GEOARCHAEOLOGY OF GLACIAL LAKES SUSITNA AND ATNA

Gerad M. Smith
University of Alaska Fairbanks, Anthropology Department, 303 Tanana Loop, Fairbanks, Alaska 99775-7720;
gmsmith2@alaska.edu

ABSTRACT

This paper presents a comprehensive review of the late Pleistocene and early Holocene geoarchaeological work pertaining to Glacial Lakes Susitna and Atna located in southcentral Alaska. It describes the radiocarbon chronology of the proglacial lakes and human occupation of the region as well as a relative chronology of undated strandlines. The data suggests that a landscape of increased dynamic glacial and large lacustrine systems in the Copper River and middle Susitna River basins persisted through the terminal Pleistocene and early Holocene period, forming prior to but existing after the initial dispersal of humans south of the Alaska Range. The presence of the glacial lakes may account for the lack of human occupation sites in the lower elevations of the upper Copper and Susitna drainages. Additionally, the late persistence of the lakes may have acted as an ecological barrier to early human dispersal into more southern regions.

INTRODUCTION

Researchers have long recognized the presence of lacustrine deposits in the Copper River Valley and have thus observed that the region was once the setting of a vast inland lake or sea (Moffit 1954; Schrader 1900). Initial conclusions were conservative, interpreting the deposits as more likely the result of smaller, localized prehistoric lakes (Mendenhall 1905; Moffit 1954; Schrader 1900; Schrader and Spencer 1901). Later, foundational studies conducted by Ferrians and Nichols in the 1960s established the concept that a vast regional glacial lake had existed, which has spurred numerous follow-up studies (Ferrians 1963a, 1963b; Ferrians and Nichols 1965; Nichols 1965). This paper brings together advances in archaeological knowledge with a comprehensive literature review of regional geologic and ecological research to provide insight into the implications of the late persistence of the lake and early human interaction with it.

The surface levels of these glacially impounded lakes left a dynamic record throughout the later Pleistocene and early Holocene; however, reconstructing a working chronology of the elevations and extents of the glacial lakes is difficult. Shorelines have not been consistently preserved throughout the Copper and Susitna River basins (Fig. 1), and lacustrine deposits have been overlain and reworked by erosion and glacial advances and retreats. Additionally, the possibility of isostatic depression from the lake and adjacent ice mass has suggested to some researchers that observed shorelines in one region might not be consistent with those observed in another (Ferrians 1984). Many of the identified glaciolacustrine deposits lack datable organic remains. Finally, many of the conclusions summarized here are increasingly out of date, as most of the radiocarbon ages used were derived prior to the availability of the accelerator mass spectrometry (AMS) measurements. To further complicate the matter, radiocarbon results have been reported inconsistently; therefore, both conventional and calibrated dates are reported, when available, and calibrated (Table 1) using Calib 7.1 online using the IntCal13 curve (Reimer et al. 2013; Stuiver et al. 2018). All calibrated dates are reported with one standard deviation. All map figures were created by the author using ArcGIS v5-6.1, unless otherwise noted.

GEOLOGICAL REVIEW

Evidence of at least four major glacial advances have been interpreted in the region. See Briner and Kaufman (2008) and Kaufman and Manley (2004) for a statewide literature review and synthesis of glacial history and Reger et al. (1990:4) for a region-specific discussion and synthesis. Yehle and Nichols (1980) argue that a fifth advance left trace evidence as well—but see also Nichols (1965, 1989). Periods of glacial advance blocked riverine drainage systems near the mouth of the Chitina River, the middle Susitna River Valley at Devils Canyon, in the upper Matanuska Valley at the Tahneta Pass, and in the Alaska Range at Mentasta Pass. These blockages resulted in the formation of long-lived massive glacial lakes, usually referred to as Glacial Lake Atna (Nichols 1965) and Glacial Lake Susitna (Williams 1989), depending on the relative locations of regional ice and water within the western Copper River and eastern Susitna River basins (Fig. 1).

The four or five glacial advances are relatively dated in much of the literature reviews listed below, but Briner and Kaufman (2008) provide a comprehensive list of chronological dates for moraine stabilization as well. The earliest pre-Illinoisan advance scraped a lava flow between the Dadina River and Kotsina River, which produced dated (K-Ar) plagioclase at 200,000 BP (Yehle and Nichols 1980), suggesting the advance occurred during Marine Isotope Stage (MIS) 7. This earliest recorded glacial advance, also known as the Darling Creek glaciation (Péwé 1975), is poorly understood but may have resulted in the Copper River basin being completely filled with ice, based on a lack of associated lacustrine sediments (Nichols 1965, 1989). The following period of drift, known as the Delta glaciation (Péwé 1965), is related to

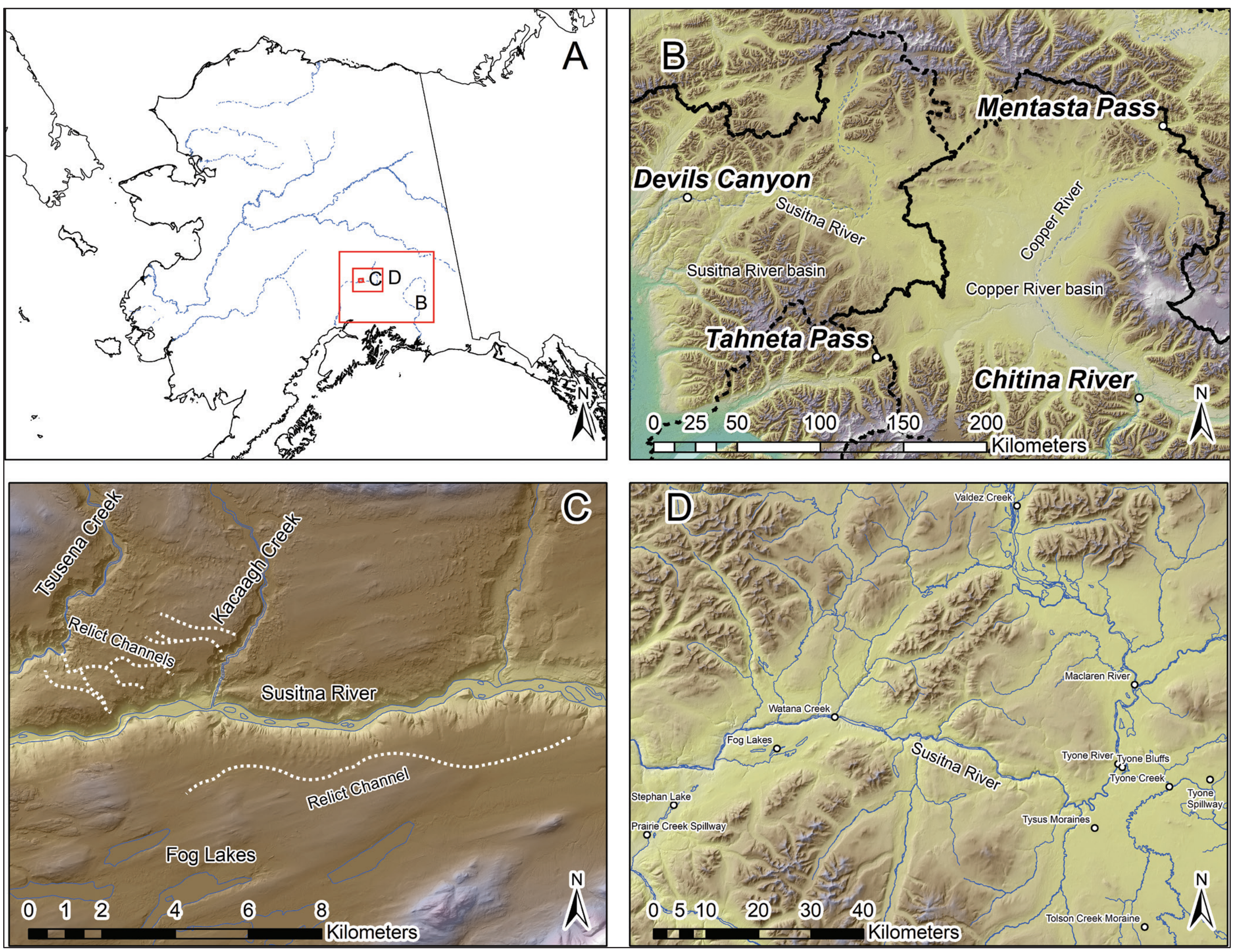

Figure 1. (A) location of inset maps; (B) location of major landmark;s (C) pre–early Wisconsin relict channels of the Susitna River above the present canyon; (D) location of major landmarks.

present lacustrine deposits and is interpreted to represent an advance and partial retreat of the ice. The resulting large meltwater lake that formed may be the source of the oldest demonstrated sediments associated with Lake Atna (Nichols 1965, 1989). However, this proglacial lake is also poorly understood.

The early Wisconsin (penultimate) glacial advance deposited till over earlier lacustrine silt and is thus interpreted to represent an ice advance into a lake-filled basin. Regionally, this period corresponds with the Donnelly glaciation (Péwé 1965) and Denali glaciation (Smith 1981). The glaciers progressed north, filling the valley and forming an ice cap in the central areas. The subsequent retreat may have begun in the south of the basin, at the northern margins of the Chugach Mountains, regressing toward the central basin area (Nichols 1965, 1989). The resulting lake formed at the periphery of this ice cap. The early Wisconsin glaciation resulted in moraine stabilization near or on the northern foothills of the Alaska Range at Healy, ranging between 60,000 and 55,000 ± 3700 ^{10}BE (Dortch 2006), and in the western foothills of the Alaska Range at the Swift River Valley after 58,000–52,500 ± 5600 ^{10}BE (Briner et al. 2005).

The earliest direct glaciolacustrine dates (^{14}C) suggest that the lake may have begun to form broadly by 40,000 RCYBP (Nichols 1989; Williams and Galloway 1986) and perhaps as early as 60,000 RCYBP [MIS 3] (reported here as only uncalibrated, see Table 1) (Ferrians 1963b, 1984, 1989). Radiocarbon dates of this age are difficult to verify and are used here with caution. However, if accurate, the dates may correlate with early Wisconsin sediments corresponding with the retreat of the penultimate period of glaciation.

A series of buried relict streambeds in the middle Susitna Valley exhibit an uncertain association with Glacial Lakes Atna and Susitna. These relict channels, found at an elevation of 720 to 680 m (described by R&M Consultants [1982] and Woodward-Clyde Consultants [1982]), suggest that prior to the early Wisconsin glaciation, the Susitna River flowed north of its present location in the Talkeetna Mountains across the high plateau upstream of Devils Canyon in the vicinity of Kacaagh Creek (previously Deadman Creek). The Susitna spilled into the current canyon of Tsusena Creek, downcutting the lower Tsusena Valley before being diverted by a later glacial dam and carving its present valley. An additional buried relict channel was also briefly described to the south between the current river valley and Fog Lakes; however, its temporal association with these relict channels is unknown (Fig. 1). The channels north of the Susitna Canyon are described as buried by at least three (then unnamed and undated) distinct glacially deposited sediment zones likely the result of local glacial advances, regionally described as the Denali glaciation (Smith 1981), the third glaciation (early phase) (Reger and Bundtzen 1990), and the Clear Valley glaciation (Thorson et al. 1981; Welsch et al. 1982). The existence of these channels illustrates the prelacustrine nature of the middle Susitna Valley.

The late Wisconsin glacial advance presents a complicated picture of several regional progressions, stagnations, retreats, and readvances during this period (Briner and Kaufman 2008). Initially, a drift sheet of ice progressed north, up the Copper River basin to the Gulkana River (Fig. 2) (Nichols 1965, 1989). The advance is termed locally as the Denali II (Péwé 1965), Hatchet Lake (Smith 1981), and Butte Lake (Welsch et al. 1982) glaciations. The period of glacial advance and retreat corresponds with several smaller periods of temperature differentials, associated with rising and falling levels of precipitation and localized glacial advances and retreats. The northwestern part of the Copper River basin and the northeastern section of the Susitna River drainage system retain the best-preserved regional geologic signatures for the proglacial lakes. Lacustrine deposits associated with these early dates suggest that the lake rose at least to an elevation of 775 m (Williams 1989), potentially filling the ice-free areas of both the Susitna and Copper River basins with one conjoined lake. The lake has been referred to as Glacial Lake Susitna, as most of the ice-free inundation area was within its drainage basin (Williams 1989), and its primary outlet system would have been west and southwest of Fog Lakes in the Talkeetna Mountains (Fig. 1), likely near Chinook, Cache, and Devil Creeks. The advance is marked by both diamicton and lacustrine sediments. This period of drift may have been limited in its advance but was characterized by a significant glacial retreat (Nichols 1965, 1989).

