



WILD TURKEY MANAGEMENT SURVEYS

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INTRODUCTION

Wild Turkeys (*Meleagris gallopavo*) were released in Marin and Sonoma counties by California Department of Fish and Game (CDFG) for sport hunting purposes in the 1980's (Gardner et al. 2004). In the past ten years, the numbers and range of this species has expanded markedly throughout both counties and the rest of California. Wild Turkeys were first detected by the standardized Christmas Bird Count (CBC) and Breeding Bird Survey (BBS) in Marin and Sonoma in the early 1990's and in California in the early 1970's.

Resource managers are concerned about the expansion of turkeys because of the possibility of direct competition with native species such as California Quail (*Callipepla californica*) and the potential impacts on habitat condition. There is concern that turkeys may serve as a vector for Sudden Oak Death (SOD) and there will be diminished oak regeneration especially in SOD affected stands (30-50% live oak mortality and up to 80% mortality in tan oak in Marin Municipal Water District; Swezy in litt.) due to heavy acorn predation by turkeys. Research at Audubon Canyon Ranch indicates that the foraging actions of turkeys, akin to "rototilling" of the soil, caused marked decrease in invertebrate abundance (Gluesenkamp pers. comm.). This level of soil disturbance may also increase opportunities for invasive plant germination.

Resource managers lack reliable, defensible scientific information on turkey abundance required to manage this species and protect native ecosystems. In cooperation with the Point Reyes National Seashore (PORE), Marin Municipal Water District (MMWD), and Audubon Canyon Ranch (ACR), we conducted surveys to estimate numbers of wild turkeys on the lands managed by these three agencies, to evaluate different count methods and the effectiveness of turkey removal programs.

PROJECT OBJECTIVES

Our primary objective was to establish a survey protocol whereby the effectiveness of Wild Turkey removal could be evaluated. Knowing that turkeys are difficult to survey, we also evaluated two existing and ongoing monitoring programs; the Christmas Bird Count (CBC) and the Breeding Bird Survey (BBS). While these surveys do not target turkeys, we evaluated how well they capture the population size and trends in Marin and Sonoma counties. Finally, a

secondary objective of our field observations was to provide information on turkey locations and movement patterns to be used by wildlife managers in planning removal strategies.

METHODS

We conducted two types of surveys: line transects and roost counts, between 15 December 2005 and 14 February 2006 (Table 1). While both of these methods have been used extensively by wildlife biologists, and both specifically for turkeys, no standardized monitoring techniques exist specifically for Wild Turkeys (Healy and Powell 1999). Line transects are a common wildlife survey technique (Burnham et al. 1980) and have been used extensively for birds (e.g., Ralph and Scott 1981, Bibby et al. 1992) and specifically for turkeys (Cobb et al. 1991).

All surveys were conducted in the morning and late afternoon to best capture turkey activities. We established ten line transect survey routes of varying length (Appendix A, Figures 1 through 9). When logistically possible we alternated transect starting points and the direction the route was surveyed. After three visits we analyzed count variation and dropped routes with very low variation (this included cases with very high counts and zero counts as long as the variation was low). We added additional routes representing similar management regimes. The number, sex (when possible), and distance to each flock was recorded. When a turkey called but was not seen we noted the detection and estimated the distance. For visual sightings, we used a laser rangefinder with a 5 m accuracy to estimate distance and the distance to all flocks were measured to infinity. In addition to line transects, we attempted to locate and document roost locations.

Sites were not randomly selected but were chosen to represent the three partner's lands. We sampled areas with management plans for turkey removal and reference areas where removal would not occur (Marin County Open Space land). We chose sites known to previously have turkeys present according to the agency biologists Kan Dhillon (NPS), Mike Swezy (MMWD), and Daniel Gluesenkamp (ACR). We sought to document variance among surveys and not conduct an inventory or presence/absence survey across the two counties. If three surveys yielded no turkey sightings, the route was dropped and another comparable route was developed.

Initially two sites were chosen on NPS land (Bear Valley and Dogtown) however after three visits with little variation in sightings, we discontinued both and added the Truttman transect. Bouverie was initially surveyed for ACR and after some difficulty finding and/or accessing a reference site, Sonoma Valley Regional Park was added. At MMWD, Sky Oaks and Yolanda Trail were initially surveyed. The Sunnyside transect was added after we found almost no turkey activity on the Yolanda transect. Reference transects where no turkey removal was planned were selected on MCOSED land after consultation with Ecologist Mischon Martin (Camino Alto and Lucas Valley).



