

Does Intensive Forest Management Affect Innate Immunity of Wild Deer Mice (*Peromyscus maniculatus*)?

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1) Project Question

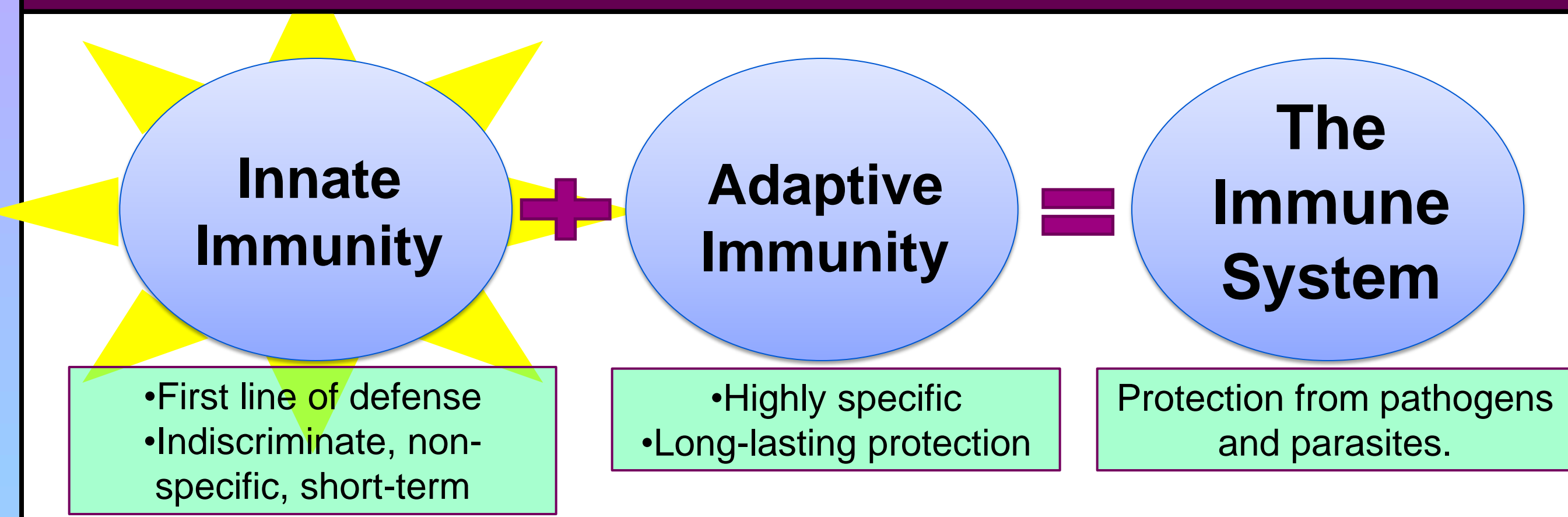


Does intensive forest management affect innate immune function of wild deer mice?

2) Background: Environmental disturbance can impair wildlife health.

- Worldwide, ecosystems are being eroded by agricultural development.¹
- This includes intensive forest management (IFM), which uses methods such as clear-cutting and herbicide application.²
- Environmental changes resulting from these agricultural activities can act as stressors for wildlife inhabiting these environments.³
- Stress can negatively affect wildlife health and immune function.⁴
- Like all mammals, the wild deer mouse (*Peromyscus maniculatus*) relies on its innate immune system for defense against pathogens.⁵
- Deer mice also play an important role in many disease cycles.⁶
- Impairing immune function in deer mice could increase disease prevalence and risk of transmission.**

