Identification of Indicators of Fishery Condition and Relative Abundance for Illex

Working Paper #xx from Illex Squid Working Group

Paul J. Rago

April 23, 2020

Introduction

This report serves two purposes 1) to examine broad patterns of fishery dependent metrics of relative Illex squid availability and fishery performance and 2) to evaluate candidate measures of system performance that could, under ideal circumstances, provide fishery management with sufficient scientific information to make in-season adjustments to quotas.

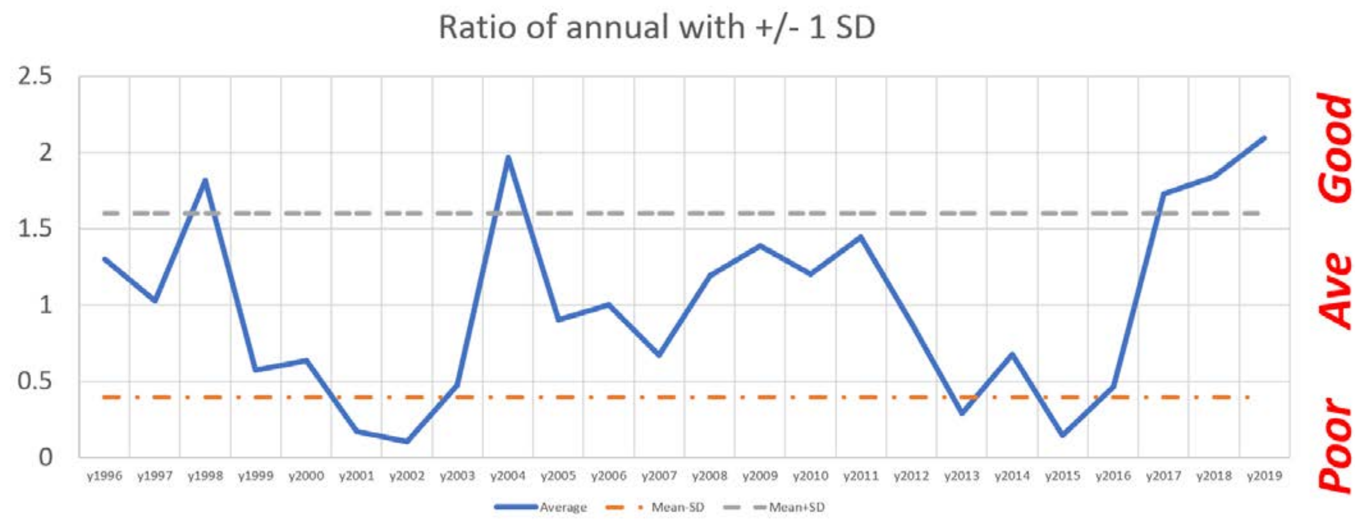
The focus herein is post hoc identification of fishing success via annual metrics. No attempt is made to derive standardized measures of relative abundance through more formal generalized modeling approaches. Such models are indeed helpful for identifying underlying relationships among data but are not, in and of themselves, sufficient to disentangle the relative effects of changes in true population abundance from changes in availability of the resource to the fishable areas. Availability varies seasonally and inter-annually, most likely driven by broadscale oceanographic factors and biological processes. The life history of Illex is known in general terms but here again, the normal constructs necessary to develop standard stock assessment models do not exist. Growth is fast and highly variable, reproduction occurs throughout the year but is rarely observed, lifespans are less than one year, and recruitment dynamics are almost completely unknown.

The purpose of these analyses is to examine or screen several candidate measures for detection of "system state" for the Illex fishery. These measures may have utility for identifying the fishery success in real time. The analyses are exploratory. Two additional working papers will address the potential use of landings time series and changes in average size of Illex as candidate measures of in-season system state using statistical quality control approaches.

Data

Vessel Trip Report data and NEFSC bottom trawl survey weight/tow (1997-2018) for these analyses were graciously provided by Lisa Hendrickson of the Northeast Fisheries Science Center. The key variables available for summary include measures of effort (#trips, Days absent, and days fished), total landings, and measures of CPUE (per trip, per days absent, per days fished). Average annual prices were provided by Jason Didden of the MAFMC. Summaries of squid average weights were provided by SeaFreeze Ltd and keypunched under the supervision of Lisa Hendrickson.

Initial determination of "system state" was developed interactively through discussions with commercial harvesters and processors, and Council and NEFSC staff. Fishing year conditions "System State" was defined as "good", "average" and "poor" conditions. There was general agreement that 1998, 2004 and 2017-2019 were good years and unanimous agreement that 2019 was the best ever observed. There was also general agreement that 2015 and 2016 were poor years. A more quantitative approach was used by computing average weekly catch rates, standardized to the overall mean for catch data supplied by the regional office. These data are not equivalent to the VTR data supplied by the NEFSC which had not yet finalized the processing of the VTR data for 2019. Years 2003 and 2016 were just above the lower threshold and were assigned as poor years.



Catch per unit effort can be measured in many ways with different variables in the numerator and denominator. Catch can be expressed in terms of total weight or if average weights are available, in terms of total numbers landed. VTR data allow effort to be defined in terms of number of trips, number of day absent (i.e., time between departure and return to port) and days fished. Catch per unit effort is often assumed to be proportional to overall abundance, but this assumption is difficult to satisfy when only a portion of the population is available within the fishing area. In these circumstances CPUE may be proportional to the availability of the stock but within season replenishment from unfished areas or emigration to unfished areas compromise CPUEs use for abundance estimation. Under conditions of assumed stationarity of external factors, CPUE would have higher value as a measure of relative abundance. Stationarity is a difficult proposition to satisfy, so one much constantly be prepared to consider other factors causing abrupt changes in apparent abundance that may be entirely unrelated to previous harvesting.

Factors most commonly identified by fishermen were average weight of squid, average price and relative catch per unit effort. Squid are a worldwide commodity and supply from US fisheries constitutes a small fraction. Prices at the beginning of the season often follow trends set by production of squid in other areas. Fishermen noted relatively little within season fluctuation in prices. All things being equal, a fixed price during the season would imply that revenue would be directly proportional to landings. Profits of course are not since costs may fluctuate with increased trip duration. At the present time, data are insufficient to estimate profitability across the entire Illex fishery. Similarly, improved methods to estimate CPUE are being developed. Advances in modeling may allow for more refined estimates of interannual and within season variations in catch rates that fully account for vessel effects, port, vessel type and so forth.

Discussions with fishermen at the Illex Summit suggested that fishing capacity could be an important metric of fishery performance. Inclusion of permit number in the VTR database allowed for an empirical determination of maximum catch and maximum catch per unit effort over the period 1997-2018. Each trip can now be expressed as a fraction of maximum capacity and assigned a decile (i.e., first decile =1:0-10%, second decile 2: 10%-20% etc.). Measures of performance across the fleet can now be expressed as the fraction of the fleet operating above a given percentile. Similarly, the average percentile of capacity for CPUE metrics can also be computed.

Biological data of average annual weights from SeaFreeze, average price per pound (in 2019 dollars), and average weight per tow from the NEFSC fall bottom trawl fishery are also included in Table 1.

