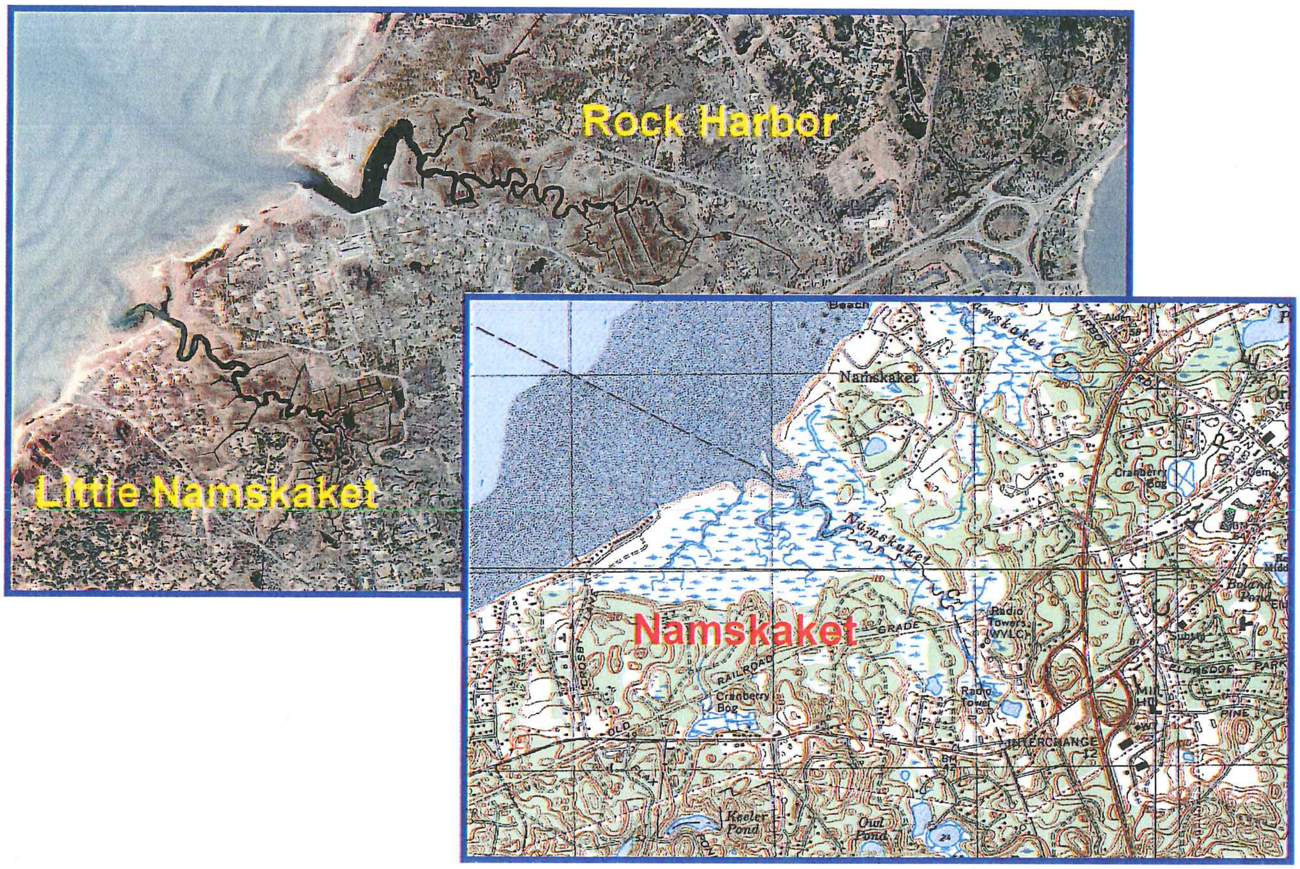
PLANNING OFFICE #1170

Massachusetts Estuaries Project

Watershed Nitrogen Loading from Lawn Fertilizer Applications within the Town of Orleans, Massachusetts



University of Massachusetts Dartmouth
School of Marine Science and Technology

Massachusetts Department of
Environmental Protection

DRAFT FINAL REPORT – FEBRUARY 2005

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ACKNOWLEDGMENTS

The Massachusetts Estuaries Project Technical Team would like to acknowledge the contributions of the many individuals who have worked tirelessly for the restoration and protection of the critical coastal resources of the Town of Orleans. Of particular note are the Town's Wastewater Planning Committee and the 14 citizens who volunteered to conduct the present survey. Without these stewards and their efforts, this lawn fertilizer study would not have been possible. Through the efforts of citizens who take the time to respond thoughtfully to surveys or collect water samples, the scientific community can ultimately refine its analyses of nutrient loadings and more accurately manage these coastal systems.

The Orleans Lawn Fertilizer Survey was conducted as a partnership between the Town of Orleans and the Massachusetts Estuaries Project. The Survey was conducted with volunteers from the Town of Orleans with technical guidance and analysis from the Coastal Systems Program at SMAST, which also funded the effort.

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Watershed Nitrogen Loading from Lawn Fertilizer Applications within the Town of Orleans

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INTRODUCTION

The primary ecological threat to the estuaries and bays associated with the Town of Orleans is degradation resulting from nutrient enrichment. At present, regions within the Town's major embayments are showing nutrient related habitat quality degradation. Loading of the critical eutrophying nutrient, nitrogen, to the embayment waters has been greatly increased over the past few decades. As build-out continues, associated increases in nitrogen loading will likely further degrade these estuarine habitats and resources, unless nitrogen management is implemented.

Typically, plant nutrients in waters exist largely as nitrogen and phosphorous and originate from a variety of sources within the surrounding watersheds. In saltwater systems, nitrogen is commonly the nutrient that regulates plant growth, and excessive amounts cause declining habitat health and eutrophication. As a component of watershed management, the quantification of nitrogen loading rates is essential in order to determine appropriate management measures. The nitrogen loading to these salt water systems, like almost all embayments in southeastern Massachusetts results primarily from on-site disposal of wastewater, with lawn fertilizer, stormwater, and atmospheric deposition being important, but secondary contributors. The Town of Orleans does not currently have centralized wastewater treatment, although septage is treated at the Tri-Town Facility. The Town of Orleans has recognized the critical issue of nitrogen management and its relation to the quality of its coastal resources and has been working with the Massachusetts Estuaries Project to establish the level of nitrogen loading which will maintain its estuarine resources for its citizens. The Massachusetts Estuaries Project (MEP), through the University of Massachusetts – Dartmouth School of Marine Science and Technology (SMAST) is also providing the scientific and technical support to the Massachusetts Department of Environmental Protection (DEP) for the development and implementation of policies on nitrogen sensitive embayments and the determination of nitrogen loadings supportive of estuarine resources to support nitrogen management planning and implementation.

The formation of critical working linkages between local communities and the MEP has made it possible for the DEP and SMAST to proceed with the development and implementation of local watershed management plans for the effective control and management of the nutrients flowing to sensitive coastal estuaries. Controlling and managing nutrient loads results in improvements in water quality and estuarine health with a direct influence on local economic sectors such as tourism, property values and the shellfish and finfish industries. The present study was conducted in partnership between the Town of Orleans Wastewater Steering Committee and the Massachusetts Estuaries Project. The purpose was to strengthen the quantitative assessment and management modeling, which is currently underway by the MEP. Specifically, *to refine estimates of the nitrogen loading to the Town's estuaries resulting from lawn fertilizer applications within their surrounding watersheds.* The effort is part of a regional survey of lawn fertilizer usage to support the application of the MEP Linked Watershed-Embayment Management Model for developing nitrogen management targets for the estuaries of southeastern Massachusetts.

