

Standard Operating Procedure (SOP) #16

Benthic Image Analysis

Version 4.0 (February 12, 2025)

Change History

New Version #	Revision Date	Author	Changes Made	Reasons for Change	Previous Version #
2.0	6/30/2007	Eric Brown	See Track Changes	Response to reviewer's comments	1.0
2.01	7/20/2007	Larry Basch	See Track Changes	Corrections, additions	2.0
3.0	8/22/2019	Kelly Kozar	Substantial updates to the PhotoGrid® software instructions, benthic image analysis, and data certification process. Updated SOP #s	To accurately reflect the PhotoGrid® software instructions and benthic image analysis steps. Added a geospatial SOP and had to renumber subsequent SOPs.	2.01
3.01	8/9/2021	Kelly Kozar	Minor updates to content.	Added reference links, minor text edits to make consistent throughout.	3.0
3.02	7/22/2022	Kim Weisenborn	Updated content to refer to new PACN I&M SharePoint. Updated figures to reflect change.	PACN data is no longer stored on a networked server (I:\ drive) and is now stored on the PACN I&M SharePoint site.	3.01
4.0	6/21/2024	Amanda McCutcheon, Kayla Vasarhelyi, Sheila McKenna	Updated instructions for CoralNet image analysis and removed PhotoGrid instructions. Added appendix describing certification steps in CoralNet.	In FY24, the PACN decided to use CoralNet, an open-source software used for benthic image analysis.	3.02

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, changes made, and reason for the change along with the new version number.

Purpose

This SOP documents the benthic image analysis protocol. The sections of this protocol are presented in order of execution: 1) Selecting the images for analysis, 2) CoralNet® analysis, 3) Identification standards, and 4) Exporting data from CoralNet. Additionally, [Appendix SOP 16.a](#) shows various examples of substrate types from digital still images taken in different parks. The use of products identified in this protocol does not imply endorsement, effectiveness, or warranty by NPS.

A master equipment list for the entire Benthic Marine Community Monitoring Protocol can be found in Appendix SOP 1.a of [SOP #1 Before the Field Season](#). The master equipment list should be

updated simultaneously if any SOP requiring an equipment list is revised.

Benthic Image Analysis

Downloading Images from the Camera

Data will be downloaded from the camera as soon as possible following the dive. See [SOP #15 Managing Photographic Images](#) for instructions on downloading and storing photographs.

Using CoralNet

[CoralNet](#) is a resource for benthic images analysis. The site deploys deep neural networks which allow fully and semi-automated annotation of images. It also serves as a data repository and collaboration platform. CoralNet is open source and free to use thanks to generous support from NSF and NOAA.

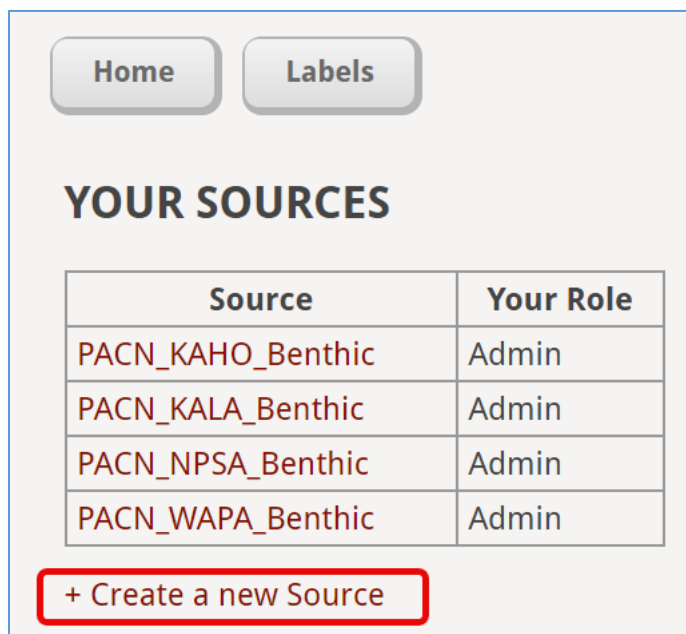
Data in CoralNet are organized in Sources that are tied to a geographic location. One Source has been setup for each PACN park location (Figure SOP 16.1). Users are given the role of either Admin, Edit or View. The PACN Data Manager will maintain the Admin role for all PACN sources and assign roles to other users as needed.

To access CoralNet all users must register for an account.

1. Visit [CoralNet \(ucsd.edu\)](https://ucsd.edu) and click “**Register**” to set up an account using your NPS.gov email address.
2. Once registered, send your username to the Data Manager so that they can add you to the Source you need access to.

Creating a New Source

1. On the Home tab click “+ **Create a new Source**” (Figure SOP 16.1).



YOUR SOURCES	
Source	Your Role
PACN_KAHO_Benthic	Admin
PACN_KALA_Benthic	Admin
PACN_NPSA_Benthic	Admin
PACN_WAPA_Benthic	Admin
+ Create a new Source	

Figure SOP 16.1. List of existing Sources in CoralNet.

2. Fill out the General Information. Set the Name to PACN_XXXX_Benthic, where XXXX is the four-letter park code. Set Visibility to **Private**, Affiliation to **National Park Service**, and provide a brief description of the data to be stored in the Source. (Figure SOP 16.2).

General Information

To learn about the differences between public and private sources, please read our [data policy](#).

* Name: PACN_KAHO_Benthic

* Visibility: Private

* Affiliation: National Park Service

* Description: Photoquads taken at Kaloko-Honokohau National Historical Park using the Pacific Island Network, National Park Service, Inventory and Monitoring Program Benthic Community Vital Signs Protocol.

Figure SOP 16.2. General Information in new Source set up.

3. Create Auxiliary Metadata fields for **Loc_Name**, **Loc_Type**, and **Unit_Code** (Figure SOP 16.3)

Names for Auxiliary Metadata Fields

We provide several standard metadata fields for your images such as Date, Camera, Photographer, etc. These 5 auxiliary metadata fields, on the other hand, can be named anything you like.

We encourage using these auxiliary metadata fields to guide how your images are organized. For example, if your coral images are taken at 5 different sites, then you can name one of these metadata fields Site, and then specify a site for each image: North Point, East Shore, etc. You will then be able to do things such as browse through all unannotated images from North Point, or aggregate coral coverage statistics over the images from East Shore.

You can use as few or as many of these 5 metadata fields as you like.

* Aux. metadata 1: Loc_Name

* Aux. metadata 2: Loc_Type

* Aux. metadata 3: Unit_Code

* Aux. metadata 4: NA

* Aux. metadata 5: NA

Figure SOP 16.3. Auxiliary Metadata Fields in new Source set up.

4. Set the number of point annotations per photos to **50** and leave the Point generation type at the default “**Simple Random**” (Figure SOP 16.4).

Image Annotation

Default image annotation area

This defines a rectangle of the image where annotation points are allowed to be generated. For example, X boundaries of 10% and 95% mean that the leftmost 10% and the rightmost 5% of the image will not have any points. Decimals like 95.6% are allowed. Later, you can also set these boundaries as pixel counts on a per-image basis; for images that don't have a specific value set, these percentages will be used.

* Left boundary X: % * Right boundary X: %
 * Top boundary Y: % * Bottom boundary Y: %

Point generation method

When we create annotation points for uploaded images, this is how we'll generate the point locations. Note that if you change this setting later on, it will NOT apply to images that are already uploaded.

* Point generation type:

Figure SOP 16.4. Image Annotation information in new Source setup.

5. Enter Latitude and Longitude for the World Location. This should be a coordinate in decimal degrees within the survey area (Figure SOP 16.5).

World Location

We'll use this to mark your source on our front-page map.
 Your source will be shown on the map if it contains at least 100 images, and the source name doesn't include words like "test".
 To get your source's coordinates, try latlong.net.

* Latitude:

* Longitude:

Figure SOP 16.5. World Location information and Create Source Button in new Source setup.

6. Click “Create Source” (Figure SOP 16.5).

Labelsets

Labelsets are the equivalent of the Species Button files in the Photogrid—for those familiar with the Photogrid® software. Each Source needs to have a Labelset before you can begin image analysis. Labelsets contain Labels which are species designations used across CoralNet including the species name, a default short code, functional group and additional information about the species. When creating a Labelset for a new source, users browse the existing labels and add them to their Labelset. Users must then update the default short code to the desired short code for analysis and data export. For PACN purposes the short code MUST be the four-letter species codes used in the Benthic Marine Community and Marine Fish Monitoring Database. Contact the PACN Data Manager if you need to create a new Labelset to ensure the correct short codes are used. PACN codes differ significantly from the default codes in CoralNet.

Labelsets have already been created for the four PACN park Sources. To view the Labelset, first access the source, then click the “**Labelset**” tab at the top of the page (Figure SOP 16.6).



Figure SOP 16.6. Main tab options within a CoralNet source.

Occasionally, a user may need to edit the short codes within the Labelset. Click “**Edit (customize) label codes**” at the bottom of the Labelset tab (Figure SOP 16.7) and edit the codes as appropriate.

Macroalgae: Membraneous: Red: Schizymeria	SCHS	Algae
Turf algae	TALG	Algae
Turbinaria (algae)	TUSP	Algae
Valonia spp.	VALO	Algae

Edit (customize) label codes
Add/Remove labels
Import label entries from CSV
Export label entries to CSV

Figure SOP 16.7. Labelset options within a CoralNet source.

Additionally, a user may need to add or remove labels from the Labelset. *Note: Before adding new labels to the labelset, check with the Data Manager first. She will let you know what the new four-letter species code will be.* Once you have corresponded with the Data Manager, then you may proceed. Click “**Add/Remove labels**” (Figure SOP 16.7) and remove labels using the “-” symbol next to the label name or add labels using the search feature to find existing species labels in CoralNet (Figure SOP 16.8). If the species you wish to add is not already listed in CoralNet, click “**Create a new label**” and fill out the new label form with as much information as you can provide (Figure SOP 16.9). If any changes are made to the Labelsets, **export the label entries to CSV**, and place the CSV file in the “[Labelsets](#)” folder within the [Benthic Marine Community Monitoring project workspace](#) in the PACN I&M SharePoint site¹.

¹ PACN I&M SharePoint site, <https://doimspp.sharepoint.com/sites/nps-PWR-PACNIM> (last accessed 12 February 2025).

ADD OR REMOVE LABELSET ENTRIES

Use this page to select which of CoralNet's labels will be included in your labelset. Afterward, you'll be able to edit (customize) the codes you use for each label.

Search labels by name:

272 selected labels:

- Acanthaster sp ☐	- Acanthastrea ☒	- Acanthastrea brevis ☐
- Acanthastrea echinata ☒	- Acropora ☒	- Acropora abrotanoides ☐
- Acropora aculeus ☒	- Acropora austera ☐	- Acropora cerealis ☐
- Acropora clathrata ☒	- Acropora cophodactyla ☐	- Acropora cytherea ☒

Figure SOP 16.8. Add or Remove Labelset Entries in CoralNet source.


✕

Note that all labels in CoralNet are made available to the whole site. When you create a label, it will show up in label searches for all other users. Additionally, you and the CoralNet labelset committee will be emailed together to facilitate discussion about the newly created label. If you'd like to ask the labelset committee about something directly, you can reach them at: coralnet-labelset@googlegroups.com

Name:

Please use English words and names.

Default Short Code:

Up to 10 characters. Only a few types of punctuation are accepted. Note that this is just a default code; you can later customize the codes that are used in your source.

Functional Group: ▼

Description:

Please use English.

Example image (thumbnail): No file chosen

For best results, please use an image that's close to 150 x 150 pixels. Otherwise, we'll resize and crop your image to make sure it's that size.

Figure SOP 16.9. Creating a new Label in CoralNet.

Uploading Images to CoralNet

Once the Source and Labelset are setup, you can upload images to CoralNet. Images should be filed and named according to [SOP #15 Managing Photographic Images](#) before uploading to CoralNet.

1. Navigate to [CoralNet](#) and log in using your Username and Password.
2. Select the appropriate source from the list of Your Sources (Figure SOP 16.10).

