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

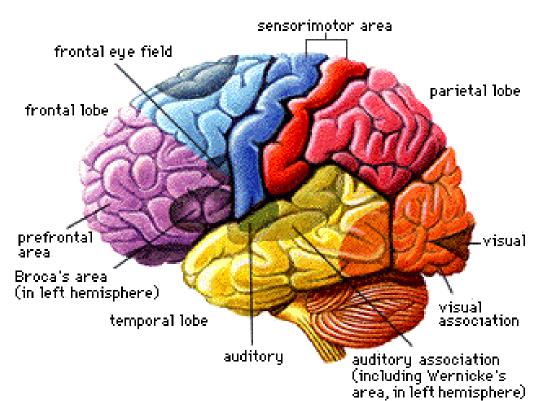
#### Jin Sook Park, Smith College '15 Corinna Keeler & Jon Caris, Smith Spatial Analysis Lab





## 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
  - O Difficult to study in humans



## Why are we interested?

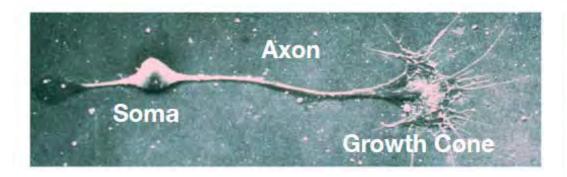
- Neurodegeneration
  - Parkinson's Disease
    - Degeneration affects physical movements & coordination
  - Alzheimer's Disease
    - Brain deterioriation
  - Other various brain & spinal cord injuries
- The more we understand the brain & how it forms, the more we can help in treating or curing patients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

## **Nervous System Development**

- Neuron
  - o Cell Body
  - o Axon
  - o Growth Cone

## Glial Cells

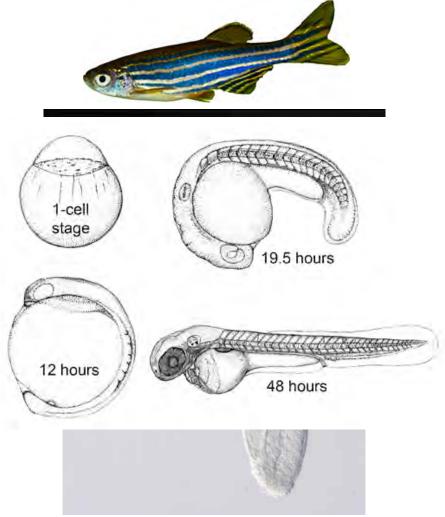
 Provides substrate for axons to grow on & guides them in the right directions





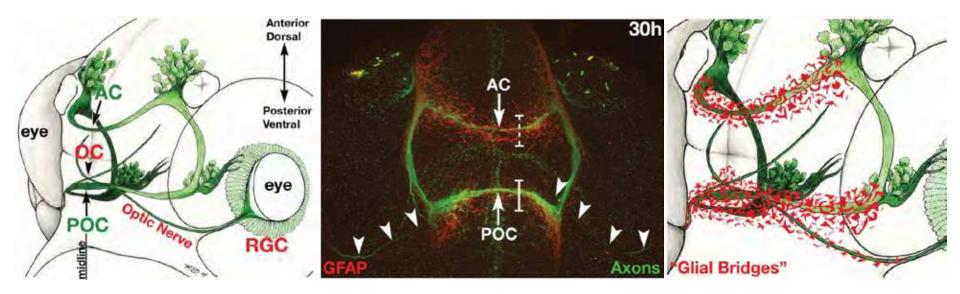
## Zebrafish Model System

- 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

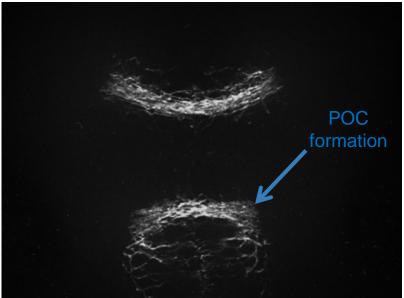
- Proteins & receptors aid interactions of axon
   & glial cells
- Guides commissural axons across midline
  - Leads in proper direction

