

# Long-term changes in food and feeding habits of common minke whales in western North Pacific region



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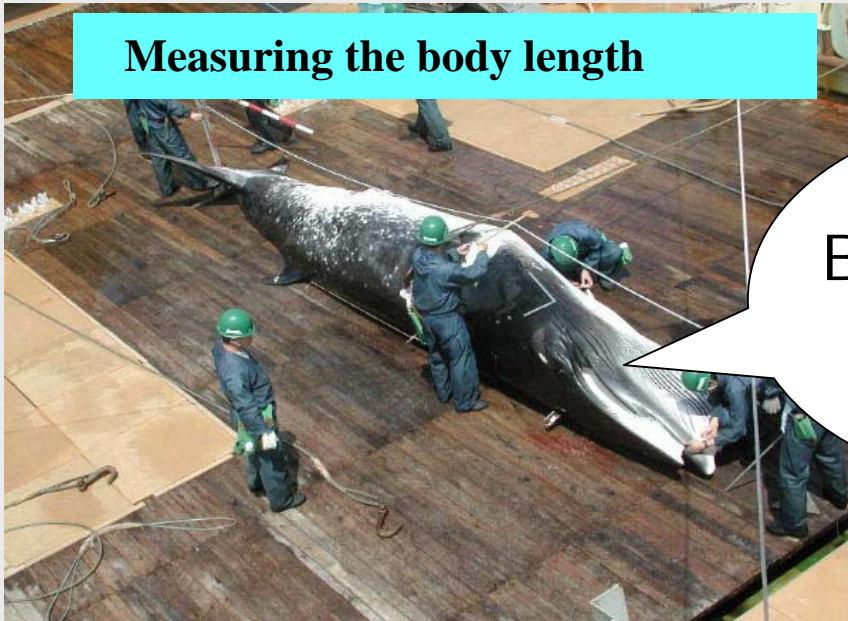
# Common minke whale