Pollen analysis from sediment cores provides a snapshot of paleoenvironmental vegetation regimes. While informative, these should not be interpreted as a complete sample. Ancient pollen samples taken from the lower Dadina River at an elevation of 550 to 600 m suggest that during the early period of lake formation, before glacial expansion, the landscape was similar to the boreal forest of today (Fig. 2). The region was characterized by *Picea* (spruce), *Betula* (birch), *Alnus* (alder), Ericaceae (heaths), and Cyperaceae (sedge), along with additional herbs (Connor 1984). These samples returned reported dates of >33,500 (I-12,321) and >40,000 RCYBP (I-12,320; I-12,322) (Table 1). A similar signal was reported near Tyone Creek (elevation ~710 m) dated at >35,000 RCYBP (Ager 1989; Williams and Galloway 1986) (Fig. 2). Ager (1989) suggests that despite the relative uncertainty of these old radiocarbon dates, these samples correlate with an early mid-Wisconsin warming period recognized across Beringia, which supported a regional vegetation regime similar to that of the 20th century. Peat samples from the Nelchina River (~600 m) suggest a treeless tundra regime existed at 38,000 RCYBP (Ager 1989; Williams and Galloway 1986), which followed the earlier (here undated) boreal forest (Fig. 2).

During the greatest extent of ice, the majority of ice-free areas were in the easternmost Susitna River basin, and thus the proglacial lake is referred to as Glacial Lake Susitna. Glacial Lake Susitna's eastern boundary was the Nen' Yese' (previously Heartland Ridge) moraine (Fig. 2). To the west, the lake was dammed near Devils Canyon and south of Stephan Lake. Earlier, the ice extent may have extended as far east upstream as Watana Creek. It extended up the Maclaren River and south to the Old Man, Little Nelchina, Curtis Lake, and Tolson Creek moraines, and it may have extended north almost to Valdez Creek, although that signal may have been a smaller proglacial lake (Williams 1989) (Fig. 2). The lake swelled to its greatest elevation of 975 m during this period (Williams 1989) (Fig. 3). At this time, possibly associated with the ice recession, the lake may have burst down the Matanuska Valley at Tahneta Pass, lowering the level to 914 m (Williams and Galloway 1986) (Fig. 3). This event was also described in detail by Wiedmer et al. (2010). Wiedmer and associates discuss the geological evidence throughout the Matanuska Valley that supports

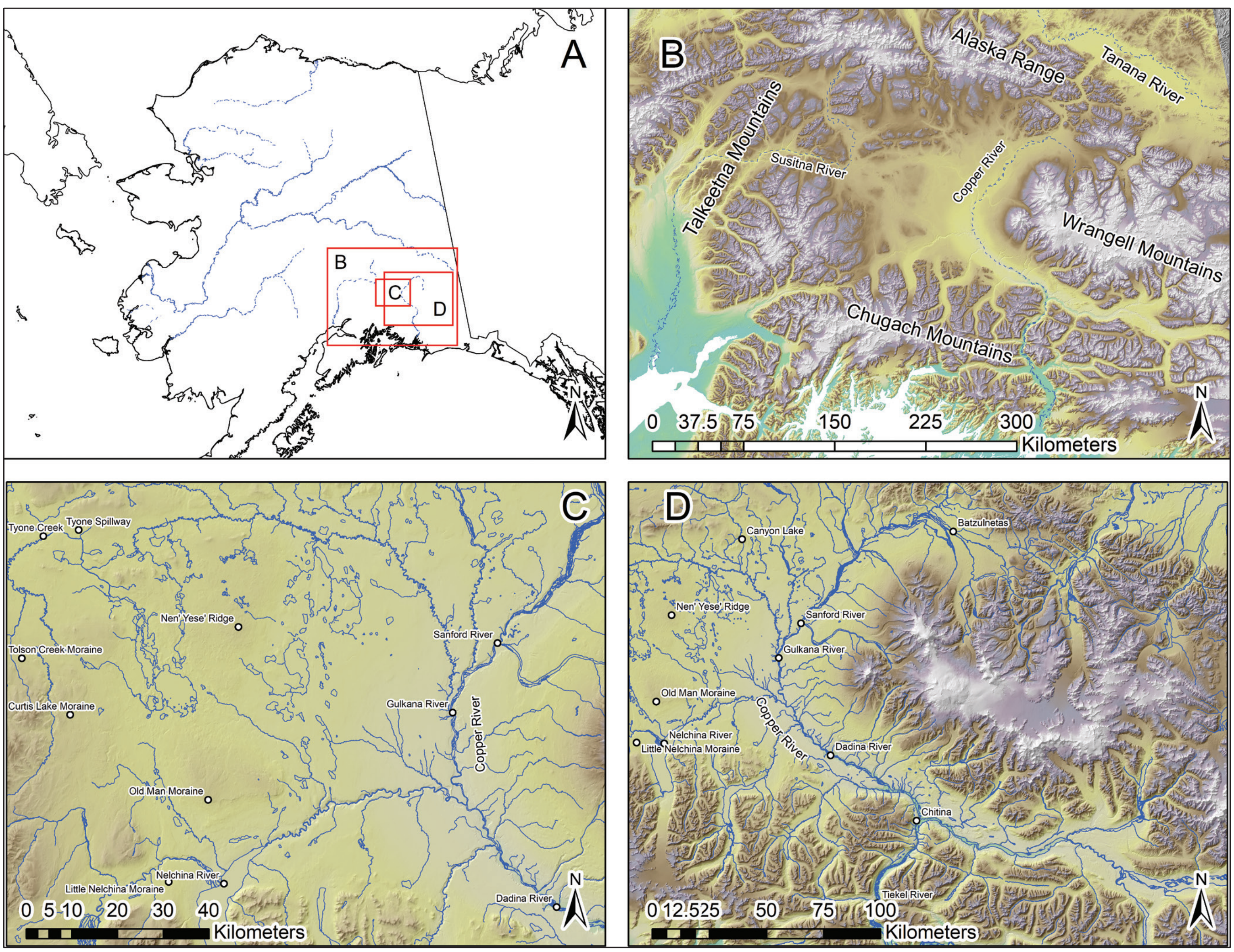

Figure 2. Location of geographic features.

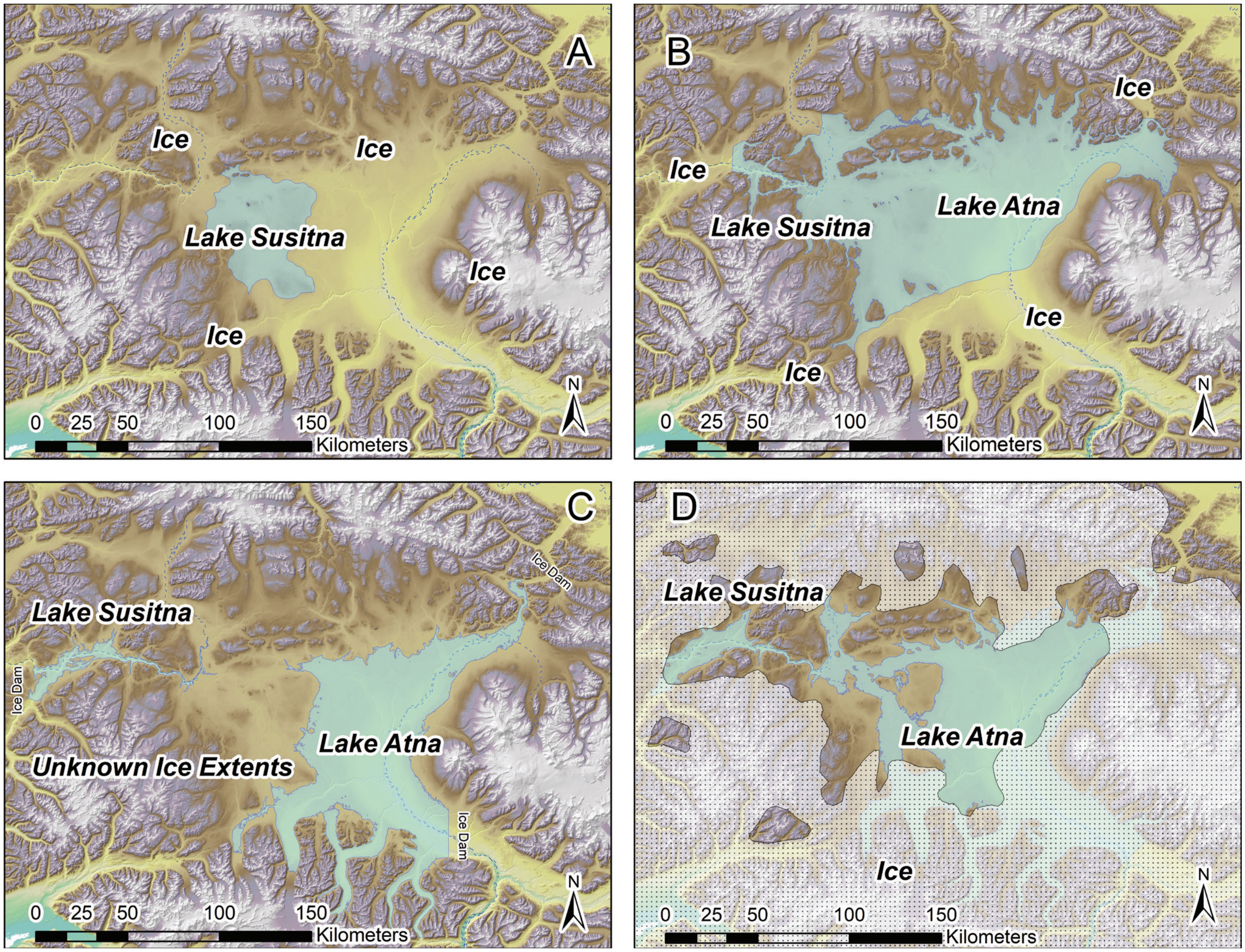

Figure 3. (A) Glacial Lake Susitna, elev. 975 m, ~32,000 RCYBP?; (B) Glacial Lakes Susitna and Atna, 914/915 m, ~30,000 RCYBP?; (C) Glacial Lake Susitna, elev. 705 m, and Glacial Lake Atna, elev. 700 m, ~29,000 RCYBP?; (D) Glacial Lakes Susitna and Atna, elev. 777 m, ~20,000 to 18,000 RCYBP(?). Ice extents in (A) and (B) derived from Williams and Galloway (1986). Ice extents in (D) derived from Dyke et al. (2003).

this idea (disputed by Reger et al. 2011); however, their time frame for the event (~15,500–26,000 RCYBP) may be based upon a misinterpretation of a limited data review of the published radiocarbon and relative geologic dates. Reger et al. (2011) explain that the evidence supports outflow at an earlier period; thus, it is more likely that the lake reached its highest level prior to 32,000 RCYBP during the final millennia of MIS 3. The 914 m lake elevation may have persisted for a longer undetermined period as ice sheets retreated from the upper Copper River valley. Undated lacustrine deposits have been recorded in the broad valley surrounding Batzuletnas, near Slana in the Copper River headwaters region, at 915 m and are assumed here to be related (Richter et al. 2006) (Fig. 3). It is unlikely that this highest lake (975 m) extended into the west much past the Tysus moraines on the Oshetna River. However, the lower level (914 to 915 m) may have left sediments farther west (possibly as far as the Watana River). Most of the current visible landscape features associated with the Tyone Spillway decanting event were likely created during this time, as they are found between the basal elevation of ~750 m and above 900 m on the large, prominent unnamed bluff located between Tyone Creek and Tyone River, and west of Susitna Lake, and on bluffs immediately to the east of Moore Lake on Tyone Creek (Connor 1984).

Following the second-oldest glacial drift event, the region entered an interstadial warming period, marked by lowered lake levels in the northeast and northwest portions of the basin around 31,000 RCYBP, persisting to 22,000 rcybp (~35,000–26,000 cal bp) (Table 1) (Thorson et al. 1981). The lake eventually drained to the point where it split into the eastern Glacial Lake Atna and western Glacial Lake Susitna at 690 masl sometime after 32,000 ± 2730 rcybp (33,533–39,247 cal bp) (Table 1), a basal date on the Tysus moraines that lie above lacustrine sediments near the present-day Tyone River (Williams 1989) (Fig. 2). In the Susitna basin, the remains of a mammoth found at an elevation of 705 m (dating to 29,450 rcybp (32,879–34,165 cal bp) (Table 1) suggest that the lake levels had either stabilized or drained below this elevation by this point (Thorson et al. 1981) (Fig. 3). Lake Atna left behind sediment strands at 701 m (32,000 rcybp), then drained to at least 655 m (31,300–28,300 rcybp) (Ager 1989; Ferrians 1989; Nichols 1989) (Fig. 3; Table 1).

