Stakeholders' Perceptions of Native Plants and Local Ecotypes in Ecological Restoration

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Abstract

Many scientists and land managers recommend using local ecotypes for restoration projects. However, there is not a scientific consensus on what constitutes "local." To gain information about production and use of locally sourced plant material, we surveyed two stakeholder groups, conservation professionals and nursery professionals, to learn if there were differences between these stakeholder groups in terms of use, sale, or perception of native and local ecotype plant material. Our survey results indicated that both conservation and nursery professionals are aware of the ecological and functional value of native plant communities, and are also familiar with associated plant sourcing issues. However, nursery professionals provide less local ecotype and source-certified plant material in their businesses than would meet the need expressed by conservation professionals for these materials. Conservation professionals also indicated that their organizations did not necessarily have specific guidelines for sourcing local ecotype native plant material. Although nursery professionals are aware of restoration techniques and the usefulness of local ecotypes, this does not appear to translate into provision of larger quantities of native, local ecotype, or source-certified plant material. We found that members of both stakeholder groups rely on trusted authorities and professional training for information, presenting an opportunity to reach both groups through combined workshops to encourage communication and facilitate availability of native plants for restoration.

Keywords*:* Restoration practices; local ecotypes; source-certified; nursery production of native species; forest herbaceous species; survey

Restoration Recap

- Native plant communities provide valuable ecosystem services and in landscapes with only remnants of such communities the restoration of key species can increase their capacity to provide such services.
- Conservation professionals and nursery professionals differ in their knowledge and perceptions of the importance of local ecotypes in restoration.
- Differences in perceptions can lead to a mismatch between availability of plant materials in nurseries versus desire to obtain those materials for ecological restoration projects.
- Both conservation professionals and nursery professionals rely heavily on professional training and trusted authorities for information, creating opportunities to facilitate interaction to better align conservation need for and nursery provision of restoration plant materials.

Introduction

Locally sourced plant material is generally regarded as the "gold standard" when reintroducing plant species in ecological restoration projects, particularly among researchers who are concerned about the potentially negative genetic consequences of non-local plants on local populations. For example, scientists are concerned that non-local sources may be less likely to exhibit long-term success if introduced into sites that differ too widely from their original environmental conditions (Linhart and Grant 1996, Joshi et al. 2001, Hufford and Mazer 2003, Bischoff et al. 2010).

There are challenges to using local ecotype plant material in practice, however. One of the most significant challenges is the lack of a clear consensus on what constitutes a local source

(McKay et al. 2005, Herman et al. 2014). Scientists have recorded genetic differentiation at the scale of meters under strong selection pressure (McGraw and Antonovics 1983), all the way to regional differences under different climate conditions (Etterson and Shaw 2001). This disparity is reflected in recommendations for sourcing material for restoration that range from as local as on the same site, to more than 160 km distant (e.g., Johnson et al. 2004, Saari and Glisson 2012).

In addition, appropriate seed and transplant zones are unknown for nearly all native shrubs, grasses, and forbs (Johnson et al. 2004). The reasons for this are complex, ranging from the scale of selection mentioned above, to differences among species in the degree to which populations are connected by the gene flow through pollen and seeds (Loveless and Hamrick 1984). For example, plant species that are wind pollinated may have highly connected regional populations, and a wider transplant zone, compared to species that are insect pollinated and thus where gene transfer among populations is limited by insect movement (McKay et al. 2005, Falk 2011). Such ambiguity hinders knowledge as to what is actually local ecotype plant material.

Restoration practitioners may also encounter obstacles to obtaining sufficient plant volume for restoration projects. Finding appropriate plant sources for restoration is particularly important for species that are unlikely to recolonize new areas themselves. For example, perennial woodland herbaceous species, which are functionally important in forest ecosystems and are missing or declining in many areas, do not propagate well by seed (Bierzychudek 1982, Mabry 2004). Examples include species such as *Asarum canadense* (wild ginger) and *Caulophyllum thalictroides* (blue cohosh), which produce small numbers of fleshy seeds that need to stay moist to remain viable, making them prone to deterioration in storage (Bierzychudek 1982, Cullina 2000). In addition, some species may take 10 years or more to reach reproductive maturity. For example, in one study seeds of 15 forest herbaceous layer species were planted in

