

Rapid Assessment Reference Condition Model

The Rapid Assessment is a component of the LANDFIRE project. Reference condition models for the Rapid Assessment were created through a series of expert workshops and a peer-review process in 2004-2005. For more information, please visit www.landfire.gov. Please direct questions to helpdesk@landfire.gov.

Potential Natural Vegetation Group (PNVG):

R5XTMB

Cross Timbers

General Information

Contributors (additional contributors may be listed under "Model Evolution and Comments")

Modelers

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Vegetation Type

Forested

Dominant Species*

QUST
QUMA3
SCHIZ4
ANGE

General Model Sources

- Literature
 Local Data
 Expert Estimate

LANDFIRE Mapping Zones

32
43

Rapid Assessment Model Zones

- California Pacific Northwest
 Great Basin South Central
 Great Lakes Southeast
 Northeast S. Appalachians
 Northern Plains Southwest
 N-Cent.Rockies

Geographic Range

This PNVG lies in central parts of Texas, Oklahoma and Kansas.

Biophysical Site Description

This PNVG generally has sandy to loam Ustalf soils that are from moderately deep to shallow (NatureServe 2005). Moderate rainfall region with periodic severe drought (Johnson and Risser 1971, 1973). The vegetation occurs in bands across the landscape associated strongly with soil type. Available soil water (dictated by soil depth, texture, and topographic position) also has a major influence on vegetation.

Vegetation Description

Historical accounts describe post-replacement shrub-scrub (early coppice) areas of cross timbers in addition to open and closed canopy conditions. The Cross Timbers is an ecotone between prairie and eastern deciduous forests. The black-capped vireo's historic range was associated with the post-replacement cross timbers vegetation type. Washington Irving and others have described areas of cross timbers that were evidently mid-seral closed and possibly late-seral closed, because of their inability to penetrate the forest on horse back and their description of the branching present in those stands. Yet others describe stands within the cross timbers that were easily traversed via wagon. Based on historical accounts and limited analysis of General Land Office survey data, more closed canopy conditions occurred on the landscape than might be expected for a frequent fire regime.

The vegetation is dominated by Post oak (*Quercus stellata*) and to a lesser extent blackjack oak (*Q. marilandica*). In the eastern extent, hickory (*Carya* spp.) and black oak (*Quercus velutina*) may be a constituent, with occasional elm (*Ulmus americana*) and eastern-red cedar (*Juniperus virginiana*) in protected areas. In open conditions the understory and canopy openings are dominated by big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*), and

*Dominant and Indicator Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.

various annual and perennial forbs with prevalence dictated by stand density and overstory canopy cover. In closed canopy conditions, groundcover has little to no herbaceous cover and is dominated by oak leaf litter. Other important woody plants include chittamwood (*Bumelia lanuginosa*), roughleaf dogwood (*Cornus drummondii*), greenbriar (*Smilax* spp.), sumac (*Rhus* spp.) and poison ivy (*Toxicodendron radicans*). Dense structure is found from the lower to upper midstory in closed canopy conditions with persistent branches composing much of structure along with numerous small to medium diameter stems. In the eastern extent, *Vaccinium* spp. may contribute to lower midstory structure in closed canopy stands. The Cross Timbers is generally found within a landscape matrix of tallgrass prairie.

Disturbance Description

This PNVG is fire regime group I, with frequent surface fires. Fire frequency is considered to be similar to adjacent forested ecosystems. The limited information available on fire chronologies is supportive of this assumption. Fire regimes are assumed to be a result of both aboriginal and lightning origin. Fire history studies from southwest Missouri and southeast Oklahoma suggest a mean fire return interval of 3-4 years. Major drought cycles occur at approximately 20 year intervals and may influence periodic stand replacement fire depending on the season of fire. Fires have been reported to occur during and following drought periods. Mosaic fire or mixed severity fire is thought to play some role associated with drought cycles where leaves and grass are the primary fuel for carrying a fire. Surface fires were primarily wind driven fires in open (prairie) conditions over a fuel bed of predominantly grass although occasionally surface fires might have occurred in leaf litter given dry conditions. Historic prairie fires have been noted to slow down or stop at the border of cross timbers vegetation, presumably when leaf moisture was high. Surface fire would penetrate or burn completely through late-seral, open stands.

