

This workflow was developed at an iDigBio workshop in January 2015. The most recent version is available at <https://github.com/iDigBioWorkflows/FlatSheetsDigitizationWorkflows> and <https://www.idigbio.org/content/workflow-modules-and-task-lists>.

## Appendix S6. Module 6: Imaging

Task ID	Task Description	Explanations and Comments	Resource(s)
T1	Capture information from folders of specimens.*	<p>Do this task if workflow includes capturing cabinet- and folder-level data as part of pre-digitization curation (see Module 1: Pre-digitization Curation).</p> <p>The information captured is folder- or cabinet-level data to be associated with specimen-level records (see T5, this module).</p> <p>Information may be machine readable (from 1D barcodes, DataMatrix codes, or QR codes) or keystroke information (Pre-digitization curation module).</p> <p>*For purposes of this module, we assume the ICN definition of specimen: “A gathering, or part of a gathering, of a single species or infraspecific taxon made at one time, disregarding admixtures, mounted either as a single preparation or as more than one preparation with the parts clearly labelled as being part of the same specimen.”</p>	<p>QR code, Data Matrix code, or barcode scanner. Machine readable folder labels or slips.</p> <p>See: iDigBio’s specimen barcode survey for list of scanners: <a href="https://www.idigbio.org/wiki/index.php/Specimen_Barcode_and_Labeling_Survey_Results#What_make_and_model_of_barcode_reader_do_you_use.3F">https://www.idigbio.org/wiki/index.php/Specimen_Barcode_and_Labeling_Survey_Results#What_make_and_model_of_barcode_reader_do_you_use.3F</a>.</p> <p>ICN Glossary definition of “specimen”: <a href="http://www.iapt-taxon.org/nomen/main.php?page=glo">http://www.iapt-taxon.org/nomen/main.php?page=glo</a>.</p> <p>Diazgranados and Funk (2013). <a href="http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3819127/">http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3819127/</a>.</p> <p>Also see Warda et al. (2011). <a href="http://www.conservations.org/publications-resources/special-projects/the-aic-">http://www.conservations.org/publications-resources/special-projects/the-aic-</a></p>

			<a href="#">guide#.VRWjg_nF-6U</a>
<b>T2</b>	Check for specimens in need of repair or filed incorrectly.	Establish and follow protocol for repairing and rerouting specimens in the digitization process (see Module 1: Pre-digitization Curation).	Conservation protocols/policy.
<b>T3</b>	Remove specimen from folder.	<p>Specimens have been previously moved to the imaging station as part of pre-digitization curation.</p> <p>As specimens are removed, ensure maintenance of original folder order and specimen order within folders (if any) via reverse stacking or some other institutionally specified method.</p> <p>Follow standard best curatorial practices for handling specimens. For example, handle folders and specimens carefully. Do not turn folders or sheets face down.</p>	
<b>T4</b>	Stamp to indicate the specimen has been imaged.	<p>Desirable for indication of divergence of original image/record from subsequent alteration of physical specimen (e.g., future annotations, insect damage). Implementation of this task varies among institutions. If included, there are several strategies by which it can be accomplished.</p> <p>Some institutions place a printed label with IMAGED followed by image date in format “YYYY-MM-DD” just below and outside the perimeter of the sheet but visible to the camera.</p> <p>Strategy if re-imaging is planned (such as after future annotations):</p> <ul style="list-style-type: none"> <li>• Ink-stamping the actual sheet with "IMAGED."</li> </ul>	Stamp.

