Guiding Gardeners to Native Plant Alternatives Using Internet Technology

Jennifer Forman Orth[1], Jacob Asiedu[1], Matthew Calder[1], William Cullina[2], Robert Stevenson[1], Robert Morris[1]

[1]University of Massachusetts Boston [2]New England Wild Flower Society

SUMMARY:

With invasive plants now one of the top environmental concerns in the U.S., many groups are working to put together lists of "native alternatives" to invasive species. We have devised a method of serving up an extensive gardeners' reference to native alternatives through a searchable, web-based interface. The web interface provides links to the current invasive plant lists from each New England state to allow gardeners to easily find species their state recommends avoiding. Visitors to the "Native Alternatives to Invasive Plants" gardening guide can then use a simple set of pull-down menus to retrieve a list of native plant substitutions for 74 different invasive plants, or can go directly to the native plants database and search 553 species records by flower color, plant height, etc. The guide suggests native alternatives based on the morphological characteristics and habitat requirements of the invasive plant selected. A comparison between our guide and two documents listing native alternatives for 26 invasive plants showed many differences between all three lists. This guide provides a comprehensive and more easily updatable alternative to paper-based public outreach that seeks to encourage the planting of native species.

Building the Guide:

1) Data Collection:

The source of the native plant database is the online, HTML version of the New England Wild Flower Society's 2005 Nursery Catalog (http://www.newfs.org/nursecat05/) (Fig. 1a). Using an implementation of Document Object Model in Java, we wrote an application to convert the raw HTML of the catalog pages (Fig. 1b). DOM created a representation of the catalog's HTML tables, making it easy to write Java code requesting text located at a specific position in the table, i.e. "row 3, column 2." Using Apache's POI library we then recreated the structure of the tables in an Excel spreadsheet file using the text pulled from the DOM objects. Some minor editing was required within Excel to deal with anomalies in the structure of the catalog pages. Image filenames were placed in a separate spreadsheet, and the catalog images were downloaded to a local machine.

Once the catalog was imported into Excel, some of the categories of data were edited in order to make the database more easily searchable (Fig. 2a). For example, the catalog notes the flower color of Butterfly Weed as "yellow to orange." This was changed to "yellow, red, orange," to ensure that this species is a match for any search for yellow, red or orange flowers. The categories of Soil, Light and Range were also changed to increase searchability. Flowering time was changed from months to more general seasons, and height was changed from a continuous range to a set of discrete measurements (i.e. "14-24 inches" became "1ft, 1.5ft, 2ft"). The species pages (see Section 2) retain the original catalog text, rather than the newly categorized data, in order to make them more readable.

A second matching spreadsheet was then compiled (Fig. 2b), using a list of 74 plants that have been evaluated for invasiveness by the Massachusetts Invasive Plant Council.

2) Generating a Searchable Database and Species Pages:

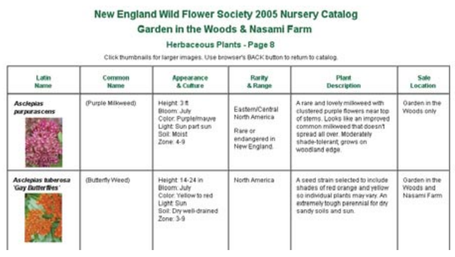
The Excel spreadsheets were imported into ObjectStore databases via another database program, FileMaker Pro. Once in ObjectStore, the databases can be searched using a series of pull-down menus representing the categories of data (a "synoptic" key, Fig. 3) – this is how the search for native plants is represented in the web interface. When the form is submitted, the choices made in the pull-down menus become a query to the database. The data returned by the query starts out in XML (Extensible Markup Language, Fig. 4), but contained in the query is a request to apply an HTML template so that it can be properly viewed in a web browser (Fig.5).

To accompany the native plant database search, a query was designed to return native plant alternatives that most closely match a selected invasive plant (Fig. 6). When the user chooses an invasive plant from the list, a query to the native plant database is generated using the Growth Form, Height, Flower Color, and Seasons in Bloom of the invasive plant. Light and Soil requirements were not included because the majority of invasive plants have a wide range of habitat types in which they can grow. If desired, the user can also restrict the query to return plants that grow in specific conditions of light and soil moisture. The query is made using "AND" as a Boolean operator. That is, if the user selects "Garlic Mustard" from the list, the query will only return plants that are herbs AND have white flowers AND bloom in spring AND are 3 feet tall.

The web interface and database queries are served up with Apache HTTP Server and Tomcat 5.0.

