Preliminary patterns in Mojave desert tortoise population densities from range-wide distance sampling

Linda Allison

US Fish and Wildlife Service

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  - Ely Field Office, Nevada BLM
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- Other logistical support

Acknowledgments

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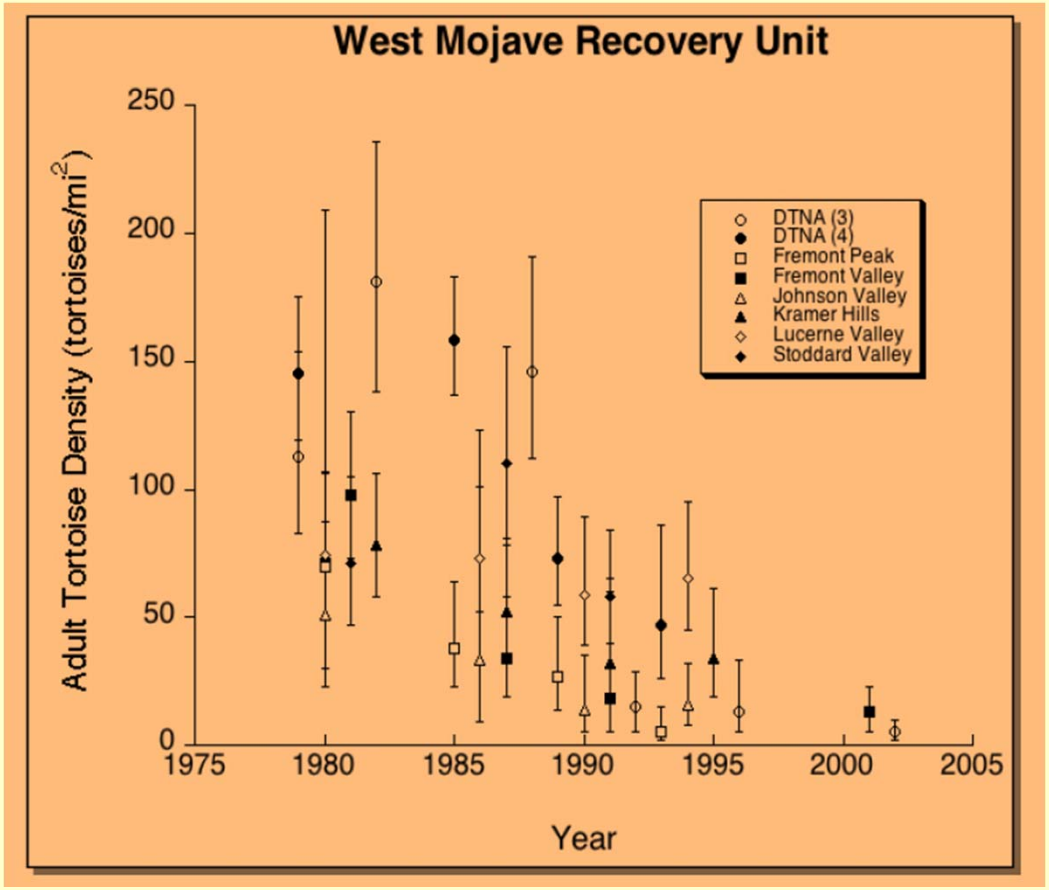
- Many originators including…
  - David Anderson and Ken Burnham
- Current caretakers
  - Ann McLuckie
  - Rohit Patil
  - Melissa Brenneman
  - Mojave Desert Ecosystem Program
- Initial analysis input
  - Dr. Tim Robinson
  - Desert Tortoise Science Advisory Committee

Describing status: 1994 and 2004

"The Western Mojave Recovery Unit included the DTNA Interior, DTNA Interpretive Center, Fremont Peak, Fremont Valley, Johnson Valley, Kramer Hills, Lucerne Valley, and Stoddard Valley Permanent Study Plots…



Tracy et al. 2004

"The … year effect yielded a significantly negative trend in adult density estimates over time ($F_{1,25} = 20.52$, $P = 0.0001$ (Fig. 4.13)….

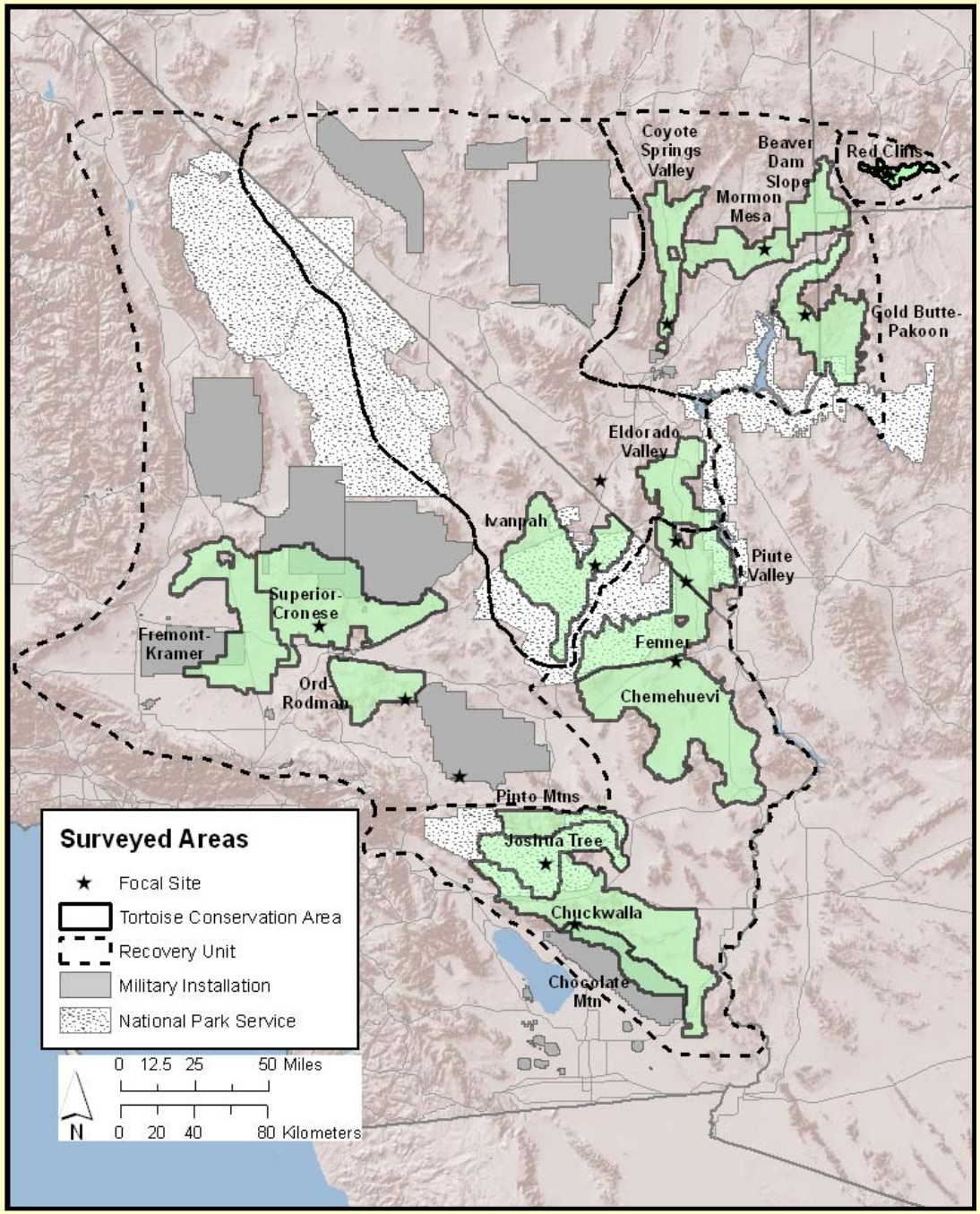
This analysis indicates that, taken together, tortoise densities on the permanent study plots located within the Western Mojave Recovery Unit are declining, as was suggested in the Recovery Plan ….