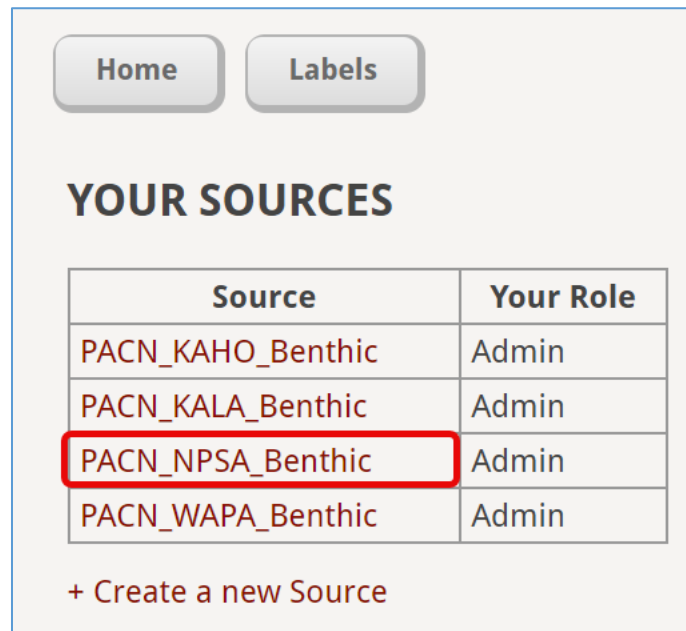


Figure SOP 16.10. Selecting a Source in CoralNet.

3. Select “**Upload**” from the main tab options at the top of the Source page (Figure SOP 16.11).



Figure SOP 16.11. Main tab options within a CoralNet source.

4. Click “**Upload Images**” (Figure SOP 16.12).

UPLOAD

Choose what you want to upload.

Upload Images

This is the first step: uploading the images you want to analyze.

Upload Metadata

Adding metadata to your images makes it easier to search for them.

Upload Points/Annotations (CPCe files)

If you've previously annotated some images using Coral Point Count, you can upload those annotations. You can also upload non-annotated points and then use CoralNet to analyze them.

Upload Points/Annotations (CSV file)

A more general format for uploading old points and annotations.

Figure SOP 16.12. Upload Images tab in CoralNet.

5. Click **“Choose Files”** (Figure SOP 16.13) and browse to the images you wish to upload.

Image files: **Choose Files** No file chosen

Name prefix (optional):

Figure SOP 16.13. Choose Files to Upload.

6. Select only the photo quadrat images, not the Start and landscape images for a single transect, then click **“Open”** (Figure SOP 16.14).

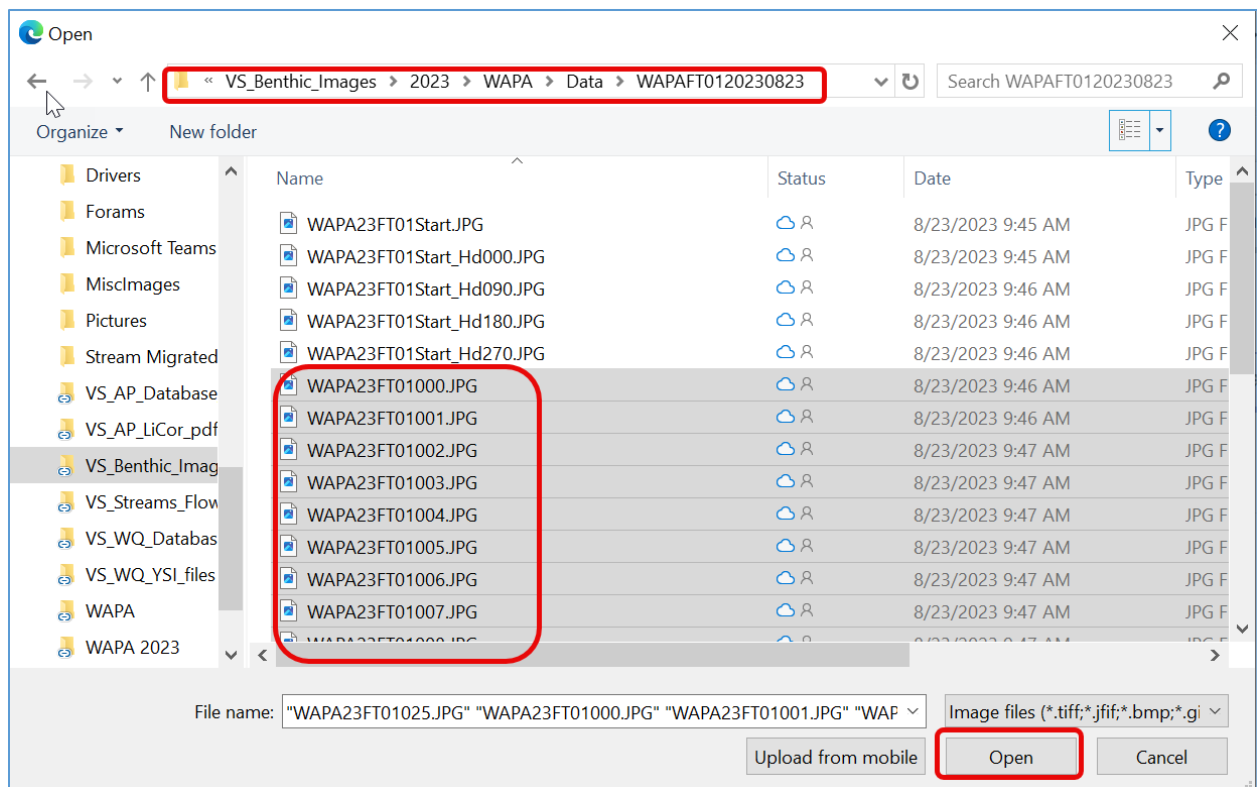


Figure SOP 16.14. File Explorer showing image selection for upload.

7. After CoralNet indicates that the files are “Ready to Upload”, click “**Start Upload**” (Figure SOP 16.15). Be patient, this could take 15-20 minutes.

Ready for upload

26 file(s) total

- **26 file(s) (75.44 MB) can be uploaded**

☒ Auto-scroll to the currently uploading file

WAPA23FT01000.JPG	2.88 MB	Ready
WAPA23FT01001.JPG	2.83 MB	Ready
WAPA23FT01002.JPG	2.65 MB	Ready
WAPA23FT01003.JPG	2.83 MB	Ready
WAPA23FT01004.JPG	2.88 MB	Ready
WAPA23FT01005.JPG	2.95 MB	Ready
WAPA23FT01006.JPG	3.02 MB	Ready
WAPA23FT01007.JPG	3.02 MB	Ready
WAPA23FT01008.JPG	2.87 MB	Ready
WAPA23FT01009.JPG	2.84 MB	Ready
WAPA23FT01010.JPG	2.99 MB	Ready
WAPA23FT01011.JPG	2.91 MB	Ready
WAPA23FT01012.JPG	3.03 MB	Ready
WAPA23FT01013.JPG	2.87 MB	Ready
WAPA23FT01014.JPG	2.81 MB	Ready
WAPA23FT01015.JPG	2.89 MB	Ready

Start upload

Figure SOP 16.15. Images Ready for Upload.

8. Once the images have uploaded, more options will appear at the bottom. Click **“Manage Image metadata”** (Figure SOP 16.16).

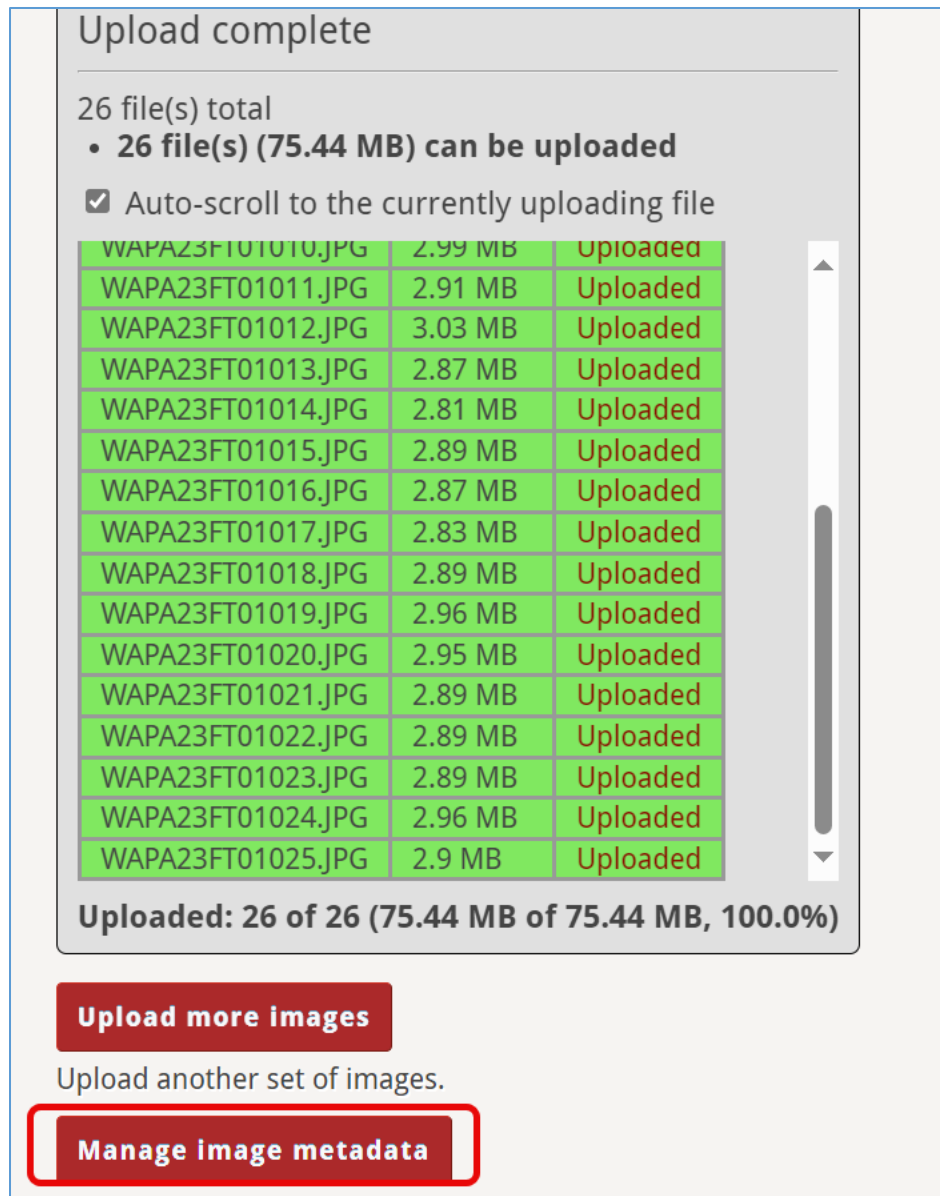


Figure SOP 16.16. Upload images tab after upload is completed.

9. On the Edit Metadata page, select the check box at the top of the list to select all 26 images (Figure SOP 16.17). Then enter the **Date**, **Loc_Name**, **Loc_Type**, and **Unit_Code**. These will autofill for all selected images. Then click “**Save Edits**” to save the metadata (Figure SOP 16.18).

EDIT METADATA ?

Photo date: Any Image name contains:

Annotation status: Any

Last annotation date: Any By: Any

Search

☒

Name	Link/Status	Date	Loc_Name	Loc_Type	Unit_Code
☒ WAPA23FT01000.JPG	Unclassified	2023-08-23	1	Fixed	WAPA
☒ WAPA23FT01001.JPG	Unclassified	2023-08-23	1	Fixed	WAPA
☒ WAPA23FT01002.JPG	Unclassified	2023-08-23	1	Fixed	WAPA
☒ WAPA23FT01003.JPG	Unclassified	2023-08-23	1	Fixed	WAPA
☒ WAPA23FT01004.JPG	Unclassified	2023-08-23	1	Fixed	WAPA
☒ WAPA23FT01005.JPG	Unclassified	2023-08-23	1	Fixed	WAPA
☒ WAPA23FT01006.JPG	Unclassified	2023-08-23	1	Fixed	WAPA
☒ WAPA23FT01007.JPG	Unclassified	2023-08-23	1	Fixed	WAPA
☒ WAPA23FT01008.JPG	Unclassified	2023-08-23	1	Fixed	WAPA
☒ WAPA23FT01009.JPG	Unclassified	2023-08-23	1	Fixed	WAPA
☒ WAPA23FT01010.JPG	Unclassified	2023-08-23	1	Fixed	WAPA

Figure SOP 16.17. Editing metadata for uploaded images.

