

# Are Ecological Receptors Sufficiently Site-Exposed To Matter? – What Deer Have To Say

**U.S. Army Center for  
Health Promotion  
and Preventive Medicine**

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**FY 08 ARMY  
IRP/MMRP  
Workshop**

**December 4, 2007**



# To Seriously Consider . . .

- Some ecological receptors of concern might not be sufficiently exposed to contaminated site media such that they can develop toxicological endpoints.
- If our premise is correct -- **i.e., that they are not sufficiently exposed** -- we might not need to concern ourselves with site remediation/restoration efforts for the protection of these receptors

# Background to this tracking study:

- **The “Problem”**: Commonly in ERAs, receptors known to have relatively large (if not vast) home ranges, are assessed at miniscule sites.
- ERAs could be significantly streamlined, if they would recognize that many commonly evaluated receptors are spatially irrelevant.
- **Risk =  $f(\text{toxicity}; \text{exposure})$**

# Background to this tracking study:

- *on paper* we know enough to justifiably screen out receptors (Two Simple Algorithms for Refining Mammalian Receptor Selection in Ecological Risk Assessments. IEAM, 1:290-298).
- **How about a field-based demonstration (of spatial irrelevance) to convince the skeptics? . . .**

# A most simple experimental design

1. Collar White-tailed deer (*Odocoileus virginianus*), an acknowledged “**cross-over species**” in health risk assessment, with state-of-the art GPS-based (satellite-tracking) location monitoring equipment.
2. Allow deer to roam freely for an entire calendar year, sampling at a respectable and highly utilitarian rate (*but not, of course, at the expense of precious battery life!*).
3. Plot the many recorded locations.
4. “Grid” animal-specific home ranges, to see how much of an animal’s time is spent at contaminated site-sized areas.

# experimental design, cont'd.

- We used female deer only - for two reasons:
  1. females have a smaller home ranges than do males
  2. to stay within budget; we had another experimental variable, namely habitat
- our “sampling” rates:

|                     |                         |
|---------------------|-------------------------|
| Feb. 1 to March 31: | <b>24</b> locations/day |
| April 1 to July 31: | <b>32</b> locations/day |
| Aug. 1 to Sept. 30: | <b>24</b> locations/day |
| Oct. 1 to Jan. 31:  | <b>32</b> locations/day |

**We had an 85% fix rate overall!!**







rocket net, set to go off



baiting a clover trap



tranquilized

slips right on . . .





**Looks like a 3 year old, wouldn't you say?**

**“Hey, now this is  
really neat!!!”**



**(Actual quote from #167)**

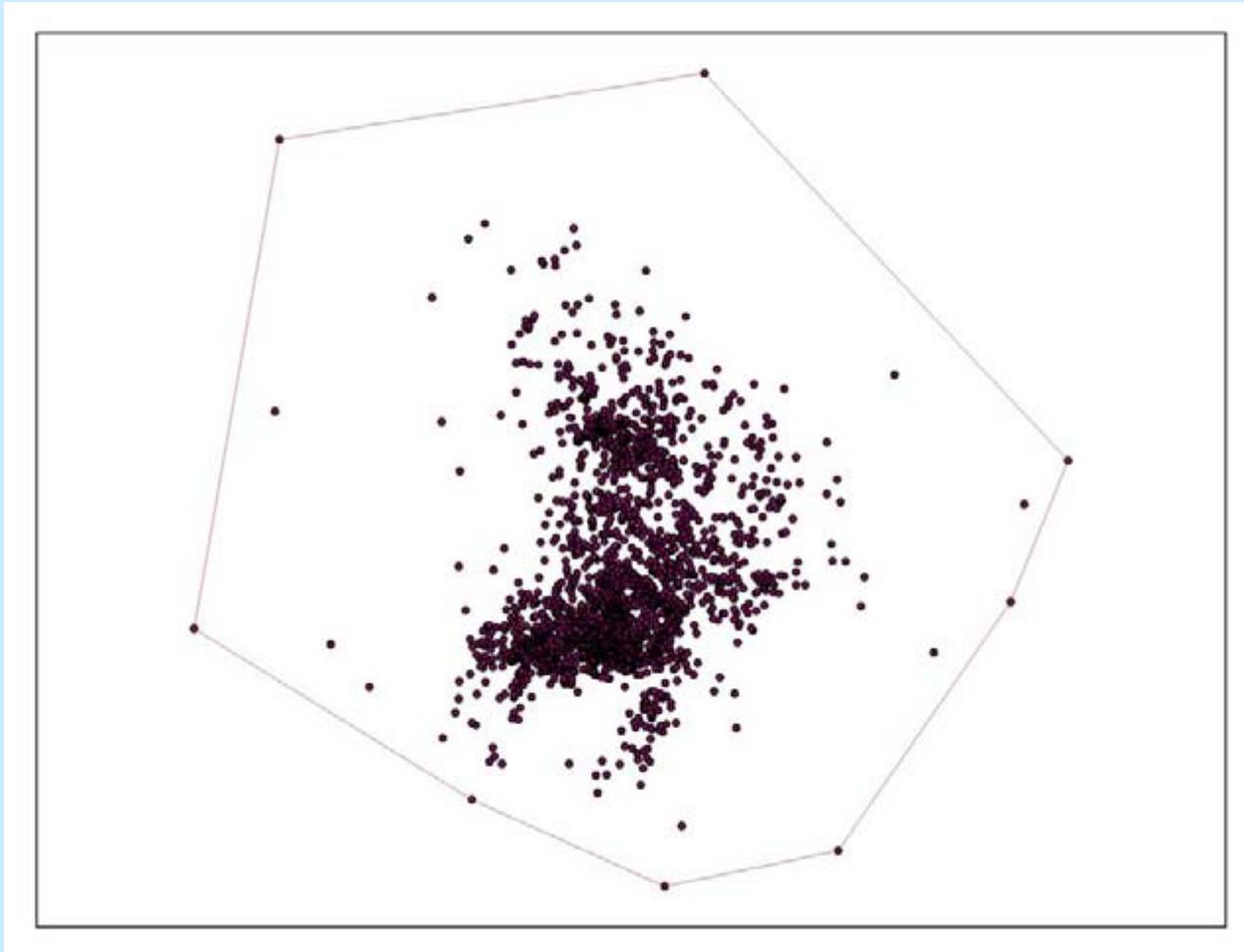


**Delaware Highlands,  
Sussex County, DE**

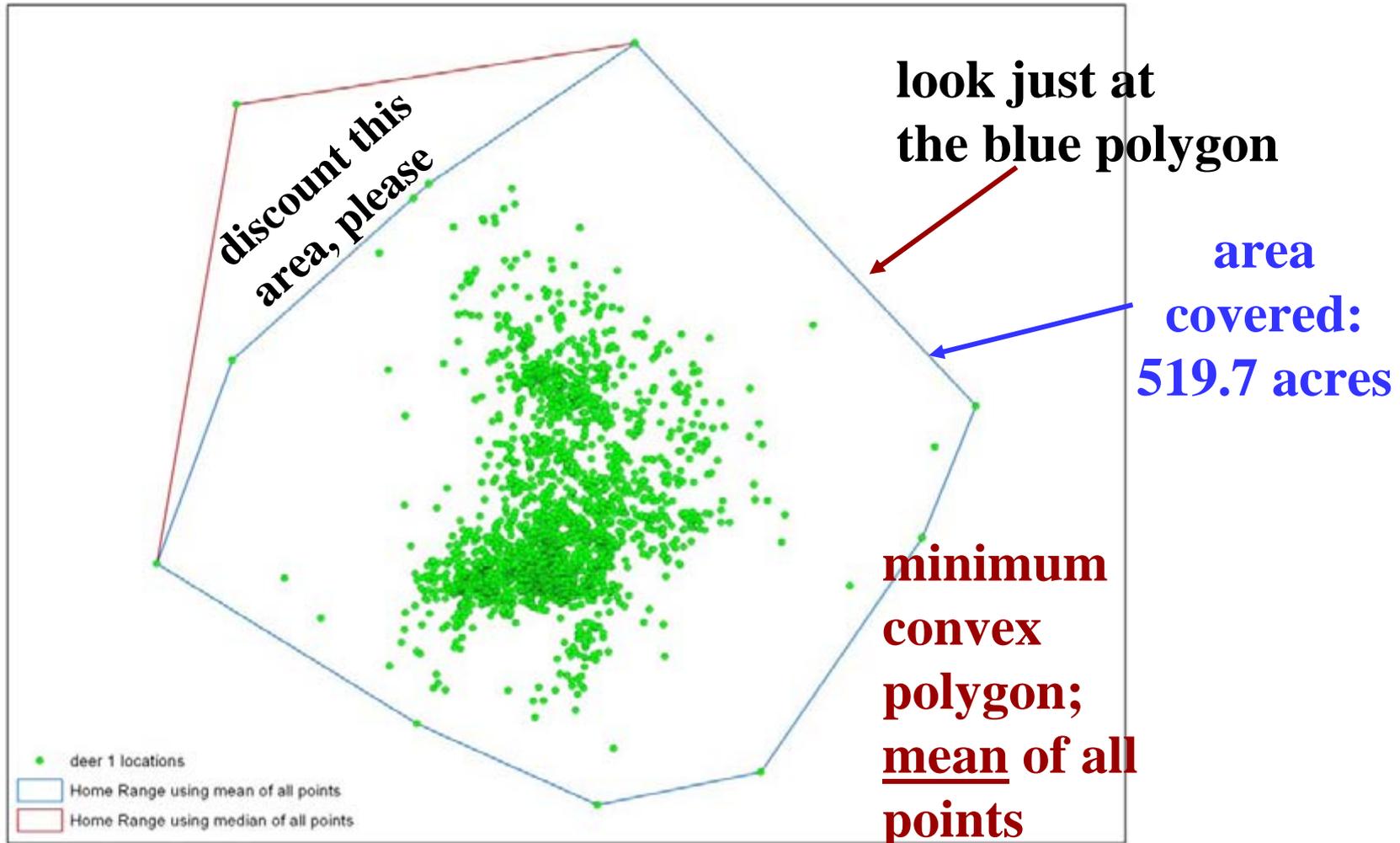
**Chesapeake Farms,  
Kent County, MD**



# Where the deer go . . . (plotting minimum convex polygons)



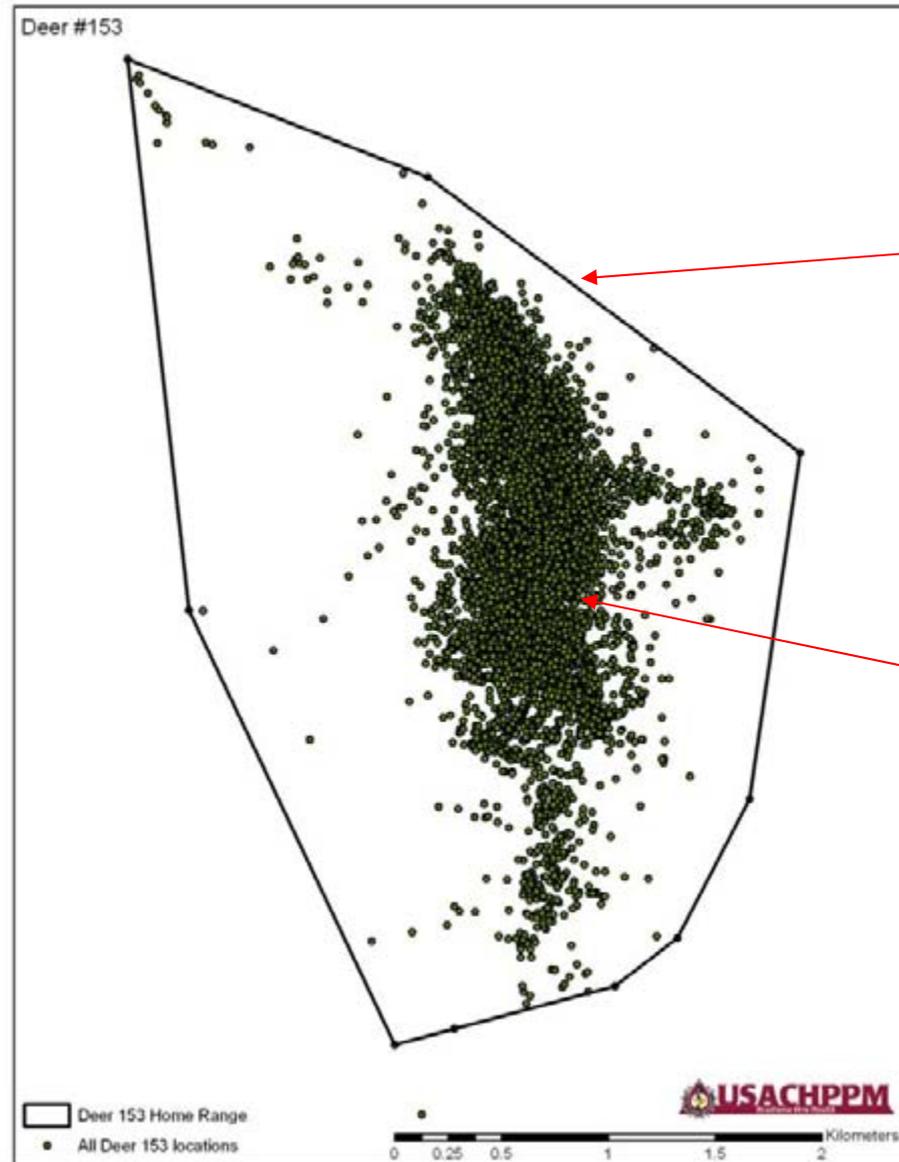
# “early returns” . . . after just 3 months



# Home ranges for female White-tailed deer, Hmmm.

- <100 acres - Natural Resource Consultants, Inc.
- 50 - 80 acres - Dept. of Nat. Resources, Cornell Univ.
- 249 acres - U.S. DOI, Nat'l. Park Service, NE Region
- 40 - 300 acres - The Mammals of Canada,  
Toronto Press
- <247.1 acres - Univ. of Michigan Museum of  
Zoology: Animal Diversity Web

# One deer, roaming freely for an entire calendar year . . .



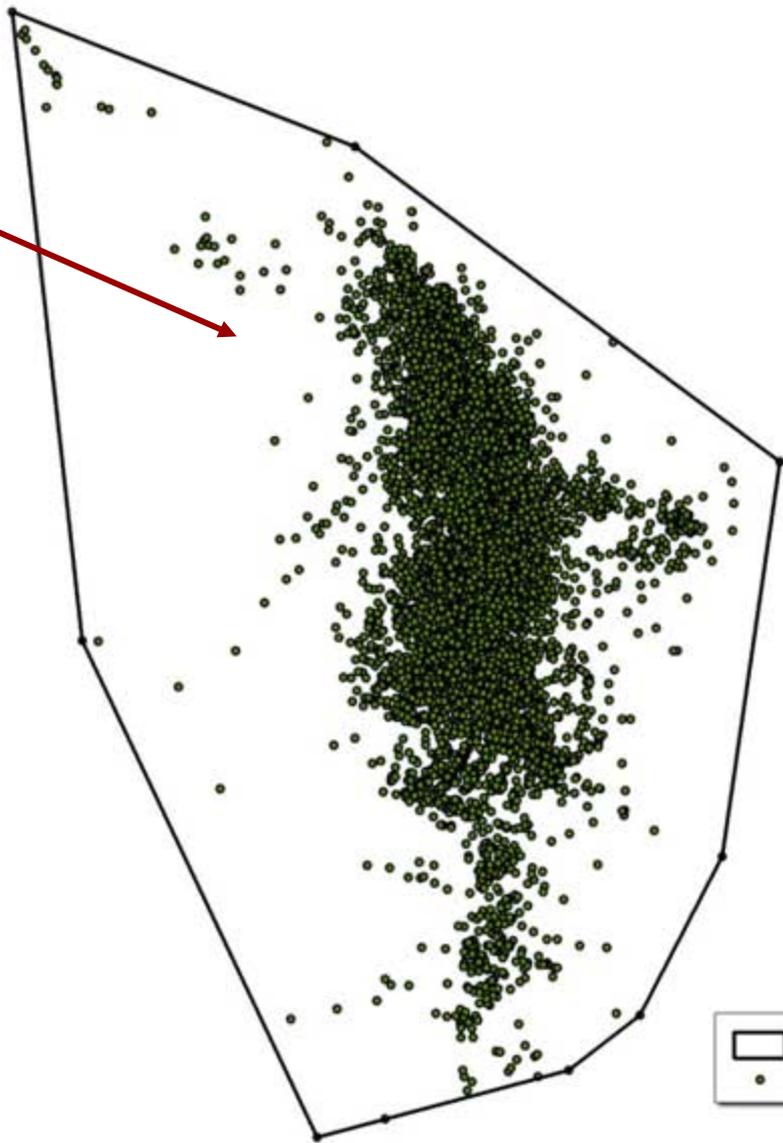
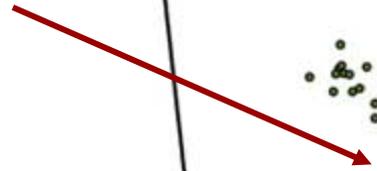
Home  
range:  
2289 acres!  
Wow!

