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Newfoundland and Labrador Region

Canadian Science Advisory Secretariat
Science Advisory Report 2023/012

STOCK ASSESSMENT OF WITCH FLOUNDER (*GLYPTOCEPHALUS CYNOGLOSSUS*) IN NAFO DIVISIONS 2J3KL

*Image. Witch Flounder (*Glyptocephalus cynoglossus*).*

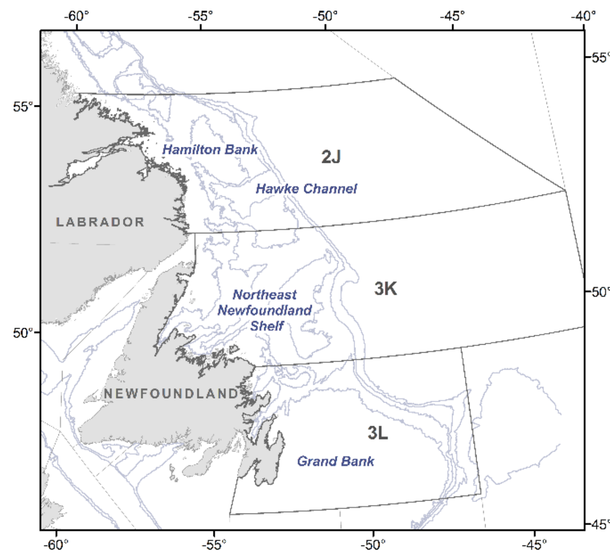

Figure 1: NAFO Divisions 2J3KL.

Context:

*Witch Flounder (*Glyptocephalus cynoglossus*) is a deepwater flatfish that reaches its northern limit of distribution in the Northwest Atlantic near Hamilton Bank off Labrador, and extends to its southern limit of distribution near the coast of North Carolina, United States of America. In the Northwest Atlantic Fisheries Organization (NAFO) Divisions (Divs.) 2J3KL, this species is primarily distributed along the shelf edge and in deeper channels around the banks, primarily in Div. 3K. The fishery for Witch Flounder in NAFO Divs. 2J3KL began in the early-1960s, and peaked in the early-1970s.*

Canada has managed Witch Flounder in NAFO Divs. 2J3KL since the establishment of the Canadian Exclusive Economic Zone (EEZ). At the 1997 NAFO Annual Meeting, NAFO adopted a Canadian proposal to implement a moratorium on 3L Witch Flounder in the NAFO Regulatory Area (NRA) consistent with the management measures taken by Canada in 1995 as the coastal state. The stock has remained under moratoria and NAFO has maintained management measures consistent with Canadian management measures for Div. 3L within the NAFO Regulatory Area.

This Science Advisory Report is from the May 10-11, 2022 2J3KL Witch Flounder Assessment. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada (DFO) Science Advisory Schedule](#) as they become available.

SUMMARY

- Recent warming, earlier phytoplankton spring bloom, and an increase in the proportion of energy-rich copepod species may have positive effects on total ecosystem production. While this ecosystem continues to experience low productivity levels, and total biomass remains well below pre-collapse levels, there are indications that conditions have improved for some species.
- Witch Flounder in NAFO Div. 2J3KL are assessed primarily based on fall DFO Research Vessel (RV) survey indices. The survey in 2021 was incomplete, therefore stock status in that year cannot be determined.
- This stock remained in the Critical Zone (89% of the Limit Reference Point) in 2020 with an 82% probability.
- A moratorium on directed fishing has been in place in Canadian waters since 1995, and in the NAFO regulatory area since 1998. A survey-based proxy indicates fishing mortality has remained low since the mid-2000s.
- The stock continues to show signs of rebuilding, with indices of biomass, abundance, and distribution increasing since the early-2000s, and the four highest values in the recruitment index series (1995 to 2020) occurring since 2013.
- Witch Flounder rely on benthic invertebrates as their principal food source and are not primarily driven by trends in forage species such as Capelin and shrimp. This is contributing to a divergence in trends between Witch Flounder and many other finfish in Div. 2J3KL that have shown stalled biomass growth since the mid-2010s.
- Consistency with the DFO decision-making framework incorporating the Precautionary Approach (PA) requires that removals from all sources must be kept at the lowest possible level until the stock clears the Critical Zone.

