



New England Fishery Management Council

50 WATER STREET | NEWBURYPORT, MASSACHUSETTS 01950 | PHONE 978 465 0492 | FAX 978 465 3116
E.F. "Terry" Stockwell, *Chairman* | Thomas A. Nies, *Executive Director*

MEMORANDUM

DATE: Wednesday, April 16, 2014

TO: Groundfish Oversight Committee (GF OSC)

FROM: Groundfish Plan Development Team (GF PDT)

SUBJECT: Gulf of Maine (GOM) cod in Statistical Reporting Area (SRA) 514

1. Background

In response to Amendment 18 (A18) scoping comments, the Groundfish Oversight Committee (GF OSC) discussed the potential impact of inshore and offshore (i.e., small and large) vessels on the Gulf of Maine (GOM) cod stock. The public was concerned that Amendment 16 removed trip limits and created an incentive for traditionally offshore vessels to target cod in the Gulf of Maine stock area (e.g., the 800 lb. GOM cod trip limit created a disincentive for larger vessels to complete a trip in the GOM. Under the trip limit, larger vessels would catch the limit when returning from an offshore trip). In addition, comments from the public suggested that increased effort by the larger vessels placed the GOM cod stock at greater risk for localized depletion. The Committee requested that the Groundfish Plan Development Team (GF PDT) examine the issue.

At the January 2014 Committee meeting, the Committee passed a motion:

To task the PDT to analyze the effort by vessel classes in statistical area 514 and adjacent areas as appropriate between FY 2004 and FY 2012; adjacent areas to include areas south of Cape Cod as the PDT deems appropriate.

2. Overview of the Approach

To date, the PDT's approach has focused on examining: changes in the distribution of GOM cod from survey information, trends in cod landings in Statistical Reporting Area (SRA) 514 and adjacent SRAs, and GOM cod catches and effort in SRA 514 by vessel size classes. However, this summary does not incorporate previous studies on the subject or compare commercial catches of GOM cod with recreational catches.

3. Examining the distribution of GOM cod

Introduction

The PDT examined broad-scale distributional patterns of GOM cod over time.

Data

Data included cod survey catches (weight) and locations (latitude and longitude) from Northeast Fisheries Science Center (NEFSC) spring bottom-trawl surveys, 1968-2011.

Methods

The data was grouped into 10 year periods: 1968-1979; 1980-1989; 1990-1999; and 2000-2011. Bagplots were constructed for each of these groupings (Figure 1). These plots are an extension of boxplots that take into account location information and provide a coarse but useful way for examining changes in the survey catches and distribution on a large spatial scale. The red asterisk is the bivariate median (i.e., catch weighted Latitude, Longitude).

Results

The analysis suggests that there has been a concentration of GOM cod into SRA 514 in the area of Stellwagen Bank, where as in the past GOM cod were more widely distributed.

Other information from the recent National Marine Fisheries Service (NMFS) stock assessment report (NEFSC 2013, CRD 13-11) shows similar broad-scale patterns (e.g., proportional distribution plots, Gini indices, centroids, landings trends) as does the recent survey report from the Maine-New Hampshire inshore GOM trawl survey (Sherman et al. 2013). Furthermore, the cod industry-based survey, in 2003-2007, was designed to examine the distribution of cod in the GOM. It was determined that cod biomass is centered in the western GOM with few fish found in the eastern GOM. These patterns are also consistent with the recent spatial distribution of cod in the NEFSC spring survey.

Discussion

Cod distribution in the GOM has contracted to the western GOM. This pattern is likely the product of, among other factors, a loss of inshore spawning components, changes in stock size, and fluctuations in environmental conditions. However, these factors were not examined in the analysis.

4. Landings and effort of GOM cod, *Steven J. Correia, Massachusetts Division of Marine Fisheries*

Introduction

The PDT examined trends in landings and number of trips by vessel class SRA from 1994 to 2012. This included an analysis of total trips, total landings, catch per unit effort (CPUE), and mean cod landings relative to SSB.

Data

The dataset is from commercial fishing vessel trip reports (VTRs) from fishing year (FY) 1994-2012 and preliminary data from FY 2013. The data includes kept GOM cod catch aggregated at the trip level/statistical area level using permit, landing date, and statistical area (511, 512, 513, 514, and 515), and commercial trip category (trip type = 1). Descriptions for SRA 510 and vessel class less than 30 are not provided because of confidentiality concerns.

Total Trips

Methods: The number of trips by vessel class was examined. The independence of trips was examined by vessel class and fishing years using a Poisson log-linear model.

Results: The number of trips by vessel class as a proportion of total trips reported within a fishing year is shown in Table 1. Total number of trips reporting keeping cod and fishing within the GOM in 2012 was approximately half of the total trips reported in 1994. Small vessels (30<50 ft) account for the largest proportion (77%) of trips through-out the time series (Figure 2, Table 1). Mid-size vessels accounted for 21% of trips landing cod, and the largest vessels accounted for less than 3% of the trips.

The proportion of trips by vessel class varies among fishing years. The frequency of trips is not independent of fishing year and vessel class (Figure 3). The number of trips for small vessels (30 to < 50 ft), was more than expected from 2001 through 2009. The opposite pattern was observed for the middle size (50 to < 75 ft) and largest vessel class (75+) in that the number of trips was less than expected from 1998 to 2009.

Discussion: This pattern likely developed in response to Frameworks 26 and 27, which were implemented in 1999 (see Appendix for an overview of management actions). Amendment 16 eliminated many of the management input control measures implemented prior to 2010. It appears as if the proportion of trips by vessel class has returned to the pre-Framework 25 period.

Total Landings

Methods: The PDT reviewed a previous PDT analysis of 1964-2010 GOM cod landings in SRAs: 511, 512, 513, 514, and 515 in order to compare total landings of cod within each SRA.

Results: Figure 4 displays GOM cod landings as a percentage of total GOM cod landings by each statistical area by calendar year. Statistical areas are ordered based on lowest to highest median percentage of GOM cod landings in that area relative to the total: 511, 512, 515, 513, and 514. The analysis suggests increased landings of GOM cod in statistical area 514 relative to other GOM areas. In 2010, nearly 77% of cod landings were taken in 514. This is well above the time-series median of 45%.

