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THE OHIO TURFGRASS SURVEY

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ABSTRACT

This paper outlines the procedures used in implementing and conducting The Ohio Turfgrass Survey. The turfgrass sample frame was a multiple frame design and consisted of a List Sampling Frame (LSF) and an Area Sampling Frame (ASF). The LSF was constructed from informational listings corresponding to the industry types of interest. The ASF utilized June Agricultural Survey (JAS) segments from previous years. The questionnaires were constructed by an industry advisory committee, which was composed of individuals from the Ohio Turf Federation (OTF), The Ohio State University (OSU), and the Ohio Agricultural Statistics Service (OASS). Initial data edits were done by hand. The final data edit and summarization were done using SAS.

KEY WORDS

turfgrass, list sampling frame, area sampling frame, SAS

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INTRODUCTION

The turfgrass industry is an industry of growing importance as well as an industry of unknown economic value. To date, turfgrass surveys have been completed in North Carolina and Michigan, and are currently being conducted in Kentucky and Pennsylvania. In Ohio, the Ohio Turfgrass Foundation (OTF) and The Ohio State University (OSU) have jointly sponsored a research project on the various economic aspects of the turfgrass industry in the state of Ohio. The Ohio Agricultural Statistics Service (OASS), within the United States Department of Agriculture (USDA), was contracted to perform data collection and proceeded through the data summarization. The purpose of the project was to estimate the total economic impact of the turfgrass industry on Ohio's economy. A statewide survey was conducted which produced accurate estimates of the dollar value impact of the turfgrass industry. The turfgrass survey included all portions of the industry and was conducted utilizing a multiple frame survey approach. In a multiple frame survey, the sample is selected from two or more sampling frames. The turfgrass survey utilized both a list sampling frame (LSF) and an area sampling frame (ASF).

The LSF was constructed by an Industry Advisory Committee composed of members from the OTF, OSU, and OASS. An LSF is a sampling frame consisting of a list of individuals, businesses, or other entities from which a sample is selected. An LSF is divided into multiple strata. In the LSF context, each stratum is a mutually exclusive list (e.g., a list of churches, a list of hospitals, ...), with each stratum also having a unique sampling rate. The sampling rate ranges from the smallest fraction to 100 percent and is applied using a random number table concept within each stratum.

The ASF was constructed by the Area Frame Section of the National Agriculture Statistics Service (NASS) in conjunction with the OASS. An ASF is a sampling frame consisting of all land area in the state from which a sample of land segments is selected. In constructing the ASF, the land is stratified based upon the percent of land cultivated. The resulting stratum is composed of segments, which are pieces of land with easily identifiable boundaries. All segments within the same stratum are targeted to have the same acreage size. Each segment is composed of tracts. A tract is an area of land, wholly contained within a segment, that is under a single operation or management.

FRAME CONSTRUCTION AND SAMPLING

ASF and LSF containment were determined by the ability to completely classify (or contain) a homogeneous group of operations into a unique and definable stratum universe. Those strata with an accurately identifiable universe number were included in the LSF. Defined strata with no identifiable universe number were treated

separately through an ASF.

In building the turfgrass LSF, the first step was to determine the industry types of interest. Once these industry types had been determined, an informational listing containing at least the name, address, and phone number of each industry was obtained. In some instances (large number of listings, extreme operators) an industry listing was further subdivided into mutually exclusive groups. Each mutually exclusive group forms an LSF stratum, as do the industry listings that were not subdivided. The original industry types of interest for the turfgrass list sample were based on comparable industry listings from the 1987 North Carolina Turfgrass Survey. The North Carolina industry types were as follows:

Airport
Athletic Field
Garden Centers
Golf
Institution
Landscape
Parks
Roadside
School
Cemetery
Church
Sod
Lawn Care

In constructing the Ohio turfgrass list sample, the Industry Advisory Committee made several changes in the aforementioned North Carolina industry listings. These changes are stated as follows:

1) Several strata were added that were not specified in the North Carolina listings. These strata were hospitals, nursing homes, cities greater than or equal to $200 million in revenue, cities less than $200 million in revenue, villages greater than 2,160 in population, villages less than or equal to 2,160 in population, counties, and racetracks. The criteria for determining both city and village strata inclusion was based on a combination of list length and sampling rates.

2) Both the golf and school listings were subdivided. The golf listing was divided into separate strata for public and private golf courses. The division basis for schools was the school district size. Those school districts having greater than 2,675 students form one strata, while those with less than 2,675 form the other school strata.

3) Several listings covered a narrower range than their North Carolina counterpart. Parks became simply a stratum of city parks. A city park listing was easily obtainable, while other parks were covered by the ASF. Roadsides were changed to state roadsides.

County and city roadsides were included on their respective county and/or city questionnaire.

4) The North Carolina institution stratum was not included. For Ohio, the institutions were covered in the hospital and nursing home strata, as well as the ASF. Athletic fields were handled in much the same manner. Athletic field information was contained in the strata pertaining to schools, cities, villages, counties, and city parks.

5) The industry listings for airports, garden centers, landscapers, cemeteries, churches, sod (sod producers) and lawn care firms remained unchanged, and each formed their own stratum.

Table 1 contains the LSF strata and their corresponding strata codes. These strata codes are arbitrarily assigned, and their meaning will be discussed in the Question\Questionnaire Construction section.

