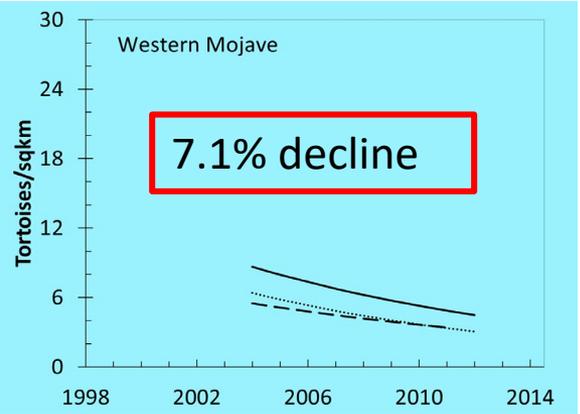
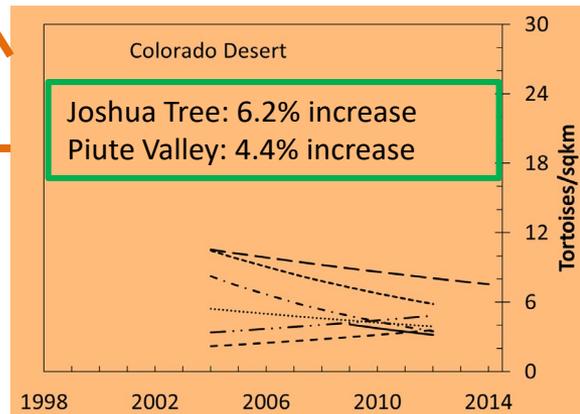
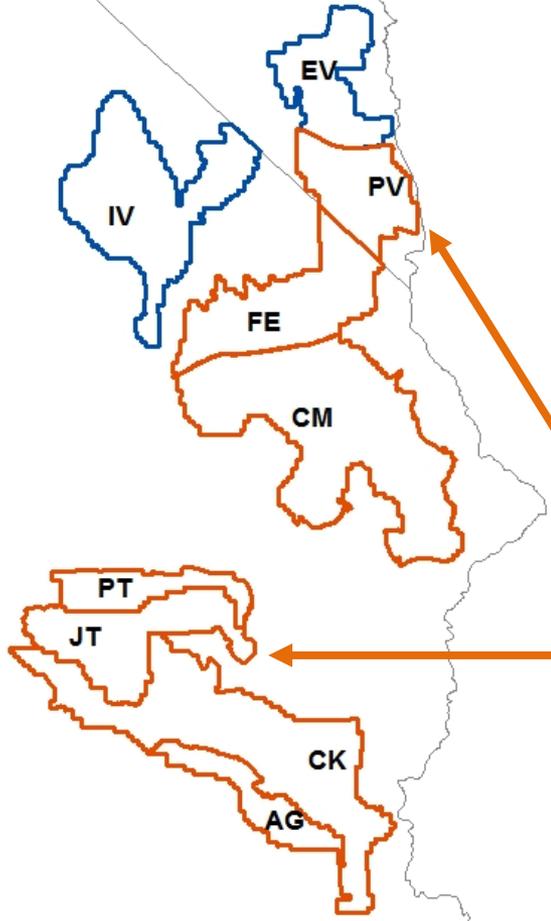
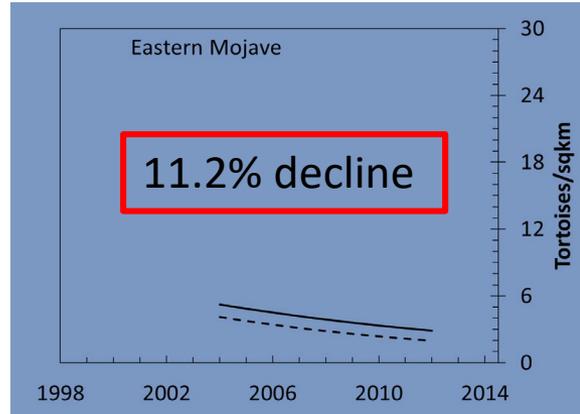
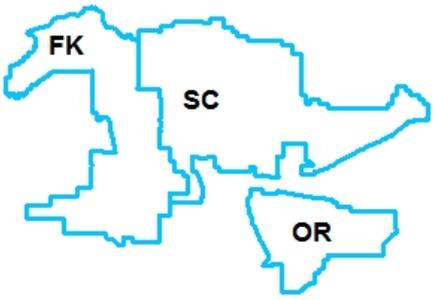
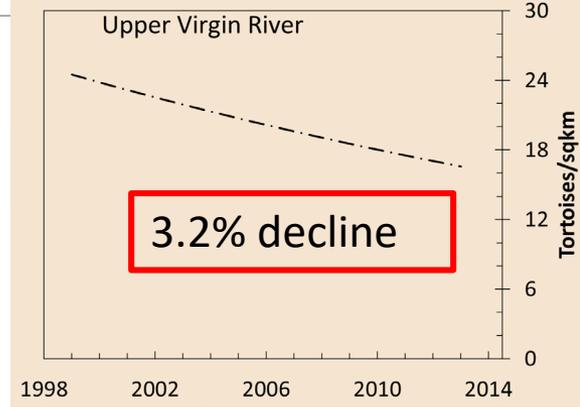
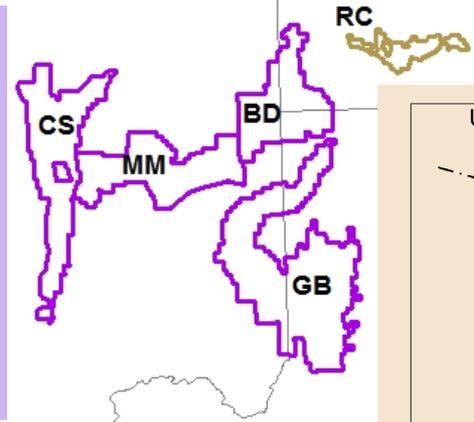
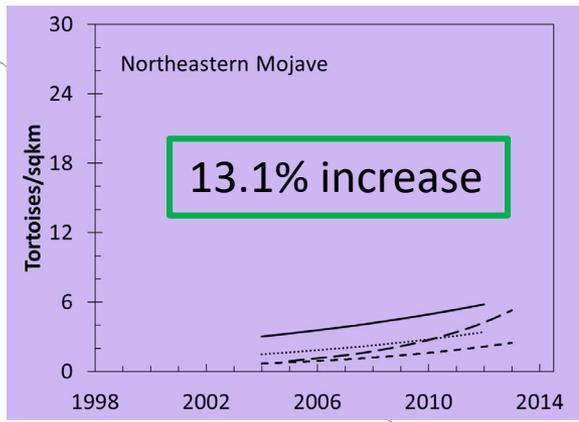