Adjacency or Identification Concerns

The PNVG occurs adjacent to tallgrass or mixed prairie or within in a landscape matrix with patches of prairie. Oaks will encroach into prairie areas of the crosstimbers without fire. The deep alluvial soils of the bottomlands are not included in this PNVG.

Scale Description

Sources of Scale Data Literature Local Data Expert Estimate

The size and connectedness of patches varies, from small patches of 200 acres to well over several thousand square miles.

Issues/Problems

Areas of Cross Timbers existed in fire shadows at the juncture of rivers or larger streams. In areas that were rocky these areas may have limited fire influence and were essentially locked up on the landscape in late seral stages (Clark 2003, Clark and Hallgren 2004). These areas varied in canopy closure depending on soil type. Some of these protected areas may have had a high surface rock component with less canopy cover and soil types with less rock may have been more dense with near complete canopy closure. Little information is available on disturbance and successional history in the Cross Timbers region. Also, lack of historical information makes determining the percentage of landscape in each class difficult.

Model Evolution and Comments

Suggested reviewers: Dr. David M. Engle and Dr. Terry Bidwell, Oklahoma State University. Dr. Bruce Hoagland, Natural Heritage Inventory, University of Oklahoma. Dr. Stacy Clark, Post-Doc University of Tennessee and also (USFS) Alabama A&M (??). PNVG description was expanded upon review.

Succession Classes

Succession classes are the equivalent of "Vegetation Fuel Classes" as defined in the Interagency FRCC Guidebook (www.frcc.gov).

Class A 15%

Early1 All Structures

Description

Oak reproduction (often coppice) to 15' tall. Community of forbs and perennial grasses. More persistent on shallow soils. Openings may be small to extensive and have scattered live trees. Early on bluestems will be in the upper canopy but will be overtaken by the coppice oak sprouts. 0-19 years of age

Indicator Species* and Canopy Position

QUST Upper
 QUMA3 Mid-Upper
 SCHIZ4 Lower
 ANGE

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Fuel Model 3**Structure Data (for upper layer lifeform)**

	Min	Max
Cover	0 %	80 %
Height	Tree Regen <5m	Tree Short 5-9m
Tree Size Class	Sapling >4.5ft; <5"DBH	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Initially grasses will be dominant life form but will rapidly be overtaken and shaded out (to some extent) by coppice regeneration.

Class B 20%

Mid1 Closed

Description

Mid-seral with closed canopy (Cover >60%) sapling to pole-sized oak with little or no herbaceous understory. Often coppice origin. Dense structure is found from the lower to upper midstory in closed canopy conditions with persistent branches composing much of structure along with numerous small to medium diameter stems. In the eastern extent, *Vaccinium* spp. may contribute to lower midstory structure in closed canopy stands. 20-79 years of age.

Indicator Species* and Canopy Position

QUST Upper
 QUMA3 Mid-Upper

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Fuel Model 9**Structure Data (for upper layer lifeform)**

	Min	Max
Cover	60 %	100 %
Height	Tree Short 5-9m	Tree Medium 10-24m
Tree Size Class	Pole 5-9" DBH	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

There is a east to west decline in average tree height and diameter corresponding to a decreasing moisture gradient. Figures given reflect the central part of the range. As one goes further west, trees may actually drop a height and size class for min and max height and size class. Trees will not move up a class going to the east.

Class C 30%

Mid1 Open

Description

Mid-seral woodland/savanna overstory with perennial grasses (Cover <60%). Open and somewhat park-like, this class may have some smaller mid-story trees but overall understory is dominated with little and big bluestem. More mesic sites may have switchgrass or other panic grass component.

