**Abstract**

There are over 100 species in the federally managed US West Coast groundfish fishery. Single-species management objectives based on proxies for the biomass corresponding to Maximum Sustainable Yield may therefore fail to fully capture this inherently multispecies fishery. We conducted a métier analysis of landings records using the Clustering LARge Applications (CLARA) algorithm and refined these clusters into métiers. Landings records from 2011-2023 were selected to represent trends in the fishery since the implementation of Individual Fishing Quotas in 2011. Gear and species were refined to select the species that combined to encapsulate 99% of the total ex-vessel revenue, resulting in 31 unique species and 12 gear types. Combinations of gear, landing month, and port were clustered into 17 unique clusters, which were subsequently combined into four métiers. The four identified métiers broadly represent the Pacific whiting midwater trawl fishery, the sablefish fish pot, longline, and setline fishery, the groundfish trawl fishery, and the flatfish trawl fisheries. The results allow us to view catch in the US West Coast groundfish fishery through a multispecies lens and serve as the foundation for future multispecies management.

**Introduction**

It is essential to quantify fleet characteristics and interactions between the main target species when calculating management objectives for fisheries. One component of this process is identifying “métiers”, where a métier is defined as “a group of fishing operations targeting a specific assemblage of species, using a specific gear, during a specific period of the year and/or within the specific area” (Deporte et al., 2012). Using métiers to group together fishing effort has become commonplace since the early 2010s (e.g., González-Álvarez et al., 2016; Briton, 2019; Pascoe et al., 2022). Métiers serve as a typology for often highly dimensional and complex fishery data to be condensed into clusters for analysis (O’Farrell et al., 2019). Individual vessels, gears, and species are, however, not confined to a single métier. For instance, González-Álvarez et al. (2016) observed that vessels generally operated in 1-6 métiers each year in Spain’s northwest artisanal fishery, and each gear type and target species, as well as other species caught as bycatch, existed in multiple métiers in the analysis conducted by Pascoe et al. (2022).

Fishing practices within a given fishery are driven by a variety of factors, from personal goals and values, the market price of target species, and a multitude of other ecological, social, and economic variables (Boonstra and Hentati-Sundberg, 2016). An important component of fisheries management is social; fishers support themselves and their families through fishing and understanding how management impacts fishing decisions is an essential consideration (Branch et al., 2006; Hilborn, 2007). Consequently, effective fishery management requires an understanding of human behavior (Hilborn, 2007), which métier analyses attempt to capture either directly (e.g., Pascoe et al., 2022.) or indirectly (this study) to some extent. Inclusion of sociocultural variables in fisheries management is increasingly becoming a point of emphasis (Nielsen and Christensen, 2006; Abernathy, 2010; Boonstra and Hentati-Sundberg, 2016; Schadeberg et al., 2021). Effective fishery management therefore requires an understanding of human behavior (Hilborn 2007), which métier analyses attempt to capture. Instead of focusing solely on individual stocks, métiers capture fisher behavior as an additional dimension for managers, and all fisheries data are indirectly driven by this selection pressure; fishers target the species that best suit their social, environmental, and economic beliefs. Métier analyses recognize that the impacts of a fishery go beyond the targeted species by focusing on human activities (i.e., selection pressure by fishers) (Tserpes et al., 2006). Schadeberg et al. (2021) note that target species selection goes beyond profit-driven motivations, as social factors can play a significant role in targeting preferences. This is further supported by Lahellec et al. (2025), who found that the driver of daily and pluri-annual decisions by fishers were driven by personal preference and social variables. As social dimensions change, targeting practices are likely to as well, requiring revision of métiers. These shifts impact the number of species caught and the gear composition of the fishery (Flores et al., 2025), which form the basis for a métier.

Social factors are not the only factors determining métiers, as ecological dimensions can also shift catch composition. Marine ecosystems are dynamic (Fogarty et al., 2016), which can lead to shifting baselines (Thrush and Dayton 2002), that impact the population sizes of commercially important species. Changing population structure of a keystone species can have cascading effects on other species, potentially shifting preferred habitats (e.g., for recruits - Love et al., 2024). Regime shifts have, for example, occurred multiple times in the northeast Pacific during the last 50 years (Beaugrand et al., 2015), which has drastically changed the structure of the ecosystem and could lead to updates to management within the ecosystem (Demirel et al., 2023).

Métiers have been identified for a variety of fisheries, with a plethora of clustering algorithms used to calculate métiers. For example, Russo et al. (2016) used Self Organizing Maps, an unsupervised machine learning algorithm, to identify métiers from unlabeled data. Hierarchical agglomerative cluster (HAC) analysis and its variants are often used to cluster métiers. For example, Lee et al. (2021) used HAC to cluster fishing effort in Taiwan’s mixed trawl fishery, Lewy and Vinther (1994) applied the same approach for Denmark’s North Sea trawl fishery, and Ruiz et al. (2021) used HAC to identify métiers in the Spanish purse seine fleet in the Bay of Biscay. Another clustering algorithm is partitioning around medoids (PAM), a variant of k-means clustering. Parsa et al. (2020) used a PAM algorithm to cluster the Australian Eastern Tuna and Billfish Fishery (ETBF), and Duarte et al. (2009) used PAM to cluster 198 commercially important taxa across Portugal. Métier analysis is often applied to mixed-gear fisheries, but there are cases when it is applied to single-gear fisheries. For example, Australia’s ETBF uses a single gear type, the pelagic longline, but there is variation in fishing practices (Parsa at al., 2020; Campbell et al., 2017). This variation relates to fishing depth, number of hooks per line, fishing location, fleet mobility, and target species (Campbell et al., 2017). A métier analysis can therefore be used to provide targeted management advice to specific sectors of a fishery as well as to the entire fishery.

The most common clustering algorithm used in métier analysis is Clustering LARge Applications (CLARA), a variant of PAM. Pascoe et al. (2022) used CLARA to cluster Australia’s Southern and Eastern Scalefish and Shark Fishery, and Szymkowiak et al. (2024) used a similar approach to identify métiers across 144 emergent fisheries in Alaska. Szynaka et al. (2024) used CLARA with multivariate regression trees to cluster southern Portugal’s mixed-gear octopus fishery, and Castro et al. (2010, 2011) used CLARA to identify métiers in the Spanish bottom otter trawl fleet and set-longline fleet outside of Spanish waters, while Abad et al. (2011) applied CLARA to Spanish fleets in coastal waters.

Principal component analysis (PCA) is often used in tandem with clustering to reduce dimensionality. For instance, Lahellec et al. (2025) used PCA with a HAC to identify métiers in the Bay of Biscay and Deporte et al. (2012) combined PCA with CLARA to identify métiers for the North Sea. Clustering for métier generation can take many forms, and the selection of a clustering method can have large impacts on the final clustering result.

*Overview of the US West Coast groundfish fishery*

The first Pacific groundfish fishery management plan (FMP) was implemented in 1982 (Pacific Fishery Management Council; PFMC, 1982). This management plan set the foundation for the management of federally managed groundfish species off the US West Coast, defined as the coastal waters off California, Oregon, and Washington state. It was designed to be flexible to meet the changing socioeconomic landscape of the fishery; this flexibility has allowed the FMP to be amended 33 times, with the last amendment ratified in 2024 (PFMC, 2024a). The FMP identifies 98 unique species, along with ‘other’ categories for rockfish (family *Scorpaenidae*), skates (family *Arhynchobatidae*), and grenadiers (family *Macrouridae*) not explicitly mentioned in PFMC (2024a).

The commercial groundfish trawl fishery is divided into two sectors: the shore-based IFQ sector and the at-sea Pacific whiting fishery. The IFQ system was implemented in 2011 through FMP Amendment 20 to the PFMC’s Groundfish FMP, where the limited-entry shore-based trawl vessels would be managed separately from limited entry at-sea vessels. Shore-based vessels would be managed under IFQs and be subject to 100% observer coverage, which was intended to help reduce at-sea discards and promote vessel specialization toward specific stocks (PFMC, 2024a). Each vessel is assigned quota pounds for 30 groundfish species at the start of the year based on their quota share ownership, and quota can be traded between quota shareholders. Gear types are variable in these fleets, from bottom trawls to commercial pole and other types of trawl gears. An open-access sector exists for groundfish, specifically for fishers who land non-whiting groundfish. Trawl gear cannot be used by this sector, which is designed for fishers who do not exclusively target groundfish (Warlick et al., 2018).

The at-sea whiting sectors strictly target Pacific whiting and process the catch at sea, in contrast to the multi-species approach of the shore-based vessels. Two cooperative-managed sectors exist within the at-sea whiting fleet. Catcher processors catch and process their landings on a single vessel. Although there is a limit of ten permits in this sector, there are no processing limits for it. The other Pacific whiting sector, often referred to as the Mothership fishery, involves smaller catcher vessels targeting whiting and returning landings to a ‘mothership’ to be processed. The Whiting Mothership Cooperative operates in a pool system, where allocations are split and allocated across five pools based on vessel participation (PFMC 2024a). Midwater trawls are the predominant gear type for the at-sea whiting fleets.

Limited-entry fixed gear sectors often target sablefish using longline or fish pots, and vessels with a sablefish endorsement target this species each year from April to December, while vessels without the endorsement fish in a daily-trip-limit fishery. In contrast to the limited-entry fixed gear fishery, open access vessels do not have permit restrictions. Given the lack of permits, landings limits for open access vessels are often lower than those for the fixed-gear sector.

There is a tribal sector to the groundfish fishery. The Makah, Hoh, Quinault Indian Nation, and Quileute tribes have treaty rights to harvest their “usual and accustomed” groundfish take; tribal take of groundfish has been upheld by the rulings of *Midwater Trawlers Cooperative v. Department of Commerce* in Oregon and *Washington v. Daley* in Washington state (Ludicello and Lueders, 2016).

