APPENDIX I

Measuring Species Diversity Among IFQ Vessels Using the Herfindahl Index

LAGC IFQ Program Review, 2016-2023

APPENDIX I – MEASURING SPECIES DIVERSITY AMONG IFQ VESSELS USING THE HERFINDAHL INDEX

Greg Ardini, Northeast Fishery Science Center, SSB

Intro and Methods

The Herfindahl Index is a metric that is commonly used to measure concentration in a market place. In this more generally utilized form, the calculation of the index involves squaring the share each firm holds in a market. For the purposes of this section, the Herfindahl Index is used to measure the concentration of revenue by IFQ vessels among various fisheries, such that the proportion of revenue from each fishery is squared (Equation 1).

$$H = \sum_{i=1}^{N} s_i^2 \#(Equation\ 1)$$

NMFS dealer data was the source for revenues and fisheries were grouped largely based on Fishery Management Plans (Table 1). The Herfindahl Index was calculated for scallop fishing years (FYs) 2004-2023 for all vessels that had an IFQ permit for at least one FY during 2010-2023. The fleet was divided into those that held both for an IFQ permit and LA permit during the same FY at some point and those that were never duel-permitted. Calculations were made for all FYs in which vessels were active. A total of 4,781 vessel/FY combinations were included for IFQ-only permitted vessels and 1,252 vessel/FY combinations for duel-permitted vessels.

Table 1. Fishery groupings for calculation of the Herfindahl Index by Vessel/Fishing Year.

Fishery	Council Managed
Bluefish	MAFMC
Dogfish	MAFMC/NEFMC
Groundfish	NEFMC
Herring	NEFMC
Highly Migratory Species	Other
Lobster	Other
Menhaden	Other
Monkfish	MAFMC/NEFMC
Red Crab	NEFMC
Scallop	NEFMC
Shrimp	Other
Squid, Mackerel, Butterfish	MAFMC
Summer Flounder, Scup, Black Sea Bass	Other
Surf Clam, Ocean Quahog	MAFMC
Tilefish	MAFMC
Whiting	NEFMC
Other	N/A

The full set of vessel/FY combinations were grouped into three different time periods to illustrate changes in reliance on scallops over time. The first time period (FYs 2004-2009) covers when these vessels were fishing under a General Category (GC) permit and when they were fishing under an IFQ permit with a fleet-wide TAC. The second period (FYs 2010-2015) covers years from the previous IFQ scallop program review. The third period (FYs 2016-2023) covers years not previously included in a program review. This method is a more simplified approach in which

all non-scallop revenue is aggregated at the vessel level. Conversely, the number of species groups a vessel lands aside from scallops will change its Herfindahl Index (Equation 1).

Results and Discussion

A plot of the Herfindahl indices for the IFQ-only vessel/FY combinations is shown in Figure 1. There is a generally upward trend, indicating a less diverse catch portfolio over time. Median values are noticeably highest during the most recent FYs of 2020-2023. The 75th percentile is close to or close to 1.0 in every fishing year, indicating the large number of vessels heavily dependent on a single fishery. Vessels that had a high index in a given FY may not necessarily derive the majority of their revenue from sea scallops, as they may rely on another fishery from Table 1. The inverse of the Herfindahl indices are presented in Figure 2. This metric represents the number of species groups that would comprise aggregate revenue if revenue shares were equal across all species (e.g. a vessel with an inverse Herfindahl index of 2.0 could attain all of their revenue from two species groups equally). The fact that the vast majority of data points lie below 2.0 indicates there is a relatively small number of fisheries that comprise most of the revenue generated by IFQ-permitted vessels. Circles in the figure are considered outliers (beyond 1.5*IQR from the 25th or 75th percentiles) and roughly correspond to inverse values >3.0 in most fishing years. Therefore, a vessel that generates revenue from three or more fisheries relatively equally is rare.

The Herfindahl indices for the duel-permitted vessel/FY combinations are shown in Figure 3. Compared to IFQ-only permitted vessels, duel-permitted vessels show an even larger concentration of revenues among fisheries. Changes over time are less apparent, as duel-permitted vessels have been heavily reliant on a small number of fisheries throughout the time series. Figure 4 shows the inverse of the Herfindahl indices presented in Figure 3. Again, the inverse Herfindahl index represents the number of species groups that would comprise aggregate revenue if revenue shares were equal across all species. In comparison to Figure 2, the distribution is even closer to 1.0, in which all vessel-level revenue is generated from a single fishery.

