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Accuracy Assessment of Classified Maps Derived from High and Midspatial Resolution Multispectral Data

Daniel Unger
Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, unger@sfasu.edu

Sean O'Melveny

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ACCURACY ASSESSMENT OF CLASSIFIED MAPS DERIVED FROM HIGH AND MIDSPATIAL RESOLUTION MULTISPECTRAL DATA

Daniel Unger, Associate Professor of Spatial Science
Sean O'Melveny, Research Assistant
Arthur Temple College of Forestry and Agriculture
Stephen F. Austin State University
Nacogdoches, Texas

Introduction
Objectives
Methods
Results
Conclusions

Satellite

Sun

Electromagnetic Rays

Reflected Energy

Satellite

Image

Image

Digital Numbers

35	35	58	63	46	41	49	40
71	71	76	71	58	51	40	31
85	89	84	83	73	49	44	42
95	100	95	101	88	62	64	67
96	108	102	101	98	88	89	92
107	98	100	109	96	96	102	91
114	103	104	104	105	104	94	94
104	103	104	104	105	94	94	94
106	105	96	96	96	95	103	104
106	114	115	106	105	94	102	94
116	114	115	106	105	103	93	94
119	118	110	116	116	111	93	93

Blue

15	15	24	32	24	15	16	13
27	28	32	32	24	24	21	17
37	36	34	45	37	20	19	17
44	49	45	53	46	31	30	36
42	46	45	44	46	32	40	38
53	42	44	52	43	42	41	47
53	51	49	50	45	42	49	48
52	43	45	46	46	43	48	48
50	45	45	46	52	43	48	48
51	48	48	47	50	45	47	47
53	50	50	49	49	47	38	47

Green

27	27	68	74	34	38	37	20
66	57	65	71	52	38	37	20
81	70	90	91	91	60	42	35
99	95	100	105	105	57	62	60
100	105	102	113	104	76	79	83
109	107	103	109	105	92	97	101
116	112	108	109	105	102	100	101
107	108	108	109	105	93	104	104
108	108	100	100	107	100	101	110
99	107	109	106	108	101	109	101
108	107	109	106	108	101	92	92
110	109	101	111	109	110	92	92

Red

Digital Numbers

35	35	58	63	46	41	49	40
71	71	76	71	58	51	40	31
85	89	84	83	73	49	44	42
95	100	95	101	88	62	64	67
96	108	102	101	98	88	89	92
107	98	100	109	96	96	102	91
114	103	104	104	105	104	94	94
104	103	104	104	105	94	94	94
106	105	96	96	96	95	103	104
106	114	115	106	105	94	102	94
116	114	115	106	105	103	93	94
119	118	110	116	116	111	93	93

Blue

15	15	24	32	24	15	16	13
27	28	32	32	24	24	21	17
37	36	34	45	37	20	19	17
44	49	45	53	46	31	30	36
42	46	45	44	46	32	40	38
53	42	44	52	43	42	41	47
53	51	49	50	45	42	49	48
52	43	45	46	46	43	48	48
50	45	45	46	52	43	48	48
51	48	48	47	50	45	47	47
53	50	50	49	49	47	38	47

Green

27	27	68	74	34	38	37	20
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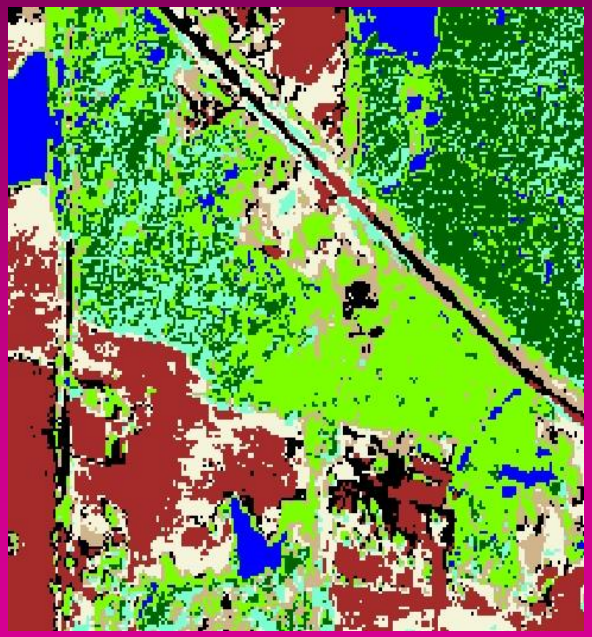
100	105	102	113	104	76	79	83
109	107	103	109	105	92	97	101
116	112	108	109	105	102	100	101
107	108	108	109	105	93	104	104
108	108	100	100	107	100	101	110
99	107	109	106	108	101	109	101
108	107	109	106	108	101	92	92
110	109	101	111	109	110	92	92

Red

Land Cover Map

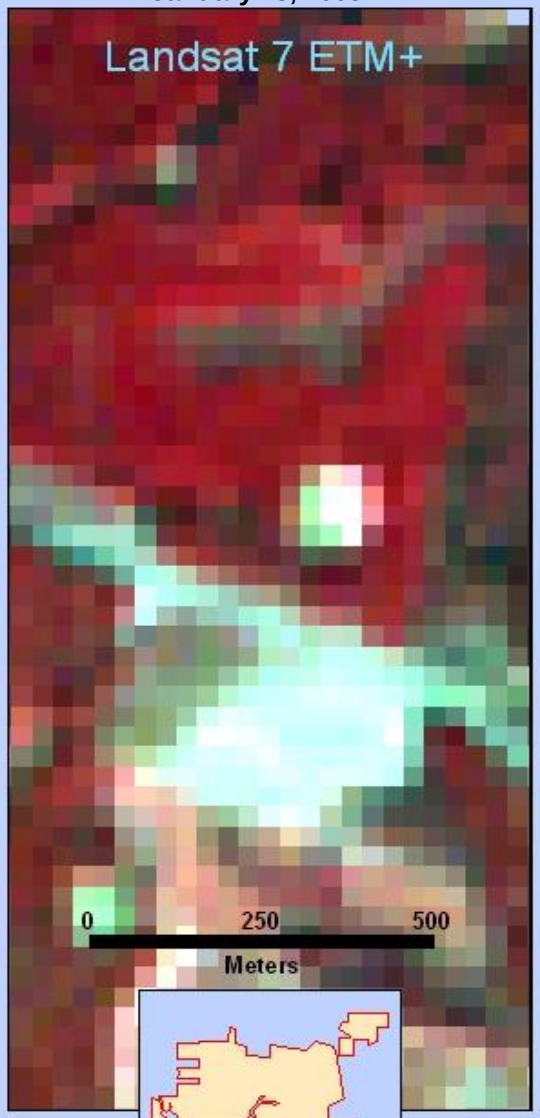


How Accurate?

Comparing Satellite Imagery Visually within the Hayter Estate

January 4, 2003

January 18, 2003



January 4, 2003

Introduction

Objectives

Methods

Results

Conclusions

Objectives

1. Determine the accuracy of Landsat 7 ETM+, SPOT 4, and QuickBird sensors in classifying land cover.
2. To compare the ability of Landsat 7 ETM+, SPOT 4, and QuickBird to differentiate land cover types in an urban environment versus a rural environment.

