Alaska Fisheries Science Center Gulf of Alaska Resource Assessment Survey Redesign and Optimization: Evaluation of 2025 Survey Results

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Executive Summary

In 2025 a survey redesign was implemented in the Gulf of Alaska (GOA) bottom trawl survey conducted by the Alaska Fisheries Science Center (AFSC). This redesign was developed over several years prior to the 2025 implementation (Oyafuso et al. 2021, Oyafuso et al. 2022) and included a re-stratification of the GOA survey area as well as an adjustment to the allocation method used to randomly assign survey stations across strata. These advancements were made to improve efficiency and were based on optimizing index precision for multiple species sampled within the survey.

The results of the 2025 GOA bottom trawl survey raised concerns that the survey redesign had an impact on the population indices for several stocks assessed by AFSC that use the GOA bottom trawl survey as the primary population index source within the stock assessment. Within this document we present analysis that evaluated the results of the 2025 GOA bottom trawl survey, including the effect of the survey redesign on the derived design-based population index estimates, the distribution of stations across the survey area (particularly the distribution across depth and habitat type), and include a simulation analysis to evaluate impacts of bottom trawl survey station reduction. We show that the population indices that resulted from the 2025 GOA bottom trawl survey are within historical range and produce trends that are consistent with historical index time series. We emphasize that the GOA bottom trawl survey redesign does not induce any bias in the time-series of population indices, but maintains a robust time series of indices provided by the GOA bottom trawl survey that are based upon unbiased sampling designs and provide our best information available to understand population trends for stocks assessed within the GOA. We note that this redesign, while made to improve efficiency and optimize precision, will still result in variable time series for some stocks and, as is the case with any survey design, can produce unexpected results.

Introduction

To ensure time series continuity, both the historical and present GOA survey designs employ an unbiased stratified random sampling method. The creation of the present GOA survey area design consisted of two aspects: 1) a genetic algorithm to determine the placement of stratum boundaries (defined by depth and National Marine Fisheries Service (NMFS) statistical district) and 2) a multispecies optimal allocation algorithm that assigns sampling effort within strata to maximize precision given a fixed number of total trawling stations across a representative set of rockfishes, flatfishes, and gadids in the GOA (see Table 1 for included taxa in the allocation algorithm).

Using the genetic algorithm to determine the placement of stratum boundaries reduced the number of sampling strata (from 59 strata within the historical design to 28 in the redesign), addressing a perennial concern raised in past Center of Independent Expert (CIE) reviews about over-stratification. There are several advantages to this restratification within the GOA bottom trawl survey redesign. Having fewer, larger strata provides the ability to allocate a minimum of 4 stations per stratum which improves the accuracy and precision of the variance estimates for those strata. Historically, the minimum of 2 stations per stratum allocated to smaller long and narrow strata along the upper continental slope often resulted in stratum variance estimates that were highly unstable and less accurate (Cochran 1977). Additionally, the redesign aligned the survey stratum boundaries with current NMFS statistical districts where they hadn't been before under the International North Pacific Fisheries Commission (INPFC) -based stratification. Under the INPFC-based stratification, stock assessment authors were required to request data be combined into subregions aligned with NMFS statistical districts. This alignment created biased abundance estimates due to ignoring necessary post-stratification adjustments (Oyafuso et al., 2022); realigning the strata with the NMFS districts eliminated this necessity.

Simulations by Oyafuso et al. (2021; 2022), based upon historical data from the GOA bottom trawl survey, confirmed the GOA bottom trawl survey redesign is unbiased and comparable to previous estimates. These simulation studies found that the GOA bottom trawl survey redesign maintains or improves the accuracy and precision of population indices and associated variances compared to the historical design for the taxa listed in Table 1. Moreover, the redesign is highly flexible, allowing effort allocation to adapt to future changes in species distribution or stock assessment requirements or as dictated by unavoidable survey effort reduction (Anderson et al. 2023).

While these simulation studies aided in the development of the GOA bottom trawl survey redesign, upon implementation in 2025 several questions arose based upon the results of the survey. The origins of these questions ranged from internal AFSC discussions to questions from GOA Groundfish Plan Team, SSC, and NPFMC members as well as from stakeholders and members of the public. These questions generally were related to the following topics:

- Consistency of the redesign with historical GOA bottom trawl survey results
- Species-type increases/decreases in 2025 population indices
- Impacts of GOA bottom trawl survey 2025 effort reduction

Within the following sections we provide analyses to address questions raised pertaining to each of these topics.

Consistency of the redesign with historical GOA bottom trawl survey results

The spatial grid overlay most recently in place to support a stratified random survey of the GOA was created in 1984 and utilized the INPFC statistical districts and NOAA bathymetry available at the time it was created (referred to as the "1984 design" in this document). The GOA resource assessment survey was conducted under various sampling designs and spatial representations from 1953 through 1983. Trawl gear and operating procedures were then standardized in 1990, which is the starting year for GOA bottom trawl survey population index time series used in stock assessment models as recommended by the GOA Groundfish Plan Team. Oyafuso et al. (2022) developed a new approach that optimized stratification of the GOA grid using updated bathymetry of the region (Zimmermann et al. 2025) and the present NMFS statistical districts instead of the INPFC statistical districts (Figure 1, Table 2). This redesign aligned GOA survey strata to existing NMFS statistical districts, improved efficiency of conducting the biennial survey (with higher quality data for the same historical effort in terms of reducing uncertainty in estimates), and increased the robustness of the survey design to future unavoidable changes in survey effort or unanticipated shifts in data or stock assessment needs. For additional information on the comparison between the historical and current designs please see the presentation made to the GOA Groundfish Plan Team in November 2024 (found at this link).

At the September 2025 Groundfish Plan Team meeting during the discussion of the 2025 GOA bottom trawl survey results there was concern as to whether observed changes in 2025 survey abundance estimates were the result of actual trends or the change in survey design. This concern was echoed at the December 2025 meeting of the SSC and NPFMC. To address these concerns, it was proposed to post-stratify historical sampling to match the 2025 bottom trawl survey restratification to determine how comparable estimates would be across the two stratification schemes.

To assess how the restratified survey design might have impacted historical biomass and abundance indices for GOA stocks, we employed a two-step reanalysis. First, historical hauls were spatially reassigned to the strata under the new survey design. Second, we utilized the “survey” R package (Lumley 2026) to re-calculate total survey biomass/abundance and associated variances using post-stratified weights to correctly account for differences in stratum inclusion probabilities of the post-stratified stations. These differences in stratum inclusion probabilities arise in post-stratification because the original inclusion probabilities were based upon the historical strata characteristics and need to be adjusted recognizing that the inclusion probability would have been different given the new strata use in the 2025 redesign. Once these stations were reassigned to the new strata and the post-stratified weights were determined, we recalculated total survey biomass and abundance across the GOA-wide region as well as GOA management subregions (Western, Central, and Eastern GOA). Data used in this analysis included historical haul-level area-swept CPUE (in kg per km^2 for biomass estimation and in numbers per km^2 for abundance estimation) from the AFSC GOA bottom trawl survey. The time-series of the surveys investigated were triennially from 1990-1999, then biennially from 2001-2023. We applied the post-stratification analysis to all Tier 5 and above stocks in the GOA (Table 3).

Results of the post-stratification analysis for each of the Tier 3, 4, and 5 stocks are provided in a Shiny app (found at this link). Reanalysis of the historical GOA bottom trawl survey time-series reveals high consistency between the original time-series and the original time-series post-stratified under the new design, both at the GOA-wide and subregional spatial scales (comparison of GOA-wide biomass across Tier 3 and 4/5 stocks is shown in Figure 2). Among stocks, generally the GOA-wide biomass and abundance estimates align most closely during periods of lower magnitude, with minor divergence occurring during peak years. Given the high overlap in the 95% confidence intervals across all stocks and index types (i.e., biomass or abundance), these divergences do not appear to be statistically meaningful.

