Comparison of the Southern New England Yellowtail Flounder Industry Based Survey with the Northeast Fisheries Science Center Bottom Trawl Survey: Annual Trends and Distributions

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Introduction

The Southern New England yellowtail flounder Industry Based Survey (SNEYT IBS) was conducted during the spring and fall of years 2003 through 2005. The SNEYT IBS used commercial boats and nets to capture yellowtail flounder, providing a wealth of information regarding length composition and age-length relationships. The SNEYT IBS has also been suggested as a source of data for the GARM process, specifically as a tuning index or to compare the distribution of catch with the Northeast Fisheries Science Center Bottom Trawl Survey (NEFSC BTS), which uses much lower sampling intensity than the IBS. Previous reviews of the SNEYT IBS have concluded that the time series is too short for use as a tuning index in stock assessment (Chouinard et al. 2007).

Since the SNEYT IBS used a different stratification of the area than the NEFSC BTS (Figure 1), direct comparisons of the results are not possible. However, using domain estimation (Särndal et al. 1992), the mean catch per tow of the SNEYT IBS can be computed using the strata defined for the NEFSC BTS. The average catch by the SNEYT IBS in the NEFSC strata cannot be used directly because the tows were not selected randomly from within the NEFSC strata, but rather from within the SNEYT IBS strata. Domain estimation accounts for the original sampling scheme while computing the mean catch per new stratum. Once domain estimation has been completed, the mean catch by NEFSC strata can be compared directly between the two surveys, both the stratified mean over time and the distribution among strata.

Methods

Details regarding the SNEYT IBS can be found in the final report (Valliere and Pierce 2007). In summary, spring and fall surveys were conducted in years 2003 through 2005, each survey consisting of approximately 300 tows. Approximately half of the tows for each survey were allocated randomly within the SNEYT IBS strata, while the locations of the remaining tows were set by fishermen. Tow start locations were used to determine the location of each tow relative to both the SNEYT IBS and NEFSC BTS strata through GIS. Determination of strata for each tow was hampered by multiple methods used to

record tow location without record of which type was being used (e.g. degrees minutes seconds, degrees minutes and tenths of minutes, and others), requiring tow end locations to be used occasionally to produce a reasonable location. The SNEYT IBS strata were based on 30 minute squares, but the exact location of boundaries for many of the strata were not defined and thus areas associated with some strata had to be estimated (Figure 2). Due to limited numbers of tows in some NEFSC strata, only NEFSC strata 01010, 01020, 01050, 01060, 01090, and 01100 were used in the analyses. Limiting the analyses to these strata and using only random tows in the SNEYT IBS reduced the number of tows in each survey to approximately 150 (range 133-163). This is nearly four times more tows than the NEFSC survey conducts in these strata (Table 1 and Figure 3).

Domain estimation was used to convert the observed catch per tow in the SNEYT IBS random tows into mean catch per tow for NEFSC BTS strata. Define y_k as the kth observation that falls into SNEYT IBS stratum h and NEFSC domain d, where n_{dh} is the sample size for this combination and H is the total number of SNEYT IBS strata. The sample size (number of tows) for SNEYT IBS stratum h is n_h while N_h is the total number of possible samples that could be taken from SNEYT IBS stratum h. Hence the probability of choosing observation y_k is n_h/N_h in NEFSC domain d. The mean for NEFSC domain d is estimated as

$$\hat{\bar{y}}_d = \sum_{h=1}^{H} \frac{N_h}{n_h} \sum_{k=1}^{n_{dh}} y_k \Bigg/ \sum_{h=1}^{H} \frac{N_h}{n_h} n_{dh} \quad .$$

The NEFSC strata areas were used to combine the converted SNEYT IBS mean catch rates into annual stratified means for comparison with NEFSC BTS values for the same year, season, and strata. Mean catch rates by strata were also compared between the converted SNEYT IBS and the NEFSC BTS by year and season. Catch rates in each stratum were multiplied by the relative size of the stratum to show the influence of each stratum on the overall stratified mean. Since the stratum areas are relatively similar, this multiplication had only a small impact on the proportions by stratum.

