Recommendations Related to the Collection of Live Plant Images and Creation of a SERNEC Live Plant Image Collection

In this document I have made a series of recommendations related to the creation of a SERNEC community collection of live plant images (originally posted on the Imaging Standards working/discussion group board of the SERNEC website). Following the recommendations is the rationale on which the recommendations are based.

I would ask that those who have an interest in the collection of live plant images discuss these recommendations at the Imaging Standards working group breakout on April 19, which I unfortunately am not able to attend. If there is a consensus at the meeting, the group could adopt, modify, or reject individual recommendations. Otherwise, individual recommendations can be discussed further on the online forum.

I am anxious to see this project move forward and if the participants in the Imaging Standards working group want to give me the green light, I am willing to volunteer to work out the logistics necessary to get a system functioning to upload metadata and images. I have been in conversation with both the Specify and MorphBank teams and they are happy to work with us to get this collection going. I can probably provide several thousand images from the Bioimages collection that can meet the recommendations listed below and form a core on which to build the collection.

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Recommendations related to the creation of a SERNEC live plant image collection

(The rationale for each of these recommendations is discussed in the text following the recommendations.)

1. Adopt the "Image Standards for Live Plants 1.0" as provisional standards for imaging live woody angiosperms, general herbaceous angiosperms, gymnosperms, ferns, and cacti. Over the next year, work toward the creation of permanent standards for these groups and if possible the development of provisional standards for other groups, including grasses, sedges, and mosses to be adopted at the 2009 SERNEC meeting.

2. A digital SLR camera with a minimum resolution of 6 megapixel is the minimum recommended equipment for acquiring images. (This does not mean that pre-existing lower quality images cannot become a part of the collection, but that future image acquisition should seek to meet this goal.)

3. JPEG with maximum quality and minimum compression is the default file format for images in the collection.

4. Photographers will, as possible, seek to photograph at least the primary features of each specimen (indicated in bold in the list of standards) as described in the Image Standards.

5. Images should be grouped by specimen (a particular individual plant) and each specimen should be georeferenced by decimal latitude and longitude (preferably from GPS waypoints).

6. Closeup images should be taken using a macro lens and illuminated by a flash to produce maximum depth of field and a dark background.

7. Each participating herbarium or organization should obtain a written statement from their sponsoring organization (e.g. university) clarifying that they control the copyright of images they produce (and therefore that they have the right to release the images to the SERNEC collection under an appropriate Creative Commons License).

8. All participants will apply a Creative Commons License no more restrictive than "Attribution-Noncommercial-Share Alike 3.0" to images they contribute to the collection. (The group should consider whether the less restrictive "Attribution-Noncommercial 3.0" license should be adopted as a least-restrictive standard instead.)

9. MorphBank will be the permanent repository for high-resolution versions of all live-plant images in the collection. (This does not preclude the creation of other repositories or mirrors of all or part of the collection.)

10. Participants will provide to MorphBank the taxonomic, specimen data (location, time/date), licensing information, and hires images. Participants will "tag" images to be included in the SERNEC collection in the manner decided by consensus and consultation with MorphBank. SERNEC will derive the metadata for the community collection by polling MorphBank.

11. Participants submitting images will do so with the understanding that their images may be used by other participants to create education products without the necessity of the asking permission. Credit for the images will be given in accordance with the Creative Commons license.

Rationale For Live Plant Image Standards

At the SERNEC meeting last year, I suggested that standards for images of live plants should be adopted by the group. It was suggested that I write some standards and present them to the group. Since then I have written standards for photographing several groups of plants based on those that I developed for myself when collecting the images for the Bioimages website that I operate. These standards have been incorporated in a paper authored by myself and Bruce Kirchoff that has been submitted to *Vulpina* and is currently under review. The draft standards image standards are listed in the following section, but first I wanted to briefly list reasons why we should collect images of live plants. I think that a consideration of this rationale is important, because these reasons will influence the way that we photograph, archive, and distribute the images that we propose to collect.

Reasons to collect images:

1. To provide a visual representation of a taxon to supplement other data presented to the public for educational purposes. A large number of images to serve this purpose are already online in various websites, e.g. http://plants.usda.gov/, http://tenn.bio.utk.edu/vascular/vascular.html, http://calphotos.berkeley.edu/, http://www.discoverlife.org/, and many others

2. To facilitate the formal educational efforts of the scientific and academic community. Examples: to provide images for classroom multimedia presentations and to include in posters and scientific papers. Typically educators who are in a hurry would use Google or Google Images to find what they want.

