# Standard Operating Procedure (SOP) #9

## *Conducting Invasive Plant Species Surveys*

Version 2.0 (September 23, 2022)

### Change History

| New Version # | Revision Date | Author | Changes Made | Reason for Change | Previous Version # |
|---|---|---|---|---|---|
| 2.0 | 9/23/2022 | Alison Ainsworth, Kathy Akamine, Jake Gross | Changed to all non-native species, allowed alien grasses category. Adjusted order added references to first cycle. Updated methodology | More inclusive monitoring was deemed possible after a full five-year cycle was complete. Clarified and updated methods based on the completion of second cycle of sampling. | 1.0 |
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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 describes how to establish fixed and rotational transects and collect Pacific Island Inventory & Monitoring Network (PACN I&M) Established Invasive Plant Species (EIPS) Monitoring field data for the parks in order to monitor change in richness, frequency proportion, and distribution of non-native plant species. Within PACN parks, managers have been working to control and monitor the state of their non-native plant species problem. This protocol is designed as a rapid assessment to provide systematically gathered long-term data for non-native plant species monitoring utilizing fixed and rotational transects established within major plant communities at each park.

Transect monitoring will be conducted within four plant community types: wet forest, subalpine shrubland, mangrove forest, and coastal strand. Transects in the subalpine shrubland and wet forest communities will be monitored for non-native species cover in contiguous 5 x 20 m plots. Transects located in mangrove forest and coastal strand communities will be monitored for non-native species cover in contiguous 5 x 10 m plots. Monitoring along transects will allow for a general assessment of the status and changes in overall non-native species populations within major plant communities of each park.  All transects are established using the same methodology with measuring tapes, but only the fixed transect are permanently marked for future sampling.

A master equipment list for this protocol is in SOP #1 Before the Field Season.  The equipment list should be updated as needed if this SOP is revised.  Prior to navigating to a transect, sanitation procedures outlined in SOP #4 Sanitation Protocol must be followed. Methods for generating transect locations and navigating are detailed in SOP #5 Transect Generation, SOP #6 Using Garmin GPS Units, and SOP #8 Using ArcGIS Field Maps Application.  Data forms for recording field observations are in Appendix E: Forms for Recording Field Data.

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## Locating and Accessing Transects and Plots

For each monitoring cycle, the project lead will ensure that the correct previously established start, mid, and end points for fixed transects are available and new proposed random start and end points and azimuths for rotational transects are generated. Prior to each field season, the project lead and field leader(s) will work with local park staff during the permitting process to ensure that access routes are safe (i.e., do not cross risky steep areas with >70% slopes) and efficient to minimize disturbance impacts. In some instances, field crews may travel along steep slopes if using an existing park route (e.g., trails, fence lines, park transects). All field crew members must evaluate the risks and hazards of their daily travels and are encouraged to speak up if they feel a route is unsafe. If transit is deemed unsafe, the crew may find an alternate route or may choose to reject the transect.

Access will typically be through a combination of vehicle and helicopter use, and hiking. A GPS (Global Positioning System) unit is used to navigate to the selected transect starts, but when satellite coverage is poor compasses and maps that offer topography and imagery are used. To the greatest extent possible, transect locations are pre-screened using a GIS (Geographic Information System) to eliminate steep or dangerous sites beforehand; however, in some instances field crew members may encounter unforeseen conditions that make a potential transect locations unsafe to access.

The field crew navigates to the proposed start or end point for a new fixed or rotational transect. **When navigating to an established fixed** transect, the crew will have start, mid, and end points in GPS; although all these points are available to the crew, the crew should navigate to the start or end to repeat transect as it was done previously. **When navigating to a <u>new</u> fixed or a rotational** transect, crews may choose to focus on the point closest to them (e.g., if the TR 32 end point is closest to trail that is used to reach the transect, it would be most efficient to navigate to the end point); this is fine in all sampling frames except HALE wet forest Kīpahulu District and KALA coastal strand Kalawao and Ho'olehua sampling frames. *All fixed Kīpahulu District wet forest transects should run from high to low elevation to avoid the spread of non-native species; except for Transect 7. Always consult HALE staff knowledgeable of invasive species patterns to best determine the best path for access to and from transects that avoids the spread of invasive plants. KALA coastal strand Kalawao and Ho'olehua should always be read from the coast to inland.* When navigating to a transect starting point, crews should minimize disturbance to vegetation whenever possible.

Crews should make a concerted effort to read fixed transects the same way as the prior cycle whenever possible. However, fixed transects can be monitored in the opposite direction from the previous cycle if time constraints make it impossible for the crew to complete the transect otherwise.

