Ellensburg Chapter Ice Age Floods Institute

Lower Lake Wenatchee Area Field Trip

Field Trip Leader:

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6 September 2025

Field Trip Overview

Welcome to the lower Lake Wenatchee area! This Ellensburg Chapter of the Ice Age Floods Institute field trip is an Eastern Cascades companion trip to the September 2016 IAFI Leavenworth to Wellington field trip. In the lower Lake Wenatchee area, we will have five stops (Figure 1) to examine: 1) big picture bedrock geology, general glacial history, and climate; 2) evidence of the Upper Wenatchee River glacier plus Glacier Peak "tephra"; 3) evidence of the Chiwawa River glacier and Mad River outlet glaciers; 4) evidence of a Napeequa-Big Meadow Creek glacier; and 5) lateral valleys created by glacial meltwater. Throughout our field day, we will emphasize connections between elements of the physical environment and human activity.

Tentative Schedule

10:00am	**Stop 1—Lake Wenatchee State Park**
11:00	Depart
11:30	**Stop 2—Northeast of Fish Lake**
12:15pm	Depart
12:45	**Stop 3--Chiwawa River Overlook**
1:45	Depart
2:00	**Stop 4—Meadow Creek Overlook**
3:00	Depart
3:30	**Stop 5—Deep Creek at Morrow Meadow**
4:15	Depart

Getting to Stop 1

Stop 1 is located in the southern portion of Lake Wenatchee State Park (Figure 2). You can access this area by taking Cedar Brae Road from WA Hwy 207 through the US Forest Service Nason Creek campground into Lake Wenatchee State Park South Campground to the beach area of the state park. Parking is available near the restrooms/concessions area and up the hill to the east. Wherever you park here you will need a Discover pass. You might bring a folding chair as I hope to spend nearly an hour on the beach here. The approximate GPS coordinates of this stop are: 47.806262°N & 120.726696°W.

Our Field Stops

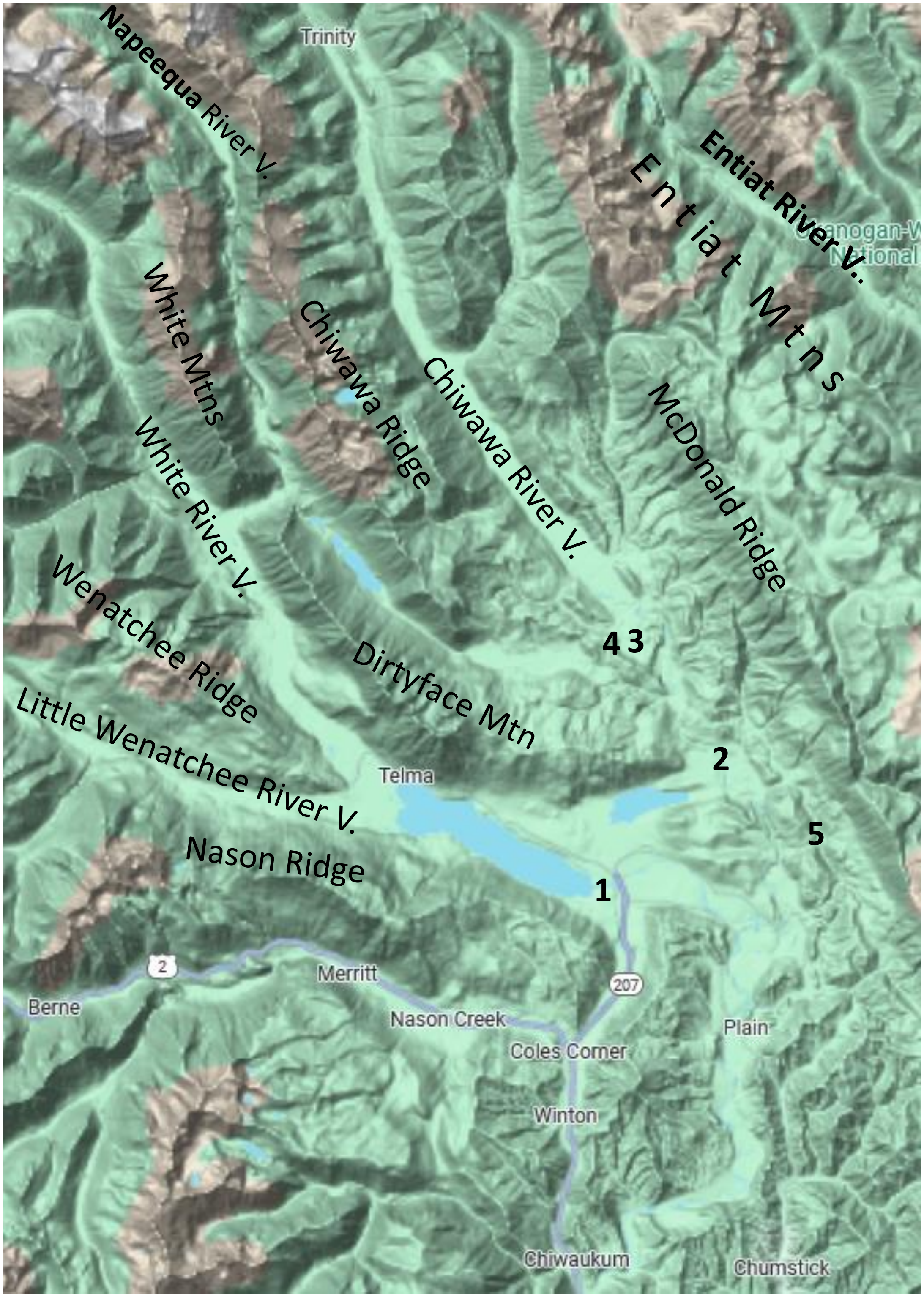

Figure 1. The approximate locations of lower Lake Wenatchee area field trip stops noted with bold numbers. Also, note the northwest-southeast orientation of many of the ridges and valleys. Source: Google Maps.

