Data overview and stock assessment for Pacific halibut (*Hippoglossus stenolepis*) at the end of 2023

PREPARED BY: IPHC SECRETARIAT (I. STEWART, A. HICKS, R. WEBSTER, AND D. WILSON; 30 OCTOBER & 20 NOVEMBER 2023)

PURPOSE

To provide the Commission with a summary of the data, stock assessment at the end of 2023.

INTRODUCTION

In 2023 the International Pacific Halibut Commission (IPHC) undertook its annual coastwide stock assessment of Pacific halibut (*Hippoglossus stenolepis*). This stock assessment represents an update, following the full assessment conducted in 2022. There are no structural changes to the assessment methods for 2023. Supporting analyses were reviewed by the IPHC's Scientific Review Board (SRB) in June (SRB022; IPHC-2023-SRB022-08, IPHC-2023-SRB022-R) and September 2023 (SRB023; IPHC-2023-SRB023-06, IPHC-2023-SRB023-R).

This document provides an overview of the data sources available for the 2023 Pacific halibut stock assessment including the population trends and distribution among IPHC Regulatory Areas based on the modelled IPHC fishery-independent setline survey (FISS), directed commercial fishery data, and results of the stock assessment. All standard data sources have been updated with new information available from 2023 for this analysis, which includes updates to data collected in previous years.

Overall, spawning biomass (SB) estimates are slightly lower than those in last year's stock assessment, but the recent estimated trend is nearly flat. Year-classes estimated for 2012 and 2014 are both larger than those occurring from 2006-2011, but well below the average observed over the last 30 years. Stock distribution trends continue to show an increasing proportion of the stock in Biological Region 2 and a decreasing proportion in Biological Region 3.

STOCK AND MANAGEMENT

The stock assessment reports the status of the Pacific halibut (*Hippoglossus stenolepis*) resource in the IPHC Convention Area. As in recent stock assessments, the resource is modelled as a single stock extending from northern California to the Aleutian Islands and Bering Sea, including all inside waters of the Strait of Georgia and Puget Sound, but excludes known extremities in the western Bering Sea within the Russian Exclusive Economic Zone (Figure 1).

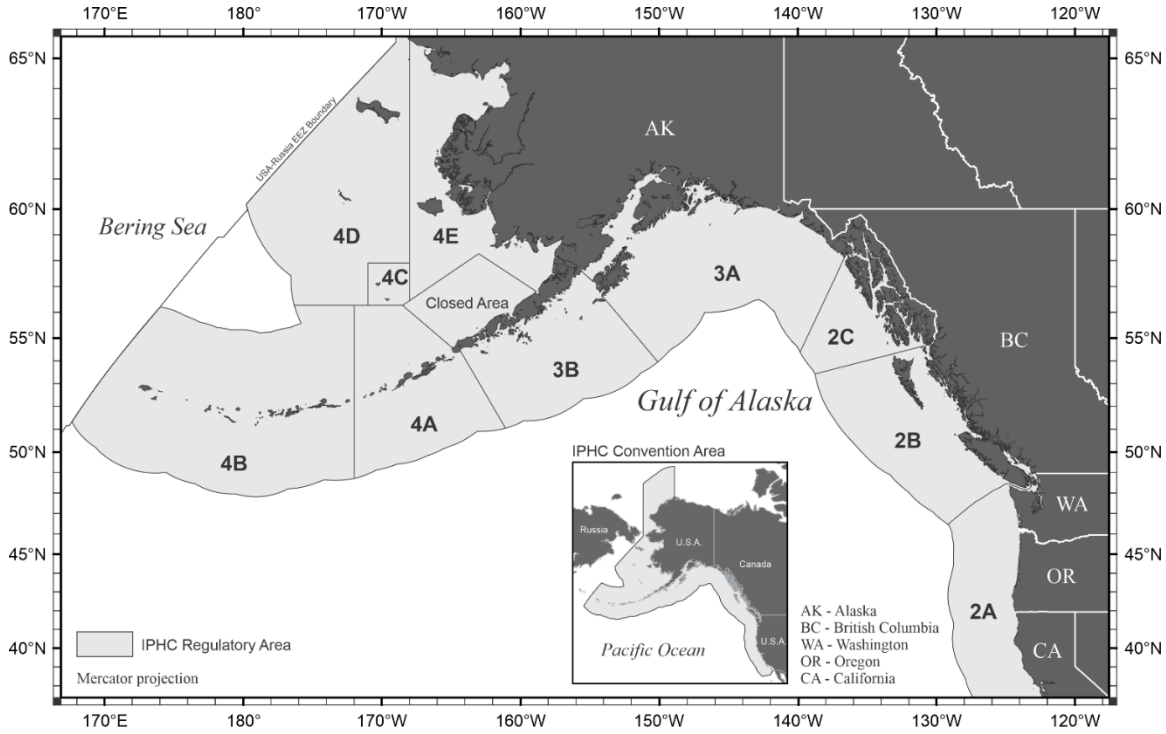

Figure 1. IPHC Convention Area (insert) and IPHC Regulatory Areas.

The Pacific halibut fishery has been managed by the IPHC since 1924. Catch limits for each of eight IPHC Regulatory Areas[1] are set each year by the Commission. The stock assessment provides a summary of recently collected data, and model estimates of stock size and trend. Short-term projections and the harvest decision table for 2024 are reported in a separate document (IPHC-2023-IM099-12 Rev_1).

DATA

Historical mortality

Known Pacific halibut mortality consists of directed commercial fishery landings and discard mortality (including research), recreational fisheries, subsistence, and discard mortality in fisheries targeting other species ('non-directed' fisheries where Pacific halibut retention is prohibited). Over the period 1888-2023, mortality from all sources has totaled 7.4 billion pounds (~3.3 million metric tons, t). Since 1923, the fishery has ranged annually from 34 to 100 million pounds (16,000-45,000 t) with an annual average of 63 million pounds (~28,000 t; Figure 2). Annual mortality was above this 100-year average from 1985 through 2010 and has averaged 37.4 million pounds (~17,000 t) from 2019-23.

2023 Fishery and IPHC FISS statistics

Data for stock assessment use are compiled by IPHC Regulatory Area, and then aggregated to four Biological Regions: Region 2 (Areas 2A, 2B, and 2C), Region 3 (Areas 3A, 3B), Region 4 (4A, 4CDE) and Region 4B and then coastwide (Figure 1). The assessment data from both fishery-dependent and fishery-independent sources, as well as auxiliary biological information, are mostly spatially complete since the late-1990s. Primary sources of information for this assessment include mortality estimates from all sources (IPHC-2023-IM099-07_Rev_1), modelled indices of abundance (IPHC-2023-IM099-09 Rev_1) based on the IPHC's FISS (in

[1] The IPHC recognizes sub-Areas 4C, 4D, 4E and the Closed Area for use in domestic catch agreements but manages the combined Area 4CDE.

numbers and weight) and other surveys, commercial Catch-Per-Unit-Effort (in weight), and biological summaries from both sources (length-, weight-, and age-composition data).

