Forest Change Detection To Estimate Forest Harvest Rates In The Central Missouri Ozarks

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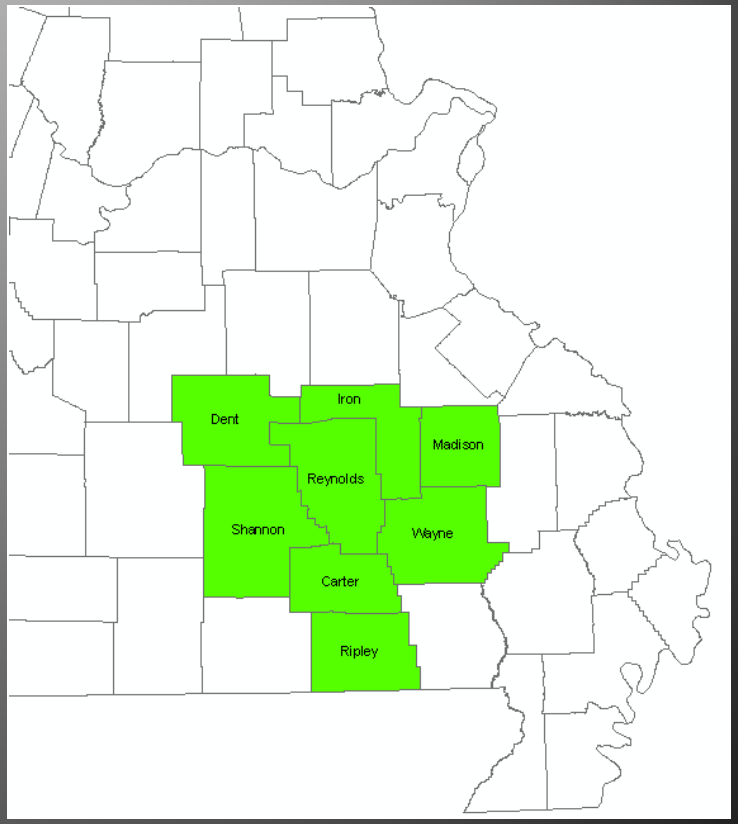
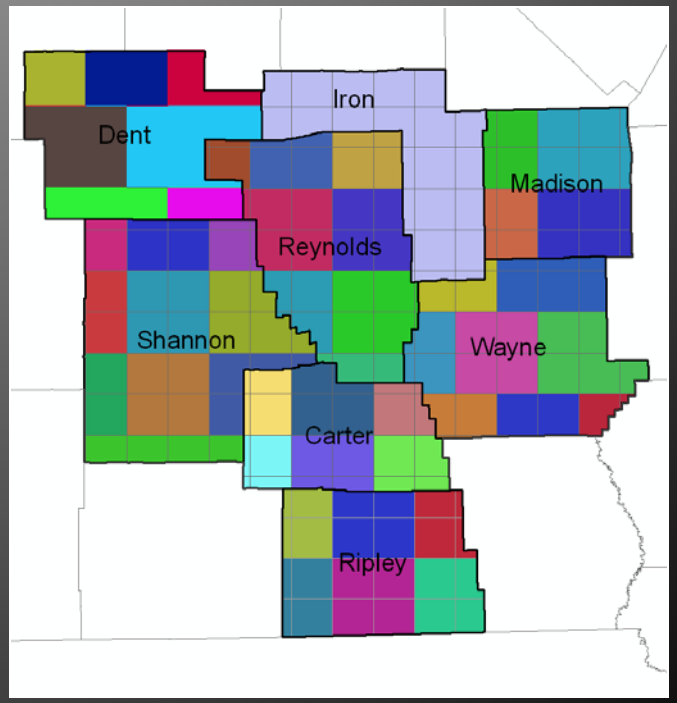
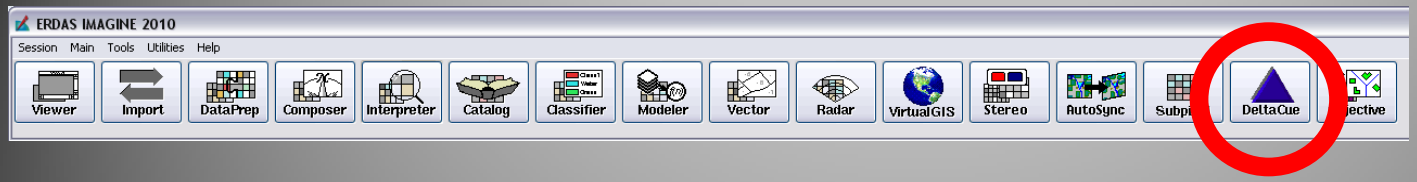
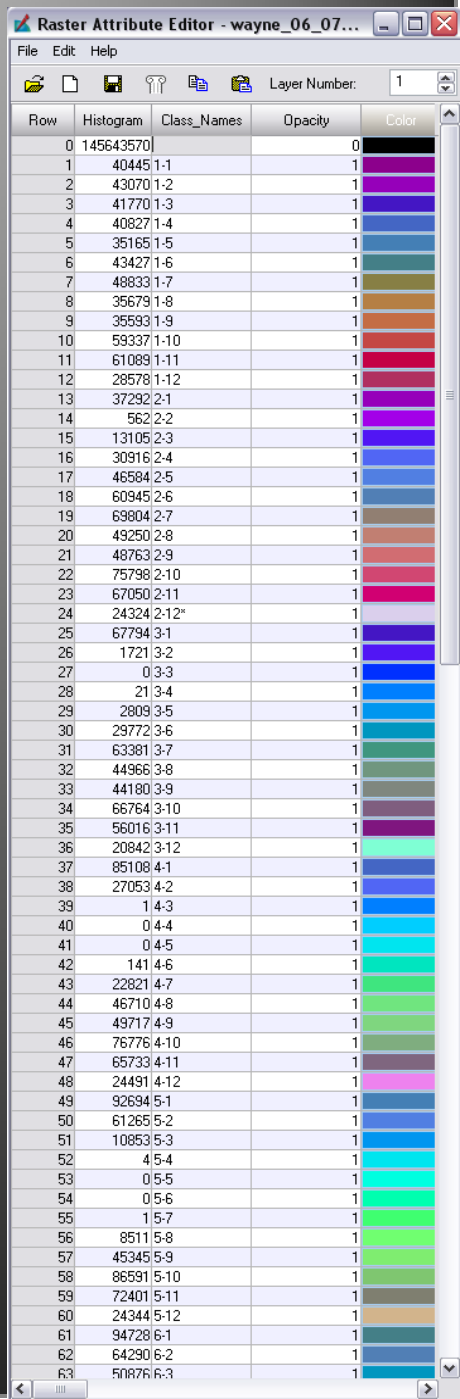
- Goal: Quantify harvesting activity in private lands, including high-grade harvesting.
- Counties: Carter, Dent, Iron, Madison, Reynolds, Ripley, Shannon, and Wayne
- Time Period: 2003-2009, with analysis done in annual intervals
  - 03 to 04, 04 to 05, 05 to 06, 06 to 07, and 07 to 09



- NAIP Imagery at 5m
  - Previously unable to run this type of analysis on NAIP due to lack of consistently repeatable automated process
    - DeltaCue provides an automated routine that allows for change analysis in a consistent and repeatable fashion
  - Tiled NAIP imagery using 10 km quads and grouping together to make 40 km quads to create manageable file sizes
    - Resulted in 53 total tiles x 5 sets of annual change = 265 total files







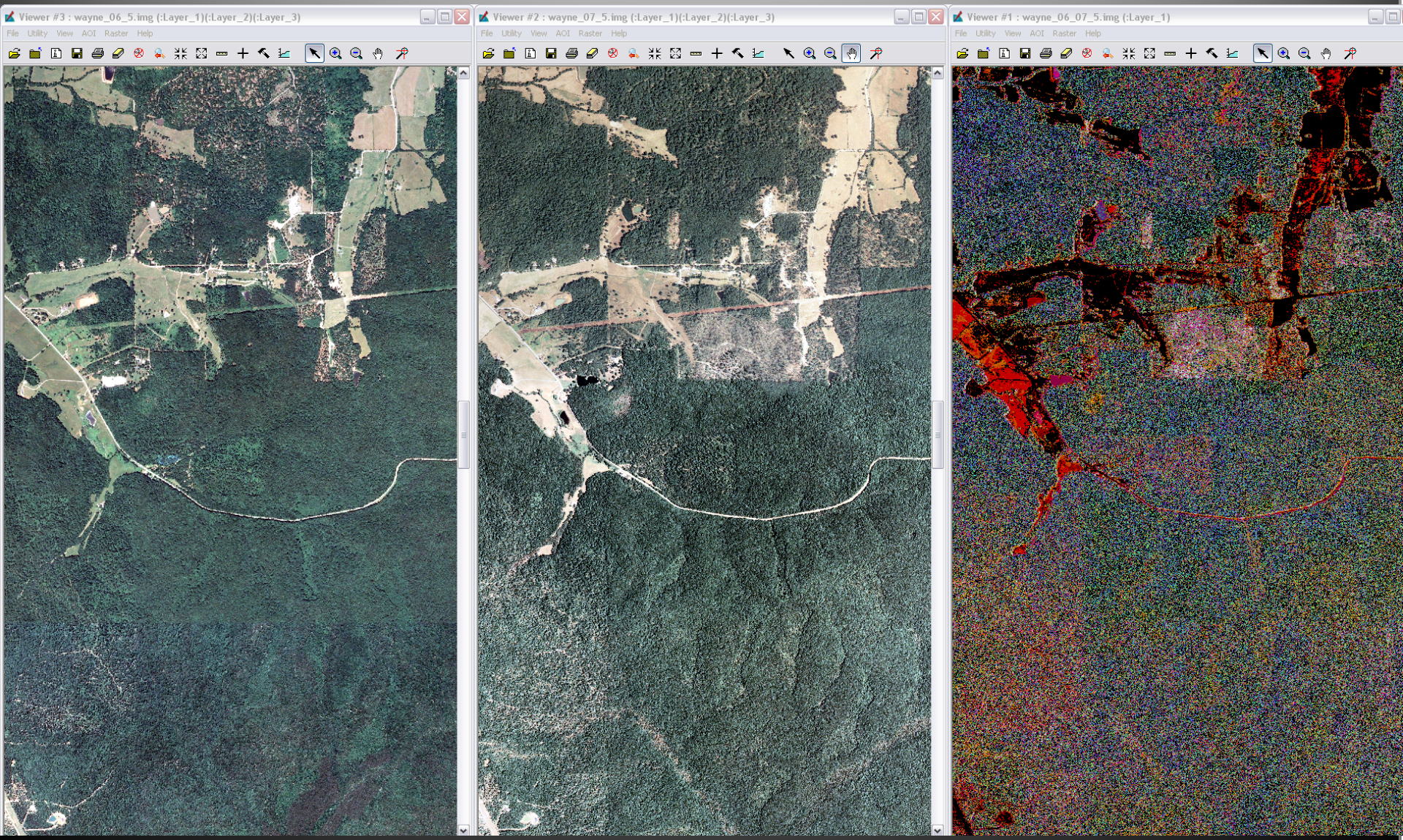
Row	Histogram	Class_Names	Opacity	Color
0	145643570		0	
1	40445	1-1	1	
2	43070	1-2	1	
3	41770	1-3	1	
4	40827	1-4	1	
5	35165	1-5	1	
6	43427	1-6	1	
7	48833	1-7	1	
8	35679	1-8	1	
9	35593	1-9	1	
10	59337	1-10	1	
11	61089	1-11	1	
12	28578	1-12	1	
13	37292	2-1	1	
14	562	2-2	1	
15	13105	2-3	1	
16	30916	2-4	1	
17	46584	2-5	1	
18	60945	2-6	1	
19	69804	2-7	1	
20	49250	2-8	1	
21	48763	2-9	1	
22	75798	2-10	1	
23	67050	2-11	1	
24	24324	2-12*	1	
25	67794	3-1	1	
26	1721	3-2	1	
27	0	3-3	1	
28	21	3-4	1	
29	2809	3-5	1	
30	29772	3-6	1	
31	63381	3-7	1	
32	44966	3-8	1	
33	44180	3-9	1	
34	66764	3-10	1	
35	56016	3-11	1	
36	20842	3-12	1	
37	85108	4-1	1	
38	27053	4-2	1	
39	1	4-3	1	
40	0	4-4	1	
41	0	4-5	1	
42	141	4-6	1	
43	22821	4-7	1	
44	46710	4-8	1	
45	49717	4-9	1	
46	76776	4-10	1	
47	65733	4-11	1	
48	24491	4-12	1	
49	92694	5-1	1	
50	61265	5-2	1	
51	10853	5-3	1	
52	4	5-4	1	
53	0	5-5	1	
54	0	5-6	1	
55	1	5-7	1	
56	8511	5-8	1	
57	45345	5-9	1	
58	86591	5-10	1	
59	72401	5-11	1	
60	24344	5-12	1	
61	94728	6-1	1	
62	64290	6-2	1	
63	50876	6-3	1	