"…recovery actions implemented since the Plan have not resulted in the reversal of this declining trend."

Surveying for Desert Tortoises
Issues to Address

- Recovery criteria based on *trends within recovery units*
- Low reproductive potential
  - 1994 Recovery Plan projected potential 1% annual population increase
- Anderson and Burnham (1996) concluded 25-year trend detection possible only with extremely precise annual density estimates

Tortoise Conservation Areas



Analysis - Predictors

- Time
  - Years since 2004 (since 1999 for Upper Virgin River)
- Space
  - Tortoise conservation areas within recovery units
- Crew experience level - proportion of team with…
  - previous distance experience
  - previous field survey experience
  - both types of previous experience

Does Experience Affect Density Estimates?

FIELD TRIALS OF LINE TRANSECT METHODS APPLIED TO ESTIMATION OF DESERT TORTOISE ABUNDANCE

DAVID R. ANDERSON,[1,2] Colorado Cooperative Fish and Wildlife Research Unit, Room 201 Wagar Building, Colorado State University, Fort Collins, CO 80523, USA
KENNETH P. BURNHAM,[1] Colorado Cooperative Fish and Wildlife Research Unit, Room 201 Wagar Building, Colorado State University, Fort Collins, CO 80523, USA
BRUCE C. LUBOW, Colorado Cooperative Fish and Wildlife Research Unit, Room 201 Wagar Building, Colorado State University, Fort Collins, CO 80523, USA
LEN THOMAS, Research Unit for Wildlife Population Assessment, Mathematical Institute, University of St. Andrews, St. Andrews, Fife, KY16 9SS, United Kingdom
PAUL STEPHEN CORN, U.S. Geological Survey, Northern Rocky Mountain Science Center, Aldo Leopold Wilderness Research Institute, P.O. Box 8089, Missoula, MT 59807, USA
PHILIP A. MEDICA,[3] U.S. Geological Survey, Western Ecology Research Center, 4765 West Vegas Drive, Las Vegas, NV 89108, USA
RONALD W. MARLOW, University of Nevada, 3245 South El Camino Road, Las Vegas, NV 89146, USA

DESERT TORTOISE MONITORING • *Anderson et al.* J. Wildl. Manage. 65(3):2001

"Experience in desert tortoise biology…did not have an apparent effect on the quality of the data or the accuracy of the estimates. Observer training, specific to line distance sampling, and field testing, are important components of a reliable survey."

Correlations between predictors

Predictor	Predictor	R^2 in Upper Virgin River	R^2 in other 4 recovery units
Distance experience	Year	0.20	0.04
Field experience	Year	0.23	0.01
Both types experience	Year	0.23	0.01
Distance experience	Field experience	0.11	0.48
Both types experience	Field experience	1.00	0.64
Both types experience	Distance experience	0.11	0.91

Upper Virgin River:

- This is a 13-year dataset, so I kept this analysis separate.
- One or occasionally 2 experienced surveyors out of about 10.
  - Therefore do not consider experience meaningful in the models for UVR

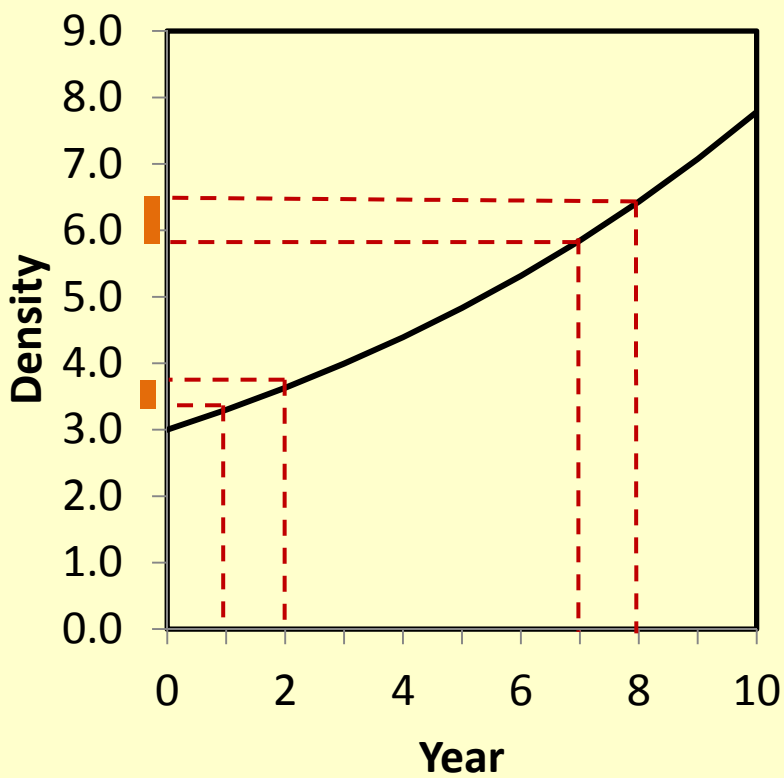
Other 4 recovery units:

- Proportion of crews with “Both” types of experience was least correlated with time.
- “Both” was highly correlated with the other 2 types of experience, so a good stand-in.

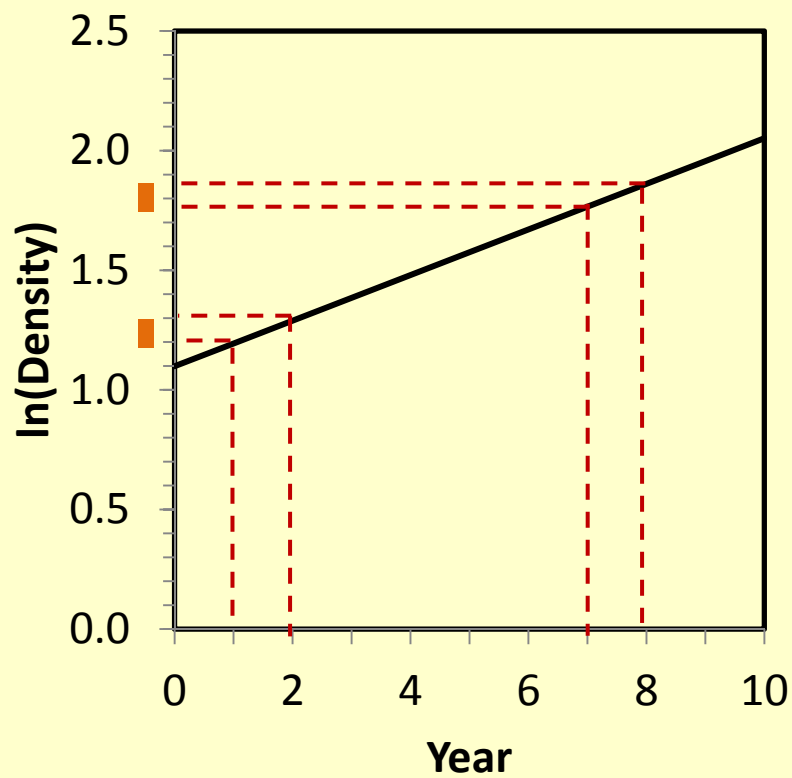
What would 10% annual growth look like?

