Influence of selective flatfish trawl gear on Chinook bycatch projections in the bottom trawl sector

Summary

Our investigation revealed evidence through comparison of Chinook bycatch rates from selective flatfish trawl gear (SFFT) versus hooded gear, together with corresponding sets of projections for potential bycatch with and without use of SFFT gear, that Chinook bycatch would likely dramatically increase if the current requirement to use SFFT gear shoreward of the RCA in the area north of 40°10' N. latitude were lifted. However, precise estimation of future bycatch for this scenario is problematic, given multiple influential sources of uncertainty, which include the future extent of bottom trawl effort in the northern shelf area (given the rebuilt status of canary rockfish), whether use of SFFT gear would be entirely discontinued by industry without the restriction in place, future groundfish landings for bottom trawl, and species composition of future shelf catch, among other sources. Based on these results, the potential for higher Chinook bycatch (than current levels) appears to be greater than we initially concluded in our presentation to the Council in March; should the fishery continue to evolve to more closely resemble the less restrictive structure reflected in Scenario 2.B.

Introduction

Selective flatfish trawls (SFFTs) were designed to reduce bycatches of overfished rockfish while maintaining access to flatfish stocks. As seen in Figures 1 and 2, SFFTs have a low-rise and a cut-back hood, as opposed to traditional trawls that have an overhanging hood. These attributes of the SFFT were designed to influence rockfish to swim up and over the head-rope to escape capture, whereas flatfish that "kick up" off the bottom upon approach of the net, tend to initially try to escape downward and thus are captured (Agenda Item D.6.c; ODFW/NFWSC Report; November 2007). The SFFT has been required since 2005 when bottom trawling shoreward of RCA in the area north of 40°10' N. latitude.

During review of the NMFS Report 1 Analytical document from the March 2017 PFMC meeting (Agenda Item I.1.a, NMFS Report 1), which will be used to inform the upcoming salmon biological opinion for the groundfish fisheries, the GMT and Council noted that the Scenario 2.B.1 predictions of what the non-whiting trawl fishery could resemble in the future (e.g., without RCA, without overfished species, increased rockfish effort, and increased effort on the shelf, historical fleet distributions) included projections that applied historical landings to recent Chinook bycatch rates (Table 1 in this report, which is a copy of Table 14 in the original NMFS Alternatives document).

For bottom trawl, there were concerns that the recent bycatch rates reflecting use of SFFT gear could result in an under-projection of future Chinook bycatches. That was based on the theory that SSFT trawls may have been an effective configuration for also reducing bycatches of stronger swimming salmon for the same reasons as with rockfish. If true, then future projections based on data including use of SFFT gear would be an underestimate of what may occur in future, if the SSFT requirement were removed (which has already been approved by Council per the gear regulations package).

The Council requested that analysts from the Groundfish Management Team (GMT) and National Marine Fisheries Service work together to investigate the influence of SFFT gear on Chinook salmon bycatches. If their results indicated a difference in bycatch between SFFT and non-selective hooded trawl gear, they asked that we incorporate estimated effects of removal of the SFFT requirement into projections of future bycatch for the non-whiting fishery.

Methods

Bycatch rate comparisons between "hooded" and SFFTs

The first step of the analysis was to determine if Chinook salmon bycatch rates were greater for "hooded" trawls than SFFTs, and if so, then modifications would need to be made for the bottom trawl sector portion of Table 1 (which is a copy of Table 14 in the Alternatives document presented in the March PFMC meeting) projections for Scenario 2.B.1. to account for these gear effects.

Since the SFFT requirement that was implemented in 2005 was limited to the area shoreward of the RCA and north of 40°10' N. latitude, comparisons of Chinook bycatch between "hooded" trawls and "cut-back" SFFTs were limited to that particular area. Due to time constraints, depth was used to identify hauls occurring shoreward of RCA (i.e., <= 100 fathoms) instead of haul coordinates; however, measures were taken to exclude high rise slope trips occurring seaward of RCA. Recent bycatch rates used to produce Table 1 are suitable for other areas since no such dramatic changes are expected (e.g., no SFFT requirement for slope; expected to continue use of large footrope hooded nets). The bycatch rate comparison was for hauls before and after the 2005 adoption of the SFFT requirement, since trips occurring before then were generally from "hooded" trawls and hauls thereafter had to be from SFFT. However, care was given to exclude the SFFT exempted fishing permit (EFP) trips that occurred prior to 2005 to ensure comparisons were truly between "hooded" trawls and SFFTs. These EFP trips could have been included, but the direction from the Council was to compare bycatch rates before and after 2005.

