5.2 Day-at-sea Tradeoffs

(A. Applegate)

5.2.1 Introduction

The purpose of a day-at-sea tradeoff[57] that apply to vessels fishing in rebuilt areas is to reduce the number of days available to fish in other areas and therefore reduce mortality elsewhere. Another purpose is to ensure that the effort shift to areas where scallops are denser in rebuilt areas does not increase mortality beyond management thresholds. The effect of fishing in rebuilt areas can also reduce mortality for the resource by shifting fishing effort away from areas of numerous small scallops. The outcome depends on the relative density of scallops within and outside the rebuilt areas. If the access program reduces effort in areas where scallop recruitment is high and small scallops abound, while focusing fishing effort on larger but relatively fewer scallops in the closed areas, fishing mortality could be less even without a day-at-sea tradeoff.for an option that allows access to rebuilt areas.

Two types of tradeoffs are possible: proportional or fixed. The biological projections (Section 5.1) were performed with a proportional day-at-sea tradeoff, equivalent to the ratio of expected LPUE to 1,400 lbs. per day. The 1,400 lbs. per day approximates the daily catch expected in other scallop fishing areas during the 2001 fishing year. If the Council chooses a higher day-at-sea tradeoff equivalent, it becomes less conservative because the LPUE ratio declines, and vice versa. For example, when LPUE in an area where the tradeoff applies is 2,100 pounds and 10,000 days-at-sea would be used to catch the TAC, this model assumes that vessels would accumulate 15,000 days and the mortality and catches elsewhere decline by the amount associated with 5,000 days of fishing effort. If the tradeoff equivalent increases to 1,750 lbs. per day, then 12,500 days would accrue and remove 2,500 days from scallop fishing effort elsewhere.

Conversely, the LPUE in the other open areas may be different than estimated by the projections. If they are higher than the assumed tradeoff equivalency, the area access program would attract less fishing effort and could be less conservative in the remaining open areas than anticipated. An example of this outcome is observable by comparing the fishing effort for 1999 and 2000 in Closed Area II. In 2000, the LPUE in the remaining open areas was higher than in 1999 and the LPUE in Closed Area II was lower in 2000. As one factor, the area access program in Framework Adjustment 13 generated 164 trips by 80 vessels (Section 4.1.6) compared to 644 trips by 187 vessels in 1999 (Section 3.2).

Under a fixed day-at-sea tradeoff system, a fixed number of days are charged for each trip into a rebuilt area with a fixed possession limit. Higher charges against the annual day-at-sea allocation for a trip is, of course, more conservative and reduces the amount of fishing effort elsewhere. Not quite as obvious is that higher possession limits in a scallop access program are conversely less conservative, because it increases the time vessels need to catch the possession limit and reduces the extra days charged with a fixed day-at-sea tradeoff. For example, if it takes six days to catch and land 10,000 lbs., the day-at-sea tradeoff for a 10 day-at-sea charge is four days. With a 15,000 lb. possession limit, the vessel would fish for nine days and only one day extra would be charged to the vessel.

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[57] A day-at-sea tradeoff is a procedure to charge vessels a greater number of days-at-sea than actually fished for trips taken into certain areas. Since the limited access scallop vessels have a fixed allocation of annual days, this procedure 'trades-off' an extra amount of the vessel's annual days-at-sea to fish in rebuilt areas. This either reduces the fishing effort elsewhere or causes the vessel to utilize more of its day-at-sea allocation if it would not have otherwise used these days during the fishing year.

5.2.2 Results and Discussion

With the 1,400 lb. proportional day-at-sea tradeoff (the way the projections were performed), the "High F" scenario is the least conservative, catching about 1.5 billion scallops (Figure 36). This is followed by the "Low F" scenario (1.1 billion), the "New Closure" scenario (900 million), and the "Amendment 7 status quo" (650 million). Fishing mortality is a function of the number of scallops caught and comparisons are made between these management options in Section 5.1.3. A fifth scenario, run during the development efforts for Amendment 10, assumed the annual target fishing mortalities for Amendment 7 and open access to the Mid-Atlantic closed areas beginning the 2001 fishing year. This scenario, accounting for a 1,400 lb. day-at-sea tradeoff equivalent estimates that are considerably higher than presented here. The "Target F" scenario, however, considered that all of the Nantucket Lightship Area, Closed Area I, and the southern half of Closed Area II would be open to fishing and that F would equal 0.28, the target fishing mortality for 2001 according to Amendment 7. This is very different from a policy where the Georges Bank Closed Areas are not open for scallop fishing or target F is 0.20.

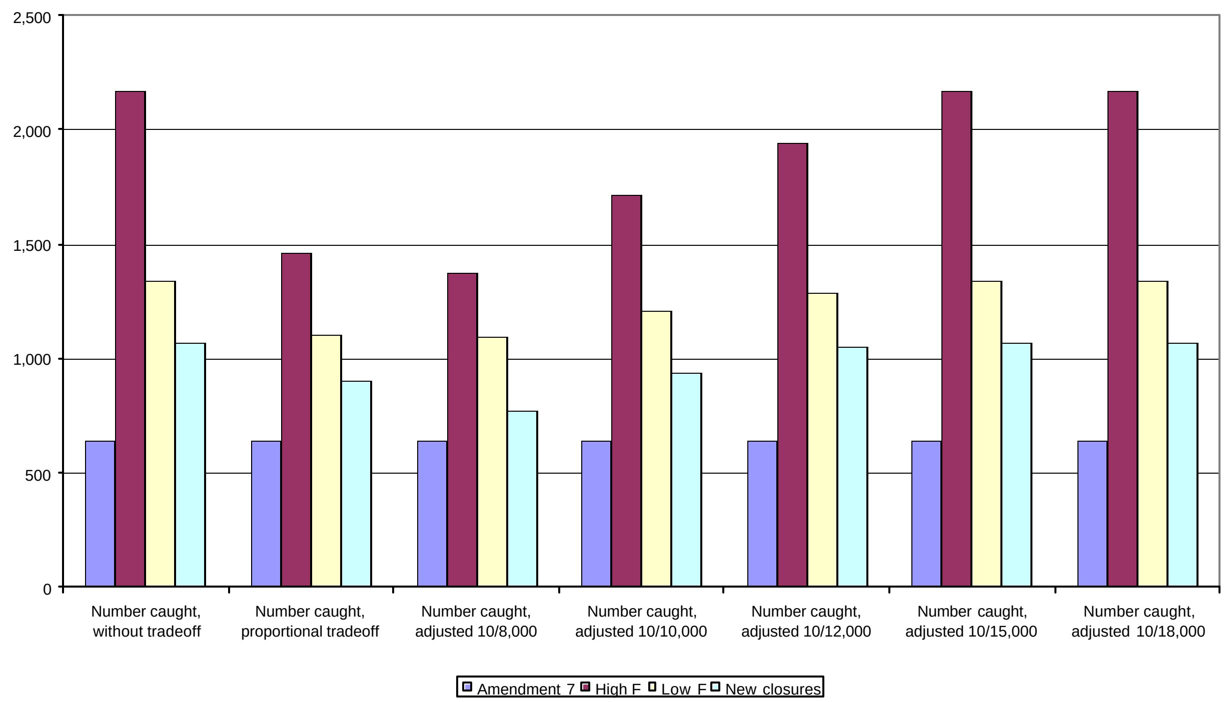

Figure 36. Comparison of the number of scallops estimated to be caught with various day-at-sea tradeoff limits in 2001 for different projection scenarios (Section 5.1.2).

