

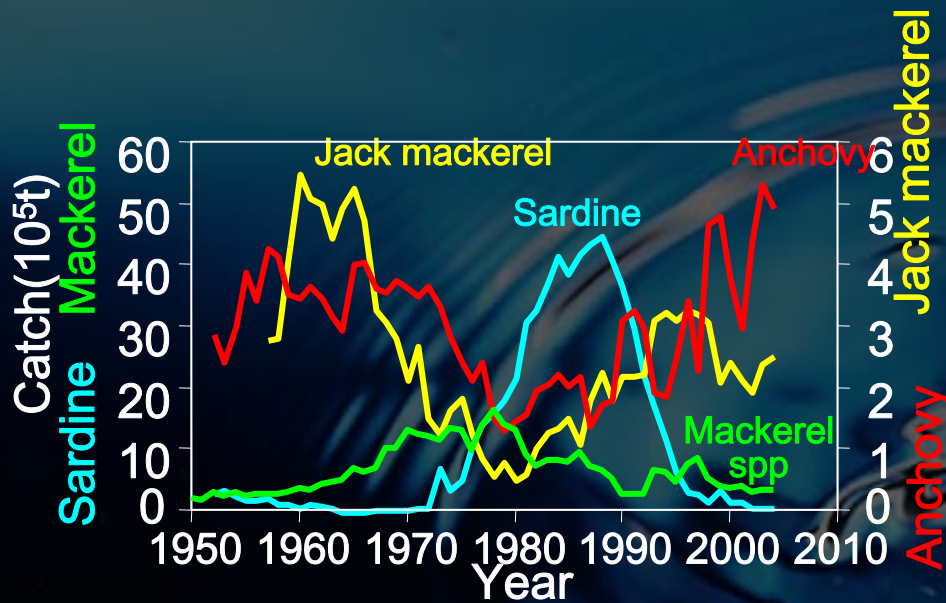
*Estimating daily ration of skipjack tuna
on larval and juvenile anchovy
in the Kuroshio–Oyashio transition
region in early summer*

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Introduction



Dominance of small pelagic fish has shifted at decadal scales.

High mortality during early life stages is a regulator of population dynamics.

- Predation is a major source of mortality throughout the life and thus a determinant of recruitment.
- Estimating daily ration of predators feeding on larvae and juveniles is required for quantifying recruitment.

Introduction

Feeding habits of predators have often been reported, but a few studies analyzed prey–predator interactions in the field.

- Distribution of larval and juvenile small pelagic fish and predators (Takahashi *et al.* 2001)
- Growth–selective predation on larval anchovy (Takasuka *et al.* 2003, 2004)

Qualitative aspects were well been reported, however quantitative data have not well obtained.

=> Estimating daily ration of predators feeding on larvae and juveniles are essential for predicting recruitment.

Introduction

Skipjack tuna was one of predatory species of larvae and juveniles.

Culture experiment

The daily ration of skipjack tuna was estimated as 15 % of body weight

(Magnuson, 1969)

=> Probably overestimated

Objectives

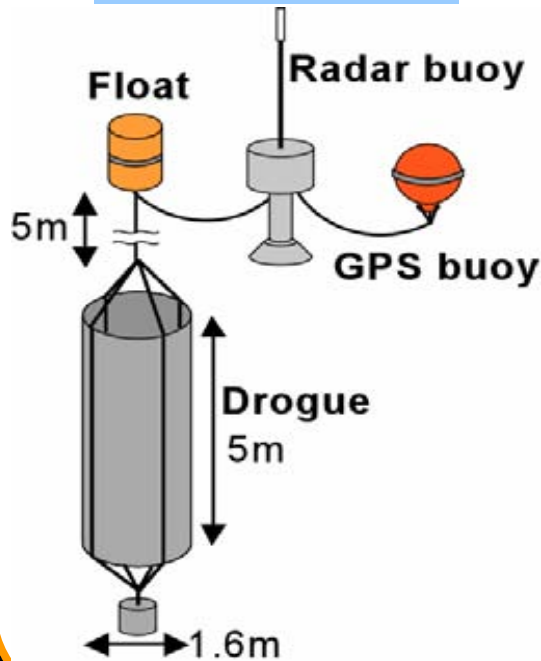
Quantitative estimation

*Daily ration of predators feeding on
larvae and juveniles*

- **Daily cycle of feeding of skipjack tuna**
- **Daily ration of skipjack tuna feeding on
larval and juvenile anchovy**

