

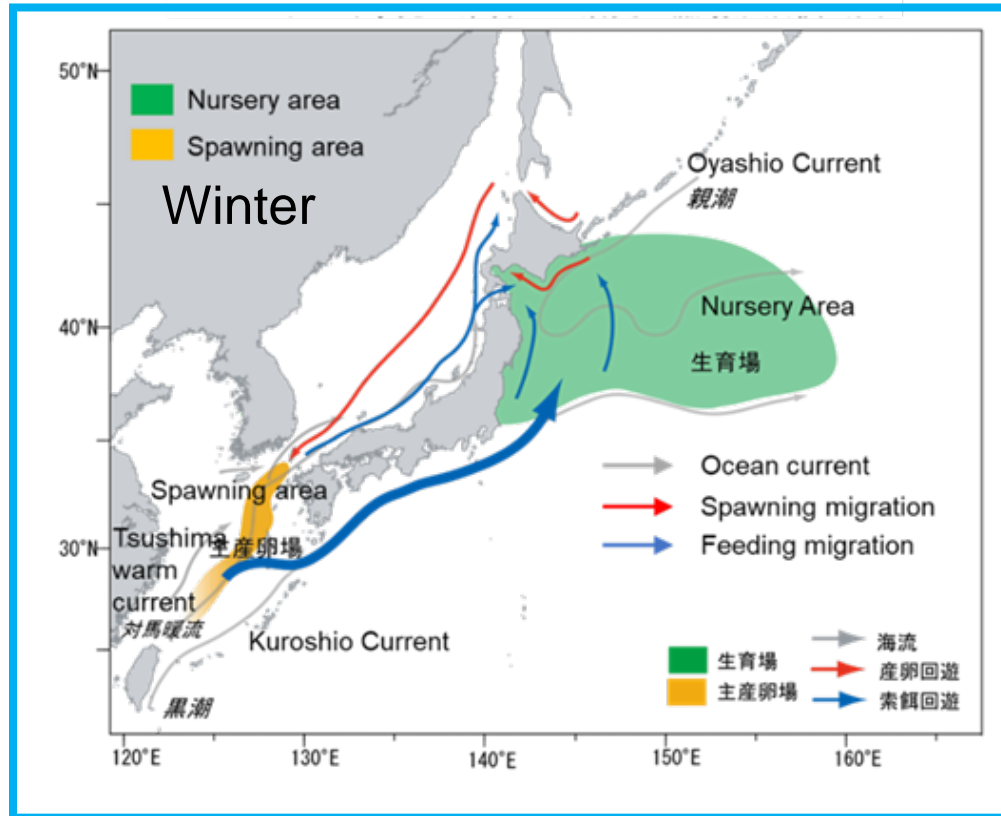
Domestic stock assessment of Japanese flying squid in Japan



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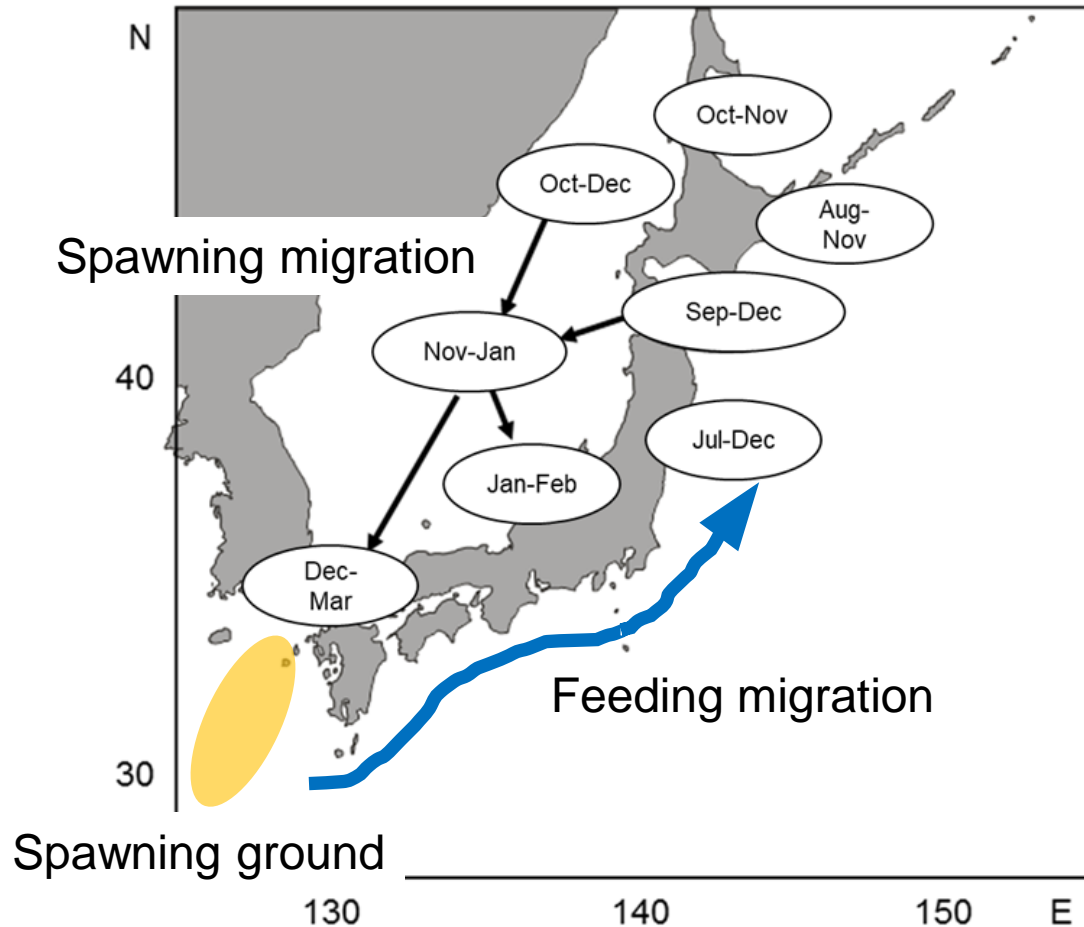
Population structure