Management of groundfish species off the US West Coast is primarily done on a single-species basis. Most stock assessments are conducted on a single-species level, which means individual target reference points (such as MSY) are calculated for a single species. Although data from other fisheries (e.g., widow rockfish bycatch in the Pacific whiting fishery, see Kinneen et al., 2025) are included in these stock assessments, model outputs are generally limited to the species in consideration. Exceptions do exist (e.g., rougheye rockfish and blackspotted rockfish have a single stock assessment, see Hicks et al., 2013), but these are often minor species within the fishery. Many unassessed and data-limited species are grouped into stock complexes (11 total complexes across the fishery) to set annual catch limits for these species (PFMC 2024a). There are also spatial variations, delimited by state (e.g., black rockfish) or latitude (e.g., yellowtail rockfish) for separate stocks (PFMC 2024a). No stock assessment in the region has defined seasonal variations (e.g., separate assessments for different times of year).

A detailed overview of the West Coast groundfish fishery can be found in PFMC (2025), and Warlick et al. (2018) provides a thorough history of the fishery.

*The Role of Métiers in Ecosystem Based Fishery Management*

No fishery species exist in isolation; harvesting one species can have cascading effects throughout the ecosystem due to trophic interactions (Libralato et al., 2014). Synthesizing multispecies considerations into fisheries management is an important component of ecosystem-based fisheries management (EBFM). The goal of EBFM is to incorporate environmental variables, bycatch and technical interactions, and trophic interactions into how fish stocks are managed (Hornborg et al., 2019). EBFM strategies can range from incorporating climate and ecosystem data into models to providing qualitative and quantitative advice on management strategies (Levin et al., 2009). Although the purpose of including ecosystem-level dynamics into management strategies is to improve the reliability and accuracy of policy estimates, few studies provide proof of this connection. Furthermore, although the Common Fisheries Policy in the European Union (EU, 2013) and the Magnuson-Stevens Act in the United States (U.S. Department of Commerce, 2007) acknowledge the importance of accounting for multispecies factors in management decisions, there are no requirements for stocks to be treated as interconnected when making management decisions. Social factors are starting to be incorporated into EBFM practices (Hornborg et al. 2019) and understanding the interplay between social factors and species targeting can help ensure future métier analysis and hence management strategies are best suited for the fisheries they govern.

Multispecies management is influenced by both technical and biological interactions in the system. Technical interactions occur when multiple species are caught together with the same unit of fishing effort; a classic example being a non-target species caught as bycatch (Sun et al., 2023). Technical interactions differ from biological interactions, which include predator-prey dynamics, competition, and symbiosis (Cardoso et al., 2015), and shape fisheries landings. Multi-target fisheries can exist based on cohabitation by economically valuable species and targeting practices can shift based on, for instance, total allowable catches (TACs). For instance, a fisher targeting two species might shift their fishing location if one species is near its TAC to catch more of the other species (see Hutton et al., 2022).

Setting management strategies based on single-species considerations has been shown to increase bycatch of non-target species (Tolotti et al., 2022) or to lead to underutilized catch limits if discarding is prohibited, and it is understood that mixed-fishery aspects are a key limitation to management approaches based on single-species management targets. Specifically, technical interactions among species and gears, along with differing availability, economic value, and abundance of species vary across space and time, exacerbating these challenges (Ulrich et al., 2012). This has led to approaches that compute potential management targets that also account for technical interactions (e.g., Pascoe et al., 2022; Zamborain-Mason et al., 2023; Del Santo O’Neill et al., 2024). Ono et al., (2018) found that neglecting technical interactions in multispecies management strategy evaluations resulted in higher lost yield than when technical interactions were accounted for. Sampson (1992) argued that characterizing fleets in bioeconomic fisheries model increases the model’s ability to accurately represent long-run fishing decisions, raising the likelihood management actions are appropriate years after they are set. McCluskey and Lewison (2008) support the notion that fleet characterization improves the ability for managers to accurately quantify fishing effort, which is essential to determining management targets.

Models that include technical interactions have been developed for groundfish in regions such as Australia (e.g., Pascoe et al., 2022), but none have been developed for groundfish off the US West Coast. The fishery for West Coast groundfish involves multiple target species and dozens of byproduct species, all of which are managed using TACs implemented as Individual Fishing Quotas (IFQs) (PFMC, 2024b), with stock status defined in terms of spawning biomass relative to a proxy for the biomass corresponding to maximum sustainable yield.

The goal of this study is to identify a potential structure for multispecies management of the US West Coast Groundfish fishery, identifying species and gears that may be managed together, as well as potential seasonal and spatial considerations in defining a multispecies management structure, by identifying métiers in the fishery. Minor species in the fishery have been managed with a multispecies approach, but there has yet to be a comprehensive management strategy for the entire fishery to set management benchmarks. Métiers serve as the structure for potential management. With over 100 unique species and dozens of gear types used, the US West Coast groundfish fishery is a prime target for multispecies management. Many of these species are primarily caught together in the same gear (e.g., widow rockfish and Pacific hake in midwater trawls); comanagement of species has the potential to maximize economic profit and reduce economic and ecological risk from missing single-species reference points (Brewster et al., 2025).

Stock assessments are costly, technical, and time-intensive. Some species have gone over a decade since their last assessment was completed, while others are updated yearly (Neubauer et al., 2018). This discrepancy can cause changes in stock structure and available catch to go unnoticed in certain species, which could cause harsh reductions in fishing for that species over time. For instance, the optimal catch limit for widow rockfish was reduced in the most recent update assessment conducted by Kinneen et al., (2025), six years after the most recent update and a decade after the benchmark assessment for the species; had this assessment been conducted across multiple species, this likely would have been caught earlier (as resources would have been spread less thin across assessment teams) and the overall OFL reduction would have been lessened (as the OFL would be spread across multiple species, not just widow rockfish). The challenges of choosing which stocks to prioritize (outlined in Neubauer et al., 2018, Method 2015, etc.) would be greatly mitigated when the pool of possible assessments is reduced to the number of métiers. With climate-related events that impact fisheries expected to increase in frequency (e.g., heat waves; Free et al., 2023), reviewing stock structure and potential changes to foish population dynamics maximizes gain and minimizes risk for the fishery and those that operate within it (Brewster et al., 2025). The métier approach also supports the progression of the US National Oceanographic and Atmospheric Administration’s (NOAA) EBFM policy to support conservation of fisheries in US waters (Harvey et al., 2025).

**Methods**

*Data used*

Data were obtained from the NOAA PacFIN database (Pacific Fisheries Information Network, 2024), and grouped into “aggregated shots”, where all landings into a particular port complex during an individual month and using a single gear type were combined into an individual shot. This was done to reduce the size of the data set for the subsequent cluster analysis and best reflect the definition of a métier as defined by Deporte et al., (2012). Shots are generally defined as a single vessel’s haul for a single day or fishing trip; the data used in this study are not at this scale due to confidentiality agreements between fishers and NOAA. In turn, adapting the data into ‘aggregated shots’ allowed for a similar analysis to be conducted with the data available for this fishery.

The data set consisted of 16,975,518 records for 1982-2024 before aggregation and contained 110 species, 91 port complexes, 37 gear types, and included landed weight and price per pound. The data set was reduced to 2011-2023 to better reflect current trends in the fishery given the implementation of IFQs in 2011. The species used in the analyses were restricted to those that had more than 5,000 metric tons of landed weight and gear types with more than 25,000 metric tons of landed weight across the reduced data set (2011-2023). This was done to reduce the data set to species and gear types that constitute at least 99% of the total ex-vessel revenue in the fishery. All trawl gears that did not exceed the landed weight threshold (shrimp trawl (single rigged and double rigged), Danish/Scottish seine trawl, pair trawl, and beam trawl) were grouped into the ‘other trawl gear’ category, which was already identified as one of the gears above the 99% threshold.

After consolidation, this led to a data set with 31 species and 12 gear types and 4,522,580 data points.

*Clustering analysis*

The clustering was conducted using the CLARA algorithm. CLARA algorithms are a variation of k-medoids clustering that are more robust to larger data sets compared to other methods, such as the original Partitioning Around Medoids (PAM) method developed by Kaufman and Rousseeuw (1990). Kaufman and Rousseeuw (1990) were the first to implement a PAM algorithm, which is a hierarchical approach to cluster analysis. The method uses medoids, an object within a cluster that minimizes average dissimilarity to the remaining objects. It is more robust for any potential irregular matrices (for this study, ex-vessel revenue) compared to centroid-related methods (Struyf et al., 1997). CLARA algorithms, developed by Kaufman and Rousseeuw (1990), are a type of PAM method designed to reduce computing time and optimize object usage during computation runs by selecting a random sample of the data, applying a PAM algorithm, and iterating until clusters are created. The faster computing time, ability to work with variable subset sizes for analysis, and the robustness with large datasets such as that for the US West Coast groundfish fishery makes CLARA algorithms a viable option to generate métiers (Kaufman and Rousseeuw, 1990).

Castro et al. (2010) used a combination of various subset sizes of métier characteristics, defined as the maximum number of shots allowed in a single cluster, before varying the number of clusters between 2 and 10. Fixed subset sizes, such as those used by Winker et al. (2013) are generally used with large subset sizes (e.g., 250+ shots per subset). In this study, there were no restrictions on subset size, given the volume of data used in the analysis, matching the methods used in other studies (e.g., Davie and Lordan, 2011) with a large (>25) number of species.