**Combinatorial Model** 

Prevents recrossing

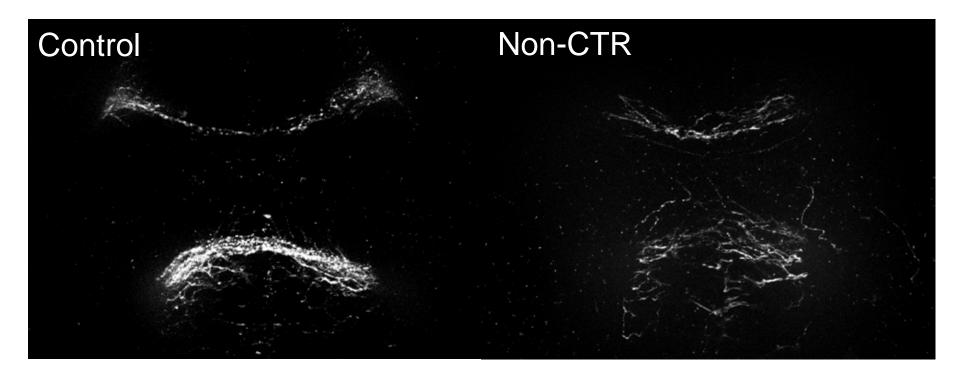
## Slit & Roundabout Guidance

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

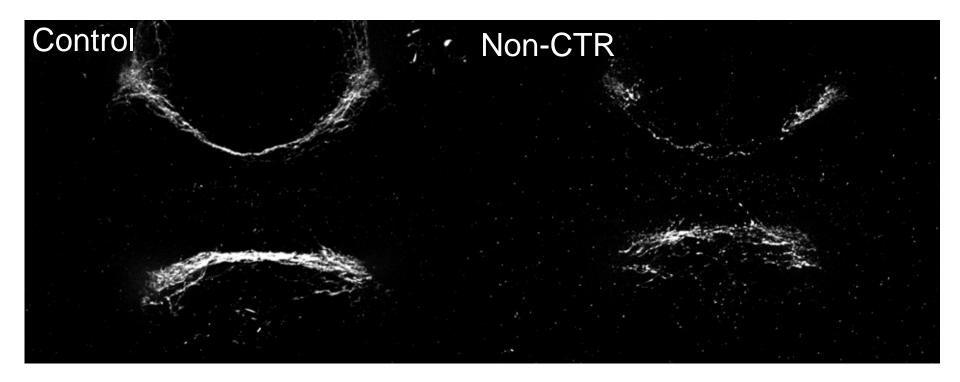


### How would the different phenotypes be quantified in an objective, unbiased way based on the forebrain images?

Noticably different formations



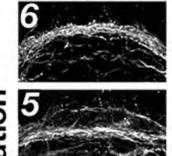
# Difficult to determine how severe the phenotypes are

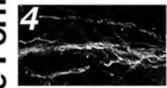


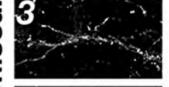
#### Quantifying Axon and Glial Phenotypes

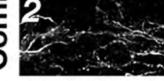
Quantitative analysis of POC formation, Glial Bridge Width, and Astroglial Positioning.