*(Balaenoptera acutorostrata)*

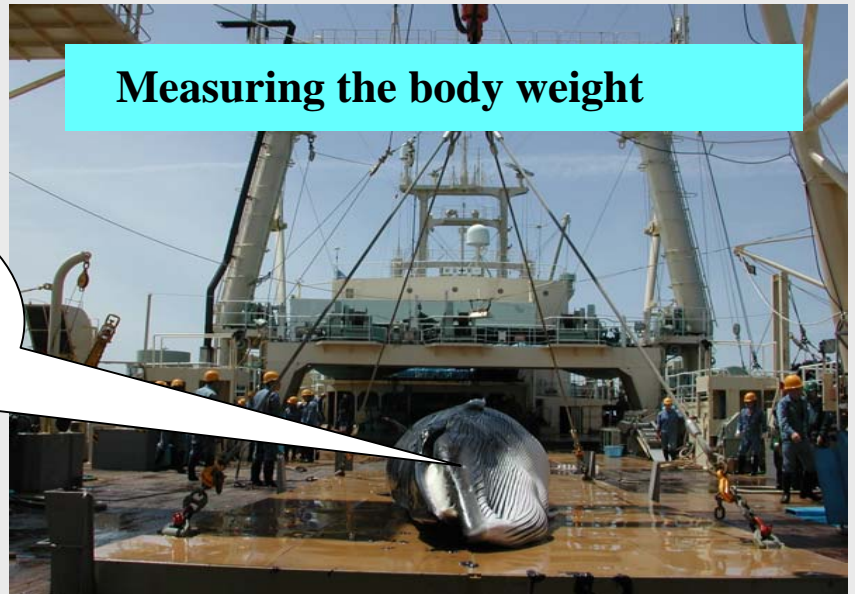


Male, Body length 7.2m Body weight 4.5t

# How much is the size of minke whale ?



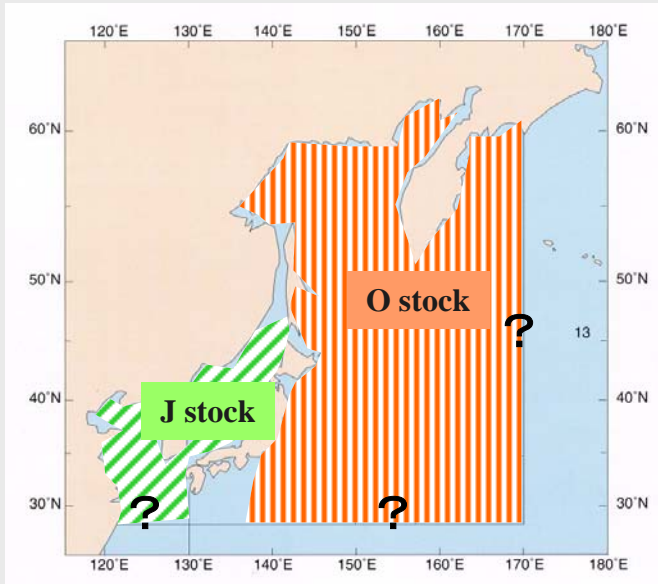
Body length  
7 - 8 m



Body weight  
5 - 6 t



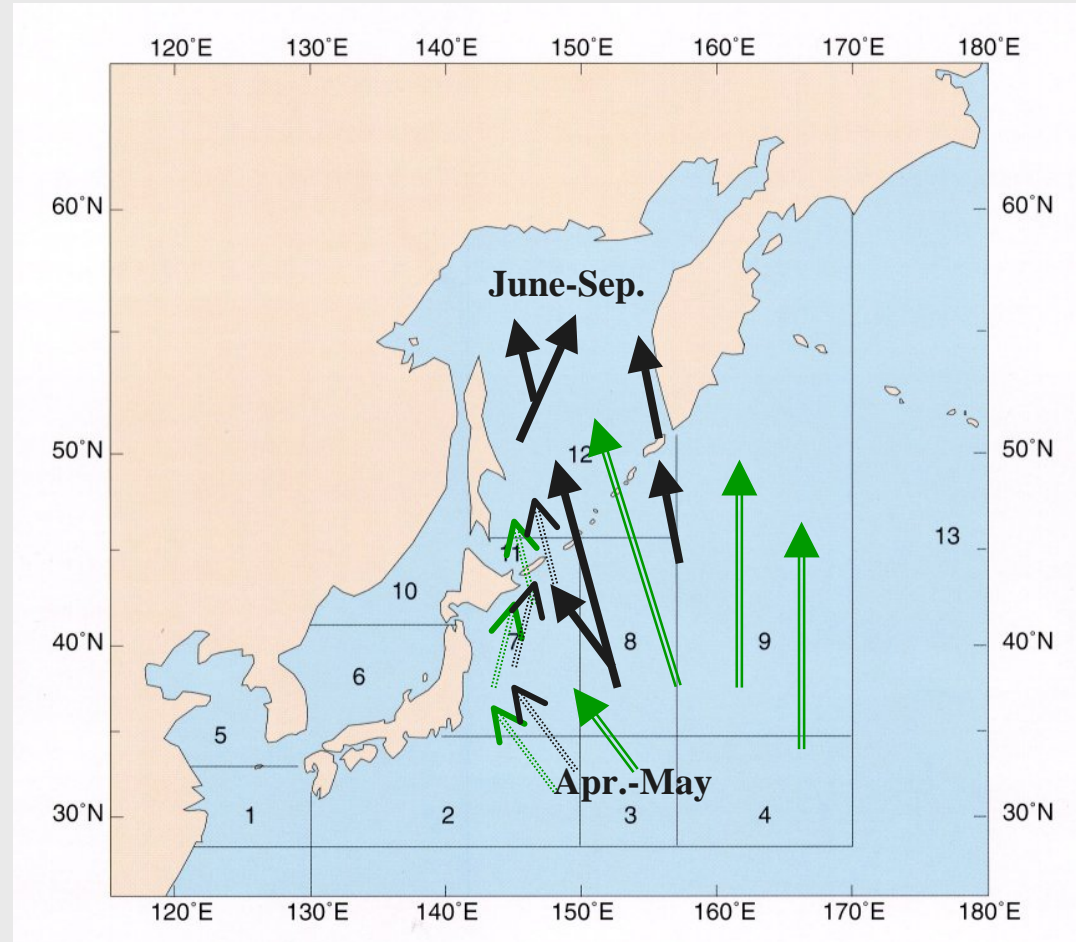
## Stock structure



Abundance (O stock)  
25,000 animals

IWC, 1992

## Migration pattern of common minke whale (O stock)

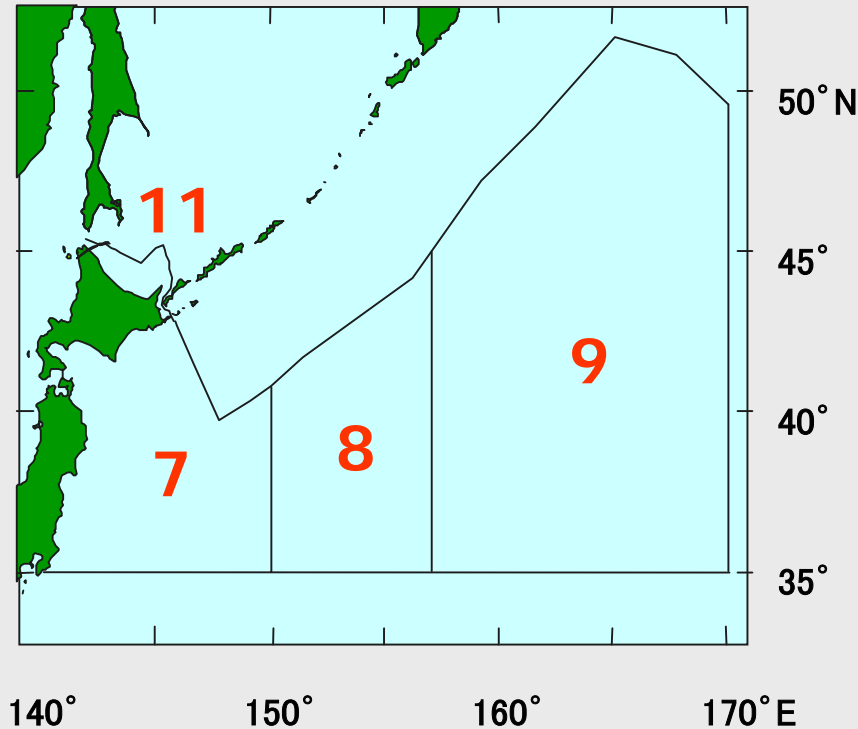


Immature

Mature  
Male

Mature  
Female

## Material and methods



- \* Commercial whaling ( - 1978)
- \* Scientific whaling (1994 - )  
**150 inds.**



## Objective

- \* To investigate **temporal and geographical variability** in the feeding ecology of minke whales
- \* To **estimate food consumption** and the **implication for marine ecosystem**

## Data

- \* Stomach contents  
(Commercial, Scientific)
- \* Sampling date and position
- \* Oceanographic data
- \* Echo-sounder analyses

# Prey species of common minke whale

## Major prey species

### Krill

*Euphausia pacifica*

### Squid

Japanese common squid

*Todarodes pacificus*

### Pisces

Japanese anchovy

*Engraulis japonicus*

Pacific saury

*Cololabis saira*

Walleye pollock

*Theragra chalcogramma*

## Minor prey species

### Copepods

*Neocalanus cristatus*

### Krill

*Thysanoessa inermis*

*T. inspinata*

*T. longipes*

### Pisces

Japanese sardine

*Sardinops melanostictus*

Chub mackerel

*Scomber japonicus*

Japanese pomfret

*Brama japonica*

Pink salmon

*Oncorhynchus gorbuscha*

Coho salmon

*O. kisutch*

Chum salmon

*O. keta*

Japanese sand lance

*Ammodytes hexapterus*

Barracudinas

*Paralepis atlantica*

Daggertooth

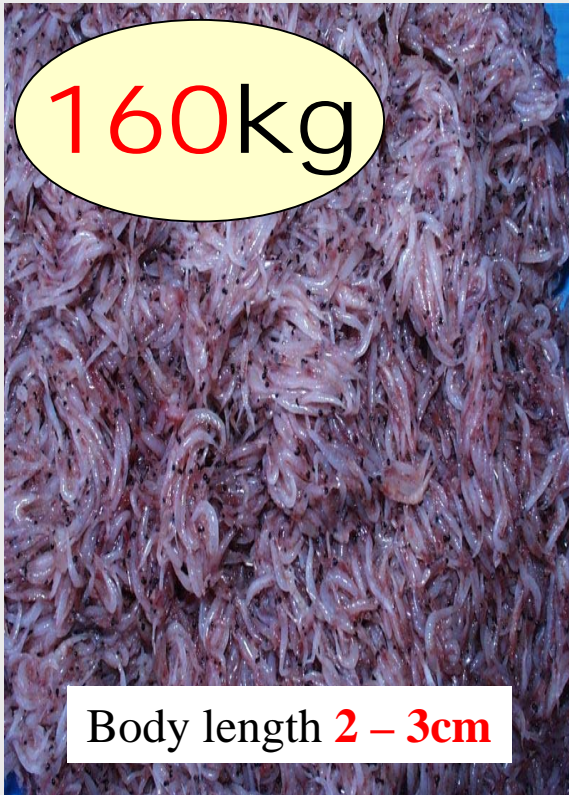
*Anotopterus pharao*



# Major prey species of common minke whales in western North Pacific

## Krill

(*Euphausia pacifica*)



## Japanese anchovy

(*Engraulis japonicus*)



