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POPULATION TRENDS AND HABITAT CHARACTERISTICS OF SWEETGRASS, *Anthoxanthum nitens*: INTEGRATION OF TRADITIONAL AND SCIENTIFIC ECOLOGICAL KNOWLEDGE

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ABSTRACT.—Sweetgrass (*Anthoxanthum nitens* (Weber) Y. Schouten & Veldkamp) is a valued plant among Native peoples of the northeastern United States and eastern Canada, but Haudenosaunee herbalists and basketweavers have reported declines in its population at traditional gathering sites. We integrate traditional ecological knowledge with field and experimental studies to identify and understand population trends of sweetgrass. The plant's habitat requirements were also investigated; it was found growing under various environmental conditions. We determined that sweetgrass is declining in sites where it was historically present throughout the northeastern United States. In traditional gathering sites, the lack of controlled burning and unsustainable harvesting may be a factor in its decline, but the greatest threats facing sweetgrass throughout the Northeast are economic development and ecological succession.

Key words: sweetgrass, *Anthoxanthum nitens*, *Hierochloe odorata*, Haudenosaunee, Iroquois, baskets.

RESUMEN.—Este estudio integra conocimiento ecológico tradicional con estudios de campo y experimentales para determinar las tendencias poblacionales del *sweetgrass* (*Anthoxanthum nitens* (Weber) Y. Schouten & Veldkamp) y las causas de estas tendencias. Los herbolarios y tejedores de cestas Haudenosaunee han señalado declives en las poblaciones de *sweetgrass* de los sitios de acopio tradicionales. Se estudiaron los requisitos de hábitat del *sweetgrass*; se encontró en condiciones ambientales variadas, por lo que se considera una especie generalista. Este estudio permitió determinar que además de declinar en los lugares de acopio, las poblaciones de *sweetgrass* también están disminuyendo en localidades donde estaba históricamente presente en todo el noreste de los Estados Unidos. En los lugares de recogida tradicionales, la ausencia de quemas controladas y la recolección insostenible son causas posibles del declive de las poblaciones de *sweetgrass*, pero las mayores amenazas a las que se enfrenta esta hierba en todo el noreste son el desarrollo económico y sucesión ecología.

RÉSUMÉ.—Le foin d'odeur, *Anthoxanthum nitens* (Weber) Y. Schouten & Veldkamp, est une plante fort estimée des Premières Nations du nord-est des États-Unis et de l'est du Canada. Les vanniers et herboristes de la Ligue des Six-Nations (Haudenosaunee) ont mentionné que les populations de cette plante étaient en déclin aux sites traditionnels de récolte. Nous intégrons le savoir écologique traditionnel aux recherches expérimentales et aux travaux de terrain afin de déterminer

et de comprendre les tendances démographiques des populations du foin d'odeur. Les paramètres définissant les habitats où se trouve la plante ont été examinés: celle-ci croît sous diverses conditions environnementales. Nous avons pu établir que le foin d'odeur est en déclin dans les sites où il était historiquement présent à travers le nord-est des États-Unis. Quant aux facteurs contribuant au déclin du foin d'odeur parmi les sites traditionnels de récolte, l'absence de brûlages dirigés et la cueillette non durable ressortent comme deux facteurs possibles. Toutefois, le développement économique et la succession écologique forment les plus grandes menaces auxquelles font face les populations de foin d'odeur dans le nord-est des États-Unis.

INTRODUCTION

Anthoxanthum nitens (Weber) Y. Schouten & Veldkamp (=*Hierochloe odorata* (L.) P. Beauv; CNWG), commonly known as sweetgrass, is a perennial grass native to North America that plays a significant role in the lives of the indigenous people who reside within its range. Although sweetgrass is most frequently used as a ceremonial smudge and incense (English 1982; Kavasch and Barr 1999), its predominant use among the Haudenosaunee (also known as Iroquois), is in basketry (Benedict 1983).

Haudenosaunee herbalists and basketweavers interviewed for this study were concerned that sweetgrass populations have diminished and that the plant is now difficult to find in many traditional gathering areas. This observation has also been reported in a publication about the basketmakers of Akwesasne: "While sweetgrass grows naturally at Akwesasne and in surrounding areas, it is becoming more difficult to locate. . ." (Lauersons 1996:31). This study was conducted in partnership with Haudenosaunee basketweavers, herbalists, and ceremonial leaders who are familiar with the ecology and use of sweetgrass. We explore the nature of Haudenosaunee traditional knowledge of sweetgrass, its population trends, and its local and regional distribution. We integrate results from the ethnographic study with an ecological analysis.

Objectives and Hypotheses.—The objectives of this project are twofold. The first objective is to determine if the population of sweetgrass is declining in the northeastern United States and, if so, to explore possible causes of this decline. The second objective is to understand habitat requirements of sweetgrass. Both objectives will be addressed through the integration of Haudenosaunee traditional and scientific ecological knowledge.

While the general distribution of sweetgrass is known (Greene 2000; Lynch and Lupfer 1995), its specific habitat requirements are largely unstudied. Published information concerning the natural habitat of sweetgrass in the northeastern United States is limited. Information indicating sweetgrass's present or historical geographical range, the abundance of sweetgrass in those areas, its population trends, and indigenous management practices associated with the plant is lacking. Traditional knowledge has the potential to enhance the botanical information that does exist.

The hypotheses we tested in this study include: sweetgrass populations are declining throughout the Northeast; development of the landscape poses a sig-

nificant threat to sweetgrass populations; competition from nonnative plants is a significant threat to sweetgrass populations; sweetgrass abundance is correlated with identifiable environmental variables that characterize its habitat; the Haudenosaunee maintain traditional knowledge of sweetgrass population trends; and the Haudenosaunee maintain traditional knowledge of its local and regional distribution.

