

Standard Operating Procedure (SOP) #5

Transect Generation

Version 2.0 (June 4, 2025)

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #
2.0	6/4/2025	Mark Wasser	Updated transect generation procedures and software versioning, file locations.	Reflect migration to ArcGIS Pro, change from local file server to SharePoint, and more efficient methodology. Standardization / consistency of spatial data management across PACN.	1.0

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 explains how to generate rotational transects using ArcGIS® Pro (v 3.3.1 as of this update) for the Pacific Island Network (PACN) Established Invasive Plant Species (EIPS) Monitoring Protocol. The procedures outlined in this SOP must be performed to generate new rotational and alternate transects for each sampling frame; fixed transects do not change and therefore should not need to be generated in the future. As transect locations may be shared between this protocol, PACN Landbirds Protocol (Camp et al. 2011), and Focal Terrestrial Plant Communities Protocol (Ainsworth et al. 2011), guidelines for all three protocols should be considered when generating transects. This SOP is based on available tools for ArcGIS used by the GIS specialist and represents one of many ways to accomplish these tasks. Once transects have been generated, [SOP #9 Conducting Invasive Plant Species Surveys](#) describes how to install contiguous plots along each transect.

Generating EIPS Sampling Locations

Fixed and rotational transects for the initial sampling cycle (2010-2014) were generated using ArcGIS Desktop 9.3 and Hawth's Tool Extension. That fixed transect generation procedure is outlined in [Appendix SOP 5.a](#). Fixed transect generation was conducted for the initial sampling cycle and has not been updated since no new fixed transects are generated in subsequent monitoring cycles.

Locations for sampling stations will be randomly selected within ArcGIS Pro using the criteria outlined below. Randomly selected alternative station locations will also be generated in case the initial location is unsuitable with respect to habitat type or possesses conditions that make it unsafe in which to work.

Rotational/Alternate Transect Start Point Generation (HAVO and HALE)

This method for generating random transect start points within a sampling frame applies to two EIPS plant communities: Wet Forest and Subalpine Shrubland at HAVO and HALE. No additional plots need to be generated for the Mangrove Wetland, only the initial fixed plots are sampled in this community. Coastal Strand is only sampled at KALA, and those plots follow a unique procedure (see section [Rotational/Alternate Transect Generation \[KALA\]](#)). Within these plant communities at HAVO and HALE, sampling transects are generated randomly using a simple random sampling strategy outlined below.

1. Open ArcGIS Pro and load the park specific map project and necessary layers including park boundaries, roads, trails, field camps, sampling frames, sampling point generation areas, and any other applicable features (helispots, etc.). There is generally a single, combined project created for EIPS and FTPC for each respective sampling year. Archived FTPC/EIPS ArcGIS Projects and spatial data are located in the FTPC “[Spatial Info](#)” folder in the PACN Monitoring Archive¹, under the year in which sampling last occurred at the respective unit. If utilizing an existing ArcGIS Pro Project (.arpx) from the PACN Monitoring Archive, save a new copy of the project in a temp local directory with the naming convention “FTPC_EIPS_[YYYY]²_[PARK]³.arpx”.

Alternatively, if building a Pro Project from scratch is necessary, Project, Layout (.pagx), and Map (.mapx) Templates are all available in the “[ArcGIS Pro Templates](#)” folder in the PACN I&M SharePoint site⁴. Master EIPS data layers such as Sampling Frames, Sampled Points, and Exclusion Areas are stored in the EIPS Master Geodatabase (PACN_EIPS_MASTER.gdb), which is located in the EIPS programmatic “[Data](#)” folder in the PACN Monitoring Archive. A local copy of the master geodatabase will also need to be downloaded (direct functionality with data housed on the SharePoint is not supported in ArcGIS Pro at this time).

2. Create a new file geodatabase (.gdb) to be used temporarily for annual rotational/alternate plot point generation. Suggested naming convention is “EIPS_[YYYY].gdb”. Save to the same temp local directory as the Pro Project working copy from Step 1.

¹ PACN Monitoring Archive, https://doimsp.sharepoint.com/sites/nps-PWR-PACNIM/monitoring_archive/ (accessed 4 June 2025).

² [YYYY] = 4-digit sampling year (e.g., 2022, 2023, etc.)

³ [PARK] = 4-letter park code (e.g., AMME, HALE, HAVO, KAHO, KALA, NPSA, WAPA)

⁴ PACN I&M SharePoint site, <https://doimsp.sharepoint.com/sites/nps-PWR-PACNIM> (accessed 4 June 2025).

3. Generate random points within the sampling area (Figure SOP 5.1). The tool will need to be run individually for each sampling frame.

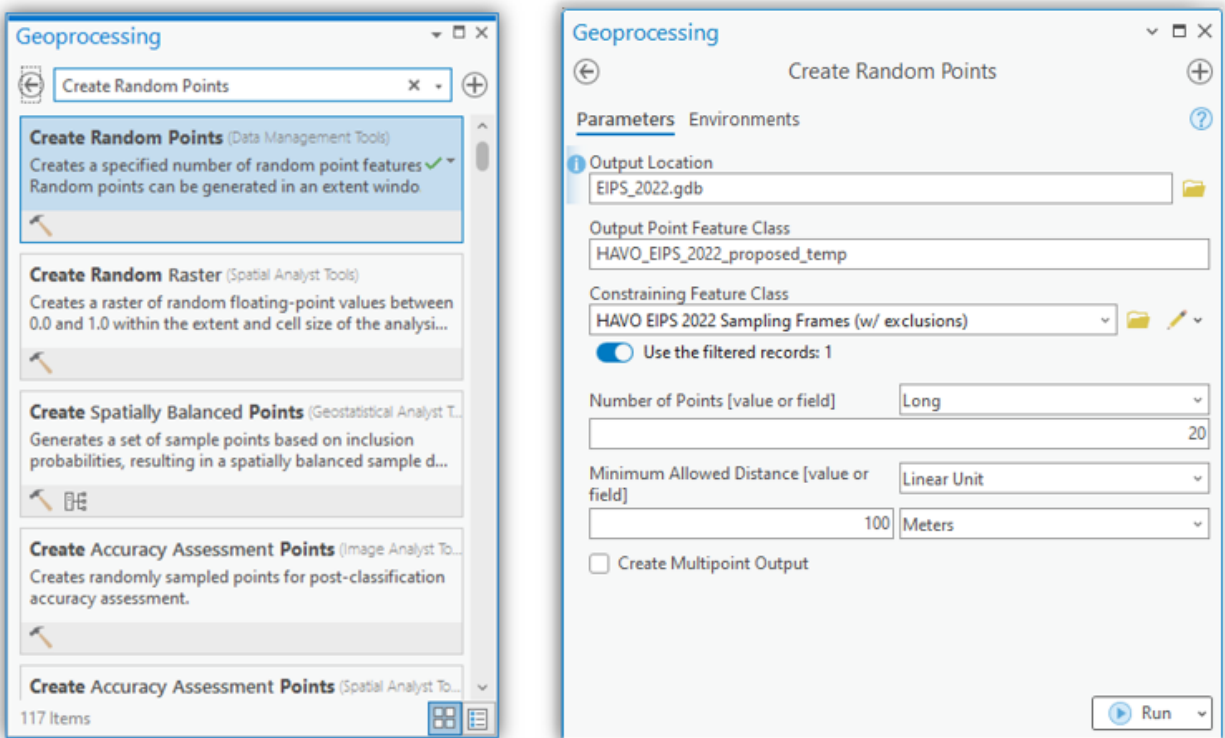


Figure SOP 5.1. Dialog box for the “Create Random Points” geoprocessing tool in ArcGIS Pro. Note relevant options constraining points to within a selected polygon, determining the number of points to generate, and to enforcing minimum distances between points.

- a. Open the Create Random Points Tool from the Geoprocessing Pane. Start typing “Create Random Points” in the search bar and the appropriate tools with display as options. Select the *Create Random Points* tool. (Alternately, the tool’s button is located within the Analysis Tab, Geoprocessing Group on the Pro ribbon)
- b. Set *Output Location* and *Output Point Feature Class* to the temp file geodatabase created in Step 2, and name as desired. Suggested feature class name = “[PARK]_EIPS_[YYYY]_proposed_temp_[sampling_frame_abbreviation]”
- c. Select the *Constraining Feature Class*. This will be the VEG_sampling_pt_generation_areas_ply feature class from the FTPC Master Geodatabase. This point generation area feature class is based on the FTPC/EIPS sampling frames, and has all buffers, exclusion areas, etc.

Important Note: *The point generation area feature class described above contains point generation areas for all the FTPC sampling frames in PACN Units. For the tool to run properly and not generate random points in all PACN Units, please apply a definition query to the feature class (before running the Create Random Points tool)*

to display only the sampling frame for which random points are being generated (Figure SOP 5.2).

