VARIATION IN COYOTE DIETS ASSOCIATED WITH SEASON AND SUCCESSIONAL CHANGES IN VEGETATION

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Abstract: Diets of coyotes (*Canis latrans*) on the Rob and Bessie Welder Wildlife Refuge (WWR) in south Texas were determined from analyses of scats collected during 1961–62, 1973–74, 1975–76, and 1978–79. Diets varied among years due to successional changes in vegetation and changes in prey abundance. Coyote diets also varied seasonally, reflecting changing abundances of a wide variety of food items, differential vulnerability of prey, effects of plant phenology, and weather conditions.

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Short-term studies have shown pronounced seasonal variation in coyote diets related to the availability of various foods (Gipson and Sealander 1976, Litvaitis and Shaw 1980, MacCracken and Hansen 1982, Van Vuren and Thompson 1982, Harrison and Harrison 1984). However, reports of coyote diets over long periods of time from the same area (e.g., Leopold and Krausman 1986) are scarce, and we are not aware of studies reporting variations in diets associated with successional changes in vegetation. In this paper we report on coyote diets on the WWR during 1961–62, 1973–74, 1975–76, and 1978–79, comparing feeding patterns among these periods and relating variations in diets to changes in vegetation and vertebrate prey populations.

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STUDY AREA

We conducted our study on the 32-km^2 WWR, located 50 km north of Corpus Christi, Texas. The area generally was described as a chaparral-mixed grass shrubland (Drawe et al. 1978). The vegetation was delineated as 16 distinct communities during the early 1960's (Box and Chamrad 1966). Substantial changes in structure and composition of the vegetation, particularly on clay and clay-loam sites, began during the late 1960's as a result of several years of above average rainfall and a reduction in livestock grazing. Early-successional-stage grasses, such as common buffalograss (*Buchloe dactyloides*), were replaced by mid- and late-successional-stage grasses, such as silver sourgrass (*Bothriochloa saccharoides*) and tall dropseed (*Sporobolus asper*) (Drawe et al. 1978). These authors felt that the herbaceous vegetation in at least 4 of the original plant communities changed sufficiently by the mid-1970's to warrant new community names. The mesquite (*Prosopis* spp.)-buffalograss community was renamed a mesquite mixed grass type, chaparral-buffalograss became chaparral-mixed grass, and huisache (*Acacia farnesiana*)-buffalograss became huisache-mixed grass. Additionally, Lindheimer pricklypear (*Opuntia lindheimeri*) became uncommon. Consequently, Drawe et al. (1978) renamed the halophyte-cactus community as halophyte-shortgrass, and the pricklypear-shortgrass type ceased to exist as a distinct community, becoming primarily part of the chaparral-mixed grass type. Incorporation of part of the pricklypear-shortgrass community into the chaparral-mixed grass community during the latter 3 periods of this study did not alter the trend of increasing abundance of some plant species noted in this paper.

Coyotes were abundant (0.8–1.0/km^2) on the area during 1978–79 (Andelt 1985). We believe that coyote densities did not change appreciably during this study.

METHODS

Coyote food habits were determined from 2,590; 570; 584; and 2,610 scats collected on roads of the WWR at approximately 2-week intervals from February 1961 to August 1962, June 1973 to May 1974, June 1975 to May 1976, and November 1978 to November 1979, respectively. Scats were placed in bags marked

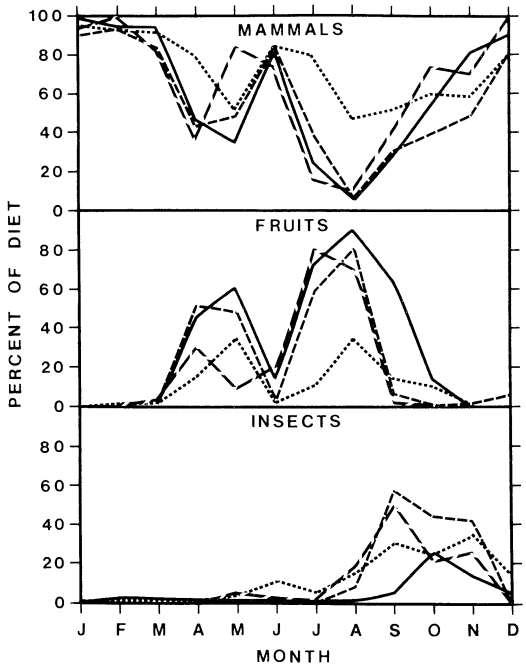

Fig. 1. Temporal patterns of 3 major food groups in coyote diets on the Welder Wildlife Refuge, Texas, 1961–62 (short-dashed line), 1973–74 (intermediate-dashed line), 1975–76 (long-dashed line), and 1978–79 (solid line).

