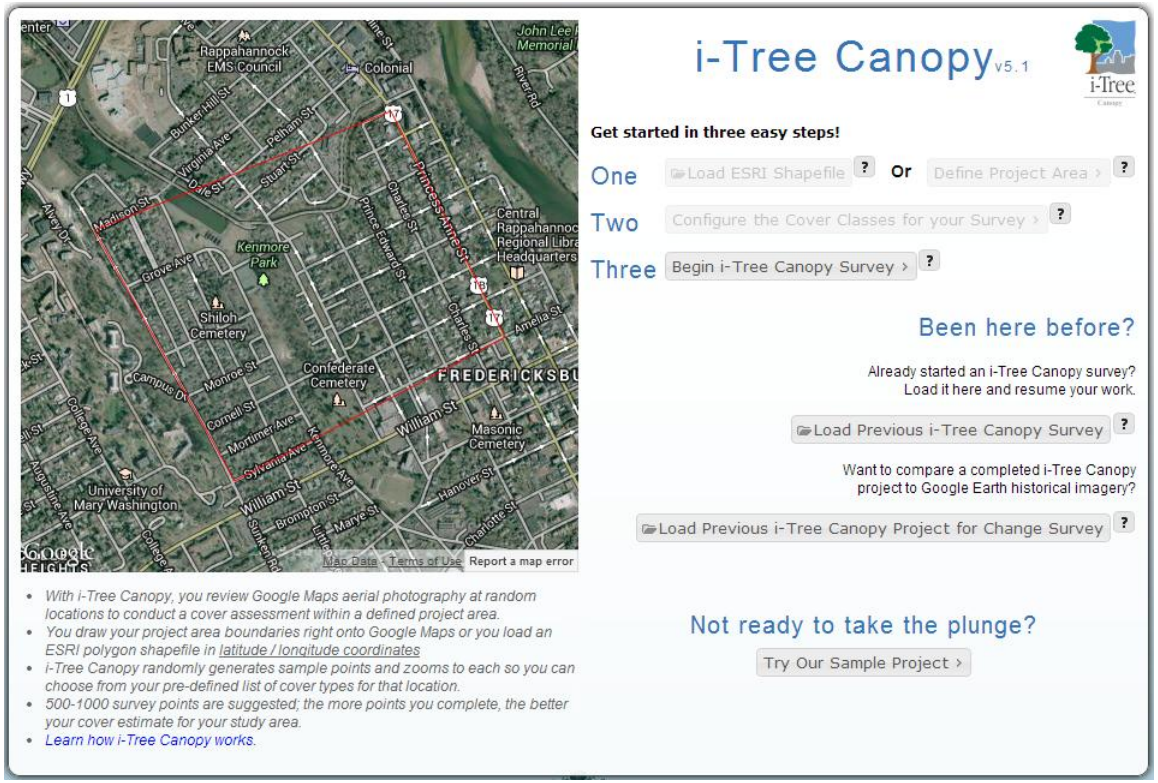
i-Tree Canopy,
a Web-based Tool for Rapid UTC Analysis and Planning