Stop 1—Lake Wenatchee State Park

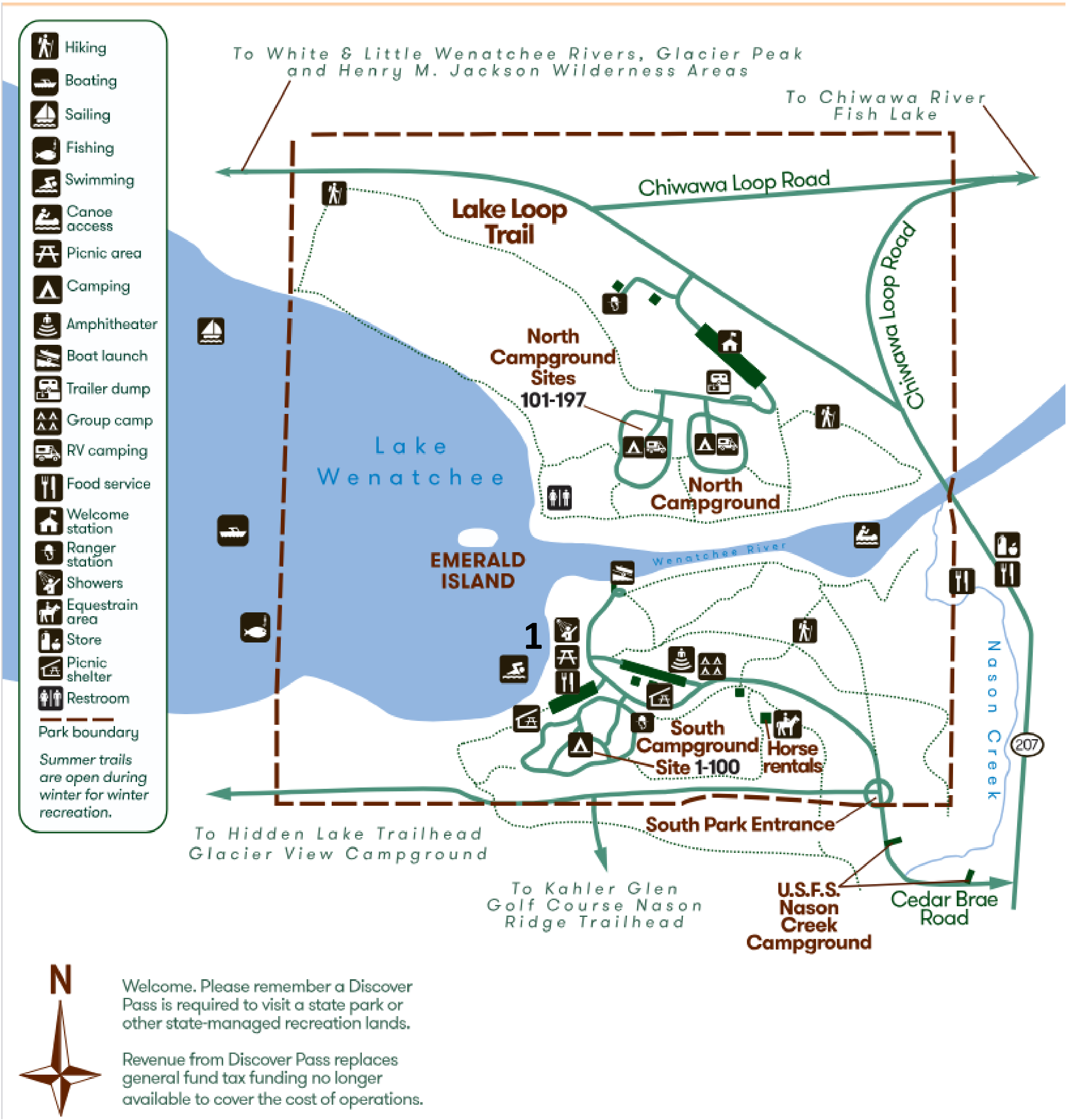

Figure 2. Approximate location of Stop 1 (bold number) within the southern portion of Lake Wenatchee State Park. Source: https://waparks.org/parks/lake-wenatchee/

Stop 1—Lake Wenatchee State Park

Location. We are located on the shores of Lake Wenatchee State Park. More regionally, we are located in the Northeastern Cascade Range, about 20 miles east of the Cascade Crest. Nason Ridge lies west, Wenatchee Ridge is to the northwest, and the White Mountains, Chiwawa Ridge, and Dirtyface Mountain lie to the north. The Entiat Mountains are located to the east (Figure 1). Further east is the Columbia Plateau. We are in the Wenatchee River Watershed. The Wenatchee River lies about 0.1 mi north of here.

Ancient Geologic Domains & Terranes: The area lies within the "Metamorphic Core" geologic domain between the Straight Creek Fault to the west and Ross Lake Fault Zone to the east (Figure 3). This domain is composed of "metamorphic" rocks (e.g., schists, gneisses, and amphibolites) of four "terranes"—Chelan Mountains, Nason, Swakane, and Little Jack—that originated elsewhere and were transported here by shifting tectonic plates. All appear to have originated at "volcanic arcs" (i.e., chains of volcanoes adjacent to subducting tectonic plates) 210->570 million years ago (Tabor and Haugerud (1999).