Traditional Ecological Knowledge.—Traditional ecological knowledge (TEK) offers a source of biological insight and potential models for conservation biology. It generally encompasses plant geography, plant ecology, and phenology, and often includes information concerning the range and distribution of a species (Kidwell 1973). This knowledge, developed through generations of interactions between native peoples and their lands, can contribute rational and reliable perspectives to the contemporary sciences (Kimmerer 2002; Mauro and Hardison 2000).

The knowledge held by Haudenosaunee practitioners concerning the population trends and habitat requirements of sweetgrass plays a vital role in this project. This knowledge, used in conjunction with a scientific ecological study, contributes to the determination of whether the population of sweetgrass is declining, and assists in understanding its habitat requirements.

METHODS

Ethnographic Methods.—The Haudenosaunee consists of six sovereign indigenous nations, whose populations continue to inhabit New York State: the Seneca, Cayuga, Onondaga, Oneida, Mohawk and Tuscarora (Grassman 1969; Herrick 1995; Lauersons 1996). Although members of all Haudenosaunee Nations produced baskets, it is mainly the Mohawks of the Akwesasne Territory who continue the tradition today (Lauersons 1996). The Akwesasne Territory, or "Land Where the Partridge Drums," is located in the St. Lawrence River Valley near Massena, New York. It is divided by the United States-Canadian border and by the border between the Canadian provinces of Ontario and Quebec (Benedict 1983; Lauersons 1996). It is home to approximately 10,000 Mohawk people, and to the art form of elaborate sweetgrass and black ash basketry (Benedict 1983).

The consultants who contributed to this paper are primarily women who are familiar with and use sweetgrass and who are members of the Onondaga and Mohawk Nations, located in central and northern New York, respectively. Some work for this project has been conducted with basketweavers of the Seneca Nation as well, who reside in western New York.

Eight formal interviews were conducted with Haudenosaunee consultants who are familiar with the ecology of sweetgrass, most are basketmakers, although herbalists and ceremonial leaders were also interviewed. The interviews took place between February and July, 2001: two elder female herbalists from the Onondaga Nation, in their late 60s, four female basketmakers from the Mohawk Nation, with ages ranging from 48–70, a male farmer and ceremonial leader in his 70s, and one female basketmaker from the Seneca Nation, aged 46. All of the consultants are fluent in English.

During the interviews, participants were guided in discussion through a list

of topics, but the direction of the interviews followed the participants' train of thought (Huntington 2000). The interview topics focused on whether the participants have noticed a change in the distribution of sweetgrass throughout the region, and if so, which factors they thought were responsible for the change. Past and current harvesting practices and land management through controlled burning were also discussed. In addition, we asked them to share information about areas where they currently gather sweetgrass, and/or traditional gathering sites where sweetgrass is no longer found.

The formal interviews were tape recorded with written permission from the consultant or handwritten notes were taken if the consultant was uncomfortable with being recorded. Each consultant signed a letter of consent and was compensated for his or her time and cooperation.

In addition to the eight formal interviews, nine informal conversations were conducted with Haudenosaunee basketmakers. One of the participants of the informal interviews was a male basketmaker from the Akwesasne Mohawk Territory who was approximately 70 years old. Eight of the participants were women, five of whom were elders ranging in age from 60–80 years, one female from the Seneca Cattaraugus Reservation in her 50s, and two beginning women basketmakers, aged 20, from the Seneca Allegheny Reservation. These conversations were generally short discussions in which a few questions were asked concerning the basketmakers' relationship to and use of sweetgrass, as well as her/his method of harvesting and knowledge of past land management practices involving controlled burning. All of the informal conversations were conducted on the Akwesasne Mohawk Territory in July, 2001.

Participant observation was used in visits to the sweetgrass gathering areas in the vicinity of the Akwesasne Territory. The observations included gathering sweetgrass with three generations of women in the Burns family, and their female friends at their grass collection sites in July of 2000 and July of 2001. This process assisted in our identification of sweetgrass and gave us the opportunity to gain an understanding of the sweetgrass habitat characteristics.

Ecological Field Methods.—Herbarium records enabled us to ascertain the historic distribution of sweetgrass in the Northeast and to obtain information on its habitat preferences. We consulted collections in four major herbaria in the Northeast: the New York State Museum in Albany, Cornell University, the New York Botanical Garden, and Harvard University. In addition, we visited the H. Lee Ferguson Museum Herbarium to obtain information on sweetgrass sites on Fisher's Island, New York. At each herbarium, sweetgrass specimens collected in the northeastern United States were studied and information regarding date of collection, the collection site, associated plants, and environmental conditions of the area were recorded.

This process resulted in over 250 records of sweetgrass throughout the Northeast. Of these, 27 sites were described in sufficient detail to find. The sites were located in: New York (14), Massachusetts (4), Connecticut (2), Vermont (3) and New Hampshire (4). These 27 "sites of record" were each visited to determine sweetgrass presence and to characterize its habitat.

Vegetation at each of the sites of record that was intact (i.e., not lost to de-

velopment) was studied in order to determine whether sweetgrass was still present at the site and to assess the relative abundance of sweetgrass and associated species. Vegetation presence and cover were quantified by placement of 30 quadrats placed in a stratified random design along three 50-m transects. Each quadrat was a circular plot with a diameter of 0.8 m (approximately 0.5 m^2). The cover of each plant species within each plot was estimated to the nearest 5%. Species were identified following Gleason and Cronquist (1991). All of the 27 sites of record were visited from mid-July to early September, 2000. By sampling in a relatively limited time frame, there was minimal variation in developmental stages of the vegetation.

In addition to vegetation sampling, canopy cover readings were taken and soil samples were analyzed in order to determine if there were significant relationships between sweetgrass abundance and these environmental variables. A Model-A spherical densiometer was used at elbow height to determine the percent canopy cover at three random points at each site. Three soil samples of 7-cm depth were also taken in random points at each site. Each of the soil samples was analyzed for texture and pH in a laboratory at the State University of New York College of Environmental Science and Forestry according to standard methods described by Wilde et al. (1972).