Table 1. Survey dates by route and county.

Site	Date
Bear Valley (NPS)	12/15/2005
Marin County	1/3/2006
	1/16/2006
Bouverie (ACR)	12/22/2005
Sonoma County	1/5/2006
	1/12/2006
	1/25/2006
	2/3/2006
	2/14/2006
Camino Alto (MCOSD)	12/19/2005
Marin County	12/28/2005
	1/10/2006
Dogtown (NPS)	12/26/2005
Marin County	1/9/2006
	1/18/2006
Lucas Valley (MCOSD)	12/26/2005
Marin County	1/4/2006
	1/11/2006
	1/23/2006
	2/2/2006
Sky Oaks (MMWD)	12/29/2005
Marin County	1/6/2006
	1/13/2006
	1/24/2006
	1/26/2006
	1/31/2006
Sonoma Valley Regional Park	1/25/2006
Sonoma County	2/3/2006
	2/14/2006
Sunnyside (MMWD)	1/24/2006
Marin County	2/2/2006
	2/8/2006
Truttman (NPS)	1/23/2006
Marin County	1/31/2006
	2/6/2006
Yolanda (MMWD)	12/21/2005
Marin County	1/4/2006
	1/12/2006
	2/10/2006

ANALYSIS and RESULTS

Winter Line Transects

Data from the winter transect surveys are summarized in Table 2 by county and transect, and shows route length, average count, standard error (SE), effort (number of surveys), and lower and upper confidence intervals (LCI and UCI). We found low variation on five transects: Bear Valley, Camino Alto, Dogtown, Sonoma Valley Regional Park, and Yolanda. Of these, only the Bear Valley transect provided a regular count of a flock of 16 individuals. The other four had zero turkeys counted on all but one survey. The Lucas Valley, Sky Oaks, Sunnyside, Truttman, and Bouverie transects and the overall county totals had very high levels of variation, providing relatively poor measure of Wild Turkey population size or ability to detect subsequent trends. Survey effort was weighted towards Marin County due to relative funding and site selection challenges in Sonoma County.

Table 2. Line transect survey results, winter 2005/06.

County	Transect	Length (m)	Average Count	SE	Number of Surveys	LCI	UCI
Marin	Bear Valley	3721	16	0	3	16	16
Marin	Camino Alto	6668	0	0	3	0	0
Marin	Dogtown	2580	0	0	3	0	0
Marin	Lucas Valley	1431	15.4	7.65	5	0.4	30.4
Marin	Sky Oaks	5793	40.33	9.43	6	21.85	58.82
Marin	Sunnyside	6375	2.33	2.33	3	-2.24	6.91
Marin	Truttman	2135	2.67	2.67	3	-2.56	7.89
Marin	Yolanda	10065	0.5	0.5	4	-0.48	1.48
MARIN	AVERAGE		12.8	3.52	30	5.91	19.69
Sonoma	Bouverie	2307	15.67	11.18	6	-6.24	37.57
Sonoma	Sonoma Valley Regional Park	3729	0	0	3	0	0
SONOMA	AVERAGE		10.44	7.67	9	-4.59	25.48

Roost Counts

All evidence of potential roosts was noted during transect surveys and some morning and evening observations were conducted to locate active roosts. Late day turkey movement patterns, vocalizations, and wing noise were all used to locate active roosts even after dark. Heavy whitewash was also observed under some potential roost trees. Roost information is summarized in Table 3 and shows Wild Turkeys using a wide variety of tree species. They appear will to use any large tree(s) with appropriate structure for landing and roosting safely.

We observed the same roosts used on several occasions but a visit the following year to a Sky Oaks roost indicated no activity.

Table 3. Roost tree information.