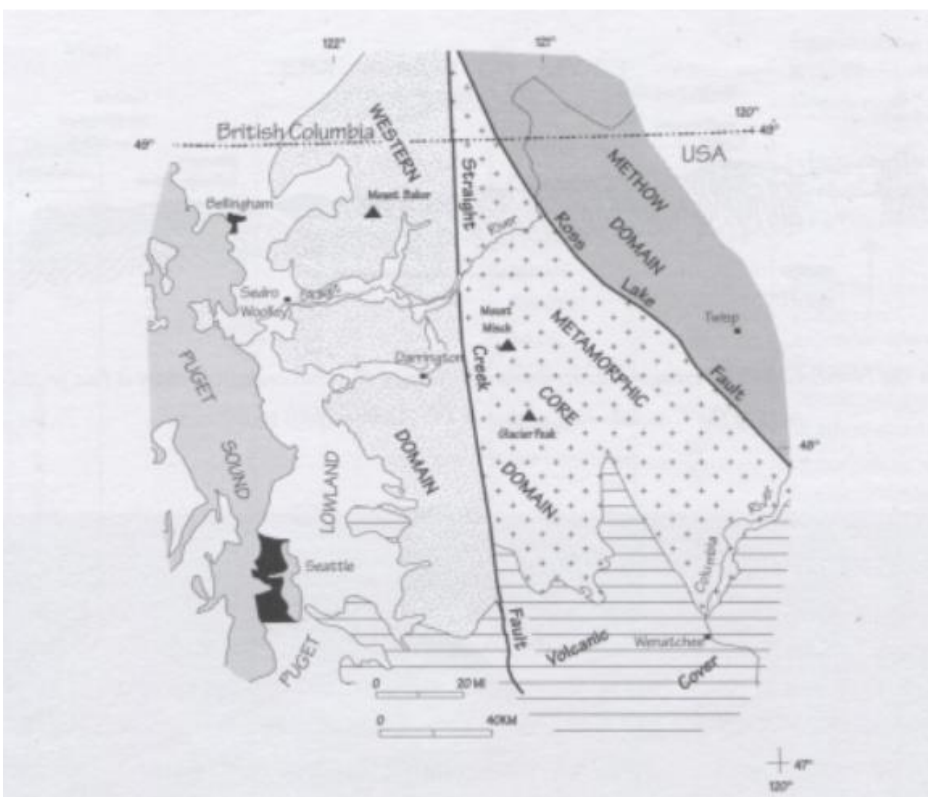

Figure 3. The three major geologic domains—Western, Metamorphic Core, and Methow--of the North Cascades. Note the Metamorphic Core Domain between the Straight Creek and Ross Lake faults. Source: Tabor and Haugerud (1999, p. 16).

Stop 1—Lake Wenatchee State Park

Tertiary Geology. Following emplacement of the terranes mentioned above, the Chumstick Basin (Evans, 1994) formed between the Entiat Fault (on the east) and the Leavenworth Fault (on the west) (Donaghy & others, 2021) (Figure 4). These were “right lateral” or “dextral strike slip faults” meaning that they were characterized by a block across the fault line moving to the right. Total lateral displacement on the faults is estimated at a minimum 12-18 miles (Tabor & others, 1987).

The Chumstick Formation formed when sediments eroded from surrounding uplands accumulated in the Chumstick Basin (Figure 4) This formation is mostly composed of non-marine sedimentary rocks, especially sandstone (from sands), shale (from silts and clays), and conglomerate (from gravel- to clay-sized sediments) (Evans, 1994).

More specifically, throughout today, we are in a landscape underlain mostly by the Deadhorse Member of the Chumstick Formation. It consists of sandstone and mudstone deposited long ago in a westward and southwestward flowing, meandering river system. The source of these sediments were igneous- and metamorphic-rich uplands to the north and northeast of the basin (Donaghy & others, 2021). The age of the Deadhorse Member is less than ~45.9 Ma (Eddy & others, 2016). Deposition of this member occurred after cessation of fault activity on the Leavenworth and Entiat faults (Evans, 1994) (Figure 4).

Linear Topography. The first thing that catches my eye as I examine “small scale” (i.e., little detail over large area) topographic maps of the area is the northwest-southeast trend of valleys and intervening ridges (Figure 1). This trend extends from the Little Wenatchee River to Lake Chelan area. Valley glaciers occupied each of these valleys and cirque glaciers were present on many of the ridges. This pattern matches up well with the Entiat Fault Zone but similar structures appear to be lacking to the west.

