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Chapter 1: Introduction

Biological invasions are recognized as one of the leading sources of environmental degradation in North America. In particular, invasive plants compete with native and even rare species for resources (e.g., Huenneke and Thomson, 1994), alter ecosystem processes such as nutrient cycling and hydrologic conditions (Carman and Brotherson; 1982, Vitousek et al. 1987), and increase the frequency and intensity of disturbances such as fire (D'Antonio and Vitousek 1992, Mack and D'Antonio 1998). They have been found to be second only to habitat destruction and fragmentation in their ability to endanger rare species (Wilcove et al., 1998). Not only is the damage environmental, but also economic. A recent estimate put the economic cost of invasive plants in natural areas, agriculture, and gardens at \$35 billion per year (Pimentel et al., 2005).

Significant effort is made to control invasive species where they occur but there is increasing awareness that the most cost-effective and efficient way to address the invasive species problem is to prevent their introduction and spread (Wittenberg et al., 2001). To do this effectively, the pathways by which species enter the continent and by which they spread throughout the continent must be understood and mitigation efforts must take place.

Invasive plants may enter in several ways. Seeds or vegetative parts capable of reproduction may hitchhike on commodities or equipment that are imported from other countries. Some weedy and invasive species have come in shipments of crop

seed, including cheatgrass (*Bromus tectorum* L.) and spotted knapweed (*Centaurea biebersteinii* DC.) (Mack, 1986). Since early in the 20th century, the federal government has regulated the purity of seed and routinely inspects imported seeds for diseases, insects, and weed contamination. However, some contaminated seed inevitably arrives. In 1988, shipments of tall fescue grass seed (*Lolium arundinaceum* (Schreb.) S.J. Darbyshire) imported from Argentina and sold through retailers such as K-Mart and WalMart, were found to contain *Nassella trichotoma* Hackel ex Arech. (serrated tussock grass), a federally listed noxious weed (U.S. Congress, 1993). The United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) has added *Senecio inaequidens* D.C. and *Senecio madagascariensis* Poir. to the list of “terrestrial noxious weeds” as well as the “list of seeds with no tolerances applicable to their introduction” (2006). Wildflower seed mixes have been “identified as potential pathway” for both of these species by the European and Mediterranean Plant Protection Organization (USDA APHIS, 2006).

Plants are also introduced intentionally into the country for a variety of uses including food, fiber production, forage, erosion control, and landscape amenity use. Most of these plants are beneficial and cause no undue problems, but a small percentage escape cultivation and cause many of the problems mentioned above. A previous study indicated that 82% of woody plants that are invading natural areas in the United States were introduced for landscape horticulture use and an additional 3% were introduced for erosion control (Reichard, 1997). However, herbaceous species are more likely to be introduced accidentally by commodity contamination. Studies in

Australia have indicated that between 57% (Kloot, 1987) and 65% (Groves, 1998) of invasive plants in Australia were introduced intentionally for horticultural use and it is likely that the United States would be similar.

In recent years "wildflower" or "meadow" seed mixes have increased in popularity in the United States. Consumers are attracted to the concept of having an easy-to-grow and attractive array of natural looking flowers in their environment. In addition to wildflower seed mixes commercially available through nurseries and grocery stores, seed mixes are often used for marketing, such as gifts from businesses or non-governmental organizations. As sales and the number of available mixtures have increased, concern has also risen that some of the mixes may contain species that could escape cultivation and cause problems in natural areas.

In order for wildflower seed mixes to be successfully grown with minimal care, they usually contain self-seeding annuals, biennials and perennials (Klett et al., 2004). These species often have no specific germination requirements and can be used in a variety of soils. Many of them are non-native and may, therefore have no natural enemies in the places they being grown (Fetzer et al., 2006). These are traits that are also associated with invasive species (Baker 1986; Reichard 1997). In many cases, the seed packets of commercially available mixes do not indicate whether or not the plants included are native or non-native. In addition, a mix may be labeled as appropriate for a certain region and contain plants that are not native to that region. The consumer may assume that what they are planting is native. This misconception may be due to

an inadequate definition of wildflower. For example, the United States National Arboretum (2006) defines wildflower as, “an herbaceous plant that is native to a given area.” One might assume that the “given area” is where the wildflower seed mix is purchased. It can also be difficult to tell from the package what the mix actually contains. If the seed packet has a plant list on the label, it often only lists the genus or the common name. Without listing the species, the consumer may unknowingly spread invasive species.

McNeely et al. (2005) insist that “public engagement” is necessary for “successful” invasive species management. In recent years, “public awareness” about the problems associated with invasive plant species has increased due to “mainstream” media (D'Antonio et al., 2004). However in a survey conducted by Colton and Alpert (1998), to determine “public awareness of biological invasions by plants,” most respondents could name least one weed, such as those that grow in home landscapes, but few were able to name any “non-native plants that actually cause problems.”

Goals and Objectives

The primary goal of this study was to establish if commonly available commercial wildflower seed mixes contain plants that are invasive and/or noxious in North America. A secondary goal was to determine whether or not gardeners have complete information about the species that are contained in these mixes. The primary objectives were to 1) identify species included in wildflower seed mixes and determine if they were considered invasive 2) determine whether or not wildflower

seed packets provided adequate labeling 3) determine how gardeners define wildflowers 4) whether or not they would intentionally plant invasive plants.

To determine if wildflower seed mixes contain invasive and/or noxious weed species, I conducted a study of twenty-nine mixes over an 85-week period. Independent sources were used to determine if any of the species grown were considered to be invasive or noxious.

Adequate labeling should include alerting consumers that they might be planting species which might be aggressive as well as accurate lists of mix components. In addition, there might be a misconception that mixes for a particular region would only contain plants that are native to that region. Therefore, the labels of the regional mixes were studied to determine if they contained information about whether or not the species included were native to those regions. During the first weekend of May, 2006, I conducted a survey of people attending three plant-related events in order to ascertain gardeners whether or not gardeners thought wildflowers were native and if they would be willing to intentionally plant an invasive plant.

Definitions

For the purposes of this study, I define a "native plant" as "one that occurs naturally in a particular region, state, ecosystem, and habitat without direct or indirect human actions" (U.S. Department of Transportation, Federal Highway Administration definition). Because natural plant distribution is determined by abiotic factors such as

climate and precipitation I consider ecoregions such as those used by the United States Forest Service to indicate to which ecoregion a species is native (USDA Forest Service, 2006). I define "invasive" as "plants that have spread into native flora or managed systems, develop self-sustaining populations, and become dominant or disruptive to management and function of those systems." This is adapted from a definition developed by a working group of the American Landscape and Nursery Association in 1997. However, I have used previously published reports to establish which species are invasive and those authors may have used a different definition. One of those reports, from the Bureau of Land Management Colorado, "BLM National List of Invasive Weed Species of Concern," only includes those "exotic species that are highly invasive in natural systems" (2007). I define "wildflower" as "herbaceous flowering plants that were known to exist in a region or a state at the time of European settlement" (Federal Highway Administration, n.d.).