BACKGROUND

Oceanography and Ecosystem Overview

The Newfoundland and Labrador (NL) shelves and the Northwest (NW) Atlantic ocean climate experience important fluctuations at decadal time scales. These climate variations can impact ecosystem productivity. For example, the groundfish fishery collapse in the late-1980s through early-1990s and more recent groundfish declines (~2015–17), were associated with cold periods. In contrast, modest groundfish community biomass improvements between the mid-2000s to mid-2010s were observed during a generally warm period. A warming trend has been ongoing on the NL shelves since 2018. 2021 was one of the warmest years on record with a value of +1.3 standard deviations (SD) above the 1991–2020 average for the NL climate index (Cyr and Galbraith 2021; Cyr et al. 2022). Satellite observations of ocean colour indicated that mean spring bloom initiation timing gradually shifted from earlier than normal during the mid-2010s, to later than normal in 2021. During the same period, changes in the copepod community composition characterized by a decrease in the abundance of small *Pseudocalanus* spp. and an increase in the abundance of large, energy-rich *Calanus finmarchicus* resulted in an overall increase in total zooplankton biomass with potential positive impacts on energy transfer to upper trophic levels in the coming years (Bélanger et al. 2022).

Ecosystems in the NL bioregion were subject to overfishing from at least the 1960s to the 1980s. This fishing pressure, in conjunction with the environmental changes indicated above, led to a regime shift in the early-1990s. This regime shift changed the structure of these ecosystems. The collapse of the groundfish community and Capelin (*Mallotus villosus)*, a key forage species, and significant increases in shellfish across ecosystems, led to a shellfish-dominated community structure on the Newfoundland Shelf (2J3K). However, these increases in shellfish did not compensate for the loss of groundfish biomass, and ecosystem biomass estimates remain well below pre-collapse levels.

Consistent signals of groundfish rebuilding and a return to a groundfish-dominated community started in the mid-2000s, coinciding with modest improvements in Capelin and the beginning of a decline in shellfish. The finfish biomass build-up plateaued in the early-2010s and remains well below the pre-collapse levels. The ecosystems in the NL bioregion remain at a low overall productivity state at the present time, likely linked to simultaneous reductions in Capelin and shrimp (*Pandalus spp.*) in recent years.

While overall ecosystem dynamics appear mostly driven by bottom-up mechanisms associated with the availability of key forage species like Capelin and shrimp, Witch Flounder dynamics seem at least partially decoupled from this overarching trend. Witch Flounder followed the general decline pattern observed in medium to large groundfishes during the late-1980s and early-1990s, but unlike them, it has shown a steady build-up trend since the regime shift (Figure 2). This divergence could be related to Witch Flounder diet, which is dominated by benthic invertebrates like polychaetes and amphipods.

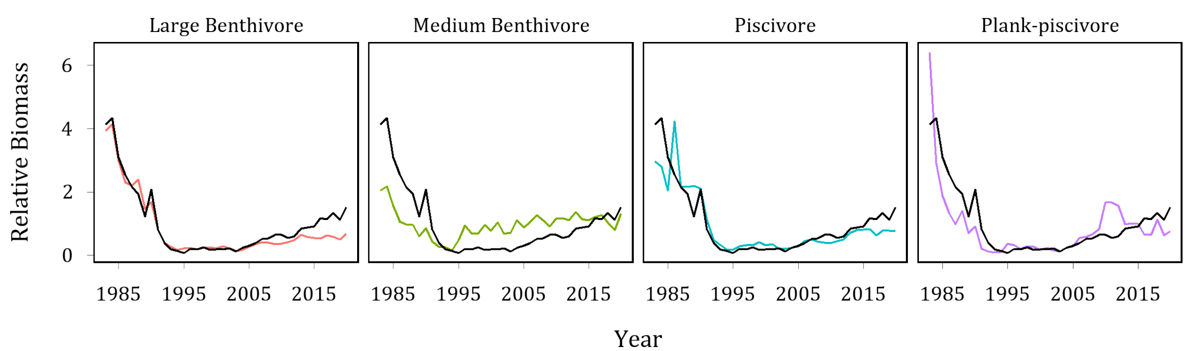

Figure 2: Trends in relative biomass (biomass in year y / average biomass) of Witch Flounder (black line) compared to various finfish functional groups in Divs. 2J3KL. Witch Flounder are a component of the medium benthivore functional group.

