

The Forest Health Technology Enterprise Team (FHTET) was created in 1995 by the Deputy Chief for State and Private Forestry, USDA, Forest Service, to develop and deliver technologies to protect and improve the health of American forests. This book was published by FHTET as part of the technology transfer series.

<http://www.fs.fed.us/foresthealth/technology/>

Cover Images:

Top Row:

Dusky clearwing, *Paranthrene tabaniformis* (Rottemberg). Photo by Gyorgy Csoka, Hungary Forest Research Institute.

Red heart of pine, *Phellinus pini* (Thore) Fr. in slash pine. Photo by David J. Moorhead, The University of Georgia.

Spruce beetle, *Dendroctonus rufipennis* Kirby, damage, Kenai Peninsula, Alaska. Photo by David J. Moorhead, The University of Georgia.

Clitocybe root disease, *Clitocybe* spp. (Fr.) Staude. Photo by Robert L. Anderson, USDA Forest Service (retired).

Musk thistle, *Carduus nutans* L. Photo by Steve Dewey, Utah State University.

Middle Row:

Eastern pine weevil (Deodar weevil), *Pissodes nemorensis* Germar, pupa. Photo by Gerald J. Lenhard, Louisiana State University (retired).

Bark beetle damage. Photo by Erich G. Vallery, USDA Forest Service.

Pine caterpillar, *Dendrolimus pini* Linnaeus. Photo by Stanislaw Kinelski.

Bottom Row:

Fire in lodgepole pine stand. Photo from USDA Forest Service - Rocky Mountain Region Archives.

Winter sunrise over fairgrounds, Zanesville, Ohio. Photo by Kenneth Gale.

Viceroy, *Limenitis archippus* (Cramer). Photo by David Cappaert.

Kudzu, *Pueraria montana* (Lour.) Merr. Photo by James H. Miller, USDA Forest Service.

Oak wilt disease, *Ceratocystis fagacearum* (T. W. Bretz) J. Hunt, leaf symptoms on live oak. Photo by Ronald F. Billings, Texas Forest Service.

Bobcat, *Lynx rufus* Schreber. Photo by Terry Spivey, USDA Forest Service.

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FORESTRY IMAGES

WWW.FORESTRYIMAGES.ORG

DEVELOPMENT METHODOLOGY AND TECHNOLOGY, 1995-2005

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Salina McAllister served a key role in this project as Digital Image Archive Specialist from 2001-2005 responsible for image editing and information management. She now serves as Administrative Assistant for the Bugwood Network. We would also like to thank Derrick Cromer and Casey Sanders for reviewing and commenting on drafts this publication.

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INTRODUCTION

The effectiveness of forest health management actions often depend upon correct identification of biological factors—insects and diseases—and an understanding of the ecosystem in which they operate (see Figure I-1). Because these organisms can be small and inconspicuous, the availability of good images aids greatly in their identification. However, ready access to quality images of these organisms and their damage has long been a problem.

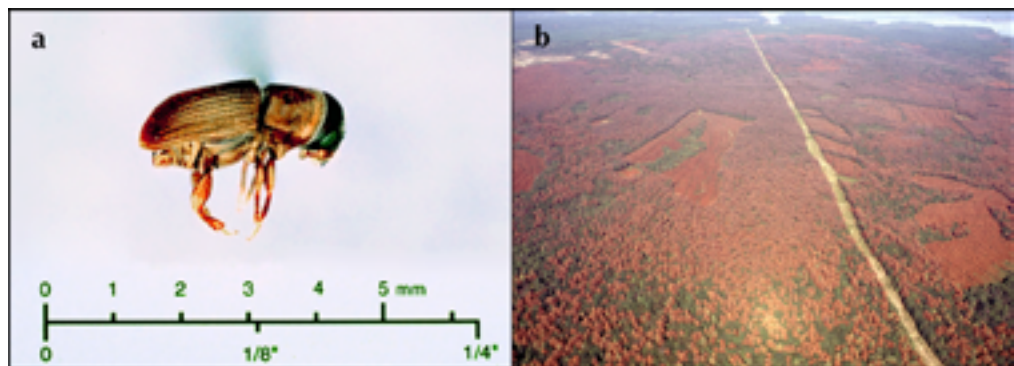


Figure I-1. a: Southern pine beetle adult (photo by Gerald Lenhard, Louisiana State University). b: Southern pine beetle damage to Indian Mounds Wilderness Area in eastern Texas, September 29, 1993 (photo by Ronald Billings, Texas Forest Service).

Throughout the years, high quality photographs of forest health-related organisms have been taken, though these images typically exist as 35mm slides in laboratories, field offices, and individual slide collections. As individuals retire or are promoted, and as offices and personnel change, these images are easily misplaced or are no longer available. Additionally, unless individuals duplicate these slides and distribute the duplicates to others, only the holder of the original slide has access to that image. And even when duplicates are made and slides are passed along to others, vital information about the slide—such as the photographer, subject identification and description of the image—is often lost, limiting the usefulness of the image in identifying the subject and its range.

Today the World-Wide Web and electronic communications applications (such as Microsoft PowerPoint®) offer exciting opportunities to capture and deliver such information to forest health managers, other professionals, and the general public.

Additionally, most printed materials are now developed and delivered to printers via computer software, using images in digital formats. However, several limitations are immediately evident to anyone looking for such images:

- locating desired, high quality images
- immediate access to images
- formats
- documentation
- release and permission for use

The availability of digitized, documented, high quality images can greatly benefit forest health planning, management, and education. To address this need, Forestry Images was developed by the Bugwood Network.

THE BUGWOOD NETWORK

The Cooperative Extension Service was established in 1914 to deliver information developed by land-grant colleges and universities to the general public. Most of Georgia's 159 counties have Cooperative Extension Service offices and agents to fulfill this mission. These agents are supported by a network of Extension faculty. Drs. G. Keith Douce and David J. Moorhead provide educational information and training for Extension agents, landowners, foresters, and resource managers in forest health and management programs. As Professor and Extension Entomologist in The University of Georgia, College of Agricultural and Environmental Sciences, Dr. Douce's responsibilities include forest entomology, integrated pest management (IPM) and coordination of the USDA Animal and Plant Health inspection Service (APHIS) Plant Protection and Quarantine (PPQ) sponsored Cooperative Agricultural Pest Survey (CAPS) program. Dr. David Moorhead, Professor of Silviculture at The University of Georgia, Daniel B. Warnell School of Forest Resources, is an authority in forest regeneration, silviculture, forest management, prescribed fire, forest herbicides, and forest IPM.

In January of 1979, at the eve of the computer revolution, Dr. Keith Douce wrote in the *Journal of Extension* an article entitled "A Blue-Sky Perspective," in which he foresaw a future where information could be "transferred directly to the user's home computer." He also stated that "it's up to every Extension professional to consider ways to take advantage of this technology, and reach out and develop innovative program applications for it." The Forestry Images system is one of the many products developed by the Bugwood Network to fulfill this vision.

In 1994, Dr. Douce and Dr. Moorhead, decided to put the "Blue-Sky Perspective" philosophy, written 15 years earlier, into action and formed the Entomology and Forest Resources Digital Information Work Group, later renamed the Bugwood Network. The Network personnel currently consists of Drs. Douce and Moorhead, a technology coordinator, a natural resources–invasive species coordinator, a computer specialist, a digital image specialist and administrative support.

The Networks' mission is:

To gather, create, maintain, promote the use of, and distribute digital information as tools to enhance and complement information exchange and educational activities.

The primary objectives of the Network are:

- Acquisition and creation of original materials
- Conversion of materials to consistent forms and formats
- Organization and maintenance of the collection of materials
- Distribution of materials using information technologies

The Network originally focused on CD-ROM-based projects in the areas of entomology, forestry, forest health and forest Integrated Pest Management (IPM) relating to Georgia and the Southeastern United States. The Bugwood website was created to support these areas. This website quickly grew and became the portal from which related sites and subject areas are accessible. The Bugwood Network of websites now consists of fifteen different sites with specific emphasis on insects, diseases, weeds, invasive plants forestry, agroforestry, agriculture, integrated pest management and information technologies in North America and other locations across the world. The Network creates new materials and converts existing materials for web delivery. It is expanding the traditional definition of Extension to a global audience through use of the World Wide Web.



“Bugwood” is simply an easy to remember brand name for the products and websites developed by the group, not unlike Google®, Yahoo!® or Microsoft®. The logo (left) depicting four arrows intersecting represents the integration of various disciplines and technologies working together toward a common goal. Network activities include development of projects using multimedia, websites, and computer imagery to enhance information and knowledge in entomology, forest health and forestry education.

During the Bugwood Networks' first five years of existence (1995-1999), the World Wide Web grew from 5.8 million internet hosts in 1995 to 43.2 million internet hosts in 1999 (<http://www.isc.org/>). The increased professional and public use of the Web allowed the Network's focus to shift from CD-ROM based projects to web based projects. The Bugwood website also grew from a small site to advertise the CD-ROM products and to host Drs. Douce and Moorhead's publications to a portal of fifteen area-specific and hosted sites distributing information based on subject area. These websites are:

- Bugwood Network, www.bugwood.org
- Forestry Images, www.forestryimages.org
- Invasive and Exotic Species, www.invasive.org
- Insect Images, www.insectimages.org

- IPM Images, www.ipmimages.org
- Forest Pests of North America, www.forestpests.org
- Bark Beetles of North America, www.barkbeetles.org
- Georgia Integrated Pest Management, www.gaipm.org
- Georgia Invasive Species Task Force, www.gainvasive.org
- Georgia Exotic Pest Plant Council, www.gaeppc.org
- Southeast Exotic Pest Plant Council, www.se-eppc.org
- Southern Forest Insect Work Conference, www.sfiwc.org
- Eastern Arc Mountains Information Source, www.easternarc.org
- Cogongrass in the Southeast U.S., www.cogongrass.org
- Regional Tropical Soda Apple Task Force, www.tropicalsodaapple.org

The traffic to the Network sites has increased from over 150,000 hits each month in 2000 (Barger et al. 2000) to over 6.5 million each month by the summer of 2005 (including the image archive sites). Numerous website projects increased the scope of the image archive both for the need of project images and through new contacts for image sources that were made while working on the projects. The evolving web-based focus of the Network led to the idea of making the image archive available to the world via a web interface. The concept of the web-based archive was presented at the University System of Georgia Annual Computing Conference in October of 1999. In 2000, three USDA Forest Service Forest Health Protection units—the Forest Health Technology Enterprise Team, the Southern Region and the Washington Office—jointly funded a two year project to develop a web-based version of the archive. The Forestry Images archive consisted of roughly 6,500 images at the end of 2000.

FORESTRY IMAGES

Forestry Images was developed with the specific purpose of making high-quality digital JPEG images freely available through the Web for educational purposes.

The project, “Forestry Images” was released in July of 2001 with 3,500 images available. Over the next two years Forestry Images grew to over 20,000 images and was averaging one million ‘hits’ each month. Images were being used in scientific journals, presentations, websites, textbooks, CD-ROMs and basically anywhere images can be used. In the fall of 2003, development began to make Forestry Images faster, more compatible, more modular, and easier to use by taking advantage of enhancements to the technology. After a year of development and testing, Forestry Images 2.0 was released in October 2004.

By September of 2005, Forestry Images was averaging two million ‘hits’ each month with over 32,000 images from 916 photographers available through the system. Visitor traffic increased 450% since 2002 to nearly 1.4 million visitor in the first three quarters of 2005.

Additionally, 42,500 requests for personal and educational usage and 4,000 requests for commercial and media uses were received from October 2004 through September 2005. All images in the system are available for educational non-profit applications at no cost to the user, the only stipulation being that each image used must be credited

to the photographer and ForestryImages.org. Commercial use requests are referred to the photographer. Forestry Images and The Bugwood Network do not collect any fees for commercial use. All non-public domain image copyrights are retained by the photographer.

Funding for Forestry Images has continued with cooperative agreements between the USDA Forest Service Forest Health Protection Units and the University of Georgia. Specific applications and web interfaces focused on invasive species and agricultural IPM have been developed through cooperative agreements with USDA APHIS PPQ, USDA CSREES, and the National Science Foundation's Center for Integrated Pest Management.

FUTURE PLANS

Cummulatively, the Bugwood Network websites have been successful in providing information for specific needs, and have received recognition for both content and design. Use has increased dramatically every year since creation, and images from the Network are being used in a wide range of applications. It has become an integral source for images used in U.S. government agency natural resource applications as well as educational programming carried out by a wide array of education professionals.

Future versions of Forestry Images will incorporate web services for sharing information and images across the Web. Macromedia Flash and other new technologies will be used to enhance user interfaces. Microsoft ActiveX and Java components will be used to enable users to upload multiple images for inclusion into the system. Plans are in development for internationalization of Forestry Images by incorporating additional languages and image location information. Forestry Images will continue to add images to meet the needs of the diverse and growing user group.

ABOUT THIS PUBLICATION

This publication focuses on the development methodology and technology behind the Forestry Images system and its four major components:

Chapter 1: Using the Website. This chapter describes the features of Forestry Images and the ways in which users can find, download, and use images available there.

Chapter 2: Submitting Photographs. This chapter discusses digital imaging, including the types of images available on Forestry Images, photography tips, workflow for scanning and editing images, and image submission guidelines.

Chapter 3: Applications. This chapter features examples of how the Forestry Images system is used and integrated into other applications.

Chapter 4: Technology Development. This chapter discusses the development of the Forestry Images website, including development and use of the database management system and the Web interface.

CHAPTER 1: USING THE WEBSITE

Forestry and forest health professionals, researchers, educators, and private citizens can access the Forestry Images website to

- browse a library of forest health-related images and their descriptions
- identify and view an image of interest
- download the image for use in presentations and publications

The site architecture, based on a relational database, enables the user to search for specific images according to various criteria and to browse existing images according to image classification. (Chapter 4 includes more details on the sites reviewed for development of the Forestry Images architecture.)

Features of Forestry Images include:

- Organization of images by organism and management type
- Use of both common and scientific names for biological organisms
- Availability of images in multiple resolutions
- Unrestricted educational and non-commercial use of images without cost

Accessing the Website

The website is available through any Web browser at *www.forestryimages.org* or an equivalent link on a related website. Opening the site brings up the homepage (Figure 1-1).

The site navigation bar at the top right of each page (Home, About Us, Join/Sign in, Your Account and Help) (Figure 1-2), the topic-based area at center, and the left side bar all use cascading style sheets to create a rollover effect and highlight the links.

The homepage allows users with different interests to locate images in two ways. A search field at the top allows the user to enter searches according to various criteria while the central portion of the page allows the user to browse images according to nested categories.

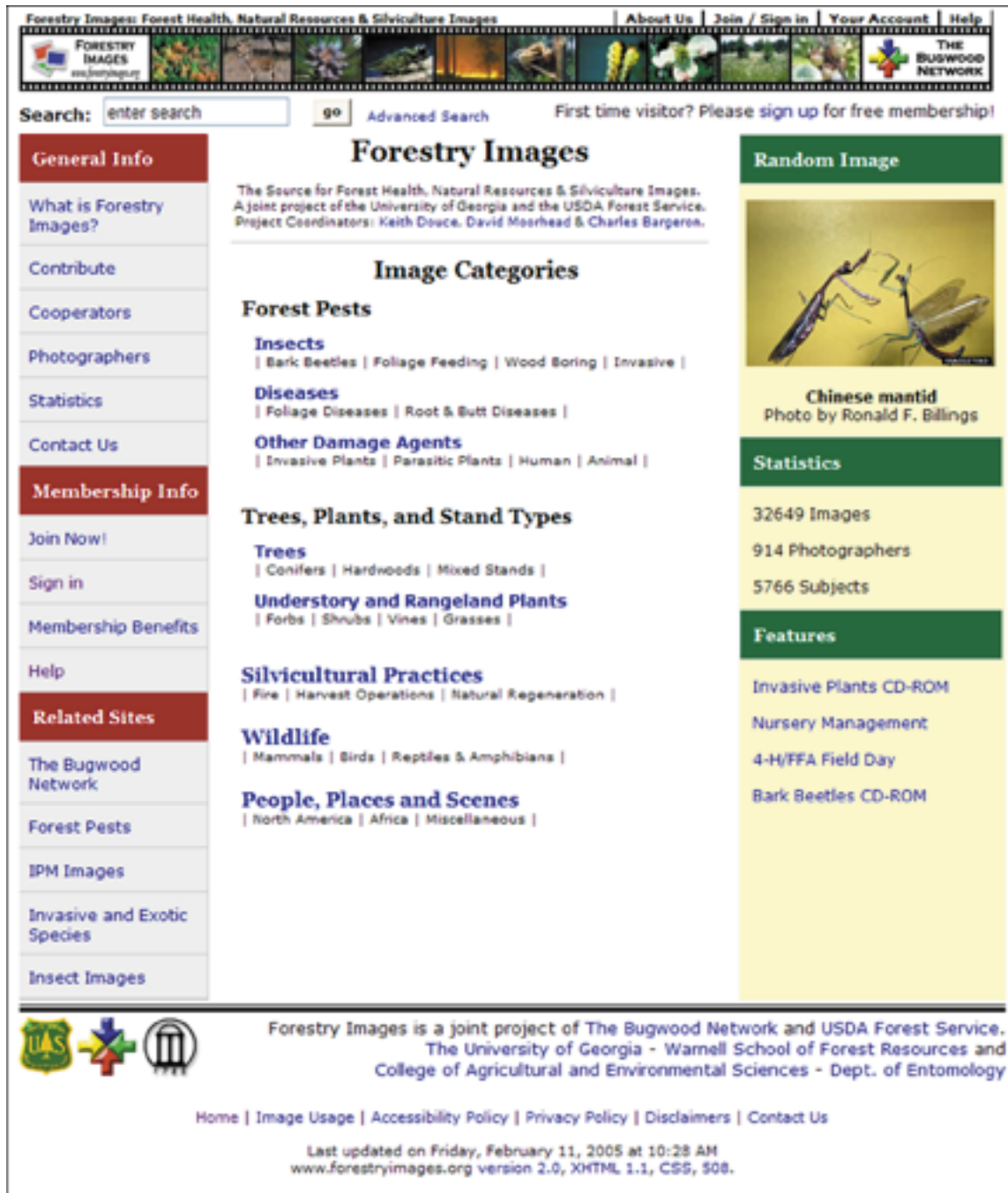


Figure 1-1. Forestry Images homepage version 2.0.

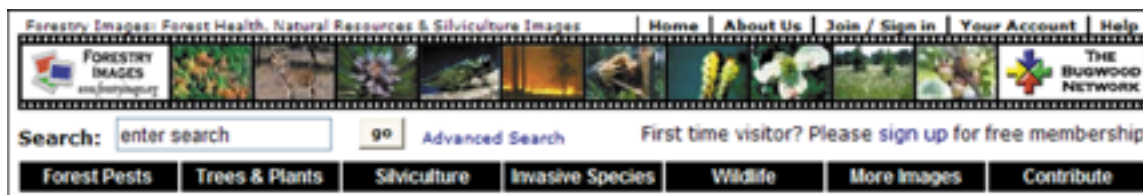


Figure 1-2. Forestry Images 2.0 header.

Searching the Website

Searches can be performed through a number of criteria, all entered in the 'Search' field in the left-hand column of the page:

- Common name
- Scientific name
- Taxonomic hierarchy
- Host
- Photographer
- Designated image number
- Descriptor and Descriptions

A search displays the fields of all available images in the system that meet the search criteria (Figure 1-3) and a link at the upper right provides a view of thumbnails for each of those images (Figure 1-4).

Search Results				
Your search for "black turpentine beetle" returned 38 of 30653 records				<View Thumbnails>
Image	Subject	Scientific Name	Descriptor	Photographer
1669048	southern pine beetle	<i>Dendroctonus frontalis</i> Zimmermann, 1868	Adult(s)	Southern Forest Insect Work Conference Archives
1669049	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Damage	North Carolina State University Archives
1669052	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Larva(e)	North Carolina State University Archives
1929031	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Damage	Tim Tigner
1929032	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Damage	Tim Tigner
2089086	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Damage	Lacy L. Hyche
2089087	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Damage	Lacy L. Hyche
2089088	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Damage	Lacy L. Hyche
2089089	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Adult(s)	Lacy L. Hyche
2516001	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Adult(s)	David T. Almquist
2516002	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Adult(s)	David T. Almquist
2733010	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Damage	Terry Price
2733011	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Adult(s)	Terry Price
3225006	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Galleries	Ronald F. Billings
3225007	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Galleries	Ronald F. Billings

Figure 1-3. Search results (description).



Figure 1-4. Search results (thumbnails).

The 'Advanced Search' option at the home page allows the user to focus the search by entering multiple search criteria at once (Figure 1-5), or simply to identify the search criteria through a set of pull-down menus with search options (Figure 1-6).

Browse Forestry Images	
Forest Pests	Silvicultural Practices
Insects	Regeneration Practices
Foliage Feeding Insects	Site Preparation: Slash Treatments
Bark Beetles	Site Preparation: Competition Control/Seedbed Preparation
Weevils	Site Preparation: Amelioration
Boring Insects	Natural Regeneration
Chewing Insects	Artificial Regeneration
Sucking Insects	
Gallmakers	Nursery Operations
Seed / Cone / Flower / Fruit Insects	Introduction
Stinging / Biting / Nuisance Insects	Bareroot
Beneficials and Insect Predators	Container
Misc. Insects	Propagation of Cuttings
	Seed Orchards, Seed Collection and Handling
Diseases	Intermediate Treatments
Root/Butt Diseases	Thinning
Stem Decays/Cankers	Timber Stand Improvement
Foliage Diseases	Fire and Fire Effects
Decline Complexes Dieback/Wilts	
Stem Rusts	Forest Products
Broom Rusts	Harvest Operations
Biotic Damage	Christmas Tree Production
Diseases of Insects	Pine Straw Production
Fungi	Maple Syrup Production
	Wood Products
Other Damage Agents	Non-Wood Forest Products
Abiotic Damage	
Human Damage	Forest Resources
Animal Damage	Soil and Water
Multi Damage	Agroforestry
	Urban Forestry
Trees	Hybrid Poplar
Conifers	Misc. Forestry
Hardwoods	
Mixed Species	Wildlife
	Mammals
Understory / Rangeland Plants	Birds
Forbs and Herbs	Reptiles & Amphibians
Grasses, Sedges and other Grass-like Plants	Worms, Snails & Leeches
Shrubs and Subshrubs	
Vines	People, Places and Scenes
Palms	North America
Ferns	
Cactus	

Figure 1-7. Forestry Images browse interface.



Figure 1-8. Areas under the domain “Trees.”

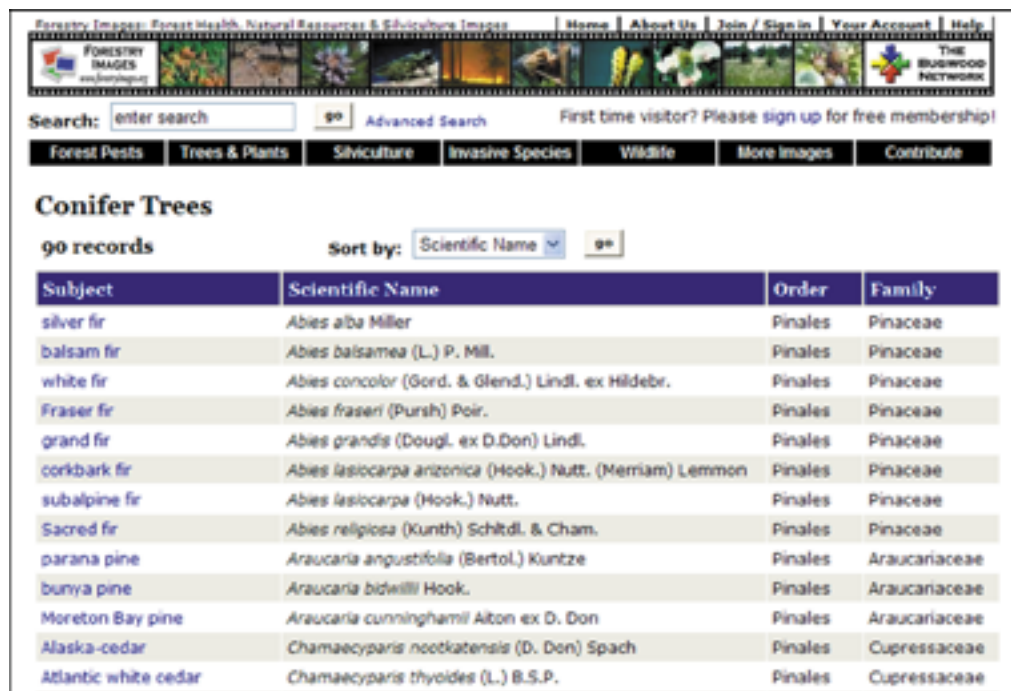




Figure 1-9. Subjects under the area “Conifer Trees.”

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longleaf pine

Trees: [Conifer Trees](#)


[Pinopsida](#) > [Pinales](#) > [Pinaceae](#) > *Pinus palustris* P. Mill.

134 records [<View Images as Host>](#) Sort by: [<View Thumbnails>](#)

Image	Descriptor	Description	Photographer
1420015	Competition	Dead scrub hardwoods and grass on herbicide treated plots, USDA Forest Service - Conecuh National Forest, Andalusia, Alabama, Feb. 1954	Thomas C. Croker
1420067	Competition	longleaf litter, Conecuh, Alabama, May 1967	W. Robert Maple
1423023	Competition	Hardwoods invading stand, Escambia Experimental Forest, May 1962	William D. Boyer
1423024	Competition	Hardwoods invading stand, Escambia Experimental Forest, September 1986	William D. Boyer
1423025	Competition	Residual hardwoods following pine harvest inhibit natural regeneration; Union Camp, Butler county, Alabama, October 1977	William D. Boyer
1420124	Damage	7-year old seedling stand heavily grazed. Compartment 94, USDA Forest Service - Escambia Experimental Forest, Brewton, Alabama, December 1954	Virgil Davis
1239005	Development	Container-grown seedlings after 3 growing seasons. Height range 6 to 14 feet. Randolph County Alabama. October 2003	David Stephens
1239009	Development	Container-grown seedling after 3 growing seasons. Height 6.5 feet. Randolph County Alabama. February 2002	David Stephens
1247238	Feature(s)	Large tap root	Terry Price
1397026	Feature(s)	grass stage	Joseph O'Brien
1423016	Feature(s)	Open grass land and longleaf "stump orchard" remain after logging. High stumps from jump-butt cat faces after naval stores production.	Thomas C. Croker
1423032	Flowers/fruit/cones	Pistillate strobili in late April, recent flowers and developing cones for current year	William D. Boyer
1423033	Flowers/fruit/cones	Pistillate strobili in mid September	William D. Boyer
1423034	Flowers/fruit/cones	Staminate strobili before (right) and after (left) shedding pollen	University of Georgia Archives
1423037	Flowers/fruit/cones	Unusual cone development on a seven year old tree; flowers initiated in fourth growing season, mature cones form by age six	William D. Boyer
1423049	Flowers/fruit/cones	Cones with heavy regeneration, May 1962	William D. Boyer
2715007	Flowers/fruit/cones	seedling germination in fall	USDA Forest Service Archives

Figure 1-10. Image description view.

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longleaf pine Trees: [Conifer Trees](#)

[Pinopsida](#) > [Pinales](#) > [Pinaceae](#) > *Pinus palustris* P. Mill.

134 records [<View Images as Host>](#) Sort by: [<View Descriptions>](#)

[< Previous >](#) **Results 121 - 134** Images per page: [[15](#)] [30](#) [60](#) [all](#)










 1150076 Stand Chuck Bargeron	 1150080 Stand Chuck Bargeron	 1162022 Stand 65-year old natural stand. Tift County Georgia. David J. Moorhead
 1162029 Stand 10-year old stand established using bareroot seedlings on a peanut field. Tifton, Georgia David J. Moorhead	 0908061 Stand 8-year old bareroot stand David J. Moorhead	 0908062 Stand 10 year-old bareroot stand. David J. Moorhead
 0908063 Stand 10 year-old bareroot stand. David J. Moorhead	 0908064 Stand 3 year-old bareroot stand. David J. Moorhead	 0908071 Stand bareroot stand in active height growth stage David J. Moorhead

Figure 1-11. Image thumbnail view.

Image Number: 0908063

Add to Shopping Cart
 PowerPoint - 768x512
 Small Print - 1536x1024
 Large Print - 3072x2048

Image Usage
 Personal
 Educational
 Media
 Commercial

longleaf pine
 Pinopsida > Pinales > Pinaceae
Pinus palustris P. Mill.

Photographer: David J. Moorhead, The University of Georgia
Descriptor: Stand
Description: 10 year-old bareroot stand.

Available Images Resolutions:
 192x128
 384x256
 768x512
 1536x1024 - Available only to registered members
 3072x2048 - Available only to registered members

More Images:
 longleaf pine
 Genus: *Pinus*
 Family: Pinaceae
 Order: Pinales
 Class: Pinopsida
 Photographer: David J. Moorhead, The University of Georgia

Image Citation:
 David J. Moorhead, The University of Georgia, www.forestryimages.org

Image Use:
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Image Information last updated on Thursday, November 07, 2002

Figure 1-12. Image details page.

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Once the user identifies an image, permission to use that image for commercial purposes can be requested from this page. When requesting permission, the user is presented with a form to complete and the results are logged to the database. An e-mail with the contents of the form is sent to the Bugwood Network and the photographer.

Downloading Images

The user may add the image to their shopping cart (Figure 1-13) for batch image downloading and usage requests, and may choose between links to each of the available resolutions. In order to download the higher resolutions the user must first register with the system: a registration screen (Figure 1-14) will appear when these resolutions are requested.

There is no cost associated with registration: registration is used as a means to track image usage and usage of the overall Forestry Images system. All information is used internally only and helps to make Forestry Images better suit the needs of the users.


Lower-resolution images (192 x 128 pixels and 384 x 256 pixels) are suitable for use in on-screen presentations and web sites; medium resolutions (768 x 512 pixels) are appropriate for in-house printing and projection (such as PowerPoint); and high-resolution images (1536 x 1024 pixels and 3072 x 2048 pixels) are sufficient for commercial printing.

Shopping Cart

The Shopping Cart feature allows you to batch download images and information. It also allows you to request permission for commercial, print and electronic media use.

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Empty Shopping Cart

Image	Information	Resolution
0908063	 <p>longleaf pine <i>Pinus palustris</i> P. Mill. Stand Photo by David J. Moorhead, The University of Georgia</p>	Small Print <input type="button" value="Update"/>

Please tell us how you plan to use these images. Thanks!

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Personal use
 Educational
 Commercial | Company name:
 Electronic or Print Media

Intended use(s):

Publication | Publ. Name:
 Web site | URL:
 PowerPoint Presentation
 Display or exhibit
 Other:

Other Comments:

Figure 1-13. Shopping Cart page.

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Forestry Images and Information | THE BUGWOOD NETWORK

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Download Images and Information

Image	Information	Download
0908063	<p>longleaf pine - <i>Pinus palustris</i> P. Mill. - Stand</p> <p>Citation: David J. Moorhead, The University of Georgia, www.forestryimages.org</p>	[image] [rtf]

[Download information in Microsoft Word format](#)
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 Forestry Images is a joint project of The Bugwood Network and USDA Forest Service.
 The University of Georgia - Warnell School of Forest Resources and
 College of Agricultural and Environmental Sciences - Dept. of Entomology

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Last updated on Tuesday, August 23, 2005 at 10:50 PM
www.forestryimages.org version 2.0, XHTML 1.1, CSS, 508.

Figure 1-14. Download page.

CHAPTER 2: IMAGE DATABASE APPLICATIONS

One of the major advantages of a species-oriented image database is that applications can be built to handle information complementing the images. The following chapter gives examples of Web applications and publications that have been developed using the Forestry Images framework and images.

Forestpests.org

Forestpests.org is an information-oriented Web application focusing on insects, diseases, weeds, and other damaging agents to forests in North America (Figure 2-1). The site includes HTML-based version of publications related to identification of, and control efforts for, forest pests. Links in the website bring up images from the Forestry Images database. From the home page of ForestPests.org, the user is presented with a choice of categories under the headers of Insects, Diseases, Weeds and Other Agents. The user is also able to view publications available on the site. The top of the page has a “Feature” and a “What’s New” section.

After the user chooses a category, a list of species with scientific name, subject name, order and family is returned. Upon choosing a species, the browser returns the corresponding page. From this page, users can browse locally hosted publications, links to remote pages, and selected images best illustrating the species. Users are also provided a link to all the images available via the Forestry Images system.

Bark Beetles of North America CD-ROM

The *Bark Beetles of North America* CD-ROM (Douce et al. 2001) and website (www.barkbeetles.org) provide users with information and images related to the most important bark beetles affecting trees in North America (Figure 2-2). The CD-ROM was the first product from the Bugwood Network to combine images and information in an easy to use HTML interface, and provides 192 high resolution images covering 28 species. The website provides links to relevant publications and images from the Forestry Images image files.