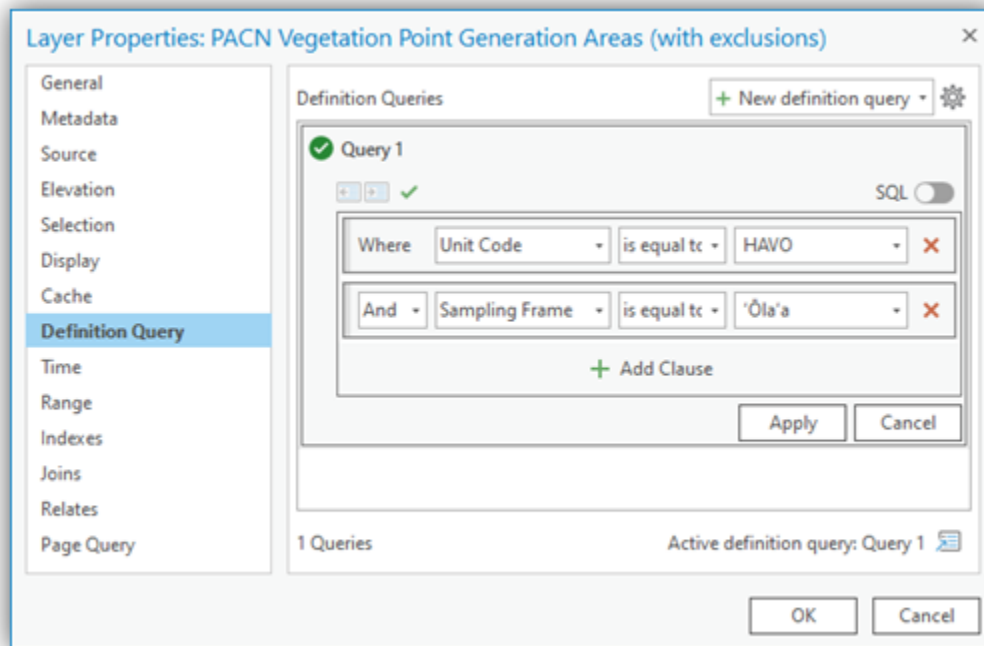


Figure SOP 5.2. Dialog box demonstrating a definition query applied to select only the relevant sampling frame from the VEG_sampling_pt_generation_areas_ply feature class from the FTFC Master Geodatabase.

- d. For *Number of Points [value or field]*, select *Long* from the dropdown. Enter the desired number of points to be generated in the box below. Refer to [Appendix SOP 5.a](#) to determine the number of points needed. Generate all rotational and alternate plots needed for the sampling frame at the same time.
 - e. For *Minimum Allowed Distance [value or field]*, select *Linear Unit* from the dropdown. For HAVO and HALE, enter 100 in the fillable box and select meters from the drop-down box for units.
 - f. **Do not** check the box for *Create Multipoint Output*—if checked, then uncheck.
 - g. Run the tool. The output generated is the random points that will be used for the creation of transect start points.
4. Populate the newly created random point feature class. Create, name, and populate the following fields in the attribute table as follows:
 - Unit_Code (Text, 5 characters long); fill in as appropriate
 - Samp_Year (Short integer); fill in as appropriate (YYYY format)
 - Community (Text, 50 long); populate as appropriate

- Samp_Frame (Text, 25 long); populate as appropriate
- Zone (Text, 25 long); populate as appropriate
- Trans_Num (Text, 5 long); populate in future steps
- Trans_Type (Text, 15 long); populate in future steps
- Placement (Text, 5); Populate all cells with the value “Start”
- Length_m (short); populate in future steps
- Azimuth (Short integer); populate in future steps
- Longitude (Double); calculate geometry in GCS: WGS 1984
- Latitude (Double); calculate geometry in GCS: WGS 1984
- GCS (Text, 30); Populate all cells with value “World Geodetic System 1984”
- GCS_Datum (Text, 30); Populate all cells with the value “D_WGS_1984”
- Legacy (Text, 3);
- UTM_X (Double); Leave <null>
- UTM_Y (Double); Leave <null>
- Random (float); populate in next step
- Trans_no (short); populate in future steps

Refer to the  [FTPC_database_labels_20210205.xlsx](#) spreadsheet for the correct values for the ‘Samp_Frame’ and ‘Zone’ fields.

5. Use the Field Calculator to generate a set of random numbers for cells in the *Random* field (Figure SOP 5.3).

- a. Open Field Calculator, and ensure the *Random* attribute field is selected, and the *Expression Type* is set to Python 3.

- b. Type the following code in the *Expression* box:

```
rand()
```

- c. Then type the following code in the *Code Block* box:

```
import random
def rand():
    return random.random()
```

- d. Click OK to run the Field Calculator.

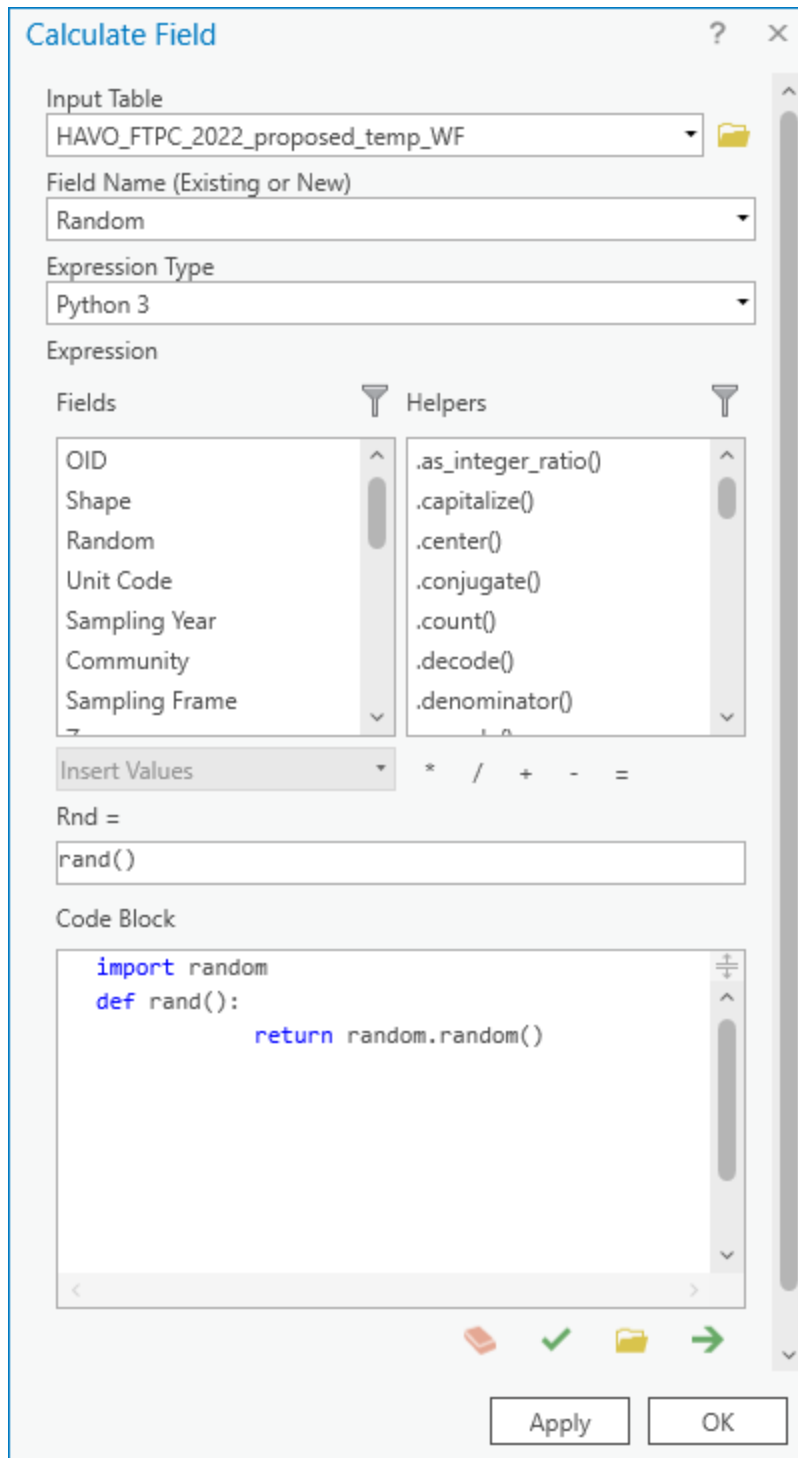


Figure SOP 5.3. Calculate Field geoprocessing tool settings and code block for generating random numbers.

6. Verify a new set of random numbers has been generated in the *Random* attribute field.

7. The rotational / alternate plot list will be sorted in the following step by the random numbers just generated – this is done to randomize the plot order.
8. Sort (ascending) the attribute table by the *Random* field. Once sorted, populate *Trans_Num* field in ascending order based on the sort, starting with rotational and then alternate plots. Rotational transects will have a two-digit number, and alternate transects will have an A prefix with a single number (starting with A1, A2, etc.). Refer to the *EIPS_transect_sampled_start_pts* feature class within the EIPS Master Geodatabase to determine the numbers to assign rotational transects (start with the next number in the sequence for that sampling frame). Also populate the *Trans_Type* field with 'Rotational' or 'Alternate' (Figure SOP 5.4).

	Unit Code	Sampling Year	Community	Sampling Frame	Zone	Transect Number	Transect Type	Placement	Length (m)	Azimuth	Longitude	Latitude	Random	Legacy	UTM
1	HALE	2023	Wet Forest	Kipahulu District	<Null>	31	Rotational	<Null>	1000	342	-156.061102	20.69167	0.007952	<Null>	<I
2	HALE	2023	Wet Forest	Kipahulu District	<Null>	32	Rotational	<Null>	1000	101	-156.110173	20.71818	0.034856	<Null>	<I
3	HALE	2023	Wet Forest	Kipahulu District	<Null>	33	Rotational	<Null>	1000	298	-156.110687	20.73095	0.069246	<Null>	<I
4	HALE	2023	Wet Forest	Kipahulu District	<Null>	34	Rotational	<Null>	1000	299	-156.087022	20.696	0.082371	<Null>	<I
5	HALE	2023	Wet Forest	Kipahulu District	<Null>	35	Rotational	<Null>	1000	147	-156.088355	20.71143	0.147518	<Null>	<I
6	HALE	2023	Wet Forest	Kipahulu District	<Null>	36	Rotational	<Null>	1000	216	-156.118126	20.70047	0.155557	<Null>	<I
7	HALE	2023	Wet Forest	Kipahulu District	<Null>	37	Rotational	<Null>	1000	228	-156.08218	20.697	0.199214	<Null>	<I
8	HALE	2023	Wet Forest	Kipahulu District	<Null>	38	Rotational	<Null>	1000	264	-156.108204	20.73514	0.241074	<Null>	<I
9	HALE	2023	Wet Forest	Kipahulu District	<Null>	39	Rotational	<Null>	1000	308	-156.124708	20.68942	0.276968	<Null>	<I
10	HALE	2023	Wet Forest	Kipahulu District	<Null>	40	Rotational	<Null>	1000	255	-156.089435	20.70997	0.353238	<Null>	<I
11	HALE	2023	Wet Forest	Kipahulu District	<Null>	A1	Alternate	<Null>	1000	342	-156.101151	20.67735	0.403898	<Null>	<I
12	HALE	2023	Wet Forest	Kipahulu District	<Null>	A2	Alternate	<Null>	1000	323	-156.089667	20.67927	0.50909	<Null>	<I
13	HALE	2023	Wet Forest	Kipahulu District	<Null>	A3	Alternate	<Null>	1000	98	-156.11034	20.71667	0.532656	<Null>	<I
14	HALE	2023	Wet Forest	Kipahulu District	<Null>	A4	Alternate	<Null>	1000	54	-156.13506	20.722906	0.561721	<Null>	<I
15	HALE	2023	Wet Forest	Kipahulu District	<Null>	A5	Alternate	<Null>	1000	359	-156.125924	20.69478	0.641127	<Null>	<I
16	HALE	2023	Wet Forest	Kipahulu District	<Null>	A6	Alternate	<Null>	1000	272	-156.111241	20.699686	0.665281	<Null>	<I
17	HALE	2023	Wet Forest	Kipahulu District	<Null>	A7	Alternate	<Null>	1000	183	-156.129979	20.704691	0.808071	<Null>	<I
18	HALE	2023	Wet Forest	Kipahulu District	<Null>	A8	Alternate	<Null>	1000	317	-156.093355	20.712222	0.811663	<Null>	<I
19	HALE	2023	Wet Forest	Kipahulu District	<Null>	A9	Alternate	<Null>	1000	119	-156.115924	20.708913	0.849571	<Null>	<I