Residential lawn fertilizer use can be an important contributor to the mass flux of nitrogen into an estuary. Residential fertilizer use is regarded by many as an obvious, easily traced, and affordably managed source of nitrogen. However, assessment reports on nitrogen contributed to estuarine waters resulting from application of lawn fertilizers are often based on assumptions and/or limited databases and sample sets, and lack substantive site-specific validation. The estimate of nitrogen loading to the aquifer is the integrated result of five factors:

1. Number of fertilizer applications per household per year
2. Lawn area (size)
3. Nitrogen added per unit lawn area
4. Leaching rate, the percent of applied nitrogen reaching groundwater
5. Attenuation, or loss of nitrogen during transport through the aquifer to the receiving waters

A current assumption in most nitrogen loading models regarding fertilizer use is that all homes apply fertilizer, which means that fertilizer is applied to each lawn within the watershed at proscribed levels each year. This assumption lacks the basis of definitive research data and has been found by the MEP to overestimate fertilizer nitrogen loads in most communities. Furthermore, this overestimation may cause errors in management plans, as it results in both an over-estimate of land-based nitrogen loads and diminishes the relative importance of other sources. Because watershed management requires a large investment of municipal resources, it is clear that each nitrogen source must be accurately determined to allow proper prioritization of management alternatives.

The focus of the Orleans Lawn Fertilizer Survey is to determine the amount of fertilizer applied to an average residential lawn on an annual basis within the Town of Orleans. This nitrogen loading term will be used, in concert with the loadings from the other nitrogen sources, by the Massachusetts Estuaries Project to determine both the total land-derived nitrogen load to each of the Town's estuaries. In addition, these data incorporated into the MEP analysis, will allow determination of the relative importance of nitrogen from lawn fertilization to the total watershed nitrogen and support accurate nitrogen management alternatives. This survey is yet another example of the partnership between the Town of Orleans and the MEP to protect/restore the coastal systems of Orleans.

METHODS

To refine the determination of the contribution of nitrogen from residential lawn fertilizers to the receiving estuarine waters associated with the Town of Orleans, a fertilizer use survey was conducted throughout the Town in 2003. Door-to-door resident interviews were conducted from July to September, as this period maximizes data capture from both year-round and seasonal residents. The interviews were conducted by 14 volunteers, trained by SMAST, on a randomly selected sample of households. Each interview centered on the presentation of a pre-designed and pre-tested questionnaire. The same questionnaire was used in all interviews and was consistent with previous SMAST surveys. The structure of the questionnaire was designed to enable the researcher to acquire as much qualitative and quantitative information on application-related nitrogen loading parameters. The primary objective was to quantify individual household fertilizer use. A secondary objective was to assess the likelihood of success of education as a means of managing nitrogen inputs through residential fertilizer usage, should it be needed.

There were essentially two parts to the survey completed for each house lot (Appendix A). The first part consisted of 22 questions presented to the resident by the volunteer regarding household fertilizer use, attitudes, and lot location. The second part consisted of four observations (notes), completed by the volunteer, which considered: 1.) lawn size, 2.) the existence of a buffer strip, and 3.) housing density. Average lawn size is a parameter in the determination of nitrogen loading from lawns to groundwater. Buffer strips work to impede the surface runoff from lawns and may increase the percentage of nitrogen attenuated. Housing density was recorded in order to determine whether or not there is a relationship between density and the use of fertilizer. Because houses located in high-density areas tend to have smaller lawns, density may also affect the degree of lawn care and thus the amount of fertilizer used.

Survey Assumptions

A number of assumptions were accepted in this study regarding the parameters measured by the survey. Some were inherent in the questions presented to residents as part of the personal interviews. The most critical and necessary inherent assumption was that residents were knowledgeable concerning their use and application of lawn fertilizer. Other assumptions, such as those regarding leach rate and attenuation, were accepted based on literature review and lack of site-specific data.

A number of assumptions were made by the researcher regarding the responses of the residents to the personal interview questions. For instance, a degree of accuracy was assumed for all inquiries, especially questions regarding the number of years the respondent resided on Cape Cod, the number of years the respondent resided in the present house, and age of the house. This assumption of accuracy is unavoidable and inherent in all surveys.

Two assumptions were made in this study regarding the number of applications per household per year. The first assumption was that the resident responding to the personal survey question about the number of lawn fertilizer applications per year was knowledgeable in this regard. The possibility exists that this was not always the case, as not all respondents applied fertilizer themselves. However, the researcher is confident that the responses regarding this question were accurate. The second assumption involved the knowledge of the resident concerning the number of applications made by professional lawn care companies. It was assumed that each resident who engaged a professional lawn care company had adequate knowledge of the amount of times said company applied fertilizer each year. In order to increase the accuracy of this data set for this parameter, professional lawn care companies were contacted as part of the lawn fertilizer use study.

Volunteers were asked to measure three parameters to the best of their ability: lawn size, buffer strip existence, and housing density. However, there were no established methods of measurement included in this study for these parameters. Therefore, data sets for each parameter may lack consistency, as each volunteer may have differed in his/her method of measurement. Considering this, these data sets were still considered valuable for the creation of general comparisons and trends of use, as well as data base accretion for lawn fertilizer use.

There were a number of questions included in the survey which addressed attitudes towards fertilizer use and fertilizer use practice. It was assumed in this study that respondents were truthful to the best of their knowledge when answering these questions. It was also assumed that the respondents had no bias towards the volunteer or the intent of the survey.

RESULTS

Lawn Fertilizer Usage

In 2003 the Town of Orleans Wastewater Steering Committee partnered with the Massachusetts Estuaries Project (MEP) to refine estimates of the nitrogen loading to the Town's estuaries resulting from lawn fertilizer applications within their surrounding watersheds. Fourteen volunteers from the Town were trained by SMAST staff and given the standardized survey form developed for this purpose by SMAST. The effort is part of a regional survey of lawn fertilizer usage to support the application of the MEP Linked Watershed-Embayment Management Model for developing nitrogen management targets for the estuaries of southeastern Massachusetts. From July through September 353 surveys were conducted, 340 were deemed to be sufficiently complete for inclusion into the analysis for the Town of Orleans. Analysis of the results by volunteer did not show any pattern or bias, but that variation increased with samples sizes <25. As a result, data from all volunteers was pooled for the synthesis presented below. A compilation of the raw data and the quality assurance analysis is presented in Appendix B.

The Survey results clearly indicated that on average the residential lawns within the Town of Orleans currently use lawn fertilizers at a lower rate than recommended as part of a standard lawn care program (4 applications per year and 0.75 lbs of nitrogen per 1000 ft^2 or 15 lbs N per 5000 ft^2 per year). The average nitrogen addition to a residential lawn in the Town of Orleans was found to be about half of this rate, 7.6 lbs N per 5000 ft^2 per year. Further analysis indicates that the primary reason for the lower average fertilizer nitrogen additions was the lower average number of applications per year (1.76 versus 4). However, further breakdown of the data indicates that residential lawn fertilizer usage can be apportioned into 3 groups: (1) no fertilizer usage – 40%, (2) application by homeowner – 26% and (3) application by lawn company – 34%. Nitrogen additions to lawns by these 3 groups were very different, again primarily due to the number of applications per year (Table 1).

Homeowners who maintain their own lawns either add no fertilizer (61% of homeowner maintained lawns) or on average fertilize only 2.16 times per year (39% of homeowner maintained lawns). However, the homeowner maintained lawns represent 66% of the lawns surveyed, the remaining 34% are maintained by lawn companies. All lawns maintained by lawn companies received at least some fertilizer additions and most of these had contracts for routine fertilization (*e.g.* Scotts, ChemLawn, The Lawn Company, etc). As a result, the average number of fertilizer applications was higher than the homeowner maintained lawns (3.5 applications per year) and the nitrogen added per application was also slightly higher, 0.94 lb N/1000 ft^2. The result of the more "disciplined" schedule of fertilizer application by the lawn care industry results in 1.6 times more additions than homeowners doing the maintenance themselves. Note that this is the more appropriate comparison than that between all homeowners and the lawn companies, which shows a 4.1 fold increase in fertilization rates, as this attributes those lawns not fertilized to the homeowner maintained pool. In actuality, in all cases the homeowners are solely responsible for the fertilization of their properties and determine into which of the 3 groups their property falls.