TABLE 1: List sampling frame strata and strata codes

LIST STRATUM DESCRIPTION	STRATUM CODES
AIRPORTS	11
CHURCHES	21
CEMETERIES	22
HOSPITALS	23
NURSING HOMES	24
PUBLIC GOLF	31
PRIVATE GOLF	32
GARDEN CENTERS	41
LANDSCAPERS	42
LAWN/GROUNDS CARE	51
SCHOOL DIST. > 2675	61
SCHOOL DIST. <= 2675	62
SOD PRODUCERS	71
CITIES >= $200M	81
CITIES < $200M	82
VILLAGES >= 2160	83
VILLAGES < 2160	84
COUNTIES	85
CITY PARKS	86
STATE ROADSIDES	87
RACETRACKS	91

After classifying all of the population units into the individual LSF stratum, each stratum was independently sampled. The sampling rate for the turfgrass survey ranged from 10 percent to 100 percent.

The primary objective of the turfgrass area sample was to obtain information from home owners, multiple family dwellings, and commercial enterprises; those individuals or operators that were not included on the turfgrass list sample. Consequently, the area sample was purposefully targeted towards the non-agricultural areas of Ohio. The land use stratification codes for the ASF in Ohio are defined in Table 2 as follows:

TABLE 2: ASF land use stratification codes and definitions

STRATUM CODE	STRATUM DEFINITION
11	General Cropland, 80% or more cultivated
12	General Cropland, 50 - 79% cultivated
20	General Cropland, 15 - 49% cultivated
31	Ag-urban, > 20 dwellings per square mile
32	Residential-commercial, non-ag, > 20 dwellings per square mile
33	Resort, non-ag, > 20 dwellings per square mile
40	Open range/pasture, 0 - 15% cultivated
50	Non-ag

Based on the desired targeting of the non-agricultural areas and the above stratum definitions, the turfgrass area sample concentrated more heavily in the urban strata (31, 32, and 33) and non-agricultural strata (40 and 50) than in the agricultural strata (11, 12, and 20).

Turfgrass data from the ASF was desired from approximately 1300 tracts. To obtain information from these 1300 tracts, an area sample containing roughly 115 selected segments was needed. This sample consisted of segments from previously selected June Agricultural Survey (JAS) area samples and, in particular, segments that had been rotated out of the OASS sampling scheme during 1984 through 1989. Each year, OASS adds in and rotates out approximately 20% of the segments within each stratum. This procedure provides year to year consistency while, at the same time, allowing for some respondent burden relief. Initially, one segment was selected from each agricultural stratum (11, 12, and 20). For the urban strata, eight sampled segments from strata 31 (or 75% of its total available segments) were included in the area sample for each of the six rotation years. In the remaining urban and non-agricultural strata (32, 33, 40, and 50), the area sample included all segments from the six year period. Sampled segments from strata 32 and 40 were represented in all six years, while sampled segments in strata 33 and 50 were only represented in the years 1984, 1985 and 1989. A random number table was used to select the sampled segments in strata 11, 12, 20, and the eight sampled segments in strata 31.

The aforementioned procedure details the selection of the initial turfgrass area sample. The final turfgrass area sample was merely an alteration of the initial sample. These changes essentially replaced older sampled segments (1984 and 1985) with newer (1988, 1989, 1990) sampled segments. The final turfgrass area sample reflected the following alterations:

1) In strata 11, 12, and 20, sampled segments from rotated out years 1984 and 1985 were replaced with 1988 and 1989 sampled segments, respectively.

2) In strata 31, six 1984 and six 1985 sampled segments were replaced by an equal number of 1988 and 1989 sampled segments, respectively. The remaining two 1984 and two 1985 sampled segments were replaced with 1990 sampled segments. Eight additional 1990 sampled segments were also included. Therefore, all twelve 1988, 1989, and 1990 sampled segments from strata 31 were included in the area sample.

3) In strata 32, 33, 40, and 50, the 1985 sampled segments were replaced by 1990 sampled segments. The 1984 sampled segments were deleted and not replaced.

Refer to Table 3 for further details in the initial and final turfgrass area frame sample selection.

After the segments were selected, each segment in the turfgrass area sample was further divided into tracts by the field enumerator during data collection. A tract in an agricultural strata often corresponds to an entire farming operation. In an urban strata, a tract could be a single house and its surrounding yard. An upper limit of twenty tracts per segment was set. A sampling of twenty tracts per segment was satisfactory in meeting both the time and monetary constraints. The tract sample selection was done by the field enumerator during the data collection period. A sample selection worksheet was enclosed with each segment package for the field enumerators. This worksheet was used to randomly select the upper limit of twenty tracts when the total number of eligible tracts per segment was greater than twenty. Appendix A contains an example of a tract sample selection worksheet.

Upon selection of a tract, every possible effort was made by the field enumerator to contact the operator. In the event that contact was not made, available tracts within the segment were not substituted for the noncontacts. Data was obtained only from originally sampled contacted tracts.

TABLE 3: Area sampling frame construction - number of segments available, the segments selected in the initial area sampling frame, and those segments selected for the final area sampling frame (by strata).

