Overview of Stock Assessment Methods and Management Measures Used for Squids and Other Short-Lived Species

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2nd Meeting of the Small Scientific Committee on Neon Flying Squid

July 8, 2025

Species Characteristics

- Short lifespan
- Rapid growth
- High natural mortality
- Strong environmental sensitivity
- Semelparous or annual reproduction

Challenges in Stock Assessment

➢Data limitations

- Limited biological data
- Variable natural mortality
- Multiple microcohorts
- Difficulty in accurate age determination

Empirical Indicators

- Data type: Data-poor
- Data used: Catch, CPUE, body size, length
- Pros: Easy to collect, inexpensive
- Cons: Unreliable for patchy distribution
- Example: Veined squid in the northeast Atlantic (Chen et al., 2006)
- Reference points: Trends in CPUE, mean size or length frequency distribution as relative indicators; no formal biological reference points due to limited data

Survey-Based Biomass Estimates

- Data type: Data-poor
- Data used: Fishery-independent surveys (bottom trawl)
- Pros: Independent from fishery effort
- Cons: Patchy distribution, uncertain catchability
- Example: Longfin inshore squid in the Northwest Atlantic (NEFSC, 2011)
- Reference points: B_{MSY} proxy

Yield/Eggs-per-Recruit Models

- Data type: Data-rich
- Data used: Spawning age, natural mortality-at-age, mean weight-at-age, gear selectivity-at-age
- Pros: Provides detailed reference points
- Cons: Constant mortality assumption invalid for semelparous species
- Example: NAFO-regulated northern shortfin squid (Hendrickson & Hart, 2006)
- Reference points: $F_{50\%}$, $F_{40\%}$, $F_{0.1}$, F_{Max}

Production Models

- Data type: Data-rich/moderate
- Data used: Time series catch and abundance indices
- Pros: Estimates biomass, fishing mortality, and can incorporate environmental effects
- Cons: Traditional models assume equilibrium; can be sensitive to recruitment variability
- Example: Western winter-spring cohort neon flying squid in the Northwest Pacific Ocean - environmentally dependent surplus production model (Wang et al., 2016)
- Reference points: B_{MSY}, F_{MSY}

Empirical Forecasting

- Data type: Data-poor
- Data used: Environmental variables, historical trends
- Pros: Quick predictions, adaptive management
- Cons: Dependent on quality and length of datasets
- Example: Octopus in the Gulf of Cadiz (Sobrino et al., 2020)
- Reference points: B_{Lim}

Depletion Models

- Data type: Data-rich
- Data used: High-frequency catch/effort data
- Pros: Real-time management responses, cohort-specific estimates
- Cons: Intensive data requirements
- Example: Patagonian longfin squid in the Falkland Islands (Winter & Arkhipkin, 2015)
- Reference points: %MSP

Size-Structured Models

- Data type: Data-rich
- Data used: Monthly fishery catch/effort and size composition
- Pros: Captures size dynamics accurately
- Cons: Requires high-quality size and CPUE data
- Example: Jumbo flying squid in the equatorial waters (Xu et al., 2018 and 2019)

Integrated Ecosystem Assessments

- Data type: Data-rich
- Data used: Stock status, ecosystem interactions, environmental data
- Pros: Ecosystem-based management perspective
- Cons: Complex, high uncertainty
- Example: NAFO Large Marine Ecosystems (Koen-Alonso et al., 2019)

Management Measures Overview

- Challenges due to rapid turnover, high mortality
- Adaptive, precautionary frameworks necessary
- Regular monitoring and flexible responses

Reference Points (RPs)

➢Cohort-specific:

- For short-lived species, RPs are often estimated separately for each cohort

➢Choosing RPs depends on:

- Data availability and quality
- Biological relevance (short lifespan, semelparous reproduction, variable recruitment)

➢Commonly used RPs:

- B_{MSY}, F_{MSY}
- %MSP (preferred for short-lived species)
- B_{Lim} (biomass threshold for data-poor stocks)

➢Examples:

- NAFO northern shortfin squid: B_{Lim}
- Japanese flying squid: cohort-specific MSY-based RPs (Beverton-Holt model & surveys)

Effort-Based Management

- Prevents overfishing by controlling effort
- Real-time data needed, difficult to implement widely
- Example: Falkland Islands *Loligo* fisheries (Rodhouse et al., 2014)

Catch-Based Management

- Clear management limits through Total Allowable Catches (TACs)
- Easier implementation
- High recruitment variability complicates TAC setting
- Example: Multiple global squid fisheries (Rosa et al., 2013)

Additional Management Measures

- Spatial/temporal closures
- Mesh size regulations
- Individual transferable quotas
- Sustainability certifications
- Example: Falkland Islands marine protected areas (Arkhipkin et al., 2015)

Conclusion

- Importance of tailored assessment and adaptive management
- Moving towards integrated ecosystem approaches
- Need for ongoing data collection improvements

Thank you and questions?