1999 and 2000, and emergence, survival, and flowering were recorded over time. Some species, including *Carex jamesii* (James' sedge) and *Isopyrum biternatum* (false rue anemone) flowered after four years, while others, such as *Podophyllum peltatum* (mayapple) and *Erythronium albidum* (trout lily) had yet to flower after 16 years (Mabry, unpublished data). Using transplants for restoration projects may be more effective for species with these characteristics than growing plants from seed. However, cultivating transplants can be costly and time-consuming, making them inconvenient to cultivate and sell in nurseries. As a result, practitioners who wish to use local ecotypes in their restoration projects may have difficulty finding nurseries that supply desired plant material in sufficient quantities or at an acceptable cost (Burton and Burton 2002, Ruhren and Handel 2003).

Given the prominence of the concern about locally sourced plant material, and the resulting importance of considering appropriate source distances when making recommendations for restoration and management, we identified two stakeholder groups who influence use of native plants for restoration: conservation professionals who use native plant materials for restoration projects, and nursery professionals who supply plant materials. We used a survey to examine questions about their knowledge about, attitudes toward, and use of native plants and local ecotypes. We developed and administered two versions of an online survey with specific queries targeted to each group. Specifically, we explored the following research questions: 1) Are there differences between conservation professionals' use of and nursery professionals' ability to provide native plant materials? 2) Are there differences among these stakeholder groups in their perceptions of restoration techniques, local ecotypes, and source-certified plant material? and 3) What are the primary sources of information used by conservation and nursery professionals to learn about local ecotypes?

Methods

The surveys for conservation professionals and nursery professionals and the protocols for their administration were reviewed and approved by the Institutional Review Board of the Office of Responsible Research at Iowa State University. The conservation professional sample frame was composed of state and county government employees and professionals who work for conservation-based nonprofits (n = 384). The nursery professional group included all members of the Iowa Nursery and Landscape Association (INLA, n = 210).

Survey to Conservation Professionals

The survey for conservation professionals had 75 questions (Supplementary Materials). First, survey respondents were asked to select their primary group affiliation, to ensure that they were classified into the correct sample frame. We asked questions about where they obtained plant materials for restoration projects and whether they primarily used seeds or plants. The next questions gauged how familiar they were with various restoration techniques and their knowledge of the ecological and functional value of native plant communities. We then supplied definitions for different types of plant materials (such as native plants, forest herbaceous perennial species, local ecotypes, and plants grown from source-identified seed) before asking which types of plant materials they used and how long they have been using them. We defined local ecotype as a plant population that originated in a specific area and has genetic adaptations to its environment and source-identified seed as any plant material that is known to have originated in a specific place and has undergone an origin-certification process (Houseal and Smith 2000).

Next, we asked about their primary sources of information and their perspectives on the use of local ecotypes in restoration. We wanted to know whether personal opinions or organizational guidelines dictated use of native plants or local ecotypes, so we asked whether the survey respondent or their employer had guidelines for sourcing plant materials for restoration. The final set of questions asked about respondents' demographic information.

Survey to Nursery Professionals

The survey for nursery professionals had 78 questions (Supplementary Materials). Survey respondents were again asked to identify their primary role in the nursery profession. Next, respondents were asked to answer a series of questions to gauge their familiarity with common restoration techniques and their opinions on the importance of restoration. We again provided a common definition for different types of plant materials and asked them to estimate the percentage of the volume of plant material they sold in those categories, and how long they had been growing those types of plants. We asked about their primary information sources about local ecotypes and included a set of questions to rate the importance of using local ecotype or locally-sourced plants in restoration.

We were interested in the degree to which customer interest influenced whether nurseries provided native plant material, so we asked if customers currently requested local ecotype or locally-sourced plant material, and whether the nursery would provide those materials if there was high customer demand. Some native herbaceous perennial species are difficult to grow from seed, so we asked how long they would try to cultivate species if they were difficult to grow, and whether high demand or profit potential would affect their decision to cultivate those species. We then asked whether the nursery currently sold local ecotype or source-certified plant material. If they did, we asked them how long they had done so, and their perception of current

and future demand for those plant materials. If respondents indicated that they did not currently sell source-certified or local ecotype plant material, we asked whether they were considering it, and what factors would cause them to consider selling those materials.