The remarkable consistency resulting from the reanalysis indicates that the new design continues an unbiased design for the GOA bottom trawl survey and is functioning as intended. Mismatches between the original and post-stratified estimators are to be expected given the random nature of the sampling process. For species with inherently patchy distributions (e.g., rockfish), no stratification design can fully overcome inherent sampling variability that translates through to survey indices. Furthermore, for such species, within a reanalysis of historical survey indices it is statistically impossible to disentangle the effects of the restratified survey design from the natural variability and "zero-heavy" skewed catch data associated with their distributions.

Species-type increases/decreases in 2025 population indices

Within the results of the 2025 GOA bottom trawl survey, it was noted that there appeared to be a consistent increase in flatfish stock population index data and a consistent decrease in rockfish stock population index data compared to the population index as determined by the 2023 GOA bottom trawl survey. To address this observation, we evaluated correlation among stocks, as well as investigated historical trends in population index changes from one survey to another to investigate whether this result was unique to the 2025 survey or occurred previously .

Correlation among species groups from the 2025 GOA bottom trawl survey were consistent with observations in previous survey years, indicating that the change in survey design did not produce unexpected results (Figure 3). In the historical time series prior to 2025 (1990-2023), there have been years when abundance of most rockfishes increased and that of most flatfishes decreased and vice versa. Spearman correlations in biomass trends over time demonstrate that relative changes in individual stocks of rockfish, flatfish, and gadids from survey to survey over the course of the more than three-decade time series remain consistent. For example, there are positive correlations among species of rockfishes, positive correlations among species of flatfishes, and negative correlations between flatfishes and rockfishes (e.g., a negative correlation between arrowtooth flounder and Pacific ocean perch, as well as other shallower water rockfishes).

Changes in abundance estimates when comparing GOA surveys display a mixture of increases and decreases that alternate during the time series among the flatfish and rockfish stocks (Figure 4). The percent changes from the 2025 survey in the context of the longer time series are well within the historical range of the combined flatfish and rockfish stocks for both the survey-over-survey percent changes and in comparison to the time series mean. While most flatfish versus rockfish stocks either increased or decreased in 2025 compared to 2023, there were exceptions that showed the opposite trends (as shown by points above or below 0 in Figure 4). Further, when comparing the 2025 versus 2023 results to previous survey-over-survey changes, there were years in which the 2025 results were replicated. For example, in the 2007 survey most flatfish stocks increased while most rockfish stocks decreased as compared to the 2005 survey results. By interpreting the present results in the context of the larger time series, it is apparent that the changes in biomass observed in 2025 were within the range of changes observed in previous survey year comparisons. Thus, we conclude that there is no evidence to suggest that the year-over-year changes in biomass among rockfish and flatfish stocks from the 2023 to 2025 survey are attributable to the new survey design used in 2025.

Impacts of GOA bottom trawl survey 2025 effort reduction

The 2025 GOA bottom trawl survey was conducted by two commercial fishing vessels chartered for 75 days each, as has been the historical practice for the GOA bottom trawl survey. Typically, these 75-day charters are split into four legs with approximately 57 fishing days and 18 non-fishing days per boat over the course of the summer. Historically, the average total number of stations was approximately 520 stations conducted over 114 fishing days, which resulted in 4.5 stations per day on average. In 2025, this was adjusted to 4.0 stations per day on average, yielding a total allocation of 450 stations. The GOA survey was not redesigned to reduce the amount of effort needed to characterize the region’s resources but was optimized to be robust to unexpected survey effort reductions, should they occur. Additionally, in 2025 the GOA bottom trawl survey aspired to complete an average of no more than 4 stations/day to mitigate ergonomic injuries. Four stations per day is the current target used in the Bering Sea and Aleutian Islands bottom trawl surveys. The 2025 GOA bottom trawl survey fished a total of 107 days and successfully completed 431 sampling stations.

We note that if provided with resources like those in 2025 for the next GOA survey in 2027, it is likely that a similar level of survey effort would result (4 stations per day on average) with an initial station allocation of 450. If it is determined that a higher level of effort and allocation of stations is required, there are two possible pathways to achieve this requirement. Either an increase in the number of qualified staff to achieve an increased number of stations per day is needed, or the charter duration would need to be increased to >75 days to increase the number of fishing days while maintaining an ergonomically appropriate day rate.

Because of the reduction in the number of stations in 2025, concerns were noted regarding the distribution of GOA bottom trawl survey stations among habitat-types and depth strata. In particular, concerns were raised that less rocky habitat was sampled and that fewer stations were allocated to deeper strata.

As an indicator of the amount rocky habitat sampled, we initially investigated the number of net tear-ups that are caused by rocky seafloor (Table 4). We found that the number of net tear-ups were comparable to historic levels, and although the damage rate was lower in 2025 than the previous two surveys, it was similar to the damage rate during the 2019 bottom trawl survey. Next, we used a rockiness raster from the 2023 EFH Five-Year Review (Pirtle et al. 2023). This raster combines information about seafloor sediments, acoustic backscatter, and historical GOA bottom trawl survey results specifically about hauls where trawl performance was scored to indicate that nets were torn at trawling locations.

A seafloor rockiness surface was developed for the GOA based on a compilation of rock features and sediment attributes to represent a continuous gradient from areas with high occurrence of rocky substrate to areas with low occurrence, following the methods of Pirtle et al. (2019). The following datasets were included for the GOA region: 1) dbSEABED format sediment and substrate features (Golden et al. 2016); 2) sediment and substrate features from digitized smooth sheets (Zimmermann and Prescott 2014, 2015); 3) EBSSED-2 regional selection of samples collected from bottom grabs and cores (Richwine et al. 2018); 4) modeled untrawlable and trawlable seafloor based on a generalized linear model of multibeam acoustic backscatter and terrain metrics available as a 6 m^2 raster dataset (Pirtle et al., 2015) that was re-gridded to 1 km^2 and exported as point locations (model predictions of untrawlable and trawlable locations are proxies for high and low occurrence of rocky substrate); 5) RACE-GAP bottom-trawl survey historic haul locations, including hauls that incurred gear damage from seafloor contact to represent locations where untrawlable rocky features were likely encountered using the corrected start positions of the on-bottom portion of tows; and 6) RACE-GAP bottom-trawl survey grid, using centroid locations for grid cells with codes indicating presence of rocky substrate features (rocky, pinnacles, snags, ledges, bottom too hard) and non-rocky substrate features (sand waves). Compiled point location data from the six datasets was gridded using natural neighbor interpolation to produce raster surfaces of 100 m^2 and 1 km^2 resolution (ArcGIS 10.7, ESRI).

The cumulative distribution of the proportion of GOA bottom survey hauls at each level of rockiness is shown in Figure 5 for each survey since 1990. The 2023 and 2025 GOA bottom trawl survey station allocations resulted in similar levels of interaction with rocky habitat, suggesting that the change in survey design alone did not cause a change in the rate of encountering rockiness level at sampled stations. There are also historical surveys in 1990 and 1993 (grey lines in Figure 5) that had similar rockiness values to both 2023 and 2025. Figure 6 shows the number of stations by depth for each rockiness level. While, as noted, the number of stations in 2025 was smaller than previous surveys, the encounter rate of rocky habitat by depth were proportionally similar to previous bottom trawl surveys in the GOA.

Rockiness and rough bottom tends to be positively correlated with depth as the vessel moves offshore in the GOA survey area. The concern about under-sampling rocky areas could be exacerbated if the new stratification led to under-sampling deeper areas. This concern stems partly from the fact that the new stratification contains larger strata with broader depth ranges than the historic design, so it is theoretically possible that some depth strata that were targeted for sampling under the historic survey design could be under sampled in the new design. In regard to this concern, it should be noted that the GOA bottom trawl survey redesign was developed by creating optimized strata that incorporate depth into their optimization.

The proportional occupation of station depths allocated in 2025 were consistent with those in previous survey years (Figures 7 and 8). Survey years in which 3 charter vessels were deployed and sampled to 1000 m depths stand out (1999, 2005-2009, and 2015), where the remaining survey years were limited to sampling in < 700 m depths (Figure 7). In 2023 and 2025, reduced effort was allocated to sampling at depths between 301-500 m compared with past surveys, and the smallest proportion of stations were allocated to depths between 501-700 m was in 2025 (Figure 8). We note, however, that unlike the 2023 sampling, the 2025 design does not have a dedicated 500-700 m stratum with attendant sample allocation minima. This is because prior analyses (Oyafuso et al. 2021, 2022) demonstrated that sampling strata with broader depth ranges adequately resolved depth-dependent variation in biomass estimates. While the stations were proportionally allocated to the different depth strata consistent with historical surveys, we acknowledge that there were fewer stations allocated to each depth strata compared to past surveys as a consequence of the reduction of the overall number of stations in 2025, particularly for depths >301 m.

