CHICKASAW PLUM: GROWTH AND USE BY NESTING BIRDS IN OKLAHOMA

By

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CHAPTER 1[a]

GROWTH OF CHICKASAW PLUM IN OKLAHOMA

ABSTRACT Management of rangelands for wildlife and livestock entails understanding growth of clonal shrubs such as Chickasaw plum (*Prunus angustifolia* Marsh.). I studied its growth in one county in north-central (Payne) and two counties in north-western Oklahoma (Ellis, Harper) during 2006–2007. I estimated age of stems and roots using growth rings and area of stands using a hand-held Global Positioning System (GPS) unit. Based on zero-intercept regression models, stands grew at similar rates (overlapping 95% CIs) among counties with a pooled estimate of 31.0 $m^2 \cdot y^{-1}$ (95% CI = 26.5–35.6 $m^2 \cdot y^{-1}$; $n = 95$). This rate showed considerable variability within and among study sites ($r^2 = 0.27$). Stem diameter increased (zero-intercept models) more rapidly in north-central Oklahoma (5.27 $mm \cdot y^{-1}$; 95% CI = 5.01–5.53 $mm \cdot y^{-1}$; $r^2 = 0.81$; $n = 53$) than in north-western Oklahoma (3.68 $mm \cdot y^{-1}$; 95% CI = 3.55–3.81 $mm \cdot y^{-1}$; $r^2 = 0.83$; $n = 102$); data pooled because of similar rates in Ellis and Harper counties). Stem height was a power function of stem age ($y = 0.97x^{0.28}$; $r^2 = 0.31$), indicating rate of growth in height ($m \cdot y^{-1}$) declined with age according to $dy/dx = 0.27x^{-0.72}$. Knowledge of the area expansion rate of Chickasaw plum clones aids in management planning to increase or decrease coverage by this shrub.

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[a] The style of this chapter follows *Rangeland Ecology & Management*.

INTRODUCTION

The rate of clonal expansion of shrub thickets in grasslands is an important consideration regarding management of wildlife habitat and livestock forage as well as efforts to restore or preserve desired ecosystems. While previous studies documented lineal expansion rate of individual clones (Duncan 1935; Barnes 1966; Gilbert 1966; Petranka and McPherson 1979; Mayes et al. 1998), attempts to quantify area expansion rate have been lacking. Also, scant information is available regarding basic biology of clonal shrubs. An example is Chickasaw plum (*Prunus angustifolia* Marsh.) (hereafter; plum) which occurs from Florida north to Tennessee and west to western Texas, Oklahoma, and Kansas (Little 1977).

In grasslands of Oklahoma, Texas, and Kansas, plum stands provide important wildlife habitat (Guthery et al. 2005). I have observed 34 species using the shrub for nesting, foraging, or cover (Chapter 4). I have also observed 2 passerines of numerical concern, painted buntings (*Passerina ciris* L.) and Bell's vireos (*Vireo bellii* Audubon), nesting in plum. The threatened lesser prairie-chicken (*Tympanuchus pallidicinctus* Ridgway) uses plum for resting, roosting, and escape cover (Donaldson 1969).

Knowledge of expansion rate of clones and growth rate of stems and roots within them assists in management planning. Managers can use the knowledge to anticipate future landscapes and plan for increase or decrease of plum, depending on objectives. Accordingly, I described growth of plum in Oklahoma. I developed models using age (root and stem) in years to predict area of stands, diameter of roots and stems, and height of stems, and I modeled the relation between stem diameter and stem height. Finally, comparison of root and stem ages provided information on frequency of topkilled stems.

METHODS

Study Areas

Data were collected during 2006 from private properties in three Oklahoma counties. The Payne County site (36˚13'N, 97˚6'W), in north-central Oklahoma, about 10 km north of Stillwater, consisted of 84 ha. This site was primarily used for hunting with limited cattle grazing. This site was in the Cross Timbers Transition of the Central Great Plains (Woods et al. 2005). This region receives precipitation ranging from 73 to 97 $cm·y^{-1}$. Temperatures range from a mean monthly low of -5 °C in January to mean monthly high of 34 °C in July. The vegetation was dominated by little bluestem (*Schizachyrium scoparium* Michx) (nomenclature follows Gould [1975]) with islands of Chickasaw plum, roughleaf dogwood (*Cornus drummondi* G. Meyer)*,* smooth sumac (*Rhus glabra* L.), and flameleaf sumac (*R. copallina* L.). Soils consisted of the Renfrow (fine, mixed, superactive, thermic Udertic Paleustolls), Coyle (fine-loamy, siliceous, active, thermic Udic Argiustolls), and Grainola (fine, mixed, active, thermic Udertic Haplustalfs) series that generally occupy upland ridge tops and side slopes (Henley et al. 1987). These series are moderately deep, well drained, and moderately to very slowly permeable loamy soils.

The Harper County site (36˚47'N, 99˚27'W), in northwest Oklahoma is about 40 km north of Woodward. This site encompassed 5 667 ha primarily used for commercial hunting and cattle grazing. This area lies in the Central Great Plains in the Rolling Red Hills ecoregion (Woods et al. 2005). The area receives precipitation ranging from 66 to 76 $cm·y^{-1}$ and temperatures ranging from mean January lows of -8 °C to mean July highs of 36 °C. The vegetation was dominated by mixed grass prairie of little bluestem, side-oats grama (*Bouteloua curtipendula* [Michx.] Torr.), blue grama (*B. gracilis* [Willd. *ex* H.B.K.] Lag.), and sand sagebrush (*Artemisia filifolia* Torr.) with patches of Chickasaw plum in uplands. Soils consisted of Quinlan (loamy, mixed, superactive, thermic, shallow Typic Haplustepts) –Woodward (coarse-silty, mixed, superactive, thermic Typic Haplustepts) and Mansker (fine-loamy, carbonatic, thermic Calcidic Paleustolls) – Potter (loamy-skeletal, carbonatic, thermic Petronodic Ustic Haplocalcids) associations occupying smooth to rolling uplands (Nance et al. 1960). These soils are shallow to moderately deep sandy loam, well drained, and moderately permeable.

The Ellis County site (36˚21'N, 99˚42'W), in northwest Oklahoma was about 27 km west of Woodward. This site had 4 856 ha primarily used for hunting and cattle grazing. This area lies in the in the Canadian-Cimarron Breaks ecoregion of the Southwestern Tablelands west of the Central Great Plains (Woods et al. 2005). The Ellis County area received 52 $cm \cdot y^{-1}$ of precipitation with temperatures ranging from mean January lows of -6 °C to mean July highs of 33 °C. The upland vegetation was dominated by lower successional grasses in a matrix of little blue stem, sand sagebrush, and Chickasaw plum. Soils consisted of Likes (mixed, thermic Aridic Ustipsamments), Otero (mixed, thermic Typic Torripsamments), Pratt (sandy, mixed, mesic Lamellic Haplustalfs), and Tivoli (mixed, thermic Typic Ustipsamments) series that occur on gently rolling upland flats (Cole et al. 1966). These soils are very deep, fine sandy loam, well drained, rapidly permeable, and limy.

Sampling and Measurement

I sampled 33 (Payne), 30 (Harper), and 32 (Ellis) stands ranging in size from 29–1 774 m^2 to model stand area as a function of stand age (Appendix). I chose gradients under the assumption stand area increases with stand age. To estimate stand age, I selected the presumptive oldest stem in a stand, i.e., greatest diameter and height (Gilbert 1966; Reinartz and Popp 1987), as the basis for age-based modeling of area. The oldest stem and attached root were removed with a sharpshooter spade and lopping shears.

Because my sampling protocol (oldest stem) resulted in under representation of younger stems, I arbitrarily selected four additional plum stands on each site. From each of these stands, I collected 5 stems and attached roots for the following ground-line diameter (cm) size classes: <1, 1–<2, …, 4–<5. Thus, I had an additional 20 samples per site for modeling diameter and height as a function of age but these additional samples were not used in modeling stand area as a function of age.

All stem and root samples were cross–sectioned, air–dried, and sequentially sanded with abrasive grits ranging from 201–15 µm (Asherin and Mata 2001). I counted annual growth rings using a dissection microscope and verified through cross–dating (Douglass 1941; Stokes and Smiley 1996). I used a staida rod to measure heights of stems and dial calipers to measure diameters (stems, roots) in the field. I measured diameter of stems at ground level and diameter of roots at their junction with a stem (Phipps 1985; Bar et al. 2006). I assumed past disturbance explained root age exceeding stem age for a particular ramet.

To estimate area, I defined a plum stand as an aggregate of stems originating from a parent plant. If ≥ 2 stands were in close proximity, a single stand was defined as a continuous aggregation of stems with a distance <1 m between stems. I estimated area of a stand using a Garmin Etrex Legend® (Garmin International, Olathe, Kansas, USA) hand-held Global Positioning System (GPS) unit. The manufacturer reports accuracy with wide area augmentation enabled to be ≤3 m. I walked the perimeter of a stand three times and estimated area. I used the average of the three estimates for modeling. The interval used to record locations was 1 second. As an accuracy check, I used Geographic Information System (GIS) analysis to estimate area of stands >100 m^2 ($n = 49$) from aerial photographs taken in 2006. Areas measured with GPS units and GIS analysis were strongly correlated ($r^2 = 0.96$; Chapter 2), suggesting the averaged GPS estimates were acceptable.

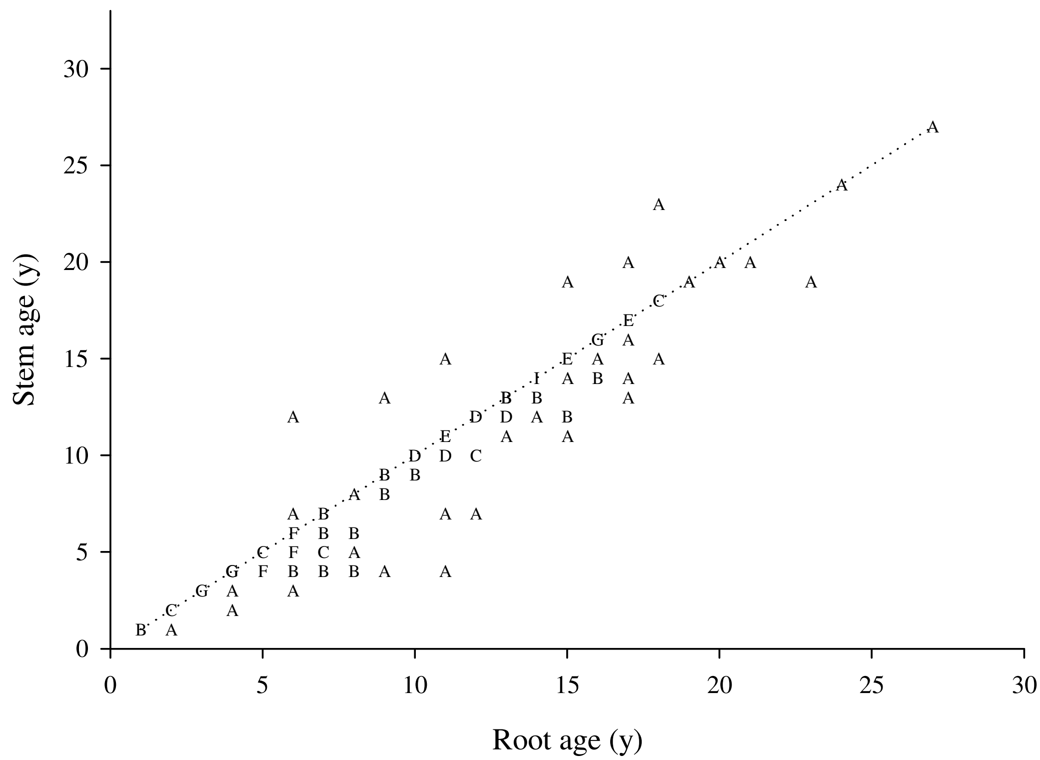
Statistical Analyses

I planned to evaluate plum growth by testing the data against established growth models. However, simplicity of the data indicated this approach would unnecessarily complicate results. I therefore used the linear, zero-intercept model ($y = bx$) or the curvilinear power model ($y = ax^b$) to model growth, as appropriate. I pooled data if the 95% CIs for the parameter b overlapped between or among sites. The 95% CIs for all reported regression coefficients (b) did not overlap 0.0. Thus, I reported results at the traditional $P < 0.05$.