8,927  
locations.  
Wow!

# principle assumption in our time-allocation analysis:

- The % of a deer's total recorded locations that occur at a given area of the home range, is a good (excellent?) approximation of the % of the deer's time spent at that area.

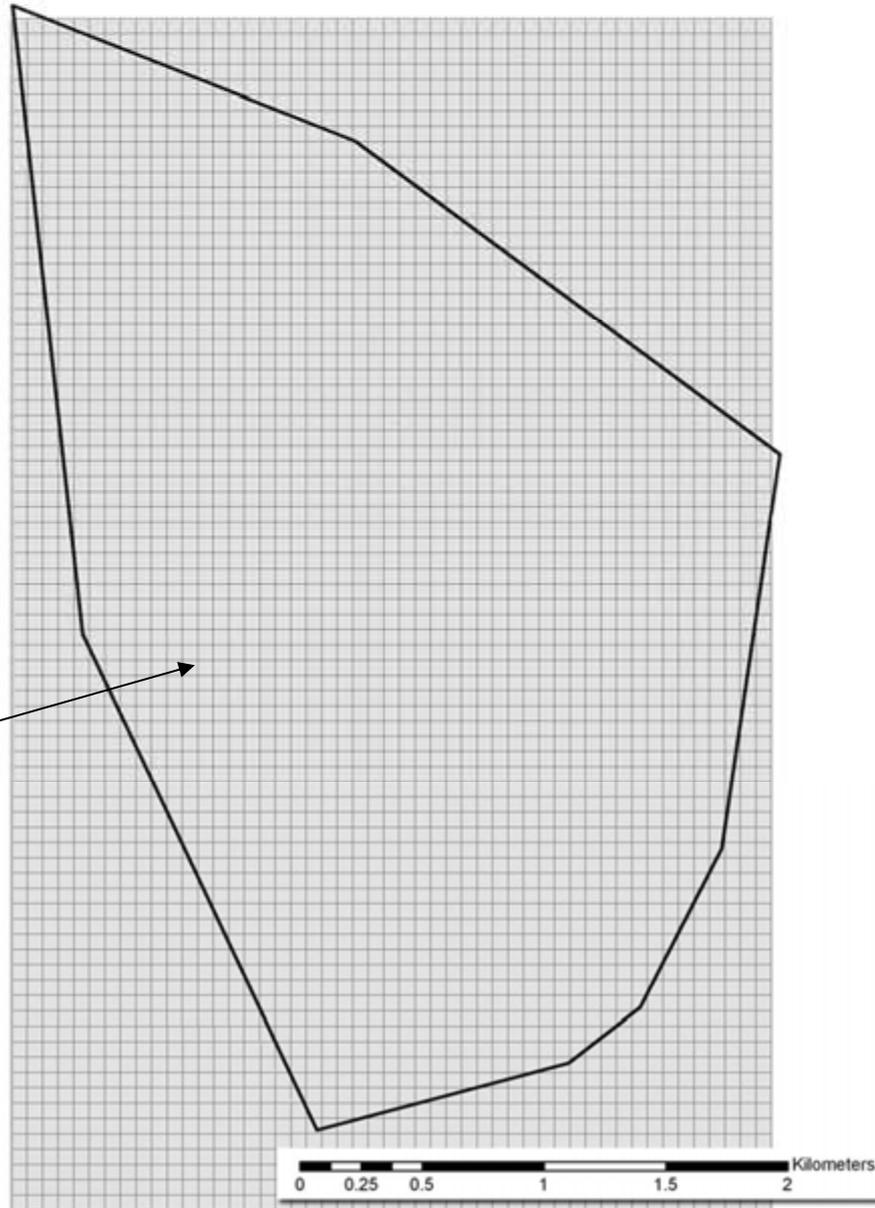
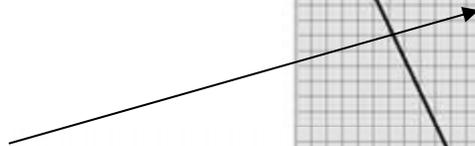
2,289 acres



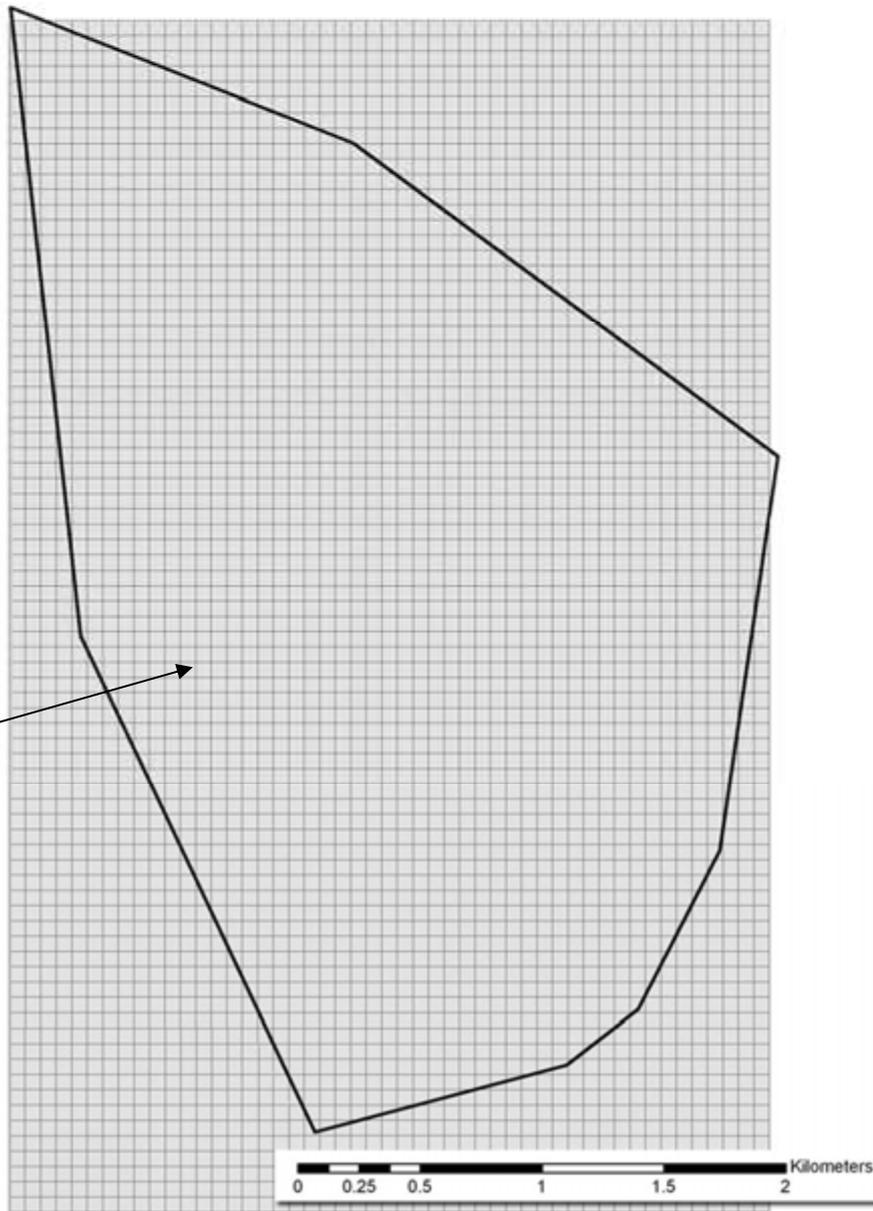
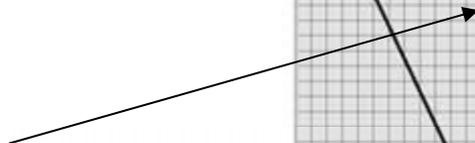
Deer 153 Home Range  
All Deer 153 locations

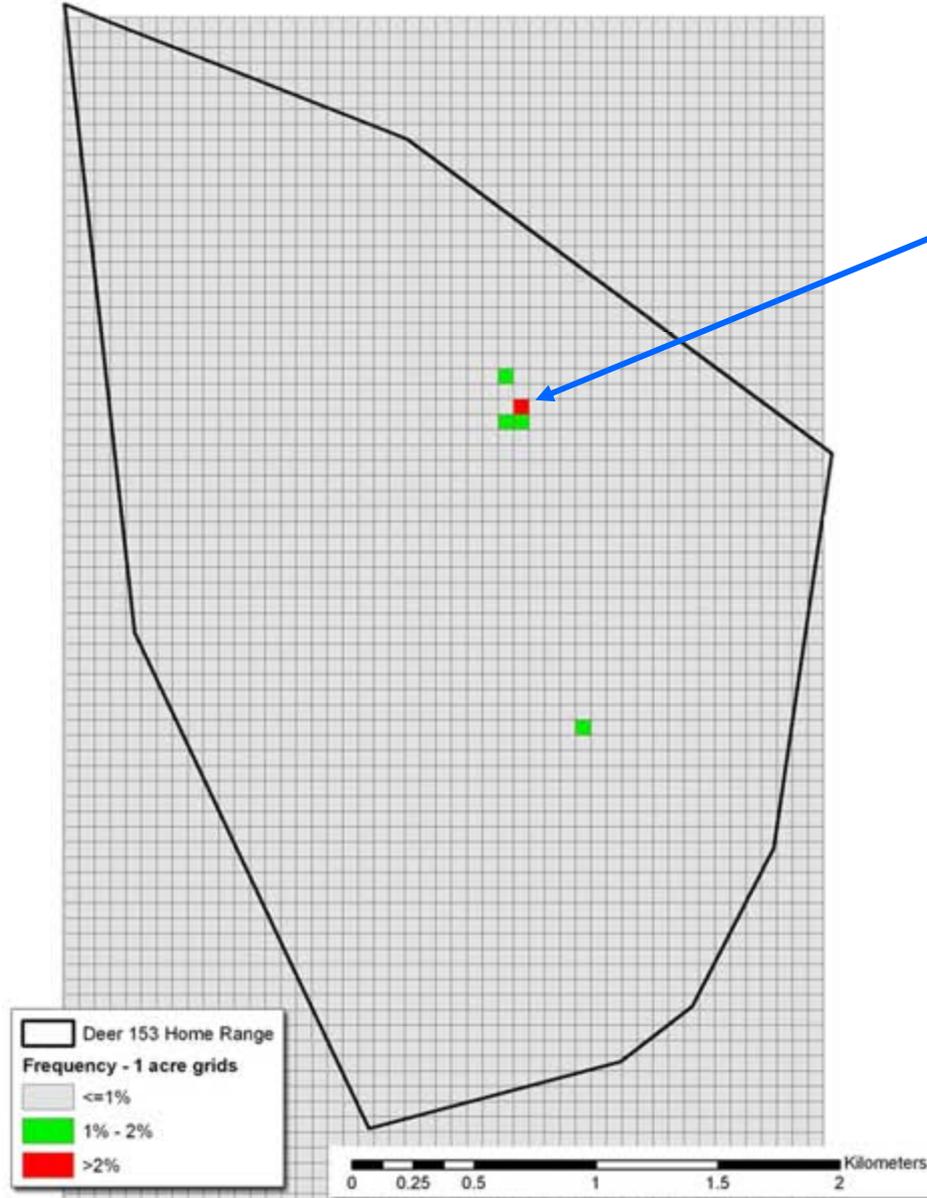
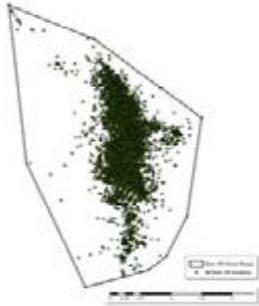


**2403 1-acre cells**



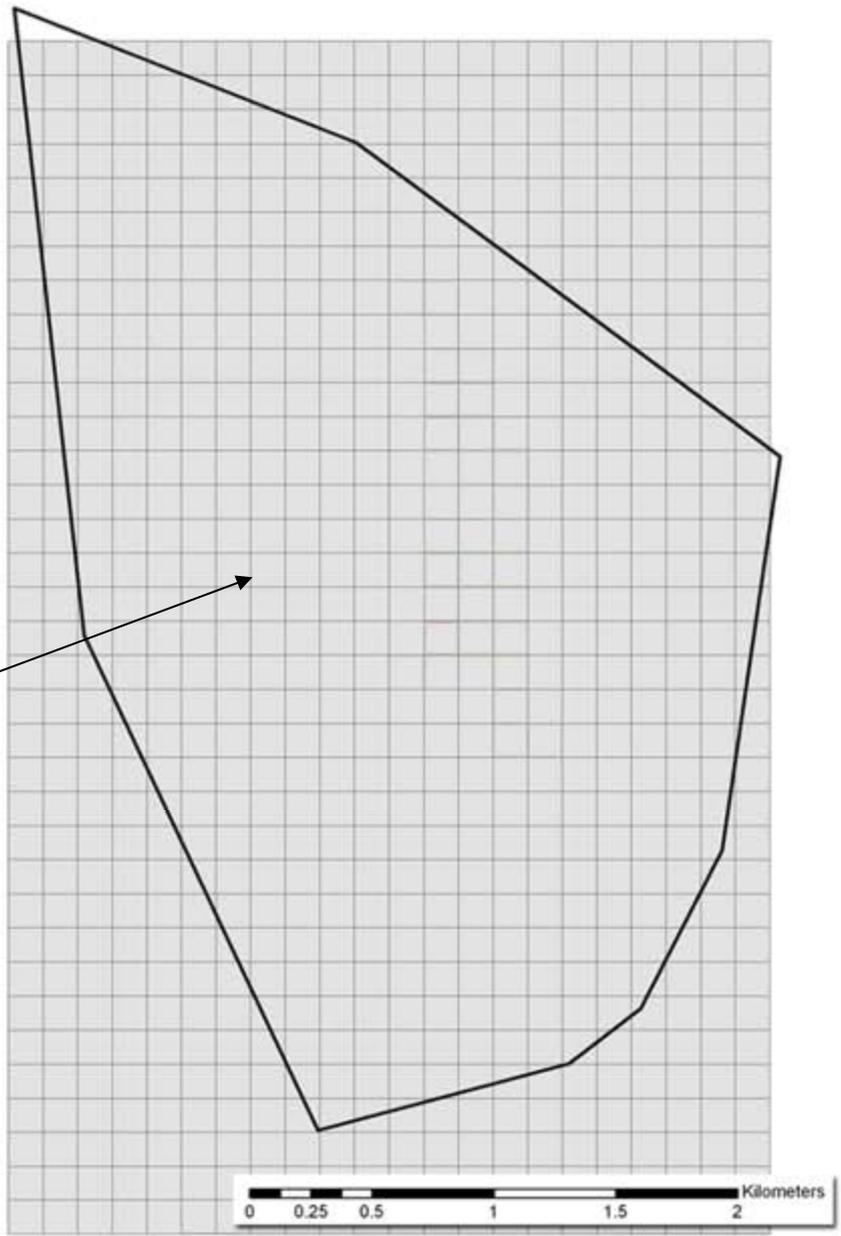
**2403 1-acre cells**

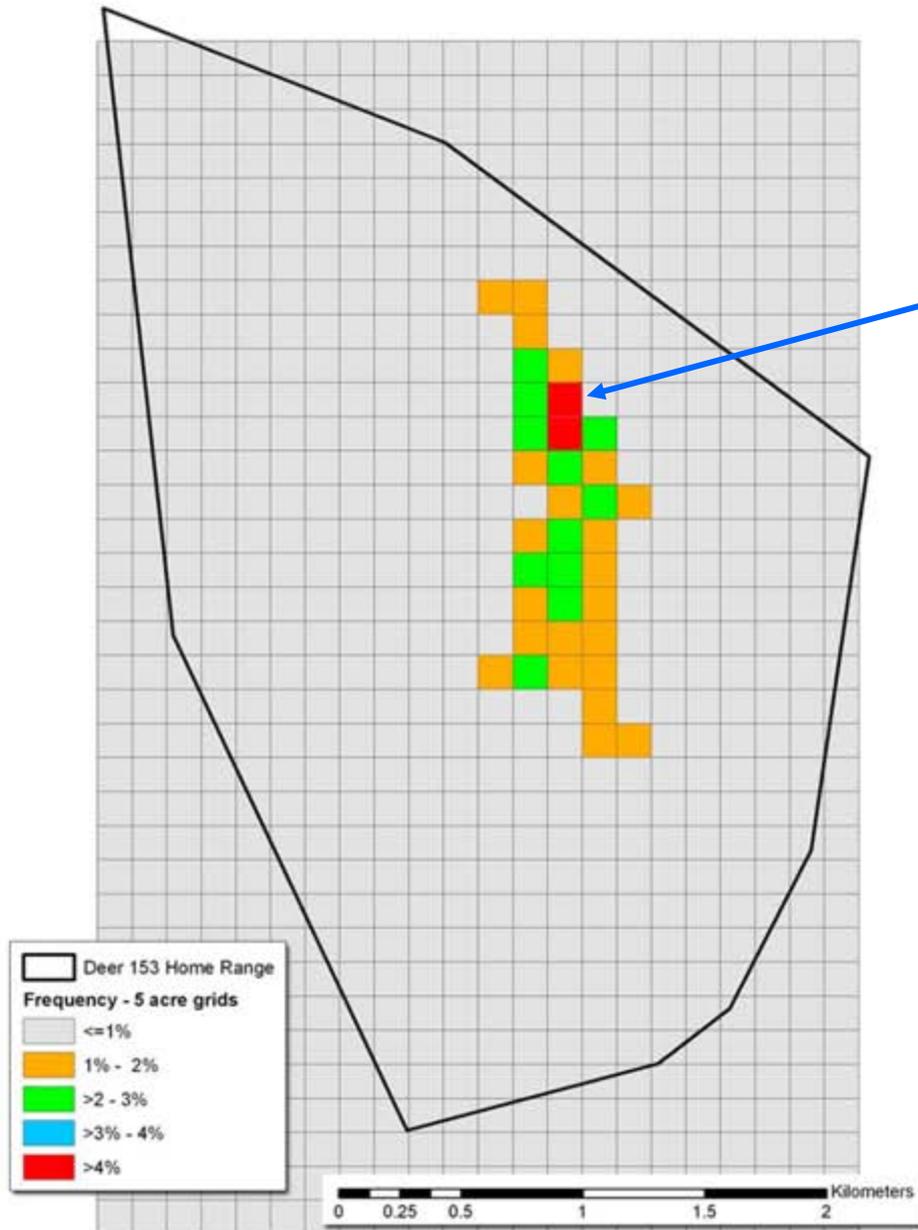
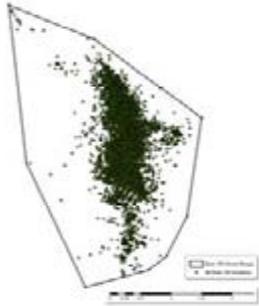




