A River Transformed: Historic Geomorphic Changes of the Lower Rio Grande in the Big Bend Region of Texas, Chihuahua, and Coahuila

David James Dean
Utah State University

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A RIVER TRANSFORMED: HISTORIC GEOMORPHIC CHANGES OF THE
LOWER RIO GRANDE IN THE BIG BEND REGION OF TEXAS,
CHIHUAHUA, AND COAHUILA

by

David James Dean

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Watershed Science

Approved:

Dr. John C. Schmidt
Major Professor

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Committee Member

Dr. Nicholas Allmendinger
Committee Member

Dr. Byron R. Burnham
Dean of Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah
2009
ABSTRACT

A River Transformed: Historic Geomorphic Changes of the Lower Rio Grande in the Big Bend Region of Texas, Chihuahua, And Coahuila

by

David James Dean, Master of Science
Utah State University, 2009

Major Professor: Dr. John C. Schmidt
Department: Watershed Sciences

Over the last century, the construction and management of large dams and streamflow diversions, and periodic drought have resulted in significant declines in stream flow of the lower Rio Grande in the Big Bend region. Reductions in mean annual flow and peak discharge have resulted in channel narrowing by the formation of vertically accreting inset floodplains. Narrowing has been temporarily interrupted by infrequent large dam releases greater than 1000 m$^3$/s that have temporarily widened the channel; however, after each of these events, narrowing has resumed. Prior to 1942, floods of this magnitude occurred approximately once every 4 years and maintained a wide sandy channel. Since 1942, they have occurred 4 times. The decline in frequency of these large floods has resulted in a channel approximately 50% narrower than in the 1940s. Since the most recent channel widening floods in 1991, the channel has narrowed between 35 and 50%. In two large floodplain trenches, we observed between 2.75 and 3.5 m of vertical accretion during the same period. Additionally, nearly 90% of bare active channel bars have been converted to vegetated floodplains. Since 1991, the cross section
channel area at the Johnson Ranch gage has decreased by approximately 30%. The reduction in cross section area and the invasion of non-native vegetation have resulted in higher flood stages, flooding at lower discharges, and continued vertical accretion.

Channel narrowing has negatively impacted the native and endemic aquatic ecosystem through the loss of ecologically important habitats such as backwaters, side channels, and low velocity portions of the channel. Reductions in cross section area and resultant increased flood stages have also endangered historic cultural sites within the Big Bend region. Restoration efforts are currently underway within the region without a clear understanding of these historical channel changes and why they occurred.

Our reconstruction of historical channel changes shows that the most significant periods of channel narrowing occurred during drought and increased stream-flow management. Management practices also appear to have enabled the invasion of non-native riparian species, which promoted sedimentation, bank stabilization, and additional channel narrowing. In order to restore historical measures of channel width, management options include non-native vegetation removal, common low magnitude dam releases that provide flood disturbance and prevent vegetation establishment, and large dam releases in excess of 1000 m$^3$/s that create and maintain a wide channel. Vegetation management is expensive and time consuming, and managed dam releases are politically unpopular and expensive, however, without the management of non-native riparian species and reinstatement of portions of the historical flood regime, ecological restoration will be difficult.

(346 pages)
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Rivers adjust their morphologies in response to changes in their flow regime, sediment supply, and size of the supplied sediment, and the style of response is partly determined by the surrounding vegetation and the width of the alluvial valley (Leopold and Maddock, 1953; Lane, 1955; Schumm, 1977; Brierley and Fryirs, 2005). In natural systems, watershed characteristics such as geology, relief, and climate control the water and sediment supply as well as the valley topography (Schumm and Lichty, 1965). Humans, however, have altered the runoff and sediment supply regime through dam construction, stream-flow diversion, ground-water pumping, and land use practices resulting in widespread changes to stream channel form (Haff, 2001). Climate change and non-native riparian vegetation invasions have exacerbated the transformation of many of the Earth’s rivers. Additionally, positive feedbacks may result in a cascade of changes resulting in a river system completely transformed from its natural state.

Dam construction and management disrupts the mass balance of water and sediment by trapping sediment in reservoirs and altering the hydrograph downstream. The resulting geomorphic effects depend upon the overall magnitude of alteration as well as the changes to the relative ratio of water and sediment supplies (Schmidt and Wilcock, 2008). In cases where the reduction in stream flow is greater than the reduction in sediment supply, the result is often channel narrowing which occurs through the formation of floodplains inset within the previously wider channel margins (Everitt, 1993; Friedman et al., 1996; Friedman et al., 1998; Allred and Schmidt, 1999). Narrowing often occurs at the expense of ecologically important habitats through bank
attachment of channel bars and the accretion of sediment within side channels and backwaters.

On many western rivers, the reduction in flood frequency and magnitude, and the shift of flood timing have favored the establishment and proliferation of non-native vegetation including tamarisk (Tamarix spp.), a shrub that is a federally designated noxious weed. In many areas, dense monocultures of tamarisk exist along rivers that previously had little vegetation along their margins. Vegetation effectively stabilizes once mobile surfaces (Thorne, 1990; Simon and Collison, 2002), reduces channel-margin flow velocities (Carollo et al., 2002), and induces sedimentation (Schultz et al., 2003) thereby creating a positive feedback between vegetation establishment and channel narrowing. Some studies show that vegetation effectively results in secondary channel abandonment and the conversion of a multi-thread river to a single thread (Tal et al., 2003; Tal and Paola, 2007).

The lower Rio Grande in the Big Bend region of Texas, Chihuahua, and Coahuila has experienced tremendous changes in stream flow, sediment supply, and vegetation cover. During the 20th century, the construction of dams, stream flow diversions, and levees on the upper Rio Grande and its largest tributary, the Rio Conchos, completely altered the hydrologic and sediment regime. On the upper Rio Grande, the operation of dams in New Mexico, and the diversion of their releases for agriculture in the El Paso-Juarez Valley, resulted in a severe depletion of stream flow downstream in the Big Bend region (Everitt, 1993; Schmidt et al., 2003). Thus, although the lower Rio Grande historically received more than two-thirds of its water from the Rio Conchos, the present flow regime is now completely dependant upon the Rio Conchos. However, consumptive
water use of the Rio Conchos has also increased during the 20th century resulting in an 86% decrease in mean annual flow since 1915 (Schmidt et al., 2003).

Channel changes immediately upstream of the Rio Conchos are relatively well understood. Stream flow reductions and unaltered sediment inputs from ephemeral tributaries caused the channel to narrow by approximately 90% between 1902 and 1970 (Everitt, 1993). Channel narrowing and vertical aggradation of the channel bed and floodplains occurred until channel capacity was so greatly reduced that overbank flooding resumed. Thus, the channel established a new balance between its altered stream flow and sediment supply. As the channel narrowed, thick stands of tamarisk colonized these new floodplain surfaces which now dominate the riparian corridor.

Downstream of the Rio Conchos, geomorphic changes are widely recognized by river users yet remain largely un-quantified. In this region, the lower Rio Grande is not confined within levees, nor is it channelized. Six protected areas exist within the United States and Mexico along this reach and all have the common goal of wilderness and ecosystem preservation. Additionally, managers are currently implementing restoration projects along the river corridor without a clear understanding of the historical geomorphic changes and/or the forcing mechanisms of those changes. Thus, the quantification of the rate, magnitude, and mechanisms of historical channel change on the lower Rio Grande will help guide reasonable targets for restoration efforts currently underway in the region.

Chapter 2 describes channel changes of the lower Rio Grande using methods applied at several spatial and temporal scales. At large spatial but temporally limited scales, I conducted aerial photograph analyses of 3 study reaches within Big Bend
National Park (BBNP), TX, and adjacent portions of Chihuahua and Coahuila, MX, to determine changes in channel width. I matched 18 historic oblique photos within the 3 study reaches, and matched 9 photos elsewhere in BBNP to describe channel changes prior the first aerial photographs. At spatially limited but temporally precise scales, I analyzed discharge measurement notes and stage plate measurements at the Johnson Ranch gage and Castolon stage plate to determine changes in the channel cross section, hydraulic geometry, and stage-discharge relationships. Additionally, I conducted stratigraphic and dendrogeomorphic analyses of inset floodplain deposits in two large floodplain trenches to determine the rate and magnitude of recent floodplain formation. The integration of these methods provides a comprehensive synthesis of channel change during the last century.

Chapter 3 specifically addresses floodplain stratigraphy and sedimentology, and I describe the mechanisms of channel narrowing and floodplain formation in BBNP. Using a high resolution tree ring dating technique (Friedman et al., 2005), I constrained the timing and magnitude of floodplain formation. I analyzed primary sedimentary structures, secondary sedimentary structures, and grain size to determine the dominant mechanisms responsible for recent floodplain formation.

The thesis concludes in Chapter 4 with a discussion of management recommendations that arise from this study.

REFERENCES CITED


CHAPTER 2
FROM CHANNEL TO FLOODPLAIN: GEOMORPHIC TRANSFORMATION OF
THE LOWER RIO GRANDE IN THE BIG BEND REGION OF TEXAS,
CHIHUAHUA, AND COAHUILA

ABSTRACT

Large-scale water development of the upper Rio Grande in the U.S. and Mexico, and of the Rio Conchos in Mexico, has resulted in channel narrowing, vertical floodplain accretion, and loss of channel capacity of the lower Rio Grande in the Big Bend region of Texas, Chihuahua, and Coahuila. Although general channel narrowing has occurred since the 1940s, the active channel width of the Rio Grande in Big Bend National Park has narrowed by 35-50% since 1991. This recent phase of narrowing occurred following a channel widening flood in 1991. Narrowing has occurred by vertical accretion of fine-grained deposits inset within natural levees. Vertical accretion has occurred on top of alternate bars of sand and gravel. In two floodplain trenches, 2.75 and 3.5m of vertical accretion were measured, all of which occurred during the past 17 years. In some localities, nearly 90% of bare, active channel bars were converted to vegetated floodplain during the same period. Channel narrowing by vertical accretion coincided with a rapid invasion of non-native riparian vegetation (*Tamarix chinensis, Arundo donax*). Upward shifts of stage-discharge relations occurred resulting in over-bank flooding at lower discharges, and continued vertical accretion despite a progressive reduction in stream flow. Thus, although peak flows were reduced by 48% and the duration of the 2-year

1 Coauthored by John C. Schmidt
flood declined during the past 17 years, over-bank flooding has continued. The loss of channel capacity and subsequent elevated flood stages have threatened historical sites throughout the park. Our results are based on methods that operate at multiple spatial and temporal scales including: hydrologic analysis of historic stream gage data, analysis of discharge measurement notes, historic oblique and aerial photograph analysis, field mapping of geomorphic surfaces, and stratigraphic and dendrogeomorphic analysis of inset floodplain deposits. These changes reflect a shift in the geomorphic nature of the Rio Grande from a laterally unstable, multi-thread, wide river with transient channel bars to a laterally stable, single-thread, channel with cohesive, vertical banks and few active in-channel bars.

1. INTRODUCTION

Climate change, dams, stream flow diversions, alluvial ground-water pumping, non-native riparian vegetation invasion, and watershed-scale land use change have altered the stream flow regime and sediment supply of many of the world’s rivers and thereby caused channel change (Hooke, 1994; Haff, 2001). Many of these channel changes are undesirable and are now the focus of river restoration efforts. Thus, it is axiomatic that restoration goals and techniques associated with these efforts be guided by sound understanding of the history of channel change and why that change occurred (Kondolf, 1995).

The Rio Grande in the Big Bend region of Texas, Chihuahua, and Coahuila has experienced tremendous changes in stream flow and sediment supply. The associated transformation of channel and floodplain geomorphology is widely recognized but has
never been well described or quantified. Restoration efforts are currently underway within the region without a clear understanding of these historical channel changes and why they occurred.

In this paper, we integrate methods applied at multiple temporal and spatial scales to develop a robust history of channel change and determine the causes of that change. We conducted detailed studies in parts of Big Bend National Park (BBNP) in the United States and in adjacent parts of Mexico. We demonstrate that due to a decrease in total stream flow and flood flow, the width of the Rio Grande is approximately half of what it was a century ago. We also describe the relative importance of various forcing mechanisms that caused the channel change and show how the trajectory of channel change was affected by non-native riparian vegetation invasion.

2. STUDY AREA

Channel change was analyzed at a few discrete locations within bedrock canyons, and in 3 alluvial reaches that comprise 14% of the 205-km length of the Rio Grande in BBNP (Fig. 2.1). All field work was conducted in BBNP, but we report remotely-sensed attributes of channel change in adjacent parts of Chihuahua and Coahuila where the Rio Grande is called the Rio Bravo.

The Big Bend region extends from the confluence of the Rio Grande and Rio Conchos 490 km downstream to Amistad Reservoir. Because stream flow from the Rio Conchos significantly augments the hydrology of the Rio Grande, we refer to the Rio Grande upstream from the Rio Conchos as the upper Rio Grande and downstream from the Rio Conchos as the lower Rio Grande.
There are five other protected areas besides BBNP in the Big Bend region: Big Bend Ranch State Park, Cañon de Santa Elena Protected Area, Maderas del Carmen Protected Area, Black Gap Wildlife Management Area, and the Rio Grande Wild and Scenic River. The proposed Ocampo Protected Area would link Cañon de Santa Elena and Maderas del Carmen in Mexico and thereby create the one of the largest bi-national conservation areas in North America.

Today, the Rio Grande in the Big Bend region is single-threaded and flows through wide alluvial valleys in structural basins and narrow canyons cut through intervening ranges. Some of the canyons are very narrow, and the channel banks are bedrock. In wider canyons, alluvium forms the channel banks. Channel slope is approximately 0.0013 in the alluvial valleys and 0.002 in the canyons. The bed of the Rio Grande is predominately sand, although alternate gravel bars form at the mouths and downstream from ephemeral tributaries.

Main-stem floods have high suspended loads of fine sediment. Sources of sediment are the Rio Conchos downstream from Luis Leon Dam (Fig. 2.1) and ephemeral tributaries that drain parts of the sparsely vegetated Chihuahuan Desert that are underlain by fine grained sedimentary and volcanic rocks. The largest ephemeral tributaries are Alamito, San Carlos, Terlingua, and Tornillo Creeks (Fig. 2.1b). Floods on these tributaries sometimes exceed the magnitude of the long-term average 2-yr flood of the lower Rio Grande, yet their combined mean annual flow is a small fraction of the total flow.

The 3 alluvial study reaches include: (1) 14.5 km between the mouth of Terlingua Creek and Castolon, TX, referred to as the Castolon reach, (2) 12.5 km in the vicinity of
the Johnson Ranch gage, referred to as the Johnson Ranch reach, and (3) 12.1 km near Boquillas, Coah, referred to as the Boquillas reach (Fig. 2.2). A stage plate near Castolon has been read daily since 1984, and is located approximately 100 m downstream from a trench that we excavated to analyze floodplain stratigraphy. The Johnson Ranch reach includes the Johnson Ranch stream gage operated by the International Boundary and Water Commission (IBWC) (gage number 08375500; Rio Grande at Johnson Ranch). Discharge at the Johnson Ranch gage has been measured since 1936. In the Boquillas reach, we excavated a trench in the floodplain approximately 2 km upstream from Boquillas, MX. At the Castolon stage plates, there are brief periods from a few days to a month when there is no record.

We also analyzed hydrologic records collected at an IBWC gage 8 km downstream from the Rio Conchos (gage number 08374200; Rio Grande below Rio Conchos). We also matched 18 historic photos within the 3 alluvial study reaches, and matched 9 photos elsewhere in BBNP.

3. HYDROLOGY

Stream flow of the lower Rio Grande has long been altered by humans, and it is impossible to reconstruct the pre-disturbance condition of the river. Irrigation diversions in northern New Mexico date to at least the late 1500s (Wozniak, 1998), irrigated agriculture supported by diversions began in the El Paso - Juarez Valley in 1659 (Stotz, 2000), and irrigated agriculture has been practiced near Presidio since the mid-1700s (Schmidt et al., 2003). In the 1890s, Mexico lodged formal complaints to the United
States on behalf of irrigators near Juarez whose water supplies were greatly diminished by upstream depletions.

Stream flow measurements in the Big Bend region began at the beginning of the 20th century. Between 1901 and 1913, prior to the construction of large dams, most of the stream flow of the lower Rio Grande came from the Rio Conchos (Schmidt et al., 2003). This occurred despite the fact that the 165,000 km² area of the upper Rio Grande is more than twice as large as the 70,000 km² drainage basin area of the Rio Conchos.

The flood regime of lower Rio Grande in the early 20th century was composed of two peaks: a small, snowmelt peak from the upper Rio Grande, and a much larger peak from monsoon rains and tropical storms in the Rio Conchos watershed (Fig. 2.3). Between August and February, more than 65% of the lower Rio Grande’s mean monthly stream flow came from the Rio Conchos, and the annual flood typically peaked in September (Schmidt et al., 2003). In contrast, between April and June, more than 80% of the lower Rio Grande’s stream flow came from the upper Rio Grande’s snow melt flood (Fig. 2.3), when there was little precipitation in the Rio Conchos watershed.

The stream flow regime of the lower Rio Grande was profoundly changed by La Boquilla Dam, completed in 1913 on the Rio Conchos, and by Elephant Butte Dam in southern New Mexico completed in 1915. Together, reservoir storage created by these dams and other dams was nearly 3 times the pre-1915 mean annual flow of the lower Rio Grande (Fig. 2.4). Reservoir storage has more than doubled since then, including two dams on the Rio Conchos downstream from La Boquilla Dam (Francesco I. Madera in 1947 and Luis L. Leon in 1967) and one downstream from Elephant Butte (Caballo in 1938). Operations of Elephant Butte and Caballo Dams eliminated the natural spring
snowmelt flood and created a high base flow that is completely diverted in the El Paso - Juarez valley (Schmidt et al., 2003). Virtually no flow now passes beyond Fort Quitman, TX, at the southern end of the El Paso - Juarez Valley (Everitt, 1998). Thus, greater than 90 percent of the present stream flow of the lower Rio Grande comes from the Rio Conchos.

Consumptive water use in the Rio Conchos watershed has increased during the 20th century, causing an 86% decrease in mean annual flow of the lower Rio Grande measured near Presidio. Mean annual flow was 72.1 m$^3$/s prior to 1915 and was 9.8 m$^3$/s between 1995 and 2005 (Fig. 2.5).

4. PREVIOUS STUDIES OF CHANNEL CHANGE OF THE RIO GRANDE ALONG AND NEAR THE INTERNATIONAL BOUNDARY

Prior to dam construction, the Rio Grande was wide, meandering, multi-threaded, and prone to avulsion (Mueller, 1975; Stotz, 2000). In the wide alluvial valleys of southern New Mexico, the channel bed often approached 1 km in width (Ainsworth and Brown, 1933). In the El Paso – Juarez Valley, the channel was narrower and more sinuous, and the adjacent floodplains were constructed of natural levees, oxbow lakes, marshes, swamps, salt pans, and sloughs (Hill, 1901; Everitt, 1998; Stotz, 2000). Vegetation communities were heterogeneous with sparse, flood tolerant patches of seepwillow (*Baccharis glutinosa*) established on sand bars, discontinuous stands of willow (*Salix exigua*) and cottonwood (*Populus* spp.) at the channel margins, and dense thickets of mesquite (*Prosopis glandulosa, Prosopis pubescens*) set back from the channel margins (Ainsworth and Brown, 1933; Everitt, 1998; Stotz, 2000). The complex
structure of the channel, adjacent floodplains, and vegetation assemblages apparently reflected the variable hydrology which included short periods of large magnitude floods and longer periods of little or no flow within the river.

With the onset of dam construction in New Mexico, widespread channel changes occurred. Channel incision began immediately after completion of Elephant Butte Dam (Lawson, 1925) and ultimately extended approximately 260 km to El Paso. The average magnitude of bed incision was about 0.9 m within 125 km from the dam and was about 0.3 m as far as 210 km from the dam (Stevens, 1938). The eroded sediment caused bed and floodplain aggradation further downstream, and the bed was higher than the adjacent streets of El Paso and Juarez in the 1930s (Lawson, 1936). In response to the threat from floods and diplomatic issues associated with an aggrading, ever-changing channel that defined the international border, the entire channel between Caballo Dam and Fort Quitman was straightened and confined by levees by 1938.

Stevens (1938, table 1) estimated that the annual suspended sediment load of the Rio Grande at El Paso decreased by more than 90% after completion of Elephant Butte Dam. Between 1906 and 1909, the average annual suspended load was $16.0 \times 10^6$ Mg/yr, and the load was $0.5 \times 10^6$ Mg/yr between 1916 and 1925. Today, the annual sediment supply to the Rio Grande in the El Paso – Juarez Valley is $0.6 \times 10^6$ Mg, because this is the amount annually removed to maintain channel capacity (Everitt, 1993). Although dam construction undoubtedly caused changes to the sediment supply of the Rio Conchos, no sediment transport data are available and changes to the sediment load are unknown.
Everitt (1993) showed that the nearly complete depletion of stream flow and the continued delivery of sediment from ephemeral tributaries that enter the Rio Grande between Ft. Quitman and Presidio caused the Rio Grande immediately upstream from the Rio Conchos to narrow by approximately 90% between 1902 and 1970. These changes occurred by aggradation of the bed of more than 2 m, as well as vertical accretion of the floodplain. Reduced transport capacity of the river resulted in accumulation of coarse debris at tributary mouths that locally steepened the river profile. Everitt classified these geomorphic changes into 3 stages: (1) a period of channel shrinking when reductions in discharge led to in-channel aggradation, (2) a period when reduced channel capacity resulted in the resumption of over-bank flooding and valley-wide aggradation, and (3) a period of gravel accumulation at tributary mouths that has re-graded the river into a series of steps.

As the channel shrank, non-native vegetation dominated by tamarisk (*Tamirix* spp.) established along the river margins. Tamarisk was present in west Texas as early as 1912 (Everitt, 1998). Ainsworth and Brown (1933) reported dense growth of native willow and mesquite, and non-native tamarisk along the Rio Grande in the El Paso - Juarez valley in 1932. Aerial photographs depicted tamarisk and non-native giant cane (*Arundo donax*) along the Rio Grande in the Presidio Valley in 1938 (LeSeur, 1945) and abandoned farmland overgrown by tamarisk in 1967. Today, tamarisk occupies areas in the Presidio Valley once dominated by cottonwood and mesquite thickets (Everitt, 1998) and the density and extent of giant cane has drastically increased over the last 20 years.
5. METHODS

Temporally detailed data include discharge measurement notes at the Johnson Ranch gage, rating relations at the Castolon stage plate, and stratigraphic and dendrogeomorphic analysis of two large floodplain trenches. Spatially extensive data include matches of ground-level photographs originally taken in the early to mid 20th century and analysis of aerial photographs first taken in 1941.

5.1. Hydrologic Data

We analyzed mean daily discharge data collected at the Johnson Ranch gage and compared those data with the longer term record of the gage below the Rio Conchos (BRC) near Presidio. There is greater imprecision in the magnitude of floods at Johnson Ranch, because discharges are measured infrequently, and flood magnitudes are typically estimated by extrapolation of rating relations developed at lower flows. During large floods, access to Johnson Ranch is sometimes blocked.

We fit a Log Pearson Type III distribution to the annual maximum of the mean daily discharge data and calculated mean annual flow and flow duration statistics from the mean daily data. We divided the 20th century into 5 sub-periods based on trends in the record at BRC. These periods are: (1) 1900 to 1914, prior to the construction of Elephant Butte and La Boquilla Dams; (2) 1931 to 1942 when stream flows were large; (3) 1943 to 1969 during extended regional drought, (4) 1970 to 1991 when stream flow was high, and (5) 1992 to 2006 during drought. Stream flow measurements were not made between 1915 and 1930. Gaging did not begin at Johnson Ranch until 1936, so no data are available for the period from 1900 to 1914 and less data are available with which
to compute flow statistics for the second period. We compared hydrologic changes among adjacent periods.

5.2. Repeat Photography of Historic Oblique Photographs

We made historic photograph comparisons in 3 geomorphic environments: (1) bedrock confined canyons, (2) wider canyons where channel banks are alluvium, and (3) unconfined alluvial reaches. We classified each site according to the current geomorphic environment and grouped the photos for comparison by location within BBNP.

We compared changes between the historic and repeated photographs by describing relative changes in channel width, accumulation or evacuation of sediment, and relative changes in vegetation cover and type. We mapped the location of the channel in Hot Springs Canyon (Fig. 2.2) as depicted in 2 photos taken in 1901. In a GIS, we calculated the average channel width within the field of view of these two historic photos, and compared channel conditions to those depicted on the 2004 digitally ortho-rectified quarter quadrangles (DOQQs). These channel width measurements within Hot Springs Canyon offer a limited spatial perspective but are essential documentation of channel conditions over 100 years ago. We used the same technique to evaluate channel narrowing in an alluvial reach immediately downstream from Hot Springs Canyon using a matched photo originally taken in 1945. The latter photo match helped us extend the record of channel change at least a decade prior to the oldest aerial photographs of the Boquillas reach.
5.3. **Analysis of Discharge Measurement Notes and Stage Plate Measurements**

We analyzed discharge measurement notes and stage measurements for the Johnson Ranch gage and the Castolon stage plate. Although discharge measurements have been collected at the Johnson Ranch gage since 1936, we were only able to obtain measurements from 1970 and between 1979 and 2006. Each discharge measurement includes water depth and mean velocity at a minimum of 20 points across the channel which are referenced to permanent markings on the cableway. Because stage at the time of measurement is recorded in relation to a fixed reference mark, channel cross-section elevation can be compared throughout the period of available data. At the Castolon stage plate, National Park Service (NPS) rangers collect stage measurements every morning. Stage at both locations are reported in relation to arbitrary datums.

We created stage discharge rating relations for Johnson Ranch, because they are not available from the IBWC. We identified the timing and magnitude of shifts in the relations. After identifying shifts in the relation at Johnson Ranch, we created rating relations at the Castolon stage plate based on discharge measured at Johnson Ranch, because the NPS collects too few discharge measurements at Castolon to develop local stage discharge relations. Although uncertainty exists concerning the stage observations, the assumed travel times of flow between the stage plate and Johnson Ranch, and limited number of discharges measured at the gage, these relations still proved valuable for identifying channel changes. We plotted measurements of channel area, channel width, and mean flow velocity against discharge to investigate how changes in the rating relation are accommodated by changes in cross section form. We investigated changes in
channel cross section shape at the Johnson Ranch gage by comparing measurements collected at flows which were approximately the magnitude of the 2-yr flood of 300 m³/s.

5.4. Stratigraphic and Dendrogeomorphic Analysis of Inset Floodplain Deposits

We excavated two trenches through the floodplain and mapped and interpreted the exposed alluvial stratigraphy. We excavated tamarisk and willow rootstock, determined the date and elevation of germination (Hereford, 1984), and analyzed changes in tree ring anatomy due to burial (Friedman et al., 2005) at the USGS labs in Ft. Collins, CO. We compared the location of the burial signals to the location of stratigraphic contacts in order to identify years in which individual stratigraphic units were deposited. We collected 8 tamarisk from the Boquillas trench site and 6 tamarisk and 1 sandbar willow from the Castolon trench site. In the Castolon trench, we found a beer can which helped constrain the dates of deposits that were older than the deposits dated by the trees.

5.5. Aerial Photograph Interpretation and Analysis

We stereoscopically analyzed aerial photographs of each study reach (Table 2.1). We electronically scanned one photo of each stereo pair and used a 3rd order polynomial correction model to georeference each of the scanned photographs to the 2004 DOQQs. The root mean square errors (RMSEs) were less than 1m for all 1980s, 1991, and 1996 photo corrections, less than 2m for the 1968 and late 1950s photo corrections, 3m for the 1941 photo corrections, and 4m for the 1948 photo corrections. The larger RMSEs for the older photographs reflect their smaller scale and poor quality.
We identified the boundaries of the active channel on each photo series. We distinguished between the active channel and floodplain by noting the differences in elevation of geomorphic surfaces above the river and the relative abundance of vegetation on near-channel deposits. We classified surfaces with abundant, mature vegetation as floodplains, and classified most of the bare surfaces as portions of the active channel. However, in many of the historic aerial photographs, delineating the active channel was difficult for two reasons: (1) dense stands of vegetation were not always present along the channel margins, and (2) there were a number of bare geomorphic surfaces at different elevations above the river. Thus, it appears that a wide range of flood discharges and frequencies removed vegetation and prevented vegetation establishment on many of the geomorphic surfaces, and there was no clear relationship between elevation and vegetation density discernable on the aerial photographs. To account for the uncertainty in delineating the active channel, we mapped our best estimate of the active channel boundary and made minimum and maximum estimates of the extent of the active channel. We considered the active channel boundary to define the extent of the area inundated by common floods. We divided the area of the active channel by the length of the channel centerline to estimate the reach average active channel width. The minimum estimated extent of the channel most likely includes surfaces inundated on an annual basis and the maximum estimated extent of the active channel most likely includes surfaces inundated by large, rare discharge events (Fig. 2.6).

To clarify the role that vegetation invasion had in causing recent change, we calculated the percentage of the active channel bars present in 1996 that had been colonized by vegetation in 2004. This was not possible for earlier photographs, because
elevated discharges obscured some of the active channel deposits. We estimated error for this metric in a similar manner to our active channel delineation by also estimating the minimum and maximum areas of the active channel bars.

5.6. Water Surface/Channel Bed Slope

We measured the longitudinal profile of the Castolon Reach in winter 2008 using a Real Time Kinematic Global Positioning System. We analyzed inflections in the water surface in relation to tributary confluences and other geographic features.

6. RESULTS

6.1. Hydrology

Peak and mean annual flows of the Rio Grande have steadily declined since 1900. Both the 2-yr flood and the mean annual flow for the period from 1931 – 1942 at the BRC and Johnson Ranch gages were higher than any other period (Table 2.2). The 3 largest floods recorded were 4,220, 2,090, and 2,500 m³/s and occurred in 1904, 1932, and 1933, respectively, at the BRC gage. These all occurred before gaging began at Johnson Ranch.

The long-term 2-yr flood at the BRC and Johnson Ranch gages are 294 m³/s and 305 m³/s, respectively. The mean annual flows at the BRC and Johnson Ranch gages for the period 1936-2006 are 32.2 m³/s and 34.6 m³/s, respectively. Mean annual flow for the entire period of record at the BRC gage is approximately 20% larger at 39.1 m³/s, because larger total stream flow occurred at the beginning of the 20th century (Table 2.2).

With the exception of the period between 1970 and 1991, the duration of floods has progressively declined during the 20th century. For the period between 1900 and
1914 at the BRC gage, the long-term duration of the 2-yr flow was 4.33%. Between 1992 and 2006, the duration of the same discharge was 0.12%. Similar changes occurred at Johnson Ranch (Fig. 2.7, Table 2.2).

