

Draft working paper for predissemination peer review only

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**Cumulative discard methodology review for catch cap monitoring in the Atlantic sea scallop  
(*Placopecten magellanicus*)**

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A working paper in support of the Cumulative Discard Methodology Peer Review

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## Introduction

The Atlantic sea scallop (*Placopecten magellanicus*) fishery operates from the Canadian border to North Carolina, from State waters to as far offshore as The Hague Line. The scallop fleet fishery functions operates as two components: a Limited Access (LA) fleet (multiday fishery) with both and a Limited Access General Category (LAGC) Individual Fishing Quota (IFQ) fleet (dayboat fishery) and non IFQ components. Scallop fishing grounds are categorized into Open and Access Areas. The fishery has operated under rotational management for Access Areas since 2004. Open Areas consist of gear exemption areas, not subject to rotational management (Figure 1). Gear types are primarily scallop dredge and scallop trawl. Regulations for dredges include minimum ring size, ring row amounts number of rows of rings in the apron, maximum dredge width, minimum mesh size, and number of dredges allowed per area and permit type. Regulations for trawl include maximum sweep length and minimum mesh size. Effort controls consist of trip limits in Access Areas for the LA fleet and in all areas for the LAGC fleet, crew limits for LA vessels, and limits of in-shell retention within Vessel Monitoring System demarcation. Furthermore, the scallop fishery utilizes Days-at-Sea management for the LA fleet. The scallop fishery is one of the most valuable fisheries in the United States<sup>1</sup>, has a healthy biomass<sup>2</sup>, and has been championed as an example of successful fisheries management.

The use of bottom dredge and trawl has led to a number of issues concerning bycatch of protected and managed species. Turtle excluding devices in the form of deflector dredges and chain mats are required for fishing west of 71°W (Figure 1). Sub components of Annual Catch Limits (ACLs) and Adjustment Measures (AMs) exist for groundfish bycatch in the scallop fishery. These are the yellowtail flounder (*Limanda ferruginea*) in the Southern New England/Mid-Atlantic (SNE) and Georges Bank (GB) Broad Stock Areas, and southern windowpane flounder (*Scophthalmus aquosus*) in the southern New England/Mid-Atlantic Broad Stock Area. Table 1 shows the species/stock and catch cap (CC) for 2010-2015. Exceeding a catch cap initiates an AM. Annual catch caps are set by the Multispecies Fisheries Management Plan (FMP) and are a function of the overall Acceptable Biological Catch (ABC) for a given year. Catch caps for yellowtail flounder have been in place for the LA fishery since 2011 and were expanded to the LAGC fishery in 2013. The windowpane catch cap has been in place since 2014.

Yellowtail and windowpane are currently discard only species for declared scallop trips<sup>3</sup>. Current quota monitoring methodology for these catch caps employs the cumulative method to

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<sup>1</sup> <https://www.st.nmfs.noaa.gov/commercial-fisheries/fus/fus14/index>

<sup>2</sup> <https://www.greateratlantic.fisheries.noaa.gov/sustainable/species/scallop/>

<sup>3</sup> <https://www.greateratlantic.fisheries.noaa.gov/nr/2014/April/14scalytprohibphl.pdf>

extrapolate bycatch (total discard,  $D$ ), derived from Northeast Fisheries Observer Program (NEFOP) observer data. Using only observed trips that occur within each broad stock area and stratification, estimates of catch cap discards are calculated from the ratio of Discard/Kept (e.g.,  $D/K$ ). The ratio estimator is continuously updated throughout the fishing year and retroactively applied to total catch (kept all,  $KALL$ ) within each strata during the fishing year.  $KALL$  is obtained from the Data Matching and Imputation System (DMIS), which incorporates Vessel Trip Reports (VTR), Vessel Monitoring System trips (VMS/AMS), and dealer data. This provides information on trip type, fleet, declaration, gear, area and landings etc.

To investigate patterns of discard in these fisheries and, the effectiveness of the current stratification scheme, we summarized discards qualitatively and quantitatively determined the probability of exceeding catch caps over the fishing year under both baseline and alternative stratifications.

## Methods

### Data sources

In-season monitoring of the scallop discard caps relies upon two main sources of data:

- 1) Northeast Fisheries Observer Program Fisheries Observer Program (NEFOP) Reports:  
The NEFOP deploys fisheries observers on commercial fishing trips in New England and Mid-Atlantic waters. For this analysis, NEFOP data was drawn from final NEFOP (Observer Database System, OBDBS) data.
- 2) Data for total pounds of all species kept on scallop trips were sourced from the Data Matching and Imputation System (DMIS). DMIS data are dealer-reported landings data matched to trip or subtrip-based data from Vessel Trip Reports (VTR) and Vessel Monitoring System (VMS) activity code declarations. VTRs are the source for area fished, landings date, and fishing gear used. VMS information is used to determine Access/Open area fishing as well as fleet type.

For this review, data for scallop fishing years 2010-2015 were used.

### Stratification

The Southern New England/Mid-Atlantic broad stock area includes the Nantucket Lightship (NLS) south of New England, as well as the Elephant Trunk (ET), Hudson Canyon (HC) and DelMarVa (DMV) access areas off the Mid-Atlantic coast. The Mid-Atlantic areas are currently managed in aggregate and known as the Mid-Atlantic Access Area (MAA, a.k.a. Megatron). The

Georges Bank broad stock area includes the Closed Area II Rotational Area and part of the Closed Area I Rotational Area.

In 2011, a working group, comprised of Northeast Fisheries Science Center (NEFSC), Northeast Regional Office (now GARFO) and New England Fishery Management Council members (NEFMC) determined methods and stratification for discard rate determination. The stratification scheme is summarized as follows (the following taken for the bycatch [monitoring webpage](#)<sup>4</sup>):

#### *SNE/MA YTF (and Windowpane) Stock Areas*

Observer data will be stratified into SNE (statistical areas  $\leq$  613) and MA (statistical areas  $\geq$  614). A separate discard rate will also be calculated for NLS. Observer data for Hudson Canyon and Delmarva will be pooled with the MA data.

#### *GB YTF Stock Area.*

Observer data will be stratified into open areas, CAI, and CAII. Additionally, data for CAI hauls that were observed in statistical areas 521 and 526 will be excluded from GB as these areas belong to the Gulf of Maine/Cape Cod and SNE/MA YTF stocks, respectively.

Separate rates are calculated for the LA and LAGC fleet, as well as for dredge and trawl gear within these fleets.

For this review, we compiled a custom package, *discard* (Galuardi et al. 2016), for the statistical software R (R Core Team 2015). This software performs discard estimation using the Cochran (1977) method (separate) described in Wigley et al. (2007) as well as sample size determinations, bootstrapped simulations and various transition rate options. Details and equations may be found in Linden, et al. (2016). D/K ratios, and corresponding D were calculated for each combination of fleet, gear and area. Monthly and annual total estimates of discard are then summed from the individual stratified estimates.

Terms of Reference 1 and 2 were performed graphically using cumulative distribution functions. Discard, measured from observed trips, was summarized according to baseline stratifications for fishing years 2010-2015. Seasonality was investigated as a possible alternative (Figure 3, 6&7). Alternate, simplified, stratifications were developed based on this assessment.

Terms of Reference 3-5 were done concurrently, using a simulation based approach to examining both baseline and alternative stratifications. In-season discard rates are subject to a

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<sup>4</sup> [https://www.greateratlantic.fisheries.noaa.gov/ro/fso/Reports/ScallopProgram/ACL\\_YT\\_catch\\_estimation\\_20120815.pdf](https://www.greateratlantic.fisheries.noaa.gov/ro/fso/Reports/ScallopProgram/ACL_YT_catch_estimation_20120815.pdf)

transition rate, termed the five trip method, where the previous seasons discard rate is used until five trips are observed. Each observed trip is weighted more heavily until only the in-season rate applies. We used this and a 365 day moving window as transition alternatives.

As the baseline stratification contains three elements (Fleet/Area/Gear), we examined simplifications versions: Gear only (Alternative 1) and Gear/Broad Area (Alternative 2). Broad area was defined as statistical areas split at area 614 (Figure 2). We applied two transition rate methods to these strata for fishing year 2015. We did not investigate previous years as AMs, open rotational areas, catch cap regulations and requirements have changed frequently. The combinations for simulation testing, may not necessarily be comparable across years given the management dynamics.

Observer data were resampled, without replacement, from known observed trips. Since the number of observed trips ( $n$ ) is a small proportion of total trips ( $N$ ), observed trips were repeated according to a ratio multiplier  $N/n$ . In this manner, we sampled from a super-population with equal probabilities.

For each simulation combination, we generated 1000 replicates of fishery wide discards, throughout fishing year 2015, at a time interval of seven days. Each run was performed on a Dell Latitude E6440 laptop computer with an i7-4600M 2.9GHz processor and 8GB or RAM. Each run was done in parallel and took 5-15 minutes, depending on the number of records in each strata. Three bycatch fisheries, three stratifications, two transition alternatives yielded a total of 18 runs.

The probability of exceeding a catch cap was assessed for each run by finding the first day with a non-zero probability of exceedance and calculating the final probability at the end of the fishing year. For each run, we calculated the mean, mean ( $\mu$ ), standard deviation ( $\delta$ ), and standard error ( $\delta/\mu$ ).

Required sample sizes to achieve a fishery wide target coefficient of variation (CV) were calculated from non-bootstrapped runs where the observer data were not resampled. These outputs yield sample size determinations within each strata that would produce a target CV (typically 30%). These run also provided an overall CV for the fishery under the assumed stratification and transition rate assessed. Applying the sample size function (get.cochran.ss.by.strat) across a range of CV targets produces CV curves for each strata within a run. These were then weighted by the realized discard within each strata to find an overall required sample size for the fishery.

## **Results and Discussion**

Discard patterns of yellowtail and windowpane showed no clear seasonal differences in discard amount (Figure 3-6). Discard amount generally ranged from 20-40 pounds/trip, with a small proportion of trips accounting for nearly all discard observed. This varied by year and fleet, with the LAGC fleet showing higher discard in 2010 for YTF SNE/MA prior to becoming subject to the catch cap (Figure 4).

The Georges Bank broad stock area is fairly far offshore (>50 nautical miles from land). The typical vessel size (<100 ft) and trips limit (600lb in FY2015/2016) makes this area highly unlikely to be fished by the LAGC fishery. Therefore, the YTF GB stock was plotted using only data from the LA fishery. This fishery showed little difference in discard pattern between years (Figure 6). Only dredge gear was used on these observed trips.

For the windowpane flounder SNE/MA stock, trawl gear showed a generally higher proportion of trips catching windowpane, although the total trips is much lower than dredge trips, while the LA fleet has a higher proportion of trips with bycatch than LAGC fleet (Figure 7 - 9).

Simulation results are found in Appendices A-C. All simulation plots show the cumulative discard for the stratification and transition rate per fishery, with empirical, non-bootstrapped, discard (blue line) as a reference and the relevant catch cap for fishing year 2015 as a dotted red line. CV curves for each strata analyzed, as well as a CV curve, weighted by discard within strata, for the entire fishery, are included in appendices A-C. A summary of all simulation results is in Table 3.

In general, the choice of transition rate had a significant impact on the pattern of calculated discard throughout the fishing year. Using a 365 day moving window for transition had variable effects on the three fisheries analyzed here. In the YTF SNE/MA and WP SNE/MA fisheries, discard rates were lower in the first part of the fishing year for all stratifications (Figures 10-15 and 26-31). In the YTF GB stock, the discard rate was higher in the early part of the year for all stratifications (Figures 18-23). This is likely due to lower and higher bycatch, respectively, in the early part of fishing year 2014 than in 2015. Use of a moving average transition had the greatest effect on the first day with a non-zero probability of exceeding the catch cap (Table 3). For example, in the YTF SNE/MA fishery, a moving average transition saw the first day of possible exceedance at day 218 of the fishing year vs. the 134<sup>th</sup> day when using the 5 trip transition. The

effect was not consistent across fisheries given the results described above. Transition rate choice had little effect on the probability at the end of the fishing year of exceeding a catch cap. This is an expected outcome as, for each stratification choice; the end of year discard estimate will be nearly identical after 1000 simulations, regardless of the transition type.

The stratifications alternatives for this exercise did affect the first day and end of year exceedance catch cap exceedance probability. For YTF stocks, stratifying by gear only lead to an earlier first day if exceedance and a near doubling of the end of year probability of exceedance. For WP, there was only a 1-2% difference in probabilities when stratifying by gear. Stratifying by broad area (ignoring Access Area specificity) affected the YTF SNE/MA fishery, but not the YTF GB or WP SNE/MA fisheries. The YTF SNE/MA effects showed a later day of first exceedance and a lower median estimate of discard by ~4000 pounds.

Standard error (CV) calculations for all simulations were fairly consistent within each fishery, regardless or stratification. All CV simulated CV estimates ranged from .15- 0.24. Generally, discard estimation in the Greater Atlantic Region has set a CV target of 30%; all schemes examined for scallop catch cap fisheries were well below this benchmark.

Each of these stratifications parses discard estimates and applies them to the KALL within their strata. Fisheries that are more heterogeneous will have larger differences between stratification schemes than those that are more homogenous in terms of fleet, gear and area. In the case of the scallop fishery catch caps, the baseline stratification likely captures the variance well enough for reasonable and timely discard estimates.

We explored the number of trips and coverage rates that would be required to reach a particular CV target within each fishery for all stratification alternatives. For these, the `get_cochran_ss` function was applied across strata for CV targets ranging from 0-100% (Figures 16-17, 24-25 and 32-33). The function returns the required sample size (number of trips) required to reach a CV of 30% within each strata (Wigley et al. 2007, Linden et al. 2016).

Since sea day allocations are made on a fishery wide basis, some summarization of this information must take place for it to be useful. Since these calculations are made using observed trips only, without knowledge of the final discard estimates within the strata, we can retroactively apply a weighting factor to the coverage rates based on the estimated discard and calculate an overall coverage rate for a target CV. Figures 16, 24 and 33 show the required number of trips within each strata to achieve a 30% CV in strata. Figures 17, 25 and 34 show a discard weighted average for the entire fishery. This is not a practical application for in-season

estimation but may be useful tool for determining allocations in subsequent years. Only the baseline stratification was used but any number of possible strata may be explored.

Table 1. Species/Stock sub-ACL Catch Caps (mt) in the Atlantic sea scallop fishery

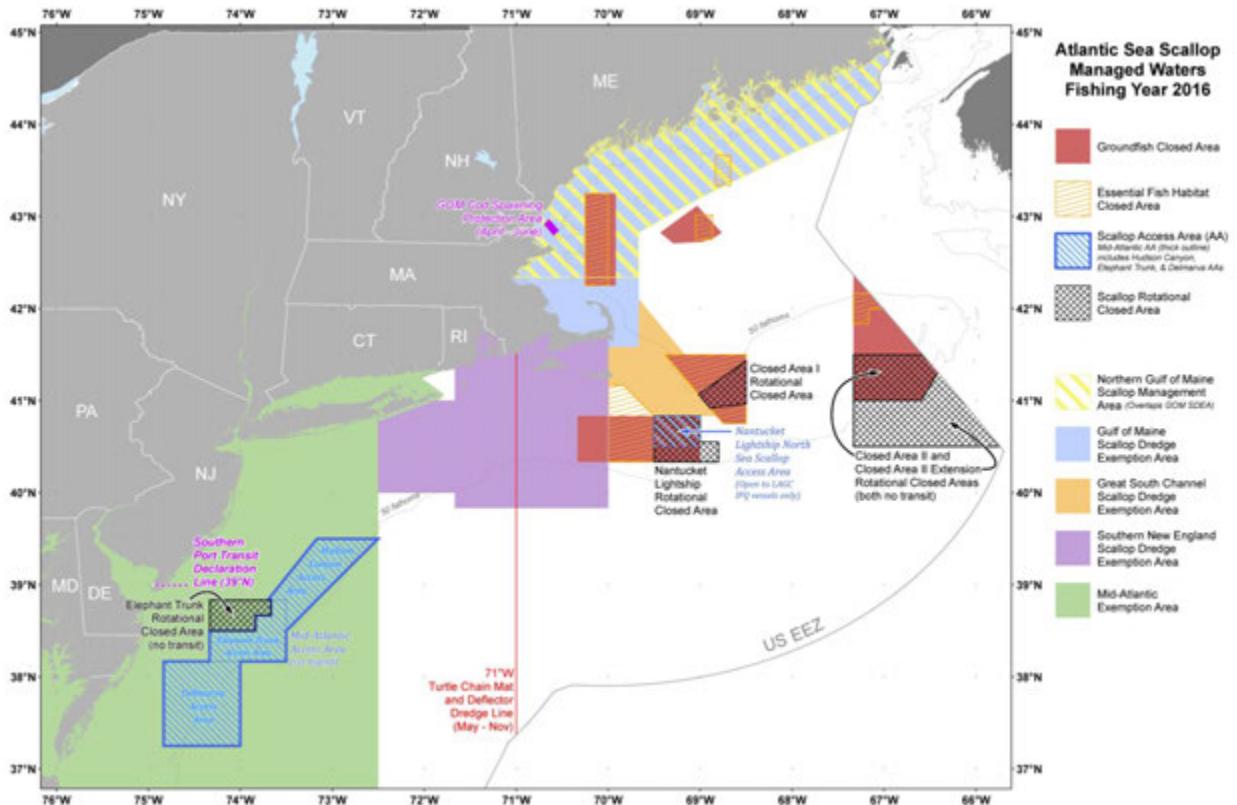
<b>Species/Stock</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>
<b>SNE/MA Yellowtail Flounder</b>	135	200.8	156.9	41.5	66	44
<b>GB Yellowtail Flounder</b>	146	82	127	43.6	50.9	30.1
<b>Southern Windowpane</b>				183	183	183

**Table 2. Matrix of simulation runs for each scallop catch cap for 2015. These were performed for the YTF SNE/MA, YTF GB and WP SNE/MA bycatch caps.**

