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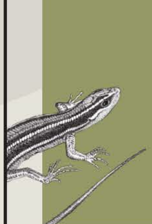

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Oregon Historical Marine Recreational Catch Reconstruction
(1979 – 2000)

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ABSTRACT

Beginning in the early 1970s, the Ocean Recreational Boat Survey (ORBS), previously known as the Ocean Salmon Sampling Project, monitored recreational ocean boat landings at Oregon coastal ports. To improve historic recreational catch estimates for marine fish (non-salmonid) from the federal Marine Recreational Fisheries Statistical Survey (MRFSS), Oregon Department of Fish and Wildlife (ODFW) staff at the Marine Resources Program comprehensively reconstruct ORBS catch estimates for all major recreational species from 1979 to 2000. Estimated catch (numbers of fish) of major species categories (flatfish, lingcod, miscellaneous fish and rockfish) are extrapolated to address gaps in sampling coverage. Species compositions from two concurrent data sources, MRFSS sampling and ORBS sampling, are applied to the category-level numbers of fish to produce species-specific estimates delineated in space (port) and time (year, month) by fishing mode. The species-specific estimates using the ORBS species compositions are recommended as the observed sample size is much larger than the MRFSS dataset and the fishing modes more closely align to those of the catch estimates.

INTRODUCTION

Accurate estimates of historical recreational catch are critical for stock assessments of managed nearshore species. The Marine Resources Program (MRP) at the Oregon Department of Fish and Wildlife (ODFW) has monitored marine recreational catch since the 1970s to provide catch estimates for fisheries management. The federal Marine Recreational Fisheries Statistical Survey (MRFSS) also monitored recreational catch from 1980 to 2000. However, there are known biases from MRFSS related to effort estimation and sampling (Voorhees et al. 2000) that resulted in catch estimates considered implausible by ODFW. To improve historic recreational catch estimates for nearshore fisheries, MRP staff reconstructed catch estimates for individual species as particular stocks were assessed over the last decade. This comprehensive historical recreational catch reconstruction is intended to replace this piecemeal approach and includes all major recreational species. The final goal of this reconstruction is to provide these catch estimates directly to federal stock assessors through the Recreational Fisheries Information Network (RecFIN), the primary data depository for West Coast recreational fisheries.

ODFW recreational monitoring programs prior to 2001 focused primarily on salmonid species, but also collected data for multi-species categories such as rockfish, flatfish, and miscellaneous fishes. There were also several single species categories, such as lingcod, halibut, and tuna during this time. Catch estimates derived from these data provide an alternative to MRFSS but they lack the comprehensive spatial and temporal coverage of MRFSS. Addressing coverage issues is a major component of this reconstruction. All database development and analysis for this reconstruction was completed in R (R Core Team 2022) and used R packages ggplot2 (Wickham 2016), tidyr (Wickham and Girlich 2022), reshape2 (Wickham 2007) and dplyr (Wickham et al. 2022).

Base Dataset

The Ocean Recreational Boat Survey (ORBS) has monitored marine recreational ocean boat landings at Oregon ports (Figure 1) starting in the early 1970s. These data and estimates of catch made from them are considered the base dataset for this analysis. This reconstruction covers from 1979 – 2000. Reconstructed estimates from prior to 1979 require additional data entry and will be developed in the future. The base dataset is only intended to represent ocean boat estimates and does not include shore and estuary catches. It also does not include estimates of discarded or illegally landed fish, though given the regulations during this time, it's likely that the magnitude of these removals was likely minimal. The base dataset provides species-specific estimates of catch in numbers of fish, but documentation on how species level estimates were derived is missing. Species estimates are presumed to be derived from catch estimates from the multi-species categories that are included in the dataset. ORBS annual reports from this era indicate the base dataset consists of monthly estimates of catch during sampled times but does not include estimates for any unsampled time periods or areas. Catch estimates would have potentially been based upon estimates of effort, collected concurrently with landings data, but documentation on methods used to estimate effort is also missing.

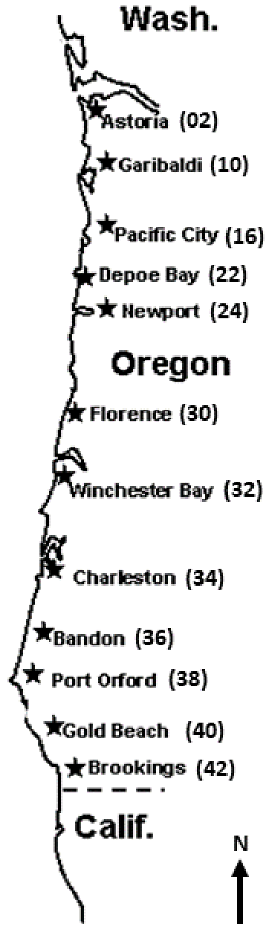

Figure 1: Recreational fishing ports (followed by their port codes) in Oregon.

The major species categories present in the base dataset for non-salmonid marine species include rockfish, flatfish, lingcod, halibut, tuna and miscellaneous. Certain categories are present throughout the entire timeframe of the dataset, while others, such as halibut and tuna, were separated from multi-species categories during this period (Figure 2). Starting in 2001, ORBS began monitoring marine fish at the individual species level, as opposed to species categories, referred to as the "modern" ORBS era. For this comprehensive reconstruction, four species categories were selected to reconstruct. These categories include rockfish, lingcod, flatfish and miscellaneous, which include the bulk of the managed marine fish species.

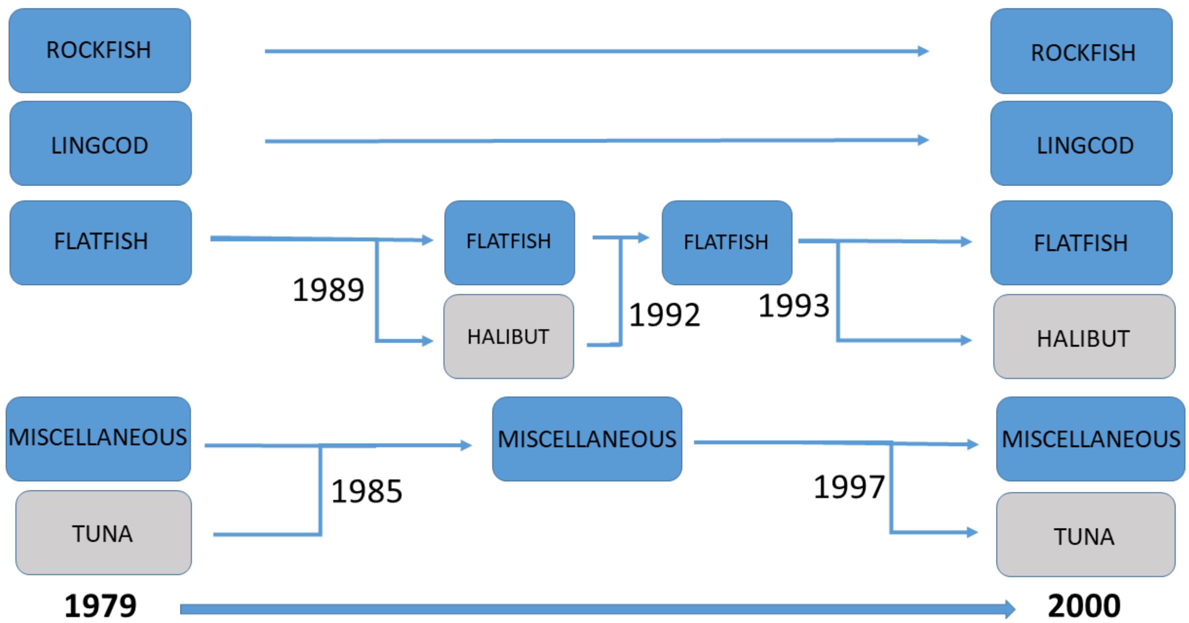

Figure 2: Recreational marine species category structure from 1979 – 2000. The blue rectangles indicate categories included in this reconstruction.

The individual species documented in the base dataset defined the species present in each category and are listed in Appendix A (Table A1). The rockfish category includes a total of 28 rockfish species, but the primary species is black rockfish (*S. melanops*), followed by blue (*S. mystinus*), yellowtail (*S. flavidus*), and canary rockfish (*S. pinniger*). Flatfishes include 17 species. The most common species include sand sole (*Psettichthys melanostictus*), Pacific halibut (*Hippoglossus stenolepis*), starry flounder (*Platichthys stellatus*) and Pacific sanddab (*Citharichthys sordidus*). Finally, the miscellaneous category includes a total of 48 species with a broad distribution of life history strategies but include mostly groundfish. The two most common species by far are cabezon (*Scorpaenichthys marmoratus*) and kelp greenling (*Hexagrammos decagrammus*), followed by chub mackerel (*Scomber japonicus*) and sablefish (*Anoplopoma fimbria*).

Pacific halibut are included in the flatfish category from 1979 – 1989 and 1992 (Figure 2). From 1990 – 1991 and 1993 – 2000, halibut are distinguished as a single species category. There is no overlap in halibut estimates between the two categories, with the exception of a few halibut in 1999, which is likely an error. Halibut catch estimates are known with a relatively high degree of certainty following the implementation of quota management in 1988, so reconstructing the halibut category at this time would not dramatically improve catch estimates. In addition, halibut regulations are very complicated, even historically, and include seasonal closures, minimum size limits, and quota management that would be necessary to consider. Pacific halibut was reconstructed within the flatfish category, as halibut were considered incidental on flatfish trips taken mostly on charter vessels during this early period (pers. comm. Lynn Mattes, ODFW).

Tuna was not reconstructed as a category, though the miscellaneous category does include small numbers of albacore tuna (*Thunnus alalunga*). No other species of tuna are included in either category. The tuna category was present in 1979 (Figure 2), though sampled landings were included under both the miscellaneous and tuna category from 1979 – 1984. From 1985 to 1997, all samples of albacore are included in only the miscellaneous category. Landings from 1979 – 1997 averaged only 298 fish per year. From 1998 – 2000, all albacore were recorded under the tuna category only, representing 77.2% of all albacore landings in the base dataset. Estimated landings averaged 4,316 fish per year from 1998 – 2000 in the base dataset, indicating a dramatic increase in albacore sport landings during this period. Given the paucity of landings within the tuna category and that the development of the albacore tuna recreational fishery is truly considered from 2000 forward (pers. comm. Eric Schindler, ODFW), this category was not chosen for this reconstruction and albacore tuna landings were reconstructed within the miscellaneous category only.

Catch estimates are delineated in space and time through multiple domains, including year, month, port and fishing mode, in the base dataset. These domains are maintained in the reconstructed catch estimates. Fishing mode includes two types of modes, trip type and boat type, which do not overlap significantly in the base dataset. Trip type (bottomfish, combination, salmon, dive, halibut, tuna) is documented in the base dataset for the years 1979 – 1987 and in some ports, 1999-2000. Boat type (private and charter) is included for years 1988 – 2000 (Figure 3). Year-round sampling occurred in some ports in 1999 and 2000, and therefore estimates in these years are available for all months. Otherwise, catch estimates are primarily from the late spring and summer months.

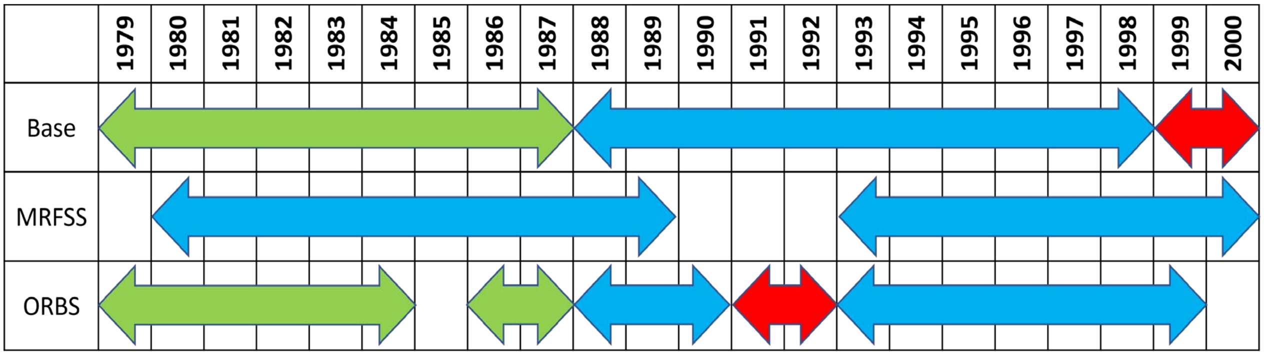

Figure 3: Structure of fishing modes within the base dataset, and the two species composition datasets, MRFSS and ORBS. The colors of the arrows denote the type of fishing mode present in each year of these datasets, including green for trip type, blue for boat type and red for both trip and boat type.

METHODS

For the catch estimates to be comprehensive, it was necessary to apply multiple expansions to account for unsampled domains (ports, years, and months), then apply species compositions to the multi-species categories to delineate catch estimates by individual species (See Figure 4 for a visual overview of the expansions).

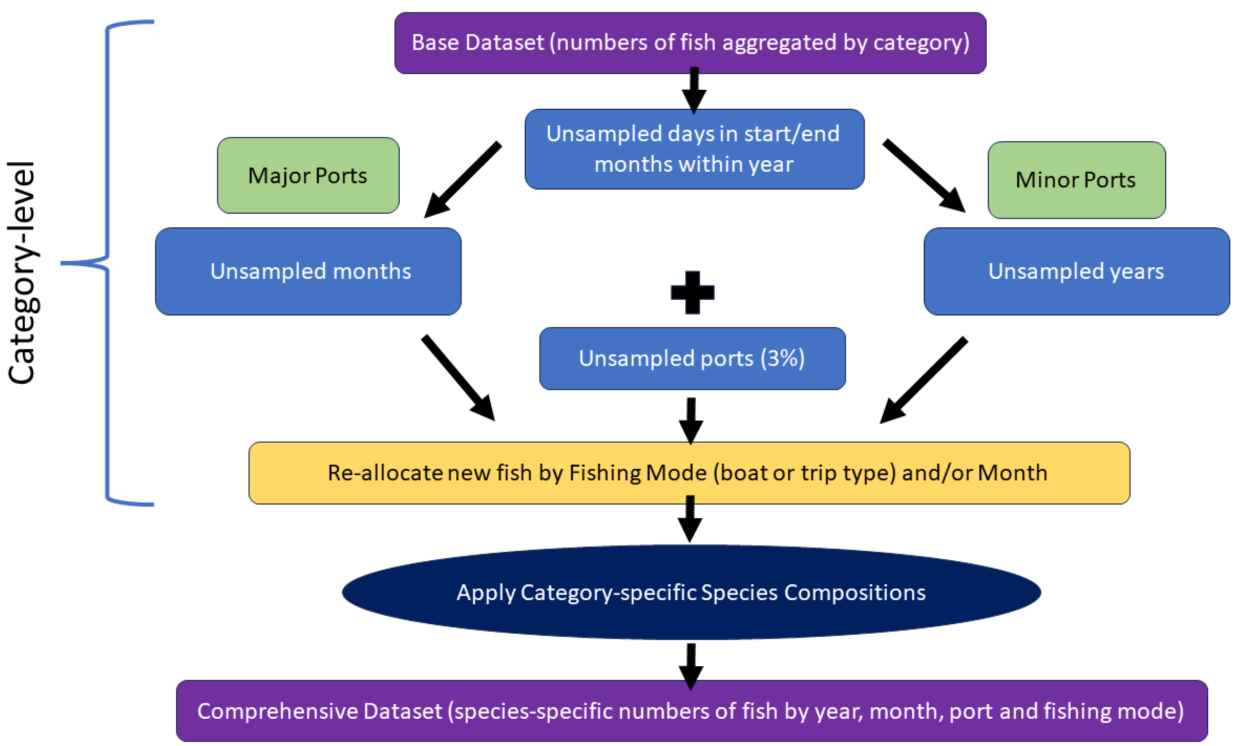

Figure 4: An overview of the category-level expansions applied prior to the application of species compositions to create a comprehensive dataset.

Overview of Temporal and Spatial Expansions

The first expansion accounts for unsampled days within the first or final month of sampling in all ports (i.e., a partial month of sampling). This expansion is necessary to complete estimated catch at the month-level, which is the finest temporal resolution in the base dataset. The second expansion accounts for unsampled months in major ports that were consistently sampled, at least seasonally, in each year (1979 – 2000). A third expansion is applied to seasonally sampled minor ports to account for a lack of annual sampling in each year. Definitions of major and minor ports are further explained below. Finally, an expansion (3% of total annual catch) is applied to account for ports that are never sampled but were presumed to have minor landings. An "other port" grouping (Port 0) was created to delineate this catch expansion. This 3% expansion is based on a study conducted in Newport in 1990, as documented in the annual Oregon Ocean Salmon Report (*Oregon Ocean Salmon Report* 1990). These four expansions are applied at the category level.

After estimating category landings that account for unsampled domains, species compositions are applied to produce species-specific estimates in numbers of fish. As mentioned previously, the species-specific catch estimates in the base dataset were unreliable and lacked documentation. This also allowed for the exploration of alternative methods to apply species composition information. There are two sources of data for species compositions, including 1) MRFSS and 2) ORBS sample data (Figure 3). However, before species compositions can be applied, the fishing mode domain (boat type/trip type) need to be consistent between the estimated category-level landings and the species composition datasets. In some cases, estimates are re-apportioned by an alternative fishing mode (e.g. by boat type instead of trip type) to match the fishing mode in a species composition dataset. This necessitated borrowing ratios of catch by fishing mode from other time periods.

Major ports in this reconstruction are defined under three criteria. These included: 1) at least one year of consistent year-round sampling, 2) had at least some catch sampling occur in each year from 1979 – 2000, and finally, 3) averaged greater than five percent of the annual sport catch. Following these criteria, the major ports include, from north to south, Garibaldi, Depoe Bay, Newport, Coos Bay and Brookings (Table 1). Minor ports, from north to south, included Astoria, Pacific City, Florence, Winchester Bay, Bandon, Port Orford, and Gold Beach. Minor ports were only sampled seasonally, the timeframe for which varied by port and year, and were not sampled in each year from 1979 – 2000 (Table 1). These ports contribute relatively little to the annual recreational catch when compared to the major ports but are important to include in this comprehensive reconstruction to fully account for total removals. One minor port, Port Orford, has year-round sampling data available; however, estimates from this port were not included in the expansion for minor ports. Instead, Port Orford was included in the expansion to account for ports that were never sampled (the previously mentioned 3% expansion). In addition to this port being sampled inconsistently between 1979 and 2000, it also had one of the lowest average annual proportions of catch (Table 1). Landings without a port specified were removed from the dataset (n = 4,632 fish or 0.059% of total fish in the base dataset). These included catch in 1999 and 2000 only and were from all four species categories.

Table 1: Ports present in the base dataset, including the type of port, years in the base dataset where sampling occurred, whether there are year-round sampling data available, and the average annual proportion of the annual recreational estimated catch from 1979 – 2000 in years when that port was sampled, based on the estimated catch from the base dataset.

Type of Port	Port	Port Code	Years of sampling in base dataset	Year-round sampling data available?	Avg. % of annual catch
Major	Newport	24	1979 - 2000	Yes	28.30%
	Brookings	42	1979 - 2000	Yes	21.27%
	Garibaldi	10	1979 - 2000	Yes	18.76%
	Depoe Bay	22	1979 - 2000	Yes	16.07%
	Coos Bay	34	1979 - 2000	Yes	8.64%
Minor	Gold Beach	40	1979 – 1988, 1998 - 2000	No	3.49%
	Bandon	36	1999 - 2000	No	2.81%
	Pacific City	16	1981 - 2000	No	2.73%
	Winchester Bay	32	1979 – 1994, 1996 - 1998	No	1.19%
	Astoria	02	1979 – 1993, 1995 - 2000	No	0.80%
	Port Orford*	38	1984, 1999 - 2000	Yes	0.74%
	Florence	30	1981 – 2000	No	0.25%

* Port Orford was ultimately not included as a separate port in this reconstruction

Partially Sampled Months Expansion

Though the base dataset only contains data at the monthly level, raw interview dates indicate that sampling did not always occur throughout the entire month at the beginning and end of each sampling season, referred to as shoulder months. An expansion factor was developed based on the proportion of days sampled compared to the total days in the month and applied to that month's catch in a particular port and year to correct for unsampled days in the month (Equation 1, Appendix B). As a simple example, if 50% of the days of the month were sampled, the expansion factor would be 1/0.5, or 2 and would result in a doubling of the catch estimate in that month. There is some potential for bias with this expansion factor, as catches outside the sampled times are likely to be lower. However, the impact of this bias is likely to be relatively small, considering that catches in these shoulder months are generally low compared to the core summer fishing season and recreational boats are generally limited by seasonal weather conditions. Two sources of data were used to determine the initial and final sampled dates for these shoulder months. The primary data used were digitized versions of raw observed effort records from 1986 - 2000. Additionally, paper sample records (ODFW "brown book") were used from 1979 – 1985. Start and end sample dates were based on the first and last date, respectively, that any sample was recorded regardless of species. Employee records were considered for this expansion but excluded due to the practice of multiple samplers covering some ports and that start dates were often confounded by training or duties other than sampling.

Annual partial month expansion factors by start and end month for major and minor ports are shown in Figures 5 and 6, respectively. As mentioned above, these expansions depend on the number of days sampled per month. Some minor ports were not sampled in all years, and therefore no expansions were developed in years lacking sampling. The development of these expansions revealed some discrepancies in the sample dates when compared to the monthly annual timeframe from the base dataset that remain be addressed. Currently, these discrepancies were excluded from the application of this expansion factor. However, most records (87.1% of the start month and 89.5% for the final month) matched the start and end month in each port and year in the base dataset. Future iterations might also consider a minimum level of sampling for this expansion to be applied. The impact of this expansion was relatively minor at the category-level (Figure 7), despite some individual expansion factors of up to 30, with the potential exception of the early 1980s in all four species categories.

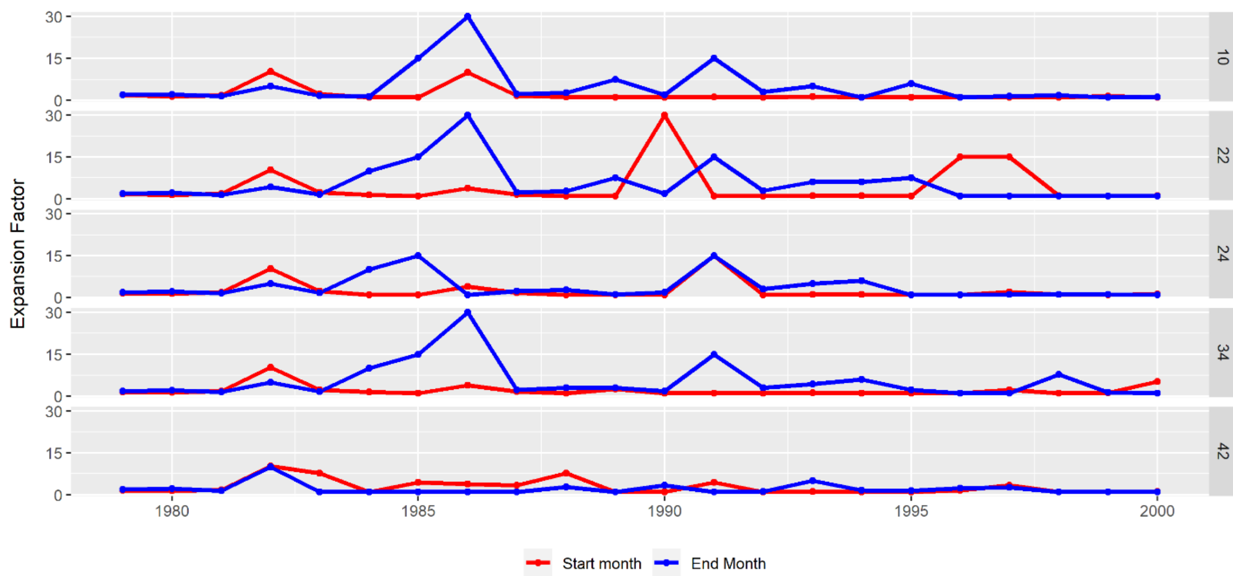

Figure 5: Annual partial month expansions for shoulder months in the five major ports. For each year, the start month expansion is in red and the end month expansion in blue. Major ports, from top to bottom, include Garibaldi (port code = 10), Depoe Bay (22), Newport (24), Coos Bay (34) and Brookings (42).

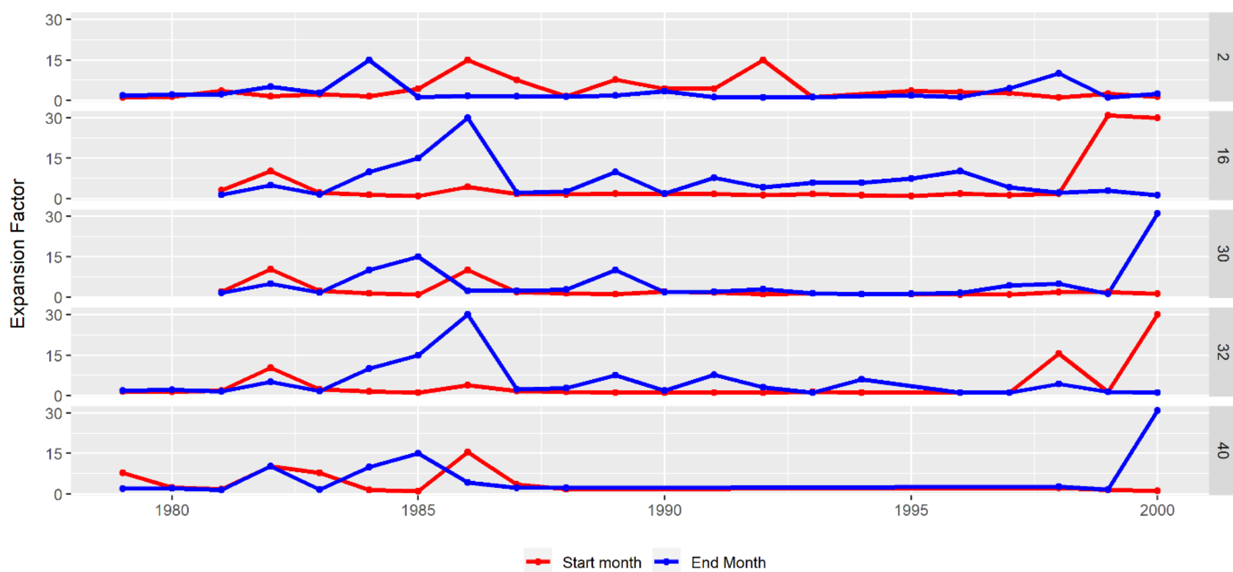

Figure 6: Annual partial month expansions for shoulder months in the minor ports. Start month expansions are in red and end month expansions are in blue. Minor ports, from top to bottom, include Astoria (port code = 2), Pacific City (16), Florence (30), Winchester Bay (32), and Gold Beach (40).

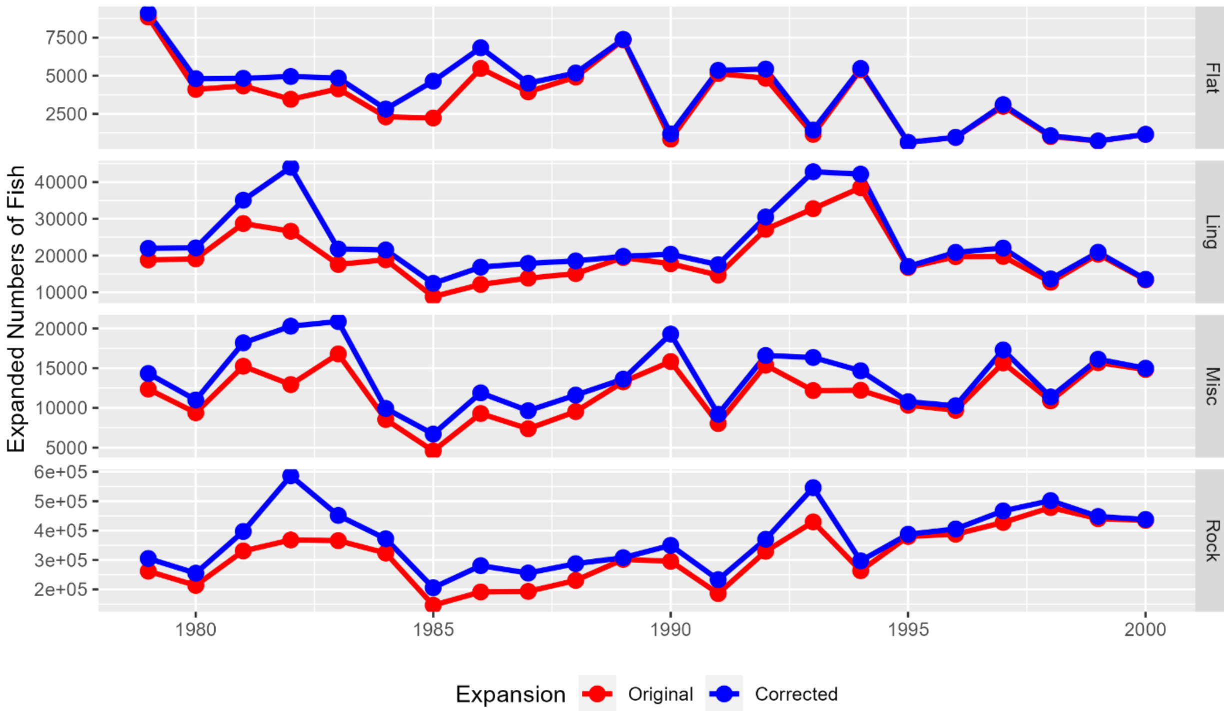

Figure 7: Results of the application of the partial month expansion factors at the category-level catch estimates for (top to bottom) flatfish, lingcod, miscellaneous, and rockfish categories. The red lines include the original base dataset estimates for shoulder months ("Original") and the blue lines are following the application of this expansion ("Corrected"). Note the variable y-axis scale.

Temporal Expansions for Major Ports

Within each major port, for each year where sampling was not conducted for the entire calendar year, the catch during the unsampled time periods (months) was expanded using the proportion of catch from corresponding time periods in years where sampling was conducted for the entire calendar year in that port. Expansion factors (Appendix B, Equations 2 and 3) were specific to the category – port domain and the timeframe of sampling in the year without year-round sampling, as detailed below.

The annual timeframe (months) that sampling occurred in each of the major ports from 1979 – 2000 was determined from the base dataset, using the presence of any species recorded in that month (see Figure 8, as an example). Annual timeframes were compared using effort data (1986 – 2000) but were nearly identical, and since there were no effort data available in 1979 – 1985, the sampling timeframes as characterized by the base dataset were used. Next, for each species category, the monthly proportion of the catch was determined from each continuously sampled year for each of the five major ports (Equation 2, Appendix B). Two data sources were used to calculate these monthly proportions (Table 2). The first source is the base dataset, which includes year-round sampling in most of the major ports in 1999 and 2000. The second source is the "modern" ORBS estimated catches (post-2000), in which sampling data from 2006

– 2017 were used, with at least one year of year-round sampling available for all major ports. The species in the modern ORBS estimated catches were assigned to each of the four marine species categories using those species present in the base dataset within each category to calculate category-specific monthly proportion of catch.

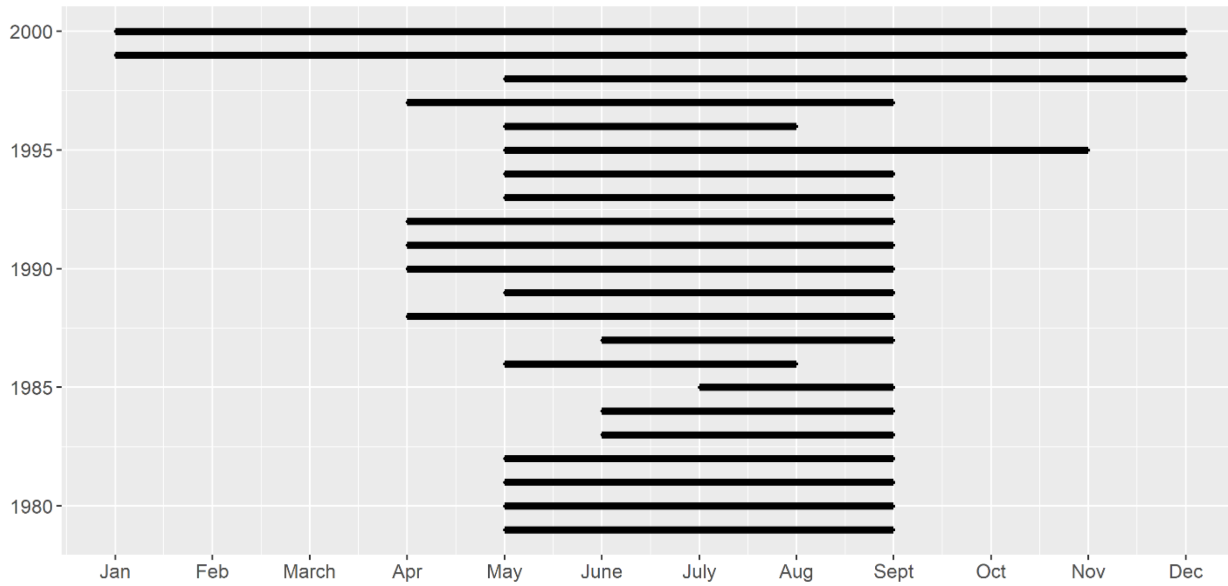

Figure 8: Annual sampling timeframe (in months) in Newport from 1979 – 2000 using the base dataset, as an example.

Table 2: Available years of year-round sampling for each major port from two datasets (base and modern ORBS sampling). Note that the total number of years by port does not exclude years removed due to fishing regulations, as those are specific to a species category.

Major Port (Code)	**Years Available (Data Source)**	**Total Years**
Garibaldi (10)	2013 (ORBS)	1
Depoe Bay (22)	1999 – 2000 (Base); 2006 – 2016 (ORBS)	13
Newport (24)	1999 – 2000 (Base); 2006 – 2017 (ORBS)	14
Coos Bay (34)	2000 (Base); 2011, 2013 (ORBS)	3
Brookings (42)	2000 (Base); 2006, 2011 – 2016 (ORBS)	8

For the modern ORBS data source (2006 – 2017), the estimated catches were used to determine monthly proportions of catch of the species in each of the categories in each major port. The estimated catches, rather than the raw numbers of fish, were used because these account for differences in monthly sampling rates, which vary throughout the year even in ports with year-round sampling. Statistical month instead of calendar month was used in the modern ORBS data, whereas the base dataset is assumed to be calendar month. Statistical month uses the statistical week and year to give a best approximation to calendar month.

In most major ports, there was more than one year of continuous sampling from which to calculate a monthly proportion of catch. Detailed examination of the monthly proportions (Figures 9 – 12) did not reveal any clear trends by species category, port or year. However, certain fishery restrictions may impact the seasonal distribution of the catch. To explore the potential impact of regulations on these temporal expansions, a detailed review of sport regulations from 1999 – 2000 and 2006 - 2017 for species within each of the four species categories was completed (see Appendix C for a table of relevant ODFW regulations). No major issues were identified that could impact the temporal distribution of catch for the lingcod or the rockfish species categories. However, regulations such as seasonal closures, substantial changes in bag limits and implementation of spatial closures for the flatfish and miscellaneous categories during this time had the potential to impact the seasonal distribution of the catch. For flatfish, 2006 was excluded because some flatfish species were subject to a more restrictive sub-bag limit that was restructured in 2007. For miscellaneous fish, 2013 – 2017 were removed as cabezon, a major component of this category, was not open until July 1 in each year. However, 2013 was retained for the temporal expansions for Garibaldi, as it is the only available year-round sampling data available for that major port. A comparison of the flatfish and miscellaneous fish annual expansion factors that included and excluded the years with regulation issues showed little impact of removing them.

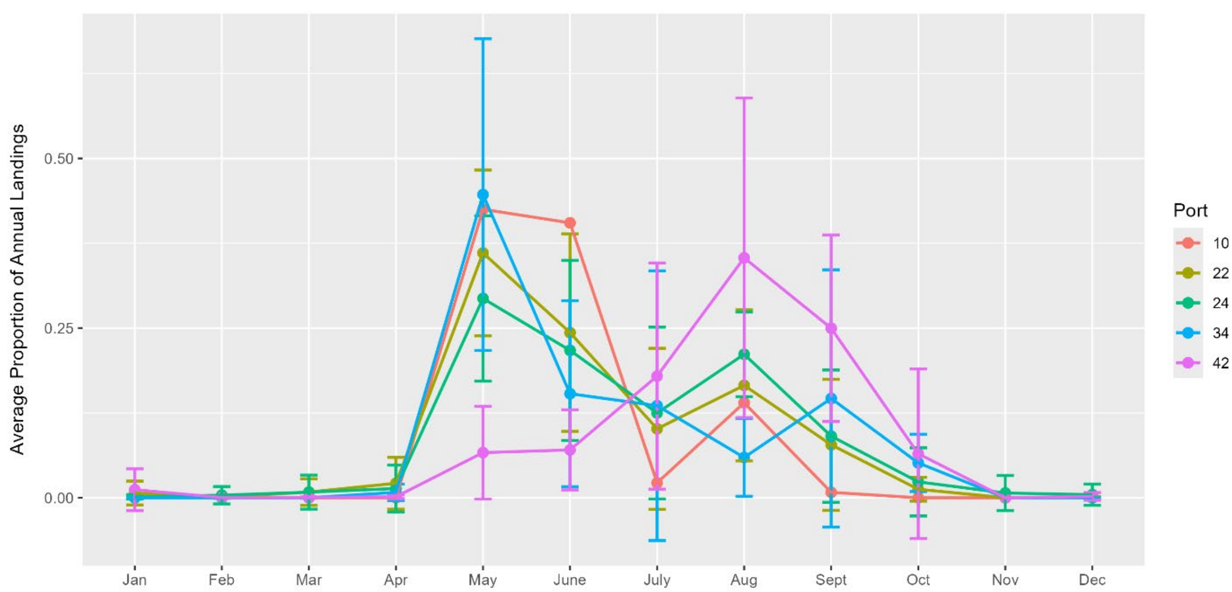

Figure 9: Flatfish category average monthly proportion of landings based on available years of year-round sampling in each major port (± standard deviation). Major ports include Garibaldi (10), Depoe Bay (22), Newport (24), Coos Bay (34) and Brookings (42).

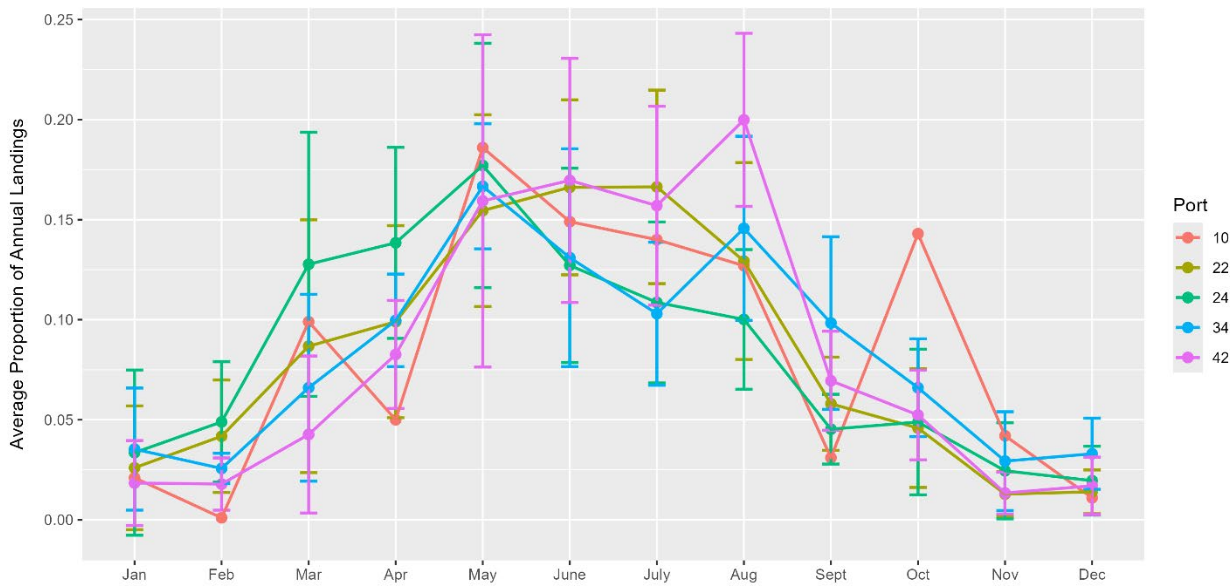

Figure 10: Lingcod category average monthly proportion of landings based on available years of year-round sampling in each major port (± standard deviation). Major ports include Garibaldi (10), Depoe Bay (22), Newport (24), Coos Bay (34) and Brookings (42).

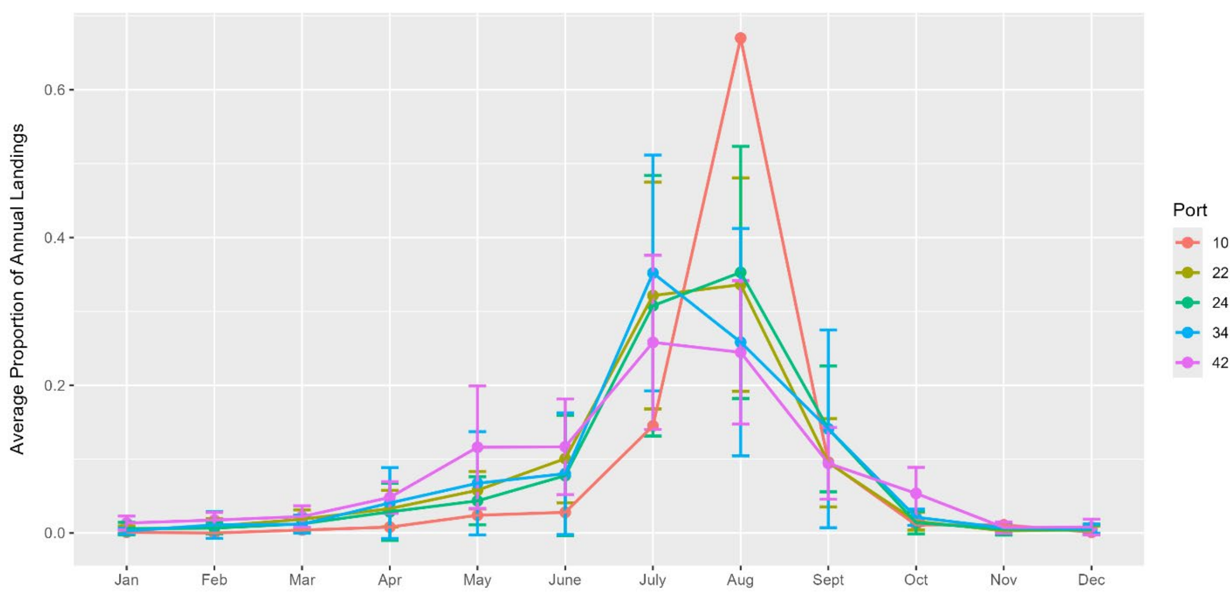

Figure 11: Miscellaneous category average monthly proportion of landings based on available years of year-round sampling in each major port (± standard deviation). Major ports include Garibaldi (10), Depoe Bay (22), Newport (24), Coos Bay (34) and Brookings (42).

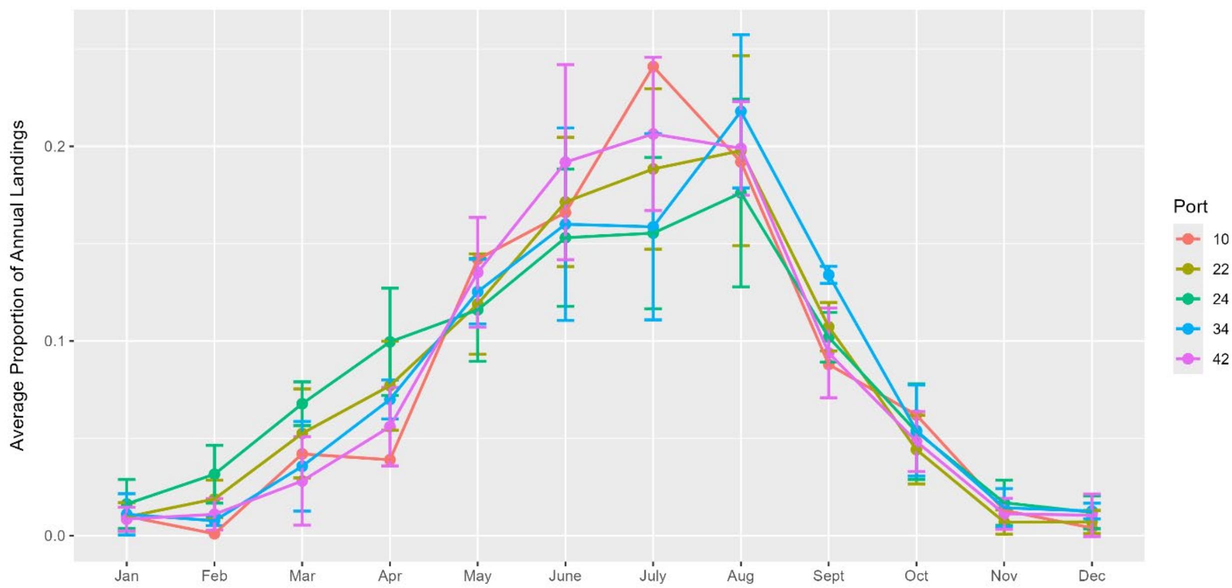

Figure 12: Rockfish category average monthly proportion of landings based on available years of year-round sampling in each major port (± standard deviation). Major ports include Garibaldi (10), Depoe Bay (22), Newport (24), Coos Bay (34) and Brookings (42).

The monthly proportion of category-level catch from each year of year-round sampling was combined with the annual sampling timeframes for each port to produce an annual expansion factor. These annual expansions were weighted equally across years of year-round data and averaged to produce a single annual expansion factor specific to each species category for each major port (Equation 3, Appendix B; Figures 13 – 16), except for Garibaldi, which had only a single year of year-round data to inform these expansions. Again, a detailed examination of the individual series of expansion factors did not reveal any clear trends by species category, port or year (Figure 17, as an example).

Expansion factors varied by category and port but had a similar general pattern across the period of the reconstruction, with highest expansion factors in the mid-1980s followed by lower expansions in the 1990s, reflecting similar sampling timeframes among the major ports. The relatively high expansions in 1985 are the result of a consistently short sampling timeframe across the major ports in that year (July – September in most ports) that excluded the months of May and June, which generally account for a high proportion of the annual catch. Anecdotal evidence from this time suggests that the 1983 El Nino greatly impacted salmon returns on the West coast, which would have impacted the length of the sampling seasons in the mid-1980s (pers. comm., E. Schindler, ODFW).

The average annual expansion factor was applied to the total category-specific catch in each year (1979 – 2000) for each major port to produce an estimate of the total catch in that year (Equation 3, Appendix B). The additional expanded numbers of fish were then apportioned by month for the unsampled months in that port and year to retain the original structure of the base dataset, using the average monthly proportion of catch from the retained years of year-round sample data to apportion the estimates outside the sampled period. Again, these monthly proportions were specific to species category and port. Expanded numbers of fish were also apportioned by boat or trip type (see subsequent sections "Boat Type Apportionment" and "Trip Type Apportionment").

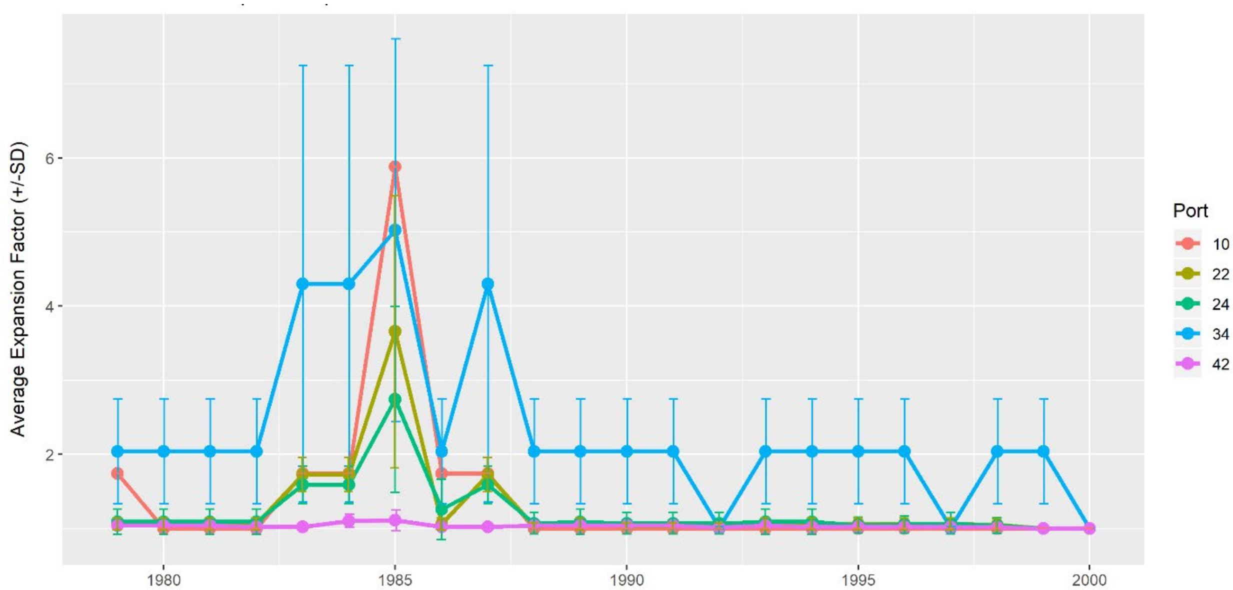

Figure 13: Average annual expansion factors for the flatfish category for each major port (± standard deviation).

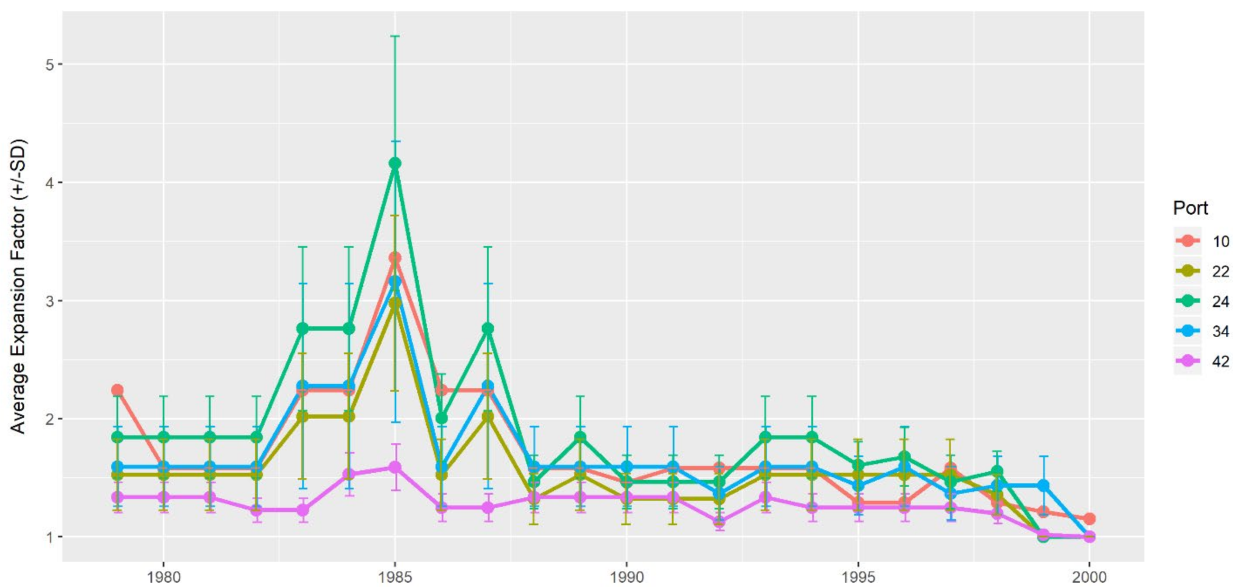

Figure 14: Average annual expansion factors for the lingcod category for each major port (± standard deviation).

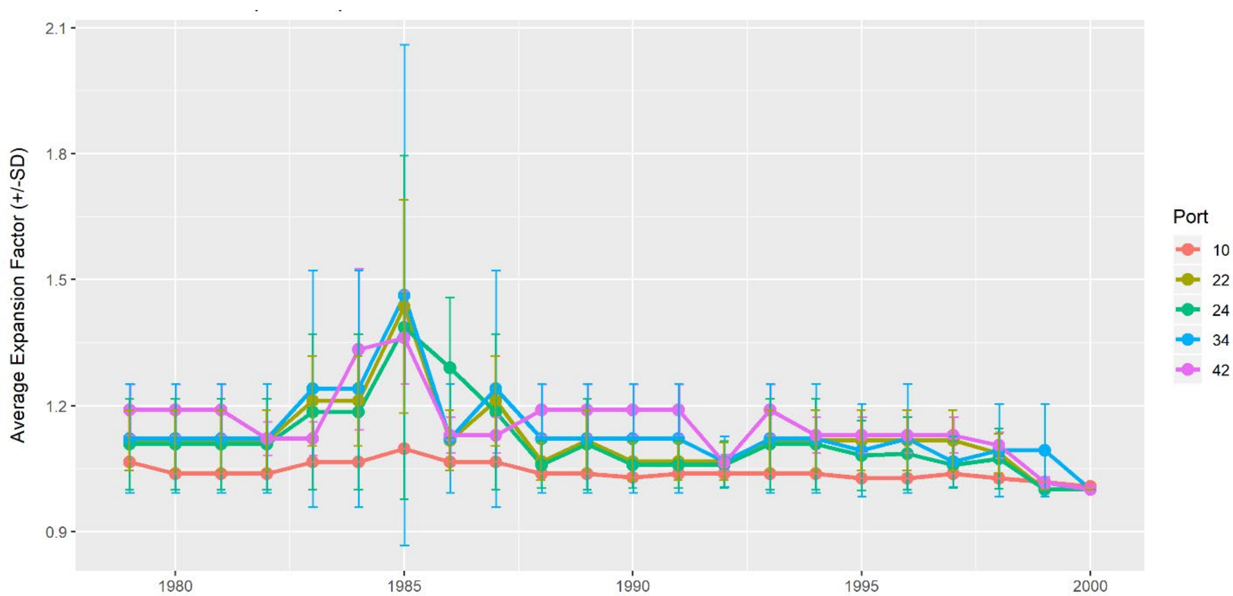

Figure 15: Average annual expansion factors for the miscellaneous category for each major port (± standard deviation).