Survey Administration and Data Analysis

We used Qualtrics Survey Software to create both surveys and generate survey links that could be e-mailed to stakeholders (Qualtrics LLC., Provo, UT). We distributed the conservation professional survey by identifying a contact person within each organization and requesting that they distribute the link to their respective employees. We distributed the nursery professional survey by contacting the Iowa Nursery and Landscape Association and requesting that they distribute the link via the INLA member email list. We sent out the first surveys with an email cover letter and unique survey link for each potential respondent. Links to surveys were sent in late April and early May, 2015, and re-sent approximately ten days later (following Dillman et al. 2014). Because the initial survey was administered at a particularly busy time for nursery professionals, we re-sent the survey link to that group in late September in an effort to improve response rates.

We used the Qualtrics analytical tool to calculate means and standard deviation to describe variation around the means for responses from both populations based on each rating scale (Steiner 1996). We used a two-sample t-test to determine whether means from the two groups were the same (using JMP Pro 11, SAS Institute, Cary, NC). We included only surveys that were more than 50% complete in our survey analysis, to ensure valid comparisons of responses within stakeholder groups between questionnaire items (e.g., question 1 versus question 14).

Results

An e-mailed cover letter explaining the purpose of the survey was sent to 384 conservation professionals, each containing an individual survey link. We received 179 responses, but included only those that were more than 50% complete in the data analysis, resulting in 145 eligible responses and a response rate of 37.8%. Cover letters and survey links were likewise sent to 210 nursery professionals. We received 50 total surveys, with 38 eligible responses, for a response rate of 18.1%.

We found differences among conservation professionals and nursery professionals for every category of survey questions. There were differences in the types of plants that stakeholders use or sell (Table 1), the length of time they have used/provided plants (Table 2), and their perception of demand for local plants (Table 3). Further, there were differences between these stakeholder groups in their familiarity with local ecotypes, the ecology and function of native plant communities and their management (Table 4), and whether local ecotypes are used in practice (Table 5). The groups also differed in where they obtained technical information on local ecotypes (Table 6). Each of these results will be displayed and described in more detail in the paragraphs that follow.

Some of the most striking differences we found were related to the use of seeds or source-identified seeds, and the use of seeds versus plants. Specifically, conservation professional respondents reported a preference for buying seed rather than plants (i.e., potted plants, plugs, or bare root plants) and for using native species, particularly prairie species, rather than cultivated ornamental species (Table 1). In addition, conservation professionals had used native species (both prairie and forest species) and source-certified plant material for longer than

nurseries had been selling them (Table 2). However, there was no difference in quantities of plants provided or used for forest herbaceous perennial species. (Table 1).

The two groups also differed substantially in their perception of the market for local ecotype and source-certified seed. Conservation professionals indicated that they had requested local ecotype and source certified plant material, while fewer nursery professionals agreed that their customers had requested these (Table 3). However, both groups agreed that source-certified plant material had a high value: conservation professionals indicated that they would be willing to pay more, and many nursery professionals indicated that they would charge more for source-certified plant material.

When nursery professionals were asked how long they would cultivate species that are difficult to grow, some reported that they would not try to cultivate such species. However, if a species was difficult to grow but financially valuable, more nursery professionals reported they would be willing to try to cultivate it, especially if customers requested it (Table 3). Nursery respondents reported that they generally do not grow or sell local ecotype or source-certified plant material, and are not necessarily considering growing them in the future. Nursery professionals indicated that demand for local ecotype plant material is currently low, and some also indicated that locating and selling source-certified plant material "is a hassle."

A greater number of conservation professionals agreed that they were knowledgeable about local ecotypes compared to nursery professionals, although both stakeholder groups agreed that native plants are a valuable natural resource (Table 4). Perceptions of the actual practice of restoration using local ecotype or source-identified seed in practice varied widely. Both conservation and nursery professionals agreed that native plants are a valuable natural resource, although they differed in how they would incorporate local and non-local plants (Table 5).