Without the proportional day-at-sea tradeoff, the number of scallops caught would of course increase due to higher fishing effort outside of the Hudson Canyon and VA/NC Areas. The Amendment 7 status quo scenario gives the same results because there would of course be no tradeoff if there is a 49 day-at-sea allocation and the Hudson Canyon and VA/NC Areas are open without additional restrictions. The increases are slight for the "New Closure" scenario, rising to 1.1 billion scallops. In these scenarios, there are either few days to be used for scallop fishing in the remaining open areas and in the latter case, there are fewer productive scallop areas to fish. In fact, if the assumption is made that vessels in the mobile scallop fleet will target scallops where LPUE is highest, the "Amendment 7 status quo" scenario predicts that there would be little or no fishing outside of the Hudson Canyon and VA/NC Areas in 2001. In the other three scenarios (all associated with a 120 full-time day-at-sea allocation and an access program with a day-at-sea tradeoff), the tradeoff reduces the total number of scallops caught by 18 to 48 percent, relative to one with no day-at-sea tradeoff (Figure 36). The largest effect of the proportional day-at-sea tradeoff occurs for the "High F" scenario, which has the highest accumulation of charged days-at-sea in the Hudson Canyon and VA/NC Areas.

Applying a fixed day-at-sea tradeoff of 10 days for each trip with the Hudson Canyon and VA/NC closed areas, has a similar effect as the proportional day-at-sea tradeoff. A 10 day-at-sea tradeoff with an 8,000 to 10,000 lb. scallop possession limit is roughly equivalent to the assumed proportional tradeoff assumed in the projection model for the "High F" and "Low F" scenarios.

Similar patterns are apparent in the 2002 and 2003 fishing years (Figure 37and Figure 38, respectively), except that the scallop catch estimates are lower for the "Amendment 7 F-target" scenario because of the lower annual fishing mortality targets. Another difference is that the day-at-sea tradeoffs for the "Amendment 7 status quo" scenario has some effect because the models predict some fishing effort outside of the Hudson Canyon and VA/NC Areas from the disproportionate effort in 2001 and the high mortality rates within the Mid-Atlantic closed areas. This would reduce LPUE and make it relatively more attractive to fish elsewhere in 2002 and 2003.

Some differences in the estimated number of scallops caught by the fishery are evident in 2003, however. The scallop catches for the "Low F" and "New Closure" scenarios are much closer to the "High F" scenario, due to the lower fishing effort and greater survival of scallops in 2001 and 2002. There are also some differences in the comparison between alternatives in 2003, because differences in projected LPUE by area have different effects on the fixed day-at-sea tradeoff strategies.

The 2002 and 2003 comparisons should be interpreted cautiously, however. Different day-at-sea tradeoff strategies would feedback to the fishing mortality in the open scallop fishing areas, outside of the Hudson Canyon and VA/NC Areas. More conservative tradeoffs would induce lower fishing mortality elsewhere and faster rebuilding, which have not been factored back into the projections at this time. If they were, catches in 2003 would be higher than indicated for the more conservative tradeoffs. One additional note is that these are short-term projections and the "New Closure" scenario rebuilds biomass in the new closed areas faster than the other scenarios. This could, in the end, increase long-term benefits compared to the other scenarios presented here, but those benefits are hidden because the areas are assumed to remain closed throughout the projection period.

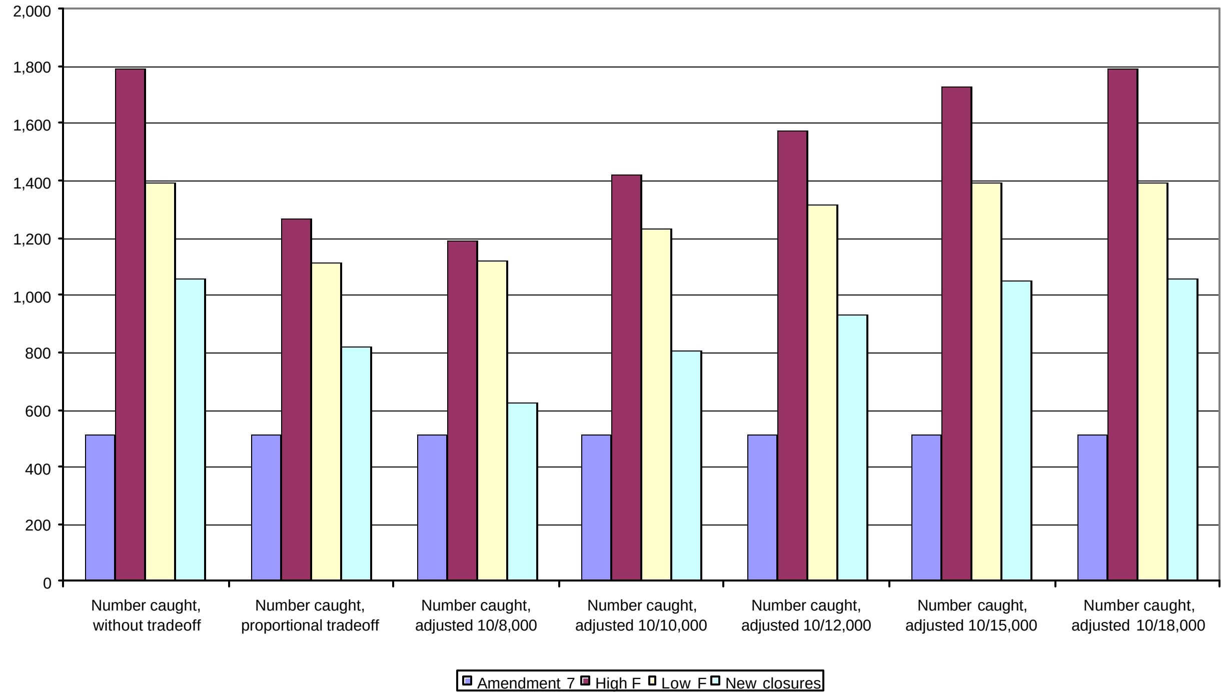

Figure 37. Comparison of the number of scallops estimated to be caught with various day-at-sea tradeoff limits in 2002 for different projection scenarios (Section 5.1.2).

