

6.2.6.1.4 Commercial experimental fisheries and extrapolation of the photographic survey data for unsurveyed areas within the closed areas

Two recent surveys have been conducted to estimate the biomass of scallops in the Nantucket Lightship Area and Closed Area I of Georges Bank. NMFS conducted a systematic grid survey using two commercial fishing vessels while CMAST conducted a photographic survey of subareas within both of the closed areas. The subareas had been identified by commercial fishermen as regions of highest productivity. The objective of this exercise was to compare these two estimation methods for commensurate areas and then to investigate the feasibility of expanding the CMAST estimates to the entire area surveyed by NMFS.

To begin this comparison it is useful to compare the overall preliminary results for the two surveys in Table 17. Detailed summaries of the dredge survey results are provided in Table 19 to Table 21. In general the results suggest a high degree of concentration of the scallop resources within each area. Over 92% of the biomass in the Nantucket Lightship occurs within a 213 NM² strata in the northeast corner of this area. Scallop concentrations in Closed Area I are somewhat more uniformly distributed but strata 1 and 4 have much lower densities.

All of the dredge-based estimates are based on a dredge efficiency of 40%. (This estimate of efficiency is also consistent with the observed commercial CPUE declines observed in Area II in 1999). The independent surveys show general correspondence at this early stage of analysis. More thorough analyses of both surveys are now underway. In particular, it is important to note that the confidence bounds are based on a normal distribution of error terms. Both surveys however, found a high degree of spatial contagion and wide variations in densities over relatively small spatial scales. Application of spatial statistics procedures may prove useful in refining the overall density estimates and confidence intervals.

As a first attempt to compare the results on a comparable spatial scale, the dredge survey data were post stratified to include only random survey stations within the boundaries of the region circumscribed by the photographic survey (Table 18). The dredge survey stations were then treated as a single stratum.

Table 17. Sampling parameters and biomass estimates for the 1999 experimental fishery and the CMAST photographic survey in the Nantucket Lightship Area and Closed Area I.

Region	Method	Area (NM ²)	# of strata	# of samples	Sam-ple Size (m ²)	Total Area Sam-pled (m ²)	Cen-tral Ten-dency Mea-sure	Biomass Estimate (million lbs)	Lower Bound (million lbs)	Upper Bound (million lbs)
NLSA	Dredge	1371	9	148	17,082	2,528,136	Mean	39.53	19.27	59.80
	Dredge	1371	9	148	17,082	2,528,136	Median ²⁹	13.47	NA	NA
	Photo	143	1	204	9.44	1925	Mean	13.50	9.30	17.90
Area I	Dredge	840	6	93	17,082	1,588,626	Mean	25.81	14.92	36.70
	Photo	363	1	454	9.44	4286	Mean	22.4	18.30	26.40

Table 18. Sampling parameters and biomass estimates for the 1999 experimental fishery and the CMAST photographic survey post stratified to include only random survey stations within the boundaries of the region circumscribed by the photographic survey.

Region	Method	Area (NM ²)	# of strata	# of samples	Sam-ple Size (m ²)	Total Area Sam-pled (m ²)	Cen-tral Ten-dency Mea-sure	Biomass Estimate (million lbs)	Lower Bound (million lbs)	Upper Bound (million lbs)
NLSA	Dredge	143	1	15	17,082	256,230	Mean	33.71	13.55	53.86
	Dredge	143	1	15	17,082	256,230	Median ³⁰	14.83	NA	NA
	Photo	143	1	204	9.44	1925	Mean	13.50	9.30	17.90
Area I	Dredge	840	1	69	17,082	1,178,658	Mean	15.77	8.85	22.68
	Photo	363	1	454	9.44	4286	Mean	22.4	18.30	26.40

²⁹ This estimate uses the median catch in each strata to estimate an overall total

³⁰ This estimate uses the median catch in each strata to estimate an overall total

Table 19. Calculation of mean total sea scallop biomass in Nantucket Lightship Area

Stratum	Area	Prop. of Total	# Stations	Mean bushels	Variance	Prop*Mean	% total	Area^2	Area^2*Var n
1	213	0.155	26	44.933	4210.40	6.981	92.00	45369	7346981
2	106	0.077	14	0.106	0.02	0.008	0.11	11236	15
3	160	0.117	18	0.074	0.02	0.009	0.11	25600	23
4	160	0.117	20	0.005	0.00	0.001	0.01	25600	0
5	183	0.133	19	0.008	0.00	0.001	0.01	33489	1
6	183	0.133	19	1.712	20.52	0.229	3.01	33489	36170
7	122	0.089	14	0.946	0.81	0.084	1.11	14884	863
8	91	0.066	10	4.135	21.36	0.274	3.62	8281	17691
9	153	0.112	8	0.016	0.00	0.002	0.02	23409	1
Total	1371	1.000	148	8.504	1005.86	7.588	100.00	1879641	3.93785

Variance=	3.93785
sd=	1.9844
cv=	0.262
Lower CI=	3.6988
Upper CI=	11.478

Lbs. Per Bushel = 7.5

Stratified Mean

Dredge Efficiency 0.4

Path Length nm 1

Dredge Width (ft) 30

Path Area nm^2 0.0049342

Stratum	Stratum Area nm^2	Possible # of Tows	Minimum Biomass mt	Minimum Biomass kklbs	Efficiency Adjusted-mt	Efficiency Adjusted-kklbs
1	213	43168	6597.5	14.5475	16494	36.3688
2	106	21483	7.7	0.0171	19	0.0427
3	160	32427	8.2	0.0180	20	0.0450
4	160	32427	0.6	0.0012	1	0.0030
5	183	37088	1.0	0.0022	3	0.0056
6	183	37088	216.0	0.4762	540	1.1905
7	122	24725	79.6	0.1754	199	0.4386
8	91	18443	259.4	0.5720	648	1.4299
9	153	31008	1.7	0.0037	4	0.0093
Total	1371	277856	7171.6	15.8133	17929	39.53

Lower	Upper
95%	95%
19.27	59.80

Table 20. Calculation of median total sea scallop biomass in Nantucket Lightship Area

