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Longfin inshore squid

2023 Management Track Assessment Report

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National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts

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This Level 2 Management Track Assessment of longfin inshore squid is an update of the 2020 Level 3 peer-reviewed Management Track Assessment. The methodologies used to conduct the 2010 benchmark assessment during SAW/SARC 51 (NEFSC, 2011a; NEFSC, 2011b) were used in this assessment as well as the 2017 and 2020 assessment updates. Based on the 2020 assessment results the stock was not overfished and overfishing was unknown during 2019 (NEFSC, 2020).

This assessment provides updates of commercial fishery catches (Table 1, Figure 3), q-adjusted, swept-area biomass estimates, and exploitation indices (catch/biomass) through 2022 (Figure 4). Cohort-specific biomass was estimated separately for the NEFSC spring surveys versus NEFSC fall + NEAMAP fall surveys. Annualized biomass estimates, recommended by the SARC/SAW 51 Working Group as annually averaged spring and fall survey biomass estimates, were also updated. Cohort-specific exploitation indices (Jan-June catch/spring survey biomass versus July-December catch/fall survey biomass) and annualized exploitation indices (annual catch/ annually averaged spring and fall survey biomass) were updated as well.

State of Stock: Based on this updated assessment, the annualized stock status for longfin inshore squid is not overfished and overfishing is unknown. The annualized catchability-adjusted, swept-area biomass in 2022 (defined as the two-year moving average of the 2022 and 2021 annually averaged NEFSC spring and fall survey biomasses) was estimated to be 121,836 mt (80% CL = 106,748, 136,923) (Figure 1), which was more than five times greater than the threshold B_{MSY} *proxy* of 21,203 mt. Overfishing status could not be determined because there are no approved fishing mortality Reference Points for the stock. The 2022 annualized exploitation index (2022 catch divided by 121,836 mt) was estimated to be 0.155 (Figure 2), which was 20.1% less than the 1987-2021 median of 0.195. However, as recommended by the 2020 assessment review panel, cohort-specific biomass and biomass Reference Points should be used to determine stock status. The recommended stock status for the cohorts caught in both the spring and fall NEFSC surveys is not overfished and overfishing is unknown. The catchability-adjusted, swept-area biomass in 2022 was estimated to be 46,336 mt (80% CL = 42,545, 50,128) (Figure 3) for the spring survey cohort and 197,335 mt (80% CL = 167,403, 227,268)(Figure 3) for the fall survey cohort, both of which were well-above the threshold B_{MSY} *proxy* of 11,152 mt for the spring survey cohort and 56,268 mt for the fall survey cohort.

Table 1: Catch and biomass assessment results for longfin inshore squid. All weights are in (mt). DWF landings are the landings from the Distant Water Fleets. Total biomass estimates in this table were not used for stock status determination because they are the two-year moving averages of the annualized q-adjusted, swept-area biomass estimates for the NEFSC spring and fall bottom trawl surveys (i.e., averages of the two surveys). Exploitation indices represent the catch in year y divided by the two-year moving average of the annualized biomass estimate in year y.

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
					Data						
US Landings	12,820	11,090	12,070	11,953	18,182	8,188	11,632	12,458	9,449	10,759	18,489
DWF Landings	0	0	0	0	0	0	0	0	0	0	0
US Discards	368	246	208	97	498	131	134	315	586	580	447
Catch for Assessment	13,187	11,336	12,278	12,050	18,680	8,319	11,766	12,773	10,035	11,339	18,936
					Model Results						
Total Biomass	93,975	109,573	NA	NA	73,762	NA	NA	63,349	NA	NA	121,836
Exploitation Index	0.14	0.103			0.253			0.195			0.155

Table 2: Comparison of Reference Points estimated in the 2020 and current assessment updates.

	2020	2023
F_{MSY} *proxy*	NA	NA
B_{MSY} *proxy*	42,405	42,405
MSY (mt)	NA	NA
Overfishing	Unknown	Unknown
Overfished	No	No

Projections: Near-term stock size projections were not possible due to the lack of an analytical assessment model that accounts for the species unique life history.