Figure SOP 5.4. Attribute Table sorted by *Random* field, with Plot Number (*Plot_Num*) and Plot Type (*Plot_Type*) fields populated appropriately. This figure is taken from FTPC and for EIPS the *Plot_Num* and *Plot_Type* would instead be *Trans_Num* and *Trans_Type*.

8. Assign random azimuths to each plot (Figure SOP 5.5).
 - a. Open the attribute table and select the *Azimuth* field. Right-click on the attribute field header and select the Field Calculator.
 - b. Use the Field Calculator to generate a set of random numbers between 1 and 360 for cells in the *Azimuth* field. Within the Field Calculator, change the Parser type to Arcade.

Type the following code in the Azimuth = box:

```
random() * (360 - 1) + 1
```

Click OK. The *Azimuth* field should be populated with random values between 1 and 360. Assuming the field type was set to short integer as specified, these will be whole numbers.

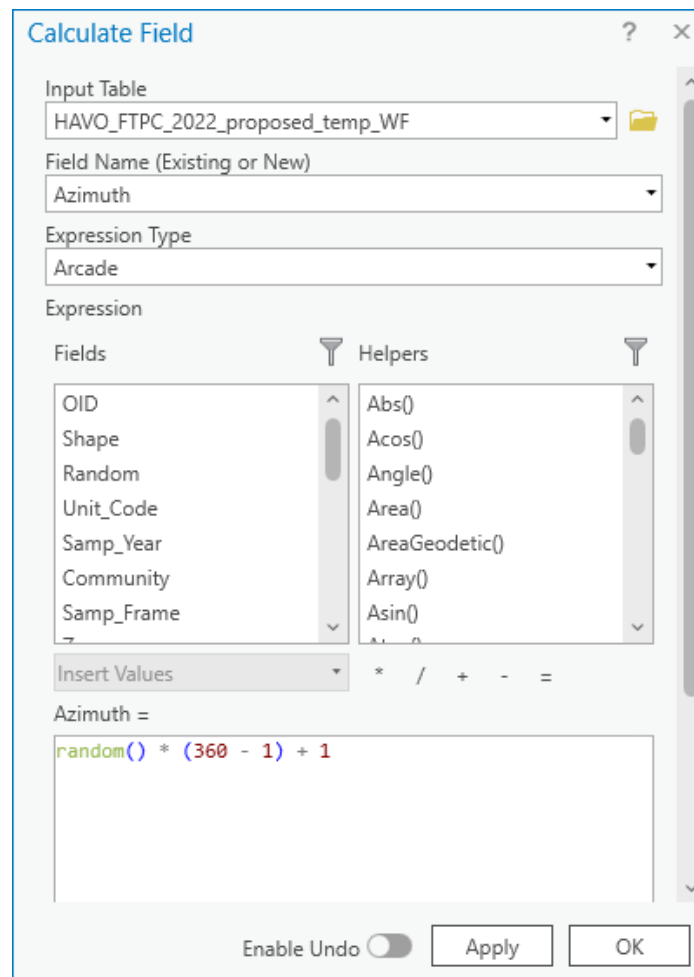


Figure SOP 5.5. Calculate Field geoprocessing tool settings and code block for generating random numbers between 0 and 359 for plot azimuths.

9. Run the *Sort* Geoprocessing Tool (Figure SOP 5.6).
 - a. Select the feature class containing the random points created in the previous steps for *Input Dataset*.
 - b. Select 'Random' for the *Sort Field* drop-down menu and 'Ascending' for *Sort Method*.
 - c. Specify your *Output Dataset* to the temp file geodatabase created in Step 2, and name the output feature class as desired. Suggested feature class name = "[PARK]_EIPS_[YYYY]_proposed_temp_[sampling_frame_abbreviation]_sort"

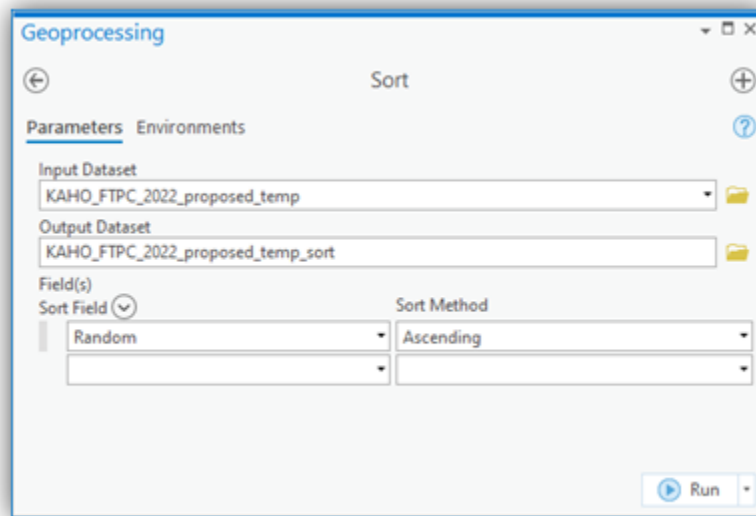


Figure SOP 5.6. The Sort geoprocessing tool in ArcGIS Pro.

10. Once the previous steps are complete, consult the PACN Botanist to verify rotational and alternate plot locations do not inhabit any previously unknown hazards, new exclusion zones, or any otherwise areas that are otherwise known to be unavailable for sampling.

Rotational/Alternate Transect Line Generation (HAVO and HALE)

This method for generating random transect line within a sampling frame applies to two EIPS plant communities detailed in the previous section: Wet Forest and Subalpine Shrubland at HAVO and HALE. End points must also be generated, but it is easier to do that once the proposed rotational transect lines have been created.

1. Within the temp geodatabase created in the previous section (EIPS_[YYYY].gdb), create a new feature class as follows:
 - a. Name = "[Unit_Code]_EIPS_[YYYY]_transect_lines"
 - b. Feature Class Type = Line

- c. M values and Z values unchecked (not a big deal if they are checked)
- d. Fields assigned as follows (can also import fields from a previous year's feature class)
 - i. Unit_Code (Text, 5)
 - ii. Samp_Year (Double)
 - iii. Community (Text, 50)
 - iv. Samp_Frame (Text, 50)
 - v. Zone (Text, 50)
 - vi. Trans_Type (Text, 24)
 - vii. Trans_Num_Full (Text, 5)
 - viii. GIS_length (Long)
 - ix. Trans_Num_sort (Long)
 - x. Azimuth (Short)
- e. Spatial Reference = WGS 1984
- f. Click Finish after page 3 (no changes pages 4-6 of the tool)

Create Feature Class

Define

Name

HALE_EIPS_2023_transect_lines

Alias

HALE EIPS 2023 Transect Lines

Feature Class Type

Type of features stored in the feature class.

Line

Geometric Properties

☐ M Values - Coordinates include M values used to store route data.
 ☒ Z Values - Coordinates include Z values used to store 3D data.

☒ Add output dataset to current map

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Previous

Next

Finish

Cancel

Create Feature Class

Fields

Import

Delete

Field Name	Data Type
OBJECTID	OBJECTID
SHAPE	SHAPE
Unit_Code	Text
Samp_Year	Double
Community	Text
Samp_Frame	Text
Zone	Text
Trans_Type	Text
Trans_Num_Full	Text
GIS_length	Long
Trans_Num_sort	Long
Azimuth	Short

Click here to add a new field

Click any field above to see its properties.

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Next

Finish

Cancel

Create Feature Class

Spatial Reference

This page is read only. The spatial reference is inherited from the feature dataset

Select the Coordinate System to view the available options.

Current XY

Details

WGS 1984

XY Coordinate Systems Available

Search

Favorites

NAD 1983 (2011)

NAD 1983

WGS 1984

NAD 1983 (MA11) UTM Zone 55N

NAD 1983 (PA11) UTM Zone 2S

NAD 1983 (PA11) UTM Zone 4N

NAD 1983 (PA11) UTM Zone 5N

NAD 1983 UTM Zone 10N

NAD 1983 UTM Zone 4N

NAD 1983 UTM Zone 5N

WGS 1984 UTM Zone 4N

WGS 1984 UTM Zone 55N

WGS 1984 UTM Zone 5N

Geographic Coordinate System

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Next

Finish

Cancel

Figure SOP 5.7. Creating the Transect Line feature class for rotational transects in ArcGIS Pro.

