Tools, Tips, and Workflows

Analyzing Swath Coverage in LP360

LP360, versions 2015.1 and above

B S A U | A W G

GeoCue Group Support
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Quality control and assurance checks should be applicable for various acquisition scenarios so as to not limit the methods that a data provider may use to obtain usable data. In that regard, some providers use collection methods that require multiple overlapping swaths in order to adhere to the project requirements. In other cases, simple side overlap to ensure there are no holes in data coverage suffices. Here, we will present some methods for analyzing collections to validate if the collection matches the intended flight plan.

Previous terminology concerning nominal pulse spacing (NPS) and nominal pulse density (NPD) worked for single swath collections, but new terminology needed to be created to represent multiple swath collections. As such, the United States Geological Survey (USGS) LIDAR Base Specification 1.2 has added the following new terms: aggregate nominal pulse spacing (ANPS) and aggregate nominal pulse density (ANPD) to describe the net overall pulse spacing and density.

In the same manner as NPS, ANPS includes only the geometrically usable part of the swaths (typically the center 95 percent for oscillating mirror systems), excludes acceptable data voids, and can be empirically calculated by creating a 1 square kilometer polygon that is representative of the overall pulse density of the flight line swath. ANPS can be calculated based off the following equation:

$$ANPS = \sqrt{Average\ Area\ per\ point}$$

where, the Average Area per point is the area of the polygon divided by the number of points contained therein.

Acceptable data voids are also included within the base specification. A data void is considered any gap within the point cloud, regardless of the cause (for instance refraction of the pulse, instrument anomalies, obstruction of the laser pulse or improper data collection). A data void should be considered if it is greater than or equal to $4(ANPS^2)$, measured using first return points only. Any data voids that exist within a single swath are not accepted, except for the following list:

- Where caused by water bodies
- Where caused by areas of low near infrared (NIR) reflectivity, such as asphalt or composition roofing
- Where appropriately filled in by another swath

With multiple swath collections it is necessary to develop a workflow in which a user could determine if the project had met the necessary coverage requirement in order to achieve the desired project density.

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LP360

Introduced in LP360 2015.1, there is now an option to export a point source ID raster. The cell values for the raster represent the number of points source ID's for that specific portion of the project. A value of two, would indicate that there is double flight line coverage for a specific area, and thus provide a check that the project is meeting the coverage requirements. A value of one, indicates single swath coverage, while any values higher than two show that the density is higher than needed.

Generating a Point Source Raster

Point source ID rasters created using the method outlined below, should be generated using only first return data that is within the geometrically usable center of the flight line swath. For the sample data being used the minimum and maximum scan angle that represents the 95% of the geometrically useable swath is equal to -18° and +18°.

The ANPS for this dataset is 1.2 meters. ANPS was obtained from the project report for this dataset, it was verified by running a statistical analysis on the dataset for first return data between the scan angles determined above within LP360. The analysis was run on a one square kilometer area.

The grid spacing for the resulting raster is equal to four times the ANPS, this will take into account data voids as defined by the USGS LBS specification mentioned above.

1. Load LIDAR data into LP360.
2. Load any feature datasets that correspond to acceptable void areas (for instance water bodies) and make sure those areas have been classified as such. These points will not be used during the export process.
3. Open the LP360 Export Wizard.
4. Set Source points to use first return points with a scan angle between -18 and +18 and exclude any points in the waterbody or other acceptable void areas.
5. Select the Surface Method of Point Insertion – dZ Images.
6. Set Cell Edge Length to twice the ANPS for the project, in this instance 4.8.
7. Under the Dz tab specify Source ID count (Figure 1).
8. Export the extent of the LIDAR layer.
9. Save the file.
10. Load the resulting raster file into ArcMap and change symbology to represent the different number of point source IDs found in the raster.
    a. In Figure 2 the red areas represent areas of the project that are only covered by a single swath of data. The green areas represent areas of the project that have double coverage and the yellow areas have triple coverage.