Species Biology

Witch Flounder is a long lived, right-eye flounder found across the North Atlantic, with distribution in the west that extends from Labrador to North Carolina. Witch Flounder are most commonly associated with shelf slope waters and deeper channels, but are present at a wide range of depths, from <100 m to well over 1,000 m. This species prefers soft substrates such as sand, clay, or mud. Historically, the highest abundance of Witch Flounder in Divs. 2J3KL was found in the Hawke Channel (Bowering 1987). Spawning of Witch Flounder in the Northwest Atlantic occurs over a prolonged period from March through September, with the highest intensity in Divs. 2J3KL considered to be from March to May. This species forms dense pre-spawning and spawning aggregations, with offshore fisheries historically targeting these concentrations (Bowering 1979, Bowering 1995).

Fishery

The fishery for Witch Flounder in NAFO Divs. 2J3KL began in the early 1960s and landings increased steadily from about 1,000 t in 1963 to a peak near 24,000 t in 1973 (Figure 3). The regulated fishery began in 1974 with a Total Allowable Catch (TAC) of 22,000 t. Catches declined rapidly, reaching 2,800 t by 1980, and subsequently fluctuated between 3,000 and 4,500 t through 1991. Landings declined further to 137 t by 1994. A moratorium on directed fishing of this stock was put in place within the Canadian EEZ in 1995, and extended to the NRA in 1998. There has been no directed fishing since this time. Since 1998, landings from bycatch ranged from 68 to 633 t. Average landings were 134 t annually across the last five years (2017–21), and were primarily from bycatch in the Canadian Greenland Halibut fishery.

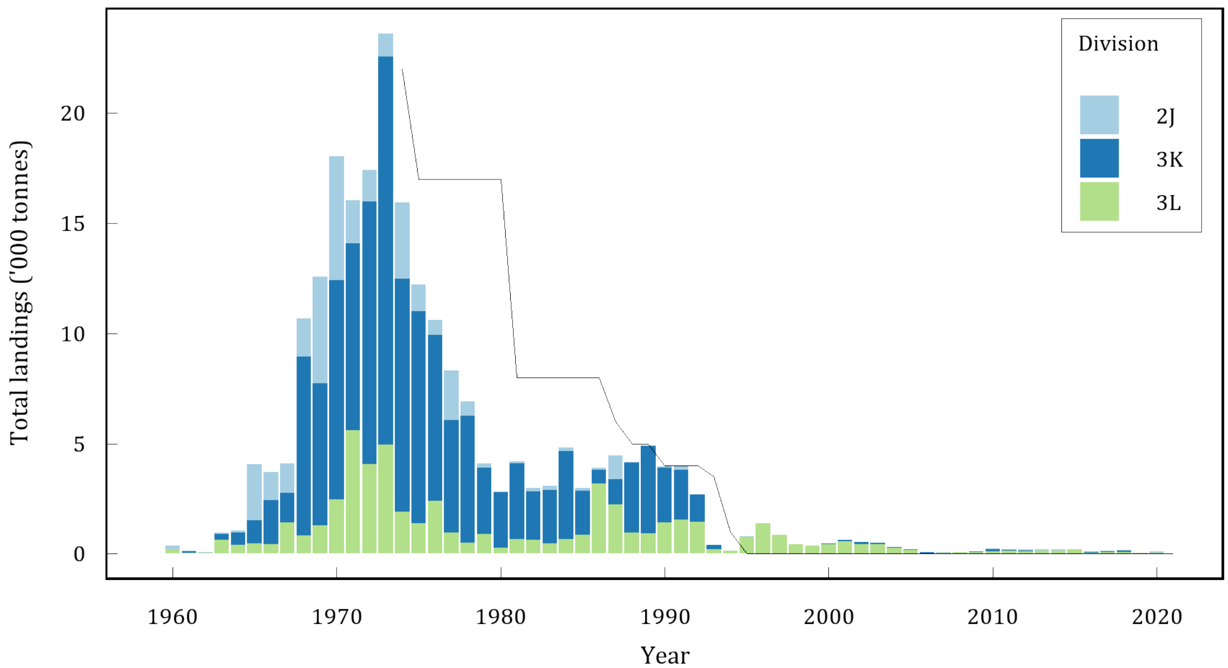

Figure 3: NAFO-reported Landings (STATLANT21A) by NAFO Division and TAC, 1960–2021. This stock has been under moratorium in Canadian waters since 1995, and in the NAFO regulatory area since 1998.

