A Comparison of Stock Assessment Models of Lemon Sole (*Microstomus kitt*) in Icelandic Waters

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Introduction

- Lemon sole (*Microstomus kitt*) is a commercially important flatfish, ranking third in catch volume among the eight main flatfish stocks in Icelandic waters, with approximately 1,250 tonnes landed in 2022.
- Primarily targeted using demersal seine and bottom trawls, which together account for over 95% of the total landings.
- Assessed under the ICES category 3 rfb-rule for data-limited stocks, with additional methods like the Gadget model also explored.

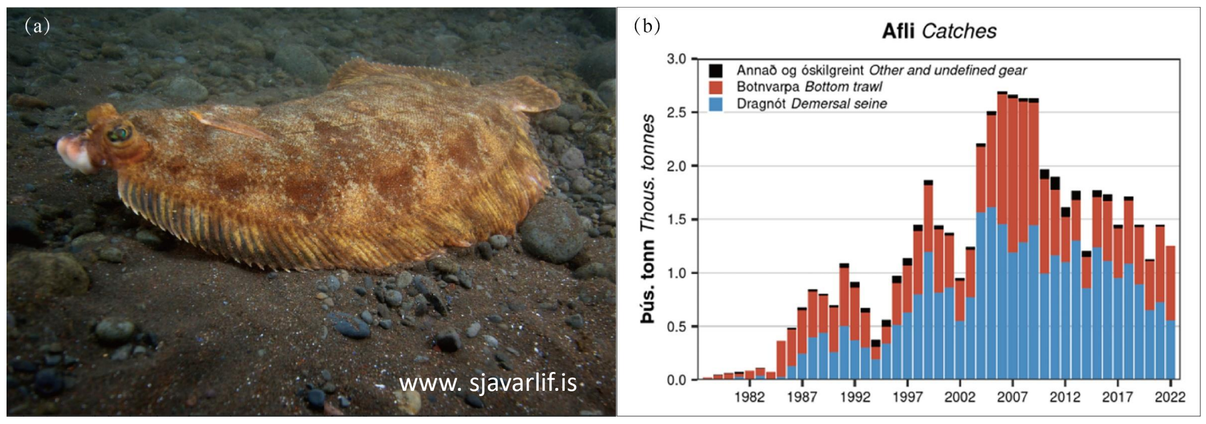

Figure 1. Lemon sole (a), and its total catch (landings) in Icelandic waters (b).

Objective

This study explores different stock assessment methods for lemon sole in Icelandic waters. The results are expected to strengthen the scientific foundation for management recommendations for this species.

- **Specific objectives**

➢ Analyze lemon sole population dynamics and harvest rate in Icelandic waters.

➢ Compare the model output and evaluate the strengths and weaknesses of each method under different data limitations.

➢ Understand the differences among stock assessment models in terms of structural assumptions and data use to improve fisheries management advice in China.

Methodology

- **Data collection**

Data are obtained from the Marine and Freshwater Research Institute (MFRI) in Iceland. The biomass index for lemon sole primarily relies on the spring groundfish surveys.

- **Assessment methods: input and ouput**

• Methods	• Data input	• Model output
• Statistical catch at age model (SAM)	• catches at age, population abundance indices at age, length at age, weight at age	• estimates of current stock size and harvest rate
• Surplus production model (SPiCT)	• catch and biomass index time series	• estimates of current stock size, harvest rates, and management reference points associated with MSY
• Data limited methods-ICES rfb-rule in Category 3 stocks	• biomass index time series, catch length distribution, life history parameters	• indicators of current relative stock status, relative harvest rate, and catch advice

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Results

- **Statistical catch-at-age models**

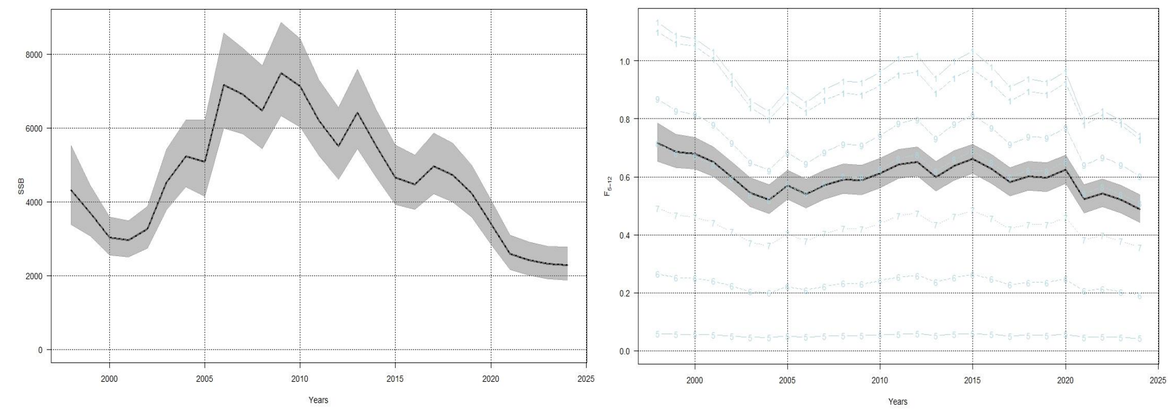

Figure 2. Estimates of spawning stock biomass (SSB) (a) and fishing mortality (b) from final SAM model.

