

Biological Applications of ArcMap as a Statistical Tool to Quantify Zebrafish Post-Optic Commissure Formation

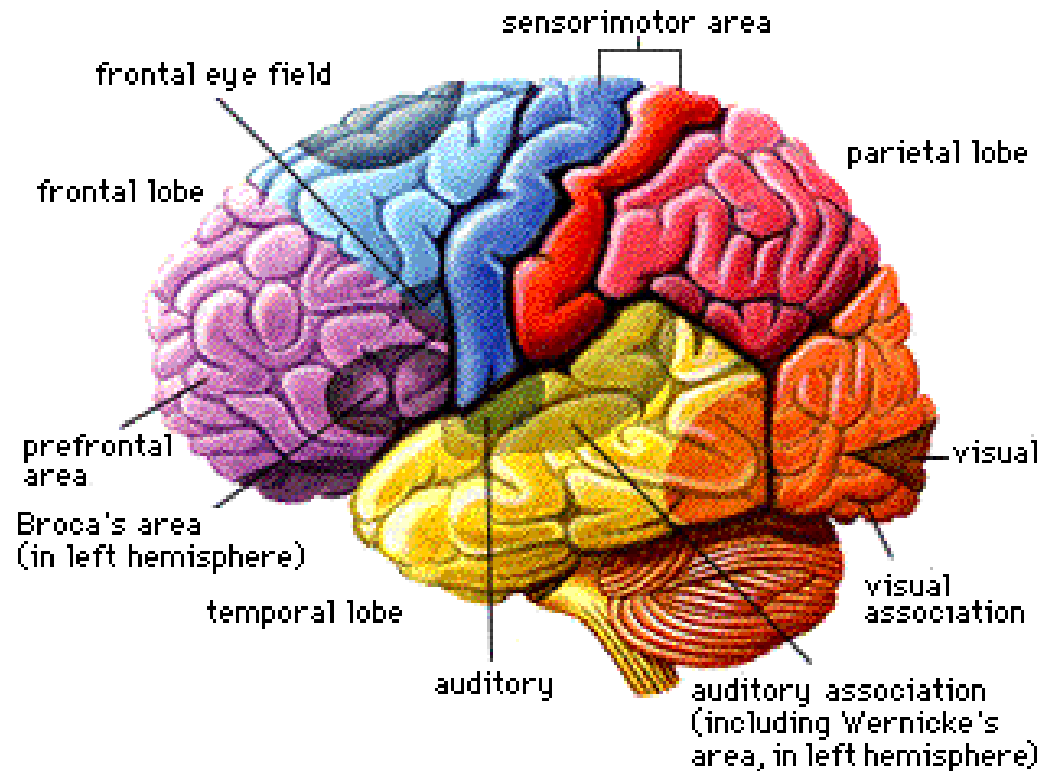
Jin Sook Park, Smith College '15

Corinna Keeler & Jon Caris, Smith Spatial Analysis
Lab



Importance of the Brain

- Complex, vital organ that governs the entire organism
- Provides connections throughout the body
- Aids in communication with the use of electrochemical signals
- Complicated, fragile structure with various functions
 - Difficult to study in humans



Why are we interested?

- Neurodegeneration
 - Parkinson's Disease
 - Degeneration affects physical movements & coordination
 - Alzheimer's Disease
 - Brain deterioration
 - Other various brain & spinal cord injuries
- The more we understand the brain & how it forms, the more we can help in treating or curing patients
 - Provide some insight on how to fix disorders in later stages of life

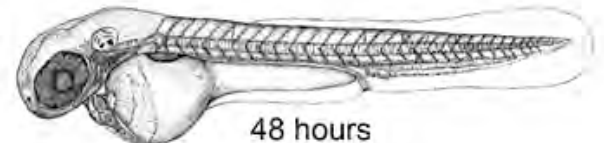
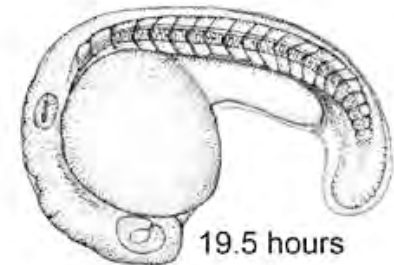
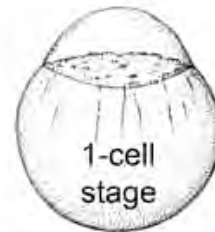
Nervous System Development

- Neuron
 - Cell Body
 - Axon
 - Growth Cone
- Glial Cells
 - Provides substrate for axons to grow on & guides them in the right directions



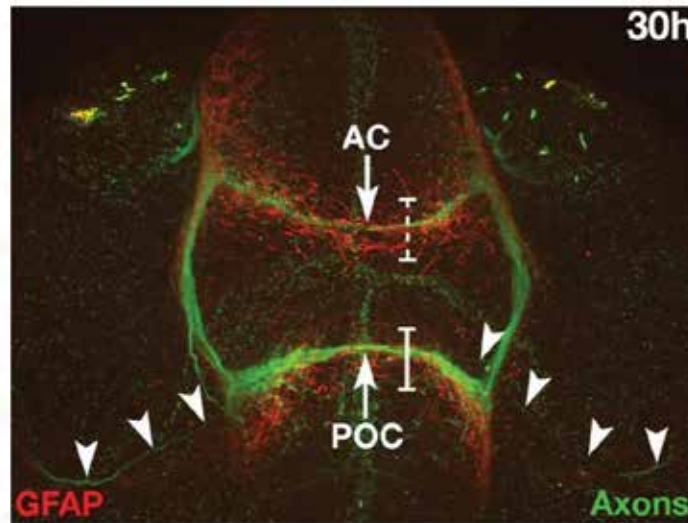
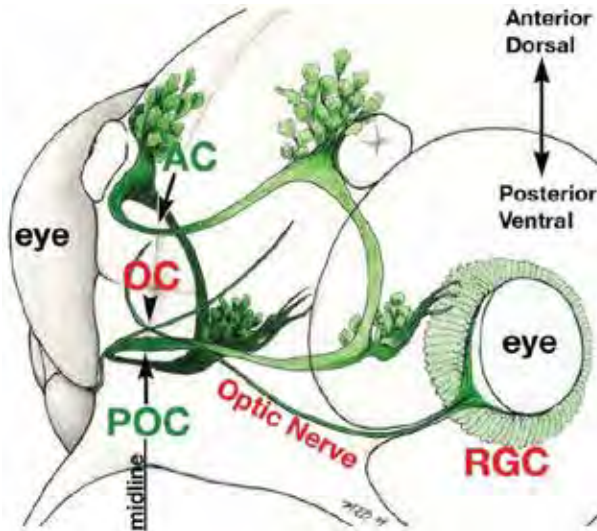
Zebrafish Model System

- Closely related to humans
 - bilateral vertebrates
- Rapidly growing organism
 - Full organism in less than 24 hours
- External fertilization
 - observe development outside the mother's body
- Transparent
- Large clutch size
 - reproduce in large numbers quickly & easily
- Can be genetically modified



Zebrafish Forebrain Anatomy

- Focus on Post-optic Commissure (POC)
 - Crucial in linking the two hemispheres of the brain & body
 - Must cross once successfully



Forebrain Development

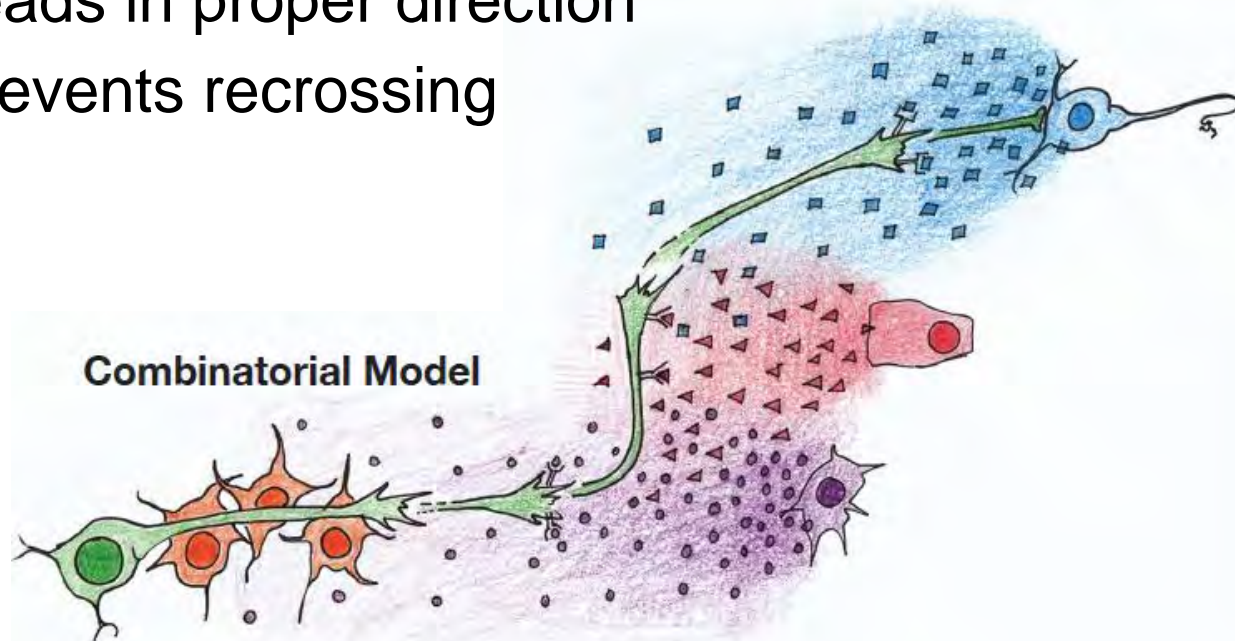


Questions to Ask

- How are commissures established in order to make appropriate connections in the brain?
- How do axons know where exactly to travel, and to only cross once across the midline?