Distribution and migration route by each stock



The winter and the autumn spawning stocks are dominant
The stock assessment has been conducted to each stock
JFS caught in the NPFC Convention Area is the winter spawning stock

Migration and Seasonal change of fishing grounds



Winter to Spring

Paralarvae are transported to the Pacific Ocean by the Kuroshio Current

Summer to Autumn

Migrating northward to feeding grounds

Late Autumn to Winter

Migrating southward to spawning grounds

- Caught by jigging, set net, bottom trawl, purse seine
- Catch by Japan and Korea during spawning migration from late autumn to winter was considered as the winter spawning stock

Biological information

Squid sampling

- Squid samples were collected by local fisheries research bodies and local fisheries associations at major ports on the Pacific side
- Samples were measured in the laboratory

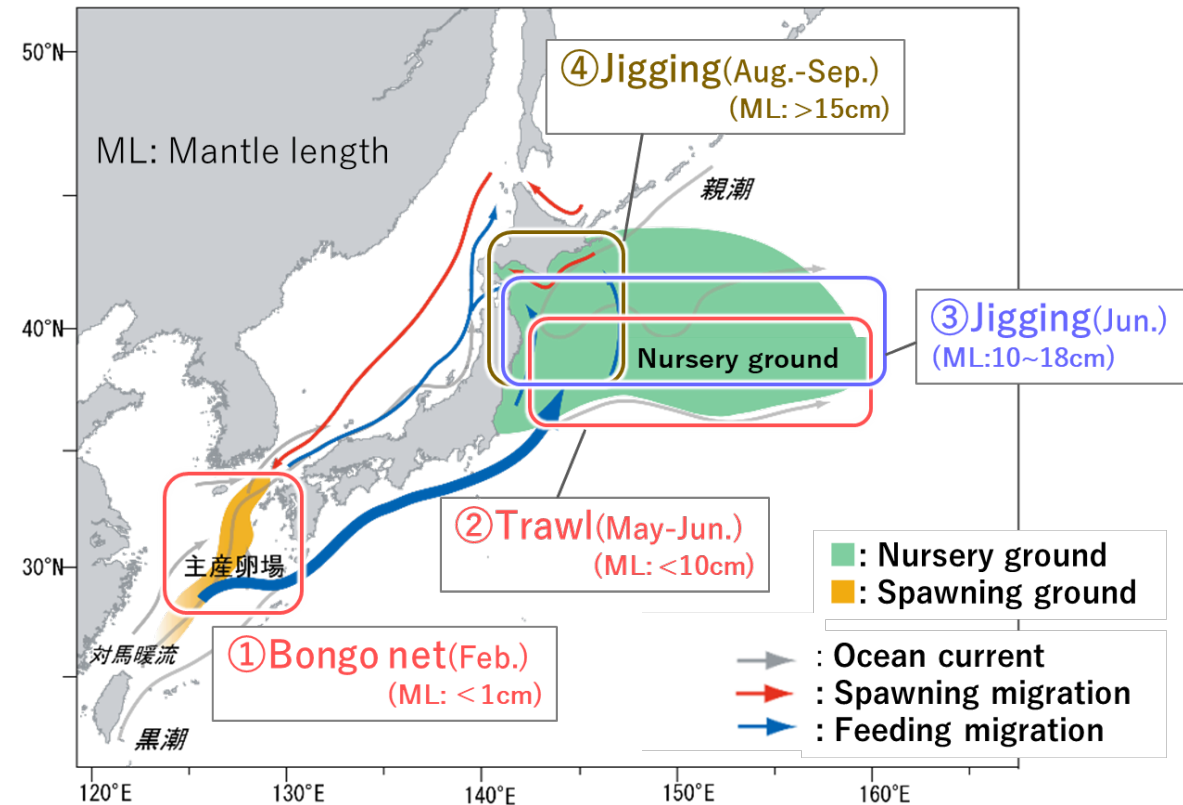
Squid measurement

- Mantle length, body weight, reproductive organ (3000-15000 individuals/year)
- Maturity classification
- Age determination (500-1200 individuals/year)