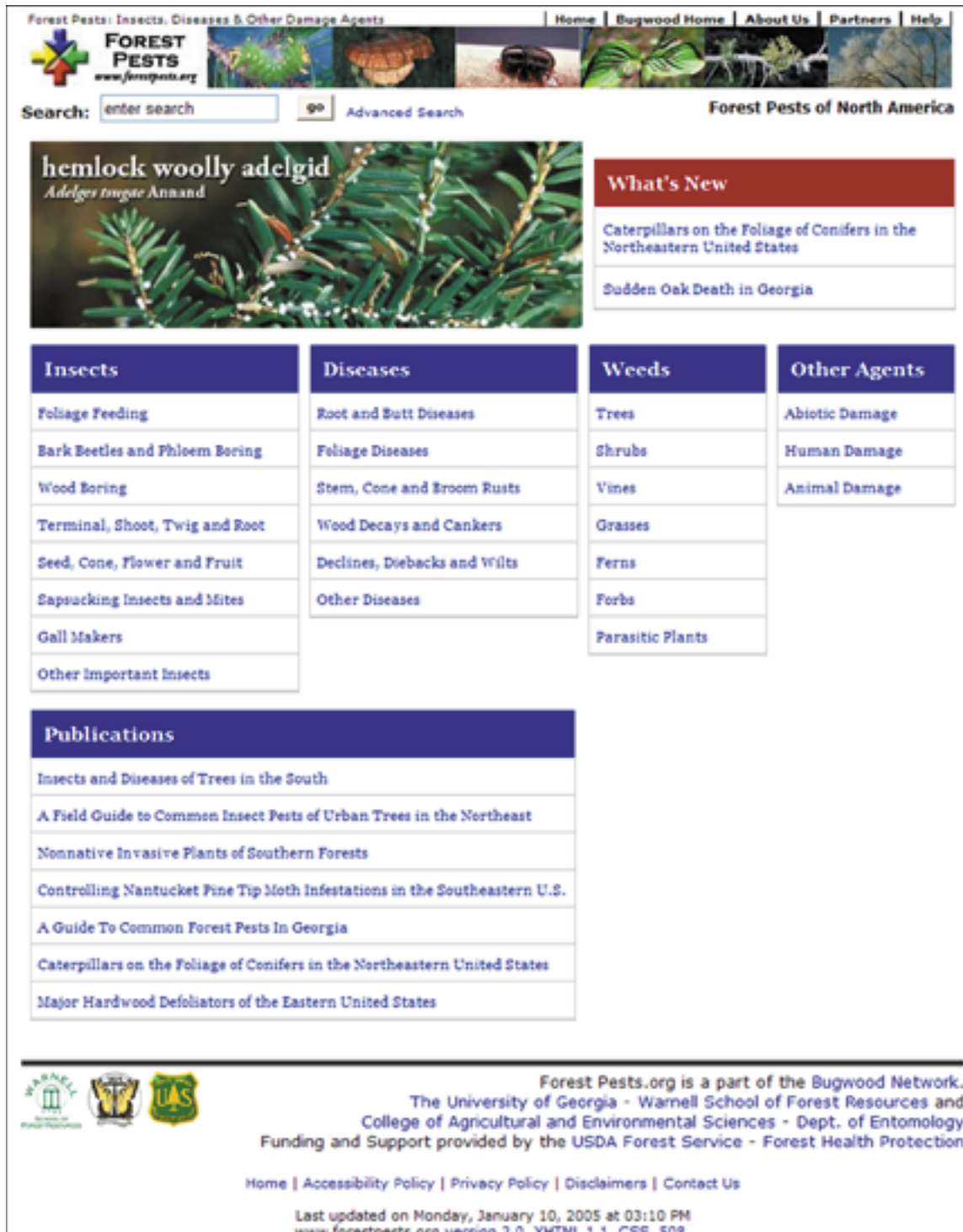


Figure 2-1. ForestPests.org homepage.



BUGWOOD
www.bugwood.org

BARK BEETLES OF NORTH AMERICA
IMAGE AND FACT SHEET LIBRARY - WWW.BARKBEETLES.ORG

General Bark Beetle Images and Information

***Dendroctonus* spp.**
 Western Pine Beetle - *Dendroctonus brevicornis* LeConte
 Spruce Beetle - *Dendroctonus engelmanni* Hopkins
 Southern Pine Beetle - *Dendroctonus frontalis* Zimmermann
 Jeffrey Pine Beetle - *Dendroctonus jeffreyi* Hopkins
 Mountain Pine Beetle - *Dendroctonus ponderosae* Hopkins
 Douglas-fir Beetle - *Dendroctonus pseudotsugae* Hopkins
 Spruce Beetle - *Dendroctonus rufipennis* Kirby
 Black Turpentine Beetle - *Dendroctonus terebrans* (Olivier)
 Red Turpentine Beetle - *Dendroctonus valens* LeConte

***Ips* spp.**
 Small Southern Pine Engraver - *Ips avulsus* (Eichhoff)
 Sixspined *Ips* - *Ips calligraphus* (Germar)
 Eastern Fivespined *Ips* - *Ips grandicollis* (Eichhoff)
 Northern Spruce Engraver Beetle - *Ips perturbatus* (Eichhoff)
 Pine Engraver - *Ips pini* (Say)

Other Conifer Beetles
 Western Balsam Bark Beetle - *Dryocoetes confusus* Swaine
 Fir Engraver - *Scolytus ventralis* LeConte

Clerid Beetle - *Thanasimus dubius* (F.)

Order Now!
Forest Insects and Their Damage
Volumes III and IV
Bark Beetles of North America



The 2 disc set includes 192 high resolution images along with publications on identification, distribution, and management.

Figure 2-2. Bark Beetles of North America webpage.

Invasive.org


Invasive.org features information and images for over 600 invasive insects, weeds, diseases, nematodes, vertebrates, and their biological control agents (Figure 2-3). These species are organized into groups based on type (insect, weed, disease, etc.). Similar to *forestpests.org*, each group page provides a list of illustrated species, including scientific name, subject name, order and family. However, unlike *forestpests.org*, the list is generated by summarizing over 70 lists of invasive species that are cross-referenced in the Forestry Images database. These lists include agency lists (such as the USDA APHIS Regulated Pest List), project lists (North American Forest Commission Exotic Forest Pest Information System), regional lists, state invasive plant lists and state noxious weed lists. The user is able to view the compiled list by type or each individual list linked from the species pages. The user can view locally hosted and linked publications along with selected images and a link to a comprehensive view of all species images.

USDA Forest Service Publications

Another feature of Invasive.org is the hosting of various publications by the USDA Forest Service FHTET (Figure 2-4). Along with hosting the online versions of these publications, images from the publications have been acquired and are stored in the Forestry Images database. Screen-resolution versions of the images in the HTML version of the publications are linked to multiple-resolution copies in the Forestry Images system: for example, all images from the very popular USDA Forest Service Southern Region publication entitled *Nonnative Invasive Plants of Southern Forests - A Field Guide for Identification and Control* (Miller 2003) are available through the *Invasive.org* website (Figure 2-5). In fact, the Web version of the publication and its images were available over two years before a printed version of the same book.


Recently, images available through Forestry Images were the primary source of images in the FHTET publication: *Invasive Plants of Asian Origin Established in the United States and Their Natural Enemies* (Zheng et al. 2004), bringing the process full-circle. Images from Forestry Images have also been used recently in the USDA Forest Service Northeastern Area *Backyard Woods* (Majeski et al. 2005) publication, as well as the *Forest Service Centennial: A new century of service* (Seeger et al. 2005).

Invasive and Exotic Species



INVASIVE SPECIES
www.invasive.org

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Invasive.org

The Source for Information and Images of Invasive & Exotic Species
A joint project of The University of Georgia's Bugwood Network, USDA Forest Service and USDA APHIS FPO.

Information and Images

- [Insects](#)
- [Weeds](#)
- [Diseases](#)
- [Other Invasives](#)
- [Biocontrol Agents](#)

Featured Collection



Forest Pests of Poland
Images by Stanislaw Kinelski
Hylabius piceus (De Geer)

Publications

- [Invasive Plants of Asian Origin Established in the United States and Their Natural Enemies](#)
- [Biological Control of Hemlock Woolly Adelgid](#)
- [Invasive Plants of the Eastern United States: Identification and Control Web Site](#)
- [Nonnative Invasive Plants of Southern Forests - A Field Guide for Identification and Control](#)
- [Biology and Biological Control of Knapweed](#)
- [Biology and Biological Control of Yellow Starthistle](#)
- [Southeast Exotic Pest Plant Council Invasive Plant Manual](#)
- [Biological Control of Invasive Plants in the Eastern United States](#)
- [Plant Invaders of Mid-Atlantic Natural Areas](#)
- [Invasive Plants of the Thirteen Southern States](#)
- [More Publications @ Invasive.org Library](#)

Related Links

- [Forestry Images](#)
- [Exotic Forest Pest Information System](#)
- [Global Pest and Disease Database](#)
- [National Agricultural Pest Information System](#)
- [PCA's Alien Plant Working Group](#)
- [Exotic Pest Plant Councils](#)
- [InvasiveSpecies.gov](#)
- [TNC Invasive Species Initiative](#)
- [Global Invasive Species Database](#)
- [North American Plant Protection Organization](#)
- [European and Mediterranean Plant Protection Organization](#)

Invasive and Exotic Species

any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem; and whose introduction does or is likely to cause economic or environmental harm or harm to human health.

G. Keith Douce, David J. Moorhead, Charles T. Bergeron,
Project Coordinators, The University of Georgia

Figure 2-3. Invasive.org homepage.

The screenshot shows the Invasive.org website interface. At the top, there is a navigation menu with links for Home, About Us, Join / Sign in, Your Account, and Help. Below the navigation is a search bar with the text 'Search: enter search' and a 'go' button. To the right of the search bar, it says 'Welcome back, Chuck Bargeron, logout?'. Below the search bar is a horizontal menu with buttons for Insects, Weeds, Diseases, Other Invasives, Publications, Collections, and Contribute. The main content area is titled 'Invasive.org Library' and lists several publications under different categories: 'USDA Forest Service - Forest Health Technology Enterprise Team', 'USDA Forest Service', 'Conference Proceedings', 'European Publications', and 'Other Publications'. Each category lists specific publications with their titles and file formats (e.g., pdf).

Invasive.org Library

USDA Forest Service - Forest Health Technology Enterprise Team

- Biological Control of Invasive Plants in the Eastern United States
- Invasive Plants of Asian Origin Established in the United States and Their Natural Enemies
- Biology and Biological Control of Yellow Starthistle
- Biology and Biological Control of Knapweed
- Biological Control of Hemlock Woolly Adelgid - pdf

USDA Forest Service

- Nonnative Invasive Plants of Southern Forests - A Field Guide for Identification and Control
- Invasive Plants of the Thirteen Southern States

Conference Proceedings

- Emerald Ash Borer: Research and Technology Development Meeting 2004 - pdf
- Emerald Ash Borer: Research and Technology Development Meeting 2003 - pdf
- Proceedings of Terrestrial Plant Invasions in the Temperate South: The Problem, Consequence, and Taking Control Presentations - June 4-5, 2003
- Proceedings of the X International Symposium on Biological Control of Weeds - July 4-14, 1999
- Exotic Pests of Eastern Forests Conference Proceedings - April 8-10, 1997

European Publications

- The Atlas of Forest Insect Pests - Polish Forest Research Institute
- Leaf mines and leaf miners - Hungarian Forest Research Institute
- Xylophagous Insects - Hungarian Forest Research Institute
- European and Mediterranean Plant Protection Organization Reporting Service

Other Publications

- Southeast Exotic Pest Plant Council Invasive Plant Manual
- Plant Invaders of Mid-Atlantic Natural Areas

Figure 2-4. Invasive.org publications.

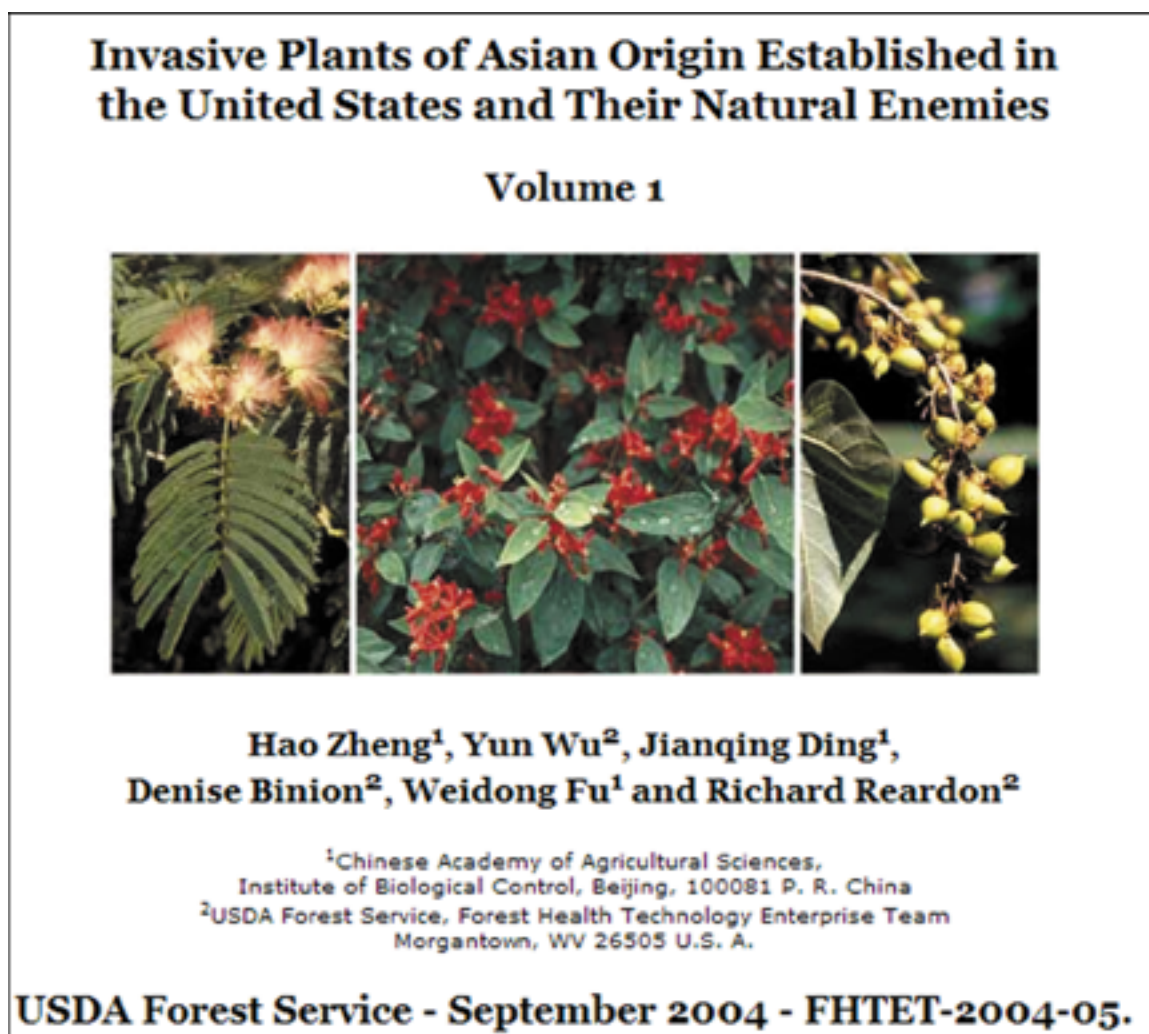


Figure 2-5. Invasive Plants of Asian Origin Established in the United States and Their Natural Enemies publication.

Invasive Plants of the Eastern United States CD-ROM

In late summer of 2003, the Bugwood Network was approached by FHTET to provide copies of the *Biological Control of Invasive Plants in the Eastern United States* (Van Driesche 2002) publication on CD-ROM for the conference *Invasive Plants in Natural and Managed Systems: Linking Science and Management and 7th International Conference on the Ecology and Management of Alien Plant Invasions*, held in Ft. Lauderdale, Florida, on November 3 to 7, 2003. In response, the Bugwood Network proposed to FHTET the production of a comprehensive CD-ROM similar to the Bark Beetles of North America CD-ROM, focusing (in this case) on invasive plants of

the eastern United States (Bargerón et al. 2003)(Figure 2-6). The Bugwood Network included USDA APHIS Plant Protection and Quarantine (PPQ) as a partner to help add Federal Noxious Weed information to the CD-ROM.

Complete text and images of four publications from the USDA Forest Service, National Park Service, U.S. Fish and Wildlife Service, and the Southeast Exotic Pest Plant Council were included on the disk. The CD-ROM addressed 97 species of interest to the eastern United States, including images and species descriptions, ecology, and control options. All images and publications were added to the Forestry Images and *Invasive.org* websites. The CD-ROM was provided to each of the attendees of the conference and included in the Southeast and Florida Exotic Pest Plant Councils magazine, (SE-EPPC/ FL-EPPC), *Wildland Weeds* (Spring 2004 Vol. 7 No. 2). To date, over 20,000 copies of the CD-ROM have been produced and distributed. FHTET has continued to provide copies of this CD-ROM to users on request.

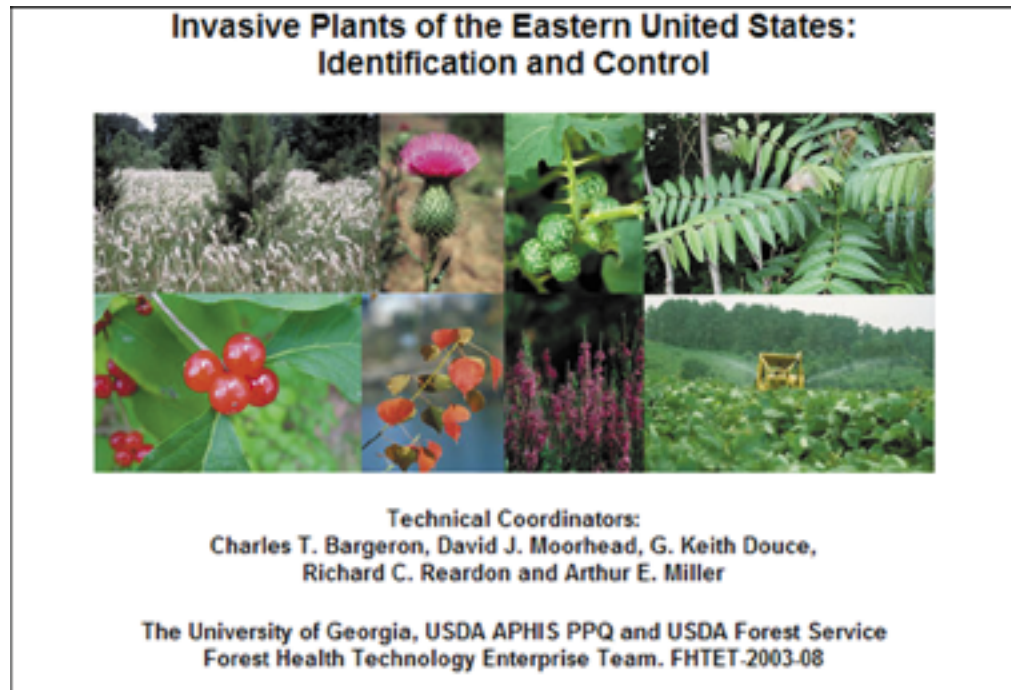


Figure 2-6. Invasive Plants of the Eastern United States: Identification and Control CD-ROM page.

North American Forest Commission Exotic Forest Pest Information System

The goal of North American Forest Commission Exotic Forest Pest Information System (ExFor) is to produce a database of information on exotic insects, mites, and pathogenic organisms with potential to cause significant damage to North American forest resources. The database contains background information on each pest and serves as a resource for regulatory and forest protection agencies in North America.

ExFor is a joint project of the member organizations of the Insect and Disease Study Group of the North American Forest Commission (NAFC). These organizations are the Canadian Forest Service, the Canadian Food Inspection Agency, SEMARNAT (Sanidad Forestal, Mexico), USDA Forest Service, and USDA APHIS. The Bugwood Network has been working with the ExFor project since 2001.

The Bugwood Network is actively pursuing images to add to Forestry Images relating to species of interest to the ExFor project (see www.spfnic.fs.fed.us/exfor, Figure 2-7). Forestry Images now provides images for 74 of the 124 species included in the ExFor project. Currently, images are statically stored in the ExFor pest records, but with links to the Forestry Images “detail” page and at additional resolutions.



Figure 2-7. North American Forest Commission Exotic Forest Pest Information System homepage.

Global Pest and Disease Database (GPDD)

The National Science Foundation Center for Integrated Pest Management (NSF-CIPM) has teamed with USDA APHIS PPQ to develop a restricted-access database of exotic invasive species of key concern to the U.S for use by USDA APHIS PPQ regulatory personnel. Selection of species for inclusion in the database is dependent on a number of factors, including their presence in other key lists and databases. The distributed web-based database system forms the conduit for a number of pest-oriented information systems and provides both external and internal APHIS information on key pest species not yet found in the United States (Figure 2-8).

The Bugwood Network is working the European and Mediterranean Plant Protection Organization EPPO, the European equivalent of USDA APHIS, to include their image collection as part of Forestry Images and *Invasive.org*. About half of their collection is currently available. Through this and the ExFor collaborations, over 4,000 images have been collected.

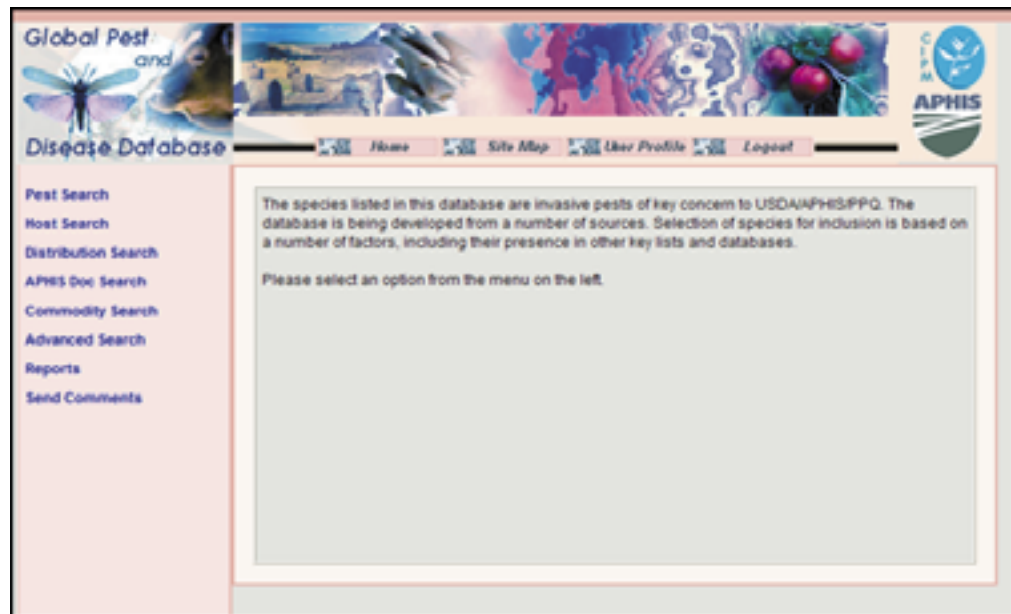


Figure 2-8. Global Pest and Disease Database homepage.

Invasivespecies.gov

Invasivespecies.gov (now *Invasivespeciesinfo.gov*) serves as the official federal reference gateway to information, programs, organizations, and services about invasive species. On the website (Figure 2-9), managed by the USDA National Agriculture Library, you can learn about the impact of invasive species and the Federal government response programs, read select species profiles, and find links to agencies and organizations dealing with specific invasive species issues. The Bugwood Network is working with the National Agricultural Library to provide images for their “species profiles.” Forestry Images currently contains images for 70 of the 77 “species profiles.”

Invasivespeciesinfo.gov
A gateway to Federal and State Invasive species activities and programs

Home Council Management Plan Search Contact Us

Welcome to Invasivespeciesinfo.gov!

We're growing! Invasivespecies.gov has outgrown its current structure. The site was first launched in 2000 in response to [Executive Order 13112](#). A major change is planned to enhance navigation and content organization, the first phase will be ready before the end of the year.

Among the changes is the launch of a new Web site managed by the National Agricultural Library – [Invasivespeciesinfo.gov](#). This Web site will serve as the official reference gateway to information, programs, organizations, and services about invasive species. In November, Invasivespecies.gov will become the official Web site for the [National Invasive Species Council](#).

On [Invasivespeciesinfo.gov](#) you can learn about the [impacts](#) of invasive species and the Federal government's [response](#), as well as read select [species profiles](#) and find links to [agencies and organizations](#) dealing with invasive species issues.

What is an Invasive Species?

An "invasive species" is defined as a species that is

- 1) non-native (or alien) to the ecosystem under consideration and
- 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. ([Executive Order 13112](#)).

Invasive species can be plants, animals, and other organisms (e.g., microbes). Human actions are the **primary** means of invasive species introductions.

This Web site is developed and maintained by USDA's [National Agricultural Library](#) (see [disclaimer](#))

invasive@nal.usda.gov NAL's Disclaimers Site Map Partnerships

USDA OAS FirstGov

Timothy
<http://www.invasivespeciesinfo.gov/index.shtml>
Last Updated: 09/15/05 10:21 AM

What's New

- Species Profiles
- Geographic Information
- News and Events
- Laws and Regulations
- Resources
- Manager's Tool Kit
- Databases
- Vectors and Pathways

Invasive Species of the Month - September / October

[Ratstonia | Species Profile](#)

The National Invasive Species Council will highlight a different invasive species every month.

Photo Information

Figure 2-9. *Invasivespecies.gov* homepage.

CHAPTER 3: DIGITAL IMAGING

A key component of Forestry Images is providing images in digital format. This chapter addresses general photography topics, including types of photographs, tips for taking quality photographs, and an introduction to digital photography. The chapter also details the guidelines for submitting photographs to Forestry Images and the internal workflow for processing those photographs, including converting slides and negatives to a digital format and color correction.

Types of Photographs

Determining what makes a picture high quality and valuable is difficult and subject to individual interpretation. Often, with natural resource professionals, the reason for taking the picture is more specific than just taking a “good picture.” Pictures of natural resource related subjects generally fall into one of these categories: identification of the organism, demonstration of an attribute or point, documentation of an event or point, explanation of a procedure, or management practices and aesthetics.

Identification

Nearly all field guides and identification keys rely on illustrations because seeing a picture or drawing of an organism greatly aids in the correct identification. These pictures may be of the whole organism or simply a specific characteristic or feature important for distinguishing that organism (Figure 3-1a and b). In addition, the type of damage and the species of host plants may be valuable for diagnosis or identification (Figure 3-1c).



Figure 3-1. Identification: a) periodical cicada, *Magicicada septendecim* (Linnaeus) (photo by Susan Ellis); b) black oak, *Quercus velutina* Lam (photo by Paul Wray, Iowa State University); c) Hypoxylon canker of oak, *Hypoxylon atopunctatum* (Schwein.:Fr.) Cooke (photo by Robert Anderson, USDA Forest Service).

Demonstration

Some pictures are taken to help demonstrate or verify an attribute or characteristic of the subject (Figure 3-2). For instance, a picture of an exotic plant infesting a natural area can help demonstrate the invasive potential of that plant, and a picture of a disease on a certain species of plant aids in demonstrating that the plant species is a host for the disease. This type of picture can lend credibility to statements made by the photographer or user of the image.



Figure 3-2. Demonstration: the flammability of cogongrass, *Imperata cylindrica* (L.) Beauv. (photo by Charles Bryson, USDA Agriculture Research Service).

Documentation

Certain events, such as a first occurrence of a species in a county or a damage event, can be captured in a photograph (Figure 3-3). While these photographs are not as “official” as herbarium records or official reports, they can serve as documentation of events.

Explanation

Many management practices or control techniques are complicated and difficult to adequately explain in words. Pictures can provide a visual representation of these types of procedures and can complement written explanations (Figure 3-4a and b).

Aesthetics

Aesthetics relate to the “good picture” concept mentioned above. Reports, cover art, presentations, posters, fliers, and other types of information transfer methods can use pictures to interest the audience and retain their attention longer, making them more receptive to the information presented (Figure 3-5).

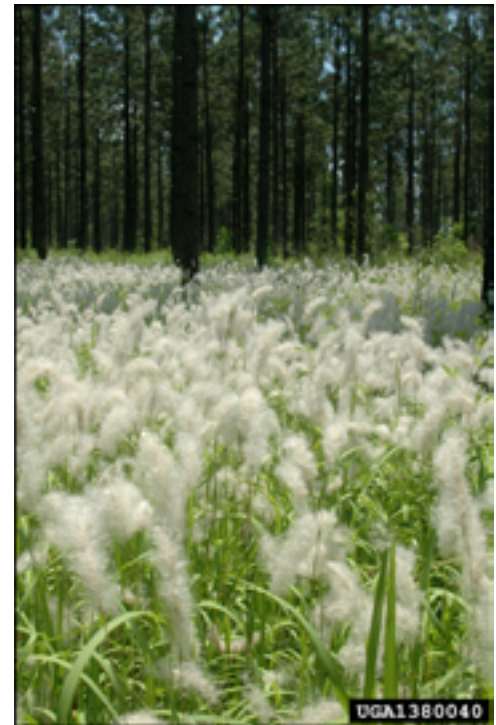


Figure 3-3. Documentation: first recorded cogongrass, *Imperata cylindrica* (L.) Beauv., infestation in Seminole County Georgia (photo by Chris Evans, University of Georgia).

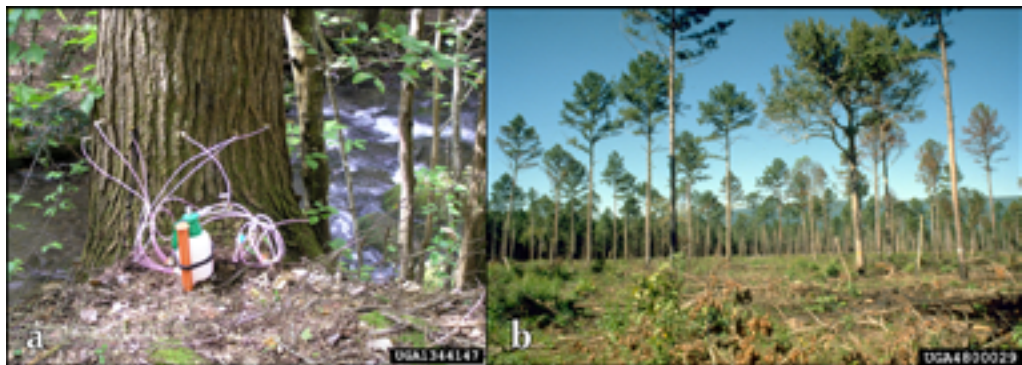


Figure 3-4. Explanation: a) Hemlock woolly adelgid, *Adelges tsugae* Annand, control using Tree IV on eastern hemlock (photo from Great Smoky Mountains National Park Archives); b) shortleaf pine, *Pinus echinata* P. Mill., stand being regenerated by the uniform seed tree method: approximately 15 shortleaf pine seed trees per acre with an average dbh of 14 in., Ouachita National Forest, LeFlore County, Oklahoma (photo by Robert Wittwer, Oklahoma State University).

Not all images fall neatly into one of these categories, and many images may fit into more than one category. Recognizing the purpose of the photograph and evaluating whether or not the goal was met is integral to deciding if the picture is useful.



Figure 3-5. Aesthetics: cottonwoods at peak of fall color, Cache la Poudre River, Colorado (photo by William Ciesla, Forest Health Management International).

Tips for Taking Good Photographs

The following section briefly explains basic techniques and gives tips for taking useful photographs that are available on most cameras. To fully understand your camera's options, refer to the user manual.

Document the Subject

When possible, try to identify the subjects of your photographs to the greatest taxonomic specificity. Many insects and some plants, cannot be identified to the species level without advanced knowledge or equipment, but identification to the genus or family level may be possible simply using field characteristics. A picture with a properly identified subject is more useful than a picture of an unidentified subject.

Often the identification can be performed later using the photograph. Familiarize yourself with the characteristics commonly needed for identification, and take several pictures of the subject's diagnostic characteristics to ensure that identification is possible (see Figure 3-6).

Once a subject is identified, decide what the purpose of the photograph is (see the discussion above) and determine the best method for achieving that purpose. Numerous books about photography exist, and many colleges, vocational schools, and private individuals offer nature photography classes. These books and classes teach in-depth techniques of nature photography.



Figure 3-6. Tree-of-heaven, *Ailanthus altissima* (P. Mill.) Swingle: notice glandular notch at the base of the leaflets (photo by Chris Evans, University of Georgia).

Framing

Frame the subject for the intended purpose. Panoramic photographs give context to the subject, mid-range shots illustrate the presence and effects of specific species, and close-ups provide details for identification of a species of interest. Decide what the purpose of the photograph is and manipulate the distance between the camera and the subject (as well as other factors discussed below) to capture it.

Focus

The photograph viewer's attention is naturally drawn to the area of the photograph that is in focus. For landscape scale photographs, most of the scene should be in focus (Figure 3-7). For subjects closer in, the photographer must decide what part of the scene is most important and therefore should be in focus. When photographing plants, the photographer can focus on the entire plant or simply an area of interest of the plant (Figure 3-8). When photographing animals, try to keep the head, at least, in focus; if the head is too big to keep it all in focus, keep the eye(s) in focus (Figure 3-9).

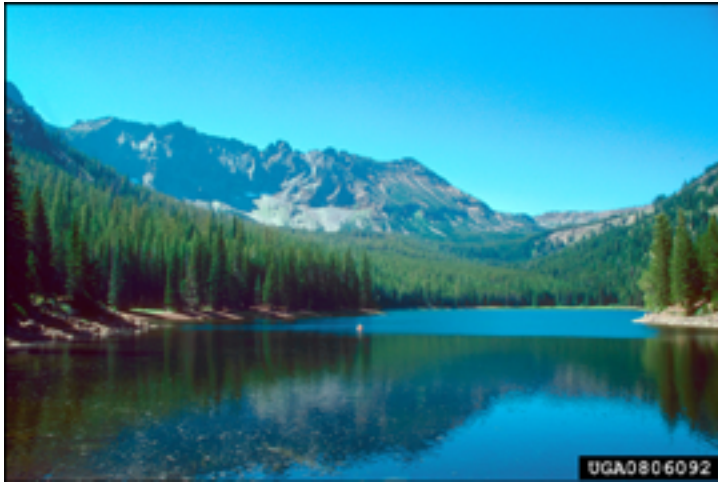


Figure 3-7. Scenic view of Strawberry Lake in Malheur National Forest, Oregon (photo by David Powell, USDA Forest Service).