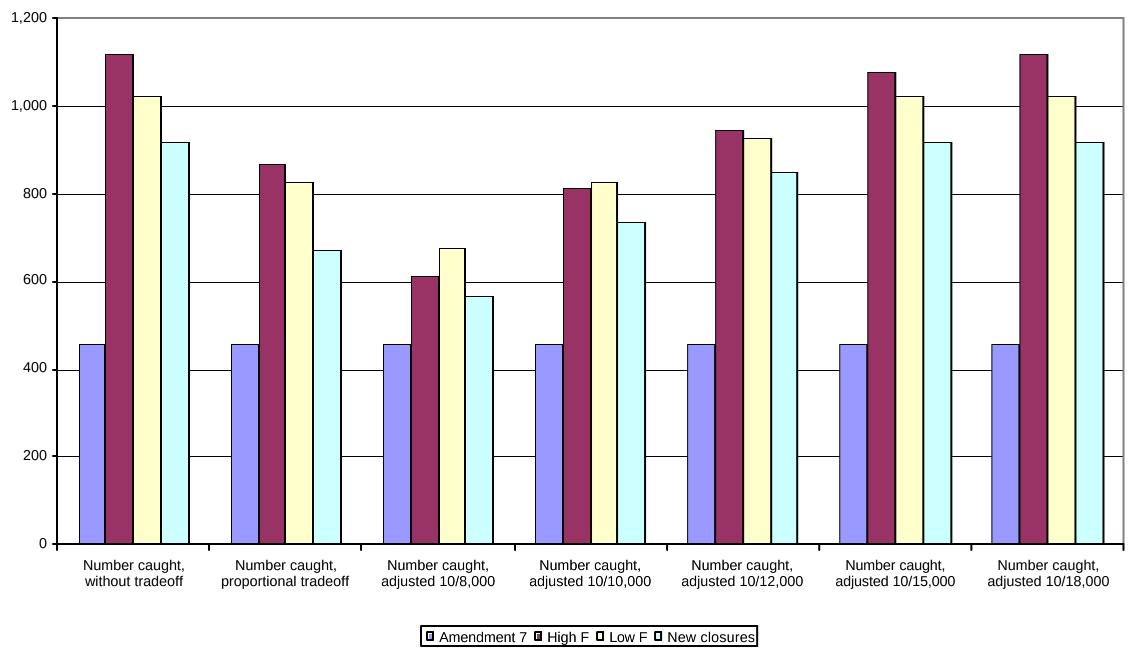

Figure 38. Comparison of the number of scallops estimated to be caught with various day-at-sea tradeoff limits in 2003 for different projection scenarios (Section 5.1.2).

5.2.3 Methods

In lieu of a process-based depletion model (similar to the method used for Framework Adjustments 11 and 13), a more simplistic method was applied to estimate the reduction in day-at-sea use and landings in open areas that would result from various scallop possession limits with a 10 day-at-sea accumulation. This method is more parsimonious with the projection model, since it in itself attempts to estimate in-season depletion by having a two-day within season time-step. Both models are sensitive to assumptions of dredge efficiency. The depletion model is sensitive to commercial dredge efficiency, while the total biomass and catch estimates are sensitive to assumptions about efficiency of the survey dredge. It is important to draw the distinction between the two quantities and realize that they may not vary in tandem over different conditions, a warning that the PDT has given for depletion model results for areas outside of Closed Area II.

Recent modifications have taken into account the limits on shucking capacity, another step that makes the projections more consistent with our expectations from a physically-based process model, like the one used for Frameworks 11 and 13. In its current form, however, the projection results and the extensions presented here still lack a direct estimate from experimental fishery data (catch per standard 10-minute tow), an estimated variance of the results, a process to account for the length of each trip rather than the average trip, a seasonal variation in meat yield, and physical parameters that when altered change the production capability of the vessel in response to different resource conditions. It also does not take into account the amount of unused days by limited access permit type, the number of possible trips for each permit type and possession limit, and the average steam time for the distribution of vessels by region. All these factors are included in the depletion model, but not here. Another significant drawback to the day-at-sea estimates in the projections is that they depend on a mathematical formula, roughly estimated from a cluster of points at the origin and one point (Closed Area II in 1999)

Considerably more data than is presently available before this meeting would be needed to estimate the results of various options via the depletion model, including experimental fishery catch rates, bycatch estimates, and the 2000 Albatross survey results. The last data would also affect the projections, however. Another factor in the decision not to attempt a depletion model estimate at this time include uncertain status quo results and the uncertainty about how to define and estimate the number of scallops caught under status quo. As a first approximation of conservation-neutral day-at-sea adjustments for trips that fish in the Mid-Atlantic closed areas, the following calculations were performed:

Unadjusted day-at-sea use (projection model)

Commercial landings per unit day-at-sea (LPUE) is estimated from an asymptotic mathematical formula that describes the increase in commercial catch as survey biomass increases and the asymptote approximates the size-specific shucking capacity. Day-at-sea use is estimated for each region/area (except for the Hudson Canyon and VA/NC Areas) by dividing the annual catch by the average LPUE at the start in end of the year. These methods and the parameters assumed by the projections are described more thoroughly in Section 5.1.2.

Proportional adjustment in day-at-sea use

Day-at-sea use in areas other than the Mid-Atlantic closed areas were reduced so as the total day-at-sea use would equal 25,000 days-at-sea for all scenarios. It was assumed that a vessel would be charged days-at-sea for trips in the Mid-Atlantic closed areas in proportion to the amount that the daily LPUE exceeded 1,400 pounds. For example, an unadjusted estimate of 14,000 days would be increased to 18,000 if the estimated LPUE was 1,800. The 4,000 day excess was deducted from the other, open fishing areas.

An ad hoc adjustment in LPUE was made (Section 5.1.2) to account for differences in the 1999 projections and preliminary 2000 survey results. The day-at-sea charge and catch were reduced by 34 percent in the Hudson Canyon and 27 percent in the Virginia Beach closed areas for all scenarios, except for the “New closures” scenario. The “New closures” scenario used the 2000 Albatross survey results directly and was reduced by only 18 percent. This method was reversed to estimate the annual effects of various day-at-sea tradeoff options and estimate total catch and mortality in the absence of the proportional day-at-sea tradeoff.

To reverse the proportional tradeoff, the following formulas were applied to the adjusted projection output:

$$DAS_{charged} = \frac{LPUE}{1400} * DAS_{adjusted}$$

$$Tradeoff = \frac{DAS_{charged} \quad DAS_{adjusted}}{\underset{area}{DAS} \quad (DAS_{HCA} + DAS_{VA/NC})}$$

$$Catch = \underset{area}{} Catch_{adjusted} * \left\{ \frac{1}{1 \quad Tradeoff} \right)$$

Flat 10-day day-at-sea adjustment

The number of days to account for the scallop possession limit was determined by dividing the possession limit by the estimated LPUE. If the expected, average trip duration was less than 10 days, the difference was added to the total day-at-sea assumed to be used while fishing in the Mid-Atlantic closed areas. The totals with adjustment were compared with the total day-at-sea allocation and the amount that the revised days-at-sea exceeded the allocation were deducted proportionally from the expected day-at-sea use in other, open fishing areas. Since it takes longer to catch higher scallop possession limit in the Mid-Atlantic closed areas, the higher possession limits are less conservative and catches are therefore higher than for the lower scallop possession limit options. It was assumed, for purposes of analysis, that vessels would use no more than 25,000 days-at-sea, regardless of the tradeoff strategy employed. This assumption can easily be changed, however, to assume that the vessels would have fewer unused days-at-sea (until the vessels use all allocated days) to account for the tradeoffs.