- Erdas Imagine DeltaCue tool used to create change classes in a pseudo-unsupervised classification manner
  - DeltaCue automatically creates 12 classes for each time period
    - 1 = highly vegetated to 12 = barren, high reflectance
  - Compares classes at a given pixel and outputs a concatenated change code.
    - For example, 1-12, would generally indicated vegetation in early scene and no vegetation in most recent date
  - Provides a general range to look for classes, which identify forest change
    - Classes that generally depicted forest harvest were: 3-12, 4-12, 5-12, and 6-12
  - Still requires manual selection of change classes

Time 1 – 2006

Time 2 – 2007

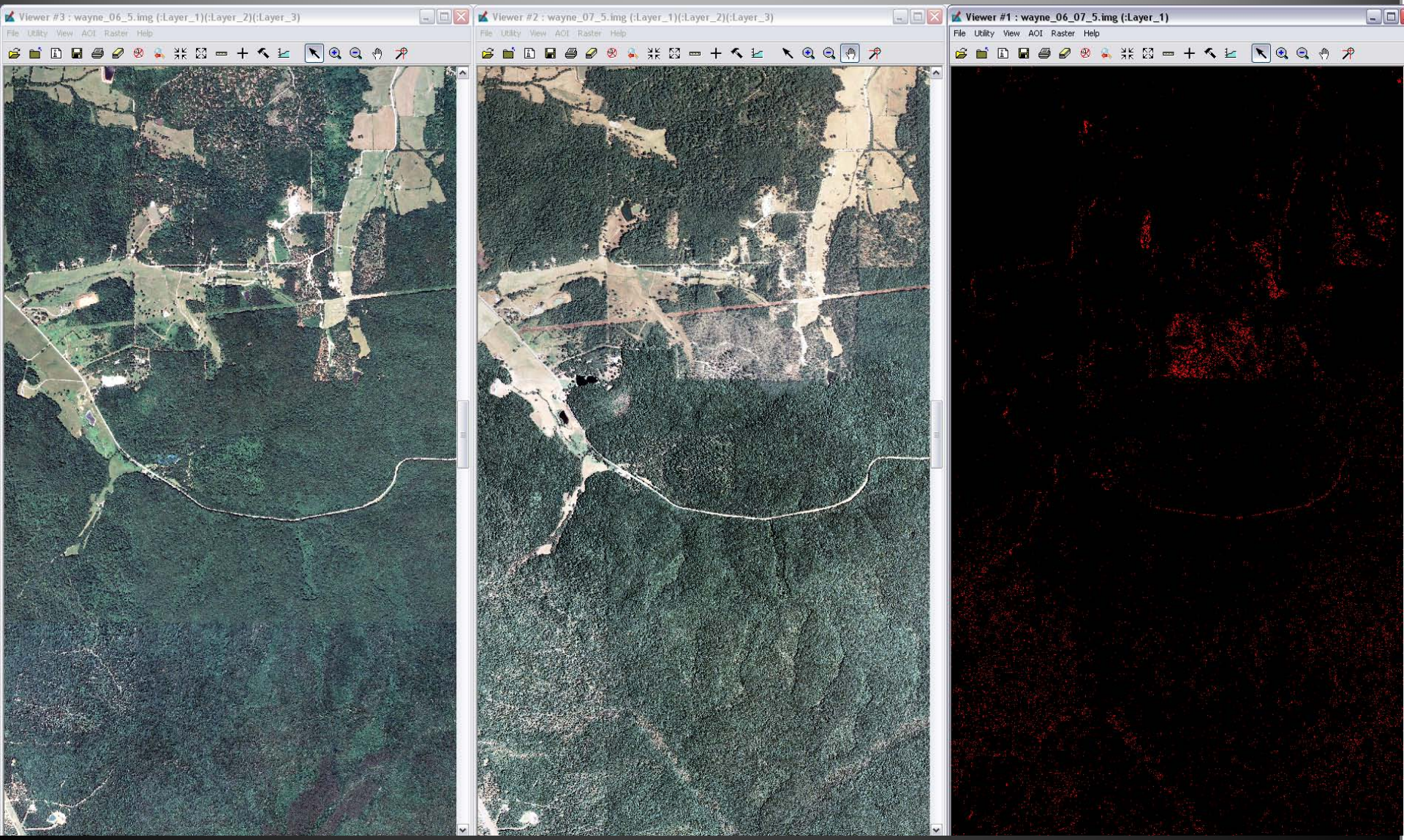
DeltaCue Output



Time 1 – 2006

Time 2 – 2007

DeltaCue Output – Manually Selected Change Classes



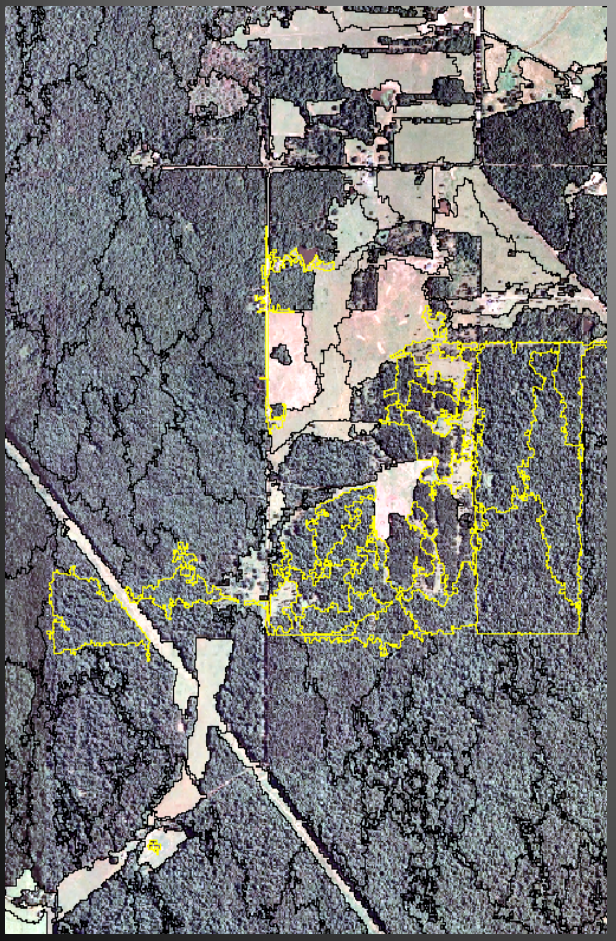
- False Positives
  - False positives occurred due to clouds, shadows, water bodies, canopy reflection, stitch/seam lines, image histogram issues and misregistration

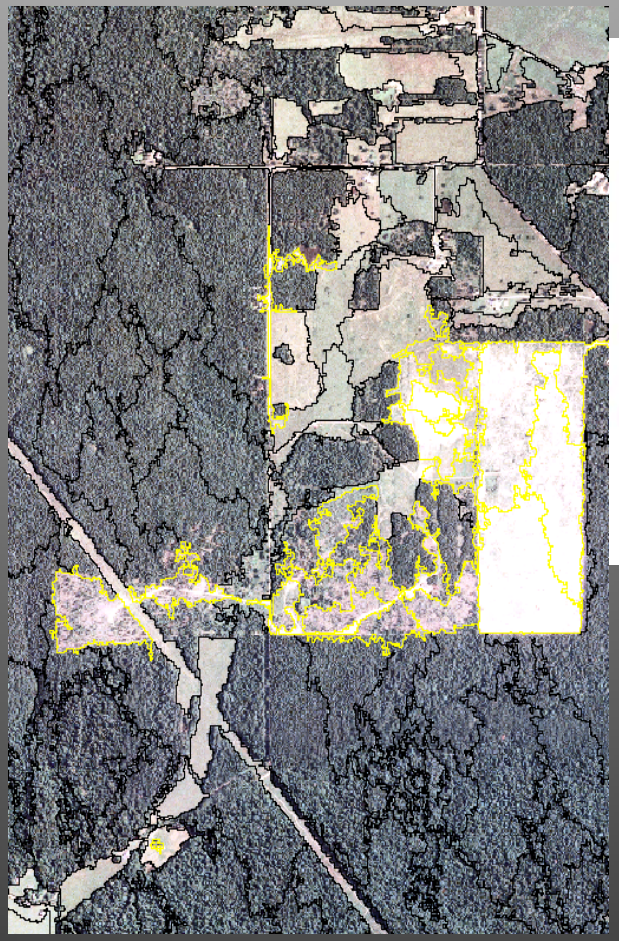
Stitch/seam line, canopy reflection and image histogram