with date collected, air dried, and stored. The 1st group of scats was analyzed by F. F. Knowlton, the 2nd and 3rd by J. G. Kie, and the 4th by W. F. Andelt. Food items were identified by comparison with reference materials and hair medulla patterns (Moore et al. 1974). Because small prey are often overestimated in diets when reported by frequency of occurrence (Martin et al. 1946, Weaver and Hoffman 1979), only items comprising >40% of each scat (determined by ocular estimate) were tabulated (Knowlton 1964, Bowen 1981).

Changes in abundance of fruiting woody species of vegetation were based upon percent cover as ascertained from permanent line-intercept transects (Canfield 1941) established in the 1950's and run periodically (Box 1959*b*; Mann 1975; L. D. Drawe, unpubl. data on file at WWR). Significant differences in coyote diets between years were determined with Sokal and Rohlf's (1969:607) method for testing the equality of 2 percentages.

Table 1. Annual coyote diets on the Welder Wildlife Refuge, Texas during 4 time periods, as determined by averaging monthly food type percentages.

Food type	1961–62	1973–74	1975–76	1978–79	$\bar{x}$
Mammals	73	57	65	61	64
Birds	2	0	2	1	1
Insects	12	13	11	5	10
Fruits	11	21	18	30	20
Misc.	2	8	5	3	5

Table 2. Percentage canopy cover, within plant communities, of plants producing fruits consumed by coyotes on the Welder Wildlife Refuge, Texas.

Fruit Plant community[a]	1957–58[b]	1973[c]	1975[d]	1979[d]
Pricklypear cactus				
Pricklypear-short grass	20.6	0.3	*e*	*e*
Liveoak-chaparral	*f*	*f*	0.1	0
Texas persimmon				
Mesquite-mixed grass	0	0.4	0	0
Chaparral-mixed grass	0	0.9	1.3	2.5
Pricklypear-short grass	0	0.8	*e*	*e*
Liveoak-chaparral	*f*	*f*	3.2	7.9
Agarito barberry				
Mesquite-mixed grass	0	0.2	0	0
Chaparral-mixed grass	2.4	9.9	10.2	11.1
Pricklypear-short grass	0.5	1.1	*e*	*e*
Liveoak-chaparral	*f*	*f*	2.3	3.4

[a] Plant community names after Drawe et al. (1978).
[b] Data from Box (1959*b*) and Mann (1975).
[c] Data from Mann (1975).
[d] Data from D. L. Drawe (on file at WWR).
[e] Plant community was considered primarily part of the chaparral-mixed grass community because of the disappearance of pricklypear cactus and similarities in vegetation (Drawe et al. 1978).
[f] Plant community composition was not determined.

RESULTS AND DISCUSSION

Overall, mammals made up about 64% of coyote diets on WWR, whereas insects and wild fruits comprised 10 and 20%, respectively (Table 1). The relative importance of these major food types in coyote diets varied seasonally, with similar trends during all 4 periods (Fig. 1). Mammals comprised the bulk of the diet from mid-November through March and during June. A bimodal pattern of fruit utilization occurred, with peaks in April–May and July–August in synchrony with the respective fruiting of individual species. Insects were unimportant in the coyote diet from January through July but comprised a significant proportion in late summer and fall when orthopterans were available. Birds represented <10% (usually <5%) of coyote diets during each month of all 4 periods.

