Overview of preliminary findings during winter 2019 International Gulf of Alaska expedition

(up to fish)

Evgeny Pakhomov

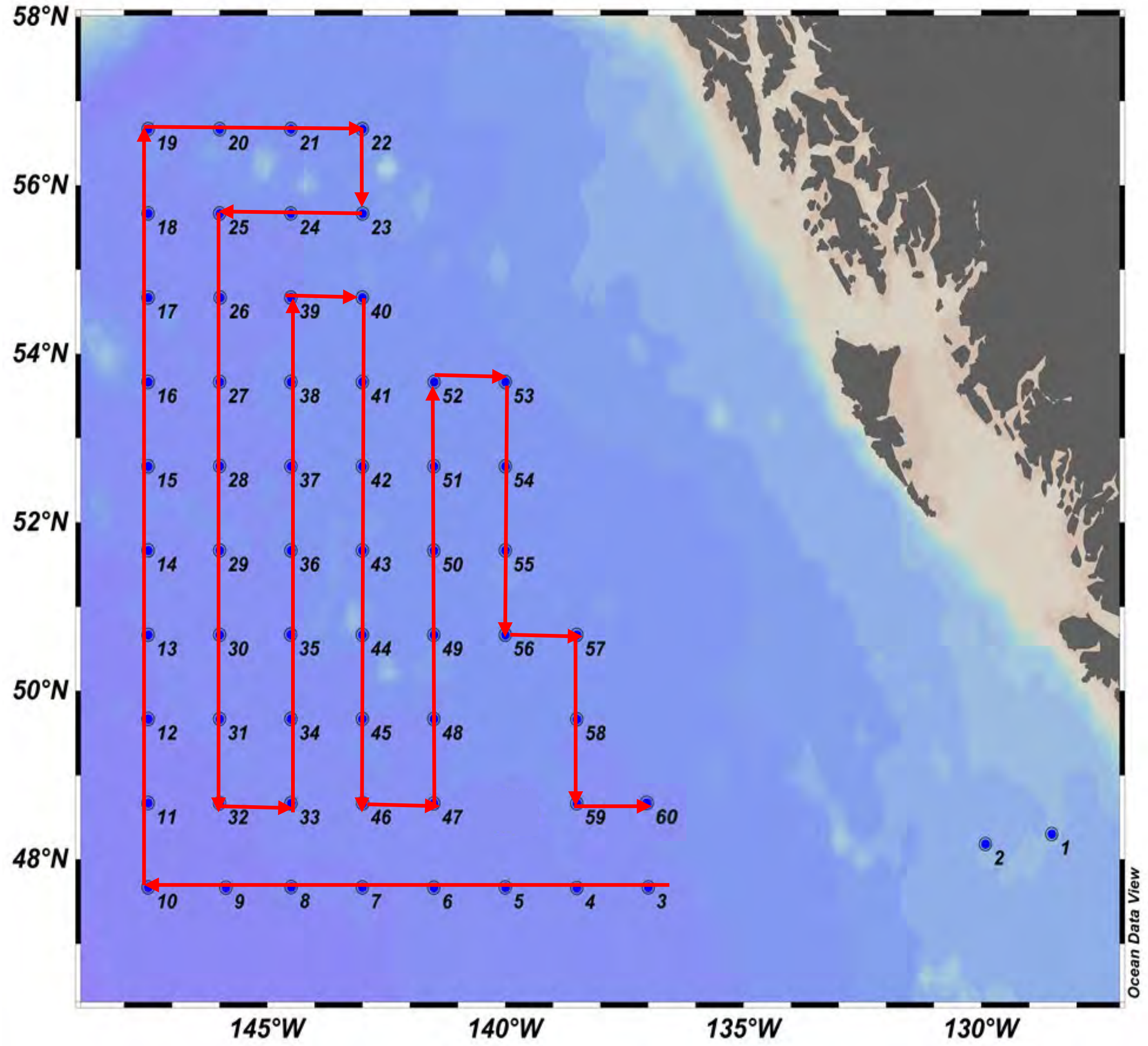
Christoph Deeg, Svetlana Esenkulova, Gerard Foley, Brian Hunt, Arkadii Ivanov, Hae Kun Jung, Gennady Kantakov, Albina Kanzeparova, Anton Khleborodov, Chrys Neville, Vladimir Radchenko, Igor Shurpa, Alexander Slabinsky, Alexei Somov, Shigehiko Urawa, Anna Vazhova, Perumthuruthil S. Vishnu, Charles Waters, Laurie Weitkamp, Mikhail Zuev, Richard Beamish

Two major expedition objectives

1. Test the hypothesis that the abundance of salmon is mostly determined by the end of the first ocean winter. Fish that grow faster and quicker in their first year survive better

2. See if an international team of researchers can work effectively together to make the discoveries we need to be responsible stewards in a future of rapidly changing ocean ecosystems

Study area and key aims



1. Characterize oceanographic setting in the Gulf of Alaska in winter 2019
2. Identify the species and stock specific distribution of Pacific salmon in the Gulf of Alaska in winter
3. Conduct first abundance estimates of Pacific salmon in eastern Pacific in winter
4. Examine health and condition of salmon in relation to region caught, ocean conditions and stock overlap
5. Test key hypothesis regulating salmon production including
   a) Critical size and period
   b) Temperature based distributions
   c) Competition between species

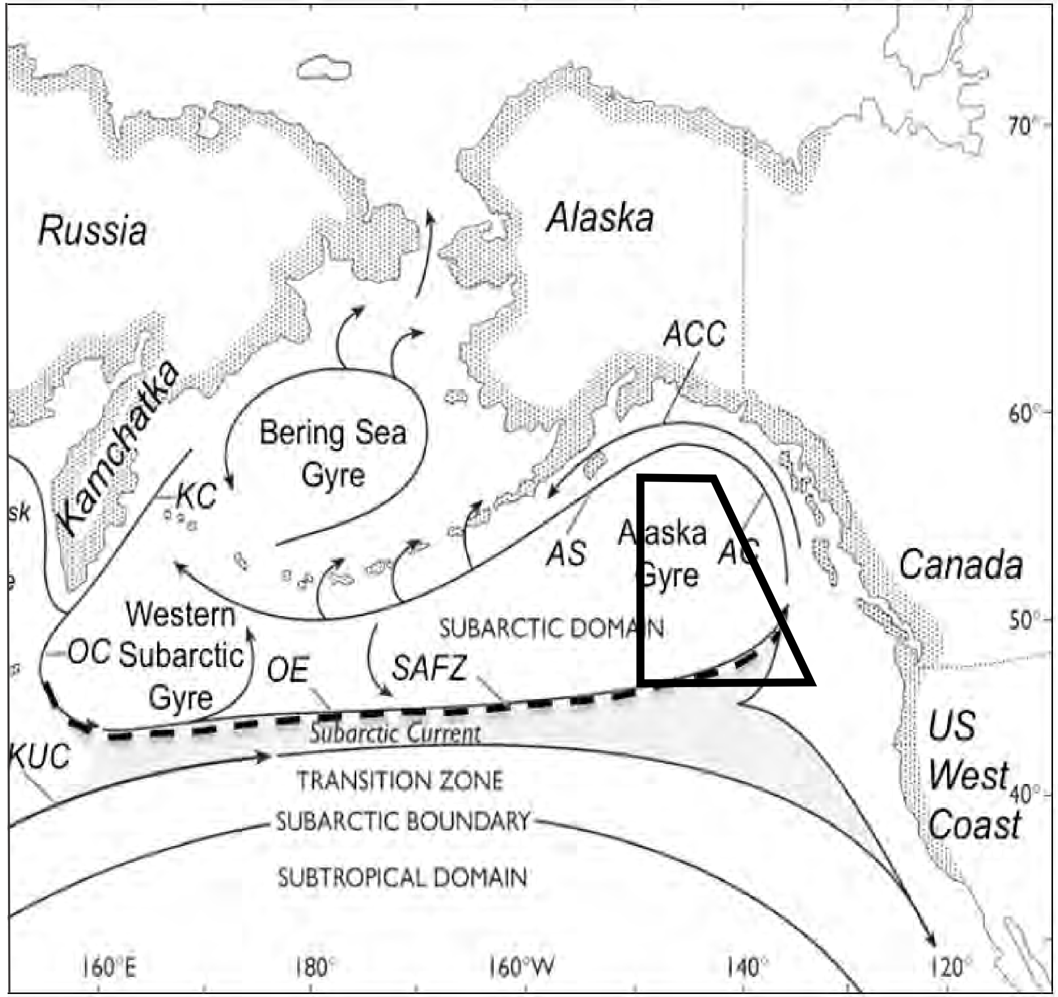
Main topic will be to look at the physical and low trophic level biology in the study area

- Physical setting during the expedition
- Chlorophyll – a distribution patterns
- Zooplankton: spatial distribution, composition and community structure
- Salmon diets and relation to zooplankton