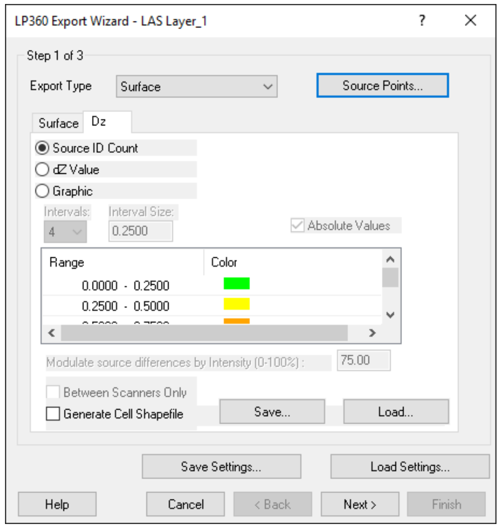

Figure 1 - Export Wizard - dZ Image: Point Source ID Count

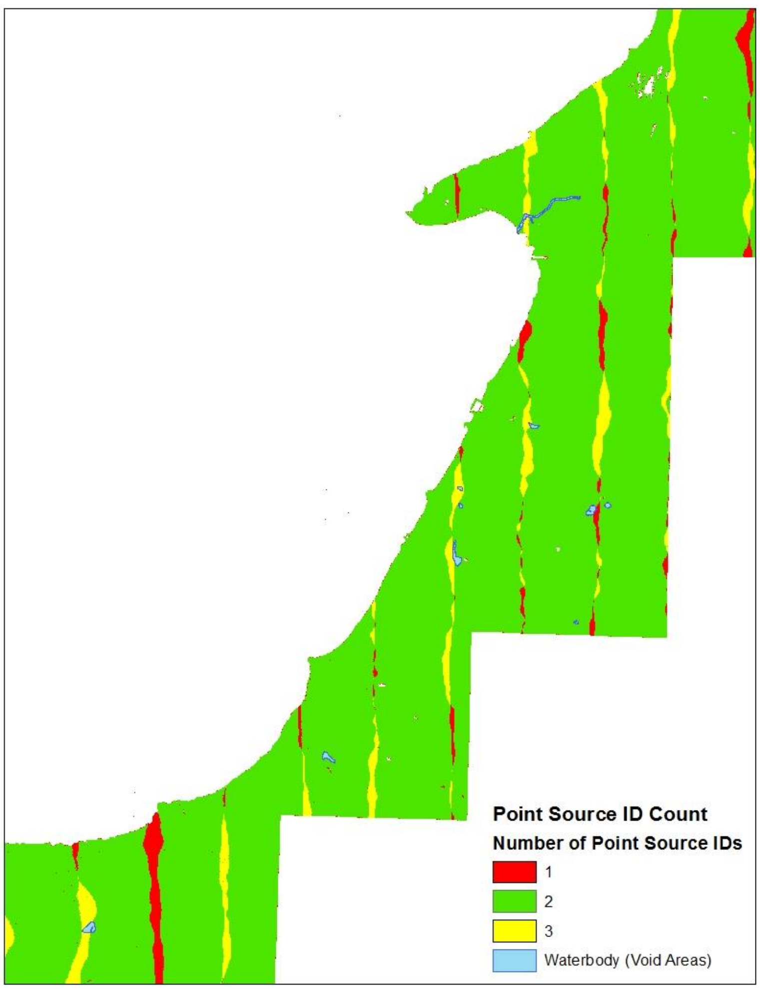

Figure 2 - Point Source ID Counts

Analyzing a Point Source ID Raster

After generating the raster, the next step is to run some analysis on the raster pixels. The pixels represent the number of point source IDs that exist within a specific project area. The analysis will determine if at least 90% of all the pixels contains double coverage. We use 90% akin to determining spatial density distribution within the LIDAR project.

When LP360 exports a raster density file it does so as a floating point raster file (FLT). In order to run any analysis on the data using ArcGIS, the file needs to first be converted to an integer based raster file. This can be accomplished in a number of ways; the workflow below explains how to accomplish this using ArcMap and the Spatial Analyst Extension.