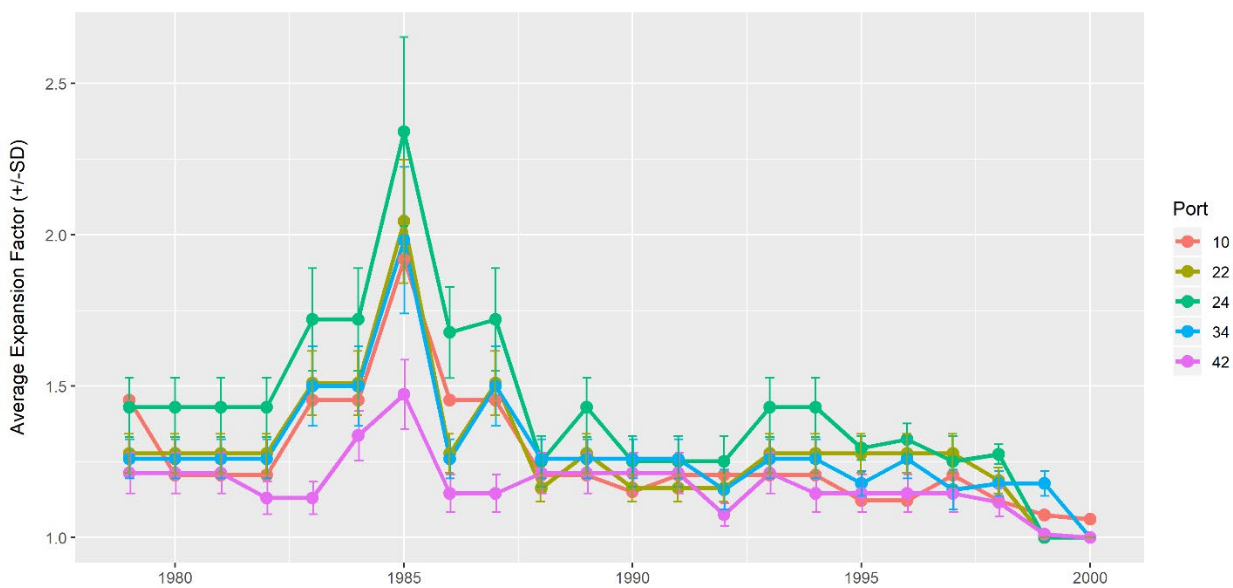

Figure 16: Average annual expansion factors for the rockfish category for each major port (± standard deviation).

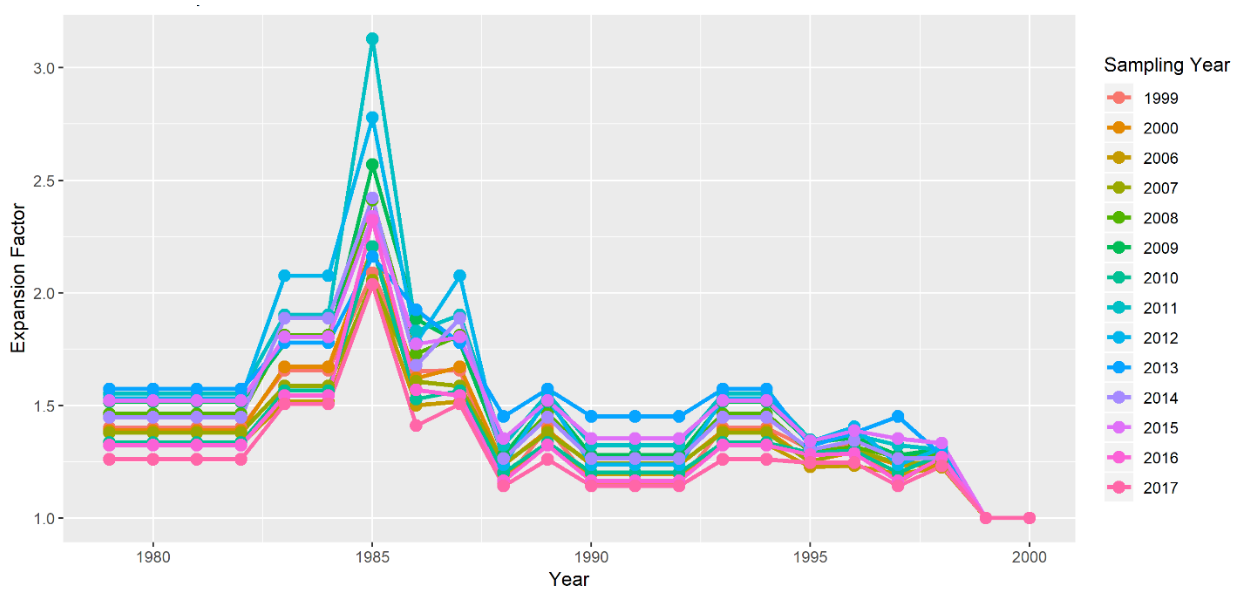

Figure 17: Annual temporal expansion factors for the rockfish category for Newport for each available year of year-round sampling data.

Spatial Expansions for Minor Ports

Minor ports include Astoria, Pacific City, Florence, Winchester Bay, Bandon, Port Orford, and Gold Beach. These ports were only sampled seasonally and only in a subset of the years included in this reconstruction. The seasonal sampling timeframe differed by year within each minor port, but generally included the summer months only (primarily, June – September). To account for catch from minor ports in unsampled years, a category-specific annual proportion of the minor port catch as compared to the total expanded catch from the five major ports in that year was calculated. This proportion was averaged using all available years where a minor port had catch (Appendix B - Equation 4; Table 3). Using the expanded catch from the major ports assumes that overall fishing trends and effort in the minor ports follow those of the major ports.

This average port-specific annual proportion was applied to the category-specific, temporally expanded total catch from the five major ports to expand catch in years in minor ports with no sampling. Expanded numbers of fish in these years were apportioned by month relative to the monthly proportion of minor port catch for all years of available sampled years in each port (Equation 5 – Appendix B). This approach implicitly assumes there is no catch outside of these seasonal timeframes within each minor port and that the maximum annual sampling timeframe is appropriate for allocating catch by month. This assumption is supported by the individual characteristics of each of these port that would limit marine fishing access outside the summer sampling season. Average proportions of minor port catch varied by port and by species category but were generally a very small component of the annual catch compared to the major ports.

Table 3: Average annual proportion of minor port catch to expanded catch in all major ports by species category.

Species Category	Minor Port (Code)					
	Astoria (02)	Pacific City (16)	Florence (30)	Winchester Bay (32)	Bandon (36)	Gold Beach (40)
Flatfish	0.139	0.043	0.045	0.068	0.005	0.007
Lingcod	0.008	0.049	0.001	0.002	0.030	0.033
Miscellaneous	0.028	0.046	0.004	0.015	0.052	0.020
Rockfish	0.004	0.020	0.002	0.009	0.030	0.028

Fishing Mode Structure for Expanded Estimates

This reconstruction explored the use of two different datasets to estimate species-specific landings from the expanded category-level landings. The first includes MRFSS interview data available from 1980 – 1989 and 1993 – 2000. The second dataset includes species compositions collected by ORBS concurrent with catch sampling from 1979 – 1999. Both species composition datasets have their benefits and drawbacks, which are explored in more detail in the Species Composition section. Aligning the fishing modes of the expanded category-specific estimates with these two species compositions dataset was necessary for this reconstruction.

There are two types of fishing mode systems present in the base dataset (Figure 3). The first mode is a trip type, which distinguishes modes of fishing by a general primary target species or species group. The most common trip types were bottomfish (77.6% of sampled fish with trip type) and salmon (19.9%), but also include combination (salmon and another trip type), halibut, tuna and dive (2.6% combined). This mode delineates monthly landings in the base dataset from 1979 – 1987. The second fishing mode system is boat type, which includes charter (69.8% of sampled fish with boat type) and private boats (30.2%). This mode delineates landings from 1988 – 2000 in the base dataset. Since the base dataset is originally ORBS sampling data, the distribution of the fishing modes within the base and ORBS species composition datasets are very similar (Figure 3). The MRFSS species composition dataset only utilizes boat type throughout the entire time series. Mode was included in the domain for expanded category-level catch estimates where it already existed in the base dataset. In some years, catch estimates were re-apportioned to a different fishing mode to align with the presence of fishing mode in the species compositions. This effectively created two separate structures of the expanded catch estimates, with fishing mode aligned to the ORBS and MRFSS species composition datasets, respectively (Figure 3).

Boat Type Apportionment

Landings from 1979 – 1987 were not separated by boat type in the base dataset, and so to align with the MRFSS species composition dataset, catch was re-apportioned by boat type during these years. For all ports and for each species category, the annual proportion of the catch for charter and private boats was calculated for each year from 1988 – 2000 using the base dataset. Visual examination of the data showed limited temporal trends (see Appendix D, but also Figure 18, as an example, for the rockfish category), though there were clearly differences by species category and by port (Figure 19). Therefore, category- and port-specific average annual proportions of catch by boat type were calculated using all available years (Equation 6, Appendix B).

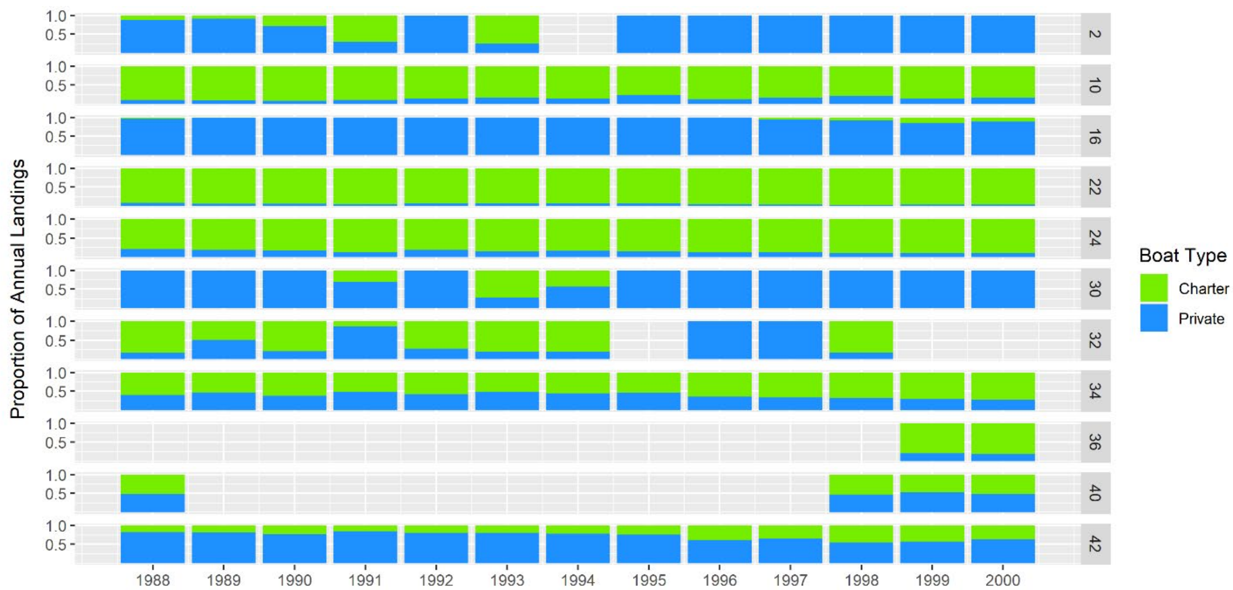

Figure 18: Annual proportion of boat mode-specific landings by port for the rockfish category, as an example. Green indicates charter vessels and blue are private vessels.

The seasonal sampling timeframe within each minor port varied by year. An average annual boat-type proportion using only June – August was considered to standardize the sampling timeframe for minor ports. However, these averages did not differ greatly from those calculated using all available months in each year, and some ports were not consistently sampled from June – August consistently, requiring that those years be excluded or have a boat type proportion based on only one or two months of sampling. Given these drawbacks, the average proportion of catch by boat type was calculated using all available months in each port and year. This average boat type proportion was applied to category-level unexpanded landings from 1979 – 1987 prior to the application of the temporal and spatial expansions to allow for delineation by boat type in the final dataset structure. For minor ports, boat type apportionments were also applied to expanded estimates in 1979 – 1987.

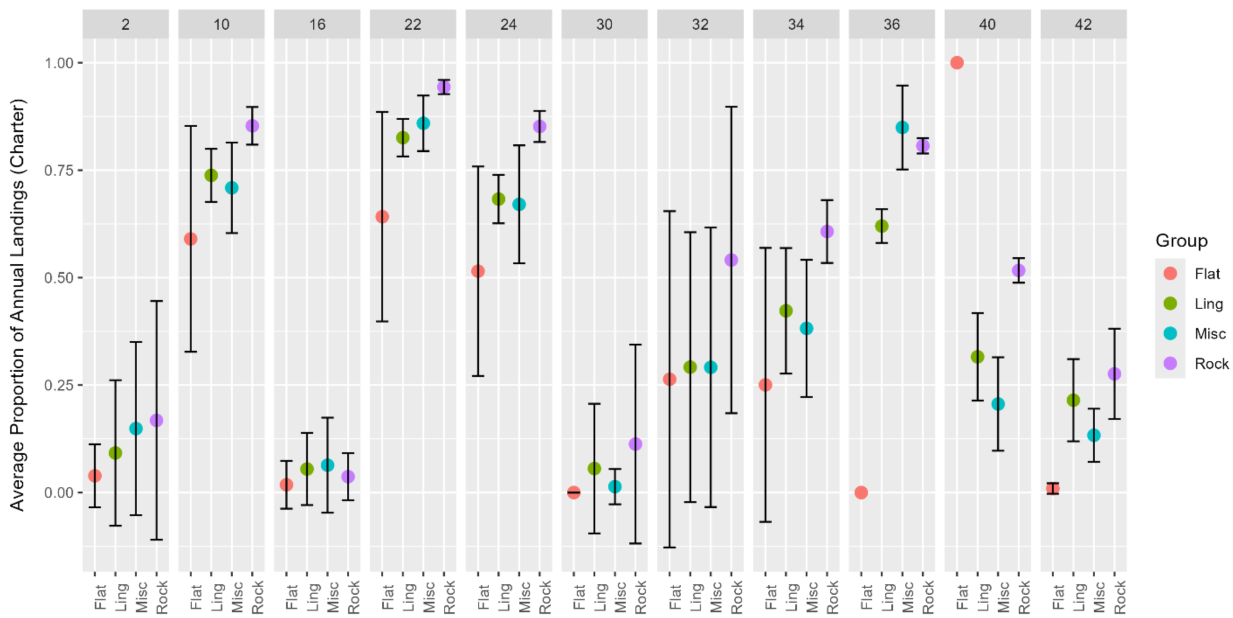

Figure 19: Average proportion of charter boat landings of each species category by port (± standard deviation, where available).

Trip Type Apportionment

Catch was apportioned by trip type where trip type was required and missing for bottomfish, salmon, and combination (salmon and another trip type) trip types. These three trip types cover 99.4% of fish in the base dataset. For all ports and each species category, the annual proportion of the catch was calculated for each of the years available (1979 -1987 and 1999 – 2000). Tuna, halibut and dive trip types were excluded due to their limited occurrence during this time period. Visual examination of the splits showed some differences between the 1979 – 1987 and 1999 – 2000 eras (see Appendix D, and Figure 20, as an example). There were also clear differences by port and species category (Figures 21 – 22).

The average proportion of catch by species category and port was calculated for each trip type (Equation 7, Appendix B). Due to the differences observed between 1979 – 1987 and 1999-2000, only annual trip type proportions from 1979 -1987 are used to calculate this average. This average proportion is applied to the additional category-level expanded landings in major ports and in minor ports with expanded catch from 1979 – 1987 to allow for complete delineation by trip type. As mentioned previously, ORBS sampling during this period was focused on recreational salmon fisheries. Examination of the monthly distribution of trip types during the year-round sampling in 1999 and 2000 showed that salmon trips were only recorded during the late spring – early fall months, suggesting that using a trip-type proportion from a typical sampling season in 1979 – 1987 might inflate the number of salmon trips in the winter when applied to expanded catch in these time periods in major ports, when there are no salmon trips occurring. To address this, trip type was applied in a two-stage approach. First, catch estimates for months outside the existing seasonal sampling timeframe in each major port were assigned the bottomfish trip type.

Second, expanded catch estimates within the existing sampling timeframe were apportioned to trip type using the average annual trip type proportion from 1979 - 1987. This approach makes use of the existing data on trip type without making invalid assumptions about salmon trips occurring outside a typical seasonal timeframe.

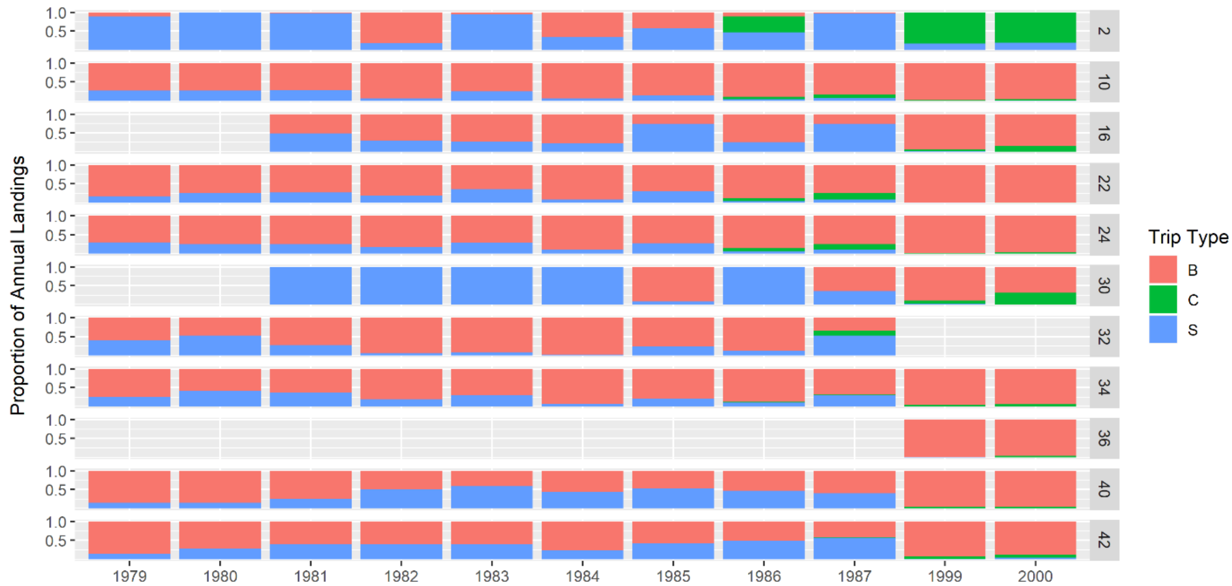

Figure 20: Annual proportion of landings by trip type for all ports and all available years for the rockfish category, as an example. Trip type includes bottomfish ("B"), combination ("C") and salmon ("S").

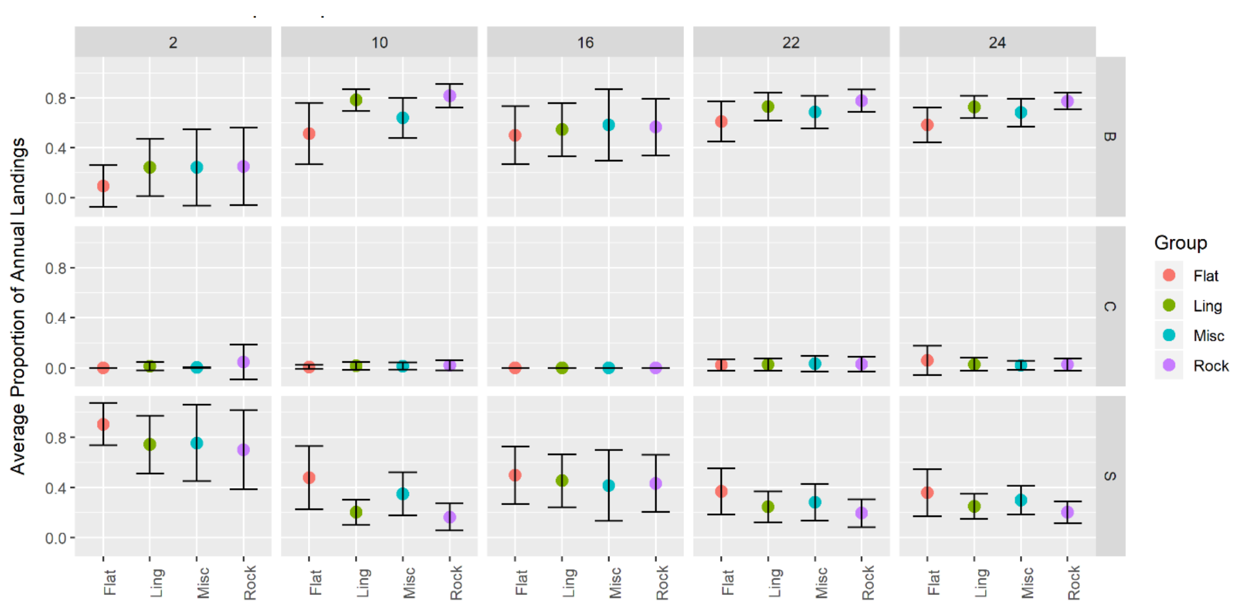

Figure 21: Average annual proportion of landings for each species category by port and trip mode for ports north of Cape Perpetua (Astoria, Garibaldi, Pacific City, Depoe Bay and Newport, respectively) (± standard deviation). The panels include different trip types, including "B" for bottomfish trip types, "S" for salmon and "C" for combination trips.

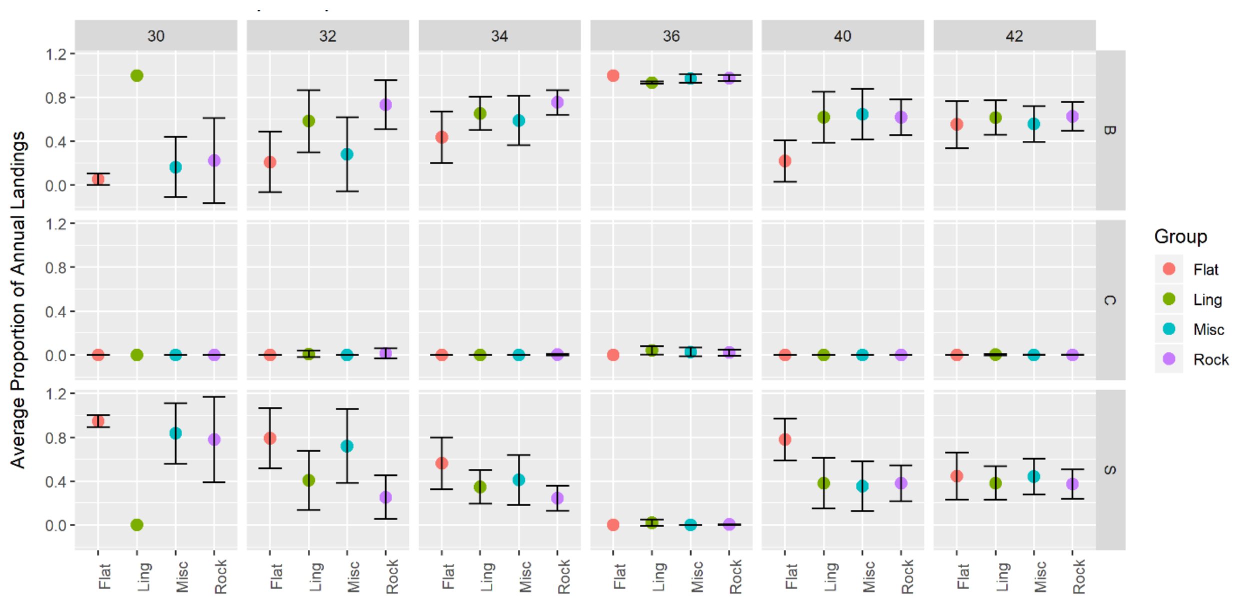

Figure 22: Average annual proportion of landings for each species category by port and trip mode for ports south of Cape Perpetua (Florence, Winchester Bay, Coos Bay, Bandon, Gold Beach and Brookings, respectively) (± standard deviation). The panels include different trip types, including “B” for bottomfish trip types, “S” for salmon and “C” for combination trips.

Other Port Expansion

A final expansion to account for ports that have never been monitored (3%) was also used. This expansion is based on a previous study in Newport in 1990 (*Oregon Ocean Salmon Report* 1990). For each unique species category - year - fishing mode domain, an “other port” (Port 0) was created to match the structure of each of the two expanded catch datasets. The 3% expansion was applied to the sum of the expanded numbers of fish for each of the category-port-year-mode domain estimates. Other ports catch do not have a month associated with them, as there are no data to reliably inform this delineation, but would be included in an annual estimate of coastwide catch.

Species Compositions

Species compositions were applied to the expanded category-level estimates for flatfish, rockfish and miscellaneous fish. Lingcod estimates, as a single species category, do not require a species composition. As mentioned previously, there are two sources of data for species compositions during this period, including MRFSS interview-level data and ORBS sampling data. Each are described in more detail below.

MRFSS Interview data - Interview level catch data from MRFSS are delineated by individual species. Interview data were aggregated to the monthly level by extracting the interview date from the ID code for each sample to calculate a proportion of the species as a component of its respective category. Individual species were assigned to a species category based on the presence of that species in the base dataset. Each sample was also assigned a port based on a combination of the county and the interview site. There can be multiple interview sites within a port, and data from any estuarine or riverine interview sites were excluded. Data include years from 1980 – 1989 and 1993 – 2000. Boat type is the only fishing mode, and includes man-made shore, beach/bank, charter and private, though only the final two modes are present in the base dataset. On average, the annual number of fish present in the MRFSS interview data represents 3.2% (range: 1.9 – 4.9%) of unexpanded landings in the base dataset (1980 – 1989, 1993 – 2000) (Table 4). Pacific halibut and albacore tuna were included in the species compositions in only the years where they are present in their species category (flatfish and miscellaneous fish, respectively).

Table 4: Numbers of fish and the proportion of numbers of fish present in each species composition dataset as compared to the base dataset for 1979 – 2000.

	Base	**MRFSS Species Composition**		**ORBS Species Composition**	
Year	**Numbers of Fish**	**Numbers of Fish**	**Proportion Compared to Base**	**Numbers of Fish**	**Proportion Compared to Base**
1979	302,101			106,744	0.353
1980	246,163	7,965	0.032	67,686	0.224
1981	379,145	4,878	0.020	136,256	0.451
1982	411,012	5,885	0.024	136,138	0.451
1983	405,381	4,563	0.019	110,194	0.365
1984	353,366	7,543	0.031	104,885	0.347
1985	161,937	8,568	0.035		
1986	218,299	6,851	0.028	94,017	0.311
1987	218,369	5,073	0.021	64,458	0.213
1988	260,172	6,806	0.028	74,164	0.245
1989	342,194	5,620	0.023	53,431	0.177
1990	333,458			93,471	0.309
1991	216,735			82,822	0.274
1992	376,894			93,795	0.310
1993	480,293	9,836	0.040	72,464	0.240
1994	323,257	9,293	0.038	108,150	0.358
1995	413,408	7,549	0.031	166,177	0.550
1996	422,720	7,686	0.031	170,522	0.564
1997	473,096	11,951	0.049	150,337	0.498
1998	524,907	10,751	0.044	193,224	0.640
1999	494,810	12,066	0.049	12,698	0.042
2000	478,984	9,601	0.039		
AVG.	**356,214**	**7,916**	**0.032**	**104,582**	**0.346**

In general, flatfish species compositions were not as prevalent as those for rockfish or miscellaneous fish in the MRFSS species compositions (Table 5). For flatfish compositions, starry flounder was the most common species (Table 6), followed by sand sole and Pacific sanddab. For MRFSS miscellaneous species compositions, the most common species were kelp greenling, striped surfperch and cabezon (Table 6). Finally, for rockfish compositions, black rockfish was the most common, followed by blue and canary rockfish (Table 6).

Table 5: Number of species compositions in the MRFSS dataset by species category and fishing mode. Species compositions samples were developed at the fishing mode-port-year-month level.

Species Category	**Boat Type**		**Total**
	Charter	Private	
Flatfish	66	142	208
Miscellaneous	464	840	1304
Rockfish	556	704	1260

Table 6: Three most common species (left to right) by species category in MRFSS species composition dataset with their average proportion (± standard deviation).

Species Category	**Species (Avg. proportion ± SD)**		
Flatfish	Starry flounder (0.66 ± 0.46)	Sand sole (0.20 ± 0.38)	Pacific sanddab (0.06 ± 0.22)
Miscellaneous	Kelp greenling (0.34 ± 0.36)	Striped surfperch (0.13 ± 0.25)	Cabezon (0.13 ± 0.26)
Rockfish	Black rockfish (0.68 ± 0.32)	Blue rockfish (0.11 ± 0.19)	Canary rockfish (0.05 ± 0.01)

ORBS species compositions - While most marine fish sampling from ORBS during this period took place at a category level, a subset of landings were also sampled for species compositions within category. Available years include 1979 – 1999, excluding 1985. On average, the annual number of fish present in the ORBS species composition dataset represents 34.6% (range: 4.2 – 64.0 %) of the fish sampled at the category level (Table 4). These compositions were collected (or recorded) at a monthly level. Species are assigned to a species category based on the presence of that species in the base dataset, as with the MRFSS species compositions. Both boat type and trip type fishing modes are included. Trip type is included from 1979 – 1987, and includes bottomfish, salmon, and combination (salmon and another trip type). Some limited compositions taken from "bottomfish & salmon" were combined with the combination trip type. Boat type was included from 1988 – 1999, including charter and private vessels. As with the MRFSS species compositions, Pacific halibut and albacore tuna were included in the species compositions in only the years where they are present in their respective species category.

Similar to the MRFSS species compositions, flatfish compositions were more limited in the ORBS dataset than miscellaneous fish or rockfish compositions (Table 7). In general, there were more compositions available during the boat type era (1988 – 2000) than the trip type period (1979 – 1987). Overall, ORBS and MRFSS datasets had similar numbers of compositions available for miscellaneous and rockfish, but ORBS has approximately four times as many flatfish compositions (Tables 5 and 7). Sand sole was the most common flatfish, followed by starry flounder and Pacific halibut (Table 8). Cabezon and kelp greenling were by far the most common species in miscellaneous fish, respectively (Table 8). The next most common species include chub mackerel and Pacific whiting. Finally, for rockfish, black rockfish was the most common rockfish, followed by canary rockfish and yellowtail rockfish (Table 8).

Table 7: Number of species compositions in the ORBS dataset by species category and fishing mode. Species compositions samples were developed at the fishing mode-port-year-month level.

Species Category	Boat Type		Trip Type			Total
	Charter	Private	Bottomfish	Salmon	Combo	
Flatfish	173	240	228	165	3	809
Miscellaneous	321	351	300	203	7	1182
Rockfish	349	387	321	230	9	1296

Table 8: Three most common species (left to right) by species category in ORBS species composition dataset with their average proportion (± standard deviation).

Species Category	Species (Avg. proportion ± SD)		
Flatfish	Sand sole (0.40 ± 0.38)	Starry flounder (0.19 ± 0.33)	Pacific halibut (0.11 ± 0.25)
Miscellaneous	Cabezon (0.41 ± 0.27)	Kelp greenling (0.37 ± 0.25)	Chub mackerel (0.04 ± 0.15)
Rockfish	Black rockfish (0.66 ± 0.29)	Canary rockfish (0.09 ± 0.11)	Yellowtail rockfish (0.08 ± 0.33)

RESULTS

Application of Expansions and Apportionments

The application of these expansions and apportionments creates category-level estimates that are comprehensive in both time and space, delineated by the year, month, port and fishing mode domains. As mentioned previously, these estimates were structured in two alternative datasets for the application of species compositions from two data sources, ORBS and MRFSS sampling. The structure of the expanded datasets differed with regards to the distribution of fishing modes throughout the reconstruction period but were otherwise identical.

The results of the application of these expansions by species category are illustrated in Figures 23 – 26. In general, the temporal expansion for the major ports had the largest impact on the numbers of fish, though in some categories, this was often equal to the expansion for the partially sampled shoulder months. The minor port expansion appeared to have less of an impact on the numbers of fish when compared to the other two expansions. The magnitude of the impact of the expansions differed by species category and year.

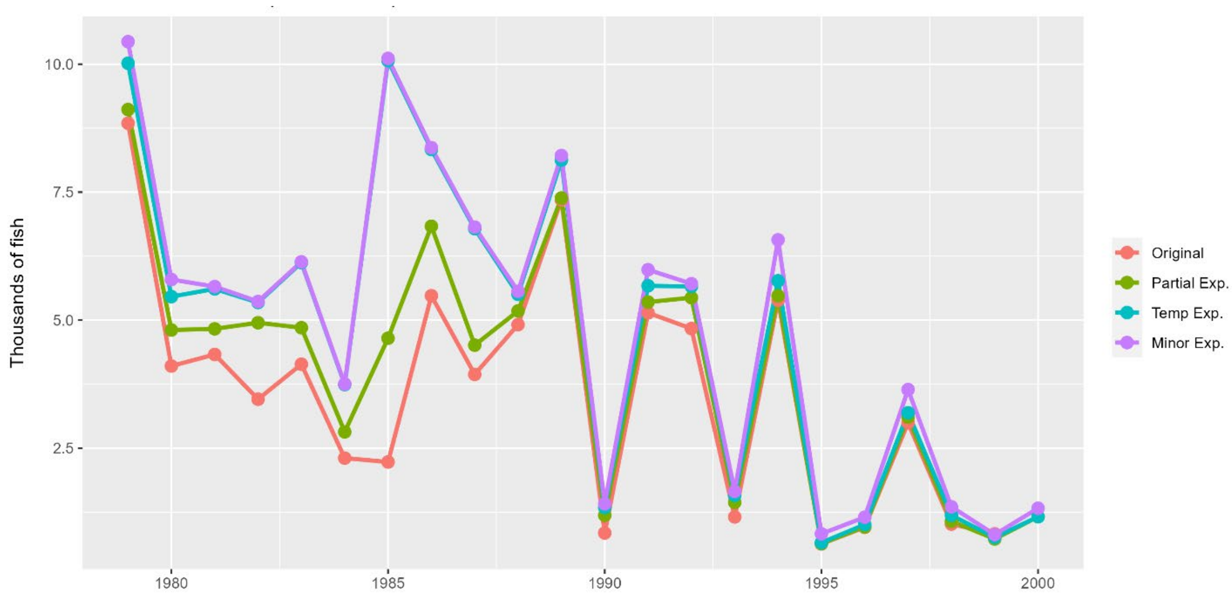

Figure 23: Results of sequential application of four expansions to the base dataset in thousands of fish for flatfish. The “Original” numbers are the base dataset raw numbers, the “Partial.Exp” refers to the partial month expansion for shoulder sampling months, the “Temp.Exp” are the temporal expansions in the major ports, and the “Minor.Exp” is the expansion for unsampled years in minor ports.

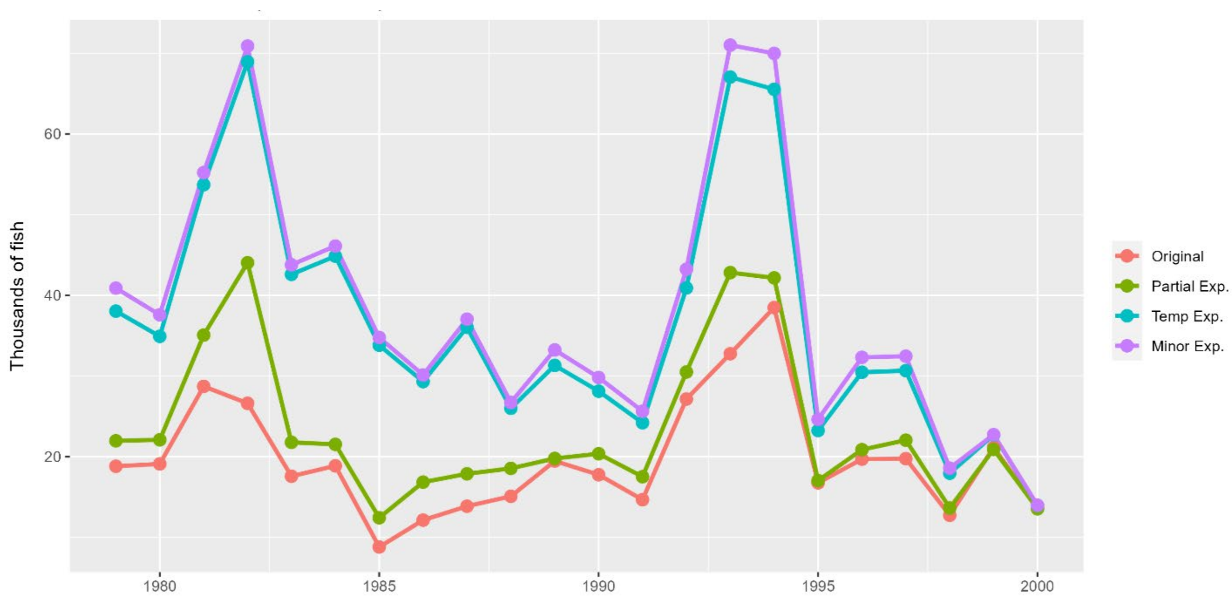

Figure 24: Results of sequential application of four expansions to the base dataset in thousands of fish for lingcod. The “Original” numbers are the base dataset raw numbers, the “Partial.Exp” refers to the partial month expansion for shoulder sampling months, the “Temp.Exp” are the temporal expansions in the major ports, and the “Minor.Exp” is the expansion for unsampled years in minor ports.

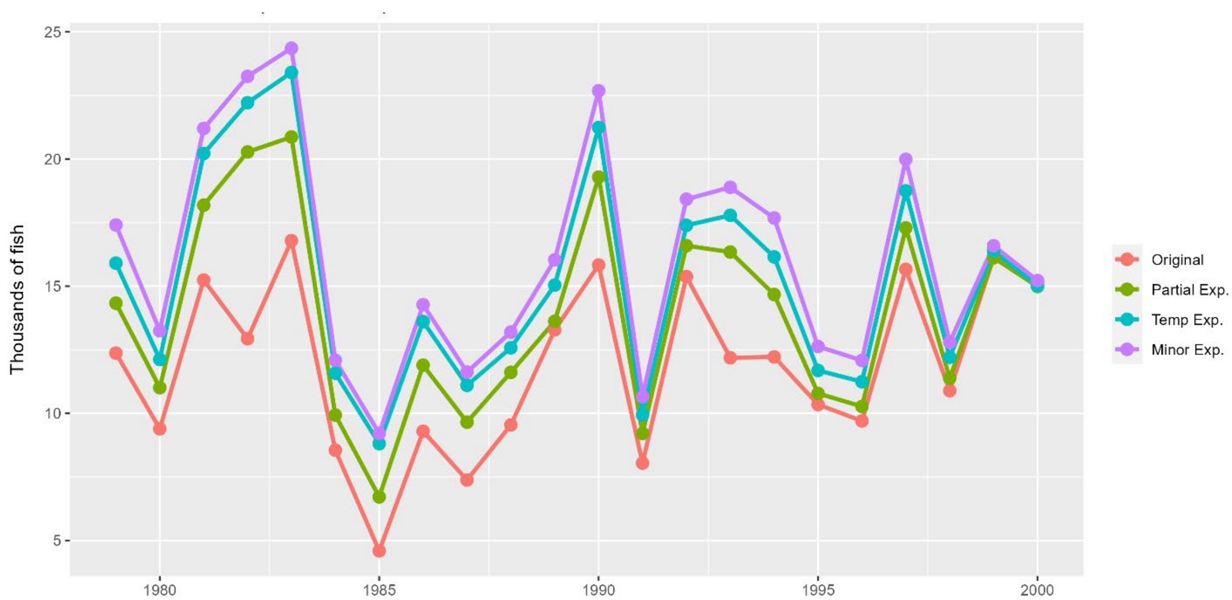

Figure 25: Results of sequential application of four expansions to the base dataset in thousands of fish for miscellaneous fish. The “Original” numbers are the base dataset raw numbers, the “Partial.Exp” refers to the partial month expansion for shoulder sampling months, the “Temp.Exp” are the temporal expansions in the major ports, and the “Minor.Exp” is the expansion for unsampled years in minor ports.

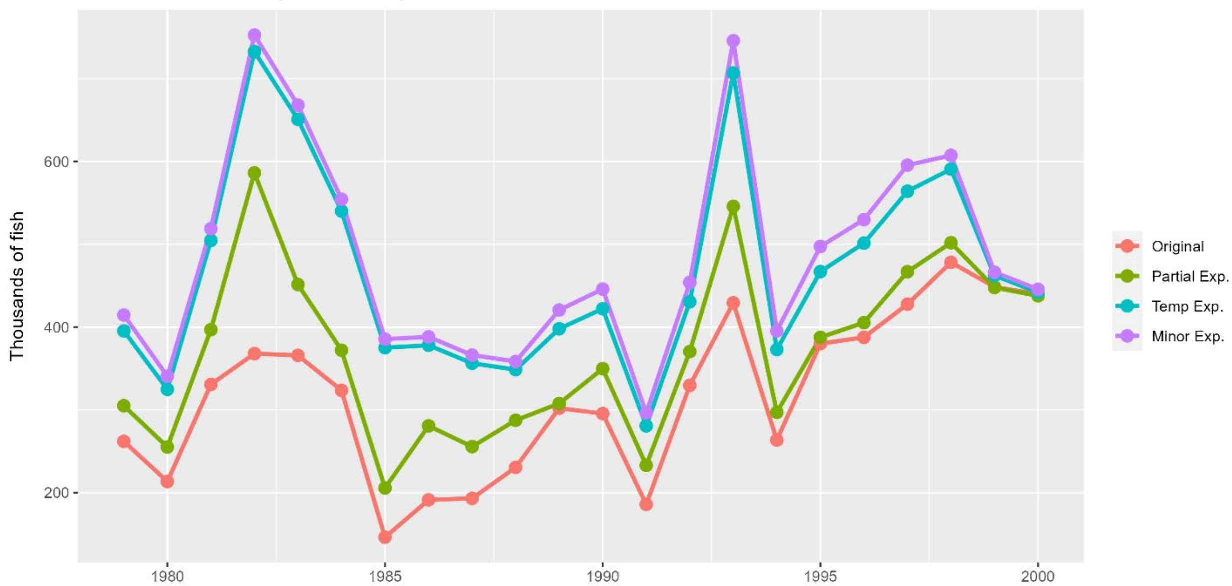

Figure 26: Results of sequential application of four expansions to the base dataset in thousands of fish for rockfish. The “Original” numbers are the base dataset raw numbers, the “Partial.Exp” refers to the partial month expansion for shoulder sampling months, the “Temp.Exp” are the temporal expansions in the major ports, and the “Minor.Exp” is the expansion for unsampled years in minor ports.

Application of Species Compositions

Species compositions from each multi-species category were matched with expanded number estimates by four domains. These domains include year, month, port and fishing mode (boat type or trip type).

Compositions were applied at four levels. The first level was an identical match with all four domains, so that a species composition was matched with an expanded catch estimate from that species category matching the mode, year, month and port domains. Any expanded catch estimate that did not have a direct match in compositions were retained for application of species compositions that matched fewer than four domains. Application of the level one species compositions was evaluated for each data source (Figures 27 – 28), and there were clear differences in effectiveness between the two compositions datasets. For the years with data, the MRFSS application averaged 21.4%, 39.7% and 45.1% of fish annually with a level one match (flatfish, miscellaneous and rockfish, respectively), though this generally increased over time. The ORBS species composition application averaged 77.1%, 78.8% and 78.9% of fish annually with a level one match within each species category (flatfish, miscellaneous and rockfish, respectively).

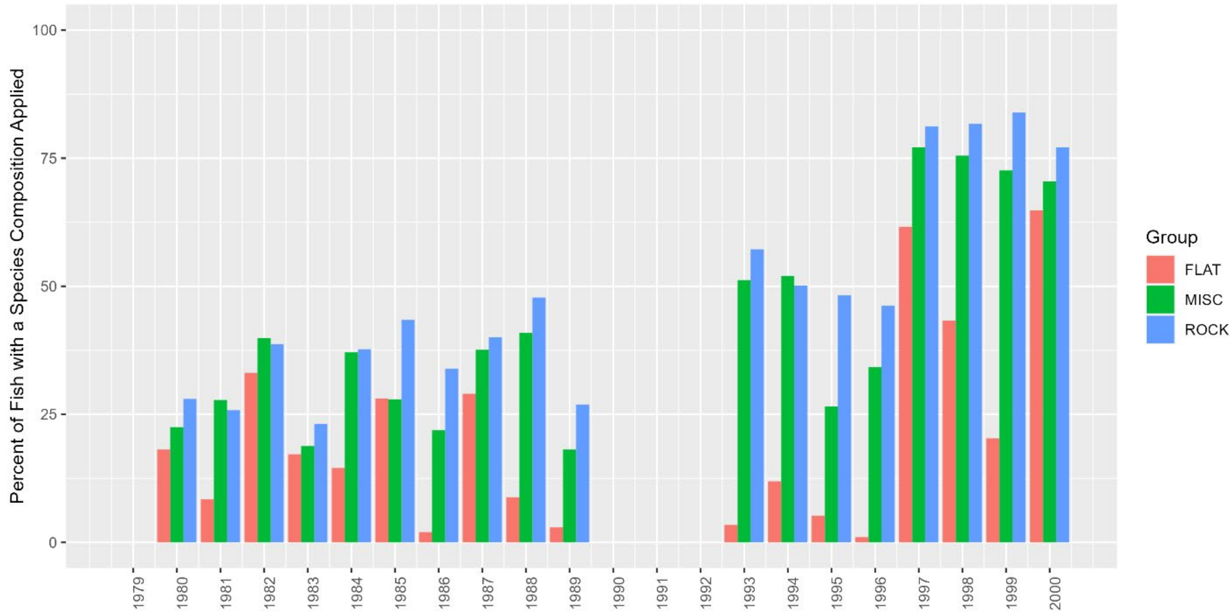

Figure 27: Level one species composition application in proportion of fish for the MRFSS species composition dataset for each multi-species category, including flatfish, miscellaneous fish and rockfish, respectively.

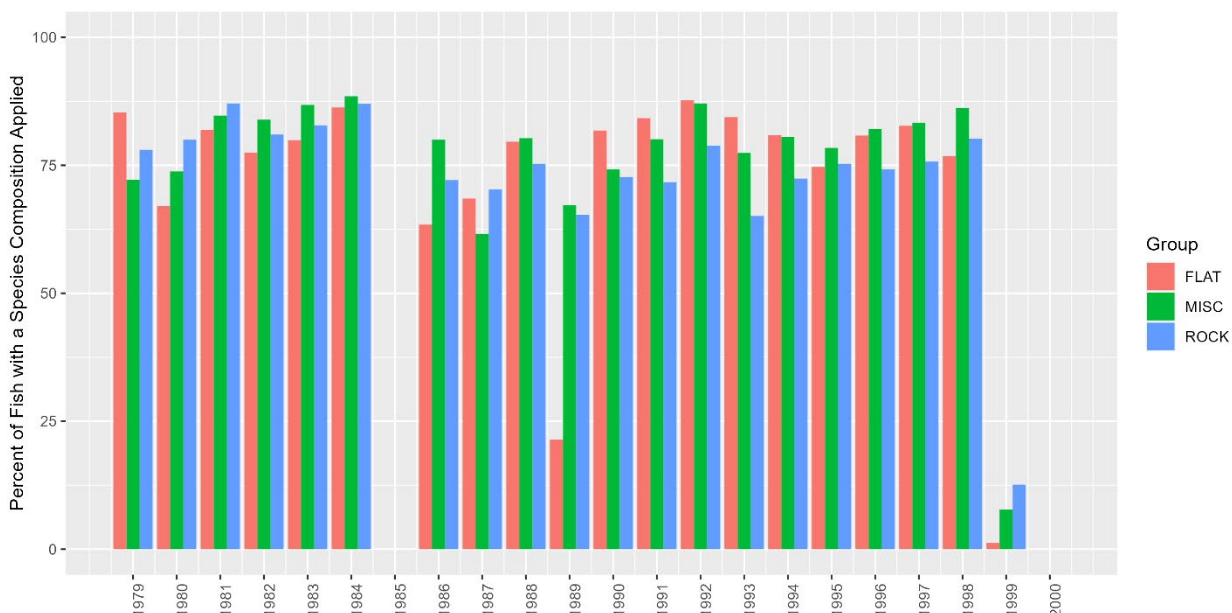

Figure 28: Level one species composition application in proportion of fish for the ORBS species composition dataset for each multi-species category, including flatfish, miscellaneous fish and rockfish, respectively.

Level two and level three applications utilized species compositions where one of the four original domains were removed from consideration and compositions were used that matched the remaining three or two domains, respectively (Table 9). The domain that was removed was dependent on both the species composition dataset (ORBS or MRFSS) and on the species category (rockfish, flatfish or miscellaneous). As an example, if fishing mode were removed, then a match was determined based on the remaining domains (year, month, and port) but from a different fishing mode. Determination of the domain to be removed at the level two or three application was developed through a compilation of regression tree analyses. These were completed for each of the species composition datasets separately, and the results are detailed in Appendix E, where recommendations are made for each species category on what the most important domains are in terms of variability in species compositions and which domains would be more appropriate to retain or substitute. Results from this analysis are summarized below and in Table 9.

Table 9: Removed domains for Level 2 and Level 3 species composition application for each of the species composition datasets (MRFSS and ORBS) and for each species category (see Appendix E for analysis).

Application Level	**MRFSS**			**ORBS**		
	Flatfish	**Misc.**	**Rockfish**	**Flatfish**	**Misc.**	**Rockfish**
Level 2	Port	Month	Month	Fishing Mode	Month	Fishing Mode
Level 3	Fishing Mode	Port	Year	Month	Fishing Mode	Month

For the MRFSS species compositions, there were no clear patterns among all species for each species category. On average, fishing mode or port was the least important domain across all three categories (Table E1). However, year was relatively consistent as the most important domain for each species category, in terms of normalized and nonparametric rankings. The ORBS species compositions contain two different definitions of fishing modes and therefore, regression tree analyses were run on two subsets of the dataset, one with only trip type (1979 – 1987) and one with only boat type (1988 – 2000). The results are mixed when viewed across species within categories. Generally, fishing mode was the least important domain, followed by month (Tables E5 and E6). The most important domain was port for flatfish and rockfish. Port or year was the most important domain for miscellaneous fish, depending on the type of ranking.

Once the level two and level three species composition applications were complete, a detailed analysis was undertaken to identify any remaining gaps. These analyses were completed for each composition dataset and species category, detailed in Table 10 and Table 11. The tables identify major remaining gaps and include recommendations on how to address them, with the goal of assigning roughly 90% of remaining fish a species composition. Recommendations were specific to the dataset and species category and were based on a combination of the regression tree analysis results, the availability of species compositions and the numbers and magnitude of the remaining gaps. In some cases, specific borrowing of compositions was recommended to fill in the gap, in others, removing a third domain was recommended.

Table 10: Level 4 gap analysis for MRFSS species composition application. The numbers of fish within the large gaps can overlap but represent different ways of categorizing the gaps.

Species Category	**Total number of Level 4 fish**	**Large Gaps (No. Fish)**	**Plan to address gaps**
Flatfish	54,437 (49.5% of total fish in category)	• 1979 (10,752) • 1990 – 1992 (13,502) • Newport (21,305) • Brookings (10,930) • Multiple gaps in all ports and all years	Remove year domain to cover 1979 and 1990 – 1992 (also covers the majority of Newport and Brookings gaps)
Miscellaneous	71,242 (19.6% of total fish in category)	• 1979 (17,929) • 1990 -1992 (53,312) • Distributed relatively evenly by mode	Remove year domain to cover 1979 and 1990 - 1992
Rockfish	328, 618 (3.0% of total fish in category)	• Port 0 – Other Port (319,423) • Pacific City (9,194)	Borrow from Garibaldi for both ports

Table 11: Level 4 gap analysis for ORBS species composition application. The numbers of fish within the large gaps can overlap but represent different ways of categorizing the gaps.

Species Category	Total number of Level 4 fish	Large Gaps (No. Fish)	Plan to address gaps
Flatfish	22,126 (19.6% of total fish in category)	• 1985 (12,306 total, 6,306 from Newport) • 2000 (1,366 total, 936 from Brookings) • Port 0 – Other Port (3,290) • Pacific City, Florence, Winchester Bay, and Brookings • Misc. other years/ports	Remove year domain for 1985 and 2000 (also covers most of Pacific City, Florence, Winchester Bay and Brookings gaps) Borrow Garibaldi for Port 0
Miscellaneous	59,919 (16.3% of total fish in category)	• 2000 (15,677, mostly from Pacific City, Depoe Bay, Newport and Brookings) • Port 0 – Other Port (10,706) • Bandon (15,808) • 1985 (9,545) • Misc. other years/ports	Borrow 1984 to cover 1985 Borrow from 1998 to cover 1999 and 2000 Borrow Garibaldi for Port 0, and Coos Bay for Bandon
Rockfish	1,643,369 (14.9% of total fish)	• 2000 (~458,000, mostly from Depoe Bay, Newport and Brookings) • 1985 (~397, 000, mostly Newport, Coos Bay and Brookings) • Port 0 – Other Port (~321,000) • Bandon (~286,000) • Gold Beach (~158,000) • 1999 (~104,000) • Misc. other years/ports	Borrow from 1998 for 1999 and 2000 Borrow from 1984 to cover 1985 Borrow from Garibaldi for Port 0, Coos Bay for Bandon and Brookings for Gold Beach

The ORBS application apportioned a greater annual proportion of fish to species at level one when compared to the MRFSS application (Figures 27 – 28), increasing confidence in these species-specific estimates with a higher level of direct matches between the expanded numbers of fish and the species compositions. In general, the efficacy of the MRFSS application increased with the level. Given that fewer fish had a level one match for this dataset, the application of the level two and level three compositions apportioned more fish than those levels in the ORBS application. For MRFSS, the largest gaps, typically the years 1979 and 1990 – 1992, had level four application levels (Figures 29 and 30). A relatively higher proportion of fish in all three of the categories had a level one match in the late 1990s than in the 1980s and early 1990s (Figure 29). For ORBS, the gap years (1985 and 2000) also had a level four application level (Figures 31 and 32), and level one matches were consistent across almost all available years, with the noted exception of 1999, when the species composition sampling decreased substantially (Figure 32).