Hypothesis

1. As the spatial resolution of digital images increases the accuracy of classification in urban areas should increase.

2. As the spatial resolution of digital images increases the accuracy of classification in rural areas should decrease.

Introduction
Objectives
Methods
Results
Conclusions

Location of Study Areas

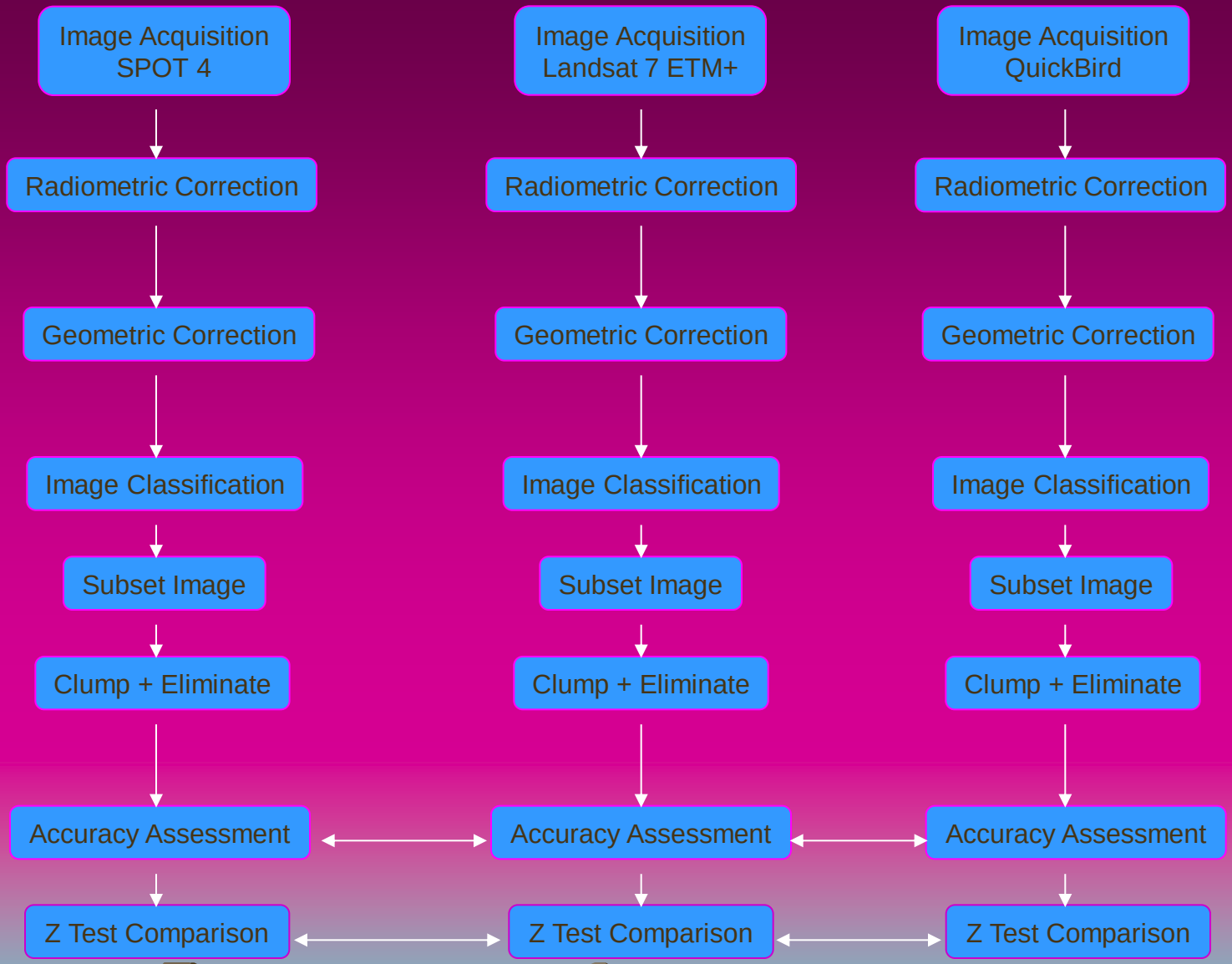


Image Acquisition SPOT 4
Image Acquisition Landsat 7 ETM+
Image Acquisition QuickBird
Radiometric Correction
Radiometric Correction
Radiometric Correction
Geometric Correction
Geometric Correction
Geometric Correction
Image Classification
Image Classification
Image Classification
Subset Image
Subset Image
Subset Image
Clump + Eliminate
Clump + Eliminate
Clump + Eliminate
Accuracy Assessment
Accuracy Assessment
Accuracy Assessment
Z Test Comparison
Z Test Comparison
Z Test Comparison

Steps in Land Classification of the City of Nacogdoches and the Hayter Estate

Satellite

Image

Digital Numbers

35	35	58	63	46	41	49	40
71	71	76	71	58	51	40	31
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Blue

15	15	24	32	24	15	16	13
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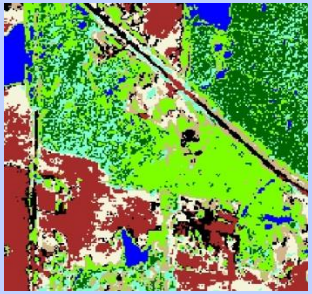
109	107	103	109	105	92	97	101
116	112	108	109	105	102	100	101
107	108	108	109	105	93	104	104
108	108	100	100	107	100	101	110
99	107	109	106	108	101	109	101
108	107	109	106	108	101	92	92
110	109	101	111	109	110	92	92

Red

Map

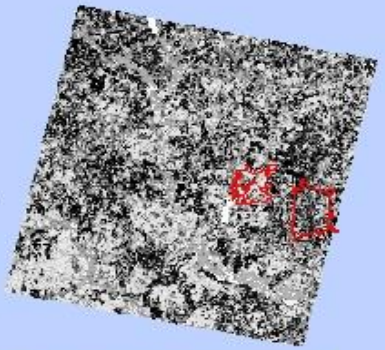


Steps in Land Classification of the City of Nacogdoches and the Hayter Estate

1. SPOT Image 4-Jan-2003
Displayed in CIR
1:1,350,000

Steps in Land Classification of the City of Nacogdoches and the Hayter Estate

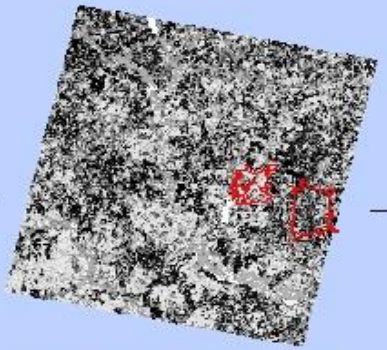
1. SPOT Image 4-Jan-2003
Displayed in CIR
1:1,350,000



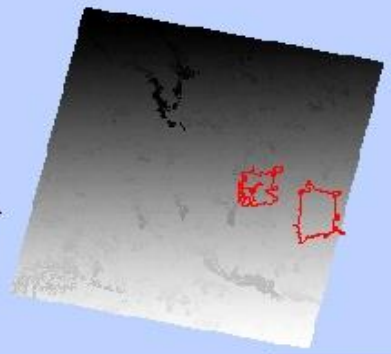
2. Orignal Image Unsupervised Classification of 100 classes.
Greyscale Thematic Map
1:1,350,000

Steps in Land Classification of the City of Nacogdoches and the Hayter Estate

1. SPOT Image 4-Jan-2003 Displayed in CIR 1:1,350,000



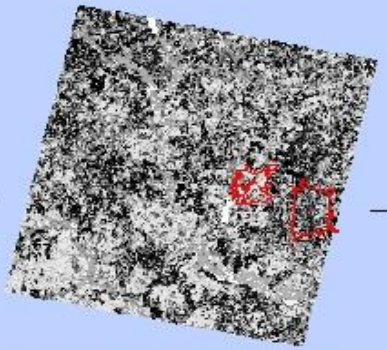
2. Orignal Image Unsupervised Classification of 100 classes. Greyscale Thematic Map 1:1,350,000



3. 100 recoded to 12 and then clumped, so that similar pixels are clumped together into like polygons. 1:1,350,000

Steps in Land Classification of the City of Nacogdoches and the Hayter Estate

1. SPOT Image 4-Jan-2003
Displayed in CIR
1:1,350,000



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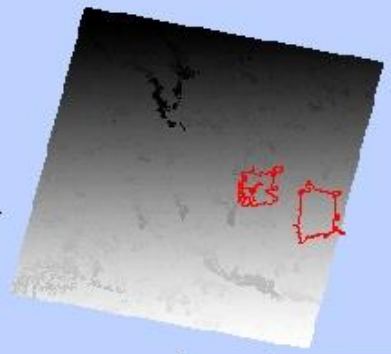
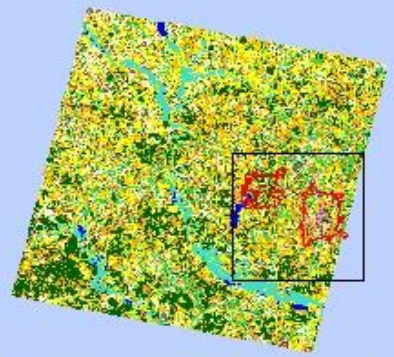
1:1,350,000



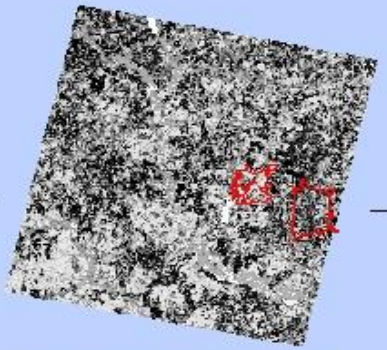
3. 100 recoded to 12 and then clumped, so that similar pixels are clumped together into like polygons.
1:1,350,000



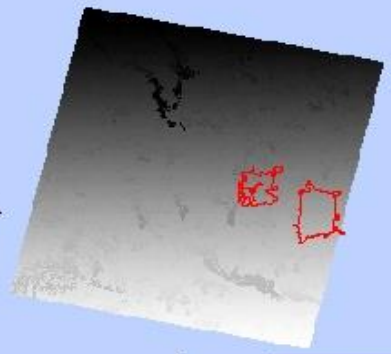
4. Eliminated Image so that island polygons, (less than 9 pixels in size) are removed from the image.
Color Thematic Map
1:1,350,000

Steps in Land Classification of the City of Nacogdoches and the Hayter Estate

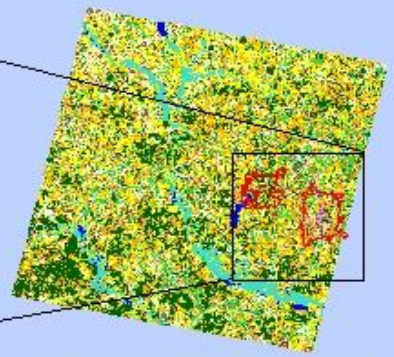
1. SPOT Image 4-Jan-2003
Displayed in CIR
1:1,350,000



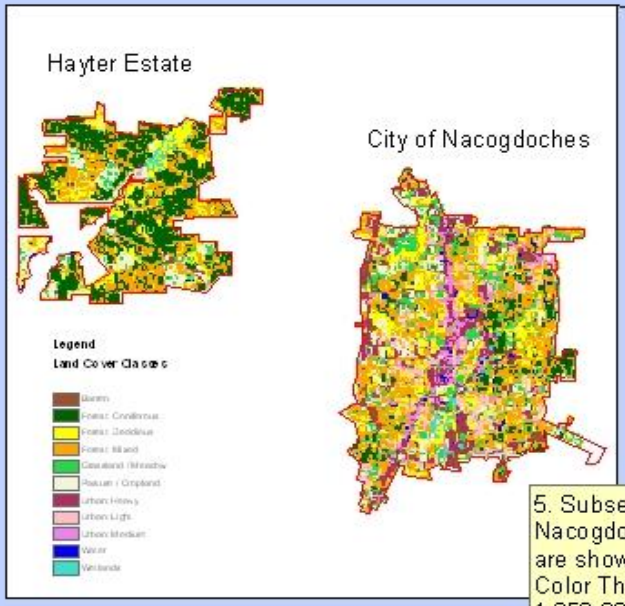
2. Orignal Image Unsupervised Classification of 100 classes.
Greyscale Thematic Map
1:1,350,000