Materials and methods

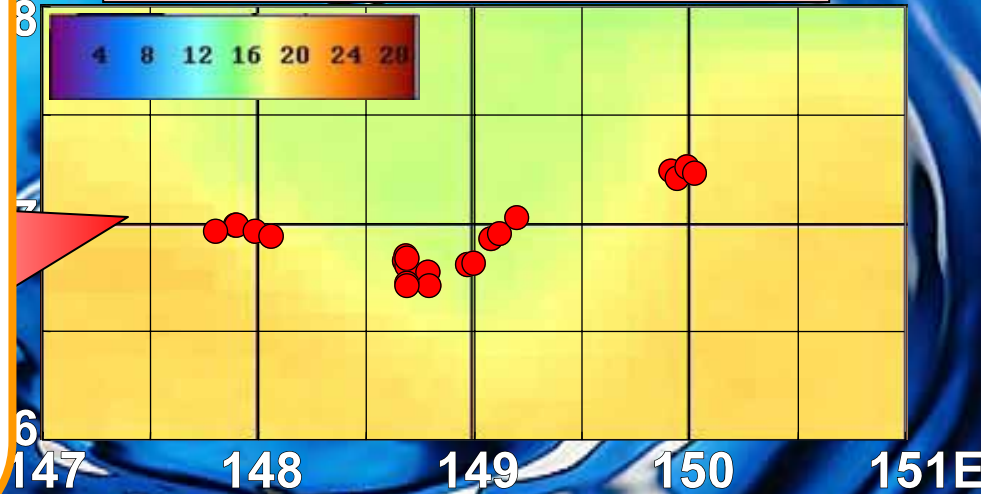
Drift GPS buoy



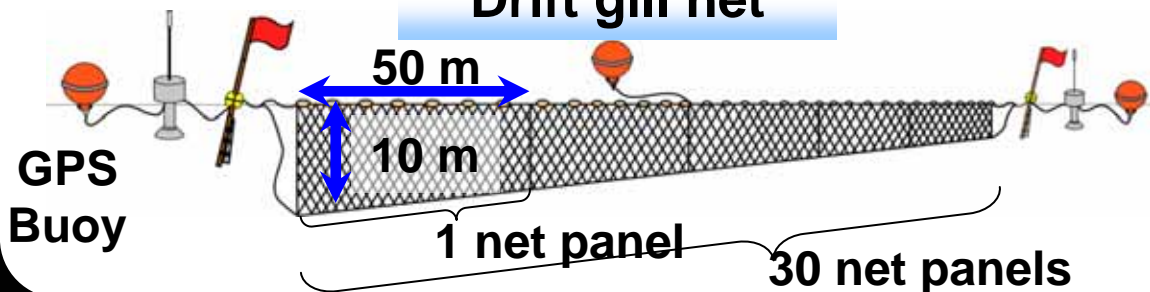
006

to transition region

Sampling areas and stations for skipjack tuna



Drift gill net



Drift gill net

- **Net panels:** 30 net panels
- **Mesh size:** 63–157 mm
- **Net setting:** 1.5–2.0 hours