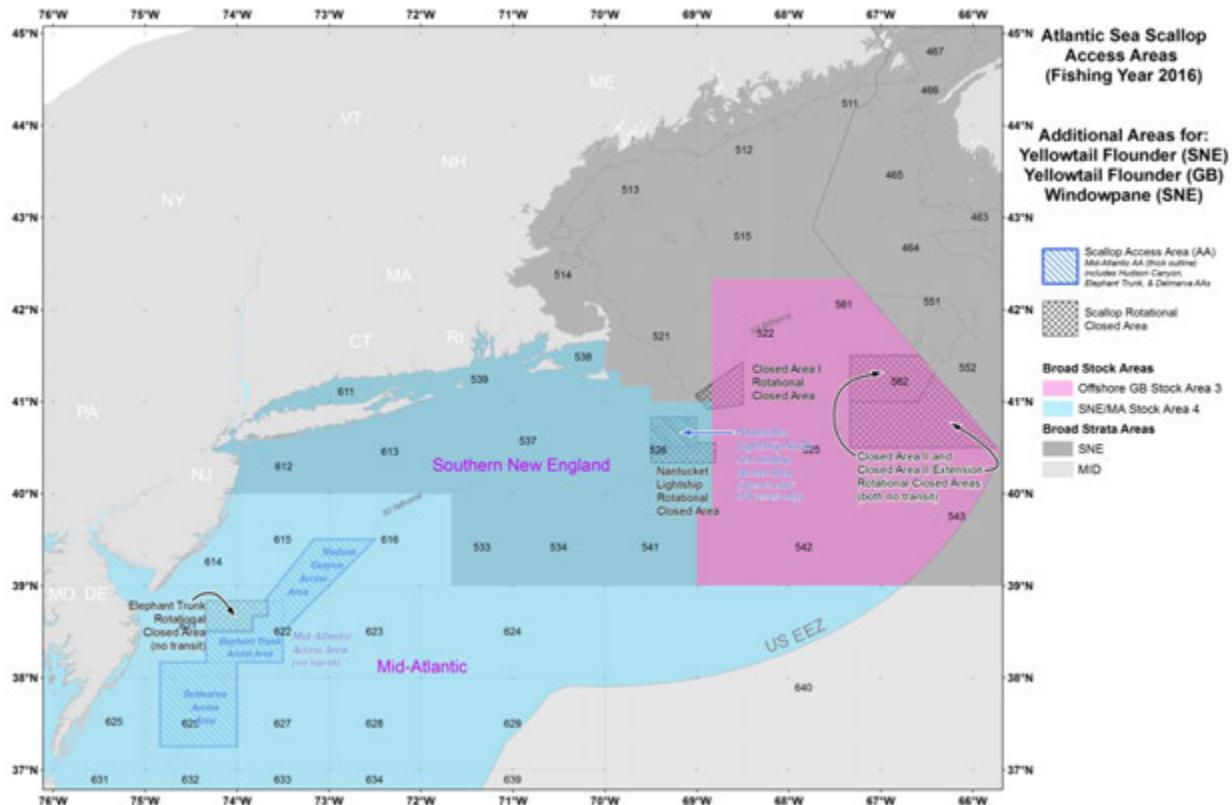
<b>Transition rate</b>	<b>Baseline (Fleet/Area/Gear)</b>	<b>Alternative 1 (Gear)</b>	<b>Alternative 2 (Area/Gear)</b>
<b>5 trips</b>	$S_0T_1$	$S_1T_1$	$S_2T_1$
<b>Moving</b>	$S_0T_2$	$S_1T_2$	$S_2T_2$
<b>Average</b>			

**Table 3. Results of simulations for yellowtail (SNE/MA and GB) and windowpane (SNE/MA) stocks. Mean median and standard deviation refer to the total estimated discard for the fishery for the fishing year. The first day that there is a non-zero probability of being over the catch cap, and the probability of being over the cap on the last day of the fishing year are included in the last two columns. The standard deviation/mean is the standard error and is analogous to a fishery wide CV.**

FISHERY	RUN	TRANS	Mean ( $\mu$ )	SD( $\delta$ )	median	$\frac{\delta}{\mu}$	First Day $P(D) >$ catch cap	P (Last Day) > catch cap
YTF_SNE	BASELINE	5TRIPS	79,222	12,334	78,582	0.16	134	8%
YTF_SNE	BASELINE	MA	79,075	11,948	78,451	0.15	218	7%
YTF_SNE	ALT1-GEAR	5TRIPS	81,935	14,573	81,091	0.18	127	15%
YTF_SNE	ALT1-GEAR	MA	82,071	14,342	81,409	0.17	162	14%
YTF_SNE	ALT2-GEAR-AREA	5TRIPS	75,627	11,366	74,994	0.15	183	4%
YTF_SNE	ALT2-GEAR-AREA	MA	75,416	11,128	74,463	0.15	232	3%
YTF_GB	BASELINE	5TRIPS	64,978	11,425	63,964	0.18	92	44%
YTF_GB	BASELINE	MA	64,713	12,119	63,594	0.19	92	41%
YTF_GB	ALT1-GEAR	5TRIPS	77,502	16,625	76,097	0.22	80	74%
YTF_GB	ALT1-GEAR	MA	77,473	16,044	76,193	0.21	80	73%
YTF_GB	ALT2-GEAR-AREA	5TRIPS	64,809	12,617	64,001	0.20	94	42%
YTF_GB	ALT2-GEAR-AREA	MA	65,048	12,454	64,169	0.19	94	45%
WP_SNE	BASELINE	5TRIPS	467,369	91,027	461,873	0.19	64	74%
WP_SNE	BASELINE	MA	465,601	95,827	454,569	0.21	141	73%
WP_SNE	ALT1-GEAR	5TRIPS	486,515	115,181	470,744	0.24	64	76%
WP_SNE	ALT1-GEAR	MA	489,499	113,735	479,869	0.23	113	75%
WP_SNE	ALT2-GEAR-AREA	5TRIPS	464,207	95,743	460,415	0.21	64	73%
WP_SNE	ALT2-GEAR-AREA	MA	457,691	94,007	450,016	0.21	148	71%

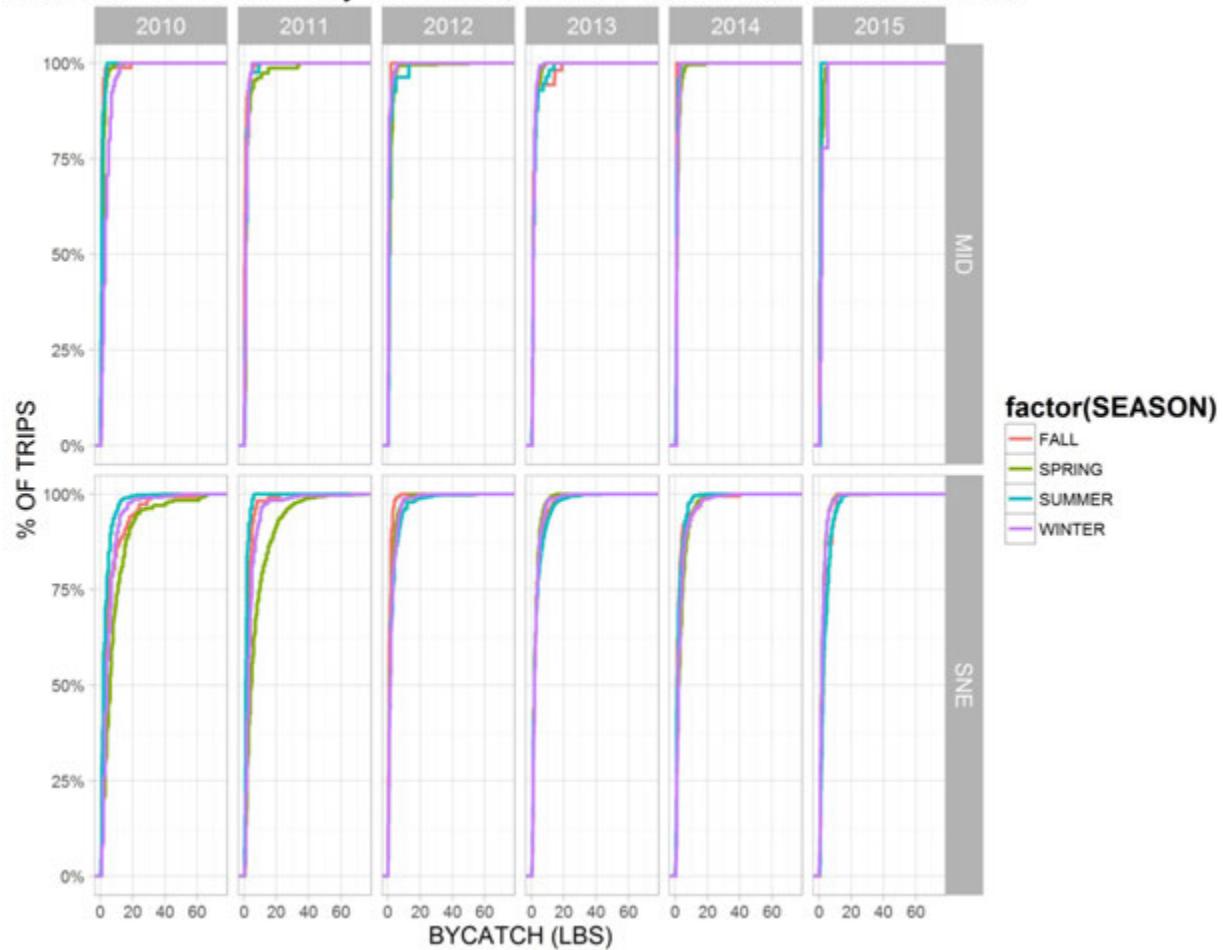


**Figure 1. Summary of current (Fishing Year 2016) Atlantic sea scallop management areas.**  
**Map credit to Dean Szumylo, GARFO**



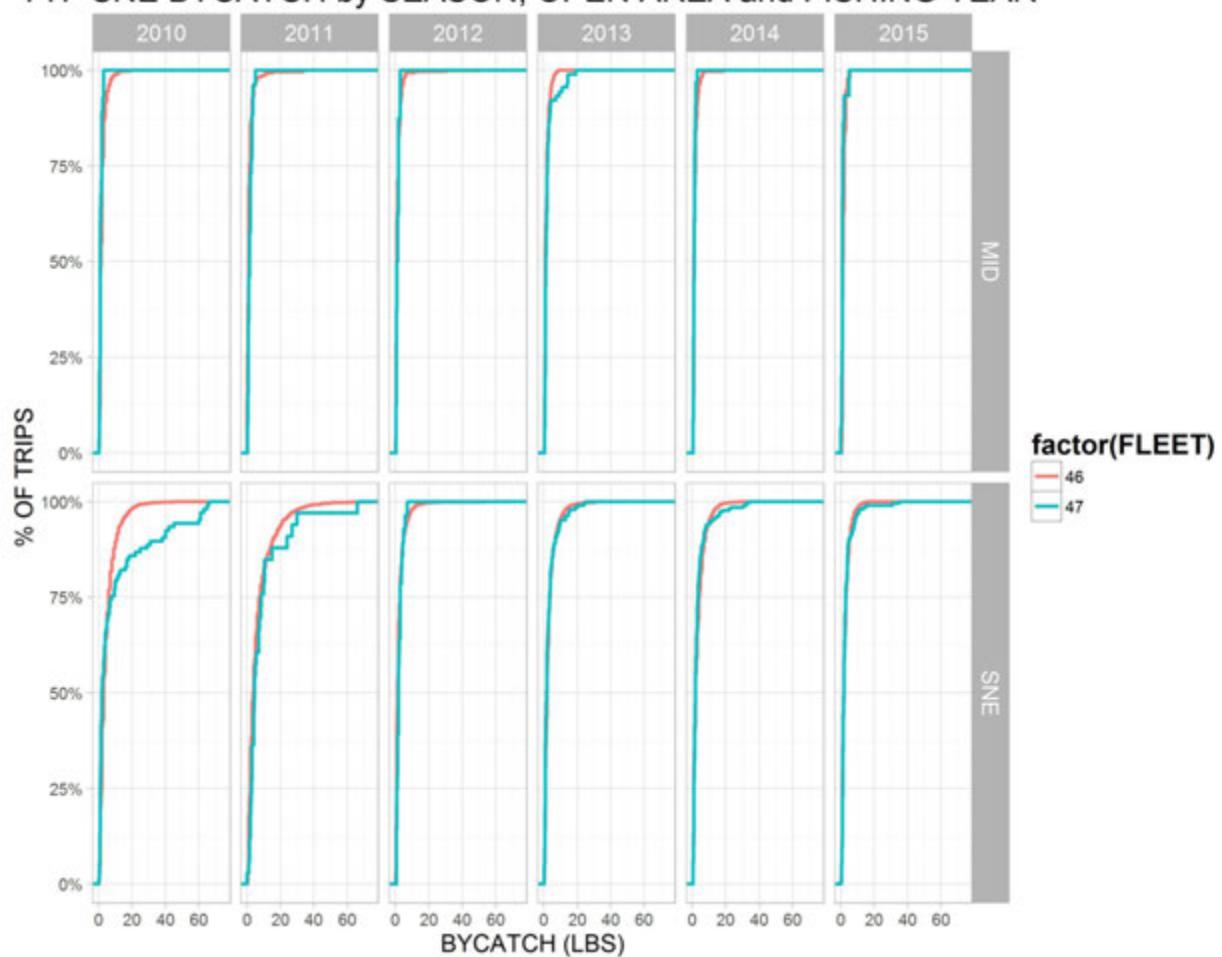
**Figure 2. Scallop Fishery extent.** Broad strata areas used in simulations are shown in grey shades. Statistical reporting areas (numbers) are labeled in black.

### YTF SNE BYCATCH by SEASON, OPEN AREA and FISHING YEAR



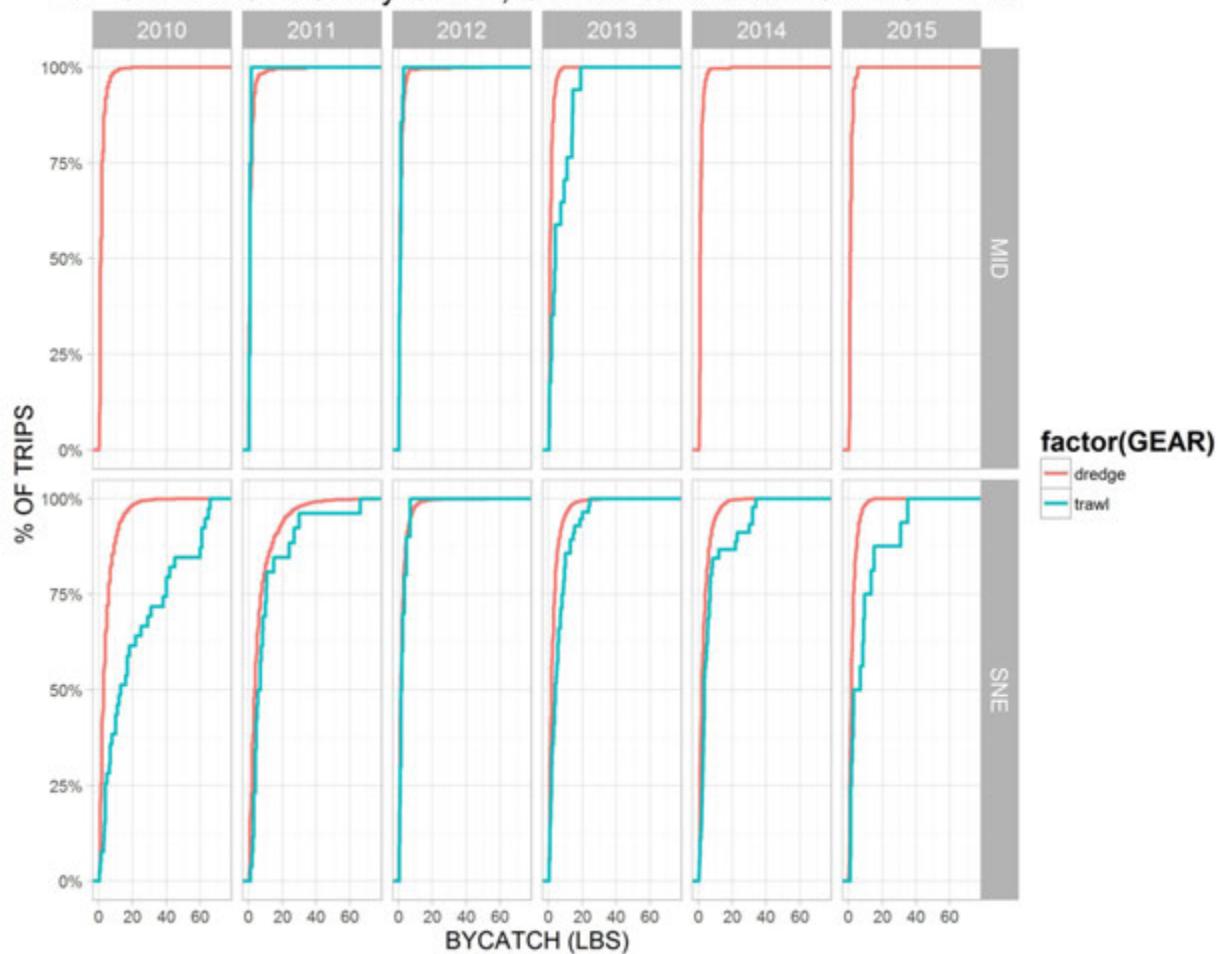
**Figure 3 Cumulative distribution plots of yellowtail founder SNE/MA discard by Year and Season, split by broad Open Area. Area here is split where SNE is statistical area <= 613 and MID is staistical area >= 614. Here, the Nantucket Lightship is not assessed separately. No consistent seasonal pattern is apparent.**