Showing 26 image results

Save Edits There are unsaved changes

Figure SOP 16.18. Saving metadata edits.

10. Repeat Steps 3-9 for all remaining transects.

CoralNet Image Analysis

The substrate under 50 random points will be identified in CoralNet for every image collected. After an initial 20 photos are analyzed by a user within the Source, images will be annotated by an automated annotation tool upon upload to CoralNet and the user will need to verify these annotations.

Note: Users may upload CSV files with point-count data and the corresponding images from other point-count software to train the automated annotation tool before the initial round of sampling images are analyzed in CoralNet. For help with this, please contact Amanda L. McCutcheon (amanda_l_mccutcheon@nps.gov).

1. Navigate to [CoralNet](#) and log in using your Username and Password.

2. Select the appropriate source from the list of Your Sources (Figure SOP 16.19).

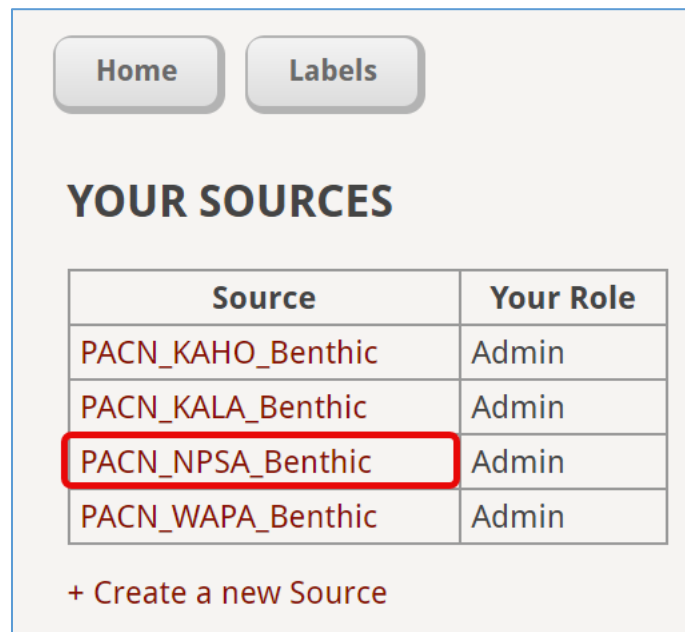


Figure SOP 16.19. Selecting a Source in CoralNet.

3. Select “**Images**” from the main tab options at the top of the Source page (Figure SOP 16.20).

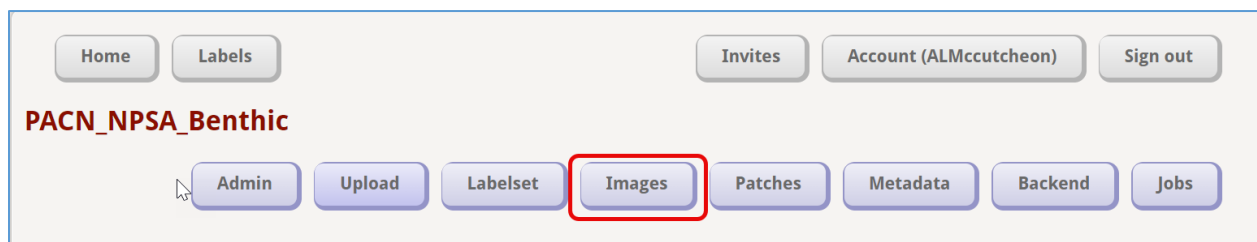


Figure SOP 16.20. Main tab options within a CoralNet source.

4. Use the image filter to locate the images you want to analyze based on Photo date and Annotation status. If the automated annotation tool was running upon upload, choose “Unconfirmed”, if not, chose “Unclassified”. Click “**Search**” (Figure SOP 16.21).

BROWSE IMAGES ?

Loc_Name: Any ▾ Loc_Type: Any ▾ Unit_Code: Any ▾ Severity: Any ▾
 Bleaching: Any ▾
 Photo date: Year ▾ 2023 ▾ Image name contains:
 Annotation status: Unclassified ▾
 Last annotation date: Any ▾ By: Any ▾
 Sort by: Name ▾ Direction: Ascending ▾
Search

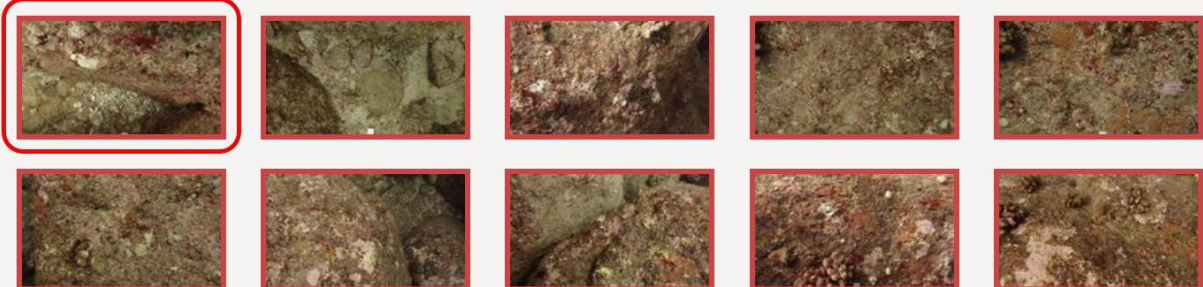


Figure SOP 16.21. Using filters to locate images for analysis.

- Click the image you would like to annotate (Figure SOP 16.21). Then, select the annotation tool tab (Figure SOP 16.22).

Image Details **Annotation Tool** Annotation History

Figure SOP 16.22. Annotation Tool tab.

- The annotation tool will place randomly selected, and numbered points on the image for you. The right-hand side of the screen will have a scroll-down list of all these points. If the automated annotation was active when the photos were uploaded the list will show the most probable substrate type, otherwise the list will be blank (Figure SOP 16.23). To begin annotation, click on the first item in this list. This will highlight point number one on the image in green.

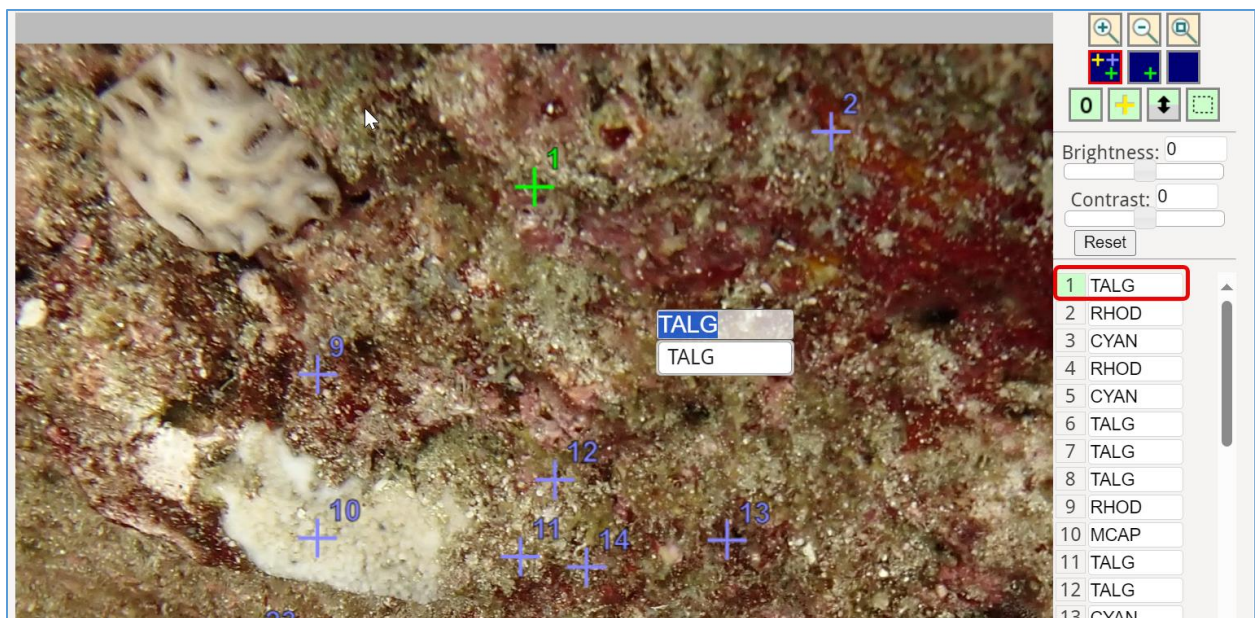


Figure SOP 16.23. Using Annotation Tool to analyze image.

- If the automated annotation tool was active during Upload, at each point, a list of the five most likely identifications, with the probability of each, will be provided by the program. Choose the proper identification from this list. If none of these options are the proper identification, or no options are provided, use the buttons corresponding to substrate type, at the bottom of the screen, to make a choice (Figure SOP 16.24). Fill in data for all 50 generated points.

BL_COCE	BL_LPUR	BL_LSCU	BL_MCAP	BL_MFLA	BL_MPAT	BL_PBRI	BL_PCOM	BL_PDAM	BL_PDUE
BL_PVEE	BL_PGRA	BL_PLIG	BL_PLOB	BL_PLUT	BL_PMEA	BL_POVE	BL_PVAR	COCE	CVAU
LBEW	LINC	LPRU	LPUR	LSCU	MCAP	MFLA	MINC	MONT	MPAT
MSTU	PBER	PBRI	PCOM	PDAM	PDUE	PEVE	PGRA	PLIC	PLIG
PLOB	PLUT	PMEA	PMOL	POCI	POSP	POVE	PSNI	PSOL	PVAR
SAED	UN/C	ACOB	ALCY	ANIM	APLA	BIVA	BRYO	CALY	CNOV
CONU	CYPR	DIDE	DIOG	DPAU	EACI	ECAL	EDIA	EMAT	EOBL
GHIA	GLRU	HASP	HESA	HMAM	HOLO	HTER	HYDR	LMUL	MERA
PALY	PEDI	PORI	PPLA	RDEN	SIDE	SINU	SPGI	TINT	TRAP
TRIP	TUNI	ZOSP	SAND	BROC	CYAN	N/C	OTHER	OTHER/FISH	PCAE
SCHI	SUBS	ACTS	AMAN	AMPH	APAC	APOG	ASPI	ASSP	BOOD
BTSP	CALG	CERA	CHLR	CHRY	COLP	DASP	DERB	DICH	DICS
DICT	DIMA	DISP	DISS	DOHA	GALA	GANO	GELI	HADU	HALI
HESM	HYDO	HYPN	HYPN	JANI	LAUR	LIAG	LOSP	LYNG	MALG
MASP	MICR	NESP	PAME	PDSP	PEYS	PHAE	PHOR	PLSP	PORT
RHOD	SARG	SCHS	STYP	SYMS	TALG	TOSP	TRCH	TRIC	TUSP
VALO									

Figure SOP 16.24. Using buttons in Annotation Tool to ID point.