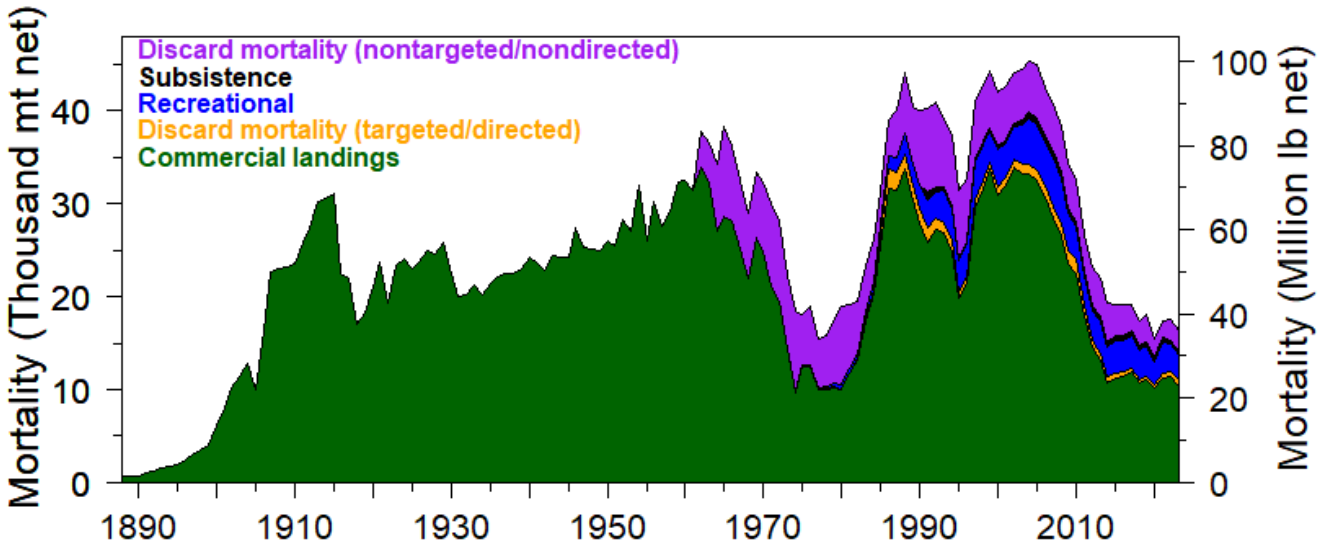

Figure 2. Summary of estimated historical mortality by source (colors), 1888-2023.

All data sources are reprocessed each year to include new information from the terminal year, as well as any additional information for or changes made to the entire time-series. Routine updates of logbook records from the 2023 and earlier directed commercial fishery, as well as age-frequency observations and individual weights from the commercial fishery were also included. Directed commercial fishery sex-ratios at age from the 2022 fishery were genetically analyzed and made available for this assessment. Mortality estimates (including changes to the existing time-series where new estimates have become available) from all sources were extended to include 2023. Available information was finalized on 6 November 2023 in order to provide adequate time for analysis and modeling. As has been the case in all years, some data remain incomplete (commercial fishery logbook and age information) or include projections for the remainder of the year (mortality estimates for ongoing fisheries or for fisheries where final estimation is still pending).

Coastwide commercial Pacific halibut fishery landings (including research landings) in 2023 were approximately 23.0 million pounds (~10,400 t), down 8% from 2022[2]. Discard mortality in non-directed fisheries was estimated to be 4.8 million pounds in 2023 (~2,200 t)[3], down 6% from 2022 and remaining below all recent estimates prior to 2019. The total recreational mortality (including estimates of discard mortality) was estimated to be 6.0 million pounds (~2,700 t) down 4% from 2022. Mortality from all sources decreased by 7% to an estimated 35.9 million pounds (~16,300 t) in 2023 based on preliminary information available for this assessment.

The 2023 modelled FISS results detailed an estimated coastwide aggregate Numbers-Per-Unit-Effort (NPUE) which decreased by 2% from 2022 to 2023, remaining at a level similar to those

[2] The mortality estimates reported in this document are those available on 6 November 2023 and used in the assessment analysis; they include projections through the end of the fishing season.

[3] The IPHC receives preliminary estimates of the current year's non-directed commercial discard mortality from the NOAA-Fisheries National Marine Fisheries Service Alaska Regional Office, Northwest Fisheries Science Center, and Fisheries and Oceans Canada in late October. Where necessary, projections are added to approximate the total mortality from ongoing fisheries through the end of the calendar year. Further updates are anticipated in January 2024.

observed in 2018-2020 (Figure 3). Biological Region 3 decreased by 6%, while Biological Region 2 increased by 3% and Biological Region 4 remained unchanged. Biological Region 4B is estimated to have increased by 5%; however, this area was not sampled in 2023 and credible intervals are appreciably wider than in recent years, reflecting a wide plausible range of potential trends, both increasing and decreasing, from 2022 to 2023. The 2023 modelled coastwide Weight-Per-Unit-Effort (WPUE) of legal (O32) Pacific halibut, the most comparable metric to observed commercial fishery catch rates, decreased by 3% from 2022 to 2023. Individual IPHC Regulatory Areas varied from an estimated 10% increase (Regulatory Area 2A) to an 8% decrease (Regulatory Area 3B) in O32 WPUE (Figure 4).

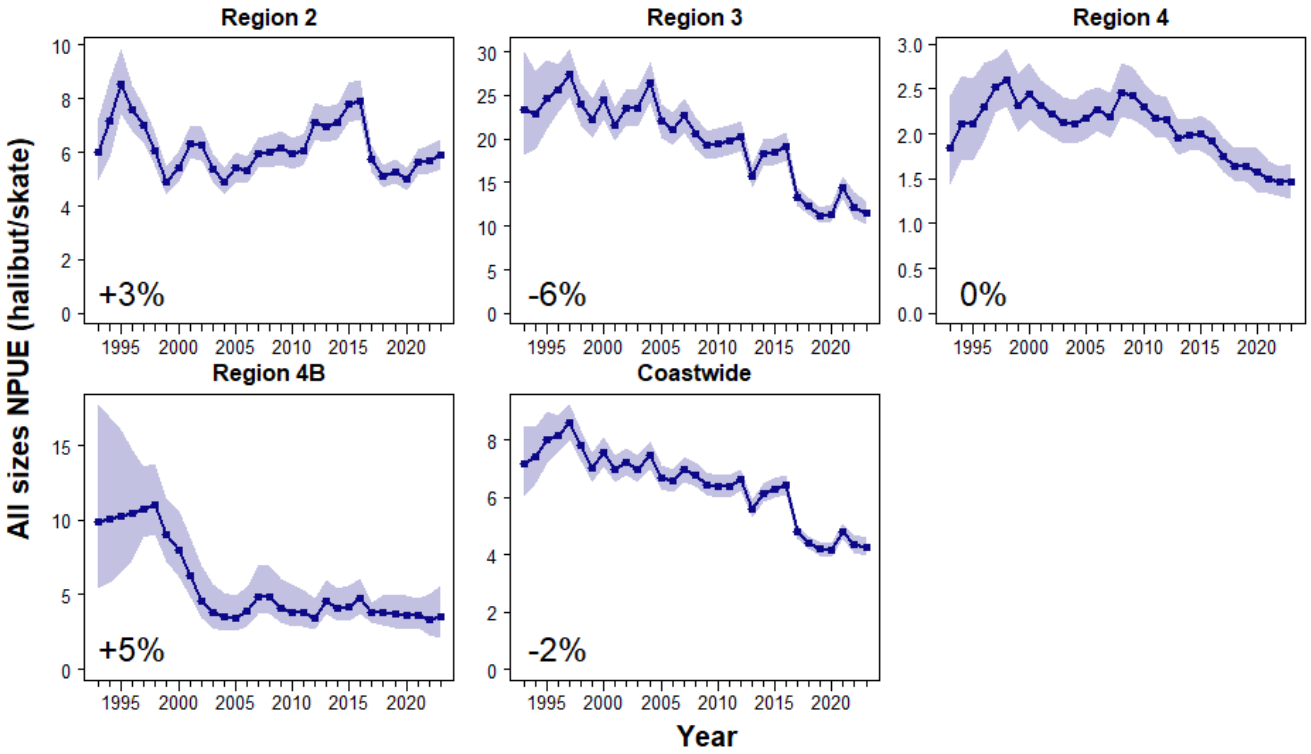

Figure 3. Trends in modelled FISS NPUE by Biological Region, 1993-2023. Percentages indicate the change from 2022 to 2023. Shaded zones indicate 95% credible intervals.