Pollen samples recovered from the Sanford River area (700 to 750 m) suggest "[t]he assemblages are dominated by pollen of Cyperaceae, Gramineae, Caryophyllaceae, *Artemisia*, *Phlox*, and other herbs…indicating that lowland areas of the Copper River Basin…were vegetated by a treeless alpine tundra between about 28 and 31 ka" (Ager 1989:90). A similar pollen signal from this time was described from the Tyone Bluffs area (Thorson et al. 1981) and also above 700 m (Fig. 2).

The most recent glacial advance began in the region roughly 21,730 rcybp (25,625–26,414 cal bp) (Table 1) (Williams 1989), or broadly between 24,000 and 11,500 rcybp (MIS 2). Glacial Lake Susitna's levels again began to increase, merging with and overtaking Lake Atna (and is referred to by both names [Williams 1989], although Glacial Lake Atna is currently preferred), rising to between 792 and 777 m, marked by an outwash kame terrace which formed at the western edge of Lake Louise (Williams 1989) (Fig. 3). The outlet of Lake Atna/Susitna was again likely in the Talkeetna Mountains to the west and southwest of Fog Lakes during this final phase (Fig. 2). The lake levels then began to subside during the subsequent interstadial as the ice retreated; lowered lake elevations are marked by late Pleistocene riverine delta features at 747 m, 774 m, and 762 m between Lake Louise and Old Man Lake (Table 1; Fig. 4). The 747 m lake level appears to have been the longest stable elevation draining through the Tyone River into Glacial Lake Susitna (17,600 ± 400 rcybp; 20,782–21,800 cal bp). Lake Atna then seems to have reversed its recession and swelled to 762 m (13,280 ± 400 rcybp; 15,308–16,518 cal bp) (Williams 1989).

During the later Pleistocene, the lakes left their remains as they repeatedly burst through ice dams at Mentasta Pass, forming delta outwash beds stretching downstream from the pass into the upper Tanana River (Foster 1970; Richter 1976; Sicard et al. 2017). These features have been dated to the Delta and Donnelly glaciations (Illinoisan and Wisconsin glaciations) (Matmon et al. 2010) and are the result of numerous large-magnitude outburst floods that flowed north into the upper Tanana River basin (Reger and Hubbard 2009; Sturm et al. 1987; Sturm and Benson 1989; Tweed and Russell 1999). In the Tok River Valley, Sicard et al. (2017) dated the late Pleistocene glaciolacustrine and glaciofluvial deposits and attributed these to the outburst floods. Both of the earlier dates provided by Williams (1989) (17,600 and 13,280 rcybp; ~21,276 and 15,931 cal bp) may contain the best analogues for the two outbursts at Mentasta Pass. Reger et al. (2008) have additionally proposed that another large proglacial lake, blocked by intermittent ice at the mouth of the Robertson River, inundated the upper Tanana River Valley and burst repeatedly, resulting in flood-related features for nearly 100 miles down the middle Tanana Valley; but no connection has been demonstrated between the Tok River outbursts and these features. The last waters of Glacial Lake Atna drained south into the Pacific through the lowest elevation point at the confluence of the Copper and Chitina Rivers (Ferrians et al. 1982).

The Susitna River Valley appears to have also been inundated during the early Holocene, to the point that the outlet of Glacial Lake Susitna could have drained either through Devils Canyon on the Susitna River or across the Prairie Creek Spillway southwest of the present-day Stephan Lake (Fig. 2). Geologic surveys undertaken by Twelker et al. (2015) describes lacustrine sediments and associated delta features in the Stephan Lake region (~670 masl) (Fig. 2). The high lacustrine sediments surrounding Stephan Lake are dated to the early Holocene, suggesting an impounded proglacial lake existed throughout the middle Susitna Valley and was possibly preceded by a decanting event from Lake Atna at the Tyone Spillway (Connor 1984; Twelker et al. 2015). However, data recovered from lake cores at Sally Lake near Watana Creek (elevation ~620 m) (Bigelow et al. 2015) did not recover evidence of an early Holocene lake.

Sirkin and Tuthill (1987:383) argue that the deglaciation of the lower Copper River through the Chugach Mountains began around 14,000 rcybp (~16,000–17,000 cal bp) and ended with the collapse of Glacial Lake Atna around 9000 rcybp (~10,000 cal bp) (Fig. 2). Williams (1986) supports their dates and suggests that the lake

Table 1. List of lacustrine sediment radiocarbon source information.

Updated elevations (m) derived from 5 m DEM[1]	RCYBP	1σ	Calibrated age[2]	Lab ID	Type	Primary citation	Secondary citation
681	7450	±400	7832–8659	W-1163	Conventional	Ives et al. 1964:61	Williams & Galloway 1986
706	8450	±200	9130–9629	L-368	Conventional	Olson & Broecker 1959	Williams & Galloway 1986
866	8480	±135	9288–9563	I-11,397	Conventional	Williams & Galloway 1986	
721	9000	±400	9551–10,576	W-568	Conventional	Rubin & Alexander 1960	Williams & Galloway 1986
671	9100	±25	10,277–10,208	CAMS 151130	AMS	Muhs et al. 2013	Pigati et al. 2013
860	9400	n/a	n/a	?	Conventional	Woodward-Clyde Consultants 1982	Reger et al. 1990
530	9400	±300	10,274–10,905	W-714	Conventional	Ferrians 1989	
752	n/a	n/a	10,740 ± n/a	?	AMS	Shimer 2009	
851	9950	n/a	n/a	W-5656	Conventional	Williams & Galloway 1986	
732	10,250	±250	11,603–12,415	W-767	Conventional	Rubin & Alexander 1960:168	Williams & Galloway 1986
851	10,260	n/a	n/a	W-5657	Conventional	Williams & Galloway 1986	
738	11,390	±300	12,968–13,551	W-848	Conventional	Rubin & Alexander 1960:172	Williams & Galloway 1986
794	13,280	±400	15,308–16,518	W-583	Conventional	Rubin & Alexander 1960:168	Williams & Galloway 1986
747	17,600	±400	20,782–21,800	W-1184	Conventional	Williams 1989	
716	21,730	±390	25,625–26,414	DIC-1861	Conventional	Thorson et al. 1981	Williams & Galloway 1986
716	29,450	±610	32,879–34,165	Beta-1862	Conventional	Thorson et al. 1981	Williams & Galloway 1986
716	31,070	±860	34,202–35,836	DIC-1862	Conventional	Thorson et al. 1981	Williams & Galloway 1986
647	31,300	±1000	34,250–36,233	W-843	Conventional	Rubin & Alexander 1960:171–172	Williams & Galloway 1986
690	32,000	±2735	33,533–39,247	Beta-1820	Conventional	Thorson et al. 1981:409	Williams & Galloway 1986
575	33,500	n/a	n/a	I-12,321	Conventional	Connor 1984	
708	>37,000	n/a	n/a	GX-8058	Conventional	Thorson et al. 1981:409	Williams & Galloway 1986
540	>37,000	n/a	n/a	I-276	Conventional	Trautman 1963:62	Williams & Galloway 1986
587	>38,000	n/a	n/a	W-295	Conventional	Rubin & Suess 1956:125–126	Williams & Galloway 1986
482	38,000	n/a	n/a	W-531	Conventional	Ferrians 1963b	Williams & Galloway 1986
600	38,000	n/a	n/a		Conventional	Ager 1989	Williams & Galloway 1986
635	38,000	n/a	n/a	bW-1337	Conventional	Levin et al. 1965:391	Williams & Galloway 1986
575	40,000	n/a	n/a	I-12,320	Conventional	Connor 1984	
482	58,600	±1100	n/a	GrN-4798	Conventional	Ferrians 1963b	Williams & Galloway 1986

1. Elevations in the text are reported as originally given. Elevations have been recalculated in this table using a 5 m DEM and their approximate reported locations. Original elevations were derived from USGS topographic maps and were assumed to have a 30 m standard deviation.
2. 1 σ, Calib 7.10, using IntCal13 (Reimer et al. 2013; Stuiver et al. 2018).

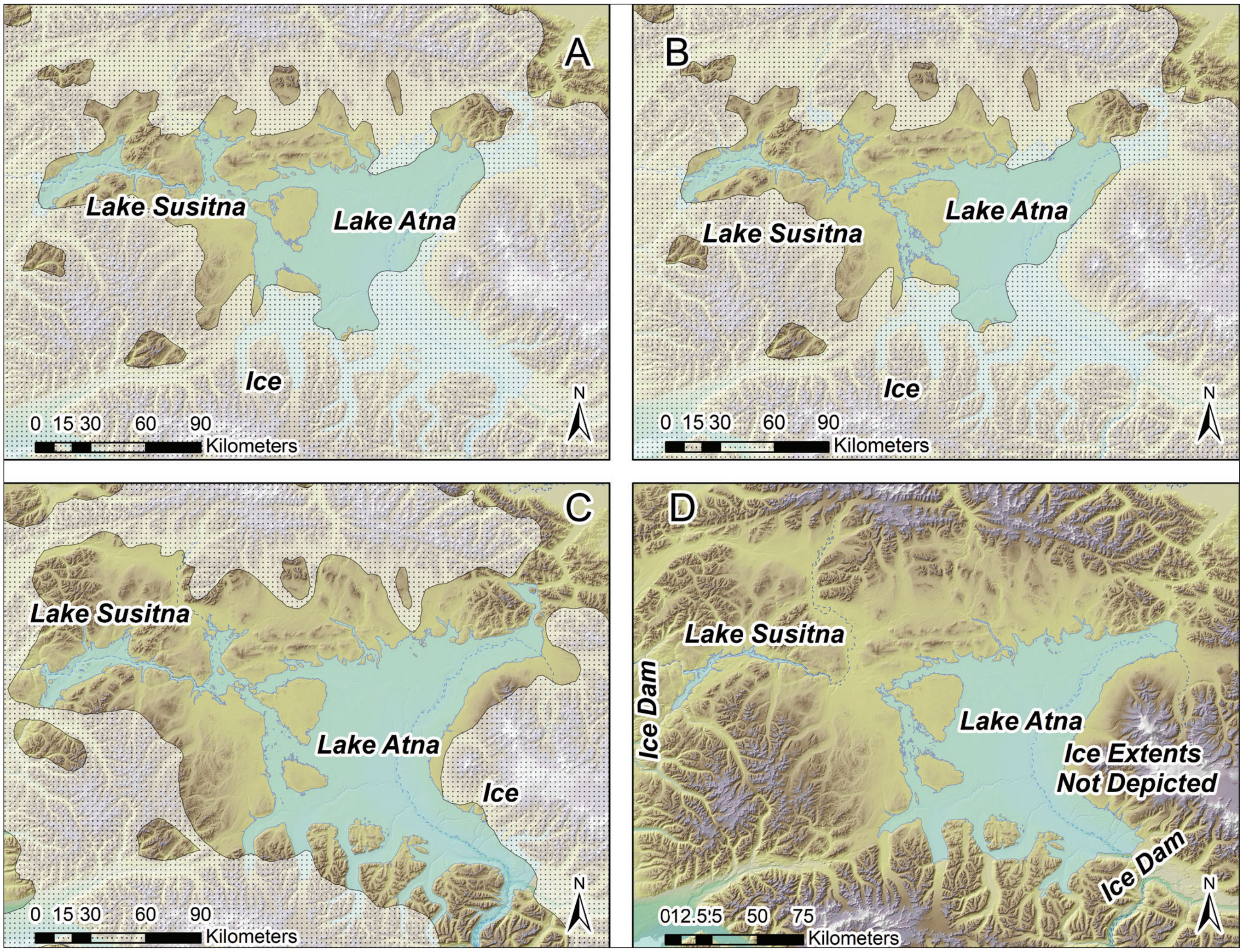

Figure 4. (A) Glacial Lakes Susitna and Atna, elev. 774 m, ~18,000 RCYBP?; (B) Glacial Lakes Susitna and Atna, 747 m, ~17,000 RCYBP?; (C) Glacial Lakes Susitna and Atna, elev. 762 m, ~13,200 RCYBP?; (D) Glacial Lakes Susitna and Atna, elev. 752 m, 10,740 cal BP. Ice extents for (A), (B), and (C) derived from Dyke et al. (2003). Ice extents not depicted in (D), as Dyke et al.'s 2003 work does not correlate well with the glacial and lake features for this time.

levels must have dropped below 600 m, allowing the canyon of the Nelchina River to be cut around ~13,000 RCYBP (~15,700 cal BP) (Fig. 2). Ferrians (1989) places a date of 9400 RCYBP (~10,680 cal BP) for dune deposits forming above lacustrine deposits in this area but supported an earlier date of ~14,000 RCYBP (~16,500 cal BP) for the lake collapse. This early date is occasionally cited as evidence of the final termination of Glacial Lake Atna but may be a misinterpretation of Sirkin and Tuthill's summary. The majority of primary work (cited here) supports evidence that the lake lasted as late as ~9400 RCYBP (10,274–10,905 cal BP) (also supported by geologic reconnaissance work near proposed hydroelectric dam sites on the middle Susitna River [Woodward-Clyde Consultants 1982]). Since several late Pleistocene and early Holocene stabilization and collapse events are now recognized, it is possible that both interpretations are based upon limited conclusions of varying data sets. Recent support for the later early Holocene collapse is recorded in sediments from Canyon Lake, located along the upper Gulkana River at an elevation of 752 m (Figs. 2 and 4). A lake core here suggests Glacial Lake Atna receded from this elevation only after 10,740 cal BP (Shimer 2009). Following this, the lake may have receded slowly over several centuries, draining in a final outburst down the Copper River (Ferrians et al. 1982:187) between 10,250 RCYBP (11,603–12,415 cal BP) (Rubin and Alexander 1960) or as late as 7450 ± 400 RCYBP (7832–8659 cal BP) (Ives et al. 1964:61) (Table 1). Undated sediments east of the Copper and Chitina Rivers' confluence indicate Lake Atna stabilized at ~460 m (Richter et al.

