DROID 4: Three-dimensional specimens in boxes/drawers

Original members: Talia Karim, Jessica Utrup, Roger Burkhalter, Ann Molineux, Una Farrell, Susan Butts, Gil Nelson

- **Talia Karim (Museum of Natural History, U. Colorado)**
- **Jessica Utrup (Peabody Museum, Yale)**
- **Roger Burkhalter (U. Oklahoma)**
- **Ann Molineux (U. Texas)**
- **Una Farrell (U. Kansas)**
- **Susan Butts (Peabody Museum, Yale)**
- **Gil Nelson (iDigBio)**

Overall preamble highlighting the need to ensure that all non-specimen objects and ancillary materials are linked to specimens. Including consistent naming conventions for files of various kinds to facilitate linking.

How To Documents:

- **Image station set up- make equipment list into wiki on iDigBio website and link to reference from workflow**

- **Image processing- putting in scale bar, grey scale, macros for batch editing, watermarking, etc**

- **Blackening/whitening document- describe how to put together a Foofer. There is a very old Journal of Paleontology Article that outlines this, but might be useful to outline how to contact your Chemistry supply store to put together the necessary components, also mention need for fume hood, and low humidity environment, and also maybe why we should NOT use magnesium anymore (doesn't really come off)**

- **Specimen Handling-**

Workflows we need to make based on this discussion:

1. **Module 0 - Pre-digitization curation workflow (do simultaneously or last)**
2. **Module 1 - Imaging objects (only deals with imaging, naming files using voice recog. software, etc)**
    a. **Cards/ledgers/field notes, etc.**
    b. **Label imaging**

    c. **3D preserved specimens, including multiple views, where appropriate (standard views; might recommend resources);**
    d. **2D specimens- flattened compression fossils, hard to image flattened specimens**
    e. **Specimens preserved in Amber/Copal**
    f. **Imaging thin sections**
    g. **CT scanning**
    h. **SEM Imaging**
    i. **Molding and casting and imaging of both**
    j. **Whole drawer imaging- will make a note that points people to the documents produced by Pinned Things Group and Whole Drawer Imaging Group**
3. **Module 2 - Data entry - Keystroking**
    a. **labels**
    b. **images**
    c. **ledgers**
4. **Module 3 - Data augmentation/enrichment/correction etc. of existing records**
5. **Module 4 - File storage/archiving (not sure this is needed as a separate module; applies mostly to imaging and can be accommodated in image processing, M1e)**

Module 0: Pre-digitization curation and set up

Task ID	Task Name	Explanations and Comments	Resources
T1	Prioritize specimens, collections objects, ledgers, field notes, catalogs to digitize.	Varies by institution. Should follow institutional digitization policies and guidelines.	• Institutional policy, • project guidelines, • active research criteria, etc.
T2	Note damage to object to be digitized that needs immediate attention.	Route to conservation workflow as necessary, based on institutional policy or curatorial practices.	Institutionally specific curation guidelines.
T3	Update specimen taxonomy (and related authority files) as necessary.	This may happen prior to the digitization of any taxonomic group. Some	Depends on the purpose of the program.

		institutions accept expert determinations. Some institutions accept the determinations in anticipation of community involvement in helping correct determinations.	Determine purpose of digitization What happens when imaging a lot in which one or more specimens is re-determined
T4	Update specimen identifications and determinations in collection and authority files in database.	This may involve augmenting existing data records and correcting database errors, locality numbers, and preparations. This task should be accomplished by a trained technician to curtail spelling errors and mis-parentings.	
T5	Divide lots and create specimen numbers for specimens.	Strategies vary, dependent upon need for identifiers for individual specimens for specific purposes; or in preparation for exemplar imaging	
T6	Associate institutionally and/or globally unique identifiers with collection objects.	The point at which unique identifiers are assigned and the identifiers placed on specimens varies by institution and may alternatively be included in other modules. Associating a Globally Unique Identifier (GUID) with each physical collection object facilitates tracking	Write directly on specimen, or use B-72/gesso and then number, or affix printed number to specimen, or bag printed number with specimen. (Depending on requirements of specimen and institutional policy)

		that object and related objects across the internet. It also ensures that every electronic record about an object can be recognized as related to that object. GUIDs might be assigned at a later stage in the workflow. If not, they are assigned here. A collection object may have more than one GUID, but a GUID must refer to one and only one object and must be persistent, meaning that the same GUID should not be re-used, even if the object is destroyed or de-accessioned.	
T7	Set up image naming convention		Technician. Institutionally specific policies and protocols for governing standard file-naming strategies. See https://www.idigbio.org/content/idigbio-image-file-format-requirements-and-recommendations

Module 1: Imaging objects

Module 1A: Ledger/card catalog/field note imaging (materials not stored with specimens)

Task ID	Task Name	Explanations and Comments	Resources
T1	Select and retrieve card, ledger, field notebook, or other ancillary document to digitize.	This workflow deals specifically with imaging cards and individual pages of ledgers and field books, whether bound or cut. Ledgers and field notebooks might reference identifiable specimens, collecting events, or collecting localities.	Technician. Institutionally specific digitization plan, guidelines, or protocols.
T2	Transport selected materials to staging area or directly to imaging or scanning station.	A staging area might be used to organize materials, cut bindings (in institutions where this is practiced), and stack materials for scanning. Transporting material to the staging area or imaging station can be independent of imaging progress and can occur in assembly-line fashion. Material moved to the staging or imaging station may exceed the quantity of material possible to image in a single session, in effect creating a backlog that encourages continuous use of imaging/scanning equipment and eliminating potential down time while awaiting the next set of material to be delivered.	Technician. Cart or transport vehicle. Staging area. Talia-Add Rolling Cabinet info