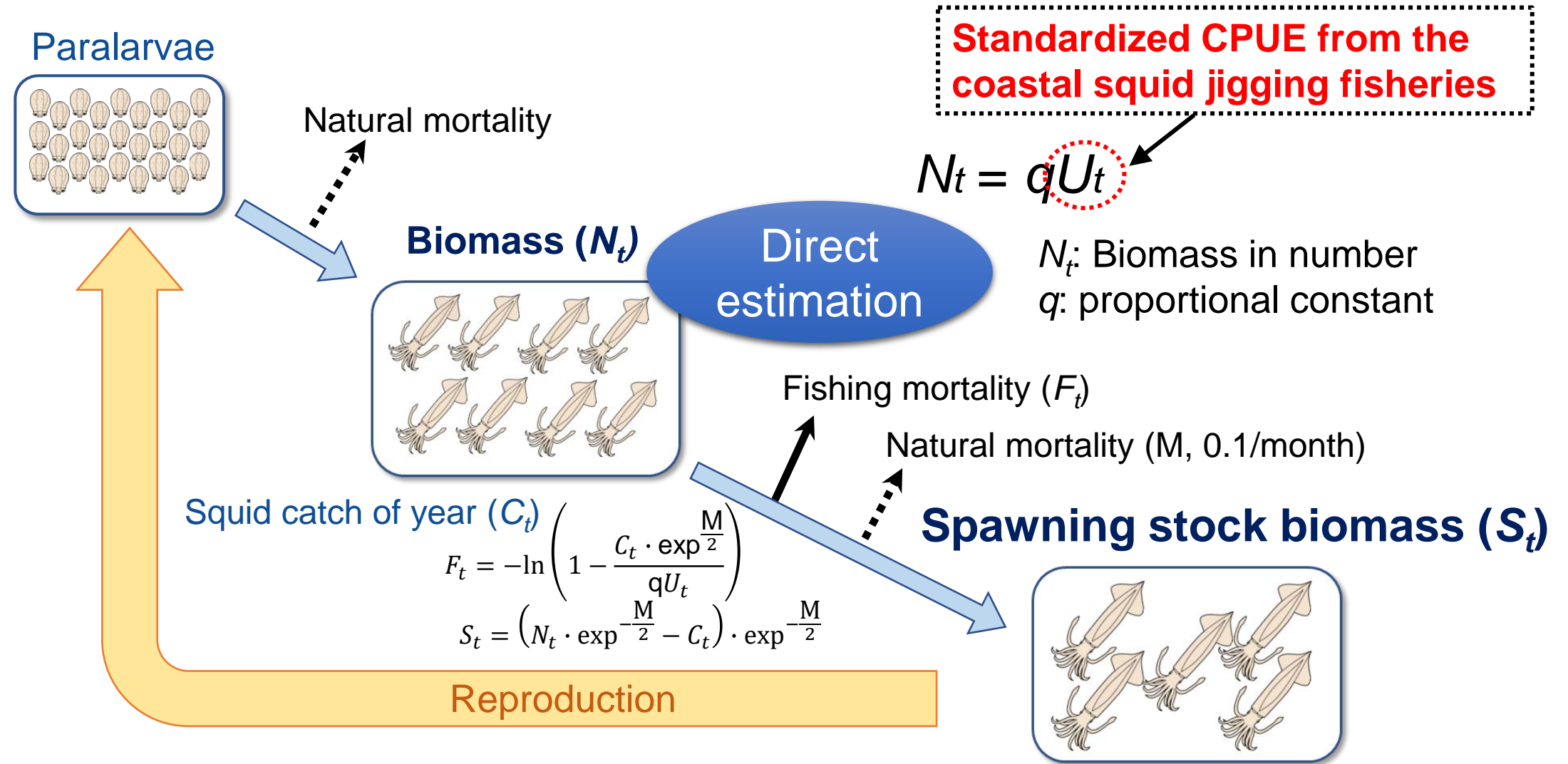
Survey

- Winter survey for paralarvae by Bongo net
- Recruitment survey by midwater trawl and jigging

Japanese survey of the winter spawning stock JFS



Biomass estimation method



Biomass (N_t) was estimated from the abundance indices (U_t) multiplied by q (proportional constant)

Input data and methods for stock assessment

Duration of the stock assessment

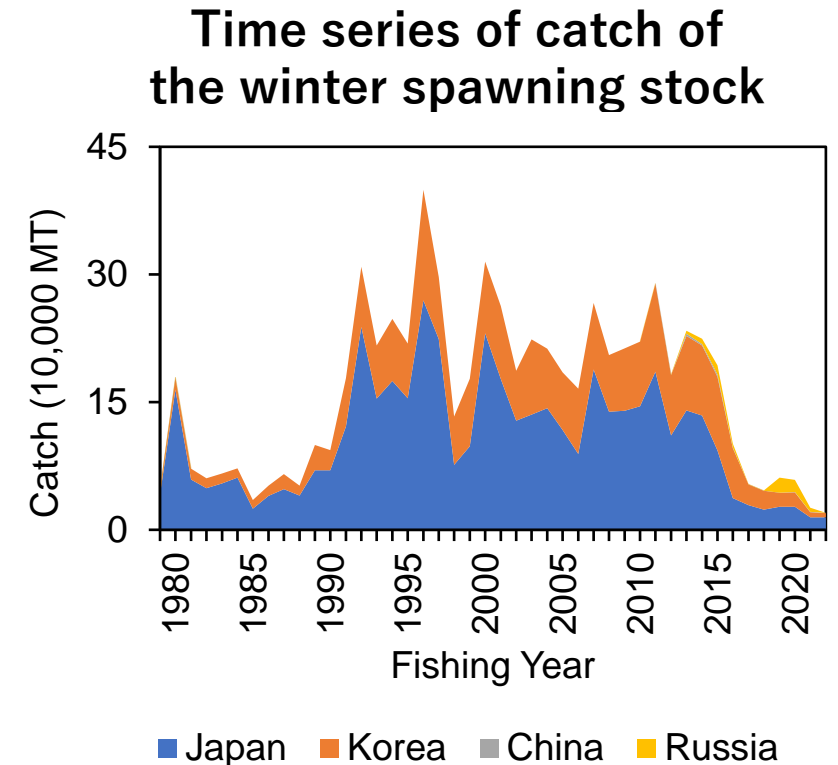
- 1979 to 2024 (Fishing year: April-March)