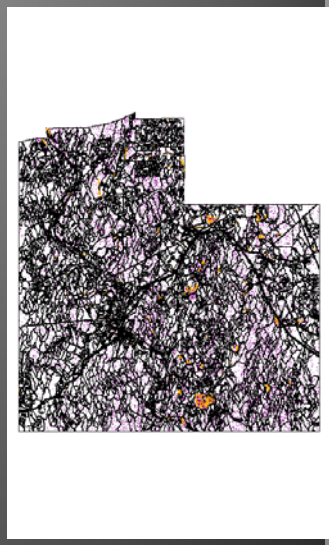
False Positives - Water Level

False Positives – Shadows and grass/crop

- Ecognition objects were generated for each tile to outline "stands" of forest change/areas of homogeneity



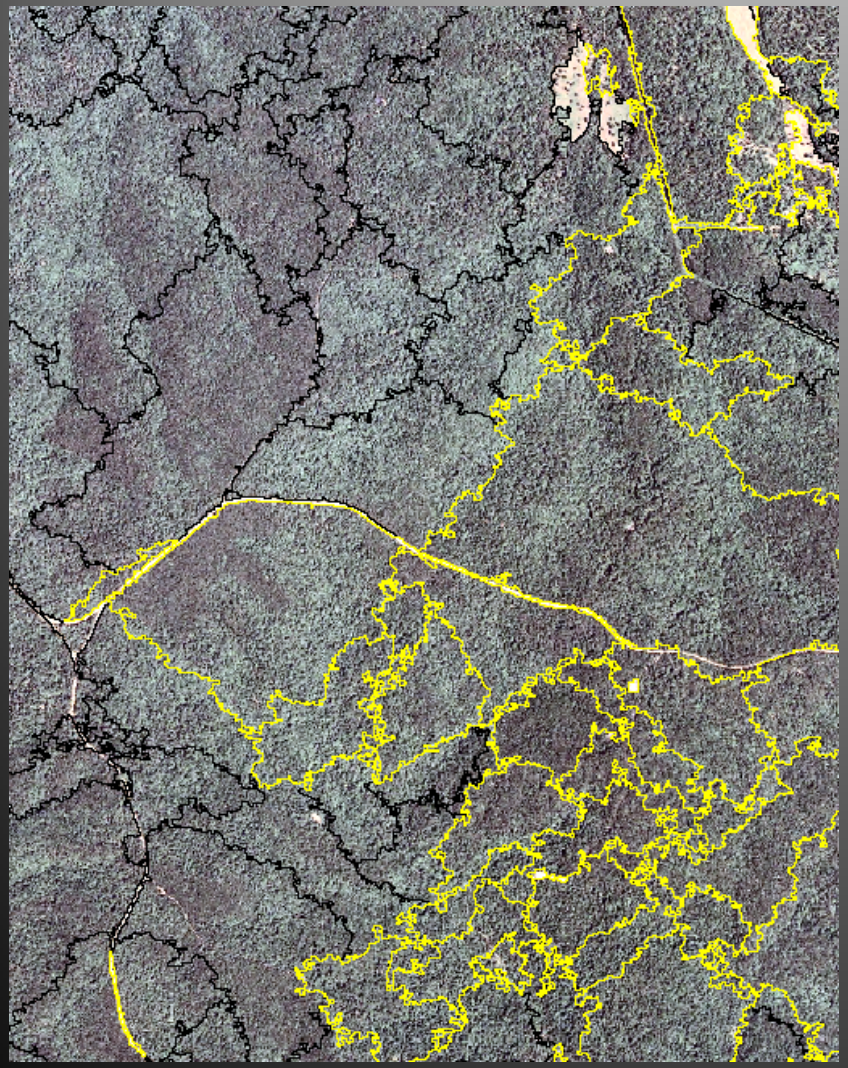


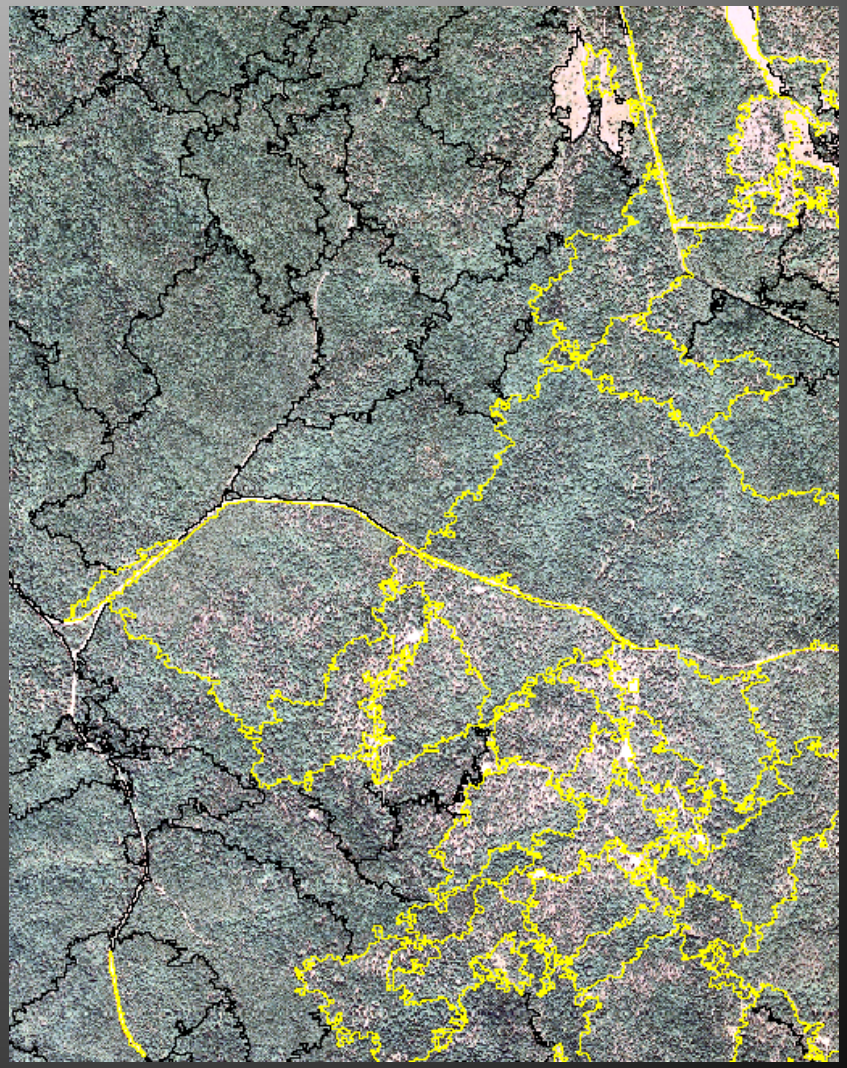


Example of objects for a tile

Objects delineating "stands" of clear-cut harvest activity

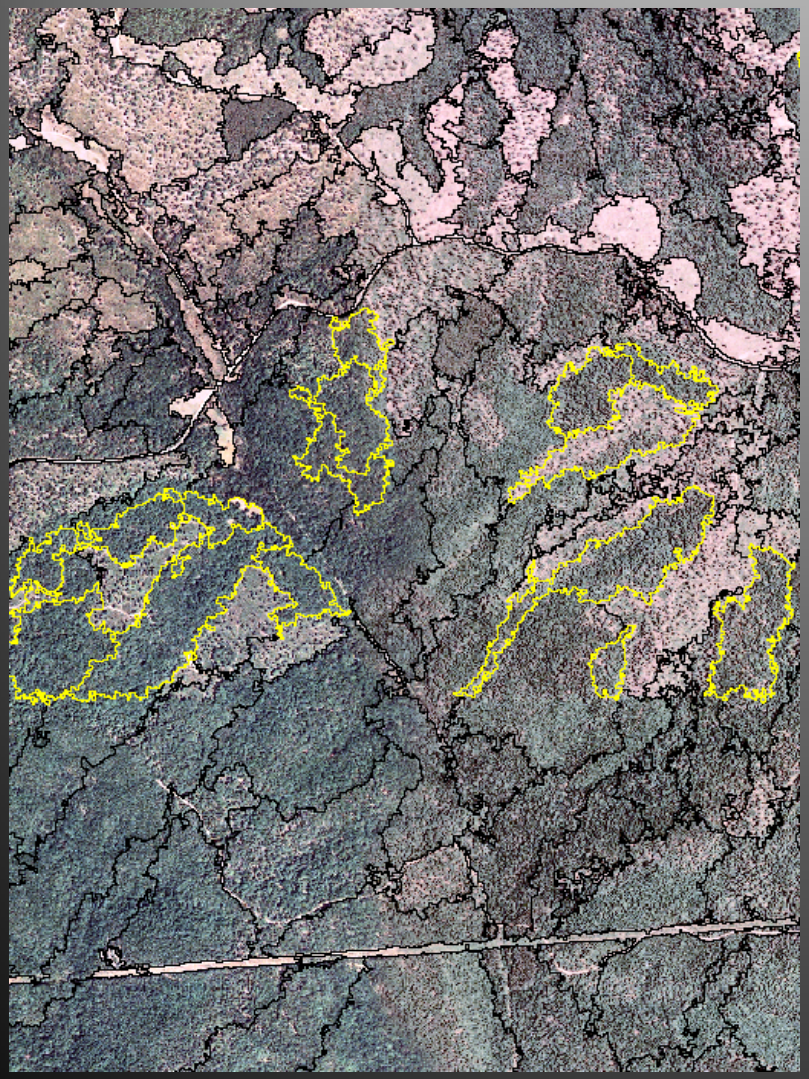
- Ecognition objects were generated for each tile to outline "stands" of forest change/areas of homogeneity