Each site was photographed and a map of the site was drawn showing proximity to water, and the arrangement of the sample plots for future monitoring studies. At the sites where the landscape had been altered through development or succession since sweetgrass was recorded, the vegetation was not formally assessed, but photographs were taken to document the change.

In addition to the 27 sites of record, five Haudenosaunee current and past sweetgrass gathering sites were studied. We identified these sites through participant observation and interviews. The ecological sampling methods used at the sites of record described above were also employed at these gathering sites.

Data Analysis.—The data from the 27 sites of record and the five sweetgrass gathering sites were included in the analysis. In order to determine which plants occurred most frequently with sweetgrass, the average percent cover for every plant species at each site of record was calculated. The total average plant cover was also calculated. Since we were interested only in those plants that might have statistically strong relationships with sweetgrass abundance, those species that had at least 1% cover over all sites and occurred with sweetgrass in at least three sites were included in the data analysis. A Satterthwaite two-sample t-test was performed for each species using SAS (version 7.0) Statistical Program (SAS Institute, Inc. 1990) with the purpose of determining if a relationship exists between these species and sweetgrass abundance. In order to determine if the presence of nonnative species was related to sweetgrass abundance, Satterthwaite two-sample t-tests were performed with the nonnative species collectively, nonnative grasses, and nonnative dicots.

Statistical analyses were then performed on the average percent canopy cover, the percent of sand, silt, and clay in the soil, and the soil pH in order to determine if they were related to sweetgrass abundance. Relationships between sweetgrass abundance and the environmental variables were tested using Pearson's correla-

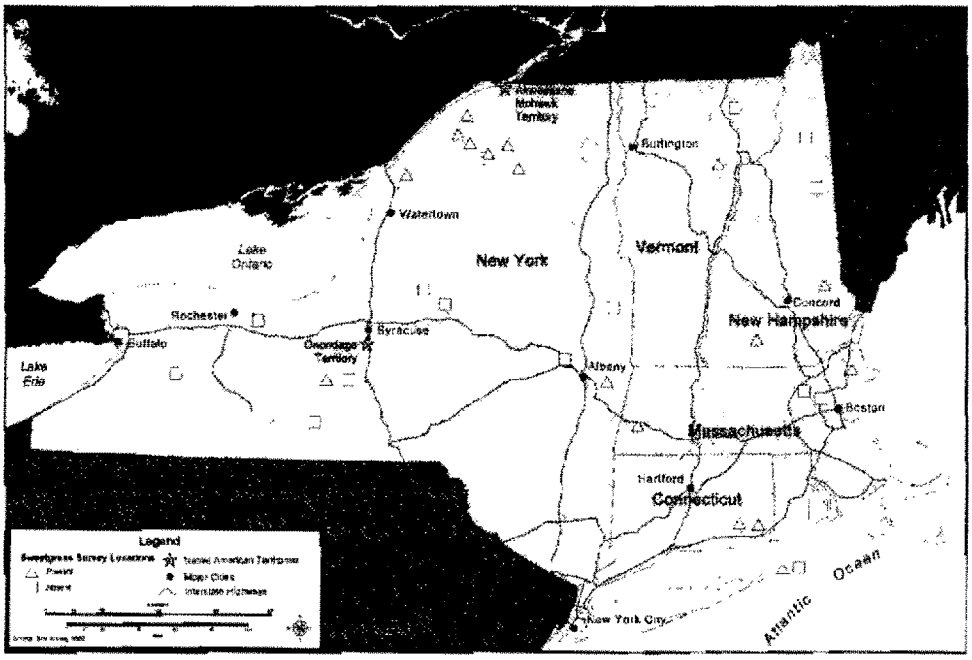

FIGURE 1.—The 32 sites that were visited throughout five northeastern states, five of which are/were Haudenosaunee sweetgrass gathering sites and 27 of which are sweetgrass sites of record.

tion coefficients and coefficients of determinations (R^2) through correlation and regression. These data were analyzed using the SAS (version 7.0) Statistical Program (SAS Institute, Inc. 1990) with sweetgrass percent cover as the dependent variable.

RESULTS

Population Status of Sweetgrass Throughout the Northeastern United States.—Sweetgrass was found at 13 of the 27 sites of record, and 4 of the 5 Haudenosaunee gathering sites. The oldest herbarium record where sweetgrass was still present was taken in 1904 from a tidal marsh in Salem, Massachusetts. In 15 of the 32 visited sites, sweetgrass was not found. The dates of the collection of sweetgrass from these 15 sites ranged from 1913 (Percy, New Hampshire) to 1982 (Wheelock, Vermont). These sites and the probable causes for sweetgrass's absence are illustrated in Figures 1 and 2 respectively.

Population Status of Sweetgrass in Traditional Gathering Sites.—Four of the traditional sweetgrass gathering sites sampled are located within 30 km of the Akwesasne Mohawk Territory, and one is in the vicinity of the Onondaga Nation Territory. In the summer of 2000, sweetgrass was in the four gathering sites located near the Akwesasne Territory: Norfolk, Saint Regis Falls, Dickinson Center, and Hogansburg, New York. Two of these sites, Norfolk and Saint Regis Falls, both are considered to be popular sweetgrass harvesting areas and have a high percentage