ASSESSMENT

Research Vessel (RV) Surveys

Stratified-random RV surveys have been conducted by DFO in the fall in Divs. 2J, 3K, and 3L since 1977, 1978, and 1981, respectively. Campelen-equivalent data are available for all three divisions starting in 1983. Details of the stratified random trawl survey design, changes in gear and survey area, are described in previous documents (see Brodie and Stansbury 2007, Brattey et al. 2008, Wheeland et al. 2019, and references therein).

Survey coverage in Divs. 2J3KL has often been incomplete over the last decade, with consistent gaps along the shelf edge. However, a limited proportion of the stock is expected to be found in these deep-water areas (DFO 2019, Wheeland et al. 2019), therefore the surveys are considered acceptable as indicators for this stock. The 2021 survey did not extend into Div. 3L and missed areas of Divs. 2J3K, primarily due to mechanical issues and limited vessel availability. Indices are therefore not available to determine stock status in 2021. Full details on recent survey performance statistics, timing, and spatial coverage can be found in Rideout et al. 2022 and references therein.

Abundance and biomass indices from RV surveys (Figure 4) declined from the mid-1980s to the early-1990s, with both indices reaching time series lows in 1995. These indices remained at a low level until around 2003, and have gradually increased since. Abundance and biomass indices in 2020 were at their highest levels since 1986 and 1990, respectively.

