DRAFT: IPHC Fishery Status Report 2018
Pacific halibut (*Hippoglossus stenolepis*)

NOTE: This document is in development. The intention is to provide a fishery-wide summary for the IPHC website

TABLE 1. Pacific halibut: Status of Pacific halibut (*Hippoglossus stenolepis*) in the IPHC Convention Area[1].

Indicators				**Stock status determination[2]**			
Biological status				**Fishing mortality[3]**		**Biomass[4]**	
	2017	2018	2019[5]	2017	2018	2018[5]	2019[5]
Mortality limit Total mortality[7] Retained mortality 5 yr av. total mortality SPRyear	40.74 Mlbs, ~ 18,479 t[6] 41.99 Mlbs, ~19,050 t[6] 34.91 Mlbs (83%), ~15,835 t[6] 43.25 Mlbs, ~19,618 t[6] 48% (29-61%)	37.21 Mlbs, ~16,878 t[6] 38.74 Mlbs, ~17,572 t[6] 31.81 Mlbs (82%), ~14,427 t[6] 41.39 Mlbs, 18,772 t[6] 49% (28-62)	n/a				
SB_{year} (Mlb)[5] SB_{year}/SB_0[5] $P(SB_{year}<SB_{30})$[5] $P(SB_{year}<SB_{20})$[5]	213 (144–292) 45% (30-66%) 2% <1%	205 (134-288) 44% (28-64%) 6% <1%	199 (125-287) 43% (27-63) 11% <1%				
Economic status	Net Economic Returns: In development						

[1] Boundaries for the IPHC stock assessment are defined as the IPHC Convention Area (see Fig. 1).
[2] An ensemble of four stock assessment models, representing a two-way cross of short vs. long time series', and aggregated coastwide vs. Areas-As-Fleets (AAF) models was used to describe the range of plausible current stock estimates.
[3] Status determined in the absence of a specific limit reference point for fishing intensity. i.e. as the stock is well above the trigger and limit biomass reference point, overfishing in not considered to be occurring.
[4] Status determined relative to the IPHC's current harvest control rule biomass limit of *SB20%*.
[5] Stock status refers to the condition of the stock as the start of the given year.
[6] Weights in this document are reported as 'net' weights, head and guts removed; this is approximately 75% of the round (wet) weight).
[7] U26 bycatch mortality does not accrue to the mortality limit.

Fishing mortality		Not subject to overfishing		Subject to overfishing		Uncertain
Biomass		Not overfished		Overfished		Uncertain

Description of the fishery

Area fished. Pacific halibut (*Hippoglossus stenolepis*) is targeted throughout its range, from the Bering Sea to the central Californian coast, as far as San Francisco Bay (Figs. 1, 2 and 3). In addition, the range extends into the waters of Russia, Korea and Japan, though at present these catches are considered minimal and are not included in the stock assessment.

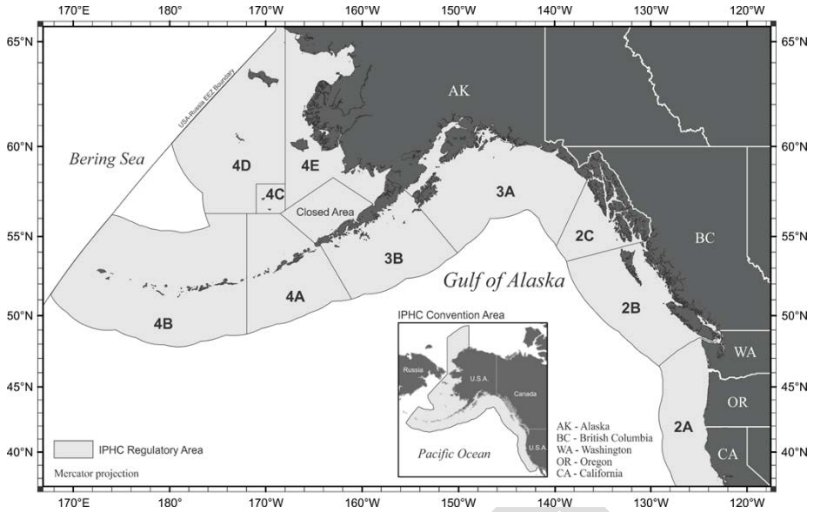

Fig. 1. IPHC Convention Area, including IPHC Regulatory Areas and the Pacific halibut geographical range within the territorial waters of Canada and the United States of America.