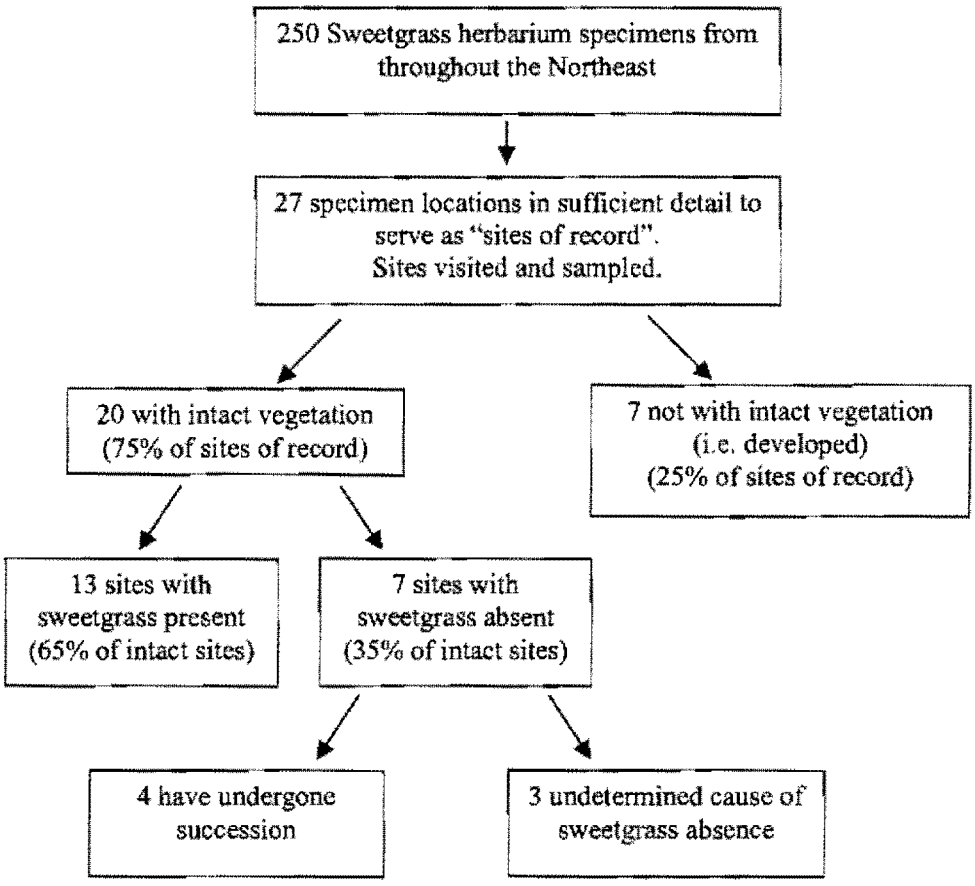

FIGURE 2.—A flow diagram illustrating the number of herbarium specimens studied, the sites of record, the intact and altered sites, the intact sites with sweetgrass present and sweetgrass absent and whether its absence is a result of succession or undetermined causes.

cover of sweetgrass. Dickinson Center, located near the Akwesasne Territory, also has a large amount of sweetgrass. A consultant who harvests sweetgrass from Dickinson Center believes that few people know of and harvest from this site. The remaining site near Akwesasne, in Hogansburg, was once a gathering site, but is no longer visited due to the relatively recent decline of sweetgrass. Sweetgrass was found only in small patches on the Hogansburg site in the summer of 2000.

The other gathering site, LaFayette, is near the Onondaga Nation Territory. In this site, a consultant stated that sweetgrass used to line a creek that runs through the area. She stated that she witnessed the population of sweetgrass slowly declining over the years until approximately 1998 when none remained. Sweetgrass was not found at this site in the summer of 2000.

Habitat Characteristics of Sweetgrass.—The habitats in which sweetgrass was found ranged from wetlands including salt marshes, fens, swamps and marshes to dry roadsides. The variations in values of environmental variables examined for this

TABLE 1.—The location, habitat type, percent sweetgrass cover, percent sand and clay, soil pH, and percent canopy cover of the 13 sites of record and four Haudenosaunee sweetgrass gathering sites where sweetgrass was found in 2000.

State	County	Region	Habitat	% Sweetgrass	% Sand	% Clay	pH	% Canopy
Connecticut	New London	Stonington	salt marsh	3.2	72.7	8.7	5.7	0
Connecticut	New London	Stonington	roadside	0.7	83.5	6.7	5.0	40.8
Massachusetts	Berkshire	N. Egremont	fen	6.8	61.7	8.8	7.6	0
Massachusetts	Essex	Salem	salt marsh	14.3	42.6	11.1	5.5	0
New Hampshire	Cheshire	Stoddard	roadside	18.8	90.0	3.7	5.5	21.6
New Hampshire	Strafford	Dover	marsh	2.5	71.4	8.5	5.0	49.5
New York	Tompkins	Groton	meadow	1.2	52.8	15.7	7.3	0
New York	Rensselaer	Taborton	roadside	4.7	87.1	4.9	7.2	42.3
New York	Essex	N. Elba	riverbank	1.7	94.2	1.9	6.1	9.9
New York	Jefferson	Fargo	roadside	4.3	94.0	2.4	7.3	18.4
New York	St. Lawrence	Potsdam	roadside	2.2	87.8	4.4	7.2	9
New York	Suffolk	Fisher's Island	brackish marsh	1.0	66.2	4.8	6.5	0
New York	Franklin	St. Regis Falls	roadside	6.0	95.5	2.0	7.2	13.1
New York	Franklin	Hogansburg	meadow	0.3	56.5	30.4	7.1	0
New York	Franklin	Norfolk	meadow	15.6	70.9	11.1	6.9	0
New York	Franklin	Dickinson Ctr.	meadow	6.5	85.8	3.7	5.7	0
Vermont	Caledonia	Danville	swamp	7.5	67.2	4.3	6.0	56.5

TABLE 2.—Results of correlation and regression analysis conducted on the environmental variables ($\alpha = 0.05$). The data included in the analysis were collected from the 13 sites of record and four Haudenosaunee sweetgrass gathering sites where sweetgrass was found in 2000.