PACN Established Invasive Plant Species Monitoring Protocol

SOP 5.11

2. Draw the transect lines for the proposed rotational and alternate (Figure SOP 5.8). This is done manually.
 - a. Add the transect lines feature class to the active map, if not already done. The rotational/alternate transect start points layer created in the previous section should also be on the active map.
 - b. Turn on labeling for the transect start points layer.
 - c. Make sure snapping is enabled for the transect start points layer and turned on in the active map/project.
 - d. Set the default distance and angular units in the Pro Project settings. Go to Project > Options. Select units on the left-hand menu. Expand the Distance Units table and select *Meter* as the default unit. Expand the Direction Units table and select *North Azimuth* as the default unit. Hit ok, and then go back to the project's active map.
 - e. From the Edit Tab on the ribbon within ArcGIS Pro, click on Create, and then select the transect line feature class from the create features template list that will appear.
 - f. If desired, configure the template with the *Unit_Code*, *Samp_Year*, *Community*, *Samp_Frame*, *Zone*, and *Trans_Type* populated as appropriate.
 - g. Draw the transect lines, starting with the lowest numbered rotational transect start point. Snap to the start point and place the first vertice for the line feature on the transect start point. Then right click and select *Distance/Direction* from the menu. Enter the azimuth for the transect in the Direction box (should list 'NAz' behind it) and enter the length between photo point segments (See [Appendix SOP 5.a](#), Table 5.a.1) in the distance box (should list 'm' behind it), then hit enter. This should place another vertex for the line at the desired distance and direction. Repeat this using the distance/direction command until the full length of the transect is drawn (usually 5 segments), and then complete the line. Repeat this for all the rotational and alternate transects. If done is ascending order based on transect number, the following step will be easier.
 - h. If the transect cannot be drawn at the specific azimuth (insufficient room in sampling frame, crosses excluded features, etc.), rotate the azimuth 90° clockwise and attempt again. Repeat until a suitable azimuth can be found. If sufficient space does not exist in any direction, discard the point and create a new one. If a different azimuth is used, update the *Azimuth* field for the start point in the point feature class.
 - i. After the lines are drawn, populate the *Trans_Num_Full*, *Azimuth*, and *Trans_Num_short* fields for each line.

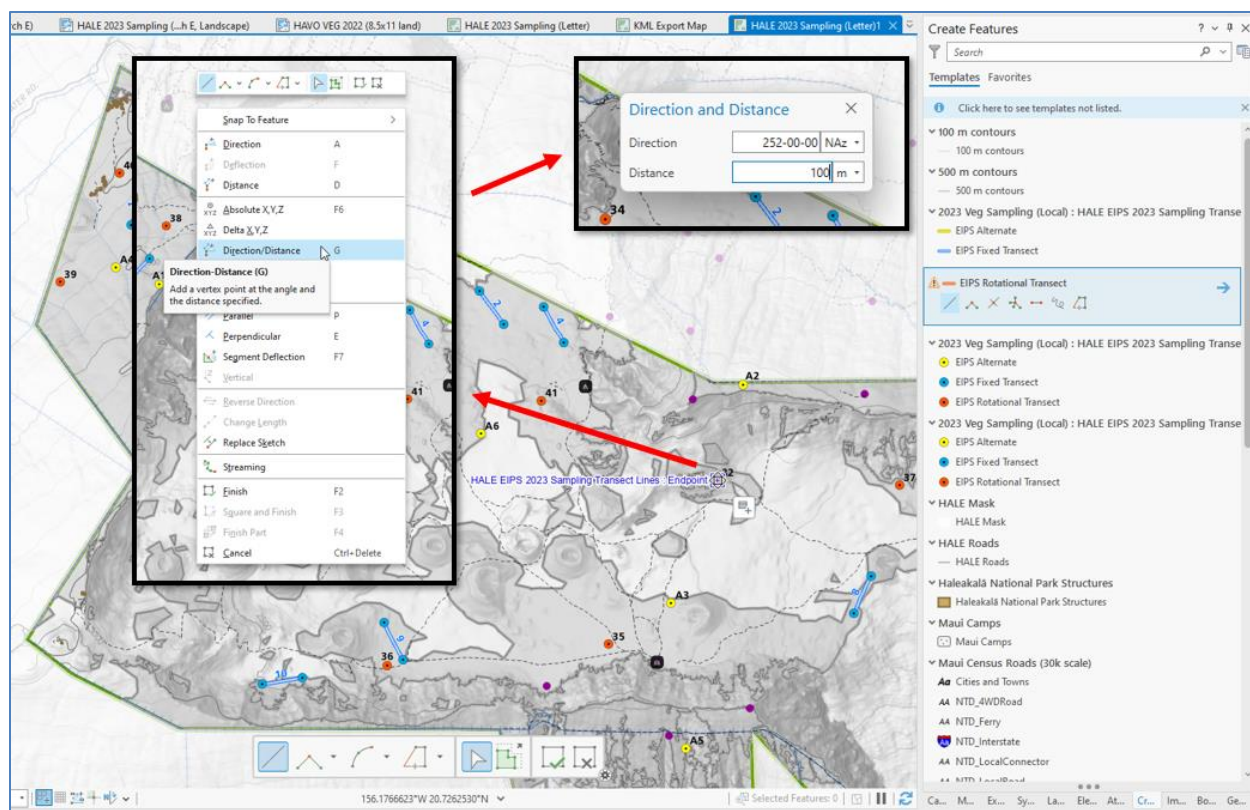


Figure SOP 5.8. Drawing transect lines for rotational transects using the Distance/Direction function within Create Features in ArcGIS Pro.

Rotational/Alternate Transect End Point Generation (HAVO and HALE)

Following start point generation and transect line generation, end points can be generated for rotational and alternate transects in the previously described sampling frames.

1. Resume editing in the point feature class previously used to generate the start points for rotational/alternate transects (Edit tab in the ribbon > Create Features > select appropriate template from the Create Features pane).
2. If desired, configure the template with the *Unit_Code*, *Samp_Year*, *Community*, *Samp_Frame*, *Zone*, and *Trans_Type* fields populated as appropriate.
3. Create the end points for the rotational/alternate transects by snapping to the ends of transect lines drawn in the previous section. Do this in ascending order for each sampling frame starting with the lowest numbered rotational transect, followed by the alternate transects.
4. Once rotational/alternate transect end point creation is complete, populate all remaining attribute fields for the end points as described in steps 4 and 7 of the start point generation section of this SOP. (One difference - the *Placement* field will be populated with the value 'End' instead of 'Start' for these end points).

5. If desired, run the Sort geoprocessing tool (previously described in Step 10 of the Start Point Generation section), sorting by *Trans_Num_Full* field (ascending), and then by *Placement* field (descending).

Rotational/Alternate Transect Generation (KALA)

Due to the culturally sensitive nature of the KALA coast, no posts were placed along the EIPS transects in the field during the initial sampling; because of this all KALA EIPS transects are now considered rotational.

The initial KALA EIPS transects (sampled in 2012), were proposed to start near the coastline in their respective substrate sampling frames, run on the same azimuth (Hoolehua / Sandy = 220° and Kalawao / Rocky = 214°), and set parallel to each other approximately 150 meters apart. In each subsequent sampling cycle (2017, 2024, and future cycles), proposed transects (11 for Hoolehua / Sandy and 16 for Kalawao / Rocky) are moved another 25 meters perpendicular to the original transect azimuth (Sandy: moved 25 m at 130° and Rocky: moved 25 m at 151°) and run on the same azimuth and length as the previous cycle's transect that each is referencing. Every fourth cycle, the transects are moved back to their original reference point from the initial 2012 transects. Actual start points may be moved inland slightly if the proposed location is too close to the water's edge.

KALA transects are also not a fixed length. 250m is the baseline length, however the transect start is placed as close to the shoreline as vegetation conditions permit (i.e. within Coastal Strand vegetation type), and then the transect is run through the Coastal Strand vegetation type and terminated when that vegetation type transitions away from Coastal Strand (generally between 200-300 meters). That decision is made on the ground by field crews and for that reason no proposed end points are generated for rotational transects at KALA. Transect lines are generated as a reference tool. See Figure SOP 5.9, below.