Nursery professionals generally agreed that nonlocal plants were appropriate for urban gardens, while conservation professionals were more likely to agree local material should be used whenever possible and should be tracked, that only local plants should be used in restoration near high quality remnants, and that planting nonlocal plant material would be detrimental to an existing plant community (Table 5).

Conservation professionals stated that local ecotypes should be used whenever possible (Table 5), but relatively few of them (21%) reported that their organizations had specific guidelines for obtaining source-certified or local ecotype plant material. The guidelines of organizations that did have them recommended boundaries based on biotic and abiotic environmental conditions (52%) or the type of restoration project (48% reported that this depended on site, for example high quality remnants versus urban parks). Some conservation professionals (22% to 29%) reported that their agency used county lines, state lines, or maximum distances from a restoration site as the boundaries for sourcing restoration plant materials. Of those who used maximum distance to guide plant acquisition, the distance reported ranged from 80 to 160 km. Respondents reported that their organizations had been recommending local ecotype plant material for 9 to 35 years, with an average of 14 years (n = 19). About a quarter of conservation professionals reported having personal, rather than organizational, guidelines for obtaining local ecotype plant material. These guidelines closely aligned with the recommended boundaries of restoration agencies.

Both conservation and nursery respondents reported using a variety of sources to learn about local ecotypes (Table 6). Conservation professionals most commonly sought trusted authorities or professional training. Nursery professionals also relied on professional training and

trusted authorities, although they were more likely than conservation professionals to consult University Extension personnel and trade journals (Table 6).

Discussion

Our survey results indicated that conservation and nursery professionals are aware of the ecological and functional value of native plant communities, and are also familiar with associated plant sourcing issues. However, nursery professionals use local ecotype and source-certified plant material in their business at a level well below the desire expressed by conservation professionals to obtain them. Conservation professionals also indicated that their organizations did not necessarily have specific guidelines for sourcing local ecotype native plant material. Thus, awareness of restoration techniques and local ecotypes does not appear to translate into a robust supply of native, local ecotype, or source-certified plant material by nurseries. Below we discuss some of the possible reasons for the mismatch between conservation use and nursery provision of native and local ecotype plant material.

Use and Sale of Native, Local Ecotypes, and Source-Certified Plant Material

Our results indicated that conservation professionals use native plant species, including source-certified plant material, more than nursery professionals sell them, and that they have been using these species for longer than nursery professionals have been selling them. This time lag reflects the fact that conservation professionals have historically used sources other than retail nurseries to obtain plant material. This is especially true in the case of prairie restoration, which has long been practiced throughout the Midwest (Jastrow 1987, Schramm 1990, Kindscher and Tieszen 1998, Allison 2002, Martin et al. 2005, McLachlan and Knispell 2005). Many conservation

professionals and/or their agencies collect their own propagules, often seed, according to a robust set of practices and protocols that have developed over time and which include specific guidelines for collection, storage, and planting (Mlot 1990, Packard and Mutel 1997). In our personal experience, the source of plant material for these projects has most often been locally collected seed from nearby remnants and bulk seed purchases through specialized growers and native plant nurseries.

In contrast to prairie restoration work, conservation professionals indicated that they used fewer forest herbaceous species and began using these species comparatively recently. There are fewer long-term forest restoration studies for the herbaceous layer (but see Metzger and Schultz 1984, McLachlan and Bazely 2001, Mottl et al. 2006). Forest restoration studies and protocols also tend to focus on restoring canopy species rather than the herbaceous layer (e.g., Thompson 1992). As a result, there are fewer manuals, protocols, and less institutional memory and expertise to guide herbaceous layer restoration practitioners (Packard and Mutel 1997, Brudvig et al. 2011).

Additionally, many conservative forest herbaceous perennials that would be the target of restoration are difficult to cultivate from seed due to rapid seed deterioration and very slow growth to maturity (Bierzyduchek 1982, Cullina 2000, Mottl et al. 2006, Mabry, unpublished data). As a result, they require different restoration techniques, such as planting seedlings instead of seed (Primack 1996, Ruhren and Handel 2003, Mottl et al. 2006). This may be an opportunity for conservation professionals to work directly with nurseries to request native and local ecotype forest herbaceous species, and to develop protocols for using plugs or other transplant stock types (e.g., bareroot plant materials) in forest restoration projects.