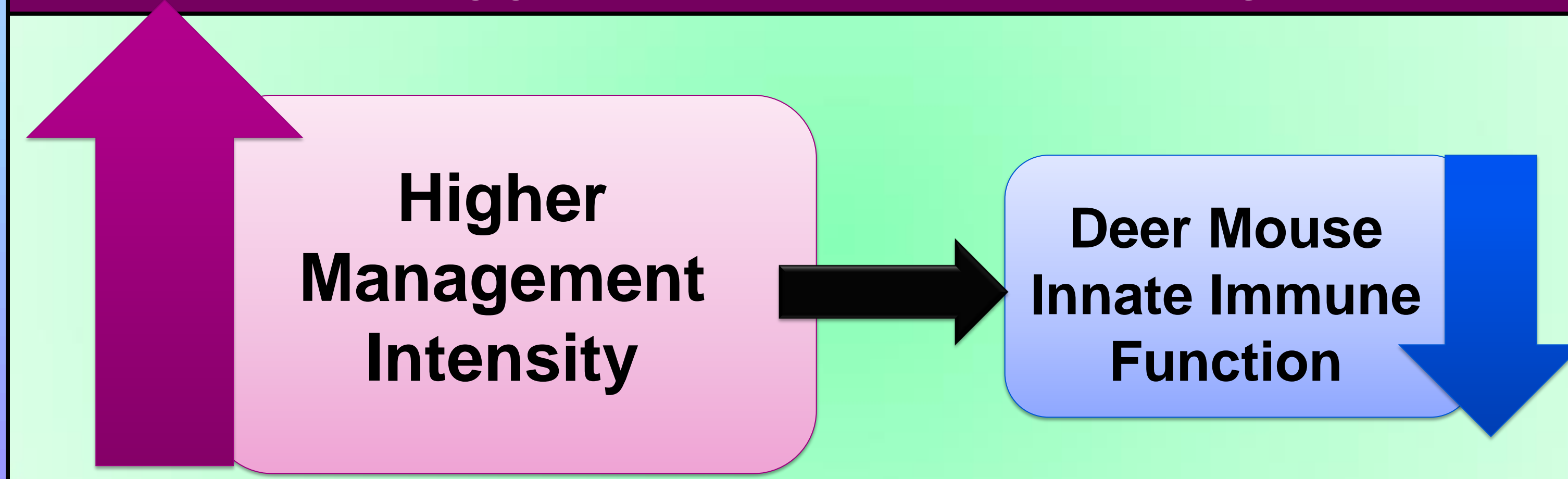
Innate immune mechanisms are the first line of defense against invading pathogens.⁹



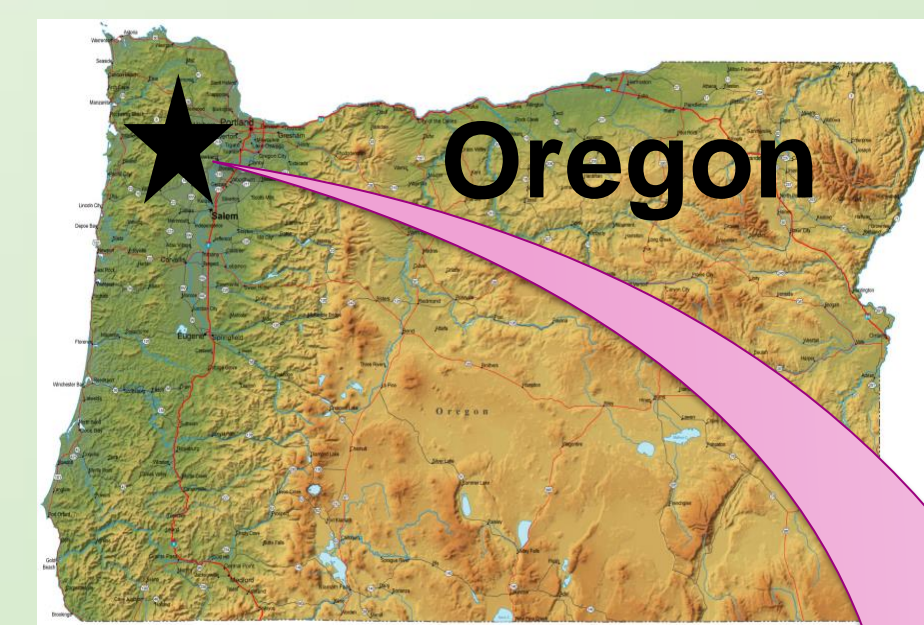
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- ³ Tilman, D., Fargione, J., Wolff, B., D'Antonio, C., Dobson, A., Howarth, R., Shindler, D., Shlesinger, W.H., Simberloff, D. and Swakhamer, D., 2001, Forecasting agriculturally driven global environmental change, *Science*, v. 292 (5515), p. 281-284
- ⁴ Acevedo-Whithouse, K. and Duffus A.L.J., 2009, Effects of environmental change on wildlife health, *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1534), p.3429-3438.
- ⁵ Martin, L.B., Weil, Z.M. and Nelson, R.J., 2008, Seasonal changes in vertebrate immune activity: mediation by physiological trade-offs, *Philosophical Transactions of the Royal Society B: Departments of Psychology and Neuroscience*, v. 363(1490), p. 321-339.
- ⁶ Meerburg, B. G., Singleton, G. R., and Kijlstra A., 2009, Rodent-borne diseases and their risks for public health, *Critical Reviews in Microbiology*, v. 35(3), p. 221-270.
- ⁷ Beutler, B., 2004, Innate immunity: an overview, *Molecular Immunology*, v. 40 (12), p. 845-859.
- ⁸ Martin, L.B., 2009, Stress and immunity in wild vertebrates: Timing is everything, *General and Comparative Endocrinology*, v. 163(1-2), p. 70-76.