Environmental variable	Correlation analysis		Regression analysis	
	Correlation coefficient	P-value	R^2	P-value
% Sand	−0.584	0.824	0.177	0.358
% Silt	0.160	0.540	0.177	0.364
% Clay	−0.159	0.542	0.177	0.343
pH	−0.163	0.532	0.177	0.421
Canopy cover	−0.069	0.793	0.177	0.744

study reflect this wide variety of habitats. The pH of the sites ranged from 5.01 to 7.63. There was a wide variation in percent canopy cover over the sweetgrass habitats as well, ranging from 0–56.5%. Sweetgrass was found primarily on sandy soils, however there was a relatively wide variation in the soil texture, from 42.6% sand to 94.2% sand. These environmental data for the 17 sites are presented in Table 1. No significant relationships ($\alpha = 0.05$) were detected between sweetgrass abundance and the environmental variables of soil pH, soil texture and canopy cover (Table 2).

Sweetgrass was found growing among other grasses and shrubs in all of the sites where it was present. It was the dominant species in four of the sites (Taborton, Norfolk, Salem, and Stoddard) but was commonly intermixed with other species and was never found growing in pure stands. A total of 141 plant species, and 110 identified genera were found to occur with sweetgrass in the sample quadrats.

Sixteen species, including sweetgrass, had a cover of at least 1% of the total area surveyed in the 17 sweetgrass sites. These species and their percent cover over the total area sampled are listed in Table 3.

The Satterthwaite t-tests revealed no significant positive relationships ($\alpha = 0.05$) between sweetgrass and co-occurring species. Significant negative relationships were found between abundance of sweetgrass and both wild carrot (*Daucus carota*) and red clover (*Trifolium pratense*) (Table 4).

Wild carrot and red clover are the only two nonnative dicots listed on Table 4. A significant negative relationship was found between sweetgrass abundance and the presence of the nonnative dicots ($\alpha = 0.05$). Sweetgrass abundance was not significantly related to either the abundance of the nonnative grasses (*Phalaris arundinacea, Bromus inermis, Agropyron repens,* and *Phleum pratense* or all nonnative plants (dicots and grasses) included in the data analysis (Table 5).

DISCUSSION

Habitat Requirements and Population Status of Sweetgrass Throughout the Northeastern United States.—The presence of sweetgrass in a wide variety of habitats and the absence of significant relationships between sweetgrass and the environmental variables studied suggest that sweetgrass is a generalist and can thrive in diverse

TABLE 3.—The species present with sweetgrass that had a percent cover of at least 1% of the total sampled area: the 13 sites of record and four Haudenosaunee sweetgrass gathering sites where sweetgrass was found in 2000.

Latin binomial	Common name	Percent cover (total)
Phalaris arundinacea L.*	reed canarygrass	7.35
Spartina patens Aiton	salt-meadow cordgrass	5.83
Anthoxanthum nitens (Weber) Y. Schouten & Veldkamp	sweetgrass	5.72
Solidago candensis L.*	Canada goldenrod	4.06
Agropyron repens L. Nevski*	quackgrass	2.70
Trifolium pratense L.*	red clover	2.86
Phleum pratense L.*	timothy grass	2.42
Vicia cracca L.*	bird vetch	2.01
Poa pratensis L.	Kentucky bluegrass	1.71
Bromus inermis Leyesser*	smooth brome grass	1.62
Panicum clandestinum L.	deertongue	1.27
Daucus carota L.*	wild carrot	1.44
Panicum virgatum L.	switchgrass	1.60
Onoclea sensibilis L.*	sensitive fern	1.44
Asclepias syriaca L.*	common milkweed	1.10
Solidagoo sempervirens L.	seaside goldenrod	1.01

Species with an asterisk (*) were found in three or more of the sampled sites and were included in the data analysis for this study.

habitats. In addition to habitat types, the amount of disturbance in areas with sweetgrass also varied. Sweetgrass was found in undeveloped marshes as well as in disturbed areas such as roadsides. There are limitations, however, to the level of disturbance in which sweetgrass can survive. One such limitation is the alteration of the landscape through development.

We hypothesized that sweetgrass populations were declining throughout the Northeast, in part due to habitat loss through development. Our data indicate that only 75% of the sites of record studied were intact; 25% of the sites had been

TABLE 4.—The results of the Satterthwaite t-tests to determine potential relationships between sweetgrass and species present in three or more sites with sweetgrass and constitute 1% or more of the total sampled area ($\alpha = 0.05$).

	Absent		Present		
Species	Sites	Mean (Std. Err)	Sites	Mean (Std. Err)	P-value
Agropyron repens	12	6.5 (1.8)	5	4.0 (1.1)	0.2678
Asclepias syriaca	14	6.0 (1.6)	3	4.3 (2.0)	0.5205
Bromus inermis	13	6.5 (1.7)	4	3.4 (1.2)	0.1751
Daucus carota	13	6.8 (1.6)	4	2.2 (0.8)	0.0218
Onoclea sensibilis	12	6.0 (1.4)	5	6.0 (3.3)	0.9078
Phalaris arundinacea	14	5.6 (1.4)	3	6.1 (4.8)	0.9259
Phleum pratense	8	6.5 (2.0)	9	5.0 (1.9)	0.6078
Solidago canadensis	13	6.1 (1.7)	4	4.5 (1.2)	0.4627
Trifolium pratense	11	7.9 (1.7)	6	1.7 (0.7)	0.0051
Vicia cracca	13	5.7 (1.5)	4	5.9 (3.5)	0.9649

TABLE 5.—Results of Satterthwaite t-tests conducted between sweetgrass abundance and the nonnative dicots, nonnative grasses and nonnative plants that were found in at least three sites with sweetgrass and at least 1% of the total area sampled ($\alpha = 0.05$).

