Trophic Dynamics of Marine Nekton and Zooplankton in the Northern California Current Ecosystem

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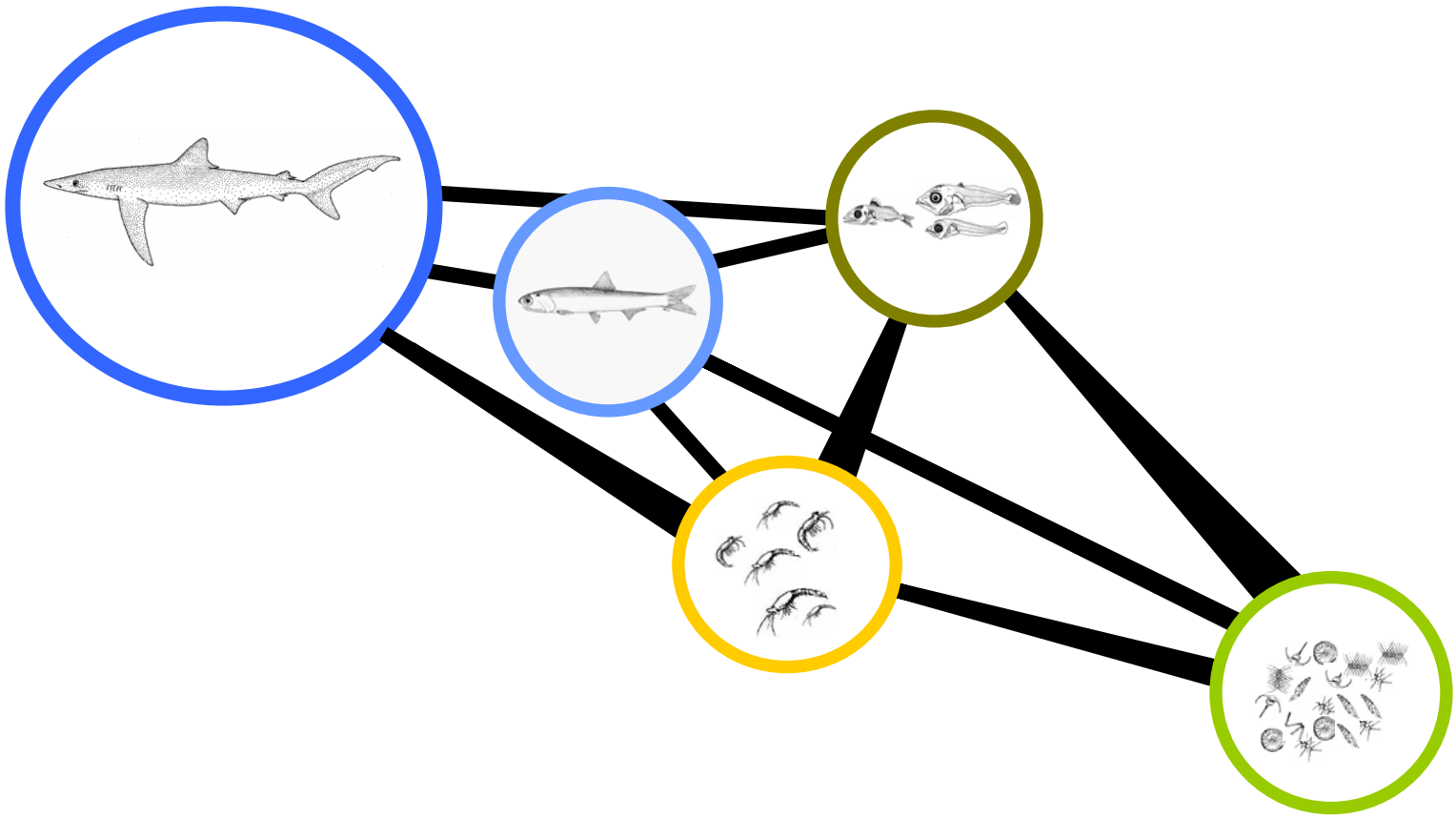


Overview

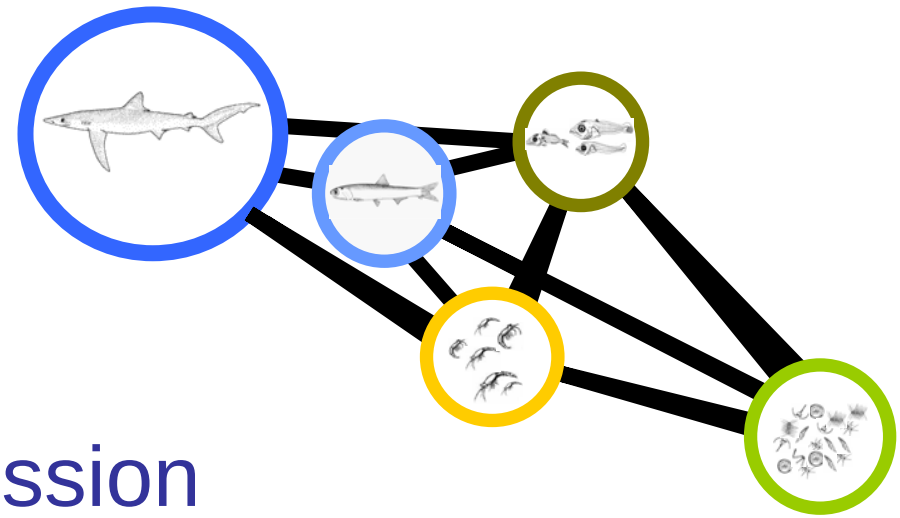
I. Background
   A. Upwelling ecosystems
   B. Northern California Current (NCC) ecosystem

II. Objectives

III. Methods
   A. Diet analyses
   B. Stable isotopes

IV. Results & Discussion

V. Conclusions



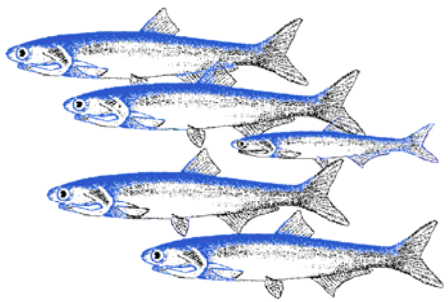
I. **Background -** Major upwelling ecosystems

