Wildlife Biology **WLB-00510**

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Appendix 1

1) We estimated deer diet during summer months based on microhistological analysis of deer pellets (Holechek and Gross 1982, Leslie et al. 1983) collected in the study area and as described in the Methods. A local plant list and samples of requested species were sent to the Wildlife Habitat and Nutrition Lab at Washington State University to aid with identification. The diet composition of black-tailed deer is presented in percent (± SE) for each of the four identified fawning areas in Table A1. Diet composition was similar across fawning areas with the exception of Plaskett Meadows which had a lower proportion of oak leaves (Kruskal–Wallis, $\chi^2 = 8.12, \mathrm{p} = 0.043$) and a higher proportion of other shrub species (Kruskal–Wallis, $\chi^2 = 7.92, \mathrm{p} = 0.047$) than other fawning areas.

2) Forage quality of Brewer's oak *Quercus garryana breweri* and mountain whitethorn ceanothus *Ceanothus cordulatus*, the species most frequently eaten by deer in our study area, were estimated from plant samples collected during summer from each fawning area. Samples of each species were collected at a minimum of four separate locations per fawning area (varied from 4–6), and from several different plants at each location. Multiple leaves were harvested from each plant from twigs smaller than the average deer browse diameter for the species (Methods). The combined samples from each fawning area were analyzed for crude protein, gross energy (calories g^{-1}), in-vitro dry matter digestibility (% IVDM), detergent fiber levels, and tannins (Martin and Martin 1982). Samples from distinct fawning areas were blended for analysis to obtain fawning area averages. Since averages did not vary among fawning areas, we calculated averages for each species across all fawning areas (Table A2). Mountain whitethorn ceanothus had significantly higher gross energy than Brewer's oak ($t_{5,7} = 12.20, \mathrm{p} < 0.001$), but lower IVDM ($t_{5,7} = -2.45, \mathrm{p} = 0.028$), protein ($t_{5,7} = -2.06, \mathrm{p} = 0.047$), and higher tannin concentrations ($t_{5,7} = 2.046,\ \mathrm{p} = 0.048$).

3) We surveyed all fawning areas in 2010 and 2011 to quantify percent cover of deer forage types and to estimate biomass of shrubs, forbs, and grasses. Herbaceous vegetation was also surveyed again in 2012. We calculated percent cover and forage biomass for each fawning area for use as covariates in survival models and report the percent coverage of all species in the entire study area in Table A3.

4) We estimated diet quality from deer pellets collected in all fawning areas using using fecal nitrogen and diaminopimelic acid (DAPA) (Hodgman et al. 1996) as an index of diet quality. There was no significant variation in DAPA (ANOVA, df = 3, F = 0.14, p = 0.94) or fecal nitrogen (ANOVA, df = 3, F = 0.83, p = 0.51) among fawning areas. There was significant variation in DAPA between years (ANOVA, df = 2, F = 8.87, p = 0.007) with 2010 showing the lowest level of DAPA and increasing values each year to a high in 2012. Fecal nitrogen showed no significant variation between years (ANOVA, df = 2, F = 2.52, p = 0.14). See all results in Table A4.

Appendix 2

1) All models used to test our hypotheses of nutrition, predator abundance, and the interaction of predator abundance and nutrition are listed in the tables below. Not all models were reported in the main text because we followed Arnold (2010) in eliminating nested models that did not improve model performance and did not report models with forage weighted by diet quality measurements since they performed more poorly than forage variables without weighting from diet quality indices.
2) All models that we used to test our hypotheses about nutrition and predator abundance covariates relating the specific risk of bear and coyote predation respectively. Only models that were within 2 ΔAIC_c of the top model were reported in the body of the main paper.

Supplementary material references

Arnold, T. W. 2010. Uninformative parameters and model selection using Akaike's information criterion. – J. Wildl. Manage. 74: 1175–1178.

Hodgman, T. P. et al. 1996. Monitoring mule deer diet quality and intake with fecal indices. – J. Range Manage. 49: 215–222.

Holechek, J. L. and Gross, B. D. 1982. Evaluation of different calculation procedures for microhistological analysis. – J. Range Manage. 35: 721–723.

Leslie, D. M., Jr. et al. 1983. Correcting for differential digestibility in microhistological analyses involving common coastal forages of the Pacific northwest. – J. Range Manage 36: 730–732.