To further evaluate the impacts of the 2025 effort reduction in the 2025 GOA bottom trawl survey, we evaluated whether thinning the total number of survey stations might disproportionately impact biomass estimates for different species groups.

A simulation analysis was conducted to evaluate the impact of haul reduction on the resulting changes in biomass estimates from the GOA bottom trawl survey. This analysis was conducted with historical data, in which the number of stations sampled within a given year were reduced from 500 to 200 stations by increments of 50 stations. Within the simulation the stations were allocated to strata based upon the original proportion of stations across strata for a given survey to mimic the allocation employed for that survey. Once the number of stations were determined for a given stratum, the historical stations conducted in that strata were sub-sampled without replacement (i.e., a random subsample of the number of stations conducted was drawn). This new set of resampled stations were then used to estimate the design-based biomass for each stock. The percent difference between the resampled estimate of biomass compared to the original biomass determined from the full set of stations sampled in that given year was computed. The results were categorized by stock type, distinguishing between rockfish, flatfish, and gadid stocks.

Results from the simulation analysis indicate a higher degree of sensitivity to station reduction for rockfish stocks as compared to flatfish or gadid stocks (Figures 9 and 10). For both flatfish and gadid stocks, as the number of stations were reduced in the simulation the percent difference in resulting biomass after reduction as compared to the historical biomass with the full set of stations was, on average, 0%, indicating that as stations are reduced the point estimates for biomass remain unbiased. However, the variability in the percent differences for flatfish and gadids increased, indicating that as stations are reduced it is likely that the point estimates will become more variable for these stocks. In comparison to the flatfish and gadid stocks, the rockfish stocks displayed a skewed distribution in percent differences towards negative values, indicating that as stations are reduced it is more likely that decreases in estimated biomass would result as compared to the point estimate of biomass with the full set of station data. This is particularly true as stations were reduced below 400, where the median percent difference for rockfish stocks became increasingly negative. This result indicates that as stations were reduced below 400-350 stations a negative bias in the estimate of GOA bottom trawl survey biomass for rockfish stocks emerged and became increasingly negative as the total number of stations was reduced. Further, the rockfish stocks displayed a larger range in percent differences as compared to flatfish and gadids, reinforcing the result that these stocks are more sensitive to survey station reductions and as stations are reduced a relatively larger variability in the GOA bottom trawl survey point estimate of biomass would result. This result is not surprising, given that rockfish stocks display a ‘zero-inflated’ distribution of survey catches, meaning that the preponderance of survey hauls have low catches, interspersed with random extremely large catches. As the number of survey stations is reduced, the likelihood that those large rockfish hauls emerge decreases, and it should be expected that variability in survey index point estimates will increase in these scenarios. These results are also replicated in the resulting coefficient of variation (CV) in GOA bottom trawl survey indices (using biomass as an example in Figure 10). As the number of survey stations are reduced, the CV in biomass increased, and increased to a larger extent for rockfish stocks as compared to flatfish or gadid stocks.

Conclusions

The transition to the sampling design employed in 2025 for the GOA resource assessment survey is a critical advancement. It successfully maintains the integrity of the long-term time series while creating a design robust to unavoidable changes in survey effort. We anticipate that this new design can improve the accuracy and precision of the abundance indices and their variance estimates for many species while employing similar levels of survey resources to those used to complete the historical GOA groundfish bottom trawl survey.

Through a variety of analyses we have shown results that support two conclusions. First, we have shown that the redesigned survey had negligible impact on survey results compared to the historic survey design. We have shown that the present survey design conducted in 2025 is within the range of previous surveys, in several characteristics besides index results, including correlation across stocks from survey-to-survey and rockiness of the ground sampled upon. Second, we have made transparent the impact of station reduction on stock type results. It remains difficult to disentangle the impacts of station reduction and true population change, although, our simulation results indicate that more than 400 stations would not induce any bias in the indices for flatfish, gadid, or rockfish stocks. This simulation reveals that fewer than 400 stations increases the risk of bias in survey biomass estimates for rockfish stocks. We emphasize the longstanding understanding that it is difficult to survey rockfish stocks and, thus, rockfish stock indices of abundance have historically been variable, and will continue to be variable. We contend that the high variability of some rockfish stock indices from the 2025 GOA bottom trawl survey was not due to survey redesign but more likely natural variations in fish distributions.

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Tables

Table 1. Taxa included in the species set used for optimizing Gulf of Alaska survey area stratification in Oyafuso et al. (2022).

Species
Pacific halibut (*Hippoglossus stenolepis*)
flathead sole (*Hippoglossoides elassodon*)
Dover sole (*Microstomus pacificus*)
rex sole (*Glyptocephalus zachirus*)
northern rock sole (*Lepidopsetta polyxystra*)
southern rock sole (*Lepidopsetta bilineata*)
Pacific cod (*Gadus macrocephalus*)
walleye pollock (*Gadus chalcogrammus*)
Pacific ocean perch (*Sebastes alutus*)
shortspine thornyhead (*Sebstolobus alascanus*)
rougheye-blackspotted rockfish complex (*Sebastes aleutianus* and *S. melanostictus*)
silvergray rockfish (*Sebastes brevispinis*)
dusky rockfish (*Sebastes variabilis*)
northern rockfish (*Sebastes polyspinis*)

Table 2. Comparison of the 1984 design of the Gulf of Alaska survey area grid and stratification with the updated bathymetry, optimized stratification, and regridding applied in the 2025 design.

GOA bottom trawl survey (1984-2023)	**GOA bottom trawl survey (2025)**
Survey Strata Determination	
Statistical Districts = INPFC statistical districts (note: these are not aligned with current NMFS districts)	Statistical Districts = NMFS statistical districts
ca. 1984 Bathymetry	2025 Bathymetry (Zimmermann et al. 2025)
Stratification: Aligned with INPFC statistical areas, subjectively assigned habitat strata, historically obsolete statistical strata, antiquated bathymetric strata	Stratification: Aligned with NMFS statistical districts, stratum boundaries informed by best-available bathymetry, multispecies optimized stratum areas
Stratified Random Survey Design	
Station Allocation: Single-species Neyman Allocation using weighting factors (from around 2 dozen fish taxa) of Stratum Area, Stratum Variance (abundance), and Ex-Vessel Price	Station Allocation: Bethel Algorithm (Bethel 1989) considers Stratum area and stratum variance (abundance) to optimize allocation while minimizing CVs across a representative set of species (see Table 1 in Oyafuso et al. 2022)
Bathymetric strata: Continuous across entire Gulf of Alaska (e.g., 500-700 m stratum is continuous from Dixon Entrance in the east to Samalga Pass in the west)	Bathymetric strata: Continuous within NMFS statistical districts, but are optimized among those districts (not continuous Gulf-wide and can vary among statistical districts)
Survey Grid: Grid cell boundaries were based on latitude and longitude and so weren't square (lines of longitude get closer together as you move north)	Survey Grid: Based on an equal-area projection so that the 5x5 km grid cells are square and will be continuous with adjacent regions using the same grid reference.
Station Occupation Rules: Inaccurate bathymetry and lack of depth consideration in sampling grid design induced complicated rules for what to do when assigned a depth stratum to sample but the depth assigned wasn't available at the assigned station	Station Occupation Rules: Bottom depth is integrated into the optimized strata so that sampling within an assigned stratum can proceed regardless of the depth under the vessel
Total Survey Footprint/Area: ~320,000 km^2	Total Survey Footprint/Area: ~315,500 km^2 (~1.4% decrease), areas outside of the designated NMFS statistical districts will no longer be sampled (portions of 618 & 659)

Table 3. GOA stocks and complexes included in the post-stratification analysis.