	Absent		Present		
Plants	Sites	Mean (Std. Err)	Sites	Mean (Std. Err)	P-value
Nonnative dicots	11	8.0 (1.7)	5	1.6 (0.6)	0.0045
Nonnative grasses	7	7.6 (2.5)	10	4.4 (1.4)	0.2882
Nonnative plants	5	6.5 (2.3)	12	5.4 (1.7)	0.7121

altered due to development. Habitats were lost due to urbanization, the establishment and maintenance of recreation areas (beaches, parks), and in one case, the reforestation of agricultural land. The findings from this study, therefore, support the hypothesis that development contributes to the loss of sweetgrass populations.

In addition to habitat alteration through development, we predicted that invasion by nonnative plants was associated with decline of sweetgrass populations. Our data indicated no significant relationship between sweetgrass abundance and presence of nonnative species. Despite the presence of exotic species at the majority of the sites, sweetgrass was still found at 65% of the intact sites of record. Of the remaining intact sites, most had undergone natural succession to native forest or shrubland and are therefore no longer suitable for sweetgrass. The persistence of sweetgrass at most of the sites independent of the presence of nonnative plants suggests that sweetgrass is not significantly threatened by nonnative plants. The herbarium records indicated only past presence of sweetgrass, however, not its abundance.

It is possible that the nonnative species do influence the sweetgrass abundance to some extent in the areas sampled. It may not be possible, however, to determine the degree to which the surrounding vegetation is affecting the sweetgrass since the herbarium and oral records did not provide records of sweetgrass abundance in the area at the time of its collection.

Two nonnative species, wild carrot (a biennial) and red clover (a perennial), were found to have a significant negative relationship with sweetgrass. These species are not considered to be invasive (Gleason and Cronquist 1991). Negative relationships found between sweetgrass abundance and the presence of wild carrot and red clover may suggest that there is some competition between them.

There is an alternative explanation to the negative relationship, however, which is more likely the cause for the negative relationships. The co-occurrence of wild carrot and red clover with sweetgrass is due to the similar habitat preferences of the species. Both of the dicots, like sweetgrass, inhabit disturbed areas, such as roadsides, waste places, and fields (Gleason and Cronquist 1991; Newcomb 1977; Reed 1971). The negative association detected likely results from environmental preferences within these habitats. Six out of the seven sites in which sweetgrass was found with at least one of these dicots (Groton, Taborton, Hogansburg, Fargo, Potsdam, and New London) were within five meters of a road. The majority of the quadrats in which wild carrot and/or red clover were found (69%) was in the transect closest to the road; in contrast, most of the quadrats in

which sweetgrass was found in these sites were in transects that were not closest to the road (57%). Therefore, the negative association between the presence of wild carrot and red clover and sweetgrass abundance may be due to environmental preferences involving the level of disturbance in the transects, rather than to competition.

Although negative relationships were found only between sweetgrass and wild carrot and red clover, other nonnative species were found with sweetgrass, some of which are considered to be invasive. These invasive plants include smooth brome grass (*Bromus inermis*) and quackgrass (*Agropyron repens*), both perennials that were introduced from Europe and now are commonly found in waste places and roadsides (Gleason and Cronquist 1991; Hitchcock 1935). Sweetgrass's extensive root system and ability to vigorously reproduce vegetatively (Greene 2000) may be responsible for its persistence against these invaders.

The most abundant plant which co-occurred with sweetgrass (7.35% cover) was reed canarygrass, (*Phalaris arundinacea*) a perennial that inhabits marshes, riverbanks, and moist areas (Hitchcock 1935). This species includes native plants as well as commercial genotypes that have European origins. There are no phenotypic differences between the native and European plants. A difference does exist between the two, however. The European genotype of reed canarygrass has a tendency to grow in monoculture and is often considered to be invasive in many natural wetlands in the United States. It grows vigorously and is able to inhibit and eliminate native species (White et al. 1993). The fact that a negative relationship was not found between reed canarygrass and sweetgrass may indicate that the plants found growing with sweetgrass are of the native genotype.

Sweetgrass was found in only 48% of the sites of record. This finding indicates that the northeastern sweetgrass population is indeed declining in sites where it was historically present. The population trends that were examined in this study are limited by information that was gathered in the past on sweetgrass habitat. Trends in sweetgrass populations throughout the Northeast were determined by its presence or absence in areas that were previously recorded as sweetgrass habitat. It is possible that although sweetgrass was absent from some sites where it was historically present, the species is colonizing other areas. The lack of information about areas where sweetgrass was absent in the past, however, makes this determination impossible.

Ethnographic Findings.—Participatory research is a method of study that provides cross-cultural opportunities for cooperation and communication (Colorado 1988). Participatory observation in this study was important to establish a rapport with the sweetgrass gatherers. Sweetgrass is primarily used by women in basketry, and men do not often gather the grass (Lauersons 1996). Many Haudenosaunee women have shared the harvesting of sweetgrass with family members and friends for countless generations. As Christine Horn, a sweetgrass gatherer in her sixties recalls: "We'd go out, the females in my family. We'd pick berries in June, and sweetgrass in July. It was a way of life at the time, this is what you did."[1]

We were taught to recognize sweetgrass by its distinct shiny, light green blades and purple base. To confirm its identification, Theresa Burns told us to crush some of the blade to release the sweet fragrance. One of the women with

whom harvesting was conducted was colorblind and had no sense of smell, and still recognized sweetgrass by its shine. Theresa Burns instructed us to harvest the sweetgrass by pinching the base of the stem, just above the ground, so as not to disturb the root. Each blade of sweetgrass is picked individually, while taking care not to bend or damage the blade. The act of "cleaning" involves the removal of any brown, dried, or broken blades and keeping the long, bright green grass (Lauersons 1996 and Shebitz, personal observation).