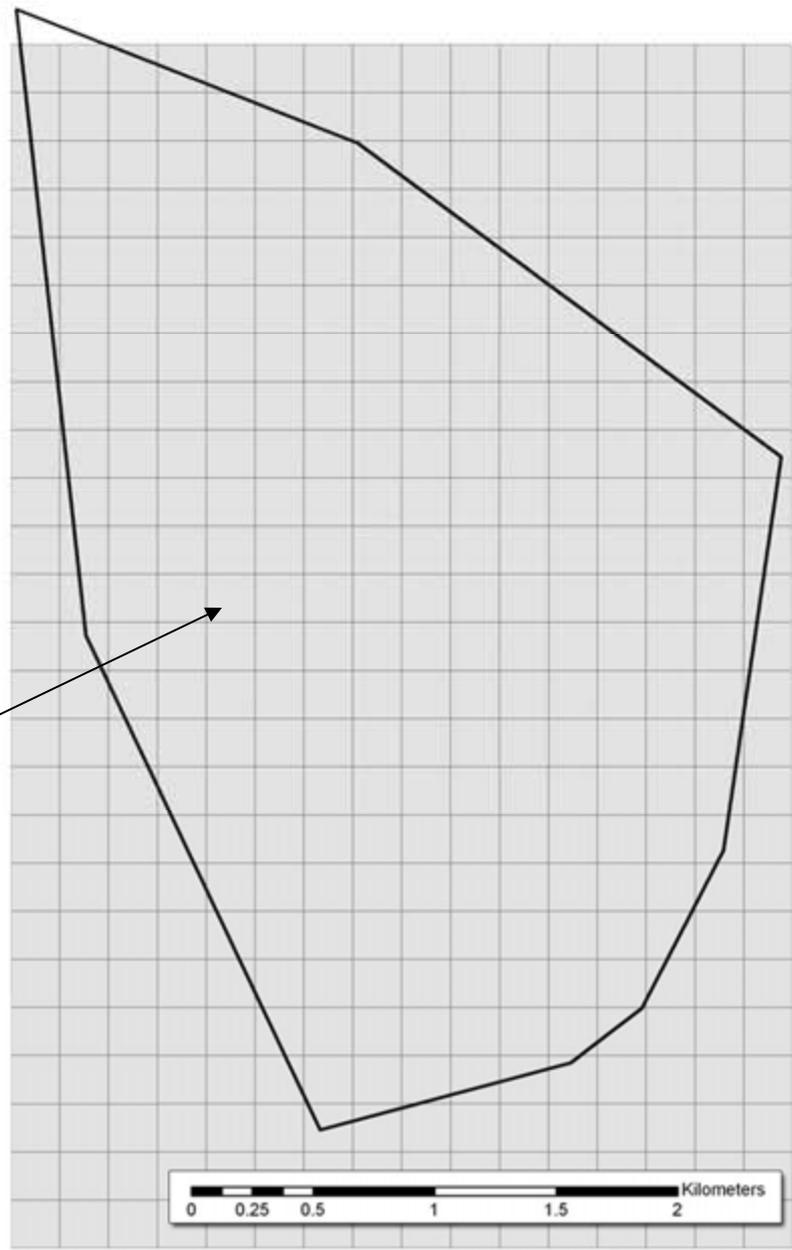
There is a **0.04%** chance that a deer would spend **2.4%** of its time in a one-acre cell/area!

**506 5-acre cells**

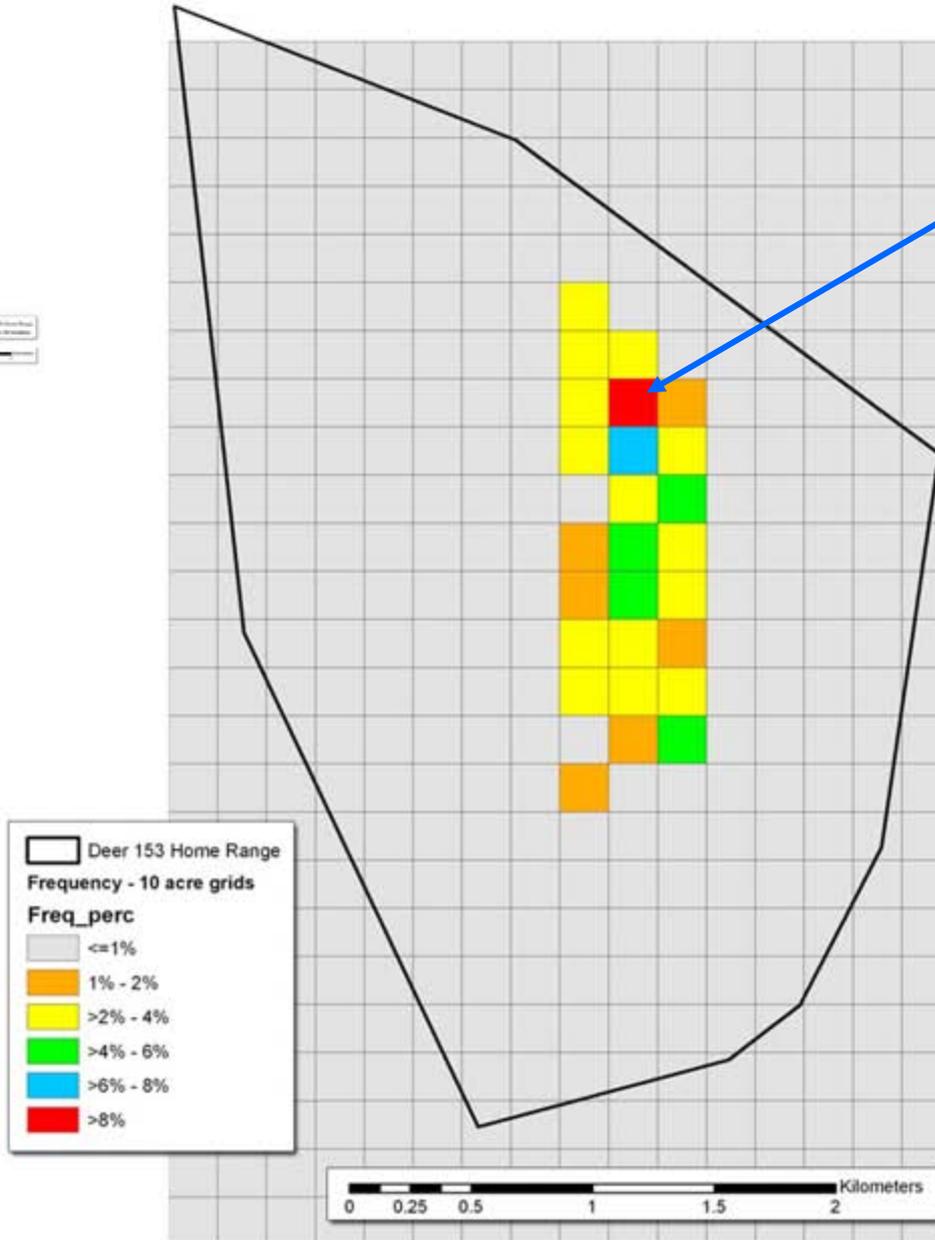
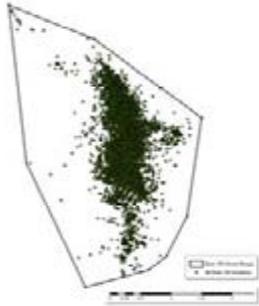




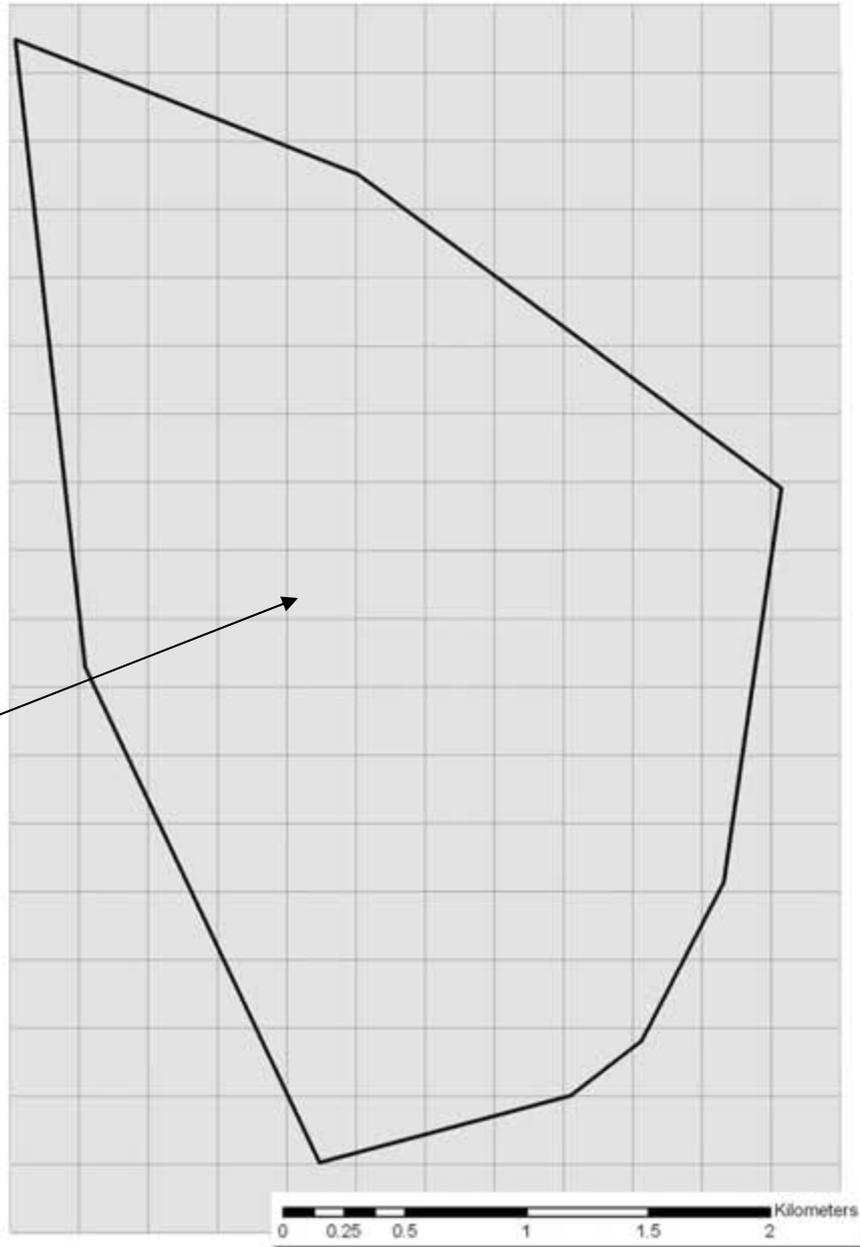
There is a **0.4%** chance that a deer would spend **5.5%** of its time in a **five-acre** cell/area!



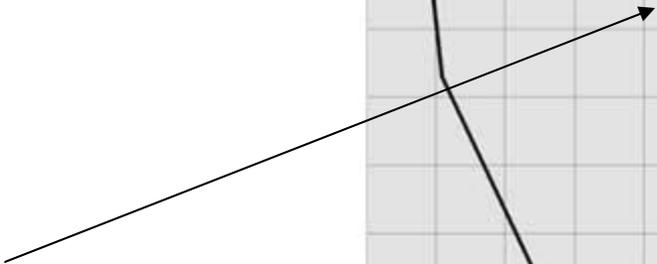
**264 10-acre cells**

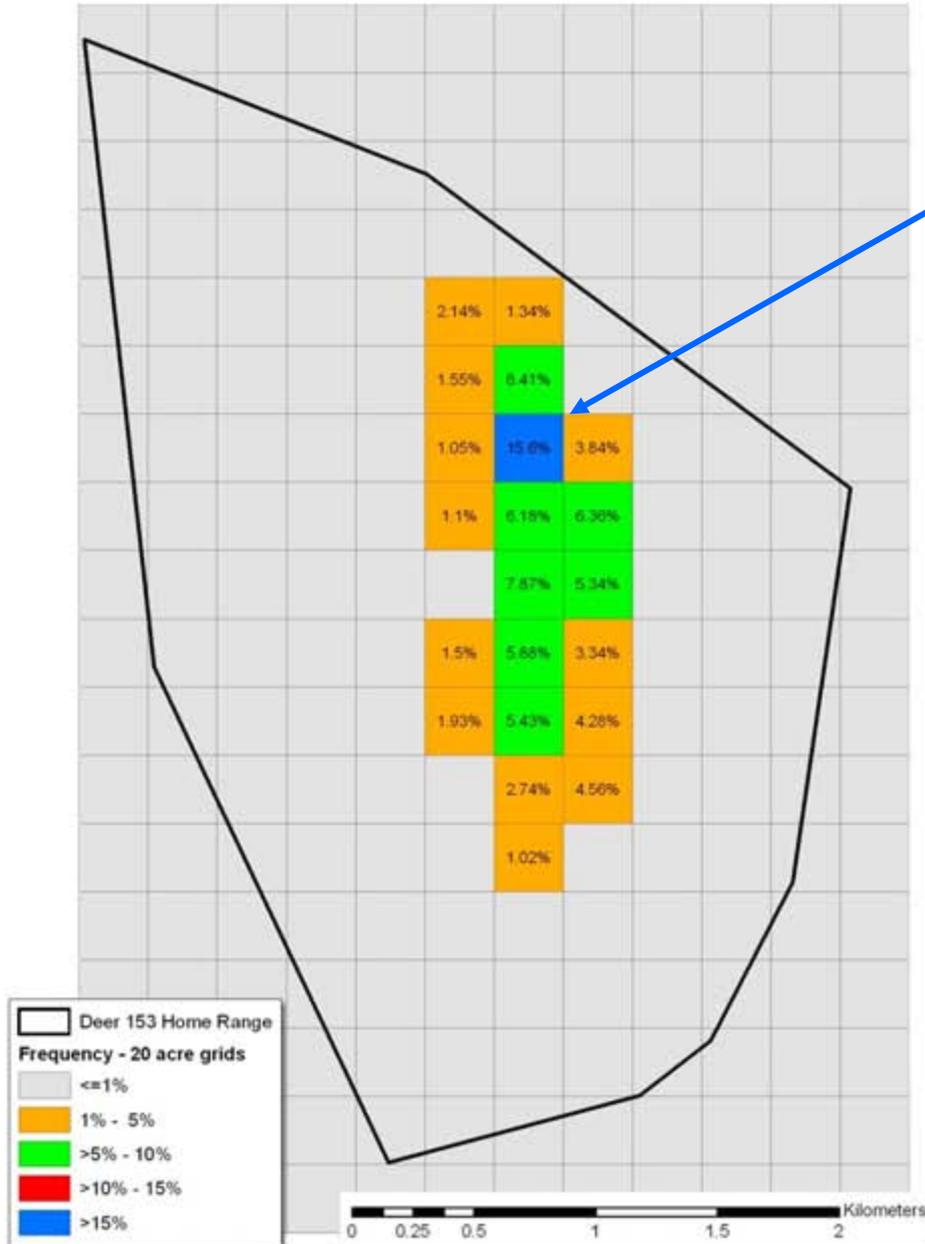
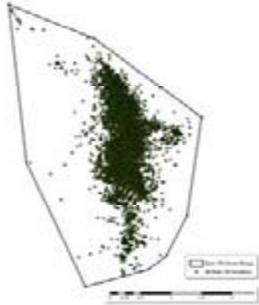


There is a **0.4%** chance that a deer would spend **10.1%** of its time in a ten-acre cell/area!