Slope of log-transformed effect is 0.10

Density



Log_e-transformed density



Regression on $\log_e$-transformed density

- Log-transform density to match population growth and decline models
- Slope of lines reflects annual *proportional* change: 0.02 slope is a 2% annual population growth rate
- Only tortoises larger than 180 mm MCL

Set of competing models

- Intercept only (single average density)
- Spatial (differences between tortoise conservation areas)
- Year
- Year + Year^2 (trends not the same throughout the period)
- Experience
- Spatial + Experience
- Spatial + Year
- Spatial + Year + Year^2
- Experience + Year
- Experience + Year +Year^2
- Spatial + Year + Year^2 + Experience

Model selection

		4 largest recovery units			Upper Virgin River		
	Parameters	ΔAIC_c	Model wgt	R^2	ΔAIC_c	Model wgt	R^2
Spatial + Year + Spatial*Year	31	0.0	0.928	0.649	0.0	0.513	0.542
Spatial + Experience	16	5.8	0.052	0.608	3.5	0.091	0.296
Spatial + Year + $Year^2$ + Exp	18	8.6	0.013	0.636	25.7	0.000	0.656
Spatial	15	10.9	0.004	0.421	0.6	0.371	---
Spatial + Year	16	12.1	0.002	0.428	*Equivalent to row1*		
Spatial + Year + $Year^2$	17	14.9	0.001	0.428	7.9	0.010	0.620

These models in the Upper Virgin River have no spatial predictor because there is only one tortoise conservation area

Does Experience Affect Density Estimates?

- No – Anderson et al. (2001)
- No – Annual removal estimates of detection on the line in training and from field data
- No – Current analysis of factors that predict density
- Training is still the basis for using novice surveyors

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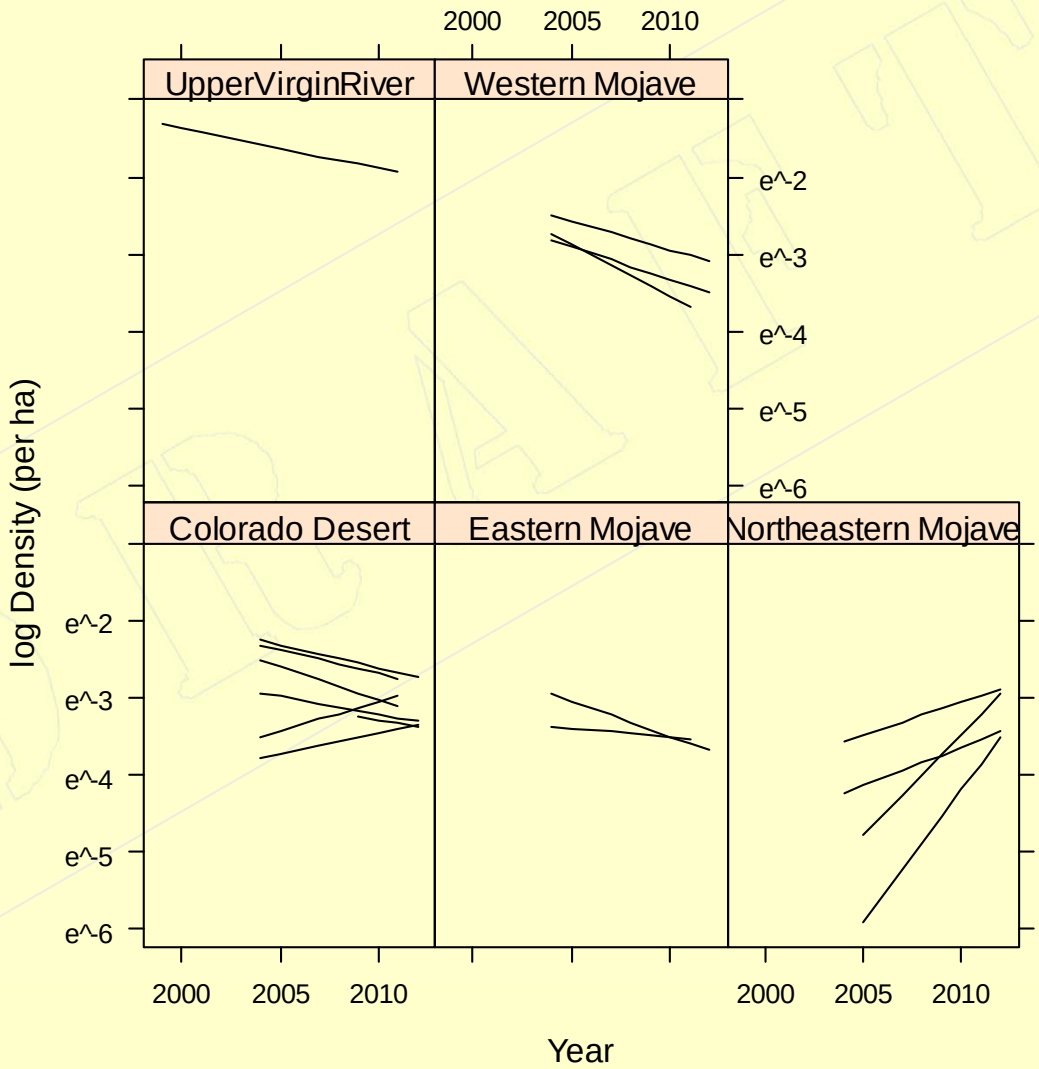
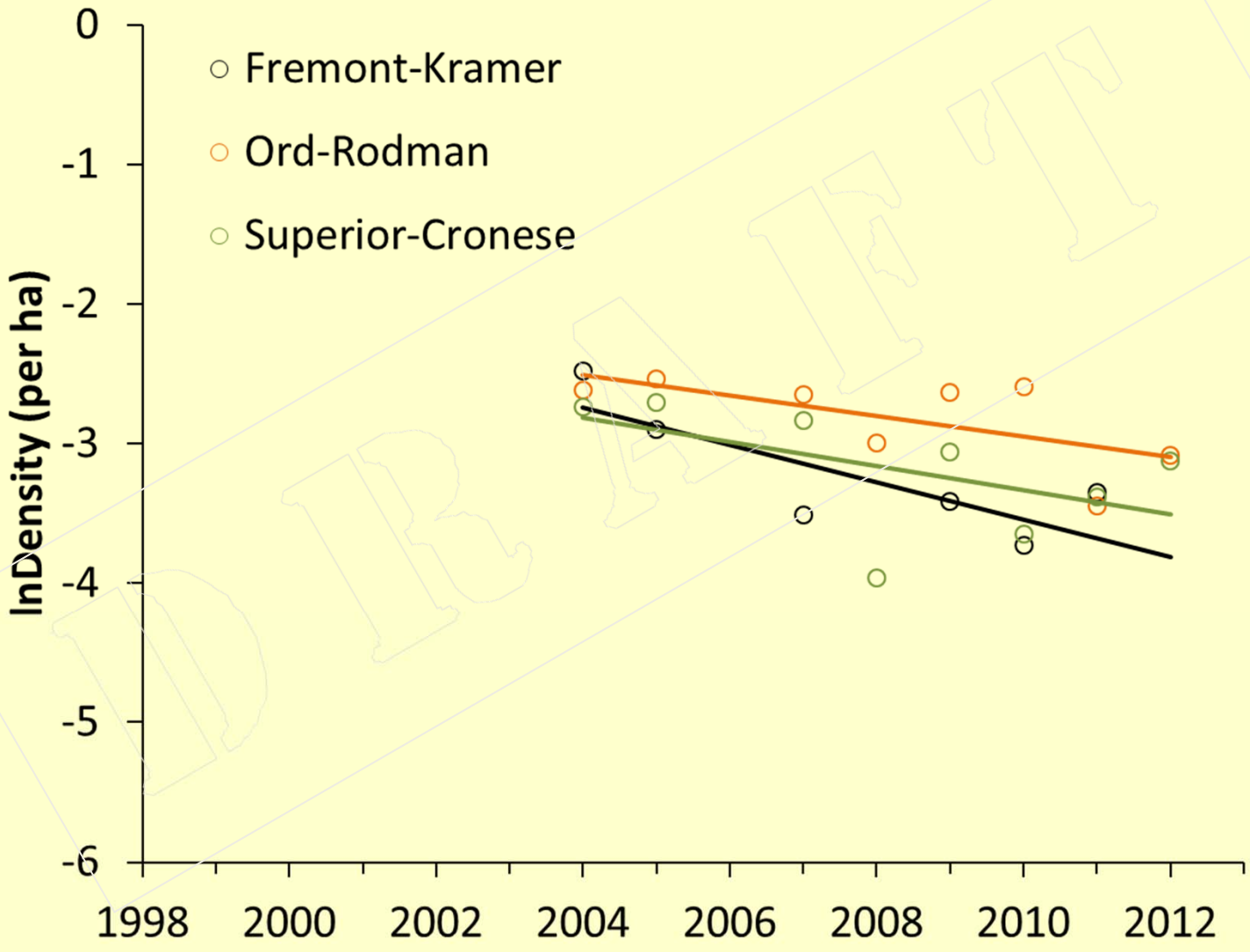
Model improvement based on more precise density estimates