Briton (2019) examined differences between hierarchical agglomerative clustering (HAC), k-means, and CLARA for Australia’s Southern and Eastern Scalefish and Shark Fishery. Results were consistent with those of Deporte et al. (2012), as k-means clustering led to unstable results, while CLARA and HAC led to similar results. k-means clustering was sensitive to shuffled data, where the order of input data was randomized, and often overemphasized small fisheries in clustering at the expense of larger fisheries (Deporte et al., 2012; Briton, 2019). These limitations made k-means clustering a poor choice for this study even though it was fastest to apply. HAC and CLARA yielded similar results, but Deporte et al. (2012) found that the optimal number of clusters *k* can vary when HAC is used and the dataset is shuffled. In contrast, despite being the slowest to run, both Deporte et al. (2012) and Briton (2019) support the use of CLARA as the best method for clustering fisheries datasets.

Briton (2019) also undertook a sensitivity analysis on Manhattan vs. Euclidean distance for CLARA analysis. Distance calculations are used to calculate the coefficient of dissimilarity on which CLARA is based. Many single-species clusters were not accurately captured using Manhattan distance, while Euclidean distance detected single-species fisheries more reliably. Finally, Briton (2019) examined different thresholds to reduce the size of the original dataset when using PCA, in terms of captured variance. It was shown that not utilizing a PCA to reduce the dataset led to clusters that best captured targeting preferences within the fishery based on comparisons involving 70% or 80% of the total variance in the final data set, or using the entire dataset (Briton, 2019). The practices outlined by Briton (2019), i.e., using Euclidean distance and no PCA to reduce dimensionality, were adopted for this study. A summary of Briton (2019), an unpublished document, can be found publicly available in Burch et al., (2021).

The analyses were conducted in R version 4.3.1 (R Core Team, 2023). The input to the CLARA algorithm was a matrix *V*, where columns were species and rows were the individual (aggregated) shots, with entries defined by the ex-vessel revenue corresponding to each species and shot. The formula for ex-vessel revenue *V* was defined as:

(1)

where  is the landed weight, in pounds, of species *s* in shot *j* and  is the price, in pounds, of species *s*. The price of a species is the average price per month for that species in a given port, using a given gear type in a year. Clusters were quantified based on ex-vessel revenue rather than landed weight because ex-vessel revenue has been recommended for use in métier analyses for many fisheries (particularly in Europe; see ICES, 2003) due to its better ability to reflect the targeting choices of fishers (Deporte et al., 2012).

Clustering analysis was undertaken using the package *vmstools*, version 0.76 (Hintzen et al., 2012), as subsequent versions of the *vmstools* package remove the functionality for métier clustering. The CLARA analysis also used the R package *cluster* (Maechler et al., 2024) with a sampling fraction of 0.1 and five samples taken for each run. The optimal number of clusters was determined using a silhouette analysis (Rousseeuw 1987), which Cope and Punt (2009) found as one of two diagnostics that consistently perform well with fishery data. Shots were grouped into *k* = 2 clusters before the silhouette analysis began. For each shot, a score for each shot was generated from -1 to 1 based on the proximity to other shots within its assigned cluster and closeness to shots in adjacent clusters. Shots that have a score close to 1 are likely to be in the correct cluster; negative scores suggest that a shot is likely in the wrong cluster. The score for each shot was summed and stored as the coefficient of dissimilarity. Then, the process was repeated with *k+1* clusters. Independent CLARA runs were conducted from *k* = 2 to *k* = *n*. After two consecutive increases to the number of clusters *k* where the coefficient of dissimilarity falls, the clustering analysis comes to a halt, and *k* (i.e., the global maximum of the silhouette analysis) clusters is selected as the optimal number of clusters. This was run across 100 random seeds to test for variation in clustering. The results of the silhouette analysis for this study are reported graphically in Supplementary Figure A.1. The model output also included a final data frame of each aggregated shot with the associated ex-vessel revenue for each species, and the cluster that was assigned to the shot.

*Simplifying the clusters to develop métiers*

A dendrogram of the data was generated using the R package *clustree* (Zappia and Oshlack, 2018). Dendrograms show the evolution of clustering from *k* = 2 clusters to the final output, showing how the set of clusters evolved. As *k* increases, the dendrogram shows how the ex-vessel revenue is split into additional clusters, whether that involved breaking up a cluster or reorganizing ex-vessel revenue from multiple clusters to create a new set of *k* + 1 clusters that minimizes the Euclidean distance among clusters.

Species composition between clusters is one component of métier determination. It is intuitive to combine clusters with similar species compositions. However, this should focus on the dominant species within a cluster. The ecological role of species (see Supplementary Table A.1) is another consideration when combining clusters. Generally, rockfish are classified as spending much of their time on the continental shelf or continental slope, which influences their catchability to different gears. Species with similar life histories are likely to be caught together and make natural pairings within a métier, making ecology a factor when deciding whether to combine clusters into a métier. Another aspect of combining clusters is gear. A single gear often targets a similar assemblage of species, making intuitive pairings. Species can also be targeted by multiple gear types, so examining landings by gear can help make informed decisions on the best way to reflect fishers’ targeting preferences within métiers.

**Results**

*Summary of clusters*

Seventeen clusters were identified. The proportion of the ex-vessel revenue by species in each métier, and the proportion of ex-vessel revenue in each métier by species are shown in Supplementary Material A. Supplemental Material B provides the total ex-vessel revenue for each species in each métier. Figure 1 shows the proportion of ex-vessel revenue in each cluster by species, while Figure 2 shows the relative proportion of ex-vessel revenue in a cluster compared to the other species in the cluster. Figure 3 shows the proportion of each gear used in a cluster. Specific proportions for each species can be found in Supplementary Figure A.2. Across all 100 random seeds the model was run across, there was no change in the final clustering.

*Details of each cluster*

Each cluster has a unique catch composition. Cluster 1 is a smaller cluster, dominated by yellowtail rockfish, which comprises 85.1% of the total ex-vessel revenue in the cluster. Midwater trawl is the dominant gear type within cluster 1, with 91.8% of the value in cluster 1 caught using this gear type. The midwater trawl catch in cluster 1 is 0.78% of the total value from midwater trawls.

Cluster 2 is a small mixed-species cluster. Lingcod constitutes 20.5% of the ex-vessel revenue of this cluster, followed by boccacio rockfish (15.3%) and chilipepper rockfish (14.6%). Two gear types dominate cluster 2: commercial pole (70.1%) and groundfish trawls with footropes less than 8 inches (29.0%). These contributions make up 6.05% and 0.58% of each respective gear’s total ex-vessel revenue.

Cluster 3 is limited to just eight species, with black rockfish comprising 85.2% of the cluster’s ex-vessel revenue and 64.2% of the species’ total ex-vessel revenue. The next-highest proportion comes from lingcod (9.01%), while yellowtail rockfish, canary rockfish, sablefish, widow rockfish, darkblotched rockfish, and boccacio rockfish make up the remaining 5.3%. Cluster 3 is almost exclusively comprised of the commercial pole fishery, with 99.9% of the ex-vessel revenue coming from this gear (24.6% of the entire commercial pole groundfish fishery).

Cluster 4 is a large multi-species cluster with every species except black rockfish (0.4%) having at least 2% of its total ex-vessel revenue in this cluster. The four dominant species within cluster 4 are petrale sole (25.6%), Dover sole (24.9%), sablefish (16.3%), and Pacific whiting (11.0%). None of these four species have the dominant proportion of their ex-vessel revenue in cluster 4, with Dover sole having the highest proportion (17.1%). Cluster 4 includes a wide variety of gear types, with roller trawls (55.3%) the dominant gear type (19.7% of the total value from roller trawl groundfish fisheries).

Cluster 5 is dominated by a single species, sablefish (97.6% of the total ex-vessel revenue), which is 67.7% of the total ex-vessel revenue for the species. Two gears dominate cluster 5: longline/setlines (60.3%) and fish pots (39.5%). Most of the value of these gears is within this cluster (99.9% of the fish pot value and 70.8% of longline/setline value).

Cluster 6 is another multi-species cluster where every species has at least some catch and 20 species have at least 15% of their ex-vessel revenue, with only two (black rockfish and Pacific whiting) below 1% of their total ex-vessel revenue. Petrale sole is the dominant species in the cluster, making up 43.5% of the cluster’s ex-vessel revenue (51.8% of its total ex-vessel revenue). Cluster 6 is also a mixed-gear fishery. Three gear types have nearly all of their value in cluster 6: flatfish trawls (91.2%), selective flatfoot trawls with small footropes (99.8%), and other trawl gears (98.7%). These gears make up 10.7%, 51.2%, and 2.71% of the cluster’s value, respectively.

Cluster 7 contains the widow rockfish midwater trawl fishery, with 67.1% of the cluster comprised of widow rockfish and 99.99% of the cluster’s value from midwater trawl. This is 50.9% of the total ex-vessel revenue for widow rockfish and 9.06% of the midwater trawl value. Two other species, Pacific whiting (22.8%) and yellowtail rockfish (8.65%) make up most of the rest of the cluster.

Two species dominate cluster 8: petrale sole (26.6%) and chilipepper rockfish (21.7%). Only 1.03% and 11.0% of the respective species’ ex-vessel revenue are present within cluster 8, however. Otter trawls are the dominant gear type in cluster 8, with 62.3% of the cluster’s value coming from otter trawls. Groundfish trawls make up 34.8% of the total ex-vessel revenue. Otter trawls (76.3%) are the only gear type with more than 2% of their total ex-vessel revenue in the cluster.

Cluster 9 is a large multi-species cluster where every species has some catch and only four species (widow rockfish, sand sole, starry flounder, and Pacific whiting) have less than 1% of their ex-vessel revenue within the cluster. Cluster 9 is dominated by three species: sablefish (39.0%), Dover sole (26.2%), and petrale sole (15.1%). Similarly to cluster 4, cluster 9 is a multi-gear cluster with roller trawls (64.7%) making up most of the cluster (57.0% of the total value from roller trawls catches).

Over 95% of cluster 10 is made up of two species: sablefish (55.2%) and shortspine thornyhead (40.2%). Longlines and setlines have the majority (97.1%) of their ex-vessel revenue in cluster 10. This is 16.5% of the ex-vessel revenue from landings from this gear type.