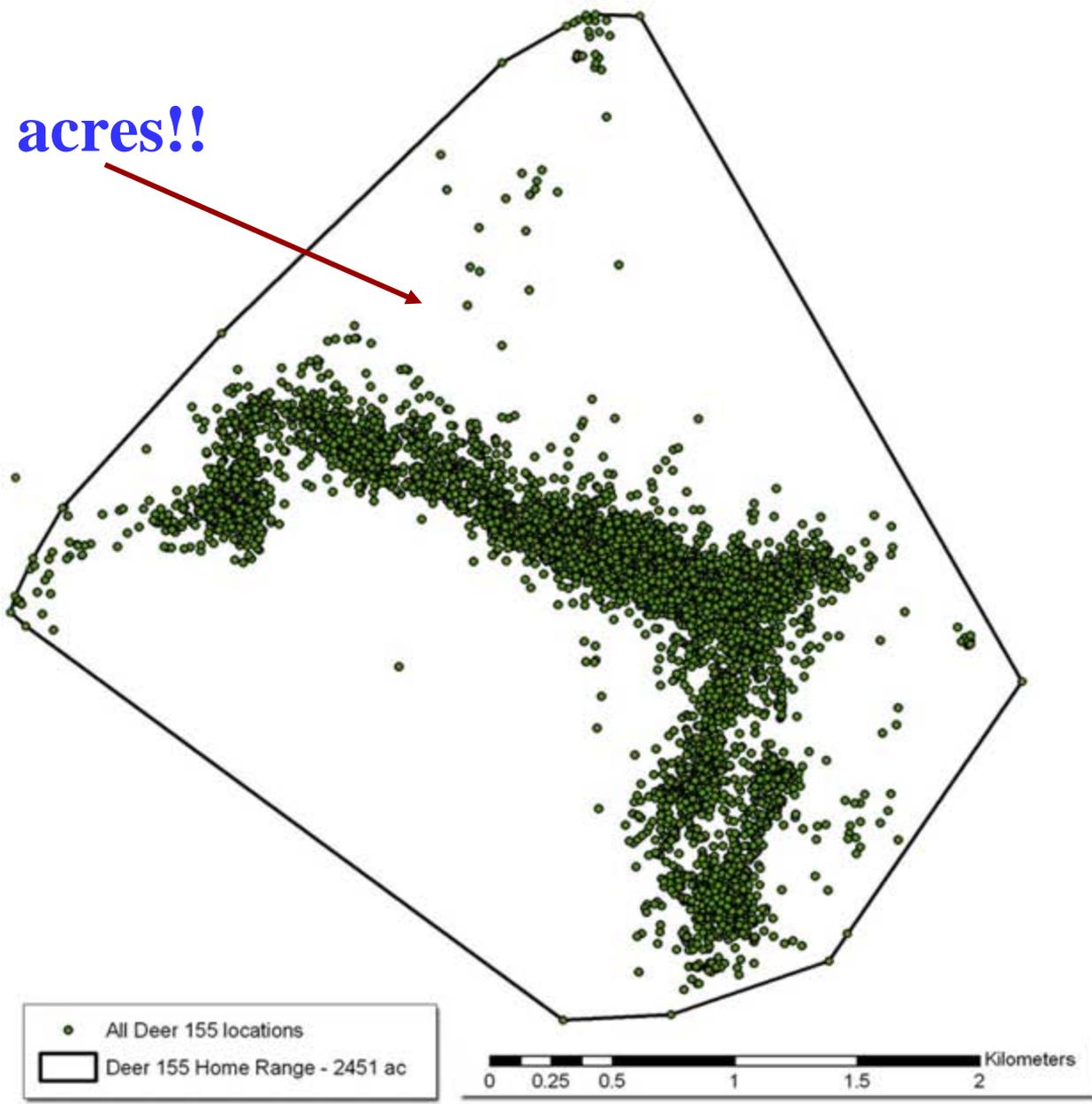
**142 20-acre cells**



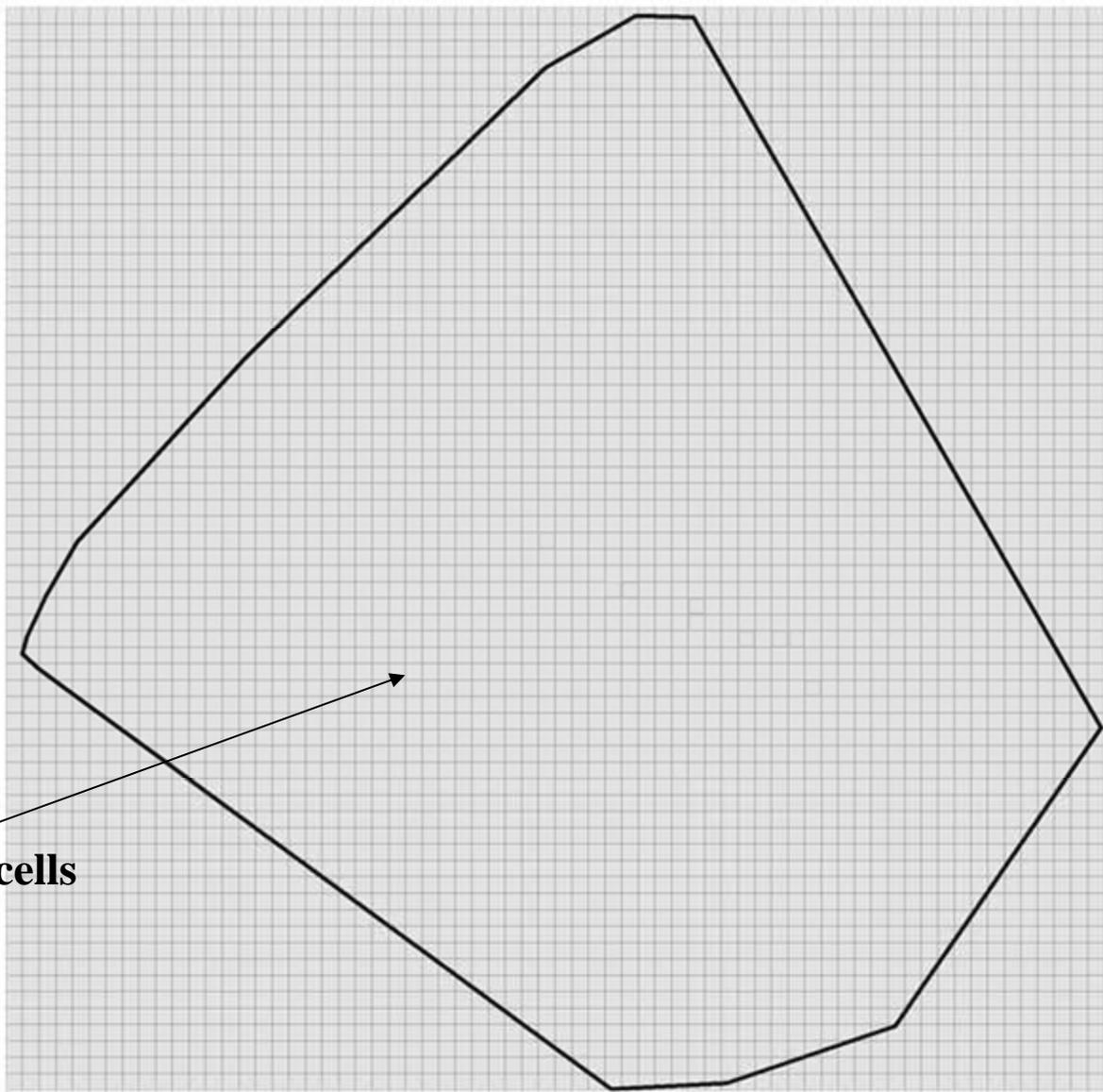
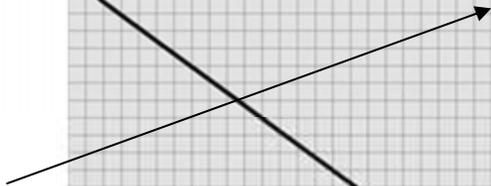


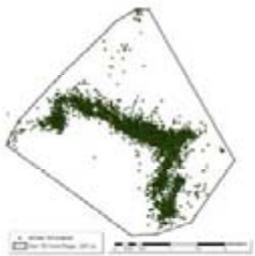
There is a **0.7%** chance that a deer would spend **15.6%** of its time in a **20-acre** cell/area!

**2,451 acres!!**



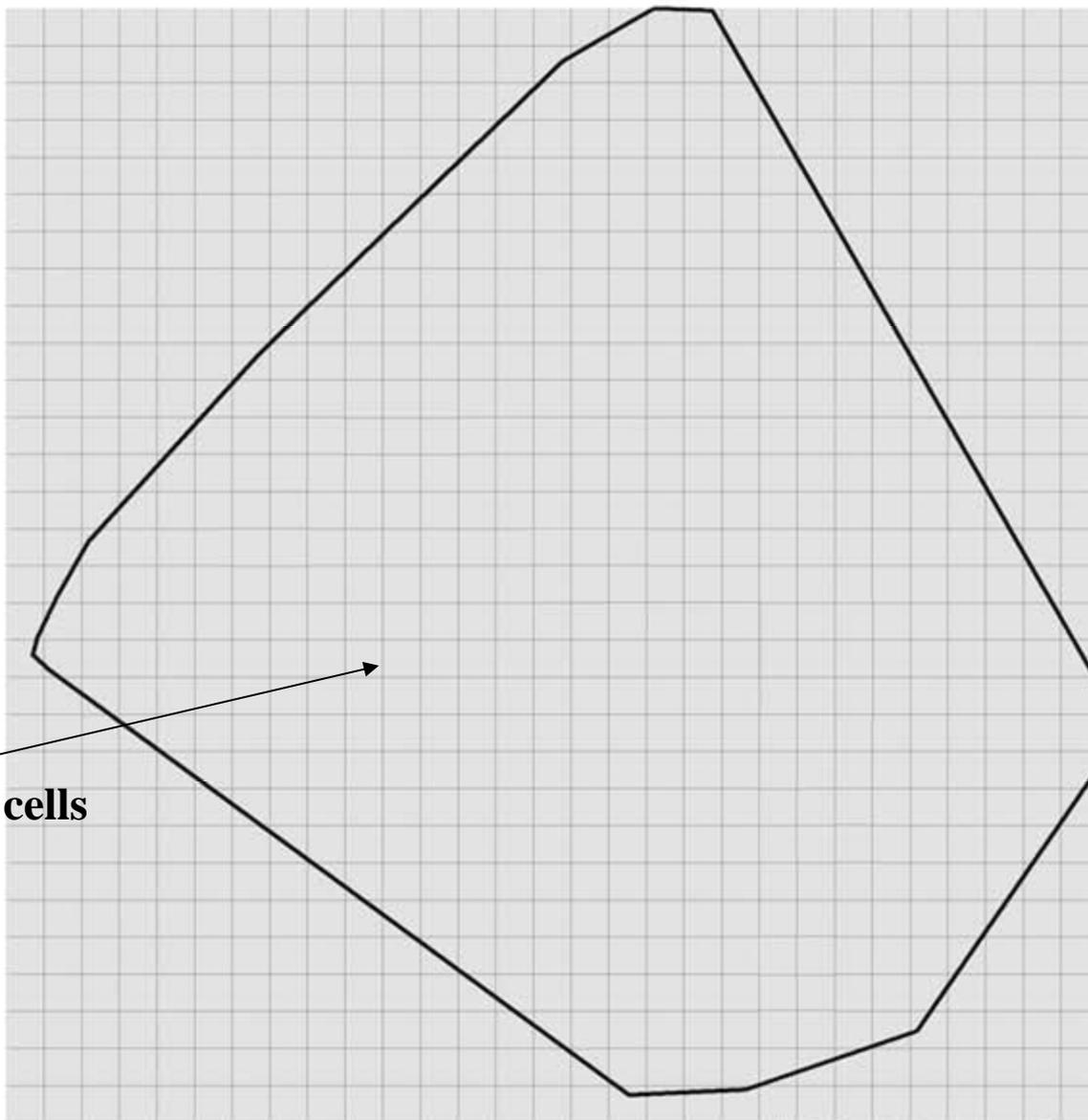
**2582 1-acre cells**

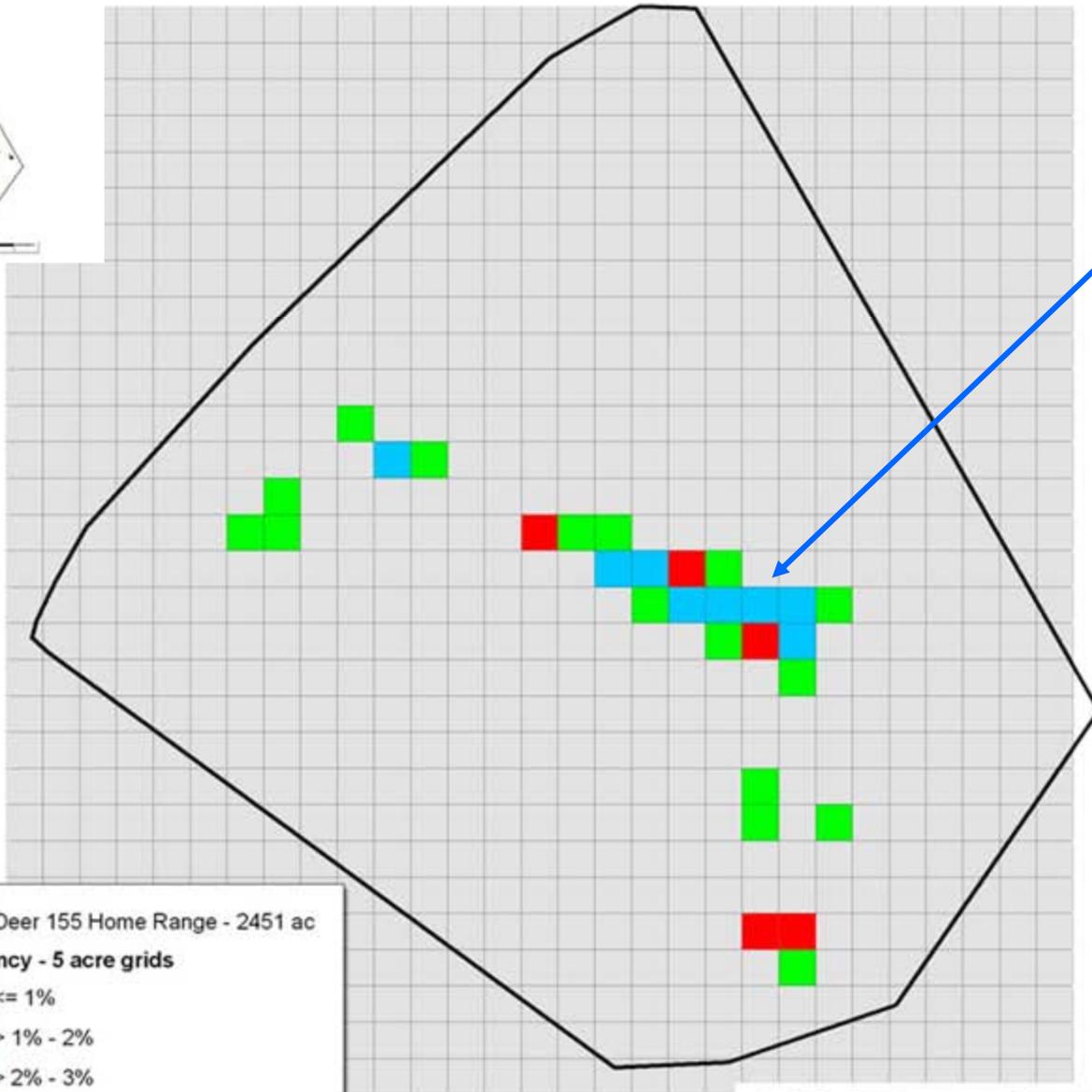
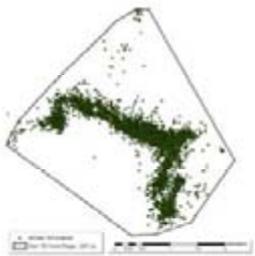




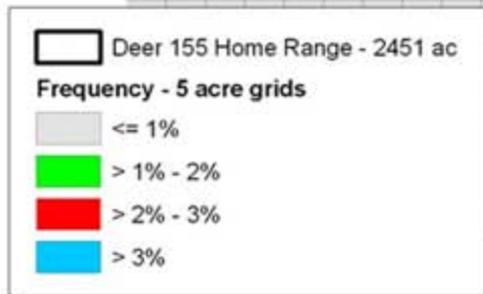
There is a **0.08%** chance that a deer would spend **1.7%** of its time in a one-acre cell/area!