- Spawning stock biomass (SSB): peaked at approximately 7,500 in 2009 before gradually declining. From 2016 to 2024, SSB decreased sharply from around 4,500 in 2019 to under 2,300 in 2024.
- Average fishing mortality: from 1998 to 2004, it decreased gradually, followed by a stable period with a slight increase until 2011. After 2014, it dropped sharply, with a notable decrease around 2020.

- **SPiCT model**

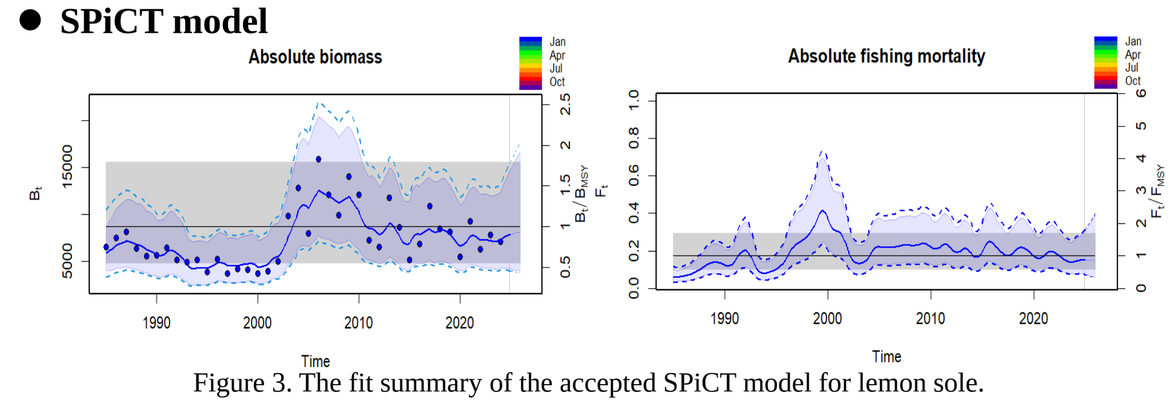

Figure 3. The fit summary of the accepted SPiCT model for lemon sole.

- Biomass: B/B_{MSY} surpassed 1 in 2004, peaked at 1.45 in 2006, then declined rapidly to the B_{MSY} level and has remained near that level since.
- Fishing mortality: peaked at ~2.2 × F_{MSY} in 1999, then declined sharply to the F_{MSY} level and has remained stable since 2004.

- **Rfb rule of ICES category 3**

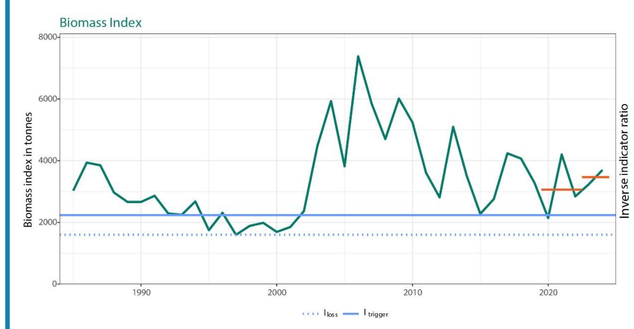

Figure 4. Biomass index since 1985

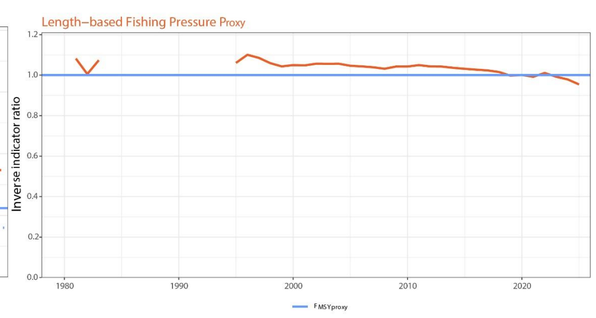

Figure 5. Length-based fishing pressure proxy.

- The current biomass trend indicator (r) : 1.13;
- The current fishing pressure indicator (f) : 1.02;
- Catch advice for the 2024/2025 and 2025/2026 fishing years: 1,184 tonnes, corresponding to a 4.1% increase over the previous fishing year's advice.

Conclusion

- The stock assessment of lemon sole in Iceland indicates: a recovering stock and reduced fishing pressure;
- Application of methods to Chinese fisheries management: flexible and adaptive assessment framework under varying data availability.

• Methods	• Pros	• Cons
• Statistical catch at age model (SAM)	• Full structure of available biological and fisheries data to produce robust, detailed and age-specific estimates	• Requires high-quality and rich data; complex to implement
• Surplus production model (SPiCT)	• Flexible and intermediate complexity framework, balancing simplicity with process realism	• Less accurate for stocks with high variability or incomplete data over time
• Data limited methods-ICES rfb-rule in Category 3 stocks	• Empirical approach suitable for data-limited contexts	• Doesn´t fully account for the complexity of fisheries dynamics