		Some institutions rely on mobile imaging stations that can be moved to the objects to be imaged, eliminating the need to transport materials to an imaging station.	
T3	Isolate card or page(s) to scan or image.	This task depends on institutional protocol and may include determining where to begin based on the stopping point for the previous day's or session's activity. Some institutions cut the binding on field notebooks or ledgers to facilitate more efficient scanning, which may trigger re-binding once these documents are digitized. Some institutions leverage equipment from other institutional resources, such as page turning equipment or book page imagers from the information or library sciences. Institutions are encouraged to seek out such resources and forge collaborations.	Technician. Institutionally specific digitization plan. Intra-institutional partnership agreements.
T4	Record image of page, card, or document.	Specific protocols vary and usually depend on the type and brand of imaging equipment used. Some institutions record	Technician. Scanner or digital SLR. Equipment- and institutionally

		entire ledger pages for subsequent linking to individual database records representing the specimens or collection objects referenced within the image. Immediate (often temporary) storage of captured images is usually provided by direct download from camera to computer as part of the image capture software workflow, which allows for an immediate quality control check and is the preferred method of temporary storage. Some institutions capture images to an internal camera card and transfer the captured files at a later time. This second method adds a time-consuming step to the process and prevents immediate quality control by the imaging technician. Imaging technology decisions might depend on whether materials are bound or unbound, and whether they can or should be fed into a document feeder attached to a scanner. Unbound material of regular shape and not subject to damage due to fragility can be	specific protocols with precise, illustrated, step-by-step instructions. Representative equipment currently in use includes: ● Canon Mark 5D and related cameras, ● Nikon D800, D3X, and related cameras, ● Kirtas APT BookScan book page scanners ● Fujitsu fi-6130Z scanner for cards, paper etc. Representative image capture software includes: ● Canon Digital Photo Professional and EOS Utility, ● Nikon Camera

		efficiently processed by scanner through a document feeder. Bound material, cards/pages of irregular shape, large documents, documents that should be kept intact (e.g. ledgers) may be better recorded by camera.	Control Pro, Nikon Capture, Nikon View Technical details to consider when acquiring imaging equipment include: ● automatic naming of imaging files, ● whole-page imaging capability, ● direct file storage from imaging device, ● image file types supported (e.g. TIF, JPG, RAW, etc.), ● availability of scanner document feeders,
T5	QC images	Check images for: ● sharp focus, ● clarity, ● completeness,	Quality control technician.

		• clear view of entire page, • correct orientation. Quality control at this stage is often an iterative task during which poor quality images are identified and re-imaged immediately and repeatedly until a satisfactory image is obtained.	
T6	Populate core metadata (process/admin/technical).	To include: • EXIF, • IPTC, • personnel details, • collection details, • date/time, • copyright. Metadata should never be stripped from archival, raw, or in-house images. This step may occur in other phases of the workflow.	• Technician. • Adobe Lightroom. • Adobe PhotoShop. • Camera manufacturer software (Digital Photo Pro; Capture NX2, etc.)
T7	Assign filename	Strategies differ. Digital cameras can often be configured to assign names automatically to a standard or customized format. Many institutions use barcode value, catalog number, field number, date recorded, or some combination of these within the file name, depending on whether the objects are collection-object or	Technician. Institutionally specific policies and protocols for governing standard file-naming strategies. See https://www.idigbio.org/content/idigbio-image-file-format-re

		collecting-event related.In general, simple file names are preferred. Procedures should ensure that file names are unique. Though filenames can be cryptic and lack discernible meaning, many institutions prefer to use meaningful values within the name. For example, some institutions include the catalog number, an indication of magnification, view angle (dorsal, ventral, lateral, etc.), and sequence numbers for multiple images of a single collection object, all of which are persistent values that maintain a static relationship to content of the image over time. It is generally best not to include taxonomic or other non-persistent data in a filename. Doing so creates the need for continuous re-visits and edits of file names as taxonomy evolves, an activity better handled via a database. In some instances, filenames are immediately recorded in a database that links newly created or	quirements-and-recommendations

		existing collection object or collecting event records to the image. Or, images are linked to corresponding database records via automated processes during other modules. Consistent and clearly stated file naming policies are important to support this linking process at whatever stage it occurs. Optional Optical Character Recognition (OCR) of images for the purpose of extracting barcode or other identifier values may be used as part of a file renaming strategy.	
T8	Process image.	Image processing involves non-destructive editing to archival files. For cards, catalogs, ledger, and other non-specimen images, adjustment to improve clarity and readability are desired.	
T8	Store file.	File storage is generally divided into several categories: ● Archival, ● High resolution for web presentation, ● Thumbnail.	● Hardware. ● Software. ● Digital Asset Management System (DAMS)
T10	Return object to storage container.	In some instances, this may require re-assembling ledger books that have been cut	● Technician. ● Cart or transport vehicle.

		for imaging. Ensuring that catalogs, cards, etc. are re-filed in the original order to ensure re-finding them is an important consideration.	
T11	Archive image.	The succeeding workflow module for many institutions involves creating database records and linking/attaching images to them, or linking/attaching existing database records to card, catalog, or ledger images. Processes for transitioning to this activity are important.	● Technician. ● Hardware.

Module 1B: Image labels associated with specimens

Task ID	Task Name	Explanations and Comments	Resources
T1	Select and retrieve specimens/lot/container and associated labels.	This workflow assumes that only labels are being imaged. For specimen imaging workflows, label imaging should be commensurate with specimen imaging to reduce redundancy and minimize specimen handling. Selection of labels to	● Institutional policy or guidelines governing digitization priorities. ● Project guidelines.

		digitize may be governed by institutionally determined digitization goals and practices.	
T2	Transport specimens/drawer to staging/photographic/scanning area	Position drawer on cart or similar to reduce travel time associated with multiple trips and to facilitate workflow	
T3	Find, isolate, extract specimens from drawer as needed, and determine the specific label(s) to be imaged.	General practice and recommendation is to image all labels associated with a specimen or collection object, regardless of data redundancy, duplication, or label type. Imaging all labels associated with a collection object while they are available is efficient and only marginally time intensive. In addition, errors in data entry can be easily discovered during proofing and subsequent reviews if labels are imaged with the specimens rather than having to troll through drawers looking for the physical labels.	Institution-wide policy for: ● selecting labels to image, ● dealing with duplicate labels. ● Camera or scanner (scanner may be better if labels enclosed in polyethylene/Mylar)