Special Comments:

- What are the most important sources of uncertainty in this stock assessment? Explain, and describe qualitatively how they affect the assessment results (such as estimates of biomass, F, recruitment, and population projections).

  For the estimation of biomass using NEFSC bottom trawl survey data, the most important source of uncertainty is the apparent productivity differences between the two intra-annual cohorts. The biomass of the cohort caught during the fall surveys is about five-fold higher than the biomass of the cohort caught in the spring surveys (NEFSC, 2011a; 2011b). However, the mean exploitation rate for the Jan-June fishery was more than three times higher on the apparently less productive spring survey cohort. Using annualized biomass and exploitation rates to determine stock status does not account for these differences, and therefore, may impact resource sustainability. The review panel for the 2020 Level 3 assessment of this stock agreed and concluded that Annual averaging of the spring and fall survey biomasses assumes that a single population is being exploited and does not account for the large difference in apparent productivity of the two intra-annual cohorts. Cohort-specific stock size estimates and Reference Points are required to determine the stock status of cephalopod species with subannual lifespans because maturation and growth rates of intra-annual cohorts exhibit a high degree of seasonal and interannual variability (Arkhipkin et al. 2020).Because the generation time for longfin squid is only 6-8 months, overfishing of a single cohort potentially could jeopardize stock sustainability due to recruitment overfishing.

  During the 2020 assessment, cohort-specific biomass Reference Points were derived separately for squid caught in the NEFSC spring versus fall bottom trawl surveys because annualized biomass estimates and Reference Points (i.e. averages of the spring and fall survey biomasses) do not account for the apparent productivity differences that exist between the two intra- annual cohorts caught during these surveys.

- Does this assessment model have a retrospective pattern? If so, is the pattern minor, or major? (A major retrospective pattern occurs when the adjusted SSB or F_{Full} lies outside of the approximate joint confidence region for SSB and F_{Full}

  These questions are not applicable to the subject assessment because an analytical model was not utilized.

- Based on this stock assessment, are population projections well determined or uncertain? If this stock is in a rebuilding plan, how do the projections compare to the rebuilding schedule?

  Projections were not possible, because there is no anaytical model from which to do so. The stock is not currently subject to a rebuilding plan but has been in the past.

- Describe any changes that were made to the current stock assessment, beyond incorporating additional years of data and the effect these changes had on the assessment and stock status.

  The 2009-2020 NEFSC spring and fall survey biomass indices now include actual rather than nominal tow distances, at the request of the NTAP. This resulted in minor changes to the indices that did not affect stock statuses for either cohort. For example, the difference between the two-year moving average biomass estimates for 2019 during this assessment versus the 2020 assessment represented a 3.5% increase of 2,290 mt which is inconsequential in relation to the magnitude of the 2019 biomass estimate in relation to the threshold

B_{MSY} proxy.

The other assessment methodology change involved the discard estimates for 2020-2022. Since the 2007 implementation of trimester-based quotas, discards have represented a minor portion of the catch; an average of 1.6% during 2007-2019. Nevertheless, the 2020-2022 discards were estimated using a new method with data from a new database, both of which differ from those used to estimate the 1989-2019 discards for the 2020 assessment. The new database, the CAMS database, was created and is maintained by the Greater Atlantic Regional Office. Some of the major differences between the two discard estimation methods and comparisons between the discard estimates for each method, during 2019-2021, are summarized in Tables 3 and 4 of the longfin squid tables file (refer to the website link provided for this assessment meeting). The 2019 landings were compared between the two discard estimation methods, as were the 2019-2021 discards, but only the CAMS discard estimates were available for 2022. The 2019 CAMS landings (12,489 mt) were only 31 mt (0.25%) higher than the 2019 landings from the Area Allocation database (i.e. cfdets2019aa Oracle table) that was formerly used in the discard estimation method as the denominator (kept weight of all species). The higher 2019 CAMS discard estimate (357 mt, CV = 0.18) was more precise than the discard estimate based on the former discard estimation method (315 mt, CV = 0.32. However, only the CAMs discard estimates for 2020-2022 were used in this assessment, because 2019 was the terminal year of the previous assessment and the 2019 discard estimate was accepted for use in the stock status determination. When the 2019-2021 CAMS discard estimates were compared with those from the former discard estimation method, most of the CAMS estimates were slightly higher, but most fell within the 90% confidence interval of the discards estimated using the former method.