Model: lnDensity = Spatial + Year + Spatial*Year	R^2
All TCAs and years 2004-2012	0.649
Total 124 density estimates	
Only estimates based on at least 5 tortoise obs	0.763
Remove 19 estimates	
Only estimates based on at least 10 tortoise obs	0.864
Remove 49 estimates	

Prevailing Mojave desert tortoise population trends



Western Mojave RU



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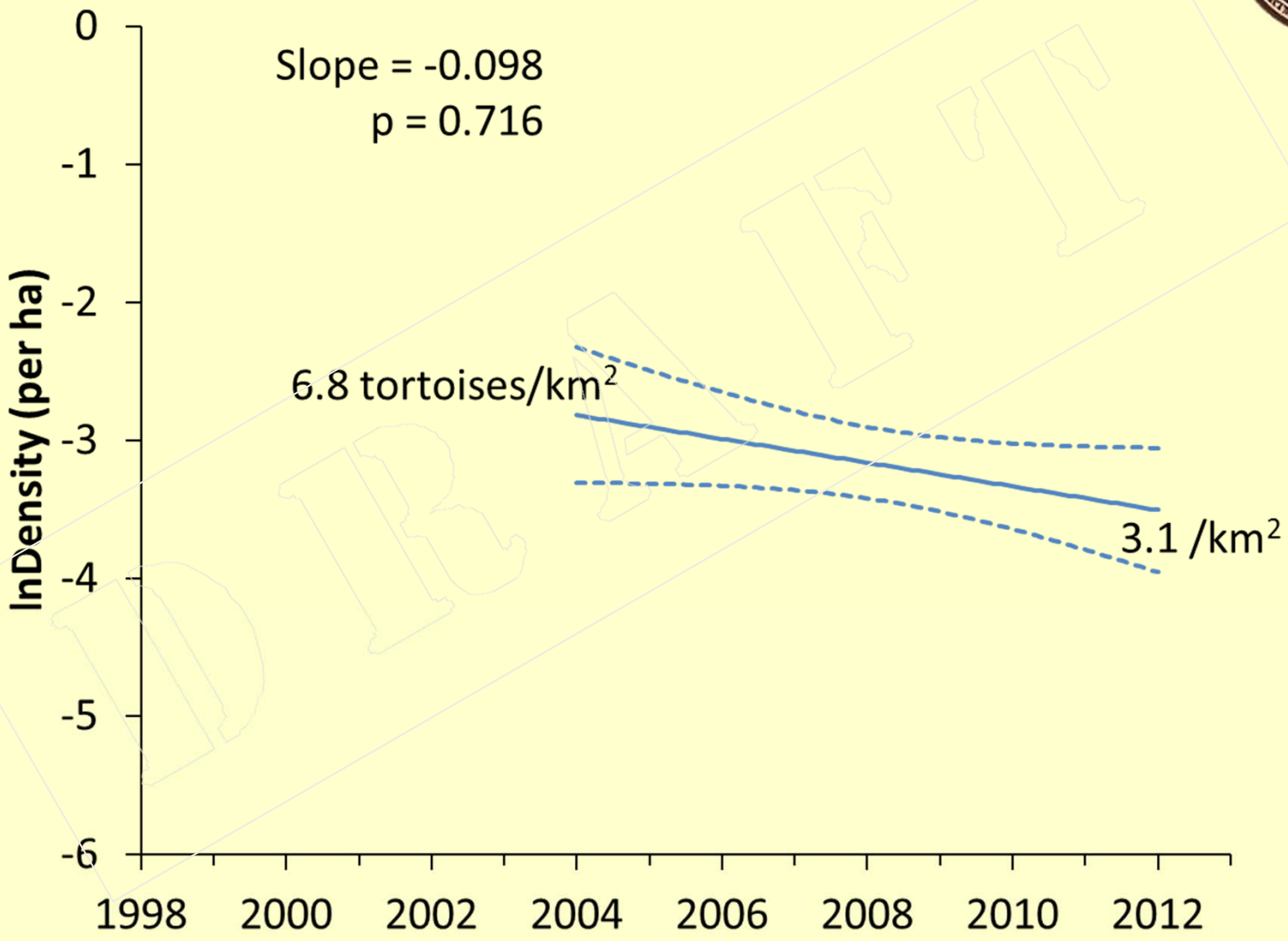
Western Mojave RU



