Marine environment induced spatial dynamics of recruited walleye pollock juveniles (*Theragra chalcogramma*) and interactions with preys and predators in Pacific coast of Hokkaido, Japan

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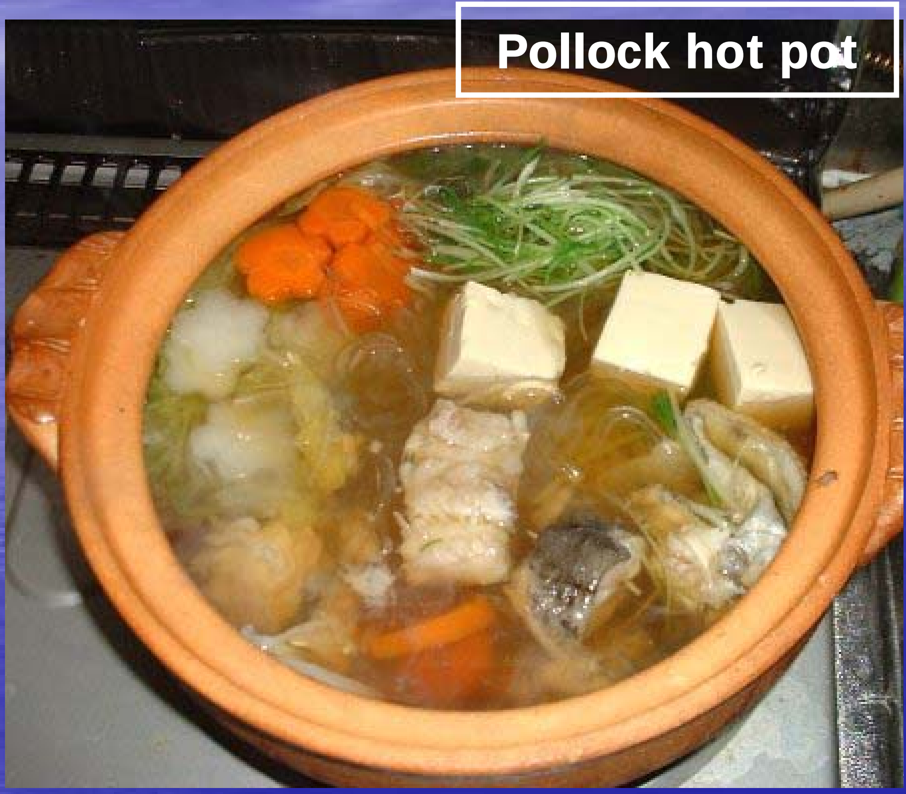
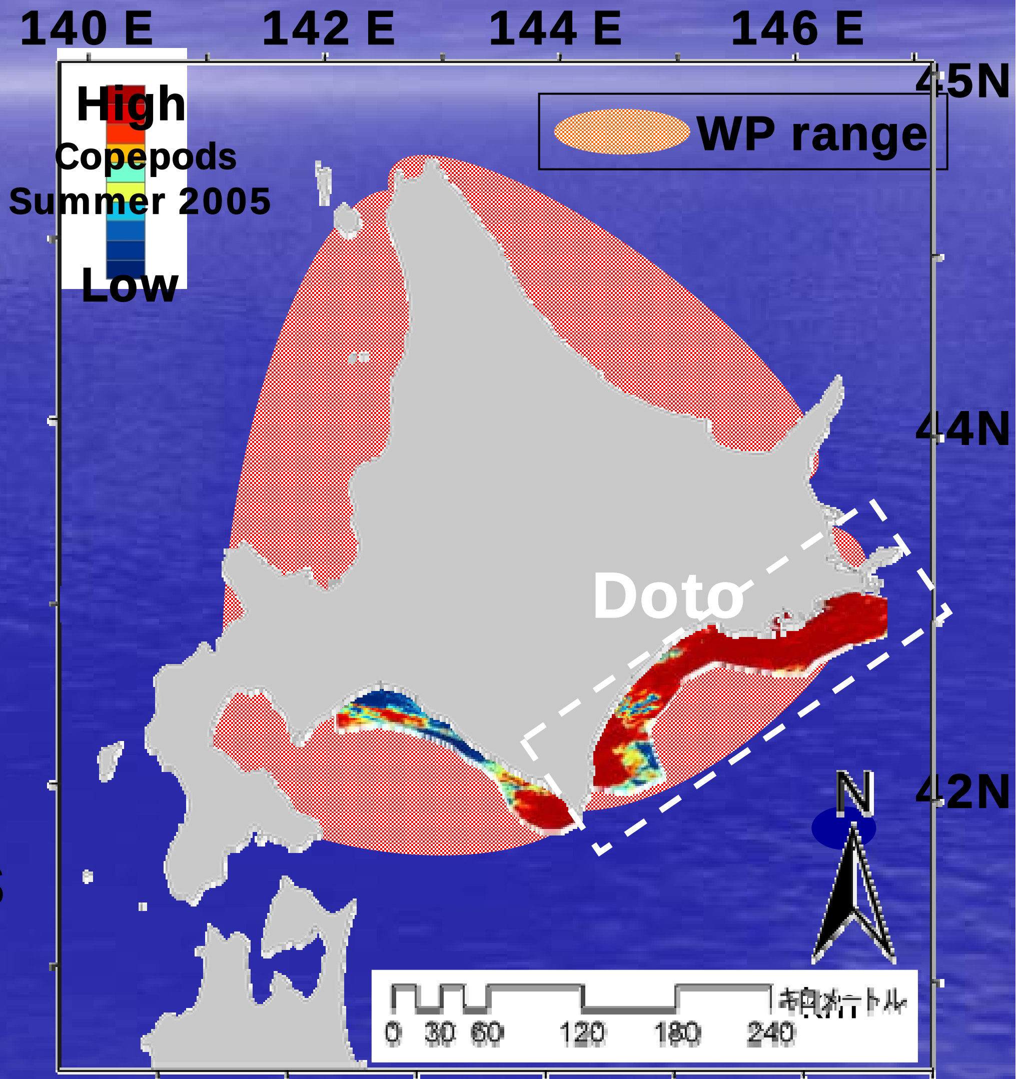
Fall…