Range-wide surveys for Mojave desert tortoises

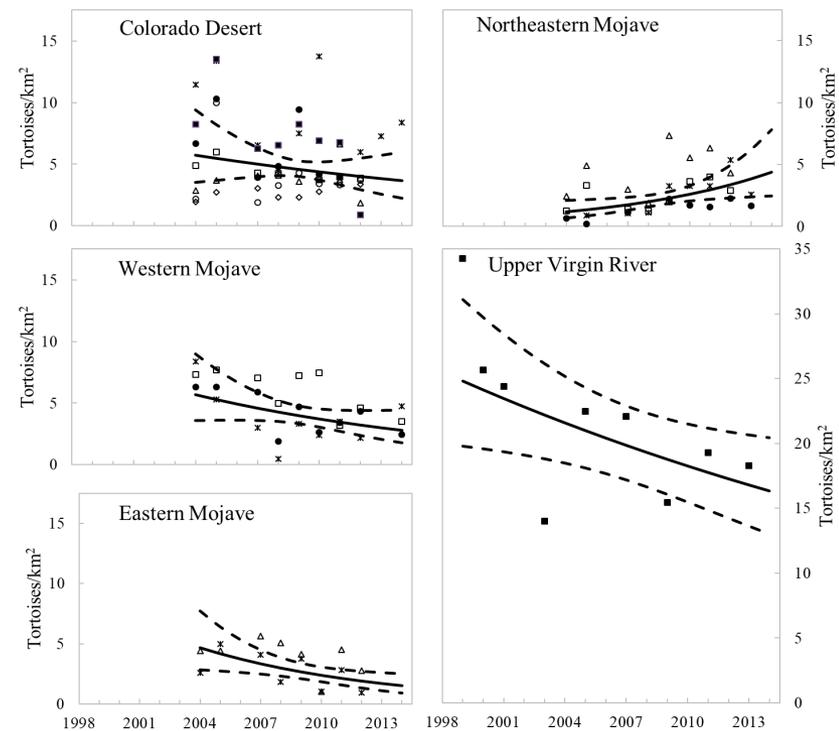
Linda Allison

USFWS Desert Tortoise Recovery Office





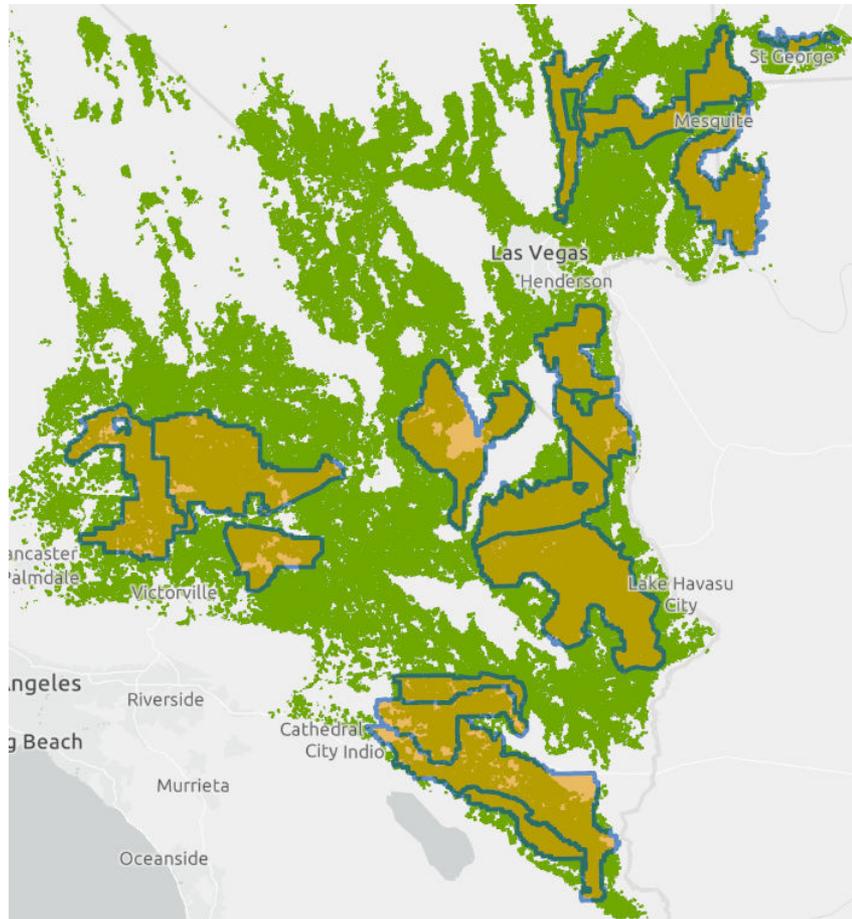
Trends in density of Mojave desert tortoises



- Trends in adult densities are declining or neutral in 4 of 5 recovery units
- Each recovery unit is represented by 1-7 separate Tortoise Conservation Areas (TCAs)
- Although declines have been ongoing over 15 years, Upper Virgin River still has higher adults densities than other recovery units.
- The recovery unit and individual TCAs with increasing trends had the lowest densities in 2004



Trends in abundance of Mojave desert tortoises



- We estimated trends in each TCA
- A natural question is, what is the desert-wide trend?