"Noxious" indicates that a state in the United States considers the species to be a pest species. Definitions of noxious may vary by state, but they generally indicate a species that is legally designated as undesirable and unwanted. For instance, the state of Washington defines a noxious plant as "a plant that when established, is highly destructive, competitive, or difficult to control by cultural or chemical practices" (Chapter 17.10 RCW). However, because noxious weed designations are often regulatory and concerned mostly with management of listed species, widespread invasive species are rarely listed. To list such species for mandatory control efforts would be unrealistic and prohibitively expensive. Thus, such harmful invasive plants

such as kudzu (*Pueraria montana* (Lour.) Merr. var. *lobata* (Willd.) Maesen & S. Almeida) and purple loosestrife (*Lythrum salicaria* L.) are not on the federal noxious weed list, although they are on lists of noxious species in some states. Lack of listing as a "noxious weed" should not be understood as an indication of lack of harm.

Chapter 2: Materials and Methods

Seed Mixes

I planted the contents of 28 different wildflower seed mixes on September 6, 2005. An additional mix was planted on January 16, 2006. The mixes were from sixteen different vendors. In order to get a reasonable representation of what types of wildflower mixes are available to consumers throughout the country, I purchased seventeen mixes through the Internet (Table 1). One of these mixes, Mix 17, was actually a wrapping paper that contained wildflower seed. Two additional mixes were sent as gifts from two of the seed vendors. Eight of the mixes were purchased locally in Seattle, WA. One of these mixes, Mix 20, had seed embedded in organic material that could be rolled out for application. Two other mixes, Mixes 18 and 19, were mixed with an inert material and contained 23% and 18% of wildflower seed respectively. In addition, two mixes that were planted were not purchased. They were both cards impregnated with wildflower seed. One of them was a promotional postcard and the other was a holiday greeting card. There is no information regarding the source of seeds in the promotional postcard, however they were given out by a local Seattle company promoting their neighborhood parks program, so this mix was considered as a local mix.

Using a soil mix consisting of 50% peat and 50% vermiculite, seeds were sown into flats 10.5” by 10.5” and 2.5 inches deep. Depending on the size of the packet 1 to 2 flats were planted per mix in order to get a substantial representation of the species

contained in the packages. The seed packets were agitated prior to sowing to ensure an even distribution of the seeds. Seeds were broadcast in each flat to simulate garden application. Per the instructions, the wildflower roll was planted intact in two flats. As no directions were included in the wrapping paper shipment, it was also planted intact. Both of the cards were cut into small pieces and spread out over one flat each. The flats were then placed in a greenhouse with blank control flats interspersed to determine ambient seed bank. The control flats received the same care as the planted flats. In addition to any natural light, the artificial environment included a photoperiod of twelve hours per day, with daytime temperatures of 72° to 78° F and nighttime temperatures of 65° to 68° F.

Germination began within three days for most mixes. After germination, the seedlings were then monitored for flowers. Once flowers appeared, dichotomous keys were used to identify the seedlings (Bailey, 1949; Jepson and Jepson, 1993; Polunin and Smythies, 1973; Clapham, Tutin, and Warburg, 1962). As plants were identified they were removed from the flats and counted. No plants were allowed to form fruit. In addition, the blank flats were monitored for weed species. Voucher specimens for most of the species identified were placed in the Hyde Horticultural Herbarium at the Center for Urban Horticulture.

Beginning at 8 weeks, fertilization was done with a general-purpose fertilizer (15-16-17) to increase flowering of the plants. There were two fertilizations during a 2 week period. No further fertilization took place until week 40, with treatments occurring

weekly for the next 4 weeks. The seedlings were treated for aphid with insecticidal soap at week 15. Subsequent treatments of insecticidal soap occurred during weeks 21 and 25. In addition, 1600 X-clude,© a pyrethrum insecticide, was applied during week 24. Data were collected through week 85, and plants that were not identified by week 85 were discarded.

Using a number of independent print and on-line sources, each of the identified plants were checked for invasive and noxious status (Table 2). Species were recorded as being present or absent on the independent lists, with no ranking of the actual or potential impact of the species in natural areas. In order to assess each mix with the source that indicated a species was invasive, it is assumed that those mixes purchased in Seattle are meant to be grown in the Pacific Northwest. In addition, unless a mix was labeled as a regional mix, it is assumed that the mix would be suitable to plant anywhere within the Continental United States.

Labels

Labels and lists were checked to determine if they included those plants that were identified. In addition, labels of regional mixes were studied to determine if there was any indication of whether or not the mix contained native plant species. Once identified, nativity was determined for plants found in those mixes that were labeled as regional mixes (USDA, ARS, National Genetic Resources Program [GRIN], 2007).

Survey

The survey and consent form were reviewed and approved through the Human Subjects Division (HSD) at University of Washington (Approval Number 06-1208-X/C, Appendices A and B). The survey, which included 100 respondents, was administered during the first weekend in May, 2006. The sampling technique I chose to use was purposive sampling, also known as judgmental sampling, a type of nonprobability sampling (Babbie, 2005). Guarte and Barrios (2006) define purposive sampling as, “a random selection of sampling units within the segment of the population with the most information on the characteristic of interest.” Participants are “chosen according to some common criteria” (Guest, Bunce, and Johnson, 2006). This is the technique that Colton and Alpert (1998) used to determine if “biological invasions by plants” was common knowledge. They surveyed respondents likely to be “sympathetic to environmental concerns” due to their repeated visits to University of California Bodega Marine Laboratory. Similarly, I chose to survey attendees of three plant-related events because they were likely to be gardeners and might have an interest in wildflowers. The events included two annual plant sales, one being the King County Master Gardener Sale and the other being the Seattle Tilth Plant Sale. I chose the Seattle Tilth sale because there was a strong possibility that the attendees would be concerned for the environment as the nonprofit organization promotes organic gardening. The third event was the annual “Celebrating Wildflowers” presented by the Washington Rare Plant Care and Conservation Program, University

of Washington Botanic Gardens. The survey included a series of six multiple choice questions (Appendix A).

Judgmental sampling enlists the technique of “handpicking” respondents (Lunsford and Lunsford, 1995). In the case of the Seattle Tilth Plant Sale, the first 40 people waiting in line before the sale and were willing to fill out a survey were chosen. This method proved unsuccessful at the Master Gardener Sale because there was no formal line, attendees came in from various locations. As an alternative, I approached people as they were shopping. Most likely, the weather was a factor in the number of responses I was able to obtain. It was cold enough to be uncomfortable when standing still, thus I was only able to obtain 29 responses. At the Celebrating Wildflowers event, I approached those attendees that did not have small children to attend to, assuming they would have more time to complete the survey. In this case, I was able to obtain 31 responses.

Table 1. Internet purchased seed mixes.

State	Mix Number(s)
Arkansas	25
California	17
Colorado	29
Maine	7
Minnesota	24
New Jersey	5,6
North Carolina	21, 22, 23
Oregon	8, 9, 10
Texas	26,27
Vermont	11, 12

Chapter 3: Results

Plant Identification

Seventy-five species were identified to genus and species. An additional dicotyledonous species was identified only to family as there were no flowers present throughout the experiment. In addition, there were three types of unidentified grasses included in two of the mixes. No grasses were indicated on the lists for these mixes. Not all plant material was identified, because the experiment was terminated after 85 weeks and the remaining plants had not flowered. It is also likely that not all plants had germinated by this time.