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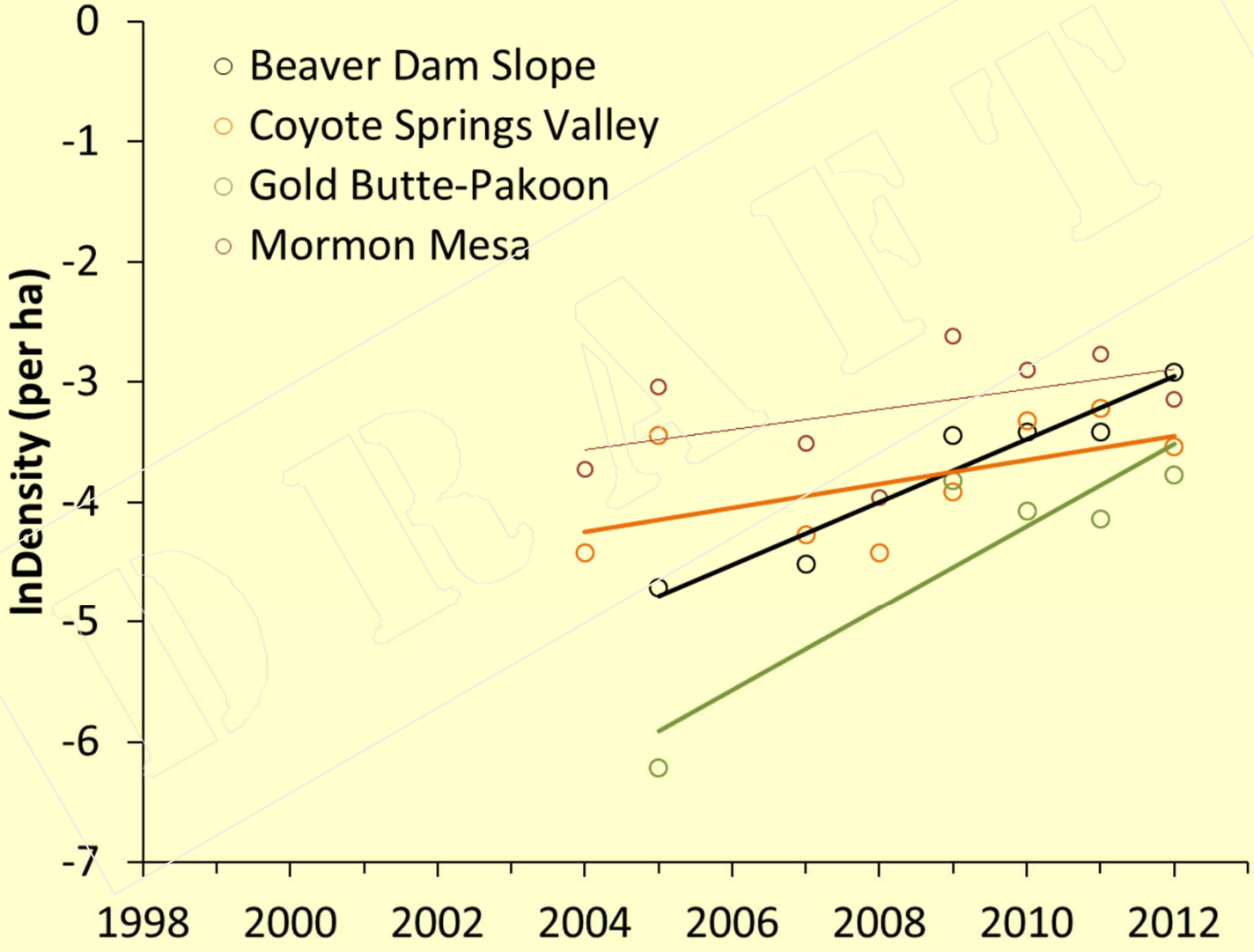
Northeastern Mojave RU



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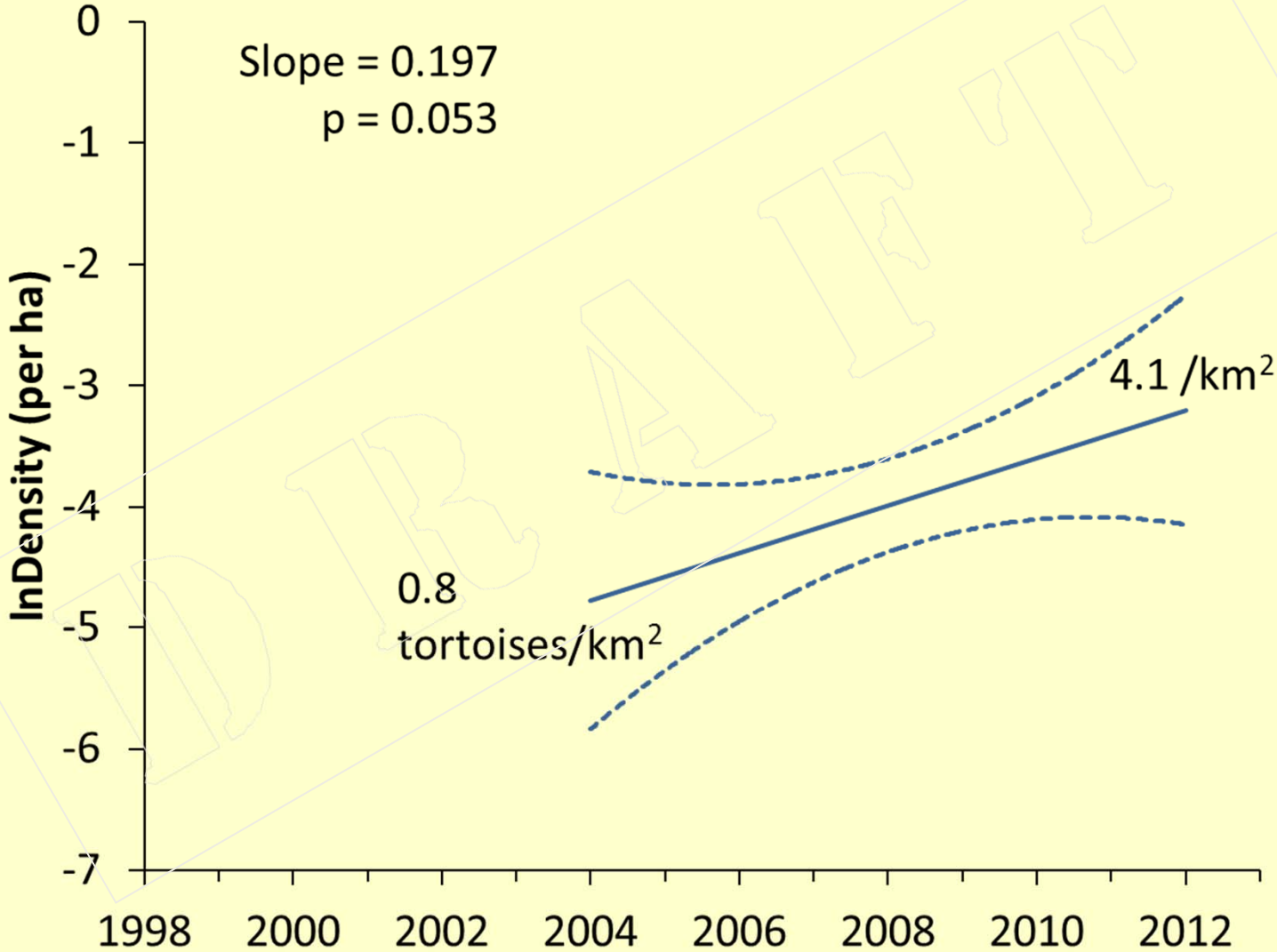
Northeastern Mojave RU