- This shows the TCAs and other potential habitat described by Nussear et al. (2009), without areas that are known to be impervious (Fry et al. 2009)
- I extrapolated densities in TCAs to all potential habitat in the same recovery unit



Change in abundance of adult Mojave desert in each recovery unit (in and out of TCAs)

Recovery Unit	Modeled Habitat (sqkm)	2004 Abundance	2014 Abundance	Change
Western Mojave	23,139	131,540	64,871	-66,668
Colorado Desert	18,024	103,675	66,097	-37,578
Northeastern Mojave	10,664	12,610	46,701	34,091
Eastern Mojave	16,061	75,342	24,664	-50,679
Upper Virgin River	613	13,226	10,010	-3,216
Total	68,502	336,393	212,343	-124,050



Habitat area based on Nussear et al. 2009

Tortoise abundance from Allison and McLuckie 2018

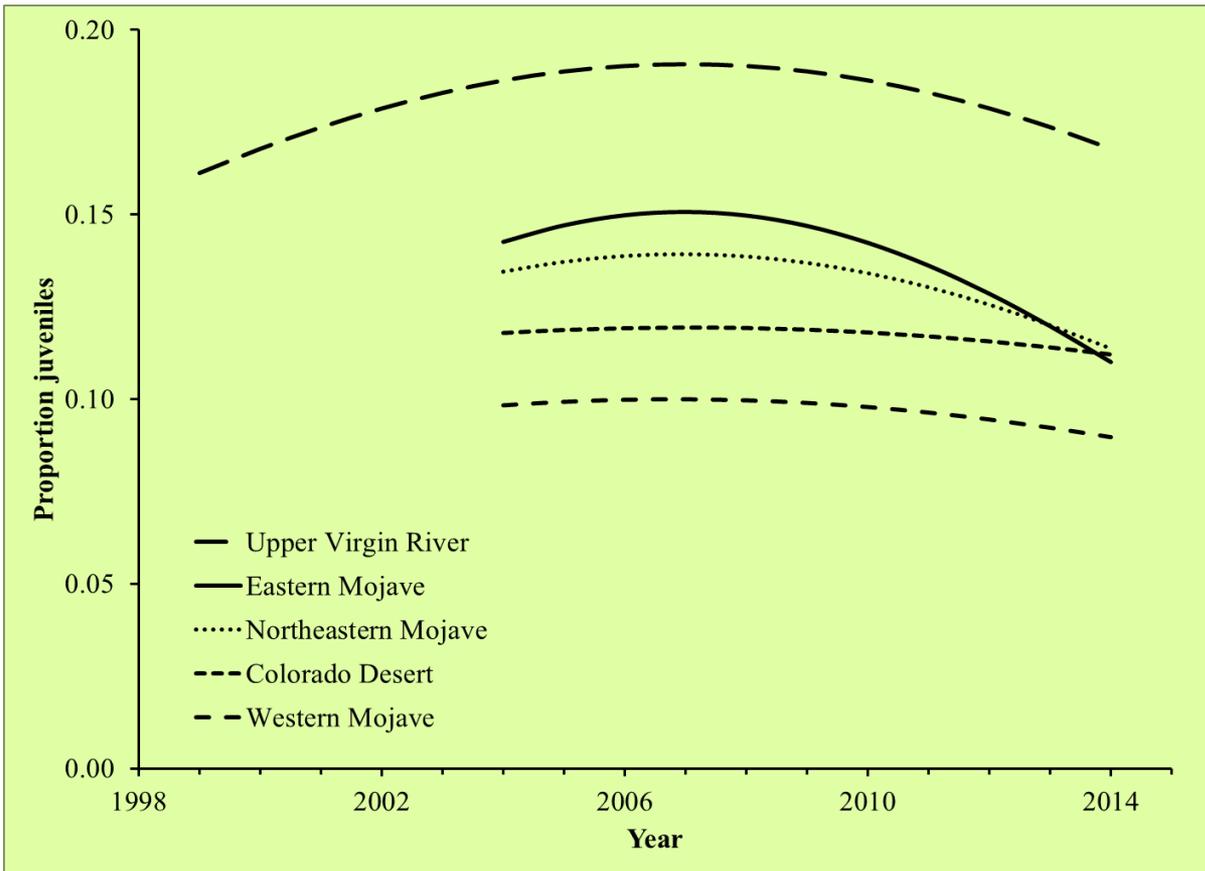
Changes in habitat area in each recovery unit