Location	Roost Tree Species	Number of Trees	Evidence used
Bear Valley	Douglas Fir	1	Evening Fly-up
Bouverie	Douglas Fir	1	Whitewash
Bouverie	Douglas Fir	4	Morning Fly-down
Deer Park	Coast Redwood	1	Evening Fly-up
Lucas Valley	California Bay Laurel	1	Evening Fly-up
Sky Oaks	Monterey Pine	3	Evening Fly-up
Sky Oaks	Coast Live Oak(1) & dead hardwood (3)	4	Evening Fly-up

Christmas Bird Count

We downloaded Christmas Bird Count data for count circles in Marin and Sonoma from the Audubon website www.audubon.org/bird/cbc (National Audubon Society 2002). This included data from two count circles in each county (Western Sonoma and Santa Rosa in Sonoma County and Southern Marin and Point Reyes in Marin County). Since these data are count data we used generalized linear models. Count data many times have a poisson or negative binomial distribution. The negative binomial distribution is identical to the poisson distribution except that it is used in cases where the data are overdispersed (e.g., the variance of the data is much greater than the mean; in contrast to the poisson distribution, where the mean and variance are equal; see Lawless 1987). The overdispersion parameter for this data was 1.197 (1.00 indicates the data is not overdispersed), and thus we chose to use the negative binomial distribution for these modeling efforts. AIC was used to quantify how well each model was supported by our data. Covariates used within our analysis included year, number of people conducting the survey, and number of people hours spent on the survey. The most general model was: year + hours + people + Count.Circle + Count.Circle*year. The most likely model suggests that these data show not only annual trends in abundance, as well as differences between the count circles, but that the linear trends across time varied among the various circles (Table 4). In fact, these three factors (year, count.circle and year*count.circle) are in all of the top models (delAIC<10). While there was still support for factors such as hours surveyed (delAIC=1.75) and people (delAIC=2.00) and the relationships were very weak, and people vs. number of turkey detected

were positive, as expected, but with high SE's (slopes = 0.0014 ± 0.0030 and -0.00013 ± 0.0090 , respectively). While the data did not support effects of hours or number of counters (Table 4), there was support for a positive linear trend (since 1998) in all count circles, except perhaps Santa Rosa (Table 5, Figure 10).

Figure 10. Annual trends in Wild Turkey using CBC.