STRATA	YEAR	SEGMENTS AVAILABLE	SEGMENTS INITIAL	SEGMENTS FINAL
11,12,20	1984	28,11,6	1,1,1	0,0,0
	1985	28,11,6	1,1,1	0,0,0
	1986	28,11,6	1,1,1	1,1,1
	1987	28,11,6	1,1,1	1,1,1
	1988	28,11,6	1,1,1	2,2,2
	1989	28,11,6	1,1,1	2,2,2
	1990	28,11,6	0,0,0	0,0,0
TOTAL		168,66,36	6,6,6	6,6,6
31	1984	12	8	0
	1985	12	8	0
	1986	12	8	8
	1987	12	8	8
	1988	12	8	12
	1989	12	8	12
	1990	12	0	12
TOTAL		72	48	52
32,40	1984	2,5	2,5	0,0
	1985	2,5	2,5	0,0
	1986	2,5	2,5	2,5
	1987	2,5	2,5	2,5
	1988	2,5	2,5	2,5
	1989	2,5	2,5	2,5
	1990	2,5	0,0	2,5
TOTAL		14,35	12,30	10,25
33,50	1984	1,1	1,1	0,0
	1985	1,1	1,1	0,0
	1986	0,0	0,0	0,0
	1987	0,0	0,0	0,0
	1988	0,0	0,0	0,0
	1989	1,1	1,1	1,1
	1990	1,1	0,0	1,1
TOTAL		4,4	3,3	2,2

Therefore, the final turfgrass area sample included six sampled segments each from strata 11, 12, and 20; fifty-two sampled segments from stratum 31; ten sampled segments from stratum 32; twenty-five sampled segments from stratum 40; and two sampled segments each from strata 33 and 50. The final turfgrass area sample contained a total of 109 segments.

QUESTION/QUESTIONNAIRE CONSTRUCTION

As with the LSF industry listing groups, the initial ideas for questionnaire development were generated from the North Carolina example. The Industry Advisory Committee met and decided on content, phrasing, and order of both the questions and questionnaires.

The committee's first decision was to create stratum specific questionnaires as opposed to the method used in North Carolina (one questionnaire for all strata - list and area). Strata were grouped according to industry similarities, and separate questionnaires were developed for each stratum group. Table 4 defines the stratum groupings as follows:

TABLE 4: LSF and ASF questionnaire groupings

FRAME	STRATA	STRATA NUMBER
LSF	AIRPORTS	11
LSF	CHURCHES	21,22,23,24
	CEMETERIES	HOSPITALS
	NURSING HOMES	
LSF	PUBLIC GOLF	31,32
	PRIVATE GOLF	
LSF	GARDEN CENTERS	41,42,51
	LANDSCAPERS	
	LAWN/GROUNDS CARE	
LSF	SCHOOL > 2675	61,62
	SCHOOL <= 2675	
LSF	SOD PRODUCERS	71
LSF	CITY >= $200M	81,82,83,84,85,86,87
	CITY < $200M	
	VILLAGE >= 2160	
	VILLAGE < 2160	
	COUNTY	
	CITY PARKS	
	STATE ROADSIDES	
LSF	RACETRACKS	91
ASF	ALL	11,12,20,31,32,33,40,50

Therefore, there were nine questionnaire types. The LSF stratum number corresponded to the questionnaire type (tens digit). The only exception was the questionnaires pertaining to garden centers, landscapers, and lawn/grounds care (strata codes 41, 42, and 51). Lawn/grounds care operators were originally separated from the other two groups, but were ultimately included on the same questionnaire.

Question groups were formed based on the type of question and the flow of the questionnaire. Each question group was then placed in a separate file. In maintaining separate question files the questions could be independently edited for content, while still maintaining a uniform appearance on the individual questionnaires. Upon editing the questions to meet the Industry Advisory Committee approval, satisfactory question files were included on the individual questionnaires based upon the questions relativity to the type of operations contained within each stratum (ie, questions relating to airports were only included on the airport questionnaires).

Although the Industry Advisory Committee spent a considerable amount of time on question content, some questions were vague and misleading. Two such problem questions are listed below. They are not the only problem questions, but are representative of some of the difficulties encountered in composing good questions.

1) How much of the lawn area receives lawn chemical/fertilizer applications:

Fewer than 3 times/year	3 or more times/year
_____ Acres	_____ Acres
_____ Sq. Ft.	_____ Sq. Ft.

If the respondent did not fertilize, the correct response was to include the unfertilized land in the 'Fewer than 3 times/year' category. Many respondents misunderstood this question and did not include the unfertilized land in either category. This under reported the land fertilized 'Fewer than 3 times/year' and, as a result, overestimated the proportion of the total land fertilized '3 or more times/year'.

2) What was the annual cost for mowing labor (own expenses) at this location during 1989? $_____

This question pertaining to mowing labor should not include equipment expenses, gasoline, etc. The field enumerators were also instructed not to include the value of the owner's time in this category. Hired expenses (lawn service) for mowing labor were recorded under a separate question. The intent of this question was to include paid individuals (children, neighbors) under own expenses for mowing labor. This was not clear to either the field enumerator or the respondents, and these paid individuals were included under hired expenses on the majority of the questionnaires.

DATA COLLECTION

Data collection is the process of retrieving the desired information from the respondents. Data was collected from the sampled respondents for both the LSF and the ASF. List data collection involved the mailing of survey questionnaires and conducting telephone reminders. The area sample data was collected through face to face interviews.