- If the stock status has changed a lot since the previous assessment, explain why this occurred.

  Overfishing status is unknown for this stock because an analytical model could not be developed by the most recent benchmark assesment Working Group given the available data. There has been no change in the overfished status of longfin inshore squid since the 2020 operational assessment, for either of the two cohorts or for both cohorts combined (i.e., based on annualized biomass and biomass Reference Points). Under the current assessment process, however, stock status for this subannual species is always reported for the prior year (i.e., for multiple generations past) and this stock status is assumed to remain the same for the next three years when the next Management Track Assessment occurs. It is imperative that both squid stocks be assessed annually so that the timing of their stock status updates are appropriate for their short lifespans.

- Provide qualitative statements describing the condition of the stock that relate to stock status.

  The use of conventional stock assessment models to assess squid stocks such as longfin inshore squid (Doryteuthis (Amerigo) pealeii), is inappropriate because they do not account for the species' subannual lifespan and semelparous reproduction. This neritic species has a lifespan of 6-8-months, and like many other loliginids, there are two dominant intra-annual cohorts; winter-hatched and summer-hatched cohorts that have different growth rates and median sizes-at- maturity (Brodziak and Macy 1996; Macy and Brodziak 2001). Length-based models are not generally used to assess squid stocks because time-consuming, expensive aging (counting of daily increments in statoliths) must be used to identify the intra-annual cohorts due to the high plasticity in individual growth rates (Arkhipkin et al. (2015). Like most squid stocks, stock size estimates of longfin inshore squid exhibit high interannual variability because each year, the population relies on new recruits to each intra-annual cohort, and recruitment levels depend on the favorability of environmental conditions (Brodziak and Hendrickson 1999; Hatfield et al. 2001).

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.

  Based on the NRCC assessment schedule, this stock is currently assessed every three years. Instead, it is recommended that this subannual species be asssessed on an annual basis, as was done historically. A Research Track Assessment is scheduled for review in 2026, following two years of research dedicated to developing a stock assessment model and Reference Points that account for the life history of this semelparous species and its two intra-annual cohorts. The research topics identified here and in previous assessments should be reviewed and prioritized prioritized by the Working Group prior to conducting any research on the stock.

During the upcoming longfin squid Research Track Assessment, the top priority should be the development of a cohort-specific assessment model that incorporates, for example, their different growth rates and median ages-at-maturity, along with spawning and non-spawning spawning natural mortality rates.

Simulation testing should be conducted to evaluate the model's ability to accurately and precisely estimate stock conditions under a wide range of scenarios, including process and measurement errors.

A method that accounts for the species' semelparous reproduction should be used to estimate separate %MSP-based Biological Reference Point proxies for each of the two intra-annual cohorts to ensure adequate spawner escapement.

Annual pre-season biomass estimates for each cohort will be necessary to set cohort-specific Annual Biological Catches and quotas. This requires a streamlined regulatory process that allows for rapid implementation of the cohort-specific quotas in order to avoid foregone yield during years of high stock size and to avoid recruitment overfishing of either cohort during years when stock size is low.

Extend the work that has been conducted on estimation of the NEFSC bottom trawl catchability of this species in both the spring versus fall bottom trawl surveys (NEFSC 2011a; Jacobson et al. 2015). Additional empirical data for estimating these catchabilities are needed to investigate the apparent productivity differences between the two cohorts caught in the NEFSC spring versus fall bottom trawl surveys. Biomass estimates for the fall NEAMAP surveys were only a small percentage of the total fall biomass, averaging 5.5% during 2009-2022, but a comparison of longfin squid catchability differences between the NEAMAP and NEFSC fall surveys might also be useful.

- Are there other important issues?
  Life history, life history, life history!