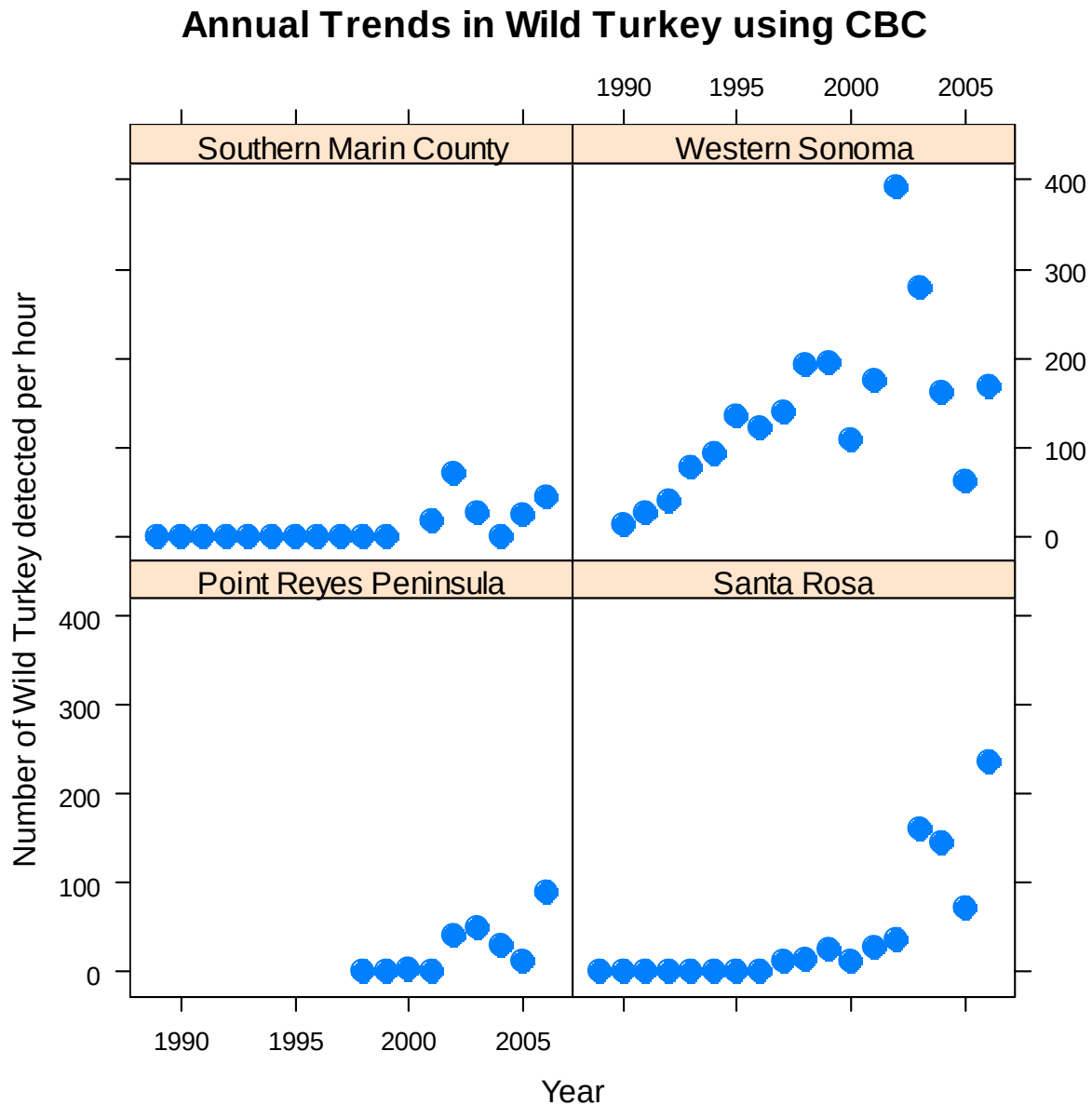


Table 4. Model Selection results for models estimating abundance of turkey using Christmas Bird Count data.

Model (response variable = number of turkey)	AIC	delAIC
year+count.circle+year*count.circle	450.90	0.00
year+count.circle+hours+year*count.circle	452.65	1.75
year+count.circle+people+year*count.circle	452.90	2.00
year+count.circle+hours+people+count.circle*year	454.04	3.14
year+count.circle	471.78	20.88
Year+count.circle+people	473.46	22.56
Year+count.circle+hours	473.77	22.87
year+count.circle+hours+people	475.25	24.35

Table 5. Average annual rate of increase (lambda, where 1.0 = stable) in turkey numbers for each count circle, based on model most supported by Christmas Bird Count data (see Table 4)

County/Count Circle	Annual Trend	Standard Error
Marin County		
Southern Marin	1.93	0.203
Point Reyes	2.03	0.4208
Sonoma County		
Western Sonoma	1.69	0.276
Santa Rosa	1.13	0.176

Breeding Bird Survey

We downloaded Breeding Bird Survey data from the United States Geological Survey website www.mbr-pwrc.usgs.gov/bbs (Sauer et al. 2005). This included data from the four survey routes in Sonoma and two in Marin counties (Glen Ellen, Bodega Bay, Mark West, and Fish Rock in Sonoma County and Fairfax and Point Reyes in Marin County). Maps of survey routes are available at www.pwrc.usgs.gov/bbs/results/routemaps/. We again performed a stepwise linear regression (using AIC for model selection) to determine what covariates best explained variation in the number of Wild Turkey detected. Year was our only covariate. The most general model

was: Year + County + County*Year + Route + Route*Year. The results, shown in Table 7, suggest this data detecting a positive trend in Marin County and no trend in Sonoma County.

Figure 11. Annual trends in Wild Turkey using BBS.