The use of totals and averages in Table 1 can obscure important aspects of seasonal dynamics. Further refinement of these measures may more "representative" measures of relative abundance but it is unlikely that a single metric will fully capture the relevant dynamics over the course of the season.

Methods and Results

Exploratory Analyses

Crude measures of catch per unit effort standardized to their means suggest a high degree of coherency among measures (Fig. 1). Raw CPUE comparisons (Fig. 2) confirm that the coherency exists irrespective of differing scales. Uncertainty in the denominators of CPUE would be expected to increase as one moves from effort defined on a trip basis, to effort based on days absent, to measure based on days fished. Days fished is estimated by fishermen and potential differences among individuals in recording of this variable may create larger deviations over time as the composition of vessels fishing in the fleet changes over time.

Alternative measures of fishing success, based on deciles of capacity all appear to have strong coherency with each other (Fig. 3) suggesting that the standardization by permit may reduce some of the variability in the raw data. Measures of fishing success, based on standardizing each permit's catches to its empirically defined capacity are poorly correlated with landings per trip (top row, Fig. 4) but correlations appear to increase slightly as CPUE is defined as days absent (middle row, Fig. 4). CPUE based on days fished appears to have even higher correlations with decile-based metrics (bottom row, Fig. 4).

Comparison of CPUE measures with data independent of the VTR suggested relatively low correlations (Fig. 5). Average ex vessel price had no apparent relationship with standardized CPUE nor did the NEFSC trawl survey estimates (right column, Fig. 5). There is a slight suggestion that a hockey stick type pattern may exist, but this may simply be an artifact of the tension=0.8, used in the Lowess fitting algorithm. Average weight from industry samples has no apparent relationship with landings per trip but a modest correlation with landings per days absent and days fished (center column, Fig. 5).

Finally, there is some suggestion that the average number of days fished per trip and average landings are inversely related (top, Fig. 6). Conversely, an increase in the fraction of trips with greater than 60% of capacity to have a positive correlation with total annual trips, which could imply that increased trips are the consequence of higher success rates across the fleet (bottom, Fig. 6). Further support for this hypothesis can be inferred from a comparison of landings, effort and CPUE (Fig. 7). Standard statistical theory suggests that the random variables X and Y/X will be negatively correlated even when X and Y are independent. The absence of a non-negative correlations in any of the CPUE vs effort plots (Row 2,3,4 Fig. 7) may be due to within-season feedback mechanisms but this has not been examined.

The high degree of collinearity among various measures of CPUE suggests parsimony when searching for predictor variables for "system status." In the following sections, multivariate methods to determine if independent variables can independently identify Good, Average and Poor years apart from their designation based on total landings.

Discriminant Analyses

As a first cut, linear discriminant analysis was used to determine if one or more measures of fishery independent or dependent variables were sufficient. Price, average weight, and the fraction of trips greater than 60% of capacity were chosen as independent variables. The overall classification accuracy was 85%

and the hypothesis test suggest the results are statistically significant as shown in the SYSTAT (2004) output below.

Variable	***Average Year***	***Good Year***	***Poor Year***
Frequency	10	4	6
Average Mean Wt (g)	112.4	139.4	93.5
Average Fraction of trips greater than 60% of Capacity	0.465	0.669	0.160
Average Price $ in 2019 dollars	0.347	0.398	0.366

```
Wilks' lambda for the hypothesis
  Lambda =    0.2376    df =    3    2    17
 Approx. F=   5.2577    df =    6    30      prob =  0.0008
```

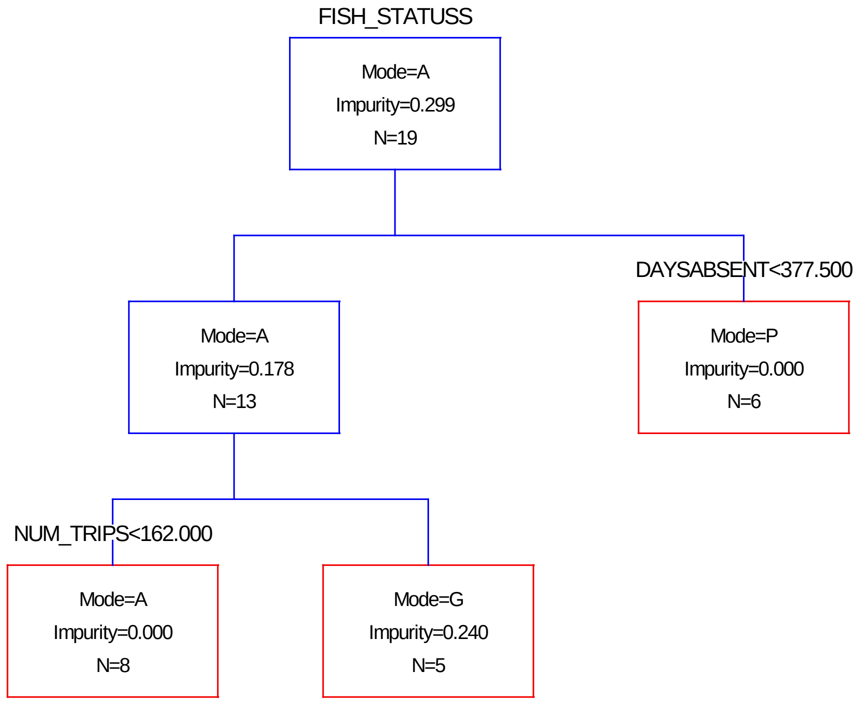
Classification matrix (cases in row categories classified into columns)

Jackknifed classification matrix

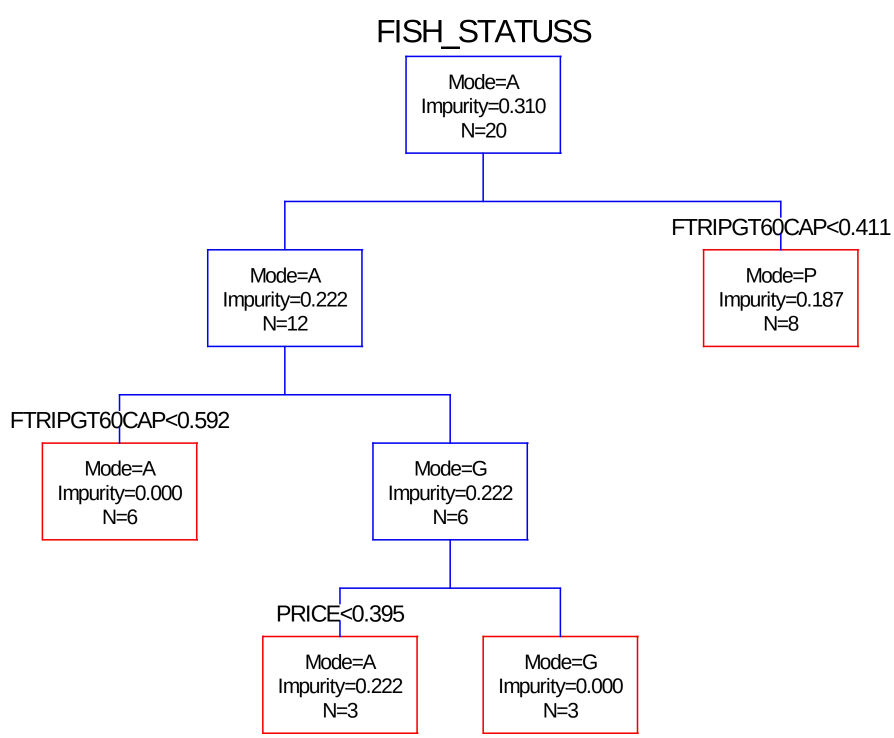
	A	G	P	%correct
A	7	1	2	70
G	0	4	0	100
P	0	0	6	100
Total	7	5	8	85