### *Transects Rejection Criteria and Relocation Procedures*

When the site for a new transect is reached, the field leader determines if the transect location is acceptable. The start of most monitoring transects must be buffered from streams (wider than 1 m), developed areas (e.g., roads, runways, houses, parking lots), trails, fence lines, archeological features, high tide lines, cliff faces, and park boundaries by at least 5 m for coastal transects and 20 m for forest/shrubland transects. Exceptions include, legacy fixed transects which are typically along established park trails or transects. If a pre-selected transect start location is rejected, the field crew attempts to establish an acceptable new transect location by: 1) selecting a new random azimuth, 2) moving the start up to 50 m in a random direction and selecting a random azimuth if necessary, 3) moving the start up to 100 m in a random direction and selecting a random azimuth if necessary 4) If limited safe options are available, adjusting the transect to fit within the safe area is acceptable, but randomization as described previously should be employed to the greatest extent possible 5) rejecting the proposed site all together and selecting a new alternate transect location from the preseason generated list. **Because transects vary in length and may be as long as 1000 m, it is important that before accepting any change to the original proposed transect that the field crew consult GPS and/or map to be sure that the transect stays within the sampling frame**. It is critical to include comments on the data form describing what actions were taken when a transect is moved or has an adjusted azimuth. When an alternate transect is used (e.g., A2) the alternate transect is renamed as a rotational transect (e.g., if R39 is the rejected rotation transect, A2 would be renamed as R39), all data forms must be labeled with the rotational transect number that the alternate is replacing. Data forms, photos, and GPS waypoints should be labeled as the rotational transect, as opposed to the alternate transect label.

## Establishing Transects and Plots

Two field crew members are recommended for most sampling frames. A third crew member is recommended in areas that are particularly difficult to traverse due to thick vegetation (e.g., in the Nāhuku/East Rift, Kīpahulu District, and Puerto Rico). All field crew members must have a compass with the correct declination. The plot is constructed with one long transect tape (50 m is recommended for all communities). The start of the transect is the 0 m mark of the transect. The 0 m end of the tape is held by one field crew member at the start in order to prevent slack, while the other crew member runs the tape the length of the plot (subalpine shrubland and wet forest: 20 m; mangrove wetland and coastal strand: 10 m). The transect tape is never staked in, it is only held by a crew member. The tapes measure slope distance rather than horizontal distance when the plot encompasses variable slopes (e.g., ravine) because this represents the ground area of the site more accurately. All tapes should be laid as close to the ground as practical (i.e., below vegetation).

### *Plot Layout along Transects*

The length of a plot is varied depending on their community type/sampling frame. Plot lengths differ by community/sampling frame (Figure SOP 9.1), with 20-meter plots in the larger sampling frames (subalpine shrubland and wet forest) and shorter 10-meter plots in the smaller sampling frames (mangrove wetland and coastal strand). Plot width is 5 meters for all community types. The transect is the centerline and the plot extends 2.5 m on each side. Width boundaries of the plot do not need to be marked, but distance from the centerline should be measured/visualized by using a lightweight 2.5 m pole or carpenter's tape, as needed.

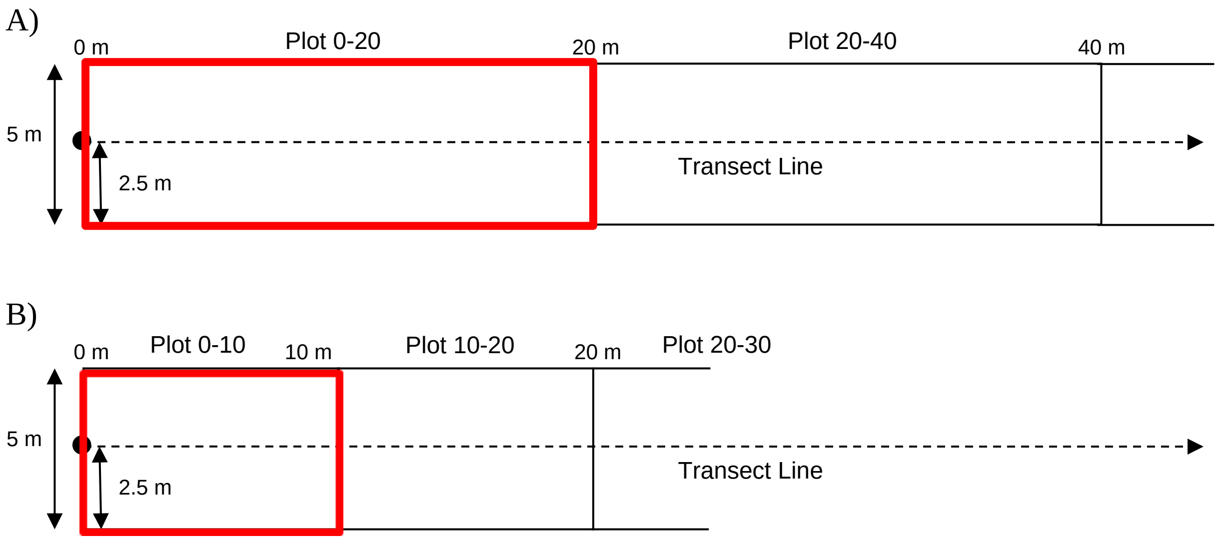


**Figure SOP 9.1.** Diagram of sampling plots established along transects. A) Subalpine shrubland and wet forest communities, plots are 5 x 20 m. B) Mangrove wetland and coastal strand plots are 5 x 10 m.

Plots are established along transects (Figure SOP 9.2.B). Total transect length varies by community/sampling frame (Figure SOP 9.2.A, Table SOP 9.1). The length of the transect varies due to the spatial constraints of the sampling frame. In wet forest (*all except Kahuku wet forest*) and in the Mauna Loa subalpine shrubland, the sampling frames are large enough to accommodate transects that are 1000 m. Conversely, transects in the mangrove wetland, coastal strand, Haleakalā subalpine shrubland, and Kahuku wet forest are confined by their linear orientation or small sampling frame size and are 500 m or shorter. *KALA coastal strand and AMME mangrove wetland transects are not uniform in length throughout a sampling frame*. In the KALA coastal strand each transect has a different length, this was done to maximize area covered in the linear sampling frame. In the AMME mangrove forest transect run from one side of the small sampling frame to the other. Some transects use one azimuth for a distance and then change azimuth to adjust to its small sampling frame.