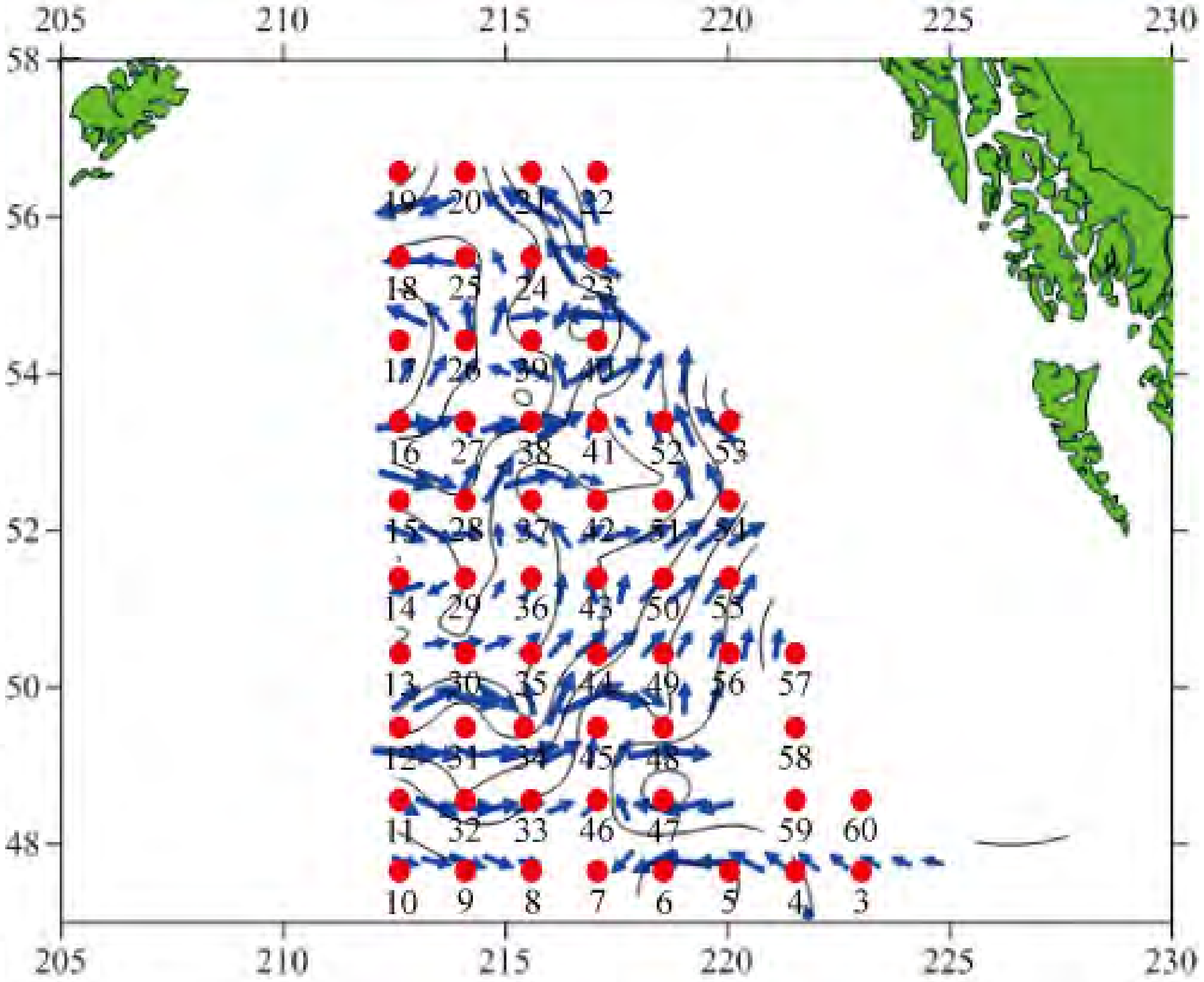
CTD and Rosette

Juday net

Regional circulation

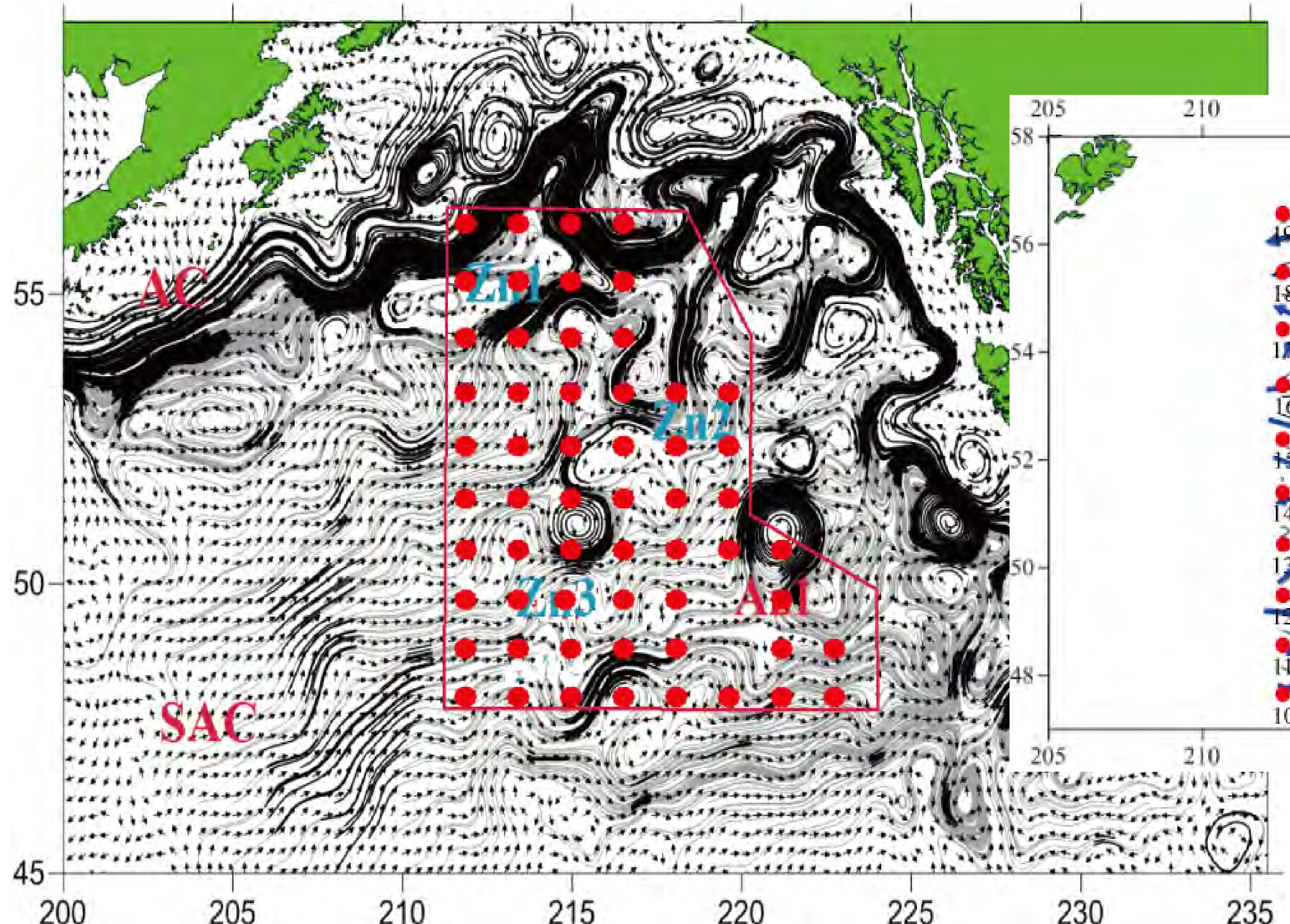


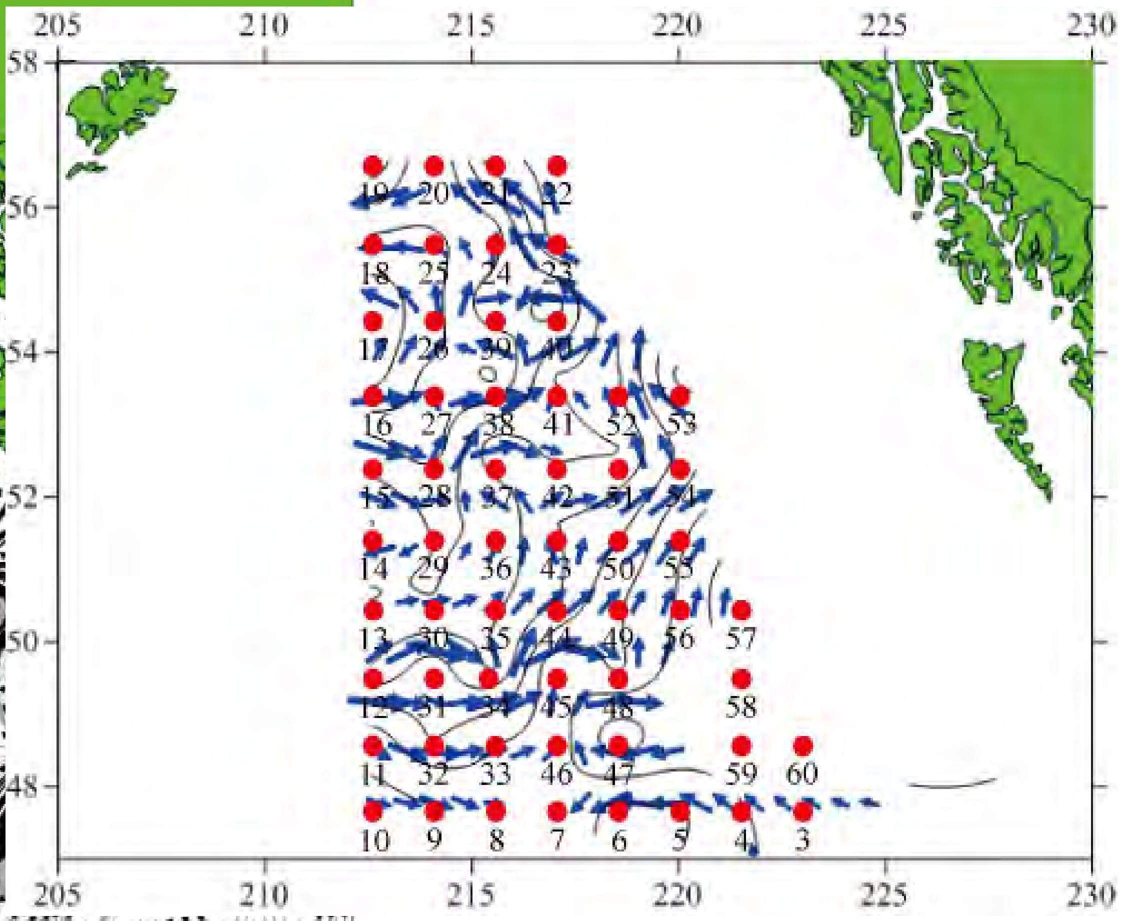
Surface currents



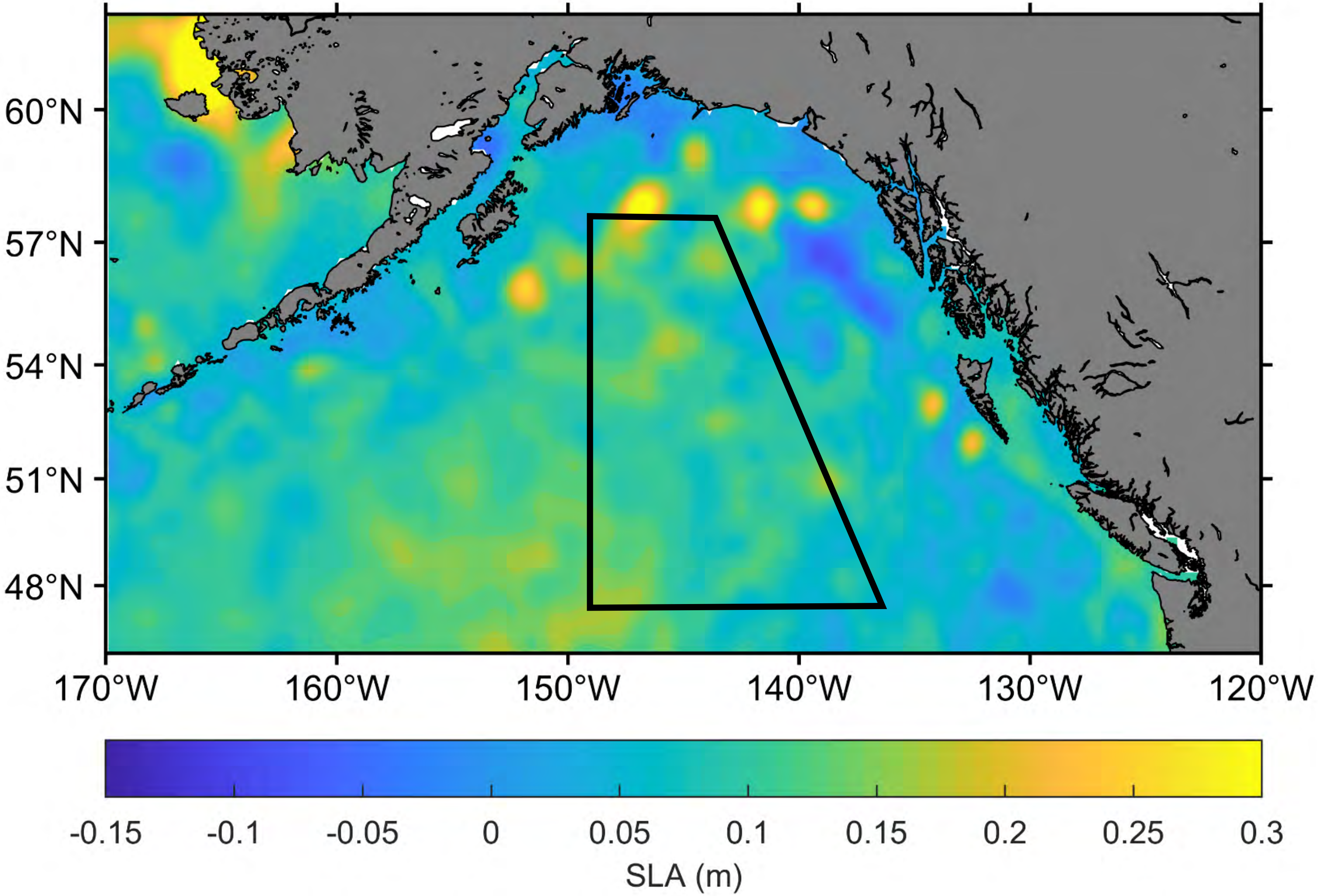
Model

Surface currents



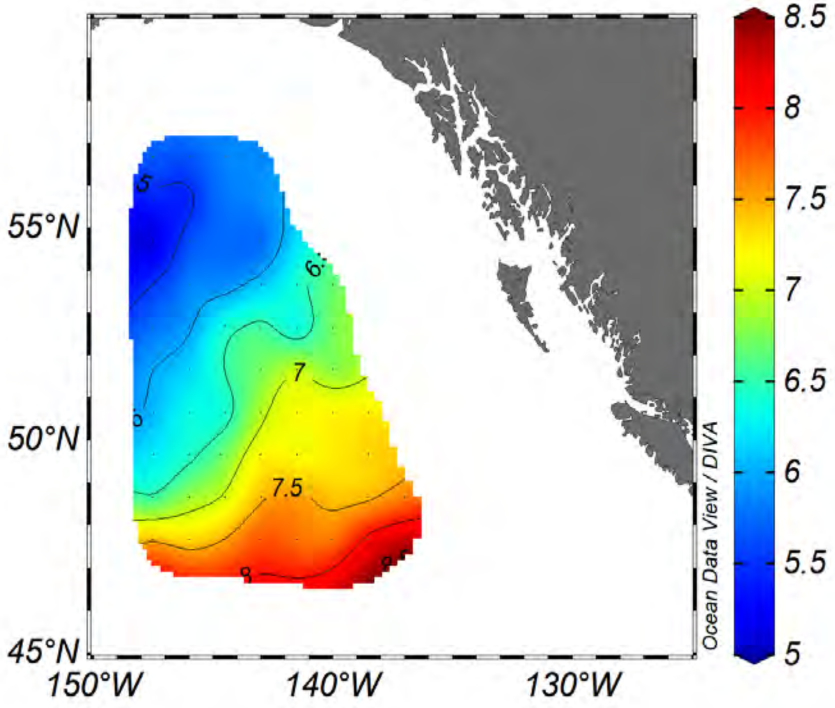


Sea Level Anomaly- February 2019

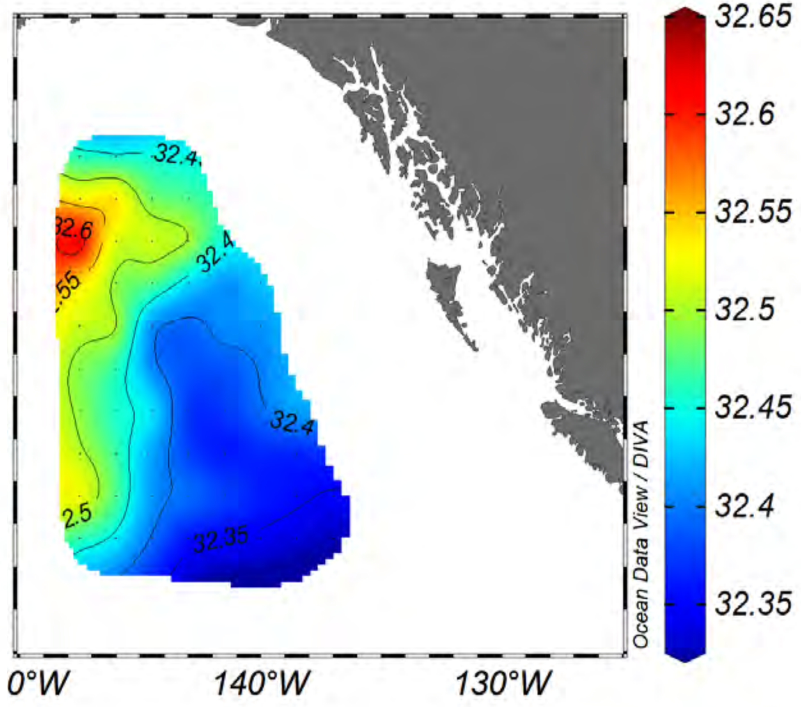


Surface temperature, salinity and critical oxygen depth

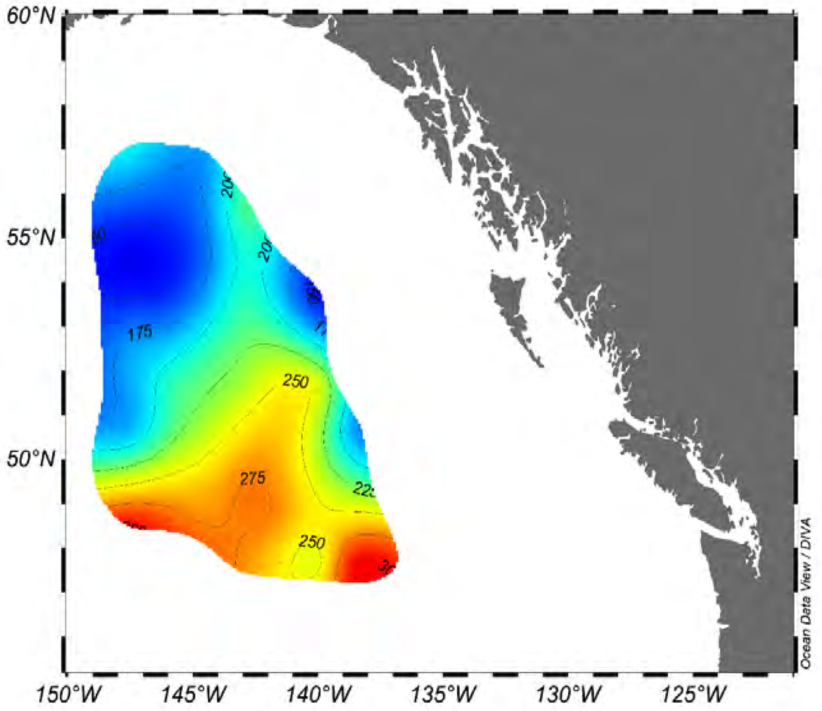
Temperature



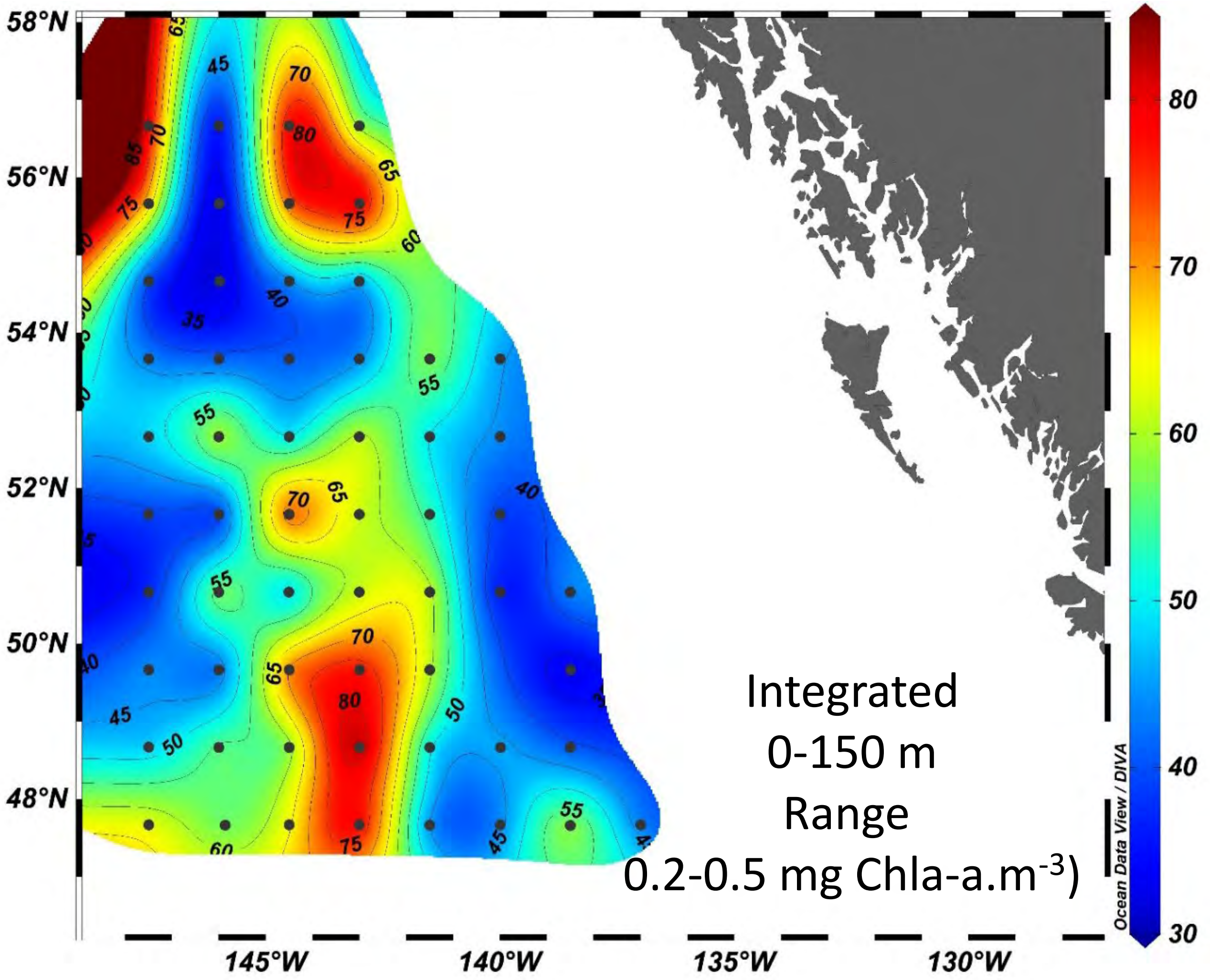
Salinity

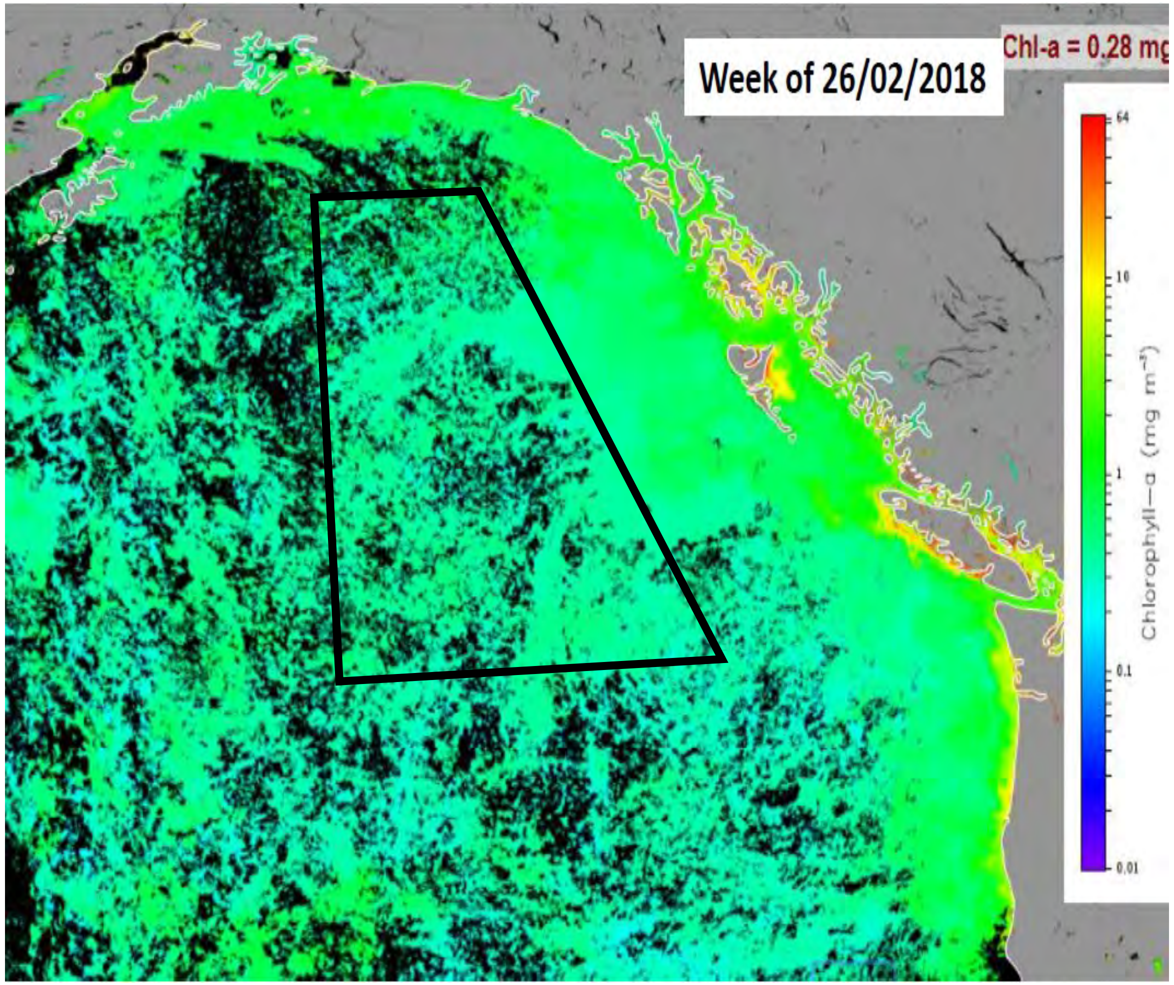


Depth of 2.5 ml/l oxygen

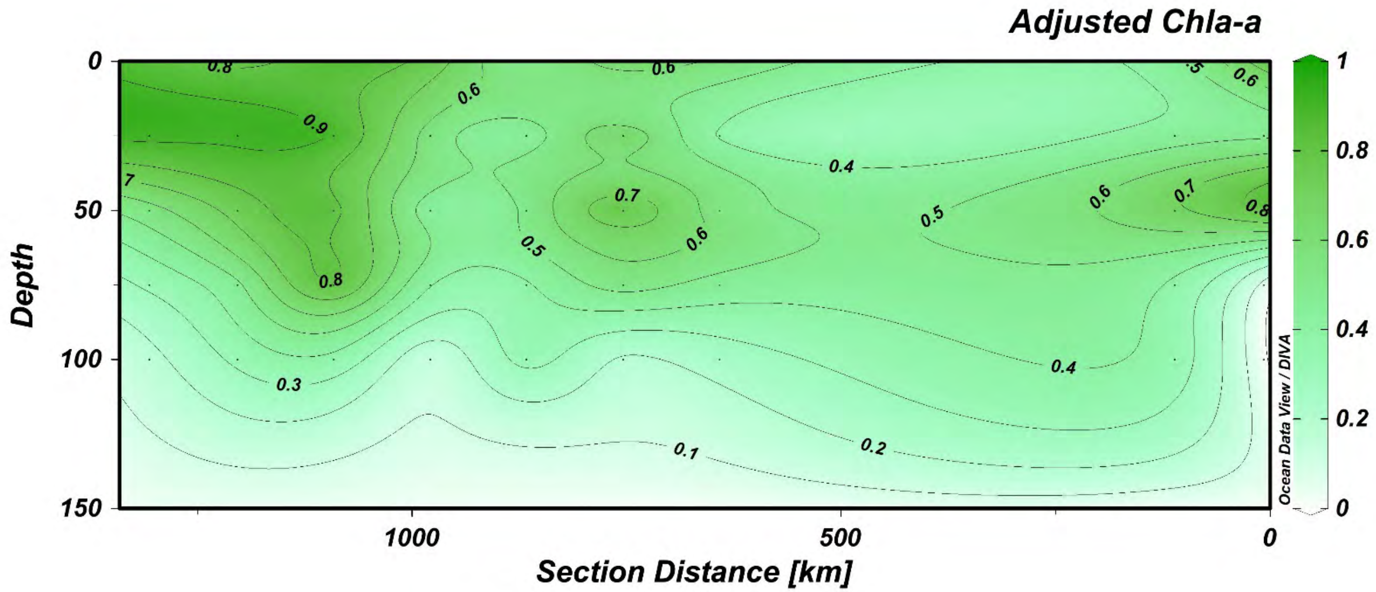


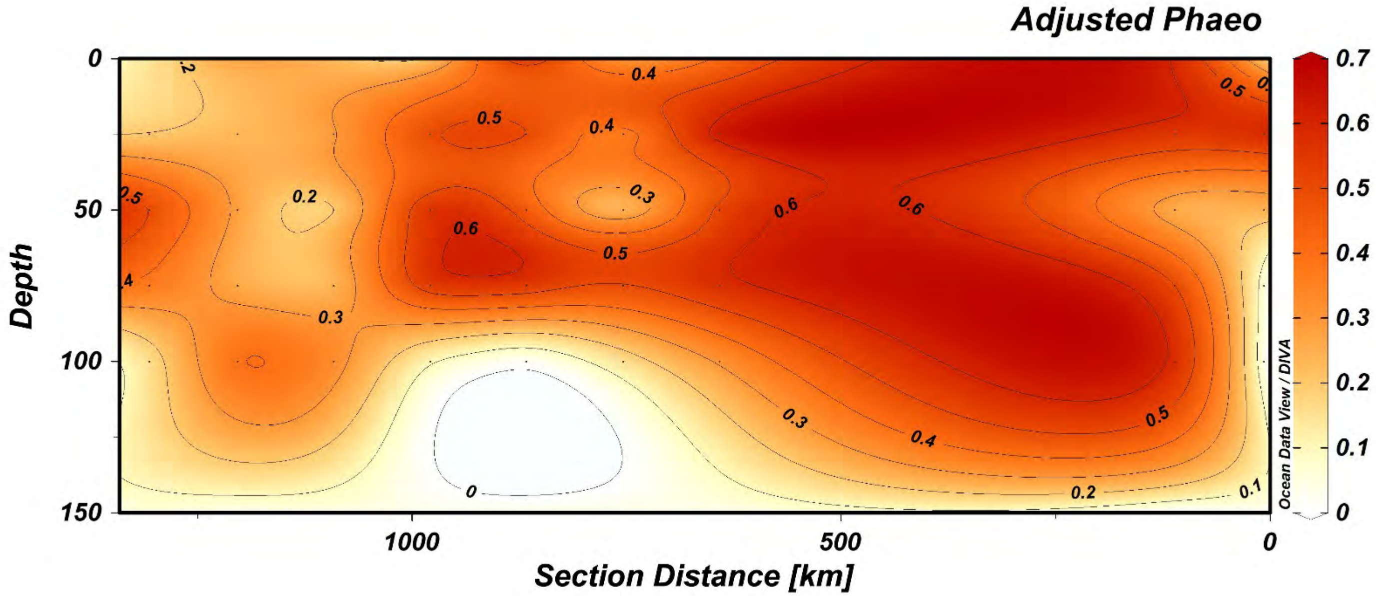
Phytoplankton biomass (mg Chl-a.m^{-2})