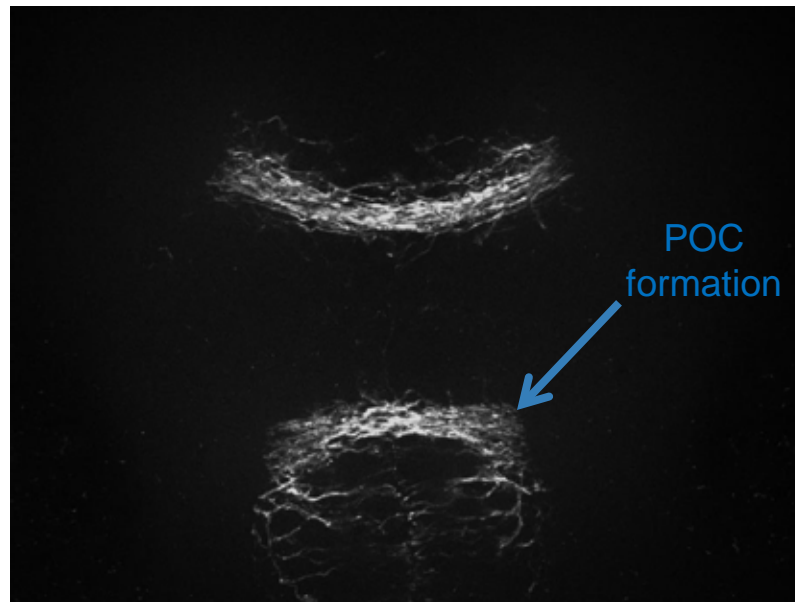
Slit & Roundabout Guidance

- Proteins & receptors aid interactions of axon & glial cells
- Guides commissural axons across midline
 - Leads in proper direction
 - Prevents recrossing



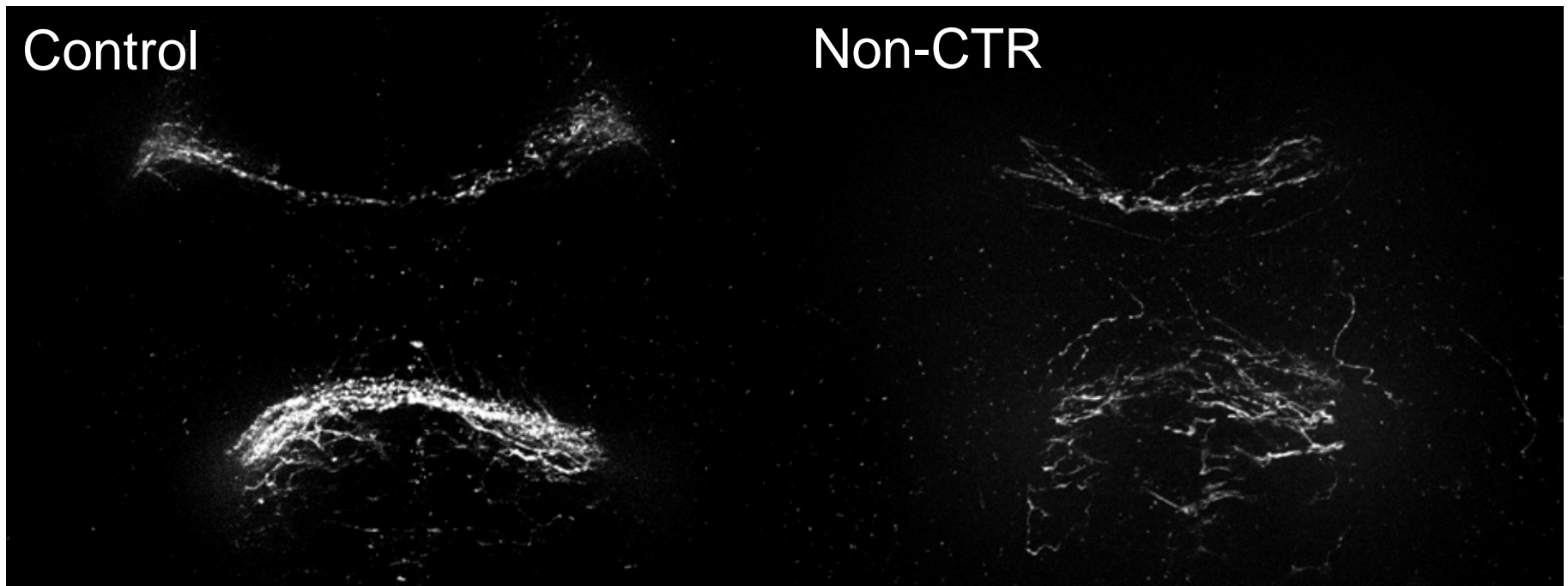
Slit & Roundabout Guidance

- To determine how Slit-Roundabout signaling mediate axon-glia interactions to promote proper commissure formation
 - Eliminate a protein or receptor → See if it has an effect on brain development

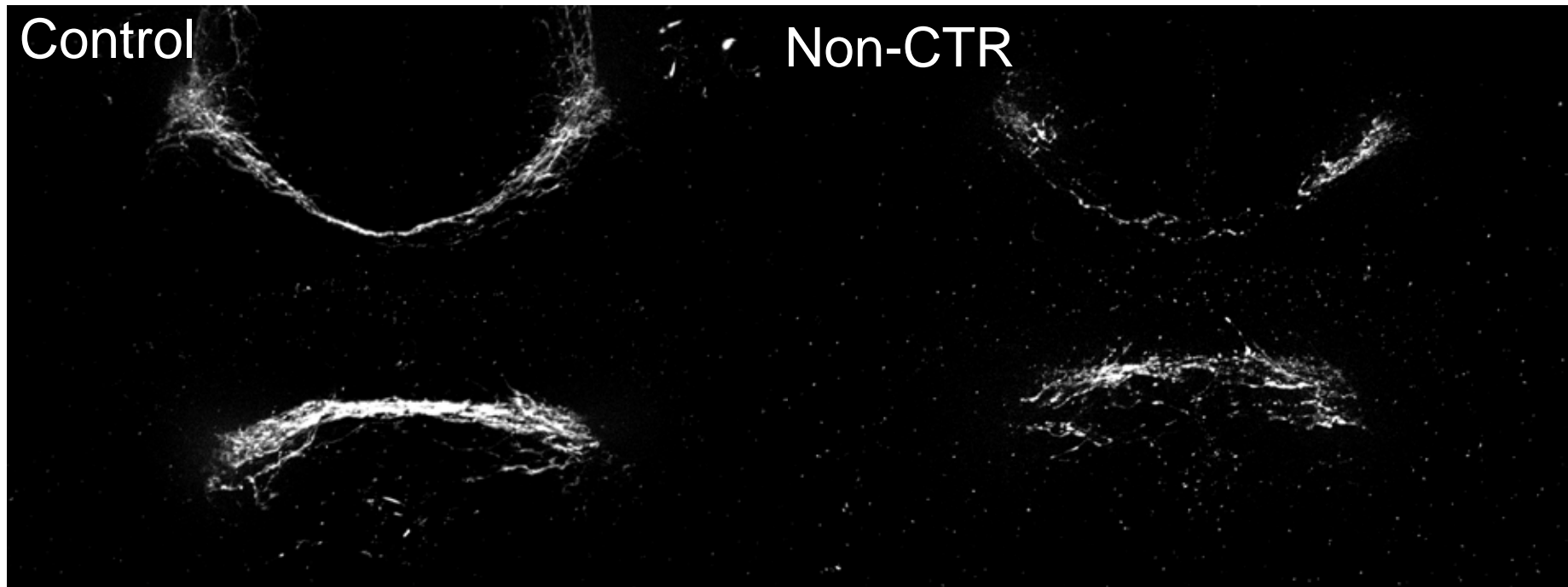


How would the different phenotypes be quantified in an objective, unbiased way based on the forebrain images?