Stop 1—Lake Wenatchee State Park

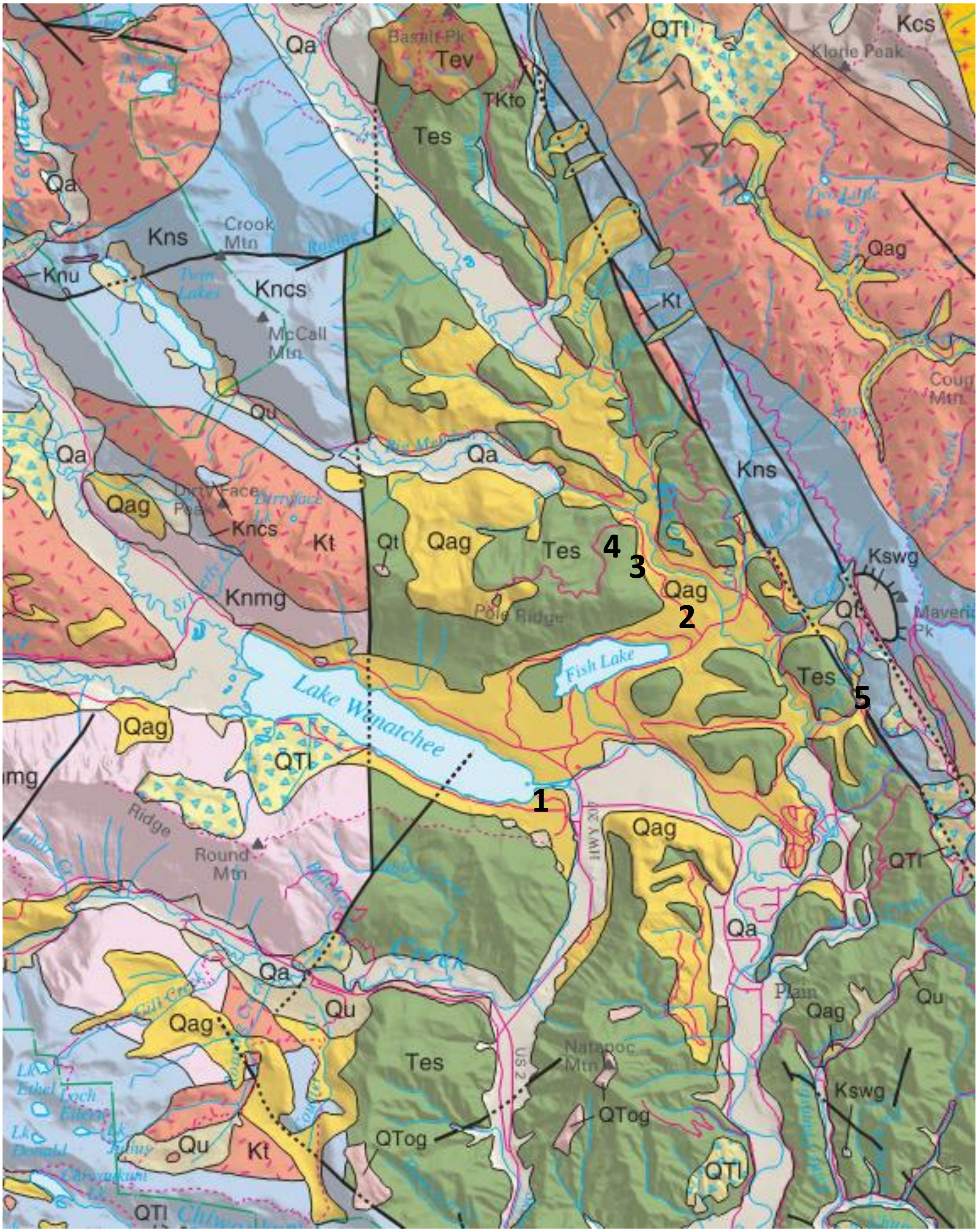

Figure 4. Simplified geologic map of the Chumstick basin and surroundings. Note how all field trip stops (bold numbers) are located within the Chumstick Formation (green Tes) or alpine glacial deposits (gold Qag) Source: Haugerud & Tabor, 2009).

Stop 1—Lake Wenatchee State Park

Weather & Climate. The weather and climate of the area is a product of latitude, elevation, and distance east of the Puget Sound and the Cascade Crest. With a latitude of about 48°N, the area is characterized by well-developed seasons distinguished by warm, dry summers and cool, wet winters (Figure 5). These warm, dry summers are one of the causes of wildfires in the area. In Plain, the average July temperature is 66°F while the coldest months, December and January, average 27°F. The average annual temperature is 46°F, which is colder than marine-influenced Seattle and lower elevation Wenatchee. The proximity to the Cascade Crest increases the potential for precipitation, especially snowfall. Overall precipitation averages ~27 in/year. Much of the winter precipitation falls as snow. Over the 1991-2020 period, snowfall averaged 114 in/year. Precipitation and snowfall amounts increase dramatically with elevation, especially to the west. Later, we will talk about how these patterns of temperature and precipitation are changing in the area.

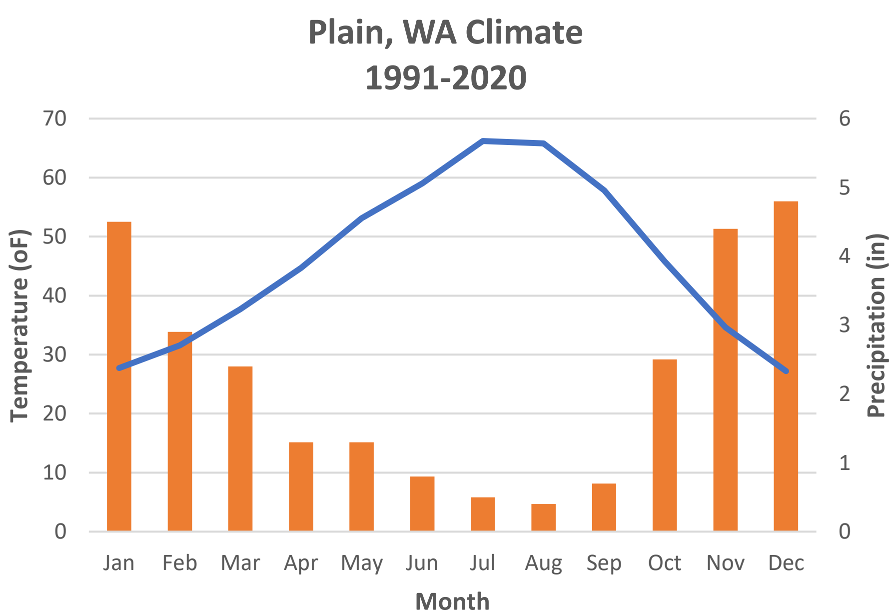

Figure 5. Temperature (line) & precipitation (bars) average at Plain, WA over the 1991-2020 period. Source: Western Regional Climate Center.

Vegetation. Eastern Cascades vegetation is characterized by coniferous forest. Here, the dominant trees are ponderosa pine and Douglas fir. Much of the forest in the vicinity is "overstocked"—i.e., too many trees/acre; therefore, it is very prone to being part of catastrophic fire during typically dry summers. Logging operations such as those seen in the vicinity of Stops 2-4 are being used to remedy this overstocked situation. In a more practical sense, the dense forest cover here obscures many of the landforms we will talk about. Luckily, we have topographic maps and "lidar" (i.e., light detection and ranging) imagery to help us better see the topography!

Stop 1—Lake Wenatchee State Park

Wenatchee River Glacier. The "Pleistocene" (i.e., ~2.6 million to ~11,600 years ago) ice ages included numerous periods of glacial advance and retreat. The glacial periods likely resulted primarily from lower temperatures (e.g., mean annual temperature that was ~7.5-~8.5°F lower than present (Porter, 1977; Porter & others, 1983; Whitlock & Bartlein, 1997).