Input data

- Catch by China and Russia are taken from the NPFC statistics
- Catch by Japan and Korea are taken from the official statistics
- CPUE from coastal squid jigging fisheries as abundance indices

Methods

- Standardization of abundance indices (Okamoto et al. 2016)
- Estimation of q
- Natural mortality (M) : 0.1/month and 0.6 as 6 months of fishing season (July to December)
- Fishing mortality (F) and spawning stock biomass (SSB) estimated through Pope's equation (Pope 1972)
- The Hockey stick model, Ricker model and Beverton-Holt model were compared as the stock-recruitment relationship



Standardization of CPUE (Okamoto et al. 2016)

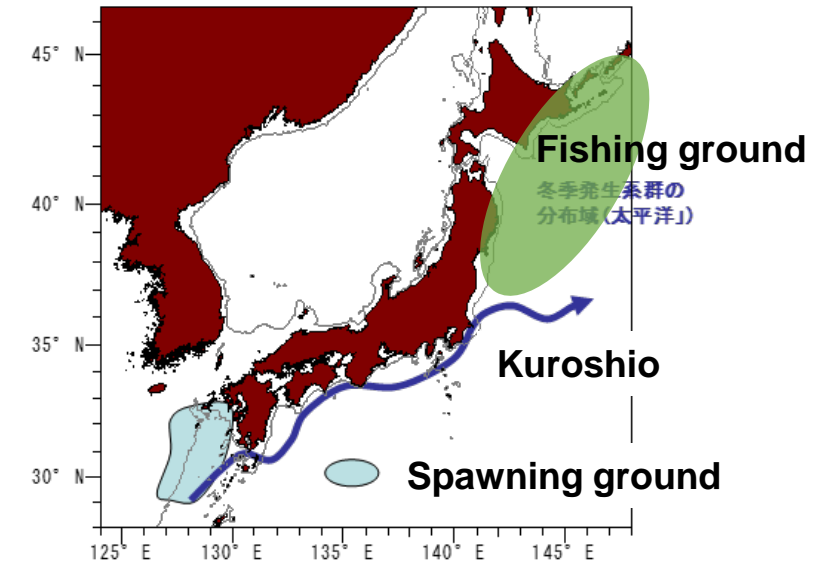
CPUE data from coastal squid jigging fisheries were used as the abundance indices

Fishing ground: Coastal waters off the northeastern part of Japan on the Pacific side

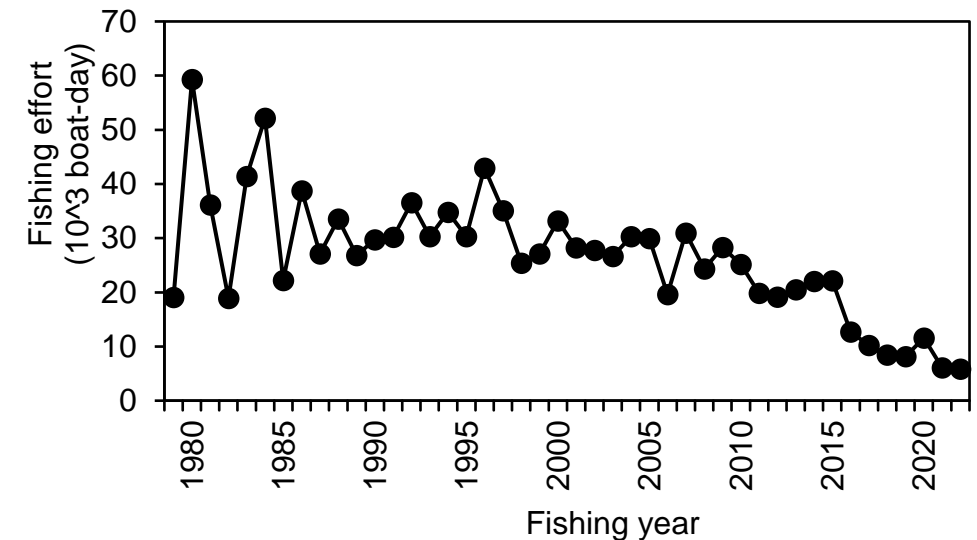
Fishing season: July to December

Fishing method: Jigging (Coastal squid jigging fisheries account for 31~98% of JFS catch by Japan in the Pacific)

Fishing effort: 6 to 11 thousand boat-day per year in last five years



Time series of fishing effort



Standardization of CPUE (Okamoto et al. 2016)

Data set: Monthly catch and number of boats with landing from sales slip data

- Sales slip data collected from 17 ports of 7 regions
- 17 ports were integrated into 7 regions, which was used as a variable of port

Statistical model: GLMM

Response variable: $\log(\text{CPUE} + \delta)$. Normal distribution error was applied