3. To create resources/products specifically designed to facilitate learning taxa characteristics and species recognition. This could include learning in a traditional plant taxonomy course or informal learning by novices using web based resources or resources created to be used on portable electronic devices. This is the purpose which I believe has the greatest promise and unfulfilled potential. Some examples:
https://mywebspace.wisc.edu/cwoodwar/web/documents/iPodKeyUserGuide.pdf
http://www.cas.vanderbilt.edu/bioimages/pages/compare-oaks.htm
and various online polyclave keys utilizing the Delta/Intkey system: http://delta-intkey.com/

4. As a non-destructive means to document occurrence and character variation of a species. This can be in the context of adding missing "dots" to occurrence maps or the documentation of the flora of particular locations (e.g. parks or nature preserves). Although the ability to document occurrence records through images is included in the Darwin Core standards, to my knowledge this has not been done on a large scale. I do not believe that live-plant images have been used in any major way to document variation. Traditional herbarium specimens are used nearly exclusively for this purpose at the present.

I believe that if properly photographed, archived, and made accessible, a single collection of images can serve all four of these general purposes. To accomplish this, I believe that images should be collected in the same systematic way that physical specimens are collected. I will not

present my rational for this because that is the topic of the paper that was submitted to *Vulpina*, which you can read later if it is published there.

Topics for discussion:
In the following sections, I will explain the rationale behind the recommendations that I have proposed above for the creation of a community database of images. Hopefully this will spark discussion on the topic and ultimately result in the creation of a resource that will help to accomplish SERNEC's educational goals.

Here are some general topics that I discuss in the following sections:
Section 1. Standards for the content of the images themselves.
Section 2. Logistics of photographing live plants rapidly and on a large scale.
Section 3. How the collected images should be archived and indexed.
Section 4. How images can be utilized by the community to create useful educational products.

Section 1. Image Standards for Live Plants 1.0

Why standardizing image content matters

I made a case above that in the creation of a community database of live-plant images, the content of the images should be standardized. What I mean by this is that particular features should be photographed for all plants and that those features should be photographed in a standardized orientation.

This kind of standardization would satisfy the purposes of the image collection (the four reasons listed in the previous section) in the following ways:

1. A set of images of all features of a live plant would give a novice a more holistic view of the species than a single image.
2. Since all important features of the plant are photographed, an educational user would know that an image of the feature they needed would be available.
3. By consistently photographing all major features of the plant, a taxon learner would be able to compare a feature of the taxon they are studying with the same feature in a comparison taxon. It is a common practice to photograph a particular feature only for species in which it is diagnostic, but the reason why it IS diagnostic is because of the contrast with the more "boring" examples of that feature in other species. Because particular features are oriented in a standardized way, comparisons are made more easily.
4. Photographing multiple features of the same individual plant ensures that enough diagnostic features are included to make it possible for an expert to verify the identity of that particular plant. This greatly increases the value of the image collection because users can be confident that images actually represent the stated species.

Where did these standards come from?

When I started the Bioimages project, I had rather vague ideas about what I should be photographing. As the project progressed, I began to figure out what features were the most helpful in representing the appearance of species in major plant categories. This became particularly apparent when I photographed many plants in the field that I had not identified and later keyed them out using the photographs that I had taken earlier.

One of the guiding principles in my photography was that the orientation of the image of a feature should reflect the typical position that the feature on the plant. For example, many herbs have basal or lower stem leaves that look quite different from upper stem leaves. The basal leaves that are most easily seen are those on the side of the plant nearest the observer and thus have their apices pointing downward as seen by the observer. Because upper stem leaves are usually somewhat erect, in order to see the upper (adaxial) surface the observer must look at a leaf on the back side of the plant and such a leaf has its apex pointing upward as seen by the observer. This is just one example, but I applied a similar thought process when deciding on the orientation of other features.

Draft Standards for Live Plant Images
What follows are draft standards from our submitted paper (currently under review). Because of their pre-publication status, they are not for general distribution.

The standards that are considered primary are shown in bold type and should be given the greatest priority if time available to photograph is limited.