Total cod landings by vessel class as reported by VTR are shown in Figure 6. The 30 to 50 ft vessel category has landed the highest proportion of cod landings throughout the time series.

Discussion: The cause of the shift in distribution of the landings is likely multi-factorial and includes a contraction in the distribution of cod as evidence in the NEFSC spring survey time series and consistent with distribution of cod as determined by the Industry Based cod survey (2003-2007). Other factors include effects from management actions that produced seasonal and year round closures within the GOM. Environmental conditions can also influence the distribution of cod and the distribution of fishing effort.

Catch Per Unit Effort (CPUE)

Methods: CPUE as kept cod landings per trip was examined by vessel class. An approach was developed to standardize CPUE. The PDT examined a priori analysis that standardized cod kept

per trip by vessel class, using fishing year 1994 and the 30 to 50 ft vessel class as a reference year. The purpose of the analysis is to examine how mean catch rates fluctuated in response to management measures.

Results:

Cod landings per Trip - The mean cod kept per trip by vessel class for SRA 514 is shown in Figure 7. Mean cod kept per trip was relatively low in 1994 for all three vessel classes. As might be expected, larger vessels have higher catch per trip than smaller vessels. Landings per trip has been generally higher since 1994 for all vessel classes. Landings per trip peaked in 2009 for all vessel groups and has declined since 2009.

Standardized cod landing per trip - Trends in the back-transformed year coefficients are shown in Figure 8. In 1994, the 50 to < 75 vessel class mean landings per trip was 1.15 times the 30 to < 50 ft class. The largest vessel class mean landings per trip was 3.17 times the 30 to < 50 ft class. The year coefficients represent changes in cod kept for 1994 for 30 to 50 ft vessel class and are factors relative to 1994 average landings per trip for 30-50. With the exception of large vessel class in 1998 and 2006, all vessel classes catch rates were better than 1994.

Discussion: After implementation of FW 25 in 1998 through 2009, the largest vessels performed worse than the other two vessel classes. After implementation of Amendment 16, the largest vessel classes relative landings per trip increased. The period of 1998 through 2009 marks an era of management via input controls. The larger size vessels have higher productivity and measures such as trip limits become more constraining compared with smaller vessels with smaller production capacity. Sectors became exempt from days-at-sea (DAS) and trip limits in Amendment 16. This allowed the largest vessels to utilize higher productivity to land more cod per trip in fishing years 2010 and 2011. Relative landings per trip declined for all vessel groups in 2012.

Mean cod landings relative to trends in SSB

Methods: Mean cod landings by vessel class were regressed on spawning stock biomass (SSB) from SARC (most recent) from 1994 to 2011. SSB was not available for 2012 (Figure 9).

Results: The regressions were significant for the 30 to < 50 ft class ($P < 0.01$) and the 50 to < 75 class (< 0.001), but not for the 75+ class ($P = 0.064$). Although the regression is close to 0.05, the diagnostics suggest a lack of fit and several points (1996, 2010 and 2011) having large influence (Figure 10). Diagnostics for the 50 to < 75 ft class suggested that caution should be used in interpreting the regression.

Discussion: The lack of fit in the model suggests that management measures implemented between 1998 and 2009 constrained production capacity of the 75+ vessel class. These analyses indicate that the mean cod landing rates for two smaller vessel categories may be susceptible to decline in exploitable biomass. The precipitous drop in mean landings per trip for all three vessel classes in 2012 may be related to declining cod biomass as indicated in declines in various fishery independent trawl surveys and a series of poor year-classes.

5. Summary Conclusions

- Cod distribution in the GOM has contracted to the western GOM; where as in the past cod was widely distributed in the GOM. Fishing effort and catches have also concentrated in SRA 514, which possibly increases the risk of localized depletion on inshore spawning cod.
- The majority of the cod catches within 514 were taken by the smaller vessels throughout the time series. However, the vessel size classes have different fishing power. Larger vessels have higher catch rates of cod compared with smaller vessels. The number of trips by larger vessels increased slightly, but the smaller vessel size class dominated the number of trips. The decline in the proportion of landings in the $30 \leq 50$ ft class was caused by declines in the total number of trips into 514 and catch per trip.
- Fishing patterns appear to have changed in response to management measures and cod distribution since vessels targeting cod will fish where the cod are. Trip limits appeared to have constrained the two larger vessel size classes compared with the smaller class ($30 \leq 50$ ft). Vessels trying to optimize revenues fish where cod are available given the (relatively high) price for cod.
- Management regulations had different effects on vessel classes. Vessel classes have differing abilities to respond to these effects (i.e. a large vessel has many more areas accessible and is not as restricted by safety concerns of traveling farther offshore or to other locations to fish, while a smaller vessel is much more constrained spatially).

6. References

Hoffman, W.S., Correia, S. J. and D. E. Pierce. 2008. Industry-Based Survey for Gulf of Maine Cod Pilot Study Final Report for Contract #: EA133F-03-CN-0109.

Northeast Fisheries Science Center. 2013. 55th Northeast Regional Stock Assessment Workshop (55th SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 13-11; 845 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at <http://www.nefsc.noaa.gov/nefsc/publications/>

Sherman, S., Stepanek, K., King, C., Eckert, R., and Tetraault, R. 2013. Annual Report on the Maine-New Hampshire Inshore Trawl Survey January 1, 2012-December 31, 2012 Contract # NA10NMF4720284 (2025) Submitted to the NOAA Fisheries Northeast Region Cooperative Research Partners Program December 2013 Available online at: <http://www.maine.gov/dmr/rm/rawl/reports/index.htm>