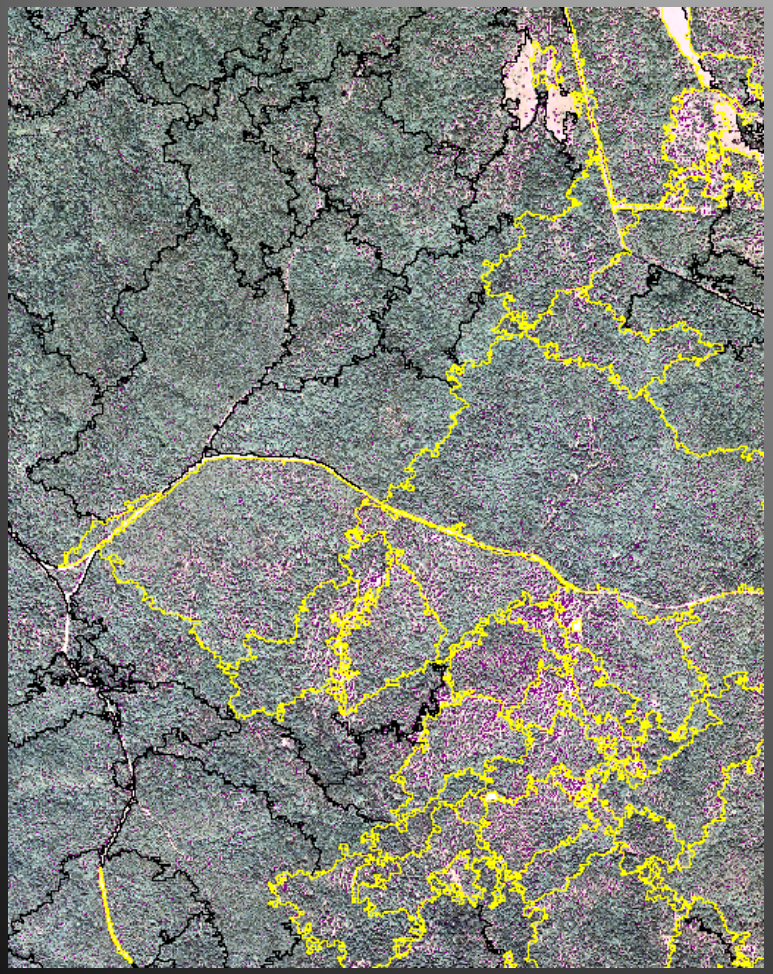
Objects delineating "stands" of high-grade harvest activity

- Ecognition objects were generated for each tile to outline "stands" of forest change/areas of homogeneity

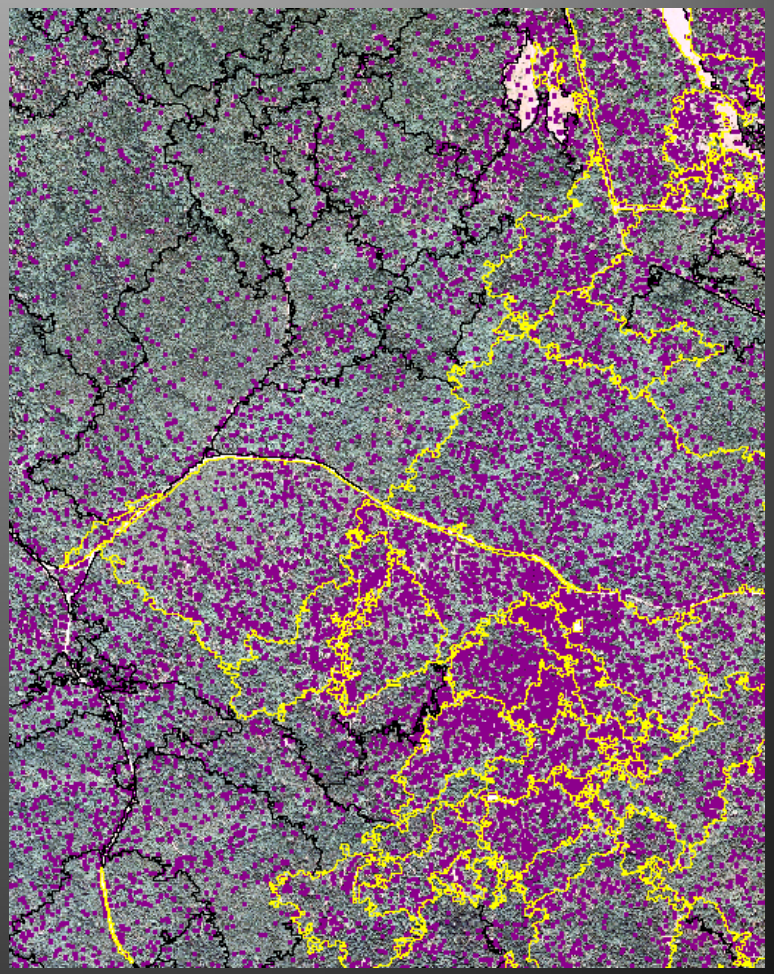


- Ecognition objects were generated for each tile to outline "stands" of forest change/areas of homogeneity

- Change pixels were expanded/grown using a 3x3 neighborhood window to mitigate salt and pepper false positives and identify object “stands” of change
  - Objects were attributed w/ number of change pixels/object

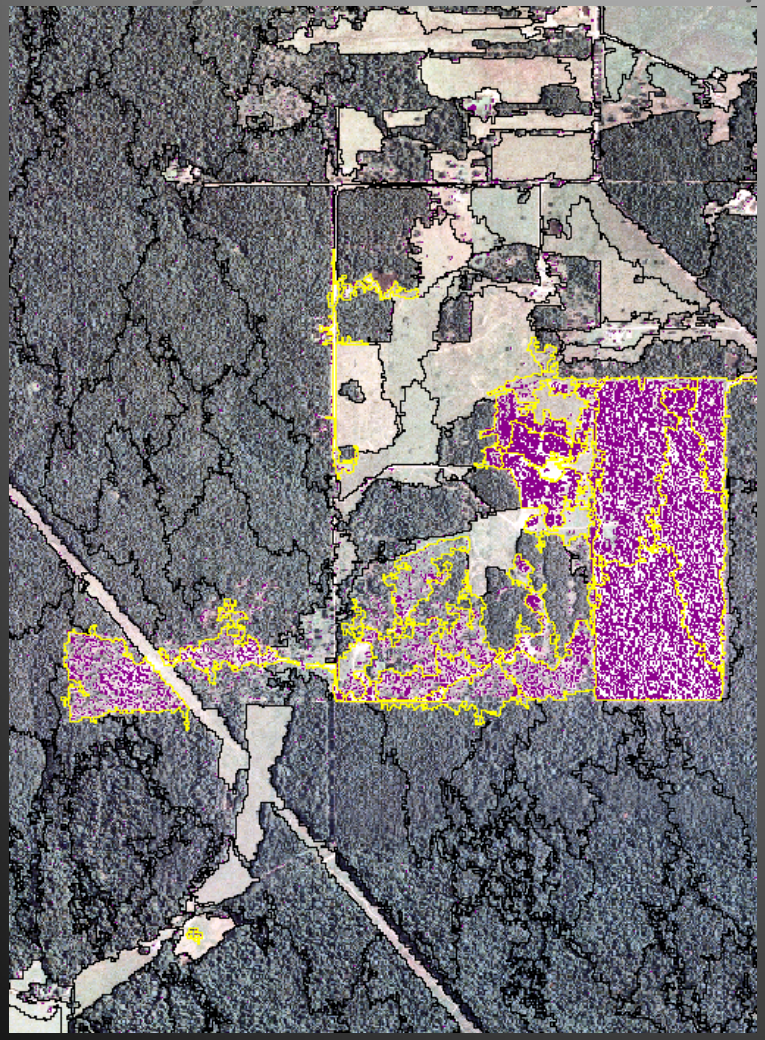


Original Change pixels

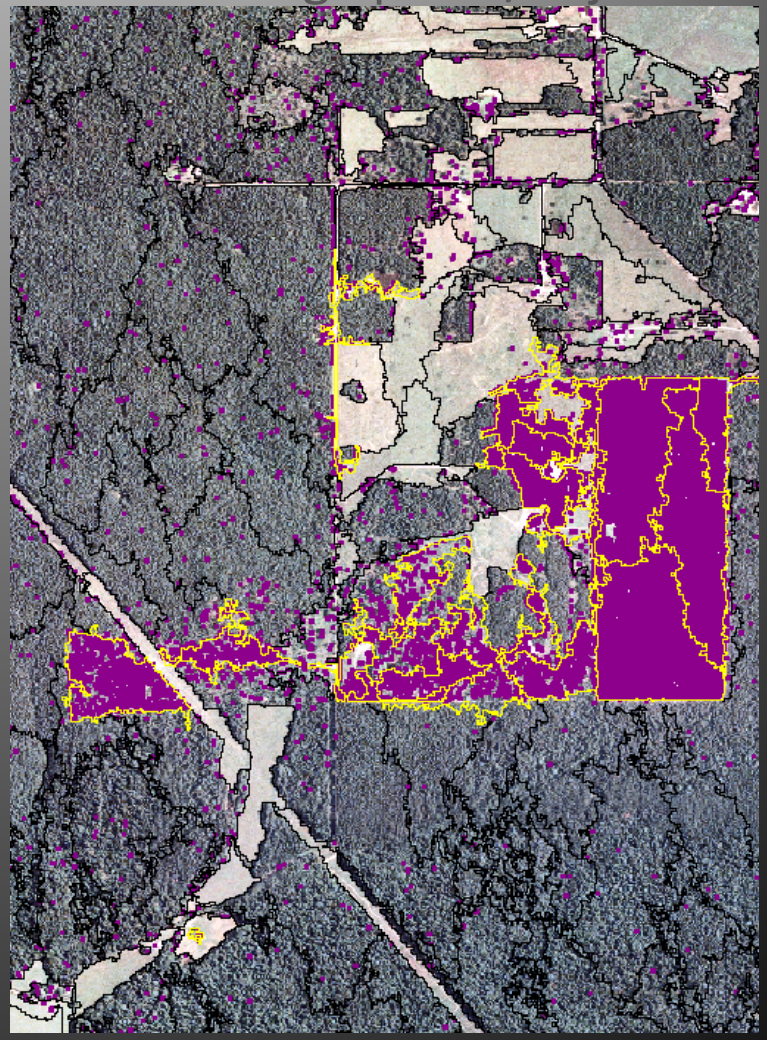


Expanded Change pixels

- Change pixels were expanded/grown using a 3x3 neighborhood window to mitigate salt and pepper false positives and identify object “stands” of change
  - Objects were attributed w/ number of change pixels/object