I. **Woody angiosperms**
A. Whole tree (or vine)

1. **entire tree - summer**
2. entire tree - winter
3. view up trunk (important in conditions where the whole tree cannot be photographed)

B. Bark (vertical orientation)

1. **of a large tree**
2. of a medium tree or the bark of a large branch
3. **of a small tree or the bark of a small branch**

C. Twig

1. **horizontal view showing the orientation of the petioles and axillary buds**
2. **horizontal view of a winter twig showing a terminal bud and several axillary buds**
3. close-up of winter twig showing leaf scar and lateral bud (vertical orientation)
4. close-up of winter twig showing terminal bud (vertical orientation)

D. Leaf

1. **upper (adaxial) surface of whole leaf oriented with apex downward, part of the lower (abaxial) surface of another leaf should be visible**
2. **margin of leaf, part of the lower surface of another leaf with major veins visible should be visible from behind**
3. several leaves showing their orientation on the twig

E. Inflorescence and flower. If imperfect photograph flowers of both sexes.

1. **whole inflorescence**
2. **lateral view of flower**
3. **frontal view of flower**
4. ventral view of flower showing perianth
5. if the flower is large, a close-up of its interior

F. Fruit

1. as borne on the plant

2. **lateral view**
3. section of fruit, or open fruit if dehiscent
4. seeds
5. young fruit

II. **Herbaceous angiosperms**
A. Whole plant

1. juvenile
2. **in flower**
3. in fruit

B. Stem (vertical orientation)

1. **showing orientation of leaf bases or petioles**

C. Leaf

1. **basal leaves, or leaves on the lower stem, with apex down**
2. **on the upper stem, with the apex up**
3. margin with lower surface of another leaf visible from behind; major veins should be visible on lower surface

D.Inflorescence and flower. If imperfect, flowers of both sexes.

1. **whole inflorescence**
2. **lateral view of flower**
3. **frontal view of flower**
4. ventral view of flower showing perianth
5. if the flower is large, a close-up of its interior

E. Fruit

1. as borne on the plant
2. **lateral view**
3. cross section of fruit, or open fruit if dehiscent
4. seeds
5. young fruit

III. **Gymnosperms**
A. Whole tree

1. **entire tree**
2. looking up trunk (important in conditions where the whole tree cannot be photographed)

B. Bark: same as woody angiosperms

1. **of a large tree**
2. of a medium tree or the bark of a large branch
3. **of a small tree or the bark of a small branch**

C. Twig

1. horizontal view after needles/scales have fallen
2. **horizontal view showing attachment of needles or scales**

D. Leaf

1. **entire needle (or scales), apex down**
2. fascicle base showing number of needles per fascicle, and scales if present
3. many needles (or scales) showing orientation on twig

E. Cone

1. male cones
2. **female cone, mature, open**
3. female cone, closed
4. female cone, receptive
5. one year-old female cone (in species requiring two years of cone development)
6. seeds

IV. **Ferns and other vascular non-seed plants**
A. Whole plant

1. entire plant, vegetative
2. **entire plant showing reproductive structures**

B. Leaf (frond)

1. **upper surface of entire frond**
2. **lower surface of entire frond**
3. margin of frond (if entire), or pinna (if compound) with lower surface of another frond/pinna visible from behind
4. stem or base of frond

D. Sporangia

1. **spore-bearing structure**

E. Gametophyte

1. microscopic view of gametophyte

V. **Cacti**
A. Whole plant

1. **entire plant**

B. "Bark"

1. lower part of stem, if different from photosynthesizing stem

C. Stem

1. **entire column, stem, or pad**

D. Areole

1. **areole, showing orientation of spines**

E. Apex

1. apical region

F. Flower: same as woody angiosperms

1. **whole inflorescence**
2. **lateral view of flower**
3. **frontal view of flower**
4. ventral view of flower showing perianth
5. if the flower is large, a close-up of its interior

G. Fruit

1. on plant
2. **lateral view**
3. cross section of fruit, or open fruit if dehiscent
4. seeds
5. young fruit

For examples of images illustrating these standards, see
http://www.cas.vanderbilt.edu/bioimages/image-standards.htm
as well as individual species pages on the site. I hope that presenting these standards will start a dialog on the subject.

Section 2. Logistics of photographing live plants rapidly and on a large scale.

I will address here several issues related to the logistics of how images are acquired. My opinions on these issues are based on what I have learned from my experience - others may have different ideas based on their experience. The issues are:

1. Should we look for existing images or collect new ones?
2. How should the collecting be done?
3. At what resolution should the images be acquired?
4. What type of camera should be used?
5. How should the images be photographed?

Should we look for existing images or collect new ones?
It would seem that the most efficient way to start a live plant image collection would be to seek out existing images. Whether or not that is a good idea or not depends on the nature of the images. An advantage of using existing images would be to avoid the problem of having to go out and find the plants. But there are several problems. In most cases the existing images would not meet the standards outlined in the previous post, i.e. the images would be taken in non-standardized orientations, making comparison with other images difficult. Usually existing images include only one or a few images of the same individual plant and if images of multiple features are available it isn't known whether they are from the same individual or not. Most existing images aren't georeferenced, at least not to the level made possible by a handheld GPS receiver.