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Virginia Tech

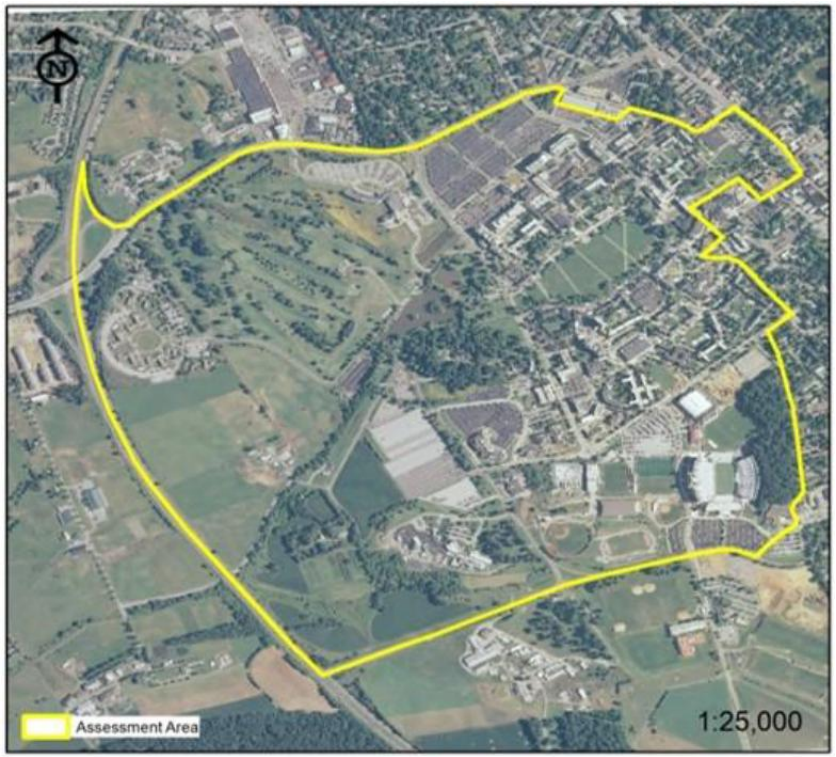
What is i-Tree Canopy?

- A tool designed to allow user to easily and accurately estimate tree and other cover classes within their city or any area they like
- A survey approach in which a human processor visually interprets randomly sampled points on aerial imagery (Google Earth) to estimate the proportions of ground cover classes

Pros & Cons

- i-Tree Canopy provides greater accessibility to UTC assessment:
  - faster UTC assessment
  - little knowledge required
  - no specialized software or remote sensing data required
- i-Tree Canopy has inherent limitations related to sampling methods.
  - Sample sizes affect precision of the UTC estimates.
  - No wall-to-wall classification map provided.

Cast Study: Virginia Tech Campus



Study Area

- Moderately urbanized land
- 885 acres of the central campus

UTC Assessments

- 4 land cover classes including water, impervious surface, non-tree vegetation, and tree canopy

Cast Study: Virginia Tech Campus (Cont'd)

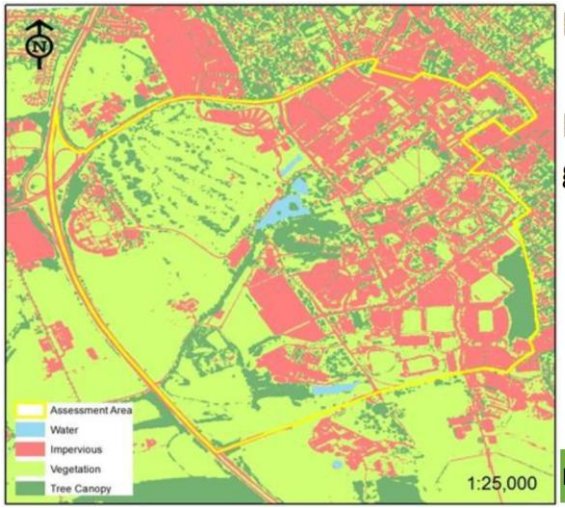


Image Classification Map

Blacksburg UTC Assessment
- Overall accuracy ---------- 96%

Estimated proportions of ground cover on campus:
- Water ---------- 1.1%
- Impervious Surface 33.1%
- Non-tree Vegetation 45.6%
- Tree Canopy ---------- 16.1%

i-Tree Canopy over-estimated impervious surfaces while under-estimated tree canopy.

PI sample sizes of ≥ 250 points
- Mean and CV stabilized
- UTC and other ground covers estimates were consistent with IC method.