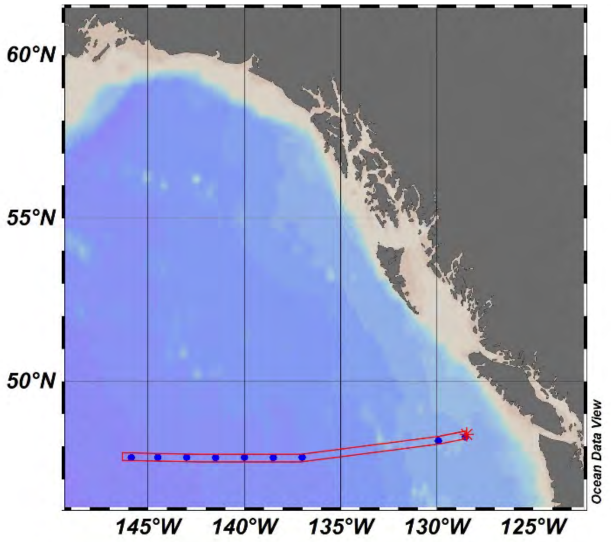




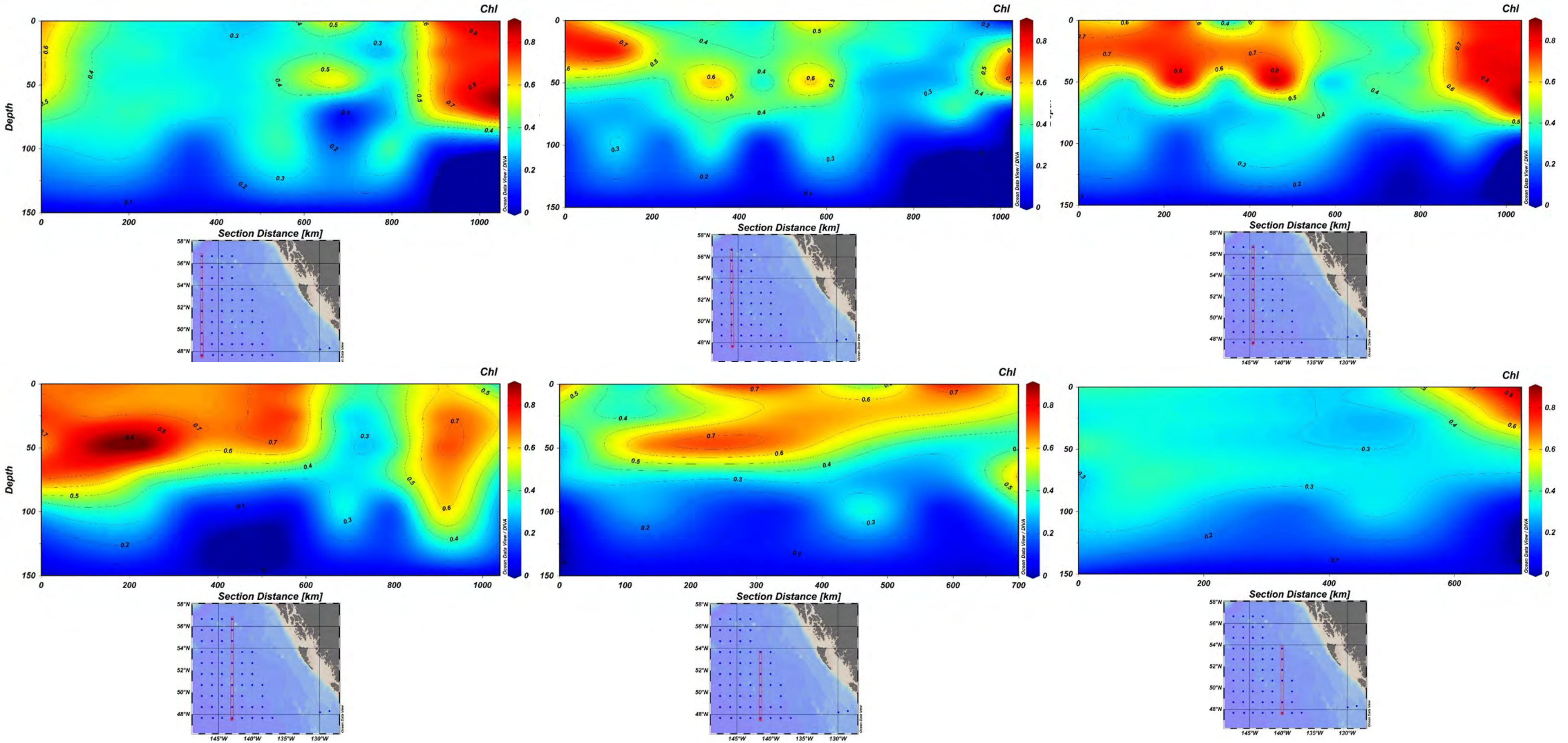
Chlorophyll – a distribution



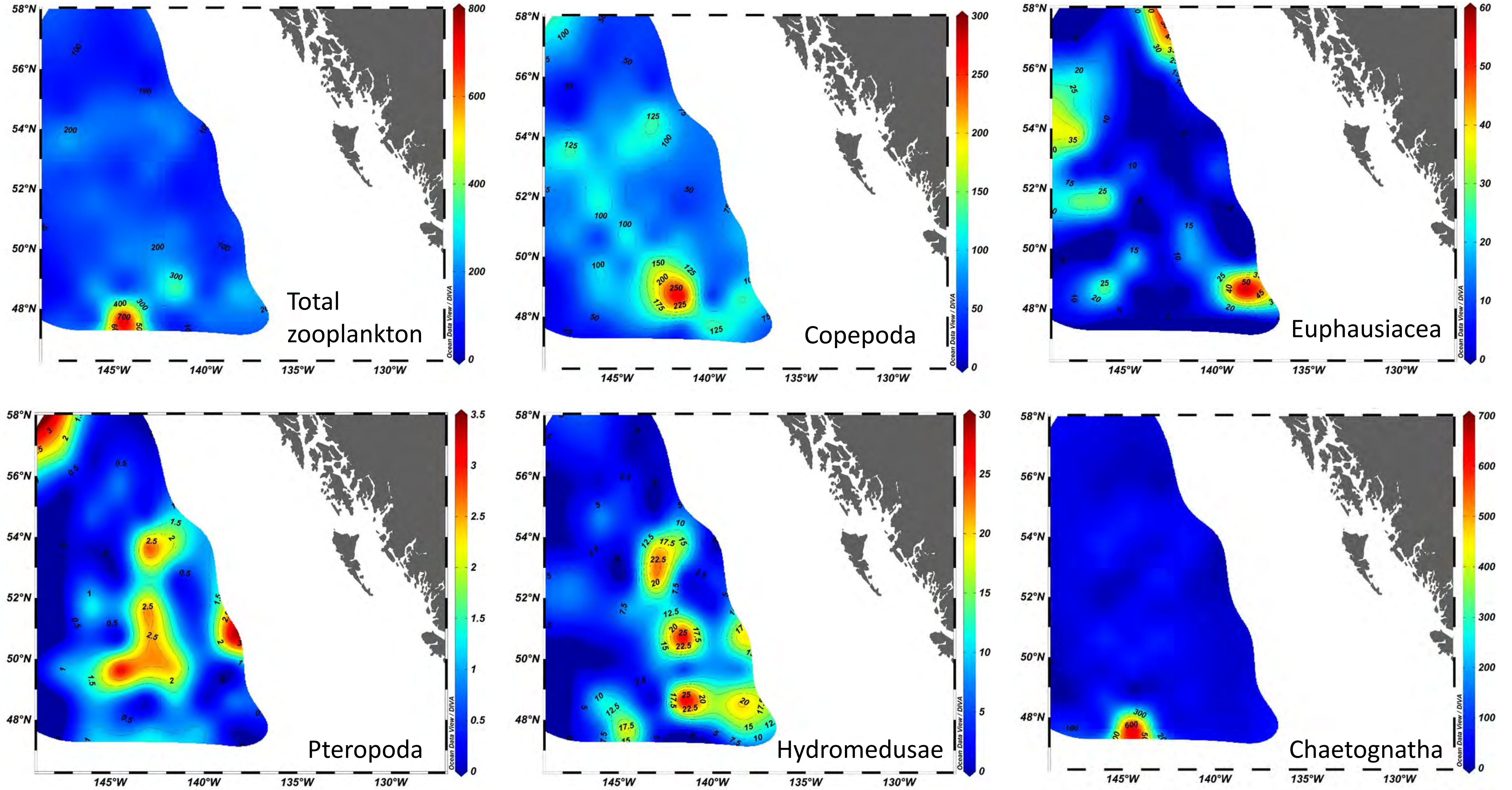




Vertical distribution of Chlorophyll - a

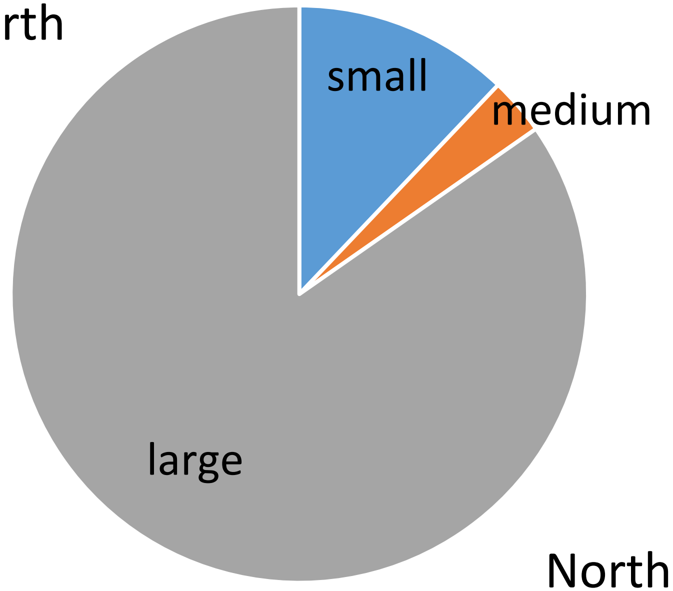


Zooplankton biomass (mgWW.m^{-3}), 0-200 m, Juday net)