8. To magnify a part of the screen, point the cursor in the area and left-click on the mouse. To reduce the image then right-click on the mouse.
9. Once all points are identified, click **“Save”**, located below the scroll list of annotations. Click **“Next”** and proceed to annotating the next image.
10. Record coral bleaching and disease as you analyze the photos.
 - a. Bleaching by point - As points are being identified, bleached coral options are provided in the list of substrate types. These options will begin with “BL_”. If the point fall on bleached coral, choose the “BL_” option for that coral species. For our purposes, corals are considered bleached only when they appear stark white, not pale as it is difficult to distinguish pale tissue from a poorly white-balanced image.
 - b. Bleaching and disease by photo – As you annotate photos, use the provided template ([YYYY PARK Benthic bleaching template.xlsx](#)) to keep track of the presence or absence of bleaching and disease in each photo.
 - i. The template has 11 columns. Park, Loc_Type, Loc_Name, Date, Analysis IDer, Frame, Coral Present?, Bleaching Severity, Disease/Bleaching, and Notes. All fields are mandatory except for Notes (Figure SOP 16.25).
 - ii. For each image, coral presence should first be determined. If coral is present, Bleaching Severity and Disease/Bleaching columns should be filled out. If not present, indicate “No Coral” for Bleaching Severity and “NA” for Disease/Bleaching.
 - iii. Bleaching Severity should be determined as 0% (not present), 1-25%, 26-50%, 51-75%, and 76-100%, based on the percentage of coral affected out of all the coral cover in the photo.
 - iv. The Disease/Bleaching field is a presence/absence measure. If disease OR bleaching are present in the photo indicate, “Yes”.
 - v. Notes can be used to elaborate on possible diseases present, uncertainty about bleaching, types of coral bleached, etc.

	A	B	C	D	E	F	G	H	I	J	K
1	Photo Name	Park	Loc_Type	Loc_Name	Date	Analysis IDer	Frame	Coral Present?	Bleaching Severity	Disease/Bleaching	Notes
2			Fixed		1						
3			Fixed		1						
4			Fixed		1		2				

Figure SOP 16.25. Bleaching and Disease spreadsheet example.

- vi. Disease symptoms include lesions and rings or bands that demarcate live healthy tissue from dead tissue. Bleaching is whitening of the tissue, which signifies a loss of the symbiotic zooxanthellae. This whitening can sometimes

be confused with coral disease or Crown-of-Thorns (COTS) Sea Star predation, which may show a somewhat similar pattern. At present, treat any complete whitening as bleaching. Do not indicate bleaching when the corals are pale in color. However, when observed at field sites, record the following metadata: whether or not there are multiple bleached colonies, estimated number, species affected, approximate maximum diameter of patch(es) of bleached corals, presence-absence or (preferably) estimated number of COTS, and location(s) within the site relative to the transect start point (compass bearing, approximate distance in meters). LJ Raymundo et al. 2008. *Coral disease handbook: guidelines for assessment, monitoring and management* provides a good reference for coral diseases that may be encountered at PACN parks.

Identification Standards

Identify the substrate under the lower right-hand quadrant of the crosshair (“+”) using the following standards (Table SOP 16.1). See [Appendix SOP 16.a](#) for examples of different substrate types.

Table SOP 16.1. Substrate identification standards.

Substrate Type	Instructions
Unnatural objects	For unnatural objects such as pin, tape, reel, you can use the N/C (non-coral) category.
Fish	Since fish are not part of the benthos, treat these as unnatural objects and select the (non-coral) category.
Other invertebrates (e.g., urchins, sea cucumbers, mollusks)	Identify to the lowest possible taxon.
Dark areas	For dark areas (e.g., shadows obscuring objects) in the image use the Subs (substrate) category
Unknown substrates	For unknown substrate use the Subs (substrate) category
Other organisms	For organisms not listed in the species button file, identify the organism to the lowest possible taxonomic group and notify the PACN Data Manager of the new species. Notify the PACN Marine Ecologist if necessary to verify the identification.
Snapping shrimp burrows	For snapping shrimp burrows in coral, use the TURF (Turf Algae) category since this category lines the burrow.
Recent broken areas	For areas of the reef that were recently broken, try to identify what it was prior to the damage. If this is not possible categorize as Unknown. In the next survey year, simply identify the new substrate (e.g., turf algae) based on whatever it now is.
Structures within algae or no structure	If structure within the algae is observable, select MALG (Macro algae) or lowest possible algal taxon. Typically, this is evaluated as height (2-3 cm) above the substrate. Use the TURF (Turf Algae) category when the substrate has no observable structure or height, and it appears like a fuzzy growth.

Distinguishing between dead coral with turf algae and macroalgae in images captured from a still photograph may be difficult but is worth taking the time to try to do accurately. The predominance of either category of substrate can be an important ecological indicator. Greater levels of macroalgae may reflect elevated nutrient levels, or lower levels of fish or urchin grazing (and possibly over-fishing). In comparison, increased dead coral with turf may indicate recent coral disease or high levels of grazing. Height (~ <2-3 cm) and the absence of an identifiable macroalgal structure can be

considered in identifying dead coral with turf. Macroalgae generally attain a height/thickness >2-3 cm and may be fleshy, filamentous, or calcified, often with conspicuous branching, blades.

When deciding whether the photo point is on dead coral with turf algae or macroalgae, you will need to evaluate other areas in the image for comparison. As with the hard corals, and other sessile benthic invertebrates, algae should be identified to the most descriptive level possible, i.e., lowest taxon possible, ideally genus or species. If this is not possible, but the alga appear fleshy and to have a height >2-3 cm, it should be identified as “macroalgae”. As the photograph provides only a two-dimensional view of the reef, the component’s “height” can be difficult to ascertain. This is where brief field notes of quadrat macrobiota composition are very important. Looking around the image, at substrates similar to and different from the one in question, will usually aid interpretation of the substrate features (colors, shading, textures, etc.). Also referring back to any field notes will help resolve the image in a third dimension resulting in more accurate identifications. When in doubt, dead coral with turf algae may be the more conservative category to record.

Export Data from CoralNet

After analyzing all the benthic images for a sampling event, the Marine Biological Science Technician should export the substrate identifications and upload them to SharePoint.

1. Navigate to [CoralNet](#) and log in using your Username and Password.
2. Select the appropriate source from the list of Your Sources (Figure SOP 16.26).

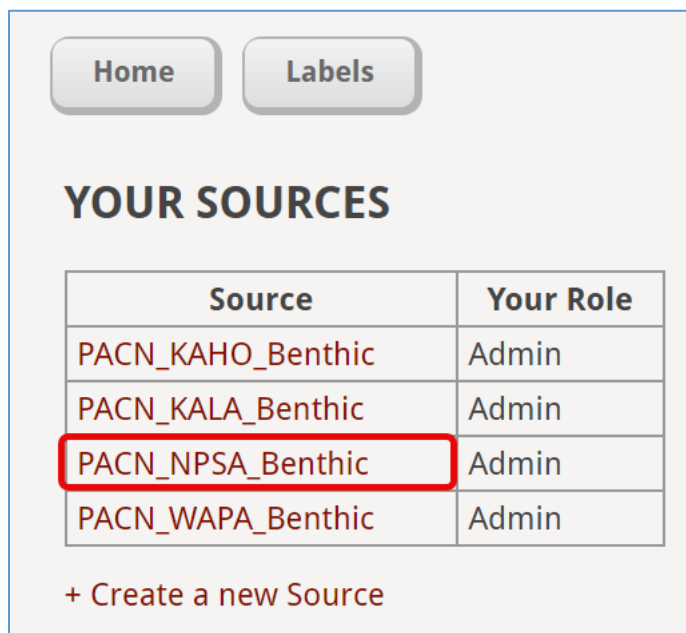


Figure SOP 16.26. Selecting a Source in CoralNet.

3. Select “**Images**” from the main tab options at the top of the Source page (Figure SOP 16.27).

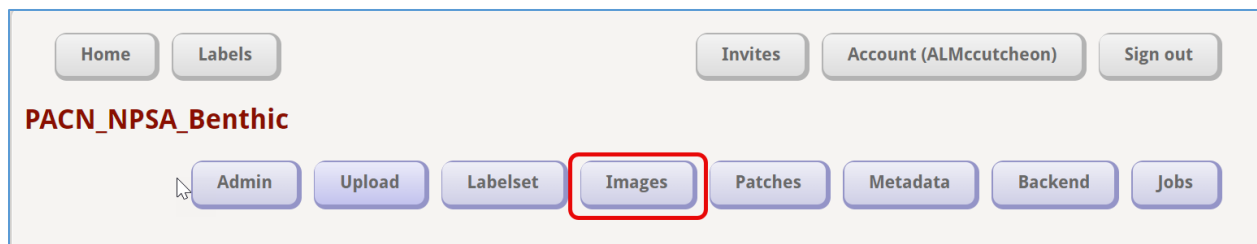


Figure SOP 16.27. Main tab options within a CoralNet source.

4. Use the image filter to locate the images from the first transect of the sampling event using the Loc_Name, Loc_Type, and Photo date filters. You may also include the Annotation status filter, but that should not be necessary as all images should have the “Confirmed” status before you begin exporting. Click **“Search”** (Figure SOP 16.28).

Figure SOP 16.28. Filtering images to the first fixed transect of a sampling year.

5. Now, 26 photos (all highlighted in green to indicate confirmed) should show below the filter. Scroll to the bottom and update the Action field to **“Export Annotations, CSV”** (Figure SOP 16.29). This action should be performed for **“All 26 image results”**. Check all the Optional column check boxes and the click **“Go”**.

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IMAGE ACTIONS

Action: Export Annotations, CSV for these images: All 26 image results

Export annotations for these images in CSV format - one row per annotation. ?

Optional columns:

- ☒ Annotator info
- ☒ Machine suggestions
- ☒ Image metadata - date and auxiliary fields
- ☒ Image metadata - other fields

Note: This can take a very long time, potentially 1 minute per 5000 annotations. If your source has thousands of images, please consider filtering your search to a smaller number of images before exporting.

Go

Figure SOP 16.29. Exporting annotation options.

6. You will be prompted to “**Save As**”. Navigate to a folder on your DOI OneDrive and save the file with the prefix “c_” followed by the park’s 4-letter code, the transect type (“FT” or “TT”), the 2-digit transect number, and the transect date formatted as YYYYMMDD (for example “c_KAHOFT0120231025.csv”).
 - a. Data are now ready to import into the Benthic Marine Community and Marine Fish Monitoring Database. Refer to [SOP #14 Data Entry, Verification, and Certification](#) and the [Benthic Marine Community and Marine Fish Monitoring Database User Guide](#) located in the “[Database](#)” folder in SharePoint for instructions on importing the data into the database.
7. Repeat Steps 1-6 for the remaining transects, exporting data from only one transect at a time.
8. Upload all of the CSV files containing annotations into the year and park subfolders within the “[CoralNet data](#)” folder in SharePoint (Figure SOP 16.30).

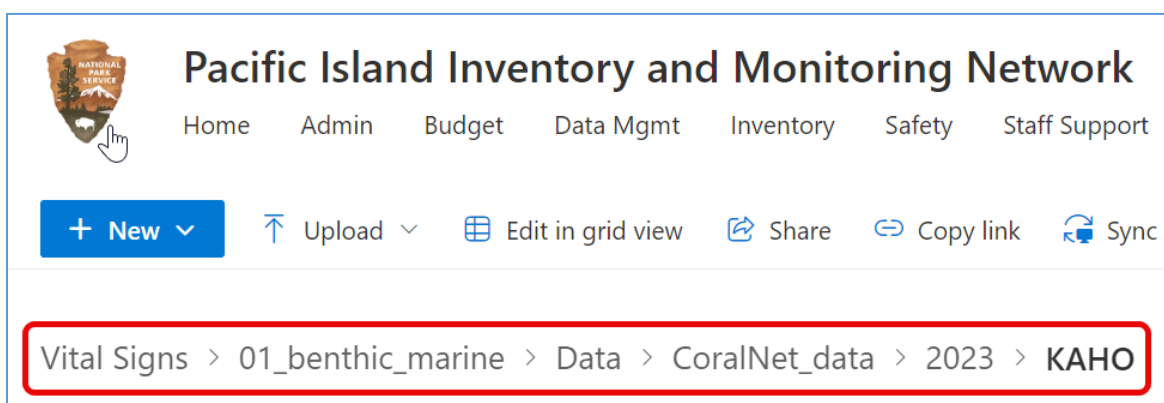


Figure SOP 16.30. Example of CoralNet data file location for a particular year and park in SharePoint.