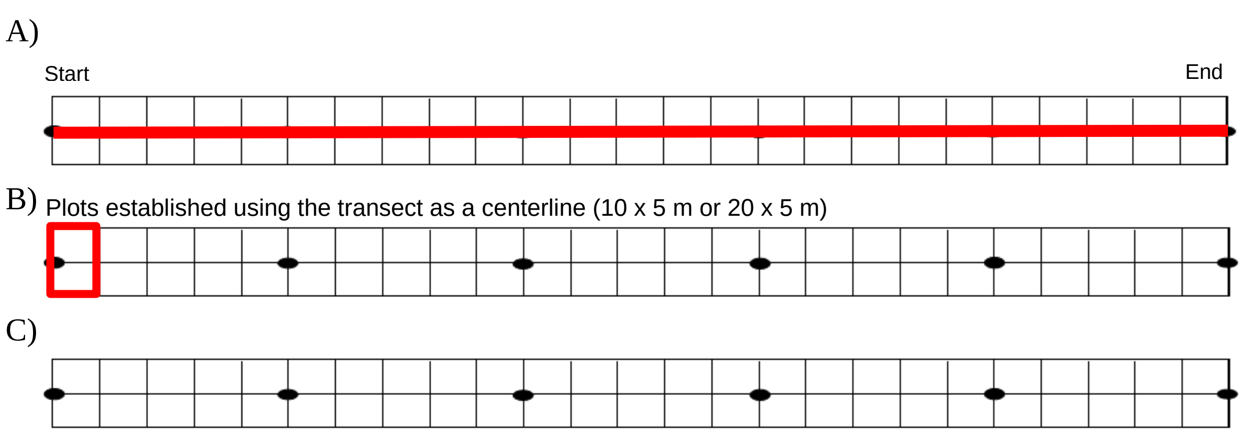


**Figure SOP 9.2.** Diagram of sampling plots established along the transect. A) Total transect length from start to the end. B) An individual plot established along the transect. C) The black dots indicate intervals designated for photos, GPS, and permanent markers. Plot interval designation explained in Table SOP 9.1.

**Table SOP 9.1.** Plot size and transect interval designation for varying transect lengths.

| Transect Length | Plot size | Photos, GPS, and Fixed plot Permanent Markers |
|---|---|---|
| Coastal strand, mangrove wetland, and Kahuku wet forests<br><500 m | 5 x 10 m | Every 50 m beginning at the start and continuing to end (e.g., 0, 50, 100, 150, 200, etc.). Total = variable (KALA 5-7), (AMME 3-8) per transect. |
| Mauna Loa and Haleakalā<br>500 m | 5 x 20 m | Every 100 m beginning at the start and continuing to end (e.g., 0, 100, 200, 300, 400, 500). Total = 6 per transect. |
| Wet forest communities*<br>1000 m | 5 x 20 m | Every 200 m beginning at the start and continuing to end (e.g., 0, 200, 400, 600, 800, 1000). Total = 6 per transect. |

*All wet forest sampling frames, except Kahuku wet forest

***New Fixed or Rotational Transects and Plots***

New fixed or rotational transects are transects that have never been set up or visited before. Field crews are provided the transect start and end for navigation and must establish the transect using the predetermined, designated azimuth. In the case that it is **more efficient to monitor the transect backwards**, the crew must document this on the data forms noting that **the proposed end point was used as the start point** and update the proposed azimuth with the new azimuth on the datasheet (i.e., the proposed azimuth + 180 = new azimuth). As the transect is walked, crew members must repeatedly check the direction of the transect to ensure it follows the intended azimuth. When establishing a new fixed transect, ensuring accurate transect azimuths will help future monitoring crews save time.

***Previously Established Fixed Transects and Plots***

Field crews should review transect data forms, photos, and efforts prior to transect visits. Operational reviews and prior monitoring cycle data forms offer guidance on the best route to the transect and any potential obstacles or safety concerns. The fixed transect should have flagging to help crew locate the transect from a distance and identify permanent posts. It is preferred that field crews monitor transects as it was done previously, if it was read from start to end, or end to start, it should be read this way again. In some instances, it may be more logistically and/or time efficient for the field crew to navigate to the point closest to them. The field lead may decide to reach transect in the most efficient manner and **notes are recorded if the established transect is read differently from the previous monitoring season.** Field crews should be aware if the transect is monitored backwards it should be recorded correctly (e.g., 500, 450, 400, etc.).

**Original transect should be replicated to best recreate the plot as it was surveyed previously**. The goal for subsequent field crews is to recreate the transect and its plots as it was surveyed previously. The associated azimuth of a fixed transect may not always be the best guidance for field crews. Thick vegetation, variations in topography, and inaccurate compass readings are a few possible reasons for a transect line deviating from the proposed/recorded azimuth. **The field crew will have all GPS points of the fixed transect and should navigate from one permanent post to**

**the next as opposed to solely relying on the transect azimuth.** When flagging is present, crews should use the markers as guidance. If previous flagging exists that runs along the transect accurately, the old flagging should be replaced with new flagging for longevity until the next sampling. If crew navigates successfully from one post to the next but original flagging could be better oriented, old flagging may be removed and replaced to better show the transect travelled. **When crews are travelling using the GPS bearing rather than the designated azimuth, crew should note the bearing used at each interval in comments** (e.g., 0-20 m bearing 178°, 20-40 m bearing 175°, etc.). In communities where the length of the plots are 10 m long (mangrove wetland and coastal strand) crews may run the transect tape 50 m at a time and have each end of the tape at a permanent post for best accuracy.