### YTF SNE BYCATCH by SEASON, OPEN AREA and FISHING YEAR



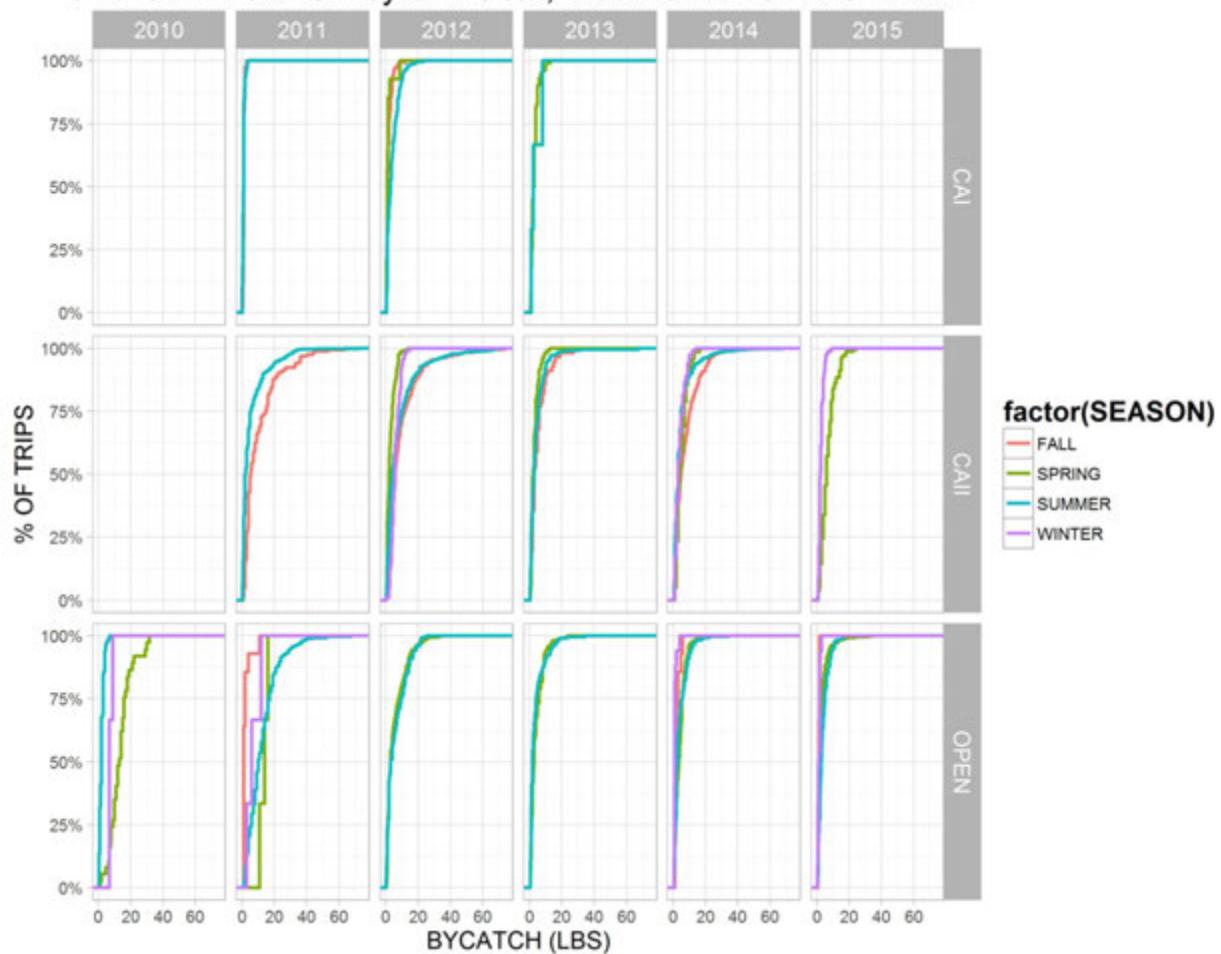
**Figure 4 Cumulative distribution plots of yellowtail founder SNE/MA discard by Year and Fleet, split by broad Open Area. Area here is split where SNE is statistical area <= 613 and MID is staistical area >= 614. Here, the Nantucket Lightship is not assessed separately. Fleet 46 is Limited Access and 47 (LA) is General Category (LAGC)**

## YTF SNE BYCATCH by GEAR, OPEN AREA and FISHING YEAR



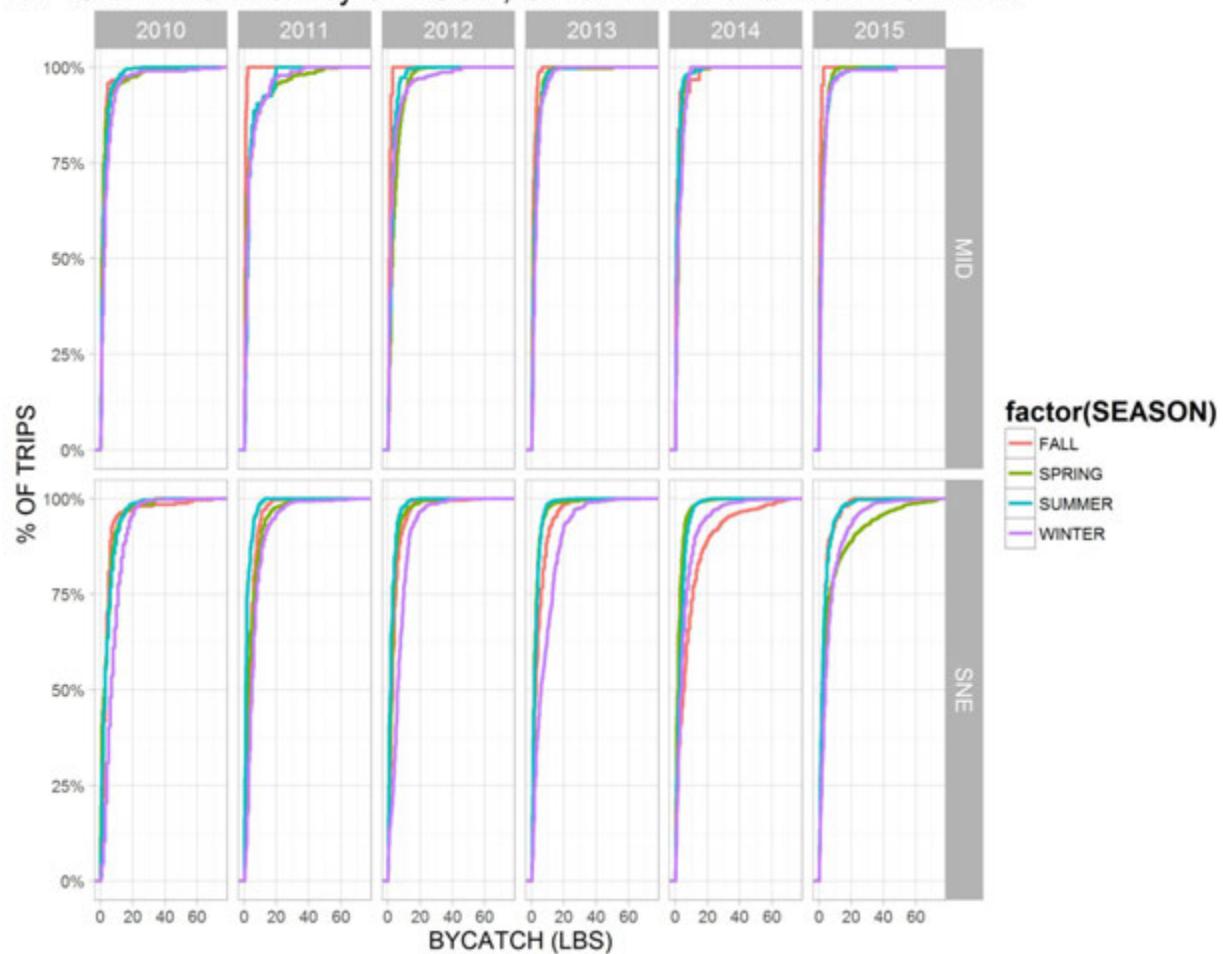
**Figure 5 Cumulative distribution plots of yellowtail founder SNE/MA discard by Year and Gear, split by broad Open Area. Area here is split where SNE is statistical area  $\leq 613$  and MID is staistical area  $\geq 614$ . Here, the Nantucket Lightship is not assessed separately.**

### YTF GB BYCATCH by SEASON, AREA and FISHING YEAR



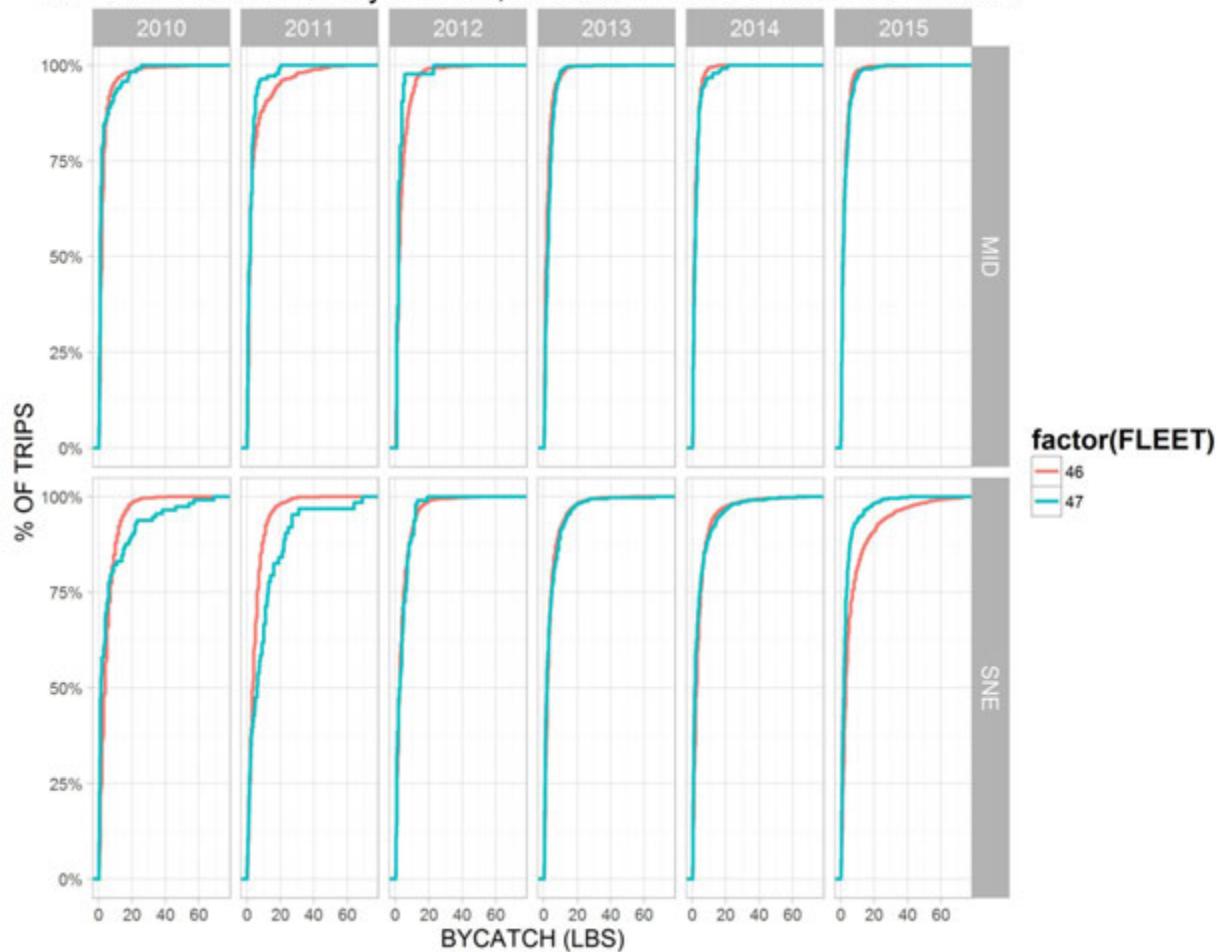
**Figure 6 Cumulative distribution plots of yellowtail founder GB discard by Year and season, split by Area. Area here is split between Open and Rotational Access areas. No consistent seasonal pattern is apparent. Only Limited Access dredge fishing occurred in this broad stock area.**

## WP SNE BYCATCH by SEASON, OPEN AREA and FISHING YEAR



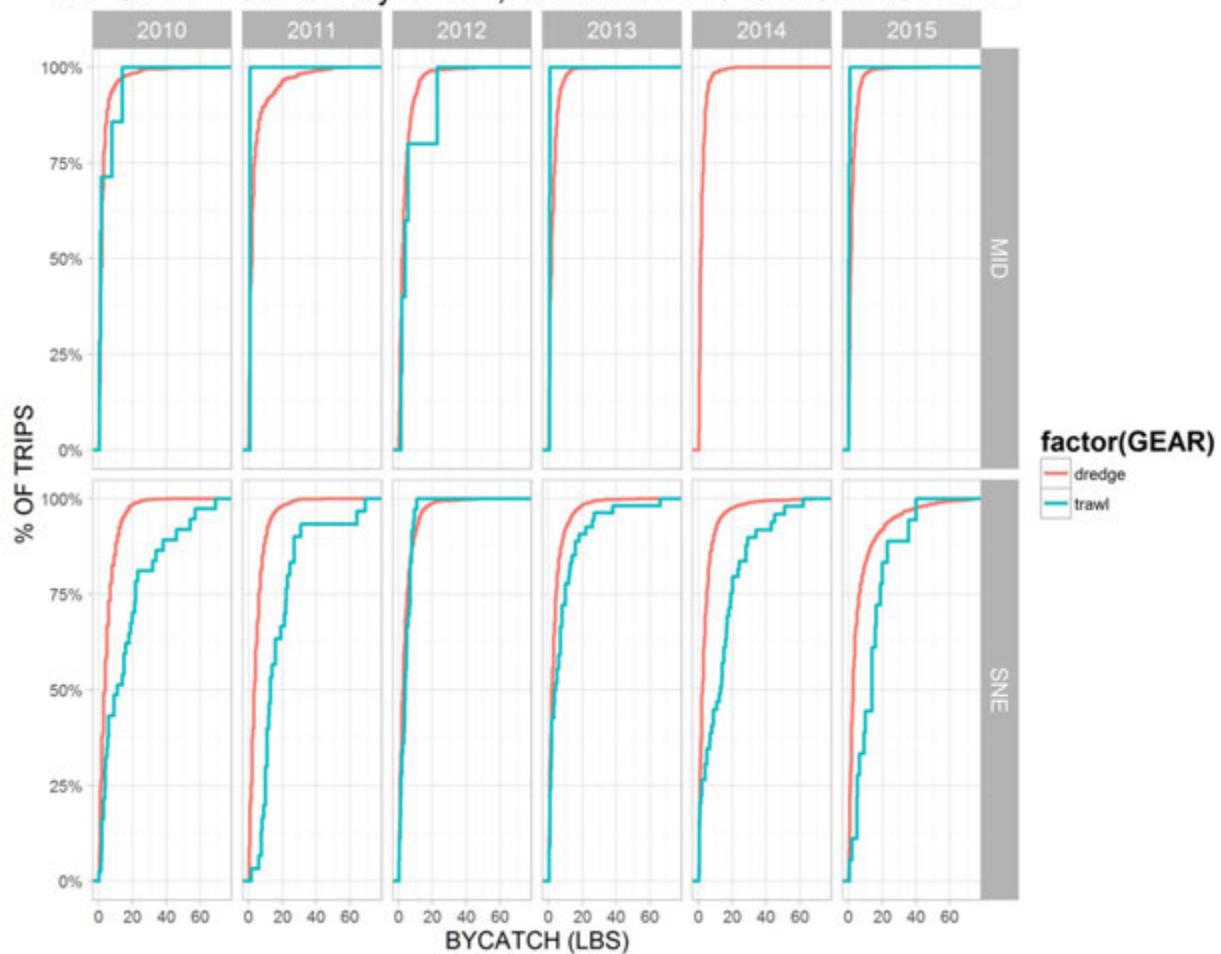
**Figure 7 Cumulative distribution plots of windowpane flounder SNE/MA discard by Year and Fleet, split by broad Open Area. Area here is split where SNE is statistical area  $\leq 613$  and MID is staistical area  $\geq 614$ . Here, the Nantucket Lightship is not assessed separately. No consistent seasonal pattern is apparent.**

## WP SNE BYCATCH by FLEET, OPEN AREA and FISHING YEAR



**Figure 8 Cumulative distribution plots of windowpane flounder SNE/MA discard by Year and Fleet, split by broad Open Area. Area here is split where SNE is statistical area <= 613 and MID is staistical area >= 614. Here, the Nantucket Lightship is not assessed separately. Fleet 46 is Limited Access and 47 (LA) is General Category (LAGC)**

## WP SNE BYCATCH by GEAR, OPEN AREA and FISHING YEAR



**Figure 9 Cumulative distribution plots of windowpane flounder SNE/MA discard by Year and Gear, split by broad Open Area. Area here is split where SNE is statistical area  $\leq 613$  and MID is staistical area  $\geq 614$ . Here, the Nantucket Lightship is not assessed separately.**

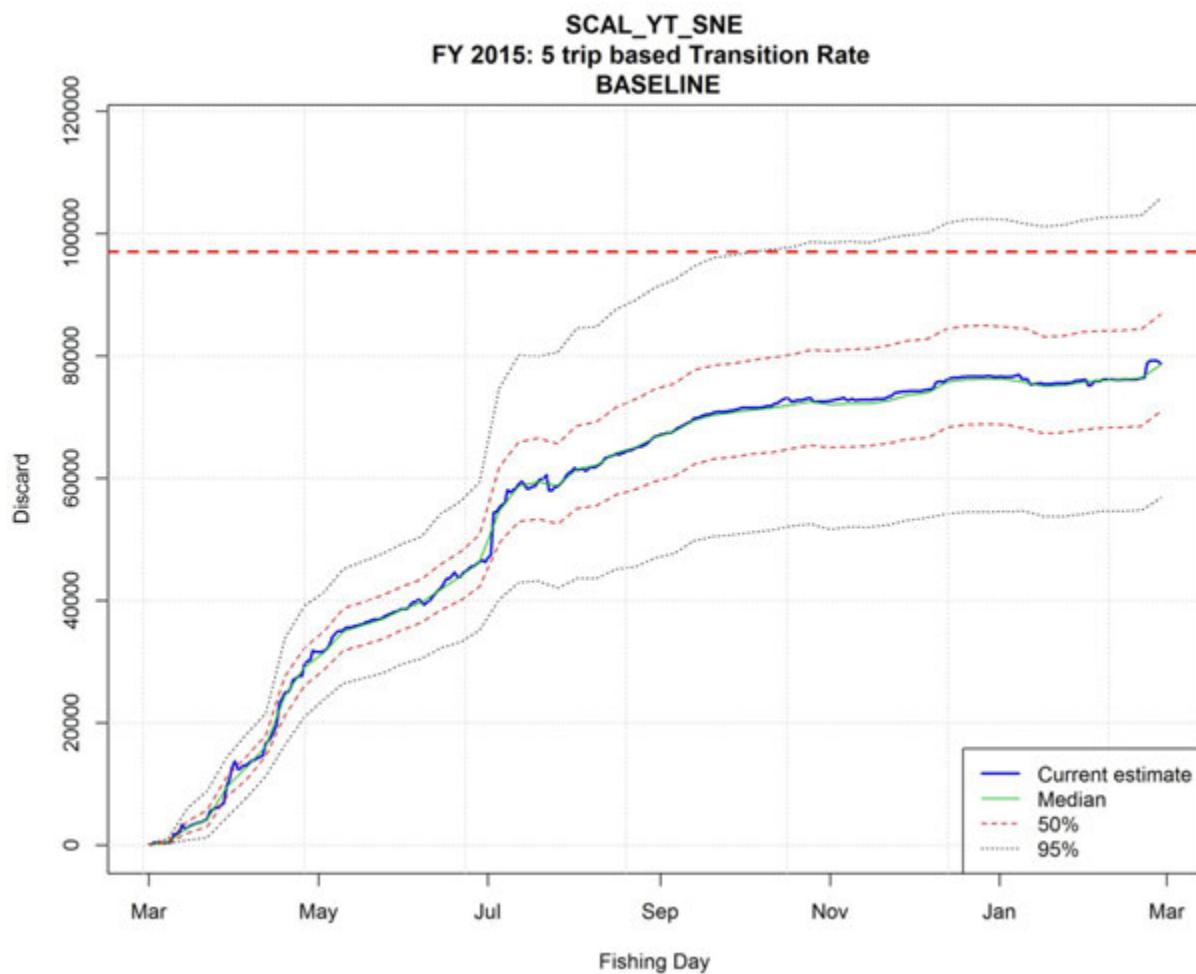
## Acknowledgments

I would like to extend my sincere appreciation to my colleagues in the Monitoring and Analysis Section of the Analysis and Program Support Division in the Greater Atlantic Regional Fisheries Office for helpful comments and discussion during this review. Thanks to Shannah Jaburek and Travis Ford for sharing their expertise in the scallop fishery and beyond and to Dean Szumylo for producing Figure 1 and inspiring Figure 2.