- Cooking fall 2006 data today

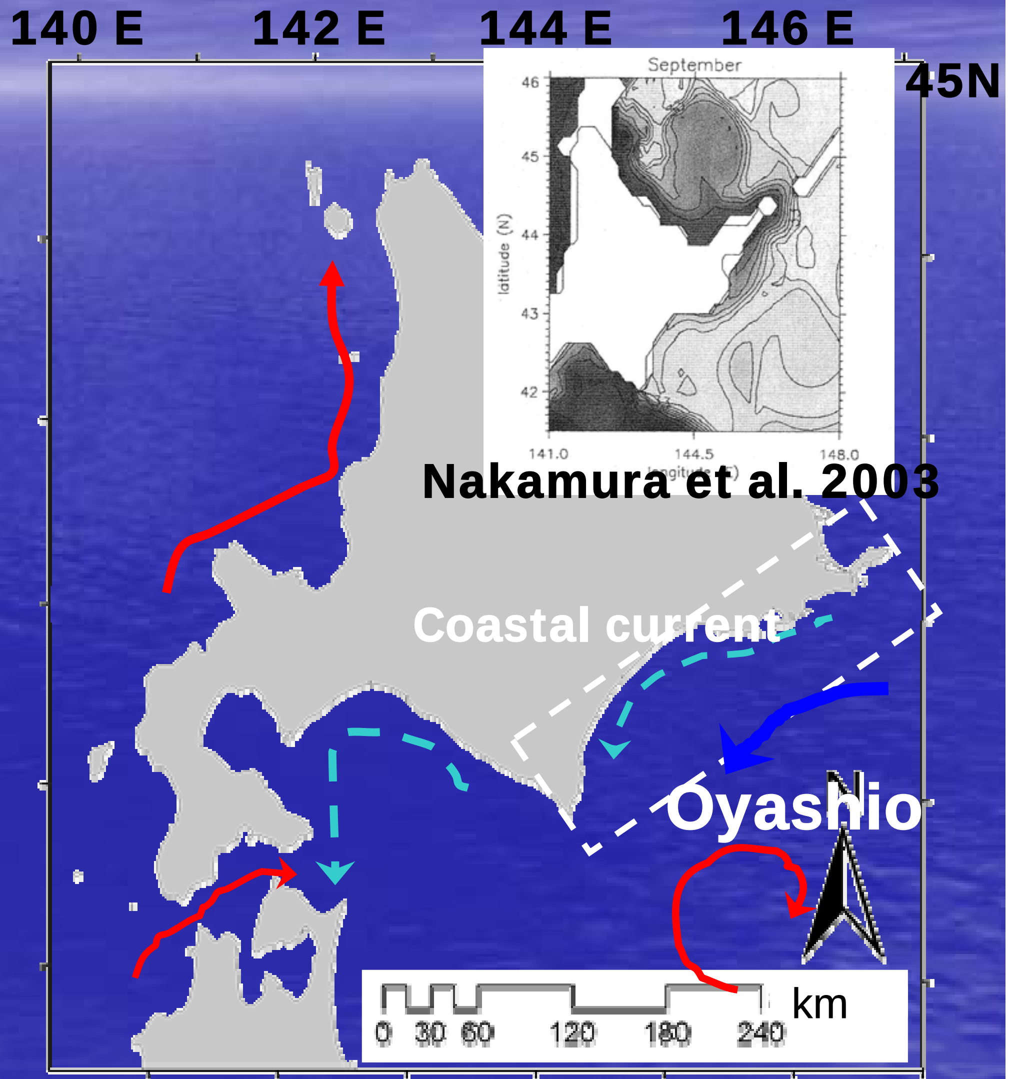
Walleye pollock in Pacific coast of Hokkaido

- Largest population along coast of Japan
- Doto area = feeding area for juveniles
  - Summer…from south, migrate into Doto area
  - Higher production with larger planktons



Doto area

- Offshore oyashio flow from northeast
  - Cold and less saline water…productive
  - Spatial extent is smaller in fall
- Coastal current
  - Affected from kuroshio-origin warm current clockwisely flow around Hokkaido
  - Generally more warm and saline compare to offshore in fall-winter



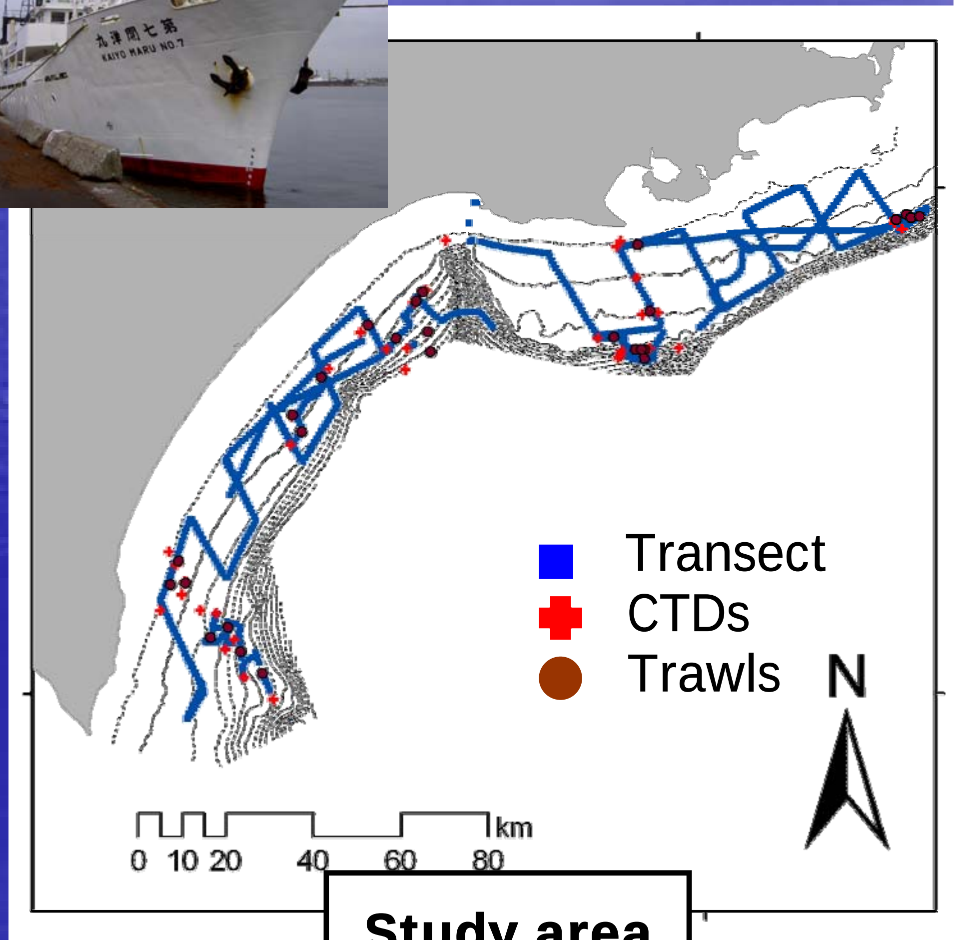
Goals

- To capture the spatial dynamics of the recruited walleye pollock in Doto area in fall
- From found dynamics, discuss the causal mechanisms from association to the environment

Study area and survey

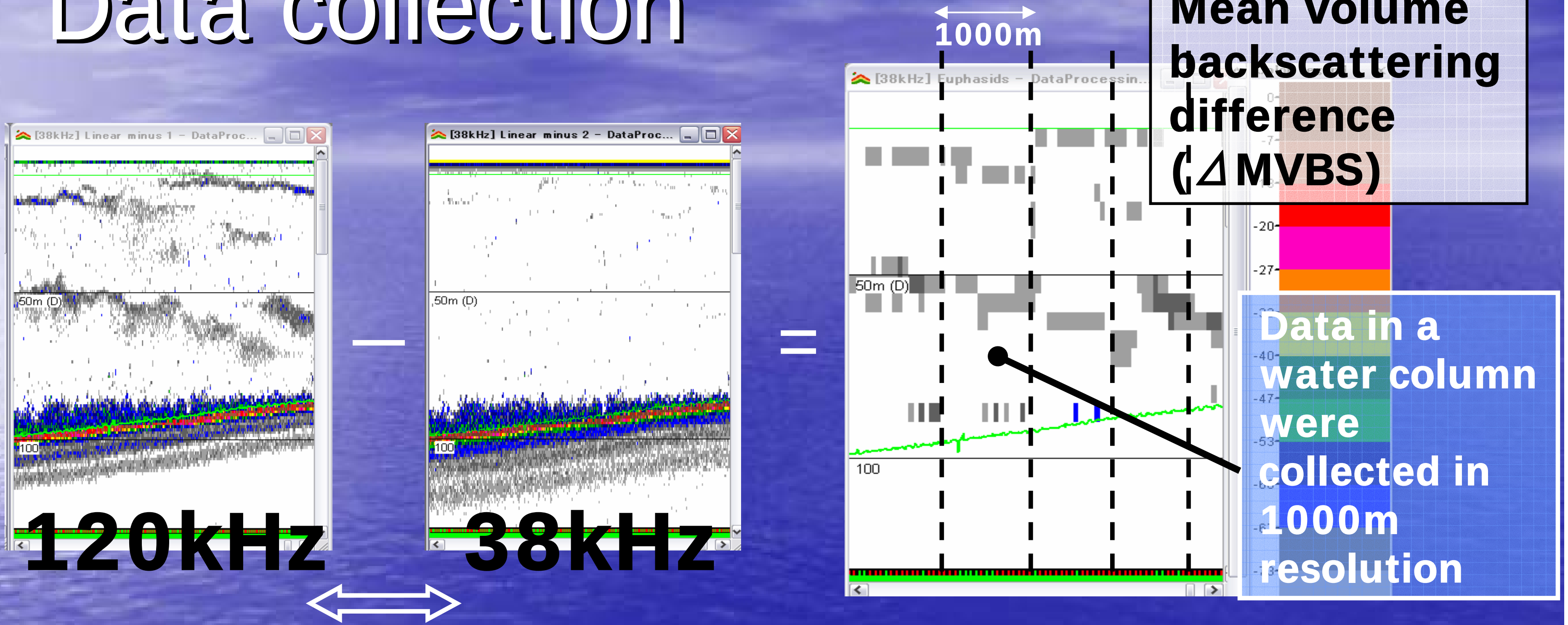
- 42-43N, 143-145E
- On shelf (depth: 0-200m)
- August 28th – September 6th 2006
- EK60 (SIMRAD)
  - 38kHz, 120kHz
- Bottom trawl (28 st.)
- FMT and Bongo net
- CTD (Temperature and Salinity: 36 st.)