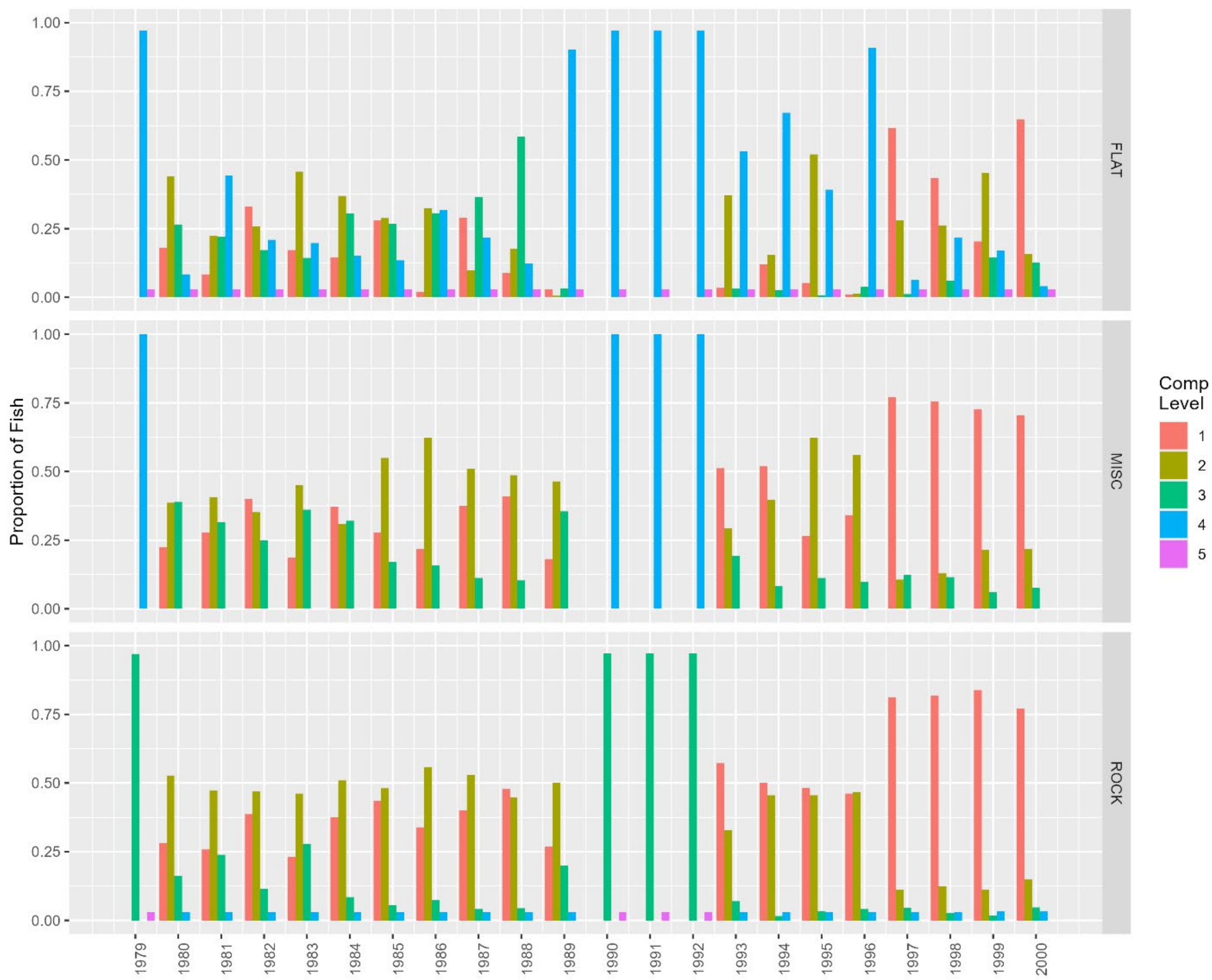

Figure 29: Annual proportion of fish with a species composition applied from the MRFSS species composition dataset for each multi-species category, including flatfish, miscellaneous fish and rockfish, by panel respectively. The composition level includes the four levels of application of species compositions (L1 – L4). Level 5 include fish where no species composition was able to be applied.

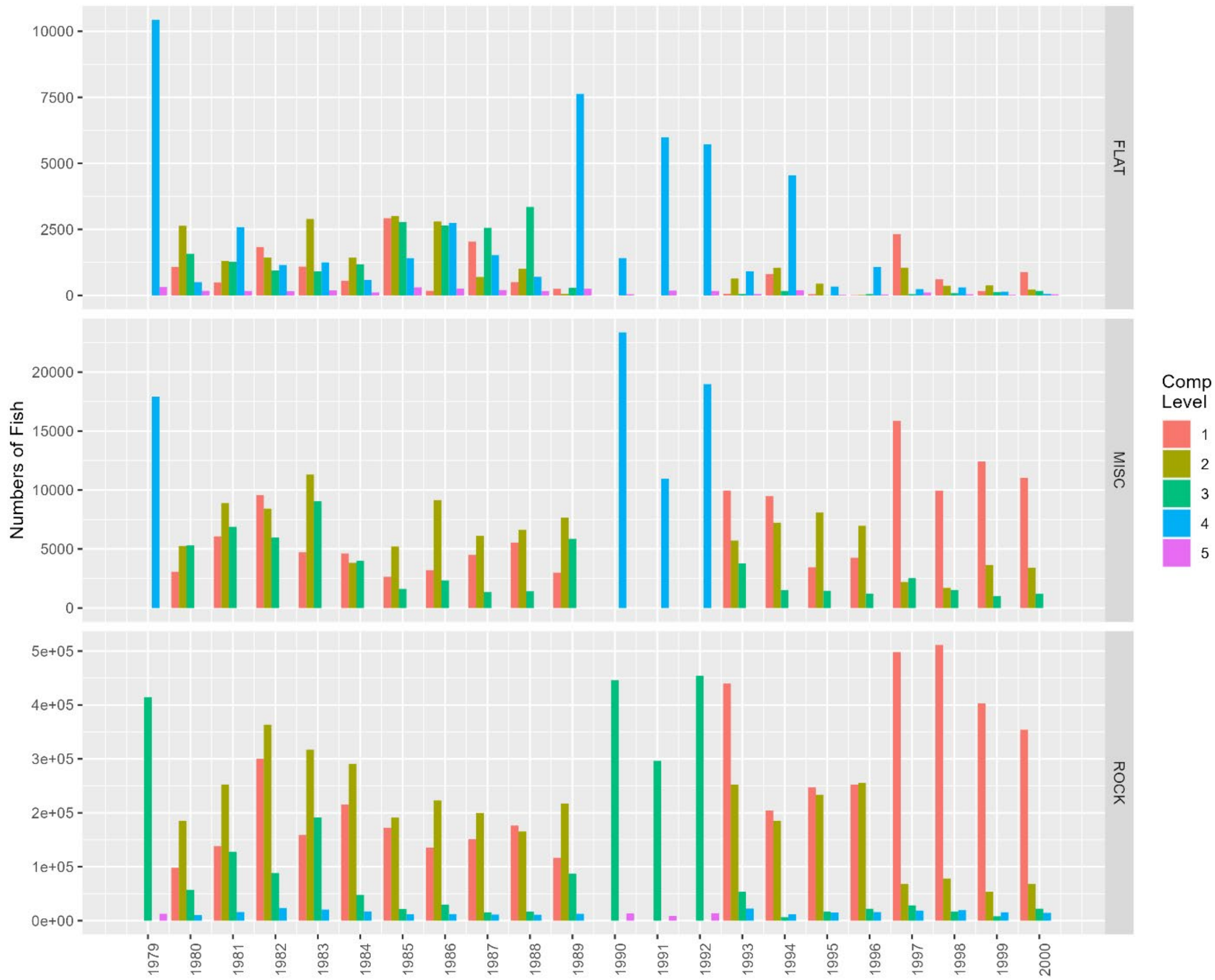

Figure 30: Annual numbers of fish with a species composition applied from the MRFSS species composition dataset for each multi-species category, including flatfish, miscellaneous fish and rockfish, by panel respectively. The composition level includes the four levels of application of species compositions (L1 – L4). Level 5 include fish where no species composition was able to be applied. Note the variable y-axis scales.

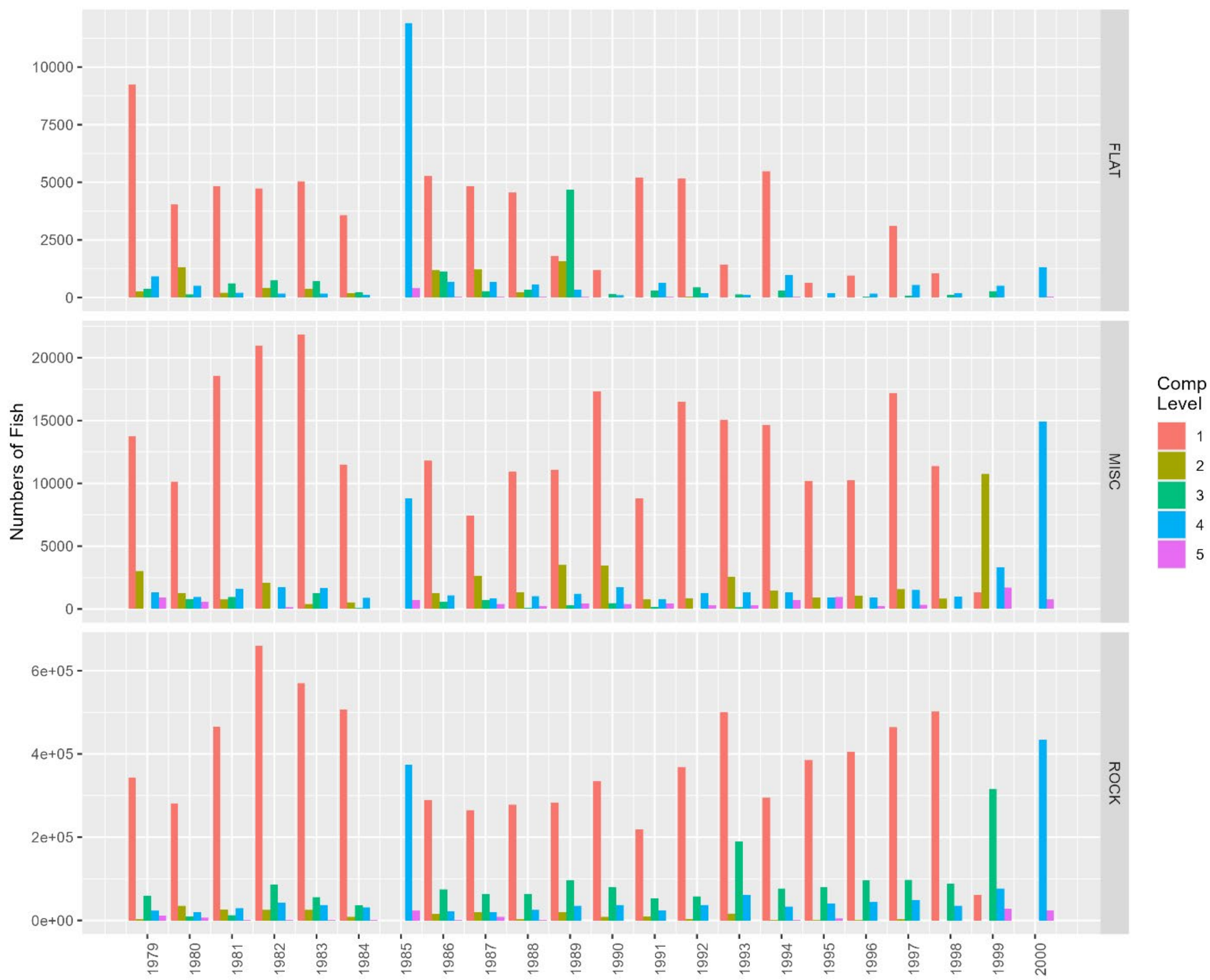

Figure 31: Annual proportion of fish with a species composition applied from the ORBS species composition dataset for each multi-species category, including flatfish, miscellaneous fish and rockfish, by panel respectively. The composition level includes the four levels of application of species compositions (L1 – L4). Level 5 include fish where no species composition was able to be applied.

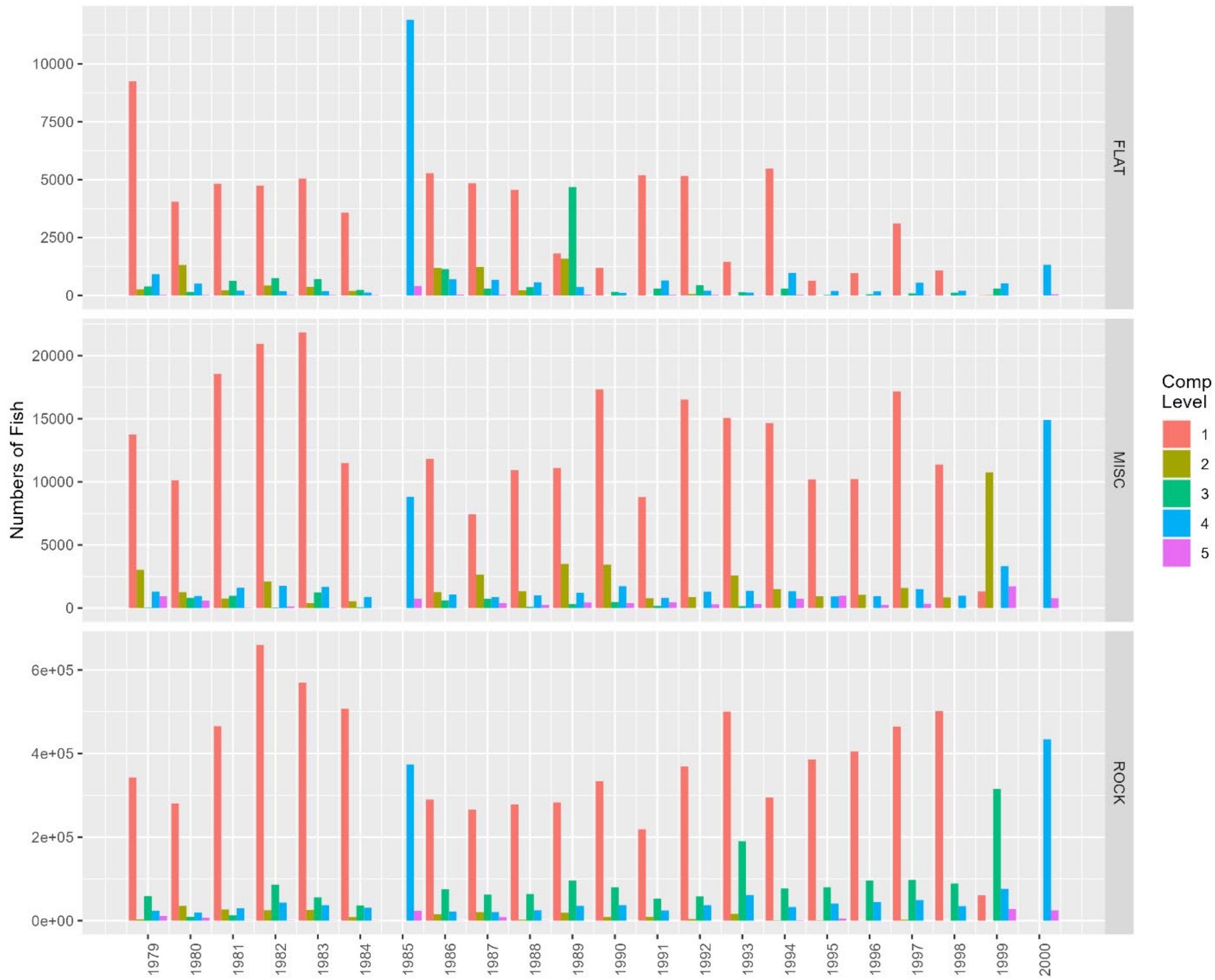

Figure 32: Annual numbers of fish with a species composition applied from the ORBS species composition dataset for each multi-species category, including flatfish, miscellaneous fish and rockfish, by panel respectively. The composition level includes the four levels of application of species compositions (L1 – L4). Level 5 include fish where no species composition was able to be applied. Note the variable y-axis scales.

There were fish that did not have a species composition applied in both applications (Figures 29 - 32, Level 5). These fish were retained in the final dataset at the unspeciated, category level. In the MRFSS application, these include both flatfish (n = 3,200 or 2.91% of total flatfish) and rockfish (n = 48,601 or 0.44% of total rockfish). The flatfish missing compositions are from the other port category (Port 0) in all years, and the rockfish are from both the other port (Port 0) and Pacific City (16) in 1979 and 1989 – 1992. In the ORBS application, these include fish from all three species categories (n = 121,916 or 0.98% of expanded numbers of fish) in all years (1979 – 2000). Rockfish was the largest contributor to those missing a species composition (n = 111,341, or 1.1% of total rockfish), followed by miscellaneous fish (n = 9,759 or 2.7% of total miscellaneous fish) and flatfish (n = 816 or 0.73% of total flatfish). Finally, there were also multiple species that were not present in species compositions that were originally present in the base dataset (Appendix A). These include English sole, rosy rockfish, white sturgeon, Pacific herring, and striped bass for the ORBS dataset. For the MRFSS dataset, these include nine flatfish, eight rockfish, and 20 miscellaneous species. The only species that is missing from both species composition datasets but present in the base dataset is English sole.

Once the level four application was completed, species specific estimates from rockfish, flatfish and miscellaneous categories were combined with lingcod expanded estimates into a single dataset that contains species-specific numbers of fish delineated by all four domains (year, month, port and fishing mode). All expansions and the level of application of the species composition are included in the datasets, allowing for the exclusion of fish missing a species composition or fish with a lower level of confidence due to a higher level of species composition application or a suspect expansion. It is anticipated that these will be evaluated on a species-specific basis. These estimates are considered coastwide estimates, with major ports having year-round estimates and minor ports seasonal estimates with a timeframe equal to their longest sampling season, from 1979 - 2000.

DISCUSSION

This reconstruction evaluated the use of two different sources of historical species compositions. The recommended reconstruction uses the ORBS species compositions. Though there is little documentation on the sampling protocol for these species compositions during this time, the use of this dataset is advantageous for several reasons. First, the relative proportion of direct matches, or level one species composition applications, was consistently higher for the ORBS dataset when compared to the MRFSS level one application (Figure 27 vs Figure 28). This increases confidence in the species composition application, without having to make assumptions regarding borrowing compositions to estimate species-specific catches from category-level estimates. ORBS samplers also appeared to have encountered at least an order of magnitude more fish than were recorded in the MRFSS interview data (Table 4). There were similar numbers of species compositions available for miscellaneous fish and rockfish, however, there were substantially more flatfish samples available from the ORBS compositions (Tables 5 and 7). Also, there were fewer species present in the MRFSS species compositions than were originally found in the base dataset (Appendix A, Table A1), whereas the ORBS composition data were only missing five species. Finally, there was less manipulation of the expanded estimates for this dataset as the fishing mode structure matched much more closely than required for the MRFSS species composition application.

The results for individual species from the two different species composition applications (MRFSS and ORBS) in this reconstruction are compared with historical recreational catch data from the original MRFSS catch estimates available on RecFIN and the original speciated base dataset in Appendix F. Depending on the species, there can be substantial differences among the datasets. Again, the use of these data should be evaluated on species-specific basis.

Future efforts to reconstruct historical recreational catch in Oregon should attempt to reconstruct landings prior to 1979 and for landings outside the ocean boat recreational fishery. While 1979 was the earliest year of this reconstruction, there was effort prior to this year and there may be data from preliminary ORBS sampling that could be utilized. For some species, landings from estuarine areas or from shore-based fishing modes can be significant. However, there are limited data to address this gap. Also, this reconstruction does not attempt to estimate biomass of landed fish. Stock Synthesis, the software utilized by the NWFSC stock assessment teams, can accept catch in either weight or numbers of fish (Methot and Wetzel 2013), so this was not deemed a high priority. For past stock assessments, ODFW staff have utilized MRFSS interview data to calculate an average annual weight per fish and applied these weights to an estimated number of fish to estimate an annual biomass. However, there are a limited number of species for which these data are available and decisions regarding the quality of those data have varied in the past. Borrowing from years where MRFSS was not sampling was also necessary. A comprehensive effort to provide these data using a consistent and methodical approach could be attempted in the future to pair with this reconstruction and provide a complete picture of the Oregon historical recreational marine fish removals.

ACKNOWLEDGMENTS

Thank you to all of the individuals who improved the quality of this reconstruction, including Patrick Mirick, Mark Freeman, Justin Ainsworth, Michelle Jones and the members of the internal review panel. Most particularly, thank you to Troy Buell, who provided thoughtful guidance and review throughout the five years of this project.

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APPENDIX A: INDIVIDUAL SPECIES INCLUDED IN RECONSTRUCTION BY SPECIES CATEGORY

Table A1: All species included in reconstruction, including their respective species category and internal species code. Species marked with a * indicate that this species is missing from the MRFSS species composition dataset and those marked with a † indicate missing from the ORBS species composition dataset.

SPECIES CATEGORY	ODFW SPECIES CODE	COMMON NAME
LINGCOD	484	LINGCOD
FLATFISH	600	MISC. SOLES
	604	PACIFIC SANDDAB
	605	CALIFORNIA HALIBUT
	606 *	ARROWTOOTH FLOUNDER
	608	PETRALE SOLE
	610 *	REX SOLE
	612 *	FLATHEAD SOLE
	614	PACIFIC HALIBUT
	618	BUTTER SOLE
	620 *	ROCK SOLE
	622 *	SLENDER SOLE
	624 *	DOVER SOLE
	626 *†	ENGLISH SOLE
	628	STARRY FLOUNDER
	630 *	C-O SOLE
	632 *	CURLFIN SOLE
	634	SAND SOLE
ROCKFISH	410	OTHER ROCKFISH
	413 *	PACIFIC OCEAN PERCH
	416	BROWN ROCKFISH
	417 *	AURORA ROCKFISH
	418 *	REDBANDED ROCKFISH
	419	SILVERGREY ROCKFISH
	421	COPPER ROCKFISH
	423 *	GOPHER ROCKFISH
	426 *	DARKBLOTCHED ROCKFISH
	428 *	SPLITNOSE ROCKFISH
	429	GREENSTRIPED ROCKFISH
	431	WIDOW ROCKFISH
	433	YELLOWTAIL ROCKFISH
	435 *	CHILIPEPPER
	436	ROSETHORN ROCKFISH
	441	QUILLBACK ROCKFISH
	442	BLACK ROCKFISH
	444	VERMILION ROCKFISH
	445	BLUE ROCKFISH
	446	CHINA ROCKFISH
	447	TIGER ROCKFISH
	449	BOCACCIO
	451	CANARY ROCKFISH
	453	REDSTRIPE ROCKFISH
	454	GRASS ROCKFISH
	455 *	YELLOWMOUTH ROCKFISH
	456 †	ROSY ROCKFISH
	457	YELLOWEYE ROCKFISH

MISCELLANEOUS	20	SHARKS
	21 *	SIXGILL SHARK
	23 *	THRESHER SHARK
	29 *	SOUPFIN SHARK
	31 *	BLUE SHARK
	35	SPINY DOGFISH SHARK
	41 *	SKATES
	42 *	BIG SKATE
	46 *	LONGNOSE SKATE
	49 *	SPOTTED RATFISH
	50	STURGEONS
	51 †	WHITE STURGEON
	55 †	PACIFIC HERRING
	201 *	PACIFIC COD
	203	PACIFIC WHITING
	204 *	PACIFIC TOMCOD
	220 *	EELPOUTS
	247	JACKSMELT
	262 †	STRIPED BASS
	290	JACK MACKEREL
	300	SURFPERCHES
	303	REDTAIL SURFPERCH
	306	STRIPED SEAPERCH
	310	WHITE SEAPERCH
	311	PILE PERCH
	350	WOLF-EEL
	370	MACKERELS
	373 *	PACIFIC BONITA
	374	CHUB MACKEREL
	375	ALBACORE TUNA
	402 *	SHELF ROCKFISH
	467 *	SHARPCHIN ROCKFISH
	477	SABLEFISH
	481	KELP GREENLING
	482	ROCK GREENLING
	483 *	WHITESPOTTED GREENLING
	490	SCULPINS
	523	BUFFALO SCULPIN
	527	RED IRISH LORD
	529	BROWN IRISH LORD
	533 *	THREADFIN SCULPIN
	541	PACIFIC STAGHORN SCULPIN
	546 *	SAILFIN SCULPIN
	556	CABEZON
	590 *	SNOWY SNAILFISH
	670 *	OCEAN SUNFISH
	682 *	UNKNOWN SPECIES

APPENDIX B: MATHEMATICAL NOTATION FOR EXPANSIONS AND APPORTIONMENTS

Definition of symbols

Indices (combinations of subscripts determine domain and specifications)

b: index for boat type (charter, private)

c: index for species category

m: index for month

p: index for port

s: index for sampled

t: index for trip type (bottomfish, salmon, combination)

y: index for year

D: total number of days

Y: total number of years

Data and Estimates (combinations of subscripts determine domain and specifications)

C: Unexpanded catch

$\hat{C}$: Estimated catch from expansion

P: Proportion

Expansion/Apportionment Equations

1) Expansion for partially sampled months (specific to port, month, and year)

$$\hat{C}_{p,y,m} = \frac{D_{p,y,m,s}}{D_{p,y,m}} C_{p,y,m}$$

2) Average monthly proportion of catch from year-round sampling (specific to species category, month, and major port)

$$P_{c,m,p} = \frac{1}{Y_{c,p,s}} \sum_{y=1}^{n} \left(\frac{C_{c,m,p}}{C_{c,p}} \right)$$

3) Expanded catch, after accounting for unsampled months in major ports (specific to species category, port and year) using th

$$\hat{C}_{c,p,y} = \frac{1}{Y_{c,p,s}} \sum_{y=1}^{n} \left(\frac{\sum P_{c,m,p,s,y}}{1} \right) C_{c,p,y}$$

4) Average annual proportion of catch in minor ports (as related to total annual expanded catch in major ports, specific to species category and port)

$$P_{c,m,p} = \frac{1}{Y_{p,s}} \left(\frac{C_{c,p,y}}{\hat{C}_{c,p,y}} \right)$$

5) Average monthly proportion of minor port catch within seasonal timeframe of sampling (specific to species category and port)

$$P_{c,m,p} = \frac{1}{Y_{p,s}} \left(\frac{C_{c,m,p,y}}{C_{c,p,y}} \right)$$

6) Average annual apportionment of catch by boat type (specific to species category and port)

$$P_{b,c,p} = \frac{1}{Y_{p,s}} \left(\frac{C_{b,c,p,y}}{C_{c,p,y}} \right)$$

7) Average annual apportionment of catch by trip type (specific to species category and port)

$$P_{c,p,t} = \frac{1}{Y_{p,s}} \left(\frac{C_{c,p,t,y}}{C_{c,p,y}} \right)$$

APPENDIX C: SELECT OREGON DEPARTMENT OF FISH AND WILDLIFE REGULATIONS

Table C1: Select ODFW sport regulations used to evaluate within-year temporal distribution of catch within each year of year-round sampling to inform expansion factors (only regulations relevant to the species in the reconstruction are included). Blue, bold underlined text are new regulations, as compared to the previous year, and red strikeout text was from the previous year but deleted in the current year. Only years relevant to analyzing the within-year temporal distribution of the catch are included.

Year	Effective Jan. 1 (i.e., regulations set preseason)	Inseason Change and Effective Date
2017	Marine Zone 7-fish daily bag limit of which no more than **four may be blue, deacon, China, copper or quillback rockfish in combination**, **no more than six may be black rockfish**, and no more than one may be a cabezon (when cabezon is open). **There is no longer a sub-bag limit for canary rockfish.** Retention of yelloweye ~~China, copper and quillback~~ rockfish is prohibited. **There is no longer a min. length limit for greenlings.** Cabezon is closed January - June.	
2016	Same as 2015 except **blue rockfish includes both deacon rockfish and blue rockfish**	7/15 Offshore of 20-fm closed for bottom fishing due to yelloweye rockfish impacts 10/1 Groundfish reopen at all depths
2015	All rockfish, greenlings, cabezon, skates, and other marine fish species not listed in the 2015 Oregon Sport Fishing Regulations in the Marine Zone: 7-fish daily bag limit in aggregate, of which **no more than three may be blue rockfish**, no more than one may be a cabezon (when cabezon is open), and (effective March 11) **no more than one may be a canary rockfish**. Retention of yelloweye, ~~canary,~~ **China, copper and quillback** rockfish is prohibited. Cabezon closed Jan- June.	
2014	Same as 2013	
2013	Cabezon closed Jan- June ~~and Oct- Dec~~	

Year	Effective Jan. 1 (i.e., regulations set preseason)	Inseason Change and Effective Date
2012	Rockfish, cabezon (16" min.), greenlings (10" min.), and other marine species not listed under Marine Zone in the Oregon Sport Fishing Regulations: 7 daily in aggregate of which no more than 1 may be a cabezon April 1 – Sept. 30. **Cabezon closed Jan-March and Oct-Dec** Lingcod (22" min.): 2 Flatfish except P. halibut: 25 Surfperch: 15 Offshore pelagic species: 25 ~~40-fm~~ **30-fathom** curve: Seaward closed April 1-Sept. 30 [for groundfish group]. Retention of yelloweye and canary rockfish is prohibited. Unlawful to take or attempt to take ~~smelt~~ **eulachon smelt** in inland waters including bays, estuaries, rivers and streams. Green sturgeon retention is prohibited.	7/21 Cabezon closed for boats
2011	Rockfish, cabezon (16" min.), greenling (10" min.), and other marine species not listed under Marine Zone in the Oregon Sport Fishing Regulations: 7 daily in aggregate of which **no more than 1 may be a cabezon April 1 – Sept. 30**. Lingcod (22" min.): 2 Flatfish except P. halibut: 25 Surfperch: 15 Offshore pelagic species: 25 Retention of yelloweye rockfish and canary rockfish prohibited. **Unlawful to take or attempt to take smelt in inland waters including bays, estuaries, rivers and streams.** Green sturgeon retention is prohibited.	7/21 Offshore of 20-fm line closed due to yelloweye rockfish impacts 7/21 Cabezon closed for boats 8/13 Groundfish retention with nearshore halibut (central coast) prohibited 10/1 All depths reopened for groundfish (yelloweye rockfish impacts sufficiently slowed) 10/1 Groundfish retention with nearshore halibut allowed again

Year	Effective Jan. 1 (i.e., regulations set preseason)	Inseason Change and Effective Date
2010	Same as 2009 including "rockfish" *et al* bag limit: 7 (misprinted in regulations booklet as 6) **Green sturgeon retention is prohibited.**	7/24 Offshore of 20-fm line closed through Dec. 31 due to yelloweye rockfish impacts 7/24 Cabezon closure for boats
2009	Same as 2008 through April 30 (adopted late), then increase in "marine fish" bag limit [see right]. Lingcod (22" min.): 2 Rockfish, cabezon (16" min.), greenling (10" min.), and other marine species not listed: 6 Retention of yelloweye rockfish and canary rockfish prohibited. Flatfish except P. halibut: 25 Surfperch: 15 Offshore pelagic species: 25	5/1 Rockfish *et al* bag limit increased to 7 (in permanent rule). 9/14 Cabezon prohibited for boats.
2008	Same as 2007.	7/7 "Rockfish" *et al* bag limit reduced from 6 to 5 and closed outside 20-fm line *through Dec. 31* [sic – see 9/7 change] and flatfish closed outside 40-fm line *through Dec. 31* [sic] 8/21 Cabezon prohib. for boats 9/7 Return to preseason regs., i.e., "rockfish" *et al* bag limit back to 6 and waters closed offshore of 40-fm line only through Sept. 30 (open offshore Oct-Dec)

Year	Effective Jan. 1 (i.e., regulations set preseason)	Inseason Change and Effective Date
2007	Lingcod (~~24~~ **22**" min.): 2 Rockfish, cabezon (16" min.), greenling (10" min.)~~, flounder, sole~~ and other marine species not listed: 6 Retention of yelloweye rockfish and canary rockfish prohibited. **Flatfish except P. halibut** ~~sanddab:~~ 25 Surfperch: 15 Offshore pelagic species: 25	8/11 Cabezon prohib. for boats
2006	Lingcod (24" min.): 2 Rockfish, cabezon (16" min.), greenling (10" min.), flounder, sole and other marine species not listed: ~~8~~ **6** Retention of yelloweye rockfish and canary rockfish prohibited. Sanddab: 25 Surfperch: 15 Offshore pelagic species: 25 40-fm curve: Seaward closed June 1-Sept. 30.	7/24 Vermilion rockfish prohib. for boats 9/23 Cabezon prohib. for boats
2000	Lingcod (24" min. **and 34" max**): ~~2~~ **1** Rockfish: ~~15, no more than 10 black rockfish~~ **10, no more than 3 canary rockfish** Other fish: 25	
1999	Lingcod (24" min.): ~~3~~ **2** Rockfish: 15, no more than 10 black rockfish Other fish: 25	

APPENDIX D: PROPORTION OF LANDINGS BY FISHING MODE

A series of figures are provided to illustrate the proportion of landings by boat type (Figures D1 – D4) and by trip type (Figures D5 – D8) over time in each port.

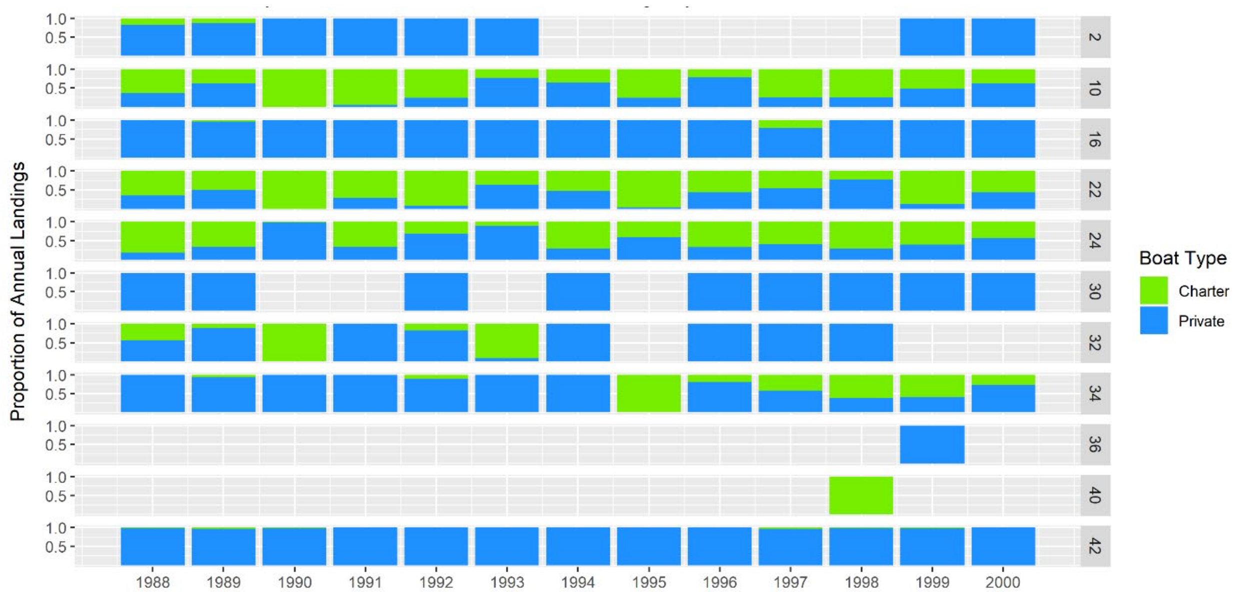

Figure D1: Annual proportion of boat mode-specific landings by port for the flatfish category. Green indicates charter vessels and blue are private vessels.

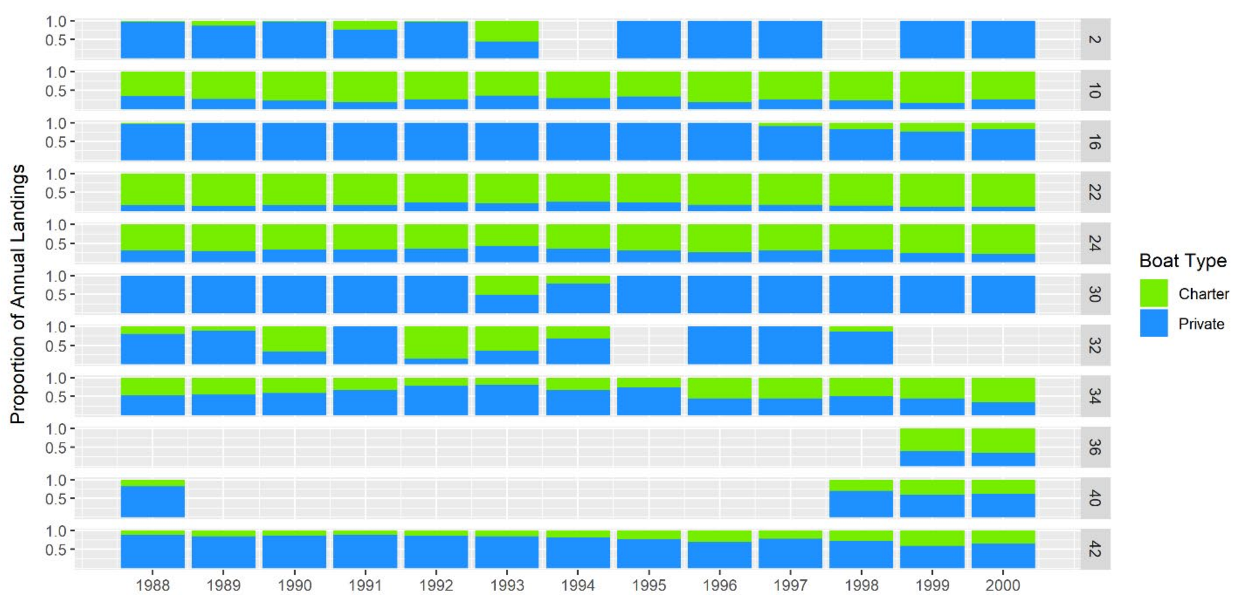

Figure D2: Annual proportion of boat mode-specific landings by port for the lingcod category. Green indicates charter vessels and blue are private vessels.

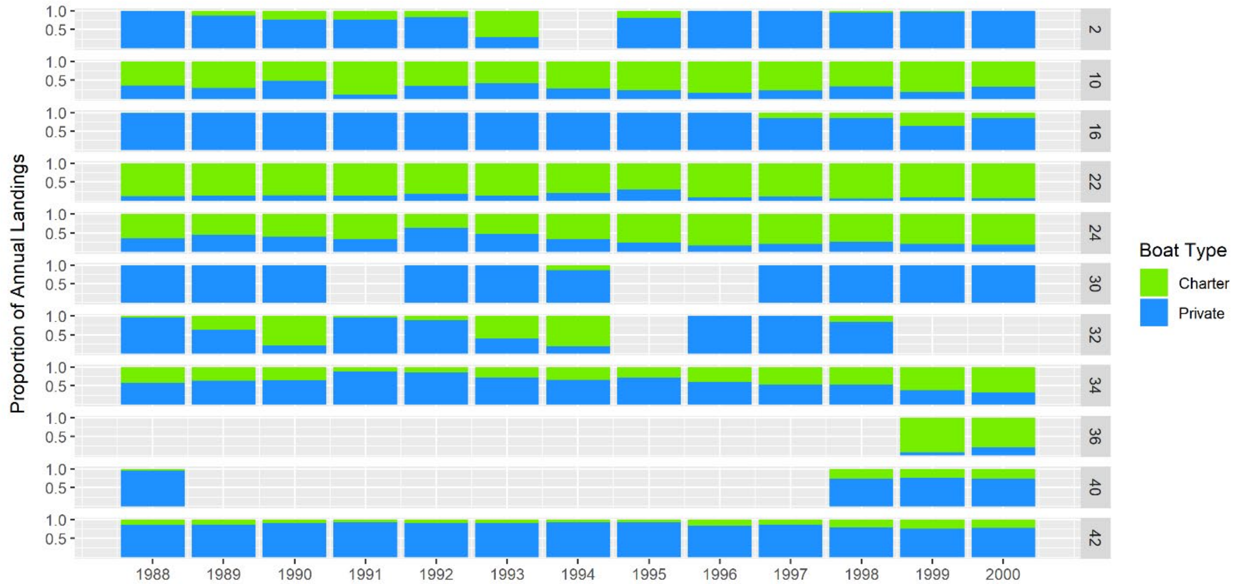

Figure D3: Annual proportion of boat mode-specific landings by port for the miscellaneous category. Green indicates charter vessels and blue are private vessels.

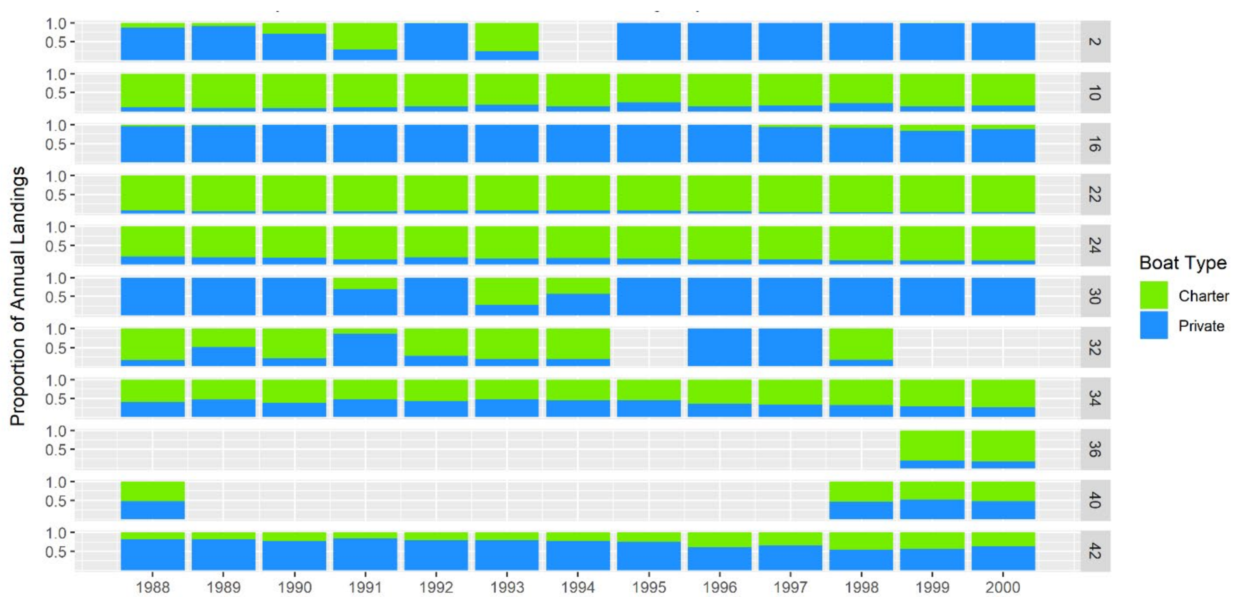

Figure D4: Annual proportion of boat mode-specific landings by port for the rockfish category. Green indicates charter vessels and blue are private vessels.

Figure D5: Annual proportion of landings by trip type for all ports and all available years for the flatfish category. Trip type includes bottomfish ("B"), combination ("C") and salmon ("S").

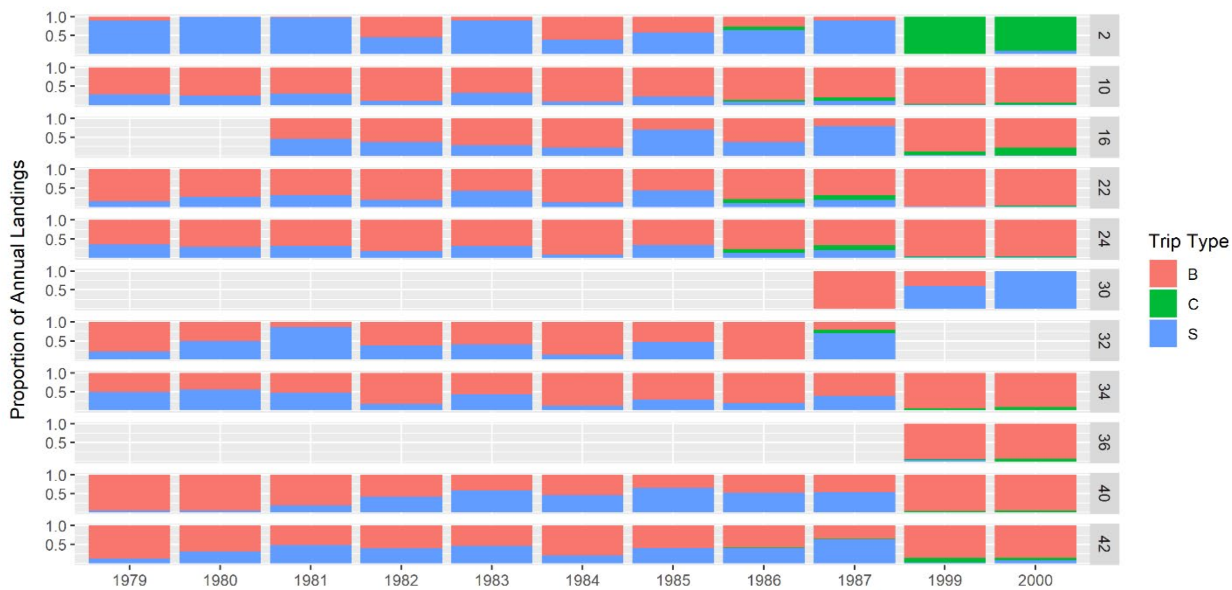

Figure D6: Annual proportion of landings by trip type for all ports and all available years for the lingcod category. Trip type includes bottomfish ("B"), combination ("C") and salmon ("S").

Figure D7: Annual proportion of landings by trip type for all ports and all available years for the miscellaneous category. Trip type includes bottomfish ("B"), combination ("C") and salmon ("S").

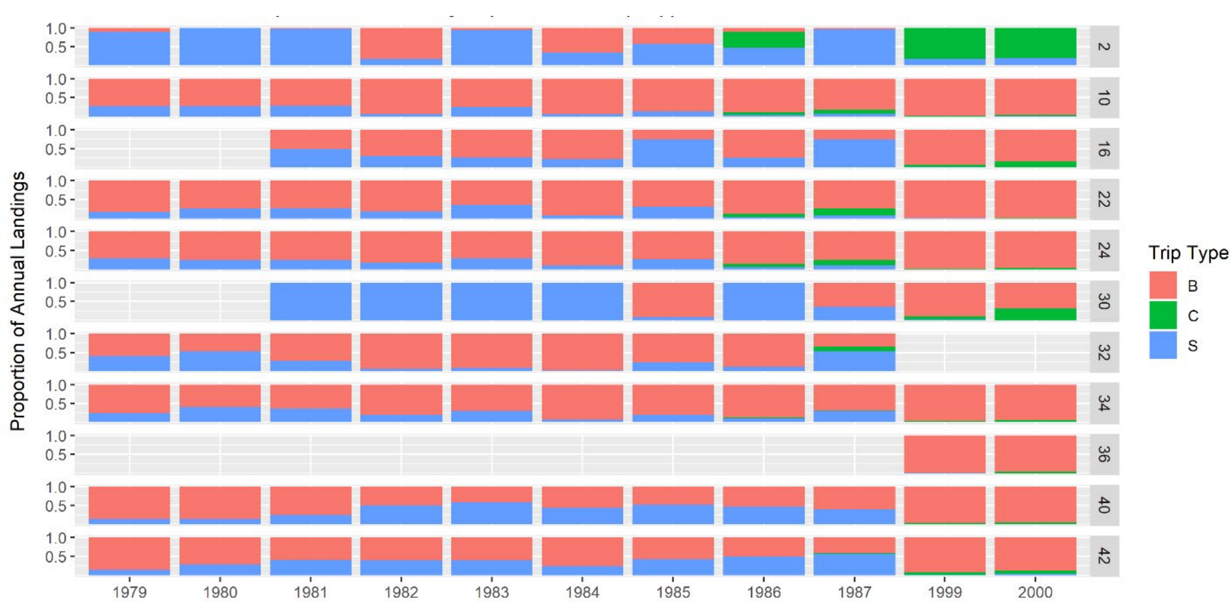

Figure D8: Annual proportion of landings by trip type for all ports and all available years for the rockfish category. Trip type includes bottomfish ("B"), combination ("C") and salmon ("S").

APPENDIX E: REGRESSION TREE ANALYSIS FOR MRFSS AND ORBS SPECIES COMPOSITION DATASETS

Background

Regression or classification trees provide for visualization of the structure of a dataset. These analyses used the rpart package in R (Therneau and Atkinson 2022). Variable importance scores are a primary result of a regression tree analysis that evaluates the overall reduction in predictive accuracy (or node impurity) if a particular variable is eliminated. For these analyses, a regression tree was completed for each species on the proportion of that species within a species composition. The variable importance scores were summarized across all species within a species category. To compare across species, variables were ranked in their importance and averaged to look at trends within a species category. Ranks were calculated in two different ways, as a non-parametric ranking (1 – 4, with 4 as the least important) and as a normalized ranking (using a normal distribution characterized by the average and the standard deviation), which allows for comparisons across species that includes the relative magnitude of the differences between ranks. The most common species within each category (the top three or four species based on the total number of fish in the base dataset) were also examined in more detail.

Results and Recommendations

MRFSS regression tree results - There were no clear patterns among all species in each species category. The average non-parametric and normalized rankings show that fishing mode was the least important variable across two of the three species categories (Table E1). The most important variable was year, which was relatively consistently across species categories.

Table E1: Average non-parametric and normalized rankings of variable importance scores for all species within a multi-species category from MRFSS species compositions. Red denotes the least important, and green as the most important variable.

Variable	Average nonparametric ranking			Average normalized ranking		
	Flatfish	Misc.	Rockfish	Flatfish	Misc.	Rockfish
Port	2.9	2.1	1.9	-0.38	0.14	0.56
Fishing Mode	2.8	3.4	3.2	-0.02	-0.66	-0.69
Year	1.5	1.9	2.2	0.84	0.43	0.25
Month	2.5	2.3	2.7	-0.31	-0.08	-0.16

Looking at the non-parametric rankings within the most common species, for flatfish, fishing mode was the least important variable for two of the four most common species in this category (sand sole and Pacific sanddab) but varied overall (Table E2). Year was the most important variable across three of the four species, and the second most important for the fourth species. For the most common miscellaneous species, the least important variable was month for three of the most common species (cabezon, kelp greenling and chub mackerel) (Table E3). The most important variable varied. Finally, for rockfish (black, blue, yellowtail and canary), there were no clear patterns in that both the least and most important variable varied (Table E4). The least important variable for two of the four species, including black rockfish, was month.

Table E2: Non-parametric and normalized rankings of variable importance scores for the four most common flatfish species from MRFSS species compositions. Red denotes the least important, and green as the most important variable.

Variable	Nonparametric Ranking				Normalized ranking			
	Sand sole	Pacific halibut	Starry flounder	Pacific sanddab	Sand sole	Pacific halibut	Starry flounder	Pacific sanddab
Port	3	4	3	3	-0.40	-1.18	-0.29	-0.52
Fishing Mode	4	2	1	4	-1.18	0.65	1.31	-1.27
Year	1	1	2	1	1.56	1.28	0.41	1.40
Month	2	3	4	2	0.03	-0.75	-1.43	0.38

Table E3: Non-parametric and normalized rankings of variable importance scores for the three most common miscellaneous species from MRFSS species compositions. Red denotes the least important, and green as the most important variable.

Variable	Nonparametric ranking			Normalized ranking		
	Cabezon	Kelp greenling	Chub mackerel	Cabezon	Kelp greenling	Chub mackerel
Port	2	2	1	0.60	-0.59	1.68
Fishing mode	1	-	3	1.29	-	-0.61
Year	3	1	2	-0.65	1.41	-0.21
Month	4	3	4	-1.25	-0.82	-0.87

Table E4: Non-parametric and normalized rankings of variable importance scores for the four most common rockfish species from MRFSS species compositions. Red denotes the least important, and green as the most important variable.

Variable	Nonparametric ranking				Normalized ranking			
	Black rockfish	Blue rockfish	Yellowtail rockfish	Canary rockfish	Black rockfish	Blue rockfish	Yellowtail rockfish	Canary rockfish
Port	2	2	1	1	0.33	0.49	1.68	1.53
Fishing mode	1	3	2	4	1.31	-0.72	-0.23	-0.99
Year	3	4	3	2	-0.18	-1.15	-0.53	0.25
Month	4	1	4	3	-1.46	1.38	-0.92	-0.79

When examining the normalized values across the most common species, for flatfish, fishing mode was two to three times less important than the next least important variable for two of the four species (sand sole and Pacific sanddab) (Table E2). For Pacific halibut, fishing mode is the second most important variable, and for starry flounder, fishing mode was the most important variable and it was over three times more important than the next most important variable (year). For the most common miscellaneous species (Table E3), month was two times less important for cabezon than the next most important variable (year), and month is the least important variable for the other two species, about 30% less important than the next important variable. For black and yellowtail rockfish, month was seven and two times less important, respectively, than the next least important (year; Table E4). For canary rockfish, month is the second least important (about 20% less); however, for blue rockfish, month was the most important variable, almost three times more important than the second most, port.