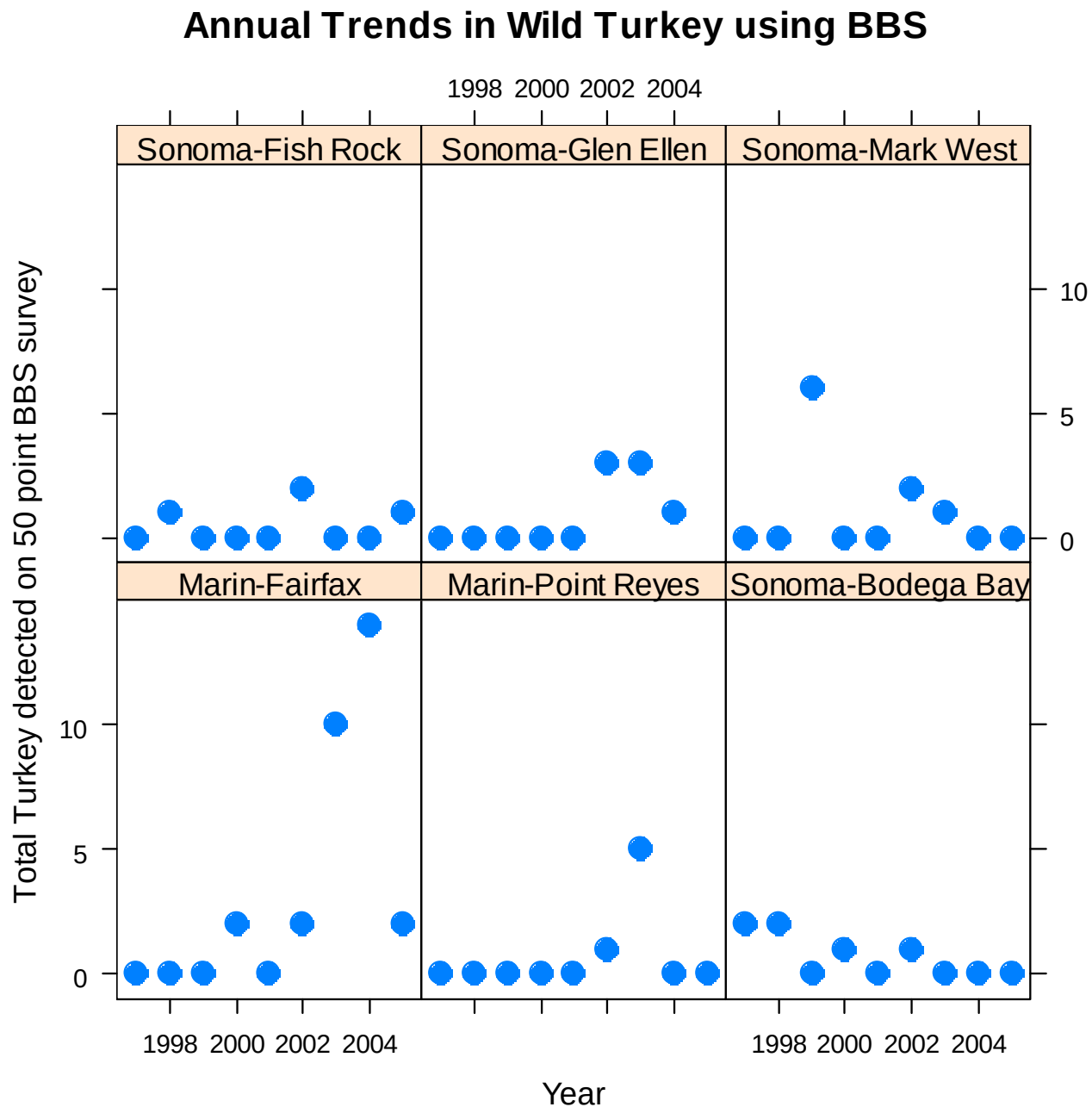


Table 6. Model Selection results for models estimating abundance of turkey using Breeding Bird Survey data.

Model (response variable = number of turkey)	AIC	delAIC
Year+county+year*county	142.20	0.00
Year+county+route+year*county	143.39	1.19
Year+county+route+year*county+year*route	145.22	3.02
Year+county	147.70	5.50
Year+county+route+year*route	148.16	5.94
Year+county+route	148.69	6.49
Year	148.70	6.50
County	149.7	7.50
Year+route+year*route	149.8	7.60
Year+route	150.60	8.40
county+route	151.00	8.80
Route	152.6	10.40

Table 7. Average annual rate of increase (lambda, where 1=stable) in turkey numbers for each county, based on model most supported by Breeding Bird Survey data (see Table 6)

County	Annual Trend	Standard Error
Marin County	1.99	0.4180
Sonoma County	0.9728	0.3301

CBC/BBS Comparison

We merged the two datasets so they were summed by route and count circle, grouping it at the county level. We ran a linear model between the two datasets, assessing how well CBC predicts the BBS and vice versa. We also examined how this might differ by county. The results, in Table 8, show there is a correlation between CBC and BBS in Sonoma County but not in Marin County.

Table 8. Model results comparing CBC and BBS data, summed for Marin and Sonoma counties.

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	17.934	30.775	0.583	0.5693
CountySonoma	146.038	49.215	2.967	0.0102 *
total:CountyMarin	3.044	4.411	0.690	0.5014
total:CountySonoma	28.240	10.028	2.816	0.0137 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Turkey Removal Activities

PRBO assisted CDFG trapper Bob Klotz in the spring 2006 before and during his Wild Turkey capture efforts at MMWD. We described daily activity patterns in the Sky Oaks area of MMWD and helped with pre-baiting in potential trap locations. Knowledge of roosts, flock movements and feeding patterns aided in developing the trapping strategy. PRBO also reported turkey behavior and roost locations to NPS staff which aided in ongoing removal activities.