Modification of projections to account for greater bycatch rates of "hooded" trawls

We retained fundamental components of Table 14 in the Alternatives document from the March PFMC meeting for this exercise, and varied some aspects of the data informing the estimates for the bottom trawl sector. We assumed the same groundfish landings, the same latitudinal

distribution of those landings and the same bycatch rates for strata outside the scope of this investigation.

We estimated stratified bycatch rates and apportioned landings by depth, area, and season, in order to produce the projections seen in Tables 2.a. through 2.f. Estimates were made for the area north of 40°10' N. latitude and shallower than 100 fm using non-SFFT bottom trawl gear (informed by 2002-2004 observer data), and for the same area using SFFT gear (using 2005-2014 observer data). Again, we used 100 fm as a simplifying proxy for the shoreward RCA, given time constraints of this request, versus the complexity and time needed to evaluate the RCA dynamically in space and time.

Assumptions regarding distribution of landings by depth strata

Because the degree of future shelf effort is uncertain (although there is a generally high expectation due in large part to the rebuilding of canary rockfish), we also varied the proportional depth distribution of landings (as a proxy for effort) between and within eras, as an axis of uncertainty. We calculated two separate ranges of estimates, one for each era (historical and recent), and showed the range within each era as well (Table 2).

The historical approach was used since it best reflects resumption of historical fishing activities in which access to the SFFT area (the shelf) was relatively unhindered (i.e., prior to constraints that include both canary and yelloweye rockfishes being declared overfished in the 2000's), and it fits with previous Council recommendations for Scenario 2.B. Our distribution of landings by depth and season for the historical approach was informed using data from bottom trawl logbooks, over the period 1995-1999. The annual, seasonal proportions of adjusted hailed pounds (retained) from logbooks was used to estimate the range of effort deeper versus shallower than 100 fm, north of 40°10' N. latitude; those appear in Table 3. Logbook compliance rates varied between 52 and 82 percent, with a mean of 68 percent for year, season and depth strata within that area and period.

The recent approach was used to acknowledge that although activity in the SFFT area may be less restricted in the future due to the rebuilding of canary rockfish, potential constraints due to yelloweye rockfish could remain. We included this for comparison because the proportion of effort in the zero to 100 fathom range is uncertain for the future and this information is influential to the outcome of this exercise. The recent approach reflects constraints due to rebuilding shelf rockfish, while the historical approach portrays a comparative lack of those constraints. The recent approach was informed by IFQ-era, (WCGOP) observer data, based on the proportion of catch that has recently occurred (i.e., 2011-2014), in the same area and strata as the historical approach.

Results and discussion

Aggregate bycatch rate comparisons by gear

As seen in Table 4 and Table 5, Chinook bycatch rates for SFFT were dramatically lower than the normal hooded small footrope trawls in pre- and post-2005 comparisons in the SFFT comparison

area (e.g., 63 times lesser for the entire timeframe). Table 4 shows bycatch rates by gear, while Table 5 shows them by both gear and era.

The purpose of dividing bycatch rates by era for selective flatfish gear type (Table 5) is to show that gear type itself is apparently driving the majority of difference in bycatch rate, rather than variation in other management measures, or even the large scale change between management systems in the recent era (e.g. trip limits versus IFQ). We acknowledge that era and gear type are not entirely separable, since bycatch rates in the area without the SFFT requirement could only be estimated from a separate (but adjacent) era, 2002-2004. The requirement has been in place since 2005.

Since bycatch rates for "hooded" trawls were considerably greater than for SFFTs in the comparison area, the projections in Table 1 were modified to account for "hooded" trawls displacing SFFTs, to represent a scenario in which the SFFT restriction is removed in the future.

The topic of comparatively high bycatch estimates by bottom trawl during the 2002-2004 era, versus later years was raised in the March PFMC meeting. The observer program (WCGOP) has been consulted on the reliability of the 2002-2004 data, and assert that those data are of sound quality and are representative of salmon catch of the fleet at that time. The data reflect that Chinook bycatch rates were high in those years, particularly in shallow strata north of 40°10' N. latitude (Table 25 in Agenda Item I.1.a, NMFS Report 2: Salmon Bycatch in the Pacific Coast Groundfish Fisheries, March 2017). However, Chinook bycatch was generally high among hauls across the distribution, rather than being unreasonably influenced by a few extreme catch events.

Projections

Projected estimates of Chinook bycatch in the bottom trawl sector for this new action were dramatically higher when assuming that the current SFFT requirement would be removed, indicating that a likely effect of removing the SFFT requirement would be a sharp increase in Chinook bycatch.