Some of the more striking changes in coyote diets were correlated with successional changes in vegetation. The virtual disappearance of pricklypear cactus from WWR (Table 2) coin-

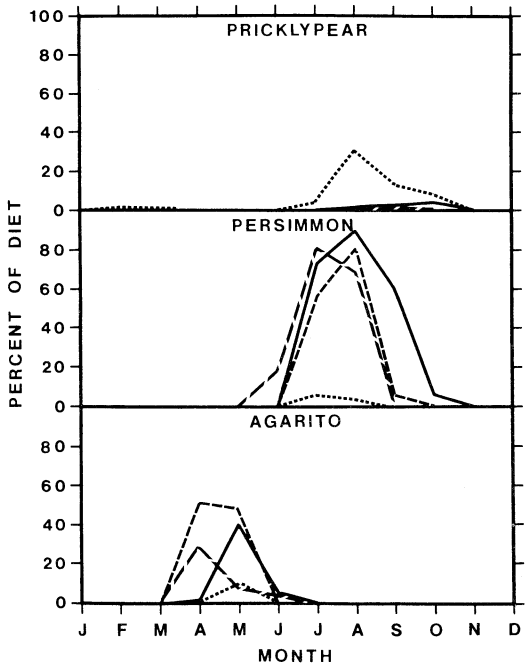

Fig. 2. Temporal patterns of 3 fruit species in coyote diets on the Welder Wildlife Refuge, Texas, 1961–62 (short-dashed line), 1973–74 (intermediate-dashed line), 1975–76 (long-dashed line), and 1978–79 (solid line).

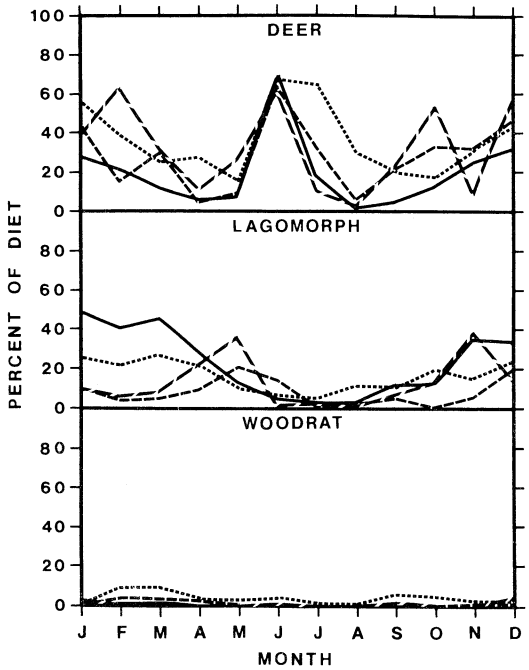

Fig. 3. Temporal patterns of 3 mammalian prey species in coyote diets on the Welder Wildlife Refuge, Texas, 1961–62 (short-dashed line), 1973–74 (intermediate-dashed line), 1975–76 (long-dashed line), and 1978–79 (solid line).

cided with a significant ($P < 0.001$) decrease of it in coyote diets in August–September of 1961–62 compared to 1973–74, 1975–76, and 1978–79 (Fig. 2). The significant 14- ($P < 0.001$) and 5-fold ($P < 0.01$) increases in utilization of Texas persimmon (*Diospyros texana*) in July–August and agarito barberry (*Berberis trifoliolata*) in April–May, respectively, by coyotes during the latter 3 periods (Fig. 2) coincided with absolute increases in canopy cover by these species (Table 2). Southern dewberries (*Rubus trivialis*) represented 5–13% in April and May 1961–62 and 9–44% in April and May 1978–79 of the foods eaten by coyotes but were not important components of the diets during the intermediate years of the study. The variation in amount of dewberries in coyote diets may have been related to fruit production rather than plant abundance because the latter was not known to change appreciably among the 4 periods.

Among mammalian prey, white-tailed deer (*Odocoileus virginianus*) constituted the largest proportion of coyote diets. These proportions followed similar trends during all 4 periods (Fig. 3) although deer comprised a significantly greater ($P < 0.001$) proportion of the diet during July–August of 1961–62 than during similar periods of the other years. Low rainfall during 1961–62 led to a delayed and protracted fawning period (Knowlton 1976), and persimmons were not as common at that time. During the latter 3 collections, fawn births occurred earlier (Kie et al. 1979, Kie and White 1985), and persimmons were abundant, effectively buffering fawns from predation.

Some changes in coyote diets apparently resulted from changes in prey abundance. The significantly greater ($P < 0.001$) consumption of deer from October through May of 1975–76 than 1978–79 coincided with a higher deer density during the former period (49/km^2 in Jan–Mar 1976, and 36 and 30/km^2 in Jan–Mar 1979 and 1980) (Kie and White 1985). Coyotes also ate significantly more ($P < 0.001$) deer from October through May of 1961–62 and 1973–74 than during 1978–79 but these differences cannot be related to variations in deer densities because the latter were estimated with different techniques (Knowlton 1964, Kie et al. 1979, Kie and White 1985). Similar changes in coyote diets

were related to variations in deer densities in western Texas (Leopold and Krausman 1986).