Stratum	Area	Prop. of Total	# Stations	Median bushels	Prop*Mean	% total
1	213	0.155	26	14.600	2.268	87.72
2	106	0.077	14	0.025	0.002	0.07
3	160	0.117	18	0.020	0.002	0.09
4	160	0.117	20	0.000	0.000	0.00
5	183	0.133	19	0.000	0.000	0.00
6	183	0.133	19	0.180	0.024	0.93
7	122	0.089	14	0.550	0.049	1.89
8	91	0.066	10	1.350	0.090	3.47
9	153	0.112	8	0.000	0.151	5.83
Total	1371	1.000	148	0.009	2.586	100.00

Lbs. Per Bushel = 7.5

Dredge Efficiency 0.4

Path Length nm 1

Dredge Width (ft) 30

Path Area nm² 0.004934

Stratum	Stratum Area nm ²	Possible # of Tows	Minimum Biomass	Minimum Biomass kkl	Efficiency Adjusted	Efficiency Adjusted-kklbs
1	213	43168	2143.7	4.7269	5359	11.8172
2	106	21483	1.8	0.0040	5	0.0101
3	160	32427	2.2	0.0049	6	0.0122
4	160	32427	0.0	0.0000	0	0.0000
5	183	37088	0.0	0.0000	0	0.0000
6	183	37088	22.7	0.0501	57	0.1252
7	122	24725	46.3	0.1020	116	0.2550
8	91	18443	84.7	0.1867	212	0.4668
9	153	31008	142.4	0.3140	356	0.7849
Total	1371	277856	2443.8	5.3885	6109	13.4713

Table 21. Calculation of mean total sea scallop biomass in Closed Area I.

Stratum	Area	Prop. of Total	# Stations	Mean bushels	Variance	Prop*Mean	% total	Area^2	$\frac{Area^2 * Var}{n}$
1	171	0.204	15	0.144	0.06	0.029	0.36	29241	126
2	170	0.202	16	12.108	568.38	2.450	30.30	28900	1026633
3	169	0.201	23	6.364	195.38	1.280	15.83	28561	242625
4	68	0.081	9	3.096	18.65	0.251	3.10	4624	9579
5	167	0.199	22	14.000	504.22	2.783	34.42	27889	639192
6	95	0.113	8	11.435	193.38	1.293	15.99	9025	218153
Total	840	1.000	93	8.275	296.41	8.087	100.00	705600	3.027647

Variance= 3.027647
 sd= 1.7400
 cv= 0.215
 Lower CI= 4.6769
 Upper CI= 11.498

Stratified Mean

Lbs. Per Bushel = 7.5

Dredge Efficiency 0.4

Path Length nm 1

Dredge Width (ft) 30

Path Area nm^2 0.004934

Stratum	Area nm^2	Possible # of Tows	Minimum Biomass	Minimum miomass kkl	Efficiency Adjusted-m	Efficiency Adjusted-kklbs	Lower 95%	Upper 95%
1	171	34656	17.0	0.0374	42	0.0936		
2	170	34453	1418.9	3.1287	3547	7.8218		
3	169	34251	741.4	1.6348	1853	4.0870		
4	68	13781	145.1	0.3200	363	0.8000		
5	167	33845	1611.7	3.5538	4029	8.8844		
6	95	19253	748.8	1.6512	1872	4.1280		
Total	840	170240	4682.9	10.3259	11707	25.815	14.929	36.701

The estimation methods produce similar results in both areas. The approximate confidence region for the estimates overlap in both areas. Additional refinement of the dredge-based estimates will be possible when the results of the efficiency estimates are derived from four separate experiments conducted in 1999. Further work on size composition will also be useful in refining the dredge and photo estimates.

Extrapolation of the photo-based biomass estimates to the entire Nantucket Lightship Area and Closed Area I is very uncertain. The basic assumption of this approach is that the ratio of biomass estimates in the sampled and unsampled areas of the photographic survey is the same as the actual biomass estimates for the dredge survey in these areas. If this assumption is made then Table 22 provides the adjusted photographic biomass estimates (all values in millions of pounds).

Table 22. Adjustments applied to the CMAST photographic survey biomass estimates to estimate biomass throughout the area survey by the 1999 experimental fishery.

Area	Dredge- Total	Dredge- Subarea	Multiplier	Photographic Estimate for Subarea	Extrapolated Photo Estimate for Total Area	Projection Model Estimate
NLSA	39.53	33.71	1.17	13.5	15.83	23.7
Area I	25.81	15.77	1.64	22.4	36.66	97.0
Total	65.34	49.48	--	35.9	52.49	120.7

The dredge based estimates for the comparable sub-areas are approximately 40% higher than those obtained from the photographic procedure. Note however that the multiplier for Area I is much higher. The biomass estimates for NLSA are also consistent with model based projection derived from the 1998 R/V Albatross survey. (The model based estimate is computed as the average of the projected population sizes at the end of 1998 and 1999). In contrast the 1998 R/V survey estimates for Area I are probably too high owing to the strong influence of several very large tows.

The stratified mean number per tow from the experimental fishery data and the swept-area biomass estimates for Nantucket Lightship Area and Closed Area I are summarized with measures of uncertainty in Table 23. Based on this new data, the mean biomass in Nantucket Lightship Area is 39.5 million lbs. and the mean biomass in Closed Area I is 25.8 million lbs. These estimates are somewhat higher than comparable estimates from the CMAST photographic survey in Nantucket Lightship Area and in Closed Area I. This result indicates that 40 percent dredge efficiency is a minimum estimate of the true value in these areas, especially since scallops that are smaller than exploitable size are observable in the photographic survey.

6.2.6.1.5 Annual Albatross survey

At the time of this analysis, the 1999 research survey data was unavailable. Mechanical difficulties postponed the annual survey and part of it was done by a comparable commercial vessel at a later date. The vessels had just returned from the survey and it takes about six weeks before the data can be processed and analyzed. Added to this delay will be problems associated with comparing (calibrating) the catch rates between the NMFS Albatross and the F/V Tradition, a vessel under contract to complete the annual survey. In lieu of this new information, the PDT projected biomass in 1999 and 2000 from the

1998 survey data, using methods described in Section 6.2.6.2 in Framework Adjustment 12 (NEFMC 1999c).