		Multiple labels for the same specimen should be imaged together. Caution is required for handling labels as some may be very fragile.	
T4	Check to make sure label and specimen are correctly associated before imaging and to ensure the two can be correctly reassociated after imaging	This step ensures that the association between label and specimen is correct before imaging. This is also an opportunity to make sure the specimen and the label can be correctly reassociated after imaging (e.g., make sure the specimen number is written on both the label and the specimen) Safest practice is to image labels from a single tray/drawer and return those labels to the tray/drawer before imaging succeeding trays/drawers.	
T5	Prepare labels for imaging.	Labels may be fragile. Technicians should be trained to handle them with	

		care. Labels may need to be flattened or unfolded. Labels affixed to specimens present special problems. Since many of these labels are old and fragile, it is safest to image the label while affixed to the specimen (whether by putting the specimen on a scanner or imaging it with a camera).	
T6	Image label(s).	Institutional policies vary regarding label imaging. Some prefer to include multiple labels in single or multiple composite images. Others prefer a single label per image. Labels with data on both sides require multiple images. Whatever policy is adopted, it is important to ensure that all images are linked to the specimen or lot database record to which they refer. A	● Adobe Lightroom or similar, ● Image capture software, ● Image processing software, ● Digital camera, ● Flatbed or other scanner, ● Institutionally specific imaging protocol.

		visible notation within the images noting which side of the label has been recorded is helpful. Including the specimen/lot catalog number or digitization project identifier within each label image ensures that an image can be visually linked to the specimen it represents. Including some or all of the data above in the image EXIF (exchangeable image file format) or associated IPTC (International Press Telecommunications Council) metadata within the image is a consideration and can be accomplished with Adobe Lightroom or similar products.	
T7	QC images Re-image as necessary	This is an iterative step during which images from T6 are checked for quality and immediately re-imaged as necessary until a satisfactory image is obtained.	Technician.

		Quality control includes: Check images for: ● sharp focus, ● clarity, ● completeness, ● clear view of entire page, ● proper orientation.	
T8	Clean/conserve label (if needed) and reassociated with specimen	● clean label and place in protective sleeve	● Groom Stick to clean label ● Mylar sleeve
T9	Return specimens to shelves or cabinets.	Ensuring that containers are re-filed in their original locations and order should be specifically stated in the written workflow protocol.	● Technician. ● Cart or transport vehicle.
T10	Archive image.	The succeeding workflow module for many institutions involves creating database records for each specimen/lot and attaching or linking label image to them, or linking/attaching the images to existing database records. Processes for transitioning to this activity are important.	● Technician, ● Database software, ● Computer hardware.

Module 1C: Imaging Three Dimensionally Preserved Specimens

Task ID	Task Name	Explanations and Comments	Resources	
T1	Select and retrieve	Some institutions	● Institutional	

	specimens/drawer of specimens from storage location.	record images of labels and specimens simultaneously, combining relevant tasks from M1A and M1B.	specimen imaging policy or project guidelines, ● Technician.	
T2	Transport selected collection objects to appropriate staging area.	- Insert comments related to staging areas for humidity issues etc. Ideally, staging areas should be located adjacent to or in close proximity of its related imaging station The destination of transported specimens will depend on whether the institution has one or more imaging stations and associated staging areas, and whether these stations are more or less permanently configured to accommodate specimens of specific types, sizes, or shapes, or to accommodate varying equipment configurations (e.g a microscope versus camera). For institutions that maintain two or more permanently configured imaging stations, this step	● Cart. ● Technician.	

		requires determining the staging area to which the specimens should be transported. This is especially true when the proximity of imaging stations do not allow shared use of a single staging area. For institutions with a single imaging station or staging area, the imaging station should be pre-configured for the selected specimens before or immediately following specimen transport. Imaging station configuration requirements imposed by various sizes and shapes of specimens underscore the efficiencies of concurrent imaging of specimens of uniform size and shape.		
T3	Find specimens in drawer.	In some workflow implementations, T3 precedes T2. Institutional strategies vary. In some instances, specimens are ordered by size to	Institutionally or project (e.g., grant, research request, etc) specific guidelines governing specimen selection criteria.	

		optimize imaging efficiency by reducing or eliminating frequent lens changes and copy stand and lighting adjustments. In other instances, specimens are selected by taxonomic group. Decisions to be made include: ● whether to image multiple or single specimens from a single lot, ● determining the best quality specimen for exemplar images, ● determining the size(s) of specimens to image from a single lot (e.g., smallest, largest, average, representatives of several size classes, etc.), ● whether to include several specimens from varying lots in a single composite		

		image.		
T4	Set up camera/imaging station (may need to be set up each time and disassembled for security reasons etc.)	Attach appropriate lens. The imaging station can then be configured for whatever size/type of fossils you have chosen in T3 in preparation for iterating through T4-T8.		
T5	Clean Specimen	Might Include: ● Cleaning dust/hairs off of specimens ● old blackening if possible/needed Typically T4, T5, and T6 occur prior to mounting (T7), but may occur after mounting, depending on the specimen.	- *compressed air; this method is specimen dependent and should be used only for sturdy specimens -air puffer and soft brush - soft bristle paint brush - tooth brush, electric, ultrasonic, or manual, depending on specimen	
T6	Blacken Specimen	Typically, cleaning and blackening occurs prior to	Blackening- ● Pro Black (reversible)	

		mounting, depending on the characteristics of the specimen. This is an optional step that might be done to increase contrast and help to bring out fine details on some specimens. Note- some blackening agents are not reversible	• Photographic opaque (reversible) • India Ink (*Not reversible) • Quink?-Susan	
T7	Whitening	Whitening-ammonium chloride	See blackening/whitening how-to document	
T8	Mount Specimen	Optional or as needed to orient specimen.	- black sand, sandbags, twist ties, blue poster stick-um(?), gum tragacanth, black toothpicks, bamboo skewers, insect pins with black cork, black velvet - caution- some materials, such as ???, may leave residue on specimens; also sand grains may become stuck on or enter parts of the specimen specimen dependent cautions above some sands might	