1. Convert the file from a floating point raster to an integer raster.
    a. ArcToolbox → Spatial Analyst Tools → Math → Int
2. *At this point an integer based raster file has been generated and the rest of the steps discuss how to determine if 90% of the raster cells contain a minimum of two point source ids.*
3. Open the Attribute Table for the resulting raster file.
4. Add a new Field called Percent.
    a. Field Type: Double
    b. Precision: 5
    c. Scale: 2
5. Run Statistics on the Count Field by right-clicking on Count and selecting Statistics, copy the Sum value.
6. Right-click on Percent and select Field Calculator.
    a. Use the following equation to determine percentage
        i. COUNT/SUM * 100
7. Review the results to determine if at least 90 percent of the cells contain a minimum of two point source IDs (this would represent double coverage of the flight lines). (Figure 3)

Table

Point Source ID Count Integer

Rowid	VALUE	COUNT	PERCENT
0	1	68190	3.09%
1	2	2004472	90.76%
2	3	135809	6.15%

Figure 3 - Percentage of cells with 1, 2 or 3 Point Source IDs

Analyzing Swath Percentage

After determining the percentage of cells that contain double coverage, the next workflow describes how to determine the percentage of overlap that exists on the swaths themselves.

The first step in determining swath overlap is to generate detailed footprints of the LIDAR swaths that represent the true extents of the LIDAR. At the current time, the easiest way to accomplish this is by using GeoCue's workflow management suite. When the LIDAR strips are imported into GeoCue, convex hulls of the data are created as a graphic. A utility step is available to change the entities from a Convex Hull (Figure 4) to a Detailed Footprint (Figure 5). Once the Detailed Footprints have been generated, then they can then be exported from the GeoCue Client and imported into ArcGIS where further analysis can be completed.

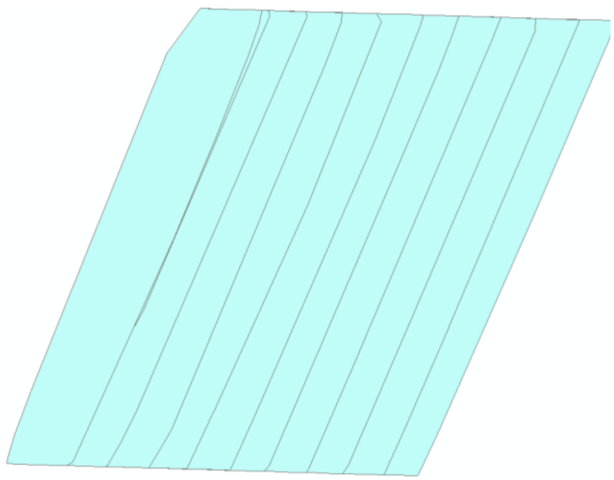

Figure 4 - Convex Hull

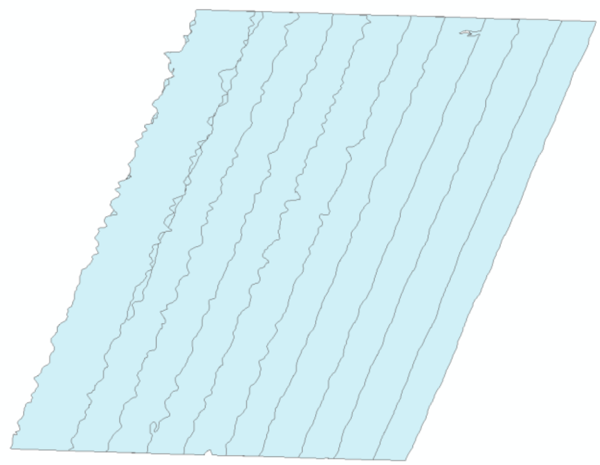

Figure 5 - Detailed Footprint

Once the footprints have been generated, the next step of the process is to determine the overlapping portions of the features using ArcMap. When the entities are exported via GeoCue, information concerning that entity is added to the attribute table including the area of the original entity. This area will come into play when determining the percentage of overlap.

To determine the areas within the Detailed Footprint that overlap run an Intersect on the Feature Class: ArcToolbox → Analysis Tools → Overlay → Intersect (Note: With ArcGIS for Desktop Basic and Standard licenses, the number of input feature classes or layers is limited to two. ArcGIS for Desktop Advanced is unlimited).