RESULTS

Estimated ages of stems and attached roots were strongly correlated ($r^2 = 0.90$, $n = 155$, Fig.1.1). For a zero-intercept model, stem age increased 0.95 y (95% CI = 0.93–0.97 y) for each 1-y increase in root age. Estimates were identical for 82 samples, stem age was less than root age for 66 samples, and stem age was greater than root age for 7 samples. Results indicated that 42.6 ± 4.4 % SE ($n = 155$) of the pooled sample had experienced past aboveground disturbance that resulted in topkill. Stem age was less than root age for 57 ± 6.9% SE ($n = 53$) of the sample for Payne County, 44 ± 6.9% SE ($n = 52$) for Ellis County, and 26 ± 6.2% SE ($n = 50$) for Harper County.

Figure 1.1. Relationship between root age and stem age for Chickasaw plum on 3 study sites in Oklahoma, USA, 2006–2007 (n = 155). Letters correspond to the numerical frequency of data points where A = 1, B = 2, C = 3,…. The dotted line corresponds to the 1:1 relationship between root age and stem age.

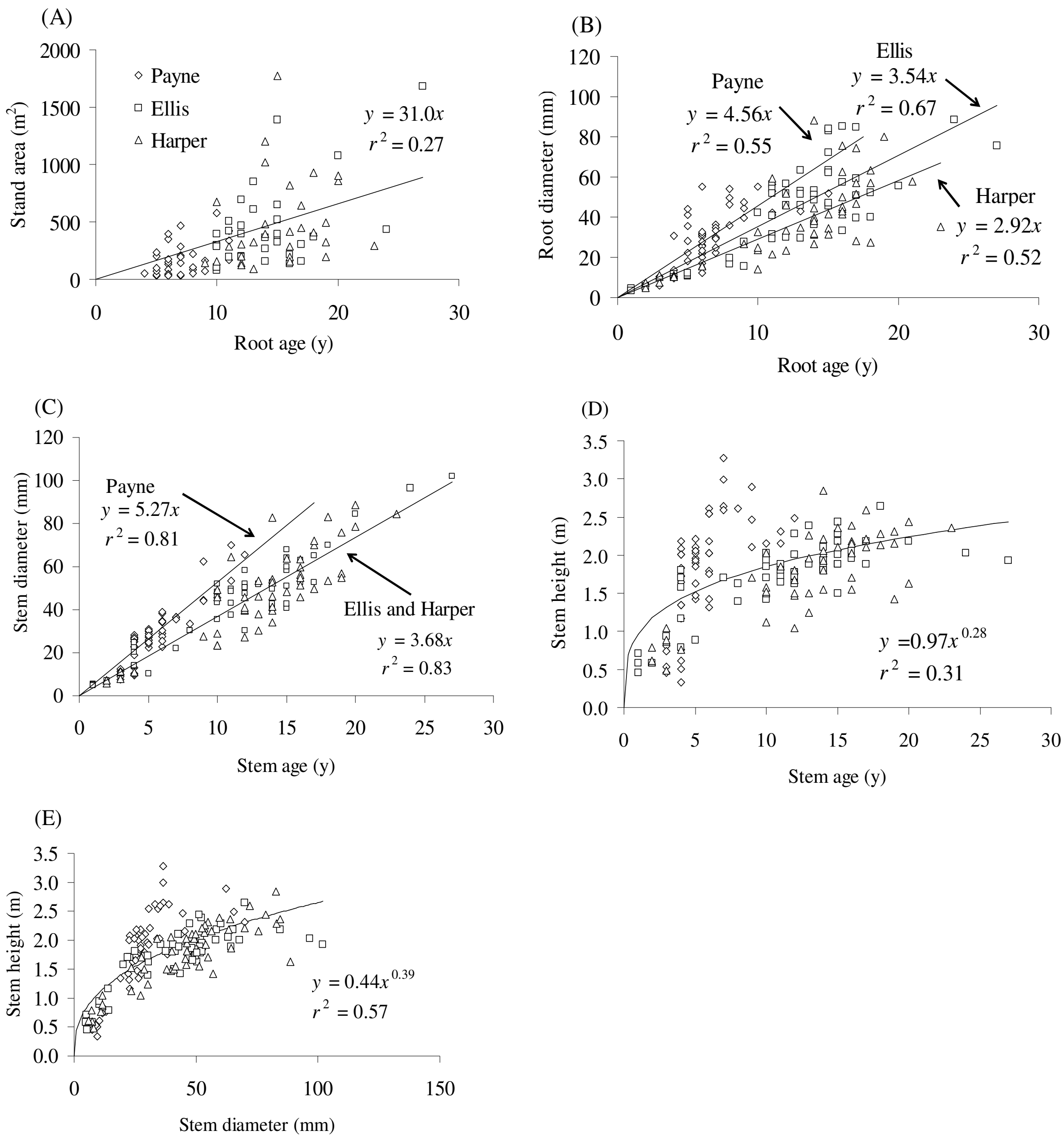


Use of root age or stem age to predict stand area yielded similar results based on overlapping 95% CIs of growth rates (Table 1.1). Likewise, 95% CIs overlapped among study sites. The pooled estimate of annual growth rate (regression coefficient) based on root age was 31.0 $m^2 \cdot y^{-1}$ (95% CI = 26.5–35.6 $m^2 \cdot y^{-1}$; Fig. 1.2A). For stands apparently not experiencing previous topkill (stem age = root age, n = 47 for samples with area measurements), growth rate was 33.2 $m^2 \cdot y^{-1}$ (95% CI = 26.3–40.1 $m^2 \cdot y^{-1}$, $r^2 = 0.24$). Apparently disturbed stands (stem age < root age, n = 43 for samples with area measurements) grew at 24.9 $m^2 \cdot y^{-1}$ based on root age (95% CI = 20.2–29.6 $m^2 \cdot y^{-1}$, r^2 = 0.36). I observed considerable variability in growth rates within and among study sites.

Table 1.1. Regression analyses (b = slope of zero-intercept model in $m^2 \cdot y^{-1}$ with 95% CIs) of the area (m^2) of Chickasaw plum stands as a function of stem and root age (x) on 3 study sites in Oklahoma, USA, 2006–2007 (LCI = lower confidence interval, UCI = upper confidence interval).

	Payne				Ellis				Harper			
Independent variable	b	LCI	UCI	r^2	b	LCI	UCI	r^2	b	LCI	UCI	r^2
Root age	24.9	18.6	31.2	0.18	31.1	23.4	38.9	0.16	32.4	23.3	41.6	0.06
Stem age	31.4	23.9	38.9	0.24	32.9	25.3	40.6	0.24	31.9	22.8	41.0	0.04

Figure 1.2. Growth models for Chickasaw plum on 3 study sites in Oklahoma, USA, 2006–2007. A, Stand area as a function of root age (n = 95). B, Root diameter as a function of root age (n = 155). C, Stem diameter as a function of stem age (n = 155). D, Stem height as a function of stem age (n = 155). E, Stem height as a function of stem diameter (n = 155).



Root diameter as a function of root age varied among study sites (Fig. 1.2B). The growth rate was 4.56 $mm \cdot y^{-1}$ (95% CI = 4.20–4.92 $mm \cdot y^{-1}$) in Payne County, 3.54 $mm \cdot y^{-1}$ (95% CI = 3.26–3.82 $mm \cdot y^{-1}$) in Ellis County, and 2.92 $mm \cdot y^{-1}$ (95% CI = 2.63–3.21 $mm \cdot y^{-1}$) in Harper County. Zero-intercept models explained between 52 and 67% of variation in root diameter.

Stem diameter increased more rapidly in Payne County (5.27 $mm \cdot y^{-1}$; 95% CI = 5.01–5.53 $mm \cdot y^{-1}$; Fig. 1.2C) than in Harper and Ellis counties pooled (3.68 $mm \cdot y^{-1}$; 95% CI = 3.55–3.81 $mm \cdot y^{-1}$). These relations were relatively strong with $r^2 \geq 0.81$ so stem diameter was a good predictor of age of stands, given that the oldest stem in a stand was identified. For Payne County, age in years (x) was predicted by stem diameter (y; mm) as $x = 0.18y$ ($n = 53$; 95% CI on coefficient = 0.17–0.19; $r^2 = 0.76$). The formula was $x = 0.26y$ for Harper and Ellis counties ($n = 102$; 95% CI on coefficient = 0.25–0.27; $r^2 = 0.81$).

Stem height was a power function of stem age for pooled data (Fig. 1.2D). The derivative of the function, $dy/dx = 0.27x^{-0.72}$, gives the estimated growth rate at a specified age. For example, growth rate at 10 y would be estimated at $0.27(10^{-0.72}) = 0.05$ $m \cdot y^{-1}$. Likewise, stem height was a power function of stem diameter (Fig. 1.2E).

DISCUSSION

The linear relationship between root age and stand area that fit data from 3 different sites indicated that clones expanded at a constant rate and simplified predictions of plum growth in central Oklahoma. An alternative to constant area growth rate is constant radial expansion and resultant quadratic increases in area. Constant area growth indicates either asymmetric expansion or a biological constraint, such as water or nutrient uptake, which prevents quadratic growth. The number of new smooth sumac ramets produced per year (a surrogate for area) increased from one (initial stem) to a maximum in about 5 y, after which the number of new ramets fluctuated or decreased (Gilbert 1966).

I observed substantial unexplained variation in the relationship between stand area and root age (Table 1.1). Potential sources of variation included intensity of interspecific competition (Peltzer 2002), small-scale differences in nutrient and water availability, genetics, and disturbance. I assumed that stands originated from expansion of one clone. If, as in some other species, several clones intermix (Mayes et al. 1998; Torimaru and Tomaru 2005), I overestimated stand area. However, clonal species which exhibit patterns of stand expansion and decreasing ramet height near the periphery, as plum, form pure clones (Gilbert 1966; Reinartz and Popp 1987; Li et al. 1999).

Most occurrences where stem age was less than root age probably indicated disturbance such as fire, drought, or herbivory resulting in topkill and resprouting. Based on the largest measured difference between stem age and root age, plum maintained the ability to resprout at least through age 5–7. Some differences between root and stem age could have resulted from measurement error. Disturbance (as indicated by stem age < root age) decreased the estimated stand expansion rate by 8.3 $m^2 \cdot y^{-1}$, but segregating data into disturbed and undisturbed stands did not explain further variation in stand expansion based on root age. Fire causes differences between root and stem age (Guerin 1993) and is a common disturbance for plum in my study area. Fire has a null or stimulatory effect on plum stem density (Adams et al. 1982). Besides fire, herbivory is a probable disturbance. However, the foliage is low-preference browse for white-tailed deer (Gee et al. 1994; Miller and Miller 1999).