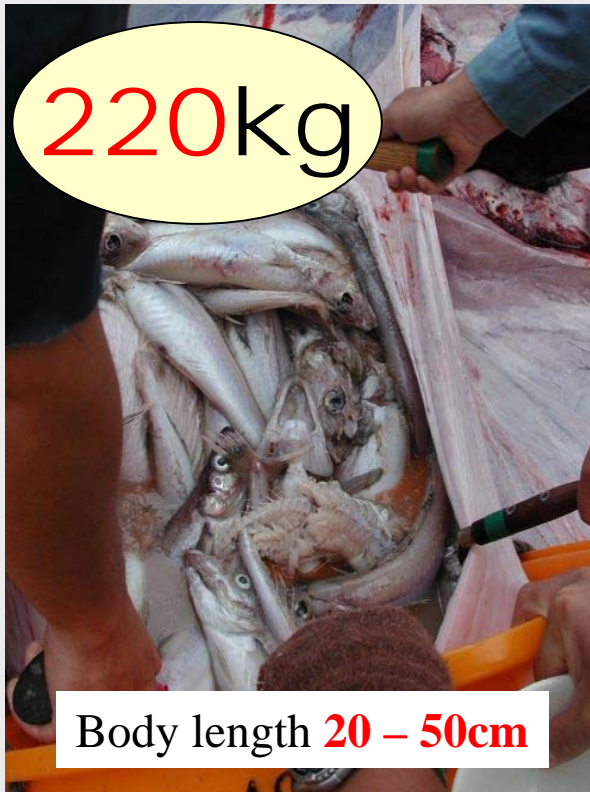
## Pacific saury

(*Colorabis saira*)



# Major prey species of common minke whales in western North Pacific

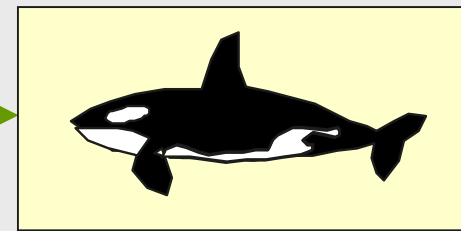
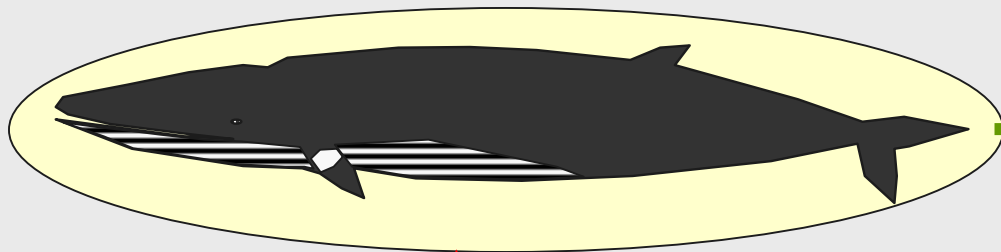
**Walleye Pollock**  
(*Theragra chalcogramma*)



**Japanese common squid**  
(*Tadarodes pacificus*)





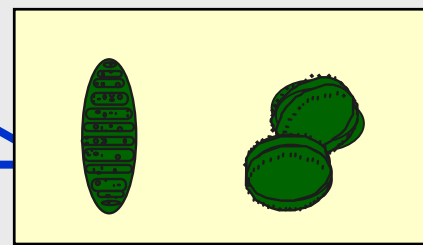
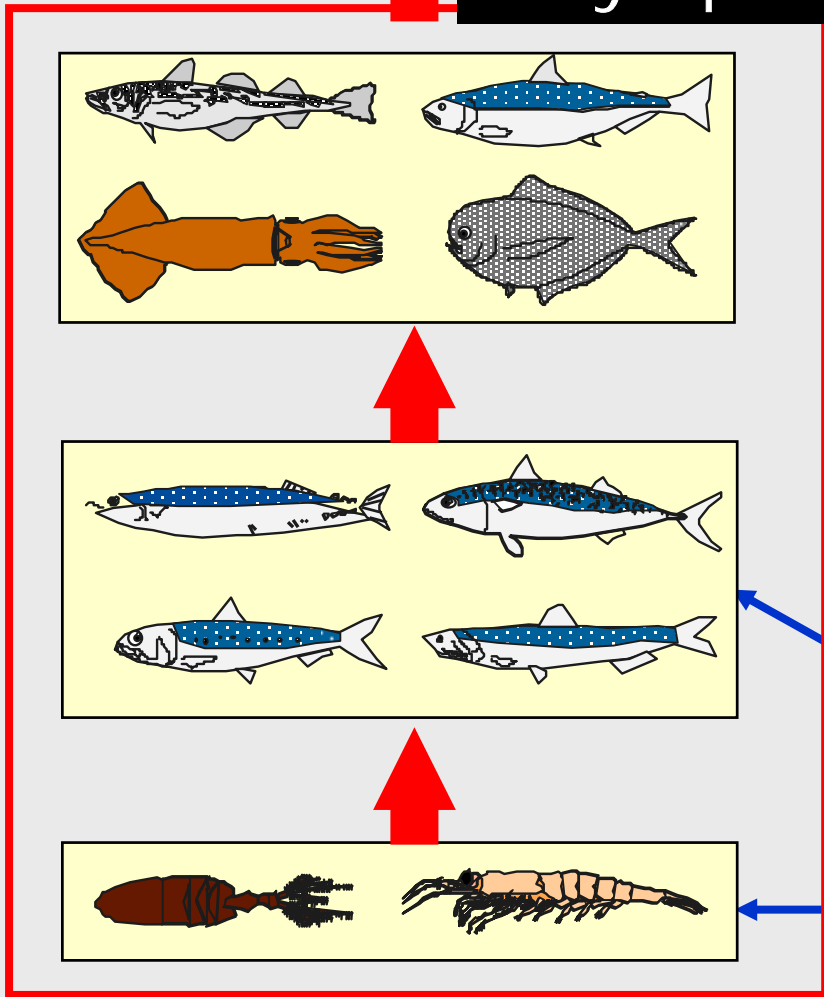