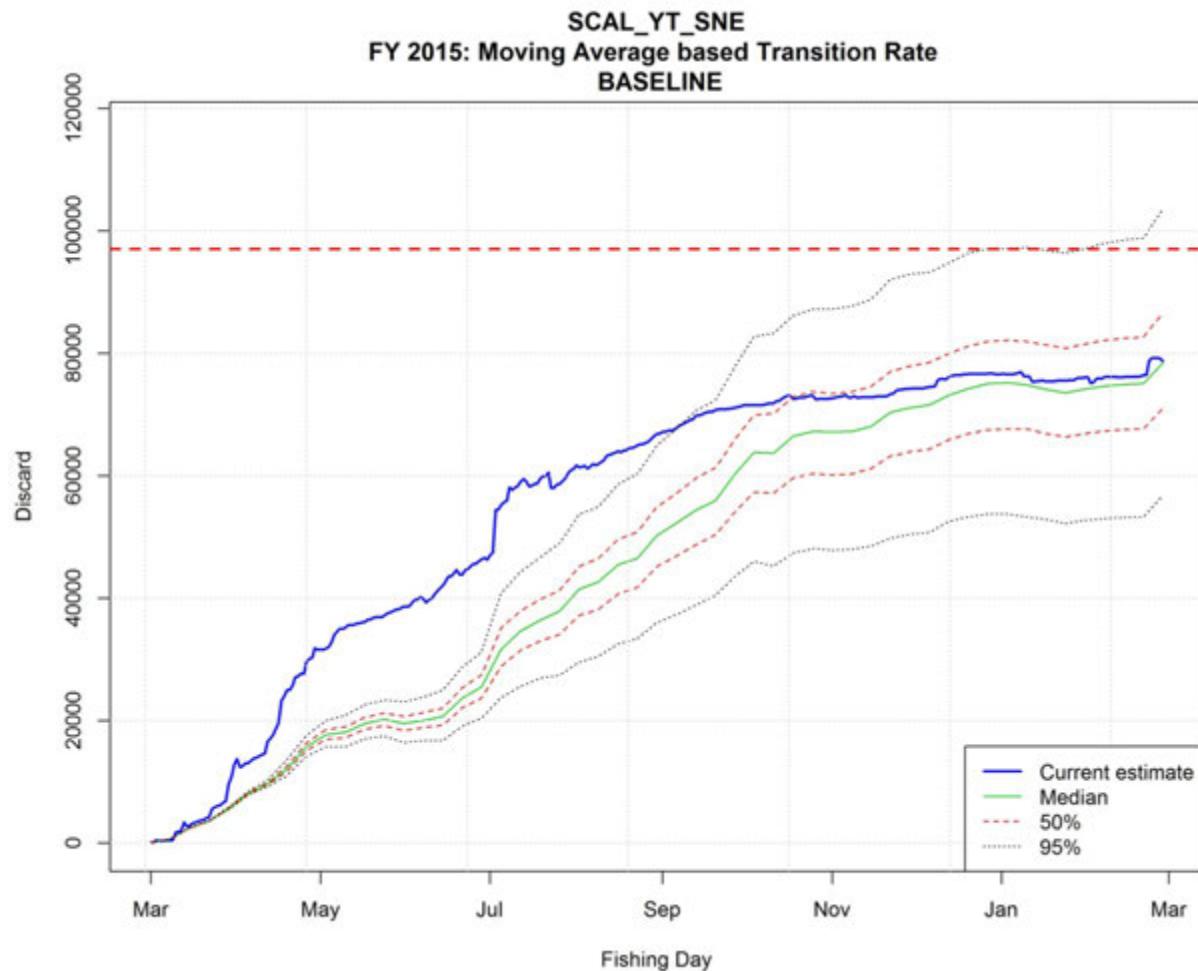
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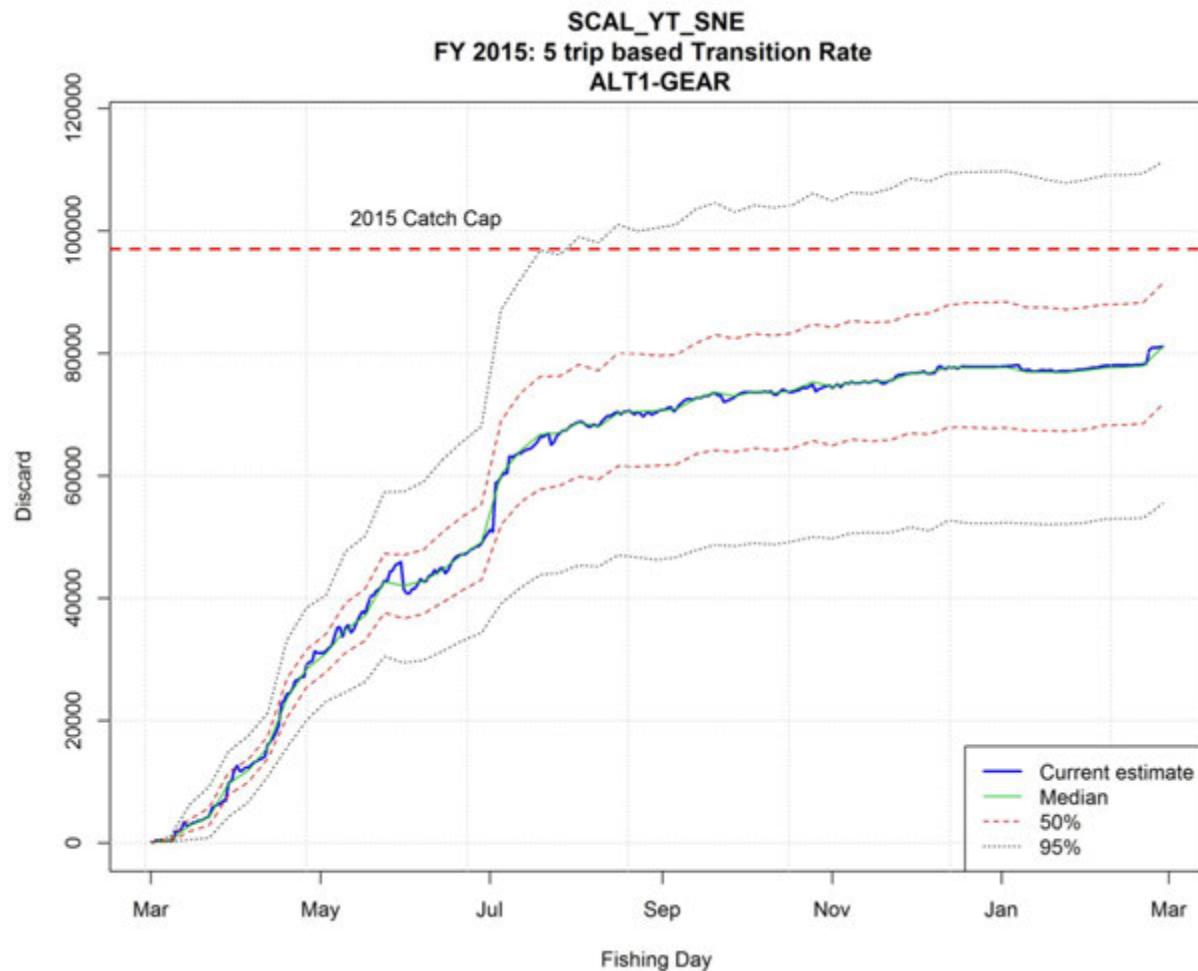
## *Appendix A. Yellowtail Flounder SNE/MA Simulation results*



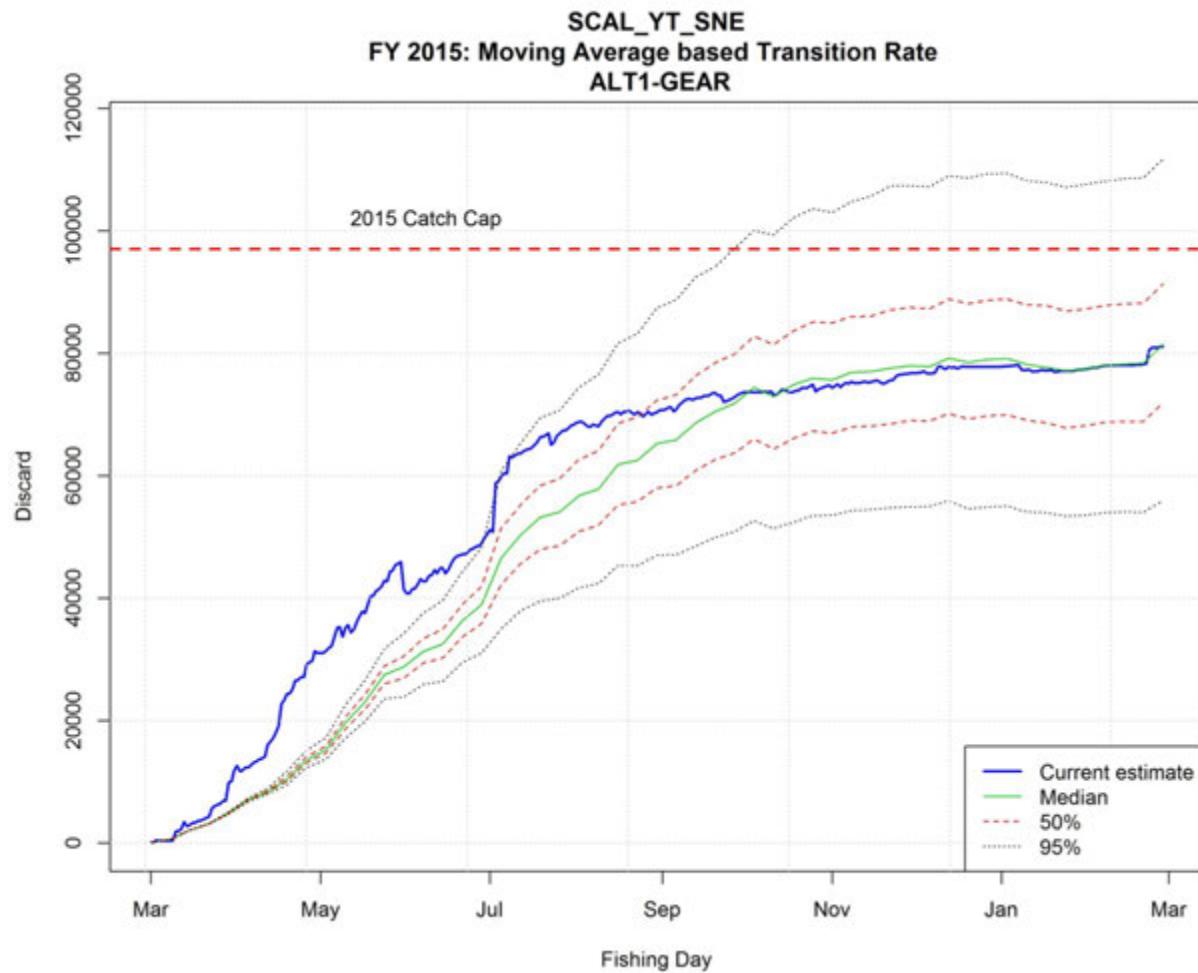
**Figure 10 YTF SNE/MA Baseline stratification and a 5 trip transition rate. Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.**



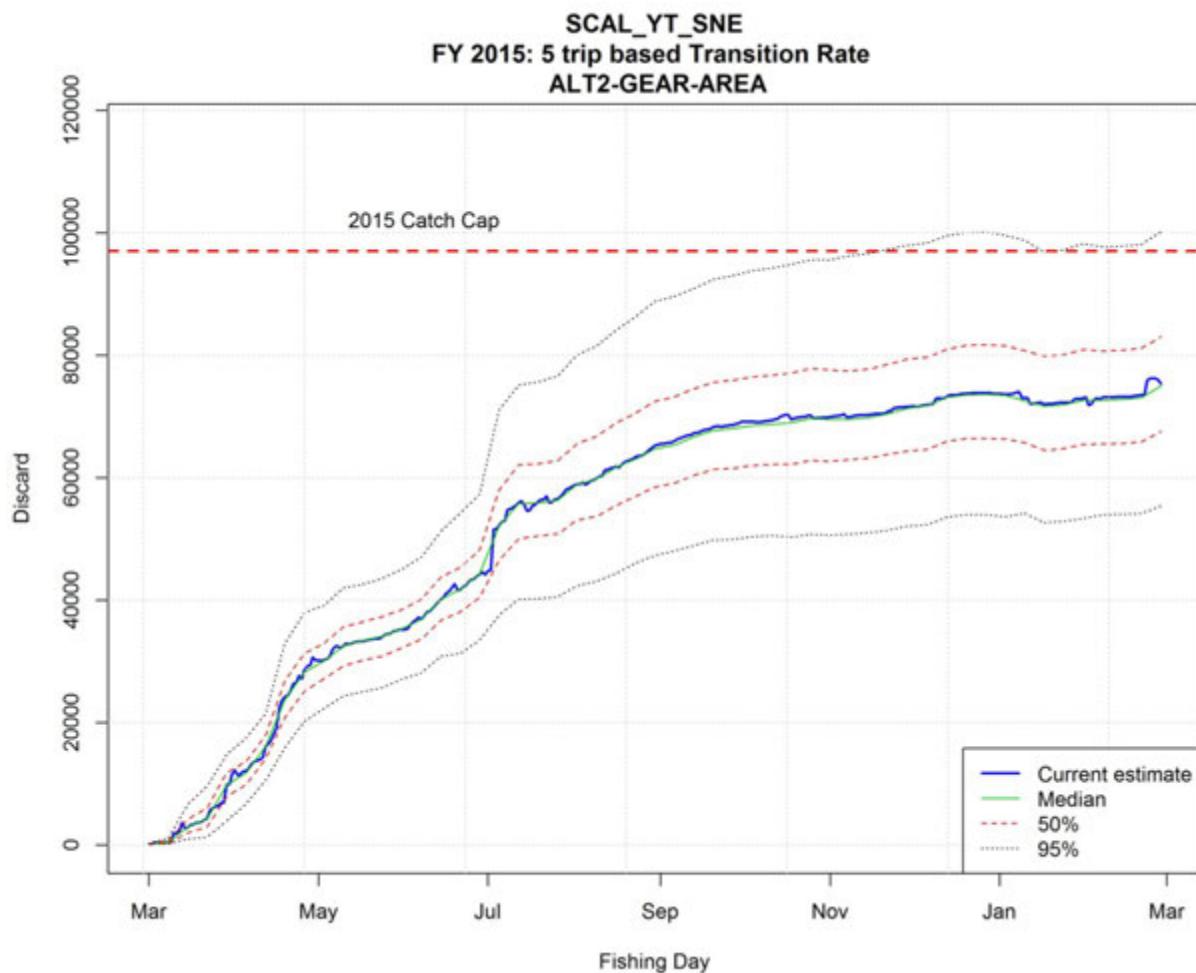
**Figure 11 YTF SNE/MA Baseline stratification and a 365 day moving average trip transition rate. Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.**



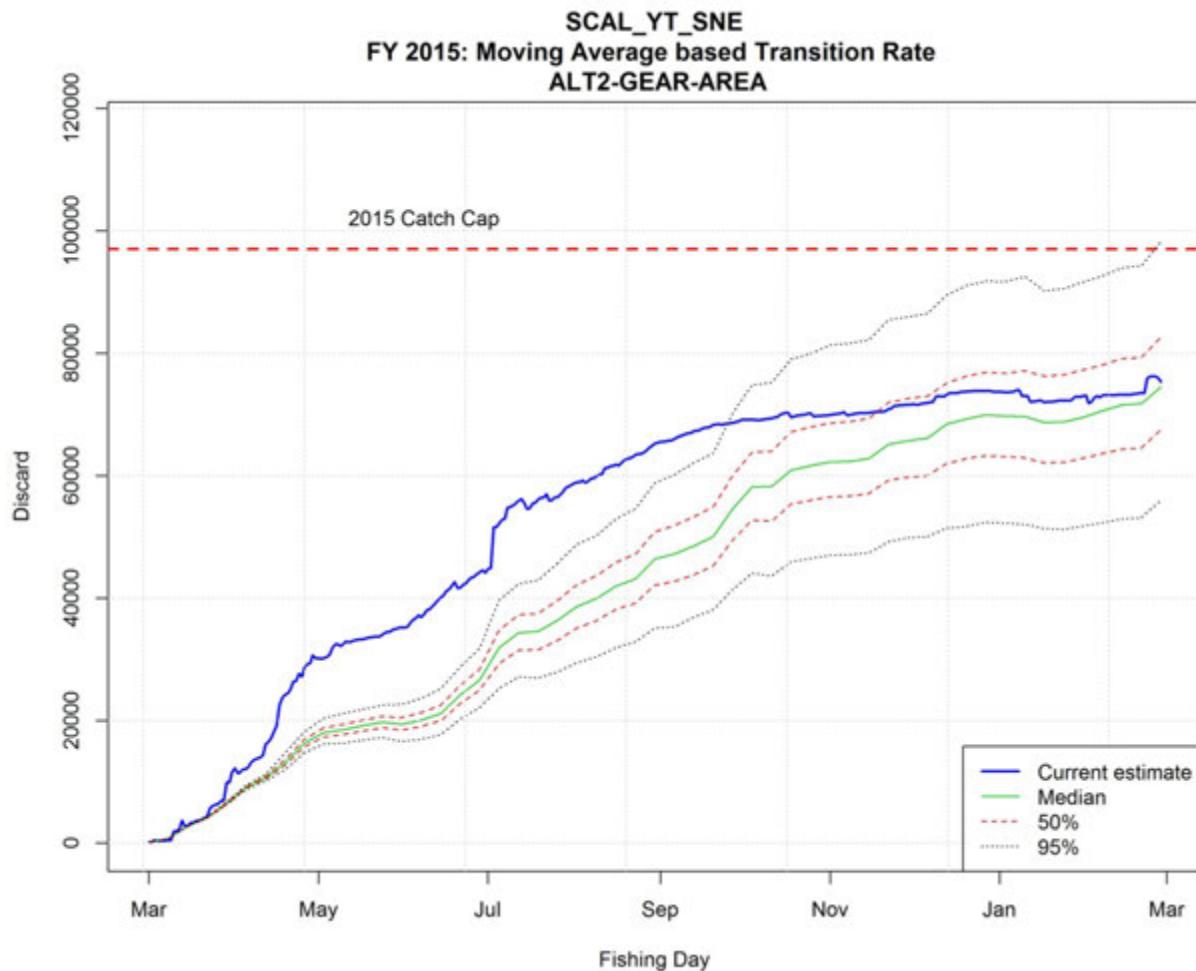
**Figure 12 YTF SNE/MA gear only stratification and a 5 trip transition rate. Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.**