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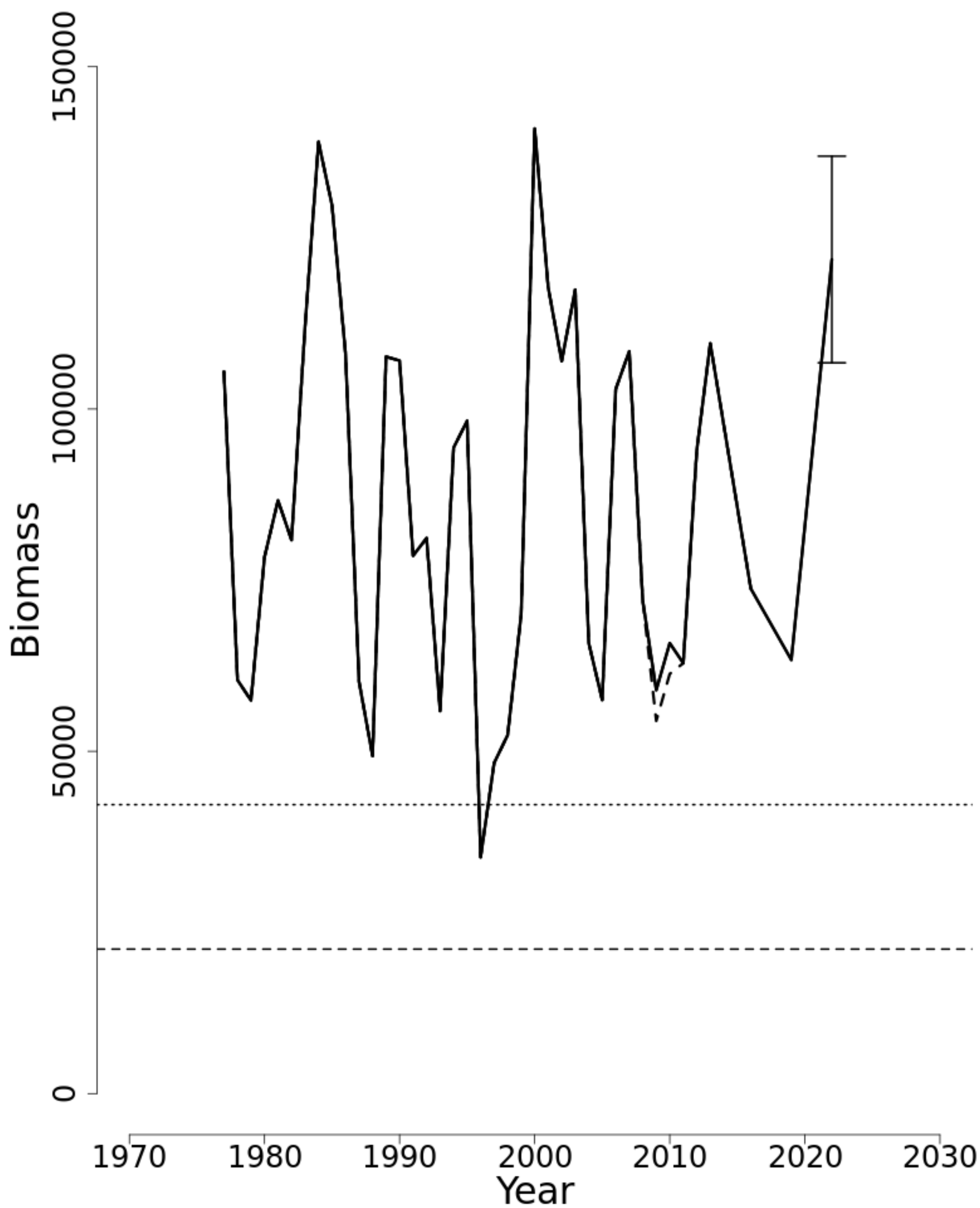

Figure 1: Trends in the two-year moving averages of annualized q-adjusted, swept-area biomass (i.e., annually averaged NEFSC spring and fall survey biomasses, in mt) of longfin inshore squid from the current assessment (solid line) and the 2020 assessment updates (dashed line). Biomass estimates are shown as interpolated values for years where biomass could not be estimated due to inadequate survey sampling coverage of longfin squid habitat (i.e., 2014 and 2020 spring and 2017 and 2020 fall surveys). The 80% confidence limits (106,748, 136,923) are shown for the 2022 biomass estimate (121,836 mt) in relation to the BMSY proxy (42,405 mt) and $B_{Threshold}$ (21,203 mt).