3. 100 recoded to 12 and then clumped, so that similar pixels are clumped together into like polygons.
1:1,350,000



4. Eliminated Image so that island polygons, (less than 9 pixels in size) are removed from the image.
Color Thematic Map
1:1,350,000



5. Subset Image so that only City of Nacogdoches and Hayter Estate are shown and magnified.
Color Thematic Map
1:250,000

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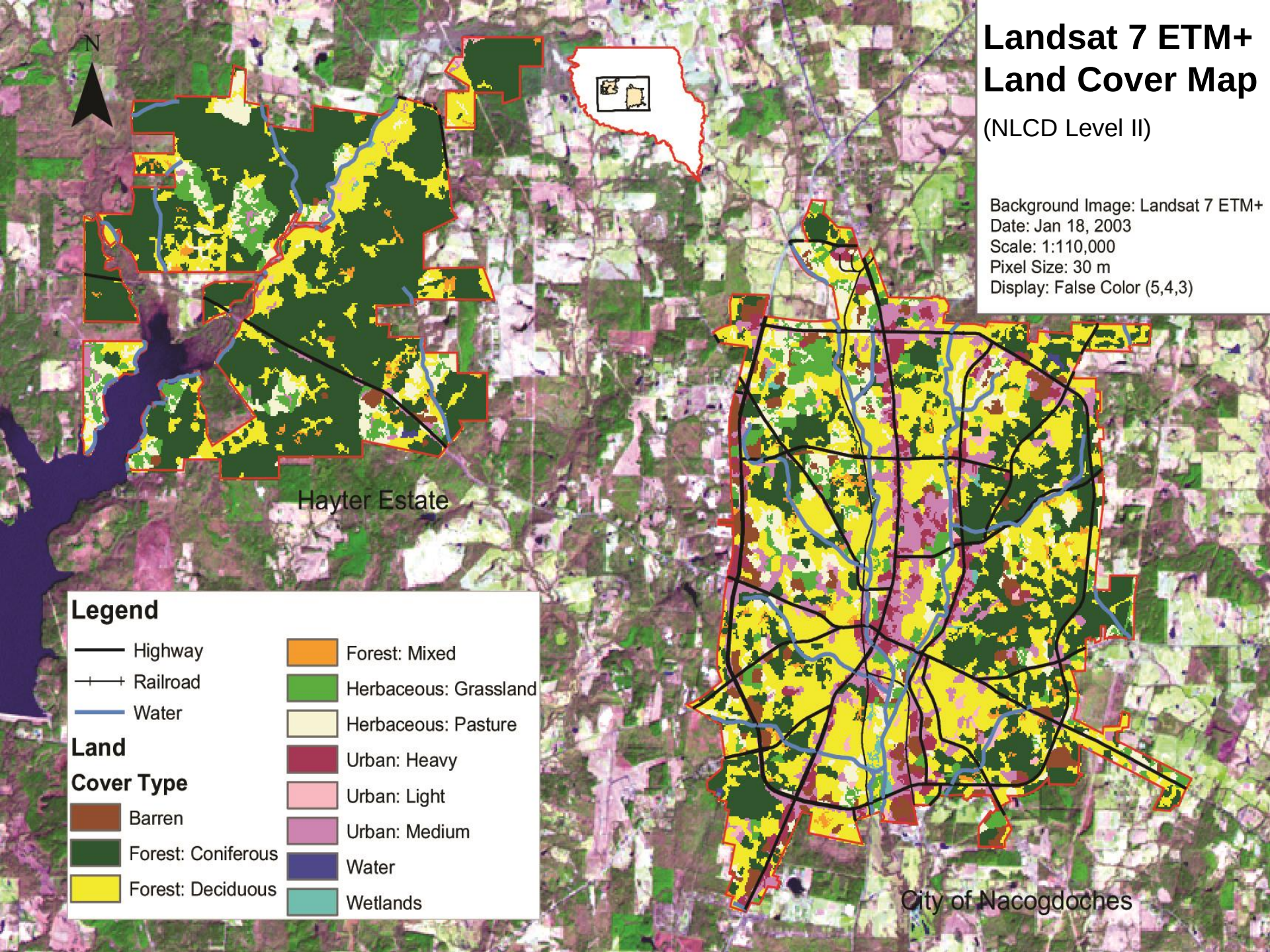
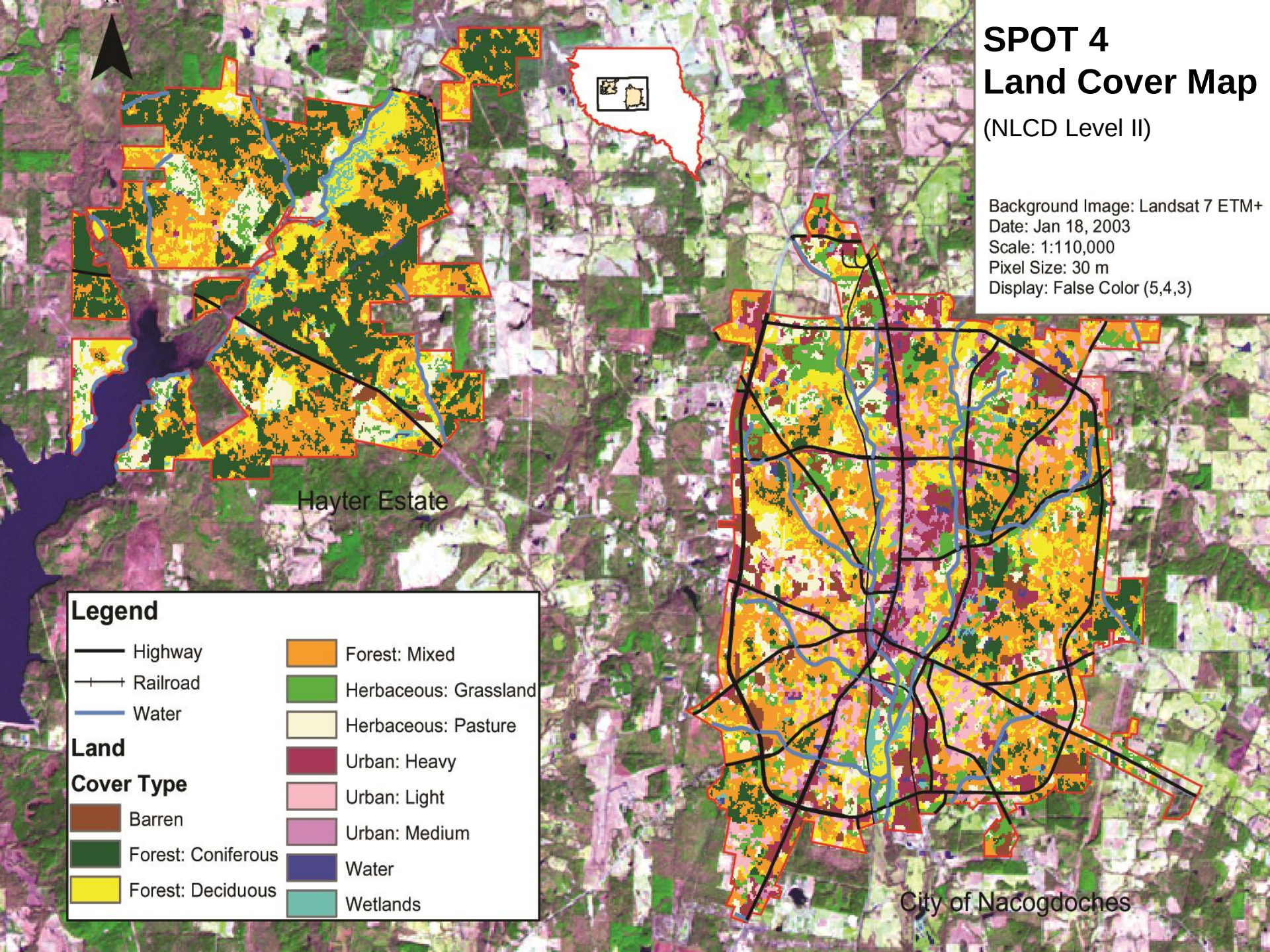
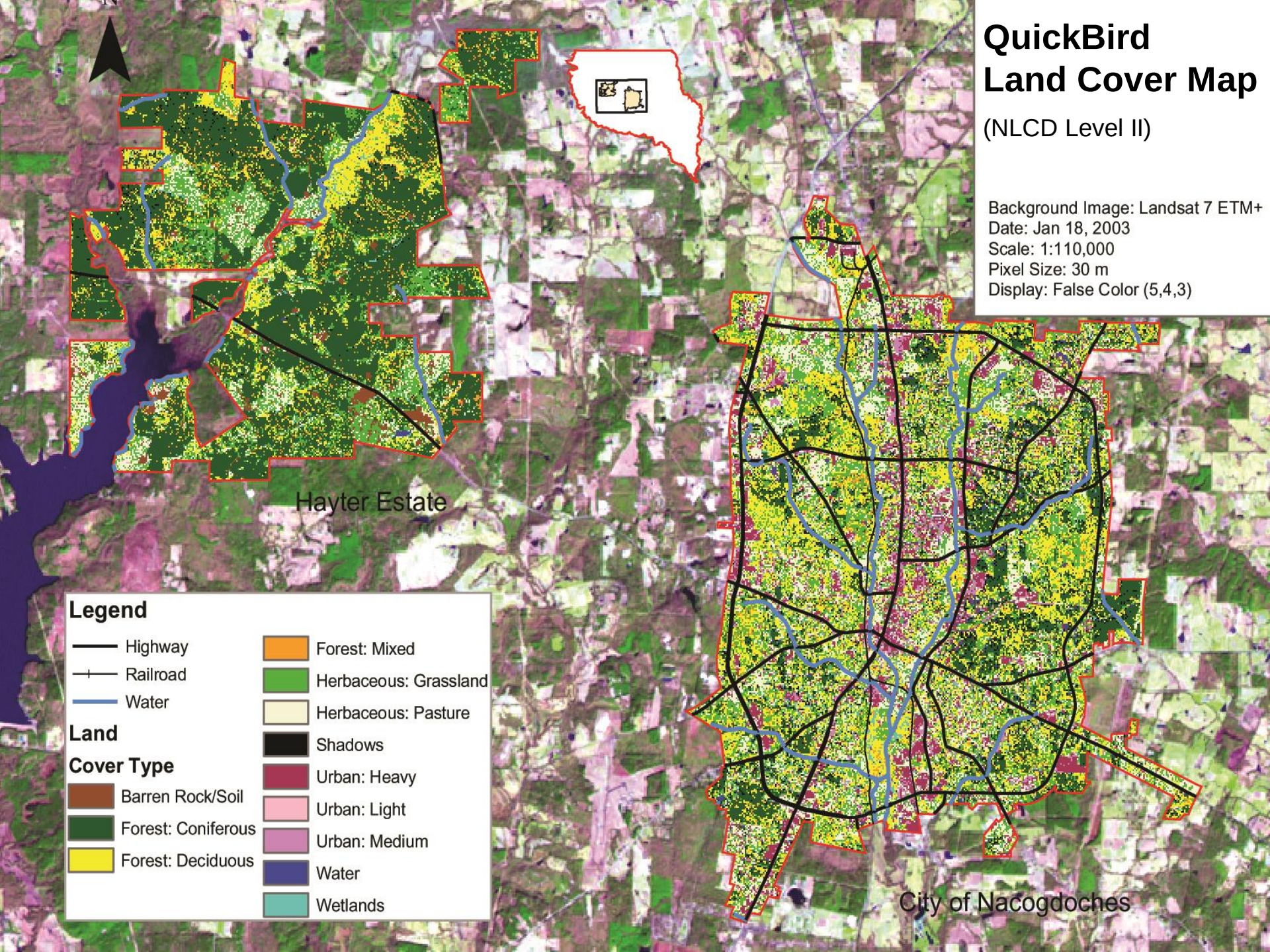
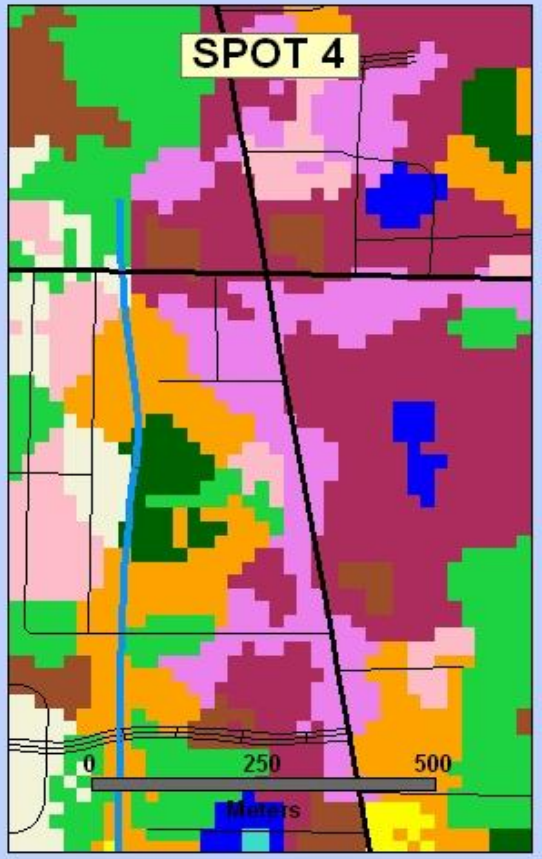
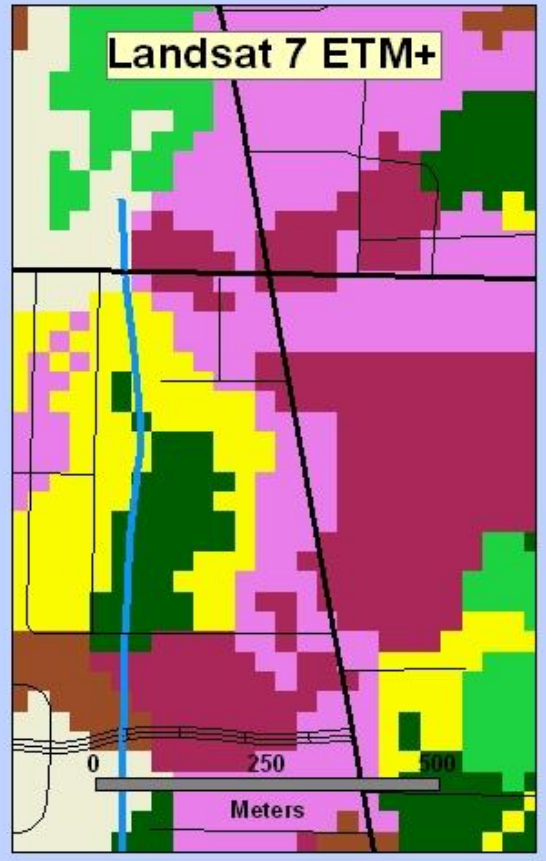