- Noticably different formations

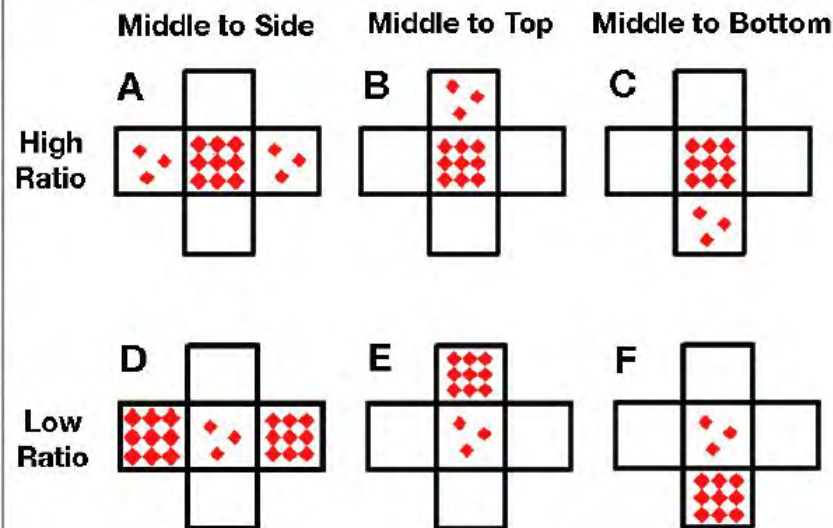
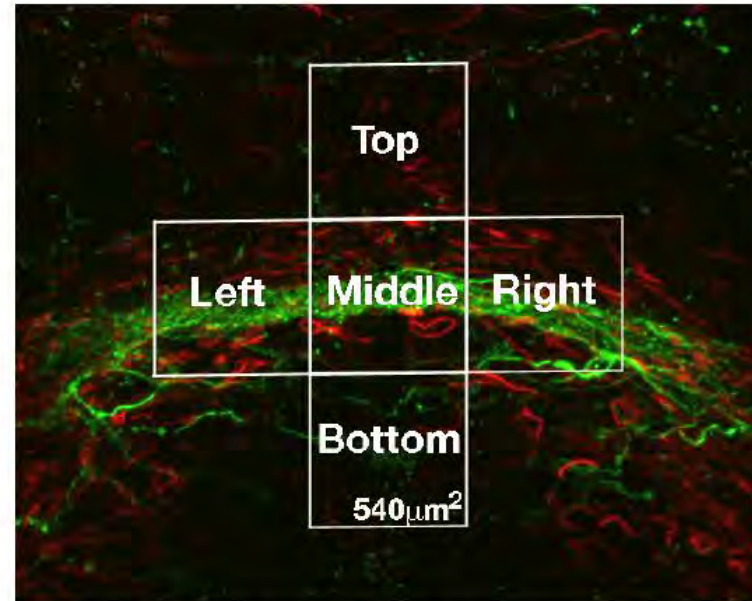
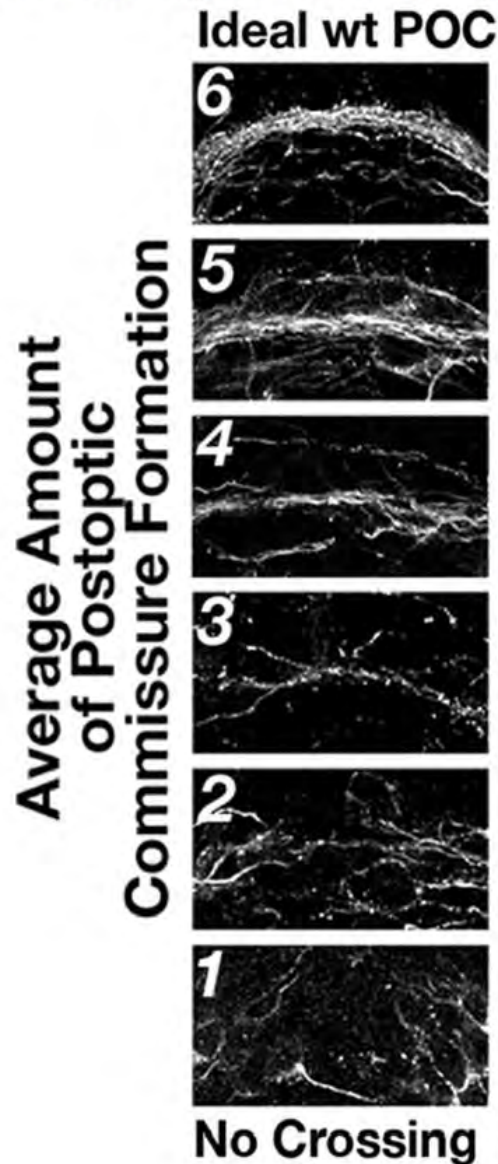


- Difficult to determine how severe the phenotypes are



Quantifying Axon and Glial Phenotypes

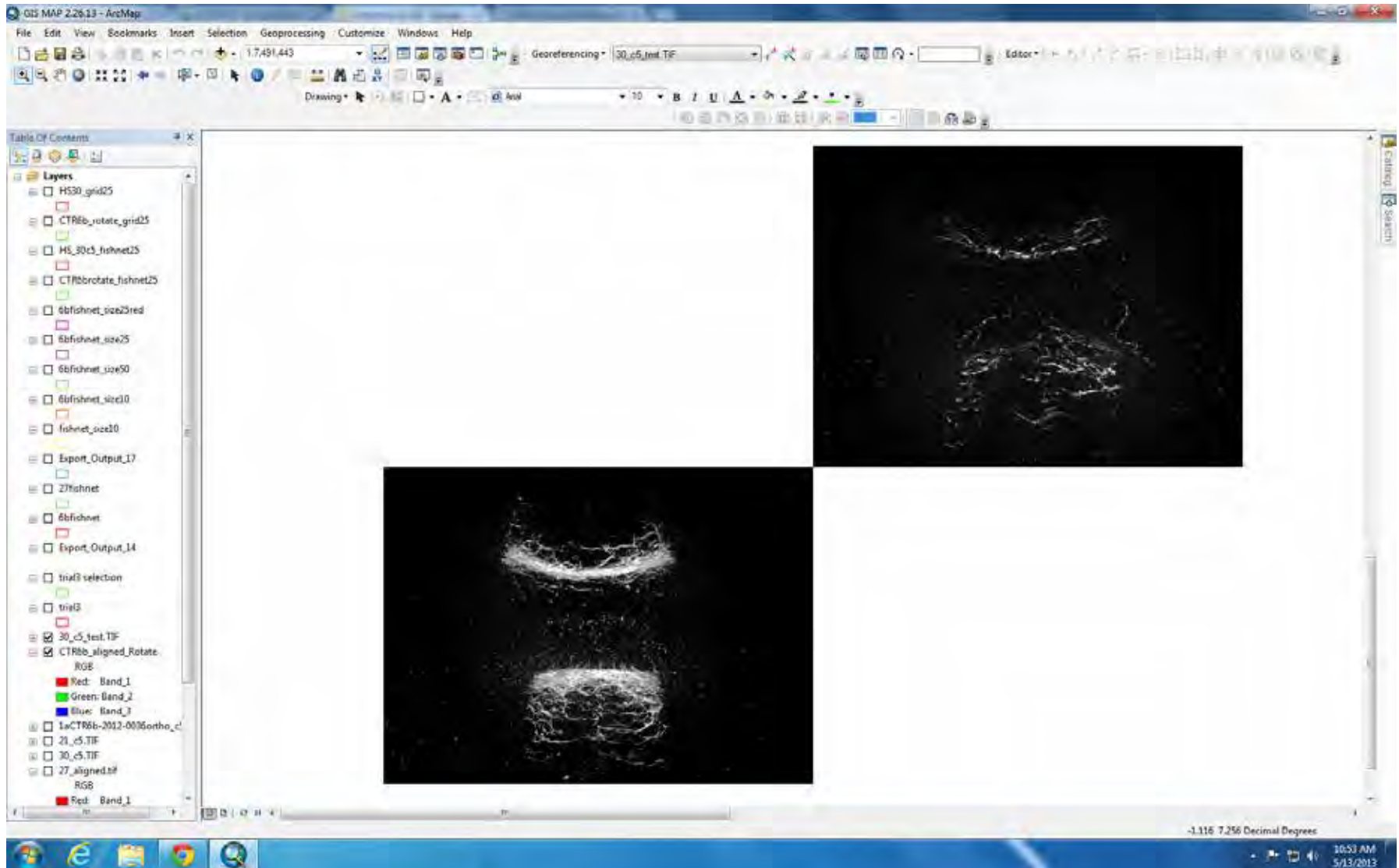
Quantitative analysis of POC formation, Glial Bridge Width, and Astroglial Positioning.



