

Comparison of the Performance of a Digital Image Analysis Method versus a Leaf Area Meter in Measuring Leaf Surface Area



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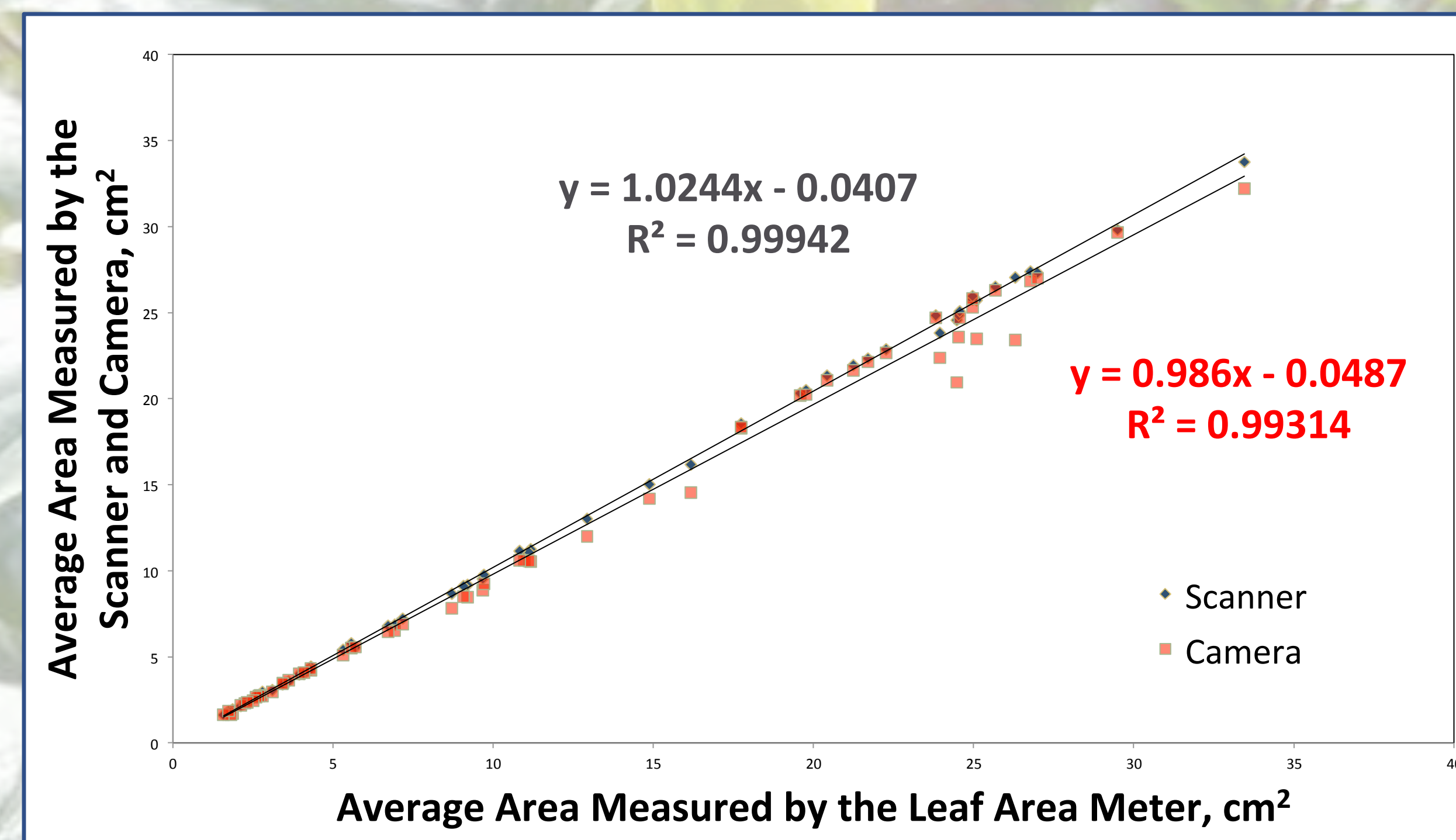
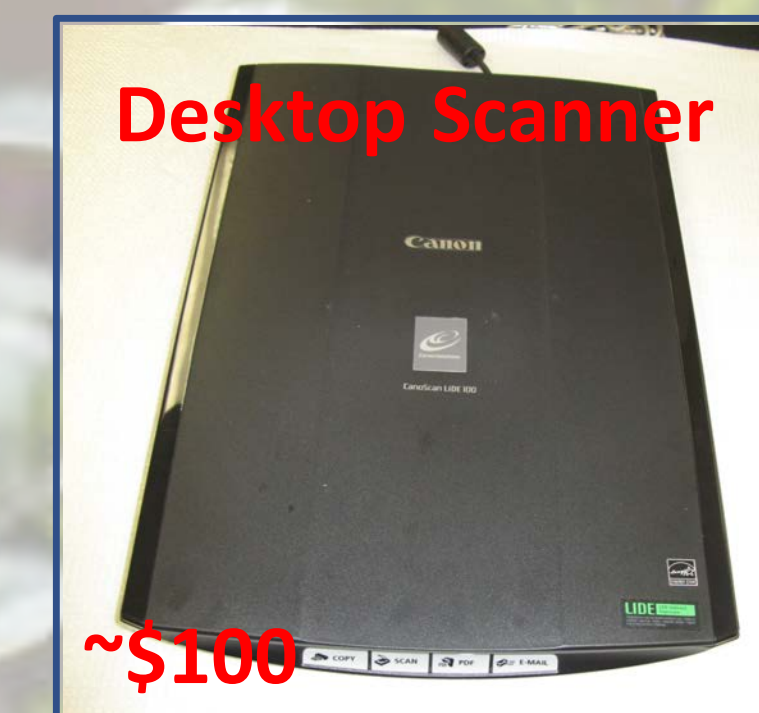
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Objective: The objective of this research project was to compare the performance of two methods of leaf surface area measurement in terms of cost effectiveness, accuracy, and practicality for field application. The two methods of measurements were digital image analysis using Adobe Photoshop CS6 and direct measurements taken with a commercially available portable leaf area meter (Model CI-202, CID Bio-Science Inc., Camas, WA).