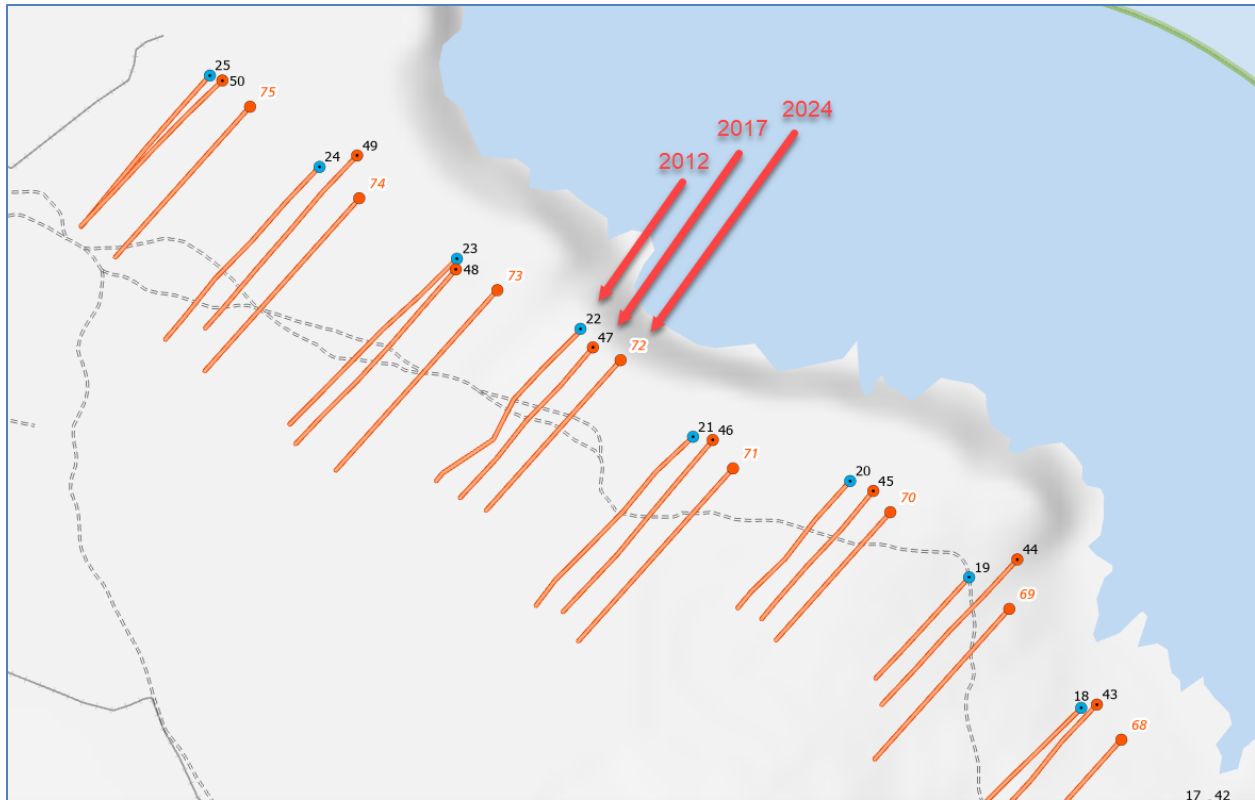


Figure SOP 5.9. Layout of the KALA EIPS Transects. All transects are rotational, set 150m apart parallel to one another, and run at the same azimuth in each sampling frame.

Rotational transect start points and lines for KALA can be generated as follows (Figure SOP 5.10):

1. Follow steps 1 and 2 from the start point creation section for HAVO and HALE to open a Pro Project, create a working geodatabase, etc.
2. Create new features classes in the working geodatabase for the transect start points and the transect lines, respectively (see Step 3B in HAVO/HALE Transect Start Point Section and Step 1 in the HAVO/HALE Transect Line Section for suggested naming conventions of these feature classes).
3. Add data layers for the previous sampling cycle's transect start points and transect lines to the project.
4. Select the previous sampling cycle's transect start/end point features. In the Edit tab within the Pro ribbon, select Copy, and then select Paste Special (drop-down option from Paste button). Select the new start/end point feature class as the destination and hit ok. A copy of the previous cycle's start/end points should now be in the new start point feature class.
5. Select the newly pasted set of start points in the new feature class and use the Move tool to move all points the correct distance and direction from the previous cycle's start locations (Hoolehua / Sandy: moved 25 m at 130° and Kalawao / Rocky: moved 25 m at 151°).

6. Edit the attribute data of the new features. Update the *Trans_Num* field values to the rotational transect numbers for the upcoming sampling cycle. Update the *Samp_Year* field values to the correct year for the upcoming sampling cycle. Recalculate geometry for the *Latitude* and *Longitude* fields.
7. Repeat steps 4-7 for the transect lines.

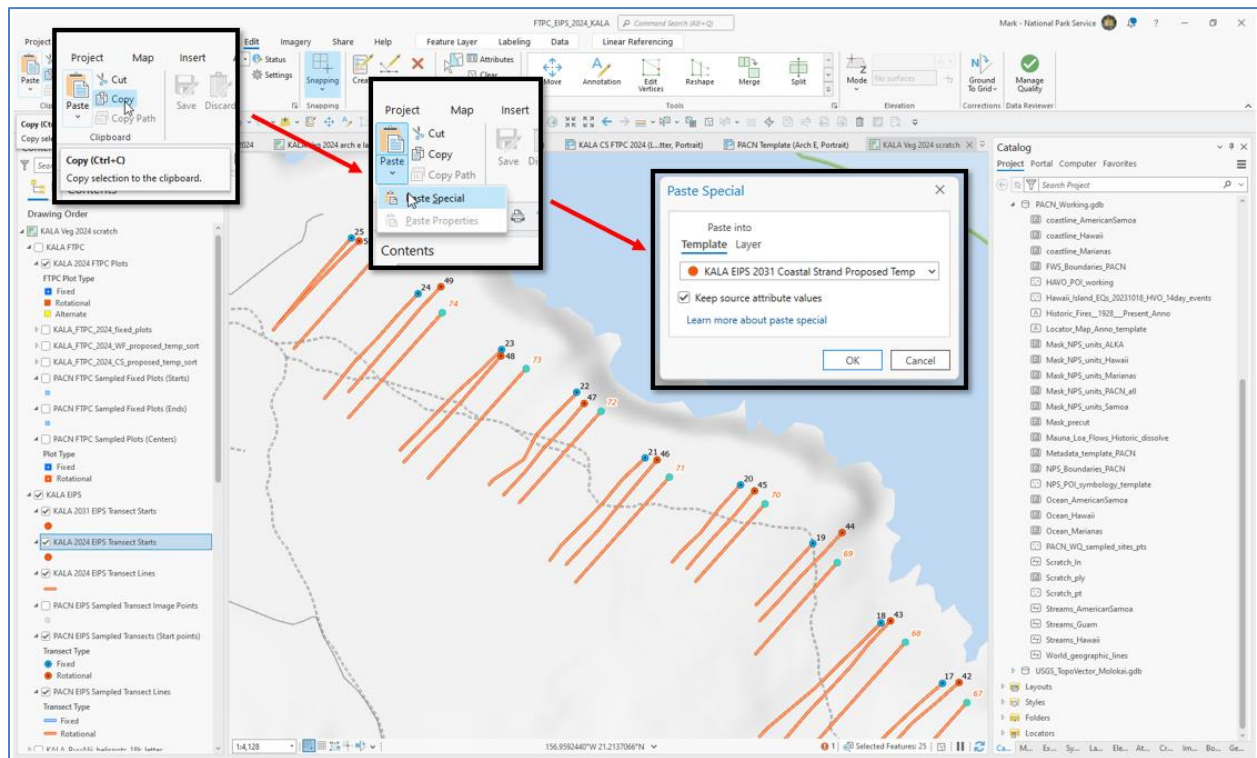


Figure SOP 5.10. Using the *Copy* and *Paste Special* commands in ArcGIS Pro to copy the previous cycle's start points for KALA EIPS Transects.

Data Management Following Rotational Plot Point Generation

After the generation of Rotational/Alternate Transect Start Points, End Points, and Transect lines, there are several data management steps that must be completed before the field season.

1. Append the feature classes for Rotational/Alternate Transect Start/End Points and Transect Lines generated in the previous sections to the *EIPS_transect_proposed_pts* and *EIPS_transect_proposed_In* feature classes, respectively, within the EIPS Master Geodatabase.
 - a. If the local copy of the EIPS Master Geodatabase (*PACN_EIPS_MASTER.gdb*) has not already been added to your Pro Project, navigate and add it via the Catalog Pane. (See Section 1 of the Start Point Generation Section for the location of the Master Geodatabases and other programmatic spatial data on EIPS Monitoring Archive within PACN SharePoint. Local copies can be downloaded from that location).

- b. From Catalog, make a copy of the local copy of the EIPS Master Geodatabase, and rename that copy with the date on the end of the name (PACN_EIPS_MASTER_[YYYYMMDD].gdb). This dated copy of the local copy of the master is for archival.
 - c. From the Catalog Pane, right-click on the EIPS_transect_proposed_pts feature class within the local EIPS Master Geodatabase copy (undated version from Step A) and select Load Data. This will open the Append geoprocessing tool and automatically populate the EIPS_transect_proposed_pts feature class as the Target Dataset.
 - d. Select the feature class of Rotational/Alternate Transect Start/End Points generated in the previous section as the Input Dataset.
 - e. Target Dataset should already be populated to EIPS_transect_proposed_pts.
 - f. For *Field Matching Type*, select ‘Use the field map to reconcile field differences’ from the drop-down menu. The *Output Fields* schema should match very closely, make any changes as needed.
 - g. Run the Append tool. Once complete, verify the year’s Rotational and Alternate points have been added successfully to the EIPS_transect_proposed_pts feature class.
2. Replace the EIPS Master Geodatabase in the EIPS programmatic “[Data](#)” folder of the PACN Monitoring Archive with the updated local copy (the undated version) which includes the newly generated random points. The dated version (from Step B above) can have the date should be uploaded to the “Archive_versions” folder within that root “[Data](#)” folder.

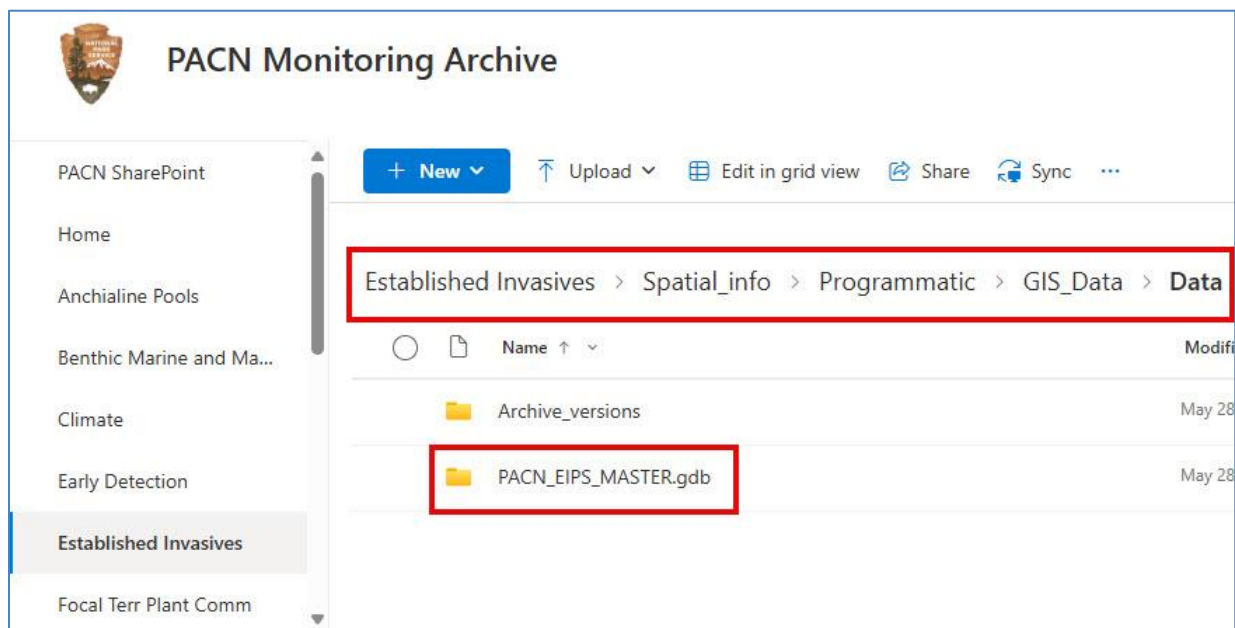


Figure SOP 5.11. Placing current copy of the master EIPS geodatabase into PACN Monitoring Archive.