Preliminary commercial fishery WPUE estimates from 2023 logbooks showed a 10% decrease from 2022 to 2023 at the coastwide level larger than the FISS index (Figure 5). The bias correction to account for additional logbooks compiled after the fishing season further increased this drop to 12%. Trends varied among IPHC Regulatory Areas, fisheries, and gears; however, all areas showed decreased CPUE in one or more index.

Biological information (ages and lengths) from the commercial fishery landings showed that in 2023 the 2012 year-class (now 11 years old) was again the largest coastwide contributor (in number) to the fish landed. This follows the same pattern observed in 2022, when the fishery transitioned from the previously most-abundant 2005 year-class. The FISS also observed the 2012 year-class at the largest proportion of the total catch of any age class. There is no clear indication of younger year-classes than 2012 in large abundance in the 2023 data. Recent trawl surveys suggest the potential for one or more strong year-classes in 2017-2018; however, it will be several years before these fish can be confirmed in the FISS and directed fisheries. Individual size-at-age appears to be increasing for younger ages (<14) and was relatively stable for older fish in most IPHC Regulatory Areas and coastwide.

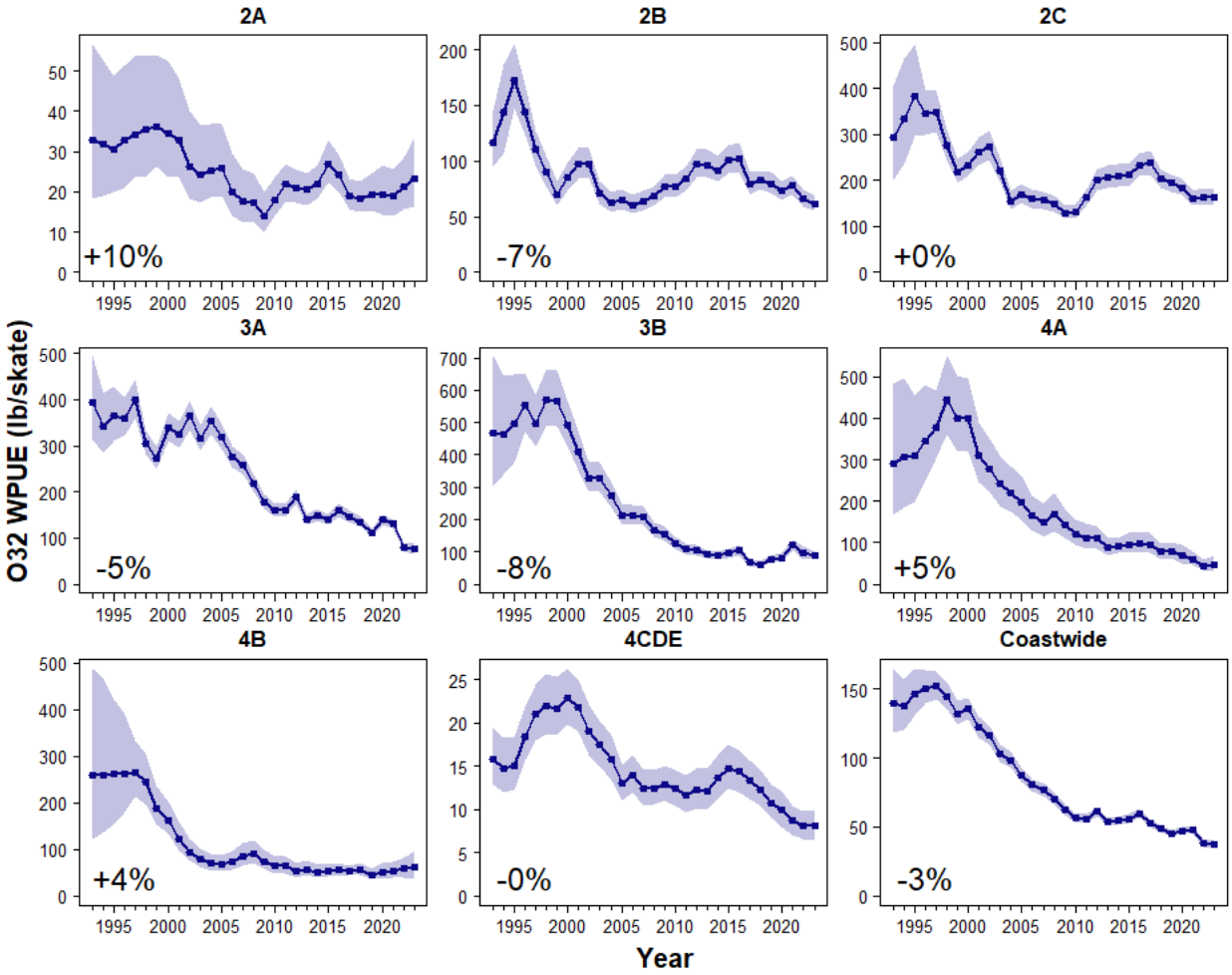

Figure 4. Trends in modelled FISS legal (O32) WPUE by IPHC Regulatory Area, 1993-2023. Percentages indicate the change from 2022 to 2023. Shaded zones indicate 95% credible intervals.

Biological stock distribution

The population distribution (measured via the modelled FISS catch in weight of all Pacific halibut) showed a continued decrease in Biological Region 3 to the lowest proportion of the coastwide stock in the time-series (Figure 6; recent years in Table 1). Biological Region 2 increased to the highest proportion observed. As there was no FISS sampling in Biological Region 4B, the credible intervals were very wide, consistent with either a decrease or increase in the proportion in this Region. Survey data are insufficient to estimate stock distribution prior to 1993. It is therefore unknown how historical distributions may compare with recent observations.