Figure 3-9. Green anole, *Anolis carolinensis* Voigt, with eye in focus (photo by Wendy VanDyk Evans).



Figure 3-8. Chinese lespedeza, *Lespedeza cuneata* (Dum.-Cours.) G. Don, with flower in focus for emphasis (photo by James Miller, USDA Forest Service).

“Focus” is often discussed in terms of a focal plane: a plane parallel to the face of the camera’s lens in which everything is in focus. Try to align areas of the photograph that need to be in focus within this plane, which may mean manipulating the subject or moving the camera.

The depth of the focal plane is not fixed, and the focal plane depth can be increased to encompass a greater range of distances from the camera. This focal depth, or depth of field, can be altered by adjusting a camera’s *f*-stop (manually or with the aperture priority setting—see the discussion on camera settings below for more detail).

The f -stop number represents the size of the lens aperture, the hole through which light passes, and values typically range from $f2$ to $f22$. Small apertures (high numbers) increase a photograph's depth of field, making more of the photograph in focus, while wider apertures (small numbers) decrease a photograph's depth of field, making less of the photograph in focus.

The ability to decide how much of the photograph is in focus is a powerful tool in photography. Using a shallow depth of field, with only a small portion of the photograph in focus, can help draw the viewer's attention to that focal area (Figure 3-10a). Using a larger depth of field allows more of the photograph to be in focus, thus allowing larger subjects to be captured completely in focus (Figure 3-10b).



Figure 3-10. Focal depth: elephant's foot, *Elephantopus nudatus* Gray flower a) taken with an f -stop of $f-4$ and b) taken with an f -stop of $f-13$ (photos by Chris Evans, University of Georgia).

Blur

Blur in a photograph is a result of movement by the subject or involuntary movement (sometimes referred to as "hand shake") by the photographer, which can be offset by the combination of aperture setting, shutter speed, and a tripod. The f -stop and shutter speed determine the amount of light received by a camera. The shutter speed determines the length of time light is allowed to enter through the aperture. Shutter speed is represented by fractions of a second; a shutter speed of $1/30$ represents the aperture being open for one-thirtieth (0.033) of a second and a shutter speed of $1/500$ represents the aperture being open for one five-hundredth (0.002) of a second. Faster shutter speeds avoid blur caused by moving subjects and hand shake while taking the picture (Figure 3-11). Using a tripod, when practical, also helps alleviate hand shake. In general, shutter speeds slower than $1/60$ require a tripod in order to capture a sharp image (Figure 3-12).



Figure 3-11. Calico pennant dragonfly, *Celithemis elisa* (Hagen, 1861), taken with fast shutter speed (photo by David Cappaert).



Figure 3-12. Stream in Great Smoky Mountains National Park taken with slow shutter speed (photo by Chris Evans, University of Georgia).

Light

The type, direction and intensity of light available affect the color and texture of an image. Hard light, from either a bright sunny day or a direct flash, emphasizes shadows, highlights, and textures. Soft light, found on early morning, late evening or cloudy days, minimizes shadows and highlights and brings out color and detail.

The direction of the light source will also influence a photograph. Frontlight highlights colors while eliminating shadows and textures (Figure 3-13a). Backlight creates silhouettes or illuminates translucent subjects (Figure 3-13b). Sidelight highlights both texture and color of a subject.



Figure 3-13. Indianpipe, *Monotropa uniflora* L.: a) taken with frontlight and b) taken with backlight (photos by Wendy VanDyk Evans).

Background

Background colors that are opposite or contrasting to the main colors of the subject help make the subject stand out in the photograph, while backgrounds similar to the main colors and shades of the subject make the subject blend in more. A busy background with many colors and shades may confuse the viewers and make discerning the boundaries of the subject difficult.

Backgrounds can be manipulated by altering the angle of the photograph to capture a contrasting background or by placing a supplied background behind the subject. Canvas or other material in a neutral or contrasting color attached to a support frame provides a portable background that can be placed behind the subject as needed.

Camera Settings

Many cameras have a series of automatic settings that can be used to simplify the photography process. Some of the common settings are 'aperture priority', 'shutter priority' and 'manual'. 'Aperture priority' allows the photographer to select the desired aperture and the camera adjusts the shutter speed to obtain the correct exposure. This setting is useful when depth of field is important, such as landscape photographs and still portraits. 'Shutter priority' allows you to select the desired shutter speed and the camera adjusts the aperture to obtain the correct exposure. This setting is useful when taking photographs of moving subjects or when not using a tripod. The 'manual' setting gives the photographer the most control over the camera's settings, but requires more knowledge of photography and more time to set up each picture.

Digital Photography

Cameras

Digital cameras offer several advantages over film cameras. Digital media can store more image files than the standard 24 or 36 exposures available in a roll of film. The ability to view images on a digital camera allows photographers to evaluate them immediately and delete unwanted images. Digital photography is more economical as it eliminates the need to buy film and pay for development. Digital images can be saved in publication-ready formats, while converting slide images to digital format is time-intensive, and the analog-to-digital conversion may cause loss of colors or quality, requiring additional adjustment. For these and other reasons, digital photography is growing in popularity.

There are two basic types of digital cameras: point & shoot and single-lens reflex (SLR) (Figure 3-14). Point & shoot digital cameras, like point & shoot film cameras, are essentially automatic, with limited ability to adjust settings. The advantages of point & shoot cameras are their lower cost (compared to SLR cameras), small size, and light weight. SLR digital cameras, like SLR film cameras, are more expensive and larger, but offer the photographer a suite of automatic settings in addition to the manual setting and through-lens focusing and framing.

As with SLR film cameras, interchangeable lenses enhance zoom and macro features. Zoom lenses allow the photographer to take “close-up” photographs at a greater distance from the subject. This is advantageous when the subject is an animal that might become scared or leave if approached. Lenses with adjustable zooms also allow for easy manipulation of the framing of a photograph. Wide-angle lenses provide a wide field of view and can be very useful for landscape photography. Macro lenses allow for close up photography and can be used to capture small subjects or minute details necessary for identification.

Several flash memory types are available with digital photography. CompactFlash, Memory Stick, and SD (Secure Digital) are the most commonly used types (Figure 3-15).

Technological advances have allowed digital photographs to reach the quality and resolution of 35mm slides. Digital cameras with at least a 6 megapixel image capacity, the equivalent of a 35mm slide, are common and relatively inexpensive. (Megapixels represent the area of the digital image: the height of the image in pixels multiplied by the width of the image in pixels.) The continuing advancement of digital technology and the coinciding drop in the price of digital cameras has increased the availability and affordability of quality equipment.



Figure 3-14. Point & shoot digital camera and SLR digital camera.



Figure 3-15. SD (Secure Digital), CompactFlash and Memory Stick.

Digital Image Formats

Newer digital cameras allow photographers to choose between JPEG, RAW, and TIFF image output—or a combination of formats—for their cameras. For most digital photographers, JPEG is the practical choice. However, with falling flash memory prices and digital SLR cameras prices dropping below \$1,000, RAW and TIFF are becoming viable options for more photographers. A simple comparison is that JPEG is like shooting slide film, “what you see is what you get”, and RAW is like shooting negatives, which can be adjusted in the “digital darkroom”.

JPEG uses “lossy” compression that abbreviates some data (depending on compression level), but which creates a smaller file that takes up less space on the memory card and downloads to a computer faster than an uncompressed file. All of the camera’s settings are imbedded into the JPEG file for reference purposes. If set to the lowest level of compression, JPEG is the best format for photographers who shoot hundreds of images each day and want to be able to use them quickly with little or no adjustment. Thus, JPEG is the most widely used image format.

A RAW file is actually raw sensor data from the camera and is not an image until it is processed further. Using “lossless” compression, RAW files do not abbreviate data but require more memory space than JPEG. Unlike JPEG and TIFF, RAW is not a standard format, as each camera manufacturer has its own proprietary format, but Adobe Photoshop CS can now read all RAW formats.

RAW is the best format for photographers who expect to spend time adjusting each image (Figure 3-16a and b). A wider range of colors, tones, contrast, and white balance is possible from the RAW sensor data. Many cameras can now save data in both RAW and JPEG formats (assuming that plenty of flash memory storage space is available—currently one gigabyte or greater), which saves the raw sensor data and the processed JPEG (Figure 3-16c). This gives the photographer more processing options.

Tagged Image Format File (TIFF) digital files combine aspects of both other formats: uncompressed data AND processed, viewable images. The tradeoff is that TIFF files are slightly larger than their RAW counterparts. TIFF images have extremely large file sizes and are not practical for most photographers to use in the field. But TIFF images are useful if the camera does not support RAW and is used in a studio setting in which images can be easily downloaded to a computer. TIFF is also the preferred format for archiving processed images.



Figure 3-16. Format comparison: a) unedited RAW, b) edited RAW, and c) unedited JPEG (photo by Chris Evans, University of Georgia).

Submission Guidelines for Images

The Forestry Images website contains guidelines for submission of images (<http://www.forestryimages.org/contribute.cfm>). A summary of the guidelines follows.

Quantity

The Bugwood Network can work with any number of images, but receiving groups of 50-100 images or image files promotes efficient processing and does not burden the photographer with an extreme amount of documentation.

Quality

Original slides should be submitted whenever possible, as they provide better color and detail than slide copies (Figure 3-17). Digital scans and image files should be submitted at the highest quality and resolution possible to maximize the usefulness of the image.

Image Formats

Slides: Submit original slides in protective sleeves or boxes (Figure 3-18) or digitized photographic slides on a CD or DVD. Received slides will be scanned and then returned to the contributor. Digitized slides should conform to the current standards for high-resolution TIFF images:



Figure 3-17. Slide scan comparison: a) from original and b) from copy (photos by Clemson University–USDA Cooperative Extension Slide Series).



Figure 3-18. Examples of packaging of 35mm slides.

- Scan slides at a high resolution (2000 PPI or greater). Scanned image files typically should be 10 megabytes or larger.
- The file format should be uncompressed TIFF. The received TIFF files will be archived in their original state.
- Crop and rotate images as required prior to submission.

Photographic negatives: Submit negatives for scanning or provide images digitized from negatives. Ideally, the images should be digitized directly from the original negatives to provide the best image for subsequent use. Use the guidelines outlined in the section on slides above if submitting scans of negatives.

Digital camera image files: Submit high-resolution image files taken with a good-quality digital camera. Use the following guidelines to ensure the best quality images are submitted to the Forestry Images system.

- Use at least a 4-megapixel digital camera if possible.
- Images should be taken at the largest size and best quality settings that the camera is able to produce.
- If sending JPEG files, please submit the best quality JPEG photos your camera can produce. Very good quality can be obtained in high-resolution JPEG files.
- If sending TIFF or RAW files, please send those, as they are the highest quality images.
- Send the least-edited, least compressed file available. JPEG uses a compression scheme that degrades the image each time it is saved: consequently, it is important to avoid repeatedly editing and saving the file before submission. If editing, cropping, or enhancing the JPEG photo using image editing software (such as Adobe Photoshop) is necessary, perform all operations in one editing session and save the edited image at the highest quality (least compressed) possible.

- Retain a copy of the original file from the digital camera in case the editing process has to be repeated.

Line drawings: If submitting line drawing-type images, please send the original artwork for scanning.

If scanning line drawings, please:

- Scan and save the files as uncompressed TIFF format at the highest practical resolution—typically resulting in a 25-megabyte file.
- If an image is a pen-and-ink drawings in black and white, scan the image as a black and white TIFF image.
- If an image contains gray lines or washes, scan the images as a grayscale TIFF image.
- If an image contains colored lines or washes, scan the images as a color TIFF image.
- Crop and rotate the images as appropriate.

Package all submissions as securely as possible. Digital submissions can be sent on CD or DVD. We request e-mail notification that the materials are underway and the date that they were sent so that we can anticipate their arrival and can schedule image processing. We will do everything possible to ensure that the items are processed and returned expeditiously.

Regardless how images are submitted, subject identification and descriptive information of each image must be provided. There are several ways this can be done:

- If submitting slides, write the appropriate information on each slide frame.
- Identify each image with a unique identifying number or text-string (on each slide frame or in the naming conventions for digital files) and send a separate hand-written sheet or electronic file (in Microsoft Word, Microsoft Excel, Corel WordPerfect, etc.) that provides descriptive information by identifying number or text string.
- After digitizing and editing the images, the Bugwood Network creates a URL for the photographer to access the images and correct and/or add image identification and descriptive information.

Photographers are asked to join the Forestry Images system at <http://www.forestryimages.org/join/> (Figure 3-19) to ensure current and correct affiliation and contact information.

The image shows a web browser window displaying the Forestry Images membership sign-up form. At the top, there is a navigation bar with the Forestry Images logo and a search bar. Below the navigation bar, there are several tabs: Forest Pests, Trees & Plants, Silviculture, Invasive Species, Wildlife, More Images, and Contribute. The main heading is "Free Membership Sign Up". Below the heading, there is a paragraph of text: "Please complete the form below to become a ForestryImages member. If you are already a member of IPMImages, InsectImages.org, or Invasive.org, you can use your existing login/password to access ForestryImages.org. If you have any questions, see the Membership Benefits page or e-mail us at: bugwood@uga.edu". The form consists of several input fields: *First name, *Last name, *Organization/Company, *E-mail address, *User Type (a dropdown menu), *Country (a dropdown menu set to "United States"), *User name, *Password, Title, Unit/Department, Address, City/State/Zip, Phone Number, and Additional Comments (a text area). A note in red text states: "Note: Your user name and password cannot contain spaces." Below the form is a button labeled "Join ForestryImages.org!".

Figure 3-19. Forestry Images membership form.

Summary of Forestry Images Workflow

The following steps are carried out to process a set of images to make them available on Forestry Images.

1. **Receive images** – Images are received as slides, negatives, or digital files, either by U.S. Mail, UPS, FedEx, or by collecting them directly from the photographer.
2. **Assign a four-digit “CD number”** – When the Forestry Images project began, slides were scanned to Kodak Photo CD, each CD had a unique four-digit number, and the images on the CD were numbered 001-999. This numbering scheme was retained when in-house scanning was started. The four digit “CD number” now refers to a set or group of images, and each image in the set is numbered consecutively, starting with 001. Thus, each image still has a unique seven-digit number.
3. **Scan slides, negatives or prints** – The appropriate scanner (as described in the hardware section, below) is used to create the digital image files. This step is skipped if images are provided in digital format.
4. **Resize, crop and color correct the images** – Using Adobe Photoshop, each image is cropped, resized, and edited following the steps described in the adjustment, editing and color correction section, below.
5. **Upload images, create database records, tag and create multiple resolution JPEGs** – A custom module was created using Macromedia® ColdFusion® and Aurigma Image Uploader™ 3.5 software to transfer images onto the servers from the image editing workstation. Alagad Image Component 2.0 for Macromedia ColdFusion is used for image manipulation, tagging, and resizing. Using these modules, images are copied to the server, database records are created, the images are tagged with the seven-digit image number, and the five resolutions of JPEGs are created on the server (Figure 3-20). Each image resolution has a unique static URL.
6. **Archive TIFF images to DVD** – The final “edited” images are recorded on two recordable DVDs, one is kept in the office and the other is stored in a bank safety deposit box.
7. **Transfer TIFF images to server** – The final “edited” images are also transferred to a network-attached storage system, which makes them available for on-request downloads.
8. **Classify images based on provided information** – Using provided information, input image information such as subject, host, descriptor, description, location, and/or domain/area into the image table.
9. **E-mail photographer link for review** – Allow photographer to review information entered into database and/or provide information for use to classify the image (Figure 3-21 and Figure 3-22).
10. **Return originals with DVD copy of scans** – Return originals to photographer along with DVD (on request) containing the edited TIFF images.

11. Make changes indicated by the photographer – Address comments provided by photographer on review of the on-line entries to complete identification of the subject and description of the images.
12. Release images – Make the images available to the public.



Figure 3-20. Administration image upload form.



Figure 3-21. Photographer review page.



Figure 3-22. Photographer image review form.

Scanning Images

In the late 1980s, Kodak® realized it needed to move into digital technologies—specifically, CD-ROMs. Kodak conducted a survey of 2,000 people worldwide, asking them what they would like to do with images on their 35mm film: viewing images on a television set was one of the most popular responses (Gosney et al. 1995). This was the inspiration for Photo CD® technology.

Kodak envisioned that users would receive a Photo CD from their local film developer containing digital versions of their 35mm images along with their prints or slides. The user would then view the images on the Photo CD in a Photo CD player for a television—or later on, on a personal computer.

To support this development, film developers could purchase a Photo CD Imaging Workstation® consisting of a scanner, data manager, CD writer, and printer. The system cost in 1999 was approximately \$70,000. In turn, film developers charged from one to three dollars per image for scanning slide film or negatives onto a Photo CD.

While Photo CD never caught on as a widely used consumer product, it became the photographic standard for uses ranging from archiving museum art to distributing stock photography (Gosney et al. 1995). Photo CD images were scanned to 18 megabyte files, which were compressed into a proprietary “Image Pac” file that is about 2 to 6 megabytes in size, each, allowing 100 images to be stored on a single CD-ROM. Each Image Pac (.pcd) image file could yield images at 128 x 192-pixel, 256 x 384-pixel, 512 x 768-pixel, 1024 x 1536-pixel, and 2048 x 3072-pixel sizes.

Because technological advances have made the Kodak Photo CD system uncompetitive, Kodak has now stopped selling, servicing and supporting the imaging workstations and stopped selling Photo CD media.



Figure 3-23. Forest Pests of North America CD cover.

The Bugwood Network began using the Photo CD format in 1994 as part of a USDA Cooperative State Research, Education and Extension Service project. The project was to convert the Southern Forest Insect Work Conference slide collection into a two Photo CD set (Douce et al. 1995). One thousand copies of *Forest Insects and Their Damage* (<http://www.bugwood.org/forestcd/>) were produced and sold. The success of this project led the USDA Forest Service Southern Region to fund two additional Photo CD projects: *Forest Pests of North America: Integrated Pest Management Photo CD Series* (<http://www.bugwood.org/ipmcd/>), a three-volume set that featured 150 insects and 150 diseases from across the United States, and *Forest Insects and Their Damage Volumes III and IV: Bark Beetles of North America* (Figure 3-23), which included 192 images in Photo CD Image Pac format and various USDA Forest Service publications relating to bark beetles.

As these Photo CDs and other Bugwood projects were developed, additional images were collected, scanned, and archived. In early 1999, the archive consisted of over 4,000 images digitized in Kodak Photo CD format. These images originated from 35mm slides selected from slide libraries across the U.S., primarily from USDA Forest Service photographers, research stations, and forest health protection units. Images were also obtained from state forestry offices, USDA Animal and Plant Health Inspection Service (APHIS) Plant Protection and Quarantine (PPQ) and University of Georgia personnel.

When the Forestry Images project started, digital imaging and digital photography were in their infancy. Kodak Photo CD was initially used as the archival media because other slide/film scanners were expensive and slow, and because the quality of the scanned images from them was not very good. Initially, a Microtek® IIIHR flatbed scanner was used to scan prints for Forestry Images. It was a three-pass scanner and took nearly 20 minutes to scan an image. Using Adobe Photoshop® version 2.5, it would take nearly ten minutes to do each of the following image editing tasks on a computer with a 66 megahertz Intel486® processor and 16 megabytes of RAM: open, crop, resize, adjust levels, adjust color, and sharpen the image. In addition to being slow, the program would also “crash” frequently. Adobe recommended 54 to 90 megabytes of RAM to handle the image and any adjustments made to the image, which was an expensive option in 1995. CD-R blanks also cost ten dollars each and would only hold 36 uncompressed images.

However, five years later, scanner technology, computer memory, and processor speed had advanced to the point that it became cheaper and faster to scan the slides in the office instead of sending them to a Photo CD provider. The Photo CD process also compressed the images slightly, cost one to three dollars per image, averaged a week turnaround period, and involved with the risk of slides being lost or damaged in the mail. In addition, DVD recorders have also become available and are reasonably priced, and recordable DVDs can hold up to 260 uncompressed digital image files.

These factors led to abandoning Photo CD in favor of in-house scanning. In the summer of 2000, a digital imaging workstation was purchased for in-house scanning. The system included a Dell® Workstation computer with dual 600 MHz Intel® Pentium III processors, 1 gigabyte of RAM, and multiple large IDE hard drives. We also attached a UMAX® Powerlook III flatbed scanner (Figure 3-24a) and a Sony® UY-S90 film scanner with a 50 slide automatic 35mm slide feeder (Figure 3-24b). The UMAX scanner featured 1200 x 2400 PPI resolution with 42-bit color and cost \$1,200. The Sony film scanner featured 3326 PPI resolution, scans a 35mm slide in 2.5 seconds and cost \$6,000. A Nikon® Super Coolscan® 4000 film scanner (Figure 3-24c) has been added to scan negatives and Kodak APS (Advanced Photo System) film. A Minolta® Dimage Scan Multi (Figure 3-24d) is used to scan medium format negatives. The scanners have now been assigned to one of two Intel® Pentium IV computers with 1 gigabyte of RAM, each.

With all the hardware in place, the Bugwood Network is now able to scan film in any format as 3072 x 2048-pixel 18-megabyte TIFF files. Slides are the preferred medium because they can be loaded into the Sony scanner and scanned fifty at a time without operator intervention. However, scanned slide images require color correction and can

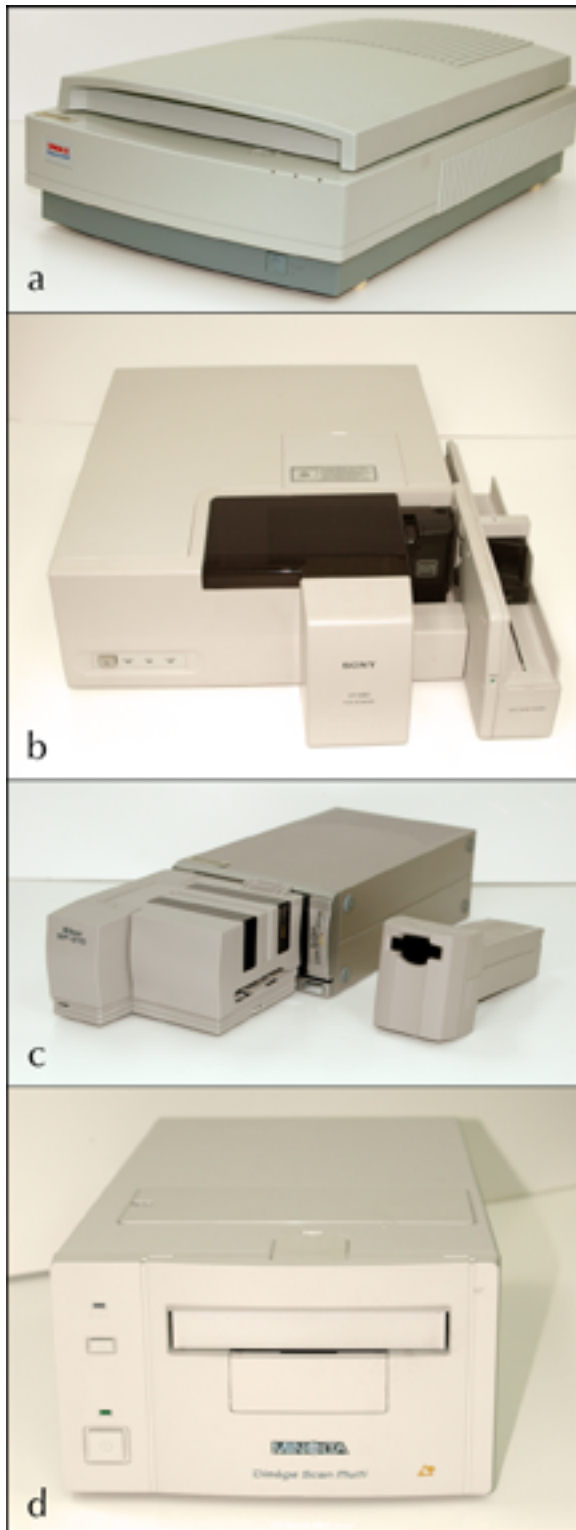


Figure 3-24. Scanners: a) UMAX® Powerlook III flatbed scanner, b) Sony UY-S90 Film Scanner, c) Nikon Super Coolscan 4000, and d) Minolta® Dimage Scan Multi.

be grainy if the originals were taken with low-speed film and then scanned at a high resolution. Once the slides are scanned, the digital image files are transferred over the network to another computer, where a Digital Image Archive Specialist using Adobe Photoshop CS2 (version 9) performs image editing and color correction. Digital images from scanned negatives seem to retain color information best, but negatives are time-consuming to scan. Prints are only scanned when no other option is available as they are second-generation images with limited color range, and the resulting digital images usually require additional color correction.

Resolution, Mode, and Format

A digital image has three important components: resolution, color depth, and format. Resolution is usually described in terms of pixels, the smallest unit of visual measurement on a computer. When an image is described as measuring 3072 x 2048 pixels, the values represent the number of pixels of the length and the width of the image, respectively. Pixels can also represent the physical size of the image: the number of pixels in the length and width of the image divided by the number of pixels per inch (PPI) in the displayed image determine the physical dimensions of an image. Thus, a 3072 x 2048-pixel image would be 10.24 x 6.83 inches at 300 PPI. Figure 3-25 shows how the values relate in Adobe Photoshop's Image Size dialog box.

One common misunderstanding is that pixels per inch (PPI) and dots per inch (DPI) are equivalent measurements. DPI is commonly used for desktop printers as a measure of the density of dots (in toner or ink) that the printer can place per linear inch on a sheet of paper. These dots are the smallest unit possible on the printer and may or may not represent the size of pixels in the digital image being printed.

There is no standard measurement of either pixels or dots. Dot values vary by printer types and models; display screens (though largely standardized) vary between 72 and 96 PPI, so images can be sized at one of these settings for on-screen use. The recommended resolution for printing photographs is 300 PPI (Busch 2004).

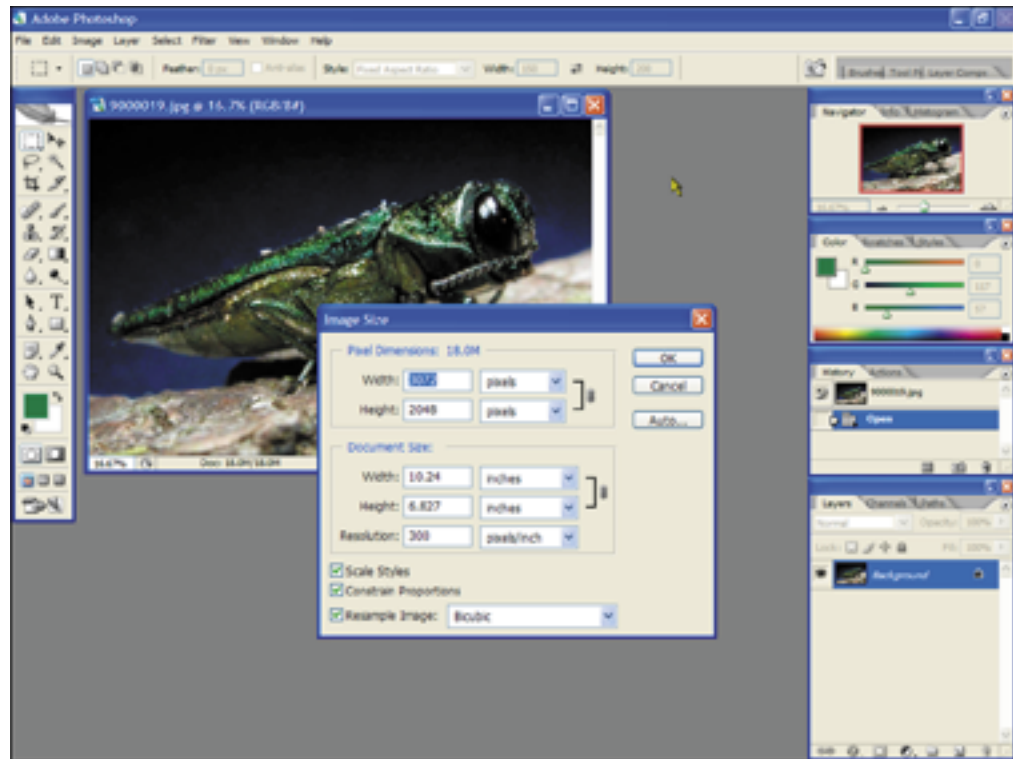


Figure 3-25. Photoshop Image Size dialog box.

Each pixel in an image can be described as a mixture of colors or “channels.” The number of channels used to represent each pixel’s color is a function of the selected color mode. There are two primary color modes for digital images: RGB (three channels) and CMYK (four channels). RGB stands for “red,” “green,” and “blue,” and all colors are defined as mixtures of these channels (Figure 3-26). RGB is used for any device that transmits or filters light, such as computer screens, and is used for most computer applications. RGB’s three channels each have 256 potential values (in typical 8-bit color depth), yielding approximately 16.7 million potential colors ($256 \times 256 \times 256$).

CMYK stands for “cyan,” “magenta,” “yellow”, and “black,” and all colors are defined as mixtures of these channels. These channels represent commercial ink colors, and CMYK is used for almost exclusively for commercial printing.

Format is the third component that determines image quality. Today, TIFF has been adopted as the archival format for Forestry Images in place of Photo CD. TIFF is an uncompressed file format, and a TIFF image at 3072 x 2048 pixels occupies about 18 megabytes (at typical 8-bit color depth).

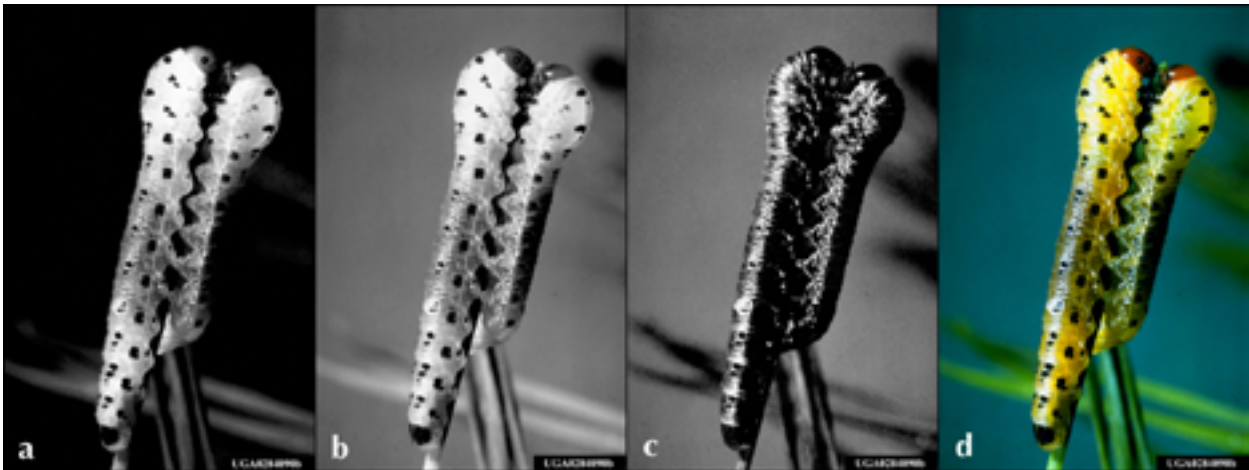


Figure 3-26. RGB channels: a) red channel, b) green channel, c) blue channel, and d) RGB composite (photo by Gerald Lenhard, Louisiana State University).

JPEG has been chosen as the file format for the Web interface as it is the standard image format for the Web. JPEG (for the Joint Photographic Experts Group, which designed the format) uses “lossy” compression, meaning some quality is reduced or “lost” when the image is compressed, to reduce file size (Figure 3-27). a typical 18 megabyte TIFF file will occupy only 1.5 megabytes in JPEG (at maximum quality setting).

The JPEG 2000 or JPEG 2 file format is a revision of JPEG that provides better compression without the loss of quality and integrates security and metadata directly in the file format. However, not all Web browsers and graphics applications are yet compatible with the JPEG 2000 format.



Figure 3-27. JPEG image: a) original image and b) image after compression (photo by Charles Barger, University of Georgia).

Editing and Color Correction

Image editing and color correction using Adobe Photoshop CS2 are done on a separate computer system with a Intel Pentium IV processor, two 120-gigabyte hard drives, and an 8X DVD recorder. The 19-inch Sony Trinitron monitor has been calibrated to ensure accurate color representation. The steps used by Forestry Images specialists for editing* in Photoshop CS2 are:

1. Open the image.
2. Crop the image.
3. Resize the image.
4. Adjust output levels for each of three RGB channels (Figure 3-28).
5. Adjust Hue, Saturation and Lightness (Figure 3-29).
6. Adjust the Shadow/Highlight settings (Figure 3-30).
7. Perform an Unsharp Mask or Smart Sharpen (Figure 3-31).
8. Save the image as a TIFF file (Figure 3-32).
9. Convert the TIFFs to JPEGs using Adobe Photoshop's Batch process.
10. Record the TIFFs to DVD.
11. Upload JPEGs to the Web server.

* Not all steps may be used for each image.