			need sifting to isolate coarse grains to reduce sand getting stuck in the specimen; reduces static electricity adhesion - create uniform background-velvet etc	
T9	Maintain the association between specimen and labels.	This step is a cautionary reminder to ensure that specimens do become separated from their labels, and that labels from one specimen are not inadvertently intermingled with those of another.		
T10	Position specimen and insert colorchecker, white/black points, scale into imaging frame.	Strategies vary. Some institutions limit image composition to specimen only, others include some or all associated labels within the image. The parameters listed here apply to both strategies. T10-T16 constitute an iterative process, often including sub-iterative processes for	Institutional policy, guidelines, or adopted references detailing standard views to be imaged. References might include: *Atlas of Invertebrate Macrofossils.* 1985. Murray, J. W. Palaeontological Association. see : http://www.worldcat.org/title/atlas-of-invertebrate-macrofossils/oclc/10696137&referer=brief_results *Treatise on*	

		accommodating the capture of multiple standard views (e.g. anterior, posterior, lateral, dorsal, etc.) or multiple images of a single view in preparation for a subsequent focus stacking workflow. For example, a complete tray or several trays of specimens might be imaged prior to commencing with T17. Views to be imaged vary by organism and fossil type and should be reflected in institutional policies or documentation. In cases of individuals photographed from lots, this label might need to remain with the specimen after imaging. It may also be necessary to place labels/tags into the imaging frame for identification and numbering purposes.	*Invertebrate Paleontology.* 1953-2007. see: http://paleo.ku.edu/**treatise**/ References to specific color checkers include: http://store.rmimaging.com/digitalgraycard-100.aspx http://www.munsellstore.com/default.aspx/MenuItemID/499/MenuGroup/Home.htm http://www.amazon.com/CameraTrax-24ColorCard-2x3-White-Balance-Guidebook/dp/B004QXU8VI/ref=sr_1_3?ie=UTF8&qid=1342555441&sr=8-3&keywords=macbeth+color+checker http://www.bhphotovideo.com/c/product/286652-REG/QP_Card_GQP201.html http://www.bhphotovideo.com/c/product/26662-REG/Kodak_1527654_Color_Separation_Guide_and.html http://www.imagescienceassociates.com/	

			mm5/merchant.mvc?Screen=PROD&Store_Code=ISA001&Product_Code=CGNT&Category_Code=TARGETS	
T11	Adjust hardware and software.	Adjust viewfinder or live view to fill frame when using camera. Adjustments might include: ● exposure, ● camera height, ● shooting mode, ● focus method, ● focus, ● aperture setting, ● zoom intensity Using cameras and camera control software that support live view (e.g., Nikon Camera Control Pro 2, Canon EOS Utility) from a computer can negate having to handle the camera itself. Tethered cameras with camera control software (e.g. Canon Digital Photo Professional, Breeze Systems DSLR Remote Pro, Nikon Camera		

		Control Pro, Helicon Remote, Zerene Stacker, etc.) can streamline transfer of image to computer or other storage media.		
T12	Record Image(s)	Voice Recognition Software can be used here to: ● write to a spreadsheet for correlating image file names to catalog numbers, ● speak ”save as” command to insert the catalog number as the image file name. Pre-sets? T12 is often an iterative step, especially when recording stereo pairs or multiple images of a single collection object for subsequent focus stacking. When multiple images are required, all should be recorded at this	Institutional policy governing the naming of image files, including guidelines for naming series of files depicting varying views of a single collection object. Voice recognition software might include: ● IBM ViaVoice (now owned by Nuance), ● Dragon Naturally Speaking, ● Windows Speech Recognition. [Need link here to a focus stacking workflow]	

		step.		
T13	Capture specimen (image data or specimen data?) data or metadata.	Institutions that record image metadata		
T14	Potential multiple images (stacking or multiple views) [GN: inserted this into T12]	Potentially take multiple images for Helicon Focus, Zerene, etc. post-processing.	maybe combine 13 & 14 with note that this may be iterative image processing later if stacked	
T15	Quality control of images while being shot (focus, unwanted items in frame, color and saturation balance)	iterative and include T16		
T16	Retake images (if necessary)			
T17	Clean specimens if whitened			
T18	Re-store specimens	Strict rules for re-shelving; technicians carefully selected	Cart	
T14	Stack images (if necessary)	selectively, often for display, not typically archival; sometimes for detail of very small specimens	Helicon (for fewer slices), Automontage, Zerene Stacker (for more/many slices: ~50), other	
	Archive images (temporary or permanent)	(If further processing is happening later)	could reverse this with T1 and include comment regarding non-destructive editing	

	Batch image processing (batch editing - crop, resize, saturation, color balance, white balance (unless calibrated earlier), scale bar)	non-destructive color checker and white spot important include color checker as strong recommendation within the imaging section. mini-color checker: http://www.imagescienceassociates.com/mm5/merchant.mvc?Screen=PROD&Store_Code=ISA001&Product_Code=CGNT&Category_Code=TARGETS	adjust with caution for not over-processing: rotation, crop, straighten, color balance/color cast, contrast, see *Avoiding twisted pixels: ethical guidelines for the appropriate use and manipulation of scientific digital images, by D. W. Cromey, Science and engineering ethics 16 (4) p. 639-67*. http://www.ncbi.nlm.nih.gov/pubmed/20567932#	
	Document changes made to image, including batch processing steps	enter into database with media record to alert users to changes made and to the availability of original		
	Human image processing for fine editing	see T3, remove image imperfections (e.g., specks or air bubbles in background), change backgrounds, extract from backgrounds, etc.	use a light hand and ethical caution, for specific purposes, e.g., EOL and other image aggregators/repositories	
	Create derivatives (jpgs for web; attach to db record; thumbnail catalog; publishing; high quality types)	attach to db if not done earlier store derivatives as appropriate		