Martin, J. S. and Martin, M. M. 1982. Tannin assays in ecological studies: lack of correlation between phenolics, proanthocyanidins and protein-precipitating constituents in mature foliage of six oak species. – Oecologia 54: 205–211.

Table A1. Diet composition (%) of black-tailed deer by fawning area in the Mendocino National Forest, California during the summer of 2010–2012. The value from each year along with the average and standard error (SE) are shown for each fawning area. Fawning area names are followed by the name of the ridge in parentheses. Cherry Hill and Coyote Rock are both on the M1 ridge, while Cold Spring and Plaskett Meadows are on the FH7 ridge.

	Cherry Hill (M1)					Coyote Rock (M1)					Cold Spring (FH7)					Plaskett Meadows (FH7)				
Forage type	2010	2011	2012	Avg.	SE	2010	2011	2012	Avg.	SE	2010	2011	2012	Avg.	SE	2010	2011	2012	Avg.	SE
Quercus spp.	76.1	76.2	76.1	76.1	0.03	49.6	70.8	75.8	65.4	8.03	85.2	59.5	76.2	73.6	7.53	19.6	10.7	35.2	21.8	7.16
Ceanothus spp.	7.4	4.9	7.2	6.5	0.80	1.6	1.3	1.8	1.6	0.15	NA	5.0	2.6	3.8	0.98	8.4	9.8	7.4	8.5	0.70
Other shrubs	5.7	5.1	5.4	5.4	0.17	23.7	11.2	13.5	16.1	3.84	4.4	8.6	16.0	9.7	3.39	23.8	28.4	17.5	23.2	3.16
Conifers	0.8	2.3	0.0	1.0	0.67	3.0	4.2	1.5	2.9	0.78	1.8	2.1	0.4	1.4	0.52	6.8	6.8	1.4	5.0	1.80
Forbs	1.4	2.4	2.5	2.1	0.35	6.4	2.1	3.3	3.9	1.28	2.8	9.5	2.1	4.8	2.36	18.2	10.0	6.2	11.5	3.54
Grasses	1.2	0.1	1.3	0.9	0.38	2.3	0.8	0.0	1.0	0.67	4.4	3.2	0.4	2.7	1.19	7.0	2.0	4.3	4.4	1.44
Lichen	5.4	6.3	6.9	6.2	0.44	11.2	6.4	1.8	6.5	2.71	1.1	6.6	0.4	2.8	1.96	9.1	18.7	14.8	14.2	2.79
Other forage	2	2.7	0.6	1.8	0.62	2.2	3.2	2.3	2.6	0.32	0.3	5.5	1.9	2.4	1.54	7.1	13.6	13.2	11.3	2.10

Table A2. Forage quality of the two most common shrub species in the diet of black-tailed deer in the Mendocino National Forest, California. *Ceanothus codulatus* was collected in 2011 and *Quercus garryana breweri* was collected in 2012. IVDM stands for in-vitro digestible matter and tannins are reported as the milligrams precipated with a standard assay divided by the amount of forage, and are a measure of the potential amount of tannin that can bind with protein and prevent digestion.

Shrub spp.	% crude protein	Gross energy (cal. g^{-1})	% IVDM	% neutral detergent fiber	% acid detergent fiber	% acid detergent lignin	Tannin
Quercus garryana breweri	17.2	4746	68.4	36.6	21.8	7.5	0.11
Ceanothus cordulatus	11.2	5062	56.9	26.3	18.3	7.0	0.16

Table A3. Most common shrub species from line transect surveys on summer fawning areas in the Mendocino National Forest, 2010 and 2011. The barren cover type primarily consists of the duff layer underneath dense forest canopy, as well as bare dirt and rock.

Cover type or species name	Scientific name	Overall % cover
Barren	NA	47.1
Herbaceous	NA	13.1
Whitethorn ceanothus	*Ceanothus cordulatus*	8.1
Brewer's oak	*Quercus garryana breweri*	7.1
White fir	*Abies concolor*	5.4
Snow berry spp.	*Symphiocarpus* spp.	3.3
Red fir	*Abies magnifica*	1.9
Live oak spp.	*Quercus agrifolia/*	
	Q. wislizeni/Q. chrysolepis	2.1
Gooseberry/currant spp.	*Ribes* spp.	1.4
Whiteleaf manzanita	*Arctostaphylos viscida*	1.4
Wild rose	*Rosa* spp.	1.1
Fern spp.	*Polystichum* and *Pteridium*	
	spp.	0.8
Bitter cherry/choke cherry	*Prunus* spp.	0.8
Ponderosa pine	*Pinus ponderosa*	0.8
Willow spp.	*Salix* spp.	0.7

Table A4. Diet quality of black-tailed deer by fawning area and year. Diet quality was measured by fecal nitrogen and diaminopimelic acid (DAPA). Both are typically used as an index of diet quality, with higher numbers indicating a higher diet quality.