N
Landsat 7 ETM+
Land Cover Map
(NLCD Level II)
Background Image: Landsat 7 ETM+
Date: Jan 18, 2003
Scale: 1:110,000
Pixel Size: 30 m
Display: False Color (5,4,3)
Hayter Estate
City of Nacogdoches
Legend
Highway
Railroad
Water
Land
Cover Type
Barren
Forest: Coniferous
Forest: Deciduous
Forest: Mixed
Herbaceous: Grassland
Herbaceous: Pasture
Urban: Heavy
Urban: Light
Urban: Medium
Water
Wetlands

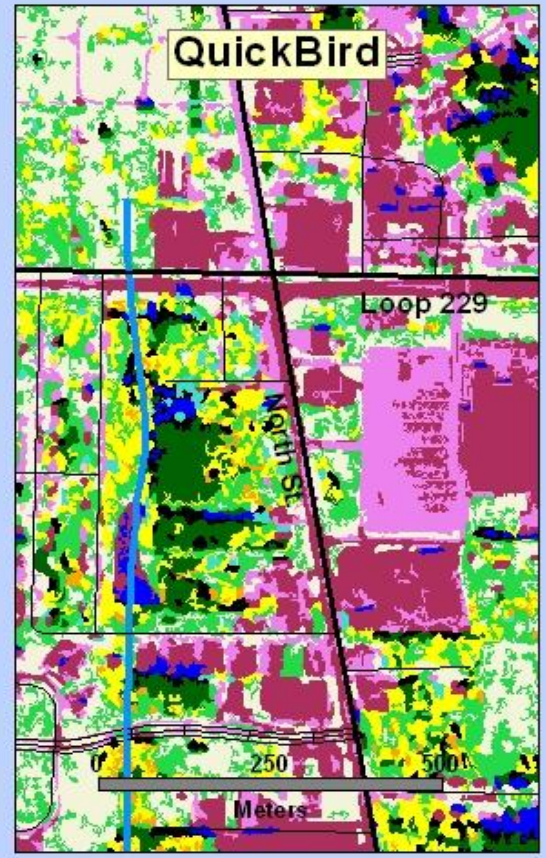

SPOT 4
Land Cover Map
(NLCD Level II)
Background Image: Landsat 7 ETM+
Date: Jan 18, 2003
Scale: 1:110,000
Pixel Size: 30 m
Display: False Color (5,4,3)
Hayter Estate
City of Nacogdoches
Legend
Highway
Railroad
Water
Land
Cover Type
Barren
Forest: Coniferous
Forest: Deciduous
Forest: Mixed
Herbaceous: Grassland
Herbaceous: Pasture
Urban: Heavy
Urban: Light
Urban: Medium
Water
Wetlands


QuickBird
Land Cover Map
(NLCD Level II)
Background Image: Landsat 7 ETM+
Date: Jan 18, 2003
Scale: 1:110,000
Pixel Size: 30 m
Display: False Color (5,4,3)
Hayter Estate
City of Nacogdoches
Legend
Highway
Railroad
Water
Land
Cover Type
Barren Rock/Soil
Forest: Coniferous
Forest: Deciduous
Forest: Mixed
Herbaceous: Grassland
Herbaceous: Pasture
Shadows
Urban: Heavy
Urban: Light
Urban: Medium
Water
Wetlands