Except for Barnes (1966), who reported an expansion rate of 306 $m^2 \cdot y^{-1}$ for aspen clones (*Populus* sp.) in Michigan, I am not aware of studies that measured clone area. Converting previously reported lineal growth rates to area expansion is not possible because of either irregular shapes of individual clones (Gilbert 1966) or because clone diameters were not reported. Assuming stands of plum spread in a circular pattern, diameter expansion in my study ranged from 1.34 $m \cdot y^{-1}$ for a 155-m^2, 5-year-old stand to 0.62 $m \cdot y^{-1}$ for a 775-m^2, 25-year-old stand. In comparison, flameleaf sumac expanded by 0.46 and 2.5 $m \cdot y^{-1}$ (Duncan 1935; Gilbert 1966; Petranka and McPherson 1979), bigtooth aspen (*P. grandidentata* Michx.) by 1 $m \cdot y^{-1}$ (Duncan 1935), sassafras (*Sassafras albidum* (Nutt.) Nees) by 0.73 $m \cdot y^{-1}$ (Duncan 1935), and Havard oak (*Quercus havardii* Rydb.) by rates ≤ 15 $m \cdot y^{-1}$ (Mayes et al. 1998).

MANAGEMENT IMPLICATIONS

These results can be used in planning the management of plum on rangelands to meet wildlife and livestock objectives. Estimates of area expansion rates can be used to predict future canopy coverage by Chickasaw plum on a particular site, recognizing that area (m^2) growth is quite variable (Fig. 1.2A). These predictions might identify time frames for a maximum expected wildlife response or time frames when canopy coverage would be too high for species such as grassland birds or optimal livestock forage production. More detailed management recommendations for wildlife must await further study of wildlife-plum interactions because the interactions are virtually undocumented at present.

CHAPTER 2[a]

GROWTH OF CHICKASAW PLUM STANDS DETERMINED WITH REMOTE SENSING

ABSTRACT Habitat management planning requires biologists to know the spread and growth rates of woody plants that provide structure and cover for wildlife. Using Geographic Information System (GIS) analysis, I collected stand-area data on Chickasaw plum (*Prunus angustifolia*) from aerial photographs on 3 sites in north-central and northwestern Oklahoma, USA, for the years 2003–2006. In 2006, I also collected stand-area data with a hand-held Global Positioning System (GPS) unit for comparison with GIS analysis. For stands >100 m^2 ($n = 49$), I observed apparent decline, stability, and growth in stand area between years; however, changes between years were small. There was substantial variation in annual relative growth (Δarea/beginning area) for stands <400 m^2 whereas larger stands had relative growth rates near 0.0. Correlation analysis indicated that if a stand had a low relative growth rate in year t, it tended to compensate with a high relative growth rate in year $t + 1$. In 2006, stand areas estimated with GPS units and GIS analysis were strongly correlated ($r^2 = 0.92$, $n = 49$), but GIS estimates were consistently smaller than GPS estimates

[a] The style in this chapter follows Journal of Wildlife Management.

INTRODUCTION

Chickasaw plum (*Prunus angustifolia*) is a clonal shrub native to Oklahoma, Texas, and Kansas (Gilman and Watson 1994). In late summer it produces a red or yellowish fruit eaten by wildlife. Chickasaw plum provides cover for potential revenue-producing wildlife such as northern bobwhites (*Colinus virginianus*) (Guthery et al. 2005) and white-tailed deer (*Odocoileus virginianus*). It also provides nesting and escape cover for many grassland birds, rodents, reptiles, and small mammals.

Chickasaw plum is viewed by wildlife managers as important cover for wildlife but is viewed by ranchers as competition for forage for livestock (Jackson and DeArment 1963). This results in wildlife managers wanting to promote it and livestock producers wanting to reduce or eliminate it. The findings from this study will provide both ranchers and wildlife manager's information for management of Chickasaw plum stands.

My objectives were to estimate stand growth between and among years, describe the relationship between relative growth rates and stand area, determine the correlation between relative growth rates of individual stands between and among years, and determine the correlation between stand area data obtained on site (GPS) and using aerial photographs (GIS).

STUDY AREA

I collected data from digital aerial photos from 3 sites in Oklahoma. The Payne county site in north-central Oklahoma was about 10 km north of Stillwater, USA, and consisted of about 84 ha. The land was primarily used for private hunting and cattle grazing. This study site lies in the Cross Timbers Transition of the Central Great Plains and is described as rough plains with stands of forest (Woods et al. 2005). This region receives precipitation ranging from 73–97 cm/year. Temperatures range from a mean of -5 °C in January to 34 °C in July. The vegetation is dominated by little bluestem (*Schizachyrium scoparium*) with islands of Chickasaw plum, roughleaf dogwood (*Cornus drummondii),* smooth sumac (*Rhus glabra*), and flame-leaf sumac (*R. copallina*).

The Harper County site in northwest Oklahoma was approximately 40 km north of Woodward, USA. This area consisted of 5,667 ha primarily used for commercial hunting and leased cattle grazing. This area lies in the Rolling Red Hills ecoregion of the Central Great Plains (Woods et al. 2005). The Rolling Red Hills are dissected gently to steeply with solution caves found in gypsum. Streams are entrenched with sandy substrates and turbid waters. This area receives precipitation ranging from 66–76 cm annually and temperatures that range from -8 °C–36 °C. The vegetation was dominated by mixed grass prairie of little bluestem, side-oats grama (*Bouteloua curtipendula*), blue grama (*B. gracilis*), yellow Indiangrass (*Sorghastrum nutans*), sand sagebrush (*Artemisia filifolia*), and shinnery oak (*Quercus havardii*), with stands of Chickasaw plum, eastern cottonwood (*Populus deltoides*), and common hackberry (*Celtis occidentalis*).

The Ellis County site in northwest Oklahoma was about 27 km west of Woodward, USA. The ranch consisted of 4,856 ha and was primarily used for hunting and leased cattle grazing. This area lies in the Canadian-Cimarron Breaks ecoregion of the Southwestern Tablelands west of the Central Great Plains (Woods et al. 2005). The geomorphology of this area consists of dissected canyons, hills, buttes, terraces, and stabilized sand dunes. Streams have sandy substrate with low water turbidity. Of the 3 study areas this area receives the least rain with an annual mean of 52 cm and temperatures that range from -6 °C to 33 °C. The vegetation was dominated by little bluestem and sand sagebrush. Along riparian zones Chickasaw plum, cottonwood, and coastal plain willow (*Salix caroliniana*) occurred.

METHODS

During September and October of 2006–2007 I identified Chickasaw plum stands on each study area. I selected stands based on a range of size classes that were used for a study of age-related use of Chickasaw plum by nesting birds. Using a Garmin Etrex Legend C® (Garmin International, Olathe, Kansas, USA) hand-held GPS device, I recorded the coordinates and area of each stand using Universal Transverse Mercator (UTM) coordinate system. Color digital orthographic photograph imagery of the study areas, in a compressed county mosaics format, was obtained for 2003, 2004, 2005, and 2006 for Payne, Ellis, and Harper counties, Oklahoma, USA. I obtained photographs from the National Agricultural Imagery Program (NAIP 2006). These photos were taken during the growing season. These photographs provided 1-m ground sample distance and were rectified to a horizontal accuracy of ±3 m. The 2-m aerial photographs were rectified to a horizontal accuracy of ±10 m (NAIP 2006). The tiling format of NAIP imagery is based on a 1.14 × 1.14 m quarter quadrangle with a 360-m buffer on all 4 sides and rectified to the UTM coordinate system. I used color photographs because they offered higher quality and contrast than black-and-white and were already geo-referenced. Therefore, vegetation boundaries were easier to delineate. For 2003 I used 1-m resolution aerial photographs; I used 2-m resolution aerial photographs for 2004, 2005, and 2006. For 2003 2-m resolution imagery was not available.

Determining Area

In 2006 I estimated stand areas on site using a Garmin Etrex Legend® hand-held GPS. The manufacturer claims accuracy with wide area augmentation system enabled to be <3 m. The recording interval use to calculate area was 1 sec. To estimate area I walked the perimeter of the stand 3 times and recorded the area each time. I used the average of 3 measurements as stand area.

I imported coordinates of Chickasaw plum stands obtained in the field into Arccatalog 9.1 ® (Environmental Systems Research Institute, Redlands, CA, USA) and from these data I created point-shape files. Using ArcInfo 9.1® I imported aerial photographs and stand point-shape files for each county. The aerial photographs with the point-shape files overlaid were used to identify the ground-identified stands. I created polygon shape files, formatted to calculate area of polygons, and imported them into ArcInfo. Using the edit-shape-file function to edit the stand-area shape file, and adjusting the map scale to 1:1,200 m, I on-screen digitized each stand perimeter 3 times to create 3 polygons that represented stand area. I then exported the data recorded in the stand-area shape file into Microsoft Excel® (Microsoft Corporation, Redmond, Washington, USA) where stand area was estimated by averaging the 3 areas. Based on the limitations of the imagery available and difficulty in detecting small stands, I excluded stands <100 m^2 in area.

Data Analysis

I estimated the relationship between stand area (m^2) in year t and stand area in year $t + 1$ using linear regression. I was interested in the regression coefficient (b). A coefficient <1 indicated an inter-annual decline in stand area, = 1 indicated stability, and >1 indicated growth.

I defined the relative growth rate (m^2/m^2) of an individual stand as

$$(A_{t+1} - A_t) / A_t$$

where $A_t =$ area (m^2) in year t. I graphically analyzed these results. I also determined between–year correlations of relative growth rates for individual stands. Stand areas estimated with GPS and GIS analysis were examined with linear regression analysis.

RESULTS

I measured 49 stands using aerial photographs taken in 2003, 2004, 2005, and 2006. Fourteen stands were in Payne County, 18 in Harper County, and 19 in Ellis County.

Areas of stands measured with GPS units and GIS analysis were strongly correlated (2006 data, $r^2 = 0.92$, Fig. 2.1). The equation giving GIS area (y) as a function of GPS area (x) was $y = 0.90x$. The intercept was not different from 0. The equation implies that GIS areas were consistently smaller than GPS areas.

Stand areas were linearly related between and among years (Fig. 2.2), but growth rates varied between years. From 2003 to 2004 stand area was stable (95% CI on b = 0.81–1.02). Stand area from 2004 to 2005 declined (95% CI on b = 0.80–0.96), and from 2005 to 2006 area increased (95% CI on b = 1.06–1.24). For the period 2003 to 2006 stand area was stable (95% CI on b = 0.88–1.11).

I observed substantial variation in annual, relative growth rates (Δarea/beginning area, m^2/m^2) for stands <400 m^2 in size (Fig. 2.3). For larger stands relative growth rate stayed near 0.0. For 2003–2004 relative growth rates on stands <400 m^2 ranged from

-0.29 to 1.2 m^2/m^2. Stands >400 m^2 ranged from -0.10 to 0.47 m^2/m^2. For 2004–2005 relative growth rates on stands <400 m^2 ranged from -0.55 to 0.59 m^2/m^2 and stands >400 m^2 ranged from -0.12 to 0.01 m^2/m^2. Relative growth rates for 2005–2006 on stands <400 m^2 ranged from -0.58 to 1.22 m^2/m^2 and stands >400 m^2 ranged from -0.30 to 0.19 m^2/m^2.