**Figure 13 YTF SNE/MA gear only stratification and a 365 day trip transition rate. Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.**

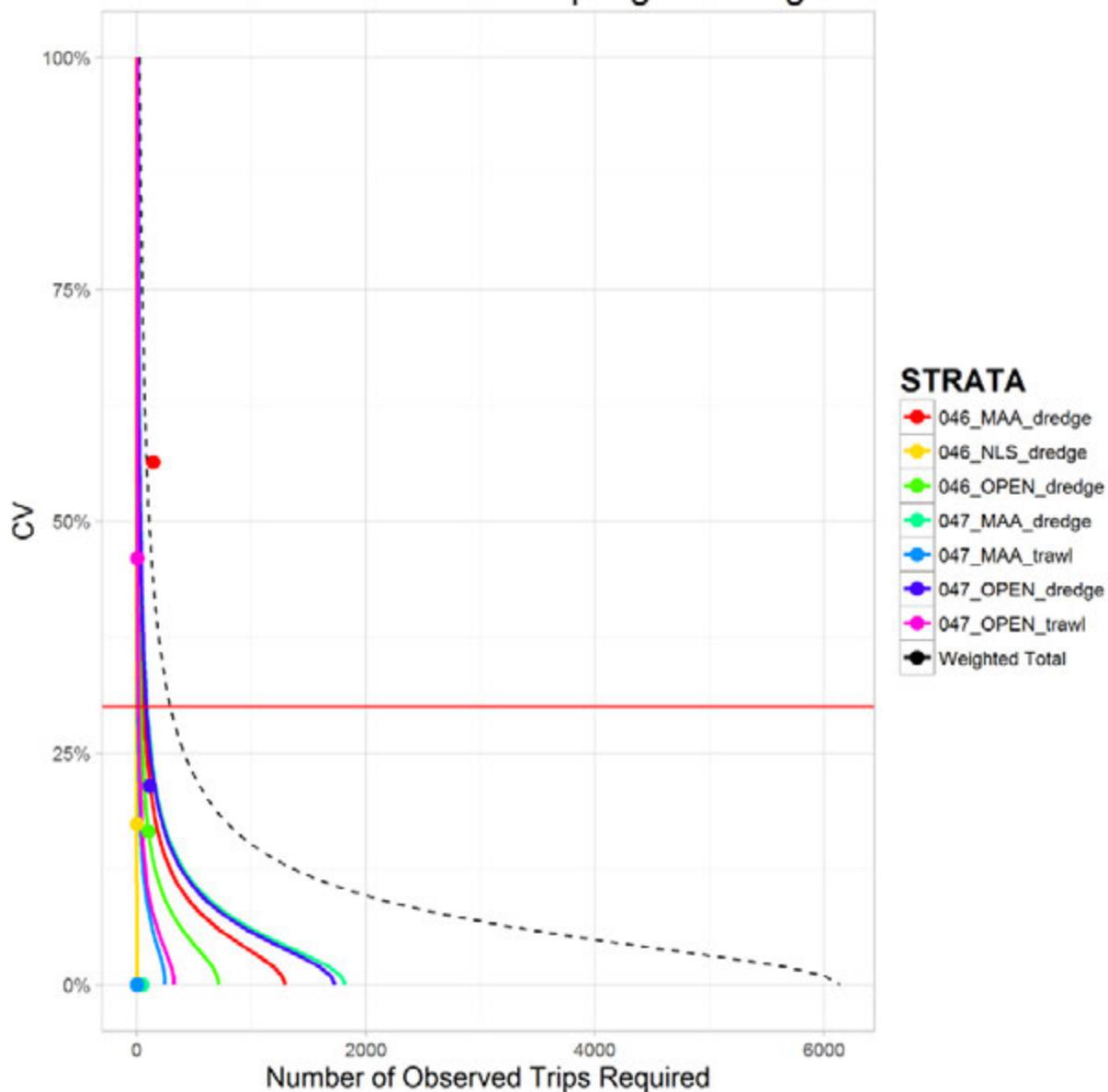


**Figure 14 YTF SNE/MA gear/area (no access areas) stratification and a 5 trip transition rate.**  
**Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.**



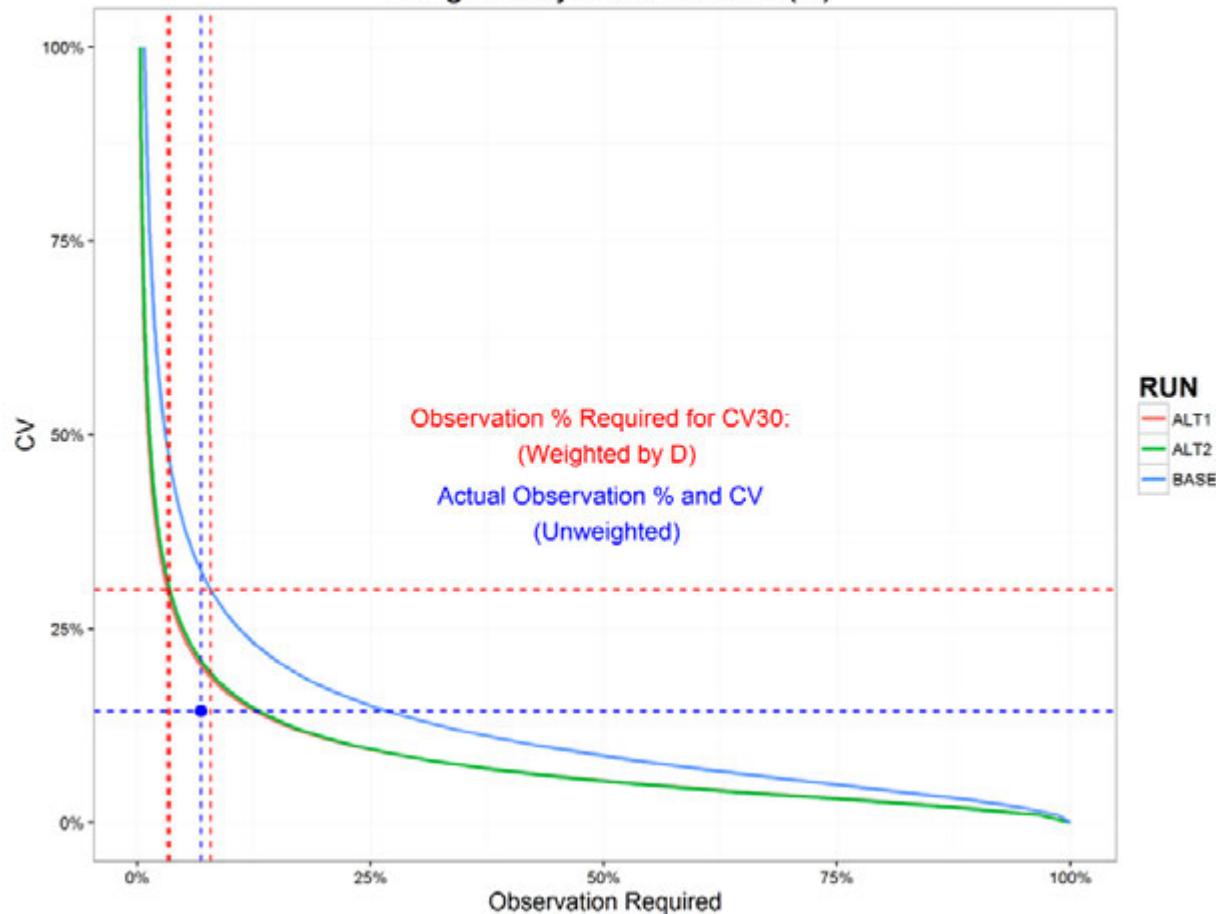
**Figure 15 YTF SNE/MA gear/area (no access areas) stratification and a 365 day trip transition rate. Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.**

## YTF SNE: Stratified Sampling Coverage

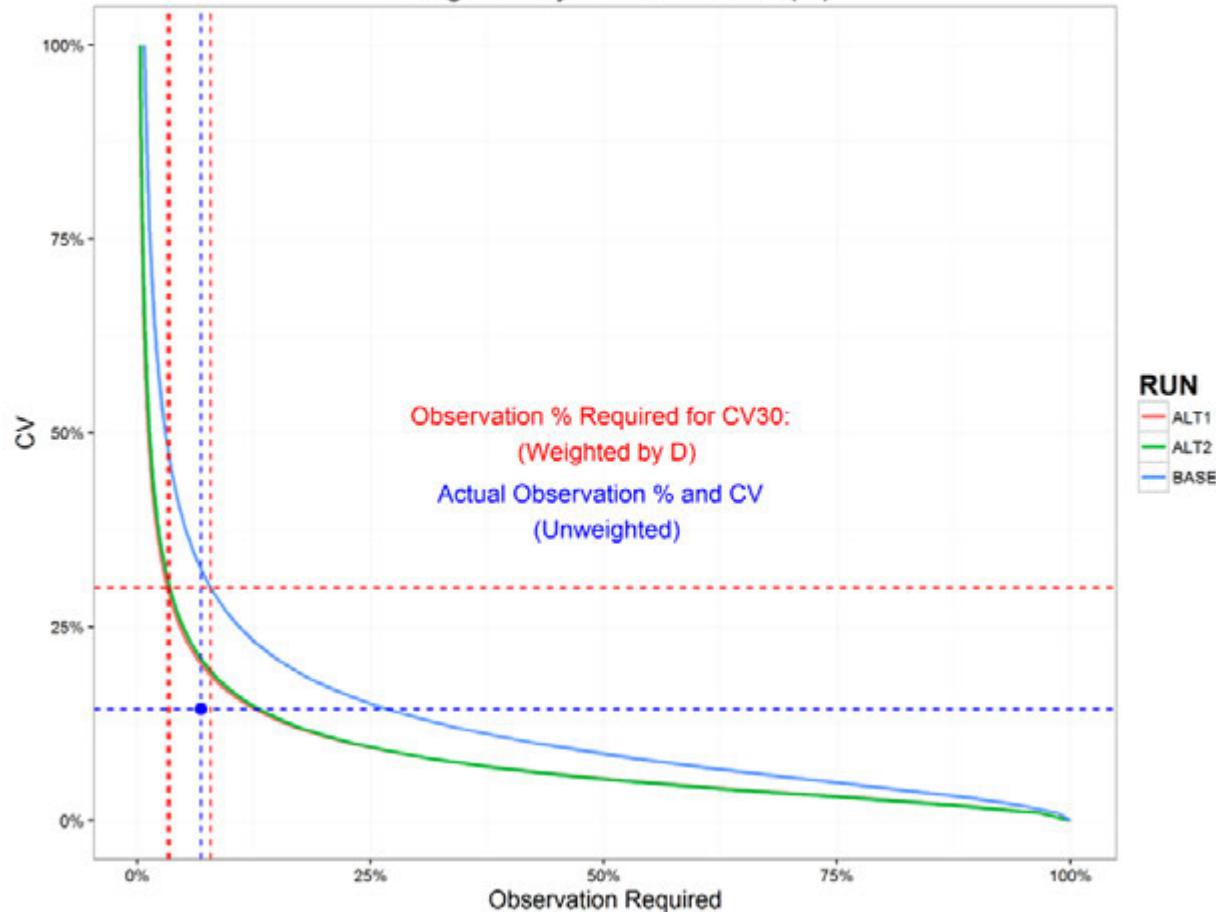


**Figure 16** Trips required for a range of target %CV for all baseline strata in the YTF SNE/MA fishery. The black dashed line is the stratified discard weighted average CV curve for the entire fishery. The dots reference the number of observed trips (x-axis) in each strata.

Yellowtail SNE/MA: Total Target Coverage  
Weighted by Total Discard (D)

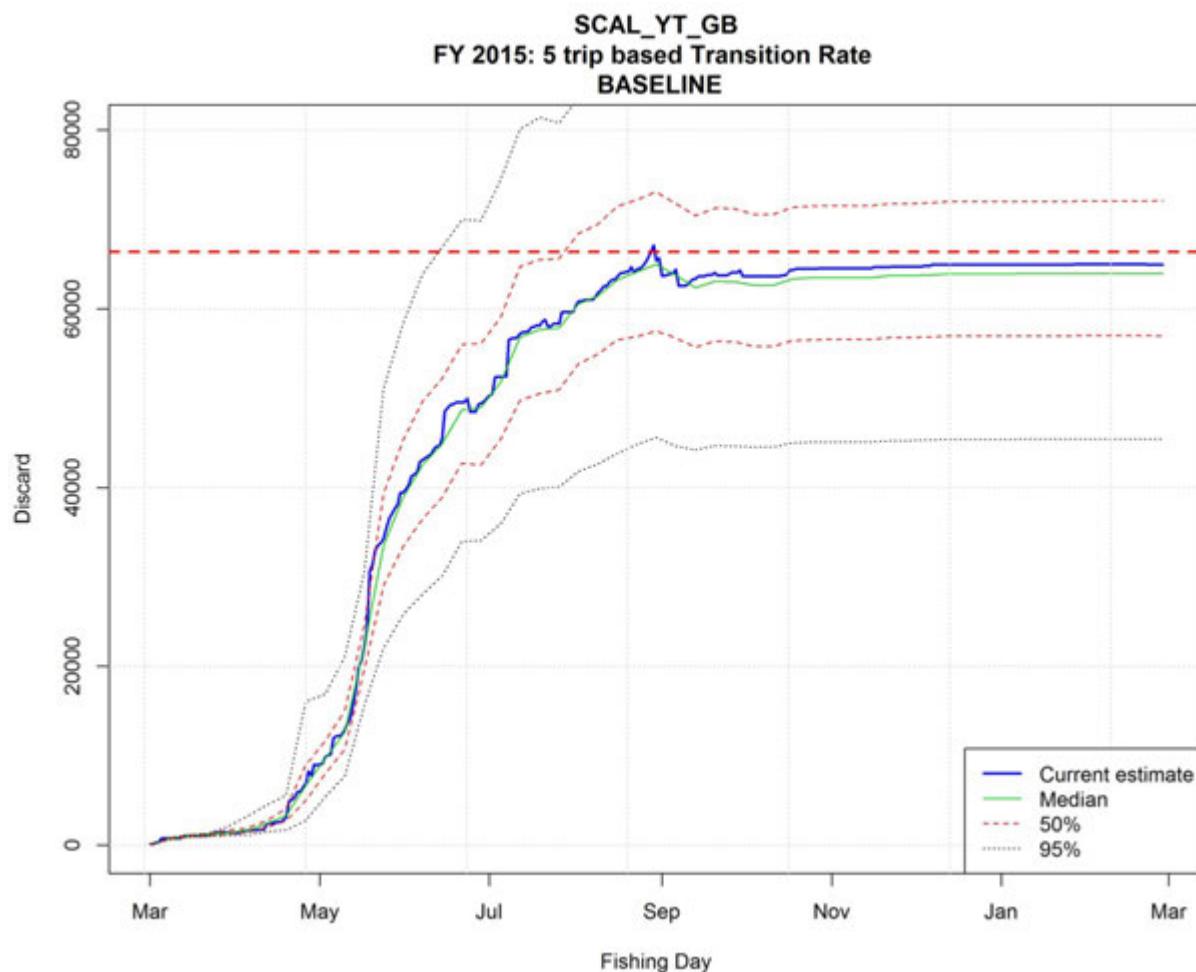


**Yellowtail SNE/MA: Total Target Coverage  
Weighted by Total Discard (D)**

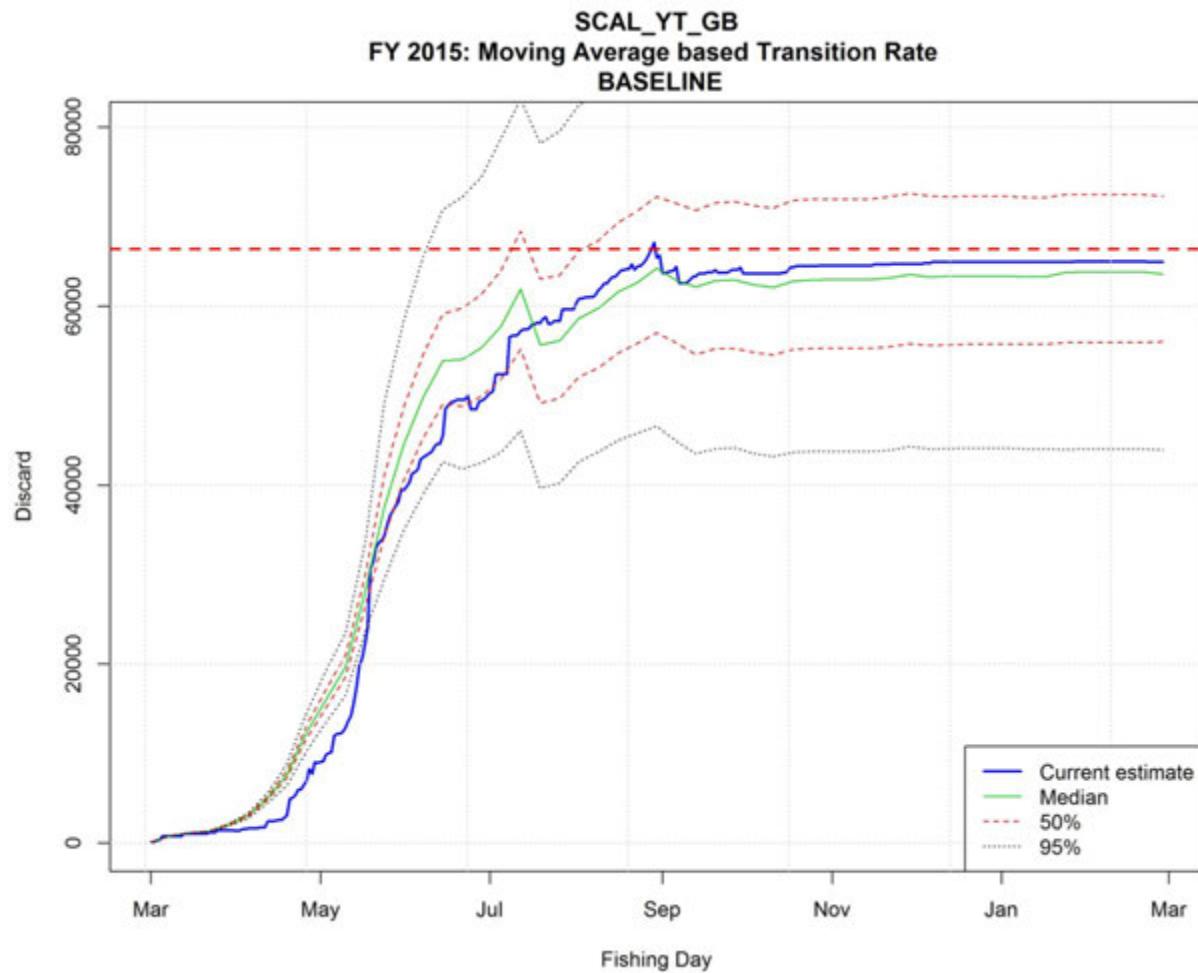


**Figure 17 Stratified discard weighted CV curve for the YTF SNE/MA fishery. Red dashed lines show the theoretical required coverage rate for the fishery to achieve a CV %30 for each alternative when weighting by estimated discard in each stratum. The dashed blue lines and dot show the actual coverage rate and unweighted, fishery wide CV. Alternative 1 and 2 runs are nearly identical for fishing year 2015.**