U.S. Geological Survey geologist I.C. Russell (1890) was the first to map the extent of past glaciers in the Eastern Cascades including the Upper Wenatchee River Watershed (Figure 6). The upper Wenatchee River Basin was south of the Cordilleran icesheet (Figure 7); therefore, the resulting glaciers impacting the watershed were <u>not</u> "ice sheets"; rather, <u>most</u> originated as small "alpine glaciers" that formed in "cirques" (i.e., amphitheater-shaped basins high on mountain sides) (Figure 8). The resulting "cirque glaciers" grew, spilling out of cirques to fill valleys and form "valley glaciers".

Pre-Late Pleistocene Wenatchee River Glacier. Russell mapped glacial evidence in the Little Wenatchee, White, and Chiwawa drainages (Figure 6). All of these valley glaciers merged to form a Wenatchee River Glacier that terminated south of Plain and north of Leavenworth (Russell, 1890). This glacier covered Stop 1. Russell did not determine the age of this most extensive glaciation other than to refer to it as "ancient". Nimick (1977) and Long (1987, 1989) have since estimated that these deposits do not date from the last glaciation; rather, they are "pre-late Pleistocene" with an estimated age of 130,000-140,000 years before present.

Late Pleistocene Wenatchee River Glacier. The late Pleistocene (i.e., younger than ~130,000 years) Wenatchee River glaciers that covered Stop 1 originated in cirques and valleys to the northwest. These glaciers extended down the main valleys of the Wenatchee River drainage multiple times, often merging with tributary cirque and valley glaciers from as far west as the Cascade Crest to form larger valley glaciers in the Little Wenatchee River and White River valleys to the northwest (Figure 6).

Glacial Evidence Here. The evidence for glacial shaping of this area is the "U-shaped trough" occupied by Lake Wenatchee, and the ridge-like "lateral moraines" and "end moraines" deposits that impound the downstream end of Lake Wenatchee (Figures 9 & 10). Glacial erosion scoured a lake Wenatchee basin that is reported to be 300 ft deep (Wolcott, 1964). Landform evidence suggests that the glacier was thick, extending 1700-1800 ft above the present-day lake surface (Russell, 1900)!

Stop 1—Lake Wenatchee State Park

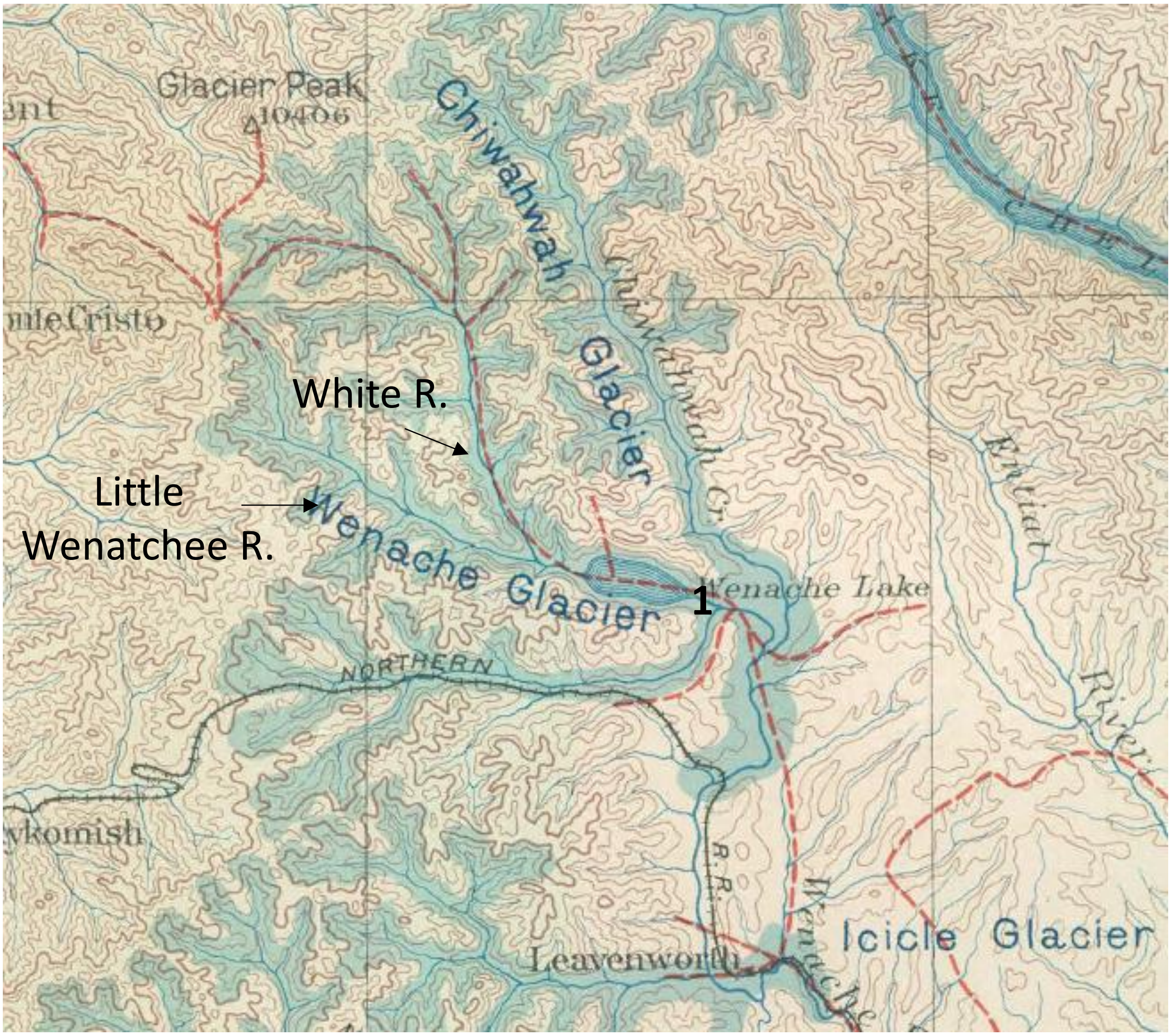

Figure 6. Pleistocene glaciers of the upper Wenatchee (i.e., Wenache) and Chiwawa (i.e., Chiwahwah) as mapped by I.C. Russell in 1898. Note the two main rivers (i.e., Little Wenatchee and White) feeding the upper Wenatchee drainage. Red dashed lines represent routes traveled. Approximate location of Stop 1 shown with bold number. Source: Part of Plate XVIII in Russell (1890).