MRFSS Recommendations - For the MRFSS species compositions, a category specific approach seems to be best for flatfish, given the variable nature of the most common species when compared to the average rankings across the category. For flatfish, port is consistently the least important variable as seen in the average rankings for all species. Fishing mode is relatively consistent as the next least important. For miscellaneous and rockfish categories, a common species approach seems to outweigh a category approach, given the variable nature of the most common species when compared to the average rankings across the category. For miscellaneous fish, month is consistently the least important across all the common species. The average rankings across all species suggest that month is of mid-importance. However, the two most common species, by far, are cabezon and kelp greenling in this category, and except for month, they have nothing in common in terms of rankings. However, given that these two species represent roughly two-thirds of this category, port is recommended as the next strata to drop, because fishing mode is the most important for cabezon and year is the most important for greenling. Finally, except for blue rockfish, month is either the least important or the next least important for three of the four most common species. However, it is the most important for blue rockfish, the second most common species. Year should be considered the next least important factor across the most common species. These contrast with the average rankings across all species, which indicate that month and year are neither the least nor most important variables.

ORBS regression tree results - The ORBS species compositions contain two different definitions of fishing mode and therefore, regression tree analyses were run on two subsets of the dataset, one with only trip type (1979 – 1987) and one with only boat type (1988 – 2000).

The results are mixed when viewed across species within categories. Average rankings, including both non-parametric and normalized rankings, across the species categories indicate that fishing mode is the least important variable, generally followed by month (Tables E5 and E6). The most consistently important variable is port, followed by year.

Table E5: Average non-parametric and normalized rankings of variable importance scores for all species within a multi-species category from ORBS species compositions during the trip type era (1979 - 1987). Red denotes the least important, and green as the most important variable.

Variable	Average nonparametric ranking			Average normalized ranking		
	Flatfish	Misc	Rockfish	Flatfish	Misc	Rockfish
Port	1.6	1.7	1.5	0.71	0.50	0.88
Trip type	3.3	3.3	3.3	-0.85	-0.75	-0.86
Year	2.0	2.2	2.1	0.28	0.02	0.22
Month	2.7	2.4	2.7	-0.27	0.06	-0.30

Table E6: Average non-parametric and normalized rankings of variable importance scores for all species within a multi-species category from ORBS species compositions during the boat type era (1988 – 2000). Red denotes the least important, and green as the most important variable.

Variable	Average nonparametric ranking			Average normalized ranking		
	Flatfish	Misc.	Rockfish	Flatfish	Misc.	Rockfish
Port	1.7	1.9	1.8	0.46	0.21	0.47
Boat type	3.3	3.2	3.0	-0.58	-0.57	-0.46
Year	2.3	1.7	2.0	-0.05	0.50	0.22
Month	2.5	2.7	2.8	-0.08	-0.44	-0.37

The average ranking results are also relatively consistent with the most common species, and only the normalized rankings are shown. For flatfish, trip or boat type is fairly consistently the least important variable, though month is often a close second when considering the normalized rankings (Table E7). Port is consistently and strongly the most important variable. In miscellaneous species, results are mixed. For cabezon and kelp greenling, month or fishing mode is the least important variable (Table E8). Port is the most important for cabezon, but kelp greenling has a comparable score for year as the most important. Chub mackerel is different than either of these. Finally, for rockfish, again, either month or fishing mode are the two least important factors, though the degree of the difference depends on the boat or trip type dataset subset (Table E9). Port is clearly the most important variable for nearly all the most common rockfish species.

Table E7: Normalized rankings of variable importance scores for the four most common flatfish species from ORBS species compositions from the two fishing mode era subsets. Red denotes the least important, and green as the most important variable.

Variable	Trip type				Boat type			
	Sand sole	Pacific halibut	Starry flounder	Pacific sanddab	Sand sole	Pacific halibut	Starry flounder	Pacific sanddab
Port	1.35	1.53	1.66	1.68	1.44	0.02	1.72	1.46
Fishing mode	-1.08	-1.06	-0.79	-0.74	-1.21		-0.62	-1.16
Year	0.56	0.23	-0.10	-0.17	0.35	1.21	-0.39	-0.64
Month	-0.84	-0.70	-0.77	-0.76	-0.58	-1.23	-0.71	0.34

Table E8: Normalized rankings of variable importance scores for the three most common miscellaneous species from ORBS species compositions from the two fishing mode era subsets. Red denotes the least important, and green as the most important variable.

Variable	Trip type			Boat type		
	Cabezon	Kelp greenling	Chub mackerel	Cabezon	Kelp greenling	Chub mackerel
Port	1.19	-0.46	-0.18	1.69	-0.02	-1.00
Fishing mode	-0.61		-1.08	-0.74		1.44
Year	0.72	1.39	-0.38	-0.21	1.23	-0.86
Month	-1.30	-0.93	1.63	-0.74	-1.22	0.43

Table E9: Normalized rankings of variable importance scores for the four most common rockfish species from ORBS species compositions from the two fishing mode era subsets. Red denotes the least important, and green as the most important variable.

Variable	Trip type				Boat type			
	Black rockfish	Blue rockfish	Yellowtail rockfish	Canary rockfish	Black rockfish	Blue rockfish	Yellowtail rockfish	Canary rockfish
Port	1.70	1.54	1.00	1.27	1.73	0.54	1.72	1.59
Fishing mode	-0.88	-1.17		-0.89	-0.60	-1.02	-0.42	-0.74
Year	-0.44	-0.50		0.68	-0.49	1.37	-0.65	0.11
Month	-0.38	0.13	-1.00	-1.07	-0.64	-0.89	-0.66	-0.95

ORBS Recommendations - Given the consistent importance of port throughout the dataset, this should not be considered as an appropriate aggregating or borrowing factor. Month and fishing mode are consistently the least important variables across most of the species, but a more nuanced approach for each species category is still recommended. For both flatfish and rockfish, fishing mode is recommended as the least important factor, followed by month. For the rockfish category, it might be advantageous to drop month first, and then fishing mode for the boat mode era, and then mode followed by month for the trip mode era. For miscellaneous fish, month is recommended to be removed first, followed by fishing mode.

APPENDIX F: COMPARISON OF ESTIMATED RECREATIONAL LANDINGS FROM MULTIPLE DATA SOURCES

This appendix documents the comparison of multiple data sources for species specific recreational catch estimates for all species. Data sources include the original base dataset (“Base”, red), the expanded numbers of fish with the MRFSS species compositions (“Expanded (MRFSS Spp.)”, blue), the expanded numbers of fish with the ORBS species compositions (“Expanded (ORBS Spp.)”, green), and the original MRFSS estimates from RecFIN (“Org. MRFSS Estimates”, yellow). Solid lines indicate the two versions of the expanded estimates, with the application of the two different species composition datasets. Note the variable y-axis scale in the following figures.

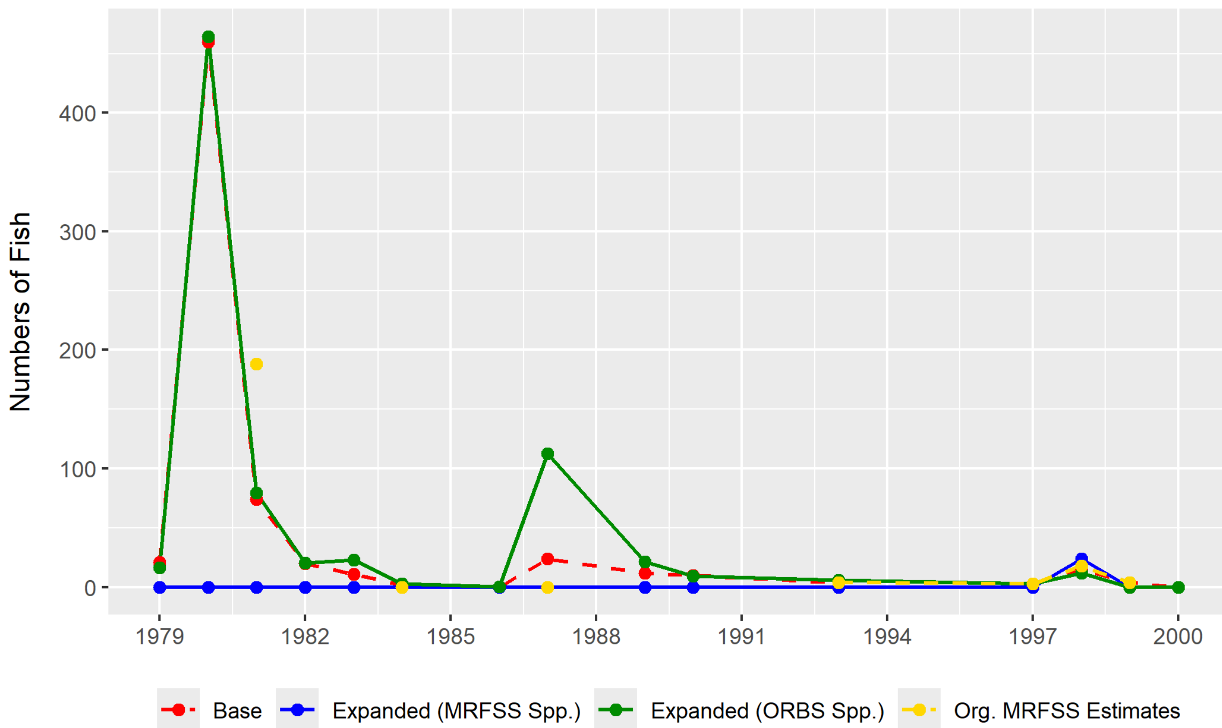

Figure F1: Comparison of historical Sharks recreational catch datasets.

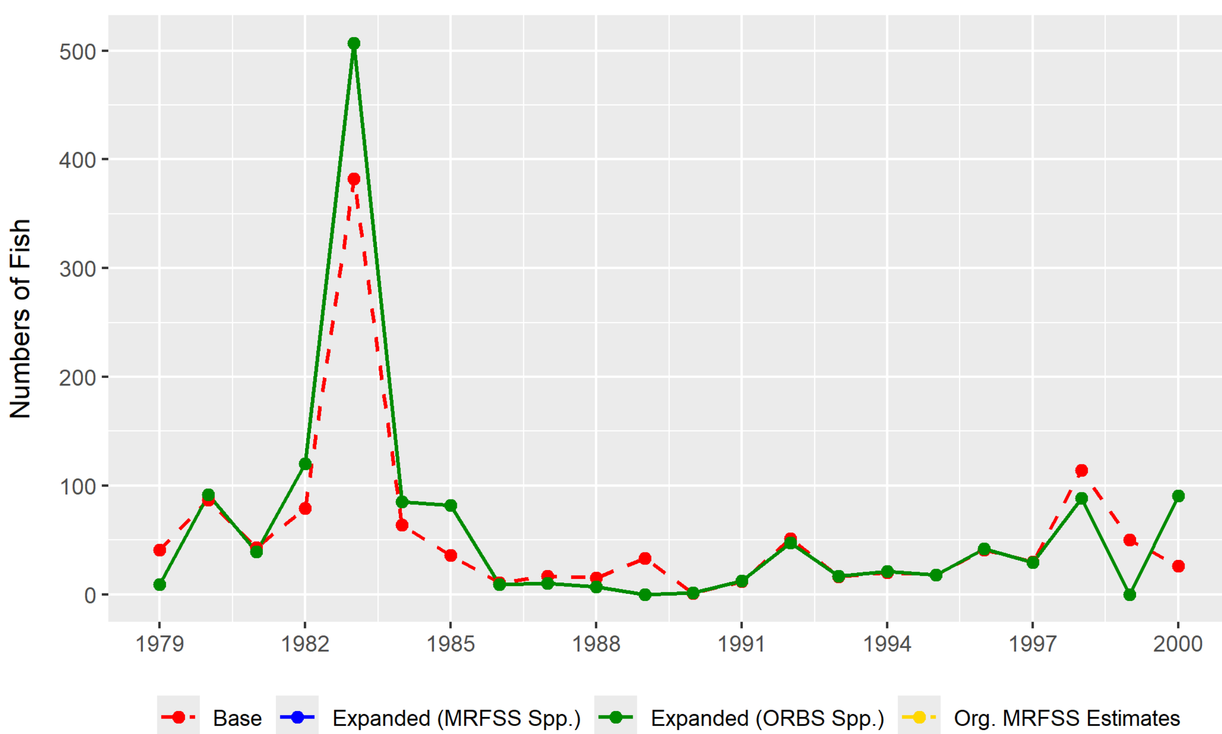

Figure F2: Comparison of historical Blue Shark recreational catch datasets.

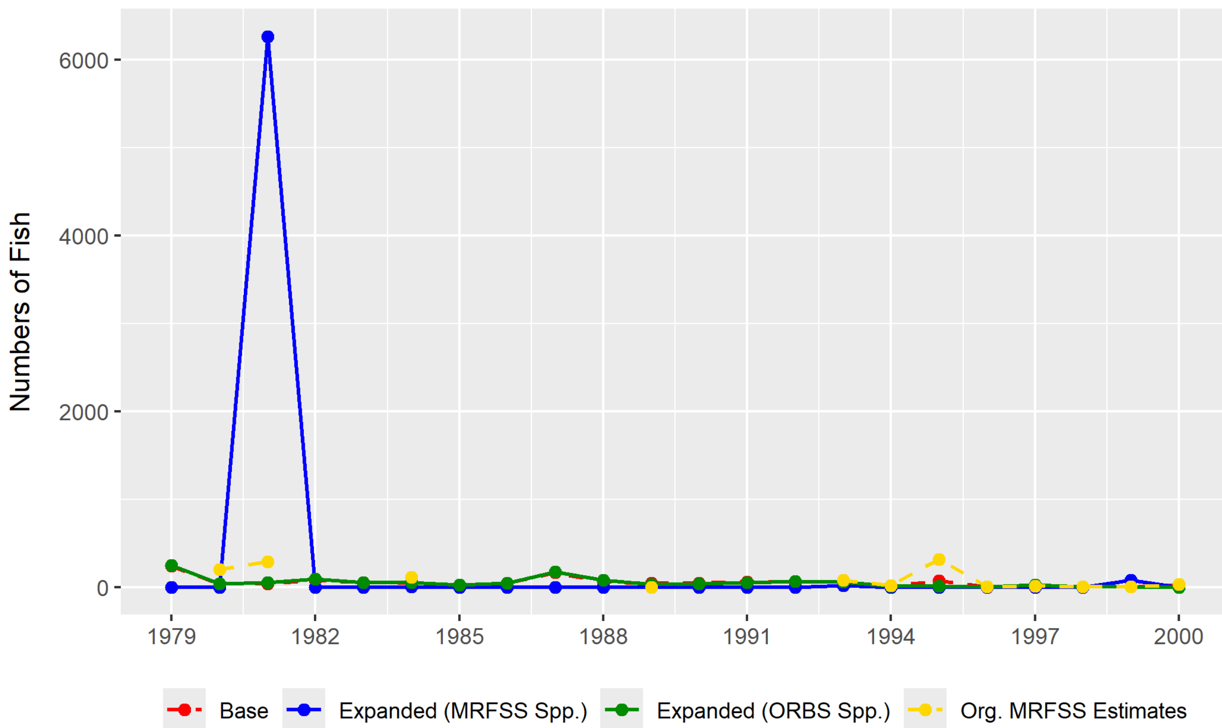

Figure F3: Comparison of historical Spiny Dogfish Shark recreational catch datasets.

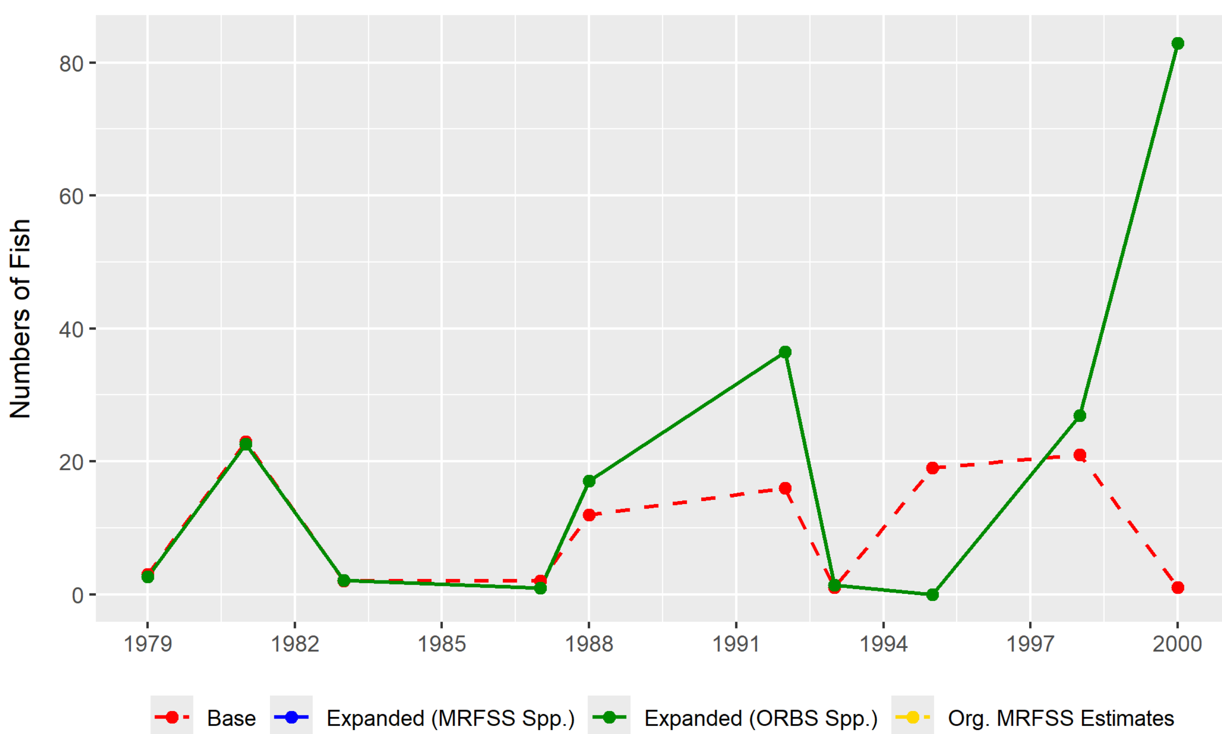

Figure F4: Comparison of historical Skates recreational catch datasets.

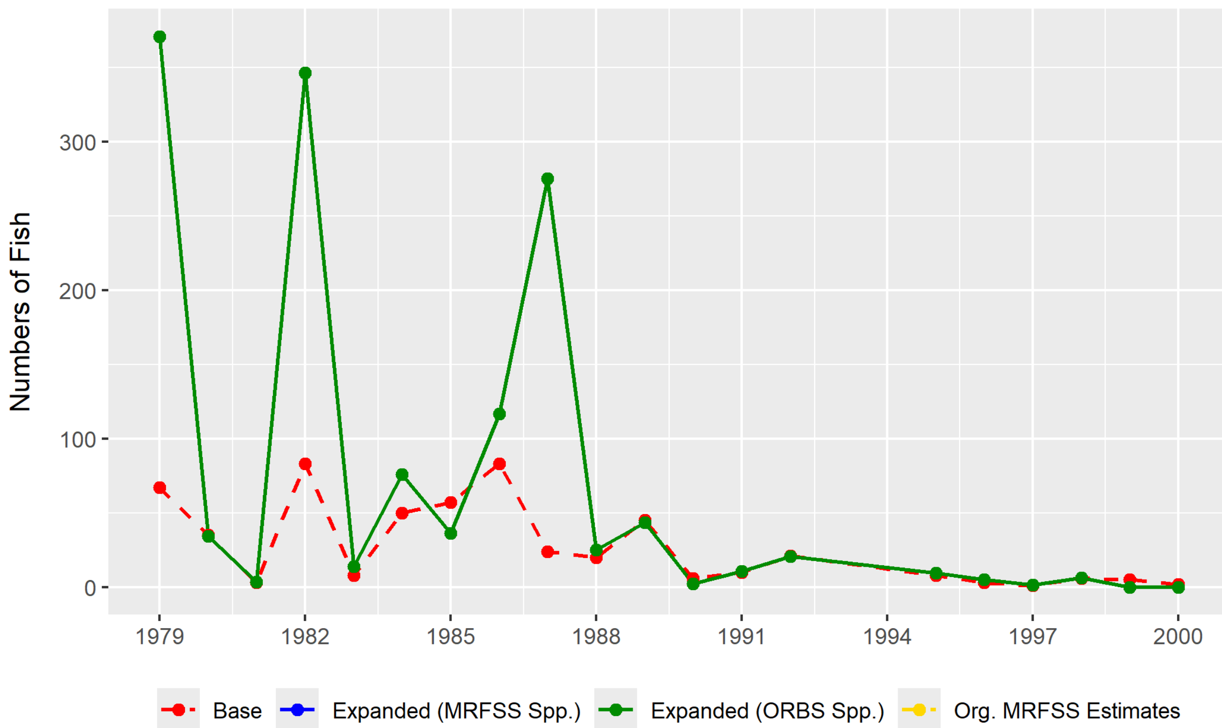

Figure F5: Comparison of historical Big Skate recreational catch datasets.

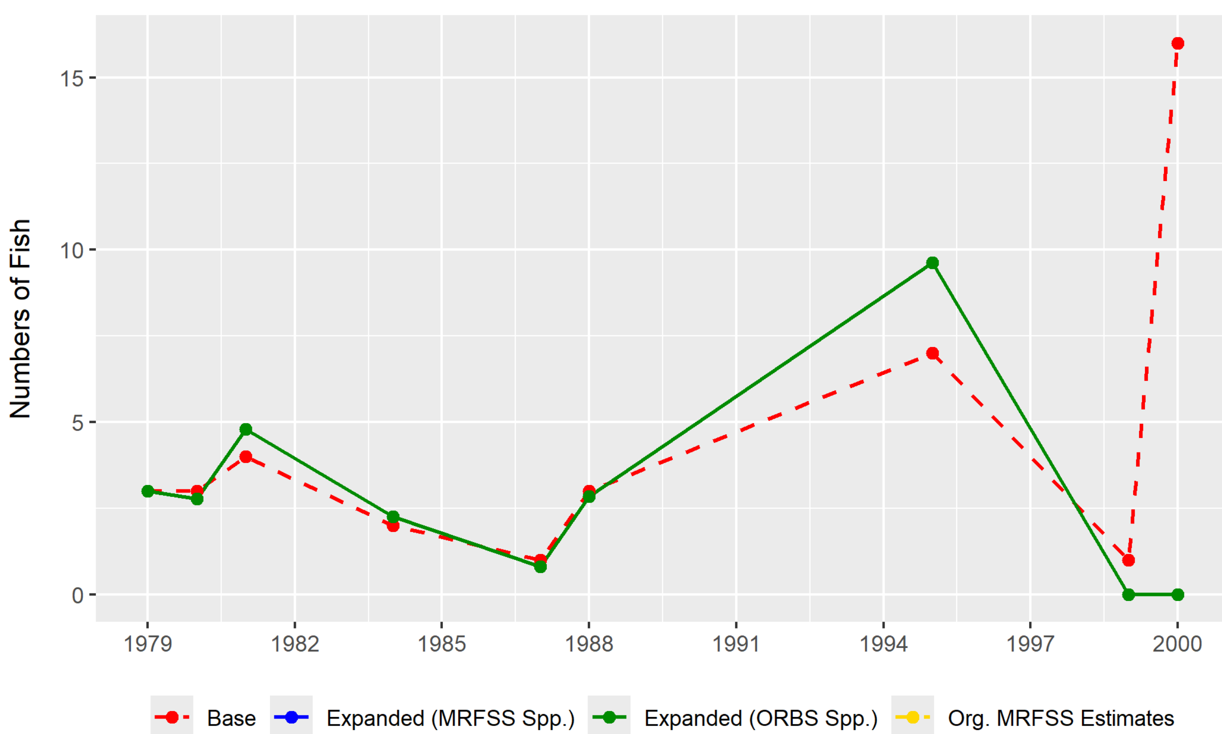

Figure F6: Comparison of historical Longnose Skate recreational catch datasets.

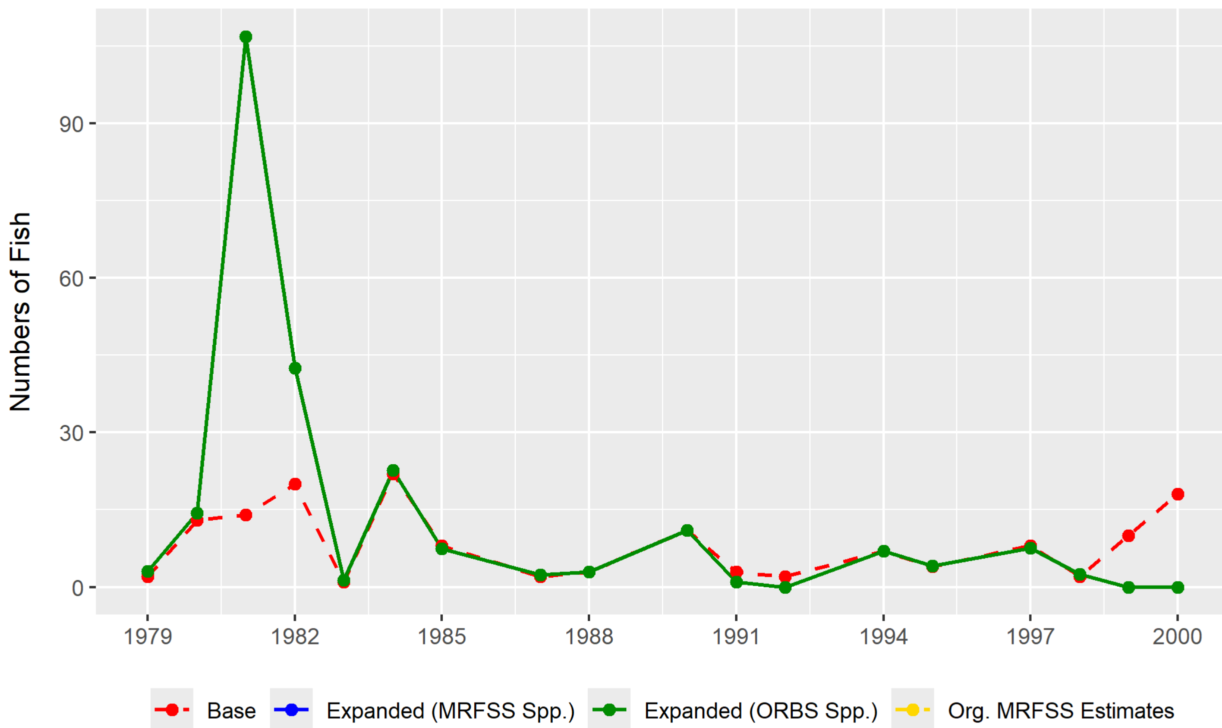

Figure F7: Comparison of historical Spotted Ratfish recreational catch datasets.

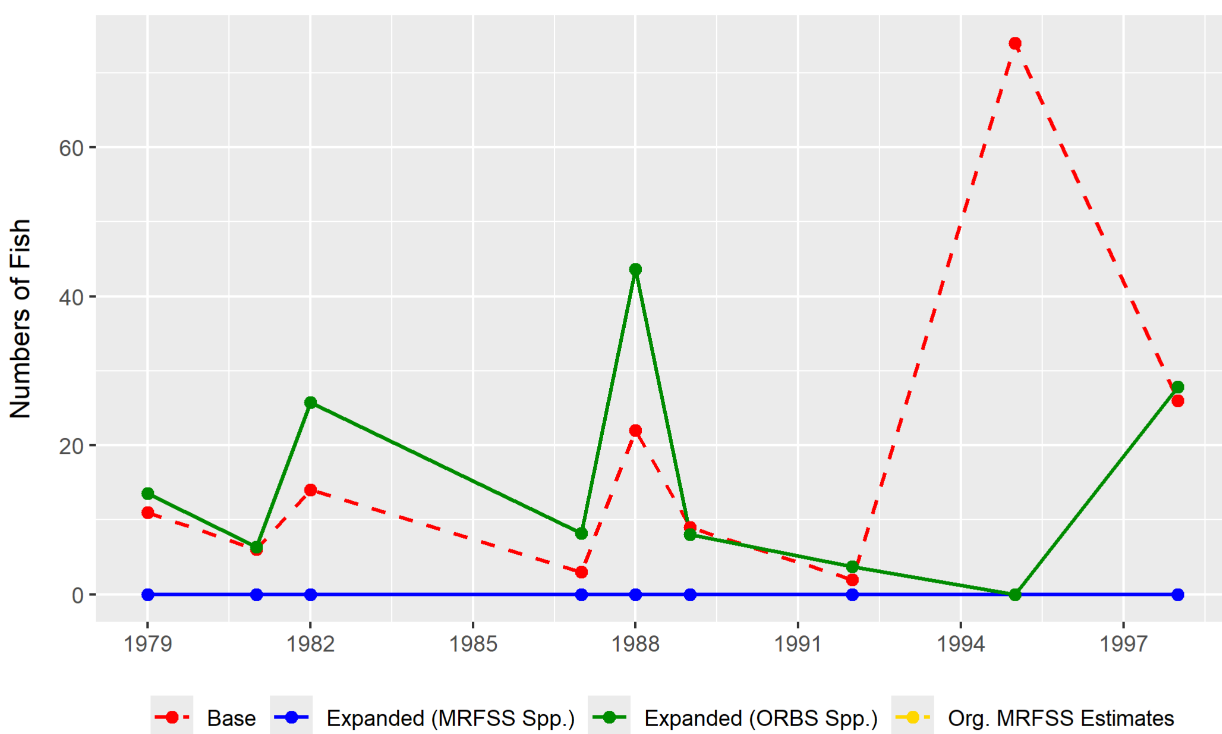

Figure F8: Comparison of historical Sturgeons recreational catch datasets.

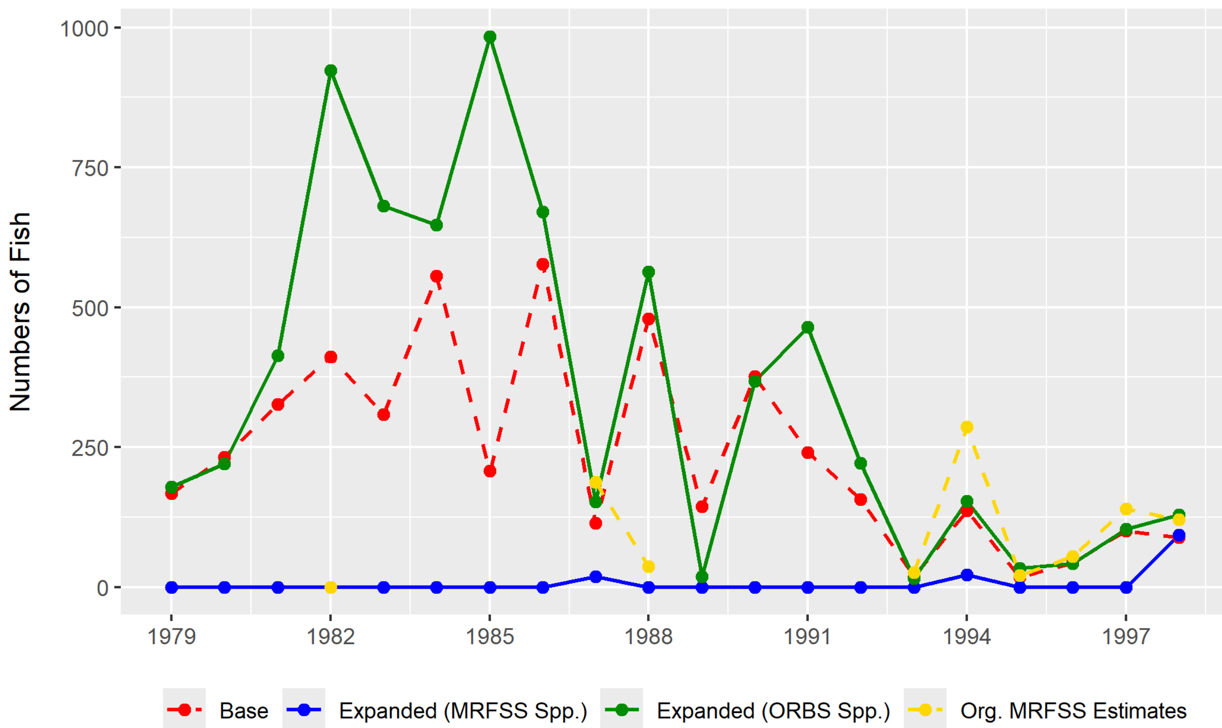

Figure F9: Comparison of historical Pacific Whiting (Hake) recreational catch datasets.

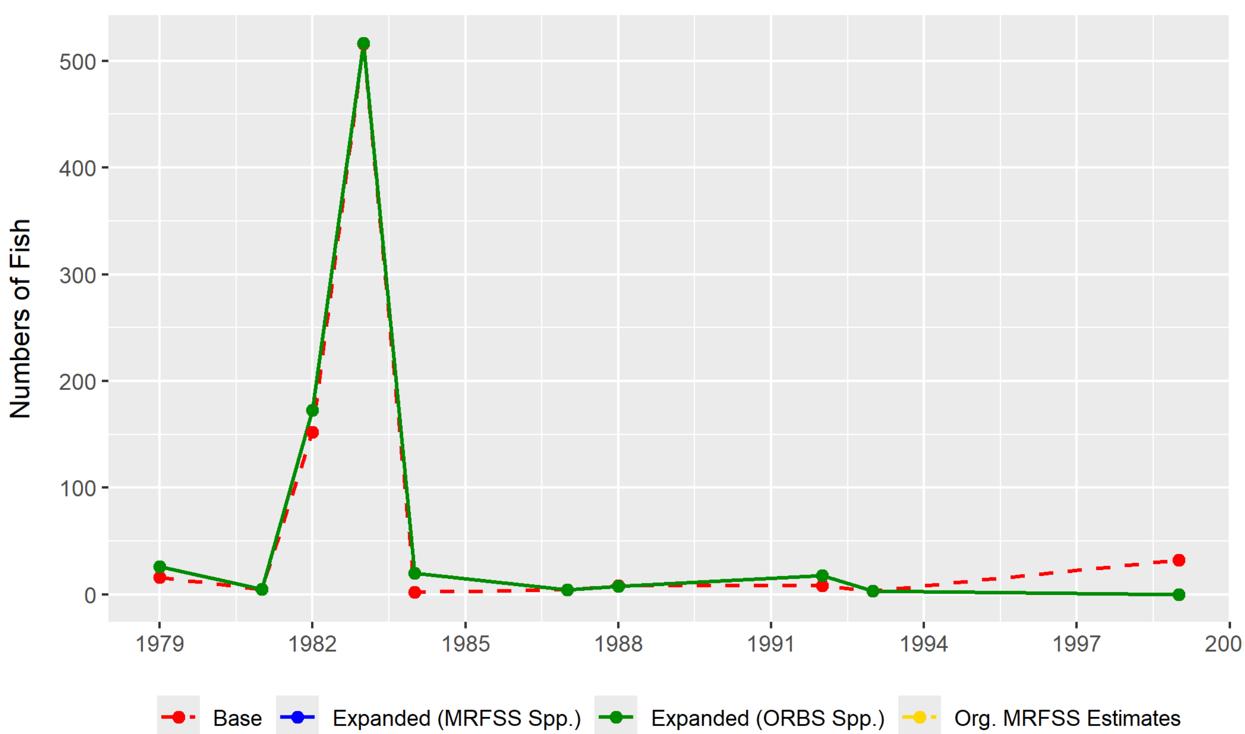

Figure F10: Comparison of historical Pacific Tomcod recreational catch datasets.

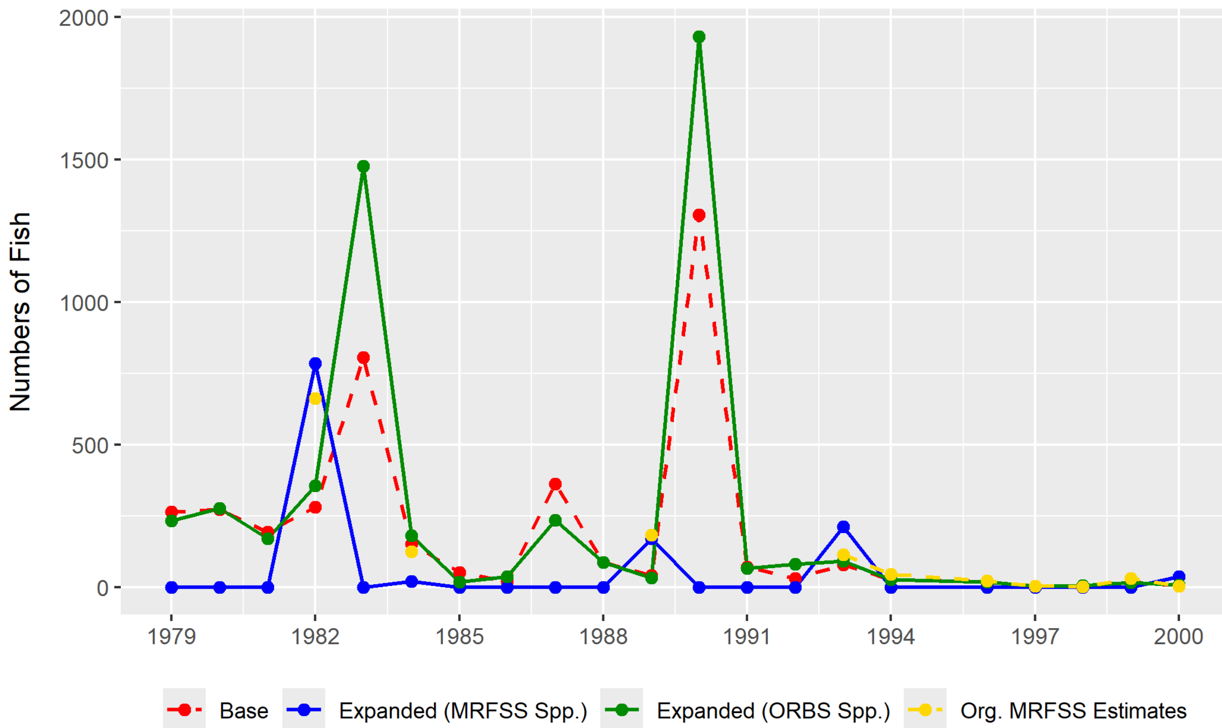

Figure F11: Comparison of historical Jack Mackerel recreational catch datasets.

Figure F12: Comparison of historical Surfperches recreational catch datasets.

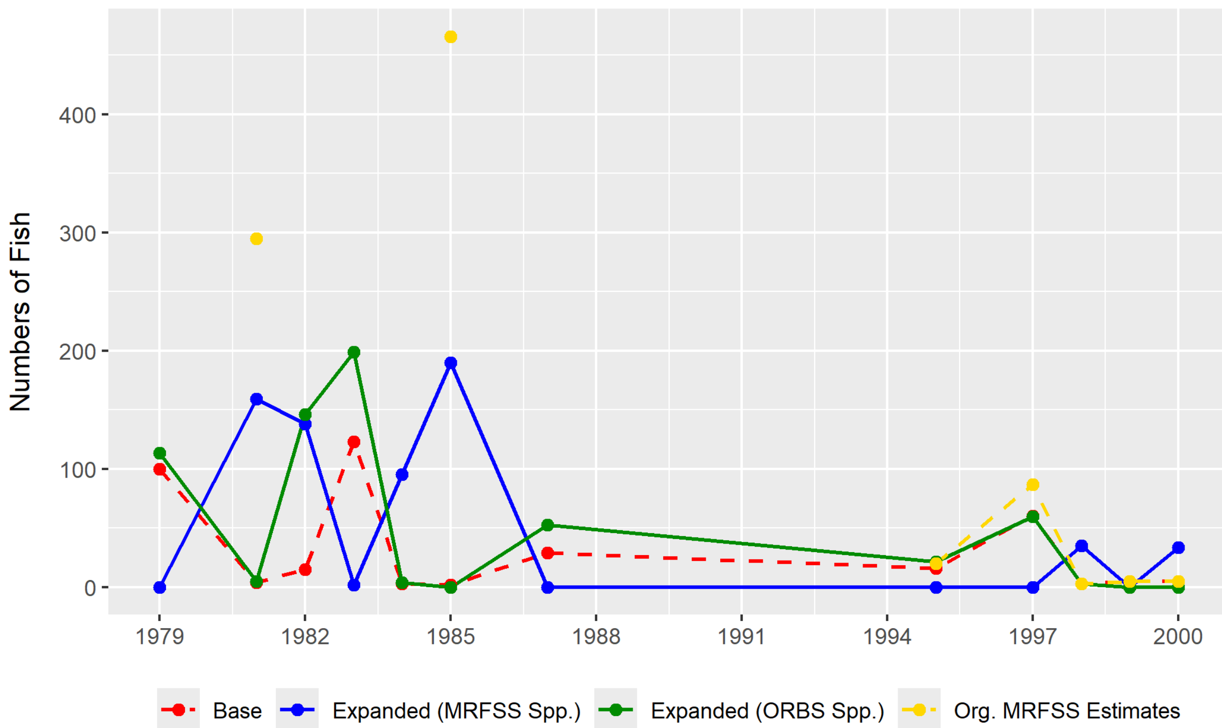

Figure F13: Comparison of historical Redtail Surfperch recreational catch datasets.

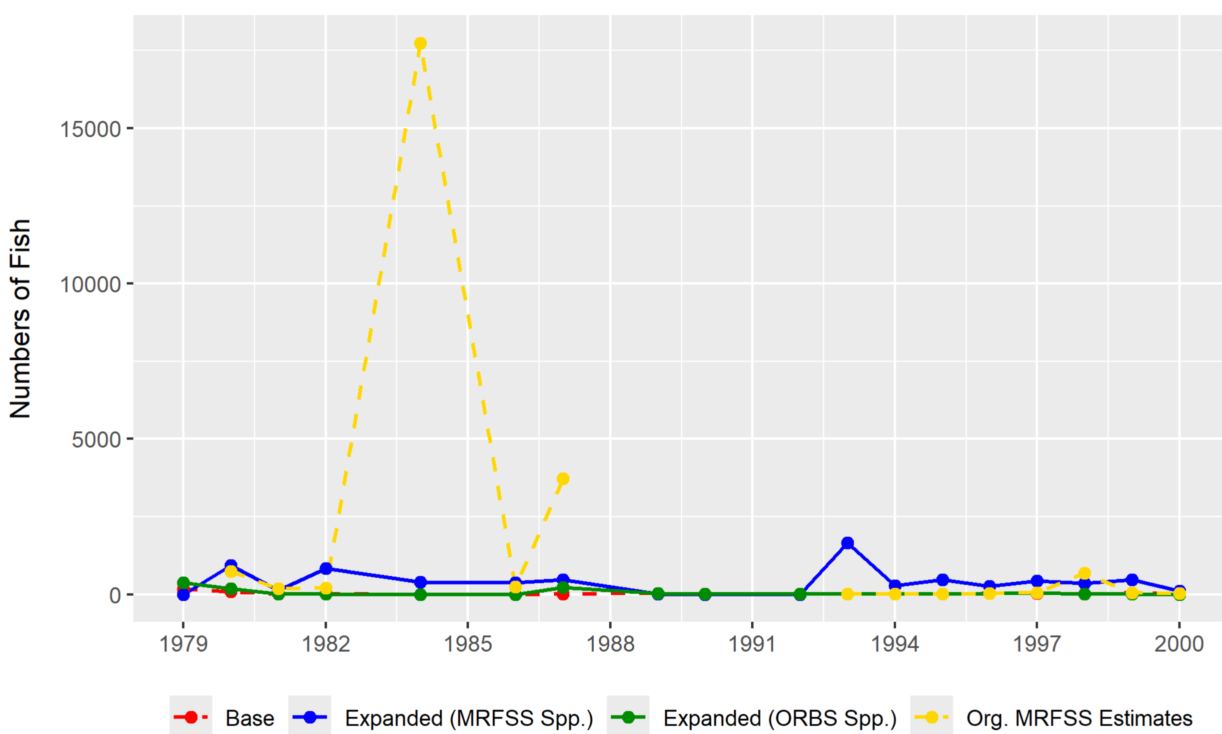

Figure F14: Comparison of historical Striped Seaperch recreational catch datasets.

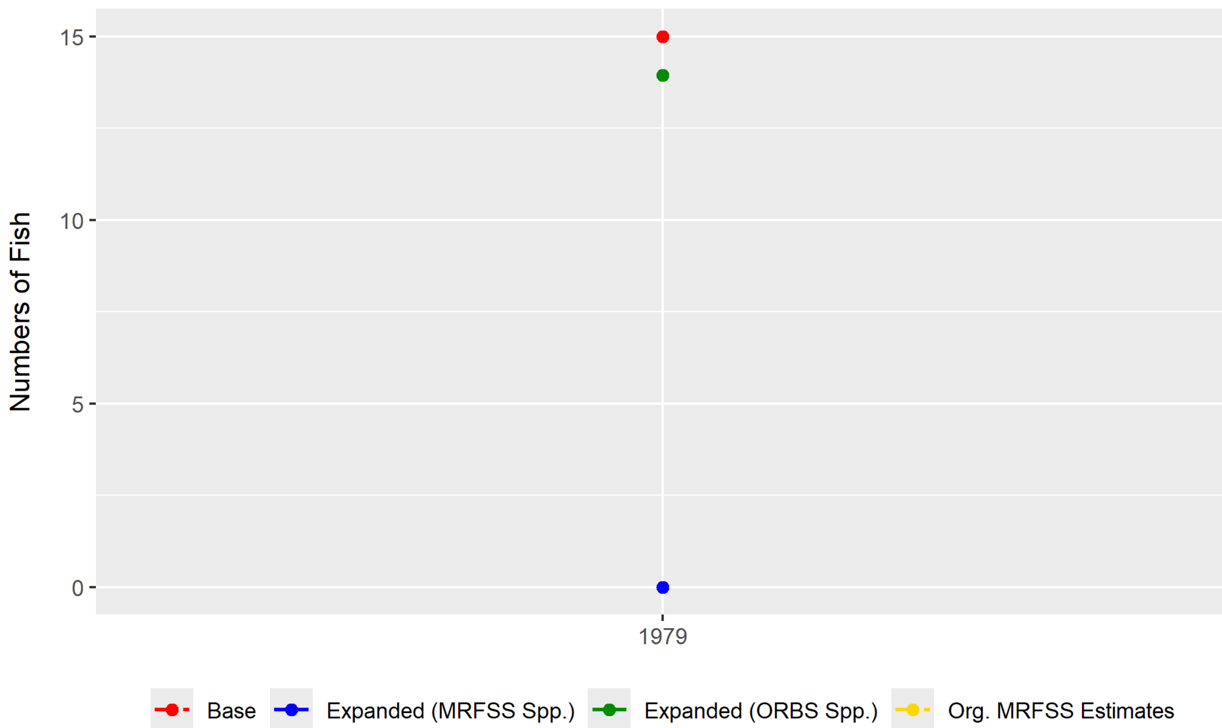

Figure F15: Comparison of historical White Seaperch recreational catch datasets.

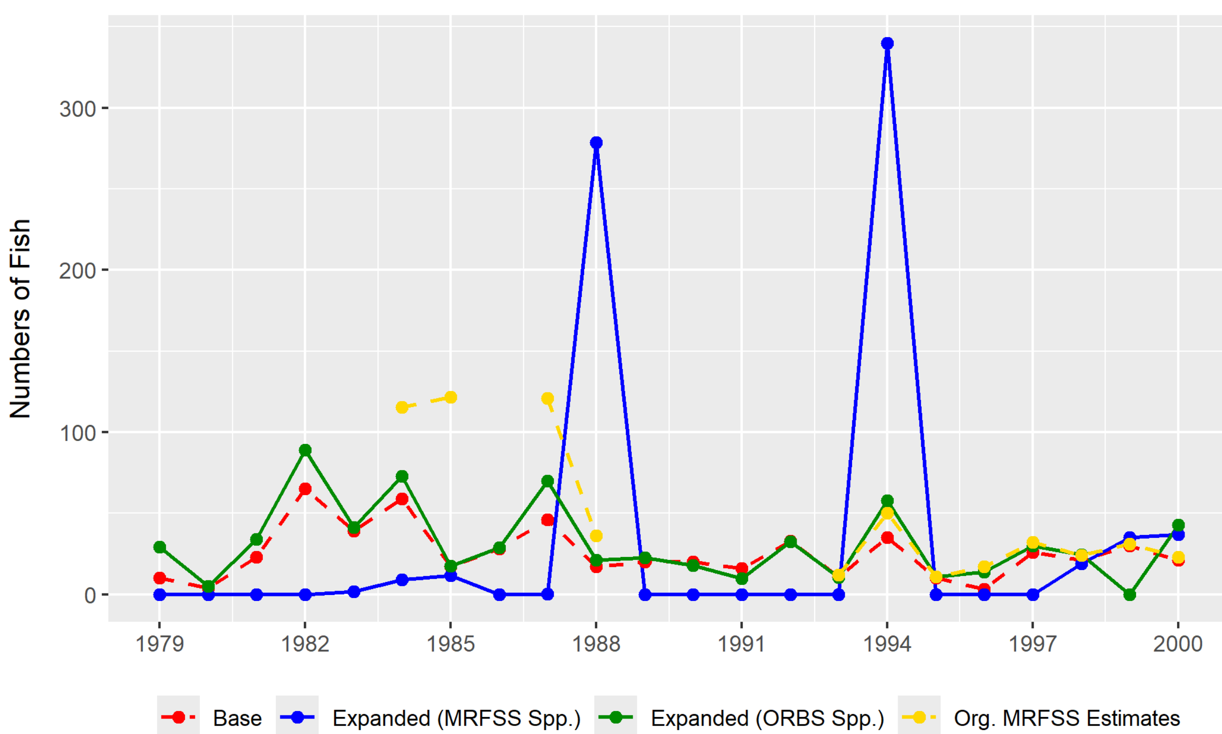

Figure F16: Comparison of historical Wolf-Eel recreational catch datasets.

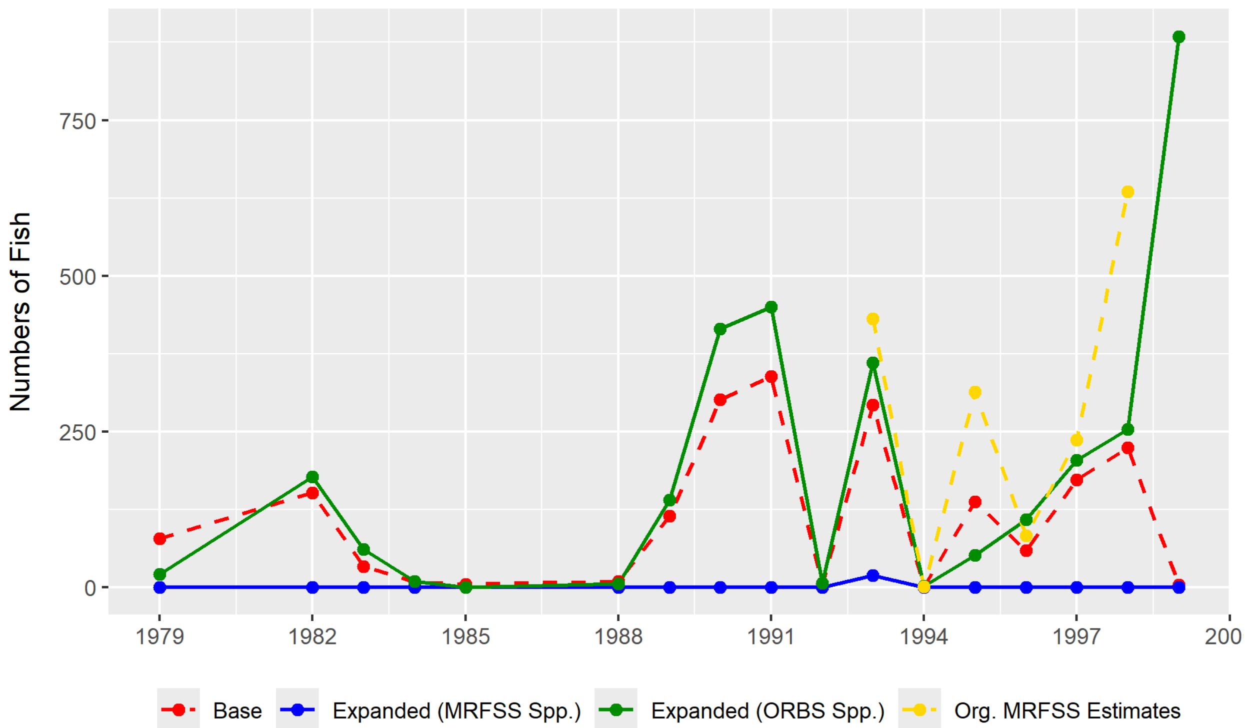

Figure F17: Comparison of historical Mackerels recreational catch datasets.