	Populate core metadata (process/admin/technical)	move to before archiving add statement regarding not renaming files above		
	Name files and associate them	using an automated process that joins images and data records based on electronic examination of image files; think this through--name as it comes from camera	probably can remove this task as it is done elsewhere--but think about it enhance the explanations regarding archiving	

Module 1D: Imaging Two Dimensional Compressed Fossils

Task ID	Task Name	Explanations and Comments	Resources
T1	Select and retrieve specimens/drawer of specimens from storage location.	Some institutions record images of labels and specimens simultaneously, combining relevant tasks from M1B and M1C.	• Institutional specimen imaging policy or project guidelines, • Technician.
T2	Transport selected collection objects to staging area.		Cart.
T3	Find specimens in drawer.	Institutional strategies vary. In some instances, specimens are ordered by size to optimize imaging	Institutionally specific guidelines governing specimen selection criteria.

		efficiency by reducing or eliminating frequent lens changes and copy stand and lighting adjustments. In other instances, specimens are selected by taxonomic group. Decisions to be made include: ● whether to image multiple or single specimens from a single lot, ● determining the best quality specimen for exemplar images, ● determining the size(s) of specimens to image from a single lot (e.g., smallest, largest, average, representatives of several size classes, etc.), ● whether to include several specimens from varying lots in a single composite image.	
T4	Mounting specimen		
T5i	Pre-imaging Specimen	Might Include: ● Cleaning	

	Preparation	dust/hairs off of specimens	
T6			
T7			
T8	Record or mark label(s) and their associated specimen(s) to ensure the two do not get separated during the imaging process.	This step ensures that the association between label and specimen is maintained.	Marking materials and equipment.
T9	Transport specimens to appropriate imaging station.	Imaging stations vary. For institutions that maintain two or more permanently configured imaging stations based on specimen size, wet/dry exposure, etc., determine which station is appropriate for the specimen being imaged and transport to that station. For institutions with limited space that supports a single imaging station at one time, select and set up the appropriate imaging station components for the specimens being imaged. The requirement for	● Cart. ● Technician.

		various sized stations underscores the efficiencies achieved by selecting specimens of uniform size or imaging requirements.	
T10	Set up camera/imaging station (may need to be set up each time and disassembled for security reasons etc.)	Attach appropriate lens	
	Set up image naming convention		
	E Position specimen. Insert color checker, white/black points, scale into imaging frame.	Strategies vary. Some institutions limit image composition to specimen only, others include some or all of the associated labels. The tasks listed here apply to both strategies. In cases of individuals photographed from lots, this label might need to remain with the specimen after imaging. It may also be necessary to place labels/tags into the imaging frame for identification and	Standard Views: <insert references> - "Atlas of Invertebrate Macrofossils." 1985. Murray, J. W. Palaeontological Association. see : http://www.worldcat.org/title/atlas-of-invertebrate-macrofossils/oclc/10696137&referer=brief_results - "Treatise on Invertebrate Paleontology." Color checker references: http://store.rmimaging.com/digitalgraycard-100.aspx http://www.munsellstore.com/default.aspx/

		numbering purposes.	MenuItemID/499/MenuGroup/Home.htm http://www.amazon.com/CameraTrax-24ColorCard-2x3-White-Balance-Guidebook/dp/B004QXU8VI/ref=sr_1_3?ie=UTF8&qid=1342555441&sr=8-3&keywords=macbeth+color+checker http://www.bhphotovideo.com/c/product/286652-REG/QP_Card_GQP201.html http://www.bhphotovideo.com/c/product/26662-REG/Kodak_1527654_Color_Separation_Guide_and.html http://www.imagescienceassociates.com/mm5/merchant.mvc?Screen=PROD&Store_Code=ISA001&Product_Code=CGNT&Category_Code=TARGETS
	Adjust hardware and software.	Adjust viewfinder or live view to fill frame when using camera. Adjustments might include: ● exposure, ● camera height,	

		• shooting mode, • focus method, • focus, • aperture setting, • zoom intensity Using cameras and camera control software that support live view (e.g., Nikon Camera Control Pro 2, Canon EOS Utility) from a computer can negate having to handle the camera itself. Tethered cameras with camera control software (e.g. Canon Digital Photo Professional or Nikon Camera Control Pro 2) can streamline transfer of image to computer or other storage media.	
	Wet with ethanol	Optional step for bringing out detail on hard to image specimens	
	Image specimen(s)	Voice Recognition Software Pre-sets Might still use stacking techniques as compression fossils are not as flat as they look.	Camera Control Pro, Canon Digi, Helicon, etc.

	Capture specimen data or metadata.	Institutions that record image metadata	
	Quality control of images while being shot (focus, unwanted items in frame, color and saturation balance)	iterative and include T16	
	Retake images (if necessary)		
	Re-store specimens	Strict rules for re-shelving; technicians carefully selected	Cart
	Stack images (if necessary)	selectively, often for display, not typically archival; sometimes for detail of very small specimens	Helicon (for fewer slices), Automontage, Zerene Stacker (for more/many slices: ~50), other
	Archive (temporary or permanent)	(If further processing is happening later)	could reverse this with T1 and include comment regarding non-destructive editing
	Batch image processing (batch editing - crop, resize, saturation, color balance, white balance (unless calibrated earlier), scale bar)	non-destructive color checker and white spot important include color checker as strong recommendation within the imaging section. mini-color checker:	adjust with caution for not over-processing: rotation, crop, straighten, color balance/color cast, contrast, see *Avoiding twisted pixels: ethical guidelines for the*

		http://www.imagescienceassociates.com/mm5/merchant.mvc?Screen=PROD&Store_Code=ISA001&Product_Code=CGNT&Category_Code=TARGETS	*appropriate use and manipulation of scientific digital images, by D. W. Cromey, Science and engineering ethics 16 (4) p. 639-67*. http://www.ncbi.nlm.nih.gov/pubmed/20567932#
	Document changes made to image, including batch processing steps	enter into database with media record to alert users to changes made and to the availability of original	
	Human image processing for fine editing	see T3, remove image imperfections (e.g., specks or air bubbles in background), change backgrounds, extract from backgrounds, etc.	use a light hand and ethical caution, for specific purposes, e.g., EOL and other image aggregators/repositories
	Create derivatives (jpgs for web; attach to db record; thumbnail catalog; publishing; high quality types)	attach to db if not done earlier store derivatives as appropriate	
	Populate core metadata (process/admin/technical)	move to before archiving add statement regarding not renaming files above	
	Name files and associate them	using an automated process that joins images and data records based on	probably can remove this task as it is done elsewhere--but think about it

		electronic examination of image files; think this through--name as it comes from camera	enhance the explanations regarding archiving