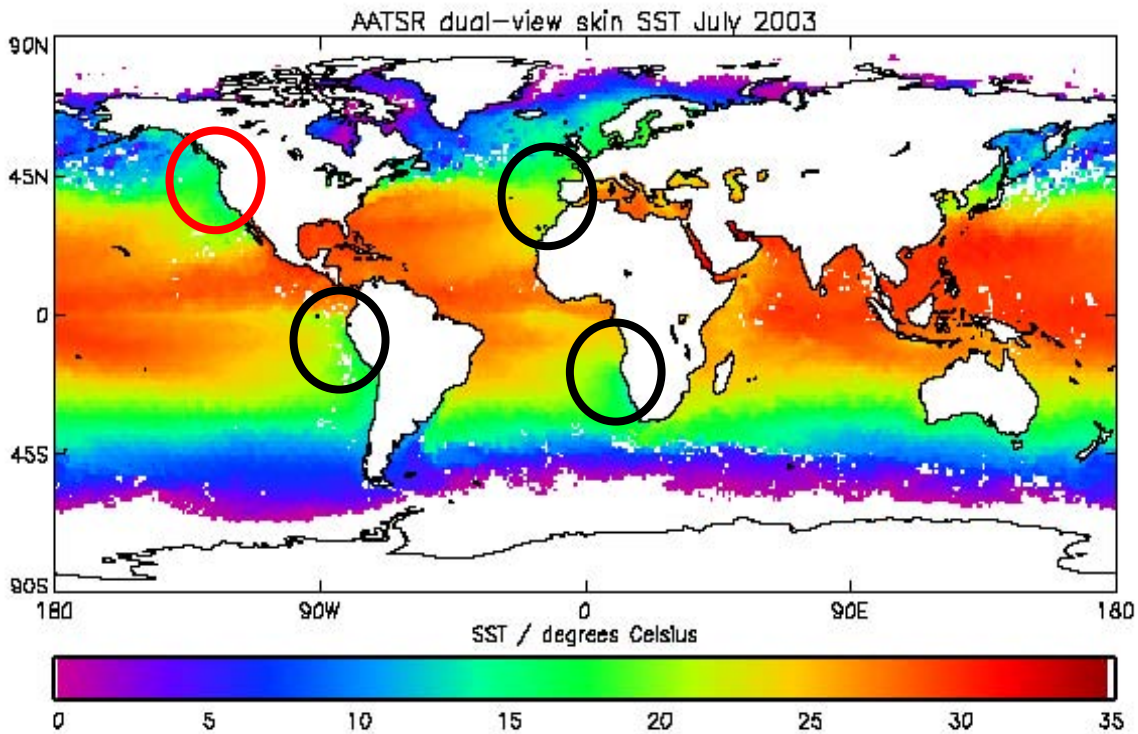
- Highly productive (primary production to higher trophic levels)
- Baitfish (sardine and anchovy), mackerel and hake
- ~0.1% of world ocean with ~50% world fisheries catch
- Direction of trophic control:

  (1) **top-down**

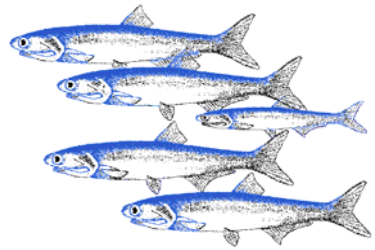
  (2) **bottom-up**

  (3) **wasp-waist**

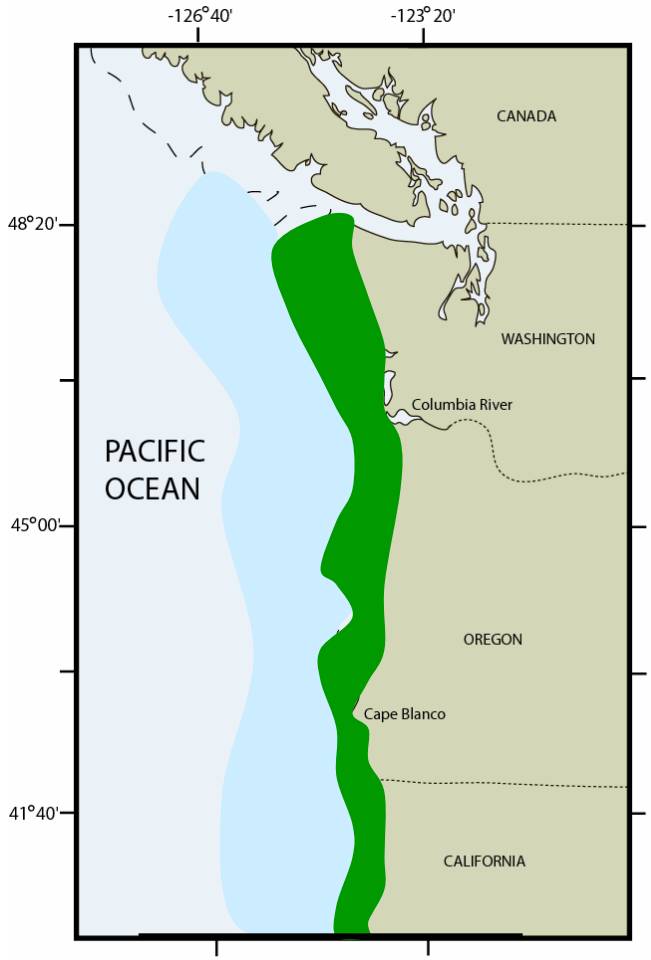




Northern CC Ecosystem



- Upwelling ecosystem
  - High nutrients
  - Base production
  - Variable - Seasonal, interannual, interdecadal
- Dominant nekton species
  - Planktivores – sardine, anchovy, herring, smelts
  - Plankt/Piscivores - jack mackerel, hake, salmonids
  - Piscivores – sharks, adult salmon
- Strong seasonal, interannual, interdecadal variation in production
- Spatially dynamic
  - shelf-near shore high primary production
  - slope-offshore lower production



II. Objectives

(i) Determine the primary trophic links between fish and zooplankton in the NCC

(ii) Determine if there is structural evidence indicative of top-down, bottom-up or wasp-waist control

Diet Analysis (stomach content analysis)

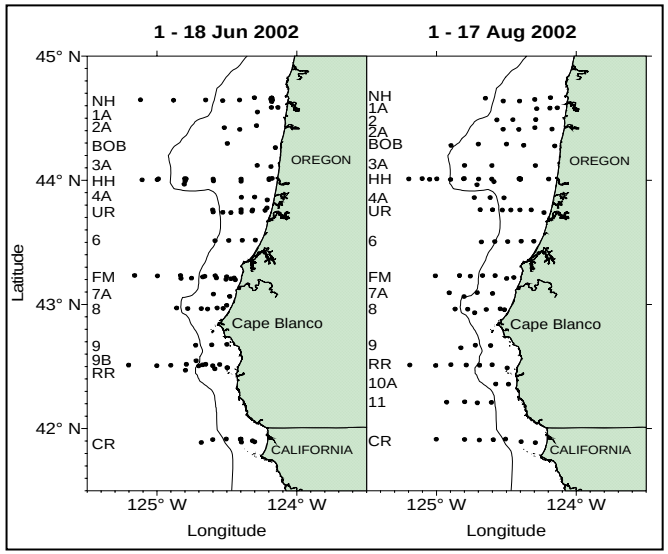
Stable Isotope Analysis

- **Carbon ($^{13}C/^{12}C$)** – tells **source production** (where food comes from)
- **Nitrogen ($^{15}N/^{14}N$)** – relative **trophic level** (**+3.4 o/oo** per trophic level)

III. Methods – Collection

- Four GLOBEC cruises
  - June and August, 2000 and 2002
  - Collected fish and zooplankton (including POM)
  - Measured SSS, SST, Chl-a

- Laboratory
  - Diet analysis – 21 spp. nekton = >3000 stomachs
  - Isotopes – 31 spp., >1500 samples



III. Methods – Measuring trophic patterns

1. Diet Analysis

a) Percent wet wt. prey contribution to diet

b) Analyzed spp. collected >4 hauls, n=10-30 individuals per haul

c) Cluster Analysis (**PRED X PREY** matrix)

- groups using MRPP

d) Indicator Species Analysis – describe dominant prey within groups

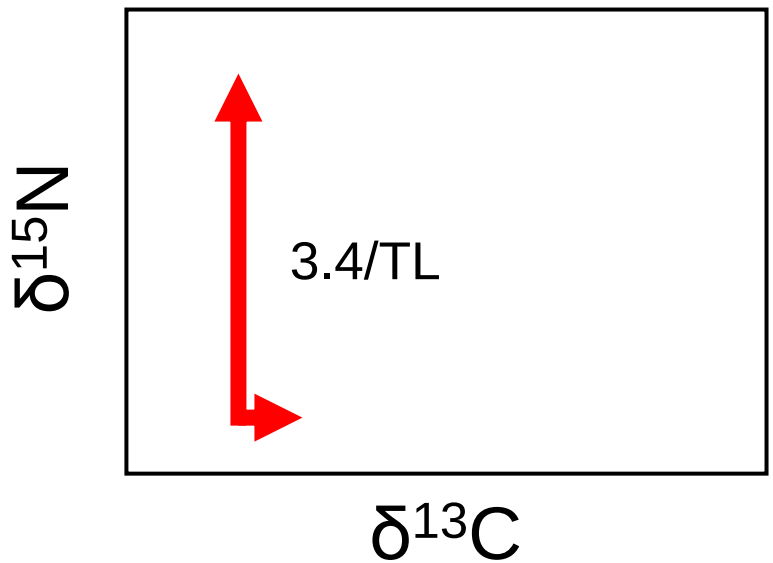
III. Methods – Measuring trophic patterns