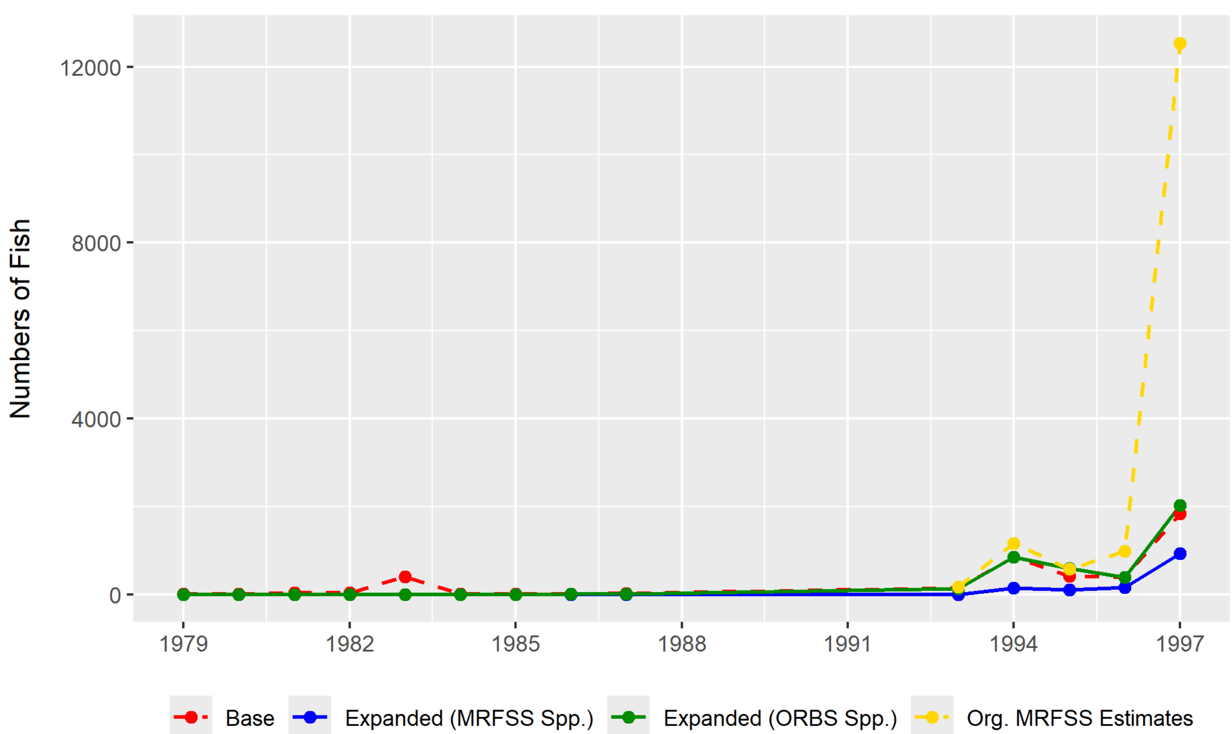

Figure F18: Comparison of historical Albacore recreational catch datasets.

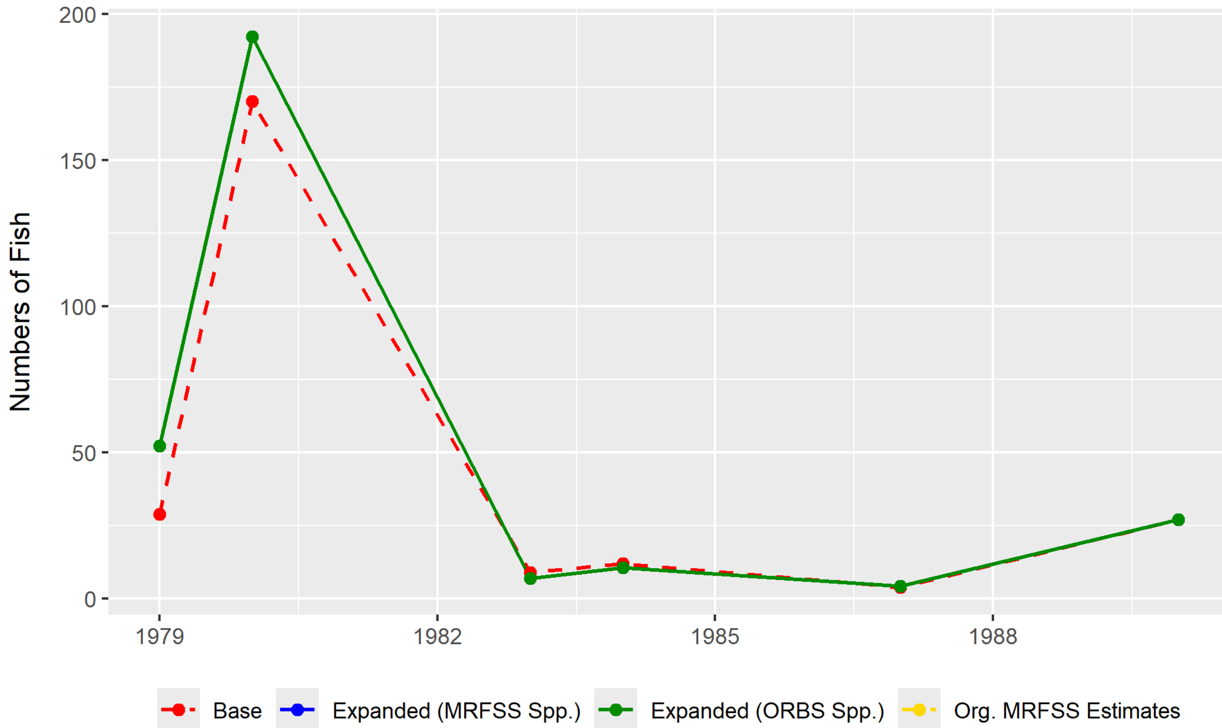

Figure F19: Comparison of historical Nominal Shelf Rockfish recreational catch datasets.

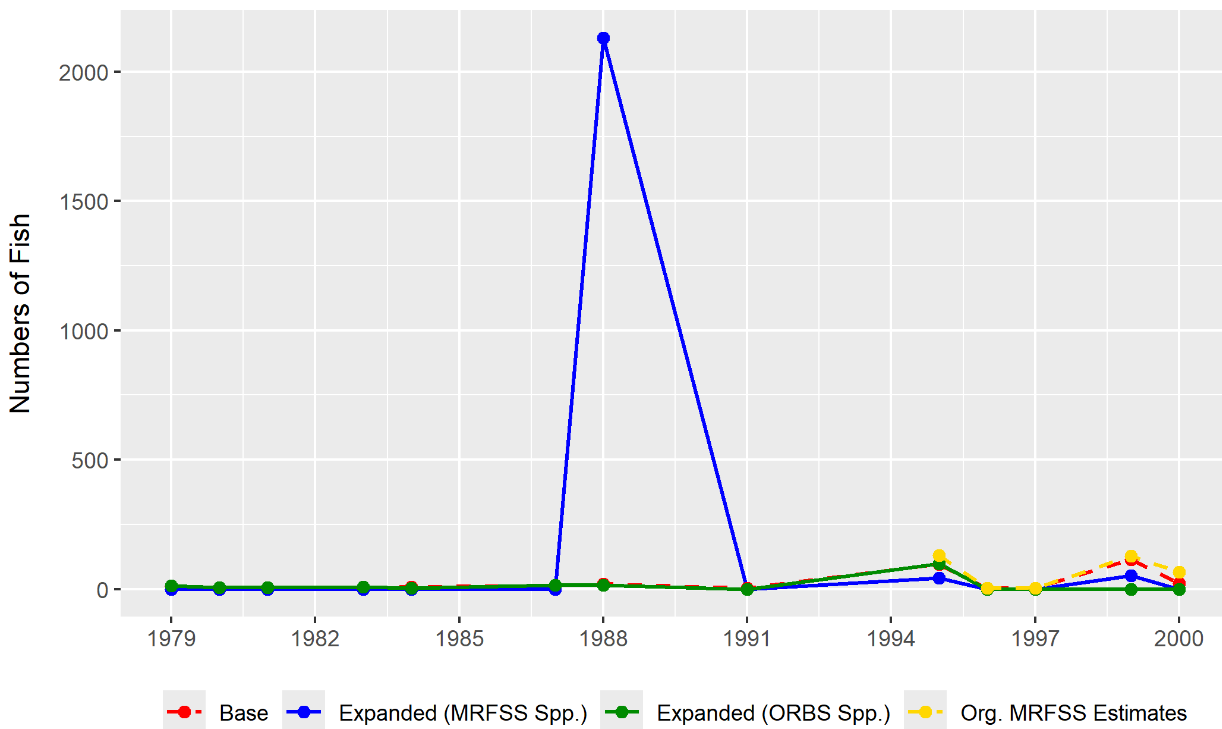

Figure F20: Comparison of historical Brown Rockfish recreational catch datasets.

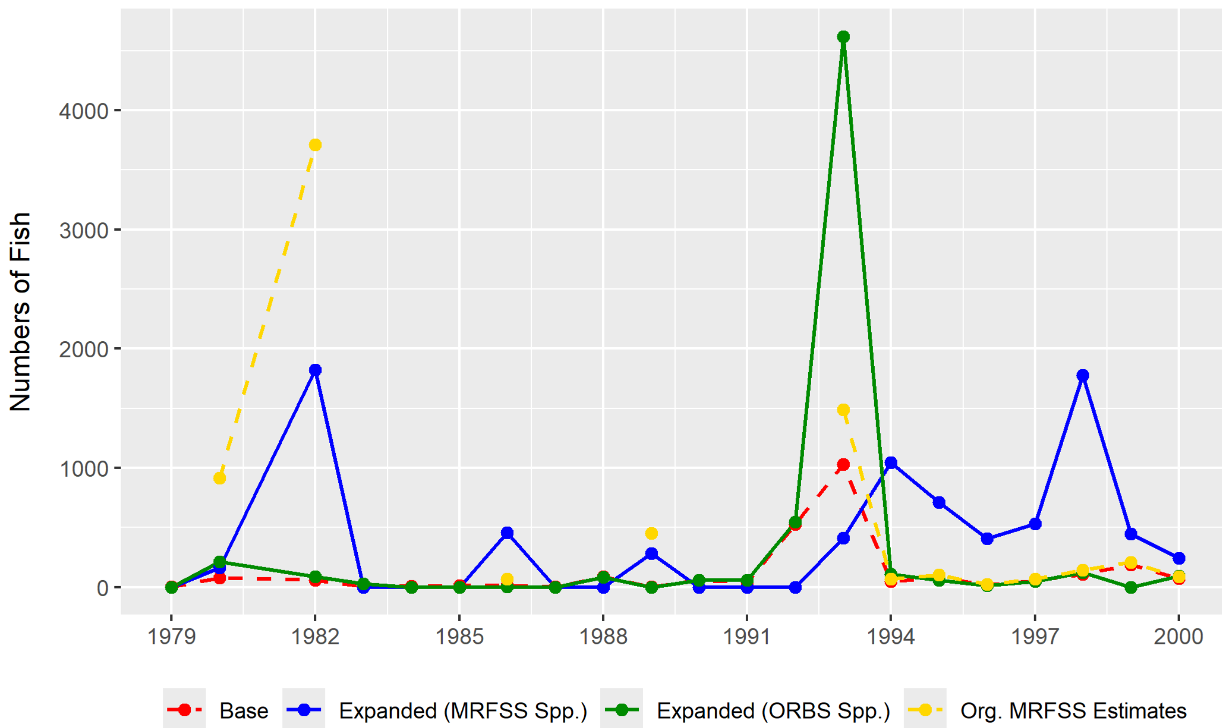

Figure F21: Comparison of historical Silvergray Rockfish recreational catch datasets.

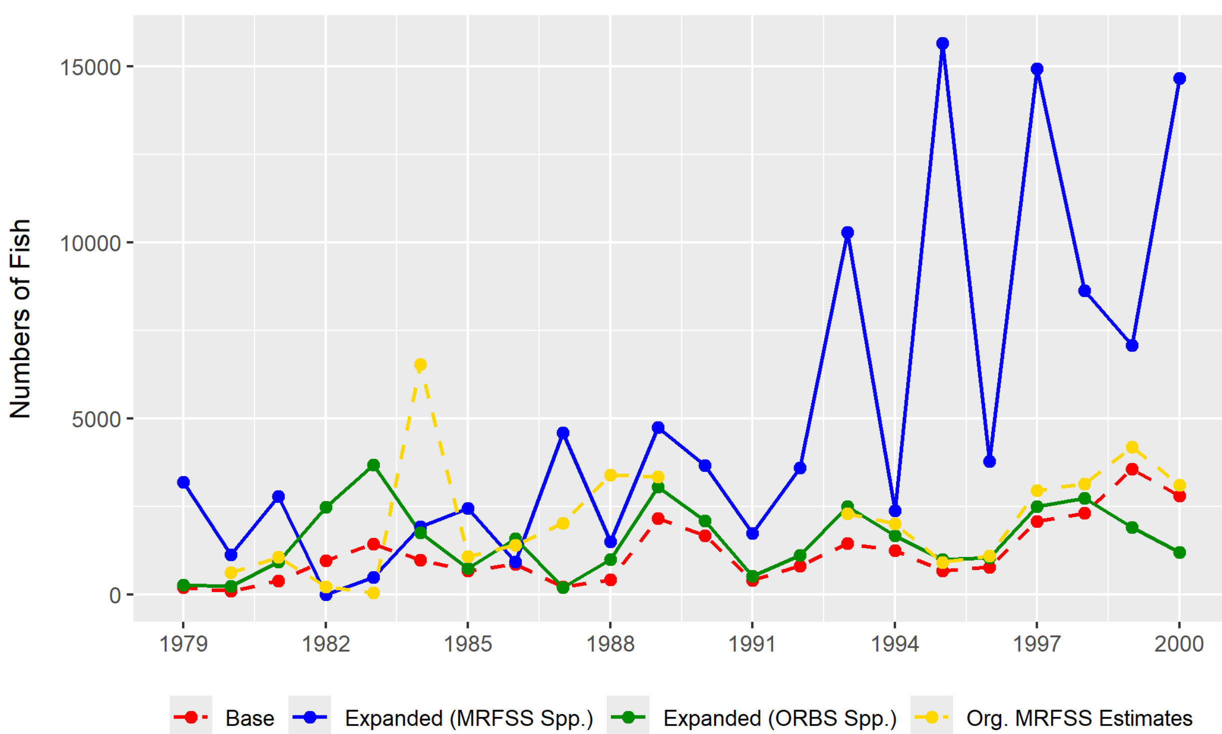

Figure F22: Comparison of historical Copper Rockfish recreational catch datasets.

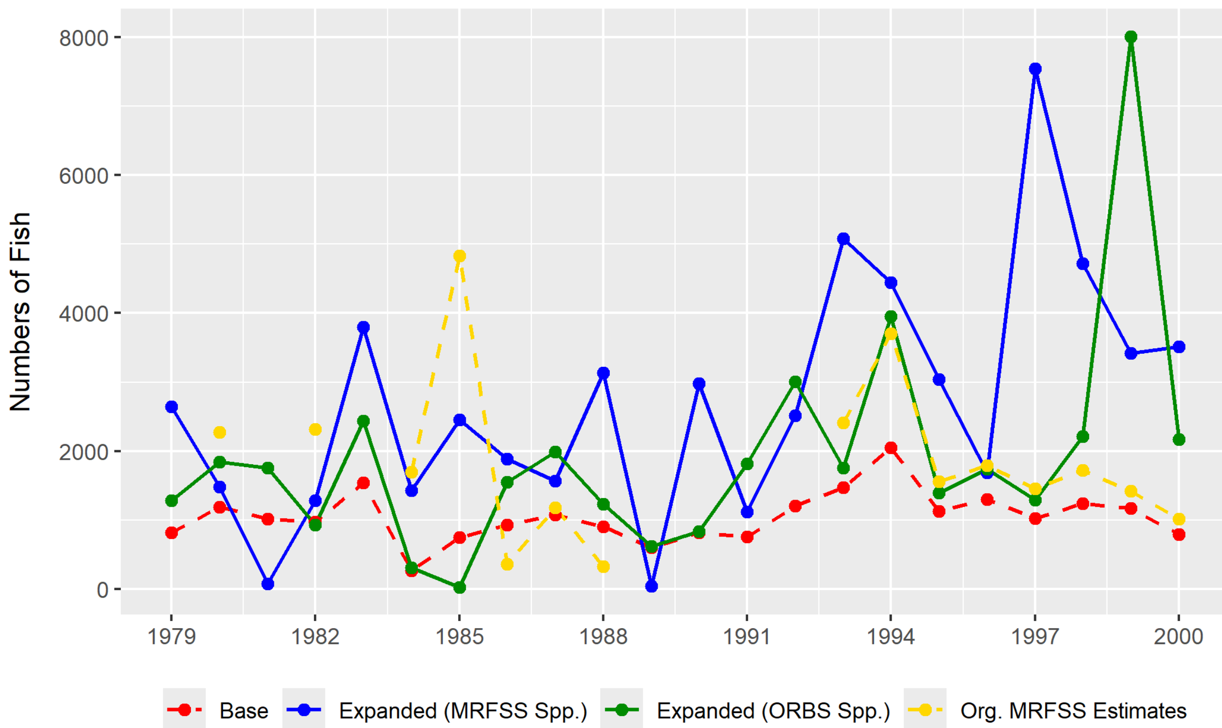

Figure F23: Comparison of historical Greenstriped Rockfish recreational catch datasets.

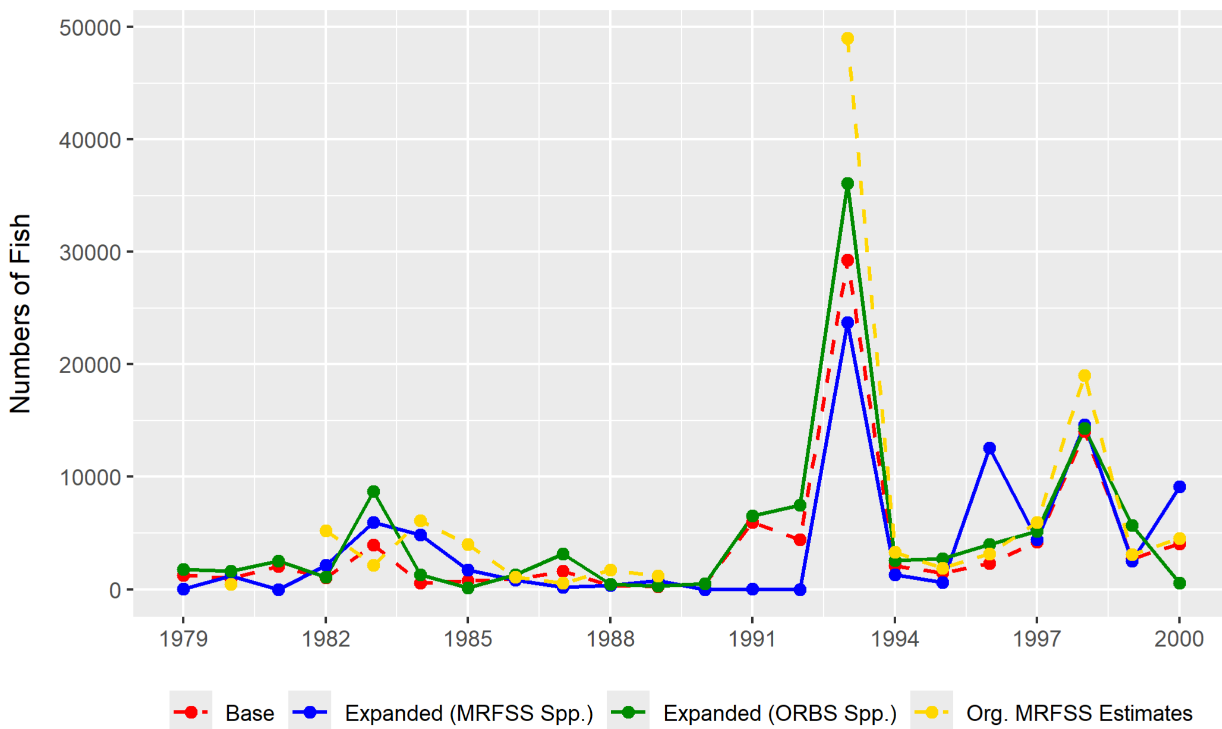

Figure F24: Comparison of historical Widow Rockfish recreational catch datasets.

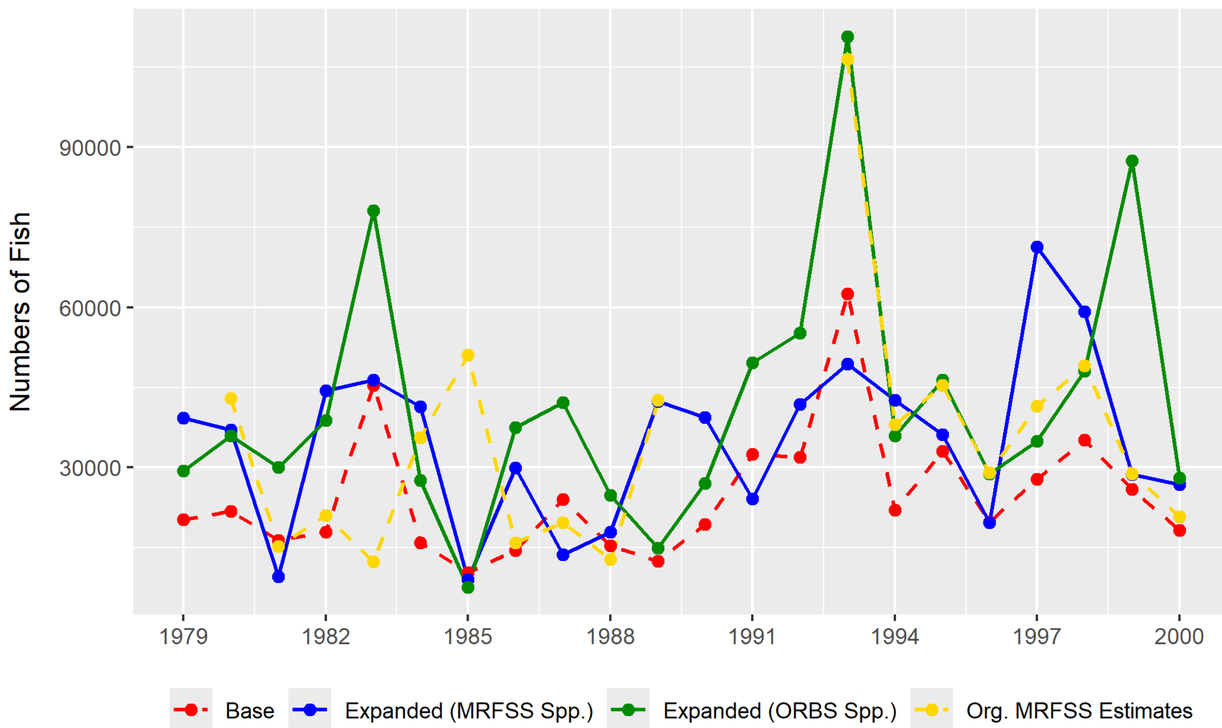

Figure F25: Comparison of historical Yellowtail Rockfish recreational catch datasets.

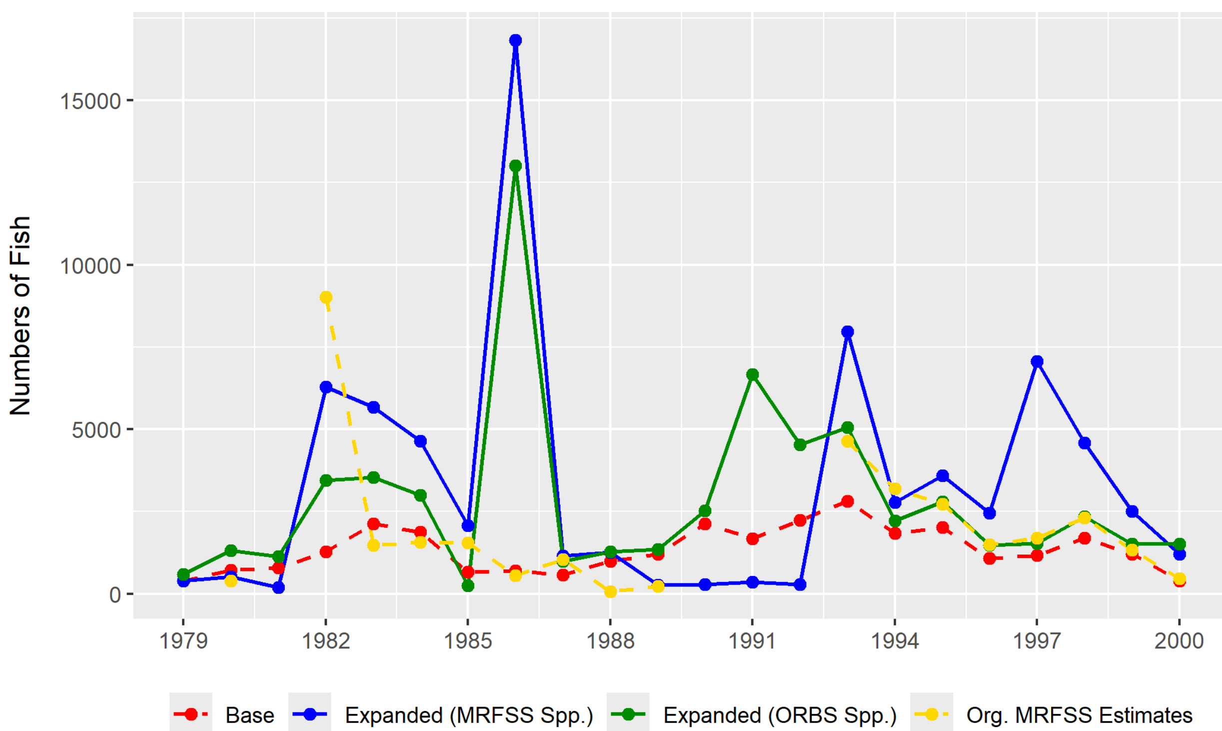

Figure F26: Comparison of historical Rosethorn Rockfish recreational catch datasets.

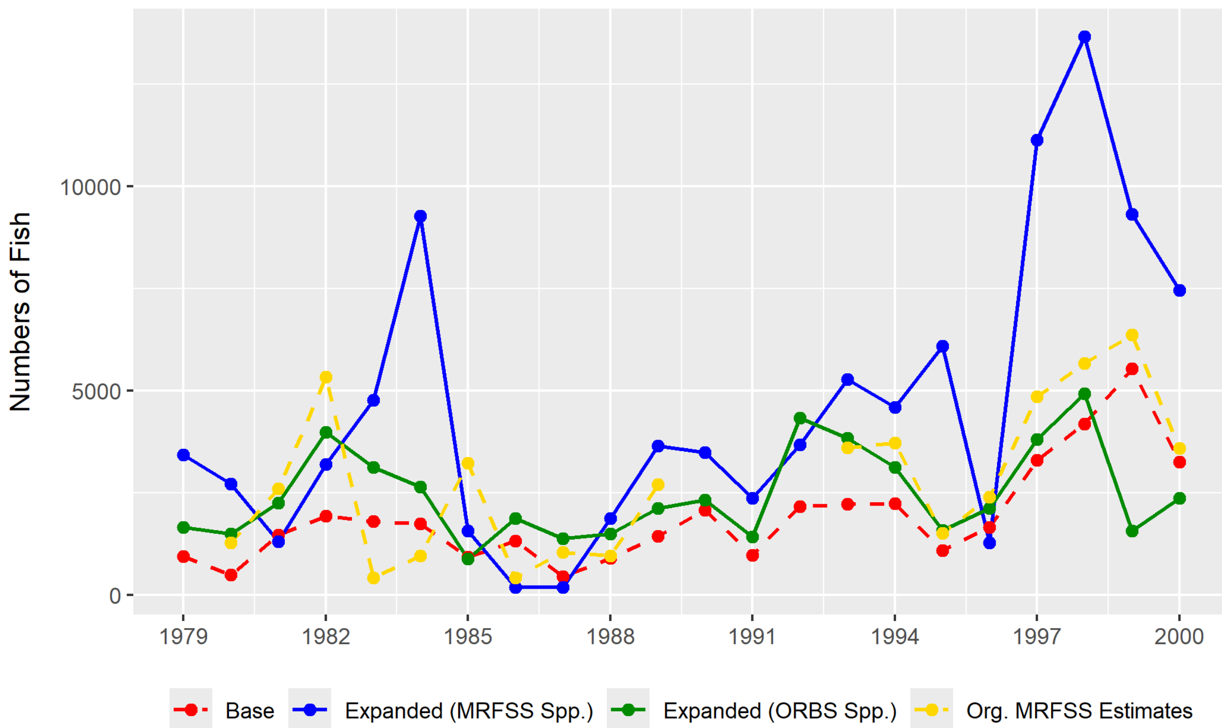

Figure F27: Comparison of historical Quillback Rockfish recreational catch datasets.

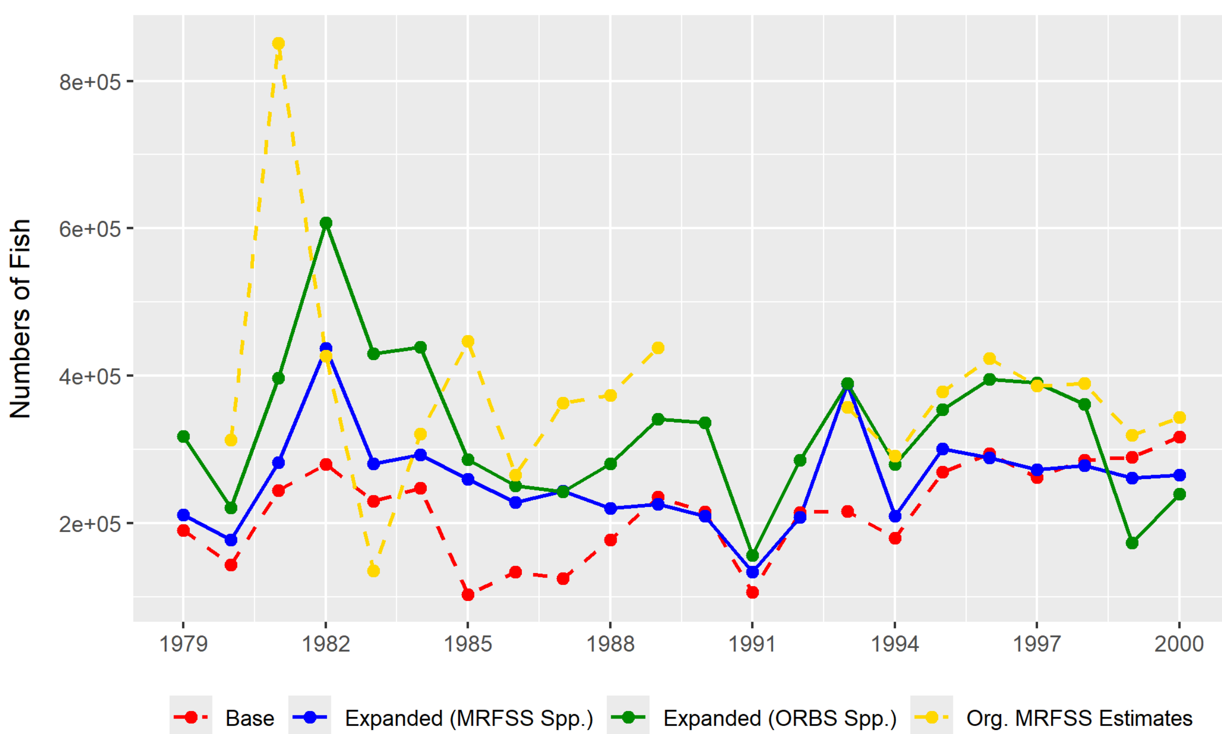

Figure F28: Comparison of historical Black Rockfish recreational catch datasets.

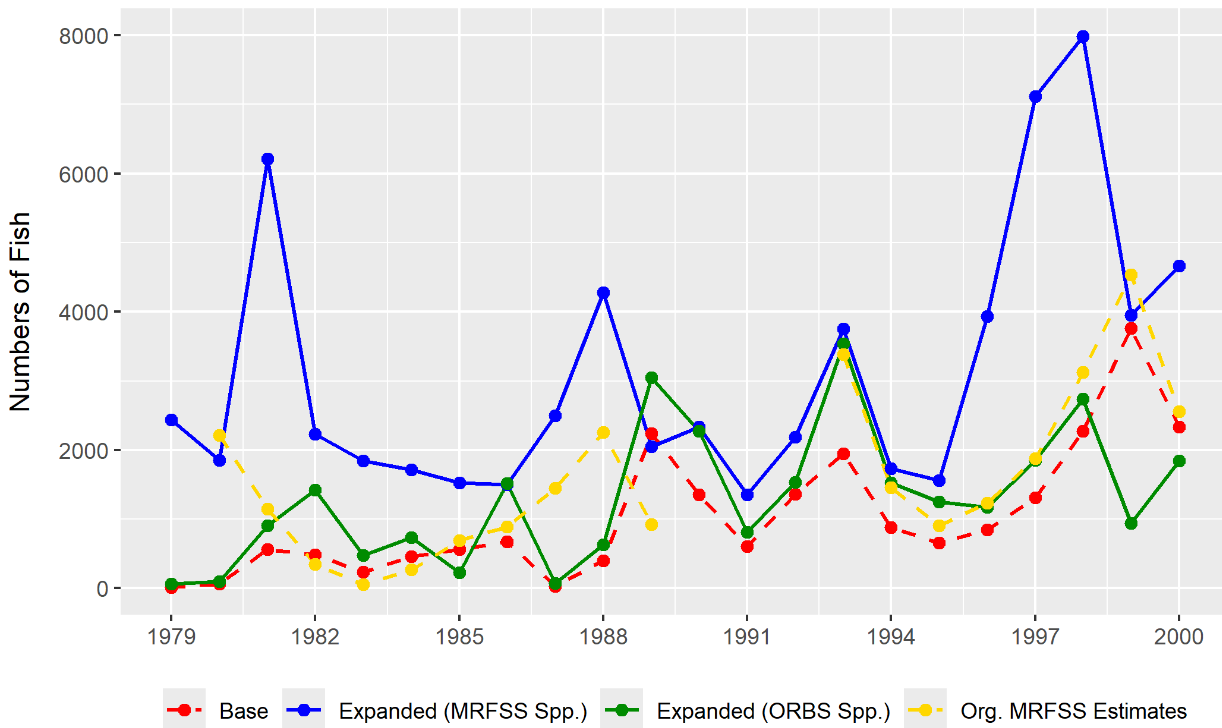

Figure F29: Comparison of historical Vermilion Rockfish recreational catch datasets.

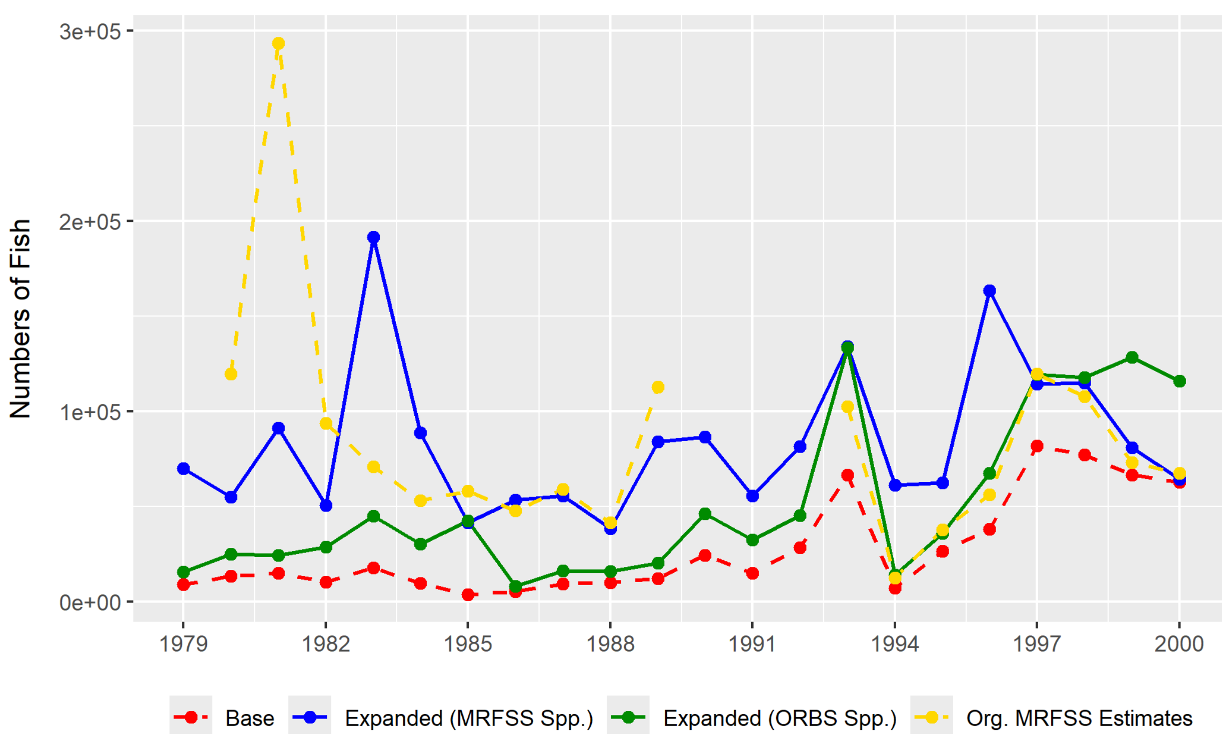

Figure F30: Comparison of historical Blue Rockfish recreational catch datasets.

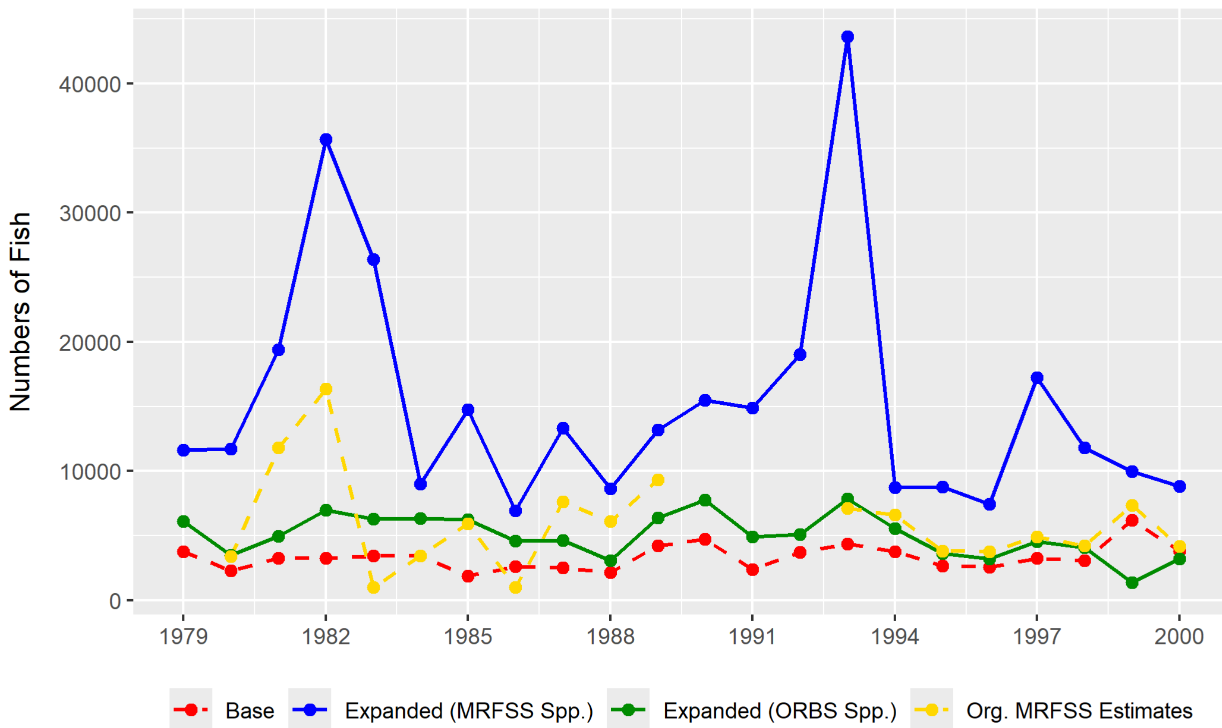

Figure F31: Comparison of historical China Rockfish recreational catch datasets.

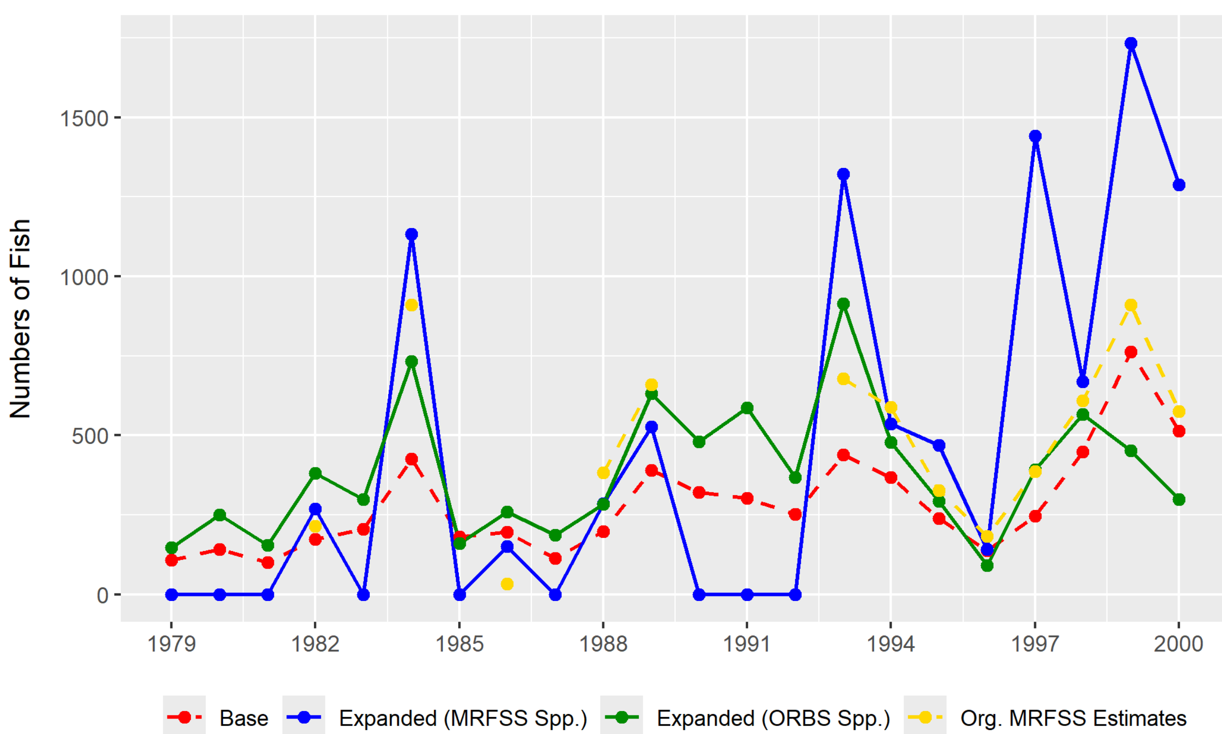

Figure F32: Comparison of historical Tiger Rockfish recreational catch datasets.

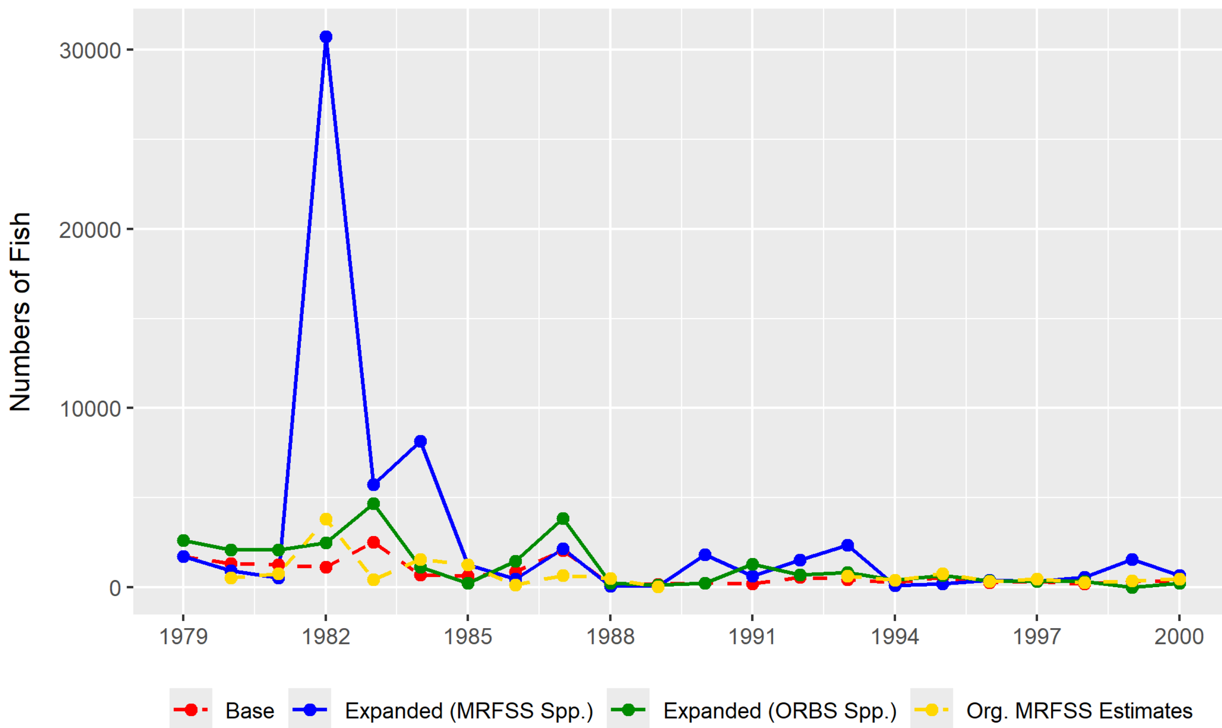

Figure F33: Comparison of historical Bocaccio recreational catch datasets.

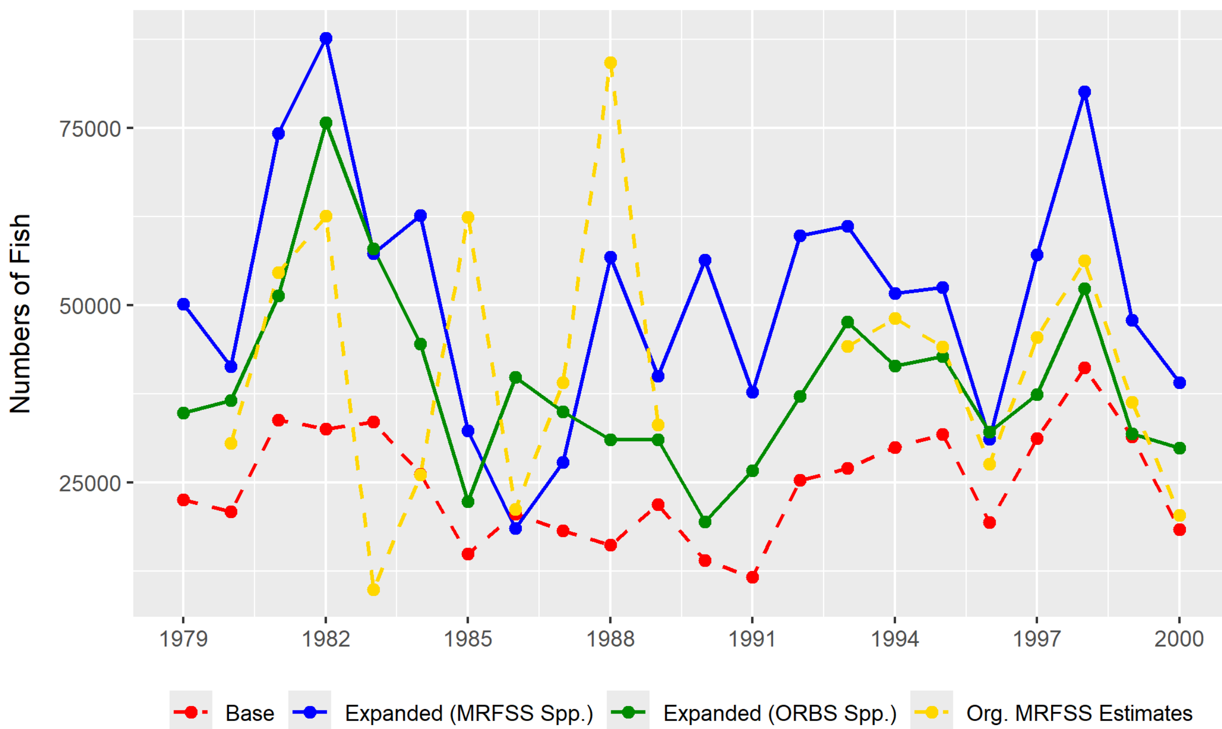

Figure F34: Comparison of historical Canary Rockfish recreational catch datasets.

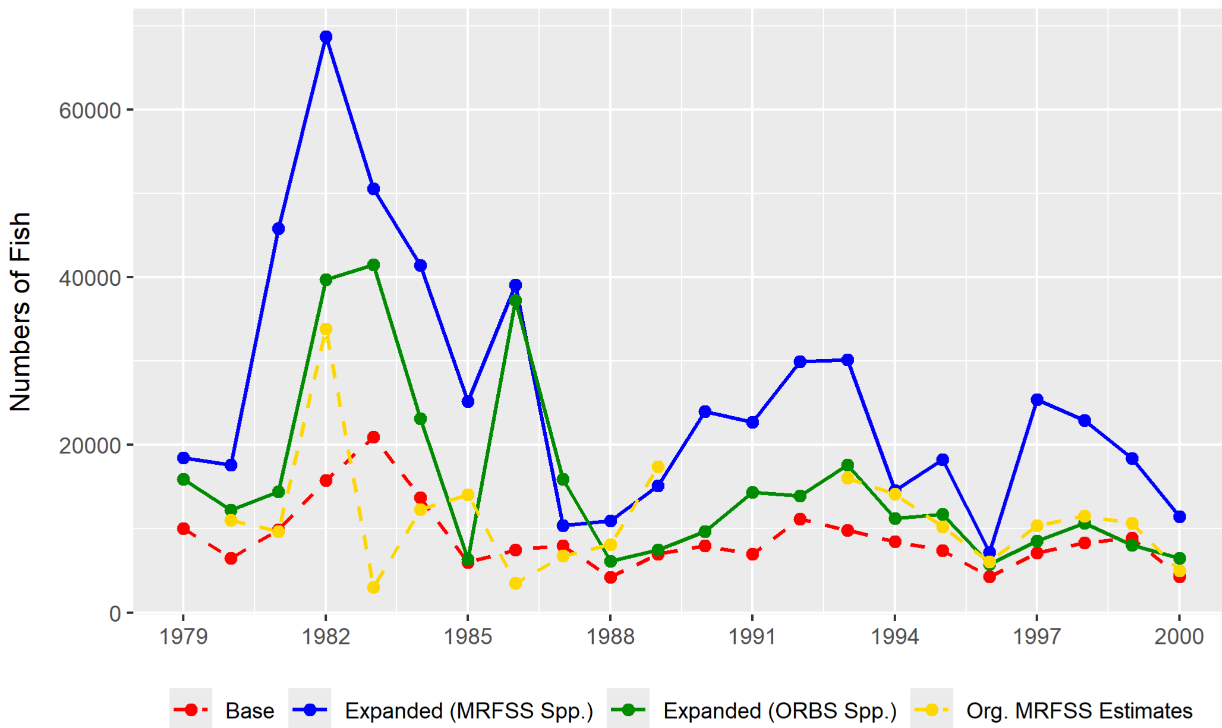

Figure F35: Comparison of historical Yelloweye Rockfish recreational catch datasets.

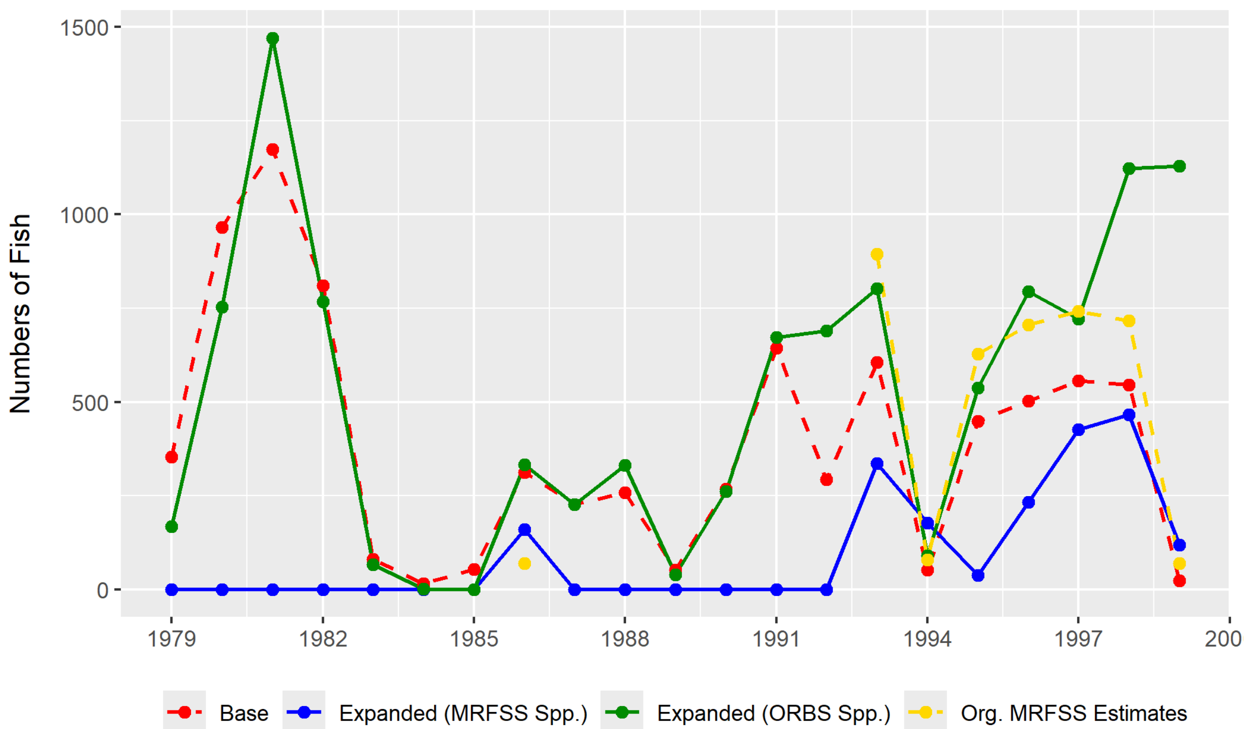

Figure F36: Comparison of historical Sablefish recreational catch datasets.