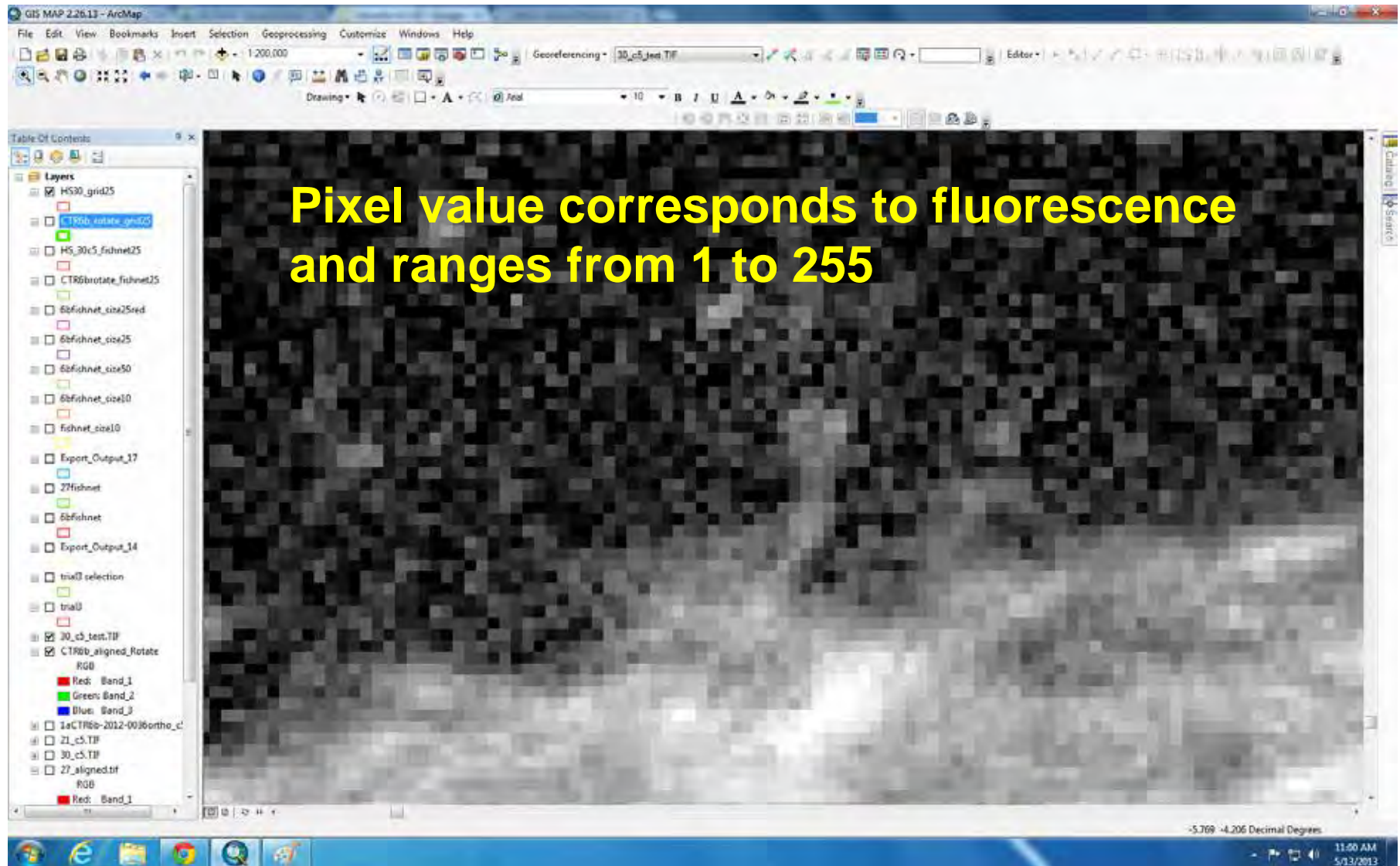
Solution?

- Objective & unbiased quantification
- Robust, consistent method
- Provide a visual representation of normal brain developement vs. abnormal development

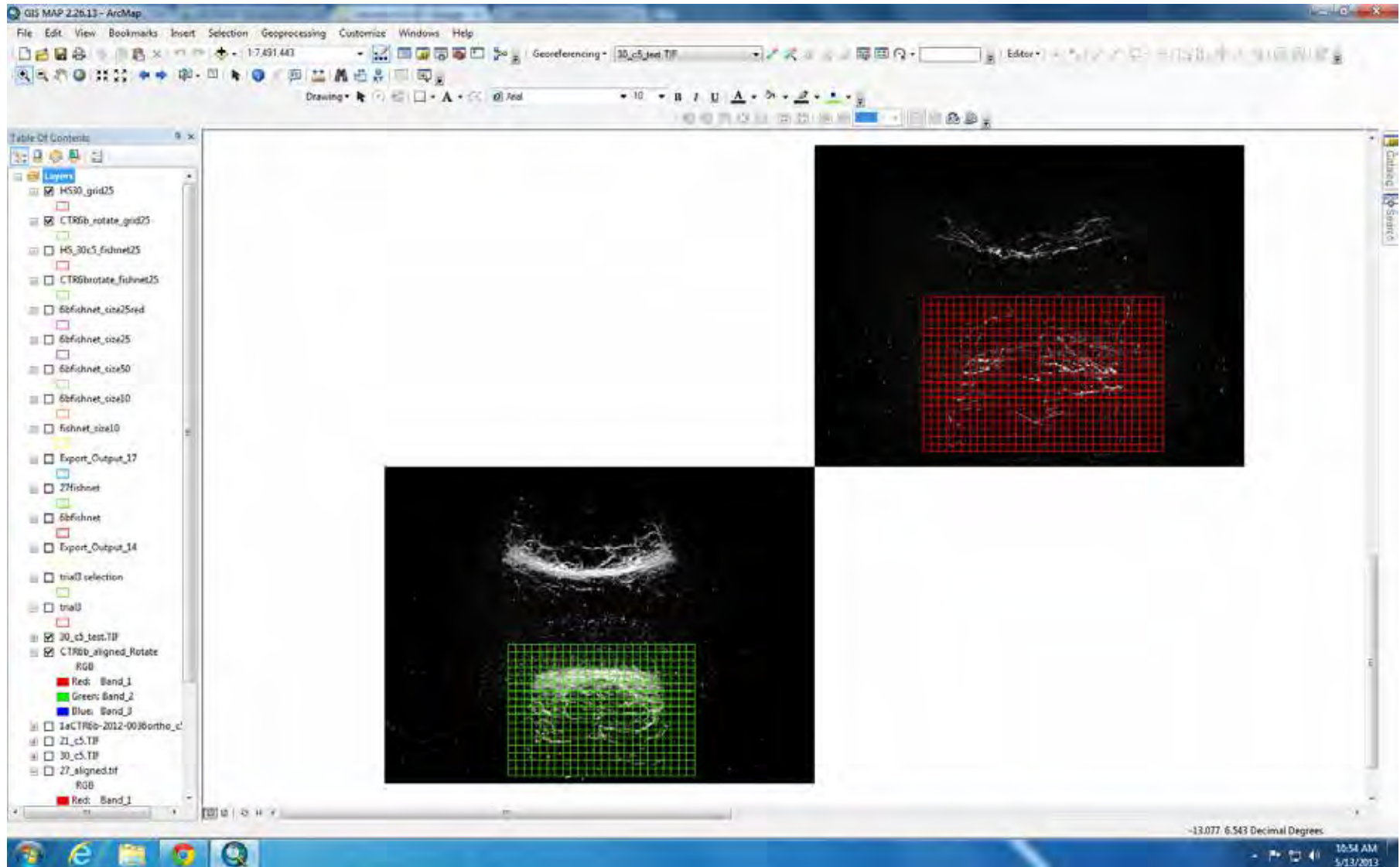
Forebrain scans... secretly just rasters