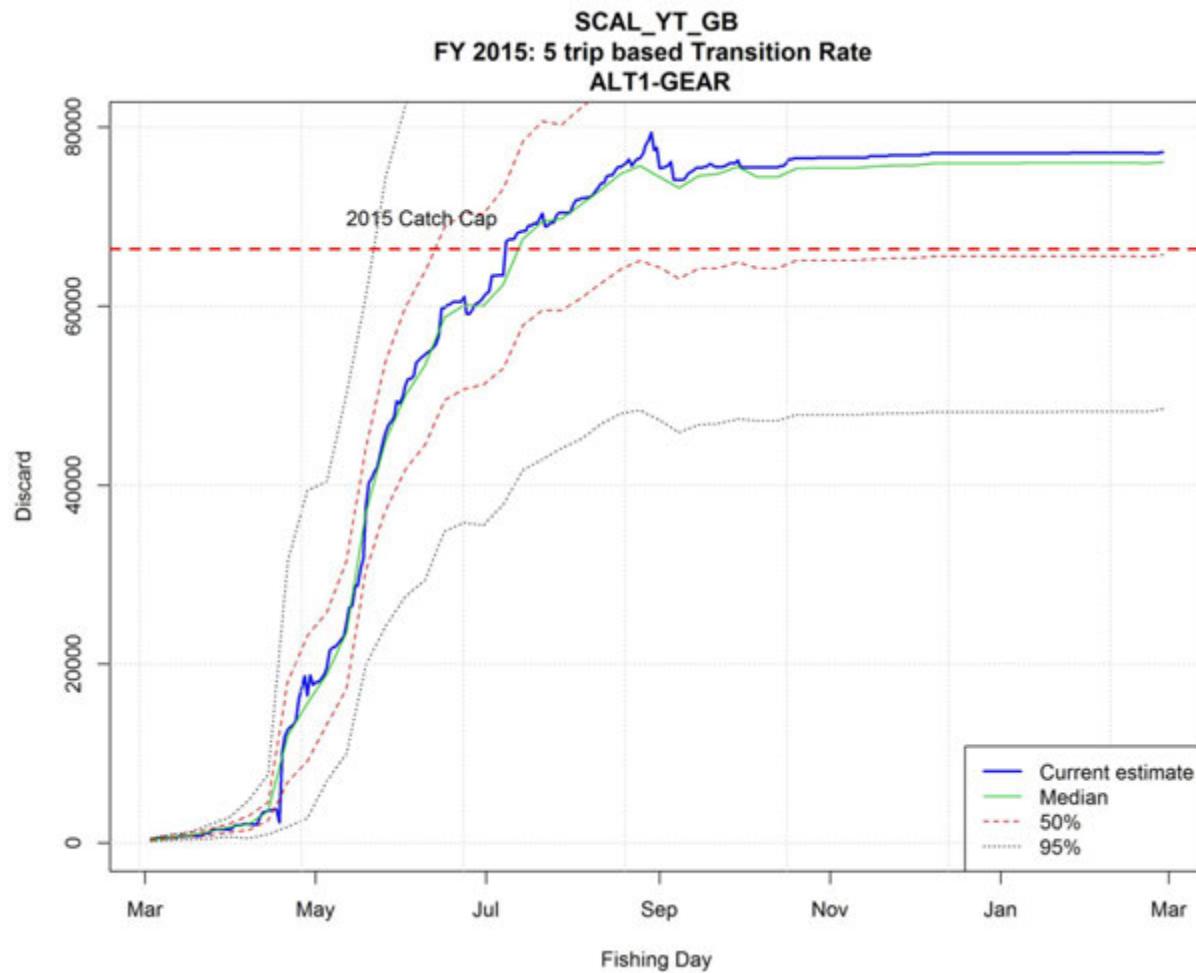
## *Appendix B. Yellowtail Flounder GB Simulation results*



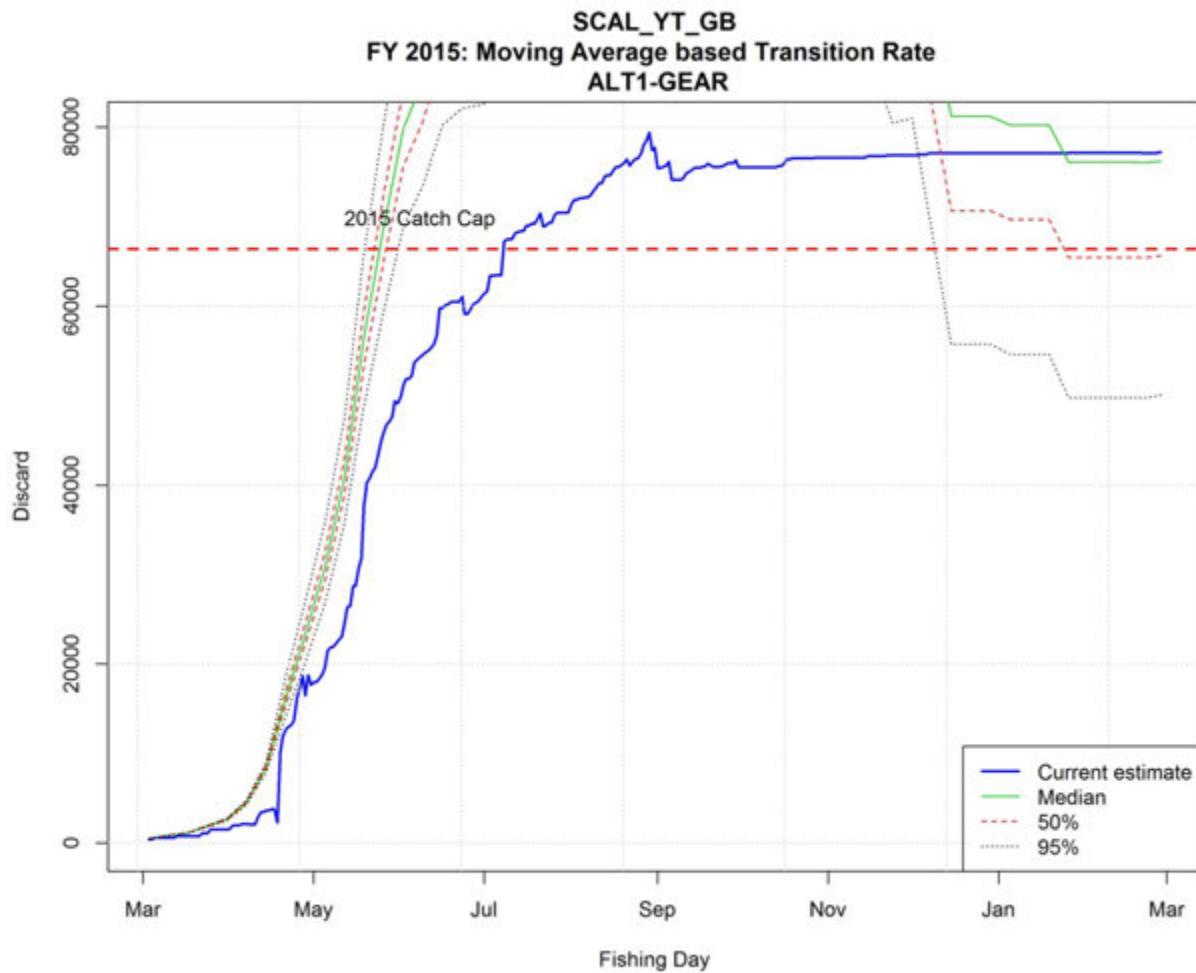
**Figure 18** YTF GB baseline stratification and a 5 trip transition rate. Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.



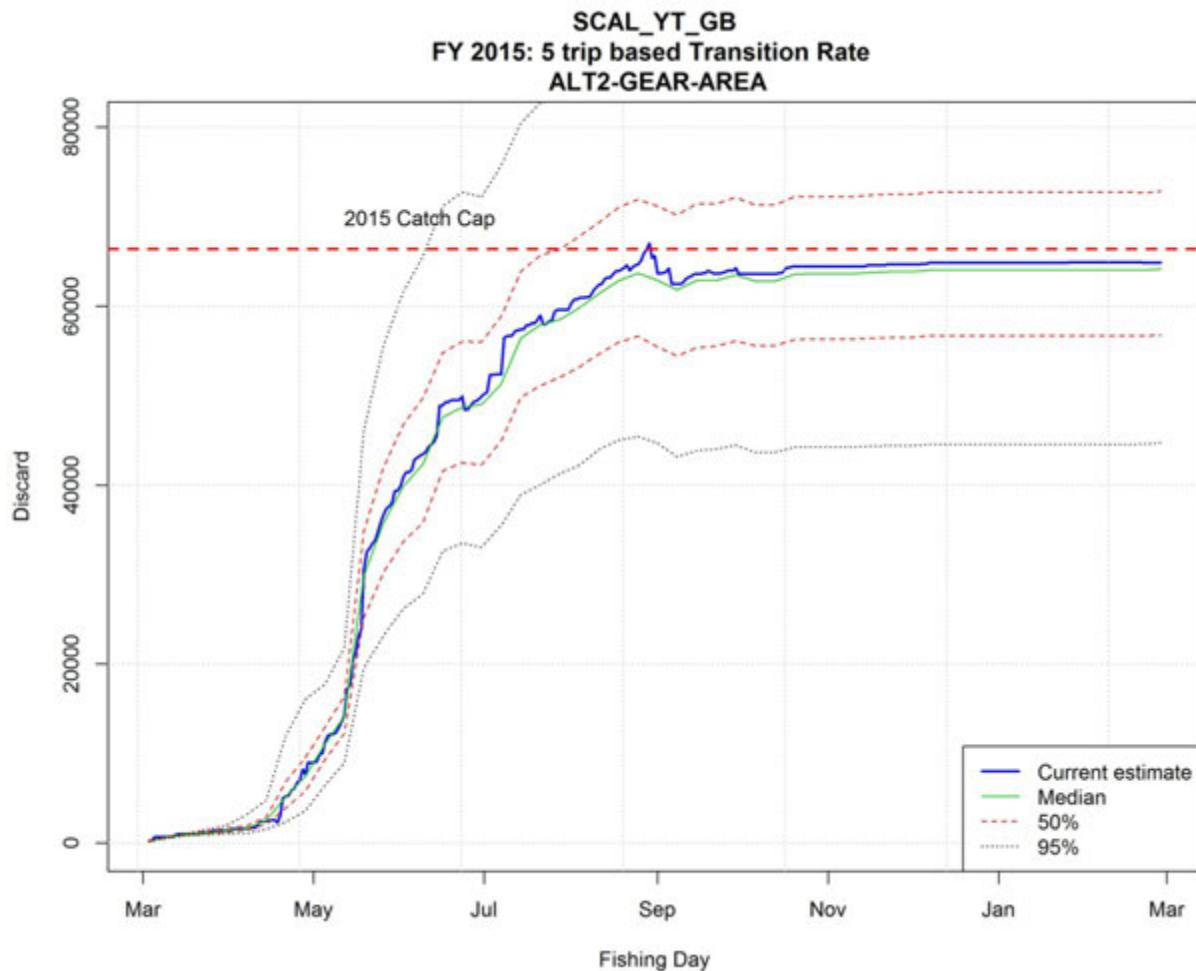
**Figure 19** YTF GB baseline stratification and a 365 day transition rate. Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.



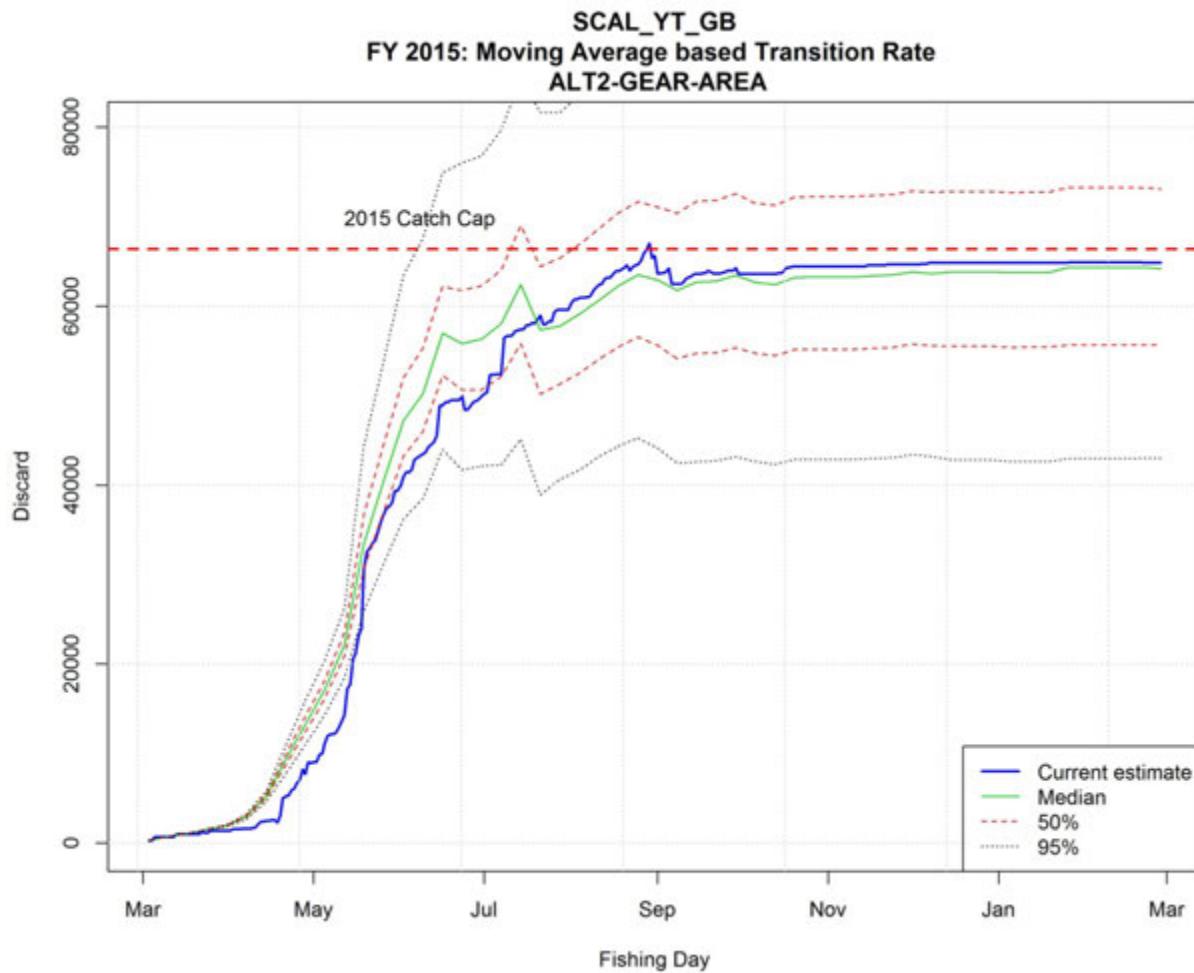
**Figure 20** YTF GB gear only stratification and a 5 trip transition rate. Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.



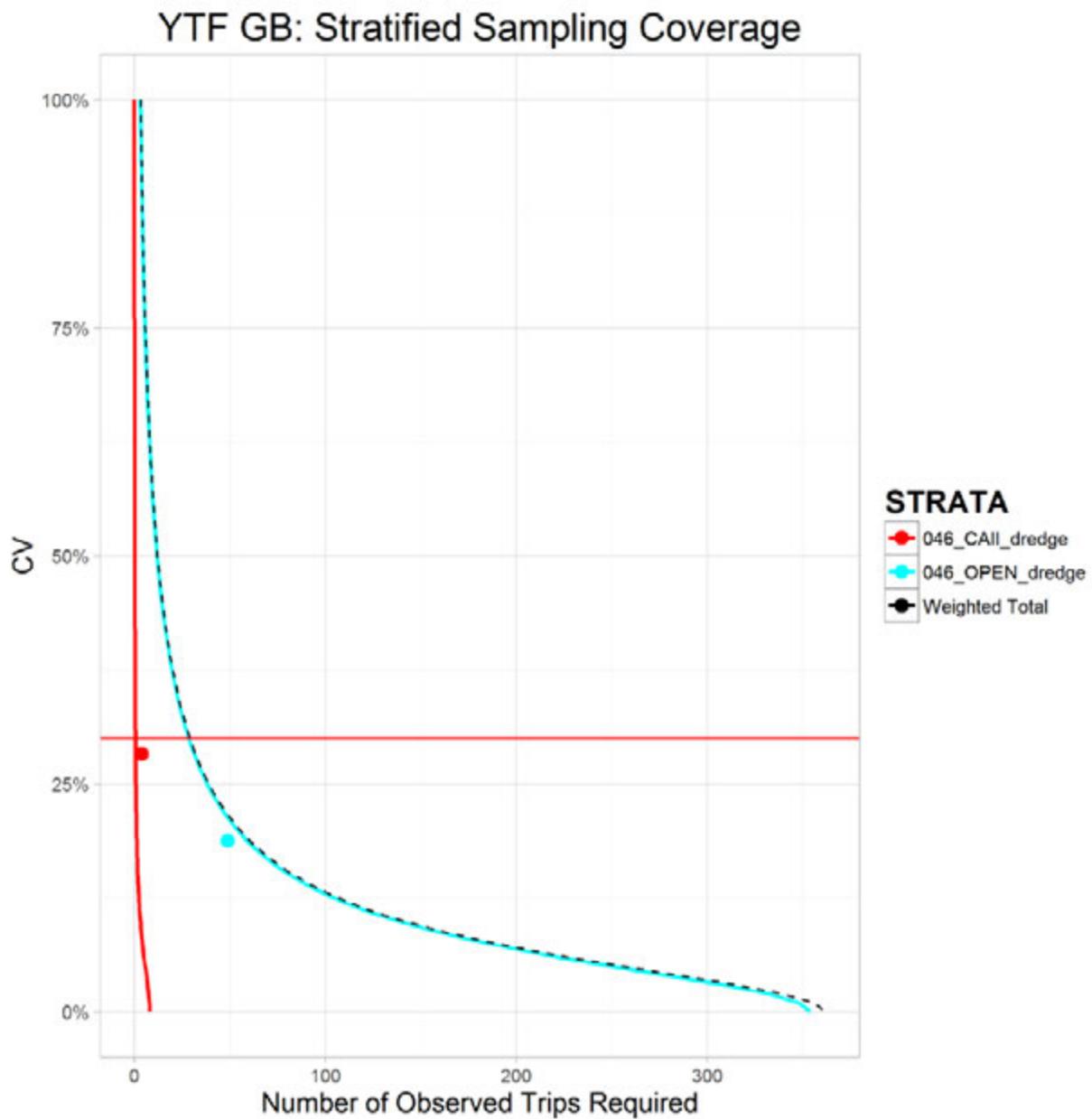
**Figure 21** YTF GB gear only stratification and a 365 day transition rate. Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.