Table 1. Summary of the number of fertilizer applications to an average lawn within the Town of Orleans, maintained by homeowners and lawn companies. Note the large proportion of surveyed lawns not receiving fertilizer (136 of 340).

	Number of Applications per Year							All Houses		Only Houses with Fertilization	
	0	1*	2	3*	4*	5	6	Total	Wt'd ** Mean	Total	Wt'd Mean
Total Survey = Homeowner + Lawn Company											
# Houses	136	39	49	30	59	24	3	340	1.76	204	2.93
Fertilization by Homeowner											
# Houses	136	33	26	11	18	0	0	224	0.85	88	2.16
Fertilization by Lawn Company											
# Houses	0	6	23	19	41	24	3	116	3.51	116	3.51
Ratio: Lawn Co./Homeowner →									4.1		1.6

* For this summary, applications of 0.5-1.5, 2.5-3.5, 3.75-4 (# appl/yr) were pooled into the 1,3,4 bins.
** Weighted averages are based upon the individual data points (non-pooled).

Community Factors Relating to Fertilizer Usage

In addition to determining fertilizer usage, a variety of zoning, landscape and community factors potentially relating to patterns of usage were investigated. Among these relational factors were whether the lot was associated with (1) saltwater resource, (2) freshwater resource, or (3) an inland site. Association with aquatic resources was defined as having frontage on the water, a waterview, a wetland view or having deeded rights of access. The underlying question was whether an association with nutrient sensitive aquatic resources was currently altering nitrogen additions to lawns. Analysis of the results from the 340 surveys did not indicate that there were any self-directed fertilizer "management" actions occurring. There was no perceptible difference in the number of lawn fertilizer applications per year between the saltwater associated (155 lots), freshwater associated (28 lots) and inland areas (157 lots), which had annual applications of 1.81, 1.99, and 1.67, respectively.

In contrast, use of the property did suggest a relationship with application rate. Many of the homes in the Town of Orleans are used seasonally, primarily as vacation homes or second homes. These seasonal homes represented 24% of the lots surveyed, with year-round homes being the remainder, 76%, of the 336 surveys where seasonality was determined. Given the activities associated with seasonal versus year-round homes it is not surprising that fertilizer use in homes with seasonal occupancy had a slightly lower number of annual fertilizer applications compared to homes with year-round occupancy, 1.40 versus 1.87. It appears that the conversion from seasonal to year-round homes may increase nitrogen loading to the watershed, not only through wastewater flows, but through increased fertilizer usage.

The lot-size and age of homes were also used to help predict future changes in fertilizer nitrogen inputs to the Orleans' estuaries as result of shifts in behavior. Lot-size or housing density did not show any relationship to fertilizer usage. There was no correlation between the lot size and the proportion of lots with use/non-use of lawn fertilizer or even in the level of usage within the sub-set, which currently apply fertilizers (Figure 1).

In contrast to lot-size, there did appear to be a pattern of increased fertilizer usage in newer homes, particularly those less than 10 year old (Figure 2). It is possible that this pattern reflects a suburbanization of the region or a difference in attitudes of new homeowners, many of whom are new to Cape Cod. Regardless of the cause, to the extent that this is borne out, it appears that new construction may result in higher per lot nitrogen addition to the watershed compared to earlier homes of the same size and occupancy. It appears that behavioral shifts associated with the occupancy of new homes and shifts from seasonal to year-round occupancy may accelerate increases in nitrogen loading associated with fertilizer usage, over current patterns. These potential behavioral shifts may result in predicted higher nitrogen loads at build-out than typically estimated at present and therefore would require higher levels of nitrogen mitigation than predicted from current patterns.

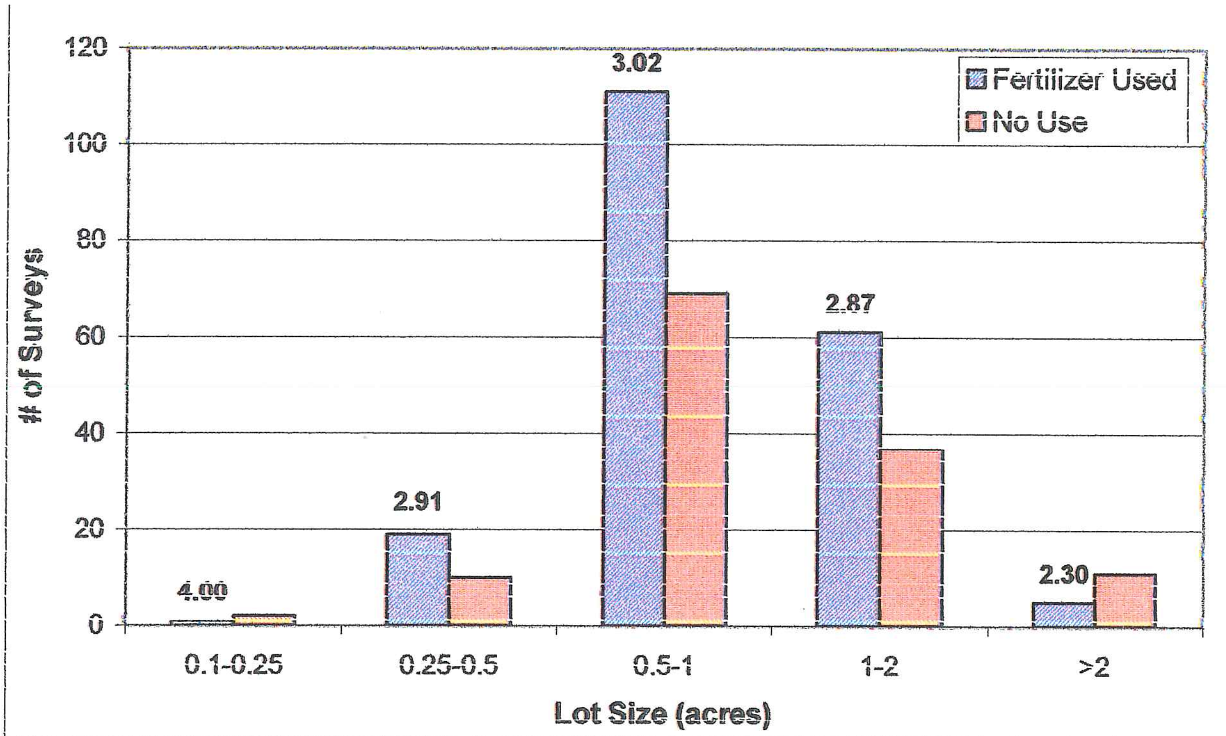

Figure 1. Relationship of fertilizer application to lot size within the Town of Orleans. Application rates (values above bars) did not vary significantly with lot size among those residences applying fertilizer. There was no discernable pattern in fertilization versus non-fertilization with lot size, with the percent using fertilizer varying from 62%-66% for lots ranging from 0.25-2 acres (accounting for 97% of lots using fertilizer).