Regression Trees

Regression trees partition the observations into discrete sets to maximize the correct classification percentage. For this exercise "regression tree" is used synonymously with "classification tree" for categorical variables. As a first approximation, all of the candidate variables were used to identify system status (Poor, Average, Good) but only two variables were chosen: DaysAbsent and Number of Trips. Both are measures of total effort and the proportional reduction in error as 0.781. Basically the model says that years in which fishing is poor are characterized by low total days absent (<377). The Average years have total trips less than 162 whereas the good years have trips greater than 162. Data are split using cut points for each variable and resulting tree of binary decisions is illustrated below.



Comparison of the "all possible variables" model with the 3 independent variables used in the discriminant analysis showed a smaller proportional reduction in error (0.651). The "poor" status was explained by the fraction of trips above 60% capacity FTRIPGT60CAP was less than 0.411. Using this eight cases fell into this category as opposed to the 6 cases identified in the original data. Average status was classified for FTRIPGT60CAP <0.582. The remaining pool of 6 cases were divided into "Average" and "Good" status when PRICE was less than $0.395.



K-Means

KMEANS splits cases into a selected number of groups by maximizing between-cluster variation and minimizing within-cluster variation. The user specifies the number of K clusters. The initial analysis used the same 3 variables used in the discriminant analyses. Outputs from SYSTAT (2004) are shown below. Group 1 was characterized by average weights, fishing success and prices below average. This group included 4 of the 6 “poor” years identified a priori (2001,2013,2015, 2016) but failed to include 2002 and 2003. Two average years were included in group 1 (2000, 2014). Group 2 was characterized by average weights and fishing success well above the mean and PRICE slightly below average. The KMEANS algorithm allows for missing variables so that 2009 and 2010, which did not have average weight data available, could be classified. Group 2 included all of the Good years but also lumped in a few average years. Group 3 had near average values for fishing success and average weight, and higher than average prices but it included a mixture of years classified as both poor and average.

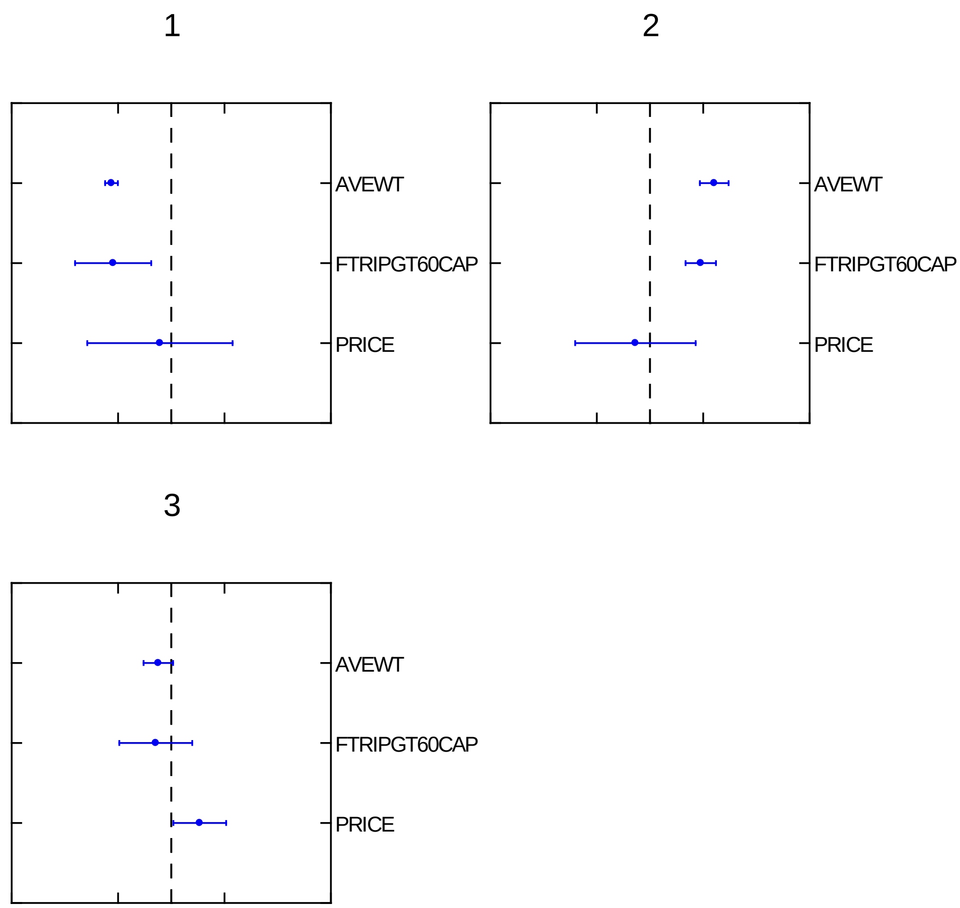
<u>K-MEANS: 3 GROUPS</u>

```
Distance metric is Euclidean distance

k-means splitting cases into 3 groups
Summary statistics for all cases
 Variable       Between SS  df    Within SS  df      F-ratio
 AVEWT            9693.011   2      439.183  17      187.600
 PRICE               0.018   2        0.108  19        1.558
 FTRIPGT60CAP        0.776   2        0.247  19       29.815
 ** TOTAL **      9693.804   6      439.538  55
 ------------------------------------------------------------------------------
Cluster 1 of 3 contains 6 cases
         Members                                    Statistics
     Case      Distance  |  Variable       Minimum       Mean   Maximum   St.Dev.
 Case   4          2.84  |  AVEWT            84.23      86.16     91.07      2.49
 Case   5          0.95  |  PRICE             0.27       0.33      0.53      0.10
 Case  17          0.29  |  FTRIPGT60CAP      0.00       0.19      0.42      0.14
 Case  18          0.31  |
 Case  19          0.23  |
 Case  20          1.12  |
 ------------------------------------------------------------------------------
Cluster 2 of 3 contains 9 cases
         Members                                    Statistics
     Case      Distance  |  Variable       Minimum       Mean   Maximum   St.Dev.
 Case   1          0.39  |  AVEWT           133.41     139.97    147.91      5.74
 Case   2          3.79  |  PRICE             0.22       0.33      0.46      0.08
 Case   8          0.05  |  FTRIPGT60CAP      0.56       0.64      0.74      0.06
 Case  10          4.35  |
 Case  11          0.09  |
 Case  12          0.06  |
 Case  13          2.65  |
 Case  21          2.11  |
 Case  22          4.58  |
 ------------------------------------------------------------------------------
Cluster 3 of 3 contains 7 cases
         Members                                    Statistics
     Case      Distance  |  Variable       Minimum       Mean   Maximum   St.Dev.
 Case   3          5.68  |  AVEWT           100.93     106.49    116.33      5.92
 Case   6          2.28  |  PRICE             0.35       0.39      0.45      0.04
 Case   7          2.20  |  FTRIPGT60CAP      0.14       0.37      0.52      0.14
 Case   9          2.26  |
 Case  14          1.49  |
 Case  15          3.21  |
 Case  16          3.19  |
```

```
Years in Group 1:  2000,2001,2013, 2014, 2015, 2016
Years in Group 2:  1997, 1998, 2004, 2006,2007, 2008, 2009, 2017,2018
Years in Group 3: 1999, 2002, 2003, 2005, 2010, 2011, 2012
```