2006), suggesting a briefly stabilized lake at this final level sometime during the early Holocene. Investigations of sediment accumulation near Chitina, where the final ice dam would have blocked Glacial Lake Atna from draining to the Pacific Ocean, at an elevation of 671 m, suggest a chronology of various terrestrial plants and land snails (Succineidae) has been present on the landscape above this elevation since 9100 ± 25 (~10,242 cal BP) (Muhs et al. 2013; Pigati et al. 2013).

To summarize the current understanding of the glacial lake collapse events, the Tahneta Pass and Tyone Spillways decanting events (elev. 910 m and 750 m, respectively) likely occurred first, ~32,000 RCYBP (~36,000 cal BP) (Williams 1989) but remain individually undated. The two Mentasta Pass floods (elev. 706 m) are dated to the late Pleistocene, with current best candidates for dates being 17,600 and 13,280 RCYBP (mean calibrated ages ~21,276 and 15,931 cal BP) (Sicard et al. 2017; Williams and Galloway 1986). Glacial Lake Susitna's possible final decanting event (elevation <700 m) dates to the early Holocene (Twelker et al. 2015). Glacial Lake Atna's signal is similar, dropping below 752 m at 10,740 cal BP (Shimer 2009), perhaps draining through the Tyone River to the lower Glacial Lake Susitna prior to this date, then lowering to and stabilizing near 500 m in the Copper River Valley (and possibly later at 366 m) (Nichols and Yehle 1969). Lake Atna finally drained into Pacific during the early Holocene, likely prior to 10,250 cal BP (Ives et al. 1964:61; Muhs et al. 2013; Richter et al. 2006; Rubin and Alexander 1960). These early Holocene dates appear to correlate with the establishment of floral species in the Copper River lowlands just after (Ager 1989; Muhs et al. 2013) (see Table 1 for list of these dates). It is the author's opinion that the terminal Pleistocene/early Holocene radiocarbon dates recovered from lower elevations (rather than the higher-elevation samples in Table 1) are more likely to reflect the actual lake levels of Glacial Lakes Atna/Susitna (Fig. 5).

ARCHAEOLOGICAL REVIEW

The early human occupation of the Tanana Valley occurred prior to, and in tandem with, the Younger Dryas chronozone (ca. 12,900–11,700 cal BP) (e.g., Potter et al. 2013). The majority of evidence suggests that humans first inhabited the interior of eastern Beringia prior to dispersing from there to the coasts (Potter et al. 2017; Wygal and Goebel 2012; Wygal and Krasinski this volume). The

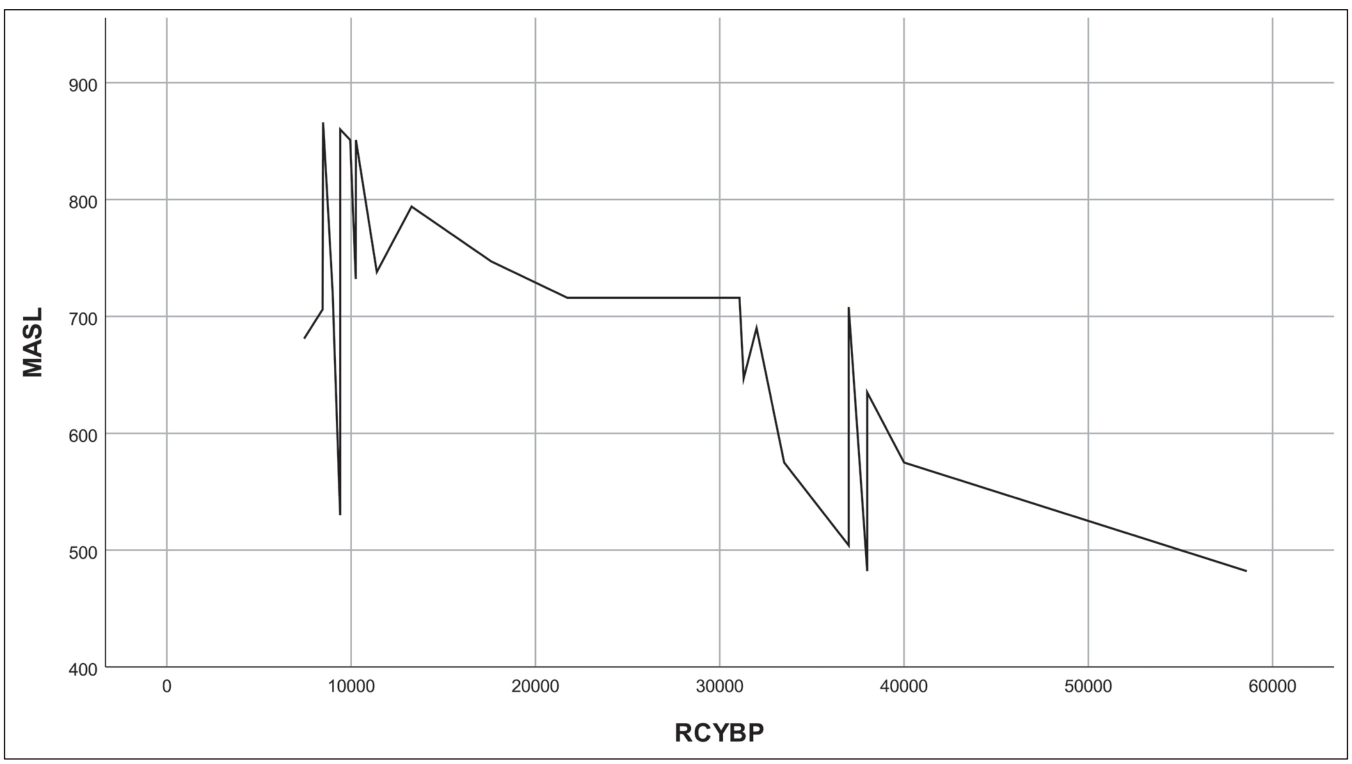

Figure 5. Generalized uncalibrated dates (RCY) and lake elevations (MASL) of Glacial Lake Atna/Susitna and mean interpolation line informed by Table 1 (dates are not calibrated, and elevations have been updated). Relatively dated strandlines not depicted.

Copper and Susitna River Valleys provide two of several potential routes from which the First Americans could access the hypothetical coastal route and are therefore an important study region for understanding these potential access corridors.

The earliest vegetation signals from south of the Alaska Range begin during the final warming period after 14,000 rcybp (~16,000–17,000 cal bp). They suggest that "during the waning of late Wisconsin glaciers [the landscape was characterized by] herb shrub tundra dominated by Cyperaceae and dwarf *Betula*" (Ager 1989:90). This signal was described in the lower Copper River Valley in lacustrine sediments at 760 m (13,280 ± 400 rcybp, 15,308–16,518 cal bp) (Williams and Galloway 1986) and bog sediments in the Tiekel River at 500 m (13,900 ± 400 rcybp, I-3796, 16,289–17,397 cal bp) (Sirkin and Tuthill 1987) (Table 1). The early low-elevation date at the Tiekel bog likely describes deglaciation of the lower Copper River Valley but doesn't rule out Glacial Lake Atna persisting later and being blocked by ice dams farther north near Chitina. The early landscape was dominated by dwarf birch and shrub tundra through the terminal Pleistocene and the spread of *Populus* and *Alnus* during the early Holocene. Shimer (2009) interprets the pollen signals as indicative of a colder arid environment that was more influenced by the regional presence of the proglacial lake rather than the global mechanisms of the Younger Dryas.

The earliest dates of human occupation in the Tanana River Valley (Holmes 2001; Potter et al. 2013; Wygal et al. 2018) currently cluster ~2000 years after the earliest published potential date for the draining of Glacial Lake Atna (Sirkin and Tuthill 1987) or ~3000 years before the latest potential dates of the disappearance of the lake (Shimer 2009). If the lake existed in tandem with human populations, it would have played a significant role, acting as a barrier to human dispersal into the lower Copper River drainage and from there to the Pacific coast. If so, it should be a major variable considered when exploring how the First Americans interacted with their unique eastern Beringian landscape. Human populations are documented along Shaw Creek upstream from its confluence with the middle Tanana River. The earliest sites in eastern Beringia include Swan Point (~14,200 cal bp) (Holmes 2001, 2011), the Holzman site (~13,700 cal bp) (Wygal et al. 2018), and the Little John site in the upper Tanana Valley (between 14,050 and 13,720 cal bp) (Easton et al. 2011). At least some of these First Americans carried with them a lithic toolkit similar to the Diuktai culture in northeastern Siberia, which appears to have been quickly adapted to the regional shifting ecology of eastern Beringia (e.g., Lanoë and Holmes 2016).

As human populations expanded and technology differentiated across eastern Beringia prior to the terminal Pleistocene, the initial populations made use of the northern flanks of the Alaska Range (Coffman 2011; Goebel 1999, 2011; Goebel et al. 1999; Hall 2015; Powers and Hoffecker 1989) and the Tanana lowlands (Hoffecker 2001; Potter 2008a, 2011). Their presence on the southern foothills of the Alaska Range, however, is not documented until after the Nenana, Delta, and Swift River Valleys had deglaciated and vegetated (12,400 and 11,300 cal bp) (Briner and Kaufman 2008; Matmon et al. 2010; Potter 2008b; Ritter 1982; Wygal 2010; Wygal and Goebel 2012).

The archaeological record currently establishes a human presence in the central Tanana Valley prior to their presence south of the Alaska Range. The Tanana assemblages suggest early groups had an intimate knowledge of the landscape, demonstrated by the long-distance travel of, or trade in, obsidian (initially inferred from an unknown source likely located in the Yukon-Tanana Uplands [Group H]) and later during the terminal Pleistocene from the Wiki Peak quarry in the northern Wrangell Mountains (Hamilton and Goebel 1999; Holmes 2001; Speakman et al. 2007) and the Batza Tena source in the central Koyukuk River Valley (Potter et al. 2017). The particular discovery and use of obsidian during the late Pleistocene is evident by remains of Wiki Peak obsidian, which appears in Broken Mammoth CZ4 (13,400 cal bp) (Reuther et al. 2011), Mead CZ4 (13,110–12,790 cal bp) and CZ3b (12,120–11,850 cal bp) (Potter et al. 2013), Walker Road component 1 dated 13,080–13,190 cal bp (Goebel et al. 2008), and Moose Creek component 1 dated 13,060–13,180 cal bp (Reuther et al. 2011). The source for Wiki Peak, located deep within the southeastern portion of the Nutzotin Mountains, is evidence that the First Americans were probing the very edges of their ecosystems into the boundaries of the Copper River basin; it further suggests that mountain ice sheets and glaciers should be considered not as natural barriers but rather as unique ecological challenges to mobility that humans faced and overcame as soon as they had familiarized themselves with the Alaska interior.

The oldest human signal found thus far south of the Alaska Range occurred at Bull River II (Wygal 2009) during the Younger Dryas. During the following warming period of the Holocene Thermal Maximum (HTM), global temperature averages for both summer and winter spiked several degrees above those of today. Though muted in Alaska (Kaufman et al. 2004), this signal correlates with a drop in effective moisture and a rise of poplar and spruce parklands (Bigelow and Powers 2001). Initial deglaciation of the principal Alaska Range valleys seems to have occurred between 12,000 and 11,300 cal BP, suggested by a complex series of dated moraine-related features (Briner and Kaufman 2008; Matmon et al. 2010; Schweger 1981). The warming period was conducive to plant dispersal from the northern Tanana River Valley, especially after 10,000 cal BP (Ager 1989; Williams and Galloway 1986). A spruce-dominated vegetation regime seems to have been established in the region between 10,000 and 8000 cal BP (Ager 1989; Shimer 2009).