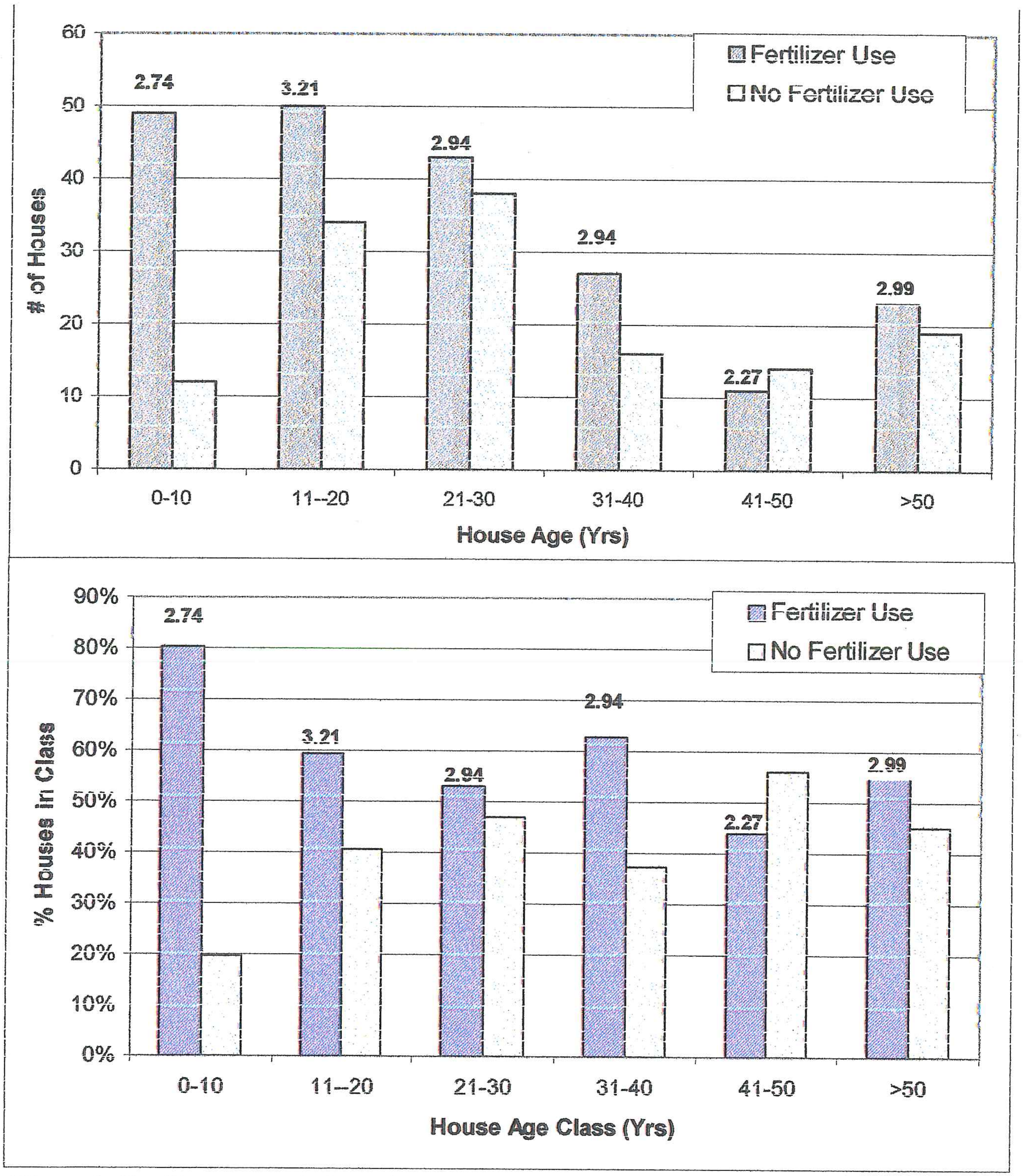

Figure 2. Fertilizer usage relative to house age, the average age of houses where fertilizer is applied was 40.4 years compared to 31 years where fertilizer is not used. It appears that new homes (<10yr) are showing higher fertilizer usage than older homes, but that application rates (values over bars, #/yr) among those using fertilizer are not related to house age.

Homeowner Attitudes

While there may be a gradual shift occurring towards increasing fertilizer use within the Town of Orleans, this trend is more likely associated with new construction and new occupancy than shifts in the activities of current residents. This is supported by the responses of 194 homeowners who currently use fertilizer, in which only 9% indicated an increased use of lawn fertilizers over the past 5 years.

There appears to be a sound foundation among the homeowners in the Town of Orleans for effective education relating to both: nitrogen management relating to lawn fertilizer usage specifically, and estuarine protection/restoration in general. The 200 homeowners surveyed who are currently using fertilizer were asked about their willingness to alter their usage on a scale of 1-5, where 1 indicated that they would not change and 5 indicated a willingness for a complete change to a new regime. Only 4% were unwilling to alter their pattern, while half (49%) were willing to fully (5 score) or almost fully (4 score) alter their current usage and another 40% would be willing to undertake moderate shifts.

Among the most important factors for protecting/restoring a community's estuarine habitats is the value placed upon the quality of these resources by the citizens. It is clear from the Survey that the residents of the Town of Orleans value the quality of their estuarine resources. Of the 336 respondents, only 3 had no opinion on the matter and the remainder considered estuarine water quality, either as extremely important (53%), very important (33%) or important (12%). Only 1% of respondents with an opinion considered the estuarine habitat quality of minor or no importance (Table 2.).

Table 2. Town of Orleans residents' responses to the question, "Of what importance is the quality of local bays and estuaries to you and your family". Total of 336 surveys. No difference was seen in comparisons of residences located in association with saltwater, freshwater or inland areas.

	Level of Importance					
Survey	Extremely Important	Very Important	Important	Minor Importance	No Importance	No Opinion
Number	178	111	39	5	0	3
%	53%	33%	12%	1%	0%	1%

Overall, the homeowners surveyed gave responses that suggest that management of lawn fertilizer nitrogen (if needed) through education would be successful and that they would support the restoration/protection of the local estuarine systems.

DISCUSSION

Residential Lawn Fertilizers and Estuarine Nitrogen Loads

The ultimate objective of the Orleans Lawn Fertilizer Studies, and associated MEP Studies, is to determine the nitrogen load from this non-point watershed source to the receiving estuarine waters. The determination of the total nitrogen load from lawn fertilization to a specific estuary requires a thorough land-use analysis to determine the spatial distribution and number of lawns. In addition an estimate of the nitrogen load contributed by an average lawn within the watershed is also required to complete the loading analysis. The MEP is currently conducting the site-specific watershed analysis, where each nitrogen source (including lawns) is being assessed for each of the estuaries associated with the Town of Orleans. In addition, the MEP assesses the attenuation (loss) of nitrogen during transport from the source to the estuarine waters. The nitrogen load contributed by an average lawn within the watersheds to these estuaries will be based upon the overall MEP database, with site-specific refinements based on the present study.

Based upon the Survey results within the Town of Orleans, it is possible to refine the lawn fertilizer based nitrogen loading to groundwater within the watersheds to the estuaries associated with the Town. This average annual loading term is estimated as: the average number of fertilizer applications per lawn *times* the average nitrogen added per 1000 ft2 per application *times* the average area of lawn per house *times* the amount of the applied fertilizer which is leached to groundwater. This represents the average annual nitrogen load to groundwater from a single lawn, but due to attenuation of nitrogen during transport, it may not be the actual nitrogen load from lawns to the estuary. This latter determination requires the full MEP analysis.