Explanatory variables: Year, Month, Port and those interaction terms

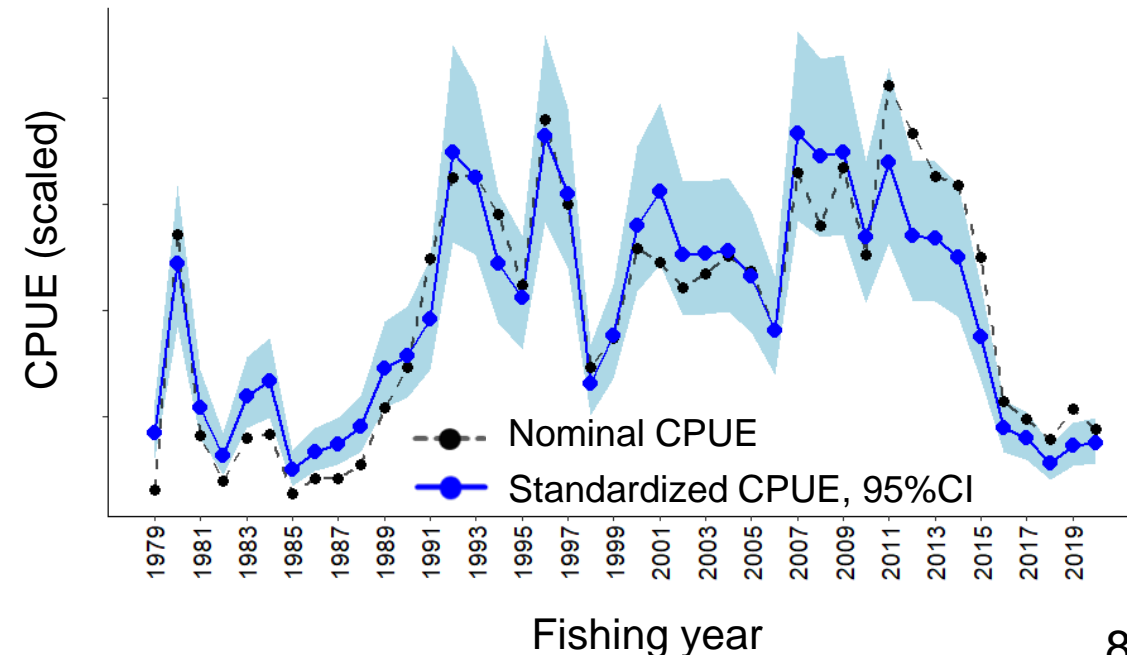
Model selection: BIC was used to select the model

$$\log(\text{CPUE} + \delta) = \text{Intercept} + \text{Year} + \text{Month} + \text{Port} + \text{Year} * \text{Port} + \text{Month} * \text{Port}$$

δ is constant.

All explanatory variables were categorical

Interactions with *Port* worked as mixed effect



Calculation of q

Assumption

□ Mean exploitation rate (C_t / N_t) for 1979-2001 = 0.3

Rationale

The exploitation rates of the autumn spawning stock were estimated to be ranged between 0.2 to 0.4 (JSNFR I 1997; 1998; Kidokoro et al. 2006)

The exploitation rates for the winter spawning stock were estimated to be at the same level (0.3) for 1979-2001 (Mori 2006, Nishijima et al. 2021, Moriyama and Okamoto 2023)

Calculation

$$N_t = qU_t$$

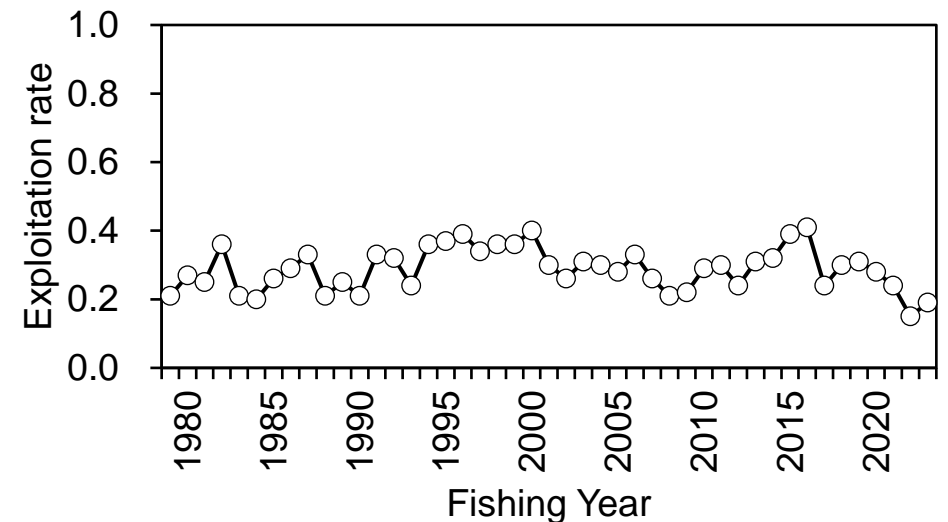
Mean C_t / N_t for 1979-2001 is 0.3.

q was calculated with $(C / U) / 0.3$

- C is catch
- U is standardized CPUE
- C / U corresponds to a mean value for 1979-2001