Cluster Profile Plots



KMEANS ANALYSES: 4 GROUPS

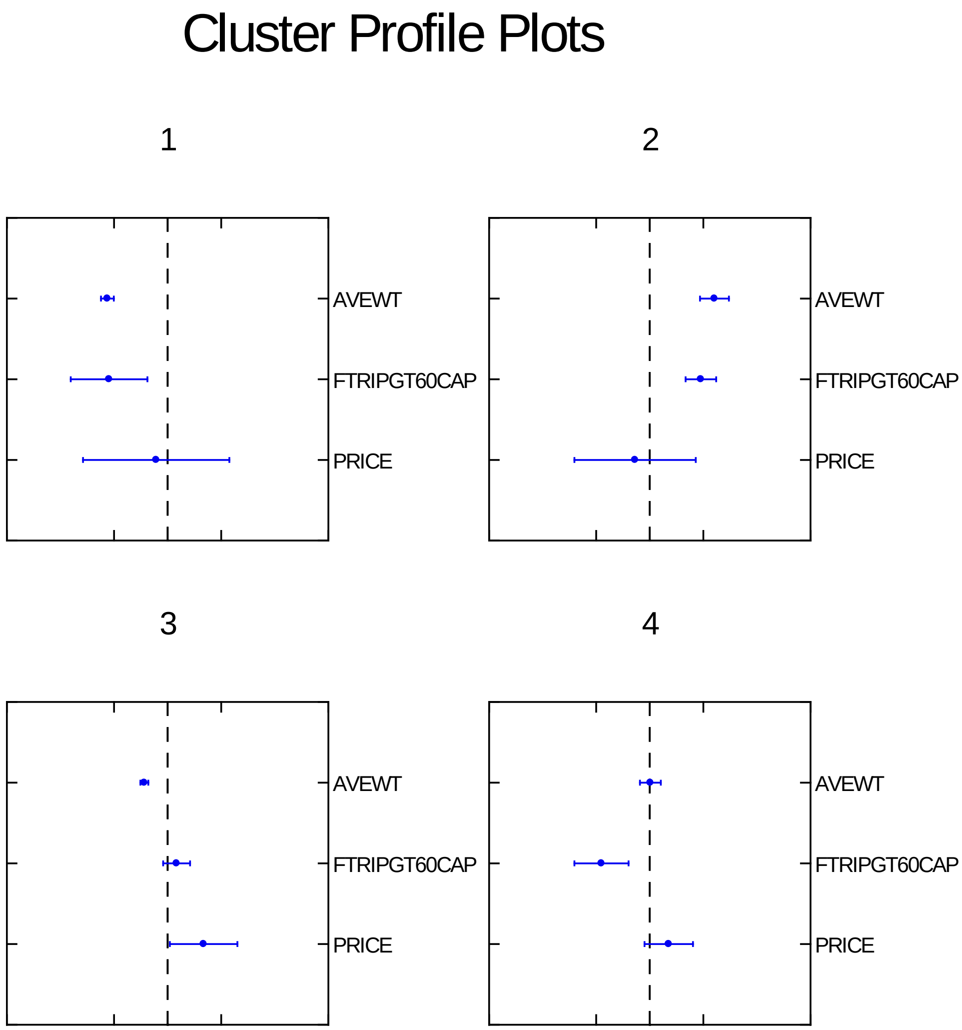
The failure of the Kmeans analysis to successfully classify the system states suggested that a larger number of groups might be warranted. The model was rerun with 4 groups. Group 2 included all of the years identified as good (1998, 2004, 2017, 2018), but also included 5 average years. Group 1 included 4 of the 6 poor years, included 2 average years. Group 4 included 2 poor years and one average year.

```
Distance metric is Euclidean distance

k-means splitting cases into 4 groups
Summary statistics for all cases
 Variable        Between SS  df    Within SS  df      F-ratio
 AVEWT             9873.585   3      258.608  16      203.625
 PRICE                0.019   3        0.107  18        1.052
 FTRIPGT60CAP         0.872   3        0.152  18       34.515
 ** TOTAL **       9874.476   9      258.866  52
 ------------------------------------------------------------------------------
Cluster 1 of 4 contains 6 cases
         Members                                    Statistics
     Case      Distance  |  Variable       Minimum      Mean   Maximum    St.Dev.
 Case    4         2.84  |  AVEWT            84.23     86.16     91.07       2.49
```

```
 Case   5          0.95  |  PRICE            0.27      0.33      0.53      0.10
 Case  17          0.29  |  FTRIPGT60CAP     0.00      0.19      0.42      0.14
 Case  18          0.31  |
 Case  19          0.23  |
 Case  20          1.12  |
 ------------------------------------------------------------------------------
Cluster 2 of 4 contains 9 cases
         Members                                    Statistics
     Case      Distance  |  Variable       Minimum       Mean   Maximum   St.Dev.
 Case   1          0.39  |  AVEWT           133.41    139.97    147.91      5.74
 Case   2          3.79  |  PRICE             0.22      0.33      0.46      0.08
 Case   8          0.05  |  FTRIPGT60CAP      0.56      0.64      0.74      0.06
 Case  10          4.35  |
 Case  11          0.09  |
 Case  12          0.06  |
 Case  13          2.65  |
 Case  21          2.11  |
 Case  22          4.58  |
 ------------------------------------------------------------------------------
Cluster 3 of 4 contains 4 cases
         Members                                    Statistics
     Case      Distance  |  Variable       Minimum       Mean   Maximum   St.Dev.
 Case   9          0.28  |  AVEWT           100.93    102.09    103.91      1.43
 Case  14          1.05  |  PRICE             0.35      0.40      0.45      0.04
 Case  15          0.67  |  FTRIPGT60CAP      0.41      0.47      0.52      0.05
 Case  16          0.65  |
 ------------------------------------------------------------------------------
Cluster 4 of 4 contains 3 cases
         Members                                    Statistics
     Case      Distance  |  Variable       Minimum       Mean   Maximum   St.Dev.
 Case   3          2.29  |  AVEWT           110.31    112.36    116.33      3.44
 Case   6          1.11  |  PRICE             0.35      0.38      0.41      0.03
 Case   7          1.18  |  FTRIPGT60CAP      0.14      0.23      0.30      0.08
```

Years in Group 1: 2000,2001,2013, 2014, 2015, 2016
Years in Group 2: 1997, 1998, 2004, 2006,2007, 2008, 2009, 2017,2018
Years in Group 3: 2005, 2010, 2011, 2012
Years in Group 4: 1999, 2002, 2003



Discussion

Collectively, the multivariate analyses suggest that a more analytical derivation of system state might be valuable. The use of +/- 1 SD captures some essential features but may not be sufficient to determine the actual fishing conditions. Moreover, conversations with fishermen and managers also suggest that the in-season dynamics of fishing activity are essential for understanding the subsequent quality of the fishing year. These results suggest that changes in relationships among variables as the season progresses may offer additional insights and reflect a more synthetic view of the system state.