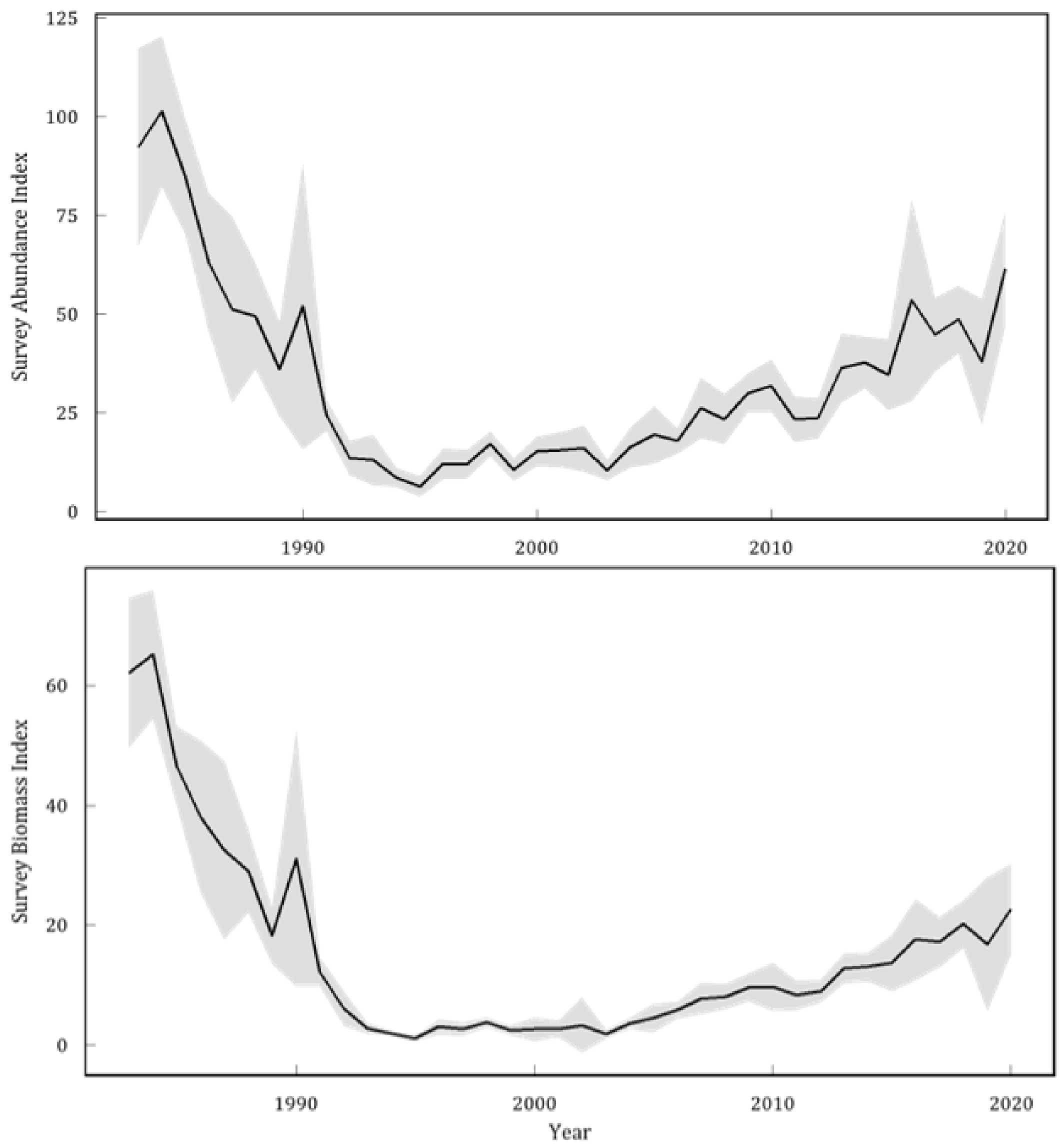

Figure 4: Abundance (top) and biomass (bottom) indices from annual fall DFO RV surveys in NAFO Divs. 2J3KL. Values are in Campelen equivalent units from 1983–95, and Campelen units from 1996–2020. Grey ribbon represents the 95% confidence intervals on annual estimates.

Coinciding with this period of increasing stock size, Witch Flounder in Divs. 2J3KL have also been expanding their distribution (Figure 5). Historically, this stock was distributed along the shelf edge, into deep channels, and to a lesser degree onto the banks of the Northeast

Newfoundland shelf and the Grand Bank, but was largely restricted to the shelf edge following stock declines through the late-1980s and early-1990s. Recently, Witch Flounder have been expanding back into deeper channels and onto areas of the banks.