Humans likely followed available taxa as they dispersed south through the Alaska Range into the headwaters of the Nenana, Susitna, Delta, and Swift Rivers. Direct archaeological evidence of human presence within the access corridors only exists in the Nenana Valley; it is lacking in the Delta, Tok, and Swift River Valleys (Table 2; Fig. 6). The river valley corridors would have been characterized by young landforms, temporary lakes associated with glacial features (Reger at al. 1990; Schweger 1981), and stagnant surface and subsurface ice (Dixon et al. 1985:I:8–55; Reger et al. 1990). Thus far, none of the early archaeological assemblages suggest the presence of any long-term seasonal camps (such as have been described in the Tanana Valley for this period). The sites are currently interpreted as the remains of short-term, task-specific camps (Betts 1987; Blong 2016; Wendt 2013; West et al. 1996a, 1996b, 1996c; Wygal 2011). The signal suggests the initial human use of the landscape was logistically mobile (Potter 2008a), perhaps indicating that people entered only seasonally and retreated north to residential camps in the Tanana Valley, incorporating the Nenana, Delta, Susitna, and Copper River headwater regions as part of a planned annual strategy. Others have argued that the lack of long-term residence sites in the southern foothills of the Alaska Range suggests that people were using a highly mobile residential strategy, with groups moving about the landscape using a noncentralized land-use system, following available resources (Blong 2016; Wygal 2009). The dispersal of ungulates into the region is inferred through available paleontological evidence of wapiti or caribou in the upper Susitna (Blong 2016:99) and vegetation and associated Denali complex toolkits in the Tangle Lakes region (Jangala and Keating 2004; Skarland and Keim 1958; Skoog 1968).

Early Beringian and terminal Pleistocene assemblages suggest that people utilized a wide variety of available food sources in the Tanana Valley (Holmes 2001; Lanoë and Holmes 2016; Potter 2008a; Potter et al. 2013; Yesner 2001). As humans dispersed from the Tanana Valley south into the Copper and Susitna River basins, they would have brought this background knowledge with them, adapting a familiar strategy of landscape use as needed, just as they appear to have done with their western Beringian toolkit as they dispersed into the east. Today, no late Pleistocene or early Holocene sites associated with lowland river or lake environments have yet been described within either the middle Susitna River or the Copper River basins (potentially the result of exploratory bias, e.g., Potter 2008a), despite the work of several large-scale archaeological exploration efforts in the Susitna drainage (e.g., Dixon et al. 1985; Neely et al. 2016) (Figs. 6 and 7; Table 2). The earliest human signals in the lower Copper River currently date to the middle Holocene (Potter 2008b). The lack of sites any earlier than this suggests that perhaps they never existed; or if they did, our data reflects an exploratory or taphonomic bias.

The oldest site south of the Alaska Range described so far is Bull River II, located near the headwaters of the Bull River (southwest of where the Nenana River enters the Alaska Range) and dated to 12,090–12,240 cal BP (Wygal 2009, 2010) (Fig. 7; Table 2). A somewhat older component has been described at the Eroadaway site to the north in the Nenana River Valley at 12,420–12,820 cal BP (Holmes et al. 2018).

Elsewhere, human movement into the middle Susitna Valley was likely hampered by stagnant ice fields, active highland glaciers, and small high-valley proglacial lakes that persisted in the Clearwater and Talkeetna Mountains between 9300 and 7500 cal BP (Reger et al. 1990:6; currently unnamed but termed in this present paper as Greater Stickwan Lake for clarity) (Fig. 6). Human occupation is marked along the lower Susitna River, at the Susitna River Overlook and Trapper Creek sites, outside of the Talkeetna Mountains (Wygal and Goebel 2012). Current examples of ice-dammed proglacial lakes survive in the Copper River basin, along the western and eastern edges of Tazlina Glacier, i.e., Iceberg Lake and an associated larger unnamed lake.

Table 2. List of culturally associated radiocarbon source information.

Site	Updated elevation (m) derived from 5 m DEM	RCYBP	1σ	Calibrated age[1]	Lab ID	Type	Primary citation	Secondary citation
Eroadaway	631	10,890	±40	12,718–12,780	Beta-245155	AMS	Holmes et al. 2018	
Bull River II[2]	1015	10,350	±50	12,090–12,240	Beta 234749	AMS	Wygal 2009	Wygal 2010
Phipps[2]	895	10,150	±280	11,281–12,159	Uga-572	AMS	West et al. 1996a	Schweger 1981; West 1975, 1998
Whitmore Ridge[2]	905	9890	±70	11,221–11,366	Beta-62222; CAMS-6406	AMS	West et al. 1996c	
Carlo Creek Component I[2]	600	9872	±65	11,210–11,341	AA-75049	AMS	Bowers 1980	Bowers & Reuther 2008
Susitna Dune I	790	9620	±50	10,862–10,959	Beta-284748	AMS	Blong 2016	
Susitna River III	858	9320	±60	10,477–10,590	OS-101613	AMS	Blong 2016	
Susitna River Overlook	123	9140	±90	10,223–10,418	Beta-208284	AMS	Wygal and Goebel 2012	
Sparks Point[2]	873	9110	±80	10,200–10,302	Beta-64577; CAMS-8299	AMS	West et al. 1996b	
Jay Creek Ridge[3]	844	7240	±110	7966–8170	Beta-7306	Conventional	Dixon et al. 1985	Dixon 1993; Mason et al. 2001; Mulliken 2016
Trapper Creek	125	7068	±49	7852–7907	AA67361	AMS	Wygal and Goebel 2012	
Butte Lake Northeast	1027	5030	±200	5582–5998	Beta-10751	AMS	Betts 1987	Wendt 2013

1. 1 σ, Calib 7.10, using IntCal13 (Reimer et al. 2013; Stuvier et al. 2018).
2. Represents closest single date to calculated median from multiple samples published.
3. A recent date suggests the Jay Creek occupation is earlier, 11,200–10,800 cal BP (Mulliken 2016:36)

The sites in the Tangle Lakes area are ascribed to the Denali complex, an early technological phenomenon associated with the northern Paleoarctic tradition/eastern Beringian tradition (Holmes 2001; West 1996), derived from the earlier Siberian Diuktai culture (Potter et al. 2013), which became (or was) the dominant technological form used during the early Holocene in the Alaska interior. The Tangle Lakes sites are associated with a number of technologically similar undated surficial scatters (West 1998). These sites are strongly associated with the shores of greater Tangle Lake, which were 16 to 30 m higher than today, at an elevation of 884 m. The lake initially formed as a proglacial lake along the northeastern margins of Maclaren Glacier (Campbell and Begét 1989). Lake Atna's northern shores lay between Upper Tangle Lake and Canyon Lake, possibly stabilizing between 752 and 732 m. Dated noncultural wood fragments appear at South Tangle Lake as early as 11,281–12,159 cal BP (10,150 ± 280 RCYBP, West et al. 1996a). Greater Tangle Lake persisted in a stable state, blocked by moraines to the southeast and north, for roughly 2500 years, and numerous beaver-gnawed pieces of wood surviving from this period attest to its ecological health. The close association of the Denali complex sites and the lakeshores suggests that nonwinter seasonal lake resources may have been the primary reason for human occupation in the area. This paleo

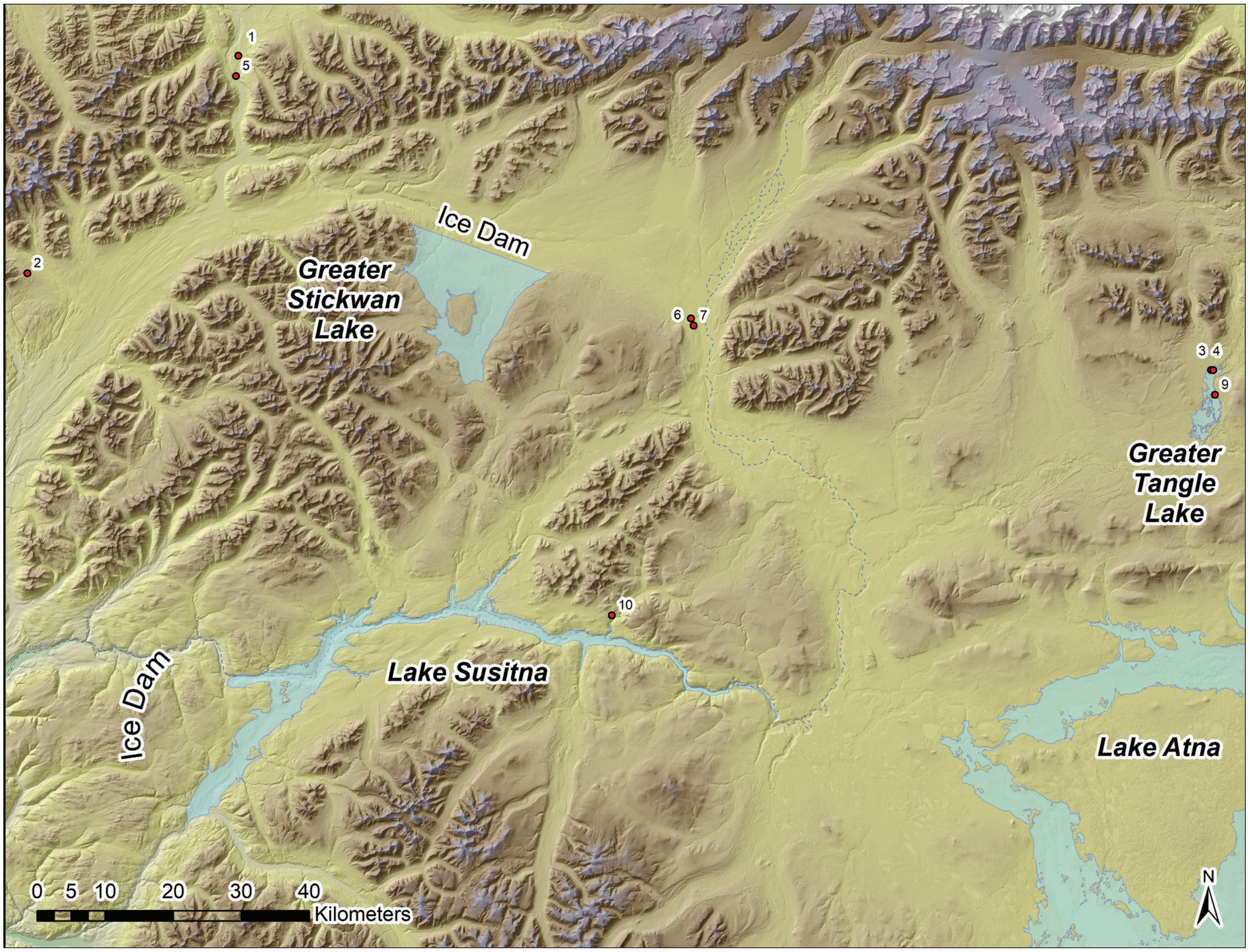

Figure 6. A palimpsest of early Holocene human occupation sites (13,000–10,000 cal BP*) and dynamic landscape of proglacial lakes. Glacial Lake Susitna's shore is set at 617 m (Twelker et al. 2015), and Glacial Lake Atna's shore is set at 752 m (Shimer 2009). Ice fields not depicted (see maps in Csejtey et al. 1978; Reger et al. 1990; Twelker et al. 2015; and Williams and Galloway 1986 for detailed information about the local Quaternary landscape). Sites are listed by number in the numeric order given in Table 2.*

lake catastrophically burst sometime after ~8544–8785 cal BP (7860 ± 110 RCYBP) (Campbell and Begét 1989; see Kokelj et al. 2015 for a modern analogue), providing an important example for other similar proglacial lakes that persisted and rapidly drained in the Talkeetna Mountains (Reger et al. 1990). The draining event occurs in tandem with the apparent disappearance of regional archaeological sites; no settlements appear around the new lakeshores or anywhere in the southern Alaska Range foothills until the later northern Archaic tradition appears throughout the region at about 6500 cal BP (Bowers 1989; Potter 2008b; West 1996).