Results of i-Tree Canopy Assessments

	10 points				12 points				25 points				50 points			
	WA[1]	IS	VA	TC	WA	IS	VA	TC	WA	IS	VA	TC	WA	IS	VA	TC
Mean[2] (%)	**0.0**	**36.0**	**45.0**	**18.0**	**0.8**	**31.7**	**50.0**	**17.1**	**0.8**	**41.2**	**45.2**	**12.8**	**0.8**	**42.2**	**43.0**	**14.0**
SD[3]	0.0	16.5	19.0	12.3	2.6	10.2	14.0	10.3	1.7	11.3	8.9	7.5	1.0	6.1	5.8	4.2
CV[3] (%)	0.0	45.7	42.2	68.3	0.0	32.4	29.1	61.3	210.8	27.5	19.6	58.6	129.1	14.4	13.6	30.2

0.24 pt/acre **0.56 pt/acre** **1.13 pt/acre**

	100 points				250 points				500 points				1000 points			
	WA	IS	VA	TC	WA	IS	VA	TC	WA	IS	VA	TC	WA	IS	VA	TC
Mean (%)	**0.0**	**36.0**	**48.0**	**14.0**	**1.0**	**38.8**	**45.8**	**14.4**	**0.9**	**38.4**	**46.3**	**14.5**	**1.1**	**38.0**	**45.4**	**14.9**
SD	1.0	6.1	7.6	2.5	0.5	2.4	1.7	1.8	0.4	2.0	1.8	1.3	0.3	1.3	1.2	0.9
CV (%)	161.0	16.9	15.5	17.8	54.2	6.2	3.7	12.6	51.5	5.2	3.9	9.0	29.2	3.4	2.7	6.0

[1] WA (water); IS (impervious surface); VA (non-tree vegetation); and TC (tree canopy)
[2] Mean of 10 replicated assessments at each point sample size
[3] SD (standard deviation); CV (coefficient of variation)

Three Basic Steps to Estimate UTC and Other Ground Covers

Step 1:
Define study area

- Import a file that delimits the boundary of your area of analysis (e.g. city boundary).

Step 2:
Define ground cover classes

- Name the land cover classes to classify (e.g. tree, grass, building).

Step 3:
Define sample size & interpret random points

- Start classifying (interpreting) each point that will be located randomly within the boundary file.

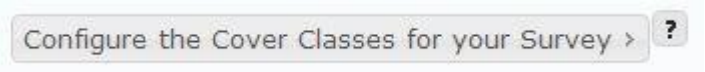
Exercise: Estimate UTC and Other Ground Covers using i-Tree Canopy

STEP 1: define the boundary of your area of analysis (e.g. city boundary).

- Digitize project boundary
- Import a shapefile through:
  - ESRI US Census 2000 TIGER data or US Census Cartographic Boundary Files
  - Detailed information is available at the website.

Exercise: Estimate UTC and Other Ground Covers using i-Tree Canopy (cont'd)

STEP 2: Name the cover classes (up to 15 classes) to classify



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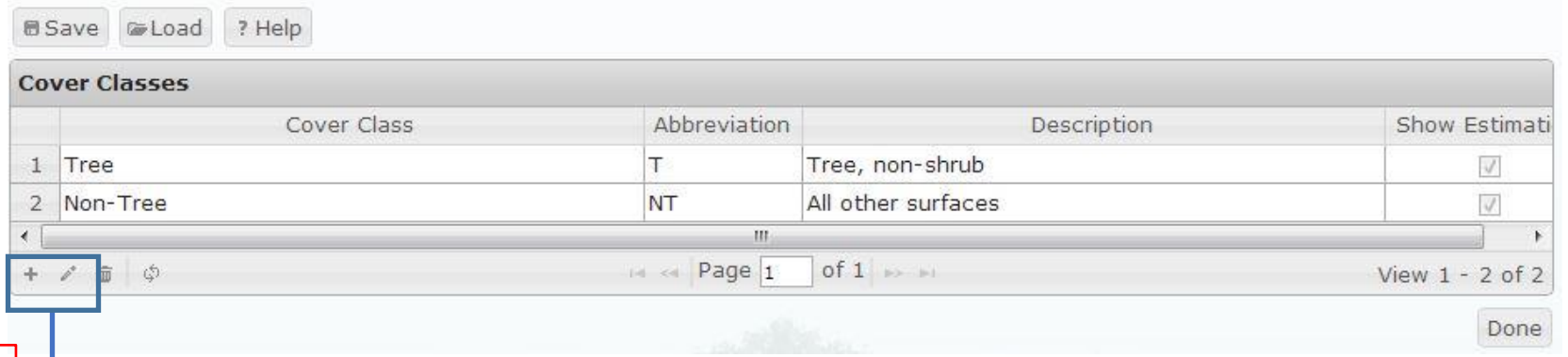