There are additional problems if the images are in film form (slides or negatives). Because film is expensive, photographers sometimes crammed several features into one image. See

http://plants.usda.gov/java/profile?symbol=BEAL2&photoID=beal2_002_ahp.tif

for an example of this. Although slide scanners are not that expensive any more, there is a large time cost associated with scanning and processing the images. Usually the film has dust specks that either detract from the quality or have to be removed digitally. The color may need to be corrected using Photoshop or some other software. The images probably will need to be cropped. In my experience, I estimated that it took me about ten times as long to scan and process an image from a slide as it took me to photograph the plant with a digital camera and process the digital image. I quickly concluded that unless the species was very difficult to find or the image represented a rare event (e.g. a flower image of a species that rarely bloomed) it just wasn't worth the effort to scan film images.

If existing images are already in digital form, represent individual features that are approximately in the standard orientations defined previously, can have their identity verified on the basis of features visible in the images from a particular plant, and can be georeferenced as decimal lat/long coordinates, then it is probably worth including them in the developing database. I believe that the last two things are important because I think that any image collection that we develop should meet the same quality standards that we would demand of physical herbarium specimens. The set of images of a particular individual should be comprehensive enough in the

features included that they could be annotated by someone other than the photographer. I also believe that since we are going to be building this database from the ground up that we should have the goal of the collection being 100% georeferenced.

How should the collecting be done?
The simple answer to this question is: the same way that you collect physical herbarium specimens, i.e. systematically and not haphazardly. Photograph species in locations where the flora needs to be documented. Photograph species that aren't well represented in your collection. Photograph multiple individuals that represent the range of variation in important characters. Because multiple images are desirable for each individual plant to be photographed, develop a routine (using a checklist if necessary) so that you don't forget to photograph important features. Take multiple shots of each feature (you can cull the bad ones later). Keep a field notebook to record the location, identity (if known), and range of image numbers for each individual plant. I have found it very helpful to set my camera's image numbering mode so that numbering is continuous (rather than resetting to one after each download). That produces a unique reference number for each image that can later be associated with the field notes. Take a GPS reading for each specimen photographed. When I do this, I name the waypoint using the image number of one of the images of that specimen so that I can associate that waypoint with the specimen without needing to take any additional notes about the GPS reading.

If you are dedicated to photographing all features of the individual (i.e. both flower and fruit), then it may be necessary to revisit the individual again. I mark the plant with flagging tape marked with the same number that I used for the GPS waypoint. Unless the plant is destroyed, I am almost always able to relocate the plant later using the GPS receiver.

Using this methodology, I have been able to collect several hundred images in a day by myself. With help, the number could have been higher.

At what resolution should the images be acquired?
The answer to this question is depends on several factors: the limitations of the camera equipment (i.e. cost and number of megapixels), the limit of the camera's memory card, the limit of the storage space on the eventual repository of the images, and the format in which one eventually wants to display the images. When I began the Biomimages project in 2002, the 3.0 megapixel SLR camera I used cost several thousand dollars. Now a good 8.0 megapixel SLR camera with macro lens is under $1000 dollars. A 4 gigabyte memory card, which can probably hold more images than one can take in a day now costs less than $25. Thus the first two items should no longer be a limiting factor for an institution with a serious commitment to collecting digital images. The issue of computer storage space is perhaps not yet trivial. 8 Mpixel images saved at their highest quality take up between about 1.5 and 4 Mbytes in jpeg format (depending on the complexity of the image with leaves on the low end and bark on the high end). Multiply that by 10 000 images and you get 40 Gbytes, which may be a significant fraction of a current laptop hard drive, but which is relatively minor for a file server. But I believe that the availability of file storage space will go up and the cost of that space will go down faster than we can collect the images. So the real issue becomes the format in which the images will be eventually be displayed. Even at full screen on a high-resolution monitor, a 0.5 Mbyte picture is adequate. Assuming that an image may be enlarged and cropped, a 1-2 MByte image (corresponding to

about 3.0 Mpixel) is probably fine. The real limiting factor is the availability for print applications. Most publishers want at least 200-300 dpi for use in a field guide or textbook. A 6 Mpixel image displayed at 300 dpi would produce a size of 7.0 x 9.4 inches, which would be close to 7.5 x 10 inches, the size of a full 8.5 x 11 page with one inch margins. Thus I think that it would be unwise at this point to embark on taking images with a camera having a resolution of less than 6 megapixels.