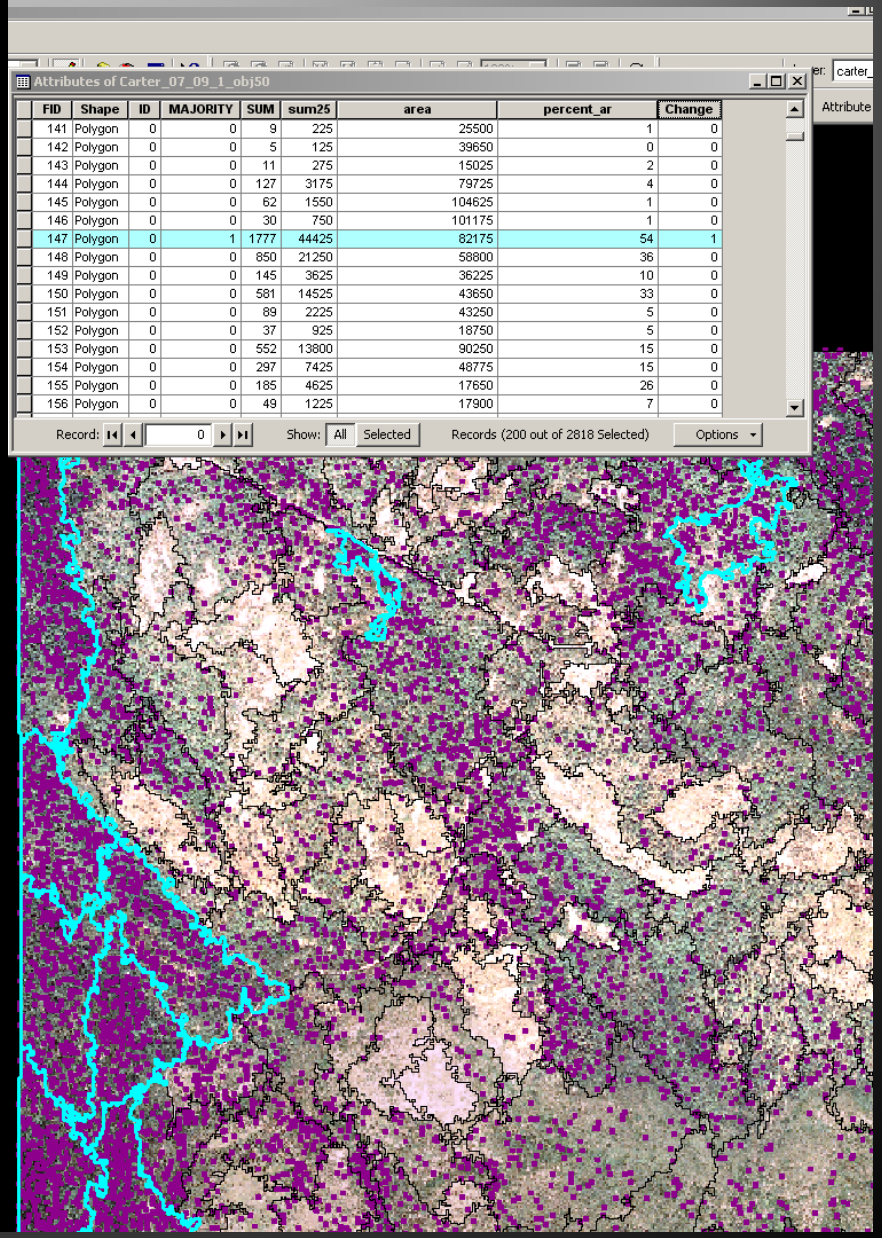


Original Change pixels

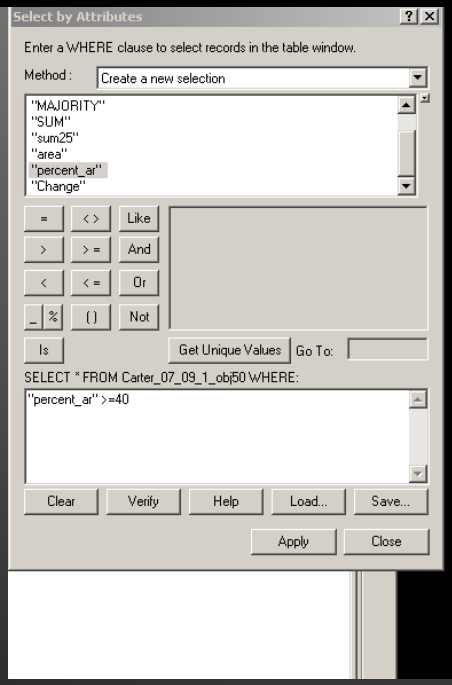


Expanded Change pixels

- % change w/in each object was calculated
- Objects w/ >= 40% change pixels were identified as change “stands”
  - The object/polygon layers were examined manually to double check for false positives and areas of change that may have been omitted

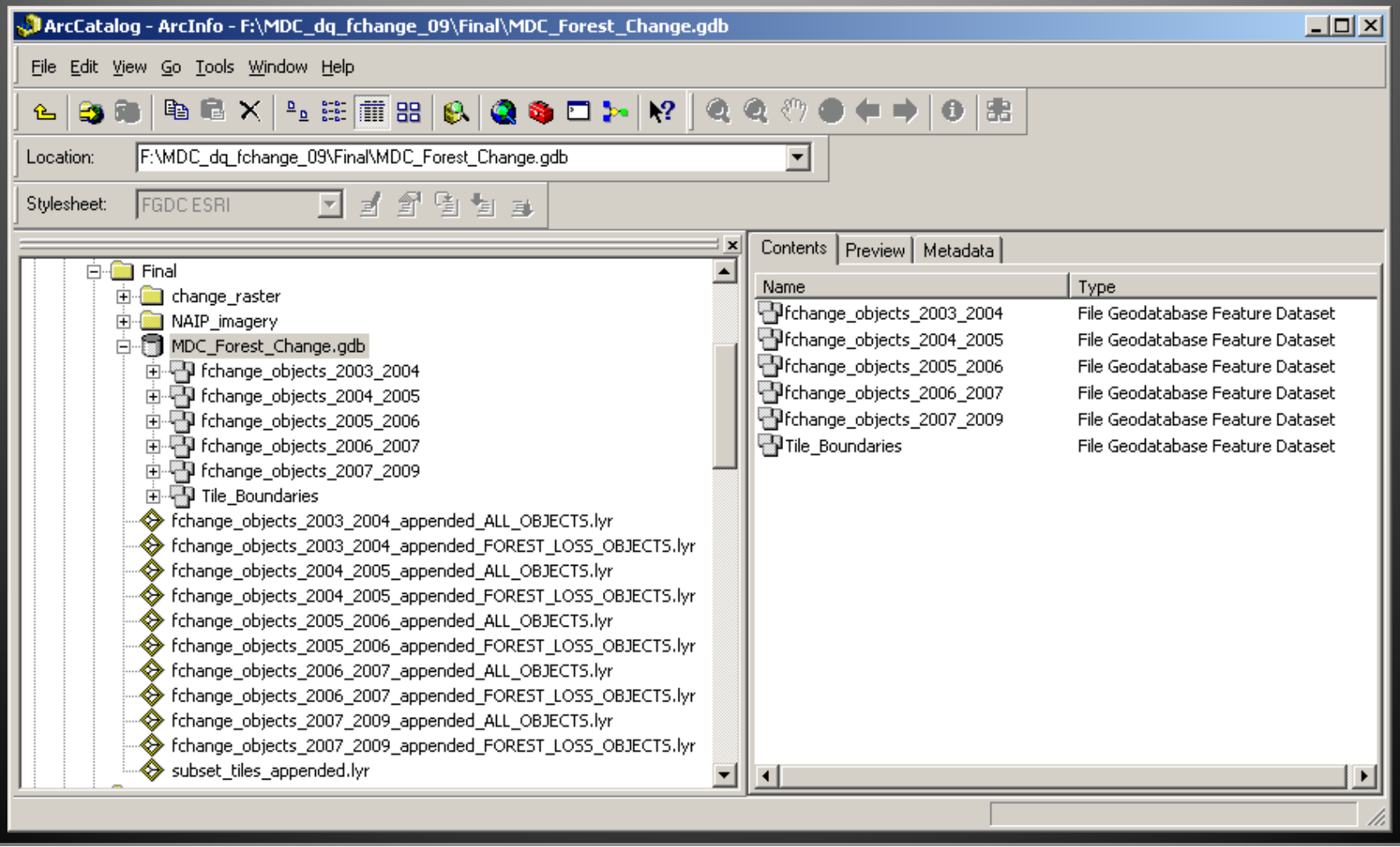


FID	Shape	ID	MAJORITY	SUM	sum25	area	percent_ar	Change
141	Polygon	0	0	9	225	25500	1	0
142	Polygon	0	0	5	125	39650	0	0
143	Polygon	0	0	11	275	15025	2	0
144	Polygon	0	0	127	3175	79725	4	0
145	Polygon	0	0	62	1550	104625	1	0
146	Polygon	0	0	30	750	101175	1	0
147	Polygon	0	1	1777	44425	82175	54	1
148	Polygon	0	0	850	21250	58800	36	0
149	Polygon	0	0	145	3625	36225	10	0
150	Polygon	0	0	581	14525	43650	33	0
151	Polygon	0	0	89	2225	43250	5	0
152	Polygon	0	0	37	925	18750	5	0
153	Polygon	0	0	552	13800	90250	15	0
154	Polygon	0	0	297	7425	48775	15	0
155	Polygon	0	0	185	4625	17650	26	0
156	Polygon	0	0	49	1225	17900	7	0



