STOCK STATUS UPDATE OF CUSK (*BROSME BROSME*) IN NAFO DIVISIONS 4VWX5Z UNDER THE PRECAUTIONARY APPROACH FRAMEWORK

Context

Commercial catch rates for Cusk have declined since the 1980s. Management measures (e.g., trip limits, overall caps, and bycatch percentages) may have contributed to this reduction in catch rates (and landings); however, it is thought the decline in catch per unit effort (CPUE) is also due to a decline in Cusk abundance. The extent of the decline in abundance is not known. Proposed reference points for Cusk and other Maritimes Region stocks were reviewed at a Fisheries and Oceans (DFO) Regional Peer Review meeting in February 2012. The framework for these reference points followed the 2009 DFO policy document "A fishery decision-making framework incorporating the Precautionary Approach," which explains in detail how the precautionary approach (PA) will be put into practice. To be compliant with the PA, fishery management plans should include harvest strategies that incorporate a Limit Reference Point (LRP) that delimits the boundary between a critical and cautious zone, and an Upper Stock Reference (USR) that delimits the boundary between a cautious and healthy zone on the stock status axis. The Halibut Industry Survey provides an ongoing time series to be used for monitoring Cusk stock status. The USR and LRP for Cusk were set at 26.6 kg/1000 hooks and 13.3 kg/1000 hooks respectively. The 3-year geometric mean was accepted as the metric for monitoring Cusk status relative to the USR and LRP.

This Science Response Report results from the Science Response Process of December 18, 2013, on the status of Cusk (*Brosme brosme*) in NAFO divisions 4VWX5Z under the Precautionary Approach Framework. Fisheries and Aquaculture Management requested the current 3-year geometric mean of the Cusk CPUE from the DFO-Industry longline survey relative to the USR (26.6 kg/1000 hooks) and the LRP (13.3 kg/1000 hooks).

Background

It is generally accepted that the abundance of Cusk has declined since the 1980s (Harris and Hanke 2010). There are indices available which can be used to determine biomass trends for Cusk; however, there is no single index that covers a long enough time-series. There are no surveys dedicated to sampling Cusk. The Maritimes Region Ecosystem Survey is not thought to be proportional to Cusk total population abundance because it does not sample the preferred habitat or depths of Cusk (DFO 2008). The Halibut Industry Survey, a longline survey that samples an area from the Grand Banks of Newfoundland, along the Scotian Shelf to Georges Bank, is considered to provide useful information on trends in Cusk abundance in NAFO Divisions 4VWX5Z since 1999. It can provide information on whether there is an increasing or decreasing trend in abundance in the current time period. It does not provide any information from before the decline in the early 1990s and so it cannot be used to calculate a reference point against which this trend can be compared to determine stock status. The survey generally runs annually from May 22nd to June 22nd. Longline gear is an effective sampling tool for Cusk as demonstrated by the commercial fishery; over 90% of landings were made by the longline fleet (Harris and Hanke 2010).

Analysis and Response

Cusk Abundance Monitoring: The Effects of Hook Saturation on CPUE[1]

Background

The validity of longline surveys as indices of abundance requires that the abundance of fish is low relative to the number of hooks set, so that the capture of one fish will not preclude the capture of another. If abundance were so high that all hooks were occupied, the gear would be saturated. This will cause CPUE to level off even as target species abundance increases. (Murphy 1960, Rothschild 1967, Obradovich 2009). To have increased confidence in an index of abundance, the occurrence of hook saturation should be determined.

Methods

The Halibut Industry Survey data are generally reported by set and not by hook. Recording of the number of individuals by species caught in a set was not always consistent. Only set weight by species is recorded for most species.

To estimate the number caught, the number of individuals was calculated using an average individual weight for that species, as reported from the Halibut Industry Survey. When there was no information on a species weight in that dataset, weight was inferred based on average weight calculated from other longline data within the observer database.

The average number of invertebrates was calculated differently from other species because there can be more than one individual per hook. Observer protocol is that for any reported species caught in a set, the minimum weight is recorded as 1 kg, whether it was one individual or more. Based on the average weight given and the minimum weight of 1 kg reported for an individual, 2 different values were calculated for the number of invertebrates per hook, the minimum and the maximum. For example, in one trip there was a combined estimated weight of 14 kg for invertebrates from the class Asteroidea. To calculate the minimum number of individuals caught, the total weight (14 kg) was divided by the observer protocol default weight of 1 kg/individual for an estimate of 14 individuals. Since the calculated average weight per individual in this class is 0.58 kg/individual, the maximum number of individuals was calculated as 14kg/0.58kg = 24 individuals.