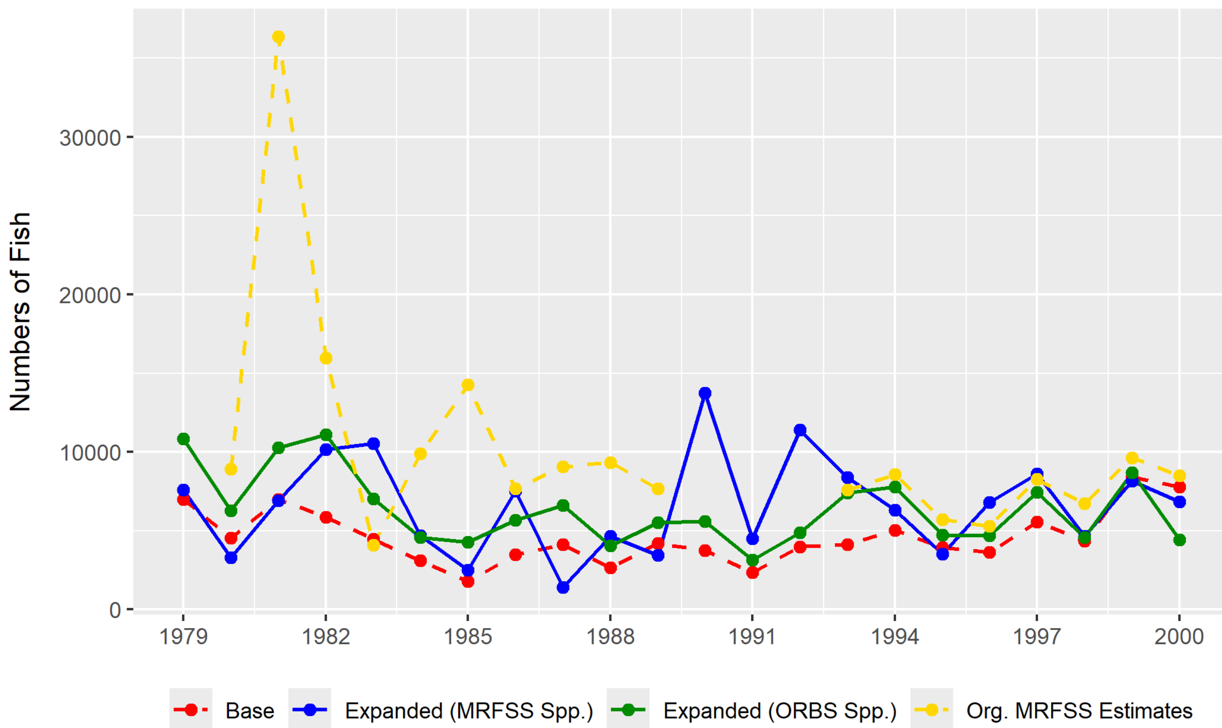

Figure F37: Comparison of historical Kelp Greenling recreational catch datasets.

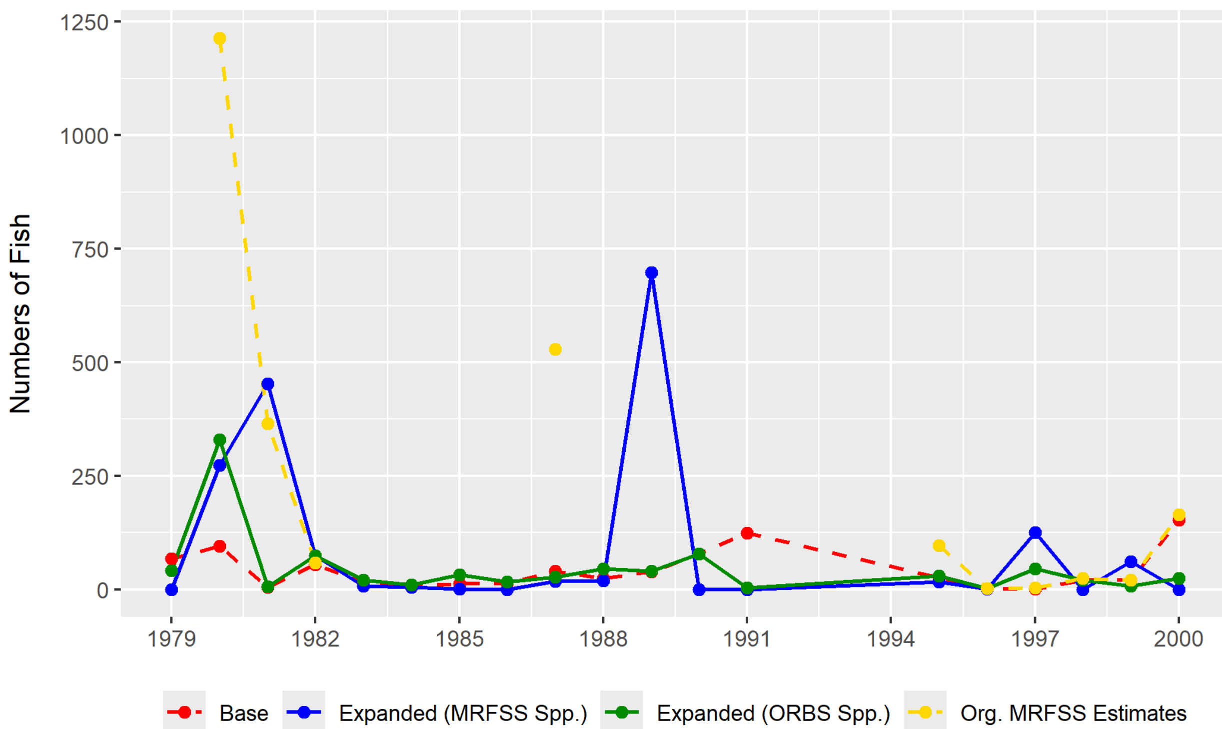

Figure F38: Comparison of historical Rock Greenling recreational catch datasets.

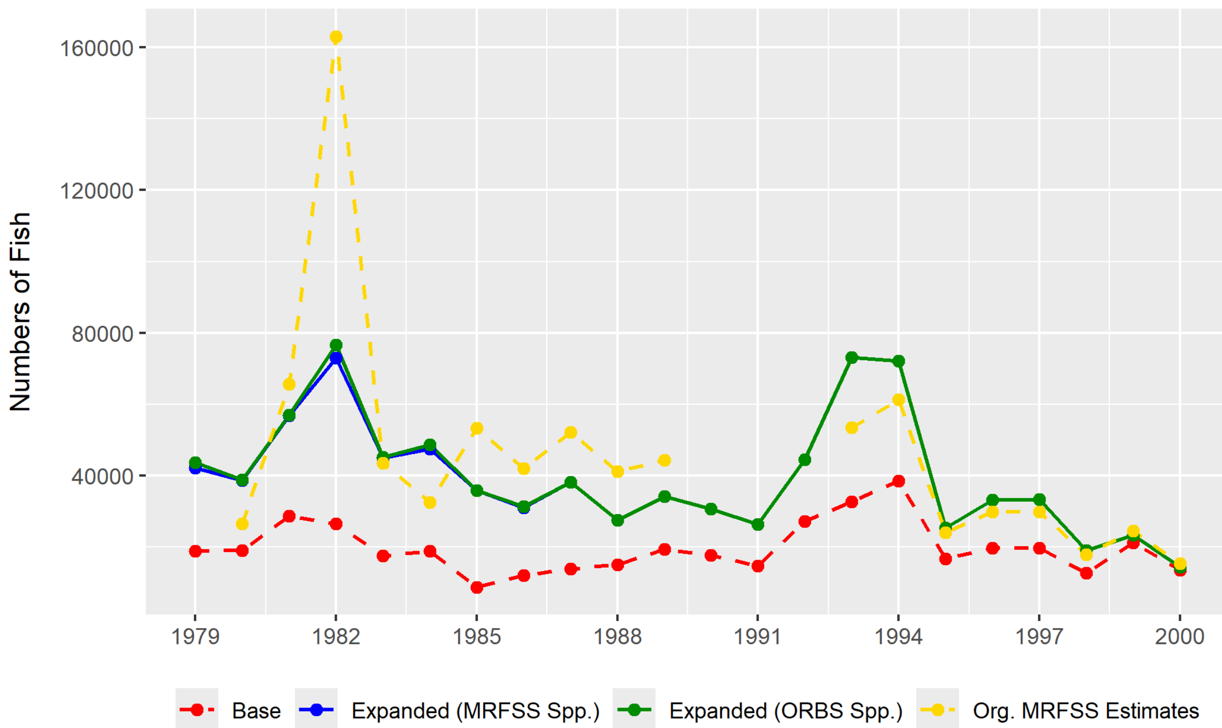

Figure F39: Comparison of historical Lingcod recreational catch datasets.

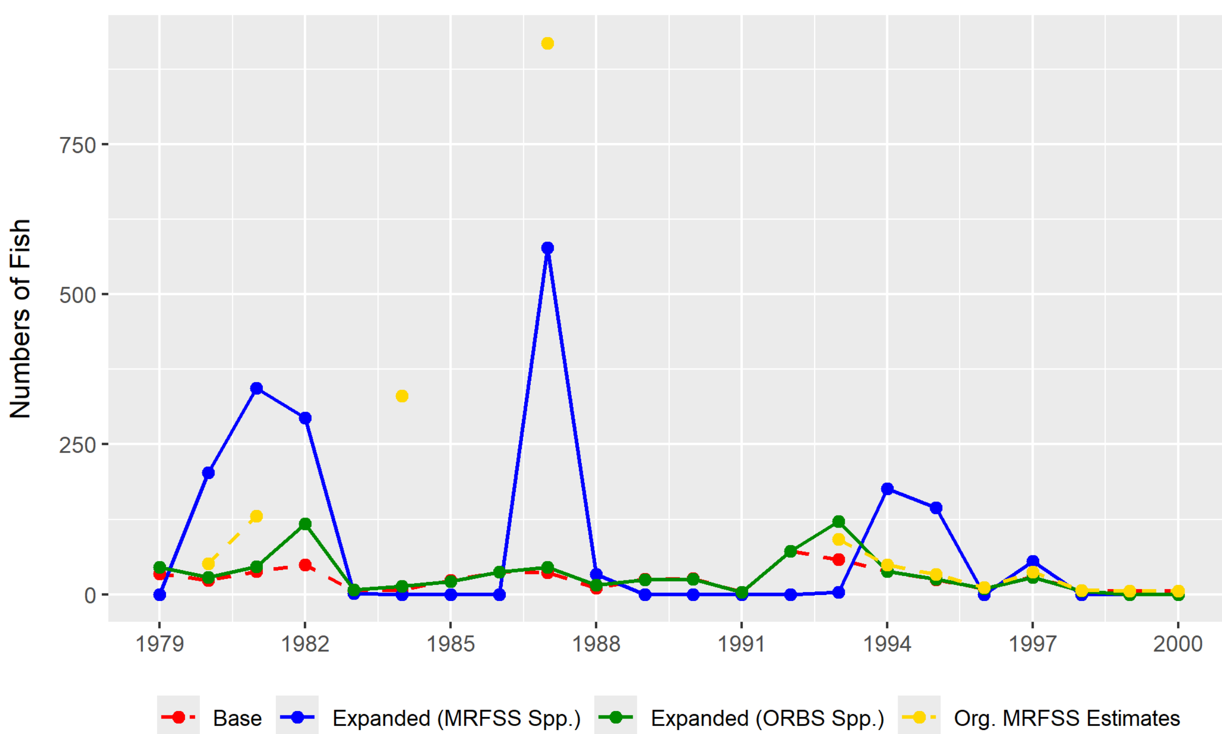

Figure F40: Comparison of historical Buffalo Sculpin recreational catch datasets.

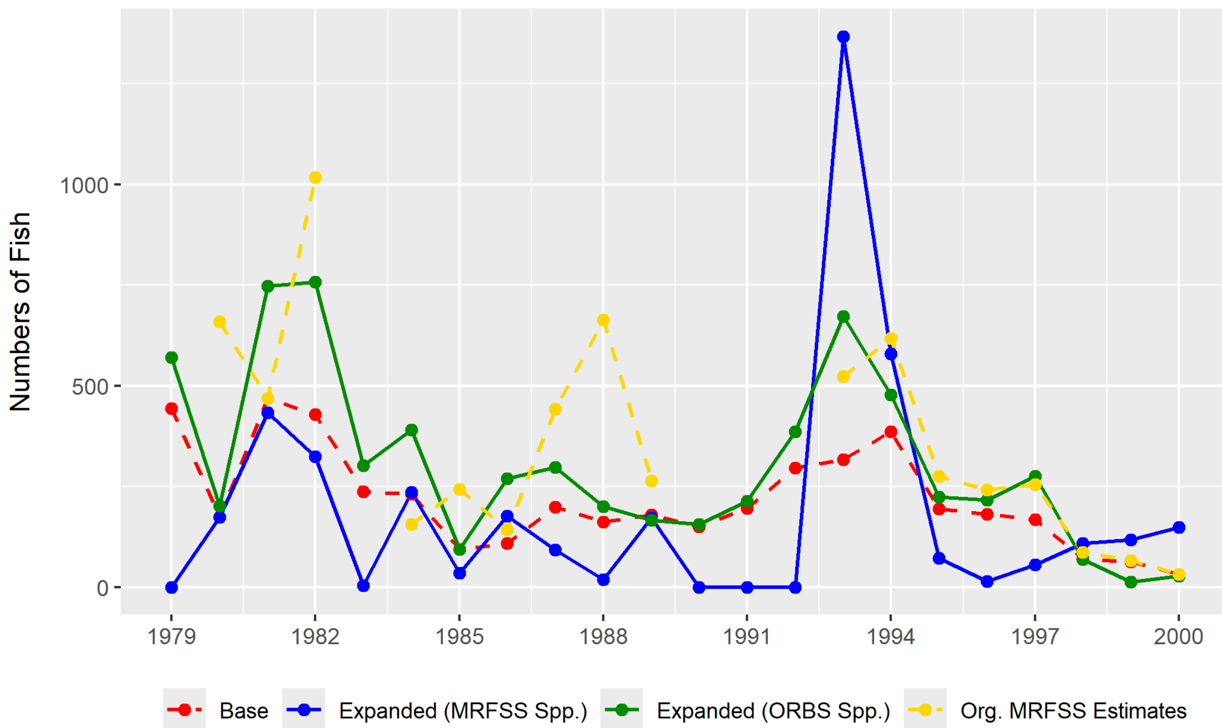

Figure F41: Comparison of historical Red Irish Lord recreational catch datasets.

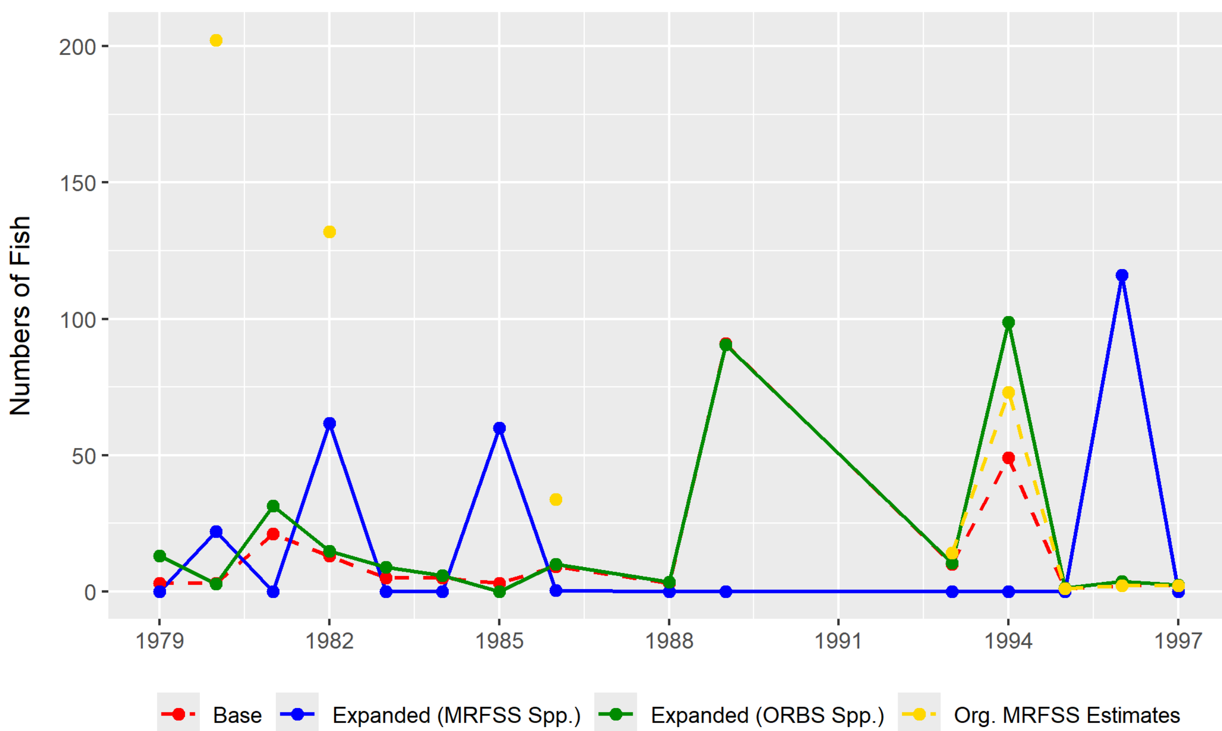

Figure F42: Comparison of historical Brown Irish Lord recreational catch datasets.

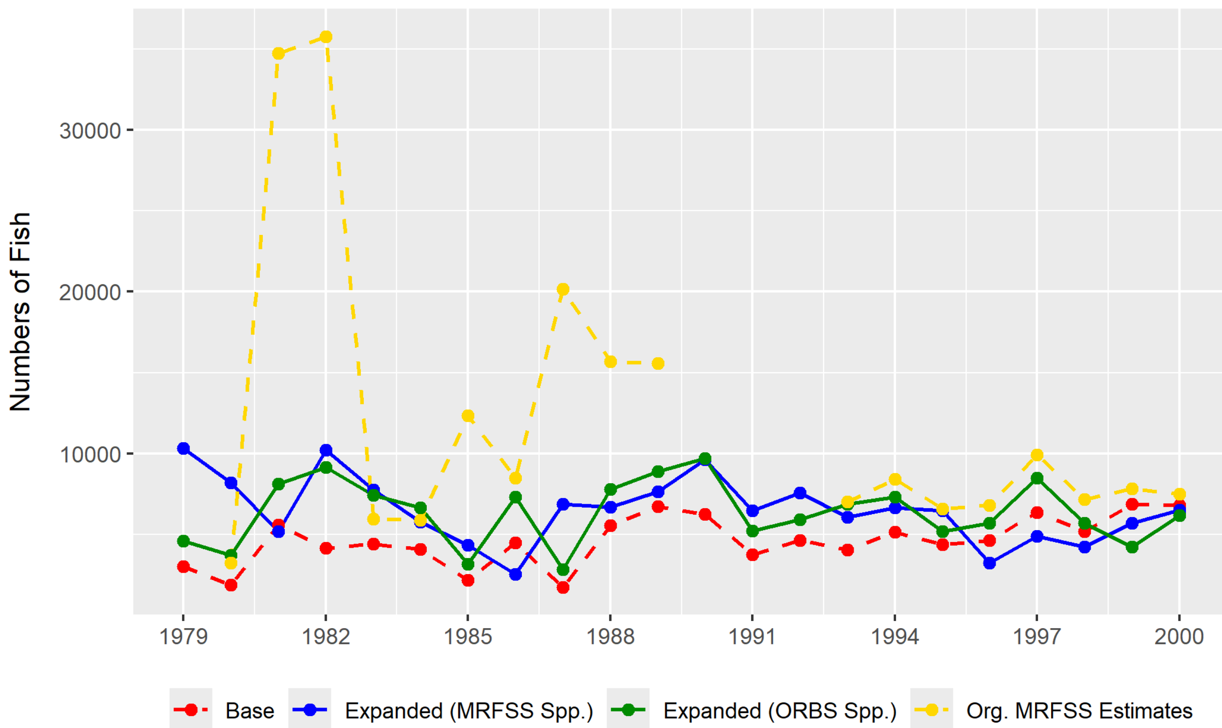

Figure F43: Comparison of historical Cabezon recreational catch datasets.

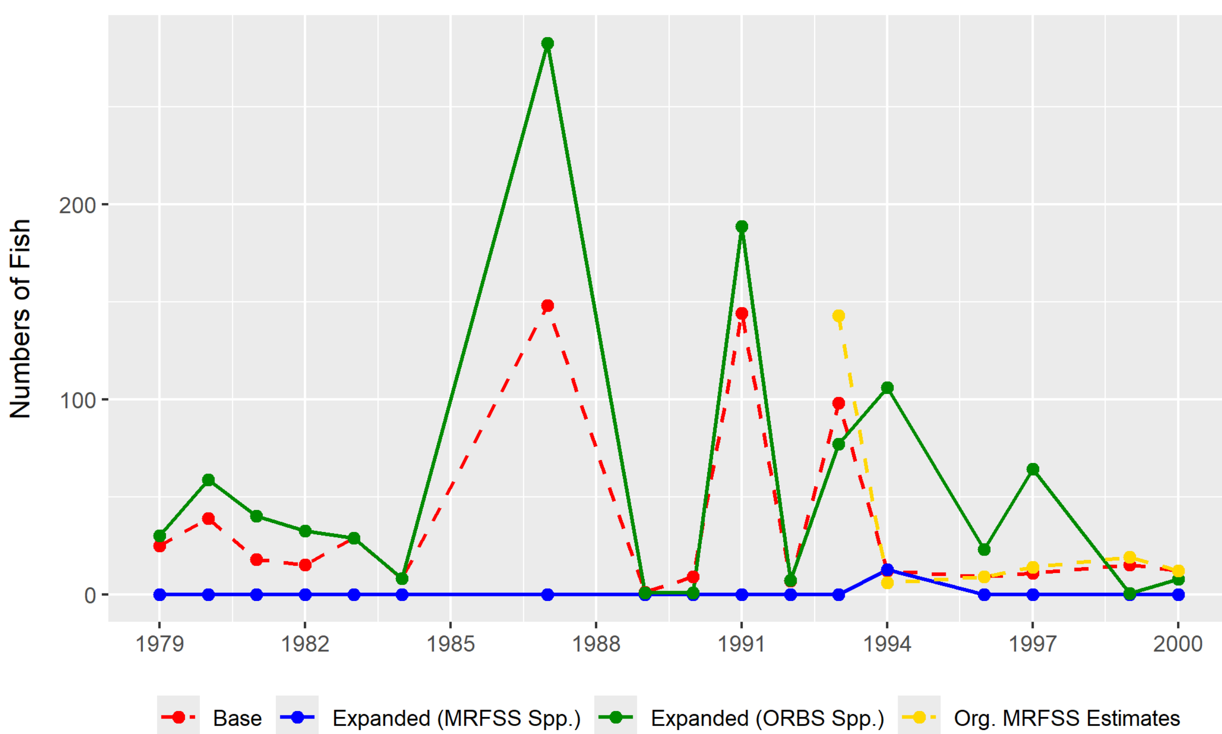

Figure F44: Comparison of historical Sole, Misc recreational catch datasets.

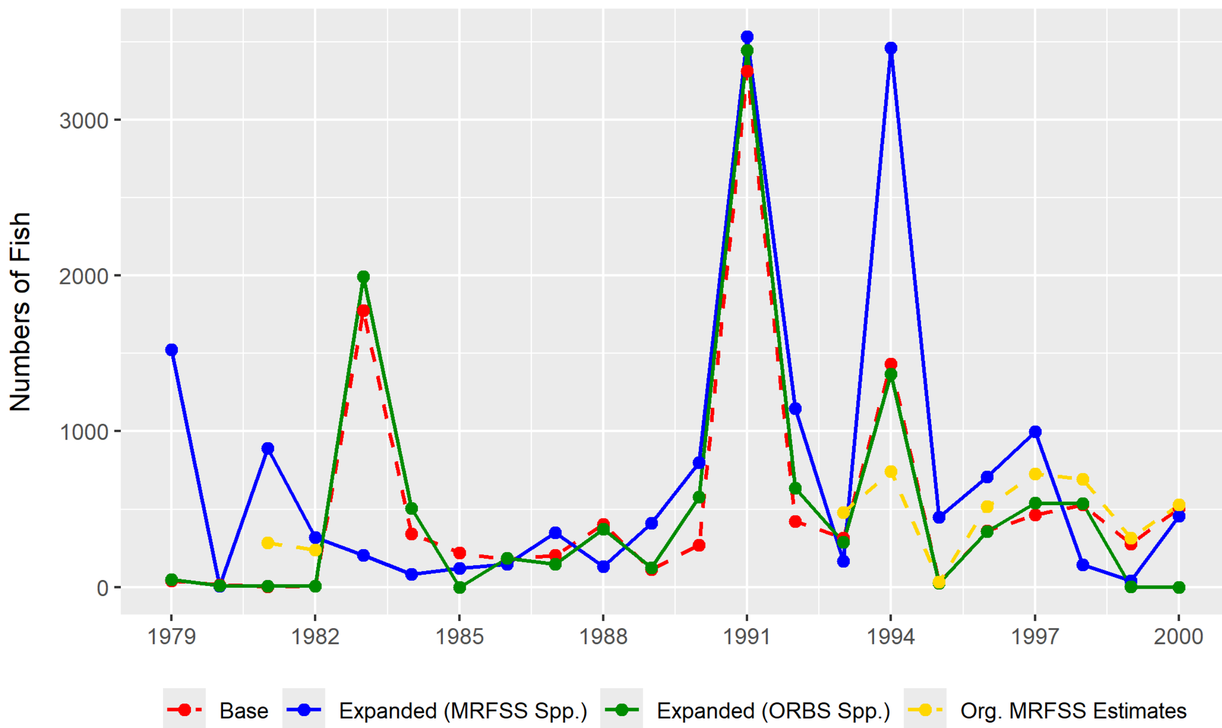

Figure F45: Comparison of historical Pacific Sanddab recreational catch datasets.

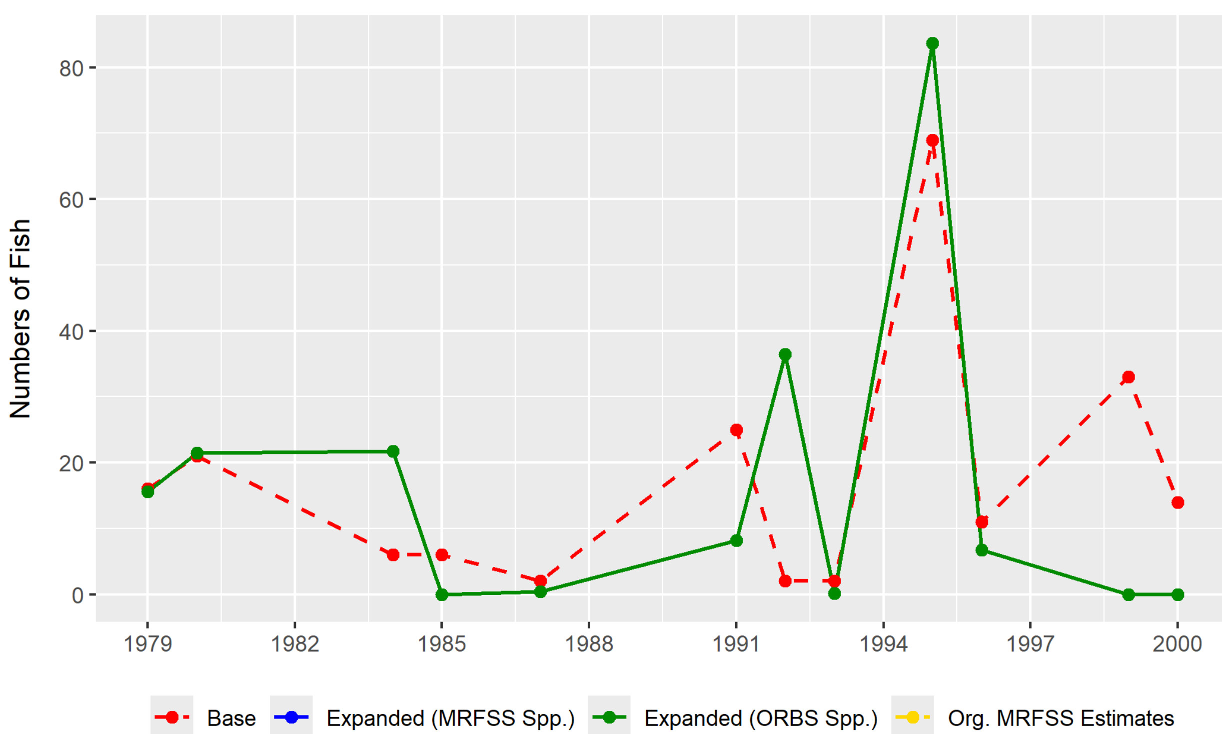

Figure F46: Comparison of historical Arrowtooth Flounder recreational catch datasets.

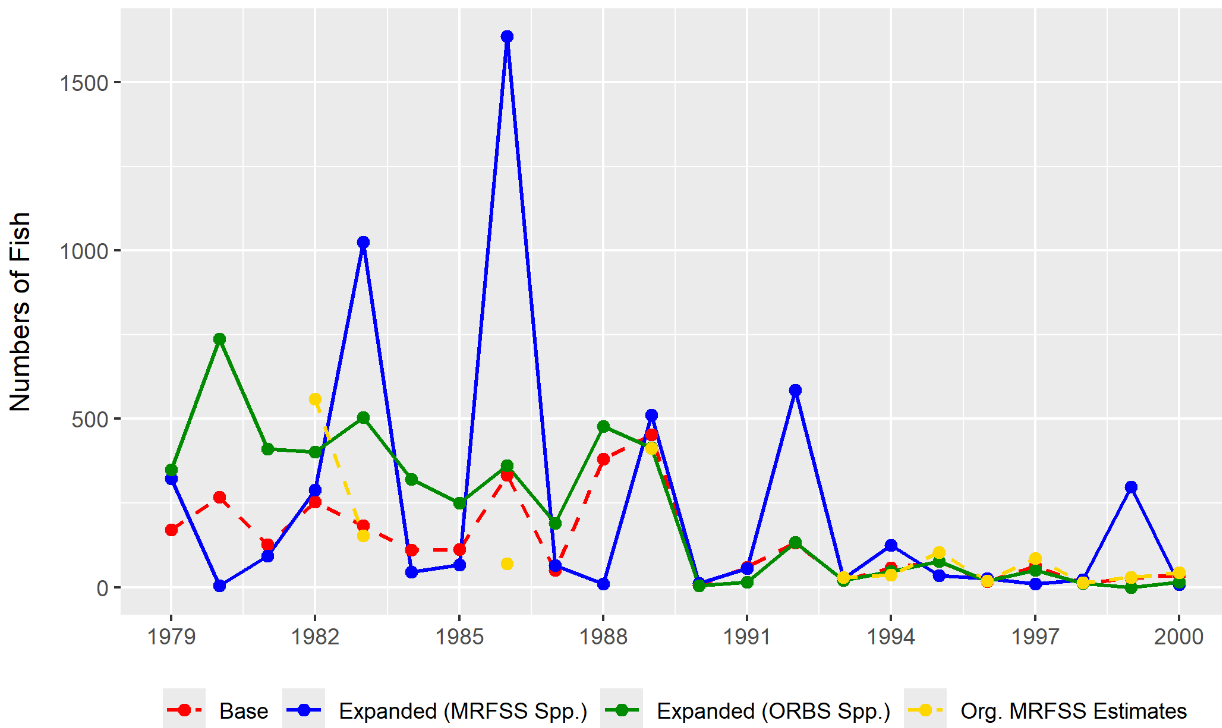

Figure F47: Comparison of historical Petrale Sole recreational catch datasets.

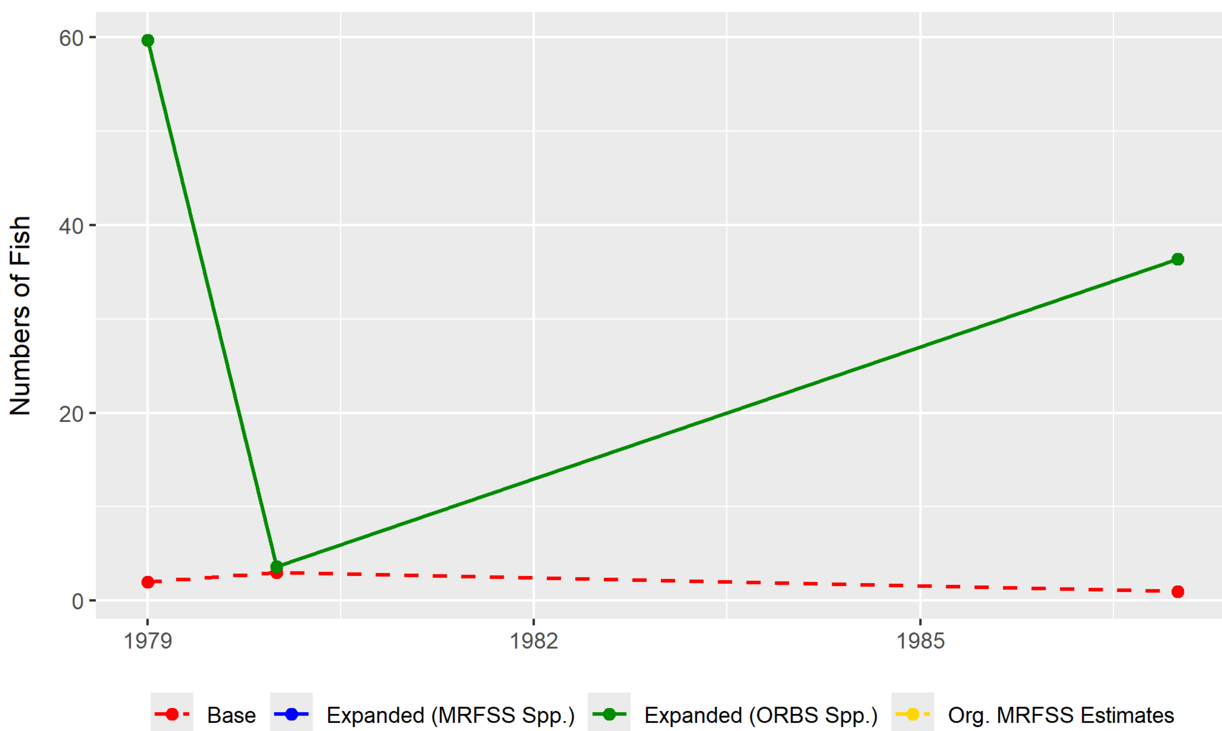

Figure F48: Comparison of historical Flathead Sole recreational catch datasets.

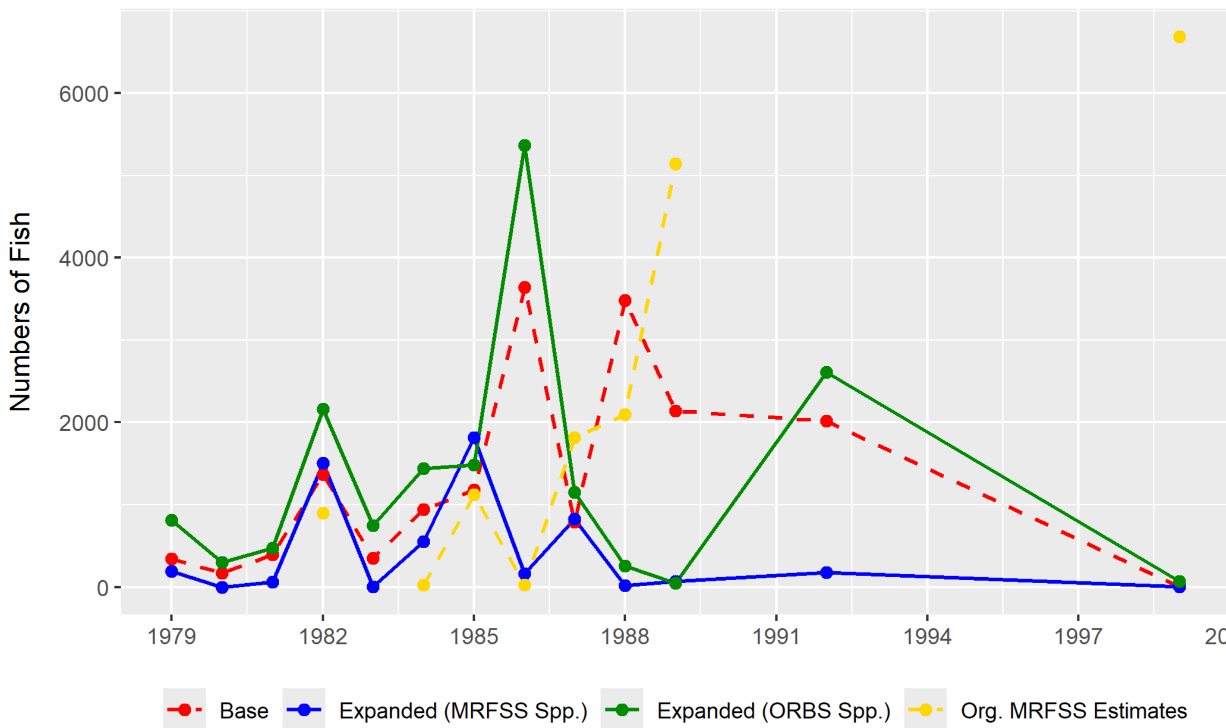

Figure F49: Comparison of historical Pacific Halibut recreational catch datasets.

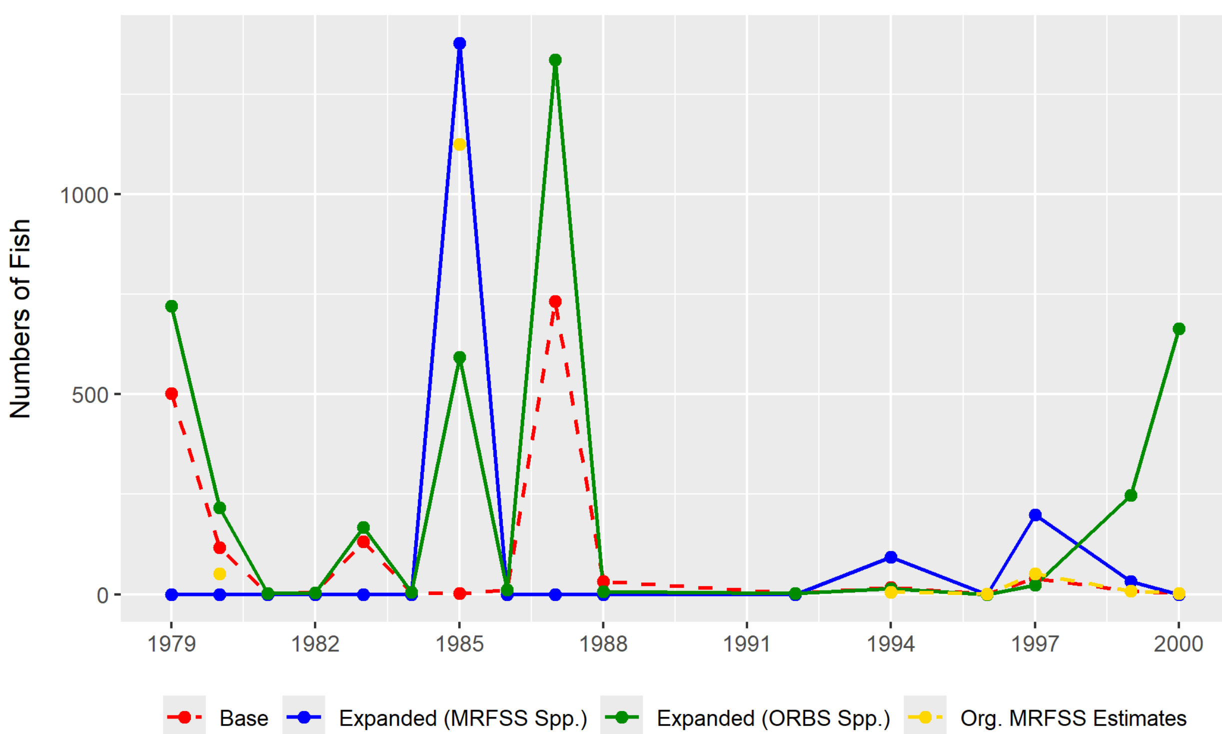

Figure F50: Comparison of historical Butter Sole recreational catch datasets.

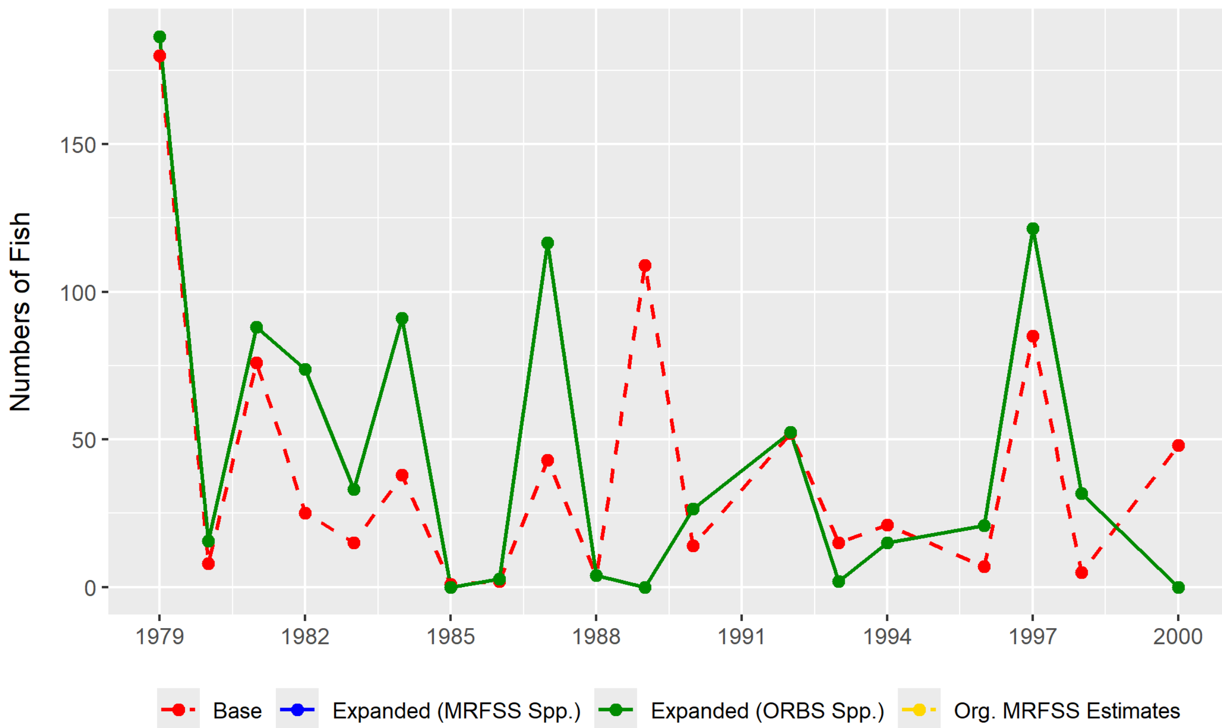

Figure F51: Comparison of historical Rock Sole recreational catch datasets.

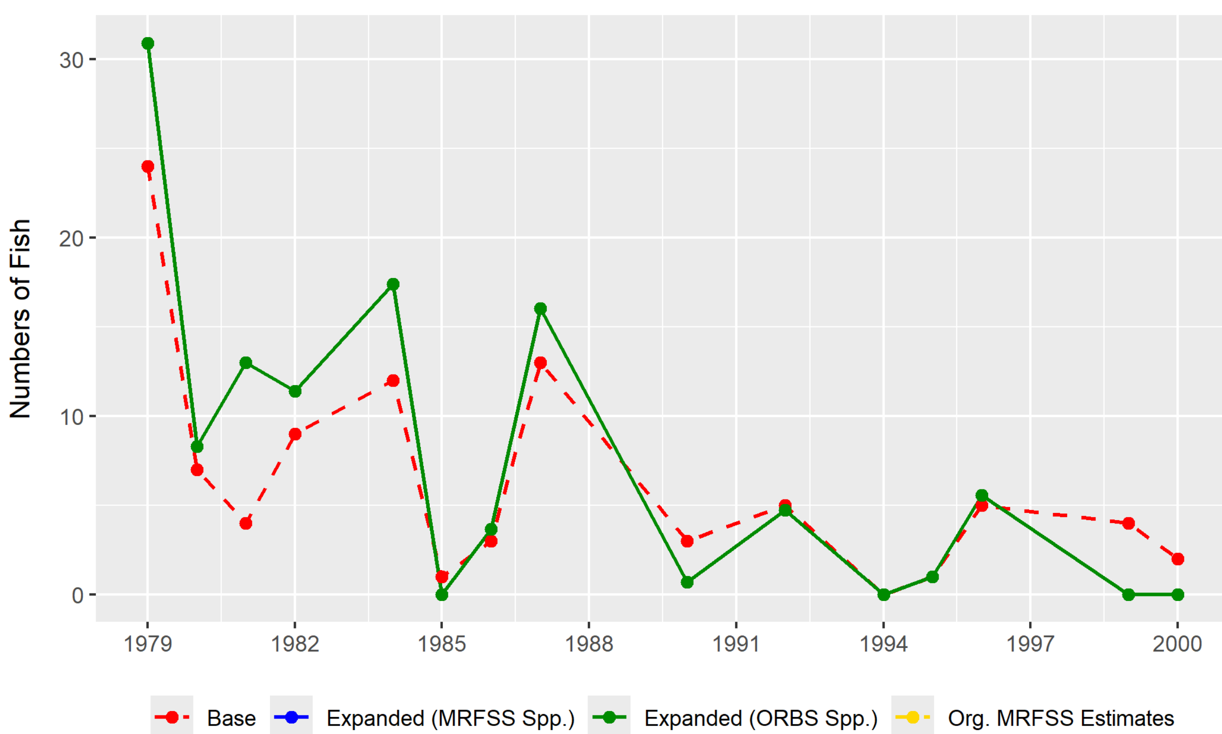

Figure F52: Comparison of historical Dover Sole recreational catch datasets.

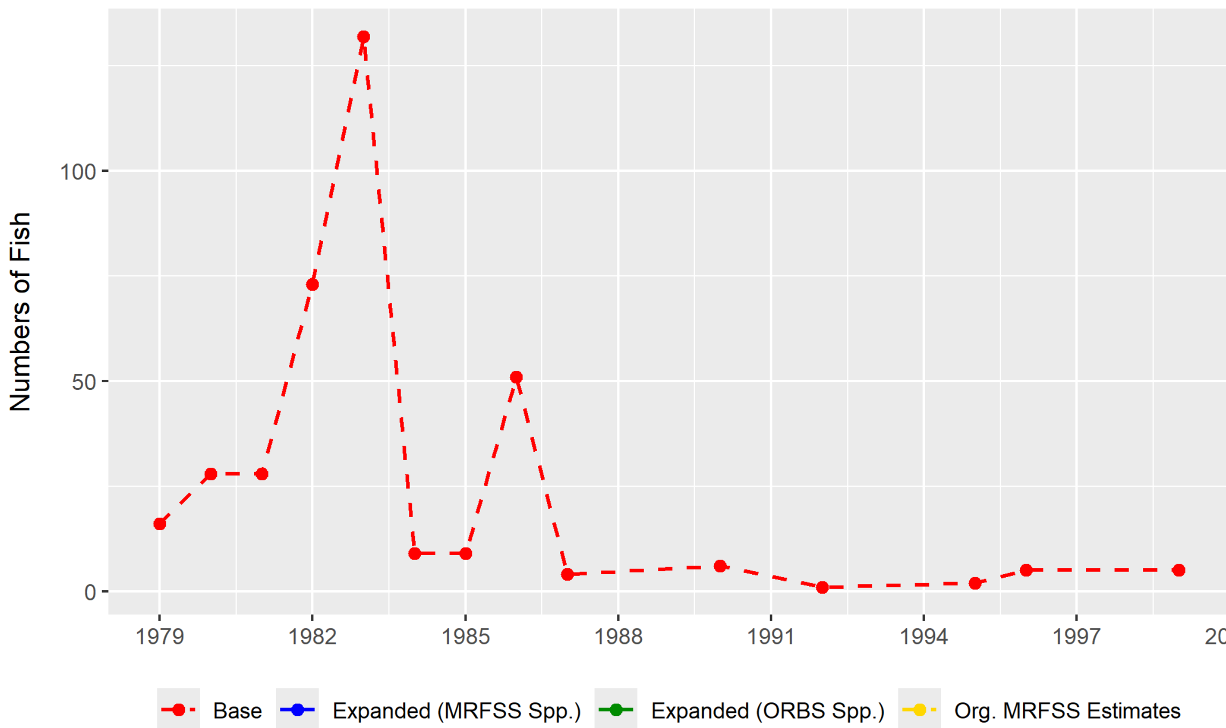

Figure F53: Comparison of historical English Sole recreational catch datasets.

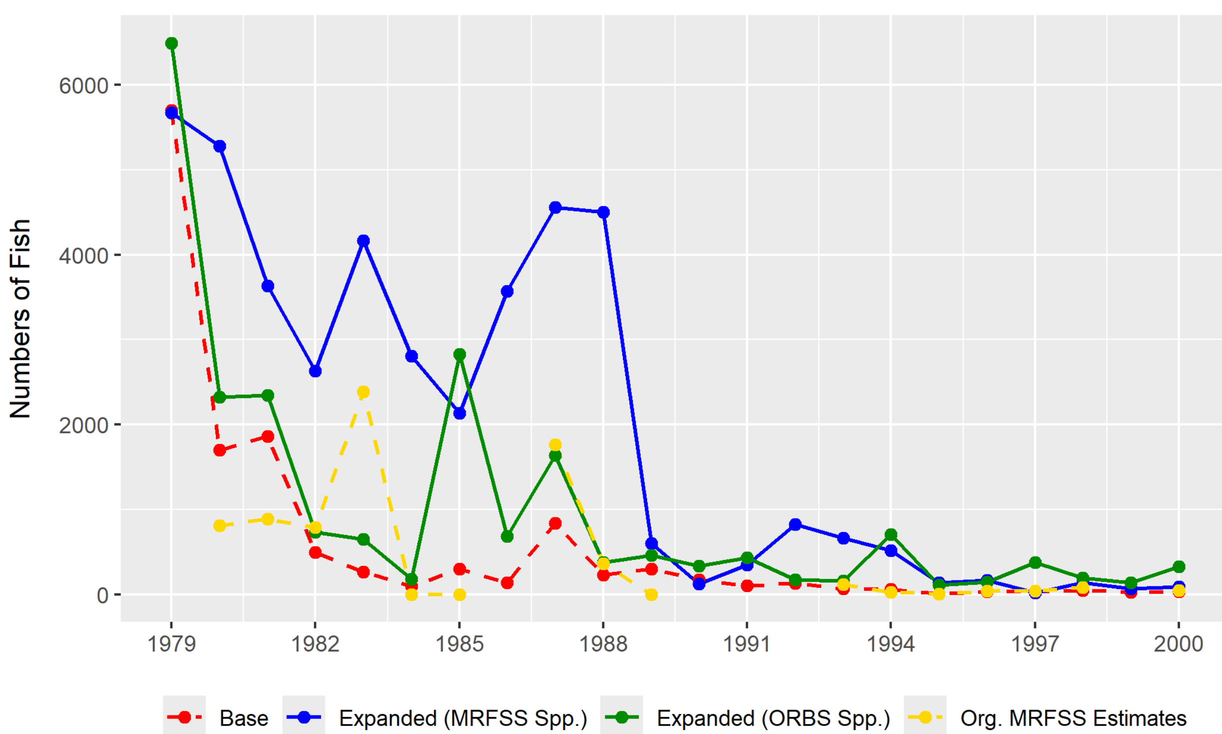

Figure F54: Comparison of historical Starry Flounder recreational catch datasets.

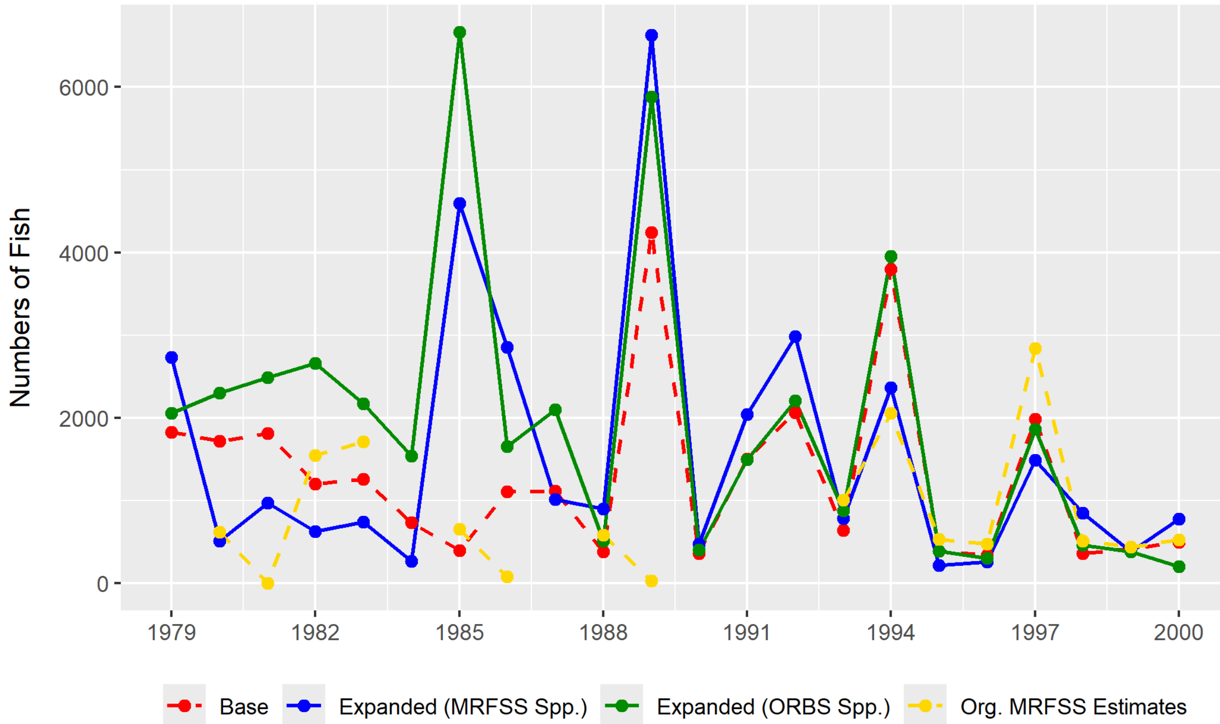

Figure F55: Comparison of historical Sand Sole recreational catch datasets.