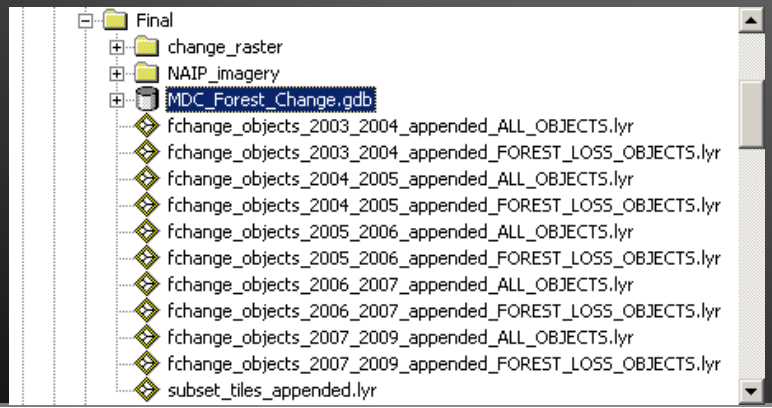
Final Data Included

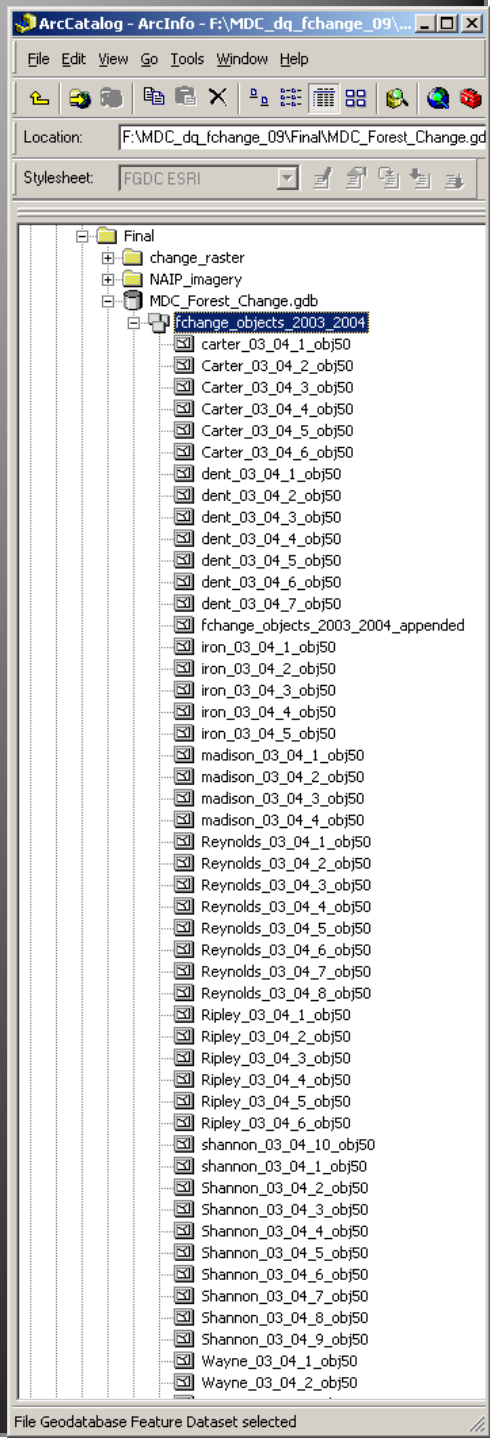
- File Geodatabase



Final Data Included

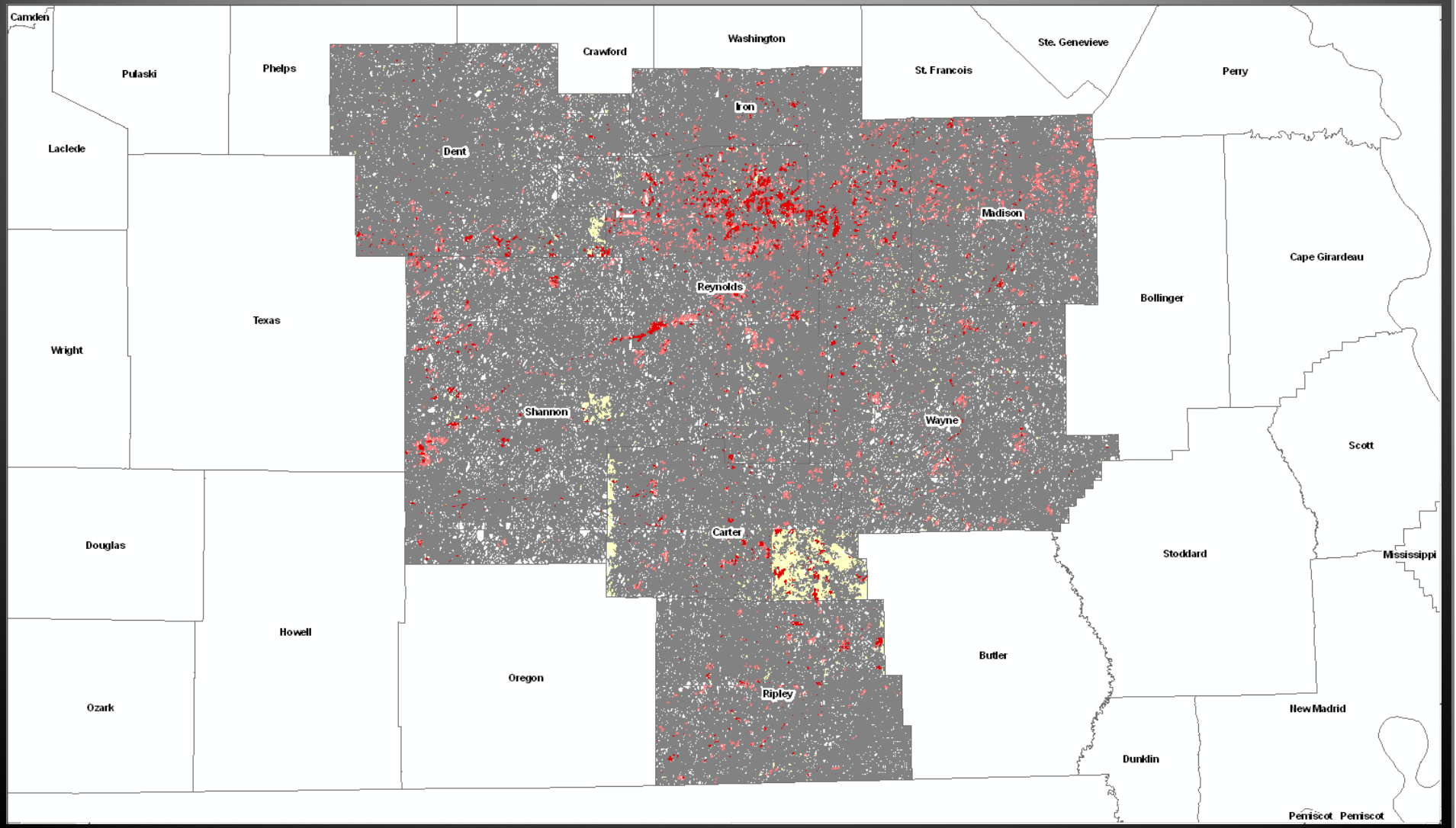
- File Geodatabase
  - Forest Change Objects
    - Organize in file geodatabase by year to year change period (i.e. fchange_objects_2003_2004)
    - 2 Layer files created
      - all objects (i.e. fchange_objects_2003_2004_appended_ALL_OBJECTS.lyr)
      - only those objects identifed as delineating forest change (i.e. fchange_objects_2003_2004_appended_FOREST_LOSS_OBJECTS.lyr)