For the list questionnaires, a standard procedure of two mailings accompanied by a telephone reminder after the second mailing was followed. The LSF had a total universe size of 19,341 elements and was divided into 21 strata. The first mailing began on April 2, 1990. Several strata questionnaires were mailed later due to difficulty in determining strata containment boundaries (strata 81, 82 and strata 83, 84) and also due to difficulty in obtaining accurate names and addresses. The second mailing began on April 27 and assumed a similar time schedule as the first mailing. If there was no response after the second mailing, approximately eight telephone enumerators conducted reminder telephone calls. Completed questionnaires were mailed to OSU and then forwarded to the OASS. The actual turfgrass LSF achieved an overall response rate of 22.4% but, due to time constraints, the data analysis was based on a response rate of 18.6%. The LSF results are further detailed in Appendix B.

The ASF data collection was done by 23 field enumerators. Prior to data collection, a turfgrass survey workshop was conducted on the morning of March 27, 1990. Due to length of the school and the nature (relative simplicity) of the turfgrass area survey, the workshop was attended by supervisors only. Each supervisor then held his/her own "mini" workshop for his/her respective field enumerators. This training method was well received by both supervisors and their field enumerators alike. Upon completion of these workshops, the field enumerators were each assigned between 1 and 8 segments. Approximately 8 - 10 tract contacts per segment were expected with an interview time of 20 - 30 minutes each. The turfgrass field enumeration period ran from April 2 - 23. The completed surveys were mailed by the field enumerators into the OASS office 2 - 3 times per week. These multiple mailings spread the work load over the entire survey period, thus enabling the office to manage the survey data collection activities. Appendix C contains further turfgrass ASF results.

Data collection problems were inherent in both the list and area samples, in part due to questionnaire unfamiliarity. LSF respondents often ignored the questionnaire, assuming it did not apply to them. Upon receiving a questionnaire, the questionnaire circulated around the office and never made it to those with primary turf care responsibility. Franchise companies represented a unique problem. Chem Lawn is both a franchise company and an extreme operator in the turfgrass industry and, therefore, of great

interest. Their corporate structure made it difficult to determine sample representation and also difficult to obtain "corporate wide" information. Much of the area frame unfamiliarity was due to sampling more heavily in the urban and non-agricultural strata, as opposed to the agricultural strata. This situation primarily resulted in the respondents being unfamiliar with the questionnaire and its intent. After the initial surprise over the survey subject, the ASF respondents were usually cooperative and positive.

DATA EDIT - HAND AND MACHINE

During the data editing process, each questionnaire was individually reviewed for cohesiveness and validity among the respondent's answers. These checks flagged relational errors, summing errors, and "missing" errors (those questions that must be answered but were not). Both a hand edit and a machine edit were performed on the turfgrass data.

Initially, a hand edit was performed. In addition to the three aforementioned errors, the hand edit also flagged interpretational errors. Broadly speaking, an interpretational error is one in which the respondent misunderstood either the question or the answer(s). For example, if the specified "other" category corresponded with another named category choice, it was moved to the appropriate category. Additionally, the hand edit checked that the responses were within an acceptable range. This acceptable range could be anywhere from (0,1) or (0,1,2,3) to a broad range that flagged extraordinarily odd acreage or dollar amounts. And finally, if subsampling was necessary, the hand edit reviewed the enumerator's subsampling schematic.

Upon completion of the hand edit, the data were entered on the computer and a SAS (SAS Institute, Inc.) machine edit was executed. The machine edit essentially checked for the same errors as the hand edit. The intent was that the methodical machine edit would flag errors that slip by the human eye. In creating the SAS program, the initial checks were created for the ASF questionnaires. Specific checks were then added for each LSF questionnaire as they were encountered. The result was one SAS program that checked both the ASF and LSF questionnaires. The machine edit was especially useful in checking relational errors (e.g., turf area mowed was larger than the total turf area) and summing errors (e.g., sum of hired expenses did not equal total hired expenses).

In retrospect, one SAS program containing subroutines for each LSF questionnaire type and for the ASF questionnaires would have been more beneficial. Initially, the data would have been sorted by frame type and strata. Upon sorting, a separate SAS data set would be created for each LSF questionnaire type and, also, a SAS data set would be created for the ASF questionnaires. For example,

there would be eight LSF data sets (recall, multiple strata sometimes corresponded to one questionnaire type) and one ASF data set. As illustrated below, (1) - (8) all pertain to the separate LSF data sets while (9) pertains to an ASF data set. Ultimately, separate SAS subroutines would be created for each of the nine data sets. Table 5 illustrates each of these data sets.

TABLE 5: Questionnaire specific data sets, each could be used in creating a unique SAS data set

GROUP #	DESCRIPTION
1	LSF - airports
2	LSF - churches, cemeteries, hospitals, nursing homes
3	LSF - public golf, private golf
4	LSF - garden centers, landscapers, lawn/grounds care
5	LSF - school district > 2675, school district <= 2675
6	LSF - sod producers
7	LSF - cities > $200M, cities <= $200M, villages, counties, state roadsides
8	LSF - racetracks
9	ASF - all strata

It would have be easier to both follow the flow of the questionnaire and to assure oneself that each check had been completed by creating a SAS subroutine for each questionnaire type.

DATA SUMMARIZATION

The final data summarization involved two distinct phases. In phase one, both LSF and ASF data were treated as one data set. Phase two broke them into two distinct data sets, where each data set was analyzed separately. Then the data sets were combined to provide estimates of the population values.