To calculate the effect of a fixed day-at-sea strategy with various scallop possession limits and day-at-sea tradeoffs, formulas similar in form to those above were applied except that the calculation of the charged days-at-sea in the Hudson Canyon and VA/NC Areas were calculated with a different formula:

$$\mathrm{DAS}_{\text{charged}} = \frac{DAS_{fixed}}{PossessionLimit \big/ LPUE} * \mathrm{DAS}_{used}$$

$$\text{Tradeoff} = \frac{\mathrm{DAS}_{\text{charged}} \quad \mathrm{DAS}_{used}}{\underset{\text{area}}{\mathrm{DAS}} \quad (\mathrm{DAS}_{\text{HCA}} + \mathrm{DAS}_{\text{VA/NC}})}$$

$$\text{Catch} = \underset{\text{area}}{\quad} \text{Catch}_{WithoutTradeoff} * (1 \quad Tradeoff)$$

For each area, the adjusted catch and mortality was computed by applying the proportion of revised day-at-sea use to the unadjusted day-at-sea use. For example, a 1,000 mt catch for an area was re-estimated as 800 mt if the revised day-at-sea estimate was 80 percent of the original value. The number of scallops caught for each day-at-sea adjustment option is simply the total catch, divided by the average exploitable meat count computed directly from the average exploitable size of scallops in the projection results.

5.3 Biomass Estimates and TAC Options for the Hudson Canyon and VA/NC Areas

(W. DuPaul, D. Rudders, A. Applegate)

5.3.1 Summary of results

This report presents the preliminary results of the commercial survey of the Hudson Canyon Closed Area. The survey was conducted aboard the F/V Alice Amanda from June 8-15, 2000. A systematic grid design was utilized with survey stations located approximately five nm apart (Figure 39). Survey stations were located both inside and outside the boundaries of the closed area. Additional stations were added along the western, northern and southern boundaries in an attempt to resolve the boundary effects on sea scallop abundance and size distribution. Survey tows were 10 minutes in duration at a speed of 4.5-5.0 kts. The sampling gear consisted of two standard 15 ft. New Bedford style sea scallop dredges with 8-inch twine tops, ring bags knit with 3.5" (88.9 mm) rings, and no tickler or rock chains. An inclinometer was attached to the frame of the starboard dredge to measure dredge angle and bottom contact time.

The results of the initial data analysis are shown in Figure 40 through Figure 45. Catch data are shown in Figure 40 through Figure 42 with scallop catches separated into two categories of shell height: less than 90 mm (Figure 40) and greater than or equal to 90 mm shell height (Figure 41). A total scallop catch at each station is shown in Figure 4.

Differences in sea scallop abundance and size structure were examined with respect to samples taken inside or outside of the closed area (Figure 43), strata calculated by dividing the closed area into equal North and South portions along the 39° 01.566′ latitude (Figure 44), and by depth regimes within the closed area (Figure 45).

The depth-stratified size frequency distributions were used to project biomass in 2001, giving a stock biomass estimate of 28,205 mt (Table 175). The method for the projection is described below and accounts for growth and natural mortality, but not fishing and new recruitment. Generally, the one-year growth potential increases with depth, because smaller scallops are found there. In the shallowest half of the Hudson Canyon Area, the biomass of the scallops is expected to grow by 21 percent before June 2001 (Table 175). Areas less than 35 fathom will account for 42 percent of the total biomass. In deeper waters, on the other hand, the scallop biomass is expected to grow by 32 percent before June 2001, because this is were the smallest scallops are found (Figure 42). By 2001, 58 percent of the total biomass will be for scallops in depths greater than 35 fathoms. Although in general small scallops increase meat weight faster than large scallops due to growth, the scallops found in the deeper water of the Hudson Canyon Area tend to be small.

Whether this is due to good recruitment in the deeper water and a slow migration of larger scallops upslope or whether this is due to slower growth rates for scallops found there remains to be determined. The PDT considered application of a slower growth rate to scallops in depths greater than 35 fathoms, but applied a general growth rate to all scallops in the Hudson Canyon Area. If the growth rate is indeed slower, the current estimates may overestimate the biomass that will be found there in 2001.

Table 172. Results of commercial survey in the Hudson Canyon Closed Area. All scallops were included in the analysis.

Sub-Area	Area (nm^2)	N (tows)	Mean (grams)	Variance	Standard Deviation
Open North	?	19	8,014.6	18,888,235.0	4,346.1
Open South	?	16	8,338.2	339,215,165.0	2,807.9
Closed North	711	62	19,145.5	7,884,538.7	18,417.8
Closed South	756	66	31,181.8	1,082,958,654.7	32,908.3

Table 173. Estimated Biomass for the Hudson Canyon Closed Area in June 2000. All scallops were included in the analysis. Harvest represents 25% of the estimated biomass.

	Total	Standard Error	Total -2*SE	Total +2*SE
Biomass (MT)	18,818.8	1763.6	15,291.6	22,345.9
Biomass (Lbs)	42,154,059.3	3,950,382.2	34,253,295.0	50,054,823

	Total	Standard Error	Total -2*SE	Total +2*SE
Harvest (Lbs)	10,538,514.8	987,595.5	8,563,323.8	12,513,705.9

Table 174. Estimated biomass for the Hudson Canyon Closed Area in June 2000. Catches of scallops with shell heights between 80 mm and 100mm were adjusted to reflect the selectivity of the 3.5" dredge at those shell heights[58]. All scallops were included in the analysis. A nominal tow length of 1 nm and a dredge efficiency of 40% were assumed for the analysis. Harvest represents 25% of the estimated biomass.

	Total	Standard Error	Total -2*SE	Total +2*SE
Biomass (MT)	20,393	1,945	16,502	24,283
Biomass (Lbs)	45,679,170	4,357,381	36,964,408	54,393,932
Harvest (Lbs)	11,419,793	1,089,345	9,241,102	13,598,483

Table 175. Estimated biomass for the Hudson Canyon Closed Area in June 2000. Catches of scallops with shell heights between 80 mm and 100mm were adjusted to reflect the selectivity of the 3.5" dredge at those shell heights.[59] All scallops were included in the analysis. Values for average tow length are derived from three sources: (1) An assumed tow length of one nm, (2) Tow length calculated from bridge log (i.e. tow start and end times correspond to winch brake set and beginning of haul back), (3) Tow length calculated from inclinometer records.

