FLORIDA FISH & WILDLIFE CONSERVATION COMMISSION

MEMORANDUM

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TO: Cory Morea, Deer Management Program Coordinator, Division of Hunting and Game Management – Game Species Management – Deer Management

THROUGH: Tim O'Meara, Wildlife Research Section Leader, FWRI

FROM: Erin Leone, Research Administrator II, FWRI – Information Science and Management – Center for Biostatistics and Modeling

DATE: April 21, 2011

SUBJECT: **Estimation of Power to Detect Changes in Days Hunted, Harvest, and Harvest per Hunter Day by DMU from the Statewide Hunter Survey**

Summary

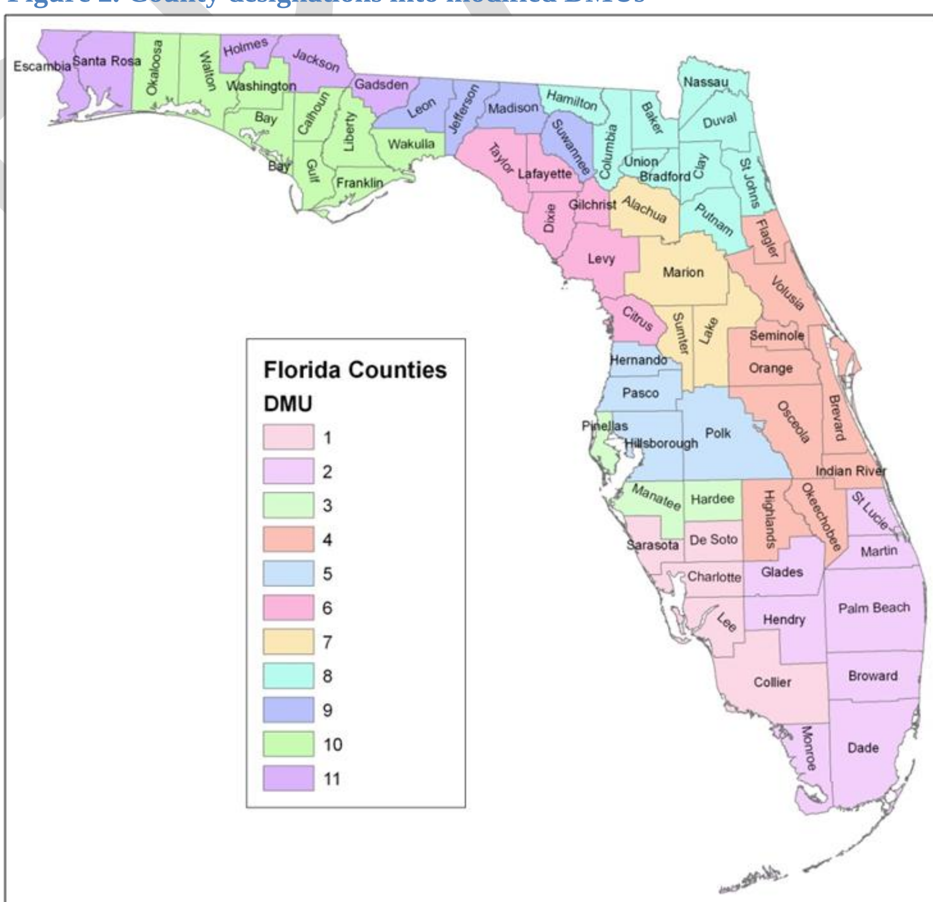
I used the 2005-2006 FWC Statewide Hunter Survey to determine what level of power can be achieved in detecting a 25% change between two years, and a trend across 5 years, in days hunted, harvest, and harvest per hunter day on each of the 11 proposed DMU. The results from this survey suggest there is sufficient power to detect changes on most DMUs, while a few (e.g. DMUs 1, 2, & 3) would be unlikely to ever produce sufficient power to detect meaningful changes.