Phase one summarization began by converting known "missing" responses from a zero to a dot. The standard OASS key entry procedure is to only key positive, non-zero responses and all other responses are computer filled by zeroes. Therefore, there is no difference between a valid zero and a missing response. SAS, however, does differentiate between the two with a zero corresponding to a valid zero and a dot indicating a missing response. The "missing" or "valid zero" problem could not be solved for all questions on the questionnaires, but the zero-dot conversion was made wherever possible. The question types most conducive to the conversion were those containing multiple responses with all responses being zero. All of the obvious missing responses were converted to dots, but the less obvious missing responses may not have been detected and, therefore,

remained unchanged.

Once the missing responses were established, a counter variable was set up for every question on the questionnaires. The counter was defined as:

$$counter = \begin{cases} 1, & question\ response(s) > 0 \\ 0, & question\ response(s) = .\ (missing) \end{cases}$$

The 0 or 1 counter variable value corresponded to whether or not the question did or did not obtain a positive response. For example, in the following question:

Q.) Who is responsible for lawn care at this location?

_____ Lawn Service Company	_____ Gardener
_____ Husband	_____ Wife
_____ Children	_____ Other

counter(Q) = _____

If the above blanks were all missing then counter(Q) = 0. If at least one blank was set equal to one then counter(Q) = 1.

In the final report, counter(Q) was used as the denominator in a proportion. For example, suppose the above question was summed over all single family homes in the ASF. Also suppose that wife = 250 and counter(Q) = 500. It would then be reported that the wife maintained lawn care responsibility in 250/500 or 50% of the single family homes in Ohio.

In completing the phase one summarization, response units were converted to reporting units, which primarily involved converting a percent to either dollars or square feet, and also converting acres to square feet. At first glance it would seem easier to convert square feet to acres but this conversion utilized division, which introduced a computational limitation. A computational limitation occurs when a decimal is automatically rounded or truncated to meet the memory capacity. The division process yielded a fractional number which was carried out in decimals, and these decimals must be either rounded or truncated. These fractional numbers will then be multiplied by an expansion factor in the phase two summarization. On the other hand, the conversion from acres to square feet utilized multiplication, which yielded whole numbers. There was no rounding or truncation involved and, therefore, no computational limitations were introduced. As a general rule, it is best to divide as close to the last step as possible, thereby introducing fewer fractional numbers (and their corresponding computational limitations).

In initiating phase two summarization, the first step was to separate the LSF and ASF questionnaires. The data for each frame was then expanded. This process is described below.

For the LSF, there was one expansion factor per stratum, which was applied at the individual record level. The list expansion factor is below. It's mathematical formula is defined in Appendix D.

$$\text{LIST EXPANSION FACTOR} = \frac{\text{universe \# per stratum}}{\text{total \# responses per stratum before computer entry cut-off date}}$$

After applying the LSF expansion to each record, the data were summed to the stratum level (the strata are listed in Appendix B). The final LSF data set contained state level information and was composed of one record for each stratum.

For the ASF, there was also one stratum level expansion factor. Upon applying the expansion factor, two weight adjustment factors were then calculated at the tract level. The stratum expansion and corresponding weight adjustments are defined below, with the mathematical formulae also following in Appendix D.

$$\text{AREA EXPANSION FACTOR} = \frac{\text{total \# segments in stratum x in Ohio}}{\text{\# sampled segments in stratum x in Ohio}}$$

$$\text{WEIGHT1 ADJUSTMENT} = \frac{\text{tract operator turf area within tract}}{\text{tract operator total turf area}}$$

$$\text{WEIGHT2 ADJUSTMENT} = \frac{\text{total \# tract contained in segment}}{\text{\# tracts interviewed}}$$

AREA EXPANSION FACTOR, which was a stratum level expansion, was greater than or equal to one and also the most difficult to understand. First, the total number of segments in each land use stratum was obtained. The total number of segments was then divided by the number of sampled segments within each stratum. The simplicity of this expansion factor was in the fact that segments within the same stratum are approximately the same acreage size. Therefore, in theory, the strata expansion factor is a ratio of acreages. WEIGHT1 ADJUSTMENT was less than or equal to one and was a tract level adjustment accounting for the percent of the tract operator's turf area contained within the tract. WEIGHT2 ADJUSTMENT was greater than or equal to one and was also a tract level adjustment. WEIGHT2 ADJUSTMENT accounted for those tracts not selected (sampling took place only in those segments containing more than twenty tracts) and/or those tracts not interviewed (operator/respondent not available).

Upon applying the above ASF expansion and adjustments, the data were summed to the place type level. The three place types were:

place type - [91, *single family home or farmstead*
92, *condominium or apartment*
93, *commercial building or other*

Therefore, the final ASF data set contained three records of state level information, one record per place type.

The ASF summarized data indicated that there were approximately 1.75 million single family detached homes in Ohio. Although no exact number for single family detached homes in Ohio exists, this number was considered an underestimate of the true total. This underestimate was due in part to the ASF sampling being carried out more extensively in the urban strata. The normal OASS sampling scheme samples most heavily in the agricultural strata and, by concentrating in the urban strata, there was a reduced number of segments eligible for sample selection. To compensate for this underestimation two procedures were considered, where both procedures involved national data from the Bureau of Census within the Commerce Department. The first procedure ratioed the 1989 data for the number of occupied single family detached dwellings to the total number of occupied housing units. The resulting ratio (at the national level) was then multiplied by the total number of occupied housing units in the state of Ohio. The second procedure again used the 1989 data for the number of occupied single family detached dwellings, but ratioed it to the number of households. This ratio was then multiplied by the total number of Ohio households. Both procedures are detailed below.