Results of the Orleans Surveys indicated that the best estimate of the average number of lawn fertilizer applications per year per residential lot is 1.76, significantly lower than the 4 applications assumed in some watershed models. This number of applications is the weighted average of the 40% of residences with no fertilizer usage, the 26% with application by homeowner (2.16 times per year) and the 34% with application by lawn company (3.5 times per year). Based upon historical data, MEP data and the present survey, the use of 0.75 lb N/1000 ft^2 of lawn per application, as recommended by the manufactures, appears to be the most reasonable estimate available. Information provided by the *Scotts* Company indicated that the nitrogen load per application is slightly higher by lawn companies compared to homeowners, 0.94 lb N/1000 ft^2. Attempts to refine the average area of lawn were also not sufficiently robust to alter the standard average lawn area of 5000 ft^2. The difficulty arises from the lack of a standard method of measurement for lawn size, the unreliability of homeowner estimates of lawn area and the difficulty of determining lawn area without direct measurements. The average lawn size of 5000ft^2, is the estimate currently accepted in most nitrogen loading models. The loss of nitrogen from lawn fertilizers through leaching to groundwater was not assessed in the present study. Instead the standard leaching rate of 20% used in regional nitrogen models was employed. This is a consistent and conservative estimate for Cape Cod soils and recognizes the use of controlled fertilizer applications.

Combining these components it is possible to determine the nitrogen load to groundwater from an average lawn in the Town of Orleans. In addition, based upon the survey data it is also possible to determine this nitrogen loading rate for lawns maintained by homeowners and lawn companies (Table 3.).

Table 3. Summary of Town of Orleans nitrogen loading to groundwater from lawn fertilization. Town-wide average application is weighted by observed homeowner and lawn company values. Includes both seasonal (24%) and year-round (76%) homes.

Fertilizer Usage	% of Surveys	Predicted Lawn Size (ft^2)	Observed Application ($lbsN/1000ft^2$)	Observed Application Rate (# apps/yr)	% Leaching Rate to Groundwater	Loading to Groundwater (lbs N /lawn/yr)
Town-wide Average						
Fertilizer Users Only	60%	5000	0.86*	2.93	20%	2.52
Fertilizer Non-Users	40%	5000	0	0	Na	0
Weighted Average	100%	5000	0.86*	1.76	20%	1.51
Homeowner – Applications						
Fertilizer Users	26%	5000	0.75	2.16	20%	1.62
Fertilizer Non-Users	40%	5000	0	0	Na	0
Weighted Average	66%	5000	0.75	0.85	20%	0.64
Lawn Company – Applications						
Fertilizer Users	34%	5000	0.94**	3.5	20%	3.29
Fertilizer Non-Users	na ***	Na	na	Na	Na	na
Weighted Average	34%	5000	0.94**	3.5	20%	3.29

* Based upon surveys;
** Based upon data provided by *Scotts Lawn Co.*, the predominant lawn company in Orleans.
*** All lawn company maintained lawns have fertilizer applications

There are three basic conclusions that can be drawn from the nitrogen loading to groundwater results from the Town of Orleans (Table 3):

- 40% of homeowners are not currently using lawn fertilizers, which greatly reduces the potential watershed nitrogen loading from this source;
- 26% of homeowners who currently use lawn fertilizers, apply them at about half the standard rate;
- 34% of homeowners currently have lawn care companies, which on average apply lawn fertilizers at slightly higher than the standard rate;
- nitrogen loading to groundwater from lawn fertilizers has been previously gauged at 3 lbs/lawn/yr with an average lawn size of 5000 ft^2, the average homeowner maintained lawn is currently contributing about one-fifth of this amount, but those maintained by lawn care companies contribute about 10% more than this estimate.
- for the average lawn within the Town of Orleans the best estimate for the contribution of lawn fertilizers to groundwater appears to be 1.51 lbs/lawn/yr or 50% of previous estimates;

Within the Town of Orleans lawn fertilizer usage likely contributes to nitrogen related declines in estuarine resources in some areas. However, at present these regions are not yet clearly delineated, although the watershed to Pleasant Bay and possibly Town Cove are likely candidates, based upon the monitoring of the receiving waters and the characteristics of their basins. In addition, it must be noted that the present use of lawn fertilizers makes its contribution to overall estuarine nitrogen loading small relative to wastewater inputs through on-site septic treatment systems. In embayments with full MEP analysis and the level of fertilizer usage seen in Orleans, lawn fertilization has generally be found to be <10% of the total watershed nitrogen input. While this is still an important and significant source of nitrogen, it is not the primary mechanism for nitrogen management within most of Cape Cod's embayment systems.

The greater issue relating to lawn fertilization in watersheds to nitrogen sensitive embayments is that the amount of nitrogen from this source can double due to changes in homeowner behavior alone, not requiring additional development of the watershed. An indication of this behavioral shift is seen in the apparent higher lawn fertilization rates in newer homes (1-10 yr old) seen in the Survey and the 33% higher usage in year-round versus seasonal homes. However, it also appears that the Town of Orleans has a citizenry both knowledgeable and willing to adjust use of fertilizers to address the overwhelming importance that they give to the health of their estuaries. Almost 9 of 10 homeowners surveyed indicated that the quality of the local bays and estuaries were either extremely or very important to them and their families and that they would be willing to undertake moderate to complete changes in their use of lawn fertilizers. It would appear that to the extent that management of nitrogen from the use of lawn fertilizers on residential properties is needed for the protection/restoration of Orleans' estuarine systems, that a citizen education program has a high potential for success. At a minimum, having homeowners not change their behavior, limits the magnitude of this source and ideally having reductions in this source reduces the need (and cost) of managing the other sources. However, it is important the there be a clear connection between the level of nitrogen reduction possible from this source and the expected level of benefit to the local estuaries and bays. It is also important that realistic expectations be presented relative to the costs and benefits of fertilizer management versus managing other local nitrogen sources.

Next Steps

Based upon the results of the Orleans Lawn Fertilizer Survey and ongoing efforts related to watershed nitrogen management planning and estuarine health, it appears the Town of Orleans is poised to design and implement plans which will restore/protect its various estuarine systems for the long-term. While lawn fertilizer usage is presently a relatively small part (<10%) of the current local nitrogen load to these estuaries, it is still a significant load and can double due to behavioral shifts alone, without increased residential build-out. Therefore, the Town should:

- continue to partner with the MEP to complete the analysis of the nitrogen thresholds for each of the Town's estuarine systems, which includes determination of the relative importance of each nitrogen source (including lawn fertilizers);
- consider an education program which indicates the role of nitrogen management in estuarine protection/restoration and the role of lawn fertilizers as one of many sources;
- initially focus any potential education for reducing nitrogen from fertilizers on the watersheds to the Pleasant Bay System and possibly Town Cove, which have documented nitrogen related habitat quality declines;
- focus potential education on reducing the number of fertilizations per year in those areas documented to have nitrogen sensitive receiving waters;
- conduct a cost analysis of nitrogen management related to each of the major sources of nitrogen contributing to the estuaries associated with the Town of Orleans, including potential effects on local businesses involved in fertilizer sales, etc.

APPENDIX A.

Survey Form

Massachusetts Estuaries Project:
Survey of lawn fertilizer usage within the Town of Orleans

Lisabeth M. White & Brian L. Howes

Coastal Systems Program

School for Marine Science and Technology

Survey#____________
Date ______________
TOV ______________

Massachusetts Estuaries Project
SMAST/ Town of Orleans

Homeowner Lawn Fertilizer Survey

Hello. I am working with the Town of Orleans and the School for Marine Science and Technology on the Massachusetts Estuaries Project. The goal of this effort is to protect and restore Orleans' coastal waters for the betterment of the citizens of Orleans. To develop accurate restoration plans, we need to have accurate information on the suite of land-uses and nitrogen applications to the land surrounding our bays and estuaries. I am here today gathering information on lawn fertilizer use as part of a town-wide survey. I was wondering if you had a few minutes to answer some questions? All answers will be kept anonymous and confidential.

My name is __________ and I am a volunteer for the Town of Orleans. I am working to provide more accurate data than is typically available to towns for comprehensive management planning.

I would like to ask you twenty-two questions, which should only take about 5 minutes of your time.