7. Tables

Fishing year	30 TO	50 TO	75 AND	total	30 TO LESS	50 TO LESS	75 AND
	LESS THAN 50	LESS THAN 75	OVER		THAN 50	THAN 75	OVER
Number of trips					Percentage of total trips in fishing year		
1994	11350	4564	793	16707	68	27	5
1995	12864	4476	679	18019	71	25	4
1996	11947	4242	701	16890	71	25	4
1997	11705	3144	382	15231	77	21	3
1998	9348	2532	279	12159	77	21	2
1999	7973	2466	166	10605	75	23	2
2000	10063	2778	199	13040	77	21	2
2001	12170	2815	192	15177	80	19	1
2002	10732	2534	171	13437	80	19	1
2003	11350	2554	222	14126	80	18	2
2004	10355	2482	272	13109	79	19	2
2005	10919	2629	258	13806	79	19	2
2006	10561	2353	227	13141	80	18	2
2007	10708	2385	250	13343	80	18	2
2008	11044	2243	255	13542	82	17	2
2009	12112	2407	310	14829	82	16	2
2010	5393	1536	433	7362	73	21	6
2011	7222	1954	622	9798	74	20	6
2012	6085	1951	669	8705	70	22	8
Total	193901	52045	7080	253026	77	21	<3

Table 1- Number of trips in GOM that reported keeping cod by statistical areas by vessel class and fishing year and the number of trips by vessel class as a percentage of the total.

Fishing Year	LESS THAN 30	30 TO LESS THAN 50	50 TO LESS THAN 75	75 AND OVER
1994	1.4	49.5	36.2	12.8
1995	0.9	43.8	45.2	10.0
1996	0.6	44.0	41.8	13.6
1997	0.6	58.5	30.8	10.1
1998	1.8	69.6	26.0	2.6
1999	1.9	72.7	23.9	1.5
2000	3.0	71.5	23.7	1.7
2001	3.5	72.5	22.2	1.8
2002	1.8	67.6	28.3	2.4
2003	1.8	69.8	26.3	2.2
2004	2.2	69.5	25.5	2.7
2005	0.3	71.6	26.2	1.9
2006	1.0	77.9	20.0	1.1
2007	0.5	77.9	19.9	1.7
2008	0.4	79.5	18.2	1.9
2009	1.1	77.3	19.6	2.0
2010	0.1	53.0	32.2	14.7
2011	0.1	44.9	35.5	19.5
2012	0.2	46.3	35.9	17.6
time series median	1.0	69.6	26.2	2.4

Table 2- Cod landings by vessel class as a percentage of total fishing year cod landings in SRA 514.

8. Figures

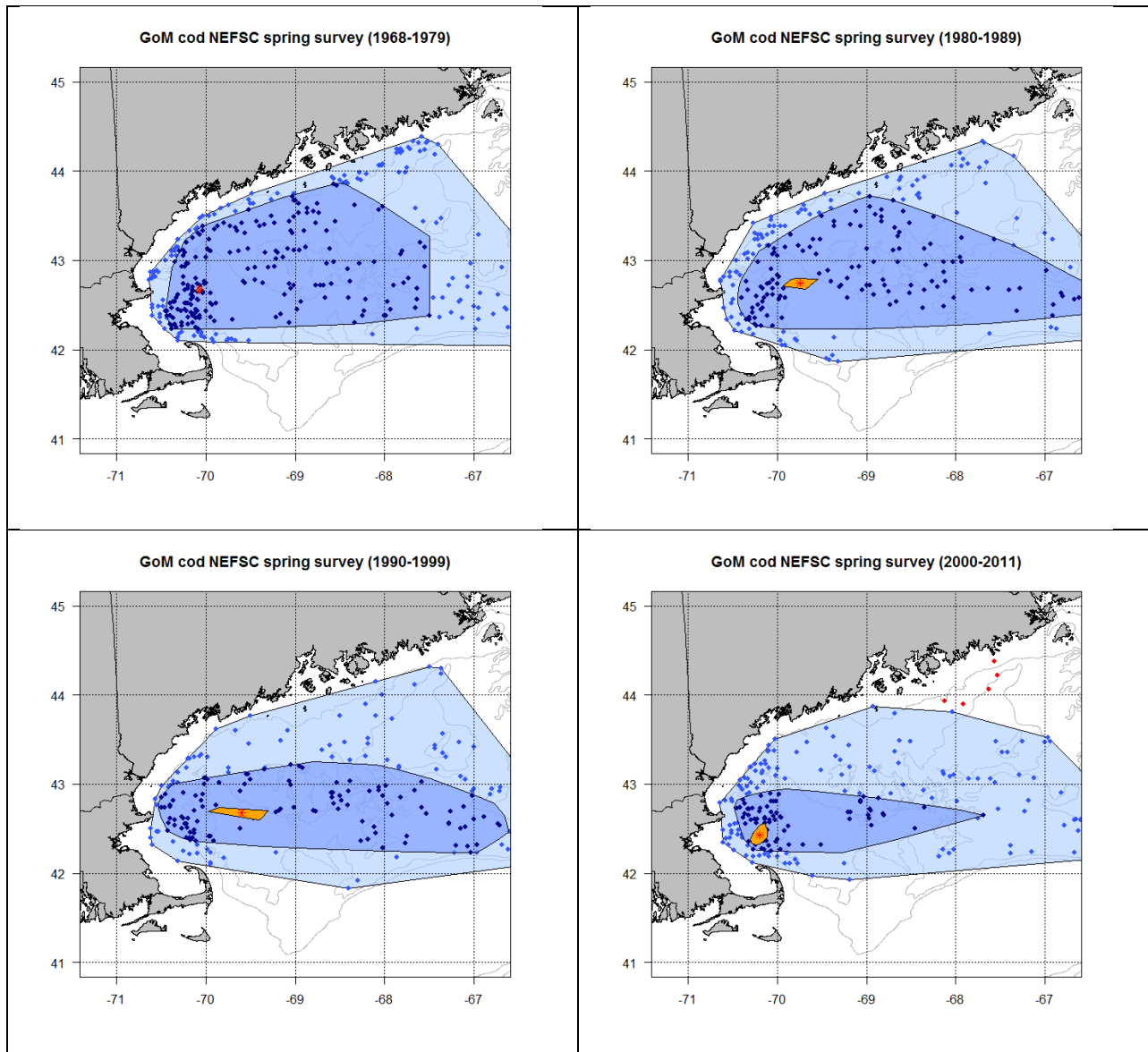


Figure 1- Bagplots of GOM cod survey catches are shown for 10 year groupings: 1968-1979; 1980-1989; 1990-1999; and 2000-2011. The red asterisk is the bivariate median (catch weighted Lat, Lon). The orange area is approximate 95% confidence interval for differences in bivariate median. The dark blue area contains the middle 50% of the data (the interquartile range, IQR). The light blue area encompasses approximately upper quartiles up to around 1 and 99%. The red dots outside of these areas are outliers (e.g., low survey catches in waters off the coast of Downeast Maine; 2000-2011). Source: NEFMC spring bottom-trawl surveys, 1968-2011. *Figure courtesy of Michael Palmer, Northeast Fisheries Science Center (NEFSC).*

