NATIONAL MARINE FISHERIES SERVICE ON EXEMPTED FISHING PERMITS

The National Marine Fisheries Service (NMFS) is providing this report to update the Pacific Fishery Management Council (Council) on the 2018 trawl gear EFP, and provide information on the sampling protocols used by the West Coast Groundfish Observer (WCGOP) and the Catch Monitor Programs.

Trawl Gear EFP

The 2018 Trawl Gear EFP began on January 1, 2018. NMFS held an open enrollment period for the EFP from November 15-30, 2017. A total of 42 vessels notified NMFS of their interest to participate in the 2018 trawl gear EFP and all vessels were permitted. Eight of the 42 vessels said they would consider fishing south of 42° North latitude.

At its March 2018 meeting, the Council recommended that NMFS reopen enrollment to allow interested vessels to join the EFP in the area north of 42° North latitude only. NMFS reopened enrollment through a public notice[1] on March 14, 2018 and closed enrollment two and a half weeks later. Five additional vessels joined in the trawl gear EFP for 2018 bring the total number of vessels permitted to 47.

As of April 5, 2018, 14 vessels have participated in the Trawl Gear EFP during the 2018 fishing year, with 2 vessels using both bottom trawl and non-whiting midwater trawl on their EFP trip. These 14 vessels have caught 176 Chinook salmon, no eulachon or sturgeon, and 6,780,117 pounds of groundfish in the EFP. Of the 176 Chinook salmon caught so far in 2018, 2 were caught north of 42° North latitude and 174 south of that line (See Table 1).[2]

Table 1. Summary of trawl gear EFP and non-EFP, non-whiting midwater trawl catches for the 2018 fishing year (as of April 5, 2018).

Region	Group	# of Vessels	Trips	Chinook (#)	Eulachon	Sturgeon	Groundfish Weight (lbs)	Groundfish Revenue ($)
N of 42	Bottom Trawl Vessels	4	15	0	0	0	766,581	$533,906
	Midwater Trawl Vessels	9	65	2	0	0	5,446,295	$1,670,288
S of 42	Bottom Trawl Vessels	2	10	174[2]	0	0	444,523	$268,817
	Midwater Trawl Vessels	1	3	0	0	0	122,718	$41,158

[1] http://www.westcoast.fisheries.noaa.gov/publications/fishery_management/groundfish/public_notices/nmfs-sea-18-07.pdf

[2] 173 Chinook from the large bycatch event south of 42°N. lat. were not counted toward the 80 fish limit south of 42°N lat. per the Council's motion at the March 2018 meeting, because although they were caught on an EFP trip, no EFP exemptions were used.

On March 1, 2018, a vessel in the EFP had a large bycatch event of 173 Chinook salmon south of 42° North latitude and seaward of the RCA. This bycatch event was discussed at the March Council meeting and raised questions about salmon sampling procedures for large bycatch events. During those discussions there appeared to be some misconceptions about the current sampling protocols that are in place. Therefore, the Council requested that NMFS return in April with information on (1) the current sampling protocols in place, particularly as they pertain to high salmon bycatch events, and (2) what can be done if there is another large bycatch of salmon on a trawl gear EFP trip or in another groundfish fishery to increase the amount of information collected. Finally, NMFS has included preliminary results from analysis of the ESU composition of the EFP bycatch event, as well as other salmon samples collected south of 42° North latitude in 2017 and 2018.

Salmon Sampling Protocols

Below is a table summarizing current sampling protocols for the At-sea Hake Observer Program (A-SHOP), West Coast Groundfish Observer Program (WCGOP), and the Catch Monitoring (CM) Program. Procedures for selecting a species composition sample are described below.

Table 2. Summary of CURRENT sampling protocols and information collected on salmonid bycatch in the groundfish trawl fisheries.

Data Point	A-SHOP	WCGOP	CM
Species ID	All salmon in species comp sample	All salmon encountered	All salmon encountered
Count	All salmon in species comp sample	All salmon encountered	All salmon encountered
Weight	All salmon in species comp sample	All salmon encountered	All salmon encountered
Sex	All salmon in species comp sample	All salmon when possible, or min 10 random sample	All salmon when possible, or min 10 random sample
Length	All salmon in species comp sample	All salmon when possible, or min 10 random sample	All salmon when possible, or min 10 random sample
Coded Wire Tag (CWT) and Adipose Fin presence	All Chinook in the sample, or min 25 random sample	All salmon when possible, or min 10 random sample	All Chinook, Coho, Chum, and Steelhead when possible, or min 40 random sample
Fin clip for genetic information	All Chinook in the sample, or min 25 random sample	All salmon when possible, or min 10 random sample	All Chinook when possible, or min 10 random sample
Species verification	Freeze 5 whole specimens of each species in sample	A species identification form for all salmonid species including a photo is required	Photos of 10 specimens of each species.