Flow duration curves indicate that between 1992 and 2006 large floods did not occur, and common to intermediate floods occurred for shorter durations (Fig. 2.8). No flows exceeded 1000 m$^3$/s, and the duration of common and intermediate floods (200 - 1000 m$^3$/s) was reduced from approximately 5% to 1% compared to previous periods (Fig. 2.8).

Between 1992 and 1995, elevated baseflows greater than 10 m$^3$/s occurred during the winter months when flow is often much lower (Fig. 2.9). Many of the elevated baseflows have flat or ramped trajectories of rise and fall which indicate that they were caused by dam releases on the Rio Conchos.

6.2. Historic Oblique Photograph Comparison

Historic oblique photographs are the oldest data that depict early 20th century geomorphology of the lower Rio Grande. These photo comparisons provide some of the motivation for restoration efforts in the region, because the evidence for subsequent channel change is so obvious. Photograph comparisons showed substantial reductions in channel width, increases in riparian vegetation predominantly by tamarisk and giant cane, floodplain aggradation, accumulation of gravel within the channel, and in a few cases, aggradation of the channel bed (Table 2.3). Channel narrowing, increases in riparian vegetation, and vertical floodplain accretion most commonly occurred in alluvial reaches and alluvial canyon reaches (Figs. 2.10, 2.11, and 2.12). Gravel accumulation has
occurred in bedrock canyon and alluvial canyon reaches, especially downstream from large tributaries (Fig. 2.9). Fine sediment was deposited on top of gravel bars and has since been stabilized by dense stands of riparian vegetation. In some cases, narrowing has converted bedrock canyon reaches into alluvial canyon reaches, as observed in Hot Springs Canyon. Downstream from Hot Springs Canyon, in an alluvial reach, narrowing occurred through the development of inset floodplains within the historic alluvial channel margins (Fig. 2.11). These inset floodplains are overgrown by tamarisk and giant cane in contrast to the upland xeric species which are growing on the historic channel bank. In many of the alluvial reaches, changes to the river corridor have been so dramatic that the once wide sandy channel and low elevation floodplain visible in the historical photographs are now completely obscured by dense vegetation (Fig. 2.12). Channel width has been maintained in the bedrock canyon reaches such as within Santa Elena Canyon, yet substantial accumulation of gravel has occurred providing evidence for local bed aggradation (Fig. 2.13).

6.3. Changes in Channel Width Based on Historic Oblique Photograph Comparison

Channel width measurements from oblique photographs indicate that the 2004 active channel was approximately 50% narrower than in 1901. In 1901, the active channel width of the Rio Grande spanned the entire width of Hot Springs Canyon. The average channel width of the canyon was 82 m in one oblique photo and 103 m in the other. The active channel widths measured from the 2004 DOQQ were 39 m and 51 m for the same photos, respectively, which is equivalent to a 51% to 52% reduction in active channel width (Table 2.4). The active channel width calculated from the alluvial
reach at the outlet of Hot Springs Canyon in 1945 was 88 m compared to 51 m in 2004; a 42% reduction.

We observed that greater than 95% of the photos taken of alluvial and alluvial canyon reaches displayed channel narrowing (Table 2.3). Of 20 photographs of in-channel deposits, 60% had noticeable accumulations of gravel. We observed substantial increases in riparian vegetation in 81% of the photographs. We did not observe increases in vegetation in the upper portion of Santa Elena Canyon, presumably because regular high flows span the canyon width and prevent vegetation establishment.

6.4. Analyses of Discharge Measurement Notes

Historic oblique photo comparisons depict channel narrowing and vertical floodplain accretion at Johnson Ranch since 1945 (Fig. 2.14). Analysis of discharge measurements at the Johnson Ranch gage showed that progressive channel narrowing has been interrupted by two channel widening floods in excess of 1,000 m$^3$/s. The first occurred on October 1, 1978, at 1,850 m$^3$/s, and was the flood of record at Johnson Ranch. This flood widened the channel by 10 m, and increased channel cross-section area by approximately 50% (Fig. 2.15a and 2.15b). We illustrated these increases with at-a-station hydraulic geometry relations instead of cross-section data, because none of the acquired discharge measurements prior to this flood were collected at discharges greater than 150 m$^3$/s and do not depict the geometry of the banks. Thus, the implications to channel form at the bank edge are extrapolated. Cross section measurements showed that within 7 years after this flood, the channel narrowed by approximately 10 m or 15% (Fig. 2.16a).
On October 3, 1990, the second channel widening flood of 1,410 m$^3$/s occurred, and another high flow of 1,030 m$^3$/s occurred 11 months later on September 27, 1991. Bank erosion by these floods widened the channel by 8 m (Figs. 2.15c and 2.16a) and scoured the bed of the channel cross section by 3 m (Fig. 2.16b). Following these floods, the channel began to narrow, and by June 1992, the scoured cross section form had filled in (Fig. 2.16b). By 2002, the channel narrowed by approximately 20% through the development of an inset floodplain (Fig. 2.16b), and by 2005, approximately 1 m of additional vertical floodplain accretion had occurred (Fig. 2.16b). Between 1991 and 2006, channel cross-section area declined by approximately 30%.

Each channel widening event resulted in subsequent increases of river stage. This is anti-intuitive because we would expect that erosion and increases in the width to depth ratio would result in decreases in river stage. We acknowledge that we don’t completely understand this phenomenon but believe these increases in stage are related to local aggradation downstream of the gage sites. Stage discharge relations showed a small, temporary increase in stage after the 1978 flood (Figs. 2.17a and 2.17c). By 1981, this shift in stage recovered to its previous position prior to flood. After the October 1990 flood, a much larger, permanent increase in stage occurred (Figs. 2.15a and 2.15d). The magnitude of this shift was approximately 0.5 m and occurred for discharges less than approximately 300 m$^3$/s. This shift occurred at both the Johnson Ranch gage and the Castolon stage plate. At the Johnson Ranch gage, cross section data do not show any discernable pattern of aggradation at the gaging cross section. However, aerial photographs show that after the October, 1990 flood, sediment was deposited downstream of the gage which has since developed into a vegetated island. Thus, at the
gage, this shift appeared to be attributable to a downstream change in control. The cause of the shift at the Castolon stage plate is less clear and because no topographic data exist there, we lack to data to determine its true cause.

A third increase in stage occurred at the Johnson Ranch gage after 2001. This shift only affected stages at discharges greater than approximately 100 m$^3$/s (Fig. 2.17c) and appears to be related to the loss of channel cross-section area that occurred as the channel narrowed and the floodplain vertically accreted.

Loss of channel capacity resulted in a reduced threshold discharge for floodplain inundation. Hydraulic geometry relationships show that the threshold discharge decreased from approximately 400 m$^3$/s in the 1990s to approximately 200 m$^3$/s in the 2000s (Fig. 2.15e). Additionally, the channel became more rectangular, shown by small increases in width for discharges below the threshold of 200 m$^3$/s (Table 2.5, Fig. 2.15e).

6.4. Dendrogeomorphic Analyses of Inset Floodplain Deposits

Dendro-geomorphologic analyses illustrate that channel narrowing occurred by the formation of vertically accreting inset floodplains over relatively short time periods (Fig. 2.18). Vertical accretion occurred by the deposition of fine grained sediment on top of bars of sand and gravel. Vertically accreted deposits are inset within natural, sandy levees that were the channel banks after the recession of the 1990 and 1991 floods. Tamarisk germinated on fine grained deposits overlying the coarse-grained gravel bars that were exposed at the base of the trenches. We measured 3.5 and 2.75 m of vertical accretion since 1991. The rate of vertical accretion was 0.2 and 0.16 m/yr at the Castolon and Boquillas trench sites, respectively. Since 1991, the channel at the Castolon and
Boquillas trench sites has narrowed by 55 and 33%, respectively, 83% and 90% of which occurred on the U.S. side of the river and was observed in the trenches. Currently, thick groves of tamarisk exist within the floodplain trough. Giant cane has colonized both the sandy levee as well as the current channel bank. We observed an abundance of buried cane within the current channel bank of the Castolon trench reflecting rapid accretion of the floodplain such that nearly 2 m of buried cane had not yet decomposed. Stratigraphic and dendrogeomorphic analyses show that changes observed in the channel geometry, stage-discharge relations, and hydraulic geometry are reflected in the floodplain stratigraphy.

6.6. Aerial Photograph Analysis

The above analyses depicted channel narrowing, vertical floodplain accretion, and vegetation invasion at discrete locations of the lower Rio Grande. Aerial photograph analyses show that the processes described above have been widespread.

The lower Rio Grande has narrowed between 34 and 57% since the first aerial photographs were collected. In the 1940s and 1950s, the best estimates of active channel width ranged between 72 m and 102 m. In 2004, the best estimates of active channel width ranged between 43 and 48 m (Fig. 2.19, Table 2.6).

Since the most recent channel widening flows in 1990 and 1991, the channel has narrowed between 36 and 52%. Narrowing occurred at a rate of 3.53, 3.07, and 1.85 m/yr in the Castolon, Johnson Ranch, and Boquillas reaches, respectively. Since 1991, the reductions in active channel width have been greater than the reductions observed over the 50 years prior.
Vegetation invasion in the 1990s coincided with the rapid rates of recent narrowing. Aerial photographs of 1991, 1996, 1998, and 2004 show that substantial accumulation of sediment within the channel occurred through the growth of channel margin and mid-channel bars (Fig. 2.20). DOQQs show vegetation growth on these surfaces by 1998. In the Castolon, Johnson Ranch, and Boquillas reaches, vegetation colonized 77, 89, and 39% of the active channel surfaces observed in 1996, respectively, which effectively converted them to floodplains (Fig. 2.20, Table 2.7).

Many of the above measures include large uncertainty which appears to be related to the time since the last large flood (Table 2.6). In the 1940s, 1980s, and 1990s, vegetation was limited, the size and elevation of geomorphic surfaces was diverse, and error was large. All of these photos were taken less than 5 years after a flood greater than 1,000 m$^3$/s. However, in 1968 and 2004, nearly a decade had passed since the last large flood. In these photos, vegetation was plentiful, active channel delineation was simple, and error was small.

6.7. Longitudinal Profile

Since 1991, coarse-grained deposits have formed at the mouths and downstream from ephemeral tributaries. At each tributary mouth within the Castolon Reach, as well as at a gravel bar near station 3000 m, a step in the profile exists (Fig. 2.21). Aerial photographs show that gravel and cobble bars at tributary mouths, and the large gravel bar at station 3000 m were either much smaller or did not exist in the past. These deposits are acting as hydraulic controls of the river profile at these locations creating long pools upstream, and steep riffles downstream.
7. SYNTHESIS OF HISTORICAL CHANNEL CHANGES

Over the last century, hydrologic and geomorphic change of the lower Rio Grande can be divided into two periods: (1) maintenance of a wide, sandy active channel bed by large floods prior to 1942, and (2) progressive channel narrowing during drought punctuated by infrequent channel resetting floods that widened the channel. These channel resetting floods are similar to Nanson’s “catastrophic floodplain stripping” (Nanson, 1986), because they temporarily interrupted and reversed the progressive channel narrowing during the latter half of the 20th century. The timeline and trajectories of observed changes are described below.

7.1. 1900-1942: Channel Maintenance

Floods and large total stream flow (Fig. 2.7) characterized the beginning of the 20th century. Historic oblique photographs (Figs. 2.10 and 2.12) depict a wide, sandy channel with low elevation floodplains and sparse annual vegetation. The four largest floods of the 20th century, in 1904, 1932, 1933, and 1938, occurred during this period. Comparison of the earliest oblique photographs and the first aerial photographs indicate that progressive channel narrowing did not occur between 1900 and 1942.

During this period, large dams were built on the Rio Conchos and the upper Rio Grande. Dam construction and irrigation diversions on the upper Rio Grande resulted in the complete loss of floods from Rocky Mountain snowmelt. Dam construction on the Rio Conchos appears to have had little effect on flows within the Big Bend region.
7.2. Post-1942: Narrowing and Resetting

The onset of regional drought from the 1940s through the 1960s resulted in decreased mean annual flows, decreased flood peaks, and channel narrowing (Table 2.2, Figs. 2.6 and 2.19). Additional dams were constructed on the Rio Conchos during this time. Vegetation establishment coincided with channel narrowing between the early 1940s and 1968. One large, long duration flood of 1,520 m$^3$/s occurred on September 27, 1958, yet there are insufficient data to determine if this flood significantly widened the channel.

Stream flow increased in the 1970s (Fig. 2.7). Hydraulic geometry relationships show that the flood of record at Johnson Ranch on October 1, 1978 widened the channel by approximately 10 m, and increased cross section channel area by approximately 50% (Fig. 2.15b). In the 1980s, mean annual flow was relatively high, and floods in excess of the long-term 2-yr flow occurred every other year, however, channel width narrowed to dimensions predating the 1979 flood.

In 1991, aerial photographs and hydraulic geometry relationships showed that the floods of 1990 and 1991 widened the channel by nearly 25% (Table 2.6, Figs. 2.15c and 2.19). With the onset of drought in 1992 (Table 2.2, Fig. 2.7), channel narrowing resumed. Sediment accumulated within the widened channel by vertical accretion of fine sediment on top of previously active channel bars. Vegetation establishment on vertically accreting surfaces resulted in the conversion of these bars to floodplains (Figs. 2.18 and 2.20).
Additionally, the growth of coarse grained deposits at tributary mouths and on gravel bars occurred which appears to be altering the river profile. These deposits have created long pools upstream, and steep riffles downstream.

The changes observed within the Big Bend region reflect the changes Everitt (1993) identified on the upper Rio Grande. First, reductions in discharge led to channel narrowing as described by Everitt’s “Stage I: Shrinking.” Second, the resultant loss of channel capacity and continued floodplain accretion was similar to Everitt’s “Stage II,” which was typified by valley wide aggradation. And finally, the alteration of the river profile by the accumulation of coarse lag deposits at tributary mouths and on gravel bars reflect Everitt’s “Stage III,” regrading. Thus, even though the upper and lower Rio Grande have distinctively different hydrologic regimes and histories of alteration, the net result of mean and peak flow reductions without similar reductions in sediment supply have created analogous changes of narrowing, floodplain accretion, and adjustment of the river profile.

8. GEOMORPHIC EFFECTS OF FLOODING

We classify the floods of the lower Rio Grande into two types based on their different geomorphic implications. Small to moderate magnitude floods (~200 – 1,000 m³/s) typically occur for short durations (< 1 x 10⁵ m³/s-days) and have contributed to channel narrowing and vertical floodplain accretion. Floods greater than 1000 m³/s, such as those that occurred in 1978, 1990, and 1991, caused channel bank erosion and reset. Prior to 1942, these large magnitude floods were common. Of the 26 years of hydrologic data available between 1901 and 1942, floods in excess of 1,000 m³/s occurred 7 times.
Many of these floods occurred for durations that exceeded $2 \times 10^5$ m$^3$/s\-days. However, since 1942, only four floods in excess of 1,000 m$^3$/s have occurred (Fig. 2.22). Thus, the reduced frequency of these floods have resulted in a shift from floods that maintained a wide channel prior to 1942 to progressive channel narrowing and episodic reset events since 1942. The decline of large, long duration, erosive floods and an increase in the proportion of small, short, tributary floods have resulted in the narrow, rectangular shaped channel that we see today.

An additional consequence of channel narrowing appears to be the loss of reach-scale heterogeneity. Aerial photographs show that as the channel narrowed, the active channel width of all three study reaches converged to a common width between 43 and 48 m (Figure 2.19). This contrasts with observations taken from the 1940s and 1950s. During these periods, the difference between our maximum and minimum active channel delineations within a reach often exceeded 10 m, and the difference of active channel width among each reach was at times greater than 20 m. The loss of reach-scale heterogeneity that appears to be coupled to processes of channel narrowing may have important implications for habitat availability for the aquatic ecosystem.

To summarize the above discussion of flooding and related cross section morphology, we present a general model that illustrates the trends of channel narrowing caused by small and moderate magnitude floods, and channel reset events caused by large floods (Fig. 2.23). A wide channel was created and maintained by frequent floods greater than 1000 m$^3$/s in the early 20$^{th}$ century (Fig. 2.23a). Progressive channel narrowing began in the 1940s with the onset of drought and the construction and management of additional infrastructure in the Rio Conchos watershed. Progressive narrowing between
the early 1940s and the late 1970s, and again between 1979 and 1991, was characterized by small and moderate magnitude flood peaks between approximately 200 and 1000 m³/s (Fig. 2.23b). Since 1942, two channel resetting floods in excess of 1000 m³/s temporarily widened the channel in 1979 and 1991 (Fig. 2.23c). Narrowing resumed after 1991, and occurred through the development of vertically accreting inset floodplains on top of active channel bars. This period of narrowing was again characterized by a lack of floods exceeding 1000 m³/s. Non-native vegetation established on fine grained deposits overlying coarse gravel bars and appears to have exacerbated channel narrowing by stabilizing these surfaces, and potentially reducing channel margin flow velocities, and trapping sediment (Fig. 2.23d).

9. FORCING MECHANISMS OF CHANGE

Three external, large scale processes are responsible for changes described above. The construction of infrastructure, i.e., dams and diversions, created large sediment sinks (Grams and Schmidt, 2005; Schmidt and Wilcock, 2008), attenuated runoff from upstream portions of the basin, and provided the potential for other alterations including the retention and diversion of large quantities of stream flow. Second, management of infrastructure affected the actual changes in stream flow, because the timing, magnitude, and duration of stream flow are determined by dam releases and diversion schedules. Third, natural processes such as climate affected the total amount of runoff available to be managed and the frequency of extreme precipitation events (i.e. hurricanes) in the Rio Conchos watershed (Douglas et al., 1993; Kim et al., 2002), and semi-natural processes such as non-native vegetation invasions affected channel margin and floodplain
hydraulics (Kouwen et al., 1969; Carollo et al., 2002; Griffin et al., 2005), bank strength and erosion thresholds (Thorne, 1990; Simon and Collison, 2002; Tal et al., 2003; Wynn and Mostaghimi, 2006), and sedimentation rates (Schultz et al., 2002). Although all of the above processes affected geomorphic change, each affected the rate and magnitude of change differently.

Through flood attenuation and sediment trapping, the construction of infrastructure causes inevitable changes to the mass balance of water and sediment, however, based on the location of infrastructure within the basin, and actual changes to stream flow downstream, the magnitude of perturbations due to infrastructure may vary. At the beginning of the 20th century, the largest increases in reservoir storage had no apparent effect on stream flow and channel morphology on the lower Rio Grande (Fig. 2.4). Both La Boquilla Dam and Elephant Butte Dam exist hundreds of kilometers upstream from the Big Bend region. Thus, even though Rocky Mountain snowmelt was retained and diverted, precipitation from monsoon rains and tropical storms still produced large floods downstream from these dams. Nearly thirty years after the construction of La Boquilla and Elephant Butte Dams, the river was as wide as observations made at the turn of the 20th century.

The construction of dams and diversions causes sediment trapping and some changes to the flow regime, but the greatest changes to flows are due to drought and the resultant management decisions to exploit the potential for water storage, flood control, and diversions to cities and farm fields. The first measurable changes in channel width occurred during the drought of the 1940s and 1950s. Although management decisions to retain flow behind dams and divert water for irrigation most likely exacerbated the effects
of this drought, no data are available to decouple the direct effects of management decisions during this period. However, the drought of the 1990s was more severe (Kim et al., 2002) and the effect of management was greater. No large floods were allowed to pass and stream flow was reduced which resulted in sediment accumulation within the channel and channel narrowing. Additionally, managed elevated baseflows (Fig. 2.9), which were a means to deliver water to users downstream, provided water subsidies for establishing vegetation, and the lack of large dam releases failed to scour seedlings from nascent channel margin surfaces. The resulting accelerated invasion of non-native vegetation (Fig. 2.20) in the 1990s and 2000s caused a positive feedback by trapping sediment on the floodplains and along the channel margins and exacerbating channel narrowing. Channel narrowing and loss of channel capacity induced upward shifts in the stage discharge relation which caused flooding at lower discharges and additional vertical accretion.

Non-native vegetation may also limit the erosion potential of future floods. Dense stands of cane and tamarisk have created high flow resistance at the channel margins, and their root mass has increased the strength of the banks. Thus, even if large floods occurred, historical dimensions of channel width may never be achieved without the management of non-native vegetation.

Our analyses show that large uncontrolled floods that occurred from emergency dam releases during tropical storms were effective at temporarily widening the channel (Figs. 2.15, 2.16, and 2.19). However, the fact that channel reset floods only occurred during emergency measures indicates that channel width will not be restored or maintained without either a change in management policy to release large floods or an
increased frequency of large tropical storms in the Rio Conchos watershed. A change in management policy is politically, economically, and socially unfavorable, because hydropower and agricultural revenue would be lost. Additionally, an increase in emergency dam releases due to tropical storms would endanger water development infrastructure and communities established on the floodplain. Thus, without the reorganization of communities living along the Rio Conchos, the willingness of irrigators to allow large quantities of water to pass, and the voluntary loss of hydropower revenue, the managed re-institution of frequent large floods to the hydrograph may be impossible. Additionally, uncontrolled releases of climatically driven floods would seriously impact the safety and economic resources of the region.

In light of the discussion above, we created a general model of historic geomorphic changes that synthesis all analyzed data and the forcing mechanism involved (Fig. 2.24). This model synthesizes data including changes in cumulative reservoir storage (Fig. 2.24a), mean annual flow (Fig. 2.24b), channel width (Fig. 2.24c), relative vegetation abundance (Fig. 2.24d), and the relative influences of forcing mechanisms. This model illustrates three main points: (1) the onset of progressive channel narrowing occurred through mean and peak flow reductions during the 1940s and 1950s drought, (2) narrowing has been temporarily interrupted by infrequent large floods on the Rio Conchos, and (3) the most significant geomorphic changes have occurred in the recent decades during extended drought, extensive water management, and non-native vegetation invasion.
10. CONCLUSIONS

Reductions in stream flow to the lower Rio Grande in the Big Bend region due to the construction and management of water infrastructure and episodes of drought have resulted in channel narrowing, vertical floodplain accretion, and vegetation establishment. The channel of the lower Rio Grande has narrowed by more than 50% since 1941. Progressive narrowing was temporarily interrupted by 2 floods in excess of 1000 m$^3$/s that widened the channel. These floods occurred in 1979 and 1991. The 1979 flood widened the channel by approximately 20%, and the 1991 flood widened the channel by over 30%. Another large flood also occurred in 1959, but we were unable to determine the geomorphic effect of that flood.

Following the flood of 1991, the channel has narrowed between 35 and 50%, when no flows exceeded 1000 m$^3$/s. In two floodplain trenches, evidence shows that 2.75 and 3.5 m of vertical accretion occurred between 1991 and 2008. Floodplains accreted at a rate of 0.16 and 0.20 m/yr. In some localities, nearly 90% of bare, active channel bars were converted to vegetated floodplains during the same period. Additionally, channel width of all three study reaches has converged to within 5 m which reveals that as channel width is reduced, heterogeneity among reaches is also reduced.

Since 1991, 2 upward shifts in the stage discharge relation occurred as the channel lost capacity, floodplains vertically accreted, and non-native vegetation established. These upward shifts resulted in over-bank flooding at lower discharges and further vertical accretion. Thus, although the 2-yr flood magnitude between 1992 and 2006 was reduced by 30 to 50% compared to the previous period, over-bank flooding and vertical accretion occurred at high rates. Additionally, during the most recent drought, coarse
grained deposits grew at tributary mouths creating a stepped pattern in the longitudinal profile.

Overall, the changes observed on the lower Rio Grande reflect a shift in the geomorphic nature of the Rio Grande from a wide, geomorphically complex river created and maintained by frequent large floods to a simple rectangular channel with steep definable banks and few bare active geomorphic surfaces. These geomorphic changes have significantly affected the native and endemic ecosystem within the region.

In order to restore channel width, management options must include large, extended dam releases that cause erosion, smaller dam release that provide flood disturbance to establishing vegetation, and active vegetation removal. Currently, managed dam releases are politically and economically unfeasible, thus, vegetation management within parks and protected areas may be the only option for attempting to limit future reductions in channel width.

11. REFERENCES CITED


LeSeur, H., 1945. The ecology of the vegetation of Chihuahua, Mexico, north of parallel twenty-eight. Publication No. 4521, University of Texas, Austin, TX, USA.


Schmidt, J.C., Wilcock, P.R., 2008. Metrics for assessing the downstream effects of dams. Water Resources Research, 44(4), W04404


Table 2.1: Flight dates for aerial photographs

<table>
<thead>
<tr>
<th>Flight Date</th>
<th>Discharge (m³/s)</th>
<th>Scale</th>
<th>Flight Date</th>
<th>Discharge (m³/s)</th>
<th>Scale</th>
<th>Flight Date</th>
<th>Discharge (m³/s)</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/12/1941</td>
<td>44.2</td>
<td>1:24,000</td>
<td>7/17/1941</td>
<td>39.4</td>
<td>1:24,000</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10/26/1948</td>
<td>34</td>
<td>1:48,000</td>
<td>10/26/1948</td>
<td>34</td>
<td>1:48,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/17/1968</td>
<td>47.3</td>
<td>1:36,000</td>
<td>10/17/1968</td>
<td>47.3</td>
<td>1:36,000</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>5/5/1986</td>
<td>16</td>
<td>1:24,000</td>
<td>11/4/1984</td>
<td>16.9</td>
<td>1:24,000</td>
<td>10/18/84</td>
<td>39.4</td>
<td>1:24,000</td>
</tr>
</tbody>
</table>

* = 1m resolution

Late 1950s Unknown 1:56,000
Table 2.2: Hydrologic characteristics at the Rio Grande below Rio Conchos gage and at the Rio Grande at Johnson Ranch gage

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2yr&lt;sup&gt;b&lt;/sup&gt;</td>
<td>MAF&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2yr&lt;sup&gt;b&lt;/sup&gt;</td>
<td>MAF&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2yr&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Below Rio Conchos</td>
<td>4220 - 9/4/04</td>
<td>422.00</td>
<td>70.31</td>
<td>518.85</td>
<td>54.52</td>
<td>232.00</td>
</tr>
<tr>
<td>Johnson Ranch</td>
<td>1850 - 10/1/78</td>
<td>657.00</td>
<td>70.93</td>
<td>283.00</td>
<td>29.07</td>
<td>346.83</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gage</th>
<th>Long term 2yr flood&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Long Term MAF&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Dur LT 2yr&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Dur LT MAF&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Dur LT 2yr&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Dur LT MAF&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Dur LT 2yr&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Dur LT MAF&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Dur LT 2yr&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Dur LT MAF&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Dur LT 2yr&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Dur LT MAF&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below Rio Conchos</td>
<td>293.7</td>
<td>39.1</td>
<td>4.33</td>
<td>43.88</td>
<td>3.38</td>
<td>27.94</td>
<td>0.71</td>
<td>14.56</td>
<td>1.14</td>
<td>27.38</td>
<td>0.12</td>
<td>6.81</td>
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<td>Johnson Ranch</td>
<td>304.6</td>
<td>34.6</td>
<td>5.53</td>
<td>40.90</td>
<td>0.84</td>
<td>19.46</td>
<td>1.39</td>
<td>31.60</td>
<td>0.41</td>
<td>10.41</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> = measurement in cubic meters per second  
<sup>b</sup> = 2-year recurrence interval flood for indicated period  
<sup>c</sup> = Mean annual flow for indicated period  
<sup>d</sup> = Duration (% of time) the long term 2 year recurrence interval flood was equaled or exceeded for indicated period  
<sup>e</sup> = Duration (% of time) the long term mean annual flow was equaled or exceeded for indicated period
Table 2.3: Summary of oblique historical photograph data

<table>
<thead>
<tr>
<th>Photo Location</th>
<th>Number of photos replicated</th>
<th>Geomorphic Classification</th>
<th>Channel Narrowing by floodplain accretion</th>
<th>Significant accumulations of Gravel</th>
<th>Significant Increase in Vegetative Cover</th>
<th>Vegetation Type (T, C, M)</th>
<th>Photos showing Bed Aggradation Degradation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santa Elena</td>
<td>8</td>
<td>4 bedrock</td>
<td>3/3</td>
<td>4/8</td>
<td>4/8</td>
<td>3T</td>
<td>4 Agg</td>
</tr>
<tr>
<td>Canyon Terlingua Creek</td>
<td></td>
<td>4 alluvial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Old River Road</td>
<td>3</td>
<td>3 alluvial</td>
<td>3/3</td>
<td>ND</td>
<td>3/3</td>
<td>3T/C/M</td>
<td>ND</td>
</tr>
<tr>
<td>River Road</td>
<td>4</td>
<td>4 alluvial</td>
<td>4/4</td>
<td>ND</td>
<td>4/4</td>
<td>4T/C/M</td>
<td>ND</td>
</tr>
<tr>
<td>Johnson Ranch</td>
<td>1</td>
<td>1 alluvial</td>
<td>1/1</td>
<td>0/1</td>
<td>1/1</td>
<td>1T/C</td>
<td>ND</td>
</tr>
<tr>
<td>Hot Springs Canyon</td>
<td>9</td>
<td>2 alluvial</td>
<td>8/8</td>
<td>8/9</td>
<td>8/9</td>
<td>7T/C, 1T/C/M</td>
<td>ND</td>
</tr>
<tr>
<td>Mouth of Boquillas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canyon</td>
<td>2</td>
<td>2 alluvial</td>
<td>2/2</td>
<td>0/2</td>
<td>2/2</td>
<td>Native Treatment Bar</td>
<td>ND</td>
</tr>
</tbody>
</table>

1 The number of photographs that show indicated change the number of photographs that have the indicated feature as a subject (Grans and Schmidt, 2002)

2T = Tamarisk, C = Giant Cane, M = Mesquite

3ND = Not Determined

4Native Treatment Bar indicates that the increased vegetation is predominantly native due to NPS restoration treatments at that location
Table 2.4: Changes in channel width based on historic oblique photograph comparison

<table>
<thead>
<tr>
<th>Photo Location</th>
<th>2004 Width</th>
<th>1901 Width</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Springs Canyon 1</td>
<td>50.7</td>
<td>103.9</td>
<td>51.2</td>
</tr>
<tr>
<td>Hot Springs Canyon 2</td>
<td>39.4</td>
<td>81.8</td>
<td>51.8</td>
</tr>
<tr>
<td>Mouth of Hot Springs Canyon</td>
<td>51.0</td>
<td>88.3</td>
<td>42.2</td>
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</table>
Table 2.5. Hydraulic geometry of the Rio Grande at the Johnson Ranch gage