Some fixed transects in the HALE wet forest Kīpahulu District have not been sampled to completion due to slow movement through areas of thick invasive vegetation and limited time within a remote backcountry trip. Crews may add new segments to help complete a transect if time permits in new sample seasons and should note new additions on the location data sheet.

### *Addressing Obstacles*

Although major landscape barriers can be avoided using GIS tools, it is expected that the field crew may still come across some physical impediments to monitoring a transect.

- When obstacles are seen prior to monitoring a transect, they may be addressed by relocating or rejecting the transect as mentioned previously.
- When obstacles occur while sampling a transect the field crew should investigate and assess the obstacle for safety and the best way to navigate around/through it.
    - **If an obstacle is safe to navigate around/through and the transect line is unimpeded**, the field crew should monitor the plot by looking into the plot from a safe location (fig 3.A).
    - If it is not possible to safely continue the transect on its assigned azimuth but the obstacle is navigable, the crew should offset (see below) or interrupt the transect. An interrupted transect will have a physical break in it, but data will be complete, and it will function as a complete transect (Figure SOP 9.3.B). This is the best option when there is a large obstacle that runs perpendicular to the transect (e.g., an earth crack, ravine, etc.) and the obstacle may be crossed, and an offset is not feasible. When this is the best option, the crew should note on data form the location (GPS point and distance along the transect) where the transect was interrupted and where it was continued, the estimated distance that was skipped, a description of the obstacle that was encountered and how it was traversed. The field crew should clear the obstacle and attempt to realign with the last known point of the transect; this can be done by line of sight or orienting with GPS point. The distance skipped to clear the obstacle will be added to the end of the transect so that the total transect area sampled is maintained. For example, if plot 40-60 m was the last plot sampled before the

interruption, the next plot sampled after the interruption will be 60-80 m regardless of the length of the interruption. If the distance skipped was 20 m then the transect will extend 20 m beyond proposed the end point.

- If it is not possible to safely continue the transect on its assigned azimuth but the obstacle is navigable, the crew should offset or interrupt (see above) the transect. An offset transect is the best option when there is an obstacle that runs parallel with the transect and the crew cannot see a way to interrupt the transect but they can offset the transect. To set up an offset transect, the transect may be moved 10 m to the right, and if still not acceptable, then 10 m to the left of the transect when standing at the end of the last plot monitored. The start of the offset transect should be measured at a 90° angle away from the end of the previous plot. Crew should then use transect azimuth to monitor the offset transect until the obstruction is cleared. Once cleared, the field crew should re-align with the original transect; this would be recorded as a transect with offset plot(s) (Figure SOP 9.C.3). If the obstruction continues, the crew may stay on the transect without realigning; this would be recorded as an offset transect (Figure SOP 9.C.4).

- If an obstacle is too large to safely navigate around/through, this will warrant truncation of the proposed transect (Figure SOP 9.3.E). If the truncated transect is from the rotational panel and is less than half the proposed length (e.g., <250 m for subalpine shrubland), then the data collected prior to discontinuation may still be used for status estimates. If from the fixed panel, then the truncated transect is only worth including in the network of fixed transects if its length exceeds half the proposed transect length (i.e., >500 m for wet forest, *except Kahuku*). Fixed transects less than half their proposed length are not worth resampling logistically nor do they permit co-location with the PACN Landbirds (Camp et al. 2009) and Focal Terrestrial Plant Community (Ainsworth et al. 2010) protocols. These truncated fixed transects can be included in the data to improve status estimates but must be treated as temporary and will not be resampled. Truncated transects may end at a random plot interval. It is the end of the transect and should have a GPS point and photos taken and notes on reason for truncation and obstacle.

- **All deviations from the original transect should be recorded including information on distances, compass directions, and other pertinent information. Obstacles should be hand drawn on transect map on Location datasheet (Form 1).**