**Prey Species**

Predator

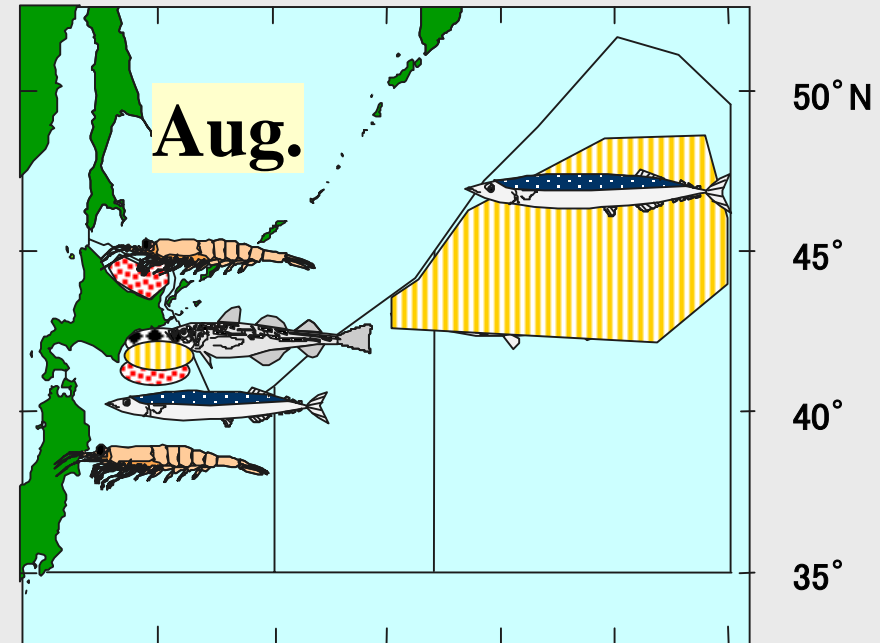
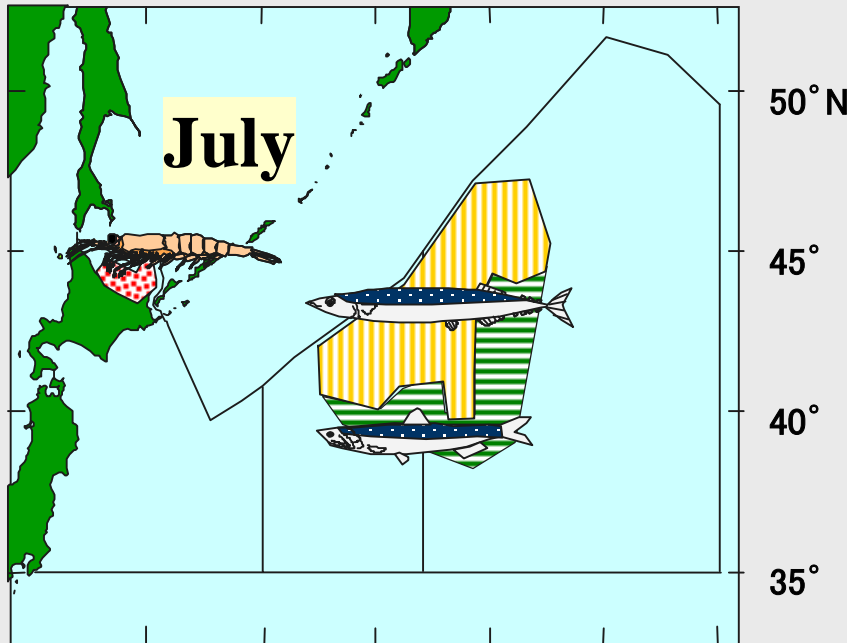
Schematic of food chain  
in relation to common  
minke whales  
in western North Pacific

Phytoplankton





# Geographical and monthly change of prey species 1994-1999 (Summer)



140° 150° 160° 170°E

140° 150° 160° 170°E

- |  |                  |   |                 |
|--|------------------|---|-----------------|
|  | Japanese anchovy |  | Krill           |
|  | Pacific saury    |  | Walleye pollock |

## Main prey species

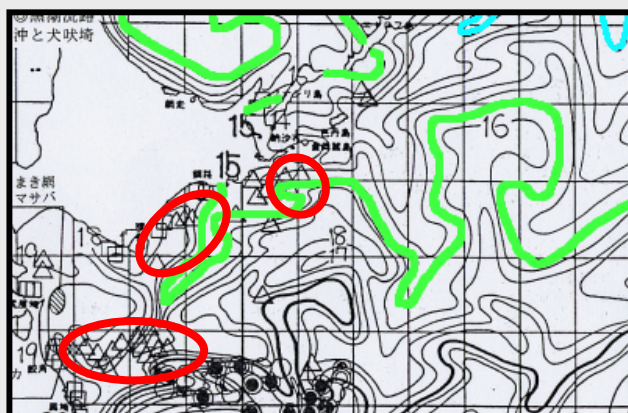
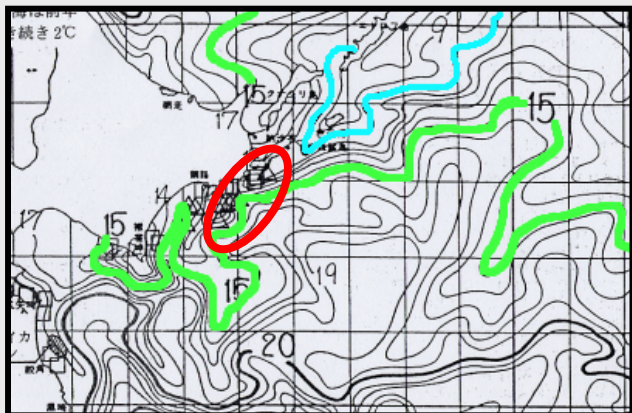
Coastal: Pacific saury, Walleye pollock, krill

Offshore: Pacific saury, Japanese anchovy

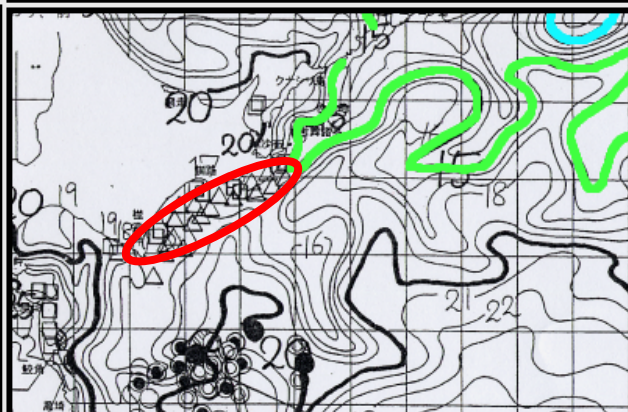
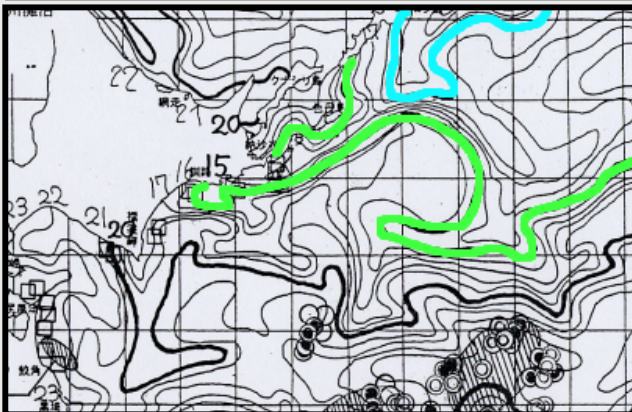