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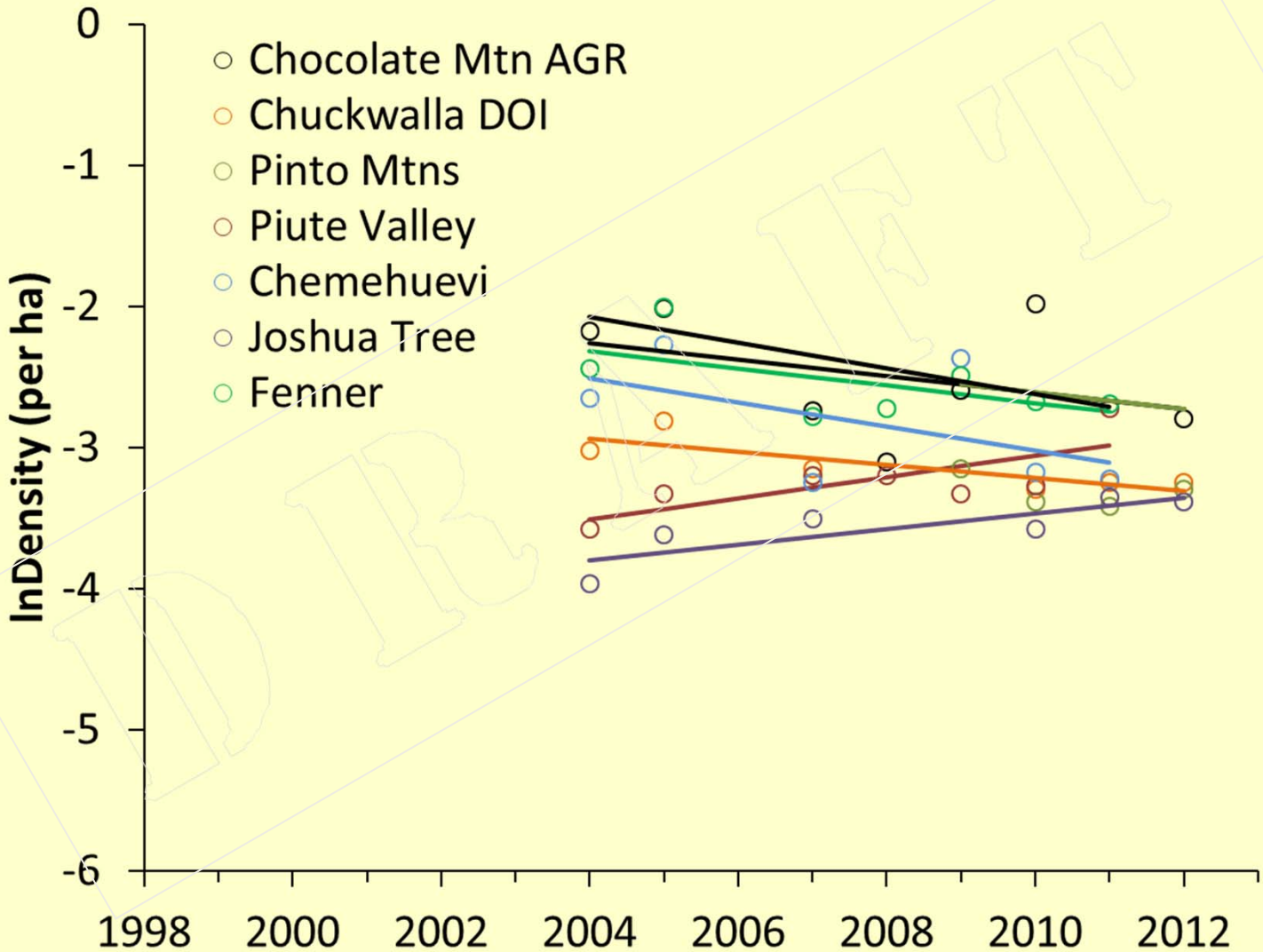
Colorado Desert RU



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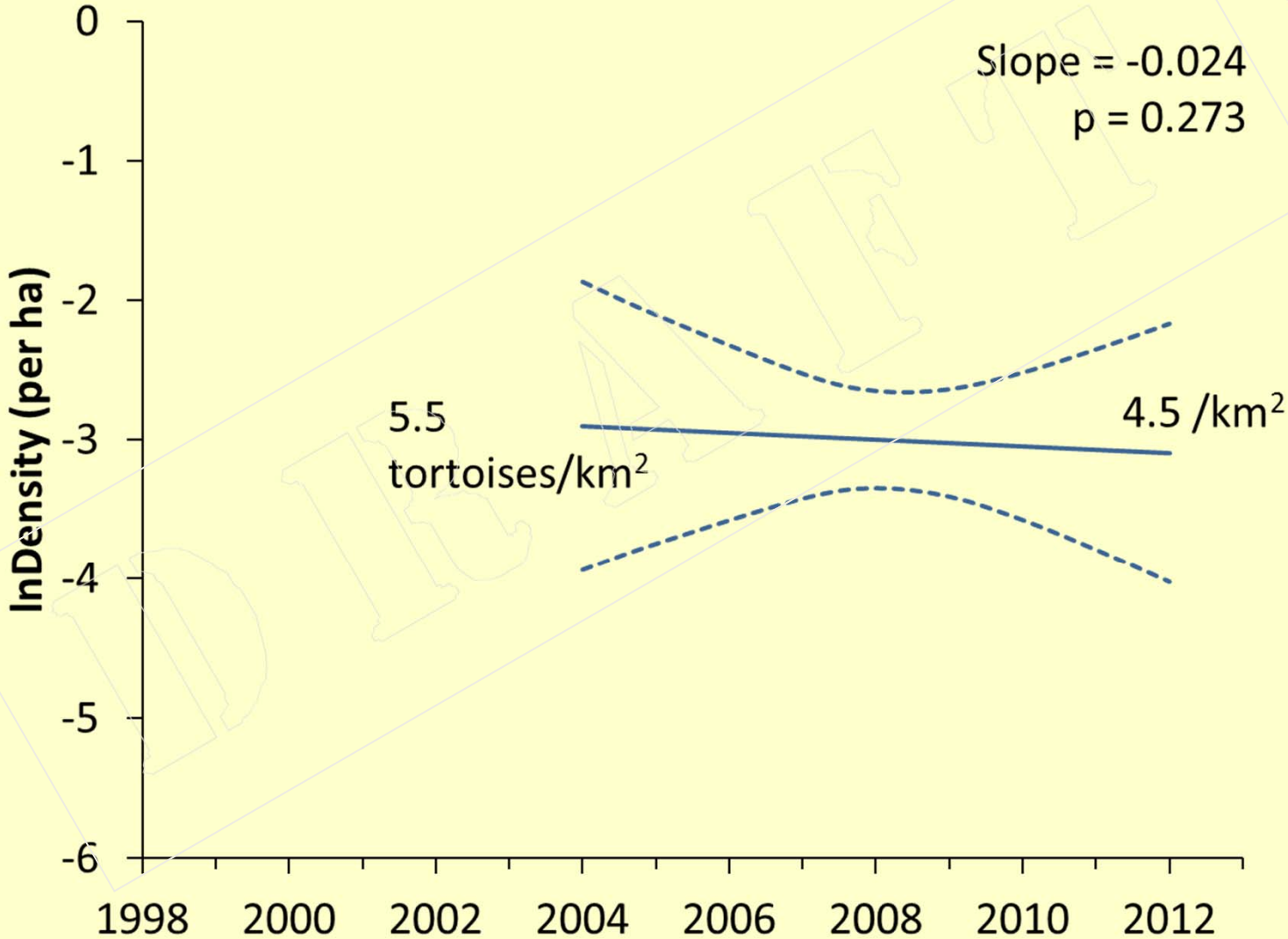
Colorado Desert RU