3) Hypothesis: Intensive forest management suppresses innate immunity.



4) Methods: Innate immune function was measured in mice sampled across three treatments.

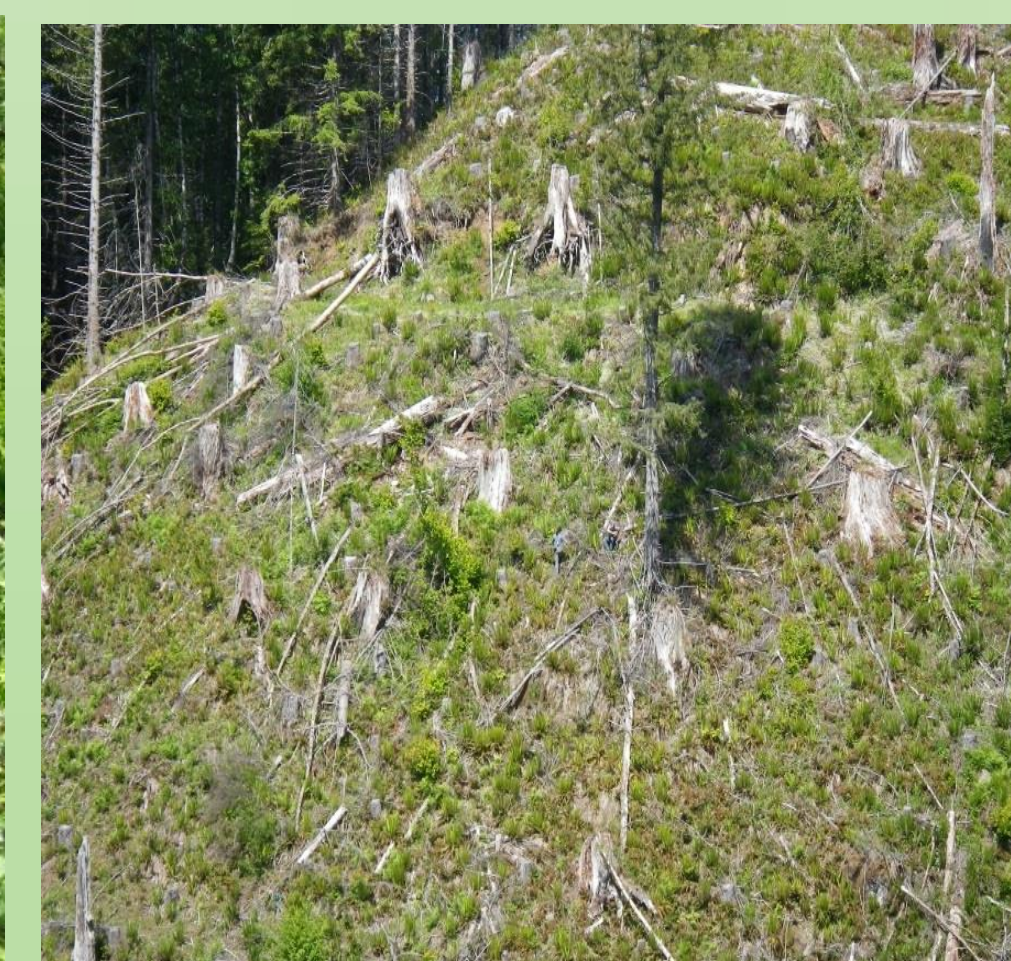


Trapping

- We trapped mice at two sites in the Oregon Coast Range. Traps were placed on plots spanning three levels of management intensity.



Older Stands
(no management for 40-50 years)



Clear Cut Control
(clear cut in last year)



Treatment
(clear cut & herbicide application in last year)

Bactericidal Assay

Bacterial growth plates ranging in whole blood dilutions.