# Distributions of Saury's fisheries grounds and water temperature

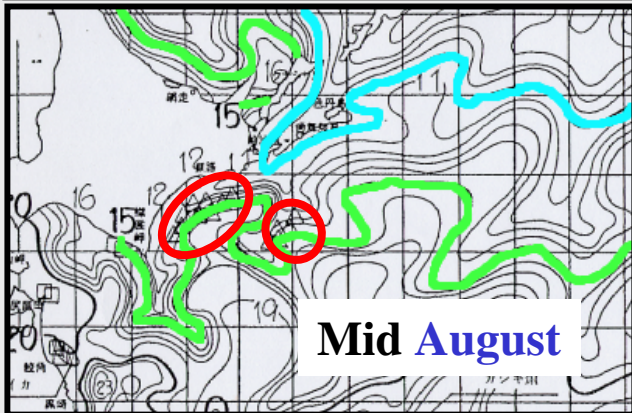
**1996**  
(1994)  
(1995)  
(1997)



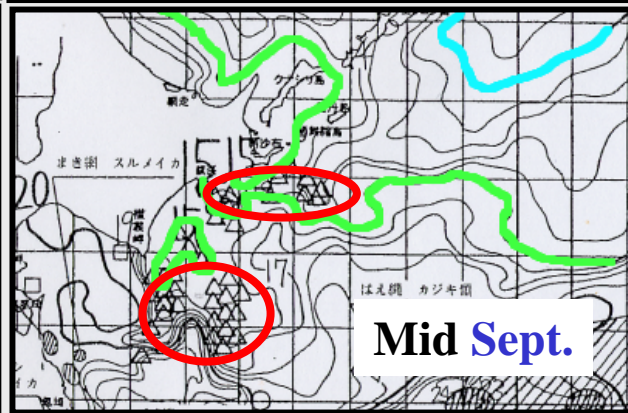
**2000**  
(1998)  
(1999)



**2002**  
(2001)



**Mid August**



**Mid Sept.**

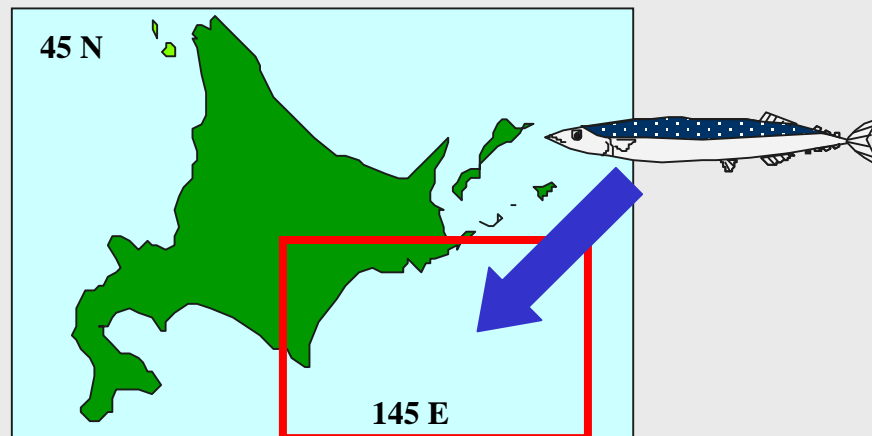
Water  
Temperature  
— 10 °C  
— 15 °C

Fisheries  
grounds



Fishing grounds in  
the North Pacific  
from JAFIC  
(1994-2002)

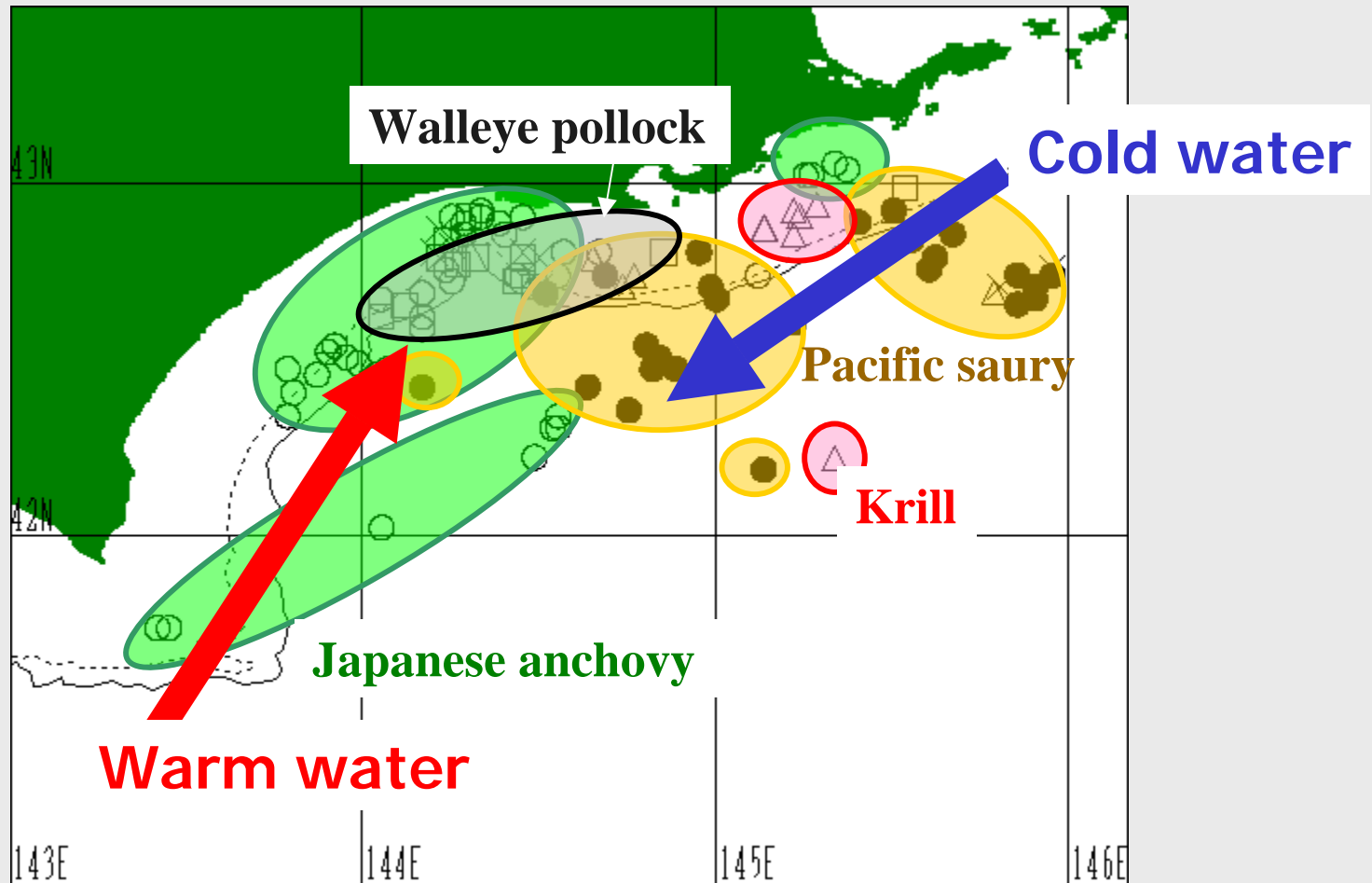
# Short-term change



Year	Water Temperature	Dominant prey species	
		May, June	Aug., Sept.
1994-1997	Normal	J. anchovy	P. saury
1998-2000	<b>Warm</b>	J. anchovy	J. anchovy
2001-2002	Normal	J. anchovy	P. saury

The going south movement of Pacific saury was delayed due to be **high sea water temperature**.