9. Upload the Excel file (.xlsx) containing the bleaching and disease information to the year and park subfolders within the “[Datasheets](#)” folder in SharePoint (Figure SOP 16.31).

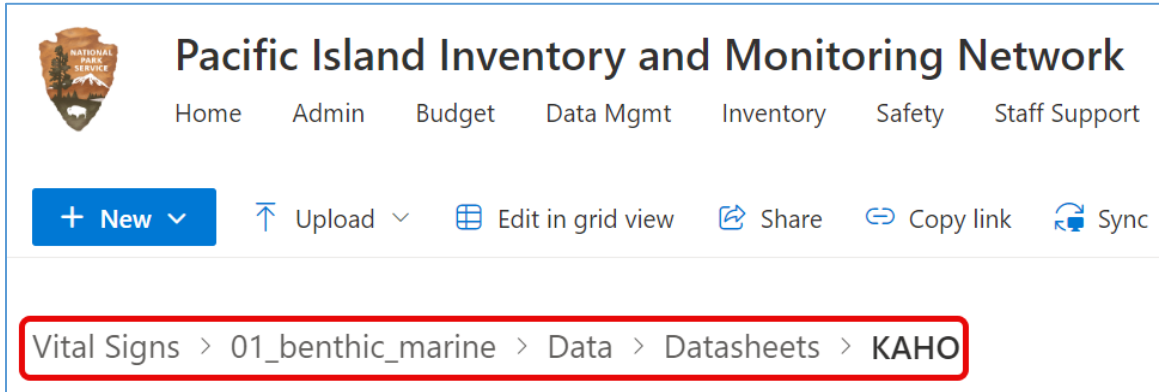


Figure SOP 16.31. Example of bleaching and disease data file location for a particular year and park in SharePoint.

10. Inform the PACN Data Manager that the CoralNet data and Bleaching/Disease data are in the correct folders.

Data Certification

Certification is the process of checking substrate identifications for 10% of the images. The Marine Ecologist at each park or the PACN Marine Ecologist is responsible for completing this task (refer to [SOP #14 Data Entry, Verification, and Certification](#)). Refer to [Appendix SOP 16.c](#) for certification steps in CoralNet.

The PACN Data Manager will randomly generate the transects to be checked by the PACN Marine Ecologist after receiving notice from the Marine Biological Science Technician that the annual CSV files are ready for review and saved in the year and park subfolders within the “[CoralNet_data](#)” folder in SharePoint (Figure SOP 16.30).

1. The PACN Data Manager will import the data in the CSV files into the working copy database for the sampling year (i.e., 2024_benthic_fish_be_working_copy.mbd).
 - a. To import the data, open the Benthic Marine Community and Marine Fish Monitoring Database front-end database file and link to the appropriate working copy database back-end file. Proceed to import the CSV files exported from CoralNet.

See the [Benthic Marine Community and Marine Fish Monitoring Database User Guide](#) for instructions on first downloading the database files to the user’s local workstation (see sub-sections under the “Introduction” section), and then on importing the data (see “Import CSV Files” section).

2. The PACN Data Manager will randomly select 10% of the images (~75 images per year) for re-examination and certification by the PACN Marine Ecologist.

3. The Benthic Marine Community and Marine Fish Monitoring Database has a proofing form that will randomly generate the transects to be re-examined.
 - a. In the front-end database, click the Proof Benthic Data button on the database's main switchboard to run the proofing tool. See the [Benthic Marine Community and Marine Fish Monitoring Database User Guide](#) for instructions for instructions on how to use the tool.
4. The PACN Data Manager will inform the PACN Marine Ecologist which transects are to be re-examined for certification.
5. The PACN Data Manager will compile the CSV files for the transects selected for certification. These files will be uploaded to the "Pre-cert_review" folder in the year and park subfolders within the "[CoralNet data](#)" folder in SharePoint (Figure SOP 16.32). These files will be re-examined by the PACN Marine Ecologist.

Keeping these files separate will keep a record of pre-certified data and certified data to archive.

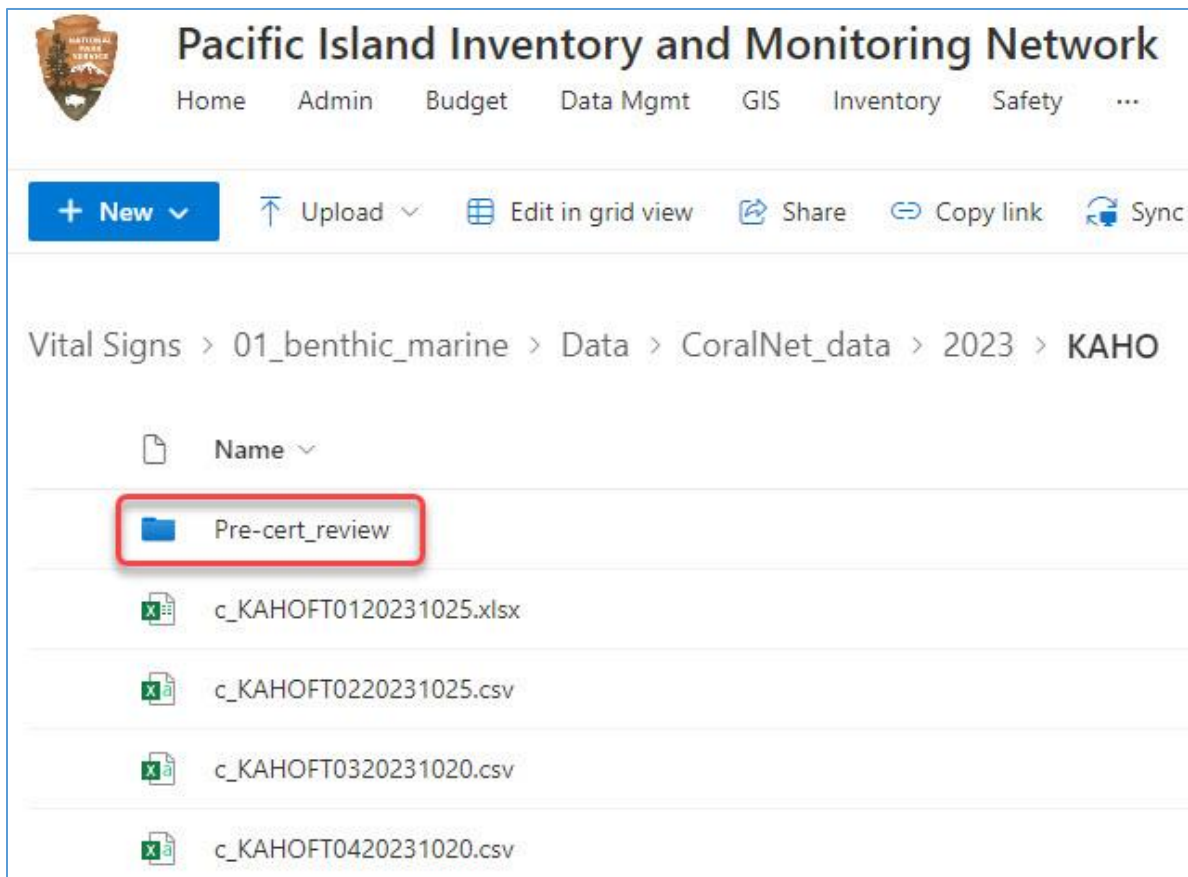


Figure SOP 16.32. Example of folder location for CSV files for the transects selected for certification for a particular year and park in SharePoint.

6. The PACN Marine Ecologist conducting the re-examination verifies that the correct substrate identifications have been recorded on the screen. See [Appendix SOP 16.c](#) for certification steps in CoralNet.
7. If corrections need to be made, then the PACN Marine Ecologist will make updates in CoralNet and logs the transect and image number using the Error Checking Data form in [Appendix SOP 16.b](#). Logging the information will allow measurement error to be estimated.
8. If the substrate identification error (overall measurement error for the 75 images) is lower than 10% (~375 total points) then the updated CSV files can now be sent to the PACN Data Manager for upload to the working copy database.
9. If the substrate identification error (measurement error) is higher than 10% then the errors need to be evaluated and corrected. For example, consistent misidentification of certain taxa would necessitate the Marine Biological Science Technician going back and updating all of the images with the correct information.
 - a. Once the errors have been resolved at the Marine Biological Science Technician level, export the data using the previous steps for exporting the data, and upload updated CSV files to the “Updated_files” folder in the year and park subfolders within the “[CoralNet_data](#)” folder in SharePoint (Figure SOP 16.33).

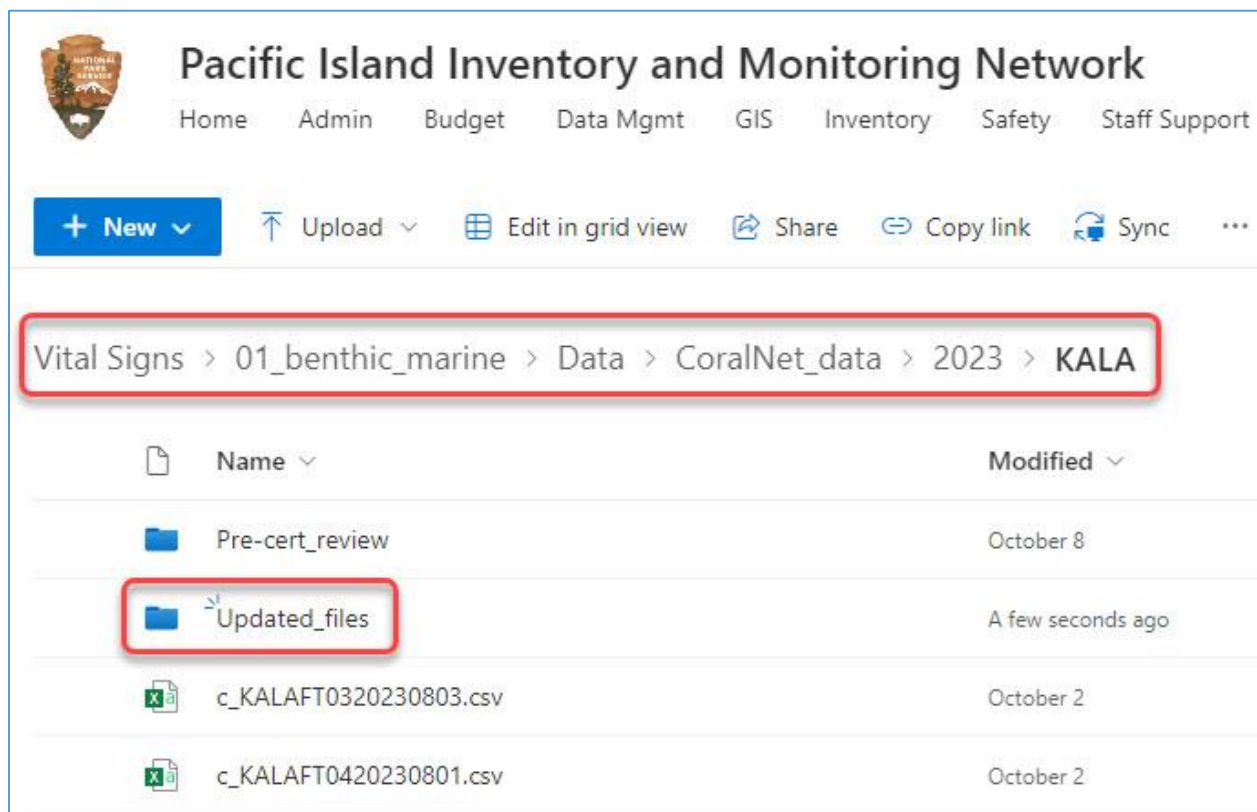


Figure SOP 16.33. Example of folder location for updated PGC and CSV files for a particular year and park in SharePoint.

- b. The PACN Marine Ecologist will re-examine 10% of these updated records, using the same process as before.
- 10. Substrate identification error must be lower than 10% in order to consider the data certified.