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Area Equation</th>
<th>R²</th>
<th>Velocity Equation</th>
<th>R²</th>
<th>Time Period</th>
<th>Width Equation</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>7.19Q^0.563</td>
<td>0.9216</td>
<td>0.14Q^0.456</td>
<td>0.89</td>
<td>1970</td>
<td>36.55Q^0.040</td>
<td>0.79</td>
</tr>
<tr>
<td>1979-1980</td>
<td>17.61Q^0.451</td>
<td>0.7396</td>
<td>0.13Q^0.441</td>
<td>0.86</td>
<td>1979-1990</td>
<td>39.35Q^0.050</td>
<td>0.35</td>
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<tr>
<td>1981-1990</td>
<td>8.29Q^0.355</td>
<td>0.9025</td>
<td>0.06Q^0.352</td>
<td>0.9</td>
<td>1991-1999 low flows^a</td>
<td>38.94Q^0.066</td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1991-1999 high flows^a</td>
<td>4.61Q^0.405</td>
<td>0.6</td>
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<tr>
<td>1991-1999</td>
<td>16.96Q^0.451</td>
<td>0.9025</td>
<td>0.11Q^0.464</td>
<td>0.85</td>
<td>2000-2006 low flows^b</td>
<td>32.79Q^0.051</td>
<td>0.37</td>
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<tr>
<td>2000-2006</td>
<td>9.041Q^0.555</td>
<td>0.9025</td>
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<td></td>
<td>2000-2006 high flows^b</td>
<td>1.08Q^0.715</td>
<td>0.84</td>
</tr>
</tbody>
</table>

^a Flows segregated by discharges higher and lower than 300 m³/s based on visual patterns in the data
^b Flows segregated by discharge higher and lower than 150 m³/s based on visual patterns in the data
Table 2.6: Active channel width of Rio Grande for Castolon, Johnson Ranch, and Boquillas reaches

<table>
<thead>
<tr>
<th>Reach</th>
<th>Flight Date</th>
<th>Active Channel Width (m) &quot;Best Estimate&quot;</th>
<th>Active Channel Width (m) Minimum</th>
<th>Active Channel Width (m) Maximum</th>
<th>Minimum Error (m)</th>
<th>Maximum Error (m)</th>
<th>% Change from Previous Photo Based on Best Estimate</th>
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</thead>
<tbody>
<tr>
<td>Castolon</td>
<td>1941</td>
<td>102</td>
<td>101</td>
<td>122</td>
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<td>20</td>
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<tr>
<td></td>
<td>1948</td>
<td>99</td>
<td>95</td>
<td>118</td>
<td>4</td>
<td>20</td>
<td>-3</td>
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<tr>
<td></td>
<td>1968</td>
<td>74</td>
<td>72</td>
<td>75</td>
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<tr>
<td></td>
<td>1986</td>
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<td>65</td>
<td>79</td>
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<td>1991</td>
<td>90</td>
<td>86</td>
<td>101</td>
<td>4</td>
<td>11</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>1996</td>
<td>68</td>
<td>66</td>
<td>95</td>
<td>2</td>
<td>27</td>
<td>-24</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>44</td>
<td>43</td>
<td>44</td>
<td>1</td>
<td>1</td>
<td>-36</td>
</tr>
<tr>
<td>Johnson Ranch</td>
<td>1941</td>
<td>88</td>
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<td>99</td>
<td>0</td>
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<tr>
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<td>2004</td>
<td>43</td>
<td>43</td>
<td>44</td>
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<td>-43</td>
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<tr>
<td>Boquillas</td>
<td>1959</td>
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<td>65</td>
<td>78</td>
<td>7</td>
<td>5</td>
<td>-43</td>
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<td>1984</td>
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Table 2.7: Percent conversion of active channel surfaces

<table>
<thead>
<tr>
<th>Reach</th>
<th>&quot;Best Estimate&quot; % Conversion</th>
<th>Minimum % Conversion</th>
<th>Maximum % Conversion</th>
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</thead>
<tbody>
<tr>
<td>Castolon</td>
<td>76.5</td>
<td>74.1</td>
<td>83.1</td>
</tr>
<tr>
<td>Johnson Ranch</td>
<td>89.4</td>
<td>87.6</td>
<td>89.5</td>
</tr>
<tr>
<td>Boquillas</td>
<td>39.1</td>
<td>34.2</td>
<td>68.4</td>
</tr>
</tbody>
</table>
Fig. 2.1: (a) Map of the Big Bend region. (b) Study area
Fig. 2.2: (a) Reach location map, (b) Castolon reach, (c) Johnson Ranch reach, (d) Boquillas reach
Fig. 2.3: Median annual hydrographs prior to 1915 at IBWC gages Rio Grande above Rio Conchos and Rio Grande below Rio Conchos near Presidio, TX and Ojinaga, Chih. See Fig. 2.2b for location of gages.
Fig. 2.4: Cumulative reservoir storage of upper Rio Grande and Rio Conchos
Fig. 2.5: Mean annual flow of segments of the Rio Grande (a) prior to 1915, (b) between 1930 and 1940, and (c) between 1995 and 2005. The thickness of the lines are proportional to the mean annual flow.
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Fig. 2.18: Stratigraphy and burial dates observed in the Castolon trench. (a) Surveyed cross section at the Castolon trench site upstream of Cottonwood Campground. Mapped stratigraphy of the Castolon trench is displayed on the left of the cross section. The approximate elevation of the 2-yr flood stage is also displayed. (b) Mapped stratigraphy of the Castolon trench. Stratigraphic contacts defined by unconformities and disconformities. (c) Castolon trench displaying locations of the dated tamarisk and willow trees (tamarisk (T), willow (W)). Approximate germination horizons are indicated in a dark black horizontal line. Dates indicate periods of sediment accretion as observed from the wood anatomy in trees. Approximate date of beer can constrains deposition for sediments deposited before 1991. Stages of the baseflow (~10 m³/s) and the approximate 2-year flood stage (305 m³/s) are also shown.
Fig. 2.19: Best estimate of the active channel width for the Castolon, Johnson Ranch, and Boquillas reaches. Note the general trend of narrowing prior to the channel resetting floods of 1990 and the rapid narrowing that occurred there after. Also, note that since 1941, the active channel width for each of the reaches has converged to within 5 m.
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Fig. 2.22: Peak discharge and duration in cms days greater than 300 m³/s. Floodplain construction flows and channel resetting flows determined from discharge measurement notes, dendrogeomorphic and stratigraphic analyses of inset floodplain deposits, and aerial photographs. Floods greater than 1000 m³/s observed at the BRC gage before operation of the JR gage also plotted. Region of inferred channel maintenance flows prior to 1942 determined from distribution of large floods. Note the frequency of floods in excess of 1000 m³/s prior to 1942, and the lack of these flood magnitudes after 1942.
Figure 2.23: General model of historic channel changes. (a) Cross section representing channel observed in historic oblique photos between 1900 and 1941. (b) Channel narrowing as observed between the 1940s and the late 1970s. (c) Channel resetting flows as observed in 1979 and 1991. (d) Repeated channel narrowing after 1991. Narrowing occurs through the development of vertically accreting inset floodplains on top of active channel bars as inferred from floodplain trenches.
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CHAPTER 3

STRATIGRAPHIC AND SEDIMENTOLOGICAL ANALYSIS OF FLOODPLAIN
FORMATION IN BIG BEND NATIONAL PARK, TX\(^1\)

ABSTRACT

On arid and semi-arid rivers with high suspended sediment loads, rivers generally narrow through the development of vertically accreting inset floodplains. The channel of the lower Rio Grande has narrowed between 35 and 50\% through the formation of vertically accreting inset floodplains between 1991 and 2008. We observed between 2.75 and 3.5 m of vertical accretion that occurred over a 17 year period in two long floodplain trenches. Within these trenches, we identified three sedimentological components of floodplain formation consisting of the active channel component, the floodplain conversion component, and the floodplain component. The active channel component consists of vertically and obliquely accreted fine grained bars on top of coarse lag deposits of sand and gravel. The floodplain conversion component consists of obliquely accreted beds displaying inclined heterolithic cross-stratification at the channel margins, and vertical accretion of fining upward couplets of sand and mud in the floodplain trough. The floodplain component is dominated by vertical accretion represented by natural levees at the channel margins and horizontally stacked muddy beds in the floodplain trough. Overall, floodplain formation evolved from mixed bedload and suspended load deposition during the initial stages to pure suspended sediment deposition in the latter stages. Grain-size analyses show that sediment fined upward through the floodplain and onshore from the channel margin.

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1. INTRODUCTION

On many rivers in arid and semi-arid regions, hydrologic reductions due to dams and irrigation diversions have resulted in channel narrowing through the development of vertically accreting inset floodplains (Graf, 1978; Friedman et al., 1998; Allred and Schmidt, 1999; Grams and Schmidt, 2002). Vertical accretion differs from lateral accretion (Leopold and Wolman, 1957) because it is a floodplain building mechanism characterized by disequilibrium (Mackin, 1948; Nanson and Young, 1981; Nanson, 1986; Pizzuto, 1994). This disequilibrium manifests itself in the vertical growth of the floodplain such that the threshold discharge for floodplain inundation continuously changes with each depositional flood event. As a result, floodplain inundation may either decrease as the channel banks grow progressively higher above the channel bed, or increase as the channel loses capacity resulting in increased flood stages for the same discharge over time.

Although many studies have addressed the magnitude and rates of vertical accretion on narrowing streams (Allred and Schmidt, 1999; Grams and Schmidt, 2002) and a few studies have described the stratigraphic relationships of these floodplains (Moody et al., 1999), few studies have shown how narrowing and vertical aggradation occur (Allmendinger, 2008; Pizzuto et al., 2008). We analyzed floodplain stratigraphy and sedimentology to describe the mechanisms of channel narrowing and floodplain formation in Big Bend National Park (BBNP), TX. We show that channel narrowing occurred by the formation of vertically accreting inset floodplains on top of previously active portions of the channel. Specifically, we describe three sedimentological components of floodplain formation that reflect similar sedimentological characteristics to those observed for scroll-bar formation (Nanson, 1980).
2. STUDY AREA

We analyzed recent floodplain formation in 2 trenches along the Rio Grande in BBNP (Fig 3.1). This study specifically addresses the mechanisms of recent channel changes and floodplain formation described in Chap. 2. BBNP lies within the greater Big Bend region, which extends from the confluence of the Rio Grande and Rio Conchos 490 km downstream to Amistad Reservoir.

Today, the Rio Grande in the Big Bend region is single-threaded, and flows through wide alluvial valleys in structural basins and narrow canyons that cross intervening ranges. Channel slope ranges from approximately 0.0013 in the alluvial valleys and 0.002 in the canyons. The bed of the Rio Grande is predominately sand, although alternate bars of gravel and cobbles exist at the mouths and downstream from ephemeral tributaries. In the alluvial valleys, numerous terraces bound the modern floodplain providing evidence of the long term cycles of incision and aggradation that occurred since the late Pliocene/early Pleistocene (Berry, 2008). Modern floodplain topography consists of ridges and swales previously identified by benches (Woodyer et al., 1979; Pizzuto, 1994), scrollbars (Leopold et al., 1964; Nanson, 1980), and point bars (Bridge, 2003, Fig 5.39d).

Main-stem floods have high suspended loads of fine sediment. Sources of sediment are the Rio Conchos downstream from Luis Leon Dam (Fig 3.1) and regional ephemeral tributaries that drain parts of the sparsely vegetated Chihuahuan Desert underlain by erodible sedimentary and volcanic rocks. The largest ephemeral tributaries are Alamito, San Carlos, Terlingua, and Tornillo Creeks (Fig 3.1).
Although spring snowmelt in the Rocky Mountains and monsoon rains and tropical storms in the Sierra Madre Occidental drove historic flood peaks, modern floods occur from dam releases on the Rio Conchos or from flash floods on ephemeral tributaries. Low magnitude, short duration floods from dam releases on the Rio Conchos and tributary flash floods cause vertical floodplain formation and channel narrowing. However, large, extended dam releases (>1000 m$^3$/s) cause floodplain erosion and channel widening. Here, we analyze floodplain stratigraphy and sedimentology to describe the mechanisms of channel narrowing following erosive floods in 1979 and 1991.

3. GEOMORPHIC BACKGROUND

Since the 1940s, construction and management of large dams on the Rio Conchos and upper Rio Grande, and intermittent periods of drought resulted in declines of mean and peak stream flow of the lower Rio Grande (Fig. 3.1). These declines resulted in significant geomorphic changes of the lower Rio Grande including channel narrowing, vertical floodplain accretion, and reductions in channel capacity. Since the 1940s, the channel has narrowed by approximately 50%.

Although the trajectory of historic channel change has been channel narrowing, Dean (Chap. 2) depicted the temporal trends as a sawtooth pattern of decadal to multi-decadal narrowing interrupted by infrequent channel widening floods. Large dam releases on the Rio Conchos caused channel widening in 1979 and 1991. Since 1991, the onset of drought, lack of large dam releases, continued sediment inputs from tributaries, and non-native vegetation invasion resulted in rapid rates of narrowing and a loss of channel capacity. Narrowing occurred through the formation of floodplains inset within
natural levees created by the 1991 floods. Elevated baseflows from dam releases and lack of significant flood disturbance led to vegetation establishment on these surfaces. The loss of channel capacity resulted in upward shifts of the stage discharge relation, continued overbank flooding, and additional vertical accretion. Since 1991, the channel has narrowed between 33 and 55%, and the floodplains have vertically accreted by 2.75 to 3.5 m.

4. FLOODPLAIN FORMATION AND STRATIGRAPHY

On semi-arid rivers, with large suspended sediment loads, vertical accretion is the dominant mechanism of deposition and channel narrowing (Schumm and Lichty, 1963; Burkham, 1972; Pizzuto, 1994; Moody et al., 1999; Allred and Schmidt, 1999; Grams and Schmidt, 2002; Pizzuto et al., 2008). Floodplain formation often occurs on the inside of meander bends resembling point benches (Woodyer et al., 1979; Pizzuto, 1994; Pizzuto et al., 2008), point bars (Bridge, 2003), and scroll bars (Nanson, 1980). On tight, outer bends, where eddy recirculation occurs, floodplains form through the development of eddy accretions (Carey, 1969) or concave-bank benches (Woodyer, 1975). On straight reaches, floodplains form by sediment trapping around vegetation (Woodyer et al., 1979). In general, vertical accretion dominates on systems where lateral migration is limited due to either geologic confinement or cohesive bank material stabilized by vegetation (Nanson, 1986).

Pizzuto, 1994; Pizzuto et al., 2008 and Moody et al., 1999 described channel narrowing following a large flood on the Powder River in 1978. In response to this flood, the channel progressively narrowed through the construction of low-lying benches composed of interbedded sand and mud on top of coarser lag deposits at the channel
margins (Moody et al., 1999). The bench crests consisted predominantly of sand which fined onshore into sandy and silty clays in the floodplain trough (Moody et al., 1999). Offshore of the floodplain crest, stratigraphy sloped toward the channel while in the floodplain trough, bedding planes were horizontal. Over time, vertical accretion and vegetation establishment resulted in the conversion of these surfaces to floodplains.

Nanson (1980) specifically described stratigraphic and sedimentologic characteristics of scroll bars and their related floodplains. Initially, gravel and sand bedload is swept onto the upstream portions of point bars, and sorted downstream as velocities decline around the channel bend. A gradual transition from bedload to suspended load occurs upward through the floodplain, and the sediments grade from large scale cross-stratified gravels and sands at the base into small-scale cross-stratified and structureless silts at the top. In the upper portions of the scroll bar, when suspended load is dominant, a distinctive floodplain ridge (initial scroll) forms near the channel that thins onshore. Above this “initial scroll,” vertical accretion through mostly suspended sediment deposition is the dominant mechanism. Sedimentologically, scroll bars evolve from coarse grained channel features to fine grained floodplain features that generally fine downstream, upward, and onshore.

5. METHODS

We excavated 2 trenches through the floodplain along relatively straight reaches of the river and mapped and interpreted the exposed stratigraphy. The Castolon trench was approximately 9 km downstream from Terlingua Creek near Castolon, TX (Fig 3.2). The Boquillas trench was approximately 1.5 km upstream from Boquillas, MX (Fig 3.2).
We excavated around the rootstock of tamarisk (*Tamarix* spp.) and willow (*Salix exigua*) trees located along the margins of the trench. We marked the location of each stratigraphic unit as it crossed the buried stock of each tree. We also noted the elevation of the rootcrown which indicates the approximate elevation at which the tree germinated (Hereford, 1984). We then removed the rootstock of the trees from the trench, and analyzed changes in tree ring anatomy due to burial (Friedman et al., 2005). We compared the location of the burial signals within the trees to the location of the stratigraphic contacts in order to identify years in which individual stratigraphic units were deposited. We collected 8 tamarisk trees from the Boquillas trench and 6 tamarisk trees and 1 willow from the Castolon trench. In the Castolon trench, we found a beer can which helped constrain the dates of deposits that were older than deposits dated by the trees. Anheuser-Busch (Sahaida, pers. comm., 2008) provided the earliest and latest possible bottling dates based on can artwork. We applied these dates to constrain the time of deposition even though the consumption of the beverage and subsequent burial of the can may have occurred after the latest possible date of bottling.

We collected sediment samples at equally spaced intervals along the length of the trenches for grain size analysis. At each sampling location, we collected samples along vertical profiles to characterize grain size trends vertically through the floodplain. We analyzed samples at ½ phi intervals. We noted the presence of primary, secondary, and vegetation induced sedimentary structures to determine depositional processes.

6. RESULTS

Dendro-geomorphic and stratigraphic analyses of floodplain deposits showed two periods of vertical floodplain accretion due to channel narrowing: from 1982.5 ± 2.5 to
1991, and from 1991 to present. The first period occurred following the recession of a large flood in 1979. The second period occurred after two large floods had widened the channel in 1991. We observed floodplain formation during the first period in the Castolon trench and the second period in both the Castolon and Boquillas trenches.

In the Castolon trench, stratigraphic analyses, and an approximate bottling date from the beer can (Sahaida, pers. comm., 2008) showed that between the early to mid 1980s and 1991, narrowing occurred as sediment obliquely (Page et al., 2003) and vertically accreted onto a buried cutbank near station 2 (Fig 3.3b). During this period, we observed at least 20 m of narrowing and 3 m of vertical accretion that occurred at a rate of \(35 \pm 8\) cm/year (Fig 3.3, station 2 - 7). The upper portion of this floodplain contained thick beds of cross stratified sand that formed a natural levee. We believe the floods of 1991 created this levee, because the base of the thick sand deposits were erosional and underlying beds were truncated, all trees offshore from this feature in the Castolon trench germinated on inset deposits after 1991, and trees T19A, T19B, and T21 in the Boquillas trench germinated in 1991 on top of this levee (Fig 3.4). Aerial photographs show that these levees were the channel banks following recession of the October 1990 flood.

Since 1991, a second period of narrowing occurred through the formation of another vertically accreting inset floodplain (Figs 3.3 and 3.4). Vertical accretion occurred by the deposition of fine grained sediment on top of bars of sand, gravel, and cobbles. Tamarisk trees germinated on fine grained deposits overlying the coarse-grained gravel bars that were exposed at the base of the trenches. We measured 3.5 and 2.75 m of vertical accretion since 1991 in the Castolon and Boquillas trench sites, respectively, and the rate of vertical accretion was 0.20 and 0.16 m/yr at these respective locations. Since 1991, the channel at the Castolon and Boquillas trench sites has narrowed by 55
and 33%, respectively, 83 and 90% of which was observed on the U.S. side within the trenches. Currently, thick groves of tamarisk are growing within the floodplain trough. Giant cane has colonized both the sandy levees as well as the current channel bank. We observed an abundance of buried cane within the current channel bank of the Castolon trench reflecting such rapid accretion of the floodplain that nearly 2 m of buried cane had not yet decomposed.

6.1 Stratigraphy and Sedimentology

Generally, floodplain stratigraphy and sedimentology consists of natural levees composed of parallel laminated and ripple drift cross stratified sand that fine onshore into horizontally bedded deposits of sand, silt, and clay. Within the natural levees, deposits generally fine upward into silt caps. In the floodplain troughs, bedding consists of fining upward couplets of very fine sand and silt overlain by silt and clay. We interpret these facies to represent three distinct sedimentological components of floodplain formation: (1) active channel component, (2) floodplain conversion component, and (3) floodplain component. Below, we describe in detail the characteristics of these components.

6.2 Active Channel Component

The active channel component is indicative of channel margin or mid-channel sandbars that are inundated by common floods (Bridge, 2003, Fig 5.54a). Sediment consists of both fine grained bedload and suspended sediment on top of coarse grained substrates (Fig 3.5a). Bedding ranges in thickness between 10 and 40 cm and consists of fine to very fine sand. These are vertically accreted on top of coarse grained gravel deposits or obliquely accreted onto the channel margins. Contacts may be erosional or conformable. Bed forms include extensive small scale ripple drift cross-stratification,
wavy parallel lamination, and to a lesser extent, climbing ripples, supercritically climbing ripples, and planar lamination (Fig 3.5b and c). Thin (5 mm - 10 cm) discontinuous bands of silt may be present. Silts are bioturbated and appear to represent past, temporary ground surfaces. Some vegetation induced sedimentary structures (VISS, Rygel et al., 2004) may be present and usually consist of root-casts and mud-filled hollows. These are formed by roots penetrating sandy substrates below the ground surface or decayed vegetation that has been replaced by mud. Lesser occurrences of downturned beds formed by decayed vegetation and soft-sediment deformation exist.

6.3 Floodplain Conversion Component

This component represents the vertical building of the active channel component as it is converted to a floodplain. This component dominantly consists of suspended load deposition, however, the occasional presence of coarse sand and fine gravel indicates that at some discharges, this component is still part of the active channel. Beds range in thickness between .05 m and 1 m, however, most beds are less than 0.20 m. Bedding either on-laps underlying topography resulting in vertical accretion or is inset obliquely within the active channel component. Contacts are dominantly conformable but thicker deposits near the channel margins may be erosional (Fig 3.6a). Near the channel margin, bedding is inclined upward and onshore and is sandy with thin caps of silt and clay (Fig 3.6a). In these locations, beds are dominated by ripple drift cross-stratification and parallel lamination that may be planar or wavy. Climbing ripples comprise a small proportion of this component. Onshore, bedding becomes horizontal with alternating couplets of thin rippled very fine to medium sand that fines upward into thicker caps of silt and clay (Fig 3.6b). Stratified sand is often only 0.02-0.05 m thick, and mud caps are
thicker and may be mud-cracked. Furthest onshore, some beds are entirely mud. Rippled sands often contain stratified vegetation fragments. Extensive bioturbation exists, especially in the muddy portions of the floodplain trough. Buried decomposing plants and extensive VISS are present including mud-filled hollows, rootcasts, upturned beds, downturned beds, and scour-and-mound beds. Although this component is dominated by vertically accreting sand and mud couplets formed by the rising and falling limbs of floods, beds occasionally contain ripple or dune stratified coarse sand and fine gravel indicating bedload transport does occasionally occur (Fig 3.6c).

6.4 Floodplain Component

This component represents floodplain building through the construction of natural levees at the channel margins and vertical accretion of the floodplain trough. Beds range in thickness between .05 m and 1 m within natural levees. Levees are often erosional at the base, but sometimes conformably drape onto underlying beds (Fig 3.7a). Levees are constructed of very fine to fine sand that contain climbing ripples, supercritically climbing ripples, ripple drift cross-stratification, planar lamination, and wavy parallel lamination (Fig 3.7). We occasionally observed complete flood cyclothems within the levees that represent deposition throughout the complete rise and fall of a flood (Nanson, 1980). Levee building sands are capped by thin bands of silt ranging in thickness between 0.005 m and 0.05 m. Some beds are obliquely inset into the natural levees which reflect deposition by small floods that do not inundate the floodplain. Levee building sands fine rapidly onshore into thin beds (0.02-0.10 cm) of faintly cross-stratified sand capped by silt and clay. Mud caps are often mud-cracked and filled with very fine sand from the overlying bed. Near the top of this component, buried layers of
tamarisk duff are sandwiched between mud and the overlying deposit reflecting past
ground surfaces. VISS and bioturbation is most prominent within this component.
Within the levees, VISS include mud-filled hollows, centroclinal cross strata, coalesced
scour fills, and scour-and-mound beds (Fig 3.8). Buried vegetation is common. Onshore
from the levees, mud-filled hollows and root casts dominate, with occasional downturned
beds. Building occurs periodically due to evidence of past ground surfaces that
accumulate vegetation duff.

6.5 Grain Size

The floodplains fine upward and onshore and mean grain sizes decrease from very
fine sand for the active channel component to coarse silt for the floodplain component
(Figs 3.3c, 3.4c, 3.9). The decrease in sorting from the active channel component to the
floodplain component reflects the difference in grain size for the sand and mud couplets
that dominate the floodplain conversion and floodplain component. Grain size trends
observed indicate that as floodplain accretion occurs, dominant bedload deposition gives
way to suspended sediment deposition.

7. DISCUSSION

Our stratigraphic and sedimentological analyses show that different stages of
floodplain formation may incorporate a variety of both horizontal and vertical
depositional relationships. In the nascent stages, we observed active channel sand bars
vertically accreting through the progressive on-lapping of sand and mud couplets.
Lateral accretion also existed as sediment was deposited at an angle inclined upward and
onshore against the channel bar or channel margin similar to epsilon cross-stratification
(Allen, 1963), inclined heterolithic cross-stratification (IHS) (Thomas et al., 1987), and oblique accretion (Page et al., 2003).

As accretion continued, these emerging floodplain features, or benches, built through coincident lateral and vertical accretion. IHS and oblique accretion of sand and mud couplets occurred at the channel margins. However, in contrast to observations of Page et al. (2003), these sediments often overtopped the crest of the developing bench, resulting in vertical accretion in the developing floodplain trough. During this stage, floodplain building became less dependent upon lateral processes and more dependent upon vertical processes.

Vertical processes were dominated by the formation of levees through suspended sediment deposition at the channel margins. Levees built upward as a ridge similar to a scroll bar (Nanson, 1980) forming steep banks at the river margin and a gentle slope toward the floodplain trough. The highest deposition rates, and thickest beds, occurred adjacent to the channel. On the lower Rio Grande, sediment supply does not appear to be limited and thus the size of the levee appears to be related to magnitude and duration of the floods and the relative amount of sediment delivered by those floods. The large levee feature in the central portion of both trenches (Figs 3.3 and 3.4) was created by floods in excess of 1000 m$^3$/s, and the subtle levee feature at the current channel margin was created by floods less than approximately 650 m$^3$/s.

Floodplain building on the lower Rio Grande is similar to many of the mechanisms outlined by previous studies, however, these mechanisms occurred along relatively straight reaches of the river. Thus, deposition during channel narrowing along straight reaches mimics deposition patterns that usually occur at concave outer bends and convex point bars of typical meandering streams with high suspended sediment loads.
(Allen, 1965; Woodyer, 1975; Woodyer et al., 1979; Nanson, 1980). During channel narrowing, active channel bars at wide portions of the channel appear to act as seeds for bench and floodplain formation similar to observations on the Powder River by Pizzuto (1994) and Moody et al. (1999).

8. CONCLUSIONS

Channel narrowing of the lower Rio Grande occurred through the development of floodplains inset within previous channel margins along relatively straight reaches of the river. Narrowing occurred by some lateral, but mostly vertical, accretion on top of coarse grained mid-channel and channel margin bars. Initial stages of floodplain formation consisted of the vertical and oblique accretion of active channel bars resulting in bench formation. During this stage, sediment consisted of well sorted ripple cross-stratified and parallel laminated very fine sand as observed in the active channel component. Building continued which was dominated by IHS and oblique accretion at the channel margins and vertical accretion in the floodplain trough. At the channel margins, sediment consisted of very fine ripple cross-stratified sand that fined onshore into fining upward couplets of very fine sand and mud. We defined these sediments as the floodplain conversion component, because vertical accretion of active channel bars resulted in a transition from bedload deposition to suspended sediment deposition indicative of a floodplain. However, bedload deposits were occasionally present indicating that at some discharges, this portion of the floodplain was still part of the active channel. The final stage of floodplain development consisted of high suspended load deposition at the channel margin that created natural levees of ripple cross-stratified very fine sand that thinned and fined onshore into vertically accreting couplets of sand and mud. Sand deposition
dominated within the levees and mud deposition dominated in the floodplain trough. These sediments constituted the floodplain component and resulted in mostly vertical accretion. Through the above processes, 2.75 to 3.5 m of vertical accretion occurred as the channel narrowed between 33 and 55% over 17 years.

9. REFERENCES CITED


Fig 3.1: (a) Map of the Big Bend region. (b) Study area
Fig 3.2: Locations of the Castolon and Boquillas trench sites. Flow is from left to right.
Fig 3.3: Stratigraphy and sedimentology observed in the Casolon trench. a) Surveyed cross-section at the Castolon trench. Mapped stratigraphy of the Castolon Trench is displayed on the left of the cross-section. b) Mapped stratigraphy of the Castolon trench. Stratigraphic contacts defined by unconformities and disconformities. c) Stratigraphic columns, grain size distributions, and dominant sedimentary structures within the Rio Grande Village trench. Grain size depicted is the dominant grain size of the bed. Internal gradational changes are not depicted. d) Castolon trench displaying original location of the dated tamarisk (tamarisk codes listed). Germination horizons are indicated in a dark black horizontal line. Dates indicate periods of sediment accretion as observed from the wood anatomy of tamarisk trees. Stages of the baseflow (~10 m3/s), the approximate 2-year flood stage (310 m3/s) are also displayed. e) Castolon trench displaying 3 sedimentological component of channel narrowing.
Fig 3.4: a) Surveyed cross section at the Boquillas trench site near the Rio Grande Village boat ramp. Mapped stratigraphy of the Boquillas trench is displayed on the left of the cross section. The approximate elevation of the 2-yr flood stage is also displayed. b) Mapped stratigraphy of the Boquillas trench. Stratigraphic contacts defined by unconformities and disconformities. c) Stratigraphic columns, grain size distributions, and dominant sedimentary structures within the Boquillas trench. Grain size depicted is the dominant grain size of the bed. Internal gradational changes are not depicted. d) Boquillas trench displaying original location of the dated tamarisk (tamarisk codes listed). Germination horizons are indicated in a dark black horizontal line. Dates indicate periods of sediment accretion as observed from the wood anatomy of tamarisk trees. Stages of the baselaw (~10 cm), the approximate 2-yr flood stage (~310 cm) are also displayed.
Fig 3.5: Sedimentological facies of the active channel component. (a) Inclined parallel laminated silty sand overlying gravel deposit at the base of the Castolon trench. (b) Ripple drift cross-stratification fining upward into silty sand. (c) Planar bedded silty sand interrupted by overlying bioturbated mud.
Fig 3.6: Sedimentological facies of the floodplain conversion component. (a) Erosional contact showing inclined parallel lamination truncating ripple drift cross-stratification below. (b) Banded couplets of fine reddish sand overlain by caps of dark mud. (c) Planar laminated bedload gravels interfingered with couplets of reddish sand and dark mud.
Fig 3.7: Sedimentological facies of the floodplain component. (a) Sediment of levee in Castolon trench nears station 27. Note the erosional truncation of parallel laminated sediment in center, and the conformable sediment drapes that form the levee crest. (b) Ripple drift cross-stratification within the levee. (c) Supercritically climbing ripples within levee. (d) Planar laminated very fine sand. (e) Erosional truncation of rippled sand by overlying planar bedded sediment. (f) Horizontally bedded vertically accreting couplets of sand and mud within floodplain trough.
Fig 3.8: Vegetation induced sedimentary structures. (a) Mud-filled root cast or animal burrow, (b) upturned beds, (c) downturned beds, (d) mud-filled hollow, (e) root-cast, (f) centro-clinal cross-stratification.
Fig 3.9. Average grain size distribution of active channel component (n = 5), floodplain conversion component (n = 21), and floodplain component (n = 36).
CHAPTER 4

CONCLUSIONS

Hydrologic data, aerial photographs, discharge measurement notes, stratigraphy, and dendrogeomorphic analyses show that the lower Rio Grande in the Big Bend region is approximately 50% narrower than in the 1940s. Narrowing occurred as the construction and management of dams, stream-flow diversions, and levees reduced the frequency of large long duration floods and increased the relative frequency of low magnitude short duration floods. Narrowing occurred through the deposition of vertically accreting floodplains inset within previously wider channel margins. Non-native vegetation invasion exacerbated narrowing by stabilizing banks and inducing further sedimentation.