Indicator Species* and Canopy Position

QUST Upper
 QUMA3 Mid-Upper
 SCHIZ4
 ANGE

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Structure Data (for upper layer lifeform)

	Min	Max
Cover	20 %	60 %
Height	Tree Medium 10-24m	Tree Medium 10-24m
Tree Size Class	Pole 5-9" DBH	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

There is a east to west decline in average tree height and diameter corresponding to a decreasing moisture gradient. Figures given reflect the central part of the range. As one goes further west, trees may actually drop a

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20-79 years of age.

height and size class for min and max height and size class. Trees will not move up a class going to the east.

Fuel Model 2

Class D 25%

Late1 Open

Description

Mid-seral woodland/savanna oak overstory with perennial grasses (Cover <60%). This class is open and park-like with a tallgrass component of little and big bluestem. More mesic sites may have switchgrass or other panic grass component. 80+ years of age.

Indicator Species* and Canopy Position

QUST Upper
QUMA3 Mid-Upper
SCHIZ4 Lower
ANGE Lower

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Structure Data (for upper layer lifeform)

	Min	Max
Cover	20 %	60 %
Height	Tree Short 5-9m	Tree Medium 10-24m
Tree Size Class	Medium 9-21"DBH	

Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

There is a east to west decline in average tree height and diameter corresponding to a decreasing moisture gradient. Figures given reflect the central part of the range. As you go further west may actually drop a height and size class for min and max height and size class. You will not move up a class going to the east.

Fuel Model 2

Class E 10%

Late1 Closed

Description

Late-seral, closed canopy (Cover >60%) oak dominated overstory community. Little to no herbaceous cover and some shrub component. Varying from east to west. Dense structure is found from the lower to upper midstory in closed canopy conditions with persistent branches composing much of structure along with numerous small to medium diameter stems. In the eastern extent, Vaccinium spp. may contribute to lower midstory structure in closed canopy stands. 80+ years of age.

Indicator Species* and Canopy Position

QUST Upper
QUMA3 Mid-Upper

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 9

Structure Data (for upper layer lifeform)

	Min	Max
Cover	60 %	100 %
Height	Tree Short 5-9m	Tree Medium 10-24m
Tree Size Class	Medium 9-21"DBH	

Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

There is a east to west decline in average tree height and diameter corresponding to a decreasing moisture gradient. Figures given reflect the central part of the range. As one goes further west, trees may actually drop a height and size class for min and max height and size class. Trees will not move up a class going to the east.

Disturbances

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Non-Fire Disturbances Modeled

- Insects/Disease
- Wind/Weather/Stress
- Native Grazing
- Competition
- Other:
- Other:

Fire Regime Group: 1

- I: 0-35 year frequency, low and mixed severity
- II: 0-35 year frequency, replacement severity
- III: 35-200 year frequency, low and mixed severity
- IV: 35-200 year frequency, replacement severity
- V: 200+ year frequency, replacement severity

Historical Fire Size (acres)

Avg: 200
 Min: 10
 Max: 2000

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inverse of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class. All values are estimates and not precise.

Sources of Fire Regime Data

- Literature
- Local Data
- Expert Estimate

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	170			0.00588	3
Mixed	250			0.004	2
Surface	6			0.16667	94
All Fires	6			0.17655	

References

Abrams, M. D. 1992. Fire and the development of oak forests. *BioScience*. 42:346-353.

Adams, D. E., R. C. Anderson, and S. L. Collins. 1982. Differential response of woody and herbaceous species to summer and winter burning in an Oklahoma grassland. *Southwestern Naturalist* 27:55-61.

Agnew, B. 1975. Dodge Leavenworth Expedition of 1834. *The Chronicles of Oklahoma* 53:376.

Anderson, R. C. 1972. Prairie history, management and restoration in southern Illinois. Pages 15-22 in J. Zimmerman, ed., *Proc. Second Midwest Prairie Conf.* Madison, WI 242 pp.