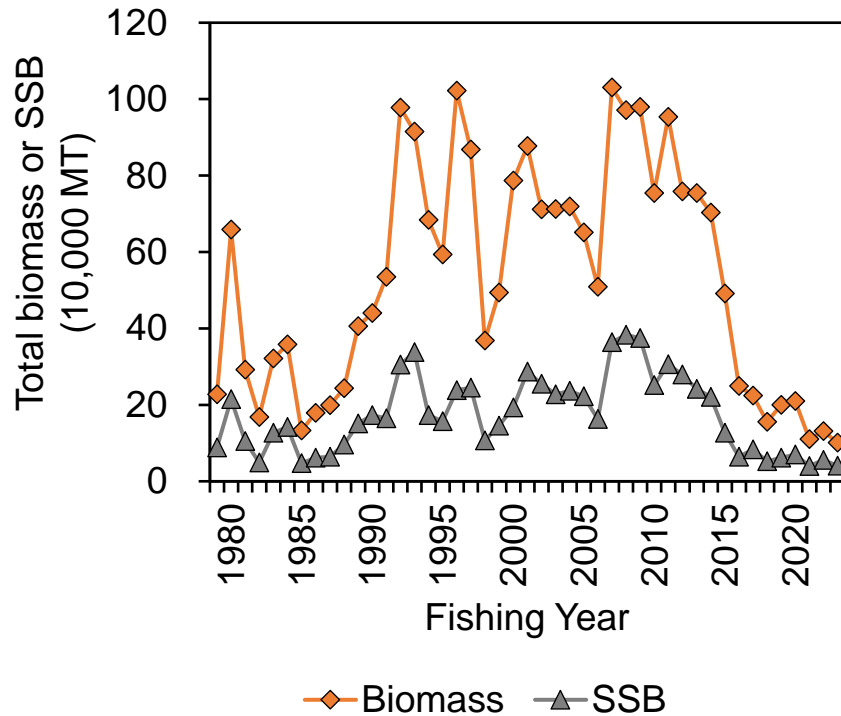
□ $q = 17.42$ in 2023 (updated annually)

Time series of exploitation rate



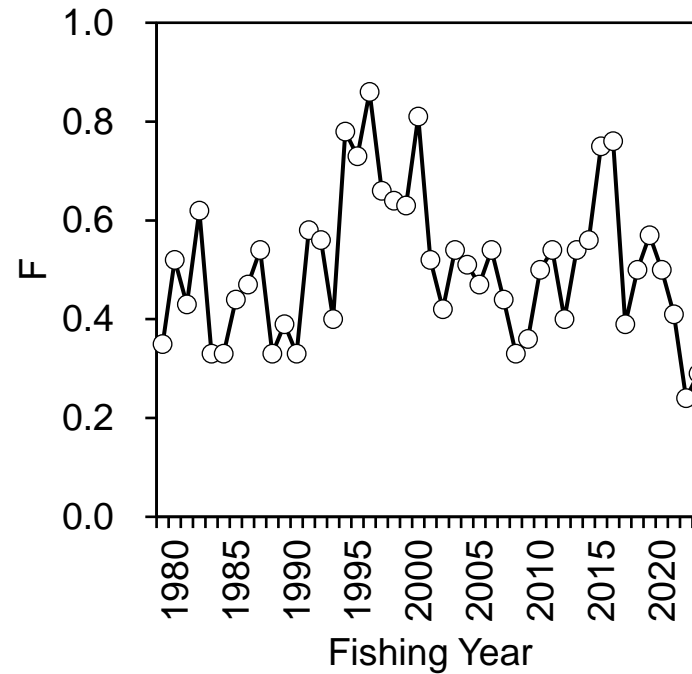
Results

Time series of biomass, SSB



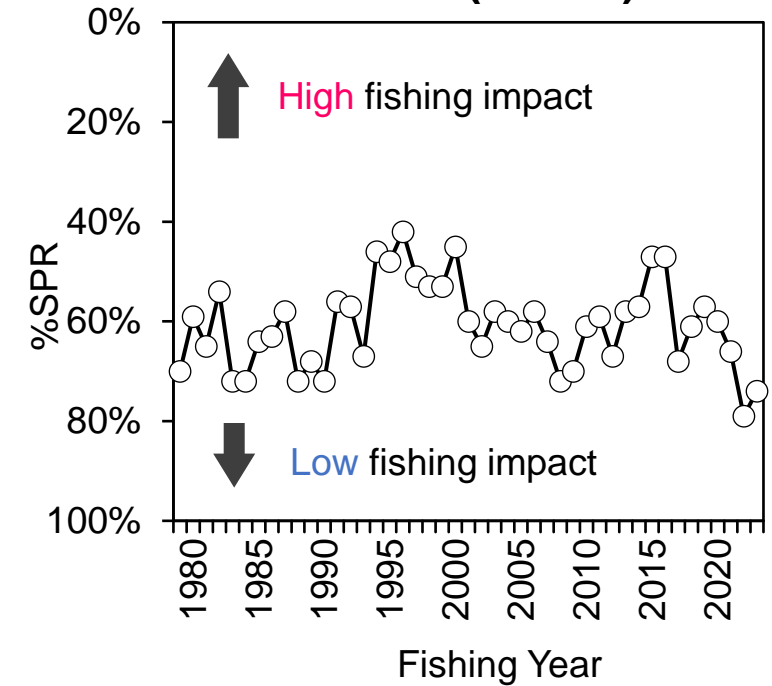
Decreased largely from 2015 to 2016 and has remained low level since then