Lagomorphs, primarily eastern cottontails (*Sylvilagus floridanus*), also frequently appeared in coyote diets during fall, winter, and spring (Fig. 3). The reduced consumption of lagomorphs during summer coincided with increased availability of fruits and deer fawns. Black-tailed jack rabbit (*Lepus californicus*) remains were identified in some scats collected during 1961–62 but were not verified in any of the collections in the latter 3 periods. Although jack rabbits were never abundant on the study area, they were seen regularly during 1961–62, when the vegetation was relatively short. However, during the latter 3 periods, only 1 jack rabbit was noted in the field. We suspect that the reduced number of sightings in the latter phases of the study reflects a decreased abundance of jack rabbits associated with vegetative changes rather than increased obscurity due to taller vegetation. These interpretations are consistent with the functional feeding response of coyotes to changing hare densities presented by Hoffman (1979).

Southern plains woodrats (*Neotoma micropus*) decreased significantly ($P < 0.001$) in coyote diets from 1961–62 to 1973–74, 1975–76, and 1978–79 (Fig. 3). The pricklypear-shortgrass community was a preferred habitat for woodrats, with pricklypear cactus providing food and cover for nest building (Box 1959*a*). Raun (1962) reported increased mortality of juvenile woodrats on the WWR in the summer and fall of 1960, which coincided with persistent flooding of burrows by heavy rains, minimal fruit production, and deterioration of pricklypear cactus. Therefore, woodrats became less abundant and less available as food for coyotes.

Domestic cattle and plains pocket gophers (*Geomys bursarius*) appeared in low proportions (usually <10%) in coyote diets throughout the year of all 4 periods. Both food items were found in smaller proportions during summer than other seasons (the summer period typically was associated with increased availability of fruits and deer fawns). The greatest use of cattle occurred during winter and coincided with the calving period. The amount of hispid cotton rats (*Sigmodon hispidus*) in coyote diets did not vary significantly during the study, representing 0–20% of the diet during each month except for 1 instance (Feb 1974) when they comprised 40% of the diet.

Coyote functional feeding responses, associated with changing seasons and relative availability and vulnerability of prey, have been documented by other studies. Some (e.g., Murie 1951, Young and Jackson 1951, Litvaitis and Shaw 1980, Harrison and Harrison 1984, Leopold and Krausman 1986) have reported coyotes utilizing native fruits comparable to that noted here, but we are not aware of other studies demonstrating changing coyote diets associated with successional changes in vegetation, even though such changes may seem intuitive.

MANAGEMENT IMPLICATIONS

Noting that coyote feeding patterns reflect the availability of a wide variety of food items, differential vulnerability of prey, and seasonal effects of plant phenology is not new. However, demonstrating that diets change with successional changes in vegetation underscores the need to accommodate such events in preparation of environmental assessments and environmental impact analyses. Judgments about the potential effect of such changes on coyote abundance also may be appropriate.

The dramatic seasonal shift by coyotes to feeding on native fruits, when they were abundant, and consumption of insects in significant amounts, when other foods were available, suggests that fruits and insects may substantially buffer predation on other species. Hence, it may be possible to predict the intensity of coyote predation on vertebrate prey through routine monitoring of fruit and insect abundance. The high consumption of fruits also suggests the potential, in some areas, for strategic plantings of appropriate fruiting species to buffer predation on desirable species, or possibly to lure coyotes to areas where they might be more easily captured.

LITERATURE CITED

ANDELT, W. F. 1985. Behavioral ecology of coyotes in south Texas. Wildl. Monogr. 94. 45pp.

BOWEN, W. D. 1981. Variation in coyote social organization: the influence of prey size. Can. J. Zool. 59:639–652.

BOX, T. W. 1959*a*. Density of plains wood rat dens on four plant communities in south Texas. Ecology 40:715–716.

———. 1959*b*. Relationships between soils and vegetation on four range plant communities on

the Welder Wildlife Refuge in South Texas. Ph.D. Thesis, Texas A&M Univ., College Station. 100pp.