At week 12, one specimen of *Epilobium ciliatum* Raf. was identified in one of the blank control flats. In weeks 15 and 17, one specimen each of *Pseudognaphalium stramineum* (Kunth) A. Anderb. was identified in another control flat located on the second bench. In addition, at week 75, two specimens of *Salix* L. were found in another control flat on the same bench. All of these flats were located near a side vent of the greenhouse.

Invasive Status

All of the wildflower mixes contained at least one species considered by the outside sources to be invasive. Three of the species, *Echium plantagineum* L., *Centaurea cyanus* L., and *Vaccaria hispanica* (Mill.) Rauschert, are considered noxious by a state or provincial agency in North America. *C. cyanus* was found in 21 mixes while the

other two were found in only one mix each. Of the 75 species identified, 16 were listed as invasive in at least one of the sources. Table 3 lists the invasive and noxious weed species contained in each mix. Table 4 includes the remaining species identified, including the unidentified grasses and the dicotyledonous plant identified as a member of the *Caryophyllaceae*. Because not all of the seeds germinated, the percentages in the tables represent the percentage of identified germinated species only.

Several of the mixes contained not only species that are considered to be invasive, but some that are considered to be noxious in at least one state or Canadian province (Table 2). For instance, *Echium plantagineum* L., Patterson's curse, was found in Mix 5, a "Mediterranean Mixture," and is listed as noxious in Oregon. This species is listed as an "A" Designated Weed as well as a species target for control (Oregon Department of Agriculture [ODA], 2007). This species is also on the Noxious Weed Quarantine List (ODA, 2007). According to Jed Colquhoun (2005), of Oregon State University Extension Service, *E. plantagineum* was found in a location that had previously been planted with a wildflower seed mix. In addition, the Oregon Invasive Species Council (OISC) has listed *E. plantagineum* as one of the "100 Most Dangerous Invaders" (2007). *E. plantagineum* contains alkaloids and could "cause chronic liver damage and death to horses and cattle if ingested" (ODA, 2006). There is no indication in the vendor's catalog or on their website that this mix should not be sold or used in Oregon.

The most common species classified as invasive was *Centaurea cyanus* L. (bachelor button), appearing in 21 of the 29 mixes (Table 3). All but one of the mixes that had a plant list included *C. cyanus* (Table 5). This European species invades native grasslands and prairies, as well as roadsides, in many places. It is listed as invasive in five of the forty-two sources checked. The State of North Carolina requires a limit of 27 seeds per pound of *C. cyanus* per the Noxious Weed Seed Law (USDA, ARS, National Genetic Resources Program, 2006). Of the 12 non-regional mixes purchased on the Internet (nine companies), only two of the companies indicated that *C. cyanus* was prohibited in North Carolina. Other species commonly included were *Papaver rhoeas* L., native to Europe and Asia (13 mixes), *Lobularia maritima* (L.) Desv., native to southern Europe (eleven mixes), *Iberis umbellata* L., native to Europe and Asia (8 mixes), and *Achillea millefolium* L., native in North America as well as Asia, Europe, and South America (7 mixes).

Mix 1, “Wildflowers for the Pacific Northwest,” included four species considered invasive by the independent sources, although *Centaurea cyanus* is the only one specifically listed as invasive in the Pacific Northwest (USDA Forest Service Pacific Northwest [PNW] Region 2005). *C. cyanus* is one of the invasive plants found on “National Forest Lands in the Pacific Northwest Region” (USDA Forest Service PNW Region, 2005). The mix contained 8.9 percent of this species. Mix 2, “Hummingbird & Butterfly Flower Garden Mixture,” was purchased in Seattle and contained 3 percent of *C. cyanus*. *Oenothera glazioviana* Micheli was also included in the mix, although it was not listed on the package and it only comprised 1.0 % of the mix. *O.*

glazioviana is considered a problem on the North Coast of California because it “readily hybridizes” with two of the native evening primroses, *O. elata* Kunth and *O. wolfii* (Munz) Raven, W. Dietr. & Stubbe (North Coast Chapter of the California Native Plant Society 2001). Oregon Department of Agriculture (ODA) Plant Division (n.d) lists *O. wolfii* as threatened and the California Native Plant Society (CNPS) lists it as, “rare, threatened, or endangered in California and elsewhere” (2007). *O. glazioviana* was found in four additional mixes, of which three listed the species as part of their mix. In addition, Mix 2 included 2.0 percent of *Digitalis purpurea* L., also found on National Forest Lands in the Pacific Northwest (USDA Forest Service PNW Region, 2005).

Digitalis purpurea, a native of Africa and Europe, was also found in Mix 9, a “Shady Blend,” purchased online. *D. purpurea* has been found to be invasive by eleven of the 44 sources. In Sequoia Kings Canyon National Park, this species is “actively invading” riparian and meadow systems (National Park Service [NPS], 2007). In addition, the neighboring community of Wilsonia, CA, provides a “continual source of propagules,” making management of this species difficult (NPS, 2007).

Mix 3, “Scattergarden Wildflower Collection,” was purchased in Seattle and *Centaurea cyanus* comprised 16.4 percent of the mix. Mix 4, “California Mix,” was purchased there as well and included *Centaurea cyanus*. However it only comprised 1.4 percent of the mix and was not listed as part of the mix so it may be an accidental inclusion. Intentionally included in this mix was *Lobularia maritima*, which

constituted 20.7 percent of the mix. The species is listed invasive by three of the forty-four sources. One of these sources is from the East Coast and the other two are California sources. According to the California Invasive Plant Council *L. maritima* has a limited impact, is considered moderately invasive and has moderate distribution (2007). The habitats *L. maritima* invades are “coastal dune, coastal scrub, coastal prairie, and riparian” (Cal-IPC, 2007). The San Diego County Invasive Ornamental Plant Guide (2000) considers *L. maritima* as moderately invasive, “having the potential to spread when planted next to open space or natural areas.”

Mix 6, a “North American Mixture” included two invasive plants, *Lobularia maritima* and *Iberis umbellata* at 21.1 and 9 percent respectively. *Iberis umbellata* is an invasive species found “in or near Custer National Forest” in the Park, MT area (USDA Forest Service Custer National Forest, 2006).

Mix 15, the promotional postcard from a local company only had two species that germinated. *Achillea millefolium* comprised 97.3 percent of the mix. Although *A. millefolium* is considered a North American native plant, it has circumboreal distribution and it can be difficult to distinguish from the European genotypes (USDA Forest Service, 2007). In addition, native and introduced phenotypes hybridize (USDA Forest Service, 2007). *A. millefolium* was listed as invasive by three of the sources. In the Pacific Northwest, *A. millefolium* is listed as invasive because it is found in the Oregon Islands National Wildlife Refuge and since it is “considered a botanical reserve,” all species that are not native to Oregon Islands are considered to

be invasive (Tempel et al., 2004). *A. millefolium* was also found in six other mixes, four of which are non-regional mixes purchased online so it is assumed they could be used anywhere. The two remaining mixes were purchased in Seattle and only one of them listed the species as a component of the mix. Colorado State University Extension recommends avoiding mixes containing *A. millefolium* because it has a “high potential for invasiveness” (Klett et al., 2004). In addition, the New Jersey Native Plant Society classifies this plant as a “Category 1, strongly invasive and widespread” (Ling, 2003). *A. millefolium* is listed in the same category as garlic mustard, *Alliaria petiolata* (Bieb.) Cavara and Grande (Ling, 2003) and is considered a serious pest. This latter species infests woodlands throughout North America.