In development	In development

Fig. 2 [insert Maps of fishery showing 2017 versus 2018 relative fishing intensity (hooks/km^2) by 1 degree squares]

In development	In development

Fig. 3 [insert Map of fishery showing 2017 versus 2018 relative fishing intensity (hours or similar for Trawl/km^2) by 1 degree squares]

Fishing methods and key species. The Pacific halibut fishery is comprised of a number of sectors that target the species using hook and line, and pot gear (demersal longline, traps/pots, recreational and charter, traditional hook and line), as well as incidental catch (bycatch) sectors, that deploy demersal trawl, troll and gillnets (Fig. 4). Sablefish (*Anoplopoma fimbria*) and rockfish (*Sebastes spp*.) are frequently caught by demersal longline gear targeting Pacific halibut.

In development	In development

Fig. 4. Distribution of Pacific halibut mortality by source in 2017 (left) versus 2018 (right)

Management methods.

The fishery is managed using a combination of input controls (gear restrictions and a closed area) and output controls (individual transferable quotas and limits on the incidental take of rockfish). Pacific halibut is subject to incidental catch (mortality) limits by demersal trawl, and other measures to reduce targeting and catch by non-directed sectors. Additional current measures include a seasonal closure to protect spawning fish from targeting.

Over the past several years, the IPHC has been revisiting its Harvest Strategy Policy through the Management Strategy Evaluation process. The interim harvest policy uses $F_{46\%}$ (the fishing intensity that reduces the spawning biomass per recruit to 46% of its unfished condition; which was the SPR levels averaged from 2014-16) as a reference, and forms the basis for triggers for further management actions, if fishing activity increases. An annual review determines whether these catch triggers have been reached. It is not clear whether the maximum catch over the chosen reference period is a valid indicator of sustainable harvest levels, given the nearly 100 years of exploitation in this fishery, or whether catch rates over the reference period are representative of unfished biomass levels. However, the harvest strategy is designed to trigger management responses if fishing increases above recent historical levels.

Fishing effort. Industrial fishing commenced in 1888 and landings increased rapidly throughout the early 1900's (Figs. 5 and 6). The number of active vessels since 1991 peaked at 5,030 vessels in 1991 and declined through the 1990s before increasing to 2,758 vessels in 1997. It has since decreased to stabilise at 1,500 or 2,000 vessels each year since 2003-2004. Historical effort, in hooks and trawl hours, in the fishery largely follows the trend in the number of active vessels (Fig. 5).

In development	In development

Fig. 5. Historical effort, in hooks and trawl hours, in the fishery largely follows the trend in the number of active vessels, longline vessels (left) trawl vessels (right)

Catch history.

Recent aggregate mortality estimates from all sources show that the directed commercial fishery represents the majority of the fishing mortality (Fig. 6). Mortality from all sources in 2018 was estimated to be 38.8 million pounds (~17,570 t), down 8% from 42.0 million pounds in 2017 (~19,050 t). Over the period 1919-2018 mortality has totaled 7.2 billion pounds (~3.2 million t),

ranging annually from 34 to 100 million pounds (16,000-45,000 t) with an annual average of 63 million pounds (~29,000 t). Annual mortality was above this long-term average from 1985 through 2010 and was relatively stable near 42 million pounds (~19,000 t) from 2014-2017. Recent mortality estimates from all sources by individual IPHC Regulatory Area reveal that Area 3A has been the largest single source throughout the last five decades, but that Area 3A and 3B represent a smaller fraction of the total in recent years than in previous decades. When mortality by source is compared among IPHC Regulatory areas, there are differing patterns in both the magnitude and distribution.

