draft working paper for peer review only

Southern red hake

2023 Management Track Assessment Report

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts

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This assessment of the southern red hake (Urophycis chuss) stock is an update of the 2020 assessment, which used an empirical method based on a catchability study (Miller et al., 2023) to estimate swept-area biomass and annual exploitation rates. The catchability study compared the groundfish survey net to a chainsweep net with an assumed efficiency of one, which allowed for model-based estimation of the efficiency of the survey vessel for specific species. This assessment updates commercial landings and discards, recreational fishery catch and survey biomass indices through 2022. Based on the 2020 assessment, the status of southern red hake was unknown as there are no reference points estimated by the empirical method. The status continues to be unknown. The survey biomass index was at a low point in 2022, but it has been variable in recent years. The estimated exploitation rate has not been greater than 7% in the past 20 years.

State of Stock: Based on this updated assessment, the status of the southern red hake (*Urophycis chuss*) stock is unknown.

Table 1: Catch and results table for southern red hake. All weights are in metric tons and estimated exploitation rates are catch/biomass expressed as a percent. There is no break in the annual estimated swept-area biomass series as a mean of the spring and fall survey biomass indices is used (fall of time t and spring of time t+1). The spring and fall indices track each other well, so the 2020 values were treated as missing and it did not create a break in the series.

	2015	2016	2017	2018	2019	2020	2021	2022
			Data					
Recreational catch	63	493	93	145	304	489	168	108
Commercial discards	872	758	451	1,285	1,372	1,845	1,047	467
Commercial landings	398	396	328	401	351	291	191	110
Catch for Assessment	1,333	1,646	872	1,831	2,027	2,624	1,406	685
			Model Results					
Estimated swept area biomass	51,593	34,093	39,783	69,648	85,815	119,433	21,491	20,980
Estimated exploitation rate	2.58	4.83	2.19	2.63	2.36	2.2	6.54	3.27

Table 2: The method used for the previous assessment and current assessment update does not estimate reference points, so overfishing and overfished status is unknown.

	2020	2023
F_{MSY} *proxy*	Unknown	Unknown
SSB_{MSY} (mt)	Unknown	Unknown
Overfishing	Unknown	Unknown
Overfished	Unknown	Unknown

Projections: There were no projections made for the southern red hake stock. Applying the mean estimated exploitation rate during the years used to set catch in 2020 (2001-2019) of 3.38 percent to the 3-year running average (2020-2022) swept-area biomass estimate of 53,968 mt produces a catch of 1826 mt.

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).

  Some of the reported landings are categorized as mixed red and white hake so the proportion of those

landings that are red hake must be estimated. However, the landings reported as mixed hake are not a large proportion of landings.

According to NEFOP observers, there have been occasions where mixed red hake and spotted hake have been landed as red hake. White, red and spotted hake mixes may occur more often than they are accounted for. The majority of the southern red hake removals are discards from other fisheries and there is the need to estimate total discards based on observed trips.
The MRIP recreational catch estimates have high levels of uncertainty.
For these reasons, southern red hake total catch is difficult to estimate with precision.

- 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}).

  The empirical method used to assess this stock does not allow estimation of a retrospective pattern.

- 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?

  There are no projections made for the southern red hake stock. The first time the empirical method was used in 2020 catch was derived from applying an exploitation rate of 2.44 percent (based on the mean estimated exploitation rate during 2009-2019, the Bigelow years) to the 3-year average (2017-2019) swept area biomass. A 10-year rebuilding plan for southern red hake began in 2021.

- 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.

  For the 2020 assessment, an empirical method based on catch efficiencies for the Bigelow trawl net, derived using a model specifically for red hake, was used to estimate annual total swept-area biomass, and from that estimate annual exploitation rates, using survey and fishery data through 2019. This assessment through 2022 uses the same method with an additional three years of data. The estimates of swept-area biomass for the pre-Bigelow years in the time series were re-estimated using the mean of all the annual efficiencies calculated for the Bigelow since 2009. With three additional years of annual efficiency estimates included, the mean efficiency changed from 0.243 to 0.249.
  For context, during the Red Hake Stock Structure Research Track peer review process in early 2020, it was determined that the AIM model, which had been used for red hake assessments since 2010, was no longer a viable alternative for stock status determination for red hake due to poor fit. For this reason, the assessment is now using an empirical approach.
  This assessment is also now using CAMS data from 2019 forward for discards and landings. During the years when discards were estimated by both CAMS and SBRM, the results were similar.

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

  Since there is currently no established method to derive reference points from the empirical approach used in this assessment, the stock status remains undetermined.