Recovery Unit	Modeled Habitat (sqkm)	Impervious surfaces (removed to get areas on left)
Western Mojave	23,139	24.6%
Colorado Desert	18,024	10.0%
Northeastern Mojave	10,664	12.6%
Eastern Mojave	16,061	16.7%
Upper Virgin River	613	34.8%
Total	68,502	17.6%

Habitat area based on Nussear et al. 2009

Impervious surfaces through 2006 from Fry et al. 2009

Relative Abundance of Smaller Tortoises (< 180 mm)

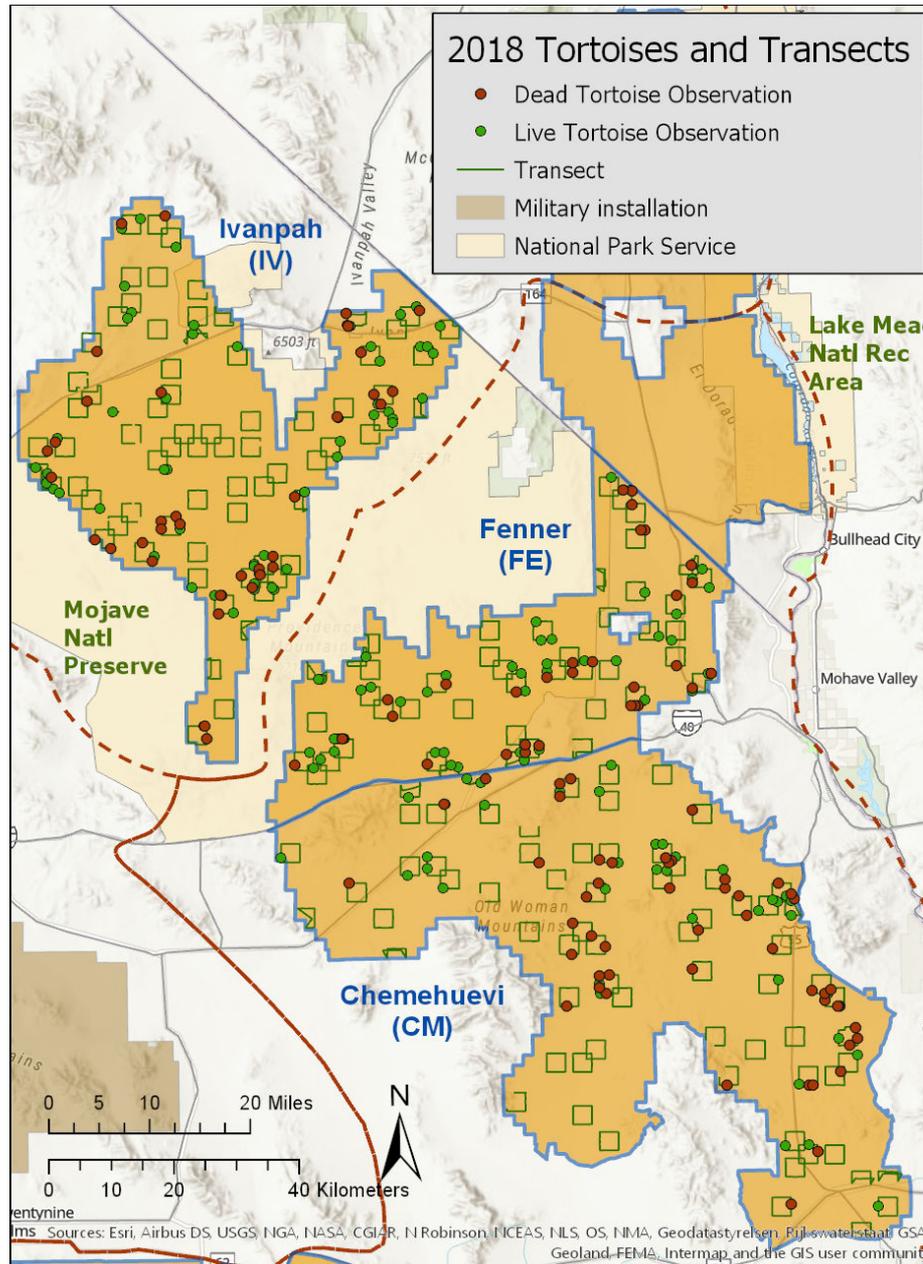


- The proportion of juveniles has been declining in all recovery units since 2007.