Mix 18, “Bird and Butterfly Wildflower Mix,” was purchased in Seattle and contained five species listed as invasive by the independent sources, although only *Centaurea cyanus* was listed as invasive in the Pacific Northwest. This species was listed on the container label and comprised 21.3 percent of the mix. In addition, Mix 11, “Proven Western Mix,” included 8 percent of *Centaurea cyanus*. Mix 19, “Cottage Garden Wildflower Blend,” was also purchased in Seattle and contained 8.5 percent *C. cyanus*.

Mix 8, an “Annual Cut Flower Blend” contained one specimen of *Hypochaeris radicata* L, listed as a Class B noxious weed in Washington State (2007). Since there was only one plant and it is a perennial plant, it is assumed that *H. radicata* was accidentally introduced into the mix. However, the more minor invasive species

Iberis umbellata was also found in the mix at the higher rate of 4.8% and was also not listed as part of the mix.

Mix 29, an “Aggressive Amendment,” had a complete plant list which included four invasive species. The mix included *Centaurea cyanus* and *Lotus corniculatus* L. each at 10.1 percent of the mix. *Lotus corniculatus* L. is a native to Asia, Africa, and Europe and is considered invasive by nineteen of the forty-four independent sources. *L. corniculatus* “forms dense mats” outcompeting native vegetation for space and light (Minnesota DNR, 2007). In addition, *L. corniculatus* benefits from prescribed burns in native prairies as fire increases seed germination (Minnesota DNR, 2007). *L. corniculatus* is difficult to manage in prairies because mechanical and chemical controls can negatively affect native species as well (Minnesota DNR, 2007). Also included in the mix was *Achillea millefolium* (4.1%) and *Glebionis coronaria* (L.) Cass. ex Spach (3.2%). *Glebionis coronaria*, synonym of *Chrysanthemum coronarium* L., is a native of Africa, Asia, and Europe. Two of the 44 sources consider the species to be invasive. California Invasive Plant Council (2007), reports that *G. coronaria* “forms dense stands that can outcompete native species in riparian and sand areas.” In addition, this species is considered as one of several species that may contribute to the “decline” of the endangered plant, *Monardella linoides* Gray ssp. *viminea* (Greene) Abrams (Cal-IPC, 2007).

Dimorphotheca sinuata D.C. was intentionally included in four mixes. *D. sinuata* is listed as “most invasive” by the San Diego Chapter of the American Society of

Landscape Architects (ASLA) it “may establish even from distant plantings to displace natives and disrupt habitats” (2000). In addition, there is a history of this species in Saguaro National Park in Arizona (NPS, 2004), although it has since been eradicated.

It should be noted that both *Cosmos bipinnatus* Cav., native to the American Southwest and Mexico (11 mixes), and *Cosmos sulphureus* Cav. (8 mixes), native to Mexico, have been listed on the Tennessee Exotic Pest Plant Council (TNEPPC) “Watch List A,” which includes plants that “naturalize and may become a problem in the future” (2004). One of the mixes containing *C. bipinnatus* is a Western regional mix and three of the mixes were purchased in Seattle and of the eight mixes containing *C. sulphureus*, one was purchased there and one is a Western regional mix. It is assumed that the other mixes containing these species could be planted anywhere in the Continental United States.

Labeling

Listing of Identified Plants

Of the 29 mixes tested, 20 included plant lists either on the seed packet or in the shipping package. Of the nine remaining mixes, plant lists for four of the mixes were located on the Internet. In addition, after being contacted, one of the companies selling three of the other mixes, sent a list of the contents of their mixes. Of the remaining two mixes with no list, one of the mixes was included as a gift from the

seed company where other seed mixes had been purchased (Mix 13). The other mix with no list was the promotional postcard (Mix 15).

Fourteen of the mixes that had lists associated with them had all of the plants that were identified to genus and species. An additional mix, Mix 14, a “Northwest Wildflower Mix” had an extensive plant list on the vendor’s website, including full scientific names. However, *Epilobium ciliatum* was not listed as part of the mix. Since it comprised only 1.6% percent of the mix and it was found in a control flat on the same greenhouse bench, it is assumed that *E. ciliatum* was not included in the mix.

Mixes 11 and 20 listed all of those plants identified to genus and species, however they did contain the unidentified grasses. Neither mix listed any type of grass as components. It is possible that the grasses were contaminants in the seed mixes, but they comprised 34.2 and 90.5 percent of those mixes respectively. Table 5 lists the remaining mixes that had incomplete lists.

Nativity of Regional Mixes

Six of the seed mixes were labeled as regional mixes. All of these mixes contained plants that were not native to the area indicated on the label. In four of these mixes, the nonnative plants were listed as part of the mix.

Of the eight species identified in Mix 6, “North American Mixture,” six are native to North American and two, *Lobularia maritima* and *Iberis umbellata* L., are native to Europe (Table 6).

Of the identified species in Mix 1, “Wildflowers for the Pacific Northwest,” six of the seventeen species are native to North America, however only two of those species, *Nemophila menziesii* Hook and Arn. and *Clarkia amoena* (Lehm.) A. Nels. & J.F. Macbr. are native to the Pacific Northwest (Table 7). Of the thirteen identified species in Mix 14, “Northwest Wildflower Mix,” ten are native to North America, but only five of those species are native to the Northwest. These include *N. menziesii*, *Gilia capitata* Sims, *Rudbeckia hirta* L., *Eschscholzia californica* Cham., and *Clarkia amoena* (Table 8).

Of the nine identified species in Mix 4, “California Mix,” four are native to North America and California (Table 9). These include *Eschscholzia californica*, *Clarkia amoena*, *Clarkia unguiculata* Lindl., and *Achillea millefolium* L. According to the website description of Mix 11, “Proven Western Mix,” is suited for use in Colorado, Utah, Montana, Idaho, Wyoming, Nevada, North Dakota, South Dakota, Eastern North America and although those species are native to the western portion of North America, only two of those species, *Rudbeckia hirta* L. and *Coreopsis tinctoria* Nutt., are native to the areas specified by the vendor (Table 10).

Finally, Mix 26, “Northeastern Wildflower Mix,” had four of ten identified species that are native to North America. Three of those species, *Rudbeckia hirta*, *Coreopsis tinctoria*, and *Lupinus perennis* L., are native to the Northeast (Table 11).

Survey

There were 100 respondents to the survey. Although it was not designed to be a multiple response survey, many respondents checked more than one item in the first three questions (Tables 12-14, Appendix A). In order to address the research questions of how gardeners define the word “wildflower” and whether or not they would intentionally plant invasive species, the analysis of the survey includes the first, second and sixth questions (Appendix A). In addition, the responses were clustered. As for the question of the definition of wildflower, the responses were clustered as “native” or not. Eighty-five percent of the respondents indicated native as their definition and 15 percent did not (Figure 1).