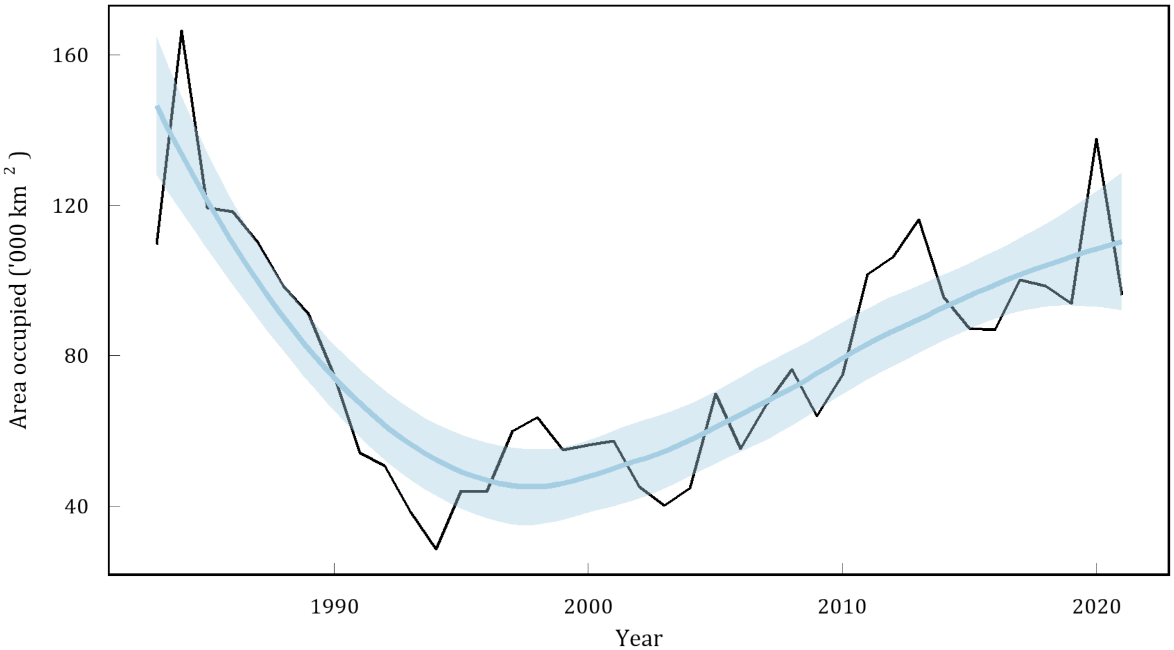

Figure 5: Design weighted area occupied (DWAO), see Busby et al. 2007, by Witch Flounder in the 2J3KL fall survey. Blue line indicates a loess smoother on the trends in DWAO.

Recruitment

In the absence of aging for this stock, two length-based indices were developed at this meeting as proxies for incoming cohorts. A pre-recruit index is defined as the abundance of fish ≥10 cm but <18 cm, and a recruitment index as the abundance of fish ≥18 cm but <26 cm in the fall survey during the Campelen series (i.e., since 1995). These length ranges were selected by examining survey abundance-at-length to identify pulses in size frequencies that were likely to represent single cohorts (Figure 6). These indices replace the previously defined pre-recruit index (<23 cm) used in previous assessments of this stock.