Native Americans in the Area. We are in an area that was used by members of the Wenatchee tribe for millennia. They lived seasonally in the lower Lake Wenatchee area, fishing, hunting, and gathering. A large camp was situated near the confluence of the Wenatchee and Chiwawa rivers. Fish weirs were built there as well as across the Wenatchee River where it exits Lake Wenatchee. Trails on the valley floor (e.g., Chiwawa River Trail) led to good berry picking areas (Beckey, 1977, 2003).

Stop 1—Lake Wenatchee State Park

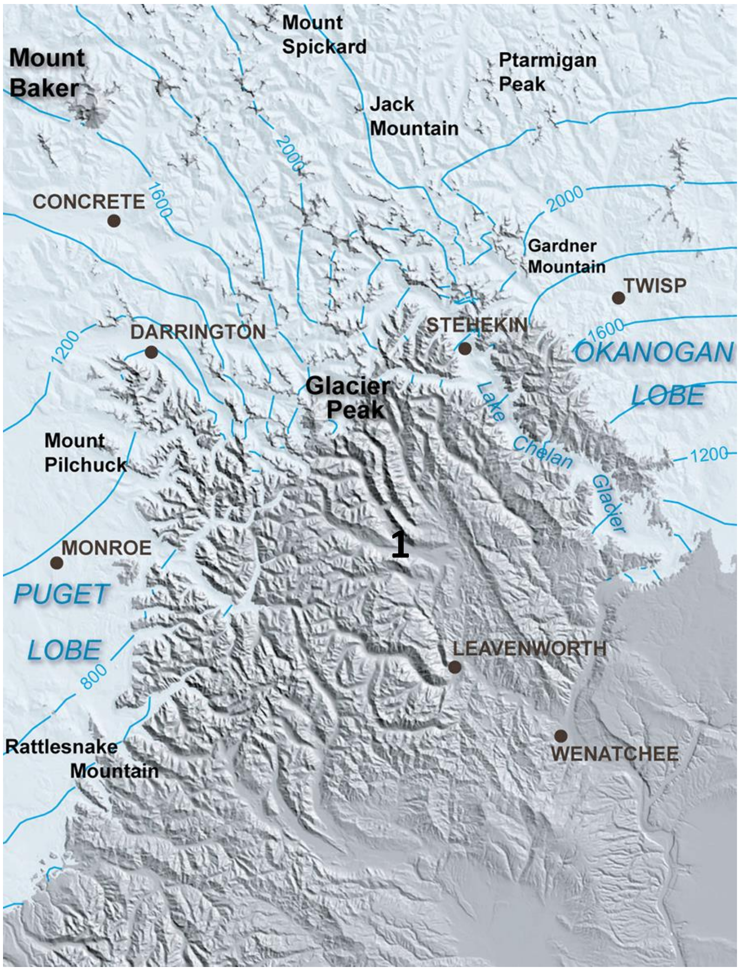

Figure 7. Location of general field trip area in relation to the Cordilleran Icesheet. Bold number indicates approximate location of Stop 1. Source: Washington Geological Survey, https://www.dnr.wa.gov/programs-and-services/geology/explore-popular-geology/geologic-provinces-washington/north-cascades#glaciation-and-erosion.1

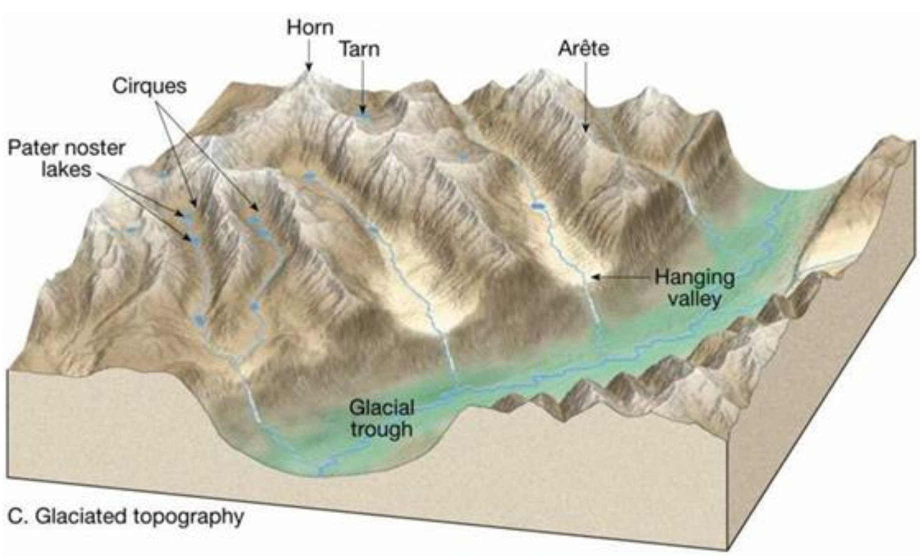

Figure 8. Alpine glacial erosional landforms. Source: https://www.dailykos.com/stories/2055445/full_content