Methods

I reproduced the power analysis from Linda (1999) with the data from the 2005-2006 FWC Statewide Hunter Survey. Because the proposed deer management units (DMU) cross county lines (Figure 1), and the data collected through the survey are at the county level, I reassigned counties to a DMU where the majority of their area fell (Figure 2). I then estimated the variability in days hunted, harvest, and harvest per hunter day (HPHD) within the 11 re-categorized DMUs, and used this measure of variability in the power analyses. I chose to use the 2005-2006 survey for convenience, having all of the data, and also because this was the last year a relatively high response rate was achieved (31.7%, as opposed to 5.89% for the 2009-2010 survey year). Because of this relatively high response rate I believe the data will provide more robust results for the power analysis, both in reduced variability but also in reduced non-response bias. However, this means I cannot speak to the transferability of these results to the most recent surveys, with lower response rates and fewer respondents per DMU. All analyses were performed in SAS v9.2 according to the methods described in Linda (1999).

Figure 1. Proposed Deer Management Units (DMU)

Figure 2. County designations into modified DMUs



Results

All results are presented as the number of responses (n) necessary in a DMU to achieve approximately 90% power in a one-way ANOVA or simple linear regression to detect a difference in log(days hunted), log(harvest), or log(harvest per hunter day), at $\alpha = 0.10$. Given that a small proportion of survey respondents report hunting in any specific county, a larger number of survey responses (n_{usable}) is required to reach the necessary number of responses for each DMU (n). If the proportion of survey respondents hunting in each DMU is defined as ($\hat{p}$), we can estimate the number of usable survey responses necessary to reach (n) by multiplying by an 'inflation factor' ($1/\hat{p}$).

$$n_{usable} = \frac{1}{\hat{p}} \times n$$

So, for example, if 205 responses are necessary to achieve 90% for detecting a decline in hunter days of 25%, but only 2.16% of hunters report hunting in DMU #1, then the total number of survey responses necessary to reach this would be:

$$n_{usable} = \frac{1}{\hat{p}} \times n = \frac{1}{2.16} \times 205 = 46.23 \times 205 = 9{,}477$$

Furthermore, if we assume a survey response rate of 31% (from the 2005-2006 statewide survey) then we would estimate that (1/0.31) x 9,477 = 30,571 surveys would need to be mailed in order to obtain the necessary number of responses in DMU #1. The number of surveys to be mailed would be 160,627 if we assumed a 5.90% response rate from the 2009-2010 statewide survey. The number of usable responses required for each DMU, as well as an estimate of the number of surveys that would need to be mailed, are shown in Tables 1, and 2, respectively.

Days Hunted

Figure 3 shows the power achievable in a one-way ANOVA to detect a 25% difference in log(days hunted) between two yearly surveys at $\alpha = 0.10$. According to the analysis 205 survey responses would be necessary in a DMU (**$n \approx 205$**) to achieve 90% power to detect a 25% decline. Likewise, Figure 4 represents the power of a simple linear regression of log (days hunted) to detect given slope parameters. 135 responses would be necessary (**$n \approx 135$**) to achieve 90% power of a simple linear regression to detect a yearly decline of 10% in log(days hunted).

Harvest

A total of 82 survey responses would be necessary in a DMU (**$n \approx 85$**) to achieve 90% power in a one-way ANOVA to detect a 25% decline between two years, $\alpha = 0.10$ (Figure 5). Only 55 responses (**$n \approx 55$**) would be necessary to achieve the same level of power to detect a 10% change per year for five years (Figure 6).

Harvest per Hunter Day

A total of 183 responses would be necessary (**$n \approx 183$**) in a DMU to achieve 90% power in detecting a 25% decline between two survey years (Figure 7), while 123 responses would be necessary (**$n \approx 123$**) to achieve 90% power in detecting a 10% decline over five years (Figure 8).