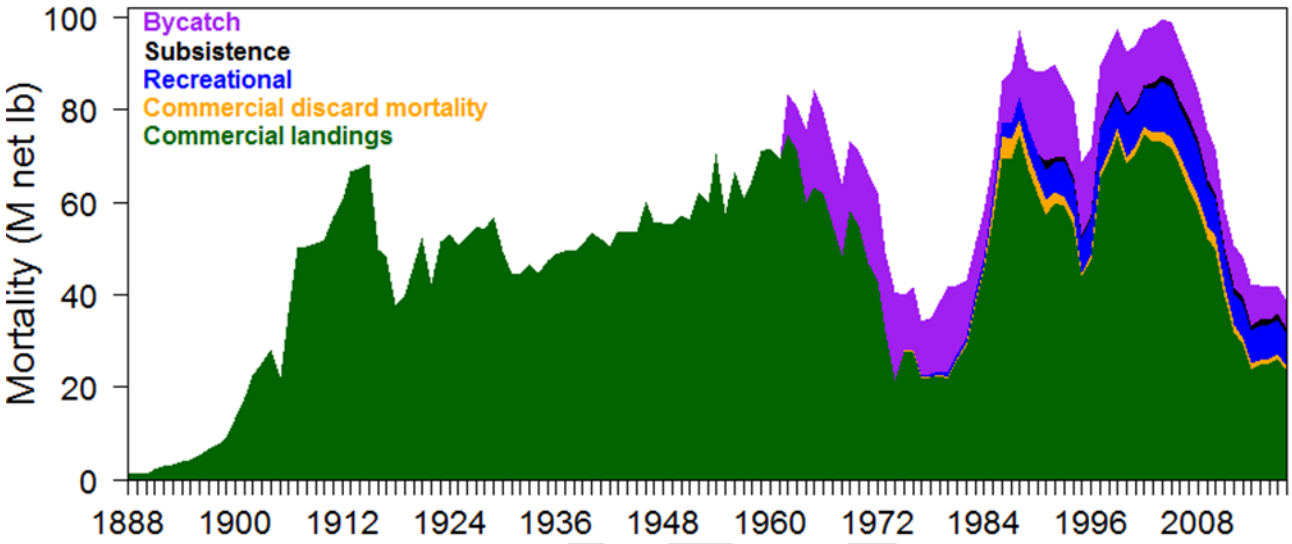

Fig. 6. Summary of estimated historical mortality by source since 1888-2018.

Table 2. Main features and statistics of the Pacific halibut fishery

To be developed

Fishery statistics	**2017 fishing season**			**2018 fishing season**		
Fishery/sector	**TAC (lbs; t)**	**Catch (lbs; t)**	**Real-value**	**TAC (lbs; t)**	**Catch (lbs; t)**	**Real-value**
Longline Commercial						
Recreational (sport)						
Subsistence (various)						
Bycatch (Trawl)						
Research (Longline)						
Total fishery						

Fishery-level statistics						
Effort						
Fishing licences/permits		1,686			1,619	
Active Vessels		1,566			1,462	
Observer coverage						
Fishing methods		Hook and line			Primarily: Hook and line; Minimally: pot	
Primary landing ports		Kodiak and Homer, Alaska			Kodiak and Seward, Alaska	
Management methods						
Primary market						
Management plan		Primarily: Catch share Minimally: Derby			Primarily: Catch share Minimally: Derby	

Biological status

Stock structure. Stock structure of Pacific halibut is not known, and populations are considered to constitute a single stock for management purposes.

Stock assessment. In 2018, an ensemble of four (4) equally-weighted models, two long time-series models, and two short time-series models either using data sets by geographical region, or aggregating all data series into coastwide summaries, were applied to the Pacific halibut (*Hippoglossus stenolepis*) stock in the IPHC Convention Area, using Stock Synthesis III software. The results here describe the approximate probability distributions derived from the ensemble of models, thereby incorporating the uncertainty within each model as well as uncertainty among models.

The results of the 2018 stock assessment indicate that the Pacific halibut stock declined continuously from the late 1990s to around 2011 (Fig. 7). Since the estimated female spawning biomass (SB) stabilized near 190 million pounds (~86,200 t) in 2011, the stock is estimated to have increased gradually to 2016. The SB at the beginning of 2019 is estimated to be 199 million pounds (~90,300 t), with an approximate 95% confidence interval ranging from 125 to 287 million pounds (~56,700-130,200 t).