Note: Minimum sample sizes of 10 will become 25 moving forward. Coho genetic sampling will be added to A-SHOP and CM protocols as well.

Note that during discussions with the various monitoring programs, it was decided to standardize minimum sample sizes across programs. Going forward all programs will strive for a minimum of 25 genetic samples for Chinook when they are found in high numbers and the observer or catch monitor is unable to sample all individuals. Therefore, in Table 2 minimum sample sizes of 10 will become 25 moving forward. This may not be possible under all scenarios and may come at the expense of other sampling duties of lower priority.

The majority of salmon encountered in the at-sea hake fishery are Chinook salmon. Due to the large volume of catch in this fishery, A-SHOP observers randomly select 50% of each haul to sample for bycatch. A-SHOP observers are instructed to sample all Chinook in the species composition sample for both CWTs and genetics. If the observer is overwhelmed with Chinook salmon in a particular haul and is not able to sample all of them for both CWTs and genetics, they are instructed to select a random subsample with a goal of 25 samples per haul.

WCGOP observers, which are deployed at-sea in the non-hake shoreside trawl fishery, and the CMs which monitor landings at the dock, collect basic information on all salmon encountered, including species ID, count, and weight. WCGOP observers and CMs endeavor to collect additional biological information and genetic samples from all salmon encountered. However, when the observer or CM is overwhelmed by the number of salmon or other sampling duties, the observer and CM are instructed to collect biological samples from a subsample instead, targeting a minimum of 10 per haul (in the case of observers) or 10 per delivery (in the case of CMs). The CM was following this protocol for the delivery of the large salmon bycatch event in the EFP on March 1, 2018. **WCGOP and the CM Program will now be revising their protocols to match the A-SHOP protocols and target a minimum sample of 25 Chinook and Coho per haul or delivery for genetic sampling.**

NMFS uses these scientifically valid subsampling protocols throughout its data collection programs to collect robust catch and bycatch information to inform management decisions. The current protocols account for all salmon bycatch in the groundfish trawl fishery and provide sufficient genetic information for the NWFSC's estimates of bycatch of individual salmon populations. We do not believe additional changes to the protocols are needed at this time. However, we understand there is interest in getting as much information as possible about bycatch in the gear EFP south of 42° North latitude. Therefore, if other management partners are interested in collecting additional data from the salmon caught in the EFP, we would be willing to accept additional assistance in sampling salmon during the offload. If this is not possible, we can assist in efforts to have the first receiver store the salmon until our management partners can collect them.

Large bycatch events of the magnitude seen in the Trawl Gear EFP on March 1, 2018 are very rare, as was described in the NMFS presentation, under Agenda Item H.8 at the March 2018 Council meeting. Since the start of the Trawl Rationalization Program in 2011, there have been 2,679 fish tickets that reported Chinook salmon. Of those tickets, only five percent (141 tickets) had more than 25 Chinook salmon. Of those 141 tickets, only 22 had more than 100 Chinook salmon.

In waters off California, where the EFP large bycatch event occurred, 43 IFQ tickets have reported Chinook salmon since 2011. Of those 43 tickets, prior to March 1, only one ticket had more than 25 salmon. The EFP event was the largest bycatch of Chinook salmon off of California since the

start of the Trawl Rationalization Program, and accounts for almost half of all Chinook caught in the trawl fishery in California since the start of that Program.

Across the various monitoring programs, sampling is quite robust. Since the catch share program was implemented in 2011, all Chinook salmon are sampled for genetic information (census) in approximately 85% of observer samples and shoreside offloads. This amounts to an average of almost 4000 chinook genetic samples taken annually coastwide.

Preliminary Results from Genetic Analysis of Salmon Samples South of 42° North Latitude

For almost 10 years, NWFSC has been studying the ocean distribution of Chinook salmon ESUs in bycatch associated with the at-sea sectors of US West Coast Pacific hake fishery. Each year, NWFSC scientists analyzed random sub-samples of several hundred fin clips take by the NOAA At-Sea Hake Observer Program (A-SHOP). Over time, we built a significant body of data and eventually showed a series of strong latitudinal clines for ESU abundance in bycatch. Consistent with general knowledge from coast-wide CWT recoveries, each ESU had a characteristic distribution (figs. 1 and 2). Northern and Columbia River ESUs dominated bycatch in the north and southern areas and coastal ESUs were more abundant in southern and central bycatch. We found that other factors could also influence ESU composition, but latitude was by far the strongest and most consistent.