Meeting with and interviewing individuals who each have their own use and understanding of sweetgrass contributed various perspectives on the importance of the plant to Haudenosaunee culture and to the environment. When asked to describe the link between sweetgrass and the Mohawk culture, Christine Horn stated: "It can't be separated, it's just being Indian."[2]

All of the individuals who took part in the formal interviews and most of the informal interviewees (five out of six) were concerned that sweetgrass populations are declining in the vicinity of their reservations. When asked about the status of sweetgrass in a formal interview, a Mohawk basketweaver who preferred to remain anonymous stated: "I can't find it anymore, it's difficult to find. It's become evasive. When going to pick it on the Rez, my old favorite spots don't have sweetgrass anymore."[3]

Both the formal and informal interviews revealed the Seneca basketmakers' beliefs that although sweetgrass was abundant in western New York in past centuries, it is now rare, if present at all, in the area. Michele Dean Stock is one of the only Seneca basketmakers remaining. She believes that the absence of sweetgrass and black ash in the area is partly responsible for the fact that traditional Seneca baskets are currently seldom made:

> To my understanding, there was a time when you can gather sweetgrass on the reservation in certain spots . . . there was a time when it was at Allegheny Reservation but it's been at least 100 years that people haven't been able to find it there.[4]

When asked why they believed that sweetgrass populations were declining, five of the eight participants in the formal interviews stated that they felt that sweetgrass is threatened by nonnative plants. As Onondaga herbalist Otatdodah Homer stated, "I blame the invaders . . . Foreign plants from other areas."[5] In particular, four of these participants specifically referred to purple loosestrife, *Lythrum salicaria* L. Purple loosestrife was found in small quantities at the two harvesting sites, Akwesasne and LaFayette, which were reported by interviewees to be past harvesting areas of sweetgrass. It was not found at any of the other 30 sites visited.

Ecological disturbance is one factor that might be responsible for the absence of sweetgrass in LaFayette, which is now a popular park. Also, the interviewee who gathered from this site believes the water in the creek to be polluted. The meadow in Hogansburg (Akwesasne) has been a popular sweetgrass gathering site for the past 50 years. The decline of sweetgrass in the Akwesasne area led me to inquire about the past land management practices in the vicinity of both the Akwesasne and Onondaga territories.

Traditional knowledge systems provide insights on the management of re-

sources and ecosystems (Berkes et al. 2000). One of the goals of the interviews was to gain an understanding of past land management and sweetgrass harvesting practices. This topic was covered to determine if a change in these practices might be the cause of the reported decline in sweetgrass populations in the vicinity of the Akwesasne Reservation and other harvesting areas.

It is possible that sweetgrass is not found on the Akwesasne meadow because of the manner in which it was harvested. Sweetgrass reproduces primarily by its rhizomes (Green 2000; Winslow 2000). To many, sweetgrass is traditionally harvested by grasping the shoots firmly at the base of the stem and pinching or pulling them until they break loose from the rhizomes and roots, which are an inch or two below the surface (English 1982). Theresa Burns explained that:

> The way I pick sweetgrass is the same way that my grandmother picks sweetgrass. She never takes the root, so that it can come back next year. As she's picking, she cleans it. I don't get as much sweetgrass as maybe somebody else does because I like to get it all clean, I don't like to clean it when I get home . . . that's the way she does it, she cleans as she goes. And she's very selective as she picks, and I am too.[6]

Not all Haudenosaunee sweetgrass gatherers, however, practice this method of harvesting. Knowledge bases, whether they are western scientific or traditional are both collective and individual in nature. As such, they reflect a diversity of perspectives. All seventeen of the consultants in both the formal and informal interviews reported that some Native gatherers are now taking the roots when they harvest the sweetgrass. Eight stated that they harvest sweetgrass from its root and do not believe that this method affects the sweetgrass population. Thomas Porter, a Mohawk leader who burns sweetgrass as an incense in ceremonies, stated in a formal interview that ". . . we take the whole plant, just pull it up, and some root comes off too, but that's not a problem, it doesn't hurt the grass."[7]

Onondaga herbalist Jeanne Shenandoah explained the lesson she received from her friend when they went out to pick sweetgrass:

> She said "Oh you have to take the roots up when you pick it." She'd have big bunches of it with the roots. She said if you don't pull the roots up, it won't stay green. And I thought, you would hope that people would be considerate so as not to take the whole patch, you know? So that it could multiply. I was really shocked when she said "Pull the roots."[8]

By pulling the entire plant and removing the roots and rhizomes from the ground, that plant's energy storage and primary reproductive means is lost. Whether this action negatively affects the overall sweetgrass population is debatable. There are documented cases where indigenous harvesting practices that involved the digging of subterranean organs of wild plants, such as rhizomes, in fact benefited the overall population of the plant. For example, M. Kat Anderson (1997:149) presents the argument that tillage activities practiced by Native Americans of California ". . . mimicked natural disturbances with which the plants coevolved, and played an ecological role that is now vacant in many wildlands, where Native Americans can no longer harvest and manage plants."

Five interviewees (three from the Burns family) stated that they were taught

from their mothers and grandmothers to cut the sweetgrass at the base of the stem, so as not to disturb the root, and that this method was used by their ancestors. All of these participants are angered when they see people, both Native and non-Native, harvesting sweetgrass from its root and believe that only recently have people begun, in their haste, to carelessly pull the roots of sweetgrass. Otatdodah Homer stated, "I think people pick it and they didn't know how to pick it. They would just pull it up from the root. And by pulling it up from the root, there goes the plant! . . . Obviously they're not properly picking."[9]

Another issue which was brought up in four of the eight formal interviews was the possibility that sweetgrass is being overharvested. The removal of the roots and rhizomes, in conjunction with overharvesting, possibly affects the sweetgrass population of Akwesasne. The Haudenosaunee Environmental Task Force warns that overharvesting particular plant species is a threat that faces the native grasses of Akwesasne. This unsustainable harvesting may eliminate whole generations of new plants as people tend to pick the strongest of plants, leaving the young and frail ones to continue to the next generation. Arquette (2000:57) comments, "Every plant has a leader among their family group. When we target the leader and discard the others, we weaken the entire remaining family group." Efforts are being made by the Task Force to educate individuals about the importance of harvesting sweetgrass sustainably. With the cooperation of the Task Force, Arquette (1999) has written an information pamphlet on preserving and restoring small plants and sweetgrass that instructs gatherers of sweetgrass to pick it sustainably, to not overharvest, and to replant roots from sweetgrass that are picked.