**Figure 22 YTF GB gear and area (no access areas) stratification and a 5 trip transition rate.**  
**Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.**

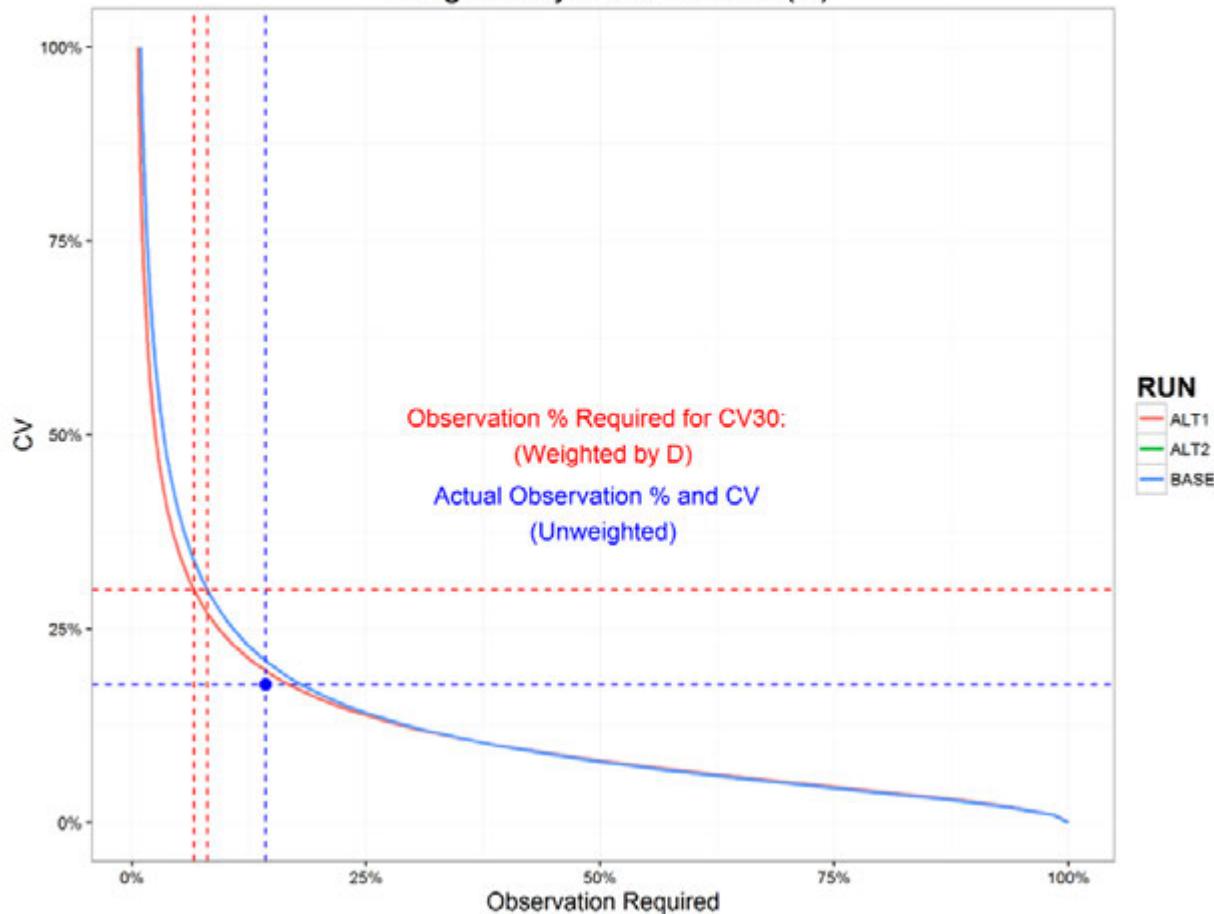


**Figure 23** YTF GB gear and area (no access areas) stratification and a 365 day transition rate. Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.



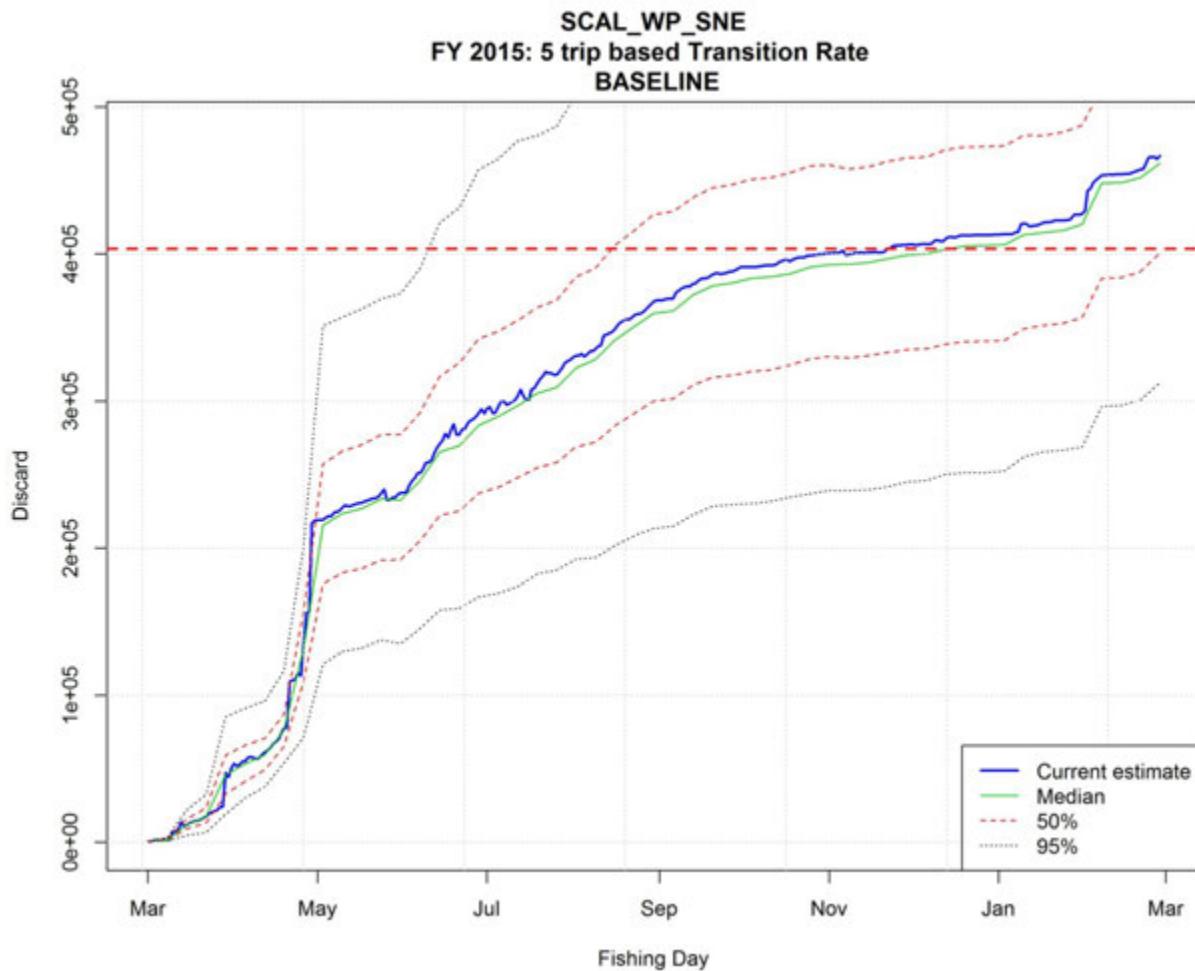
**Figure 24** Trips required for a range of target %CV for all baseline strata. The black dashed line is the stratified discard weighted average CV curve for the YTF GB fishery. The dots reference the number of observed trips (x-axis) in each strata.

### Yellowtail GB: Total Target Coverage Weighted by Total Discard (D)

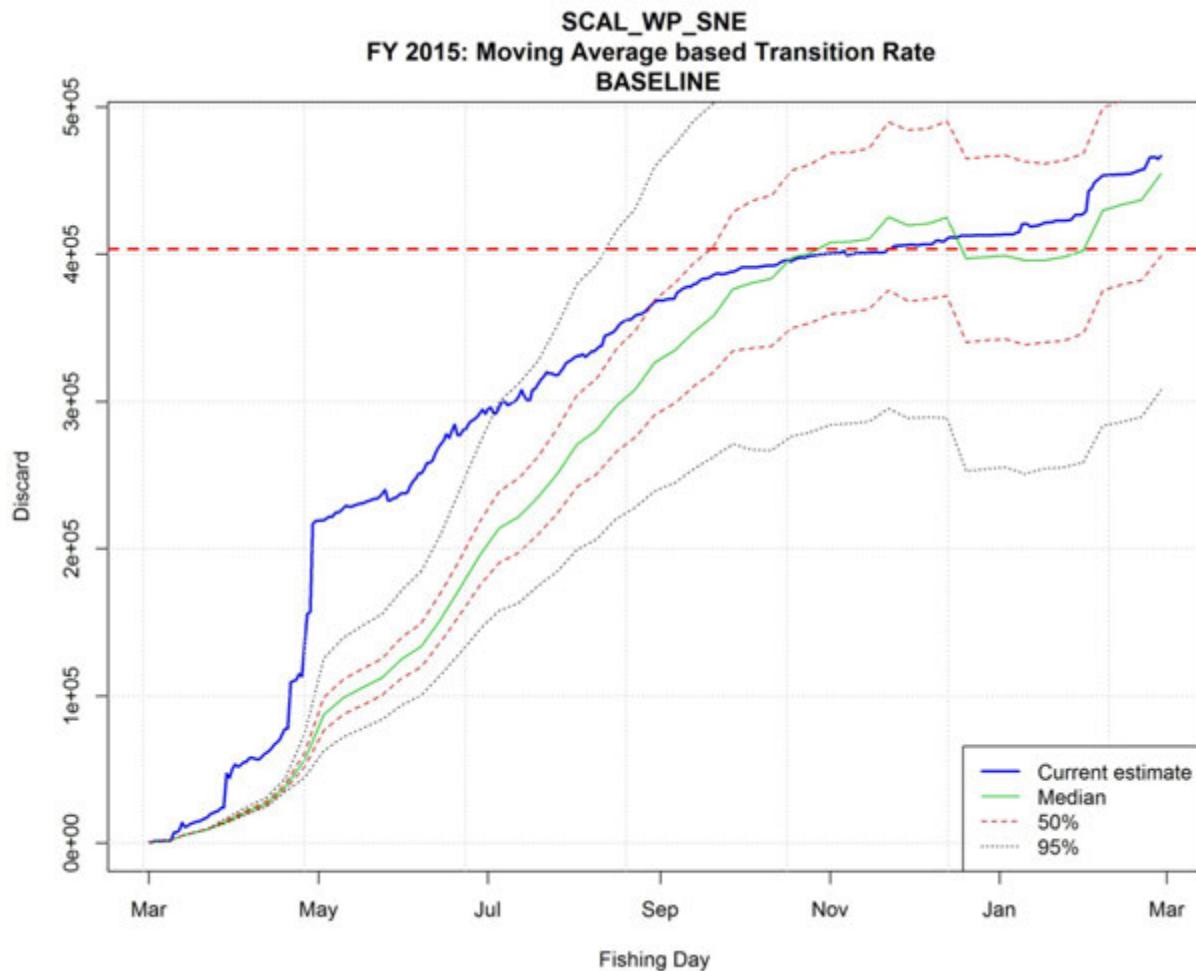


**Figure 25 Stratified discard weighted CV curve for the YTF GB fishery.** Red dashed lines show the theoretical required coverage rate for the fishery to achieve a CV %30 for each alternative when weighting by estimated discard in each stratum. The dashed blue lines and dot show the actual coverage rate and unweighted, fishery wide CV. The unweighted CV is very close to the weighted CV curve given that there are only two strata in the baseline and the CAII sample size is very small relative to the Open Area sample size. There was no difference in alternate I and II since there was only a single gear type fished (dredge). During fishing year 2015, there were very few trips in CAII, resulting in strikingly similar results between the baseline and alternate I.

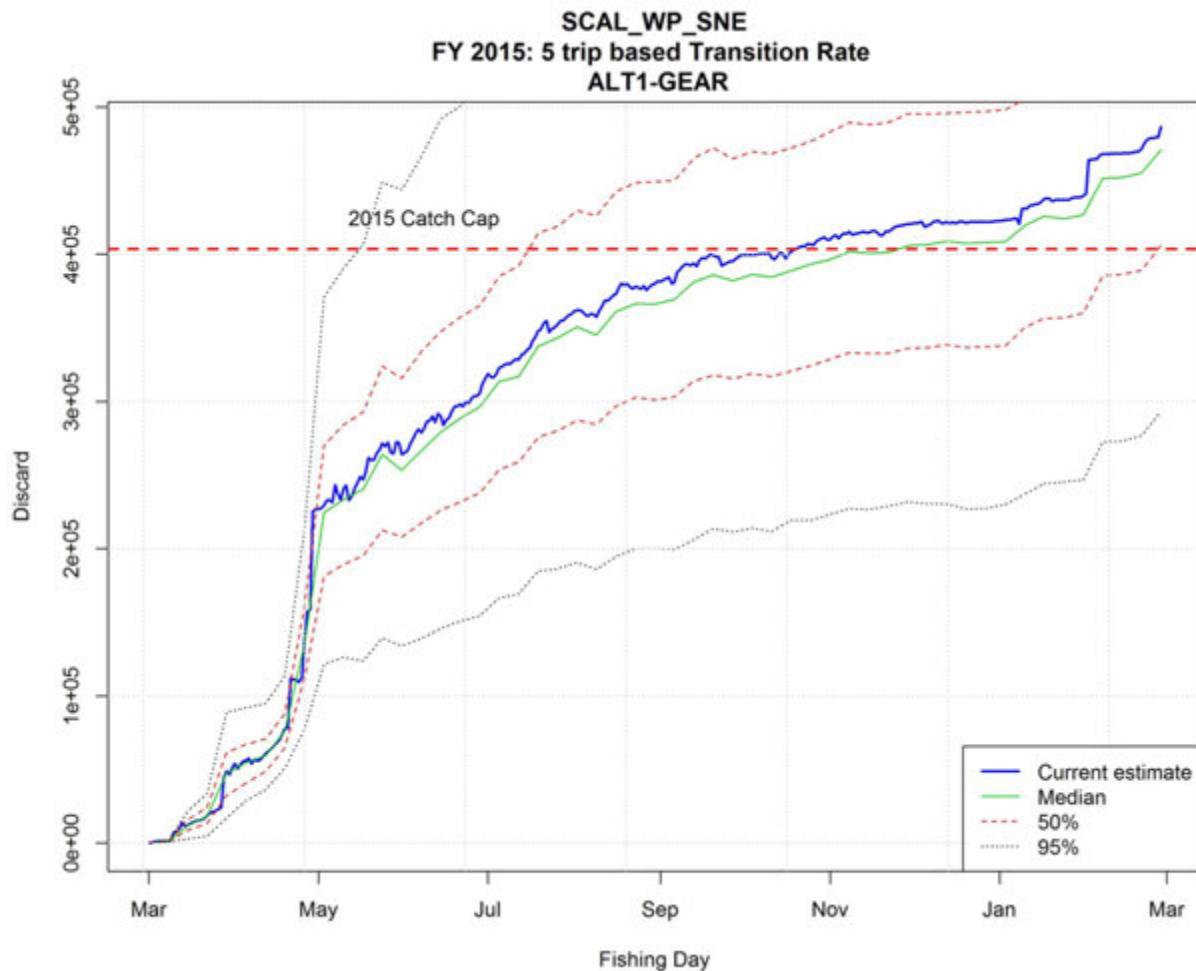
*Appendix C. Windowpane flounder SNE/MA Simulation results*



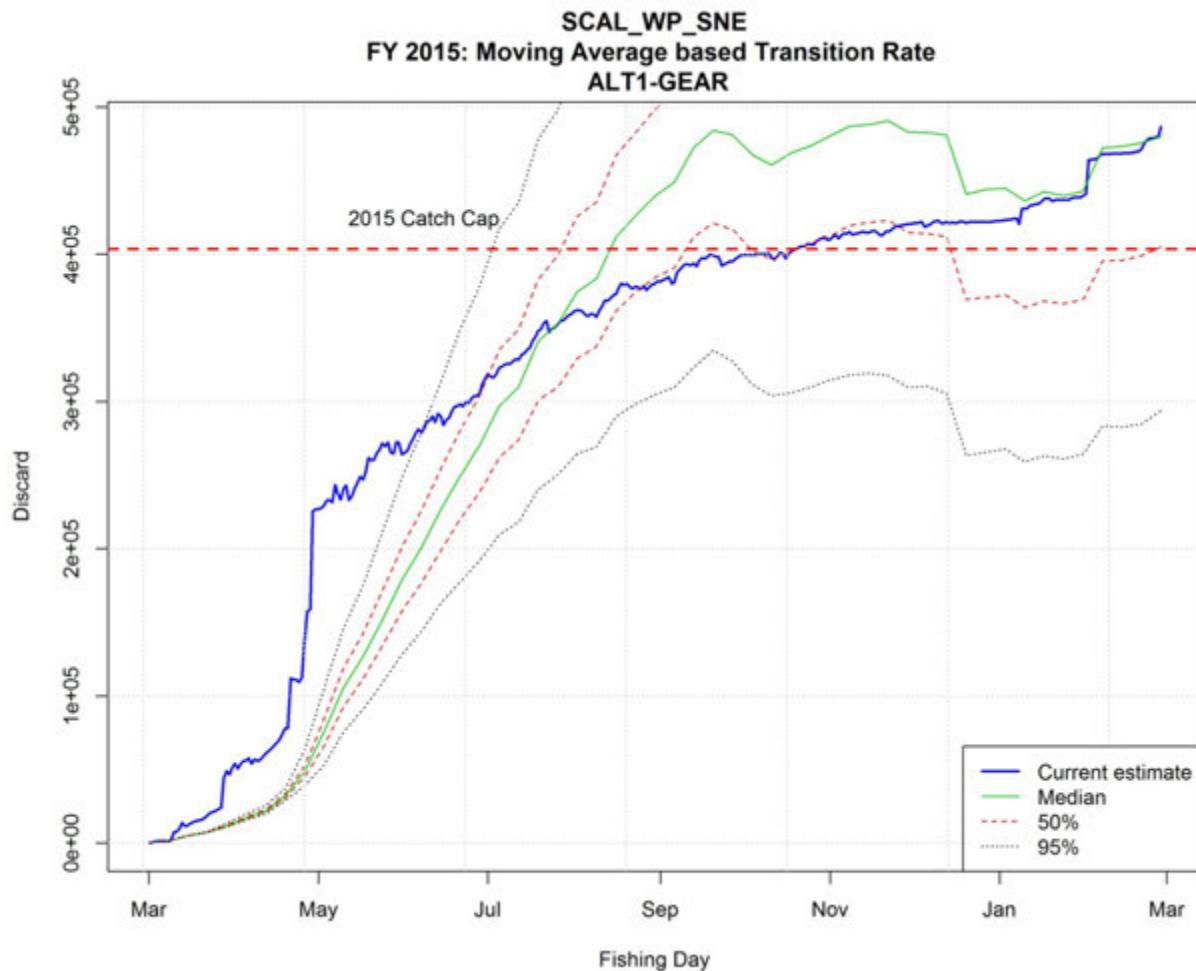
**Figure 26 WP SNE/MA baseline stratification and a 5 trip transition rate. Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.**