Question 2 asked why they would choose to plant wildflowers. The choices, “native” and “attract wildlife and/or butterflies” imply that the gardeners are concerned about the environment. The other responses included “inexpensive” and “easy to plant” seem to imply that the respondent is pragmatic. In the “other” category, there were both environmental answers and pragmatic answers, so those were grouped accordingly. The respondents were then clustered as “concerned for the environment,” “pragmatic,” or “both.” Fifty-eight percent of those surveyed were considered as “concerned for the environment,” 17 percent were considered “pragmatic,” and 25 percent were considered “both” (Figure 2).

Question 6, asked whether or not they would plant an attractive, ornamental plant if they knew it was invasive. The choices were yes and no, however some respondents

said they would only plant it if they could contain it in some way. Ninety-five percent of respondents would not choose to plant an invasive, while 3 percent would plant an invasive, 2 percent would only do so if they could contain it (Figure 3).

Summary

Seventy-five plants were identified to genus and species. An additional plant was identified only to family, that being *Caryophyllaceae*. In addition, three types of grasses were found, but were not identified to genus and species due the lack of flowers present.

Sixteen of the seventy-five plants identified to genus and species were found to be listed as invasive by at least one of the independent sources (Table 2). In addition, all 29 of the mixes contained at least one invasive plant as identified by the independent sources (Table 3).

Labels and lists were located for twenty-seven mixes. Of those, only 14 had all of those plants identified to genus and species. Two additional mixes had no lists associated with them.

Six of the mixes were labeled as regional mixes. Nativity was verified for each of the identified plants in these mixes. All of the mixes contained plants that were not native to the area indicated on the label.

A survey of probable gardeners attending plant-related events was done to determine if they defined wildflowers as native and why they would choose to plant wildflowers.

In addition, they were surveyed to determine if they would intentionally plant an invasive plant. Eighty-five percent of those surveyed associated considered wildflowers to be native. Of those surveyed, fifty-eight percent of the responses were categorized as being “concerned for the environment.” Seventeen percent of the respondents were considered “pragmatic,” while the remaining twenty-five percent fell into both categories.

Finally, when asked if they would plant an attractive, ornamental plant even if they knew it was invasive, ninety-five percent said they would not. Three percent indicated they would without qualification, and the remaining 2 percent would do so only if they could contain it.

Table 2. Invasive and noxious weeds found in seed mixes. The numbers following the plant names correspond with the independent print and online sources

<i>Family Name</i>	<i>Scientific Name</i>	Common Name	Noxious Listing	Invasive	Native to NA
<i>Asteraceae</i>	<i>Dimorphotheca sinuata</i> ^{18,35}	Cape Marigold	No	Yes	No
<i>Asteraceae</i>	<i>Centaurea cyanus</i> ^{7, 10,16,19,44}	Bachelor buttons	Yes	Yes	No
<i>Asteraceae</i>	<i>Hypochaeris radicata</i> ³⁹	Cat's ear	No	Yes	No
<i>Asteraceae</i>	<i>Achillea millefolium</i> ^{15,26,40,41}	Yarrow	No	Yes	Yes
<i>Asteraceae</i>	<i>Glebionis coronaria</i> ^{12,13}	Garland chrysanthemum	No	Yes	No
<i>Boraginaceae</i>	<i>Echium plantagineum</i> ^{1,22}	Patterson's Curse	Yes	Yes	No
<i>Brassicaceae</i>	<i>Lobularia maritima</i> ^{8,12,18}	Sweet Alyssum	No	Yes	No
<i>Brassicaceae</i>	<i>Iberis umbellata</i> ¹⁴	Candytuft	No	Yes	No
<i>Caryophyllaceae</i>	<i>Vaccaria hispanica</i> ^{8,36,37,38}	Cow Cockle	Yes	Yes	No
<i>Dipsacaceae</i>	<i>Scabiosa atropurpurea</i> ^{10,21}	Mourningbride	No	Yes	No
<i>Fabaceae</i>	<i>Lotus corniculatus</i> ^{2,3,4,5,6,9,10,11,14,16,17,18,24,27,28,29,32,33,42,43,44}	Birdsfoot trefoil	No	Yes	No
<i>Malvaceae</i>	<i>Malva sylvestris</i> ¹⁴	High Mallow	No	Yes	No
<i>Onagraceae</i>	<i>Oenothera glazioviana</i> ^{10,34,43}	Red-sepal evening primrose	No	Yes	No
<i>Papaveraceae</i>	<i>Papaver rhoeas</i> ¹⁴	Corn Poppy	No	Yes	No
<i>Scrophulariaceae</i>	<i>Digitalis purpurea</i> ^{10,12,16,19,20,23,25,30,42,44}	Foxglove	No	Yes	No
<i>Nyctaginaceae</i>	<i>Mirabilis jalapa</i> ¹⁸	Marvel of Peru	No	Yes	No

¹ Oregon. Oregon State Weed Board. 2007 Noxious Weed Policy and Classification System. 6, 9. ODA Plant Division, Noxious Weed Control. Feb. 2007. 23 Aug. 2007 http://www.oregon.gov/ODA/PLANT/WEEDS/oswb_index.shtml.

² NatureServe Explorer. 2007. Natureserve. 22 Aug. 2007 <http://www.natureserve.org/explorer/index.htm>

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Table 2 continued

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Table 5. Mixes with incomplete lists

Scientific Name	1	2	3	4	5	8	9	10	12	16	17	18	27
<i>Achillea millefolium</i>		4.1											
<i>Ammi majus</i>											8.7		
<i>Calendula officinalis</i>						8.6						0.4	0.2
<i>Centaurea cyanus</i>				1.4									
<i>Clarkia amoena</i>											1.7		
<i>Clarkia unguiculata</i>		3.0						0.2					
<i>Collinsia heterophylla</i>								0.3					
<i>Cosmos bipinnatus</i>		0.3											
<i>Cosmos sulphureus</i>			0.7										
<i>Epilobium ciliatum</i>													
<i>Gilia capitata</i>					1.1								
<i>Gilia tricolor</i>						0.9							
<i>Gypsophila elegans</i>							1.5						
<i>Hypochaeris radicata</i>						0.2							
<i>Iberis umbellata</i>						4.8							
<i>Leucanthemum maximum</i>													
<i>Lobularia maritima</i>		0.3											
<i>Nemophila menziesii</i>								1.5	1.0				
<i>Nicotiana glauca</i>	0.5	4.1											
<i>Oenothera glazioviana</i>		1.4											
<i>Oenothera speciosa</i>		9.8									43.5		
<i>Papaver rhoeas</i>							0.1						
<i>Phacelia campanularia</i>		1.1				4.1							
<i>Rudbeckia hirta</i>						8.9							
<i>Salvia coccinea</i>											0.8		
<i>Zinnia elegans</i>									1.0				