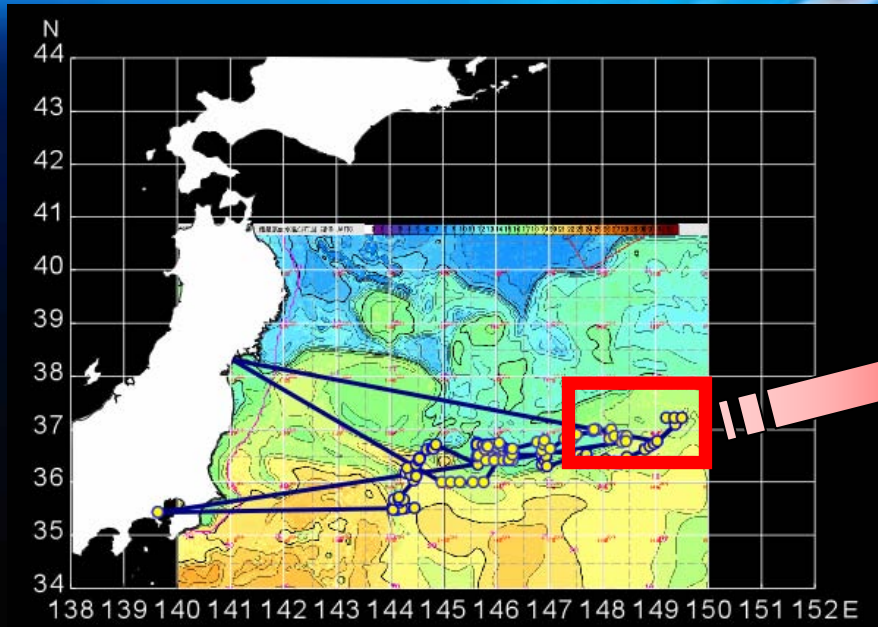


Materials and methods

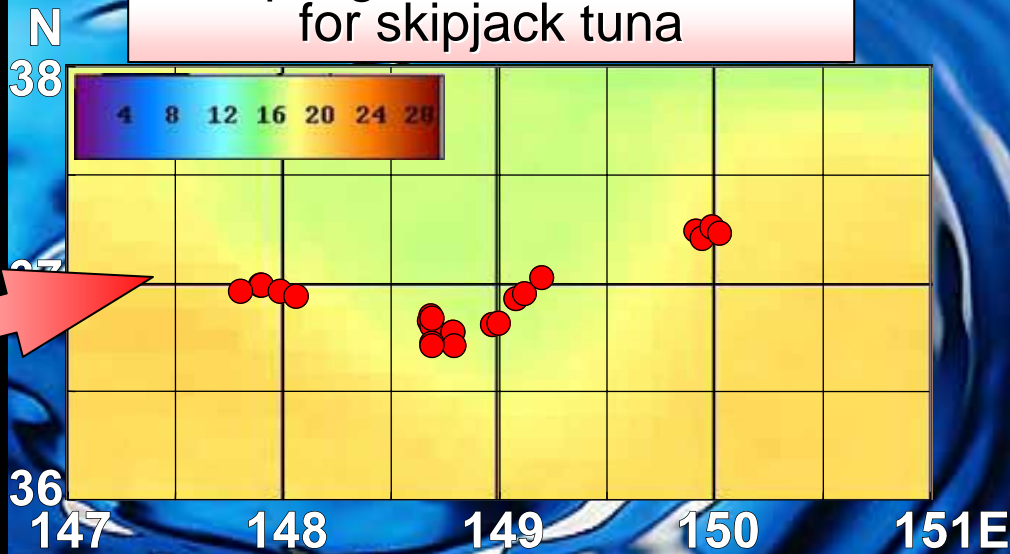


May–June, 2006

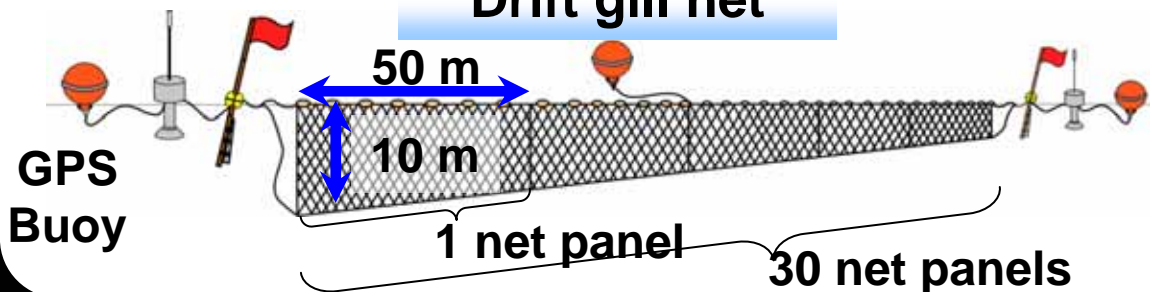
Kuroshio–Oyashio transition region



Sampling areas and stations for skipjack tuna



Drift gill net

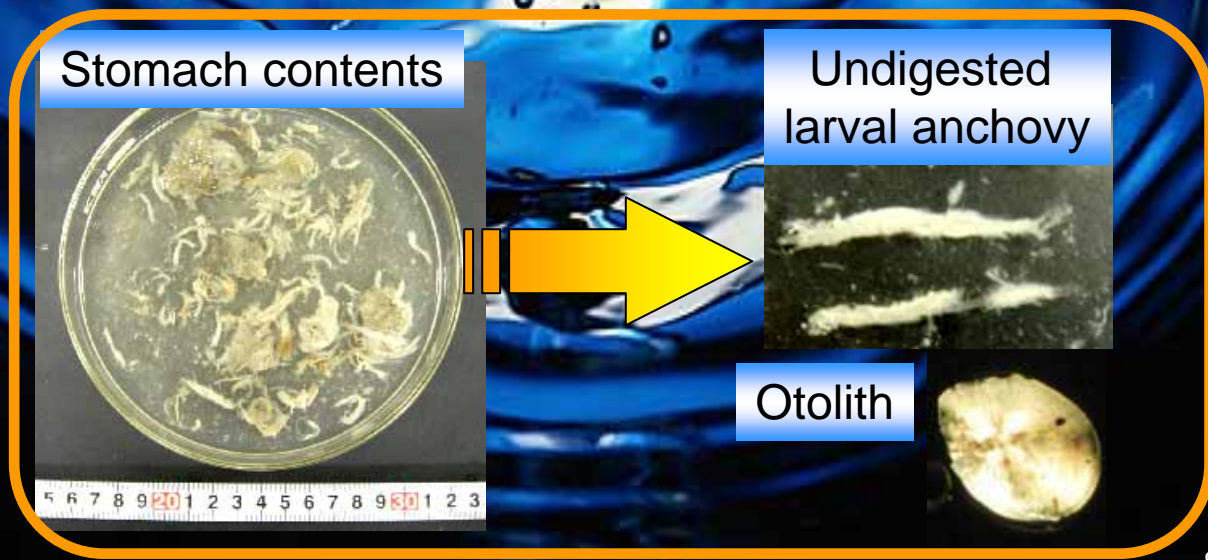
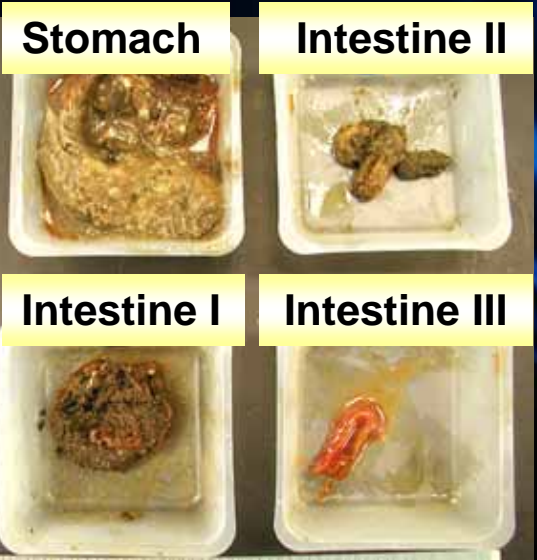
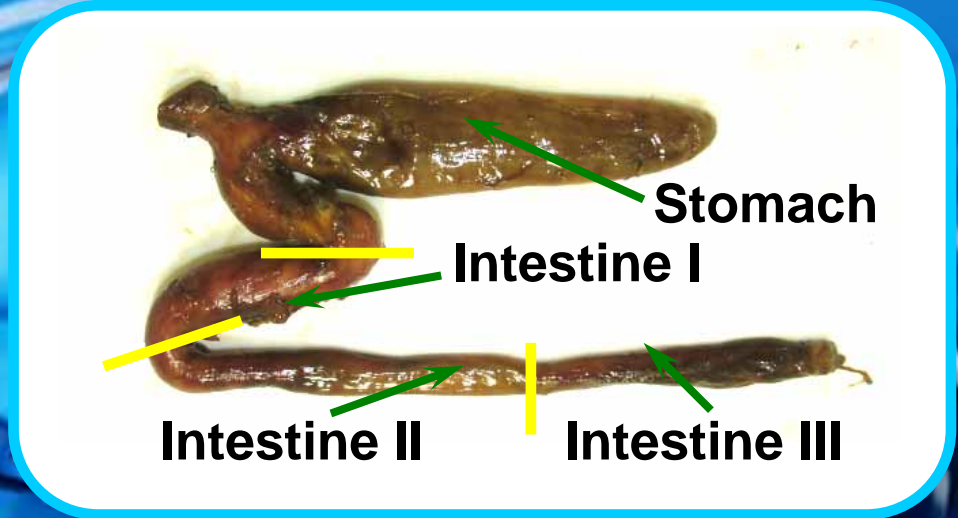


