Remote Sensing on Neal Smith NWR

Images collected with a U.S. Fish and Wildlife Service unmanned aerial system (UAS) from August 20 to August 22, 2019.

30 August 2019

Survey Data

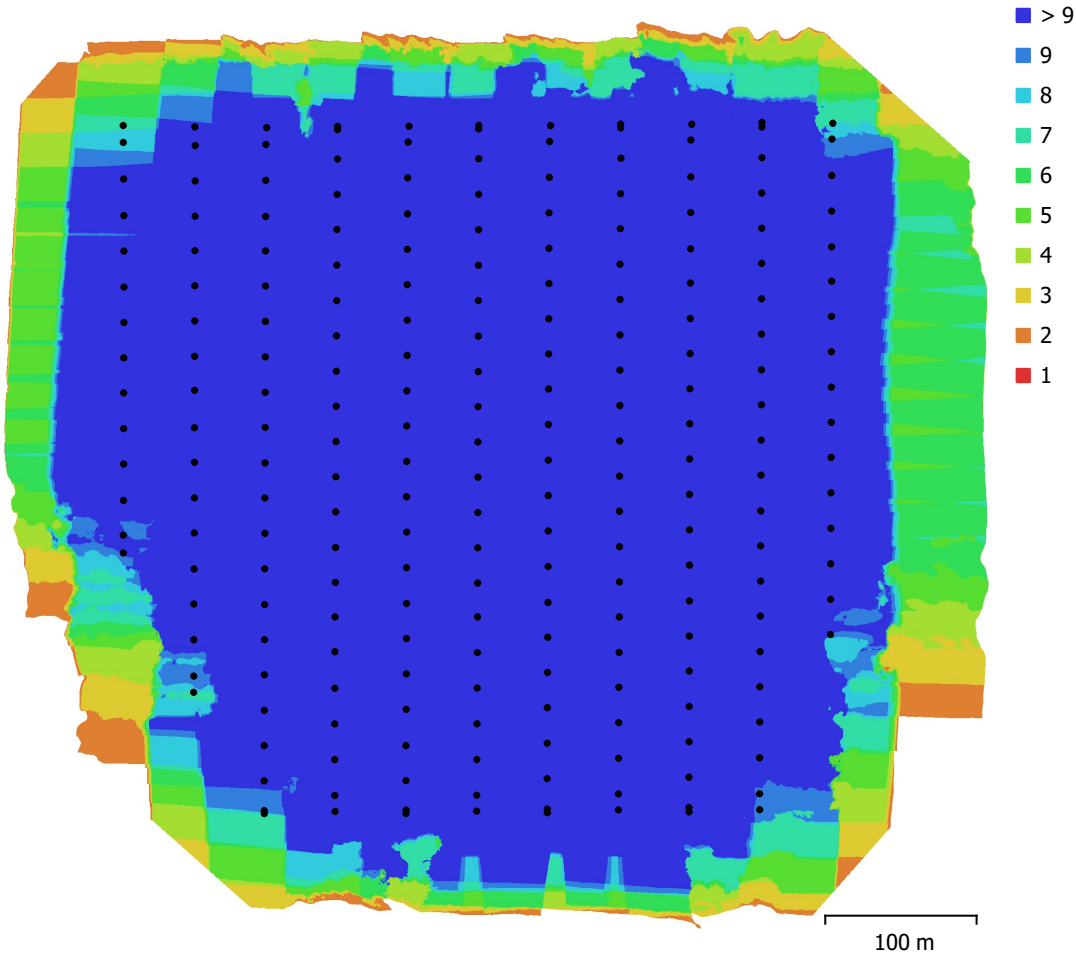

Fig. 1. Camera locations and image overlap.