- The ability of a standardized volume of mouse whole blood to kill *E. coli* (bactericidal activity; **BCA**) provides a measure of innate immunity.

$$\frac{(\# \text{ control colonies} - \# \text{ sample colonies})}{\# \text{ control colonies}}$$

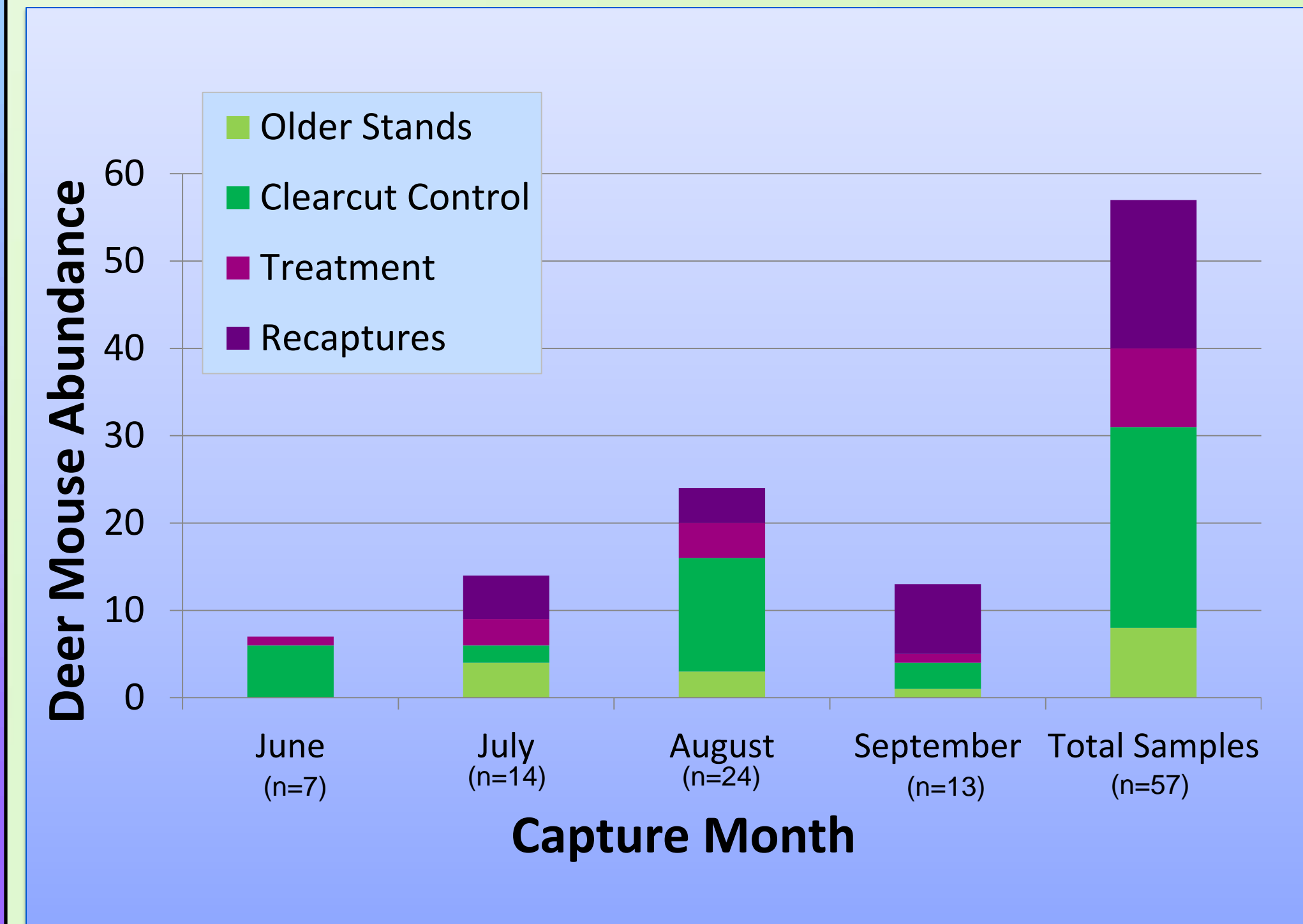
- One-way ANOVA (alpha=0.05) was used to compare mean BCA across treatments.

