

Critical scales of heterogeneity: *unraveling the relationship between group behavior, home range size, and resource dispersion*

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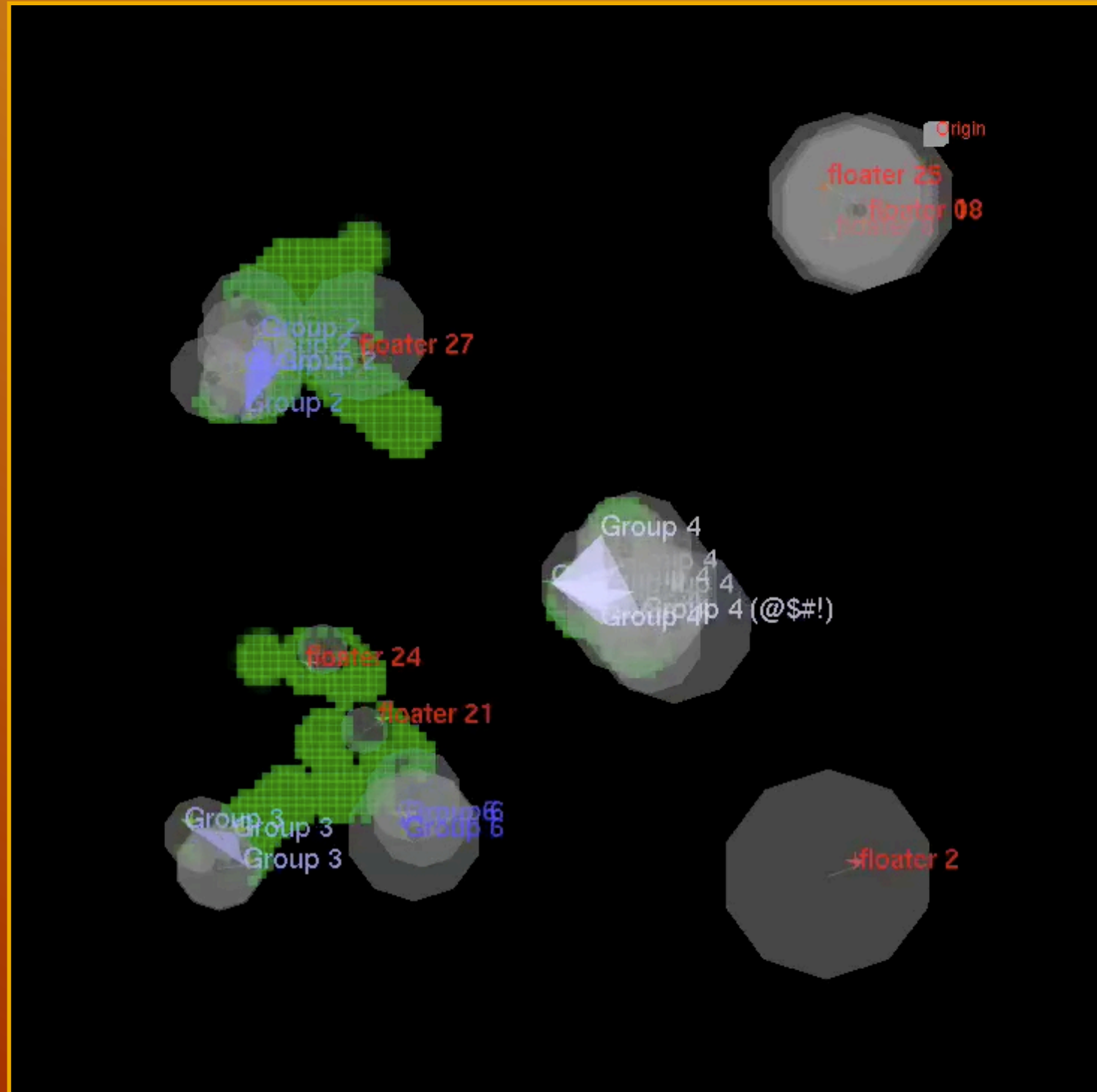
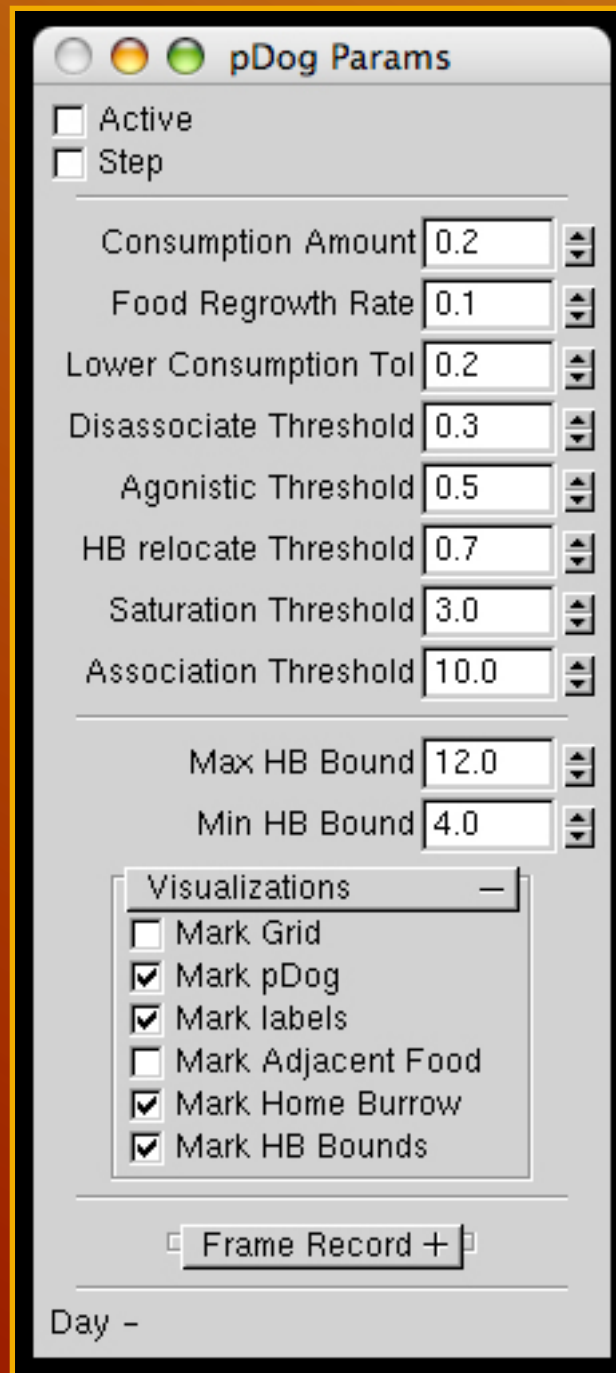


Jennifer L. Verdolin

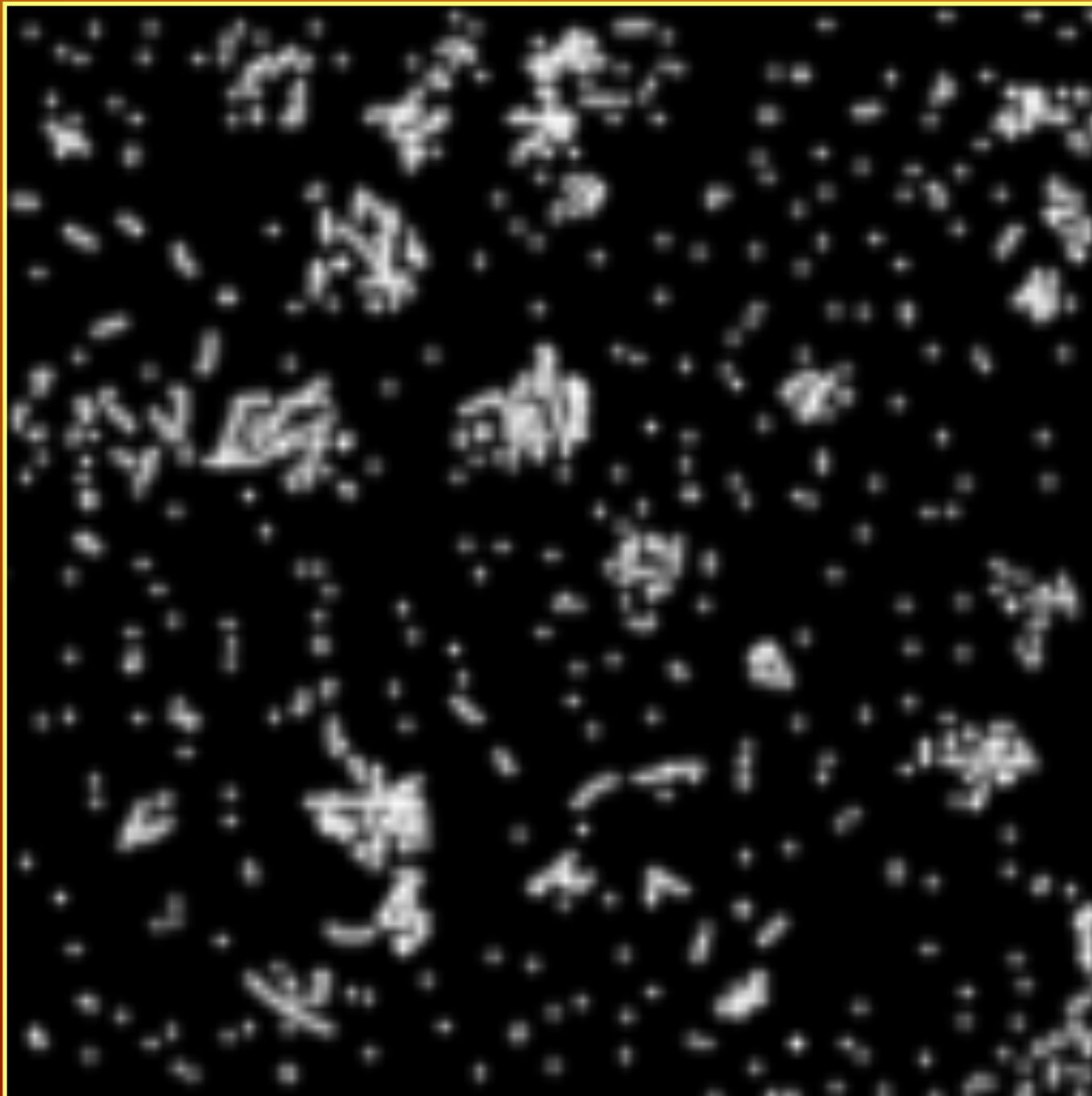


Dylan Moore

The *fieldTest* simulator:

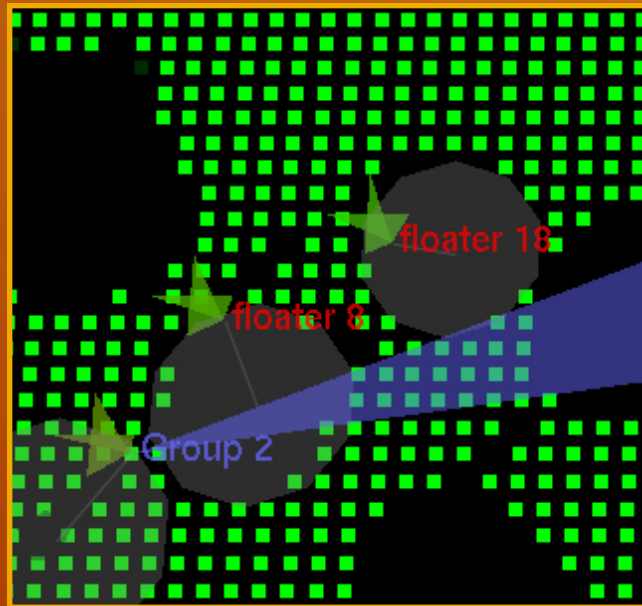


How *fieldTest* works:

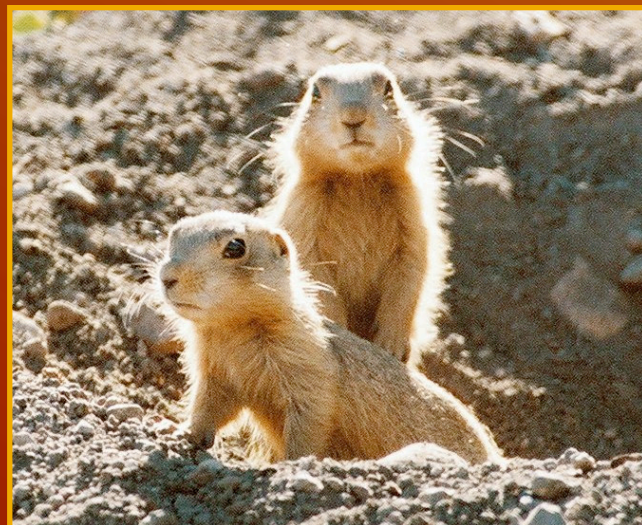


Food located on
two-dimensional,
bounded grid

How *fieldTest* works:

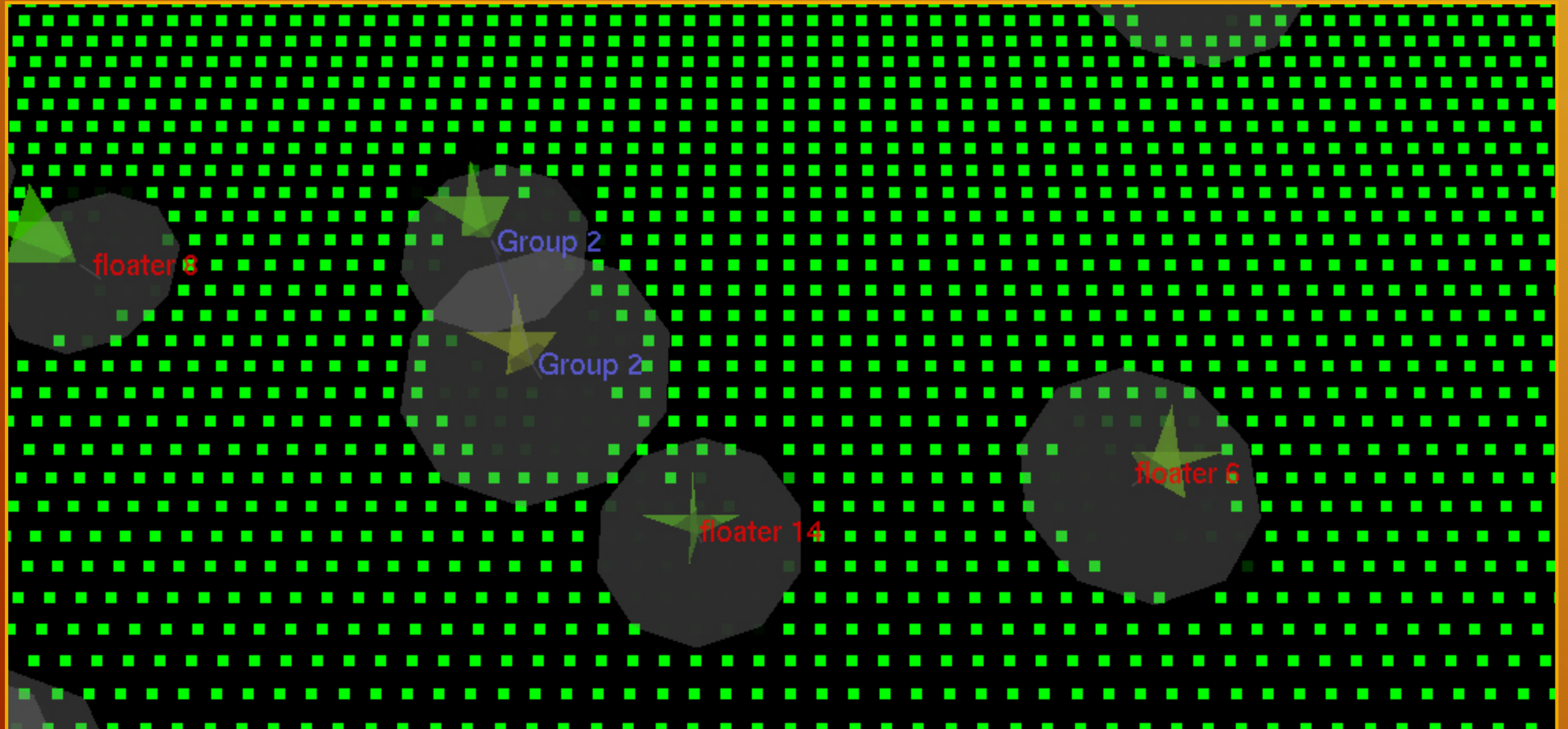


Assumes resource acquisition is the primary motivator of behavior; individuals decide whether to join & defend a group based on their foraging success



Inspired by prairie dogs, but works for any organism that displays group defense of territory based on food availability

How *fieldTest* works:

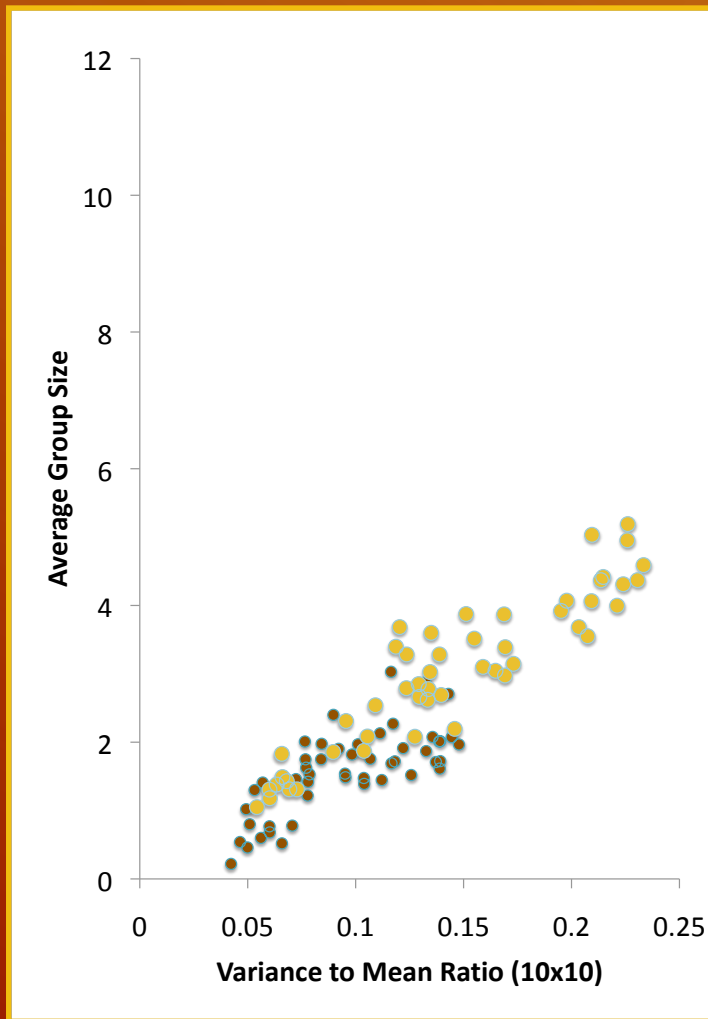


Outputs number of groups, group sizes,
group territory sizes, and number of floaters

Previous work using *fieldTest*:

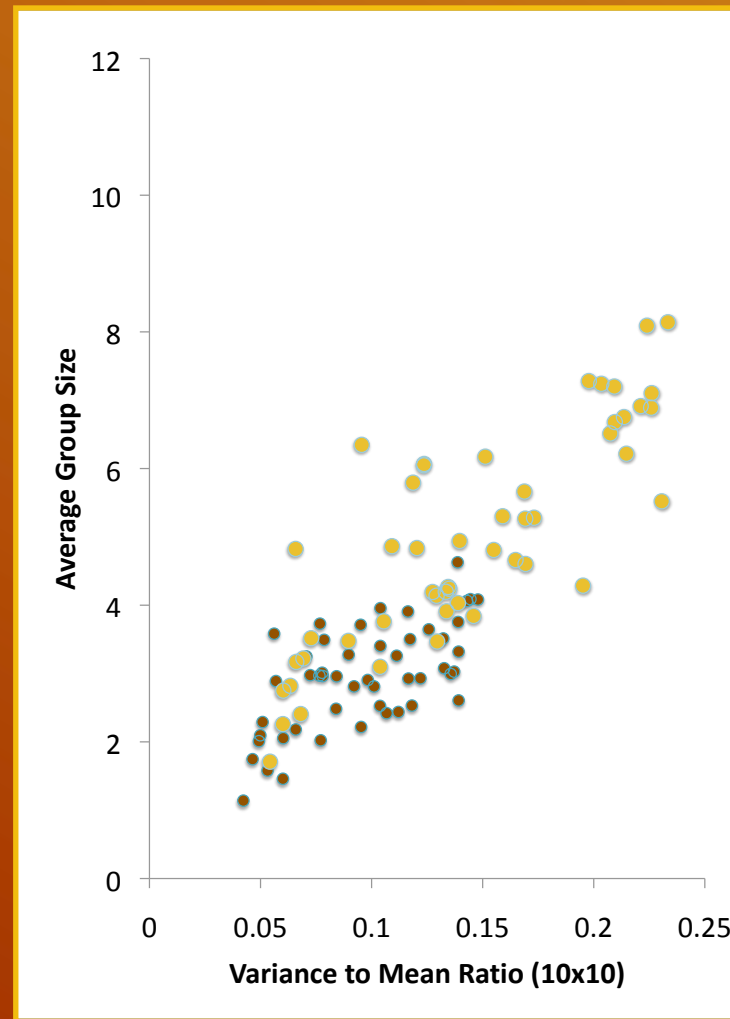
testing the relationship between resource heterogeneity & emergent social phenomena

$R^2 = 0.81, P < 0.001$



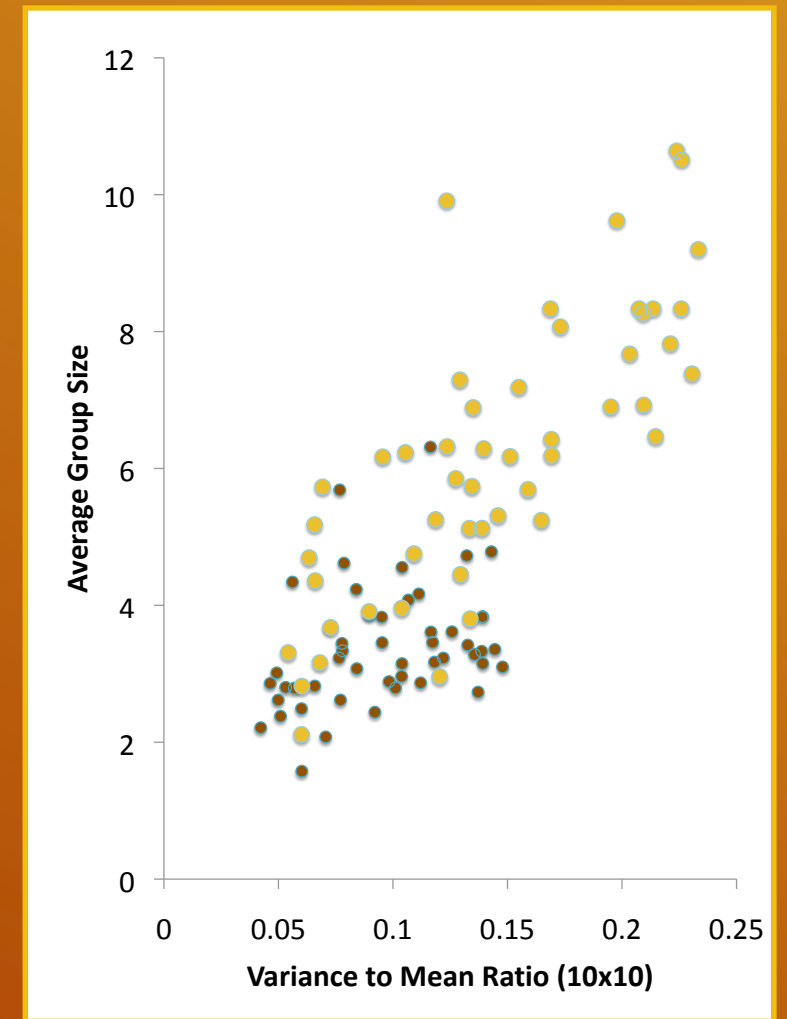
Regrowth = 5%

$R^2 = 0.69, P < 0.001$



Regrowth = 10%

$R^2 = 0.59, P < 0.001$

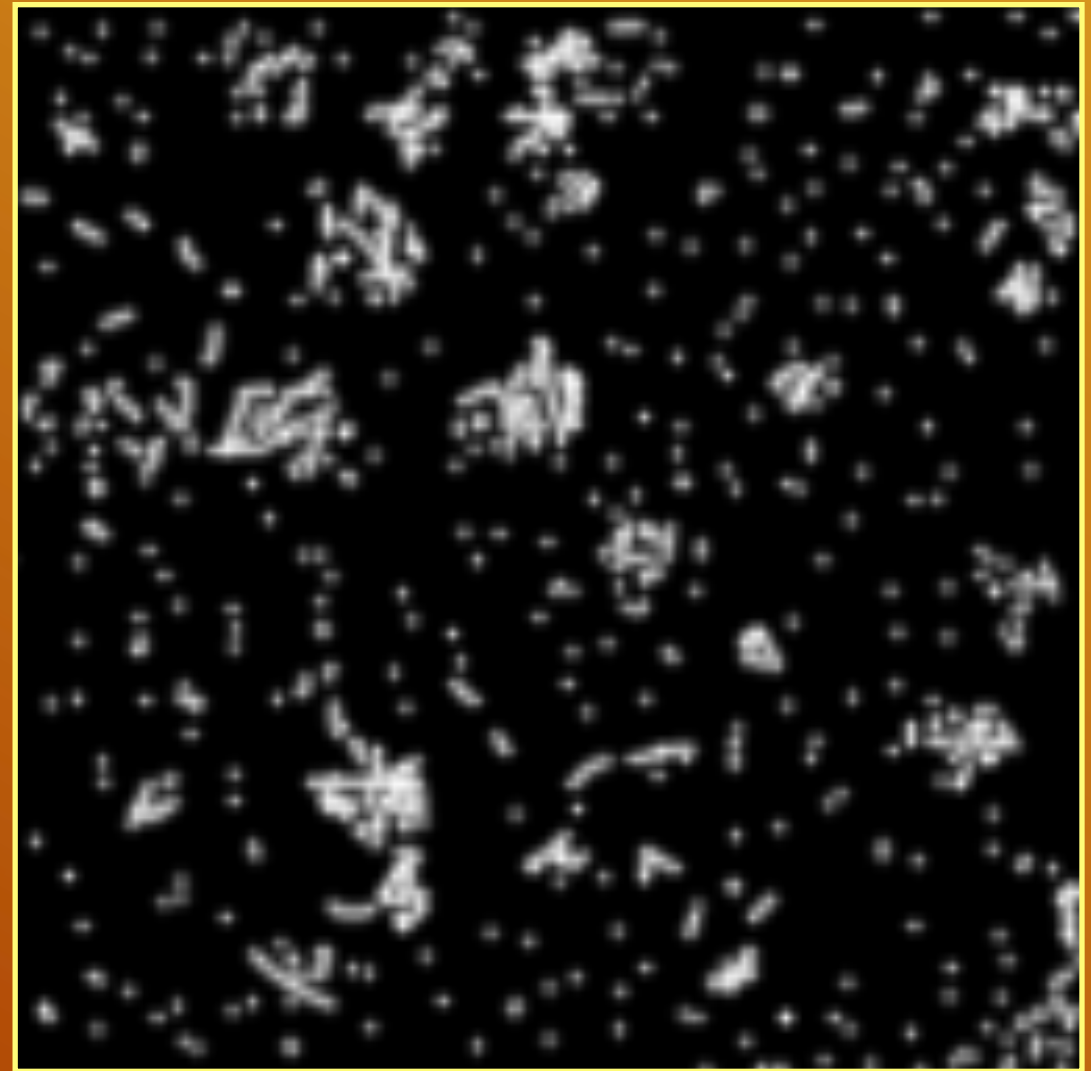
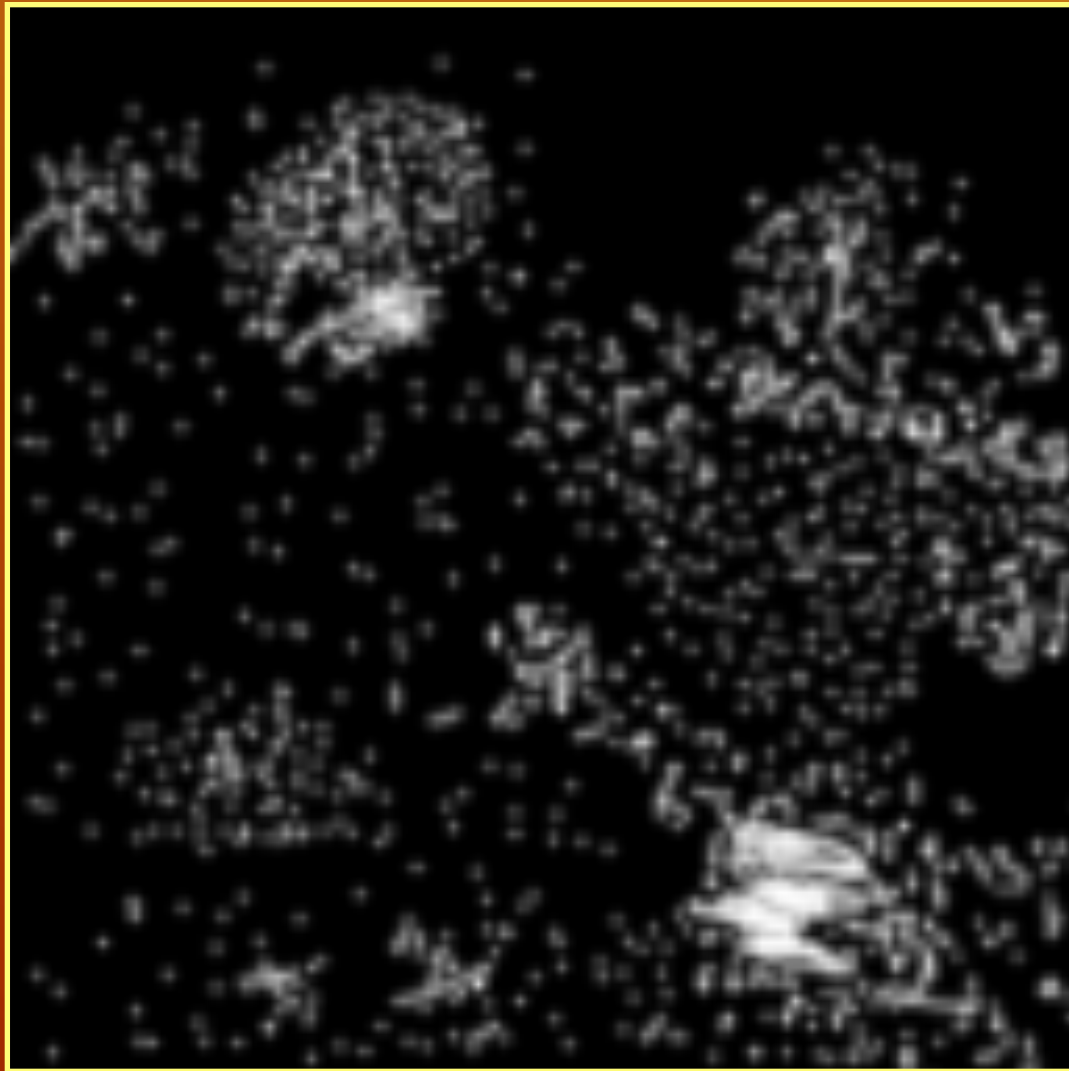


Regrowth = 15%

Scale of Heterogeneity:

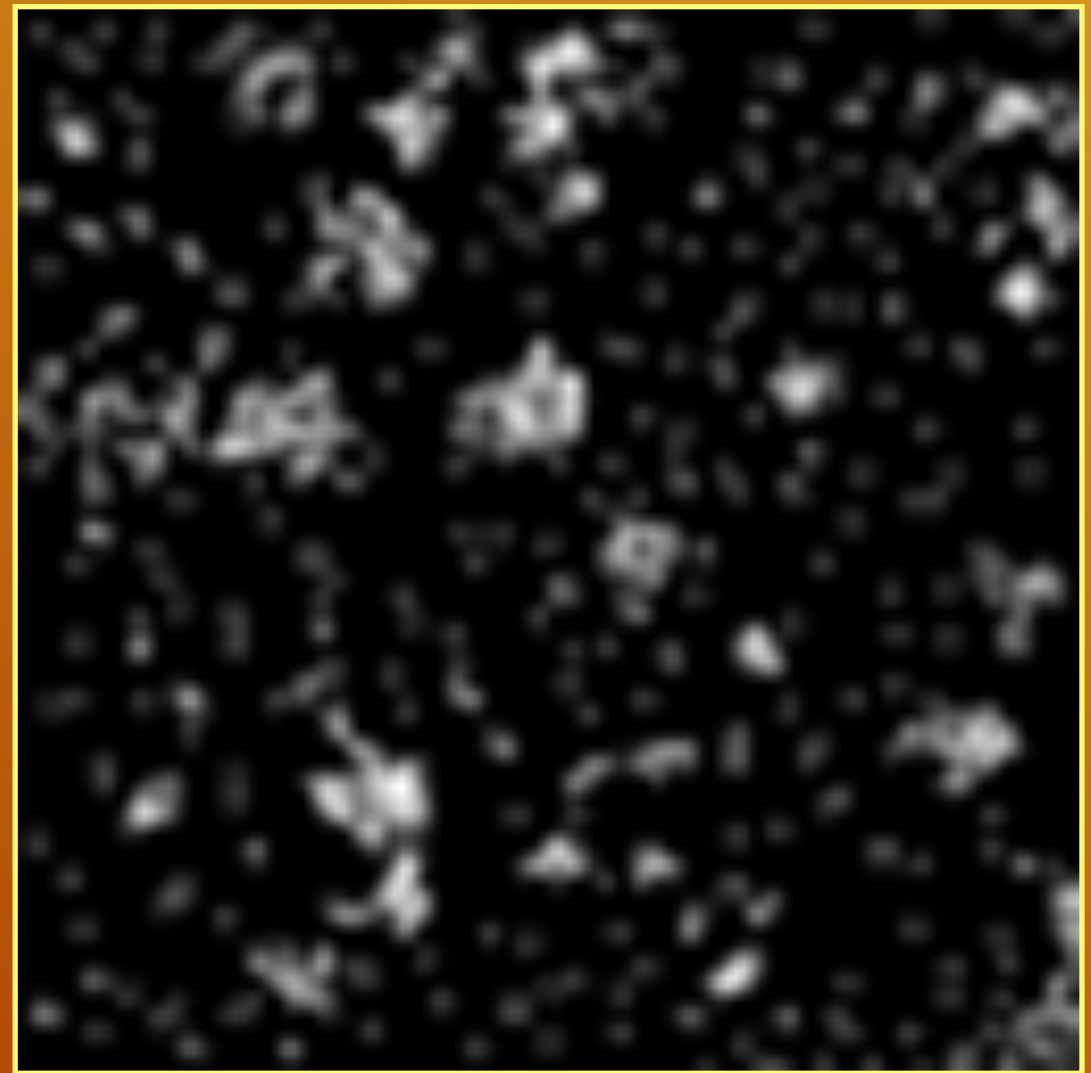
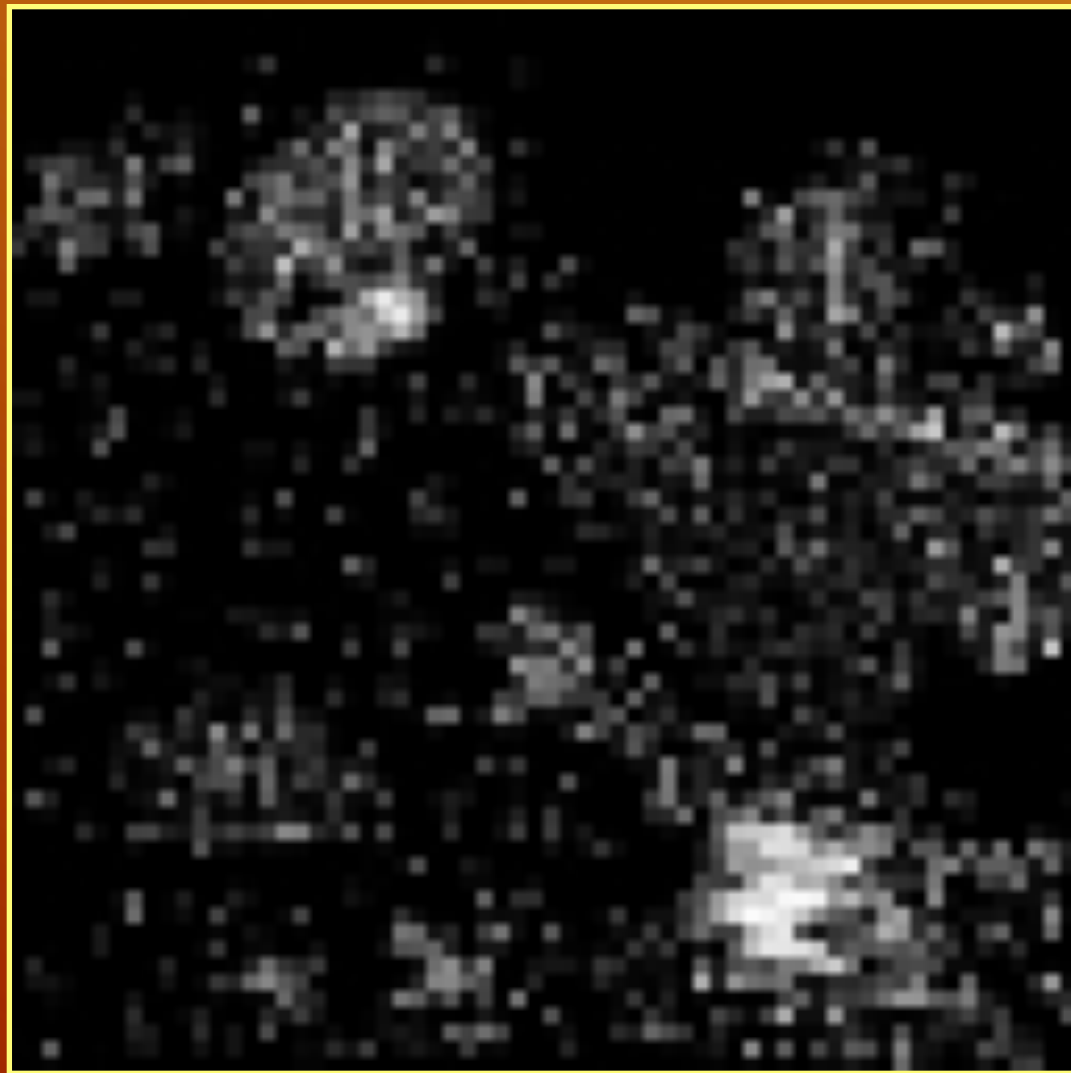
- ★ We measure the heterogeneity of our virtual landscapes as the variance-to-mean ratio
- ★ To make this measure, we need to specify the grain size at which to sample
- ★ The calculated variance-to-mean ratio for a particular landscape can vary drastically depending on what grain size is chosen

Heterogeneity at different scales:



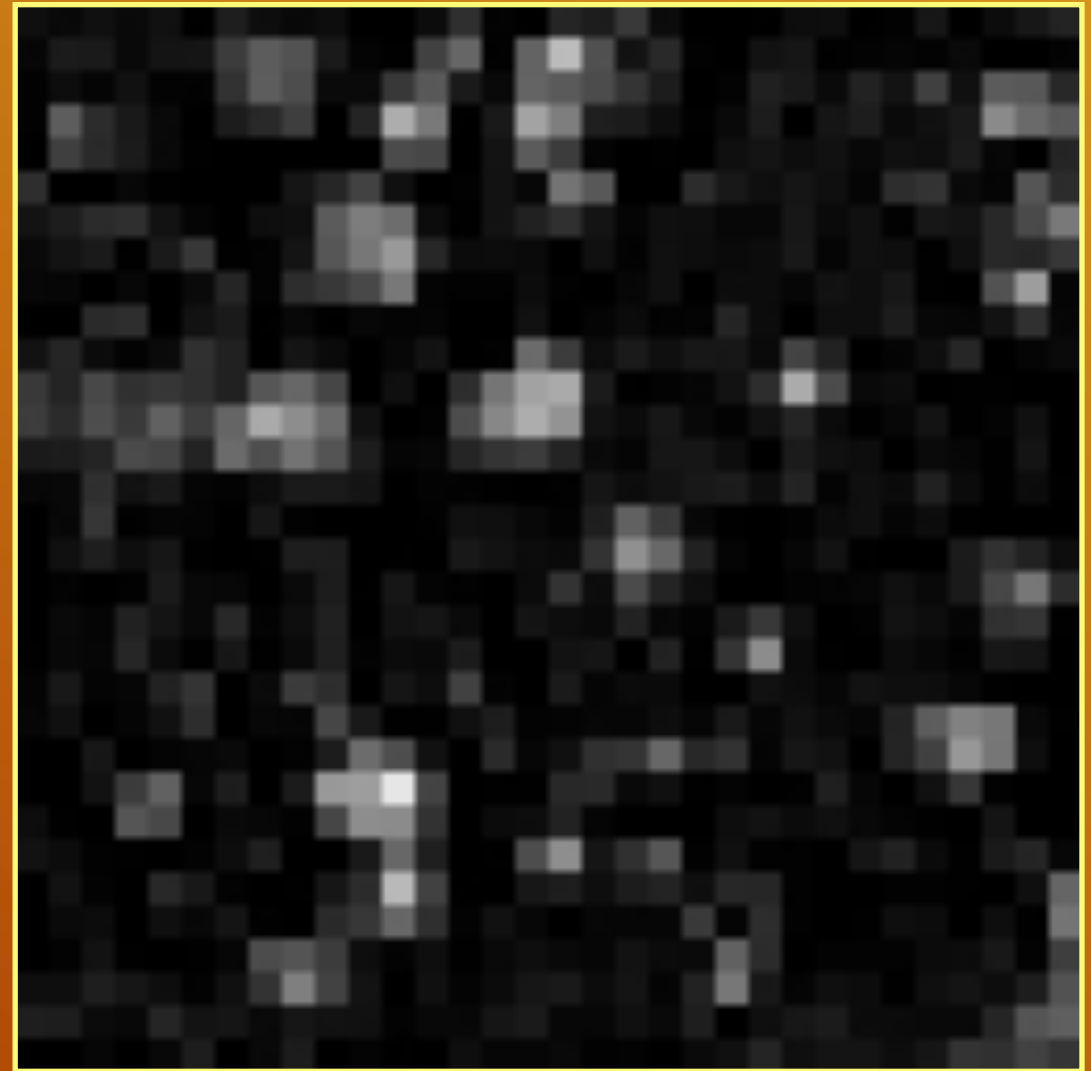
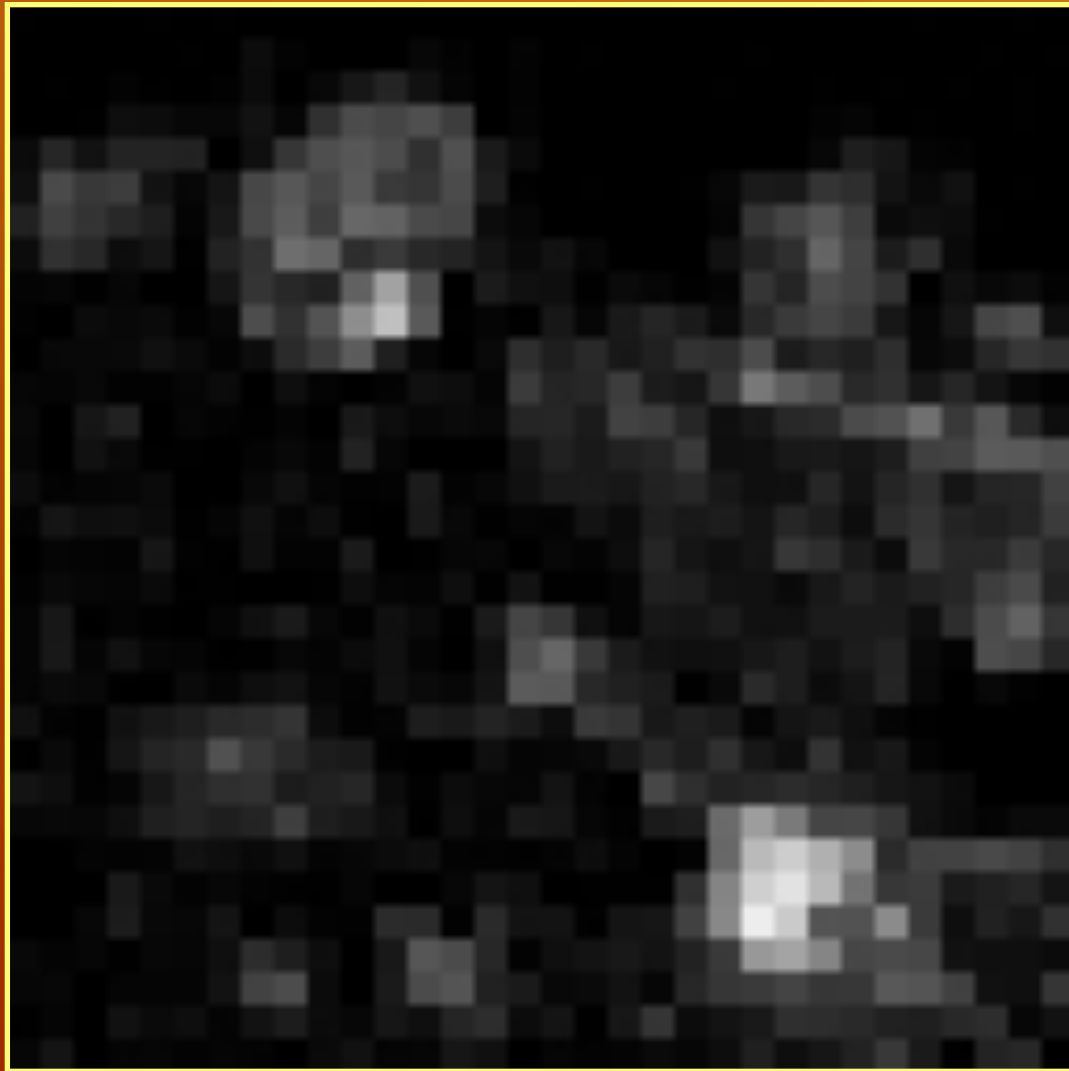
Grain Size = 1 x 1

Heterogeneity at different scales:



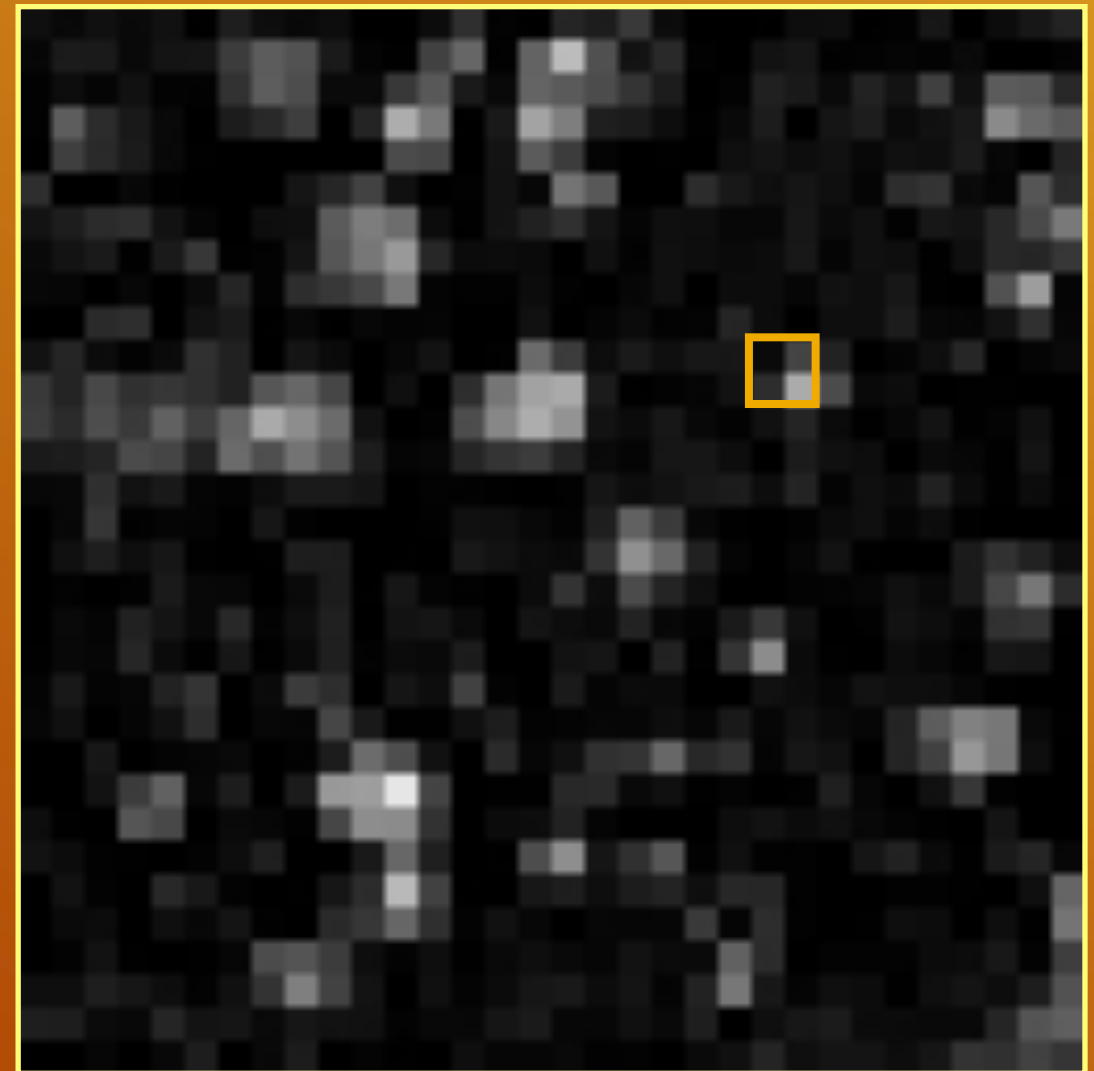
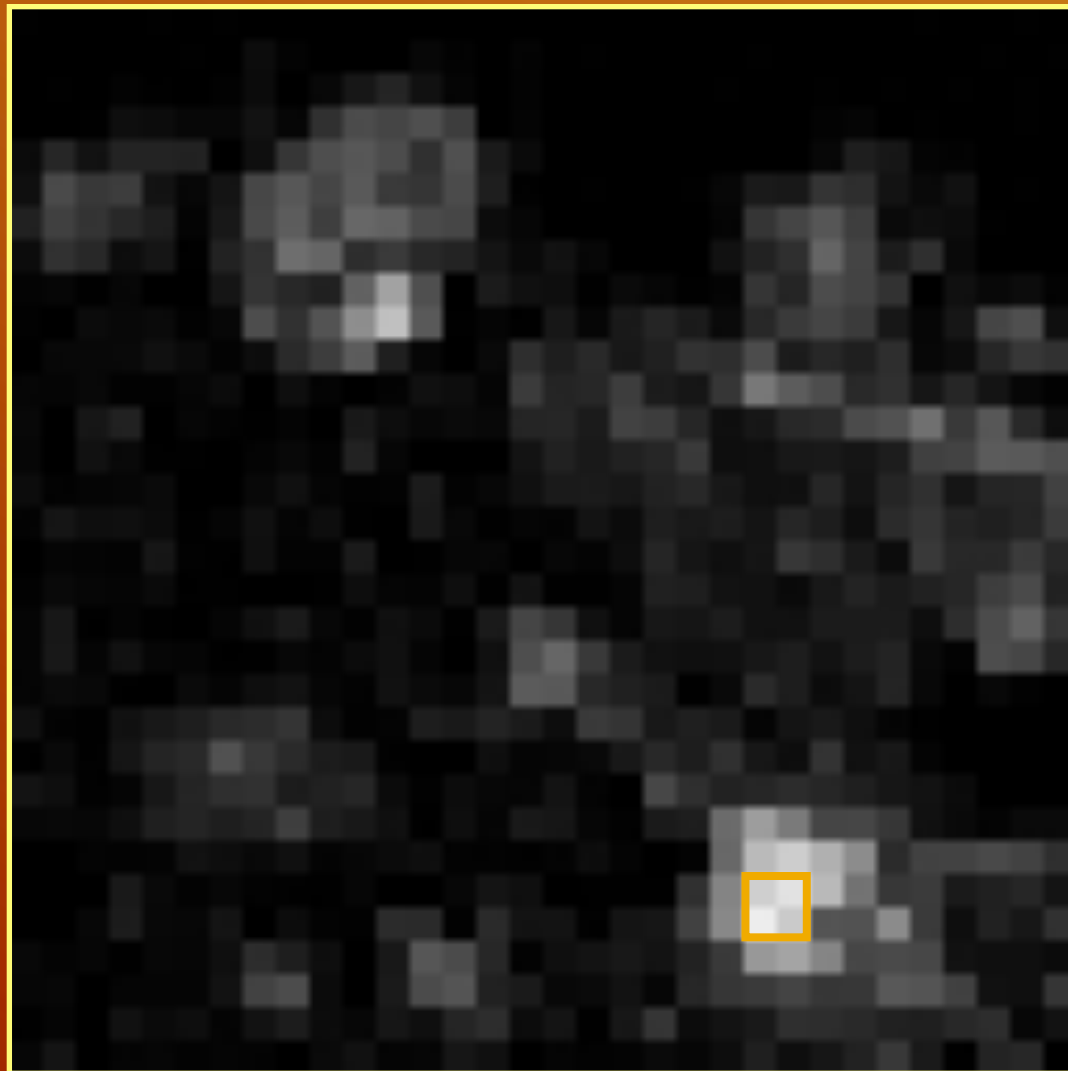
Grain Size = 2 x 2