Module 2: Data entry

Module 2: Data Entry from Ledger/Card/Label/Catalog Images

Task ID	Task Name	Explanations and Comments	Resources
T0	Check for duplicate catalog numbers.	This may also occur during cataloging or at data entry time, depending upon institutional implementation.	how to deal with duplicates when found--institutional policy. options: ● add suffix ● line out number and replace ● link previously published numbers within database
T1	Navigate to file folder in which image files are stored.		make database decisions relative to fields to enter; level of parsing; skeleton vs robust
T2	Create verbatim data from image file (keystroking, OCR, etc.)	from label image, OCR, catalogs, ledgers Must include a statement about status of OCR, NLP technology	Technician. Technology. Standards and authority files for names (collectors, determined by), geo locations, etc. Entry standards,

		OCR as add on; assess return on investment	verbatim at entry, perhaps cleaned and standardized later. Early standards make entry easier. Standards for what to catalog and data content completeness. (e.g., locality, identification, collector, date, field number, lat/lon) Preserve verbatim entry even if interpreted data is entered.
T3	Clean/verify data. Explanation:This step can also be done way later as a separate, disconnected step. Always being edited and cleaned up.	Following keystroking, expert (curator, researcher, collection manager, or other knowledgeable person reviews and cleans	Data entry technician. Knowledgeable expert.
T4	Create interpreted data, add data from field notebooks, monographs, reports, etc. Update taxonomy. Georeference later, too.	Does this include steps like checking taxon names for valid spelling? Or is that Module 3?	Human
T5	Clean and verify data.		Human
T6	QC data and correct if necessary.		Human
T7	Augment data if necessary/desired (taxonomy, georeferencing)	Augmenting data, such as adding georeferences, might be best accomplished via a separate georeferencing	Human, technology

		workflow. Data entry may happen directly into the database or prepared and imported into the database. For systems in which data entry happens in external datasets (as in Specify), newly created datasets (e.g., in Excel) are imported into the dastabase.	
T8	Spot check data	Check some select number of records for accuracy and complete upload (further explanation). Look for boilerplate fields for specific purposes or because they are standard fields to be included.	

Proactive Digitization

Task ID	**Task Name**	**Explanations and Comments**	**Resources**
T1	Collect object in field	This process requires negotiation and discussion with collectors.	
T2	Utilize pre-formatted spreadsheet for field data collection	Populate complete record, to include locality descrip, field id, date collected, georeference, datum	
T3	Image euthanized specimen		(Imaging could happen in the field or in the lab)

T4	Proof data at the collection	• format • determinations • check spelling • assign catalog number	
T5	Upload spreadsheet to db	This is an iterative step	
T6	Catalog or accession and catalog specimen	note whether the accession is shared between collections	Dependent on institutionally specific policy
T7	generate specimen label	This comes from the database.	
T8	Record image	maintain any label submitted by the collector in jar with the specimen; in situations with many species in a single jar the collection mgr might dup that label and store the copies in the variety of jars into which the specimens are eventually place. Or, a single image is made of the label and linked to each record; label is often an event level data element	
	store specimen in collection		

Need to make these a Mod 1? The current 2A could precede the remainder of the imaging modules

Module 2A: Phototank Immersion Imaging: Equipment Set-up*

TaskID	Task Name	Explanations and Comments	Resources
T1	Retrieve appropriate size phototank or wet box.	Phototank size varies, common sizes are approximately 13.5 × 10.25 inches and 15.75 × 12.25 inches. These dimensions are well suited for lateral/dorsal/ventral views of small to medium-sized fishes to about 300 mm long and 63 mm wide (smaller tank) and 370 mm long and 75 mm wide (larger tank). Tanks and wet boxes may be vertically or horizontally oriented (see http://www.mcz.harvard.edu/Departments/Ichthyology/fish_imaging.html for horizontal)	Phototank(s) are constructed of ordinary 1/4th inch plate glass (1/8th inch for front pane of small tanks) bonded together with clear silicone adhesive. (be advised that ethanol will deteriorate silicon over time)
T2	Assemble tools and accessories	For field use, these essentials can be stored with the phototank and laptop in a crushproof and watertight carrying case suitable for carry on luggage (Pelican case).	Accessories include: · 4-ply mat board in several background colors, · 3/16th inch foam board with flat black surface for camera blind, · glass cleaner, · paper towels

			or lint-free cloth, · long and small forceps, · large metal binder clips, · 12-inch plastic or metal rulers, · stiff wire, · assortment of needles and insect pins, · calipers, · a system for tagging individual specimens
T3	Retrieve specimen immobilization plate.	Each tank requires a separate glass plate to immobilize the subject. The free plate can be 1/8th (smaller tank) or 1/4th (larger) inch thick and slightly shorter and deeper than the inside dimensions of the tanks (e.g., 13 × 10.25 and 15 × 12 inches). Plates should have smooth edges.	Specimen immobilization plate(s).
T4	Fill tank(s).	The tank should be filled with clear bottled or filtered/deionized tap water (or clean, fresh 70% ethanol or glycerin if working	Supply of clear bottled or filetered/deionized tap water. 70% ethanol or glycerin