Lingcod is the dominant species in cluster 11, constituting 57.2% of its total value. Just 7.64% of the lingcod fishery is within cluster 11, which is the highest contribution from any species. Commercial poles are the dominant (95.3%) gear type in cluster 11; this is 23.4% of the total value from commercial pole landings.

Cluster 12 is another small cluster. The dominant species is bocaccio rockfish (44.3% of the cluster value); revenue for this species is, however, just 0.92% of the total bocaccio rockfish ex-vessel revenue. Bank rockfish (1.18%) are the only species with more than 1% of its species-specific ex-vessel revenue in cluster 12. Commercial pole is 94.5% of the cluster value, but since cluster 13 is small, this makes up just 0.76% of commercial pole landing value.

Cluster 13 is limited to just nine species and represents 0.003% of the fishery, making it the smallest cluster. One species dominates this cluster: spiny dogfish, where 4.34% of this species’ ex-vessel revenue makes up 95.6% of the cluster. The only gear within cluster 13 is longline/setline, making this cluster the only one with just a single gear type.

Sablefish are the dominant (33.4%) species within cluster 14, despite only 0.57% of the total sablefish ex-vessel revenue residing in cluster 14. Two gears make up most of the cluster: groundfish trawls with small footropes (57.5%) and commercial pole lines (37.8%). These contributions are 9.74% and 27.5% of the gear’s total ex-vessel revenue, respectively.

Just 17 of the 31 species have catch within cluster 15. Blackgill rockfish composes 46.4% of the cluster and has the highest per-species proportion of ex-vessel revenue, (11.9%). This is the only species with a contribution above 5%. Commercial pole landings comprise the majority of the cluster, with 95.3% of the cluster’s ex-vessel revenue. This value is just 5.87% of the total commercial pole value.

Cluster 16 is another small cluster. Lingcod is the dominant (90.7%) species within cluster 16. No other species has more than 0.1% of its value within this cluster. Only three gears contribute value to this cluster: commercial pole (42.5%), longline/setlines (35.2%), and flatfish trawls (22.3%).

Cluster 17 is the largest cluster and contains the majority of the Pacific whiting fishery comprising 89.7% of the cluster, and 95.5% of Pacific whiting ex-vessel revenue value located in cluster 17. This is also the case for walleye pollock, as 89.9% of its ex-vessel is contained within this cluster, despite comprising just 0.07% of the cluster. This cluster is nearly all (99.99998%) midwater trawl revenue. 87.9% of the total ex-vessel revenue from midwater trawl landings is in cluster 17. The small remaining portion of value comes from other trawl gear.

*Effects of location*

Port complex was not a differentiator between clusters. Nearly all ports (95.3%) were split across multiple clusters, except for Del Norte, Friday Harbor, Pacific City, and Salmon River, which each only have a single gear type. Revenue was more often split between clusters than within the same cluster even when looking across a single gear type at a specific port complex.

Although port-specific metrics were not a significant differentiator of clustering, location played a role in how clusters were allocated to métiers. Figure 4 shows the proportion of ex-vessel revenue by state. All of the catch by clusters 2, 8, 10, 12, and 15 was landed in ports in California. Approximately 85% of the catch by cluster 14 was also landed in California. The other clusters are mixed-location clusters.

*Developing métiers*

*Information from dendrograms*

Dendrograms can be used to synthesize clusters into métiers if an increase in *k* leads to a cluster being broken into two without movement of records into other clusters. However, this is not always the case. There are many instances in Figure 5 where one cluster is broken up across multiple new clusters and divisions can occur with more than just one cluster being affected when the number of clusters is increased. This makes it difficult to use dendrograms in defining métiers.

Another way dendrograms can be helpful is by seeing how a cluster has evolved over time. For example, Figure 5 shows how cluster 5 has stayed relatively constant throughout the clustering process, with no new records entering the cluster and only three instances of records leaving the cluster with an increase in *k*. This suggests that cluster 5 is unlikely to be combined with many, if any, clusters when the clusters are refined into métiers. There are some key differences in the composition of the sablefish longline catch between the clusters. For example, hauls in cluster 5 tended to have higher value (e.g., the median sablefish ex-vessel revenue per haul was 428% greater in cluster 5 than in cluster 9) and included longspine and shortspined thornyheads, as well as rougheye rockfish. In contrast, Cluster 9 often landed significant quantities of blackgill rockfish, which is infrequent in landings in cluster 5.

*Selection of a set of métiers for further analysis*

Seventeen métiers are likely too many to define management objectives for, given the need to compute selectivity and retention patterns for each combination of métier, gear, and species. The marked differences in gear type between the clusters can make them difficult to combine. For instance, cluster 9 contains 85.4% of the long-footroped groundfish trawls, while cluster 5 contains no catch from this gear type. This is also the case with roller trawl landings, where 63.63% of their total ex-vessel revenue is in cluster 9, but only 0.174% in cluster 5. Much of the value from cluster 9 not from longline/setlines comes from trawls, while only three gear types are present in cluster 5 (set net, fish pot, and longline/setlines). Even though cluster 5 (99.8%) and cluster 9 (0.22%) contain the entirety of the set net fishery, set nets contribute the smallest amount of ex-vessel revenue (0.003% of the entire fishery). Due to the small proportion of total ex-vessel revenue in both cluster 9 and the fishery, combining all set net revenue into a single cluster can reduce the effectiveness of a métier by focusing on noise rather than signal. Commercial pole landings are spread across 14 of the 17 clusters (Figure 4), making it difficult to combine all commercial pole catch into a single cluster.

Application of the approach for simplifying métiers leads to four métiers, labeled A, B, C and D (Table 1).

*Description of the selected métiers*

Métier A contains 36.7% of the total ex-vessel revenue and is composed of clusters 1, 7, and 17 (Tables 1 and 2), which are similar in terms of gear and species. Eight species have at least 25% of their ex-vessel revenue within the métier: canary rockfish, Pacific whiting, redstripe rockfish, spiny dogfish, splitnose rockfish, walleye pollock, widow rockfish, and yellowtail rockfish (Table 3). The species in this cluster are primarily midwater species, as 97.4% of the midwater trawl ex-vessel revenue lies in métier A (Table 2). Canary rockfish, widow rockfish and yellowtail rockfish are common targets of midwater trawlers and are bycatch for many Pacific hake fisheries (Langseth et al., 2023; Kinneen et al., 2025; Oken et al., 2025). Spiny dogfish tend to occupy the midwater for their first 20 years of life before preferring demersal habitat later in life (Beamish et al., 1982). Historically, spiny dogfish were caught more frequently in bottom trawls but often discarded, while much of the midwater trawl landings were kept. However, bottom trawl landings have reduced significantly since 2009; currently, most of the catch from spiny dogfish is from midwater trawl gear (Gertseva et al., 2021).

Métier B contains most of the revenue for flatfish trawl, other trawl gear, commercial pole, and all the revenue for selective flatfish trawl gear fisheries (Table 2). Given the gear configuration in this métier, it is unsurprising that many of the species in this métier are flatfish, such as the arrowtooth flounder, English sole, petrale sole, rex sole, sand sole, and starry flounder (Table 3). Other demersal species, such as the longnose skate, are also represented in this métier. Métier B is the smallest of the four métiers, comprising just 11.4% of the total ex-vessel revenue. Despite this, métier B contains the most clusters (3, 6, 11, 12, 13, 15, and 16). Combined, however, these clusters (except for cluster 6) make up just 0.53% of the total ex-vessel revenue. The clusters in métier B are generally comprised of line and pole landings. However, the dominant gear type is short-roped groundfish trawls, specifically within clusters 2 and 14. This provides a strong gear-based connection with cluster 6, as much of the ex-vessel revenue in cluster 6 comes from trawl gear. This gear-based connection also includes flatfish landings, making this pairing intuitive.

Métier C combines clusters 4, 8, 9, and 14, which contain 24.5% of the total ex-vessel revenue, and is primarily a trawl-based métier (Table 2). Otter trawls and long-footroped groundfish trawls have over 90% of their ex-vessel revenue in this cluster, while short-footroped groundfish trawls (61.8%) and roller trawls (84.5%) also have much of their revenue in this métier. In terms of species composition, this métier contains many of the demersal rockfish species such as the blackgill rockfish, chilipepper rockfish, and darkblotched rockfish (Table 3). The dendrogram of cluster evolution (Fig. 5) also supports the merging of these clusters. From *k* = 16 to *k* = 17, a single cluster is broken up into clusters 4 and 14. Some of the records from cluster 9 were also moved into cluster 14, showing that these clusters are likely located close together in the clustering space. Most of the flatfish revenue not included in métier B is included in métier C, with the key distinction being the trawl gears used (Table 2). Commercial pole landings are also in métier C (35.8% of its ex-vessel revenue), but this gear contains just 0.008% of the ex-vessel revenue for all West Coast groundfish since 2011, making these records a very small proportion of métier C. Differences between gears support the separation of métiers B and C. For example, 52.0% of the selective flatfish trawl ex-vessel revenue is in cluster 6 (métier B). However, there is not a single record from this gear type in clusters 4 and 9, the two clusters that contribute the majority of the ex-vessel revenue to métier C. A similar trend is evident for long-footroped groundfish trawls, although there are some records for this gear (0.70%) in cluster 6.