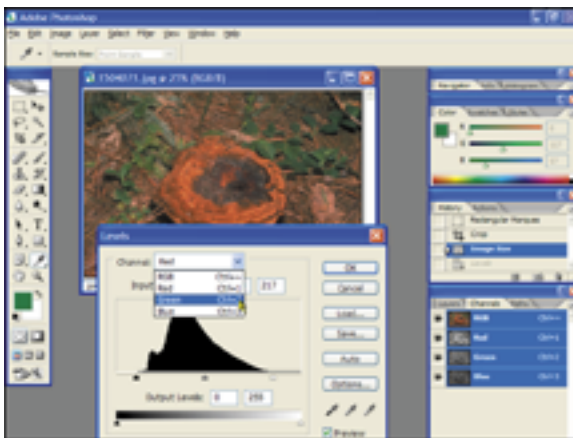


Figure 3-28. Adjusting levels for each of the three RGB channels.

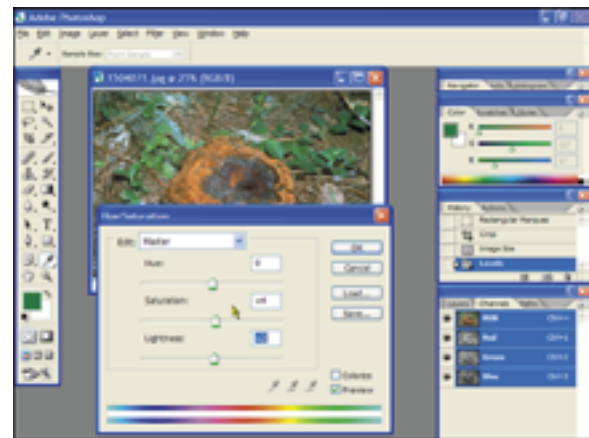


Figure 3-29. Adjusting hue, saturation and lightness.

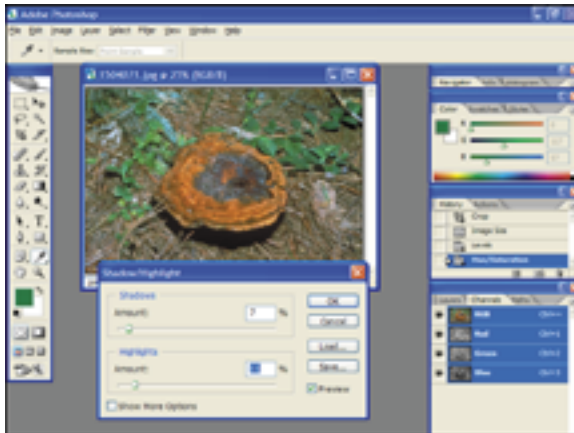


Figure 3-30. Adjusting shadows and highlights.

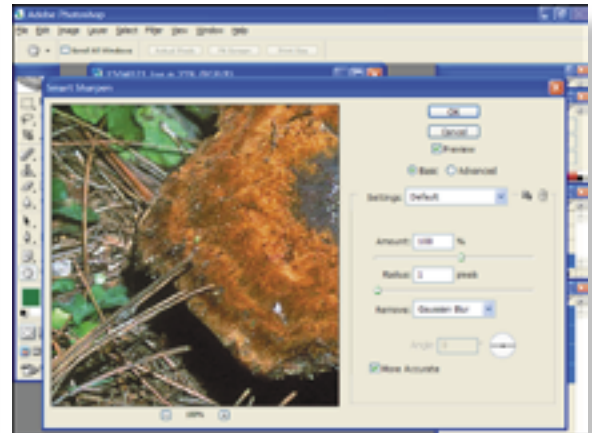


Figure 3-31. Performing 'Smart Sharpen'.

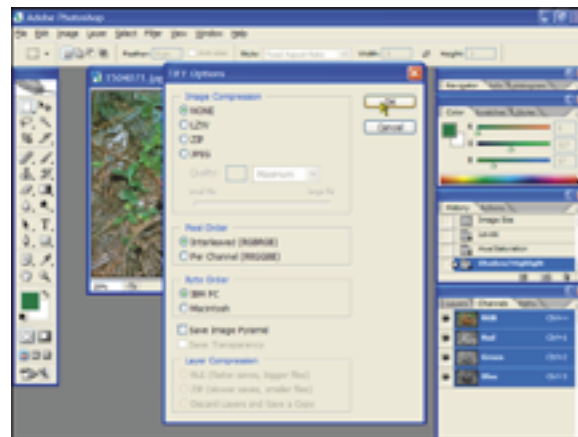


Figure 3-32. Saving an image in TIFF.

CHAPTER 4: TECHNOLOGY DEVELOPMENT

Every image is taken for a reason, and an image can be worth a thousand words. But sometimes an image is self explanatory for its given purpose while another is not: Figures 4-1a and 4-1b are obviously an ant and an elephant, but the next two pictures (Figures 4-1c and 4-1d) mean very little without some description. Thus, images in isolation do not always provide complete information and must be accompanied by explanatory text. This is viewpoint that drove development of the Forestry Images system.

The Forestry Images system has three major components: the images (discussed previously), the database system, and the Web interface. The database system is the most complex and most important of the components: the database system components define and regulate the collection, storage, management, and use of data (Rob and Coronel 2002). The Web interface drives information access and retrieval by the distributed users of the system. The following sections describe how these components were designed, integrated, and implemented.

Database Management System

Background

The first 4,000 images collected by the Bugwood Network were documented in a non-relational Corel Paradox[®] database, using Microsoft Excel[®] spreadsheet software, or by hand with pen and paper. However, quickly locating both images AND their related information soon became a problem. A database management system (DBMS) needed to be designed and implemented to allow for efficient retrieval of images and information. If the database management system is designed using a properly implemented relational model, then data integrity can be virtually guaranteed.

The Network personnel developed several prototypes of this image archive database internally over a period of about four years, but recognized that limitations and problems existed with each successive prototype. In 1999, Charles Barger, working with the Bugwood Network, was enrolled in an advanced database management systems/software engineering course taught by Dr. Anne Pierce at Georgia Southern University. The course required a team of students to develop an operational database



Figure 4-1. Images: a) ant, b) African elephant, c) rebuilding of U.S. Embassy in Dar es Salaam, Tanzania (image taken on September 11, 2001), and d) southern pine beetle infestation just across the South Carolina border with Georgia in 2002, there was a large infestation in South Carolina but no outbreaks in Georgia. Photos by Charles Barger, University of Georgia.

application. The team—consisting of Charles Barger, Lee Phillips, Greger Jacobsen and Jason Smith—decided to convert the existing image archive data system into a fully operational relational database application. The students, working closely with Drs. Douce and Moorhead, gathered information from the previous work on the project to develop a relational database management system that was flexible yet precise.

The Bugwood Collaborative Image Database system developed by the computer science students at Georgia Southern University served as a foundation for the Forestry Images database. The initial system, using Microsoft® Access 97 relational database management system software, provided desktop access to the database by administrators of the Network: image information on the image server could be retrieved, added, updated, and deleted from any locally networked computer.

In this system, information is stored in individual database tables following the properly normalized relational model. This helps to protect data and referential integrity by virtually eliminating duplication of information. For example, each subject's scientific information is only entered once and then accessed by all applicable image pages.

Eventually, the backbone of the original system developed using Microsoft Access 97 was migrated to Microsoft® SQL Server 7.0 to enhance performance and take advantage of higher throughput capacity. This required only slight modifications to the original application. The key features of the desktop application include:

- Data entry
- Data retrieval
- Report and legal release letter generation
- Statistics on numbers of images by author, subject, category, domain and project
- Administrative access to protected tables and database design

Current System

There are five major parts to the database system: hardware, software, people, procedures and data (Rob and Coronel 2002). The Forestry Images system now consists of the following parts:

- **Hardware:** Intel® Xeon™ based system
- **Software:** Microsoft® SQL Server 2000 running on Microsoft® Windows server™ operating system
- **People:** Bugwood Network Personnel
- **Procedures:** Stored procedures in Microsoft SQL Server 2000 and ad hoc queries written in Macromedia® ColdFusion®
- **Data:** Information centered around Images, Subjects and Members

Hardware. The database system is currently running on a Dell® PowerEdge® 2850 server (Figure 4-2). It features two 64-bit Intel Xeon processors running at 3.0 gigahertz and 2 megabytes of L2 cache. The processors have Hyper-Threading technology that allows multi-threaded software applications to execute threads in parallel (www.intel.com): this virtually doubles the number of processors the operating system and applications use. The system also has 2 gigabytes of registered memory as well as redundant power supplies. The server has two 73 gigabyte 15,000 RPM hard drives running in a RAID (redundant array of independent disks) 1 configuration. RAID 1 mirrors data across the two drives so that, if either drive fails, the other continues to function for both until the failed drive is replaced. Forestry Images utilizes two additional servers: one as the Web server and one as the image server. Other Bugwood Network sites are separated onto additional servers to maximize through-put and processing speed.



Figure 4-2. Bugwood Network servers.

Software. Microsoft SQL Server 2000, released in August of 2000 is the latest release of Microsoft's enterprise database product. This client-server relational database system is the leading database on the Windows platform (http://www.microsoft.com/sql/demos/sql_timeline/pr/Marketgrowth.pdf) and is reasonably priced for academic use. The primary reason Microsoft SQL Server was chosen as the DBMS platform was because the original database was designed in Microsoft Access 97, which was easily migrated to Microsoft SQL Server. Microsoft® Windows 2000 Server was the chosen operating system because it is easy to manage and includes an integrated Web server. Microsoft® Windows Server System® 2003 was released in April of 2003 and includes a more secure and powerful Web server. Forestry Images was upgraded to Microsoft Windows Server System 2003 in August of 2005.

People. The Bugwood Network sets up, operates, maintains, and supports all servers, computer hardware, and software for the project. The computer technicians that provide support also have other responsibilities, requiring that all hardware and software to be as easy to maintain as possible.

Procedures. The procedures of the database system are defined to extract data from the database for specific needs. The first Forestry Images system was built using the Microsoft Access interface to extract data. Microsoft Access used prebuilt queries and forms to interact with the data. Ad hoc queries were used to access information that was not commonly needed. The forms and queries were built using the graphical tools in Access.

When Forestry Images was ported to the Web, a middleware product was needed to interface a Web server with a database. There were three major middleware platforms available: Microsoft® Active Server Pages (ASP); PHP: Hypertext Preprocessor; and Macromedia ColdFusion. ASP ran on Windows servers using the built-in Web server and thus didn't require the purchase of additional products. However, early versions of ASP were difficult to code and didn't have advanced development tools. PHP was an open-source middleware product and not as stable as a commercially available product. The final option, Macromedia ColdFusion was chosen as the best alternative.

ColdFusion refers to both the application server and the language. ColdFusion was released in 1995 and has the following advantages (Forta and Weiss 2003):

- Tag-based development
- Easy to test and roll out
- Contains processing and formatting functions
- Easy to maintain
- Powerful development environment and debugger
- Built in database drivers
- Scalable, multi-threaded and service based
- Built on Java architecture
- Supports all major standards and initiatives

The disadvantage of ColdFusion is that the application server must be purchased at \$1,299 for the Professional version and \$5,999 for the Enterprise version. The educational version is priced at \$859 for the Professional version and \$3,959 for the Enterprise version (*www.macromedia.com*, September 2005). The actual costs of ColdFusion compared to ASP are shown in Figure 4-3.

Product	ColdFusion Professional		ASP	
		\$799.95		\$0
Verity full text searching	Included at no extra charge	\$0	Verity K2 Bronze	\$31,000.00
Charting	Included at no extra charge	\$0	Not included; Dundas Chart	\$699.00
POP support	Included at no extra charge	\$0	Not included; AspPOP	\$69.95
Server-side HTTP support	Included at no extra charge	\$0	Not included; AspHTTP	\$49.95
Server-side FTP support	Included at no extra charge	\$0	Not included; Dart FTP Tool	\$249.00
File uploads	Included at no extra charge	\$0	Not included; AspUpload	\$149.00
Total cost		\$799.95		\$32,216.90

Figure 4-3. ColdFusion features compared to ASP (from Ben Forta, *ColdFusion Developer's Journal*, Volume 4, Issue 12, December 2002).

Forta (2002) states:

So, why buy ColdFusion when ASP (or JSP or PHP or Perl or ...) is free? Well, if they were indeed free that would be a very good question. But, as you can see, they are not free, and thus it's not a good question at all. The truth is that the question should be exactly the opposite - with ColdFusion being such a bargain, offering such value for the money and ongoing savings in development costs, why would you ever want to use a supposedly free product?

Macromedia also has information on its website relating to the use of ColdFusion (<http://www.macromedia.com/software/coldfusion/proven/>). This includes the following:

- More than 125,000 ColdFusion servers deployed
- An estimated base of over 300,000 developers
- ColdFusion purchased by more than 10,000 organizations
- Relied on by 40% of the Media Metrix Top 50 Web Properties
- Used by nearly all major branches and agencies of the U.S. federal government
- Used to develop more than 19.7 million ColdFusion pages (source: Google)

ColdFusion is a powerful and stable platform and language. It has proven a solid choice for the four years it has been used for the Forestry Images system.

The two features of ColdFusion that were primarily used in Forestry Images system are custom tags and the CFQUERY with CFOUTPUT tags. Custom tags are reusable, developer-authored extensions to the ColdFusion language (Churvis et al. 2003). Forestry Images uses custom tags on each page to include header and footer information. The header and footer custom tags are included at the top and bottom of each page as shown below:

```
<cf_fiheader title="Forestry Images - Insects">
Page Content
</cf_fiheader>
```

These tags displayed the original Forestry Images header and footer (Figure 4-4).



Figure 4-4. Original Forestry Images header (top) and footer (bottom).

These have been updated in Forestry Images 2.0 and are now included using one paired custom tag as shown below:

```
<cf_imglayout title="About #REQUEST.stApp.sitename#">
Page Content
</cf_imglayout>
```

Note that `#REQUEST.stApp.sitename#` refers to a variable defined in the application configuration file (Application.cfm) and is being used for portability purposes. The new header and footer are shown in Figure 4-5.

The changes and the reasons for the changes between the old and new header and footer are described in the next chapter.



Figure 4-5. Forestry Images 2.0 header (top) and footer (bottom).

The CFQUERY and CFOUTPUT tags are used to query the database and display the information on the Web page. An example of CFQUERY and CFOUTPUT is shown below:

```
<cfquery name="getsubject" datasource="#primary#">
select TBL_subject.SUB_name as name, TBL_subject.SUB_genus
as genus, TBL_subject.SUB_species as species,
TBL_subject.SUB_class as class, TBL_subject.SUB_
order as sorder, TBL_subject.SUB_family as family,
TBL_subject.SUB_variety as variety, TBL_subject.
SUB_identifier as identifier, SUB_syn as syn, SUB_
verified as verify, TBL_subject.SUB_definition as
definition
from TBL_subject
where SUB_id = #url.sub#
</cfquery>
<cfoutput query="getsubject" >#name#</cfoutput>
```

The CFQUERY tag requires two attributes: name and datasource. The name attribute is used by later CFOUTPUT tags to reference what structure variable the data is stored in. The datasource variable refers to the Data Source Names (DSNs) as defined in the ColdFusion Administrator. The variable #primary# is used in this example as another application-level variable used for portability purposes. The code inside the tag is simply standard SQL code with the addition of the ability to use ColdFusion variables. The variable used in the example is a URL variable derived from the URL. Other types of variables are query results, local, CGI, file, form, cookie, and client. The combination of these two tags is used on almost every page of the Forestry Images system.

A new feature of ColdFusion MX 6 is called ColdFusion Components or CFCs. ColdFusion is not an object oriented language; however, CFCs allow developers to use some of the functionality of object-oriented programming within ColdFusion. CFCs can include code, methods, and data and are designed to be reused. They also include built-in documentation and security. CFCs can be designated as a Web service by changing the access attribute of the `cffunction` tag (method) to “remote.” It is recommended that ColdFusion applications be built in layers with the content separated from presentation. When redesigning Forestry Images, CFCs were used along with stored procedures whenever possible. The following CFCs were created to encapsulate the queries and stored procedures:

- area.cfc
- author.cfc
- category.cfc
- image.cfc
- stats.cfc
- subject.cfc
- taxonomic.cfc

These components are passed variables and call stored procedures or queries. They return data back to the calling template that can be outputted to the browser using the `CFOUTPUT` tag. An example of a CFC call is:

```
<cfinvoke component="com.bugwood.image" method="subject"
           returnvariable="gettherecords">
  <cfinvokeargument name="subid" value="#url.sub#">
  <cfinvokeargument name="sort" value="#url.sort#">
</cfinvoke>
```

The data returned from the CFC call can be outputted using the `CFOUTPUT` tag with the `query` attribute set to the “returnvariable” name. In this case the returnvariable would be ‘gettherecords’. The code for the CFC is:

```
<cfcomponent displayname="Image" hint="This component
           retrieves images from database">
  <cffunction name="subject" access="public"
           returntype="query">
    <cfargument name="subid" type="numeric" required="true">
    <cfargument name="sort" type="numeric" default="2"
           required="no">
    <cfstoredproc procedure="sp_getimgsub"
           datasource="#REQUEST.stApp.DSN#">
      <cfprocparam TYPE="in" cfsqltype="CF_SQL_INTEGER"
           dbvarname="sub" value="#subid#">
```

```
<cfprocparam TYPE="in" cfsqltype="CF_SQL_INTEGER"
  dbvarname="sortBy" value="#sort#">
<cfprocresult name="gettherecords" resultset="1">
</cfstoredproc>
<cfreturn gettherecords>
</cffunction>
</cfcomponent>
```

This CFC utilizes the ColdFusion tag CFSTOREDPROC to call a stored procedure from the SQL Server database.

Stored procedures are SQL statements stored in the database in a compiled form to provide more efficient access of data. These procedures are optimized on the server providing the quickest possible access to the data. They reduce the amount of network traffic between the database server and the Web server, and provide security because actual database fields are hidden from the end-users. Stored procedures allow for the use of variables and IF-THEN-ELSE statements. Along with CFCs, stored procedures simplify ColdFusion coding and maintenance, and optimize the use of ColdFusion and Microsoft SQL Server.

Data

The final part of the database system is the data itself. The Forestry Images system has three primary tables which drive additional tables. These tables are TBL_image, TBL_subject, and TBL_author. The TBL_subject table and its related tables include the taxonomic information, categories, common names, references, and other related information. The TBL_author table includes all information for photographers, contacts, and registered members of the system. The TBL_image links the TBL_subject and TBL_author tables for subject, host, photographer, and contact information. It also links to tables including domain and area classification as well as location information. A full description of the image is also included. The TBL_image table includes 55,680 images, of which 32,343 are released (as of September 13, 2005). The TBL_subject table includes 10,266 subjects and the TBL_author table includes 22,249 records for photographers, contacts and members (as of September 13, 2005). Appendix 1 includes the full data dictionary.

A comprehensive database to categorize/classify images is essential in order to store images and make them easy for users to find on the website. Since Forestry Images deals both with subjects that have a traditional taxonomy (binomial nomenclature) and subjects that are non-taxonomically based (forestry practices, stand types, etc.), a database that is flexible enough to allow for the inclusion of both subject types is necessary. A thorough review of online database-driven taxonomic resources revealed several projects using taxonomic databases. The four most relevant projects, including their focus and structure, are:

- Integrated Taxonomic Information System.** The Integrated Taxonomic Information System (ITIS; www.itis.usda.gov, Figure 4-6) is a U.S. government-based website that provides access to standardized nomenclature and hierarchal taxonomy for organisms from both aquatic and terrestrial habitats. In addition to the taxonomy, ITIS provides common names in different languages, synonyms, identifiers, and a taxonomic serial number that is unique to ITIS. While ITIS covers a wide scope of subjects, it is far from complete, and though the future goal of ITIS is to provide nomenclature and taxonomy for all organisms, the current focus is only the biota of North America. Many of the subjects in Forestry Images are not found in North America and exceed the current scope of ITIS. Additionally, the data structure for ITIS does not easily allow for inclusion of non-taxonomic subjects.

The screenshot shows the ITIS Report page for *Dendroctonus frontalis* Zimmermann, 1868. The page includes a navigation menu, search results, and detailed taxonomic information.

ITIS Report
[Home](#) [About Data](#) [Data Access](#) [Submit Data](#) [Tools](#) [Comment](#)

[Go to Print Version](#)

Results of: Search in every Kingdom for all containing 'southern pine beetle'

***Dendroctonus frontalis* Zimmermann, 1868**
 Taxonomic Serial No.: 114914

Taxonomy and Nomenclature

Kingdom:	Animalia
Taxonomic Rank:	Species
Synonym(s):	
Common Name(s):	dendroctone méridional du pin [French] southern pine beetle [English]
Taxonomic Status:	
Current Standing:	valid
Data Quality Indicators:	
Record Credibility Rating:	verified - standards met

Taxonomic Hierarchy

Kingdom	Animalia -- Animal, animals, animaux
Phylum	Arthropoda -- arthropodes, arthropods, Artrópode
Subphylum	Hexapoda -- hexapods
Class	Insecta -- hexapoda, insectes, insects, insecto
Subclass	Pterygota -- insects ailés
Infraclass	Neoptera -- modern, wing-folding insects
Order	Coleoptera Linnaeus, 1758 -- beetles, besouro, coléoptères
Suborder	Polyphaga Emery, 1886
Infraorder	Cuculiformia Lameere, 1938
Superfamily	Curculionoidea Latreille, 1802
Family	Curculionidae Latreille, 1802 -- charançons, snout beetles, weevils
Subfamily	Scolytinae Latreille, 1804
Genus	Dendroctonus Erichson, 1836
Species	<i>Dendroctonus frontalis</i> Zimmermann, 1868 -- dendroctone méridional du pin, southern pine beetle

References

Expert(s):	
Expert:	
Notes:	

Figure 4-6. ITIS taxonomy page.

- PLANTS Database.** The PLANTS database (<http://plants.usda.gov>, Figure 4-7) is a USDA Natural Resources Conservation Service (NRCS) project with many cooperators. The focus of PLANTS is taxonomic information about native and naturalized vascular plants of the U.S., including Puerto Rico and the Virgin Islands, and native and naturalized mosses, lichens, and hepatics (liverworts and hornworts) of the North American continent. PLANTS is similar to ITIS in data structure and provides taxonomy, identifiers, common names, synonyms, and some images for different taxonomic levels. While very complete concerning North American plants, it does not cover insects, animals, or plants not found in the United States.

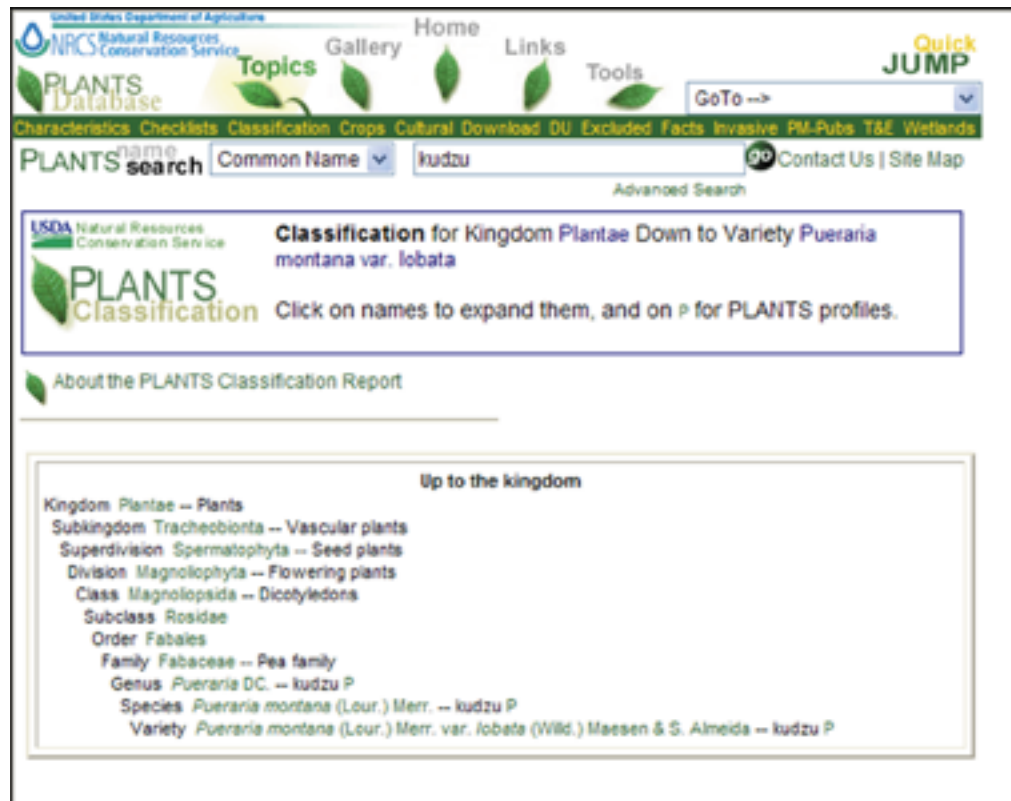


Figure 4-7. PLANTS taxonomy.

- Access to Biological Collections Data schema.** The Access to Biological Collections Data schema (ABCD; <http://www.bgbm.fu-berlin.de/TDWG/CODATA/default.htm>) was developed for standardizing data storage for biological collections, including the typical specimen collections (e.g. herbaria) and field observations. This XML schema was developed to facilitate data sharing by standardizing database fields and structure. Fields included in ABCD's schema are the typical taxonomic levels, specimen specific details (such as date, sex, and location) and fields which help denote where the data originated (e.g. holding institution). While ABCD is a very promising schema for biological data, in particular for data sharing, it does not meet the needs of Forestry Images due

to ABCD's reliance on specimen-based subjects. Inclusion of non-taxonomic subjects into the ABCD schema alongside the traditional taxonomic subjects is difficult.

- **Darwin Core.** The Darwin Core, an XML schema similar to ABCD, is used to facilitate the sharing and integration of primary biological data (<http://darwincore.calacademy.org>). The Darwin Core specifies a data structure for storing information that documents the occurrence of organisms in space and time and of organisms in biological collections. Darwin Core allows for the combination of data from multiple sources by specifying a minimum number of required fields and allows the users to further define the fields necessary for the specific application. Darwin Core was designed specifically for data sharing and is not intended as a model for managing databases. While it does allow for project-specific customizations, it focuses on observations/collections which have a heavy reliance on taxonomy.

When combining taxonomic and non-taxonomic information into a single table, a unique taxonomic name cannot be used to distinguish subjects. Similarly, common names are often shared by several species and cannot be used as the unique identifier for subjects. Unique subject records are distinguished in the Forestry Images TBL_subject table by a unique combination of taxonomic name and common name. Each record in the TBL_subject table is automatically assigned a subject number, which is used to denote that subject in all Bugwood applications. Some subjects will have no scientific name, thus relying solely on a unique common name to distinguish subjects. But some organisms—particularly from international sources—do not have an accepted common name; therefore, reliance on the taxonomic name as the distinguishing factor is necessary.

The Forestry Images TBL_subject table is structured with a subject name (common name for an organism) followed by tiered taxonomy. All taxonomic levels above genus are placed in separate tables. Genus, species, subspecies, and identifier are all located in individual fields within the TBL_subject table. If the subject does not have a taxonomic level specified (for example no subspecies listed for that species), then the appropriate fields are classified as 'N/A'. Additional fields in the TBL_subject table, discussed later in this chapter, are used to help categorize the subjects, create automatic links to appropriate websites, and list references used for taxonomic and common names.

Forestry Images started with the primary focus of forest health related images. The Pest Trend-Impact Plot Systems (PTIPS) codes, used by the USDA Forest Service for identifying problems in forest stands, were used as the base for the Forestry Images database. To include other specific organisms of interest the non-taxonomic structure was built upon by adding tiered hierarchical taxonomic tables with the genus and species fields occurring within the TBL_subject table.

The fields included within the TBL_subject table and the methods used for classifying images, including adding a new subject, are explained in detail below.

- 1. Subject.** The first step in classifying images is assigning a subject to the image. If the subject already exists in the TBL_subject table, then the image is assigned the corresponding subject number. If the subject is taxonomically based and does not exist in the TBL_subject table, then a reference for the common and scientific names is found. Later in this chapter are discussions of the primary sources of taxonomy and of non-taxonomic subjects. Once the correct common and scientific names are found, the subject table is checked once again for any possible synonyms. The scientific name (including identifier) and the common name are entered into the required fields of the subject table. Additionally, comma-delimited fields exist for synonyms for both common and scientific names. This becomes important when users are trying to find images of a subject using an old or uncommon name.

Each record in the TBL_subject table is placed in an individual division. These divisions are used to help classify subjects beyond general taxonomy. Examples of divisions include insects, diseases, other damage agents, plants, wildlife, silvicultural practices, and management. Further, each subject is assigned to one or two categories. These categories are division-specific and allow for more exact definition of subject matter. Examples of categories under the plants division include Shrub, Grass or Grass-like, Nonvascular, and Forbs/herbs. Examples of categories under the insect division include Bark Beetles, Boring Insects, Gallmaker Insects, and Beneficial Insects. Because subjects can often fit into several categories, an optional second category field was added, allowing for the subjects to be organized according to specific features, such as growth type or damage type, in addition to the standard taxonomic divisions.

If the subject was found in ITIS, PLANTS, or CABI's Index of Fungi (<http://www.indexfungorum.org/>), then the appropriate serial number or code used by that taxonomic database is placed in the corresponding TBL_subject field. Automatic links to these taxonomic projects have been created on the subject page and any image pages using that subject. The last step to recording a new subject is to denote what references were used for the common and scientific names. Often, with international subjects, a standard reference does not exist and common names cannot be found. In cases where no standard taxonomic reference is found, an Internet search is used to find whatever information exists on that subject and the most current and complete taxonomic information is entered. Additionally, the photographer is queried about the information used to originally identify the subject.

- 2. Host.** The second step in classifying an image is the optional host field. This is an image-specific field and is not intended to list what species *can* serve as a host, but what specie *is* serving as a host in that particular image. Many pictures will not have a host, either because the subject does not biologically have hosts (many plant species, for example) or the subject is not on a host in that particular image (for example, when a picture of an adult insect is not shown feeding on a plant). The definition of host is general enough to include the type of tree on which a forestry practice is being implemented, as well as the general definition of 'host' as

it pertains to insects, diseases, damage, and parasitic plants. Host species are also included in the subject table.

3. **Photographer/Contact.** Each image is credited to the photographer. In the cases where the photographer is not known, the institute or agency where the photo originated is listed as photographer. All known contact information known is listed for each photographer (including mailing address, phone/fax number, and e-mail address) in the TBL_author table. Updated contact information is essential for relaying commercial requests to the appropriate photographer. A separate name is listed as the contact if the image is received from someone other than the photographer. This is often the case when the image comes from a book, is part of an organization's archives, or the original photographer is deceased.
4. **Descriptor.** Each image has a descriptor listed. The required descriptor is selected from a predefined set of single word identifiers used to broadly describe the stage/focus of the image. For example, the appropriate life stage of a pictured insect would be chosen from the following descriptors: egg(s), larva(e), pupa(e), cocoon(s), or adult(s). Similar descriptors exist for images with other subjects such as flower(s), foliage or symptoms. Additional descriptors allow for descriptions of images that do not focus on a particular life stage—for example damage, control, infestation, treatment, and research. Similar descriptors exist for images with other subjects, such as forestry practices, diseases, plants, animals, etc. This allows users to quickly surmise the focus of the image without having to see the thumbnail and to sort similar images together (sort by descriptor option).
5. **Description.** The optional description field is an undefined text box to allow for inclusion of any narrative specifics of the image beyond the simple descriptor. Typical uses of this field include any history or explanation needed to clarify the focus of the image and stating the context of the image. The description field is particularly useful with silvicultural images which often need a longer explanation to fully describe the practice shown in the image. The description field allows users to get a sense of what the photograph is about without having to see the thumbnail. This is especially helpful if the user is on a slow connection.
6. **Location.** Image locations are classified to the greatest degree of specificity known. Location can be specific to town/county in the U.S. and to country outside the U.S.—though in many cases the only information available is the country of origin (if the image originated outside of the U.S.) or state of origin (if the image originated inside the U.S.).
7. **Domain/Area.** The image specific classification scheme was designed to compliment the division/category classification scheme for subjects. The domain/area scheme allows classification of images of the same subject into separate relevant areas. This becomes particularly useful for insects/diseases that can attack a variety of plants or for plants that can grow wild, are grown as crops, or may be used as an ornamental. Examples of domain/areas include Forestry/Hardwood, Forestry/Conifer, Forestry/Harvest Operations, Wildlife/Birds, Wildlife/Reptiles, Natural Resources/Right-of-Ways, and Roadsides.

Once all of the above areas are added to the database, a link to the image is sent to the photographer (or contact) for verification of the information.

Web Interface

The process of information architecture involves five steps: research, strategy, design, implementation, and administration (Rosenfeld and Morville, 2002). The following steps were completed in the research phase of development for the original web-based Forestry Images system:

- an extensive Web search for similar sites
- a literature review and review of commercial sites
- a search for “packaged” software solutions

Similar Sites

The first type of sites reviewed was university and federal agency image gallery sites. The three focus sites were the USDA Photography Center (<http://www.usda.gov/oc/photo/opchomea.htm>), USDA ARS Image Gallery (<http://www.ars.usda.gov/is/graphics/photos/>), and Iowa State University Entomology Image Gallery (<http://www.ent.iastate.edu/imagegal/>). All of these sites are static image galleries and are not database driven. The USDA ARS and Iowa State sites provide access to images used in articles created by each group.

The ARS site (Figure 4-8) features images from the Agricultural Research Magazine and contains roughly 2,000 images, each of which contains an image number, a description, and photo credits. These images are available in three resolutions: a low resolution (less than 300 pixels wide) for Web use, an medium resolution (640 pixels wide) for use with PowerPoint, and a high resolution (2700 pixels wide) for commercial printing. The images are organized in nine different categories: Animals, Crops, Education, Field research, Fruits and Vegetables, Illustrations, Insects, Lab Research, and Plants. The images are available completely free by completing a form informing USDA ARS how the images were to be used.