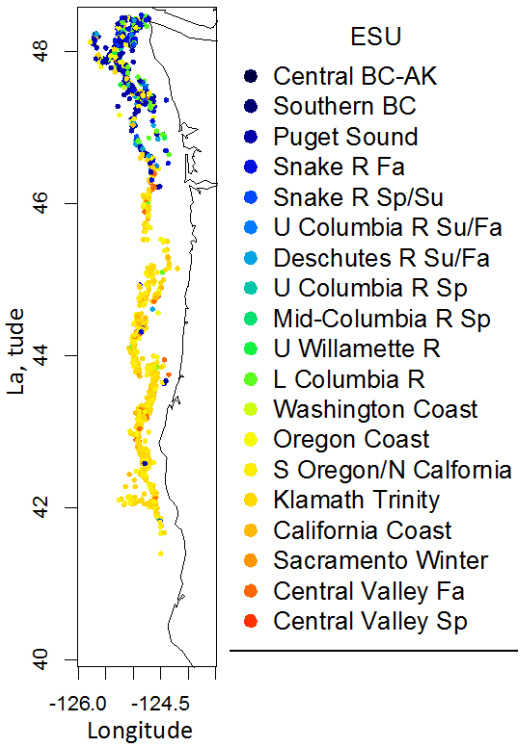

Figure 1. Distribution of Chinook salmon ESUs in bycatch from the at-sea sectors of US West Coast Pacific hake fishery 2008 – 2015. ESUs color coded from blue in the north to red in the and south showed a strong effect of latitude in at-sea bycatch.

We used multinomial logistic regression (MLR) to develop a predictive model for ESU composition as a function of mean latitude for a particular group of samples (Fig. 2). Extensive

ground-truthing through independent cross validation was conducted in the context of NOAA's recent Biological Opinion and Section 7 Consultation Regarding the Pacific Fisheries Management Council's Groundfish Fishery Management Plan (results not shown). Those analyses and results are now being finalized for publication.

