Historical Accounts of Arroyo Cutting in The Southwest: A Brief Outline and List of Accounts

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HISTORICAL ACCOUNTS OF ARROYO CUTTING IN THE SOUTHWEST: A BRIEF OUTLINE AND LIST OF ACCOUNTS

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> "Valid conclusions as to the merits of these theories cannot be reached until historical data on the time at which erosion began have been accumulated."
>
> Kirk Bryan (1926)

Kirk Bryan made this statement regarding the debate about the causes of the widespread arroyo cutting that was observed in the Southwestern United States around the turn of the 20th century. Bryan also made the Rio Puerco a central part of the debate that was to unfold about the causes of arroyo cutting by collecting accounts of incision from residents of the Rio Puerco Valley who watched it happen (see Appendix 1; Aby, 2017 and references therein). In brief, many streams flowing through valleys containing 5–20+ m of Holocene alluvium incised their beds between a few and as many as 20+ m in the late 19th and early 20th centuries. This incision had profound impacts on residents, irrigation systems, and probably groundwater levels. The three main causes of arroyo cutting alluded to by Bryan above are: climate changes, overgrazing, and intentional or inadvertent concentration of streamflow by "drainage concentration features" (DCFs).

This short paper presents a summary of historical information gathered on the timing and causes of arroyo cutting in New Mexico, Arizona, Colorado, and Utah, inspired by Kirk Bryan's suggestion from almost a hundred years ago. The data discussed here, as well as the geologic and historical context of arroyo-cutting, are more fully treated by Aby (2017). Arroyo cutting has long been said to have happened mainly in the late 19th century. This compilation (Appendix 1; Figs. 1 and 2) of arroyo-cutting events largely confirms this, but also shows that significant numbers of events occurred in the early 20th century and some as early as the 1860s—possibly the 1760s. The history of the long-running debate about the causes of arroyo cutting in the American Southwest is beyond the scope of this paper, but several summaries are available (e.g., Tuan, 1966; Graf, 1983; Betancourt, 1990). In short, climate change and overgrazing have often been suggested as causes of historical arroyo cutting, but climate changes are, in general, not in phase or synchronous across the study area, and the effect of grazing on incision, from a process standpoint, is not clear (Aby, 2017 and references therein).

The book-length treatment of the subject by Cooke and Reeves (1976) suggested that many arroyos may have been caused by what they termed "drainage concentration features" (DCFs), a category that includes roads, trails, irrigation ditches (acequias), flood-control structures, and any other man-made structure that concentrate runoff. Their seemingly strong argument has often been overlooked or downplayed. The compilation of dates provided here, along with the observations of firsthand witnesses strongly implies that DCFs did indeed have a strong influence on the location and timing of arroyo cutting. They were often explicitly named as the cause of incision at the time. The earliest recorded arroyo-cutting events in the Southwest occurred in the earliest-settled areas (e.g., the Virgin River of Utah; Webb, 1985), and some structures were explicitly designed to cause incision (e.g., Sam Hughes' ditch in Arizona; Betancourt, 1990). The earliest historical evidence of gullying in the Rio Puerco drainage (not included in Appendix 1) is an order by Governor Capuchin for residents of Los Quelites (founded in 1765 on the Rio Puerco near the confluence with the Rio San Jose) to address the erosion of agricultural fields (Betancourt, 1980; Love, 1997).

Considering the data compiled in Appendix 1, the following observations seem particularly relevant to the debate about the cause(s) of arroyo cutting:

- Forty-four of the 145 historical accounts listed contain an explicit account of the cause of incision as determined at the time.
- Of these accounts, 30 (68%) cite DCFs as the cause, 12 (27%) cite overgrazing, and two (4.5%) cite a combination of these two causes.

It comes as no surprise that erosion has been a recurring issue for human beings for as long as they have had the ability to affect drainage systems. Patrick Henry is reported to have said (referring to Virginia in the late 1700s) that, "He is the greatest patriot who stops the most gullies" (Hall, 1937). Thomas Jefferson was also an advocate of erosion control methods designed to stop loss of topsoil and the formation of gullies (Hall, 1937). Soil erosion and gullying in Africa was reported (with distasteful colonial condescension) to have followed tsetse fly eradication as new areas became safe to live in or, conversely, when people were confined to tsetse fly-free areas. (Champion, 1933; Hobley, 1933). Deforestation, upland erosion, and coastal alluviation followed Polynesian migrations across the South Pacific (W.R. Dickinson, written communication, 1998). In South Africa, dongas or sluits (arroyos) may have formed as early as the late 18th century (shortly after settlement) and have been attributed to overgrazing, cattle trails, wagon tracks, and/or draining of wetlands for agriculture (Rowntree, 2013; Boardman, 2014). Arroyos also formed