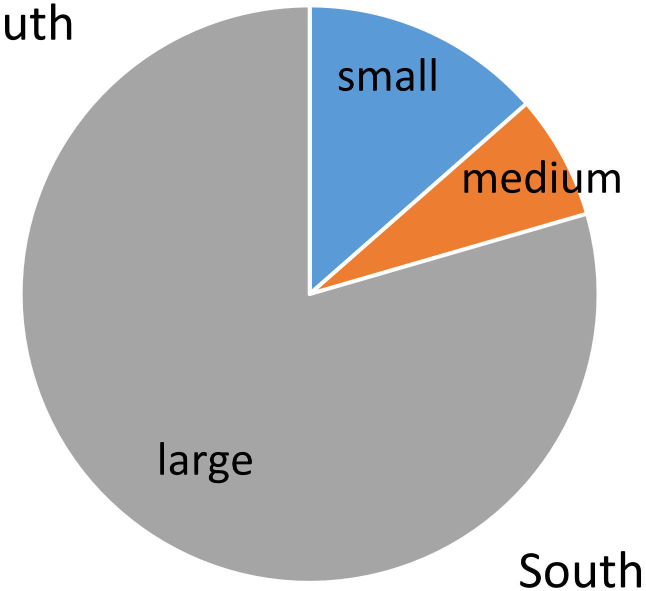


Juday net, 0-200 m, Biomass, mgWW.m^{-3}

North



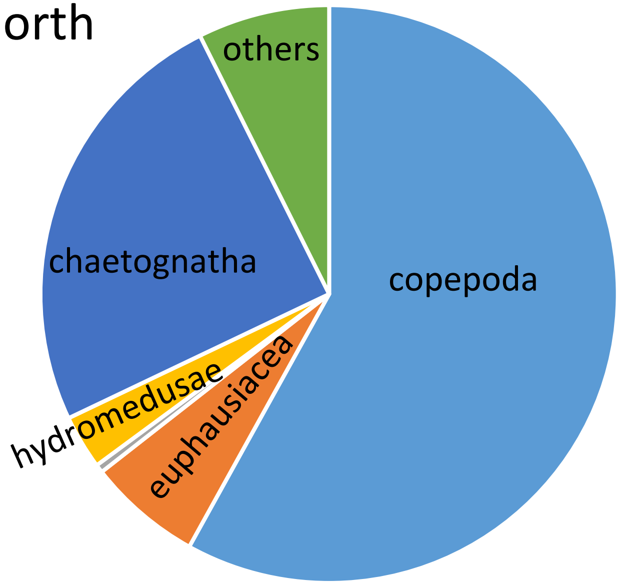
South



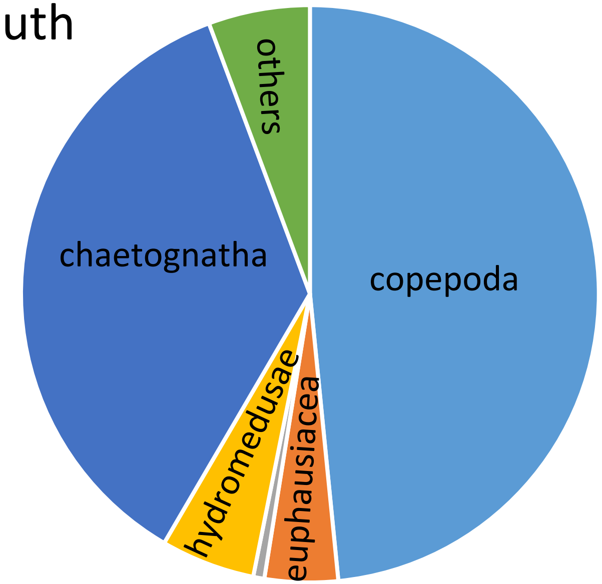
Total biomass
187 ± 135 mgWW.m^{-3}

Total abundance
1602 ± 452 ind.m^{-3}
Copepods 88 ± 8 %

North



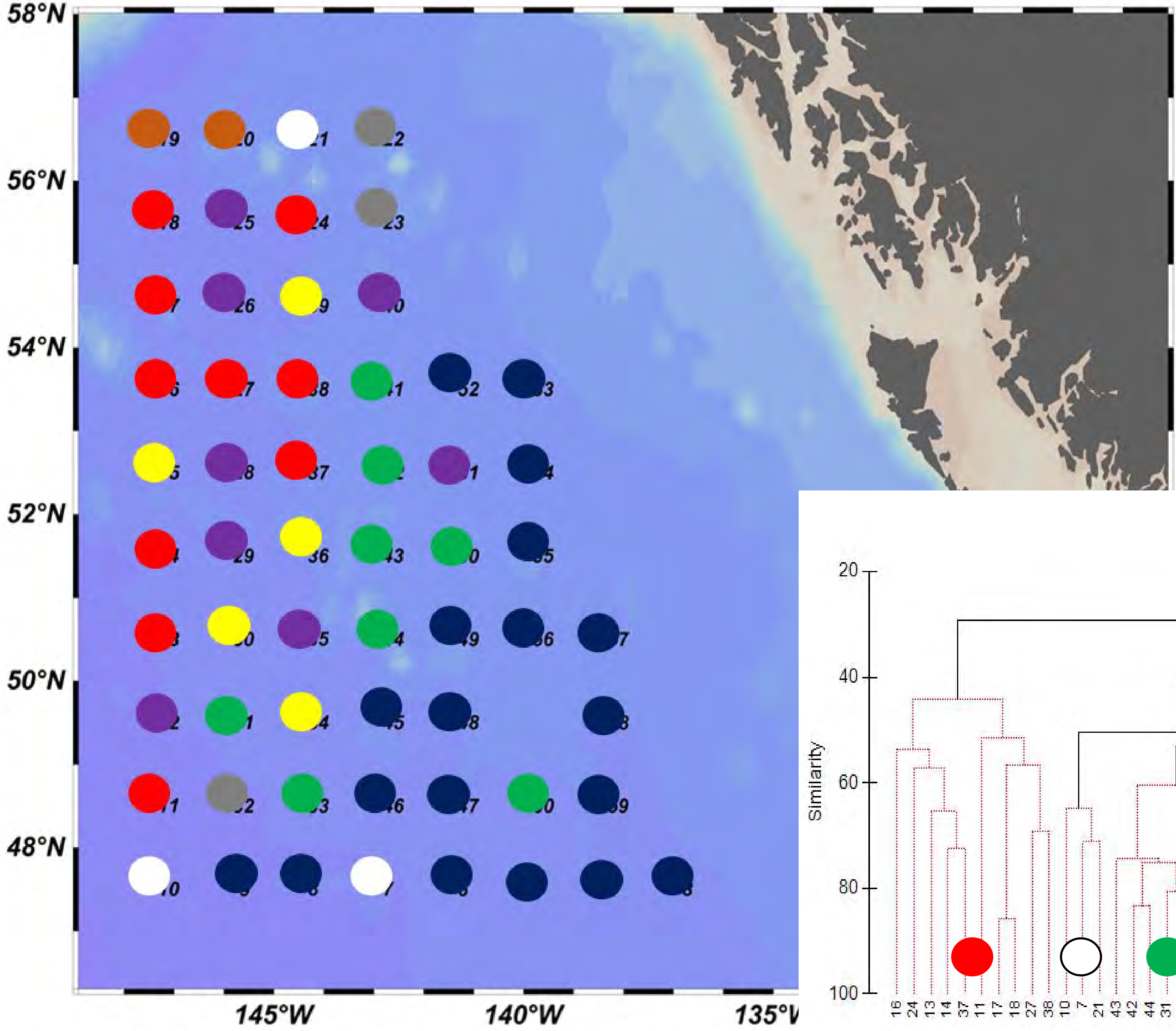
South

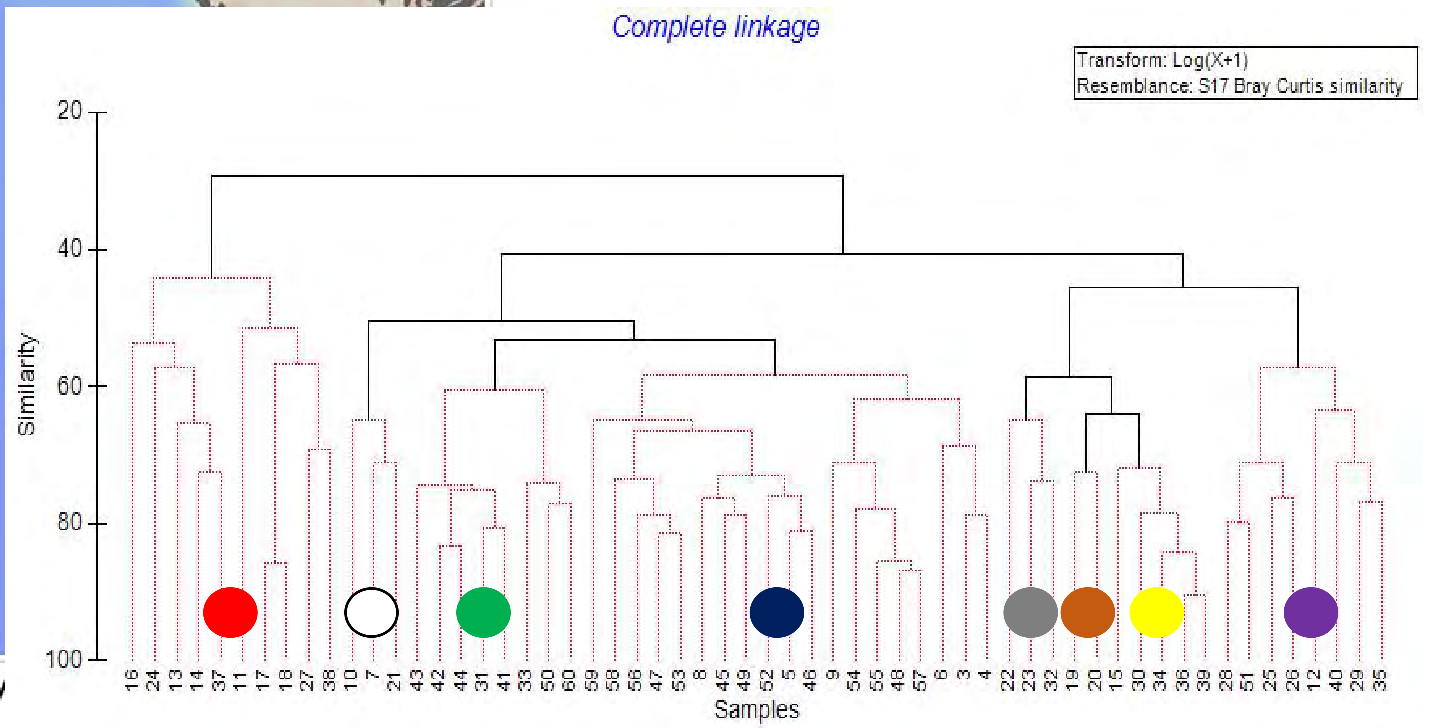


Total biomass
128 ± 47 mgWW.m^{-3}

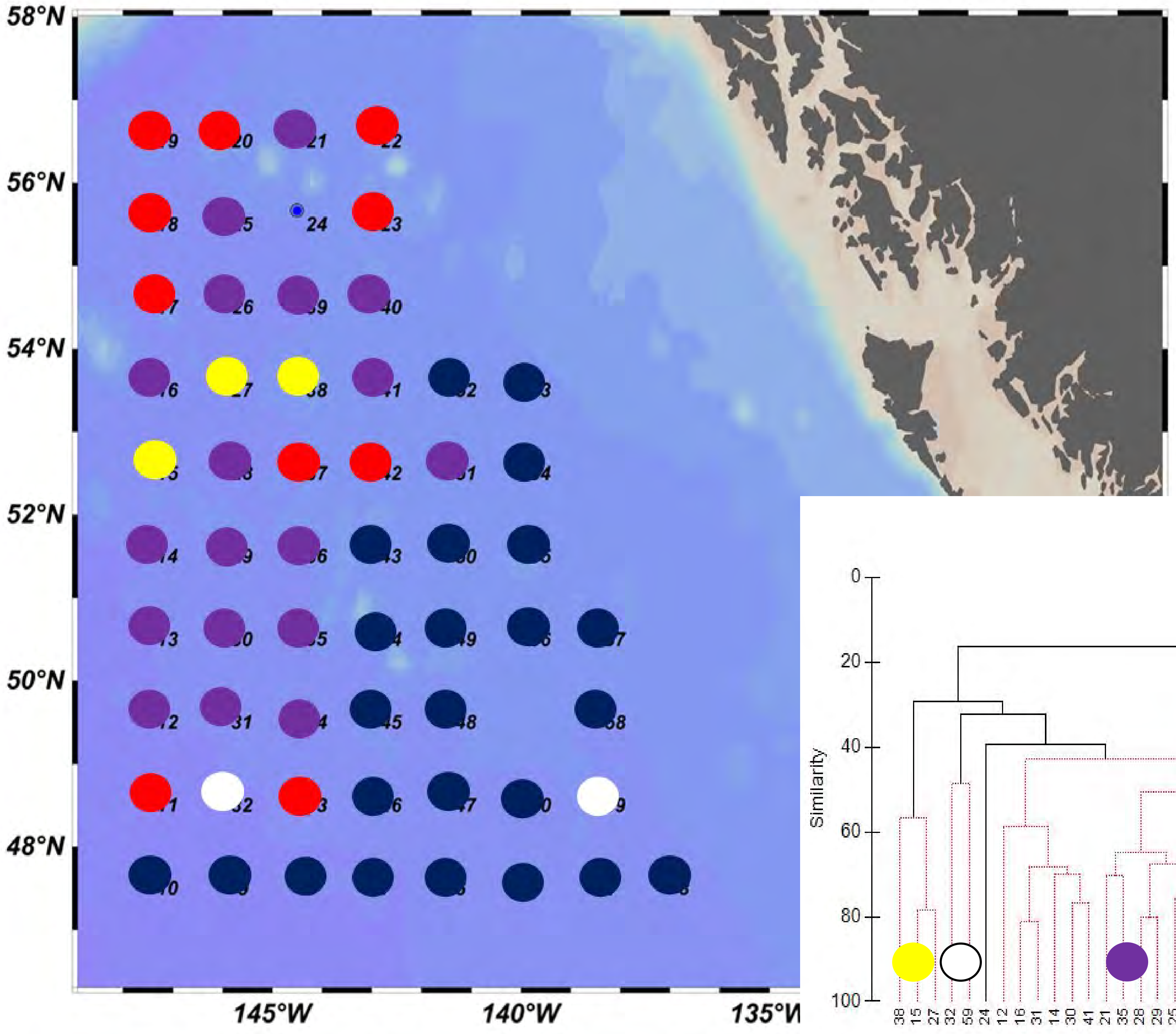
Total abundance
1007 ± 512 ind.m^{-3}
Copepods 93 ± 5 %

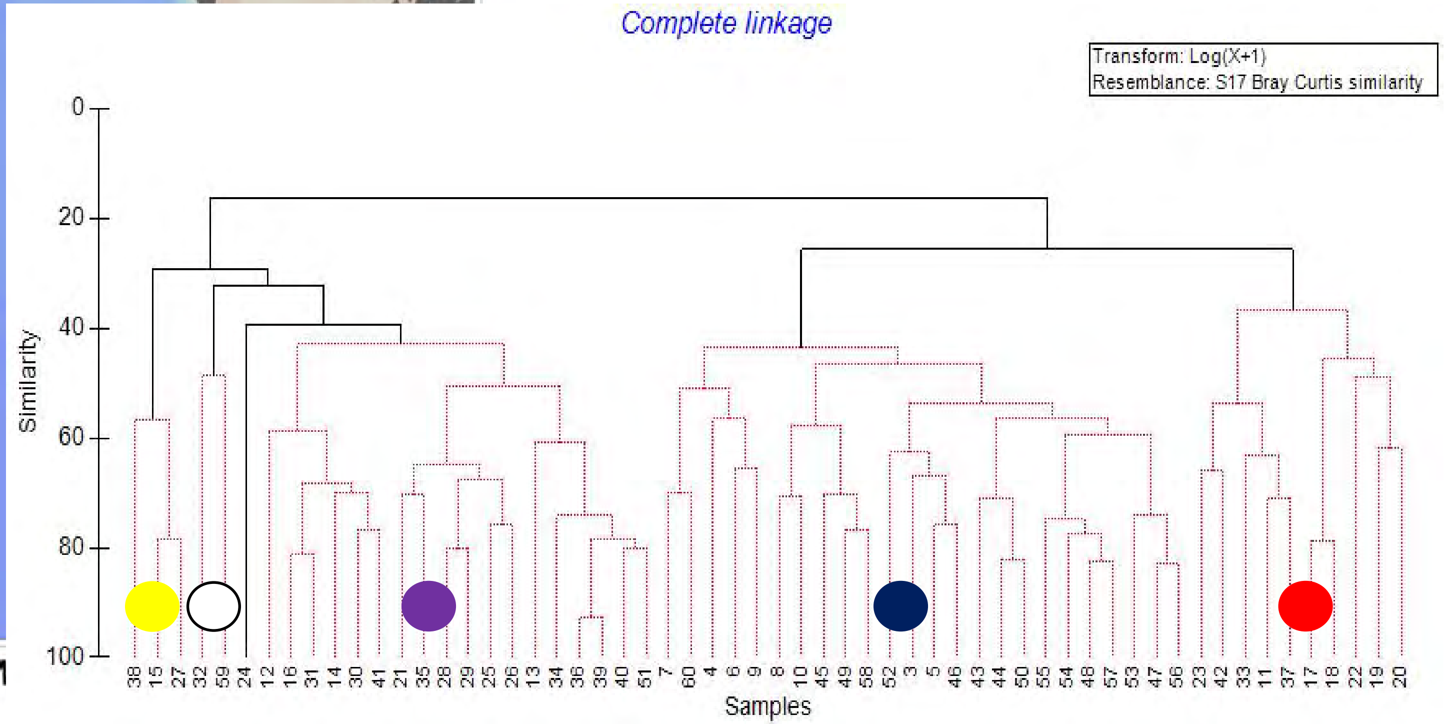
Distribution of zooplankton assemblages, all species, Juday net, 0-50 m

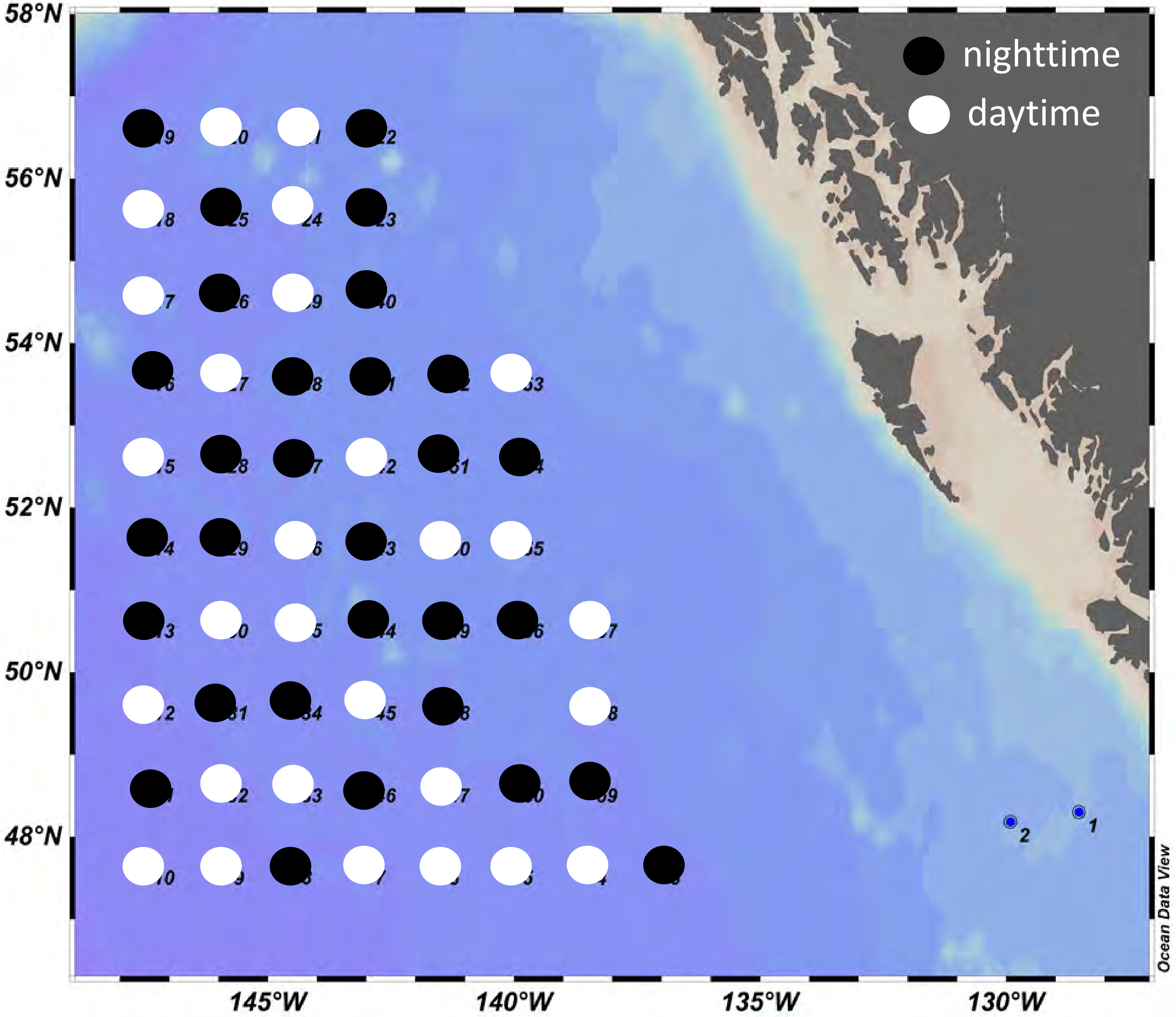




Distribution of zooplankton assemblages, larger species, Juday net, 0-50 m



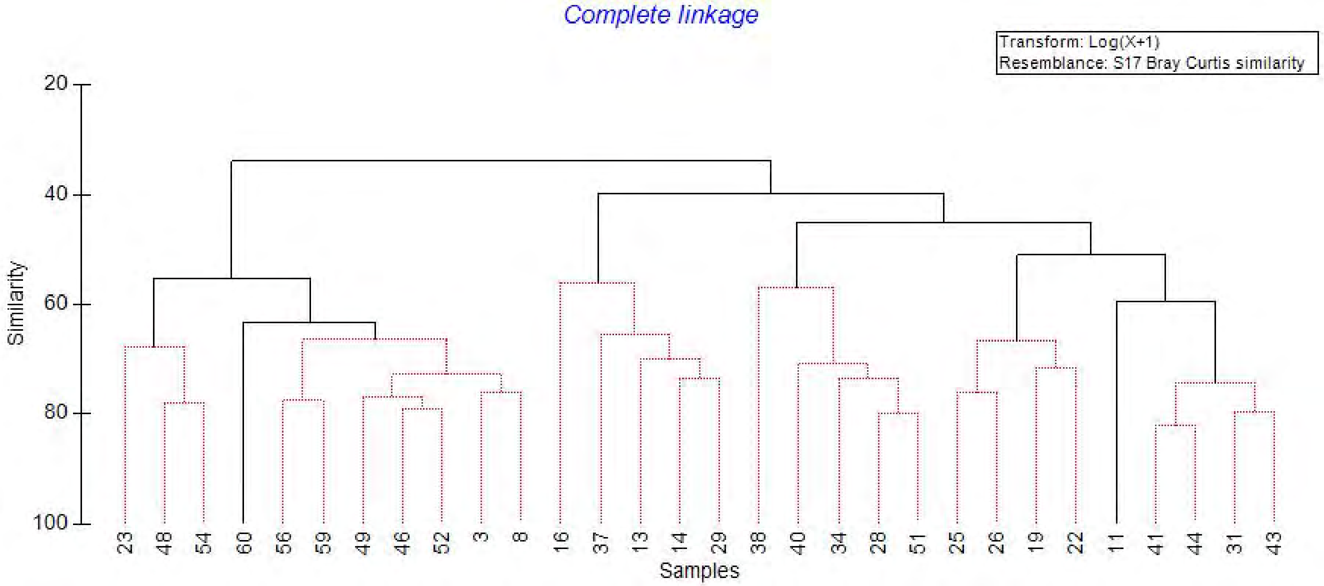




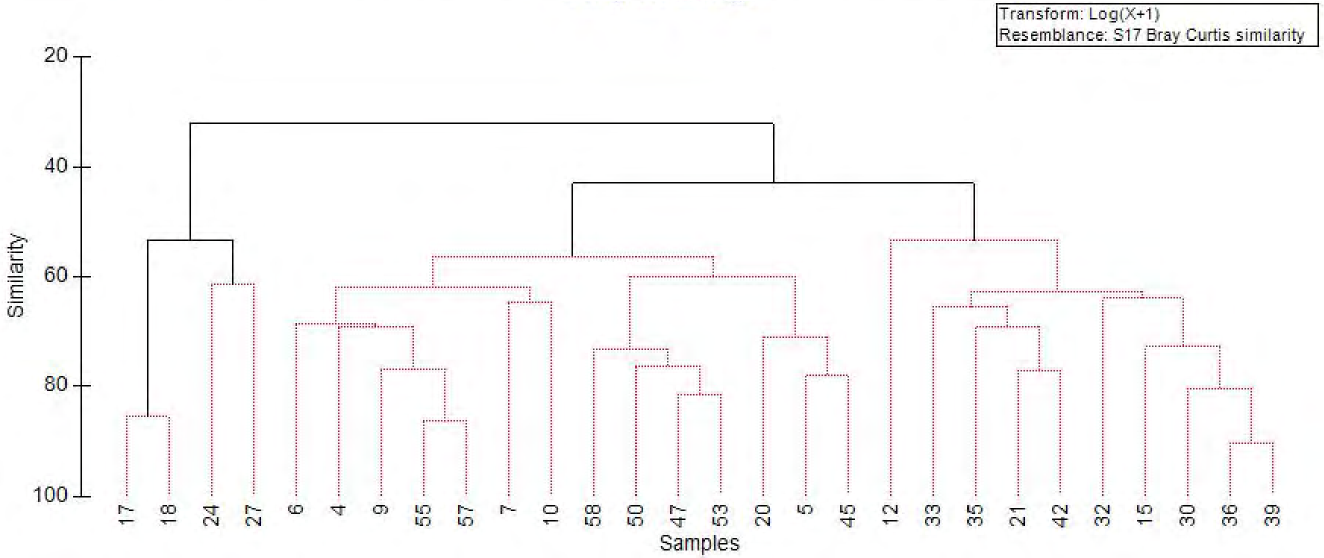
58°N
56°N
54°N
52°N
50°N
48°N
145°W
140°W
135°W
130°W
nighttime
daytime
Ocean Data View