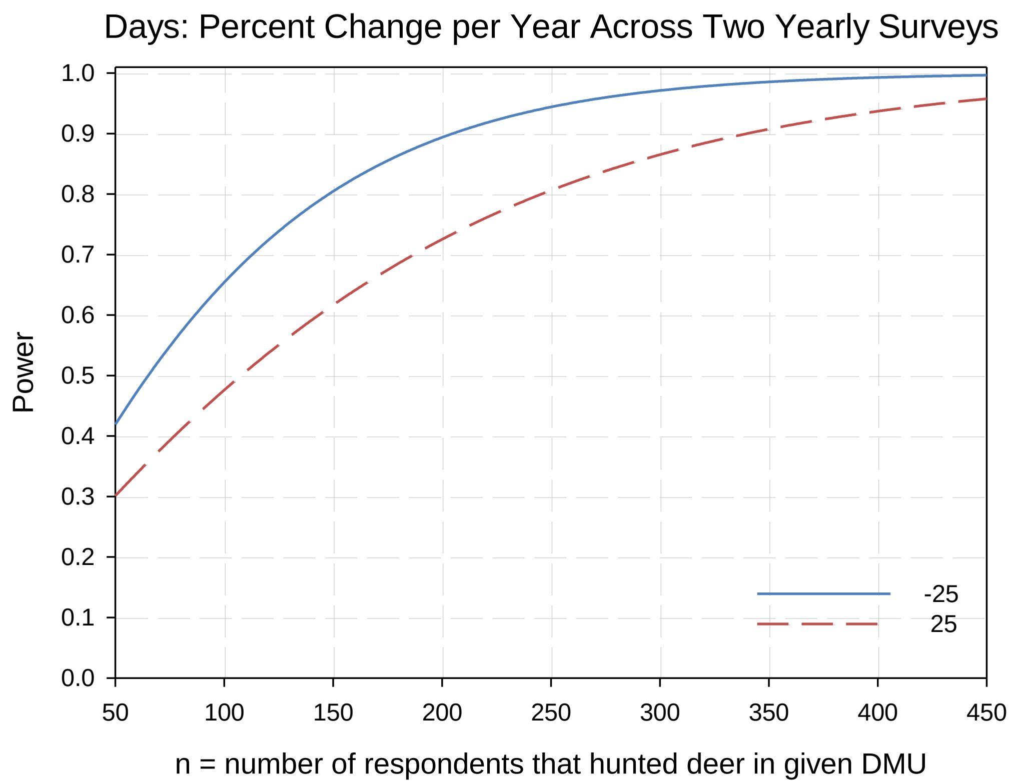


Figure 3: Power of an one-way ANOVA to detect a difference in log(days hunted) between two yearly surveys at α = 0.10.