Comparison of Land Cover Maps within the City of Nacogdoches



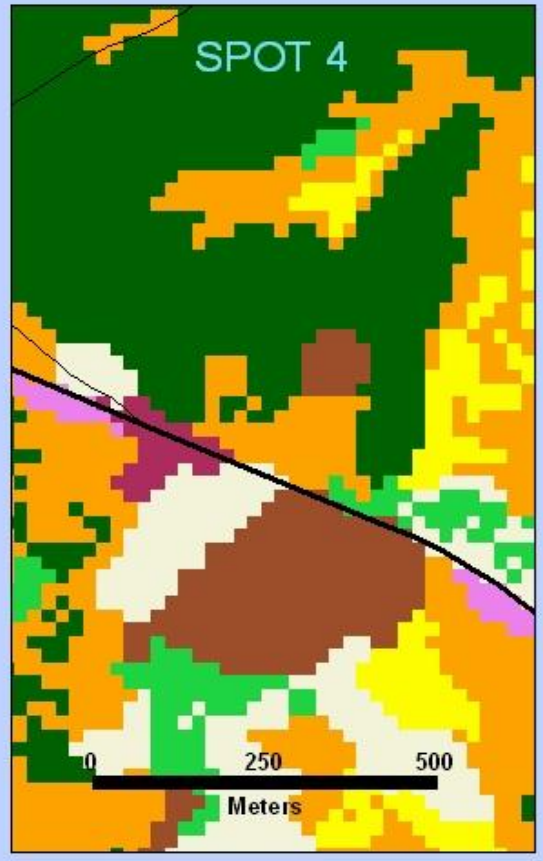


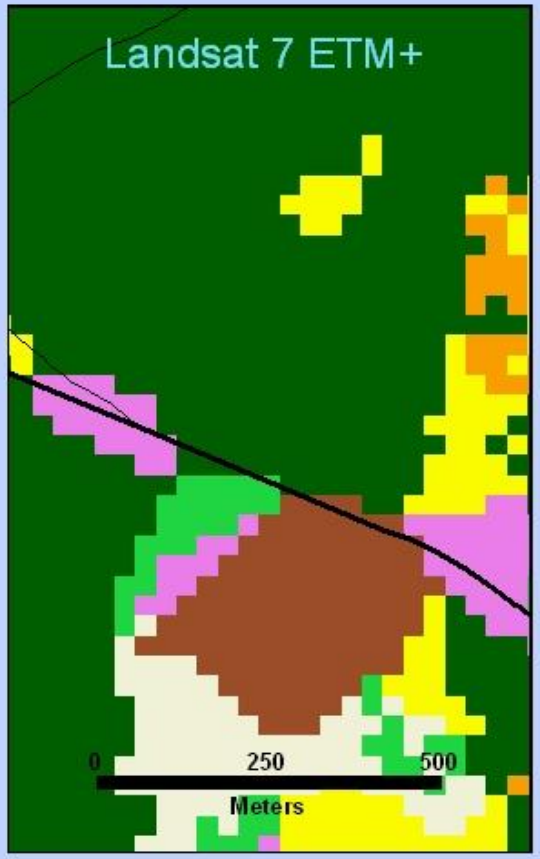


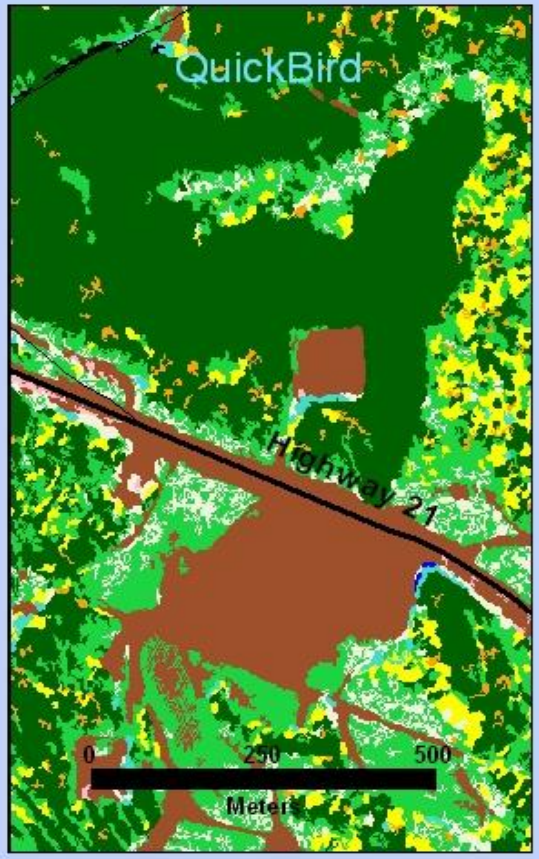
Land Cover

- Barren
- Grassland
- Hardwood
- Mixed
- Pasture
- Pine
- Shadows
- Urban Heavy
- Urban Light
- Urban Medium
- Water
- Wetlands

Comparison of Land Cover Maps within the Hayter Estate







Land Cover

- Barren
- Forest: Coniferous
- Forest: Deciduous
- Forest: Mixed
- Herbaceous: Grassl
- Herbaceous: Pastur
- Urban: Heavy
- Urban: Light
- Urban: Medium
- Water
- Wetlands

Accuracy of Classification

– Classification Categories using National Land Cover Data (NLCD) Level II.

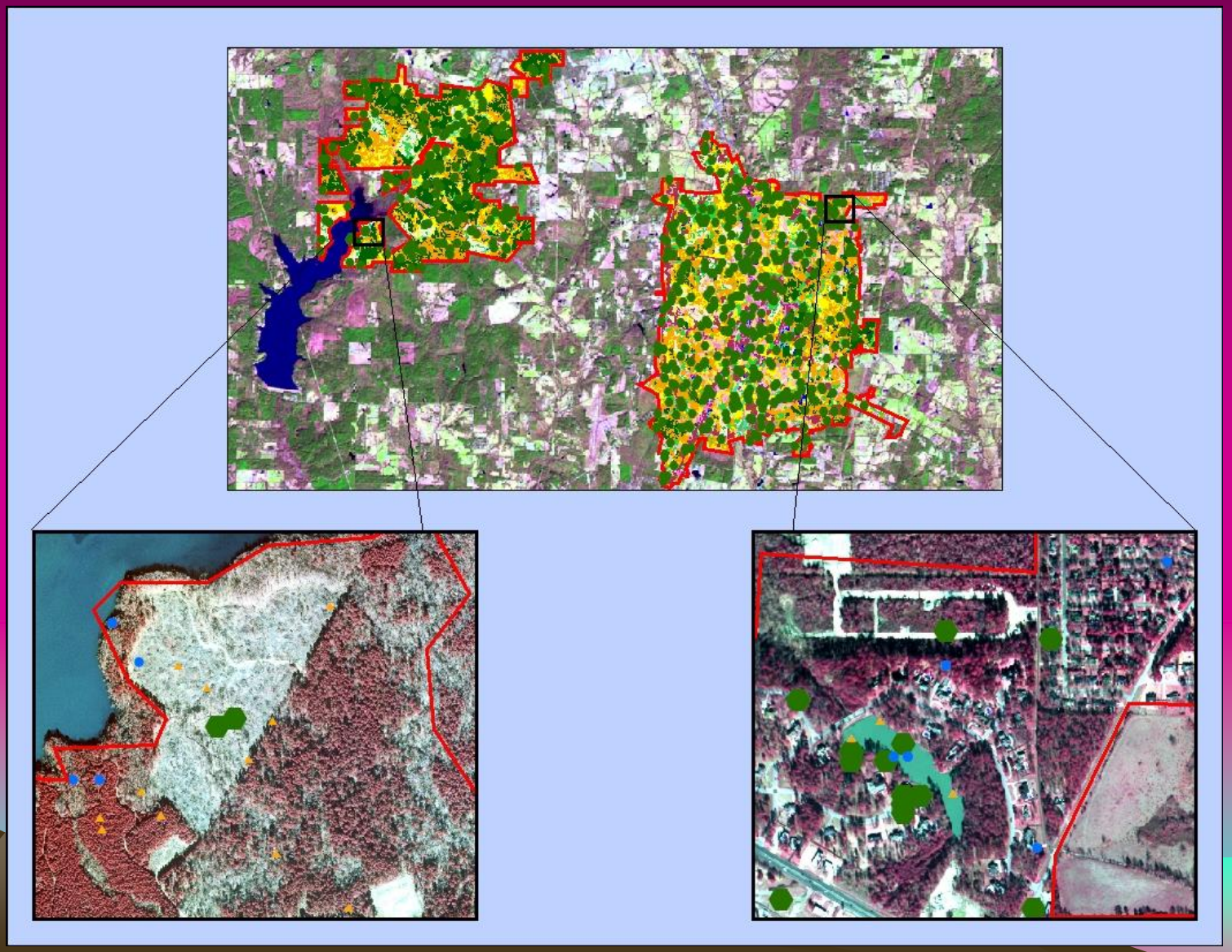
Land Cover Definitions representing east Texas from the NLCD 2000 Classification

1. Water
2. Forest: Coniferous
3. Forest: Deciduous
4. Forest: Mixed
5. Herbaceous: Grassland
6. Herbaceous: Pasture
7. Barren
8. Urban: Light
9. Urban: Medium
10. Urban: Heavy
11. Wetlands
12. Other

Accuracy of Classification

- Comparison of Ground Control Points to Classified Map
  - 576 control points for each satellite scene over the entire study area.
  - Control points located using a stratified random sample scheme.
  - One meter digital aerial photos for reference data source (acquisition date January 1, 2003).

Location of Control Points for Accuracy Assessment



SPOT 4 Accuracy Assessment: Determined from 576 stratified random points, using NLCD 2000 Level II Classification.

		REFERENCE (1)										
		Water	Forest: Coniferous	Forest: Deciduous	Forest: Mixed	Herbaceous: Grassland	Herbaceous: Pasture	Barren	Urban: Light	Urban: Medium	Urban: Heavy	Wetlands
	Water	9	1	1	2			1	5	4	4	3
C	Forest: Coniferous		74	1	2			2	1			
L	Forest: Deciduous		2	31	18	4	6		5			
A	Forest: Mixed		42	5	40	5	1		7			2
S	Herbaceous: Grassland		1	3	2	19	16		9		1	
S	Herbaceous: Pasture	1		5	3	15	16	3	6		1	
I	Barren	1	1	2	1	5	6	6	4	3	5	2
F	Urban: Light		1	1	3	2	2	5	28	3		
I	Urban: Medium	2		4	1	1	3	3	8	11	3	1
E	Urban: Heavy					4	1	1	6	16	17	
D	Wetlands	4		5	1		1	1	4	4	3	10
(2)	Total	17	122	58	73	55	52	22	83	41	34	18
	Producers Accuracy	52.9%	60.7%	53.4%	54.8%	34.5%	30.8%	27.3%	33.7%	26.8%	50.0%	55.6%

	Total Points	576		Null hypothesis: K=0. If Z >= 1.96 then reject null hypothesis.
	Z-Statistic	1.6057369	Do not reject	

SPOT 4 Accuracy Assessment: Determined from 576 stratified random points, using NLCD 2000 Level II Classification.