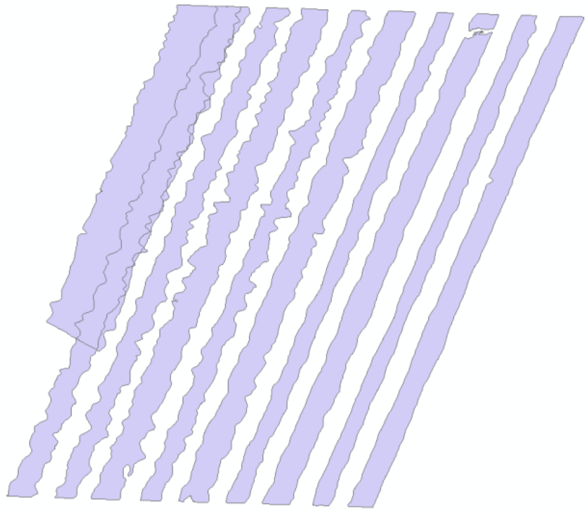

Figure 6 - Overlapping Flight Lines

Once the overlap area has been determined, the original flight lines need to be split down the center. The most efficient way to do this is to export the geometry of the flight line trajectories from within GeoCue. These trajectories represent the center of the flight lines (Figure 7).

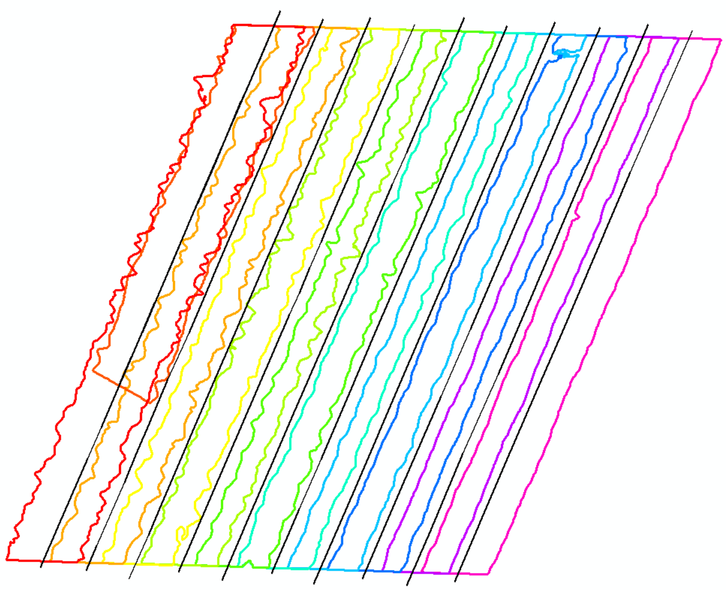

Figure 7- Trajectories

After importing the trajectories into ArcMap, the next step is to create cross sections of the trajectories that are clipped to the project boundaries. This will allow the user to determine the flight line swath width at multiple areas. To accomplish this step, use LP360's Cross Sections Point Cloud Task and clip the section length to the detailed footprint graphic (Figure 8).

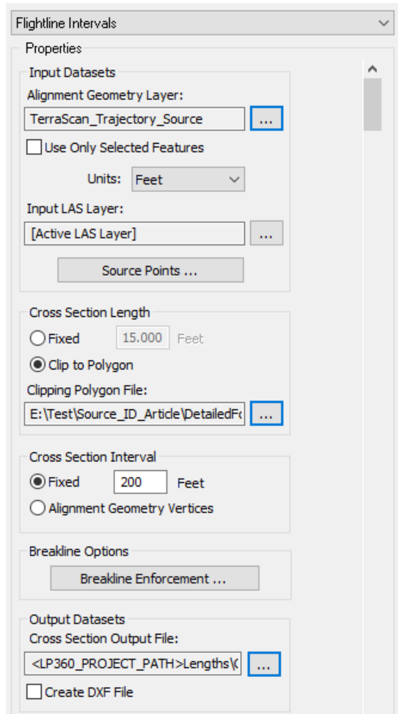

Figure 8 - Cross Sections Point Cloud Task

Add a new attribute field to the cross section feature class called SwathLength. Use the Calculate Geometry tool (Figure 9) to determine the length of the swath at each section.