Number of images:	224	Camera stations:	224
Flying altitude:	122 m	Tie points:	328,208
Ground resolution:	3.64 cm/pix	Projections:	860,285
Coverage area:	0.339 km²	Reprojection error:	0.592 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
Anafi (4mm)	4608 x 3456	4 mm	1.34 x 1.34 µm	No
Anafi (4mm)	4608 x 3456	4 mm	1.34 x 1.34 µm	No

Table 1. Cameras.

Camera Calibration

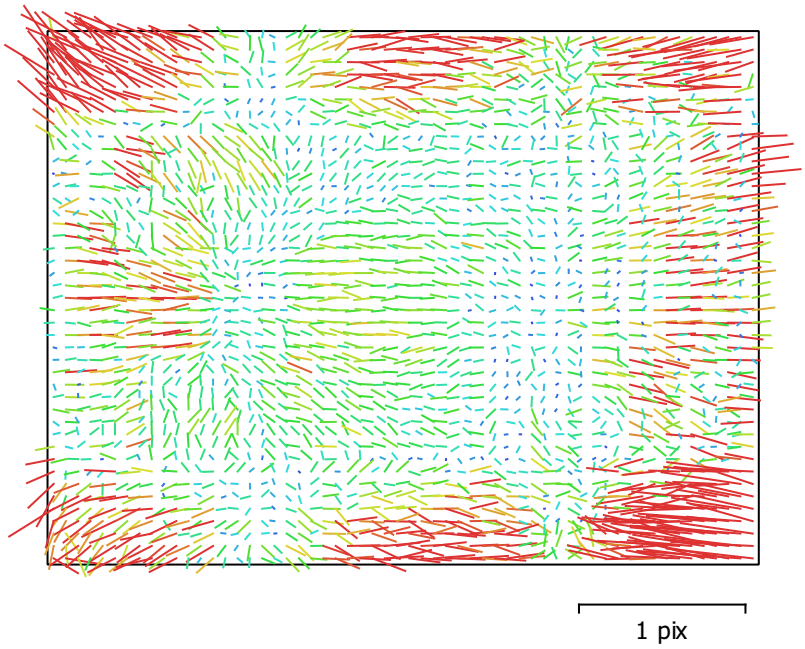

Fig. 2. Image residuals for Anafi (4mm).

Anafi (4mm)

222 images

Type	Resolution	Focal Length	Pixel Size
Frame	**4608 x 3456**	**4 mm**	**1.34 x 1.34 µm**

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	K3	P1	P2
F	**2976.62**	0.53	1.00	-0.21	-0.27	-0.02	0.03	0.00	0.04	-0.07	0.23	0.02
Cx	**32.7879**	0.11		1.00	0.05	-0.31	0.05	-0.00	-0.02	0.03	0.12	-0.09
Cy	**-2.78033**	0.1			1.00	-0.16	-0.33	-0.01	-0.00	0.02	-0.08	0.23
B1	**-0.00775281**	0.21				1.00	0.07	0.01	-0.00	-0.01	-0.13	-0.11
B2	**21.1709**	0.26					1.00	0.02	-0.01	0.01	0.08	-0.14
K1	**-0.000489682**	4.3e-005						1.00	-0.76	0.70	-0.10	-0.11
K2	**0.00352941**	8.3e-005							1.00	-0.98	-0.03	0.01
K3	**-0.00358625**	6.2e-005								1.00	0.03	-0.00
P1	**0.00368162**	2.9e-006									1.00	-0.02
P2	**0.000622739**	3.8e-006										1.00

Table 2. Calibration coefficients and correlation matrix.