An analysis of various forcing mechanisms show that although dams trap sediment and attenuate flood peaks in their reservoirs, the management of the dams during drought has the greatest effect on channel morphology. Short, low magnitude dam releases cause channel narrowing and elevated baseflows from water deliveries to the lower basin promote vegetation establishment on active channel bars. More importantly, we show that large dam releases are effective at widening the channel and maintaining channel width.

Channel narrowing is widely believed to be negatively impacting the native and endemic in stream aquatic habitat through the loss of ecologically important habitats such as back waters, side channels, low velocity areas of the channel. In order to restore
historic measures of channel width, restoration activities must include the reinstitution of historical portions of the hydrograph, and the management of non-native vegetation.

4.1 MANAGEMENT OPTIONS

We propose three management options for restoring and maintaining channel width: (1) large magnitude, channel resetting dam releases that erode channel banks and create a diverse array of in channel geomorphic surfaces, (2) frequent, small dam releases that provide flood disturbance, prevent vegetation establishment, and do not promote vertical floodplain accretion, and (3) local vegetation management.

Evidence from discharge measurement notes and aerial photographs show that dam releases in excess of 1000 m$^3$/s that occur for extended durations are effective at widening the channel. However, analyses of hydraulic geometry relationships and channel cross section measurements show within 5 years after a channel resetting event, channel width usually contracts to measures predating the reset (Figs 2.14a, and 2.16b). Therefore, to maintain a wider channel through channel resetting floods, the frequency of these floods must increase.

Many studies show that through bank stabilization, increases in channel margin roughness, and reduction in lateral migration rates, vegetation effectively promotes channel narrowing and vertical floodplain accretion (Graf, 1978; Gran and Paola, 2001; Tal et al., 2003; Griffin et al., 2005; Tal and Paola, 2007). Thus, vegetation management must be an integral part of any restoration plan. Management is most important following channel resetting floods, because bare, moist surfaces that are created by these events are optimal for seedling establishment (Horton, 1960; Everitt, 1980; Scott et al.,
In early life stages, many riparian species including tamarisk must (Scott et al., 1996) remain protected from disturbance to survive. Erosion and burial of seedlings from high flows may effectively limit survival (Friedman and Auble, 1999; Levine and Stromberg, 2001; Polzin and Rood, 2006). Thus, frequent, small dam release floods that fill the channel yet do not overtop the banks may provide the disturbance necessary to prevent non-native seedling establishment on low active channel surfaces. Our analyses of floodplain deposits indicate that these flows must be less than approximately 200 m$^3$/s, because flows in excess of this discharge cause over-bank flow, vertical floodplain accretion, and channel narrowing, thus undermining the purpose of the release.

We recognize that the potential for both large and small dam releases for environmental purposes is small. Indeed, large dam releases may only occur through the chance of tropical storms that fill Rio Conchos reservoirs, necessitating a dam release. However, the potential of vegetation disturbance floods are possible through the present framework of management. International treaties, interstate compacts, and instate rights define a context of water allocation that is rarely changed once established. International treaties between the United States and Mexico negotiated in 1906 and 1944 (U.S. and Mexico, 1906; U.S. and Mexico, 1944) determined the amount of water available for consumptive use by each country from the upper Rio Grande, Rio Conchos, other tributaries, and the lower Rio Grande. Within this framework, management decisions regarding reservoir operations, irrigation needs, and available water resources determine year to year and seasonal flows. Although the volume of water entitled to users is defined by law, the manner in which a volume of water is transferred from one stakeholder to another is not. For example, elevated baseflow releases that occur in the
late fall and winter months are generally water delivery flows that transfer water from upper basin reservoirs to the lower basin. In 1993 and 1995, elevated baseflows for water delivery occurred for nearly 100 and 50 days, respectively, but never exceeded 20 m$^3$/s (Fig 2.8). If these releases were restructured to be shorter and larger in magnitude, they could serve two purposes: vegetation control through managed flood disturbance, and water delivery to the lower basin.

We admit speculation concerning the effectiveness of the flood disturbance method. Tamarisk and giant cane are opportunistic colonizers. Tamarisk seeds are viable nearly 7 months of the year (Everitt, 1980), and giant cane may establish through deposition of small root fragments (Bell, 1997). Additionally, plants that have matured beyond the seedling stage may tolerate floods. In the Big Bend region, plants may grow sufficiently in 1 to 2 years following germination to survive flood disturbance. However, aerial photographs and hydrologic analyses indicate that the most successful establishment period for vegetation in the 1990s was between 1992 and 1998 when flood disturbance in the form of the two year flood was reduced, and elevated managed baseflows occurred. Thus, frequent flood disturbance, without promoting vertical floodplain accretion, may limit successful seedling establishment, and must be considered as a management option.

At the local level, vegetation management must consist of the removal of non-native vegetation, most importantly, giant cane, which grows in impenetrable thickets, overhangs the channel, and directly affects channel margin flow. This is especially important in the absence of disturbance flows following channel resetting events, or periods of low flow when bare moist surfaces are exposed for establishment. At this
time, it is uncertain whether the current dense vegetation will effectively limit the erosion potential of a future large flood. Thus, vegetation removal may potentially destabilize vegetated banks, and limit the roughness effects at the channel margins, potentially maximizing the erosive potential of future large floods.

Frequent, large, dam release floods are the best option for restoring and maintaining channel width and diverse in-stream geomorphic features. In the absence of these flows, vegetation management through on site removal and managed environmental floods appears to be the best method for limiting the rate and magnitude of channel narrowing and vertical floodplain accretion.

4.2 REFERENCES CITED


APPENDIX

SUPPLEMENTAL STRATIGRAPHIC AND DENDROGEOMORPHIC DATA
Big Bend - Ring Reading Notes

Ring Reader: J.R.  

Reading Date: 3/26/07

Site ID: 19A Rio Grande Village  

Collection Date: Jan. 2007

Tree/Hole ID: 19A  

Slab ID: G5

Ring Counts/Notes:

J2X Filename: KG19A J2X.txt  

Number of radii measured: 2

J2X Series ID: KG19A G5A, KG19A G5B

Jhi - Recorded radii A + B into J2X.

<table>
<thead>
<tr>
<th>Slab</th>
<th>1st yr</th>
<th>Diametral Measurement (cm)</th>
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<tbody>
<tr>
<td>G5</td>
<td></td>
<td>19.4</td>
</tr>
<tr>
<td>G6</td>
<td></td>
<td>20.5</td>
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<td>G7</td>
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<td>20.8</td>
</tr>
<tr>
<td>G8</td>
<td></td>
<td>12.8</td>
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</tbody>
</table>

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
</tr>
</thead>
</table>

Wood Anatomy Change Notes:

Radii A + B - 1991 - 2006

*06 - narrow
*07 - wider
*08 - wide
*09 - bit of felled ring
*10 - odd, late wood-false ring?
*11 - 99 - wide, healthy yrs.
Big Bend – Ring Reading Notes

Ring Reader: J.K.  
Reading Date: 3/26/07

Site ID: Rio Grande Village  
Collection Date: Jan. 2007

Tree/Hole ID: 19A  
Slab ID: 2

Ring Counts/Notes:

J2X Filename: RG19A J2X.txt

Number of radii measured: 2

J2X Series Id: RG19A 2A,  RG19A 2B

JR: Recorded radii A+B into J2X.

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion:

Start Year:  
Stop Year:  
Proportion:

Start Year:  
Stop Year:  
Proportion:

JR: burial after '03

MS: slight buildup after 2000?

Wood Anatomy Change Notes:

Radii A+B - 1991-2006

- No obvious pith (?), Mike says yes, there is pith.
- 05+06 - compressed
- '04 - wide
- '02 - false ring
- '01 - narrower
- '99 - slight false ring
- '98 - one spot on slab is injury.

91 - large center w/ tiny pith, cracked
92-93 - similar
Big Bend - Ring Reading Notes

Ring Reader: J.R.  Reading Date: 3/26/07

Site ID: Rio Grande Village  Collection Date: Jan. 2007

Tree/Hole ID: 19A  Slab ID: 3

(Top M/N) (YN)

Ring Counts/Notes:

J2X Filename: RG19A32X.txt

Number of radii measured: 2

J2X Series Id: RG19A3A, RG19A3B

J.R. - Recorded radii A & B into J2X.

Proportion of circumference with secondary growth:

Start Year: ______  Stop Year: ______  Proportion: ______

Start Year: ______  Stop Year: ______  Proportion: ______

Start Year: ______  Stop Year: ______  Proportion: ______

J.R. - damage compression after 03

Wood Anatomy Change Notes:

Radii: A + B - 1991 - 2006 - center cracked

'04 - '06 - narrow rings

'01 - '03 - Similar

'95 - '99 - wide yrs.

'94 - narrower

'93 - bit of false ring

'92 - narrow

'91 - center of Teeny pith, large yrs. and false rings.
Big Bend - Ring Reading Notes

Ring Reader: /K
Reading Date: 

Site ID: Rio Grande Village
Collection Date: Jan. 2007

Tree/Hole ID: 19A
Slab ID: / (c/p)

Ring Counts/Notes:

J2X Filename: RG19A_j2X.txt
Number of radii measured:

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes:

- No pit
- All root weird
- Buried
- estab. 1991
Big Bend - Rio Grande Village

Tree 19A

- 10-12 cm
- 9-11 cm
- 12-16 cm
- 7.5-8 cm
- 9-8 cm
- 5 cm

RG-19A-GS
RG-19A-1
RG-19A-2
RG-19A-3
RG-19A-4
RG-19A-5
RG-19A-6

Θ = made GS
Θ = made L2/f vs M1/N + N/A
Θ = made M1/N + N/A
Θ = made of
Θ = made of
Θ = made of

cont. ->
BIG BEND - RIO GRANDE VILLAGE

TREE 19A

~43 cm

RG-19A - 15
4 = shell, Tag
Big Bend - Ring Reading Notes

Ring Reader: J.R. + D.D

Site ID: 210 Grovet Village

Tree/Hole ID: 198

Slab ID: GS

Collection Date: Nov. 2006

Describing Bumet: Tar has 2 sections and is heavily weathered.

J2X Filename: RG19B32X.JEX

Number of radii measured: 8

J2X Series Id: RG19B32R RG19B32R

Proportion of circumference with secondary growth:

Start Year: _______ Stop Year: _______ Proportion: _______

Start Year: _______ Stop Year: _______ Proportion: _______

Start Year: _______ Stop Year: _______ Proportion: _______

Wood Anatomy Change Notes:

**-injury in 95**

*Centex has Rot - Difficult to see pith, may be barely present*

3/4 cut

Early 98

95 - shallow

91 - wide

84 - wide

93 - wide

93 Bad Dry
Big Bend - Ring Reading Notes

Ring Reader: L. R. + D. D.  

Site ID: Rio Grande Valley  

Tree/Hole ID: 198  

Reading Date:  

Collection Date: Nov. 2006  

Slab ID:  

J2X File Name: R619R32A.TVT  

Number of radii measured: 2  

J2X Series Id: R619R2A R619R2B  

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Wood Anatomy Change Notes:

9/1/2006

- Buried after 2000  
- OV - wide - relatively  
- 97 - 00 - similarly narrow  
- 97 - 000 similar  
- Injury in 95 - cracked  
- Below ring in 93  
- 91 center w/ healthy pitch
Big Bend – Ring Reading Notes

Ring Reader: J.K. & D.D.  
Reading Date: 

Site ID: P16 Grande Village  
Collection Date: Nov. 2006  

Tree/Hole ID: 1778  
Slab ID: 3  

Ring Counts/Notes:  

J2X Filename: RCG1983A.Tyr  
Number of radii measured: 3  
J2X Series Id: RCG1983A RCG838  

Proportion of circumference with secondary growth:  

Start Year:  
Stop Year:  
Proportion: 
Start Year:  
Stop Year:  
Proportion: 
Start Year:  
Stop Year:  
Proportion: 

Wood Anatomy Change Notes:  

[97-2000]  
- Buried after 1600  
- 01 - band appears healthier than in slab 2 - Unburied? Happy lipe? Walker Burial?  
- 92-2000 $d/12.2  
- Injury in 95-96  
- 94 Color  
- 99 Rate Ring  
- 97 93- same x 95  
- 91- hallig you ll eat 06
Big Bend - Ring Reading Notes

Ring Reader: J.K. D.D.  

Reading Date: 

Site ID: Rio Grande Village  

Collection Date: Nov. 2006

Tree/Hole ID: 143  

Slab ID: 4

Ring Counts/Notes:

12X Filename: RG1953BR.txt  

Number of radii measured: 2  

12X Series Id: RGEB091 P4 MR YP

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:  

Start Year: Stop Year: Proportion:  

Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes:

- 01-06 - Compressed.  
- 95-96 - Highly compressed.  
- 91 - Center 2/1 Healthy tissue.  
- After 93 - Wood looks burnt.
Big Bend – Ring Reading Notes

Ring Reader: ___________________  Reading Date: ___________________

Site ID: Rio Grande Village  Collection Date: Nov. 2006

Tree/Hole ID: 1918  Slab ID: <

Ring Counts/Notes:

12X Filename: R6.191852x.txt

Number of radii measured: 2

12X Series Id: R6.191854  R6.191858

Proportion of circumference with secondary growth:

Start Year: __________  Stop Year: __________  Proportion: __________

Start Year: __________  Stop Year: __________  Proportion: __________

Start Year: __________  Stop Year: __________  Proportion: __________

Wood Anatomy Change Notes:

9/7/2006

- Shift in "butt" of stem where plant appears to be classified
  - Pith Zone
  - Center '91
  - 95-98 wide growth
- Measure from 91-94
- Burnt after '92? But maybe all Burnish
**Big Bend – Ring Reading Notes**

<table>
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<th>Reading Date:</th>
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<td>Collection Date: <code>Nov 2006</code></td>
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<tr>
<td>Tree/Hole ID: <code>198</code></td>
<td>Slab ID: <code>C</code></td>
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**Ring Counts/Notes:**

- **J2X Filename:** `R6198RJ2X.TXT`
- **Number of radii measured:**
- **J2X Series Id:** `R6198CA R6198CA`

**Proportion of circumference with secondary growth:**

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<th>Stop Year:</th>
<th>Proportion:</th>
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</table>

**Wood Anatomy Change Notes:**

- `91 - ?`
- **No Path**
- **all Buried:** `?`
- `91 - 93 Visible`
Bro Benc - Rio Grande Village

TREE 17B

RG-19B-0

4.5 cm

RG-19B-05

265 cm

RG-19B-1

RG-19B-2

RG-19B-3

RG-19B-4
Big Bend - Ring Reading Notes

Ring Reader: D.J. T.S. A.               Reading Date:       

Site ID: Rio Grand Village               Collection Date: 8/2/1987       

Tree/Hole ID: 74               Slab ID: 65

Ring Counts/Notes:

J2X Filename: K62165x1,73T          

Number of radii measured: 2          

J2X Series Id: K62165A, K62165B

Proportion of circumference with secondary growth:

Start Year:       Stop Year:       Proportion:       

Start Year:       Stop Year:       Proportion:       

Start Year:       Stop Year:       Proportion:       

Wood Anatomy Change Notes:


- 04 - 96 - similarly wide
- 03 - wide
- 02 - wide with false ring
- 97 - 2000 - similarly wide
-96 - narrow

- 95 - wide
- 94 - false ring
- 93 - wide
- 92 - wide with false ring
- 91 - center with false ring
Big Bend - Ring Reading Notes

Ring Reader: John

Site ID: Rio Grande Valley

Tree/Hole ID: 21

Reading Date:

Collection Date: 1992-07-28

Slab ID: 0

Ring Counts/Notes:

J2X Filename: R.GRV.RX.TXT

Number of radii measured: 6

J2X Series Id: R6-21A_R6-22B

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

J.K. - perhaps burial after 03

Wood Anatomy Change Notes:

Radii A+B 1991-2006

'94-'06 - Similarly wide

'01-'03 - Similar w/false ring

'97-'2000 - Similarly wide

'94-'95 - False ring - wide

'91 - '93 - False rings

'91 - Center cracked w/pith
Big Bend - Ring Reading Notes

Ring Reader: J.R. + D.D.  
Reading Date: 

Site ID: Rio Grande Village  
Collection Date: Nov. 2006 - Jan. 2007  

Tree/Hole ID: 21  
Slab ID: 3  

(R/I/m)

Ring Counts/Notes:

12X Filename: RG2132x.txt

Number of radii measured: 2

12X Series Id: RG2132, RG2138

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
JR - buried after 03

Wood Anatomy Change Notes:

Radii A+B - 1991-2006

- 89 - 96 - similar
- 91 - 99 - similar width
- 01-02 - false rings
- 96-99 - wide
- 96-99 - wide
- 92-95 - wide
- Diameter and Grain Increased
Big Bend - Ring Reading Notes

Ring Reader: J.R. Date: __________

Site ID: R. Counter: ________

Tree/Hole ID: p1

Reading Date: __________ Collection Date: __________ Jan. 2007

Slab ID: __________

(M1/M2)

Ring Counts/Notes:

J2X Filename: R021J3X.txt

Number of radii measured: 0

J2X Series Id: R3121?, R3152?

Proportion of circumference with secondary growth:

Start Year: __________ Stop Year: __________ Proportion: __________

Start Year: __________ Stop Year: __________ Proportion: __________

Start Year: __________ Stop Year: __________ Proportion: __________

J. R. - burial signal after 2003. looks buried after 91/3 0

Wood Anatomy Change Notes:

'04 - '06 - Narrowing

'01 - '03 - Similar width false rings

2000 - false ring wider

1999 - mostly throughout yr.

'96 - '99 - wide

'93 - '95 - wide

'91 - center false ring no pitch 0

mt. A after yr.
Big Bend – Ring Reading Notes

Ring Reader: D. D. J. K.  
Reading Date: 

Site ID: Zia Grande Village  
Collection Date: Nov 2006 – Jan. 2007  

Tree/Hole ID: 31  
Slab ID: 2  
(M2/N)

Ring Counts/Notes:

J2X Filename: ZiaGrande.TXT  
Number of radii measured: 2

J2X Series Id: RZ21XJ RZ21XB  

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:  
Start Year: Stop Year: Proportion:  
Start Year: Stop Year: Proportion:  

J.R. – burn after ’02. Looks like burn after ’97.

Wood Anatomy Change Notes:

’04 – ’06 - narrowing  
’04 – ’03 - wide with false rings  
2000 - false ring  
1999 - lg. false ring  
’95 – ’99 - wide  
’91 - center w/ no pith
Big Bend - Ring Reading Notes

Ring Reader: J.K. + D.D.  
Reading Date: 

Site ID: Rio Grande Village  
Collection Date: November 2006, Jan. 2007

Tree/Hole ID: 21  
Slab ID: 8  
(No)

Ring Counts/Notes:

I2X Filename: RG218A.txt
Number of radii measured: 2
I2X Series Id: RG218A, RG218B

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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J.R.- Buried after 71

Wood Anatomy Change Notes:

Radii A + B - 1991 - 2006

[Sketch of wood anatomy changes]

2000-08 - false rings
98+1999 - false ring wide
-91 - center can't detect pink
Big Bend - Ring Reading Notes

Ring Reader: J.R. & D.D.  Reading Date:

Site ID: Rio Grande Village  Collection Date: Nov. 2006 Jan. 2007

Tree/Hole ID: 21  Slab ID: 9 (o/p)

Ring Counts/Notes:

12X Filename: RG2132X.txt

Number of radii measured: 2

12X Series Id:

Proportion of circumference with secondary growth:

Start Year: _______  Stop Year: _______  Proportion: _______

Start Year: _______  Stop Year: _______  Proportion: _______

Start Year: _______  Stop Year: _______  Proportion: _______

J.R. - possible burial effect '90. All!

Wood Anatomy Change Notes:

`01-06 - compressed
`02 - false ring
1999 - false ring

`93 - 2006 - similar widths
`92 - pinches, half moon
`91 - wide
`90 - wide, not set

Radii A+B - 1990 - 2006
Big Bend – Ring Reading Notes

Ring Reader: J.R. & D.D.  

Site ID: Rio Grande Village  

Tree/Hole ID: 21  

Collection Date: Nov. 2006 Jan. 2007  

Slab ID: 11

Ring Counts/Notes:

J2X Filename: RG217J2X.txt 

Number of radii measured: 2  

J2X Series Id: RG2111A, RG2111B

Proportion of circumference with secondary growth:

Start Year: ______  
Stop Year: ______  
Proportion: ______

Start Year: ______  
Stop Year: ______  
Proportion: ______

Start Year: ______  
Stop Year: ______  
Proportion: ______

J.R. - burnish all

Wood Anatomy Change Notes:

Injury between 01 & 02  
1999 - false ring  
73 - 2000 - embossed wood - poorly boled  
'90 - center w/o pith.
Big Bend - Ring Reading Notes

Ring Reader: J.R. & D.S.   Reading Date:  
Site ID: Río Grande Village   Collection Date: Jan. 2007  
Tree/Hole ID: 21   Slab ID: 12  

Ring Counts/Notes:  
12X Filename: RG21J2Y.txt  
Number of radii measured: 2  
12X Series Id: Rh2ll28 Rh2ll28

Proportion of circumference with secondary growth:  
Start Year:   Stop Year:   Proportion:  
Start Year:   Stop Year:   Proportion:  
Start Year:   Stop Year:   Proportion:  
- J.R. All Buried

Wood Anatomy Change Notes:  
- 97: False Ring  
- 98: White dots
- Some Rings difficult to read (01-00?)  
- Hard to identify Pitch  
- Both blue staining in center
Big Bend – Ring Reading Notes

Ring Reader: J.K. + D.D.                        Reading Date: ______________________

Site ID: R.i.e Grand Site Village              Collection Date: __________ Jan. 2006

Tree/Hole ID: 21                                Slab ID: 14

Ring Counts/Notes:

12X Filename: R.G. 21 S.Y. Y. Y.              
Number of radii measured: 2

12X Series Id: R(21/NA) R(21/4R)

Proportion of circumference with secondary growth:

Start Year:_________  Stop Year:_________  Proportion:_________
Start Year:_________  Stop Year:_________  Proportion:_________
Start Year:_________  Stop Year:_________  Proportion:_________
Start Year:_________  Stop Year:_________  Proportion:_________
J.T. Hill studied

Wood Anatomy Change Notes:

1996 - 2000
97: Fat, hard  - No Pitch
98: Hard

- Radii A - 94 - 2000
- Radii B - 97 - 2000
**Big Bend - Ring Reading Notes**

**Ring Reader:**

Site ID: Rin Creek 4

Tree/Hole ID: 21

Reading Date:

Collection Date: Jan. 2007

Slab ID: 16

**Ring Counts/Notes:**

12X Filename: R62/Var.txt

Number of radii measured: 2

12X Series Id: R62/16a R62/16b

**Proportion of circumference with secondary growth:**

<table>
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<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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</table>

*SR All Buried*

**Wood Anatomy Change Notes:**

- No Pith - All Rots Poorly

*Not Many Distinguishable Years - Not Worth Measuring - Don't Do X*
Big Bend Rio Grande Village

TREE 21

7 - 10.5 cm
RG - 21 - GS

19 cm
RG - 21 - 1

10 cm
RG - 21 - 2

10 - 12 cm
RG - 21 - 3

(Top & Bottom measured)

& max = 21/16

13 - 15 cm
RG - 21 - 4

6 - 8 cm
RG - 21 - 5

3 - 5 cm
RG - 21 - 6

cont. →
Big BEND - RIO GRANDE VALLEY
TREE 21

~8 cm    RG-21-7   ☐ = mail M1/N

~7 cm    RG-21-8   ☐ = mail N/0

5.5 cm    RG-21-9   ☐ = mail o/p

6 cm    RG-21-10

7-8 cm    RG-21-11   ☐ = mail P/0

6 cm    RG-21-12   ☐ = mail a/R

6 cm    RG-21-13

~7 cm    RG-21-14   ☐ = mail R/S

~9 cm    RG-21-15
Big Bend - Rio Grande Village

TKEE 21

5.5 - 6.5 cm  RG-21-16  \( \Theta = \text{meas. 3/7} \)

6 cm  RG-21-17

9 cm  RG-21-18

6.5 - 7 cm  RG-21-19  \( \Theta = \text{meas. 3/7} \)

7.85 cm  RG-21-20

8.14 cm  RG-21-21  \( \text{well burried.} \)
Big Bend - Ring Reading Notes

Ring Reader: J.R.  Reading Date: 3/12/07

Site ID: Rio Grande Village (RG)  Collection Date: Nov. 2006

*Tree/Hole ID: 320 50 32 5  Slab ID: GS

Removal details: 10
Spot 1 J2X/Lincoln

Ring Counts/Notes:

J2X Filename: RG335J2X.CXT

Number of radii measured: 2

J2X Series Id: RG335GSA  RG335GB

D.D. - Recorded radii A+B into J2X.

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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Wood Anatomy Change Notes:

Radii A + B 1995 - 2006  Center is cracked.

05 - long line
04 - "    11
03 - las hole ringing
all years are change.
95 - center up with D (bad line through)
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 3/12/07

Site ID: Rio Grande Village  
Collection Date: Nov. 2006

Tree/Hole ID: 335  
Slab ID: 2  A/B

Ring Counts/Notes:

J2X Filename: KG335J2X.txt

Number of radii measured: 2

J2X Series Id: KG335 2A, KG335 2B

D.D. - Recorded radii A & B into J2X.

Proportion of circumference with secondary growth:

<table>
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<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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Wood Anatomy Change Notes:

Radii A + B - 1995 - 2006  
Center is curved.

'03-'06 - wide wire.
'02 - narrow wire.
'99 - slight false rings.
'96-'01 - wide wire.
'95 center split. @

Big Bend - Ring Reading Notes

Ring Reader: J.R.  Reading Date: 3/12/07

Site ID: Río Grande Village  Collection Date: Nov. 2006

Tree/Hole ID: 335  Slab ID: 5

Ring Counts/Notes:

12X Filename: KG335T2X.txt

Number of radii measured: 2

12X Series Id: KG335A, KG335B

D.D. - Recorded radii A & B into T2X.

Proportion of circumference with secondary growth:

Start Year:  Stop Year:  Proportion:

Start Year:  Stop Year:  Proportion:

Start Year:  Stop Year:  Proportion:

M.S. burned after 05 possibly '04

Wood Anatomy Change Notes:

Radii A+B - 1895 - 2006  Center is cracked.

'05 +'06 - show slight burn
'04 - medium fire
'03 - fire
'02 - fire
'99 - fire
'97 - fire
'96 - fire
'95 - center which is


Big Bend – Ring Reading Notes

Ring Reader: J.K.  
Reading Date: 3/12/07

Site ID: Rio Grande Village  
Collection Date: Nov. 2006

Tree/Hole ID: 335  
Slab ID: 6

Ring Counts/Notes:

J2X Filename: RG335C1-A, RG335C2-B

Number of radii measured: 2

D.D. - Recorded radii A + B into J2X.

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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</table>

Wood Anatomy Change Notes:

Radii A + B - 1995 - 2006  
Center is cavitated.

'04 - '06 - Slow, slight burial
'04 - wide
'02 - narrow; w/ late ring
'99 - slight taper
'98 - '01 - wide
'96 - wide (stretched)
Big Bend - Ring Reading Notes

Ring Reader: J.R.                                      Reading Date: 3/12/07
Site ID: Rio Grande Village                          Collection Date: Nov. 2006
Tree/Hole ID: 335                                        Slab ID: 7

Ring Counts/Notes:

J2X Filename: KG 3357A, 3357R

Number of radii measured: 2

D.P. found radii A + B into J2X

Proportion of circumference with secondary growth:

Start Year:________  Stop Year:________  Proportion:________
Start Year:________  Stop Year:________  Proportion:________
Start Year:________  Stop Year:________  Proportion:________

J.R. - burial 84-02
MS - burial after 03

Wood Anatomy Change Notes:

Radii A + B - 1995 - 2006  Center is cracked
84 - 06 - burial sign
83 - intermittent false ring
90 - intermittent false ring
97 - 01 - end
95 - end of log
Big Bend - Ring Reading Notes

Ring Reader: J.R.                                      Reading Date: 3/10/97

Site ID: Rio Grande Village

Tree/Hole ID: 335

Collection Date: Nov. 2006

Slab ID: 9

Ring Counts/Notes:

J2X Filename: KG335J2X12X1

Number of radii measured: 2

J2X Series Id: KG3359A, KG3359B

D.J. - Exposed into soil

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion: 


M.S. - Buried after '02.

Wood Anatomy Change Notes:


'95 - discoloration, split.

'96 - discoloration, split. right.

'97 - '01 - weak.
Big Bend - Ring Reading Notes

Ring Reader: J.K.  
Reading Date: 3/4/07
Site ID: Rio Grande Village  
Collection Date: Nov. 2006
Tree/Hole ID: 335  
Slab ID: 11

Ring Counts/Notes:

J2X Filename: RG 335 J2X 3x4
Number of radii measured: 2
J2X Series Id: KG 3351A, KG 3351B

DD: Entered into J2X

Proportion of circumference with secondary growth:

<table>
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<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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J.K. - Buried after 2001
M.J.S. - Buried after '01, 2000-01 Transitional or shallow burial

Wood Anatomy Change Notes:

RedLists B - 1994-2001

2001 - wide
'02 - narrow
'99 - 01 - similar
'00 - '99 - slight change
'97 - '98 - wider
'99 - trace of false ring
Big Bend – Ring Reading Notes

Ring Reader: J.K. Reading Date: 3/4/03
Site ID: Río Grande Village Collection Date: Nov. 2006
Tree/Hole ID: 235 Slab ID: 12

Ring Counts/Notes:

12X Filename: RG 23512 A, 23512 B
Number of radii measured: 2

12X Series Id: RG 23512 A, RG 235 B
DD Extract into 5dx

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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Wood Anatomy Change Notes:

Radii A+B - 1994 - 2002

02 = small, usual
01 = wide
97 = 2000 - usual
96 = usual
95 = small
94 = new center with pitch + Δ in wood anatomy after 96.
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 12/4/97

Site ID: Rio Grande Village  
Collection Date: Nov. 2006

Tree/Hole ID: 335  
Slab ID: 14

Ring Counts/Notes:

J2X Filename: RG 335 J2X.txt

Number of radii measured: 2

J2X Series Id: RG 335 14 A  
RG 335 14 B

DD entered into J2X

Proportion of circumference with secondary growth:

Start Year: _____  
Stop Year: _____  
Proportion: _____

Start Year: _____  
Stop Year: _____  
Proportion: _____

Start Year: _____  
Stop Year: _____  
Proportion: _____

J99 - Burial site over 99 a center.
M.S. - buried after as early as 97.