- Juveniles will not bolster adult numbers in the near term

Allison and McLuckie 2018



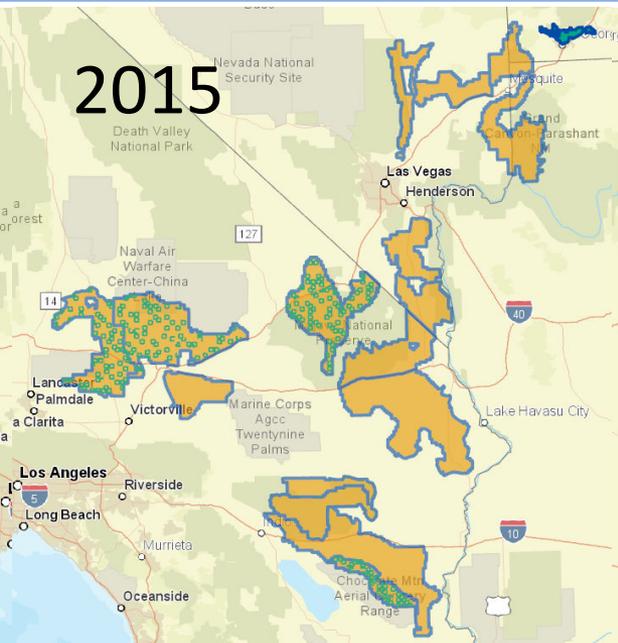
Where do these density estimates come from?



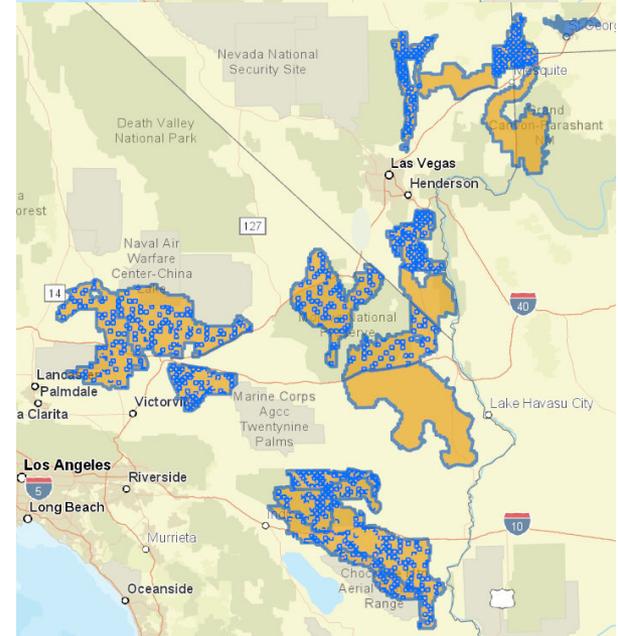
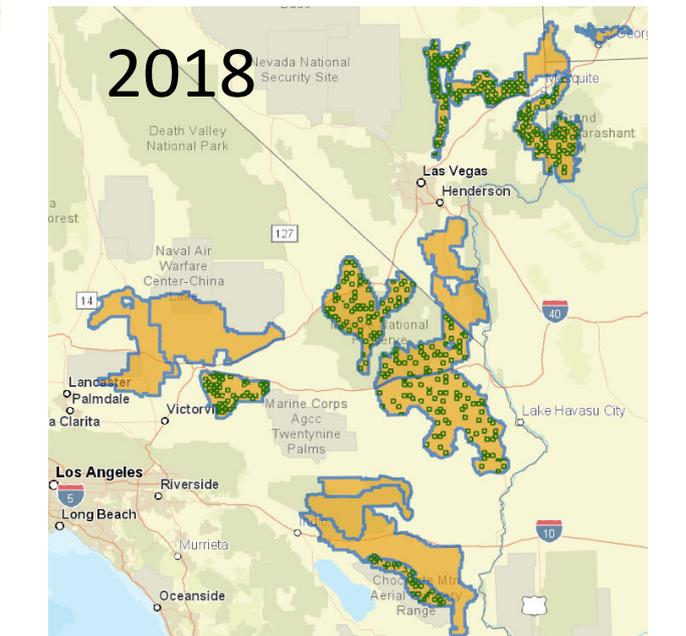
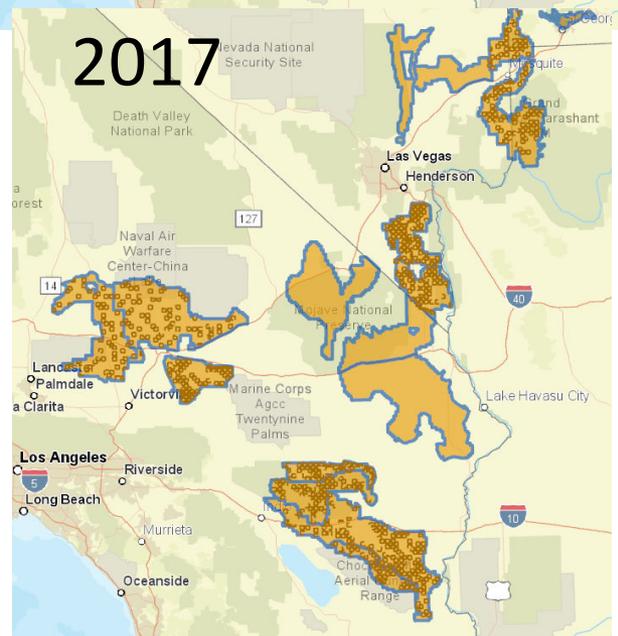
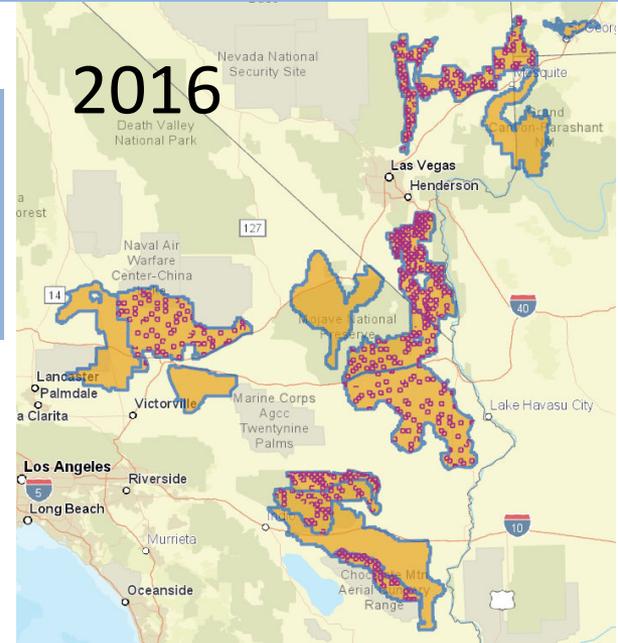
- Each green square represents a day of work for 2 people + support
- The number of transects is set to find just enough tortoises for a credible density estimate
- This results in surveys that cover 0.5 – 2% of the area of each stratum