R/V No.7 **Kaiyo** maru



Study area

Data collection

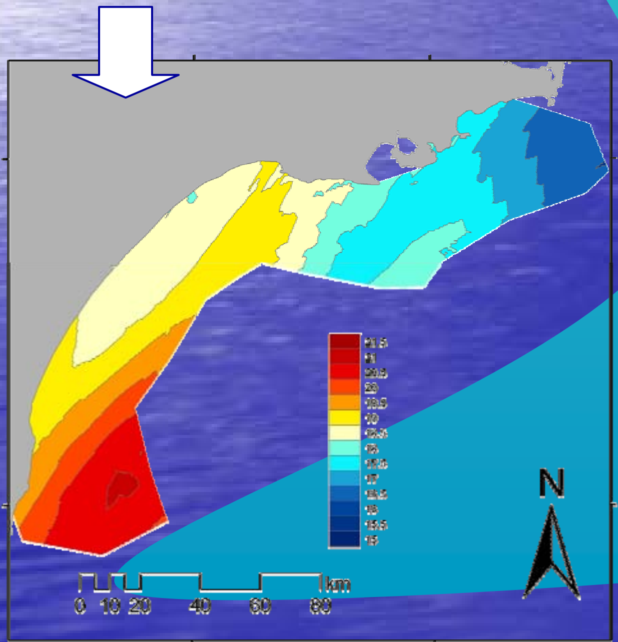


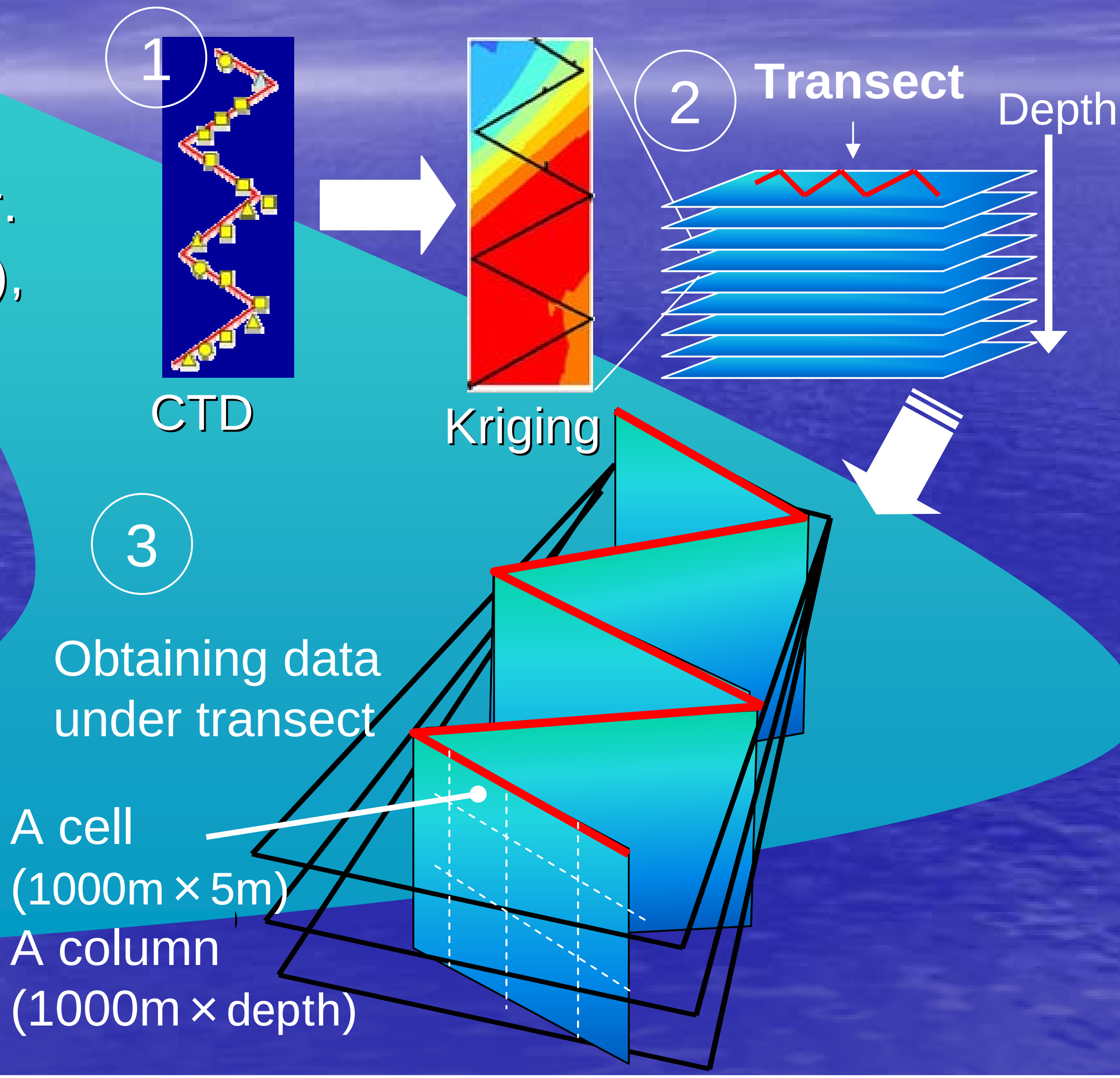
(Everson et al. 1993, Miyashita et al. 1997)

- **Juveniles**...obtained ΔMVBS from fish schools where sampling trawl confirmed >97% of catch is 0-age pollock
- **Planktons** (potential foods)...obtained ΔMVBS from models (**<u>Euphausids</u>**: DWBA, **<u>Small planktons</u>**: High-pass sphere)

Environmental data processing

Ordinal kriging interpolation (ArcGIS ver. 9.1)…RMS<0.5℃(Temp.), <0.06(Sal.)