		REFERENCE (1)												
		Water	Forest: Coniferous	Forest: Deciduous	Forest: Mixed	Herbaceous: Grassland	Herbaceous: Pasture	Barren	Urban: Light	Urban: Medium	Urban: Heavy	Wetlands	Total	Users Accuracy
C	Water	**9**	1	1	2			1	5	4	4	3	30	30.0%
L	Forest: Coniferous		**74**	1	2			2	1				80	92.5%
A	Forest: Deciduous		2	**31**	18	4	6		5				66	47.0%
S	Forest: Mixed		42	5	**40**	5	1		7			2	102	39.2%
S	Herbaceous: Grassland		1	3	2	**19**	16		9		1		51	37.3%
I	Herbaceous: Pasture	1		5	3	15	**16**	3	6		1		50	32.0%
F	Barren	1	1	2	1	5	6	**6**	4	3	5	2	36	16.7%
I	Urban: Light		1	1	3	2	2	5	**28**	3			45	62.2%
E	Urban: Medium	2		4	1	1	3	3	8	**11**	3	1	37	29.7%
D	Urban: Heavy					4	1	1	6	16	**17**		45	37.8%
	Wetlands	4		5	1		1	1	4	4	3	**10**	33	30.3%
(2)	Total	17	122	58	73	55	52	22	83	41	34	18	**261**	Total Correct
	Producers Accuracy	52.9%	60.7%	53.4%	54.8%	34.5%	30.8%	27.3%	33.7%	26.8%	50.0%	55.6%	Overall	**45.3%**
													Kappa	39.1%

Total Points **576**

Z-Statistic 1.6057369 Do not reject

Null hypothesis: K=0. If Z >= 1.96 then reject null hypothesis.

SPOT 4 Accuracy Assessment: Determined from 576 stratified random points, using NLCD 2000 Level II Classification.

		REFERENCE (1)												
		Water	Forest: Coniferous	Forest: Deciduous	Forest: Mixed	Herbaceous: Grassland	Herbaceous: Pasture	Barren	Urban: Light	Urban: Medium	Urban: Heavy	Wetlands	Total	Users Accuracy
CLASSIFIED	Water	**9**	1	1	2			1	5	4	4	3	30	30.0%
	Forest: Coniferous		**74**	1	2			2	1				80	92.5%
	Forest: Deciduous		2	**31**	18	4	6		5				66	47.0%
	Forest: Mixed		42	5	**40**	5	1		7			2	102	39.2%
	Herbaceous: Grassland		1	3	2	**19**	16		9		1		51	37.3%
	Herbaceous: Pasture	1		5	3	15	**16**	3	6		1		50	32.0%
	Barren	1	1	2	1	5	6	**6**	4	3	5	2	36	16.7%
	Urban: Light		1	1	3	2	2	5	**28**	3			45	62.2%
	Urban: Medium	2		4	1	1	3	3	8	**11**	3	1	37	29.7%
	Urban: Heavy					4	1	1	6	16	**17**		45	37.8%
	Wetlands	4		5	1		1	1	4	4	3	**10**	33	30.3%
(2)	Total	**17**	**122**	**58**	**73**	**55**	**52**	**22**	**83**	**41**	**34**	**18**	261	Total Correct
	Producers Accuracy	52.9%	60.7%	53.4%	54.8%	34.5%	30.8%	27.3%	33.7%	26.8%	50.0%	55.6%	Overall	45.3%
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Total Points 576

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SPOT 4 Accuracy Assessment: Determined from 576 stratified random points, using NLCD 2000 Level II Classification.

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CLASSIFIED	Water	**9**	1	1	2			1	5	4	4	3	30	30.0%
	Forest: Coniferous		**74**	1	2			2	1				80	92.5%
	Forest: Deciduous		2	**31**	18	4	6		5				66	47.0%
	Forest: Mixed		42	5	**40**	5	1		7			2	102	39.2%
	Herbaceous: Grassland		1	3	2	**19**	16		9		1		51	37.3%
	Herbaceous: Pasture	1		5	3	15	**16**	3	6		1		50	32.0%
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	Urban: Light		1	1	3	2	2	5	**28**	3			45	62.2%
	Urban: Medium	2		4	1	1	3	3	8	**11**	3	1	37	29.7%
	Urban: Heavy					4	1	1	6	16	**17**		45	37.8%
	Wetlands	4		5	1		1	1	4	4	3	**10**	33	30.3%
(2)	Total	**17**	**122**	**58**	**73**	**55**	**52**	**22**	**83**	**41**	**34**	**18**	261	Total Correct
	Producers Accuracy	**52.9%**	**60.7%**	**53.4%**	**54.8%**	**34.5%**	**30.8%**	**27.3%**	**33.7%**	**26.8%**	**50.0%**	**55.6%**	Overall	45.3%
													Kappa	39.1%

Total Points 576

Z-Statistic 1.6057369 Do not reject

Null hypothesis: K=0. If Z >= 1.96 then reject null hypothesis.

SPOT 4 Accuracy Assessment: Determined from 576 stratified random points, using NLCD 2000 Level II Classification.

		REFERENCE (1)												
		Water	Forest: Coniferous	Forest: Deciduous	Forest: Mixed	Herbaceous: Grassland	Herbaceous: Pasture	Barren	Urban: Light	Urban: Medium	Urban: Heavy	Wetlands	Total	Users Accuracy
CLASSIFIED (2)	Water	**9**	1	1	2			1	5	4	4	3	**30**	30.0%
	Forest: Coniferous		**74**	1	2			2	1				**80**	92.5%
	Forest: Deciduous		2	**31**	18	4	6		5				**66**	47.0%
	Forest: Mixed		42	5	**40**	5	1		7			2	**102**	39.2%
	Herbaceous: Grassland		1	3	2	**19**	16		9		1		**51**	37.3%
	Herbaceous: Pasture	1		5	3	15	**16**	3	6		1		**50**	32.0%
	Barren	1	1	2	1	5	6	**6**	4	3	5	2	**36**	16.7%
	Urban: Light		1	1	3	2	2	5	**28**	3			**45**	62.2%
	Urban: Medium	2		4	1	1	3	3	8	**11**	3	1	**37**	29.7%
	Urban: Heavy					4	1	1	6	16	**17**		**45**	37.8%
	Wetlands	4		5	1		1	1	4	4	3	**10**	**33**	30.3%
	Total	17	122	58	73	55	52	22	83	41	34	18	261	Total Correct
	Producers Accuracy	52.9%	60.7%	53.4%	54.8%	34.5%	30.8%	27.3%	33.7%	26.8%	50.0%	55.6%	Overall	45.3%
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Total Points 576
Z-Statistic 1.6057369 Do not reject

Null hypothesis: K=0. If Z >= 1.96 then reject null hypothesis.

SPOT 4 Accuracy Assessment: Determined from 576 stratified random points, using NLCD 2000 Level II Classification.

		REFERENCE (1)												
		Water	Forest: Coniferous	Forest: Deciduous	Forest: Mixed	Herbaceous: Grassland	Herbaceous: Pasture	Barren	Urban: Light	Urban: Medium	Urban: Heavy	Wetlands	Total	Users Accuracy
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	Forest: Coniferous		**74**	1	2			2	1				**80**	**92.5%**
	Forest: Deciduous		2	**31**	18	4	6		5				**66**	**47.0%**
	Forest: Mixed		42	5	**40**	5	1		7			2	**102**	**39.2%**
	Herbaceous: Grassland		1	3	2	**19**	16		9		1		**51**	**37.3%**
	Herbaceous: Pasture	1		5	3	15	**16**	3	6		1		**50**	**32.0%**
	Barren	1	1	2	1	5	6	**6**	4	3	5	2	**36**	**16.7%**
	Urban: Light		1	1	3	2	2	5	**28**	3			**45**	**62.2%**
	Urban: Medium	2		4	1	1	3	3	8	**11**	3	1	**37**	**29.7%**
	Urban: Heavy					4	1	1	6	16	**17**		**45**	**37.8%**
	Wetlands	4		5	1		1	1	4	4	3	**10**	**33**	**30.3%**
	Total	17	122	58	73	55	52	22	83	41	34	18	261	Total Correct
	Producers Accuracy	52.9%	60.7%	53.4%	54.8%	34.5%	30.8%	27.3%	33.7%	26.8%	50.0%	55.6%	Overall	45.3%
													Kappa	39.1%

Total Points 576
Z-Statistic 1.6057369 Do not reject

Null hypothesis: K=0. If Z >= 1.96 then reject null hypothesis.

Accuracy of Classification

- Kappa Statistic
  - Combines Overall, Users and Producers Accuracies

$$\hat{K} = \frac{N\sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r} (x_{i+} * x_{+i})}{N^2 - \sum_{i=1}^{r} (x_{i+} * x_{+i})}$$

N is the total number of observations, r is the number of rows in the matrix,
xii is the number of correct observations in each category,
xi+ and x+i are the totals of each category for the rows and columns respectively.

SPOT 4 Accuracy Assessment: Determined from 576 stratified random points, using NLCD 2000 Level II Classification.