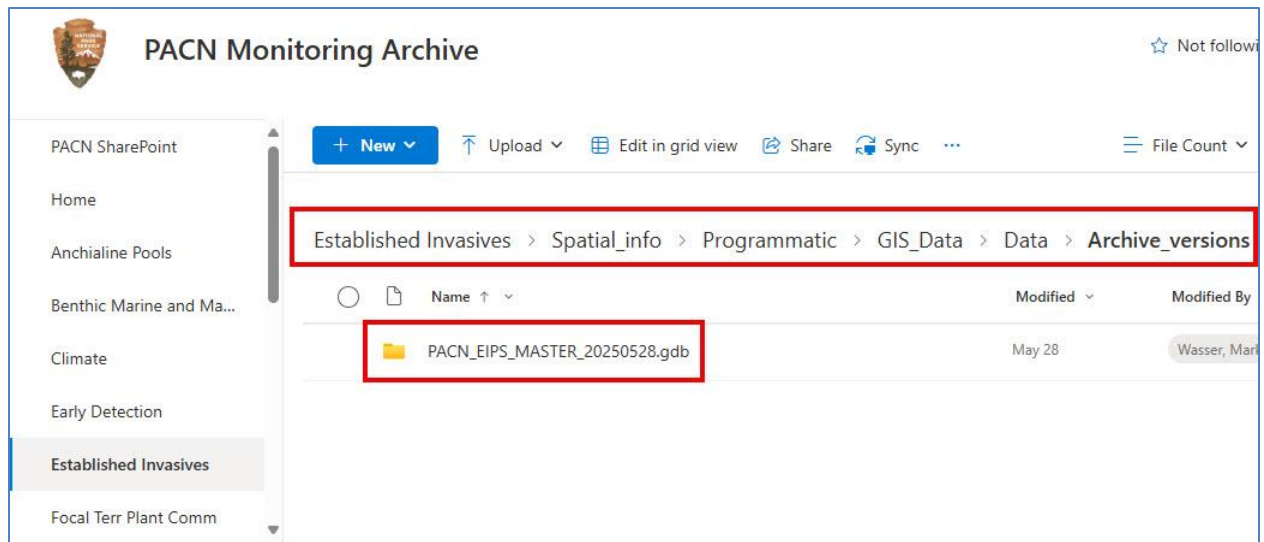


Figure SOP 5.12. Placing archival (dated) copy of the master EIPS geodatabase into PACN Monitoring Archive.

3. HAVO and HALE Only – Create a new feature class containing all the monitoring plots for the current field season (Fixed, Rotational, and Alternate) (Figure SOP 5.13).
 - a. If not done already, add the EIPS_transect_sampled_start_pts feature class within the EIPS Master Geodatabase to the local Pro Project.
 - b. Apply a definition query to the EIPS_transect_sampled_start_pts feature class to display only the fixed plots for the current sampling frame(s).
 - c. Use the Merge geoprocessing tool to create a new feature class that combines the fixed plots from the EIPS_transect_sampled_start_pts feature class with the rotational and alternate plots feature class created in the previous sections.

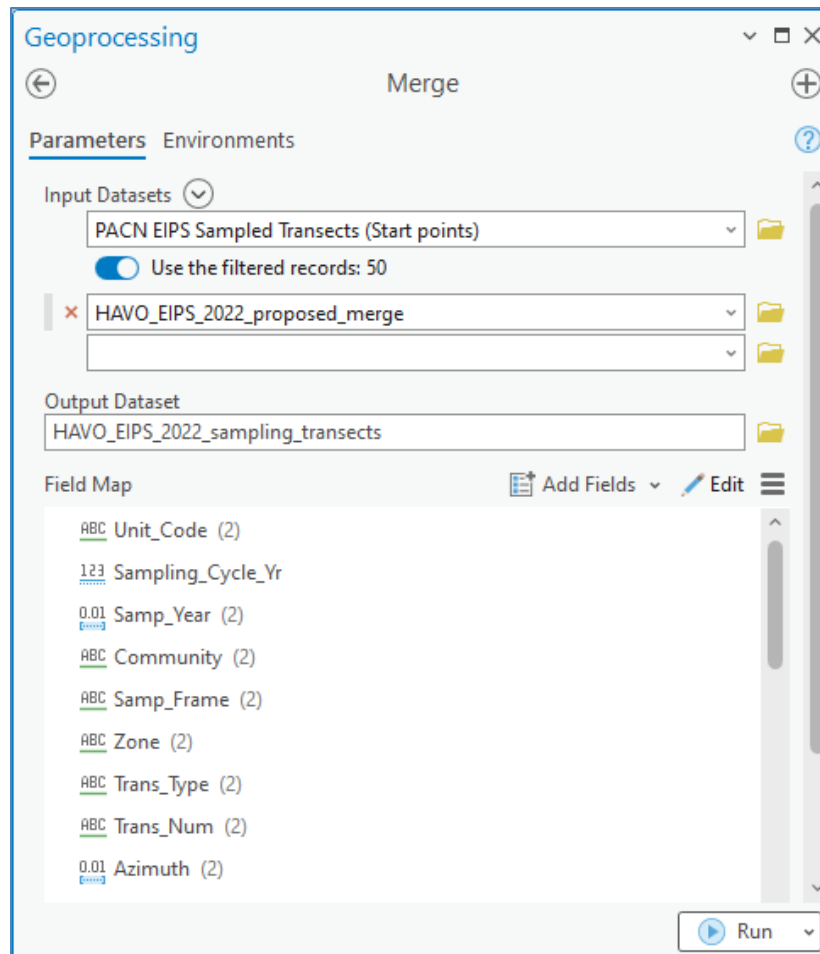


Figure SOP 5.13. Merge geoprocessing tool used to combine existing fixed transects and newly created rotational and alternate transects into a single feature class.

4. Export the newly created feature class with all sampling plots for the current year (or, in the case of KALA, the proposed rotational transect feature class since that is all the plots) as a shapefile to the local temp directory (Figure SOP 5.14). To export, right-click on the feature class in the Contents Pane, then select Data > Export Features. Naming convention = *[PARK]_Transects_[YYYY]_starts_ends.shp*

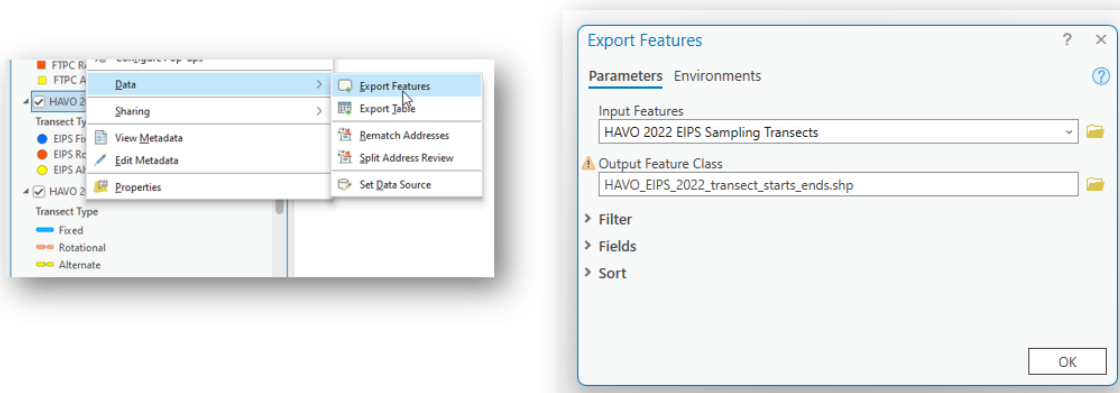


Figure SOP 5.14. Exporting feature class containing sampling transects to a shapefile.