PROCEDURE 1

$$\frac{\#\text{ occupied single family detached dwellings}}{\text{total number of occupied housing units}} * \#\text{ Ohio occupied housing units}$$

$$= \frac{56,559,000}{90,888,000} * 4,523,900 = 2,815,193 \text{ occupied single family detached dwellings in Ohio}$$

PROCEDURE 2

$$\frac{\#\text{ occupied single family detached dwellings}}{\text{total number of households}} * \#\text{ Ohio households}$$

$$= \frac{56,559,000}{93,450,900} * 4,161,700 = 2,518,773 \text{ occupied single family detached dwellings in Ohio}$$

While the calculations from the first procedure represented a possible overestimation, it was believed that the second procedure calculations more accurately represented the Ohio population, while at the same time compensated for the shortcomings in the OASS urban sampling scheme. Therefore, the resulting calculation from the

second procedure, 2,518,773 occupied single family detached dwellings in Ohio, was chosen for the final report. All other ASF data were then adjusted accordingly.

CONCLUSIONS

The importance of the turfgrass industry is greatly illustrated by the number of states participating in turfgrass surveys. To date, five states, including Ohio, have conducted or are currently conducting turfgrass surveys. As the interest in the turfgrass industry rises and more states begin conducting turfgrass surveys, there becomes a need for some standardization in the survey procedures. Currently, each state has independently created its own frame, strata definitions, and enumerator guidelines. A NASS turfgrass handbook containing these general rules and guidelines would assist in simplifying and standardizing the turfgrass survey, and thus enable other states to make use of the past procedures and to stop "recreating the wheel".

I propose that a turfgrass comparison study be done on all states that have completed a turfgrass survey. This study will evaluate each state's procedures and ultimately formulate an agency example to be followed by all upcoming turfgrass surveys.

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APPENDIX A: 1989 Ohio Turf Survey

Sample Selection Worksheet

Use only if more than 20 tracts are eligible for interview

Stratum	Segment	Tract
0 __ __	__ __ __ __	0

Tracts Eligible for Sampling_____

Eligible Tracts Divided by 20 =_____

Sampling Steps

1. Divide the number of eligible tracts by 20 and round the answer to 3 decimal places. Enter "this number" in column 1, line 1.

   Complete each cell in column 1 by multiplying "this number" by the line number.

2. Complete column 2 by rounding the number in column 1 up to the next whole number.

3. Cross out all numbers in the random number table in the lower right corner of the page that are larger than the number of tracts eligible to be sampled.

4. Starting in the upper left corner of the random number table and working down the columns, circle the numbers in the positions represented by the entries in column 2. Skip crossed out numbers. Enter the circled numbers in column 3, and mark the corresponding tracts for sampling on the Tract Record Sheets.

	Column 1	Column 2	Column 3
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

76	68	98	33	62	67	18	42	81
49	02	26	08	70	04	50	69	40
75	30	65	82	64	52	78	85	77
36	28	01	90	91	57	35	27	53
92	16	61	87	03	38	44	45	07
09	100	13	24	72	94	25	59	95
46	48	39	55	37	88	96	89	32
84	66	43	29	71	86	22	23	74
51	54	99	06	21	10	41	20	34
15	11	60	47	79	19	56	31	05

APPENDIX B: List Sampling Frame Results

TABLE 1: Universe numbers and sampling percentages

LIST FRAME	STRATA	UNIVERSE NUMBER	PERCENT SAMPLED
AIRPORTS	11	96	100
CHURCHES	21	12,740	10
CEMETERIES	22	351	100
HOSPITALS	23	410	50
NURSING HOMES	24	1,121	50
PUBLIC GOLF	31	457	100
PRIVATE GOLF	32	158	100
GARDEN CENTERS	41	526	100
LANDSCAPERS	42	1,232	66
LAWN/GROUNDS CARE	51	419	100
SCH. DIST. > 2675	61	184	100
SCH. DIST. <= 2675	62	519	42
SOD PRODUCERS	71	53	100
CITIES >= $200M	81	57	100
CITIES < $200M	82	184	33
VILLAGE >= 2160	83	141	33
VILLAGE < 2160	84	556	13
COUNTIES	85	86	100
CITY PARKS	86	7	100
STATE ROADSIDES	87	1	100
RACETRACKS	91	43	100
TOTALS		19341	29

Further research indicated that in some strata (for example, airports) the universe size is smaller than originally indicated. The universe size is adjusted accordingly and, therefore; the universe size in Table 1 is smaller than first mail, number of mailouts, in Table 2.

Of the 88 counties in Ohio, two did not have governmental structures conducive to completing the questionnaire. They were not sent a questionnaire and therefore are not included in the universe.

The category containing villages < 2160, strata 84, was deleted from the data analysis, although retained for reporting the response rate. Roadside upkeep and park maintenance are done on a concerned citizen/able body basis in these villages. Formal records and accounts are not kept.