Reasonable biomass estimates from the 1998 survey were calculated in Nantucket Lightship Area and Closed Area II, but the biomass estimate for Closed Area I is very sensitive to four very large tows in one part of Closed Area I. The stratified mean biomass estimate in Closed Area I was very high (111.9 million lbs.) compared to the photographic survey and the experimental fishery (36.7 and 25.8 million lbs., respectively). Since the Albatros estimate is very sensitive to these anomalous tows, the PDT did not use this survey to estimate biomass in Closed Area I.

The projected biomass for the beginning of the 1999 calendar year³¹ is 26.48 million lbs. for the Nantucket Lightship Area, 111.90 million lbs. for Closed Area I, and 33.25 million lbs. for Closed Area II. These same 10-year projections indicate a biomass change of 45.7, 47.3, and 26.8 percent for these areas during 1999, respectively. Most of the increase during 1999 was estimated to occur during the first half of 1999, as the large year class first observable in the 1998 survey grew quickly and entered the exploitable size range.

Since this biomass growth mainly occurred prior to the experimental survey, the photographic survey, and the proposed fishing seasons for the closed areas, an approximation of mid-year change in biomass was made by averaging the January 1 biomass for 1999/2000 and for 2000/2001, respectively. Thus the 1999/2000 biomass average approximates the biomass that was present at the time of the 1999 surveys and the 2000/2001 biomass average approximates the biomass that would be present³² at the time of the proposed closed area fisheries.

On this basis, the projected change in mid-year biomass from 1999 to 2000 is 16.3, 17.0, and 27.3 percent for Nantucket Lightship Area, Closed Area I, and Closed Area II, respectively. This projected change in biomass was used to forecast the biomass in the 2000 fishing year based on all three sources of data.

³¹ This represents a six-month 'bridge' projection from July-August 1998 (the last available survey) to December 31, 1999, applying an estimated fishing mortality open areas of Georges Bank and the Mid-Atlantic and an estimated 3,678 mt catch from Closed Area II.

³² This calculation is dependent on the fishing mortality that occurs prior to the fishery. For this purpose, no fishing mortality prior to mid-year was assumed in the closed areas. To calculate the day-at-sea tradeoffs, the change in biomass during the first half of 2000 was assumed based on a projection assuming an allocation of 120 full-time days-at-sea.

Table 23. Biomass estimates for the three closed areas from CMAST photographic survey, experimental fishery, and research survey data. The biomass values from each survey have been extrapolated to the entire closed area and adjusted by the expected change in exploitable biomass between 1999 (when the surveys were conducted) and 2000 when access is proposed by this framework adjustment.

	Nantucket		
	Lightship Area	Closed Area I	Closed Area II
CMAST photographic survey			
Number of samples	204	454	0
Mean scallops/m	0.508	0.330	NA
Standard error	0.084	0.030	
Mean biomass (million lbs.)	13.50	22.40	
Upper 95% confidence limit	17.90	26.40	
Lower 95% confidence limit	9.30	18.30	
Adjusted to total area			
Mean biomass (million lbs.)	15.83	36.67	NC
Upper 95% confidence limit	20.99	43.22	
Lower 95% confidence limit	10.91	29.96	
1999 Experimental Fishery			
Number of samples	148	93	0
Stratified mean number/tow	7.59	8.09	NA
Standard deviation	1.98	1.74	
Mean biomass (million lbs.)	39.53	25.81	
Upper 95% confidence limit	59.80	36.70	
Lower 95% confidence limit	19.27	14.93	
Median biomass (million lbs.)	13.47	NC	NC
Stratified mean in photographic survey area	33.71	15.77	
1998 Annual Albatros Survey			
Number of samples	29	19	39
Mean number/tow (full recruits)	120.4	1124.3	120.9
Mean weight/tow (kg, full recruits)	3.92	24.47	3.04
Swept-area biomass (million lbs.)	18.18	75.96	26.22
Projected 1999 swept-area biomass (million lbs.)	26.48	111.90	33.25
Projected percent change in biomass in 1999 - 2000 at survey	16.3%	17.0%	27.3%

6.2.6.1.6 TAC estimates for the 2000 fishing year

Scallop TACs are used to prevent the total catch from exceeding thresholds that are consistent with maximum sustainable yield and fishing mortality goals for scallop fishing in formerly closed areas. This threshold for the entire resource is $F = 0.24$, or 19.4 percent of the average number of scallops in the population during the fishing year. Although an approximation due to in-season growth, this fraction can also be applied to mid-year biomass to estimate TACs that are consistent with this policy.

Given the availability of data and the potential for outliers in each data set that would produce spurious results, the PDT identified the following sources of data and biomass estimates to recommend TACs for accessing closed areas during 2000:

- ♦ Nantucket Lightship Area: CMAST photographic survey extrapolated to the entire area and the 1999 experimental fishery swept area estimate assuming a 40 dredge efficiency. Both estimates were projected to 2000, by applying the change in mid-year biomass from the biological projections

assuming no catch in 1999. Also included in the biomass estimate was the biological projection results from 1998 survey data, assuming no catch in 1999.

- ◆ Closed Area I: CMAST photographic survey extrapolated to the entire area and the 1999 experimental fishery swept area estimate assuming a 40 dredge efficiency. Both estimates were projected to 2000, by applying the change in mid-year biomass from the biological projections assuming no catch in 1999.
- ◆ Closed Area II: Biological projections from 1998 survey data, assuming a 3,678 mt scallop catch in 1999.

Mid-year biomass was approximated from the calendar year projections (Section 6.2.6.2 in Framework Adjustment 12; NEFMC 1999c) by averaging the biomass at the beginning of 1999 and 2000, and the beginning of 2000 and 2001. Although this method is not technically correct, it provided a reasonable approximation of the change of biomass from the time of the 1999 surveys to the time of the proposed access in 2000, given a TAC that would be consistent with the events that are expected between the surveys and the proposed fisheries.