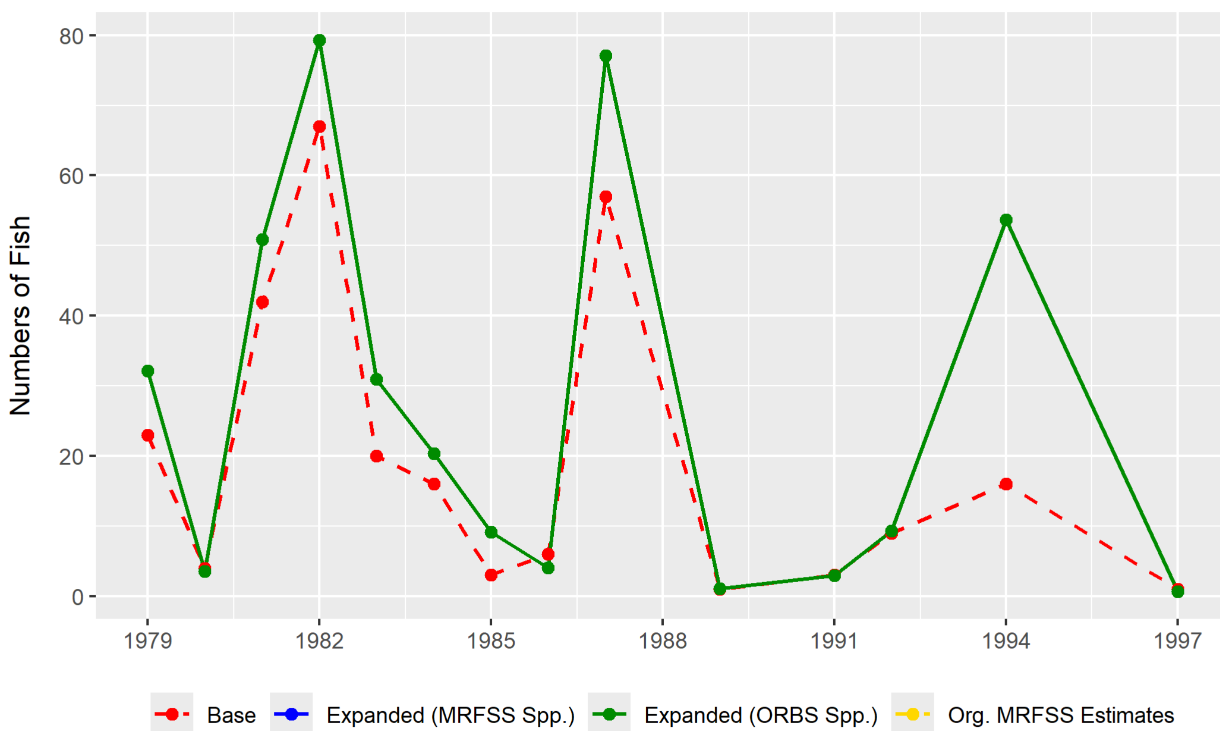

Figure F56: Comparison of historical Ocean Sunfish recreational catch datasets.

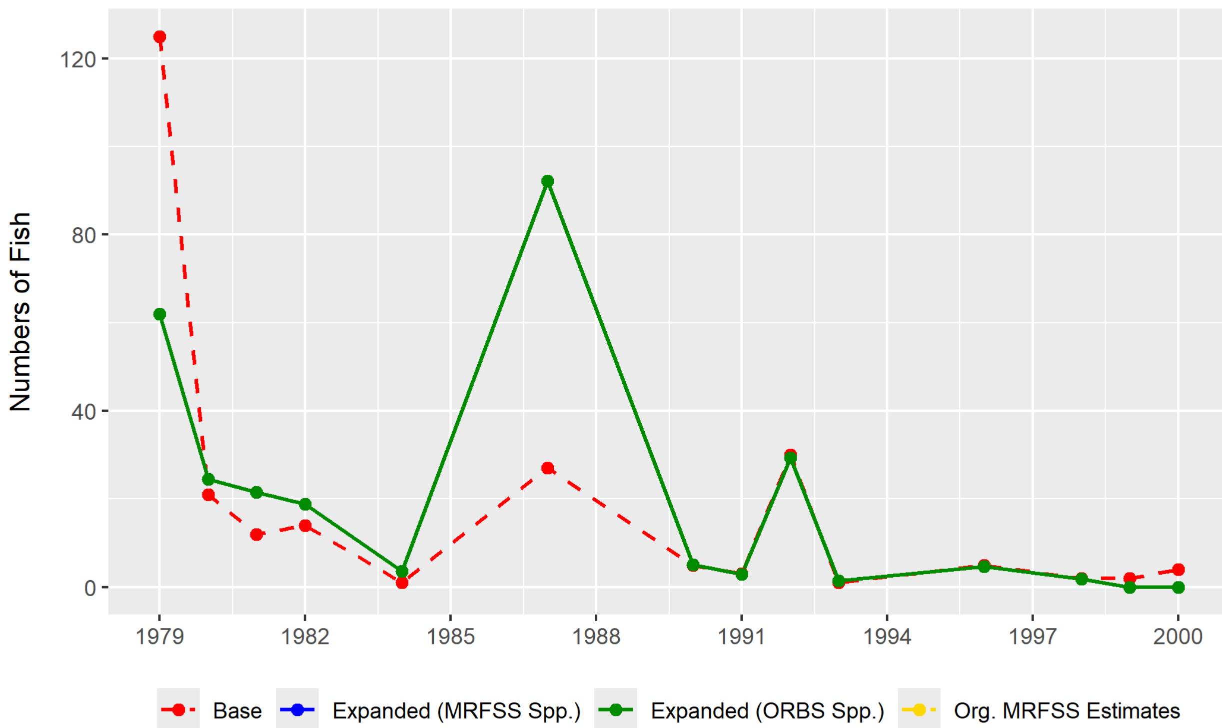

Figure F57: Comparison of historical Unknown Species recreational catch datasets.

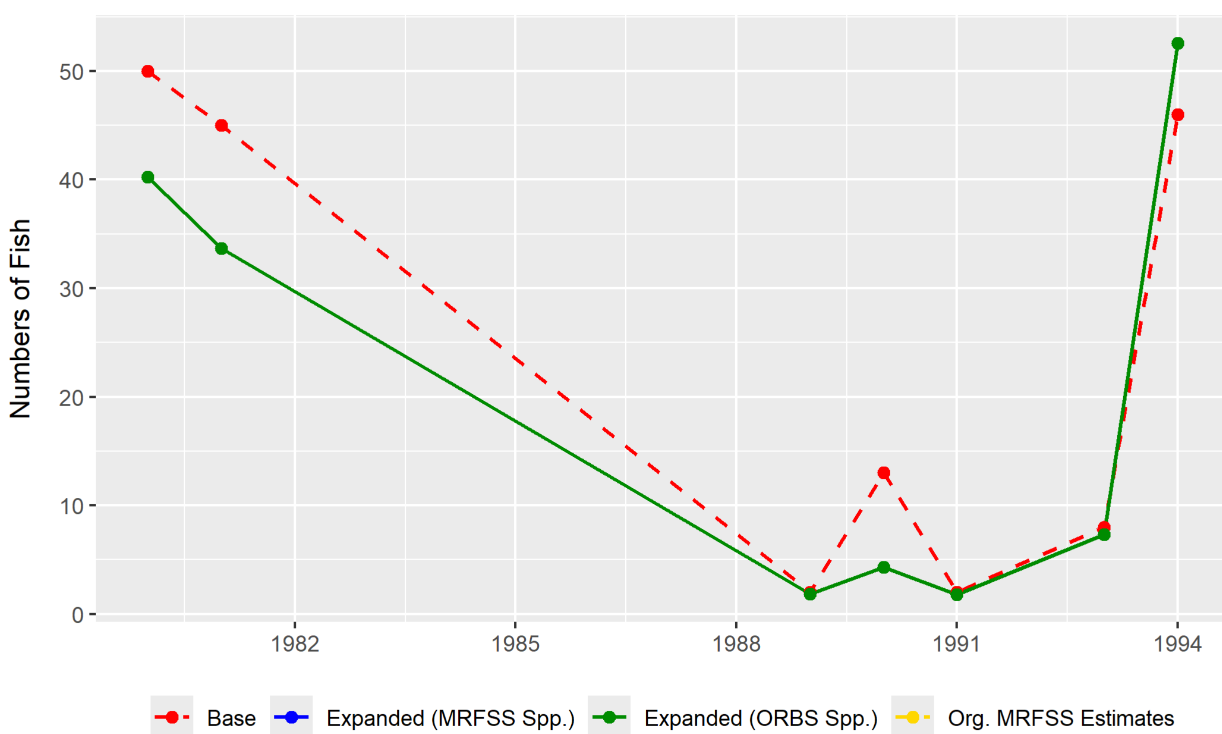

Figure F58: Comparison of historical Pacific Cod recreational catch datasets.

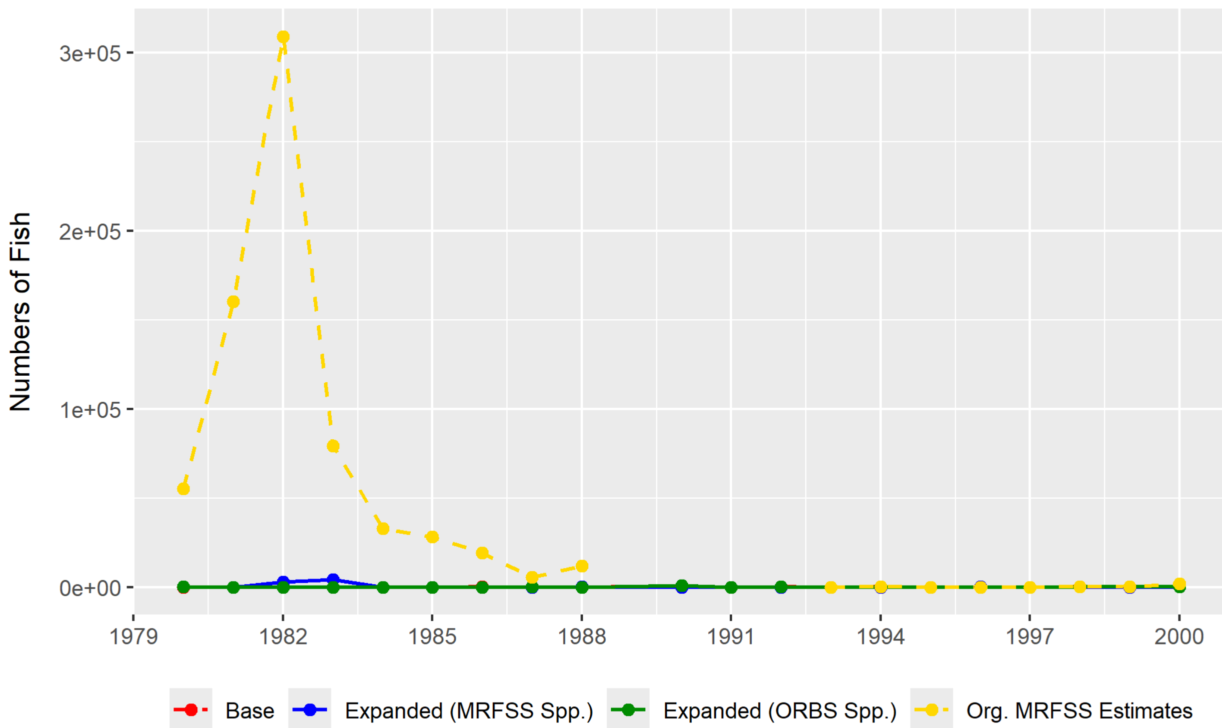

Figure F59: Comparison of historical Other Rockfish (Nominal) recreational catch datasets.

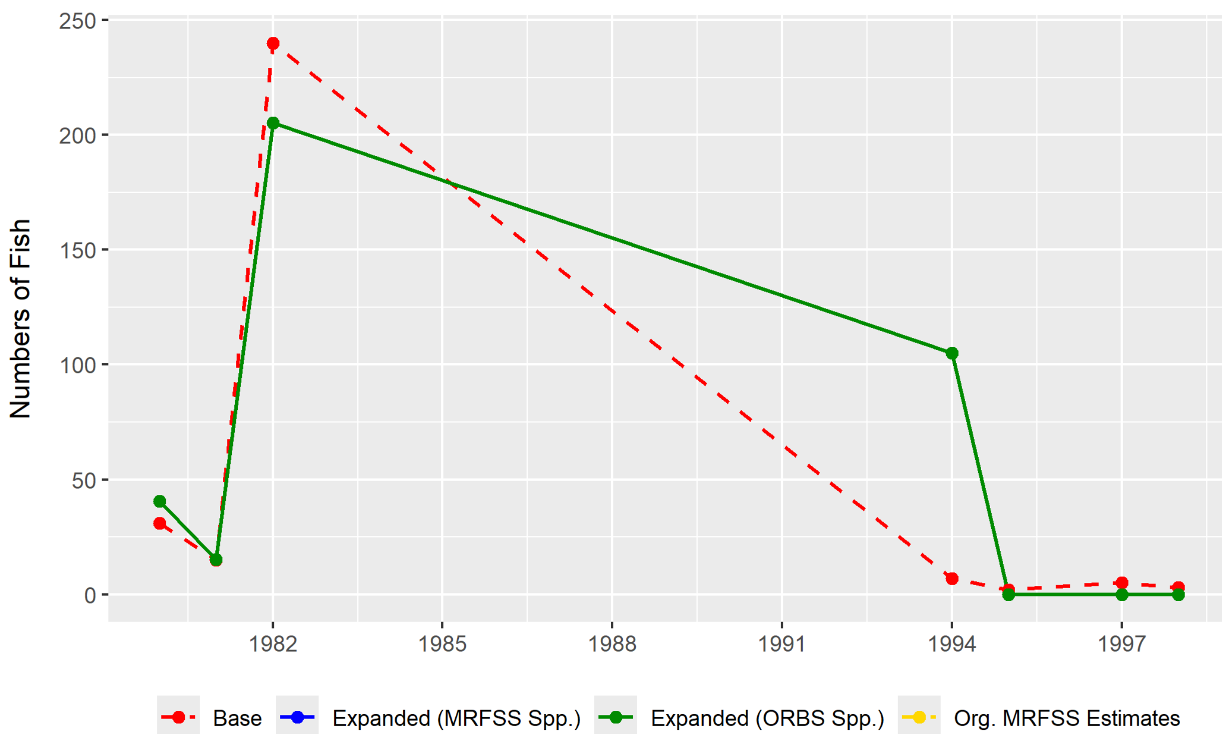

Figure F60: Comparison of historical Darkblotched Rockfish recreational catch datasets.

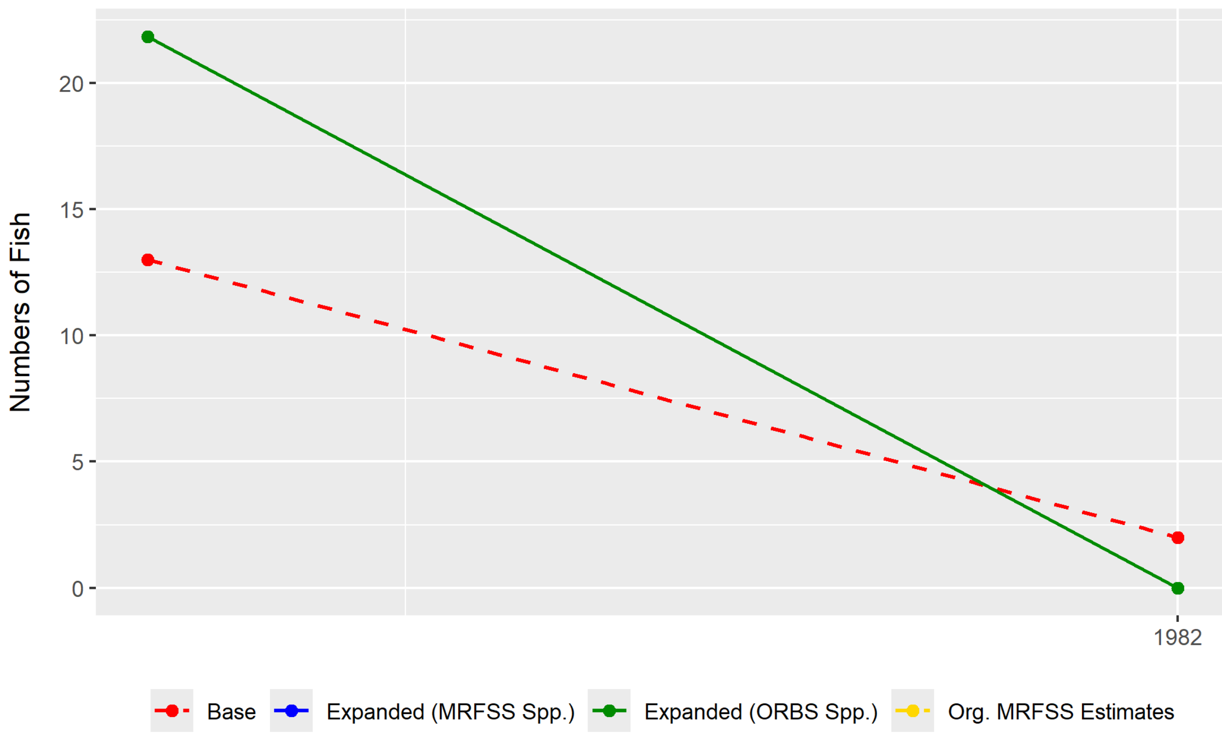

Figure F61: Comparison of historical Splitnose Rockfish recreational catch datasets.

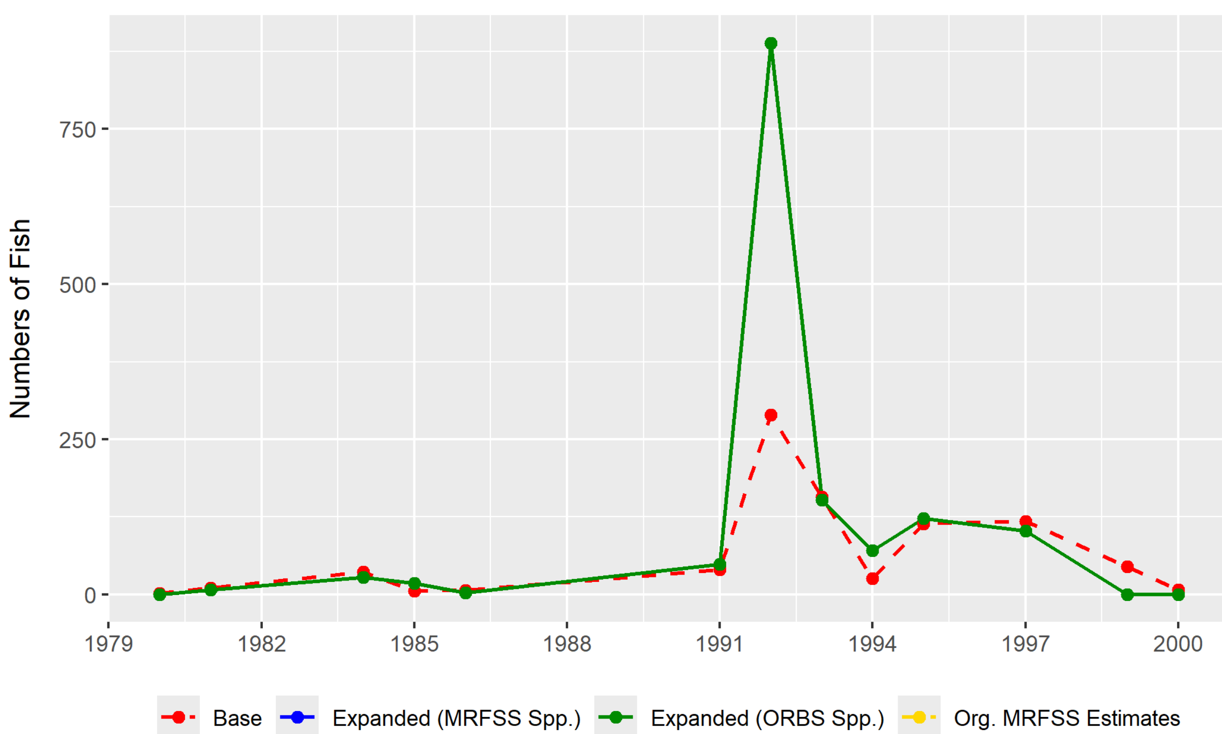

Figure F62: Comparison of historical Chilipepper recreational catch datasets.

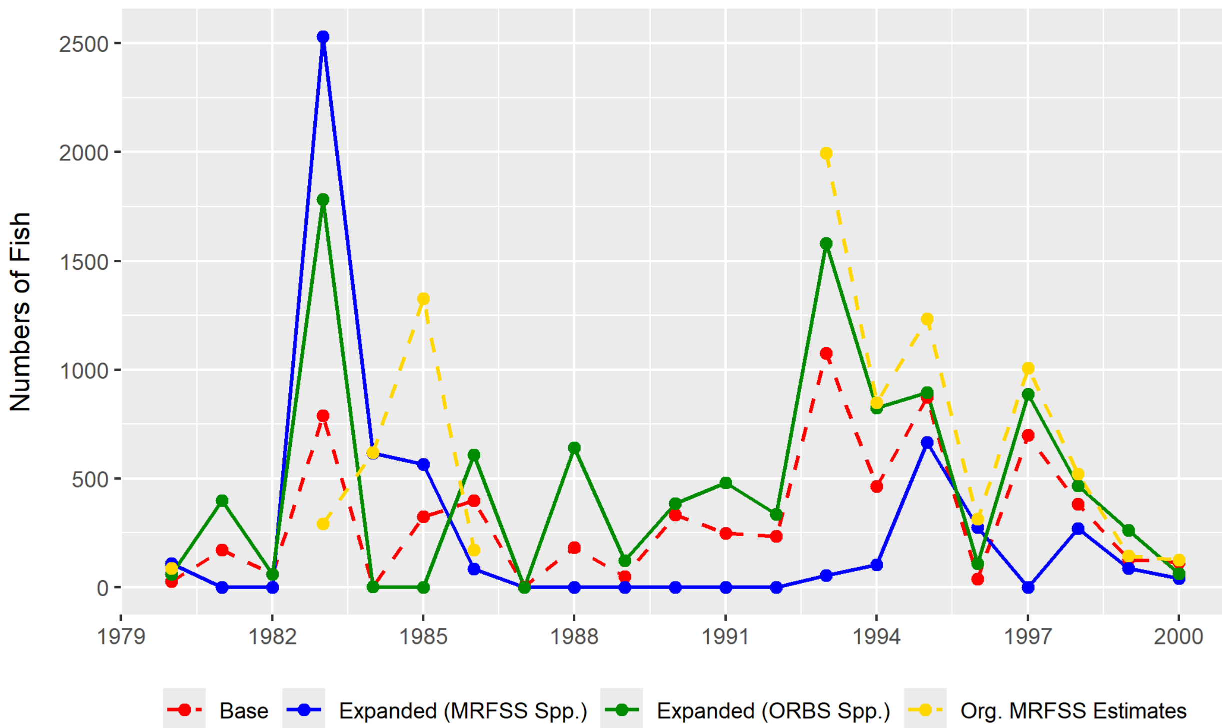

Figure F63: Comparison of historical Redstripe Rockfish recreational catch datasets.

Figure F64: Comparison of historical Whitespotted Greenling recreational catch datasets.

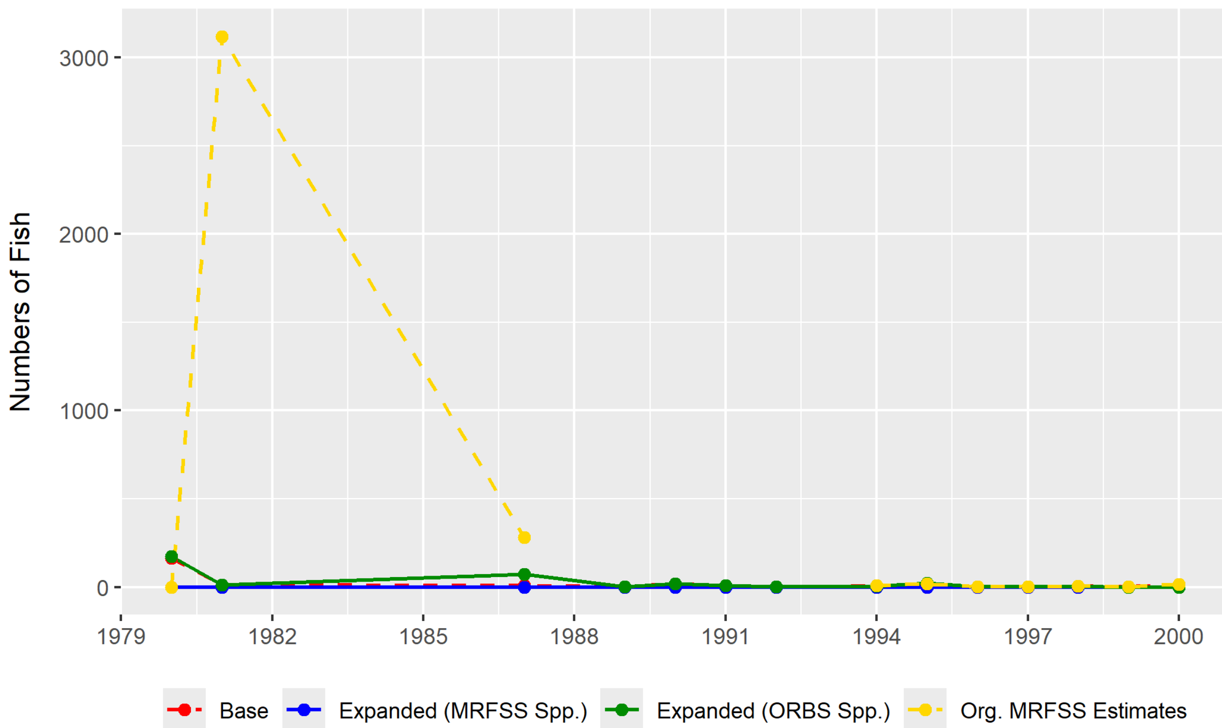

Figure F65: Comparison of historical Sculpins recreational catch datasets.

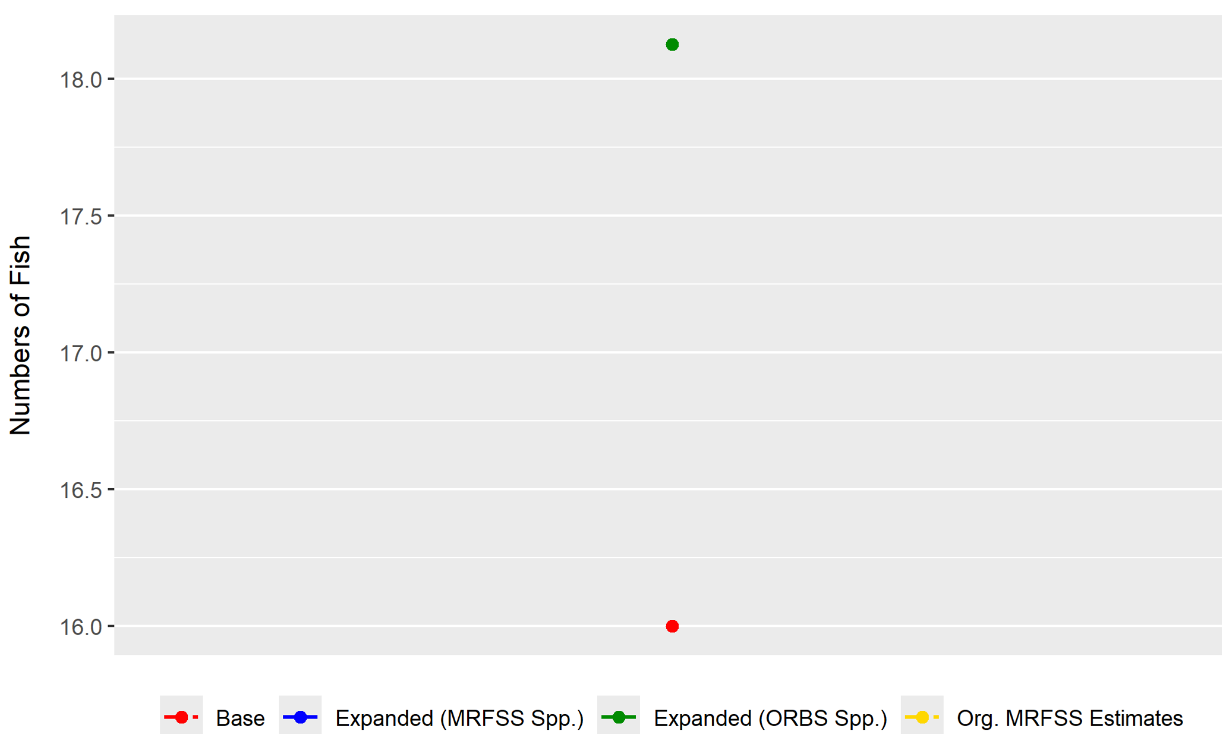

Figure F66: Comparison of historical C-O Sole recreational catch datasets.

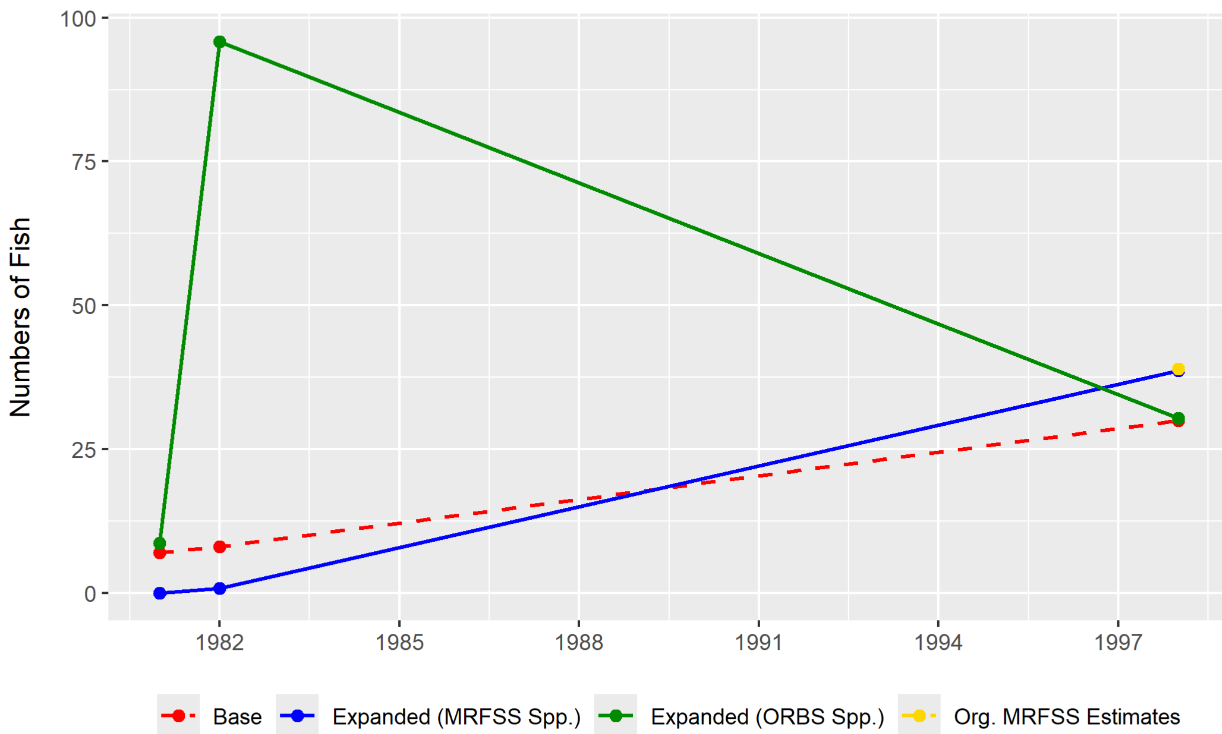

Figure F67: Comparison of historical Jacksmelt recreational catch datasets.

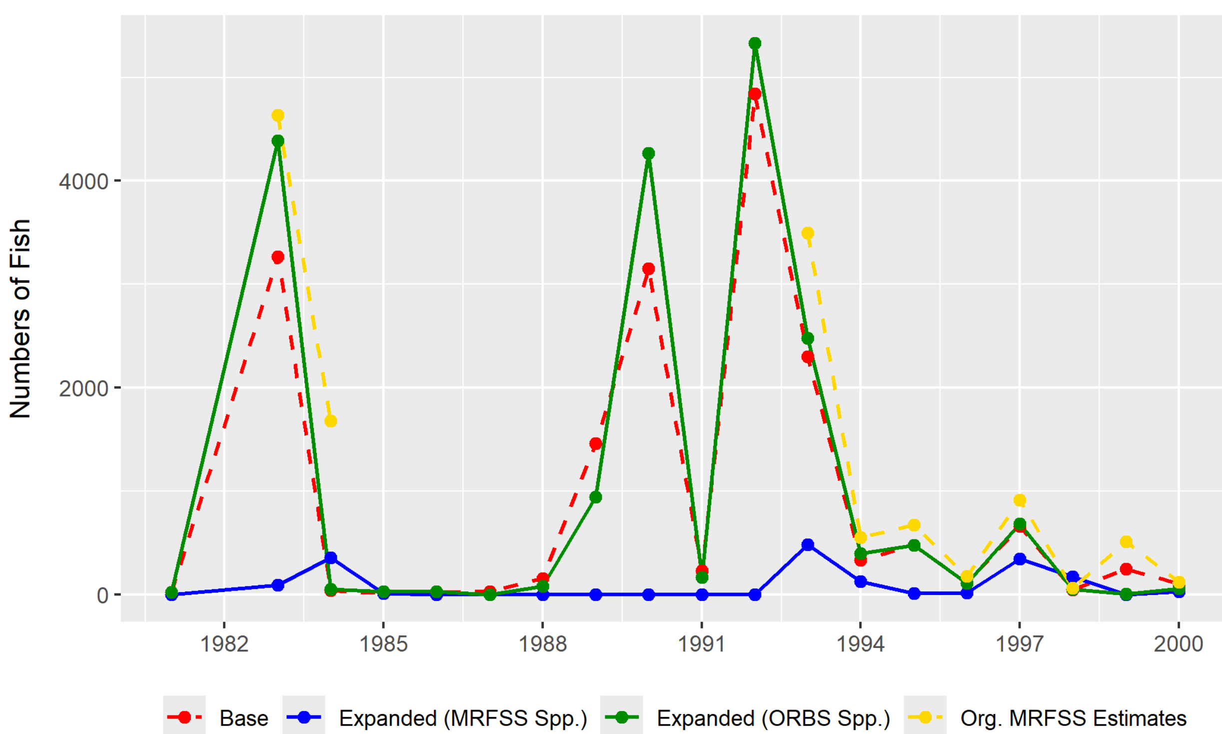

Figure F68: Comparison of historical Chub Mackerel recreational catch datasets.

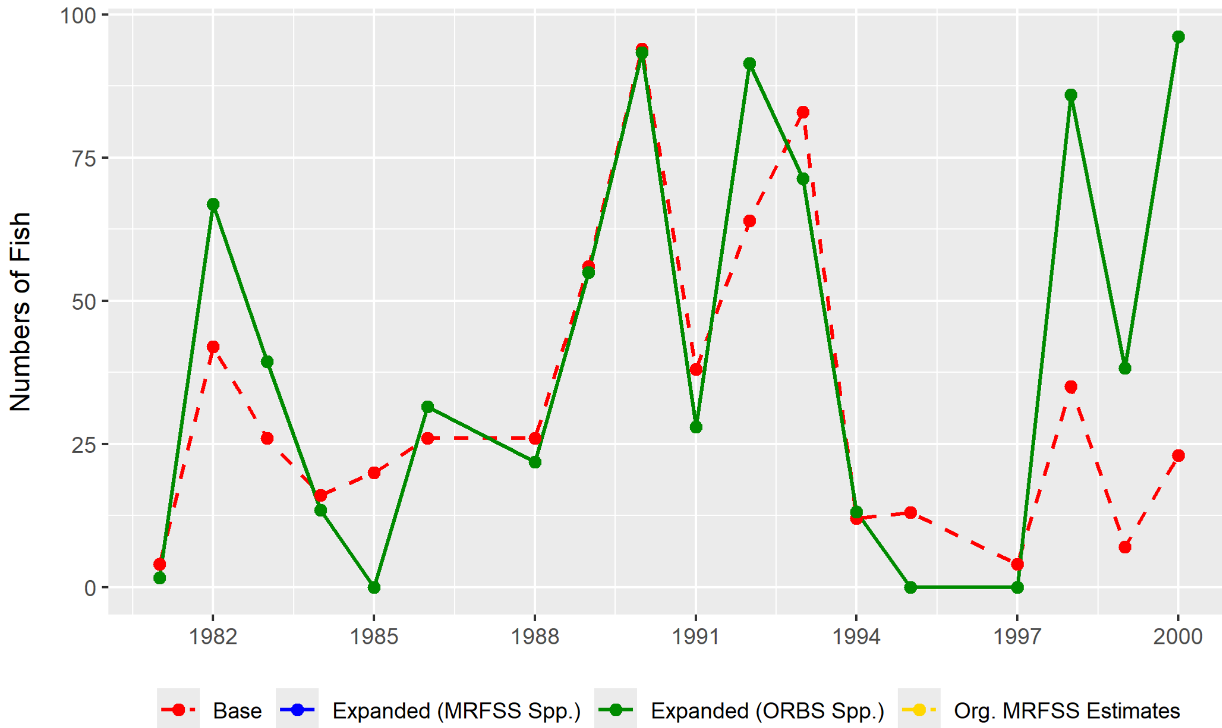

Figure F69: Comparison of historical Redbanded Rockfish recreational catch datasets.

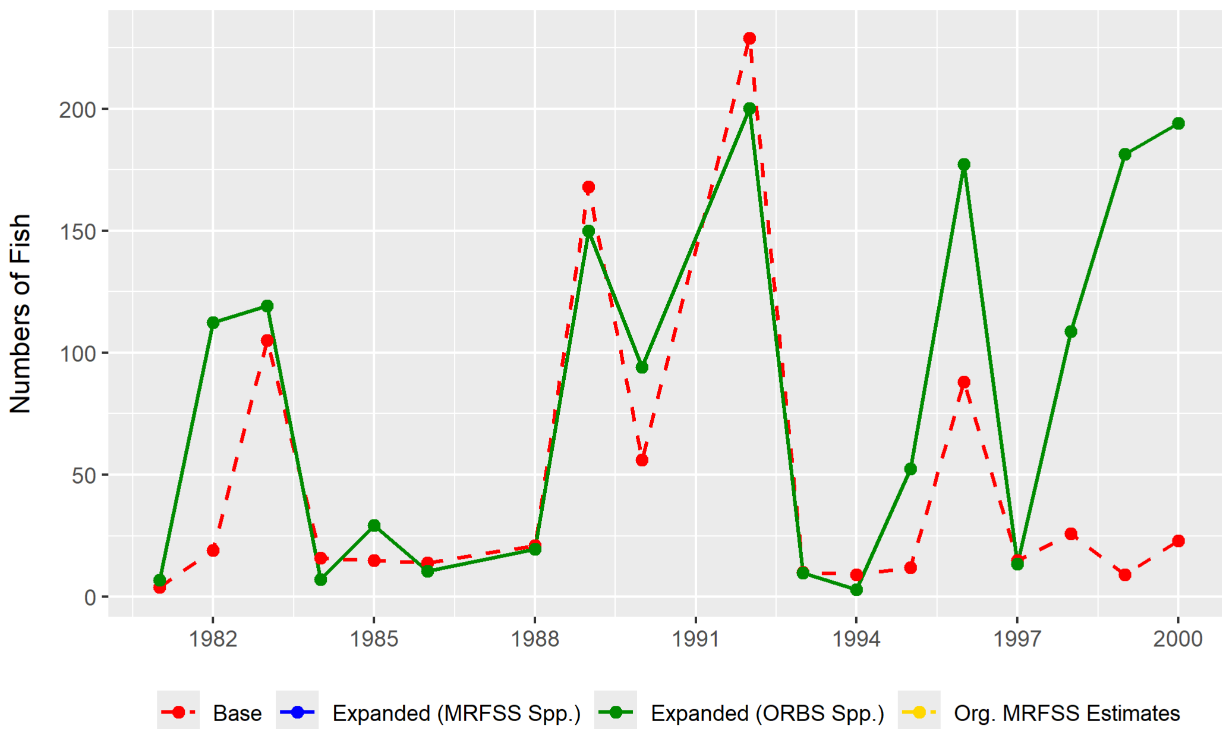

Figure F70: Comparison of historical Gopher Rockfish recreational catch datasets.

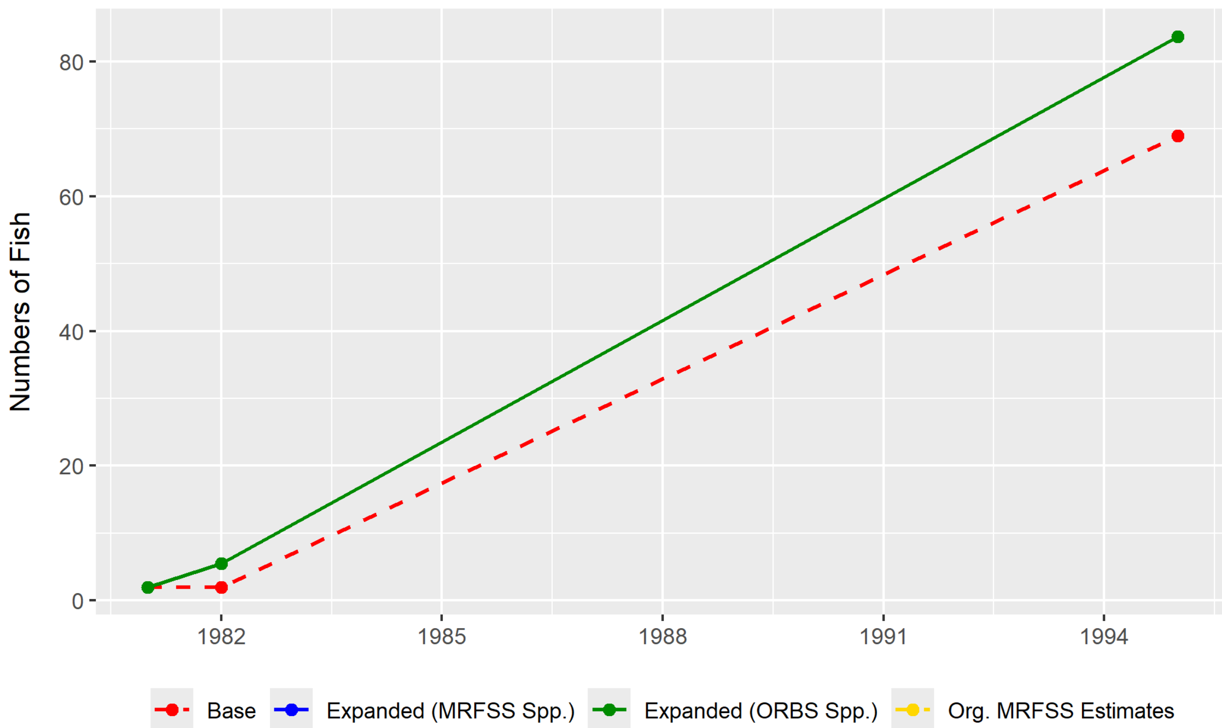

Figure F71: Comparison of historical Curlfin Sole recreational catch datasets.

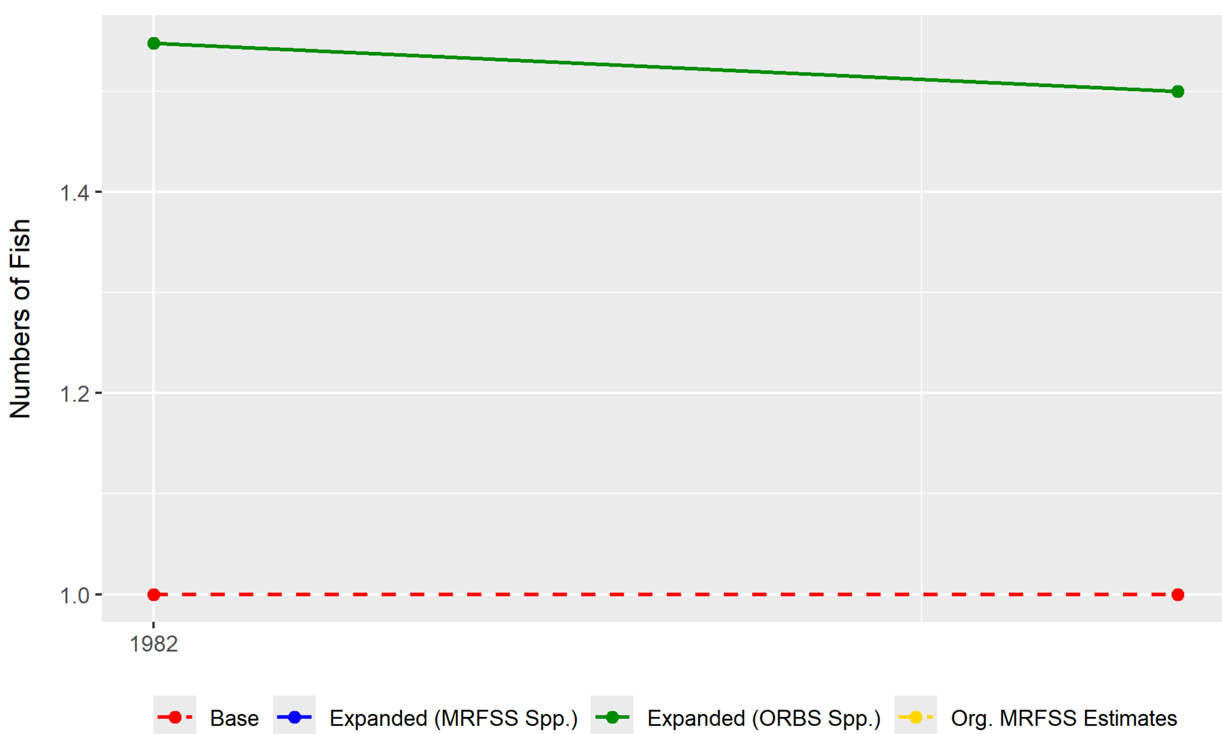

Figure F72: Comparison of historical Slender Sole recreational catch datasets.

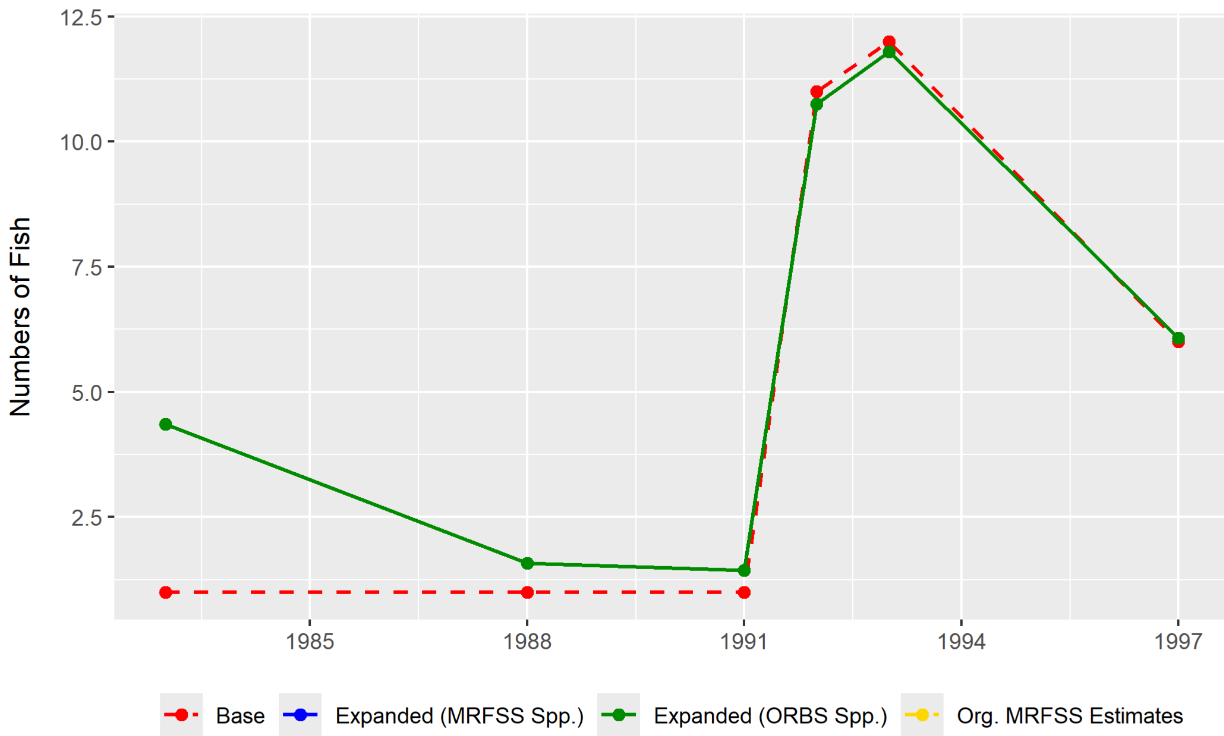

Figure F73: Comparison of historical Soupfin Shark recreational catch datasets.

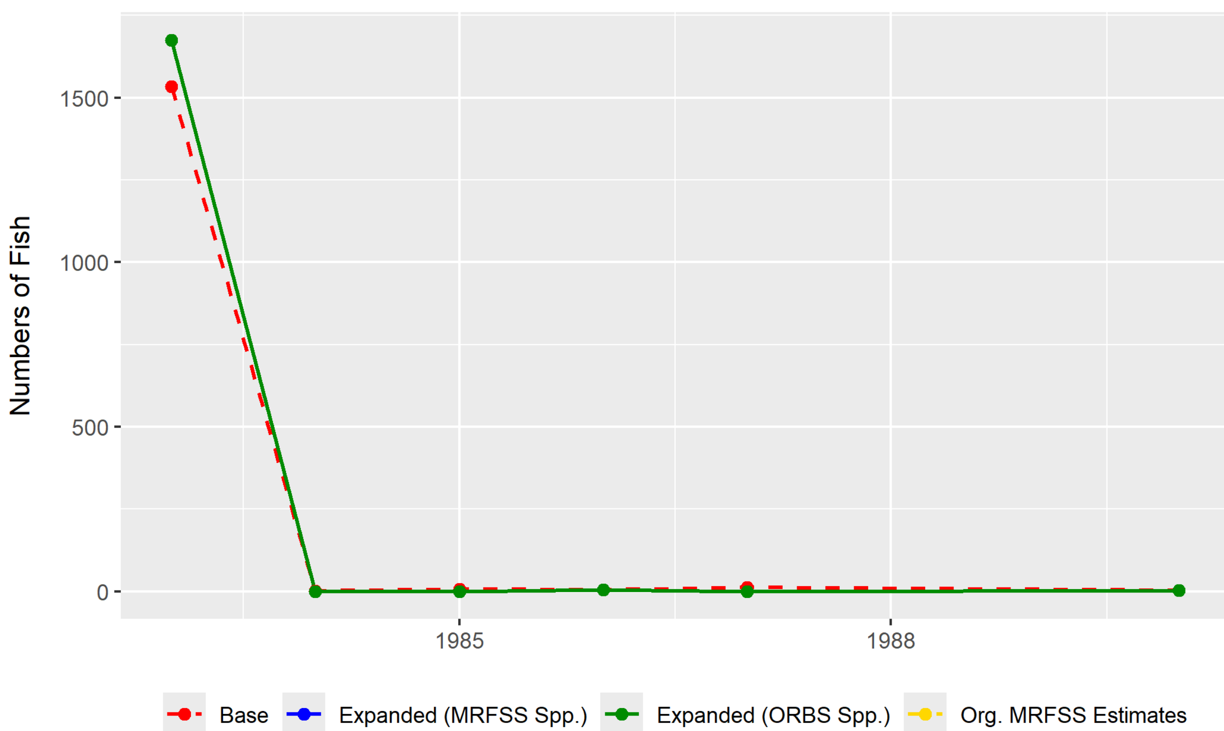

Figure F74: Comparison of historical Pacific Bonita recreational catch datasets.