Analyses

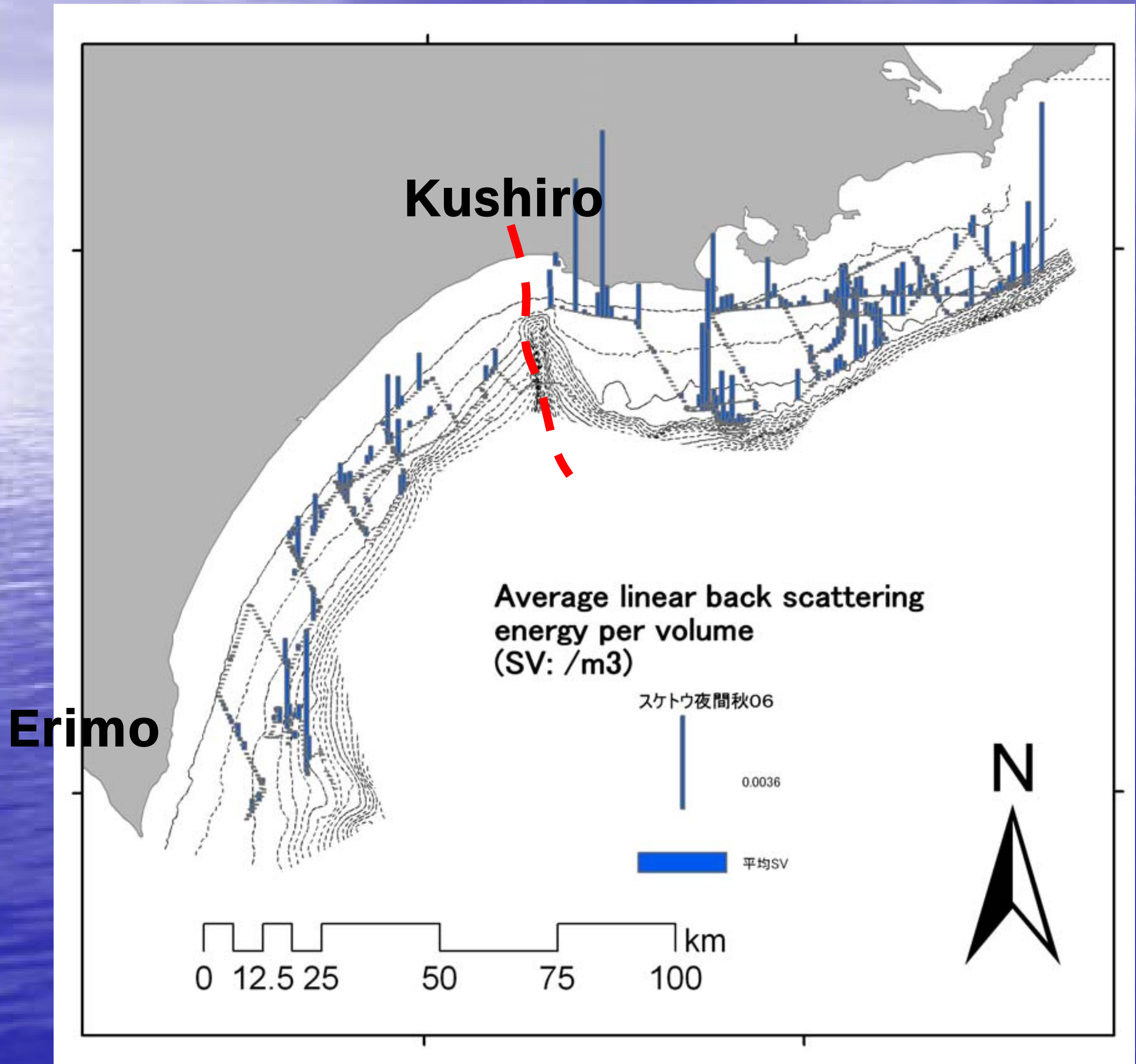
- Calculation of energy consumed
  - as index of cost being at the specific location
- Observation of associations between fish and Variables
  - environment, potential foods, and “cost”
- Test of associations to variables
  - Kendall’s rank correlation coefficient
  - Generalized additive regression

$$C = AcW^{Bc} f_{(T)} P$$

Ciannelli et al. 1998

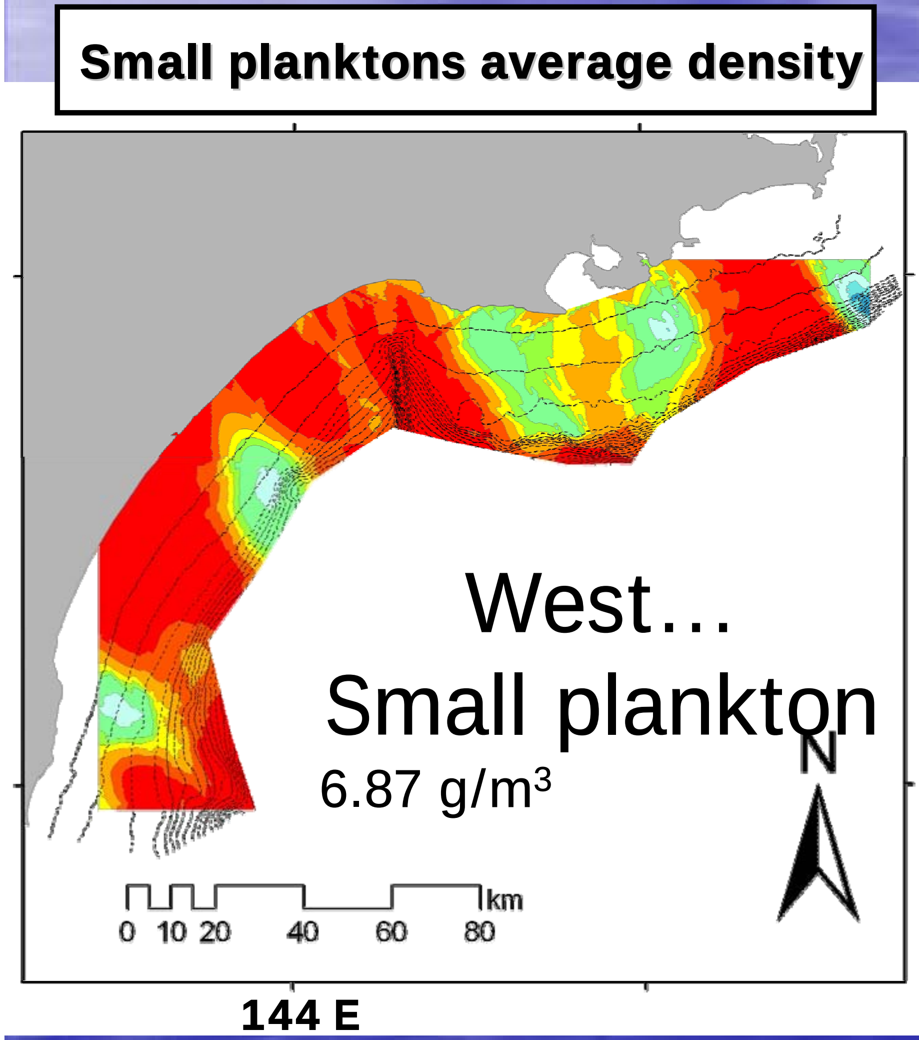
C: energy consumed (g/g/day)
Ac: Intercept of the allometric function
Bc: Slope of the allometric function
F(T): Function of optimum and maximum temperature for the fish
P: Proportion of maximum consumption (=1, this time)