Requests for Local Ecotypes and Source-Certified Plant Material

The mismatch between conservation professional use and nursery availability of some forms of plant material indicates that it may be difficult for restorationists to locate suitable stock for their projects. Very few nursery professionals reported selling plants grown from source-certified seed, which limits restoration efforts by professionals who may seek local ecotype plant material in commercial nurseries. Nursery professionals indicated that they would be willing to supply source-certified or local ecotype plant material if customers requested it or if it has the potential to be financially valuable, which is consistent with other reports (Herman et al. 2014). However, nursery professionals did not necessarily agree that their customers (to date) had requested local ecotype or source-certified plant material. Conservation professionals who wish to purchase native plants from local nurseries may need to work directly with nurseries to request that they grow and provide the desired plant material.

Knowledge and Perceptions of Native Plant Communities and Local Ecotypes

Conservation professionals reported stronger agreement with statements about ecological value of native plant communities and their management than did nursery professionals, which likely contributed to their stronger preferences for local seed sources. Despite this group's preference for use of local ecotype plant material, particularly in or near high quality remnant plant communities, only about a quarter of respondents indicated that they or their organization had specific guidelines for obtaining local ecotype plant material. The relatively small number of conservation organizations and professionals with specific plant acquisition guidelines suggests that personal opinions or convictions may not necessarily translate into guidelines for use of local ecotypes in restoration projects.

Conservation organizations may hesitate to set specific plant material guidelines because there is substantial debate on the scale at which genetic differentiation between populations occurs, and therefore lack of agreement as to what constitutes a local source (McKay et al. 2005). Some studies have suggested that appropriate collection zones for plant species could be based on plant traits related to gene flow, particularly whether they are wind- versus insect-pollinated or outcrossing versus self-compatible (Falk 2011). The latter two attributes are predicted to be associated with lower gene flow and therefore genetically distinct populations across smaller scales (Loveless and Hamrick 1984). Data we have collected indicates that the ability to self-pollinate may be a good predictor, but that outcrossed species were highly variable (Gerken Golay 2013, Mabry, in review). Other work also suggests that plant traits alone may not be a consistent predictor of population-level genetic variation and therefore collection zone (Loveless and Hamrick 1984, Kramer et al. 2015). Non-adaptive genetic variation, including founder effects, genetic drift, and phenotypic plasticity also contribute to uncertainty regarding collection zones and may make firm guidelines difficult to set (Kawecki and Ebert 2004). Because the scale of genetic differentiation between populations (and therefore collection zones) is still the subject of active inquiry, some restoration professionals have developed protocols that could be of broader use to conservation organizations (e.g., Millar and Libby 1989, McKay et al. 2005). However, the abundance of scientific information on the subject, some of it conflicting, may affect organizations' willingness or ability to create firm guidelines for seed sources.

Information Sources

Respondents from both stakeholder groups indicated that professional training and trusted authorities were their primary sources of information about local ecotypes. Restoration scientists, extension professionals, and members of organizations interested in facilitating restoration

projects could offer workshops that engage both groups to encourage discussion and collaboration. This technique has been effective in increasing knowledge of restoration concepts, promoting communication between groups, and encouraging participants to engage in new behaviors (e.g., Gerken Golay et al. 2014).

Such workshops could provide a venue to share ideas about native plant propagation and local ecotype availability and encourage collaboration between groups to ensure consistent demand for and availability of more native plant species. For example, Herman et al. (2014) organized the *Plant Material Sources for Ecological Restoration Conference*, which included restoration practitioners, researchers, and nursery professionals. Individuals from each group had the opportunity to present their work and perspectives on sourcing plant material for restoration projects. Similar workshops could be designed and implemented to build rapport among conservation and nursery professionals leading to collaboration supporting production and use of a broader range of plant materials appropriate for ecological restoration efforts.