References

SYSTAT (2004) **Systat** Software, Inc., San Jose California USA, www.sigmaplot.com

Table 1. Summary of annual landings, fishing effort, various measures of CPUE, average weight data from industry data, average price, and NEFSC Bottom Trawl Survey data, 1997-2019.

Vessel trip report data represent data for all trips and all months in each year.

													Measures of Fishing Capacity by Permit								
	Vessel Trip Report Data						Crude Measures of CPUE			Standardized Crude CPUE				Average Decile			Industry Wt Samples		Market	Fishery Independent	
Year	Total Landings (lbs)	Total number of sub trips	Total Number of Days Absent	Total Number of Days Fished	Average Days Absent/ Trip	Ave Days Fished/ Trip	Landings/ TRIP	Landings/ Days Absent	Landings/ Day Fished	Stdzed Landings / TRIP	Stdzed Landings/ Days Absent	Stdzed landings/ Days Fished	Fraction of trips >60% capacity	Average of Decile of Capacity /Trip	Average of Decile of Landings /Days Absent	Average of Decile of Landings /Day Fished	Ave Wt over season (g)	Stded Ave Wt over season	Average Price in 2019 adj$	NEFSC Fall Bottom Survey (kg/tow)	Category based on total catch and fishermen's perspective
1997	12,487,387	119	490.5	245.7	4.574	1.187	104,936	25,457	115,914	0.81	0.86	0.79	0.69	6.16	4.33	3.53	139.3	1.227	0.315	0.52	A
1998	30,990,251	387	1,212.5	466.2	3.029	0.711	80,078	25,559	125,299	0.62	0.86	0.86	0.74	5.35	3.81	3.07	133.4	1.175	0.300	1.4	G
1999	9,157,291	108	469.6	329.0	3.819	1.123	84,790	19,500	71,346	0.65	0.66	0.49	0.27	3.68	2.18	1.61	116.3	1.025	0.375	0.19	A
2000	8,465,053	69	377.5	208.3	3.635	0.978	122,682	22,424	76,434	0.95	0.76	0.52	0.20	3.96	2.19	1.54	91.1	0.802	0.280	0.71	A
2001	4,881,549	40	200.8	154.9	6.182	1.721	122,039	24,308	88,019	0.94	0.82	0.60	0.11	3.23	2.03	1.50	84.5	0.745	0.325	0.32	P
2002	2,939,761	24	135.7	88.6	5.147	1.528	122,490	21,667	68,976	0.94	0.73	0.47	0.14	2.50	1.54	1.04	110.4	0.973	0.354	0.44	P
2003	3,743,665	33	124.4	76.9	4.033	0.916	113,444	30,094	124,292	0.87	1.01	0.85	0.30	3.70	1.85	1.12	110.3	0.972	0.407	1.95	P
2004	34,475,321	285	1,042.5	263.8	3.794	0.664	120,966	33,070	218,281	0.93	1.11	1.49	0.69	6.52	4.36	3.31	140.0	1.233	0.395	0.41	G
2005	12,013,468	109	481.3	244.1	4.295	1.090	110,215	24,962	105,013	0.85	0.84	0.72	0.52	5.36	3.04	2.10	102.6	0.903	0.400	0.74	A
2006	16,768,428	120	482.7	174.5	4.184	0.843	139,737	34,740	187,420	1.08	1.17	1.28	0.56	5.67	3.98	3.08	147.5	1.299	0.314	2.85	A
2007	5,103,602	46	199.8	106.9	4.345	0.938	110,948	25,540	116,948	0.86	0.86	0.80	0.58	5.46	3.48	2.74	135.4	1.192	0.224	1.31	A
2008	16,872,492	98	425.5	142.0	4.191	0.780	172,168	39,653	209,129	1.33	1.34	1.43	0.65	6.48	3.74	2.08	103.9	0.915	0.250	0.98	A
2009	20,037,893	90	435.8	153.4	4.874	0.941	222,643	45,982	241,101	1.72	1.55	1.65	0.63	6.31	3.26	2.00	*	*	0.276	0.93	A
2010	25,301,309	162	710.7	202.3	4.265	0.937	156,181	35,603	178,430	1.20	1.20	1.22	0.46	5.14	2.93	1.93	*	*	0.354	0.53	A
2011	31,976,628	219	1,068.9	444.8	4.943	1.209	146,012	29,917	133,877	1.13	1.01	0.92	0.49	5.54	3.24	2.11	100.9	0.889	0.454	0.54	A
2012	15,300,989	101	461.1	299.0	4.031	1.177	151,495	33,187	123,975	1.17	1.12	0.85	0.41	4.20	2.45	1.50	101.0	0.889	0.405	0.54	A
2013	6,507,481	84	340.2	196.8	4.502	1.207	77,470	19,131	77,673	0.60	0.64	0.53	0.16	3.79	3.10	2.15	85.7	0.755	0.274	0.36	P
2014	14,527,138	81	463.0	178.5	5.744	1.032	179,347	31,377	175,152	1.38	1.06	1.20	0.42	5.09	2.85	2.58	85.7	0.755	0.294	0.64	A
2015	4,096,159	35	173.0	133.4	5.038	1.375	117,033	23,684	93,584	0.90	0.80	0.64	0.00	2.20	1.43	1.00	85.8	0.756	0.311	0.52	P
2016	7,543,692	68	348.6	245.1	5.209	1.450	110,937	21,637	77,435	0.86	0.73	0.53	0.27	3.74	1.68	1.22	84.2	0.742	0.526	0.66	P
2017	37,625,133	221	810.8	223.4	3.828	0.651	170,249	46,403	335,699	1.31	1.56	2.30	0.65	6.18	3.90	3.41	136.3	1.201	0.459	#	G
2018	50,446,666	430	1,291.6	311.0	3.097	0.552	117,318	39,056	270,419	0.90	1.32	1.85	0.59	6.18	4.48	3.94	147.9	1.303	0.438	1.32	G
2019	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	142.0	1.251	0.466	0.60	G
Average	16,875,516	133	533.9	222.2	4.398	1.046	129,690	29,680	146,110	1	1	1	0.43	4.84	2.99	2.21	112.1	0.987	0.351	0.84	

* = data not yet available for analysis

\# = NEFSC Survey incomplete in 2017.