2. **Stable Isotopes**

a. $^{13}C/^{12}C$ Corrected for lipids

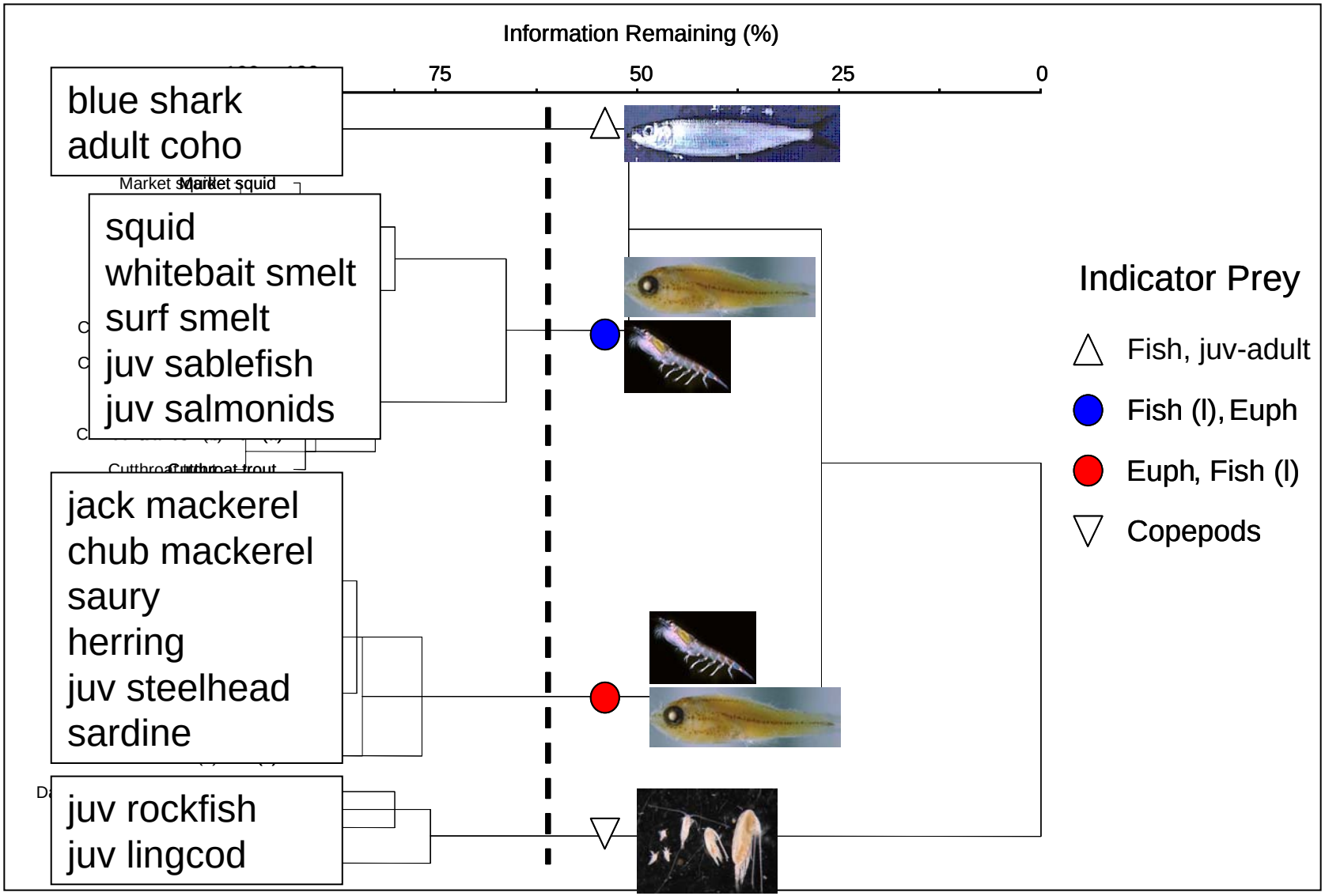
b. 3-5 individual sampled per spp., per site

c. $\delta^{15}N$ compared to trophic cluster groups based on diets



IV. Results – Cluster and Indicator Species Analysis

YR 2000 (June and August combined)