Such collaboration between growers and restoration practitioners has already been used successfully in Iowa by the Integrated Roadside Vegetation Management program, which is a collaborative program supported by the Iowa Department of Transportation, the University of Northern Iowa, Natural Resource Conservation Service centers in Iowa and Missouri, and private nursery growers (Houseal and Smith 2000). The program provides affordable local ecotype, source-certified seed to establish native prairie species on state and county roadsides. Source-identified seed is collected and grown in seed increase plots, and eventually seed is sold commercially by licensed nursery growers. One of the advantages of this program is that the seed can be used on Department of Transportation lands, which ensures consistent demand for the

source-certified seed produced. If a similar program were developed for forest herbaceous species, the partnership could ensure that nursery growers have a consistent market.

Conclusions

Conservation practitioners and nursery professionals are key players in the restoration of native plant communities and could play a critical role in increasing the use of native species in restoration. Recent attention to forest understory restoration in particular provides new opportunities for collaboration among stakeholders for identification of best practices in sourcing plant materials, their cultivation, and their use in restoration projects.

Supporting ongoing dialogue between these groups could ensure steady availability of a greater variety of native plant materials for restoration practitioners, and create enough demand for nursery professionals to profitably grow them and make them more widely available. Examples of collaboration between growers and users of prairie plant propagules suggest that similar arrangements could be key to more rapid development of practices and protocols to support the relatively nascent area of forest ecosystem restoration. This is particularly important with respect to the perennial herbaceous layer, and ultimately to recovery of critical ecosystem services these plants provide as a crucial component of intact forest ecosystems.

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Table 1. Percent of respondents indicating types of plants used, bought or sold by conservation professionals and nursery professionals. Means and standard deviations (in parentheses) are determined using a six-point rating scale (where 0% = 1, 1-9% = 2, etc.). Asterisks indicate significant differences between stakeholder group means at $p \leq 0.05$ using a two-sample t-test. CP = Conservation Professionals and NP = Nursery Professionals.

Survey question and group	Mean (SD)	df	t	*p*-value	0%	1-9%	10-24%	25-49%	50-74%	75-100%
Approximately what percentage of plant material for restoration/sales volume of plants fits the following categories?										
Plants grown from source-identified seed										
CP (n = 128)	3.6 (2.0)*	156	1.975	< 0.0001	22.7	14.1	9.4	13.3	11.7	28.9
NP (*n* = 30)	2.1 (1.6)				58.1	16.1	6.5	3.2	12.9	3.2
Seeds										
CP (*n* = 122)	4.1 (1.9)*	149	1.975	< 0.0001	17.2	9.8	8.2	12.3	12.3	40.2
NP (*n* = 29)	1.5 (0.7)				58.6	37.9	0.0	3.4	0.0	0.0
Plants										
CP (*n* = 121)	2.7 (1.7)*	148	1.975	0.0006	28.1	28.1	14.9	9.1	8.3	11.6
NP (*n* = 29)	4.0 (1.8)				13.8	13.8	10.3	10.3	27.6	24.1
Native plants										
CP (*n* = 134)	5.1 (1.6)*	163	1.975	< 0.0001	9.0	1.5	6.0	6.0	6.7	70.9
NP (*n* = 31)	2.7 (1.2)				9.4	46.9	21.9	12.5	6.3	3.1
Prairie plants										
CP (*n* = 131)	4.6 (1.7)*	160	1.975	< 0.0001	10.7	3.8	11.5	7.6	16.8	49.6
NP (*n* = 31)	2.2 (1.0)				15.6	62.5	15.6	3.1	0.0	3.1
Forest species (all)										
CP (*n* = 131)	3.7 (1.9)*	159	1.975	0.0002	16.8	16.8	13.7	10.7	16.8	25.2
NP (*n* = 30)	2.4 (1.2)				12.9	61.3	16.1	3.2	0.0	6.5
Forest herbaceous perennial species										
CP (*n* = 125)	2.5 (1.7)	154	1.975	0.6478	38.4	26.4	12.0	4.0	8.0	11.2
NP (*n* = 31)	2.4 (1.2)				18.8	53.1	12.5	6.3	9.4	0.0

Table 2. Percent of respondents indicating length of time conservation and nursery professionals have been buying or selling different plant groups. Means and standard deviations (in parentheses) are determined using a five-point rating scale (N/A = 1, 0-2 years = 2, etc.). Asterisks indicate significant differences between stakeholder group means at $p \leq 0.05$ using a two-sample t-test. CP = Conservation Professionals and NP = Nursery Professionals.