1

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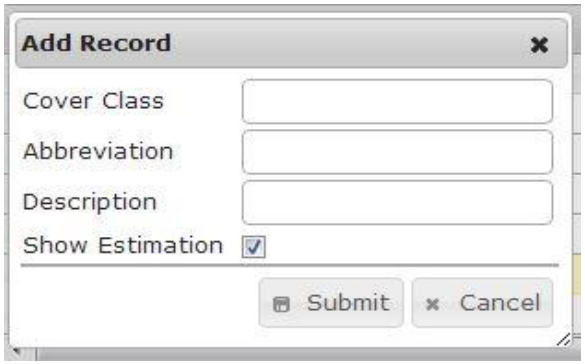
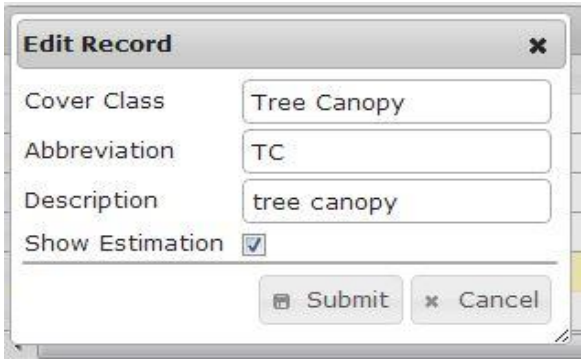
Add new cover class