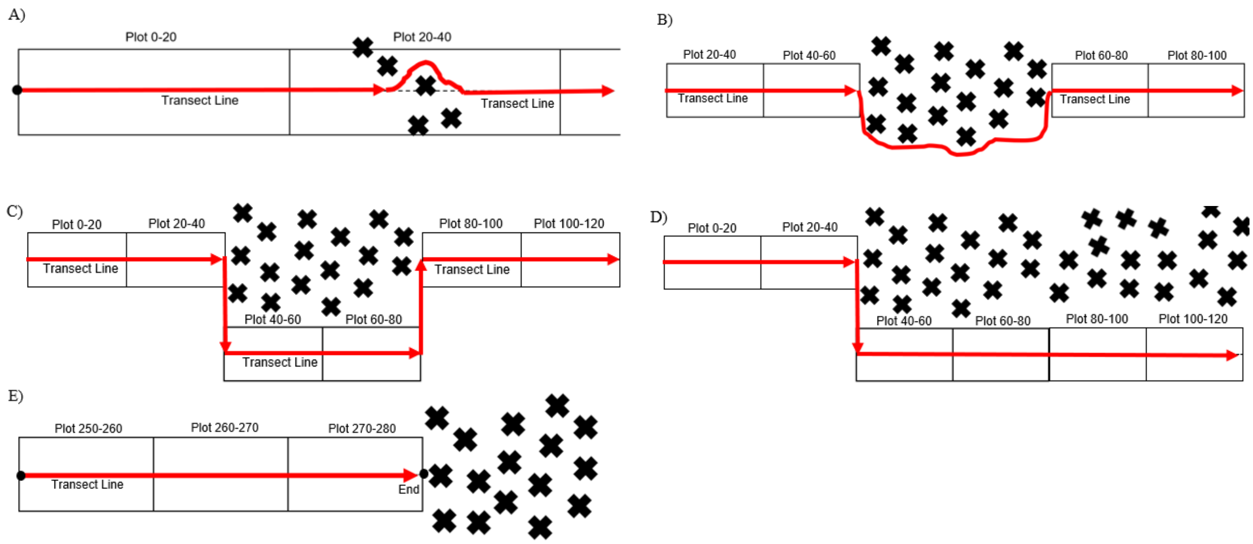


**Figure SOP 9.3.** Addressing obstacles in the field. A) Safe navigation around/through an obstacle while maintaining the transect. B) An interrupted transect. C) An offset plot(s) that returns to original transect line. D) An offset transect. E) A truncated transect.

### *Marking Permanent Fixed Transects and Plots*

Fixed transects will be revisited every five years (seven years in 2021-2027) during their designated sampling cycle.  Permanent posts are important to locate and recreate the transect and plots. Permanent posts used will vary depending on park, community type, and sampling frame (Table SOP 9.2).  Fixed transects must be marked as precisely as possible since trend analysis relies on these same plots being resampled in the future.

Permanent posts, GPS points, and photographs will occur at the beginning and end of each fixed transect as well as at designated transect intervals (Table SOP 9.1).  While rotational transects do not receive any permanent markers or flagging, GPS points and photographs are still collected at these designated plot intervals.

Flagging

Blue flagging is used along the entire length of a fixed transect to aid in navigation during revisits. Flagging is used on any “long-standing” vegetation to help assist in future location on the plot. “Long-standing” vegetation should be thought of as vegetation that will likely still be there in 6-7 years (e.g., a tree). A tree trunk is more likely to be compared to a branch; similarly, a tree fern caudex is more likely to be long-standing compared to a frond. In areas without “long-standing” vegetation (e.g., a grassland, a fernland, etc.) the crew should not use flagging, as the flagging will not survive the five years between cycles. Crews may get creative and flag anything that is “long-standing” (e.g., rocks, CWD that is sound, etc). Blue flagging is used to navigate the transect, while blue and pink (red flagging may be used interchangeably with pink) together indicate location of permanent posts at designated transect intervals where GPS points and photos are collected.

**Table SOP 9.2.** EIPS transects within each sampling frame and permanent posts used for fixed transects.

| Cycle Year | Park | Community | Sampling Frame | M = Metal Posts P = PVC posts | Transects | Fixed | Rotational |
|---|---|---|---|---|---|---|---|
| 1 | HAVO | Wet Forest | ʻŌlaʻa | M & P | 20 | 10 | 10 |
| 1 | HAVO | Wet Forest | Nāhuku / East Rift | M & P | 20 | 10 | 10 |
| 2 | HAVO | Wet Forest | Kahuku | M & P | 30 | 15 | 15 |
| 2 | HAVO | Subalpine Shrubland | Mauna Loa | M | 20 | 10 | 10 |
| 2 | KAHO | Coastal Strand | Kaloko-Honokōhau | NA | | | |
| 3 | HALE | Wet Forest | Kīpahulu District | M & P | 20 | 10 | 10 |
| 3 | HALE | Subalpine Shrubland | Haleakalā | M | 20 | 10 | 10 |
| 3 | KALA | Wet Forest | Puʻu Aliʻi | NA | | | |
| 3 | KALA | Coastal Strand | Kalawao | NA | 25 | NA | 25 |
| 3 | KALA | Coastal Strand | Ho'olehua | NA | | NA | |
| 4 | NPSA | Wet Forest | Tutuila | NA | | | |
| 4 | NPSA | Wet Forest | Taʻū | NA | | | |
| 5 | AMME | Mangrove Wetland | Puerto Rico | M & P | 8 | 8 | NA |

<u>Permanent Posts</u>

Permanent posts consist of 0.01 m x 0.5 m metal posts (e.g., rebar, stainless steel threaded rods, or something similar) covered with PVC post (when allowed, see Table SOP 9.2) and marked with pink (or red) and blue flagging. The metal posts are installed with at least 0.3 m of the rod above ground. In rocky substrates, setting the rod may require a tool (i.e., a 5 lb sledgehammer or a rubber mallet) to keep the marker vertical. Many of the rocky substrates (e.g., subalpine shrubland at HAVO and HALE and coastal strand at KALA Kalawao) have metal posts that were not buried in the ground to protect sensitive resources and ensure compliance with the National Historic Preservation Act. These sites have metal posts that were laid on the ground in relatively secure sites (i.e., should not roll away). White PVC pipe (inner diameter of 0.01 m) is slid over the metal post to increase marker visibility (Table SOP 9.2). In the subalpine shrubland and coastal strand communities additional PVC posts are NOT used.