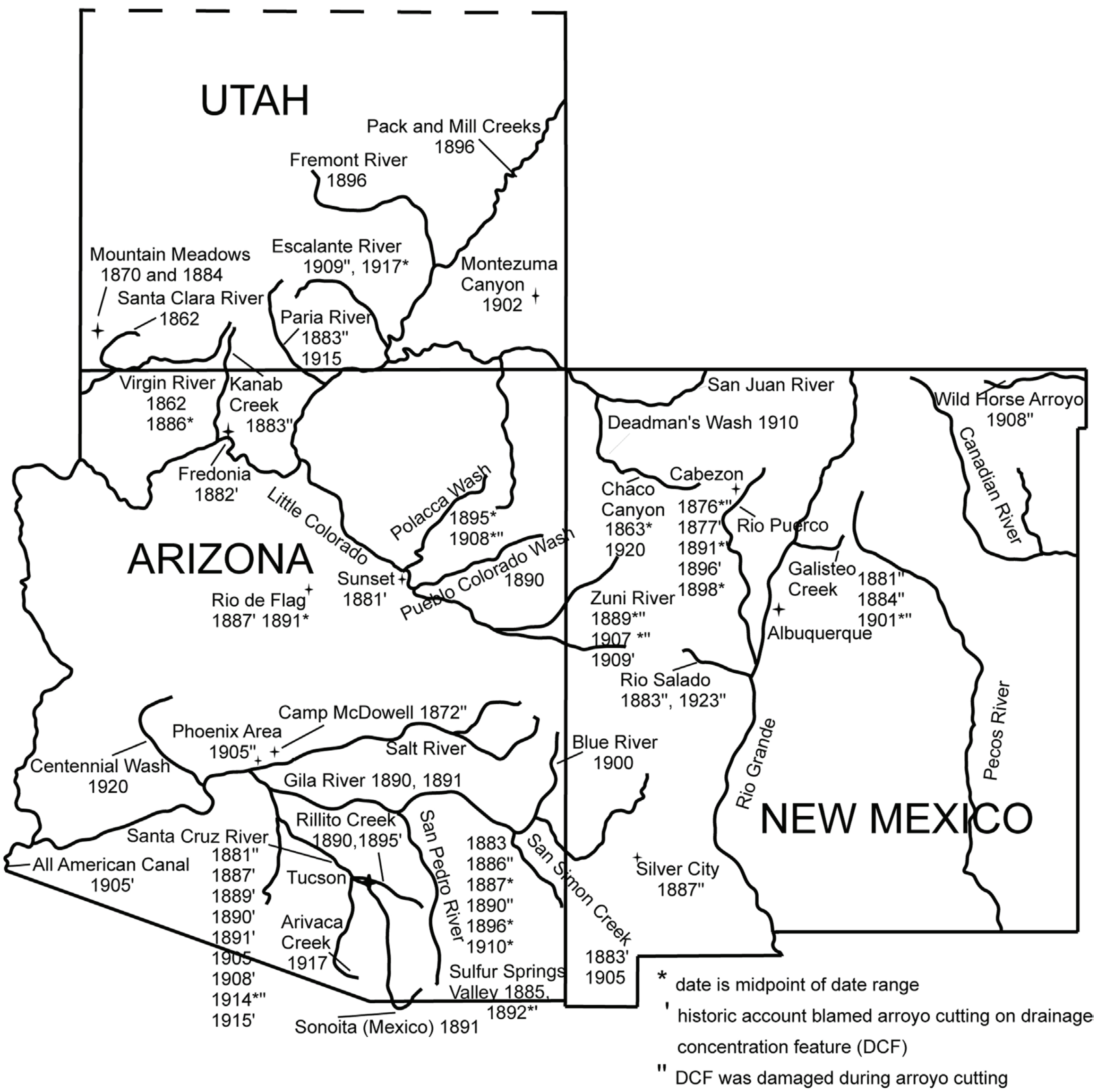

Figure 1. Location of sites for which specific years or ranges of years of arroyo cutting were found (Appendix 1) and locations mentioned in text. Other locations listed in Appendix 1 can be found in associated references. Only selected rivers and streams associated with historic data are shown. Douglas Creek in northwestern Colorado (Appendix 1) is not shown.

in formerly swampy meadows of New South Wales, Australia, shortly after the initial agricultural expansion following European colonization (Prosser and Slade, 1994). In the Southwestern United States, draining of cienegas (wet meadows) for malaria prevention in the late 1800s may also have had a direct but undocumented influence on streams (Hastings, 1959; Cooke and Reeves, 1976), but one that would likely enhance erosion. Huckleberry, et al. (2009 and references therein) cite evidence that the location of cienegas may have been determined by the location of beaver dams and removal of beaver from some areas may have also contributed to incision.