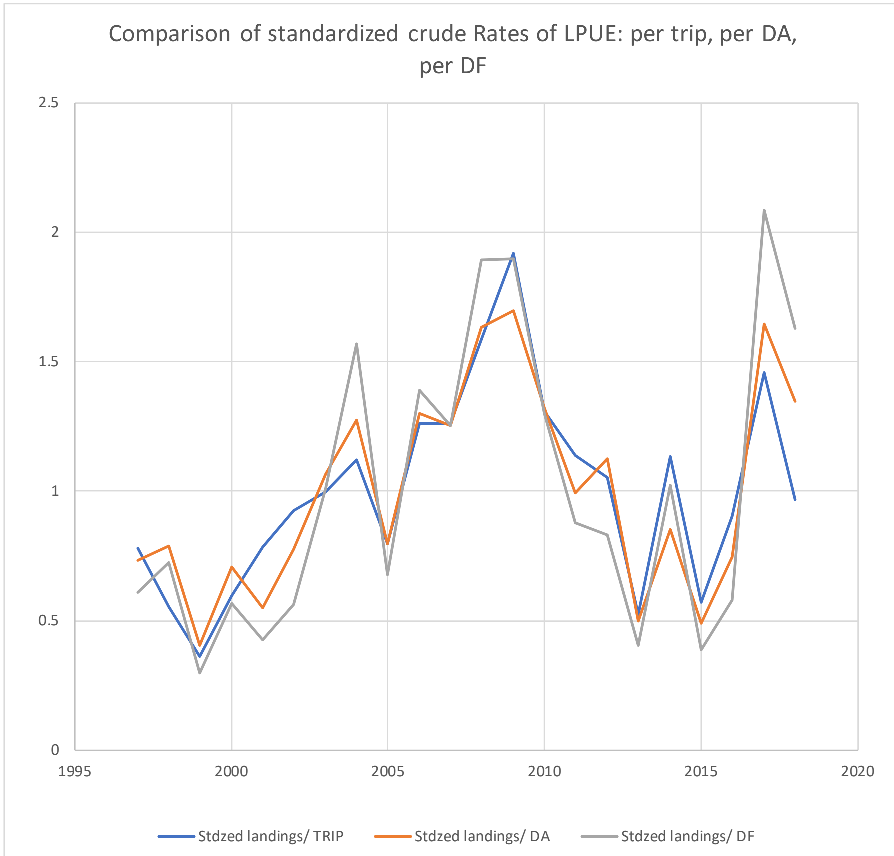


Figure 1. Crude estimates of average catch per unit effort for VTR data, 1997-2018. All measures of CPUE are standardized to their respective means.

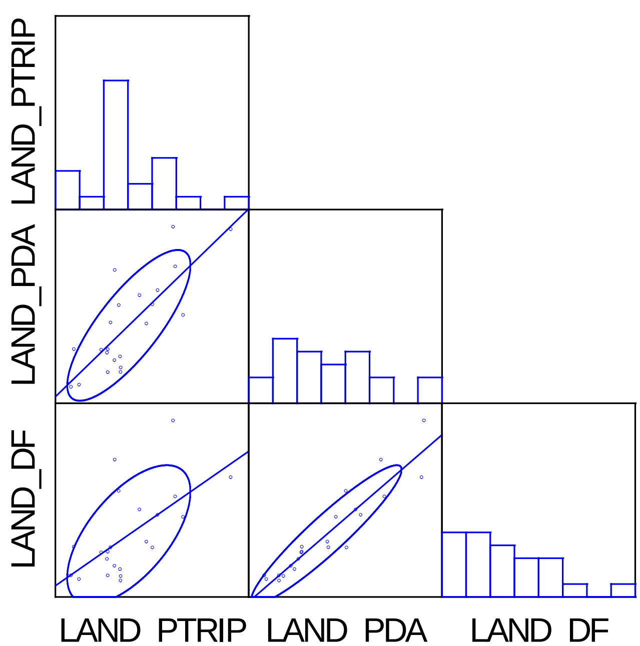


Figure 2. Cross correlation plots for three measures of crude catch per unit effort based on landings per day fished (LAND_DF), landings per trip (LAND_PTR) and landings per day absent (LAND_PDA) for 1997-2018 based on VTR data. Confidence ellipse has a probability level of 0.687.

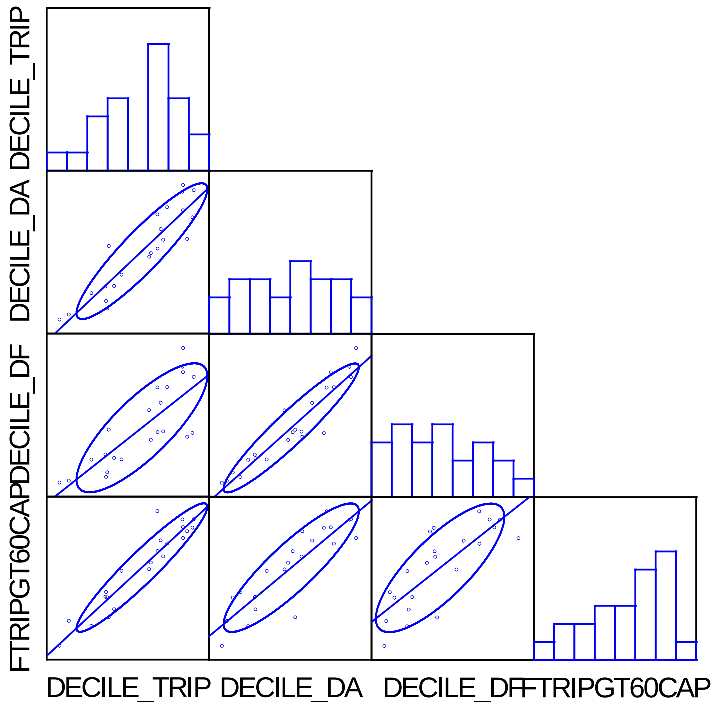


Figure 3. Cross correlation plots for four measures of fishery success based on the deciles catch per unit effort relative to empirically derived maximum levels. Variables include deciles of catch per trip (DECILE_TRIP), deciles of catch per day absent (DECILE_DA), deciles of catch per day fished (DECILE_DF), and fraction of trips exceeding 60% of the maximum observed capacity (FTRIPGT60CAP) for 1997-2018 based on VTR data. Confidence ellipse has a probability level of 0.687.