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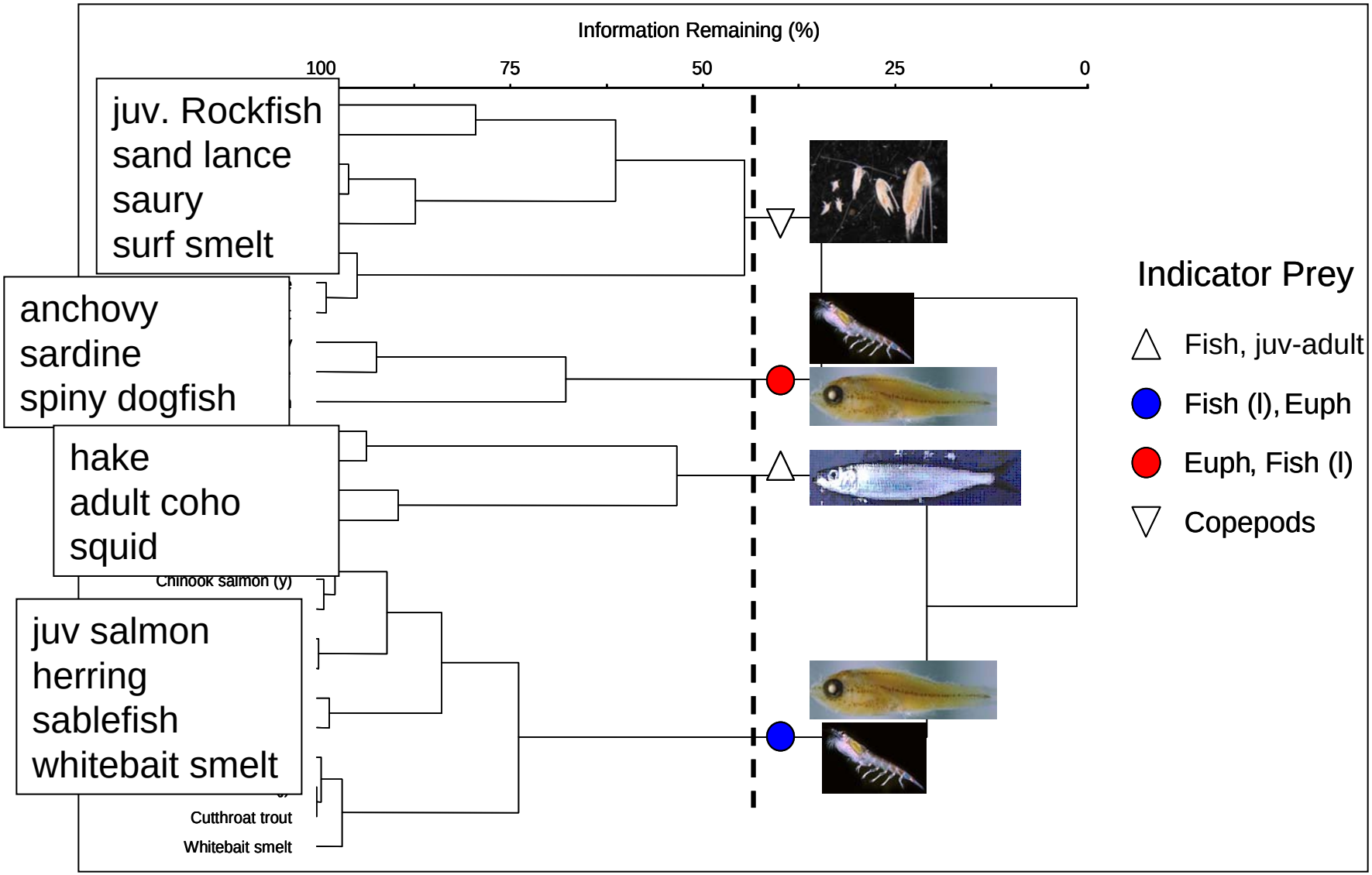
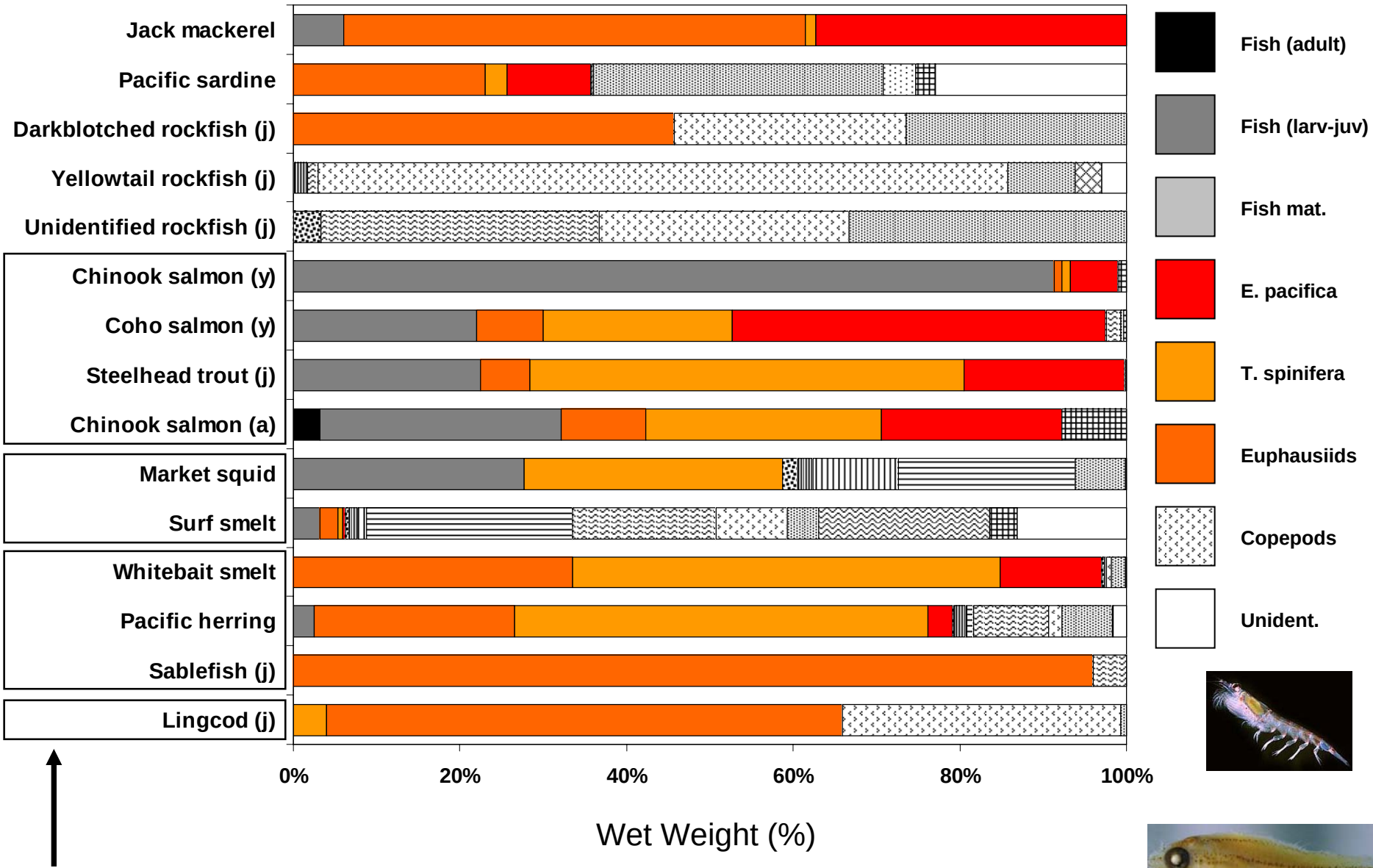
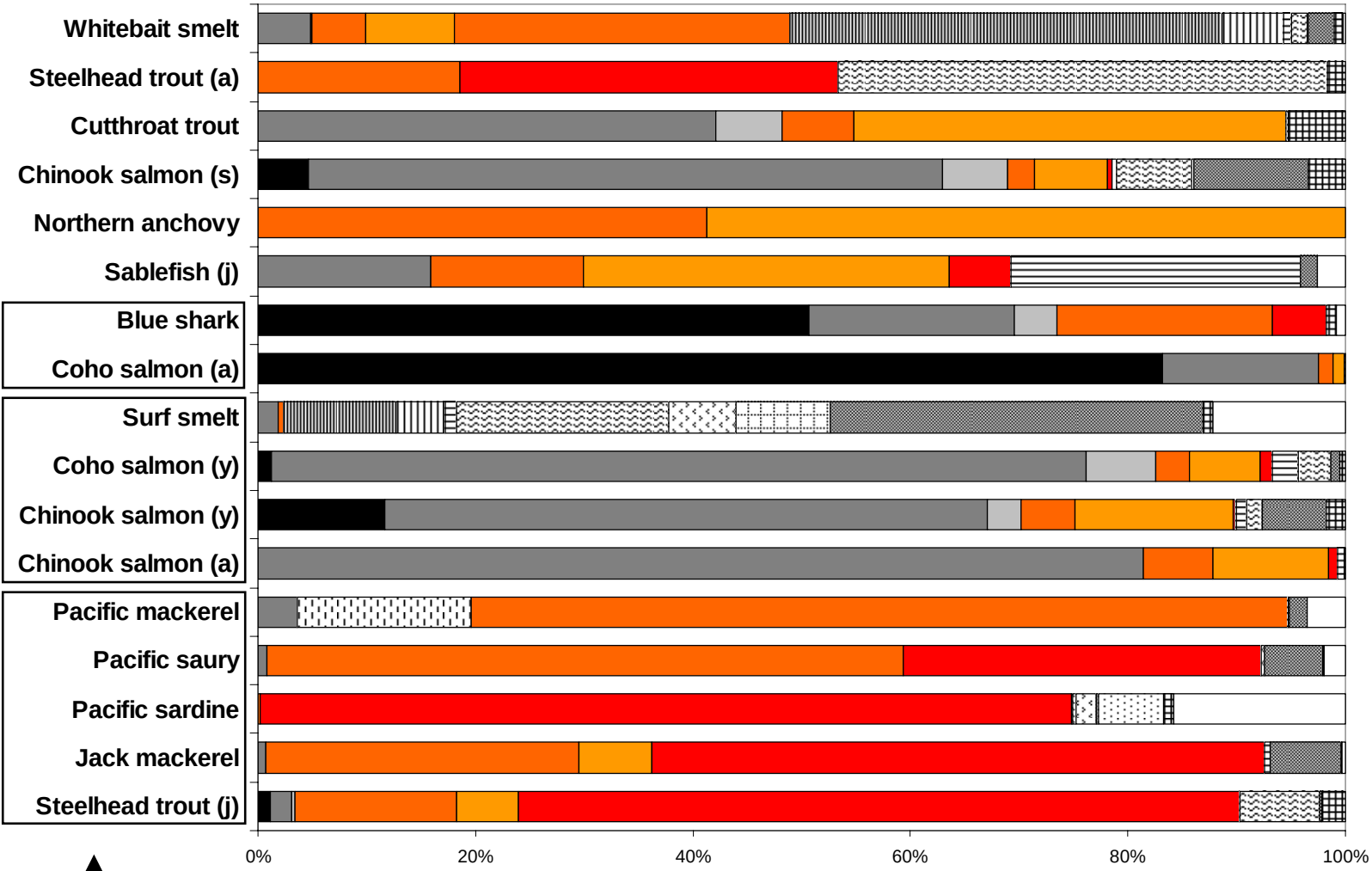