Methodology: The first step in the digital image analysis was to obtain a picture of the leaf with a digital camera or desktop scanner. In order to provide a measurement reference for the Photoshop analysis, the background for the leaf image included a laminated sheet of graphing paper with known dimensions of each square and a ruler. The image was then imported into Photoshop and the measurement scale of the image was set using the known measurements of the ruler or graphing paper. After the scale was set, Photoshop outlined the leaf, the user made minor adjustments, and the leaf surface area was calculated and recorded. In using the portable leaf area meter, the user simply placed a leaf specimen under the plastic cover, set the scanner on the platform track, and slid the scanner over the leaf.

Plants Used: The three tree leaf species sampled were *Ilex vomitoria*, commonly known as Yaupon, *Eucalyptus camaldulensis*, commonly known as Red River Gum, and *Ilex opaca*, commonly known as American Holly. These particular species were selected for their differences in shape and were among the species being tested in a separate research project on air pollution control.



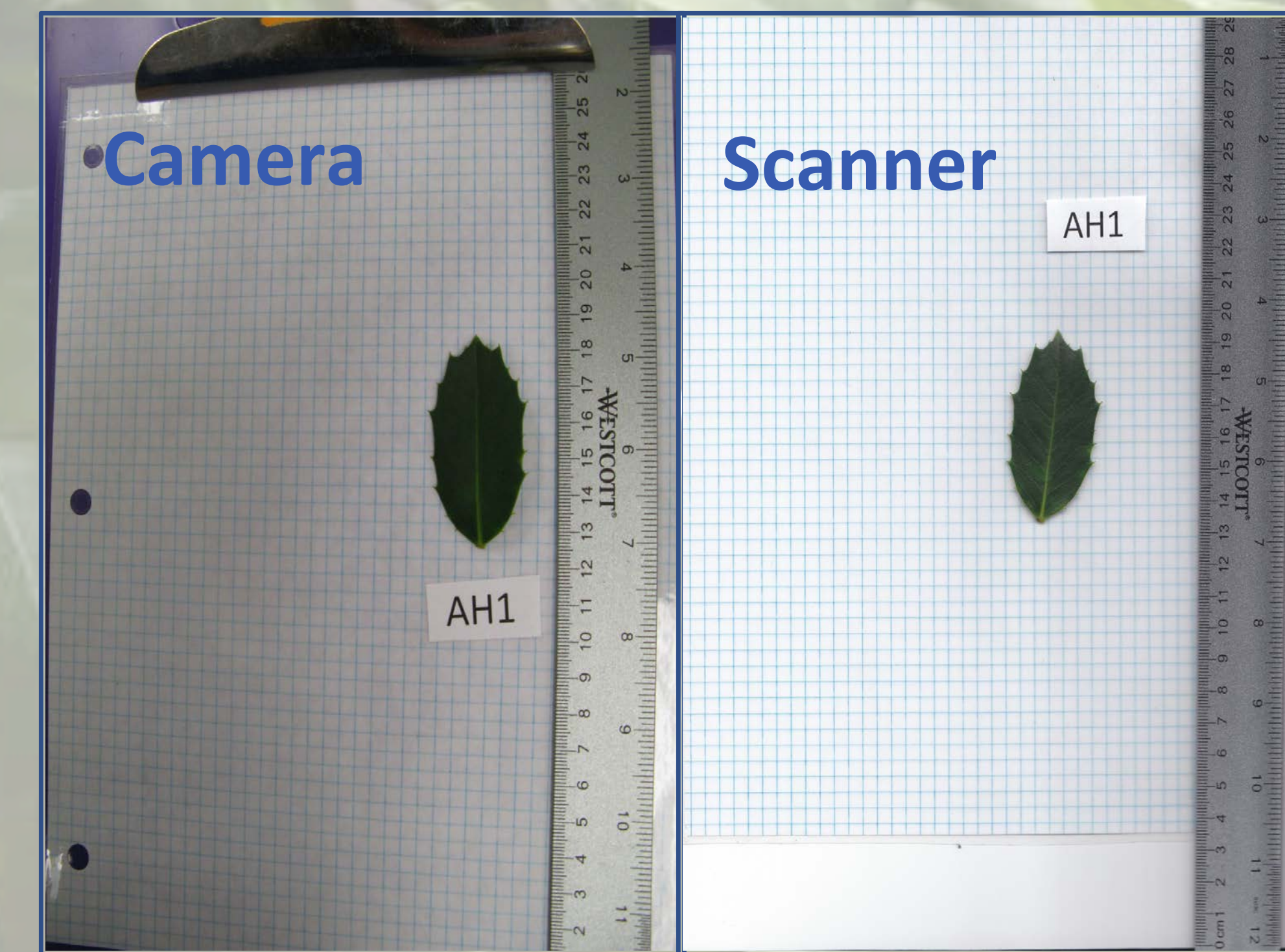
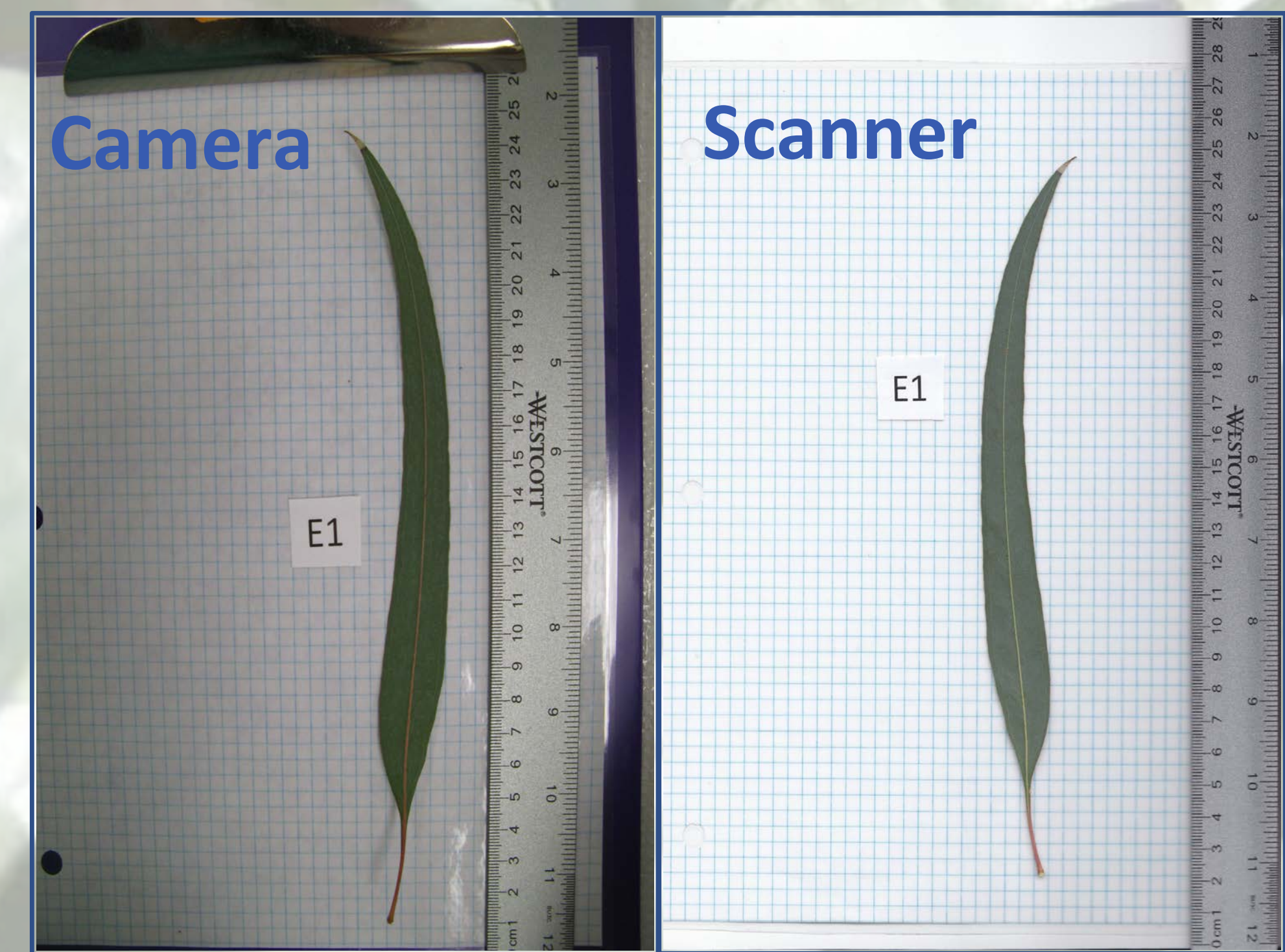
Results and Summary: Both methods yielded somewhat similar data, but the precision between the two methods depended on the leaf shape. The Yaupon leaves had the most precise results because the leaves had a simple shape. Digital image analysis was more time consuming than the leaf area meter, but digital analysis can be cheaper. There are free or low cost versions of Photoshop and other comparable programs. Digital cameras and desktop scanners are cheaper than the leaf area meter. The camera and leaf area meter are the most practical for field application.