Tier 3	Tier 4/5
Arrowtooth flounder	Big skate
Dover sole	Longnose skate
Dusky rockfish	Other rockfish complex
Flathead sole	Other skates complex
Northern rock sole	Shallow-water flatfish complex
Northern rockfish	Shortraker rockfish
Pacific cod	Shortspine thornyhead
Pacific ocean perch	Spiny dogfish
Rex sole	
Rougheye/blackspotted rockfish complex	
Southern rock sole	
Walleye pollock	

Table 4. Count of Gulf of Alaska bottom trawls coded with net damage (2017-2025) and, specifically, trawls with net damage attributable to each vessel.

Year	No. Hauls w/Net Damage	No. Hauls on AKP with Net Damage	No. Hauls on OEX with Net Damage
2017	17	7	10
2019	7	3	4
2021	15	5	10
2023	14	3	11
2025	9	3	6

Figures

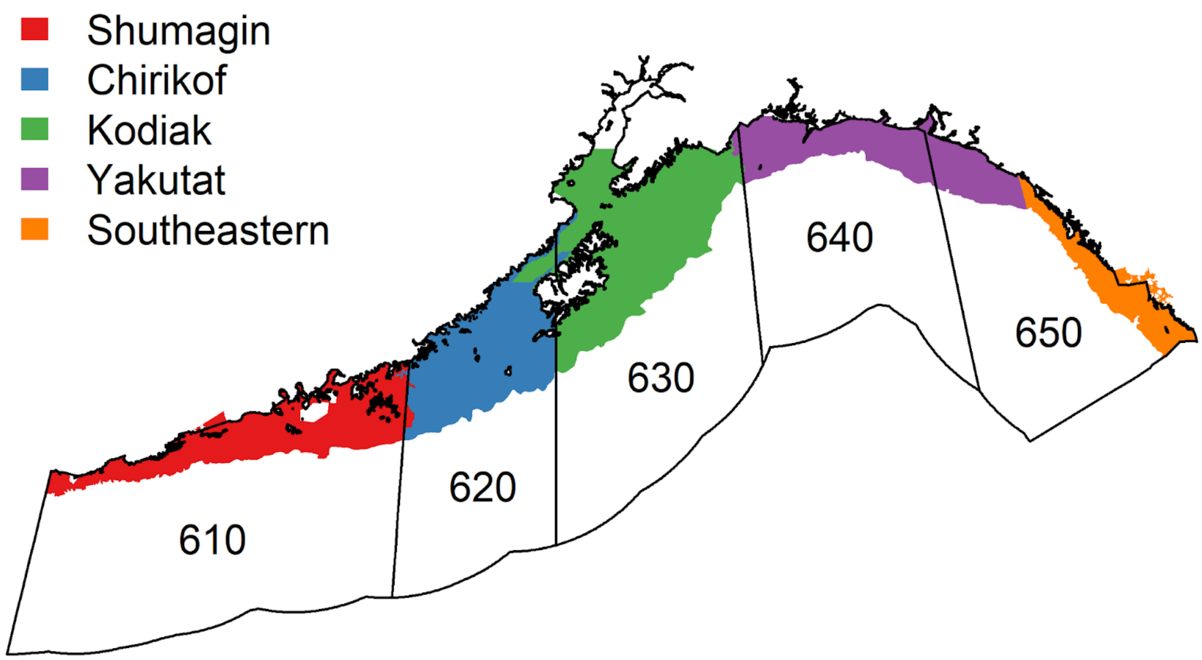


Figure 1. Colored areas represent historical INPFC statistical sampling districts, numbered polygons (black lines) represent NMFS statistical districts defining optimized, restratified survey footprint relative to the historic colored areas.

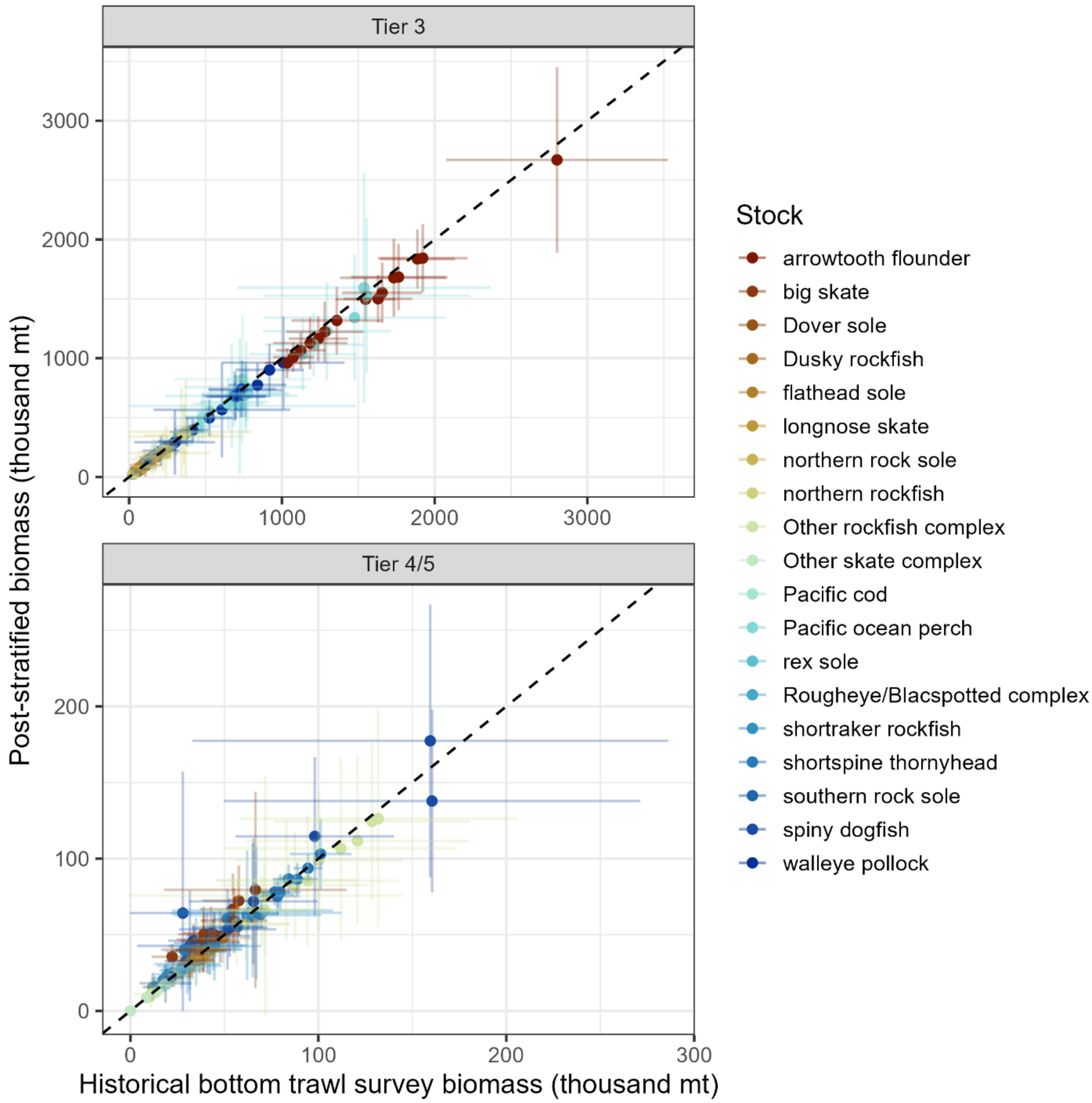
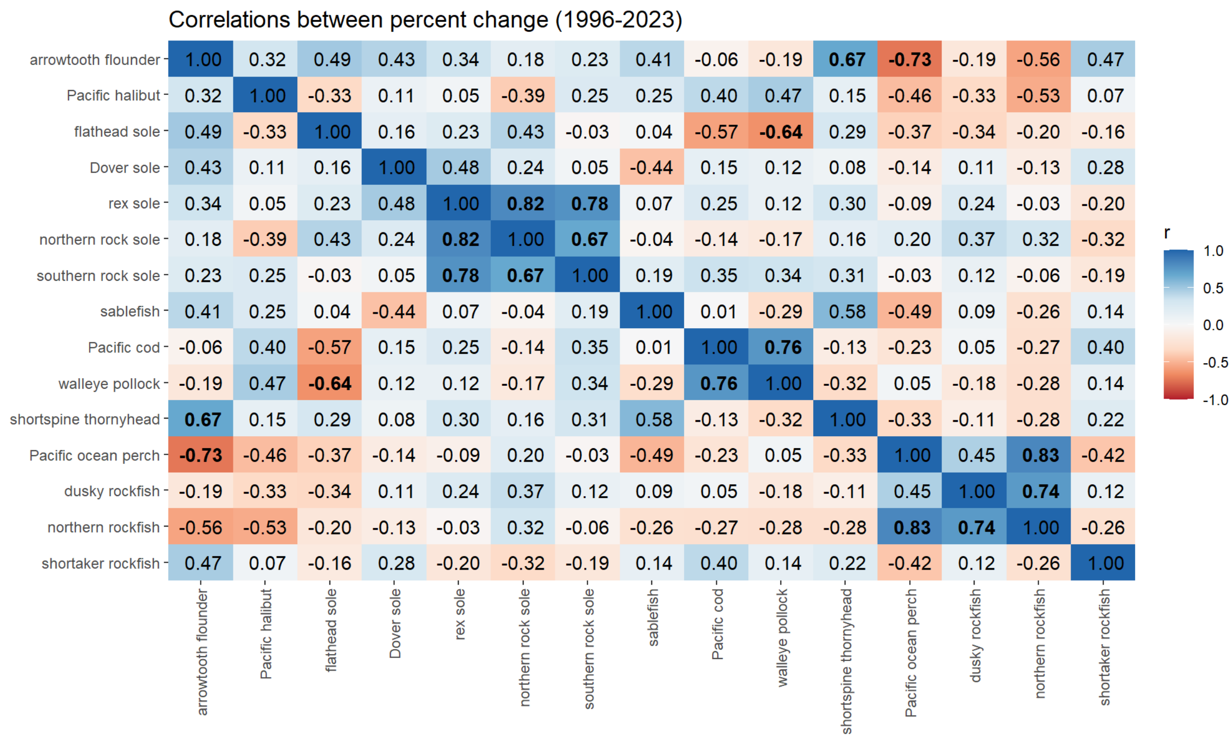