- **All permanent posts are labeled with brass tags, all other old tags should be removed.**
    - **At the time of transect installation** permanent posts were labeled with “hard tags”. They were attached to the posts with I&M, EIPS, transect number, year and month of transect installation, appropriate transect and meter mark (e.g., 0 m, 50 m, 100 m,

etc.), and transect azimuth. In locations that permitted it, aluminum (soft) tags were labelled with the same information and were be attached to the permanent posts; therefore, each transect should have a tag on permanent post.

- **Starting in 2017**, new factory stamped permanent numbered **brass tags** were installed on the permanent posts for all fixed transects. The original hard tags were hand-dremmeled and many are illegible after five years. These new tags have an I&M identifier and a stamped number, but no information regarding which transect or meter post is labeled. It is critical that the Transect Location form (Appendix E) includes the brass tag number and that this information is transferred to the database. Because tags may be used out of numerical order (e.g., F05 50 m post: #03, F05 100 m post: #12), careful record keeping is critical.

<u>Witness Trees</u>

Witness trees are a reference for the location of a fixed transect's permanent posts. Witness trees should be marked with blue and pink (or red) flagging. If available, crews should flag a long-standing tree branch, or a suitable substitute, directly above the permanent marker. If vegetation does not permit this, then a witness tree should be chosen by their proximity to permanent posts. All witness trees should be recorded on Transect Location data form (APP E). Witness trees should be drawn on transect map with the following notes: Species, DBH, and an approximate distance and bearing from the witness tree to the post; if directly over post note branch (tree, rock, etc.) flagged and 0 m @ 0 °. Witness tree location and status should be checked every visit. If the witness tree has died, a new witness tree should be chosen, flagged, and notes on changes recorded.

## Recording Data

All data forms have the same header that should be filled out. The header includes: 1) Park Code, 2) Plant Community, 3) Location (Sampling Frame), 4) Transect #, 5) Date, and 6) Observers. All these items should be filled out on each data form, on both the front and back. Keep handwriting legible. The "Observers" field should list the data recorder initials first so if there are any follow up questions upon data entry/analysis, the data recorder can be referred to. Form 1, Plot Location, should have initials of every crew member that worked in the plot. Some data forms require multiple pages if space on the first page is exhausted (e.g., Form 3, Species Cover). If more than one page of the same form is used, the bottom of the page should be filled out to state page number and total pages (e.g., Page 1 of 4, Page 2 of 4, etc.). Prior to field work, field crew lead should have all necessary data forms and extra pages printed. Additionally, all previously sampled fixed plots datasheets will be accessible to crew in the field on tablet for reference. Table SOP 9.3 shows a breakdown of what parks are monitored and their associated communities.

### *Documenting Transect Location (Form 1)*

If a crew is visiting a new transect (e.g., rotational), or using a new route to a fixed plot, helpful instructions for future access should be included, such as: 1) any roads or trails used to reach the transect starting point, 2) the point at which the field crew left road/trail access to reach the transect starting point, and 3) the route used to reach the transect (i.e. did crew take direct route or follow a fenceline or topographic feature?). A section of the location form is available to record safety issues, problems encountered, changes, and comments. Any non-standard methods of data collection need to be documented here. Fixed transects should have permanent markers at the start, end, and in designated intervals. Field crew should note if any markers are missing/replaced or additional markers are installed. The program lead will read this section for each plot during data certification. **Providing detailed notes on the location form "comments" section is the best way to ensure protocol and data issues are permanently documented and corrected.**

**If there is a problem when monitoring a fixed transect** (e.g., a post installed in an incorrect spot, missing post, etc.) the crew should note it on the datasheet and no action is necessary. During the following monitoring cycle all problems should be assessed by the project lead, lead vegetation technician, and/or field crew lead. **Each problem should have a plan of action and upon subsequent monitoring the problem should be verified and addressed as planned**; the crew should record notes on actions taken and problem addressed. If the problem is disproved (e.g., post exists in the correct spot), the crew will record notes that the problem was disproven, and no action needed.

The field leader or a designated crew member with good attention to detail creates a hand drawn map of the transect. A map should be drawn for all transects; however, fixed transects require extra detail and information, complete with permanent post locations and distances and directions from witness trees to the permanent posts. It is also helpful for any other distinct features (proximity to road, trail, or fence line, topography, disturbances, etc.). It is essential that clear text be included for locating transects and future transect setup so that the transect can be reread even if posts are missing. Other important items to note on the map include rare or endangered species so that crews can easily note presence or absence of the species in the future. Hand drawn maps need to be updated for each fixed transect. Good notes are important as future field crews will rely on the details of this page.

### *Collecting GPS Points (Form 2)*

Latitude and longitude of **are collected at each designated transect interval (Figure SOP 9.2.C)**. Physically writing the coordinates on the datasheet is required (used as a backup) for rotational plots, new fixed plots, or fixed plots with coordinate errors. Fixed plots with accurate coordinates (i.e. GPS point matches the post location) do not require hand-written latitude and longitude on the datasheet, instead just write "good" across the coordinates section.