Two clusters (5 and 10) make up métier D. This métier makes up 27.6% of the total ex-vessel revenue. These two clusters completely isolate the fish pot (99.9%) and set net (99.8%) fisheries, and contain the vast majority (87.5%) of the longline and setline fisheries (Table 2). The dominant species is sablefish, which is the species with the highest average ex-vessel revenue across the period. Sablefish are generally targeted with longlines and fish pot (Johnson et al., 2023) (Table 3), which match the gear composition of this métier. Bycatch in fish pots targeting sablefish is generally low for the 30 other species considered in this study (Johnson et al., 2023). Longlines/setlines also target sablefish and were not separated during the clustering process. Cluster 10 is dominated by longline/setline records and the catch composition is similar to the records in cluster 5. Species richness was lower for cluster 10 and this cluster landed more thornyheads compared to cluster 5. Given the relative lack of bycatch in the fishery, only two species have at least 25% of their ex-vessel revenue in this cluster: shortspined thornyhead and rougheye rockfish. It is natural to combine these clusters together as they contain a significant portion of sablefish and longline/setline ex-vessel revenue.

Many gears exist in small proportions in a métier. These landings are likely incidental catch or bycatch and are unlikely to have large impacts on the final reference points. Given the small proportion of the métiers these gears make up, they could be ignored when defining the métier and would not considered part of the gears that comprise the métier and calculating reference points or for other management objectives. The gears that have the potential to be removed from the métiers when calculating management targets are denoted with an asterisk in Table 2.

**Discussion**

Our analysis shows that many of the groundfish species off the US West Coast are not found within a single cluster, nor are clusters inherently single-species (Supplemental Material B). Every species is split across multiple clusters and métiers, with walleye pollock having the smallest distribution (7 of the 17 clusters). Only two species, Pacific whiting and walleye pollock, have only one cluster with more than 5% of their total ex-vessel revenue (cluster 17 for both species), supporting the notion that most species are split between clusters.

Only five species have the vast majority (>70%) of their ex-vessel revenue in one cluster. Those that do are generally only caught using one type of gear (e.g., Pacific whiting in midwater trawls), and are confined to just two clusters (6 and 17). Of the 31 species in the study, 19 of them have over 50% of their total ex-vessel revenue within one cluster, but the remaining value is often split across multiple clusters (Supplemental Material B). A different trend holds true for gear type. Of the 12 gear types, nine have at least 70% of their total value in one cluster. For the four gear types without a clear dominant cluster assignment, their ex-vessel revenue is split up between multiple clusters, with each having at least three clusters with more than 10% of the gear’s total value within it.

*Use of the métier analysis for management purposes*

Selecting métiers for management purposes

Clusters form the foundation for métier analysis. Merging clusters of similar structure and of smaller size helps refine the algorithmically defined clusters into métiers that can be used for management-related analyses. Clusters should be combined into métiers based on species, gear composition, and, if applicable, location, seasonality and a dendrogram. Métiers should not be too large that any analysis based on them would not elucidate targeting preference by encapsulating too large of a proportion of the fishery. Conversely, it is important that métiers are not so small that the métier is not meaningful at the level at which assessments are conducted and management targets are computed. In addition, focusing too much on smaller clusters can hinder the efficacy of defining métiers; for instance, cluster 13 (the smallest cluster in this study; 0.003% of total ex-vessel revenue) is more likely to reflect “noise” in data than providing a basis for setting management targets. Although these clusters should not be disregarded in métier formation, clusters with higher ex-vessel revenue should be weighted more heavily when determining métier structure. Information from industry experts should also be used alongside the clustering analysis to form final métiers (Pascoe et al., 2022).

Dendrograms can be a beneficial tool when defining métiers (e.g., Marchal 2008; Palialexis and Vassilopoulou 2016; Lee et al., 2021) if each leaf has a relationship to a single clade at each level of clustering. However, in this study, clusters were often broken into multiple (< 3) clusters as *k* increased to *k + 1*. This makes it challenging to use a dendrogram such as Figure 5 as evidence to support assigning clusters to métiers, as a cluster’s records are often split between multiple clusters at lower values of *k*.In addition, in this study, location and seasonal differences were not strong determinants of clustering and were therefore not used in determining assignments to métiers. Therefore the primary basis for the métiers in this study are size of the cluster, species composition and gear type.

We find that the West Coast groundfish fishery can be represented by four métiers (A, B, C, and D). Broadly, métier A is comprised of shelf rockfish and roundfish caught in midwater trawl gears, métier B represents non-sablefish slope rockfish caught in flatfish trawls, métier C comprises the groundfish trawl fishery targeting flatfish and elasmobranchs, while métier D comprises the sablefish fishery in fish pots while including flatfish, elasmobranchs, and a select few shelf rockfish landed in set nets and line and pole fisheries (Table 4). A heuristic for the development of the métiers in this study can be found in the supplementary materials.

Use for management purposes

Métiers have been applied for reasons other than calculating target reference points. For instance, Ovando (2025) used métiers in a framework to simulate fishing pressure within Marine Protected Areas (MPAs), Binch et al. (2024) utilized an OSMOSE model (Shin and Cury, 2001) with defined métiers to simulate how demersal trawling in the North Sea may shift based given MPA designations, and Tzantos et al. (2024) developed a métier sustainability index (MSI25), which evaluates fishing sustainability at the métier level rather than by stock. Marçalo et al. (2025) used métiers to examine shifts in common dolphin bycatch across various fisheries in the Algarve region of southern Portugal with the introduction of acoustic deterrent devices and Chaji et al. (2025) examined the impacts of offshore wind energy production on scallop production in the Northeastern United States, viewing potential impacts to three distinct métiers of scallop production. Kasper et al. (2022) used a métier analysis to define fleets in the ecosystem model Atlantis in Icelandic waters, while Letschert et al. (2025) developed FISHCODE, an agent-based fisheries model for German fisheries in the North Sea, where agents can dynamically change the métier they are operating in for each trip. Métiers can serve as the foundation for bioeconomic models and set the foundation for adaptive management of fisheries (Quiroga and Blanz, 2025).

*Caveats and future work*

There are some limitations to the analysis. Many past métier analysis (e.g., Pascoe et al. 2022; Castro et al. 2010; Briton 2019, etc.) have analyzed catch by individual vessel per day (or time at sea), which makes it easier to elucidate targeting preferences by fishers and can capture technical interactions within a fishery (and métier) at a finer scale. However, aggregated shots are adequate for the purposes of developing the multispecies technical models on which management reference points can be based given the métiers represent large segments of the fishery.

Certain rockfish species (e.g., quillback rockfish [*Sebastes maliger*], yelloweye rockfish [*Sebastes ruberrimus*]) are considered overfished off the US West Coast and are of particular interest to managers (Langseth, 2024; Johnston et al., 2025). These species should be examined in a multispecies context once their fisheries are reopened. Overfished species were excluded from this analysis because there was no revenue for them since the introduction of the IFQ system in 2011, and for some species much earlier, such as yelloweye rockfish, which was declared overfished in 2002 (Johnston et al., 2025). Many species, such as black rockfish, have stock assessments conducted at the state level or other spatial delineation. As location was not a significant determinant of cluster, these delineations were difficult to capture in this analysis. Spatial considerations can be a factor when defining métiers, and best practices should be considered when applying spatial models to extend métiers to management (e.g., Kapur et al. (2021) with MSY). The ranges of these species are similarly not limited to solely the US West Coast. Fish cannot identify manmade borders; many stocks have ranges and significant catch in Canadian and Mexican waters, making management a multinational effort.

There is no universally defined way to conduct a métier analysis, and different approaches to conducting the analysis could lead to differing results. Future métier analysis should be adaptable to new methods within the field as new methods (e.g., machine learning - Sulanke et al., 2025; Kühn et al., 2025) continue to be developed for clustering fisheries data. Some authors (e.g., Ulrich et al., 2012) contend that métier analyses may not accurately capture targeting by fishers accurately. For example, imperfect data, shifting baselines and effort allocations, and disagreements between the approach of scientists and fishers can all lead to métiers not accurately reflecting fishing conditions. To combat this, we use the best practices outlined by Briton (2019) to cluster data and refine these clusters into métiers.

*Conclusions*

We generated clusters based on ex-vessel revenue for 31 groundfish species commonly caught in US federally managed fisheries off the US West Coast. As discussion around management shifts to include multispecies or ecosystem-based approaches, finding suitable ways to model and manage large, complex systems becomes crucial. Using clustering algorithms to determine groupings of species to be managed represents a simple, reproducible manner for the foundation of métiers. This study also demonstrates how to refine clusters from a large (17) number into an appropriate number of métiers (here 4) to compute selectivity and retention patterns for reference point calculation. Given the coarse scale of the data relative to other clustering analysis, this study provides a framework for data-limited clustering to take place in other regions across the world. The methods and results outlined in this study can be used to enhance fisheries management on the US West Coast and serve as a launchpad for future work related to multispecies and ecosystem-based fisheries management objectives.

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**Data and materials availability statement**

The datasets presented in this article are not readily available because of confidentiality agreements between fishers and NOAA. Requests to access the datasets should be directed to NOAA. Code and full-resolution figures for this study can be found at https://github.com/willpatrone/USWestCoastMetiers.

**Conflicts of Interest**

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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**References**

Abad, E., Punzón, A., Castro, J., Marín-González, M., & Silva, L. (2011). Métiers of the Northern Spanish coastal fleet using fixed gears. *Centro Oceanográfico de Vigo*.

Abernathy, K. E. (2010). Fishing for What? Understanding Fisher Decision-Making in Southwest England, Doctoral thesis, University of East Anglia, Norwich

Beaugrand, G., Conversi, A., Chiba, S., Edwards, M., Fonda-Umani, S., Greene, C., ... & Sugisaki, H. (2015). Synchronous marine pelagic regime shifts in the Northern Hemisphere. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *370*(1659), 20130272.

Beamish, R. J., G. A. McFarlane, K. R. Weir, M. S. Smith, J. R. Scarsbrook, A. J. Cass and C.C. Wood. 1982. Observations on the biology of Pacific hake, Walleye pollock and Spiny Dogfish in the Strait of Georgia, Juan de Fuca Strait and off the west coast of Vancouver Island and United States, July 13-24, 1976. Canadian Manuscript Report of Fisheries and Aquatic Sciences 1651:150p.