Estimates ranged between 7,896 and 13,833 Chinook, with a mean of 10,994 based on 2011 to 2014 effort distribution by depth; or 18,149 to 25,364, with a mean of 22,397 based on late 1990s effort distribution by depth from logbook data (Tables 2a. through 2.f.). Both sets of estimates sharply contrast with the current mean estimate in Table 14 of the Alternatives document (reproduced here as Table 1), of just 1,159 chinook for bottom trawl, using recent bycatch rates and 1990s landings, and assuming continued use of recent trawl gear, under the existing regulations. Each one of the sub-tables in (a. through f.) in Table 2 compares directly to Table 1.g. (Table 14.g. in the March Alternatives document), to illustrate the potential effect of removing the requirement to use selective flatfish trawl gear in the area shoreward of the 100 fm RCA line, north of 40°10'.

We see large differences in expected bycatch according to different assumptions about distribution of effort by depth, within versus outside of the SFFT area (Table 3); with the larger estimated effort shallower than 100 fm in the 1990s, together with stark differences in bycatch rates between

gear types, combining to drive the widely differing bycatch estimates. Estimates assuming historical distributions of effort by depth incur some additional uncertainty due to logbook compliance rates from those years and strata (see Methods section) and other general aspects of logbook data (self-reported, etc.).

We used two different ranges of effort distribution (as retained mt of groundfish) by depth within the area north of 40°10' N. latitude, as this assumption was very influential upon the results. The left hand column, which includes Tables a., c., and e. assume the same distribution of effort by depth informed by by recent observer data, from 2011 to 2014. The right hand column, which includes Tables b., d., and f. assume the distribution of effort by depth informed by historical logbook data from 1995-1999.

Although summer distribution of groundfish bottom trawl landings (proxy for effort) was similar between data sources and eras, winter distribution of landings in the area was dramatically lower in recent years than in the late 1990s (Table 3). This is the primary source of difference between estimates in Table 3, between left and right columns.

The higher bycatch estimates produced by substituting hooded gear for SFFT gear makes us question whether we were too skeptical of the reliability of EDCP data, and the resulting high bycatch estimates in Table 18 of the March NMFS Alternatives document. The degree of similarity between the mean estimate for bottom trawl bycatch (using means of each axis) in Table 2.d. of 22,397 Chinook (which was made using historical depth distributions) to the same estimate in Table 18.e. of the Alternatives document from the March 2017 PFMC meeting of 20,751 is notable.

The use of hooded bottom trawl gear inside the area of the current SFFT restriction during the years when the EDCP study was conducted (late 1990s) is indicated for that time period, so it is not surprising that our gear-based correction of recent bycatch rates used in the original Scenario 2.B.1 brought us closer to the estimate in Scenario 2.B.2 (which used EDCP bycatch rates, with the same range of landings). The lack of an SFFT requirement during the late 1990s when the EDCP was conducted is one of many contemporary management restrictions that were not in place at that time (in addition to lack of an RCA, rockfish species were not yet declared overfished or operating under rebuilding plans, trip limit management, and pre-buyback).

Estimates from Table 18 made using EDCP bycatch rates also fall within confidence intervals of estimates made in Erickson et al. 1994 from the Pikitch study; that study's time period also fell within that regime of minimal management restrictions (most notably pre-RCA and pre-SFFT), many of which likely have measurable impacts on salmon bycatch. Both studies were also conducted before the vessel buyback program, which as discussed in the March Alternatives document, could promote overestimation of future Chinook catch from using historical data, if the current lower capacity fleet were more efficient, and if voluntary avoidance of salmon is greater under the new management system (although for salmon, the direct incentive of quota, which exists for overfished rockfish for example, is lacking).

We explored data from the Pikitch study of the late 1980s (Erickson and Pikitch 1994) for use in the alternatives document. Initial summary statistics from the study database showed that the

number of hauls containing salmon by gear type was insufficient for our analysis. However, after we had completed the Alternatives document for the March meeting, we received revised statistics, which revealed there were sufficient numbers hauls with salmon for our analytical needs. Although it was too late at that point in the process to bring in new data and conduct additional analyses, findings from the work previously done using Pikitch study data in Erickson and Pikitch (1994) are still useful to compare with and contextualize the estimates we made using EDCP data (which fit the criteria for the scenario that Council recommended well).