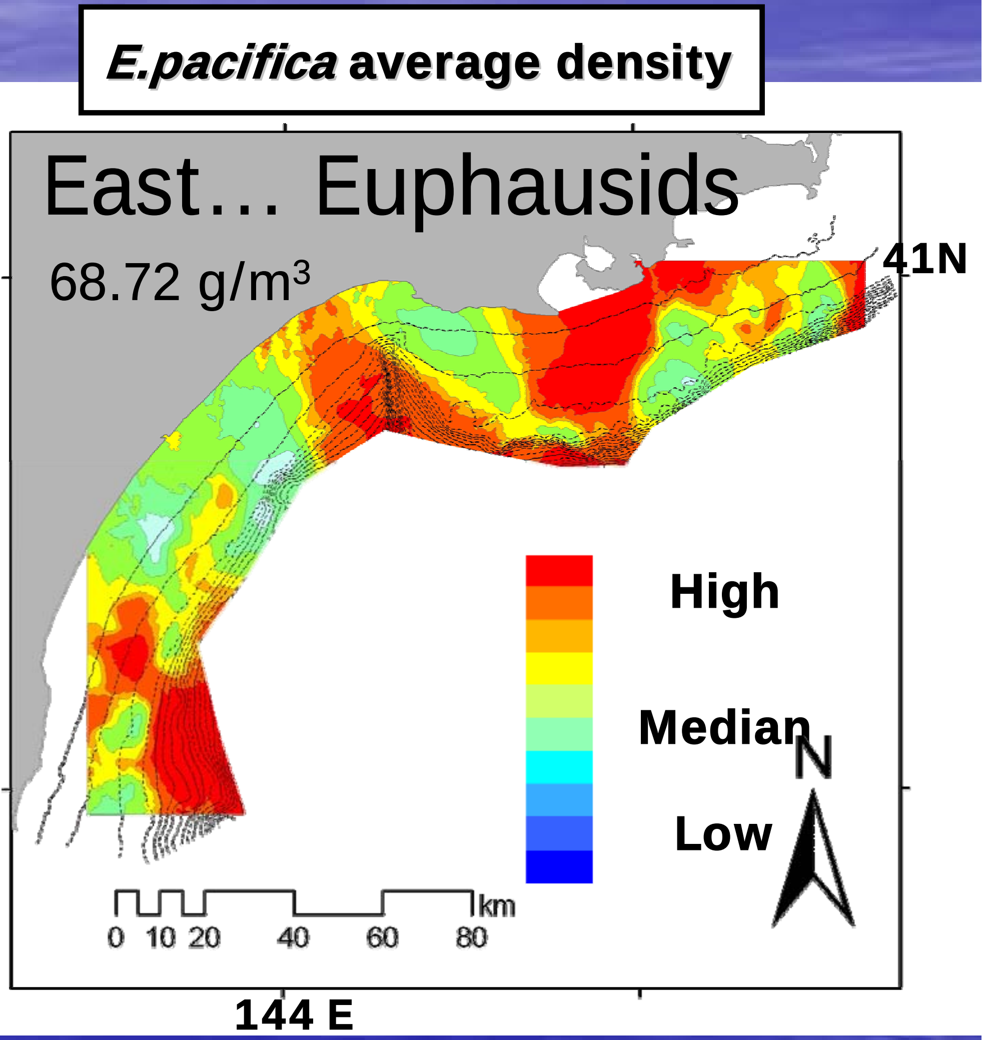
Results



- Fish concentrate Eastern Doto (>144.3E: Kushiro)
- Some extreme in western edge (Erimo)

Results



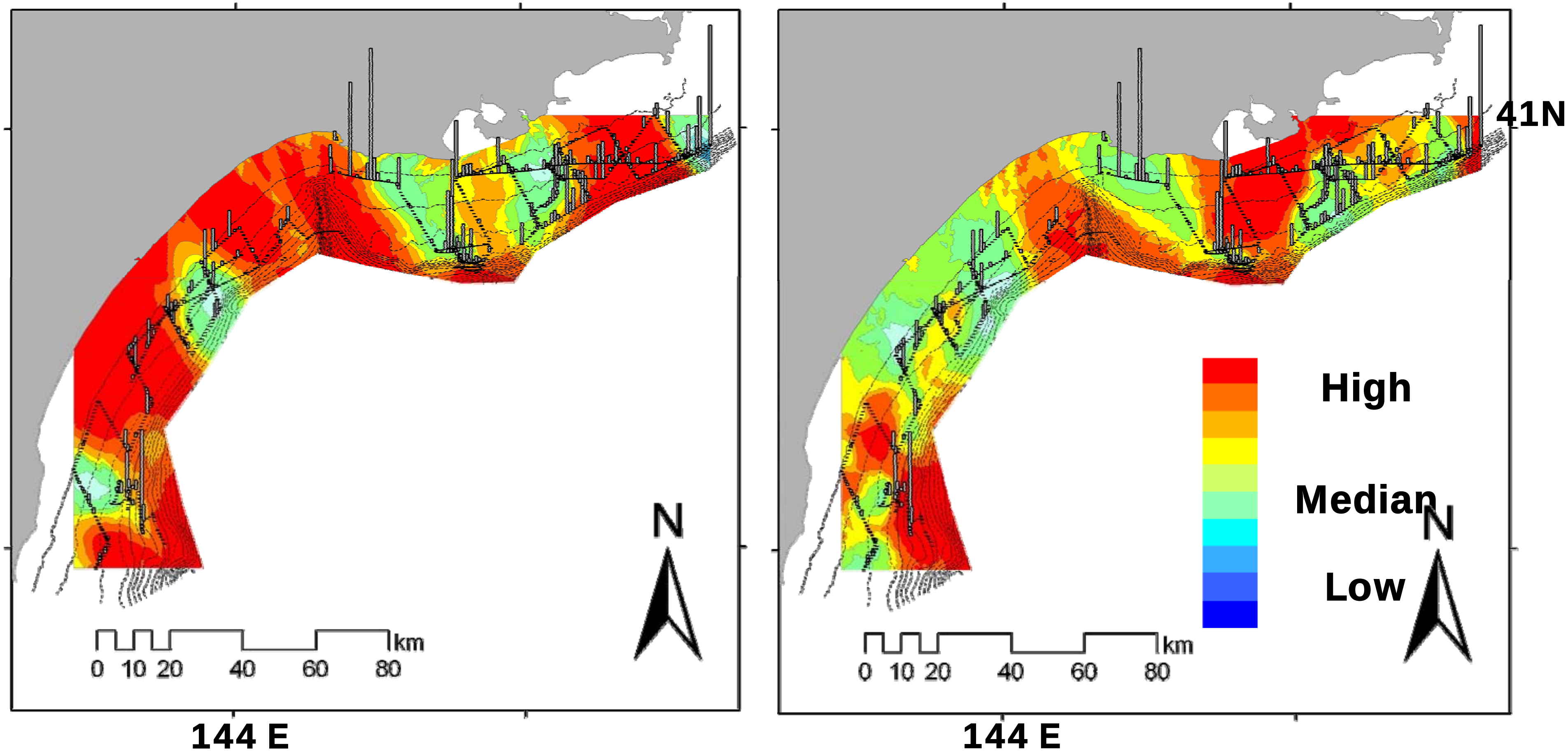


Near-shore “Mirror image”