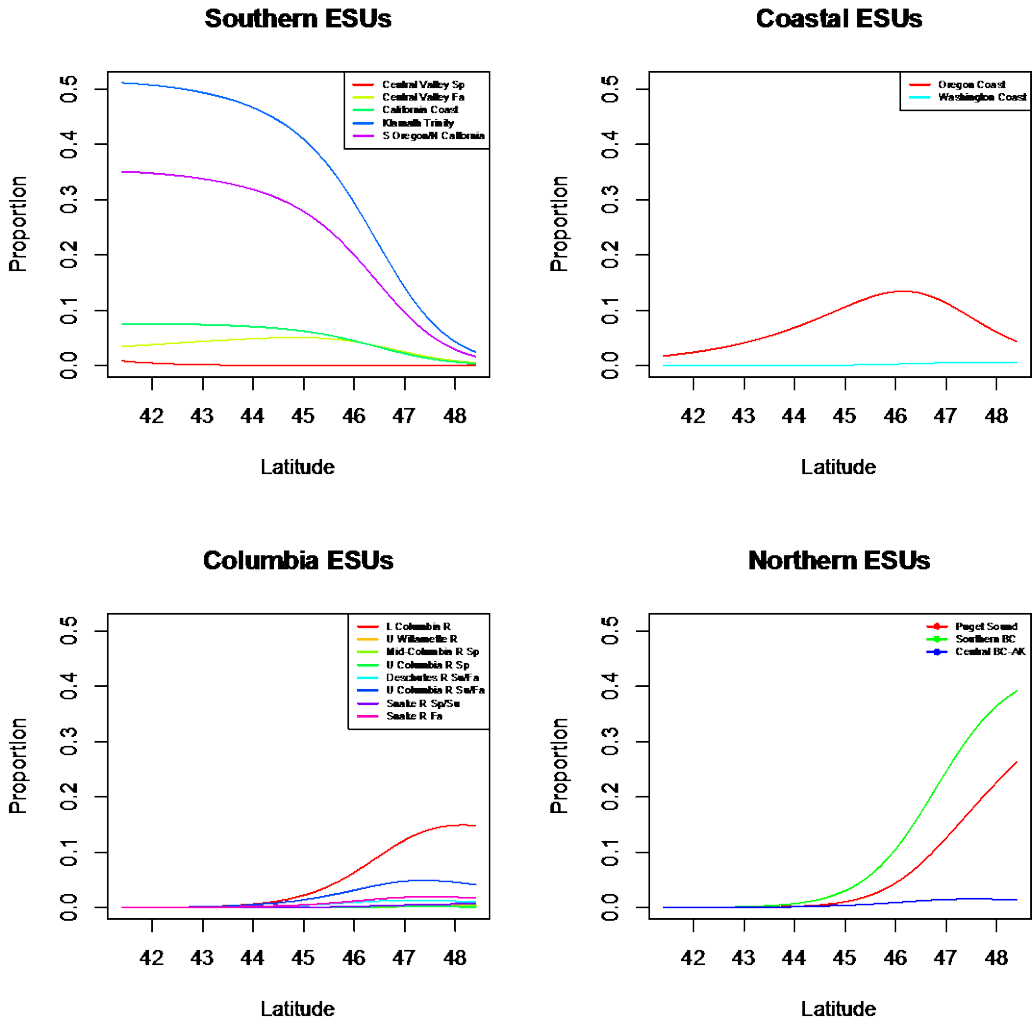

Figure 2. Multinomial logistic regression plots relating ESU proportion at given latitude were derived from 8 years of bycatch sampling in the at-sea sectors of the US West Coast Pacific hake fishery. Those predictive models were used to frame expectation and help inform likely ESU composition in bottom trawl and EFP fisheries south of latitude 42, where essentially no stock-composition data are available.

In the current study, we had two specific goals: 1) Infer the numbers of Chinook salmon from each ESU taken in the "Lightning Strike" haul, and 2) Examine ESU composition in bottom trawl and exempted fishery permit (EFP) fisheries south of latitude 42.

Materials and Methods

From recent tissue collections (2017 and 2018) the following Chinook salmon samples were identified to be included in the current analysis: 49 from bottom trawl/EFP (including the Lightning Strike sub-sample of 10 fish), 16 from shoreside hake, and 31 from the California halibut

fishery. Metadata included length, weight, sex, mark status, fishery, gear, date, location, depth, trip and haul ID, vessel name, and fish ticket number. Only date, location, and fishery were considered in this preliminary analysis.

DNA was extracted by membrane capture, and genotyping was carried out using the internationally standardized GAPS microsatellite markers (Moran et al. 2018). By using conditional maximum likelihood mixture modeling analysis, we carried out two classes of genetic mixture analysis, individual fish assignments (maximum a posterior probability of group membership) and fitted proportions of contributing ESUs (providing a more robust and unbiased estimate than a simple tally of individual assignments). The individual assignments were the primary result for the 10 samples of the Lightning Strike, but to address the issues of the small sample size in the bycatch event, we conducted two additional analyses for comparison. First, we estimated ESU composition at the latitude reported for the Lightning Strike by using the latitudinal regression model derived from samples from the at-sea hake fishery. (This model includes very few southern samples.) Second, we used the 2017 and 2018 bottom trawl/EFP samples from south of latitude 42 to develop an estimate of ESU composition (fitted proportions) from this specific fishery in this region. This would give us two independent comparative estimates, albeit crude, for the likely composition of Chinook salmon ESUs taken in the Lightning Strike, as well as likely composition of future bycatch in these fisheries.

Results

Despite some technical difficulties related to sample quality, we successfully genotyped and assigned the following samples to putative ESU: 30 from bottom trawl and EFP, 6 from shoreside hake, and 31 from the California halibut fishery (Table 3). Average assignment probability was high for the samples that were genotyped successfully (>0.98). Samples that failed, typically failed completely. We have revisited our collection and training materials to assure that Observers and Samplers are using methods to obtain the best quality samples possible.