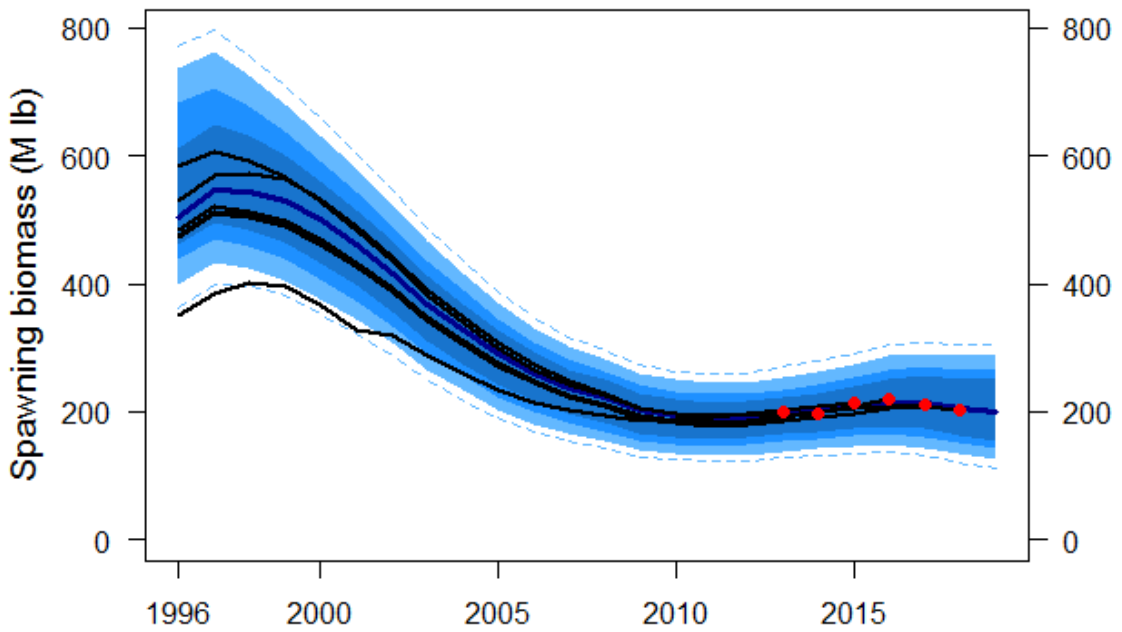

Fig. 7. Retrospective comparison among recent IPHC stock assessments. Black lines indicate estimates of spawning biomass from assessments conducted from 2012-17 with the terminal estimate shown as a point, the shaded distribution denotes the 2018 ensemble: the dark blue line indicates the median (or "50:50 line") with an equal probability of the estimate falling above or below that level; 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.

IPHC Harvest Strategy Policy. To adhere to the IPHC's interim harvest strategy policy, 2019 catches could be increased from those taken in 2018; however this is projected to result in continued decline of the spawning biomass. Options for consideration are provided in the Harvest Decision Table of paper IPHC-2019-AM095-09.

- **Fishing intensity**: The Commission does not currently have a coastwide target or limit fishing intensity reference point. However, an SPR of 46% is currently used as a reference level from the period 2014-16.
- **Spawning biomass**: Current female spawning biomass has a very low probability of being below the IPHC threshold (trigger) reference point of SB_{30}, and thus, also the IPHC limit reference point of SB_{20}.

Stock status determination.

Female spawning stock biomass of Pacific halibut at the beginning of 2018 was estimated to be 43% (27–63%) of the SB_0 (unfished levels) defined by the interim harvest strategy policy (Table 1). The probability that the stock is below the SB_{30} level is estimated to be 11%, with less than a 1% chance that the stock is below SB_{20}. Thus, on the weight-of-evidence available, the Pacific halibut stock is determined to be **not overfished** ($SB_{2019} > SB_{20\%}$). The IPHC does not have an explicit coastwide fishing intensity target or limit reference point, making it difficult to determine if current levels of fishing intensity are consistent with the interim harvest strategy policy objectives. However, given the healthy female spawning biomass and the TAC set for 2018 only being marginally higher than the levels estimated to maintain biomass at current high levels, on the weight-of-evidence, the stock is classified as **not subject to overfishing**.

Outlook. Stock projections were conducted using the integrated results from the stock assessment ensemble. The IPHC harvest decision table provides a comparison of the relative

risk (in times out of 100), using stock and fishery metrics, for a range of alternative harvest levels for 2019. The harvest decision table (Table 3) rows are divided into four sections:

1) The block of rows entitled “Stock Trend” provides for evaluation of the risks to short-term trend in spawning biomass, independent of all harvest policy calculations.

2) The second block of rows reports the risks relative to the spawning biomass reference points (“Stock Status”).

3) The third block of rows reports fishery performance (probability of decreased future yield) relative to the interim management procedure. Specifically, the probabilities correspond to the likelihood of having to reduce yield in future years to return to the reference SPR level (in this case 46%).

4) The fourth section (a single row) illustrates the uncertainty in current fishing intensity via the probability that a given level of harvest might exceed the reference level ($F_{46\%}$) in 2019.

Table 3. Harvest decision table for 2019. Columns correspond to yield alternatives and rows to risk metrics. Values in the table represent the probability, in “times out of 100” (or percent chance) of a particular risk.