Wood Anatomy Change Notes:

Radii A 48-1994-2001 (some outer scarring)

01 - wide

'97 - 2000 - thinner

'96 - fiber rings - good wood

'95 - small

'94 - center with pitch 0

end wood center.
Big Bend - Ring Reading Notes

Ring Reader: J. R.  
Reading Date: 7/12/67

Site ID: Rio Grande Village  
Collection Date: Nov. 2006

Tree/Hole ID: 335  
Slab ID: 16

Ring Counts/Notes:

J2X Filename: 335.T4X.T45  
Number of radii measured: 2

J2X Series Id: RG 33516 A, RG 33516 B  
D.J. Entered into J2X

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

J.R. - Buried after 1996.
M.S. - Buried after 96.

Wood Anatomy Change Notes:

Outer finger stable.

'97 - Mature b. wind or B  
'96 - Good wood, slight pitch rise  
'95 - Good wood  
'94 - Center w/pith +
Big Bend - Ring Reading Notes

Ring Reader: J.R.                                                Reading Date: 3/2/07
Site ID: Rib Grande Village                                    Collection Date: Nov. 2006
Tree/Hole ID: 335                                              Slab ID: 17

Ring Counts/Notes:

12X Filename: RG 335 J2X.2XT
Number of radii measured: 2
12X Series Id: RG 33517A, RG 33517B
Fresno, 1974 J0r

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
1. & 2. buried after '30,
M.S. - buried after '35,
Wood Anatomy Change Notes:
Radii A & B 1994 - '76, slab is rot, 
'94 - center of pitch.
Big Bend – Ring Reading Notes

Ring Reader: J.K. 
Reading Date: ________________

Site ID: Ridgeland Village (KF) 
Collection Date: Nov. 2006

Tree/Hole ID: 335 
Slab ID: 20

Ring Counts/Notes:

J2X Filename: RG 335 J2X, etc.
Number of radii measured:

J2X Series Id:

DO NOT

Proportion of circumference with secondary growth:

Start Year: 
Stop Year: 
Proportion: 

Start Year: 
Stop Year: 
Proportion: 

Start Year: 
Stop Year: 
Proportion: 

---

M.R. burned after 96.
M.R. burned after 96.
Wood Anatomy Change Notes:

1993 - 1996

- Perhaps new ring dating to 93. 
Big Bend

Tree 33.5

10-12 cm  BB-335-7

~16 cm  BB-335-8

6-8 cm  BB-335-9

11.5-14 cm  BB-335-10

~6 cm  BB-335-11

5-8 cm  BB-335-12

~4 cm  BB-335-13

\*12 cm (deep 30 cm)

\(\Diamond\) = Half D/F

(2 contexts)
Big Bend
TREE 33.5

- 6 cm  BB-335-14
- 6 cm  BB-335-15
- 7.5 cm BB-335-16
- 6.5 cm BB-335-17
- 9 cm  BB-335-18

19 cm  BB-335-19
       (outer wood rotted)

13.5 cm BB-335-20
       (sanded Top & Bottom)
       (outer wood rotted)

Note: Refer to (7) on p. 43
Big Bend - Ring Reading Notes

Ring Reader: JKL
Reading Date: 2/12/07
Site ID: Rio Grande Village (RG)
Collection Date: Nov. 2006
Tree/Hole ID: 34A
Slab ID: GS
(Top + Bottom: 1.5, 1.8)

Ring Counts/Notes:

J2X Filename: RG34A J2X.txt
Number of radii measured: 2
J2X Series Id: RG-34AGSA, RG34AGSB
DD Entered Into Tax

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
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Wood Anatomy Change Notes:

Top-Radii A+B - 2000 - 2006

'06 = small
'01 = false rings
'05 = wider
'04 = wide, false rings 2000 - center with false
'03 = narrower
'02 = widest, piece of false rings
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 3/2/07

Site ID: Rio Grande Village  
Collection Date: Nov. 2006

Tree/Hole ID: 34A  
Slab ID: 2
(2 cm < r < 5 cm) main B/C

Ring Counts/Notes:

J2X Filename: KG34AJ2X.txt

Number of radii measured: 2

J2X Series Id: KG34A2A, KG34A2B

DD Edward Jox

Proportion of circumference with secondary growth:

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<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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<td>1981</td>
<td>1982</td>
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J. R. - burned in '05
M. S. - burned after '04.

Wood Anatomy Change Notes:

Radii A + B - 1979 - 2006

'06 - burn
'05 - burned or compressed
'04 - wide V-buf of false ring
'02 + '03 - similar
'01 - narrower inside ring

2000 - minor white false rings
1999 - small center w/ pitch 0
Big Bend – Ring Reading Notes

Ring Reader:  J.R.  
Reading Date:  3/13/07  

Site ID:  Río Grande Village  
Collection Date:  Nov. 2006  

Tree/Hole ID:  34A  
Slab ID:  3  

Ring Counts/Notes:

J2X Filename:  RG34A3A2x.txt  
Number of radii measured:  2  

J2X Series ID:  RG34A3A, RG34A3B  
D.O. entered into J2X.  

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

J.D. 05 chive burials  
M.S. – burial after ‘04.  

Wood Anatomy Change Notes:

2000- small center w/ pitch  
1999- small center w/ pitch  

‘06 - unmeas  
‘05 - buried at compressed  
‘04 - wide (yellow)  

‘02 – ‘03 - similar  
‘01 – unmeasured w/thin rings
Big Bend - Ring Reading Notes

Ring Reader: J. R.  
Reading Date: 5/13/07

Site ID: Rio Grande Village  
Collection Date: Nov. 2006

Tree/Hole ID: 34A  
Slab ID: 4  
Note - level surface

Ring Counts/Notes:

J2X Filename: 34A J2X.txt
Number of radii measured: 2
J2X Series ID: KG34A4A, KG34A4B
‘D.D. entered into SAS

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

J. ½ - buried after 04
M. ½ - buried w/in 04 evidence of burial

Wood Anatomy Change Notes:

Radii A+B - 1999 - 2006

'05 +'06 - show some burial
'04 - wide

'02 +'03 - similar narrower
'01 - narrower with rings

2000 - narrow w/ fine false rings
1990 - small center w/ pith 0
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 7/13/07

Site ID: Rio Grande Village 
Collection Date: Nov. 2006

Tree/Hole ID: 34A  
Slab ID: 7

Ring Counts/Notes:

J2X Filename: \textit{RG \_4 \_A \_x \_x \_x}

Number of radii measured: 2

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion: 
Start Year: Stop Year: Proportion: 
Start Year: Stop Year: Proportion:

Jr4 - buried after 2004
Ms - buried after 2003.

Wood Anatomy Change Notes:

\underline{Rad4' A + B - 1999 - 2006}

'05 + '06 - buried
'04 - wide
'02 + '03 - similar
'01 - false ring

2000 - here and with false rings
1999 - small center w/pitch
Big Bend – Ring Reading Notes

Ring Reader: J.R.  Reading Date: 3/26/97

Site ID: Rio Grande Village  Collection Date: Nov. 2006

Tree/Hole ID: 34A  Slab ID: 8

Ring Counts/Notes:

J2X Filename: RG34A J2X.txt

Number of radii measured: 2

J2X Series Id:

Di ended into Jyr

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

J.R. - burial after 03.
M.S. - buried after 03.

Wood Anatomy Change Notes:

Radial 4 & 5 - 1997 - 2006

Radial 4 & 5 - 06 - broad
Radial 4 - 04 - compressed
Radial 4 - wide
'03 - narrow
'02 - narrow

'01 - narrow w/ false ring
2000 - narrow w/ false rings
1999 - very narrow w/ false ring
'98 - very narrow
'97 - center large w/ pitch.
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 3/1/02

Site ID: Rio Grande Village  
Collection Date: Nov. 2006

Tree/Hole ID: 24 A  
Slab ID: 9

Ring Counts/Notes:

12X Filename: RG34AJ2X.txt
Number of radii measured: 2

12X Series Id: RG34A9A, RG34A9B

DB. treated with Jox

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion: 

Start Year:  
Stop Year:  
Proportion: 

Start Year:  
Stop Year:  
Proportion: 

Mai - buried after 2003.

Wood Anatomy Change Notes:

Radii A+B. 1997-2005

"2+03 - similar
"01 - narrow + yellow
"2000 - narrow white ring (black)
"1999 - very narrow white ring

'98 - narrow
'97 - center wide white ring
Big Bend - Ring Reading Notes

Ring Reader: J.R.
Site ID: Rio Grande Village
Tree/Hole ID: 344
Slab ID: 10
Collection Date: Nov. 2001

Ring Counts/Notes:
J2X Filename: RG344J2X.txt
Number of radii measured: 2
J2X Series Id: RG344J2X

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

J.R. - break after '83.
MS1 - break after '83.

Wood Anatomy Change Notes:
Radii A+B - 1997 - 2006
'94 - '06 - Brown
'03 - wide
'02 - narrower
'01 - narrow & yellow
'00 - narrow w/few tiny
1999 - narrow + fine ring
1998 - narrower
1997 - smaller + tiny with 0
Big Bend - Ring Reading Notes

Ring Reader: [Name]

Site ID: Rio Grande Village

Tree/Hole ID: 344

Reading Date: 3/12/67

Collection Date: Nov. 20016

Slab ID: [ID]

(hole D/F3)

Ring Counts/Notes:

J2X Filename: RG 344 J2X.txt

Number of radii measured: 2

J2X Series Id: [Series ID]

D.J. entered into J2X

Proportion of circumference with secondary growth:

Start Year: [Year]  Stop Year: [Year]  Proportion: [Proportion]

Start Year: [Year]  Stop Year: [Year]  Proportion: [Proportion]

Start Year: [Year]  Stop Year: [Year]  Proportion: [Proportion]

J1K - burned 1932
M.S. - burned after 1952

Wood Anatomy Change Notes:

Radii A + B - 1996 - 2004

1996 - condition w/good pitch

1997 - wide
Big Bend – Ring Reading Notes

Ring Reader: J. R.  
Reading Date: 5/13/17

Site ID: R'd Creede Village  
Collection Date: Nov. 2006

Tree/Hole ID: 34A  
Slab ID: 12

Ring Counts/Notes:

12X Filename: RG 34A J2X.txt

Number of radii measured: 2

12X Series Id: P16 34A J2X, RG 34A J2X

D.D. extended into 50X

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

J.R. – Buried after '02.

Wood Anatomy Change Notes:

Radii A+B - 1996 - 2002

c1 & c2 similar, but c1 is yellow.
2000 - false rings + 3 cauls
1999 - false rings (est: tree cracking)
97 - very narrow
97 - wide
Big Bend - Ring Reading Notes

Ring Reader: J.K.  
Reading Date: 3/10/06

Site ID: Río Grande Village  
Collection Date: Nov. 2006

Tree/Hole ID: 34A  
Slab ID: 13

Ring Counts/Notes:

J2X Filename: RG34AJ2X.txt
Number of radii measured: 2

J2X Series Id: RG34A13A, RG34B13B

D.D. entered into jar

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

J.R. - barrel after 01

Wood Anatomy Change Notes:

RG34AJB - 1996 - 2001  
(cracked center)

'91 - small
'H00 - false ring 4 variable width
'99 - very narrow
'98 - very narrow
'97 - wide

1996 - center w/pitch 3
Big Bend – Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 3/3/67

Site ID: Rio Grande Village  
Collection Date: Nov. 2008

Tree/Hole ID: 34A  
Slab ID: 14

Ring Counts/Notes:

J2X Filename: RG34A1J2X.txt

Number of radii measured: 2

J2X Series Id: RG34A1, RG34A1B

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:  
Start Year: Stop Year: Proportion:  
Start Year: Stop Year: Proportion:

J.R. - bush cut 2 1/2, 1978-80

Wood Anatomy Change Notes:


198 – 2001 – compacted very narrow  
2000 – tight  
199 – wide  
198 – compact with pitch
Big Bend - Ring Reading Notes

Ring Reader: J.R.
Reading Date: 3/16/17

Site ID: Rio Grande Village
Collection Date: Nov. 2007

Tree/Hole ID: 34A
Slab ID: 15
F3/16

Ring Counts/Notes:
J2X Filename: RG34A32x.txt
Number of radii measured: 2
J2X Series Id: RG34A15F, RG34A15B
DD dated 11/30/3X

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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</tbody>
</table>

J.R. - basic line 97, 98+99 compressed very much

Wood Anatomy Change Notes:

Radii A + P - 1995 - 1997

Compressed after 97
97 - wide
96 - cell w/ pitch 3
Big Bend - Ring Reading Notes

Ring Reader: J.K.  
Reading Date: 3/3/97

Site ID: Río Grande Village  
Collection Date: Nov. 2006

Tree/Hole ID: 34A  
Slab ID: 18  
(Top + Bottom combined)

Ring Counts/Notes:

J2X Filename: KG34A52X7RT

Number of radii measured: 2

J2X Series Id: KG34A12A KG34A18B

I.D. central and sax

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion:

Start Year:  
Stop Year:  
Proportion:

Start Year:  
Stop Year:  
Proportion:

J.K. - Banded after 77

Wood Anatomy Change Notes:

Top 1996 + 1997

Center is '96 w/first
Big Bend – Ring Reading Notes

Ring Reader: J.R. 

Reading Date: 3/13/07

Site ID: Rio Grande Village

Collection Date: Nov. 2006

Tree/Hole ID: 34A

Slab ID: 19

Ring Counts/Notes:

J2X Filename: R634A19A.2x.txt

Number of radii measured: 2

J2X Series Id: R634A19A, R634A23.

P. D. Order #5615

Proportion of circumference with secondary growth:

Start Year: .......................... Stop Year: .......................... Proportion: ....................

Start Year: .......................... Stop Year: .......................... Proportion: ....................

Start Year: .......................... Stop Year: .......................... Proportion: ....................

J.R. – Buried Feb. 97 n 76.

Wood Anatomy Change Notes:

Radii A + B - 1995 - 1997

97 - narrow
96 - wide
95 - new center w/ microscopic pitch
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 3/3/07

Site ID: Rin Grande Village  
Collection Date: Sep 2005

Tree/Hole ID: 34A  
Slab ID: 21

(F/3)

Ring Counts/Notes:

12X Filename: RG_34A_12X.txt

Number of radii measured: 2

12X Series Id: RG_34A_21A_20050928

Proportion of circumference with secondary growth:

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<thead>
<tr>
<th>Start Year:</th>
<th>Stop Year:</th>
<th>Proportion:</th>
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</tbody>
</table>

J.R. - dead after '95.

Wood Anatomy Change Notes:


'95 - center w/ good pitch.
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 3/13/86

Site ID: Rio Grande Village  
Collection Date: Nov. 2007

Tree/Hole ID: 34A  
Slab ID: 23 (6/11)

Ring Counts/Notes:

J2x Filename: RG34A32X.txt

Number of radii measured: 2

J2x Series Id: RG34A234 RG34A238

OD Entered into J2X

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

J.R. - band of in '96.

Wood Anatomy Change Notes:

Radii A + B - 1995 - 96.

'95 - center with
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 3/13/67

Site ID: Rin Grande Village
Collection Date: Jan 2006

Tree/Hole ID: 34A  
Slab ID: 25

Ring Counts/Notes:

J2X Filename: RG34A J2X.txt

Number of radii measured: 2

J2X Series Id: RG34A25A R634A25k

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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<tbody>
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</tbody>
</table>

J.R. - trees after 96.

Wood Anatomy Change Notes:

Radii A + B - 95 - 96

95-w/ good pith
Big Bend – Ring Reading Notes

Ring Reader: J.R. Reading Date: 1/23/83
Site ID: K1o Givide Village Collection Date: Nov. 2006
Tree/Hole ID: 34A Slab ID: 26

Ring Counts/Notes:

J2X Filename: R0.34A.J2X.7.xi
Number of radii measured: 2
J2X Series Id: R0.34A.54A R0.34A.52B
DB added to slab sax.

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

J.R. Bumil after 96.

Wood Anatomy Change Notes:

Radii A + B - 1994-96

96 - narrow
95 - wide w/younger center
94 - small, new, older center w/pith
Big Bend - Rio Grande Village

Tree 34A

JR,
3/2007
Pg. 143

<table>
<thead>
<tr>
<th>Size</th>
<th>Code</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>~35cm</td>
<td>RG-34A-0</td>
<td>(stems)</td>
</tr>
<tr>
<td>~4cm</td>
<td>RG-34A-1</td>
<td></td>
</tr>
<tr>
<td>5cm</td>
<td>RG-34A-2</td>
<td>(centres)</td>
</tr>
<tr>
<td>6cm</td>
<td>RG-34A-3</td>
<td></td>
</tr>
<tr>
<td>4cm</td>
<td>RG-34A-4</td>
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<tr>
<td>4.5-6cm</td>
<td>RG-34A-5</td>
<td></td>
</tr>
<tr>
<td>~5cm</td>
<td>RG-34A-6</td>
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<tr>
<td>~4cm</td>
<td>RG-34A-7</td>
<td></td>
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<tr>
<td>4.5cm</td>
<td>RG-34A-8</td>
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<tr>
<td>~4cm</td>
<td>RG-34A-9</td>
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<tr>
<td>6.5cm</td>
<td>RG-34A-10</td>
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<tr>
<td>6.5cm</td>
<td>RG-34A-11</td>
<td></td>
</tr>
</tbody>
</table>

= sand/dirt

= null
**Big Bend - Rio Grande Village**

**TREE 34A**

- 7 cm: RG-34A-12 (Top Sanded)
- ~4 cm: RG-34A-13 (Top Sanded)
- 6.5 cm: RG-34A-14 (Top Sanded)
- 6.5 cm: RG-34A-15 (Top Sanded)
- ~5 cm: RG-34A-16
- 5.5 cm: RG-34A-17 (Top Sanded)
- 2.5 cm: RG-34A-18 (Top + Bottom Sanded)
- 0.5 cm: RG-34A-19 (Top Sanded)
- ~7 cm: RG-34A-20
- ~5 cm: RG-34A-21 (Top Sanded) Head = F/G
- ~10 cm: RG-34A-22
Big Bend - Rio Grande Village

Tree 344

- ~5.5 cm ~5.5 cm ~5 cm ~6 cm

RG-34A-23 (Top: Sanded Side)

RG-34A-24

RG-34A-25

RG-34A-26

J.R.
3/2002
RG-34A
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 5/18/07  
Collection Date: Jan. 2007  
Site ID: Rio Grande Village 
Tree/Hole ID: 34B  
Slab ID: GS

Ring Counts/Notes:
J2X Filename: RG34B_J2X.txt
Number of radii measured: 2
J2X Series Id: RG34B_GSA, RG34B_GSB

J.R. - Recorded radii A+B into J2X.

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
</tr>
</thead>
</table>

Wood Anatomy Change Notes:

Radii A+B - 1997 - 2006

- 06 - wide
- 04/05 - narrow
- Radii A+B - wide
- 02 - wide w/ false ring
- 01 - wide
- 2000 - wide w/ false ring

- Wood surface questionable since quiet yrs after 2000
- Check through center
- Stem elongated

97 - 99 - wide w/ false rings
97 - center w/ pitch 0
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 5/18/07

Site ID: Rio Grande Village  
Collection Date: Jan. 2007

Tree/Hole ID: 34B  
Slab ID: 1

(2 centers)

Ring Counts/Notes:

J2X Filename: RG34B J2X.txt

Number of radii measured: 2

J2X Series Id: RG 34B 1A, RG 34B 1B

J.R. - Recorded radii A + B into J2X.

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion:

Start Year:  
Stop Year:  
Proportion:

Start Year:  
Stop Year:  
Proportion:

Wood Anatomy Change Notes:

Radii A + B - 1997 - 2006

Radii A

03 - 06 - narrow
02 - wider
01 - wide
97 - 2000 - wide w/ false rings
97 - center w/ good pith ⊗

Radii B

04 - 06 - wide
02 - very wide
02 - wide w/ false ring
97 - narrower w/ false ring
97 - 2000 - wide w/ false rings
97 - center w/ good pith ⊗
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 5/18/07

Site ID: Rio Grande Village
Collection Date: Jan. 2007

Tree/Hole ID: 34B  
Slab ID: 3  (B/c)

Ring Counts/Notes:

J2X Filename: RG34B32X.txt
Number of radii measured: 2

J2X Series Id: RG34B3A, RG34B3B

J.R. - Recorded radii A+B into J2X.

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion:  
Start Year:  
Stop Year:  
Proportion:  
Start Year:  
Stop Year:  
Proportion:

J.R. - Burial after 04.
Maka - burial after 04.

Wood Anatomy Change Notes:

Radii A+B - 1997 - 06

'97-'03 - all wide
'02 - false ring
'00 - cracked; injury
'97-'99 - false ring

97 - crack w/ with 0
Big Bend - Ring Reading Notes

Ring Reader: J.R. Reading Date: 5/18/07

Site ID: Rio Grande Village Collection Date: Jan. 2007

Tree/Hole ID: 34B Slab ID: 6

(Bottom Sanded)(c/d)

Ring Counts/Notes:

J2X Filename: RG 34B J2X.txt

Number of radii measured: 2

J2X Series Id: RG 34B6 A, RG 34B6 B

J.R. - Recorded radii A & B into J2X.

Proportion of circumference with secondary growth:

Start Year: _______ Stop Year: _______ Proportion: _______

Start Year: _______ Stop Year: _______ Proportion: _______

Start Year: _______ Stop Year: _______ Proportion: _______

J.R. - Buried after 03.

M.S. - Buried after 03 pseudoekater.

Wood Anatomy Change Notes:


97 - 03 - w.r.

01 & 02 - darker wood

2000 - crack, injury

98 & 99 - lower ring fold, fiber injury in 98

96 - small new center on 96th 9
Big Bend - Ring Reading Notes

Ring Reader: J.R.          Reading Date: 5/18/07
Site ID: Rio Grande Village           Collection Date: Jan. 2007
Tree/Hole ID: 34B               Slab ID: 8

Ring Counts/Notes:
J2X Filename: RG34B72X.txt
Number of radii measured: 2
J2X Series Id: RG34B7A, RG34B7B

J.R. - Recorded radii A + B into J2X.

Proportion of circumference with secondary growth:

Start Year:        Stop Year:        Proportion:
Start Year:        Stop Year:        Proportion:
Start Year:        Stop Year:        Proportion:

M.S. - Buried after 03 partial in 03 also

Wood Anatomy Change Notes:

on 'B', '02 + '03 - Similar
'01 - large, darker wood, wide false ring
'98 - '00 - bits of false rings,
2000 - Injury
1996 - center, small width @
Big Bend - Ring Reading Notes

Ring Reader: J.R.  

Reading Date: 5/18/07  

Site ID: Rio Grande Village  

Collection Date: Jan. 2007  

Tree/Hole ID: 348  

Slab ID: 9  

(Top + Bottom Sanded)

Ring Counts/Notes:

12X Filename: RG34B3J2X.txt

Number of radii measured: 2

12X Series Id: RG34B9A, RG34B9B

J.R. - Recorded radii A+B into J2X.

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

M.S. - Burial after '02.

Wood Anatomy Change Notes:

Top: Radii: A+B - 1996-2002

2001 - wide, dark wood
197 - 2000 - wide opposite ring bits
96 - center width
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 5/13/07

Site ID: Rio Grande Village  
Collection Date: Jan. 2007

Tree/Hole ID: 34B  
Slab ID: 11 (1F)

Ring Counts/Notes:

12X Filerame: RG34B J2X, .txt

Number of radii measured: 2

12X Series Id: RG34B 11A, RG34B 11B

J.R. - Recorded radii A+B into J2X.

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

J.R. - Buried after '02, possibly earlier also.
M.S. - Buried after '02 & period by 01 after 2000.

Wood Anatomy Change Notes:

Radii A+B - 1996 - 2002

'01 & '02 - similar  
2000 - false ring  
'96-'97 - wide  
'97-'99 - false rings  
'96 - center of small pitch 0
Big Bend - Ring Reading Notes

Ring Reader: J.R. Reading Date: 5/19/07
Site ID: Rio Grande Village Collection Date: 1/6 Jan 2007
Tree/Hole ID: 34B Slab ID: 13

Ring Counts/Notes:

J2X Filename: RG34B J2X.txt
Number of radii measured: 2
J2X Series Id: RG34B13A, RG34B13B

J.R. - Recorded radii A + B into J2X.

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
J.R. - buried after 1999,
M.S. - buried after 2000, 99-partial burial,

Wood Anatomy Change Notes:

2000- narrower '99 - narrower
'98 - wide w/fore rings '97 - wide w/fore rings in late wood.
'96 - center w/fore rings & pith.
Big Bend - Ring Reading Notes

Ring Reader: J.R. Reading Date: 5/18/07
Site ID: Rio Grande Village Collection Date: 1/3/2007
Tree/Hole ID: 34B Slab ID: 14

Ring Counts/Notes:

J2X Filename: RG34B14A J2X.txt
Number of radii measured: 2
J2X Series Id: RG34B14A, RG34B14B
J.R. - Recorded radii A + B into J2X.

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year:</th>
<th>Stop Year:</th>
<th>Proportion:</th>
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</table>

M.S. - burned after 2000 + partial in '99

Wood Anatomy Change Notes:

Radius A - 1996-1999

Radius B - 1996-2001

1999 - narrow
98 - wide w/false ring
97 - wide w/false ring
96 - wide center w/pitch &
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 5/18/07

Site ID: Río Grande Village  
Collection Date: Jan. 2007

Tree/Hole ID: 34B  
Slab ID: 15  
(Top sanded)

Ring Counts/Notes:

12X Filename: RG34B J2x.txt

Number of radii measured: 2

12X Series Id: RG34B15A, RG34B15B

J.R. - Recorded radii A+B into J2x.

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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</tbody>
</table>

J.R. - broad after 99.

M.S. - broad after partially 97 + strong after 99.

Wood Anatomy Change Notes:

Radii A+B - 1996 - 1999

'99 - narrow
'98 - wide with false ring
'97 - wide with false ring
'96 - wide center of small pith & false ring.
Big Bend - Ring Reading Notes

Ring Reader: J.R.                                      Reading Date: 5/18/07
Site ID: Rio Grande Village                           Collection Date: Jan. 2007
Tree/Hole ID: 34B                                     Slab ID: 14

Ring Counts/Notes:

J2X Filename: RG 34B J2X.txt
Number of radii measured: 2
J2X Series Id: RG 34B/6A, RG 34B/6B

J.R. - Recorded radii A + B into J2X.

Proportion of circumference with secondary growth:

Start Year:          Stop Year:          Proportion:
Start Year:          Stop Year:          Proportion:
Start Year:          Stop Year:          Proportion:

J.R. - Beginning after '77 or '78.
R.S. - But it after '77.

Wood Anatomy Change Notes:

'98 - Wide with bit of false ring
'97 - False ring
'96 - False ring
'95 - Small of tiny lines
'94 - New center with small pith
Big Bend - Ring Reading Notes

Ring Reader: J.K.  
Reading Date: 5/18/07

Site ID: Rio Grande Village  
Collection Date: Jan. 2007

Tree/Hole ID: 34B  
Slab ID: 18

(F/G)

Ring Counts/Notes:

J2X Filename: RG348J2X.txt

Number of radii measured: 2

J2X Series Id: RG34B18A, RG34B18B

J.K. - Recorded radii A+B into J2X.

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

JR - Burned after 96.
MS - Built after

Wood Anatomy Change Notes:

Radii A + B ~ 1994 - 1996
94 - wide with pitch
95 - tiny false rings
96 - false ring
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 5/17/07

Site ID: Río Grande Village  
Collection Date: Jan. 2007

Tree/Hole ID: 34B  
Slab ID: 20  
(Top and Bottom Sanded)

Ring Counts/Notes:

J2X Filename: RG34B_J2X.txt

Number of radii measured: 2

J2X Series Id: RG34B20A, RG34B20B

J.R. recorded radii A + B into J2X.

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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</tbody>
</table>

J.R. - Burn after '96
M.S. - Burn after '96

Wood Anatomy Change Notes:

96 - False rings
95 - Tiny false rings
94 - Center widening w/pith ☑
Big Bend - Ring Reading Notes

Ring Reader: J.R.  Reading Date: 5/18/07
Site ID: Rio Grande Village  Collection Date: Jan. 2007
Tree/Hole ID: 34B  Slab ID: 23

Ring Counts/Notes:

12X Filename: RG34B,12X,2XT
Number of radii measured: 2
12X Series Id: RG34B23A, RG34B23B

J.R. - Recorded radii A + B into 12X.

Proportion of circumference with secondary growth:

Start Year:  Stop Year:  Proportion:
Start Year:  Stop Year:  Proportion:
Start Year:  Stop Year:  Proportion:
Burst in '96

Wood Anatomy Change Notes:
Radii A + B - 1994 - '95,

'95 - false ring
'94 - center still has pith, but some not present.
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 

Site ID: Río Grande Village  
Collection Date: Jan. 2007  
Tree/Hole ID: 34B  
Slab ID: 24

Ring Counts/Notes:

J2X Filename:

Number of radii measured: 

J2X Series Id: 

NO J2X

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion:  
Start Year:  
Stop Year:  
Proportion:  
Start Year:  
Stop Year:  
Proportion:  

Wood Anatomy Change Notes:

'94 + '95 present & still stem wood. Center rotted so pith unseen.

'94 - may be estab. yh. May still be a year or 2 extending into clay but stem too rotted to call for sure.
BIG BEND - RIO GRANDE VILLAGE

TREE 34B

RG-34B - 6

RG-34B - 7

RG-34B - 8

RG-34B - 9

RG-34B - 10

RG-34B - 11

RG-34B - 12

RG-34B - 13

cont. →
<table>
<thead>
<tr>
<th>Big Bend - Rio Grande Village</th>
<th>J.R.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TREE 348</td>
<td>7/17</td>
</tr>
<tr>
<td>5cm. RG-34B-23 (Top Seeded)</td>
<td>7/17</td>
</tr>
<tr>
<td>8cm. RG-34B-24 (Top Seeded)</td>
<td>7/17</td>
</tr>
</tbody>
</table>

Note: RG-34B-23 and RG-34B-24 are likely referring to specific tree or plant species, with the notation indicating some form of treatment or identification.
Big Bend - Ring Reading Notes

Ring Reader: J.R.  Reading Date: 5/19/07
Site ID: Rio Grande Village  Collection Date: Jan. 2007
Tree/Hole ID: 35  Slab ID: G S

Ring Counts/Notes:

J2X Filename: RG35J2X.txt

Number of radii measured: 2
J2X Series Id: RG35GSA, RG35GSB

JKI-Recorded radii A + B into J2X.