Table 2 gives the breakdown of scallop landings revenue relative to overall landings revenue for IFQ-only permitted vessels. A higher percentage of vessels in the most recent time period derive 75% - <100% or 100% of their revenue from scallops relative to the two earlier time periods. Of particular significance, the number of vessels in each revenue grouping other than 100% declined in the most recent time period. This may indicate a concentration of revenue among fewer IFQ vessels; further exploration is warranted. The percentage of vessels deriving 0% or 0.1% - <25% of their revenues from scallops declined slightly from 2016-2023 compared to 2010-2015. The percentage of vessels with 0% of ex-vessels revenues from scallops is considerably higher compared to the pre-IFQ period, possibly indicating vessels that had previously participated in the fishery but now lease out their quota. Table 3 gives the same breakdown as the previous table among duel-permitted vessels. These vessels derive the vast majority of their revenues from scallops for all time periods. There was a noticeable increase in the number of vessels deriving 100% of their revenues from scallops during 2016-2023 compared to the earlier time periods.

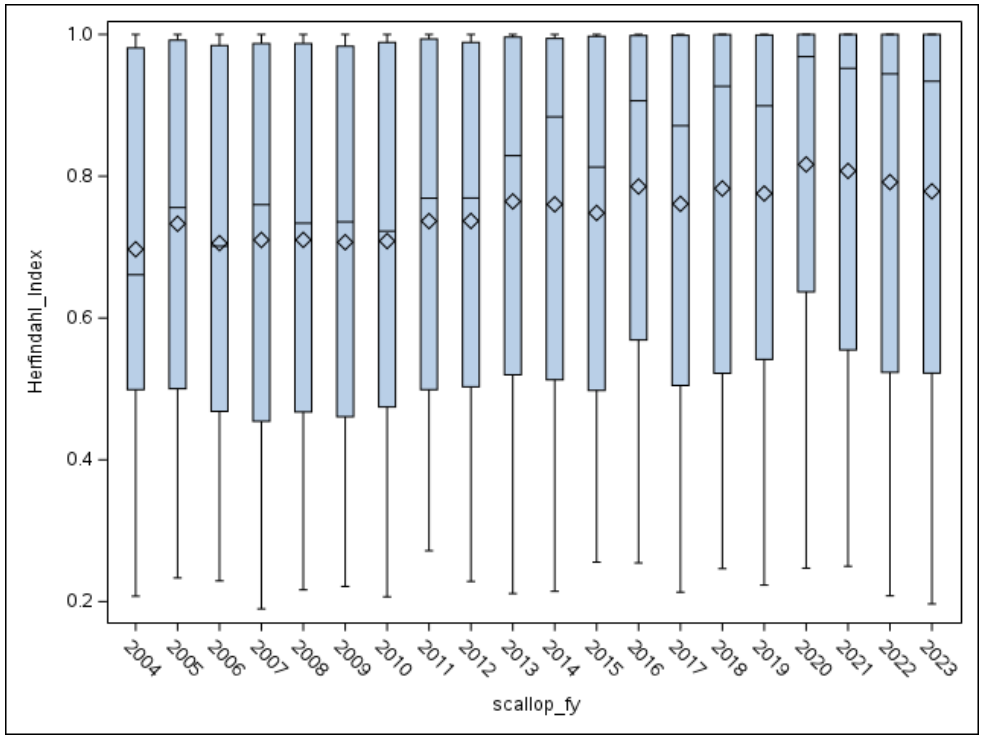

Figure 1. Herfindahl indices by vessels holding an IFQ permit in at least one fishing year from 2010-2023, includes all active vessel/fishing year combinations; no LA permits