Results

Small planktons density vs. fish

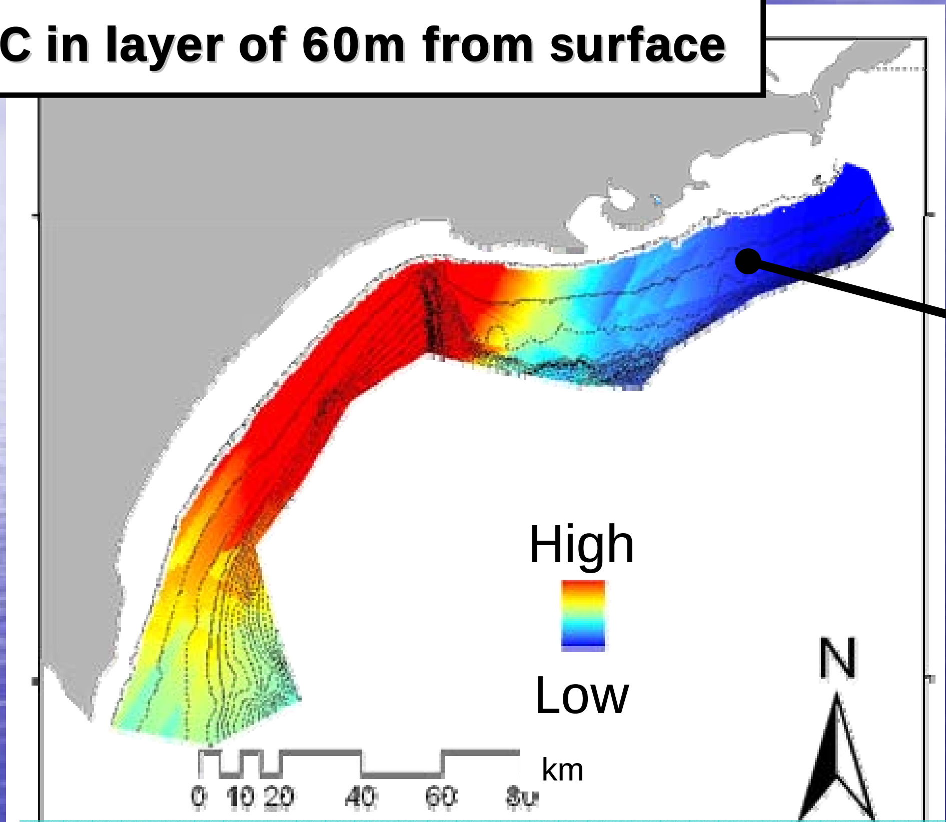
***E.pacifica* density vs. fish**

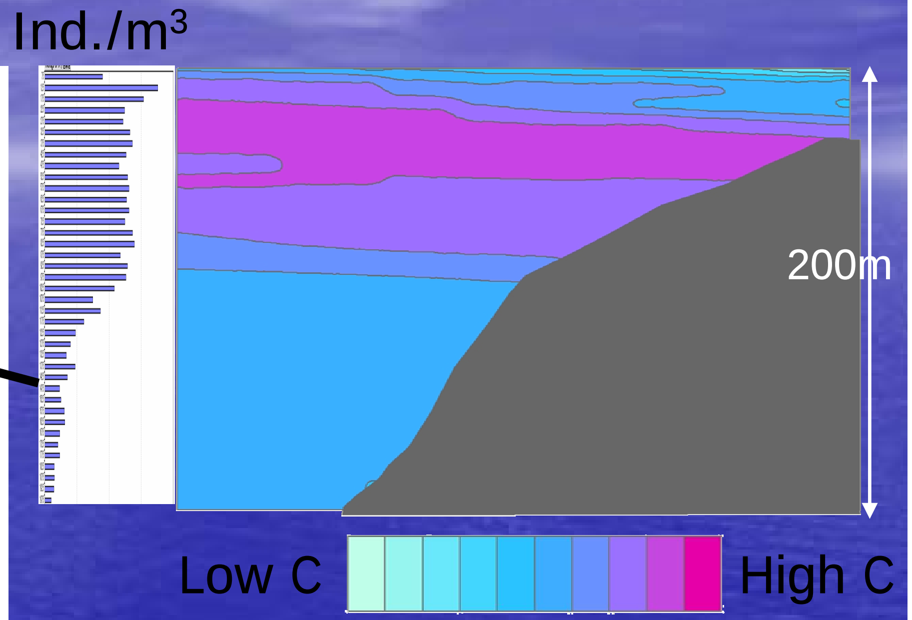


Finer scale…not obvious associations

Results

C in layer of 60m from surface





Above: A vertical profile of C of pointed location compared to the vertical distribution pattern of the fish

- Relatively "costly" water generally observed in shallower depth
- Western Doto requires more consumption cost in the distribution depth layer (>-100m)

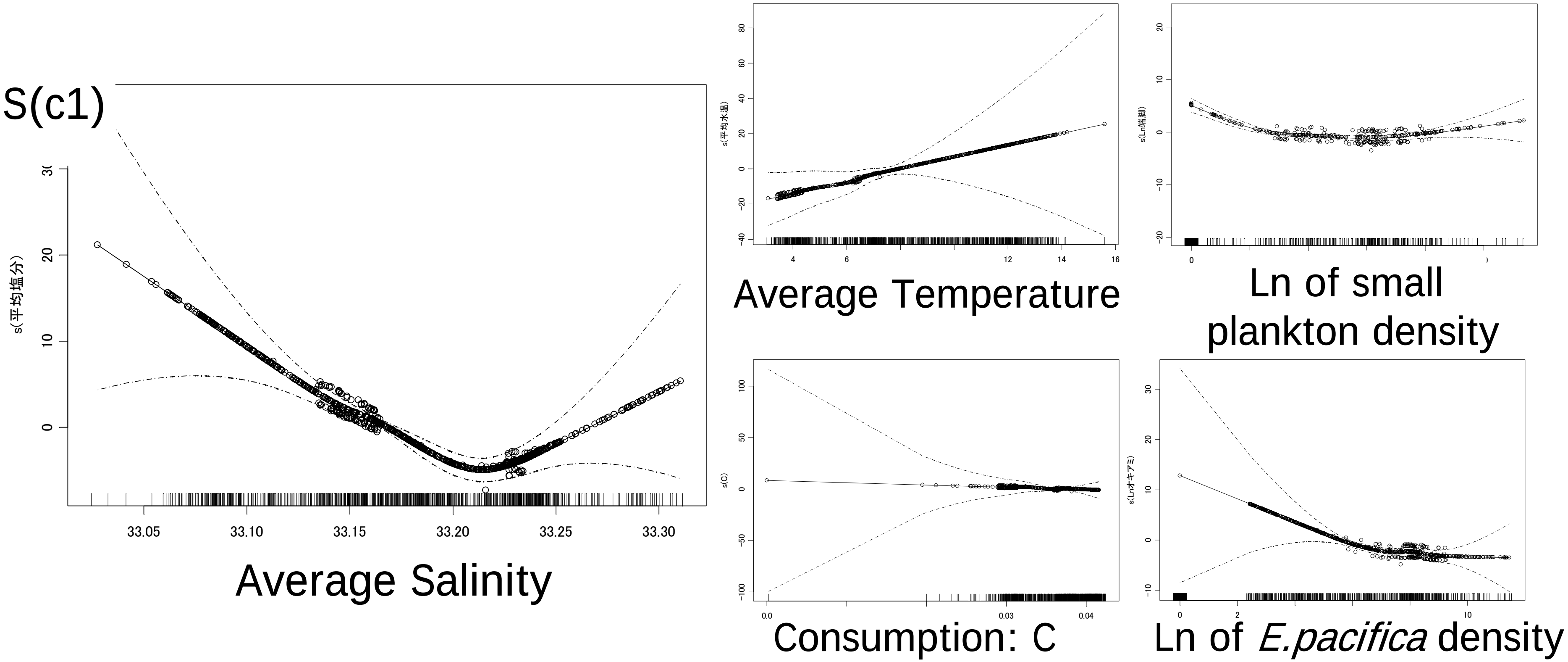
Results (general trend: Kendall's τ)

Kendall's rank correlation coefficient with average pollock density in each water column (under an 1-km section of the transect)

	τ	P
Temperature	0.17	≦0.001
Salinity	-0.12	≦0.001
Consumption	0.17	≦0.001
E.pacifica density	-0.24	≦0.001
Small plankton density	-0.33	≦0.001