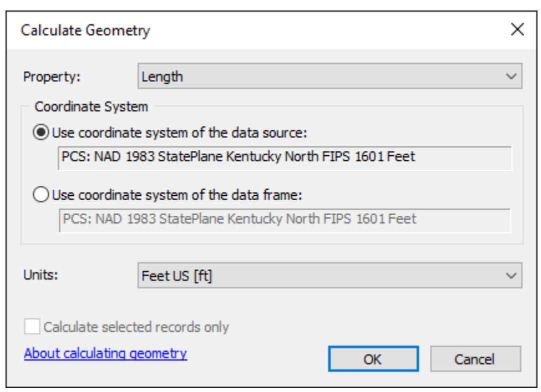

Figure 9 - Calculate Swath Length

Clip (ArcToolbox → Analysis Tools → Extract → Clip) the resulting Cross Section Feature Class by the Swath Overlap Feature class and calculate the swath length of the resulting feature. At this point, the attribute table should contain the length of the original swath in addition to the length of the overlap. Add one more field for percent and use the following field calculator equation to determine the percentage of overlap for each station:

OverlapLength/ SwathLength * 100

At this point, the calculations are done, but for visualization purposes a user could then take the overlap lengths and convert from a line to a point using the midpoint value (ArcToolbox → Features → Feature Vertices To Points). Once the information is a point, it can then be displayed using various symbology methods (Figure 10) for an easier status review.

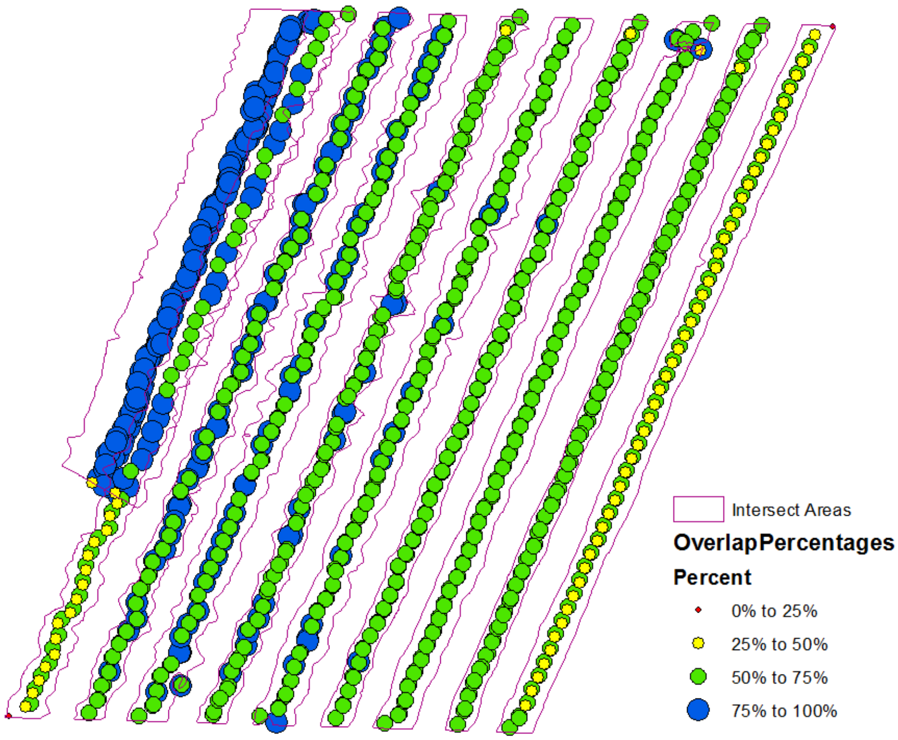

Figure 10 - Percentage Overlap

In keeping with providing users with QAQC tools, GeoCue Group provides multiple ways to determine swath coverage within their datasets. For additional information concerning the methods mentioned please contact GeoCue Group Support (support@geocue.com).