Survey question and group	Mean (SD)	df	t	*p*-value	N/A	0-2 years	3-5 years	6-10 years	➢ 10 years
How long you have been using/selling the following groups of species?									
Native plants									
CP (*n* = 134)	4.3 (1.1)*	164	1.975	< 0.0001	5.2	3.0	12.7	11.9	67.2
NP (*n* = 32)	2.1 (1.7)				65.6	6.3	3.1	0.0	25.0
Prairie plants									
CP (*n* = 131)	4.2 (1.2)*	161	1.975	< 0.0001	7.6	2.3	13.6	13.6	62.9
NP (*n* = 32)	1.9 (1.5)				71.9	3.1	3.1	9.4	12.5
Forest species (all)									
CP (*n* = 132)	3.9 (1.5)*	161	1.975	< 0.0001	13.6	9.1	8.3	9.8	59.1
NP (*n* = 31)	2.1 (1.6)				65.6	6.3	3.1	6.3	18.8
Forest herbaceous perennial species									
CP (*n* = 127)	3.0 (1.7)*	156	1.975	0.0056	31.5	15.7	11.0	5.5	36.2
NP (*n* = 31)	2.1 (1.6)				65.6	6.3	3.1	6.3	18.8
Plants grown from source-identified seed									
CP (*n* = 125)	3.5 (1.6)*	153	1.976	< 0.0001	19.8	11.1	13.5	11.9	43.7
NP (*n* = 30)	1.5 (1.2)				83.9	6.5	0.0	0.0	9.7

Table 3. Percent of respondents indicating requests for local ecotype and source-certified plant materials. Means and standard deviations (in parentheses) are determined using a five-point rating scale (1 = strongly disagree, 5 = strongly agree). Asterisks indicate significant differences between stakeholder group means at $p \leq 0.05$ using a two-sample t-test. CP = Conservation Professionals and NP = Nursery Professionals.

Survey question and group	Mean (SD)	df	t	*p*-value	Strongly disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I/my customers have requested local ecotype plant material.									
CP (*n* = 133)	4.2 (0.9)*	164	1.974	< 0.0001	0.8	4.9	13.8	43.1	37.4
NP (*n* = 33)	2.6 (1.1)				18.2	30.3	21.2	30.3	0.0
I/my customers have requested source-certified plant material.									
CP (*n* = 132)	3.6 (1.0)*	163	1.975	< 0.0001	1.7	21.6	33.6	28.4	14.7
NP (*n* =33)	2.4 (0.9)				18.2	36.4	36.4	9.1	0.0
I would be willing to pay more/would charge more for local ecotype/source-certified plant material.									
CP (local ecotype) (*n* = 132)	3.9 (0.9)*	294	1.968	0.0331	2.4	4.0	26.4	44.0	23.2
CP (source-certified) (*n* = 132)	3.6 (1.0)				1.7	14.9	34.7	34.7	14.0
NP (local ecotype/source-certified) (*n* = 33)	3.5 (0.9)				3.0	6.1	39.4	42.4	9.1

Table 4. Percent of respondents indicating knowledge of native plant communities, restoration, and local ecotypes. Means and standard deviations (in parentheses) are determined using a five-point rating scale (1 = strongly disagree, 5 = strongly agree). Asterisks indicate significant differences between stakeholder group means at $p \leq 0.05$ using a two-sample t-test. CP = Conservation Professionals and NP = Nursery Professionals.

Survey question and group	Mean (SD)	df	t	*p*-value	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly Agree
I am knowledgeable about local ecotypes.									
CP (*n* = 144)	4.2 (0.7)*	178	1.973	< 0.0001	0.0	2.1	12.3	53.4	32.2
NP (*n* = 36)	3.6 (0.8)				0.0	11.1	30.6	47.2	11.1
I am familiar with the ecological value of native plant communities.									
CP (*n* = 145)	4.5 (0.7)*	179	1.973	0.0473	0.7	0.7	3.4	40.8	54.4
NP (*n* = 36)	4.2 (0.6)				0.0	0.0	8.3	63.9	27.8
I am familiar with the functional value of native plant communities.									
CP (*n* = 145)	4.5 (0.7)	179	1.973	0.0812	0.7	1.4	2.7	42.9	52.4
NP (*n* = 36)	4.2 (0.5)				0.0	0.0	5.6	69.4	25.0
I stay up-to-date on changes in best management practices for native plant community restoration.									
CP (*n* = 145)	4.1 (0.8)*	179	1.973	0.0006	0.0	4.8	12.2	54.4	28.6
NP (*n* = 36)	3.6 (0.8)				0.0	8.3	38.9	41.7	11.1

