'Radiant' (11.7%), 'Royalty' (8.5%), 'Hopa' (7.0%), 'Indian Magic' (6.6%), and 'Snowdrift' (5.7%) were the most commonly mentioned discontinued selections over all regions (Table 4). 'Radiant' and 'Royalty' ranked first or second in the central, east-central and east regions, whereas 'Hopa' was the most frequently discontinued cultivar in the west-central region. Interestingly, japanese flowering crab (*M. floribunda*) was the cultivar most often discontinued in the western region.

Apple scab was identified as the most prevalent crabapple disease across all regions (67.8%) except in the west-central region, where fire blight was considered most problematic (80.9%). The higher frequency of fire blight is due to later blooming periods at higher elevations (Smith, 1998).

Disease resistance has been stressed more than any other topic with regard to crabapples at the university level (Iles and Stookey, 1997). However, respondents in our study believe their retail and commercial clients are more concerned with flowers and growth habit.

A promotional campaign should be modeled after the Perennial Plant Association's (PPA, Hilliard, Ohio) perennial of the year to highlight the best crabapple selections. Suggested selections may change as climactic conditions change across the United States, thus encouraging the use of the best cultivars and species available.

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Profile of the Virginia Commercial Greenhouse Industry

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ADDITIONAL INDEX WORDS. floriculture, nursery, survey

SUMMARY. A survey was conducted in 2000–01 to provide a comprehensive description of Virginia's commercial greenhouse industry. A total of 274 responses were analyzed. Responses were categorized based on the amount of heated greenhouse space: small, medium, large, or other (including part-time). The survey included questions about growing space, number of employees, education and experience of respondent, crops grown, gross receipts, and target markets. Seventy-five percent of the respondents were owners or owners/growers and respondents reported an average of 15 years experience. Most greenhouse operations were classified as small or less than 10,000 ft² (929.0 m²). A wide variety of crops were reported, with more than 50% growing bedding plants and nearly 50% growing herbaceous perennials in the greenhouse. Market outlets were about equally divided between wholesale and retail.

A survey of the greenhouse and perennial production segment of the ornamental horticulture industry in Virginia was developed and conducted by faculty of the Department of Horticulture at Virginia Polytechnic and State University (Virginia Tech) and faculty of the Virginia Cooperative Extension (VCE) Service with input

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from industry representatives. Due to the lack of faculty dedicated to serving the Virginia greenhouse industry since the early 1990s, this survey was designed to assist new faculty in floriculture, entomology, and plant pathology to assess the size, distribution, crops, and market channels in order to develop new research and extension programs. There are few examples of this sort of needs assessment survey; one has been done for the State of Colorado (Panter, 1994) and proved very helpful in the creation of our survey. We were also concerned with inclusiveness of small growers. Existing sources of data such as the U.S. Department of Agriculture (USDA) Floriculture Crops Summary excludes growers with less than $10,000 in gross sales and also excludes individual crop details from growers whose gross sales are less than $100,000 (USDA, 2002). Herbaceous perennial production, whether in the greenhouse or out-of-doors, was also of interest to the surveyors; several questions targeted this aspect of floriculture.

The main objectives of the survey were 2-fold: to characterize the scope of the industry and to identify needs and interests of producers to help plan research and educational programming. This article addresses the first objective through a detailed analysis of the Virginia greenhouse industry in terms of size and nature of operation, plant materials grown, cultural practices, and marketing strategies.

Materials and methods

Development and administration of the survey instrument. The survey instrument was developed by the extension specialist for greenhouse crops and an assistant professor of floriculture with input from industry representatives. Assistance with formatting of the questions was provided by extension specialists in program evaluation. The instrument was designed to gather basic information regarding the scope of the greenhouse industry in Virginia, to look at various cultural practices of growers, to determine training and research interests of greenhouse operators, and to identify the major issues facing the industry. The final survey consisted of 33 questions, many of which had multiple parts. Participants were asked for 242 different pieces of information with the opportunity to make additional comments.