1. Do you maintain this house or does someone else? **Myself** **Someone else**
2. How long have you lived on the Cape? _______ in this house? ________
3. How old is this house? ______ **years old**
4. Are you a seasonal or year-round resident? **Seasonal** **Year-round**
5. What is your age? **(circle one)** **20-35** **36-50** **51-65** **66-older**
6. Is fertilizer applied to your lawn? **Yes** **No**
7. Do you or a commercial company apply it? **Myself** **Company**
8. If it applied commercially, which company do you use? ______________
9. If you apply it, where do you generally purchase the fertilizer? **(check one)**
   __________**lawn and garden center,** *such as Mahoney's or Agway*
   ___________**hardware store,** *such as True Value*
   ___________**large retail store,** *such as Sears, Wal-Mart, or BJ's*
10. What type of fertilizer do you use? **Liquid** **Solid**
11. How often is fertilizer applied? ______ **times per year**
12. Which time(s) of the year is it applied? **(circle all that apply)**
    Early Spring **Late Spring** **Early Summer** **Late Summer** **Fall**
13. How much fertilizer is used per application? ______________
14. How often do you water your lawn? _________________
15. Do you water immediately after applying fertilizer? **Yes** **No**
16. Do you water immediately before applying fertilizer? **Yes** **No**
17. Have you used more, less, or the same amount of fertilizer in the last 5 years?
    More **Less** **Same** **(circle one)**

18. If this study shows that fertilizer is a major contributor to the nutrient load of Cape Cod embayments, would this alter your current use of fertilizer? **Yes** **No**

19. On a scale of one to five, how much would you be willing to change your use of fertilizer, with 1 indicating no changes, and 5 indicating total change? **(circle one)**

1 2 3 4 5

20. Do you know what watershed your house is in? (And which embayment does this watershed feed into?)

21. Do you have a (check all that apply)

________ **waterfront lot**
________ **saltmarsh front**
________ **deeded access to saltwater**
________ **deeded access to freshwater (pond/lake)**
________ **saltwater view**
________ **freshwater view**

22. Of what importance is the quality of local bays and estuaries to you and your family?

a. no importance
b. minor importance
c. important
d. very important
e. extremely important
f. no opinion

Thank you very much and I appreciate the time you have taken to help me gather this information for the management of our local waters.

NOTES:

1. Grass collected: yes no
2. If on the water, did the lot have lawn down to the water or a buffer strip?
3. What was the approximate lawn size?
4. What was the housing density? 1/10- ¼ acre, ¼-½ acre, ½- 1 acre, 1-2 acre, >2 acre

APPENDIX B.

Summary of 2003 Results

Massachusetts Estuaries Project:
Survey of lawn fertilizer usage within the Town of Orleans

Lisabeth M. White & Brian L. Howes

Coastal Systems Program

School for Marine Science and Technology, UMD

Summary

During the summer of 2003 the Town of Orleans Wastewater Steering Committee partnered with the Massachusetts Estuaries Project (MEP) to refine estimates of the nitrogen loading to the Town's estuaries resulting from lawn fertilizer applications within their surrounding watersheds. Fourteen volunteers from the Town were trained by SMAST staff and given the standardized survey form developed for this purpose by L.M. White of SMAST. The effort is part of a regional survey of lawn fertilizer usage to support the application of the MEP Linked Watershed-Embayment Management Model for developing nitrogen management targets for the estuaries of southeastern Massachusetts. Of the 353 surveys conducted, 340 were deemed to be sufficiently complete for inclusion into the analysis for the Town of Orleans. A compilation of the results is presented in the "Compilation of Results" section below.

Quality Assurance

Data quality was determined in several ways:

- Volunteers were given a training session by SMAST staff;
- Multiple volunteers were employed in the surveys
- Surveys were distributed, not focused on a single region of Town
- Houses were selected at random.
- Results of fertilizer application rates were similar between volunteers, particularly when sample sizes were large (>25/volunteer).

The latter point, above, is based upon an analysis of the data collected by each of the fourteen survey volunteers. Given that the primary focus of the study was to refine the amount of fertilizer usage on the lawns of Orleans, we examined the average number of fertilizer applications per house determined by each volunteer (Figure A-1). The average application rate determined from the 340 surveys across all fourteen volunteers was 1.76 applications/year. In all cases where a volunteer completed 25 or more surveys, the average rate per volunteer was generally with 10% of the overall mean and always within 20%. That deviations from the overall mean are due to sample size in the censuses of less than 25 homes, rather than bias, is supported by the fact that pooling these small sample size datasets results in an average 10% lower than the overall population mean. It appears that potential variations in technique between volunteers did not result in discernable differences in survey results, at least in this key parameter.

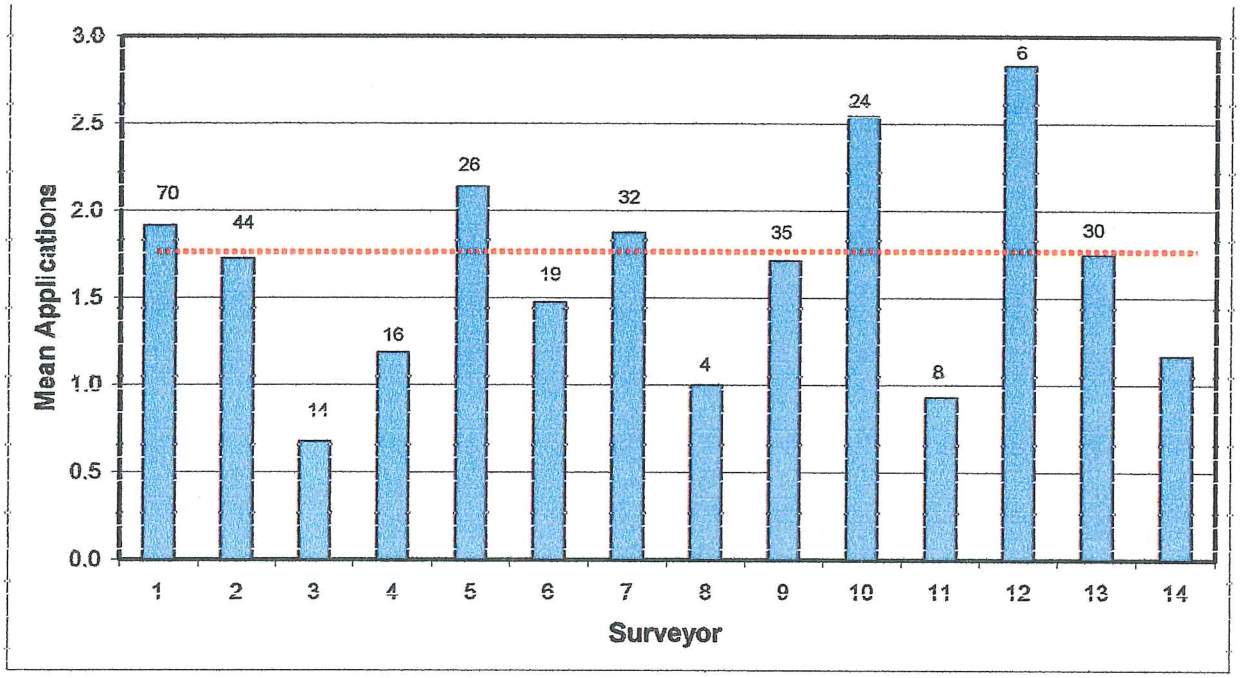

Figure A-1. Average number of fertilizer applications per year among the respondents censused by each of the 14 surveyors. The horizontal dashed line is the overall mean of the 340 surveys. The number above the bar represents the number of residences surveyed. The high variability among surveyors appears to be related to the number of residents included in the various means.