		<ul style="list-style-type: none"> <li>• Writing in pencil the imaged date "YYYY-MM-DD" immediately below this stamp (the date can be erased and changed before re-imaging).</li> <li>• Alternately, some institutions write the date in permanent ink each time an image is recorded to ensure a record of imaging episodes for each specimen.</li> </ul> <p>Strategy if re-imaging is not planned:</p> <ul style="list-style-type: none"> <li>• Ink-stamping the actual sheet with "IMAGED YYYY-MM-DD" using a date-roller-type stamp.</li> </ul> <p>Strategy if permanent indication of imaged date on actual sheet is not desired:</p> <ul style="list-style-type: none"> <li>• Pre-printing a small slip of paper to fit onto the border of the imaging field for the scanner or camera (near color standard or scale bar) with "This image generated YYYY-MM-DD".</li> </ul> <p>Some institutions also include notation of imaging technique and resolution, e.g. "This specimen imaged YYYY-MM-DD by a scanner at 600 PPI."</p> <p>Some institutions choose to stamp individual specimens while others stamp the folder, meaning its entire contents, as imaged.</p> <p>Some institutions wait to stamp until after the actual specimen image has been captured.</p>	
<p><b>T5</b></p>	<p>Apply a specimen barcode to each sheet<sup>†</sup>, if not already applied.</p>	<p>For some institutions, this task may have been completed previously, either as a step in pre-digitization curation (Module 1: Pre-digitization Curation), or as a separate barcode application workflow.</p> <p>Possible locations for barcode placement:</p>	<p>Barcodes.</p>

		<ul style="list-style-type: none"><li>● Placed near the label, if images will be cropped to label and barcode</li><li>● Along bottom edge of sheet to easily locate a specimen in a folder without removing folder from cabinet. This placement may also facilitate OCR on label images (see T14).</li><li>● Adjacent to accession number for institutional association.</li><li>● In upper right corner of sheet to facilitate scanning with barcode reader.</li><li>● For sheets with more than one specimen, each with its own label, each specimen may have a different barcode, which should be attached next to its label.</li><li>● To facilitate future OCR or other data extraction technologies, orienting the barcode sticker vertically or horizontally relative to the sheet works best.</li></ul> <p>† In cases where a botanical specimen is spread across multiple separate preparations/items (e.g., specimens spanning multiple sheets, bulky items separate from sheet, etc.), there are different approaches. The approach that your institution chooses will depend partly on what institutional barcodes represent.</p> <p>For the case of one barcode per botanical specimen:</p> <ul style="list-style-type: none"><li>● Use one barcode for the specimen and affix to primary sheet/preparation (e.g., affix to “Sheet 1 of n”, where n is the total number of sheets).</li><li>● To physically keep track of other items that belong to a particular specimen:<ul style="list-style-type: none"><li>○ Write the barcode number on the remaining item labels, OR</li><li>○ Keep multiple items together (e.g., in a folder</li></ul></li></ul>	
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		<p>or box, clipped together, etc.)</p> <ul style="list-style-type: none"><li>• In some databases (e.g., Specify 6.0, 7.0), multiple preparations of a specimen are databased and associated with the specimen record.</li></ul> <p>The above assumes that it is possible to recognize multiple preparations of a specimen (e.g., sheets marked as “Sheet 1 of n,” “Sheet 2 of n,” etc.) and does not refer to botanical duplicates of the same specimen.</p> <p>For the case of one barcode per preparation/item:</p> <ul style="list-style-type: none"><li>• Each sheet or object might be given a different barcode, regardless of whether or not they are part of the same specimen.</li></ul> <p>Barcode placement for packets and exsiccatae or other series is often dependent on institutional decision and whether packets are fastened to sheets and whether exsiccatae are bound or have been separated.</p> <p>In the case of single or multiple packets fastened to sheets, barcodes may be placed on the packet or on the sheet just above or below the packet or vertically oriented to the left or right of the packet if it will not fit above or below. In the case of free packets, barcodes may be placed on the front of the packet, below the label, if there is room. If there is no room below the label an external tab may be glued to the bottom of the label for affixing the barcode. Commonly, barcodes are affixed directly to the label. Visibility in placing barcodes on packets is the key. It is not recommended to place the barcode on the back of the packet, within the packet, or anywhere that will render the barcode hidden in packet images or when quickly thumbing</p>	
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		<p>through a tray of specimens.</p> <p>For bound exsiccatae, we recommend affixing a barcode to each separate specimen, even when there are two or more specimens on a single sheet. Determining what constitutes a specimen is usually straightforward as each specimen generally has a separate label.</p>	
<b>T6</b>	Scan barcode into database.	<p>Perform this task if collection database and specimen record already exist but barcode number has not yet been captured. The barcode is often scanned into the database field that maps to <code>dwc:catalogNumber</code>.</p> <p>See Task T16. Creating or amending a record (after imaging) provides an alternate approach to capturing the barcode value into a database.</p>	Barcode scanner.
<b>T7</b>	Create skeletal record if specimen record does not yet exist, via one of several entry techniques, e.g., keystroke entry, pick-lists, voice recognition.	<p>Skeletal record must contain:</p> <ul style="list-style-type: none"> <li>Barcode value (at most institutions represented in database as <code>dwc:catalogNumber</code>).</li> </ul> <p>Skeletal record might also contain:</p> <ul style="list-style-type: none"> <li>The “filed-as” name or most recent taxonomic identification.</li> <li>Location of specimen in herbarium (cabinet).</li> <li>Other folder-level information (high-level geography).</li> <li>As alternative to T6, capture accession number for later association with existing database records.</li> <li>Critical data items transcribed from sheet (e.g., collector name, collector number, date collected, high-level geographic description such as state or country) entered via keyboard or voice recognition software. Use controlled vocabularies and pick-lists when</li> </ul>	<p>Microphone for voice recognition. Computer, keyboard. Database. Speech recognition software.</p> <p>The software used to create the skeletal record varies. Some possibilities are the authoritative institutional database, a spreadsheet, or a lightweight custom purpose application (e.g., a web-based or Java application).</p>