Another relevant consideration is that if the SFFT requirement is discontinued, some fishers who target flatfish in the area may continue to use it, given its reported effectiveness at limiting catch of potentially bothersome unintended species like hake, in addition to bycatch of salmon and rockfish, and reports of better fuel efficiency (Patrick Mirick, ODFW, pers. com.) If this were the case, it would mean that actual impacts on salmon would be lower than we estimate here. The degree to which the use of SFFT gear would be discontinued by fishers, if the requirement were dropped, is not something that we explored in our analysis.

Projected landings are also uncertain, although the late 1990s landings used in Tables 3 and 4 are similar in aggregate, and for many key species as model-based projections in the 2017-2018 harvest specifications. Uncertainty in species composition of projected landings is also influential, in that both current projections in the 2017-18 harvest specifications and the late 1990s landings used here were high for flatfish species like Dover sole. If the expectation for harvest of shelf flatfish is overly optimistic, that should mean lower salmon impacts than we show here. Using the 1990's landings for Scenario 2 conveys several advantages, as many currently constraining management restrictions are missing, which was the Council request for the time period (and subsequent discussion among council members, NMFS analysts, and a workgroup of the GMT) to represent this scenario. Using this representative time period also enables utilization of the inherent depth, area, season, gear, and subsector distributions, which was also part of the Council rationale to phrase the request in that way.

Stock composition

We determined the stock composition of the revised bycatch estimates using the methodology for Scenario 2.B.1. described in NMFS Report 1 from the March 2017 Council meeting (NMFS 2017)[1]. We applied the stock composition proportions to the mean depth distribution estimates for the recent and 1990s depth distributions described above for the bottom trawl component of the non-whiting scenario (Tables 3c and 3d). The mid-water bycatch estimates have not been revised since described in NMFS 2017. The results of the analysis are presented in Figure 3. The results presented to the Council during the March meeting for this scenario are provided in Figure 4 for comparison. The bycatch distribution among areas did not change as a result of the new analysis and the approach was the same as used previously. Therefore, the pattern of distribution and proportional distribution to bycatch across ESUs remains the same as presented to the Council in

[1] We are exploring several alternative approaches suggested by the SSC in March but have not yet completed that work.

March. However, the magnitude of bycatch for many of the ESUs is significantly greater than what we had estimated under Scenario 2.B.1. assuming bycatch rates would remain similar to recent years. Estimated bycatch per ESU increases from 100 to less than one thousand, to 500 to several thousand for the primary contributing ESUs. These results are similar to the estimates based on the EDCP data (Scenario 2.B.2.) in NMFS 2017. Based on these results, the potential for higher Chinook bycatch (than current levels) appears to be greater than we initially concluded in our presentation to the Council in March; should the fishery continue to evolve to more closely resemble the less restrictive structure reflected in Scenario 2.B.

References

Erickson, D.L. and Pikitch, E.K., 1994. Incidental catch of chinook salmon in commercial bottom trawls off the US West Coast. North American Journal of Fisheries Management, 14(3), pp.550-563.

National Marine Fisheries Service (NMFS). 2017. Alternatives for Salmon Bycatch Management in the Pacific Coast Groundfish Fisheries. Report to the Pacific Fisheries Management Council Prepared By National Marine Fisheries Service. Sustainable Fisheries Division, West Coast Region. March 2017. 94 p. + Appendices