Acknowledgements:

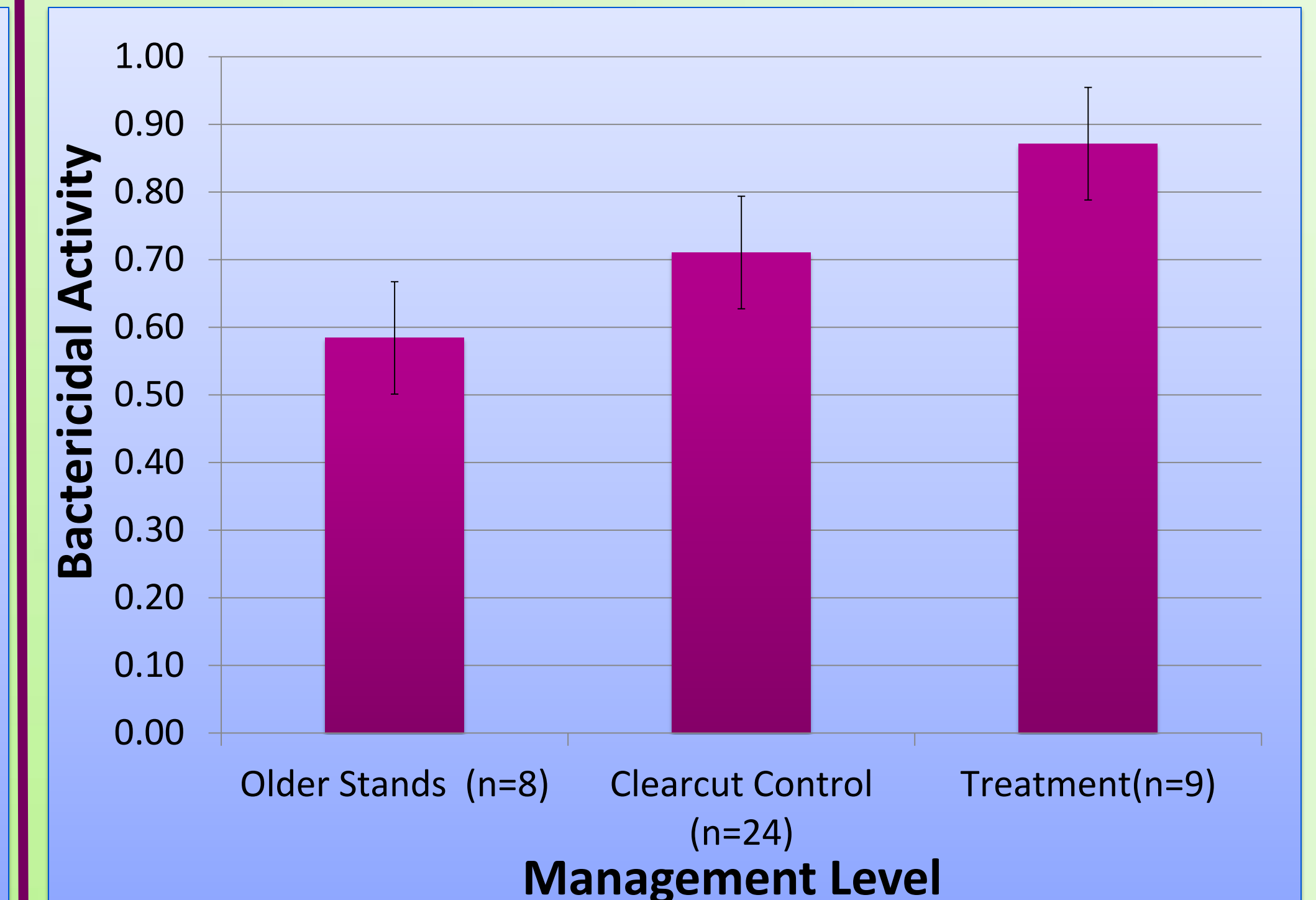
I would like to thank the Howard Hughes Medical Institute as well as the Undergraduate Research Innovation, Scholarship, Creativity Grants for funding through the summer. I would also like to thank the entire Jolles field crew and lab group for all of their support.

5) Results: Mice from treatment plots had highest bactericidal activity.