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

  According to the 2023 State of the Ecosystem Report, red hake in the mid-Atlantic in 2022 were in above-average body condition, but this has been variable in recent years. They were in below-average condition in 2021 and had below-average productivity in 2019 (the last year of data available for survey-based productivity). However, according to the report, southern red hake had exceptionally productive years in 2011 and 2013.
  Southern red hake have been getting smaller (in both length and weight) at age over time.

  Analyses done during the Red Hake Stock Structure Research Track and for this assessment indicate that southern red hake biomass is not necessarily driven by fishing since exploitation rates are low. It is possible that changing environmental conditions have caused the population of southern red hake to decline as a result of physical conditions that reduce survival, or competition for the same resources by other species. Estimated

consumption of southern red hake (by both different fish species and larger red hake) is about 1800 mt per year on average, but estimates vary substantially from year to year and there is not a clear trend over time (Smith, 2020).

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

  The assesssment could be improved with further exploration of a method to derive reference points based on the catchability studies and the stock biomass estimates they enable us to determine.
  It would be helpful to understand the changes in distribution of both southern red hake and other species that might compete with southern red hake.

- Are there other important issues?

  Since this method does not generate analytical reference points, overfishing status can be determined by comparing current estimated exploitation rates to rates from a time period when the fishery was determined to have been sustainable, for instance. Overfished status could be determined by comparing the current estimated swept-area biomass to either the whole time series or a time period when the stock was considered to be in good condition.

  The swept-area biomass method offers a way to qualitatively assess the level of removals and stock status. In the case of southern red hake, less than six percent of the biomass is estimated to have been removed every year since 2003. Estimated biomass has increased since a low point in 2005 which could be the result of decreased removals. But there is evidence (including the failure of the AIM model, which depends on a relationship between removals and survey biomass) that reducing fishing may not result in increased biomass.

References:

Miller, T., Richardson, D., Politis, P., Blaylock, J. 2023. Estimation of survey efficiency and biomass for commercially important species from industry-based paired gear experiments. Fisheries Research volume 259, article 106565.

Most recent assesment:
Fall Management Track Assessments 2020 Northeast Fisheries Science Center Reference Document 22-08, 173 p. Available at: https://repository.library.noaa.gov/view/noaa/39404

Most recent benchmark assessment:
Northeast Fisheries Science Center. 2011. 55^{th} Northeast Regional Stock Assessment Workshop (51^{st} SAW) Assessment Report. US Dep Commer, NOAA Fisheries, Northeast Fisheries Science Center Ref Doc 11-01,79 p. https://repository.library.noaa.gov/view/noaa/3766

State of the Ecosystem Report, 2023, Mid-Atlantic region. Available at:
https://www.fisheries.noaa.gov/new-england-mid-atlantic/ecosystems/state-ecosystem-reports-northeast-us-shelf