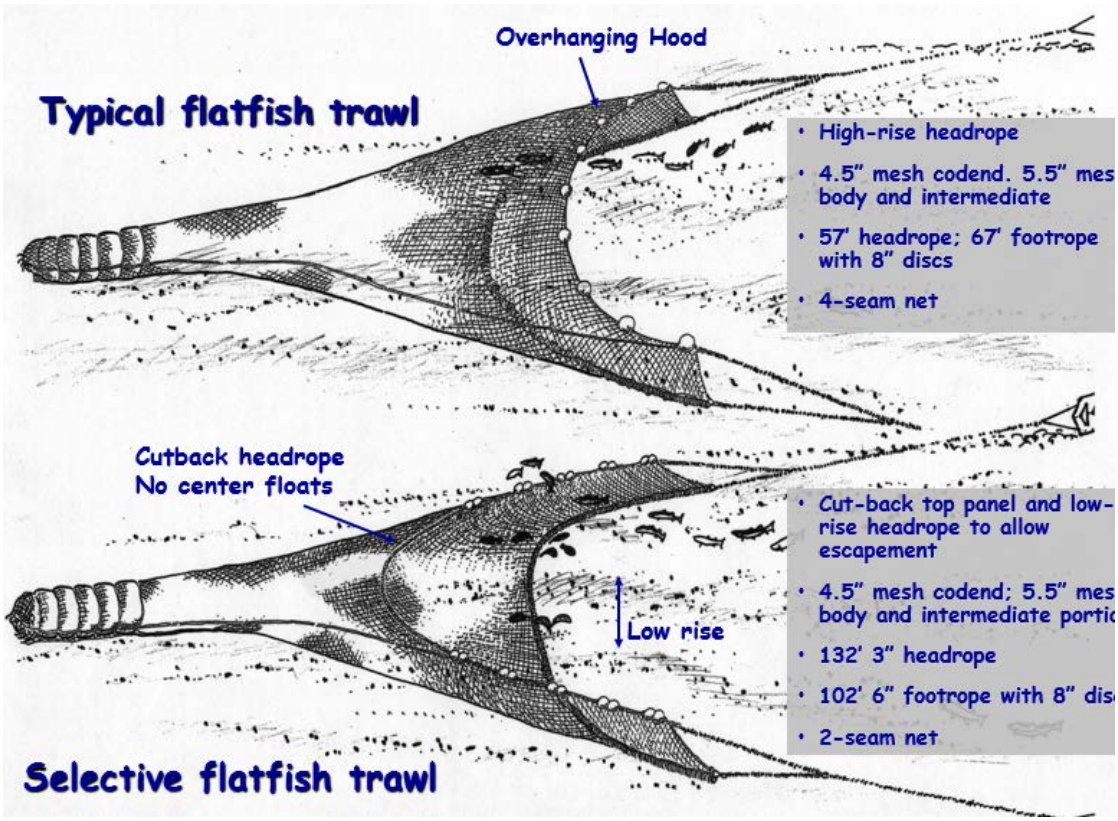

Figure 1. Comparison of typical flatfish trawl with selective flatfish trawl (credit ODFW).

Figure 2. Front view of selective flatfish trawl (photo credit ODFW).

Tables 1.a. through 1.i. *(Copy of Table 14 from the Alternatives document presented in March 2017 PFMC meeting*). Annual Chinook bycatch predictions for **Scenario 2.B.1.** by sectors (bottom trawl, and midwater non-whiting trawl), and seasons (summer and winter), with stratified sums. Refer to labels in the table for identities of stratified estimates. We used bycatch rate and retained FMP groundfish catch for each sector separately, as axes of uncertainty, in nine combinations each, based on interannual means, minima and maxima of the data identified in the Council motion and through discussions with a working group of the GMT. We used years 1995-1999 for landings (pre-RCA, pre-overfished rockfish stocks, etc), and used the same bycatch rates as in Table 2, those of recent years. See text for justifications and caveats. Chinook bycatch rates were calculated as count per mt of retained whiting catch, and groundfish catch is reported as mt (retained).

a. Bottom trawl, summer.

Bycatch rates (x)		0.002	0.015	0.028
GF landings (y)		Min	Mean	Max
20,482	Min	51	315	569
24,470	Mean	61	376	679
28,522	Max	71	438	792

b. Midwater non-whiting trawl, summer.

Bycatch rates (x)		0.230	0.762	1.294
GF landings (y)		Min	Mean	Max
329	Min	76	251	426
750	Mean	173	572	971
1,060	Max	244	807	1,371

c. Sum sectors, summer.

GF landings (y)		Bycatch rates (x)		
		Min	Mean	Max
20,811	Min	127	566	995
25,221	Mean	234	948	1,650
29,581	Max	315	1,246	2,163

d. Bottom trawl, winter.

Bycatch rates (x)		0.018	0.045	0.085
GF landings (y)		Min	Mean	Max
12,669	Min	232	576	1,071
17,233	Mean	315	783	1,456
21,091	Max	386	959	1,782

e. Midwater non-whiting trawl, winter

Bycatch rates (x)		0.106	0.263	0.420
GF landings (y)		Min	Mean	Max
267	Min	28	70	112
803	Mean	85	211	337
1,319	Max	140	347	554

f. Sum sectors, winter

GF landings (y)		Bycatch rates (x)		
		Min	Mean	Max
12,936	Min	260	646	1,183
18,036	Mean	401	994	1,793
22,410	Max	526	1,305	2,336

g. Sum seasons, bottom trawl.

GF landings (y)		Bycatch rates (x)		
		Min	Mean	Max
33,151	Min	283	890	1,639
41,703	Mean	376	**1,159**	2,136
49,613	Max	457	1,397	2,574

h. Sum seasons, non-whiting midwater.

GF landings (y)		Bycatch rates (x)		
		Min	Mean	Max
597	Min	104	321	538
1,553	Mean	258	783	1,308
2,379	Max	384	1,154	1,924

i. Sum seasons and sectors.