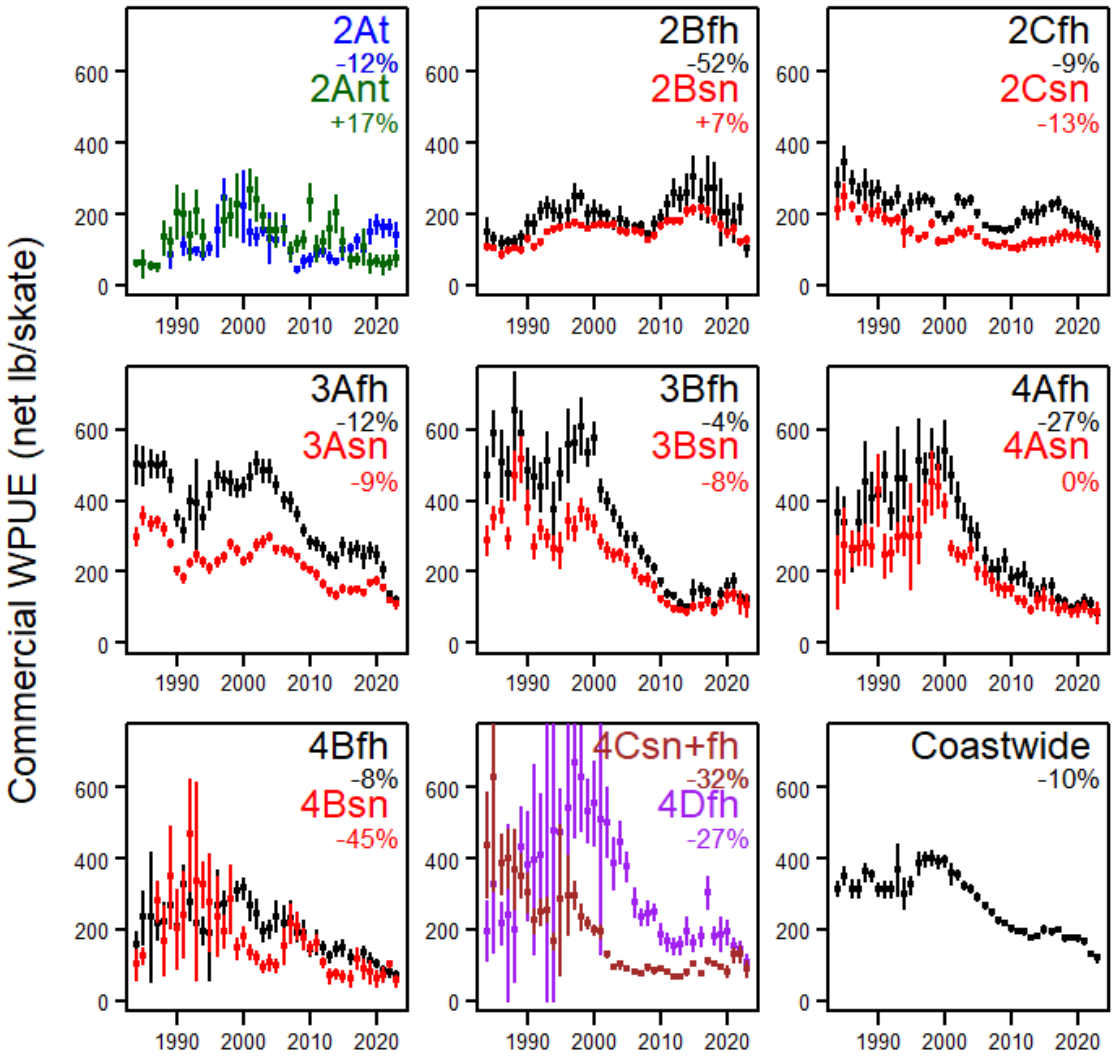

Figure 5. Trends in commercial fishery WPUE by IPHC Regulatory Area and fishery or gear, 1984-2023. The tribal fishery in 2A is denoted by "2At", non-tribal by "2Ant", fixed hook catch rates by "fh" and snap gear catch rates by "sn" for IPHC Regulatory Areas 2B-4D. Percentages indicate the change from 2022 to 2023 uncorrected for bias due to incomplete logbooks (see text above). Vertical lines indicate approximate 95% confidence intervals.

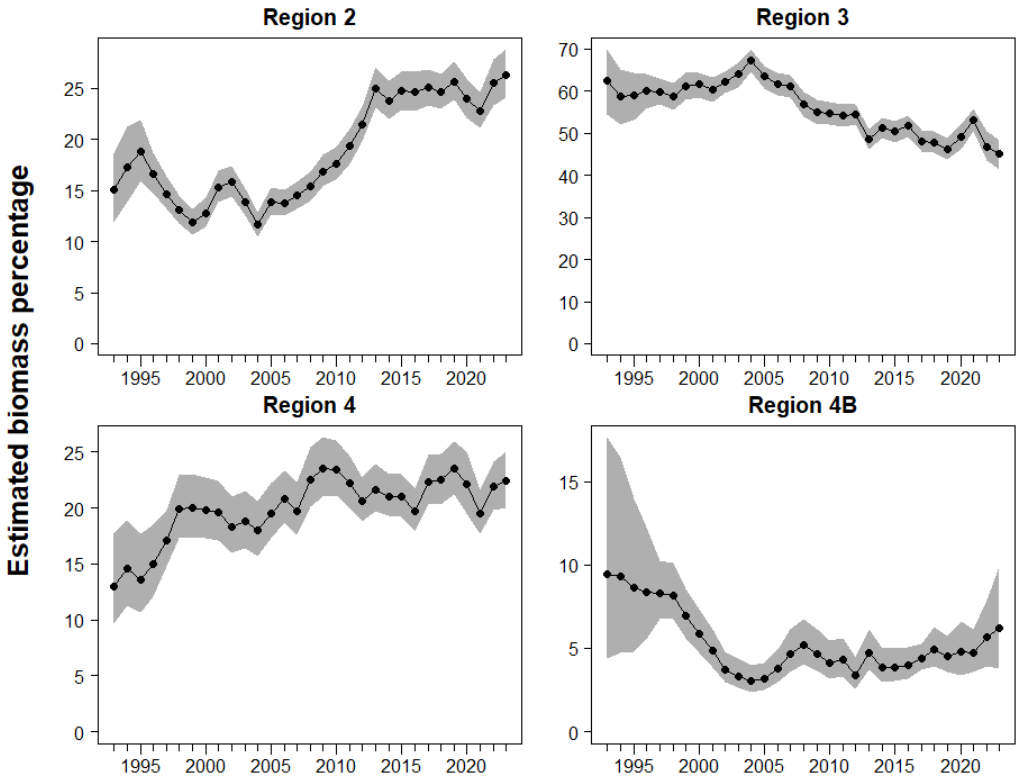

Figure 6. Estimated stock distribution (1993-2023) based on modelled survey catch weight per unit effort of all sizes of Pacific halibut. Shaded zones indicate 95% credible intervals.

Table 1. Recent stock distribution estimates by Biological Region based on modelling of all Pacific halibut captured by the FISS.

Year	Region 2 (2A, 2B, 2C)	Region 3 (3A, 3B)	Region 4 (4A, 4CDE)	Region 4B
2019	25.7%	46.3%	23.5%	4.5%
2020	24.0%	49.1%	22.2%	4.8%
2021	22.7%	53.0%	19.5%	4.7%
2022	25.5%	46.8%	22.0%	5.7%
2023	26.3%	45.0%	22.5%	6.2%

STOCK ASSESSMENT

This stock assessment continues to be implemented using the generalized stock synthesis software (Methot and Wetzel 2013). The analysis consists of an ensemble of four equally weighted models: two long time-series models, reconstructing historical dynamics back to the beginning of the modern fisheries (1888), and two short time-series models incorporating data only from 1992 to the present, a time-period for which estimates of all sources of mortality and survey indices for all regions are available. For each time-series length, there are two models: one fitting to coastwide aggregate data, and one fitting to data disaggregated into the four Biological Regions. This combination of models includes uncertainty in the form of alternative hypotheses about several important axes of uncertainty, including: natural mortality rates (estimated in three of the four models), environmental effects on recruitment (estimated in the long time-series models), and other model parameters.

The results of this stock assessment are based on the approximate probability distributions derived from the ensemble of models, thereby incorporating the uncertainty within each model (parameter or estimation uncertainty) as well as the uncertainty among models (structural uncertainty). This uncertainty provides a basis for risk assessment and reduces the potential for abrupt changes in management quantities as improvements and additional data are added to individual models. The four models continue to be equally weighted. Within-model uncertainty was propagated through to the ensemble results via the maximum likelihood estimates and an asymptotic approximation to individual model variance estimates. Point estimates in this stock assessment correspond to median values from the ensemble with the simple probabilistic interpretation that there is an equal probability above or below the reported value.