		<p>applicable.</p> <ul style="list-style-type: none"> <li>• For exsiccati, capture exsiccati title and exsiccati number.</li> </ul> <p>Some institutions do not enter data at this juncture. However, some suggest that capturing some data (e.g., family and genus), followed immediately by creating a batch of records in sequential barcode order for subsequent data entry might improve efficiency. Furthermore, providing some skeletal data can increase the usability of the collection early in the project.</p>	
<b>T8</b>	Turn on imaging lights.	<p>Ensure that all lights are on and functioning and shadows are minimized. If using an imaging station that is not enclosed, consider ambient light from the room and windows. Your imaging environment may require that you turn off other lights in the area (e.g., the overhead lights in the room) or close the imaging room door. Allow for any warm-up period that may be required for the particular light source used.</p> <p>Maintain consistent lighting for the duration of the project and perform routine checks of lighting source.</p>	Lighting system.
<b>T9</b>	Stage specimen.	<p>Place and align specimen in imaging frame, light box, light tent, copy stand, or scanner. Having a guide for specimen positioning ensures that specimens are photographed in a consistent orientation and are in alignment with field of view. Examples of specimen guides include alignment pins (thumbtacks pushed up through the bottom of a velveteen-covered mat board), a herbarium sheet attached to the imaging platform on which the sheet to be imaged is placed, and attached metal guides in the shape of an “L.” See Imaging Station Setup modules (modules 3–5) for additional details on specimen alignment techniques.</p>	Lighting and copy stand or scanner. Imaging frame.