The change in the approximate mid-year biomass is 16.3 percent for Nantucket Lightship Area (Table 23), 17.0 percent for Closed Area I, and 27.3 percent of Closed Area II. Except for Closed Area II, the change in mid-year biomass is less than the change in biomass between the beginning of 1999 and the beginning of 2000. The reason for this is that the strong 1998 year class³³ is growing quickly during 1999 and entering the exploitable size range. As a result, the biological projection estimates a considerable increase in biomass between the end of 1998 and the end of 1999 (Tables 12 to 18 in Framework Adjustment 12; NEFMC 1999c).

Most of the increase in exploitable biomass occurs in early 1999, however. Using the calendar year increase to adjust surveys conducted mid-year would in effect double count this considerable growth. In the latter half of 1999 and early 2000, the growth of this year class is expected to slow and fewer scallops (of younger age) will be recruiting into the exploitable size range.

The average 1999 biomass estimates from the surveys identified above are: 24.5, 31.2, and 26.2 millions lbs. in Nantucket Lightship Area, Closed Area I, and Closed Area II, respectively (Table 24). Applying the projected change in mid-year biomass between 1999 and 2000 gives a 2000 fishing year estimate of 28.5, 36.5, 33.4 million lbs. respectively.

Applying an exploitation rate consistent with $F = 0.24$, gives TACs of 5.5, 7.1, and 6.7 million lbs. for the proposed scallop access into Nantucket Lightship Area, Closed Area I, and Closed Area II, respectively (Table 24). One-percent of these TACs, totaling 193,000 lbs. is intended to fund scallop research (Section 5.1.3.2.1), leaving 19.1 million pounds to determine trip allocations and potential trip limits for accessing each closed area.

³³ For convenience, this is referred to as the 1998 year-class because 1998 was the year that these scallops were first observable. In reality, these scallops are already two to three years old at that time.

Table 24. Adjustment of 1999 biomass estimates and calculation of 2000 scallop TACs for access to Georges Bank closed areas.

	Nantucket Lightship Area	Closed Area I	Closed Area II	All
Mean biomass estimate				
1999 average (million lbs.)	24.51	31.24	26.22	81.98
2000 projected swept area biomass (million lbs.)	28.52	36.54	33.37	98.43
TAC (million lbs.) at F=0.24	5.53	7.09	6.67	19.29
TAC (mt) at F=0.24	2,509	3,215	3,025	8,750
One percent research set aside (lbs.)	55,321	70,884	66,690	192,895
Fishery TAC (million lbs.)	5.48	7.02	6.60	19.10

6.2.6.1.7 Trip allocations and trip limits

To estimate the number of trips that can be allocated, the fishery TAC (Table 24) is simply divided by the trip limit that would apply if it is assumed that any trip into the closed area will catch the allowable trip limit. For example, the 5.48 million pound TAC for the Nantucket Lightship Area can allow for 548 trips with a 10,000 pound trip limit. Similarly, the total number of 15,000 pound trips to catch 6.6 million lbs. in Closed Area II is 440 trips.

Determination of how many trips to allocate to each vessel is a little more complicated, however. The first step is to determine how many vessels are likely to participate. Consistent with the successful policy for Framework Adjustment 11, the PDT assumed that all vessel with active permits would fish in the Nantucket Lightship Area and in Closed Area I. There are 328 limited access scallop vessels with active permits, including 247 that used one or more scallop days-at-sea in 1998 (Table 8 in Framework Adjustment 12; NEFMC 1999c), 14 vessels that are known to have fished in Closed Area II in 1999 but not 1998, and the remaining 67 vessels with a scallop limited access permit. This does not include the 37 Confirmation of Permit Histories (Table 8 in Framework Adjustment 12; NEFMC 1999c) that could be assigned or transferred to a suitable scallop fishing vessel to take advantage of the new opportunities and the higher (predicted) catch rates.

The PDT thought that although fewer vessels actually fished in Closed Area II during 1999, many more vessels could choose to fish in Nantucket Lightship Area and Closed Area I, due to closer proximity to shore. Simultaneous openings and greater opportunities to fish may also attract vessels that would not have otherwise fished as well. Although this could be viewed as a conservative estimate, reducing the number of trips allocated at the beginning of the season, the PDT believes that this estimate is reasonable, especially given the potential for an in-season adjustment of trips based on actual participation.

In Closed Area II, on the other hand, 178 limited access scallop vessels have so far taken at least one Closed Area II trip. The number of unique participants has continued to rise throughout October 1999, during the preparation of this document. The PDT agreed that the actual number of participants in the Closed Area II fishery was the best assumption to use. Two reasons for assuming participation for fewer vessels in Closed Area II are 1) not all limited access scallop vessels are capable of taking trips to Closed Area II, either due to distance and economics or safety, and 2) simultaneous openings of Nantucket Lightship Area and Closed Area I could divert effort from the more offshore area reducing activity compared to conditions in 1999.

For an initial estimate of the number of trips that vessels in the three categories could take, it was assumed that the day-at-sea allocations would remain at 1999 levels (i.e. 120 full-time days) and that the day-at-sea tradeoff is 10 days for each trip into a closed area. Since an occasional vessel would only have

10 days-at-sea to fish for scallops, the maximum number of trips it could take is therefore one. Similarly a part-time vessel with 48 days-at-sea could at most take four trips to the closed areas.

Given the number of vessels with each type of limited access permit and their assumptions about fishing in each closed area, the number of trips to allocate is either one or two in Nantucket Lightship Area and Closed Area I (Table 25). Lower trip limits imply that more trips could be allocated, since each trip would land a smaller fraction of the TAC. Due to the assumption about participation by 178 vessels in Closed Area II, rather than all active permits (328), the potential allocations for Closed Area II range from two to four trips.

Together, three trips could be allocated (Table 25) to limited access vessels to fish in the three closed areas with an 18,000 lbs. trip limit (occasional vessels taking only one trip), and up to eight trips with an 8,000 lbs. trip limit (occasional vessels taking one trip, part-time vessels taking four trips). If a vessel takes all the trips it might be allocated to fish in the closed areas and there is a ten day-at-sea tradeoff, these trips could use up 25 to 67 percent of the total days allocated, assuming 1999 allocations continue.