Juday net, 0-50 m

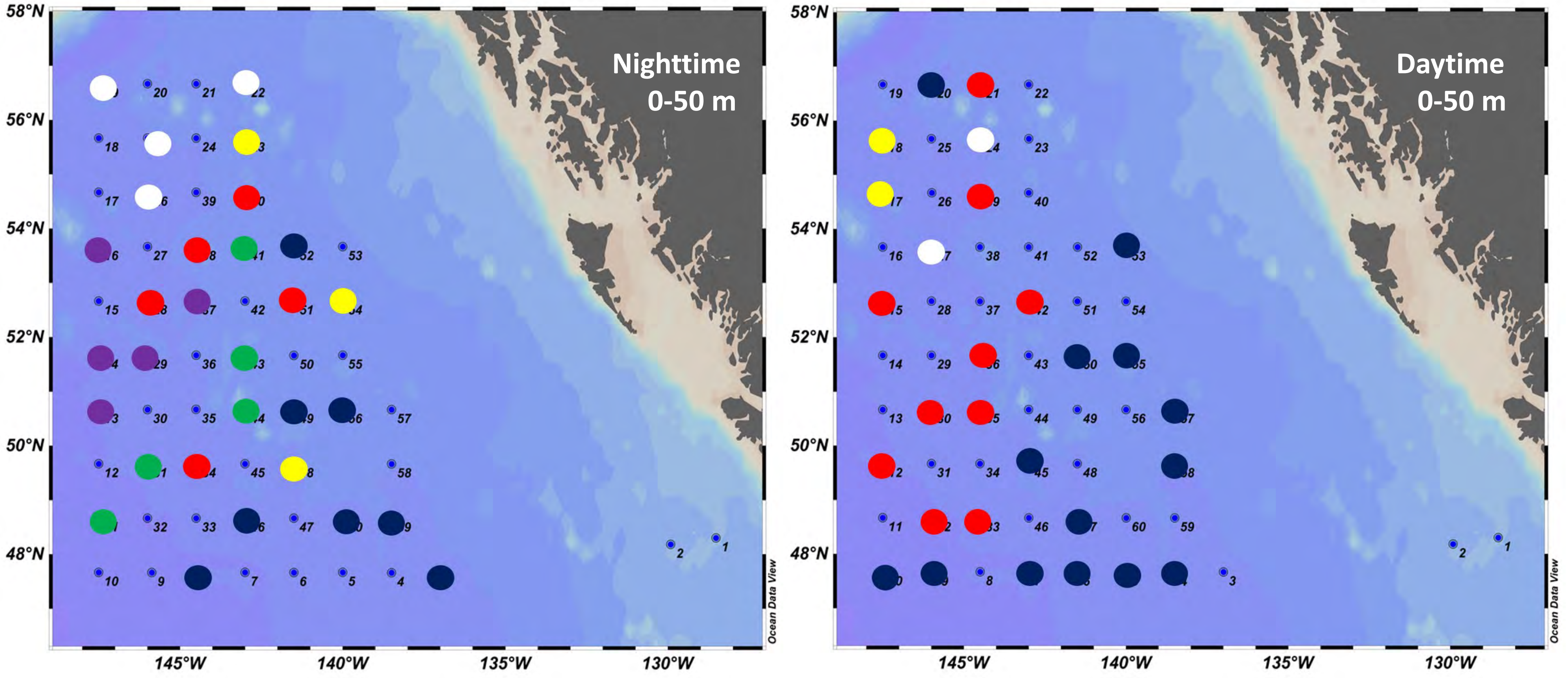
Nighttime



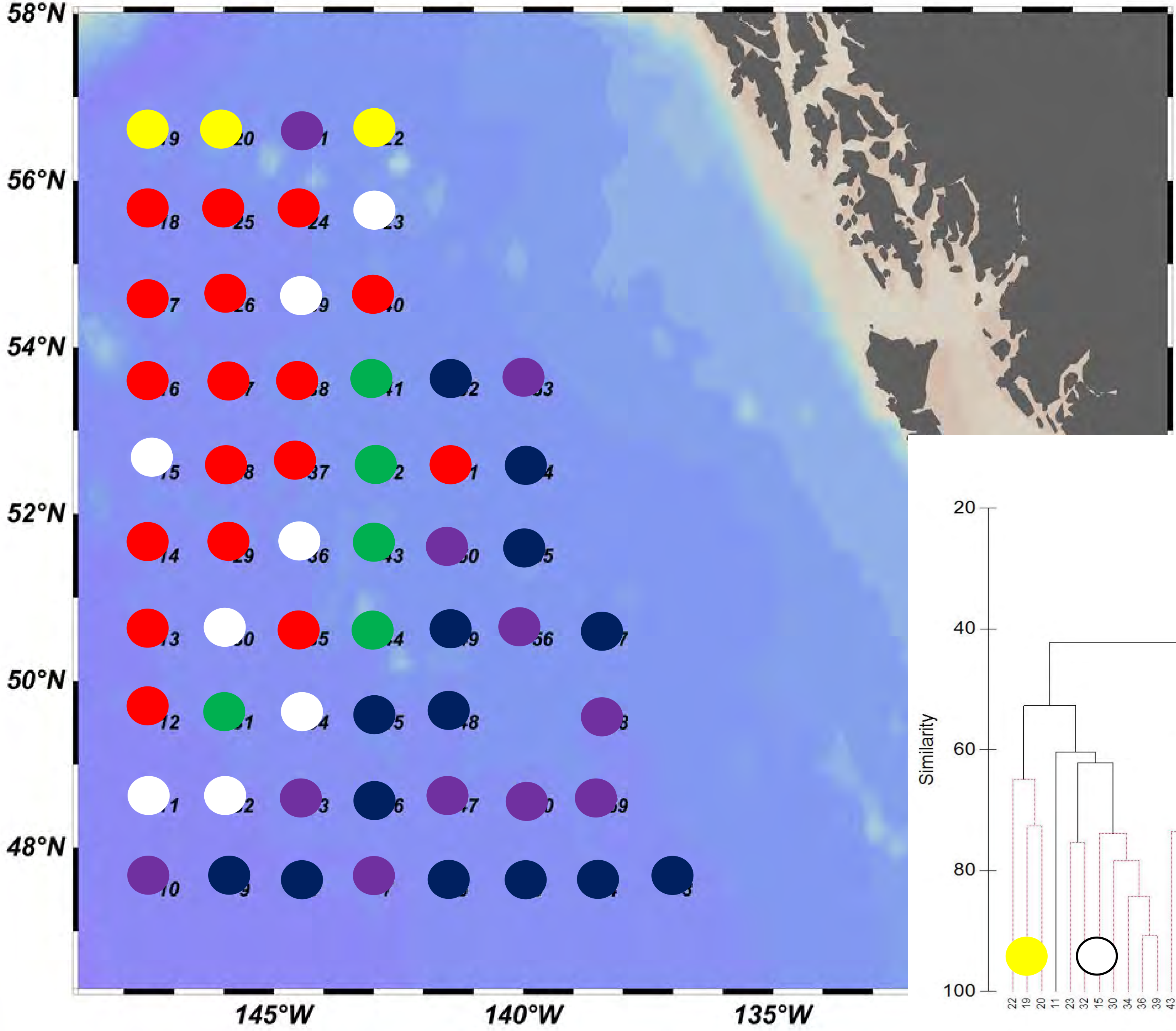
Daytime

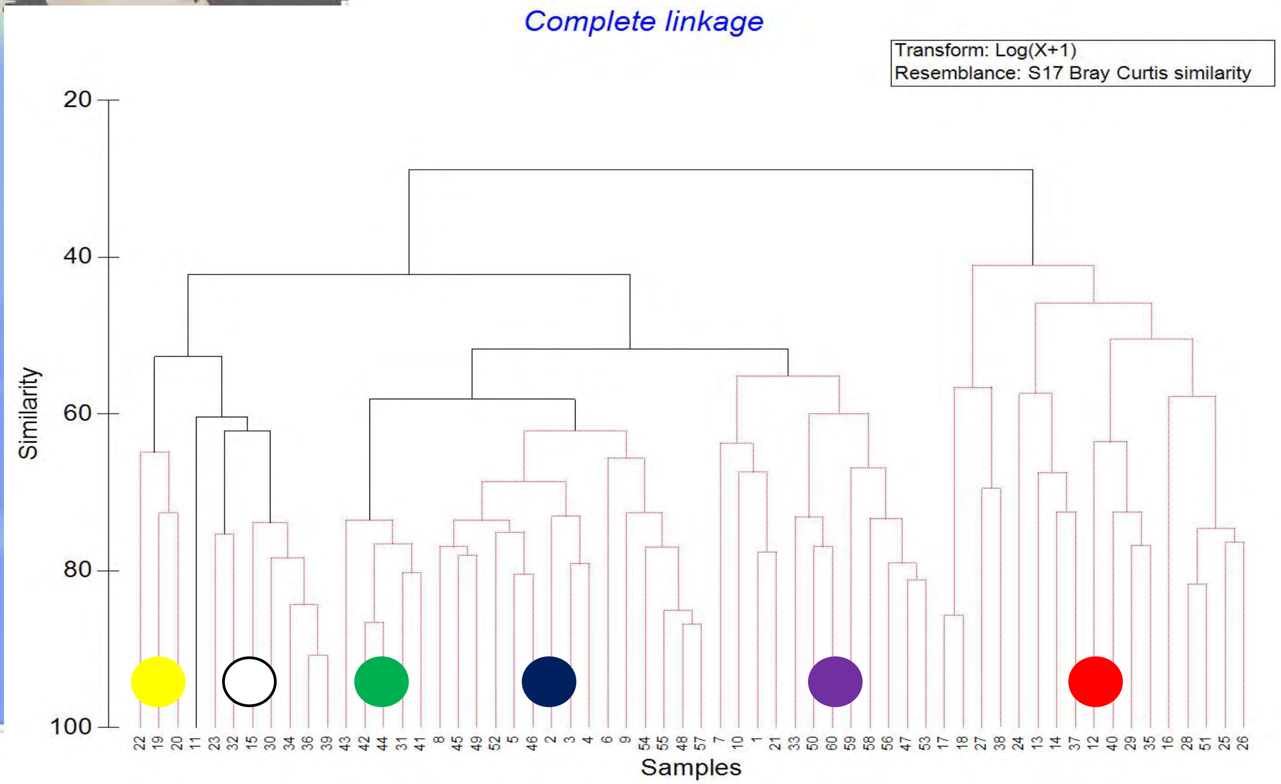


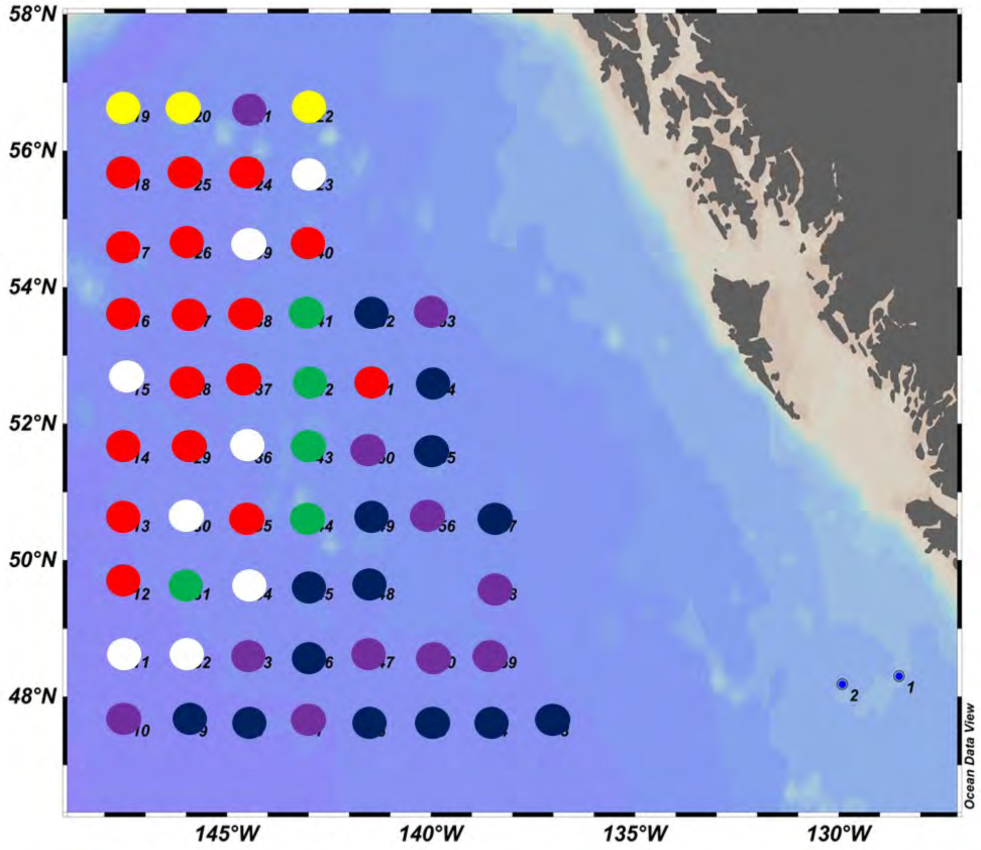
Distribution of zooplankton assemblages, Juday net, 0-50 m



Distribution of zooplankton assemblages Juday net, 0-200 m







Abundance, 0-200 m, ind.m^{-3}	% *Oithona similis*
1799 ± 421	34
1299 ± 415 (*Globigerina bulloides*)	40
787 ± 396 (*Frittilaria borealis, L. helicina*)	70
1608 ± 365	63
1115 ± 499	67
889 ± 230	56

Species accounting for >80% of cluster abundance

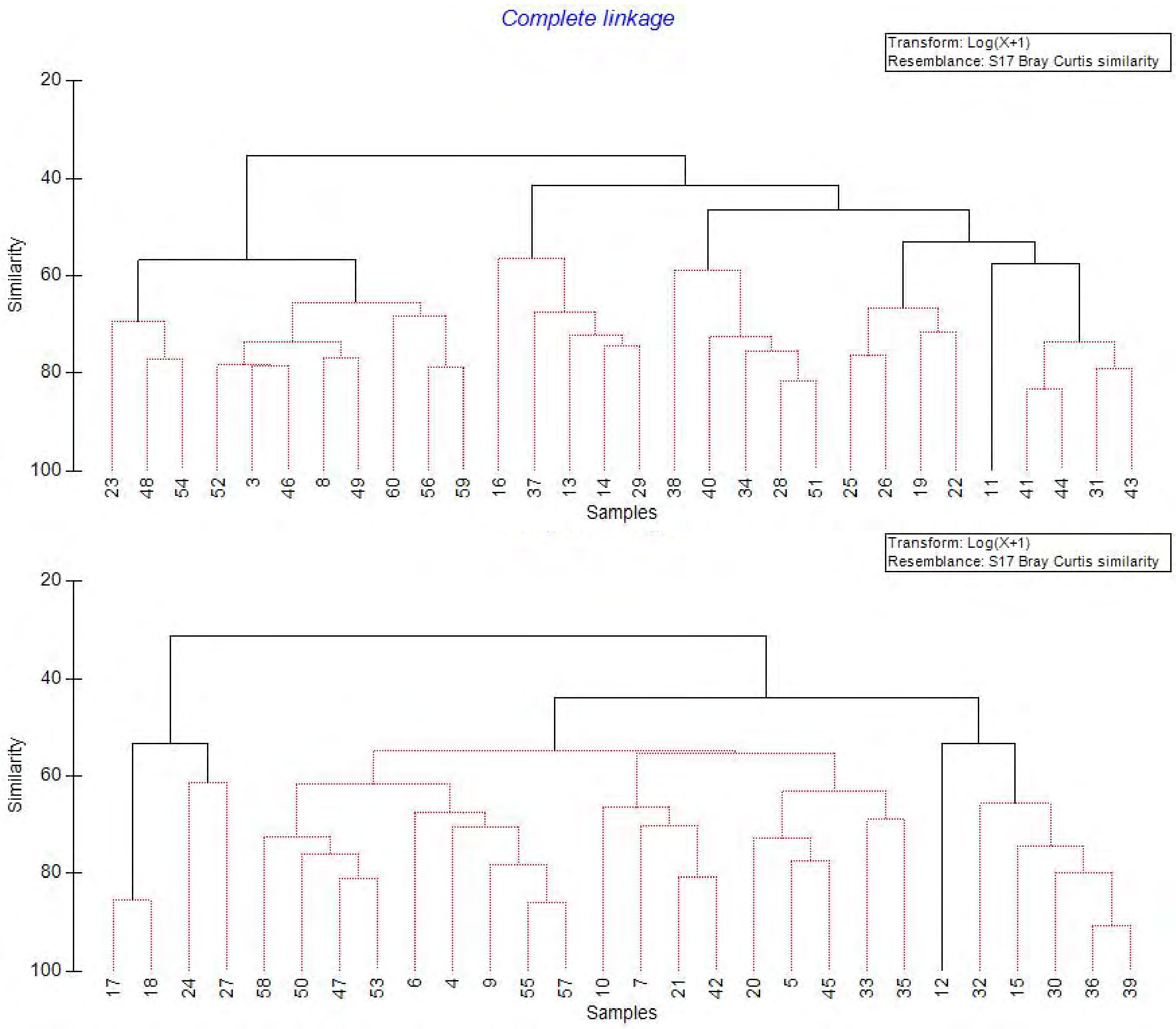
Oithona similis, Copepoda nauplia + copepodites, *Pseudocalanus newmani, Metridia pacifica, Neocalanus* copepodites

Oithona similis, Copepoda nauplia + copepodites, *Microcalanus pygmaeus, Neocalanus* copepodites