A broad mailing list of potential greenhouse businesses was built by combining the mailing lists of the Virginia Nursery and Landscape Association (Christiansburg, Va.), the Virginia Flower Growers Association (Blacksburg, Va.), smaller regional grower groups, the customer list of a large supplier of horticultural goods, and lists of greenhouse growers provided by county extension agents. There was concern this combined list might contain some duplication, as well as a large number of growers or landscapers who may not be in the greenhouse business. To address this concern, the first item on the instrument allowed the respondent to note that he/she was not currently engaged in the greenhouse business. Participants were asked to return the survey indicating that operating a greenhouse was not their primary business, if this were the case. The survey instrument was administered according to the method described in Dillman (1978) The initial mailing included a cover letter explaining the purpose of the survey, support of state industry organizations, and stressed confidentiality of collected data. One week after the initial mailing, the entire mailing list received a post card encouraging participation in the project. Third and fourth mailings included an explanatory letter and a new copy of the survey was sent to those who had not responded to earlier mailings.

Number of responses. Of the 980 initial surveys mailed, 503 of these businesses were neither operating greenhouses nor growing herbaceous perennials. Four respondents indicated that tobacco (*Nicotiana tabacum*) transplants were their only crop—these surveys were not included in the analysis. Forty-five surveys were determined to be undeliverable, duplications, or so badly damaged in the mail that they were unidentifiable and unusable, leaving 428 potential responses. After the final mailing, a total of 274 usable responses were analyzed, for a response rate of 64%.

An initial review of the responses from greenhouse operators indicated that slightly over half (51%) had no full time, year-round employees other than family members. With such a large number of respondents, we wanted to further catagorize these businesses into part-time or full-time. We felt that this area required further examination, and developed a brief follow-up questionnaire that explored the nature of these operations more fully. As a result of two mailings, 75% of the follow-up surveys were returned of 139 sent. Growers were asked whether operating the greenhouse was the primary occupation of any adult in the family, as well as how many family members and others worked full or part time, year around or seasonally in the greenhouse. They were also asked whether they were part of a larger operation and which months the greenhouse was in operation. The responses indicated that the vast majority of these businesses were, in fact, commercial in orientation. Most were either part of a larger farm or nursery or were the primary occupation of at least one adult in the household.

For each response, frequencies were calculated using SPSS (SPSS, Inc., Chicago). Data were subjected to a one-way analysis of variance.

Results and discussion

Development of categories. This survey, in its entirety, was an assessment of the capabilities, attitudes, training, and research needs of greenhouse operators. We hypothesized that the

Table 1. Categorization of responses: full-time greenhouse operations in the state of Virginia based on heated greenhouse space.

Category	Definition	No.	Percent of total respondents[z]
Small	<10,000 ft^2[y] of heated space	152	57.6
Medium	10,000 to 29,999 ft^2 of heated space	50	18.9
Large	>30,000 ft^2 of heated space	39	14.3
Other	Not based on size, but on limited activity	23	8.7

[z]Based on 264 respondents - size of greenhouse operation could not be determined for 10 respondents.
[y]1 ft^2 = 0.0929 m^2.

Table 2. Business profiles of greenhouses in the state of Virginia summarized by size: age of business, gross receipts, and number of employees.

Profile	Means categorized by size of greenhouse operation[z]				
	Overall mean	Other	Small	Medium	Large
Gross receipts ($) (1999) (n=176)	456,103	10,035 c	127,592 b	265,441 b	1,715,544 a
Years under current owner (n=258)	13.4	10.0 b	10.3 b	17.2 a	21.3 a
Number of employees					
Year around, full time (n=263)	5.1	0.0 b	2.6 b	3.9 b	19.3 a
Seasonal (n=261)	6.4	1.1 b	3.8 b	5.3 b	24.0 a

[z]Values within a row differ significantly at $P \leq 0.01$; Mean separation within greenhouse size by Waller-Duncan t test.

size of the greenhouse operation would influence many aspects of the survey responses such as potential markets, interests, and issues; also, the amount of controlled space would determine crop selection, pest problems, and degree of automation. Heated greenhouse space was decided upon as the most significant factor in determining whether a full-time greenhouse operation was considered small, medium or large (Table 1). Most businesses were classified as small or less than 10,000 ft^2 (929.0 m^2) [analogous to four freestanding 28 × 96 ft houses (8.5 × 29.3 m)]. Gross revenues were considered as a factor for categorization, but rejected, because a large percentage of respondents did not provide revenue information. On this basis, thirty-four operations were categorized as small and one was considered a medium sized operation. Twenty- three were considered part time or self-declared hobby status, and classified as other; only nine respondents provided so little information that they could not be categorized. This resulted in a total of 241 truly full-time operations responding. The USDA floriculture crops summary (USDA, 2002) reported 224 Virginia growers with gross receipts above $10,000. Other data gathered on production space included unheated greenhouse space, outdoor container production area, and field production area. Data gathered for these categories did not vary significantly with the size of the business as defined by heated greenhouse space. Unheated space reported by 120 operations ranged from 190 ft^2 (17.7 m^2) to 7.9 acres (3.20 ha), with a mean of 12,040 ft^2 (1,118.5 m^2) and a total of 1,444,757 ft^2 (134,217.9 m^2), about 33 acres (13.4 ha). Most respondents (170) reported having outdoor container production area averaging 4.0 acres (1.62 ha) for a total of 671 acres (271.6 ha). Field production of herbaceous perennials averaged 2.0 acres (0.81 ha) for 55 responses, totaling 107 acres (43.3 ha) statewide.