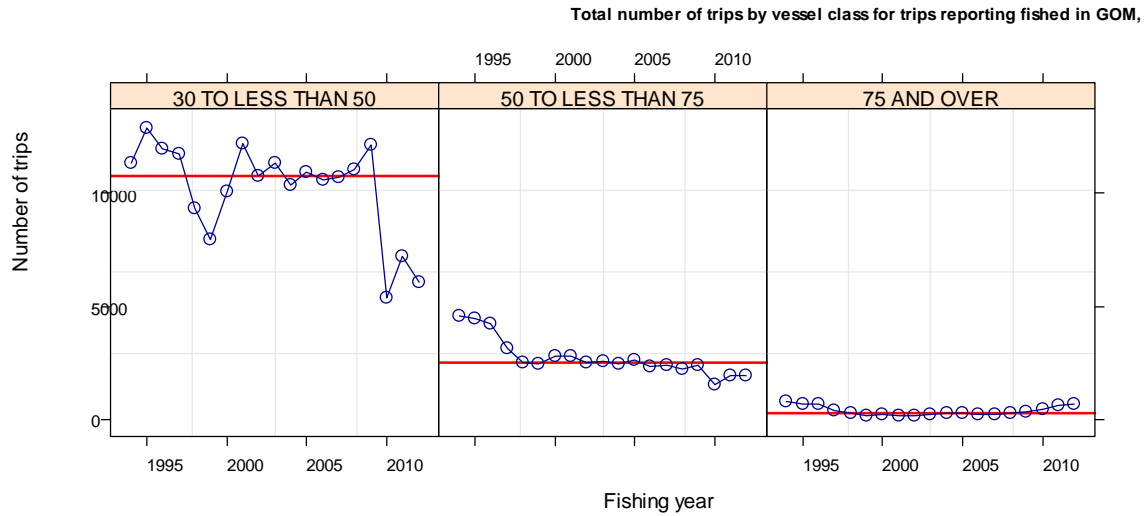


Figure 2- Number of trips reporting cod kept and fishing within the GOM by fishing year and vessel class size. Redline is time series median.

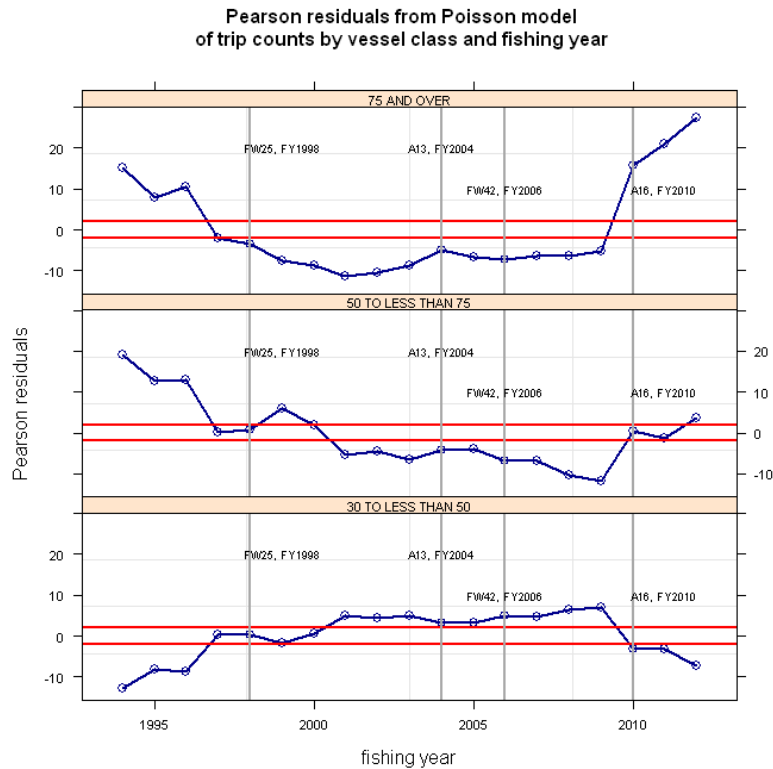


Figure 3- Pearson residuals from the Poisson log-linear model. Residuals greater than 2 or less than -2 indicate significant lack of fit to independence. Positive residuals represent more observed trips than expected. Negative residuals indicate fewer observed trips than expected. Gray vertical lines represent approximate date of implementation of major groundfish management actions.