Table 3. ESU counts of individual fish assignments for three sample sets (note that the 9 Lightning Strike samples represent a subset of the bottom trawl/EFP sample set, see text)

Lightning Strike haul	N	Mean latitude
California Coastal	1	
S. Oregon and N. California Coastal	2	
Upper Klamath-Trinity Rivers	6	
Total	9	41.8375
Bottom trawl and EFP S of 42		
California Coastal	3	
Central Valley Fall	5	
S. Oregon and N. California Coastal	5	
Upper Klamath-Trinity Rivers	17	
Total	30	41.3928
Shoreside hake Eureka and Ft Bragg		
California Coastal	1	
S. Oregon and N. California Coastal	1	
Upper Klamath-Trinity Rivers	4	
Total	6	<42.00
CA Halibut (all S of 38)		
Central Valley Fall	31	
Total	31	37.7282

As an alternative description of the likely ESU composition of the 173 Chinook salmon in the Lightning Strike haul, as well as to inform more general ESU-specific impacts in this region (e.g., in future bycatch events), we present counts based on modeled predictions from multinomial logistic regression (MLR) and also from fitted ESU composition estimates for the 30 bottom trawl/EFP samples that we analyzed here (Table 4).

Table 4. Modeled estimate of ESU proportions from multinomial logistic regression (MLR) at the latitude of the Lightning Strike haul (41.838). Specific numbers of Chinook from different ESUs are reported here based on the MLR estimate, actual observation of individual assignments (for the 9), and finally for the 173 total assuming either the MLR distribution and also the observed distribution among 30 bottom trawl/EFP fish that were successfully genotyped.

ESU	MLR Est	MLR est Sample (9)	**Observed Sample (9)**	MLR est Haul (173)	Assuming dist obs in 2017-2018 Haul (173)
Sacramento W	N/A	N/A	**0**	N/A	0
Central Valley Sp	0.0056	0	**0**	1	0
Central Valley Fa	0.0371	0	**0**	6	28
California Coast	0.0759	1	**1**	13	17
Klamath Trinity	0.5088	5	**6**	88	99
S Oregon/N CA	0.3490	3	**2**	60	28
Oregon Coast	0.0221	0	**0**	4	0
Washington Coast	0.0000	0	**0**	0	0
L Columbia R	0.0003	0	**0**	0	0
U Willamette R	0.0000	0	**0**	0	0
Mid-Columbia R Sp	0.0000	0	**0**	0	0
U Columbia R Sp	0.0000	0	**0**	0	0
Deschutes R Su/Fa	0.0002	0	**0**	0	0
U Columbia R Su/Fa	0.0005	0	**0**	0	0
Snake R Sp/Su	0.0000	0	**0**	0	0
Snake R Fa	0.0001	0	**0**	0	0
Puget Sound	0.0000	0	**0**	0	0
Southern BC	0.0003	0	**0**	0	0
Central BC-AK	0.0001	0	**0**	0	0

In comparing the ESU composition estimated from MLR versus that observed in 2017 – 2018 bottom trawl/EFP samples from south of latitude 42, it appeared that the model may be under estimating Central Valley fall contribution and over estimating S Oregon/N California (Fig. 3).