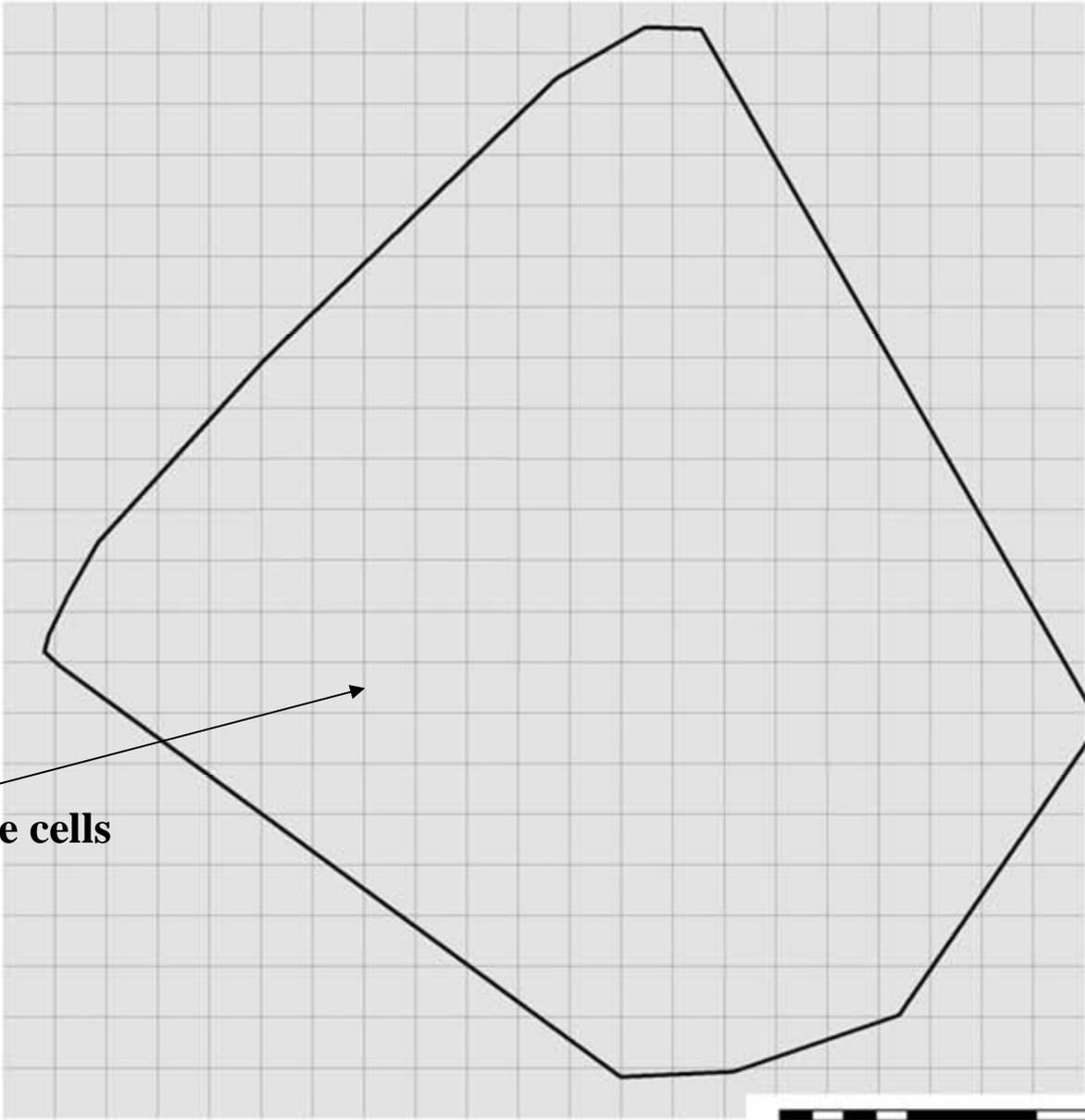
**540 5-acre cells**





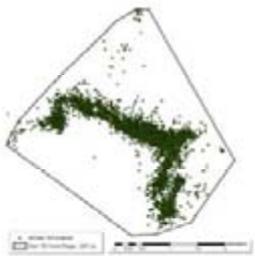
There is a **1.5%** chance that a deer would spend **4.9%** of its time in a **five-acre** cell/area!



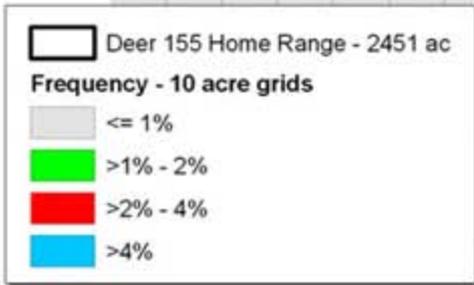


**284 10-acre cells**

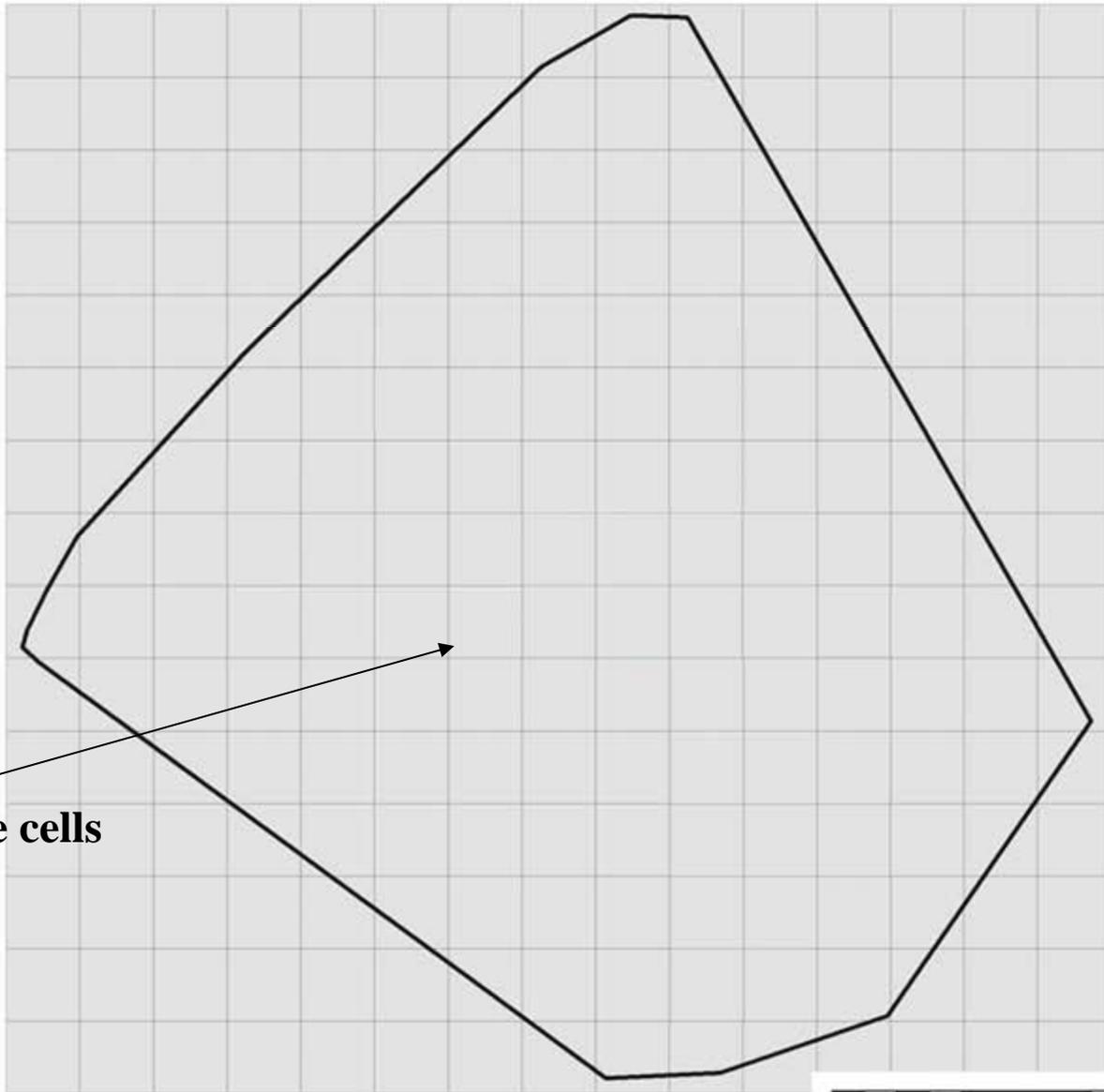


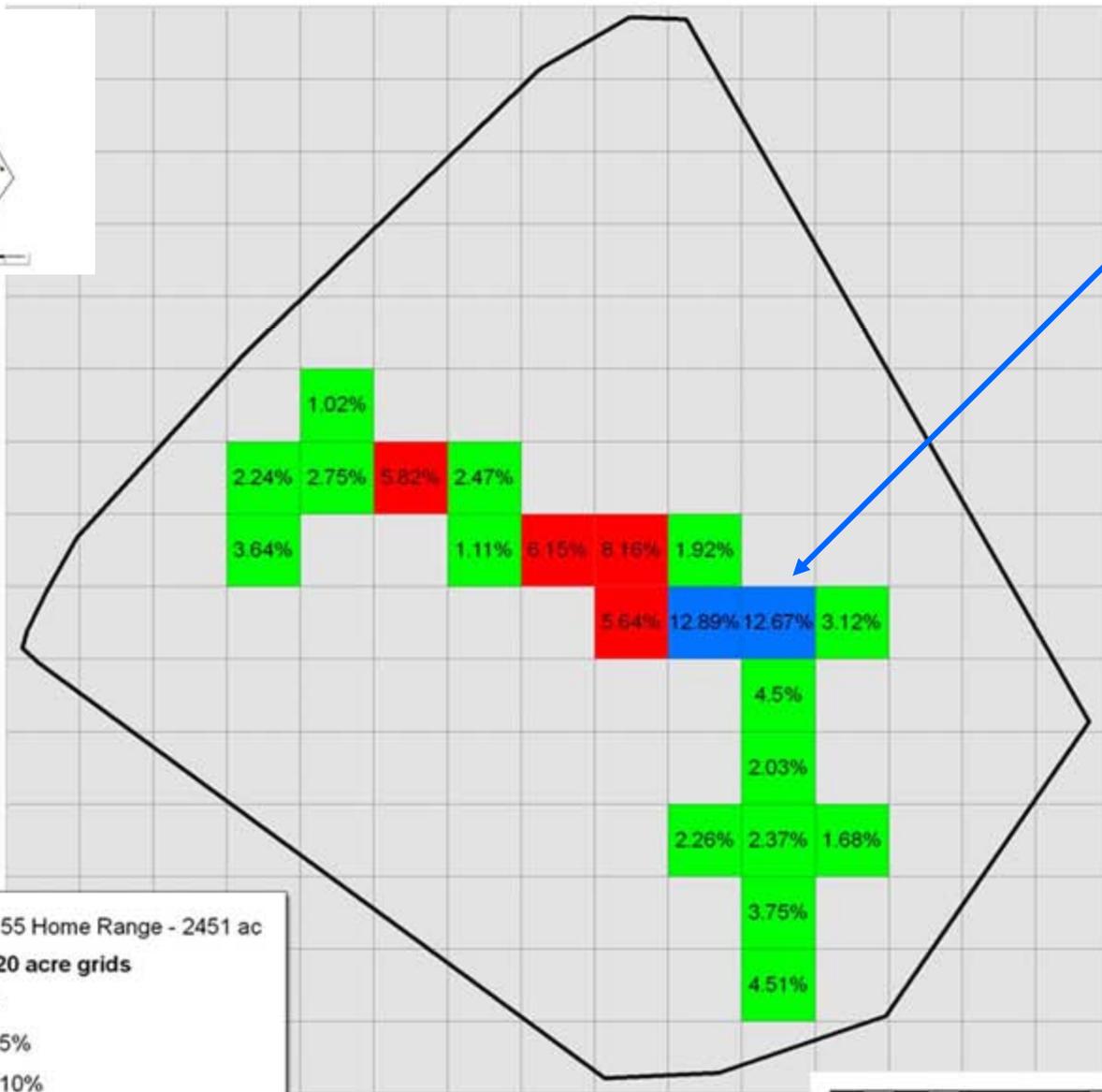
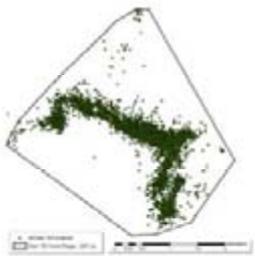


There is a **2.1%** chance that a deer would spend **8.0%** of its time in a ten-acre cell/area!



**147 20-acre cells**



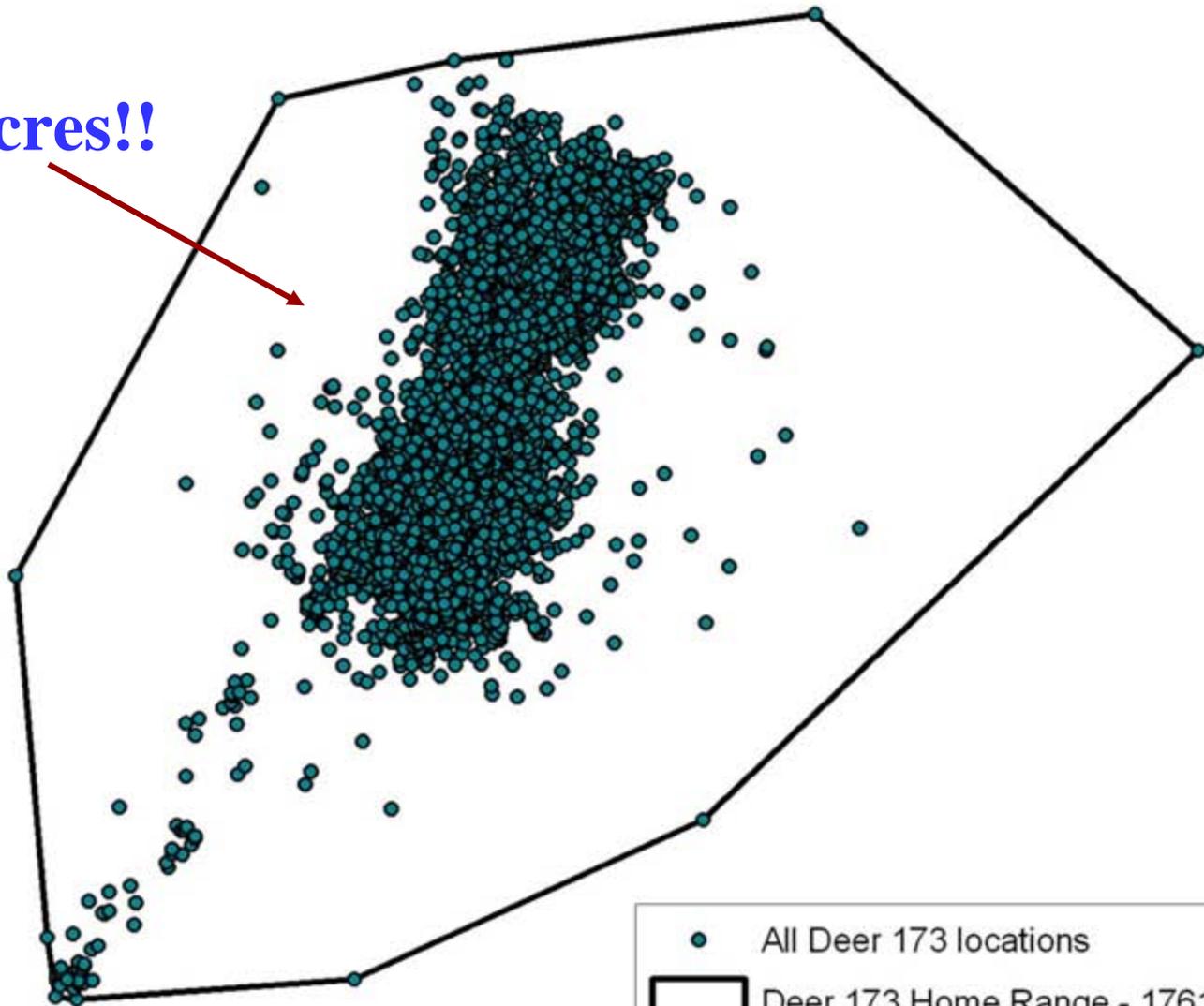


There is a **1.4%** chance that a deer would spend **12.9%** of its time in a **20-acre** cell/area!