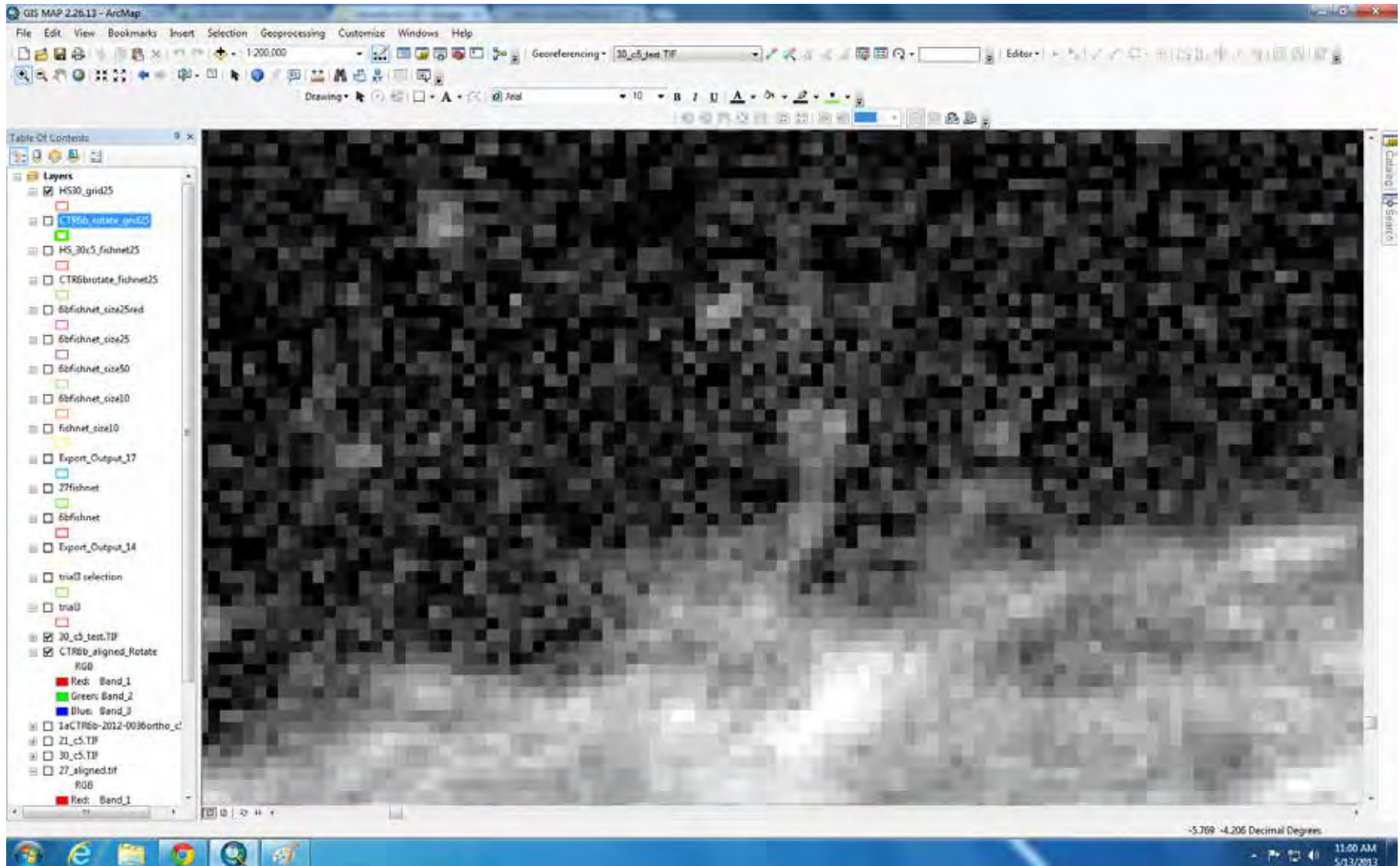
Forebrain scans... secretly just rasters



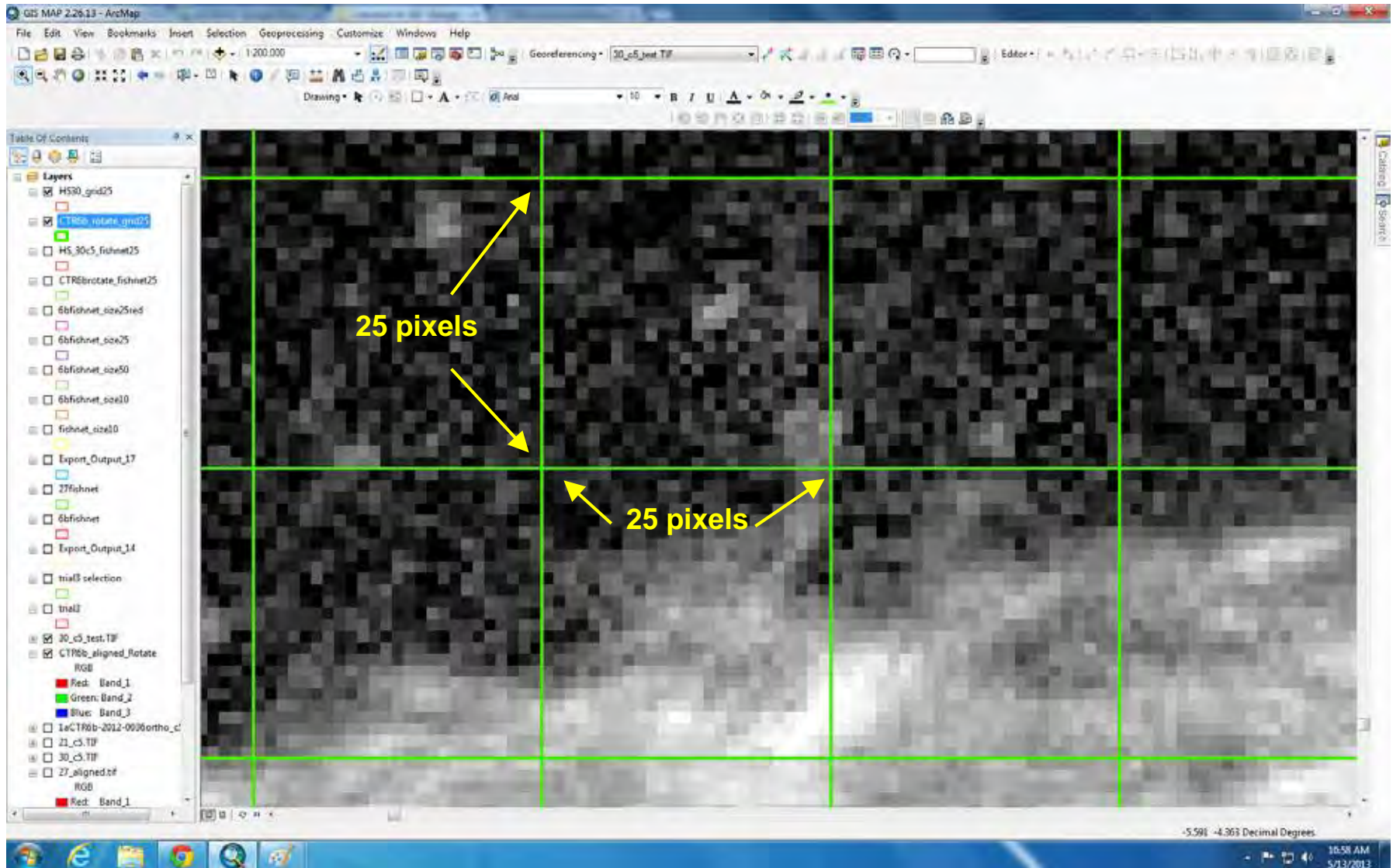
Analyzing images using "fishnets"



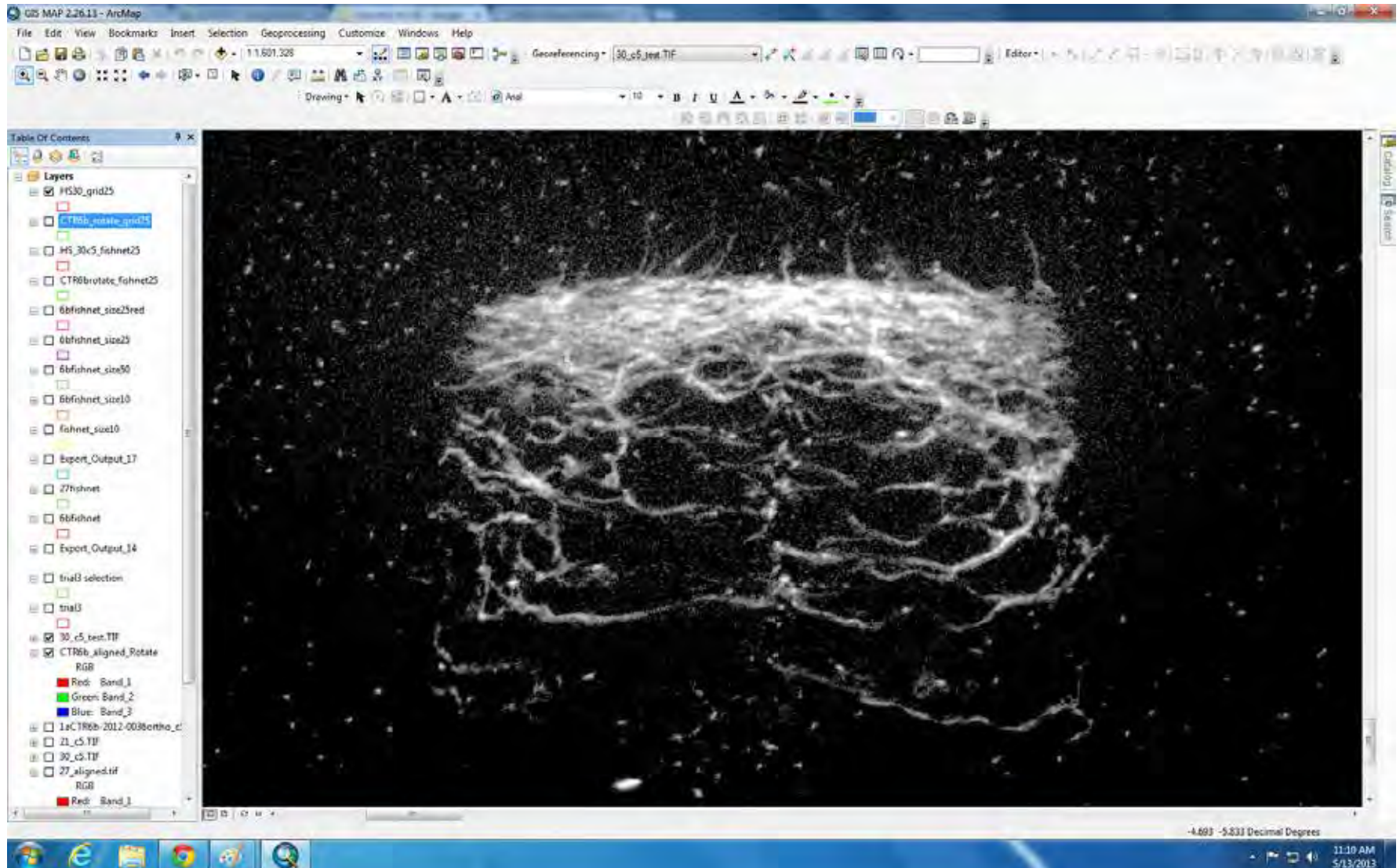
Analyzing images using "fishnets"