Another issue is the format in which the images should be stored. It has been suggested to me that I should archive all of my images in RAW format rather than JPEG so that they can be more easily manipulated (lighting and color adjustments) in the future. I have reached the conclusion that this is unnecessary because at the rate I acquire and process images I simply won't take the time to make those adjustments. It is easier and more cost efficient (in terms of time) to just take 10 images of everything and erase nine of them then to agonize over a single bad image in Adobe Photoshop. In addition, the ability to view JPEG images is nearly universal, so having the images in jpeg format avoids maintaining two separate collections of hires images (the RAW ones and the ones that people can actually look at).

What type of camera should be used?
I believe that the simple answer to this question is: a digital SLR (single lens reflex) camera. I have experimented with several "point and shoot" digital cameras and they have simply not been up to the job of taking high quality close-up images. In some of the higher-end point and shoot cameras, it is possible to control the focus points and use manual lighting settings. But it involves pressing a lot of buttons rather than just turning the focus ring on a real lens.

The other reason for using an SLR is that there probably isn't just one lens that is good for taking both macro shots of feature details and relatively wide angle shots of the whole plant in its environment (especially trees). I use two lenses: a compact macro for closeups and a zoom 28-105 mm lens for distant shots. One important consideration that should noted by persons familiar with film photography is that lenses behave differently on digital camera backs than they do on film backs. I was used to the idea that a 50 mm lens would produce a "normal" image (i.e. neither wide angle nor closeup). However, when I started using a 50 mm lens on a digital back, all of the images were on the "closeup" side and I couldn't fit as much in the frame as I wanted. The reason for this is that the CCD detector on a standard digital camera is smaller than a 35 mm film negative or slide. The typical "crop factor" on a digital camera is about 1.5, so a 50 mm lens on a digital camera really behaves like a 75 mm lens on a film camera. Thus with its crop factor, my zoom lens actually behaves like a 49-168 mm lens (i.e. "normal" to 168 mm telephoto).

There are two other issues that could eventually influence camera selection. The JPEG file format has the capability of storing a lot of embedded information about the conditions under which the image was taken (this is called EXIF information). Two items of relevance to this discussion are GPS coordinates and focus information. If a camera is GPS enabled, it can embed the GPS coordinates in the EXIF information, eliminating the need to record the location of the specimen separately using a handheld unit. Unfortunately, last time I checked, there weren't many cameras on the market that do this yet. The other thing is that if the camera records information from the autoranging sensor about the distances used in determining how to autofocus the camera, it should theoretically be possible to calculate the magnification of the

image automatically without having to put a ruler in the picture. Unfortunately, my camera doesn't record this information and I don't know how common this is.

How should the images be photographed?
The image standards that I posted previously give recommendations for the orientation of the objects to be photographed. Here I will give my opinion of the camera settings that will provide the best quality of images.

There are three basic camera settings that can be adjusted for a particular photograph. The ISO is the functional sensitivity of the detector in the camera - this would be the equivalent of the "film speed" for a film camera. Lower ISO provides better image quality, but requires more light. Higher ISO allows taking an image with less light, but at the expense of poorer quality. So we would like to take images at the lowest ISO possible. The shutter speed determines how long the camera collects light from the object. With a tripod and no wind, the shutter speed doesn't matter much, but with a hand-held camera and wind a higher shutter speed is necessary to prevent blurring from relative camera/object motion. For distant objects, 1/60 second is OK, but for closeup shots, the higher the better. Unfortunately, higher shutter speed reduces the light available to the detector. The third setting is the aperture (f-stop). A wide aperture (low f-stop) lets a lot of light into the camera, but reduces the depth of field (the range of the object that is in focus). A narrow aperture (high f-stop) is the best for detail work, but again this reduces the light available to the camera. So achieving the optimal combination of low ISO, high shutter speed, and narrow aperture is difficult when taking closeup shots under ambient light conditions and virtually impossible under the dimmer light conditions in a closed forest or on a cloudy day. The solution is to use a flash.

Here is an example of a closeup image that I took under ambient light conditions on a cloudy day in the forest:
http://www.cas.vanderbilt.edu/bioimages/image/s/spov--flcloseup15124.htm
As you can see the image is dim and out of focus, the color off, and distracting objects are visible in the background. In contrast, this image:
http://www.cas.vanderbilt.edu/bioimages/image/s/stdi3-fropen-end24567.htm
was taken under an even more dense canopy on an overcast day just before it started to rain, but this time using the build-in flash on my camera. As you can see, the focus is better, colors more accurate, and the distant background is black.