Figure 2. Comparison between historical GOA bottom trawl survey biomass and biomass determined after post-stratifying within 2025 GOA bottom trawl survey redesigned strata (for Tier 3 and Tier 4/5 stocks and complexes assessed by AFSC, shown with 95% confidence intervals).



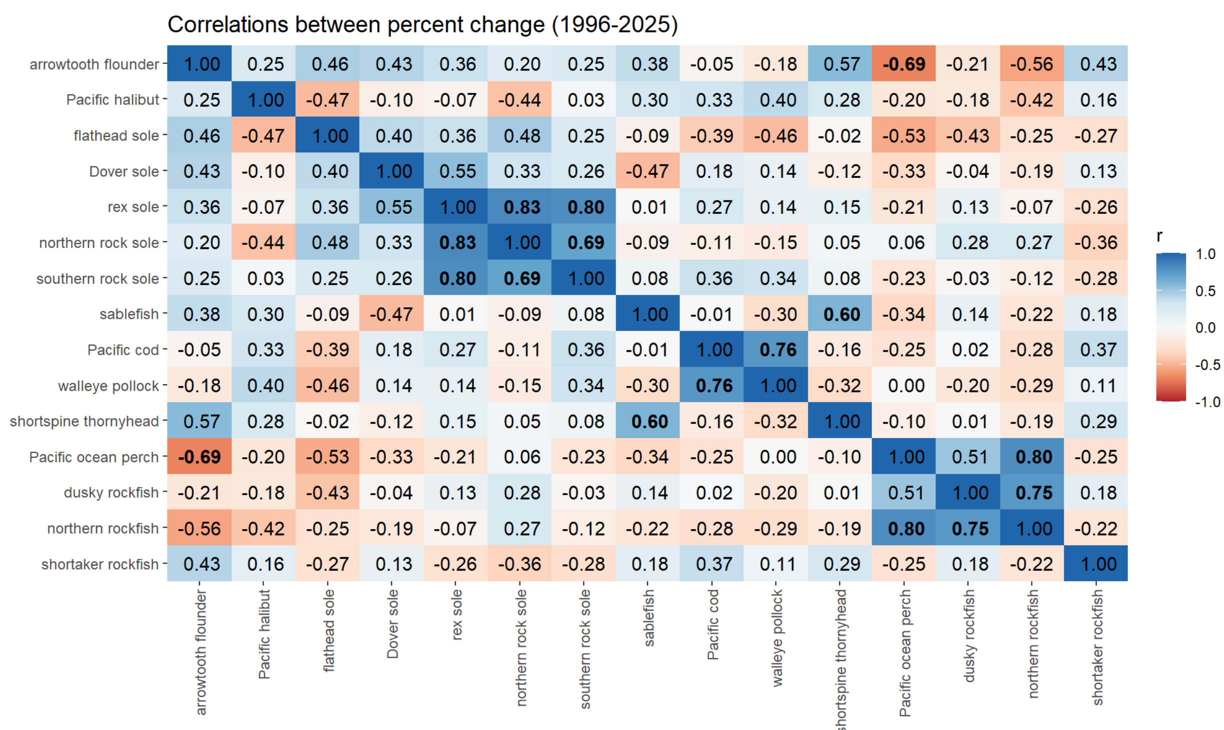


Figure 3. Spearman correlations between percent change in estimated biomass between GOA stocks, using GOA data from 1996-2023 and 1996-2025.