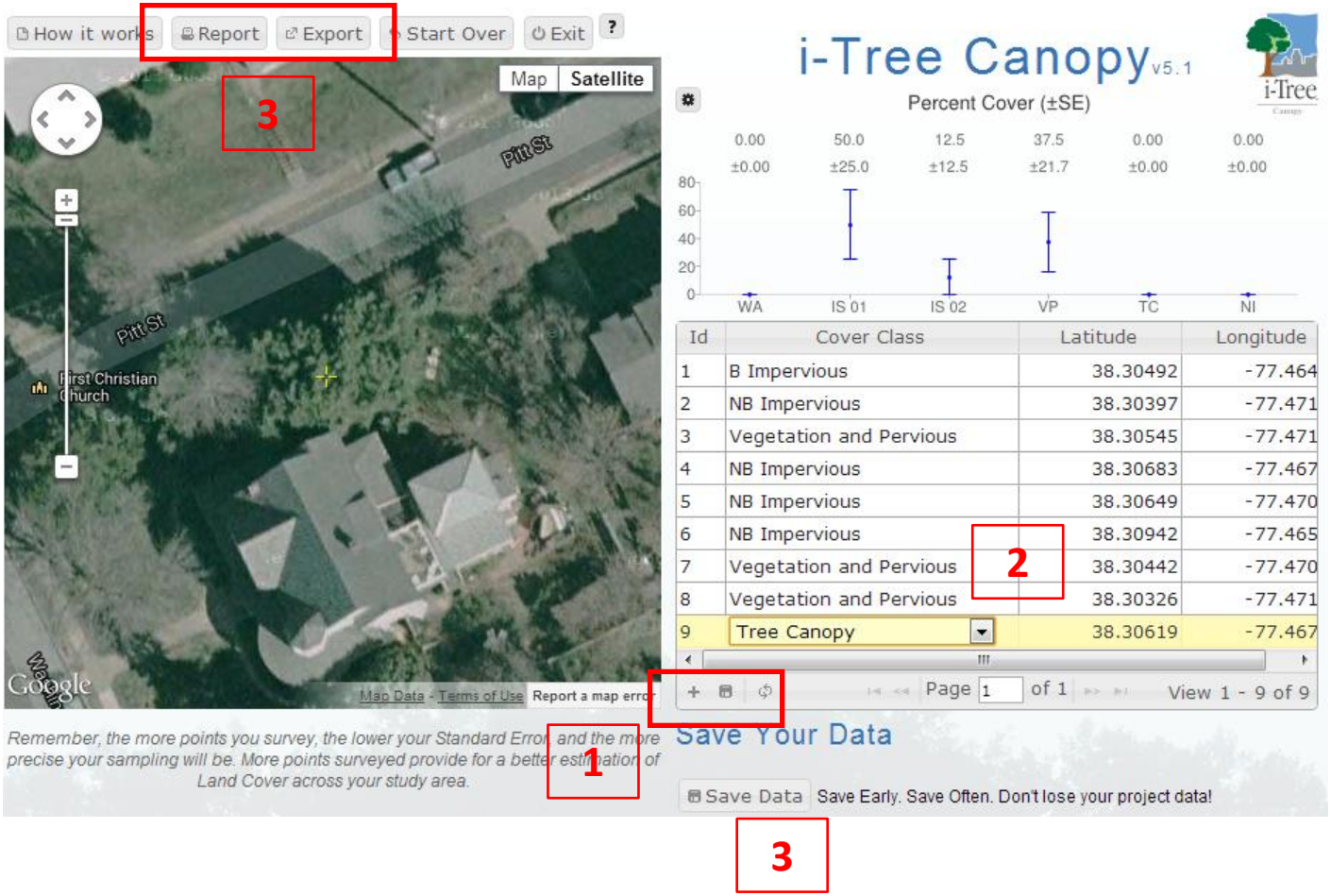


Edit cover class



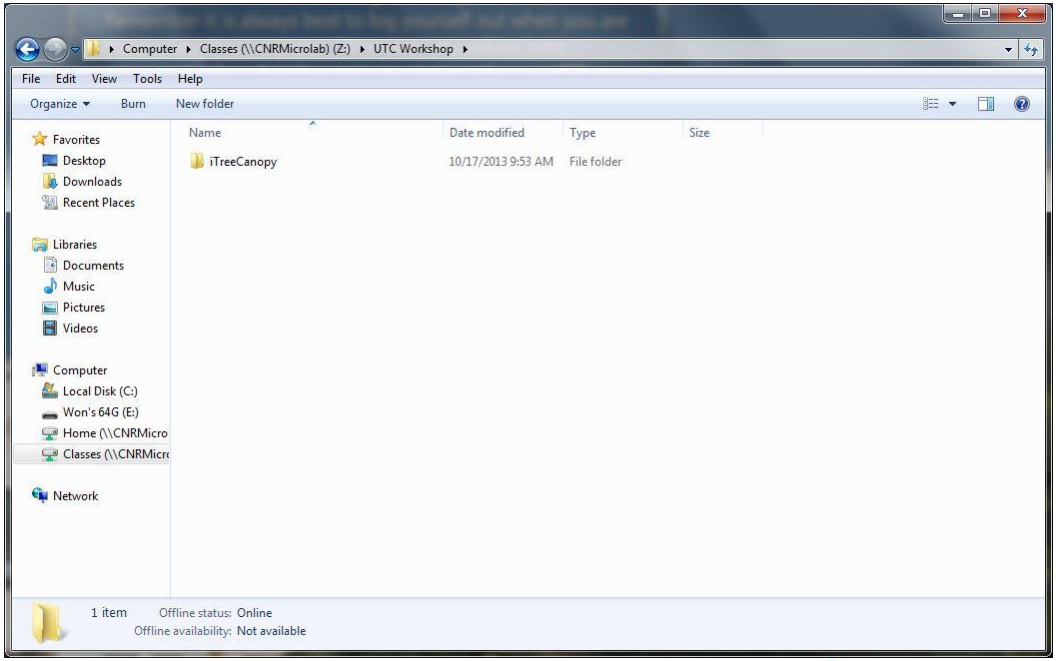
Exercise: Estimate UTC and Other Ground Covers using i-Tree Canopy (cont'd)

STEP 3: Start classifying (interpreting) each point that will be located randomly within the boundary file.