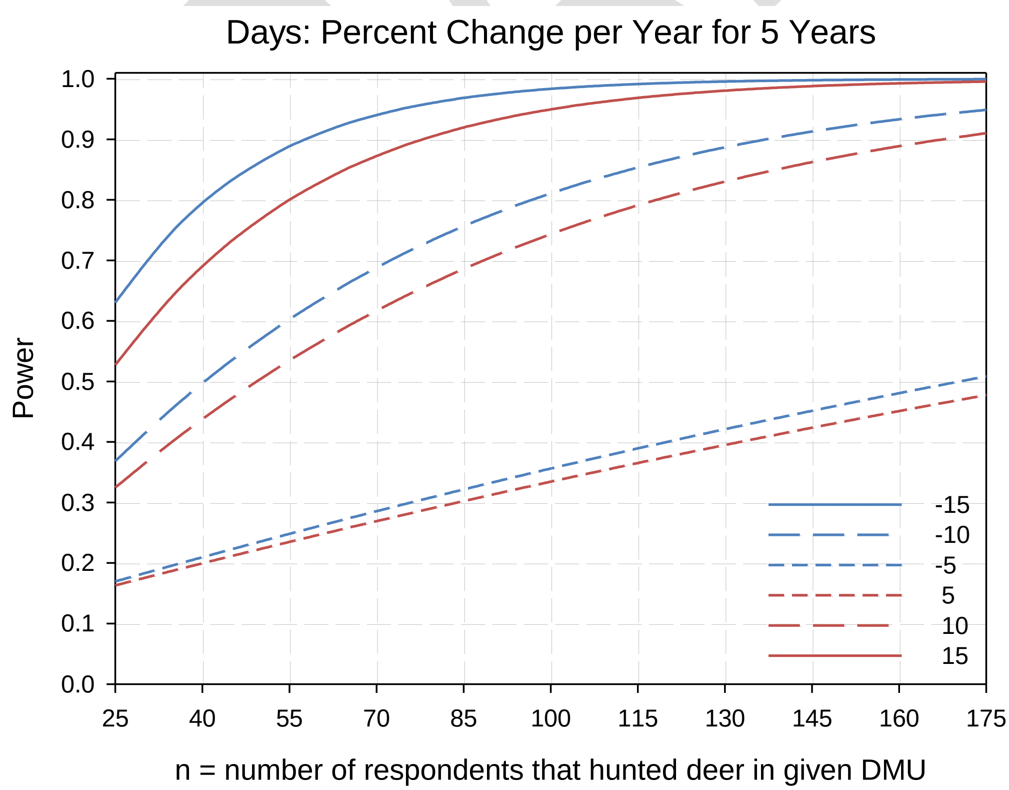


Figure 4: Power of a simple linear regression of log(days hunted) and year to detect a given slope across 5 years, α = 0.10.

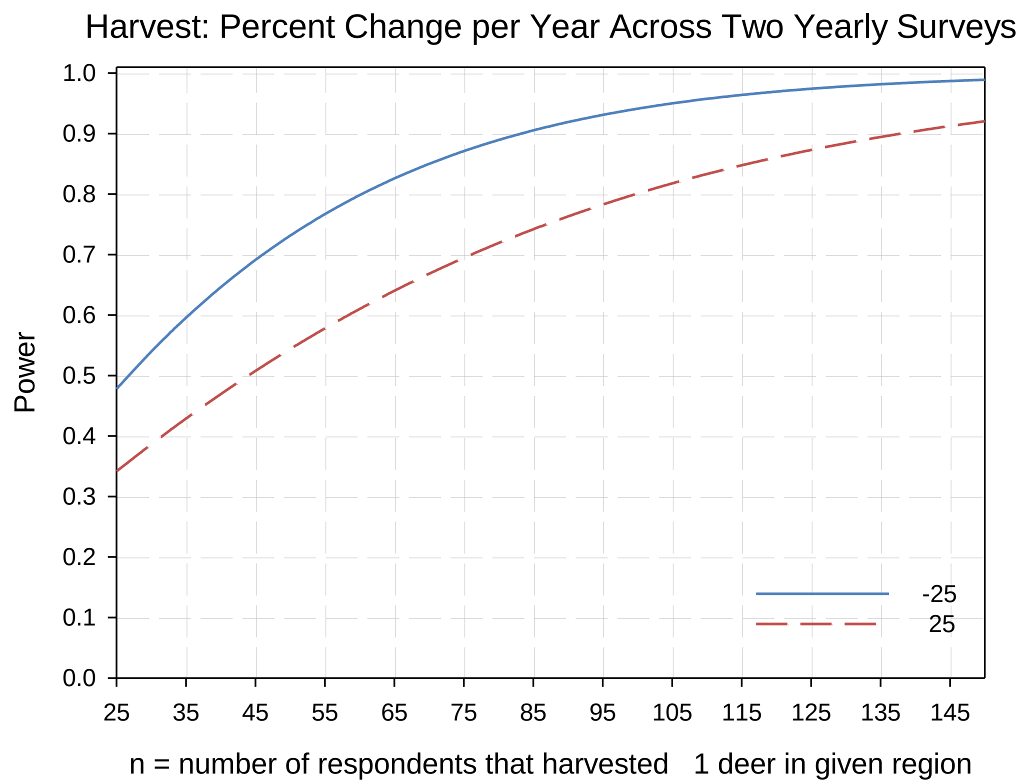


Figure 5:Power of a one-way ANOVA to detect a difference in log(harvest) between two yearly surveys at α=0.10.