This stock assessment represents an update, following the full assessment conducted in 2022 (IPHC-2023-SA01). There are no structural changes to the assessment methods for 2023. Supporting analyses were reviewed by the IPHC's Scientific Review Board (SRB) in June (SRB022; IPHC-2023-SRB022-08, IPHC-2023-SRB022-R) and September 2023 (SRB023; IPHC-2023-SRB023-06, IPHC-2023-SRB023-R).

The most influential source of new information in this assessment was the directed commercial fishery logbook trend, including the 2023 estimate as well as an updated (and lower) estimate of the catch-rate in 2022. The addition of just this information resulted in an 11% decrease in the 2023 spawning biomass estimate, compared to that in the 2022 stock assessment. Although differences in trend between the FISS and commercial fishery are not uncommon in the historical time-series, the sensitivity of this year's assessment results highlights the importance of both time-series in estimating the stock size and trend.

BIOMASS, RECRUITMENT, AND FISHING INTENSITY TRENDS

The results of the 2023 stock assessment indicate that the Pacific halibut stock declined continuously from the late 1990s to around 2012 (Figure 7). That trend is estimated to have been largely a result of decreasing size-at-age, as well as lower recruitment than observed during the 1980s. The spawning biomass increased gradually to 2016, and then decreased to an estimated 171 million pounds (~77,500 t) at the beginning of 2023. At the beginning of 2024 the spawning biomass is estimated to have increased slightly (largely due to the rapidly maturing 2012 year-class) to 174 million pounds (78,900 t), with an approximate 95% credible interval ranging from 111 to 258 million pounds (~50,400-116,900 t; Figure 8). The recent spawning biomass estimates from the 2022 stock assessment are very consistent with previous analyses up 2021, and slightly below most recent estimates (Figure 9).

The IPHC's interim management procedure uses a relative spawning biomass of 30% as a trigger, below which the reference fishing intensity is reduced. At a relative spawning biomass limit of 20%, directed fishing is halted due to the critically low biomass condition. This calculation is based on recent biological conditions: weight-at-age and estimated recruitments currently influencing the stock. Thus, the 'dynamic' calculation measures only the effect of fishing on the spawning biomass, and not natural fluctuations due to recruitment variability and weight-at-age. The relative spawning biomass in 2024 was estimated to be 42% (credible interval: 20-56%) slightly higher than the estimate for 2023 (41%). The probability that the stock is below the $SB_{30\%}$ level is estimated to be 26% at the beginning of 2023, with a 1% chance that the stock is below $SB_{20\%}$. The two long time-series models (coastwide and areas-as-fleets) show different results when comparing the current stock size to that estimated at the historical low in the 1970s. The

AAF model estimates that recent stock sizes are well below those levels (44%), and the coastwide model above (168%). The relative differences among models reflect both the uncertainty in historical dynamics (there was very little data available from IPHC Regulatory Areas 4A-4CDE prior to the 1970s) as well as the importance of spatial patterns in the data and population processes, for which all of the models represent only simple approximations.

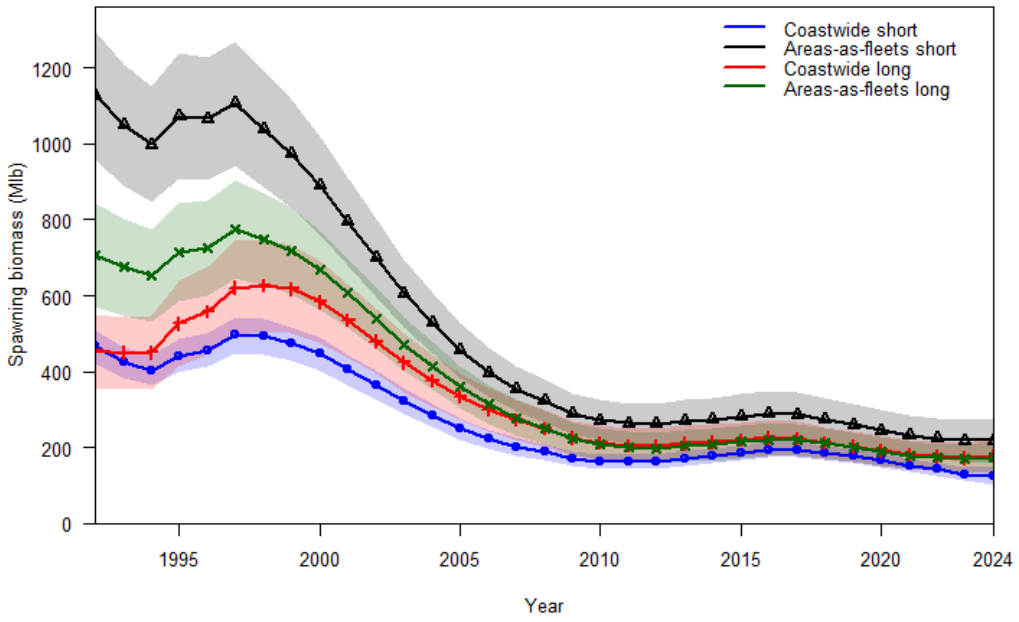

Figure 7. Estimated spawning biomass trends (1992-2024) based on the four individual models included in the 2023 stock assessment ensemble. Series indicate the maximum likelihood estimates; shaded intervals indicate approximate 95% credible intervals.

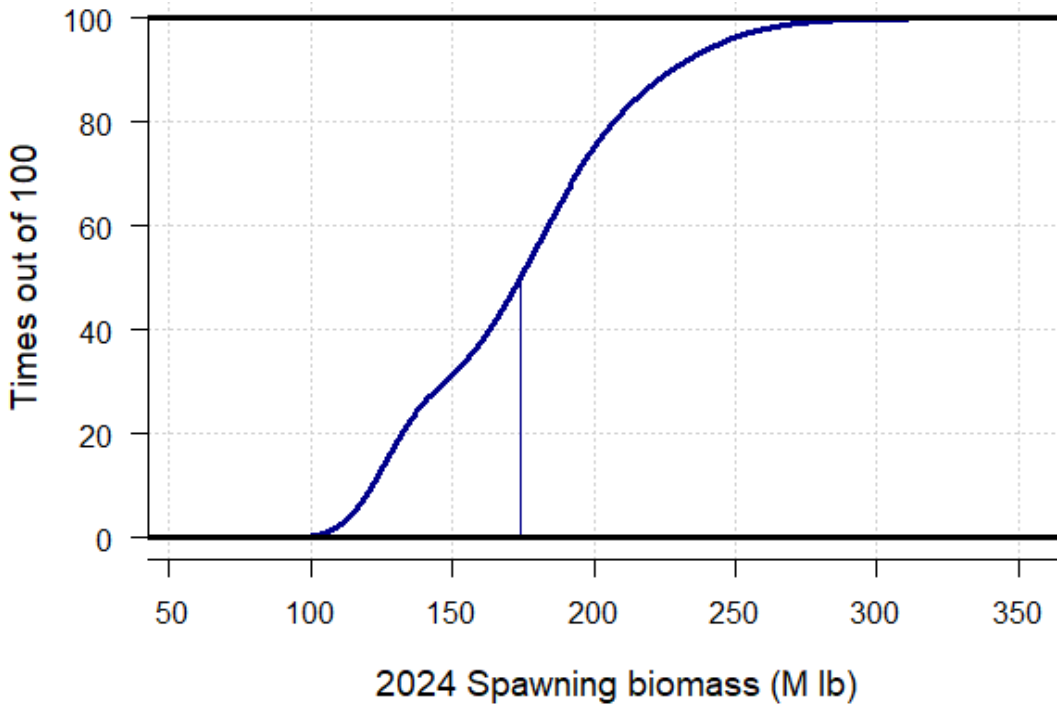

Figure 8. Cumulative distribution of the estimated spawning biomass at the beginning of 2024. Curve represents the estimated probability that the biomass is less than or equal to the value on the x-axis; vertical line represents the median (174 million pounds, ~78,900 t).