Iowa State University’s Entomology Image Gallery (Figure 4-9) provides several hundred images of insects, plants and plant diseases. These images are organized into ten categories:

- Beetles
- Lice
- Butterflies, Moths, and Caterpillars
- Plant Diseases and Damage
- Cicadas and Leafhoppers
- Plants
- Flies and Mosquitoes
- Ticks
- Grasshoppers and Crickets
- True Bugs



Figure 4-8 - USDA Agricultural Research Service image gallery website.

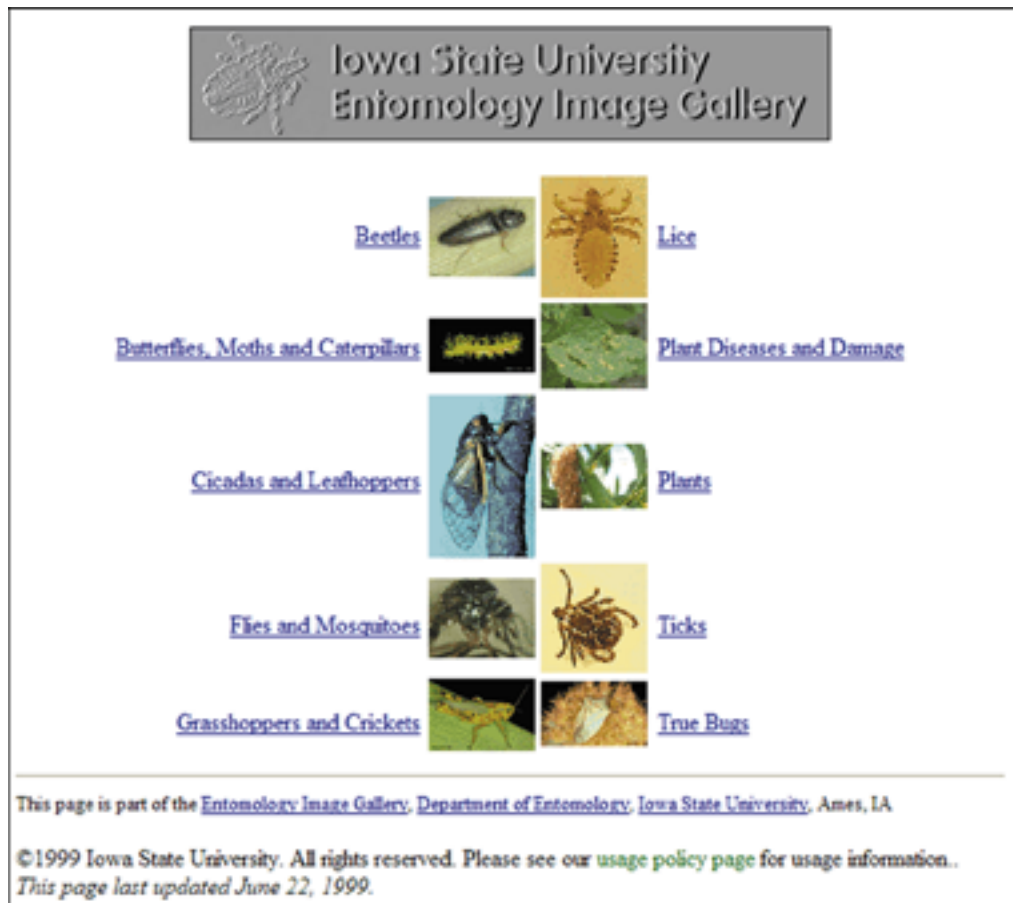


Figure 4-9. Iowa State University Image Gallery website.

Under each category, the images are subdivided into family common names and then into common or scientific name. The images are high quality, but only available as low resolution files (less than 600 pixels wide). These images are copyrighted and can be used without permission only for student projects.

The USDA Photography Center provides a large number of images, all of which are in the public domain (Figure 4-10). These images are available at a maximum resolution of 640 pixels wide. The information about the images is similar to the USDA ARS site and includes image number, description, and photographer. The site includes 25 categories divided into subcategories that are used for browsing images. The images are added as collections, featured on the home page, and available in higher resolutions or as slides for a small fee.



Figure 4-10. USDA On-Line Photography Center photo categories.

Stock Photography Sites

After reviewing the University and USDA image galleries, it was clear that Forestry Images was going to be different than those sites. Forestry Images needed to be similar to stock photography sites, but without the commercial shopping cart and purchasing options. A number of major stock photography sites were identified for review (Engh 2000). The following sites were reviewed in August of 2000 and used as inspiration for the original Forestry Images interface:

- Ditto – “visual search of the Web using pictures” – *www.ditto.com*
- Altavista Image Search – *http://www.altavista.com/image/default*
- Corbis.com and CorbisImages – *www.corbis.com*
- Imagebank (now part of Gettyimages) – *www.gettyimages.com*
- Comstock – *www.comstock.com*
- SuperStock – *www.superstockimages.com*
- Photodisc (now part of Gettyimages) – *www.gettyimages.com*

There were many similarities between these sites, and the major features were used to model the site design for the original Forestry Images Web interface.

Software Options

With any software or Web project, one option is to purchase an off-the-shelf software product. However, there weren't many options available at the time the project began and none were found that would work using our existing database. The primary product that was analyzed was Extensis Portfolio (*www.extensis.com/portfolio*). Portfolio is “visual database from your selected files and folders.” It also allows Web publishing from the database using “several professionally designed templates.” However, we found that the database was very limited and relied primarily on keywords. (Extensis now offers a product called Portfolio Server that allows connection to SQL based databases.)

Two other products were reviewed: ACDSee (*www.acdsystems.com*) and ThumbsPlus (*www.cerious.com*). ACDSee is a “digital photo software and picture viewer.” It includes a powerful search tool that automatically indexes folders of images and allows additional information such as keywords and descriptions to the images. ACDSee also includes tools to upload Web albums and create HTML slideshows.

ThumbsPlus is now described as “a highly customizable image database/ thumbnails/ graphics editor application.” It is now more of a competitor to ACDSee, but originally it was simply a tool to create Web-based image galleries. While these tools are useful for generating image galleries, they would not support the level of detail needed for the Forestry Images system.

Original Web Interface

A custom Web interface was designed and released in July 2001 using Web design concepts and technologies available at the time. The original interface only provided links to the upper-level divisions off the home page of the site. Users visiting the site for the first time were not instantly provided with the scope and the quantity of images available. However users were able to successfully navigate the site (Figure 4-11) and the number of users increased dramatically during the three years it was available.

Website Redesign

A redesign of Forestry Images was initiated in September of 2003 and completed in January 2004 to incorporate new and improved Web technologies. Many of the site's pages had not been modified since late 2002, and the number of images increased dramatically from 3,500 to nearly 20,000. The revision was dubbed Forestry Images version 2.0. Following a period of internal and external testing the new interface was launched on October 1, 2004 (Figure 4-12).



Figure 4-11. Forestry Images homepage version 1.0.



Figure 4-12. Forestry Images homepage version 2.0.

The first step of the site redesign was to define the project (Goto and Cotler 2002). Analyzing the Web log statistics and conducting a survey of the site's users were two of the ways the goals for the redesign were determined. This helped to identify which pages of the site were the most popular and should be further developed. The Web statistics also provided information about the user's Web browser and operating systems, which was very helpful for determining platforms for testing. The survey provided information on how images were being used and the specific enhancements users wanted. The most popular use for the images was in Microsoft PowerPoint presentations, so specific instructions have been provided on the download page to facilitate image use in this application. One user commented that the addition of a search box on every page would be a useful feature. This was implemented in the redesign.

The use of stored procedures and ColdFusion Components (CFCs) as discussed previously was defined as a goal of the redesign to make the site more modular. Modularity was important because it allowed Forestry Images' sister sites—*www.ipmimages.org*, *www.insectimages.org* and *www.invasive.org*—to instantly use the new features of version 2.0. Another goal of the redesign was compliance to compatibility standards. The World Wide Web Consortium's (W3C) XHTML 1.1 standard was chosen for HTML syntax. The W3C's Web Accessibility Initiative and the U.S. Section 508 guidelines were chosen for both handicap access and device compatibility. Many of the comments from the survey praised the site on being easy to use: thus, the redesign needed to ensure that the site's original usability and style were maintained.

Website Statistics

Analyzing website log files is an important way to measure success of a website. Web statistics can also be useful in determining areas of the site that need redesigning. The following statistics were taken from a report of log files for the original Forestry Images website for the period of January 1, 2003, through December 31, 2003. (Complete statistics for use of Forestry Images version 2.0 for October 2004 through July 2005 are available in Appendix 2.)

- The site received 13.8 million hits and 6.4 million page views from 900,000 visitors.
- This was an average of 35,000 hits each day with nearly half of them consisting of page views (hits include both images and page views).
- Each of the 2,300 daily visitors visited 14 pages on average and spent an average of 12½ minutes on the site.

Figure 4-13 shows the trend of hits, page views, and visitors for the year. It shows a decrease in traffic for the months of June and December, but an overall increase of traffic in the last quarter of the year. The decrease is probably due to holidays and summer vacation, as our primary target audience is university faculty and students, as well as K-12 teachers and students. The overall increase shows not only more users are discovering our site, but they are spending more time browsing it.

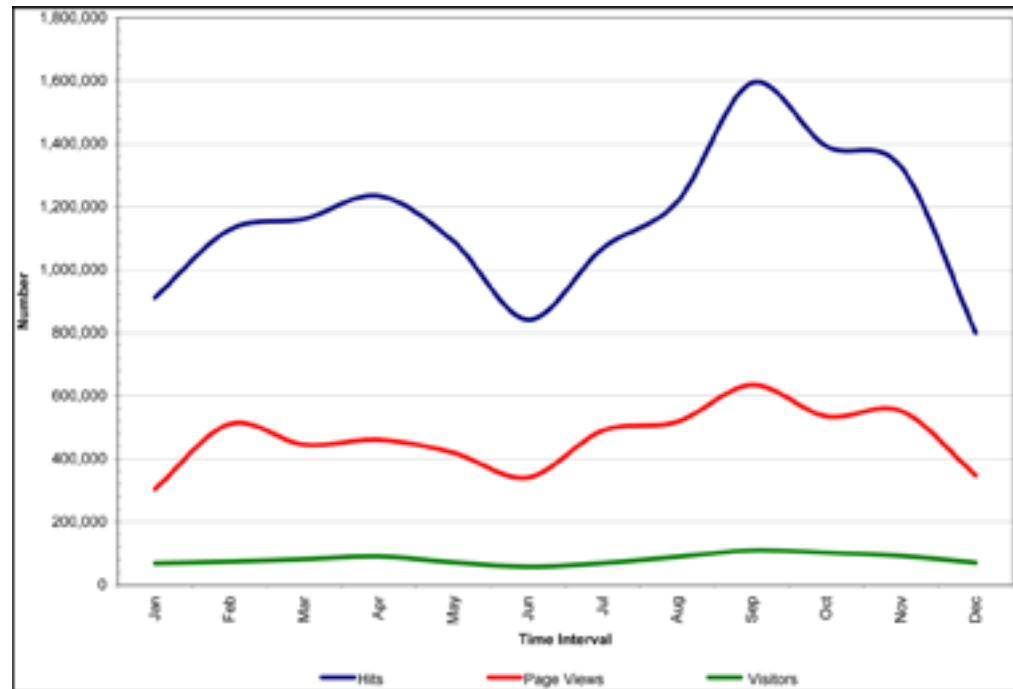


Figure 4-13. Hits, page views and visitors, 2003.

Web log files also provide valuable information regarding those pages that the users accessed. Figure 4-14 shows nearly ninety percent of the traffic to the site was directed to the browse and root directories. These directories provide interfaces to access the images and their related information. The ‘search’ feature, which is included in the “search” and “cgi-bin” directories, received 5 percent of the traffic and was made more accessible in the new version to increase the usage of this very important feature. Other features such as collections, statistics, products, member features, help, and general site information received only 5 percent of site traffic, and thus were less important to the site redesign.

Individual page traffic provides even better clues for how users are using the site. Figure 4-15 shows that most of the site traffic was directed to subject-specific pages and the image detail pages. This is a good indication that the users are accessing the actual content of the site. It is also unusual that the home page access is such a small part of the site traffic, because—according to Nielsen and Tahir (2001)—a home page typically receives more page views than any other page on a website.

The redesign addressed increasing traffic to the homepage. However, it was more important that the site redesign focus on the subimages.cfm and detail.cfm pages and that those pages provide easy access to other information on the site.

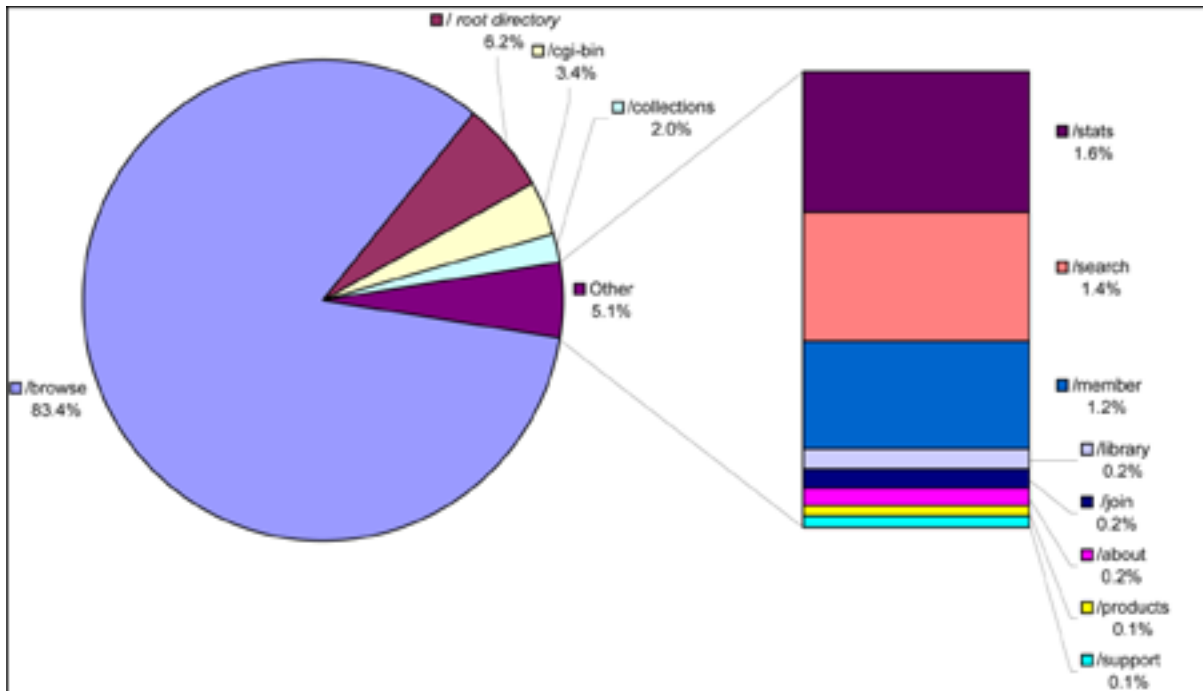


Figure 4-14. Traffic by directory, 2003.

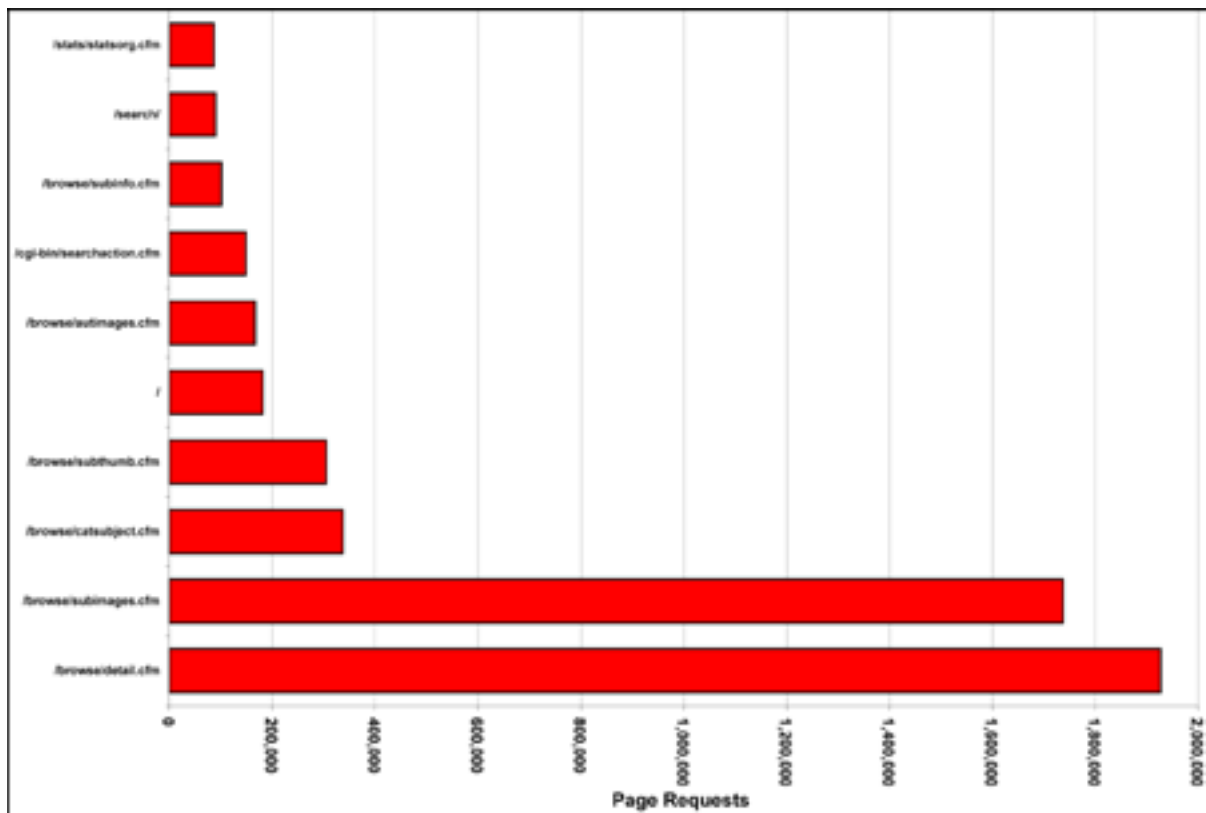


Figure 4-15. Traffic by page, 2003.

As shown in Figure 4-16, a majority of users also entered the site via the subimages.cfm and detail.cfm pages. This was probably due to the fact that the Google search engine provides most of the traffic to the site (see Figure 4-17).

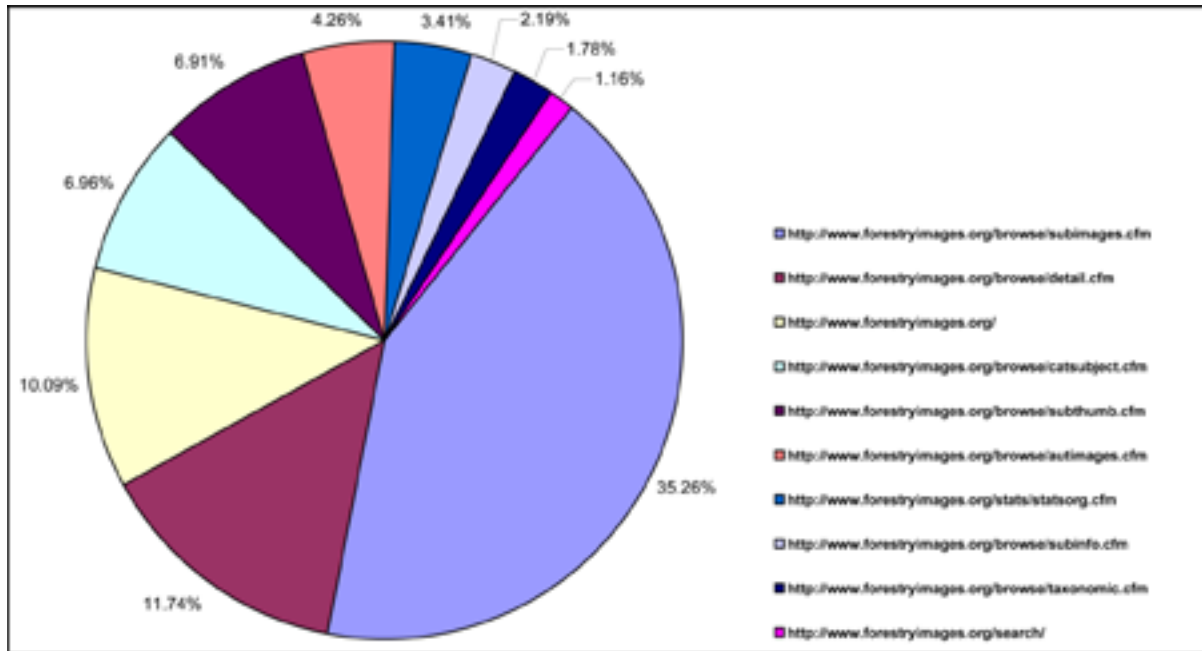


Figure 4-16. Site entry points, 2003.

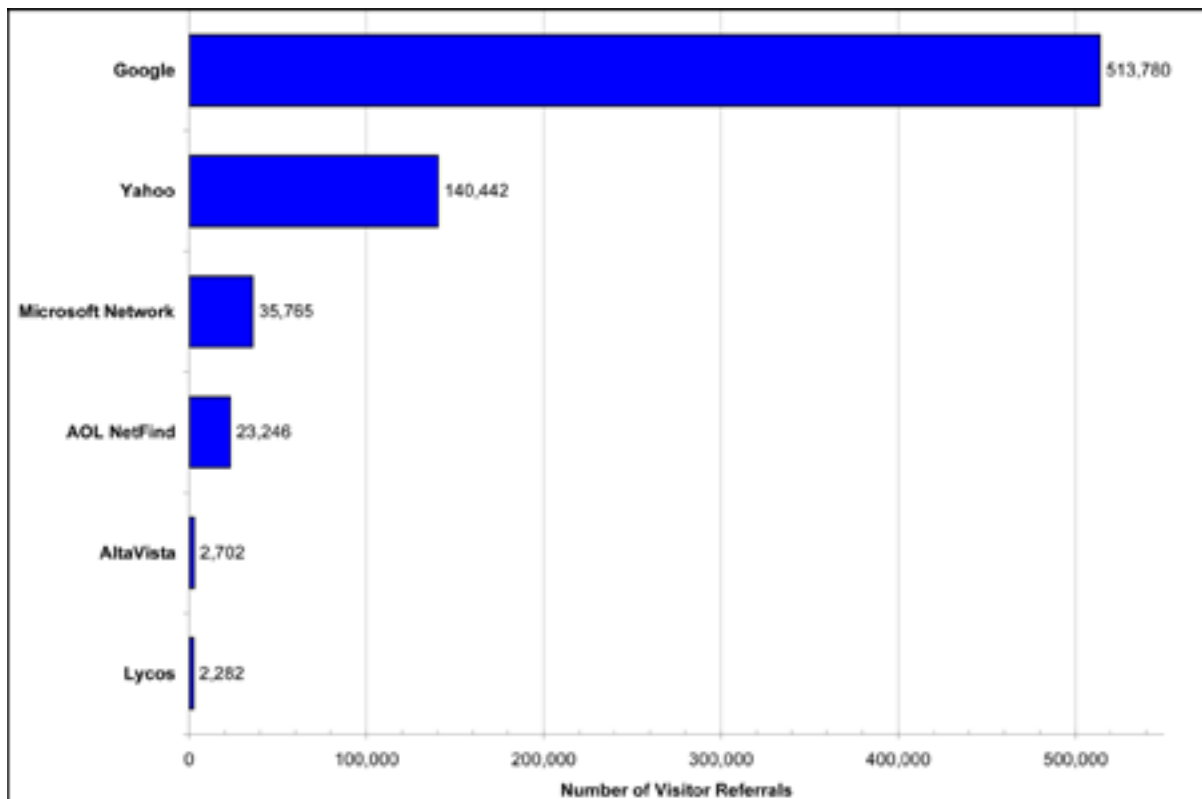


Figure 4-17. Top referring sites, 2003.

According to the Google site:

We are able to index dynamically generated pages. However, because our Web crawler can easily overwhelm and crash sites serving dynamic content, we limit the amount of dynamic pages we index.

(<http://www.google.com/webmasters/2.html#A1>)

Thus, Google indexes these database-driven pages when users are searching for specific terms (see Figure 4-18). As a result, users are sent directly to the content pages and not exploring other aspects of the site. The Nielsen//NetRating site (*<http://www.nielsen-netratings.com/>*) listed the top five parent companies for the month of January 2004 as:

1. Microsoft
2. Yahoo!
3. Time Warner (AOL Netfind)
4. Google
5. U.S. Government

The top four entries are the major search engine/portal sites on the Internet. They are also the top search engines referring users to the Forestry Images site (Figure 4-17)—though not in that order.

Google is by far the leading referrer. Yahoo, listed as second-most, was actually using the Google search engine for all of 2003, but now uses its own search technology (News.com, February 17, 2004). The Google search engine receives more than 200 million requests a day (Wired 2004) and utilizes a technology called PageRank, described below in an excerpt from their website:

PageRank relies on the uniquely democratic nature of the Web by using its vast link structure as an indicator of an individual page's value. In essence, Google interprets a link from page A to page B as a vote, by page A, for page B. But, Google looks at more than the sheer volume of votes, or links a page receives; it also analyzes the page that casts the vote. Votes cast by pages that are themselves "important" weigh more heavily and help to make other pages "important."

Important, high-quality sites receive a higher PageRank, which Google remembers each time it conducts a search. Of course, important pages mean nothing to you if they don't match your query. So, Google combines PageRank with sophisticated text-matching techniques to find pages that are both important and relevant to your search. Google goes far beyond the number of times a term appears on a page and examines all aspects of the page's content (and the content of the pages linking to it) to determine if it's a good match for your query.

(<http://www.google.com/technology/index.html>)

Forestry Images has a very high PageRank value. A search for "forestry" via the Google search engine on March 4, 2004, returned Forestry Images as the twelfth result. A search for "forestry images" returned the Forestry Images site as the first result. Under

the Google Directory category: **Science > Agriculture > Forestry > Pests and Diseases**, Forestry Images was ranked third in PageRank order. Even though the high ranking and traffic from Google's search engine is important, Forestry Images does not score high results on Google's Image Search, and work was done in the redesign to help correct this.

Figure 4-18 shows the top search phrases that send users to the site. The top 20 search terms result in only seven percent of the overall phrases used to reach the site. This again shows that users are finding the site by searching for specific phrases and are directed to the specific content.

Another topic in the user analysis is identifying their distribution by country and means of access. Figure 4-19 shows the distribution of users by country.

Nearly 91 percent of the users are from predominantly English-speaking countries, with most of the traffic originating in the United States. However, over 18 percent of the traffic is from outside of the U.S.—a fairly high percentage, given that the content of the site is focused primarily at a U.S. audience. The distribution of registered users is similar to overall users, with 7,967 of the 10,379 users being from the U.S. The remaining users are from 137 different countries. Projects are in the works to expand the international content of the site and possibly to translate the site into other languages.

Figure 4-20 shows the distribution of users by organization or internet service provider. This figure is interesting because users are so varied that the largest organization represented only 1 percent of the traffic, and it is the largest home ISP, America Online.

Until recently Web developers had to develop for two different platforms: Netscape Navigator and Microsoft Internet Explorer. Today, all the current browsers are compatible with the World Wide Web Consortium (*www.w3.org*) specification and most of the Netscape Navigator 4.x users have upgraded. Netscape 4.x had a very large base of users and many did not upgrade, but its final release was in October of 1998 (<http://www.blooberry.com/indexdot/history/browsers.htm>), and is now not a major factor in Web design. Microsoft Internet Explorer 6 was released in October of 2001 (<http://www.blooberry.com/indexdot/history/browsers.htm>) and is the most widely used browser by visitors to the Forestry Images site (Figure 4-21).

Due to time and budget constraints and because Windows-based machines are used by 85 percent of site visitors (Figure 4-22), the redesign and testing of the Forestry Images website was done with Internet Explorer 6.0 as the target browser and Windows XP and 2000 as the target operating systems.

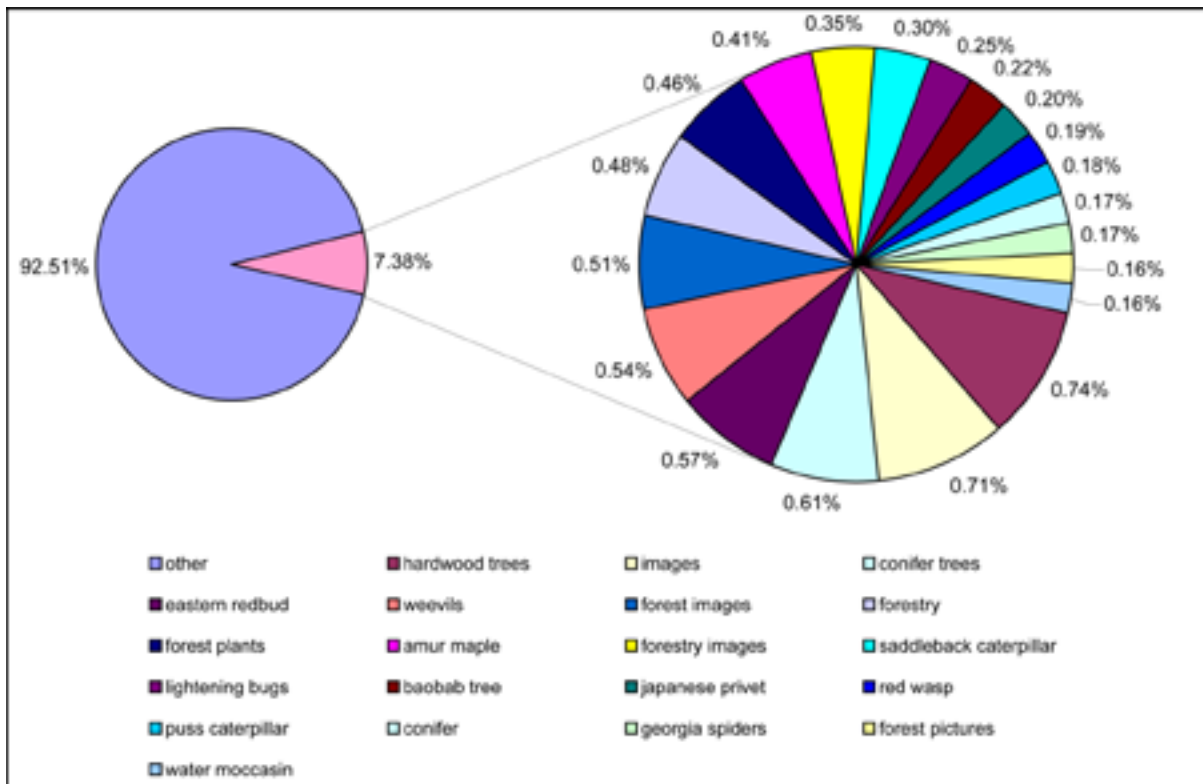


Figure 4-18. Top Search Phrases, 2003.

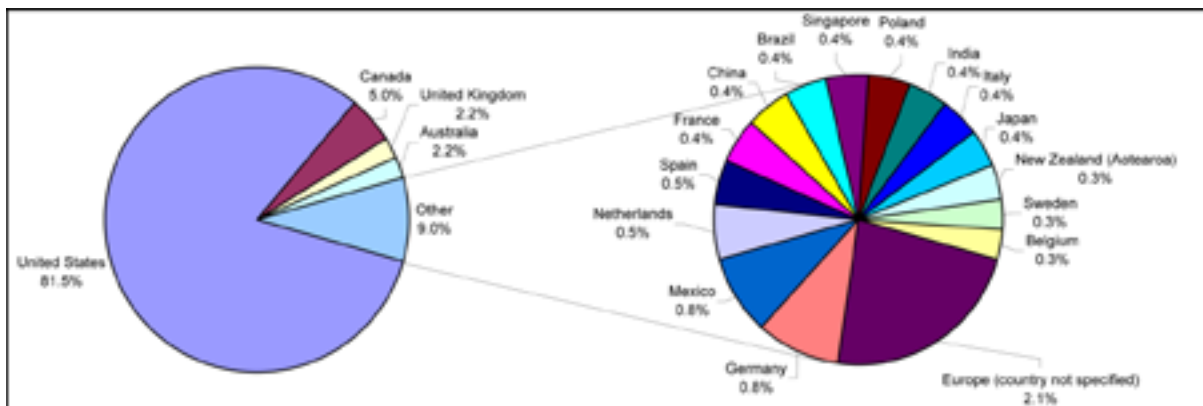


Figure 4-19. Country of Origin.