At first I only used the flash when I couldn't get enough light without the flash, but eventually I started taking all of my closeups with the flash. Using my macro lens, a flash, and manual settings, I can get sharp, detailed images using ISO 100 (the lowest setting), f32 (the narrowest aperture possible for my camera), and 1/200 second. At this aperture, focusing is almost irrelevant because the depth of field is so great. The 1/200 second shutter speed is fast enough to eliminate any blurring from movement of the plant and camera. At this setting, the flash effectively lights objects about 50 cm or less from the camera, so objects more distant than that are not seen and the background is black, e.g.
http://www.cas.vanderbilt.edu/bioimages/image/n/nysy--frinfruct29397.htm

Based on this experience, I recommend using a flash with minimum aperture (i.e. highest f stop) and maximum shutter speed for all closeup shots, even when ambient light is adequate for no flash. For distant shots, this is not possible. The strategy I use is to set the shutter speed on 1/60 second and the aperture to a moderate value (like f8) and then set the ISO to the lowest value that I can get away with under ambient lighting conditions. On a bright day that is usually ISO 100. On a cloudy day it may be higher. On a dim day, I usually hedge my bets by trying many shots with different combinations of settings and then choosing the image that looks the best on my computer later.

I know that there may be a difference of opinion as to whether features look better with a black or white background. My justification for choosing black as the standard background is simple: it happens automatically with no additional editing work if closeups are taken with a flash. If we want to collect a lot of images with minimal labor, that is a desirable situation.

Section 3. How the collected images should be archived and indexed.

The question of how a community collection of live plant images should be maintained needs to be addressed on two levels. On one level are questions relating to the ownership and control of the images, and the extent to which others can use the images without requesting permission or paying a licensing fee. On another level are questions regarding the logistics of image storage and making them available to other members of the community and the public.

Copyright and Licensing

Under current law, unless a photographer specifically releases work into the public domain, images are protected by copyright without any action on the part of the photographer. Nevertheless, when images are published on the Internet, it is best to make clear to potential users the conditions under which the images can be used. There are now categories of permitted uses that have been standardized as Creative Commons (http://creativecommons.org/) licenses. These licenses allow the copyright owner to retain some rights while allowing some uses without requiring permission.

In the context of SERNEC's educational goals, it seems clear that a licensing standard less restrictive than "all rights reserved" must be adopted for a community image collection. A license from the "Creative Commons Attribution-Noncommercial" category would allow the creation and free dissemination of teaching aids and resources for the general public while protecting the photographers' ability to require users to obtain permission and pay for licensing an image that is to be used in a commercial product. The least restrictive license in this category is a Creative Commons Attribution-Noncommercial 3.0 license, which allows non-commercial users to "copy, distribute, display and perform the work, as well as make derivative works based on it." In our draft image standards paper, Bruce Kirchoff and I recommended this license for images to be included in a community collection of live plant images. The Creative Commons Attribution-Noncommercial-Share Alike 3.0 license is slightly more restrictive because it permits users to make derivative works only if those works are distributed "only under the same license or one compatible with the one that governs the licensor's work." This license is significant because it is the default license currently adopted by MorphBank. The most restrictive license in the category, Creative Commons Attribution-Noncommercial-No Derivative Works 3.0, would be unsuitable for our use because it would prevent the creation of the types of resources we want to make available to educators. Of course, photographers would have the option of a less restrictive license that allows for commercial use or to release the images into the public domain (a requirement for employees of the Federal government).

Who is the copyright owner?

A simple answer is "the photographer". However, if the photographer were collecting the images as a part of his or her responsibilities as an employee of an institution, then ownership of the images would be governed by the intellectual property policies of the institution. The status of images can be murky because in themselves they might be considered a creative work and fall under one policy, but as a part of a website, they might be considered "technology" and fall under another policy. In my case, since I did not use substantive Vanderbilt resources in taking the images and since taking the images was not a part of my job requirements, I was recognized as the copyright owner. However, if I were to capitalize on my association with Vanderbilt in the

promotion of the Bioimages website, then ownership would shift to Vanderbilt, and I would lose control over their use. The important thing is to get copyright issues straightened out with your institution's technology transfer office before things get complicated and to have them put into writing your understanding about who will control the use of the images and where any revenue generated from commercial licensing will go.

Commercial users

Adoption of a Creative Commons Attribution-Noncommercial license still requires commercial users to contact the copyright owner for permission to use an image. There are several things to consider when you license one of your images to a commercial user (e.g. textbook, magazine). First of all, you are not selling the user the image - you are granting them a license to use the image for a specific purpose (a particular work for a particular time). This license should be non-exclusive, i.e. your allowing them to use the image does not prevent you from doing anything else that you want with the image. I also believe that unless the commercial user represents a cause that you want to support, you should not allow commercial users to license an image for free. Although they would be happy to use the image for free (and publishers will sometimes suggest that you should let them), most publishers recognize paying to license images as a legitimate business expense and will pay a fair price. Allowing free commercial use depresses the market and makes it difficult for professional photographers to make a living. If you don't want the money, then require them to make a donation to your favorite charity in lieu of a licensing fee. If you can funnel the money back into your herbarium, in a year or two you may generate enough revenue to cover the cost of your SLR camera and lens.