Time series of F



Decreased from 2020 to 2022 but slightly increased in 2023

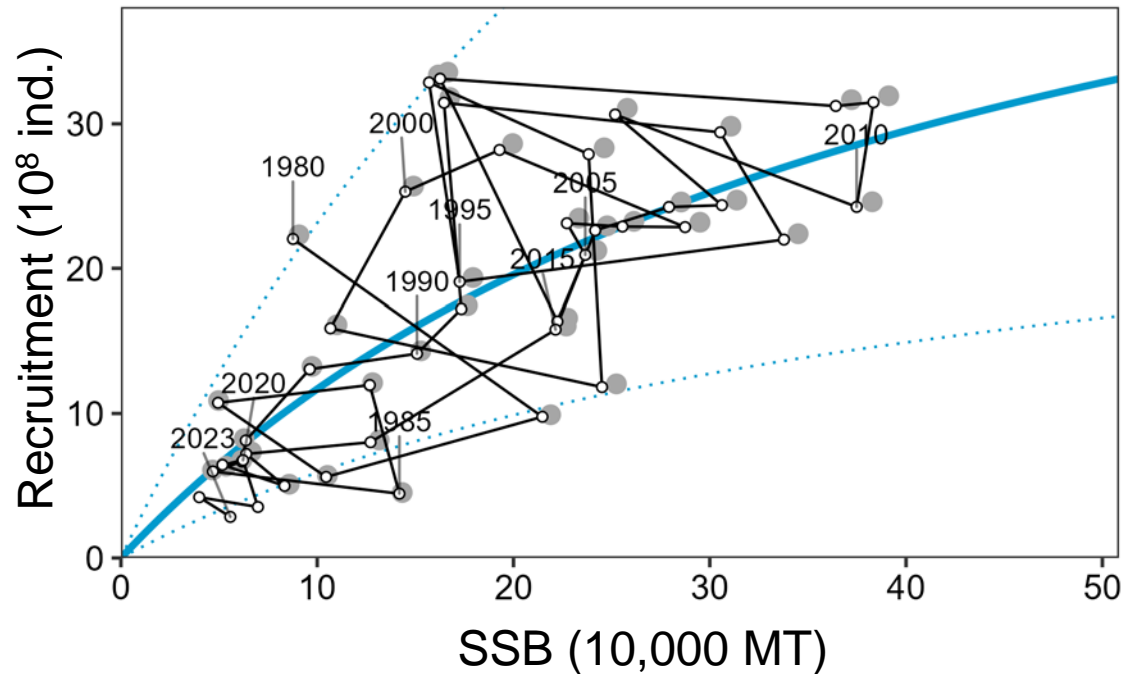
Spawning stock biomass per recruitment (%SPR)



Increased from 2020 to 2022 but slightly decreased in 2023

Stock status

Stock-recruitment relationship

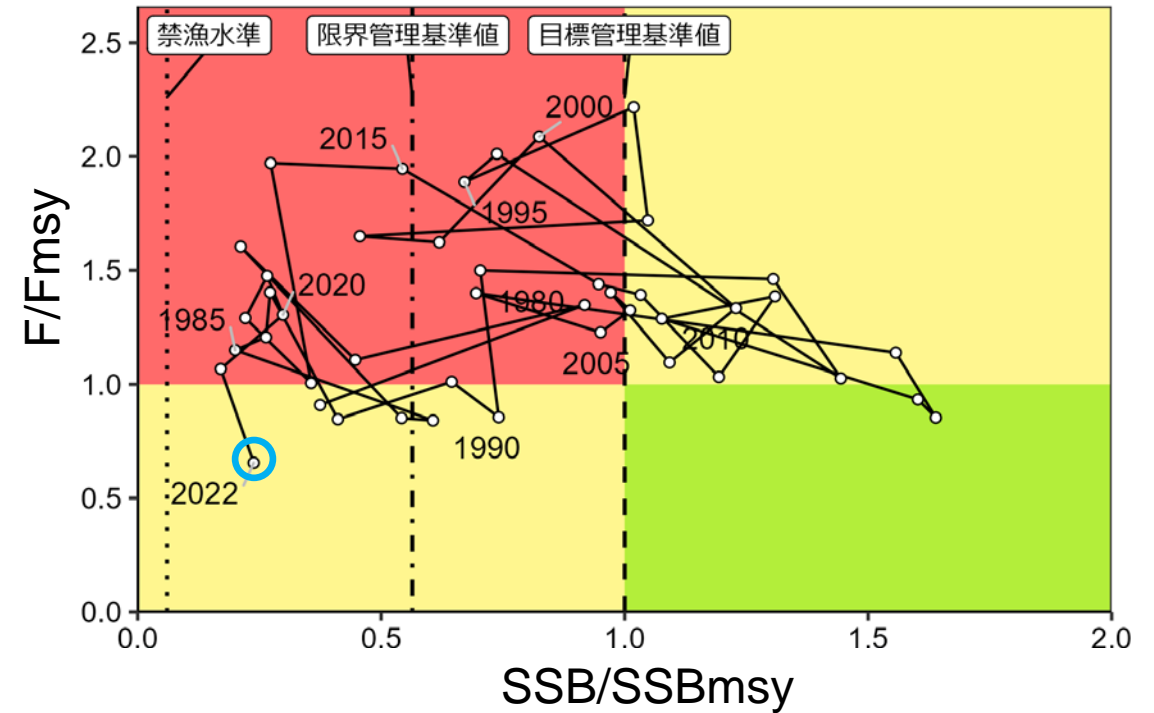


The Beverton-Holt stock-recruitment model was applied

MSY reference points were estimated by a stochastic simulation with a random variability of recruitment based on the stock-recruitment relationship