DISCUSSION

If we assume that our current archaeological data set reflects an accurate sample of the past, it would appear that humans actively avoided utilizing the lowland landscape of the Copper River until the late Holocene, preferring the uplands throughout the early and middle Holocene. The avoidance suggests that either an ecological barrier (such as the proglacial lakes or something else) or a cultural barrier prevented humans from farther movement south (assuming that data visibility is not the result of research bias). A cultural barrier would be difficult to test. People in the southern Alaska foothills would have been faced with the draw of ecologically rich riverine basins either to

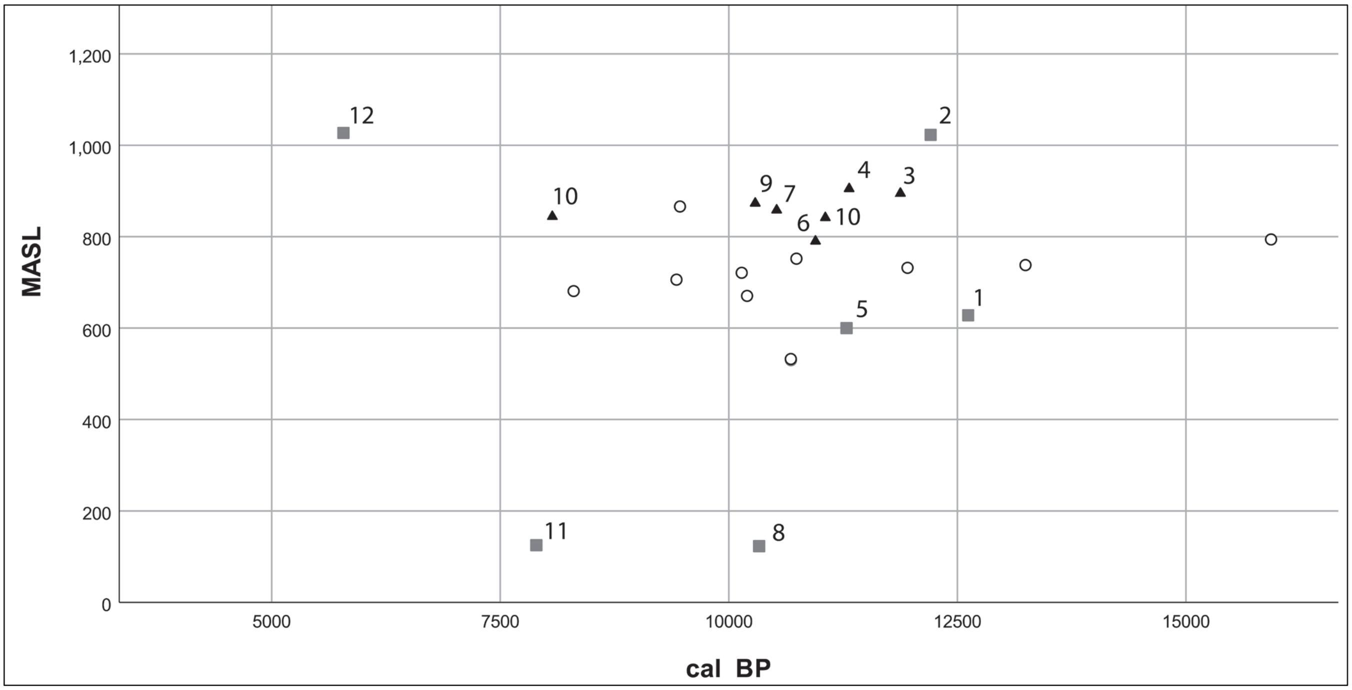

Figure 7. Generalized calibrated dates (cal BP) of sites and lake elevations (m) of Glacial Lake Atna/Susitna informed by Tables 1 and 2 (elevations have been updated, derived from 5 m DEM). Triangles refer to cultural sites in the upper Susitna basin, Tangle Lakes area, and Copper River basin. Squares refer to regional sites outside these basins. White dots refer to lacustrine sediment dates. Sites listed by number in numeric order as given in Table 2. Jay Creek Ridge (11) is depicted twice: its original date and the more recent date reported in Mulliken (2016).

the north (the Tanana) or the south (the Copper). If these early groups were living on an annual cycle south of the Alaska Range and couldn't move north, and were additionally prohibited from southern movement, then they would be faced with developing a successful landscape strategy that facilitated living full-time in the southern Alaska Range/Susitna Valley uplands. This strategy isn't unknown to the region; later features interpreted as house pits (traditionally used as winter-season residences) are preserved at XMH-035 in the Tangle Lakes area (Potter 2008a), at TLM-302 in the middle Susitna Valley (Hays et al. 2014), and at Butte Lake in the upper Nenana basin (Betts 1987; Wendt 2013). However, these sites all date to the last few millennia of the Holocene (see also the story of the Mountain People in *Shem Pete's Alaska* [Kari and Fall 2016]), suggesting this strategy was not practiced prior to the northern Archaic tradition of the middle Holocene. Permanent upland subsistence use is a risky strategy and does not facilitate large populations, as ecological resources tend to be much more variable than in the lowlands. In the ethnographic record, full-time, year-round upland use tended to be a less common land-use strategy. It was resorted to by Athabascan and Inuit groups during periods of population pressure, a perception that upland resources had increased relative to the lowlands, or the lack of available food in the lowlands (Burch 1998; John 1996; Matesi 2016; Raboff 2001; Smith 2012). Here, it is concluded that the early Holocene inhabitants of the region were likely intimately associated with the older Tanana Valley cultures and that their lack of archaeological visibility in the lower elevations of the Susitna and Copper River areas is due to the presence of the large glacial lakes there.

CONCLUSION

If an ecological barrier blocked human dispersal south of the southern foothills of the Alaska Range, the only such barrier yet demonstrated is the one formed by the glacially dammed lakes of the Susitna and Copper River Valleys and the lingering ice caps and stagnant glaciers in the Talkeetna and Clearwater Mountains (Reger et al. 1990). This conclusion is supported by the numerous later, early Holocene radiocarbon dates supporting the glacial lake's persistence. Other potential ecological barriers could have existed, such as the availability of important annual resource variety for exploitation. Hunting strategies were also dependent on which animals were dispersing and successfully settling into the new landscape on a long-term predictable basis and on when the first anadromous fish began to populate the valley (currently unknown). Long-distance migrating animals would likely have been first to disperse into the region, but this represents a nonlinear function and is difficult to model. However, the documented late presence of the enormous glacial lakes, coupled with the fact that no late Pleistocene or early Holocene sites have been found below the surface elevations of the lakes within their basins (Fig. 7) and the subsequent known floral dispersal and unknown faunal dispersal period, provides the best evidence yet for an ecological barrier to human expansion farther south into the Copper River lowlands. From the limited evidence summarized here, it would appear that humans interacted for several millennia with the lake boundaries, which acted as a geographic barrier to the southern movement of fauna and humans into the middle Susitna and Copper River Valleys.

ACKNOWLEDGEMENTS

The author would like to thank Dr. James Kari for many interesting discussions about the potential of human interactions with Lake Atna, which we initially presented together at the annual Alaska Anthropological Association meeting in 2017. Also, National Park Service archaeologists Lee Reininghaus, Alison Pease, and geologist Michael Loso, for allowing me to participate in field reconnaissance of Glacial Lake Atna–related features within Wrangell–St. Elias National Park. Finally, I am indebted to all the past work of many archaeologists and geologists throughout the Copper and upper Susitna River basins, especially Richard VanderHoek, who have researched these questions extensively throughout the past several decades.

REFERENCES

Ager, Thomas A.

1989 History of Late Pleistocene and Holocene Vegetation in the Copper River Basin, South-Central Alaska. In *Late Cenozoic History of the Interior Basins of Alaska and the Yukon: Proceedings of a Joint Canadian-American Workshop,* edited by L. David Carter, Thomas D. Hamilton, and John P. Galloway, pp. 89–92. U.S. Geological Survey Circular 1026.

Betts, Robert C.

1987 Archaeological Investigations at Butte Lake, Alaska: A Report to the University of Alaska Museum Geist Fund. Master's thesis, Department of Anthropology, University of Alaska Fairbanks, Fairbanks.

Bigelow, Nancy H., and W. Roger Powers

2001 Climate, Vegetation, and Archaeology 14,000 to 9000 cal yr BP in Central Alaska. *Arctic Anthropology* 38(2):171.

Bigelow, Nancy H., Joshua D. Reuther, Matthew Wooller, and Kristi Wallace

2015 *Holocene Landscape and Paleoenvironments. Susitna-Watana Hydroelectric Project (FERC No. 14241)*. Initial study report prepared for the Alaska Energy Authority. University of Alaska Fairbanks, Fairbanks.

Blong, John C.

2016 Prehistoric Landscape Use in the Central Alaska Range. Ph.D. dissertation, Department of Anthropology, Texas A&M University, College Station.

Bowers, Peter

1980 *The Carlo Creek Site: Geology and Archaeology of an Early Holocene Site in the Central Alaska Range*. Occasional Paper No. 27, Anthropology and Historic Preservation, Cooperative Park Studies Unit, University of Alaska, Fairbanks.

1989 *Tangle Lakes Archaeological District Revised National Register Nomination*. National Park Service National Register of Historic Places, Washington, D.C.

Bowers, Peter M., and Joshua D. Reuther

2008 AMS Re-dating of the Carlo Creek Site, Nenana Valley, Central Alaska. *Current Research in the Pleistocene* 25:58–61.

Briner, Jason P., and Darrell S. Kaufman
2008 Late Pleistocene Mountain Glaciation in Alaska: Key Chronologies. *Journal of Quaternary Science* 23(6–7):659–670.

Briner, Jason P., Darrell S. Kaufman, William F. Manley, Robert C. Finkel, and Marc W. Caffee
2005 Cosmogenic Exposure Dating of Late Pleistocene Moraine Stabilization in Alaska. *Geological Society of America* 117:1108–1120.

Burch, Ernest S.
1998 *Iñupiaq Eskimo Nations of Northwest Alaska*. University of Alaska Press, Fairbanks.

Campbell, Kathy, and James E. Begét
1989 Moraine Dam Failure and Flood at Tangle Lakes, Alaska Circa 8000 Years BP. *Geological Society America Abstracts with Programs* 21(5):63.

Coffman, Samuel C.
2011 Archaeology at Teklanika West (HEA-001): An Upland Archaeological Site, Central Alaska. Master's thesis, University of Alaska, Fairbanks.

Connor, Cathy L.
1984 Late Quaternary Glaciolacustrine Vegetational History of the Copper River Basin, South-Central Alaska. Ph.D. dissertation, University of Montana, Missoula.

Csejtey, Béla, Jr., Willis H. Nelson, David L. Jones, Norman J. Silberling, R. M. Dean, M. S. Morris, Marvin A. Lanphere, James G. Smith, and Miles L. Silberman
1978 *Reconnaissance Geologic Map and Geochronology, Talkeetna Mountains Quadrangle, Northern Part of Anchorage Quadrangle, and Southwest Corner of Healy Quadrangle, Alaska*. Open File Report 78-558A, Department of the Interior, U.S. Geological Survey. Alexandria.

Dixon, E. James, Jr.
1993 *Quest for the Origins of the First Americans*. University of New Mexico Press, Albuquerque.

Dixon, E. James, George S. Smith, William Andrefsky, Jr., Becky M. Saleeby, and Charles J. Utermohle
1985 *Susitna Hydroelectric Project: Cultural Resources Investigations 1979–1985. University of Alaska Museum*. Alaska Power Authority, Federal Energy Regulatory Commission Project No. 7114. On file at University of Alaska Museum of the North, Fairbanks.

Dortch, Jason M.
2006 Defining the Timing of Glaciation in the Central Alaska Range using Terrestrial Cosmogenic Nuclide and Optically Stimulated Luminescence Dating of Moraines and Terraces. Master's thesis, University of Cincinnati, Cincinnati.

Dyke, Arthur S., A. Moore, and Lennart Robertson
2003 *Deglaciation of North America*. Open File 1574, 2 Sheets, Geological Survey of Canada, Ottawa.

Easton, Norman A., Glen R. McKay, Patricia B. Young, Peter Schnurr, and David R. Yesner
2011 Chindadn in Canada? Emergent Evidence of the Pleistocene Transition in Southeast Beringia as Revealed by the Little John Site, Yukon. In *From the Yenisei to the Yukon: Interpreting Lithic Assemblages Variability in Late Pleistocene/Early Holocene Beringia*, edited by Ted Goebel and Ian Buvit, pp. 289–307. Texas A&M University Press, College Station.