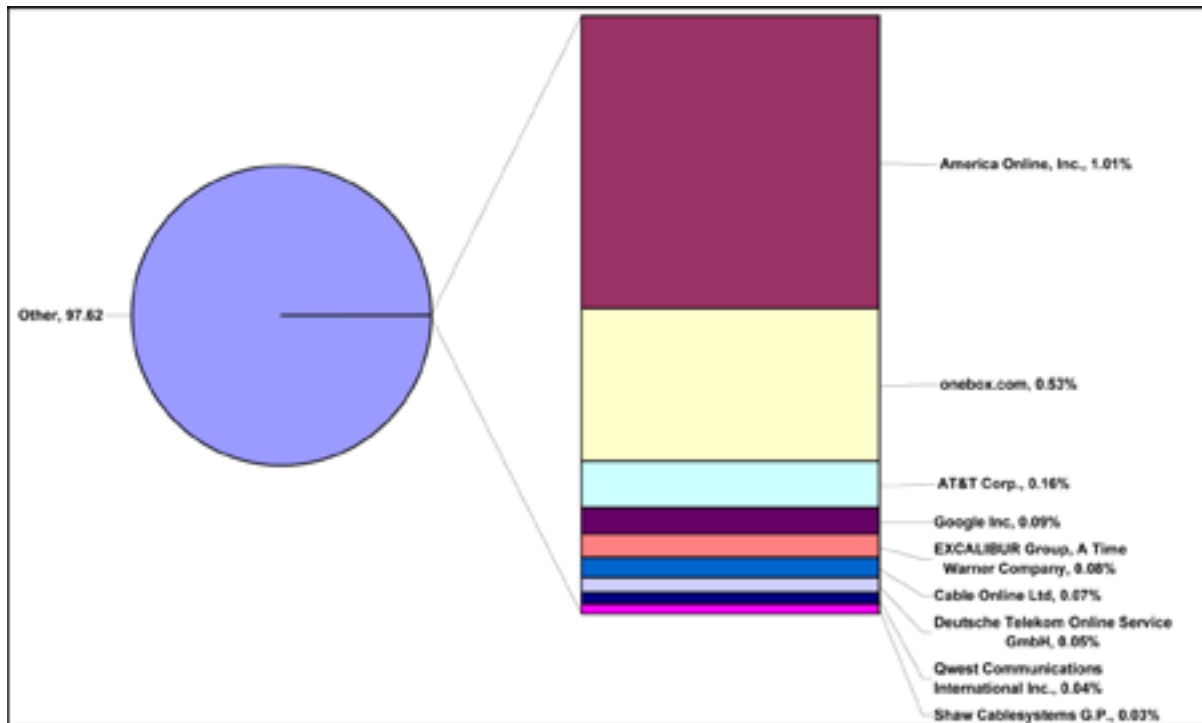


Figure 4-20. Top Organizations or ISP.

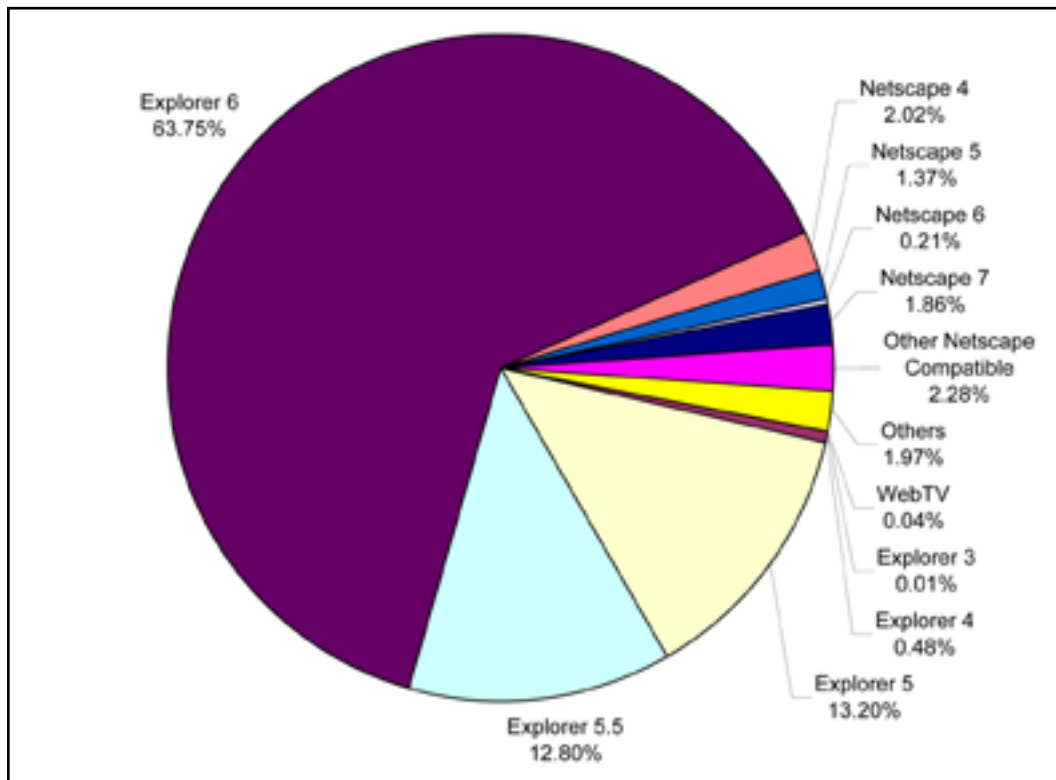


Figure 4-21. Top Browsers.

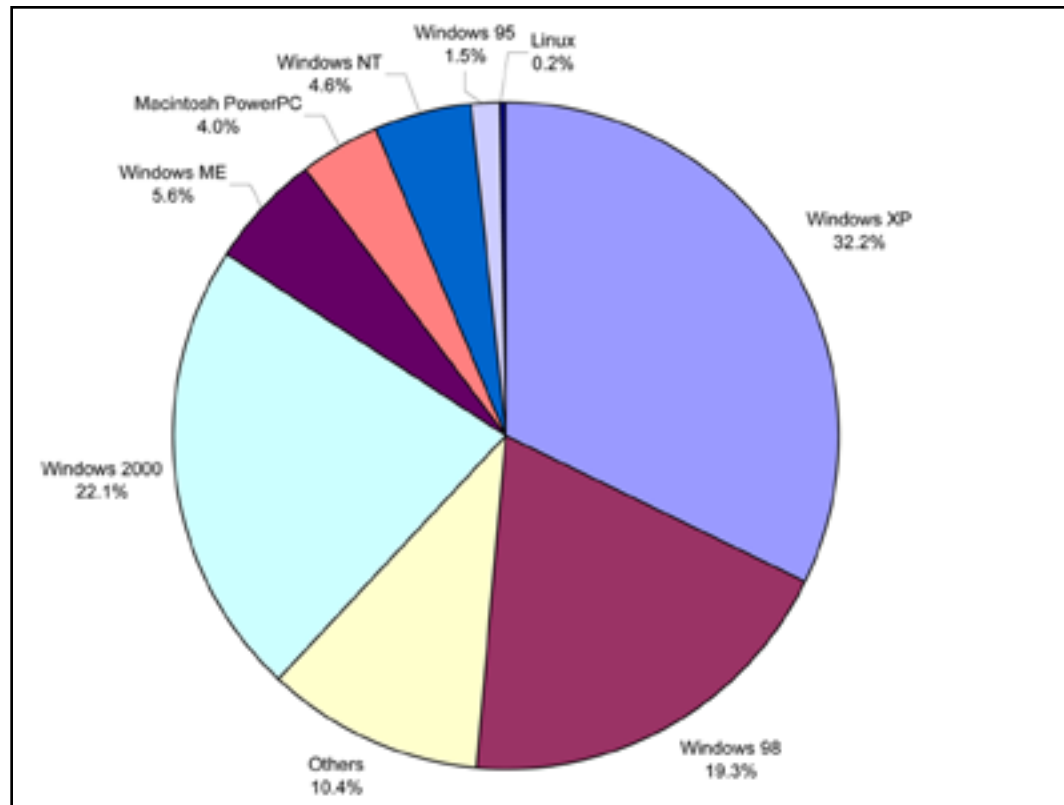


Figure 4-22. Top Operating Systems.

Site Survey

As part of the analysis of Web traffic, a survey was posted on the Forestry Images home page and sent to all registered members of the site to get usage feedback and improvement suggestions. Results of the site survey are included in Appendix 3.

Website Design Concepts

Web design is a complex and controversial topic, and there is no consensus on how best to design for finding information (Spool et al. 1999). Many of the so called “experts” are simply usability engineers that have applied human computer interaction techniques to the website design.

This approach works well enough, but there are many issues with website design that are contradictory and confusing. For example, look at two of the most popular sites on the Internet, the MSN home page (www.msn.com) and Google (www.google.com), sites that are quite different. Google is simple in layout, fast, and works well; as a result, people use it. By contrast, MSN is crowded and complex, but it allows users with many different interests—from sports to stocks to shopping—to quickly access information without wading through multiple levels of pages. So what constitutes good Web design? The best answer is: “it depends.” But what do the experts say?

“Quality, Brevity and Bandwidth”

David Siegal, *Creating Killer Websites* (1996)

“Don’t Make Me Think”

Steve Krug, *Don’t Make Me Think:
A Common Sense Approach to Web Usability* (2000)

“Usability rules the Web. Simply stated, if the customer can’t find a product, then he or she will not buy it. The Web is the ultimate customer-empowering environment. He or she who clicks the mouse gets to decide everything.”

Jacob Nielsen, *Designing Web Usability* (2000)

“The goal is to provide for the needs of all your potential users.”

Patrick Lynch and Sarah Horton, *Web Style Guide* (1999)

“Navigation is invisible when it’s working.”

Jared M. Spool, *Website Usability* (1999)

“Embrace the Medium, Know Your Code, Degrade Gracefully, Be Simple, Be Fast, Be Clear”

Jeffrey Veen, *Hot Wired Style* (1997)

Homepage Design

These concepts provide the basis for the design of the original Forestry Images and the current version 2.0 (Figures 4-23 and 4-24). The redesign of Forestry Images began with the homepage. According to Lynch and Horton (1999), the homepage acts as a logical point of entry into the site and its design drives the design of the rest of the website. The homepage also allows users with different interests to follow different directions. Even though the homepage is not the most accessed page in the Forestry Images website, it is still very important to the site.

The most noticeable difference between the two pages is font size. Most of the text on the page has been slightly increased and changed to either Georgia or Verdana fonts. Microsoft designed these fonts specifically for the best on-screen viewing. These two fonts replace Arial on all pages of the site. The information at the top of the page has been compressed or removed to provide faster access to the image categories. Under each of the image categories, links to the primary subcategories are available. These have been added to allow users quick access images under each of the categories. The ‘Random Image’ feature has also been minimized to save space on the page. This allows the addition of ‘Statistics’ to the homepage. The statistics will provide first-time visitors to the site a quick look at the scope of the site. Features were also moved to the right side bar. The ‘Search’ feature and the ‘Join’ link were moved to the header and are included on each of the site’s pages. The feature-based bar on the original homepage has been removed and replaced on internal pages with a topic-based bar (Figure 4-25).

The site navigation bar at the top right of each page (Home, About Us, Join/Sign in, Your Account, and Help), the topic-based bar, and the left-side bar all now use cascading style sheets to create a roll over-effect and highlight the links.

Nielsen and Tahir (2001) outline homepage design guidelines in their book, *Homepage Usability: 50 Websites Deconstructed*. A few of the key guidelines implemented in the Forestry Images homepage are listed below:

- Logo and name in upper-left corner
- Tag line
- ‘About Us’, ‘Contact Us’, and ‘Privacy Policy’ links
- ‘Help’ link in upper right corner
- Use of examples to illustrate site content
- ‘Search’ function placed at the top of the body of the page
- Links to high priority tasks



Figure 4-23. Forestry Images homepage version 1.0.



Figure 4-24. Forestry Images homepage version 2.0.

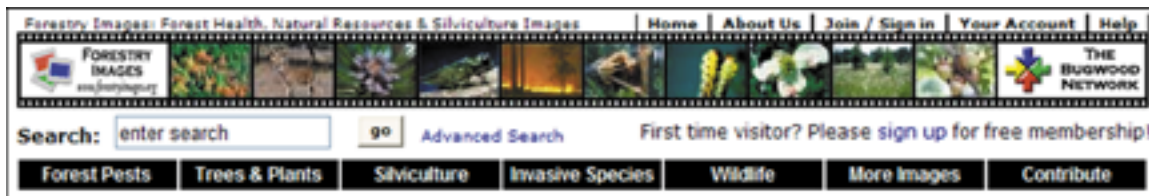


Figure 4-25. Forestry Images 2.0 header.

Most websites follow these recommendations, which lowers the learning curve for sites of similar design. The footer of the Forestry Images site also includes links to the USDA Forest Service and each of the represented University of Georgia units. This meets the requirements of The University of Georgia’s Institution Identity Program, defined at *www.uga.edu/identity/website.html*.

Page Dimensions. The homepage is now 750 pixels wide by 900 pixels tall, which allows viewing on an 800 x 600-pixel resolution screen without scrolling horizontally and requires scrolling only two screens vertically. Most of the page is available at 1024 x 768 resolution. These were the two most popular resolutions by our users and by general computer users. Some researchers argue that users seldom scroll Web pages (Lynch and Horton 1999). Thus, important features need to be placed “above the fold” (Nielsen & Tahir 2002) or in the visible part of the browser without scrolling. Figures 4-26 and 4-27 show the home page at 800 x 600-pixel and 1024 x 768-pixel resolutions, respectively, and show the information located “above the fold” in each case.

Cascading Style Sheets. In the early days of the Web, developers had to rely on presentational markup, such as the tags, to control the display of a Web page. This led to messy, unreadable code. In 1996, the W3C developed and recommended a standard called Cascading Style Sheets (CSS), which separates presentation from structure. CSS allows all formatting to be done in HTML and much more (Meyer 2000). Forestry Images initially used style sheets in a lesser capacity, but now uses them to their full advantage. Version 2.0 employs two style sheets: one for the home page and one for the rest of the site. Style sheets are now used to emphasize links by changing background colors and help to speed page access. The style sheet is downloaded once for the site and stored in the users Internet cache; it is then accessed to format each page requested. CSS also reduces updating and maintenance time by allowing global changes to be made in one file (Zeldman 2003). Both style sheets used on Forestry Images are compliant with the W3C’s standard for CSS version 2 and can be validated at <http://jigsaw.w3.org/css-validator/>.

XHTML. XHTML is the reformulation of HTML 4.01 in XML (Extensible Markup Language) and combines the strength of HTML 4 with the power of XML (see <http://www.w3.org/MarkUp/>). XHTML is currently at version 1.1 and is much stricter to XML rules than the first version. Jeffery Zeldman (2003) in his book *Designing with Web Standards* outlines the top 10 reasons to convert to XHTML:

1. Current markup standard
2. Designed to work with other XML languages
3. More consistent than HTML
4. Provides a bridge to future versions
5. Works as well on older browsers as HTML
6. New browsers render XHTML faster than HTML
7. Works well with wireless devices, screen readers, and other non-traditional devices
8. Part of a family of standards including CSS and W3C Document Object Model
9. Promotes better coding
10. Promotes validation of pages

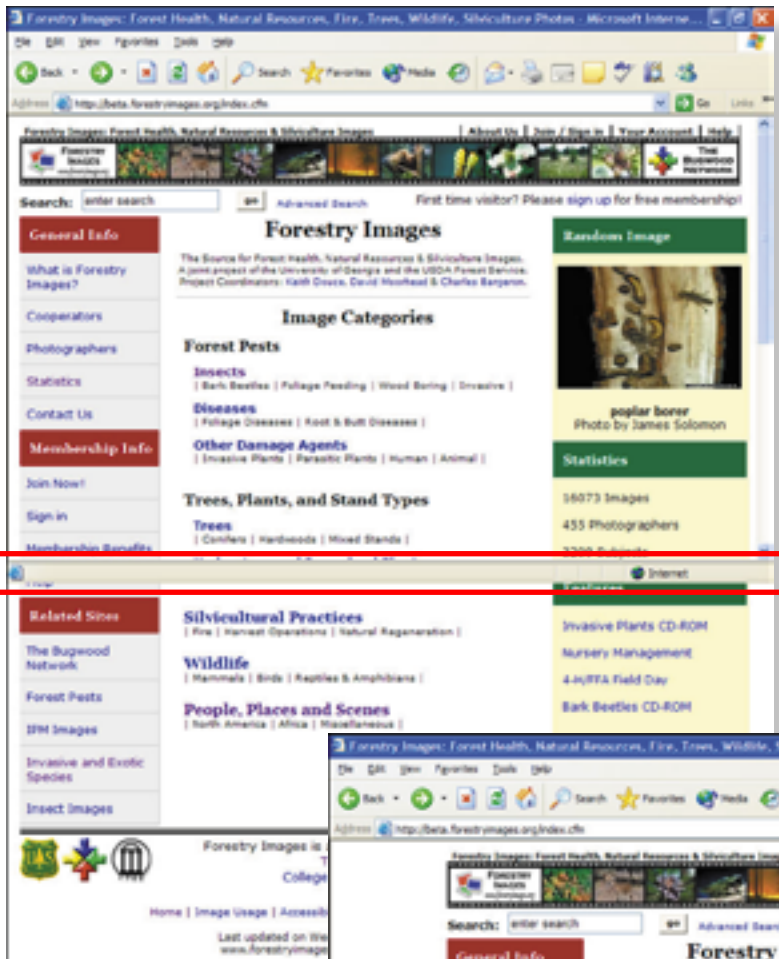
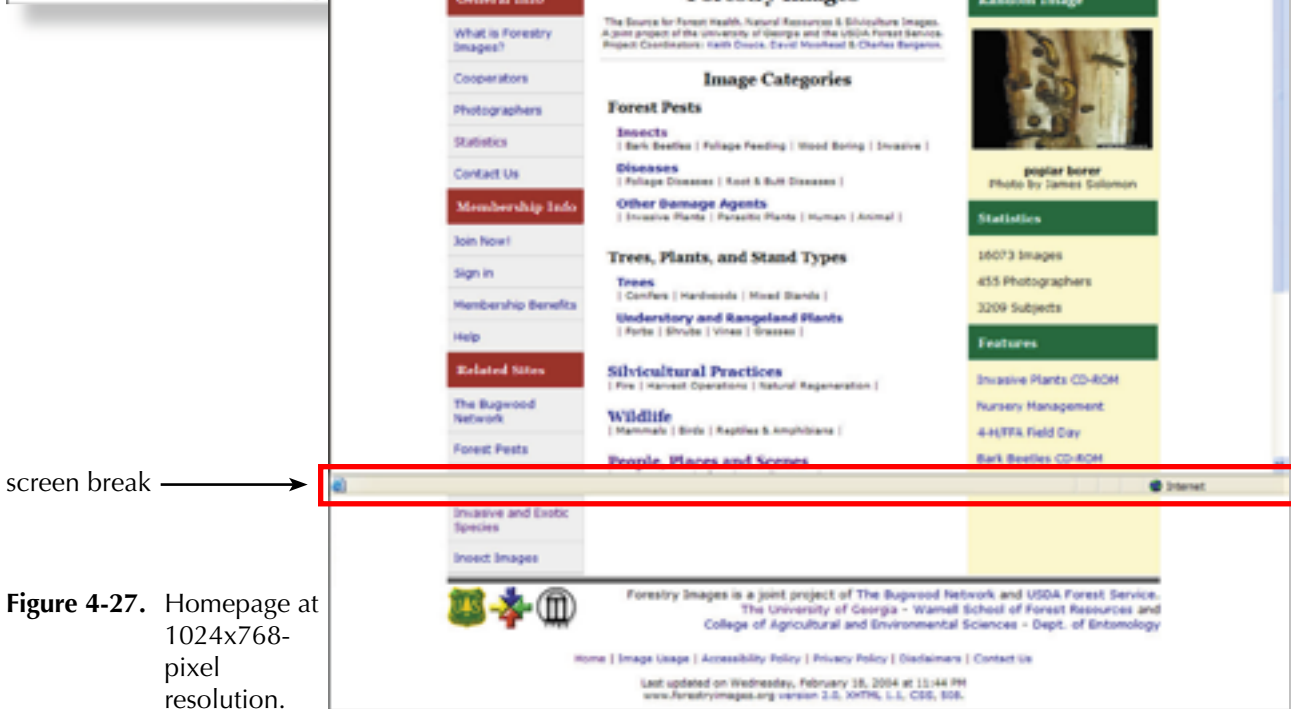


Figure 4-26. Homepage at 800x600-pixel resolution.

← screen break



← screen break

Figure 4-27. Homepage at 1024x768-pixel resolution.

He begins the book by stating that 99.9 percent of websites are obsolete and are going to have to be redone to meet Web standards in the near future. One of the goals of version 2.0 of Forestry Images was to completely meet the requirement of XHTML 1.1. Each page of the original site contained from a few to hundreds of errors when validated with the W3C Markup Validation Service (<http://validator.w3.org/>). The primary changes that had to be made are listed below:

- Close all tags
- Close empty tags with a space and a slash
- Use alternatives such as ‘<’ for ‘less-than’, ‘>’ for ‘greater-than’, and ‘&’ for an ampersand (&)
- Quote all attribute values
- Write all tags and attributes in lowercase
- Declare DOCTYPE and content type

After the changes were made, each of the pages were validated using the Markup Validation Service to ensure compatibility and reduce errors.

Accessibility. There are two important facts to consider when building “accessible” websites. First of all, 7.3 million Americans have vision problems, 6.9 million have hearing problems and 6.3 million have difficulty using their hands (Clark 2003). Second, within each of these groups, over 20 percent have Internet access (Clark 2003). Ignoring these individuals eliminates them as potential users of a site. Another benefit to developing accessible websites is better compatibility with mobile devices such as cell phones, Palm OS, and Pocket PC devices.

In 1998, the U.S. Congress updated the Rehabilitation Act of 1973 in The Rehabilitation Act Amendments (Section 508) to require that all federal agencies make their electronic and information technology accessible to people with disabilities. The W3C also developed a set of stricter guidelines for use by all developers called Web Content Accessibility Guidelines. These guidelines (available at <http://www.w3.org/TR/WCAG10/full-checklist.html>) include three priority levels of compliance:

- Priority 1 – basic requirement for some groups to be able to use Web documents.
- Priority 2 – removes significant barriers to accessing Web documents.
- Priority 3 - improves access to Web documents.

Many of the Section 508 and W3C guidelines are related to access by the visually impaired using a screen reader. Questions arose about the applicability of these guidelines to Forestry Images. How do image archive sites resolve this complicated issue? Also, because Forestry Images was developed as a cooperative agreement between the USDA Forest Service (a federal agency) and the University of Georgia, is the site required to meet Section 508 requirements? Nevertheless, version 2.0 of Forestry Images strives to meet all of the Section 508 requirements and most of the W3C guidelines. The Section 508 requirements are listed below (from www.section508.gov).

1194.22 Web-based intranet and internet information and applications.

- (a) A text equivalent for every non-text element shall be provided (e.g., via “alt,” “longdesc,” or in element content).
- (b) Equivalent alternatives for any multimedia presentation shall be synchronized with the presentation.
- (c) Web pages shall be designed so that all information conveyed with color is also available without color, for example from context or markup.
- (d) Documents shall be organized so they are readable without requiring an associated style sheet.
- (e) Redundant text links shall be provided for each active region of a server-side image map.
- (f) Client-side image maps shall be provided instead of server-side image maps except where the regions cannot be defined with an available geometric shape.
- (g) Row and column headers shall be identified for data tables.
- (h) Markup shall be used to associate data cells and header cells for data tables that have two or more logical levels of row or column headers.
- (i) Frames shall be titled with text that facilitates frame identification and navigation.
- (j) Pages shall be designed to avoid causing the screen to flicker with a frequency greater than 2 Hz and lower than 55 Hz.
- (k) A text-only page, with equivalent information or functionality, shall be provided to make a website comply with the provisions of this part, when compliance cannot be accomplished in any other way. The content of the text-only page shall be updated whenever the primary page changes.
- (l) When pages utilize scripting languages to display content, or to create interface elements, the information provided by the script shall be identified with functional text that can be read by assistive technology.
- (m) When a Web page requires that an applet, plug-in or other application be present on the client system to interpret page content, the page must provide a link to a plug-in or applet that complies with §1194.21(a) through (l).
- (n) When electronic forms are designed to be completed on-line, the form shall allow people using assistive technology to access the information, field elements, and functionality required for completion and submission of the form, including all directions and cues.
- (o) A method shall be provided that permits users to skip repetitive navigation links.
- (p) When a timed response is required, the user shall be alerted and given sufficient time to indicate more time is required.

All requirements are met and verified using the Watchfire Bobby (<http://bobby.watchfire.com/bobby/html/en/index.jsp>) and Cynthia Says (<http://www.cynthiasays.com/>) validation services. The services test both the Section 508 requirements and the W3C guidelines. The primary guideline from the W3C site that was not met is from the Priority 2 section stating: “Use relative rather than absolute units in markup language attribute values and style sheet property values.” This guideline was not implemented in order to maintain a uniform fixed layout regardless of screen resolution.

Search. There are two primary ways to locate information on a website: searching and browsing. Some users prefer to search the site, while others will want to browse it (Rosenfeld & Morville 2002). This was illustrated with our site survey, in which roughly half of the respondents preferred searching for images while half preferred browsing. Forestry Images version 2.0 upgrades the search feature in numerous ways. The interface was completely rebuilt so that, once a search is completed, the results both in the description view (Figure 4-28) and the thumbnail view are sortable (Figure 4-29). Both views also are identical to their browse interface. Secondly, a user defined function (UDF) was implemented that cleans the data entered into the search field. Many of the errors encountered by the search engine involved the use of characters the Verity search engine does not recognize. This includes parentheses, which are frequently used in search strings. This function was written by Simon Potter, revised by Raymond Camden, and made available free from the Common Function Library Project (www.cflib.org).

Search Results				
Your search for "black turpentine beetle" returned 38 of 30653 records				<View Thumbnails>
Image	Subject	Scientific Name	Descriptor	Photographer
1669048	southern pine beetle	<i>Dendroctonus frontalis</i> Zimmermann, 1868	Adult(s)	Southern Forest Insect Work Conference Archives
1669049	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Damage	North Carolina State University Archives
1669052	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Larva(e)	North Carolina State University Archives
1929031	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Damage	Tim Tigner
1929032	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Damage	Tim Tigner
2089086	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Damage	Lacy L. Hyche
2089087	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Damage	Lacy L. Hyche
2089088	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Damage	Lacy L. Hyche
2089089	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Adult(s)	Lacy L. Hyche
2516001	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Adult(s)	David T. Almquist
2516002	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Adult(s)	David T. Almquist
2733010	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Damage	Terry Price
2733011	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Adult(s)	Terry Price
2733012	black turpentine beetle	<i>Dendroctonus terebrans</i> (Olivier)	Damage	Donald E. Bilsman

Figure 4-28. Search results (descriptions).



Figure 4-29. Search results (thumbnails).

Finally, ColdFusion includes two search engines licensed from Verity (www.verity.com). The original Forestry Images system utilized the standard or VDK server. Version 2.0 implements the high-performance Verity K2 Sever. The server indexes a query of all viewable fields of all available images in the system.

Browse. The most difficult part of designing a site such as Forestry Images is developing a system for browsing that makes sense to the user. More time has been spent developing how to organize images than any other aspect of the project. This is not a problem unique to Forestry Images: everyone who is involved in information architecture is becoming a librarian (Rosenfield & Morville 2002), and organizing information is becoming a vital part of all Web design (Rosenfield & Morville 2002).

Before a database was designed or a record created, time was spent developing a classification system. The system involves two primary parts: subjects are divided into divisions and categories; images are divided into domains and areas. These are seamlessly integrated into the ‘browse’ function of the website, and the end users never know that the distinction exists. Examples of each breakout are shown below, and a full list of relevant breakouts is shown from the “browse all” page of Forestry Images (Figure 4-30):

Division and Category

- Insects
- Foliage Feeders
- Bark Beetles
- Diseases
- Root/Butt Diseases
- Foliage Diseases
- Wildlife
- Mammals
- Birds

Domain and Area

- Regeneration Practices
- Natural Regeneration
- Artificial Regeneration
- Nursery Operations
- Bareroot
- Container

Many of these divisions were derived from existing standard reference materials:

Forest Insects – Coulson, R. N., and J. A. Witter. 1984 *Forest Entomology: Ecology and Management*. John Wiley and Sons, Inc. New York, 669 p.

Forest Diseases – Tainter, F.H., and F.A. Baker. 1996. *Principles of Forest Pathology*. John Wiley and Sons, Inc. New York, 803 pp.

Trees & Plants – USDA, NRCS. 2001. *The PLANTS Database, Version 3.1, National Plant Data Center, Baton Rouge, LA 70874-4490 USA*. <http://plants.usda.gov/>

Silviculture - Society of American Foresters. 1994. *Silviculture Working Group Terminology*.

Browse Forestry Images	
Forest Pests	Silvicultural Practices
Insects	Regeneration Practices
Foliage Feeding Insects	Site Preparation: Slash Treatments
Bark Beetles	Site Preparation: Competition Control/Seedbed Preparation
Weevils	Site Preparation: Amelioration
Boring Insects	Natural Regeneration
Chewing Insects	Artificial Regeneration
Sucking Insects	
Gallmakers	
Seed / Cone / Flower / Fruit Insects	
Stinging / Biting / Nuisance Insects	
Beneficials and Insect Predators	
Misc. Insects	
Diseases	Nursery Operations
Root/Butt Diseases	Introduction
Stem Decays/Cankers	Bareroot
Foliage Diseases	Container
Decline Complexes Dieback/Wilts	Propagation of Cuttings
Stem Rusts	Seed Orchards, Seed Collection and Handling
Broom Rusts	
Biotic Damage	
Diseases of Insects	
Fungi	
Other Damage Agents	Intermediate Treatments
Abiotic Damage	Thinning
Human Damage	Timber Stand Improvement
Animal Damage	Fire and Fire Effects
Multi Damage	
Trees	Forest Products
Conifers	Harvest Operations
Hardwoods	Christmas Tree Production
Mixed Species	Pine Straw Production
	Maple Syrup Production
	Wood Products
	Non-Wood Forest Products
Understory / Rangeland Plants	Forest Resources
Forbs and Herbs	Soil and Water
Grasses, Sedges and other Grass-like Plants	Agroforestry
Shrubs and Subshrubs	Urban Forestry
Vines	Hybrid Poplar
Palms	Misc. Forestry
Ferns	
Cactus	Wildlife
	Mammals
	Birds
	Reptiles & Amphibians
	Worms, Snails & Leeches
	People, Places and Scenes
	North America

Figure 4-30. Forestry Images browse interface.

The browse interface follows a simple hierarchal system. The user first selects the division or domain from the homepage, then chooses from a list of categories or areas within their first choice (Figure 4-31), and receives a table of all subjects found in this classification that displays the subject's name, scientific name, taxonomic order, and family (Figure 4-32). Each of these fields is sortable in a similar fashion to the search interface described previously.

The second selection takes the user to the subject page (Figure 4-33), the most popular page on the site. This page allows the user to view all the images along with their descriptors, descriptions, and photographers and presents the full scientific taxonomy of the subject. Each of the taxonomic levels is hyperlinked to a list of their children. For example, clicking on the order Coleoptera would present a list of all families in that particular order. Each of the fields is again sortable.

The user may also choose to switch to a thumbnail view (Figure 4-34) of the images. This page is similar to the description view but includes small (192 x 128-pixel) versions of the images. It can also be sorted and includes the full taxonomic classification. The thumbnail page provides options to increase the number of images shown on each page and to browse between pages.



Figure 4-31. Areas under the domain "Trees."

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Conifer Trees

90 records Sort by:

Subject	Scientific Name	Order	Family
silver fir	<i>Abies alba</i> Miller	Pinales	Pinaceae
balsam fir	<i>Abies balsamea</i> (L.) P. Mill.	Pinales	Pinaceae
white fir	<i>Abies concolor</i> (Gord. & Glend.) Lindl. ex Hildebr.	Pinales	Pinaceae
Fraser fir	<i>Abies fraseri</i> (Pursh) Poir.	Pinales	Pinaceae
grand fir	<i>Abies grandis</i> (Dougl. ex D. Don) Lindl.	Pinales	Pinaceae
corkbark fir	<i>Abies lasiocarpa arizonica</i> (Hook.) Nutt. (Merriam) Lemmon	Pinales	Pinaceae
subalpine fir	<i>Abies lasiocarpa</i> (Hook.) Nutt.	Pinales	Pinaceae
Sacred fir	<i>Abies religiosa</i> (Kunth) Schtdl. & Cham.	Pinales	Pinaceae
parana pine	<i>Araucaria angustifolia</i> (Bertol.) Kuntze	Pinales	Araucariaceae
bunya pine	<i>Araucaria bidwillii</i> Hook.	Pinales	Araucariaceae
Moreton Bay pine	<i>Araucaria cunninghamii</i> Alton ex D. Don	Pinales	Araucariaceae
Alaska-cedar	<i>Chamaecyparis nootkatensis</i> (D. Don) Spach	Pinales	Cupressaceae
Atlantic white cedar	<i>Chamaecyparis thoides</i> (L.) B.S.P.	Pinales	Cupressaceae

Figure 4-32. Subjects under the area “Conifer Trees.”

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longleaf pine

Trees: [Conifer Trees](#)


[Pinopsida](#) > [Pinales](#) > [Pinaceae](#) > *Pinus palustris* P. Mill.

134 records [<View Images as Host>](#) Sort by: [<View Thumbnails>](#)

Image	Descriptor	Description	Photographer
1420015	Competition	Dead scrub hardwoods and grass on herbicide treated plots, USDA Forest Service - Conecuh National Forest, Andalusia, Alabama, Feb. 1954	Thomas C. Croker
1420067	Competition	longleaf litter, Conecuh, Alabama, May 1967	W. Robert Maple
1423023	Competition	Hardwoods invading stand, Escambia Experimental Forest, May 1962	William D. Boyer
1423024	Competition	Hardwoods invading stand, Escambia Experimental Forest, September 1986	William D. Boyer
1423025	Competition	Residual hardwoods following pine harvest inhibit natural regeneration; Union Camp, Butler county, Alabama, October 1977	William D. Boyer
1420124	Damage	7-year old seedling stand heavily grazed. Compartment 94. USDA Forest Service - Escambia Experimental Forest, Brewton, Alabama. December 1954	Virgil Davis

Figure 4-33. Image description view.

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FORESTRY IMAGES  THE BIRCHWOOD NETWORK

Search: [Advanced Search](#) First time visitor? Please [sign up](#) for free membership!