Diets June 2000



Boxes = trophic cluster groups

Diets August 2000

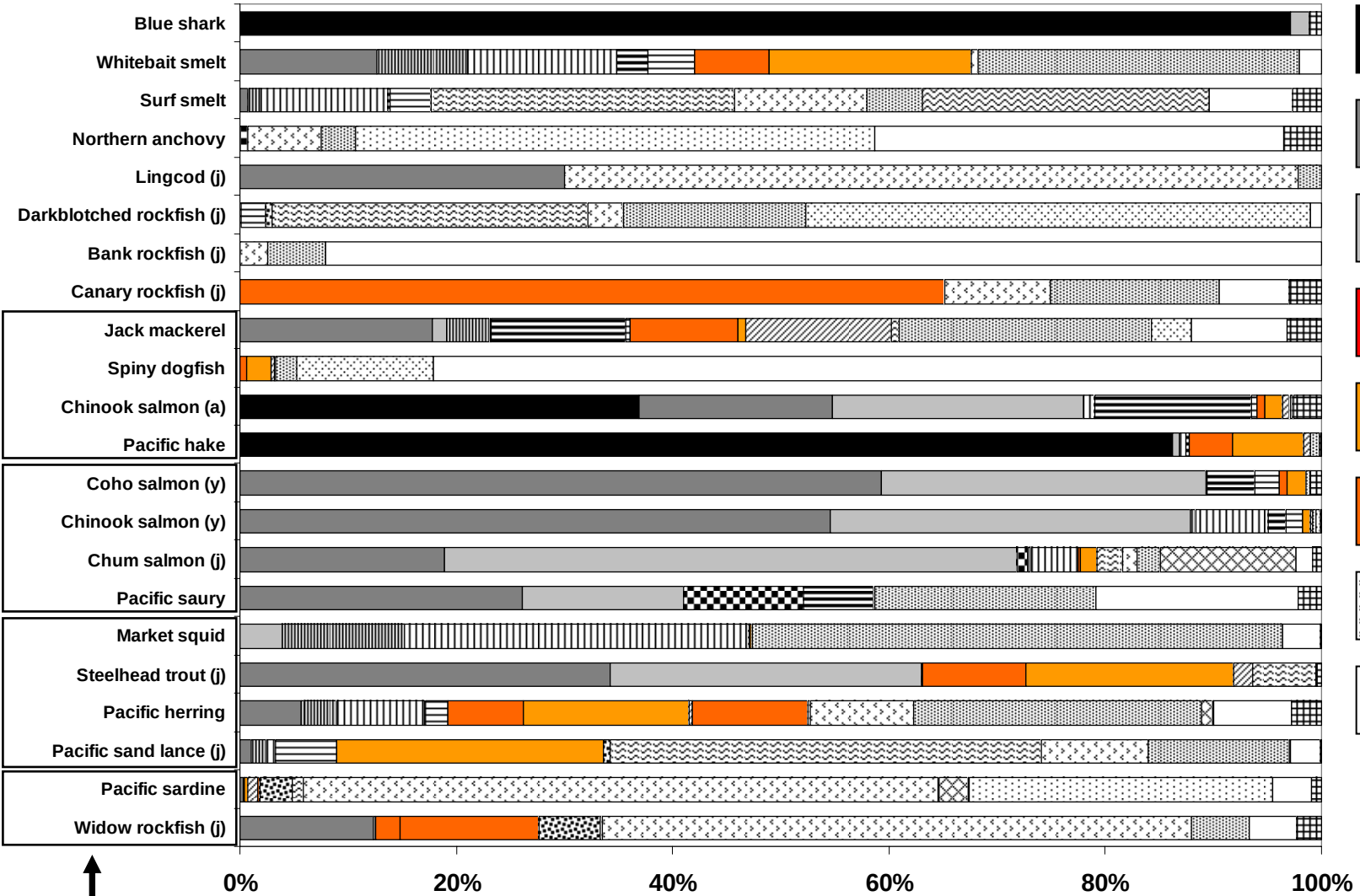


PREY

- Fish (adult)
- Fish (larv-juv)
- Fish mat.
- E. pacifica
- T. spinifera
- Euphausiids
- Copepods
- Unident.

Boxes = trophic cluster groups

Diets June 2002



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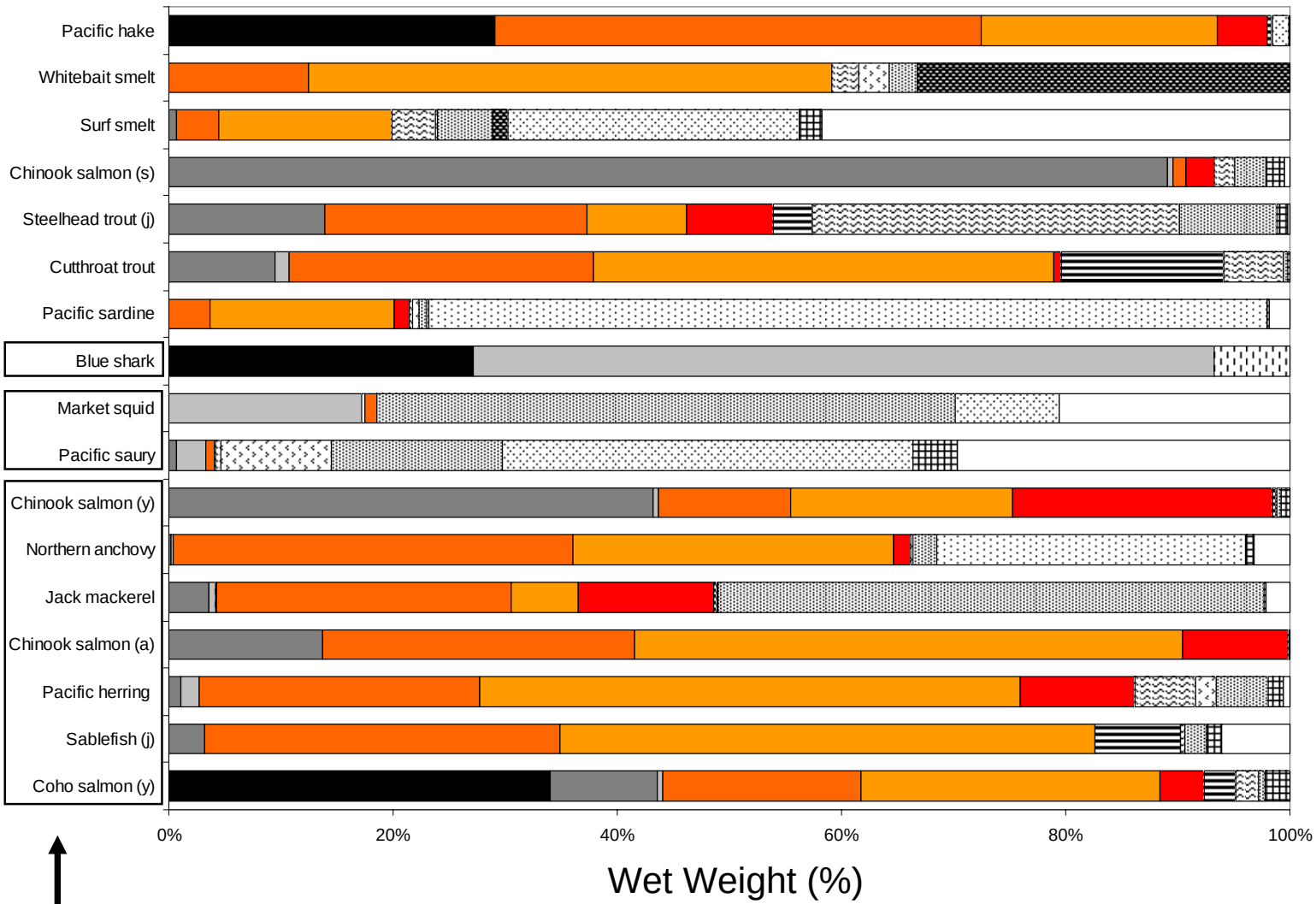

