draft working paper for peer review only



# Northern red hake

# 2023 Management Track Assessment Report

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This assessment of the northern red hake (Urophycis chuss) stock is an update of the 2020 assessment which used an empirical method based on a chain-sweep catchability study (Miller et al., 2023) to estimate swept-area biomass and annual exploitation rates using survey and fishery data through 2019. Based on the 2020 assessment, the status of the stock was unknown as the swept-area biomass method used does not estimate biological reference points. This assessment uses the same method with updated commercial landings, commercial discard estimates, recreational fishery catch estimates and survey biomass indices through 2022. The stock status of northern red hake continues to be unkown, but the exploitation rate is estimated to be less than one percent and the biomass has been trending upward since 2006.

**State of Stock:** An empirical method which does not estimate reference points is used for this assessment, so the status of the northern red hake (*Urophycis chuss*) stock is unknown.

Table 1: Catch and results table for northern 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.

	2014	2015	2016	2017	2018	2019	2020	2021	2022
Data									
Recreational catch	2	8	3	16	4	16	15	6	16
Commercial discards	195	263	253	131	172	207	140	798	628
Commercial landings	68	101	146	78	99	111	51	45	69
Catch for Assessment	265	373	402	225	276	334	205	849	714
Model Results									
Estimated swept area biomass	125,782	$275,\!983$	208,908	239,269	239,138	180,438	198,293	183,734	283,733
Estimated exploitation rate	0.208	0.126	0.176	0.092	0.117	0.131	0.104	0.462	0.252

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
Over fishing	Unknown	Unknown
Over fished	Unknown	Unknown

**Projections:** There were no projections made for the northern red hake stock. Applying the mean estimated exploitation rate during the years used to set catch in 2020 (1981-1994) of 1.41 percent to the 3-year running average (2020-2022) swept-area biomass estimate of 221,920 mt produces a catch of 3129 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 reported landings are categorized as mixed hake so the portion of those landings that are red hake must be estimated. There may be more mixed hake landings that are landed as red hake as well. Since most red hake that are caught are discarded, much of the catch used for the assessment relies on the estimation of total discards.

For these reasons total red hake removals have a certain degree of uncertainty.

• 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 northern red hake stock, and it is not under a rebuilding plan. The first time this empirical method was used in 2020, catch advice was derived by applying the mean exploitation rate estimated for the northern red hake stock during the years 1981-1994 to the mean estimated northern red hake swept-area biomass from the years 2017 through 2019.

• 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 (in Bigelow units) 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 0.235 to 0.239.

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.

Red hake on George's Bank have been in good or above average body condition since 2019, according to the 2023 State of the Ecosystem report. Red hake in the Gulf of Maine have been in good, above average, or neutral condition since 2011, one of the longest periods of any of the species included in the analysis. According to the report, Gulf of Maine red hake had especially productive years in 2016 and 2019. As with many stocks, the mean weight and length at age of northern red hake have decreased over time.

The spring and fall NEFSC survey biomass indices for northern red hake are currently at their highest levels since the beginning of the survey time series, and the exploitation rate has been estimated to be less than one percent per year since the early 1990s.

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

The assessment 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.

• Are there other important issues? None.

### **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 assessment:

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. Available at: https://repository.library.noaa.gov/view/noaa/3766

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

Final report of the red hake stock structure working group, 2020. Northeast Fisheries Science Center Reference Document 20-07, 189 p. Available at: https://repository.library.noaa.gov/view/noaa/49147



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



Figure 2: Trends in estimated estimated exploitation rate (catch/biomass), in percent, of northern red hake between 1981 and 2022 from the current assessment.



Figure 3: Total catch of northern red hake between 1981 and 2022



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