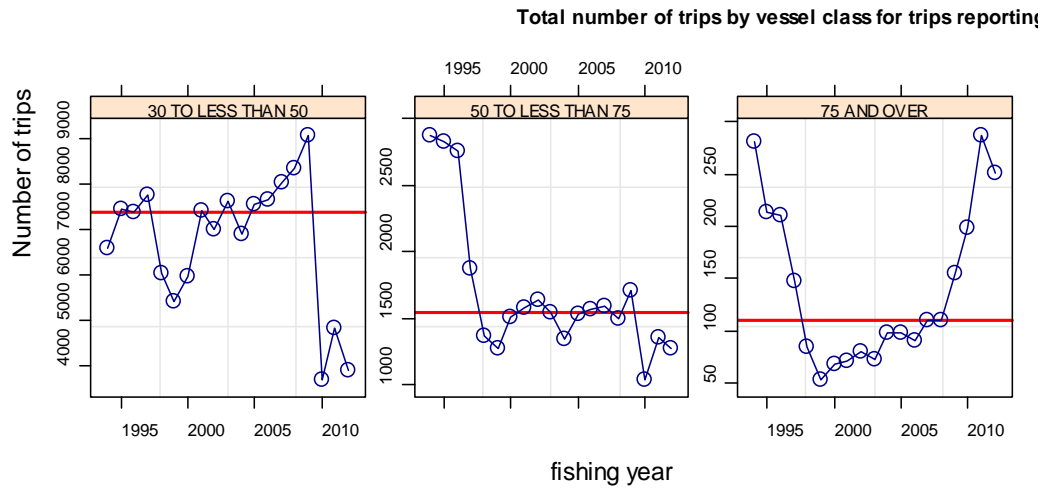
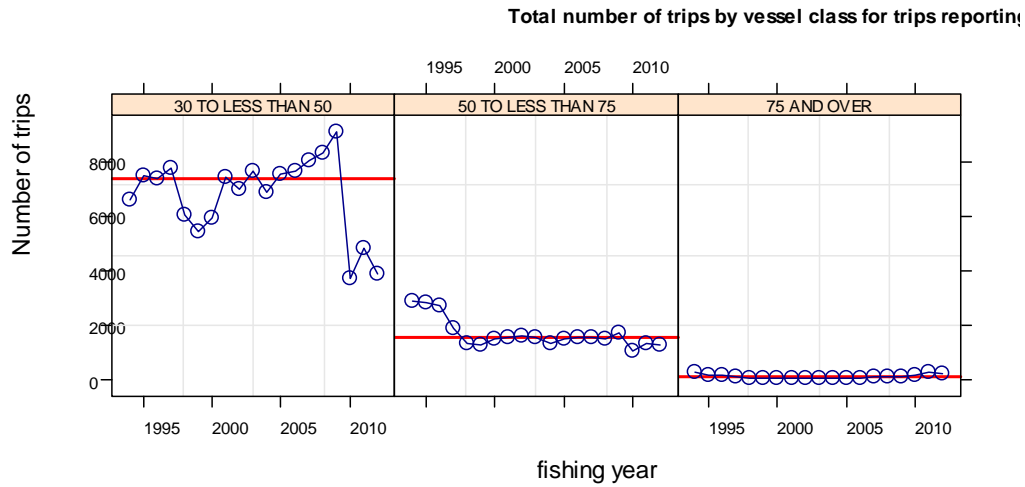


Figure 4 - Number of trips landing cod from SRA 514 for 1994-2012 by vessel class. Both panels are for the same data. The y-axis scale varies for the bottom panels. Red line is time series median for the time series within vessel class.

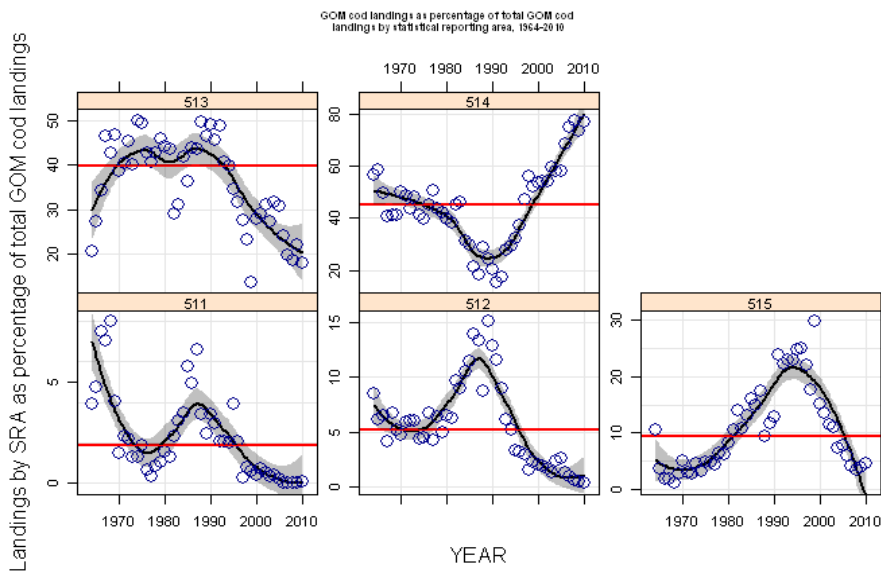
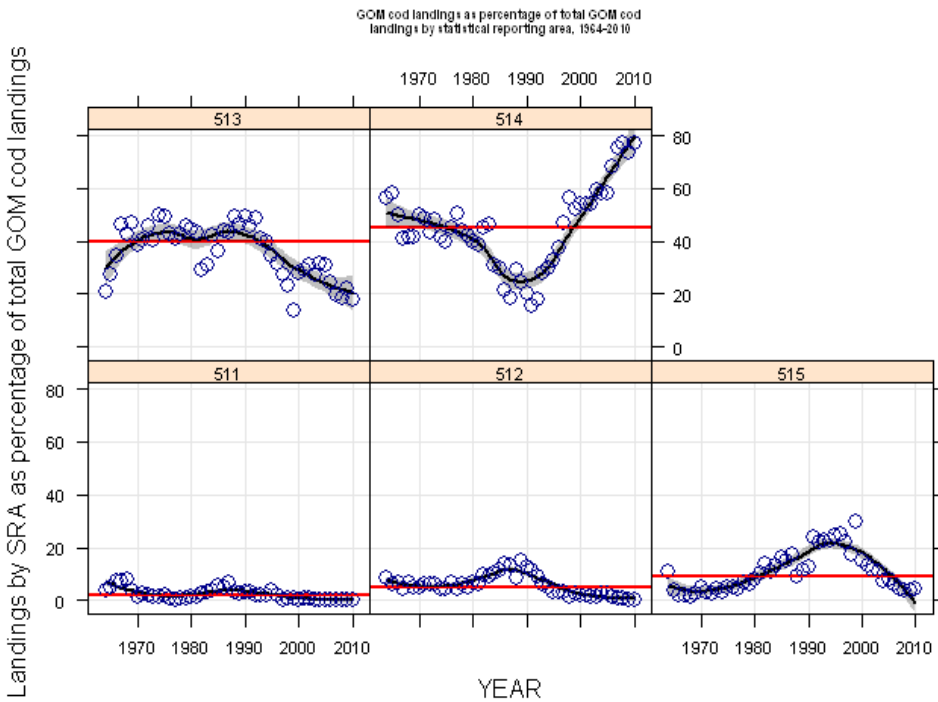


Figure 5 - Cod landings by SRA as a proportion of annual landing in calendar year. Red line is time series median. Y-axis varies among panels in bottom graphic. Smooth black line is a general additive model (GAM). Gray polygon is approximate 95% confidence interval on the smooth fit.