		<p>Check for plant parts or other materials obscuring collection label or barcode, or remove plant parts that are obscuring the specimen and place them in a fragment packet, if this is in accordance with institutional policy.</p> <p>See T13 for information about fragment packets.</p>	
<b>T10</b>	Place or ensure placement of scale bar and color standard and make certain they are clean and visible.	<p>Images should include visible scale bar and color standard. Some institutions place them on the sheet. It is recommended to affix the scale and color standard to framing outside of the margin of the specimen but clearly visible in the imaging field of view to reduce manual manipulation steps and increase efficiency. See Imaging Station Setup modules (modules 3–5) for additional details on types and placement of scales and color standards.</p>	<p>Scale. Color standard.</p>
<b>T11</b>	Adjust camera settings if necessary.	<p>Ideally, camera settings (ISO, aperture, shutter speed, white balance) should be set once during station assembly and checked at the start of each session.</p> <p>Focus may be manual or auto, depending upon camera selected and institutional preference. If manual is selected, it is recommend to use gaffer tape to prevent lens creep.</p> <p>Autofocus ensures automatic adjustments to varying depths of field between bulky and flat specimens. However, sheets lacking areas of contrast within the autofocus points may result in autofocus failure. One way around this is to place a ruler or other suitable object (e.g., institutional logo) in the center of the sheet for focus.</p>	<p>Camera. Institutional protocols regarding camera setup and configuration.</p>
<b>T12a</b>	Release shutter to capture image.	It is important during this task not to physically touch and potentially shake	Wireless, tethered, or mouse-activated



		<p>the camera.</p> <p>Camera control software will allow image capture using the spacebar or mouse. Otherwise, a wireless or tethered remote shutter release can be used.</p>	<p>shutter release.</p>
<b>T12b</b>	<p>Scan complete specimen sheet.</p>	<p>This alternate imaging method is for those institutions using scanner technology, often in association with the Global Plants Initiative (GPI). The GPI protocol can be found in the JSTOR Plants Handbook. The steps in the scanning process are performed in place of T10–T15 and include:</p> <ul style="list-style-type: none"> <li>• preview,</li> <li>• check image, adjust if necessary,</li> <li>• use selection tool to drag an area around the herbarium sheet,</li> <li>• when the image is satisfactory, click AUTOFOCUS,</li> <li>• scan,</li> <li>• perform quality control: check for pixelation, blurriness, lines in the scan, green color in corners, and color separation along edges (See JSTOR Handbook for examples; check in-depth the first scan and selected scans at regular intervals thereafter,</li> <li>• set image format (TIFF), image compression (NONE), byte order (IBM PC)</li> <li>• save image,</li> <li>• resume at T16</li> </ul>	<p>See: JSTOR Plants Handbook, <a href="http://www.snsb.info/SNSBInfoOpenWiki/attach/Attachments/JSTOR-Plants-Handbook.pdf">http://www.snsb.info/SNSBInfoOpenWiki/attach/Attachments/JSTOR-Plants-Handbook.pdf</a>.</p>
<b>T13</b>	<p>Image fragment packet.</p>	<p>Implementation of this task varies among institutions. If included, there are several methods by which it can be accomplished.</p> <p>One strategy includes:</p> <ul style="list-style-type: none"> <li>• open the packet and spread the enclosure,</li> <li>• ensure that the expanded packet flaps do not obscure important</li> </ul>	