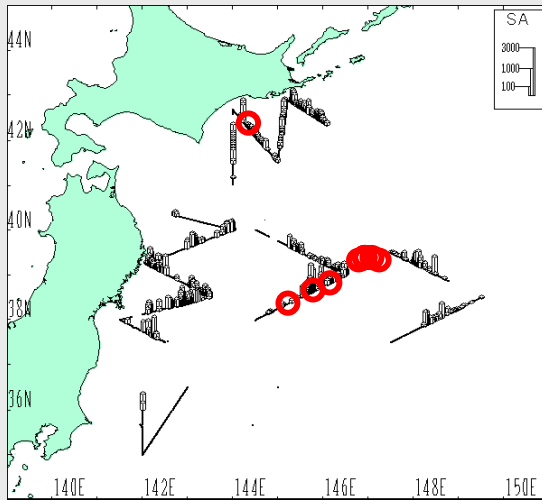
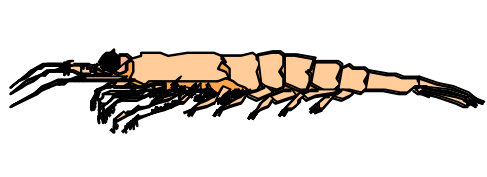
# Distribution of common minke whales and their prey species around east of Hokkaido in September and October, 2003



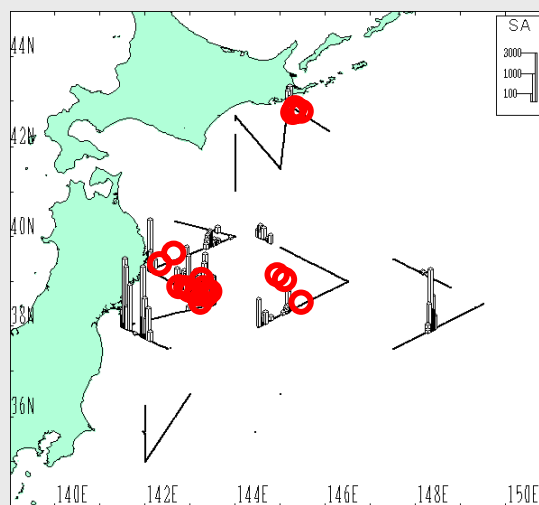
**Minke whales are opportunistic feeders.**



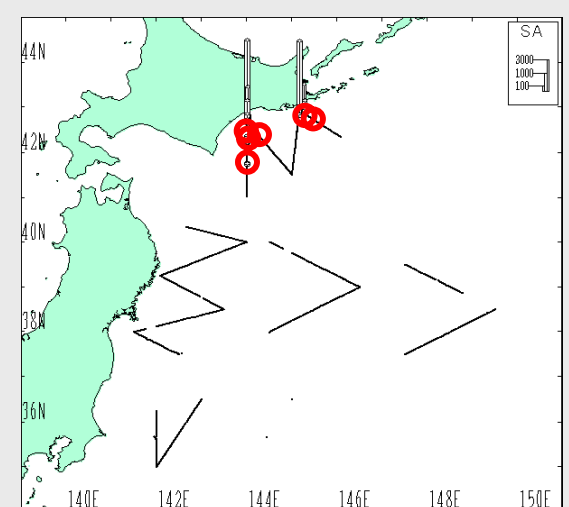
# Results of echo-sounder and sighting position of minke whales in May and June, 2001



**Krill**



**Japanese anchovy**



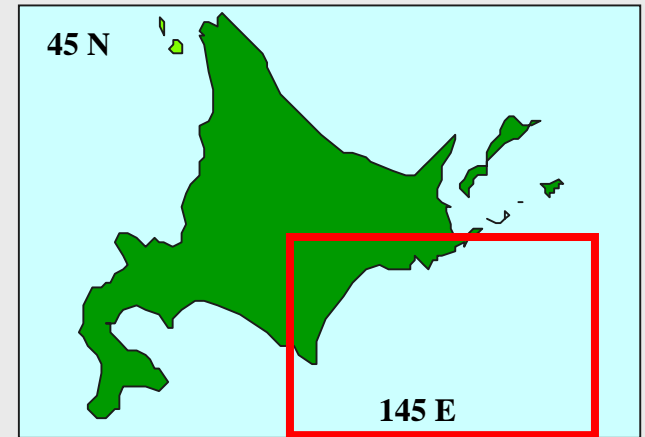
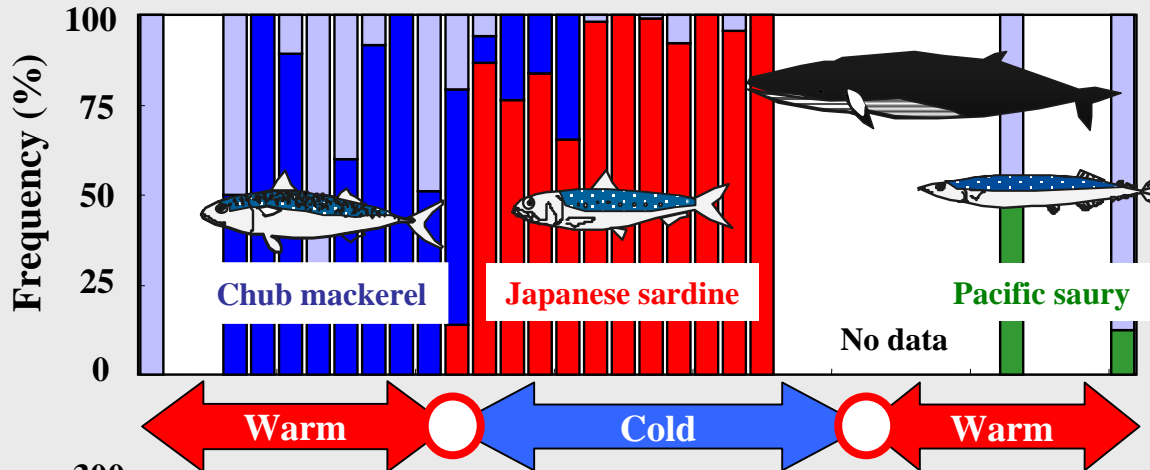
**Walleye pollock**