	DAPA			% fecal nitrogen		
Fawning area	2010	2011	2012	2010	2011	2012
Cherry Hill	0.28	0.44	0.57	2.46	3.12	3.11
Coyote Rock	0.37	0.42	0.62	2.30	2.74	3.09
Cold Spring	0.49	0.40	0.52	2.72	2.94	2.64
Plaskett Meadows	0.46	0.43	0.55	3.04	2.90	3.25

Table B1. All Cox proportional hazard models that were tested for nutrition, predator abundance, predator-nutrition interaction, and individual nuisance variables for summer and winter mortality of juvenile black-tailed deer. CaptureWeek is the age of juvenile deer at capture in weeks (1 or 2 weeks old), birth weight is the estimated weight at birth, oak is the average oak forage biomass available in the fawning area, fecal N is the average percent fecal nitrogen in deer pellets in a given fawning area, DAPA is the average index for DAPA from deer pellets in a given fawning area, oak_fecalN and oak_DAPA are the available oak forage weighted by the respective index of diet quality, predator is the relative abundance of both bears and coyotes (camera detections per night × 100) per fawning area per month long trapping period, and Spring Precip. is the amount of precipitation in the spring (April and May) before a given summer. Interaction terms are indicated variable × variable. Variables that were significantly correlated with mortality risk are indicated by (+) and (–) showing that an increase of that covariate is related to increasing or decreasing mortality risk respectively, while (0) indicates no significance.

Hypothesis	Covariates	AICc	ΔAIC_c	Deviance (–2LL)
Nutrition + Individ.	CaptureWeek (0) Birth weight (–) Oak (–)	542.56	0.00	536.38
Nutrition + Individ.	CaptureWeek (0) Birth weight (–) Oak_FecalN (–)	542.63	0.07	536.45
Nutrition + Predation + Individ.	CaptureWeek (0) Birth weight (–) Oak (0) Predator (0)	543.42	0.86	535.11
Nutrition	Birth weight (–) Oak (–)	543.48	0.91	539.39
Nutrition + Predation	Birth weight (–) Oak (–) Predator (0)	543.61	1.05	537.43
Nutrition + Individ.	CaptureWeek (0) Birth weight (–) Oak_DAPA (–)	543.87	1.30	537.68
Nutrition + Predation + Interaction	Birth weight (–) Oak (–) Predator (0) Oak × Predator (0)	543.95	1.39	535.64
Nutrition + Predation + Individ.	CaptureWeek (0) Birth weight (–)	544.57	2.00	538.38

	Predator (0)			
Nutrition + Predation + Interaction + Individ.	CaptureWeek (0) Birth weight (–) Oak (0) Predator (0) Oak × Predator (0)	544.65	2.08	534.18
Nutrition + Predation + Interaction + Individ.	CaptureWeek (0) Birth weight (0) Oak (0) Predator (0) Birth weight×Predator (0)	545.14	2.58	534.68
Nutrition + Predation	Birth weight (–) Predator (–)	545.44	2.87	541.35
Nutrition + Predation + Interaction	Birth weight (–) Oak (–) Predator (0) Birth weight × Predator (0)	545.49	2.93	537.19
Predation + Individ.	CaptureWeek (–) Predator (0)	547.04	4.48	542.95
Nutrition	Birth weight (–)	547.21	4.65	545.18
Individ.	CaptureWeek (–)	547.49	4.92	545.46
Nutrition + Predation + Individ.	CaptureWeek (0) Oak (0) Predator (0)	547.78	5.21	541.59
Predation	Predator (0)	548.18	5.61	546.15
Nutrition	Oak (0)	548.41	6.70	546.38
Null model	Null	549.26	5.85	549.26
Nutrition	Fecal N (0)	549.51	6.70	547.48
Weather	Spring Precip. (0)	551.05	6.95	549.02
Nutrition	DAPA (0)	551.14	8.48	549.12
Individual	Sex (0)	551.15	8.58	549.12
Nutrition	Herbaceous forage (0)	551.27	8.59	549.24
Nuisance variable	Fawning area (0)	552.37	8.71	546.34
Nuisance variable	Year (0)	552.83	9.81	548.80