Table 6. Mix # 6 North American Mix

Scientific Name	Native to Region	Included in label
<i>Clarkia unguiculata</i>	Yes	Yes
<i>Eschscholzia californica</i>	Yes	Yes
<i>Gilia capitata</i>	Yes	Yes
<i>Iberis umbellata</i>	No	Yes
<i>Lobularia maritima</i>	No	Yes
<i>Nemophila maculata</i>	Yes	Yes
<i>Nemophila menziesii</i>	Yes	Yes
<i>Rudbeckia hirta</i>	Yes	Yes

Table 7. Mix #1 Wildflowers for the Pacific Northwest

Scientific Name	Native to Region	Included in label
<i>Centaurea cyanus</i>	No	Yes
<i>Clarkia amoena</i>	Yes	Yes
<i>Clarkia unguiculata</i>	No	Yes
<i>Collinsia heterophylla</i>	No	Yes
<i>Coreopsis tinctoria</i>	No	Yes
<i>Gypsophila elegans</i>	No	Yes
<i>Iberis umbellata</i>	No	Yes
<i>Leucanthemum maximum</i>	No	Yes
<i>Linaria maroccana</i>	No	Yes
<i>Linum perenne</i>	No	Yes
<i>Lobularia maritima</i>	No	Yes
<i>Nemophila menziesii</i>	Yes	Yes
<i>Nicotiana alata</i>	No	No
<i>Papaver rhoeas</i>	No	Yes
<i>Rudbeckia hirta</i>	No	Yes
<i>Silene armeria</i>	No	Yes

Table 8. Mix #14 Northwest Wildflower Mix

Scientific Name	Native to Region	Included in label
<i>Clarkia amoena</i>	Yes	Yes
<i>Clarkia unguiculata</i>	No	Yes
<i>Collinsia heterophylla</i>	No	Yes
<i>Epilobium ciliatum</i>	No	No
<i>Eschscholzia californica</i>	Yes	Yes
<i>Gilia capitata</i>	Yes	Yes
<i>Gilia tricolor</i>	No	Yes
<i>Layia platyglossa</i>	No	Yes
<i>Leucanthemum maximum</i>	No	Yes
<i>Lobularia maritima</i>	No	Yes
<i>Nemophila maculata</i>	No	Yes
<i>Nemophila menziesii</i>	Yes	Yes
<i>Papaver rhoeas</i>	No	Yes
<i>Rudbeckia hirta</i>	Yes	Yes

Table 9. Mix#4 California Mix

Scientific Name	Native to Region	Included in label
<i>Achillea millefolium</i>	Yes	Yes
<i>Centaurea cyanus</i>	No	No
<i>Clarkia amoena</i>	Yes	Yes
<i>Clarkia unguiculata</i>	Yes	Yes
<i>Eschscholzia californica</i>	Yes	Yes
<i>Gypsophila elegans</i>	No	Yes
<i>Leucanthemum maximum</i>	No	Yes
<i>Lobularia maritima</i>	No	Yes
<i>Silene armeria</i>	No	Yes

Table 10. Mix #11 Proven Western Mix

Scientific Name	Native to Region	Included in label
<i>Centaurea cyanus</i>	No	Yes
<i>Clarkia unguiculata</i>	No	Yes
<i>Coreopsis tinctoria</i>	Yes	Yes
<i>Cosmos bipinnatus</i>	No	Yes
<i>Cosmos sulphureus</i>	No	Yes
<i>Dimorphotheca sinuata</i>	No	Yes
<i>Glebionis coronaria</i>	No	Yes
<i>Gypsophila elegans</i>	No	Yes
<i>Layia platyglossa</i>	No	Yes
<i>Leucanthemum maximum</i>	No	Yes
<i>Phacelia campanularia</i>	No	Yes
<i>Poaceae spp.</i>	No	No
<i>Rudbeckia hirta</i>	Yes	Yes

Table 11. Mix #26 Northeastern Wildflower Mix

Scientific Name	Native to Region	Included in label
<i>Centaurea cyanus</i>	No	Yes
<i>Consolida ajacis</i>	No	Yes
<i>Coreopsis tinctoria</i>	Yes	Yes
<i>Gaillardia pulchella</i>	No	Yes
<i>Gypsophila muralis</i>	No	Yes
<i>Leucanthemum maximum</i>	No	Yes
<i>Lupinus perennis</i>	Yes	Yes
<i>Oenothera glazioviana</i>	No	Yes
<i>Papaver rhoeas</i>	No	Yes
<i>Rudbeckia hirta</i>	Yes	Yes