Ferrians, Oscar J., Jr.
1963a Till-like Glaciolacustrine Deposits in the Copper River Basin, Alaska. *Geological Society of America* 73:151.
1963b *Glaciolacustrine Diamicton Deposits in the Copper River Basin, Alaska*. Geological Survey Research 1963—Short papers in geology and hydrology: U.S. Geological Survey Professional Paper 475-C:C121–C125.
1984 Pleistocene Glacial History of the Northeastern Copper River Basin, Alaska. *Geologic Society of America Abstracts with Programs* 16(5):282.
1989 Glacial Lake Atna, Copper River Basin, Alaska. In *Late Cenozoic History of the Interior Basins of Alaska and the Yukon: Proceedings of a Joint Canadian-American Workshop*, edited by L. David Carter, Thomas D. Hamilton, and John P. Galloway, pp. 85–88. U.S. Geological Survey Circular 1026.

Ferrians, Oscar J., Jr., and Donald R. Nichols
1965 Copper River Basin. In *Guidebook for Field Conference F, Central and South-central Alaska*, edited by C. B. Schultz and H. T. U. Smith, pp. 93–114. Nebraska Academy of Sciences, International Association for Quaternary Research, VII Congress, Lincoln.

Ferrians, Oscar J., Donald R. Nichols, and John R. Williams
1982 Copper River Basin. In *Guidebook to Permafrost and Quaternary Geology along the Richardson and Glenn Highways between Fairbanks and Anchorage,*

Alaska, edited by Troy L. Péwé and Richard D. Reger. University of Alaska Fairbanks.

Foster, Helen L.
1970 *Reconnaissance Geologic Map of the Tanacross Quadrangle, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-593,* 1 plate, scale 1:250,000. U.S. Geological Survey, Alexandria, VA.

Goebel, Ted
1999 Pleistocene Human Colonization of Siberia and Peopling of the Americas: An Ecological Approach. *Evolutionary Anthropology* 8(6):208–227.
2011 What Is the Nenana Complex? Raw-Material Procurement and Technological Organization at Walker Road, Central Alaska. In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia*, edited by Ted Goebel and Ian Buvit, pp. 199–214. Texas A&M University Press, College Station.

Goebel, Ted, William R. Powers, and Nancy H. Bigelow
1999 The Nenana Complex of Alaska and Clovis Origins. In *Clovis: Origins and Adaptations*, edited by Robson Bonnichsen and Karen L. Turnmire, pp. 49–79. Center for the Study of the First Americans, Oregon State University, Corvallis.

Goebel, Ted, Robert J. Speakman, and Joshua D. Reuther
2008 Obsidian from the Late-Pleistocene Walker Road Site, Central Alaska. *Current Research in the Pleistocene* 25:88–90.

Hall, Patrick T.
2015 Functional Comparisons between Formal and Informal Tools Sampled from the Nenana and the Denali Assemblages of the Dry Creek Site. Master's thesis, Department of Anthropology, University of Alaska, Fairbanks.

Hamilton, Thomas D., and Ted Goebel
1999 Late Pleistocene Peopling of Alaska. In *Ice Age Peoples of North America: Environments, Origins, and Adaptations*, edited by Robson Bonnichsen and Karen L. Turnmire, pp. 156–199. Oregon State University Press, Corvallis.

Hays, Justin M., Charles M. Mobley, William E. Simeone, Patrick T. Hall, Gerad M. Smith, James E. Kari, Crystal L. Glassburn, Carol Gelvin-Reymiller, and Peter M. Bowers
2014 *Report of the 2013 Cultural Resource Inventory for the Susitna-Watana Hydroelectric Project, Middle Susitna River, Alaska*. Alaska Office of History and Archaeology, Alaska State Historic Preservation Office, Alaska Division of Parks and Outdoor Recreation, Bureau of Land Management Alaska State Office, and URS Corp., Anchorage.

Hoffecker, John F.
2001 Late Pleistocene and Early Holocene Sites in the Nenana River Valley, Central Alaska. *Arctic Anthropology* 38(2):139–153.

Holmes, Charles E.
2001 Tanana River Valley Archaeology Circa 14,000 to 9000 BP. *Arctic Anthropology* 38(2):154–170.
2011 The Beringian and Transitional Periods in Alaska: Technology of the East Beringian Tradition as Viewed from Swan Point. In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia*, edited by Ted Goebel and Ian Buvit, pp. 179–191. Texas A&M University Press, College Station.

Holmes, Charles E., Joshua D. Reuther, Jacob S. Adams, Peter Bowers, and Allison Little
2018 The Eroadaway Site: Lithic Technological Variability at a Late Glacial Subalpine Camp in the Central Alaska Range. *Alaska Journal of Anthropology* 16(1):44–70.

Ives, Patricia C., Betsy Levin, Richard D. Robinson, and Meyer Rubin
1964 U.S. Geological Survey Radiocarbon Dates VII. *Radiocarbon* 6:37–76.

Jangala, John, and Thomas Keating
2004 A Preliminary Report of the Gulkana Project: A Random Sample and Evolving Geoarchaeological Probabilistic Survey of the Gulkana National Wild and Scenic River. Unpublished manuscript, Bureau of Land Management, Glennallen Field Office, Glennallen, AK.

John, Peter
1996 *The Gospel According to Peter John*. Alaska Native Knowledge Network, Fairbanks.

Kari, James, and James A. Fall
2016 *Shem Pete's Alaska: The Territory of the Upper Cook Inlet Dena'ina*, revised second edition. University of Alaska Press, Fairbanks.

Kaufman, Darrell S., Thomas A. Ager, N. John Anderson, Patricia M. Anderson, John T. Andrews, Patrick J. Bartlein, Linda B. Brubaker, Larry L. Coats, Les C. Cwynar, Matthew L. Duvall, Arthur S. Dyke, Mary E. Edwards, Wendy R. Eisner, Konrad Gajewski, Aslaug Geirsdóttir, Feng S. Hu, Anne E. Jennings, Michael R. Kaplan, Michael W. Kerwin, Anatoly V. Lozhkin, Glen

M. MacDonald, Gifford H. Miller, Cary J. Mock, Wyatt W. Oswald, Bette L. Otto-Bliesner, David F. Porinchu, Kathleen Rühland, J. P. Smol, Eric J. Steig, and Brent B. Wolfe
2004 Holocene Thermal Maximum in the Western Arctic (0–180°W). *Quaternary Science Reviews* 23:529–560.

Kaufman, Darrell S., and William F. Manley
2004 Pleistocene Maximum and Late Wisconsinan Glacier Extents across Alaska, U.S.A. In *Quaternary Glaciations—Extent and Chronology, Part II, North America*, edited by Jürgen Ehlers and Phillip L. Gibbard, pp. 9–27. Developments in Quaternary Science: v. 2B. Elsevier, Amsterdam.

Kokelj, Steve, Jon F. Tunnicliffe, Denis Lacelle, and Robert H. Fraser
2015 Increased Precipitation Drives Mega Slump Development and Destabilization of Ice-Rich Permafrost Terrain, Northwestern Canada. *Global and Planetary Change* 129:56–68.

Lanoë, François B., and Charles E. Holmes
2016 Animals as Raw Material in Beringia: Insights from the Site of Swan Point CZ4B, Alaska. *American Antiquity* 81(4):682–696.

Levin, Betsy, Patricia C. Ives, Charles L. Oman, and Meyer Rubin
1965 U.S. Geological Survey Radiocarbon dates VIII. *Radiocarbon* 7:372–398.

Mason, Owen K., Peter M. Bowers, and David M. Hopkins
2001 The Early Holocene Milankovitch Thermal Maximum and Humans: Adverse Conditions for the Denali Complex of Eastern Beringia. *Quaternary Science Reviews* 20:525–548.

Matesi, Joseph
2016 *Gwich'in Athabascan Place Names Steese National Conservation Area, Draanjik River and Porcupine River*. Alaska Native Language Center, University of Alaska Fairbanks.

Matmon, Ari, Jason P. Briner, Gary Carver, Paul Bierman, and Robert C. Finkel
2010 Moraine Chronosequence of the Donnelly Dome Region, Alaska. *Quaternary Research* 74:63–72.

Mendenhall, Walter C.
1905 *Geology of the Central Copper River Region, Alaska*: U.S. Geological Survey Professional Paper 41. U.S. Geological Survey, Alexandria.

Moffit, Fred H.
1954 *Geology of the Eastern Part of the Alaska Range and Adjacent Area*. U.S. Geological Survey Bulletin 989-D. U.S. Geological Survey, Alexandria.

Muhs, Daniel R., James R. Budahn, John P. McGeehin, E. Arthur Bettis III, Gary Skipp, James B. Paces, and Elisabeth A. Wheeler
2013 Loess Origin, Transport, and Deposition Over the Past 10,000 Years, Wrangell-St. Elias National Park, Alaska. *Aeolian Research* 11:85–99.

Mulliken, Katherine M.
2016 Holocene Volcanism and Human Occupation in the Middle Susitna River Valley, Alaska. Master's thesis, Department of Anthropology, University of Alaska Fairbanks.

Neely, Burr J., Patrick T. Hall, and Gerad M. Smith
2016 *Annual Report of the 2014 Cultural Resource Inventory on Cook Inlet Regional Working Group Lands for the Susitna-Watana Hydroelectric Project, Susitna River, Alaska*. Alaska Office of History and Archaeology, Alaska State Historic Preservation Office, Alaska Division of Parks and Outdoor Recreation, Bureau of Land Management Alaska State Office, and URS Corp., Anchorage.

Nichols, Donald R.
1965 Glacial History of the Copper River Basin, Alaska [abstract]: International Association for Quaternary Research, 7th Congress, Boulder, Colorado, 1965, Proceedings, v. 22, p. 360.
1989 Pleistocene Glacial Events, Southeastern Copper River Basin, Alaska. In *Late Cenozoic History of the Interior Basins of Alaska and the Yukon; Proceedings of a Joint Canadian-American Workshop*, edited by L. David Carter, Thomas D. Hamilton, and John P. Galloway, pp. 78–80. U.S. Geological Survey Circular 1026. U.S. Government Printing Office, Washington, DC.

Nichols, Donald R., and Lynn A. Yehle
1969 *Engineering Geologic Map of the Southeastern Copper River Basin, Alaska: U.S. Geological Survey Miscellaneous Investigations 524,* 1 sheet, scale 1:125,000. U.S. Geological Survey, Alexandria, VA.

Olson, Edwin A., and Wallace S. Broecker
1959 Lamont Radiocarbon Measurements V. *American Journal of Sciences Radiocarbon Supplement* I:1–28.

Péwé, Troy L.
1965 Multiple Glaciation in the Headwaters Area of the Delta River, Central Alaska. In *Short Papers in the Geologic and Hydrologic Sciences, 1961*. U.S.

Geological Survey Professional Paper 424D, p. D200–D201. U.S. Geological Survey, Alexandria, VA.
1975 *The Quaternary Geology of Alaska. U.S. Geological Survey Professional Paper 385*. U.S. Geological Survey, Alexandria, VA.

Pigati, Jeffrey S., John P. McGeehin, Daniel R. Muhs, and E. Arthur Bettis III
2013 Radiocarbon Dating Late Quaternary Loess Deposits Using Small Terrestrial Gastropod Shells. *Quaternary Science Reviews* 76:114–128.

Potter, Ben A.
2008a A First Approximation of Holocene Inter-Assemblage Variability in Central Alaska. *Arctic Anthropology* 45(1):89–113.
2008b Radiocarbon Chronology of Central Alaska: Technological Continuity and Economic Change. *Radiocarbon* 50(2):181–204.
2011 Late Pleistocene and Early Holocene Assemblage Variability in Central Alaska. In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia*, edited by T. Goebel and I. Buvit, pp. 215–233. Texas A&M University Press, College Station.

Potter, Ben A., Charles E. Holmes, and David R. Yesner
2013 Technology and Economy among the Earliest Prehistoric Foragers in Interior Eastern Beringia. In *Paleoamerican Odyssey*, edited by Kelly E. Graf, Caroline Ketron, and Michael R. Waters, pp. 463–485. Center for the Study of the First Americans, Department of Anthropology, Texas A&M University, College Station.

Potter, Ben A., Joshua D. Reuther, Vance T. Holliday, Charles E. Holmes, D. Shane Miller, and Nicholas Schmuck
2017 Early Colonization of Beringia and Northern North America: Chronology, Routes, and Adaptive Strategies. *Quaternary International* 444(B):36–55.

Powers, William R., and John F. Hoffecker
1989 Late Pleistocene Settlement in the Nenana Valley, Central Alaska. *American Antiquity* 54(2):263–287.

R & M Consultants, Inc.
1982 *Susitna Hydroelectric Project: 1980–81*. Geotechnical Report: Alaska Power Authority, v. 2, part 2, Appendix G–K, Anchorage.

Raboff, Adeline Peter
2001 *Iñuksuk: Northern Koyukon, Gwich'in, and Lower Tanana 1800–1901*. Alaska Native Knowledge Network, Fairbanks.