These potential trip allocations were applied in Section 6.2.6.1.10 in the Framework 11 depletion model to estimate the effects of the various options and to estimate the minimum day-at-sea tradeoff needed to be conservation-neutral. Since which areas will be approved for access by scallop vessels in 2000 is currently unknown and the actual day-at-sea tradeoff is unspecified at this point, some additional fine-tuning is possible through an iterative process between this calculation and the depletion model. It might cause a small increase the number of trips that could be allocated with more a tradeoff of more than 10 days.

Table 25. Assumed vessel participation and maximum trip allocations for trip limits in common for all areas.

	Nantucket Lightship Area	Closed Area I	Closed Area II	All
Expected vessel participation				
Full-time	236	236	174	
Part-time	43	43	4	
Occasional	49	49	0	
Total estimated participation	328	328	178	
Trips limit (lbs. meat weight) Total number of trips to allocate				
8000	685	877	825	
10000	548	702	660	
12000	456	585	550	
15000	365	468	440	
18000	304	390	367	
Trips limit (lbs. meat weight) Number of trips per vessel to allocate				
8000	2	2	4	8
10000	1	2	3	6
12000	1	1	3	5
15000	1	1	2	4
18000	0	1	2	3

6.2.6.1.8 Finfish bycatch

Two new sources of data exist to estimate the potential for bycatch: observer data for Closed Area II and the experimental fishery data for Nantucket Lightship Area and Closed Area I. At the present time, however, data is still coming in from the Closed Area II fishery and there hasn't been sufficient time to rigorously examine the experimental fishery data for all bycatch species. Due to the high vulnerability of the gear and importance to the Multispecies FMP and fleet, the PDT focused on characterizing the distribution and estimating the mean bycatch rates for yellowtail flounder. Where possible, the number of fish by species as bycatch was incorporated in the closed area model (Section 6.2.6.1.10) to estimate the probable impacts.

Closed Area II

In Closed Area II, yellowtail flounder bycatch was carefully monitored by placing observers on 25 percent of all trips, consistent with the objectives of Framework Adjustment 11. Although the catch of all species was observed, only yellowtail flounder and scallop catch was analyzed in detail. At the time of analysis, only data through October 4, 1999 were available. Since that time, the scallop catches per day-at-sea appear to continue declining, but the yellowtail flounder bycatch appears to be increasing (Figure 3) as vessels may be fishing in areas of high scallop and yellowtail flounder abundance, taking less care to avoid yellowtail flounder at the fishery nears the yellowtail flounder TAC.

As anticipated by the Framework Adjustment 11 analysis, the scallop landings per day (24-hours) has declined since the initial access to Closed Area II. This effect is the combined result of a depletion effect (predicted by Framework 11), changes in the geographical distribution of effort during the season, changes in crew size and practices by vessels fishing in Closed Area II, and changes in the fleet characteristics for vessels fishing in Closed Area II. Dr. William DuPaul and others are currently observing the fleet with TAC set-aside funding to identify the effect and interaction of these factors in determining catch rates. This information and analysis will be very useful to fine-tune future closed area access models.

The weekly median scallop landings and yellowtail flounder catch is shown in the table below. This data with related statistics is also given in Appendix II. As of October 20, 1999, scallop trips in Closed Area II were calculated by NMFS to land 686,000 lbs. of yellowtail flounder and 4.7 million lbs. of scallop meat.

This ratio (0.147) was used to adjust the weight per 10-minute tow data from the 1998 experimental fishery in Closed Area II. For various reasons, the ratio of yellowtail flounder to scallops was much less than estimated by the Framework Adjustment 11 analysis (0.62, NEFMC 1999a – Table 106). Possible factors in the lower bycatch rate are larger twine tops in the Closed Area II fishery³⁴, non-uniform fishing practices that differed from the experimental fishery³⁵, and longer tow times than affected dredge fullness and possibly bycatch rates³⁶.

³⁴ Framework Adjustment 11 requires vessels to use 10-inch twine tops, while the 1998 experimental fishery used 6-inch twine tops.

³⁵ The experimental fishery employed a uniform distribution of tow locations to estimate biomass, while the commercial fishery focused on areas of abundant, large scallops in the SW and NE quadrats in the open portion of Closed Area II.

³⁶ The experimental fishery required standard tows of 10-minutes, while fishermen report an average tow duration of 60 minutes, but this may have changed during the Closed Area II fishery.

Table 26. Closed Area II catch rates for scallops and yellowtail flounder for observed trips.

<i>Week</i>	<i>Number of reported trips</i>	<i>Reported scallop landings (lbs. meat weight per 24 hours)</i>	<i>Number of observed trips</i>	<i>Observed scallop landings (lbs. meat weight per 24 hours)</i>	<i>Yellowtail flounder catch (lbs. whole per 24 hours)</i>	<i>Ratio</i>	<i>Days to catch scallop trip limit</i>
23	15	2050	7	1413	255	0.18	4.88
24	134	2736	61	2000	194	0.10	3.65
25	183	2555	61	1889	196	0.10	3.91
26	150	2656	30	1599	228	0.14	3.77
27	203	2400	26	1858	103	0.06	4.17
28	203	2295	24	1531	134	0.09	4.36
29	173	2050	56	1639	146	0.09	4.88
30	147	1980	48	1169	65	0.06	5.05
31	135	1835	39	1243	52	0.04	5.45
32	97	2068	31	1500	171	0.11	4.84
33	82	1893	40	1452	73	0.05	5.28
34	68	2000	38	1215	35	0.03	5.00
35	61	1800	32	1288	60	0.05	5.56
36	75	1984	37	1356	122	0.09	5.04
37	34	1767	17	786	56	0.07	5.66
38	115	1500	55	1000	99	0.10	6.67
39	86	1400	23	975	201	0.21	7.14

Nantucket Lightship Area and Closed Area I

The experimental fishery conducted in July and August 1999 gave new information about potential scallop and finfish catch rates in Nantucket Lightship Area and Closed Area I. This data is preliminary however and not all data are yet available for analysis. Below is a summary of the estimates from the experimental fishery program. Although this information is crucial to estimating the effects of the proposed closed area access options, it is also instructive to visually examine the catch distributions in Appendix II.

The data indicate that scallops are abundant in strata 1 and 8 in the Nantucket Lightship Area (Table 19; see Appendix II for a map of strata) and strata 2, 3, 5, and 6 in Closed Area I (Table 21). The data also indicate that the predominant catch is for monkfish, followed by yellowtail flounder and barndoor skate (Table 27). No cod or haddock were observed in Nantucket Lightship Area and were a very minor component of the catch in Closed Area I.