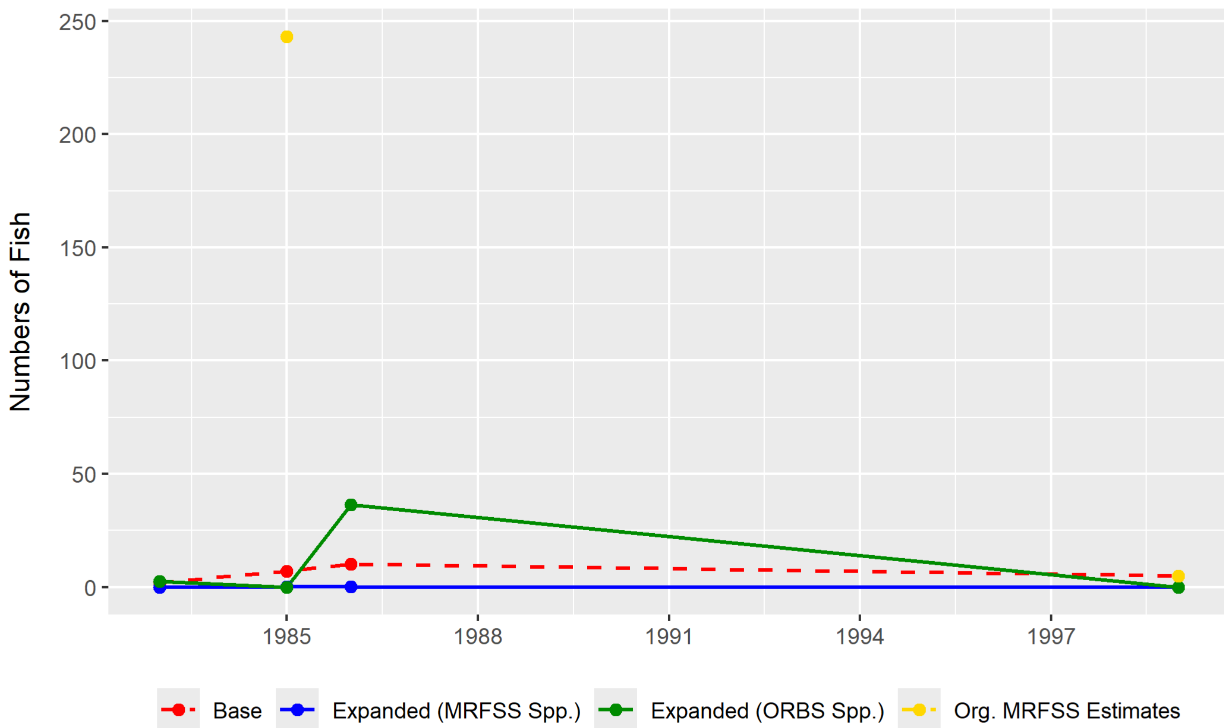

Figure F75: Comparison of historical Pacifc Staghorn Sculpin recreational catch datasets.

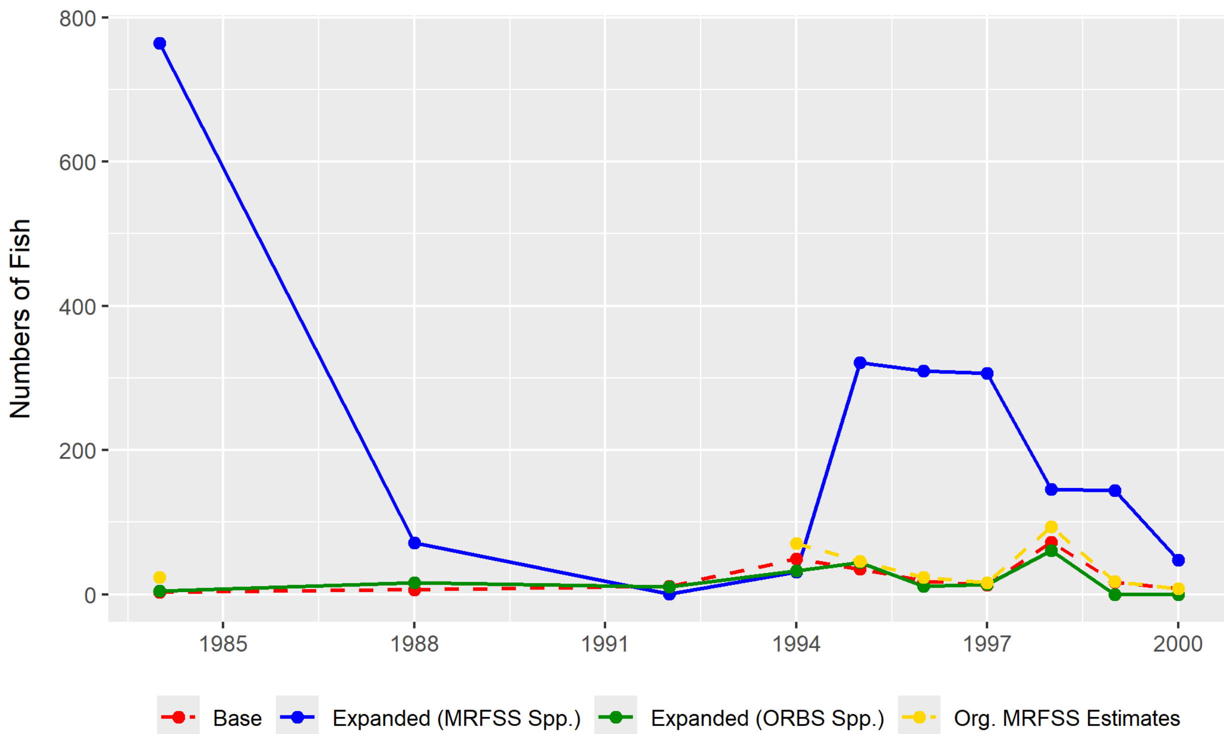

Figure F76: Comparison of historical Grass Rockfish recreational catch datasets.

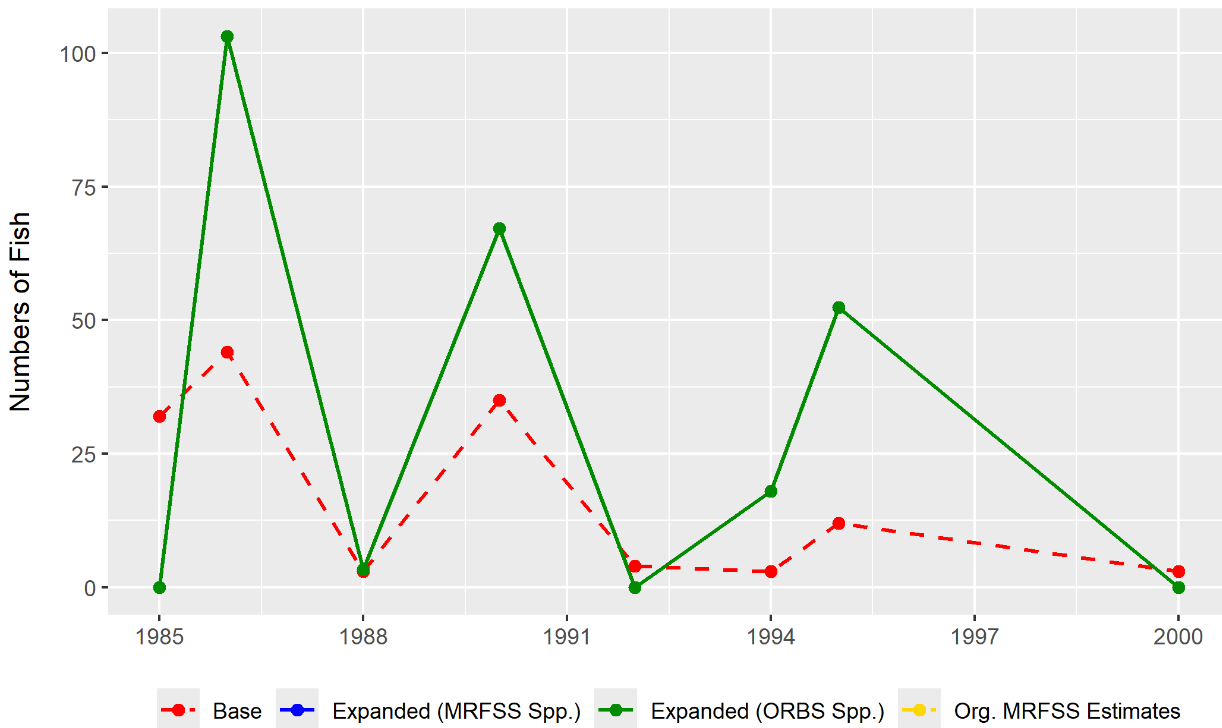

Figure F77: Comparison of historical Pacific Ocean Perch recreational catch datasets.

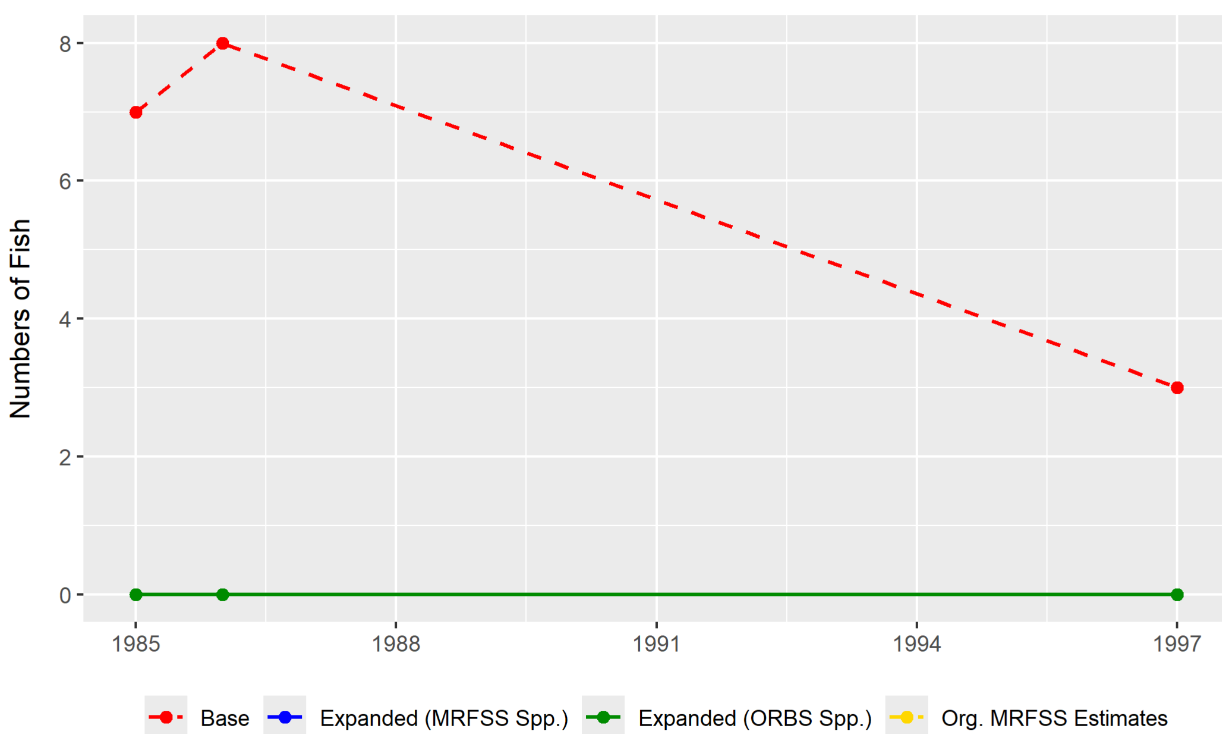

Figure F78: Comparison of historical Aurora Rockfish recreational catch datasets.

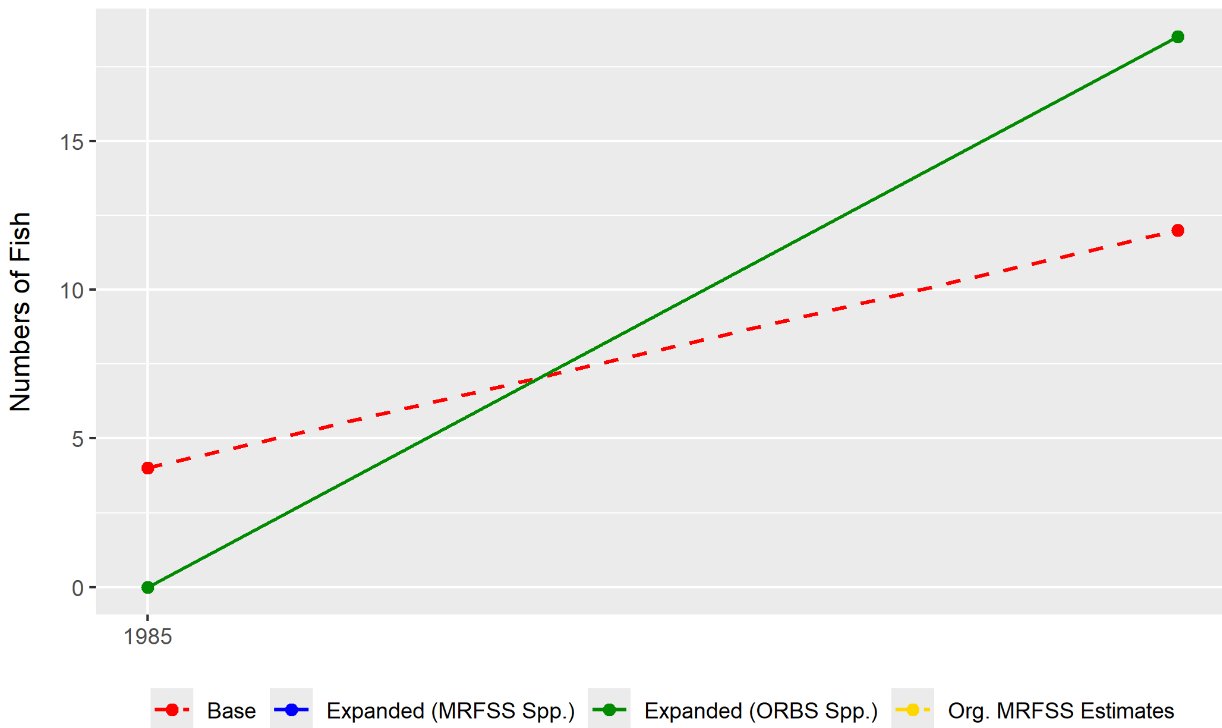

Figure F79: Comparison of historical Rex Sole recreational catch datasets.

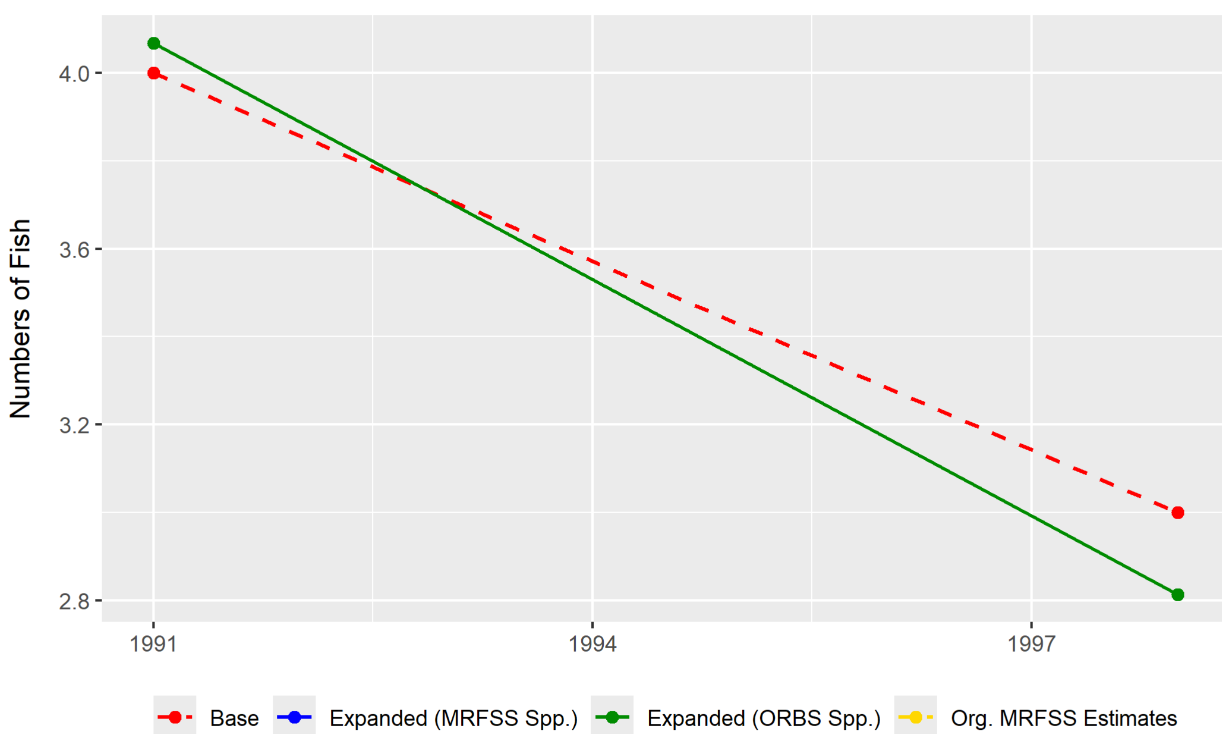

Figure F80: Comparison of historical Thresher Shark recreational catch datasets.

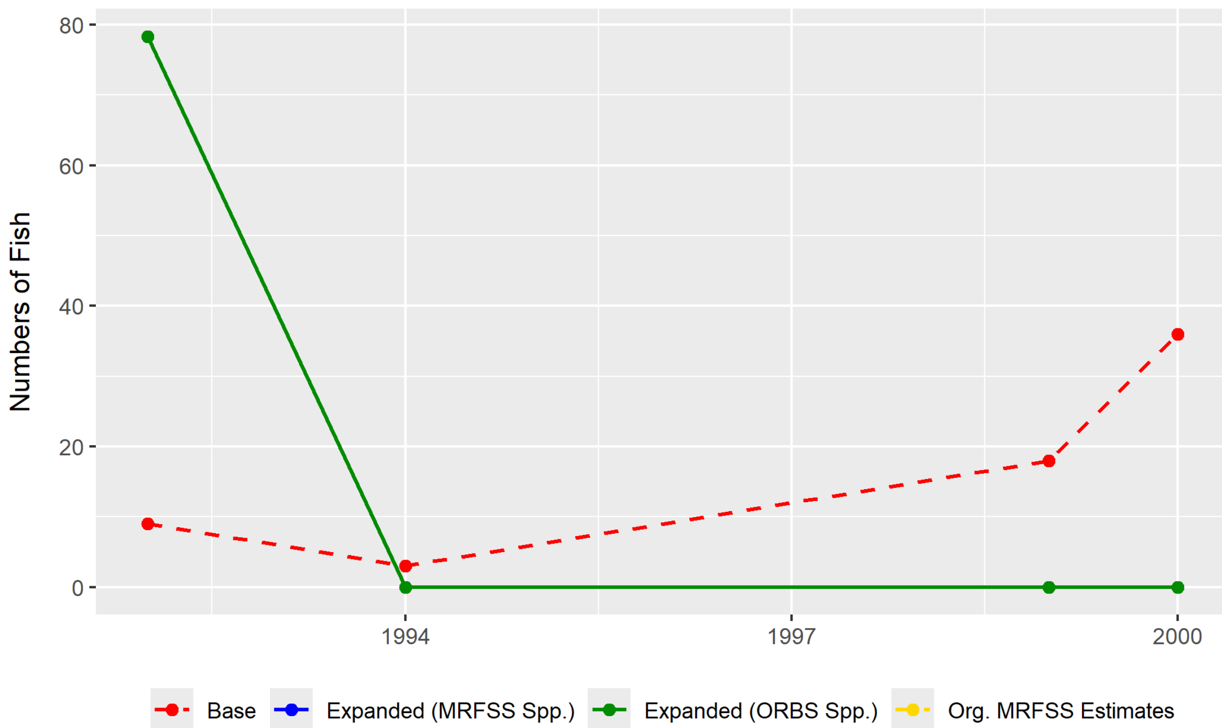

Figure F81: Comparison of historical Yellowmouth Rockfish recreational catch datasets.

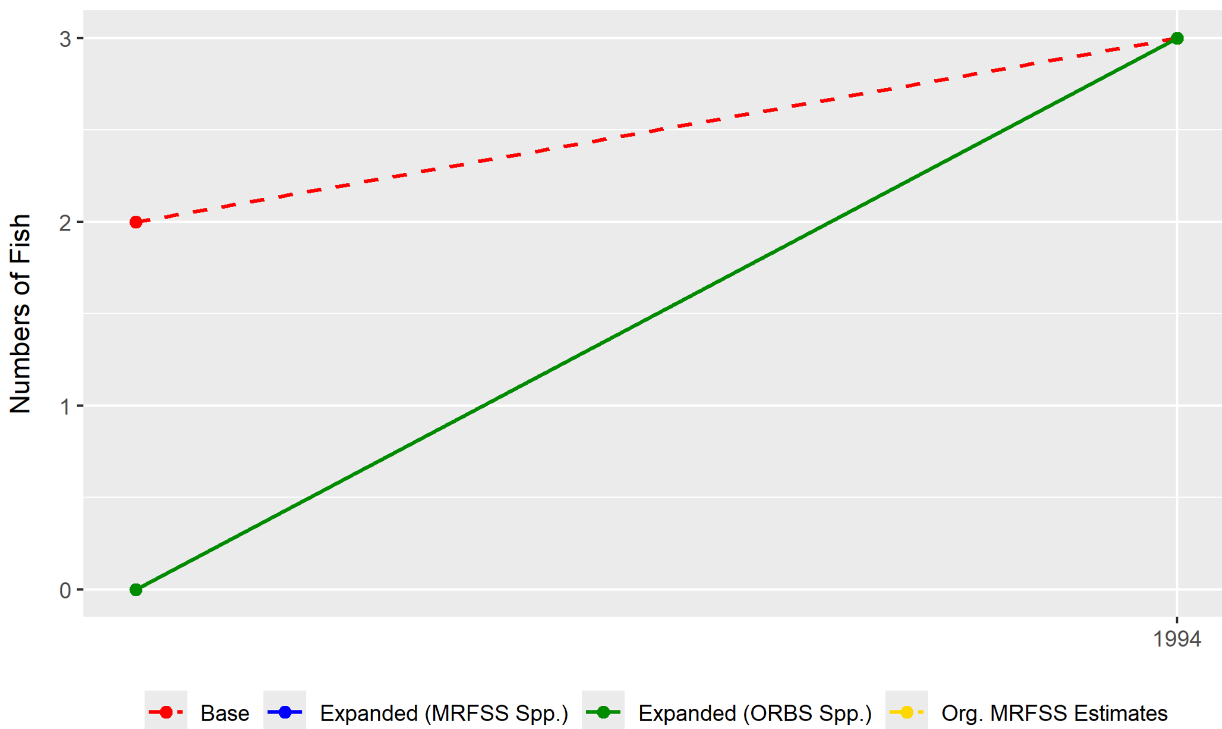

Figure F82: Comparison of historical Threadfin Sculpin recreational catch datasets.

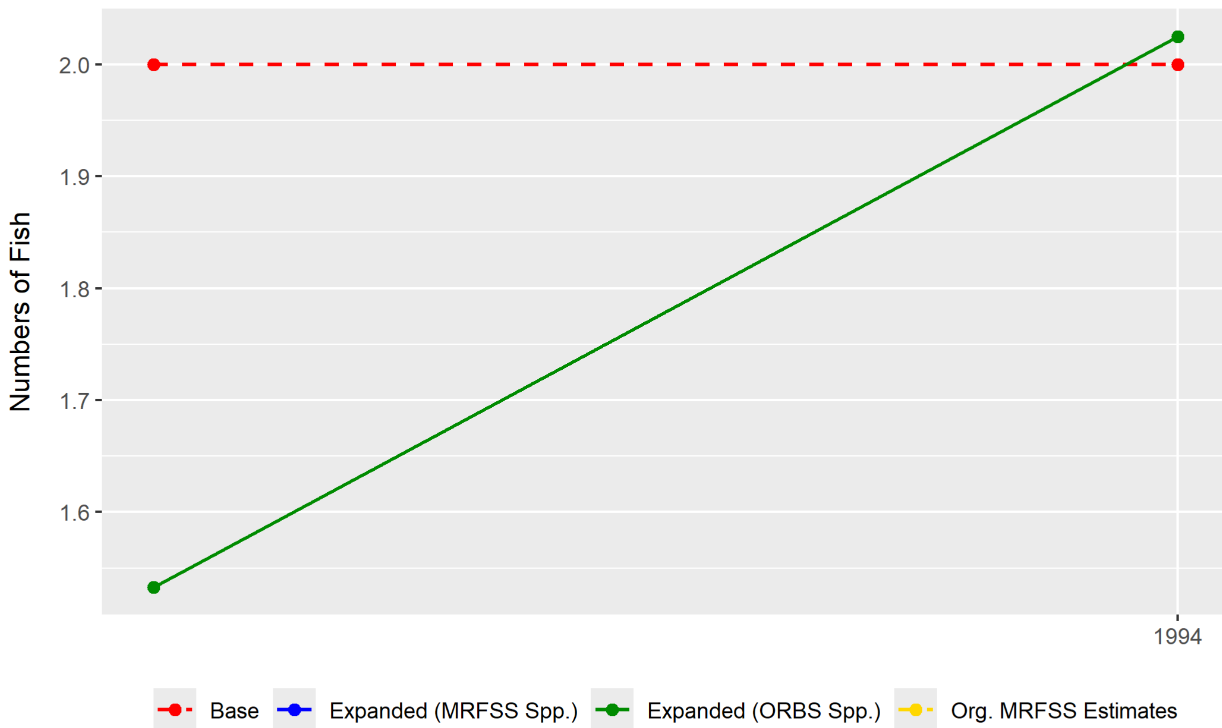

Figure F83: Comparison of historical Sailfin Sculpin recreational catch datasets.

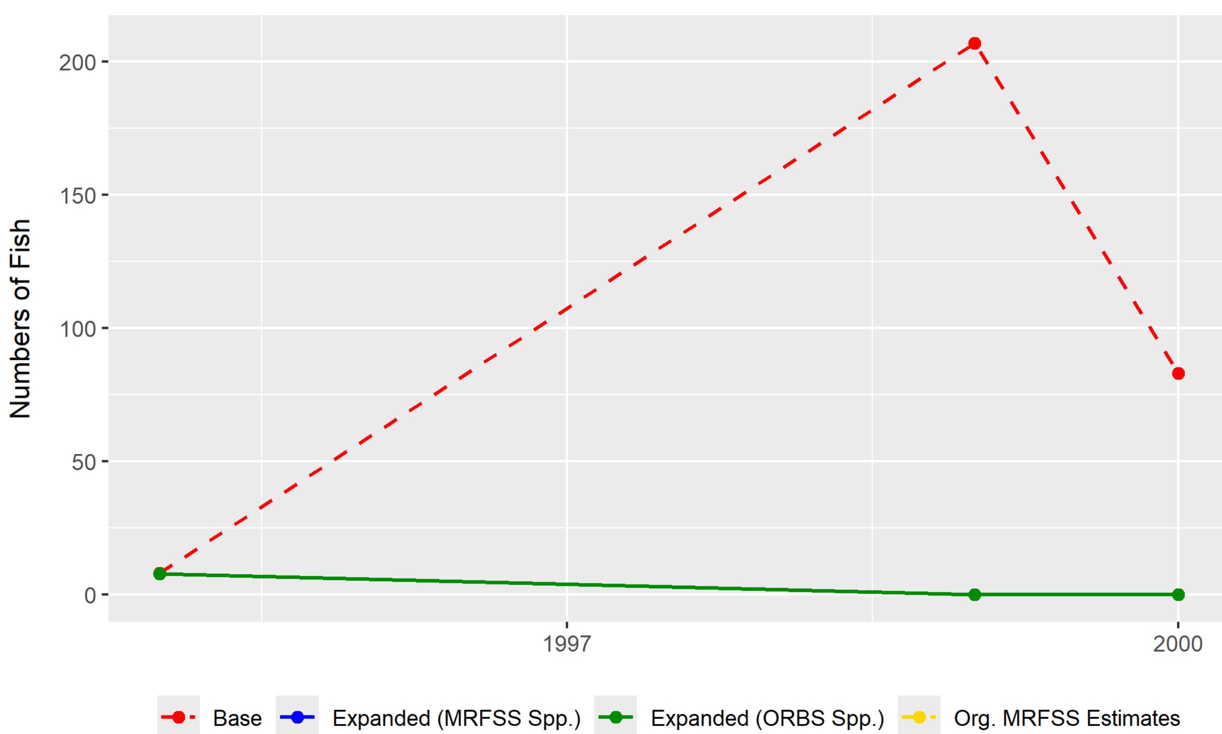

Figure F84: Comparison of historical Snowy Snailfish recreational catch datasets.

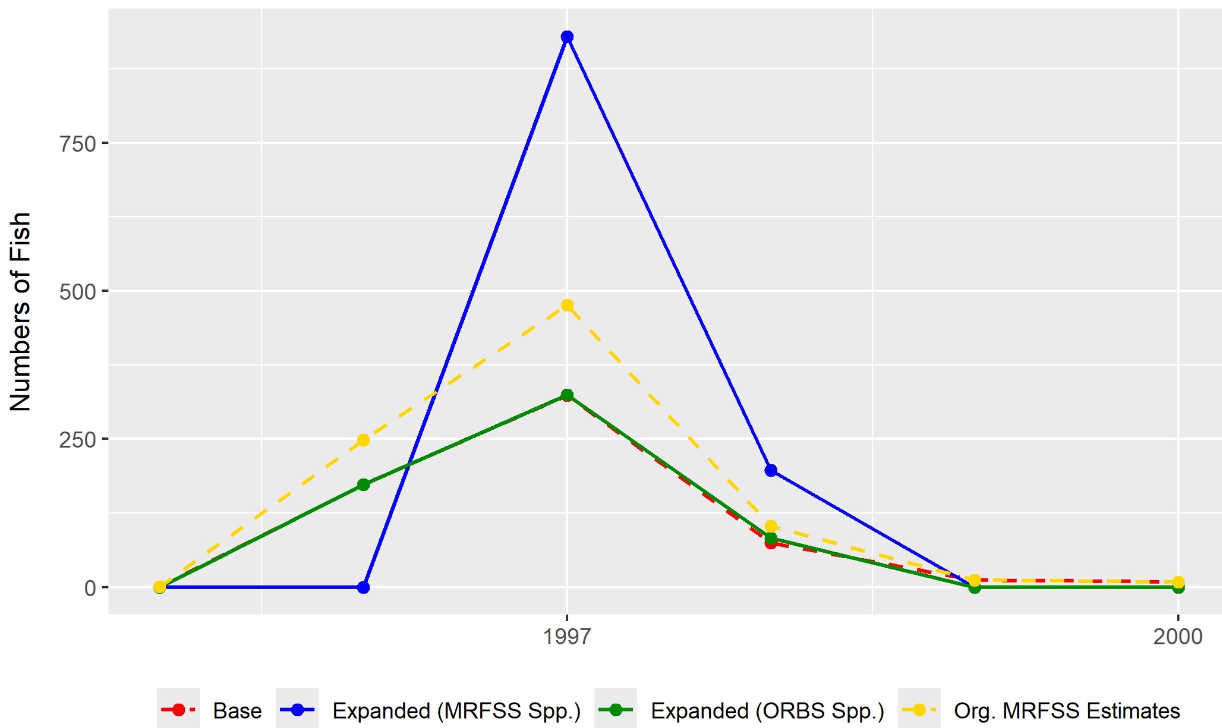

Figure F85: Comparison of historical California Halibut recreational catch datasets.

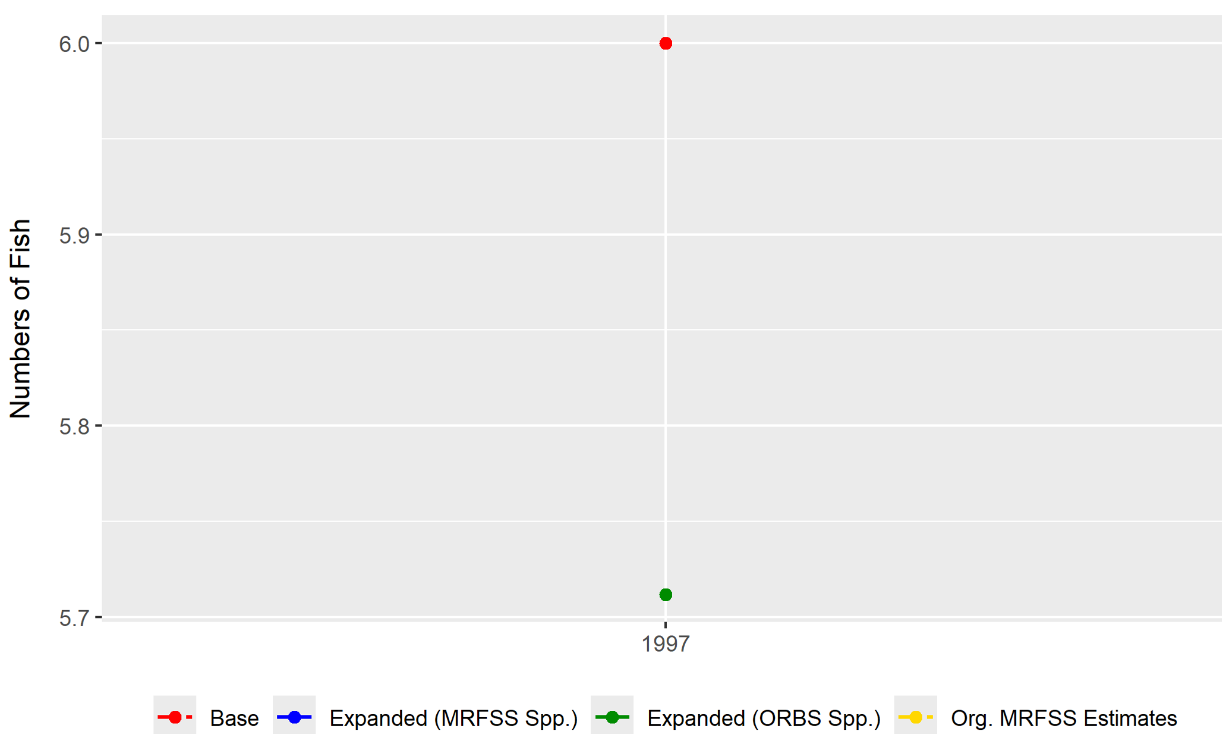

Figure F86: Comparison of historical Sixgill Shark recreational catch datasets.

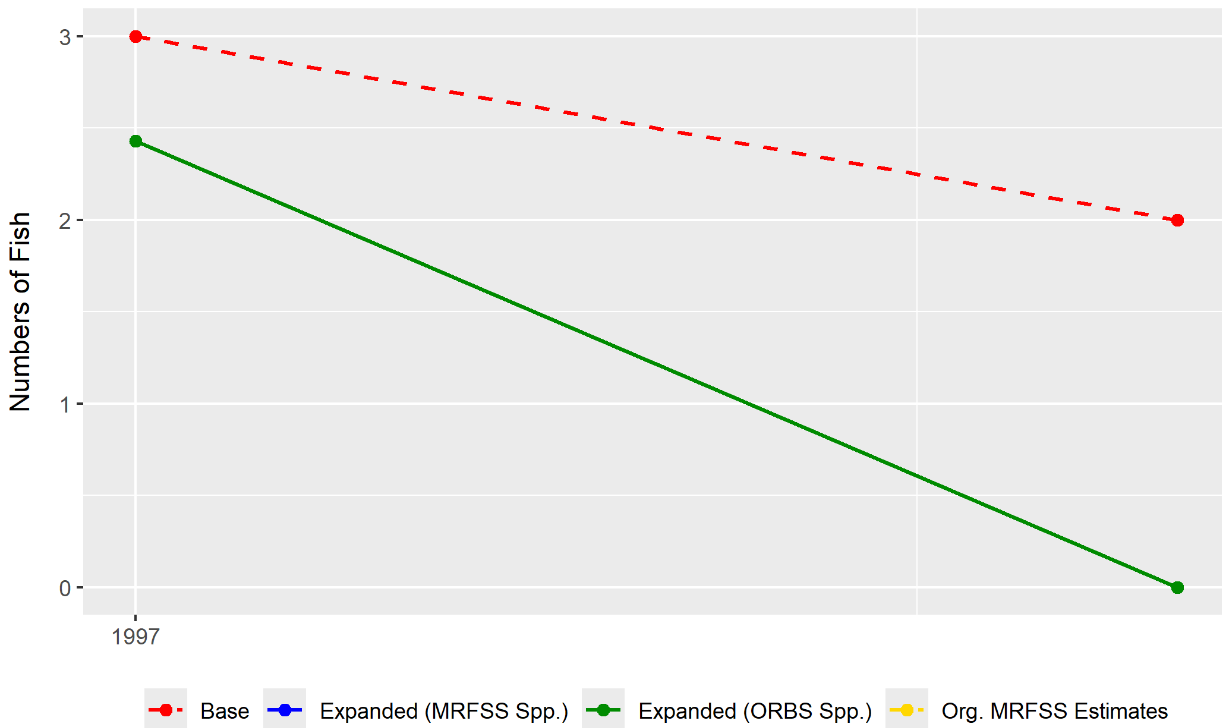

Figure F87: Comparison of historical Eelpouts recreational catch datasets.

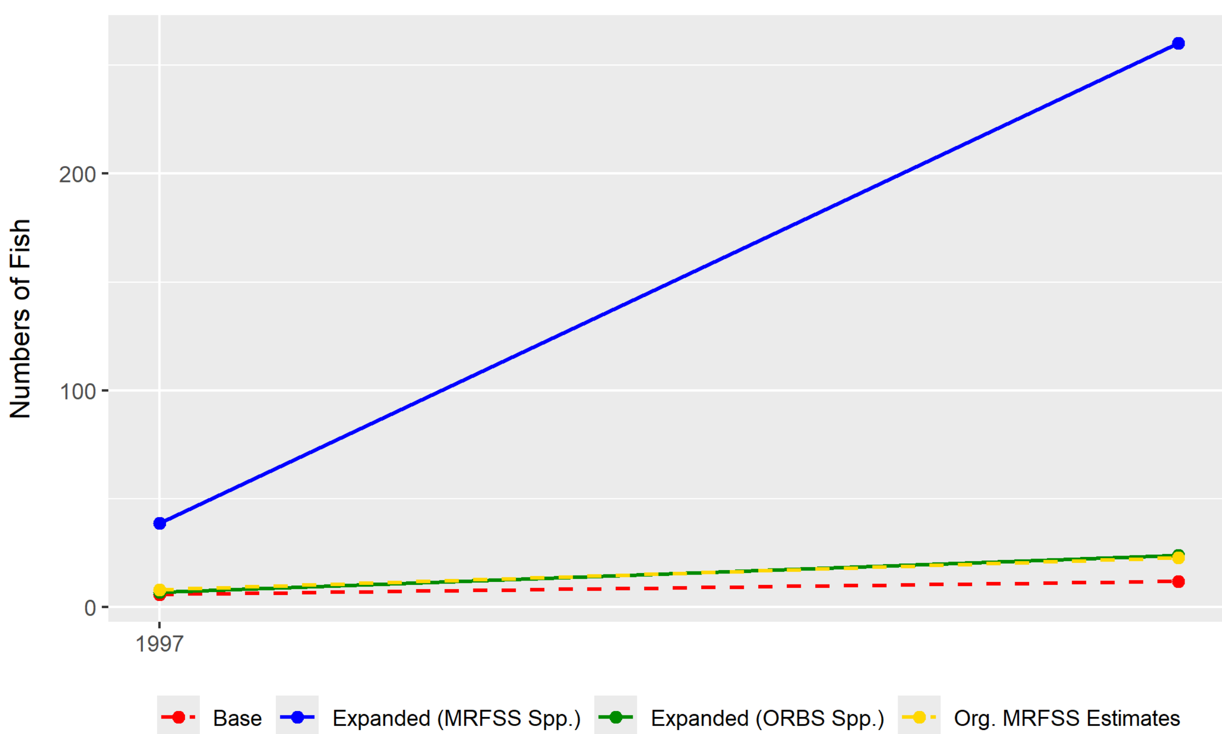

Figure F88: Comparison of historical Pile Perch recreational catch datasets.

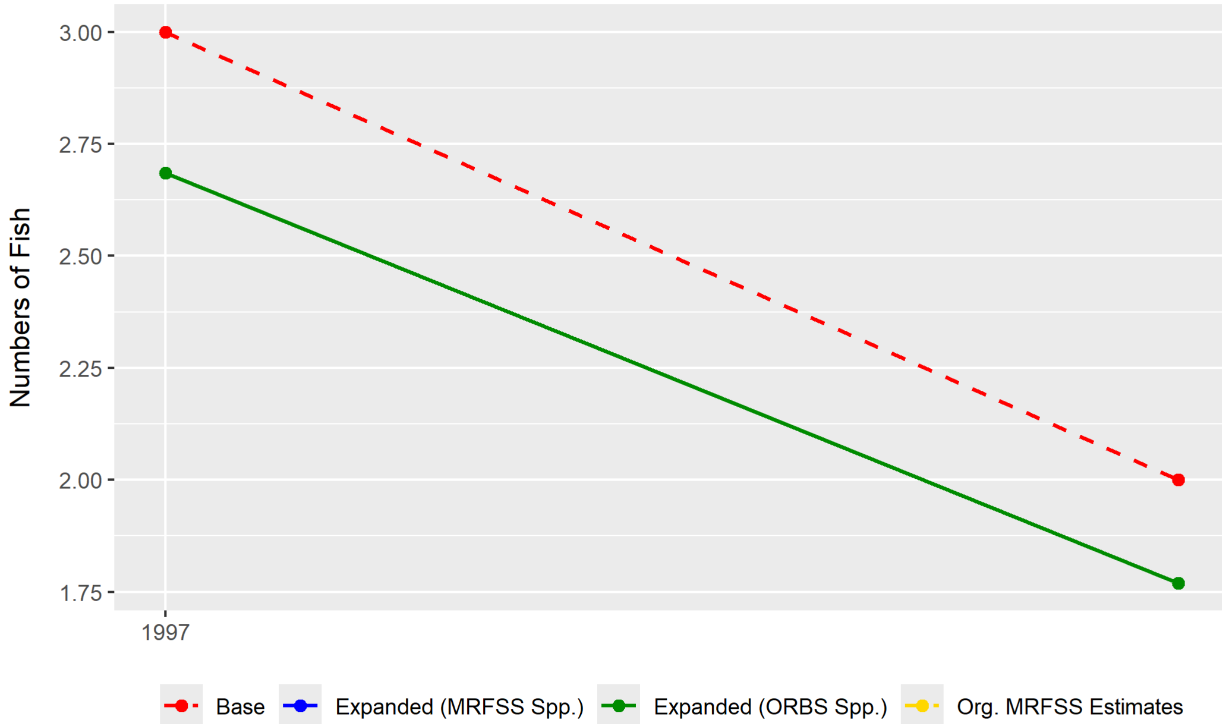

Figure F89: Comparison of historical Sharpchin Rockfish recreational catch datasets.

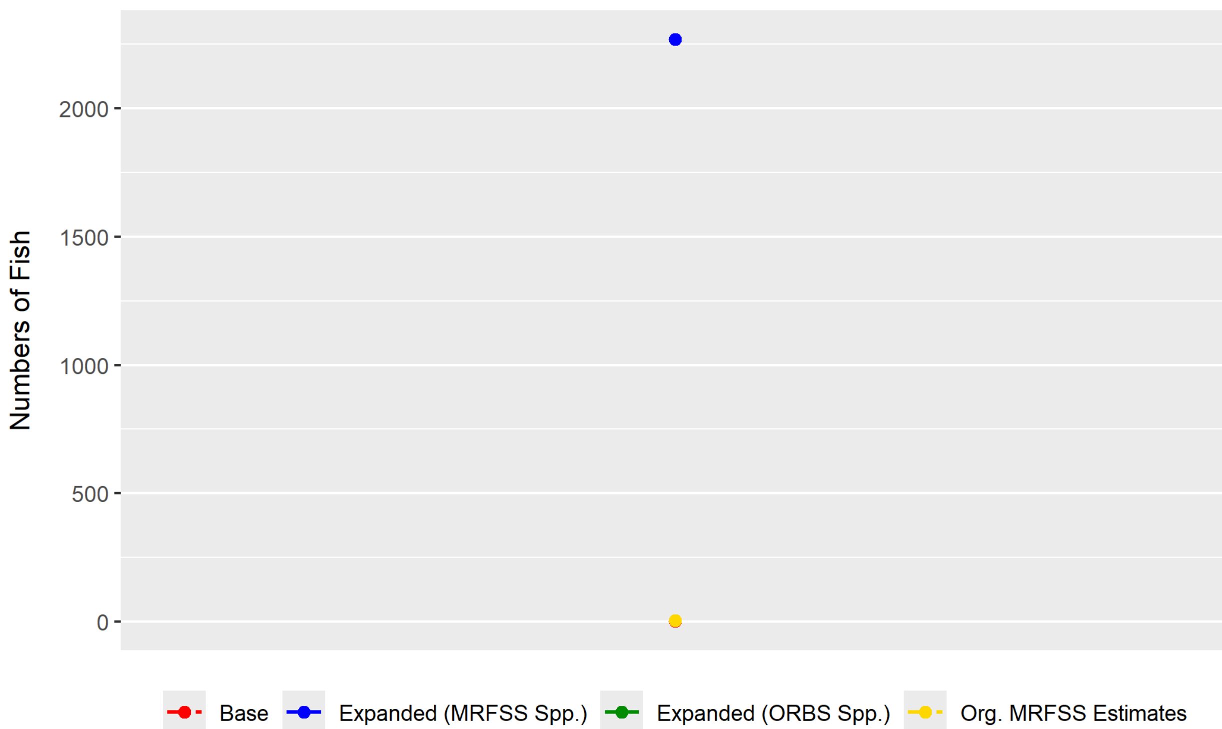

Figure F90: Comparison of historical White Sturgeon recreational catch datasets.

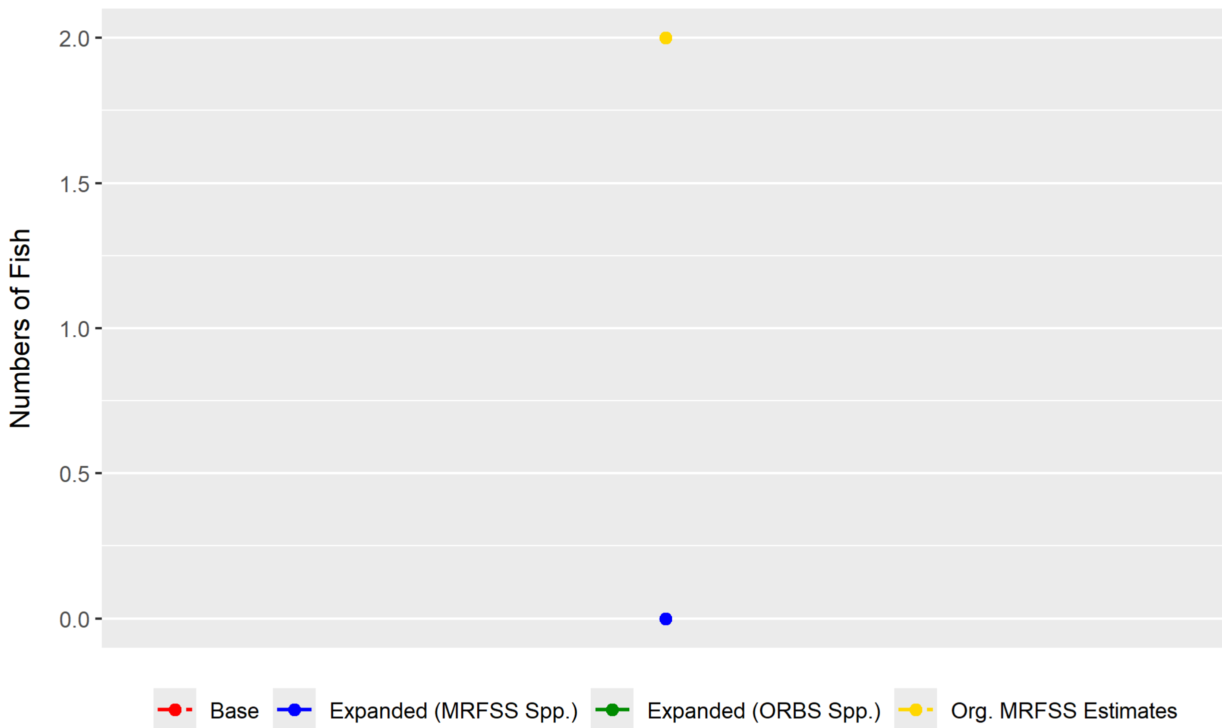

Figure F91: Comparison of historical Pacific Herring recreational catch datasets.

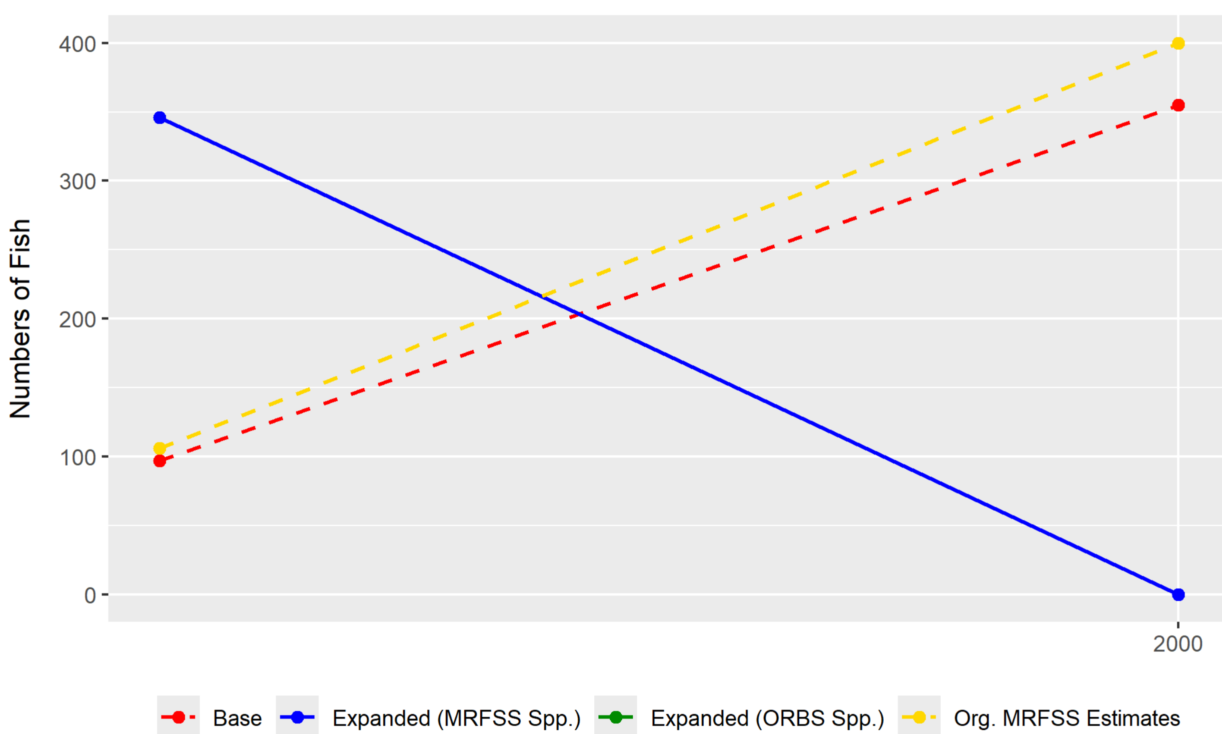

Figure F92: Comparison of historical Rosy Rockfish recreational catch datasets.

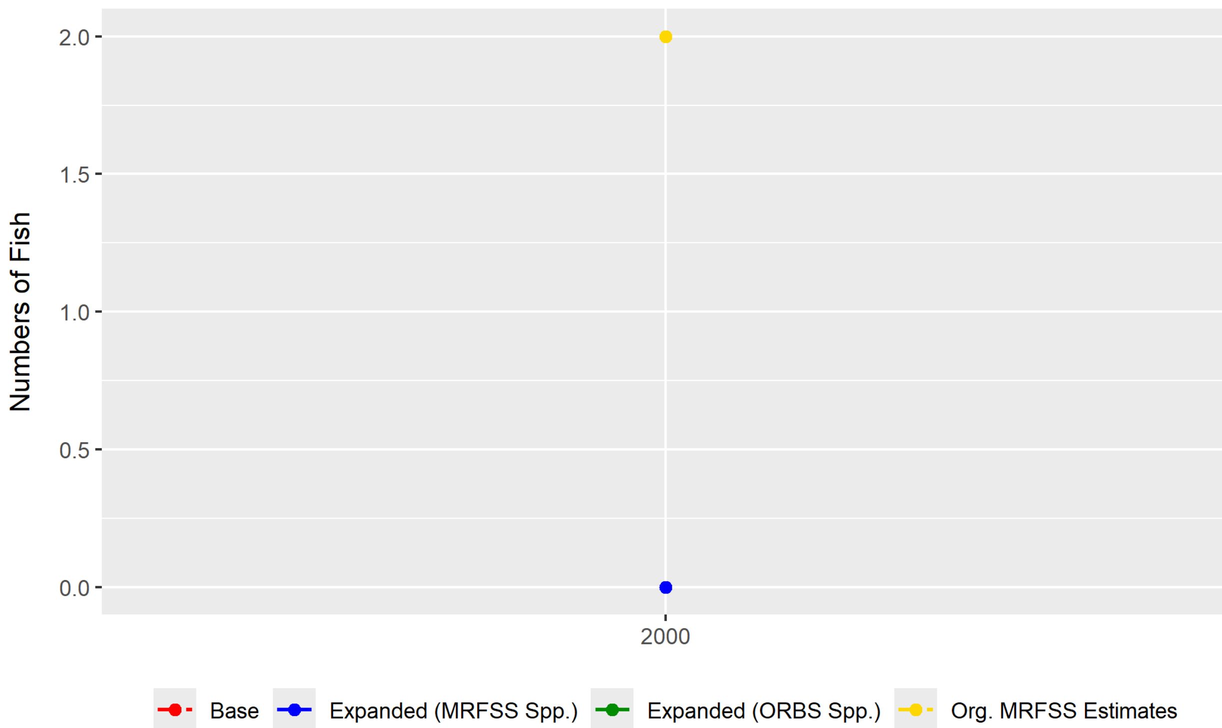

Figure F93: Comparison of historical Striped Bass recreational catch datasets.

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