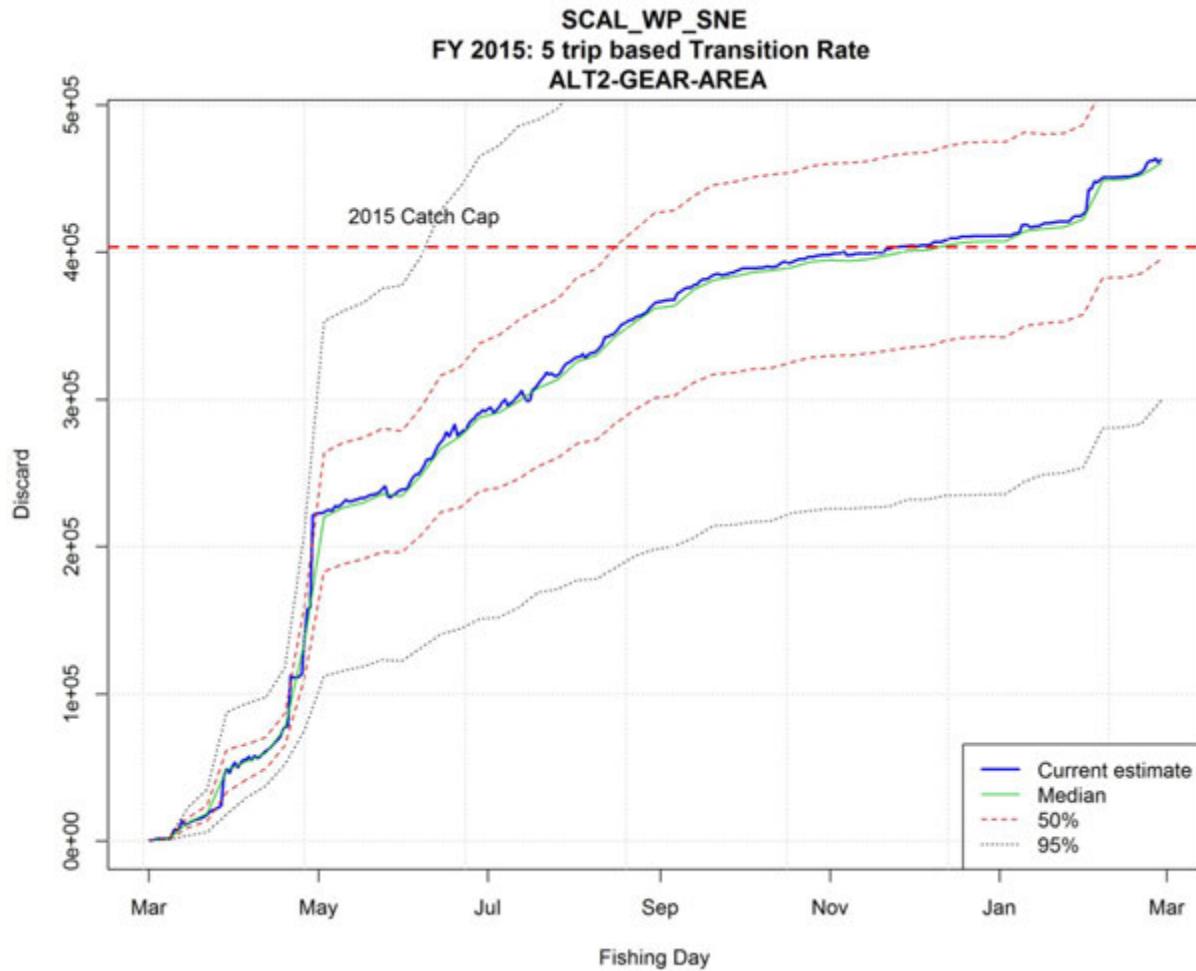
**Figure 27 WP SNE/MA baseline stratification and a 365 day transition rate. Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.**



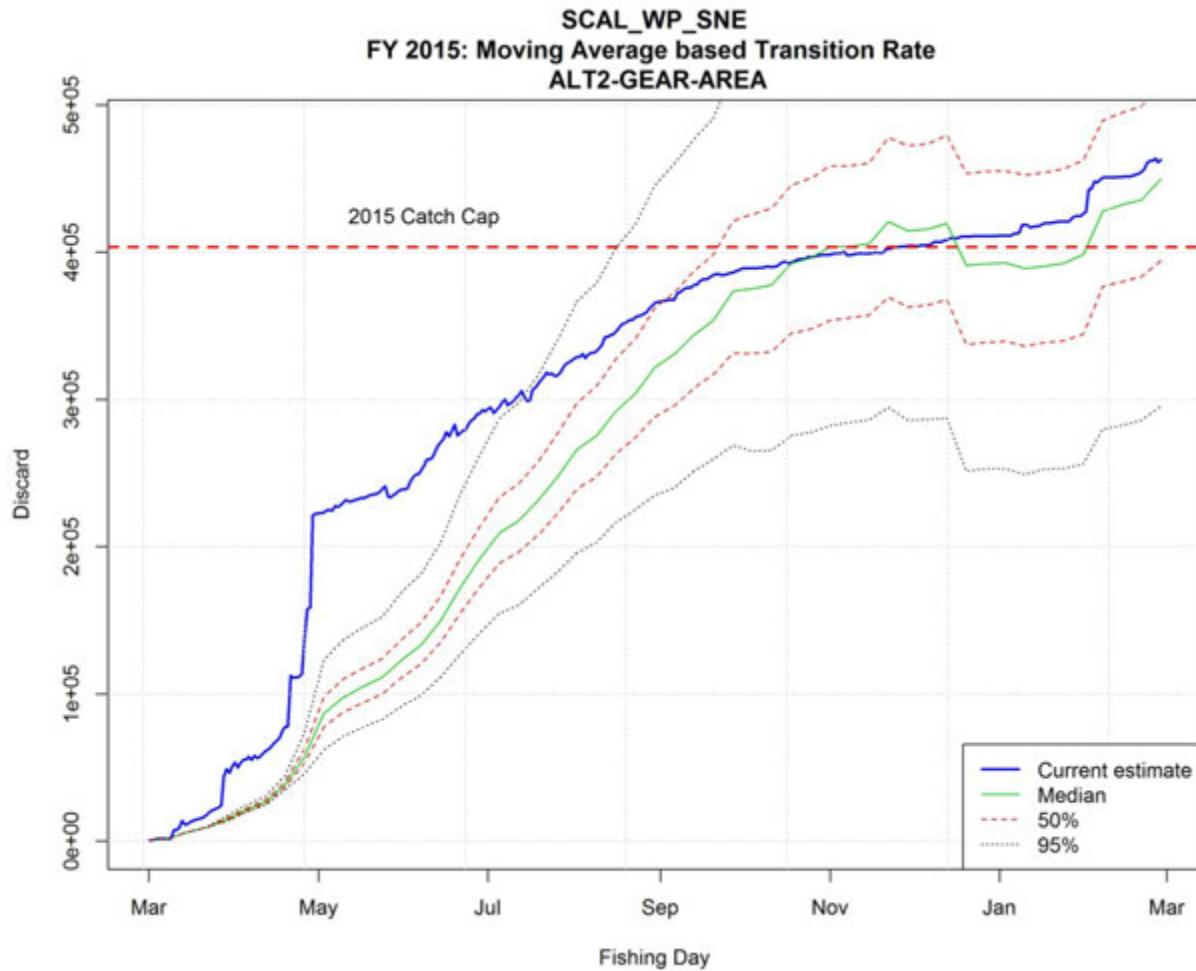
**Figure 28 WP SNE/MA gear only stratification and a 5 trip transition rate. Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.**



**Figure 29 WP SNE/MA gear only stratification and a 365 day transition rate. Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.**

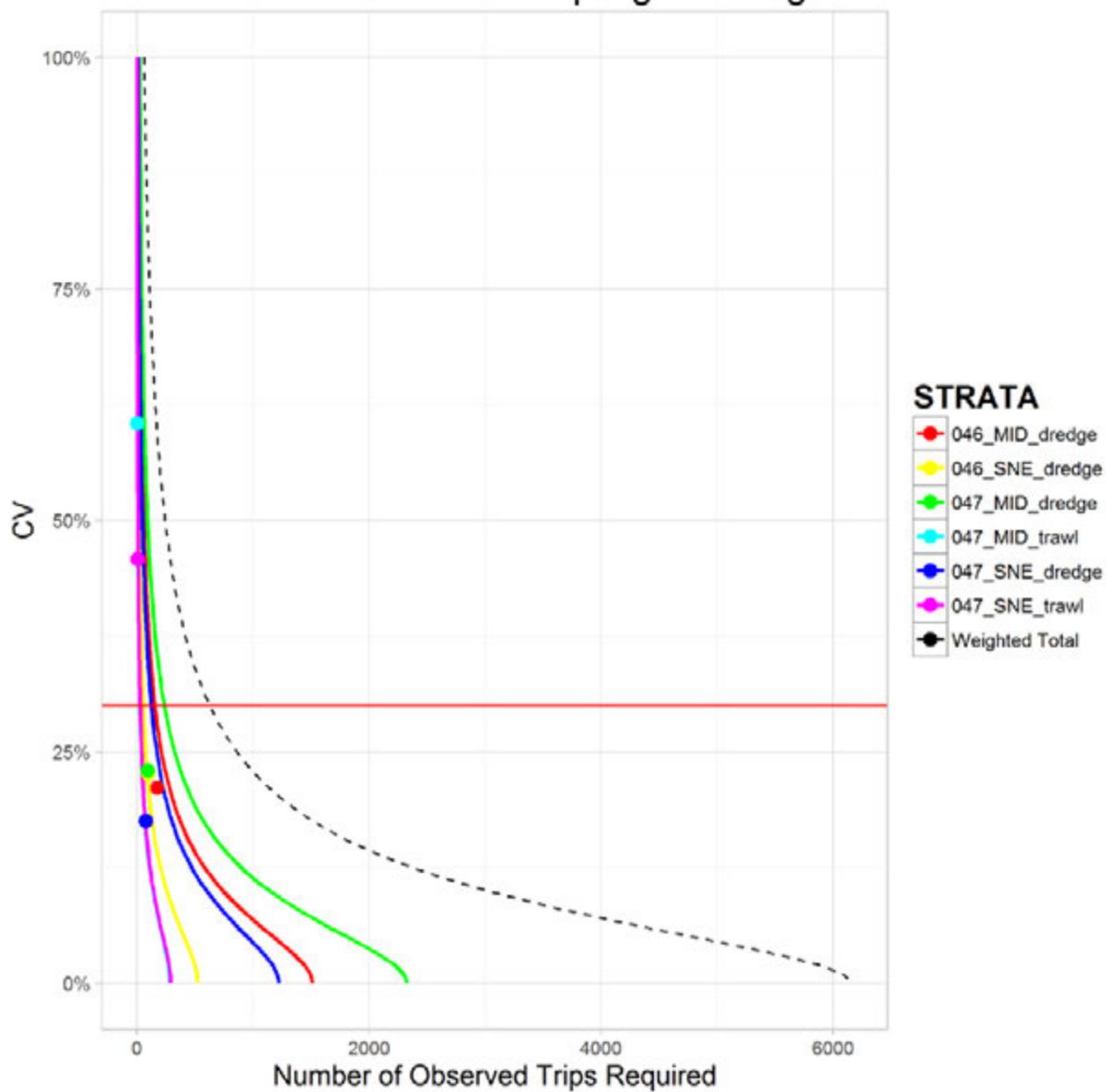


**Figure 30** WP SNE/MA gear and area (no access areas) stratification and a 5 trip transition rate. Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.



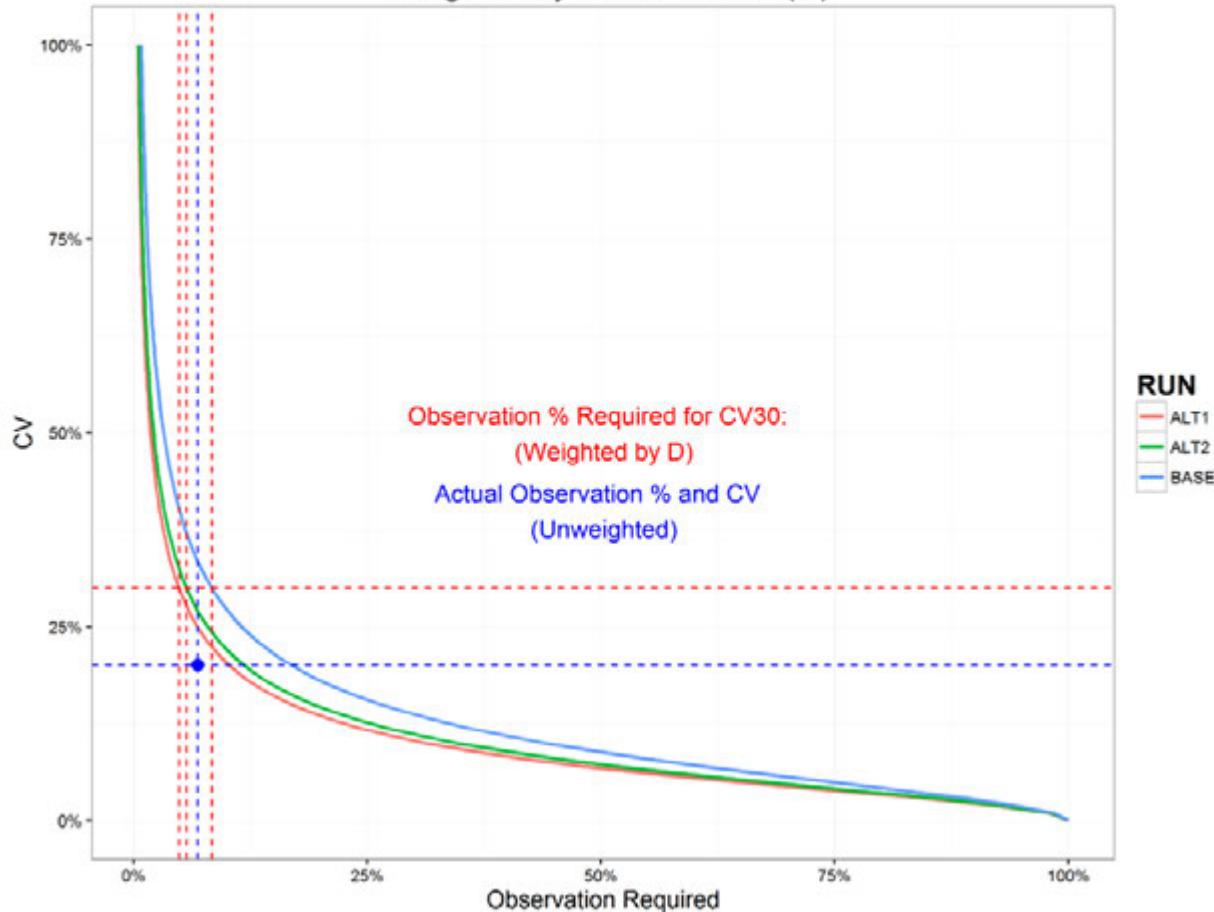
**Figure 31** WP SNE/MA gear and area (no access areas) stratification and a 365 day transition rate. Dark red dotted line is the catch cap for fishing year 2015. Current estimate refers to a baseline run without bootstrapping.

## WP SNE: Stratified Sampling Coverage



**Figure 32** Trips required for a range of target %CV for all baseline strata. The black dashed line is the stratified discard weighted average CV curve for the WP SNE/MA fishery. The dots reference the number of observed trips (x-axis) in each strata.

### Windowpane SNE/MA: Total Target Coverage Weighted by Total Discard (D)



**Figure 33 Stratified discard weighted CV curve for the WP SNE/MA fishery.** Red dashed lines show the theoretical required coverage rate for the fishery to achieve a CV %30 for each alternative when weighting by estimated discard in each stratum. The dashed blue lines and dot show the actual coverage rate and unweighted, fishery wide CV. Alternative 1 and 2 are nearly identical for fishing year 2015 and require slightly lower coverage rates.

## *Appendix D. Terms of reference*

### **Terms of Reference- In-Season Discard Methodology Peer Review**

#### **GARFO Analysis and Program Support Division – July 2016**

1. For each fishery subject to in-season discard monitoring utilizing the cumulative discard method, summarize the variability in discard rate by measurable strata: fishery, gear, area, season, volume of catch, etc.
2. Identify more optimal applications of the current cumulative method for in-season estimation of discards in comparison to existing cumulative discard methodology and stratification schemes. Alternatives identified will include
  - a. Existing cumulative discard methodology and stratification scheme as a baseline
  - b. Pooling data across current stratifications to increase information and precision. As an example, pooling across sectors and gears.
  - c. Including seasonality as a stratification
  - d. Allocate/restrict sampling requirements to those strata which in aggregate constitute a target fraction of total stock-specific discards. (i.e, excluding or minimizing sampling for strata with negligible discard totals)
3. Methods identified in TOR 2 will be compared using the following metrics
  - a. Precision of the discard estimates for a given level of observer coverage
  - b. Consistency of discard estimates calculated over the course of the fishing year.
  - c. Precision and consistency of the CV discard metric for a given level of observer coverage
  - d. Sensitivity to missing or erroneous data.
4. Examine methods for including data from past years to improve predicting the in-season estimation of discards.
5. Use archived data to simulate in-season behavior (with various time steps and discarding patterns) and recommend a preferred method for each fishery with consideration of the following:
  - a. Feasibility, particularly the implications of stratum size and within-year pattern of precision.
  - b. The probability and timing of premature closure (i.e. false positive).
  - c. The probability and magnitude of exceeding a cap (i.e. e. false negative).