Figure 1 - The HTML (Web-based) version of the New England Wild Flower Society 2005 Nursery Catalog

1a. Catalog viewed from a web browser



1b. Catalog viewed in raw HTML. Text is in bold black, HTML code is in red.

```
<tr align="left" valign="top">
  <td><p style="font-weight: bold; font-style: italic;"><a name="1" id="1"></a>Asclepias
      purpurascens</p>
      p style="font-weight: bold; font-style: italic;" align="center"><a href="http://www.newfs.org/
      nursecat05/pix/
      Asclepias-purpurascens-3.jpg">
      <img src="NEWFSNurseryCatalog05-08_files/Asclepias-purpurascens-3.jpg" alt="Asclepias purpurascens"
      border="0" height="96" width="72"></a></p>
  </td>
  <td>(Purple Milkweed)</td>
  <td>Height: 3 ft<br>
     Bloom: July<br>
     Color: Purple/mauve<br>
     Light: Sun part sun<br>
     Soil: Moist<br>
     Zone: 4-9</td>
  <td><p>Eastern/Central North America</p>
      <p>Rare or endangered in New England.</p></td>
  <td>A rare and lovely milkweed with clustered purple flowers near top of stems. Looks
      like an improved common milkweed that doesn't spread all over. Moderately shade-
      tolerant; grows on woodland edge. </td>
  <td>Garden in the Woods only</td>
</tr>
```

Figure 2 - Excel Data Tables

2a. The Excel version of the New England Wild Flower Society 2005 Nursery Catalog

Growth Form	Images	Family	Scientific Name	Genus	Species	Common Name	Height	Plant Height	Months in Bloom	Seasons in Bloom	Flower Color	Color of Flowers	Light	Soil	Zone	Range	Plant Description
herb	catalogpics/Asclepias-purpurascens-3.jpg#catalogpics/Asclepias-purpurascens-3.jpg	Asclepiadaceae	Asclepias purpurascens	Asclepias	purpurascens	Purple Milkweed	3 ft	3 ft	July	summer	purple/ mauve	purple, mauve, light purple	sun, part sun	moist	4-9	Eastern North America, Central North America	A rare and lovely milkweed with clustered purple flowers near top of stems. Looks like an improved common milkweed that doesn't spread all over. Moderately shade-tolerant; grows on woodland edge.
herb	catalogpics/Asclepias-tuberosa-red-form.jpg#catalogpics/Asclepias-tuberosa-red-form.jpg	Asclepiadaceae	Asclepias tuberosa 'Gay Butterflies'	Asclepias	tuberosa 'Gay Butterflies'	Butterfly Weed	1 ft, 1.5 ft, 2 ft	14-24 in	July	summer	yellow to red	yellow, red, orange	sun	dry, well-drained	3-9	North America	A seed strain selected to include shades of red orange and yellow so individual plants may vary. An extremely tough perennial for dry sandy soils and sun.

red: edited to make data more searchable
black: imported text identical to catalog
blue: category of data added to existing database

2b. The Excel table for invasive plants in Massachusetts

Growth Form	Family	Scientific Name	Genus	Species	Common Name	Height	Months in Bloom	Seasons in Bloom	Flower Color	Color of Flowers	Light	Soil	Invasiveness
tree	Aceraceae	Acer platanoides	Acer	platanoides	Norway maple	60 ft	April-May	spring	yellow-green	yellow-green, green, yellow	sun, part sun, part shade, shade	moist, wet, dry, moderately dry, well-drained	invasive
tree	Aceraceae	Acer pseudoplatanus	Acer	pseudoplatanus	Sycamore maple	70 ft	April-May	spring	yellow-green	yellow-green, green, yellow	sun	moist, wet, dry, moderately dry, well-drained	invasive