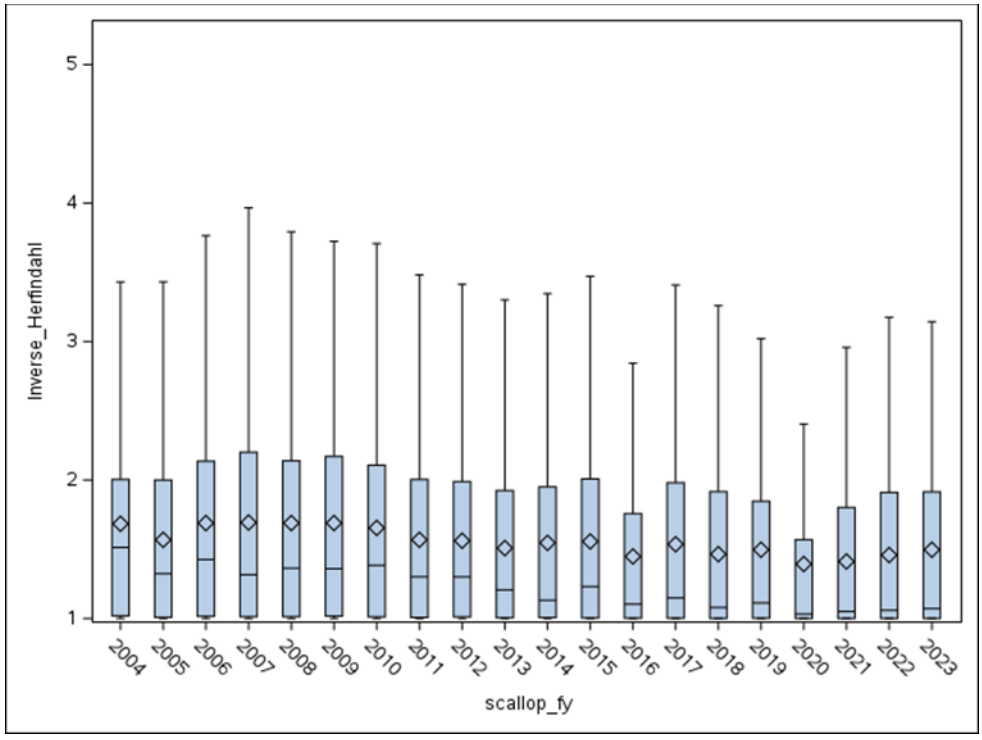

Figure 2. Inverse of the Herfindahl indices among vessels holding an IFQ permit in at least one fishing year from 2010-2023, includes all active vessel/fishing year combinations; no LA permits

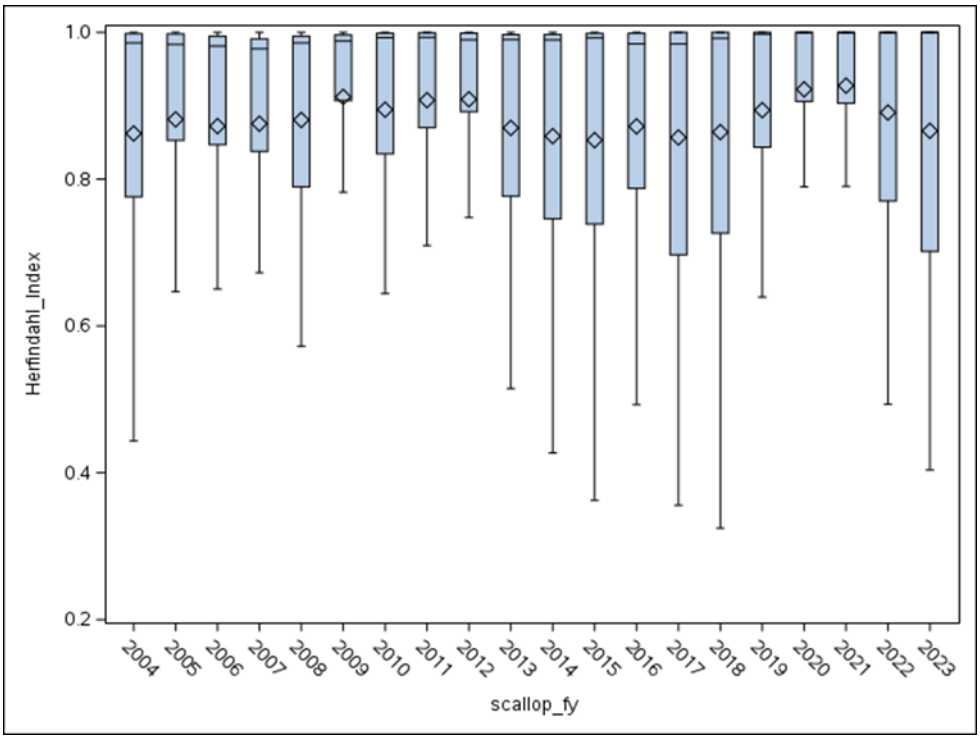

Figure 3. Herfindahl indices by vessels holding both an IFQ and LA permit in at least one fishing year from 2010-2023, includes all active vessel/fishing year combinations