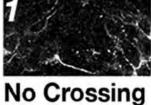
#### **Ideal wt POC**

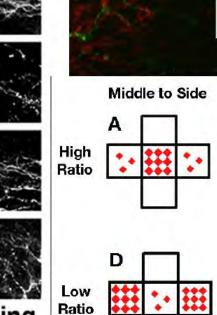


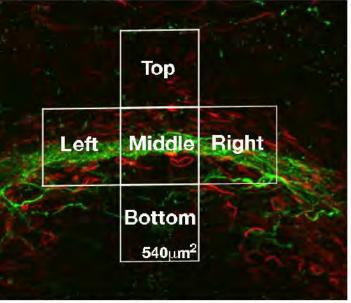






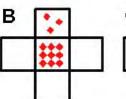


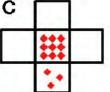


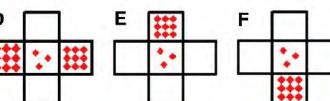


to Side Middle to Top

Middle to Bottom







Commissure Formation

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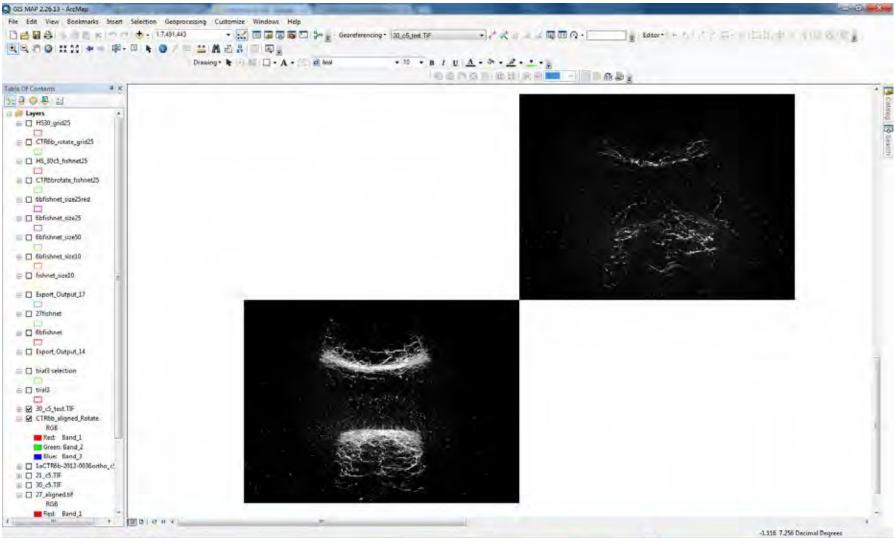
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## Solution?

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

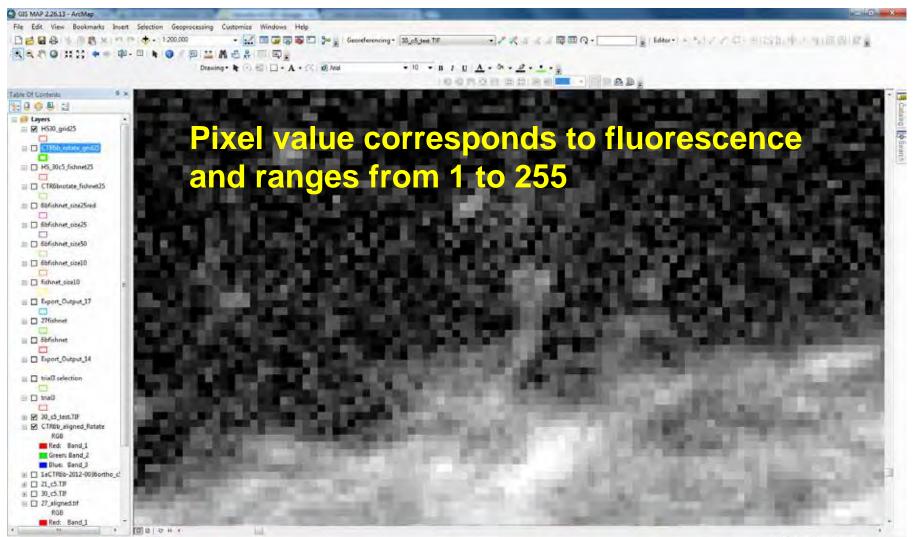
#### Forebrain scans... secretly just rasters



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#### Forebrain scans... secretly just rasters

