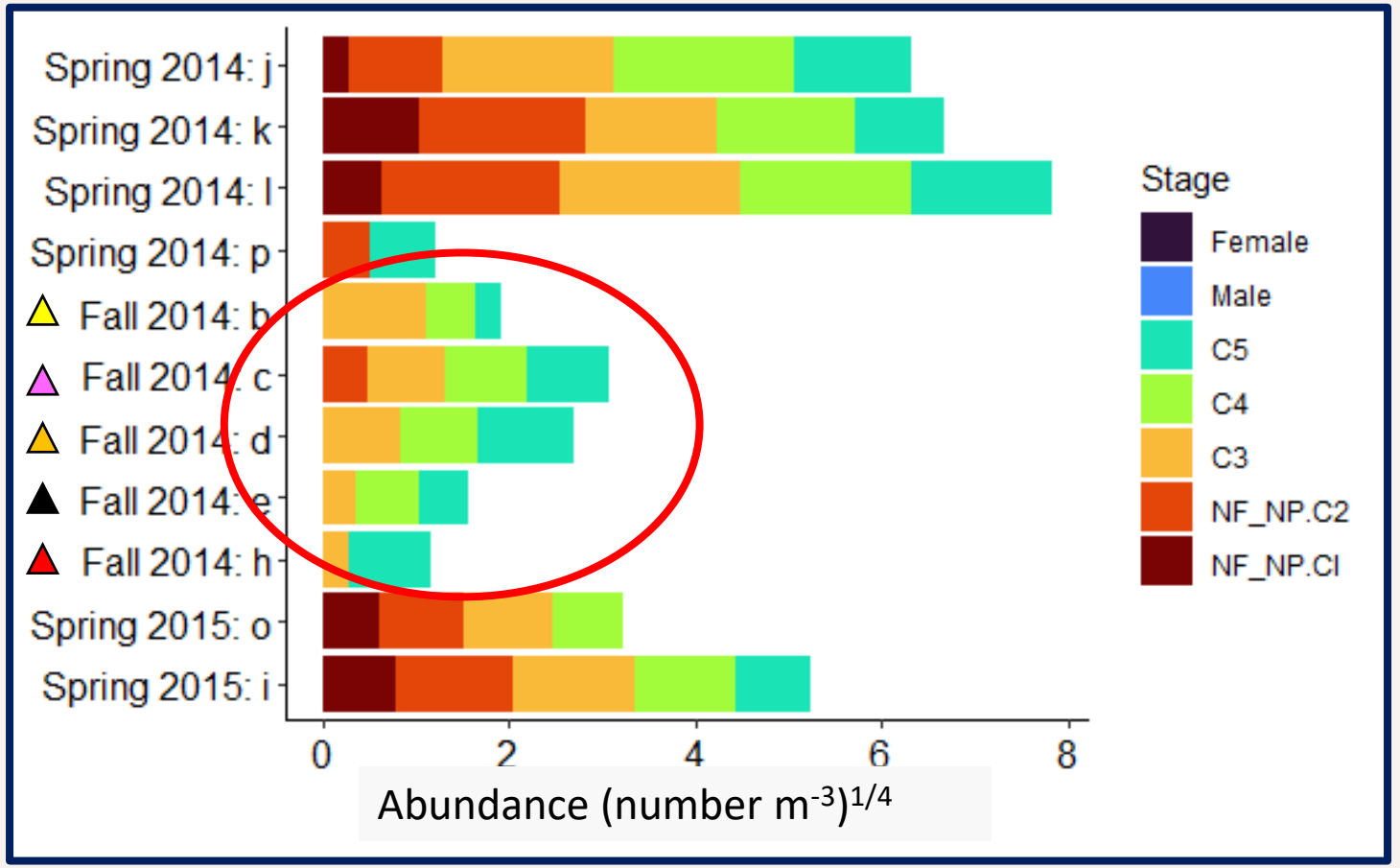


photo credit: Russ Hopcroft



Unexpected C2's & C3's

Warm year 2nd cohort? Advection?

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Co-Authors

David Kimmel: guidance and support, R

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Phyllis Stabeno: oceanography

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Julie Keister, Deana Crouser, Adam Spear, Jesse Lamb,

Libby Logerwell, David Kimmel for feedback on talk

EcoFOCI Presenters

- **Julie Keister: NBS Ecosystem**

Tomorrow 9:15 am S10

- **Emily Lemagie: Temp extremes**

Tomorrow 10:50 am S02

- **Lauren Block: Phenological Shifts**

Tomorrow 3:00 pm S10

- **Jesse Lamb: Poster**

Juv pollock diets during heat wave

- **Wei Cheng: Poster**

Impacts of Ex-Typhoon Merbok

Funding from NPRB



Contact: colleen.harpold@noaa.gov

Questions?



Contact: colleen.harpold@noaa.gov