2019 Alternative			No fishing mortality					Status quo		*Reference SPR=46%*								
Total mortality (M lb)			0.0	11.7	21.8	31.8	37.6	39.0	40.4	41.8	43.1	44.3	45.5	46.8	48.3	49.9	61.8	
TCEY (M lb)			0.0	10.0	20.0	30.0	35.8	37.2	38.6	40.0	41.3	42.5	43.7	45.0	46.5	48.1	60.0	
2019 Fishing intensity			$F_{100\%}$	$F_{78\%}$	$F_{64\%}$	$F_{54\%}$	$F_{49\%}$	$F_{48\%}$	$F_{47\%}$	$F_{46\%}$	$F_{45\%}$	$F_{44\%}$	$F_{43\%}$	$F_{42\%}$	$F_{41\%}$	$F_{40\%}$	$F_{34\%}$	
Fishing intensity interval			--	56-87%	41-76%	31-67%	27-63%	26-62%	25-61%	25-60%	24-59%	23-59%	23-58%	22-57%	22-56%	21-55%	17-49%	
Stock Trend (spawning biomass)	in 2020	is less than 2019	1	3	26	60	77	81	84	87	90	92	93	95	96	97	>99	a
		is 5% less than 2019	<1	<1	1	10	26	30	34	37	39	41	43	45	48	50	78	b
	in 2021	is less than 2019	1	7	41	75	90	93	94	96	97	98	98	99	99	99	>99	c
		is 5% less than 2019	<1	1	11	42	57	61	65	69	73	77	80	83	87	90	99	d
	in 2022	is less than 2019	1	12	51	82	93	94	96	97	98	98	99	99	99	>99	>99	e
		is 5% less than 2019	<1	3	28	58	76	79	83	86	88	90	92	93	95	96	>99	f
Stock Status (Spawning biomass)	in 2020	is less than 30%	5	7	11	14	17	17	18	18	19	19	20	20	21	21	25	g
		is less than 20%	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	h
	in 2021	is less than 30%	3	7	13	20	24	25	25	26	27	27	27	28	29	29	33	i
		is less than 20%	<1	<1	<1	<1	1	1	1	1	2	2	2	3	3	4	10	j
	in 2022	is less than 30%	2	8	17	25	28	29	29	30	30	31	31	32	33	33	41	k
		is less than 20%	<1	<1	<1	2	4	5	6	7	8	9	10	12	13	15	24	l
Fishery Trend (TCEY)	in 2020	is less than 2019	0	<1	18	26	40	45	51	56	60	63	66	69	73	77	95	m
		is 10% less than 2019	0	<1	12	25	29	33	37	42	47	51	54	58	62	66	95	n
	in 2021	is less than 2019	0	<1	20	28	46	51	56	60	64	67	70	73	77	81	97	o
		is 10% less than 2019	0	<1	16	26	35	39	44	49	53	56	59	63	66	71	97	p
	in 2022	is less than 2019	0	<1	22	32	50	54	58	62	66	69	72	76	79	83	98	q
		is 10% less than 2019	0	<1	19	28	40	45	49	53	56	60	62	66	69	73	98	r
Fishery Status (Fishing intensity)	in 2019	is above $F_{46\%}$	0	<1	16	25	35	40	46	50	56	59	62	65	69	72	92	s

The stock is projected to decrease over the period from 2019-21 for all TCEYs greater than 20 million pounds (~9,070 t), corresponding to an SPR of 64% (Table 3). At the *status quo* TCEY (37.2 million lb, ~16,900 t), which corresponds to an estimated SPR of 48% the probability of at least a 5% decrease in stock size increases from 30% (2020) to 79% (2022). At the reference level (and SPR of 46%) those probabilities increase to 37 and 86%. The reference level corresponds to an 87/100 (87%) chance of stock decline through 2020. There is less than a one

third chance (<34/100) that the stock will decline below the threshold reference point ($SB_{30\%}$) in any year for projections evaluated over three years with all the levels of fishing intensity up to and including an SPR of 40%.

Economic status

Key economic trends.

In development

Performance against economic objective. The absence of an explicit economic target makes it difficult to determine how effectively the fishery's harvest strategy policy is delivering maximum NER to the Canadian and American communities. However, it is clear from the high catches, low levels of latent effort and low levels of unfished TAC that this fishery is most likely achieving its maximum economic yield. Changes in NER are uncertain because of the lack of information about changes in cost structures of the industry sectors.

Environmental status

In development