Reger, Richard D., and Thomas. K. Bundtzen
1990 *Multiple Glaciation and Gold-Placer Formation, Valdez Creek Valley, Western Clearwater Mountains, Alaska*. State of Alaska, Anchorage.

Reger, Richard D., Thomas K. Bundtzen, and Thomas E. Smith
1990 *Geology of the Healy A-3 Quadrangle, Alaska*. Public data file 90-1. Alaska Division of Geological and Geophysical Surveys, Fairbanks.

Reger, Richard D., and Trent D. Hubbard
2009 Evidence for Late Wisconsin Outburst Floods in the Tok-Tanacross Basin, Upper Tanana River Valley, East-Central Alaska (poster). Geological Society of America Annual Meeting, Portland, Oregon, October 21, 2009.

Reger, Richard D., Thomas Lowell, and Edward B. Evenson
2011 Discussion of "Late Quaternary Megafloods from Glacial Lake Atna, Southcentral Alaska, U.S.A." *Quaternary Research* 75(1):301–302.

Reger, Richard D., De Anne S. P. Stevens, and Diana N. Solie
2008 Evidence of Multiple Late Pleistocene Outburst Floods, Upper Tanana River Valley, Eastcentral Alaska. Cordilleran Section (104th Annual) and Rocky Mountain Section (60th Annual) Joint Meeting, Las Vegas.

Reimer, Paula J., Edouard Bard, Alex Bayliss, J. Warren Beck, Paul G. Blackwell, Christopher B. Ramsey, Caitlin E. Buck, Hai Cheng, R. Lawrence Edwards, Michael Friedrich, Pieter M. Grootes, Thomas P. Guilderson, Haflidi Haflidason, Irka Hajdas, Christine Hatté, Timothy J. Heaton, Dirk L. Hoffmann, Alan G. Hogg, Konrad A. Hughen, K. Felix Kaiser, Bernd Kromer, Sturt W. Manning, Mu Niu, Ron W. Reimer, David A. Richards, E. Marian Scott, John R. Southon, Richard A. Staff, Christian S.M. Turney, and Johannes van der Plicht
2013 IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0–50,000 Years Cal BP. *Radiocarbon* 55(4):1869–1887.

Reuther, Joshua D., Natalia S. Slobodina, Jeffery T. Rasic, John P. Cook, and Robert J. Speakman
2011 Gaining Momentum: Late Pleistocene and Early Holocene Archaeological Obsidian Source Stud-

ies in Interior and Northeastern Beringia. In *From the Yenisei to the Yukon: Interpreting Lithic Assemblages Variability in Late Pleistocene/Early Holocene Beringia*, edited by Ted Goebel and Ian Buvit, pp. 270–288. Texas A&M University Press, College Station.

Richter, Donald H.
1976 *Geologic Map of the Nabesna Quadrangle, Alaska: U.S. Geological Survey Miscellaneous Investigations Map I-932*, 1 plate, scale 1:250,000. U.S. Geological Survey, Alexandria.

Richter, Donald H., Cindi C. Pretter, Keith A. Labay, and Nora B. Shew
2006 *Geologic Map of the Wrangell-Saint Elias National Park and Preserve, Alaska*. Scientific Investigations Map 2877. U.S. Geological Survey, Alexandria, VA.

Ritter, Dale F.
1982 Complex River Terrace Development in the Nenana Valley near Healy, Alaska. *Geological Society of America Bulletin* 93:346–356.

Rubin, M., and C. Alexander
1960 U.S. Geological Survey Radiocarbon Dates V. *Radiocarbon* 2:129–185.

Rubin, Meyer, and Hans E. Suess
1956 U.S. Geological Survey Radiocarbon Dates III. *Science* 123(3194):442–448.

Schrader, Frank C.
1900 *A Reconnaissance of a Part of Prince William Sound and the Copper River District, Alaska.* U.S. Geological Survey 20th Annual Report, 1898–99, Pt. VII Exploration in Alaska in 1898, pp. 341–423. U.S. Geological Survey, Alexandria, VA.

Schrader, Frank C., and Spencer, Arthur Coe
1901 *The Geology and Mineral Resources of a Portion of the Copper River District, Alaska*. U.S. Geological Survey Special Publication, 94 pp. U.S. Geological Survey, Alexandria, VA.

Schweger, Charles E.
1981 Chronology of Late Glacial Events from the Tangle Lakes, Alaska Range, Alaska. *Arctic Anthropology* 18(1):97–101.

Shimer, Grant T.
2009 Holocene Vegetation and Climate Change at Canyon Lake, Copper River Basin, Alaska. Master's thesis, University of Alaska, Fairbanks.

Sicard, Karri R., Travis J. Naibert, Trent D. Hubbard, Evan Twelker, Alicja Wypych, Melanie B. Werdon, Amanda L. Willingham, Robert J. Gillis, Lauren L. Lande, and Rainer J. Newberry
2017 *Explanation of Map Units: Geologic Map of the Tok River Area, Tanacross A-5 and A-6 Quadrangles, Eastern Alaska Range, Alaska* (1:63,360 scale). Preliminary Interpretive Report 2017-3. State of Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys, Anchorage.

Sirkin, Les, and Samuel J. Tuthill
1987 Late Pleistocene and Holocene Deglaciation and Environments of the Southern Chugach Mountains, Alaska. *Geological Society of America Bulletin* 99:376–384.

Skarland, Ivar, and Charles J. Keim
1958 Archaeological Discoveries on the Denali Highway, Alaska. *Anthropological Papers of the University of Alaska* 6(2):79–87.

Skoog, Ronald
1968 Ecology of the Caribou (*Rangifer tarandus granti*) in Alaska. Ph.D. dissertation, University of California, Berkeley.

Smith, Gerad M.
2012 Highland Hunters: Prehistoric Resource Use in the Yukon-Tanana Uplands. Master's thesis, Department of Anthropology, University of Alaska Fairbanks.

Smith, Thomas E.
1981 *Geology of the Clearwater Mountains, South-Central Alaska*. Geologic Report 60, Alaska Division of Geological and Geophysical Surveys, Fairbanks.

Speakman, Robert J., Charles E. Holmes, and Michael D. Glascock
2007 Source Determination of Obsidian Artifacts from Swan Point (XBD-156), Alaska. *Current Research in the Pleistocene* 24:143–145.

Stuiver, Minze, Paula J. Reimer, and Ron W. Reimer
2018 CALIB 7.1. http://calib.org

Sturm, Matthew, and Carl S. Benson
1989 *Jökulhlaups from Strandline Lake, Alaska, with Special Attention to the 1982 event*. Alaska Division of Geological and Geophysical Surveys Report of Investigations, Fairbanks.

Sturm, Matthew, James E. Begét, and Carl S. Benson
1987 Observations of Jökulhlaups from Ice-Dammed Strandline Lake, Alaska: Implications for

Paleohydrology. In *Catastrophic Flooding,* edited by Larry Mayer and David Nash, pp. 79–94. Allen and Unwin, Boston.

Thorson, Robert M., E. James Dixon, Jr., George S. Smith, and Alan R. Batten
1981 Interstadial Proboscidean from South-Central Alaska; Implications for Biogeography, Geology, and Archaeology. *Quaternary Research* 16:404–417.

Trautman, Milton A.
1963 Isotopes, Inc., Radiocarbon Measurements III. *Radiocarbon* 5:62–79.

Tweed, Fiona S., and Andrew J. Russell
1999 Controls on the Formation and Sudden Drainage of Glacier-Impounded Lakes: Implications for Jökulhlaup Characteristics. *Progress in Physical Geography* 23(1):79–110.

Twelker, Evan, Trent D. Hubbard, Alicja Wypych, Karri R. Sicard, Rainer J. Newberry, David A. Reioux, Lawrence K. Freeman, and Lauren L. Lande
2015 *Explanation of Map Units: Geologic Map of the Talkeetna Mountains C-4 Quadrangle and Adjoining Areas, Central Alaska* (1:50,000 scale). Preliminary Interpretive Report 2015-6. State of Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys, Fairbanks.

Welsch, Dennis, Robert Goodwin, and Norman Ten Brink
1982 Late Quaternary Glaciations of the Talkeetna Mountains, Alaska Labs. *Geological Society of America Abstracts with Programs* 14(6):353–354.

Wendt, Michael L.
2013 Integrating Climate Change with Human Land Use Patterns: Archaeology of Butte Lake Northeast. Master's thesis, Department of Anthropology, University of Alaska Fairbanks.

West, Frederick H.
1975 Dating the Denali Complex. *Arctic Anthropology* 12(1):76–81.
1996 Beringia and New World Origins II. The Archaeological Evidence. In *American Beginnings: The Prehistory and Palaeoecology of Beringia*, edited by Frederick H. West, pp. 537–559. University of Chicago Press, Chicago.
1998 Tangle Lakes. In *Archaeology of Prehistoric Native America: An Encyclopedia,* edited by Guy E. Gibbon and Kenneth M. Ames. Garland, New York.

West, Frederick H., Brian S. Robinson, and Mary Lou Curran
1996a Phipps Site. In *American Beginnings: The Prehistory and Paleoecology of Beringia*, edited by Frederick H. West, pp. 381–386. University of Chicago Press, Chicago.

West, Frederick H., Brian S. Robinson, and R. Greg Dixon
1996b Sparks Point. In *American Beginnings: The Prehistory and Paleoecology of Beringia*, edited by Frederick H. West, pp. 394–398. University of Chicago Press, Chicago.

West, Frederick H., Brian S. Robinson, and Constance F. West
1996c Whitmore Ridge. In *American Beginnings: The Prehistory and Paleoecology of Beringia*, edited by Frederick H. West, pp. 386–394. University of Chicago Press, Chicago.

Wiedmer, Michael, David R. Montgomery, Alan R. Gillespie, and Harvey Greenberg
2010 Late Quaternary Megafloods from Glacial Lake Atna, Southcentral Alaska, U.S.A. *Quaternary Research* 73(3):413–424.

Williams, John R.
1989 A Working Glacial Chronology for the Western Copper River Basin, Alaska. In *Late Cenozoic History of the Interior Basins of Alaska and the Yukon; Proceedings of a Joint Canadian-American Workshop*, edited by L. David Carter, Thomas D. Hamilton, and John P. Galloway, pp. 81–84. U.S. Geological Survey Circular 1026.

Williams, John R., and John P. Galloway
1986 *Map of Western Copper River Basin, Alaska, Showing Lake Sediments and Shorelines, Glacial Moraines, and Location of Stratigraphic Sections and Radiocarbon-dated Samples*. Open-File Report 86-390, 30 pp., scale 1:250,000, U.S. Geologic Survey, Alexandria, VA.

Woodward-Clyde Consultants
1982 *Quaternary Geology*. Final report on seismic studies for Susitna Hydroelectric Project (Subtasks 4.09–4.15). Acres American Incorporated report, pp. 3.1–3.20. Buffalo.

Wygal, Brian T.
2009 The Prehistoric Colonization of Southcentral Alaska: Human Adaptations in a Post-Glacial World. Ph.D. dissertation, Department of Anthropology, University of Nevada, Reno.

2010 Prehistoric Upland Tool Production in the Central Alaska Range. *Alaska Journal of Anthropology* 8(1):107–119.

2011 The Microblade/Non-Microblade Dichotomy: Climatic Implications, Toolkit Variability, and the Role of Tiny Tools in Eastern Beringia. In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia,* edited by Ted Goebel and Ian Buvit, pp. 234–254. Texas A&M Press, College Station.

Wygal, Brian T., and Ted Goebel
2012 Early Prehistoric Archaeology of the Middle Susitna River Valley, Alaska. *Arctic Anthropology* 49(1):45–67.

Wygal, Brian T., and Kathryn E. Krasinski
2019 Post-Glacial Human Colonization of Southern Alaska: The Archaeology of Trapper Creek. *Alaska Journal of Anthropology*, this volume.

Wygal, Brian T., Kathryn E. Krasinski, Charles E. Holmes, and Barbara A. Crass
2018 Holzman South: A Late Pleistocene Archaeological Site along Shaw Creek, Tanana Valley, Interior Alaska. *PaleoAmerica.* doi.org/10.1080/20555563.2017.1408358.

Yehle, Lynn A., and Donald R. Nichols
1980 *Reconnaissance Map and Description of the Chetaslina Volcanic Debris Flow (New Name), Southeastern Copper River Basin and Adjacent Areas, South-Central Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-1209,* 1:250,000 scale. U.S. Geological Survey, Alexandria, VA.

Yesner, David R.
2001 Human Dispersal into Interior Alaska: Antecedent Conditions, Mode of Colonization, and Adaptations. *Quaternary Science Reviews* 20:315–327.