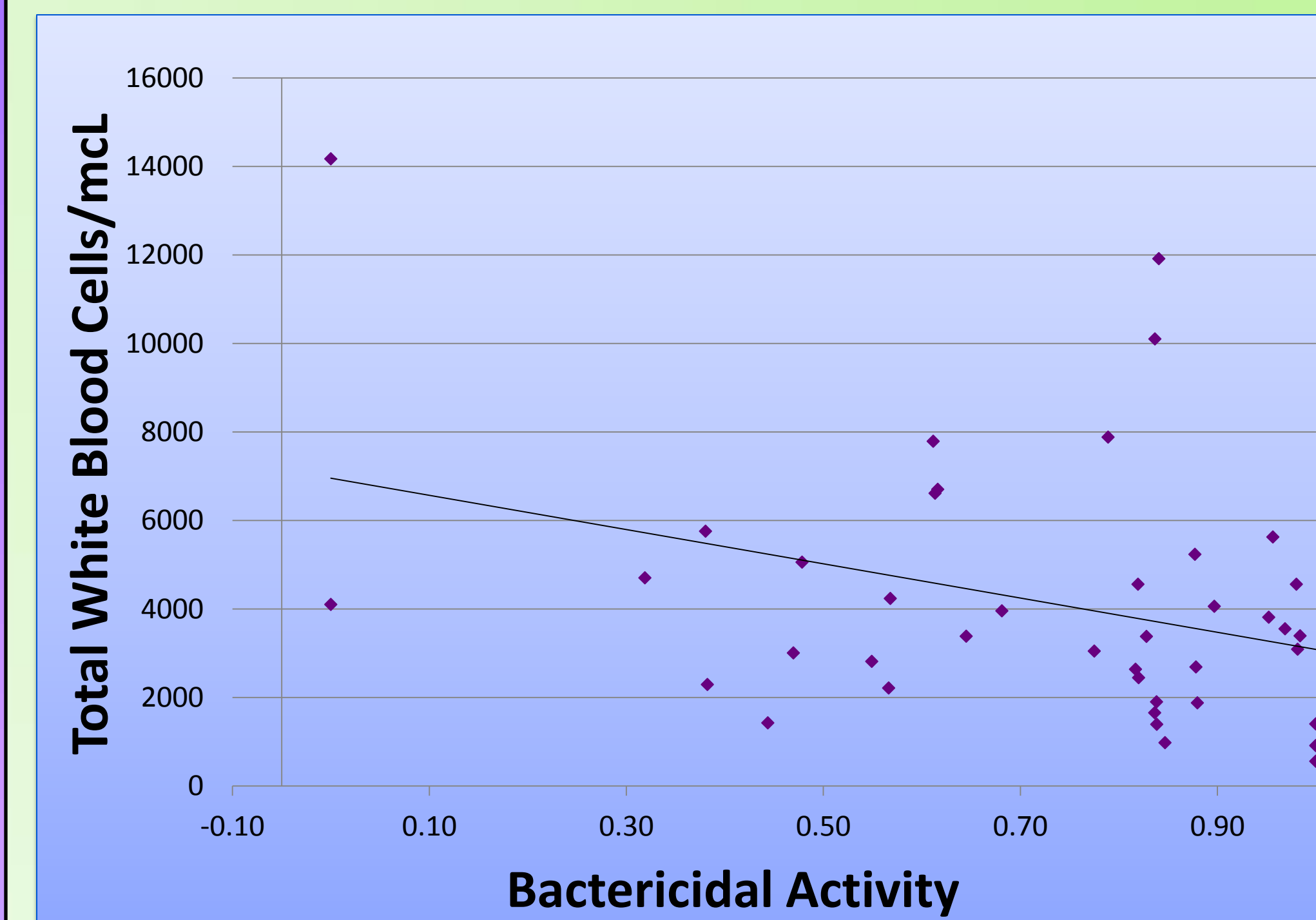
a) Between June and September 2011, 57 deer mice (including 17 recaptures) were trapped on 12 plots (4 plots/treatment).