Drift gill net

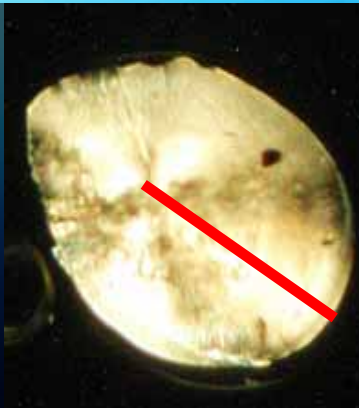
- **Net panels:**
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Gut contents analysis

The digestive tract was divided into 4 portions by the anatomical method. (Tominaga and Shibusawa 1978)

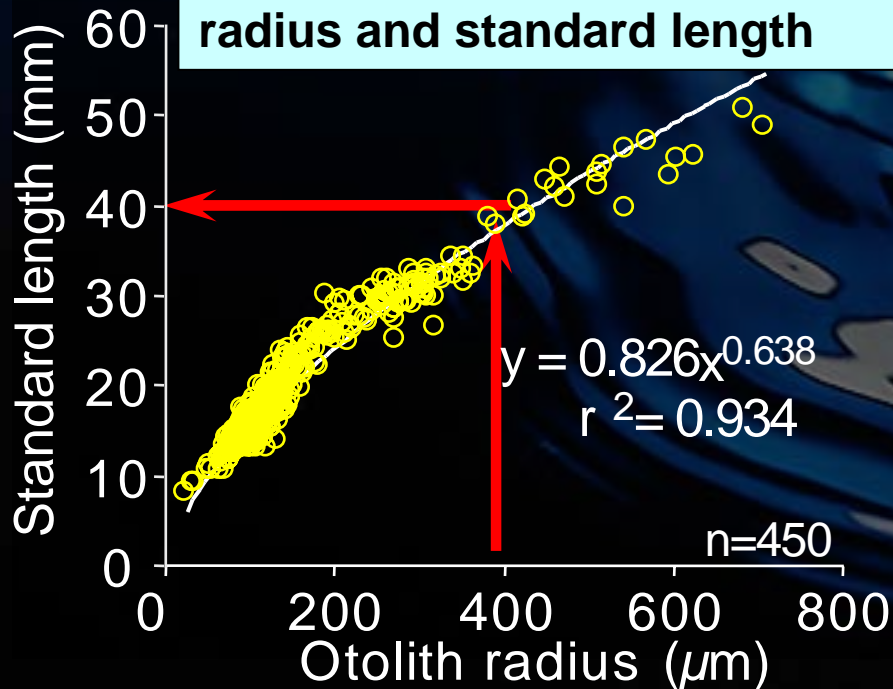


Estimating standard length and body weight of anchovy

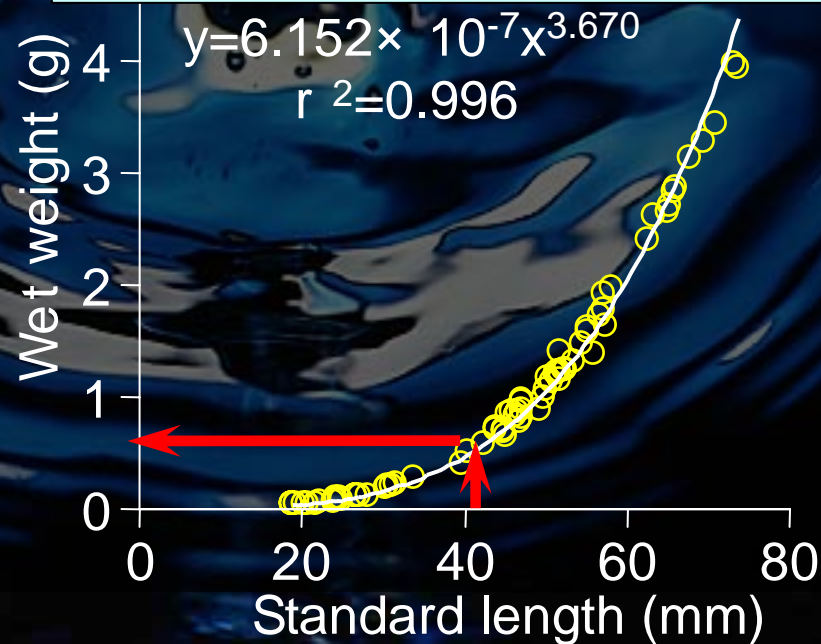


Maximum radius measured for the otoliths from digestive tract

Relationships between otolith radius and standard length



Relationships between standard length and body weight



24 hours sampling

Drift gill net

Net panels:

30 net panels

Net setting: 1.5–2.0 hours

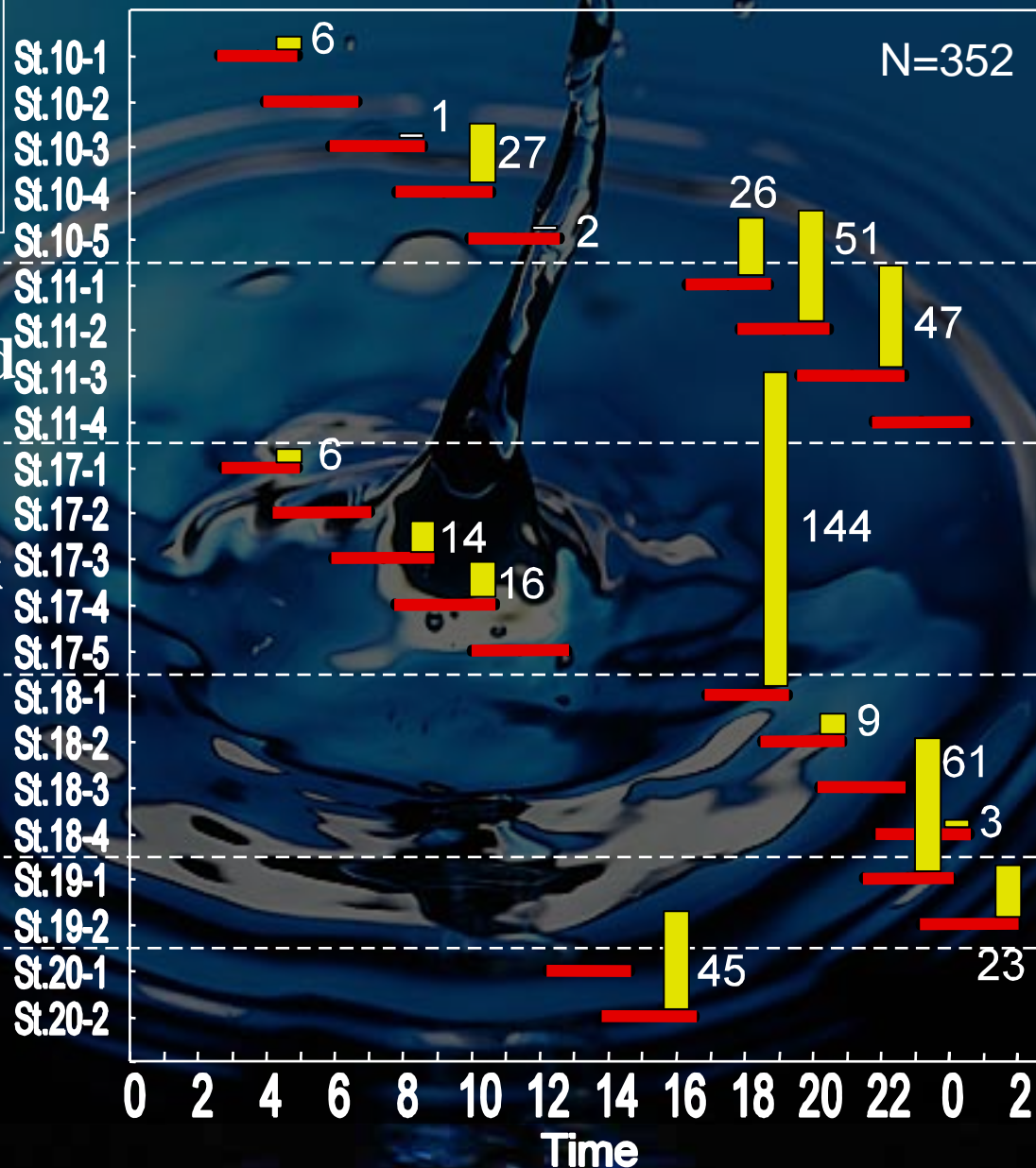
➤ The number of the skipjack tuna captured increased at night

➤ A total of 352 individuals of skipjack tuna were collected.

⇒ Digestive tracts of 85 individuals were analyzed.