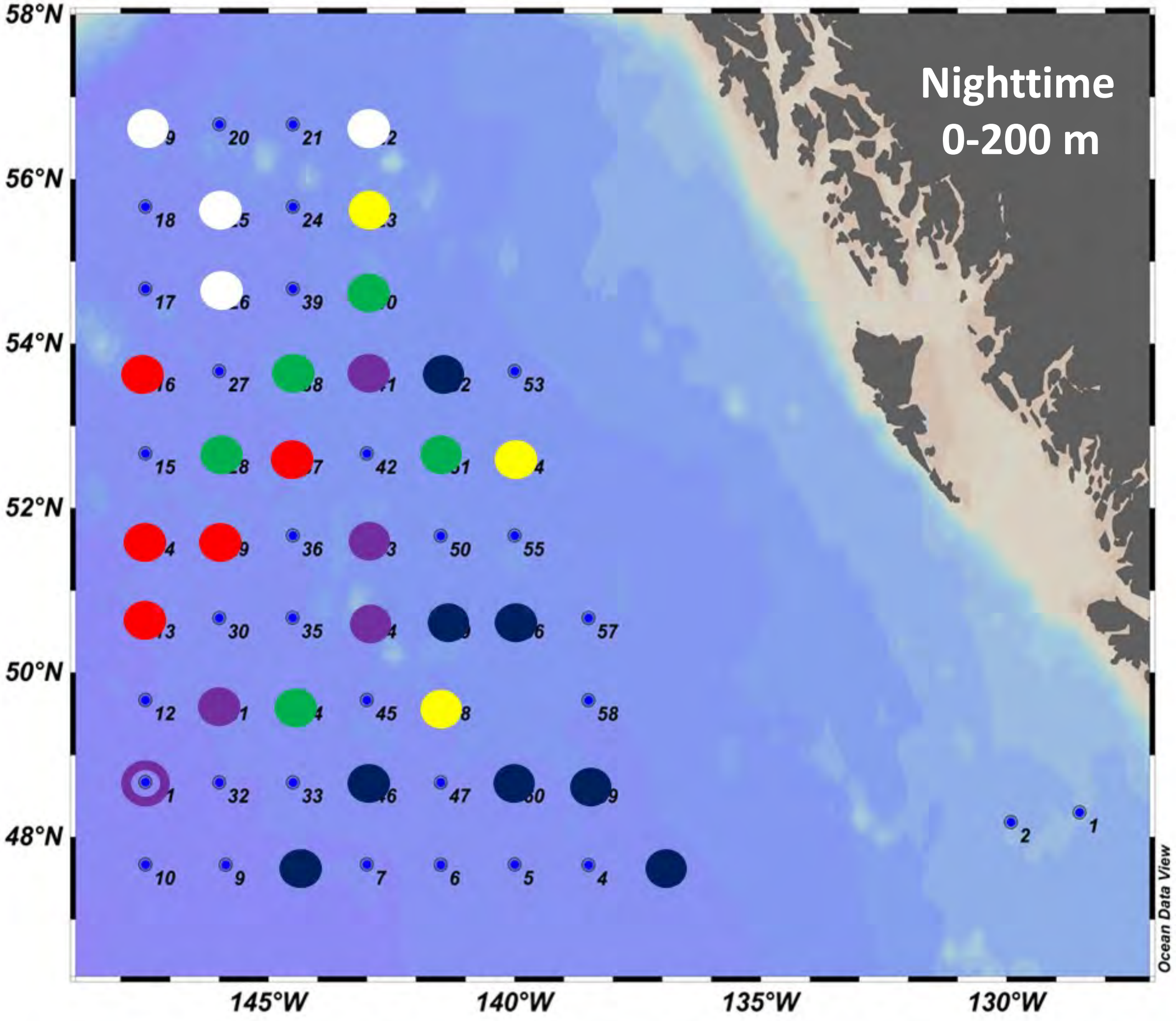
Juday net, 0-200 m

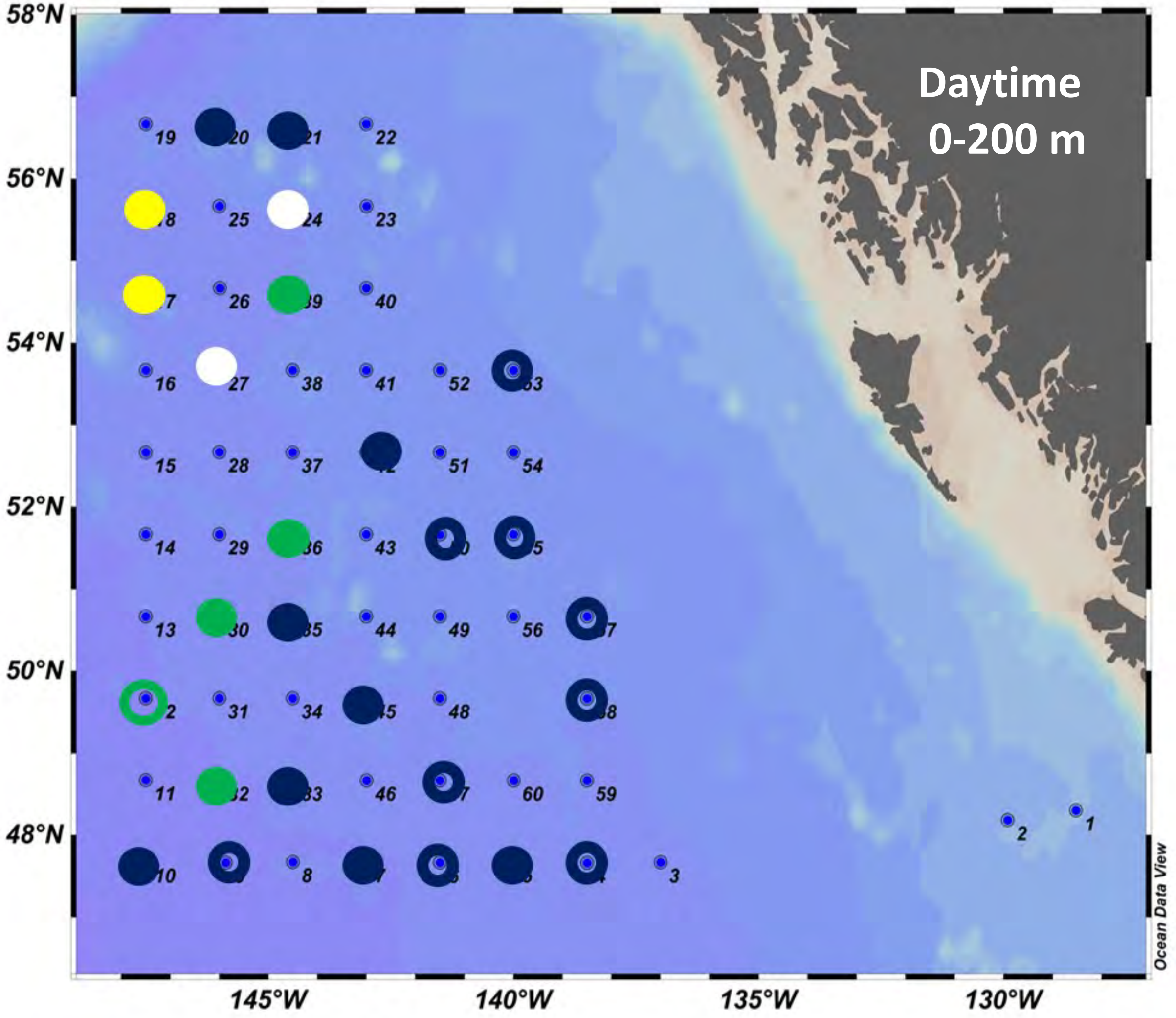
Nighttime

Daytime

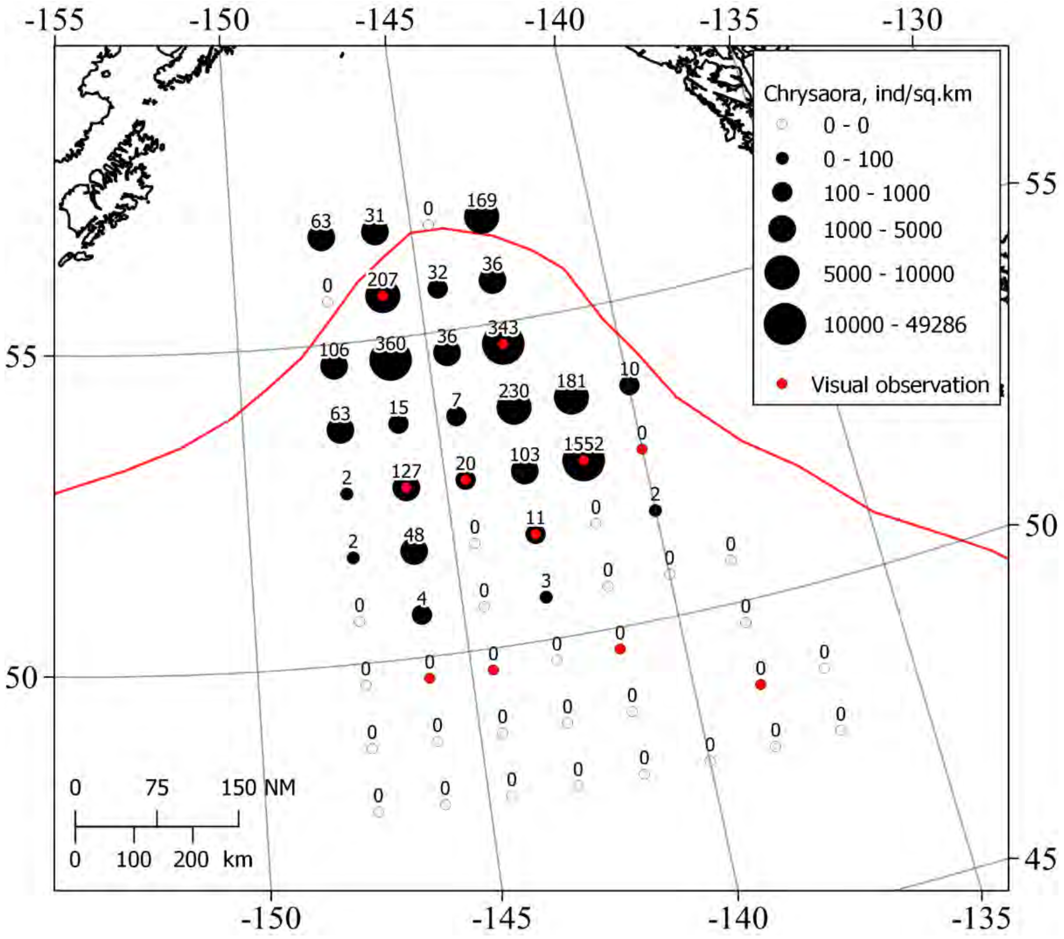


Distribution of zooplankton assemblages, Juday net, 0-200 m

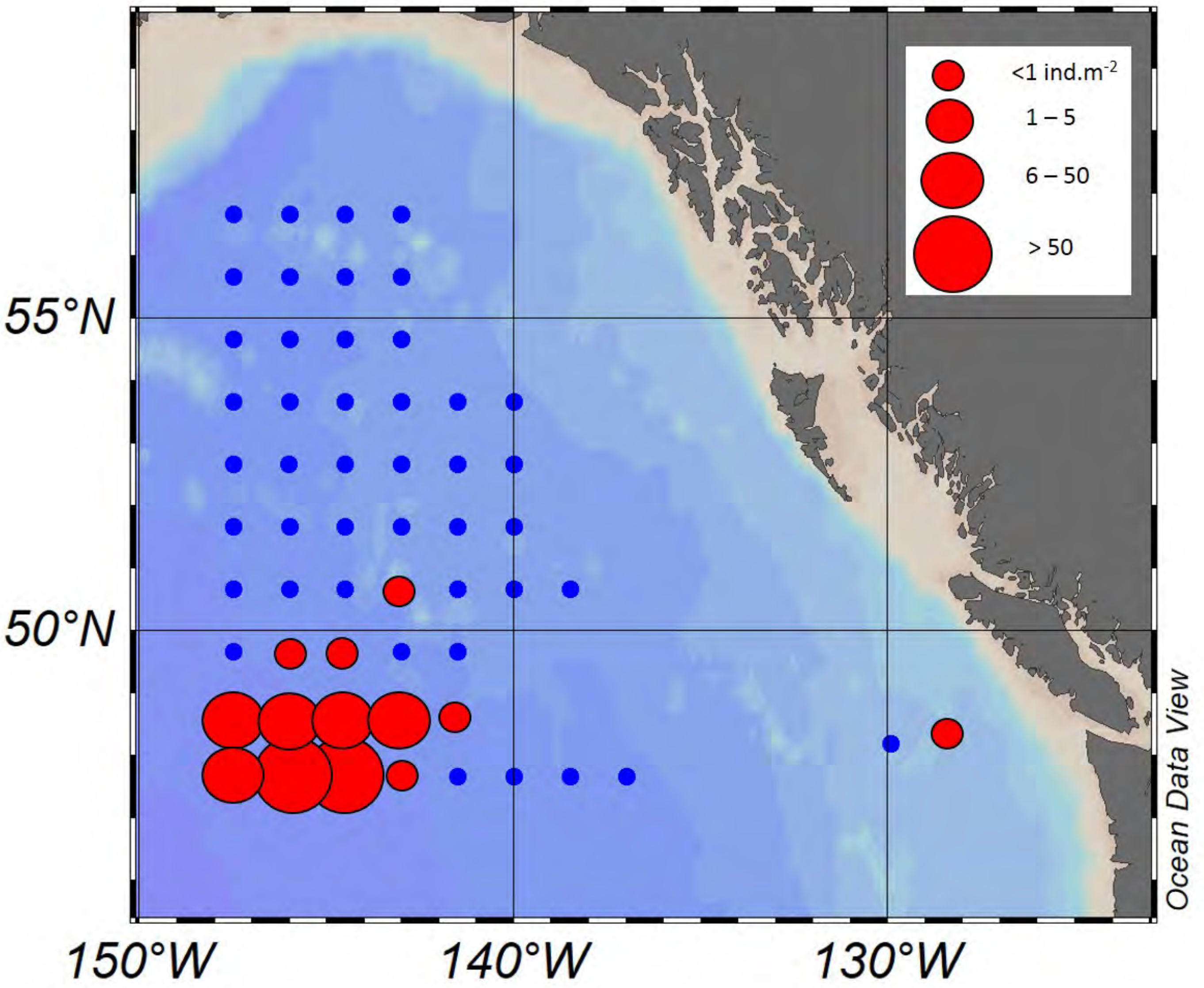




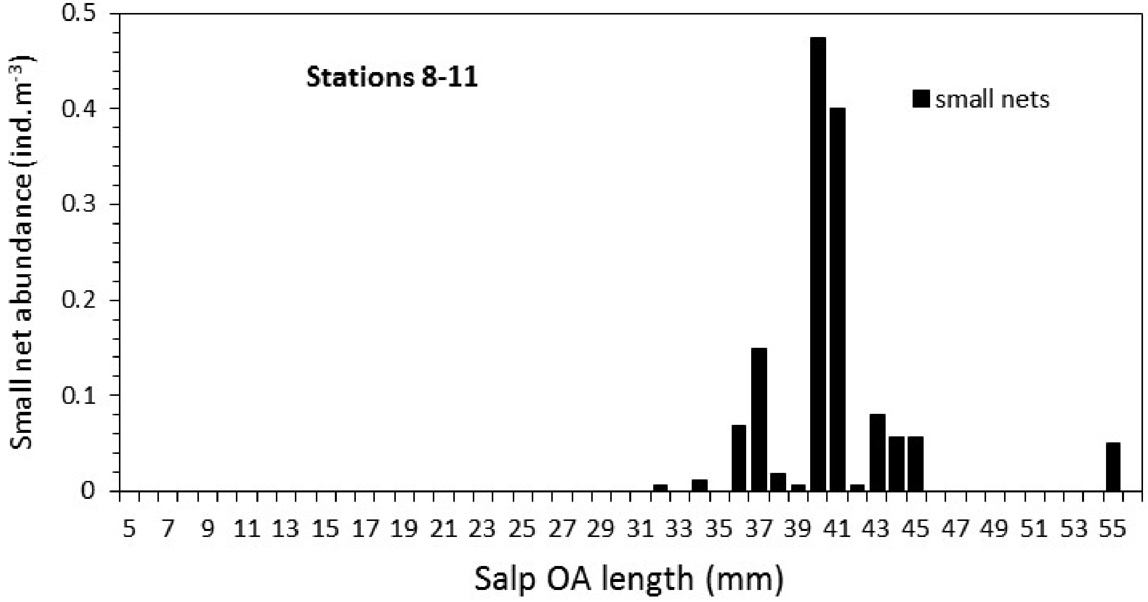
Chrysaora spp. distribution

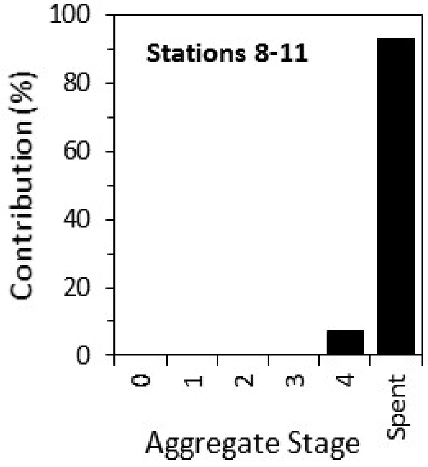


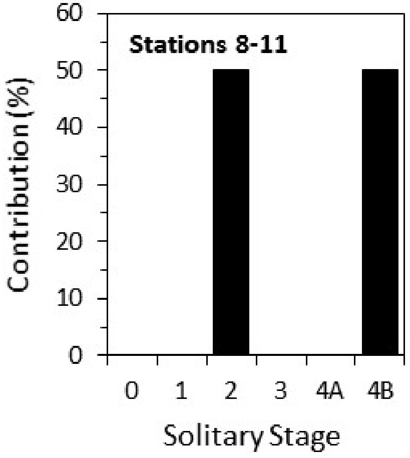
Salpa aspera distribution

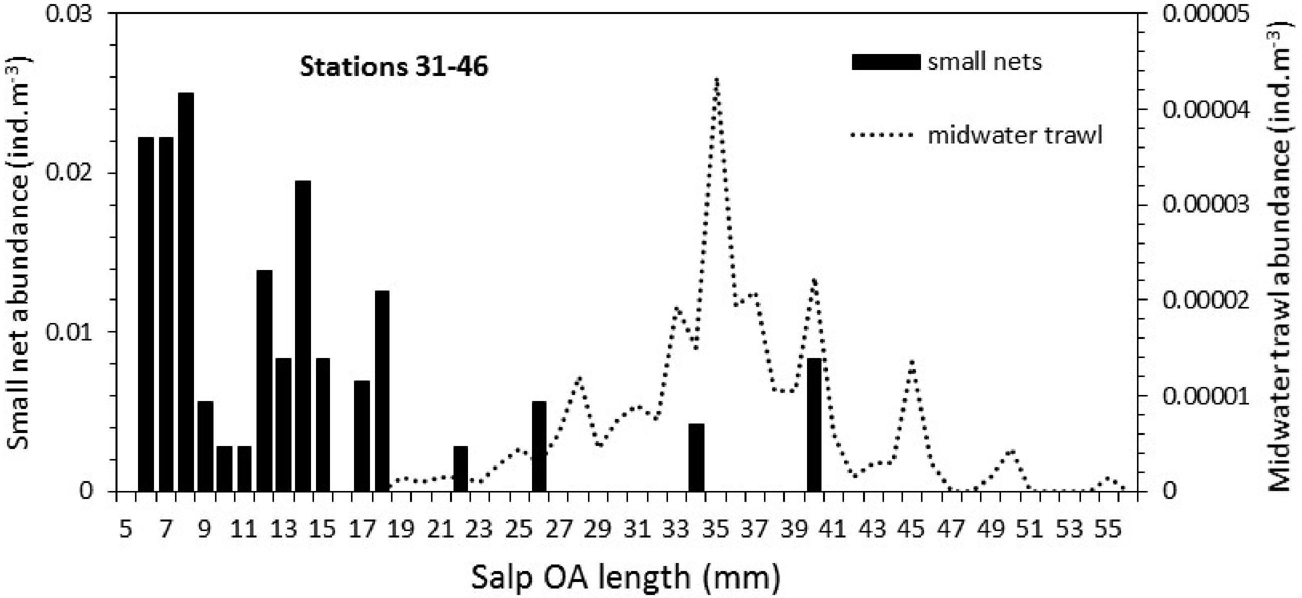


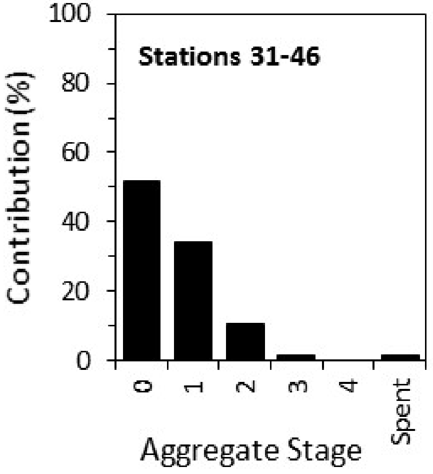
Salpa aspera biology

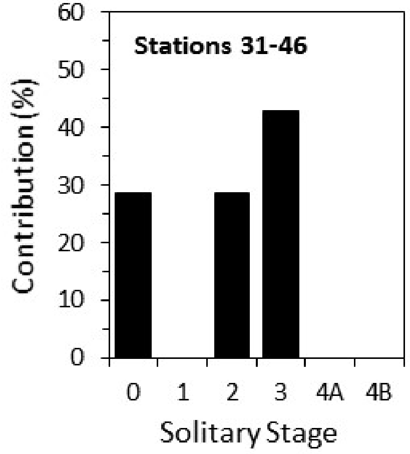












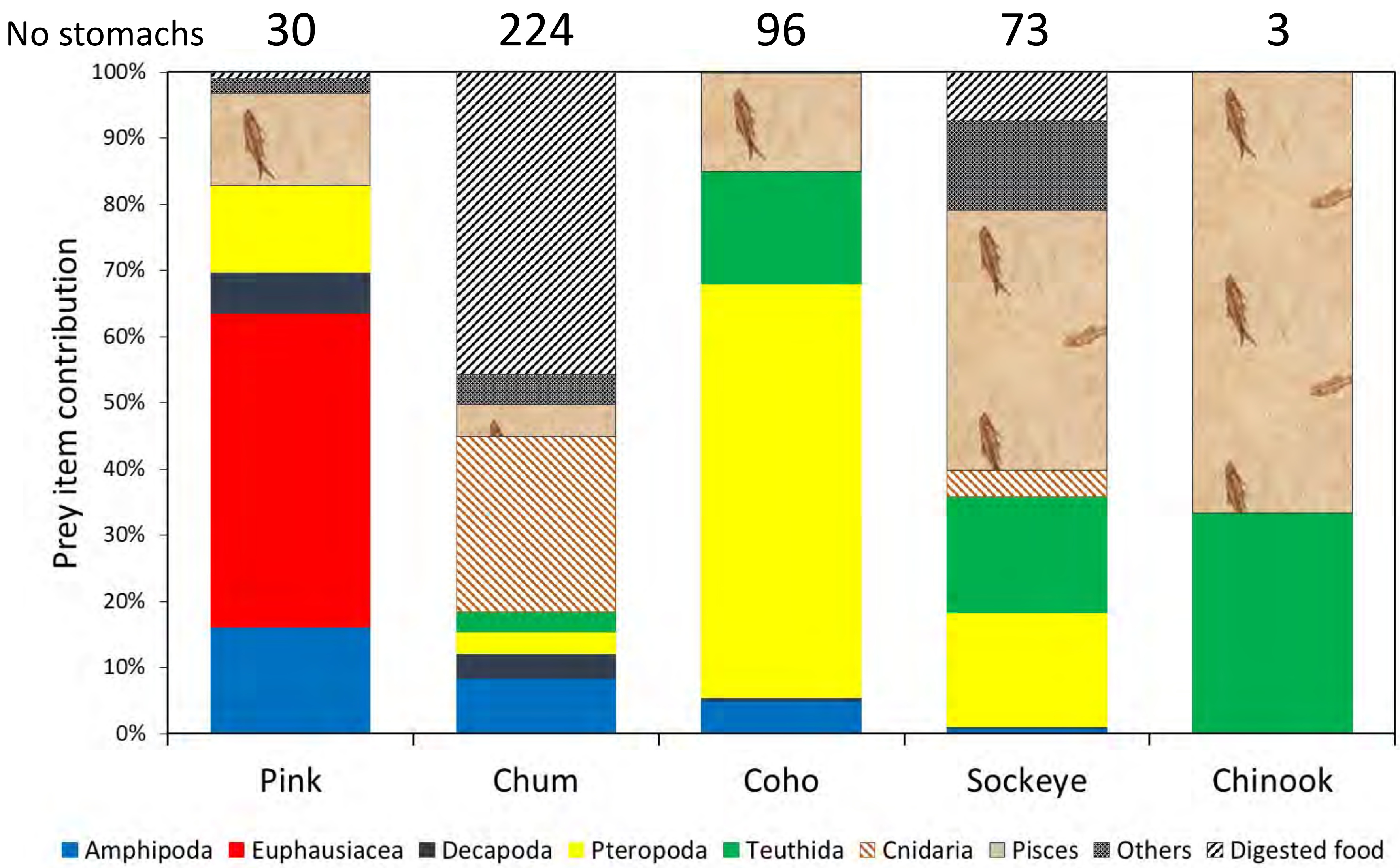
Salmon diets

Pteropod - *Clio pyramidata*
10-15mm

Coho stomach contents

Krill – *Euphausia pacifica*