Deer 155 Home Range - 2451 ac  
**Frequency - 20 acre grids**  
 <= 1%  
 >1% - 5%  
 >5% - 10%  
 >10%

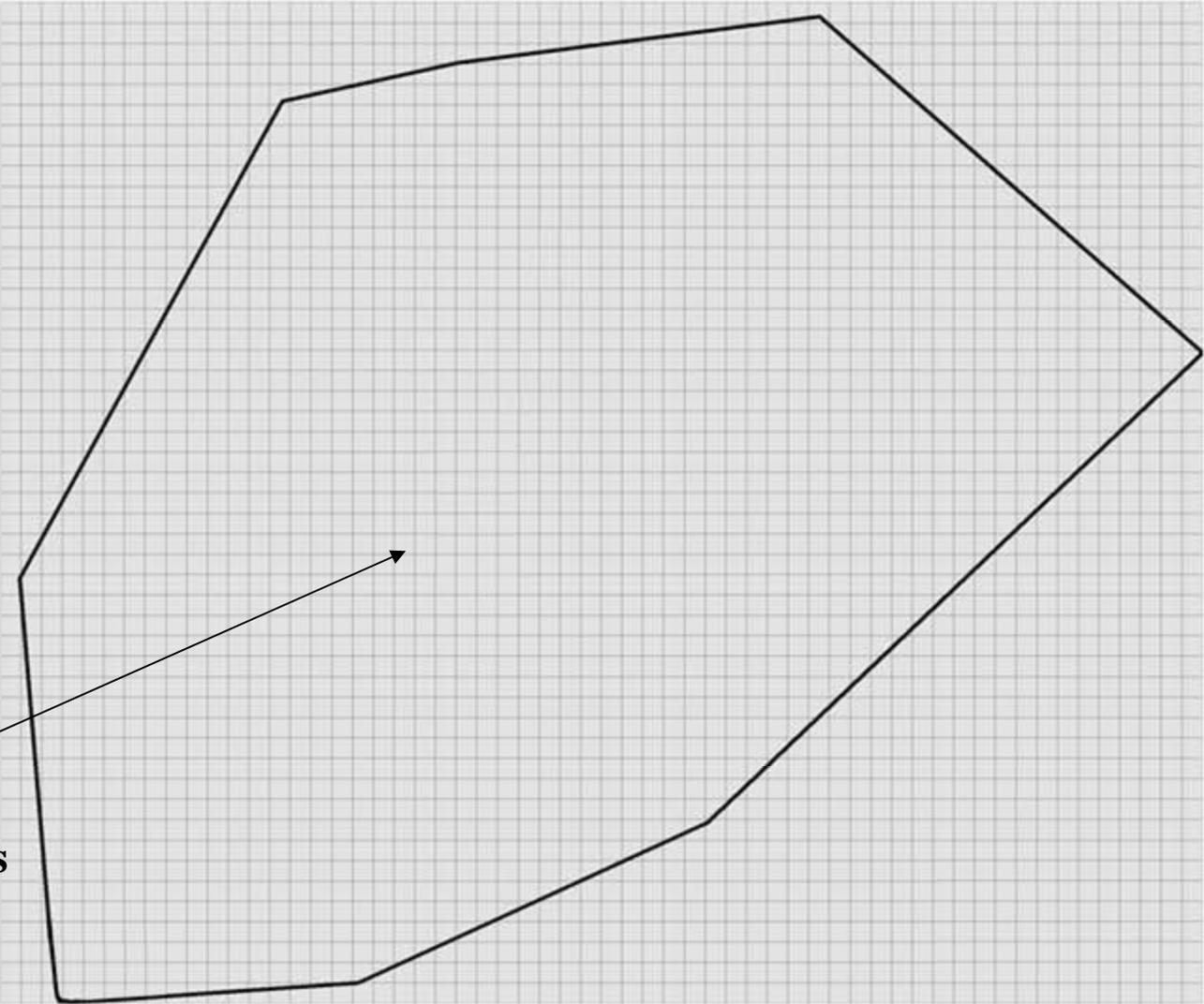


1,761 acres!!



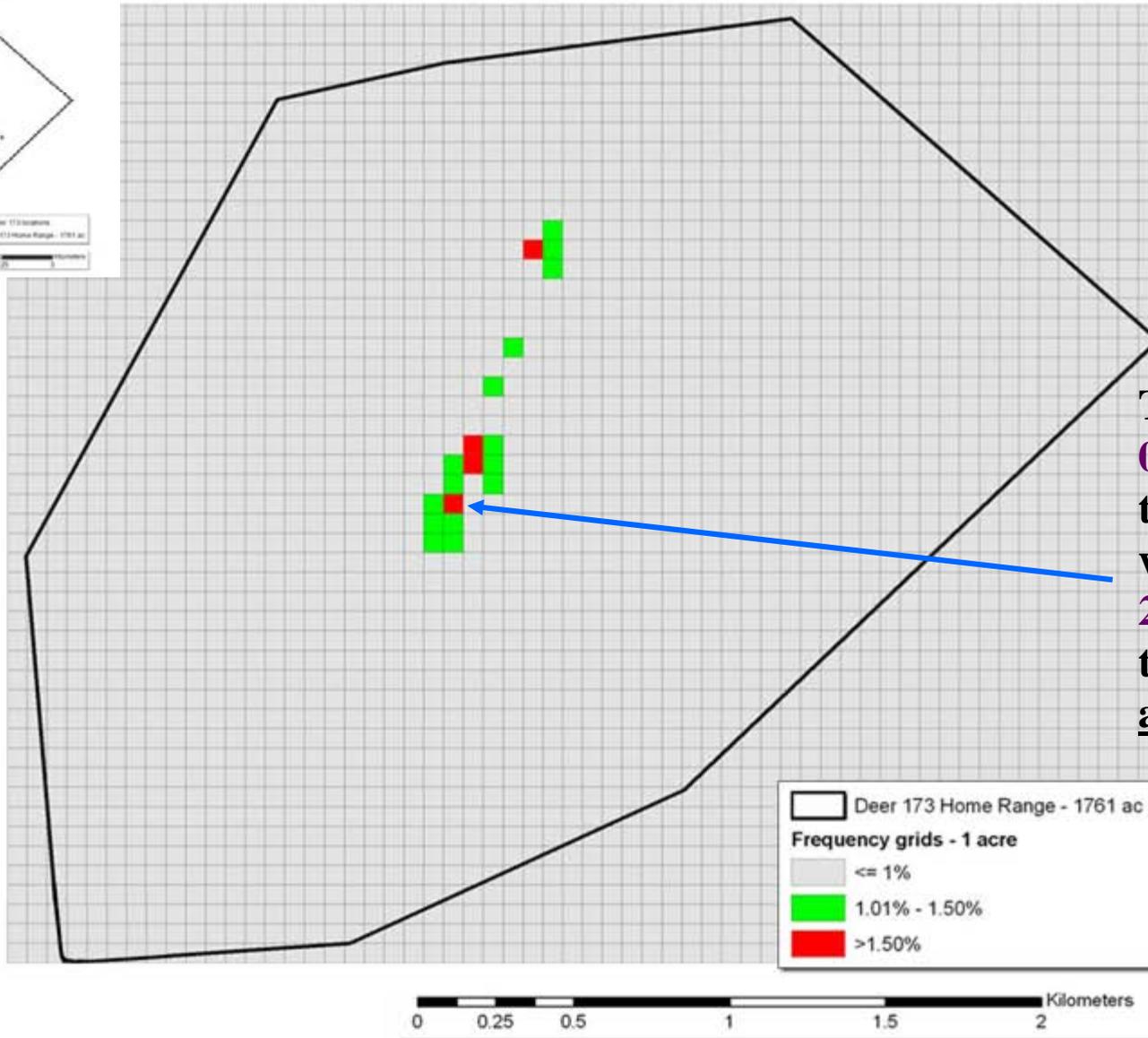
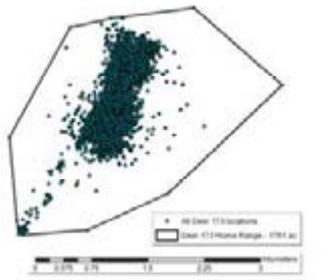
|   |                               |
|---|-------------------------------|
| ● | All Deer 173 locations        |
| □ | Deer 173 Home Range - 1761 ac |





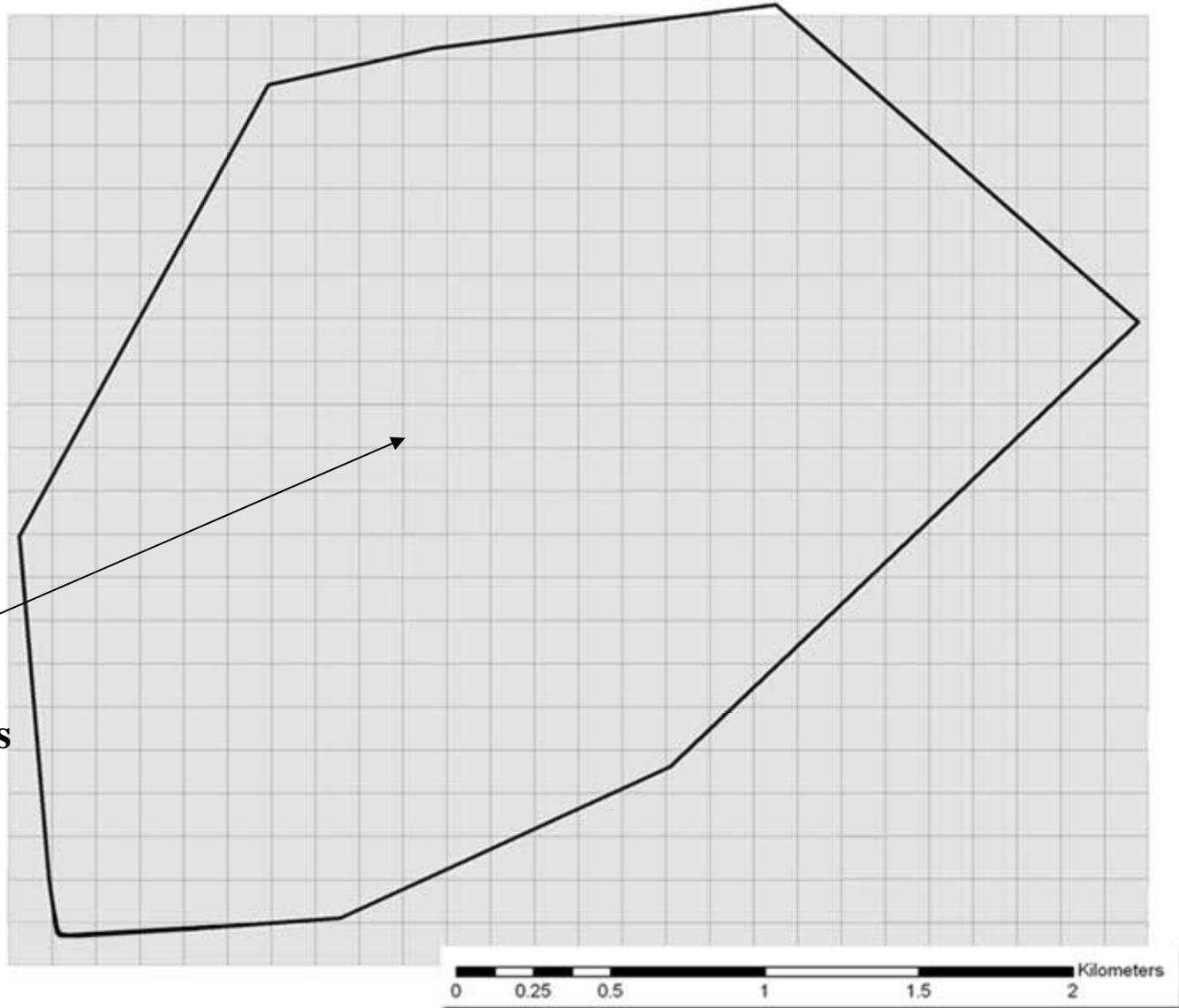
**1863 1-acre cells**

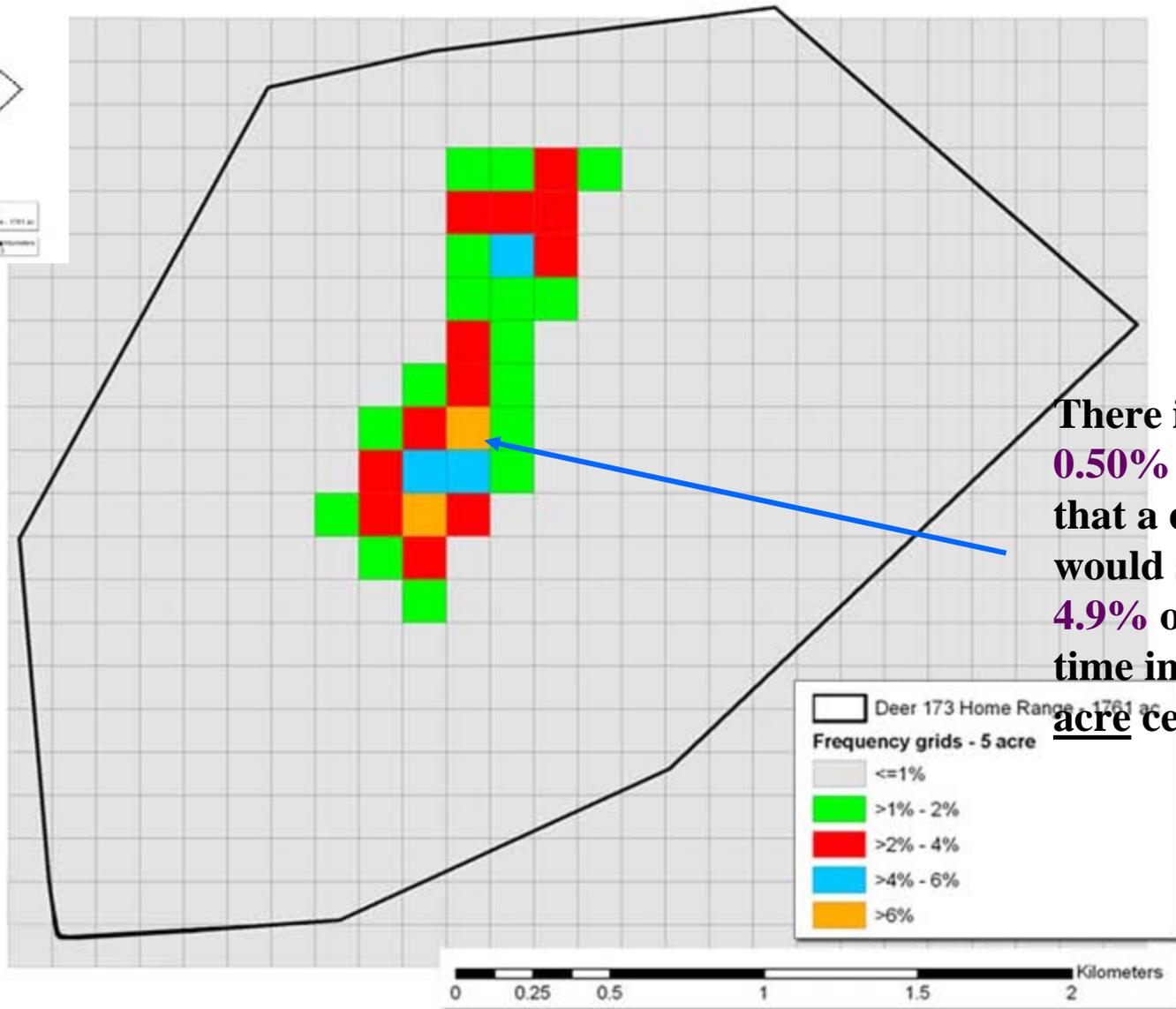
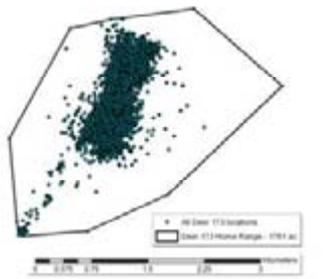




There is a **0.21%** chance that a deer would spend **2.07%** of its time in a one-acre cell/area!