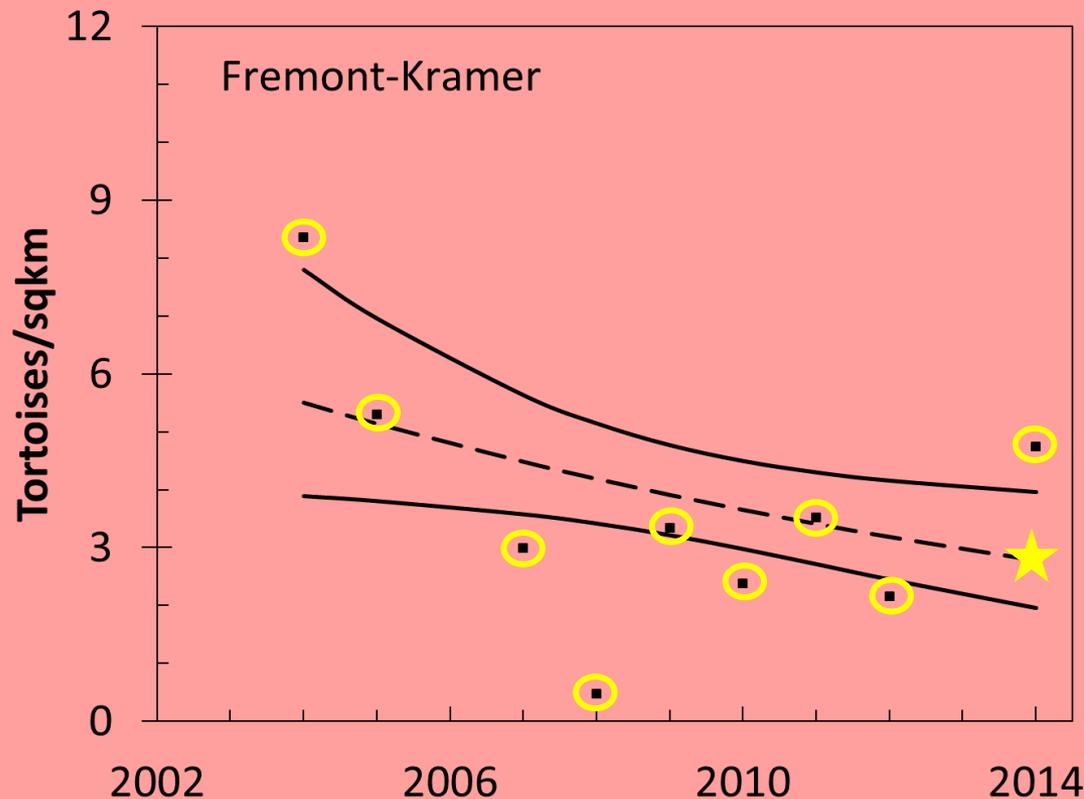
Where do these density estimates come from?