20-30mm

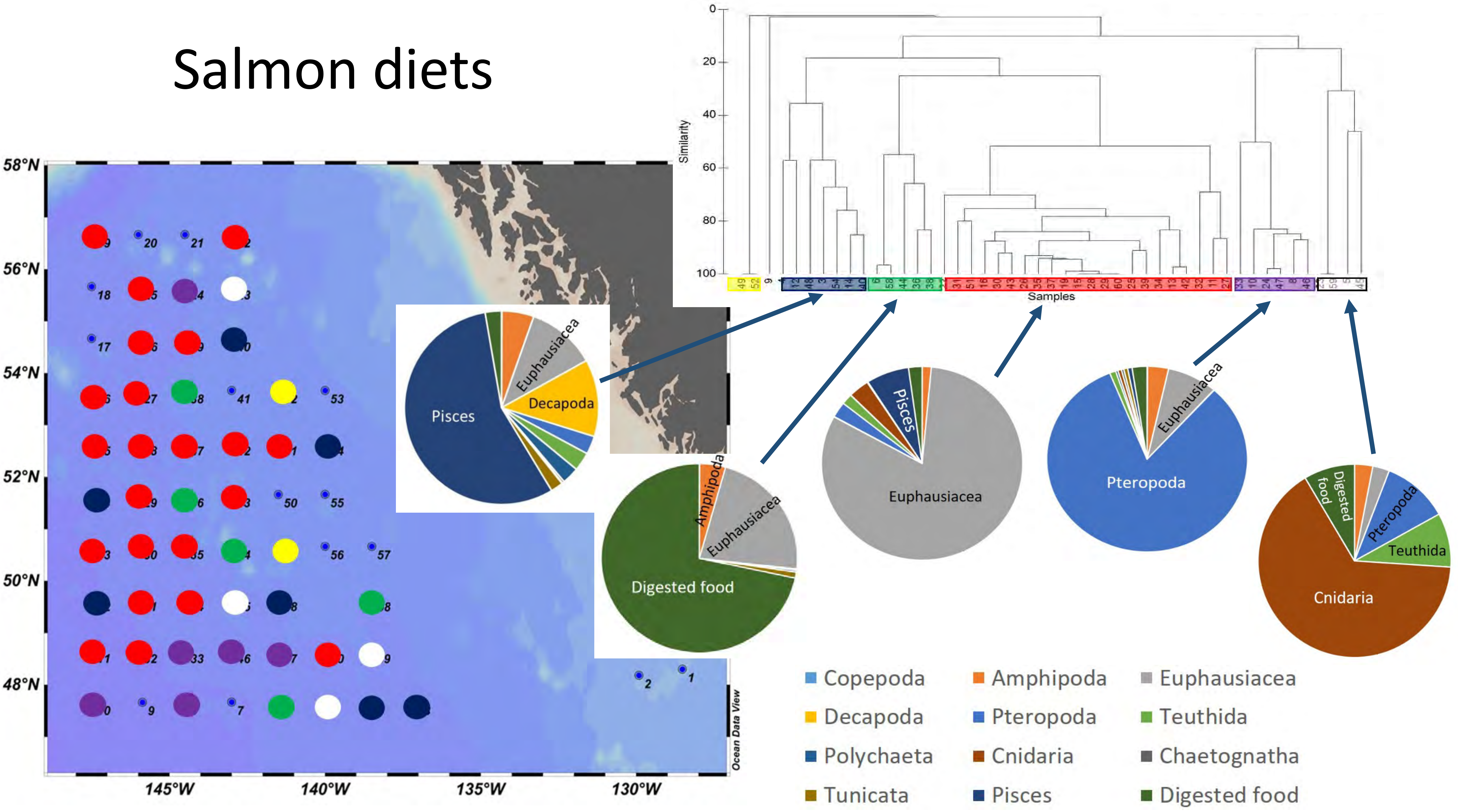
Major prey taxa by salmon species

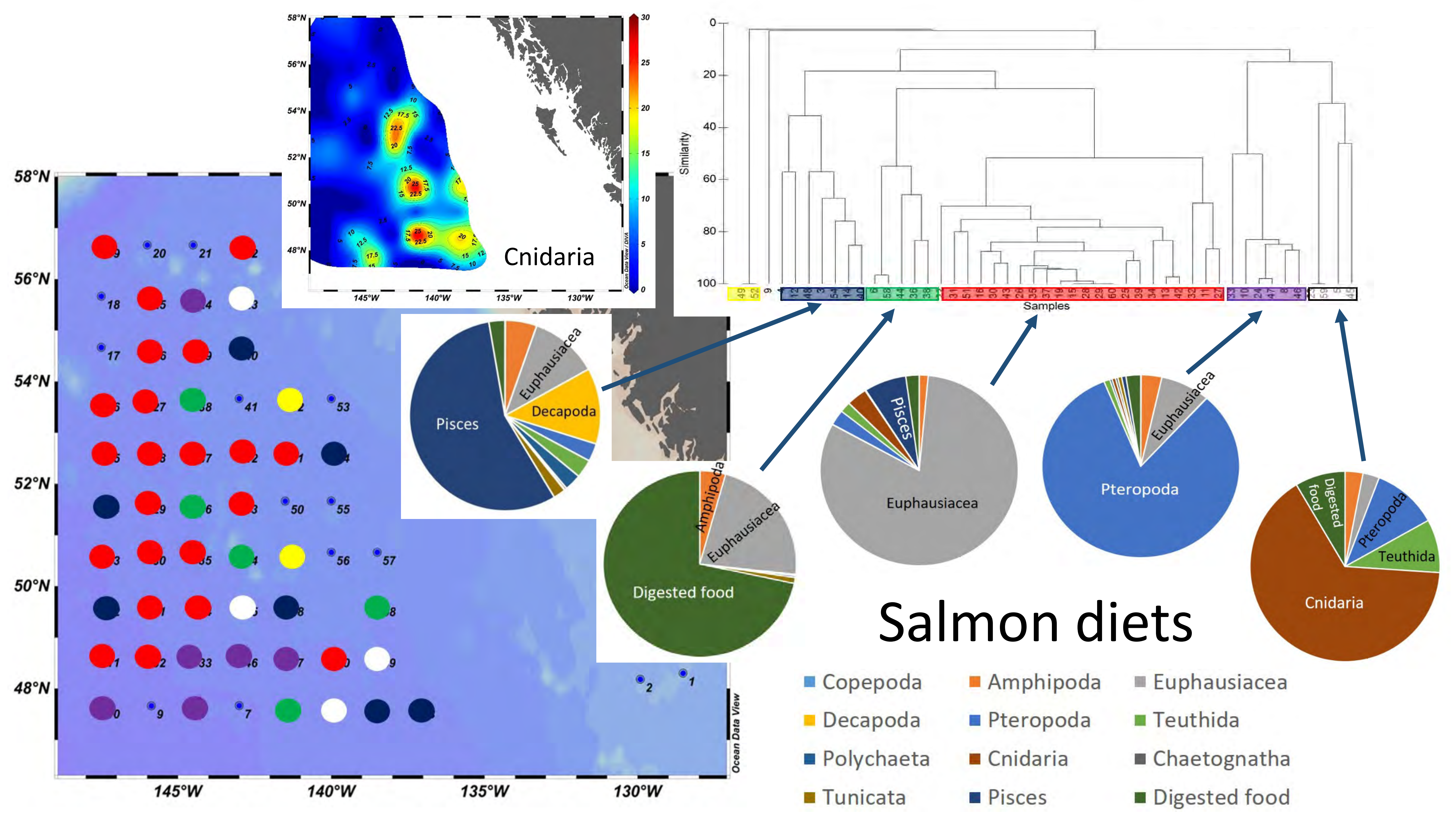


Feeding intensity of salmon species

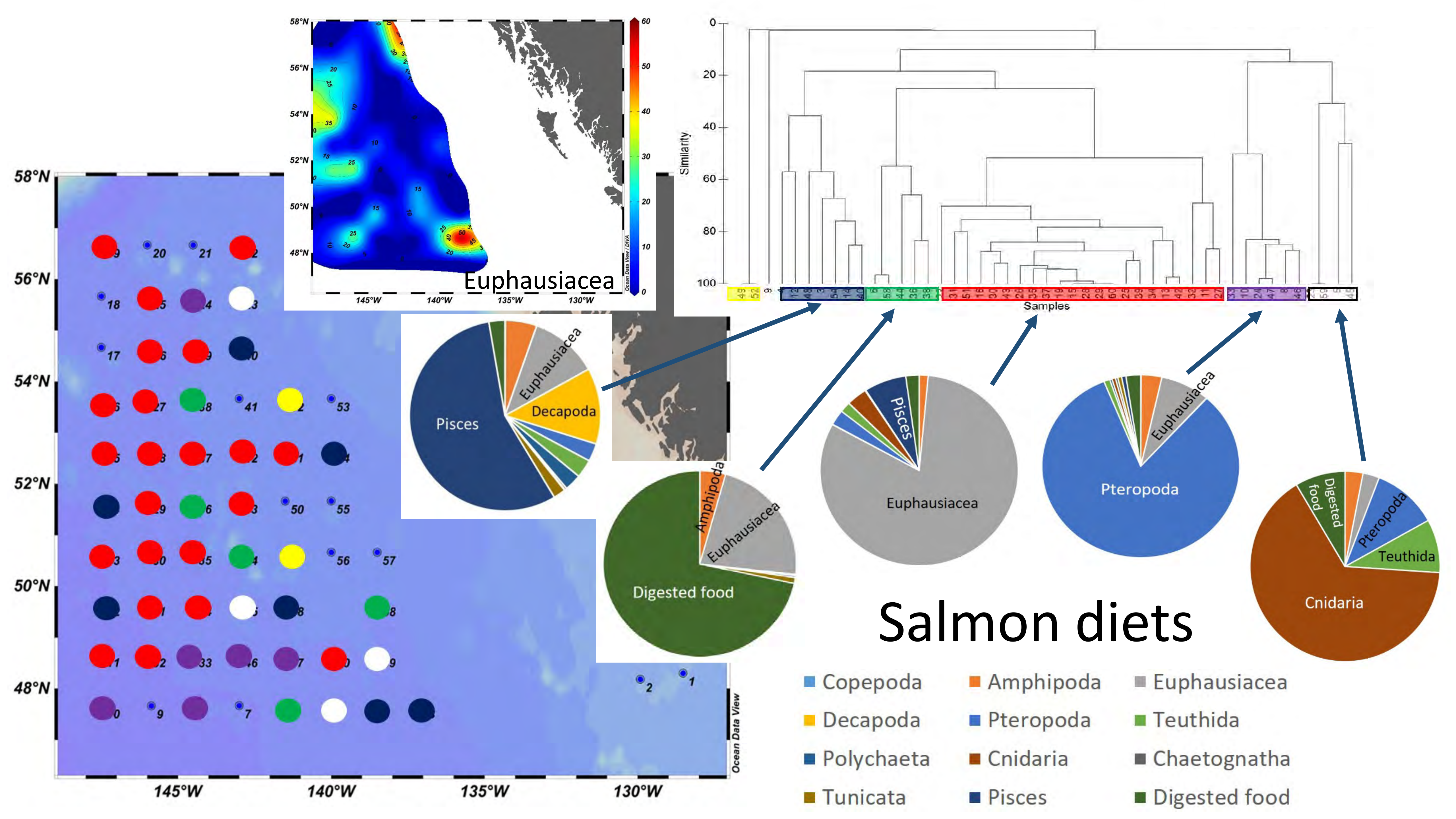
		No	% empty	GFI, % BW	
				Mean	Max
Pink	Sta. 3-6	16	6.3	0.23	0.53
	Sta. 32-45	14	7.1	1.22	3.61
Chum		224	6.3	0.38	3.02
Coho		96	3.1	1.35	4.92
Sockeye		73	11.0	0.53	1.70
Chinook		3	0	2.15	5.72

Salmon diets

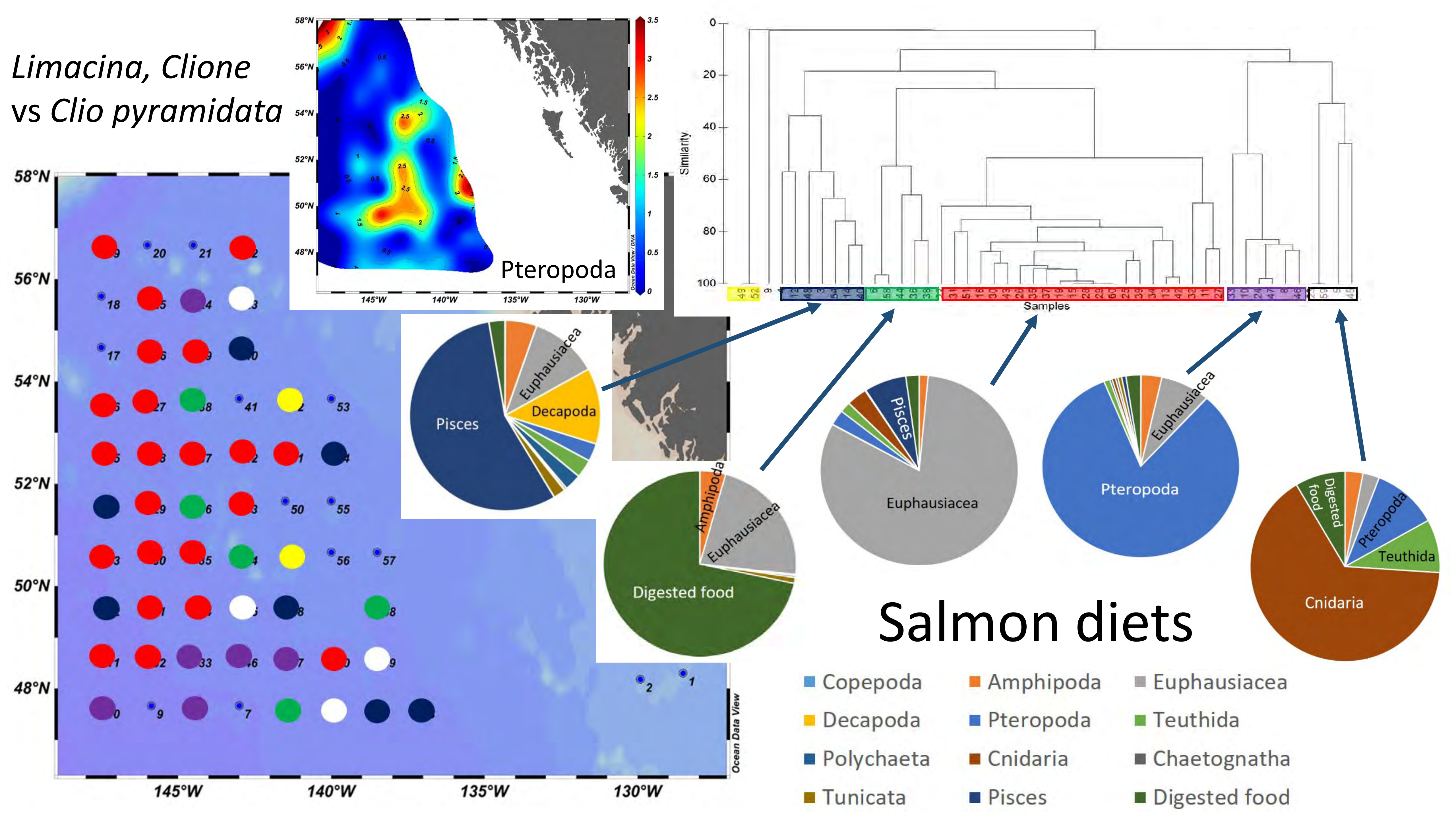




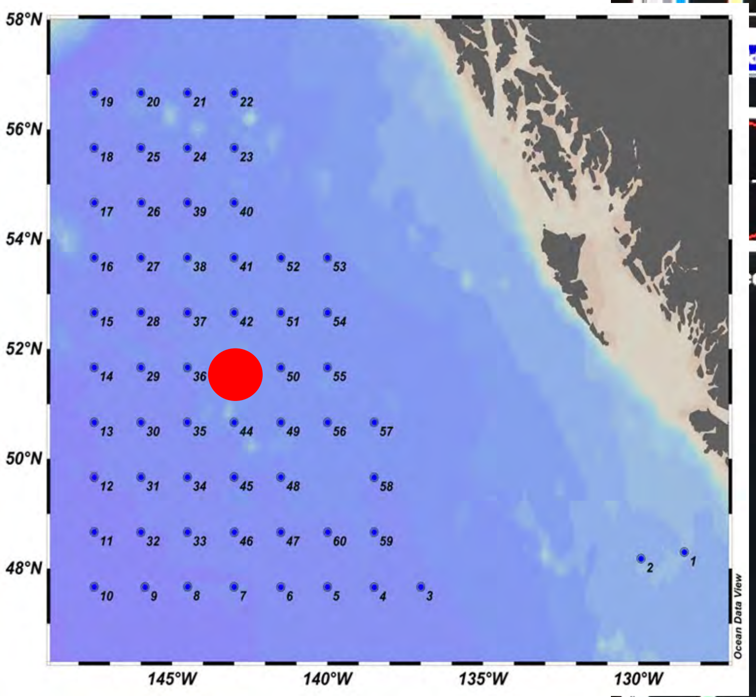
Salmon diets
Cnidaria
58°N
56°N
54°N
52°N
50°N
48°N
145°W
140°W
135°W
130°W
Ocean Data View
Similarity
Samples
Pisces
Decapoda
Euphausiacea
Amphipoda
Digested food
Pteropoda
Teuthida
Copepoda
Polychaeta
Cnidaria
Chaetognatha
Tunicata