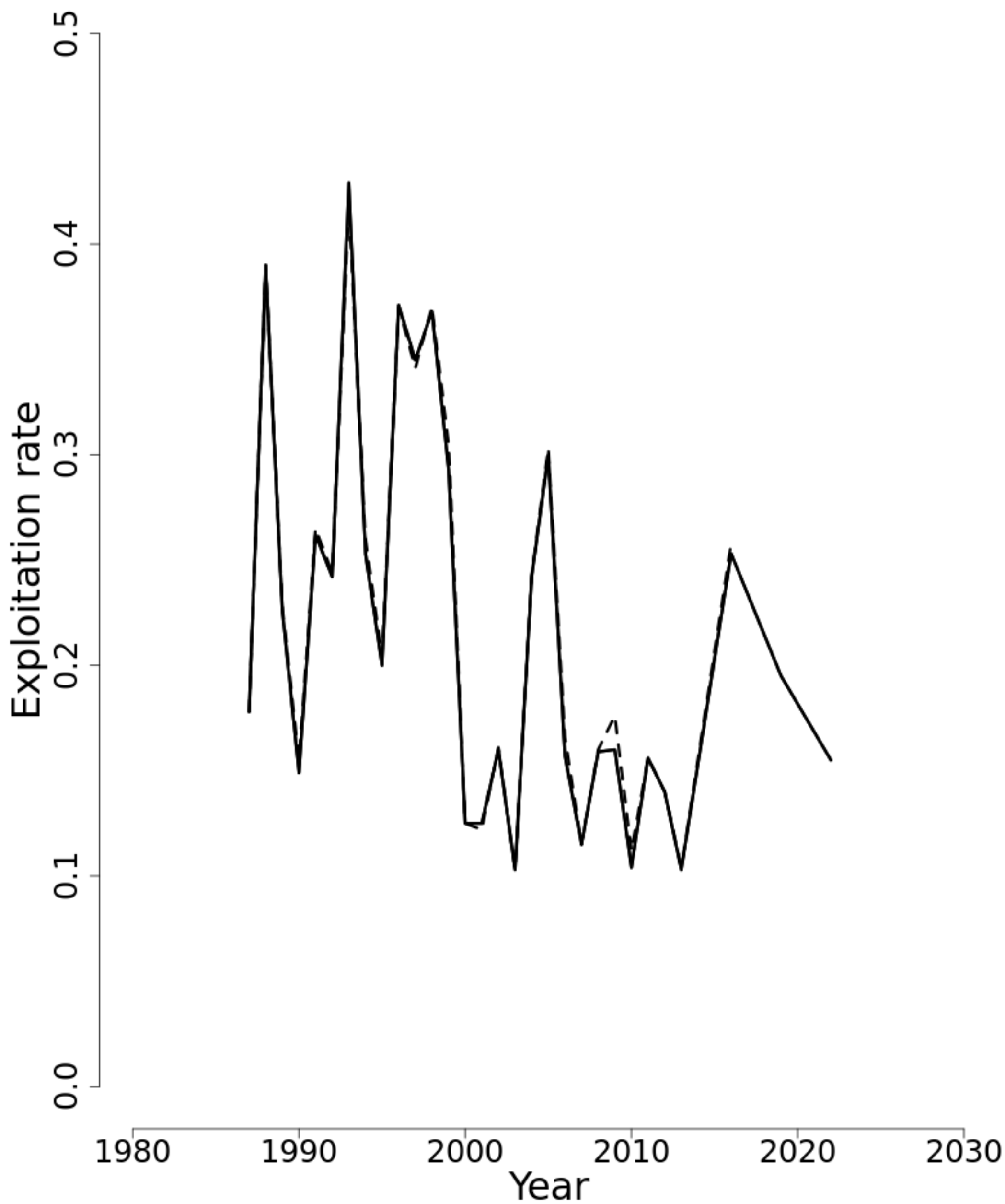

Figure 2: Trends in annualized exploitation indices (annual catch/two-year moving average of the annualized NEFSC spring and fall survey biomass estimates) of longfin inshore squid during the U.S. fishery time period (between 1987 and 2022 from the current assessment (solid line) and the 2020 assessment updates (dashed line). Exploitation rates are shown as interpolated values for years with only a single biomass estimate due to inadequate survey sampling coverage of longfin squid habitat (i.e., the 2014 and 2020 spring and 2017 and 2020 fall surveys).