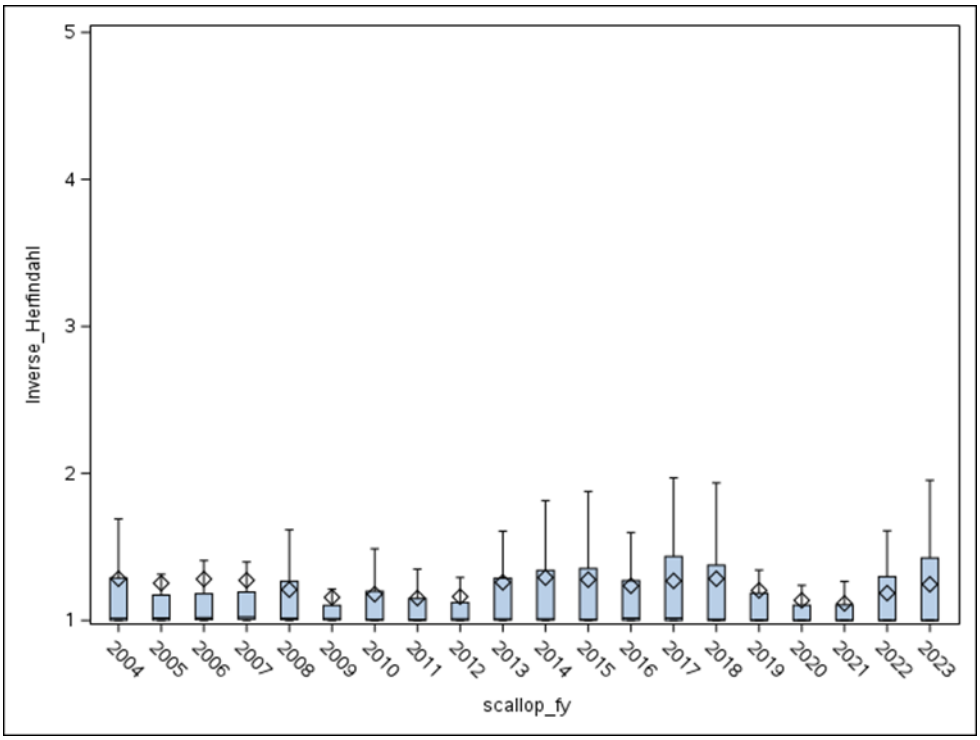

Figure 4. Inverse of the Herfindahl indices among vessels holding both an IFQ and LA permit in at least one fishing year from 2010-2023, includes all active vessel/fishing year combinations

Table 2. Reliance on revenue from scallops among vessels holding an IFQ permit in at least one fishing year from 2010-2023; no LA permits

% Revenue from Scallops	2004-2009	2010-2015	2016-2023
0%	47 (13.1%)	74 (24.0%)	53 (19.0%)
0.1% - <25%	106 (29.4%)	69 (22.4%)	54 (19.4%)
25% - <50%	50 (13.9%)	30 (9.7%)	28 (10.0%)
50% - <75%	24 (6.7%)	24 (7.8%)	19 (6.8%)
75% - <100%	124 (34.4%)	101 (32.8%)	99 (35.5%)
100%	9 (2.5%)	10 (3.3%)	26 (9.3%)

**Note: if an IFQ-permitted scallop vessel had no revenue from any fishery during an entire time period, it is not included*

Table 3. Reliance on revenue from scallop among vessels holding both an IFQ permit and LA permit simultaneously in at least one fishing year from 2010-2023

% Revenue from Scallops	2004-2009	2010-2015	2016-2023
0%	0	0	C
0.1% - <25%	5 (7.4%)	C	C
25% - <50%	C	C	4 (5.7%)
50% - <75%	C	8 (11.8%)	5 (7.1%)
75% - <100%	58 (85.3%)	58 (85.3%)	48 (68.6%)
100%	C	0	11 (15.7%)

**Note: if a duel-permitted (LA-IFQ) vessel had no revenue from any fishery during an entire time period, it is not included. C indicates that the data is confidential.*