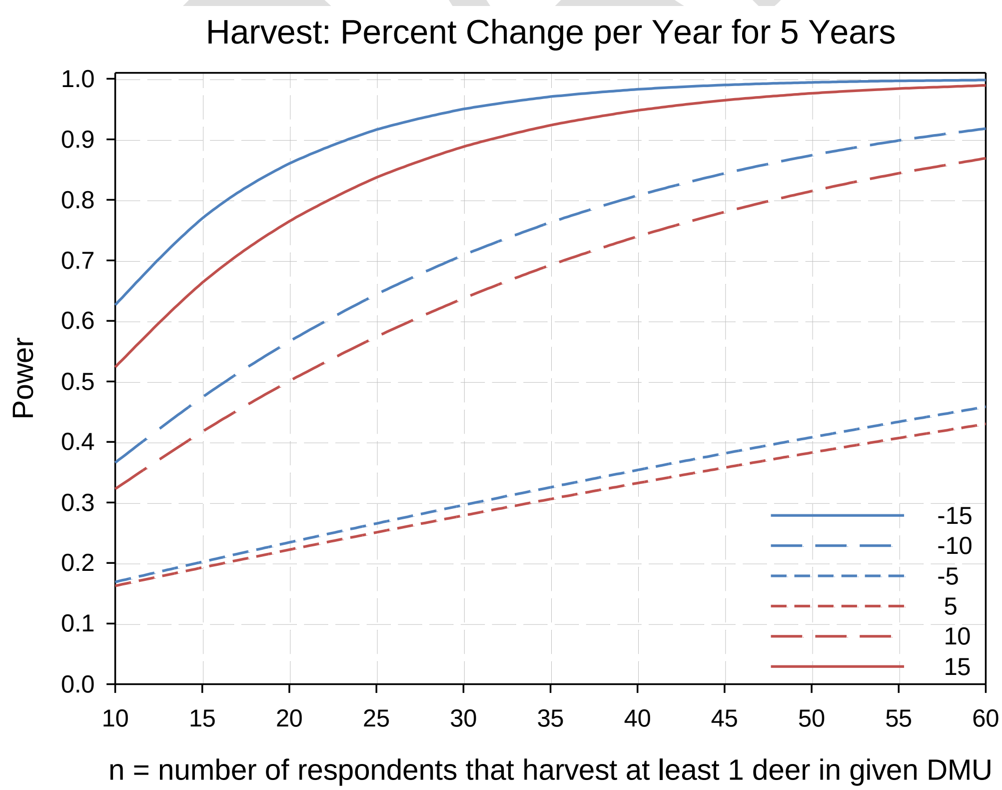


Figure 6: Power of a simple linear regression of log(harvest) and year to detect a given slope over five years, α=0.10

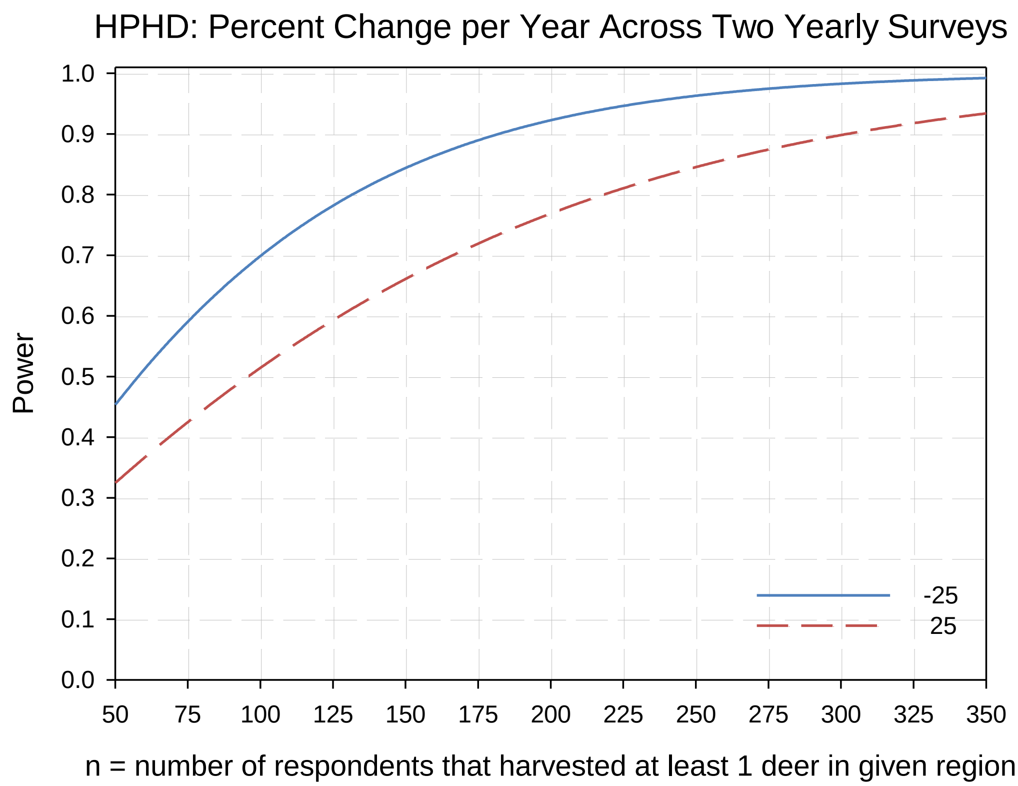


Figure 7: Power of a one-way ANOVA to detect a difference in log(HPHD) between two yearly surveys at α=0.10.