PROFILE OF RESPONDENTS. Survey instructions stressed the importance of having the survey completed by the person in the company who has the best understanding of the business and the industry as a whole. Six job titles were offered to indicate the position of the person completing the survey. There was no significant difference in job titles of respondents across the size categories. Owner-growers completed 70% of the surveys, while another 15% were submitted by owners. General managers and head growers completed 8% and 3%, respectively. The other category was indicated by 3% of the respondents. Only 1% failed to indicate a job title.

Years of experience in the greenhouse industry varied significantly based on size of the greenhouse operation and experience increased as size increased with a mean of 15.6 years in the field. Other and small businesses averaged 12.2 and 13.1 years experience respectively, and medium and large businesses averaged 18.9 and 21.9 years respectively. When asked to indicate their highest level of education completed from a list of six options, over half (58%) had college degrees, whether 2-year, 4-year, or postgraduate. Of those completing 4-year degrees, 21.4% majored in horticulture and another 17.9% studied other branches of agriculture or plant science. When offered options as to horticultural training, half of respondents (50.4%) indicated no formal training in horticulture

Respondents were asked to indicate in which of several professional or trade organizations, if any, they held memberships. Of the 242 responses, memberships reported include the Virginia Nursery and Landscape Association (21%), Virginia Flower Growers Association (14%), Shenandoah Valley Nursery and Greenhouse Growers Association (Luray, Va.) (12%), Professional Plant Growers Association/ Bedding Plants International (now defunct) (Des Moines, Iowa) (4%), Society of American Florists (Alexandria, Va.) (2%), and Other (12%). Mailing lists from the first three groups were used in developing the survey mailing list, probably skewing the membership percentage. Membership in some, but not all organizations, varied with the size of the greenhouse operations, with the overall trend of the larger the operation, the more likely the respondent was an organization member (data not shown). Other responses were varied and ranged from local trade groups to national organizations focusing on one species of plant. Of particular interest is the fact that 45% indicated that they hold no membership in professional or trade association.

BUSINESS PROFILE. The survey included a series of questions about gross receipts, the age of the business, and size of the operation (growing space and number of employees). Respondents were asked to indicate annual gross receipts for the greenhouse portion of their business for 1999 (Table 2). More than a third (35.8%) declined to answer this question, with the percent who declined to answer decreasing as the size of the greenhouse operation increased. This information was provided by 85% of the large greenhouse operations, but given by only 60.5% of the small operations. The overall mean for gross receipts from those answering the question was $456,103 with an overall median of $90,000. The USDA Floriculture survey categorizes all crop data by gross receipts, and includes only data from growers grossing more than $100,000 (USDA, 2002). The USDA survey does include growers with gross receipts of $10,000 and greater in total grower numbers and gross value of sales. For comparison purposes, the mean gross sales for Virginia was $321,400 (USDA, 2002)

Table 3. Comparison of crops grown in the state of Virginia by size of greenhouse operation.