	Tow Length	Biomass (MT)	Standard Error	Biomass -2*SE	Biomass +2*SE
Assumed	1.0	20,393	1,945	16,502	24,283
Bridge Log	0.8218	24,874	2,372	20,128	29,619

[58] Correction factors for scallops in the 80-100 mm shell height interval are taken from selectivity values found on page 99 in DuPaul et al. 1989a.
[59] Correction factors for scallops in the 80-100 mm shell height interval are taken from selectivity values found on page 99 in DuPaul et al. 1989a

	Tow Length	**Biomass (MT)**	**Standard Error**	**Biomass -2*SE**	**Biomass +2*SE**
Inclinometer	0.9786	20,851	1,989	16,873	24,829

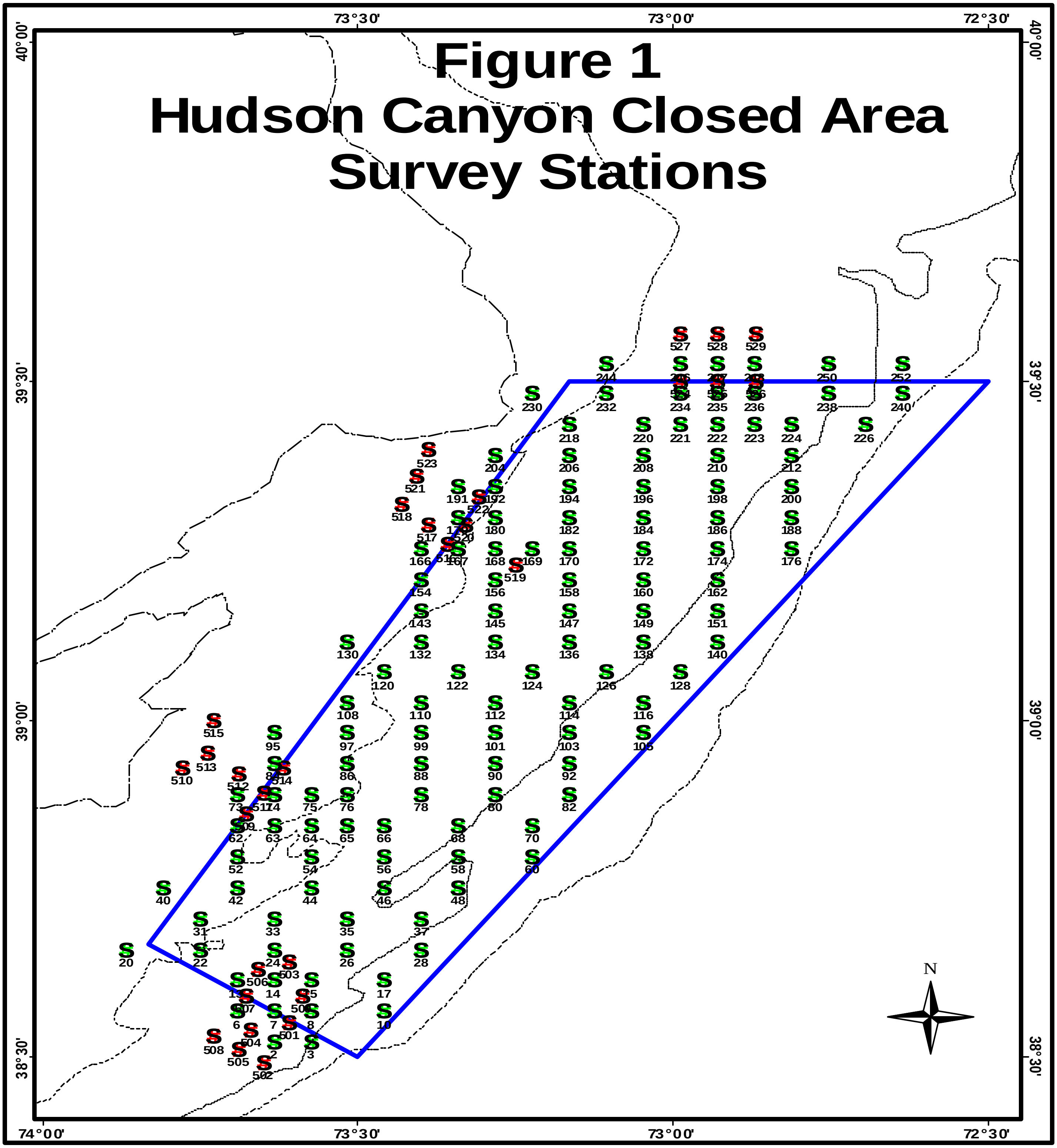

Figure 39. Hudson Canyon Area Experimental Fishery survey stations, July 2000.

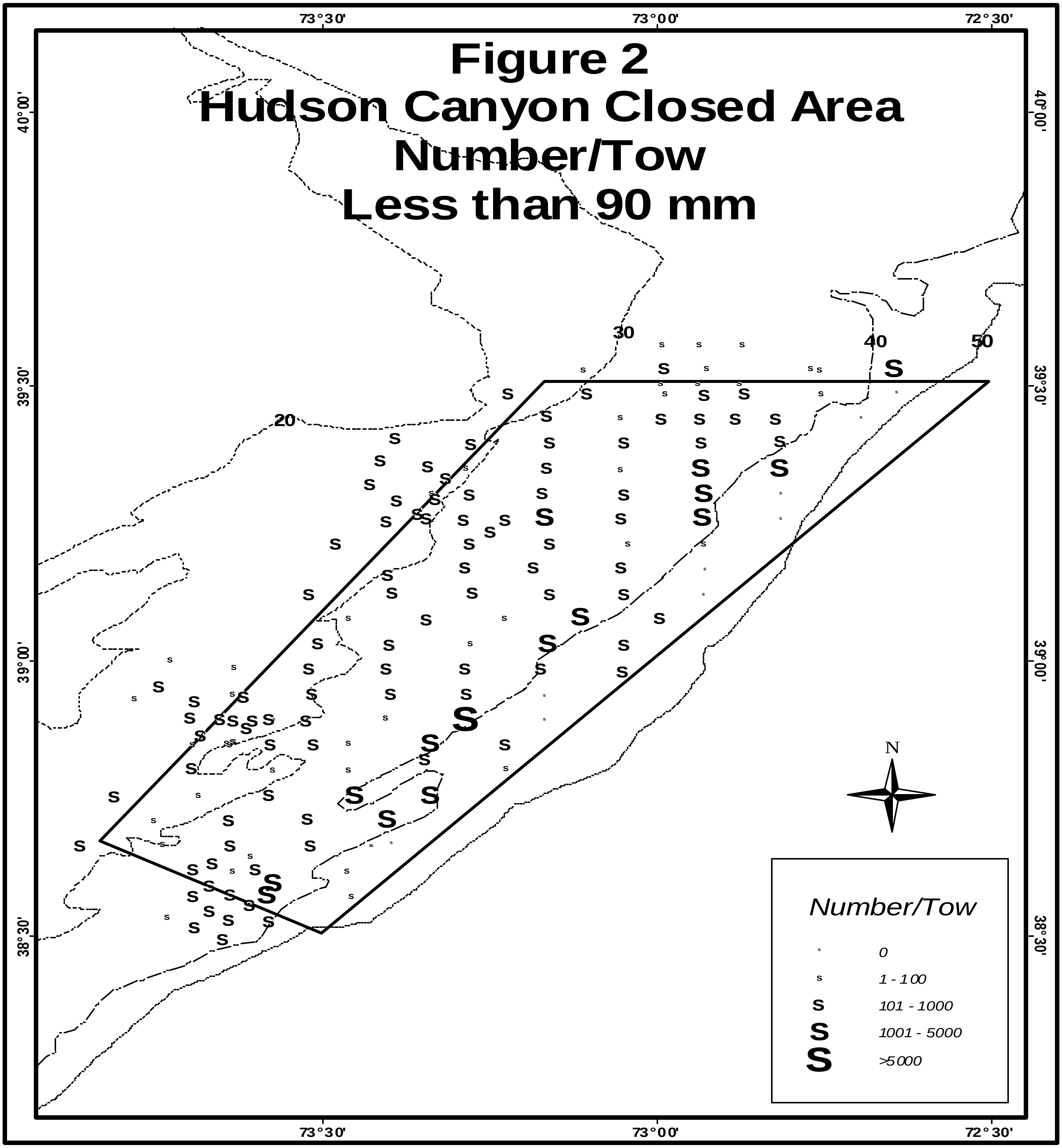

Figure 40. Hudson Canyon Area number per tow, for scallops less than 90 mm.