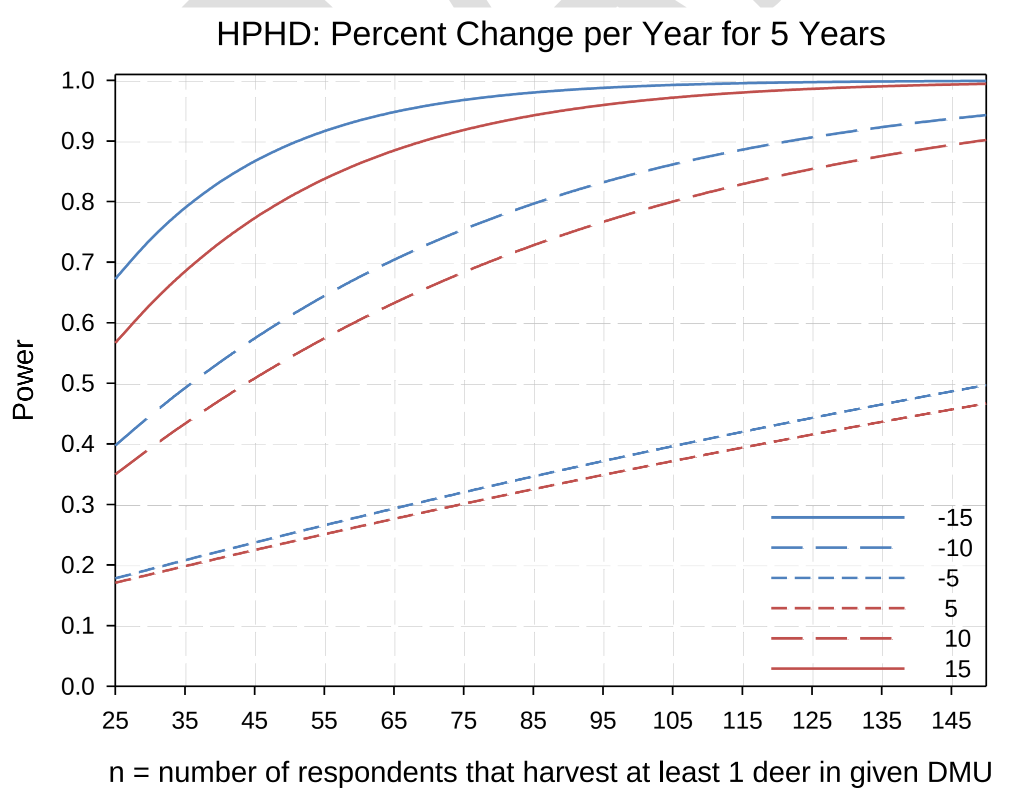


Figure 8: Power of a simple linear regression of log(HPHD) and year to detect a given slope over five years, α=0.10

Table 1. Number of responses received in the 2005-2006 survey for each DMU, as well as the relative proportion of respondents that hunted in each region ($\hat{p}$), the inflation factor ($1/\hat{p}$), the proportion of hunters that harvested ≥ 1 deer ($\hat{\pi}$) and that the inflation factor ($1/\hat{\pi}$), and an estimated number of usable responses necessary in order to achieve 90% power to detect a 25% decline between 2 years and a 10% decline per year for 5 years in log-transformed days hunted, harvest, and harvest per hunter day (HPHD). **Bold** values indicate more responses than received in the 2005-2006 survey (5,224) year.