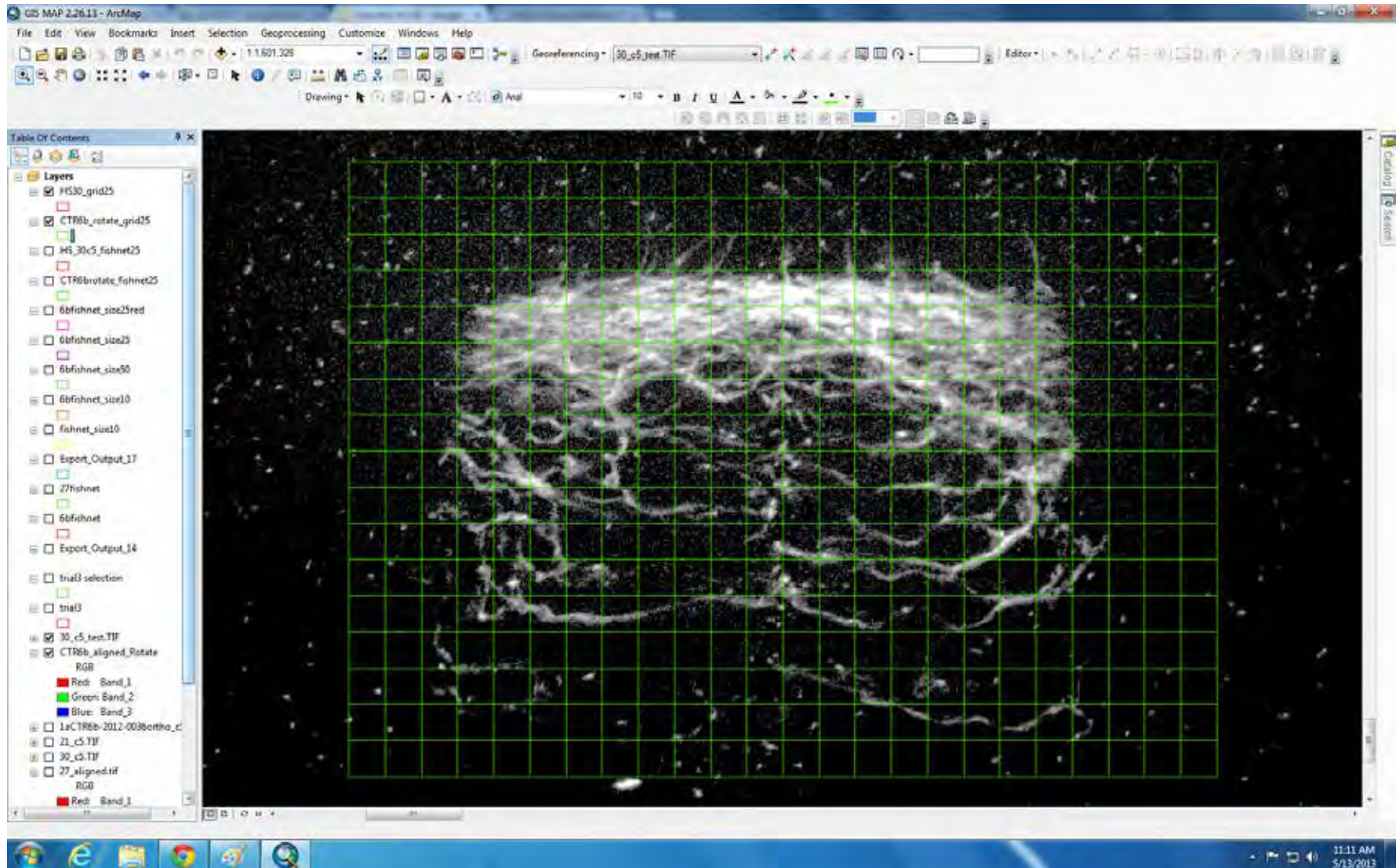
Analyzing images using "fishnets"