Crop	Overall growing crop (%)	Growing crop (%) by size of greenhouse operation			
		Other (n=23)	Small (n=149)	Medium (n=47)	Large (n=39)
Bedding plants					
Baskets[z]	64.2	56.5	56.4	85.1	77.5
Flats	62.7				
Pots[z]	67.9	60.9	61.1	87.2	82.5
Flowering potted plants					
Geraniums (*Pelargonium ×hortorum*)[z]53.0	43.5	40.3	80.9	80.0	
Chrysanthemums (*Dendranthema ×grandiflora*)[z]	37.7	30.4	30.2	55.3	52.5
Poinsettias (*Euphorbia pulcherrima*)[z]23.5	4.3	12.1	42.6	57.5	
Other[z]	47.0	39.1	38.3	72.3	60.0
Foliage plants					
Baskets[z]	39.2	30.4	31.5	53.2	60.0
Pots	34.7				
Perennials					
In greenhouse	49.3				
Outdoors	60.8				
Cut flowers					
In greenhouse–ground beds	3.7				
In greenhouse–containerized[z]	4.1	0.0	1.3	2.1	17.5
Outdoors–ground beds	10.1				
Herbs					
Containerized plants	50.4				
For consumption	10.1				
Vegetables					
Transplants[z]	54.1	52.2	49.0	76.6	52.5
Greenhouse tomatoes (*Lycopersicon esculentum*)	7.5				
Other vegetables for consumption	11.6				
Plugs					
Annual bedding plants	25.7				
Perennials	22.0				
Vegetables[z]	21.3	17.4	16.8	31.9	32.5
Other					
Aquatic plants	14.6				
Tobacco (*Nicotiana tabacum*) transplants	1.9				

[z]Significant difference by greenhouse size at $P \leq 0.01$.

When asked how many years their greenhouse had been in business under the current ownership, responses ranged from 3 months to 66 years. The mean age of the business increased as size increased (Table 2). To estimate the number of people employed in the greenhouse industry in Virginia, the survey asked how many people, other than family members, were employed by the business on a year around, full-time basis (Table 2). All but 4.0% of the respondents replied to this question but just over half (50.4%) had no employees fitting this description. The growers reported a total of 1,343 year around, full time employees that were not family members.

PRODUCTS AND MARKETS. Respondents were asked to indicate which of 24 types of crops they were growing. Nine general categories of crops—bedding plants, foliage plants, perennials, vegetables, flowering potted plants, cut flowers, herbs, plugs, and other—were further divided into more specific groups (Table 3). Responses for 10 of the crops varied significantly by size of the greenhouse operation; for the remaining 14 crops there was no difference in response based on size.

Well over half of respondents indicated they were growing bedding plants of some kind. The next most frequently cited crop was outdoor-grown perennials, followed by potted geraniums (*Pelargonium ×hortorum*), containerized herbs, greenhouse-grown perennials, and "other" flowering plants. Less than one-fourth of respondents (mostly medium and large operations) are producing poinsettias (*Euphorbia pulcherrima*). Growers are taking advantage of the increased demand for perennials (Behe and Heilig, 2000) with nearly half of respondents producing perennials in the greenhouse. With most growers located in USDA hardiness zones 7 and 8, more than half are producing perennials outside. Perennial production statistics are scarce, as the USDA floriculture crops summary has not identified herbaceous perennials as a specific category until this year. However, Behe and Heilig (2000) report a similar figure of 51% of greenhouse growers nationally are producing perennials.

Virginia Tech floriculture faculty have specific research interests concerning perennial production and we felt it would be useful to know the most frequently-grown perennials in the state (Table 4). If respondents indicated in the previous question that they grew perennials, they were asked to list the six flowering perennials grown in the largest quantities. The open-ended nature of this question led to a variety of

response formats; some cited exact botanical names, some common names, and others listed a type of plant, such as ornamental grasses. After accounting for this variation and duplication, 126 different perennials were named in the top six. Eight of the top 10 perennials listed by Virginia growers were also noted in a nation-wide producer survey of members of the Ohio Florists Association (Columbus, Ohio) and Bedding Plants International (Behe and Heilig, 2000).

Respondents were also asked whether they planned to add new kinds of crops in the next 1 to 3 years, and if so, what the new category would be. Less than half (42%) answered yes, 49% no, and 8% failed to respond to the query. Size of the operation did not significantly impact the responses. The open-ended nature of the second part of the question resulted in responses that were difficult to catagorize with some naming a particular species and others mentioning broad categories such as woody plants. Some of the "yes" respondents were undecided as to new crop specifics; one grower stated " ...You must be able to adapt to the market...retail demands [are] always changing."

Product branding or point of purchase (POP) programs are becoming a major force in the floriculture industry, especially for vegetatively propagated annuals and perennials. However, less than half (43%) of survey respondents indicated that they participate in these programs. Of the four choices offered, Proven Winners (Dekalb, Ill.) was the dominant POP program in Virginia, with 71% of those indicating participation. This was followed by the Flower Fields (Carlsbad, Calif.) (29%), Blooms of Bressingham (Sacramento, Calif.) (18%) and Athens Select (Bonsall, Calif.) (6%). Percent of growers using Proven Winners and Flower Fields programs did differ by size of greenhouse operation, with medium and large growers more likely to be participating than small.