		REFERENCE (1)												
		Water	Forest: Coniferous	Forest: Deciduous	Forest: Mixed	Herbaceous: Grassland	Herbaceous: Pasture	Barren	Urban: Light	Urban: Medium	Urban: Heavy	Wetlands	Total	Users Accuracy
CLASSIFIED (2)	Water	9	1	1	2			1	5	4	4	3	30	30.0%
	Forest: Coniferous		74	1	2			2	1				80	92.5%
	Forest: Deciduous		2	31	18	4	6		5				66	47.0%
	Forest: Mixed		42	5	40	5	1		7			2	102	39.2%
	Herbaceous: Grassland		1	3	2	19	16		9		1		51	37.3%
	Herbaceous: Pasture	1		5	3	15	16	3	6		1		50	32.0%
	Barren	1	1	2	1	5	6	6	4	3	5	2	36	16.7%
	Urban: Light		1	1	3	2	2	5	28	3			45	62.2%
	Urban: Medium	2		4	1	1	3	3	8	11	3	1	37	29.7%
	Urban: Heavy					4	1	1	6	16	17		45	37.8%
	Wetlands	4		5	1		1	1	4	4	3	10	33	30.3%
	Total	17	122	58	73	55	52	22	83	41	34	18	261	Total Correct
	Producers Accuracy	52.9%	60.7%	53.4%	54.8%	34.5%	30.8%	27.3%	33.7%	26.8%	50.0%	55.6%	Overall	45.3%

Kappa 39.1%

Total Points 576

Z-Statistic 1.6057369 Do not reject

Null hypothesis: K=0. If Z >= 1.96 then reject null hypothesis.

Accuracy of Classification

- Kappa Statistic
  - Is normally distributed which allows us to conduct z-tests to determine the significance:
- Of each classified map from a random classification or

$$Z = \frac{\hat{K}_1}{\sqrt{\hat{\text{var}}(\hat{K}_{1)}}}$$

- Compare two classified maps

$$Z = \frac{\left|\hat{K}_1 - \hat{K}_2\right|}{\sqrt{\hat{\text{var}}(\hat{K}_1) + \hat{\text{var}}(\hat{K}_2)}}$$

Summary of Accuracy Assessments using NLCD Level II Classification

			SENSOR Landsat 7 ETM+	SPOT 4	QuickBird
ASSESSMENT	Whole Scene	Overall	57.2%	45.4%	41.0%
		Kappa	51.8%	38.9%	33.6%
		Z-Score	4.859	1.600	1.397
		Significance	**Reject**	**Do Not Reject**	**Do Not Reject**
	Rural	Overall	73.6%	59.9%	50.2%
		Kappa	63.2%	45.0%	36.4%
		Z-Score	7.172	3.798	2.527
		Significance	**Reject**	**Reject**	**Reject**
	Urban	Overall	49.6%	39.4%	35.6%
		Kappa	44.6%	35.6%	28.0%
		Z-Score	1.343	0.802	0.620
		Significance	**Do Not Reject**	**Do Not Reject**	**Do Not Reject**

Significance at alpha = 0.05, Null hypothesis: K=0. If Z >= 1.96 then reject null hypothesis.

Kappa Statistic Significance

$\kappa > 0.75$ denotes excellent reproducibility

$0.4 \leq \kappa \leq 0.75$ denotes good reproducibility

$0 \leq \kappa \leq 0.4$ denotes marginal reproducibility

Overall Accuracy Signficance

Minimum Level of Accuracy at 85-90%.

Accuracy of Classification

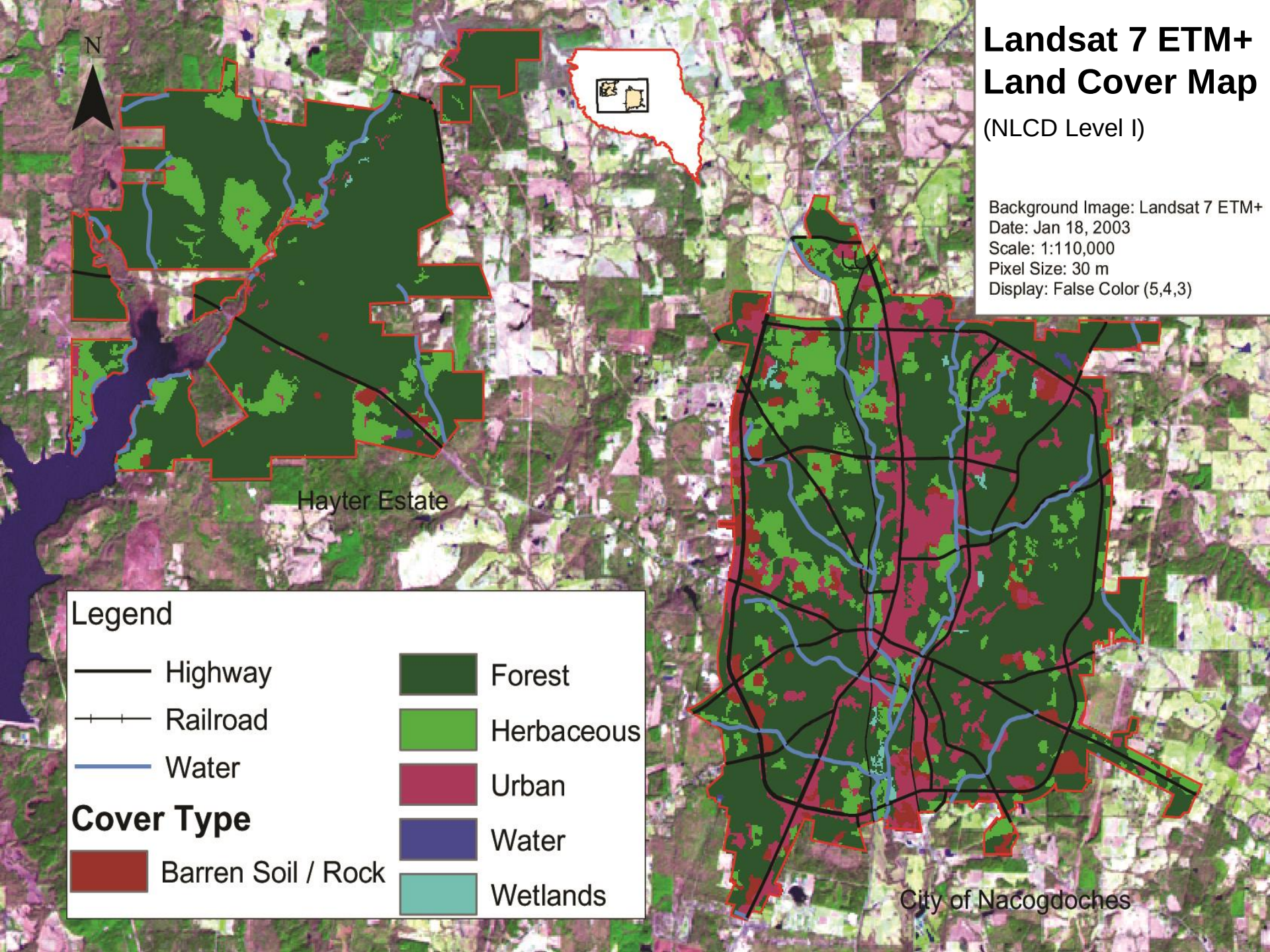
- Since half of the scenes were not significantly different from a random pattern and
- The scenes did not meet minimum overall accuracy standards and
- The scenes did not meet good kappa reproducibility standards
- Each scene was reclassified using NLCD Level I (Phase II).