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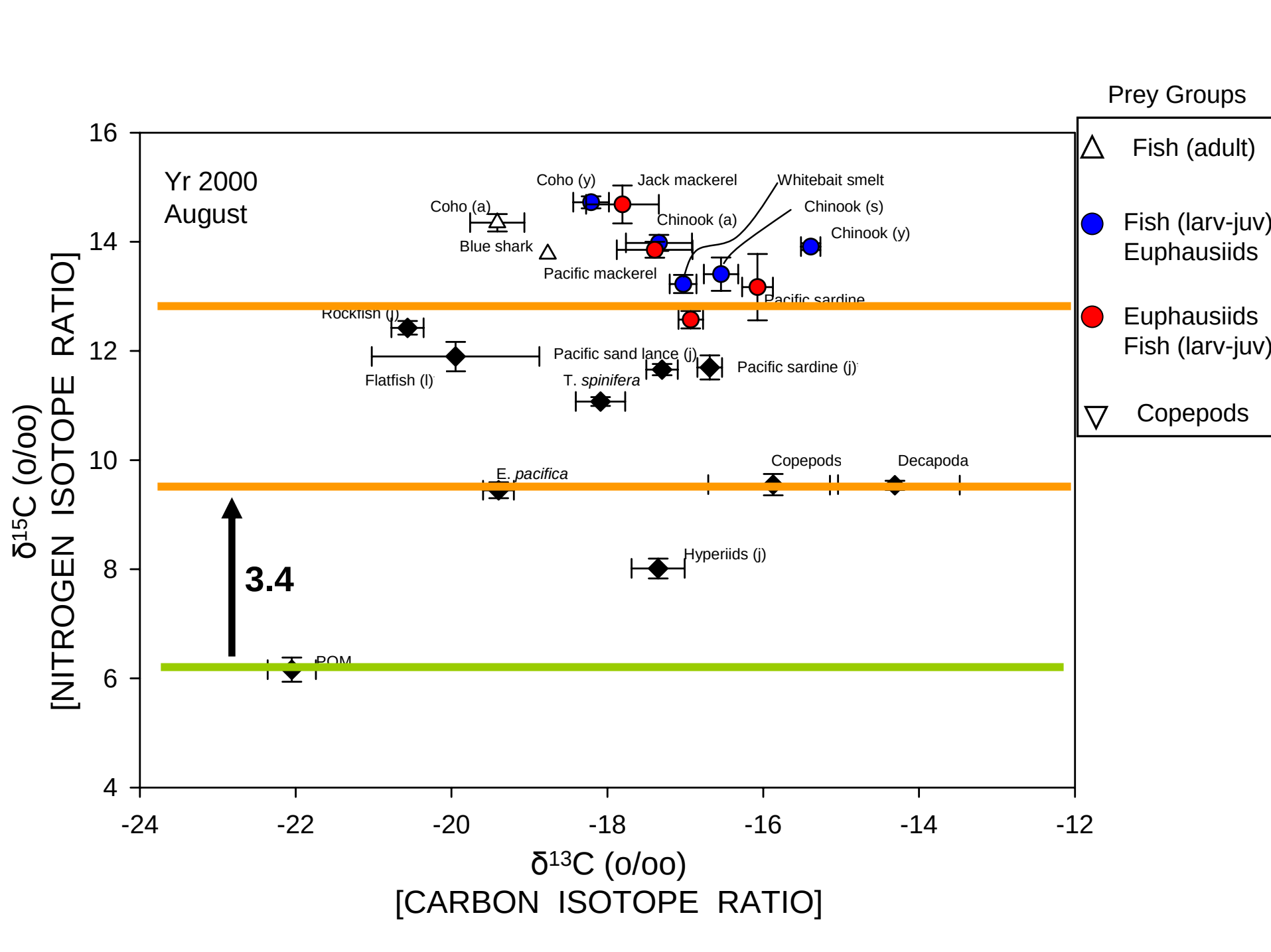
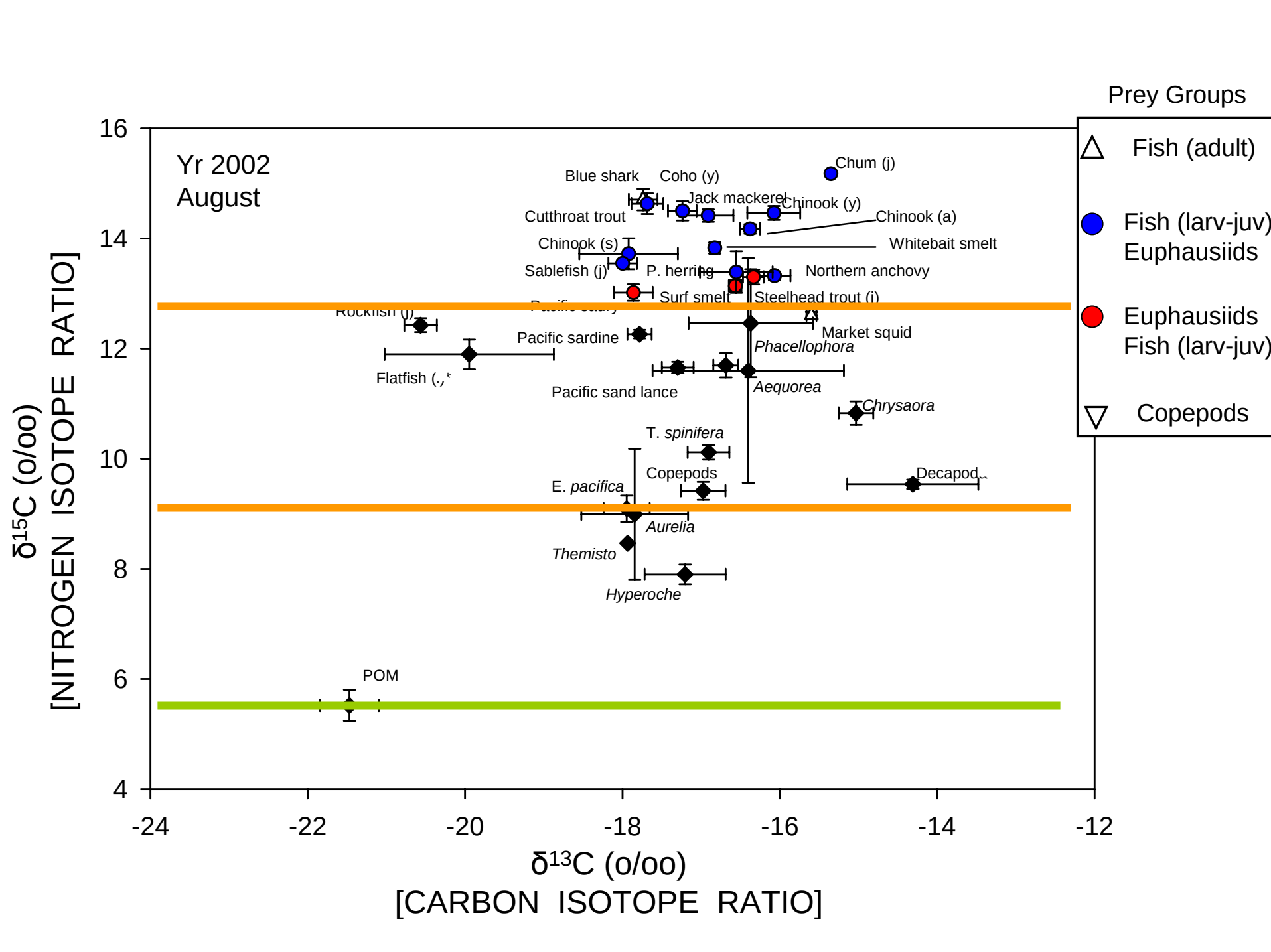
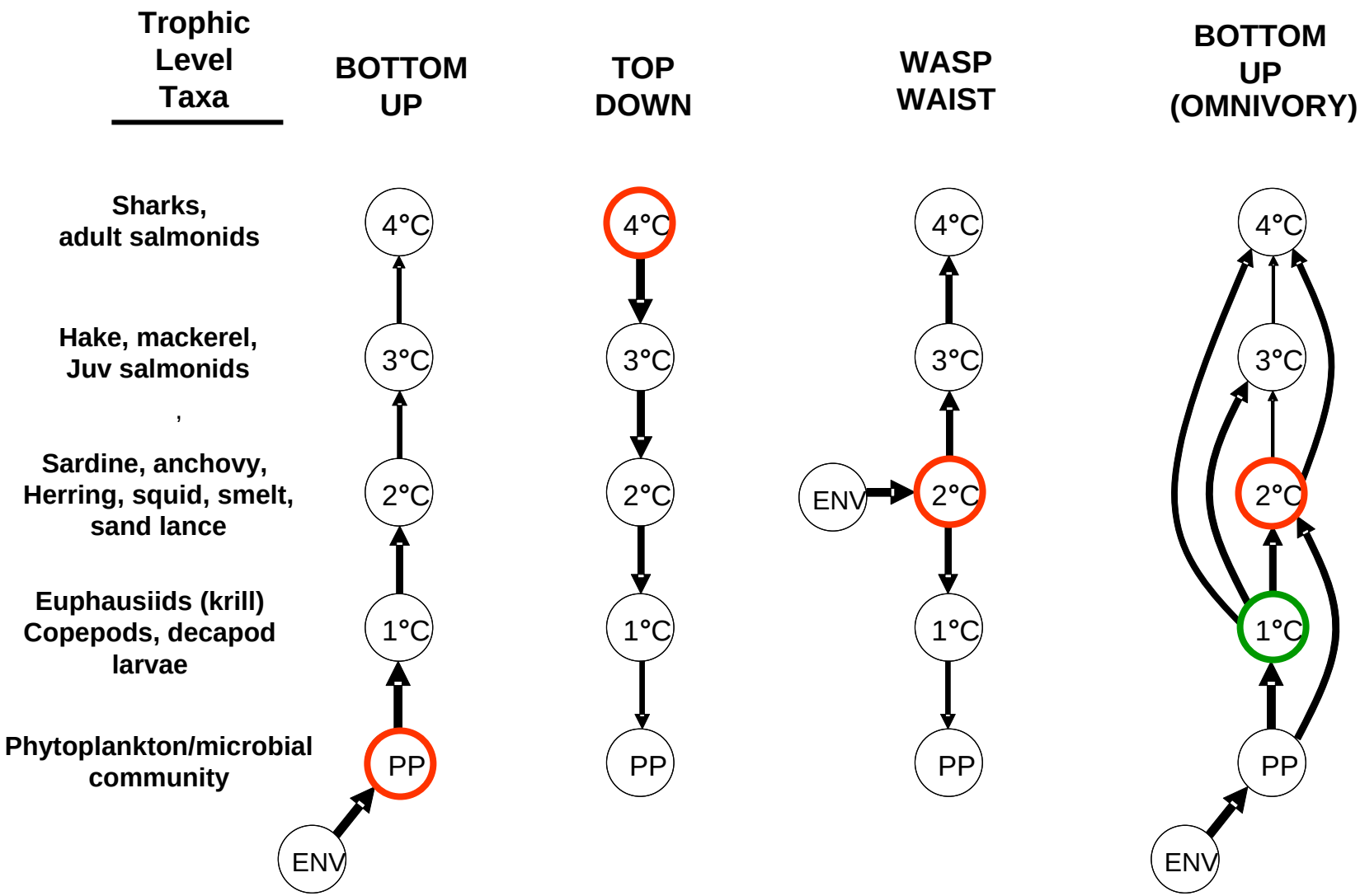