**○ Minke whale**

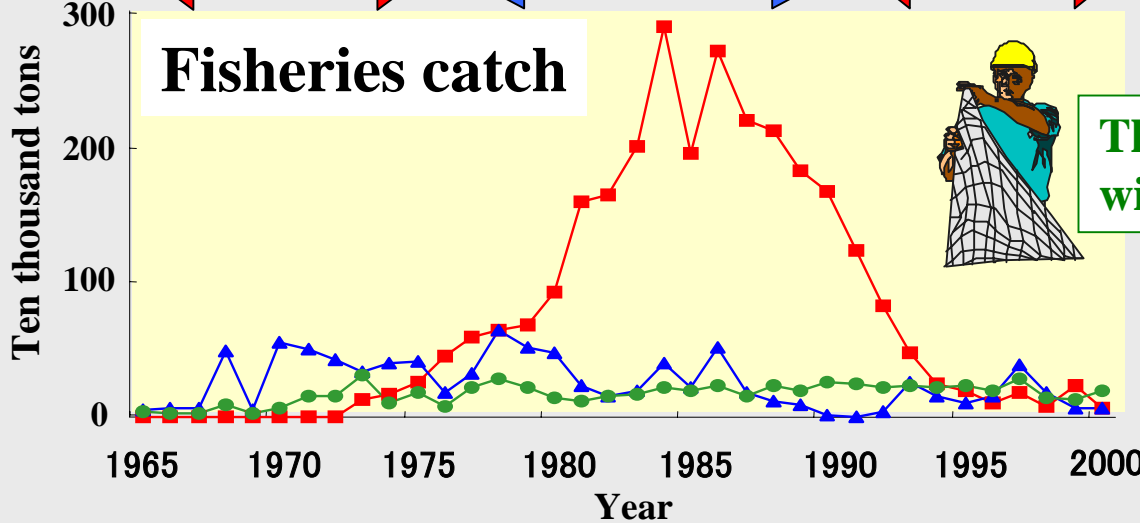
**Minke whale can feed on abundant prey in each area.**

# Long-term change

## Dominant prey of minke whale



Regime shifts



These changes were corresponded with regime shifts.

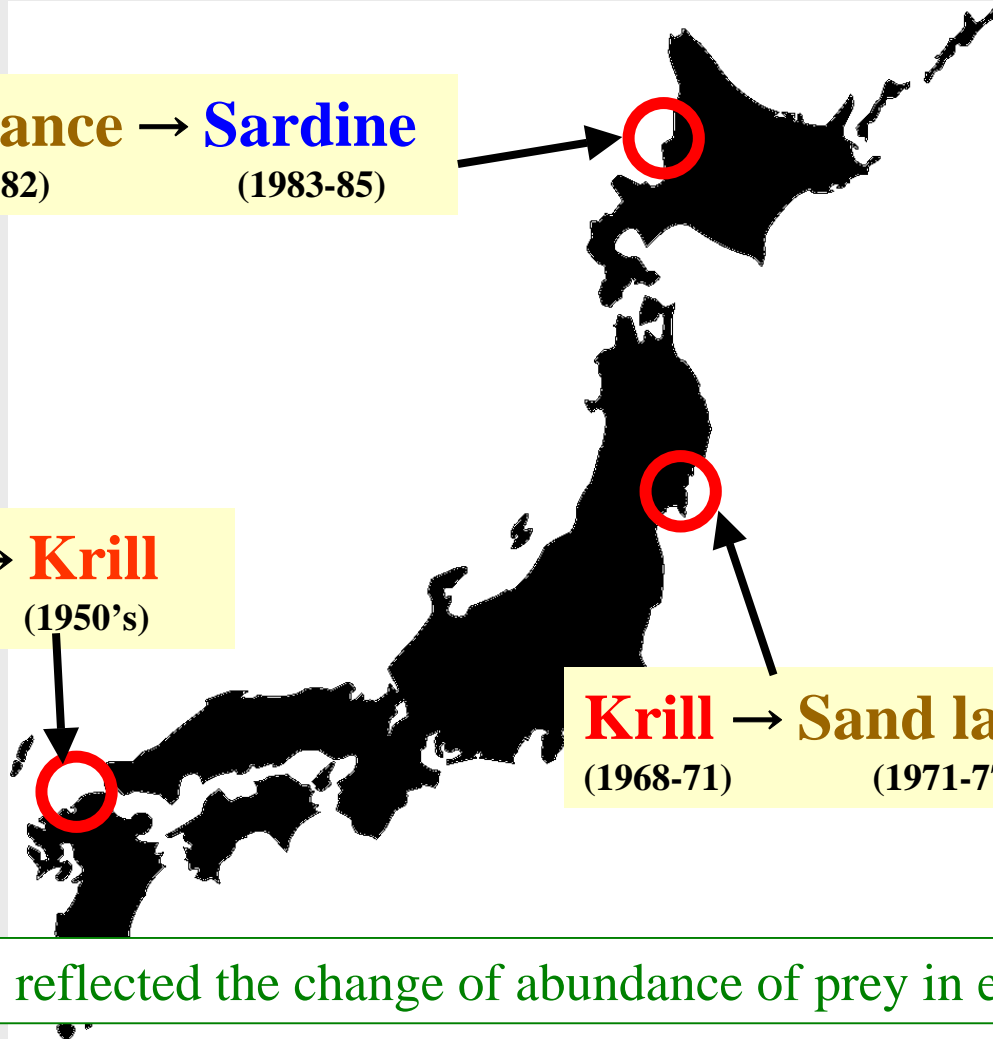
Tamura and Fujise (2002)

# Long-term change

**Krill** → **Sand lance** → **Sardine**  
(1970-75) (1976-82) (1983-85)

**Sand lance** → **Krill**  
(1948-49) (1950's)

**Krill** → **Sand lance** → **Sardine**  
(1968-71) (1971-77) (1978-87)



Prey switching was reflected the change of abundance of prey in each area and season



## Daily prey consumption of common minke whale

$$D = 206.25M^{0.783} ; I = D / E *$$

\*: Sigurjonsson and Vikingsson (1998)

*D* : Daily require energy contents (kcal per day)

*M* : Body weight of whales (kg)

*I* : Daily prey consumption (kg per day)

*E* : Energy contents of prey species (kcal per kg)