Although barndoor skate catches were high in the experimental fishery, nearly all of the bycatch occurred outside the areas (Appendix II) that are proposed for scallop access. Large catches of barndoor skate were in the south-central portion of Nantucket Lightship Area (Appendix II), outside of the northeast corner that is proposed for access. A relatively high catch in the Closed Area I experimental fishery was actually outside of the boundary of Closed Area I. If this area, where barndoor skates were observed, is productive scallop habitat, the access program could actually benefit barndoor skate.

Table 27. Mean number of animals captured per 10-minute tow in an experimental fishery conducted during July and August 1999.

	<i>Nantucket Lightship Area</i>	<i>Closed Area I</i>
Number of tows	188	132
Scallops (pounds meat)	51.72	53.36
Yellowtail flounder	1.01	3.76
Cod	0.00	0.17
Haddock	0.00	0.03
Monkfish	5.00	5.95
Barndoor skate	0.61	0.46

During the analysis of impacts for this framework adjustment, it was possible to obtain only the size frequency distribution for the yellowtail flounder catch in Nantucket Lightship Area. Weights at size were applied to these data to estimate the catch per 10-minute tow in weight. These data were further post-stratified with the same stratification method to estimate the stratified mean weight per tow for the scallop catch (Table 19). The mean weight per tow in Nantucket Lightship Area was 0.47 kg and the highest catches occurred in strata 8 and 1, respectively (Table 28). For purposes of estimating the effects of allowing access to the northeast corner of the Nantucket Lightship Area (**Figure 15**), the mean catch per tow for strata 1 and 8 were combined, giving a stratified mean weight per tow of 1.22 kg.

No size frequency data were available from the experimental fishery in Closed Area I to estimate the mean weight per tow. In lieu of this data, the mean weight of yellowtail flounder caught in Nantucket Lightship Area was applied to the mean number per tow in Closed Area I to estimate the catch rate. This assumption about mean size was applied to the stratified mean number per tow in strata 2, 3, and 5 to estimate the bycatch rate for Closed Area I in the area where access is proposed (**Figure 15**). The mean catch per 10-minute tow was estimated to be 1.76 kg.

Yellowtail flounder in the Nantucket Lightship Area are considered to be from the Southern New England stock. On the other hand, the boundary of Closed Area I overlaps the distribution of the Southern New England, Cape Cod, and Georges Bank yellowtail flounder stocks. Although previous tagging studies indicated a high degree of fidelity between adjacent stocks (Table 29), most of the yellowtail flounder caught in Closed Area I were close to the adjacent boundaries of all three stocks (comparing **Figure 15** for the stock boundaries and Appendix II for the catch distribution). The yellowtail caught in the scallop fishery within Closed Area I are therefore of indeterminate origin, at least during July and August.

Discard mortality

No studies of discard mortality of yellowtail flounder in scallop dredges is known and few conclusions can be drawn to justify a different discard mortality rate than assumed for the Closed Area II scallop fishery. Some tagged fish have been recaptured in Closed Area II after a few days at liberty, but the data are preliminary and no analysis has yet been performed. Another factor in estimating discard mortality is that some discarded dead fish may be counted more than once when they are recaptured by another vessel in the vicinity. Both factors (non-zero survival and recapture of dead discards) tend to overestimate the catch of yellowtail flounder.

Table 28. Mean stratified weight of yellowtail flounder caught on a 10-minute tow during a July to August experimental fishery.

Stratum	Area	Prop. of Total	# Stations	Mean numbers	Prop*Mean	% total	Mean weight (lbs)	Prop*Mean	% total	Mean fish weight (kg)	
1	213	0.155	26	2.615	0.406	31.72	2.7	0.419	45.79	0.47	
2	106	0.077	14	0.500	0.039	3.02	0.52	0.040	4.39	0.47	
3	160	0.117	18	0.389	0.045	3.54	0.4	0.047	5.10	0.47	
4	160	0.117	20	0.150	0.018	1.37	0.15	0.018	1.91	0.45	
5	183	0.133	19	0.105	0.014	1.09	0.11	0.015	1.60	0.48	
6	183	0.133	19	0.105	0.014	1.09	0.11	0.015	1.60	0.48	
7	122	0.089	14	0.571	0.051	3.97	0.59	0.053	5.73	0.47	
8	91	0.066	10	3.900	0.259	20.21	4.02	0.267	29.13	0.47	
9	153	0.112	8	0.375	0.435	33.98	0.39	0.044	4.75	0.47	
Total	1371	1.000	148	0.004	1.281	100.00		0.916	100.00	0.469	
Lbs. Per Bushel =		7.5									
Dredge Efficiency		0.4		Path Length nm		1		Dredge Width (ft)		30	
								Path Area nm^2		0.004934	

Stratum	Area nm^2	Possible # of Tows	Minimum Biomass	Minimum miomass	Efficiency Adjusted	Efficiency Adjusted-kk/lbs
1	213	43168	384.0	0.8466	960	2.1166
2	106	21483	36.5	0.0806	91	0.2014
3	160	32427	42.9	0.0946	107	0.2365
4	160	32427	16.5	0.0365	41	0.0912
5	183	37088	13.2	0.0292	33	0.0730
6	183	37088	13.2	0.0292	33	0.0730
7	122	24725	48.0	0.1059	120	0.2647
8	91	18443	244.6	0.5394	612	1.3486
9	153	31008	411.3	0.9070	1028	2.2675
Total	1371	277856	1210.4	2.6690	3026	6.6725

Table 29. Observed movements of yellowtail flounder among stock areas (GOM: northern Gulf of Maine; CC: Cape Cod; GB: Georges Bank; SNE: Southern New England; MA: Mid-Atlantic) from Royce et al. (1959), Lux (1963a, 1963b), and Lux (unpublished). From NEFSC 1999a.