GF landings (y)		Bycatch rates (x)		
		Min	Mean	Max
33,748	Min	387	1,212	2,178
43,257	Mean	634	1,942	3,444
51,991	Max	841	2,551	4,499

Tables 2a. through 2.f. Each one of these tables compares directly to Table 1.g. (Table 14.g in the March Alternatives document), to illustrate the potential effect of removing the requirement to use selective flatfish trawl gear in the area shoreward of the RCA, north of 40°10' N. latitude. We used two different ranges of groundfish landings distribution by depth within the area north of 40°10' N. latitude, as this assumption was very influential on the results. The left column, which includes Tables a., c., and e. assume the same distribution of landings by depth informed by recent observer data, from 2011 to 2014. The right column, which includes Tables b., d., and f. assume the distribution of landings by depth informed by historical logbook data from 1995-1999. The results indicate that a likely effect of removing the SFFT requirement would be a sharp increase in Chinook bycatch.

a. Bottom trawl, assuming min shelf effort, 2011-2014.

		Combined stratified BC rates (x)		
GF landings (y)		Min	Mean	Max
33,151	Min	1,613	6,803	15,290
41,703	Mean	1,951	**7,896**	17,648
49,613	Max	2,281	9,124	20,367

b. Bottom trawl, assuming min shelf effort, 1995-1999.

		Combined stratified BC rates (x)		
GF landings (y)		Min	Mean	Max
33,151	Min	4,989	14,750	30,167
41,703	Mean	6,419	**18,149**	36,631
49,613	Max	7,629	21,317	42,878

c. Bottom trawl, assuming mean shelf effort, 2011-2014.

		Combined stratified BC rates (x)		
GF landings (y)		Min	Mean	Max
33,151	Min	2,191	9,540	21,513
41,703	Mean	2,629	**10,994**	24,648
49,613	Max	3,066	12,675	28,376

d. Bottom trawl, assuming mean shelf effort, 1995-1999.

		Combined stratified BC rates (x)		
GF landings (y)		Min	Mean	Max
33,151	Min	6,365	18,059	36,416
41,703	Mean	8,237	**22,397**	44,558
49,613	Max	9,803	26,362	52,263

e. Bottom trawl, assuming mean shelf effort, 2011-2014.

		Combined stratified BC rates (x)		
GF landings (y)		Min	Mean	Max
33,151	Min	2,724	12,044	27,199
41,703	Mean	3,256	**13,833**	31,051
49,613	Max	3,793	15,931	35,704

f. Bottom trawl, assuming max shelf effort, 1995-1999.

		Combined stratified BC rates (x)		
GF landings (y)		Min	Mean	Max
33,151	Min	7,313	20,381	40,836
41,703	Mean	9,485	**25,364**	50,135
49,613	Max	11,295	29,882	58,857

Table 3. Stratified bycatch rates of Chinook salmon (as min, mean, and maximum of year by season rates) in the non-whiting groundfish bottom trawl sector by gear, era and season, for the area north of 40°10’ N. latitude, and less than 100 fm, used to inform projections in Table 1. Selective flatfish trawl gear has been required shoreward of the RCA in this area since 2005.

Gear	Hooded small footrope		Selective flatfish trawl	
Source	Observer, 2002-2004		Observer, 2005-2014	
Season	Summer	Winter	Summer	Winter
Min	0.1845	2.1609	0.0000	0.0000
Mean	1.0807	4.3228	0.0149	0.0905
Max	2.5406	7.4831	0.0631	0.3116

Table 4. Bycatch rate comparison from WCGOP observed hauls 2002-2014, by gear type.

Bottom trawl type	Era	Haul count	Chinook count	Groundfish mt	Chinook per MT	X higher
Hooded small footrope	2002-2004	3,214	2,517	1,287	1.955	63.8
Cut-back selective flatfish	2005-2014	10,103	259	8,446	0.031	---

Table 5. Bycatch rate comparison from WCGOP observed hauls by gear type and era.

Bottom trawl type	Era	Haul count	Chinook count	Groundfish mt	Chinook per MT	X higher
Hooded small footrope	2002-2004	3,214	2,517	1,287	1.9551	294.76
Cut-back selective flatfish	2005-2010	4,558	18	2,714	0.0066	---
Cut-back selective flatfish	2011- 2014	5,545	241	5,733	0.0420	6.34

Table 6. Estimated annual proportions of groundfish landings in the non-whiting groundfish bottom trawl sector shallower than 100 fm, for the area N of 40°10’ N. latitude, for two eras and data sources used to inform projections in Table 1.