Anderson, R. C. and L. E. Brown. 1986. Stability and instability in plant communities following fire. *American Journal of Botany* 73:364-368.

Axelrod, D. I. 1985. Rise of the grassland biome, central North America. *Botanical Review* 51:163-201.

Beilmann, A. and L. Brenner. 1951. The recent intrusion of forests in the Ozarks. *Ann. Missouri Botanical Garden* 38:261-282.

Bidwell, T. G. and D. M. Engle. 1992. Relationship of fire behavior to tallgrass prairie herbage production. *Journal of Range Management* 45:579-584.

Brown, James K.; Smith, Jane Kapler, eds. 2000. *Wildland fire in ecosystems: effects of fire on flora*. Gen. Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 257 p.

Box, T. W. 1967. Brush, fire and West Texas rangeland. *Tall Timbers Fire Ecology Conf. Proc.* 6:7-19.

*Dominant and Indicator Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.

- Bragg, T. B. and L. C. Hulbert. 1976. Woody plant invasion of unburned Kansas bluestem prairie. *Journal of Range Management* 29:19-23.
- Bruner, W. E. 1931. The vegetation of Oklahoma. *Ecological Monographs*. 1:100-188.
- Clark, S. L. 2003. Stand dynamics of an old-growth forest in the Cross Timbers of Oklahoma. Ph.D. Dissertation, Oklahoma State University, Stillwater, OK.
- Clark, S.L. and S.W. Hallgren. 2004. Age estimation of *Quercus marilandica* and *Q. stellata*: applications for interpreting stand dynamics. *Canadian Journal of Forest Research* 34:1353-1358.
- Clark, S.L. and S.W. Hallgren. 2004. Can oaks be aged from bud scars? *Southwestern Naturalist* 49:243-246.
- Clark, S.L. and S.W. Hallgren. 2004. Dynamics of oak (*Quercus marilandica* and *Q. stellata*) reproduction in an old-growth Cross Timbers forest. *Southeastern Naturalist* 2:559-574.
- Clark, S. L., S. W. Hallgren, D. M. Engle, and D. W. Stahle. 2004. Fire Events Coupled with Settlement and Drought Influence Stand Dynamics in a Xeric *Quercus* forest. *Journal of Applied Ecology* IN REVIEW.
- Costello, D. F. 1969. The prairie world. Crowell Co. New York, NY.
- de Pourtales, C. (G. F. Spaulding, ed.) 1832. On the western tour with Washington Irving; The journal and letters of Count de Pourtales. University of Oklahoma Press, Norman, OK.
- Duck, L. G., and J. B. Fletcher. 1944. A survey of the game and fur bearing animals of Oklahoma. Oklahoma Game and Fish Commission. State Bulletin. No. 3, Oklahoma City, OK.
- Dyksterhuis, E. J. 1948. The vegetation of the western cross timbers. *Ecological Monographs* 18:327-376.
- Dyksterhuis, E. J. 1957. The savanna concept and its use. *Ecology* 38:435-442.
- Engle, D. M., T. G. Bidwell, and R. E. Masters. 1996. Restoring Cross Timbers ecosystems with fire. *Trans. North American Wildlife and Natural Resources Conference* 61:190-199.
- Ellsworth, H. L. 1832. A narrative of a tour of the Southwest in the year 1832. in Williams, S. T. and B. D. Simison, eds. *Washington Irving on the Prairie*. 1937. American Book Co. New York, NY.
- Elwell, H. M. 1970. Burning and 2,4,5-T on post and blackjack oak rangeland in Oklahoma. Oklahoma Agricultural Experiment Station, Stillwater, OK.
- Engle, D. M. and J. F. Stritzke. 1995. Fire behavior and fire effects on eastern redcedar in hardwood leaf-litter fires. *Int. J. Wildland Fire*. 5:135-141.
- Foreman, C. T. 1947. The cross timbers. Star Printery. Muskogee, OK.
- Gregg, J. 1844. Commerce of the prairies. Hanna, A. and W. H. Goetzman, eds. J. B. Lippincott Co. Philadelphia, PA.