———, AND A. D. CHAMRAD. 1966. Plant communities of the Welder Wildlife Refuge. Rob and Bessie Welder Wildl. Found. Contrib. 5, Ser. B, Sinton, Tex. 28pp.

CANFIELD, R. H. 1941. Application of the line intercept method in sampling range vegetation. J. For. 9:388–394.

DRAWE, D. L., A. D. CHAMRAD, AND T. W. BOX. 1978. Plant communities of the Welder Wildlife Refuge. Rob and Bessie Welder Wildl. Found. Contrib. 5, Ser. B, Sinton, Tex. 42pp.

GIPSON, P. S., AND J. A. SEALANDER. 1976. Changing food habits of wild *Canis* in Arkansas with emphasis on coyote hybrids and feral dogs. Am. Midl. Nat. 95:249–253.

HARRISON, D. J., AND J. A. HARRISON. 1984. Foods of adult Maine coyotes and their known-aged pups. J. Wildl. Manage. 48:922–926.

HOFFMAN, S. W. 1979. Coyote-prey relationships in Curlew Valley during a period of low jackrabbit density. M.S. Thesis, Utah State Univ., Logan. 139pp.

KIE, J. G., M. WHITE, AND F. F. KNOWLTON. 1979. Effects of coyote predation on population dynamics of white-tailed deer. Pages 65–82 *in* D. L. Drawe, ed. Proc. 1st Welder Wildlife Foundation Symposium. Rob and Bessie Welder Wildl. Found. Contrib. B-7, Sinton, Tex.

———, AND ———. 1985. Population dynamics of white-tailed deer (*Odocoileus virginianus*) on the Welder Wildlife Refuge, Texas. Southwest. Nat. 30:105–118.

KNOWLTON, F. F. 1964. Aspects of coyote predation in south Texas with special reference to white-tailed deer. Ph.D. Thesis, Purdue Univ., Lafayette, Indiana. 189pp.

———. 1976. Potential influence of coyotes on mule deer populations. Pages 111–118 *in* G. W. Workman and J. B. Low, eds. Mule deer decline in the West: a symposium. Utah State Univ. and Utah Agric. Exp. Stn., Logan.

LEOPOLD, B. D., AND P. R. KRAUSMAN. 1986. Diets of 3 predators in Big Bend National Park, Texas. J. Wildl. Manage. 50:290–295.

LITVAITIS, J. A., AND J. H. SHAW. 1980. Coyote movements, habitat use, and food habits in southwestern Oklahoma. J. Wildl. Manage. 44: 62–68.

MANN, D. K. 1975. Vegetational change in four major plant communities of the Welder Wildlife Refuge from 1957–58 to 1973. M.S. Thesis, Utah State Univ., Logan. 73pp.

MACCRACKEN, J. G., AND R. M. HANSEN. 1982. Seasonal foods of coyotes in southeastern Idaho: a multivariate analysis. Great Basin Nat. 42:45–49.

MARTIN, A. C., R. H. GENSCH, AND C. P. BROWN. 1946. Alternative methods in upland gamebird food analysis. J. Wildl. Manage. 10:8–12.

MOORE, T. D., L. E. SPENCE, AND C. E. DUGNOLLE. 1974. Identification of the dorsal guard hairs of some mammals of Wyoming. Wyo. Game and Fish Dep. Bull. 14. 177pp.

MURIE, A. 1951. Coyote food habits on a southwestern cattle range. J. Mammal. 32:291–295.

RAUN, G. G. 1962. A local population of the woodrat (*Neotoma micropus*) in south Texas. Ph.D. Thesis, Univ. Texas, Austin. 121pp.

SOKAL, R. R., AND F. J. ROHLF. 1969. Biometry. W. H. Freeman and Co., San Francisco, Calif. 776pp.

VAN VUREN, D., AND S. E. THOMPSON, JR. 1982. Opportunistic feeding by coyotes. Northwest Sci. 56:131–135.

WEAVER, J. L., AND S. W. HOFFMAN. 1979. Differential detectability of rodents in coyote scats. J. Wildl. Manage. 43:783–786.

YOUNG, S. P., AND H. H. T. JACKSON. 1951. The clever coyote. The Stackpole Co., Harrisburg, Pa., and Wildl. Manage. Inst., Washington, D.C. 411pp.

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