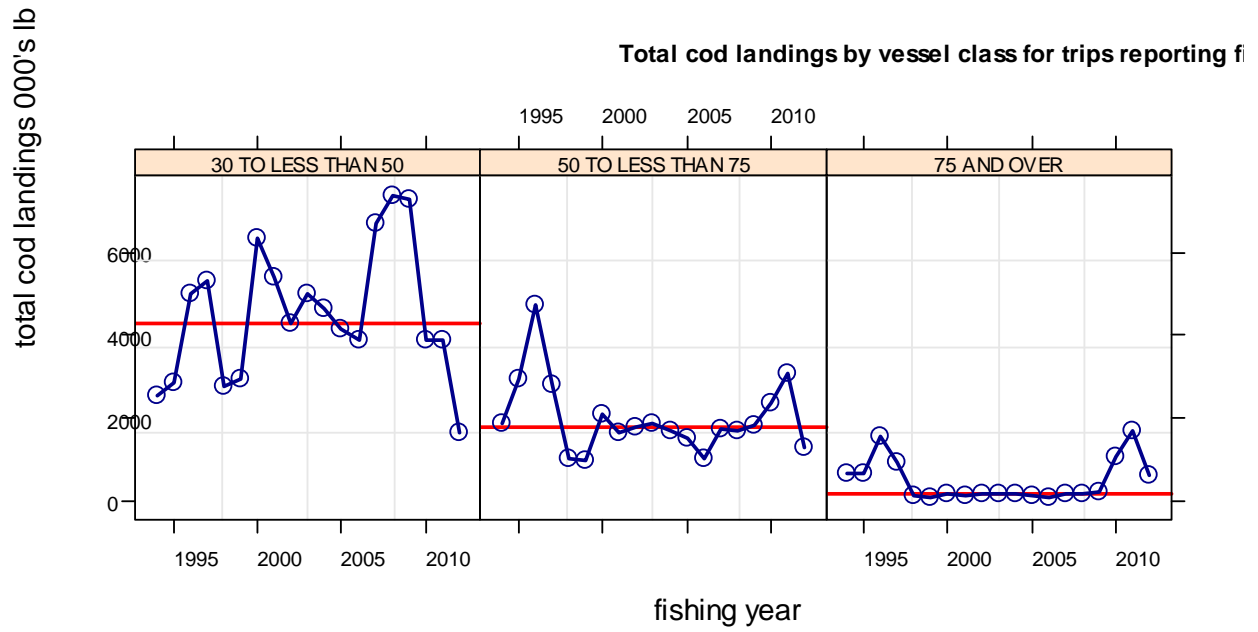


Figure 6- Total cod landings reported for SRA 514 by vessel class. Red line is time series median.