TABLE 2: First mailing results

LIST FRAME	STRATA	FIRST MAIL NUMBER OF MAILOUTS	FIRST MAIL NUMBER OF RETURNS	FIRST MAIL PERCENT RETURNED
AIRPORTS	11	104	16	15.4
CHURCHES	21	1,274	93	7.3
CEMETERIES	22	361	52	14.4
HOSPITALS	23	213	12	5.6
NURSING HOMES	24	569	51	9.0
PUBLIC GOLF	31	457	81	17.7
PRIVATE GOLF	32	162	43	26.5
GARDEN CENTERS	41	537	39	7.3
LANDSCAPERS	42	891	69	7.7
LAWN/GROUNDS CARE	51	462	40	8.7
SCH. DIST. > 2675	61	184	42	22.8
SCH. DIST. <= 2675	62	216	35	16.2
SOD PRODUCERS	71	75	13	17.3
CITIES >= $200M	81	57	8	14.0
CITIES < $200M	82	61	4	6.6
VILLAGE >= 2160	83	46	7	15.2
VILLAGE < 2160	84	75	3	4.0
COUNTIES	85	86	9	10.5
CITY PARKS	86	7	0	0.0
STATE ROADSIDES	87	1	1	100.0
RACETRACKS	91	45	7	15.6
TOTALS		5883	625	10.6

where

$$\text{FIRST MAIL, PERCENT RETURNED} = \frac{\text{FIRST MAIL, NUMBER OF RETURNS}}{\text{FIRST MAIL, NUMBER OF MAILOUTS}} * 100$$

TABLE 3: Second mailing results

LIST FRAME	STRATA	SECOND MAIL NUMBER OF MAILOUTS	SECOND MAIL NUMBER OF RETURNS	SECOND MAIL PERCENT RETURNED
AIRPORTS	11	88	20	22.7
CHURCHES	21	1,181	114	9.7
CEMETERIES	22	309	40	12.9
HOSPITALS	23	201	23	11.4
NURSING HOMES	24	518	59	11.4
PUBLIC GOLF	31	376	81	21.5
PRIVATE GOLF	32	119	35	29.4
GARDEN CENTERS	41	498	54	10.8
LANDSCAPERS	42	822	79	9.6
LAWN/GROUNDS CARE	51	422	53	12.6
SCH. DIST. > 2675	61	142	39	27.5
SCH. DIST. <= 2675	62	181	36	19.9
SOD PRODUCERS	71	62	7	11.3
CITIES >= $200M	81	49	10	20.4
CITIES < $200M	82	57	9	15.8
VILLAGE >= 2160	83	39	7	17.9
VILLAGE < 2160	84	72	0	0.0
COUNTIES	85	77	21	27.3
CITY PARKS	86	7	3	42.9
STATE ROADSIDES	87	N/A	N/A	N/A
RACETRACKS	91	38	6	15.8
TOTALS		5258	696	13.2

where

$$\text{SECOND MAIL, PERCENT RETURNED} = \text{FIRST MAIL, NUMBER OF MAILOUTS} - \text{FIRST MAIL, NUMBER OF RETURNS}$$

$$\text{SECOND MAIL, PERCENT RETURNED} = \frac{\text{SECOND MAIL, NUMBER OF RETURNS}}{\text{SECOND MAIL, NUMBER OF MAILOUTS}} * 100$$

TABLE 4: Total number of respondents

LIST FRAME	STRATA	TOTAL NUMBER RESPOND	TOTAL NUMBER RESP. BEFORE CUT-OFF DATE
AIRPORTS	11	36	31
CHURCHES	21	207	189
CEMETERIES	22	92	85
HOSPITALS	23	35	25
NURSING HOMES	24	110	89
PUBLIC GOLF	31	162	125
PRIVATE GOLF	32	78	72
GARDEN CENTERS	41	93	66
LANDSCAPERS	42	148	131
LAWN/GROUNDS CARE	51	93	77
SCH. DIST. > 2675	61	81	61
SCH. DIST. <= 2675	62	71	62
SOD PRODUCERS	71	20	15
CITIES >= $200M	81	18	15
CITIES < $200M	82	13	8
VILLAGE >= 2160	83	14	12
VILLAGE < 2160	84	3	3
COUNTIES	85	30	18
CITY PARKS	86	3	0
STATE ROADSIDES	87	1	1
RACETRACKS	91	13	10
TOTALS		1321	1095

where

TOTAL, NUMBER RESPOND = FIRST MAIL, NUMBER OF RETURNS + SECOND MAIL, NUMBER OF RETURNS

TOTAL, NUMBER RESP. BEFORE CUT-OFF DATE = actual number of questionnaires received by the computer data entry cut-off date.

TABLE 5: Response rates and expansion factors

LIST FRAME	STRATA	RESPONSE RATE PERCENT RESPOND	RESPONSE RATE PERCENT RESP. BEFORE CUTOFF	EXPANSION FACTOR
AIRPORTS	11	37.5	34.6	3.097
CHURCHES	21	1.6	16.2	67.407
CEMETERIES	22	26.2	25.5	4.129
HOSPITALS	23	8.5	16.4	16.400
NURSING HOMES	24	9.8	19.3	12.596
PUBLIC GOLF	31	35.4	35.4	3.656
PRIVATE GOLF	32	49.4	48.1	2.194
GARDEN CENTERS	41	17.7	17.3	7.970
LANDSCAPERS	42	12.0	16.6	9.405
LAWN/GROUNDS CARE	51	22.2	20.1	5.442
SCH. DIST. > 2675	61	44.0	44.0	3.016
SCH. DIST. <= 2675	62	13.7	32.9	8.371
SOD PRODUCERS	71	37.7	26.7	3.533
CITIES >= $200M	81	31.6	31.6	3.800
CITIES < $200M	82	7.1	21.3	23.000
VILLAGE >= 2160	83	9.9	30.4	11.750
VILLAGE < 2160	84	0.5	4.0	185.333
COUNTIES	85	34.9	34.9	4.778
CITY PARKS	86	42.9	42.9	N/A
STATE ROADSIDES	87	100	100	1.000
RACETRACKS	91	30.2	28.9	4.300
TOTALS		22.4	18.6	N/A