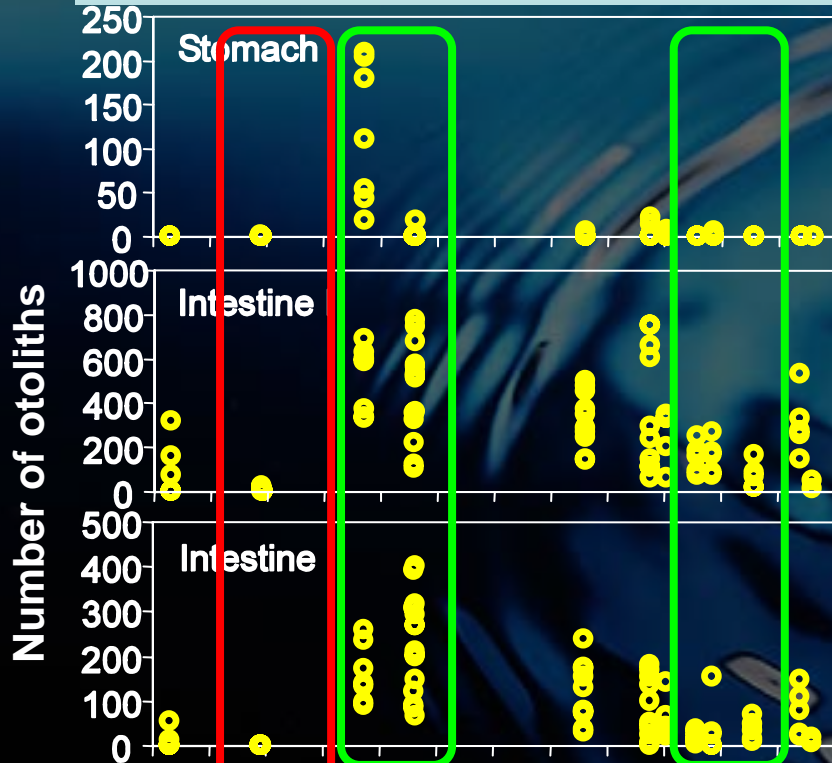
FL 47.0 ± 3.5 cm

BW 2.1 ± 0.6 kg

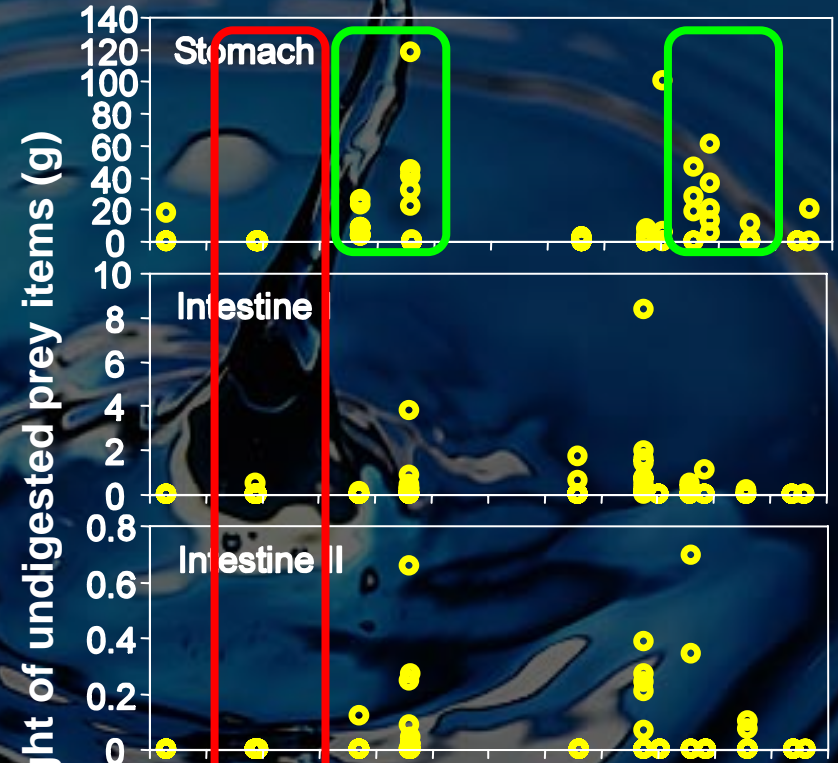


Daily cycle of feeding

Otolith of larval and juvenile anchovy (in number)



Undigested prey items (in weight)



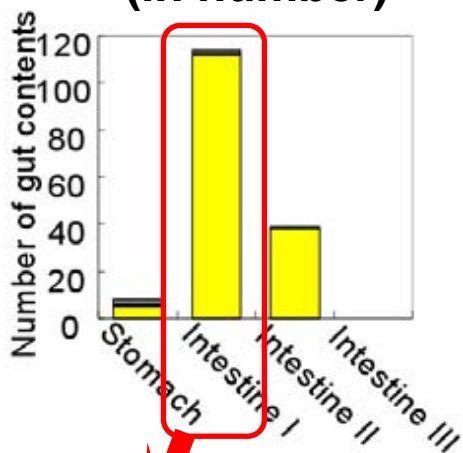
- Skipjack tuna fed during the daytime, and did not feed anymore in the midnight.
- Start time of feeding: Sunrise (ca. 3:50)
End time of feeding: Sunset (ca. 18:30)

Time

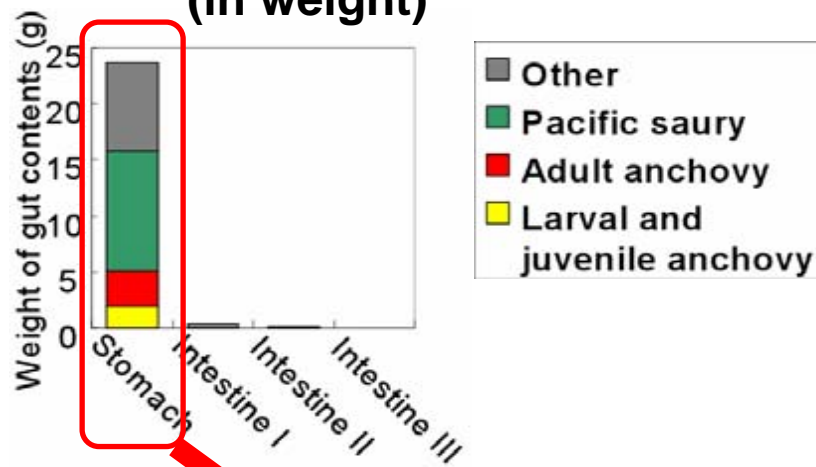
Time

Estimating daily ration of skipjack tuna

Composition of prey items
(in number)



Composition of prey items
(in weight)



Daily ration of skipjack tuna on
larval and juvenile anchovy

Intestine I contents

Otolith of larval and juvenile
anchovy

Daily ration of skipjack tuna on
prey items other than larval
and juvenile anchovy

Stomach contents

Undigested prey items

Total daily ration of skipjack tuna

Exponential model of daily ration

(Elliott and Persson 1978)

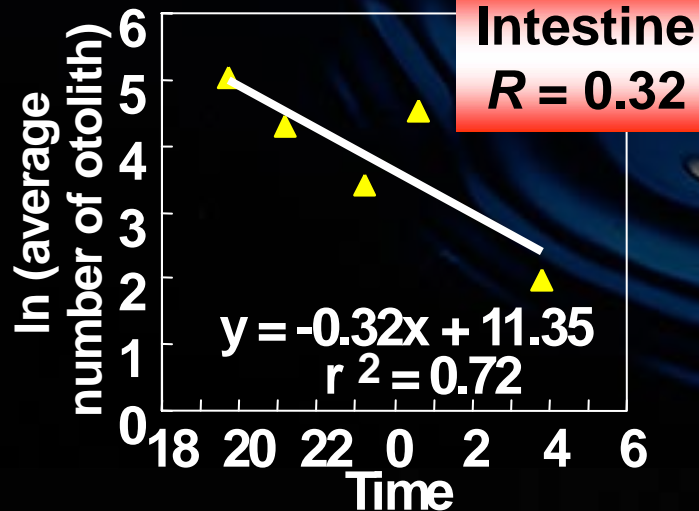
$$C_t = F_t = \frac{(S_t - S_0 e^{-Rt})Rt}{1 - e^{-Rt}}$$

S: the rate of stomach and intestine contents
F: the rate of food consumption
R: the rate of gastric evacuation
C_t: the actual amount of food consumed