Forest Pests | Trees & Plants | Silviculture | Invasive Species | Wildlife | More Images | Contribute

longleaf pine Trees: [Conifer Trees](#)

Pinopsida > Pinales > Pinaceae > *Pinus palustris* P. Mill.

134 records <View Images as Host> Sort by: <View Descriptions>

< Previous > **Results 121 - 134** Images per page: [15] 30 60 all










 1150076 Stand Chuck Bargeron	 1150080 Stand Chuck Bargeron	 1162022 Stand 65-year old natural stand. Tift County Georgia. David J. Moorhead
 1162029 Stand 10-year old stand established using bareroot seedlings on a peanut field. Tifton, Georgia David J. Moorhead	 0908061 Stand 8-year old bareroot stand David J. Moorhead	 0908062 Stand 10 year-old bareroot stand. David J. Moorhead
 0908063 Stand 10 year-old bareroot stand. David J. Moorhead	 0908064 Stand 3 year-old bareroot stand. David J. Moorhead	 0908071 Stand bareroot stand in active height growth stage David J. Moorhead

Figure 4-34. Image thumbnail view.

The “final” page of the browse interface is called the detail page (Figure 4-35) and includes all available information relating to an image, the proper citation for the image, and a statement on how the image can be used and provides links to additional images by subject, host, and photographer. From this page, the users can now request permission to use the image for commercial purposes.

Image Number: 0908063

Add to Shopping Cart
 PowerPoint - 768x512
 Small Print - 1536x1024
 Large Print - 3072x2048

Image Usage
 Personal
 Educational
 Media
 Commercial

longleaf pine
 Pinopsida > Pinales > Pinaceae
Pinus palustris P. Mill.

Photographer: David J. Moorhead, The University of Georgia
Descriptor: Stand
Description: 10 year-old bareroot stand.

Available Images Resolutions:
 192x128
 384x256
 768x512
 1536x1024 - Available only to registered members
 3072x2048 - Available only to registered members

More Images:
 longleaf pine
 Genus: *Pinus*
 Family: Pinaceae
 Order: Pinales
 Class: Pinopsida
 Photographer: David J. Moorhead, The University of Georgia

Image Citation:
 David J. Moorhead, The University of Georgia, www.forestryimages.org

Image Use:
 This image may be copied and used, in whole or in part, for any non-profit, educational purpose provided that all reproductions bear an appropriate credit. Any commercial or other use of the image requires the written permission of the photographer or contact organization, and Forestry Images.

Image Information last updated on Thursday, November 07, 2002

Figure 4-35. Image detail page.


When requesting permission, the user is presented with a form to complete and the results are logged to the database. An e-mail with the contents of the form is sent to the Bugwood Network and the photographer. The user may add the image to their shopping cart (Figure 4-36) for batch downloading, compile usage requests, and choose between links to each of the available resolutions. In order to download the higher resolutions (1536 x 1024 pixels and 3072 x 2048 pixels) (Figure 4-37), the user must first register with the system.

Shopping Cart

The Shopping Cart feature allows you to batch download images and information. It also allows you to request permission for commercial, print and electronic media use.

All images may be copied and used, in whole or in part, for any non-profit, educational purpose provided that all reproductions cite photographer and <http://www.forestryimages.org/>. Any commercial or media use of the image requires the written permission of the photographer and Forestry Images.

Empty Shopping Cart

Image	Information	Resolution
0908063	 <p>longleaf pine <i>Pinus palustris</i> P. Mill. Stand Photo by David J. Moorhead, The University of Georgia</p>	Small Print Update

Please tell us how you plan to use these images. Thanks!

Note permission must be granted for commercial, print and electronic media uses. An e-mail will be automatically sent to the photographer and Forestry Images for those uses.

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 Educational
 Commercial | Company name:
 Electronic or Print Media

Intended use(s):

Publication | Publ. Name:
 Web site | URL:
 PowerPoint Presentation
 Display or exhibit
 Other:

Other Comments:

Figure 4-36. Shopping Cart.

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Search: [Go](#) [Advanced Search](#) Welcome back, Chuck Bargeron, [logout?](#)

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Download Images and Information

Image	Information	Download
0908063	<p>longleaf pine - <i>Pinus palustris</i> P. Mill. - Stand</p> <p>Citation: David J. Moorhead, The University of Georgia, www.forestryimages.org</p>	<p>[image] [rtf]</p>

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 Forestry Images is a joint project of The Bugwood Network and USDA Forest Service.
 The University of Georgia - Warnell School of Forest Resources and
 College of Agricultural and Environmental Sciences - Dept. of Entomology

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Last updated on Tuesday, August 23, 2005 at 10:50 PM
www.forestryimages.org version 2.0, XHTML 1.1, CSS, 508.

Figure 4-37. Download page.

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- 2001 Database Market
http://www.microsoft.com/sql/demos/sql_timeline/pr/Marketgrowth.pdf
- Access to Biological Collections Data (ABCD) schema
<http://www.bgbm.fu-berlin.de/TDWG/CODATA/default.htm>
- ACDSee
<http://www.acdsystems.com/>
- Alagad Image Component
<http://www.alagad.com/>
- Altavista Image Search
<http://www.altavista.com/image/default>
- Aurigma Image Uploader
<http://www.aurigma.com/Products/ImageUploader/>
- Browser Timelines
<http://www.blooberry.com/indexdot/history/browsers.htm>
- Common Function Library Project
<http://www.cflib.org/>
- Comstock
<http://www.comstock.com/>
- Cooperative Agricultural Pest Survey
<http://www.ceris.purdue.edu/napis/docs/caps.html>
- Corbis.com and CorbisImages
<http://www.corbis.com/>
- Cynthia Says
<http://www.cynthiasays.com/>
- Darwin Core
<http://darwincore.calacademy.org>
- Ditto
<http://www.ditto.com/>
- Extensis Portfolio
<http://www.extensis.com/portfolio/>
- Forest Insects and Their Damage
<http://www.bugwood.org/forestcd/>
- Forest Pests of North America: Integrated Pest Management Photo CD Series
<http://www.bugwood.org/ipmcd/>
- Global Pest and Disease Database
<https://www.gpdd.info/>

- Google
<http://www.google.com/>
- Imagebank (now part of Gettyimages)
<http://www.gettyimages.com/>
- Index Fungorum
<http://www.indexfungorum.org/>
- Integrated Taxonomic Information System
<http://www.itis.usda.gov/>
- Intel
<http://www.intel.com/>
- Internet Systems Consortium, Inc.
<http://www.isc.org/>
- Iowa State University Entomology Image Gallery
<http://www.ent.iastate.edu/imagegal/>
- Macromedia, Inc.
<http://www.macromedia.com/>
- The Microsoft Network
<http://www.msn.com/>
- News.com
<http://www.news.com/>
- Nielsen//NetRatings
<http://www.nielsen-netratings.com/>
- Exotic Forest Pest Information System (NAFC-ExFor)
<http://www.spfnic.fs.fed.us/exfor/>
- Photodisc (now part of Gettyimages)
<http://www.gettyimages.com/>
- Section 508
<http://www.section508.gov/>
- SuperStock
<http://www.superstockimages.com/>
- ThumbsPlus
<http://www.cerious.com/>
- The University of Georgia, Institution Identity Program, Web Site Design
<http://www.uga.edu/identity/website.html>
- USDA ARS Image Gallery
<http://www.ars.usda.gov/is/graphics/photos/>
- USDA Photography Center
<http://www.usda.gov/oc/photo/opchomea.htm>

USDA, NRCS. The PLANTS Database

<http://plants.usda.gov/>

Verity, Inc.

<http://www.verity.com/>

Watchfire Bobby

<http://bobby.watchfire.com/bobby/html/en/index.jsp>

The Web Standards Project

<http://www.webstandards.org/act/campaign/buc/>

World World Wide Web Consortium

<http://www.w3.org/>

O'Reilly XML.com

<http://www.xml.com/>

APPENDIX 1 – DATA DICTIONARY

Primary Keys are designated in **bold** and represent the unique identifier of the row.

Foreign Keys are in *italics* and represent attribute in one table whose values match the primary key of another table.

TBL_Country_Abr (210 records)

This table stores a list of the countries of the world and the mailing abbreviation for each country. It is used as a lookup table for the country attribute in the author table to allow for consistency of country names.

Data Element Name	Type	Description
Country_ID	int NOT NULL	ID field
Country_Name	varchar (255)	Country Name
Country_Abr	varchar (255)	Country Mailing Abbreviation

TBL_ImageMarker (1 record)

This table is used to automatically assign the seven digit image number to digitally submitted images. The CurrentCD field assigns the first 4 digits and the CurrentImage field assigns the final 3 digits.

Data Element Name	Type	Description
CurrentImage	int	Final 3 digits of Image Number
CurrentCD	int	First 4 digits of Image Number
id	int IDENTITY NOT NULL	ID Field

TBL_area (114 records)

This table stores the areas in which the images belong. It is used to further breakdown the domains in to more specific groups.

Data Element Name	Type	Description
AREA_ID	int IDENTITY NOT NULL	ID Field
AREA_name	varchar (200)	Area Name
<i>DOMAIN_ID</i>	int NOT NULL	Domain ID

TBL_author (22249 records)

This table stores information about the photographers, contacts, members and publication authors. The attributes allow for international contacts.

Data Element Name	Type	Description
AUT_ID	int IDENTITY NOT NULL	ID Field
AUT_lname	nvarchar (100)	Last Name
AUT_fname	nvarchar (100)	First Name
AUT_title	nvarchar (100)	Title
AUT_org	nvarchar (100)	Organization/Company
AUT_unit	nvarchar (100)	Unit/Department
AUT_addr1	nvarchar (100)	Address Line 1
AUT_addr2	nvarchar (100)	Address Line 2
AUT_addr3	nvarchar (100)	Address Line 3
AUT_country	int NULL	See TBL_Country_Abr
AUT_email	nvarchar (50)	E-mail Address
AUT_web	nvarchar (300)	Web Address (URL)
AUT_phone	nvarchar (25)	Telephone Number
AUT_fax	nvarchar (25)	Fax Number
AUT_updated_date	datetime NULL	Date Created/Date Updated
AUT_notes	ntext	Any additional information or comments
AUT_UserID	nvarchar (20)	User supplied User Name to log into system
AUT_password	nvarchar (20)	User supplied password to log into system
AUT_status	bit NULL	True or False to designate active or inactive membership
AUT_usrlevel	int NULL	See TBL_autlevel
AUT_type	int NULL	See TBL_auttype
AUT_site	int NULL	1 – Joined Forestry Images 2 – Joined IPM Images 3 – Joined Invasive.org 4 – Joined Insect Images

TBL_autlevel (5 records)

This table is used to classify individuals in the TBL_author by access level.

Data Element Name	Type	Description
levelid	int NOT NULL	ID Field
levelname	varchar (50)	Author's level: User Power User Photographer Editor Administrator

TBL_auttype (9 records)

This table is used to classify individuals in the TBL_author by employment type.

Data Element Name	Type	Description
typeid	int NOT NULL	ID Field
type	varchar (100)	Employment Type: Government Employee (city/county/state/federal) University Faculty/Staff Extension Agent/Specialist Industry Homeowner/Landowner Teacher Student Other Unspecified

TBL_category (81 records)

This table is used to store the categories that are used to classify the subjects into groups. These groups are primarily the categories from the USDA Forest Service Field Sampled Vegetation database—VEG_DISTURBANCE_CATEGORIES.

Data Element Name	Type	Description
CAT_ID	int IDENTITY NOT NULL	ID Field
CAT_name	varchar (60) NOT NULL	Category Name
CAT_div	varchar (50)	Used to group categories into: Insects Diseases Invasives Other Damage Agents Plants Scenic Silvicultural Practices Trees Wildlife

TBL_class (70 records)

This table stores the highest level of taxonomic hierarchy data. See taxonomy chapter for more details.

Data Element Name	Type	Description
classid	int NOT NULL	ID Field
class	varchar (50)	Class
class_name	varchar (255)	Class Common Name
subphylum	varchar (50)	Subphylum
subphylum_name	varchar (255)	Subphylum Common Name
phylum	varchar (50)	Phylum
phylum_name	varchar (255)	Phylum Common Name
kingdom	varchar (50)	Kingdom
kingdom_name	varchar (255)	Kingdom Common Name
<i>ref</i>	int	References TBL_reference.ref_id
status	bit	True or False to indicate completeness
TSN	int	Taxonomic Serial Number from Integrated Taxonomic Information System

TBL_collection (1109 records)

This table stores information about user created collections of images.

Data Element Name	Type	Description
collection_id	int IDENTITY NOT NULL	ID Field
collection_name	char (25)	Collection Name
<i>collection_aut</i>	int	References TBL_Author.AUT_ID
collection_description	nvarchar (250)	Collection Description
collection_password	char (10)	Password used to limit access to shared collections

TBL_collectionimage_bridge (4603 records)

This table stores the many-to-many relationship between TBL_image and TBL_collection. Each collection contains multiple images and each image may be in multiple collections.

Data Element Name	Type	Description
<i>collection_id</i>	int NOT NULL	References TBL_collection.collection_id
<i>imagenum</i>	char (7)	References TBL_Image.IMG_num
bridgeid	int IDENTITY NOT NULL	ID Field

TBL_descriptor (90 records)

This entity is used to store a list of common descriptors for the images. It allows for searching by the descriptors because they will be chosen from a preset list. Descriptors are used to designate life stages (egg, larva, pupa, adult), plant parts (bark, fruit, flower, plant, foliage) and other breakouts.

Data Element Name	Type	Description
DESC_ID	int IDENTITY NOT NULL	ID Field
DESC_name	varchar (50)	Descriptor

TBL_div (15 records)

This table is used to group subjects into higher level than categories.

Data Element Name	Type	Description
divid	int IDENTITY NOT NULL	ID Field
divname	char (50)	Division

TBL_domain (16 records)

This entity stores the domains in which the images belong to. It is the broadest of the classifiers for images. Example domains are Forestry, Agricultural Systems, Fruits and Nuts, Ornamentals, and Wildlife.

Data Element Name	Type	Description
DOM_ID	int IDENTITY NOT NULL	ID Field
DOM_name	varchar (50)	Domain

TBL_family (1356 records)

This table stores the first level of taxonomic hierarchy data.

Data Element Name	Type	Description
familyid	int IDENTITY NOT NULL	ID Field
SUB_family	nvarchar (100)	Family
familyname	varchar (100)	Family Common Name
suborder	nvarchar (100)	Suborder
orderid	int NOT NULL	References TBL_Order.Orderid
status	bit	True or False to indicate completeness
TSN	int	Taxonomic Serial Number <i>from</i> Integrated Taxonomic Information System
ref	int	References TBL_reference.ref_id
synonyms	varchar (100)	Other Common Names

TBL_image (55680 records)

This table is the basis for the entire database. The attributes include links to the author, subject, host, domain, area and descriptor tables, as well as various other fields that include a full description, release information, and dates that the image is received and data updated.

Data Element Name	Type	Description
IMG_num	char (7)	ID Field, used for image tag and file name
<i>IMG_subject_code</i>	int	Primary Subject of Image References TBL_subject.SUB_ID
<i>IMG_Host</i>	int	Primary Host shown in Image References TBL_subject.SUB_ID
<i>IMG_author_code</i>	int	Photographer References TBL_author.AUT_ID
<i>IMG_contact_code</i>	int	Contact References TBL_author.AUT_ID
<i>IMG_descriptor</i>	int	References TBL_descriptor.DESC_ID
IMG_description	ntext	Full Description of image
IMG_released	bit	Photographer has released image for use
IMG_public	bit	Image is available through the web interface
IMG_verified	bit	Image has been verified by staff
IMG_date_acquired	smalldatetime	Date image was added to database
IMG_date_updated	smalldatetime	Date information was updated
<i>IMG_Domain_Prim</i>	int	Primary Domain References TBL_domain.DOM_ID
<i>IMG_Domain_Sec</i>	int	Secondary Domain References TBL_domain.DOM_ID
<i>IMG_Domain_3rd</i>	int	Tertiary Domain References TBL_domain.DOM_ID
<i>IMG_Area_Prim</i>	int	Primary Area References TBL_area.AREA_ID
<i>IMG_Area_Sec</i>	int	Secondary Area References TBL_area.AREA_ID
<i>IMG_Area_3rd</i>	int	Tertiary Area References TBL_area.AREA_ID
IMG_max_res	int	Maximum resolution available: 1 – 192x128 2 – 384x256 3 – 768x512 4 – 1536x1024 5 – 3072x2048
IMG_datetaken	varchar (50)	Date image was taken by photographer
<i>IMG_batchid</i>	int	References TBL_imagebatch.batchid
IMG_comments	varchar (500)	Additional comments regarding image
<i>IMG_source</i>	int	Source of scan/file 1 – Sony Film Scanner 2 – Nikon Film Scanner 3 – Digital Camera (jpeg) 4 – Digital Camera (tiff) 5 – Other (tiff) 6 – Other (jpeg) 7 – PhotoCD
IMG_filename	varchar (50)	Original file name

TBL_imagebatch (30 records)

This table is used for internal purpose to help track groups of images/slides as they are received.

Data Element Name	Type	Description
batchid	int IDENTITY NOT NULL	ID Field
batchname	char (100)	Batch Name
batchnotes	text	Batch Notes
batchcreatedate	datetime	Date batch was created

TBL_imagecomments (19 records)

This table is used for photographers to make comments on images.

Data Element Name	Type	Description
commentid	int IDENTITY NOT NULL	ID Field
<i>userid</i>	int	References TBL_author.AUT_ID
<i>imagenum</i>	char (7)	References TBL_Image.IMG_num
date	datetime	Date comment entered
comment	text	Comment

TBL_imagelog (14,441,269 records)

This table logs access to images.

Data Element Name	Type	Description
<i>IMG_num</i>	char (8)	References TBL_Image.IMG_num
IP	nvarchar (100)	IP Address of user accessing image
<i>userid</i>	nvarchar (50)	Logs user if logged in References TBL_author.AUT_ID
date	datetime	Date image was accessed

TBL_imageproject_bridge (3306 records)

This table stores the many-to-many relationship between TBL_image and TBL_project. Each project contains multiple images and each image may be in multiple projects.

Data Element Name	Type	Description
<i>IMG_ID</i>	char (7)	References TBL_Image.IMG_num
<i>PRJ_ID</i>	int	References TBL_project.PRJ_ID
PRJ_Number	nvarchar (15)	Project number, for example number on CD-ROM
PRJ_Description	ntext	Description
Bridge_ID	int IDENTITY (1, 1)	ID Field

TBL_imglocation (9534 records)

This table links images to the location that the image was taken.

Data Element Name	Type	Description
id	int IDENTITY NOT NULL	ID Field
<i>Imgnum</i>	char (7) NOT NULL	References TBL_Image.IMG_num
<i>continent</i>	int	References TBL_loccont.contid
<i>country</i>	int	References TBL_loccountry.id
<i>state</i>	int	References TBL_locstate.state
<i>county</i>	int	References TBL_loccounties.id
<i>city</i>	int	References TBL_loccity.id
<i>location</i>	int	References TBL_loc.locid
loctxt	varchar (100)	Specific location information

TBL_imgseries (664 records)

This table stores the many-to-many relationship between TBL_image and TBL_series. Each series contains multiple images and each image may be in multiple series.

Data Element Name	Type	Description
linkid	int IDENTITY	ID Field
<i>imagenum</i>	char (7)	References TBL_Image.IMG_num
<i>seriesid</i>	int	References TBL_series.id
seriesnum	int	Series number, to order images

TBL_loc (0 records)

This table stores information about specific locations.

Data Element Name	Type	Description
locid	int IDENTITY NOT NULL	ID Field
locname	char (100)	Location Name
loctype	char (100)	Location Type (such as National Forest, National Park, State Park, etc.)
locnotes	text	Notes about Location
lockey	int	External ID of Location
<i>locstate</i>	int	References TBL_locstate.id

TBL_loccity (23449 records)

This table includes cities for use in location table.

Data Element Name	Type	Description
id	int IDENTITY NOT NULL	ID Field
STATE	int	State FIPS code
CITYFIPS	int	City FIPS code
CNTYFIPS	int	County FIPS code
CITY	varchar (255)	City Name

TBL_locont (6 records)

This table includes continents for use in location table.

Data Element Name	Type	Description
contid	int NOT NULL	ID Field
contname	char (100)	Continent Name

TBL_loccounties (3141 records)

This table includes counties for use in location table.

Data Element Name	Type	Description
ID	int IDENTITY NOT NULL	ID Field
CNTYNAME	varchar (255)	County Name
COUNTY	int	County FIPS code
STNAME	varchar (255)	State Name
STATE	int	State FIPS code

TBL_loccountry (258 records)

This table includes countries for use in location table.

Data Element Name	Type	Description
NAME	varchar (255)	Country Name
ID	int NOT NULL	ID Field
<i>CONT</i>	int	References TBL_locont.contid
FORMER	varchar (255)	Former Country Name

TBL_locstate (51 records)

This table includes states and regions for use in location table.

Data Element Name	Type	Description
STATENAME	varchar (255)	State Name
STATE	int NOT NULL	ID Field
COUNTRY	int	References TBL_loccountry.id
CONT	int	References TBL_locont.contid

TBL_log (1,008,418 records)

This table logs access to all pages.

Data Element Name	Type	Description
id	int IDENTITY NOT NULL	ID Field
URL	nvarchar (500)	Accessed URL
IP	nvarchar (100)	IP Address of user accessing image
userid	nvarchar (50)	Logs user if logged in References TBL_author.AUT_ID
date	datetime	Date and Time of Access

TBL_order (289 records)

This table stores the second level of taxonomic hierarchy data. See taxonomy chapter for more details.

Data Element Name	Type	Description
orderid	int IDENTITY (1, 1) NOT NULL	ID Field
sorder	varchar (100)	Order
ordername	varchar (100)	Order Common Name
synonyms	varchar (200)	Other Common Names
classid	int NOT NULL	References TBL_Class.Classid
ref	int	References TBL_reference.ref_id
status	bit	True or False to indicate completeness
TSN	int	Taxonomic Serial Number <i>from</i> Integrated Taxonomic Information System

TBL_problems (55 records)

This table allows users to report problems they occur on the site.

Data Element Name	Type	Description
problemid	int IDENTITY NOT NULL	ID Field
ipaddress	char (50)	IP Address of User
description	text	Description of Problem
reproducible	char (10)	Whether or not the problem can be reproduced
browser	char (100)	Browser Type and Version
OS	char (50)	Operating System
name	char (50)	User's Name
email	char (50)	User's E-mail Address
ddate	datetime	Date and Time of Problem

TBL_project (14 records)

This tables stores completed projects and projects in progress. Each image that is used in a project is assigned a project number that is stored in this entity. This entity allows for reports and queries showing which images have been released on subject CDs or were part of slide sets such as the Southern Forest Insect Work Conference set.

Data Element Name	Type	Description
PRJ_name	nvarchar (75)	Project Name
PRJ_ID	int NOT NULL	ID Field
PRJ_info	Ntext	Information about Project
access	Bit	True or False to indicate whether the Project is Public

TBL_random (218 records)

This table stores a list of image numbers for images randomly displayed on home page of Forestry Images.

Data Element Name	Type	Description
randomid	int IDENTITY NOT NULL	ID Field
<i>img_num</i>	char (7)	References TBL_Image.IMG_num

TBL_random_insects (98 records)

This table stores a list of image numbers for images randomly displayed on home page of Insect Images.

Data Element Name	Type	Description
id	int IDENTITY NOT NULL	ID Field
<i>imgnum</i>	char (7)	References TBL_Image.IMG_num

TBL_random_inv (40 records)

This table stores a list of image numbers for images randomly displayed on home page of Invasive.org.

Data Element Name	Type	Description
id	int IDENTITY NOT NULL	ID Field
imgnum	char (7)	References TBL_Image.IMG_num

TBL_random_ipm (24 records)

This table stores a list of image numbers for images randomly displayed on home page of IPM Images.

Data Element Name	Type	Description
id	int IDENTITY NOT NULL	ID Field
imgnum	char (7)	References TBL_Image.IMG_num

TBL_references (81 records)

This table stores references used for Subject and Taxonomic Tables.

Data Element Name	Type	Description
ref_id	int IDENTITY NOT NULL	ID Field
ref_name	varchar (100)	Reference Name
ref_url	varchar (255)	Reference URL
ref_description	nvarchar (1000)	Full Citation

TBL_searchqueries (876,013 records)

This table logs queries entered into search field.

Data Element Name	Type	Description
id	int IDENTITY NOT NULL	ID Field
squery	nvarchar (100)	Search Query

TBL_series (45 records)

This table stores information about series of images.

Data Element Name	Type	Description
id	int IDENTITY NOT NULL	ID Field
name	nvarchar (200)	Series Name
seriesgroup	int	Groups Series

TBL_subject (10266 records)

This table stores subject information related to each image. By using this entity all images of a single subject are guaranteed to have consistent data. In most cases this includes all scientific information for an insect or disease, but for images that are not of scientific nature these attributes will be null.

Data Element Name	Type	Description
SUB_ID	int IDENTITY NOT NULL	ID Field
SUB_name	varchar (100)	Common Name
SUB_kingdom	varchar (50)	OLD – Kingdom
SUB_phylum	varchar (50)	OLD – Phylum
SUB_class	varchar (50)	OLD – Class
SUB_order	varchar (100)	OLD – Order
SUB_family	varchar (100)	OLD – Family
<i>SUB_family_id</i>	int NOT NULL	References TBL_family.familyid
SUB_genus	varchar (100)	Genus
SUB_species	varchar (100)	Species
SUB_variety	varchar (100)	Variety or Subspecies
SUB_identifier	varchar (100)	Identifier or Author of Scientific Name
<i>SUB_div</i>	int	References TBL_div.divid
<i>SUB_cat1</i>	int	Primary Category References TBL_category.CAT_ID
<i>SUB_cat2</i>	int	Secondary Category References TBL_category.CAT_ID
SUB_complete	bit	True/False, Information Complete
SUB_verified	bit	True/False, Information Verified
SUB_accepted	bit	True/False, Information Accepted
SUB_date_updated	datetime	Date added or updated
SUB_notes	text	Additional Notes and Comments
SUB_syn	varchar (255)	Subject Name synonyms
SUB_syntax	varchar (255)	Scientific Name synonyms
SUB_french	char (100)	French
SUB_plants	char (20)	PLANTS Code
SUB_itis	int	ITIS TSN
SUB_funindex	int	CABI FunIndex ID
SUB_fsveg	char (10)	FSVEG Disturbance Agent Code
SUB_definition	text	Definition of Subject if Applicable
<i>SUB_reference_name</i>	int	Common Name Reference References TBL_reference.ref_id
<i>SUB_reference_tax</i>	int	Taxonomic Reference References TBL_reference.ref_id
SUB_ref_name_url	varchar (150)	Common Name Reference Stores URL of references not stored in TBL_Reference
SUB_ref_tax_url	varchar (150)	Taxonomic Reference Stores URL of references not stored in TBL_Reference

TBL_subjectlog (11,547,239 records)

This table logs access to subjects.

Data Element Name	Type	Description
SUBID	int	References TBL_Subjet.SUB_ID
IP	nvarchar (50)	IP Address of user accessing subject
<i>userid</i>	int	Logs user if logged in References TBL_author.AUT_ID
date	datetime	Date and Time subject was accessed

TBL_usercomments (5952 records)

This table allows photographers to provide information about submitted images.

Data Element Name	Type	Description
commentid	int IDENTITY NOT NULL	ID Field
<i>userid</i>	int	References TBL_author.AUT_ID
<i>imgnum</i>	char (7)	References TBL_Image.IMG_num
subname	varchar (100)	Subject Common Name
sciname	varchar (100)	Subject Scientific Name
description	text	Description of images
comments	text	Comments about image
dateupdated	datetime	Date information entered
release	bit NOT NULL	True/False Release of Image
hostname	varchar (100)	Host of Image
complete	bit	Information Updated in TBL_image
location	varchar (250)	Location of Image

TBL_userinfo (13440 records)

This table stores access information for users such as access time and date, and browser.

Data Element Name	Type	Description
id	int IDENTITY NOT NULL	ID Field
<i>userid</i>	char (20)	References TBL_author.AUT_ID
IP	nvarchar (100)	IP Address of User
hostname	nvarchar (100)	NOT IMPLEMENTED
date	datetime	Date and Time of Login
browser	nvarchar (200)	Browser Used
resolution	nvarchar (50)	NOT IMPLEMENTED
colordepth	nvarchar (50)	NOT IMPLEMENTED
platform	nvarchar (50)	NOT IMPLEMENTED

APPENDIX 2 – VERSION 2.0 STATISTICS

As presented in Chapter 4: Technology Development: Web Interface, analyzing website logs is an important way to measure the usefulness and performance of a website. This appendix includes a detailed analysis of the site traffic since the release of Forestry Images version 2.0 in October 2004 through December 2005.

Forestry Images traffic increased significantly from 251,226 unique visitors in 2002 to 2,522,831 unique visitors in 2005 (Table A2-1). Forestry Images hits and page requests have increased from 3,824,091 page requests and 8,208,610 hits in 2002 to 12,056,813 page requests and 32,638,658 hits in 2005 (Table A2-1).

Table A2-1. Forestry Images visitor, page views and hits from 2002 to 2005.

Year	Visitors	Page Views	Hits
2002	251,226	3,824,091	8,208,610
2003	721,473	5,144,569	12,651,402
2004	1,133,538	7,819,303	19,212,120
2005	2,522,831	12,056,813	32,638,658

Traffic for the first eleven months of Forestry Images version 2.0 is similar to traffic shown previously for 2003 (Figure 3-6, pg 66). Traffic steadily increased, with slight decreases in December and July, probably due to holidays and summer vacations (Figure A2-2).

Forestry Images traffic by directory was relatively unchanged, with 93 percent of traffic to version 2.0 compared to 90 percent of traffic in 2003 (Figure 3-7, pg 67) directed to the browse and root directories (Figure A2-3).

However, with version 2.0, the traffic received to the image detail page (Figure A2-4: */browse/detail.cfm*) increased sharply compared to traffic in 2003 (Figure 3-8, pg 68) and compared to the subject specific page (Figure A2-4: */browse/subimages.cfm*).

One reason that the image detail page traffic increased was many users were directed to the detail page from search engines. Entry traffic to the detail page increased from 11.74 percent in 2003 (Figure 3-9, pg 69) to 25 percent in 2005, while traffic to the subject specific page stayed roughly the same—35.26 percent in 2003 to 33.7 percent in 2005 (Figure A2-5).

Before and after the website redesign, the majority of users were referred to Forestry Images by the Google search engine (Figure A2-6) on submitting a query. However, the other top five search engines changed from Google, Yahoo, Microsoft Network (MSN), AOL NetFind and AltaVista (Figure 3-10, pg 70), before the redesign, to Google, About.com, Yahoo, AOL NetFind, and MSN Search, after the redesign.

A recent report from Nielsen//NetRatings (<http://www.nielsen-netratings.com/>) ranked search engine use for July 2005 as:

1. Google Search	46.2%
2. Yahoo! Search	22.5%
3. MSN Search	12.5%
4. AOL Search	5.4%
5. My Way Search	2.2%

Traffic to Forestry Images would ideally match closer to overall search engine rankings to maximize traffic to the site. Research is being done to address the decrease in traffic from the MSN Search site and to increase traffic from Yahoo.

As in 2003, users are finding the site by searching for specific search terms (Figure 3-11, pg. 72). Since the release of version 2.0, the top 24 search terms resulted in only 3.23 percent of overall phrases used to reach the site (Figure A2-7).

Percentage of traffic from predominantly English speaking countries decreased from nearly 93 percent in 2003 (Figure 3-12, pg. 73) to 85 percent (Figure A2-8). This is probably due to the increase of images of non-U.S. species added in the last two years and, therefore, the site's increased relevance to foreign users.

Microsoft Internet Explorer 6 has increased its user-base among Forestry Images users, while other Microsoft and Netscape browsers have decreased (Figure 3-14, pg. 75). Mozilla Firefox, Apple Safari, and Opera browsers have increased their user-base (Figure A2-9). Forestry Images has been thoroughly tested with Mozilla Firefox, and slight modifications have been made to ensure consistent viewing of the site on both it and Internet Explorer 6.

The number of Microsoft Windows XP users has nearly doubled from 2003 (Figure 3-15, pg. 76), while non-Windows based users still represent less than 5 percent of total Forestry Images user-base (Figure A2-10). Thus, it is still not practical to spend time testing Forestry Images on non-Windows based operating systems.