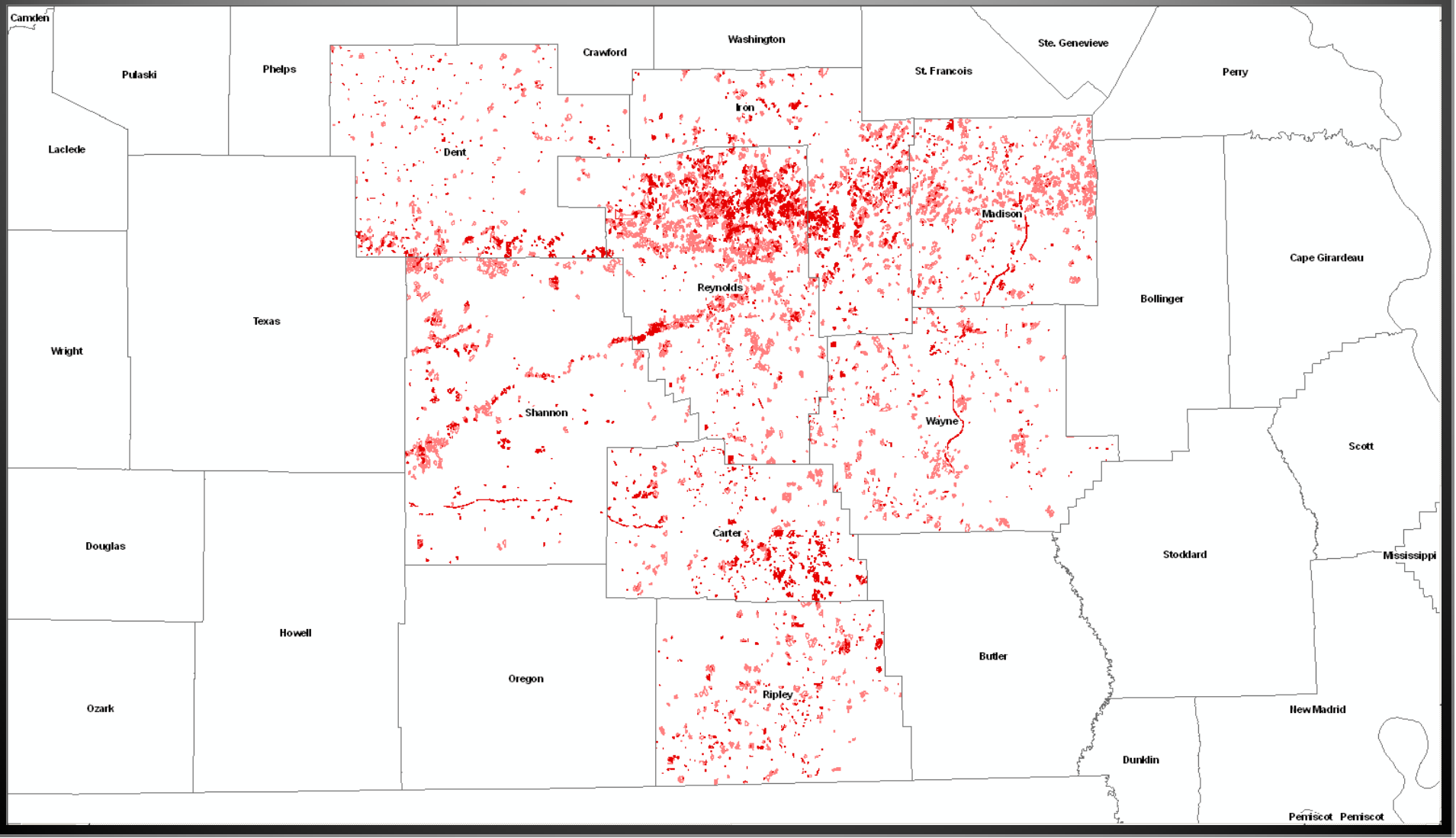
Data Included

- All Objects – 2007-2009



Data Included

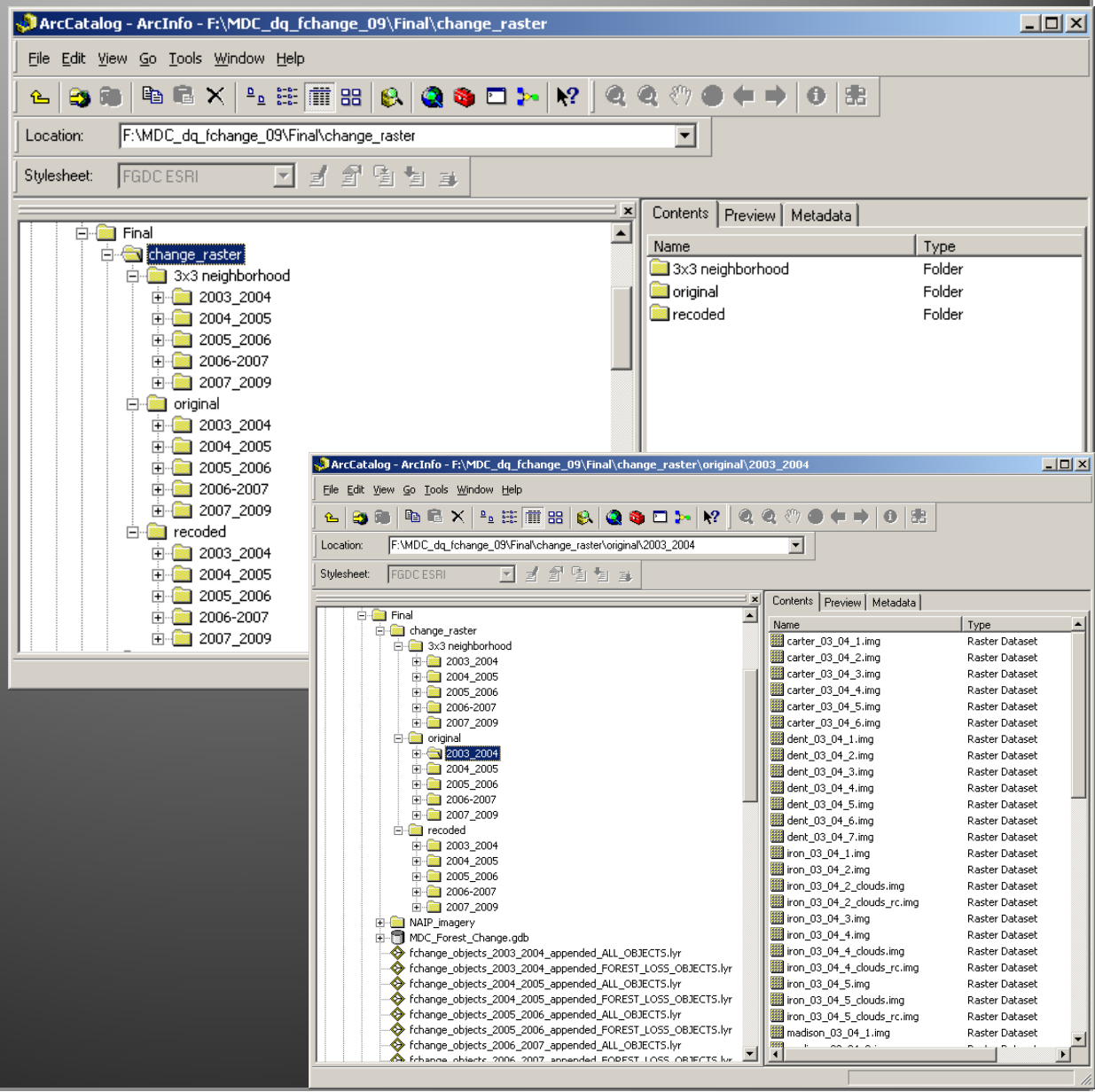
- Forest Loss Objects – 2007-2009



Final Data Included

Raster Change Data

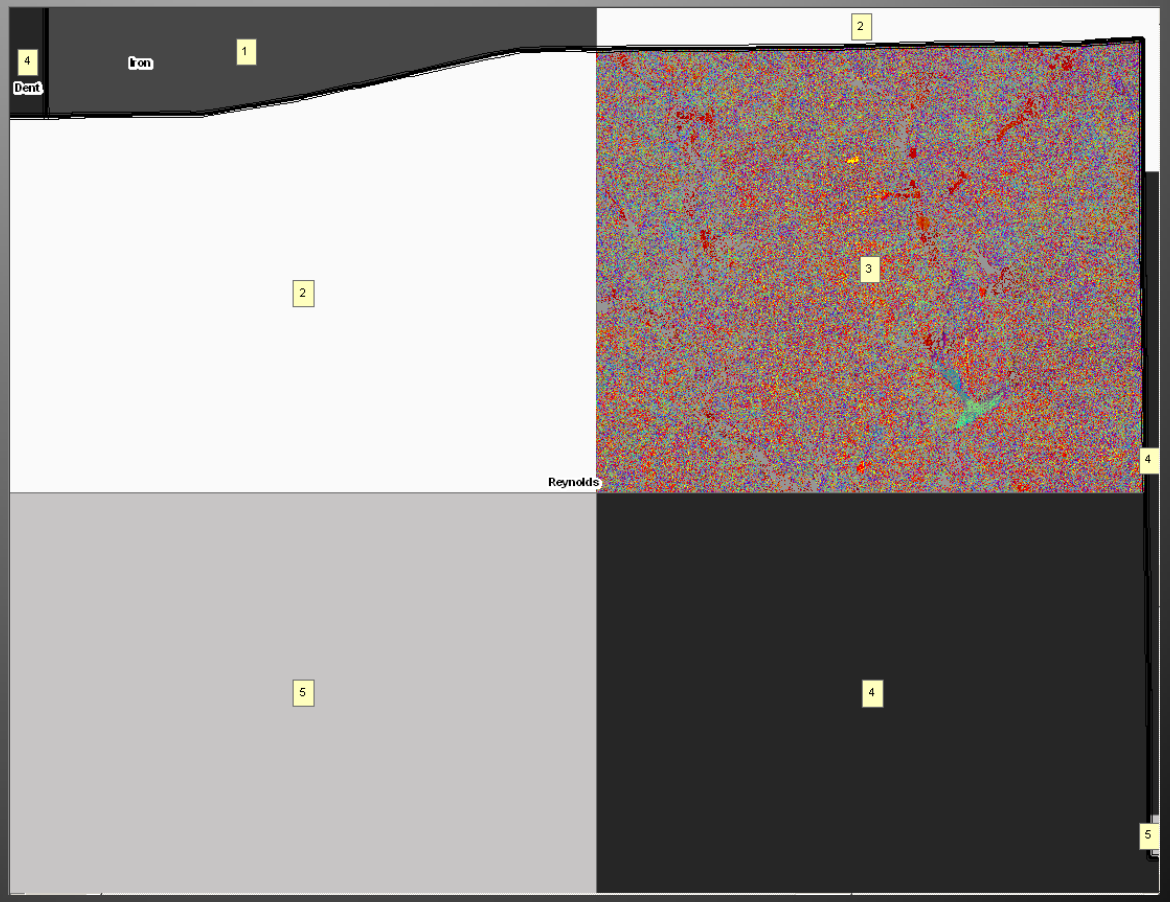
- Change Raster
  - Original
    - Direct output from Delta Cue
    - Pixels classed by year to year combination of change
    - Manually interpreted to identify pixels representing forest loss
    - Organized by year to year change and tile
  - Recoded
    - Pixel classes identified as forest loss in original rasters recoded to 1, all other values equal 0
    - Organized by year to year change and tile
  - 3x3 Neighborhood
    - Recoded pixels equal to 1 expanded based on sum function in a 3x3 window
    - Used to populate change within objects
    - Mitigate salt and pepper false positives
    - Expand “patches” of forest loss by growing pixels together
    - Organized by year to year change and tile



Final Data Included

Raster Change Data

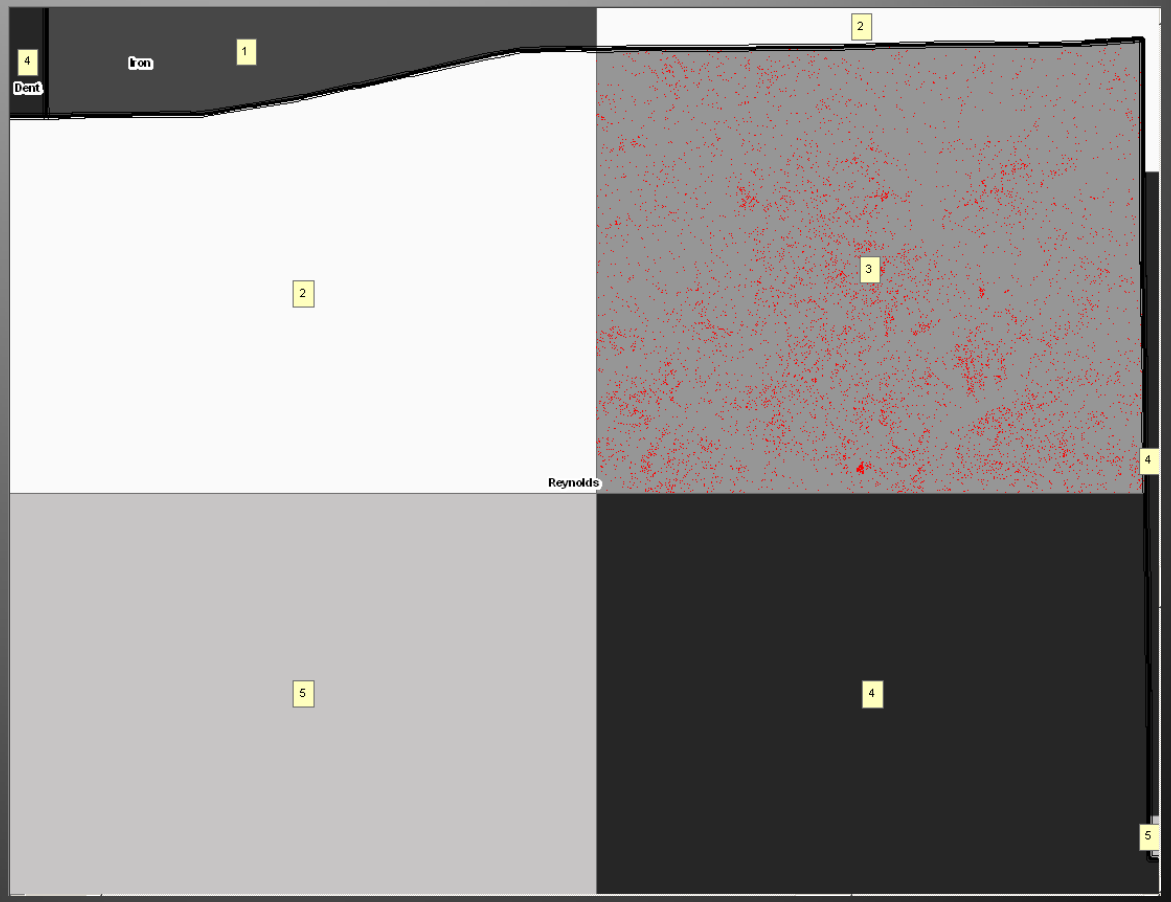
- Change Raster
  - Original Reynolds_07_09_3
    - Direct output from Delta Cue
    - Pixels classed by year to year combination of change
    - Manually interpreted to identify pixels representing forest loss
    - Organized by year to year change and tile