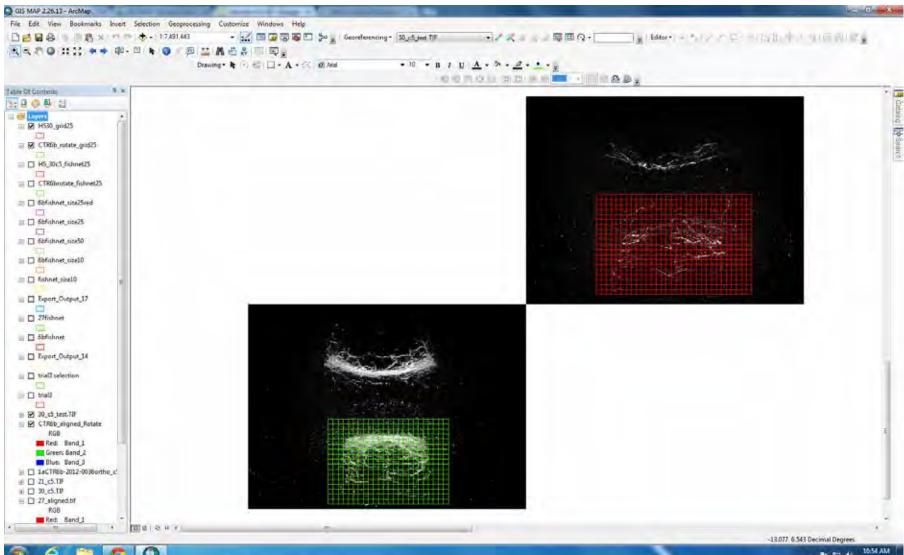


-5.769 -4.206 Decimal Degrees

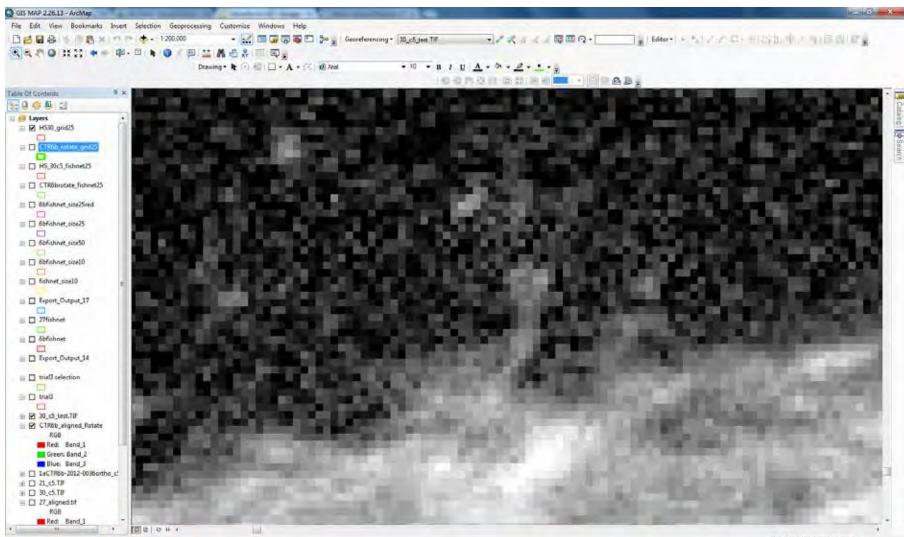
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## Analyzing images using "fishnets"



## Analyzing images using "fishnets"



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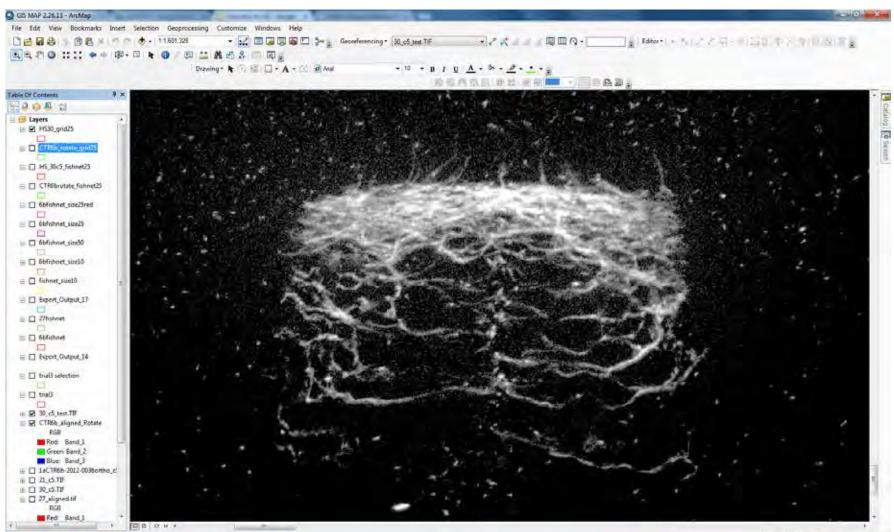
## Analyzing images using "fishnets"