Yr 2000
August
Prey Groups
Fish (adult)
Fish (larv-juv)
Euphausiids
Euphausiids
Fish (larv-juv)
Copepods
Coho (y)
Jack mackerel
Whitebait smelt
Coho (a)
Chinook (s)
Chinook (a)
Chinook (y)
Blue shark
Pacific mackerel
Pacific sardine
Rockfish (j)
Pacific sand lance (j)
Pacific sardine (j)
Flatfish (l)
T. spinifera
Copepods
Decapoda
E. pacifica
Hyperiids (j)
3.4
POM
δ15C (o/oo)
[NITROGEN ISOTOPE RATIO]
δ13C (o/oo)
[CARBON ISOTOPE RATIO]
16
14
12
10
8
6
4
-24
-22
-20
-18
-16
-14
-12


Yr 2002
August
Prey Groups
Fish (adult)
Fish (larv-juv)
Euphausiids
Euphausiids
Fish (larv-juv)
Copepods
Chum (j)
Blue shark
Coho (y)
Jack mackerel
Chinook (y)
Cutthroat trout
Chinook (a)
Chinook (s)
Whitebait smelt
Sablefish (j)
P. herring
Northern anchovy
Surf smelt
Steelhead trout (j)
Rockfish (j)
Market squid
Pacific sardine
Phacellophora
Flatfish (.,
Pacific sand lance
Aequorea
Chrysaora
T. spinifera
Copepods
Decapod
E. pacifica
Aurelia
Themisto
Hyperoche
POM
16
14
12
10
8
6
4
-24
-22
-20
-18
-16
-14
-12
δ15C (o/oo)
[NITROGEN ISOTOPE RATIO]
δ13C (o/oo)
[CARBON ISOTOPE RATIO]