Table 5. Percent of respondents reporting perceptions on use of local ecotype and source-certified plant material in practice. Means and standard deviations (in parentheses) are determined using a five-point rating scale (1 = strongly disagree, 5 = strongly agree). Asterisks indicate significant differences between stakeholder group means at $p \leq 0.05$ using a two-sample t-test. CP = Conservation Professionals and NP = Nursery Professionals.

Survey question and group	Mean (SD)	df	t	*p*-value	Strongly disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
3) I think that the source of plant material for restoration projects is not important.									
CP (*n* = 133)	2.1 (0.9)	163	1.975	0.0749	22.6	54.1	16.5	5.3	1.5
NP (*n* = 32)	2.4 (1.0)				18.8	43.8	15.6	21.9	0.0
4) I think it is appropriate to plant nonlocal-ecotype plant material in an urban garden.									
CP (*n* = 132)	3.0 (0.8)*	162	1.975	0.0005	3.0	21.2	50	23.5	2.3
NP (*n* = 32)	3.6 (0.7)				0.0	6.3	37.5	50.0	6.3
5) I believe that it is important to keep track of where plant material is originally collected.									
CP (*n* =133)	4.2 (0.8)*	164	1.974	0.0151	0.0	2.3	14.3	47.4	36.1
NP (*n* = 33)	3.8 (1.0)				3.0	6.1	24.2	42.4	24.2
2) It is important to restore native plant communities regardless of the plant material source.									
CP (*n* = 133)	3.3 (1.0)	163	1.975	0.5409	3.8	22.6	29.3	33.8	10.5
NP (*n* = 32)	3.4 (1.1)				9.4	12.5	15.6	56.3	6.3
1) I believe that native plant communities are a valuable natural resource.									
CP (*n* = 133)	4.7 (0.6)*	164	1.975	0.0029	0.0	0.8	2.3	27.1	69.9
NP (*n* = 33)	4.3 (0.5)				0.0	0.0	3.0	60.6	36.4
7) I believe restoration should use only local ecotype plant material in/near a high-quality remnant plant community.									
CP (*n* = 133)	4.2 (1.0)*	163	1.975	< 0.0001	0.8	5.3	18.8	26.3	48.9
NP (*n* = 32)	3.4 (0.8)				0.0	12.5	40.6	43.8	3.1
6) I believe that it is important to use local ecotype plant material whenever possible.									
CP (*n* = 133)	4.3 (0.7)*	163	1.975	0.0008	0.8	0.8	7.5	50.4	40.6
NP (*n* = 32)	3.8 (1.0)				0.0	12.5	21.9	40.6	25.0
8) I think that using non-local plant material would be detrimental to an existing plant community.									
CP (*n* = 133)	3.5 (0.9)*	163	1.975	0.0002	1.5	6.0	46.6	32.3	13.5
NP (*n* = 32)	2.8 (1.0)				6.3	31.3	40.6	15.6	6.3

Table 6. Sources of information on local ecotypes and source-certified plant material. Respondents were asked to check all that applied.

Survey question	Conservation professionals (%, *n* = 135)	Nursery professionals (%, *n* = 32)
What are your primary sources of information about local ecotypes?		
Trade journals	9.6	37.5
University extension office (Iowa State University Horticulture or Forestry Extension)	43.7	53.1
Scientific literature (Ecological Restoration, Restoration Ecology, Ecology, etc.)	39.3	18.8
Professional training (workshops, special training)	78.5	56.3
School coursework (general biology, forestry, botany, horticulture, restoration classes)	35.6	21.9
Trusted authority (supervisor, colleague, friend, etc.)	79.3	40.6
I am not familiar with this term	0.7	9.4
Other (please specify)	8.1	6.3