CONCLUSIONS and RECOMMENDATIONS

Evaluating winter Wild Turkey populations and the effectiveness of removal presented several challenges. Turkeys are not evenly distributed across Marin and Sonoma counties. Turkeys are focused in areas with food sources such as cattle and horse operations and golf courses. Turkeys travel in winter flocks, essentially presenting themselves as one large count entity rather than the individuals making up a flock. Survey transects were chosen to obtain a sample of both participating landowners properties and respective management strategies. Surveying the entire county would be cost and time prohibitive. Birds were sometimes detected before or after the formal survey time and just outside the survey area. Removal activities for the partners are quite varied in geographic extent, seasonal timing, and ongoing effort.

Our survey results exhibited high variation and make precise predictions of local population size very difficult. These results suggest that effort would need to be increased significantly; most likely to levels that would be cost prohibitive. However, if the requirement was only to detect a trend in population size over long periods of time, it is possible that efforts would not need to be increased so dramatically. Population estimates derived from the CBC and BBS survey results can be highly variable (across years). While precise trend monitoring will be equally difficult, it

may be possible to provide coarse resolution over long time periods even at current levels of effort. As an example, these current BBS results estimate a population growth rate of between 1.15 and 2.83 for Marin County since ~1990 (95% confidence). Results from Sonoma County are less informative (λ : 0.313 – 1.63). We can derive similar results using the Christmas Bird Count data. Neither data are able to provide subtle changes (5-25% changes) in a short time frame (<10 years). However, it will most likely be possible to detect large changes (a doubling or halving) in population size at the county level over a period of 10 years.

The CBC showed high variation especially in the last five years when count totals decreased after a fairly steady increase. This may be a symptom of the difficulty in obtaining accurate counts or could reflect a true fluctuation in the population. According to the Birds of North America species account (Eaton 1992), turkey populations can be regulated by cyclical factors including fall rains, available winter food, surface water and poult mortality rates. These or other cyclical events may explain the apparent downturn in the more recent counts.

We recommend consideration of other survey methods which may produce better population counts in areas of concern and that will aid in future turkey removal activities. Areas such as Bear Valley and Sky Oaks showed turkeys focusing activities at feeding locations. Although flocks range beyond the food sources, a regular count in these locations would likely yield lower variation. The use of bait stations may be another option for focusing turkey activities (creating new artificial food sources) and would likely make planned removal activities easier to successfully accomplish. Regular dawn or dusk counts at roosts could also yield lower variation and would aid in planning and conducting removal. Simply documenting turkey distribution could prove useful as well. NPS biologists used telemetry equipment on a small sample of birds and this helped locate the flock for counts and removal.

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LITERATURE CITED

- Bibby, C. J., N. D. Burgess, and D. A. Hill. 1992. *Bird Census Techniques*. Academic Press Inc. San Diego, CA.
- Burnham, K. P., D. R. Anderson, and L. J. Laake. 1980. Estimation of density from line transect sampling of biological populations. *Wildlife Monographs* 72:1-202.
- Cobb, D. T., J. L. Kalso, G. W. Tanner. 2001. Refining population estimation and survey techniques for Wild Turkeys. *Proceedings of the National Wild Turkey Symposium* 8:179-185.
- Eaton, Stephen W. 1992. Wild Turkey. *In The Birds of North America*, No. 22 (A. Poole, P. Stettenheim, and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.
- Gardener, S., T. Blankenship, and J. Decker. 2004. Strategic plan for Wild Turkey management. State of California, The Resources Agency, Department of Fish and Game, Sacramento, CA.
- Healy, W. M., and S. M. Powell. 1999. Wild Turkey harvest management: biology, strategies, and techniques. U.S. Fish and Wildlife Service Biological Technical Publication. BTP-R5001-1999.
- National Audubon Society. 2002. The Christmas Bird Count Historical Results [Online]. Available <http://www.audubon.org/bird/cbc> [January 2007]
- Ralph, C. J., and J. M. Scott. 1981. Estimating the numbers of terrestrial birds. *Studies in Avian Biology* 6.
- Sauer, J. R., J. E. Hines, and J. Fallon. 2005. The North American Breeding Bird Survey, Results and Analysis 1966 - 2005. Version 6.2.2006. USGS Patuxent Wildlife Research Center, Laurel, MD.