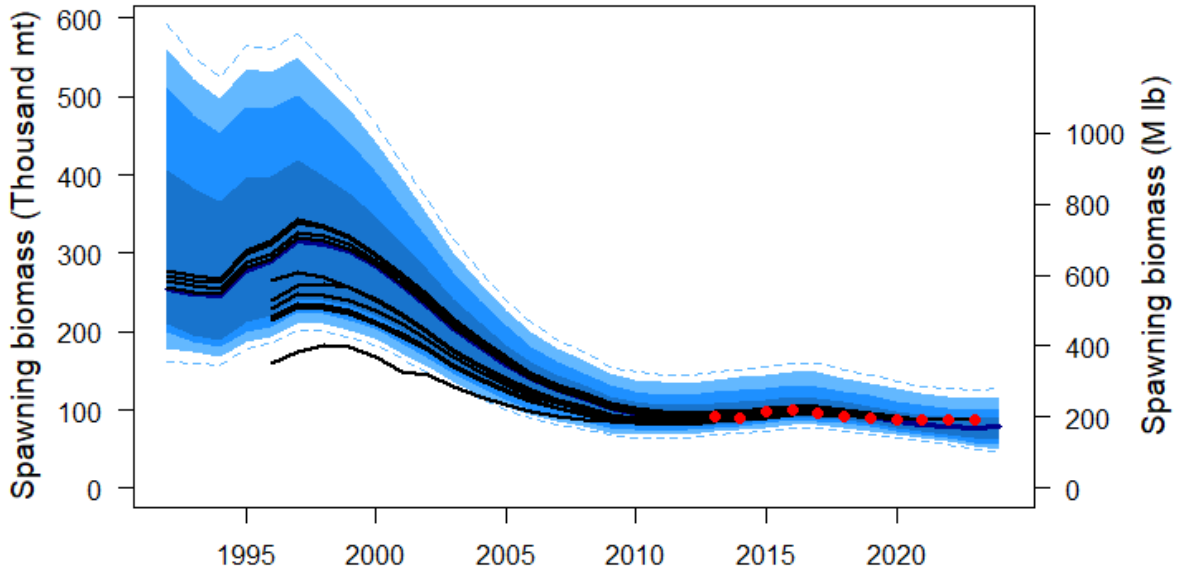

Figure 9. Retrospective comparison of female spawning biomass among recent IPHC stock assessments. Black lines indicate estimates from assessments conducted in 2012-2022 with the terminal estimate shown as a red point. The shaded distribution denotes the 2023 ensemble: the dark blue line indicates the median (or "50:50 line") with an equal probability of the estimate falling above or below that level; and colored bands moving away from the median indicate the intervals containing 50/100, 75/100, and 95/100 estimates; dashed lines indicating the 99/100 interval.

Average Pacific halibut recruitment is estimated to be higher (50 and 53% for the coastwide and AAF models respectively) during favorable Pacific Decadal Oscillation (PDO) regimes, a widely recognized indicator of ecosystem productivity in the north Pacific (primarily the Gulf of Alaska). Historically, these regimes included positive conditions prior to 1947, from 1976-2006 and from 2014-2019, with poor conditions from 1947-1975, 2007-2013 and after 2020 (through September 2023). Although strongly correlated with historical recruitments, it is unclear whether recent conditions are comparable to those observed in previous decades.

Pacific halibut recruitment estimates show the recent large cohorts in 1999 and 2005 (Figure 10). Cohorts from 2006 through 2011 are estimated to be much smaller than those from 1999-2005, which has resulted in a decline in both the stock and fishery yield as these low recruitments have moved into the spawning biomass. Based on age data through 2023, individual models in this assessment produced estimates of the 2012 year-classes that were similar to the average level observed over 1994-2005. The 2012 year-class is estimated to be 42% mature in 2023 and the maturation of this cohort has a strong effect on the short-term projections. The 2023 data indicate that the 2014 year-class is larger than those observed from 2006-2011, but smaller than 2012. Estimates of year-classes after 2014 remain very uncertain.

The historical time-series of fishing intensity is estimated to be considerably lower in the 2022 and 2023 stock assessments than in previous analyses until around 2015 (Figure 11). Several recent stock assessments (2016-2016 and 2018) produced terminal estimates of fishing intensity very similar to this year's results; in contrast, the 2017, and 2019-2021 stock assessments all estimated a higher level of fishing intensity in the terminal years. All of these models estimated the highest fishing intensity between 2005 and 2010.

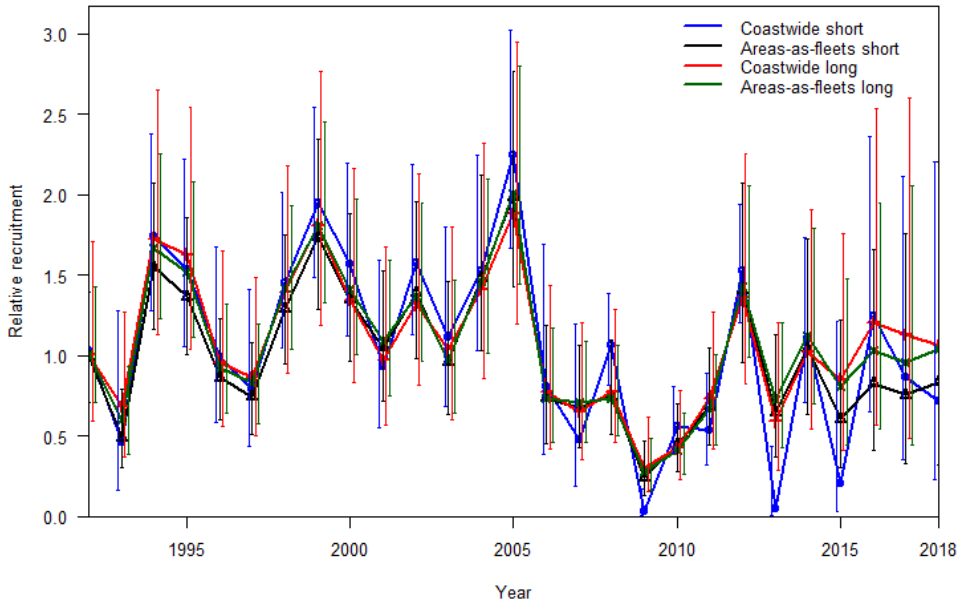

Figure 10. Estimated trends in age-0 relative recruitment (standardized to the mean for each model) from 1992-2018, based on the four individual models included in the 2023 stock assessment ensemble. Series indicate the maximum likelihood estimates; vertical lines indicate approximate 95% credible intervals.