DMU	Number of respondents that hunted in region	Proportion of respondents ($\hat{p}$) that hunted in region	Inflation factor ($1/\hat{p}$)	Proportion of hunters ($\hat{\pi}$) in region that harvested ≥ 1 deer	Inflation factor ($1/\hat{\pi}$)	Number of respondent necessary to detect:					
						25% decline between 2 years			10% decline/year for 5 years		
						Days	Harvest	HPHD	Days	Harvest	HPHD
1	113	2.16	46.23	38.94	2.57	**9,477**	**9,735**	**21,726**	**6,241**	**6,530**	**14,603**
2	177	3.39	29.51	33.33	3.00	**6,050**	**7,261**	**16,205**	3,984	4,870	**10,892**
3	53	1.01	98.57	47.17	2.12	**20,206**	**17,135**	**38,240**	**13,306**	**11,493**	**25,702**
4	577	11.05	9.05	39.34	2.54	1,856	1,887	4,212	1,222	1,266	2,831
5	296	5.67	17.65	19.26	5.19	3,618	**7,514**	**16,769**	2,383	5,040	**11,271**
6	480	9.19	10.88	36.04	2.77	2,231	2,476	**5,526**	1,469	1,661	3,714
7	369	7.06	14.16	30.62	3.27	2,902	3,791	**8,461**	1,911	2,543	**5,687**
8	442	8.46	11.82	37.78	2.65	2,423	2,565	**5,725**	1,596	1,721	3,848
9	234	4.48	22.32	44.02	2.27	4,577	4,159	**9,281**	3,014	2,789	**6,238**
10	529	10.13	9.88	45.56	2.19	2,024	1,777	3,967	1,333	1,192	2,666
11	346	6.62	15.10	52.89	1.89	3,095	2,341	**5,224**	2,038	1,570	3,511

Table 2. Estimated number of surveys that would need to be mailed in order to achieve 90% power to detect a 25% decline between 2 years or a yearly decline of 10% in log-transformed days hunted, harvest, and harvest per hunter day (HPHD) assuming a 33.7% response rate (2005-2006) or a 5.89% response rate (2009-2010) for each DMU. Values in **bold** indicate survey numbers greater than those mailed in 2005-2006 (16,501) or 2009-2010 (40,000).

	33.7% Response Rate (2005-2006 Survey Year)						5.90% Response Rate (2009-2010 Survey Year)					
	25% decline over 2 years			5 year decline of 10%			25% decline over 2 years			5 year decline of 10%		
DMU	Days	Harvest	HPHD	Days	Harvest	HPHD	Days	Harvest	HPHD	Days	Harvest	HPHD
1	**28,122**	**28,888**	**64,469**	**18,519**	**19,376**	**43,332**	**160,630**	**165,003**	**368,237**	**105,781**	**110,672**	**247,504**
2	**17,954**	**21,547**	**48,086**	11,823	14,452	**32,320**	**102,549**	**123,071**	**274,659**	**67,532**	**82,548**	**184,607**
3	**59,959**	**50,845**	**113,470**	**39,485**	**34,103**	**76,267**	**342,475**	**290,418**	**648,128**	**225,532**	**194,792**	**435,627**
4	5,507	5,600	12,497	3,627	3,756	8,400	31,458	31,986	**71,383**	20,716	21,454	**47,978**
5	10,736	**22,297**	**49,760**	7,070	14,955	**33,445**	**61,322**	**127,355**	**284,220**	**40,383**	**85,421**	**191,033**
6	6,620	7,348	16,398	4,360	4,928	11,022	37,815	**41,970**	**93,665**	24,903	28,151	**62,955**
7	8,612	11,250	**25,107**	5,671	7,546	**16,875**	**49,190**	**64,259**	**143,407**	32,394	**43,100**	**96,388**
8	7,190	7,612	**16,988**	4,735	5,106	11,418	**41,066**	**43,479**	**97,033**	27,043	29,163	**65,219**
9	13,580	12,340	**27,540**	8,943	8,277	**18,510**	**77,569**	**70,485**	**157,303**	**51,082**	**47,277**	**105,728**
10	6,007	5,274	11,770	3,956	3,538	7,911	34,312	30,125	**67,230**	22,596	20,206	**45,187**
11	9,184	6,946	15,502	6,048	4,659	10,419	**52,460**	39,675	**88,543**	34,547	26,611	**59,512**