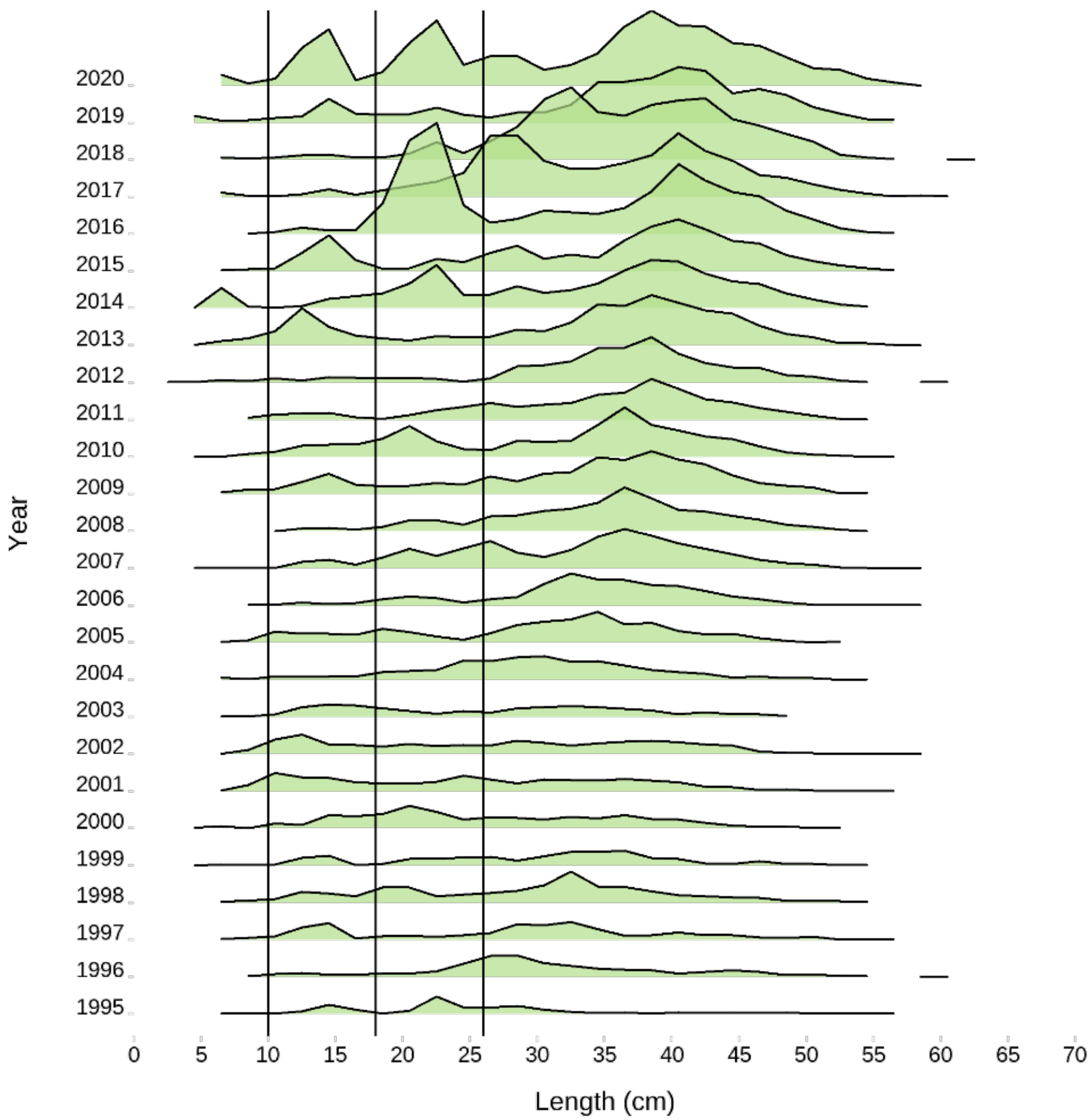

Figure 6: Length frequency of Witch Flounder captured during the fall RV survey in NAFO Divs. 2J3KL since 1995 (Campelen series). Vertical lines indicate the size definitions of the pre-recruit (9.5–17.5 cm) and recruitment (17.5–25.5 cm) indices.

The inshore strata that were sampled from the mid-1990s to mid-2000s are excluded from these indices in order to make values comparable among years with varying survey coverage. However, inshore strata have been shown to contain a high number of small fish in some years (Wheeland et al. 2019). When inshore strata are not sampled, the survey is likely to be missing a portion of the pre-recruit and recruit abundance; however the magnitude of this is unknown and may also be impacted by recent shifts in stock distribution.

A series of positive pre-recruit anomalies indicate improved recruitment since 2013–14. In 2020, the pre-recruit index was a time series high, and the recruitment index was the second highest in the time series (Figure 7). This increased recent abundance of small fish is also evident in length frequency modes from the survey.

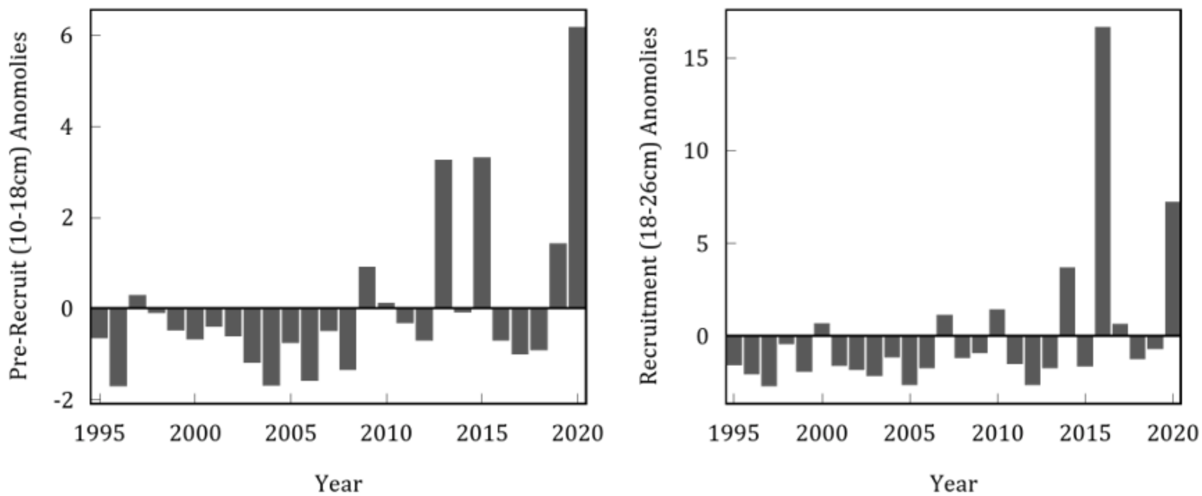

Figure 7: Pre-recruit (10 to 18 cm) and Recruitment (18 to 26 cm) index anomalies for the Campelen series. Positive anomalies indicate good pre-recruit or recruitment signals, while negative anomalies indicate poor signals, with both anomaly time series showing improvements in the latter portion of the series.