Final Data Included

Raster Change Data

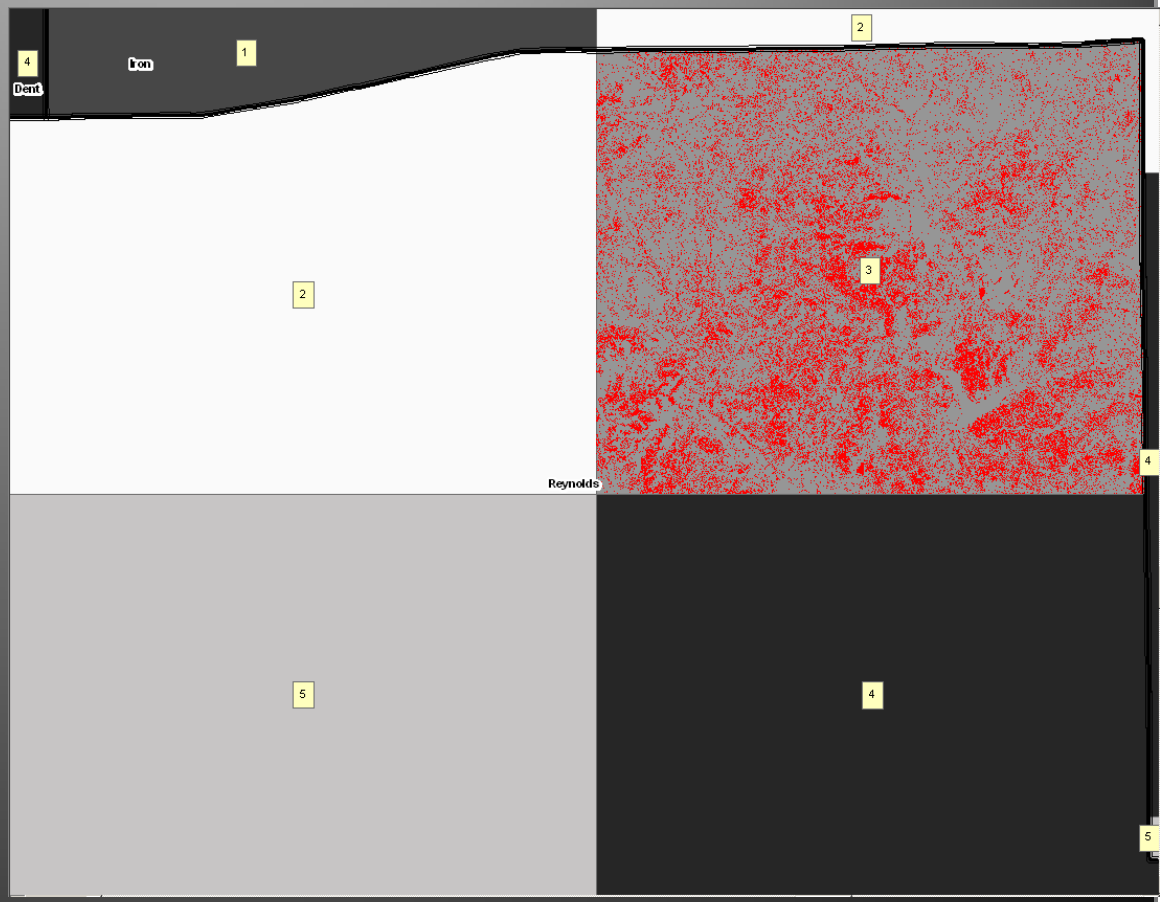
- Change Raster
  - Recoded Reynolds_07_09_3
    - Pixel classes identified as forest loss in original rasters recoded to 1, all other values equal 0
    - Organized by year to year change and tile



Final Data Included

Raster Change Data

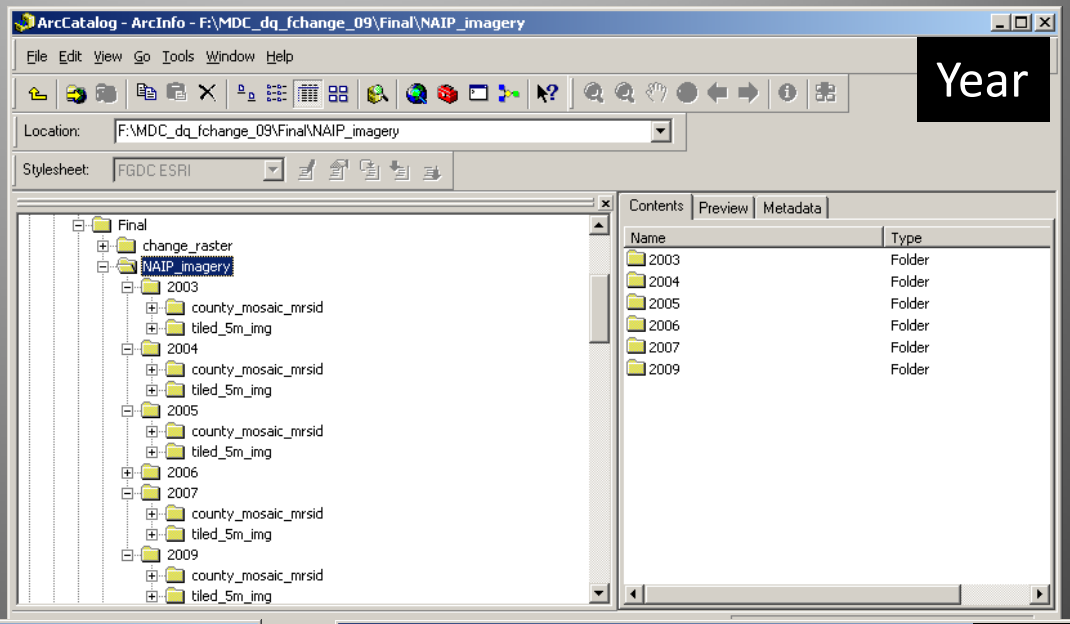
- Change Raster
  - 3x3 Neighborhood Reynolds_07_09_3
    - Recoded pixels equal to 1 expanded based on sum function in a 3x3 window
    - Used to populate change within objects
    - Mitigate salt and pepper false positives
    - Expand “patches” of forest loss by growing pixels together
    - Organized by year to year change and tile

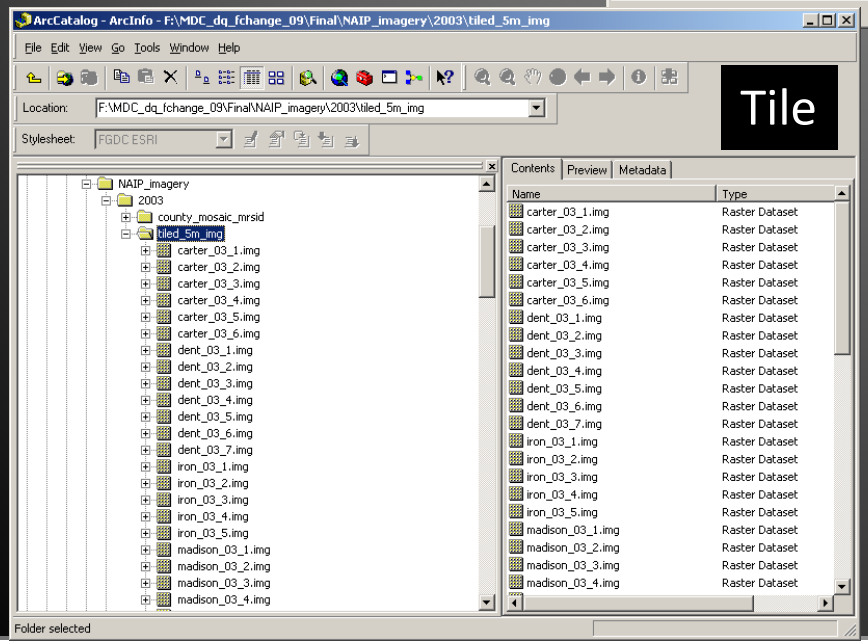


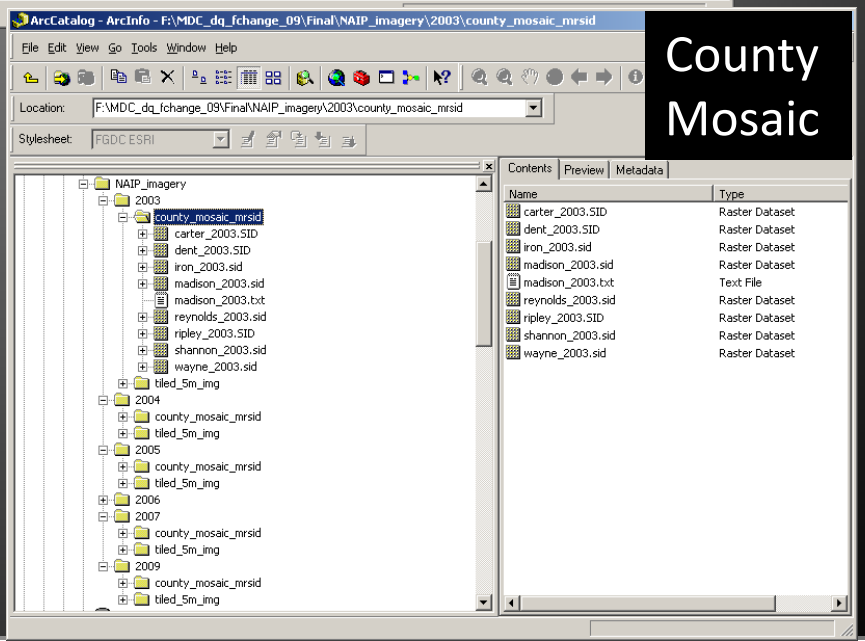
Final Data Included

Raster Change Data

- NAIP Imagery
  - Organized by year, tiles, and county Mosaic







- Findings:
  - Pros
    - Provides ability to identify fine-scale forest harvesting activity in a consistent and repeatable manner
    - Process provides ability to identify regeneration as well, however for this project didn’t have the time
  - Cons
    - More appropriate for projects not requiring a short turn around time
    - Spatial misregistration and shadows at such a fine scale make a huge impact on results, notably false positives

- Lessons Learned
  - Automate/batch all possible Erdas Imagine processes by copying and pasting programming syntax into text document and then submit instead of manually clicking buttons and submitting each process to batch
  - Manual interpretation of Delta Cue results can not be avoided due to inability to effectively normailze NAIP imagery
  - Creation of fine scale (5m) forest cover mask would greatly aid in detection of forest change as well as in interpretation of Delta Cue results
  - Detection of forest regeneration is also possible with datasets created from Delta Cue, will require a significant number of hours to interpret

Questions or comments?

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