Results and Discussion

The survey stratified mean catch per tow (kg) for the SNEYT IBS and NEFSC BTS followed similar patterns, although the magnitude of the catch rates was quite different (Figure 4). The SNEYT IBS caught approximately 30 times more yellowtail flounder than the NEFSC BTS. This difference is caused by the different nets used in the surveys, as can be seen by comparing the number of positive tows for yellowtail flounder between the two surveys (Table 1), as well as the focus of the SNEYT IBS on areas of prime yellowtail flounder habitat. This can be seen by comparing the distribution of NESC BTS tows with yellowtail flounder in Figure 3 relative to SNEYT IBS survey area in Figure 2. Since the SNEYT IBS strata focused on areas of higher yellowtail flounder abundance, it is not surprising that they had a higher catch rate. This difference has implications for the number of fish available for biological sampling, but does not necessarily mean that the

NEFSC BTS is biased. The relatively strong correlation between the two surveys is encouraging.

The limited number of positive tows for the NEFSC BTS means that this survey will be expected to be more variable at the strata level than the SNEYT IBS, which has many more positive tows (Figure 5). While generally the NEFSC BTS is able to detect the strata with the highest concentrations of yellowtail, there are occasions when it does not, for example, stratum 01010 in the 2003 fall survey and stratum 01100 in the 2005 spring survey. These results demonstrate the utility of high sampling density for small scale spatial analysis. However, the lack of full coverage of the NEFSC BTS strata by the SNEYT IBS means that the SNEYT IBS proportions by strata are biased, thus weakening any comparisons between the SNEYT IBS and NEFSC BTS.

Population abundance of yellowtail flounder in the southern New England region is low. At the last Groundfish Assessment Review Meeting (Mayo and Terceiro 2005), the Southern New England-Mid Atlantic stock was found to be overfished and overfishing was occurring. There are two implications for this result. First, these low population abundance means that comparison of trends between the SNEYT IBS and NEFSC BTS should be made only cautiously, and only when there is a large contrast in abundance over time. As means of comparison, the NEFSC BTS had catch rates nearly an order of magnitude higher (equal to those of the SNEYT IBS) in the 1960s and early 1970s when stock abundance was much higher. Secondly, the stock definition used for assessment and management is much larger than the area covered by the SNEYT IBS. Had the full stock area been surveyed during the SNEYT IBS, the sampling density would have been much lower or the cost of the survey would have been much higher. Not surveying the entire stock area limits the ability to incorporate results of the SNEYT IBS into the stock assessment. This demonstrates the trade-offs that must be decided when designing an industry based survey.

Conclusions

The large number of tows and flatfish net used in the SNEYT IBS allowed it to document the spatial distribution of yellowtail flounder in part of the Southern New England-Mid Atlantic stock region and provided much needed biological samples for the assessment. Domain estimation allows comparison of the stratified mean between the SNEYT IBS and the NEFSC BTS, which is encouraging, but is too short to draw strong conclusions. The distribution of yellowtail flounder at the level of NEFSC strata is not well determined by the NEFSC BTS as seen by comparison with the SNEYT IBS.

Acknowledgments

Special thanks to Stephen Smith (DFO) for pointing out the use of domain estimation in a similar situation.

Literature Cited

Chouinard, G., M. Martin, and J. Sowles. 2007. Peer Review of the Southern New England Yellowtail Industry-Based Survey.

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Särndal, C.-E., B. Swenson, and J. Wretman. 1992. Model assisted survey sampling. Springer-Verlag, New York.

Valliere, A. and S. Pierce. 2007. Southern New England Industry-Based Yellowtail Flounder Survey, 2003-2005. Pilot Study Report submitted to the National Marine Fisheries Service for Contract EA 1337-03-CN-00112.

Table 1. Number of tows (N) and number of tows containing yellowtail flounder (Npos) for the SNEYT IBS and NEFSC BTS by strata during spring and fall of years 2003 through 2005 used in the analyses. Percentages in the Npos columns denote the overall proportion of positive tows in that survey.