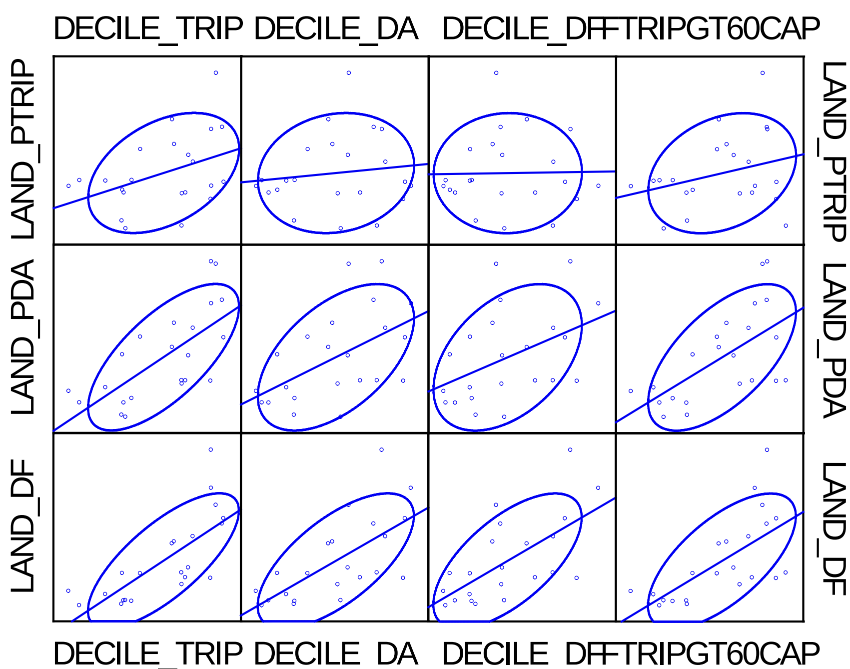


Figure 4. Comparison of correlations among measures of catch per unit effort based on landings per unit of effort (Row variables, LAND_DF, LAND_PDA, LAND_PTRIP) with deciles of fishing capacity for equivalent measures of effort (column variables DECILE_TRIP, DECILE_DA, DECILE_DF, FTRIPGT60CAP). Confidence ellipse has a probability level of 0.687.

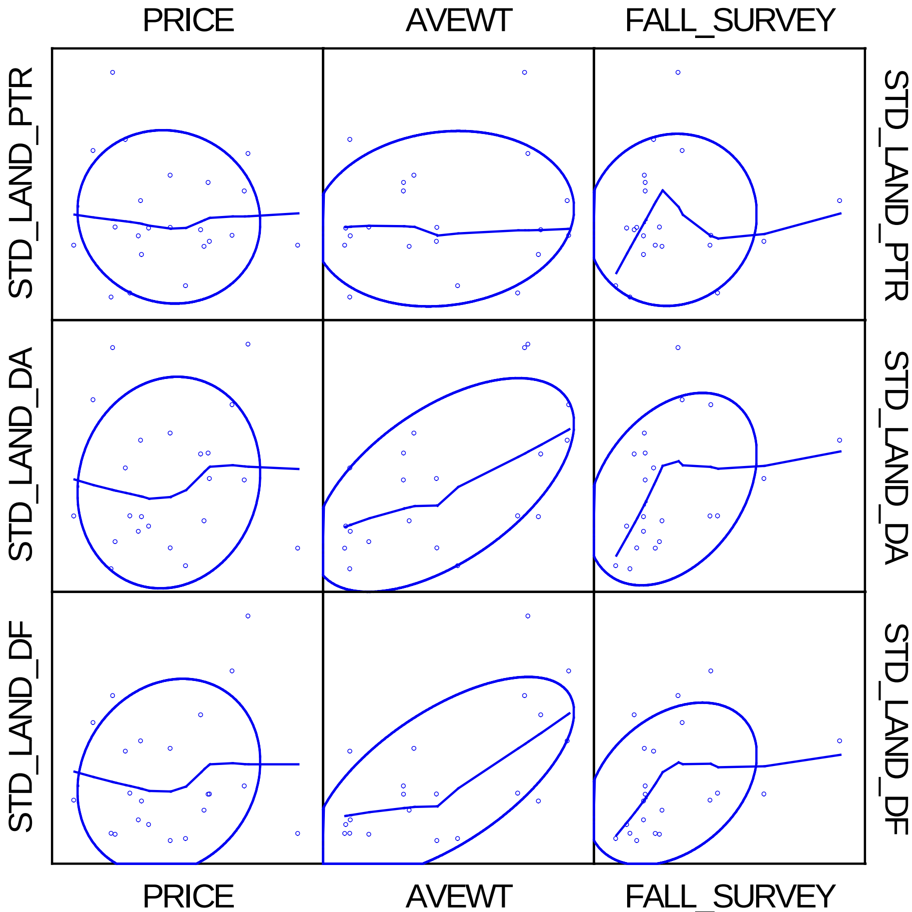


Figure 5. Relationship between standardized measures of CPUE (STD_LAND_DF, STD_LAND_DA, STD_LAND_DF) vs three candidate predictor variables: average weight in industry supplied samples (AVEWT), average price over the season (PRICE), and NEFSC fall survey weight/tow (FALL_SURVEY). Confidence ellipse has a probability level of 0.687. Lines represent Lowess smooths of data with tension = 0.8.