We also wanted to investigate the importance of various markets to Virginia's greenhouse operators. When asked to indicate the percent of their greenhouse business devoted to wholesale, retail, and other categories, response varied by size of operation, with large businesses most likely to be involved in wholesale (7 4%). Overall, the proportion of business was fairly evenly divided between wholesale and retail (44% and 51%, respectively). other business accounted for 5%, with comments indicating that proportion of the business was frequently related to landscaping, property maintenance, farm, or personal use.

Recognizing that many greenhouse operations have more than one target market, they were given eleven potential outlets and asked to rank their top three markets in order of importance in generating revenue (Table 5). Retailing directly from their own greenhouse was by far the most important outlet to the largest number of respondents, with 59% reporting this in their top three markets and 43% ranking this market as most important. This was the only market category where response did vary significantly by size of operation (data not shown). Other, small, and medium-sized greenhouse operation responses were similar with 61%, 68%, and 64%, respectively, placing "direct from greenhouse" among their top three markets. However, of the large greenhouse operations responding, less than half (49%) named this market in their top three. Other wholesale outlets written in were grocery stores (thirteen times) and hardware stores (five times). Farmers markets were the dominant other market, with 17 of 44 citations.

The information collected from this survey has provided detailed information about the size, composition,

Table 4. Top herbaceous perennials grown in Virginia by quantity; cited 10 or more times and percent of perennial growers producing this plant (n=193).

Common name	Genus or category[z]	Frequency cited (no.)	Perennial growers producing this plant (%)
Hosta	*Hosta*	63	32.6
Coneflower	*Rudbeckia*	62	32.1
Daylily	*Hemerocallis*	58	30.0
Purple coneflower	*Echinacea*	46	23.8
Tickseed	*Coreopsis*	41	21.2
Stonecrop	*Sedum*	31	16.0
Verbena	*Verbena*	26	13.4
Foxglove	*Digitalis*	22	11.4
Phlox	*Phlox*	22	11.4
Columbine	*Aquilegia*	21	10.9
Candytuft	*Iberis*	21	10.9
Butterfly bush	*Buddleia*	20	10.4
Pinks	*Dianthus*	19	9.8
Shasta daisy	*Leucanthemum*	16	8.3
Sage	*Salvia*	16	8.3
Ornamental grasses	Ornamental grasses	15	7.8
False spirea	*Astilbe*	12	6.2
Delphinium	*Delphinium*	12	6.2
Iris	*Iris*	11	5.7
Scabiosa	*Scabiosa*	11	5.7
Hollyhock	*Alcea*	12	5.2
Lavender	*Lavandula*	10	5.2
Peony	*Paeonia*	10	5.2

[z]The levels of specificity of plant names reported were widely variable; therefore they were grouped under the appropriate genus or category.

Table 5. Ranking of most important markets for Virginia greenhouse growers in terms of revenue generated (n= 258).

Market	Ranking = 1st, 2nd, or 3rd most important (%)	Ranking = most important (%)
Retail direct from greenhouse	58.8	43.1
Wholesale to garden centers	40.9	16.8
Wholesale to landscapers	36.5	5.8
Wholesale to other retailers	17.2	4.4
Wholesale to other	17.2	4.4
Retail from adjoining store	15.7	6.2
Wholesale to florists	13.9	3.3
Wholesale to own landscape business13.1	5.1	
Wholesale to property management firms	8.8	0.4
Wholesale to mass marketers	7.7	4.0
Internet sales	2.6	0.4
Mail-order sales	2.6	0.4

and markets of the state of Virginia's greenhouse and herbaceous perennial industry. We also propose that the needs and interests of Virginia greenhouse operators are very similar to those of comparably-sized operations in other states, particularly thoughout the mid-Atlantic and southeastern parts of the United States. Therefore, the information garnered in this survey should be of value to persons involved in extension and outreach to their state's greenhouse growers. Educational and research program development by Virginia Tech floriculturists can be better defined to fit the profiles of the grower clientele. The small size of most operations and the importance of local retailing directly from the greenhouse has implications in educational topic selection. Research on labor-saving products or methods/techniques for small-scale production and retail marketing would improve the profitability of these operations. Recognizing the different categories of greenhouse operations in the state will enhance our ability to serve the various clientele groups.

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