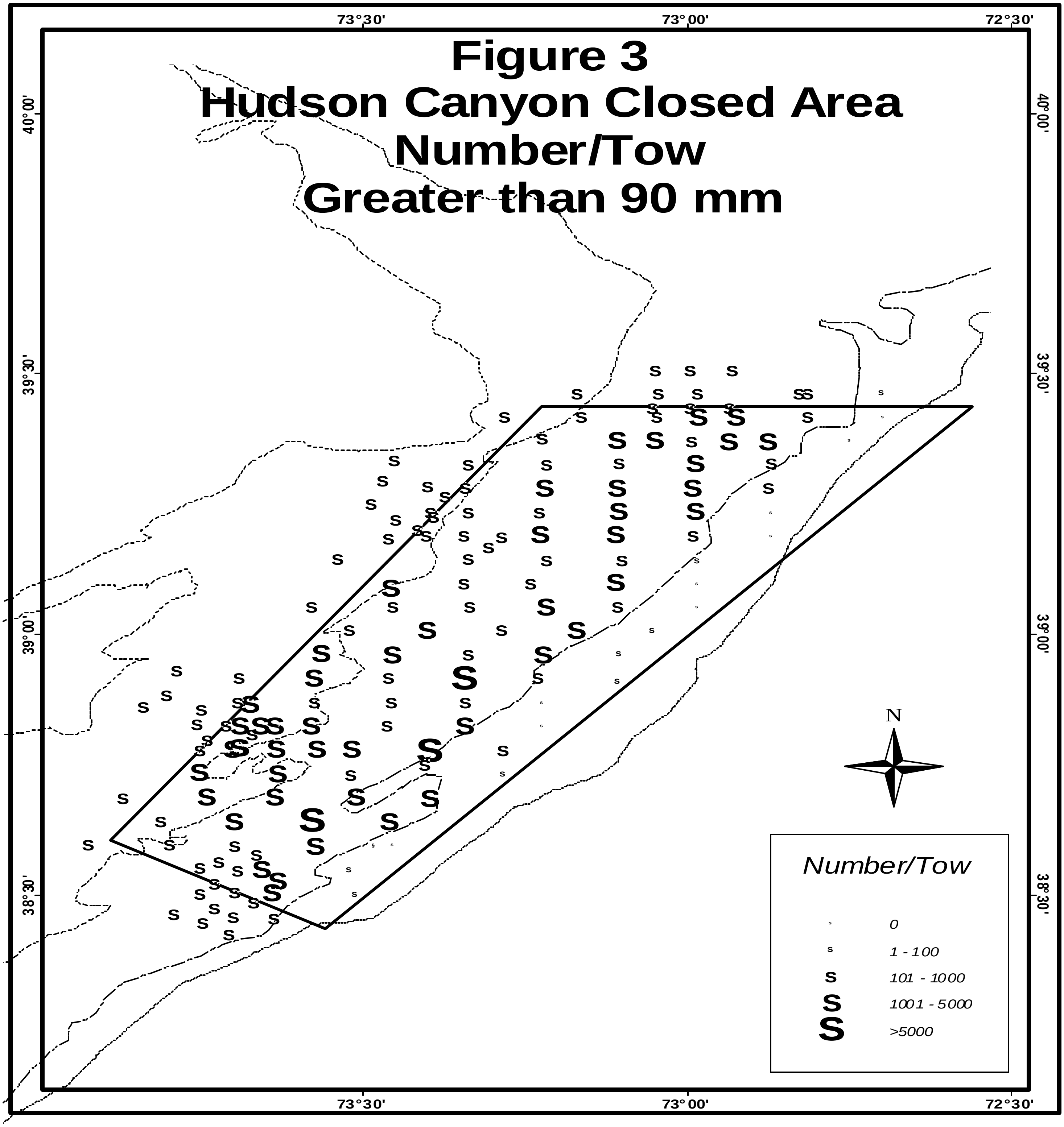

Figure 41. Hudson Canyon Area number per tow, for scallops greater than 90 mm.