SNEYT IBS

NEFSC	2003 spr		2003 fall		2004 spr		2004 fall		2005 spr		2005 fall	
Strata	N	Npos	N	Npos	N	Npos	N	Npos	N	Npos	N	Npos
01010	32	27	25	14	36	31	28	9	32	28	27	21
01020	19	5	30	21	22	10	31	13	21	5	33	26
01050	15	14	17	11	15	15	18	14	20	20	8	7
01060	28	16	36	25	29	27	23	19	33	30	34	24
01090	14	14	17	14	22	20	12	11	19	19	11	9
01100	25	24	38	26	27	25	45	31	28	26	39	31
sum	133	100	163	111	151	128	157	97	153	128	152	118
		75%		68%		85%		62%		84%		78%

NEFSC BTS

NEFSC	2003 spr		2003 fall		2004 spr		2004 fall		2005 spr		2005 fall	
Strata	N	Npos	N	Npos	N	Npos	N	Npos	N	Npos	N	Npos
01010	6	3	7	0	7	2	7	0	7	4	7	5
01020	6	0	7	1	7	0	7	1	7	1	7	2
01050	5	2	5	3	5	4	5	2	5	4	5	5
01060	8	0	8	2	8	2	8	2	8	3	8	2
01090	5	0	5	2	5	1	5	2	5	4	5	4
01100	8	5	8	1	8	3	8	1	8	0	8	1
sum	38	10	40	9	40	12	40	8	40	16	40	19
		26%		23%		30%		20%		40%		48%

Figure 1. Comparison of the SNEYT IBS strata (shaded rectangles) with the NEFSC BTS strata used in these analyses (polygons). To convert the NEFSC BTS strata labels elsewhere in this document to those in the figure drop the leading '01' and ending '0' and report as a number, for example 01060 becomes 6.

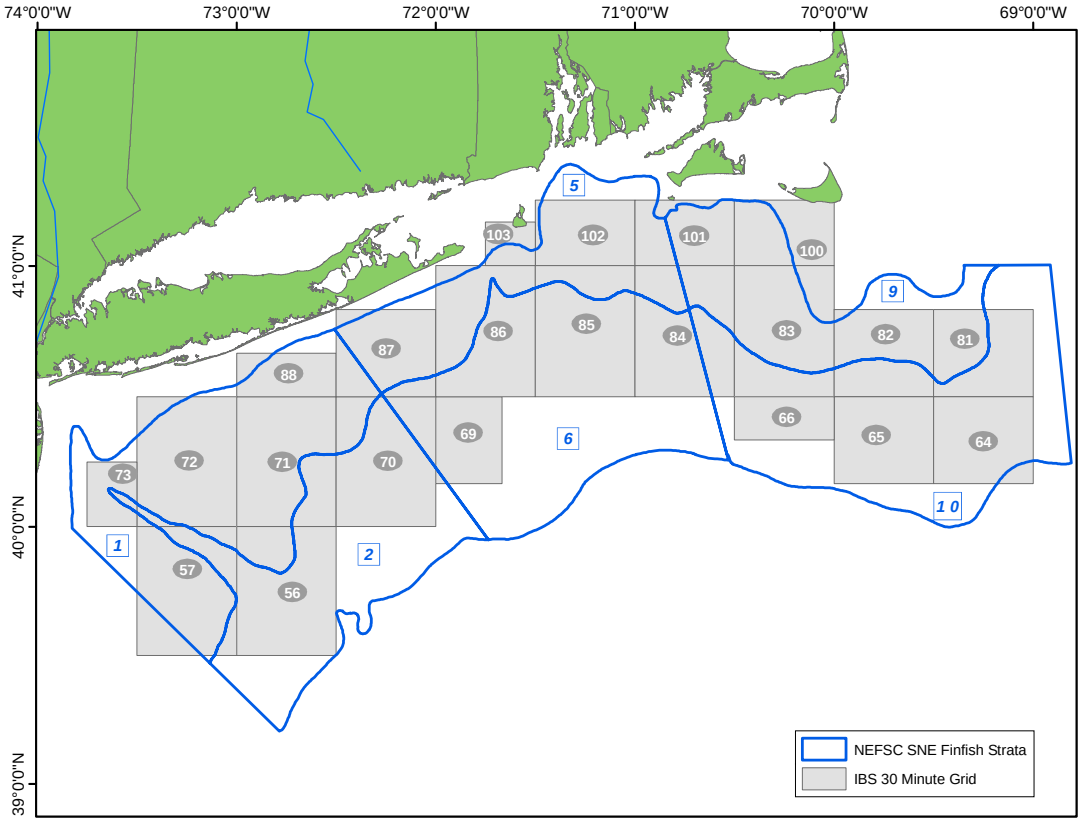

Figure 2. Locations of SNEYT IBS tows (dots) relative to estimated boundaries for the SNEYT IBS strata. Note that both randomly selected location and industry selected stations are shown on this map.