Source	Logbook data, 1995-1999		Observer data 2011-2014	
Season	Summer	Winter	Summer	Winter
Min	0.3805	0.1907	0.2829	0.0299
Mean	0.4259	0.2553	0.4121	0.0387
Max	0.4608	0.2992	0.5297	0.0472

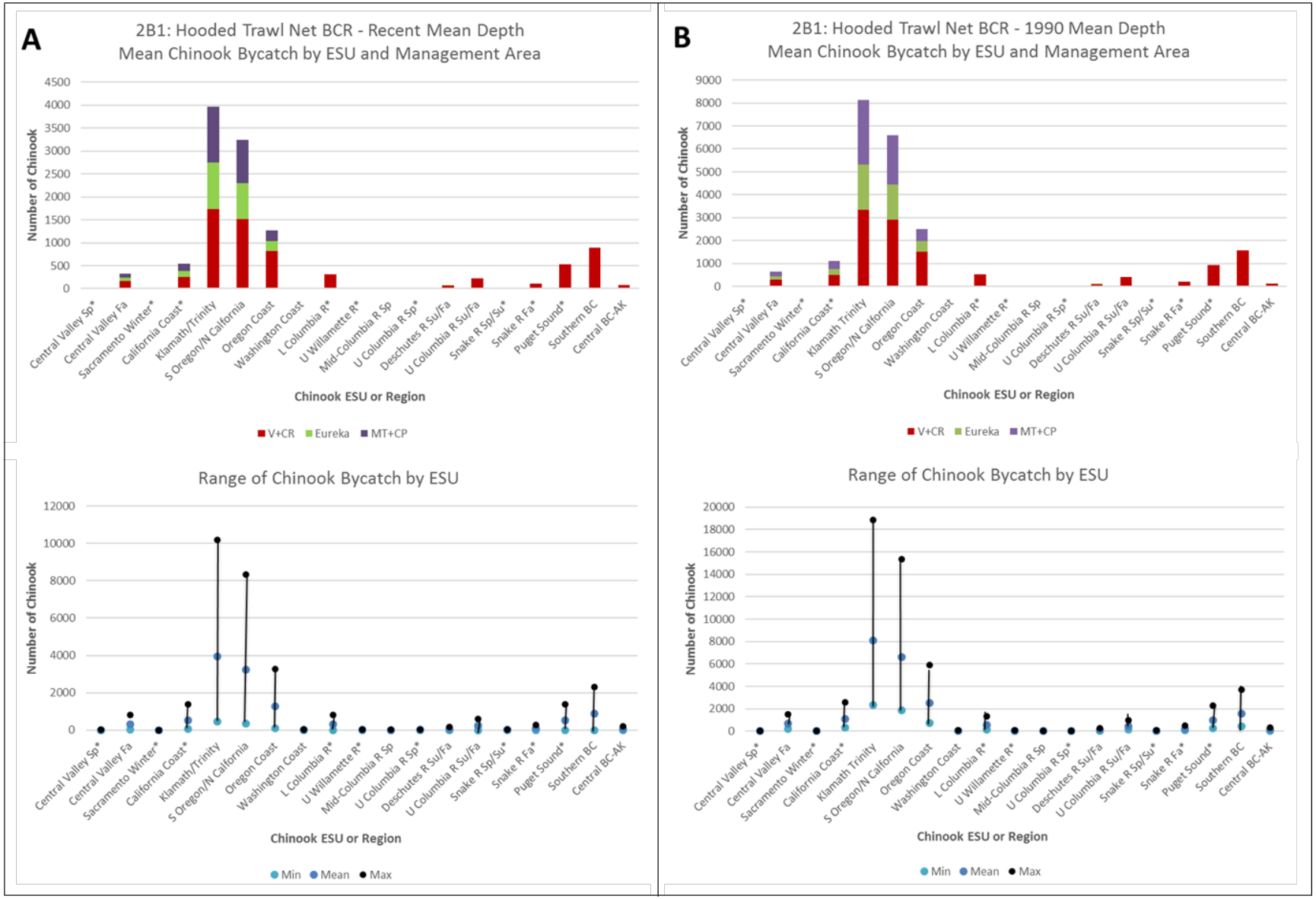

Figure 3. Plots of estimated bycatch in numbers of Chinook and distribution in the non-whiting fishery based on the mean and range of annual bycatch in Tables 10c and 10d adjusted to reflect stock composition for the recent mean depth distribution (Panel A), and 1990s mean depth distribution (Panel B) scenarios. The upper figures of Panels A and B show estimated mean annual bycatch by ESU and management area. The bottom figures show the range of estimated annual impacts by ESU. ESUs listed under the Endangered Species Act are starred.