Stop 1—Lake Wenatchee State Park

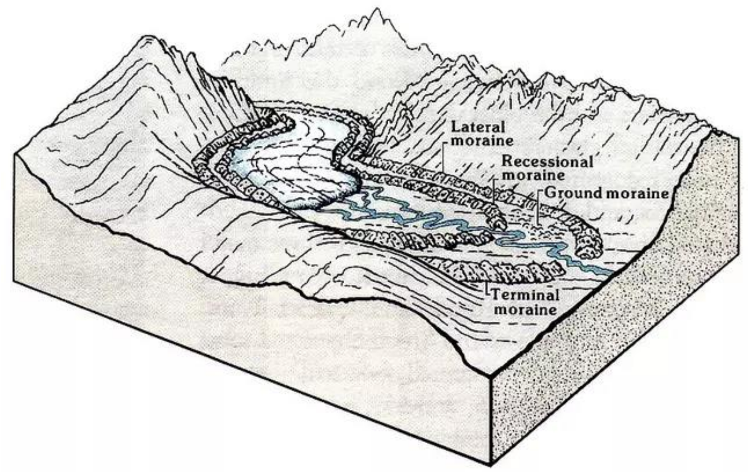

Figure 9. Moraine types associated with alpine glaciation. For our purposes, terminal and recessional moraines are end moraines. Source: https://serc.carleton.edu/download/images/181751/moraines.webp

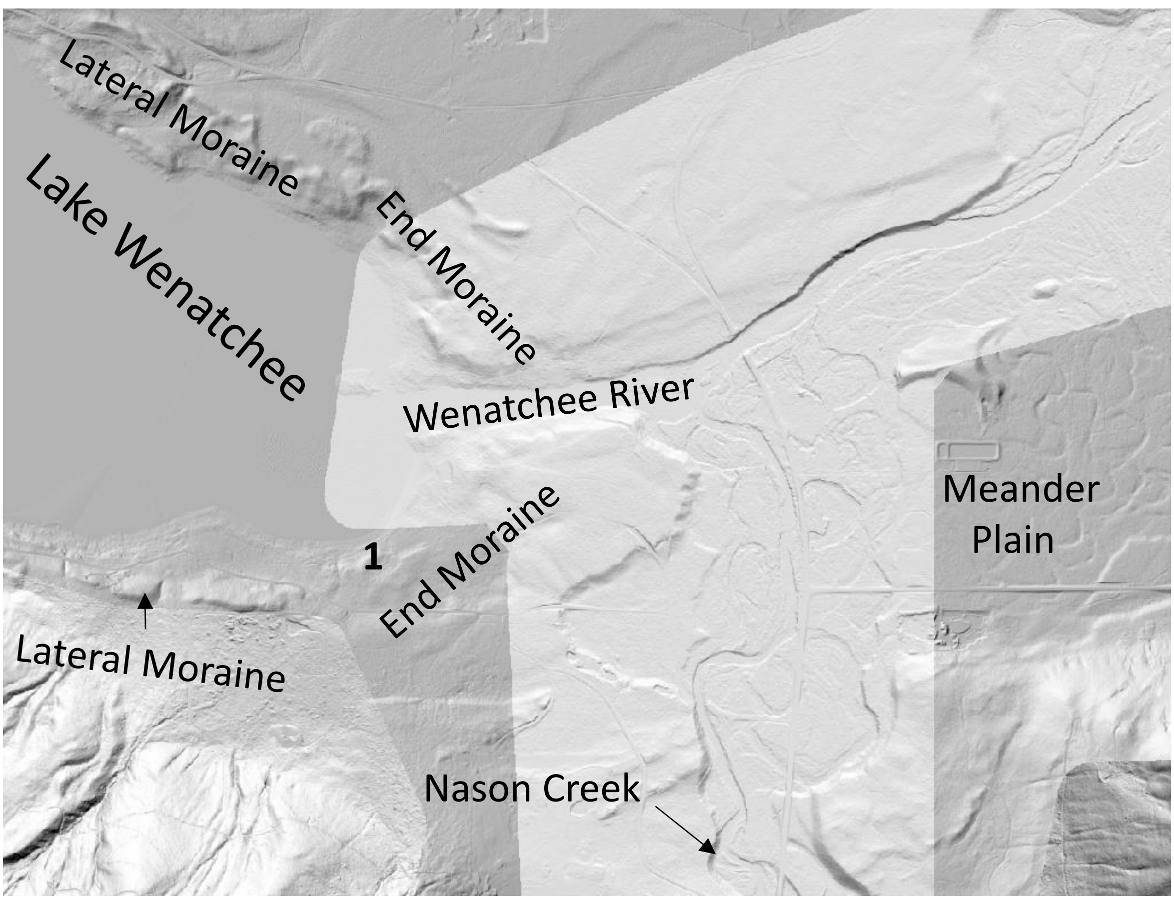

Figure 10. Vertical, overhead, lidar view of downstream end of Lake Wenatchee. Note lateral and end moraines impounding Lake Wenatchee. The end moraine was breached by the Wenatchee River following glaciation. The river, combined with Nason Creek, has meandered over a large area to form a "meander plain". Bold number indicates location of Stop 1. Source: Washington Lidar Portal.

Enroute to Stop 2

Return to WA 207 (Figure 11). Turn left onto WA 207 and proceed for less than a mile to the Chiwawa Loop Road. Bend right onto this road and continue for ~1.25 mile to the Chiwawa River Road (USFS 6200). Turn left onto this road and follow it for ~2.4 miles just past the Fish Lake Snopark to USFS road 6300. Turn left onto this road and proceed ~0.5 miles to poorly marked USFS road 111 on the right. Pull onto this road and find a place to park along the side. GPS coordinates: 47.845837°N & 120.678154°W. From our parking spot, we will walk less than 0.25 through a US Forest Service timber harvest area to a low ridge.