5. Copy the newly created shapefile to the directory listed below within the [EIPS Monitoring project workspace](#) on the PACN SharePoint (Figure SOP 5.15). This will be used by field staff to upload sampling points to Garmin GPS units. Within the [EIPS Monitoring project workspace](#), copy new shapefiles to –
[Spatial Info/\[YYYY\]/\[PARK\]/GIS_Data/Shapefiles_for_upload/](#)

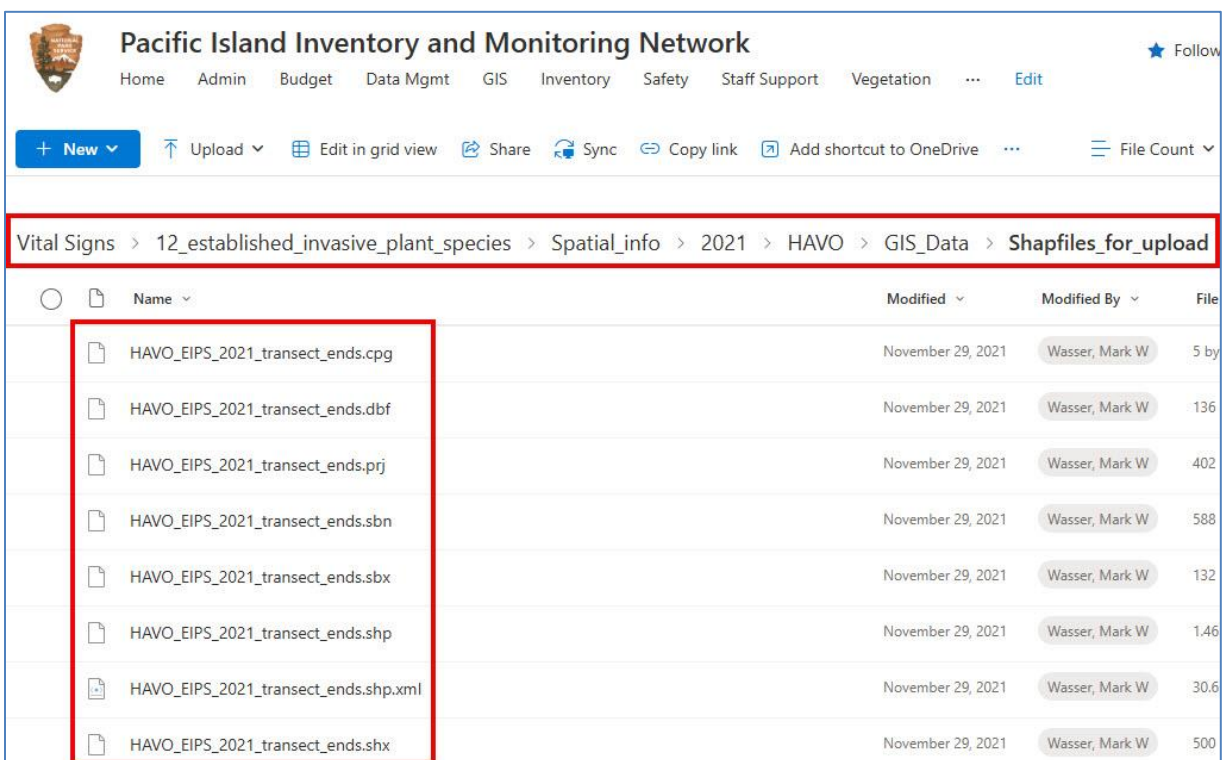


Figure SOP 5.15. Example of exported shapefile location for a particular year and park in SharePoint.

6. Publish the feature class of all sampling points for the current year created in Step 3 of this section to ArcGIS Online (AGOL) for use in electronic data collection with the Field Maps® App. (Publishing privileges in AGOL are required to complete this step).
 - a. From the Contents pane, right-click on the feature class and select *Sharing > Share as Web Layer*.
 - b. Populate item details as appropriate (see Figure SOP 5.16) and select appropriate publishing location based on publishers AGOL folder structure and organization. Also specify the following parameters.
 - i. Layer Type = Feature
 - ii. Share with PACN_Vegetation Group
 - iii. Enable Editing
 - iv. Enable Sync
 - v. Enable Export Data
 - vi. Preserver Editor Tracking Info
 - vii. Set time zone to UTC-10:00 Hawaii

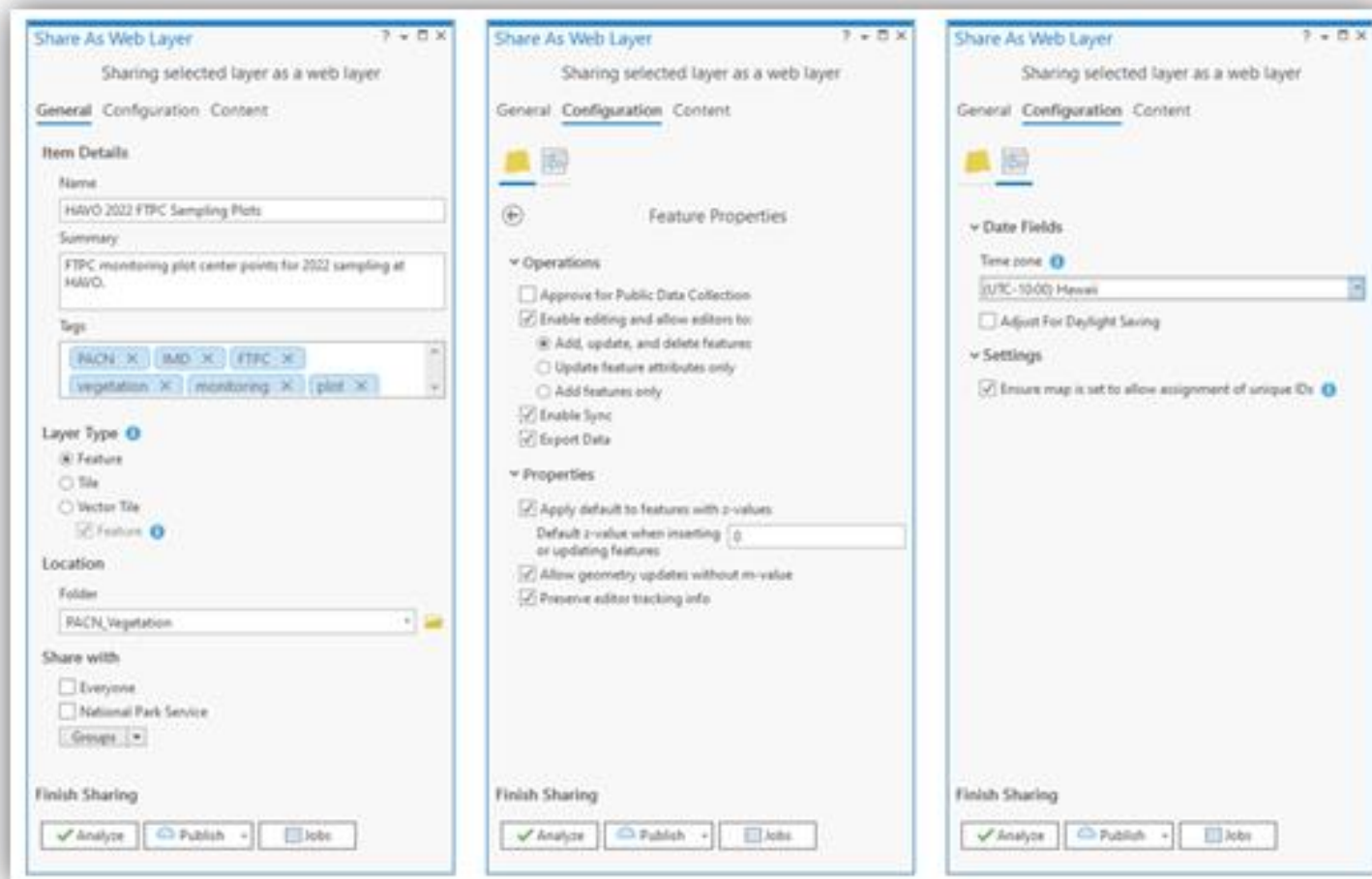


Figure SOP 5.16. Example of publication settings for sampling points feature class published to ArcGIS Online (AGOL). The screenshots are shown for FTFC – change name and tags accordingly (EIPS Sampling Transects instead of FTFC Sampling plots), but all other settings remain the same.

- c. Analyze and then Publish. Once published to AGOL, the PACN GIS Specialist will use this published layer as part of the web map deployed for electronic data collection via the Field Maps App.
7. Save a copy of the temporary File Geodatabase to the [EIPS Monitoring project workspace](#) in SharePoint as follows – [Spatial Info](#)/[YYYY]/[PARK] (Figure SOP 5.17). The ArcGIS Pro Project, Map Template, and Layout Template used for point generation are shared with FTFC and will be published to the FTFC Monitoring project workspace (detailed in [FTPC SOP #5 – Generating Sampling Point Locations with GIS](#)).