### *Photographing Transects and Plots (Form 2)*

Photographs will be taken at transect start, end, and designated transect intervals along the transect (Table SOP 9.1; Figure SOP 9.2.C) for both fixed and rotational transects. At the designated transect interval there will be two photographs taken for rotational transects and four photographs taken for fixed transects. The first photograph will be taken along the transect looking toward the end (in the direction of the transect azimuth) and the second photo looking back to the start of the transect (in the direction of the back azimuth) (Figure SOP 9.3). These two directional photos are taken at both rotational and fixed transects and should be taken with the camera at a height of 1.4 m using "landscape" orientation of camera. For photos taken where any movable foliage is directly obstructing the view of the photographer, the photographer may move it to get a more accurate photo if it does not cause any permanent damage to the plant. For fixed transects, a third and fourth photo is taken of the permanent posts to assist with relocation. These post photos should include at least two photos to get an idea of where it exists in the landscape (including witness tree if possible). Additional photos of the transect are encouraged and can be taken using the "Other" category along with comments. These photos can include staff photos, obstacles, transect disturbance (pig damage, fallen trees, etc.), a beautiful view, etc. Pictures are an easy and efficient way to convey information and they are always helpful for presentations and SOPs.

ESRI's Field Maps App will be used for all sampling photos (e.g., plot photos, plant photos, etc.). See SOP #8 Using ArcGIS Field Maps Application for guidance on using ESRI's "Field Maps" App.

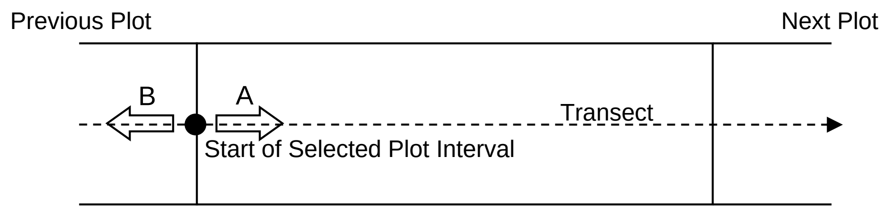


**Figure SOP 9.3.** Schematic of photographs taken at designated transect intervals. For the first photo (A), the photographer stands on the transect line at the start of the plot and captures the view toward the next plot. For the second photo (B), the photographer will capture the view along the previous plot.

***Collecting Non-native Plant Species Data (Form 3)***

**All nonnative plant species encountered within each plot along the transect are recorded.** Aerial vegetated cover is the estimated vegetation cover as seen by a bird's-eye view of the vegetation. Field crew members record the aerial cover using modified Braun-Blanquet cover classes (Table SOP 9.3; Mueller-Dombois and Ellenberg 1974) for each non-native species found within the plot (2.5 m on each side of the plot centerline) while walking along the transect for the length of the sampling plot (subalpine shrubland and wet forests: 20 m; mangrove and coastal strand: 10 m). It is useful to have a pre-defined idea of what a given percentage of the area of a plot would look like. For example (Figure SOP 9.4), a 5 x 20 m plot such as those in the wet forest and subalpine shrubland has an area of 100 $m^2$ and therefore a single percent is 1 $m^2$. For the coastal strand and mangrove wetland (5 x 10 m plots) a single percent is 0.5 $m^2$.

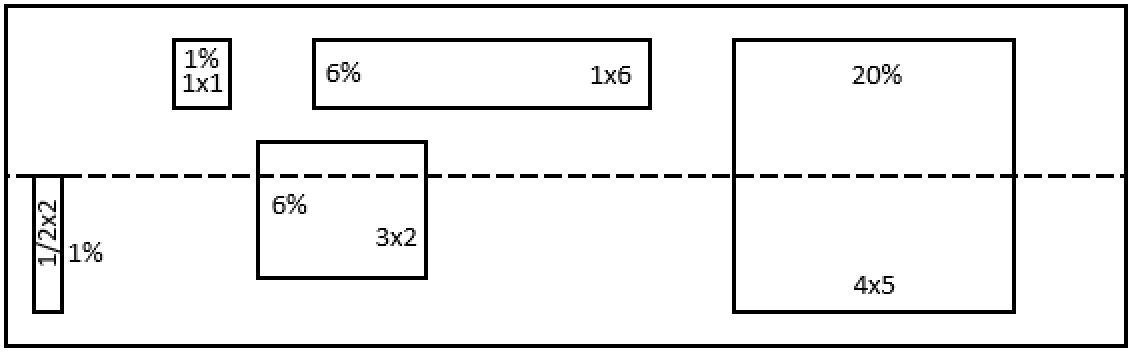


**Figure SOP 9.4.** Examples of percentage of area in relation to plot size. Shown here is a 20 x 50 m plot with percentage of area and corresponding dimensions.

The crew member recording the cover data should remain on/near the transect line and only one pass through the plot should be made while looking for species and estimating cover. **This protocol is designed to be a rapid assessment** and each plot completed relatively quickly. Species occupying different layers of the forest (low ground cover, shrub-layer, canopy, etc.) are estimated independently (i.e., a non-native tree growing above a non-native grass does not reduce the non-native grass cover). Thus, it is possible to have more than one non-native species at 75-100% cover if they occupy two different forest layers). These cover classes are designed to be easy to learn and relatively quick to estimate.