Release site	Recapture site						Proportional recaptures				
	GOM	CC	GB	SNE	MA	sum	GOM	CC	GB	SNE	MA
CC	2	345	1	4	0	352	0.006	0.980	0.003	0.011	0.000
GB	0	0	148	8	0	156	0.000	0.000	0.949	0.051	0.000
SNE	0	5	16	578	14	613	0.000	0.008	0.026	0.943	0.023
MA	0	0	0	64	28	92	0.000	0.000	0.000	0.696	0.304
sum	2	350	165	654	42	1213					

Thus, the current policy to estimate yellowtail flounder catch is conservative and risk-averse, making the most conservative assumption on both counts. On the other hand, the TAC recommendation and current policy is to choose a yellowtail flounder TAC that is based on the total biomass and historic catch throughout the stock area. Any catches of yellowtail flounder outside of the closed areas therefore

exceed the historic distribution of catches by fleet. Across the stock, these two different policies (estimating catch and setting a TAC) hopefully balance out.

Scientists and observers familiar with the effects of scallop fishing report that observable mortality is highly variable, ranging from near zero to near 100 percent. The mortality rate appears to depend on many factors, including bottom type, air and water temperature, and handling practices. A study by Robinson et al. (1993) using trawls with tow durations ranging from one to three hours, indicated that discard mortality for yellowtail flounder also had high variability, but few conclusions can be drawn to apply the results to scallop dredge gear.

Studies identified in Framework Adjustment 11 (NEFMC 1999a) show that larger twine tops can be effective in reducing finfish catch and the larger twine top in Closed Area II appears to have been one factor keeping yellowtail flounder catches lower than predicted. Reducing fishing time (dredge bottom time) and increasing escapement appear to be the best ways to reduce discard mortality of finfish bycatch.

6.2.6.1.9 Finfish bycatch TAC recommendations

Of the stocks that the Multispecies Monitoring Committee recommended TACs, Southern New England and Georges Bank yellowtail flounder are the only ones that have significant bycatch by scallop dredges. Table 30 shows the TAC recommendations and the reported landings for 1998, the most recent complete year available. Also shown is the percent of landings recorded from 1982 to 1993 by vessels using scallop dredges. Data since 1994 was not compiled because of the large management effects caused by the closure of the three groundfish areas to scallop vessels and by the low trip limit for groundfish bycatch (300 pounds). Using the latter data would underestimate the true catch rates that were associated with scallop fishing.

The Cape Cod stock has no TAC recommendation, so assuming that the catch remains constant (the stock is considered to be overfished), a TAC that is consistent with the proportion of landings coming from scallop vessels in 1982-1993 is 41 mt (Table 30). The yellowtail flounder landings from 1982 to 1993 were not available by stock and gear for Southern New England and Georges Bank stocks. The average landings of yellowtail flounder by vessels using scallop dredges was assumed to be 15 percent of total landings.

Taking into account the 47 mt annual average for the Cape Cod stock in 1982 to 1993, the average proportion of landings from the Southern New England and Georges Bank stock is 15 percent (Table 30). Applying this percentage to the 2000 TAC recommendations for all catches, this leaves 876 mt as a potential TAC for closed area access. The remaining 2,877 mt between the 2000 TAC for the stock and the sum of the TAC for closed area access (876 mt) and 1998 landings (1,816 mt for the Southern New England and Georges Bank stocks) by all gears other than dredges, will provide an adequate buffer to allow for increased catch by the multispecies fleet and by the scallop fleet when fishing outside of the groundfish closed areas.

Using this information and considering the stock boundaries, a potential approach is to set the TAC for the Nantucket Lightship Area at the TAC for Southern New England yellowtail flounder (Table 30). Since most of Closed Area I overlaps the Georges Bank stock, a pragmatic approach to setting the TACs for closed area access would be to have one TAC (725 mt) that applies to all catches by the scallop vessels within Closed Area I and Closed Area II. Setting separate TACs for each area would require an estimate of the proportion of the Georges Bank stock within each area, a factor that varies with time and stock condition.

Table 30. Proposed TACs for yellowtail flounder.

	1998 landings (mt)	Percent caught by scallop dredges (1982 - 1993)	2000 TAC (mt)	Proposed TAC for scallop fishery (mt)
Southern New England	369	15.0% ³⁷	951	50
Georges Bank	1800	15.0%	4618	693
Cape Cod	1244	3.3%	N/A	32
Nantucket Lightship Area TAC (mt)				50
Closed Area I and Closed Area II TAC (mt)				725

6.2.6.1.10 Conservation-neutral day-at-sea tradeoffs, effort estimates, and expected catch

A slight modification to the depletion model developed for Framework Adjustment 11 (Section 8.1.1.4) allowed to simultaneously estimate the combined effect on fishing effort in ‘open’ area from different trip allocations in each of the three areas. Through an iterative process, a day-at-sea tradeoff was calculated until the predicted total number of scallops with access was equal to the estimated number of scallops in the ‘open’ areas of Georges Bank and the Mid-Atlantic with no access to closed areas. Since fishing mortality is calculated on the basis of the proportion of total numbers removed from the exploitable size range of the stock, this should achieve a conservation-neutral effect with regard to scallops.

The purpose of the depletion model is to estimate and simulate a mass balance between fishing effort in the ‘open’ areas, the number of allocated trips in the closed areas and the day-at-sea tradeoffs, and the amount of unused days in the fishery. The calculations were done as if 120 days would be allocated to full-time limited access scallop vessels in 2000³⁸. The estimate also assumed that 48 days would be allocated to part-time vessels, allowing them to take no more than 4 ten-day trips in the groundfish closed areas. Similarly, the estimate assumed that occasional vessels could only take one trip, since their annual day-at-sea allocations would total 10 days.

This assumption is important because if more days were allocated in 2000, vessels would have a greater opportunity to increase fishing effort that might not have otherwise been used if the access to closed areas did not occur³⁹. In order to be conservation-neutral under this condition, the day-at-sea tradeoffs could be higher than those calculated here. Conversely, if less days are allocated in 2000, fewer unused days might become active due to closed area access and in fact insufficient days might exist to fish all of the allocated trips into closed areas. In this case, no day-at-sea tradeoff would be necessary because almost all of the effort in the closed areas would be transferred from fishing effort in the ‘open’ areas.

³⁷ The historic proportion of yellowtail flounder catch by vessels using scallop dredges was assumed to be 15 percent in Framework Adjustment 11.