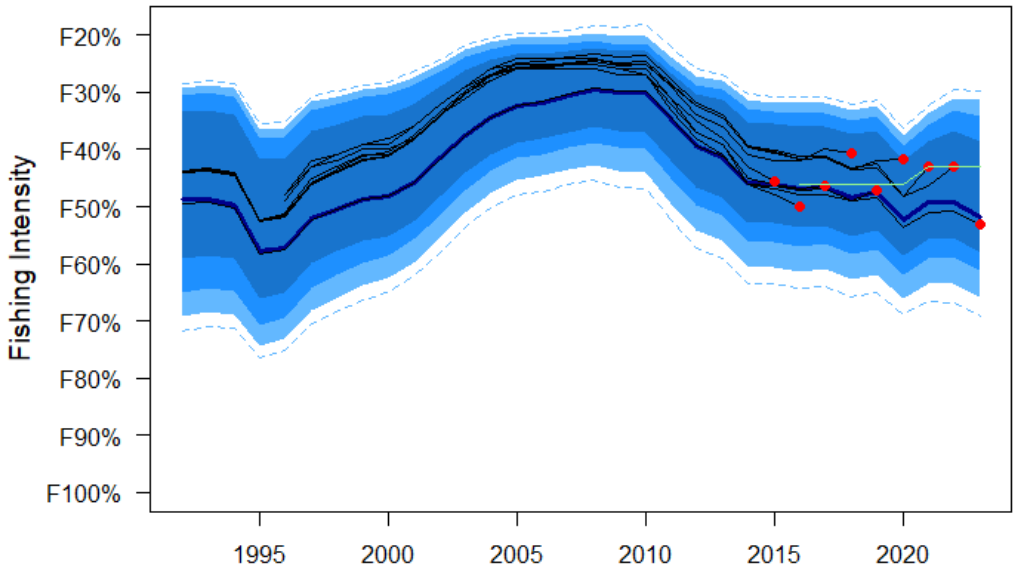

Figure 11. Retrospective comparison of fishing intensity (measured as $F_{xx\%}$, where xx% indicates the Spawning Potential Ratio (SPR) or the reduction in the lifetime reproductive output due to fishing) among recent IPHC stock assessments. Black lines indicate estimates of fishing intensity from assessments conducted in 2014-2022 with the projection for the mortality limit adopted based on that assessment shown as a red point. The shaded distribution denotes the 2023 ensemble: the dark blue line indicates the median (or "50:50 line") with an equal probability of the estimate falling above or below that level; and colored bands moving away from the median indicate the intervals containing 50/100, 75/100, and 95/100 estimates; dashed lines indicating the 99/100 interval. The green line indicates the reference level of fishing intensity used by the Commission in each year it has been specified ($F_{46\%}$ during 2016-2020 and $F_{43\%}$ thereafter).

The IPHC's interim management procedure specifies a reference level of fishing intensity of $F_{43\%}$ (SPR=43%); this equates to the level of fishing that would reduce the lifetime spawning output per recruit to 43% of the unfished level given current biology, fishery characteristics and demographics. The 2023 fishing intensity is estimated to correspond to $F_{52\%}$ (credible interval: 31-66%; Table 2). The most recent four years (2020-2023) are estimated to correspond to the lowest levels of fishing intensity since the mid-1990s. Comparing the relative spawning biomass and fishing intensity over the recent historical period shows that the relative spawning biomass decreased as fishing intensity increased through 2010, then subsequently increased (Figure 12).

Table 2. Status summary of the Pacific halibut stock and fishery in the IPHC Convention Area at beginning of 2024.

Indicators	Values	Trends	Status
BIOLOGICAL			
SPR_{2023}: P(SPR<43%): P(SPR<limit):	52% (31-66%)[2] 27% LIMIT NOT SPECIFIED	FISHING INTENSITY REDUCED FROM 2022 TO 2023	**FISHING INTENSITY BELOW REFERENCE LEVEL**[3]
SB_{2024} (MLBS): SB_{2024}/SB_0: $P(SB_{2024}<SB_{30})$: $P(SB_{2024}<SB_{20})$:	174 (111–258) Mlbs 42% (20-56%) 26% 1%	SB INCREASED 2% FROM 2023 TO 2024	**NOT OVERFISHED**[4]
Biological stock distribution:	SEE TABLES AND FIGURES	REGION 3 DECREASED, REGION 2 INCREASED FROM 2022 TO 2023	**REGION 3 AT THE LOWEST OBSERVED PROPORTION**
FISHERY CONTEXT			
Total mortality 2023: Percent retained 2023: Average mortality 2019–23:	35.87 Mlbs, 16,270 t[1] 83% 37.37 Mlbs, 16,951 t	MORTALITY DECREASED FROM 2022 TO 2023	**2023 MORTALITY NEAR 100-YEAR LOW**

[1] Weights in this document are reported as 'net' weights, head and guts removed; this is approximately 75% of the round (wet) weight.
[2] Ranges denote approximate 95% credible intervals from the stock assessment ensemble.
[3] Status determined relative to the IPHC's interim reference Spawning Potential Ratio level of 43%.
[4] Status determined relative to the IPHC's interim management procedure biomass limit of $SB_{20\%}$.

MAJOR SOURCES OF UNCERTAINTY

This stock assessment includes uncertainty associated with estimation of model parameters, treatment of the data sources (e.g., short and long time-series), natural mortality (fixed vs. estimated), approach to spatial structure in the data, and other differences among the models included in the ensemble. Although this is an improvement over the use of a single assessment model, there are important sources of uncertainty that are not included.

The assessment utilized six years (2017-22) of sex-ratio information from the directed commercial fishery landings. However, uncertainty in historical ratios remains unknown. Additional years of data are likely to further inform selectivity parameters and cumulatively reduce uncertainty in future stock size estimates. The treatment of spatial dynamics and

movement rates among Biological Regions, which are represented via the coastwide and AAF approaches, has large implications for the current stock trend, as evidenced by the different results among the four models comprising the stock assessment ensemble. This assessment also does not include mortality, trends, or explicit demographic linkages in Russian waters, although such linkages may be increasingly important as warming waters in the Bering Sea allow for potentially important exchange across the international border.