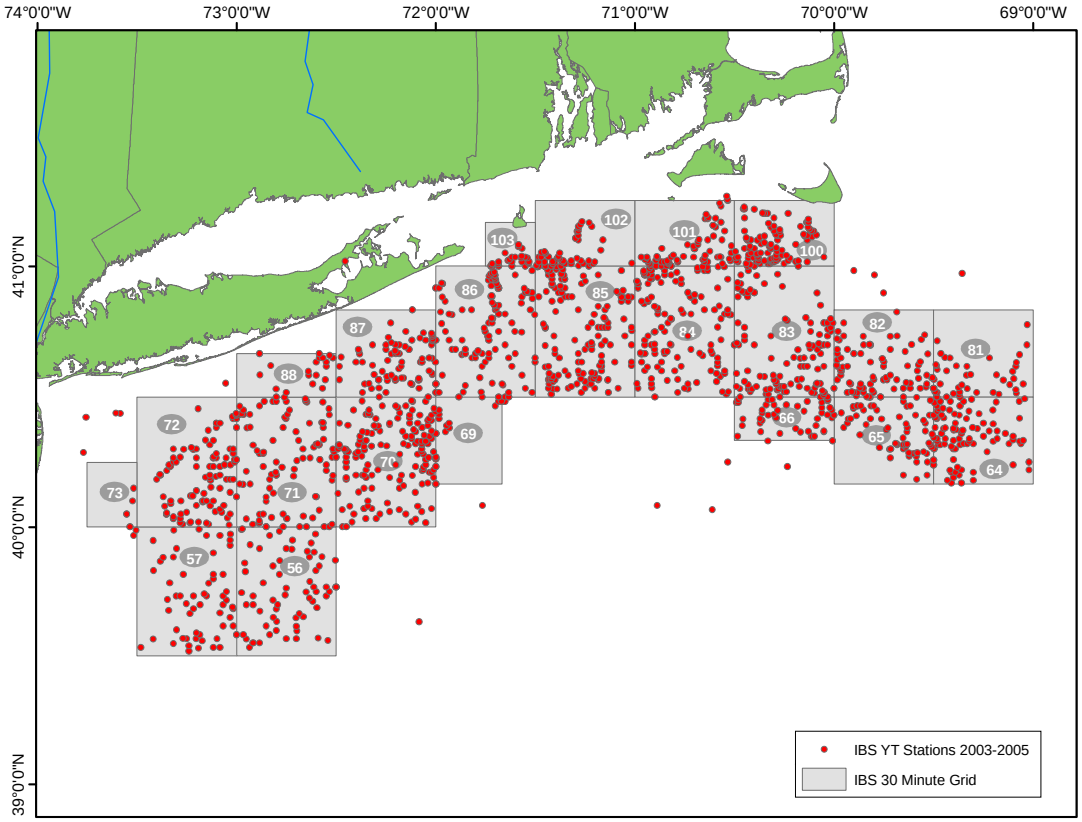

Figure 3. Location of NEFSC BTS tows during spring and fall of years 2003 through 2005. Filled circles denote tows which caught yellowtail flounder, while the crosses denote tows which did not catch yellowtail flounder.