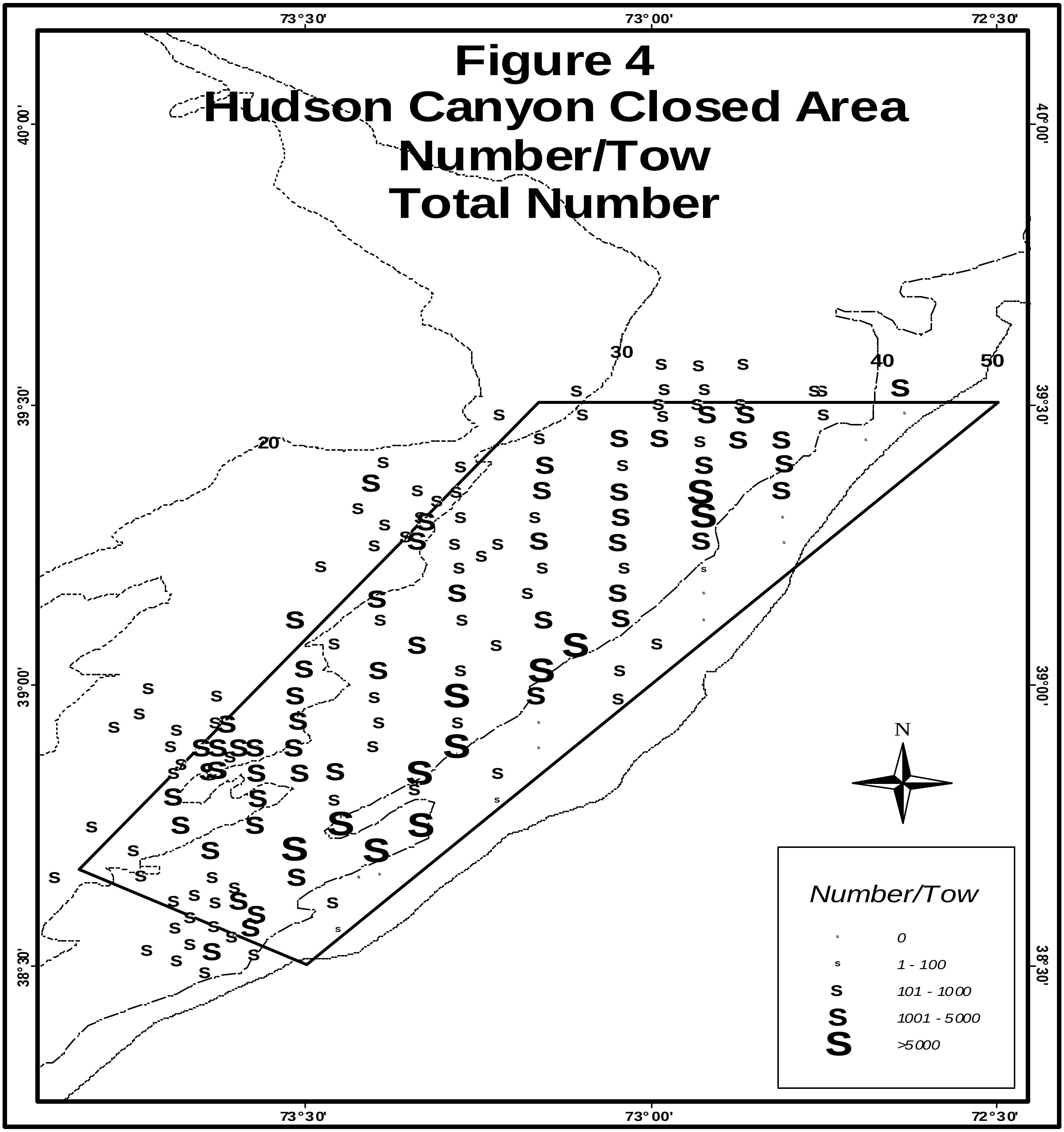

Figure 42. Hudson Canyon number per tow, all scallops.

Table 11 Depth stratified sea scallop biomass estimates for 2001. Results reflect increases in scallop growth from June 2000 to June 2001. Scallops with shell heights less than 80 mm were excluded from the analysis. Add-in stations were not included in the analysis. A nominal tow length of 1 nm. and a dredge efficiency of 40% are assumed for the absolute biomass calculation.

Depth (fathoms)	# of stations	Area (proportional)	Mean Weight per Tow 2000 (g)	Projected Mean Weight per Tow 2001 (g)	Biomass growth potential (percent), 2000-2001	Projected Total 2001 Biomass (mt)	$Area^2$*variance
21-25	1	15.61	14,790	16,606	12.3%	131	-
26-30	16	249.70	26,780	31,431	17.4%	3,972	15.0 e^9
31-35	30	468.19	26,403	32,590	23.4%	7,722	123.2e^9
36-40	31	483.80	49,600	65,558	32.2%	16,051	321.8e^9
41-47	16	249.70	1,836	2,606	41.9%	329	719.5e^9
Total	94	1467	29,812	37,991	27.4%	28,205	

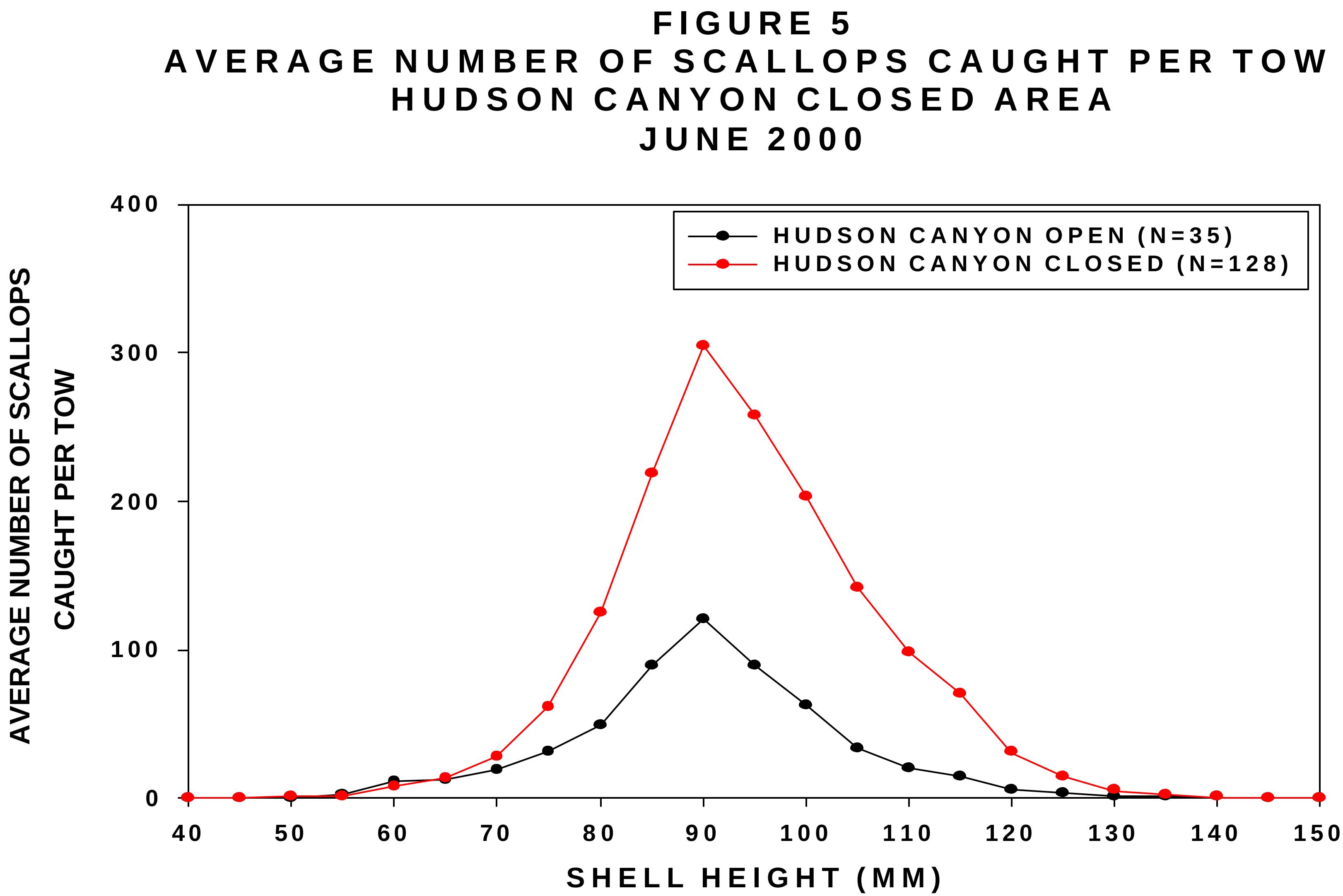

Figure 43. Size frequency distribution of scallops inside and adjacent to the Hudson Canyon Area, June 2000.