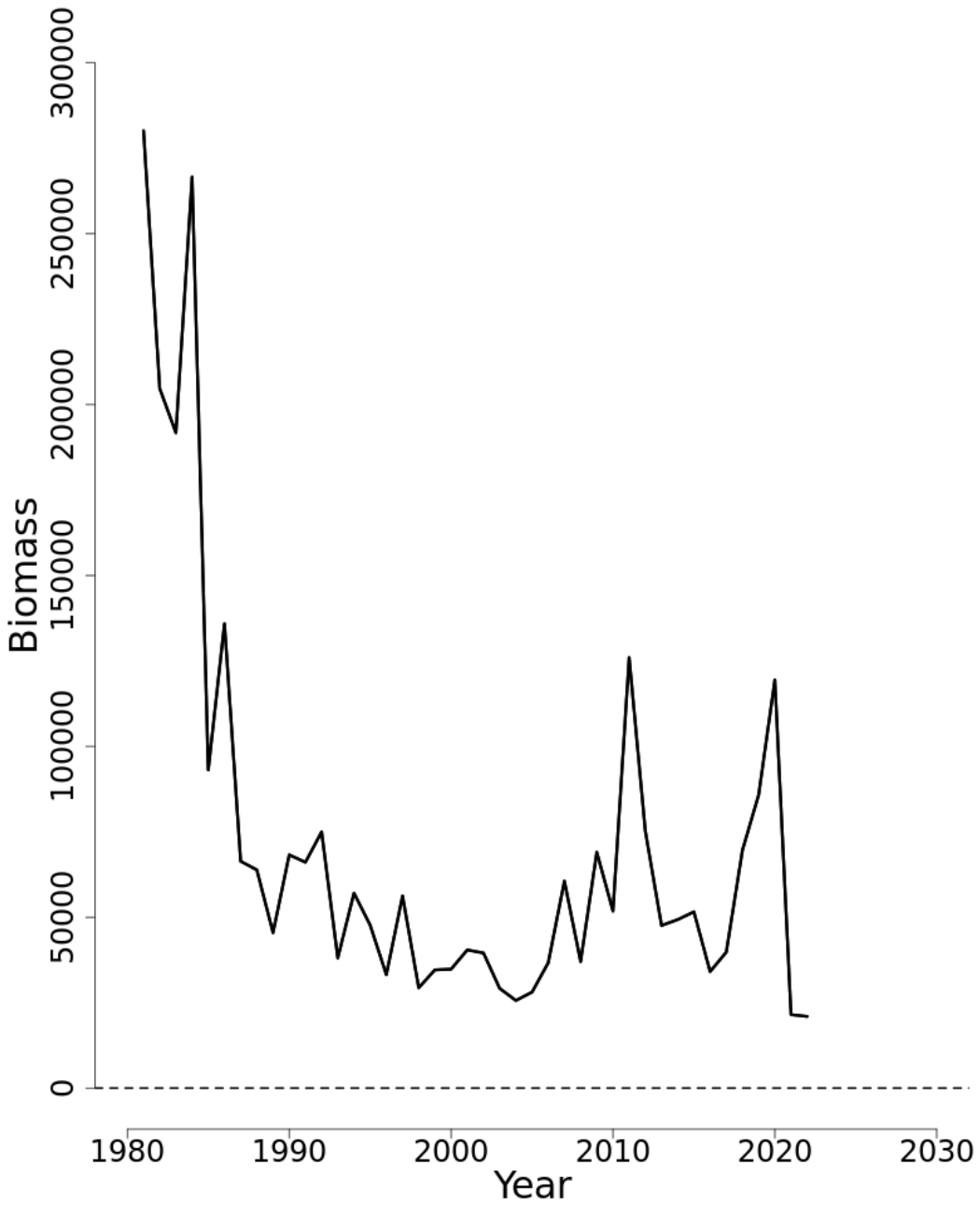

Figure 1: Trends in estimated swept area biomass in metric tons of southern red hake between 1981 and 2022 from the current assessment.