Compiled Results of Orleans Surveys

Fourteen individual volunteers from the Town of Orleans conducted the field surveys in the summer of 2003. The completed surveys were evaluated and compiled by Coastal Systems Technical Staff at SMAST. Presented below are the responses to the questions to the survey, found in Appendix A. Overall, 353 surveys were conducted, with 340 being sufficiently complete to support the data analysis. Therefore the maximum number of respondents to a question is 340, although occasionally answers were not filled in. These "blanks" were generally less than 3% of the surveys for any one question. The following are the results for the parameters surveyed:

1. House Maintenance
    - 340 residents responded
    - 80% stated that they maintained their residence themselves
    - 20% stated that someone else maintained their residence
2. A) The average length of time a resident resided on Cape Cod was 17.9 years
   B) The average length of time a resident lived in their current dwelling was 14.4 years
3. The average age of their current dwelling was 34.7 years
4. Residency
    - 336 residents responded
    - 76% stated that they were year-round residents
    - 24% stated that they were seasonal residents

5. Resident Age
    - 375 residents responded
    - 12% stated that they were 36-50 years of age
    - 35% stated that they were 51-65 years of age
    - 53% stated that they were 66 years of age or older
6. Fertilizer Use (Y/N)
    - 340 residents responded
    - 60% stated that they applied lawn fertilizer at least one time per year
    - 40% stated that they did not apply lawn fertilizer at all
7. Use of a Lawn Care Company for Lawn Fertilizer Application
    - 340 residents responded
    - 57% stated that they used a commercial company
    - 43% stated that they applied fertilizer themselves
8. Name of Lawn Care Company
    - 116 residents responded
    - 67% stated that they used *Scott's/The Lawn Company/ChemLawn* as their professional lawn care company
    - 33% used a company other than *Scott's* (see index for listing)
9. Location of Fertilizer Purchase
    - 85 residents responded
    - 84% stated that they purchased their fertilizer at a lawn and garden center
    - 16% stated that they purchased their fertilizer at a hardware store or large retail store
10. Type of Fertilizer (Solid/Liquid)
    - 168 residents responded
    - 83% stated that a solid fertilizer was applied to their lawn
    - 17% stated that a liquid or liquid/solid fertilizer was applied to their lawn
11. Fertilizer Applications per Year
    - 340 residents responded
    - The overall average number of applications per resident per year was 1.76
    - The average number of applications per year for those residents who employed a professional lawn care company to apply fertilizer was 3.52
    - The average number of applications per year for those residents who applied fertilizer themselves was 2.16
12. Time of Year of Fertilizer Application
    - 182 residents responded
    - 74% stated that they applied fertilizer in early spring
    - 48% stated that they applied fertilizer in late spring
    - 51% stated that they applied fertilizer in early summer
    - 40% stated that they applied fertilizer in late summer
    - 68% stated that they applied fertilizer in fall
13. Amount of Fertilizer Used per Application: **Uncertain Data Results**
14. Lawn Watering Frequency
    - 283 residents responded
    - 67% of the residents stated that they watered their lawn to some extent
    - 33% of the residents stated that they never watered their lawn

15. Of those residents that watered their lawn, 60% stated that they watered immediately after fertilizer was applied
16. Of those residents that watered their lawn, 4% stated that they watered immediately before fertilizer was applied; 36% stated that they watered both before and after fertilizer was applied
17. 5-Year Use History
    - 194 Residents Responded
    - 9% stated that their use of fertilizer has increased in the past 5 years
    - 15% stated that their use of fertilizer has decreased in the past 5 years
    - 76% stated that their use of fertilizer has stayed the same in the past 5 years
18. Willingness to Alter Current Use (Y/N)
    - 201 residents responded
    - 90% stated that they would be willing to alter their current fertilizer use
    - 7% stated that they would not be willing to alter their current fertilizer use
    - 3% stated maybe/didn't know
19. Willingness to Alter Current Use (1-5 scale)
    - 200 homeowners who currently apply fertilizer responded
    - The average willingness to alter current use was 3.6
    - The median willingness to alter current use was 4
20. Knowledge of Watershed
    - 304 residents responded
    - 57% stated that they knew what watershed they resided in
21. Lot Location
    - 340 house lots were surveyed for lot location
        - 46% were associated with saltwater
        - 8% were associated with freshwater
        - 46% were inland with out aquatic frontage, view or deeded rights
22. Importance of Quality of Bays and Estuaries
    - Overall 336 residents responded
        - 1% stated that bay quality had minor importance
        - 12% stated that bay quality was important
        - 33% stated that bay quality was very important
        - 53% stated that bay quality was extremely important
        - 1% had no opinion

NOTES

1. Buffer Strip Existence
    - 79 properties were surveyed for buffer strip
    - 78% of the properties were lots with buffer strips
2. Approximate Lawn Size
    - 306 house lots were surveyed
    - The average approximate lawn size was 11,879 ft^2
3. Housing Density
    - 326 properties were surveyed
    - 65% of the properties were located in a housing density of 1/10 to 1 acre lot sizes
    - 35% of the properties were located in a housing density of $1\text{-}2^+$ acres lot sizes

Final Report May 17, 2004

SMAST/MEP Lawn & Fertilizer Study (2/26/04 incomplete)
Orleans 2003-2004
Contact Sara Sampieri (SaraJaneSamp@aol.com) 508-951-6334

SMAST pick up 8/12/03 – surveys # 112 - Grass samples # 50
SMAST pick up 8/18/03 – surveys # 74 - Grass samples # 40
SMAST pick up 9/2/03 – surveys # 149 - Grass samples # 84
Mail in 9/3-9/15/04 – surveys # 21 - Grass samples # 8

(SMAST 2/05
353 Surveys
340 complete)

Total submitted; Surveys 356 (11% 0f homes) Grass Samples 182 (6% of lawns)

Other fertilizer applications in Orleans

A. Report from John Coppla, **Scotts Lawn Service** (formerly The Lawn Company)
(Data confirmed by e-mail9/8/03 and letter 4/6/03)

Number of customers, by 3 Orleans zip code

a. 02662 (South Orleans PO Boxes) 92
b. 02653 (Orleans, PO boxes and all delivered) 250
c. 02643 (East Orleans PO Boxes) 185

Total 2003, 527 homes (16% of homes in town)

Normal fertilizer application pattern is 5 applications;

1) Early Spring 1.0 lb , 24% controlled release. Mixture is 22-0-6 and "Pre-M emergent crabgrass control. Broadleaf weeds if present will be treated.

2) Early Summer 1.0 lb 50% controlled release. Mixture is 25-3-12. Broadleaf weeds if present will be spot treated as needed. Surface insect problems if present will also be addressed.

3) Summer 0.75 lb 50% controlled release. Mixture is 21-3-8 OR 25-3-12. Spot treatment of broadleaf weeds and surface insects will be provided as needed.

4) Early Fall 1.0 lb 50% controlled release. Mixture is 25-3-12

5) Late Fall 0.96 lb 23% controlled release. Mixture is 32-33-6

Late Fall high calcium granular limestone is applied

Scotts Lawn Service estimates 4.71 lbs Nitrogen / per 1000 square feet of lawn / per season.

Mr. Coppla estimates most customers get 5 application plan but some get limited or "1 shot" service. He estimates the average (1000sq.ft.) would probably be 3.5 lbs nitrogen per year and a 5-application plan would be 4.71 lbs nitrogen or 0.94 lbs per application. He further calculates, based on the 3.5 application average the average property receives 3.29 pounds of nitrogen per 1000 square feet per year.