Costs preclude surveying every TCA every year

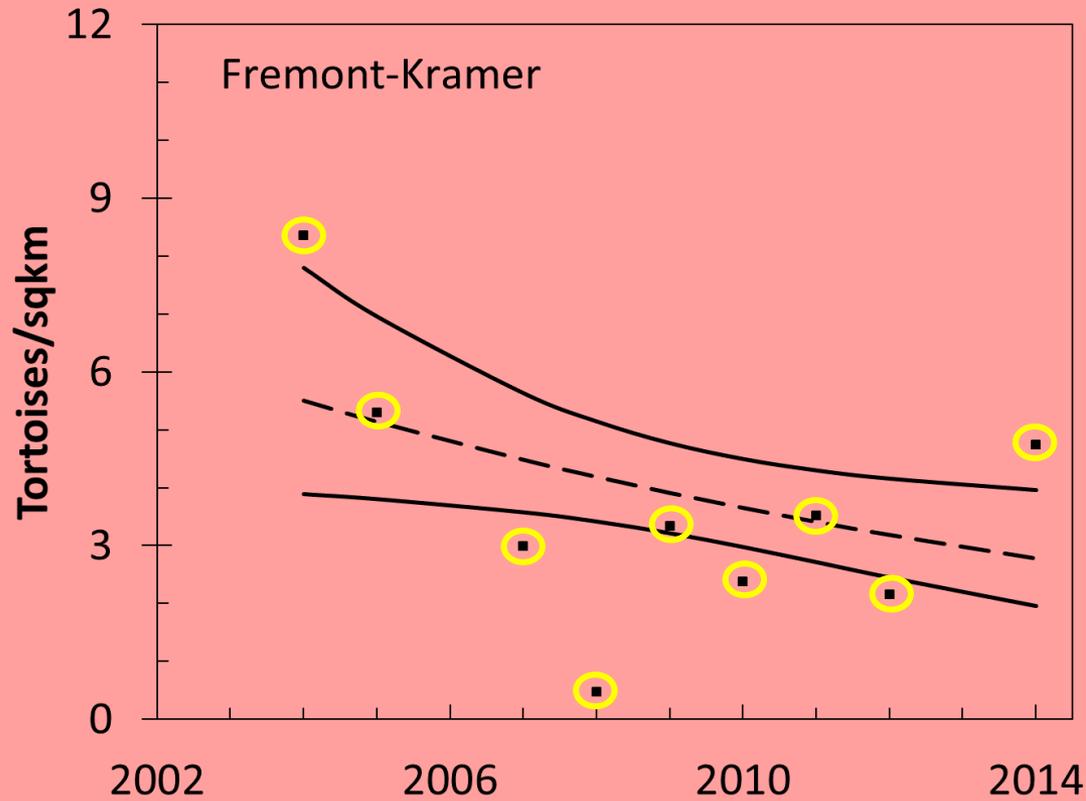


How are annual estimates related to trend estimates?



- The dashed line here is the estimated population trend. Which estimate is most supported – the recent-year estimate or the trend estimate?
- Based on the trend, there were 2.8 tortoises/sqkm in 2014. The trend estimate!!
- The line and that estimate are based on 9 years of data
- The annual survey in 2014 estimated 4.7 tortoises/sqkm based on one of the 9 years

How are annual estimates related to trend estimates?



- The range of annual estimates doesn't mean tortoise numbers were really jumping around
- Instead, it shows that our estimates are ok but not very precise.
- We will only update trend estimates after we have a few more years of data in each TCA, after 2020.

What does the coordination effort cost?