Correlation analysis suggested a weak linear relationship between inter-annual stand relative growth rates for 2003–2004 to 2004–2005 (r = -0.4, P = 0.004, n = 49) and 2004–2005 to 2005–2006 (r = -0.4, P = 0.003, n = 49) (Fig. 2.4). The period 2003–2004 to 2005–2006 showed no relationship (r^2 = 0.04, P = 0.159, n = 49).

Figure 2.1. Comparison of areas estimated with Global Positioning System and Geographic Information System analyses of Chickasaw plum stands in north-central and northwestern Oklahoma, USA, 2006.

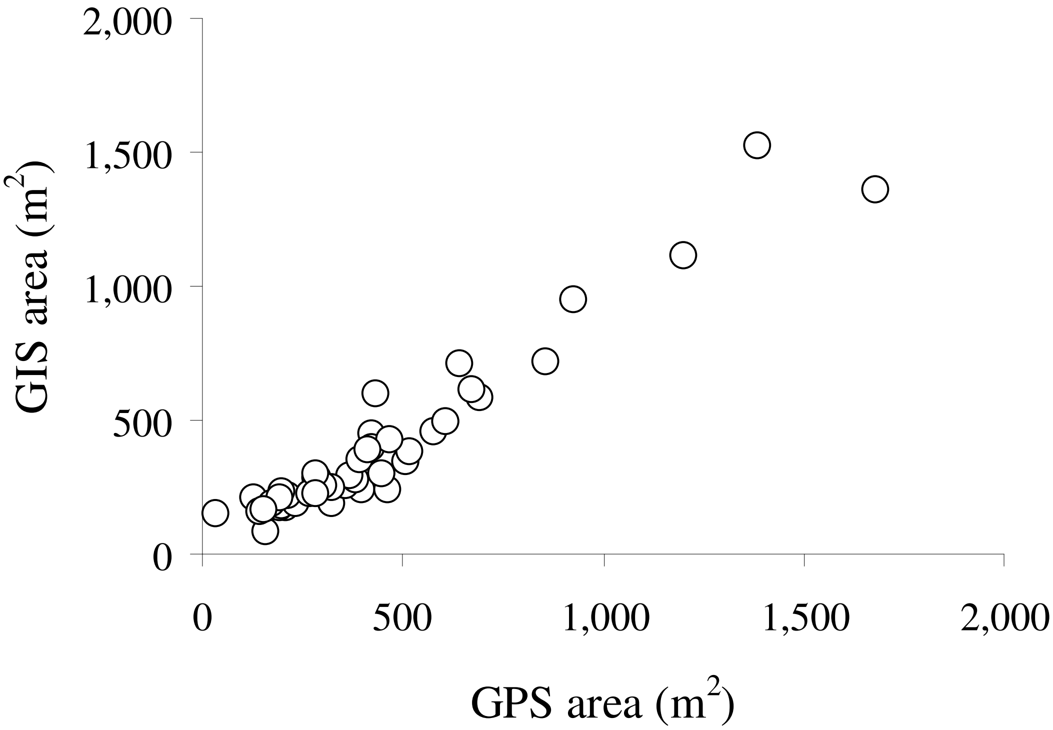


Figure 2.2. Area (m^2) of Chickasaw plum stands in year $t + 1$ as a function of area in year t (except for 2003–2006 comparison) in north-central and northwestern, Oklahoma, USA, 2003–2006.

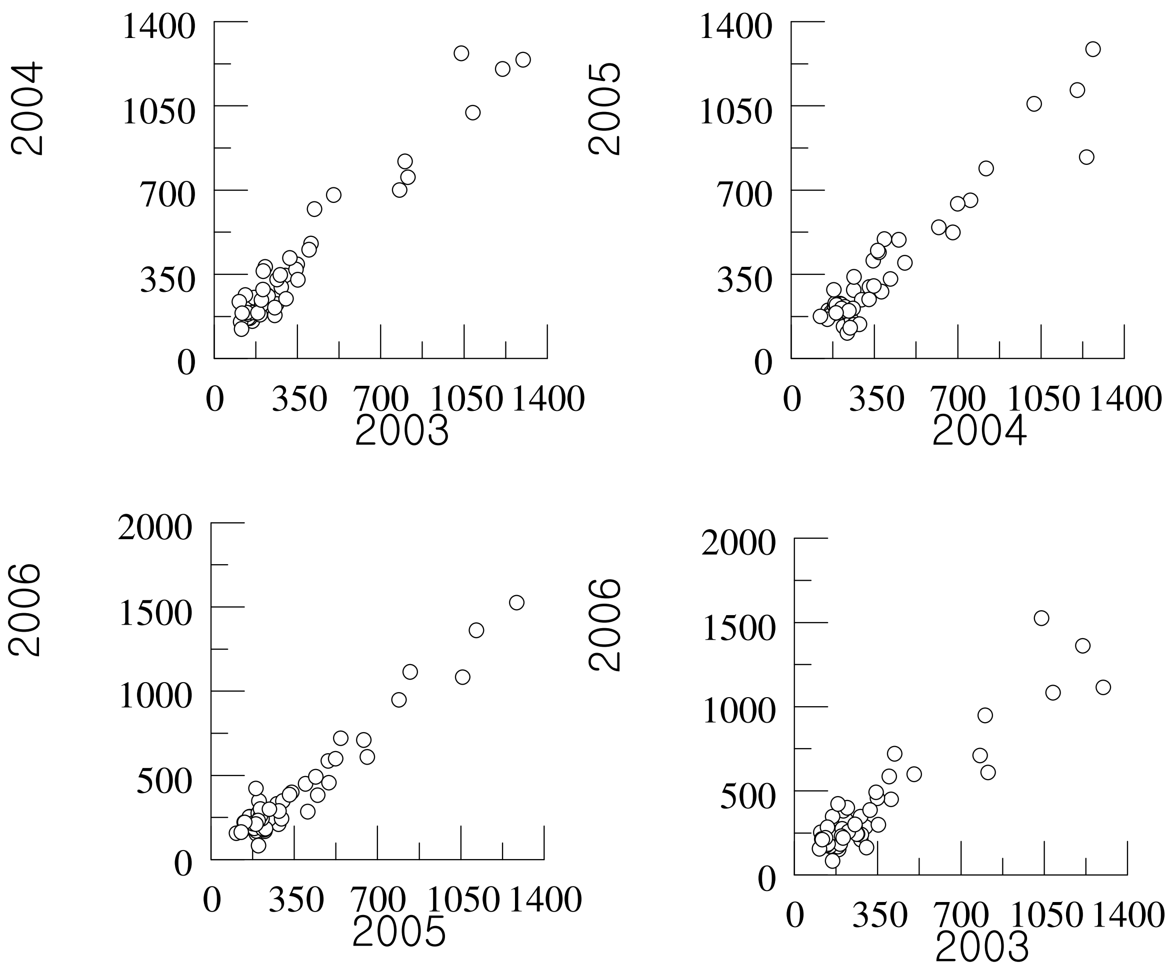


Figure 2.3. Relative, inter-annual growth rate (Δarea/beginning area) of Chickasaw plum stands >100 m^2 in size as a function of beginning stand area in north-central and northwestern Oklahoma, USA, 2003–2006.

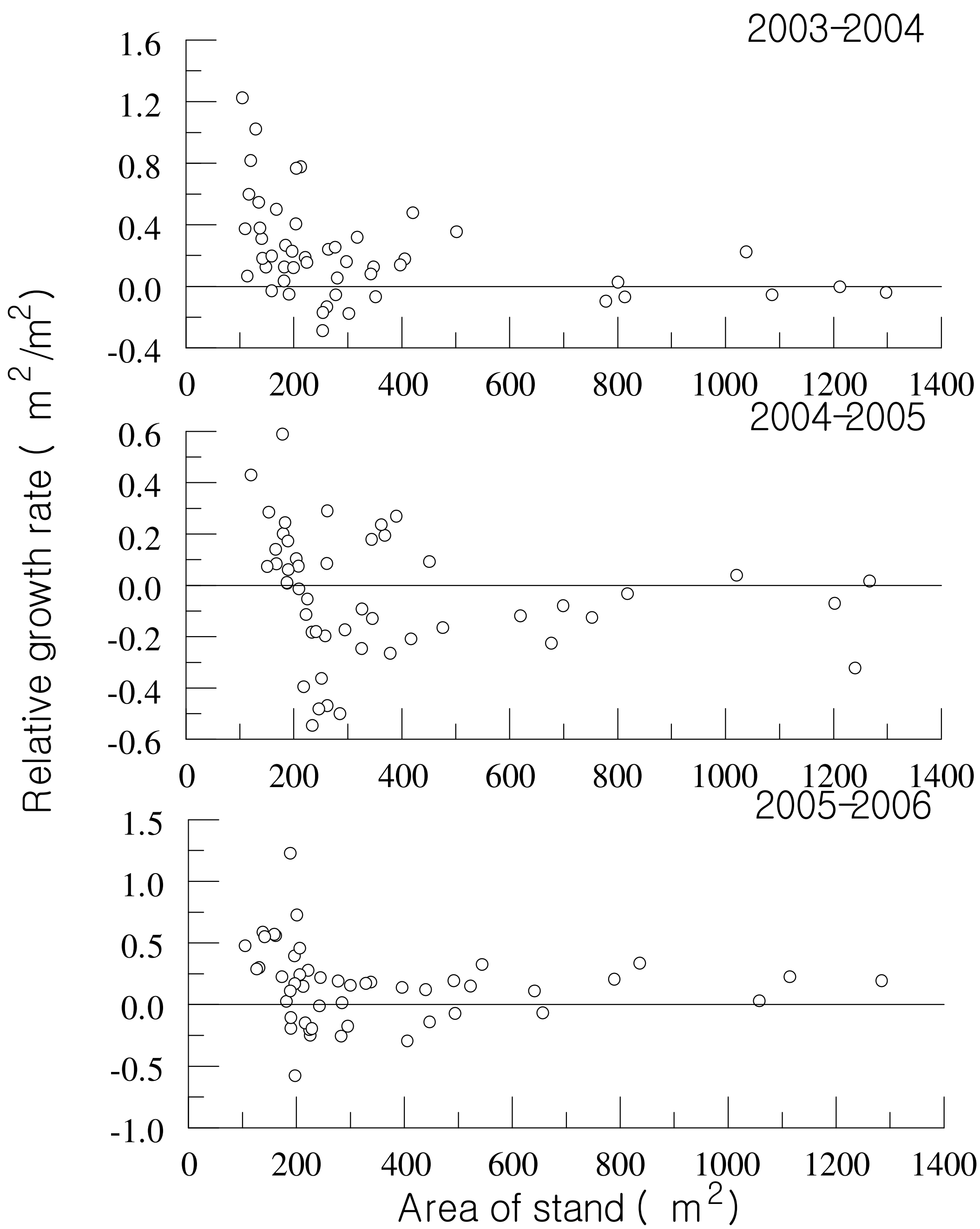
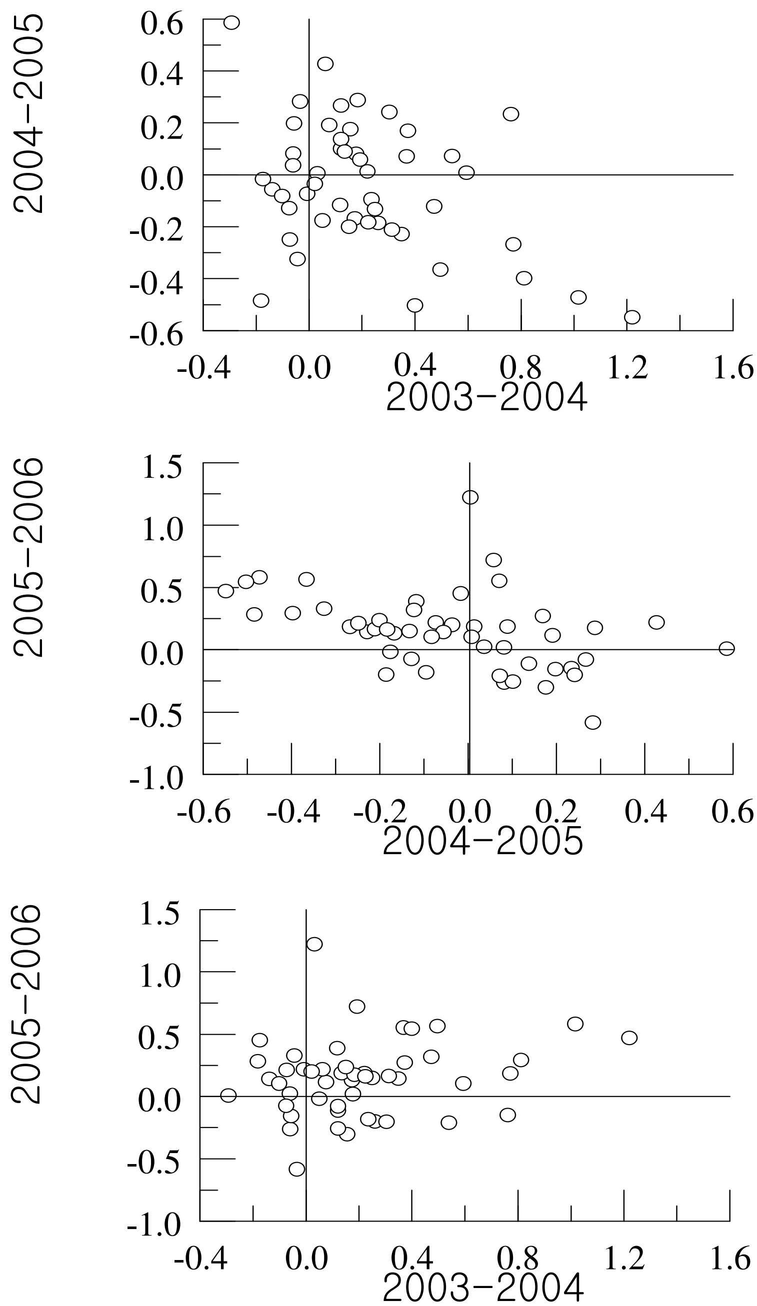