Hook saturation was determined by estimating the percent of hooks that were occupied and unoccupied during a fishing set. This was estimated for all of the data combined by year. Due to the possible variation in the number of individuals per hook for invertebrates (not counted individually), hook saturation was calculated using the maximum number of invertebrates per hook and the minimum number caught per hook. One fishing trip was excluded from the analysis as it did not provide any information on the number of hooks hauled.

Results

There was no difference in the percent of hooks occupied per set (average of approximately 8%) when the maximum versus the minimum value was used to calculate the number of invertebrates caught (Table 1). Hook saturation varied by year and ranged from 5.3% to 13.5% (Table 2). The percent of sets that had a hook saturation value > 75% was 8, and saturation value > 50% was 41 (out of a total of 2682 sets); hook saturation for the majority of the sets was <10% (2037/2682) (Table 1).

[1] P. Emery and L.E. Harris unpublished internal report for DFO Science (Does Hook Saturation affect the ability to monitor Cusk abundance using the Halibut longline survey 1998-2011).

Table 1. Hook saturation summary in Halibut Industry Survey from 1998-2011.

	Calculation Method	
	Maximum*	**Minimum***
Average of % Occupied	8.4	8.3
Average of % Unoccupied	91.6	91.7
Total of # Hooks Hauled	2535487	2535487
Total Hook occupancy	199164	199067
Number of Sets	2682	2682
Number of Sets over 50%	41	40
Number of Sets over 75%	8	8
Number of Sets under 10%	2037	2033

* Number of invertebrates calculated per hook. The minimum and maximum values only apply to sets with invertebrates.

Table 2. Summary data of hook saturation calculation values by year for minimum (minimum number of invertebrates per hook) and maximum (maximum number of invertebrates per hook) calculations.

Year	Total # Hooks Hauled	Average # Hooks Hauled	Average % Occupied/Set (Minimum)	Average % Occupied/Set (Maximum)
1998	204165	936.5	8.3	8.3
1999	151225	1057.5	9.4	9.4
2000	173122	995.0	7.7	7.7
2001	162530	1028.7	8.9	8.9
2002	178973	967.4	13.5	13.5
2003	171749	959.5	11.8	11.8
2004	160175	976.7	7.1	7.1
2005	155215	929.4	9.6	9.6
2006	175872	920.8	7.8	7.8
2007	214877	863.0	8.2	8.2
2008	237354	892.3	6.7	6.7
2009	167485	900.5	5.3	5.3
2010	177885	921.7	5.9	5.9
2011	204860	980.2	7.0	7.0
All Years	2535487	945.4	8.3	8.3

The majority of annual average hook saturation levels were less than 10%, which suggests that hook saturation does not negatively bias the index of abundance when using the Halibut Industry Survey data. There were low numbers of trips that had saturation levels greater than 50% and even fewer with greater than 75%. These findings are consistent with previous examination of this data set (Jim Simon, Department of Fisheries and Oceans, Bedford Institute of Oceanography, Dartmouth, Nova Scotia; personal communication).

To obtain a more accurate estimate, it is recommended that the number of hooks occupied be recorded in addition to combined weight per set.

Since the majority of average hook saturation rates were low (less than 10%), including the estimates of maximum saturation, hook saturation does not appear to be an issue in the Halibut Industry Survey for the years in the analysis (1998 to 2011).

Status of Cusk Biomass under the Precautionary Approach Framework

The Halibut Industry Survey began in 1998; however, the data from 1998 were excluded due to a lesser number of sets in that year. Though it is a fixed station design, not all stations are sampled in all years. The 57 fixed stations used to calculate the USR and LRP (Harris et al. 2012) were included in this analysis. This portion of the survey includes some of Cusk's preferred habitat including deeper areas along the shelf edge, although only a few of these stations were in the Gulf of Maine, the area of highest commercial landings. The catches per set, the highest of which is 600 kg, were used to calculate standard CPUE in kilograms per 1000 hooks. It was assumed that the survey standard of 1000 hooks was fished in the single set with Cusk where the number of hooks was not recorded. Where stations had multiple sampling trips within the same calendar year, the average CPUE for the year was taken for that station.