Fitted mean catch per trip by FY and vessel class in S

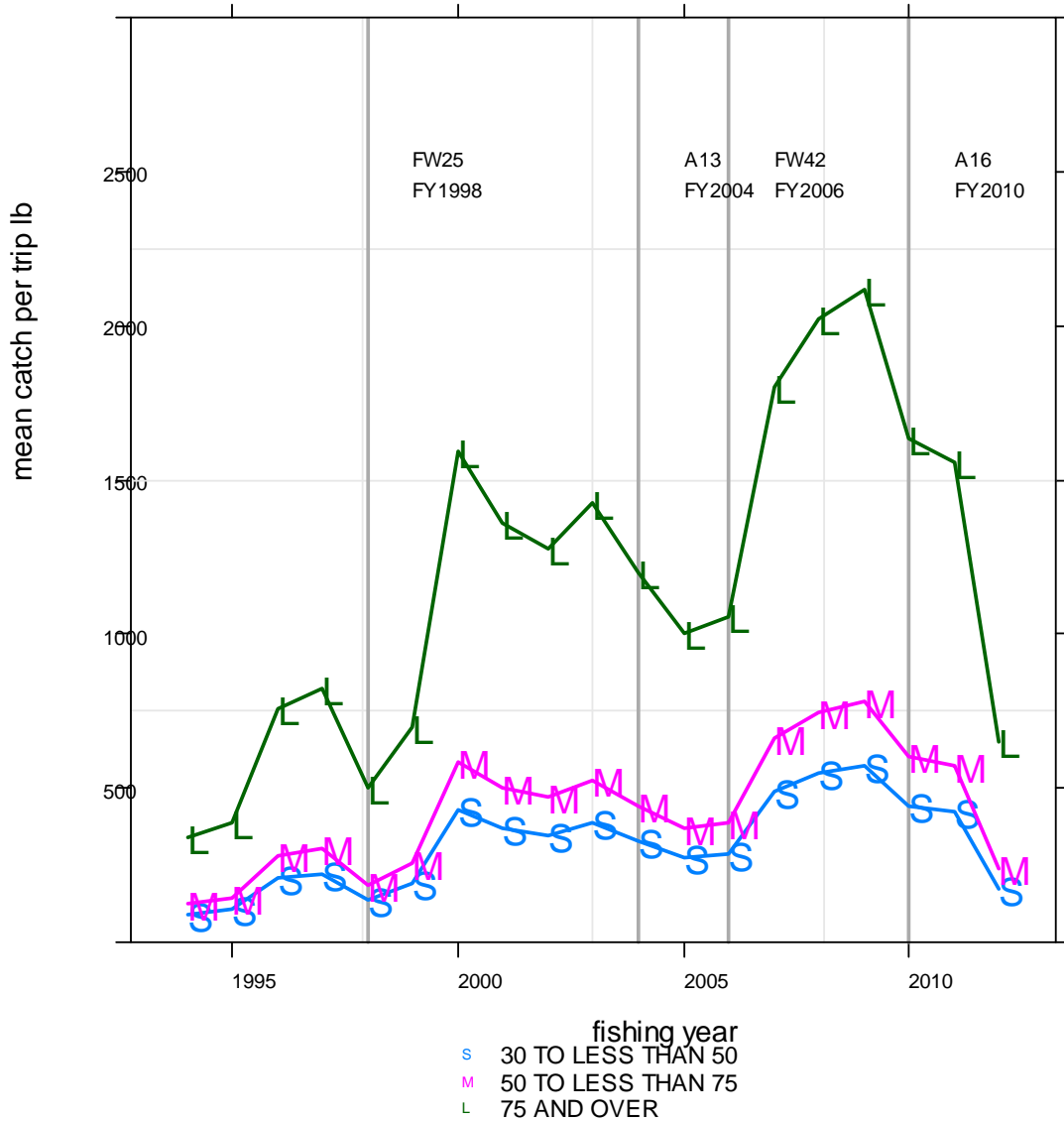


Figure 7 - Mean cod kept per trip by vessel category. Mean based on back-transformed fitted values from the linear model conducted on log transformed data. Gray vertical lines represent approximate date of implementation of major groundfish management actions.

Ratio cod.kept per trip to 1994 and vessel cla

Back-transformed year coefficients by vessel class
in SRA 514, fishing years 1994-2012

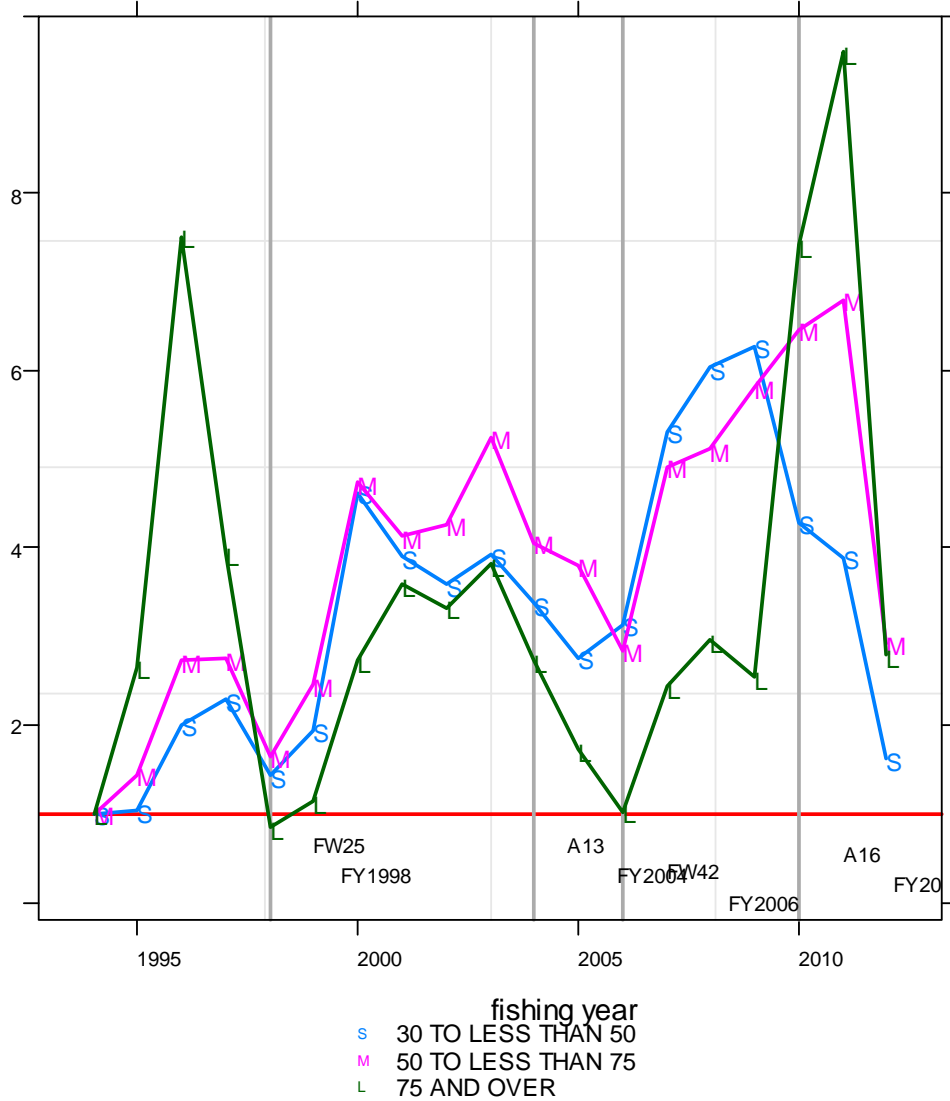


Figure 8 - Mean cod kept per trip as ratio of catch per trip in 1994 standardized to vessel class 30 to 50 ft. Red line =1. Values above 1 indicate that the average catch rate was higher than 1994. Gray line indicates approximate date of implementation of major groundfish management actions.