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:  
Start Year: Stop Year: Proportion:  
Start Year: Stop Year: Proportion:  

Wood Anatomy Change Notes:

Radii A & B > 2000-2006
2005 - wider
2004 - wider w/false ring
02 & 03 - wider, similar
03 & 04 - wider w/false rings
2000 - center w/good pitch
Big Bend – Ring Reading Notes

Ring Reader: J.R.                                      Reading Date: 5/9/07
Site ID: Rio Grande Village                          Collection Date: Jan. 2007
Tree/Hole ID: 35                                       Slab ID: 2

Ring Counts/Notes:
J2X Filename: RG35J2X:J2X
Number of radii measured: 2
J2X Series Id: RG352A, RG352B

J.R. - Combined radii A+B into J2X.

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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</tbody>
</table>

M.S. - Evidence of slight burial after '04.

Wood Anatomy Change Notes:

Radii A+B 2000 - 2006

2006 - wider
2004 - wider with false rings
2003 - wider, similar
2002 - wider with false rings
2000 - central with good pith (?)
Big Bend - Ring Reading Notes

Ring Reader: J.K. 

Site ID: Rio Grande Village

Tree/Hole ID: 35

Reading Date: 5/9/07

Collection Date: Jan. 2007

Slab ID: 3

Ring Counts/Notes:

J2X Filename: RG35J2X.txt

Number of radii measured: 2

J2X Series Id: RG35ZA, RG35ZB

J.K. - entered under A+B into J2X.

Proportion of circumference with secondary growth:

Start Year: 
Stop Year: 
Proportion: 

Start Year: 
Stop Year: 
Proportion: 

Start Year: 
Stop Year: 
Proportion: 

45 - Slight burr on 84.

Wood Anatomy Change Notes:

Radii: A+E - 2000-2006

56 - wide

04 - wide of false rings

02 - '03 - similar

01 - false rings

2000 - center w/good pitch
Big Bend - Ring Reading Notes

Ring Reader: J.K.  
Reading Date: 5/9/07
Site ID: Rio Grande Village  
Collection Date: Jan. 2007
Tree/Hole ID: 35  
Slab ID: 5

Ring Counts/Notes:

J2X Filename: RG355J2X.txt
Number of radii measured: 2
J2X Series Id: RG355A, RG355B

J.K. - Recorded radii A+B into J2X.

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

M.S. - budir after 04 & partial w/in 04,

Wood Anatomy Change Notes:

Radii A+B - 2000-2006
06 - wide, but narrowing
05 - narrower
04 - wide
03 + 02 - similar, 03 false ring
01 - wide w/false ring
2000 - center w/pith 0
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 5/9/07

Site ID: Rio Grande Village  
Collection Date: Jan. 2007

Tree/Hole ID: 35  
Slab ID: 7

Ring Counts/Notes:

12X File Name: R G 35 J2X EXT

Number of radii measured: 2

12X Series Id:

Don't J2X

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion:

Start Year:  
Stop Year:  
Proportion:

Start Year:  
Stop Year:  
Proportion:

J.R. - Burned after 04
M.S. - Burned after 03

Wood Anatomy Change Notes:

Radii A - 1996 - 2000  
Radii B - 1996 - 2003

Wood broken
Big Bend – Ring Reading Notes

Ring Reader: J.R.  Reading Date: 5/9/07
Site ID: K:0 Grande Village  Collection Date: Jan. 2007
Tree/Hole ID: 35  Slab ID: 8

Ring Counts/Notes:

12X Filename: RG35J2X.txt
Number of radii measured: 2
12X Series Id: RG35PA, RG35PB

J.R. recorded radii A+B into J2X.

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

J.R. Buried after '03.
Mi. Buried after '03

Wood Anatomy Change Notes:
Radii A+B - 1996 – 2004
Big Bend – Ring Reading Notes

Ring Reader: J.R.                                      Reading Date: 5/9/07

Site ID: Rio Grande Village                           Collection Date: Jan. 2007

Tree/Hole ID: 35                                      Slab ID: 9

Ring Counts/Notes:

J2X Filename: RE35J2X.txt

Number of radii measured: 2

J2X Series Id: RE359A, RE359B

\textit{J.R. - traced radii A+B into J2X.}

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

\textit{J.R. - Drawn Jan. 03.}

\textit{M.S. - Burial}

Wood Anatomy Change Notes:

\textit{Radius A - 1976 - 2004}

<table>
<thead>
<tr>
<th>Year</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>'98</td>
<td>Ring increment invisible</td>
</tr>
<tr>
<td>'97</td>
<td>White</td>
</tr>
<tr>
<td>'96</td>
<td>White, center w/ pitch</td>
</tr>
</tbody>
</table>

\textit{Radius B - 1996 - 2003}

<table>
<thead>
<tr>
<th>Year</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>'98</td>
<td>Ring increment invisible</td>
</tr>
<tr>
<td>'97</td>
<td>White</td>
</tr>
<tr>
<td>'96</td>
<td>White, center w/ pitch</td>
</tr>
</tbody>
</table>
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 5/9/07

Site ID: Rio Grande Village  
Collection Date: Jan. 2007

Tree/Hole ID: 35  
Slab ID: 10

Ring Counts/Notes:

12X Filename: \textit{RG35J2X, E2X}  
Number of radii measured: 2

12X Series Id: \textit{RG3510A, RG3510B}

J.R.: Recorded radii \textit{A + B} into J2X.

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Year</td>
<td>Stop Year</td>
<td>Proportion</td>
</tr>
<tr>
<td>Start Year</td>
<td>Stop Year</td>
<td>Proportion</td>
</tr>
</tbody>
</table>


m.s.: Buried after 1996, partially in 02

Wood Anatomy Change Notes:

<table>
<thead>
<tr>
<th>Radii: \textit{A + B}</th>
<th>1996 - 2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>'03 - wide</td>
<td>'97 - wide</td>
</tr>
<tr>
<td>'02 - thick ring</td>
<td>'96 - center of small, dark pith</td>
</tr>
<tr>
<td>'01 - wide diffuse ring</td>
<td></td>
</tr>
<tr>
<td>2000 - wide diffuse ring</td>
<td></td>
</tr>
<tr>
<td>'99 - narrow</td>
<td></td>
</tr>
<tr>
<td>'98 - very narrow diffuse ring</td>
<td>narrow</td>
</tr>
</tbody>
</table>
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 5/9/07

Site ID: Río Grande Village  
Collection Date: Jan. 2007

Tree/Hole ID: 35  
Slab ID: 12

Ring Counts/Notes:

J2X Filename: RG35J2X.EXT

Number of radii measured: 2

J2X Series Id: RG3512A, RG3512B

J.R. - Pended radii A & B into J2X.

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

J.R. - Cream of 1000.
M.S. - Burned after 2000.

Wood Anatomy Change Notes:

Radii A & B - 1996 - 2003

- Increase width
- Narrow
- Trunk wider
- Twigs wider
- Stems wider
- Twigs narrower
- Vines
- Injury
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 5/14/07

Site ID: Rio Grande Village  
Collection Date: Jan. 2007

Tree/Hole ID: 35  
Slab ID: 13

Ring Counts/Notes:

J2X Filename: RG35J2x.txt

Number of radii measured: 2

J2X Series Id: RG3513A, RG3513B

J.R. - Recorded radii A+B int J2X.

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

J.R. - basal after 2000.

MS - basal after 2000.

Wood Anatomy Change Notes:

Radii A+B - 1996 - 2000

2000 - narrowing
'99 - '98 - none

'97 or '98 - injury

96 - center w/damaged fibers
Big Bend - Ring Reading Notes

Ring Reader: J.K.  
Reading Date: 5/14/07

Site ID: Rio Grande Village  
Collection Date: Jan. 2007

Tree/Hole ID: 35  
Slab ID: 14

Ring Counts/Notes:

I2X Filename: RG35J2X.txt

Number of radii measured: 2

I2X Series Id: RG3514A, RG3514B

J.R. - Recorded radii A+B into J2X.

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>


M.S., buried after 2000.

Wood Anatomy Change Notes:

Radii: A+B - 1996 - 2000

199+ 2000 - Increment
198 - very narrow
197 - wide
196 - wide center with decay
Big Bend - Ring Reading Notes

Ring Reader: J.K. 

Reading Date: 5/14/07 

Site ID: Río Grande Village 

Collection Date: Jan. 2007 

Tree/Hole ID: 35 

Slab ID: 15 

(F3/F)

Ring Counts/Notes:

J2X Filename: RG352X.txt 

Number of radii measured: 2 

J2X Series Id: KG3515A, KG3515B 

J.K. - Measured radii A+B into J2X. 

Proportion of circumference with secondary growth:

Start Year: 

Stop Year: 

Proportion: 

Start Year: 

Stop Year: 

Proportion: 

Start Year: 

Stop Year: 

Proportion: 

J.K. - buriel after '97 

M.S. - burial later '98 

Wood Anatomy Change Notes:

Radii A+B - 1996-98 

'98 - extreme narrow 

'97 - narrowing 

'96 - wide center w/ good pit & false ring
# Big Bend - Ring Reading Notes

<table>
<thead>
<tr>
<th>Ring Reader: J.R.</th>
<th>Reading Date: 5/14/07</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site ID: Rio Grande Village</td>
<td>Collection Date: Jan. 2007</td>
</tr>
<tr>
<td>Tree/Hole ID: 35</td>
<td>Slab ID: 17 (F16)</td>
</tr>
</tbody>
</table>

### Ring Counts/Notes:

- **12X Filename:** KG35J2X.txt
- **Number of radii measured:** 2
- **12X Series Id:** KG3517A, KG3517B

J.R. - Recorded radii A + B into J2X.

### Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1976</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

J.R. - Buried after '77.

MS1 - Buried after '77 partially in '97

**Wood Anatomy Change Notes:**

- Radii A + B - 1996-1997
- '96 - center w/work, wide
- '97 - narrow
Big Bend - Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 5/14/07

Site ID: Río Grande Village  
Collection Date: Jan. 2007

Tree/Hole ID: 35  
Slab ID: 19 (G/H)

Ring Counts/Notes:

J2X Filerame: RG35J2X.txt

Number of radii measured: 2

J2X Series Id: RG3519A, RG3519B

J.R. - Recorded radii A+B into J2X.

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

J.R. - burial after '96.
MiSi - burial after '96
Wood Anatomy Change Notes:

Radii A+E - 1996 - '97

'96 - center of good pith + false ring,
'97 - normal
Big Bend – Ring Reading Notes

Ring Reader: J.R.  
Site ID: Rio Grande Village 
Tree/Hole ID: 35  
Reading Date: 5/4/07 
Collection Date: Jan. 2007  
Slab ID: 21

Ring Counts/Notes:

J2X Filename: RG35J2X.TXT

Number of radii measured: 2 
J2X Series Id: RG3521A, RG3521B

JKI - Revised radii A+B into J2X.

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
</tr>
</thead>
</table>

JKI, burned after 96.
M.S. - burned after 96
Wood Anatomy Change Notes:

Radii A+B – 1996

'96 - wide center w/ pith (oblongated)
'97 - visible necrosis
Big Bend - Ring Reading Notes

Ring Reader: J.K.  Reading Date: 5/14/07

Site ID: Rio Claude Village
Collection Date: Jan. 2007

Tree/Hole ID: 35  Slab ID: 23

Ring Counts/Notes:

J2X Filename: KG35J2X.txt

Number of radii measured: 2

J2X Series Id: KG35 23 A, KG35 23 B

J.K. - Recorded radii A + B into J2X.

Proportion of circumference with secondary growth:

Start Year:  Stop Year:  Proportion:
Start Year:  Stop Year:  Proportion:
Start Year:  Stop Year:  Proportion:

J & J. - burned after '96.
M.S. - burned after '96.

Wood Anatomy Change Notes:

Radius A - 1996 - '97
97 - wide late wood
96 - wide center of good pitch + thin ring.

Radius B - '96
96 - wide center, light wood.
Big Bend – Ring Reading Notes

Ring Reader: J.R.  
Reading Date: 5/14/07

Site ID: Rio Grande Village
Collection Date: Jan. 2007

Tree/Hole ID: 35  
Slab ID: 24  
(Bottom Sanded)

Ring Counts/Notes:

12X Filerame: RG35J2X.txt
Number of radii measured: 2

12X Series Id: RG3524A, RG3524B

J.R. - Recorded radii A + B into J2X.

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Wood Anatomy Change Notes:

Radii A+B - 1996

96 - large center with pitch 0
Big Bend - Ring Reading Notes

Ring Reader: J.R.  Reading Date: 5/14/07
Site ID: Rio Grande Village  Collection Date: Jan. 2007
Tree/Hole ID: 35  Slab ID: 25
(Top + Bottom Samples)

Ring Counts/Notes:

J2X Filename: RE35J2X4XT

Number of radii measured:

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year:  Stop Year:  Proportion:
Start Year:  Stop Year:  Proportion:
Start Year:  Stop Year:  Proportion:

Wood Anatomy Change Notes:

Top - Pith present
Bottom - Appears to be all root:
Est. 1996
Big Bend – Ring Reading Notes

Ring Reader: J.K.                                    Reading Date: 5/14/07
Site ID: Rio Grande Village                          Collection Date: Jan. 2007
Tree/Hole ID: 35                                      Slab ID: 26
                                                      (Bottom sanded)

Ring Counts/Notes:

12X Filename:

Number of radii measured:

12X Series Id:

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Wood Anatomy Change Notes:

Estab. 1996 - between Top & Bottom of thin piece.

All Root
Big Bend - Rio Grande Village

TREE 35

- RG 35-6: D = R eed G S
- RG 35-1
- RG 35-2: (Top Sanded)
- RG 35-3: B = R eed B/c
- RG 35-4
- RG 35-5: (Top Sanded)
- RG 35-6: (2 coats 2 eelers)
- RG 35-7: (Top Sanded)
- RG 35-8

Cont. →
<table>
<thead>
<tr>
<th>Depth</th>
<th>Code</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.5-7cm</td>
<td>RG-35-9</td>
<td>(Top Sanded) $\Box = nail F/F_3$</td>
</tr>
<tr>
<td>7.5cm</td>
<td>RG-35-10</td>
<td>(Top Sanded)</td>
</tr>
<tr>
<td>8.5cm</td>
<td>RG-35-11</td>
<td></td>
</tr>
<tr>
<td>9cm</td>
<td>RG-35-12</td>
<td>(Top Sanded)</td>
</tr>
<tr>
<td>7cm</td>
<td>RG-35-13</td>
<td>(Top Sanded)</td>
</tr>
<tr>
<td>6.5cm</td>
<td>RG-35-14</td>
<td>(Top Sanded)</td>
</tr>
<tr>
<td>6.5cm</td>
<td>RG-35-15</td>
<td>(Top Sanded) $\Box = nail F_2/F$</td>
</tr>
<tr>
<td>19cm</td>
<td>RG-35-16</td>
<td></td>
</tr>
<tr>
<td>6.5cm</td>
<td>RG-35-17</td>
<td>(Top Sanded) $\Box = nail F/F_5$</td>
</tr>
</tbody>
</table>

cont.
Big Bend – Rio Grande Village

**TREE 35**

<table>
<thead>
<tr>
<th>Size (cm)</th>
<th>Sample ID</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>RG-35-18</td>
<td>(Top Sanded)</td>
</tr>
<tr>
<td>6.5</td>
<td>RG-35-19</td>
<td>@ = haid G/H</td>
</tr>
<tr>
<td>13</td>
<td>RG-35-20</td>
<td></td>
</tr>
<tr>
<td>~6</td>
<td>RG-35-21</td>
<td>(Top Sanded)</td>
</tr>
<tr>
<td>~8</td>
<td>RG-35-22</td>
<td>@ = haid H/I w/s</td>
</tr>
<tr>
<td>~11</td>
<td>RG-35-23</td>
<td>(Top Sanded)</td>
</tr>
<tr>
<td>~13</td>
<td>RG-35-24</td>
<td>(Bottom Sanded)</td>
</tr>
<tr>
<td>~12</td>
<td>RG-35-25</td>
<td>(Top &amp; Bottom Sanded)</td>
</tr>
<tr>
<td>~9</td>
<td>RG-35-26</td>
<td>(Bottom Sanded) - root</td>
</tr>
</tbody>
</table>
Big Bend - Ring Reading Notes

Ring Reader: Irwin
Reading Date: Nov.

Site ID: Castolon
Collection Date: Feb. 2008

Tree/Hole ID: 15
Slab ID: GS

Ring Counts/Notes:

J2X Filename: CS15 J2X.txt
Number of radii measured: 2

J2X Series Id: CS15GSA, CS15GSB

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes: (1998 - 2007)
2007 - med.
06 - regrowth
05 - med, ultrafine ring x3ent.
04 - med, ultrafine ring x2ent.
03 - med, ultrafine ring x1ent.
02 - med, ultrafine, fine ring x4way.
01 - med, ultrafine ring x4 way.
00 - ultrafine ring x4 way.
99 - ultrafine
98 - center, brown, normal pitch.
Big Bend - Ring Reading Notes

Ring Reader: L. Roth
Reading Date: 

Site ID: Castolon
Collection Date: Feb. 2008

Tree/Hole ID: 15
Slab ID: 3 \( \frac{E_{118}}{E_{237}} \)

Ring Counts/Notes:

J2X Filename: CS15 J2X.txt

Number of radii measured: 2

J2X Series Id: CS153 A, CS153 B

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes: (1997 - 2007)

2007 - wider
- 06 - med, wide; 1/2 ring w/3/4 cut
- 05 - wider, wide; 1/2 ring w/3/4 cut
- 04 - wide; wide; 1/2 ring w/3/4 cut
- 03 - med, wide; ring w/3/4 cut
- 02 - med, wide; ring in late yrs.
- 01 - med, wide; ring in late yrs.

2000 - narrower
- 99 - wider
- 98 - wider
- 97 - New center, small, cracked within fifth.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date:
Site ID: Castolon
Collection Date: Feb. 2008
Tree/Hole ID: 15
Slab ID: 4

Ring Counts/Notes:

J2X Filename: CS15J2X.txt

Number of radii measured: 2

J2X Series Id: CS154A, CS154B

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes: (1997 - 2007)

2007 - wide
2006 - med, w/take ring 74%
2005 - med, w/take ring 74%
04 - wide, w/take ring 74%
03 - med, w/prominent take ring n/s way
02 - med, w/take ring in late yrs
01 - med, w/take ring in late yrs
2000 - narrower
99 - wide
98 - wide
97 - center, small, cracked
writing path
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date: 

Site ID: Castolon
Collection Date: Feb. 2008

Tree/Hole ID: 15
Slab ID: 5 (E4/3)

Ring Counts/Notes:

J2X Filename: CS155A, CS155B

Number of radii measured: 2

Proportion of circumference with secondary growth:

Start Year: 
Stop Year: 
Proportion: 

Start Year: 
Stop Year: 
Proportion: 

Start Year: 
Stop Year: 
Proportion: 

Wood Anatomy Change Notes: (1997 - 2007)

2007 - wide slightly limited.  
06 - med, wide false ring v. weak  
05 - wide, 8 false rings v. 7 solid  
04 - wide, 10 false rings v. solid  
03 - wide, prominent false ring v. solid  
02 - wide false ring in late yrs.  
01 - med, wide false ring in late yrs.  
'00 - med. bit of false ring.  
99 - wide  
98 - med.  
97 - center, crooked w/pith.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date: 

Site ID: Castolon
Collection Date: Feb. 2008

Tree/Hole ID: 15
Slab ID: 6 (E4, E5)

Ring Counts/Notes:

J2X Filename: CS15J2X.txt

Number of radii measured: 2

J2X Series Id: CS156A, CS156B

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
</tr>
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<tbody>
<tr>
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<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Wood Anatomy Change Notes: (1997 - 2007)

2007 - Mid, abnormal
2006 - Mid, #1 close ring w/3% wide, slight overlap
25 - Wide #1 close ring w/3% wide, Jensen
24 - Wide, #1 close ring w/3% wide
23 - Wide, prominent false ring w/3% wide
22 - Wide, false ring in late yrs.
21 - Mid, #1 close ring date unsure
2000 - mid, #1 close ring date unsure
1999 - Wide

98 = Wide
97 = Center, crack, tiny paths
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Reading Date: __________

Site ID: Castolon

Collection Date: Feb. 2008

Tree/Hole ID: 15

Slab ID: 8 (E3/E2)

Ring Counts/Notes:

J2X Filename: c515j2x.txt

Number of radii measured: 2

J2X Series Id: c5158a, c5158b

Proportion of circumference with secondary growth:

Start Year: __________ Stop Year: __________ Proportion: __________

Start Year: __________ Stop Year: __________ Proportion: __________

Start Year: __________ Stop Year: __________ Proportion: __________

Wood Anatomy Change Notes: (1997-2007)

2005-07 - Hallowing - Buried,
04 - Wide w/false ring -- 2/4 out,
03 - Wide w/pontoon false ring on bark,
02 - Wide w/false ring late in yr.,
01 - med. w/false ring in late yr.,
2000 - nbd.,
99- wide
98- wide
97- Ceru, cracked w/ by pith.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth  
Reading Date: 

Site ID: C35L010  
Collection Date: Feb. 2008  

Tree/Hole ID: 15  
Slab ID: 9 (E? E2)  

Ring Counts/Notes:

J2X Filename: C35J2X.ENC  

Number of radii measured: 2  

J2X Series Id: C359A, C359B  

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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Wood Anatomy Change Notes: (1997 - 2004)

2000 - med.  
99 - Very wide  
98 - Wide  
97 - Center cracked with pitch.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Reading Date: 

Site ID: Cas talon

Collection Date: Feb. 2008

Tree/Hole ID: 15

Slab ID: 10 (E2)

Ring Counts/Notes:

J2X Filename: CS15 J2X1X4

Number of radii measured: 2

J2X Series Id: CS1510A, CS1510B

Proportion of circumference with secondary growth:

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<tr>
<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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Wood Anatomy Change Notes: (1997 - 2004)

2001 - med, slight bands, early ring late.
03 - wide prominent false ring near - damage on Radius E.
02 - wide
01 - narrow false ring in late 91.
2000 - med.,
99 - med/wide
98 - med/wide
97 - center, broad and w/ small pith.
Big Bend - Ring Reading Notes

Ring Reader: J Roth
Reading Date: __________

Site ID: Castalon
Collection Date: Feb. 2008

Tree/Hole ID: 15
Slab ID: 11 (E D)

Ring Counts/Notes:

J2X Filename: c515j2x.txt

Number of radii measured: 2

J2X Series Id: c51511A, c51511B

Proportion of circumference with secondary growth:

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<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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Wood Anatomy Change Notes: (1997 - 2004)

'93 - wide inner false ring, n/3 out.
'02 - wide
'01 - narrower w/ false ring in late Aug.
'99 - med.
'98 - wide, brown
'97 - center lot of false rings w/pith.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth  
Reading Date: 

Site ID: Castolon  
Collection Date: Feb. 2008  

Tree/Hole ID: 15  
Slab ID: 14 (c3) (c2) 

Ring Counts/Notes: 

J2X Filename: cS15J2X.txt  
Number of radii measured: 2  
J2X Series Id: cS1514A, cS1514B 

Proportion of circumference with secondary growth:  

Start Year: 
Stop Year: 
Proportion: 

Start Year: 
Stop Year: 
Proportion: 

Start Year: 
Stop Year: 
Proportion: 


- 2003 - med. paired bands  
- 2002 - narrow on 2, wide on A  
- Faint false ring in dates 98  
- 01 - wide w/ thick ring in late yr, slight band sign  
- 2000 - wide  
- 99 - wide, very  
- 98 - wide  
- 97 - center cracked w/pith
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Reading Date:

Site ID: Castlen

Collection Date: Feb. 2008

Tree/Hole ID: 15

Slab ID: 15 (B)

Ring Counts/Notes:

J2X Filename: CS15J2X.EXT

Number of radii measured: 2

J2X Series Id: CS1515A, CS1515B

Proportion of circumference with secondary growth:

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<th>Start Year:</th>
<th>Stop Year:</th>
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2003 - Resineous on B
2002 - Some burls in 03+02
2001 - Wide w/true ring - 3/4 out, slight burls.
2000 - Slight false ring, mid/late
99 - Very wide, bit of false ring
98 - Very wide
97 - Center w/both, bit of false ring
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Site ID: Castolon

Tree/Hole ID: 15

Reading Date:

Collection Date: Feb. 2008

Slab ID: 18

(multi centered)

- Bottom switches to another stem -

(Shown on drawing of CS/15/17)

Ring Counts/Notes:

J2X Filename: CS/15J2X.txt

Number of radii measured: 2

J2X Series Id: CS/15/18A, CS/15/18B

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: (1997 - 2001)

2001 - Buried under C. false ring n-74 out.
2000 - Wide - Buried
1999 - Wide, slight Buried.
98 - Very Wide.
97 - Growing Center w/False ring & pith.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Site ID: Castolon

Tree/Hole ID: 15

Reading Date:

Collection Date: Feb. 2008

Slab ID: 19 (c3)

Ring Counts/Notes:

J2X Filename: CS15J2X.txt

Number of radii measured: 2

J2X Series ID: CS1519A, CS1519B

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes:

Radix A - 1997-2000

97-98 - wide, vertical, false rings.
98 - wide, mixed colors.
99 - wide, slight burned, partial false rings.
2000 - wide, burned, partial false rings.

Radix B - 1994-2000

2000 - less wide than 1997, burned, false rings.
99 - wide, slight burned, partial false rings.
98 - wide, unwashed colors.
97 - burned, burned, uncture ring in base 97.
96 - burned.
95 - medium, cracked, false ring, art.
94 - medium, cracked, pith.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date: 

Site ID: Castldon
Collection Date: Feb. 2008

Tree/Hole ID: 15
Slab ID: 20 (C4/C3)

Ring Counts/Notes:

J2X Filename: CS15J2X.txt

Number of radii measured: 2

J2X Series Id: CS1520A, CS1520B

Proportion of circumference with secondary growth:

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<th>Start Year</th>
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Wood Anatomy Change Notes: Rodell: A to B - 1994 - 1999

- 96 - 97 = decayed on A, bit of ft.
- 95 - mid/wide w/1st, weather ring w/5 way.
- 94 - mid, checked w/1st, center & pitch.
Big Bend - Ring Reading Notes

Ring Recoder: J. Koth
Reading Date: __________

Site ID: Castleon
Collection Date: Feb. 2008

Tree/Hole ID: 15
Slab ID: 21

Ring Counts/Notes:

J2X Filename: CS15J2X.txt

Number of radii measured: 2

J2X Series Id: CS1521A, CS1521B

Proportion of circumference with secondary growth:

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<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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1999 - Burned, wide
'98 - Very wide
'97 - narrow, bit of false ring in late year
'96 - narrow, bit of false ring
'95 - med/wide w/ false ring on 1/2 way.
'94 - Center, cracked w/pith.
**Big Bend - Ring Reading Notes**

Ring Reader: J. Roth

Reading Date: 

Site ID: Castolon

Collection Date: Feb. 2008

Tree/Hole ID: 15

Slab ID: 23 \( \frac{c2}{c1} \)

Ring Counts/Notes:

J2X Filename: CS15J2X.txt

Number of radii measured: 2

J2X Series Id: CS1523A, CS1523B

Proportion of circumference with secondary growth:

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**Wood Anatomy Change Notes: (1994 - 1998)**


77 - narrow/avg. within ring edge in late 91.

76 - narrow w/d of false rings.

75 - med. prominent false ring ring x 1/2 way.

74 - center, cracked width.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date: 

Site ID: Castolon
Collection Date: Feb. 2008

Tree/Hole ID: 15
Slab ID: 25

Ring Counts/Notes:

J2X Filename: CS1525A.txt

Number of radii measured: 2

J2X Series Id: CS1525A, CS1525B

Proportion of circumference with secondary growth:

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<th>Start Year</th>
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Wood Anatomy Change Notes: (1994 - 1997)

Buried after 1996.

1997 - narrow, burned.
96 - narrow, slight of flame rings.
95 - mid, white heartwood.
94 - center, cracked depth.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date: 

Site ID: Castolon
Collection Date: Feb. 2008

Tree/Hole ID: 15
Slab ID: 26 (c1/84)

Ring Counts/Notes:

J2X Filename: CS15J2X.txt

Number of radii measured: 2

J2X Series Id: CS1526A, CS1526B

Proportion of circumference with secondary growth:

Start Year: 
Stop Year: 
Proportion: 

Start Year: 
Stop Year: 
Proportion: 

Start Year: 
Stop Year: 
Proportion: 

Wood Anatomy Change Notes: (1994-1996)

Buried after 1996.
1996 - red. bit of false ring.
95 - mid. w/ false rings in xw.
94 - center, small crack up to xw.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date: 

Site ID: Castolon
Collection Date: Feb. 2008

Tree/Hole ID: 15
Slab ID: 28

Ring Counts/Notes:

J2X Filename: CS15J2X.txt

Number of radii measured: 2

J2X Series Id: CS15-28A, CS15-28B

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: (1994-1995)

- 95 - wood, xylem ring relief
- 95 - wood, vitreous ring relief
- 96 - center, cracked with pitch

Signed after 1996...
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date: 

Site ID: Castolon
Collection Date: Feb. 2008

Tree/Hole ID: 15
Slab ID: 29

Ring Counts/Notes:

J2X Filename: CS15J2X TXT

Number of radii measured: 2

J2X Series Id: CS1529 A, CS1529 B

Proportion of circumference with secondary growth:

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<th>Start Year</th>
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Buried after 1995.

1996 - compressed w/burial signs, never a/A, med, or B.
95 - compressed w/ slight burnish.
94 - cracked, med.
93 - New center, cracked w/ pitch, red/orange
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Site ID: Costolon

Tree/Hole ID: 15

Reading Date: 

Collection Date: Feb. 2008 

Slab ID: 30

Ring Counts/Notes:

J2X Filename: CS15J2X.txt

Number of radii measured: 2

J2X Series Id: CS1530A, CS1530B

Proportion of circumference with secondary growth:

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<th>Start Year</th>
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Wood Anatomy Change Notes: (1993-1996)

Burned after 94
96 - has some burned sign
95 - has some burned sign, med.
94 - med. - burn on 'B'
93 - red/orange center, slight white pitch.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date: __________

Site ID: Castolon
Collection Date: Feb. 2008

Tree/Hole ID: 15
Slab ID: 31

Ring Counts/Notes:

J2X Filename: CS15J2X.txt

Number of radii measured: 2

J2X Series Id: CS153/A, CS153/B

Proportion of circumference with secondary growth:

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<th>Start Year:</th>
<th>Stop Year:</th>
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Wood Anatomy Change Notes: (1993-1995)

Buried after 94.
94 shows some slight burned sign.
93 - growing center, red orange w/ pitch, slight check.
mean still see false ring action in 95.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Reading Date: 

Site ID: Castelou

Collection Date: Feb. 2008

Tree/Hole ID: 15

Slab ID: 33

Ring Counts/Notes:

J2X Filename: cs15 J2X.txt

Number of radii measured: 2

J2X Series Id: cs1533A, cs1533B

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: (1993-1994)

Buried after 94.