		within the lab or collection) to minimize formation of air bubbles on specimen and glass. Stream or lake water (or original collection ethanol or glycerin) is unsuitable because it lacks the desired clarity and suspended debris is a significant distraction in an otherwise good photo. Any water will accumulate debris over an extended photo session, and an ample supply of clean photo water must accompany extended forays.	
T5	Position lighting to tank or tank to lighting.	In the field, ambient lighting is utilized with the tank and hand-held reflectors oriented to maximize the even distribution of light and minimize glare and shadows on the subject. In the lab the phototank is stationed between two pairs of incandescent bulbs positioned to the side and slightly above the top of the tank. Polarizing filters are	Field imaging: · reflector plates for directing light onto the subject. Lab imaging: · incandescent photo lamps · lamp stands · Hand-held polarizing filter

		useful for reducing glare or overexposed hot spots on the specimen, particularly on the snout[AB1] .	
T6	Retrieve camera.	The advantage of the D-SLR design and micro lens is the enhanced ability to reliably focus on very small specimens.	Digital SLR camera with capacity for 6× or higher zoom and 12 megapixels or higher resolution, preferably with ~60mm macro lens.
T7	Fit camera to tripod, as necessary.	Fitting the camera to a tripod enhances stability, focus, and depth-of-field. T7 and T8 are repeatable adjustments and are also referenced in M2CT1-T2.	Standard or mini-tripod (latter especially for field use).
T8	Fit camera lens through blind.	Fitting the camera lens through a flat black camera blind eliminates reflections of the camera and photographer from being captured in the specimen image.	Camera blind constructed of 3/16th inch foam board with flat black surface and circular orifice large enough to fit a camera lens through.

*2009 — **Sabaj Pérez, M. H.** Photographic atlas of fishes of the Guiana Shield. p. 53–93 *In*: Vari, R. P., C. J. Ferraris, Jr., A. Radosavljevic, and V. A. Funk, eds. Checklist of the freshwater fishes of the Guiana Shield. Bulletin of the Biological Society of Washington, no. 17.

Module 2B: Phototank Immersion Imaging: Specimen Preparation*

TaskID	Task Name	Explanations and Comments	Resources
T1	Select specimen to image.	The overarching strategy when photographing fishes for identification purposes is to maximize the content and accuracy of information in the image. This aim determines which among multiple specimens is photographed, how it is illuminated and arranged for display, and which color background is used. Selection criteria include: · peak coloration, · fins and scales intact, · informative morphology for identification, · impressiveness of specimen. Selections may include live or alcohol specimens.	
T2	Inspect and clean specimen.	Carefully inspect specimen and clean	

		it of foreign debris, mucous, grit, suspended particles, residual cheesecloth fibers that might adhere to preserved specimens.	
T3	Anesthetize (and euthanize) live specimen.	An anesthetized fish (e.g., with a few drops of MS-222 is quickly euthanized in a container of strong (30–50%) formalin, which often causes the body to straighten and fins to become completely erect. Otherwise, an anesthetized specimen may be removed to a tray of shallow formalin and small forceps carefully used to hold the fins erect without damaging them. Formalin can also be dripped onto the fins of an unfixed specimen using a syringe and needle while pinning the fin in erect position onto a polystyrene board. This has the benefit of not affecting the coloration of the rest of the specimen adversely before recording the image.	

		Shown in the last image here: http://kermadec.aucklandmuseum.com/2011/how-to-process-a-fish-size-tag-sample-and-record/. The most important consideration when photographing live specimens is time; bright colors and iridescences are soon lost in formalin. Fatty skin, as in pseudopimelodid catfishes, also becomes opaque in formalin, obscuring any underlying color.	
T4	With specimen flat and fins erect, carefully wedge specimen between the front plate of the phototank and free glass plate.		· Free glass plate. · Phototank.
T5	Set free glass plate at an angle, braced against a metal binder clip attached to the sides of the tank or between the free glass plate and the back of the tank.	Positioning laterally compressed fishes in this manner is easy. Dorsoventrally depressed specimens, particularly those with pectoral spines, require more attention to achieve a vertical lateral view. Maintaining pectoral	· Free glass plate. · Metal binder clips. · Long forceps. · Metal ruler.

		spines folded against the body as the specimen is wedged between the two glass plates requires practice and patience. Long forceps, a metal ruler and stiff wire are useful tools for fine-tuning a specimen's posture, arranging long delicate features such as barbels, and dislodging air bubbles that form on the fish. Preserved specimens offer fewer options for achieving an ideal posture. Laterally contorted specimens can often be made to appear more linear by tightly wedging them between the two plates of glass. Partial or complete folding of fins are more difficult to resolve. In some cases insect pins (carefully inserted in the body opposite the side to be imaged) may be used to prop up the anterior most portions of fins. This technique, however, may cause small	

		tears in the fin membranes. Information content of a fish image is diminished when the specimen is tilted or otherwise poorly positioned.	
T6	Select appropriate background.	Dark specimens with opaque fins often render best and with more dramatic effect against flat black backgrounds. Specimens with black pigment in fin membranes or along distal fin margins usually render better with a light blue background, which provides better contrast for and highlights the dark pigmentation. Transparent fins lacking pigmentation and with clear margins (especially live specimens), are often lost against light Backgrounds and sometimes require adjusting the tank relative to the light source to provide	4-ply mat board backgrounds in several background colors, including flat black and dull light blue.

		side or back lighting. Choice of background color often involves trade-offs, and is ultimately a reflection of personal taste determined via trial and error.	
T7	Place scale bar.	Use water/alcohol proof measuring devie or cut out a 10+ mm portion of a plastic ruler, dip it in water and adhere it to the outside front of the phototank beneath the specimen within the photographic field.	Minimum 10 mm plastic ruler and a cutting instrument.
T8			
T9			

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Module 2C: Phototank Immersion Imaging: Image Capture*

TaskID	Task Name	Explanations and Comments	Resources
T1	Mount camera on tripod	A tripod-mounted	DSLR Camera. Tripod.