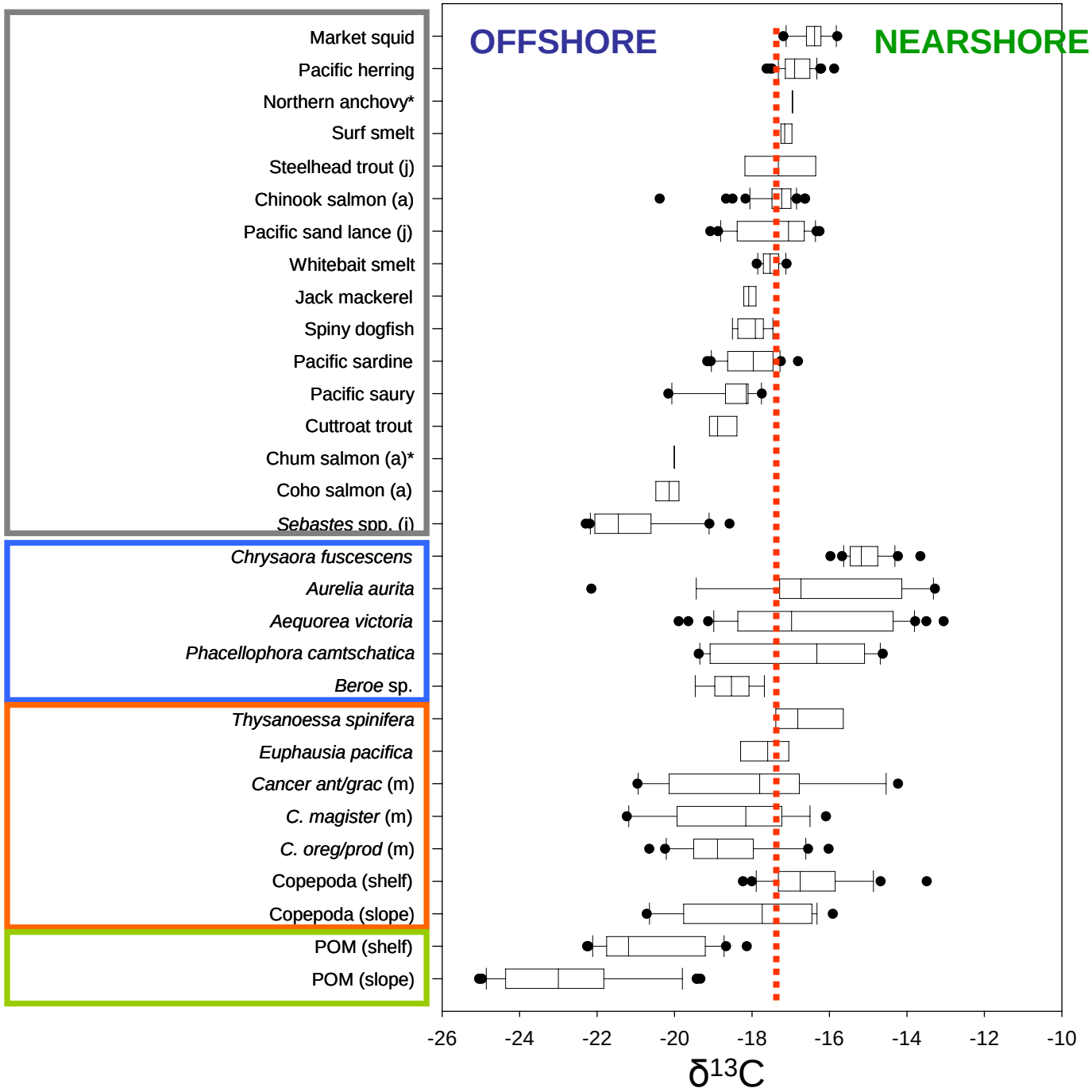

Trophic Level Taxa
BOTTOM UP
TOP DOWN
WASP WAIST
BOTTOM UP (OMNIVORY)
Sharks, adult salmonids
Hake, mackerel, Juv salmonids
,
Sardine, anchovy, Herring, squid, smelt, sand lance
Euphausiids (krill) Copepods, decapod larvae
Phytoplankton/microbial community
4°C
3°C
2°C
1°C
PP
ENV

Nekton

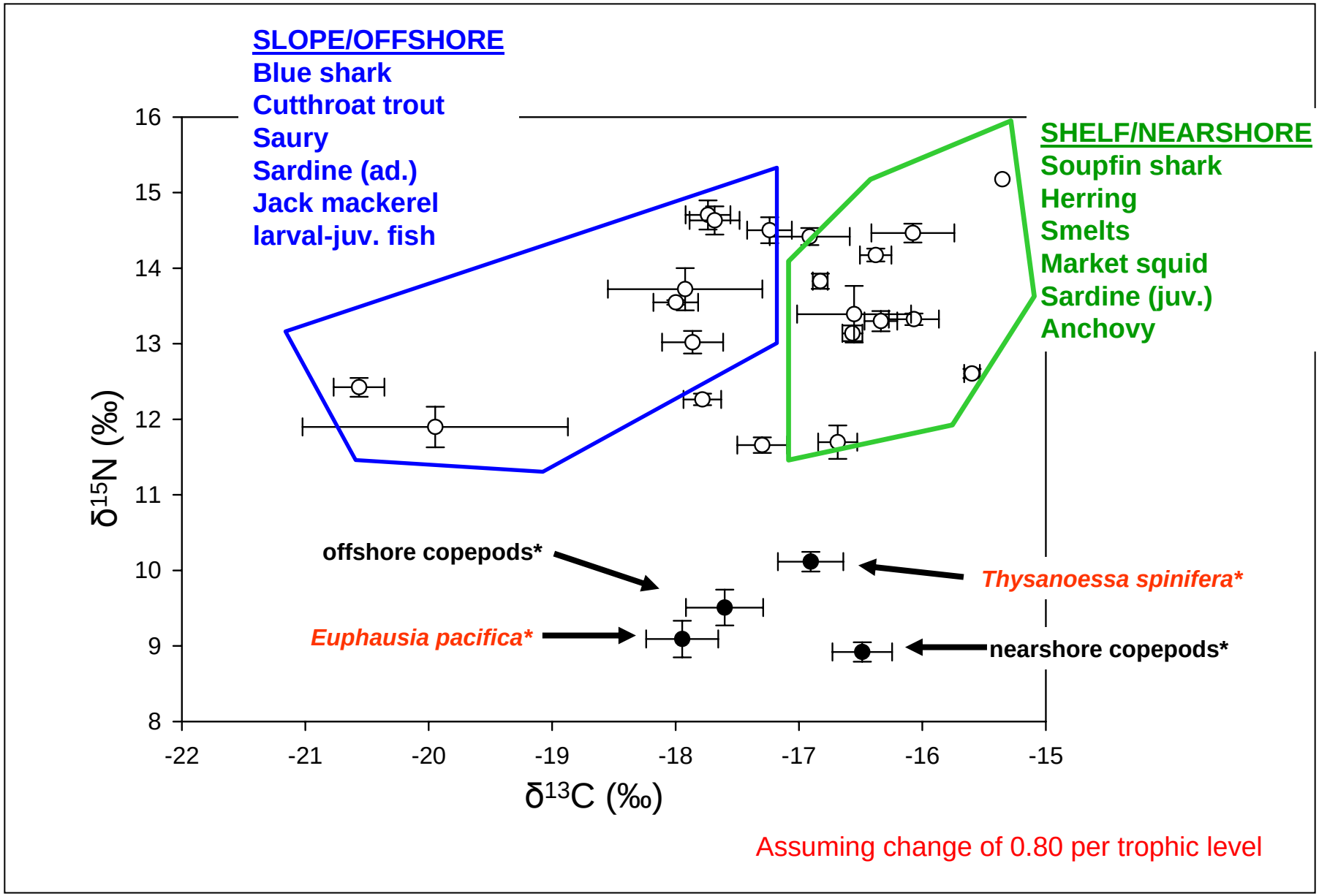
Gelatinous zooplankton

Crustacean zooplankton

Particulate Organic Matter (POM)



Division of NCC food web using $\delta^{13}C$ and $\delta^{15}N$



Assuming change of 0.80 per trophic level

*Mann-Whitney test – significant difference in $\delta^{13}C$ between near shore and offshore sites

Trophic Structure Conclusions

- Seasonally and interannually variable
- Many species exhibited considerable dietary overlap (euphausiids and larval-juvenile fish)
- Trophic structure more indicative of bottom-up control with omnivory prominent during this period
- Cross-shelf spatial structure to the NCC food web