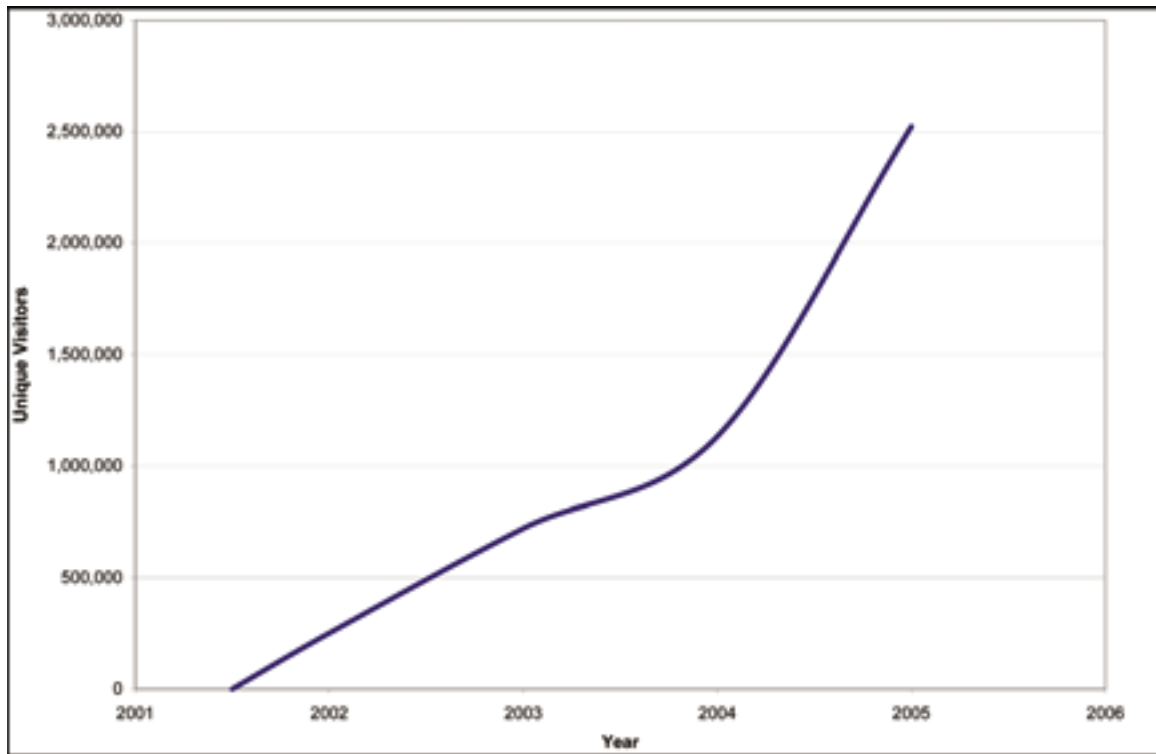


Figure A2-1. Forestry Images unique users, 2001-2005.

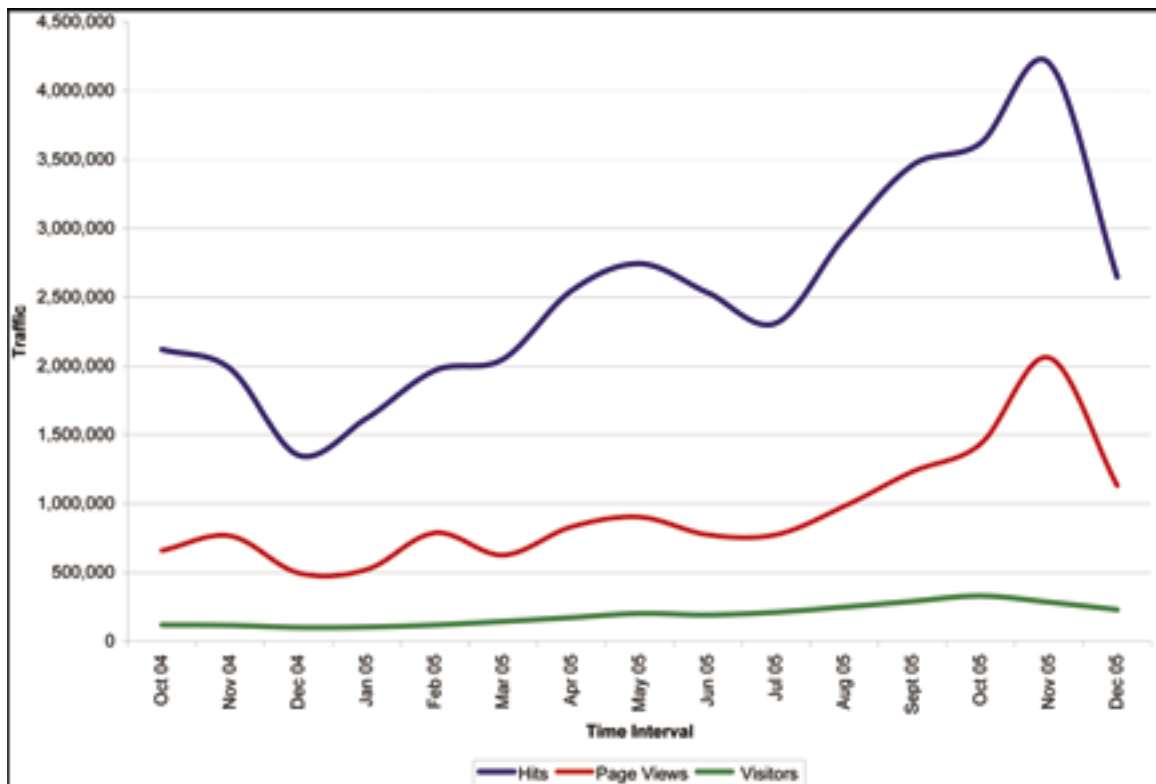


Figure A2-2. Forestry Images v2.0 Hits, Page Requests and Visitors, October 2004 – December 2005.

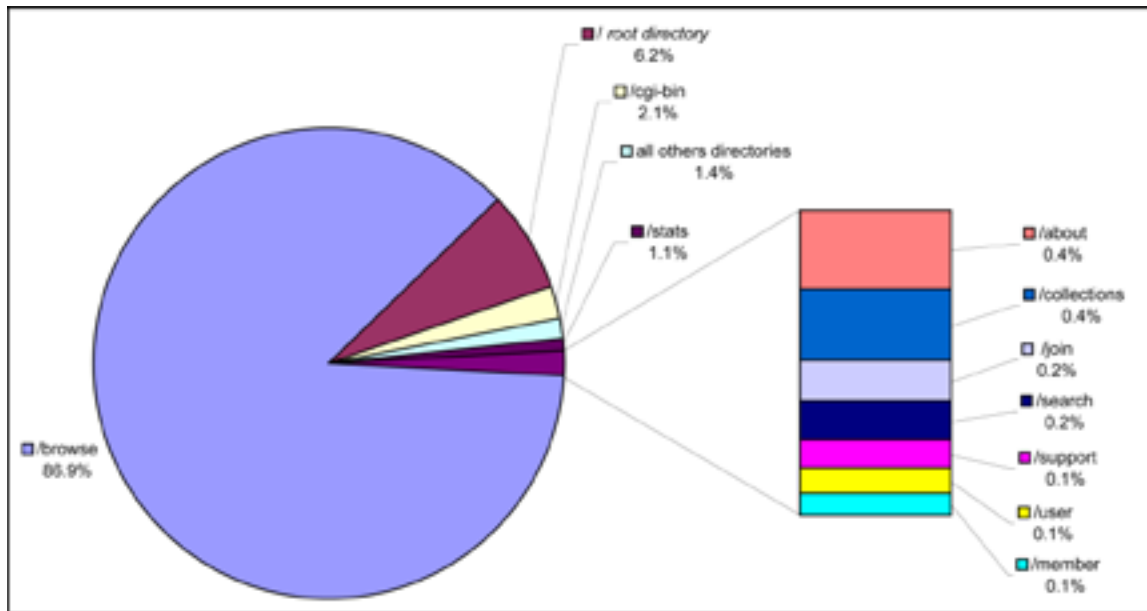


Figure A2-3. Forestry Images v2.0 Traffic by Directory, October 2004 – December 2005.

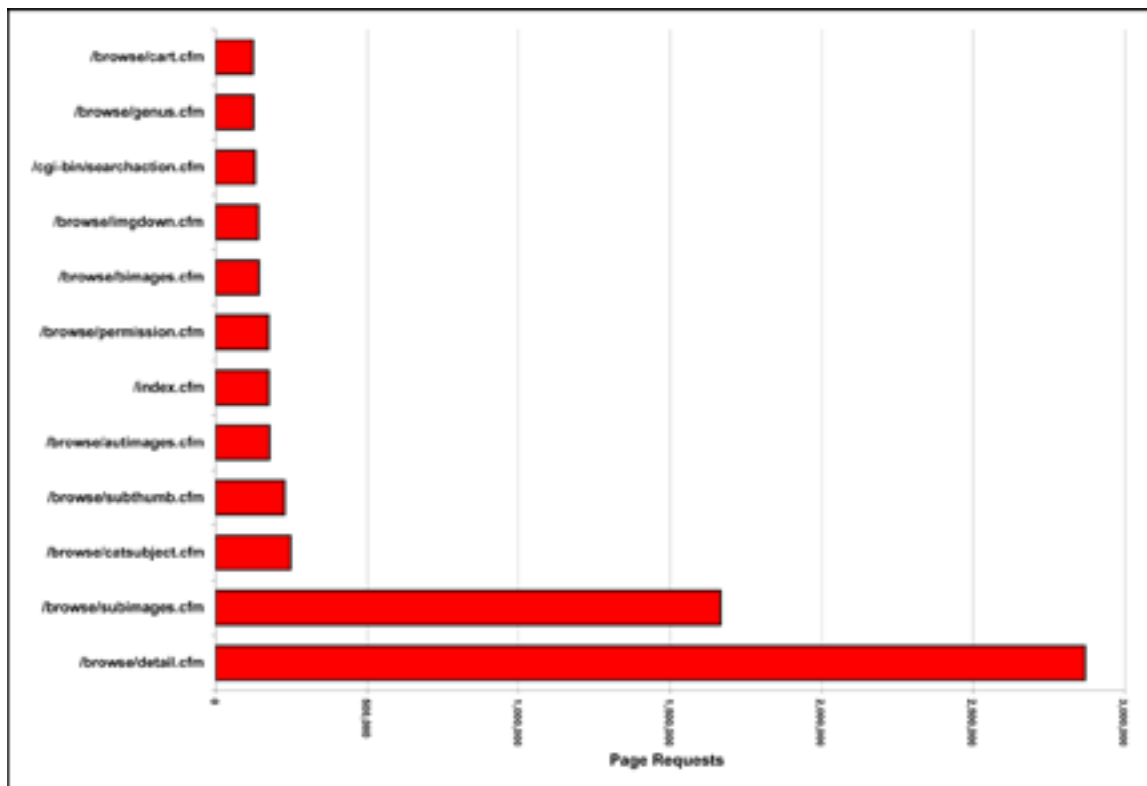


Figure A2-4. Forestry Images v2.0 Traffic by Page, October 2004 – December 2005.

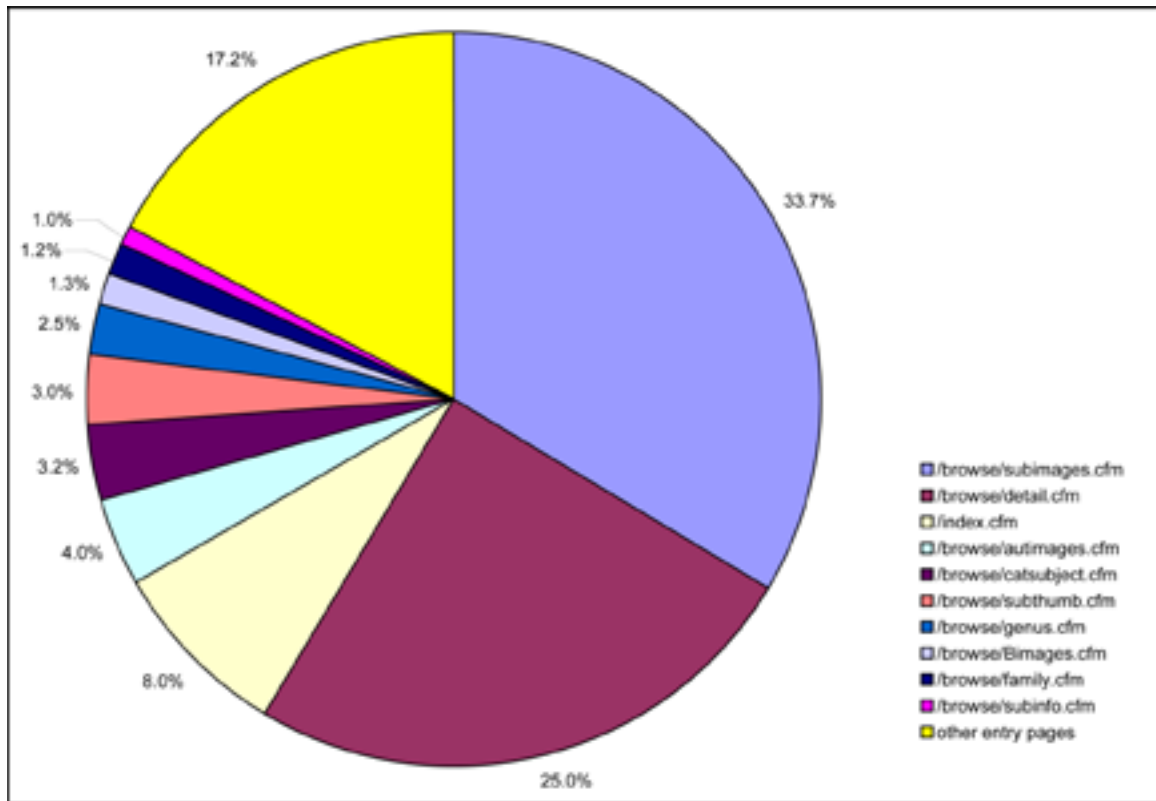


Figure A2-5. Forestry Image v2.0 Site Entry Points, October 2004 – December 2005.

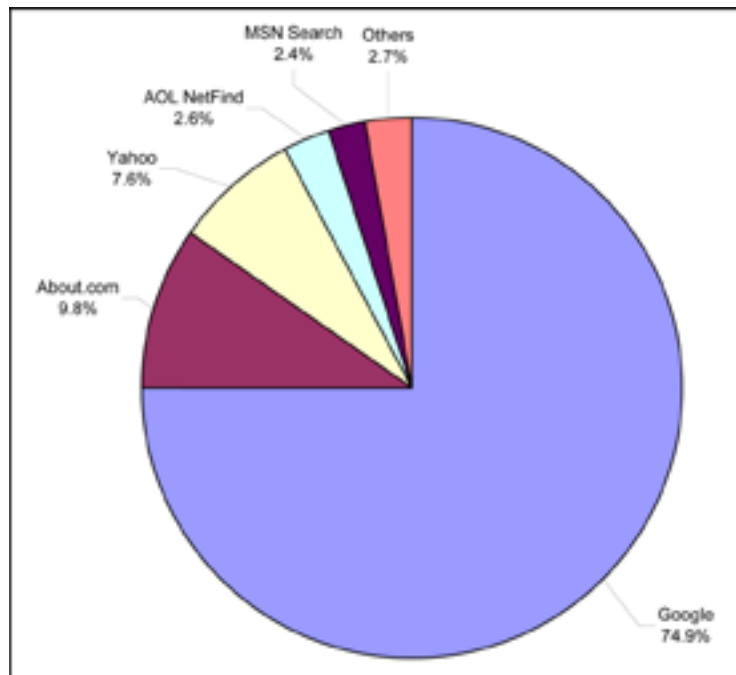


Figure A2-6. Forestry Images v2.0 Top Referring Sites, October 2004 – December 2005.

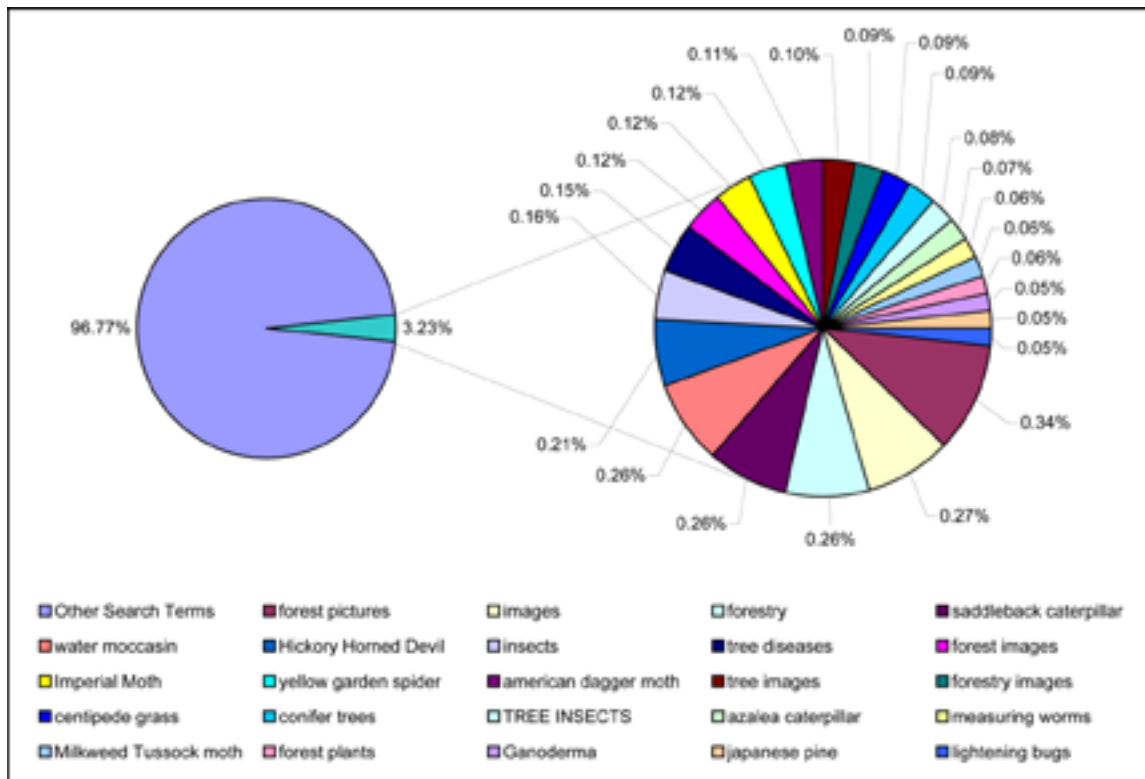


Figure A2-7. Forestry Images v2.0 Top Search Phrases, October 2004 – December 2005.

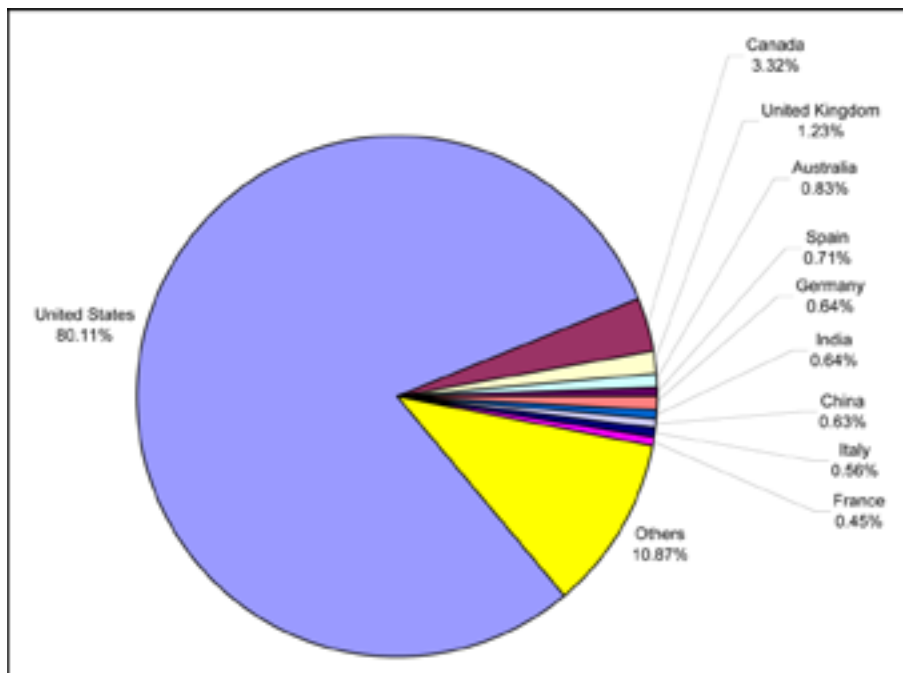


Figure A2-8. Forestry Images v2.0 Country of Origin, October 2004 – December 2005.

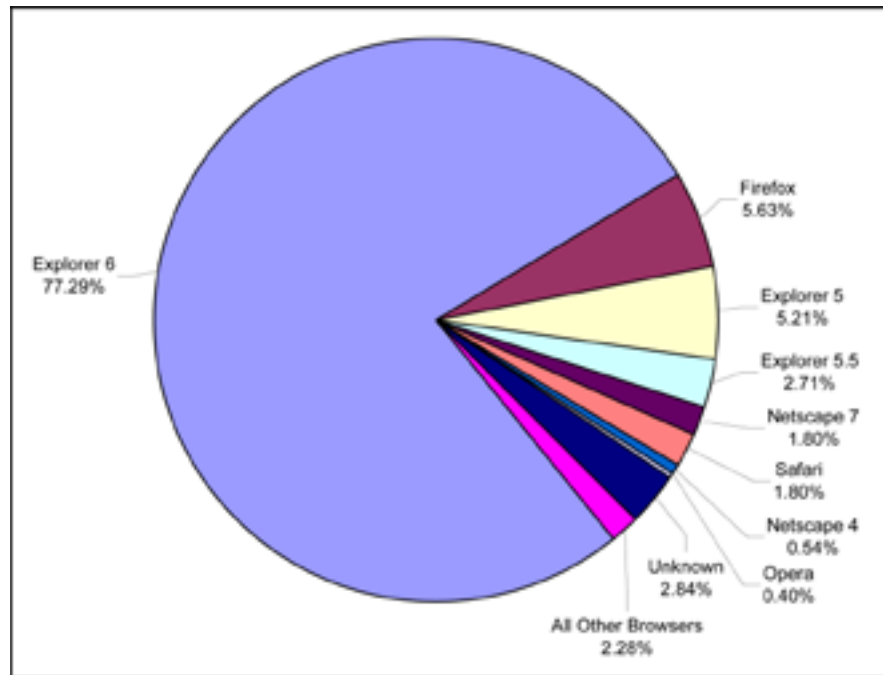


Figure A2-9. Forestry Images v2.0 Top Browsers, October 2004 – December 2005.

APPENDIX 3 – SITE SURVEY

A survey was posted on the Forestry Images home page and sent to all registered members of the site to get usage feedback and improvement suggestions. A summary of the seventy-three survey replies for the period of July 23 to August 21, 2003, is included in the following pages. Many of these comments were used as guidance for the redesign of the site.

Country:

United States	55
Canada	4
Spain	2
Nigeria	2
Australia	2
United Kingdom	1
Poland	1
New Zealand	1
Iran	1
India	1
Argentina	1
Austria	1
Cameroon	1

Interests (Check all that apply)

Forestry	57
Entomology	55
Invasive Species	48
Plant Pathology	44
Natural Resources	35
Horticulture	32
Wildlife	31
Botany	29
Agriculture	26
Regulatory	13
Other	65

Frequency of Use:

New User	21
less than 10 times a year	18
1 to 5 times a month	20
5 to 10 times a month	10
more than 10 times a month	4

How useful is the site?

Very Useful	55
Somewhat Useful	12
Not Useful	0
No Answer	6

What would you like to see improved?

- A way to find a species when you have a description but not a name.
- Addition of more photos of damage caused by forest insects.
- Additional slides on invasives: some bark beetle species slide libraries are under-represented. Slides depicting management or suppression activities taken to mitigate pest effects.
- Advanced search feature for multiple criteria and/or a way to sort the hit list. For example, if I want *Dendroctonus frontalis* adults, I need to work through 214 images of all SPB life stages plus a number of associates.
- Arranged by categories such as home pests, turf pests, leaf eaters, fruit borers, etc.
- Be more selective and improve the quality of some of the photos.
- Better descriptions of pictures.
- Everything is great.
- I use the site to help me identify plants and trees. I wouldn't mind seeing an email address where I can mail digital images of leaves, bark, flowers, etc. and have an expert identify them for me.
- I would like to see complete presentations on various subjects that could be used for training or providing information. I would like to see keys developed using images of some of the more important groups of insects, such as bark beetles of North America.
- Images of healthy crops. Classification of images according to damage, including affected crops.
- Just keep adding images, as I know you are doing.
- Keep adding images of new organisms.
- More good quality photos from across the world.
- More images (4).
- More images and better resolution.
- More images of the same subject.

- More images: that's what keeps me coming back.
- More informative information for students: things such as where the pest has spread to, in the world. Method of spread etc. would be useful.
- More knowledge about insects.
- More narrow search criteria.
- More non-native invasive organisms, even those that have not been found in the U.S. yet.
- More photos of damage and insect life stages.
- Not much—excellent pictures.
- Perhaps adding slides related to bio-control agents for noxious weeds.
- Pictures of the same trees at different angles (POV).
- Since I am a new user I do not have enough exposure to your site to give any constructive comments as yet. :)
- The more images, the better.
- The website coordinators and the photographers have to work closely to make sure that the photo captions are correct.
- To connect the photos with the description of the plague or disease: biology, symptoms, damages, methods to fight, etc.
- Variety.
- Weed out the poor quality slides and retain the good material.

What is your favorite feature of the site?

- Ability to access digital versions of my own slides quickly.
- Ability to access my own photos for Power Point presentations.
- All of the information.
- Average quality of the images.
- Categories and search ability.
- Do not have a favorite web site for images, I search the www.
- Ease of access, variety of photos and publications available.
- Ease of navigation.
- Ease of use (5).
- Easy to access and great photos.
- Finding bugs.
- Haven't used it enough to know yet.

- I like much the photographs, the connections with other pages and the one that is a project opened in that people of different countries participate, which provides very ample visions.
- Identification drill down.
- My favorite features are the quality photos.
- Number and quality of the images.
- Quality of images (2).
- Quantity of images, high res available!!
- So far I find the search engine helpful in reducing the number of picture I would need to view to find what I may be looking for.
- The different picture sizes.
- The great number of images.
- The numerous pictures you have of each item. Especially the leaves.
- The quantity and quality of the images.
- Thumbnails.
- Variety and close-ups.
- Variety of photos (2).

What areas would you like us to add images to?

- All (3).
- Basically work on quality improvement.
- Biological fight: antagonistic, entomopatógenos parasitoides, predators, organisms, etc.
- Bugs, Plant Disease.
- Field crops.
- Forest insect pests.
- Forestry and particularly damage caused by forest insects.
- Haven't used it enough yet.
- Historical forestry images.
- I do not know as yet....I'm a first time viewer.
- Insects, diseases, forest trees.
- International pests or those likely to be introduced. Tree species and identifying parts (cones, seeds, bark, foliage).
- Invasive insects.

- Just continue to add new pests.
- More images showing signs and symptoms associated with insect disturbances.
- More invasive, exotic insect.
- More non-native invasive organisms, even those that have not been found in the U.S. yet.
- More tree disease, insect, and defect pictures.
- My images are too small. Have many historic images e.g., Donovans images of Australia 1806 plates in large format.
- No particular request at this time.
- Oriental fruit moth damage on apple.
- Ornamentals.
- Panoramic/scenic.
- Pathology, Entomology, Urban Forestry.
- Pests found in and around homes and commercial locations. Structural pests.
- Symptoms of herbicide effects on trees (by herbicide active ingredient).
- Tree species identification.
- Unusual/exceptional trees section.
- Urban forestry.

How do you find images on our site?

Using the Search Feature	34
Browsing the Image Categories	32
From an External Search Engine	4
No Answer	3

What is your display resolution?

640 x 480	1
800 x 600	15
1024 x 768	22
1280 x 1024	8
Other	1
Don't Know	26

How are you connected to the Internet?

Office Network/LAN	33
Modem	20
DSL/Cable	15
No Answer	5

How do you use the images on our site?

PowerPoint	47
Posters	18
Newsletters	16
Websites	13
Journals/Magazines	7
Books	5
Newspapers	3
Other	72

Please provide an example of use.

- Amber-marked birch leafminer poster.
- As an Arborist I use your images to show my customers what they are dealing with.
- As PowerPoint slide presentations to enhance the learning of students in my applied entomology course (part of a new horticulture program).
- Awake! magazine of the Watchtower Society.
- Conveyed some of your images of invasive plants to a newspaper writer for an in-depth article. I use the images on media releases, also.
- Dendrology and Introduction to Forestry lectures.
- Develop PowerPoint presentation for work in Nicaragua.
- Educational presentations.
- Have used several in PowerPoint presentations for training sessions. Also used a few in revision of Insect and Disease Field Guide for our Region (all properly credited, of course!).
- I am a Science Olympiad coach, we have an event called Forestry this year. I am searching for anything that has to do with forests and their health and economic resources. I'm not sure how I will use this site, but I like what I see.
- I am responsible for putting the bulletin together at my local church and find your site to be a wonderful resource for images.
- I do an article on Southern Pine Beetle and refer the paper to this site for images.
- I photograph insects in my area and use the site to determine the species.
- I use the photos in my lectures.
- I use them to ID insects I find.
- I.D. of invasives.
- Identification to determine best methods to eliminate or encourage.
- Images used in pest leaflets or PowerPoint Presentations

- In order to distribute courses directed to professionals of the gardening on Plagues and Diseases.
- Just knowledge for my family.
- Lectures in entomology classes.
- My predominant use of images is for teaching, either as JPEG slide shows or part of a PowerPoint presentation.
- Often use images for PowerPoint presentations at either professional meetings or during training sessions.
- Personal images books to compare visual plant diseases or insects in the field.
- Personal info.
- Personal interest.
- Personal knowledge.
- Pest Management Training Sessions.
- Photos of specific plants, insect damage, etc. to enhance research publications.
- PowerPoint presentation made at Southern Forest Insect Work Conference. Rather than scanning my original slides I accessed my slides available in digital format on forestryimages.org.
- PowerPoint presentations for training purpose and public awareness.
- PowerPoint presentations for extension and training purposes.
- Preparing presentations of *P. japonica* emergence.
- Presentations for students – lectures e-learning program at our university.
- Presentations to foresters, Christmas tree growers, Sugarbush operators, etc. I visit your site if I need an image I don't have, which is infrequent.
- Presentations to landowners.
- Primarily use images for poster/PowerPoint presentations. However, I have used images for office publications like brochures, biological evaluations, functional assistance letters etc.
- Print images and use them in the field for identification.
- School programs using PowerPoint.
- School projects for students mainly: Biology, Horticulture, and Geography.
- Student Manuals.
- To help association members and clients visualize what plants look like and how external forces affect them.
- To learn how to identify plants and trees in nature. Self education.

- To show others what bugs are attacking trees, what the names of things are.
- Training about forest pests using PowerPoint. Refer others to specific images after I have diagnosed a pest problem.
- Utilize images in our woodland owners' newsletter that we produce three times a year.
- When I need images of invasive species that I do not have for presentations, this site is my first choice to look for them.
- *www.ento.csiro.au/aicn*
Plant Health CD (has website and other information)
Not sure whether I used some on free screen savers; usually the images size that I can access is fine by me and I do not login unless I need large format. I very much appreciate it.

Which Bugwood Sites have you visited? (Check all that apply)

<i>www.forestryimages.org</i>	71
<i>www.bugwood.org</i>	41
<i>www.insectimages.org</i>	35
<i>www.barkbeetles.org</i>	25
<i>www.forestpests.org</i>	24
<i>www.invasive.org</i>	23
<i>www.ipmimages.org</i>	15
<i>www.gaipm.org</i>	4

Would you like to contribute to the archive?

No	42
Yes	31
Already contributed	16

If so, what would be the subject matter of the images?

- Additional bark beetle images or slides showing the effects of bark beetle attacks.
- Any good images that don't duplicate what you already have.
- Bark beetle associated fungi and mites.
- Bugs.
- Central American forestry and pest management.
- Field crop insects.
- Forest insects, general insects.
- Forest insects, especially bark beetles.
- Forest Insects/Alaska.
- Forest pests.

- Home pests.
- Horticulture and forest pests.
- I could contribute more, but just don't find the time to do it.
- I have many more images of domestic and international forest pests I will be sending you over the next few years.
- If you would like digital imagery, we have plenty of new slides related to spruce beetle, mountain pine beetle, pinyon ips and *Ips typographus*.
- I'm presently a contributor. I take pictures of forest insects and diseases, including many close-ups of insects.
- Invasive species.
- I've previously contributed to insect images.
- Local naval stores photos.
- Many subjects.
- Mostly forest insects.
- Plagues and diseases in parks and gardens.
- Plantain spp.
- Selection of forest related images, tree identification and a few invasives.
- SFIWC images.
- Structural pests.
- Tree rings/old growth/historical sites/Before(old) & after(recent) shots.
- Various insects, disease (e.g. oak wilt), trees, etc.
- Weeds.

Detected Browser

IE 6 Win	37
IE 5.5 Win	19
IE 5 Win	5
AOL 8 Win	4
IE 5 Mac	3
Netscape 4.x Win98	2
Netscape 6.0 Win	2
Netscape 7 Mac	1

Other Comments

- As new user, and relatively new to land and forestry ownership, finding your descriptions, including images, most helpful for identification purposes. Thanks for the great site!
- Congratulations by the great offered quality of in these pages.
- Excellent resource for those of use involved in forest health protection activities. Thanks for providing this resource to us!!
- Excellent resource.
- Excellent site...very valuable to me and my staff.
- For some reason my browser, Internet Explore 5.1, does not display the thumbnail images in the "Thumbnail View" mode.
I'd like to see a search box on every page.
The long loading time of the long drop-down menu lists annoys me.
- I use your site for further continuing education.
- I used the site once for a project and probably will use it again.
- I would like to see and/or hear about other peoples findings in regards to unusual tree growths and formations.
- If I come upon an image that I feel you might find useful I would be glad to submit it.
- I'm a new user so can't comment on improvements. Great resource tho' for anyone wanting to ID "critters".
- Keep up the good work (3 times).
- Keep up the good work. This is a novel and extremely helpful resource.
- Keep up the good work. You are providing a very valuable service to many. Thanks!
- Please keep the site up and working!!
- Thanks for providing this valuable service.
- The web sites have been very useful to me and others involved in forestry and pest management. Keep up the good work.
- This is an extremely valuable endeavor that has produced outstanding results and is of critical value to the forest science community.
- This site is a fantastic resource. As more species are added, it will only improve.
- To know appropriate control measure.
- Very useful product!