STOCK STATUS

The limit reference point (LRP) for this stock is set at 40% Maximum Sustainable Yield (BMSY), where a survey-based proxy for BMSY is defined as the mean of the survey biomass indices from the 1983–84 fall RV surveys. This stock remained in the Critical Zone (89% of the LRP) in 2020 (Figure 8) with an 82% probability. The survey in 2021 was incomplete, therefore stock status in that year cannot be determined. Consistency with the DFO decision-making framework incorporating the PA requires that removals from all sources must be kept at the lowest possible level until the stock clears the Critical Zone.

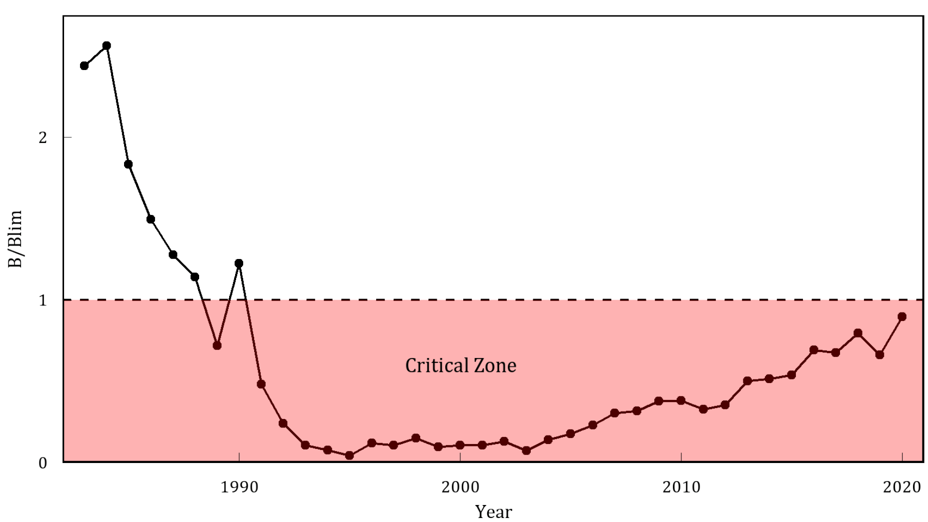

Figure 8: Stock status relative to the limit reference point (Relative Biomass, B/B_{lim})

Sources of Uncertainty

Due to the limited survey coverage described above, full indices of abundance and biomass are unavailable for 2021. However, the meeting examined the available information from Divs. 2J3K and there were no indications of a significant deviation from recent levels apparent for either abundance or biomass.

Varying survey coverage within the fall RV survey throughout the time series introduces uncertainty into the indices, though the magnitude of these impacts cannot be fully determined. Surveys in the late-1990s and early-2000s indicate potentially high recruitment inshore in some years. However, a lack of consistent coverage has prevented a full understanding of those inshore recruits relative to the remainder of the stock area.

Current understanding of the impact of missed survey areas is based on past distribution of this stock; there is heightened uncertainty in these assumptions in the context of shifting ocean climate and changes in species distributions.

This stock has not been aged since 1994 and age validation studies have not been completed for this species. This precludes the use of any age-based analytical assessment methods. An age validation study is being undertaken by DFO-NL, and preliminary results and progress were presented to the meeting. As this work is ongoing, information cannot yet be used to inform this assessment.

A lack of analytical assessment model means that total stock size, and fishing and natural mortality rates cannot be quantified; survey-based proxies are used instead. In addition, we are unable to project stock trends forward.

Witch Flounder diet consists primarily of polychaetes and other small benthic invertebrates such as amphipods. However, indices do not currently exist to track availability or trends in the forage resources that support this stock.

CONCLUSIONS AND ADVICE

This stock continues to show signs of rebuilding. Indices of biomass, abundance, and distribution have been increasing since the early-2000s, and recent recruitment levels have reached the highest in the time series (1995–2020). However, stock size remains well below historic levels, and survey biomass has been consistently below the LRP since 1991, with the stock remaining in the Critical Zone in 2020. Stock status in 2021 cannot be determined.

Consistency with the DFO decision-making framework incorporating the PA requires that removals from all sources must be kept at the lowest possible level until the stock clears the Critical Zone.

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SOURCES OF INFORMATION

This Science Advisory Report is from the May 10-11, 2022 2J3KL Witch Flounder Assessment. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

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