where

$$\text{RESPONSE RATE, NUMBER RESPOND} = \frac{\text{TOTAL, NUMBER RESPOND}}{\text{UNIVERSE NUMBER}} * 100$$

$$\text{RESPONSE RATE, NUMBER RESP. BEFORE CUT-OFF} = \frac{\text{TOTAL, NUMBER RESP. BEFORE CUT-OFF DATE}}{\text{FIRST MAIL, NUMBER OF MAILOUTS}} * 100$$

$$\text{EXPANSION FACTOR} = \frac{\text{UNIVERSE NUMBER}}{\text{TOTAL, NUMBER RESP. BEFORE CUT-OFF DATE}}$$

The three respondent questionnaires received for city parks, strata 86, came in after the computer entry cut-off date. After considerable searching at OSU and NASS they were not located and, therefore; are not represented in the final results. If they had been located they would have been keyed in, thereby creating data and an expansion factor, and, ultimately, representation in the final report.

TABLE 6: Enumeration dates - mail and telephone

LIST FRAME	STRATA	MAILING DATES FIRST	MAILING DATES SECOND	TELEPHONE DATES
AIRPORTS	11	04/02/90	04/27/90	05/15-18/90
CHURCHES	21	04/02/90	04/27/90	05/15-18/90
CEMETERIES	22	04/02/90	04/27/90	05/15-18/90
HOSPITALS	23	04/02/90	04/27/90	05/15-18/90
NURSING HOMES	24	04/02/90	04/27/90	05/15-18/90
PUBLIC GOLF	31	04/02/90	04/27/90	05/15-18/90
PRIVATE GOLF	32	04/02/90	04/27/90	05/15-18/90
GARDEN CENTERS	41	04/02/90	04/27/90	05/15-18/90
LANDSCAPERS	42	04/02/90	04/27/90	05/15-18/90
LAWN/GROUNDS CARE	51	04/02/90	04/27/90	05/15-18/90
SCH. DIST. > 2675	61	04/04/90	04/27/90	05/15-18/90
SCH. DIST. <= 2675	62	04/04/90	04/27/90	05/15-18/90
SOD PRODUCERS	71	04/05/90	04/27/90	05/15-18/90
CITIES >= $200M	81	04/13/90	05/02/90	05/15-18/90
CITIES < $200M	82	04/13/90	05/02/90	05/23-24/90
VILLAGE >= 2160	83	04/13/90	05/02/90	05/23-24/90
VILLAGE < 2160	84	04/13/90	05/02/90	05/23-24/90
COUNTIES	85	04/25/90	05/15/90	+05/28/90
CITY PARKS	86	04/25/90	05/15/90	+05/28/90
STATE ROADSIDES	87	09/20/90	NA	NA
RACETRACKS	91	04/04/90	04/27/90	05/15-18/90

APPENDIX C: Area sampling frame results

AREA STRATA	# OF SEGMENTS	TRACTS INTERVIEWED	EXPANSION FACTOR	ENUMERATION DATES
11	6	19	4778.667	04/02-23/90
12	6	63	2087.167	04/02-23/90
20	6	61	1104.167	04/02-23/90
31	52	463	480.731	04/02-23/90
32	10	103	1222.9	04/02-23/90
33	2	30	172.5	04/02-23/90
40	25	102	248.2	04/02-23/90
50	2	2	71.5	04/02-23/90
TOTALS	109	843		

There is one exception to the above results. In strata 31, segment 5244 is approximately 0.5 the size of all other segments in that strata. Therefore the expansion factor for only that segment is doubled. Thus yielding a new expansion factor of 961.462 for all data from strata 31 segment 5244.

APPENDIX D: LSF and ASF direct expansion formulae

The LSF direct expansion formula is as follows:

$$\hat{Y}_{LSF,\ STATE} = \sum_{h-1}^{L} \sum_{i-1}^{n_h} e_{hi} y_{hi}$$

where L - the number of list frame strata in the turf survey

e_{hi} - the expansion factor for sample unit i within stratum h

- $\frac{N_h}{n_h}$

- $\frac{\text{the population in statum } h}{\text{the usable sample units in stratum } h}$

y_{hi} - the reported value of the commodity of interest for sample unit i within stratum h

And the ASF direct expansion is:

$$\hat{Y}_{ASF,\ STATE} = \sum_{h-1}^{L} \sum_{i-1}^{t_h} e_{hi} w1_{hi} w2_{hi} y_{hi}$$

where L - the number of area frame strata in the turf survey

t_h - the number of sample units within statum h

e_{hi} - the expansion factor for sample unit i within stratum h

$w1_{hi}$ - weight 1 for sample unit i within stratum h

- the proportion of the operator's total turf area contained within sample unit i of stratum h

$w2_{hi}$ - weight 2 for sample unit i within stratum h

- the proportion of the tracts interviewed within the sampling unit

y_{hi} - the reported value of the commodity of interest for sample unit i within stratum h