Appendix SOP 16.a. Substrate examples

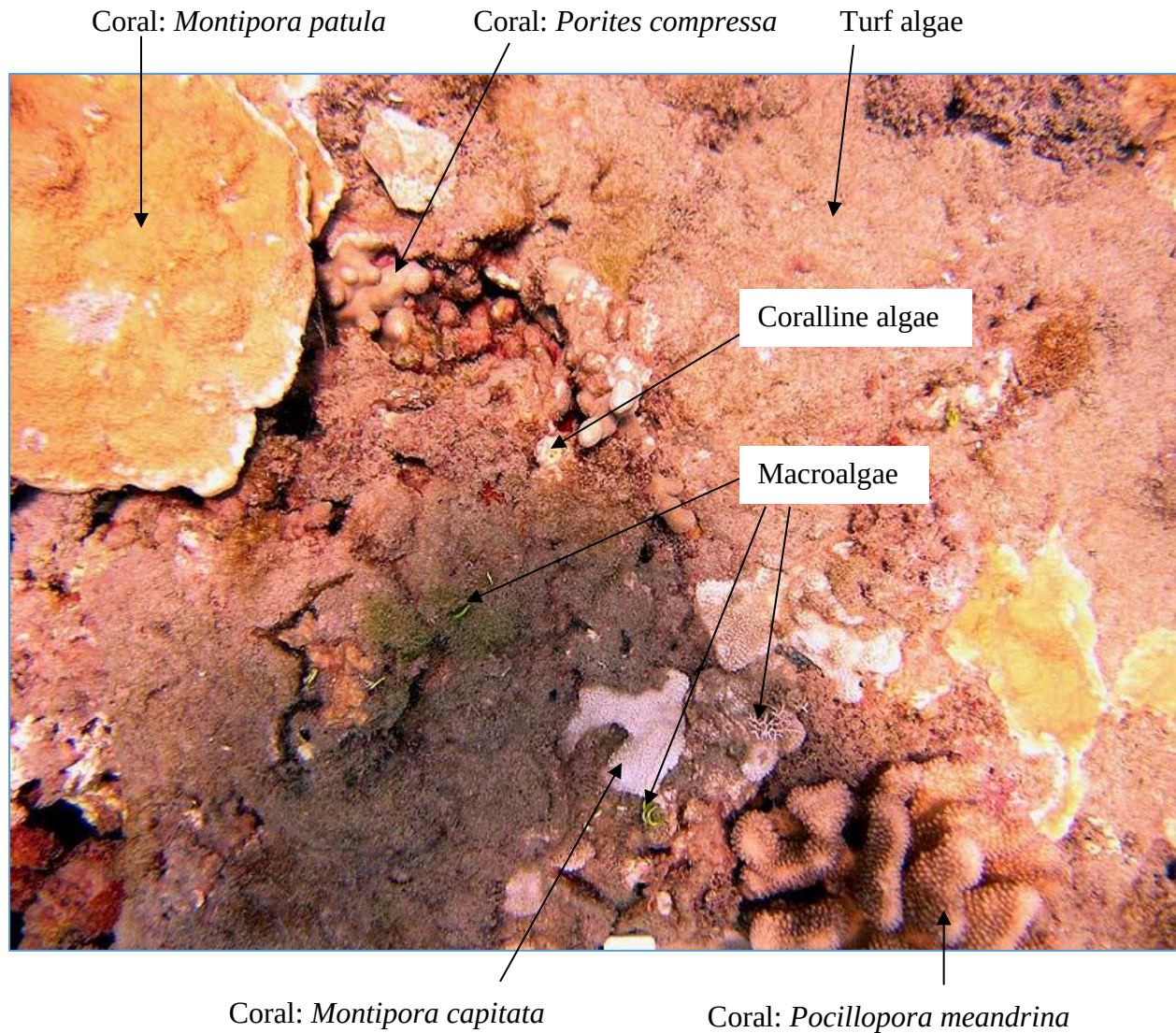


Figure SOP 16.a.1. Examples of substrate types from digital still images from Hawaii.

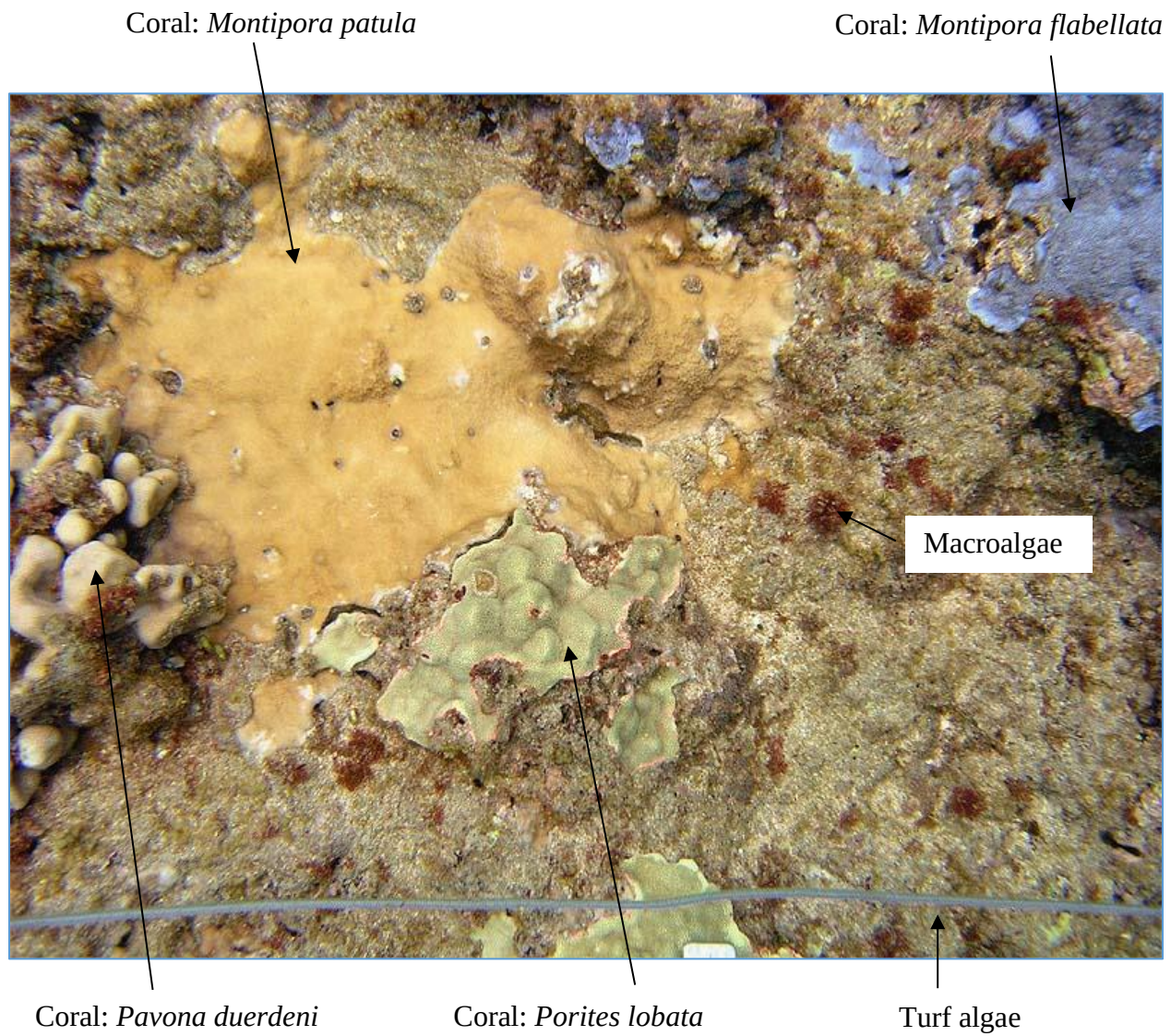


Figure SOP 16.a.2. Examples of substrate types from digital still images from Hawaii.

Appendix SOP 16.b. Error Checking Data Form

Data form for error checking of point identifications in photoquadrat images

Year:

Photogrid IDer:

Park:

Total Number of Images Checked:

Marine Ecologist:

Total Number of Points Checked:

Events	Transect	Image	Point #	Incorrect Substrate	Correct Substrate
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					

Appendix SOP 16.c. Certification Steps in CoralNet

Follow these procedures when certifying park benthic marine data:

1. The PACN Database Manager will send the PACN Marine Ecologist: 1) a CSV file for each transect to be checked, 2) the bleaching and disease spreadsheet that contains this data for all transects, and 3) the data error form (Figure SOP 16.c.1) where all errors are entered in order to calculate the error rate. Download all files to a folder on the desktop and save. The number of transects to be checked is equivalent to 10% of the total number of transects sampled for that year (e.g., 30 transects would mean 3 transects to be checked). When correcting the data, document the correction on the data error form. For example, if an error was found for WAPA Fixed 12, enter the Transect, Image/Frame and the Point where the error occurred, then enter the incorrect substrate the correct substrate. Download all files to a folder on the desktop and save.

Data form for error checking of point identifications in photoquadrat images

Year: 2023
Park: WAPA
Marine Ecologist: Sheila McKenna

PhotoGrid®
ID# Amanda McCutcheon
Total Number of Images Checked: 26
Total Number of Points Checked: 1300

Events	Transect	Image	Point #	Incorrect Substrate	Correct Substrate
1	F12	10	#33 (on csv file row 544)	TALG	MALG
2	F12	16	#47 (on csv file row 848)	PMAS	LPUR
3					
4					
5					
6					
7					
8					
9					
10					

Figure SOP 16.c.1. Data error form.

2. Log into [CoralNet](https://coralnet.ucsd.edu/)² using your account and go to Your Source page (Figure SOP 16.c.2). In Your Sources section click the park for which you will be checking data. For example, for 2023 WAPA Fixed 12, you would click PACN_WAPA_Benthic.

² Coral Net, <https://coralnet.ucsd.edu/> (last accessed 12 February 2025).

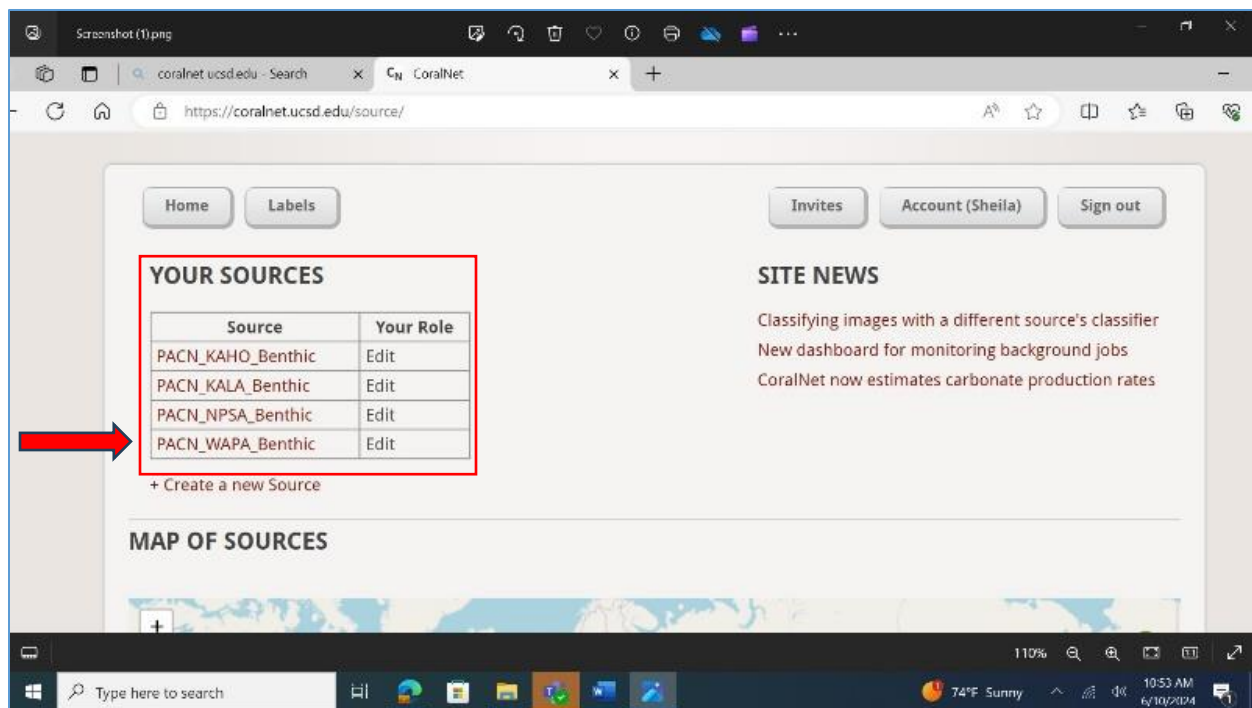


Figure SOP 16.c.2. Log into CoralNet and navigate to Your Sources.