Binch, L., Poos, J. J., & van de Wolfshaar, K. Effort Shifts to Ecosystem Impacts: Marine Protected Areas Influence Fish Populations and Food Webs. *Available at SSRN 5024902*.

Branch, T. A., Hilborn, R., Haynie, A. C., Fay, G., Flynn, L., Griffiths, J., Marshall, K. N., et al. 2006. Fleet dynamics and fishermen behavior: lessons for fisheries managers. Canadian Journal of Fisheries and Aquatic Sciences, 63: 1647–1668.

Brewster, L. R., Townsend, H., Link, J. S., Edwards, F., DePiper, G., Hansell, A. C., & Cadrin, S. X. (2025). A practical guide to economic frontiers for evaluating benefits of multispecies fisheries management. *North American Journal of Fisheries Management*, *45*(3), 369-385.

Boonstra WJ, Hentati-Sundberg J. Classifying fishers’ behaviour. An invitation to fishing styles. Fish Fish 2016; 17 :78–100. https://doi.org/10.1111/faf.12092

Briton, F., 2019. Defining metiers and fleets for the SESSF using multivariate statistical methods. Unpublished document presented to the December 2019 SERAG meeting.

Burch P, Sutton, C, Cannard, T, Briton, F and Sporcic, M (2021). An investigation of the bycatch of rebuilding species and other selected species in the Southern and Eastern Scalefish and Shark Fishery. December 2021, CSIRO, Australia.

Campbell, R., Zhou, S., Hoyle, S., Hillary, R., Haddon, M., and Auld, S. (2017). Developing Innovative Approaches to Improve CPUE Standardisation for Australia’s Multispecies Pelagic Longline Fisheries. Final report for project 2014-021. Canberra: The Fisheries Research Development Corporation

Cardoso, I., Moura, T., Mendes, H., Silva, C., & Azevedo, M. (2015). An ecosystem approach to mixed fisheries: technical and biological interactions in the Portuguese multi-gear fleet. ICES Journal of Marine Science, 72(9), 2618-2626.

Carvalho, F., Winker, H., Courtney, D., Kapur, M., Kell, L., Cardinale, M., ... & Methot, R. D. (2021). A cookbook for using model diagnostics in integrated stock assessments. *Fisheries Research*, *240*, 105959.

Castro, J., Punzón, A., Pierce, G. J., Marín, M., & Abad, E. (2010). Identification of métiers of the Northern Spanish coastal bottom pair trawl fleet by using the partitioning method CLARA. Fisheries Research, 102(1-2), 184-190.

Castro, J., Marín, M., Pierce, G. J., & Punzón, A. (2011). Identification of métiers of the Spanish set-longline fleet operating in non-Spanish European waters. *Fisheries Research*, *107*(1-3), 100-111.

Chaji, M., Ardini, G., Harsch, M., Haynie, A., Lee, M. Y., McManus, B., ... & Thunberg, E. (2025). Assessing Impacts of Offshore Wind Development: An Analysis of the Minimization of Economic Exposure of the Scallop Fishery Through the Regulatory Process. *Fisheries Oceanography*, e12717.

Cope, J. M., & Punt, A. E. (2009). Drawing the lines: resolving fishery management units with simple fisheries data. Canadian Journal of Fisheries and Aquatic Sciences, 66(8), 1256-1273.

Davie, S., and Lordan, C. (2011). Examining changes in Irish fishing practices in response to the cod long-term plan. ICES J. Mar. Sci. 68, 1638–1646. https://doi.org/10.1093/icesjms/fsr052

Del Santo O’Neill, T. J., Rossberg, A. G., & Thorpe, R. B. (2024). An efficient tool to find multispecies MSY for interacting fish stocks. Fish and Fisheries, 25(3), 441-454.

Demirel, Nazli, Ekin Akoglu, Aylin Ulman, Pınar Ertor-Akyazi, Güzin Gül, Dalida Bedikoğlu, Taner Yıldız, and I. Noyan Yilmaz. "Uncovering ecological regime shifts in the Sea of Marmara and reconsidering management strategies." *Marine Environmental Research* 183 (2023): 105794.

Deporte, N., Ulrich, C., Mahévas, S., Demanèche, S., Bastardie, F. Regional métier definition: a comparative investigation of statistical methods using a workflow applied to international otter trawl fisheries in the North Sea. ICES Journal of Marine Science.

Duarte, R., Azevedo, M., & Afonso-Dias, M. (2009). Segmentation and fishery characteristics of the mixed-species multi-gear Portuguese fleet. *ICES Journal of Marine Science*, *66*(3), 594-606.

Ekerhovd, N. A., & Steinshamn, S. I. (2016). Economic benefits of multi-species management: The pelagic fisheries in the Northeast Atlantic. Marine Resource Economics, 31(2), 193-210.

EU. 2013. Regulation (EU) No 1380/2013 of the European Parliament and of the Council on the Common Fisheries Policy. Official Journal of the European Union, L 354: 22–61.

Fisher, M. C., Moore, S. K., Jardine, S. L., Watson, J. R., & Samhouri, J. F. (2021). Climate shock effects and mediation in fisheries. *Proceedings of the National Academy of Sciences*, *118*(2), e2014379117.

Fogarty, M. J., Gamble, R., & Perretti, C. T. (2016). Dynamic complexity in exploited marine ecosystems. *Frontiers in Ecology and Evolution*, *4*, 68.

Free, C. M., Anderson, S. C., Hellmers, E. A., Muhling, B. A., Navarro, M. O., Richerson, K., ... & Bellquist, L. F. (2023). Impact of the 2014–2016 marine heatwave on US and Canada West Coast fisheries: Surprises and lessons from key case studies. Fish and Fisheries, 24(4), 652-674.

Gertseva, V. Taylor, I.G., Wallace, J.R., Matson, S.E. 2021. Status of the Pacific Spiny Dogfish shark resource off the continental U.S. Pacific Coast in 2021. Pacific Fishery Management Council, Portland, OR. Available from http://www.pcouncil.org/groundfish/stock-assessments/

González-Álvarez, J., García-de-la-Fuente, L., García-Flórez, L., del Pino Fernández-Rueda, M., & Alcázar-Álvarez, J. L. (2016). Identification and characterization of métiers in multi-species artisanal fisheries. A case study in northwest Spain. Natural Resources, 7(6), 295-314.

Harvey, C. J., Dereynier, Y. L., Morrison, W. E., Cudney, J. L., Dick, D. M., Ford, T., ... & Link, J. S. (2025). The US Ecosystem‐Based Fisheries Management Policy and Road Map: Assessing Progress and Applying Lessons Learned. Fish and Fisheries.

Hicks, A. C., Wetzel, C., & Harms, J. (2013). The status of rougheye rockfish (Sebastes aleutianus) and blackspotted rockfish (S. melanostictus) as a complex along the US West Coast in 2013. *Draft dated*, *6*(24), 2013.

Hilborn, R. 2007. Managing fisheries is managing people: what has been learned? Fish and Fisheries, 8: 285–296.

Hintzen, N.T., Bastardie, F., Beare, D., Piet, G.J., Ulrich, C., Deporte, N., Egekvist, J., & Degel, H. VMStools: Open-source software for the processing, analysis and visualisation of fisheries logbook and VMS data. Fisheries Research. 115-116:31-43; 2012, <https://doi.org/10.1016/j.fishres.2011.11.007>

Hornborg, S., van Putten, I., Novaglio, C., Fulton, E. A., Blanchard, J. L., Plaganyi, E., Bulman, C., et al. 2019. Ecosystem-based fisheries management requires broader performance indicators for the human dimension. Marine Policy, 108: 103639.

Hutton, T., Pascoe, S., Deng, R. A., Punt, A. E., & Zhou, S. (2022). Effects of re-specifying the Northern Prawn Fishery bioeconomic model to include banana prawns. *Fisheries Research*, *247*, 106190.

Iudicello, S., & Lueders, S. B. (2016). A survey of litigation over catch shares and groundfish management in the pacific coast and northeast multispecies fisheries. *Envtl. L.*, *46*, 157.

Johnson, K. F., Wetzel, C. R., & Tolimieri, N. (2023). Status of sablefish (Anoplopoma fimbria) along the US West Coast in 2023. *Pacific Fisheries Management Council, Portland, Oregon*.

Johnston, M., Rosemond, R. C., Perl, E., Whitman, A., Barros, M., Champagnat, J., Schamp, A., Schiano, S., and Caltabellotta, F. (2025) Status of Yelloweye rockfish off the U.S. West Coast in 2025. Pacific Fishery Management Council. [XX] p.

Kapur, M. S., Siple, M. C., Olmos, M., Privitera-Johnson, K. M., Adams, G., Best, J., ... & Punt, A. E. (2021). Equilibrium reference point calculations for the next generation of spatial assessments. *Fisheries Research*, *244*, 106132.

Kasper, J. M., Oostdijk, M., Baranowska, E., & Sturludóttir, E. Implementation of a métier-based dynamic fisheries model in the Atlantis model for Icelandic waters.

Kinneen, M., Goodman, M., Sulc, A., Balstad, l., Diaz, R., Randrup, K., Patrone, W., Spencer, L., Morell, A., Rovellini, A., Dedrick, A., Grunloh, N., Bargas, M., Hopkins, S., Gersteva, V., Oken, K., Taylor, I., Haltuch, M., & Hamel, O. (2025). Stock Assessment Update: Status of Widow Rockfish (Sebastes entomelas) Along the U.S. West Coast in 2025. Pacific Fishery Management Council, Portland, Oregon.