Fig. 3 - Synoptic Key for the Native Plant Database

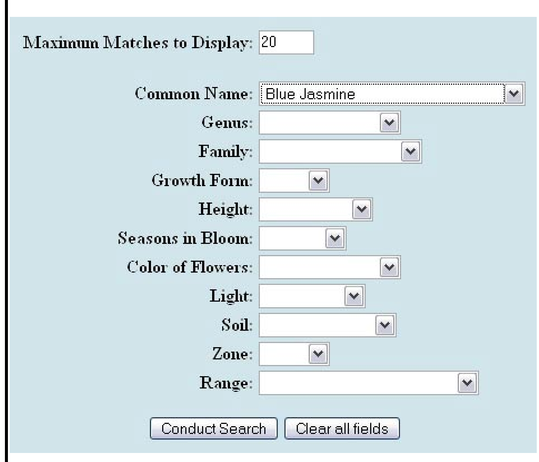


Fig. 4 - Sample XML returned by a query to the native plant database for "Blue Jasmine"

```
<EFGDocument TYPE="NewEnglandWildflower2005Data">
-   <TaxonEntry>
-   <Items name="Plant Description">
-   <Item name="NEWFS_Propagator_and_Nursery_Manager_Bill_Cullina_calls_this_the_
    wedding_cake_flower...">NEWFS Propagator and Nursery Manager Bill Cullina calls
    this the wedding cake flower...
</Item>
</Items>
-   <Items name="Height">
<Item name="2_ft">2 ft</Item>
<Item name="2.5_ft">2.5 ft</Item>
<Item name="3_ft">3 ft</Item>
<Item name="4_ft">4 ft</Item>
</Items>
-   <Items name="Months in Bloom">
<Item name="May-July">May-July</Item>
</Items>
-   <Items name="Seasons in Bloom">
<Item name="spring">spring</Item>
<Item name="summer">summer</Item>
</Items>
-   <Items name="Flower Color">
<Item name="violet/white">violet/white</Item>
</Items>
-   <Items name="Plant Height">
<Item name="2-4_ft">2-4 ft</Item>
</Items>
-   <Items name="Scientific Name">
<Item name="Clematis_crispa">Clematis crispa</Item>
</Items>
-   <Items name="Common Name">
<Item name="Blue_Jasmine">Blue Jasmine</Item>
</Items>
-   <Items name="Growth Form">
<Item name="herb">herb</Item>
</Items>
-   <Image name="Images">
catalogpics/Clematis-crispa.jpg#catalogpics/Clematis-crispa.jpg
</Image>
</TaxonEntry>
</EFGDocument>
-   <!-- $Id: presentXML.jsp,v 1.4 2005/03/29 14:20:25 kasiedu Exp $ -->
```

Fig. 5 - Sample Web Page (HTML) returned by a query to the native plant database for "Blue Jasmine"

Testing the Guide:

- The native plant alternatives database found at least one alternative for 77% (57) of the invasive plants.
- The number of suggestions per species ranged from 1 (11 invasives) to more than 20 (7 invasives). There were 17 invasive plants that did not have any alternatives in the current native plant database, while some native shrubs seem to fit the profile of many invasives and were repeatedly suggested.
- In informal testing, recommended species often seemed to be a good fit for a gardener trying to replace an invasive plant with a similar-looking native species. However, the native alternatives suggested by our database are currently dependent on which native plants are being sold by NEWFS. This limits the number of matches returned for each invasive plant.
- **The ease of updating the database to add or remove native or invasive plants (the author needs only to provide an Excel spreadsheet) makes this an excellent alternative to the traditional static documents typically used in native plant educational outreach.**

Two documents that recommend native alternatives to invasive plants (Cullina 2002 and Abbey 2004) were used to compare the predictive ability of the native plant alternatives database to the opinions of experts (Fig. 7). A total of 26 different invasive plants were investigated. The suggestions from our database varied greatly from the experts' recommendations in two ways:

1) In several cases, our database would only have one or two recommendations, while the experts would have several; the reverse situation was also common.

2) There were very few cases where the database recommended the same species, or even the same genera, as the experts. This is especially interesting because the author of one document is also the main author of the NEWFS catalog that we use as our data source. A possible reason for this is that the experts were considering characters that we do not include in our database. Another possibility is that the experts were recommending natives that are not available through the NEWFS nurseries.

Fig. 6 - Interface for matching invasive plants with native species

Fig. 7 - Sample results comparing three sources of native plant alternatives for invasive plants