B. Middle School grounds and athletic fields 7-1-03 thru 6-30-04.
Information from Paul Richard, Head Custodian, confirmed by letter 2/04

1. Product/Company "Tru Green".
2. 3 applications per year - fall, spring and summer.
3. Each application , 4 lbs/1000 sq. ft.
4. Area treated is 6.5-7 acres
5. Mixture is 25-3-8

In the period 1999-2003 (4 years) the school used the Lawn company, now Scotts. They applied a mix of 24-5-11, 4 times a year at a rate of 4 lbs /1000sq.ft. Over the same area, 6.5-7 acres. This works out to between 3,100 and 3,4000 pounds of nitrogen per year, over a ton and a half.

C. Town of Orleans, public property, includes parks and all landscaping.
Information is from Paul Fulcher, Supervisor Parks and Recreation Department

See detailed applications below
SUMMERY Town property that is **fertilized:**
722,880 sq. ft. OR 18.06 acres WITH 2117.5 Lb/N/Year

Town Property **not fertilized:**
225,040 sq ft. OR 5.6 acres

Date submitted March 26, 2004

To: Gussie McKusick,
Chairperson, Wastewater Management Plan Steering Committee

From: Paul O. Fulcher
Superintendent, Parks & Beaches Department

Subject: Fertilizer use on Town owned properties

The following is a list of properties maintained by the Orleans Park and Beaches Department; I have broken the area into five different categories.

Category #1 Areas fertilized four times per year using 18-9-18 IBDU fertilizes with _ lb. N/1000 on approximately April 15th and June 1st and 1 lb. N/1000 on approximately September 1 and October 20th.

Eldredge field playing field only	124,200 sq. ft.
Volunteer field elementary school	53,400 sq. ft.
Leo P. Miller field elementary school	40,200 sq. ft.

Category #2 Areas fertilized three times per year using 18-9-18 IBDU fertilized with 1lb. N/1000 on approximately May 20th, September 1, and October 20th

Little League Field	28,120 sq. ft.
Eldredge Field Terrace Area	23,000 sq. ft.
Village Green	53,186 sq. ft.
Soldiers Monument	4,280 sq. ft.
Academy Place	13,300 sq. ft.
Snow Library	27,792 sq. ft.

Category #3 Areas fertilized three times per year using 26-3-13 35% IBDU 1lb. N/1000 in mid May, late August and late October

Depot Square	21,376 sq. ft.
Police Station	21,838 sq. ft.
Barley Neck Island	1,678 sq. ft.
Center Cemetery	17,100 sq. ft.
Eldredge Small Memorial	25,000 sq. ft.

Category #4 Area fertilized two times per year using 26-3-13 35% IBDU 1lb. N/1000 in mid to late May and beginning to middle of September

Window on the Cove	20,600 sq. ft.
Jonathan Young Windmill	26,800 sq. ft.
So. Orleans Park	14,800 sq. ft.
Town Office Building	16,368 sq. ft.
Council on Aging	12,108 sq. ft.
Meadow on the Cove	13,000 sq. ft.
Eldredge Field Outskirts	79,080 sq. ft.
Elementary School Outskirts	85,654 sq. ft.

Category #5 Areas not fertilized.

Gavigan's Cottages	12,242 sq. ft.
American Legion Hall	24,648 sq. ft.
Meetinghouse Pond	13,400 sq. ft.

Pilgrim Lake	4,700 sq. ft.
East Orleans Cemetery	118,750 sq. ft.
Small E.O. Cemetery	4,700 sq. ft.
Jonathan Young Windmill	*19,800 sq. ft.
Window on the Cove	*6,700 sq. ft.
Meadow on the Cove	20,100 sq. ft.

*Portions of these properties are fertilized portions are not.

The Town of Orleans Parks and Beaches Department has not used pesticides or herbicides on any of the lawns for the last three years. We follow an I.P.M. Program on all properties and do not use these products unless absolutely necessary for safety concerns.

If I can be of further assistance please give me a call.

cc: Town Administrator

According to my calculations;

1. In '03- The Commercial Lawn Service served 527, 16% of homes. The 5 application schedule applied 4.71 pounds N / 1,000 sq.ft. lawn / year, or 33-41 pounds N on a lawn 8-10,000 sq. feet. This is more than 7 "people worth of N.
2. Middle school property with 6.5 to 7 acres of area and applies 3,100 to 3,400 pounds of N per year. This equates to 563 people worth of N.
3. Town properties apply fertilizer to 18 acres of land using 2,117 pounds of N per year. This equates to 385 people worth of N.

Survey # 539
Date__________
TOV__________

SMAST University of Massachusetts Dartmouth
The School for Marine Science and Technology

Massachusetts Estuaries Project
SMAST/Town of Orleans

Homeowner Lawn Fertilizer Survey

Hello. I am working with the Town of Orleans and the School for Marine Science and Technology on the Massachusetts Estuaries Project. The goal of this effort is to protect and restore Orleans' coastal waters for the betterment of the citizens of Orleans. To develop accurate restoration plans, we need to have accurate information on the suite of land-uses and nitrogen applications to the land surrounding our bays and estuaries. I am here today gathering information on lawn fertilizer use as part of a town-wide survey. I was wondering if you had a few minutes to answer some questions? All answers will be kept anonymous and confidential.

My name is _________ and I am a volunteer for the Town of Orleans. I am working to provide more accurate data than is typically available to towns for comprehensive management planning.

I would like to ask you twenty-two questions, which should only take about 5 minutes of your time.

---

1. Do you maintain this house or does someone else? **Myself** **Someone else**
2. How long have you lived on the Cape? __________ In this House? ________
3. How old is this house? ______ **years old**
4. Are you a seasonal or year-round resident? **Seasonal** **Year-round**
5. What is your age? **(circle one)** **20-35** **36-50** **51-65** **66-older**
6. Is fertilizer applied to your lawn? **Yes** **No**
7. Do you or a commercial company apply it? **Myself** **Company**
8. If it is applied commercially, which company do you use? ____________________
9. If you apply it, where do you generally purchase the fertilizer? **(check one)**
   __________ **lawn and garden center,** *such as Mahoney's or Agway,*
   __________ **hardware store,** *such as True Value,*
   __________ **large retail store,** *such as Sears, Wal-Mart, or BJs?*
10. What type of fertilizer do you use? **Liquid** **Solid**
11. How often is fertilizer applied? _____**times per year**

12. Which time(s) of the year is it applied? **(circle all that apply)**
Early Spring **Late Spring** **Early Summer** **Late Summer** **Fall**

13. How much fertilizer is used per application? ___________

14. How often do you water your lawn? ________________

15. Do you water immediately after applying fertilizer? Yes No

16. Do you water immediately before applying fertilizer? Yes No

17. Have you used more, less, or the same amount of fertilizer in the past 5 years?
More Less Same (circle one)

18. If this study shows that fertilizer is a major contributor to the nutrient load of Cape Cod embayments, would this alter your current use of fertilizer? Yes No

19. On a scale of one to five, how much would you be willing to change your use of fertilizer, with 1 indicating no changes and 5 indicating total change? (circle one)
1 2 3 4 5

20. Do you know what watershed your house is in? (And which embayment does this watershed feed into?)

21. Do you have a (check all that apply)
_____ waterfront lot
_____ saltmarsh front
_____ deeded access to salt water
_____ deeded access to freshwater (pond/lake)
_____ saltwater view
_____ freshwater view

22. Of what importance is the quality of local bays and estuaries to you and your family?
a. no importance
b. minor importance
c. important
d. very important
e. extremely important
f. no opinion

Thank you very much and I appreciate the time you have taken to help me gather this information for the management of our local waters.

NOTES:

1. Grass collected: yes no
2. If on the water, did the lot have lawn down to the water or a buffer strip?
3. What was the approximate lawn size?
4. What was the housing density? $^{1}/_{10}$-¼ acre, ¼-½ acre, ½-1 acre, 1-2 acre, >2 acre