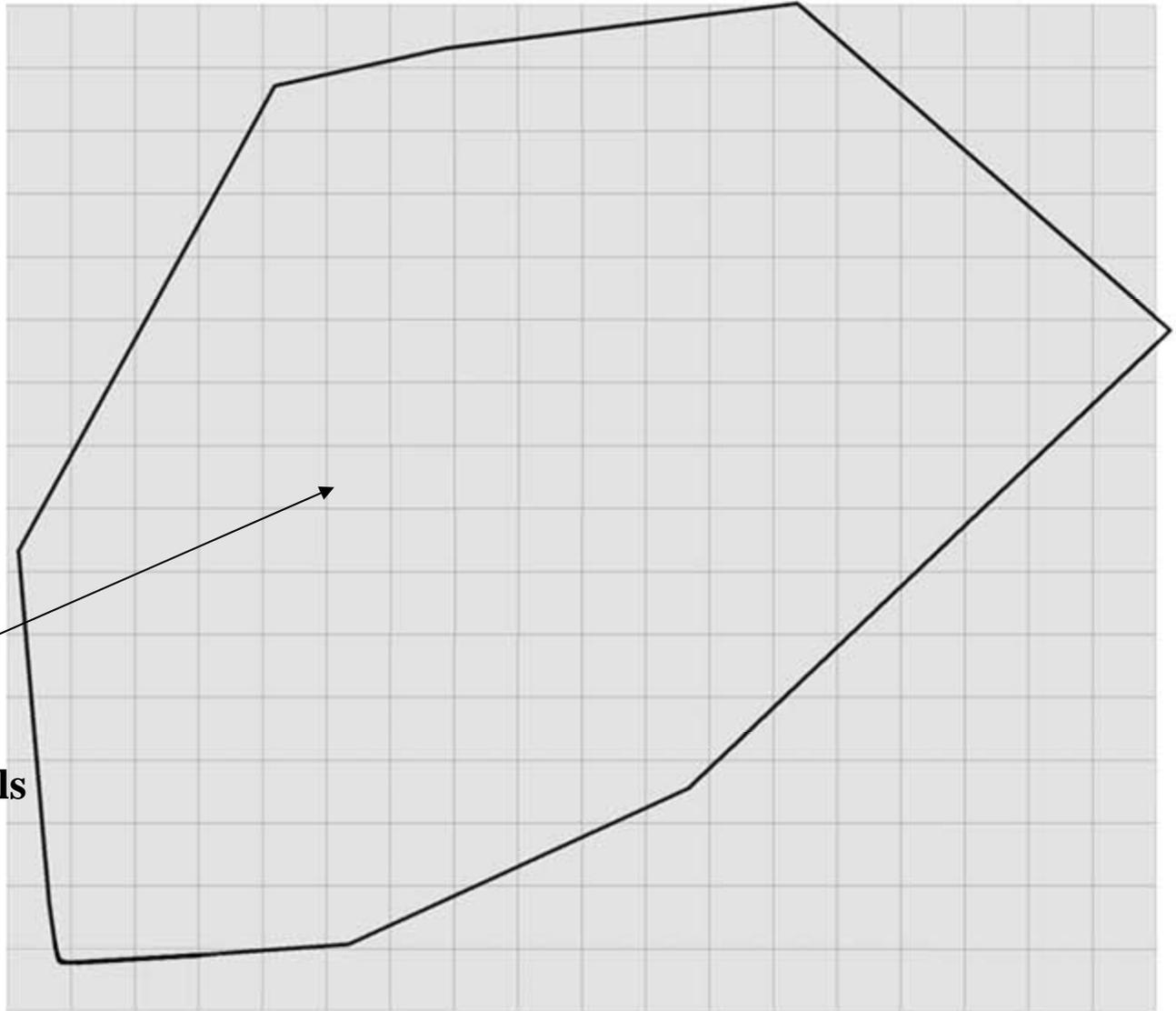
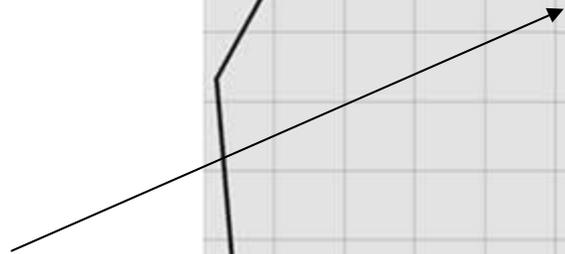
**398 5-acre cells**

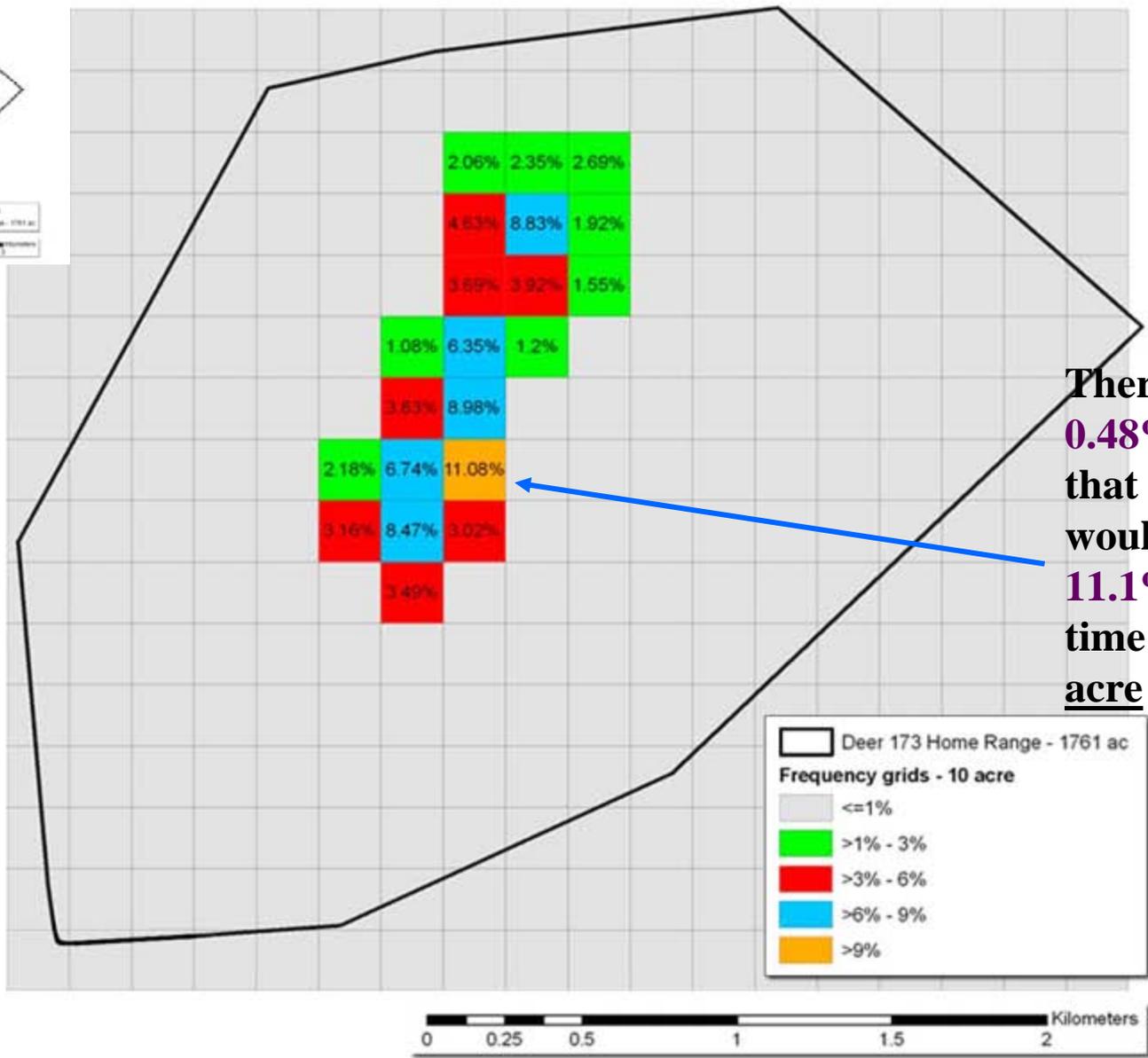
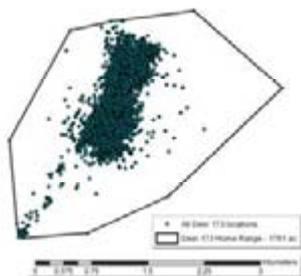




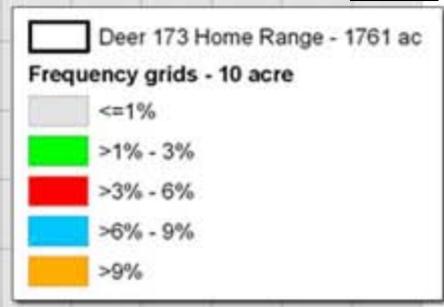
There is a **0.50%** chance that a deer would spend **4.9%** of its time in a **five-acre** cell/area!

**209 10-acre cells**



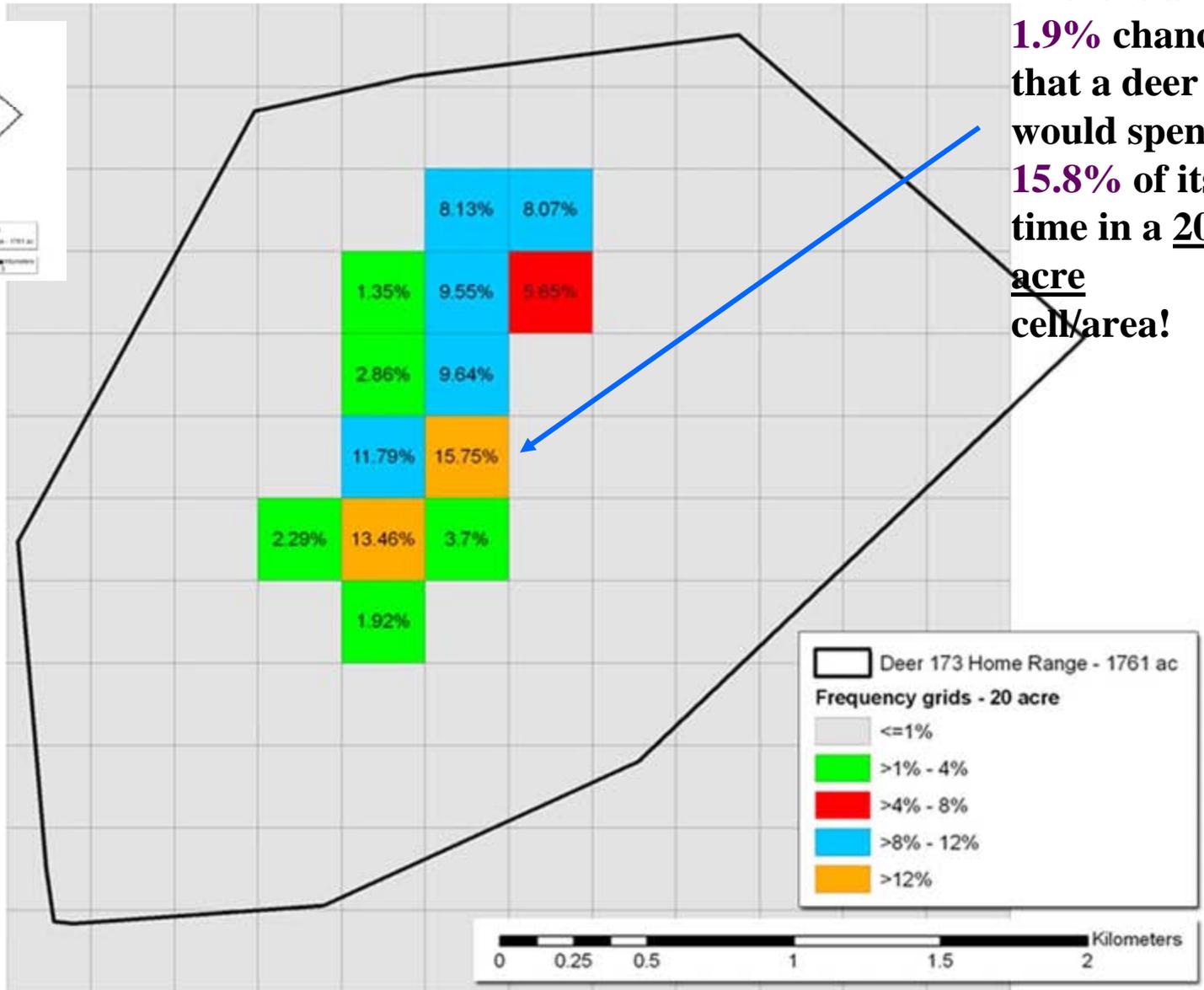
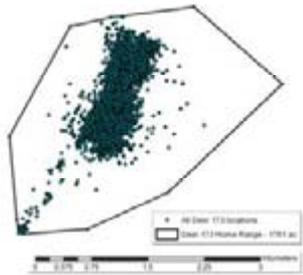


There is a **0.48%** chance that a deer would spend **11.1%** of its time in a ten-acre cell/area!



**108 20-acre cells**





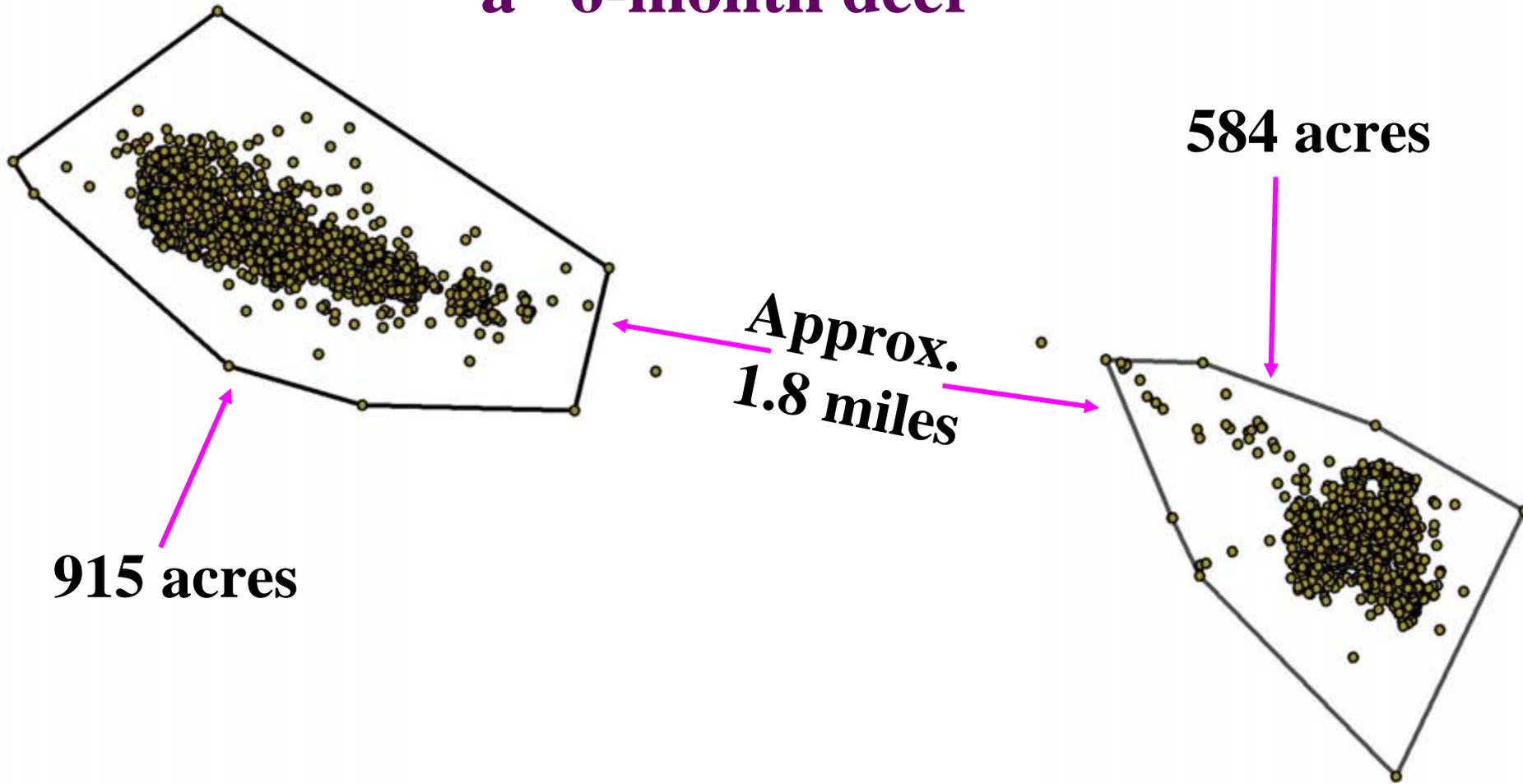
There is a **1.9%** chance that a deer would spend **15.8%** of its time in a 20-acre cell/area!



Three deer, each roaming freely for an entire calendar year . . .