(see, Ichinokawa et al. 2017, ICES JMS, for details)

Kobe plot



SSB is lower than SSB_{msy}, and F is lower than F_{msy} in 2022

Summary

- ✓ The estimated total biomass of the winter spawning stock decreased largely from 2015 to 2016 and has remained low level since then
- ✓ The MSY-based reference points were estimated from the stochastic simulation with the Beverton-Holt stock-recruitment relationship
- ✓ In 2023, the estimated total biomass was 101,000 MT and SSB was 41,000 MT
- ✓ SSB was lower than SSB_{msy}, and F was lower than F_{msy} in 2022

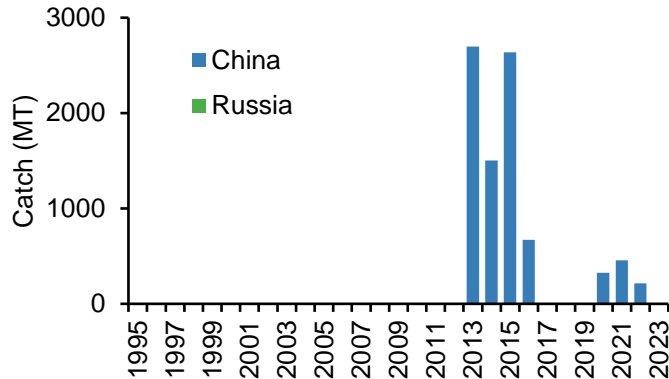
Future issues

- ✓ In the current stock assessment method, there are uncertainties such as using fixed q value
- ✓ SAMUIKA (State-space Assessment Model Used for IKA, Nishijima et al. 2021) or SPiCT could be the potential stock assessment model applied for the future domestic JFS stock assessment in Japan

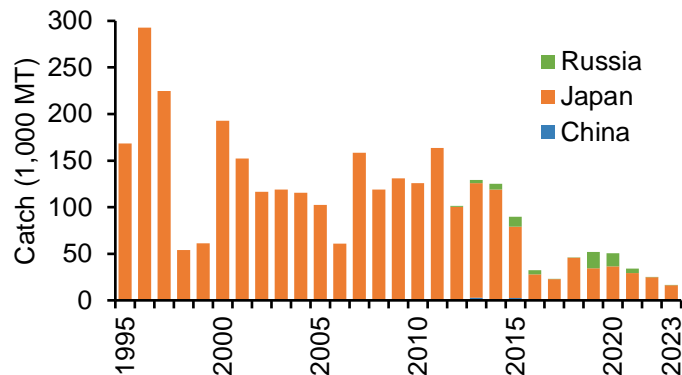


Japanese flying squid

Catch in the CA

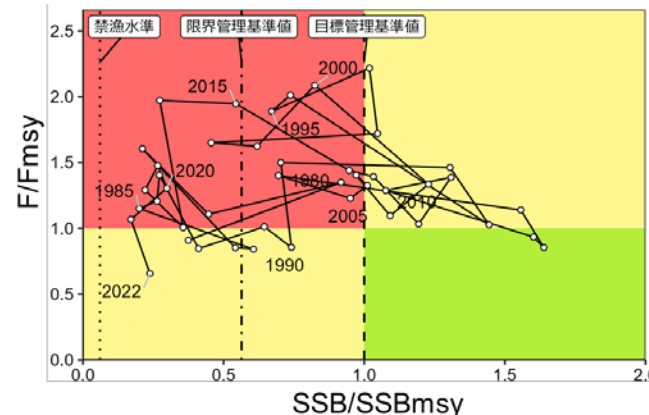
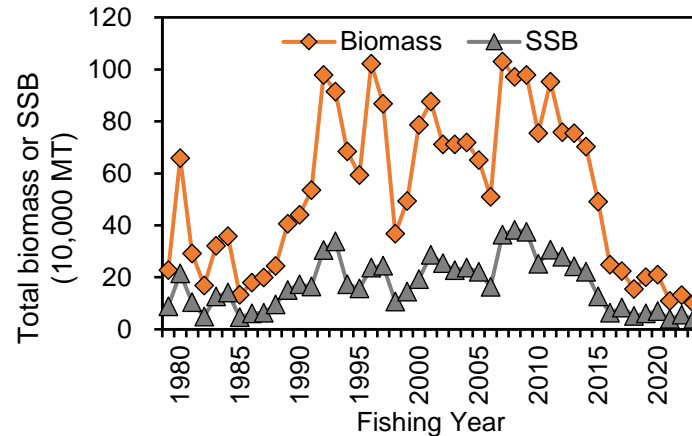


Catch in the NW and CA



Domestic Assessment

Status of stock (Japan domestic)



Comments on Status

- There was no catch in the CA in 2023
- Majority of catches comes from Japanese and Russian national waters
- In the Japanese domestic stock assessment of the winter spawning stock JFS, SSB was lower than SSBmsy, and F was lower than Fmsy in 2022