Kühn, B., Cayetano, A., Fincham, J. I., Moustahfid, H., Sokolova, M., Trifonova, N., ... & Uusitalo, L. (2025). Machine learning applications for fisheries—at scales from genomics to ecosystems. *Reviews in Fisheries Science & Aquaculture*, *33*(2), 334-357.

Lahellec, G., Daurès, F., & Lehuta, S. (2025). Revealing the adaptation strategies of pelagic fleets in the Bay of Biscay by combining fishery data and fishers’ knowledge. *ICES Journal of Marine Science*, fsae171.

Langseth, B.J., K.L. Oken, A.D. Whitman, J.E. Budrick, T.S. Tsou. 2023. Status of Canary Rockfish (Sebastes pinniger) along the U.S. West Coast in 2023. Pacific Fishery Management Council, Portland, Oregon. 256p.

Langseth, B.J. 2024. 2023 Rebuilding analysis for quillback rockfish (Sebastes maliger) in U.S. waters off the coast of California based on the 2021 stock assessment. Pacific Fishery Management Council, Portland, Oregon. 21p.

Lee, Y. J., Su, N. J., Lee, H. T., Hsu, W. W. Y., & Liao, C. H. (2021). Application of métier-based approaches for spatial planning and management: A case study on a mixed trawl fishery in Taiwan. *Journal of Marine Science and Engineering*, *9*(5), 480.

Lewy, P., & Vinther, M. (1994). Identification of Danish North Sea trawl fisheries. *ICES Journal of marine Science*, *51*(3), 263-272.

Love, G. D., Siders, Z. A., Gandy, D. A., Pine III, W. E., Baker, S., & Camp, E. V. (2024). Unexpected stability in faunal population abundances following an estuary‐wide collapse of oysters. *Ecosphere*, *15*(8), e4857.

Libralato S, Pranovi F, Stergiou K et al. Trophodynamics in marine ecology: 70 years after Lindeman. Mar Ecol Prog Ser 2014;512:1– 7. <https://doi.org/10.3354/meps11033>

Maechler, M., Rousseeuw, P., Struyf, A., Hubert, M., Hornik, K.(2024). cluster: Cluster Analysis Basics and Extensions. R package version 2.1.7.

Marçalo, A., Carvalho, F., Frade, M., Bentes, L., Monteiro, P., Pontes, J., ... & Gonçalves, J. M. (2025). Reducing Cetacean Interactions With Bottom Set‐Nets and Purse Seining Using Acoustic Deterrent Devices in Southern Iberia. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *35*(2), e70061.

Marchal, P. (2008). A comparative analysis of métiers and catch profiles for some French demersal and pelagic fleets. ICES Journal of Marine Science, 65(4), 674-686.

McCluskey, S. M., & Lewison, R. L. (2008). Quantifying fishing effort: a synthesis of current methods and their applications. *Fish and fisheries*, *9*(2), 188-200.

Methot RD. Prioritizing fish stock assessments. Washington, D.C.: NMFS, NOAA, US Department of Commerce; 2015. Available from: https://www.st.nmfs.noaa.gov/Assets/stock/documents/PrioritizingFishStockAssessments\_FinalWeb.pdf

Neubauer, P., Thorson, J. T., Melnychuk, M. C., Methot, R., & Blackhart, K. (2018). Drivers and rates of stock assessments in the United States. PLoS One, 13(5), e0196483.

Nielsen, J. R., and Christensen, A. S. (2006). Sharing responsibilities in Danish fisheries management—experiences and future directions. Mar. Pol. 30, 181– 188. https://doi.org/10.1016/j.marpol.2004.12.002

O’Farrell, S., Chollett, I., Sanchirico, J. N., and Perruso, L. (2019). Classifying fishing behavioral diversity using high-frequency movement data. Proc. Natl. Acad. Sci. U.S.A. 116, 16811–16816. https://doi.org/10.1073/pnas.1906766116

Oken, K.L., I.G. Taylor, M.L. Feddern, A.D. Whitman and F.P. Caltabellotta. 2025. Status of the yellowtail rockfish stock off the U.S. West Coast north of 40°10′ in 2025. Pacific Fishery Management Council, Portland, Oregon. [XX] p

Ono, K., Haynie, A. C., Hollowed, A. B., Ianelli, J. N., McGilliard, C. R., & Punt, A. E. (2018). Management strategy analysis for multispecies fisheries, including technical interactions and human behavior in modelling management decisions and fishing. Canadian Journal of Fisheries and Aquatic Sciences, 75(8), 1185-1202.

Ovando, D. (2025). Predicted effects of marine protected areas on conservation and catches are sensitive to model structure. *Theoretical Ecology*, *18*(1), 7.

Pacific Fisheries Information Network (PacFIN) retrieval dated July 10, 2024, Pacific States Marine Fisheries Commission, Portland, Oregon ([www.psmfc.org](http://www.psmfc.org/)).

Pacific Fishery Management Council (PFMC). 1982. Pacific Coast groundfish plan: Fishery management plan and environmental impact statement for the California, Oregon and Washington groundfish fishery. Portland: Pacific Fishery Management Council (https://www.pcouncil.org/documents/1982/01/final-fishery-management-plan-and-supplemental-environmental-impact-statement-for-the-washington-oregon-and-california-groundfish-fishery.pdf/)

Pacific Fishery Management Council (PFMC). (2024a). Status of the Pacific Coast groundfish fishery: stock assessment and fishery evaluation. (<https://www.pcouncil.org/documents/2024/08/status-of-the-pacific-coast-groundfish-fishery-stock-assessment-and-fishery-evaluation-august-2024.pdf/>)

Pacific Fishery Management Council (PFMC). (2024b). Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, And Washington Groundfish Fishery. (https://www.pcouncil.org/documents/2022/08/pacific-coast-groundfish-fishery-management-plan.pdf/)

Pacific Fishery Management Council (PFMC). (2025). Literature Review of Life History Aspects of All 86 Groundfish Species Managed by the Pacific Fishery Management Council. (<https://www.pcouncil.org/documents/2025/02/h-6-attachment-3-stock-structure-literature-review.pdf/>)

Palialexis, A., & Vassilopoulou, V. (2012). Metier identification in trammel net fisheries in Greece. Oral paper presented at the 10th Panhellenic Symposium of Oceanography and Fisheries, Athens.

Parsa, M., Emery, T. J., Williams, A. J., & Nicol, S. (2020). A robust métier-based approach to classifying fishing practices within commercial fisheries. Frontiers in Marine Science, 7, 552391.

Pascoe, S., Punt, A. E., Hutton, T., Burch, P., Bessell-Browne, P., & Little, L. R. (2022). Estimating economic-based target reference points for key species in multi-species multi-métier fisheries. *Canadian Journal of Fisheries and Aquatic Sciences*, *80*(4), 732-746.

Quiroga, E., & Blanz, B. (2025). A Framework to Quantify Adaptation to Multiple Drivers. *arXiv preprint arXiv:2502.07463*.

R Core Team (2023). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Rousseeuw, P.J. Silhouettes: A graphical aid to the interpretation and validation of cluster analysis. Journal of Computational and Applied Mathematics. 20:53-65; 1987, <https://doi.org/10.1016/0377-0427(87)90125-7>

Ruiz, J., Louzao, M., Oyarzabal, I., Arregi, L., Mugerza, E., & Uriarte, A. (2021). The Spanish purse-seine fishery targeting small pelagic species in the Bay of Biscay: landings, discards and interactions with protected species. *Fisheries Research*, *239*, 105951.

Russo, T., Carpentieri, P., Fiorentino, F., Arneri, E., Scardi, M., Cioffi, A., & Cataudella, S. (2016). Modeling landings profiles of fishing vessels: An application of Self-Organizing Maps to VMS and logbook data. *Fisheries Research*, *181*, 34-47.

Sampson, D. B. (1992). Fishing technology and fleet dynamics: predictions from a bioeconomic model. Marine Resource Economics, 7(1), 37-58.

Schadeberg, A., Kraan, M., & Hamon, K. G. (2021). Beyond métiers: social factors influence fisher behaviour. *ICES Journal of Marine Science*, *78*(4), 1530-1541.

Shin, Y. J., & Cury, P. (2001). Exploring fish community dynamics through size-dependent trophic interactions using a spatialized individual-based model. Aquatic Living Resources, 14(2), 65–80. https://doi.org/10.1016/S0990-7440(01)01106-8

Struyf, A., Hubert, M., & Rousseeuw, P. (1997). Clustering in an object-oriented environment. Journal of Statistical Software, 1, 1-30.

Sulanke, E., Rubel, V., Berkenhagen, J., Bernreuther, M., Stoeck, T., & Simons, S. (2025). Amending the European fishing fleet segmentation based on machine learning and multivariate statistics. Fisheries Research, 281, 107190.

Sun, M., Li, Y., Suatoni, L., Kempf, A., Taylor, M., Fulton, E., ... & Chen, Y. (2023). Status and management of mixed fisheries: a global synthesis. *Reviews in Fisheries Science & Aquaculture*, *31*(4), 458-482.

Szymkowiak, M., Steinkruger, A., & Hayes, A. L. (2024). Alaska's emergent fisheries processes. *Ocean & Coastal Management*, *249*, 107004.

Taylor, I.G., K.F. Johnson, B.J. Langseth, A. Stephens, L.S. Lam, M.H. Monk, A.D. Whitman, M.A. Haltuch. 2021. Status of lingcod (Ophiodon elongatus) along the northern U.S. west coast in 2021. Pacific Fisheries Management Council, Portland, Oregon. 254p.

Thrush, S. F., & Dayton, P. K. (2002). Disturbance to marine benthic habitats by trawling and dredging: implications for marine biodiversity. *Annual review of ecology and systematics*, *33*(1), 449-473.

Tolotti, M., Guillotreau, P., Forget, F., Capello, M., & Dagorn, L. (2023). Unintended effects of single-species fisheries management. Environment, Development and Sustainability, 25(9), 9227-9250.