Table B2. All Cox proportional hazards models for juvenile survival in winter. Models tested whether covariates related to weather, habitat, or elevation were related to winter mortality. The PDO covariate is the Pacific Decadal Oscillation index, winter chamise *Adenostoma* spp. and winter oak *Quercus* spp. and winter herbaceous are all measurements of the area of that habitat type in a given wintering area, elevation is the average weekly elevation for all adult female deer in a wintering area, the birth weight is estimated birth weight of a given juvenile deer, and summer oak is the amount of oak forage on the fawning area where the juvenile was born. Variables that were significantly correlated with mortality risk are indicated by (+) and (–) showing that an increase of that covariate is related to increasing or decreasing mortality risk respectively, while (0) indicates no significance.

Hypothesis	Covariates	AICc	ΔAIC_c	Deviance (–2LL)
Weather	PDO (+)	139.12	0.00	131.04
Null	Null	141.98	2.86	141.98
Habitat	Winter chamise (0)	142.02	2.91	139.94
Habitat	Winter oak (0)	142.16	3.04	140.08
Winter severity + Habitat	Elevation (0)	143.19	4.07	141.10
Nutrition carryover	Birth weight (0)	143.38	4.26	141.30
Habitat	Winter herbaceous (0)	143.56	4.45	141.48
Nutrition carryover	Summer oak (0)	143.83	4.71	141.76

Table B3. Cumulative incidence function models related to the risk of summer bear and coyote predation on juvenile black-tailed deer. Ridge is a categorical variable designating the MH1 and FH7 ridge, and an increase or decrease in risk shows that bear predation risk is higher or lower on FH7 than M1. Oak is the amount of available oak *Quercus* spp. forage in a fawning area, herbaceous forage is the amount of available herbaceous forage in a given fawning area in a given year, bear is the relative bear abundance in a given fawning area during a given month (daily camera trap detections × 100) and coyote is the relative coyote abundance, capture week is the age in weeks of a juvenile deer at capture, and birth weight is the estimated birth weight of juvenile deer. Variables that were significantly correlated with mortality risk are indicated by (+) and (–) showing that an increase of that covariate is related to increasing or decreasing mortality risk respectively, while (0) indicates no significance.

Bear cumulative incidence function models

Hypothesis	Covariates	AICc	ΔAIC_c	Deviance (–2LL)
Spatial variation	Ridge (0)	259.78	0.00	257.63
Nutrition	Oak (0)	260.43	0.65	258.40
Nutrition + Predator + Predator×Nutrition	Oak (–) Bear (0) Bear × Oak (Fig. 4)	260.46	0.68	254.27
Spatial + Predator + Predator × Spatial	Ridge (+) Bear (0) Bear × Ridge (0)	261.32	1.54	254.36
Predator	Bear (0)	262.55	2.77	260.52
Nutrition	Birth weight (0)	263.72	3.94	261.69
Individ.	Capture week (0)	263.73	3.95	261.70
Nutrition + Predator	Birth Weight (0) Bear (0)	264.31	4.53	260.22
Predator + Individ.	Bear (0) Capture week (0)	264.58	4.80	260.49
Nutrition + Individ.	Birth weight (0) Capture week (0)	265.72	5.28	261.63
Nutrition + Predator + Individ.	Birth weight (0) Bear (0) Capture week (0)	266.39	5.96	260.21

Coyote cumulative incidence function models

Hypothesis	Covariates	AICc	ΔAIC_c	Deviance (–2LL)
Nutrition	Herbaceous forage (0)	146.85	0.00	144.82
Nutrition	Birth weight (–) Herbaceous forage (0)	147.22	0.37	143.12
Nutrition	Birth weight (0)	148.01	1.16	145.98
Predator	Coyote (0)	149.69	2.85	147.66
Individual	Capture week (0)	149.69	2.85	147.66
Nutrition + Individual	Birth weight (0) Capture week (0)	150.06	3.21	145.97