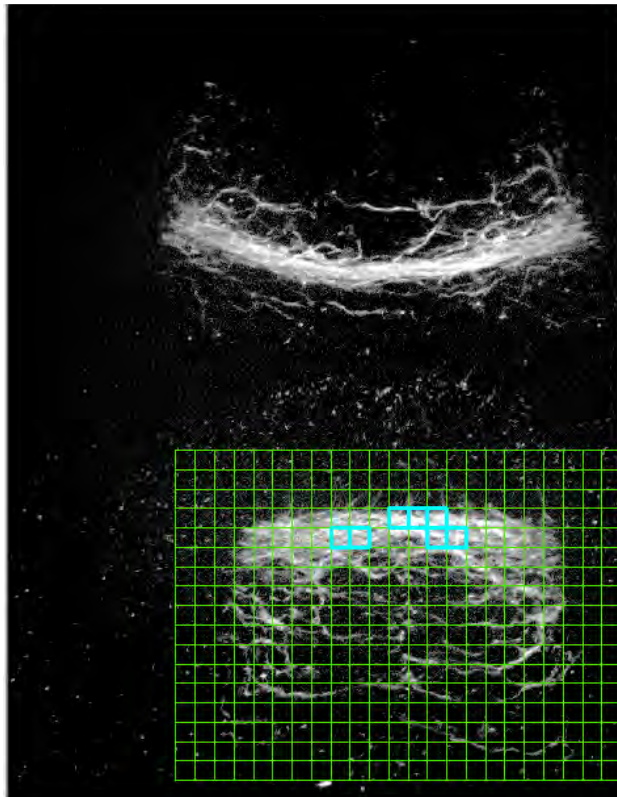
Quantifying commissure formation



Quantifying commissure formation



Using raster analysis tools



Table

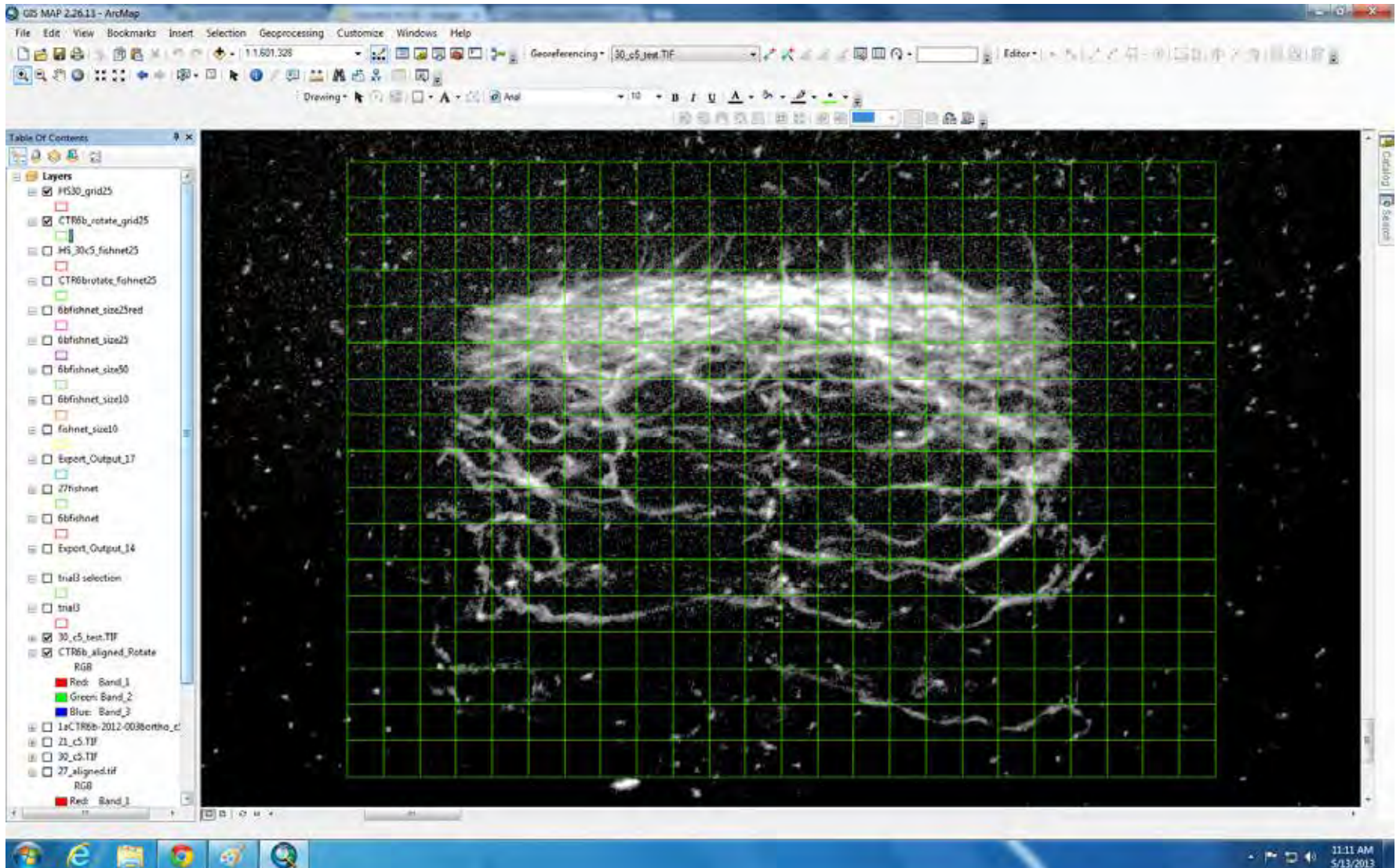
CTR6b_rotate_grid25

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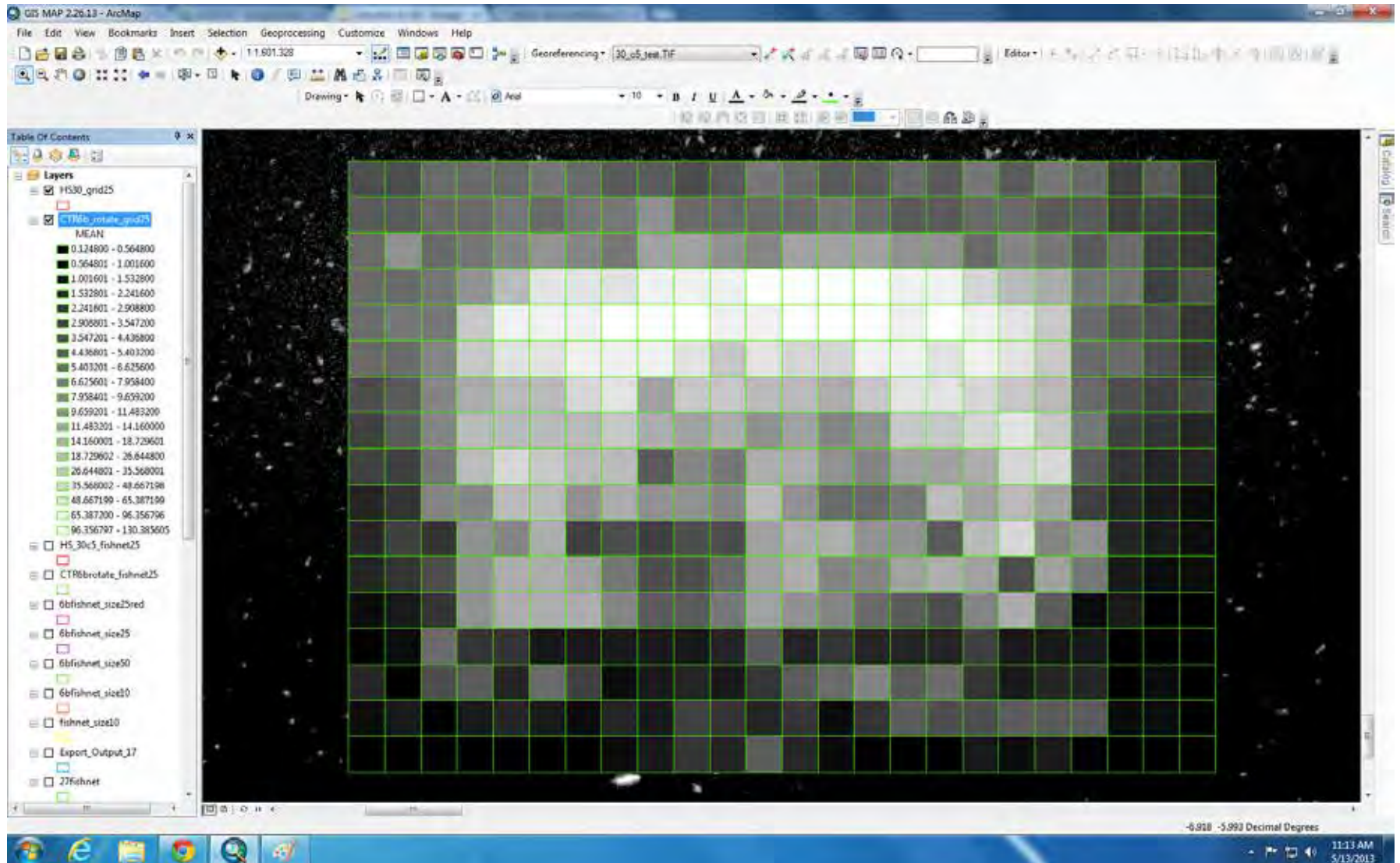
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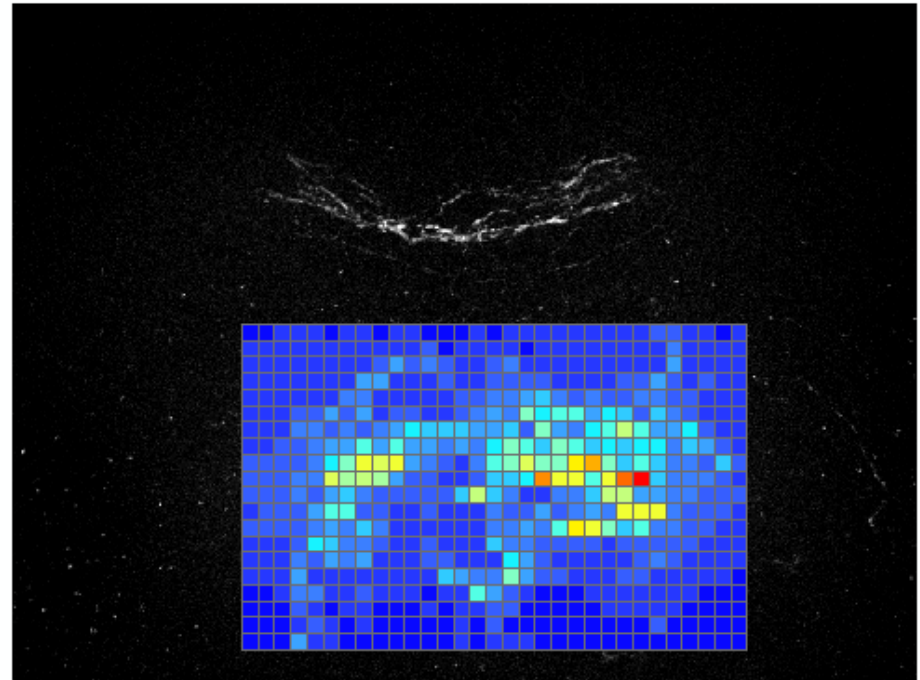
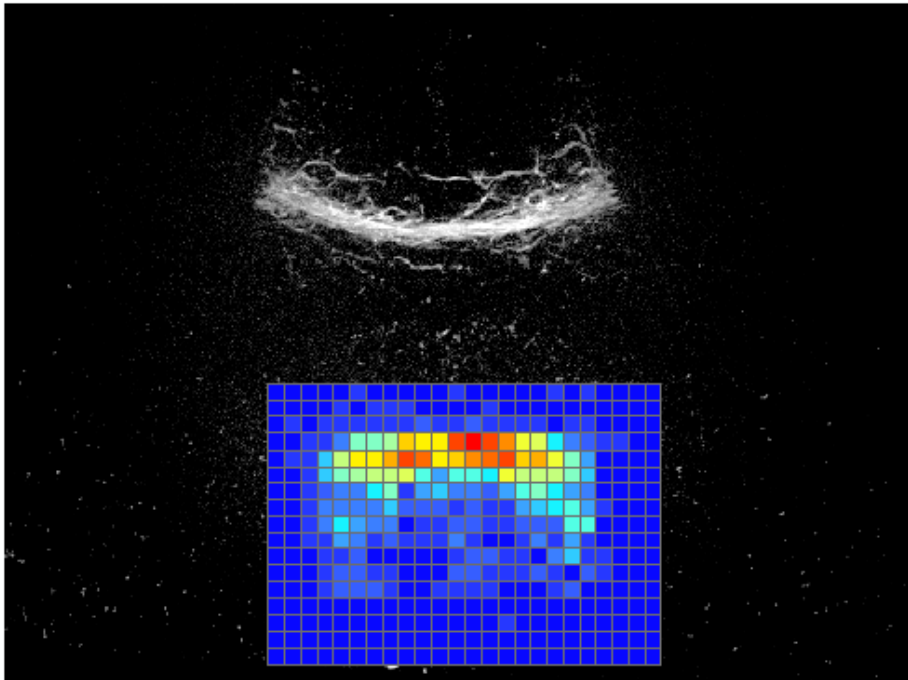
Visualizing raster analysis