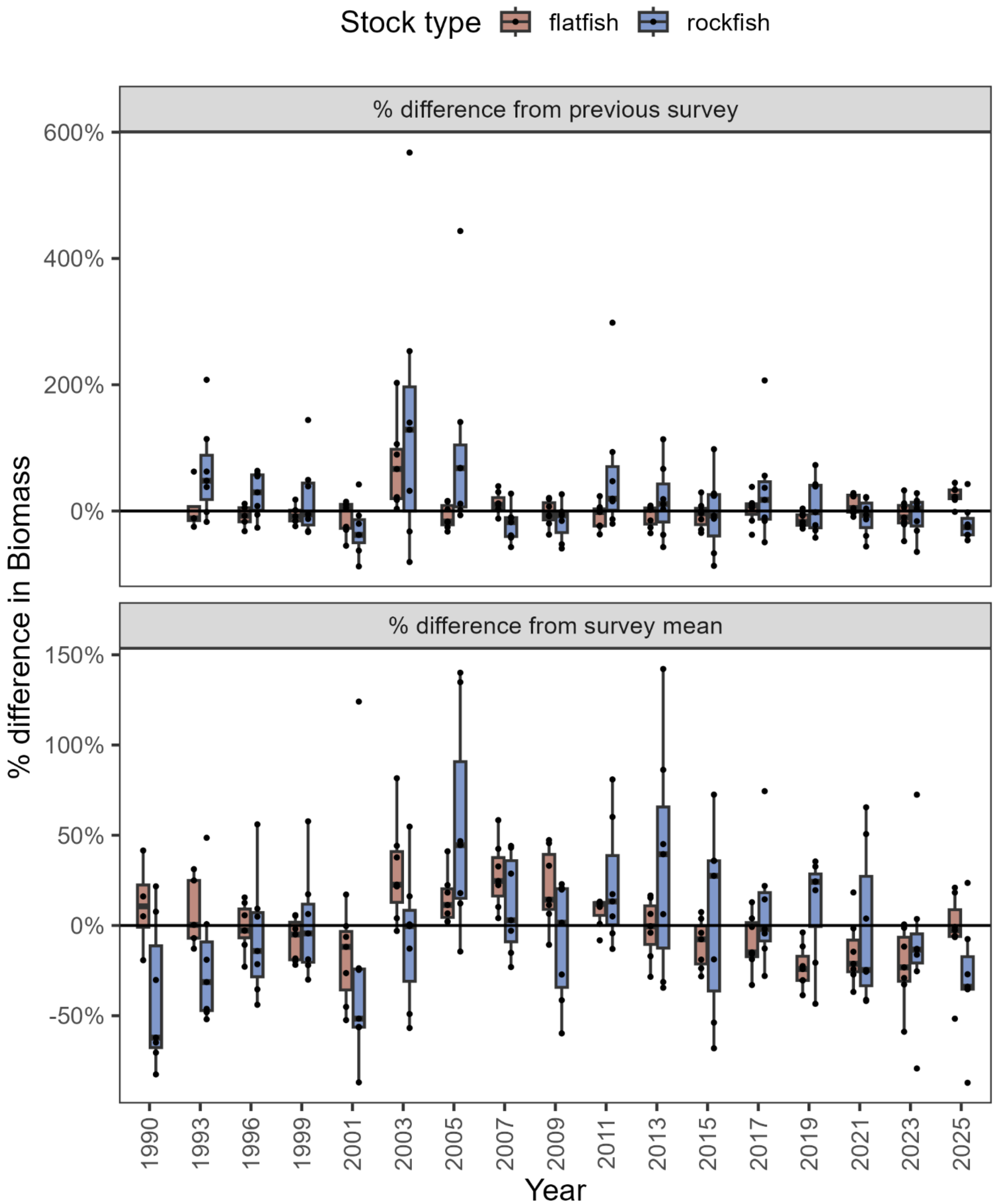


Figure 4. Percent differences in biomass among assessed flatfish and rockfish stocks. The top panel shows percent differences from the previous survey, and the bottom panel shows percent differences from the time-series mean. Each point in this plot represents a stock within the 'flatfish' or 'rockfish' stock type.

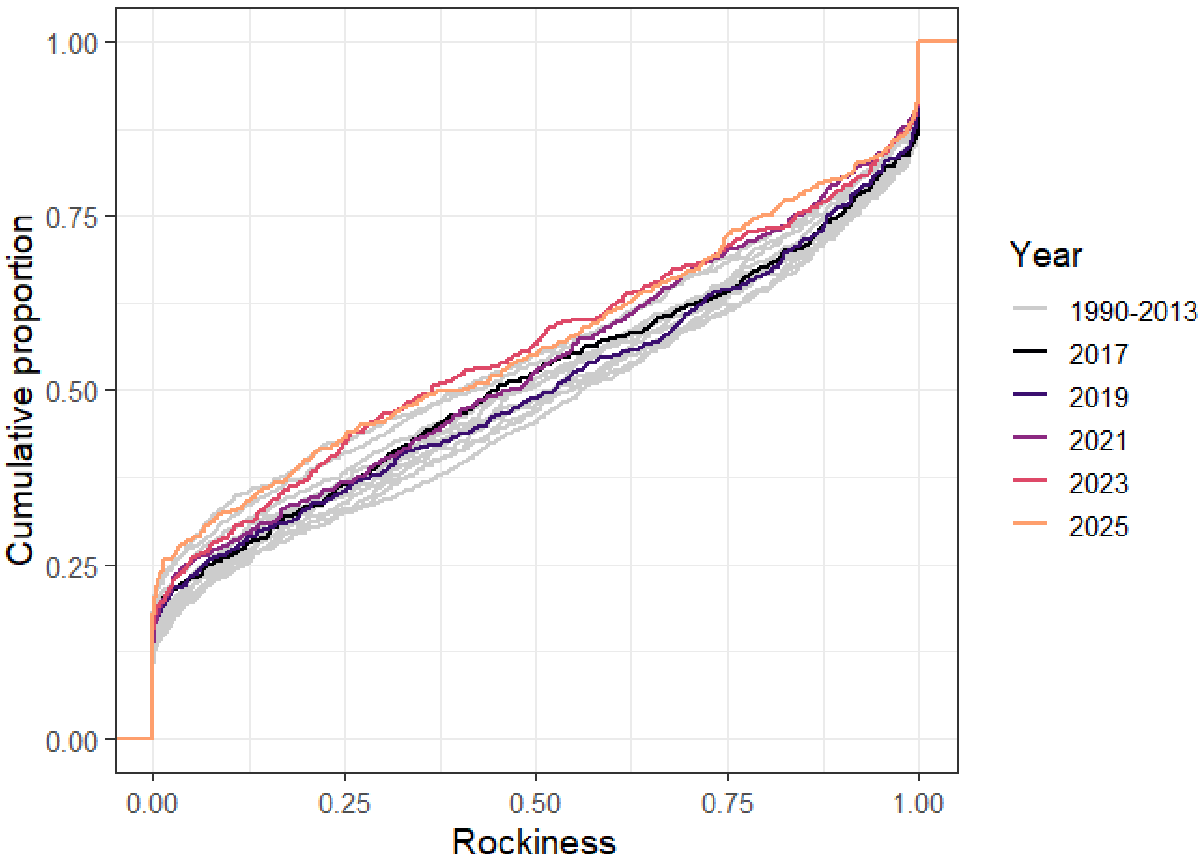


Figure 5. Cumulative distribution of stations sampled for each degree of rockiness. The rockiness index ranges from 0 (not rocky) to 1 (the most rocky). Each point represents the cumulative proportion of GOA bottom trawl survey hauls that had a rockiness value lower than the value on the x-axis.