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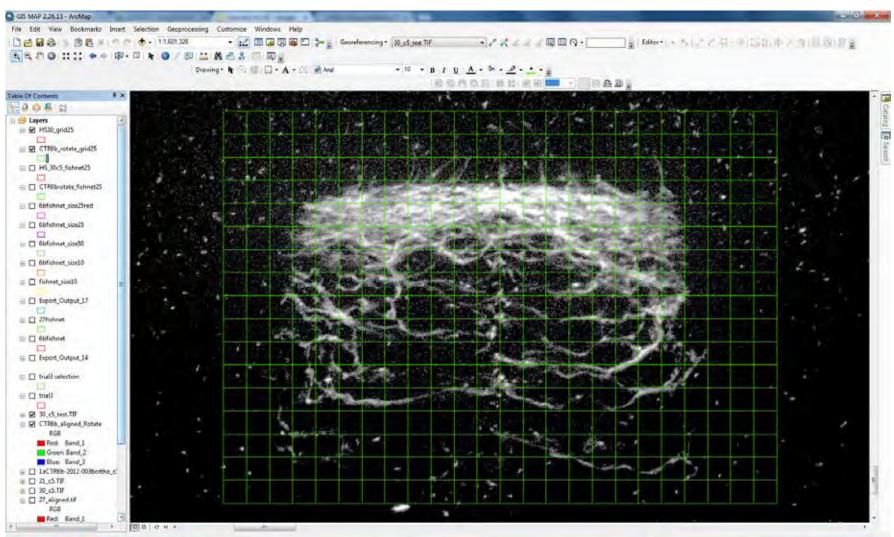
## **Quantifying commissure formation**





-4.693 -5.833 Decimal Degrees

## **Quantifying commissure formation**

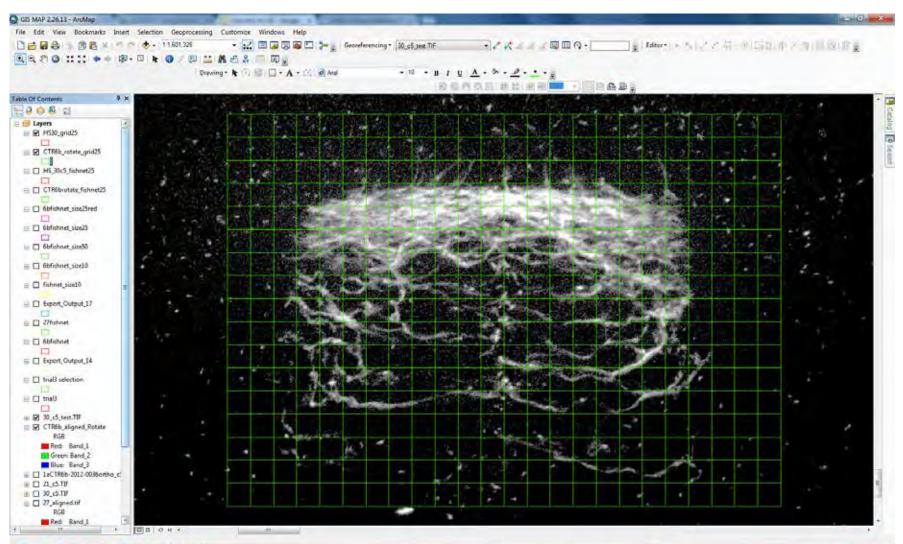


## Using raster analysis tools

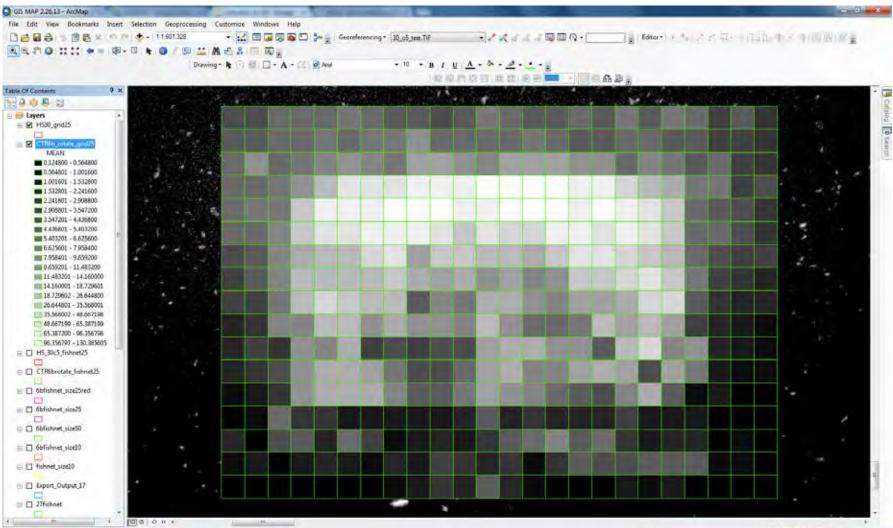
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## **Visualizing raster analysis**