- Temperature and consumption had positive association to juvenile abundance in the water column
- Salinity and food density had negative association to juvinile abundance in the water column

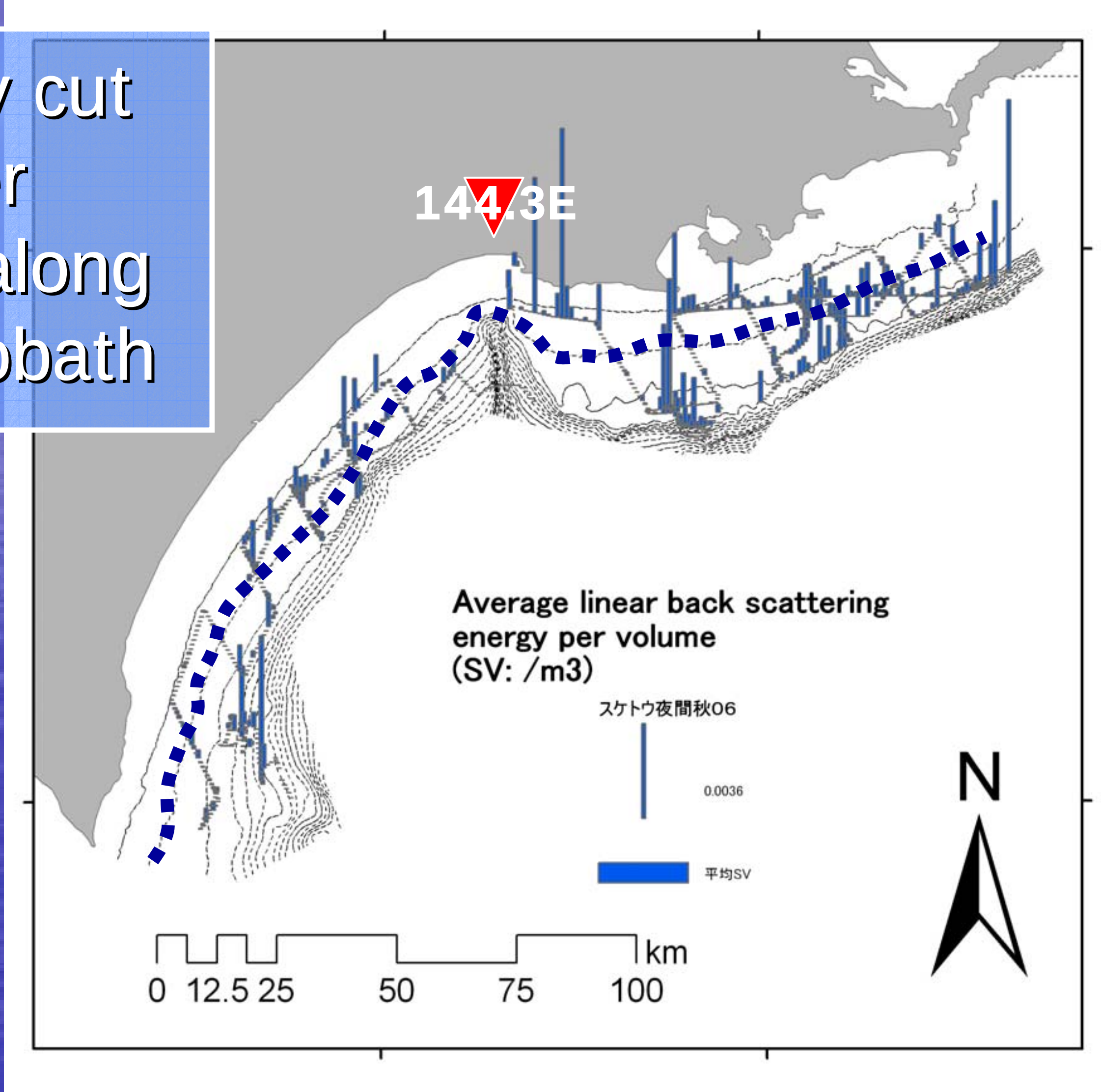
Results (Important determinant: GAM)



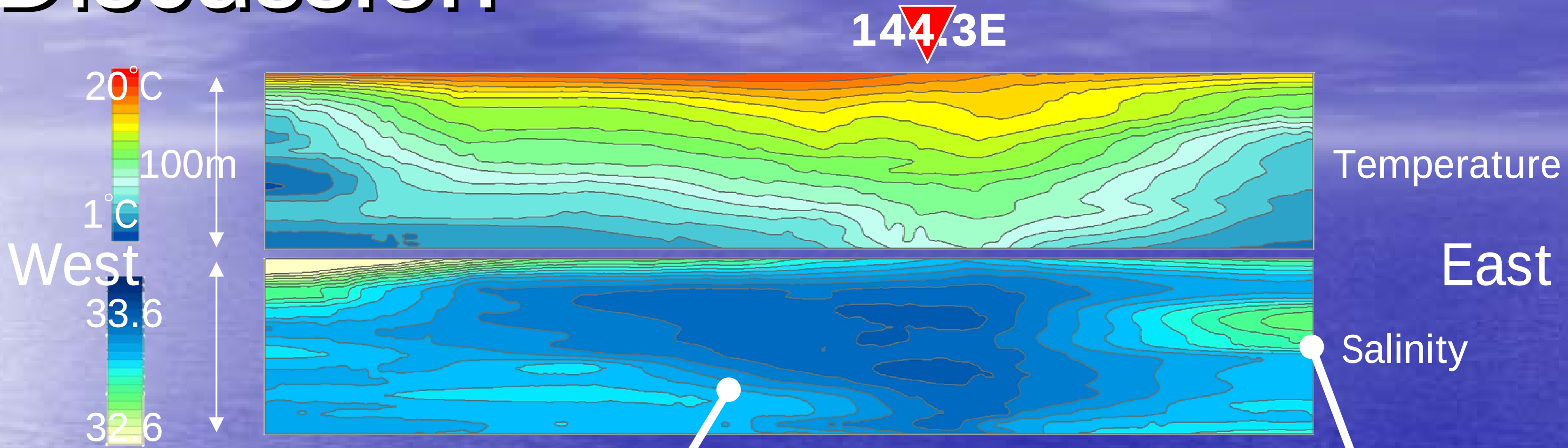
- Salinity showed significant relationship to explain presence or absence of juvenile pollock (P<0.05)
- Correlation b/w temperature and salinity