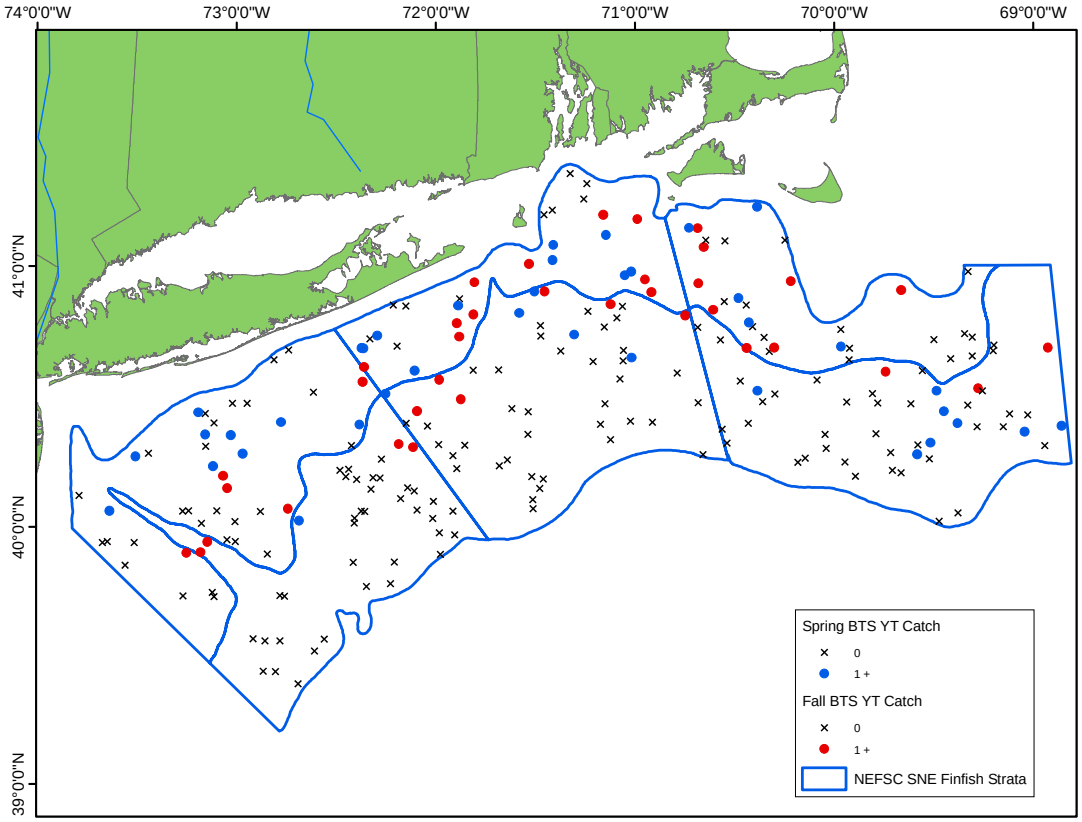

Figure 4. Comparison of stratified mean catch per tow (kg) for NEFSC strata 01010, 01020, 01050, 01060, 01090, and 01100 from the SNEYT IBS and NEFSC BTS for spring and fall of years 2003 through 2005.