The USR and LRP for Cusk in NAFO Divisions 4VWX5Z are 26.6 kg/1000 hooks and 13.3 kg/1000 hooks, respectively (Harris et al. 2012). The recent trend in the Halibut Industry Survey (3-year running geometric mean) was used to determine the status of the Cusk biomass in relation to the reference points. An average over several years was proposed for ongoing monitoring of stock status due to variability in the survey data. The geometric mean was suggested in preference to the arithmetic mean because it dampens the impact of occasional very high sample points on the average, providing slightly enhanced stability. The mean CPUE from the Halibut Industry Survey has been at or above the proposed LRP for the last 3 years although a high level of uncertainty is indicated by the wide confidence interval. The 3-year geometric mean (2011-2013) of the CPUE is 18.1 kg/1000 hooks, which suggests that the stock is in the cautious zone (Figure 1).

The lack of consistent sampling of stations by the Halibut Industry Survey is a source of uncertainty in relation to our ability to accurately monitor trends in Cusk abundance on an ongoing basis.

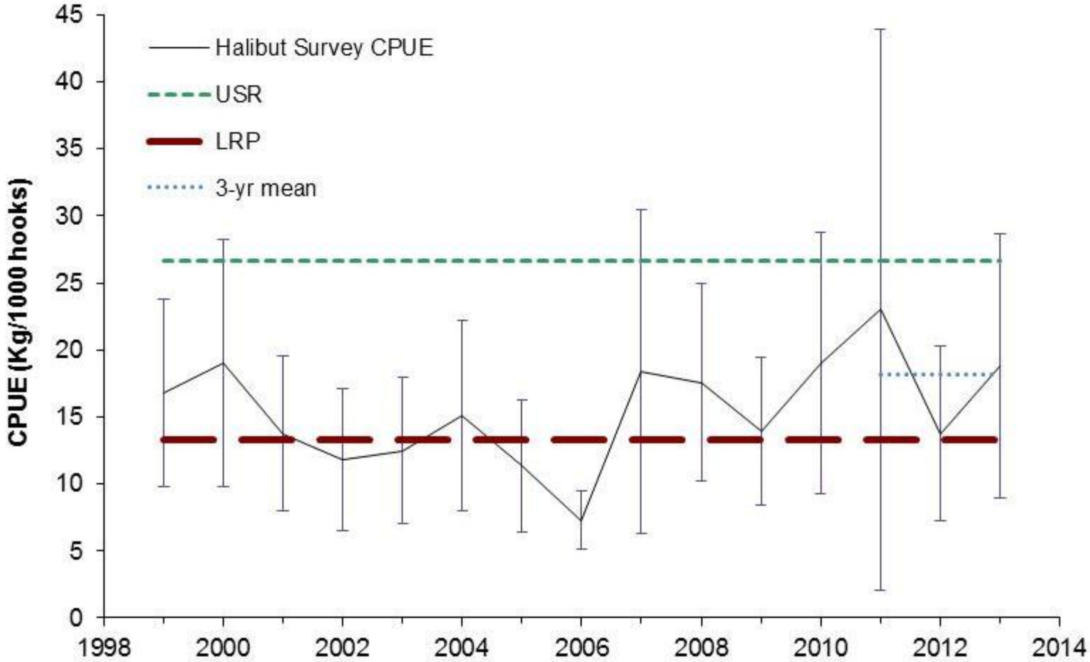

Figure 1. The green dashed reference line represents the upper stock reference point (80% of MSY proxy), the red dashed reference line represents the limit reference point (40% of MSY proxy), the solid black line represents the Halibut Industry Survey CPUE (kg/1000 hooks) for stations sampled in all years (n=50) including the 95% confidence interval and the dotted blue line represents the geometric mean of the CPUE for 2011-2013.

Conclusions

The mean Cusk CPUE from the Halibut Industry Survey has been at or above LRP for the last 3 years, although a high level of uncertainty is indicated by the wide confidence interval. The 3-year geometric mean (2011-2013) of the Cusk CPUE is 18.1 kg/1000 hooks, which suggests that the stock is in the cautious zone (Figure 1). Hook saturation does not appear to be a source of bias in the Halibut Industry Survey data since the majority of hook saturation levels were less than 10%.

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Date: January 7, 2014

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This Report is Available from the:

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ISSN 1919-3769

Correct Citation for this Publication:

DFO. 2014. Stock Status Update of Cusk (*Brosme brosme*) in NAFO Divisions 4VWX5Z Under the Precautionary Approach Framework. DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/019.

Aussi disponible en français :

MPO. 2014. Mise à jour de l'état du brosme (Brosme brosme) dans les divisions 4VWX5Z de l'OPANO au regard du cadre de l'approche de précaution. Secr. can. de consult. sci. du MPO, Rép. des Sci. 2014/019.