Camera Calibration

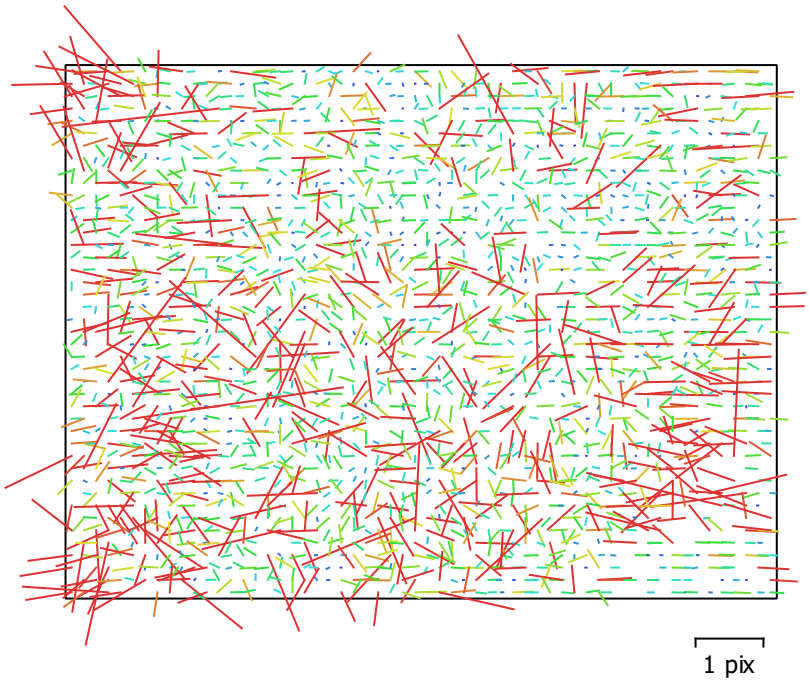

Fig. 3. Image residuals for Anafi (4mm).

Anafi (4mm)

2 images

Type	Resolution	Focal Length	Pixel Size
Frame	**4608 x 3456**	**4 mm**	**1.34 x 1.34 µm**

	Value	Error	Cx	Cy	B1	B2	P1	P2
F	**2975.66**							
Cx	**32.7393**	0.33	1.00	0.13	-0.07	0.00	0.65	-0.06
Cy	**0.294803**	0.45		1.00	-0.03	0.00	0.08	0.36
B1	**-0.222907**	0.22			1.00	0.07	-0.00	-0.02
B2	**21.2472**	0.26				1.00	-0.00	0.01
P1	**0.00363923**	2.1e-005					1.00	-0.05
P2	**0.000535977**	2e-005						1.00

Table 3. Calibration coefficients and correlation matrix.