Exercise: Estimate UTC and Other Ground Covers using i-Tree Canopy (cont'd)

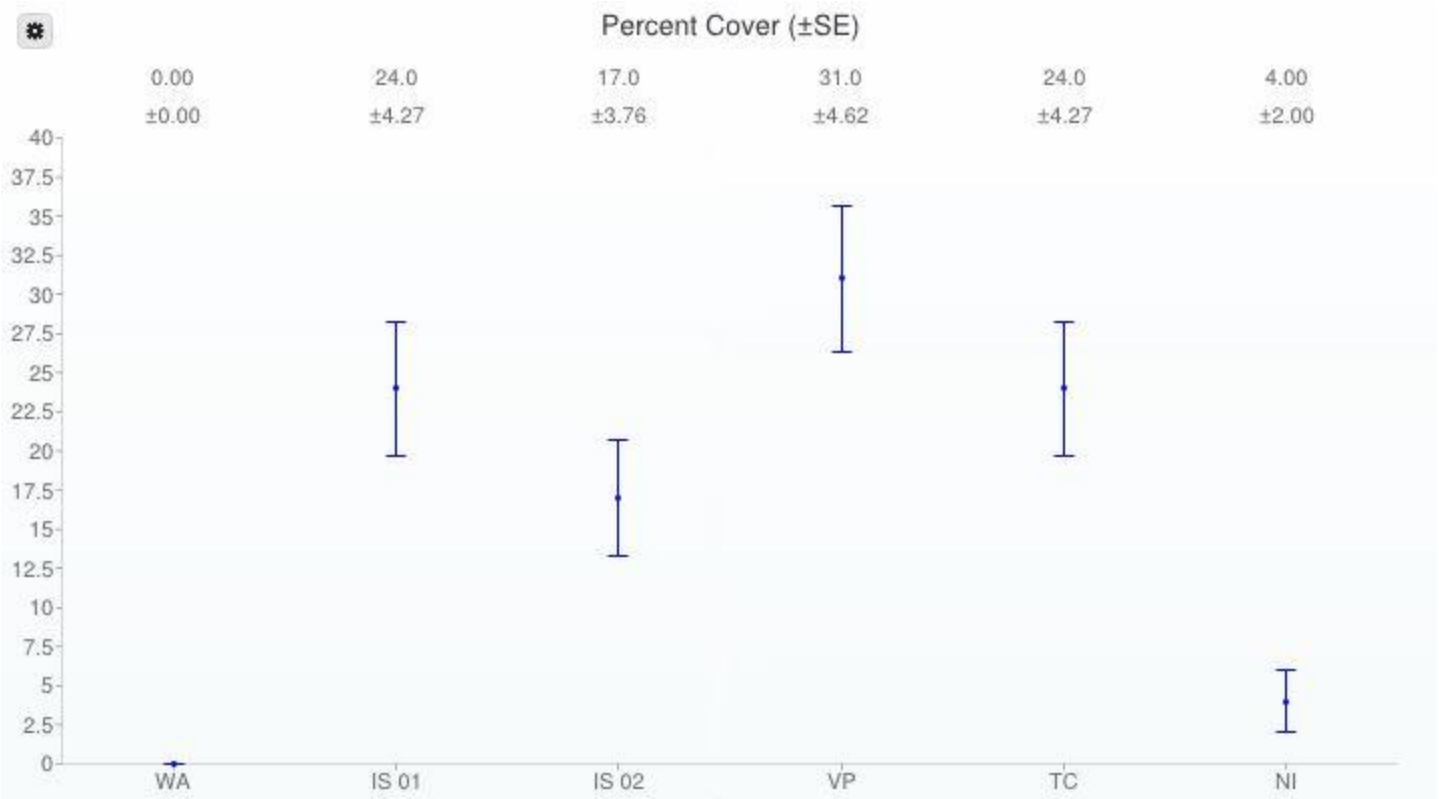
- Let's do your own works.
- We will have 50 samples points per each person.
- Project boundary and land cover classes are available in "iTreeCanopy" folder at Z:\UTC Workshop\
  - Project area boundary shapefile: **UTC_ExerciseArea.shp**
  - Pre-defined land cover classes: **UTC_LC Classes**