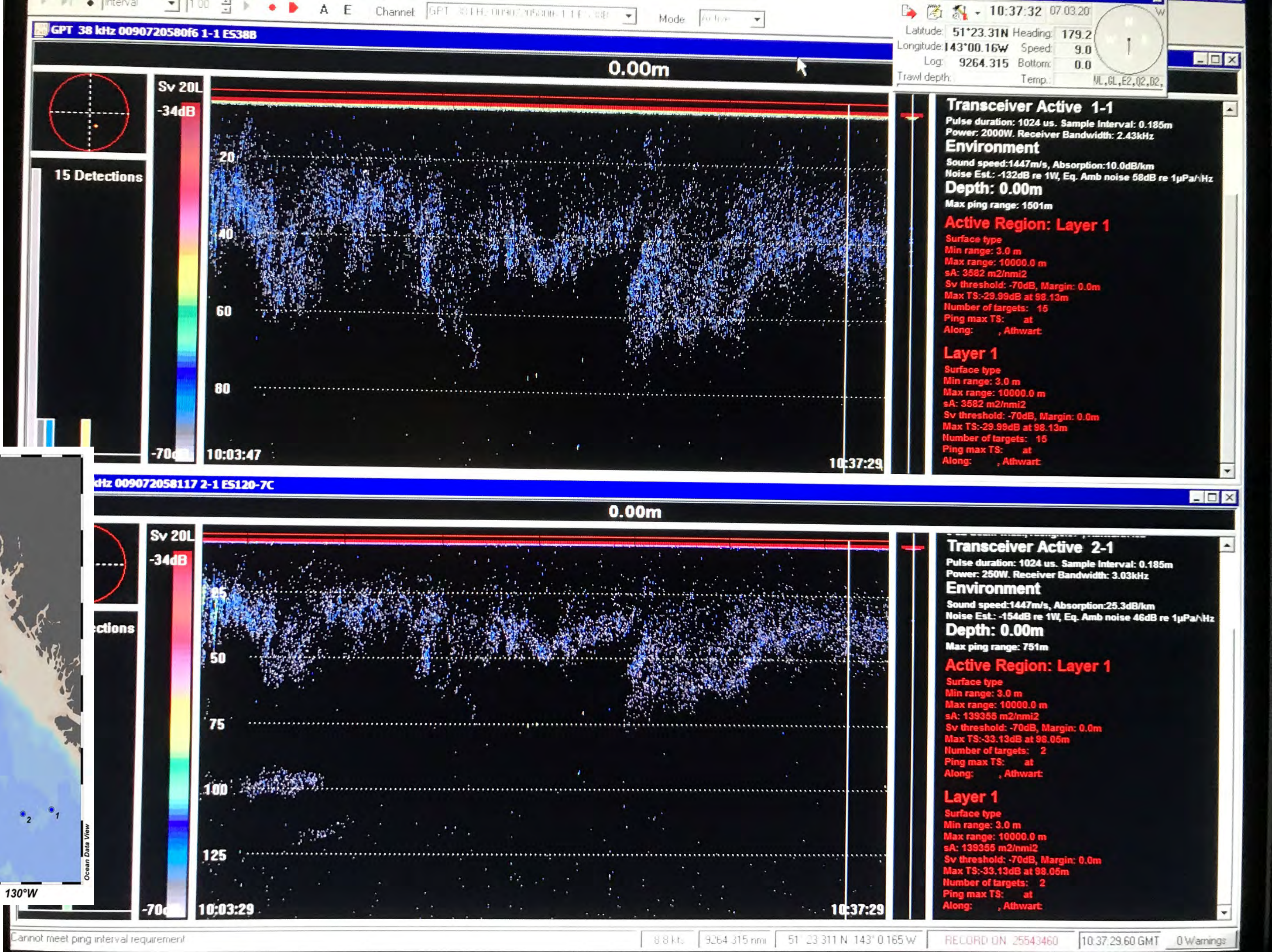
Euphausiacea
Similarity
Samples
Pisces
Euphausiacea
Decapoda
Amphipoda
Digested food
Pteropoda
Digested food
Teuthida
Cnidaria
Salmon diets
Copepoda
Amphipoda
Euphausiacea
Decapoda
Pteropoda
Teuthida
Polychaeta
Cnidaria
Chaetognatha
Tunicata
Pisces
Digested food


Limacina, Clione vs Clio pyramidata
Pteropoda
Ocean Data View / DIVA
Ocean Data View
58°N
56°N
54°N
52°N
50°N
48°N
145°W
140°W
135°W
130°W
Similarity
Samples
Pisces
Decapoda
Euphausiacea
Amphipoda
Digested food
Pteropoda
Teuthida
Cnidaria
Salmon diets
Copepoda
Amphipoda
Euphausiacea
Decapoda
Pteropoda
Teuthida
Polychaeta
Cnidaria
Chaetognatha
Tunicata
Pisces
Digested food

Station 43

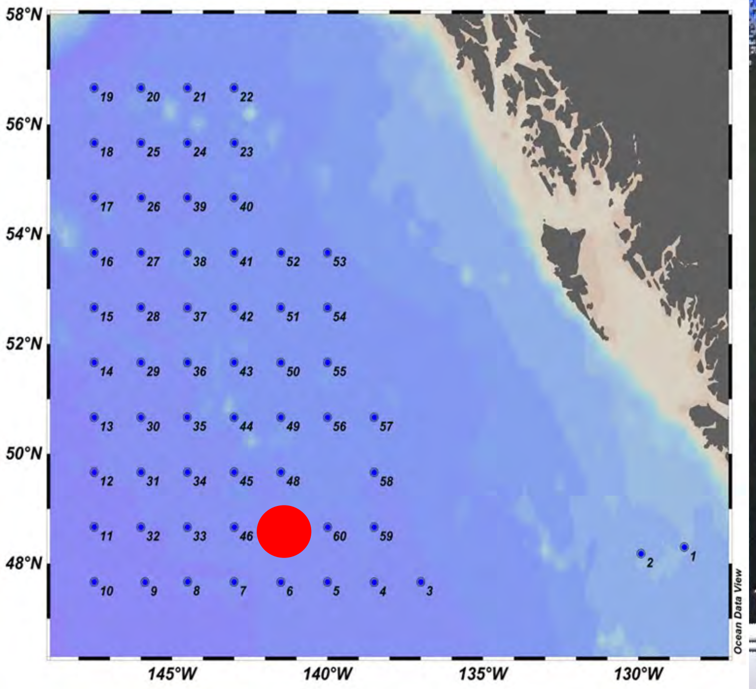


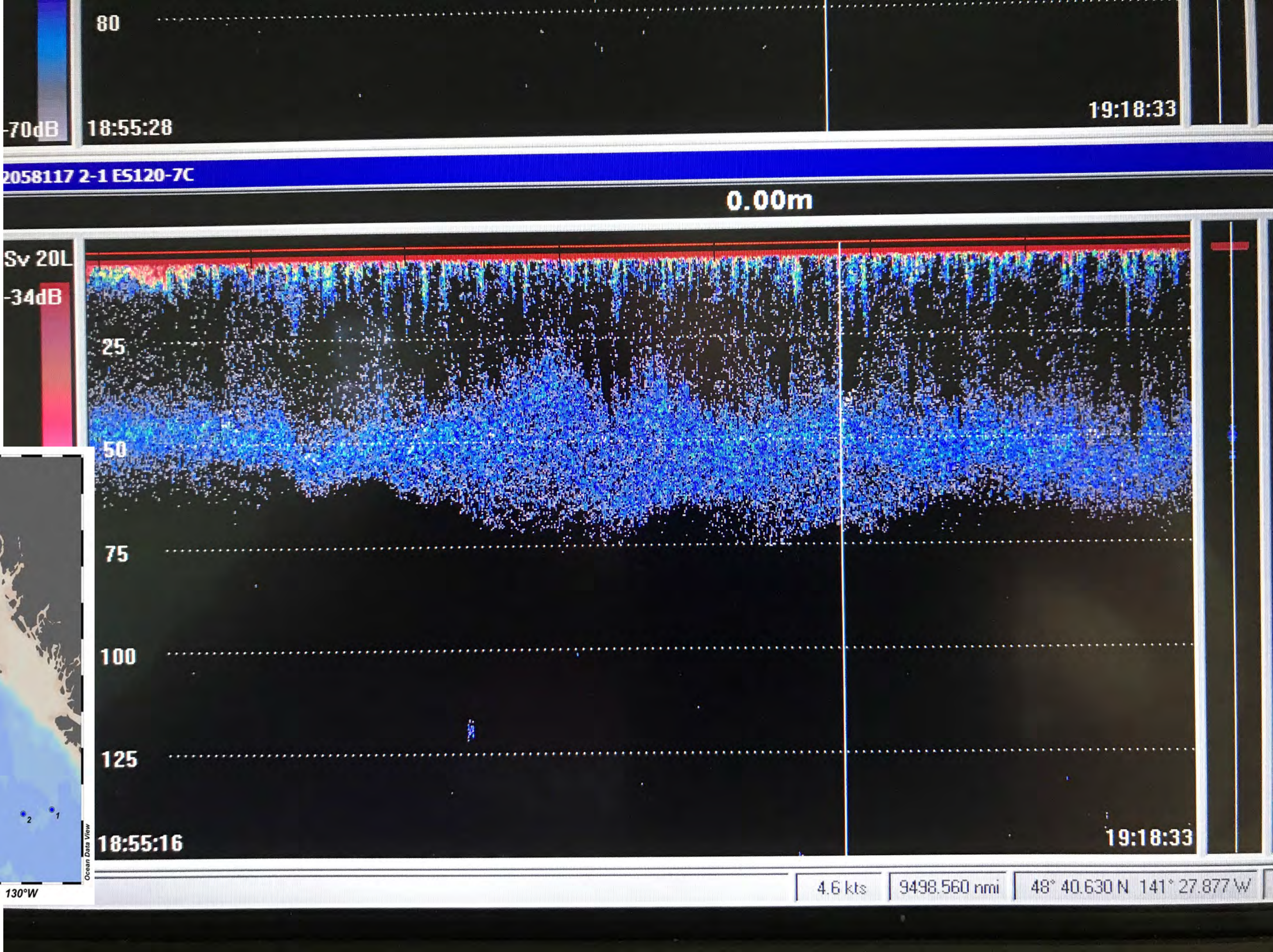
58°N
56°N
54°N
52°N
50°N
48°N
145°W
140°W
135°W
130°W
19
20
21
22
18
25
24
23
17
26
39
40
16
27
38
41
52
53
15
28
37
42
51
54
14
29
36
50
55
13
30
35
44
49
56
57
12
31
34
45
48
58
11
32
33
46
47
60
59
10
9
8
7
6
5
4
3
2
1
Ocean Data View



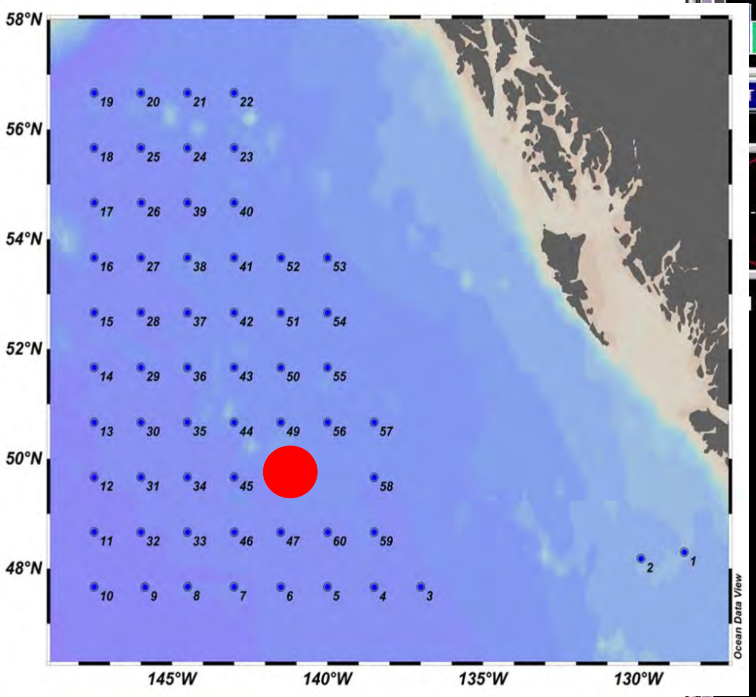
GPT 38 kHz 0090720580f6 1-1 ES38B
Channel
Mode
10:37:32
Latitude 51°23.31N Heading 179.2
Longitude 143°00.16W Speed 9.0
Log 9264.315 Bottom 0.0
Trawl depth Temp
0.00m
Sv 20L
-34dB
-70dB
15 Detections
20
40
60
80
10:03:47
10:37:29
Transceiver Active 1-1
Pulse duration: 1024 us. Sample Interval: 0.185m
Power: 2000W. Receiver Bandwidth: 2.43kHz
Environment
Sound speed:1447m/s, Absorption:10.0dB/km
Noise Est.: -132dB re 1W, Eq. Amb noise 58dB re 1µPa/√Hz
Depth: 0.00m
Max ping range: 1501m
Active Region: Layer 1
Surface type
Min range: 3.0 m
Max range: 10000.0 m
sA: 3582 m2/nmi2
Sv threshold: -70dB, Margin: 0.0m
Max TS:-29.99dB at 98.13m
Number of targets: 15
Ping max TS: at
Along: , Athwart
Layer 1
Surface type
Min range: 3.0 m
Max range: 10000.0 m
sA: 3582 m2/nmi2
Sv threshold: -70dB, Margin: 0.0m
Max TS:-29.99dB at 98.13m
Number of targets: 15
Ping max TS: at
Along: , Athwart
kHz 009072058117 2-1 ES120-7C
0.00m
Sv 20L
-34dB
-70dB
25
50
75
100
125
10:03:29
10:37:29
Transceiver Active 2-1
Pulse duration: 1024 us. Sample Interval: 0.185m
Power: 250W. Receiver Bandwidth: 3.03kHz
Environment
Sound speed:1447m/s, Absorption:25.3dB/km
Noise Est.: -154dB re 1W, Eq. Amb noise 46dB re 1µPa/√Hz
Depth: 0.00m
Max ping range: 751m
Active Region: Layer 1
Surface type
Min range: 3.0 m
Max range: 10000.0 m
sA: 139355 m2/nmi2
Sv threshold: -70dB, Margin: 0.0m
Max TS:-33.13dB at 98.05m
Number of targets: 2
Ping max TS: at
Along: , Athwart
Layer 1
Surface type
Min range: 3.0 m
Max range: 10000.0 m
sA: 139355 m2/nmi2
Sv threshold: -70dB, Margin: 0.0m
Max TS:-33.13dB at 98.05m
Number of targets: 2
Ping max TS: at
Along: , Athwart
Cannot meet ping interval requirement
9264.315 nmi
RECORD ON
10:37:29.60 GMT
0 Warnings

Station 47

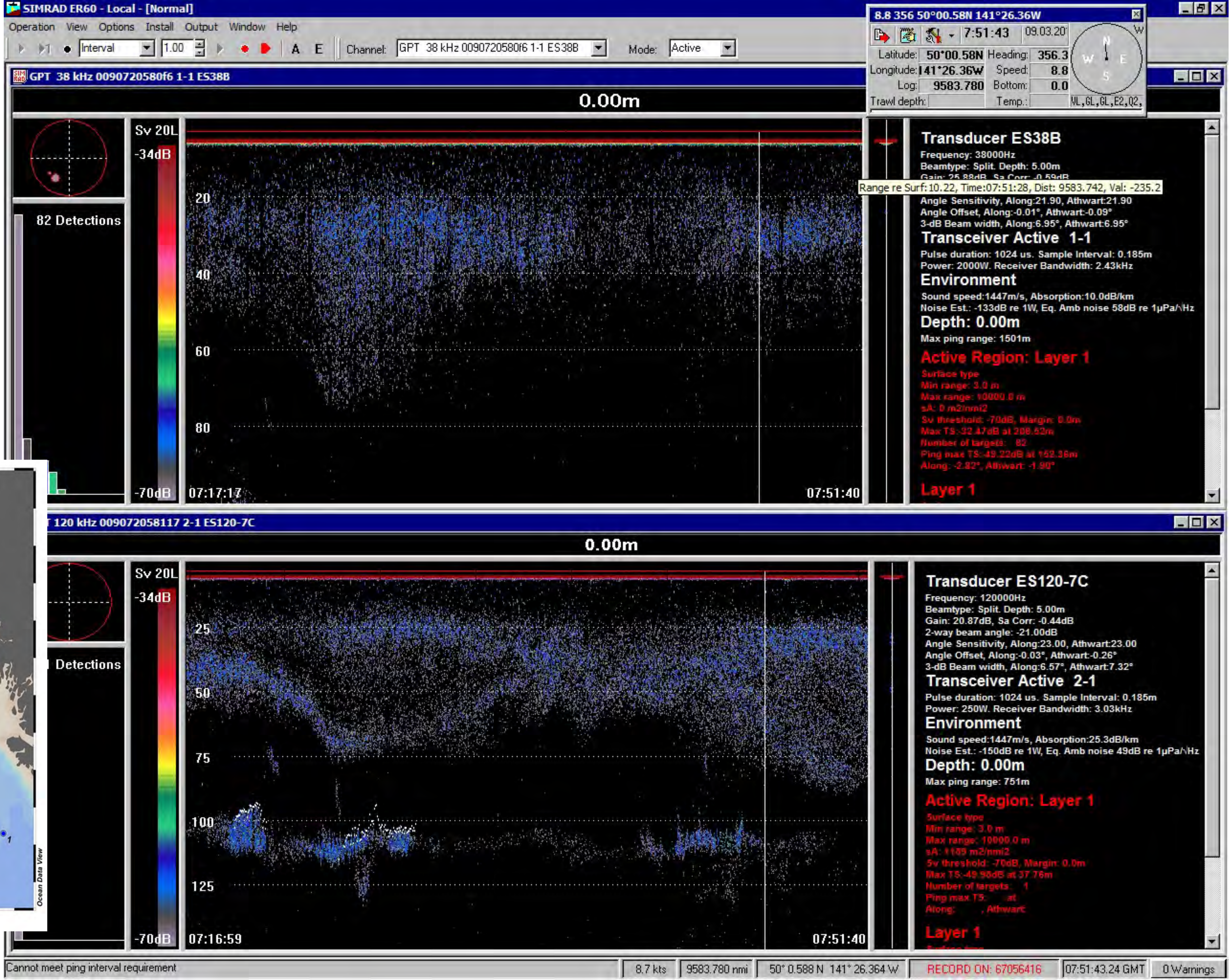

58°N
56°N
54°N
52°N
50°N
48°N
145°W
140°W
135°W
130°W
19 20 21 22
18 25 24 23
17 26 39 40
16 27 38 41 52 53
15 28 37 42 51 54
14 29 36 43 50 55
13 30 35 44 49 56 57
12 31 34 45 48 58
11 32 33 46 60 59
10 9 8 7 6 5 4 3
2 1
Ocean Data View


80
-70dB
18:55:28
19:18:33
2058117 2-1 ES120-7C
0.00m
Sv 20L
-34dB
25
50
75
100
125
18:55:16
19:18:33
4.6 kts
9498.560 nmi
48° 40.630 N 141° 27.877 W

Station 48



58°N
56°N
54°N
52°N
50°N
48°N
145°W
140°W
135°W
130°W
Ocean Data View



SIMRAD ER60 - Local - [Normal]
Operation View Options Install Output Window Help
Interval
1.00
Channel:
GPT 38 kHz 009072058016 1-1 ES38B
Mode:
Active
8.8 356 50°00.58N 141°26.36W
7:51:43
09.03.20
Latitude: 50°00.58N
Heading: 356.3
Longitude: 141°26.36W
Speed: 8.8
Log: 9583.780
Bottom: 0.0
Trawl depth:
Temp.:
GPT 38 kHz 009072058016 1-1 ES38B
0.00m
Sv 20L
-34dB
-70dB
82 Detections
07:17:17
07:51:40
Transducer ES38B
Frequency: 38000Hz
Beamtype: Split. Depth: 5.00m
Range re Surf: 10.22, Time: 07:51:28, Dist: 9583.742, Val: -235.2
Angle Sensitivity, Along:21.90, Athwart:21.90
Angle Offset, Along:-0.01°, Athwart:-0.09°
3-dB Beam width, Along:6.95°, Athwart:6.95°
Transceiver Active 1-1
Pulse duration: 1024 us. Sample Interval: 0.185m
Power: 2000W. Receiver Bandwidth: 2.43kHz
Environment
Sound speed:1447m/s, Absorption:10.0dB/km
Noise Est.: -133dB re 1W, Eq. Amb noise 58dB re 1μPa/√Hz
Depth: 0.00m
Max ping range: 1501m
Active Region: Layer 1
Layer 1
120 kHz 009072058117 2-1 ES120-7C
0.00m
Sv 20L
-34dB
-70dB
Detections
07:16:59
07:51:40
Transducer ES120-7C
Frequency: 120000Hz
Beamtype: Split. Depth: 5.00m
Gain: 20.87dB, Sa Corr: -0.44dB
2-way beam angle: -21.00dB
Angle Sensitivity, Along:23.00, Athwart:23.00
Angle Offset, Along:-0.03°, Athwart:-0.26°
3-dB Beam width, Along:6.57°, Athwart:7.32°
Transceiver Active 2-1
Pulse duration: 1024 us. Sample Interval: 0.185m
Power: 250W. Receiver Bandwidth: 3.03kHz
Environment
Sound speed:1447m/s, Absorption:25.3dB/km
Noise Est.: -150dB re 1W, Eq. Amb noise 49dB re 1μPa/√Hz
Depth: 0.00m
Max ping range: 751m
Active Region: Layer 1
Layer 1
Cannot meet ping interval requirement
8.7 kts
9583.780 nmi
50° 0.588 N 141° 26.364 W
RECORD ON: 67056416
07:51:43.24 GMT
0 Warnings

First cut conclusions

- Encountered development of phytoplankton bloom and possibly copepod reproduction
- Uniform mesozooplankton assemblages
- Yet, unique macrozooplankton assemblages
- Overall, low zooplankton density
- Strong diet preferences of five salmon species
- Except Coho and Chinook, salmonids had low feeding intensity. Only Pink showed spatial (and possibly temporal) differences in feeding intensity
- There is a strong mismatch between Juday net zooplankton distribution and prey items found in salmon stomachs