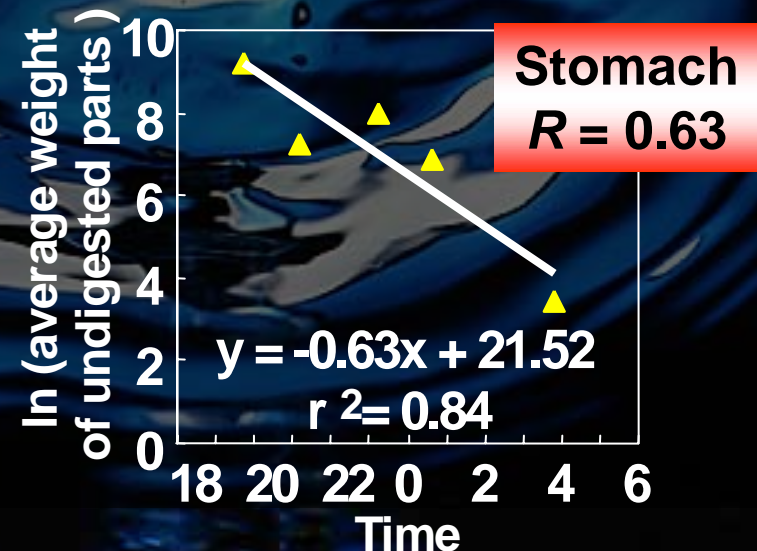
Expression of the rate of gastric evacuation (R)

$$\ln(S_t) = \ln(S_0) - Rt$$

R of otolith of larval and juvenile anchovy



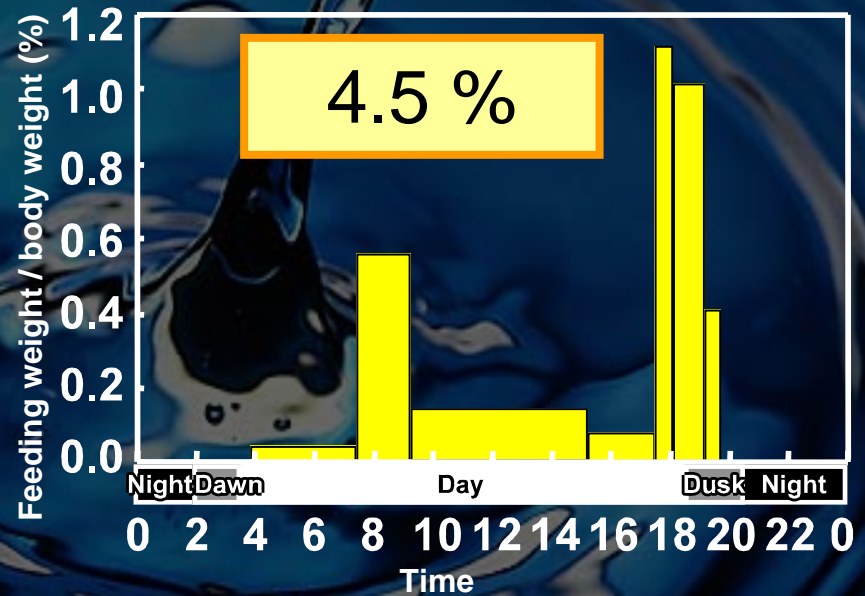
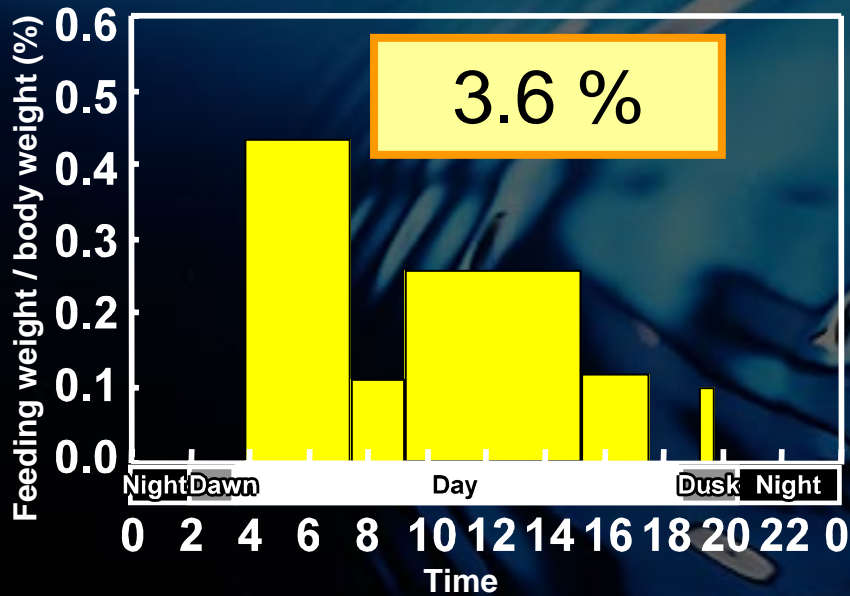
R of undigested prey items (e.g. fish, crustaceas)



Estimating daily ration of skipjack tuna

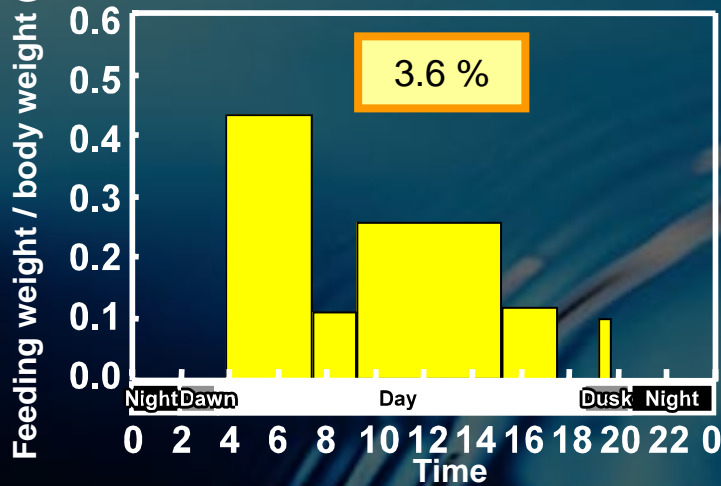
Daily ration of skipjack tuna on larval and juvenile anchovy