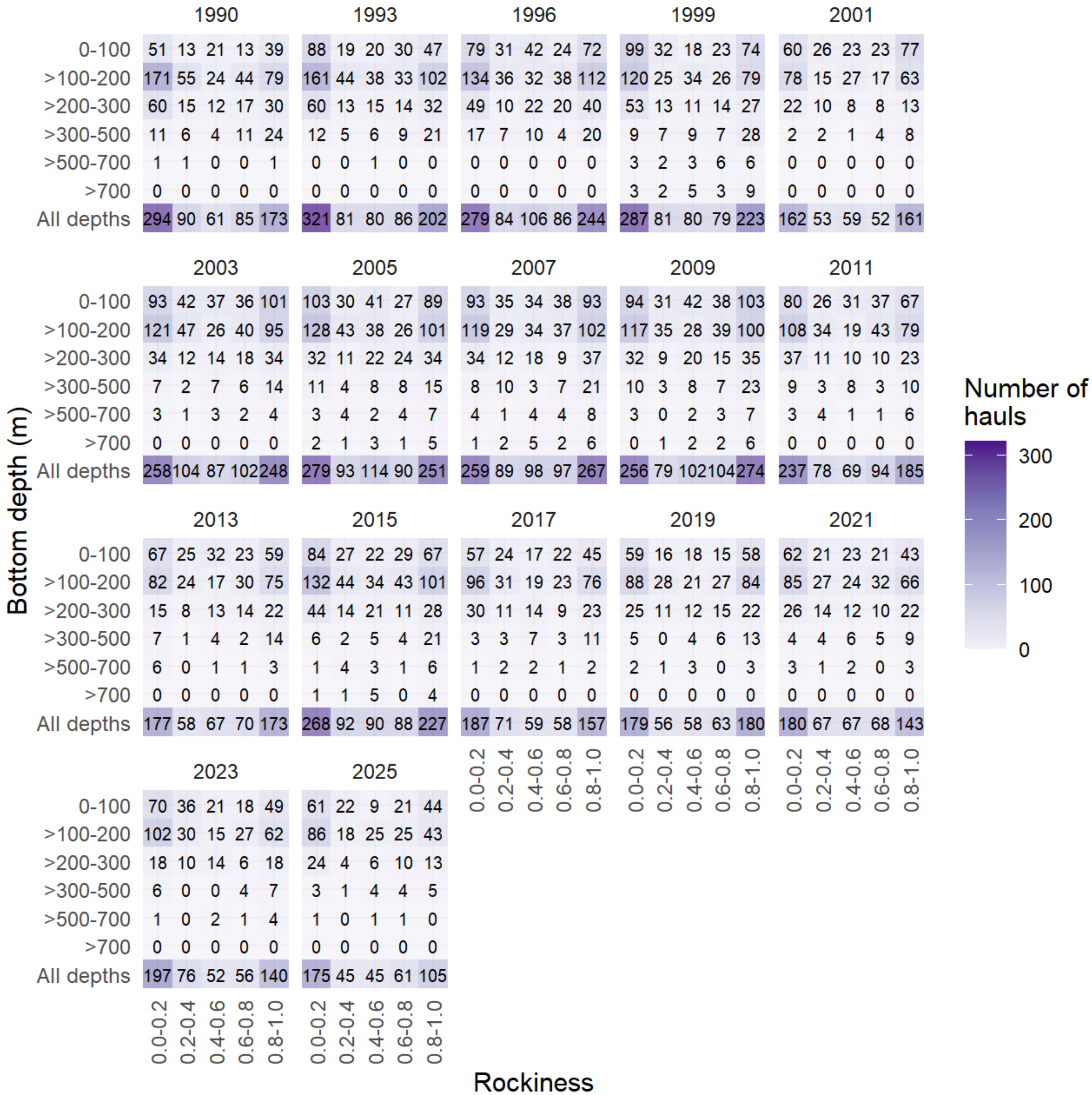


Figure 6. Count frequency of stations sampled in each depth bin (y axis) and rockiness bin (x axis) from 1990-2025. Cells are shaded darker for larger numbers of samples. The x axis represents binned rockiness values from 0 (not rocky) to 1 (the most rocky) based on an analysis of the rockiness raster from the 2023 EFH Five-Year Review.

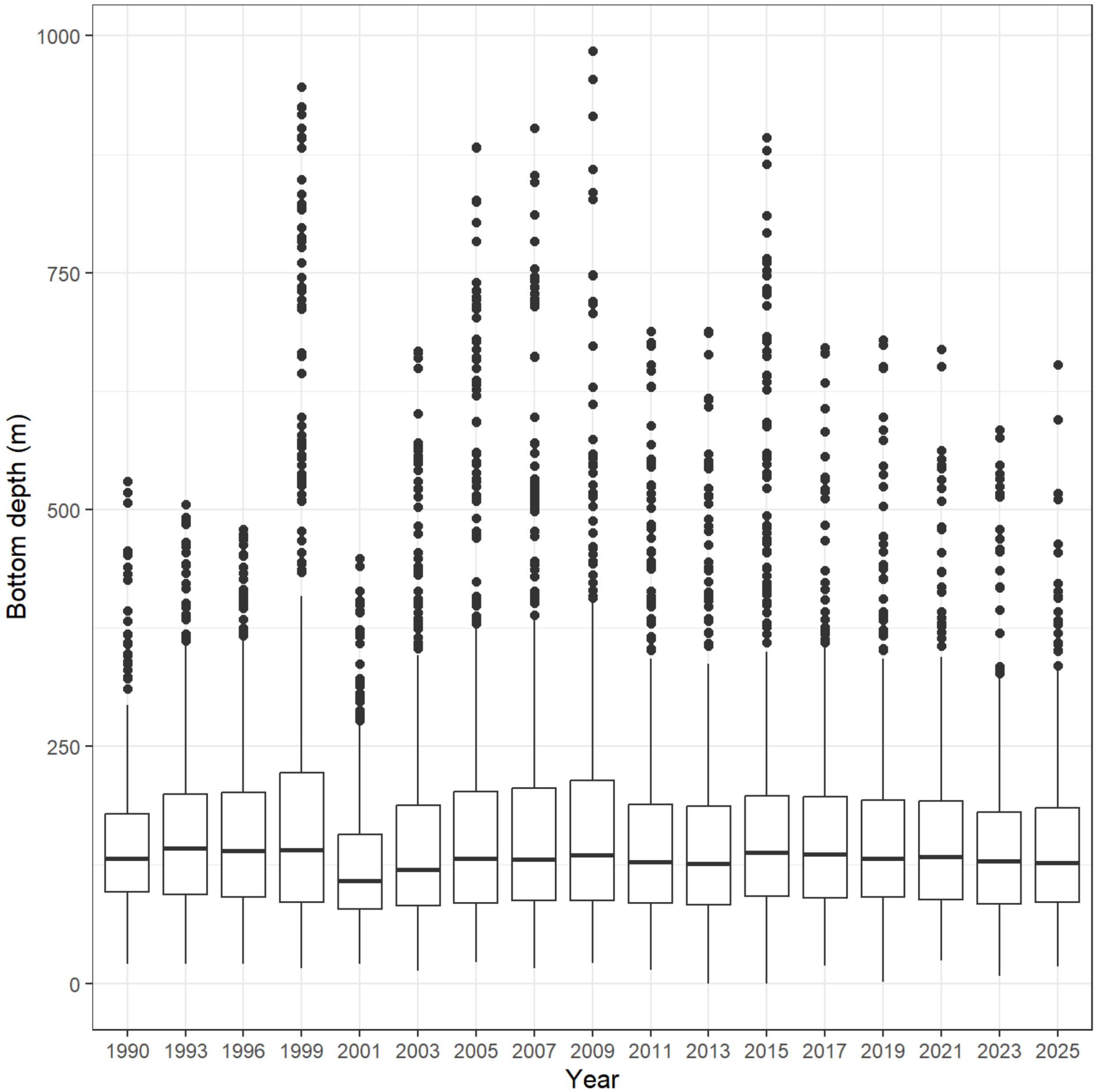


Figure 7. Boxplot of bottom depths sampled in the GOA bottom trawl survey from 1990-2025.

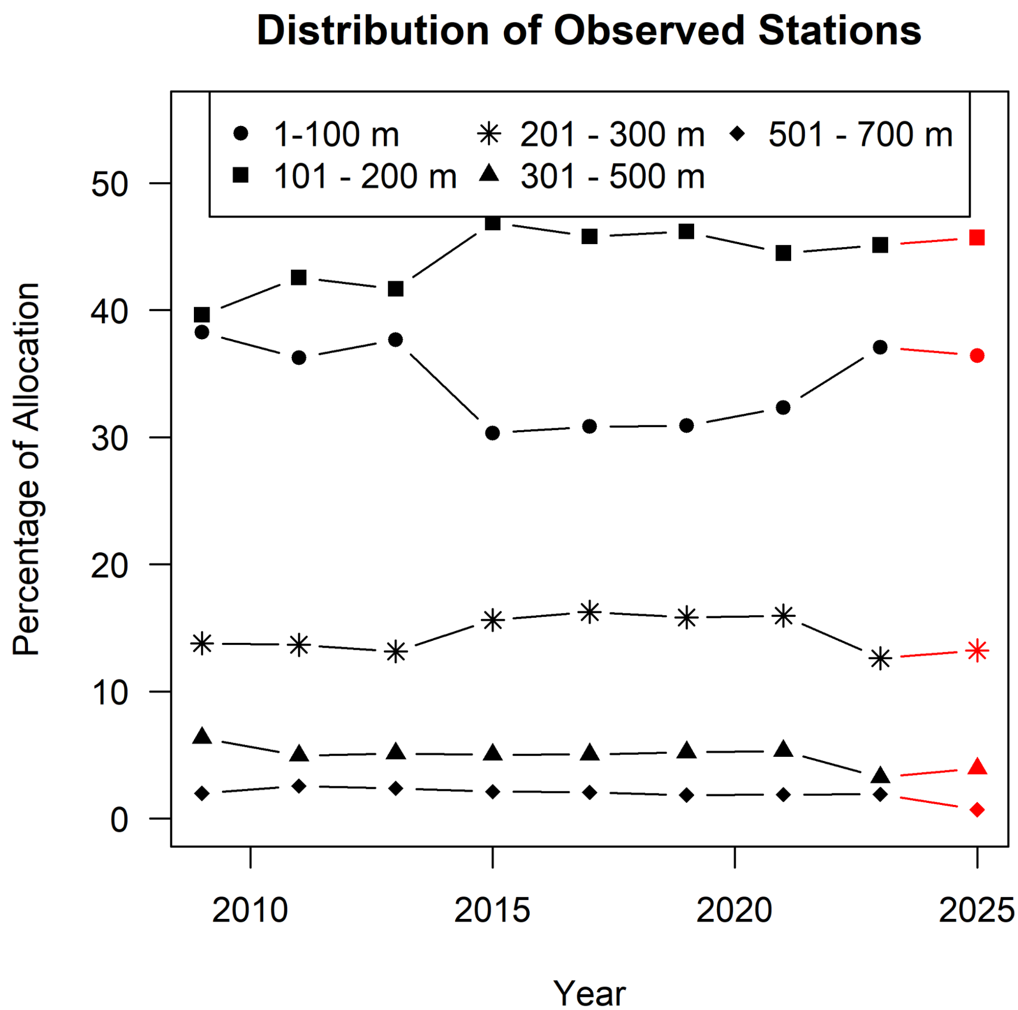


Figure 8. Proportion of stations allocated to depth ranges of allocated since the 2009 GOA bottom trawl survey.