Figure 2.4. Comparison of inter-annual and biannual relative growth rates (Δarea/ beginning area, m^2/m^2) of Chickasaw plum stands in north-central and northwestern Oklahoma, USA, 2003–2006.



DISCUSSION

One of the major limitations in this project was the resolution of available aerial photographs. I used 1-m resolution aerial photographs for 2003 and 2-m resolution for other years. At these scales delineating the edges of stands areas was problematic. I addressed this problem by taking the mean of 3 replications to estimate areas.

Correlations of 2006 GIS and GPS stand measurements showed that both methods gave similar results (Fig. 2.1). The GIS method tended to underestimate stand area in comparison with the GPS method. A possible explanation of this outcome is that I was better able to observe the boundaries of stands on the ground than with aerial imagery.

The linear relationship between stand size in year $t + 1$ as a function of size in year t implies a stand decreases or increases by a constant proportion of itself, independent of its area. In this study, increases and decreases neutralized each other because stand area at the end of 3 years was similar to starting stand size.

MANAGEMENT IMPLICATIONS

These results can be used in planning and management of Chickasaw plum on rangelands to meet wildlife and livestock objectives. The technique used here may provide information for further studies of wildlife use of Chickasaw plum and other woody structures.

CHAPTER 3[a]

USE OF CHICKASAW PLUM BY NESTING BIRDS

ABSTRACT To manage nesting habitat, biologists must know the birds that nest in a plant species and the properties of that plant at nest sites. I described bird nesting in Chickasaw plum (*Prunus angustifolia*) in Oklahoma during the 2007 and 2008 nesting seasons. I collected data on nest dimensions (height, depth, inside and outside diameter) and construction materials to identify the species that built inactive nests. For all nests I measured height aboveground. For stems that supported a nest I measured height and diameter and estimated stem age based on an established growth model. I also estimated the age and area of plum stands used for nesting. I observed 5 and inferred 4 species for a total of 9 species nesting in plum: Bell's vireo (*Vireo bellii*; $n = 3$), blue grosbeak (*Passerina caerulea*; $n = 4$), brown thrasher (*Toxostoma rufum*; $n = 11$), field sparrow (*Spizella pusilla*; $n = 5$), greater roadrunner (*Geococcyx californianus*; $n = 1$), mourning dove (*Zenaida macroura*; $n = 4$), northern cardinal (*Cardinalis cardinalis*; $n = 10$), northern mockingbird (*Mimus polyglottos*; $n = 30$), and painted bunting (*Passerina ciris*; $n = 1$). Nest height was consistent among species at averages ranging from 0.7 ± 0.13 m SE for field sparrows to 1.1 ± 0.07 m SE for northern mockingbirds. Bell's vireos and field sparrows nested on younger stems (average age = 7 yr) than the other species (average age = 12–15 yr). The results indicated that relatively old (≥10 yr) stands of

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[a] The style in the chapter follows Journal of Wildlife Management.

Chickasaw plums are important components of habitat for this shrub-nesting guild in Oklahoma.

INTRODUCTION

Chickasaw plum (*Prunus angustifolia*) is a major woody structure component in many parts of the Southern Great Plains as well as the southern United States (Little 1977). Guthery et al. (2005) provided evidence that northern bobwhites (*Colinus virginianus*) selected mixed shrub cover that included Chickasaw plum in the Texas Rolling Plains. Patten et al. (2005) demonstrated that lesser prairie-chicken (*Tympanuchus pallidicinctus*) survival in northwestern Oklahoma and New Mexico was positively correlated with higher shrub cover that included Chickasaw plum. Given the dominant role Chickasaw plum plays on many landscapes more information is needed to better understand how it is used by wildlife. To manage nesting habitat, biologists must know the birds that nest in a plant species and the properties of that plant at nest sites.

My objectives were to identify the species of birds that nest in Chickasaw plum stands in Oklahoma and to describe properties of these nest sites. Properties included nest height aboveground, stem characteristics (diameter, age, height, and density), and stand characteristics (age and area). Because I encountered inactive nests, I also developed and evaluated a dichotomous key to identify nesting species based on nest dimensions and construction materials.

STUDY AREAS

Data were collected May through July 2007 and 2008 on private properties in 2 Oklahoma counties. The Harper County site in northwest Oklahoma was about 40 km north of Woodward, USA. This site encompassed 5,667 ha primarily used for commercial hunting and cattle grazing. This area lies in the Rolling Red Hills ecoregion of the Central Great Plains (Woods et al. 2005). The area receives precipitation ranging from 66 to 76 cm per yr and temperatures ranging from mean January lows of -8° C to mean July highs of 36° C. The vegetation was dominated by mixed grass prairie of little bluestem (*Schizachyrium scoparium*), side-oats grama (*Bouteloua curtipendula*), blue grama (*B. gracilis*), and sand sagebrush (*Artemisia filifolia*) with stands of Chickasaw plum in uplands.

The Ellis County site in northwest Oklahoma was about 27 km west of Woodward, USA. This site had 4,856 ha primarily used for hunting and cattle grazing. This area lies in the Canadian-Cimarron Breaks ecoregion of the Southwestern Tablelands west of the Central Great Plains (Woods et al. 2005). The Ellis County area received 52 cm per yr of precipitation with temperatures ranging from mean January lows of -6° C to mean July highs of 33° C. The upland vegetation was dominated by lower successional grasses in a matrix of little bluestem, sand sagebrush, and Chickasaw plum.

METHODS

I located nests by searching stands of plum and by observing bird behaviors such as short flushes, alarm calls, nesting, carrying fecal material or food in bill, distraction displays, and vocalizations by nestlings (Winters et al. 2003). I searched areas with high stand densities of plum to survey as many stands as possible during each searching period. I recorded nest location using a Garmin Etrex Legend® (Garmin International, Olathe, Kansas, USA) hand-held Global Positioning System (GPS) unit along with a nest record that contained the location of the nest, stage of nesting, description of nest materials, date, and time (Martin and Geupel 1993). I monitored active nests every 3–5 days until termination (destruction, fledging, abandonment). Upon termination I measured nest site properties described below.

I measured nest dimensions using dial calipers (General Hardware Manufacturing Company, New York, USA) to identify nesting species for inactive nests. Dimensions (mm) included cup depth, inside and outside diameters, and nest height. I developed a dichotomous key to nesting species (Table 3.1) based on published data on nest dimensions (Nice 1922, Mumford 1952, Stabler 1959, Walkinshaw 1968, Kinser 1973, Partin 1977, Harrison 1979, Means and Goertz 1983, Baicich and Harrison 1997).

I also measured properties of the nest and nesting substrate. I measured aboveground height (m) of the nest and height of nesting stem with a staida rod (DeWalt Industrial Tool Company, Baltimore, Maryland, USA). I measured nesting stem diameter at ground level with dial calipers. Stem density surrounding the nest was measured using the point-centered quarter method (Cottam and Curtis 1956). The point directly beneath the nest crosses the center point of 4 quadrants with axes aligned with the 4 cardinal directions. The distance (r_i) between the central point and the closest living stem in each quadrant was measured with a staida rod to the nearest centimeter (Dix 1961). To calculate stem density (*D*) at a nest I used the equation,

$$D = 1 \big/ \left(\sum r_i / 4 \right)^2 .$$

Table 3.1. Key for identifying nests of bird species in Oklahoma, USA, based on nest dimensions and construction materials.

1 a. Nest unlined, platform type, or scantly lined. — mourning dove

1 b. Nest lined with forbs, grasses, hair, or other soft material. — go to 2.

2 a. Nest basket-like, deep, well woven, built between 2 branches. —Bell's vireo

2 b. Nest cup-like built on primary or secondary stem. — go to 3.

3 a. Nest constructed of grasses. — go to 8.

3 b. Nest base constructed of twigs and or forbs and leaves. — go to 4.

4 a. Inside diameter of nest ≤ 65 mm. — go to 9.

4 b. Inside diameter of nest > 65 mm. — go to 5.

5 a. Inside diameter of nest ≤ 95 mm. — go to 6.

5 b. Inside diameter of nest > 95 mm. — go to 7.

6 a. Outside diameter ≤ 130 mm and or inside depth < 40 mm. — northern cardinal

6 b. Outside diameter > 130 mm and or inside depth ≥ 40 mm. —northern mockingbird

7 a. Depth of nest ≤ 60 mm. — brown thrasher

7 b. Depth of nest > 60 mm. — loggerhead shrike

8 a. Inside diameter of nest < 55 mm. — field sparrow

8 b. Inside diameter of nest ≥ 55 mm. — go to 9.