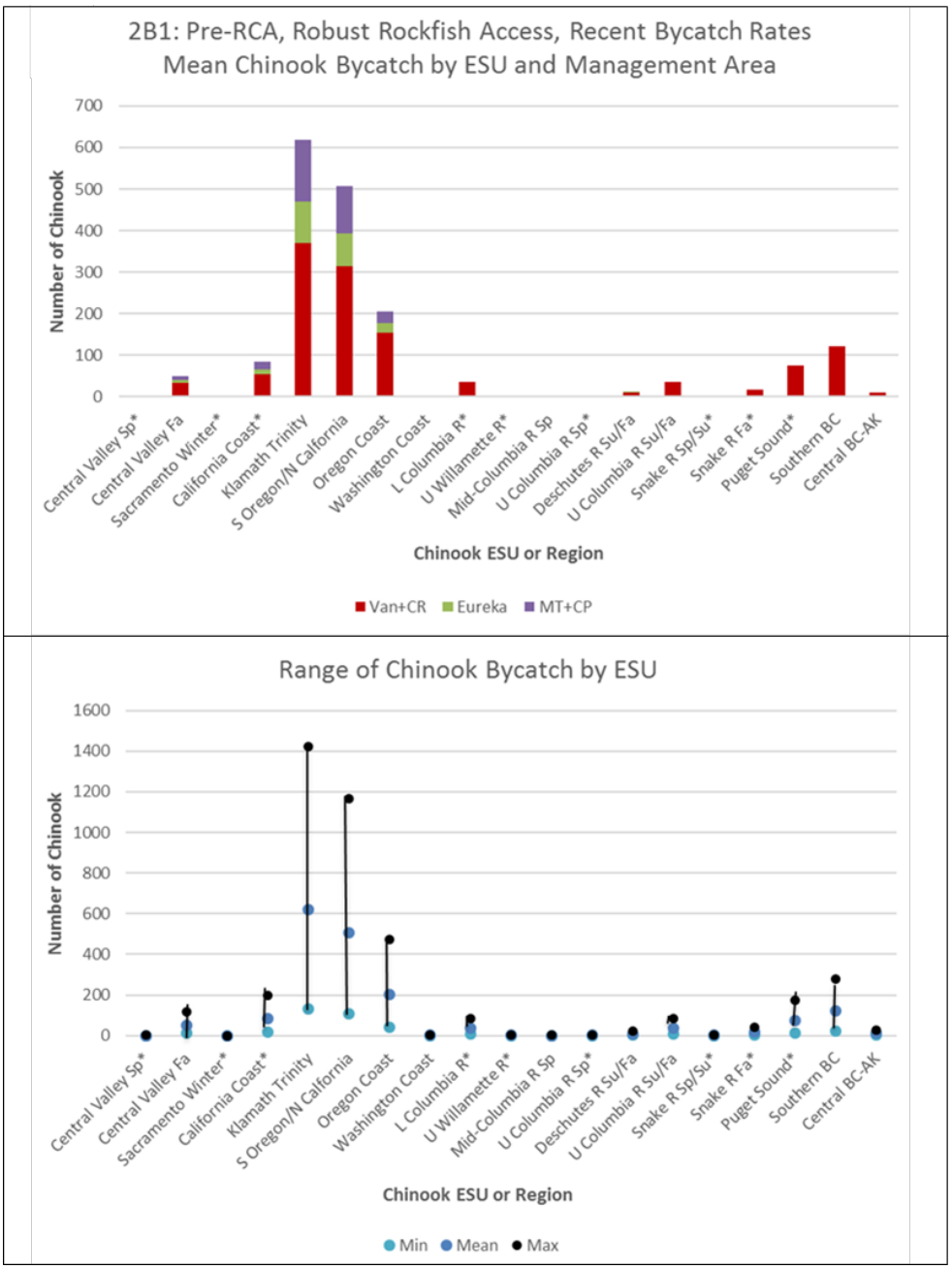

Figure 4. Plots of estimated bycatch in numbers of Chinook and distribution in the non-whiting fishery based on the mean and range of annual bycatch for Scenario 2B1 as presented at the March 2017 Council meeting (pre-RCA, recent bycatch rates, NMFS 2017). The upper figure shows estimated mean annual bycatch by ESU and management area. The bottom figure shows the range of estimated annual impacts by ESU. ESUs listed under the Endangered Species Act are starred.