³⁸ Framework Adjustment 12, submitted by the Council in December 1999, would allocate 120 days for full-time, 48 days for part-time, and 10 days for occasional scallop vessels, if approved by the Secretary.

³⁹ Although the Council submitted Framework Adjustment 12, recommending a 120 day-at-sea allocation, this point is repeated here to identify how conservation neutrality if the day-at-sea policies change or Framework Adjustment 12 is disapproved.

6.2.6.1.10.1 Proposed Action

The analysis of the proposed action uses the same assumptions and methods that were used to estimate the effects of the alternatives considered but rejected (Section 6.2.6.1.10.2). The main difference between one of the alternatives with a 10,000 scallop possession limit and the proposed action is the day-at-sea tradeoffs that would be required. Under the 10,000 pound scallop possession limit alternative, the day-at-sea tradeoffs would be unique for each area, ranging from 9 to 12 days for each trip (Table 31). Since the CPUE in each area differs due to differences in biomass per m², the varying day-at-sea tradeoffs were chosen for analysis to impose a relatively constant fraction between days fished and days-at-sea accumulated in each closed area. To ease enforcement and improve compliance, the Council chose an constant 10 day-at-sea automatic accumulation for all three areas.

The estimated results for the proposed action is very similar to the rejected alternatives, except that the total bottom time is slightly higher and the total scallop yield is also slightly higher. Compared to the 10,000 pound rejected alternative (with varying day-at-sea accumulation), the days fished (i.e. “actual days-at-sea used”) increases from 25,924 to 26,431 days (Table 31). The day-at-sea trade-off ratio thus declines from 1.57:1 to 1.51:1.

Since the day-at-sea trade-off or ratio is slightly less, there are more days-at-sea left to fish in the open areas. As a result, total scallop landings in the open areas is expected to be higher (9,534 mt vs. 9,276 mt; Table 31), while the expected landings from the closed area access program remain about the same as for the 10,000 pound rejected alternative. Total scallop landings are therefore a little higher for the proposed action (15,997 mt) than for the rejected alternatives. The expected landings are estimated to be 15 percent higher than the status quo (Table 31), whereas the total scallop landings would be 14 percent higher than the status quo. There are negligible differences in average meat yield, about 23.2 meats per pound.

Since the proposed action does not substantially affect the estimated days fished in the closed areas, all of the bycatch estimates are nearly equal to the 10,000 pound scallop possession limit rejected alternative. Total yellowtail bycatch is estimated to be 683 mt for all three areas under the proposed action. Cod, haddock, and barndoor skate bycatch was estimated for all three areas, but because the 1999 experimental fishery data had not been converted to weights, these estimates were given as a numeric index, to compare alternatives. Bycatch data for some species were only available from the Closed Area II experimental fishery in 1998⁴⁰.

Estimates in greater detail are given in Appendix I. For the proposed action, the estimated days fished are 4,049 in Closed Area II, 3,310 in Closed Area I, and 2,055 in the Nantucket Lightship Area. From these estimates, combined with the number of limited access vessels, the number of allocated trips, and the 10 day-at-sea accumulation, the day-at-sea trade-off or ratio is estimated to be 1.32 for Closed Area II, 1.75 for Closed Area I, and 1.52 in the Nantucket Lightship Area. All other factors being equal, the access program is somewhat more conservative in Closed Area I than in other areas. On the other hand, profitability would actually be higher in Closed Area I, since catch rates are high and it takes less time to catch and land 10,000 pounds of scallop meats.

The estimated scallop catch is 2,422 mt from Closed Area II, 2,622 mt from Closed Area I, and 1,420 mt from the Nantucket Lightship Area (Appendix I). These estimated landings are naturally less

⁴⁰ More data will be available from the experimental fishery during 1999 in Closed Area I and the Nantucket Lightship Area, as well as from logbook and sea sampling data from Closed Area II during 1999, but these data were not available for analysis at the time of this report.

than the TACs, because of the method used to allocate trips to limited access scallop vessels (Section 6.2.6.1.7). An in-season adjustment is therefore necessary to allow the fishery to catch the TAC if fewer vessels participate than expected or the average landings on closed area trips is less than 10,000 pounds. Using the same methods and the observed yellowtail flounder catches in the Closed Area II commercial scallop fishery in 1999 and the experimental Closed Area I and Nantucket Lightship Area fisheries in 1999, the expected yellowtail flounder bycatch is 472 mt from Closed Area II, 200 mt for Closed Area I, and 12 mt for the Nantucket Lightship Area (see Appendix I for detailed model results for each area). These bycatch estimates are less than the combined 725 mt yellowtail flounder TAC for Closed Area I and 2, and the 50 mt yellowtail flounder TAC for the Nantucket Lightship Area.

The above analysis does not include the effects of the access program for general category vessels (Section 5.1.7.3). On the other hand, it also excludes the five-percent TAC set-aside (Section 5.1.3.2.3). Total scallop yield and bycatch, including access by all eligible vessels, is therefore somewhat higher than those estimated above. The scallop landings and finfish bycatch could be as much as five-percent higher than estimated. Even so, the total catch including general category vessels is still likely to be below the total TAC for both scallops (Section 5.1.3.1) and yellowtail flounder (Section 5.1.4). In the case of yellowtail flounder, the combined catch would be about 705 mt as long as the dredges in use by general category vessels have finfish catches that are equivalent or less than the larger dredges that limited access scallop vessels may use.

6.2.6.1.10.2 Alternatives Considered but Rejected

As described above, the potential trip allocations for each trip limit (Section 6.2.6.1.7) were evaluated for conservation-neutrality with respect to the predicted number of scallops caught for the entire resource. With a low trip limit and a higher allocation of trips, the day-at-sea tradeoff to achieve conservation-neutrality is less. As the trip limit increases, the day-at-sea tradeoff also increases, partly to compensate for the shorter total steam time associated with a lower number of trips to the closed areas. Except for the 18,000 pound trip limit option, the day-at-sea tradeoffs roughly correspond to one day accumulated for each 1,000 pounds landed. This relationship is slightly non-linear and increases a bit faster than the trip limit does (Figure 27).