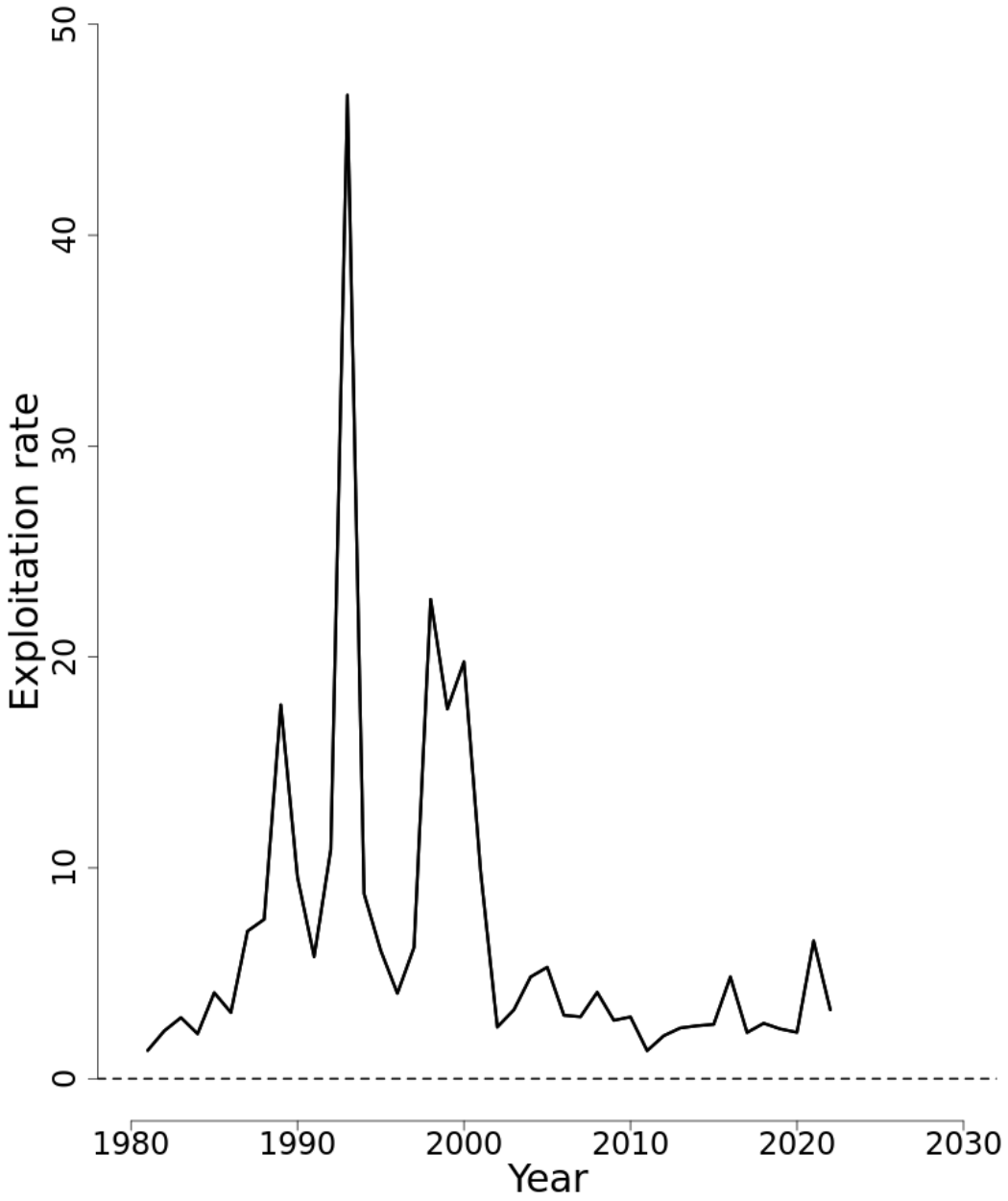

Figure 2: Trends in estimated exploitation rate in percent of southern red hake between 1981 and 2022 from the current assessment.

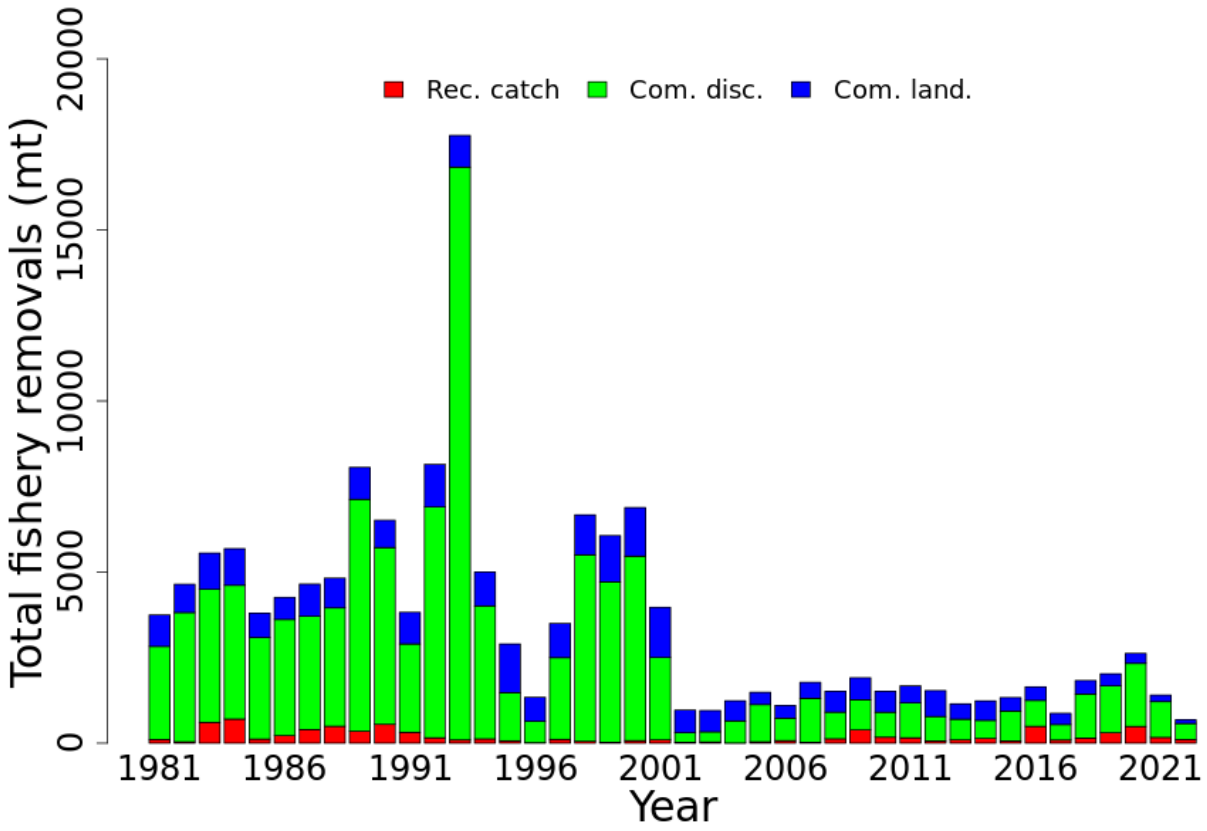

Figure 3: Total catch of southern red hake between 1981 and 2022 by the commercial and recreational fleets.