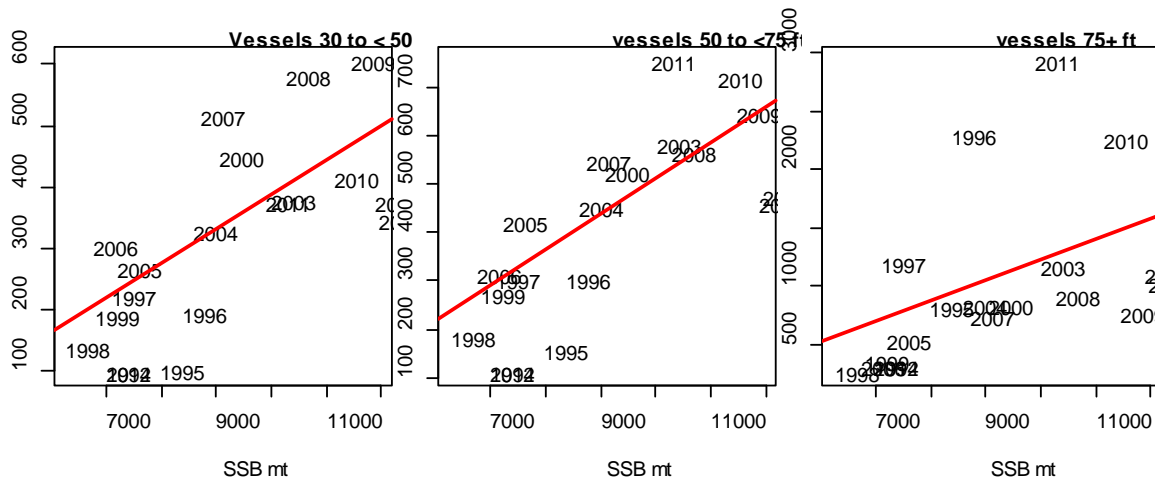


Figure 9 - Scatterplot of mean cod kept per trip against spawning stock biomass by vessel class for trips within SRA 514. Red line is regression fit.

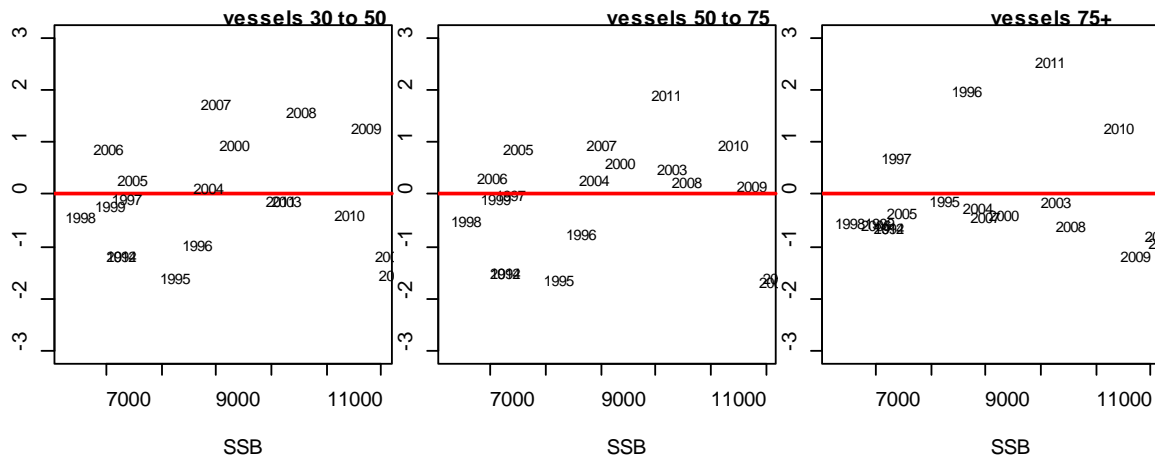


Figure 10 - Standardized residuals from regression of mean cod kept per trip by vessel class for trips within SRA 514.

Appendix: Summary of major regulatory actions that have affected the Gulf of Maine Atlantic cod fishery since 1973.

Date	Regulatory action	Cod end minimum mesh size (in)	Minimum fish size (in)		Commercial trip limits	Recreational trip limits	Closures	Differential DAS Counting
			Commercial	Recreational				
01/01/73		4.5	?	?				
01/01/77	Groundfish FMP	5.125	16	16				
01/01/82			17	15				
01/01/83		5.5						
01/01/89			19	19				
04/01/92	<i>Shrimp trawl fishery: Nordmore grate regulation, groundfish bycatch prohibited</i>							
05/01/94	Amendment 5	6.0						DAS monitory w/ reduction schedule, mandatory reporting
05/01/96	Amendment 7			20				Accelerated DAS reduction
05/01/97	Framework 20			21	1000 lbs day for first 4 days, then 1500 lbs/day; no overall cap but RA had authority to reduce limit			
05/01/98	Framework 25				700 lbs/day; no overall cap but RA had authority to reduce limit		WGOM (Jeffreys Ledge, Stellwagen Bank)	
06/25/98					400 lbs/day; no overall cap but RA had authority to reduce limit			
02/01/99	Framework 26						Additional month-block closures for February to April	
05/01/99	Framework 27	6.5 square/6.0 diamond			200 lbs/day; no overall cap			
05/28/99					30 lbs/day			
08/03/99	Interim rule				100 lbs/day, 500 lbs max per trip; modifications to running clock			
01/05/00	Framework 31				400 lbs/day, 4000 lb/trip		Additional month-block closures for February	
06/01/00	Framework 33	6.5 square/6.5 diamond						
11/01/00							One month closure of Cashes Ledge	
							Additional month-block closures for May - June 2003;	
05/01/02	Interim rule		22	23	500 lb/day, 4000 lb/trip	10 cod/person	Cashes Ledge Closed year round	20% reduction in DAS
06/01/02	Revised interim rule		19					

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Date	Regulatory action	Cod end minimum mesh size (in)	Minimum fish size (in)		Commercial trip limits	Recreational trip limits	Closures	Differential DAS Counting
			Commercial	Recreational				
08/01/02	Emergency rule		22			5 - 10 cod/person (seasonal)		
05/01/04	Amendment 13				800 lb/day, 4000 lb/trip		WGOM, Cashes Ledge and rolling closures continued	Further reduction in DAS
05/01/06	Emergency rule				600 lb/day, 4000 lb/trip			
11/22/06	Framework 42			24	800 lb/day, 4000 lb/trip	Possession prohibited November to March 31st		DAS counted 2:1 in inshore GOM
05/01/09	Interim rule					Possession prohibited November to April 15		
05/01/10	Amendment 16				None for sector vessels, varies in-season for common pool, handgear A and B vessels (50 lb/trip - 800 lb/day, 4000 lb/trip)	10 cod/person, Possession prohibited November to April 15	Some changes to rolling closures for sector vessels Whaleback closure April 1 - June 30 (commercial and recreational)	DAS counted in 24 - hour blocks; no differential DAS counting except as AMs
05/01/11	Framework 45							
05/01/12	Framework 47			19		9 cod/person, Possession prohibited November to April 15		