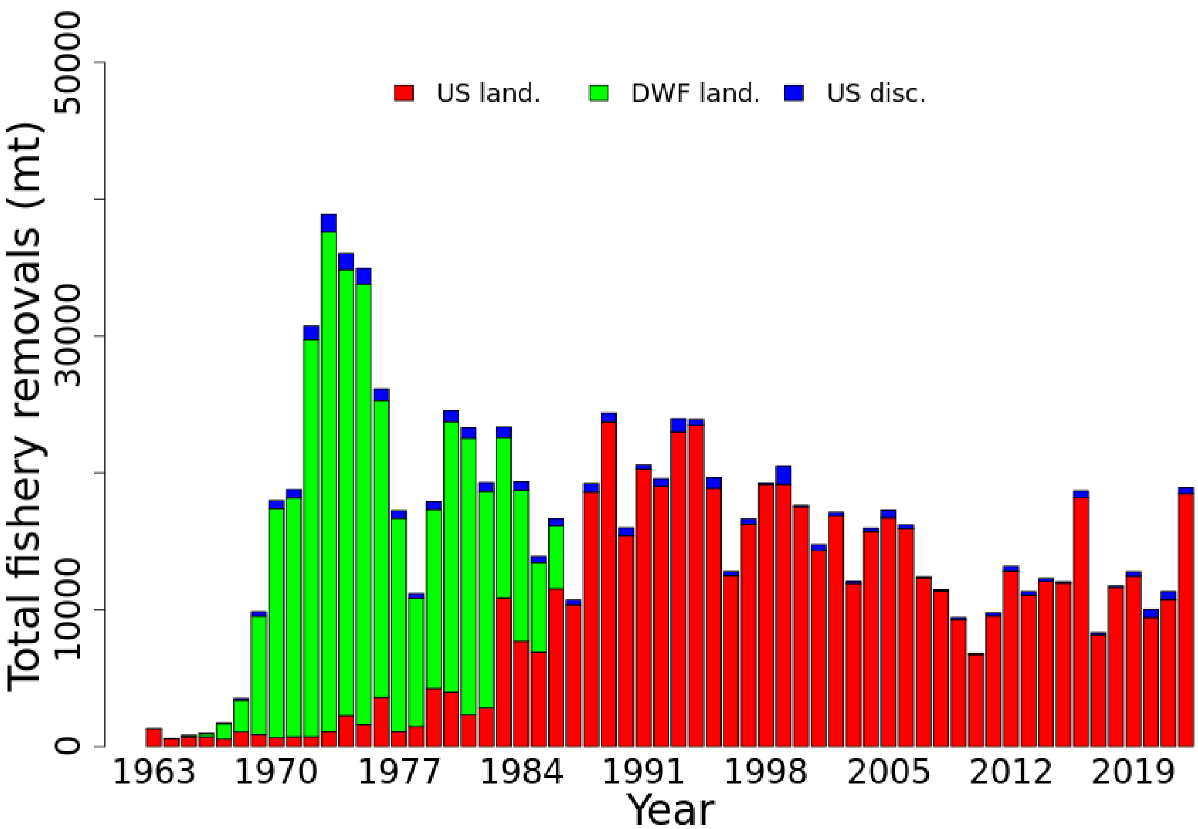

Figure 3: Total catches of longfin inshore squid between 1963 and 2022 by fleet (commercial) and disposition (landings or discards). DWF landings are the Distant Water Fleet landings, but the discards for this fleet are unknown.