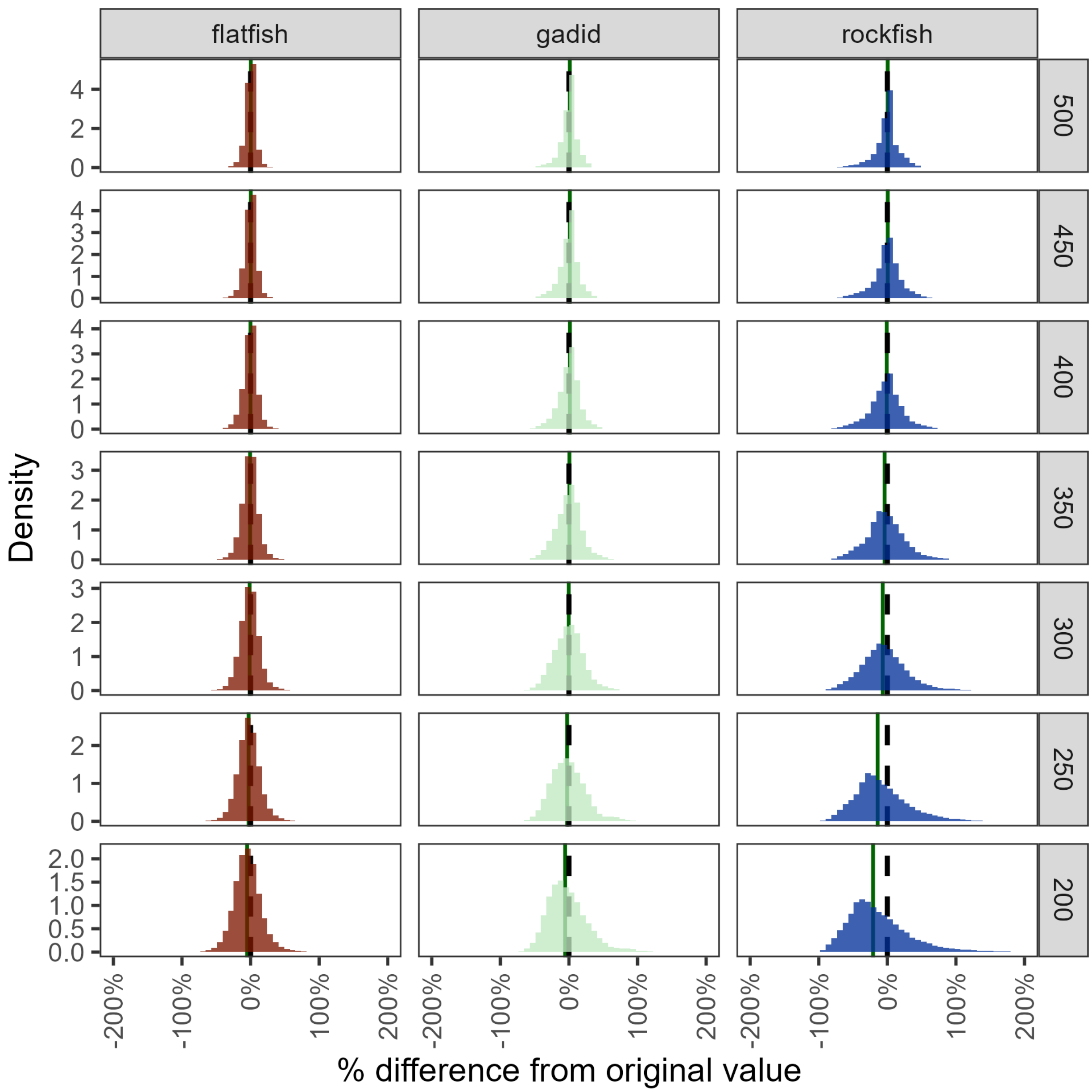


Figure 9. Distribution of percent differences from biomass estimates obtained after simulating reduction in stations (shown along rows of panels) as compared to the historical GOA bottom trawl survey biomass. These results are categorized by flatfish, gadid, and rockfish stock types. The vertical dashed black line is 0% percent difference, and the solid vertical green line is the median percent difference.

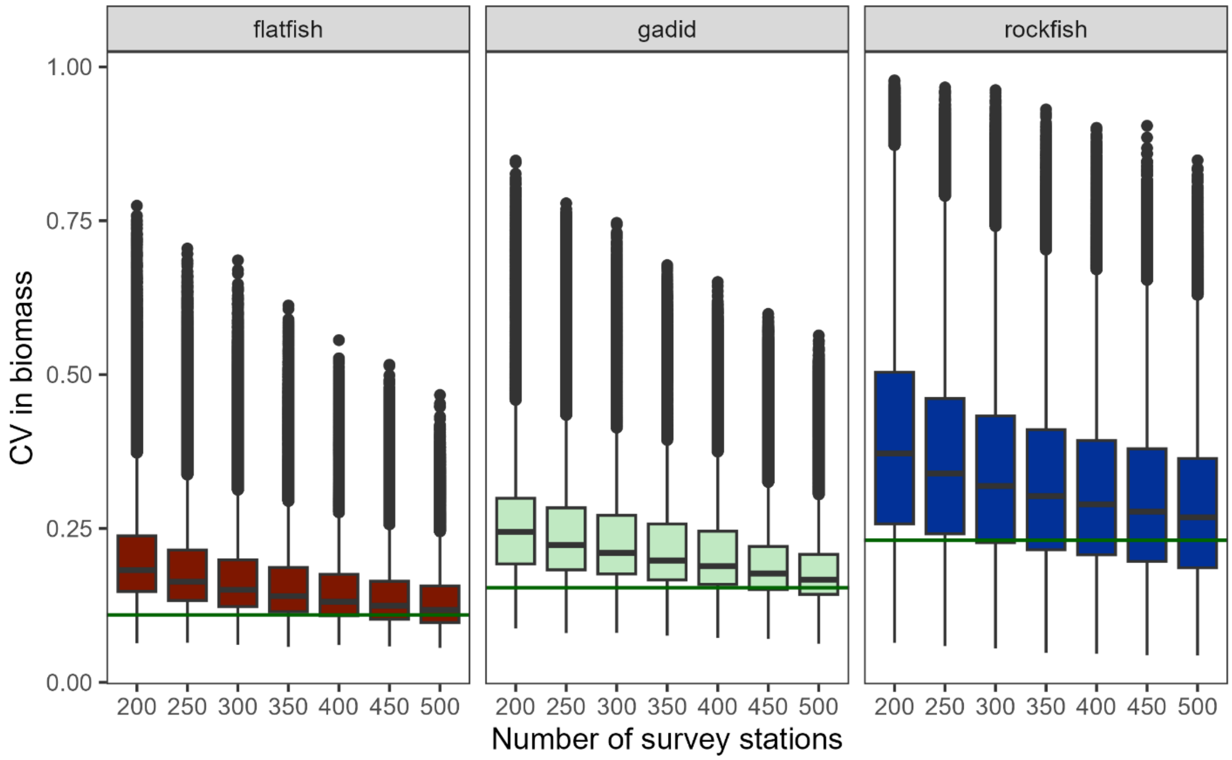


Figure 10. Boxplots of resulting coefficient of variation (CV) in biomass after simulating reductions in GOA bottom trawl survey stations. These results are categorized by flatfish, gadid, and rockfish stock types. The horizontal green line is the median historical CV for each stock type.