9 a. Inside diameter of nest < 60 mm and inside depth < 50 mm — painted bunting

9 b. Inside diameter of nest ≥ 60 mm and inside depth ≥ 50 mm — blue grosbeak

I defined a plum stand as an aggregate of stems originating from a parent plant. If ≥ 2 stands were in close proximity, a single stand was defined as a continuous aggregation of stems with a distance <1 m between stems. I measured the area of a stand using the GPS unit described earlier. The interval used to record locations was 1 second. The manufacturer reports accuracy with wide area augmentation enabled to be ≤3 m. To measure the area I walked the perimeter of a stand 3 times recording the measurement each time. I used the average of the 3 estimates for the final estimate. As an accuracy check, I used Geographic Information System (GIS) analysis to estimate area of stands >100 m^2 (n = 49) from aerial photographs taken in 2006. Areas measured with GPS units and GIS analysis were strongly correlated ($r^2 = 0.92$; Chapter 2), suggesting the averaged GPS estimates were acceptable.

I estimated nesting stem and stand age using the model developed for Harper and Ellis counties in Chapter 1. Stand age was based on the presumptive oldest stem in a stand. The estimating equation was $y = 0.26x$ where y = age (yr) and x = stem diameter (mm). I rounded age estimates to the nearest integer.

My use of inactive nests made it necessary to estimate age of nests so that I could obtain age of stems and stands when the nest was active. I classified nests as current yr (age = 0 yr), previous yr (age = 1 yr), or older. Nests lacking previous years' leaf litter in the cup were classified as current year. Nests with light accumulations of previous years' leaf litter were classified as1 yr old. Nests were classified as >1 yr old with heavier accumulation of leaf litter and slightly too heavily degraded construction materials. Estimated age of stems and stands used for nesting was adjusted according to nest age estimates.

Data Analysis

This work was a simple descriptive study motivated by a desire to know the bird species that nest in plum and the properties of their nest sites, particularly age of stems and stands. Accordingly, I did not use statistical significance testing for 2 reasons. First, differences among species are inevitable by virtue of their evolutionary adaptations so significance testing was gratuitous. Second, significance or lack thereof depends to a high degree on sample size (Cohen 1994, Johnson 1999) and, accordingly, the null hypothesis is regarded as non-scientific (Guthery 2008). I present simple descriptive statistics with occasional reference to overlap of 95% CLs.

RESULTS

I searched 390 plum stands and found 48 nests (29 current-year including 6 active, 14 1 yr old, 5 >1 yr old) in May–July 2007. During May–July 2008 I searched 384 stands and found 44 nets (17 current-year including 9 active, 9 1 yr old, and 18 >1 yr old). The 23 nests >1 yr old were not used for analyses. Fifteen active nests were used to test the dichotomous key, which correctly identified all known species. Nine species nested in plum (Table 3.2). Species visually identified were Bell's vireo (*Vireo bellii*), brown thrasher (*Toxostoma rufum*), field sparrow (*Spizella pusilla*), northern mockingbird (*Mimus polyglottos*), and painted bunting (*Passerina ciris*). Inferred nesting species based on the dichotomous key included blue grosbeak (*Passerina caerulea*), northern cardinal (*Cardinalis cardinalis*), and mourning dove (*Zenaida macroura*). During 2008 I identified a greater roadrunner (*Geococcyx californianus*) nest based on nest dimensions; this species was not in the key.

I found only 1 nest each for the painted bunting and greater roadrunner (Table 3.2). Lacking replicates for these species and thus having no measure of variability, I limit results on nest height and properties of habitat to the tabulated data.

Table 3.2. Measurements (mm) used to identify nests in Chickasaw plum, 2007–2008, Oklahoma, USA.

Species (*n*) Variable	$\bar{x}$	SE	Min.	Max.
Bell's vireo (3)				
Inside diameter	49.3	6.30	42.0	62.0
Outside diameter	70.1	19.90	48.0	103.3
Depth	57.7	9.40	46.0	76.2
Height	66.7	9.40	52.0	84.1
Blue grosbeak (4)				
Inside diameter	62.9	5.09	56.0	83.1
Outside diameter	92.8	16.90	43.8	124.0
Depth	27.5	3.88	19.0	40.5
Height	65.0	7.27	43.0	88.7
Brown thrasher (11)				
Inside diameter	96.5	4.03	68.5	114.1
Outside diameter	143.9	6.60	113.5	197.8
Depth	43.7	4.60	19.0	79.0
Height	95.8	5.72	50.0	116.5
Field sparrow (5)				
Inside diameter	47.7	2.10	41.0	53.5
Outside diameter	55.0	5.20	55.0	83.2
Depth	29.7	7.00	5.4	43.7
Height	63.5	5.01	53.0	80.8
Greater roadrunner (1)				
Inside diameter	121.0			
Outside diameter	267.0			
Depth	5.0			

Species (*n*) Variable	$\bar{x}$	SE	Min.	Max.
Height	97.0			
Mourning dove (4)				
Inside diameter	85.5	2.23	79.0	88.8
Outside diameter	142.6	1.98	136.9	145.7
Depth	23.3	11.50	10.0	57.8
Height	73.1	9.12	45.8	83.6
Northern cardinal (10)				
Inside diameter	75.4	2.50	65.5	91.0
Outside diameter	118.7	3.30	96.0	150.0
Depth	36.2	3.20	20.5	61.2
Height	80.8	5.80	41.2	113.3
Northern mockingbird (30)				
Inside diameter	83.0	1.53	66.5	95.7
Outside diameter	142.7	1.83	114.0	170.4
Depth	40.6	2.50	11.0	73.5
Height	89.0	3.40	54.0	135.1
Painted bunting (1)				
Inside diameter	64.5			
Outside diameter	106.5			
Depth	46.0			
Height	68.0			

Mean nest height was relatively consistent (overlapping 95% CLs) across species with $n > 1$. Mean height ranged from 0.7 ± 0.13 m SE for field sparrows to 1.1 ± 0.07 m SE for northern mockingbirds (Table 3.3).

Results for stems that supported nests indicated 2 groups of species with respect to stem use. Bell's vireos and field sparrows tended to nest in younger stems whereas blue grosbeaks, brown thrashers, mourning doves, northern cardinals, and northern mockingbirds tended to nest in older stems. Stem diameter averaged about 29 mm for vireos and field sparrows versus 46–56 mm for the remaining species (Table 3.3). Because age and height of stems were a function of diameter (Chapter 1), the same pattern held for these variables. The average age of stems for vireos and field sparrows was 7 yr versus 12–15 yr for the other species. Mean height of the stem supporting a nest was 1.6–1.7 m for vireos and field sparrows; mean height was 2.1–2.3 m for the species that used older stems.

The density of plum stems at nest sites was variable and showed no clear pattern across species. Density ranged from $3.2 \pm 0.84/m^2$ SE for cardinals to $8.3 \pm 2.3/m^2$ SE for field sparrows (Table 3.3).

Plum stands used by field sparrows averaged 9 yr old, whereas stands for the other species averaged 14–17 yr old (Table 3.3). The average age of nesting stems and plum stands was the same for blue grosbeaks and mourning doves, indicating these species tended to use the oldest stems in stands. The remaining birds tended to use stems that were 1–7 yr younger than the oldest stem in a stand. In general, stand area followed the same relations as stand age because area is a function of age (Chapter 1). The minimum area of a nesting stand for all species except mourning doves was ≤ 72 m^2. The smallest stand used by mourning doves was 294 m^2.

Table 3.3. Nest height and properties of habitat for birds that nested in Chickasaw plum, 2007–2008, Oklahoma, USA.

Species (n) Variable	$\bar{x}$	SE	Min.	Max.
Bell's vireo (3)				
Nest height (m)	1.0	0.39	0.3	2.2
Stem				
Diameter (mm)	29.5	11.0	15.0	51.0
Age (yr)	8.0	3.03	3.0	13.0
Height (m)	1.7	0.38	1.2	2.5
Density (no./m^2)	4.1	1.00	1.5	6.2
Stand				
Area (m^2)	257.0	91.00	53.0	423.0
Age (yr)	16.0	5.18	6.0	22.0
Blue grosbeak (4)				
Nest height (m)	1.0	0.12	0.7	1.4
Stem				
Diameter (mm)	54.6	8.85	34.3	85.0
Age (yr)	14.0	2.35	8.0	21.0
Height (m)	2.3	0.22	1.6	2.9
Density (no./m^2)	5.9	2.33	1.6	10.3
Stand				
Area (m^2)	321.0	199.00	72.0	1,111.0
Age (yr)	14.0	2.27	9.0	21.0

Species (*n*) Variable	$\bar{x}$	SE	Min.	Max.
Brown thrasher (11)				
Nest height (m)	0.9	0.06	0.6	1.2
Stem				
Diameter (mm)	55.7	7.12	35.5	115.3
Age (yr)	15.0	1.87	9.0	30.0
Height (m)	2.2	0.10	1.6	2.6
Density (no./m^2)	4.6	1.49	0.7	17.2
Stand				
Area (m^2)	445.0	135.00	22.0	1,378.0
Age (yr)	17.0	1.90	9.0	30.0
Field sparrow (5)				
Nest height (m)	0.7	0.13	0.4	1.2
Stem				
Diameter (mm)	28.7	6.60	14.0	52.8
Age (yr)	5.0	0.99	3.0	7.0
Height (m)	1.7	0.33	1.0	2.7
Density (no./m^2)	8.3	2.27	4.6	17.2
Stand				
Area (m^2)	115.6	39.70	29.0	233.8
Age (yr)	9.0	1.43	8.0	14.0

Species (n) Variable	$\bar{x}$	SE	Min.	Max.
Greater roadrunner (1)				
Nest height (m)	1.4			
Stem				
Diameter (mm)	59.5			
Age (yr)	15.0			
Height (m)	2.3			
Density (no./m^2)	3.8			
Stand				
Area (m^2)	9.0			
Age (yr)	15.0			
Mourning dove (4)				
Nest height (m)	0.9	0.15	0.7	1.3
Stem				
Diameter (mm)	55.9	8.74	41.2	81.1
Age (yr)	14.0	2.53	10.0	21.0
Height (m)	2.3	0.19	2.0	2.8
Density (no./m^2)	4.4	1.88	0.9	7.9
Stand				
Area (m^2)	453.4	75.20	294.0	645.0
Age (yr)	14.0	2.54	10.0	21.0

Species (*n*) Variable	$\bar{x}$	SE	Min.	Max.
Northern cardinal (10)				
Nest height (m)	0.9	0.08	0.7	1.5
Stem				
Diameter (mm)	46.1	4.65	24.0	72.6
Age (yr)	11.0	1.22	6.0	19.0
Height (m)	2.1	0.34	1.4	2.7
Density (no./m^2)	3.2	0.84	0.6	8.2
Stand				
Area (m^2)	278.5	129.50	43.3	1,680.5
Age (yr)	15.0	1.63	8.0	27.0
Northern mockingbird (30)				
Nest height (m)	1.1	0.07	0.7	2.3
Stem				
Diameter (mm)	52.3	2.92	22.4	94.2
Age (yr)	13.0	0.78	6.0	25.0
Height (m)	2.2	0.07	1.1	2.9
Density (no./m^2)	4.7	0.78	0.7	22.8
Stand				
Area (m^2)	287.7	48.50	24.0	1210.0
Age (yr)	15.0	0.74	7.0	25.0

Species (*n*) Variable	$\bar{x}$	SE	Min.	Max.
Painted bunting (1)				
Nest height (m)	0.8			
Stem				
Diameter (mm)	54.0			
Age (yr)	14.0			
Height (m)	1.9			
Density (no./m^2)	2.3			
Stand				
Area (m^2)	443.0			
Age (yr)	23.0			

DISCUSSION

I observed or inferred 9 species of birds nesting in plum. It is probable that other species nest in plum but none was found during this study. Other candidate species include loggerhead shrikes (*Lanius ludovicianus*), dickcissel (*Spiza americana*), and indigo bunting (*P. cyanea*) (Reinking 2004). Except for dickcissel these species were uncommon on both study sites. The Oklahoma breeding bird atlas identifies dickcissels as nesting in shrubs but there is evidence that these species are obligate ground-nesting birds and may only rarely nest low in shrubs (Wary et al. 1982, Winter 1999, Reinking 2004). Guthery et al. (2005) observed bobwhites nesting in mixed shrubs that consisted predominantly of plum. Miller and Miller (1999) noted stands provide nesting cover for northern bobwhites, northern mockingbirds, brown thrashers, and gray catbirds (*Dumetella carolinensis*).