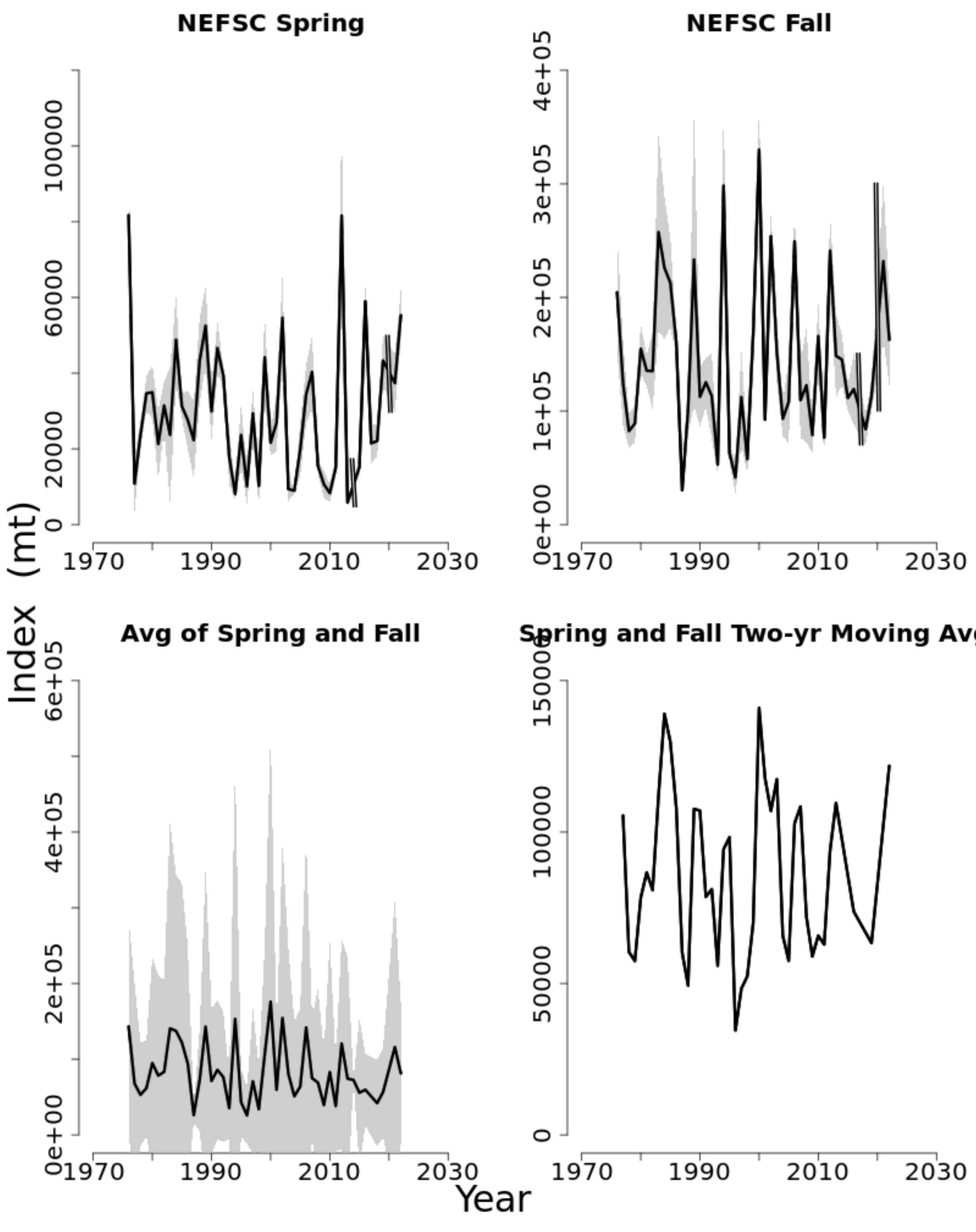

Figure 4: Swept-area, q-adjusted biomass estimates (mt) for longfin inshore squid between 1976 and 2022 for the NEFSC spring and fall bottom trawl surveys (top panels), annualized NEFSC survey biomass (i.e. averages of the biomass estimates for these two surveys) and two-year moving averages of the annualized biomass estimates. Due to inadequate survey sampling coverage of longfin squid habitat during the 2014 and 2020 spring surveys and the 2017 and 2020 fall surveys, biomass estimates during these years are not shown in the two top panels, but have been interpolated in the biomass time series shown in the bottom panels.