Grzybowski, J. A., D. H. Tazik, and G. D. Schnell. 1994. Regional analysis of black-capped vireo breeding habits. *Condor* 96:512-544.

Hoagland, B. W. 2000. The vegetation of Oklahoma: a classification for landscape mapping and conservation planning. *Southwestern Naturalist* 45:385-420.

Hoagland, B. W., I. H. Butler, F. L. Johnson, and S. Glenn. 1999. The Cross Timbers. In: R. C. Anderson, J. S. Fralish, and J. M. Baskin (eds). *Savannas, Barrens, and rock outcrop plant communities of North America*. Cambridge University Press, New York.

Irving, W. 1935. *A tour of the prairies*. Harlow Publ., Oklahoma City, OK. 252 pp.

Johnson, F.L., and P. G. Risser. 1971. Some vegetational-environment relationships in the upland forests of Oklahoma. *Ecology* 60:655-663.

Johnson, F. L., and P. G. Risser. 1973. Correlation analysis and annual ring index of central Oklahoma blackjack and post oak. *American Journal of Botany* 60:475-478.

Johnson, F. L. and P. G. Risser. 1975. A quantitative comparison between an oak forest and an oak savannah in central Oklahoma. *Southwestern Naturalist* 20:75-84.

Kennedy, R. K. 1973. An analysis of selected Oklahoma upland forest stands including both overstory and understory components. Ph.D. Dissertation, University of Oklahoma, Norman, OK.

Komarek, E. V. 1965. Fire ecology-Grasslands and man. *Proc. Ann. Tall Timbers Fire Ecology Conf.* 4:169-220.

Komarek, E. V. 1974. Effects of fire on temperate forests and related ecosystems: Southeastern United States. Pages 252-277 in T.T. Kozlowski and C.E. Ahlgren, eds., *Fire and ecosystems*. Academic Press, New York, NY. 542 pp.

Kuchler, A. W. 1974. A new vegetation map of Kansas. *Ecology* 55:586-604.

Masters, R. E., J. E. Skeen, and J. Whitehead. 1995. Preliminary fire history of McCurtain County Wilderness Area and implications for red-cockaded woodpecker management. Pages 290-302 in D. L. Kulhavy, R. G. Hooper, and R. Costa. (eds.). *Red-cockaded woodpecker: Species recovery, ecology and management*. Center for Applied Studies, Stephen F. Austin University, Nacogdoches, Tx.

NatureServe. 2005. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of 13 January 2005.

Powell, J., and D. P. Lowry. 1980. Oak (*Quercus* spp.) sprouts growth rates on a central Oklahoma shallow savanna range site. *Journal of Range Management* 33:312-313.

Penfound, W. T. 1962. The savanna concept in Oklahoma. *Ecology* 43:774-775.

Penfound, W. T. 1968. Influence of a wildfire in the Wichita Mountains Wildlife Refuge, Oklahoma. *Ecology* 49:1003-1006.

Rebertus, A. J., and B. R. Burns. 1997. The importance of gap processes in the development and maintenance of oak savannas and dry forests. *Journal of Ecology* 85:635-645.