Camera Locations

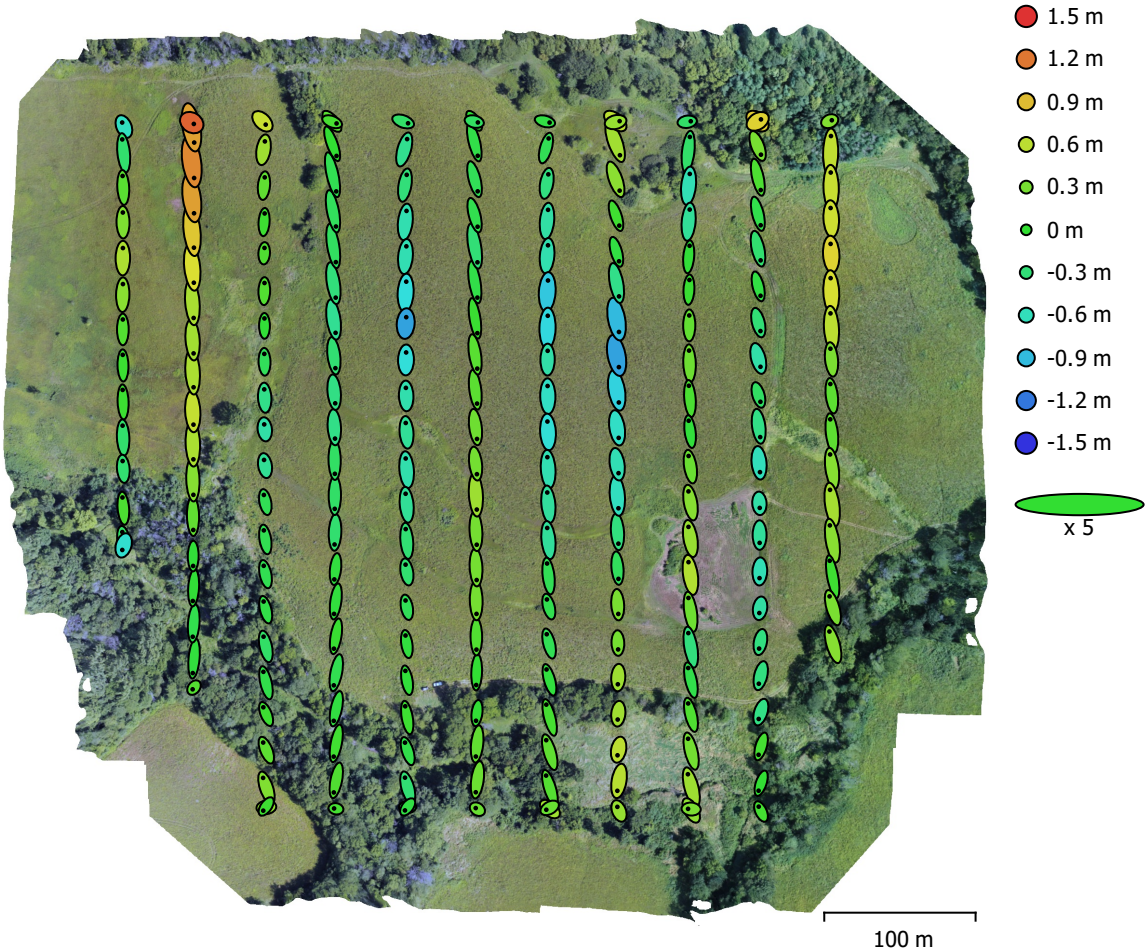

Fig. 4. Camera locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated camera locations are marked with a black dot.

X error (m)	Y error (m)	Z error (m)	XY error (m)	Total error (m)
0.552655	2.84286	0.413716	2.89608	2.92548

Table 4. Average camera location error.
X - Longitude, Y - Latitude, Z - Altitude.