Discussion

Vertically cut the water column along 100m isobath



Discussion



Warm and saline costal water

Intrusion from offshore oyashio branch

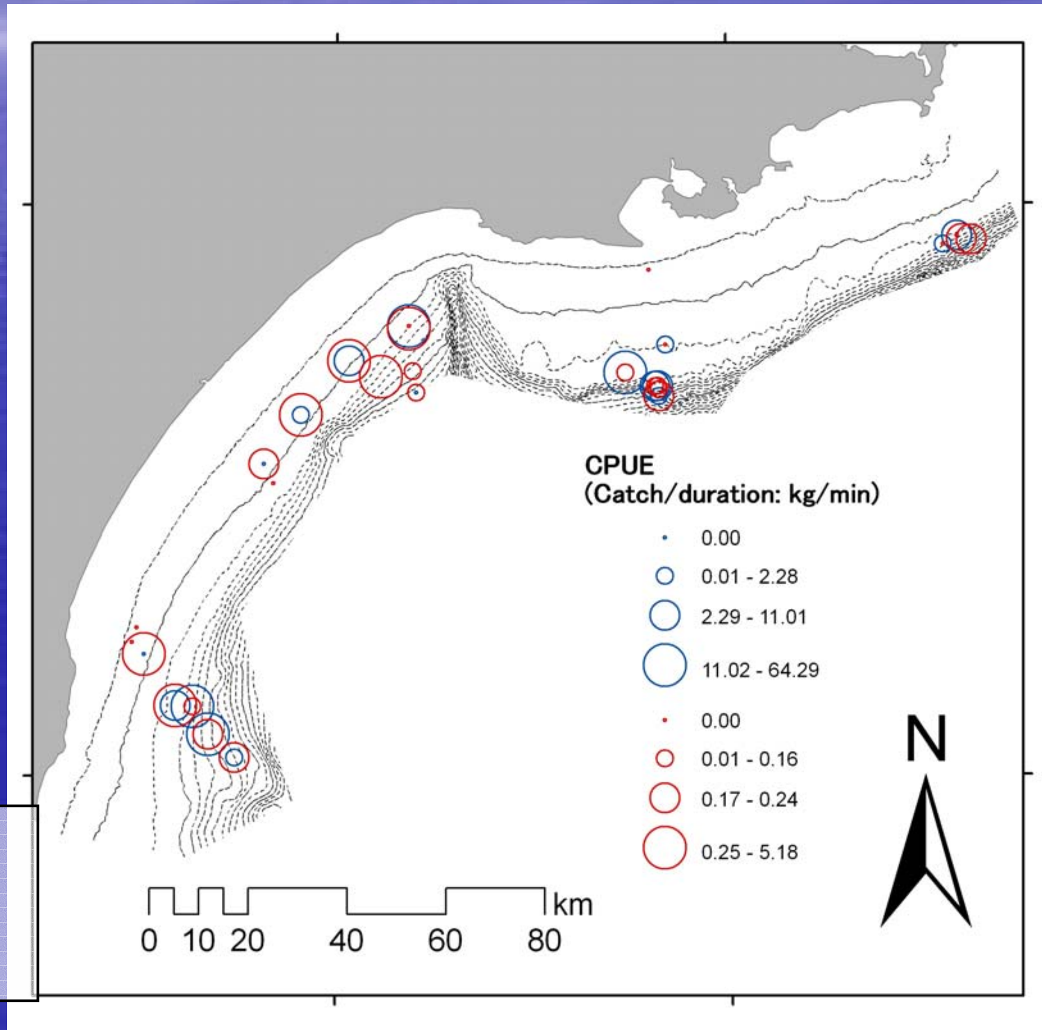
- Salinity did matter…occurrence trend in offshore origin water
- Less saline and warmer water; more fish in water column… distribution environment is offshore oyashio environment extended to nearshore/shallow area

Discussion

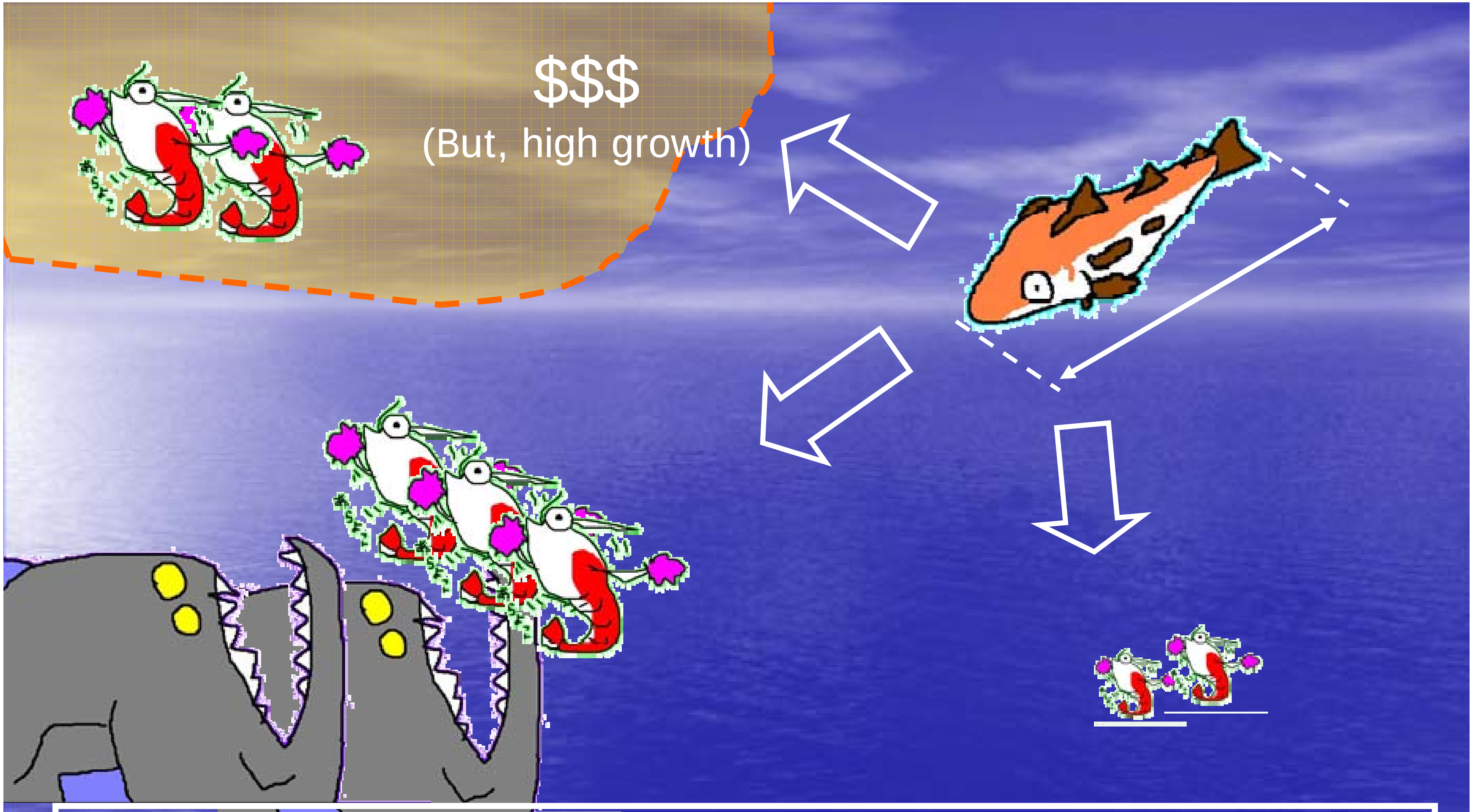
- Why were juveniles more in the eastern Doto?
  - Larger planktons such as Euphusids transported from north
  - Juveniles in fall is larger…Euphausids = better food for them
  - Less “cost” to be in the eastern Doto in fall
- But, more juveniles in “poor” water column in finer scale!
  - Something is making them to do so
- Why were more juveniles in “expensive” water column?
  - If there are enough food source filling their needs (benefit), potentially more growth: C=R+F+U+Growth(Winberg, 1956)
  - Also, different cost or risk might make them do so

Discussion

- Interaction with larger fishes from offshore
  - Occupying where the food condition is better
  - Predations



Adult pollock and Arrowteath Flounders CPUE (quartiles: kg/min. tow)



(1) They probably balance their size-dependent cost, benefit, and risk
(2) Species interaction is causing scale-dependent responses on distribution of fall juveniles

Next

- Quantification and test of cost-benefit-risk relationship in the juvenile distribution
- Time-series analysis
  - Spatio-temporal dynamics of CBR relationship
  - Offshore/nearshore oyashio dynamics
- Finding migration passages and habitats for specific size classes…modeling

He needs help

From "C-B-R" relationship, hope to provide a tool to balance of future fishing CBR and efficient management!

Acknowledgements

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