	or copy stand.	camera facilitates long exposures.	Camera manual.
T2	Place camera behind black foam board blind and insert lens through a central circular aperture.	The blind prevents the phototank glass from reflecting the camera and photographer into the image.	Black foam blind.
T3	Set camera white balance.	The white balance setting should match the light source, (e.g. incandescent, daylight, etc.)	
T4	Position camera/tripod to ensure that the specimen will occupy		

	about 90% of the frame.		
T5	Set ISO, shutter speed, and aperture.	An ISO of 200 allows smaller f-stops (hence enhanced depth of field). Set f-stop between 11 and 16, Allow camera to automatically select the shutter speed to match the ISO and f-stop settings. Alternately, select the shutter speed manually, utilizing the camera's light	

		meter.	
T6	Set camera/lens to macro mode, if required by the camera.	Depending on the lens, the zone of focus might be different. The ⅓ - ⅔ rule is flipped for standard lenses versus macro lenses.	
T7	Set camera focusing on autofocus and position the camera's focus point on the center of the subject.	Autofocus generally works fine as long as the active area of focus includes important features on the fish, not the scale bar or background.	
T8	Select image type.	Depending on potential use of	https://www.idigbio.org/sites/default/

		the image, images may be recorded as one or a combination of RAW (NEF for Nikon, CR2 for Canon, DNG), TIFF, or JPEG, with several levels of JPEG (fine, normal, basic, varying by compression ratio, and pixel count). RAW files preserve the most complete set of image data and provide the best opportuni	files/sites/default/files/Image_File_Format_Recommendations_and_Standards.pdf

		ty for non-destructive editing and post-imaging processing, but usually require ancillary processing software. Uncompressed TIFF images also retain a full complement of image data, result in larger file sizes, and are subject to destructive editing. DNG is an open standard RAW file format recorded directly	

		by some cameras. Many RAW formats can be converted to DNG by freely accessible conversion software.	
T9	Pose specimen.		
T10	Record image.	In the field, particularly when the sun is intermittently blocked by clouds, it is advisable to record multiple images for each of several combinations of exposure and	Mat boards for shading subject.

		aperture (f-stop) settings. Full sunlight often highlights fine structures but may also wash out bright colors or result in over-exposed hot spots on the snout or dorsum. The phototank should be carefully oriented with respect to the light source, and extra mat boards used to shadow harsh sunlight and maintain vibrant	

		colors. The number of individual images to record per specimen is proportional to: . the impressiveness or uniqueness of the specimen, . the time expended to pose it properly, and . the difficulty of accessing	

		of the specimen (especially for field images).	
T11	Insert uniquely numbered reference tag into tank and record reference image.	Uniquely numbered reference tags allow for subsequent tracking and matching of multiple field or lab images of a single specimen to a correlated entry in a field book or image log, preventing specimen misidentification.	Pre-numbered or unnumbered identification tags.

T12	Affix uniquely numbered reference tag to specimen and record the number, specimen length, and other specimen characteristics in a field image log.	An image log is useful for recording the standard length of the specimen and other characteristics. Such practices greatly facilitate subsequent annotation of images with catalog and measurement data. Data entered into the log may also include geographic coordinates from a global positioning system	Image log.

		(GPS). Many newer digital cameras have a built in or accessory global positioning system receiver that records and embeds latitude, longitude, altitude and universal time as image metadata. Collecting event metadata may also be stored in an initial entry in the field log, facilitating georeferencing and later entry of	

		collecting event data into an electronic database.	
T13	Record reference image for later identification.		

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Module 2D: Phototank Immersion Imaging: Image Processing/Editing*

TaskID	Task Name	Explanations and Comments	Resources
T1	Open image processing software.	Adobe PhotoShop is popular and widely used. The tasks itemized here refer mostly to this software. Camera-manufacturer specific image management and processing software is also available and is sometimes distributed with the purchase of a DSLR camera.	Photo processing software, e.g. Adobe PhotoShop, Adobe Lightroom, Canon Digital Professional, Nikon Capture NX 2, GIMP, etc.

		Note: PhotoShop and similar image processing software packages are sophisticated tools with extensive capabilities for manipulating images and usually require intensive experience to master. A full accounting of these capabilities is beyond the scope of this document. Those recording and processing images of scientific specimens should become familiar with at least the fundamentals of one or more of these packages.	
T2	Open an original image.	Opening RAW images in PhotoShop or other image processing software may require a software plug-in. If so, accept the default values assigned by the plug-in while opening or importing the image.	
T3	Create a new layer that duplicates the layer of the original image.	Editing should never be effected on an original image.	
T4	Create a blank layer	Masking colors may	

	for masking.	be black, white, or a shade from the original background, the latter of which can be selected with the eyedropper tool.	
T5	Using the paint bucket tool or the edit/fill tool, fill the mask layer with the appropriate color.		
T6	Move filled mask layer to bottom of layers dialog.	The mask layer should be dragged below all other layers in the layers dialog to act as the background for the finished image.	
T7	Make the specimen layer active and use a drawing tool to carefully trace the specimen's precise contours.	Tracing the contours is in preparation for merging the specimen image with the solid background represented by the solid-filled mask layer. PhotoShop CS5 and later include quick selection and refine edges tools to make this process easier.	
T8	Create a layer from the traced outline and turn off the original image in the layers dialog.	This will isolate the cutout on the black background.	
T9	Adjust image quality.	A suite of tools is	

		available for adjusting image quality, including: · color balance, · contrast adjustment, · hue/saturation, · cloning and spot healing (for removing imperfections, e.g. bubbles, debris) · dodging and burning, · unsharp mask (for sharpening soft focus images).	
T10	Add visible scale to image.	Render a solid scale bar within the images can be accomplished by: · rotating the entire image so the ruler piece in the photograph is horizontal, · using the rectangular marquee tool to select and copy a 5 or 10-mm-long portion, · rotating the entire image back to its intended final position, · pasting the copied selection, thereby creating a new layer, · adjusting the brightness/contrast of this layer to extreme values to render a	

		black or white bar that is then labeled accordingly with the text tool.	

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AMNH labeling procedures and protocols: http://preparation.paleo.amnh.org/20/labeling and http://collections.paleo.amnh.org/assets/AMNH_Specimen_Labeling_Procedures.pdf

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[AB1]Once we have had time to evaluate the ePhoto Box plus this may also become a useful tool (http://www.eboxbio.com) as used by the herbarium community