		<p>plant material (weights can be used to hold the packet flaps down),</p> <ul style="list-style-type: none"><li>● capture image.</li></ul> <p>Another strategy includes:</p> <ul style="list-style-type: none"><li>● open the packet,</li><li>● remove the packet contents to a paper tray that is the same dimensions as the packet,</li><li>● close the packet,</li><li>● place the paper tray on top of the packet (with weights, if necessary),</li><li>● capture the image.</li></ul> <p>And another:</p> <ul style="list-style-type: none"><li>● If there are only plant bits in a fragment pack and the majority of the specimen is on the main sheet, leave fragment pack closed and image entire sheet.</li><li>● If fragment packet contains entire specimen and label is standard in bottom right corner, open packet, place weights on flap corners and take image.</li><li>● If packet contains information on outside (label, additional specimen data), take two images (one barcode as you are only dealing with one specimen)—one with the fragment pack closed so the label data/additional data is showing and one image with the fragment pack open so the actual specimen can be seen. This approach will require that a protocol is developed for multiple image names that refer to the same specimen (usually by appending a character to the file name).</li></ul> <p>Bryophyte and lichen packets may be free, or fastened in lots to herbarium sheets. Packets may be:</p> <ul style="list-style-type: none"><li>● opened during image capture to</li></ul>	
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		<p>reveal the contents or labels on the inside of the packet tab,</p> <ul style="list-style-type: none"> <li>• kept closed with only an image of the label recorded,</li> <li>• or some combination of both.</li> </ul> <p>If images are recorded of open bryophyte/lichen packets, contamination of succeeding specimens should be avoided by cleaning the substrate between images, especially when the contents have been removed from the packet.</p>	
<b>T14</b>	Image the specimen label for later OCR processing.	<p>These <u>optional</u> label images might result in greater OCR accuracy than images of entire sheets as well as increase rate of recognition.</p> <p>If barcode has been placed near the label at the bottom of the specimen sheet, it will also be included within this image.</p> <p>Images intended for later OCR processing should have an x-height (height in pixels of the lower case “x”) not less than about 15 pixels.</p> <p>If imaging labels only, consider black-and-white or monochrome setting on your camera, as this can reduce file size.</p> <p>Multiple images of a specimen will entail greater image management effort and care will need to be taken to ensure that images are associated with appropriate record/specimen.</p>	
<b>T15</b>	Check image quality, including focus, exposure, and presence/visibility of barcode.	<p>This task is one of several quality control checks.</p> <p>Some suggest checking exposure at the start of an imaging session and every 15–20 specimens. Likewise for focus, if using manual focus.</p>	Application that detects barcode in the image (see Resources in next task).

<p><b>T16</b></p>	<p>Rename file.</p>	<p>Rename the image file as the specimen barcode.</p> <p>Some institutions utilize camera control functions that name files to barcode sequence specifications as the image is recorded, hence eliminating the need to rename files.</p> <p>Other institutions utilize a file renaming application (BCR, BardecodeFiler, reBar) to rename the image file to match the barcode value. This can sometimes be an iterative step through execution of a batch operation to process numerous files.</p> <p>Alternatives to file renaming include storing the camera-generated filename in a database record and associating that record with the specimen's barcode. This assumes that camera-produced names remain unique, even if new or multiple cameras are put into service.</p>	<p>Applications for renaming files based on barcode:</p> <p>NYBG approach (utilizes BardecodeFiler): <a href="https://github.com/NYBG-Herbarium">https://github.com/NYBG-Herbarium</a></p> <p>NEVP approach (reBar, utilizes ZBar): <a href="https://github.com/psweeney-YU/reBar">https://github.com/psweeney-YU/reBar</a>.</p> <p>PNW Herbaria approach: <a href="http://www.pnwherbaria.org/documentation/imaging-computer-configuration.zip">http://www.pnwherbaria.org/documentation/imaging-computer-configuration.zip</a></p>
<p><b>T17</b></p>	<p>Scan barcode into database record.</p>	<p>Some institutions create a database record here by scanning the barcode into the database, a step that can also precede image capture as outlined above.</p> <p>If task T6 has been completed, then task T17 should be skipped.</p>	<p>Barcode scanner.</p>
<p><b>T18</b></p>	<p>Check for damage to specimen that might have occurred during imaging.</p>	<p>If damage occurred, follow protocol for repairing and rerouting specimens in the digitization process. Upon rerouting, continue with T19.</p>	<p>Conservation policy/plan.</p>
<p><b>T19</b></p>	<p>Return specimen to the collection/folder and then herbarium.</p>	<p>Ensure maintenance of original folder order and specimen order inside folder (if required) via reverse stacking or other strategy as noted in task T3.</p> <p>Drop-tags are helpful for keeping track of where imaging left off.</p>	

		<p>Follow standard best practices for handling herbarium specimens.</p> <p>Some institutions keep specimens unfiled until images and data have been subjected to final quality control procedures effected during the image processing module. This strategy is dependent upon space available, protocol, pace of operation, and quantity of images processed.</p>	
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