Feeding days: **200 days**

*E* : **Japanese anchovy** (S.L 120mm) **1,530 kcal/ kg**

**Pacific saury** (S.L 300mm) **3,140 kcal/ kg**

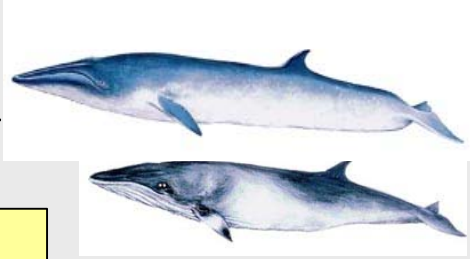
**Zooplankton** (krill) **850 kcal/ kg**

→ **Average contents: 1,700 kcal/ kg**

→ Daily prey consumption: **200 kg**

# Future output of JARPN II research

**Whales**



**Our results**  
\* Prey composition  
\* Prey consumption

MULTSPEC  
model



**Squid**



**Walleye pollock**



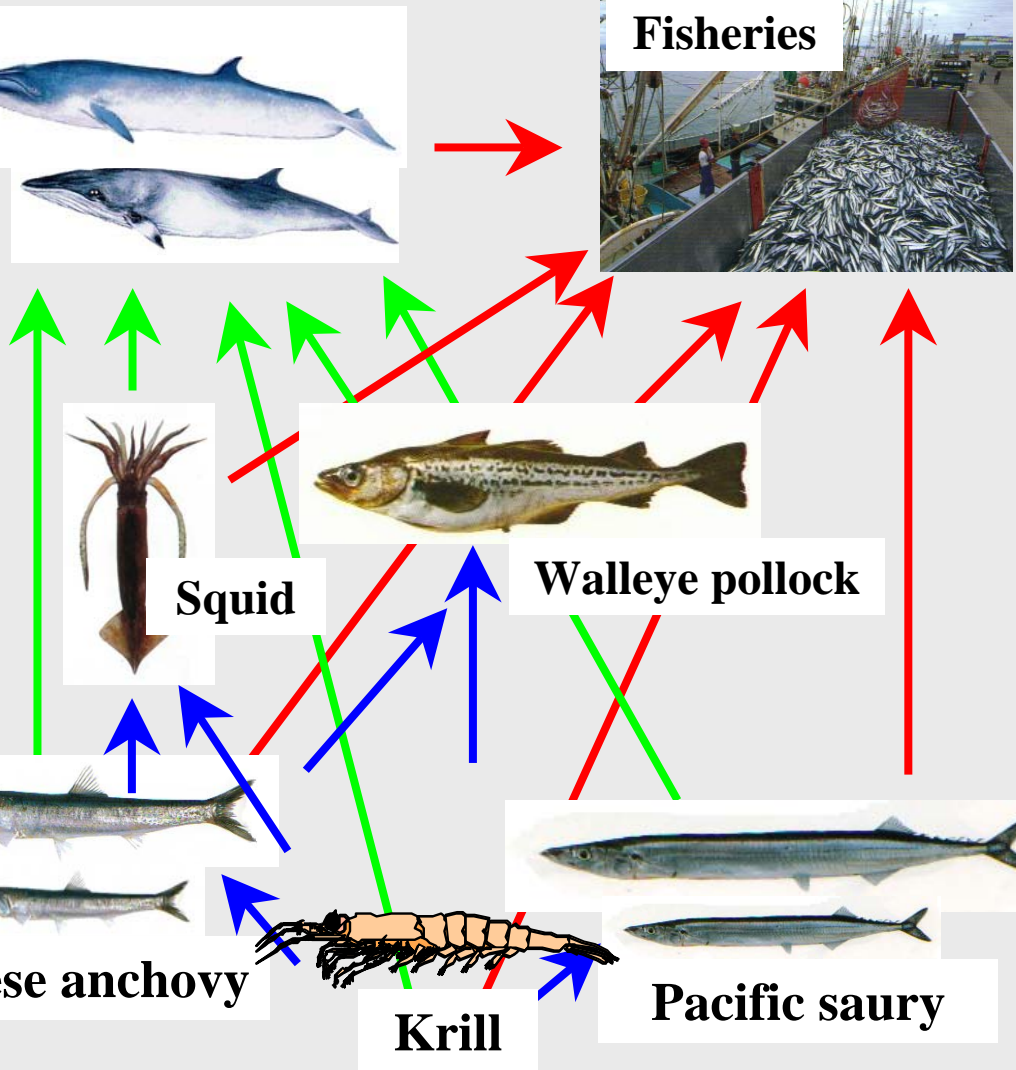
**Japanese anchovy**



**Krill**



**Pacific saury**



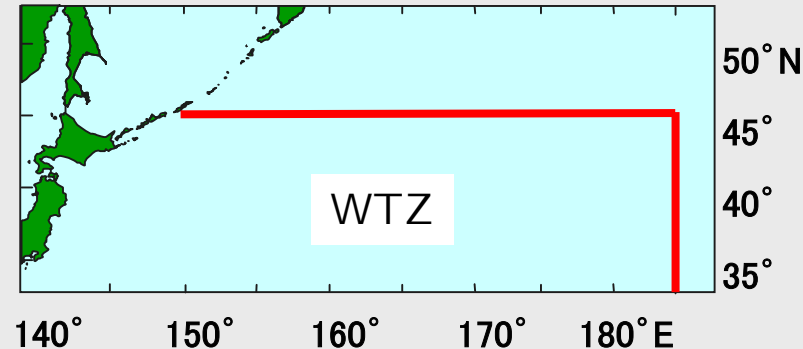
# PICES region **WTZ** (Western Tropical Zone)

Common minke whale :

about **12,000** animals

Daily prey consumption :

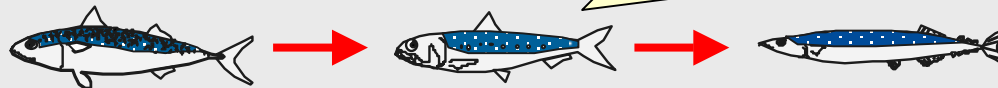
about **2,300** tonnes



Seasonal prey consumption (180 days)

: about **414,000** tonnes

**Prey switching ?**



The impact of food consumption will change in marine ecosystem. → **Interaction (whale, prey)**





## Future work

### PICES SCIENTIFIC REPORT No. 14, 2000

Hunt, Kato and McKinnell

Total amount of food consumption by marine mammal


13,020,000 mt

Lack of quantitative and qualitative information

- **Abundance** of marine mammals
- **Prey species** (Area, Season, Year)

# Conclusions

- \* There are **geographical, seasonal and yearly changes in the prey species** of minke whales.
- \* These changes are explained by **difference in prey availability**, which is conditioned by change in **regime shift**.
- \* The daily prey consumption of minke whale was estimated at **200 kg**.



The temporal and geographical variability in the feeding ecology of marine mammals will affect the ecosystem.

We need a long-term research for marine mammals to understand some issues such as **abundance estimates, feeding ecology of marine mammals** in PICES region.