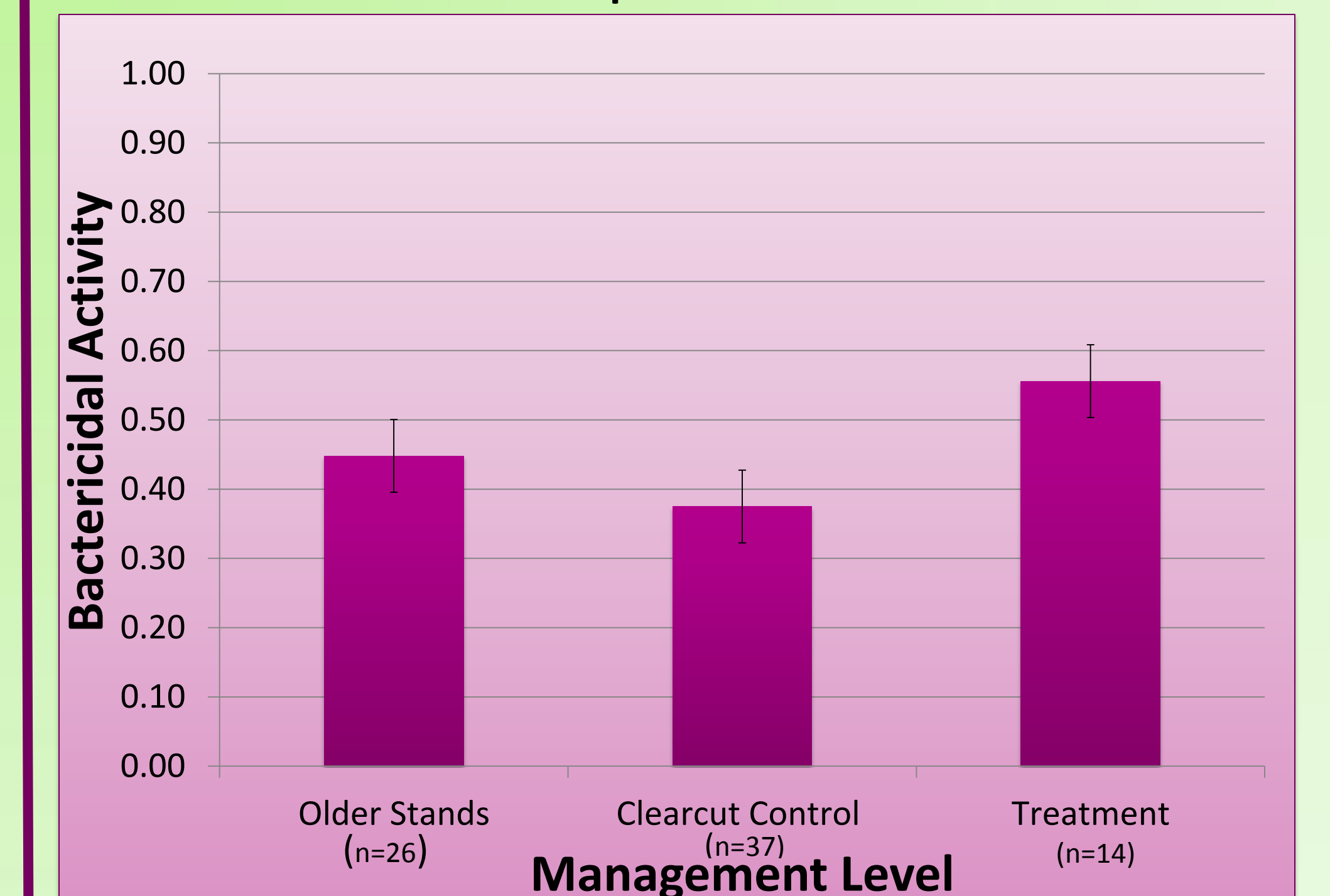
b) Mean bactericidal activity of whole blood was highest in deer mice (*Peromyscus maniculatus*) from intensively treated plots (P=0.06).



c) Mice with highest BCA have the lowest total number of white blood cells per microliter of whole blood (p=0.03, linear regression).



d) Mean bactericidal activity in Townsend's chipmunks (*Tamias townsendii*) was generally lower and did not show the same pattern across treatments.



6) Discussion: Deer mouse innate immunity is affected by forest management intensity.

- Deer mice from most intensively managed plots have highest mean BCA compared to animals from less managed sites.
- Total white blood cell counts are inversely related to BCA.
 - **Up-regulation of 'cheap', non-cellular innate immune defenses (e.g. complement) could be due to stress associated with habitat loss.**¹⁰
- Townsend's chipmunks have lower mean BCA compared to deer mice and BCA does not appear affected by forest management level.
 - **Different species vary in their investment in different immune defenses and may be differentially affected by environmental disturbance.**



Future Directions

- Increase sample size to confirm trends.
- Examine effects of pathogens and macroparasites on immune function and relate to management intensity.