- The next screen to appear will be for WAPA images. Click the Metadata tab (Figure SOP 16.c.3).

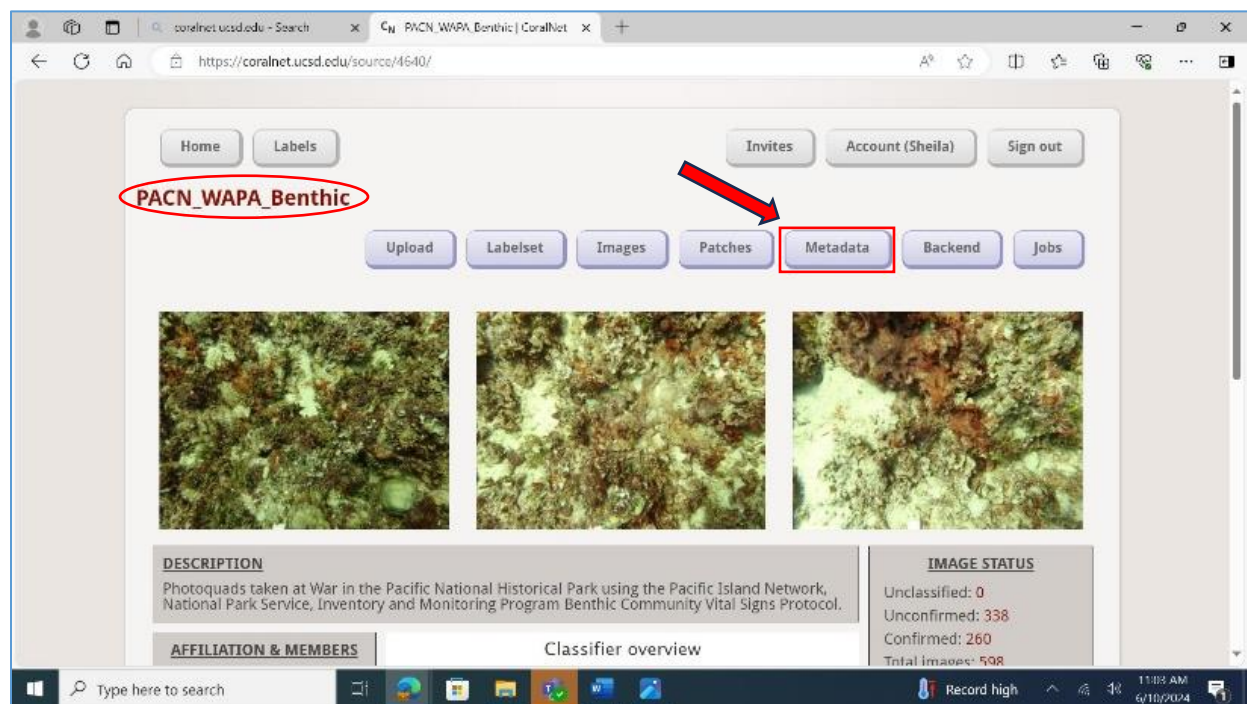


Figure SOP 16.c.3. Images displayed for the selected park.

- The following screen will appear (Figure SOP 16.c.4). Go into Edit Metadata and select the transect to check. For our example, 2023 WAPA Fixed 12, the *Loc_Name* selected is "12",

Loc_Type selected is “Fixed”, *Unit_Code* selected is “WAPA” and for *Photo date* choose “Year” and then “2023”. Click the red Search button.

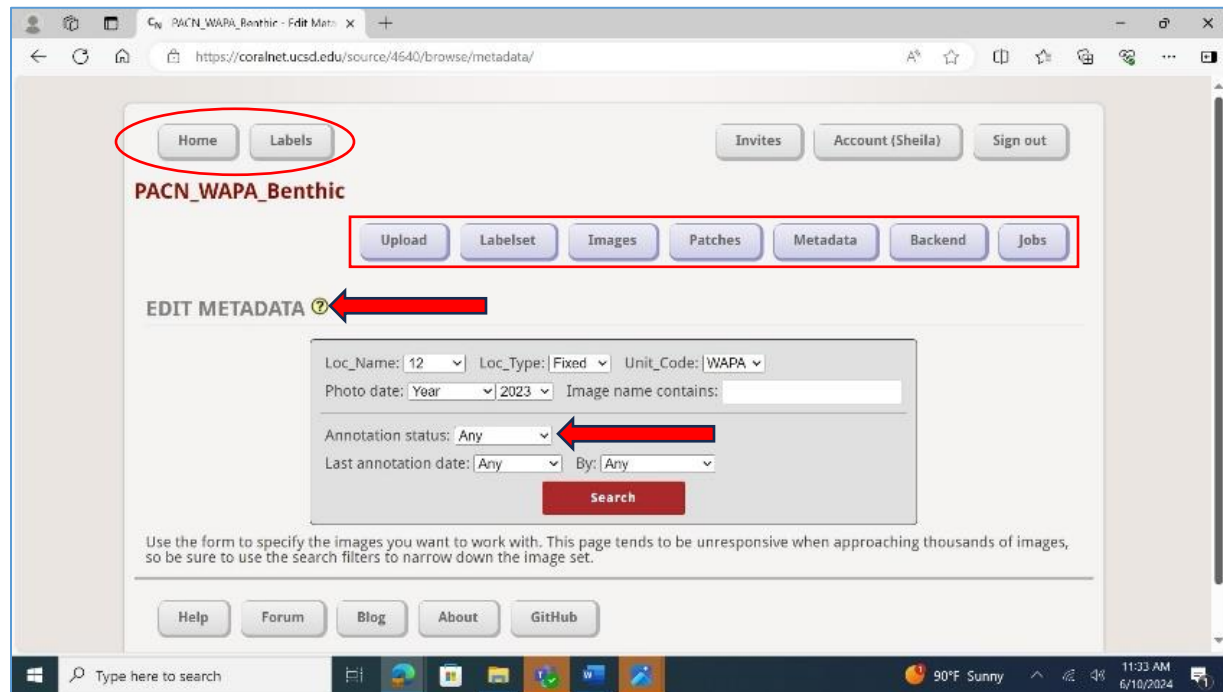


Figure SOP 16.c.4. Searching for the metadata for the selected criteria.

5. In the following screen the name of the transect with each associated photo image (0 to 25) will appear (Figure SOP 16.c.5). Click on the *Link/Status* “Confirmed” beginning with the first image. For our example the first image to check is WAPA23FT120000.JPG.

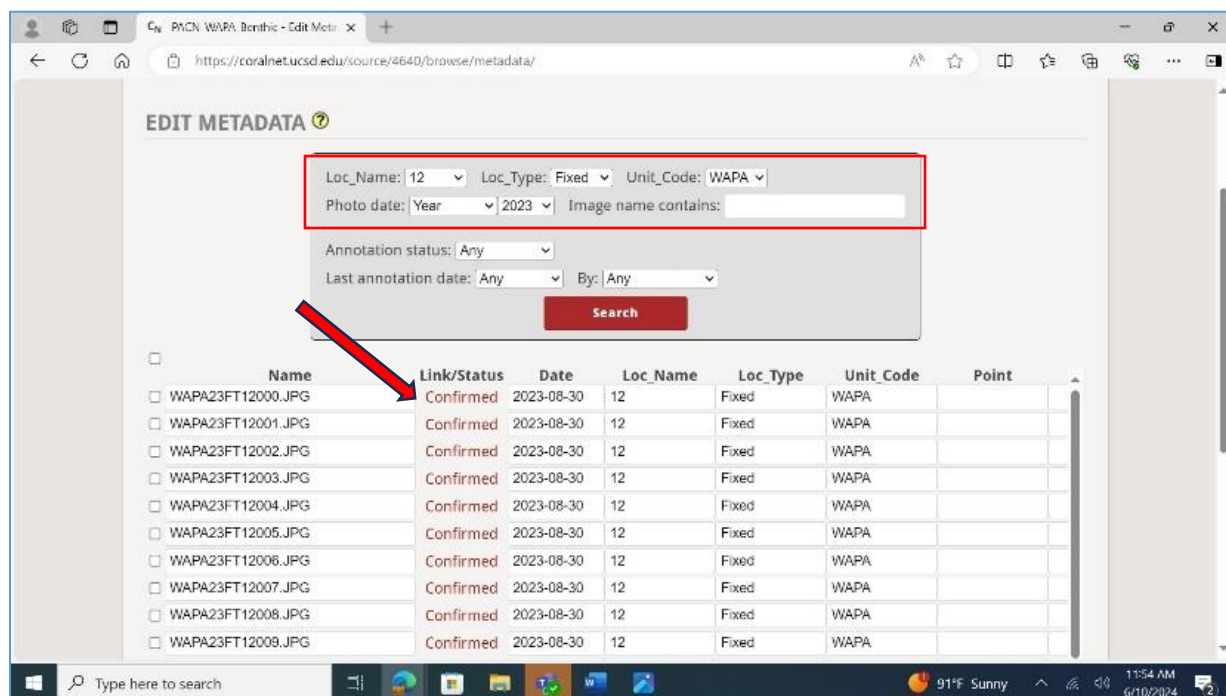


Figure SOP 16.c.5. Click on the displayed Link/Status in order to view the image.

6. The following screen will appear (Figure SOP 16.c.6), showing the corresponding image to be checked. Click the Annotation Tool button for the points to display.

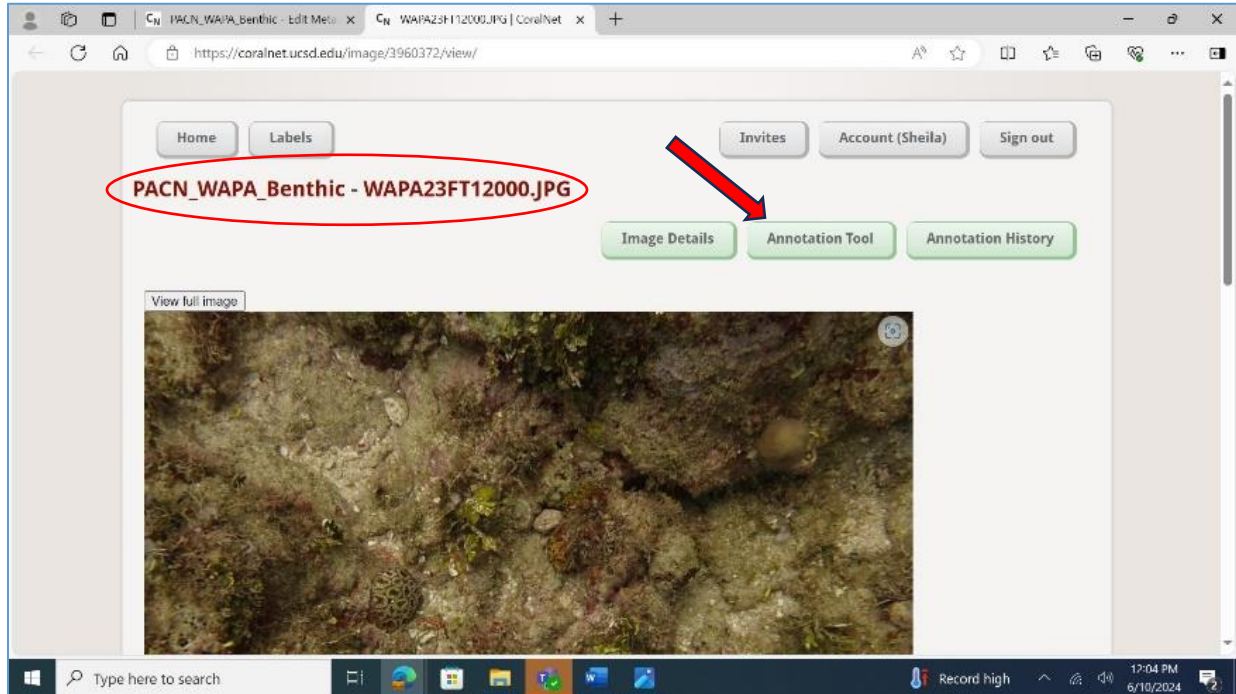


Figure SOP 16.c.6. Image display.