I found virtually no literature on bird nesting in Chickasaw plum so there are few comparative data to discuss. Stoddard (1931) noted that large and dense plum stands provide protective cover for bobwhites. Larger stands would tend to be older stands based on the growth models given in Chapter 1.

Likewise, there is a paucity of literature on the ages of nesting substrates. My results indicated that average age of stands used by nesting birds was ≥10 yr. My estimates of age of stems and stands were subject to a good deal of uncertainty, as evidenced by the 95% CLs on parameter estimates (Chapter 1).

MANAGEMENT IMPLICATIONS

The major implications of this study relate to age of plum stems as related to use by nesting birds. Based on the growth equation in METHODS, a plum sprout or bare-root seedling would require about 8 yr of growth to reach the average diameter of stems used by nesting Bell's vireos or about 16 yr to reach the diameter used by the single greater roadrunner nest observed. Thus, establishment of plum nesting cover where none exists will require considerable time. The time requirement could be reduced by transplanting single ramets of large diameter or by using a tree spade to transplant clusters of appropriately sized nesting stems. Preliminary research suggests that tree-spade transplants experience low survival unless they are coppiced (stems cut off at low levels; Adam West and Rod Will, Department of Natural Resource Ecology and Management, Oklahoma State University, personal communication). Coppicing these transplants would result in similar time requirements as bare-root seedlings to reach a suitable stem diameter for nesting. If plum is slated for reduction to increase livestock forage or perhaps to favor prairie-obligate birds, these results suggest that preservation of older stands among those available would also preserve nesting cover for all members of the shrub-nesting guild I studied.

CHAPTER 4[a]

NATURAL HISTORY OBSERVATIONS OF CHICKASAW PLUM IN OKLAHOMA

ABSTRACT Understanding the natural history of wild plants and animals can aid in understanding field process and making management decisions. I gathered incidental natural history observations on the use of Chickasaw plum (*Prunus angustifolia*) by mammals, birds, reptiles, and invertebrates in 3 counties in Oklahoma during fall 2006 through summer 2008. I observed 6 species of mammals, including domestic livestock, associated with plum. Mammals used plum for thermal and resting cover and to a lesser extent food. Passerines were the most frequent taxon of the 20 species of birds observed using plum for nesting, singing, resting, foraging, and/or escape. I also observed 2 reptile species and 6 invertebrate species using plum.

[a] The style in this chapter follows Journal of Wildlife Management.

INTRODUCTION

Chickasaw plum (*Prunus angustifolia*; hereafter, plum) is a clonal shrub native to Oklahoma, Texas, and Kansas (Gilman and Watson 1994). Its current distribution stretches from the western edge of the southern Great Plains south and east to the Atlantic Coast. Individual plants can grow to 15 m tall and stands can spread to areas >1 ha. It is drought tolerant and prefers well drained, acidic, sandy soils. In the spring, it produces showy white flowers and is one of the few shrubs that flower before leaves are produced. In summer it produces a red or yellowish fruit that is consumed by wildlife (McCarty et al. 2002).

One of the first accounts of Chickasaw plum came in 1714 when John Lawson published *The History of Carolina*. He described 5 types of native plum, 1 of which was most likely Chickasaw plum. John Bartram, considered the father of American botany, believed it had been introduced by the Chickasaw Indians east of the Mississippi River through trade among tribes (Hatch 1998). In 1773 William Bartram, son of John Bartram, embarked upon a 4-year journey through 8 southern colonies. From his exploration he concluded plum was often associated with Native American villages, lending support for the idea that plum was cultivated by Native Americans. One of the first accounts of plum cultivation by early colonists came in 1812 when Thomas Jefferson planted plum at Monticello, where it grows today (Hatch 1998). There is also some evidence that George Washington grew plum at Mount Vernon as well.

In the early 19th Century Chickasaw plum was not seen as a commercially marketable fruit because of its large stone and scant flesh (Hatch 1998). For the most part wild plum was relegated to use by settlers who had little or no access to mainstream cultivated fruit. Even thought early naturalists recognized the importance of native plums it was not until 1814 that the first indigenous cultivar emerged from a plum seedling in Knox County, Tennessee. By 1900 many other promising cultivars had emerged.

Chickasaw plum contains chemicals that are astringent and sedative and the bark and roots also contain phloretin, which has antibacterial properties (Smythe 1901, Lewis and Elvin-Lewis 1977). Native American tribes including the Pawnee, Kiowa, Lakota, Crow, and Assiniboin used plum for food and medicine (Gilmore 1977). The Teton Dakota tribe of Nebraska was known to use the young sprouts of the plum in a healing ceremony called Waunyampi. The Omaha, Sac, Fox, and Cheyenne tribes used the boiled root bark to treat canker sores and diarrhea (Youngken 1924, Smith 1928, Kinderscher 1987).

Over the last century the value of plum as food and medicine has diminished. Today it is valued for the food and cover it provides for livestock and wildlife. However, people's knowledge of wild plum is the jellies their grandmother used to make and the extent of plum's use by wildlife and livestock is virtually undocumented. Accordingly, my objective was to gather descriptive natural history data on use of plum by mammals, birds, reptiles, and invertebrates.

STUDY AREAS AND METHODS

I collected data from fall 2006 through summer 2008 on private properties in 3 Oklahoma counties. See Chapter 1 for descriptions of these sites. I recorded natural history observations while conducting a bird nesting study and stem study. Observations included the use of plum by mammals, birds, reptiles, and invertebrates.

RESULTS

Mammals

Mammals appeared to use plum primarily for screening cover and to a lesser extent food. White-tailed deer (*Odocoileus virginianus*) and domestic cattle were often observed resting in stands of plum at mid-day during summer (Table 4.1). Plum is also a minor component of the white-tailed deer diet (Gee et al. 1994). In prairie habitats that lack large stands of trees, plum appears to provide loafing areas and thermal cover for large mammals. On many occasions calves were observed resting in stands during the morning hours while the herd grazed nearby. Large stands may be used by mother cows as laying-out cover for calves. Eastern woodrat (*Neotoma floridana*) nests were common in stands of plum. Eastern cottontail rabbits (*Sylvilagus floridanus*) were observed in riparian areas. Since no rabbit burrows were found I concluded that these areas were most likely used to forage. One North American porcupine (*Erethizon dorsatum*) was observed perched in a stand in spring 2008 (Brett Cooper, Department of Natural Resource Ecology and Management, Oklahoma State University, personal communication). It had climbed a large stem and was feeding on young plum shoots and buds.

Birds

Birds were the most frequent users of plum. Twenty species were observed using it for nesting, singing perches, resting cover, foraging, and escape cover (Table 4.1). Passerine species were the most frequent and diverse users of stands. These birds primarily used stands for nesting and stems as singing perches. Northern mockingbirds (*Mimus polyglottos*) were the most common nesting species and tended to use older stands (Chapter 3). Dickcissel (*Spiza americana*) were the most common species singing from plum branches followed by painted buntings (*Passerina ciris*), field sparrows (*Spizella pusilla*), and northern mockingbirds. Gallinaceous species were the second most common users and were observed using stands primarily as resting and escape cover. Northern bobwhites (*Colinus virginianus*) were the most frequent users of the Galliforms. They were regularly observed resting in stands or escaping to stands when flushed. Rio Grande turkey (*Meleagris gallopavo intermedia*) was most commonly observed on the Ellis County site foraging around or escaping into stands.

Reptiles

The ornate box turtle (*Terrapene ornate*) was common on Ellis and Harper County sites in and around stands. I assumed they ate ripe plums that had fallen to the ground or used stands for cover. Western diamond-backed rattlesnakes (*Crotalus atrox*), as well as prairie rattlesnakes (*C. viridis*), were common on the Ellis and Harper County sites but only the western diamond-backed was observed within a stand.

Invertebrates

Six species of invertebrates were observed using stems and stands for nesting, resting, and foraging. In early spring eastern tent caterpillars (*Malacosoma americanum*) were the most observed invertebrate. Caterpillar nests were common in plum stands and caterpillars fed on plum leaves. These caterpillars did not defoliate the entire stand and appeared to not have any lasting effect on stands. The stands that had been affected quickly re-grew lost leaves and evidence of caterpillar infestation was almost non-existent later in the growing season. The common paper wasp (*Polistes exclamans*) nests were most commonly found on the periphery of stands under moderately dense leaf cover. Aphids (*Acyrthosiphon* sp.) were also relatively common and found feeding on young plum shoots. Aphid infestation was most common on stands near riparian zones and non-existent in stands on upland areas. Like the eastern tent caterpillars aphid infestation appeared to occur in early May and end in mid to late June. Lepidopterans observed were Olympia marble (*Euchloe olympia*), common wood nymph (*Cercyonis pegala*), and goatweed leafwing (*Anaea andria*). They were observed resting on stems but after the fruit had ripened, and had began to rot; large numbers of goatweed leafwing could be found feeding on the fruit.

Table 4.1. Natural history observations of mammals, birds, reptiles, and invertebrates associated with Chickasaw plum, 2006–2008, Oklahoma, USA.

Group	Species	Observation
Mammals		
	Coyote (*Canis latrans*)	On 1 occasion I observed a coyote moving from stand to stand in a manner suggesting it was tracking pray.
	Domestic cow (*Bos taurus*)	Dense stands provided shade and cover. During mid-day cattle rested in large stands. Calves stayed in stands while the herd grazed nearby.
	Eastern cottontail (*Sylvilagus floridanus*)	Cottontails were found <10 m from stands and were quick to retreat into them when disturbed.
	Eastern woodrat (*Neotoma floridana*)	Middens built in stands. These nests tended to be centrally located within stands and large.
	North American porcupine (*Erethizon dorsatum*)	This species was observed by Brett Cooper feeding on young stems and buds.
	White-tailed deer (*Odocoileus virginianus*)	On many occasions I flushed deer from stands. In most instances stands were >400 m^2 and located in uplands. These stands appear to provide mid-day resting areas.
Birds		
	Bell's vireo (*Vireo belli*)	During early spring these birds called from or foraged within stands. These birds were rarely perched on exposed branches. I located 3 nests in dense foliage.

Group

Species

Observation

Blue grosbeak (*Passerina caerulea*)

These birds called from exposed upper stems. I also found 4 inactive nests on large stems with dense foliage located near the center of large stands. It appears that tall stems are primarily used as singing perches and nesting sites.

Brown thrasher (*Toxostoma rufum*)

This species was found most often foraging in, on, or around stands. I located 11 nests on stems in moderately dense foliage in large plum stands.

Cassin's sparrow (*Aimophila cassinii*)

This species frequently used stands and stems for singing perches.