Sometimes commercial users will offer a "take-it-or-leave-it" price for licensing, but more commonly will negotiate a price. I have found the Stock Photo Price Calculator at http://photographersindex.com/stockprice.htm very helpful in suggesting a price for licensing.

IT IS NOT NECESSARY to mark up images with your name or a copyright notice! The copyright and Creative Commons license notices can be placed as text next to the image. Defacing the images themselves with notices accomplishes nothing. Legitimate commercial users will respect your text notices and illegitimate users will not pay attention to a notice on an image any more than they will text.

Logistics of image cataloging and storage

I see there being three components to the creation of a successful SERNEC community collection of live plant images. First, the participating institution needs a system for data entry and cataloging that can feed images into the larger collection. Optimally this system would be a part of the institution's existing infrastructure for maintaining their collection database. This system would also allow the institution to maintain sufficient records for servicing licensing requests from commercial users. Second, there needs to be a permanent repository for the images that can archive the hires images and maintain metadata on them. Third, there needs to be a web portal that can showcase the community image collection and house products that are created using the community collection.

Entering specimen information

In order to make an image usable and available, it needs to be associated with taxonomic

information, its collection time and location, and other images of the same specimen. Preparing images can be as time-consuming as collecting them. Therefore creating a system to efficiently create an image database using data from the collection notebook, GPS receiver, and EXIF data embedded in the images themselves will be important.

I have spent some time experimenting with using the Specify collections software to deal with images as collection objects. Although Specify has the capability to display images, in its current form it does not have enough data fields to manage all of the data which should be associated with each image and hand-entry of lat/long data from GPS for each specimen is painfully slow. At this point, I think that Specify would best be used to enter the following logbook information for a live plant image specimen: taxonomic information, collector information, collection location name, and range(s) of image numbers associated with the specimen. These data could then be exported to a file. Dedicated software could then open the Specify export file, a GPS export file, an EXIF extraction file, and a file listing and allow a user to merge all of the data for a specimen into a single database. If the institution already uses Specify to manage physical herbarium specimens, the live image specimens can be recorded in the same system.

Archiving the images

In order to create a community image collection that is broader than that of a single institution, the images must be made available in some publicly accessible archive. That archive could be created from scratch or an existing archive could be utilized. I believe that MorphBank provides all of the functions necessary to serve as the archive we need for the collection. In particular, MorphBank is set up:

- associate images from the same live plant specimen
- preserve and present the location information for the specimen
- accept images and their metadata in bulk
- serve the images in thumbnail, websize, and hires versions from stable URLs.
- feeds Darwin Core data into the global biodiversity system
- create Views that can correspond to the recommended live plant image standards that I listed in the first section of these recommendations.

Although it would be possible to create a resource apart from MorphBank from scratch that could serve these functions, that would be an unnecessary duplication of effort. With regards to the last item I listed above, if a list of live plant image standards is adopted by SERNEC, we should create a list of standardized "views" that correspond to that list. All participants in the community database could then use flag their images according to the appropriate view so that other users would know which images are available in the database that present plant features in the same standardized manner.

As I mentioned in the Copyright and Licensing section above, Morphbank uses a default Creative Commons license of Attribution-Noncommercial-Share Alike 3.0 . Morphbank allows users to specify a different license (see the 01-14-08 news post at http://www.morphbank.net/About/News/) upon request, so if we agreed to use the less restrictive Creative Commons Attribution-Noncommercial 3.0 license we could do so and as far as I can tell, it would be consistent with Morphbank's copyright policy (http://www.morphbank.net/About/Copyright/). However, I think to do so would require a

special arrangement (they say to "email us"), so the easy way out would be to just go with the Share Alike version. The practical implication of that would be that users of images in the SERNEC community collection could not create a non-commercial product and then place some kind of restriction on it (such as prohibiting modification or free distribution) that is more restrictive than Attribution-Noncommercial-Share Alike 3.0 . So I think some discussion needs to take place on this before the groundrules for a SERNEC community collection of live plant images are set.