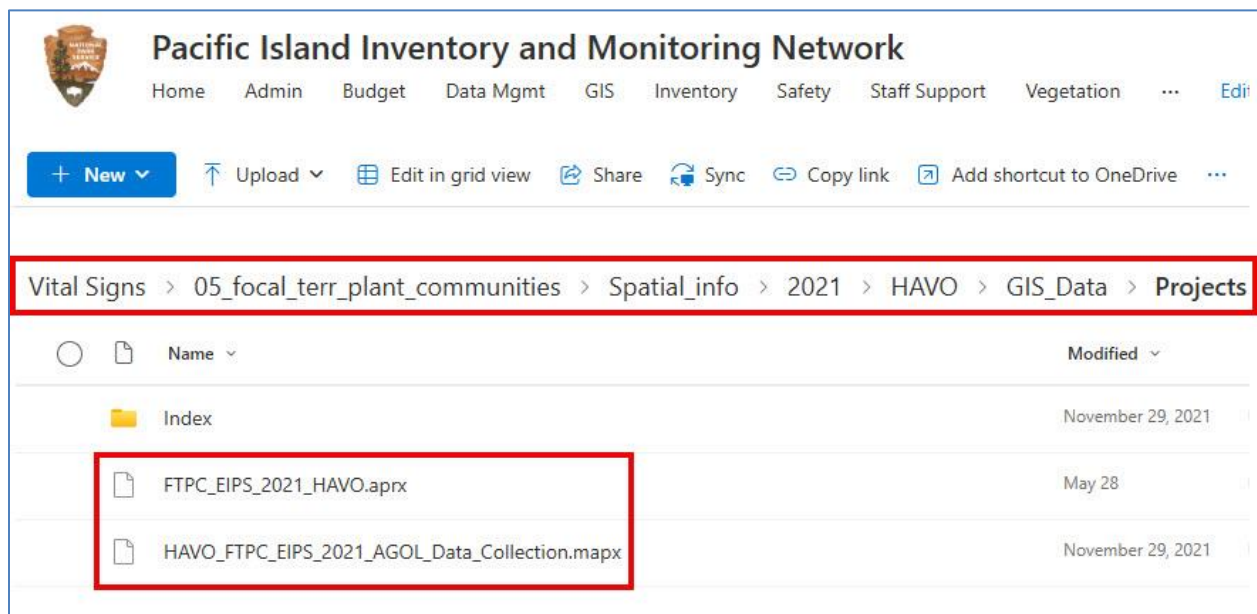
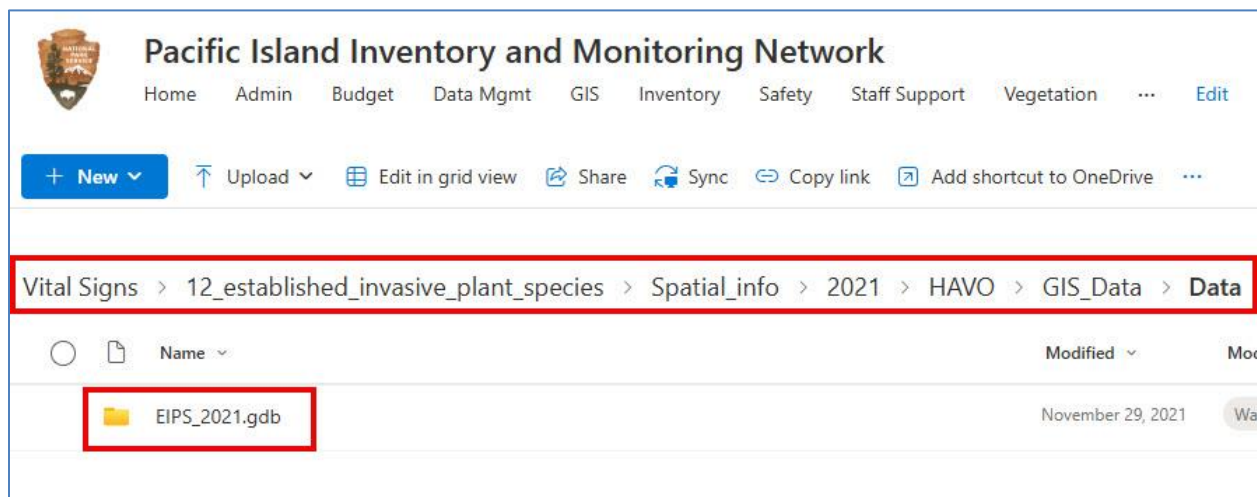


Figure SOP 5.17. Example of exported geodatabase, project, and map template locations for a particular year and park in SharePoint. The geodatabase is stored in the EIPS Monitoring Project Workspace, but the project and map templates are shared with FTFC and stored in that project workspace.

Defining Plots from Random Sampling Points

Using the random sampling points generated above, follow [SOP #6 Using Garmin GPS Units](#) to locate these points in the field, and [SOP #9 Establishing and Marking Vegetation Monitoring Plots](#) to establish and mark rectangular plots around these points.

Literature Cited

- Ainsworth, A., P. Berkowitz, J. D. Jacobi, R. K. Loh, and K. Kozar. 2011. Focal terrestrial plant communities monitoring protocol: Pacific Island Network. Natural Resource Report NPS/PACN/NRR—2011/410. National Park Service, Fort Collins, Colorado.
- Camp, R. J., T. K. Pratt, C. Bailey, and D. Hu. 2011. Landbirds vital sign monitoring protocol – Pacific Island Network. Natural Resources Report NPS/PACN/NRR—2011/402. National Park Service, Fort Collins, Colorado.

Appendix SOP 5.a. Methodology Used for generation of initial fixed and rotational transects for first monitoring cycle, 2010-2014.

Procedures for Generating Fixed Transects and Initial Rotational Transects

Fixed transects were established along available legacy transects. Subsections of the legacy transects were selected as fixed transects using the “Random Point on Polylines” feature of the ET GeoWizard extension for ArcGIS. Most areas did not have a sufficient number of legacy transects, and the remaining fixed transects were randomly generated in the same fashion as the rotational transects. Rotational transects for the initial sampling cycle were generated in ArcMap® 9.3 using the “Random Point Generation” tool within Hawth’s Tools. Generating new rotational and alternate transects for future sampling cycles follows a two-step procedure: (1) generate buffers and screen hazards and (2) generate transects. The GIS specialist has the necessary ArcMap documents and base layers (park boundaries, streams, roads, etc.) to generate the required rotational transects for subsequent sampling cycles, as described below. To the greatest extent possible, this protocol will share transects with the PACN Landbirds (Camp et al. 2011) and Focal Terrestrial Plant Communities (Ainsworth et al. 2011) protocols. Table SOP 5.a.1 lists the required number of each type of transect for each frame.

Table SOP 5.a.1. Guidelines for transect generation for each sampling frame. At least three alternative transects should also be generated for each sampling frame in case a new location is rejected in the field.

Park	Focal Community	Sampling Frame	Fixed Transects	Rotational Transects	Transect Length (m)	Photo Point Distance (m)	Plot Dimensions (m)	Legacy Available?
HAVO	Wet Forest	Nāhuku/ East Rift	10	10	1000	200	5 x 20	Yes
HAVO	Wet Forest	‘Ōla’a	10	10	1000	200	5 x 20	Yes
HAVO	Wet Forest	Kahuku	15	15	250	50	5 x 10	Yes
HAVO	Subalpine shrubland	Subalpine shrubland	10	10	500	100	5 x 20	No
HALE	Wet Forest	Wet forest	10	10	1000	200	5 x 20	Yes
HALE	Subalpine shrubland	Subalpine shrubland	10	10	500	100	5 x 20	No
KALA	Rocky Shoreline	Coastal Strand	0*	16	Variable, around 250	50	5 x 10	No
KALA	Sandy Shoreline	Coastal Strand	0*	11	Variable, around 250	50	5 x 10	No
NPSA	Wet Forest	Ta’ū	10	10	500	100	5 x 20	Yes
AMME	Mangrove Forest	Mangrove Forest	6	0	Variable	50	5 x 10	Yes

* Due to the culturally sensitive nature of the KALA coast, no posts were placed along the EIPS transects in the field during the initial sampling; because of this all KALA EIPS transects are now considered rotational.

Generating Fixed Transects along Legacy Transects

Where possible, fixed transects were randomly established along legacy transects. If not all of the fixed transects could be placed along legacy transects, new transects as well as alternatives in case of rejection in the field were generated following the same procedures as for rotational transects. In most sampling frames, no more than one fixed transect was randomly placed along each legacy transect. Because legacy transects in NPSA and HALE are few in number but very long, in some cases more than one fixed transect was randomly placed along a legacy transect with a minimum 500 m buffer between fixed transects in those wet forest sampling frames. To generate fixed transects along existing legacy transects for the initial sampling cycle, the following procedure was used:

1. Using the “Random Points on Polylines” feature of the ET GeoWizards extension for ArcGIS (9.3), a point was generated along the selected legacy transect.
2. From the point, the fixed transect was extended the appropriate length (Table SOP 5.a.1) along the legacy transect in a randomly chosen direction.
 - If the legacy transect was too short to fit the entire fixed length in the first direction, the fixed transect was extended in the opposite direction.
 - If the length of the fixed transect still did not fit after trying both directions and the legacy transect was long enough to accommodate the entire length, the point was adjusted in the appropriate distance to accommodate the length in the first direction.
 - If a legacy transect was too short to contain the entire length of a fixed transect, the fixed length was extended past the end of the legacy transect in the first direction.
 - Once established, the sample transect was oriented in the same direction as the legacy.
3. Transect numbers and X and Y Universal Transverse Mercator (UTM) coordinates were assigned for the start and end points of each transect.

Park Special Considerations: Exceptions to the guidelines above occurred. Given the small size of the mangrove forest sampling frame, the entire length of all legacy transects was used at AMME, and no rotational transects were/are used. At KALA, the shape and size of the coastal strand sampling frame as well as management concerns regarding spread of invasive species led to the exclusion of rotational transects and a stratified array of fixed transects. Fixed transects at KALA start 16 m in from the inland edge of the sampling frame and extend to within 16 m of the coastline. They are spaced every 200 m and, for those over the same substrate type, are parallel to one another. Given the difficulty of the terrain in HALE wet forest, all transects were required to have an endpoint near or cross an existing access points such as roads, trails, or existing legacy transects.

Appendix SOP 5.b. Buffer/Hazard Screening for Transects

An important step in generating new transect locations for upcoming sampling cycles is to screen for hazards and generate buffers around all major unrepresentative features such as paved roads, boundaries, trails, etc. These buffer zones represent areas that cannot contain transect lines. Buffers are created using the following criteria for exclusion:

- Areas within 3 m of roads, trails, streams, coastlines, cultural features or other unrepresentative features.
- Areas within 50 m of existing fixed sampling transects.
- Locations with a slope greater than 70% (35°).

A buffer has already been created using the above criteria. These areas have been incorporated into a feature class used for point generation – the FTPC VEG_sampling_pt_generation_areas_ply feature class from the FTPC Master Geodatabase. This point generation area feature class is based on the EIPS/FTPC sampling frames, and has all buffers, exclusion areas, etc. created to meet plot centroid requirements described here. If using this buffer layer, always verify accuracy before using.

If a buffer around unrepresentative features does not exist and cannot be easily generated, individual points may be evaluated after generation by performing the following steps:

1. Based on the highest resolution digital elevation model (DEM) available, create a slope raster using the “Surface Tools” in Spatial Analyst. If a slope raster already exists in the I&M GIS database, this step may be skipped.
2. Run the “Extract Values to Points” tool located within the “Extraction” subfolder of the Spatial Analyst Toolset. This tool uses the slope raster to compute slope for each point.
3. Based on the interpolated slope values, discard all points that do not meet the slope criteria. Furthermore, if a plot location lies next to dangerous slopes that could fall within or on the edge of plot boundaries, eliminate this point as well. In general, only the wet forests of KALA, NPSA, and HALE have large areas with slopes greater than 70%. In the other sampling frames, extreme slopes are distributed more sparsely (if at all) across the frame.