Heterogeneity at different scales:



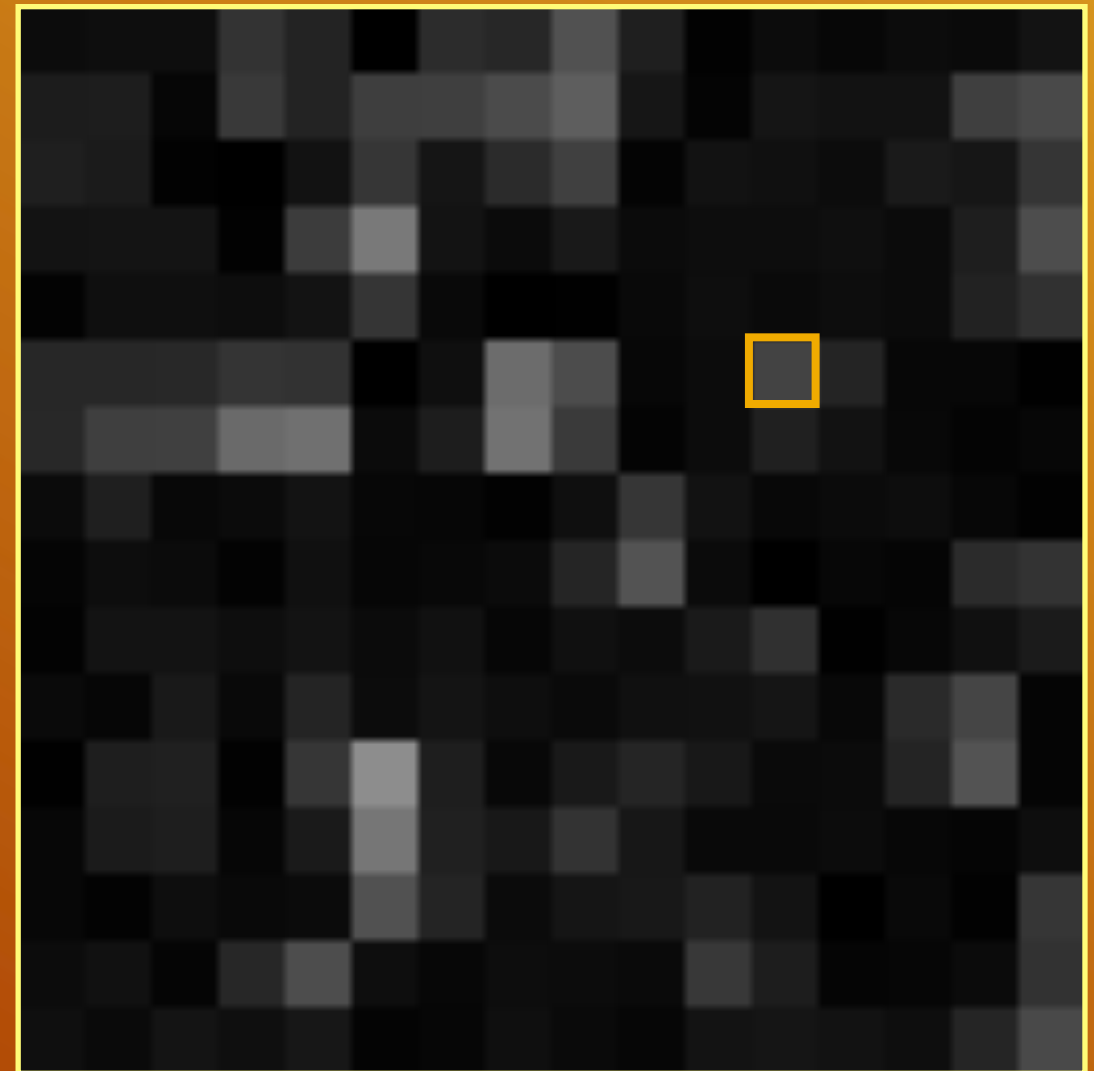
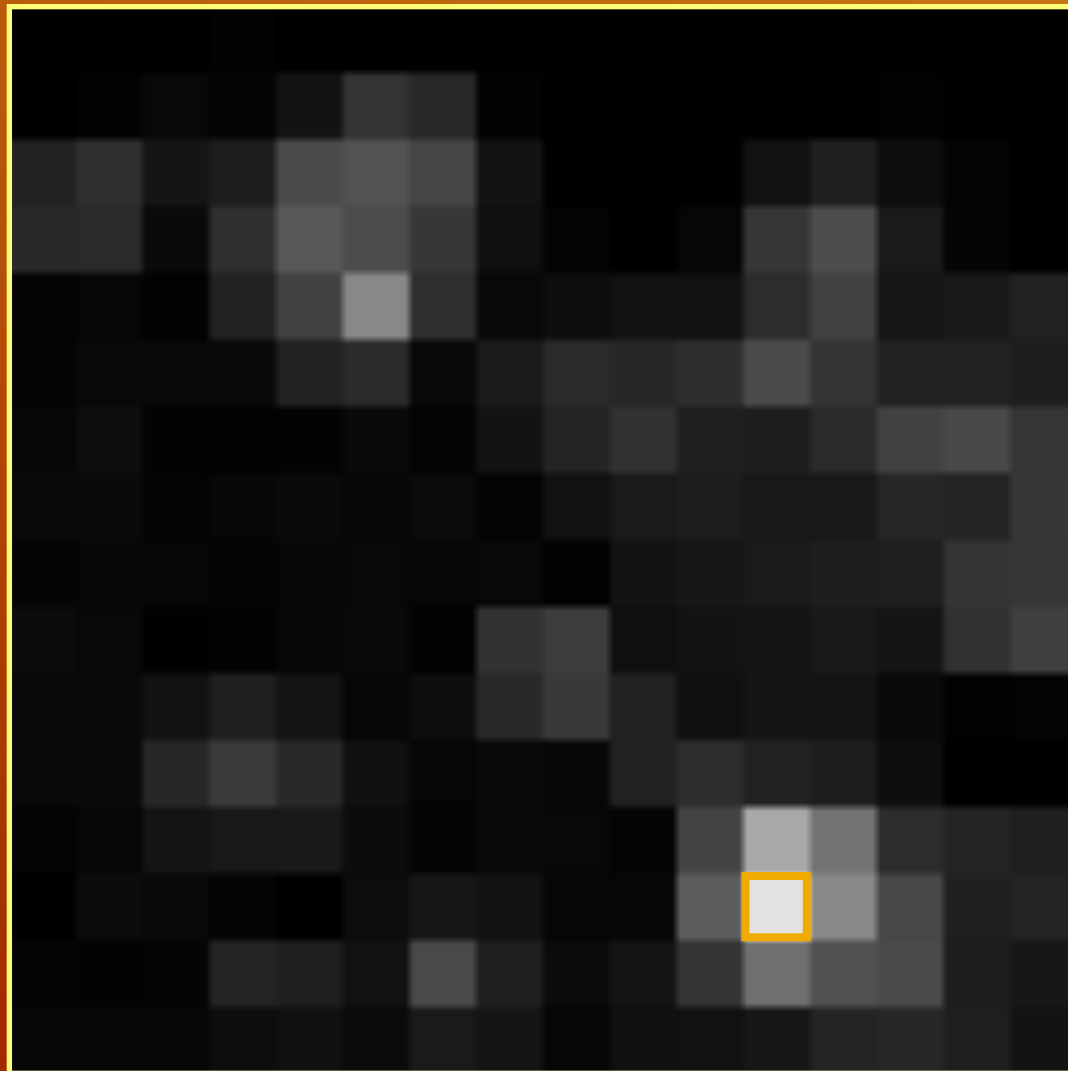
Grain Size = 4 x 4

Heterogeneity at different scales:



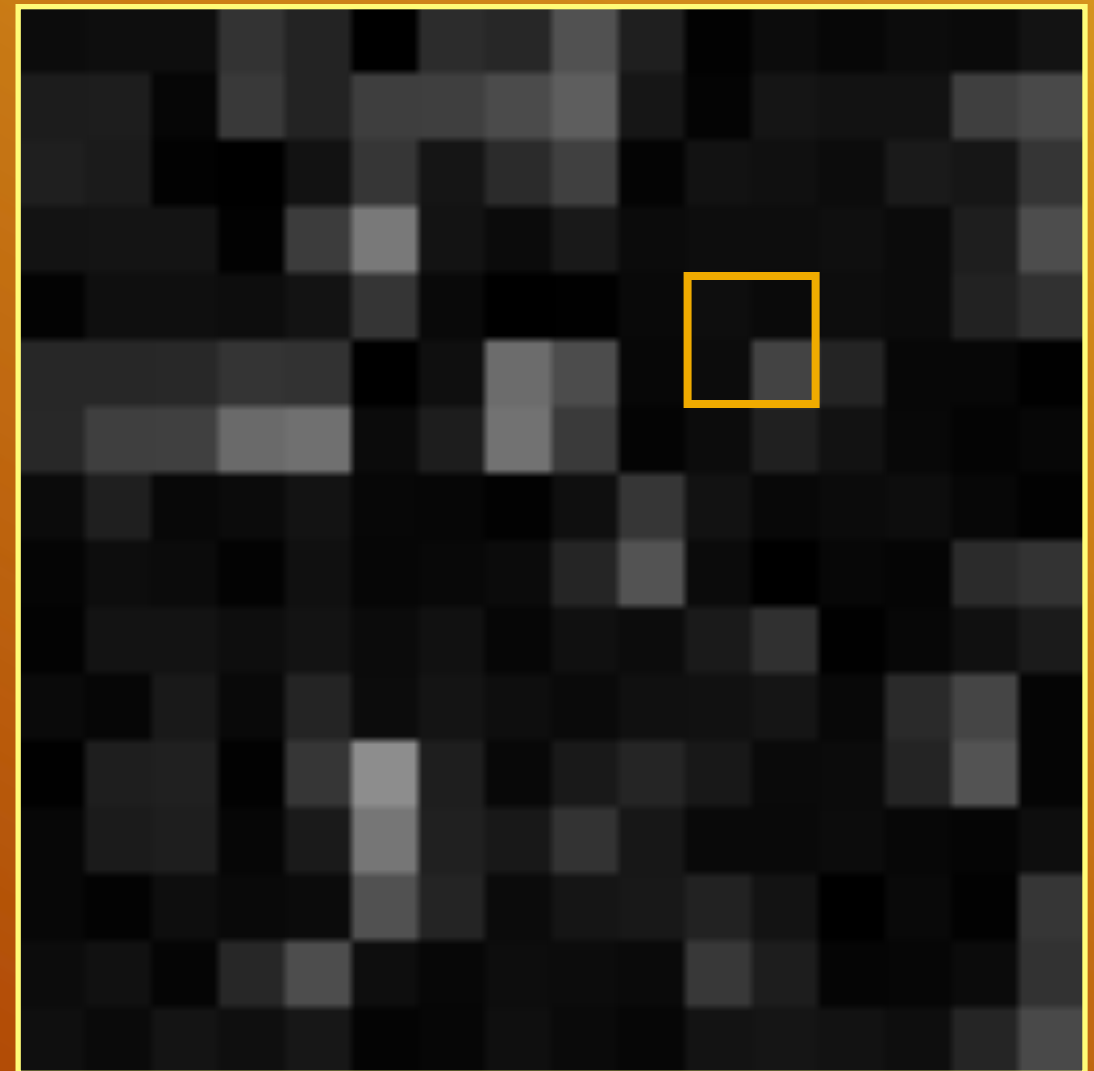
Grain Size = 4 x 4

Heterogeneity at different scales:



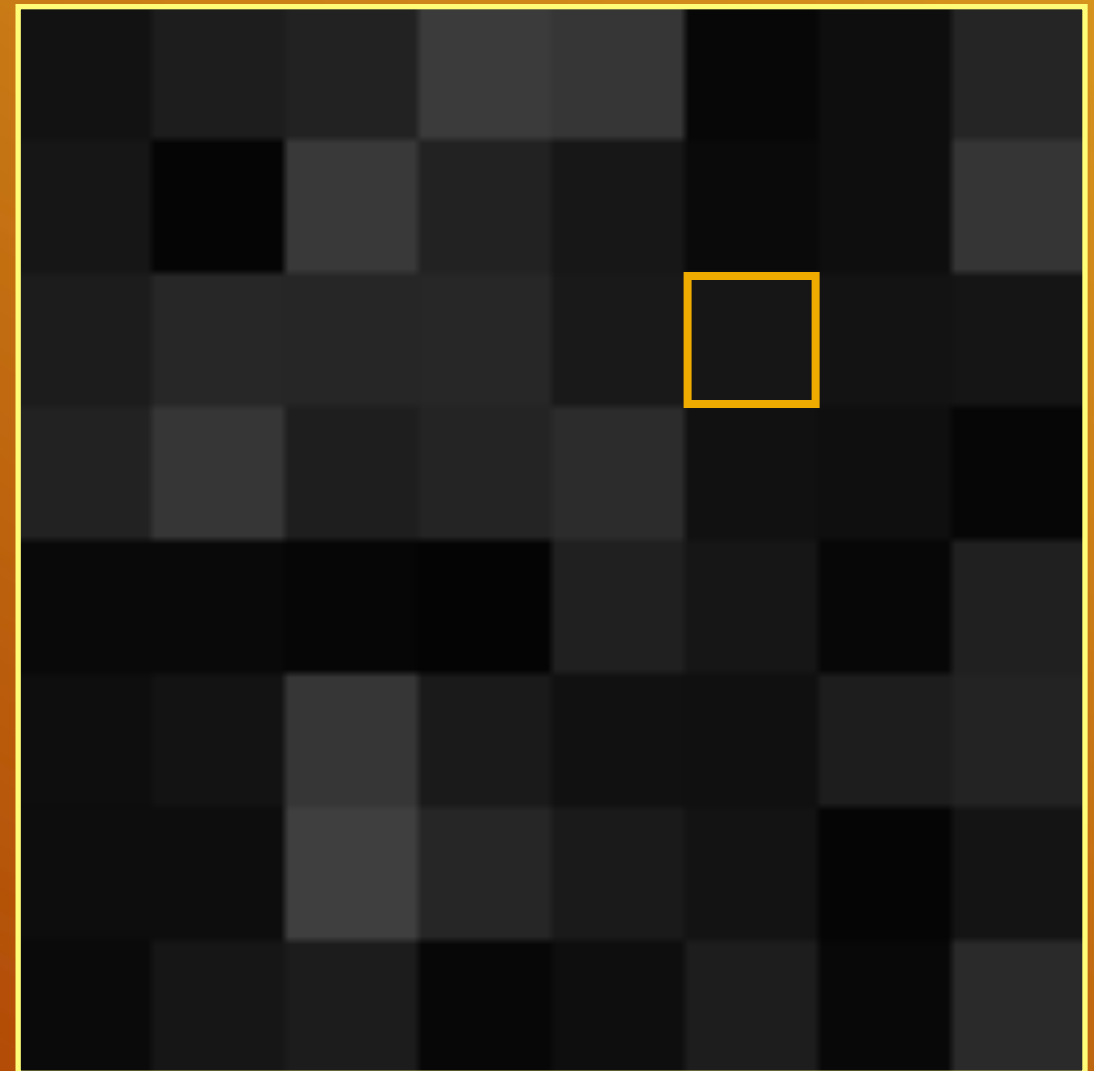
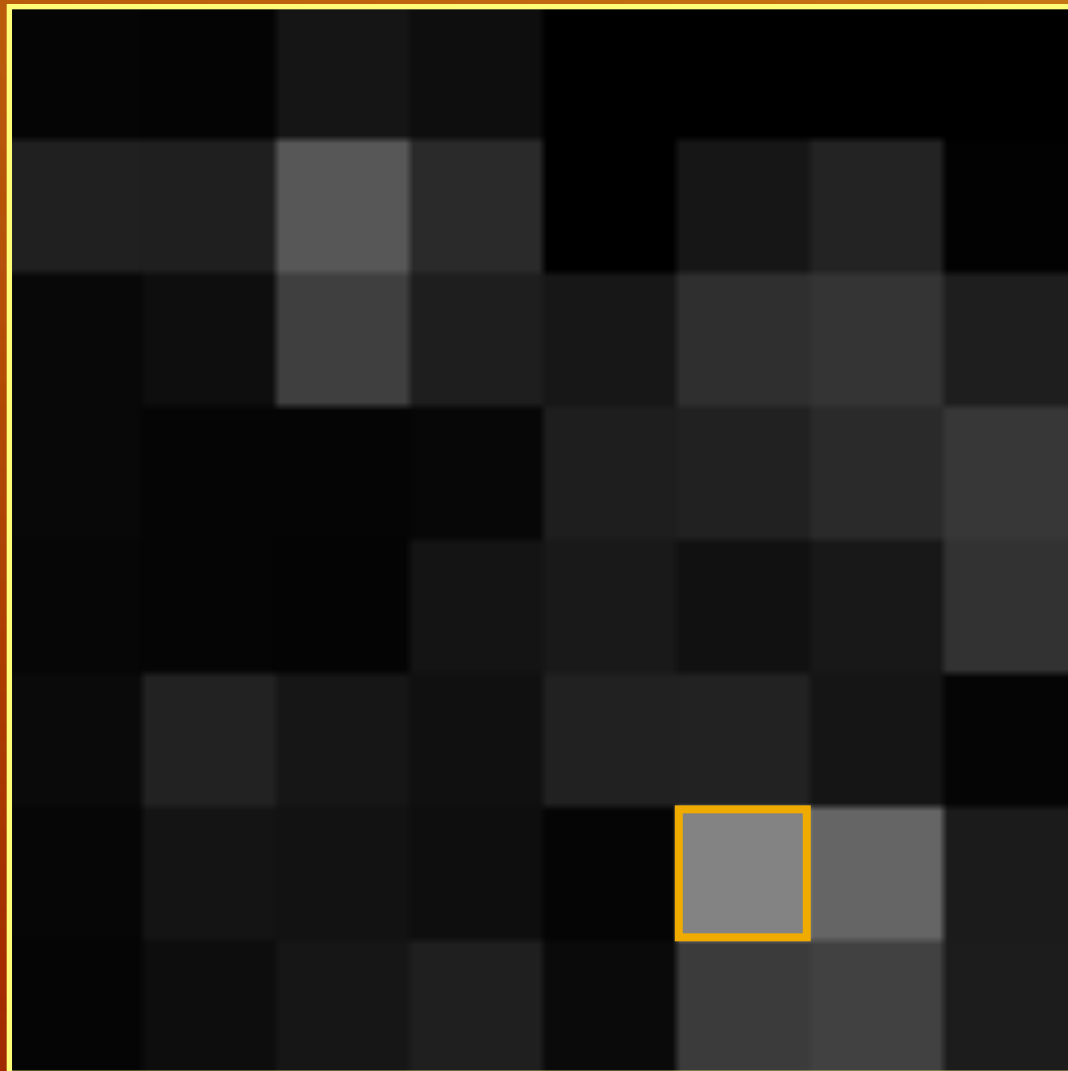
Grain Size = 8 x 8