One source outlines a process of arroyo cutting that is particularly direct: discussing the area near Datil, New Mexico, Agnes Morley stated that, "The roads down the canyon were any level stretch over which a wagon could pass. When the ruts had become incipient arroyos and the high centers [between the ruts] made traffic impossible, new wagon tracks had appeared beside the old until erosion claimed its own and a real arroyo forced an entirely new route" (Cleveland, 1941; p. 26).

Ultimately, the true cause(s) of arroyo cutting may remain obscure (Miller, 2017), and it should not be forgotten that geomorphic/alluvial systems can pass internal thresholds that cause incision without external drivers such as climate change or human impacts (Patton and Schumm, 1975). Individual sites may also, of course, be affected by multiple processes simultaneously. The presence of paleoarroyos in many areas also shows that incision can occur in the absence of the types of DCFs discussed here. However, any debate is conditioned by the data available to constrain possible conclusions, and the observations made by many eyewitnesses to late 19th and early 20th century arroyo cutting cannot be dismissed out of hand (Bryan, 1926; Aby, 2017).

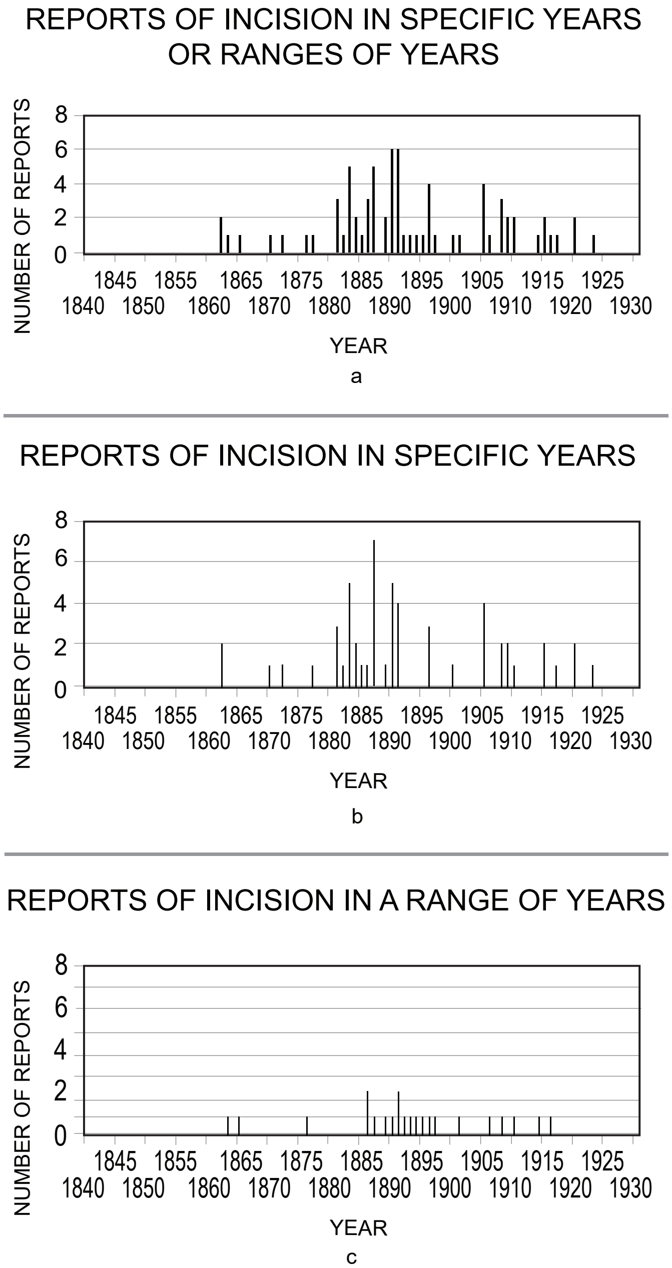

Figure 2. Graphs of reported incision dates: A: Reports of incision in a specific year or range of years. B: Reports in a specific year only. C: Reports in a range of years only. Midpoint of ranges is used in 2A and 2C. Figure 2A is combination of data in 2B and 2C. Data from Appendix 1. Figure from Aby (2017).

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Appendix can be found at
https://nmgs.nmt.edu/repository/index.cfml?rid=2025001

View to the south along the Rio Puerco above La Ventana.