Visualizing raster analysis

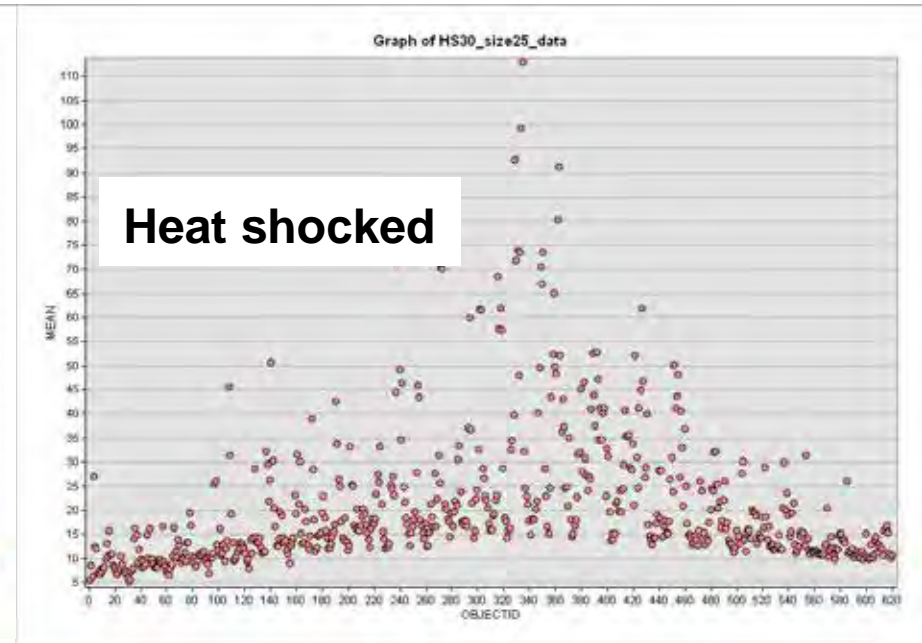
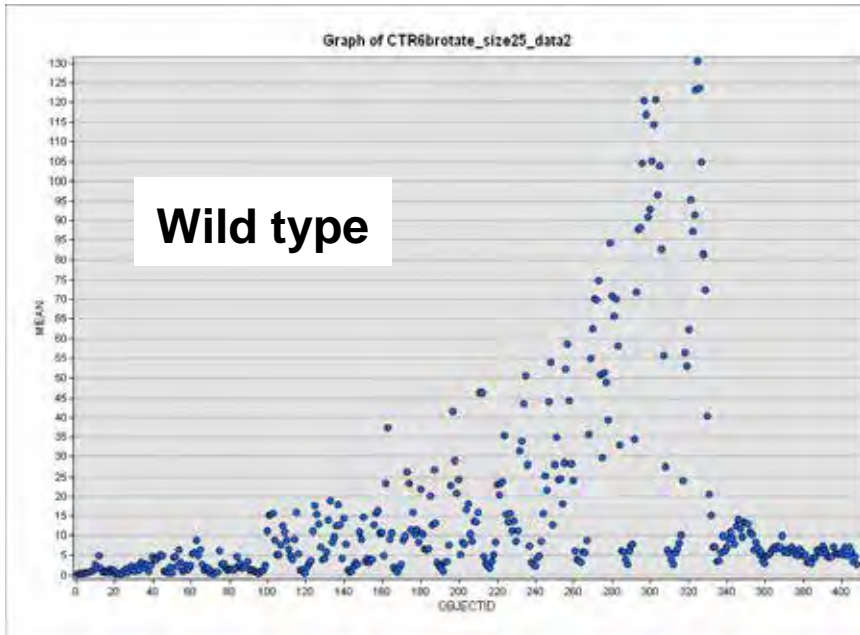


Visualizing raster analysis



Current work and next steps

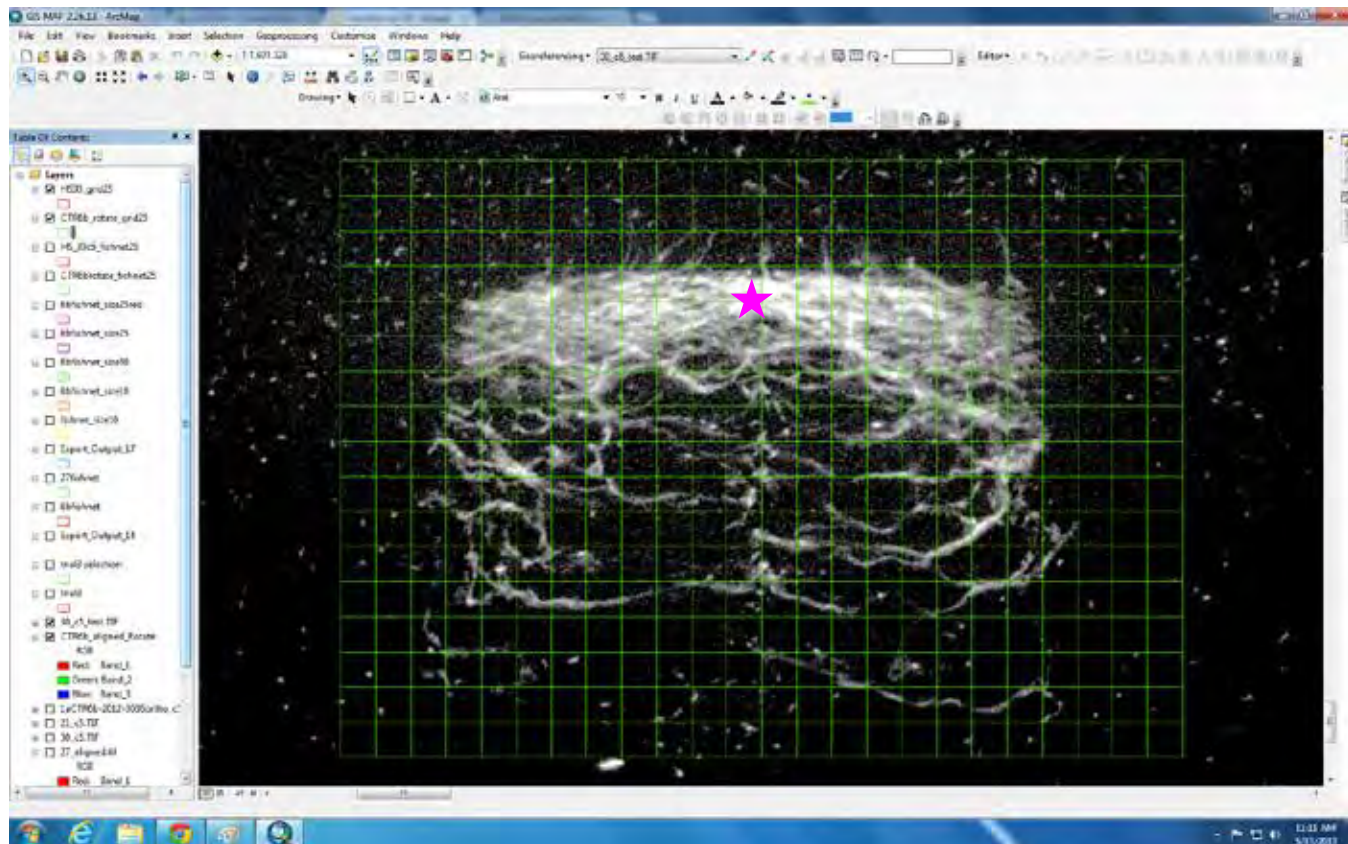
Graphing fluorescence distribution



- Graph shows Mean fluorescence vs. Object ID
- Want to graph Mean fluorescence vs. Distance from a center line on commissure to measure "wandering"

Need consistency between images

Possible to snap fishnet to a center point place on the commissure?



Acknowledgements

- Dr. Michael Barresi, Dept. of Biological Sciences, Smith College
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- Smith College STRIDE Program