Heterogeneity at different scales:



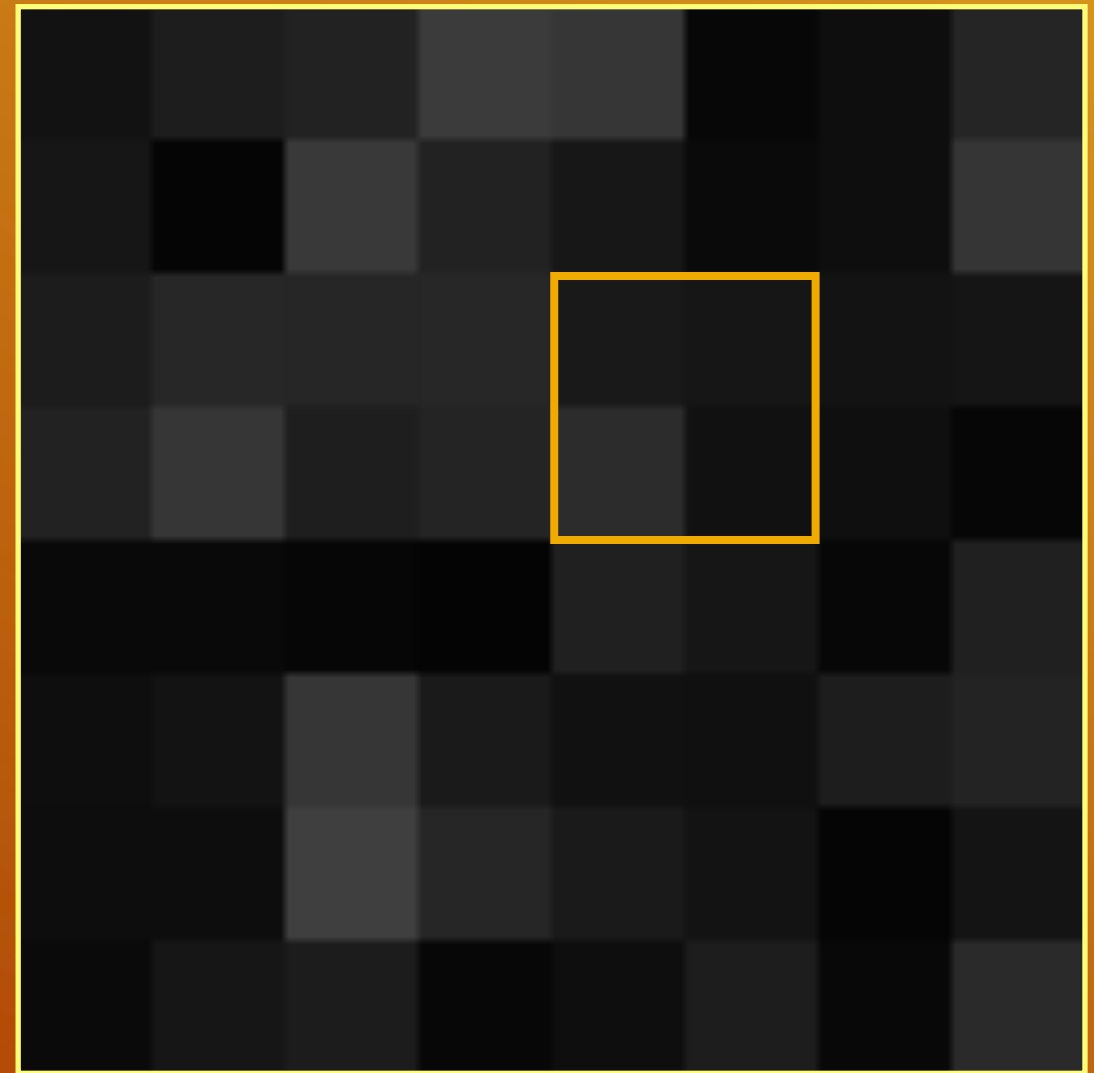
Grain Size = 8 x 8

Heterogeneity at different scales:



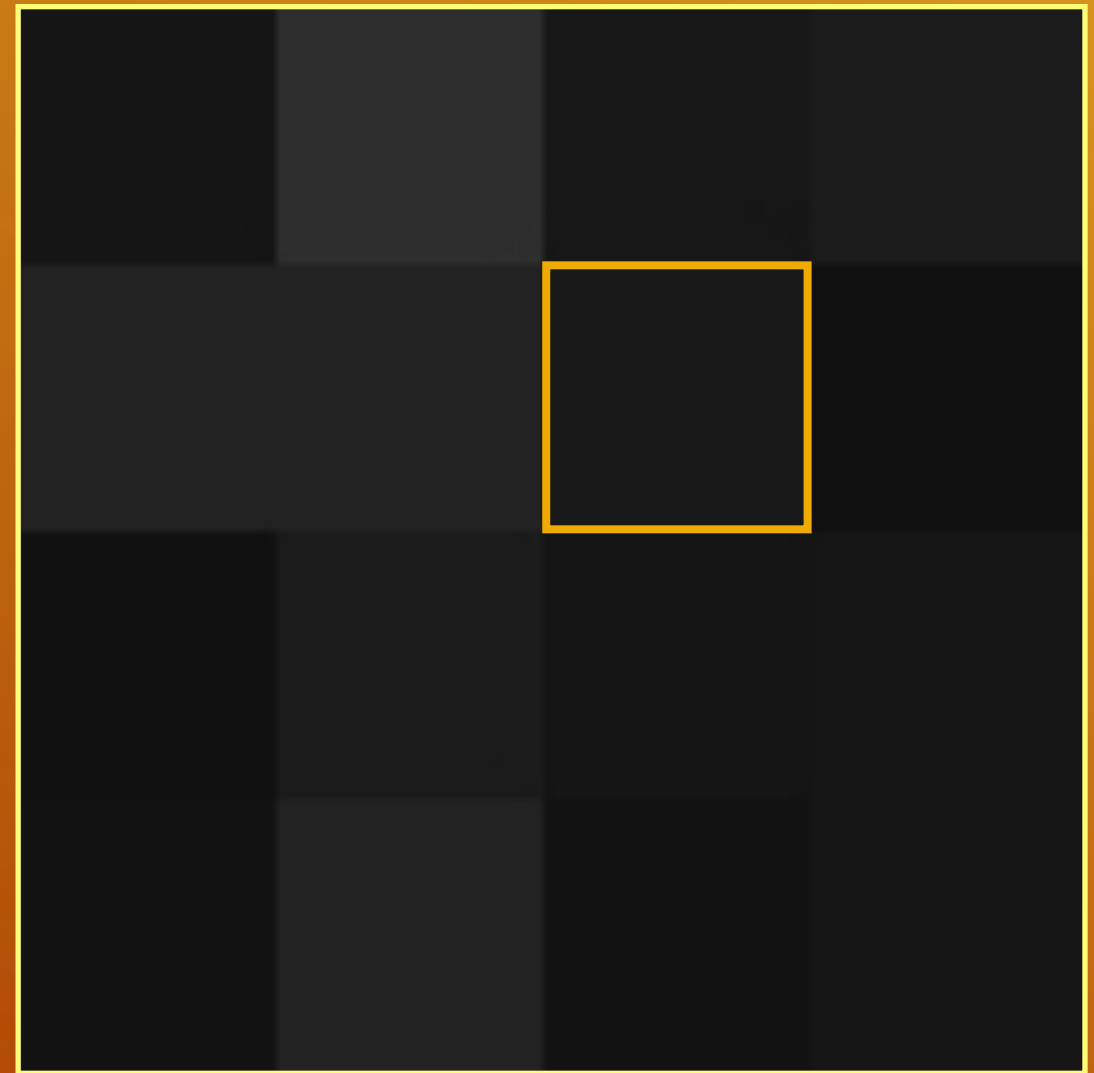
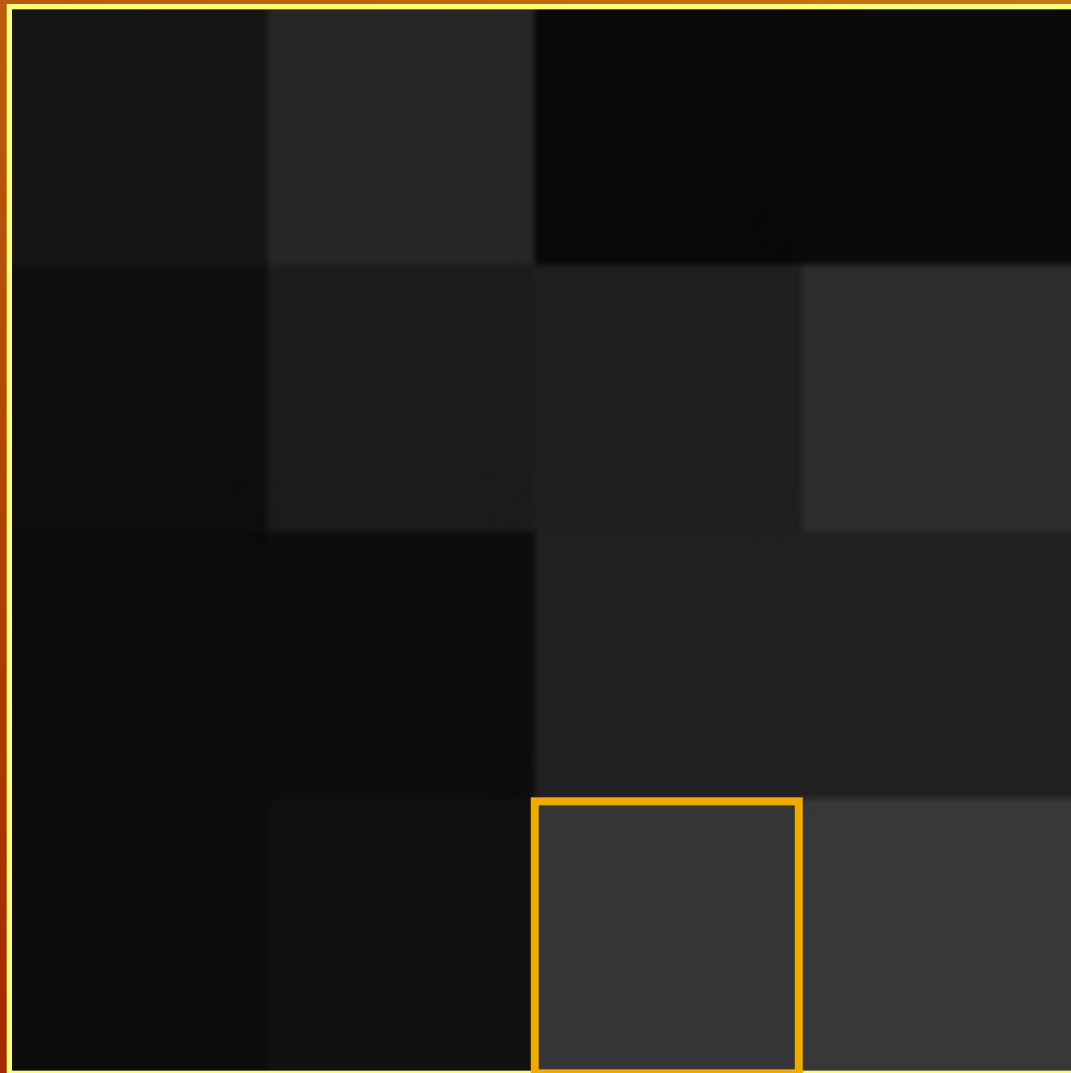
Grain Size = 16 x 16

Heterogeneity at different scales:



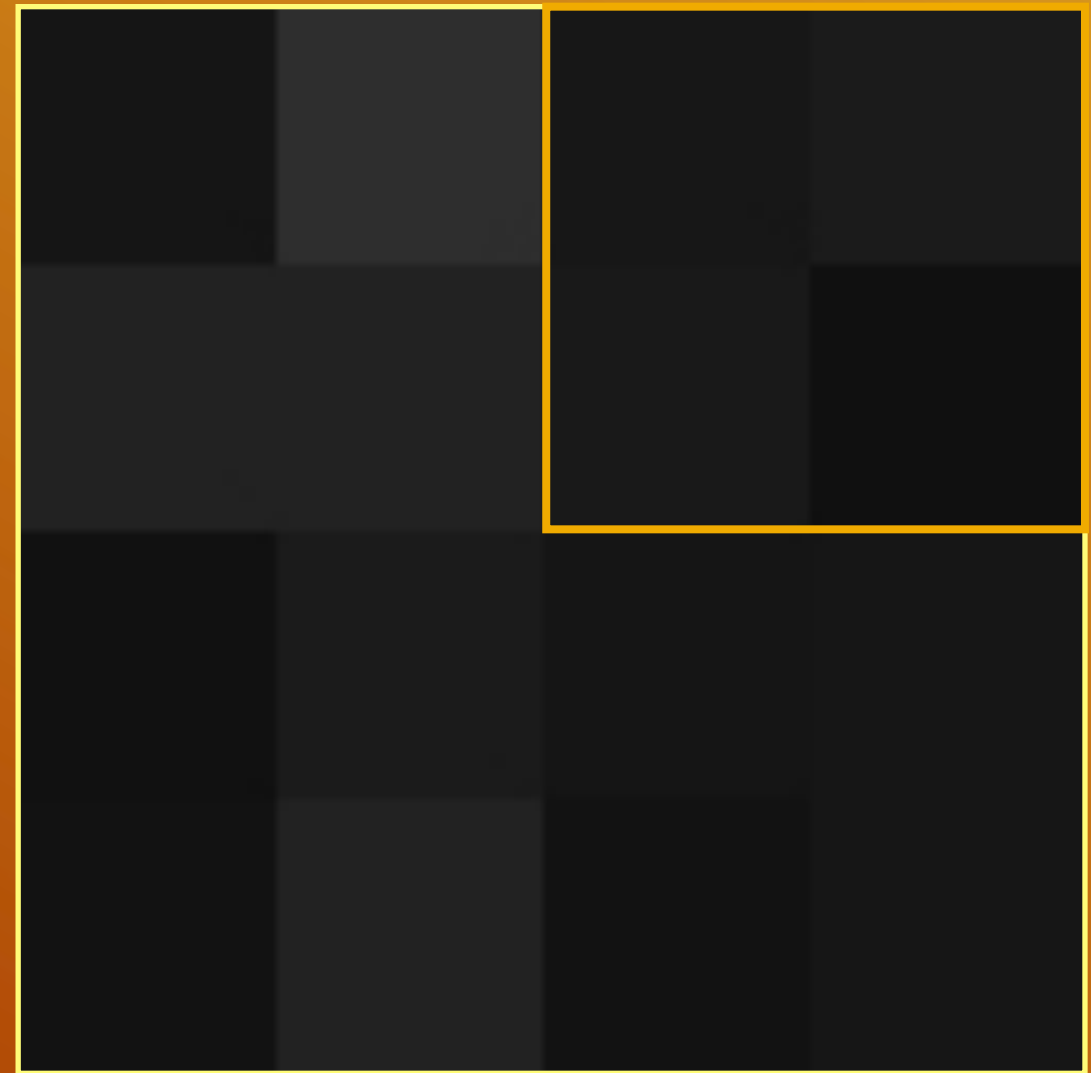
Grain Size = 16 x 16

Heterogeneity at different scales:



Grain Size = 32 x 32

Heterogeneity at different scales:



Grain Size = 32 x 32

Heterogeneity at different scales:



Grain Size = 64 x 64

What we really want to know:



When
we form groups
based on resource
heterogeneity, the
scale we really care
about is...