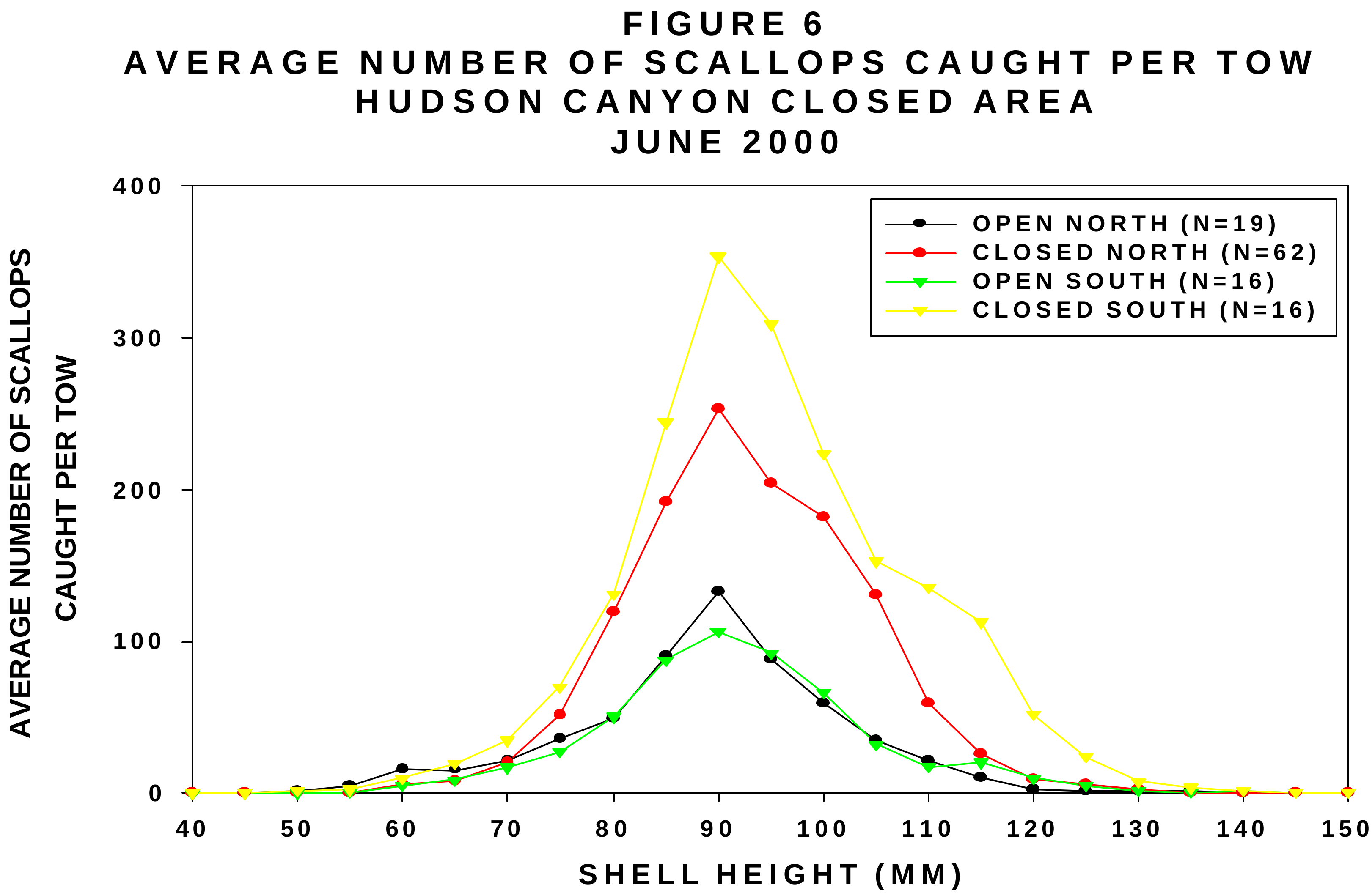

Figure 44. Size frequency distribution of scallops inside and adjacent to the northern and southern portions of Hudson Canyon Area, June 2000.

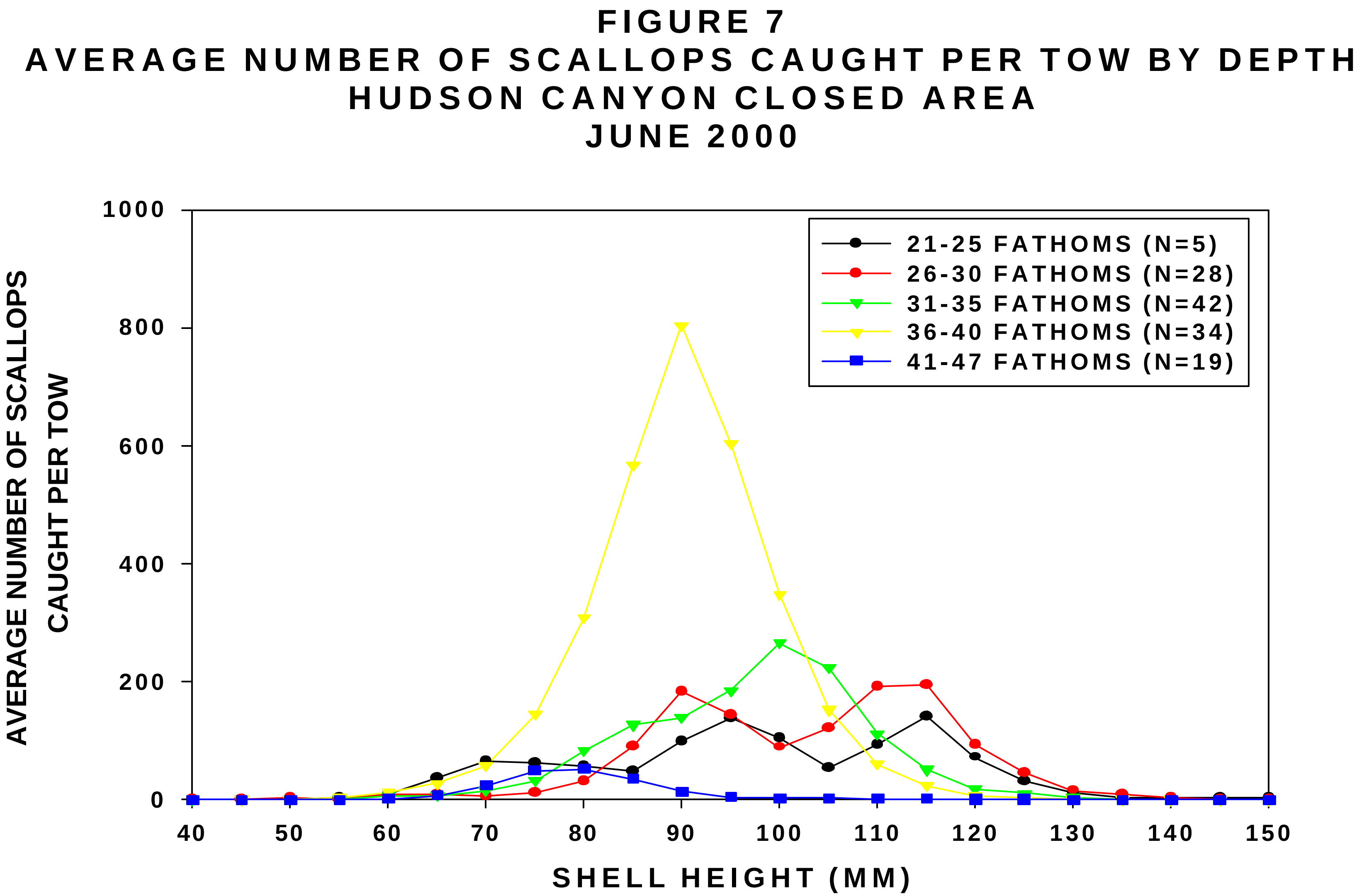

Figure 45. Size frequency distribution of scallops by depth within the Hudson Canyon Area, June 2000.