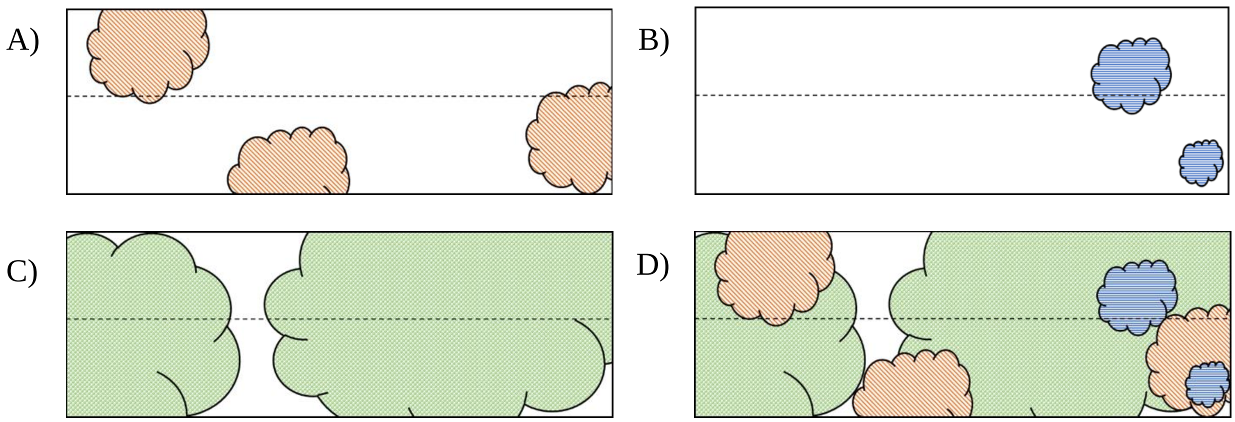


**Figure SOP 9.5.** Examples of aerial species cover within a plot and cover class. A) Cover class 4 = 10% - 25%. B) Cover class 3 = 5% - 10%.C) Cover class 7 = 75% -100%. D) Total cover may equal >100%.

A species is in the plot if any foliage or stem material—live or dead— within the plot boundary is connected to a live individual**. If only dead individuals are present in the plot, they are recorded as "dead and present" by adding "-D" after the six-letter code**. The six-letter code (first three letters of the genus followed by the first three letters of the species) for a species can be used on the Presence form if the species is common and the code is well known to all crew members. If the species is uncommon, or the species needs further identification then the full scientific name should be written out on the form. Additionally, when recording a species code, the park specific species list should be reviewed as there may be duplicate 6 letter codes that are distinguishable by a suffix (e.g., *Syzygium samarangense* = SYZSAM1 and *Syzygium samoense* = SYZSAM2). Field crew leads should be aware when duplicate codes occur and make all crew members aware of it. In these situations, it is best to write out the full species name or enough additional letters to differentiate which species is being recorded.

Notes regarding any conditions that may explain why the species is dead (e.g., drought, seasonality, or treatment) are included. Litter material within the plot is not recorded as species presence. Non-native species of interest (e.g., *Morella faya* in HAVO Kahuku units) not located within the designated plot may also be listed on the data form with "out" written in the space for cover class.

**Table SOP 9.3.** Modified Braun-Blanquet cover classes and ranges of cover (Mueller-Dombois and Ellenberg 1974) recorded for each target invasive plant species.

| Cover Class | Range of Cover |
|---|---|
| 1 | < 1% |
| 2 | 1% - <5% |
| 3 | 5% - <10% |
| 4 | 10% - <25% |
| 5 | 25% - <50% |
| 6 | 50% - <75% |
| 7 | 75% - 100% |

In some sampling frames, cover is not recorded for every non-native plant species rather a composite group cover is estimated. Specifically, in the HAVO Kahuku Paddocks zone, many non-native pasture grass species are present and intermixed due to the recent land use practices of this area. For this zone, each non-native grass species present is still recorded within each plot, but cover will only be estimated for the composite group "alien grasses" to increase sampling efficiency. This is appropriate because proposed park management actions do not differ among the various pasture grasses in this zone.

### *Unknown Species*

When unknown species are present within the plot the field crew should follow the appropriate procedures to adequately document, collect, and identify the species. For correct procedure, please see the "Unknown Species" section of Focal Terrestrial Plant Communities (FTPC) SOP #10 Conducting Community Vegetation Surveys.

### *Refrain from species removal in and around plots*

When conducting vegetation monitoring it may be tempting to remove/uproot species that are known to be invasive in nature, especially if these species are in areas that will most likely not be visited by anyone soon. The purpose of I&M's vegetation protocols is to monitor the temporal and spatial changes in vegetation. It is imperative that crews do not take actions that may disproportionately influence future vegetation sampling. Pulling a weed in a fixed plot without removing the surrounding population will result in an underestimate of invasive plant abundance and could negatively impact monitoring results and resource management guidance. Instead of removing invasive species, the crew should note the area of the occurrence and communicate with resource management staff so a proper sweep of the area can be conducted.

As mentioned previously, crews may remove portions of a plant or even uproot an individual to assist with species identification. This is following guidelines (refer to FTPC SOP #10 Conducting Community Vegetation Surveys) that ensure that any species removal will not change the vegetative future of the landscape and is not an attempt to eradicate a species.

I&M should work with NPS resource management. Prior to the field season there may be a list of target species that crews should look out for, take GPS points, and other field notes. This may be a rare and endangered species (any species on Threatened and Endangered provided by NRM) or target invasive species that need active management (e.g., *Sphaeropteris cooperi* in HAVO).

## 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.

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