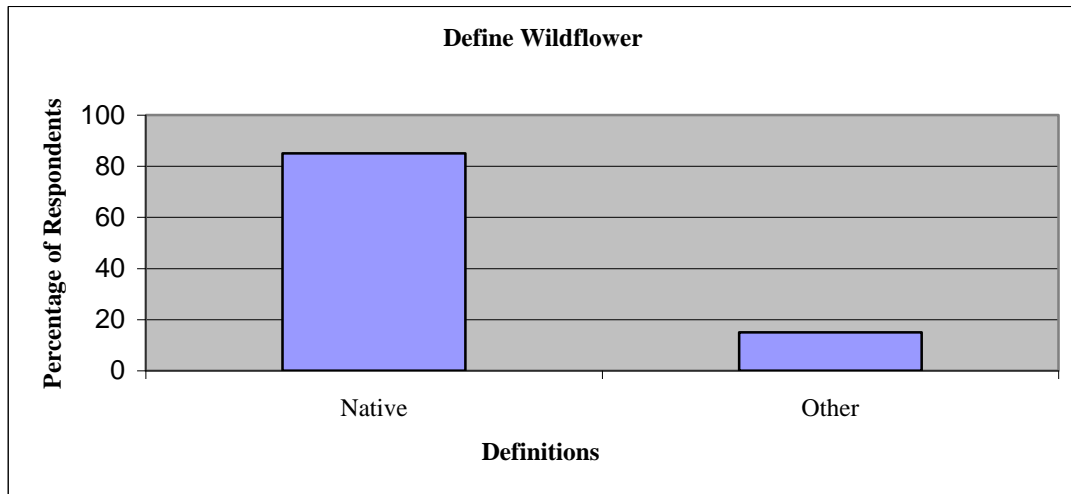


Figure 1. Definition of Wildflower

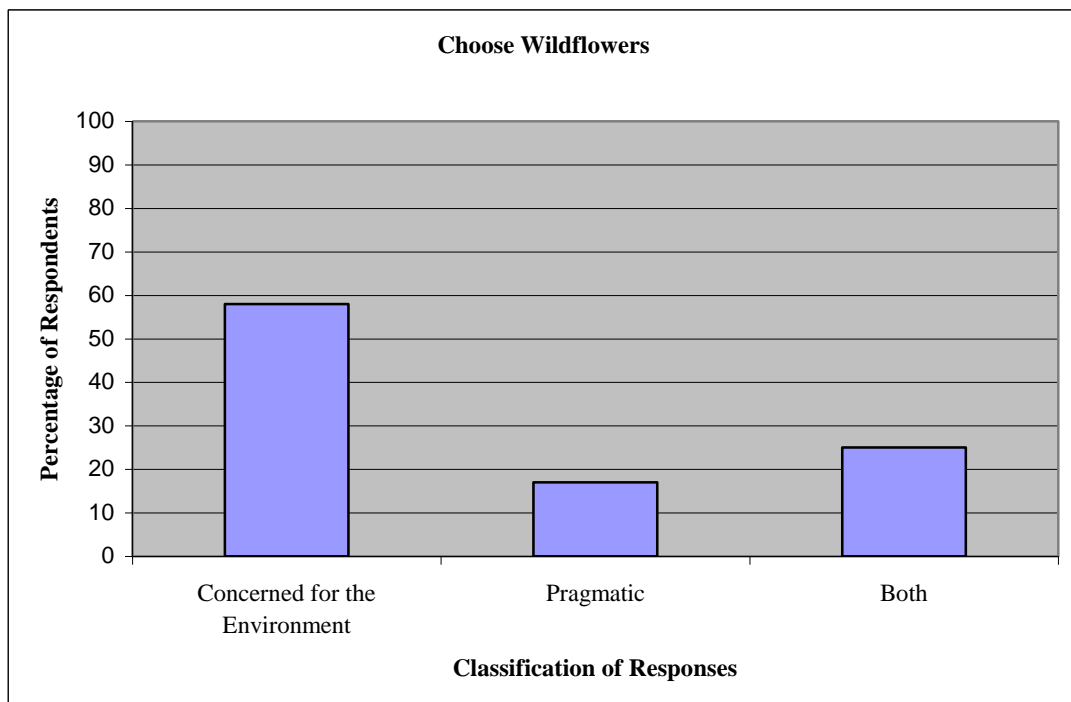


Figure 2. Why Choose Wildflowers?

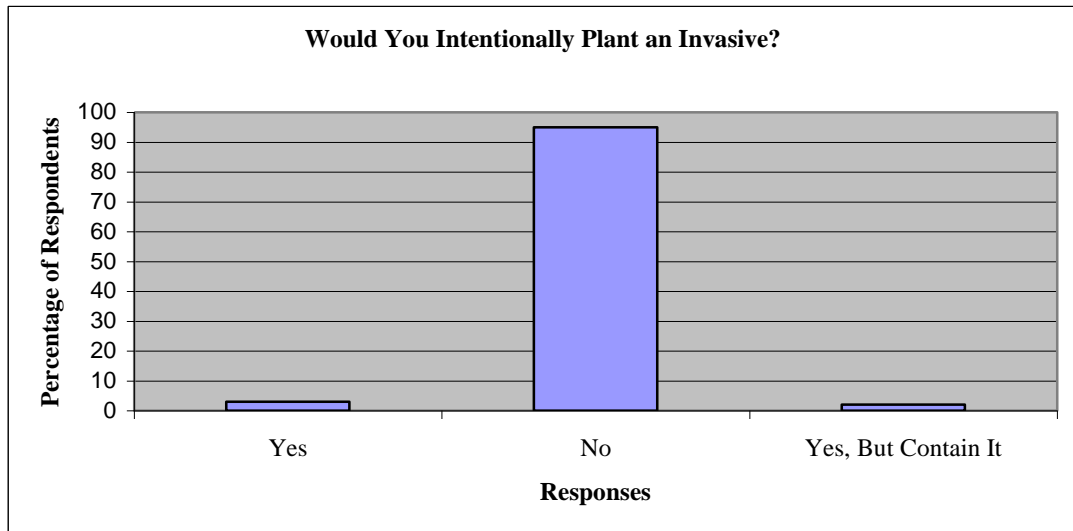


Figure 3. Would You Plant an Invasive?

Chapter 4: Discussion

The seed mixes contained a variety of species, native, non-native, invasive and non-invasive. One hundred percent of the 29 mixes contained at least one invasive species. Twenty-seven mixes had plant lists. Only fourteen of those mixes, 51.9%, contained all of the plants indicated on those lists. Two of the mixes had no information available about which species were included. In addition, although the lists were obtained for the non-labeled mixes, it is assumed that the average consumer would not bother with trying to locate these lists. Thus, even consumers who are aware of invasive plants may inadvertently spread invasive plants through the mixes, based on the survey-revealed assumption the “wildflowers” are native.

The names of the mixes may also lead the consumer to believe that they are planting native species to their area. There were six mixes that were labeled as regional mixes. None of these mixes were completely native mixes. It should be noted that in most cases, the non-native plants were listed on the label and/or lists associated with those mixes. It should be noted that most of those plants that are non-native in the regional mixes are not considered invasive.

It is possible that some additional species were included in the mixes and did not germinate. Seedlings were removed as they were identified not only for identification purposes, but to reduce competition in order to allow for the success of other seedlings. I believe that this increased the number of identifiable species. Still, it is possible that competition for light and space may have prevented some species from

blooming and therefore were not identified. Other species may have been biennial or perennial and would not bloom until the second year. The plants became infested with aphids due to the stress of the crowded conditions and this may also have prevented the flowering of plant material. Interspecific competition may be different in a field study due to varying climatic conditions and possible predators and the results would therefore be different.

Not all of the species listed as invasive are equal in their destructive potential. However, rather than rank them based on my subjective understanding of their invasive ability across the continent, I have relied on the outside sources to determine whether they should be considered invasive or not.

It is important to recognize that not all of the species considered invasive in my study are invasive in the areas in which the seeds were purchased. However, previous studies have determined a strong correlation between being invasive in at least one location and the ability to invade new locations (Reichard and Hamilton, 1997; Pheloung, 2001). Presumably, if a species has traits which enable it to become invasive in one place, it is likely to express them after other introductions. The diversity of possible climates and cultural conditions in which the seeds may be sown increases the potential that the species may express those weedy traits. One of the hallmarks of weedy species that has been known for some time is that they have the ability to grow under a number of diverse conditions (Baker, 1986), a condition often referred to as having a "wide ecological amplitude."

While it may be argued that the use of wildflower mixes by home gardeners is unlikely to lead to invasions in natural areas, the reality is that invasive plants, by virtue of their biology, do not stay where they are planted. They generally have high seed production, good seed viability, and good dispersal characteristics. Furthermore, as evidenced with this study, many people do not distinguish between native wildflowers and any other "wildflower." There is concern that some helpful citizens may be trying to "enhance" the beauty of natural areas by sowing the wildflower mixes. The Mt. Baker/Snoqualmie district of the United States Forest Service (USFS) reports that they get requests from citizens to allow them to sow the mixes in the forests (L. P. Martin, USFS Botanist, personal communication). They believe that others may be doing this without first asking permission.

Finally, while I found that 16 of the 75 species included in the mixes were invasive and/or noxious species, it should be noted that 59 of the species, or 78.7% of the species appear to have no history of being invasive. Clearly it is possible to produce attractive wildflower mixes that contain no intentionally included invasive species.

Although purposive sampling is nonprobability sampling and may not be truly representative of a population, it can be used "legitimately" for an "exploratory" survey (Kent, 2001). Further research is needed to address not only the questions from this survey, but those questions included in Colton and Alpert's (1998) survey as well.

Chapter 5: Conclusion

The idea that the commercial seed trade industry has long been a vector for the intentional introduction of weedy plants is not new. Mack (1991) found that by the end of the 19th century seed trade catalogues listed a number of species that were already invasive in the United States, such as *Eichhornia crassipes* (Mart.) Solms and *Isatis tinctoria* L. Mack concluded that at least 139 alien species had been spread by the seed trade industry by 1900 and that the use of seeds planted at high densities enhanced the opportunity for eventual naturalizations.