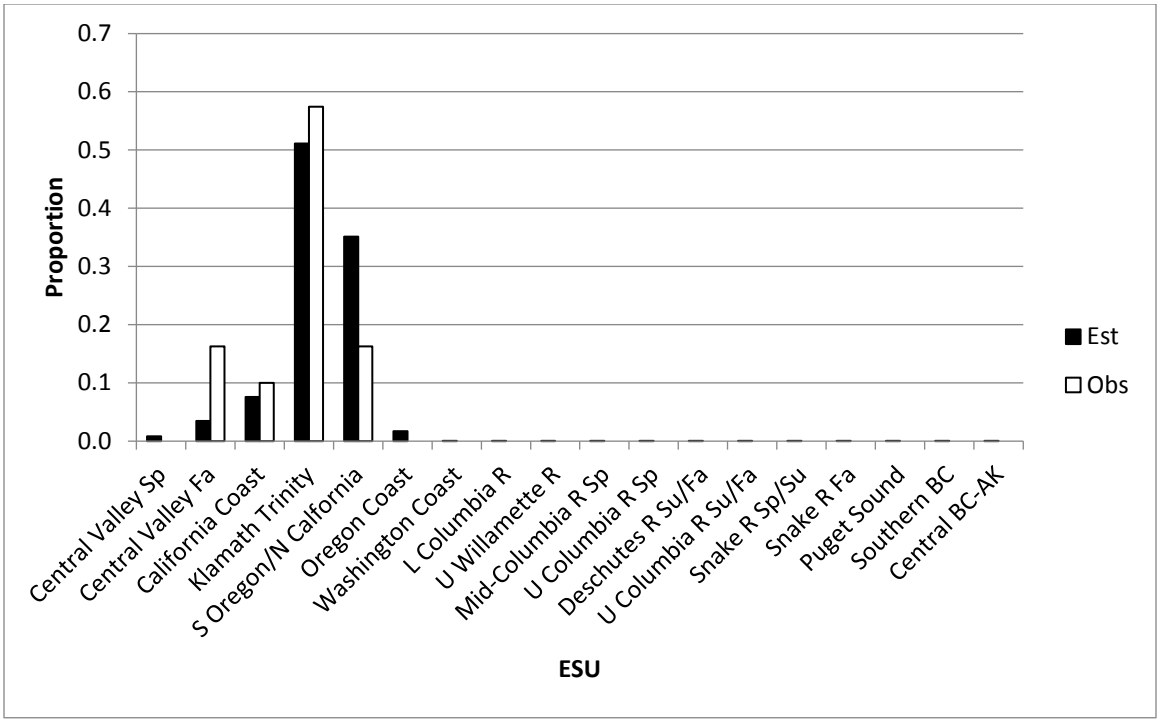

Figure 3. ESU composition for 30 bottom trawl/EFP samples (2017 – 2018, south of latitude 42) including an estimate derived from the at-sea latitudinal regression model (Est) as well as the observed composition (fitted proportions) based on the current genetic mixture analysis (Obs).

Discussion

In this study, we sought to estimate bycatch impacts in bottom trawl and EFP fisheries south of latitude 42. We used genetic mixture analysis to assign individual Chinook salmon to their putative ESU of origin and counted the specific numbers of fish from each ESU. Because the sample sizes are small, we conducted additional analyses to estimate the proportion of fish likely to be from each ESU. Almost nothing was known about ESU-specific impacts in non-hake groundfish fisheries so we applied information from study of the at-sea sectors of the US West Coast Pacific hake fishery to the bottom trawl/EFP samples analyzed here.

Our MLR prediction for the ESU composition of nine fish sampled from the Lightning strike estimate was close to the observed proportions from that small sample. Recognizing the limitations in a sample of 9 fish, we also offer estimated numbers for the total bycatch event of 173 based on two different potential distributions, one from MLR and the other from the distribution observed in the bottom trawl/EFP samples that we analyzed in the current study from the same region. Those two approaches allowed us to compare (preliminarily) the compositions observed in bottom trawl/EFP bycatch with those observed in at-sea bycatch at the same latitude with the estimate from the small sample size from the actual Lighting Haul. Comparison of those estimated and observed distributions suggested that the at-sea model might be under estimating catch of Central Valley fall ESU and over estimating S Oregon/N California in the area south of 42. It might be that, as a general trend, the at-sea fleet encounters fish from the Central Valley fall Chinook salmon ESU at lower rates than the bottom trawl vessels. However, the two results might diverge due to relatively small sample sizes in all our collections. Current, on-going efforts will help resolve this issue.

An additional caveat in the interpretation of our genetic mixture analysis is intra-annual temporal variability in ESU composition. As described above, latitude was found to be the strongest predictor of ESU identity. Yet there are clearly temporal shifts within the year, particularly at smaller scales, likely reflecting migrations of specific life stages. It might be that the group of 173 fish in the Lighting Haul happened to include a migratory cohort, not necessarily indicative of ESU composition over the entire fishing season. It is at that larger scale that the MLR model has been most useful.

Future Directions

Given current management interests, our top priority for genetic analysis in the immediate future is to expand our examination of southern bottom trawl and EFP bycatch samples to include additional years prior to 2017. An equal priority is to analyze as many shoreside samples as possible from Eureka and Ft Bragg (all hauls south of latitude 42). Secondarily, we will analyze random sub-samples from those same collection programs coastwide. These actions will support an immediate assessment of current Chinook ESU impacts of southern bycatch in new and existing fisheries. Further, we will better understand the extent to which the at-sea latitudinal model can be used to make inferences about these non-whiting fisheries. The at-sea model is informed by thousands of observations over an 8-year period. That data set is unquestionably the current benchmark for our understanding of the coastwide distribution of Chinook salmon ESUs in bycatch. This study was an effort to fully exploit that information as we shift focus to the currently poorly-explored bycatch in the bottom trawl and EFP fisheries. Importantly, the extensive sampling across both space and time in the at-sea hake fishery allows robust model estimates of bycatch composition for that fishery; larger samples, again distributed across the southern geography and across years, will be a key component of developing a similarly rigorous model for the bottom trawl fishery.

References

Moran, P., J. Dazey, L. LaVoy S. Young. 2018. Genetic mixture analysis supports re-calibration of the Fishery Regulation Assessment Model. Fisheries. In press