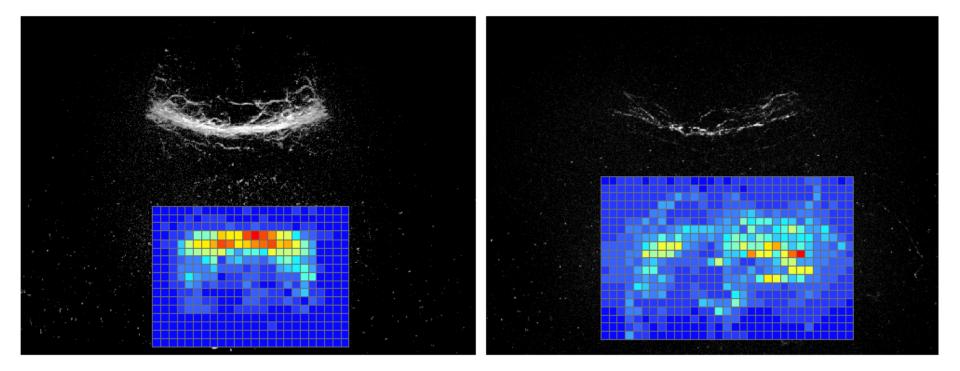


## **Visualizing raster analysis**



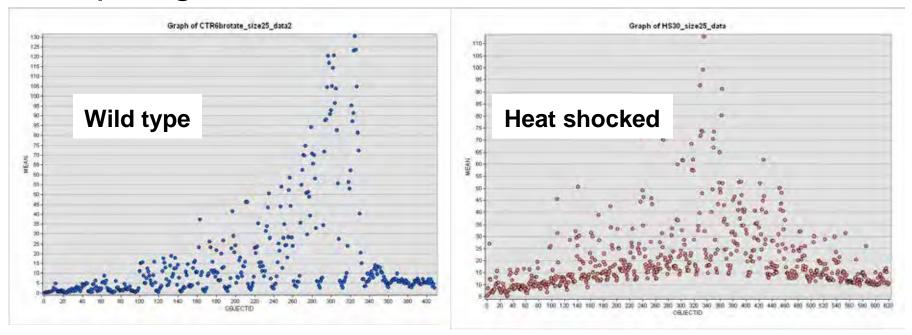
-6.918 -5.993 Decimal Degrees

### Visualizing raster analysis



## **Current work and next steps**

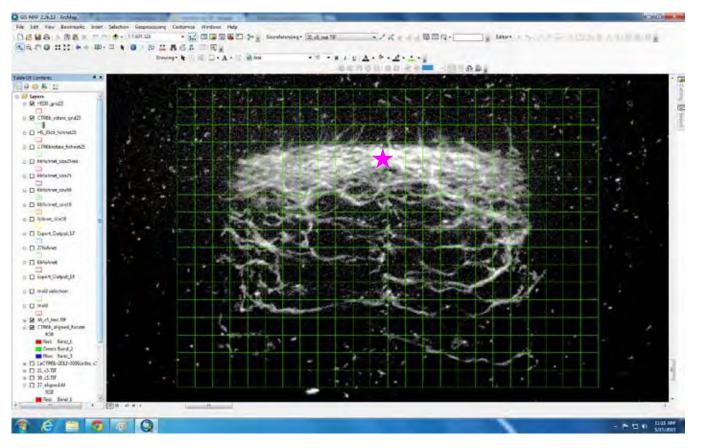
Graphing fluorescence distribution



- 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
- Smith College Summer Undergraduate Research Fellowships (SURF) Program
- Smith College STRIDE Program