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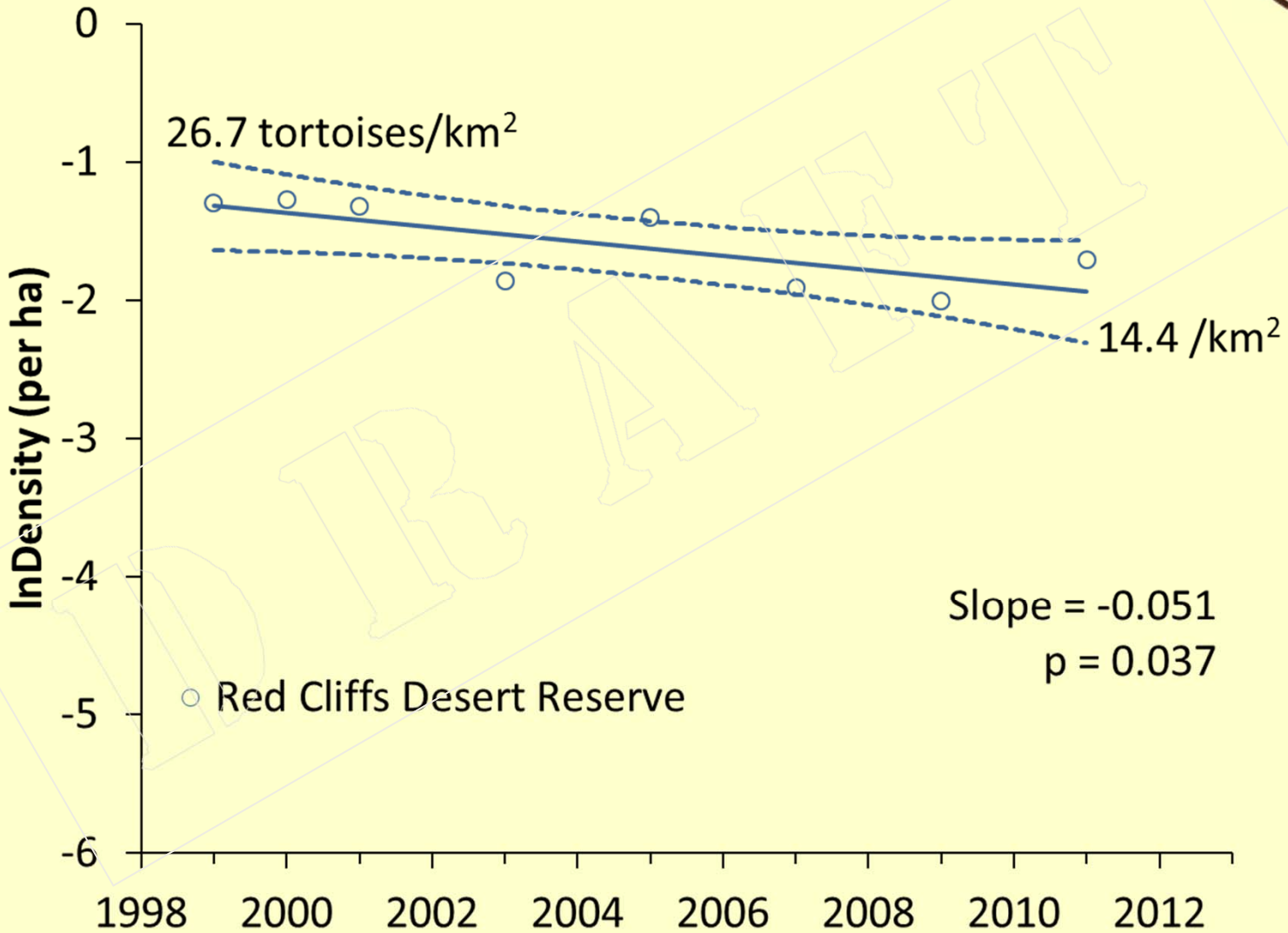
Eastern Mojave RU