# “Early returns” from our Delaware study area -- a “6-month deer”



915 acres

584 acres

Approx.  
1.8 miles

# Fascinating Summary Stats . . .

| Deer | Days tracked | Total locations | Home range |
|------|--------------|-----------------|------------|
| #153 | 361          | 8,927           | 2289       |
| #155 | 339          | 7,937           | 2451       |
| #173 | 343          | 7,023           | 1761       |
| # 45 | 365          | 10246           | 1514       |

# Fascinating Summary Stats . . .

| Deer | Days tracked | Total locations | Home range  |
|------|--------------|-----------------|-------------|
| #153 | 361          | 8,927           | 2289        |
| #155 | 339          | 7,937           | <b>2451</b> |
| #173 | 343          | 7,023           | 1761        |
| # 45 | 365          | <b>10246</b>    | 1514        |

# Fascinating Summary Stats . . .

| Deer | Days tracked | Total locations | Home range  | Greatest % of time spent in an area |         |          |          |
|------|--------------|-----------------|-------------|-------------------------------------|---------|----------|----------|
|      |              |                 |             | 1 acre                              | 5 acres | 10 acres | 20 acres |
| #153 | 361          | 8,927           | 2289        | 2.4                                 | 5.5     | 10.1     | 15.6     |
| #155 | 339          | 7,937           | <b>2451</b> | 1.7                                 | 4.9     | 8.0      | 12.9     |
| #173 | 343          | 7,023           | 1761        | 2.0                                 | 4.9     | 11.1     | 15.8     |
| # 45 | 365          | <b>10246</b>    | 1514        | 3.0                                 | 8.0     | 12.8     | 14.9     |

# Fascinating Summary Stats . . .

| Deer | Days tracked | Total locations | Home range  | Greatest % of time spent in an area |         |          |             |
|------|--------------|-----------------|-------------|-------------------------------------|---------|----------|-------------|
|      |              |                 |             | 1 acre                              | 5 acres | 10 acres | 20 acres    |
| #153 | 361          | 8,927           | 2289        | 2.4                                 | 5.5     | 10.1     | 15.6        |
| #155 | 339          | 7,937           | <b>2451</b> | 1.7                                 | 4.9     | 8.0      | 12.9        |
| #173 | 343          | 7,023           | 1761        | 2.0                                 | 4.9     | 11.1     | <b>15.8</b> |
| # 45 | 365          | <b>10246</b>    | 1514        | 3.0                                 | 8.0     | 12.8     | 14.9        |

# Fascinating Summary Stats . . .

| Deer | Days tracked | Total locations | Home range  | Greatest chance of an area having a maximum time occupancy (%) |         |          |          |
|------|--------------|-----------------|-------------|--|---------|----------|----------|
|      |              |                 |             | 1 acre   | 5 acres | 10 acres | 20 acres |
| #153 | 361          | 8,927           | <b>2289</b> | 0.04   | 0.4     | 0.04     | 0.7      |
| #155 | 339          | 7,937           | 2451        | 0.08   | 1.5     | 2.1      | 1.4      |
| #173 | 343          | 7,023           | 1761        | 0.21   | 0.5     | 0.48     | 1.9      |
| # 45 | 365          | <b>10246</b>    | 1514        | 0.06   | 0.29    | 0.55     | 1.0      |

# Fascinating Summary Stats . . .

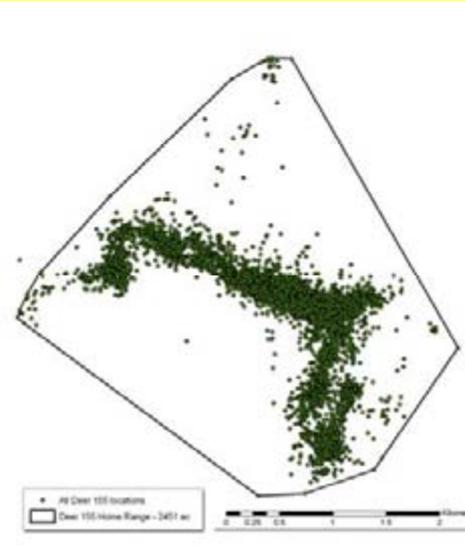
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|------|--------------|-----------------|-------------|--|---------|------------|----------|
|      |              |                 |             | 1 acre   | 5 acres | 10 acres   | 20 acres |
| #153 | 361          | 8,927           | <b>2289</b> | 0.04   | 0.4     | 0.04       | 0.7      |
| #155 | 339          | 7,937           | 2451        | 0.08   | 1.5     | <b>2.1</b> | 1.4      |
| #173 | 343          | 7,023           | 1761        | 0.21   | 0.5     | 0.48       | 1.9      |
| # 45 | 365          | <b>10246</b>    | 1514        | 0.06   | 0.29    | 0.55       | 1.0      |

**And don't forget that deer sleep!!**



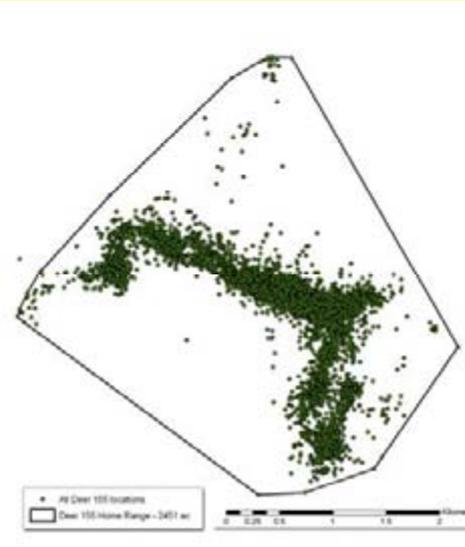
| Deer | Days tracked | Total locations | Home range  | Greatest % of time spent in an area |         |          |             |
|------|--------------|-----------------|-------------|-------------------------------------|---------|----------|-------------|
|      |              |                 |             | 1 acre                              | 5 acres | 10 acres | 20 acres    |
| #153 | 361          | 8,927           | <b>2289</b> | 2.4                                 | 5.5     | 10.1     | 15.6        |
| #155 | 339          | 7,937           | 2451        | 1.7                                 | 4.9     | 8.0      | 12.9        |
| #173 | 343          | 7,023           | 1761        | 2.0                                 | 4.9     | 11.1     | <b>15.8</b> |
| # 45 | 365          | <b>10246</b>    | 1514        | 3.0                                 | 8.0     | 12.8     | 14.9        |

## A closer look at our “Italian” Deer . . .



| cell size  | # of cells | most time spent in a cell (%);<br>chance of such a cell (%) |
|------------|------------|---|
| 10         | 284        | 8.0 / 0.7   |
| 20         | 147        | 12.9 / 1.4  |
| 30         | 107        | 15.9 / 1.9  |
| 40         | 83         | 16.6 / 1.2  |
| 50         | 70         | 17.5 / 1.4  |
| 60         | 58         | 20.6 / 1.7  |
| 70         | 51         | 24.7 / 2.0  |
| 80         | 47         | 30.1 / 2.1  |
| 90         | 39         | 25.6 / 2.6  |
| 100        | 38         | 23.5 / 2.6  |
| <b>200</b> | <b>23</b>  | <b>Drum roll . . . .</b>                                    |

## A closer look at our “Italian” Deer . . .

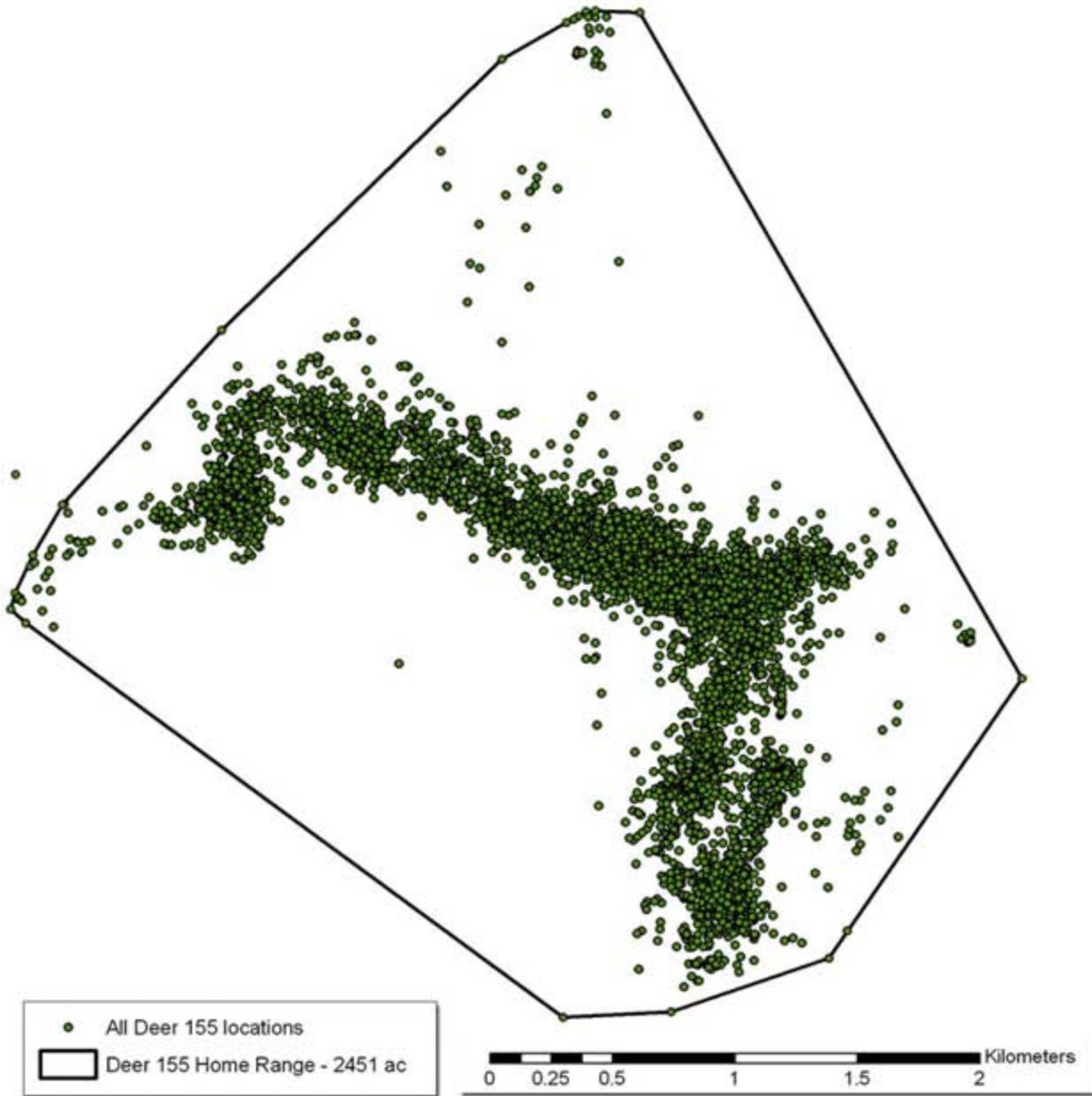


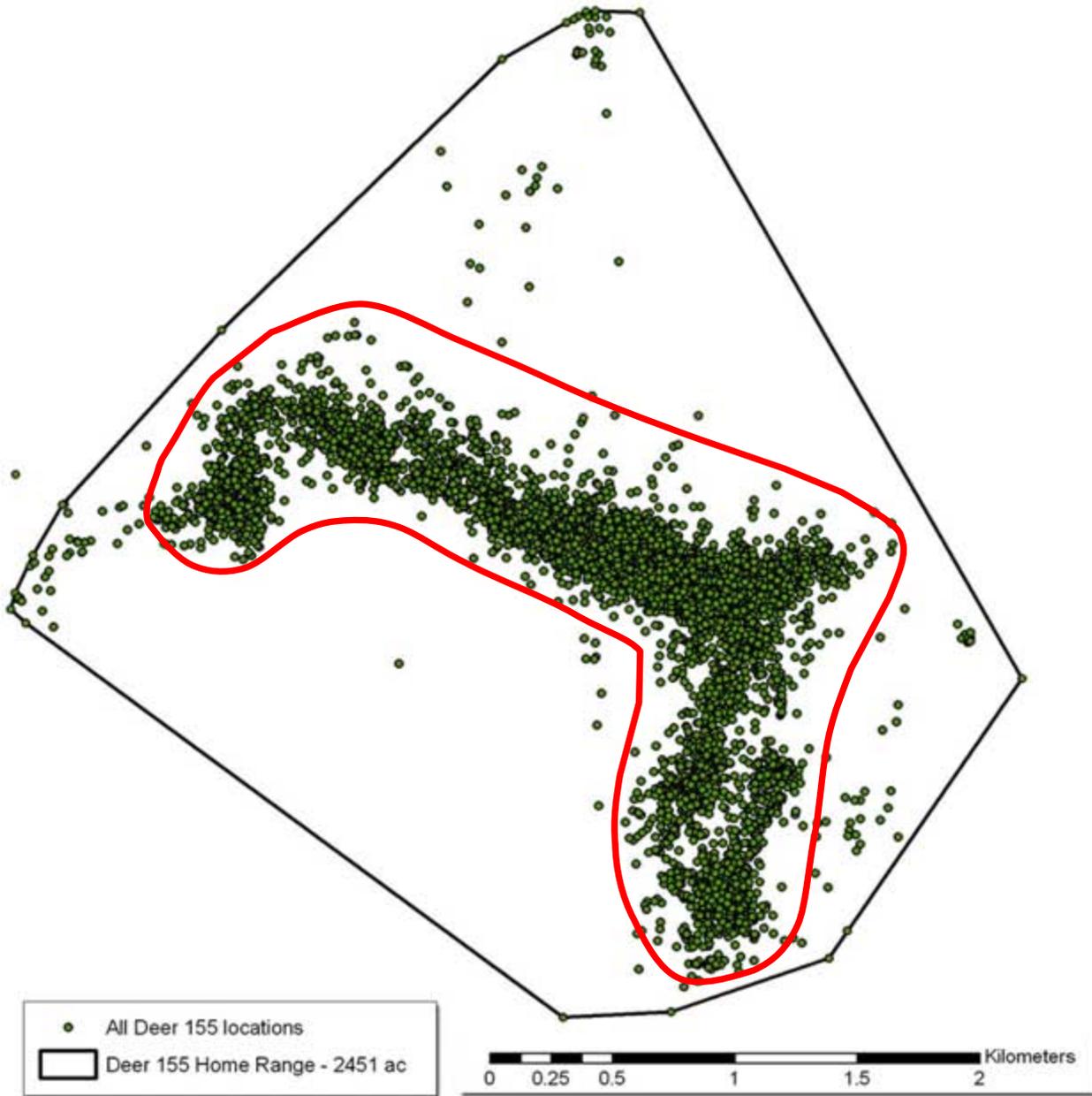
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| 70         | 51         | 24.7 / 2.0  |
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| 90         | 39         | 25.6 / 2.6  |
| 100        | 38         | 23.5 / 2.6  |
| <b>200</b> | <b>23</b>  | <b>27.4 / 4.3</b>   |

# **IMPORTANT:** FEEDBACK FROM LAST MONTH'S SETAC MEETING

“What about acute effects?”

“Have you ever heard of a salt lick?”





# Preliminary Conclusions

1. Female deer (White-tailed deer; *Odocoileus virginianus*) show every indication of having a vastly larger home range than has been previously understood. There is every reason to suspect that males are also covering vastly greater territory than we know.
  
2. Given the realistic sizes of contaminated sites that submit to ERAs, we have indications that deer are not spatially relevant for either human health or eco risk assessments!

# Preliminary Conclusions, cont'd.

3. With the most minimal of time spent contacting contaminated site-sized properties, realistically there are rather limited opportunities for deer - and probably many other high profile receptors - to be sufficiently exposed chemically such that they would:
- a) develop tox responses. (This may explain why we don't seem to know of eco ill-effects in the field.)
  - b) accumulate contaminants in their edible tissues, thereby eliminating a human health venison-consumption concern!

**(Please do recall CHPPM's 'famous' APG and Joliet AAP deer studies!)**

# **Preliminary Conclusions, cont'd.**

**4.** We don't need to come on to modeling to gain a useful and reliable sense of deer movements and opportunities for chemical exposure.

**5.** It may be plausible and defensible to suggest that remediation and restoration events, intended to protect ecological resources, are unnecessary in the common case – again, because receptors are not sufficiently exposed.

next steps

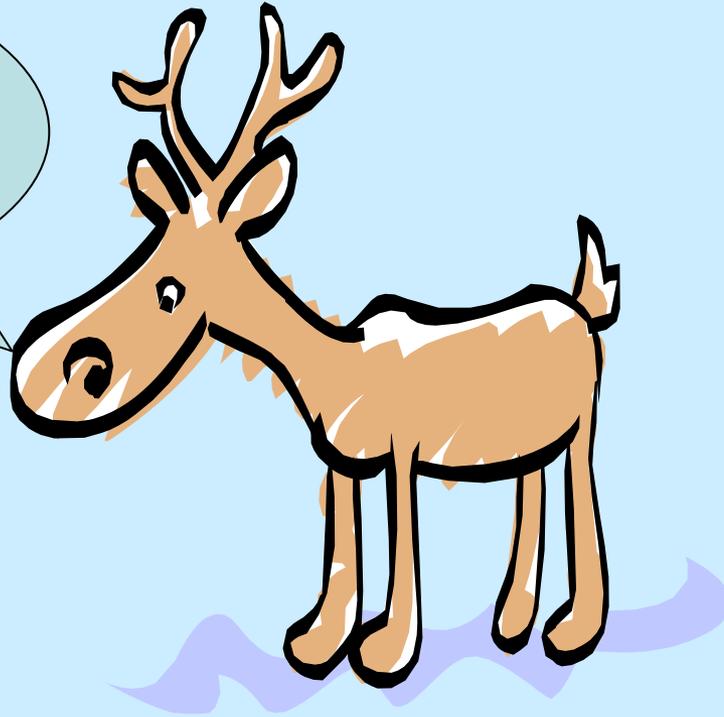
How about tracking



?

**And . . . Thank You!**

**Have you seen  
my collar  
anywhere?**



**Time for a question or two?**