Dickcissel (*Spiza americana*)

This species called from the tallest stems of stands.

Field sparrow (*Spizella pusilla*)

These birds used stems as perches and nesting sites. I found 4 nests on small stems located on the edge of large stands.

Greater roadrunner (*Geococcyx californianus*)

On the Ellis and Harper county study sites roadrunners would flush or run into stands to escape. I located 1 nest.

Lark bunting (*Calamospiza melanocorys*)

Perched on stems of plum during spring migration.

Lark sparrow (*Chondestes grammacus*)

These sparrows called from the taller stem within stands.

Mississippi kite (*Ictinia mississippiensis*)

These raptors were primarily encountered soaring over pastures with an abundance of plum.

Group Species Observation
Birds
Morning dove (*Zenaida macroura*)
I found 4 nests in small stands with large stems and sparse foliage. Doves also perched on large stems during warm parts of the day.
Northern bobwhite (*Colinus virginianus*)
Coveys were regularly flushed from stands. When coveys did not flush they were seen running into stand to escape. When bobwhites were encountered in stand they tended to run to the far end and hold. If they were pressed further they would run a short distance from the edge of the stand and flush towards an adjacent stand or other cover.
Northern cardinal (*Cardinalis cardinalis*)
Rarely observed, this bird used stands for perching and nesting. I found 10 nests.
Northern mockingbird (*Mimus polyglottos*)
These birds were the most observed using stands. I found 30 nests located on large stems in dense to very sparse foliage.
Painted bunting (*Passerina ciris*)
This species called from the tallest stems of stands. I located 1 nest.
Red-tailed hawk (*Buteo jamaicensis*)
These raptors were primarily encountered perched in trees near pastures with an abundance of plum stands.
Ring-necked pheasant (*Phasianus colchicus*)
Observed on all 3 study sites calling from stands.
Rio Grande turkey (*Meleagris gallopavo intermedia*)
Frequently observed foraging near and escaping into stands when disturbed. These observations were most common in Ellis County.

Group	Species	Observation
Birds		
	Western meadowlark (*Sturnella neglecta*)	
		These birds called from the tallest stems of stands.
	Yellow-billed cuckoo (*Coccyzus americanus*)	
		On 1 occasion 2 were flushed from a stand.
Reptiles		
	Ornate box turtle (*Terrapene ornate*)	
		This species was observed in or near stands. It is possible they were consuming ripe plums that had fallen to the ground or using the structure of the stand.
	Western diamond-backed rattlesnake (*Crotalus atrox*)	
		This species was observed once in a large stand.
Invertebrates		
	Common paper wasp (*Polistes exclamans*)	
		These wasps where common in larger stands. Nests were built on secondary stems and were usually small with 5–7 wasps tending the nest.
	Common wood nymph (*Cercyonis pegala*)	
		On many occasions this species was found resting on stems.
	Eastern tent caterpillar (*Malacosoma americanum*)	
		The tents of this caterpillar were abundant in stands. Most infested stands tended to have 1 nest. Once the caterpillars hatched they quickly defoliated the surrounding stems but rarely defoliated the entire stand.
	Goatweed leafwing (*Anaea andria*)	
		This was the most abundant species of insect observed in 2007. They where found resting and when rotten fruit was present found feeding on it in large numbers.

Group Species Observation
Invertebrates
Olympia marble (*Euchloe olympia*)
Observed resting on stems.
Aphids (*Acyrthosiphon* sp.)
Relatively common, found feeding on young plum stems in riparian areas.

DISCUSSION

Plum stands and fruit have been shown to benefit wildlife (Stoddard 1931). There is also evidence it benefits domestic livestock. The primary benefit for livestock is the shade within large stands. McIlvain and Shoop (1971) showed that shade increased summer mass gain in yearling steers by 8.6 kg per head during a 4-year study on rangelands in northwestern Oklahoma. Shade has also shown to be as effective as water and supplemental feeding as a tool to promote uniform grazing of pastures. Heat stress due to the lack shade has been shown to affect the breeding performance in cattle (Erb and Waldo 1952, Stott 1961).

Plum is also important food source and cover for wild turkey (*Meleagris gallopavo*), black bear (*Ursus americanus*), coyotes (*Canis latrans*), fox (*Vulpes* sp.), ring-tailed cat (*Bassariscus astutus*) and a minor diet component of the white-tailed deer (Thwaites 1904, Martin et al. 1951, Gee et al. 1994, Miller and Miller 1999). It has also been shown to be important thermal and protective cover for northern bobwhites (Guthery et al. 2005, Hiller et al. 2007). The benefits of plum stands in terms of cover for the threatened lesser-prairie chickens (*Tympanuchus pallidicictus*) have been documented (Donaldson 1969, Copelin 1963) in western Oklahoma and Patten et al. (2005) in Oklahoma and New Mexico. Donaldson (1969) observed lesser-prairie chickens using plum stands for resting, roosting, and escape cover year round. Copelin (1963) suggested that lesser prairie-chicken required brushy cover including plum for shade during summer. Patten et al. (2005) demonstrated that lesser prairie-chicken survival in northwestern Oklahoma and New Mexico was positively correlated with higher shrub cover that included plum.

MANAGEMENT IMPLICATIONS

I encourage wildlife and range managers to consider the natural history and use of plum by wildlife when making decisions regarding removal or augmentation of plum. More detailed management recommendations for wildlife must await further study of wildlife-plum and livestock-plum interactions because the interactions are, at present, virtually undocumented.

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APPENDIX. Age, area, and coordinates (UTM for UTM NAD 83) of Chickasaw plum stands used to estimate age as a function of stem and root age in 3 Oklahoma Counties, USA, 2006.

County Age (yr)	Area (m^2)	Northing	Easting
Payne			
4	53	4010284	670615
5	202	4010294	670520
5	29	4010490	670540
5	39	4010389	670471
5	70	4010229	670558
5	234	4010253	670628
5	99	4010263	670674
6	128	4009910	670573
6	351	4009957	670472
6	398	4009947	670406
6	86	4009959	670341
6	34	4009846	670461
6	43	4010487	670529
6	44	4010463	670509
6	150	4010395	670420
6	30	4010251	670573
6	173	4010237	670683

County			
Age (yr)	Area (m^2)	Northing	Easting
Payne			
7	287	4009890	670550
7	143	4009942	670602
7	33	4009896	670419
7	211	4009849	670480
7	196	4010262	670526
7	40	4010470	670571
7	464	4010339	670369
8	83	4009865	670323
8	219	4010261	670543
8	102	4010455	670587
8	53	4010312	670927
9	161	4010074	670603
9	72	4010144	670506
10	576	4010257	670745
11	169	4010282	670498
11	423	4010415	670560
11	339	4010410	670380

County			
Age (yr)	Area (m^2)	Northing	Easting
Ellis			
10	299	4024719	435846
11	398	4024281	434978
11	1388	4023822	437497
11	425	4024213	435387
11	106	4024224	435394
11	195	4024280	435421
12	79	4024245	434725
12	284	4024200	435324
12	466	4024247	435421
13	200	4024259	434875
13	693	4024313	434749
13	393	4024750	435738
13	850	4023951	437466
14	361	4024347	434671
14	157	4026421	438024
15	510	4024263	434705
15	521	4024265	434680
15	324	4024335	434652

County			
Age (yr)	Area (m^2)	Northing	Easting
Ellis			
15	386	4024371	434698
15	652	4023561	437631
15	396	4024249	435302
15	197	4024276	435722
16	215	4025576	438279
16	269	4024213	435416
17	608	4024263	434928
17	306	4024310	434635
17	155	4024314	434968
17	140	4024677	435821
18	369	4024252	435049
20	1081	4023448	437589
24	434	4026413	438015
27	1681	4024085	436922
Harper			
9	322	4072620	459753
10	144	4069390	465744
10	154	4069083	466180

County			
Age (yr)	Area (m^2)	Northing	Easting
Harper			
11	283	4072592	460016
12	304	4072587	459731
12	122	4068541	466412
12	675	4069231	467375
12	203	4070634	468606
14	146	4072626	459735
14	1018	4072367	459981
14	94	4069012	465583
14	1202	4069414	467218
14	394	4069467	467174
15	326	4069630	465678
15	1774	4071782	459116
15	479	4068943	465724
16	821	4069405	465757
16	194	4071922	459918
16	159	4068714	465864
16	284	4068876	465991
16	414	4069935	468337

County			
Age (yr)	Area (m^2)	Northing	Easting
Harper			
17	856	4069313	465788
17	448	4068781	468004
17	645	4069963	468540
18	412	4069384	465794
18	930	4069350	465892
18	289	4068403	466399
19	198	4071882	460015
21	901	4069545	465754
23	496	4069011	465646

CURRICULUM VITA

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Title of Study: CHICKASAW PLUM: GROWTH AND USE BY NESTING BIRDS IN OKLAHOMA

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Major Field: Natural Resource Ecology and Management

Scope and Method of Study: I collected stem and stand data to develop growth models for Chickasaw plum (*Prunus angustifolia*), stand-area data for comparison of area data measured with a hand held Global Position System (GPS) unit and Graphical Information System (GIS) analysis, bird nest data to describe nesting in Chickasaw plum, and incidental natural history observations on the use of Chickasaw plum by wildlife in 3 Oklahoma counties during 2006–2008.

Findings and Conclusions: I sampled Chickasaw plum stands (n = 95) and stems (n = 155) ranging in size from 29–1 774 m^2 to develop growth models. Based on zero-intercept regression models, stands grew at similar rates (overlapping 95% CIs) among counties with a pooled estimate of 31.0 m^2/yr (95% CI = 26.5–35.6 m^2/yr; n = 95). This rate showed considerable variability within and among study sites ($r^2 = 0.27$). Stem diameter increased (zero-intercept models) more rapidly in north-central Oklahoma (5.27 mm/yr; 95% CI = 5.01–5.53 mm/yr; $r^2 = 0.81$; n = 53) than in north-western Oklahoma (3.68 mm/yr; 95% CI = 3.55–3.81 mm/yr; $r^2 = 0.83$; n = 102); data pooled because of similar rates in Ellis and Harper counties). Stem height was a power function of stem age ($y = 0.97x^{0.28}$; $r^2 = 0.31$), indicating rate of growth in height (m/yr) declined with age according to $dy/dx = 0.27x^{-0.72}$. In 2006, stand areas estimated with GPS units and GIS analysis were strongly correlated ($r^2 = 0.92$, $n = 49$). There was substantial variation in annual relative growth (Δarea/beginning area) for stands <400 m^2 whereas larger stands had relative growth rates near 0.0. Correlation analysis indicated that if a stand had a low relative growth rate in year t, it tended to compensate with a high relative growth rate in year t +1. I observed 5 and inferred 4 species for a total of 9 species nesting in plum. Nest height was consistent among species at averages ranging from 0.7 ± 0.13 m SE for field sparrows (*Spizella pusilla*) to 1.1 ± 0.07 m SE for northern mockingbirds (*Mimus polyglottos*). The results indicated that relatively old (≥10 yr) stands of Chickasaw plums are important components of habitat for this shrub-nesting guild. I observed 6 species of mammals, including domestic livestock, associated with plum. Mammals used plum for thermal and resting cover and to a lesser extent food. Passerines were the most frequent taxon of the 20 species of birds observed using plum for nesting, singing, resting, foraging, and/or escape. I also observed 2 reptile species and 6 invertebrate species using plum.

ADVISER'S APPROVAL: Dr. Fred S. Guthery