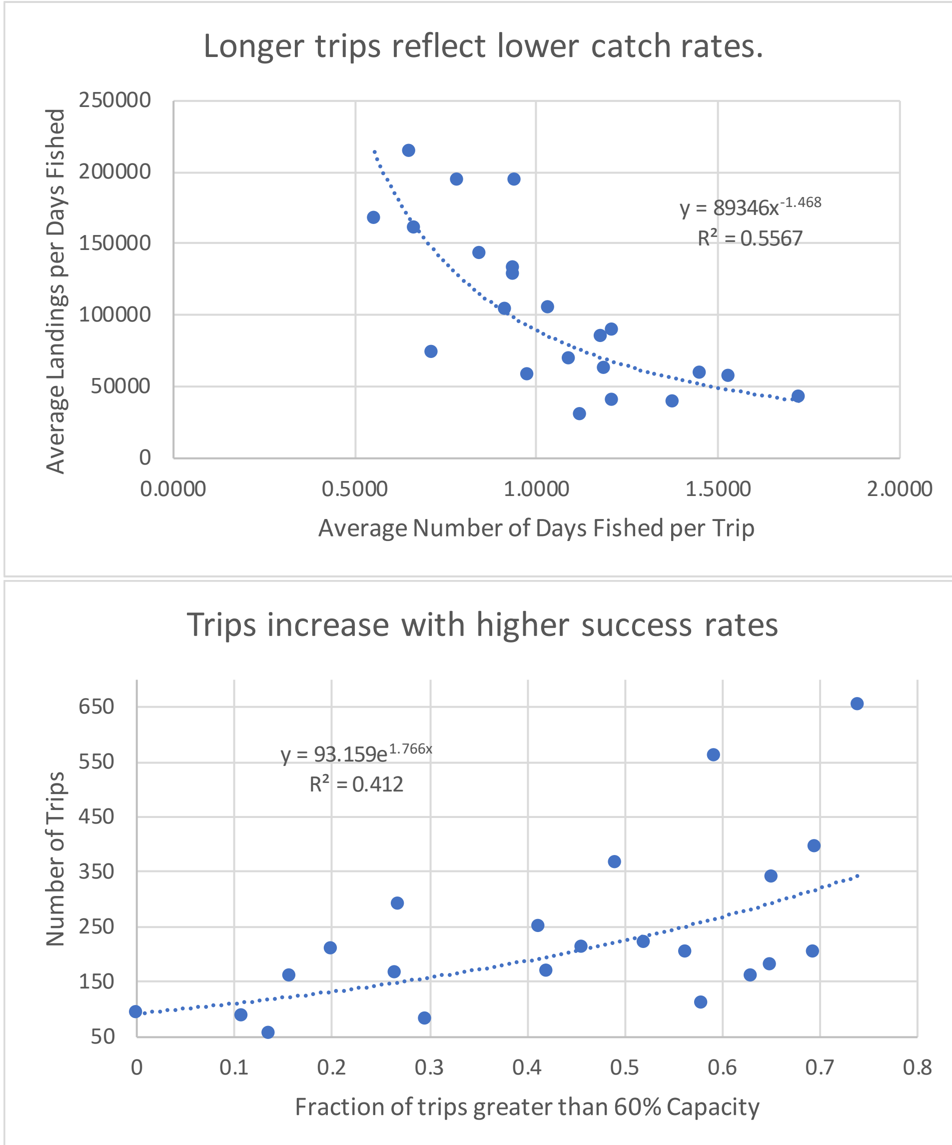


Figure 6. Average landings per day fished vs average number of days fished (top panel), and number of trips taken vs fraction of trips with greater than 60% capacity (lower panel).

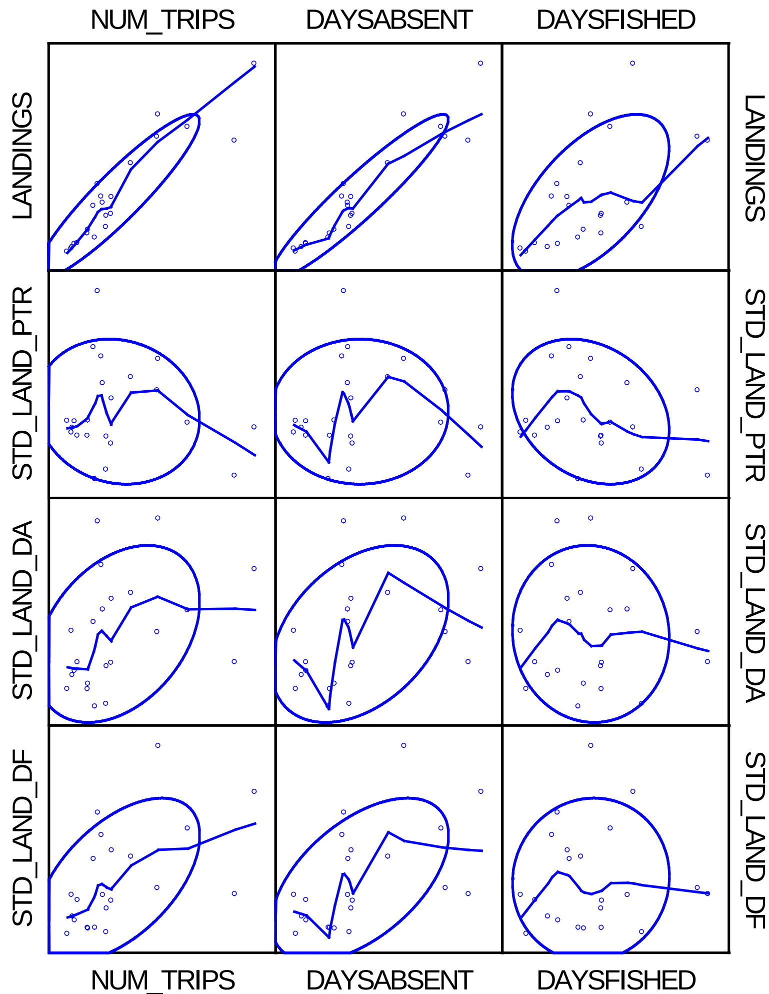


Figure 7. Relationship between landings, CPUE and measures of effort for VTR data, 1997-2018.

Appendix

Discriminant Function –additional details

Group A discriminant function coefficients

	AVEWT	FTRIPGT60CAP	PRICE	Constant
AVEWT	-0.002			
FTRIPGT60CAP	0.198	-40.085		
PRICE	-0.177	13.053	-151.618	
Constant	0.424	-16.271	132.740	-42.190

Group G discriminant function coefficients

	AVEWT	FTRIPGT60CAP	PRICE	Constant
AVEWT	-0.066			
FTRIPGT60CAP	-8.577	-1530.725		
PRICE	-3.113	-715.617	-478.605	
Constant	32.456	5009.849	2206.759	-4373.834

Group P discriminant function coefficients

	AVEWT	FTRIPGT60CAP	PRICE	Constant
AVEWT	-0.004			
FTRIPGT60CAP	0.267	-103.506		
PRICE	-0.177	83.088	-128.738	
Constant	0.724	-77.692	100.871	-44.670

Between groups F-matrix -- df = 3 15

	A	G	P
A	0.000		
G	3.111	0.000	
P	6.833	11.476	0.000

Eigenvalues

2.460	0.216

Canonical correlations

0.843	0.422

Cumulative proportion of total dispersion

0.919	1.000

Wilks' lambda= 0.238
Approx.F= 5.258 df= 6, 30 p-tail= 0.0008

Pillai's trace= 0.889
Approx.F= 4.267 df= 6, 32 p-tail= 0.0029

Lawley-Hotelling trace= 2.676
Approx.F= 6.245 df= 6, 28 p-tail= 0.0003

Canonical discriminant functions

	1	2
Constant	-3.395	-8.048

AVEWT	0.004	0.057
FTRIPGT60CAP	7.527	-5.098
PRICE	-0.622	10.512

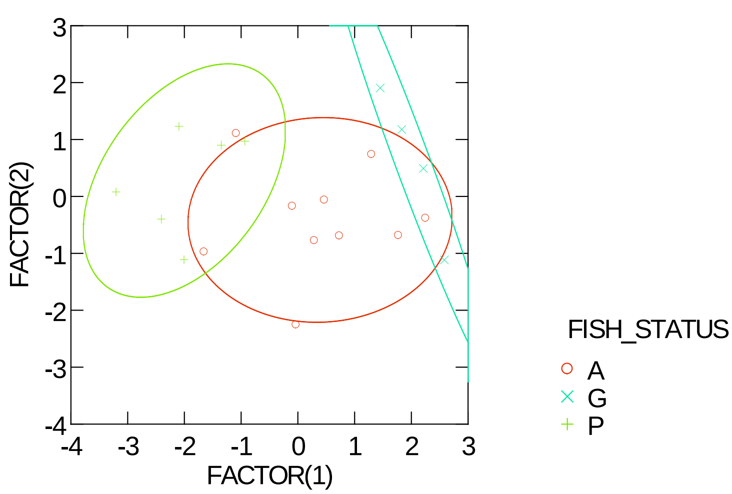
Canonical discriminant functions -- standardized by within variances

	1	2
AVEWT	0.077	0.978
FTRIPGT60CAP	0.959	-0.649
PRICE	-0.045	0.759

Canonical scores of group means

	1	2
A	0.392	-0.413
G	2.019	0.614
P	-1.999	0.279

Canonical Scores Plot



Regression Tree Analyses–additional details

lll