Daily ration of skipjack tuna on prey items other than larval and juvenile anchovy

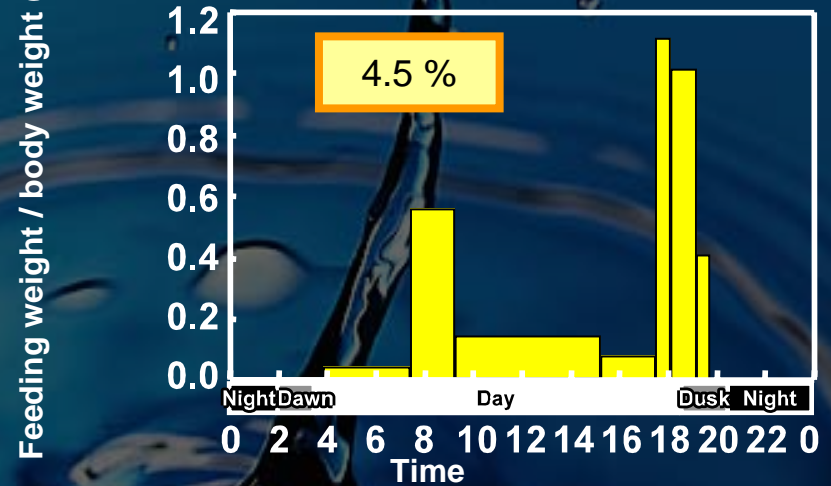


Daily ration of skipjack tuna (avg. 47 cm, 2.1 kg) on larval and juvenile anchovy corresponded to 3.6 % of the body weight.

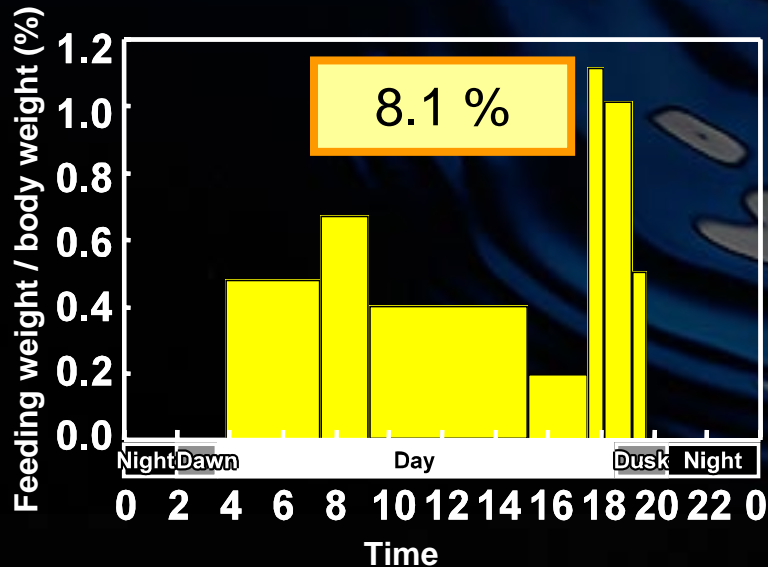
Daily ration of skipjack tuna on larval and juvenile anchovy



Daily ration of skipjack tuna on prey items other than larval and juvenile anchovy



Total daily ration of skipjack tuna

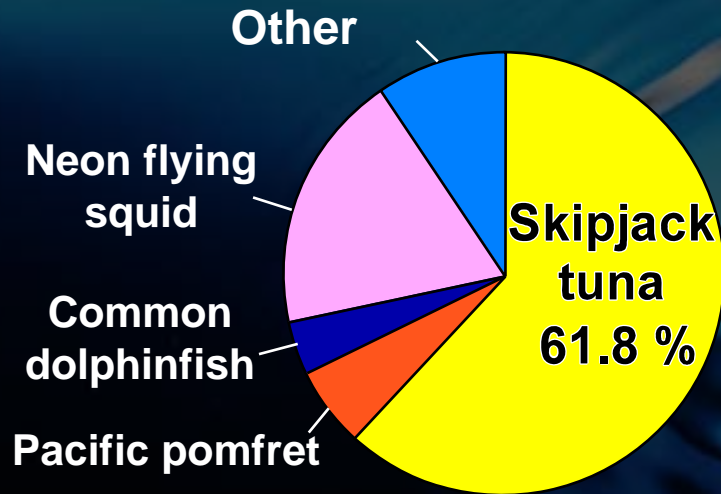


An individual skipjack tuna (avg. 47 cm, 2.1 kg) was estimated to consume ca. 1000 individuals (79.7 g) of larval and juvenile anchovy per day. This corresponds to 45 % of the total daily ration.

Summary

- **Daily cycle of feeding pattern**
 - ⇒ **Daytime: Feeding**
 - ⇒ **Nighttime: No feeding**
- **Daily ration of skipjack tuna was 8.1 % (in weight)**
- **Daily ration of skipjack tuna on larval and juveniles anchovy was 3.6 % (in weight)**
- **Larval and juvenile anchovy accounted for 45 % of the total daily ration of skipjack tuna**

**Potential predators
collected by drift gill
nets (in number)**



➤ **Skipjack tuna occupied 61.8 % of potential predators collected around the anchovy shoals.**

Estimating the daily rations of the other predators by a similar method.