Question:

What scale (i.e. grain size) used to calculate heterogeneity best predicts emergent social phenomena?

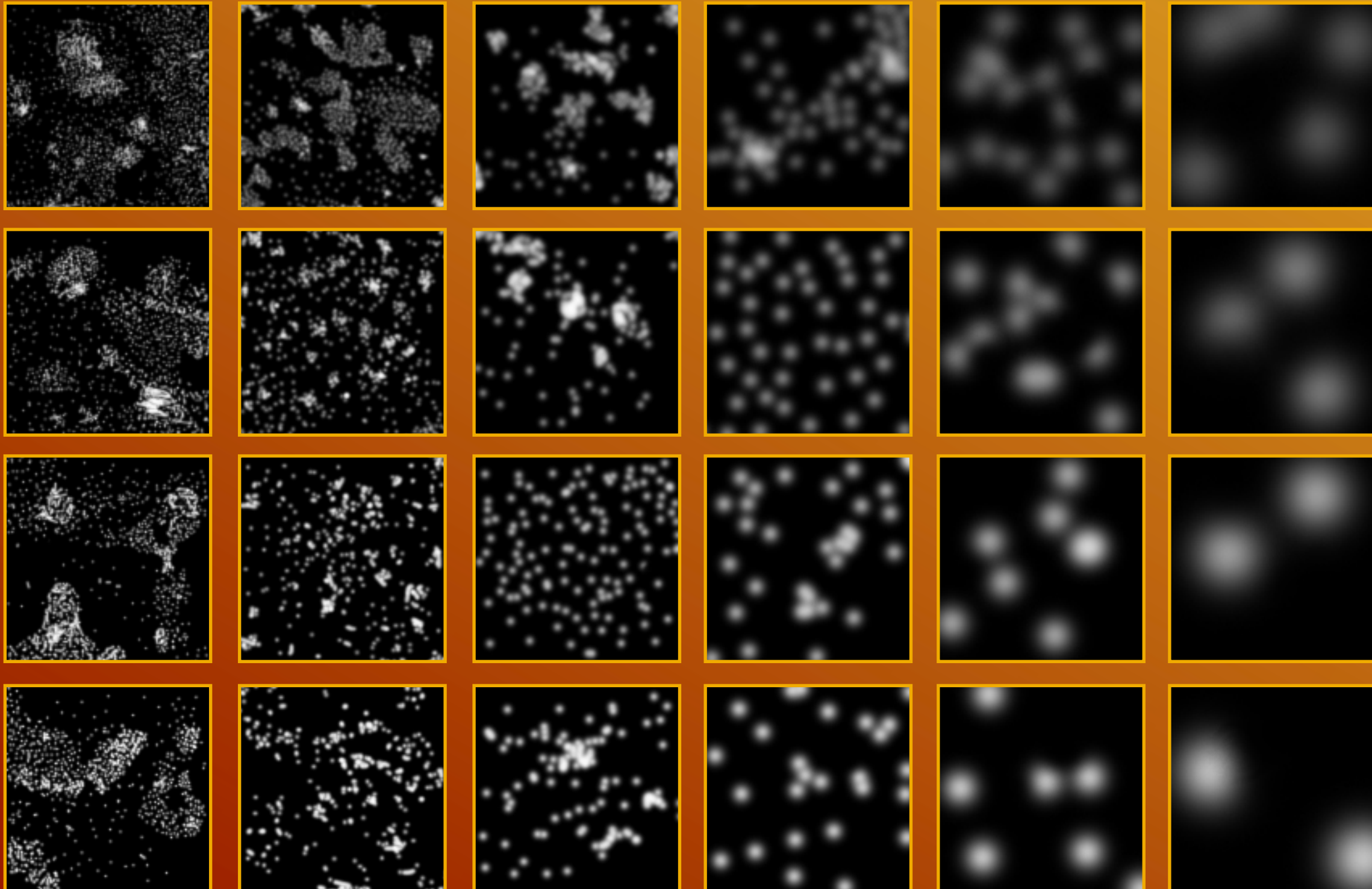
Hypotheses:

H₁: Intermediate grain sizes should best predict emergent social phenomena

H₂: If individuals have larger home ranges, the ideal grain size should increase

128x128 grids generated in Photoshop

Increasing patch size



Increasing per-patch food density

Why 128 x 128 landscapes?

Grain Size:

1x1

2x2

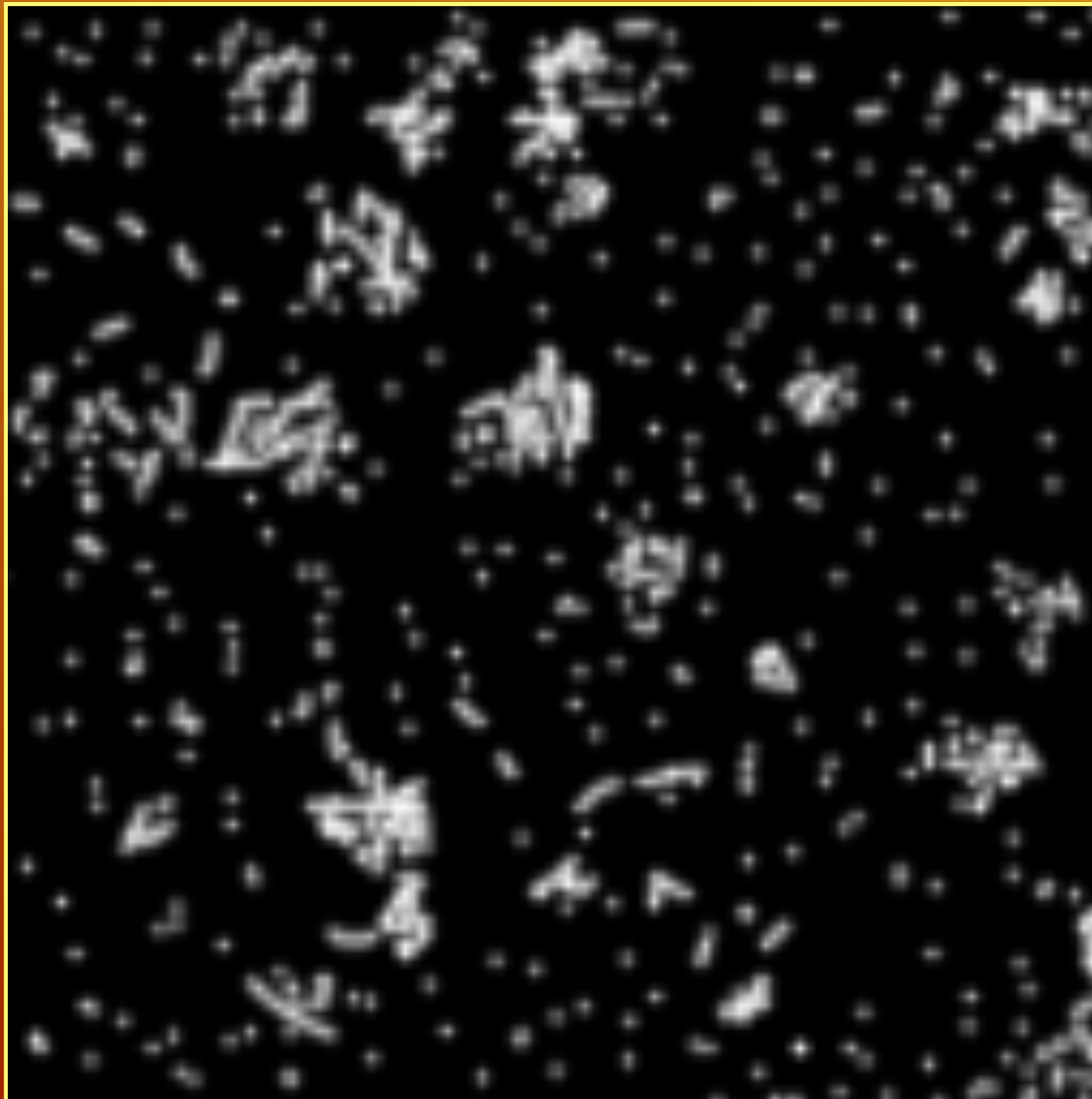
4x4

8x8

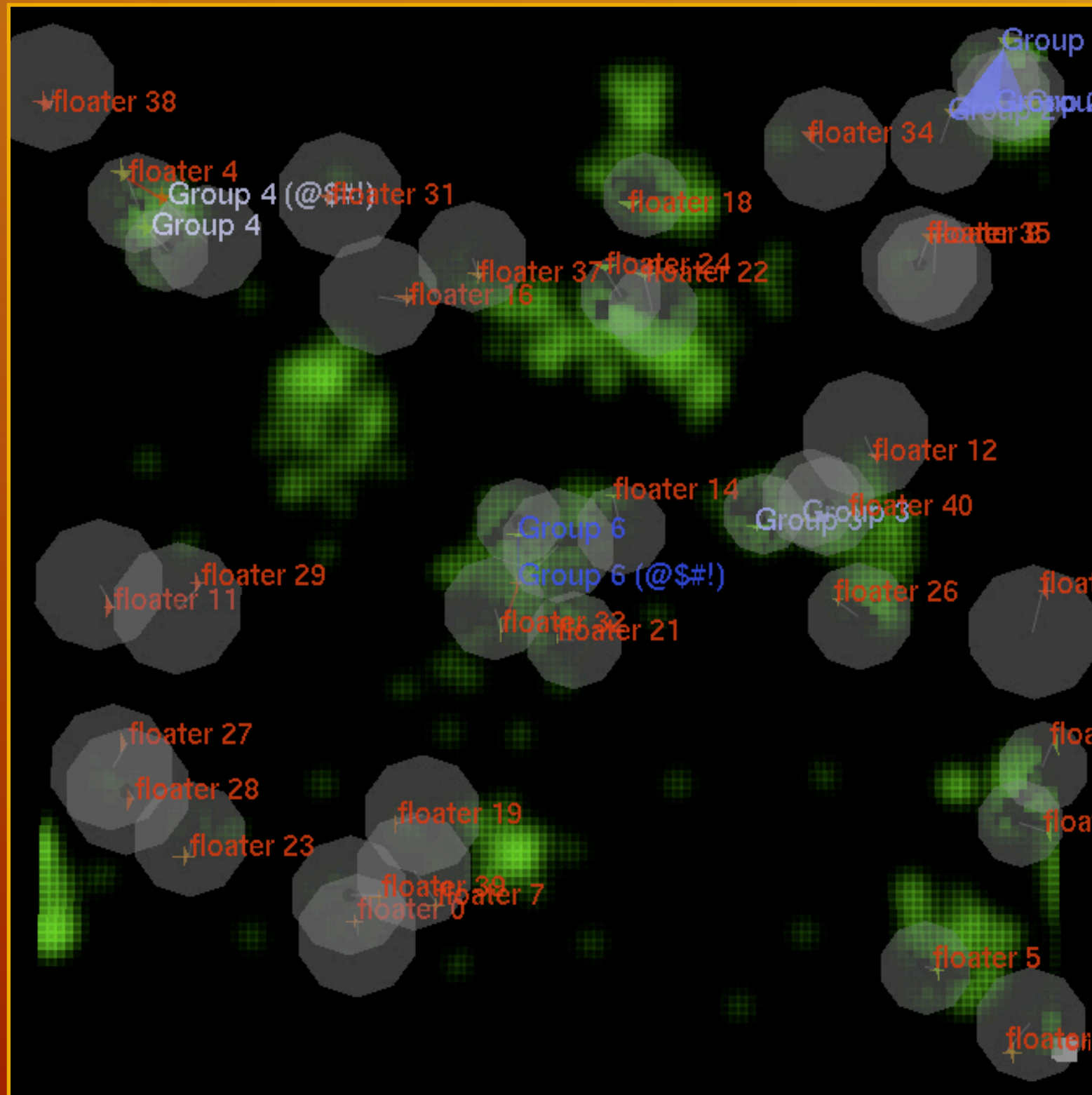
16x16

32x32

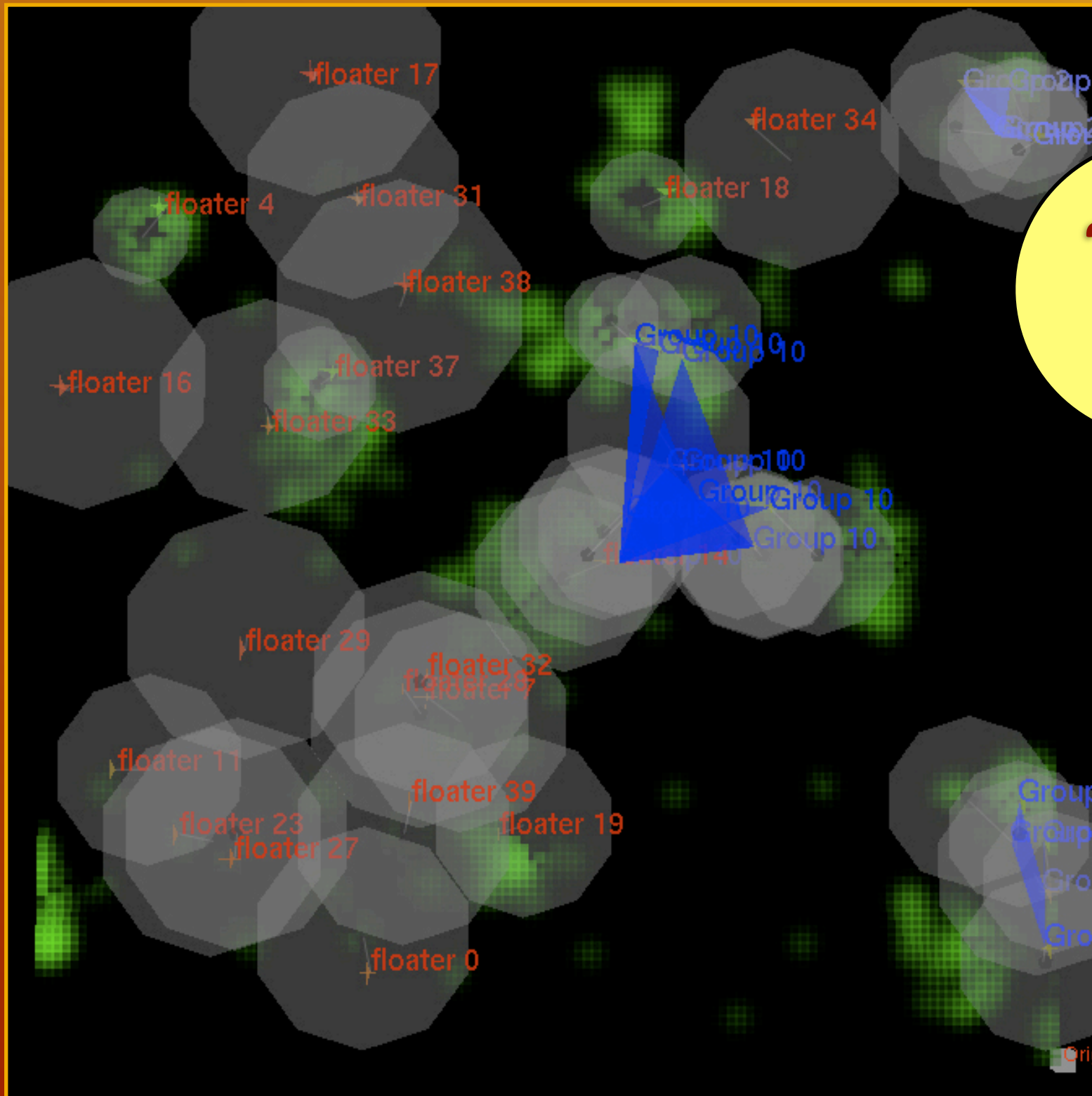
64x64



Varying Maximum Home Range Size:

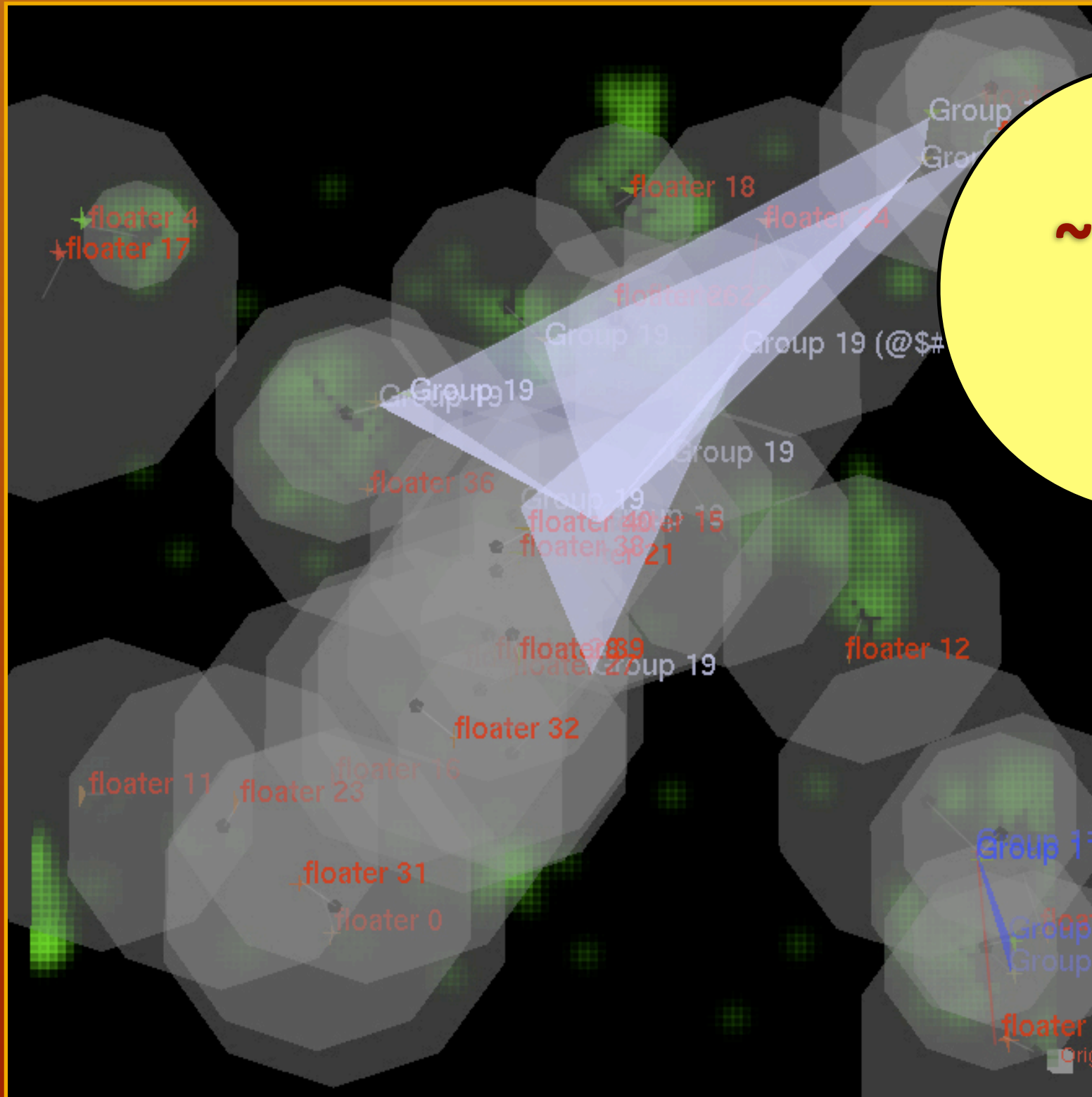


Varying Maximum Home Range Size:



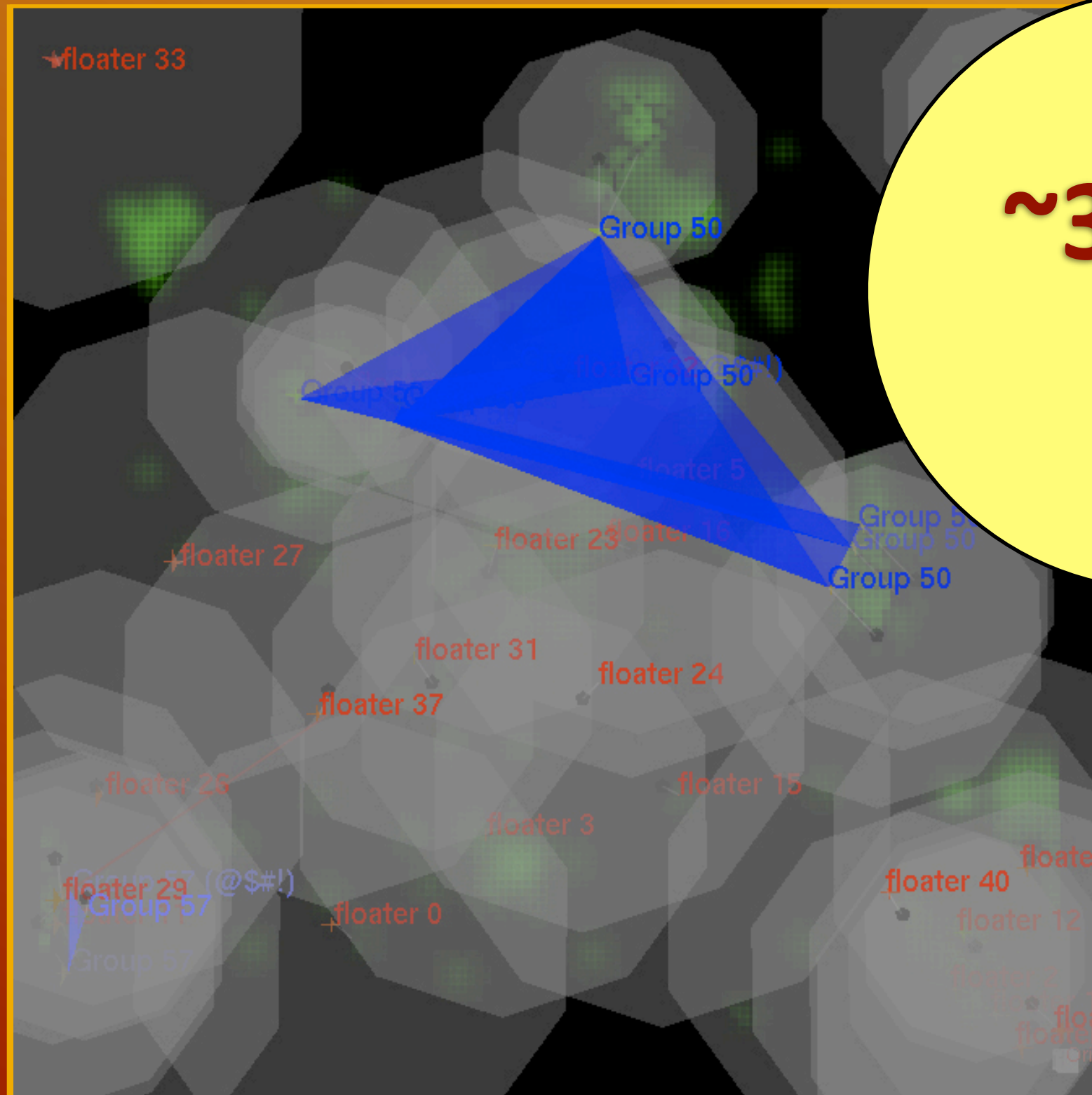
**~800
m²**

Varying Maximum Home Range Size:



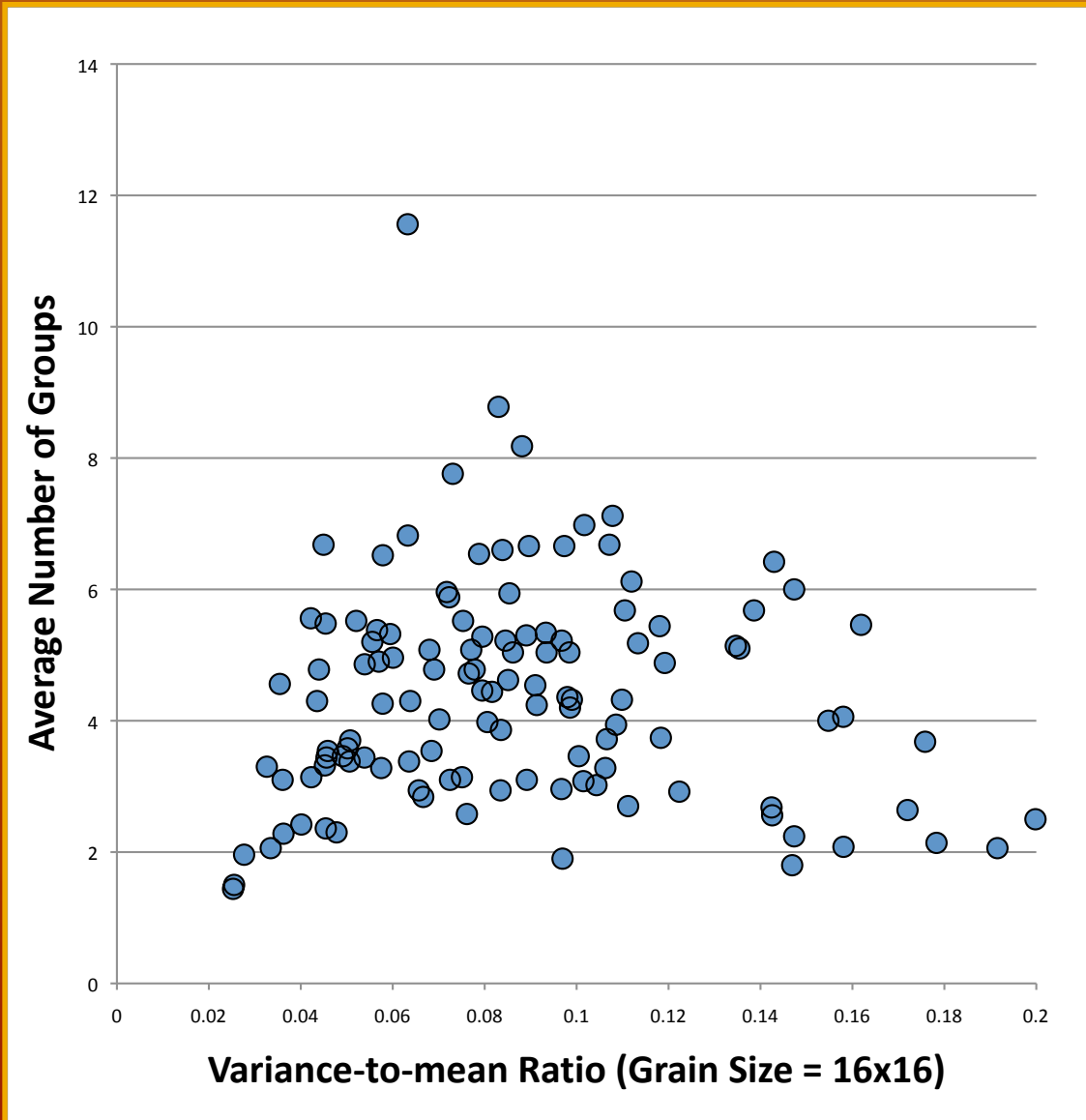
**~1,800
m²**

Varying Maximum Home Range Size:

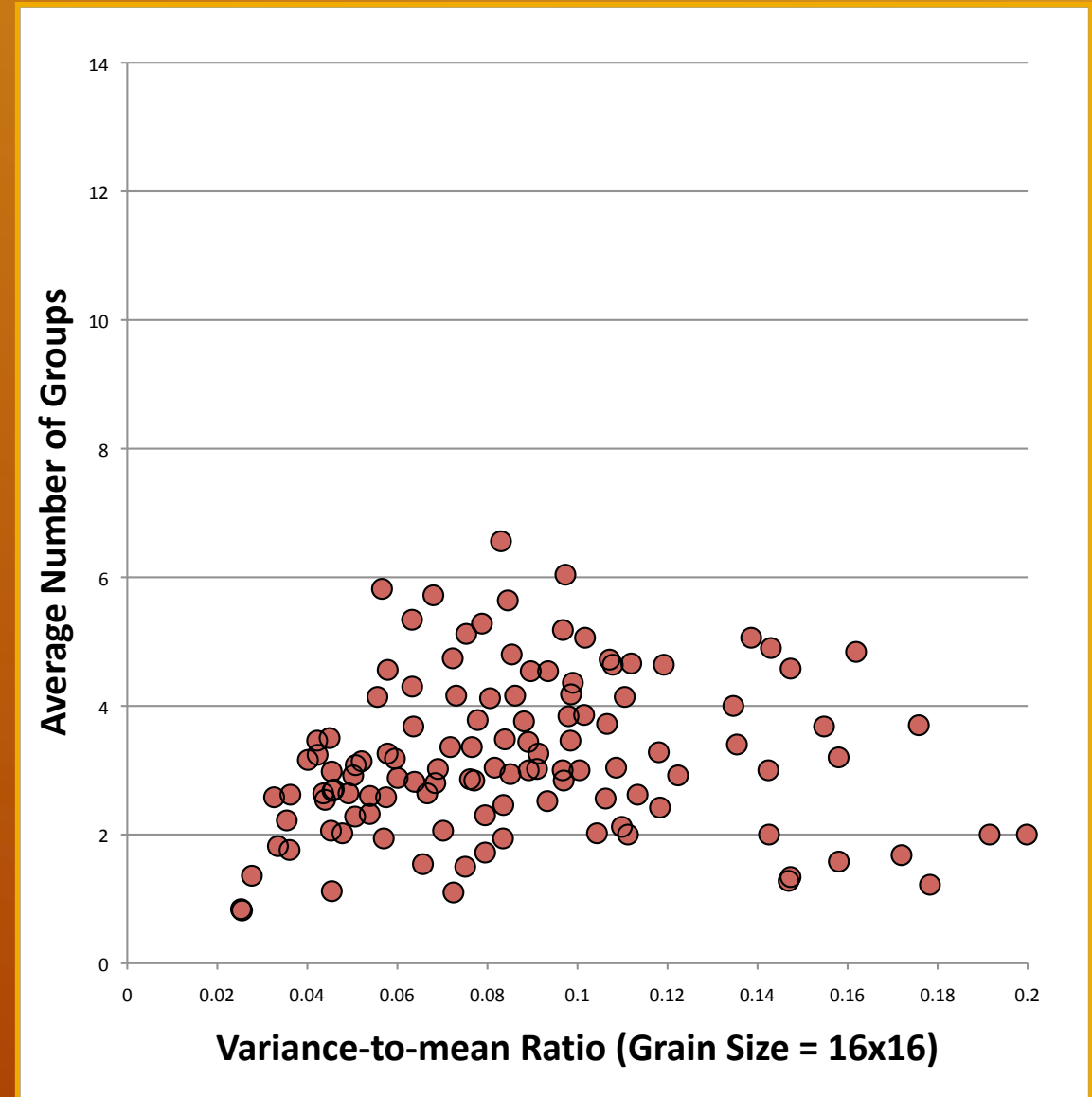


**~3,200
m²**

Using R^2 to determine the most informative scale of heterogeneity:



Max. Home Range Area = ~200



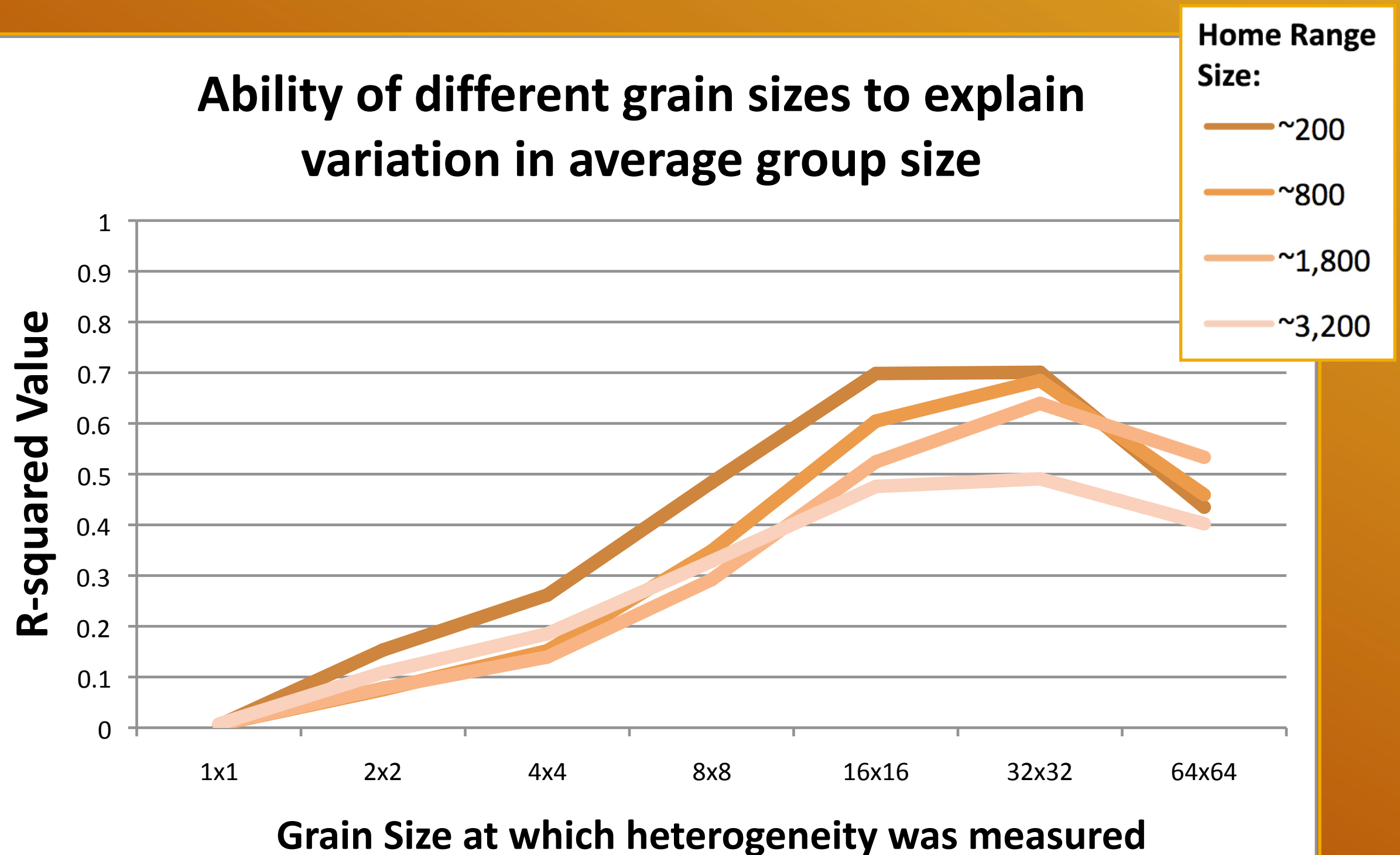
Max. Home Range Area = ~800

R^2 : Scale of Heterogeneity vs. Average Group Size

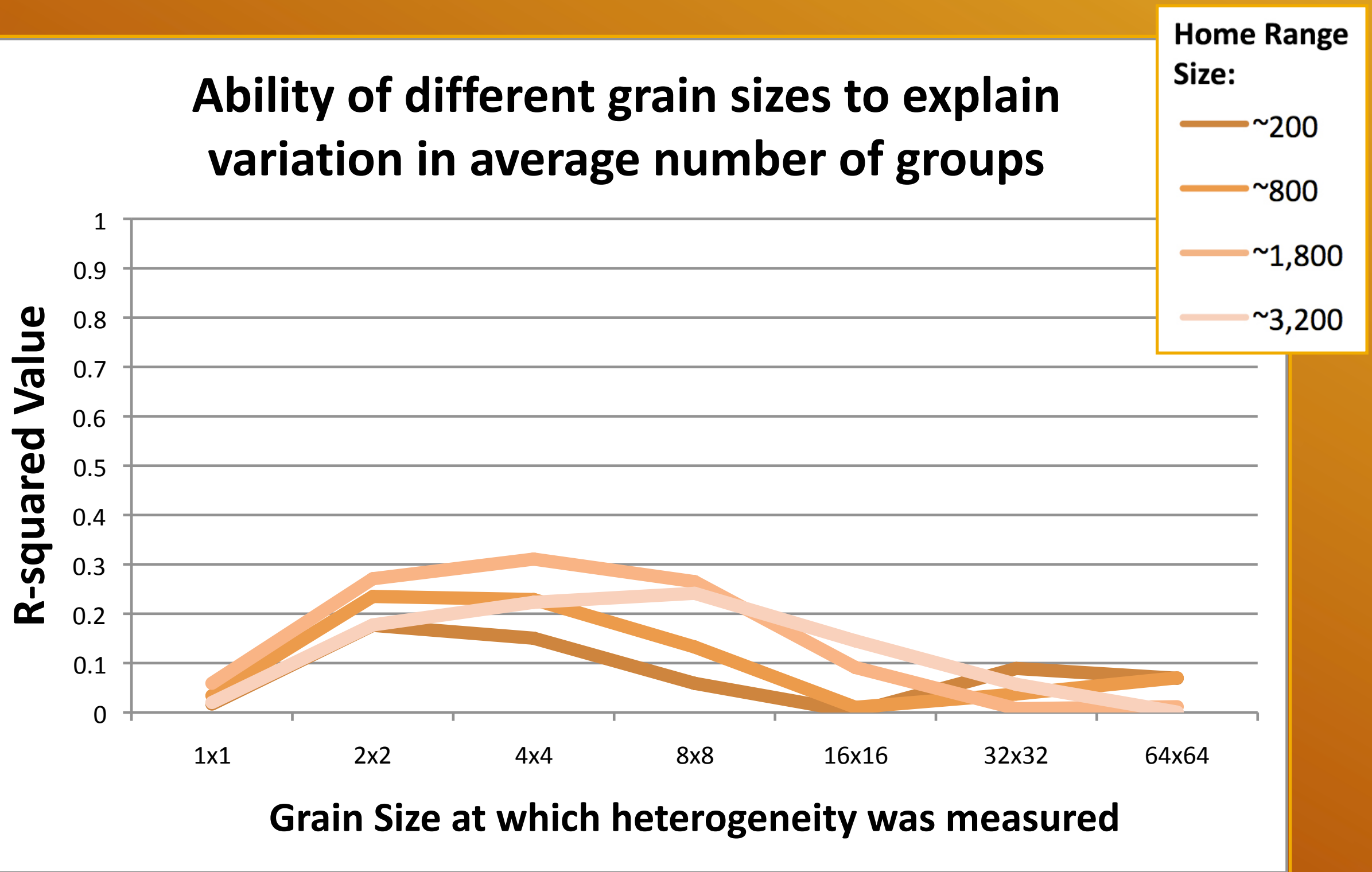
Grain Size at which heterogeneity was measured	Maximum Home Range Size			
	~200 m ²	~800 m ²	~1,800 m ²	~3,200 m ²
1x1	0.005 ^{NS}	0.006 ^{NS}	0.006 ^{NS}	0.007 ^{NS}
2x2	0.153 ^{***}	0.075 ^{**}	0.078 ^{**}	0.109 ^{**}
4x4	0.262 ^{***}	0.152 ^{***}	0.139 ^{***}	0.185 ^{***}
8x8	0.484 ^{***}	0.349 ^{***}	0.292 ^{***}	0.328 ^{***}
16x16	0.698 ^{***}	0.605 ^{***}	0.524 ^{***}	0.476 ^{***}
32x32	0.701 ^{***}	0.685 ^{***}	0.640 ^{***}	0.491 ^{***}
64x64	0.435 ^{***}	0.459 ^{***}	0.533 ^{***}	0.402 ^{***}

**** = $P < 0.01$, *** = $P < 0.001$**

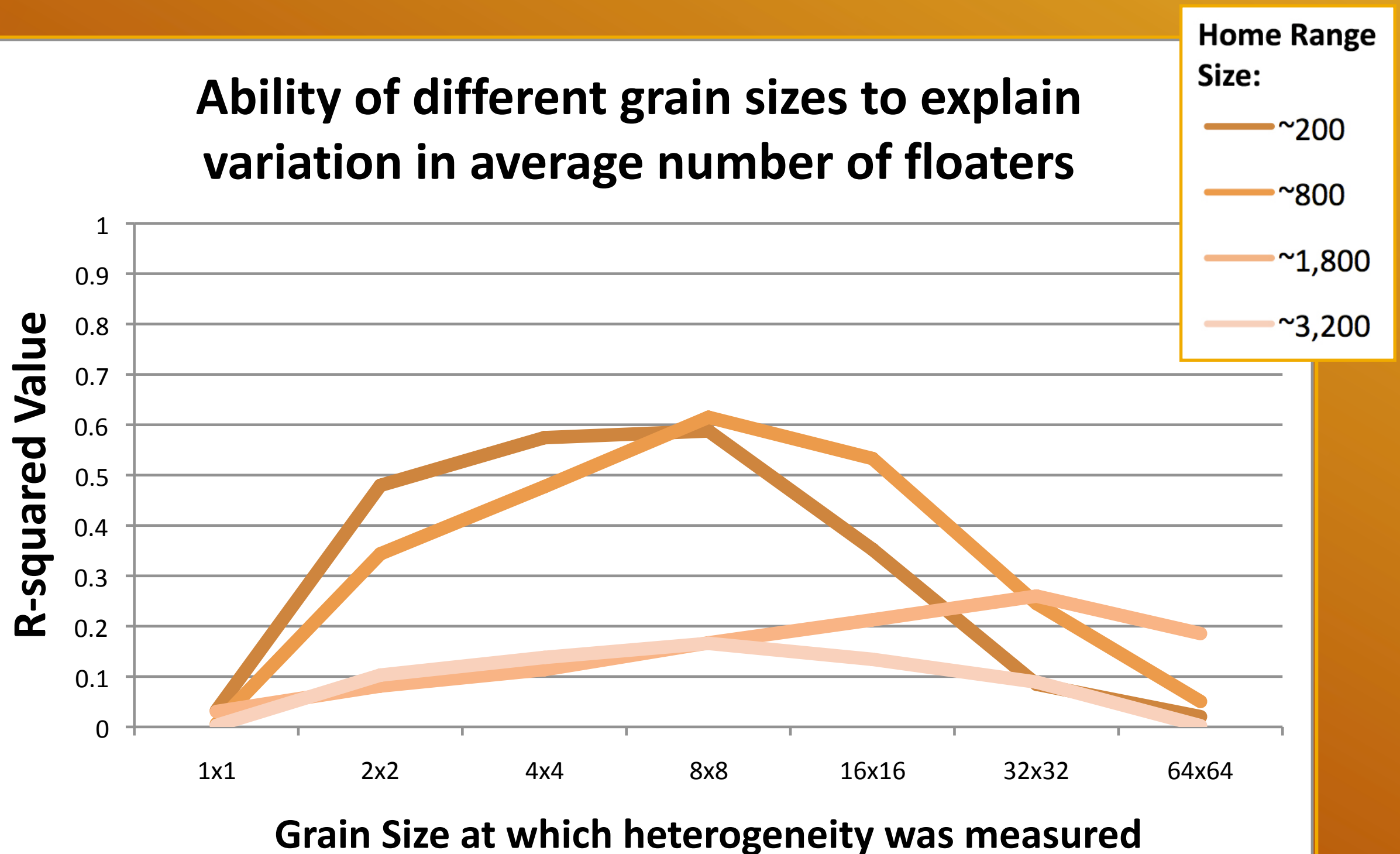
R^2 : Scale of Heterogeneity vs. Average Group Size



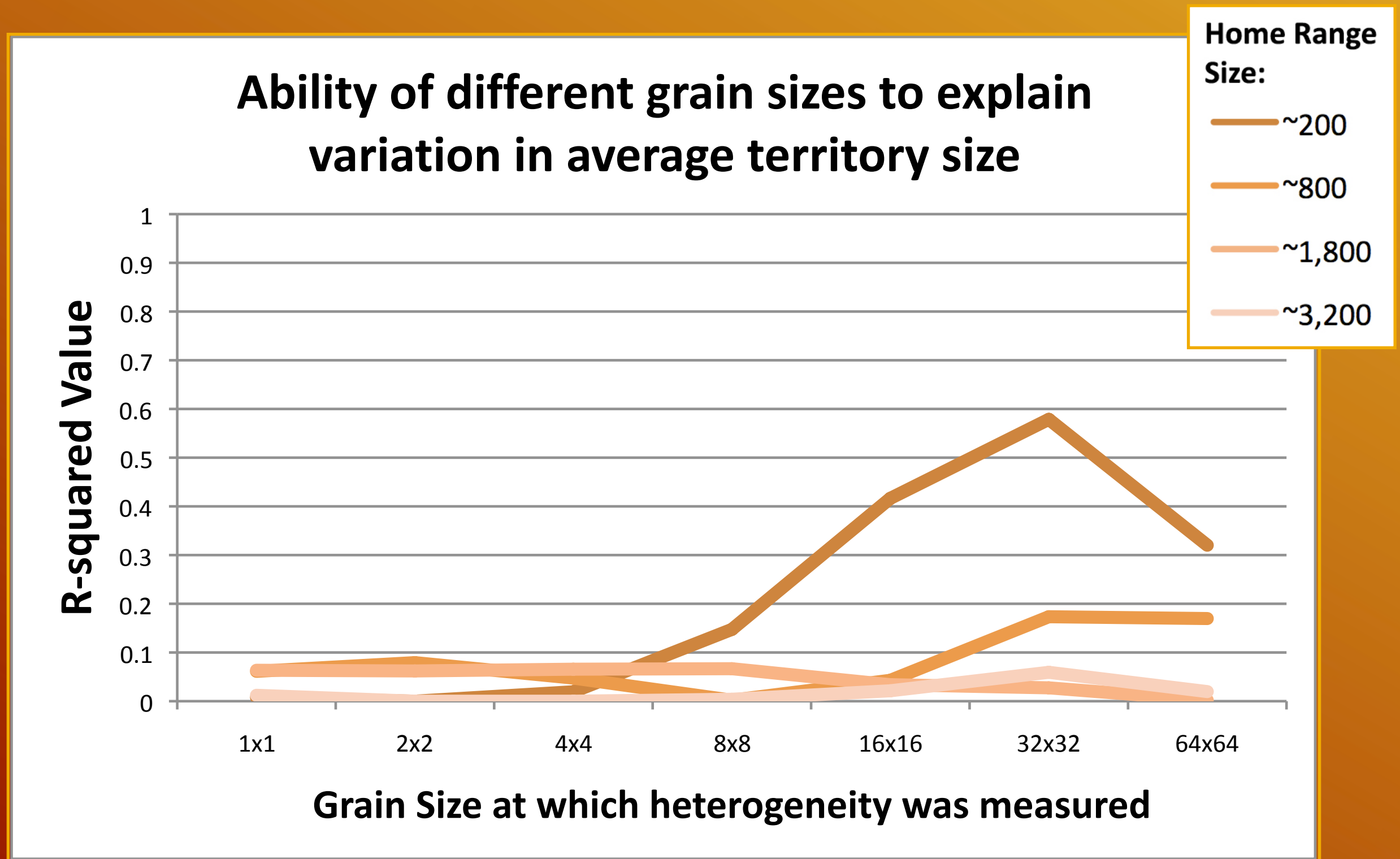
R^2 : Scale of Heterogeneity vs. Number of Groups



R^2 : Scale of Heterogeneity vs. Number of Floaters



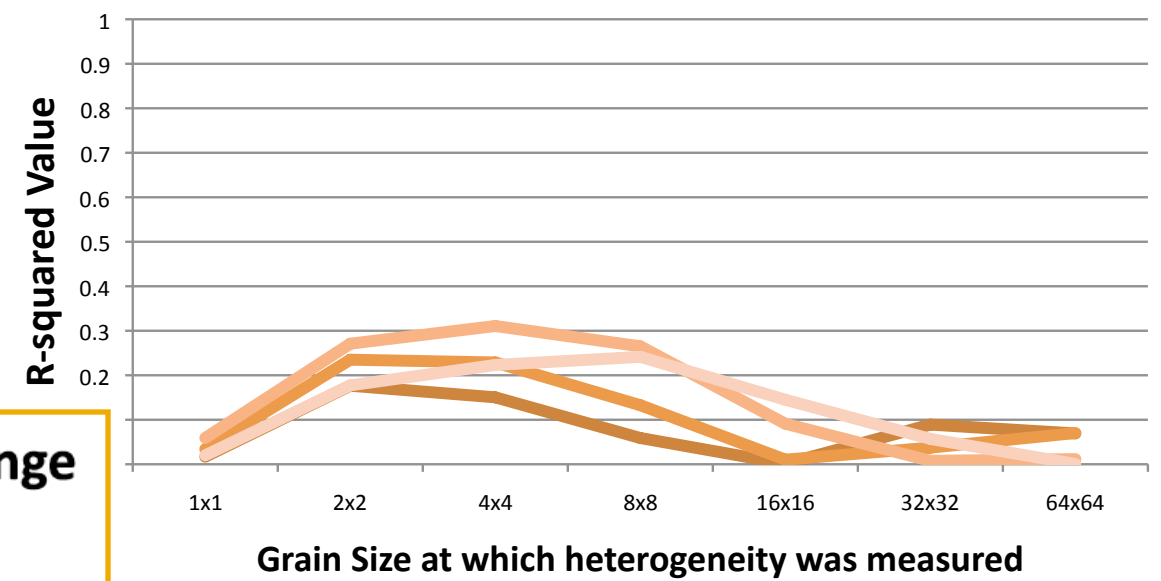
R^2 : Scale of Heterogeneity vs. Average Territory Size



Ability of different grain sizes to explain variation in average group size



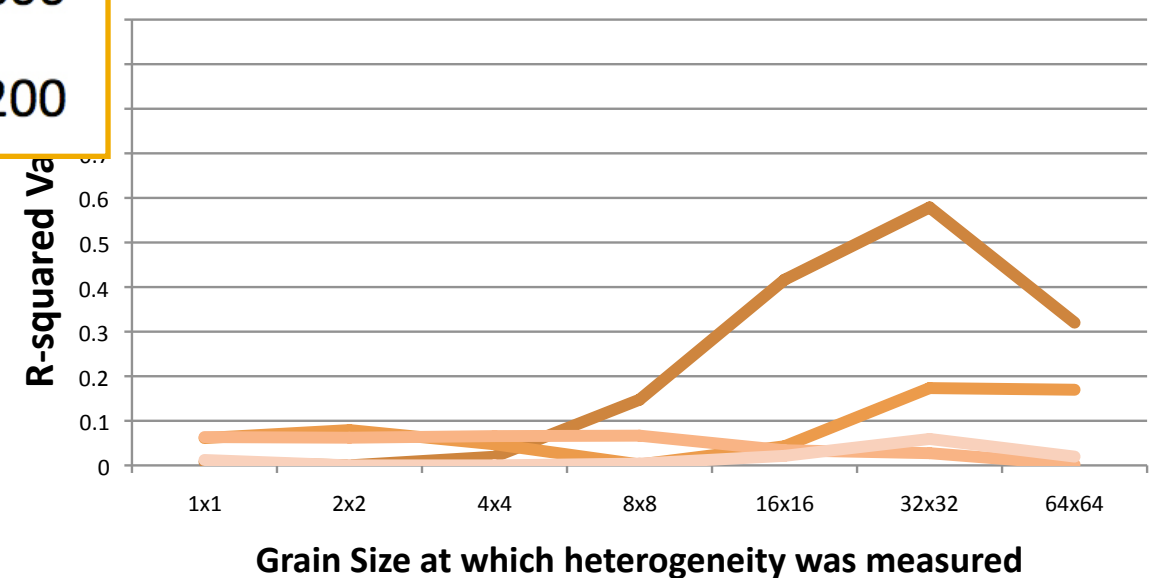
Ability of different grain sizes to explain variation in average number of groups



Ability of different grain sizes to explain variation in average number of floaters



Ability of different grain sizes to explain variation in average territory size



Home Range Size:

- ~200
- ~800
- ~1,800
- ~3,200

Conclusions:

- ★ Choosing the “right” scale of heterogeneity is critical to explaining emergent social phenomena
- ★ Not all emergent social phenomena are equally well-explained by heterogeneity
- ★ The scale of heterogeneity that best predicts variation in emergent social phenomena can be specific to each particular phenomenon
- ★ Varying the potential home range size of individuals affects the ability of heterogeneity to explain emergent social phenomena

Practical Applications:

- ★ Furthers our understanding of how landscape features influence emergent social phenomena
- ★ Allows us to consider the role of scale in influencing emergent social phenomena
- ★ Provides a simulation with the power to inform field work: helping field ecologists decide at what scale(s) to measure heterogeneity

Questions?

**Additional information on this research project and
my other work and interests can be found at:**

www.christopherxjjensen.com