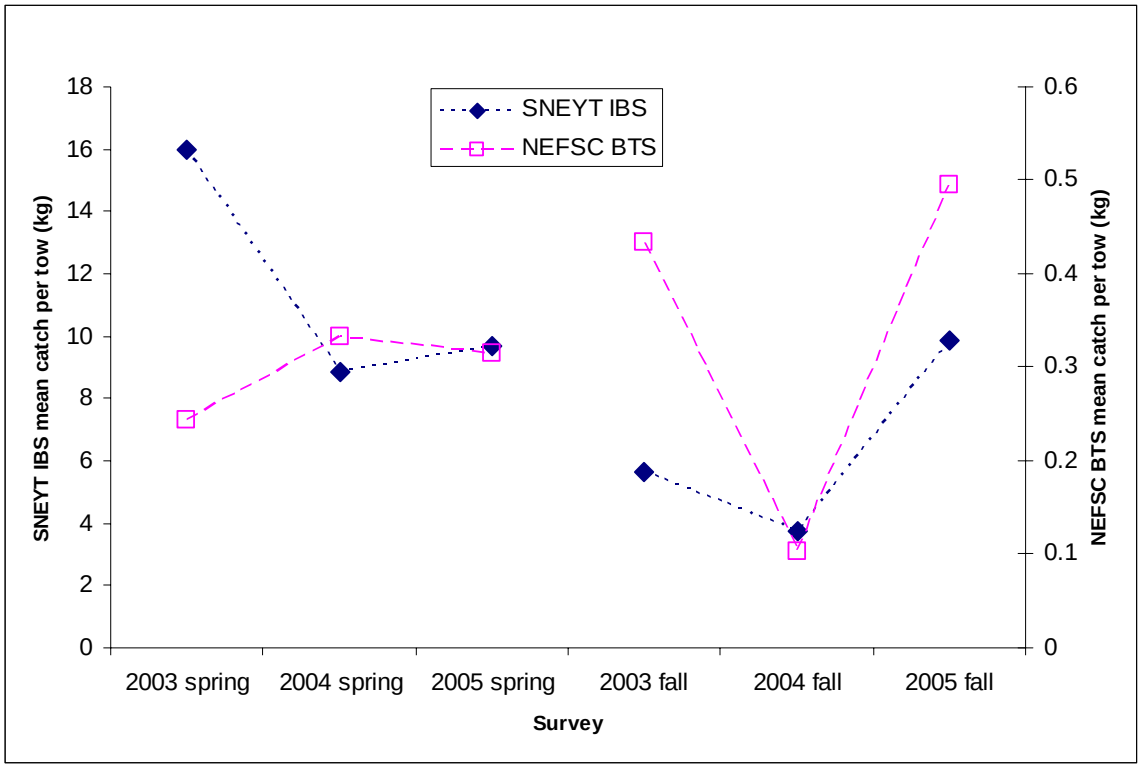
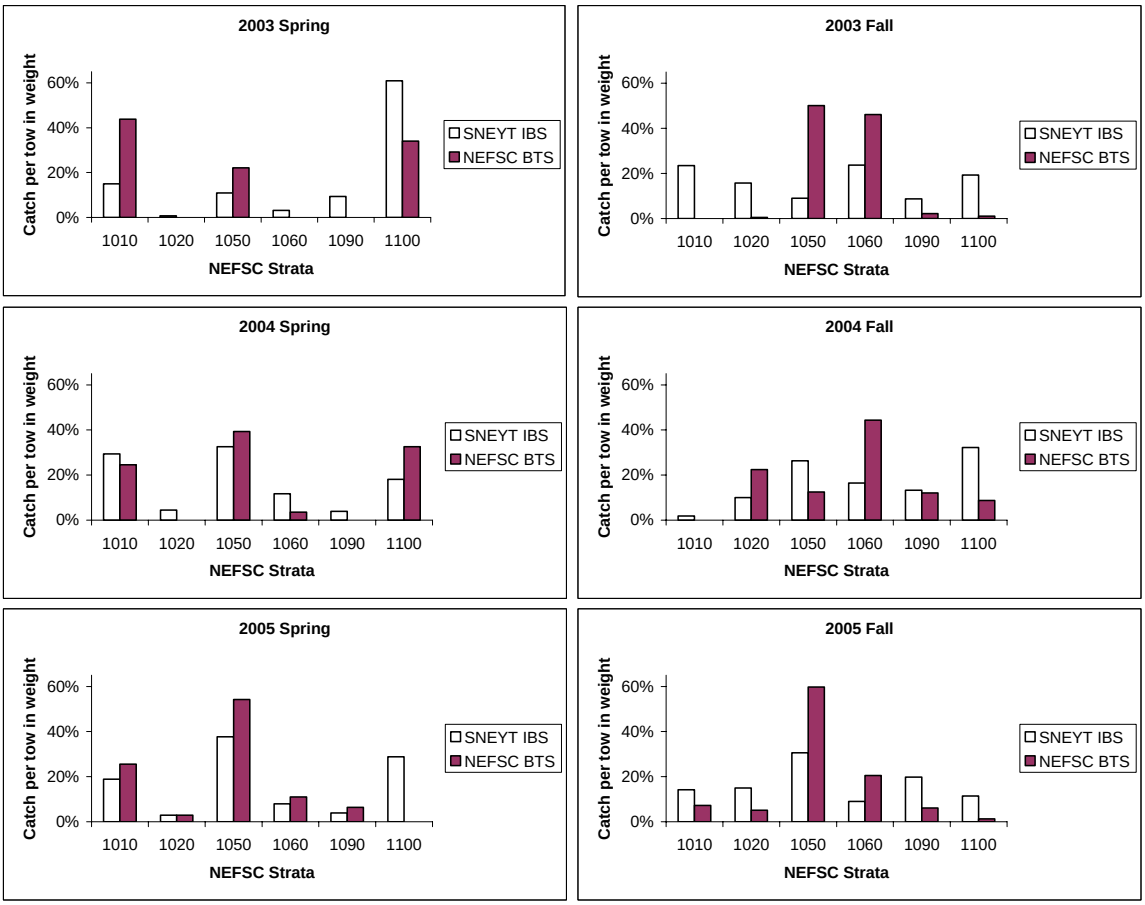
Figure 5. Proportion of catch, weighted by stratum area, for the SNEYT IBS and NEFSC BTS during spring and fall surveys of years 2003 through 2005. Note the leading zeros for stratum definition have been dropped in this figure.