94 still has some heurit lignum, a little larger than previous slab.

93 center growing, red/orange, w/good pitch.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth  
Reading Date: 

Site ID: Castelou  
Collection Date: Feb. 2008  

Tree/Hole ID: 15  
Slab ID: 3 4 (R2\over R1)

Ring Counts/Notes:

J2X Filename: C515J2X.txt

Number of radii measured: 2

J2X Series Id: C515 34A, C51534B

Proportion of circumference with secondary growth:

Start Year:  Stop Year:  Proportion: 
Start Year:  Stop Year:  Proportion: 
Start Year:  Stop Year:  Proportion: 

Wood Anatomy Change Notes: (1993-1994)

Buried after 1994. 
Top - '93 - Center, red/orange w/ clear pith. 
Bottom appears to be all root w/ no pith, but see root slab...
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date:

Site ID: Castolon
Collection Date: Feb. 2008

Tree/Hole ID: 15
Slab ID: 35

Ring Counts/Notes:

J2X Filename: 0515J2X.txt

Number of radii measured:

J2X Series Id: J2X

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes:
All Root - on bottom.
Top appears like it may have a tiny pith hole, but
there is a cut/sec that goes into the center,
making it difficult to discern 100%.
So, establishment is 1993.
BIG BEND - CASTECOHO

THE E 15" Trench

5-6.5cm  CS15.9  $d = \frac{E}{B}$  (Sendal)

8cm  CS15.10  $d = \frac{E}{B}$  (Sendal)

9cm  CS15.11  $d = \frac{E}{B}$  (Sendal)

13.5cm  CS15.12

16cm  CS15.13

15cm  CS15.14  $d = \frac{E}{C}$  (Sendal)

5.5cm  CS15.15  $d = \frac{E}{B}$  (Sendal)

5.5cm  CS15.16

8.5cm  CS15.17  2 stones squared (Sendal, side 2cm)

5.2cm  CS15.18  2 stones joined here  (Sendal)
Big Bend - Ring Reading Notes

Ring Reader: J.R. 
Reading Date: 

Site ID: C6018 
Collection Date: Feb. 2008 

Tree/Hole ID: 23-2 
Slab ID: G5 

Ring Counts/Notes:

J2X Filename: cs3272x.txt 

Number of radii measured: 2 

J2X Series Id: cs23265A, cs23265B 

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion: 
Start Year: Stop Year: Proportion: 
Start Year: Stop Year: Proportion: 

Wood Anatomy Change Notes: (1993 - 2007)

2007 - wide with age ring date in yr.
1996 - wide of prominent face is ~3/4 way through.
05 - wide of prominent face ring is out.
04 - wide of inner ring is ~3/4 way out.
03 - very wide w/false rings early mid there in yr.
02 - wide of outer rings.
01 - med. w/hazy false rings late in yr.
2000 - med. w/false rings on 1/2 way through.
Big Bend - Ring Reading Notes

Ring Reader: \( J \text{Kof} \)  
Reading Date:  

Site ID: Castejon  
Collection Date: Feb. 2008  

Tree/Hole ID: 23-2  
Slab ID: 2 \( (\frac{E2}{4}) \)  

Ring Counts/Notes:  

J2X Filename: cs2322j2x.txt  
Number of radii measured: 2  
J2X Series Id: cs2322A, cs2322B  

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Wood Anatomy Change Notes: 1997 - 2007  

- 2007 - Med. stem with lots  
- 06 - y. false ring not very out.  
- 05 - late y. false ring at 36 out.  
- 04 - wide y. false ring at 36 out.  
- 03 - wide y. prominent false ring early and another shriv.  
- 02 - wide y. false ring at 1/3  
- 01 - cracked at end of y. false ring late in yr.  
- 00 - wide y. false ring late in yr.  
- 99 - wide + elongated

- 98 - wide, dark, 1st false ring.  
- 97 - new year with tiny pith.  

Big Bend - Ring Reading Notes

Ring Reader: JKw

Reading Date:

Site ID: Colorado

Collection Date: Feb. 2008

Tree/Hole ID: 23 - 2

Slab ID: 3

Ring Counts/Notes:

J2X Filename: c5232J2X.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: (97 - 2007)

- 97 - Slightly compressed, false thin glaze
- 98 - Wide, lot of false rings
- 99 - Center splitting
- 00 - False ring, thin, wide
- 01 - Prominent false ring...part
- 2000 -沿线 wide false ring thin
- 01 - Wide, elongated winter rings
Big Bend - Ring Reading Notes

Ring Reader: J. Rothery

Site ID: 4971

Tree/Hole ID: 23-2

Reading Date: 

Collection Date: Feb. 2008

Slab ID: 4 (E6)

Ring Counts/Notes:

J2X Filename: 05222222X.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: (1997-2007)

- 87 - Bobby
- 66 - prominent false ring slight burial
- 65 - weak, major false ring
- 54 - wide, false ring, 5/4 wide
- 53 - weak, minor false ring
- 52 - wide, false ring
- 51 - prominent false ring 1/2 out, 2000 - wide, false ring, 1/2 out
- 99 - wide, isolated false rings

- 98 - wide, bit of false ring
- 77 - center of ring path
Big Bend - Ring Reading Notes

Ring Reader: ___________________  Reading Date: ____________

Site ID: ___________________  Collection Date: Feb. 2008

Tree/Hole ID: 23-2  Slab ID: 6 (52)

Ring Counts/Notes:

J2X Filename: C52326A.txt

Number of radii measured: 2

J2X Series Id: C52326A  C52326B

Proportion of circumference with secondary growth:

Start Year: ____________  Stop Year: ____________  Proportion: ____________

Start Year: ____________  Stop Year: ____________  Proportion: ____________

Start Year: ____________  Stop Year: ____________  Proportion: ____________

Wood Anatomy Change Notes: (1997-2007)

07 - Broad + increasing
06 - Prominent bands: ~2% way
05 - Wide diffuse ring, ~2% way
04 - Wide diffuse ring, ~2% way
03 - Wide diffuse ring, ~2% way
02 - Thin diffuse ring, ~2% way
01 - Thin diffuse ring, ~2% way
2000 - N.D., thin diffuse ring, ~1% way
99 - N.D., thin diffuse ring, ~1% way
98 - N.D., thin diffuse ring, ~1% way
97 - Center, white damage + small +

97 - Center, white damage + small +
Big Bend - Ring Reading Notes

Ring Reader: John Poth
Reading Date: 

Site ID: Cañón del Cobre
Collection Date: Feb. 2008

Tree/Hole ID: 23-2
Slab ID: 8 (E/3)

Ring Counts/Notes:

J2X Filename: <file_extension>

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes: (1977 - 2005)

Kadine A

2005 - Compressed
04 - Wide 1/2 false ring.
03 - Wide approximate false ring 1/2 wide.
02 - Wide false ring.
01 - Some damage within false ring.
2000 - Crack between 1/2 false ring 1/2 way.
99 - Wide false ring
98 - False ring
97 - Broken off tip.

Kadine B

2005 - Wide false ring 1/2 way.
04 - Wide false ring 1/2 way.
03 - Wide approximate false ring.
02 - Wide false ring.
01 - Some damage within false ring 1/2 way.
2000 - Wide false ring 1/2 way.
99 - False ring 1/2 way.
98 - False ring 1/2 way.
97 - Crooked width.
Big Bend - Ring Reading Notes

Ring Reader: J. Keld

Site ID: Canyons

Tree/Hole ID: 23-2

Slab ID: 10
(2 centers)

Collection Date: Feb. 2008

Reading Date:

Ring Counts/Notes:

J2X Filename: __________

Number of radii measured: __________

J2X Series Id: __________

Proportion of circumference with secondary growth:

Start Year: __________

Stop Year: __________

Proportion: __________

Start Year: __________

Stop Year: __________

Proportion: __________

Start Year: __________

Stop Year: __________

Proportion: __________

Wood Anatomy Change Notes: (1977-2004)

Buill after 2004

BY = wide intercal ring 1/4 cent.

BS = wide, major false ring 1/2 cent.

BS = wide, false ring 1/2 cent.

DA = damaged false ring 3/4 cent.

D2 = damaged false ring 1/4 cent.

D3 = damaged false ring 1/2 cent.

H2 = medium false ring.

H6 = wide, false ring.

La = expanding center of pin.
Big Bend - Ring Reading Notes

Ring Reader: J.K\textsuperscript{+} J	

Reading Date: 

Site ID: Castl'oh	

Collection Date: Feb. 2008

Tree/Hole ID: 23-2	

Slab ID: 11 \(\frac{58}{63}\)

Ring Counts/Notes:

J2X Filename: 052323J2X 4x+ 

Number of radii measured: 2

J2X Series Id: 

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion: 
Start Year: Stop Year: Proportion: 
Start Year: Stop Year: Proportion: 

Wood Anatomy Change Notes:

Buried after 2004

'04 - narrow w/ false ring
'03 - wide w/ major false rings & 1 half ring
'02 - wide w/ false ring 1/2 way
'01 - med. damaged w/ major falsitng 3/4 wood
2000 - med. w/ false ring half way
98-99 - med. w/ false rings
'97 - center, cracked w/ pitch.
Big Bend - Ring Reading Notes

Ring Reader: J.K. Date: __________

Reading Date: __________

Site ID: Queen 6-15 __________

Collection Date: Feb. 2008

Tree/Hole ID: 23-2 __________

Slab ID: 13 (f2) __________

Ring Counts/Notes:

J2X Filename: __________

Number of radii measured: 2 __________

J2X Series Id: __________

Proportion of circumference with secondary growth:

Start Year: __________ Stop Year: __________ Proportion: __________

Start Year: __________ Stop Year: __________ Proportion: __________

Start Year: __________ Stop Year: __________ Proportion: __________

Wood Anatomy Change Notes: (1997-2004)

Same as slab II.
Big Bend - Ring Reading Notes

Ring Reader: J. Krofta

Reading Date: 

Site ID: C42

Collection Date: Feb. 2008

Tree/Hole ID: 23-2

Slab ID: 15 (B)

Ring Counts/Notes:

J2X Filename: c523232x.txt

Number of radii measured: 2

J2X Series Id: c523215a, c523215b

Proportion of circumference with secondary growth:

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<th>Start Year</th>
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<th>Proportion</th>
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</table>


Burned after 2003
2003: some duff/ride on B
52 - wide, false rings, damaged
91 - med. damage, w/false rings 3/4 out
2000 - med. damage - false rings 1/2 way
98 & 99 - wide w/false rings
97 - center, cracked w/ pitch.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Reading Date: 

Site ID: Castolon

Collection Date: Feb. 2008

Tree/Hole ID: 23-2

Slab ID: 16

Ring Counts/Notes:

J2X Filename: cse-2 J2X.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes: (1997 - 2002)

2002 - wide in A, wide in B
91 - wide in A, wide in B / false ring % out, damaged

2000 - wide, damaged, false ring % way
99 - wide w/ false rings
98 - wide w/ false rings % out
97 - center, growing up, birth

Dated after 2002
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date:

Site ID: Castolon
Collection Date: Feb. 2008

Tree/Hole ID: 23-2
Slab ID: 18 \( \frac{6}{65} \)

Ring Counts/Notes:

J2X Filename: C5232J2X.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes: (1997 - 2001)

Rotted slab.

Radius A
'98, '99 - wide w/ false rings, some rd.
'97 - rooted with rooted away-center

Radius B
2000 - rooted w/ false rings, rd.
2000 - wide w/ false ring rd.

Buried after 2000.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Site ID: Castolon

Tree/Hole ID: 23-2

Reading Date:

Collection Date: Feb. 2008

Slab ID: 19 (c2x)

Ring Counts/Notes:

J2X Filename: cs232 J2X2xt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes:

Center Rotted,

Radiant A
- 99 - wide false rings
- 18 - wide false rings
- 87 - mostly rotten + gone
- still cont'd

Radiant B
- 2003 - wide false rings 72 way
- 99 - wide w/ false rings (only 1 left)
- 95 - wide w/ false ring + some rot
- 97 - mostly rotten + gone

Burial date: 2000.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Reading Date: __________

Site ID: Castolon

Collection Date: Feb. 2008

Tree/Hole ID: 23-2

Slab ID: 2 | (x4)  

Ring Counts/Notes:

J2X Filename: cs > 32 J2X.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

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<th>Start Year</th>
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Wood Anatomy Change Notes: Buried after 1999

Radius A (1999)

- Center rotted
- 98 - wide w/ 3rd yearly rings
- 99 - med. rot, w/ false rings

Radius B (99-2000)

- 2000 - Some burial - wide false rings
- 1999 - wide w/ false rings
- 99 - ½ rotted
- 97 rotted - but can see where rays meet in a center
Big Bend - Ring Reading Notes

Ring Reader: J. R. ------- Reading Date: -------

Site ID: C05------- Collection Date: Feb, 2008

Tree/Hole ID: 232 Slab ID: 22 (note is scratched off)

Ring Counts/Notes:

J2X Filename: c52322J2X.txt

Number of radii measured: 2

J2X Series Id: c52322A, c52322 B

Proportion of circumference with secondary growth:

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<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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</thead>
</table>

Wood Anatomy Change Notes: Buried after 1998

Species A

- Still looks like 1997 though
- 99 - wd, dense w/ wide rings, formal density
- 98 - poorly filled - mad

Species B

- 2000 - buried - mad
- 99 - wide w/ thin rings
- 98 - indistinguishable - broken - faded
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date: 

Site ID: Castolon
Collection Date: Feb. 2008

Tree/Hole ID: 23-2
Slab ID: 24 (6/3)
(Top)

Ring Counts/Notes:

J2X Filename: cs232J2X.txt

Number of radii measured: 2

J2X Series Id: 

LAST SLAB

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes: Buried after 1998

1999 - med. burned - false ring.
'98 - wide, mostly rotten - cracks + holes.
1997 - mostly rotten - wide - cracks + holes.
96 - looks like a new year + pith still present - cracked through center.
So, actual estimate is 1996.

pith still present
CASTOLUM, 2BA2

Tree (4.5-6cm) C6-23.2.0

4.5 cm C6-23.2.65  mad = 95

4.5 cm C6-23.2.1

4.5 cm C6-23.2.2  mad = \frac{50}{64}

4.5 cm C6-23.2.3  mad = \frac{13}{64}

6.0 cm C6-23.2.4  mad = \frac{15}{64}

3.5-4.0 cm C6-23.2.5

5.0 cm C6-23.2.6  mad = \frac{45}{64}

13.0 cm C6-23.2.7

2.8 cm C6-23.2.8  mad = \frac{64}{63}
BIG BEND - CAPE COW

Tree 23.2 - 23A2

4.0cm  CS-23.2.9

~8.5cm  CS-23.2.10  Top has two cuts. (Sanded)

~6.5cm  CS-23.2.11  NAIL = \frac{E}{2}  (Sanded)

~4.0cm  CS-23.2.12  NAIL = \frac{E}{2}  Sandled

~2.0cm  CS-23.2.13  CS-23.2.14

~9.5cm  CS-23.2.15  NAIL = \frac{D}{2}  (Sanded)

~4.5cm  CS-23.2.16  NAIL = \frac{D}{2}  (Sanded)

~2.0cm  CS-23.2.17

~6.8cm  CS-23.2.18  NAIL = \frac{E}{2}  (Sanded)
Big Bend - Castolon

Tree 2342 = 23.2

6.7 cm  05.23.2.19  hail = \frac{c^2}{e^2}

5.5 cm  05.23.2.20

7.9 cm  05.23.2.21  hail = \frac{e^2}{c^2}

6.5 cm  05.23.2.22  hail = ?

6.6 cm  05.23.2.23

3.5-7 cm  05.23.2.24  hail = \frac{c^2}{e^2}
Big Bend - Ring Reading Notes

Ring Reader: JR Oth

Site ID: Castlegn

Tree/Hole ID: 23-3

Reading Date:

Collection Date: Feb. 2008

Slab ID: G5

Ring Counts/Notes:

J2X Filename: CS 2332X.txt

Number of radii measured: 2

J2X Series Id:

Could be better sanded data.

Proportion of circumference with secondary growth: (1998 - 2007)

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes:

06 - 05 - Similar widths (shoulder 'B')
04 - Very wide w/false ring in out.
03 - Narrower than 04 w/2 false rings in out.
02 - Narrow to w/2 false rings in out.
01 - Narrow w/false ring in out. w/2 rings.
2000 - Similar to 01 w/false ring in out. w/2 rings. cracked between 2000 & 2001.
1999 - Wide w/false ring 1/2 way in out.
75 - Center w/pitch.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date: 

Site ID: Castolon
Collection Date: Feb. 2008

Tree/Hole ID: 23 - 3
Slab ID: 3

Ring Counts/Notes:

J2X Filename: cs 333 J2X.txt

Number of radii measured: 2

J2X Series Id:
'\text{send better Dave.}'

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: (1998 - 2007)

'06 - 05 - similar widths
'04 - very wide w/late ring a/bart
'03 - very wide w/late rings n/bart
'02 - very wide w/false ring ½ way,
'01 - narrow w/false ring ½ way, hot on it.

2000 - med. w/false ring ½ way.
1999 - wide w/false ring ½ way.
'98 - wide, center w/ pitch & a little bollecd.'
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Reading Date: 

Site ID: Carst/en

Collection Date: Feb. 2008

Tree/Hole ID: 23-3

Slab ID: 4

Ring Counts/Notes:

J2X Filename: 25233J2X.J2X

Number of radii measured: 2

J2X Series Id: 

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes: (1997-2007)


1980 - 1981 - similar width. 1984 has false ring on 35 and.

1983 - very wide w/false rings.

1987 - slightly splayed. 1988 w/false ring.


1999 - wide w/false ring.

1999 cut. 1999 is cracked. Some rot.

1977 cut at head, w/some rot. 1987 cut at head, w/some rot.
# Big Bend - Ring Reading Notes

**Ring Reader:** J. Roth  
**Reading Date:**

**Site ID:** Castolon  
**Collection Date:** Feb. 2008

**Tree/Hole ID:** 23-3  
**Slab ID:** 5

**Ring Counts/Notes:**

<table>
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<th>J2X Filename:</th>
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**J2X Series Id:**

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<th>Proportion of circumference with secondary growth:</th>
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<td><strong>Start Year:</strong></td>
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<td>Start Year:</td>
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**Wood Anatomy Change Notes:** (1997 - 2007)

- '07 - slight defined ring w/ false ring.  
- '06 - prominent false ring ½ way through.  
- '05 - similar wide widths w/false rings.  
- '03 - very wide w/false ring ½ way out.  
- '02 - narrower w/false rings ½ way out.  
- '01 - narrower than '02, w/false ring ½ way out.  
- Some damaged wood.  
- 2000 - wide w/false rings ½ way through.  
- 1999 - wide w/false ring ½ way out.  
- '98 - wide w/false rings a little damage.  
- '97 - central, cracked w/ split.  

- 2000 - wide w/false rings ½ way through.  
- 1999 - wide w/false rings ½ way out.  
- '98 - wide w/false rings a little damage.  
- '97 - central, cracked w/ split.  

- '07 - slight defined ring w/ false ring.  
- '06 - prominent false ring ½ way through.  
- '05 - similar wide widths w/false rings.  
- '03 - very wide w/false ring ½ way out.  
- '02 - narrower w/false rings ½ way out.  
- '01 - narrower than '02, w/false ring ½ way out.  
- Some damaged wood.  
- 2000 - wide w/false rings ½ way through.  
- 1999 - wide w/false ring ½ way out.  
- '98 - wide w/false rings a little damage.  
- '97 - central, cracked w/ split.  

- 2000 - wide w/false rings ½ way through.  
- 1999 - wide w/false rings ½ way out.  
- '98 - wide w/false rings a little damage.  
- '97 - central, cracked w/ split.  

- 2000 - wide w/false rings ½ way through.  
- 1999 - wide w/false rings ½ way out.  
- '98 - wide w/false rings a little damage.  
- '97 - central, cracked w/ split.
Big Bend - Ring Reading Notes

Ring Reader: J Roth

Site ID: Castleon

Tree/Hole ID: 23-3

Slab ID: \( \frac{55}{54} \)

Ring Counts/Notes:

J2X Filename: C523J2X.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

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<th>Start Year</th>
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Wood Anatomy Change Notes: (1997 - 2007)

07 - Narrowing - minimal evidence of false ring
06 - prominent false ring in 2 way through, slight narrowing
05 - wider, no change, both hole false rings
04 - hole false rings in 2 way out,
01 - med. false ring, wide and cracked at end of 2000
1999 - wider false ring, one way,
98 - wide, wide damage,
97 - center, v small with...
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Site ID: Castolon

Tree/Hole ID: 23-3

Reading Date: ___________

Collection Date: Feb. 2008

Slab ID: P

Ring Counts/Notes:

J2X Filename: 05233J2X.EXT

Number of radii measured: 2

J2X Series Id: ___________

Proportion of circumference with secondary growth:

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<th>Start Year</th>
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Wood Anatomy Change Notes: (1997 - 2005)

'07 - burned, Renewal
'06 - prominent false ring #2 way, burned signs
'04 - '05 - similarly wide, W/False ring - '05 has slight burnish.
'03 - wide W/inner false ring #3 way
'02 - wide w/False ring #3 way.
'01 - narrowing w/prominent false ring #3 out.
2000 - wide w/false ring #3 way through.
1999 - wide w/False ring #3 way through.
1998 - wide W/damage.
1997 - center - damaged.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth  
Reading Date: 

Site ID: Castanlow  
Collection Date: Feb. 2008  

Tree/Hole ID: 23-3  \( \frac{E_3}{E_2} \)  
Slab ID: 11  

Ring Counts/Notes:

J2X Filename: C5233J2X.EXT  

Number of radii measured: 2  

J2X Series ID: C523311A, C523311B

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: (1997 - 2004)

Buried after 2004. 04-wide w/fewer rings in yrs.

03+02 - wide w/false rings ½ way through.
01 - increased w/strong false ring ½ out.
2000 - narrower on B than A, false ring ½ way.
1999 - wide w/false ring ½ way through.
98 - wide, cracked.
97 - wide, center cracked.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Site ID: Castolon

Tree/Hole ID: 23 - 3

Reading Date:

Collection Date: Feb. 2008

Slab ID: 13

Ring Counts/Notes:

J2X Filename: CS23J2X.EXT

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: (1997 - 2004)

- Annual after 793, 03 - wide w/false rings.
- 02 - wide w/false ring a½ way.
- 01 - wide w/false ring full out.
- 2000 - narrowing w/false ring a½ way.
- 1999 - wider w/false ring a½ way through, obliterated
- 98 - wide, oblong w/false ring.
- 97 - med. center w/false rings & tiny pith
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Reading Date: 

Site ID: Castelan

Collection Date: Feb. 2008

Tree/Hole ID: 23-3

Slab ID: 16 (E/1)

Ring Counts/Notes:

J2X Filename: c5233J2x.txt

Number of radii measured: 2

J2X Series Id: 

Proportion of circumference with secondary growth:

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03+02 - Similar widths. Boiled after 2002; Whistle rings.
81 - Middle, Whistle ring - No cut, streak between 01+02.
2000 - Wide, Whistle ring is way through.
9999 - Wide, Whistle ring is way through.
99 - Wide
97 - Hard, Center, Whistle rings + tiny pith.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Site ID: Castelon

Tree/Hole ID: 23-3

Reading Date: __________
Collection Date: Feb. 2008

Slab ID: 18

Ring Counts/Notes:

J2X Filename: cs233j2x.txt

Number of radii measured: 2

J2X Series Id: __________

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: 1997-2003

'92-'03 - wide w/false rings
'01 - med. w/major false ring ~ 3/4 out.
2000 - med. w/false ring 1/2 way.
'99 - showing; wide w/false ring 1/2 way through.
'98 - wide
'97 - center, w/false ring & tiny pith.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date: 

Site ID: Castolon
Collection Date: Feb. 2008

Tree/Hole ID: 23-3
Slab ID: 19

Ring Counts/Notes:

J2X Filename: cs23_j2x.txt

Number of radii measured: 2

J2X Series Id: 

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: (1997 - 2002)


2002 - Slightly buried in sandy reddish forest soil, mini ½ way.

01 - Wide #1 last ring ¾ out.

2000 - Hammer on ½ than 2, wider ring ¾ out.

99 - Hammer on ½ than 2, wider ring an inside part of 2.

98 - Wide ½ #1 taller ring.

97 - Center wider #2 taller ring, ½ to ¾.
Big Bend - Ring Reading Notes

Ring Reader: J. Roll

Reading Date:

Site ID: Castolon

Collection Date: Feb. 2008

Tree/Hole ID: 23-3

Slab ID: 20

(Top)

Ring Counts/Notes:

J2X Filename: C5233 J2X.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: (1997 - 2001)


2001 - Shown slight burried w/false ring w/s way through yr. - Wide
2000 - Wide w/false ring w/s way.
99 - wide w/false ring w/s way.
98 - wide.
97 - Wide center w/false ring bit cracked w/pith.
Big Bend - Ring Reading Notes

Ring Reader: Jim Rieth

Reading Date: 

Site ID: Castelow

Collection Date: Feb. 2008

Tree/Hole ID: 23-3

Slab ID: 21

Ring Counts/Notes:

J2X Filename: LS2833J2X.DXT

Number of radii measured: 2

J2X Series Id: 

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: (1997 - 2001)

Burned after 2000.

2001 - White, frost rings ½ way through.
2000 - Holes on the 01 whitewash ½ way.
99 - White w/ false rings early & late
98 - White, some damage
97 - Center, damaged w/ splitting, elongating, false rings
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Site ID: Castolon

Tree/Hole ID: 23-3

Reading Date:

Collection Date: Feb. 2008

Slab ID: 22

Ring Counts/Notes:

J2X Filename: CS23J22X22X

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: (1997 - 2001)

Buried after 2000:

2001 - large w/ false ring 1 way - buried
2000 - narrowing w/ false ring ~ 3/4 age
99 - wide 1st w/ false ring ~ 3/4 age
98 - wide
97 - elongated w/ out + pith - center - false ring.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date: 

Site ID: Castileum
Collection Date: Feb. 2008

Tree/Hole ID: 23-3
Slab ID: 24

Ring Counts/Notes:

J2X Filename: cs233J2X.txt

Number of radii measured: 2

J2X Series Id: 

Proportion of circumference with secondary growth:

<table>
<thead>
<tr>
<th>Start Year:</th>
<th>Stop Year:</th>
<th>Proportion:</th>
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Wood Anatomy Change Notes: (1997 - 2001)

Buried after 2000.
2000 - slight burial slight w/late ring at 1/3 out.
1999 - wide w/late ring at 1/2 way.
'98 - very wide, some damage.
'97 - center, oblong, tiny pitch, some damage.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth  
Reading Date:  

Site ID: Casalon  
Collection Date: Feb. 2008  

Tree/Hole ID: 23-3  
Slab ID: 26  

Ring Counts/Notes:  

J2X Filename: CS233J2X.txt  

Number of radii measured: 2  

J2X Series Id:  

Proportion of circumference with secondary growth:  

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Wood Anatomy Change Notes: (1997 - 2001)  

Buried after 1999.  

2001 - Buried w/ false ring still visible.  
2000 - Buried w/ false ring & narrower than previous sites.  
1999 - Compressed, some burial evidence - narrowen, false ring.  
1998 - Very wide,  
1997 - Shrinkled center, cracked w/ pitch & grey false ring.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date: 

Site ID: Castolon
Collection Date: Feb. 2008

Tree/Hole ID: 23-3
Slab ID: 27

Ring Counts/Notes:

J2X Filename: cs233J2X.txt

Number of radii measured: 2

J2X Series Id: 

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: (1997 - 2000)

Buried after 1999.

2000 - had few rings
99 - pitted bark &/or internal ring
98 - white w/some rot.
97 - center w/pitch & some rot.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth  

Reading Date: 

Site ID: Castolon  

Collection Date: Feb. 2008  

Tree/Hole ID: 23-3  

Slab ID: 29

Ring Counts/Notes:

J2X Filename: C5233J2X.6X6

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

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<th>Proportion</th>
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Wood Anatomy Change Notes: (1997-2000)

Buried after 1999.

2000 - buried W full ring $1/2$ way in yr.

1999 - wide on L, narrow on R.

98 - wide with little damage.

98 - centre with tiny pith.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth
Reading Date: 

Site ID: Cashboard
Collection Date: Feb. 2008

Tree/Hole ID: 23-3
Slab ID: 31

Ring Counts/Notes:

J2X Filename: c5233j2x.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

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<th>Proportion</th>
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Wood Anatomy Change Notes: (1997 - 99)

Burned after 1999

99 - slightalian sign, wide bit of false ring.
98 - wide
97 - center of false ring + string path.
**Big Bend - Ring Reading Notes**

<table>
<thead>
<tr>
<th>Ring Reader:</th>
<th>J. Roth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site ID:</td>
<td>Castolan</td>
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<tr>
<td>Tree/Hole ID:</td>
<td>23-3</td>
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<td>Slab ID:</td>
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**Reading Date:**

**Collection Date:** Feb. 2008

**Ring Counts/Notes:**

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<td>J2X Series Id:</td>
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**Proportion of circumference with secondary growth:**

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**Wood Anatomy Change Notes:**

- 97 - Slight burn, wide, false ring late yr.
- 98 - Slight burn, narrower than '99.
- 97 - Center with.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Reading Date: 

Site ID: Castl/on

Collection Date: Feb. 2008

Tree/Hole ID: 23-3

Slab ID: 34

Ring Counts/Notes:

J2X Filename: cs233j2x.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

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<tr>
<th>Start Year</th>
<th>Stop Year</th>
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</table>

Wood Anatomy Change Notes: (97-99)

Burial after 99

'99: lot of false rings, slight burial
'98: med.
'97: center with false ring knot.
Big Bend - Ring Reading Notes

Ring Reader: J. Roth

Site ID: Castolon

Tree/Hole ID: 23-3

Reading Date:

Collection Date: Feb. 2008

Slab ID: 37

Ring Counts/Notes:

J2X Filename: cs33j2x.ext

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

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<th>Start Year</th>
<th>Stop Year</th>
<th>Proportion</th>
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</table>

Wood Anatomy Change Notes:

Pith still present. 1997-98

97 center % of ring + pith
98 - med.