Another necessary component of the archiving process is creating a mechanism by which images that are deposited in MorphBank can be identified as a part of the SERNEC community collection. This could be done in several ways. One would be to have SERNEC as the "Institution name" for submitted images. This would automatically associate every record with a URL to a SERNEC portal. Another possibility would be for the "institution name" to be the name of the actual institution (i.e. the herbarium or university) and to use SERNEC as one of the two "project names" that can optionally be associated with each record. There needs to be a consensus on how we are going to do this so that once images start entering MorphBank, they are all flagged in the same way.

SERNEC web portal for showcasing community images

Once images start flowing into the collection from various institutions, there needs to be some way to let people know what images are there and what products are available that make use of the images. I'm not going to talk much here about what this should be partly because that is the topic of the last post I'm going to make and partly because "what this should be" is pretty much laid out in the list of SERNEC goals. Here I am more concerned with the logistics of how a SERNEC portal would interface with the other two components of the system (the institution's database and the archive).

A fundamental issue is how the SERNEC portal would "know" what images are part of its community collection. One possibility would be for the institutions to "report" the images that they have submitted (i.e. a transaction from the institution's database to the SERNEC portal). I think a better idea would be for the SERNEC portal to periodically "poll" MorphBank by exporting the result of a search for all items with a "project name" (or institution name) of SERNEC and then parse out the resulting XML file to update the SERNEC live plant image database.

Once the SERNEC portal "knows" what images it has to work with, it can then inform users what is available. This could be done by presenting thumbnails as the result of a search or allow users to browse categories of images (images from a particular state, taxon, or view type - i.e. leaves, flowers, etc.). The other thing that the SERNEC portal would do would be to host products created with images from the community collection. Again, I'm not going to specify what all of those things might be here, but I would say that I think there should be an understanding that images which go into the collection are "fair game" for others to use in the creation of products. For example, although the terms of use of the Bioimages allow educational and non-commercial use of the images without permission, as a courtesy I still receive requests for permission from those types of users. This should be unnecessary, at least among participants in the community collection. The system we create should provide attribution automatically

through links from the image to the record in MorphBank that provides details on the photographer, institution, and license. If we do not create a system that produces automatic attribution, then we hobble the creative process by requiring someone who produces something like an interactive key to email a dozen people to get their blessing to use their images. The portal itself should have generic instructions or a mechanism for finding out who the image owner is and the default licensing terms so that information doesn't have to be manually associated with each image in the product.

Where should this portal be located? I think the answer to this will be determined by the larger group. It needs to be wherever the other SERNEC resources are going to be located (i.e. the "virtual herbarium", range maps, etc.) I am told that the UT Sunsite has the appropriate resources to assist with this and that NBII will eventually host the collaborative portal.

Section 4. How images can be utilized by the community to create useful educational products.

There is no point in us creating a database of live plant images unless we have ways to use them that advance the goals of SERNEC. It seems clear to me that a live plant image database would be very helpful in advancing the following general goals of SERNEC:
GOAL 2. Develop a digital library, a “virtual herbarium,” which will include a database of collection label data, specimen images and live plant images.
GOAL 5. Evaluate strategies for disseminating information within the network and to the general public. Emphasis will be on region-wide initiatives, or programs that can be easily replicated state-by-state.
GOAL 6. Determine ways to make botanical information in the Southeast accessible to all.

However, when I look at the specific tasks that are suggested under each of these goals, there are only a few that are directly applicable to live plant images:
Goal 2, item 7. Make images of live plants or herbarium specimens available online for each species found in each state.
Goal 5, item 2. Publish online teaching aids for K-12. These would include botany studies that are grade-specific and that make use of the database information in an inquiry-based approach.
Also under Goal 5 items 3-5 might be advanced by live plant images, although that is not specifically mentioned.

Many of the tasks involve the digitization and dissemination of information from herbarium specimens, which is a good thing in itself. However, I hope that as a group SERNEC can rise to the challenge of avoiding "persistence of set" and also adopt new and creative approaches to achieving the goals of disseminating information to the general public and making botanical information in the Southeast accessible to all. How can we create educational products that can be downloaded onto iPods? How can we create a visual key that can be used by a 4th grader? Can we create "ready to fly" PowerPoints that can be modified by teachers who want to teach about plants but have no botany training? All of these things that I just mentioned should probably involve the use of live plant images and we should collect those images in a way that would make the creation of these products possible.

I am not claiming that I know the best uses of live plant images, but I do believe that those uses can go far beyond simply making an online "field guide" that provides a picture of each species in the southeast. I hope that we can have a discussion here that will lay out some of these uses and that the discussion will guide the development of the standards we adopt for the collection, archiving, and dissemination of the images. Because of the overlap in interests, I hope that this discussion should take place in parallel with the discussions of the Education and Outreach working group.