Invasive Plant	Our database suggests:	Cullina (2002)	Abbey (2004)
Elaeagnus angustifolia (Russian Olive)	*Amelanchier canadensis* (Shadbush, Canada Serviceberry)	*Ceanothus* spp. (Ceanothus)	*Aronia arbutifolia* (Chokeberry)
E. umbellata, (Autumn Olive)	*Chamaecyparis thyoides* 'Glauca Pendula' (Weeping Atlantic White Cedar)	*Cercocarpus* spp. (Mountain Mahogany)	*Fothergilla gardenii, F. major* (Fothergilla)
	Cotinus obovatus (American Smoketree)	*Chionanthus virginicus* (Fringetree)	*Ilex glabra* (Inkberry)
	Ilex verticillata (Winterberry Holly)	*Eleagnus commutatus* (Silverberry)	*Ilex verticillata* (Winterberry)
	Physocarpus opulifolius 'Diablo' (Ninebark)	*Myrica* spp. (Bayberry)	*Viburnum trilobum* (Highbush cranberry)
	Viburnum dentatum v. lucidum (Arrowwood)	*Osmanthus americanus* (Wild Olive)	
	Viburnum lentago (Nannyberry)	*Prunus americana* (Wild Plum)	
	Viburnum nudum v. cassinoides (Witherod)	*Prunus maritima* (Beach Plum)	
	Viburnum opulus v. americanum 'Wentworth' (American Cranberry Bush)	*Prunus monsoniana* (Wildgoose Plum)	
	Viburnum prunifolium (Black Haw)	*Quercus ilicifolia* (Scrub Oak)	
		Shepardia canadensis, S. argentea (Silverberry)	
		Styrax americanus (American Snowbell)	
		Styrax platanifolius (Sycamore-leaf Snowbell)	
		Viburnum prunifolium (Black Haw)	

red: sources in agreement

Future Work:

Future versions of the EFG software used to create the database and queries will include the capability to do "OR" searches (ex. Show me all the plants that are Herbs OR Shrubs AND have white flowers). We also hope to implement a system where the user can mark interesting species and produce a printable "shopping list" of native plants.

We will be working with gardeners and landscapers to identify the characters that they consider most important to when selecting a plant, and add this data to the database when possible.

The next version of the "Native Alternatives to Invasive Plants" website will include terrestrial plants from the invasive lists of all six New England states, and will include photos of the listed plants. We also hope to continue to increase the number of native plants that are potential matches by adding more databases from other sources of native plants.

REFERENCES:

Abbey, Timothy M., editor. 2004. Native Alternatives for Invasive Ornamental Plant Species. The Connecticut Agricultural Experiment Station, for the Connecticut Invasive Plant Working Group, Connecticut.
Batcher, Michael S. and Stiles, Shelly A. 2000. ELEMENT STEWARDSHIP ABSTRACT for Lonicera maackii (Rupr.) Maxim (Amur honeysuckle), Lonicera morrowii A. Gray (Morrow's honeysuckle), Lonicera tatarica L. (Tatarian honeysuckle), and Lonicera x bella Zabel (Bell's honeysuckle) The Bush Honeysuckles. The Nature Conservancy, Virginia.
Bluestem Nursery. 2005. Ornamental Grasses. British Columbia.
Brand, Mark. 2001. UConn Plant Database of Trees, Shrubs and Vines. University of Connecticut, Connecticut.
Connecticut Botanical Society. 2005. Gallery of Connecticut Wildflowers. Connecticut.
Cullina, William . 2002. Native Trees, Shrubs & Vines: A Guide to Using, Growing, and Propagating North American Woody Plants. Houghton Mifflin.
Lawlor, Fran. 2001. ELEMENT STEWARDSHIP ABSTRACT for Vincetoxicum nigrum (L.) Moench. & Vincetoxicum rossicum (Kleopov) Barbarich Swallow-wort. The Nature Conservancy, Virginia.
Little, Elbert L. 1980. The Audubon Society Field Guide to North American Trees: Eastern Region. Alfred A. Knopf. New York.
Massachusetts Invasive Plant Advisory Group. 2005. The Evaluation of Non-Native Plant Species for Invasiveness in Massachusetts. MNLA, Massachusetts.
Mehrhoff, L. J., J. A. Silander, Jr., S. A. Leicht, E. S. Mosher and N. M. Tabak. 2003. IPANE: Invasive Plant Atlas of New England. Department of Ecology & Evolutionary Biology, University of Connecticut.
Newcomb, Lawrence. 1977. Newcomb's Wildflower Guide. Little, Brown and Company, Boston.
Niering, William A. and Olmstead, Nancy C. 1979. The Audubon Society Field Guide to North American Trees: Eastern Region. Alfred A. Knopf, New York.
Nuzzo, Victoria. 1997. ELEMENT STEWARDSHIP ABSTRACT for Lonicera japonica. The Nature Conservancy, Virginia.
Perry, Leonard P. 2005. PSS123 Herbaceous Garden Plants Course Web Page. University of Vermont, Vermont.
USDA, NRCS. 2005. The PLANTS Database, Version 3.5 - Conservation Plant Characteristics . National Plant Data Center, Baton Rouge, LA.

ACKNOWLEDGEMENTS:

The authors wish to thank the New England Wild Flower Society for the use of the 2005 Native Plant Catalog to create this product.

The EFG Project (http://efg.cs.umb.edu) is funded in part by the NSF.