Upper Virgin River RU



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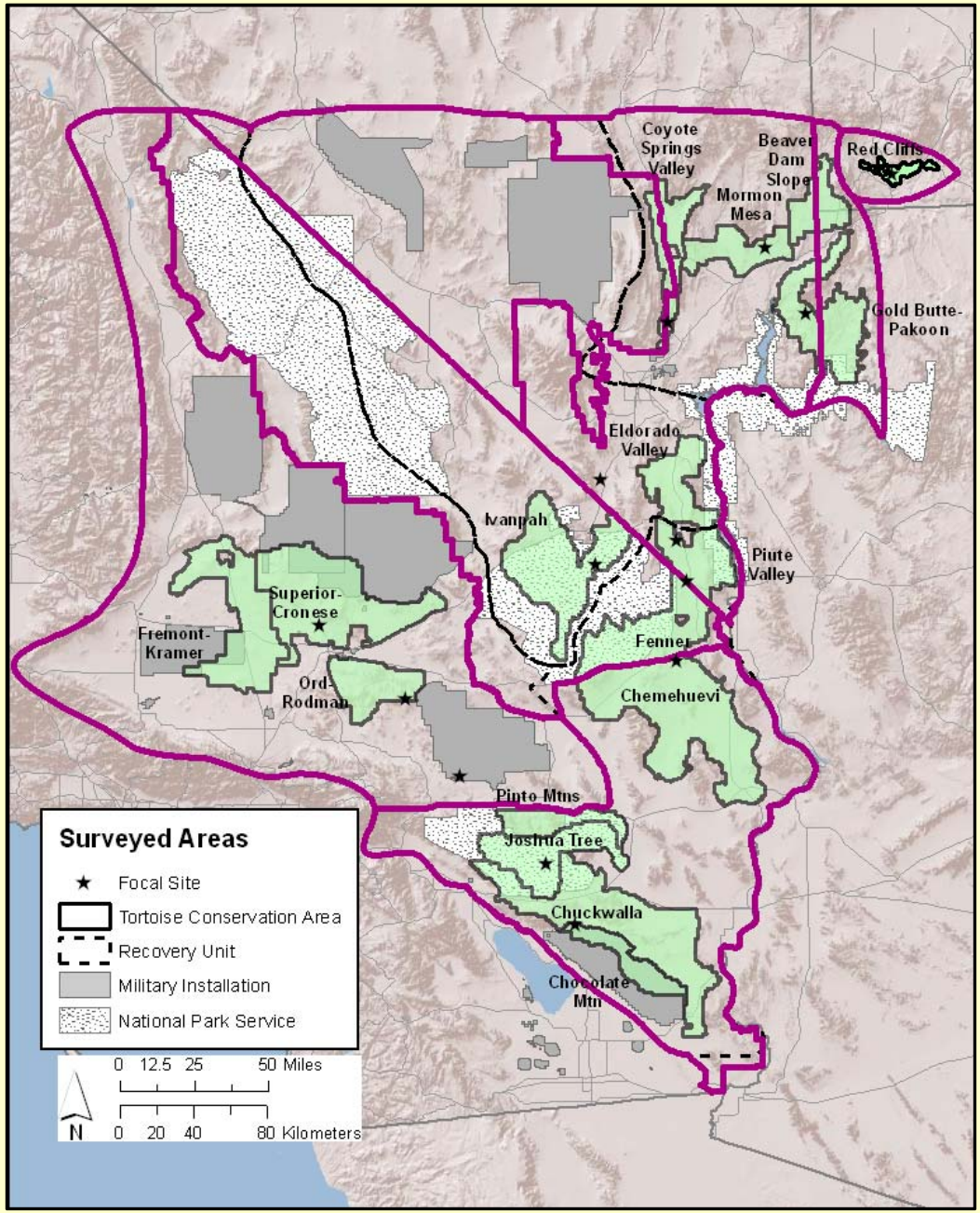
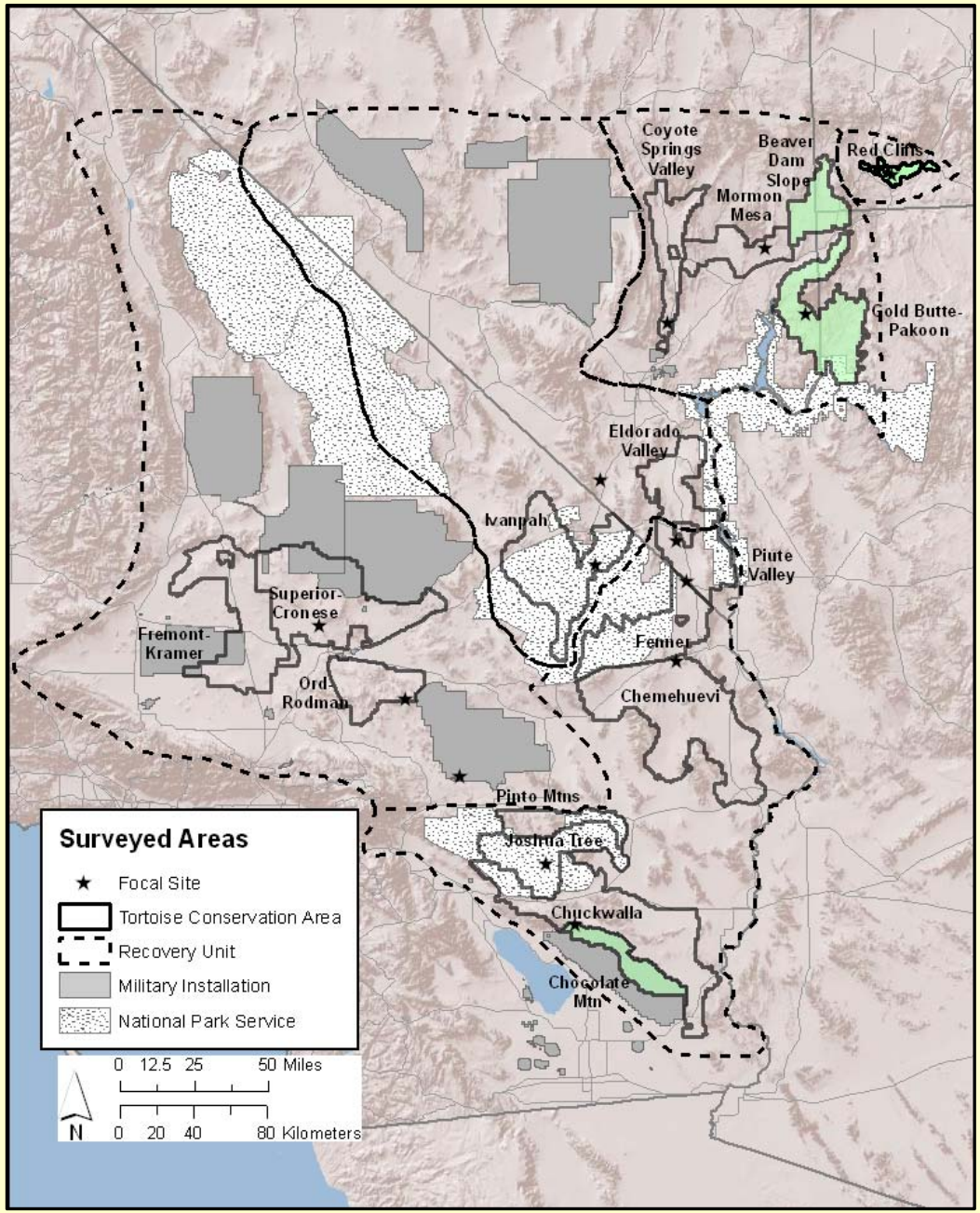
Recovery Implementation Teams (RITS): recovery targeted at tortoise conservation areas



2013: Monitoring 4 Tortoise Conservation Areas



Conclusions

- Observer experience has not affected density estimates in different parts of the desert
- Preliminary years of monitoring show some emerging TCA-specific trends
- A statistically significant trend in a TCA means we are comfortable accepting the direction of the trend (increasing or decreasing).
- Tortoise abundance in Piute Valley, Mormon Mesa, Beaver Dam Slope, and Gold Butte-Pakoon TCAs has been increasing

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Conclusions

- TCAs in a recovery unit tend to reflect similar trends; however, trends recovery-unit-wide are only statistically significant in NE Mojave and Upper Virgin River
- There is evidence of declining abundance in Upper Virgin River over the past 13 years
- Potential increasing trends are not limited to slow improvements from increased reproductive success; larger population growth rates can only result from improved survivorship of reproductive and pre-reproductive tortoises

Conclusions

- Analyzing trends by TCA allows us to forego monitoring where there is insufficient funding
- Increased detections (>10 per TCA) are associated with better trend modeling (higher R^2)
- These results are directly relevant to describing ongoing status of Mojave desert tortoises
- This project is directly relevant to assessing success of current and future recovery planning - RITs