In addition to unsustainable harvesting of sweetgrass, the absence of controlled burning might be responsible for the decline in sweetgrass populations. Many indigenous societies create small-scale disturbances, such as fire, to "nurture sources of ecosystem renewal" (Berkes et al. 2000:1256). Fire is a significant ecological factor in maintaining perennial grasses in grassland ecosystems (Anderson 1996). Fires set by indigenous people were often used to increase yields, recycle nutrients, clear detritus, and promote growth of desired plants in the midst of reduced competition (Anderson 1996). Since some plants used in basketry require burning, the absence of controlled burning, and modern fire suppression policies have created difficulties for contemporary weavers (Ortiz 1993).

All of the consultants for this study stated that they recall land being burned by their grandparents, mostly for the regeneration of hay. In fact, two of the interviewees remember that the fields from which they used to harvest sweetgrass were burned for hay until approximately 50 years ago. Theresa Burns recalled that:

> Most of the time what they burned for was hay. So that the hay would come in, they'd always burn it. In the spring, right after the snow went away. . . . [S]uch a great smell, the burning. I used to walk through [the fields] and just get all full of the grass smoke, it was great. They did that because . . . burning puts all the nutrients back in the soil.[10]

The increased abundance of sweetgrass in these areas was probably not the aim of the burning, but a result of it nevertheless. Two individuals who took part

in informal interviews, both of whom were elders from the Akwesasne territory, stated that burning has been done specifically to encourage sweetgrass growth. The consultants of both informal and formal interviews explained that although some controlled burning is still carried out, the practice has become much less common over the course of the past 50 years. When we inquired why burning was not practiced often, the consultants responded that now people are too concerned about burning their neighbor's homes, there is not a great deal of space left. Thomas Porter explained, "Growing up in Akwesasne, I used to help my family burn our land, and the land around our area. . . It's hard to control fire. When wind blows, it could burn the homes and the whole forest."[11]

At each interview, we expected to hear that the consultant thought that the absence of controlled burning might be responsible for the decline of sweetgrass in traditional gathering areas. This possibility was not brought up in any of the interviews, however, until we explained our theory. The tolerance of sweetgrass to fire (Walsh 1994) was discussed with each consultant. Since fire does not consume the underground rhizomes, the grass can recover from burning, while benefiting from the increased sunlight and nutrient availability (Lynch and Lupfer 1995). The rhizomes of sweetgrass often sprout after aerial portions are burned and culms arise from among the dead foliage of the preceding year (Walsh 1994). It is possible that the foliage protects basal buds from fire damage in the spring, when the dead foliage is rich in moisture (Walsh 1994). After our perspective was explained, the interviewees agreed that the lack of controlled burning in the vicinity of their nation's territory might be responsible for its current absence in past gathering sites.

Through the interviews, the strength of the connection between the Haudenosaunee people and sweetgrass was made apparent, as was their concern for the fate of sweetgrass. Otatdodah Homer explained there is a fear ". . . that it's becoming extinct. . . It's important to our culture and we want to keep it alive, to keep using it. . . I think that scientists should know that it's sacred to us native peoples. . ."[12]

CONCLUSION

Berkes et al. (2000:1521) stated, "Indigenous groups offer alternative knowledge and perspectives based on their own locally developed practices of resource use." This understanding was central to the research presented in this study. The knowledge possessed by the Haudenosaunee proved to be valuable in identifying population trends and in characterizing sweetgrass ecology and habitat. Detailed knowledge of past and present harvesting techniques and land management practices, such as controlled burning, contributed to understanding of the influences that may be responsible for the difficulties in locating sweetgrass in traditional gathering areas.

Most of the threats that face sweetgrass populations throughout the Northeast are no different than the threats that face other midsuccessional species that inhabit moist areas. Habitat destruction brought about through the draining of wetlands, suppression of natural fires, lack of controlled burning, and ecological succession, has led to the replacement of sweetgrass habitat with altered landscapes.

These threats are a result of shifts in cultural practices; as the Haudenosaunee have changed their traditional land management practices and urbanization encroaches upon what remains of the undeveloped landscape.

The integration of knowledge bases in this study allowed us to frame and approach the questions concerning ecological requirements and population trends of sweetgrass. Approaching this project from both an ecological and ethnographic perspective enhanced the understanding of sweetgrass for this study, and may prove to be beneficial in future sweetgrass conservation efforts. On the Onondaga and Akwesasne territories, a return to traditional land management practices such as controlled burning and sustainable harvesting practices may be the primary means to ensure that sweetgrass populations persist. The continued presence of sweetgrass in the vicinity of the territories will enable traditions associated with the plant to endure.

NOTES

[1] Christine Horn, interview, July 12, 2001.

[2] See note 1.

[3] Anonymous interview, February 15, 2001.

[4] Michele Dean Stock, Seneca basketmaker, interview, July 10, 2001.

[5] Otatdodah Homer, Onondaga herbalist, interview, February 15, 2001.

[6] Theresa Burns, interview, February 15, 2001.

[7] Thomas Porter, a Mohawk leader, interview, May 30, 2001.

[8] Jeanne Shenandoah, Onondaga herbalist, interview, April 25, 2001.

[9] See note 5.

[10] See note 6.

[11] See note 7.

[12] See note 5.

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