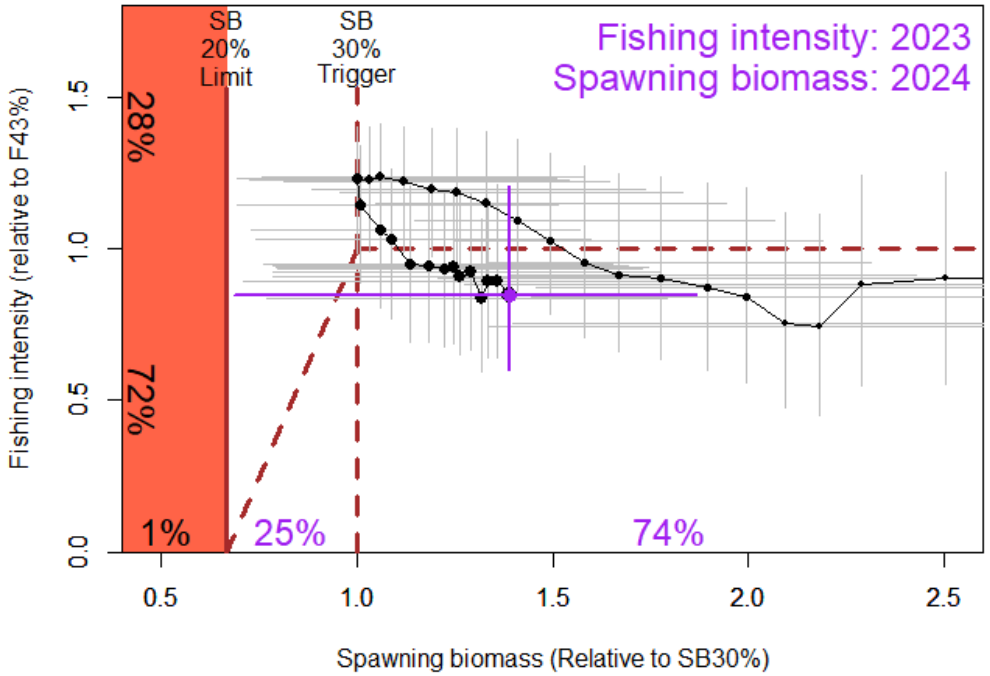

Figure 12. Phase plot showing the estimated time-series (1992-2024) of spawning biomass and fishing intensity relative to the reference points specified in the IPHC's interim management procedure. Dashed lines indicate the current $F_{43\%}$ (horizontal) reference fishing intensity, with linear reduction below the $SB_{30\%}$ (vertical) trigger, the red area indicates relative spawning biomass levels below the $SB_{20\%}$ limit. Each year of the time series is denoted by a solid point (credible intervals by horizontal and vertical whiskers), with the relative fishing intensity in 2023 and spawning biomass at the beginning of 2024 shown as the largest point (purple). Percentages along the y-axis indicate the probability of being above and below $F_{43\%}$ in 2023; percentages on the x-axis the probabilities of being below $SB_{20\%}$, between $SB_{20\%}$ and $SB_{30\%}$ and above $SB_{30\%}$ at the beginning of 2024.

Additional important contributors to assessment uncertainty (and potential bias) include the lag in estimation of incoming recruitment between birth year and direct observation in the fishery and survey data (6-10 years). Like most stock assessments, there is no direct information on natural mortality, and increased uncertainty for some estimated components of the fishery mortality. Fishery mortality estimates are assumed to be accurate; therefore, uncertainty due to discard mortality estimation (observer sampling and representativeness), discard mortality rates, and any other documented mortality in either directed or non-directed fisheries (e.g., whale depredation) could create bias in this assessment. Maturation schedules and fecundity are currently under renewed investigation by the IPHC. Historical values are based on visual field assessments, and the simple assumption that fecundity is proportional to spawning biomass and that Pacific halibut do not experience appreciable skip-spawning (physiologically mature fish which do not actually spawn due to environmental or other conditions). To the degree that

maturity, fecundity or skip spawning may be temporally variable, the current approach could result in bias in the stock assessment trends and reference points. New information will be incorporated as it becomes available; however, it may take years to better understand trends in these biological processes at the scale of the entire population. Projections beyond three years are avoided due to the lack of mechanistic understanding of the factors influencing size-at-age and relative recruitment strength, the two most important factors in historical population trends.

Due to the many remaining uncertainties in Pacific halibut biology and population dynamics, a high degree of uncertainty in both stock scale and trend will continue to be an integral part of an annual management process. Results of the IPHC's ongoing Management Strategy Evaluation (MSE) process can inform the development of management procedures that are robust to estimation uncertainty via the stock assessment, and to a wide range of hypotheses describing population dynamics.

SCIENTIFIC ADVICE

Sources of mortality: In 2023, total Pacific mortality due to fishing decreased to 35.87 million pounds (16,270 t), slightly below the 5-year average of 37.37 million pounds (16,951 t). Of that total, 83% comprised the retained catch (Table 2), equal to the percent utilized in 2022 and down from 87% in 2021.

Fishing intensity: The 2023 fishing mortality corresponded to a point estimate of SPR = 52%; there is a 27% chance that fishing intensity exceeded the IPHC's current reference level of $F_{43\%}$ (Table 2). The Commission does not currently have a coastwide fishing intensity limit reference point.

Stock status (spawning biomass): Current (beginning of 2024) female spawning biomass is estimated to be 174 million pounds (78,900 t), which corresponds to an 26% chance of being below the IPHC trigger reference point of $SB_{30\%}$, and a 1% chance of being below the IPHC limit reference point of $SB_{20\%}$. The stock is estimated to have declined 23% from 2016 to 2023, then increased by 2% to the beginning of 2024. The relative spawning biomass (compared to the biomass projected to be present at the beginning of 2024 in the absence of any fishing) is currently estimated to be 42%, after reaching the lowest point in the recent time series (30%) in 2011. Therefore, the stock is considered to be '**not overfished**'.

Stock distribution: After increases in 2020-2021, the proportion of the coastwide stock represented by Biological Region 3 has decreased in both 2022 and 2023 to the lowest estimate in the time-series, (Figure 6, Table 1). This trend occurs in tandem with increases in Biological Region 2. The lack of FISS sampling in Biological Region 4B in 2023 has resulted in increased uncertainty in both the trend and scale of the stock distribution in this Region.

Additional risks not included in this analysis: Directed commercial fishery catch rates coastwide, and in nearly all IPHC Regulatory Areas were at or near the lowest observed in the last 40 years. The absolute level of spawning biomass is also estimated to be near the lowest observed since the 1970s. The directed commercial fishery transitioned from the 2005 year-class to the 2012 year-class in 2022, with the 2012 year-class again the most numerous in the landed catch in 2023. This shift from older to younger (and smaller fish) has contributed to observed reduced catch rates. This year-class is estimated to be only 42% mature in 2023; the

current spawning stock is heavily reliant on this single year-class. Environmental conditions continue to be unpredictable, with important deviations from historical patterns in both oceanographic and biological processes observed across the stock range in the last decade.

RESEARCH PRIORITIES

Research priorities for the stock assessment and related analyses have been consolidated with those for the IPHC's MSE and the Biological Research program and are included in the IPHC's 5-year research plan (IPHC-2023-IM099-06).

OUTLOOK

Short-term projections and the harvest decision table for 2024-2026 are reported in a separate document (IPHC-2023-IM099-12 Rev_1).

ADDITIONAL INFORMATION

A more detailed description of the stock assessment (IPHC-2024-SA-01) and the data sources (IPHC-2024-SA-02), will be published directly to the stock assessment page on the IPHC's website. That page also includes recent peer review documents and previous stock assessment documents. Further, the IPHC's website contains many interactive tools for both FISS and commercial fishery information, as well as historical data series providing detailed tables of data and other information.

RECOMMENDATION/S

That the Commission:

a) **NOTE** paper IPHC-2023-IM099-10 Rev_1 which provides a summary of data and the results of the 2023 stock assessment.

REFERENCES

IPHC. 2023a. Report of the 22nd session of the IPHC scientific review board (SRB022). Meeting held in Seattle, WA, USA, 20-22 June 2023. IPHC-2023-SRB022-R. 23 p.

IPHC. 2023b. Report of the 23rd session of the IPHC scientific review board (SRB023). IPHC-2023-SRB023-R. 26 p.

Methot, R.D., and Wetzel, C.R. 2013. Stock synthesis: A biological and statistical framework for fish stock assessment and fishery management. Fisheries Research **142**(0): 86-99. doi:http://dx.doi.org/10.1016/j.fishres.2012.10.012.

Stewart, I., and Hicks, A. 2023a. Development of the 2023 Pacific halibut (*Hippoglossus stenolepis*) stock assessment. IPHC-2023-SRB022-08. 18 p.

Stewart, I., and Hicks, A. 2023b. Development of the 2023 Pacific halibut (*Hippoglossus stenolepis*) stock assessment. IPHC-2023-SRB023-06. 8 p.

Stewart, I., and Hicks, A. 2023c. Assessment of the Pacific halibut (*Hippoglossus stenolepis*) stock at the end of 2022. IPHC-2023-SA-01. 37 p.

Webster, R. 2022. Space-time modelling of survey data. IPHC-2022-IM098-09 Rev_1. 6 p.