Tserpes, G., Peristeraki, P., & Nielsen, J. R. (2006). Ecological side-effects of fishing from the fisheries management perspective. In *Developments in Aquaculture and fisheries Science* (Vol. 36, pp. 267-294). Elsevier.

Tzanatos, E., Castro, J., Forcada, A., Matić-Skoko, S., Gaspar, M., and Koutsikopoulos, C. 2013. A Métier-Sustainability-Index (MSI25) to evaluate fisheries components: assessment of cases from data-poor fisheries from southern Europe. – ICES Journal of Marine Science, 70:78–98.

U.S. Department of Commerce (2007). Magnuson-Stevens Fishery Conservation And Management Act as amended by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (P.L. 109-479). Public Law 94-265.

Ulrich, C., Gascuel, D., Dunn, M. R., Le Gallic, B., & Dintheer, C. (2001). Estimation of technical interactions due to the competition for resource in a mixed-species fishery, and the typology of fleets and métiers in the English Channel. Aquatic Living Resources, 14(5), 267-281.

Ulrich, C., Wilson, D. C., Nielsen, J. R., Bastardie, F., Reeves, S. A., Andersen, B. S., & Eigaard, O. R. (2012). Challenges and opportunities for fleet-and métier-based approaches for fisheries management under the European Common Fishery Policy. *Ocean & Coastal Management*, *70*, 38-47.

Warlick, A., Steiner, E., & Guldin, M. (2018). History of the West Coast groundfish trawl fishery: Tracking socioeconomic characteristics across different management policies in a multispecies fishery. *Marine Policy*, *93*, 9-21.

Winker, H., Kerwath, S. E., & Attwood, C. G. (2013). Comparison of two approaches to standardize catch-per-unit-effort for targeting behaviour in a multispecies hand-line fishery. Fisheries Research, 139, 118-131.

Zamborain-Mason, J., Cinner, J. E., MacNeil, M. A., Graham, N. A., Hoey, A. S., Beger, M., ... & Connolly, S. R. (2023). Sustainable reference points for multispecies coral reef fisheries. Nature Communications, 14(1), 5368.

Zappia L, Oshlack A. Clustering trees: a visualization for evaluating clusterings at multiple resolutions. GigaScience. 2018;7. https://doi.org/10.1093/gigascience/giy083

**Tables**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cluster | Métier | Species Group | Habitat | Dominant Gear Group(s) | Proportion of Ex-Vessel Revenue |
| 1 | A | Rockfish | shelf | midwater trawl | 0.32% |
| 2 | B | mixed | mixed | bottom trawl/line and pole | 0.07% |
| 3 | B | rockfish | shelf | line and pole | 0.20% |
| 4 | C | flatfish/roundfish | mixed | mixed trawl | 5.62% |
| 5 | D | roundfish | slope | set net and fish pot/line and pole | 24.1% |
| 6 | B | flatfish/roundfish | mixed | bottom trawl | 10.9% |
| 7 | A | rockfish | shelf | midwater trawl | 3.40% |
| 8 | C | mixed | shelf | bottom trawl | 0.36% |
| 9 | C | flatfish/roundfish | mixed | bottom trawl | 17.9% |
| 10 | D | roundfish/rockfish | slope | line and pole | 3.49% |
| 11 | B | roundfish/rockfish | mixed | line and pole | 0.20% |
| 12 | B | rockfish | mixed | line and pole | 0.01% |
| 13 | B | elasmobranch | shelf | line and pole | 0.003% |
| 14 | C | mixed | mixed | bottom trawl/line and pole | 0.59% |
| 15 | B | mixed | mixed | line and pole | 0.05% |
| 16 | B | roundfish | slope | set net and fish pot/line and pole | 0.01% |
| 17 | A | roundfish/rockfish | shelf | midwater trawl | 33.0% |

Table 1: Summary of each cluster and métier. Note: The connection between gears and gear group can be found in Table A.2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Gear | Métier | | | |
|  | A | B | C | D |
| Fish Pot | 0% | 0.02%\* | 0.07%\* | 99.9% |
| Flatfish Trawl | 0% | 91.37% | 8.63%\* | 0% |
| Groundfish Trawl (Otter) | 0% | 9.01%\* | 90.99% | 0% |
| Groundfish Trawl, Footrope < 8 In. | 0.01%\* | 37.61% | 61.76% | 0.63%\* |
| Groundfish Trawl, Footrope > 8 In. | 0% | 1.70% | 97.03% | 1.27%\* |
| Longline Or Setline | 0.00% | 0.10%\* | 12.41% | 87.49% |
| Midwater Trawl | 97.35% | 0.01%\* | 2.64%\* | 0% |
| Other Trawl Gear | 0.00% | 98.68% | 1.21%\* | 0.11%\* |
| Pole (Commercial) | 3.54%\* | 60.28% | 35.81% | 0.38%\* |
| Roller Trawl | 0% | 15.30% | 84.53% | 0.17%\* |
| Selective Ff Trawl, Small Footrope | 0% | 100% | 0% | 0.03%\* |
| Set Net | 0% | 0% | 0.22% | 99.78% |
| Gear Group |  |  |  |  |
| Bottom Trawl | 0.00% | 35.68% | 63.97% | 0.35%\* |
| Line and Pole | 0.16%\* | 2.75%\* | 13.44% | 83.65% |
| Midwater Trawl | 97.35% | 0.01%\* | 2.64%\* | 0.00% |
| Set Net & Fish Pot | 0% | 0.02%\* | 0.07%\* | 99.91% |
| Total | 36.7% | 11.4% | 24.5% | 27.6% |

Table 2: Summary of each cluster by gear type. Note values of zero are true zeros while values of 0.00% have some catch, but are negligible. \* Small sources if revenue (<10%) that could potentially be ignored when computing management reference points.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Species | Métier | | | |
|  | A | B | C | D |
| Arrowtooth Flounder | 0.53% | 26.80% | 72.20% | 0.48% |
| Bank Rockfish | 0.14% | 26.92% | 65.92% | 7.02% |
| Black Rockfish | 0.51% | 71.41% | 11.14% | 16.94% |
| Blackgill Rockfish | 0.02% | 17.27% | 62.12% | 20.59% |
| Bocaccio | 2.60% | 33.39% | 58.57% | 5.44% |
| Canary Rockfish | 31.34% | 42.51% | 19.56% | 6.59% |
| Chilipepper Rockfish | 0.98% | 24.82% | 72.29% | 1.91% |
| Darkblotched Rockfish | 8.52% | 15.97% | 68.79% | 6.72% |
| Dover Sole | 0.02% | 24.33% | 75.40% | 0.25% |
| English Sole | 0.09% | 67.97% | 31.55% | 0.39% |
| Lingcod | 1.34% | 56.49% | 26.86% | 15.30% |
| Longnose Skate | 0.03% | 35.52% | 59.75% | 4.70% |
| Longspine Thornyhead | 0.00% | 5.84% | 86.54% | 7.62% |
| Pacific Cod | 0.19% | 81.17% | 17.29% | 1.35% |
| Pacific Ocean Perch | 15.85% | 30.32% | 52.79% | 1.04% |
| Pacific Sanddab | 0.00% | 69.74% | 16.57% | 13.70% |
| Pacific Whiting | 97.99% | 0.00% | 2.01% | 0.00% |
| Petrale Sole | 0.03% | 51.83% | 47.81% | 0.34% |
| Redstripe Rockfish | 79.44% | 12.18% | 8.34% | 0.04% |
| Rex Sole | 0.18% | 39.19% | 60.45% | 0.17% |
| Rougheye Rockfish | 7.71% | 4.48% | 24.05% | 63.76% |
| Sablefish | 0.23% | 3.12% | 23.40% | 73.25% |
| Sand Sole | 0.00% | 83.35% | 9.35% | 7.30% |
| Shortspine Thornyhead | 0.12% | 4.54% | 45.97% | 49.37% |
| Silvergray Rockfish | 4.93% | 42.07% | 44.90% | 8.11% |
| Spiny Dogfish | 63.03% | 19.93% | 9.09% | 7.94% |
| Splitnose Rockfish | 36.99% | 17.76% | 42.24% | 3.01% |
| Starry Flounder | 0.01% | 72.15% | 27.57% | 0.27% |
| Walleye Pollock | 90.16% | 4.34% | 5.47% | 0.03% |
| Widow Rockfish | 94.22% | 1.39% | 4.35% | 0.04% |
| Yellowtail Rockfish | 76.21% | 15.83% | 7.68% | 0.27% |
| Ecological Group |  |  |  |  |
| Slope Rockfish | 0.39% | 69.02% | 3.60% | 26.99% |
| Shelf Rockfish | 72.68% | 1.25% | 12.31% | 13.75% |
| Flatfish | 0.04% | 0.45% | 39.28% | 60.23% |
| Roundfish | 92.18% | 0.71% | 3.75% | 3.35% |
| Elasmobranchs | 4.63% | 4.93% | 34.39% | 56.05% |
| Total | 36.7% | 11.4% | 24.5% | 27.6% |

Table 3: Summary of each cluster by species and species group

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Gear or Species | Métier | | | |
|  | A | B | C | D |
| Gear Group |  |  |  |  |
| Bottom Trawl | No | Yes | Yes | No |
| Line and Pole | No | No | Yes | Yes |
| Midwater Trawl | Yes | No | No | No |
| Set Net & Fish Pot | No | No | No | Yes |
| Ecological Group |  |  |  |  |
| Slope Rockfish | No | Yes | No | Yes |
| Shelf Rockfish | Yes | No | Yes | Yes |
| Flatfish | No | No | Yes | Yes |
| Roundfish | Yes | No | No | No |
| Elasmobranchs | No | No | Yes | Yes |

Table 4: Ecological and gear groups represented in each métier