Attributions of Uncertainty to Interpret Points (Richardson and Moskal, 2013)

- Height, edge, shadow, and their combination
- Interior forest canopy

Summary of UTC and Other Ground Cover Estimation



Cover Class	Description	Abbr.	Points	% Cover
Water	water	WA	0	0.00 ±0.00
NB Impervious	non-building impervious	IS 01	24	24.0 ±4.27
B Impervious	building impervious	IS 02	17	17.0 ±3.76
Vegetation and Pervious	Vegetation and pervious	VP	31	31.0 ±4.62
Tree Canopy	tree canopy	TC	24	24.0 ±4.27
Non-interpretable	points, which are not interpretable	NI	4	4.00 ±2.00

Comparing Two Methods: Image Classification vs. i-Tree Canopy

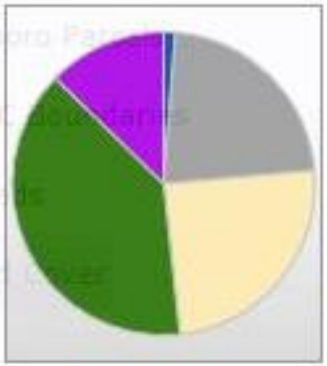
- i-Tree Canopy (100 points)

Cover Class	Description	Abbr.	Points	% Cover
Water	water	WA	0	0.00 ±0.00
NB Impervious	non-building impervious	IS 01	24	24.0 ±4.27
B Impervious	building impervious	IS 02	17	17.0 ±3.76
Vegetation and Pervious	Vegetation and pervious	VP	31	31.0 ±4.62
Tree Canopy	tree canopy	TC	24	24.0 ±4.27
Non-interpretable	points, which are not interpretable	NI	4	4.00 ±2.00

- i-Tree Canopy (200 points)

Cover Class	Description	Abbr.	Points	% Cover
Water	water	WA	3	1.50 ±0.87
NB Impervious	non-building impervious	IS 01	47	23.5 ±3.00
B Impervious	building impervious	IS 02	40	20.0 ±2.83
Vegetation and Pervious	Vegetation and pervious	VP	59	29.5 ±3.22
Tree Canopy	tree canopy	TC	46	23.0 ±2.98
Non-interpretable	points, which are not interpretable	NI	5	2.50 ±1.12

- UTC Mapper



i-Tree Canopy over-estimated impervious surfaces while under-estimated tree canopy.

Comparing Two Methods: Image Classification vs. i-Tree Canopy (cont'd)

	UTC Mapper	i-Tree 100	i-Tree 200	i-Tree 500*
WA	1.30	0.00	1.50	4.2
IS 01	22.30	24.00	23.50	26.0
IS 02	12.70	17.00	20.00	19.4
VP	24.70	31.00	29.50	31.2
TC	**39.00**	**24.00**	**23.00**	**19.6**
NI	-	4.00	2.50	0

	Analyst 1	Analyst 2	Analyst 3	Analyst 4	Analyst 5	Analyst 6	Analyst 7	Analyst 8	Analyst 9	Analyst 10		Total	%
WA	0	4	0	2	2	0	1	8	1	3		21	4.2
IS 01	9	16	15	18	13	7	16	9	12	15		130	26.0
IS 02	13	6	11	6	8	12	4	18	11	8		97	19.4
VP	13	16	14	15	12	16	21	11	25	13		156	31.2
TC	15	10	10	9	15	15	8	4	1	11		98	19.6
NI	0	0	0	0	0	0	0	0	0	0		0	0.0
	50	52	50	50	50	50	50	50	50	50		502	100.4