Burned off in 1999.
Big Bend

Castañon

Table 23, Section 3

10


6:5

5:23:3:12

5:23:3:13 Grid E2

5:23:3:14

5:23:3:15

5:23:3:16 Grid E1

5:23:3:17

5:23:3:18 Grid E1 = 5

8cm 5:23:3:19 (Sandblasted)

4.5-5cm 5:23:3:20 (Sandblasted) Top + Bottom

7cm 5:23:3:21 nail = 5/5

5cm 5:23:3:22 nail = 5/5
Big EEND

Castolon Tree 23 - 25, Z

-7.5 cm: c5.23.3.23

-8.0 cm: c5.23.3.24

-8.0 cm: c5.23.3.25

6-9 cm: c5.22.3.26

7.0 cm: c5.22.3.27

Top: Bottom: (Sanded)

6.5 cm: c5.22.3.28

-6.5 cm: c5.22.3.29

(Sanded)

-6.0 cm: c5.23.2.30

7.0 cm: c5.23.2.31

(Sanded)

-9.0 cm: c5.23.2.32
BIG BEND
CASTOLON ~ Tree 23 stem 3

(8.5 cm)  
(8 cm)  
(-7.5 cm)  
(-4.5 cm)  
(-10 cm)  

C5 23.3.33  
C5 23.3.34  
C5 23.3.35  
C5 23.3.36  
C5 23.3.37  

rail = \frac{C5}{c1} (Sanded)
Big Bend - Ring Reading Notes

Ring Reader: D.L. - J.R. Reading Date: ___________

Site ID: ______________ Collection Date: Feb. 2008

Tree/Hole ID: __________ Slab ID: __________

Ring Counts/Notes:

J2X Filename: ________________

Number of radii measured: __________

J2X Series Id: ________________

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes:

'57 - wide
'66 - narrow
'69 - slightly wider than '66
'67 - wide at outer ring of the structure sometimes.
'71 - wider than '69 - many broad color rings and prominent
      ray of the inner heartwood.
'04 - narrow and deep.
'05 - wide - many dark color rings.
'02 - narrow - deep.
'99 - very thin
'99 - very thin - dark
'95 - medium - dark brown
'98 - medium
'95 - medium at outer ring.
'94 -
'93 -
'05 -
'02 -

82 - thin - dark grey/charcoal
Big Bend - Ring Reading Notes

Ring Reader: 
Reading Date: 

Site ID: 
Collection Date: Feb. 2008 

Tree/Hole ID: 
Slab ID: 

Ring Counts/Notes:

J2X Filename: 
Number of radii measured: 
J2X Series Id: 

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion: 
Start Year: Stop Year: Proportion: 
Start Year: Stop Year: Proportion: 

Wood Anatomy Change Notes:

07 - medium to wide
06 - medium to narrow
05 - very narrow
04 - medium to wide
03 - wide = false ring = very annular
02 - wide = many false rings
01 - narrow
00 - wide = dark grey/brown
99 - very narrow = dark brown
98 - medium thick = very
Big Bend - Ring Reading Notes

Ring Reader: ____________________________

Reading Date: _________________________

Site ID: _______________________________

Collection Date: Feb. 2008

Tree/Hole ID: ___________________________

Slab ID: 3 ______________________________

Ring Counts/Notes:

J2X Filename: __________________________

Number of radii measured: __________________________

J2X Series Id: __________________________

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes:

07 - Flushing
06 - Renew - section in spot
05 - wide than 06
04 - wide - False Ring 2% gap present
03 - within 04 - false ring end 3% gap present
02 - wide
01 - renewal - missing band
00 - Hard Sapwood Brown
99 - Black - Dark Brown
Big Bend - Ring Reading Notes

Ring Reader: 

Site ID: 

Tree/Hole ID: 

Reading Date: 

Collection Date: Feb. 2008 

Slab ID: 

Ring Counts/Notes:

J2X Filename: 

Number of radii measured: 

J2X Series Id: 

Proportion of circumference with secondary growth:

Start Year: 
Stop Year: 
Proportion: 

Start Year: 
Stop Year: 
Proportion: 

Start Year: 
Stop Year: 
Proportion: 

Wood Anatomy Change Notes:

07 - Medium spacing - Curved in Toward Slab 
06 - Thin - Toward Slab 
05 - Medium spacing - Toward Slab 
04 - Wide - Toward Slab 
03 - Close than 04 - Toward Slab 
02 - Medium - Toward Slab 
01 - Thin - Toward Slab 
00 - None - Toward Slab 
96 - Medium - Fake Ring on Fake二手房 
95 - Medium - 2 Fake Rings 
94 - Thin - Fake Rings 
93 - Tight Spacing 
92 - Medium 
91 - Medium 
90 - Medium 
89 - Medium 
88 - Medium 
87 - Medium - Small Ring/Small Fake Ring halfway through ring
Big Bend - Ring Reading Notes

Ring Reader:  
Site ID:  
Tree/Hole ID:  
Reading Date:  
Collection Date: Feb. 2008  
Slab ID: G, Na, V

Ring Counts/Notes:

J2X Filename:  
Number of radii measured:  
J2X Series Id:

Proportion of circumference with secondary growth:

Start Year:  Stop Year:  Proportion:  
Start Year:  Stop Year:  Proportion:  
Start Year:  Stop Year:  Proportion:

Wood Anatomy Change Notes:

07 - Medullary Banded  
06 - Wood - White Thickened  
05 - Medium - White Banded  
04 - White - Slightly Banded  
03 - White - White Ring  
02 - White-Verrucous White - Dark Grey  
01 - Thin - Color Boundary  
00 - White - 5

99 - Dark Grey - Dark Grey  
98 - Medium - Grey  
96 - Medium - Grey  
95 - Medium - Dark Grey  
94 - Medium - Small Rift  
93 - Medium - Small Rift

Page: 299
Big Bend - Ring Reading Notes

Rina Reader: [Blank]  
Reading Date: [Blank]

Site ID: 32shl/w  
Collection Date: Feb. 2008

Tree/Hole ID: [Blank]  
Slab ID: [Blank]

Ring Counts/Notes:
J2X Filename: [Blank]
Number of radii measured: [Blank]
J2X Series Id: [Blank]

Proportion of circumference with secondary growth:

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<th>Stop Year</th>
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Wood Anatomy Change Notes:

| 07 | Medium - Brown. |
| 06 | Dark gray - faded to gray, no dimension. |
| 05 | Medium - brown, no dimension. |
| 03 | Color - often brown - no dimension. |
| 02 | Color - Brown |
| 01 | Very thin - thin Secondary wood |
| 00 | Color - Black Brown |

98 - Medium - grayish Brown
97 - Dark gray - faded to gray, no dimension.
96 - Medium - Brown, no dimension.
95 - Medium - color, no dimension.
94 - Medium - grayish
Big Bend - Ring Reading Notes

RIng Reader: ____________________
Reading Date: ____________________

Site ID: ____________________
Collection Date: Feb. 2008

Tree/Hole ID: 234__________
Slab ID: 10 NL 6 4

Ring Counts/Notes:

J2X Filename: ____________________
Number of radii measured: ________________
J2X Series Id: ____________________

Proportion of circumference with secondary growth:

Start Year: ______ Stop Year: ______ Proportion: ______
Start Year: ______ Stop Year: ______ Proportion: ______
Start Year: ______ Stop Year: ______ Proportion: ______

Wood Anatomy Change Notes:

07 - Thin Burls
06 - Very Thin - Indistinct - nearly imperceptible
05 - Very Thin Branch
04 - Medium - Transitioned Burls
03 - Burls - Harlequin ~ 90% by volume
02 - Large - Variable in Color
01 - Thick - olate Burls - not well developed

80 - White - Black - Brown / Gray
79 - Very Thin - dark brown
78 - Burls not grown
77 - Grayish / Brown / Dark - Blue - Red ~ 2 way reduced
76 - Red
75 - Red, ~ 1 way reduced
74 - Medium
74-07 Burned off ~ 5-05
Big Bend - Ring Reading Notes

Ring Reader: 12 - 32

Site ID: 1234

Tree/Hole ID: 23

Reading Date: 

Collection Date: Feb. 2008

Slab ID: 12 34 E

Ring Counts/Notes:

J2X Filename:

Number of radii measured:

J2X Series Id:

Proportion of circumference with secondary growth:

<table>
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<tr>
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Wood Anatomy Change Notes:

05 - Thin - Barren
06 - Very Thin - Only fewinset - Barren
07 - Thin - Barren
09 - Medium - Barren
08 - Wide - Grey color ring - 30% redwood
10 - Wide - Vascular - 50% redwood
11 - Very Thin - 2 inset - Barren - 40% redwood
01 - Wide
02 - Very - Thin - Barren - 90% redwood

98 - Medium - Barren
97 - Barren - Foliage ring 3 5 any
96 - Medium - Barren - 90% redwood
95 - Barren - 90% Foliage Ring 10% redwood
94 - Barren - Foliage Ring

03 - 99
Big Bend - Ring Reading Notes

Ring Reader: D9 - P9

Site ID: A5/3/20

Tree/Hole ID: 93/3

Reading Date:________________________

Collection Date: Feb. 2008

Slab ID: 16/ 16/ 16

Ring Counts/Notes:

J2X Filename: ____________________________

Number of radii measured:________________

J2X Series Id: ____________________________

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes:

07 - Thin Burned
09 - Very thin to super-thin - Burned / Mend 50 Y
05 - Very thin - Burned!
04 - Burned
03 - Burned - Light grey. Also grey or 50% burned.
02 - Light variable or extra.
01 - Very thin - Often secondary incident - Paper Burned
00 - Undet. Burned

99 - Very thin - Dark Burned
98 - Ashen - Gray
97 - Mild - Grey - Burned Ring 50% out
96 - Mild - Burned - Burned Ring - 50% out
95 - Mild
94 - Ashen - Black - Burned
93 - Undet. - Burned
Big Bend - Ring Reading Notes

Ring Reader:  RR  

Site ID:  Castler  

Tree/Hole ID:  233  

Reading Date:  

Collection Date:  Feb. 2008  

Slab ID:  5  

Ring Counts/Notes:  

J2X Filename:  

Number of radii measured:  

J2X Series Id:  

Proportion of circumference with secondary growth:  

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Wood Anatomy Change Notes:  

07 = Buried - buried  
06 = Intermediate - bald 3rd surf.  
05 = Buried - buried  
04 = Medium - buried  
03 = Medium - Buried  
02 = Under - skeleton log 1/2 3/4 skeleton  
Buried  
01 = Prior becoming buried - buried  
00 = Under - grey - rare - bald log 1/2 skeleton  

99 = Thin - Dark brown  
98 = Medium - grey  
97 = Medium - grey - rare - bald log 1/2 skeleton  
96 = Medium - bald log - 3/4 skeleton  
95 = Medium  
94 = Medium  
93 = Medium  
92 = Medium  
91 = Medium  
90 = Medium  
99 = Buried after 00 or 01.
Big Bend - Ring Reading Notes

Ring Reader: D. H. Fel. ___________________  Reading Date: ___________________

Site ID: ____________  Collection Date: Feb. 2008  Slab ID: ________  

Tree/Hole ID: 238  

Ring Counts/Notes:

J2X Filename: ___________________

Number of radii measured: ___________________

J2X Series Id: ___________________

Proportion of circumference with secondary growth:

Start Year: ____________  Stop Year: ____________  Proportion: ____________

Start Year: ____________  Stop Year: ____________  Proportion: ____________

Start Year: ____________  Stop Year: ____________  Proportion: ____________

Wood Anatomy Change Notes:

07-08 - Compressed Bark 19.5 Year Flattening 20.5 - 21.5 Bark
04 - Buried - Thin - Med
03 - Medium - Grayish - Buried
02 - Med to wide - Grayish - Buried
01 - Very Thin - Buried - Already Tightly Imbedded
96 - Wide - Grayish to Buff - Buried or partially Buried, 20.5 Year 1/2 way
95 - Thin - Brown
94 - Medium - Grayish - Buried
93 - Medium - Brown
97 - Medium - Olive

16 - Medium - False Ring 20.5 - 21.5 Buried
15 - Med - Dark Brown
14 - Medium - Brown
97 - Buried after 97
Big Bend - Ring Reading Notes

Ring Reader: [Handwritten]

Reading Date:

Site ID: [Handwritten]

Collection Date: Feb. 2008

Tree/Hole ID: 232

Slab ID: [Handwritten]

Ring Counts/Notes:

J2X Filename:

Number of radii measured:

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes:

02 - Void-

03 - Broad-

04 - Void-

01 - Very thin-

00 - Hinge-

99 - Dead-

98 - Hard-

97 - Medium-

96 -
Big Bend - Ring Reading Notes

Ring Reader: [Name]  
Reading Date: 

Site ID:  
Collection Date: Feb. 2008

Tree/Hole ID:  
Slab ID:  

Ring Counts/Notes:

J2X Filename:

Number of radii measured:

J2X Series Id:

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes:

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<tr>
<th>Year</th>
<th>Change</th>
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<tbody>
<tr>
<td>90</td>
<td>New big growth immediately around ~2 ft.</td>
</tr>
<tr>
<td>93</td>
<td>Buried after 07.</td>
</tr>
<tr>
<td>95</td>
<td>Red Brown</td>
</tr>
<tr>
<td>94</td>
<td>Red Brown</td>
</tr>
<tr>
<td>97</td>
<td>Buried</td>
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[Other text and tables related to wood anatomy change notes]
Big Bend - Ring Reading Notes

Ring Reader: ____________________  Reading Date: ____________

Site ID: ____________________  Collection Date: Feb. 2008

Tree/Hole ID: 236h  Slab ID: 23

Ring Counts/Notes:

J2X Filename: ____________________

Number of radii measured: ____________________

J2X Series Id: ____________________

Proportion of circumference with secondary growth:

<table>
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<tr>
<th>Start Year:</th>
<th>Stop Year:</th>
<th>Proportion:</th>
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</table>

Wood Anatomy Change Notes:

01 - 01 - Burnt - Dead tree
00 - Light gray - Dead - Takes ring tiny
99 - Thin - Dead
98 - Med - Light gray - Burnt
97 - Med - Burnt or partially
96 - Light color - Takes tiny ring
95 - Med - Brown
94 - Med
93 - Very small amount

93-07 - Burnt after 96.07
Big Bend - Ring Reading Notes

Ring Reader:  DJM
            Reading Date: 

Site ID:  Sabino
            Collection Date: Feb. 2008

Tree/Hole ID:  030
            Slab ID:  23, 4a, 6a

Ring Counts/Notes:

J2X Filename:

Number of radii measured:

J2X Series Id:

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes:

01-07: Initial available - Burned
18: Red heart - Burned, roller ring in top
95: Thin, darker score
78: Thin, burned
77: Red - burned
96: Red - burned, probably burned
95: Red - Barren
94: Red - Barren
93: Thin
Big Bend - Ring Reading Notes

Ring Reader: 
Reading Date: 

Site ID: 
Collection Date: Feb. 2008

Tree/Hole ID: 35 
Slab ID: 

Ring Counts/Notes:

J2X Filename:

Number of radii measured: 

J2X Series Id:

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes:

- 93-07: Heartwood - Bark, Bark - Heartwood - Heartwood - Heartwood - Bark
- 95: Warm, Warm, Warm
- 94: Medium, Medium
- 93: Medium, Medium
- 92: Medium, Medium
- 91: Medium, Medium
- 90: Medium, Medium
- 89: Medium, Medium

93-07: Bark, Bark, Bark
95-07: Bark, Bark, Bark
96-07: Bark, Bark, Bark
97-07: Bark, Bark, Bark
98-07: Bark, Bark, Bark
Big Bend - Ring Reading Notes

Ring Reader: 784 577

Reading Date: 

Site ID: 

Collection Date: Feb. 2008

Tree/Hole ID: 22X

Slab ID: 2K

Ring Counts/Notes:

J2X Filename: 

Number of radii measured: 

J2X Series Id: 

Proportion of circumference with secondary growth:

Start Year: 
Stop Year: 
Proportion: 

Start Year: 
Stop Year: 
Proportion: 

Start Year: 
Stop Year: 
Proportion: 

Wood Anatomy Change Notes:

07 - 01 - Barred - Dead dry
90 - Barred - Promix
99 - thin - Barred
98 - Medium - Barred
97 - Hard - Barred
96 - Bond - Barred - Sooty log ~ 1/2 outwards
95 - may
94 - wide - faint outer boundary
93 - proc -
Big Bend - Ring Reading Notes

Ring Reader: [Name]  
Reading Date: 

Site ID: [Code]  
Collection Date: Feb. 2008

Tree/Hole ID: 250  
Slab ID: 26

Ring Counts/Notes:

J2X Filename:  
Number of radii measured:

J2X Series Id: 

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion: 

Start Year:  
Stop Year:  
Proportion: 

Start Year:  
Stop Year:  
Proportion: 

Wood Anatomy Change Notes:

- 93-95 - Burned
- 95 - Fire
- 94 - Fire - Hard cut
- 93 - Fire - Burned

Buried after 95
Big Bend - Ring Reading Notes

Ring Reader: Dick Tela
Reading Date:

Site ID: 313
Collection Date: Feb. 2008

Tree/Hole ID: 233
Slab ID: 26

Ring Counts/Notes:

J2X Filename:

Number of radii measured:

J2X Series Id:

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes:

83 - 07 - Trunk, pith small
85 - 07 - Trunk, bark bls.
93 - 07 - Trunk, pith small
95 - 07 - Trunk, pith small
83 - 07 - Trunk, collar 2 1/2 way
85 - 07 - Trunk, collar 2 1/2 way
**Big Bend - Ring Reading Notes**

**Ring Reader:** 314 - TR  
**Reading Date:** 

**Site ID:** 24  
**Collection Date:** Feb. 2008  
**Tree/Hole ID:** 289  
**Slab ID:** 29  

**Ring Counts/Notes:**

**J2X Filename:** 

**Number of radii measured:** 

**J2X Series Id:** 

**Proportion of circumference with secondary growth:**

- **Start Year:** 
- **Stop Year:** 
- **Proportion:** 

- **Start Year:** 
- **Stop Year:** 
- **Proportion:** 

- **Start Year:** 
- **Stop Year:** 
- **Proportion:** 

**Wood Anatomy Change Notes:**

- 07-98 - Undecayed, Buried 
- 97 - Slightly Buried 
- 96 - Narrow 
- 95 - Small, Medium 
- 94 - Medium, Large 
- 93 - Small to Wide 

- 93-07 Buried after 05
Big Bend - Ring Reading Notes


Reading Date: 4/1/08

Site ID: Castrejon - Big Bend (CS)  

Collection Date: Feb. 2008

Tree/Hole ID: T2X-W114a  

Slab ID: GS

Ring Counts/Notes:

J2X Filename: CS28J2X.TXT

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion:

Start Year:  
Stop Year:  
Proportion:

Start Year:  
Stop Year:  
Proportion:

Wood Anatomy Change Notes:

07: width 2/3
06: A 4.5 fatter ring on outer edge near pith appears to overlap ring

05: inside of 05 appears fatter but transition appears to be more clean. Appears like here becomes back of

04: saw faint fatter density on inside and outside of ring

03: inside appears fatter on inside but does not appear to change however ring appears more clean density

02: 1.5cm wide however 4-5 false rings within

01-07
Big Bend - Ring Reading Notes

Ring Reader: XXXX

Reading Date: 4/4/07

Site ID: Castleton Big Bend

Collection Date: Feb, 2008

Tree/Hole ID: Tor-willow

Slab ID: Slab 1-1

Ring Counts/Notes:

J2X Filename: C52pJ2X.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes: 2001 - 2007

07 - wide, cork layer big on outer edge.
06 - narrower than 07, all ~3 inner rings on outside of log.
05 - Inside of log opens. false buds get closer downstream - lacks a distinctive change in vessel width.
04 - inner cork edge thick on places.
03 - Inside log opens further as that a no distinctive change in vessel change, sometimes some black brown elongation
02 - wider
01 - cork false caps thinned. Also, a second stem to cork appear present with ring pitch cracked.
Big Bend - Ring Reading Notes

Ring Reader: DD + JR  
Reading Date: 4/15/88

Site ID: Carlsbad - Big Bend  
Collection Date: Feb, 2008

Tree/Hole ID: 2x  
Slab ID: 2

Ring Counts/Notes:

J2X Filename: C S R J2 X . TXT

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: 2001-2007

07 - widest ring
06 - narrow ring  1
  - Ring present on outer 1/2 of ring
  - Ring appears broken or a distinct change in wood core
  - Wood with sap bark

05 - Ring present, where described above, a usual ring is found but present on outer edge of ring

04 - Narrow outer edge of ring is made of 2 rings, with 3 rings still present
Big Bend - Ring Reading Notes

Ring Reader: DP, TN

Reading Date: 4/1/08

Site ID: Eastern - Big Bend

Collection Date: Feb. 2008

Tree/Hole ID: J2X-6661

Slab ID: 3, N9L 69

Ring Counts/Notes:

J2X Filename: C5APJ2X.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes: 2001-2007

04 - Wide - Checking to look for pressure
06 - 3 - False rings still present on outer edge of ring 06-07 flooding phase
05 - Rather clear even though some transition to splits, narrower, wider
04 - Wide
03 - Thin - Check graining on sides of ring, narrower, fading
02 - Close to boundary of 02/03, slightly pressure wider
01 - False rings 3/8 prove to exist forward of 01/02 boundary

 knots, cracks noted and Secondary and due to drying out, they un further so another year the rings called out pressure.
Big Bend - Ring Reading Notes

Ring Reader: PDJR
Reading Date: 4/1/08

Site ID: Cadiz - R ring base
Collection Date: Feb. 2008

Tree/Hole ID: T28, 11/16
Slab ID: < 68

Ring Counts/Notes:

J2X Filename: C528J2X.txt
Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes: 2001 - 2007

07: wid
06: false rings still present on outer edge. 9 because clock bending. 05: 03 remains.
05: appears defective nowadays.
04: false ring on outer edge. 04:
03: there is trunk bending at 02/03 bending. 03 appears to be in 02 additional. 02 remains.
02: contains what looks like an additional ring.
01: false ring still present
Big Bend - Ring Reading Notes

Ring Reader: D. J. K.  
Reading Date: 4/ 10/07

Site ID: Canolke - Big Bend  
Collection Date: Feb. 2008

Tree/Hole ID: 2AZW-01403  
Slab ID: 6 - NW-1 - E7/16

Ring Counts/Notes:

J2X Filename: CS2PJ2X.CXT

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: 2001 - 2007

01 - wide - slightly porous.  
06 - slightly porous - false rings still present on outer edge.  
05 - prisms of new wood on fault.  
061 - false ring on outer edge.  
03 - thin.  
02 - wide.  
01 - false rings still present.  
Width.
Big Bend - Ring Reading Notes

Ring Reader: DB + TR
Reading Date: 4/1/08

Site ID: ntv
Collection Date: Feb. 2008

Tree/Hole ID: th
Slab ID: 8 New 6c
e

Ring Counts/Notes:

J2X Filename: C S 2 P J2X.ex

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year: ____________ Stop Year: ____________ Proportion: ____________
Start Year: ____________ Stop Year: ____________ Proportion: ____________
Start Year: ____________ Stop Year: ____________ Proportion: ____________

Wood Anatomy Change Notes: 2001 - 2007

07-06: wide > open  Bore 05
05: Bore  Boreal after 04, slightly prone
04: wide
03: Toot bore rings present throughout
02: wide
01: bore rings present throughout with


Big Bend - Ring Reading Notes

Ring Reader: DD + T2

Reading Date: 4/10/08

Site ID: Pedernales - Big Bend

Collection Date: Feb. 2008

Tree/Hole ID: 7CK-77005

Slab ID: 9 NL FG E

Ring Counts/Notes:

J2X Filename: CS28J2X.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion: 

Start Year: Stop Year: Proportion: 

Start Year: Stop Year: Proportion: 

Wood Anatomy Change Notes: 2001-2007

07-06 - Bands to False rings w/ both, both wide. Bands after 06.

05 - 5/32" pores narrower.

04 - wide

03 - narrower

02 - wide

01 - False rings throughout, wide w/ pitch.
Big Bend - Ring Reading Notes

Ring Reader: DD*TE  
Reading Date: 01/31

Site ID: NPS 382  
Collection Date: Feb. 2008

Tree/Hole ID:  
Slab ID: 11/25

Ring Counts/Notes:

J2X Filename: CSJ2X.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Wood Anatomy Change Notes: 2001-2007

06-07 - dual
04-05 - dual 2x4
03 - thin
02-01 - 2x4 rings thinned
01 - w/pith
Big Bend - Ring Reading Notes

Ring Reader: 3-5k  
Reading Date:  

Site ID: F.2.0  
Collection Date: Feb. 2008  

Tree/Hole ID:  
Slab ID: 44 442 2E  

Ring Counts/Notes:  

J2X Filename: C52T2k.txt  

Number of radii measured: 2  

J2X Series Id:  

Proportion of circumference with secondary growth:  

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Wood Anatomy Change Notes: 2001-2007  

01-02 - compression  
04-05 - Bended > Bended  
05-06 - Slight decrease - part of bended 01  
01 - Late rings thinned  
01-04
Big Bend - Ring Reading Notes

Ring Reader: D.L.         Reading Date: 4/1/98

Site ID: j.j.j.j.j.j.j.j.j.j.

Collection Date: Feb. 2008

Tree/Hole ID: j.k.l.k.l.j.

Slab ID: 1n 1n 1n 1n 1n 1n 1n

Ring Counts/Notes:

J2X Filename: c527j2x.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year:  Stop Year: Proportion:
Start Year:  Stop Year: Proportion:
Start Year:  Stop Year: Proportion:

Wood Anatomy Change Notes:  2001 - 2007

01 - 0% increase
03 - Difficult to score due to build.
04 - Shows signs of burial 04 of 04 buried
01 - Width 1/4" of width.
Big Bend - Ring Reading Notes

Ring Reader: PD JR
Reading Date: 4/10/14

Site ID: salcow
Collection Date: Feb. 2008

Tree/Hole ID: t20.11.19
Slab ID: 1x 16/8 G

Ring Counts/Notes:

J2X Filename: C S2 J2X, F 4

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes: 2001-2002

Everything burned after 01

Pith still present.
Big Bend - Ring Reading Notes

Ring Reader: DO JH  
Reading Date: 4/1/08

Site ID: Cash/Ar  
Collection Date: Feb. 2008

Tree/Hole ID: T08 salads  
Slab ID: 60 N 00 60 0L
e

Ring Counts/Notes:

J2X Filename: c522j2x,  
Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Start Year:  
Stop Year:  
Proportion:  

Wood Anatomy Change Notes: 2001-2004

- Everything found after 01 01-04 not 01-04. Difficult to identify late xyle.
  Pith still present
- Measure 1st year only.
Big Bend - Ring Reading Notes

Ring Reader: \( J R \)  
Reading Date: 

Site ID: Castlack  
Collection Date: Feb, 2008  

Tree/Hole ID: 28  
Slab ID: 21  

Ring Counts/Notes:

\[ J2X \] Filename: CS28 J2X.txt  
Number of radii measured: 2  
\[ J2X \] Series Id:  

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes:

- Band present, post present,
- Buried after 2001 - center
Big Bend - Ring Reading Notes

Ring Reader: D.D. & J.R.  Reading Date: 4

Site ID: Castoloh  Collection Date: Feb. 2008

Tree/Hole ID: 28  Slab ID: 21-1

Ring Counts/Notes:

J2X Filename: cs 28j2x2x2

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year:  Stop Year:  Proportion:

Start Year:  Stop Year:  Proportion:

Start Year:  Stop Year:  Proportion:

Wood Anatomy Change Notes: 2000 - 2003

- center = 2000 width

- additional center year seen here, may have been on previous slab, but
  - buried after 2000, too crooked to see well.

- 2003 very compressed, bands discernible
Big Bend - Ring Reading Notes

Ring Reader: DD + 52
Reading Date: 4/1/98

Site ID: estlbw
Collection Date: Feb. 2008

Tree/Hole ID: 128-1
Slab ID: B2

Ring Counts/Notes:

J2X Filename: c52pJ2X.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year: _______ Stop Year: _______ Proportion: _______

Start Year: _______ Stop Year: _______ Proportion: _______

Start Year: _______ Stop Year: _______ Proportion: _______

Wood Anatomy Change Notes: (2000 - 2002)

Appears to be a new ring present in 2000
- Everything best seen after 2001
- Pith still present
- 2001-02 - no change
- 2003 not clear enough to measure - compressed
Big Bend - Ring Reading Notes

Ring Reader: DD+70
Reading Date: 4/14

Site ID: 096C
Collection Date: Feb. 2008

Tree/Hole ID: 714000
Slab ID: 24

Ring Counts/Notes:

J2X Filename: CS28J2X.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:
Start Year: Stop Year: Proportion:

Wood Anatomy Change Notes: (1979-2001)

- New gum - 1999 center
- Pith present
Big Bend - Ring Reading Notes

Ring Reader: [Redacted]  Reading Date: 4/1/98
Site ID: Acadian  Collection Date: Feb. 2008
Tree/Hole ID: [Redacted]  Slab ID: 25

Ring Counts/Notes:

J2X Filename: CS28J2X.txt

Number of radii measured: 2
J2X Series Id:

Proportion of circumference with secondary growth:

Start Year: ______  Stop Year: ______  Proportion: ______
Start Year: ______  Stop Year: ______  Proportion: ______
Start Year: ______  Stop Year: ______  Proportion: ______

Wood Anatomy Change Notes: (1999-2000)
- center 1999
- pith 1 additional ring in middle (2)
- all annual after 00.
- still pith present
Big Bend – Ring Reading Notes

Ring Reader: J.K.  
Reading Date: 

Site ID: Castolon  
Collection Date: Feb. 2008

Tree/Hole ID: T28  
Slab ID: 26  

Ring Counts/Notes:

J2X Filename: CS28J2X.txt  
Number of radii measured: 2

J2X Series Id:  

Proportion of circumference with secondary growth:

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Wood Anatomy Change Notes: (1999 - 2000)

- center is 1999
- pith still present,
Big Bend - Ring Reading Notes

Ring Reader: JL
Reading Date:

Site ID: Castolon
Collection Date: Feb. 2008

Tree/Hole ID: T28
Slab ID: 28

Ring Counts/Notes:

J2X Filename: CS28J2X.txt

Number of radii measured: 2

J2X Series Id:

Proportion of circumference with secondary growth:

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<th>Start Year</th>
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Wood Anatomy Change Notes:
- End of tree center -1999
- pitch present
- burned after '99,

- Potential estimate year is 1999.
Big Bend - Castolon

Tree 28 (willow)

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\[ \text{J. Roth} \]

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\[ \text{0} \]
BIG BEND - CASTOLON

TREE 25 (willow)

(6cm) c.5.28.19
(5cm) c.5.28.20

hail = 60

Sanded

Sanded

Sanded

Sanded

Sanded (top below)