7. The numbered points will show up as follows (Figure SOP 16.c.7). Begin checking points identified starting with 1 on the image with the numbered data column on the right.

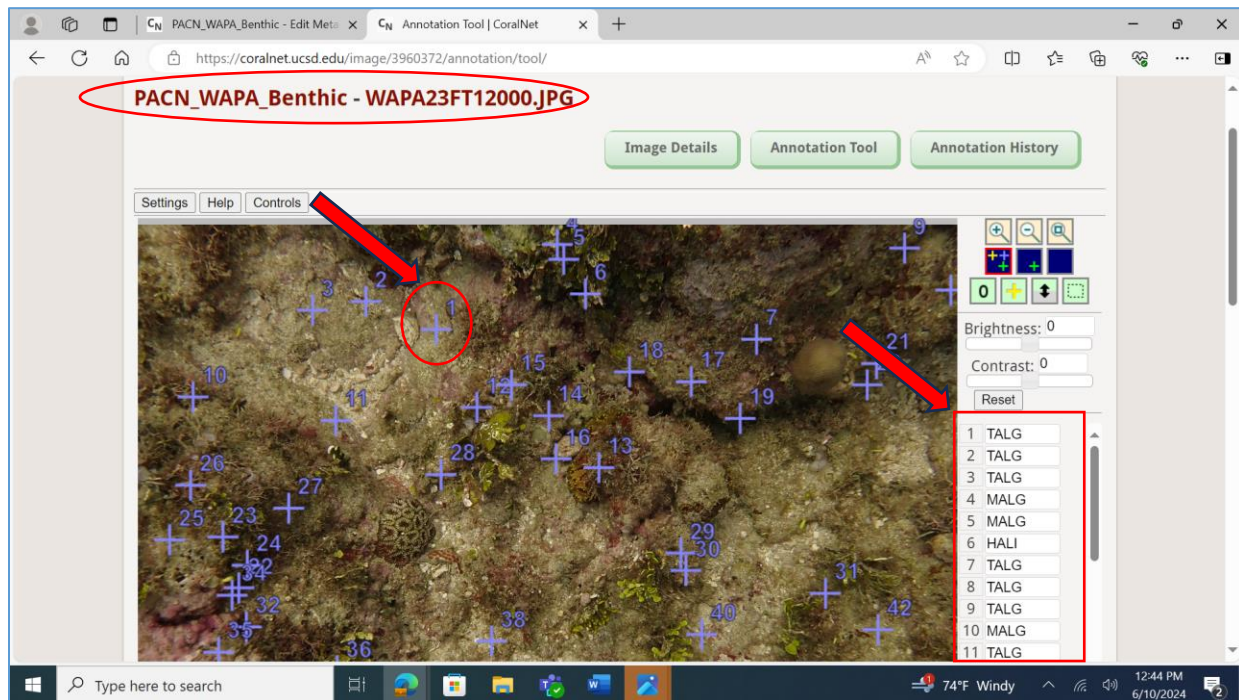
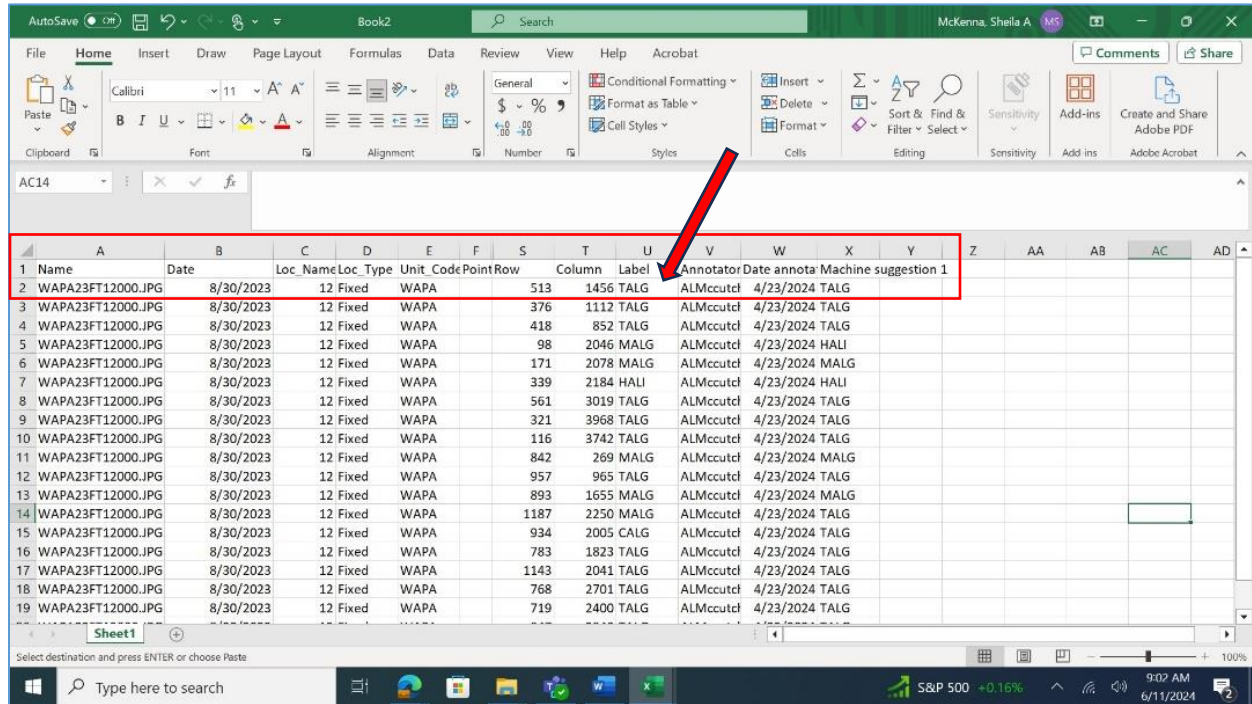


Figure SOP 16.c.7. Image display with points.

- Open the transect CSV file and locate the corresponding row to your image. Check that the identification code matches what is indicated in the CoralNet program (Figure SOP 16.c.8). For example, in the WAPA FT 2023FT120000 image, point +1 is identified as TALG. Look for the corresponding row for that image and point in the CSV file and check to see that it matches.



1	Name	Date	Loc. Name	Loc. Type	Unit	Code	Point	Row	Column	Label	Annotator	Date annota	Machine suggestion 1
2	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		513	1456	TALG	ALMccutd	4/23/2024	TALG	
3	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		376	1112	TALG	ALMccutd	4/23/2024	TALG	
4	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		418	852	TALG	ALMccutd	4/23/2024	TALG	
5	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		98	2046	MALG	ALMccutd	4/23/2024	HALI	
6	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		171	2078	MALG	ALMccutd	4/23/2024	MALG	
7	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		339	2184	HALI	ALMccutd	4/23/2024	HALI	
8	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		561	3019	TALG	ALMccutd	4/23/2024	TALG	
9	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		321	3968	TALG	ALMccutd	4/23/2024	TALG	
10	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		116	3742	TALG	ALMccutd	4/23/2024	TALG	
11	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		842	269	MALG	ALMccutd	4/23/2024	MALG	
12	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		957	965	TALG	ALMccutd	4/23/2024	TALG	
13	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		893	1655	MALG	ALMccutd	4/23/2024	MALG	
14	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		1187	2250	MALG	ALMccutd	4/23/2024	TALG	
15	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		934	2005	CALG	ALMccutd	4/23/2024	TALG	
16	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		783	1823	TALG	ALMccutd	4/23/2024	TALG	
17	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		1143	2041	TALG	ALMccutd	4/23/2024	TALG	
18	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		768	2701	TALG	ALMccutd	4/23/2024	TALG	
19	WAPA23FT12000.JPG	8/30/2023	12	Fixed	WAPA		719	2400	TALG	ALMccutd	4/23/2024	TALG	

Figure SOP 16.c.8. Comparing identification code between CoralNet and the CSV file.

- If the substrate is misidentified in CoralNet, document the error on the data error form with the location of the incorrect substrate (transect, image and point # with row number in CSV; (Figure SOP 16.c.9). Change the incorrect substrate ID to the correct substrate ID in CoralNet. CoralNet will automatically record your change on the annotation record history.

Data form for error checking of point identifications in photoquadrat images

Year: 2023

Park: WAPA

Marine Ecologist: Sheila McKenna

Transect: a

Photogrid ID: Amanda McCutcheon

Total Number of Images Checked: 26

Total Number of Points Checked: 1300

Events	Image	Point #	Substrate	Correct Substrate
1	F12	10	#33 (on csv file row 544) TALG	MALG
2	F12	16	#47 (on csv file row 848) PMAS	LPUR
3				
4				
5				
6				
7				
8				
9				
10				

Figure SOP 16.c.9. Log errors into the data error form.

- After you have completed checking the point data in CoralNet, you will begin to check the bleaching and disease spreadsheet (2nd file sent by Data Manager; Figure SOP 16.c.10). Open the corresponding spreadsheet and locate the indicated image while viewing the same image on CoralNet. For the example, 2023 WAPA Fixed Transect 12 Image/Frame 0, labeled in row #184. Check that Bleaching Severity and Disease/Bleaching fields are filled out according to what is seen in the image/frame. If there is an error, update the CSV file and document this on the data error form.

	A	B	C	D	E	F	G	H	I	J	K	L
	Photo Name	Park	Loc_Type	Loc_Name	Date	Analysis_Date	Analysis IDer	Frame	Coral Present?	Bleaching Severity	Disease/Bleaching	Notes
182	WAPA23FT07024	WAPA	Fixed		7/8/23/2023	4/21/2024	Amanda McCutche	24	Yes	0%	No	
183	WAPA23FT07025	WAPA	Fixed		7/8/23/2023	4/21/2024	Amanda McCutche	25	Yes	0%	No	
184	WAPA23FT12000	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	0	Yes	0%	No	
185	WAPA23FT12001	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	1	Yes	0%	No	
186	WAPA23FT12002	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	2	Yes	0%	No	
187	WAPA23FT12003	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	3	Yes	0%	No	
188	WAPA23FT12004	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	4	Yes	0%	No	
189	WAPA23FT12005	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	5	Yes	0%	No	
190	WAPA23FT12006	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	6	Yes	1-25%	Yes	Bleaching
191	WAPA23FT12007	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	7	Yes	0%	No	
192	WAPA23FT12008	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	8	Yes	0%	No	
193	WAPA23FT12009	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	9	Yes	0%	No	
194	WAPA23FT12010	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	10	Yes	0%	No	
195	WAPA23FT12011	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	11	Yes	0%	No	
196	WAPA23FT12012	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	12	Yes	0%	No	
197	WAPA23FT12013	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	13	Yes	0%	No	
198	WAPA23FT12014	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	14	Yes	1-25%	Yes	Bleached
199	WAPA23FT12015	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	15	Yes	0%	No	There's p
200	WAPA23FT12016	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	16	Yes	0%	No	
201	WAPA23FT12017	WAPA	Fixed		12/8/30/2023	4/23/2024	Amanda McCutche	17	Yes	0%	No	

Figure SOP 16.c.10. Bleaching and disease spreadsheet.

11. Once you have completed this step for all transects, export the updated transect data to CSV, following the instruction in [Export Data from CoralNet](#).
12. Send the exported transect CSV and updated bleaching and disease spreadsheet to the Data Manager, letting her know that the data has been certified.