My findings suggest that this is still the case and that wildflower seed mixes do have the potential for spreading invasive species and noxious weeds. It is very possible that wildflower seed mixes are available that don't contain invasive species. However, this study demonstrates how unreliable the labels can be – many contained species that were not on the label. It may be necessary to sow the seeds of individual species in self-created mixes in order to avoid invasive or noxious weeds. This is also the conclusion of the Lady Bird Johnson Wildflower Center, the nationally recognized institution for education and research about wildflowers in Austin, Texas. Their instructions for both wildflower meadow gardening and large scale wildflower plantings agree with my findings:

The Wildflower Center does not recommend planting pre-packaged wildflower seed mixes. It is difficult to determine a mix's composition, both for the species and their relative percentage. Mixes often contain a high percentage of

species that are outside their natural ranges. You're better off buying individual native wildflower seeds or making your own mix. (2001a)

The Wildflower Center also provides instructions for making a mix (2001b). They recommend asking seed companies about seed quality. For instance, companies should be able to provide information about germination rates that may help determine the amount of a species that should be included in the mix. Many states have laws that require the date of the most recent germination test on the label. They also recommend asking for the purity of the seed lot, to determine that the seeds of other species, including weeds, are not included, nor are chaff or broken seeds. They suggest that grasses make up about 50% of the meadow mix created because they provide support for tall flowers, add color and texture to the landscape, and provide food and cover for wildlife (2001a). Grasses are usually not intentionally included in commercial mixes. They also provide information about how to manage a meadow seeding for many years of enjoyment.

These steps may be beyond the capabilities of the average person interested in a colorful wildflower meadow in their backyard. I therefore encourage ecologists to work with horticulturists, garden centers, and seed companies in their areas to develop regionally specific mixes that could be sold commercially. Voluntary codes of conduct, to protect “plant diversity and natural areas,” have been “endorsed by professional organizations of the nursery, botanical garden, and landscape architect industries, the gardening public, and by relevant government agencies” (Lodge et al.,

2006). Hopefully with time, seed companies will join this pursuit of protecting the environment and educating consumers. The interest in native and non-invasive species should be nurtured in the gardening public. As the survey implies, gardeners are unclear about what a native plant is and they do not want to plant invasive plants. If I fault seed companies for producing mixes that contain species which may be harmful to natural areas, and if I blame consumers for buying and planting them, I should be ready to help identify alternatives.

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Appendix A: Survey Questions

The purpose of this survey is to determine whether or not consumers know what they are getting when they plant wildflower seed mixes. You do not have to answer every question.

How do you define the word "wildflower?" Choose the definition that mostly closely fits your concept.

- Native flowering plants growing in National Parks and other wild areas
- Attractive herbaceous flowers
- Easy to grow flowers
- Other,
explain_____

Why would you choose to plant wildflowers?

- Native
- Attract wildlife/butterflies
- Inexpensive
- Easy to plant
- Other,
explain_____

What do you expect when you plant wildflowers?

- Low maintenance
- Drought tolerant
- Long-lasting color
- Alpine meadow
- Other,
explain_____

How do you categorize your gardening experience?

- Beginner
- Some experience
- Many years of experience

Do you consider yourself an environmentally responsible gardener?

- Yes
- No

If you knew that an attractive ornamental plant was invasive, would you still plant it?

- Yes, if yes, why?_____
- No, if no, why not?

Table 12: Definition of Wildflower

		Responses		Percent of Cases
		N	Percent	N
Definition of Wildflower Frequencies ^(a)	Native flowering plants growing in National Parks and other wild areas	80	74.8%	80.0%
	Attractive herbaceous flowers	8	7.5%	8.0%
	Easy to grow flowers	9	8.4%	9.0%
	Other	10	9.3%	10.0%
Total		107	100.0%	107.0%

a Dichotomy group tabulated at value 1.

Table 13: Why Would You Choose Wildflowers

		Responses		Percent of Cases
		N	Percent	N
Choosing Wildflowers Frequencies ^(a)	Native	56	29.6%	56.0%
	Attract Wildlife/Butterflies	65	34.4%	65.0%
	Inexpensive	20	10.6%	20.0%
	Easy to Grow	38	20.1%	38.0%
	Other	10	5.3%	10.0%
Total		189	100.0%	189.0%

a Dichotomy group tabulated at value 1.

Table 14: What do you expect when you plant wildflowers?

		Responses		Percent of Cases
		N	Percent	N
Expectations Frequency of Response ^(a)	Low Maintenance	74	45.7%	74.0%
	Drought Tolerant	38	23.5%	38.0%
	Long-Lasting Color	23	14.2%	23.0%
	Alpine Meadow	10	6.2%	10.0%
	Other	17	10.5%	17.0%
Total		162	100.0%	162.0%

a Dichotomy group tabulated at value 1.

Table 15. How do categorize your gardening experience?

Beginner	Some Experience	Many Years of Experience
23	46	31

Table 16. Are you an environmentally responsible gardener? Would you plant an invasive plant?

	Yes	No
Do you consider yourself an environmentally responsible gardener?	99	1
If you knew that an attractive ornamental plant was invasive, would you still plant it?	5	95

Appendix B: Consent Form

UNIVERSITY OF WASHINGTON
CONSENT FORM
Wildflower Seed Mix Study

Investigator:
Lorraine Brooks
Master of Science Student, College of Forest Resources
206-282-2902

Investigators' statement

We are asking you to be in a research study. The purpose of this consent form is to give you the information you will need to help you decide whether or not to be in the study. Please read the form carefully. You may ask questions about the purpose of the research, what we would ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When all your questions have been answered, you can decide if you want to be in the study or not. This process is called 'informed consent.'

PURPOSE OF THE STUDY

We would like to better understand what people think of when they decide to plant wildflower seed mixes. We want to interview gardeners with different gardening experiences. We would like to determine if gardeners are getting what they expect when they plant wildflower seed mixes.

PROCEDURES

If you choose to be in this study, I would like you to fill out a survey. It will take about 5 minutes. It will have questions about wildflower seed mixes. For example, it will ask:

- Why would you choose to plant wildflowers?
- What do you expect when you plant wildflowers?

You do not have to answer every question.

RISKS, STRESS, OR DISCOMFORT

Some people feel that providing information for research is an invasion of privacy. I have addressed concerns about your privacy later in this consent form.

BENEFITS OF THE STUDY

We hope that the results of this study will help consumers make safe choices when buy wildflower seed. You may not directly benefit from this study.

OTHER INFORMATION

Being in this study is voluntary. You can stop at any time. Information about you is anonymous. Your responses are not linked to your name. If the results of this study are published or presented, we will not use your name.

Signature of investigator Typed or printed name _____
Date

Subject's statement

This study has been explained to me. I volunteer to take part in this research. I have had a chance to ask questions. If I have questions later on about the research I can ask one of the investigators listed above. If I have questions about my rights as a research subject, I can call the Human Subjects Division at (206) 543-0098. I will receive a copy of this consent form.

Printed Name of Subject _____
Signature of subject _____
Date