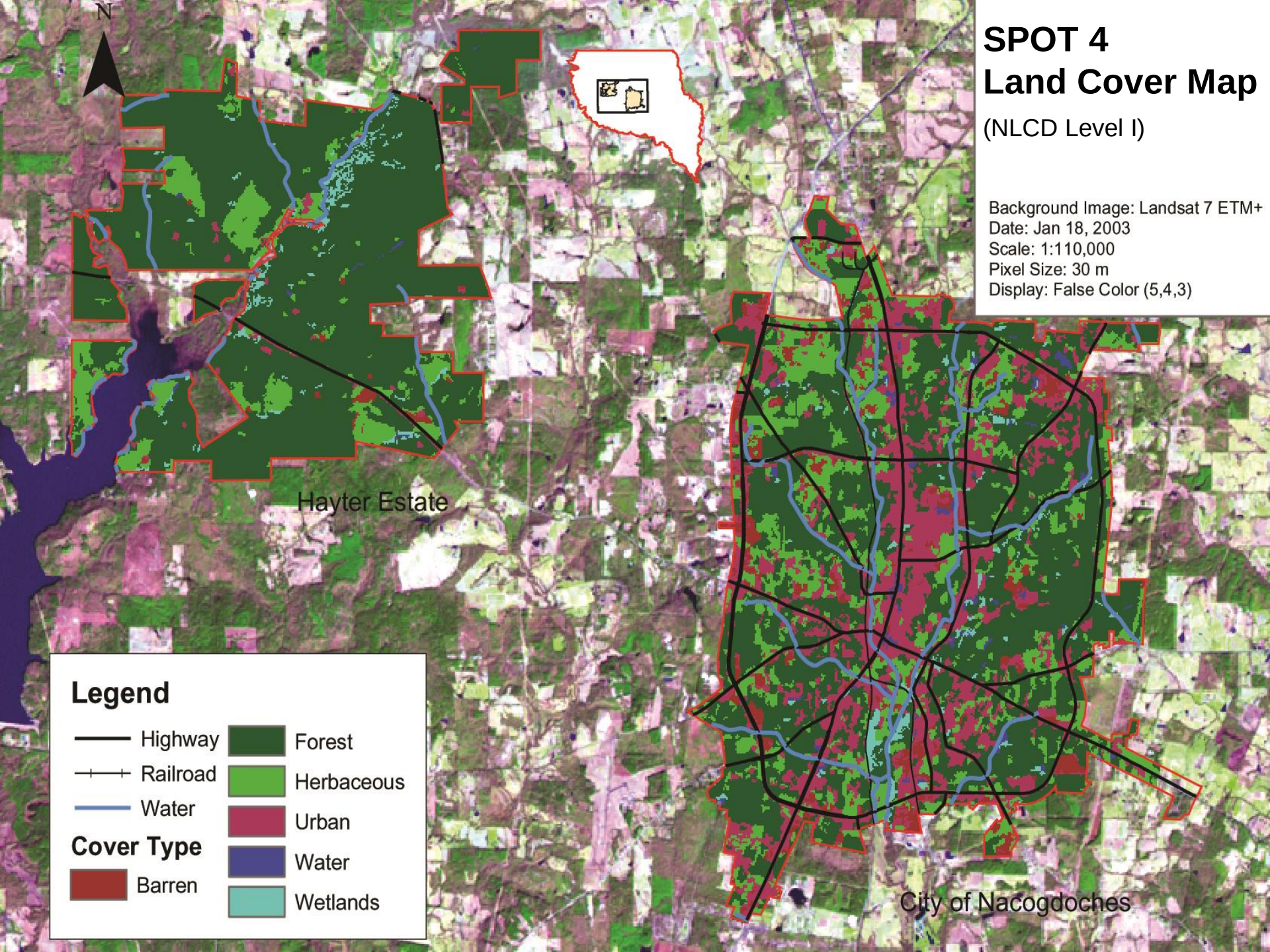
Accuracy of Classification

– Classification Categories using National Land Cover Data (NLCD) Level I.

Land Cover Definitions representing east Texas from the NLCD 2000 Classification Level I

1. Water
2. Forest
3. Herbaceous
4. Barren
5. Urban (Developed)
6. Wetlands
7. Other


N
Landsat 7 ETM+
Land Cover Map
(NLCD Level I)
Background Image: Landsat 7 ETM+
Date: Jan 18, 2003
Scale: 1:110,000
Pixel Size: 30 m
Display: False Color (5,4,3)
Hayter Estate
City of Nacogdoches
Legend
Highway
Railroad
Water
Cover Type
Barren Soil / Rock
Forest
Herbaceous
Urban
Water
Wetlands


N
SPOT 4
Land Cover Map
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Background Image: Landsat 7 ETM+
Date: Jan 18, 2003
Scale: 1:110,000
Pixel Size: 30 m
Display: False Color (5,4,3)
Hayter Estate
City of Nacogdoches
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Urban
Water
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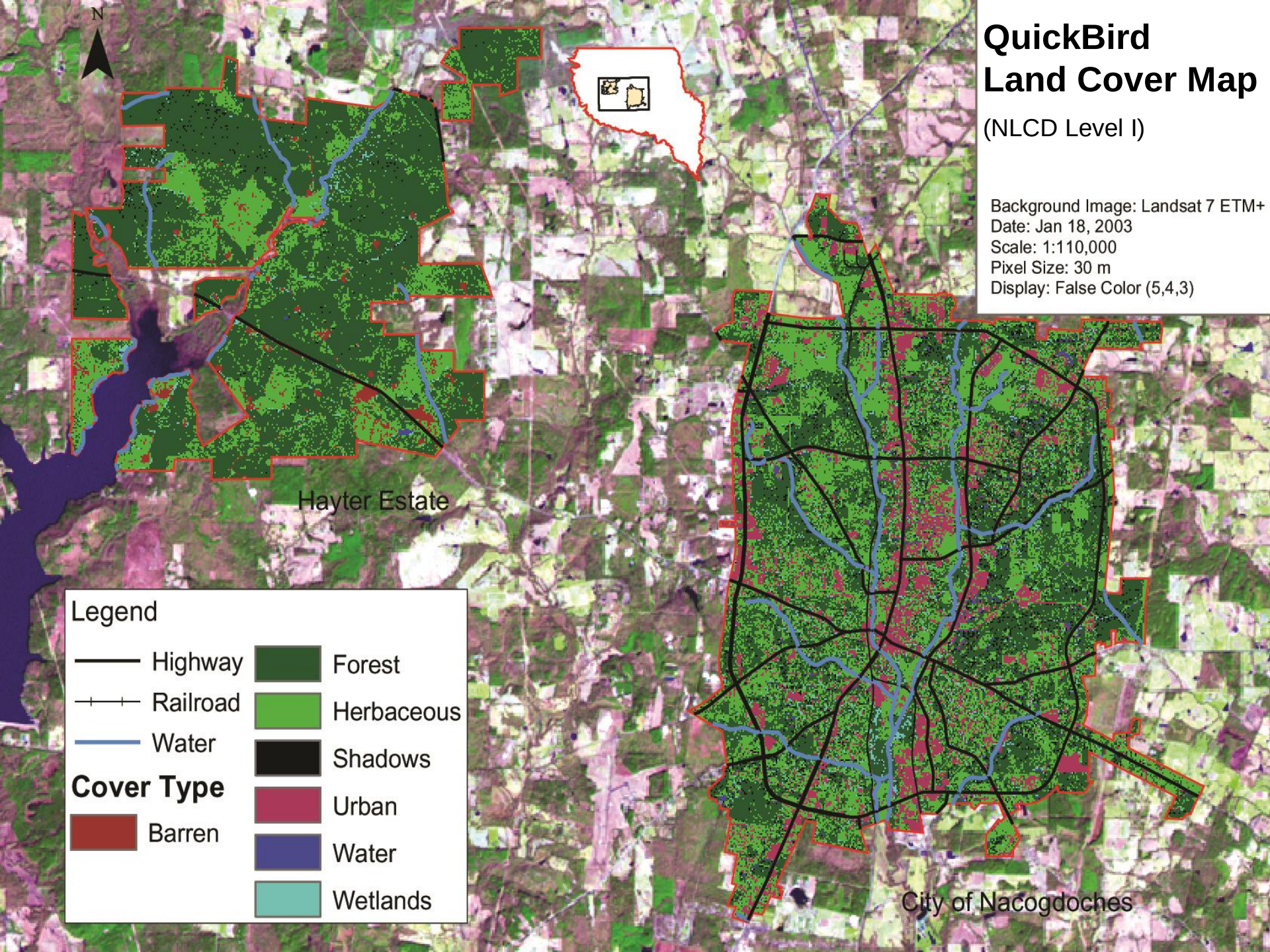
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Display: False Color (5,4,3)
Hayter Estate
City of Nacogdoches
Legend
Highway
Railroad
Water
Cover Type
Barren
Forest
Herbaceous
Shadows
Urban
Water
Wetlands

SPOT 4 Accuracy Assessment: Points within the Hayter Estate (Rural), using NLCD 2000 Level I Classification.

		REFERENCE (1)							
		Water	Forest	Herbaceous	Barren	Urban	Wetlands	Total	Users Accuracy
CLASSIFIED (2)	Water	3					1	4	75.0%
	Forest		115	8	1	1		125	92.0%
	Herbaceous		7	17				24	70.8%
	Barren		2	1	0		1	4	0.0%
	Urban		1	2		0		3	0.0%
	Wetlands	1	4	1			1	7	14.3%
	Total	4	129	29	1	1	3	136	Total Correct
	Producers Accuracy	75.0%	89.1%	58.6%	0.0%	0.0%	33.3%	Overall	81.4%
								Kappa	53.0%

Total Points 167

Z-Statistic 10.49035011 Reject

Null hypothesis: K=0. If Z >= 1.96 then reject null hypothesis.

Summary of Accuracy Assessments using NLCD Level I Classification

			SENSOR Landsat 7 ETM+	SPOT 4	QuickBird
ASSE	Whole Scene	Overall	79.3%	68.3%	63.4%
		Kappa	70.8%	55.6%	49.2%
		Z-Score	24.768	23.708	61.762
		Significance	**Reject**	**Reject**	**Reject**
SSME	Rural	Overall	90.1%	81.4%	63.6%
		Kappa	77.1%	53.0%	32.7%
		Z-Score	16.630	10.490	8.202
		Significance	**Reject**	**Reject**	**Reject**
NT	Urban	Overall	74.6%	62.8%	63.2%
		Kappa	66.2%	50.4%	51.0%
		Z-Score	39.768	9.265	7.900
		Significance	**Reject**	**Reject**	**Reject**

Significance at alpha = 0.05, Null hypothesis: K=0. If Z >= 1.96 then reject null hypothesis.

Kappa Statistic Significance

$\kappa > 0.75$ denotes excellent reproducibility

$0.4 \leq \kappa \leq 0.75$ denotes good reproducibility

$0 \leq \kappa \leq 0.4$ denotes marginal reproducibility

Overall Accuracy Signficance

Minimum Level of Accuracy at 85-90%.

Introduction
Objectives
Methods
Results
Conclusions

Conclusion

- Landsat 7 ETM+ consistently was the most accurate at:
  - both levels of classification
  - over all scenes (Entire Image, Rural and Urban)
  - was more accurate in a Rural setting (90% Level I) than in an Urban environment (75% Level I)

Conclusion

- SPOT 4 (at all levels):
  - was more accurate in a Rural setting (81% Level I) than in an Urban environment (63% Level I)

Conclusion

- QuickBird was consistently the least accurate at:
  - all two levels of classification
  - over all scenes (Entire Image, Rural and Urban)
  - highest accuracy level was in a rural setting (64% Level I)

Conclusion

- Landsat 7 ETM+ was the most accurate due to its better spectral resolution
- Shadows on the QuickBird image decreased accuracy
- Smaller spatial resolution on QuickBird increased confusion between classes

Time for Questions?