- Rice, E. L. and W. T. Penfound. 1959. The upland forests of Oklahoma. *Ecology* 40:593-608.
- Risser, P. G. and E. L. Rice. 1970. Phytosociological analysis of Oklahoma upland forest species. *Ecology* 52:940-945.
- Roe, S. A. 1998. The vegetation of a tract of ancient cross timbers in Osage County, Oklahoma. M.S. Thesis, Oklahoma State University, Stillwater, OK 86p.
- Rossen, J. F., 1994. *Quercus stellata* growth and stand characteristics in the *Quercus stellata* *Quercus marilandica* forest type in the cross timbers region of central Oklahoma. In Proceedings of the North American Conference on Savannas and Barrens. Illinois State University, Normal IL.
- Russell, F. L., and N. L. Fowler. 1999. Rarity of oak saplings in savannas and woodlands of the eastern Edwards Plateau, Texas. *Southwestern Naturalist* 44:31-41.
- Russell, F. L., and N. L. Fowler. 2002. Failure of adult recruitment in *Quercus buckleyi* populations on the Eastern Edwards Plateau, Texas. *American Midland Naturalist* 148:201-217.
- Sapsis, D. B. and J. B. Kauffman. 1991. Fuel consumption and fire behavior associated with prescribed fire in sagebrush ecosystems. *Northwest Science* 65:173-179.
- Schulz, C. A., and D. M. Leslie. 1992. Autumn and winter bird populations in herbicide-treated cross timbers in Oklahoma. *The American Midland Naturalist*. 127:215-223.
- Schulz, C. A., D. M. Leslie, R. L. Lochmiller, and D. M. Engle. 1992. Herbicide effects on cross timbers breeding birds. *Journal of Range Management* 45:407-411.
- Schmidt, Kirsten M, Menakis, James P., Hardy, Colin C., Hann, Wendel J., Bunnell, David L. 2002. Development of coarse-scale spatial data for wildland fire and fuel management. Gen. Tech. Rep. RMRS-GTR-87. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 41 p. + CD.
- Shutler, A. and B. Hoagland. 2004. Presettlement vegetation in the cross timbers, Carter County, Oklahoma, 1871. *Oklahoma Academy of Science* 84:IN PRESS.
- Stahle, D. W., and J.G. Hehr. 1984. Dendroclimatic Relationships of post oak across a precipitation gradient in the southcentral United States. *Annals of the Association of American Geographers* 74:561-573.
- Stahle, D. W., J. G. Hehr, G. G. Hawks, M. K. Cleaveland, and J. R. Baldwin. 1985. Tree-ring chronologies of the southcentral United States. Tree-Ring Laboratory and Office of the State Climatologists, University of Arkansas, Fayetteville, AR. 128 pp.
- Stahle, D. W., and P. L. Chaney. 1994. A predictive model for the location of ancient forests. *Natural Areas Journal*. 14:151-158.
- Smeins, F. 1994. Cross timbers-Texas-Little bluestem-post oak. SRM 732. Pages 107-108 in T,N, Shiftlet, ed. *Rangeland cover types of the United States*. Soc. Range Manage., Denver, CO. 152 pp.
- Stein, H. F. and R. F. Hill eds. 1993. *The culture of Oklahoma*. University of Oklahoma Press. Norman, OK.

- Stroud, H. A. 1968. Conquest of the prairies. Texan Press. Waco, TX.
- Tharpe, B. C. 1923. Ecologic investigations in the Red River Valley. University of Texas Bulletin 2327:89-155
- Tharpe, B. C. 1926. Structure of Texas vegetation east of the 98th meridian. University of Texas Bulletin 2606:1-172.
- Trollope, W. S. W. 1984. Fire in savannah. Pages 151-175 in P. de V. Booysen and N.M. Tainton, eds., Ecological effects of fire in South African ecosystems. Springer-Verlag, New York, NY. 426 pp.
- U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2002, December). Fire Effects Information System, [Online]. Available: <http://www.fs.fed.us/database/feis/>.
- Weaver, J. E. and F. E. Clements. 1938. Plant Ecology. 2nd ed. McGraw Hill. New York. 601 pp.
- White, A. S. 1986. Prescribed burning for oak savanna restoration in central Minnesota. Res. Pap. NC-266, USDA Forest Service, Washington, D.C. 12.pp.
- Wright, H. A. and A. W. Bailey. 1982. Fire ecology. John Wiley and Sons, New York, NY. 501 pp.