Encountered Difficulties:

- Leaf Area Meter
 1. The same user had to perform all of the measurements and had to attempt to maintain the same speed when scanning each leaf.
 2. Measurements had to all be performed soon after leaf collection.
 3. Leaves could not be revisited at a later date if further measurements were needed.
 4. Field measurements would require the removal of the leaf from the tree.
 5. Meter was more expensive than a scanner or camera.
- Photoshop
 1. Time consuming to use Adobe Photoshop CS6 and manually digitize each leaf.
 2. Some images taken with a digital camera had shadows that required user manipulation to the outline of the leaf.
 3. The outlines of the spikes on the tips of the American Holly leaves had to be manually adjusted.
 4. Desktop scanner is not easily portable for fieldwork.

Advantages:

- Leaf Area Meter
 1. Produces results more quickly than Photoshop digitization would.
- Photoshop
 1. Do not have to perform all of the required measurements in one day.
 2. Allows user to revisit images if the need arises.
 3. Camera is suited for nondestructive measurements of leaves in the field.
 4. Camera and desktop scanner are inexpensive.



	Average Area cm ²			Average Perimeter cm			Average Length cm			Average Width cm		
	Camera	Scanner	Meter	Camera	Scanner	Meter	Camera	Scanner	Meter	Camera	Scanner	Meter
E1	26.28	26.49	25.66	49.64	49.58	38.72	22.59	22.58	18.44	3.45	3.27	2.08
E2	26.87	27.38	26.76	41.65	42.67	33.63	19.09	19.71	15.82	3.21	2.49	2.44
E3	32.21	33.77	33.45	49.69	51.12	40.63	22.34	23.15	19.18	3.93	3.64	2.58
	Average Area cm ²			Average Perimeter cm			Average Length cm			Average Width cm		
	Camera	Scanner	Meter	Camera	Scanner	Meter	Camera	Scanner	Meter	Camera	Scanner	Meter
Y1	5.58	5.57	5.70	10.53	10.54	10.77	4.09	4.11	3.68	1.97	1.94	2.07
Y2	2.81	2.83	2.73	8.07	8.17	7.21	2.98	3.04	2.41	1.51	1.51	1.54
Y3	2.74	2.97	2.78	8.14	8.40	7.33	3.34	3.45	2.67	1.22	1.33	1.35
	Average Area cm ²			Average Perimeter cm			Average Length cm			Average Width cm		
	Camera	Scanner	Meter	Camera	Scanner	Meter	Camera	Scanner	Meter	Camera	Scanner	Meter
AH1	12.02	13.01	12.93	17.96	18.79	16.74	5.81	6.05	5.60	3.04	3.33	3.15
AH2	8.89	9.57	9.67	13.84	14.20	14.21	4.48	4.80	4.58	2.90	3.00	2.90
AH3	9.26	9.78	9.71	14.58	15.42	14.03	4.65	4.87	4.47	2.90	3.13	2.97