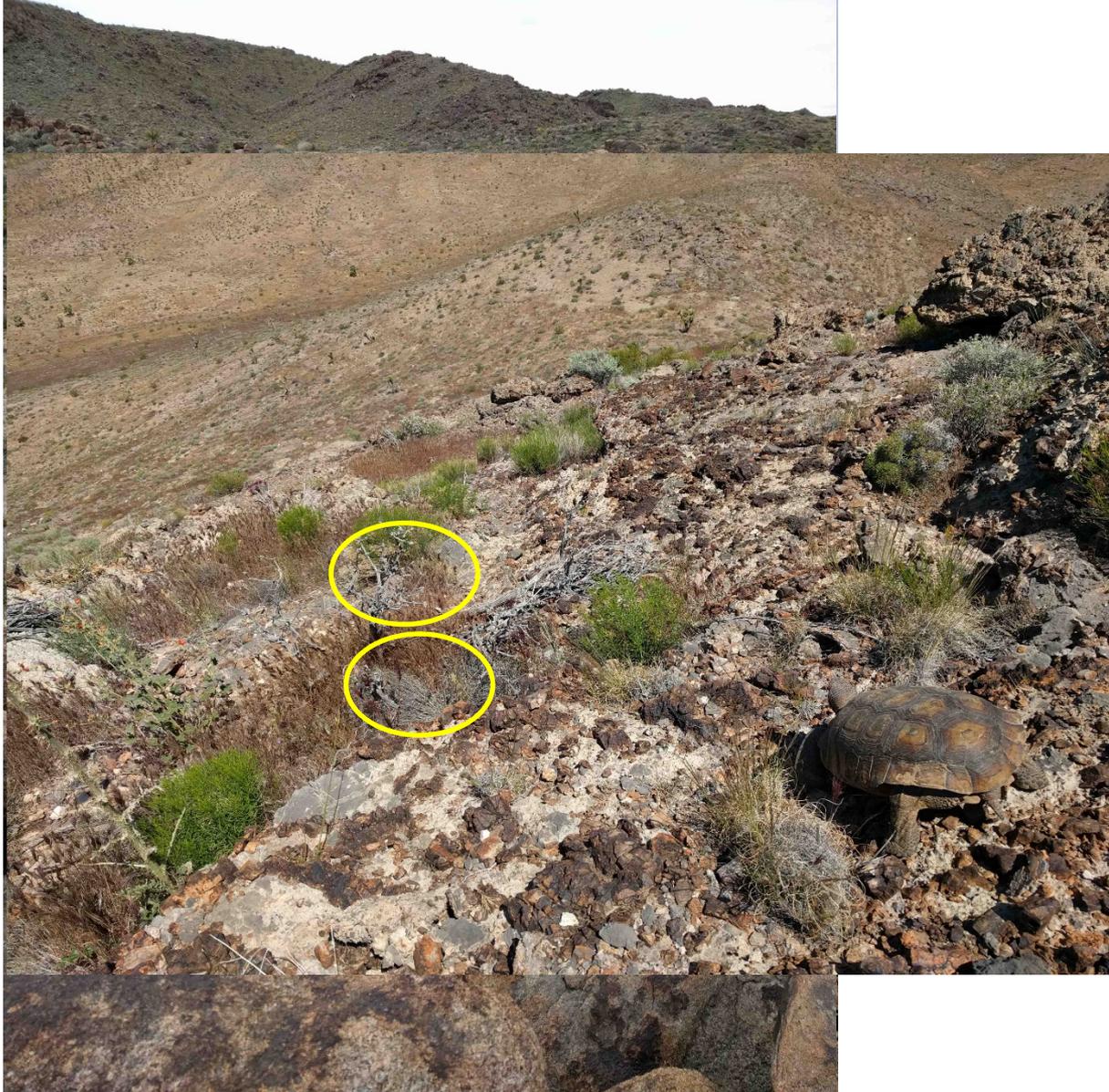
Annual funding to survey half of the TCAs each year. Contracting costs are \$1300/transect (2019 dollars).

Land manager	% habitat	Cost
California (70% of range)		\$680,000
BLM	61%	
DOD	20%	
NPS	17%	
State	2%	
Nevada (28% of range)		\$300,000
BLM	75%	
DOD	9%	
NPS	7%	
DOE	6%	
State/County	3%	
Arizona (2% of range)		\$45,000
BLM	84%	
NPS	13%	
State	2%	
Utah (NE Mojave not UVR = 0.6% of range)		\$20,000
BLM	89%	
State	11%	
ANNUAL TOTAL		\$1,045,000

- Costs determine the number of TCAs surveyed each year
- In 2015, area-proportionate funding contributions were set for each land-management agency
- More consistent and larger contributions from BLM and DOD since 2015 have lowered the per-transect cost, reflected here



What does the coordination effort provide?



In addition to logistical coordination:

- Standardized training in distance sampling across the range
- After field tests of different survey methods, distance sampling was selected by the MOG in 1999 for range-wide population estimates



What does the coordination effort provide?



- Distance sampling involves 2-person teams
- As well as maintenance of 7 telemetry sites



Range-wide monitoring of Mojave desert tortoises - conclusions



1. Credible, range-wide survey results are required for delisting
2. Challenges to range-wide surveys include
 - Rare tortoises are also cryptic
 - We have to complete all surveys while tortoises are active in the spring
 - The scale is large and the costs reflect this!
3. Survey coordination
 - Standardizes training and credible protocols across the range
 - Uses common telemetry sites and data collection systems
 - Allows for unified data quality control and management
 - Reports comparable density estimates across the range and across years
 - Planning optimizes stratum coverage and long-term trend description
4. Adult trends are similar within recovery units, where numbers are declining in 4 of the 5 recovery units.
5. Trend estimates will be revised when there are sufficient additional data (3 more data points per TCA). The next trend analysis will follow 2020.