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Impact of missed strata on abundance-at-age estimates of Greenland halibut from the Canadian fall 2J3K and spring 3LNO surveys in 2018

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Abstract

Several survey strata inhabited by Greenland halibut were missed during the Canadian fall 2J3K and spring 3LNO surveys in 2018. The removal of sets from these strata from previous years had minimal impact on survey biomass estimates. Estimates from these surveys were therefore accepted for use in the calculation of the harvest control rule (HCR) for Greenland halibut in SA2+3KLMNO during the June 2019 Scientific Council meeting. Age disaggregated estimates, however, were not evaluated at that time. It was therefore recommended that the potential *impact on age structure be examined before these indices are included in any age structured model*. Here we present results from age-based stratified analyses that include and exclude sets from the strata missed in 2018 from surveys between 1995-2017. Our age disaggregated analyses revealed that the missed strata had a minimal impact on the estimates of mean number per tow at age for most age groups. There were, however, differences >10% in recent indices of ages 9 and 10+ from the Canadian fall 2J3K survey and age 1 from the Canadian spring 3LNO survey when the missed strata were excluded. These values should be treated with caution as they may introduce bias in an age-structured model.

Introduction

The Canadian fall 2J3K and spring 3LNO surveys were incomplete in 2018 and several strata inhabited by Greenland halibut were missed. Estimates of mean weight per tow from both of these surveys are used in the calculation of the harvest control rule (HCR) for Greenland halibut in SA2+3KLMNO. To assess the potential impact of these gaps on estimates of mean weight per tow, indices were re-calculated with these strata excluded during the June 2019 Scientific Council meeting and it was determined that values were comparable. The potential impact of these missed strata on age disaggregated estimates, however, were not evaluated. *"STACREC therefore recommended that the 2018 Canadian fall 2J3K and spring 3LNO indices be included in the calculation of the HCR but that the impact on age structure be examined before these indices are included in any age structured model"* (NAFO, 2019). Here we present comparisons of age-based estimates with and without the missed strata.

Methods

Methods are the same as those described in Rideout (**2019**). In short, only the Campelen time series was examined (i.e. 1995 – present for the fall 2J3K survey, 1996 – present for the spring 3LNO survey) and strata that were incomplete in the 2018 surveys were excluded from past years and stratified estimates of mean numbers per tow were re-calculated. Note that deep-water strata (>732 m) were missed in the fall 2J3K survey while shallower strata were missed in the spring 3LNO survey (Rideout and Ings, **2019**).

Results

Estimates of mean numbers per tow at age from stratified analyses that include all strata were largely comparable to estimates from an analysis that excludes strata missed in the fall 2J3K (Figure 1) and spring 3LNO surveys (Figure 3). The Canadian fall 2J3K survey showed the greatest differences, where MNPT indices tended to be higher for ages 1-6 and lower for ages 7-10+ when the missed strata were excluded from the calculations (Figure 1). There are also temporal patterns in the deviations in the Canadian fall 2J3K survey, where the mean difference from the last five years tends to be smaller than the time series mean (Figure 1). Here we focus on more recent differences as they are likely a better representation of the bias introduced by the missed strata. Mean differences from the last five years exceeded 10% for several age groups; specifically, ages 9 and 10+ from the Canadian fall 2J3K survey (Figure 1) and age 1 from the Canadian spring 3LNO survey (Figure 3). The 10+ estimates of MNPT was the only index to exceed a 20% difference (Figure 1). The differences were generally smaller when MNPT values were converted to proportions and only the 8+ age group from the 2J3K survey differed by more than 10% (Figures 2, 4).

Discussion

Greenland halibut are a deep water species that occupy greater depths as they grow/age (Morgan et al., **2012**; Wheeland and Morgan, **2019**). This is likely why MNPT estimates for older age groups are lower when the deep water strata missed in 2J3K in 2018 are excluded from our analyses. Likewise, MNPT estimates for younger age groups are higher because areas that younger fish tend not to inhabit were excluded (i.e. there are fewer zeros to decrease the MNPT index). The relatively shallow strata missed in the spring 3LNO survey had a greater impact on younger fish.

It is clear from the results presented here that poor survey coverage can have disproportionate impacts on different age groups. Whether the 2018 indices are suitable for use in an age-structured assessment model is an open question. If we were to apply the preliminary guidelines proposed by STACREC - where a difference of <10% is acceptable, 10-20% is questionable, and a difference of >20% is rejected (NAFO, **2019**) - most of these indices are acceptable, several are questionable (MNPT of age 9 and proportions of ages 8+ from the 2018 Canadian fall 2J3K survey, and MNPT of age 1 from the Canadian spring 3LNO survey) and one (MNPT of ages 10+ from the 2018 Canadian fall 2J3K survey) should be rejected. The preliminary guidelines were focused on aggregate indices and the guidelines reccomend that cases that fall in the 10-20% range require further investigation (e.g. assess patterns in age disaggregated indices). In this case, little extra can be done to determine whether the results from these surveys are potentially misleading or not. The answer to this question may depend on how these data are used in an age-structured assessment model, and sensitivity tests and/or expert judgement is required to assess the consequences of including or excluding these indices.

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Greenland halibut: Divs.2J3K Autumn

Figure 1. Canadian (NL) RV survey MNPT indices at age (top) and proportional differences (bottom) in these indices when they are calculated with (blue) and without (red) the strata missed during the incomplete survey of 2J3K in the fall of 2018. Mean percent difference from the whole time series and the last five years is represented by dotted and dashed lines, respectively. Years with spatial coverage issues are indicated by open symbols; these values were not included in the percent difference calculations.



Greenland halibut: Divs.2J3K Autumn

Figure 2. Canadian (NL) RV survey MNPT indices at age, converted to proportions (top), and proportional differences (bottom) in these values when they are calculated with (blue) and without (red) the strata missed during the incomplete survey of 2J3K in the fall of 2018. Mean percent difference from the whole time series and the last five years is represented by dotted and dashed lines, respectively. Years with spatial coverage issues are indicated by open symbols; these values were not included in the percent difference calculations.



Greenland halibut: Divs.3LNO Spring

Figure 3. Canadian (NL) RV survey MNPT indices at age (top) and proportional differences (bottom) in these indices when they are calculated with (blue) and without (red) the strata missed during the incomplete survey of 3LNO in the spring of 2018. Mean percent difference from the whole time series and the last five years is represented by dotted and dashed lines, respectively. Years with spatial coverage issues are indicated by open symbols; these values were not included in the percent difference calculations.



Greenland halibut: Divs.3LNO Spring