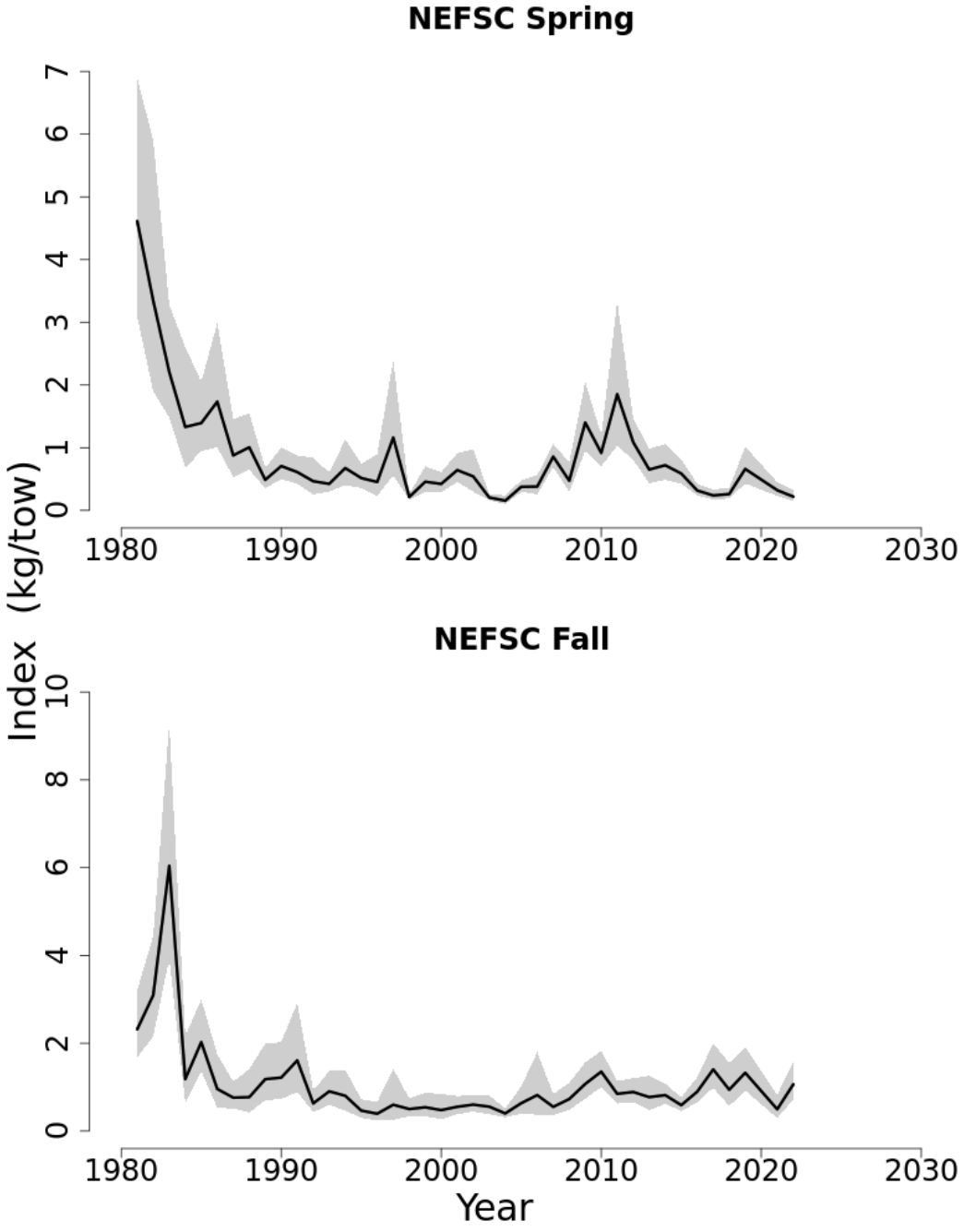

Figure 4: Indices of biomass for southern red hake between 1981 and 2022 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys. The approximate 90% lognormal confidence intervals are shown.