Digital Elevation Model

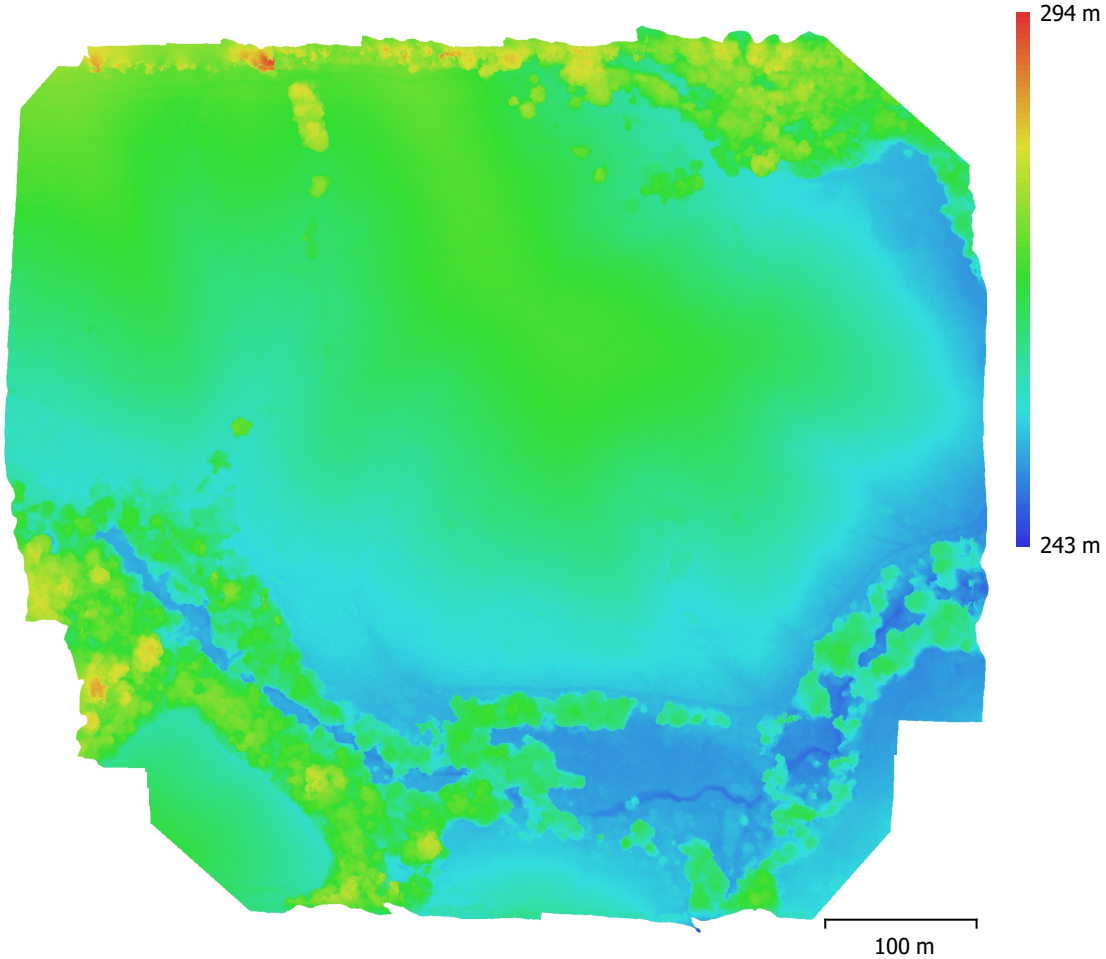

Fig. 5. Reconstructed digital elevation model.

Resolution:	14.5 cm/pix
Point density:	47.3 points/m²

Processing Parameters

General	
Cameras	224
Aligned cameras	224
Coordinate system	WGS 84 (EPSG::4326)
Rotation angles	Yaw, Pitch, Roll
Point Cloud	
Points	328,208 of 341,063
RMS reprojection error	0.15432 (0.592054 pix)
Max reprojection error	0.521926 (27.29 pix)
Mean key point size	3.49502 pix
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	2.72085
Alignment parameters	
Accuracy	High
Generic preselection	Yes
Reference preselection	Yes
Key point limit	40,000
Tie point limit	4,000
Adaptive camera model fitting	Yes
Matching time	4 minutes 46 seconds
Alignment time	2 minutes 32 seconds
Optimization parameters	
Parameters	f, b1, b2, cx, cy, k1-k3, p1, p2
Adaptive camera model fitting	Yes
Optimization time	9 seconds
Software version	1.5.2.7838
Depth Maps	
Count	224
Depth maps generation parameters	
Quality	Medium
Filtering mode	Aggressive
Processing time	12 minutes 25 seconds
Dense Point Cloud	
Points	22,822,278
Point colors	3 bands, uint8
Depth maps generation parameters	
Quality	Medium
Filtering mode	Aggressive
Processing time	12 minutes 25 seconds
Dense cloud generation parameters	
Processing time	11 minutes 37 seconds
Software version	1.5.2.7838
DEM	
Size	6,963 x 6,928
Coordinate system	WGS 84 / UTM zone 15N (EPSG::32615)
Reconstruction parameters	
Source data	Dense cloud
Interpolation	Enabled
Processing time	55 seconds

General	
Software version	1.5.2.7838
Orthomosaic	
Size	17,879 x 16,471
Coordinate system	WGS 84 / UTM zone 15N (EPSG::32615)
Colors	3 bands, uint8
Reconstruction parameters	
Blending mode	Mosaic
Surface	DEM
Enable hole filling	Yes
Processing time	6 minutes 25 seconds
Software version	1.5.2.7838
Software	
Version	1.5.2 build 7838
Platform	Windows 64