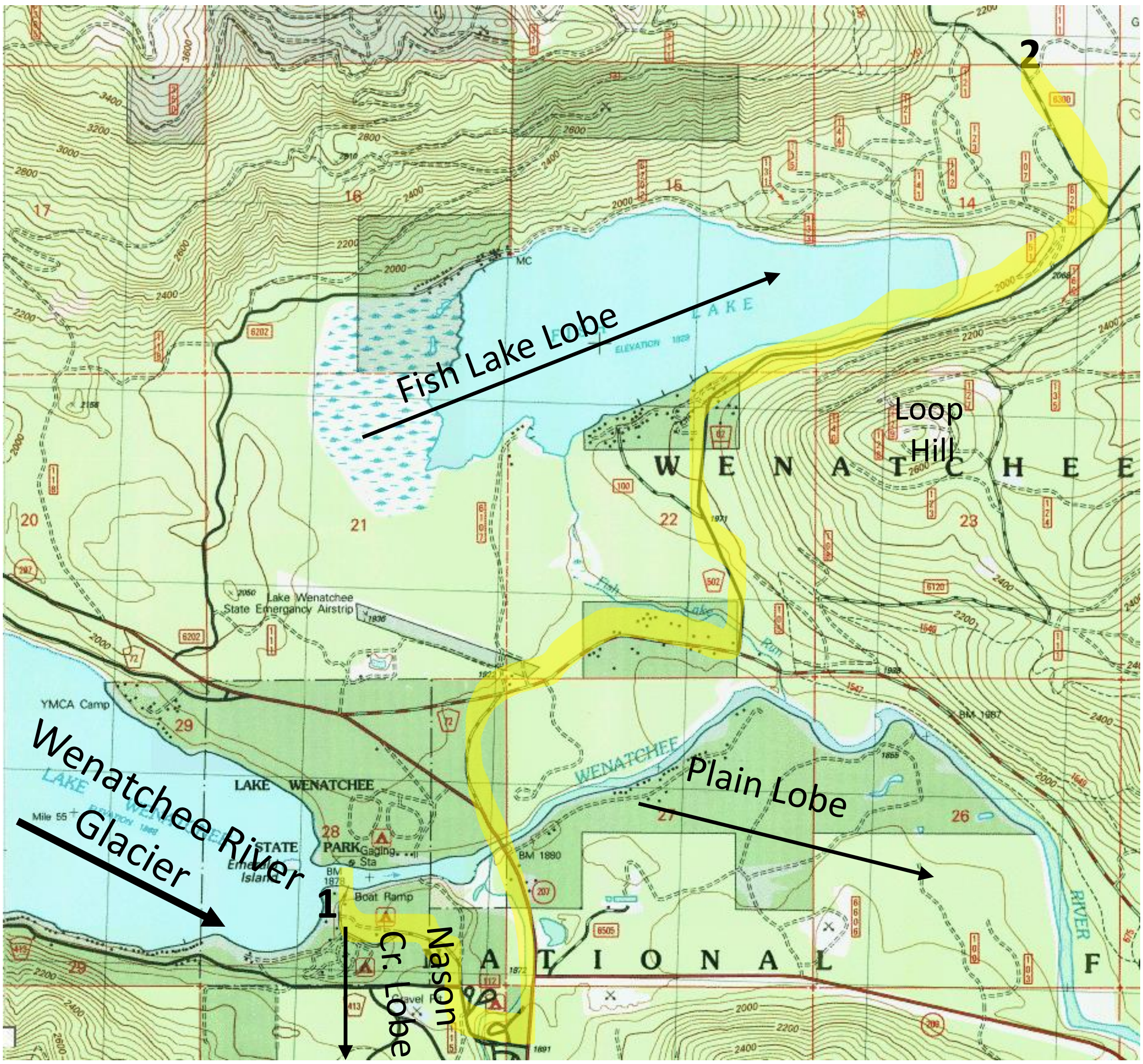

Figure 11. The landscape and highlighted route between Stops 1 & 2 (bold numbers). Also, note the Main Wenatchee River glacier (bold arrow) and the informally named Fish Lake, Plain, and Nason Creek glacier lobes (lighter arrows) during the "Plain" late Pleistocene glaciation. Source: Caltopo.com.

Stop 2—Northeast of Fish Lake

Location. We are located on a low ridge northeast of our parking spot. Fish Lake is to the southwest, Pole Ridge is to the west and the Chiwawa River and Entiat Mountains are to the East.

Glacial Evidence Here. We are standing on glaciated terrain. The evidence for this is the low ridge (i.e., moraine) (Figures 12 & 13) and the scattered, large crystalline boulders ("erratics") that appear as pimple-like features when viewed from above (Figures 12 & 14). The ridge we are on arcs to the east (Figure 12). This tells us that this and other adjacent ridges are lateral and end moraines that were deposited by a glacier coming from the Wenatchee River Valley rather than from the Chiwawa River Valley (just east of here). This was one of three lobes of the late Pleistocene Wenatchee River glacier—the Fish Lake lobe (Figure 11)—during "Plain II, III, & IV" time (see below). The lobes resulted from the interaction of the Wenatchee River Glacier with pre-existing hills cored by sedimentary Chumstick Formation. Loop Hill separating Fish Lake from the Wenatchee River diverted part of the Wenatchee River Glacier to the east. Scouring by the lobe excavated a shallow lake basin (~135 ft deep) (Wolcott, 1964) now occupied by Fish Lake that is enhanced by end moraine (see below). Using old school, stereo aerial photographs, Nimick (1977) mapped five distinct end moraines here associated with the late Pleistocene "Plain" glaciation (Figure 12). He then differentiated them by age (Plain I, II, III & IV) based on soil development and boulder weathering characteristics. Plain I is the oldest while Plain IV is the youngest. It is not known whether these are "recessional moraines" (i.e., formed during brief stops on a general recession) or if they indicate readvances within the late Pleistocene. Given the presence of lake sediments and well-sorted sands between the moraines elsewhere, and differences in age-dependent weathering, it seems more likely that these were separate late Pleistocene readvances. Plain III end moraine holds in Fish Lake while Plain IV end moraine impounds Lake Wenatchee. We are standing on Plain II moraine here.

Stop 2—Northeast of Fish Lake

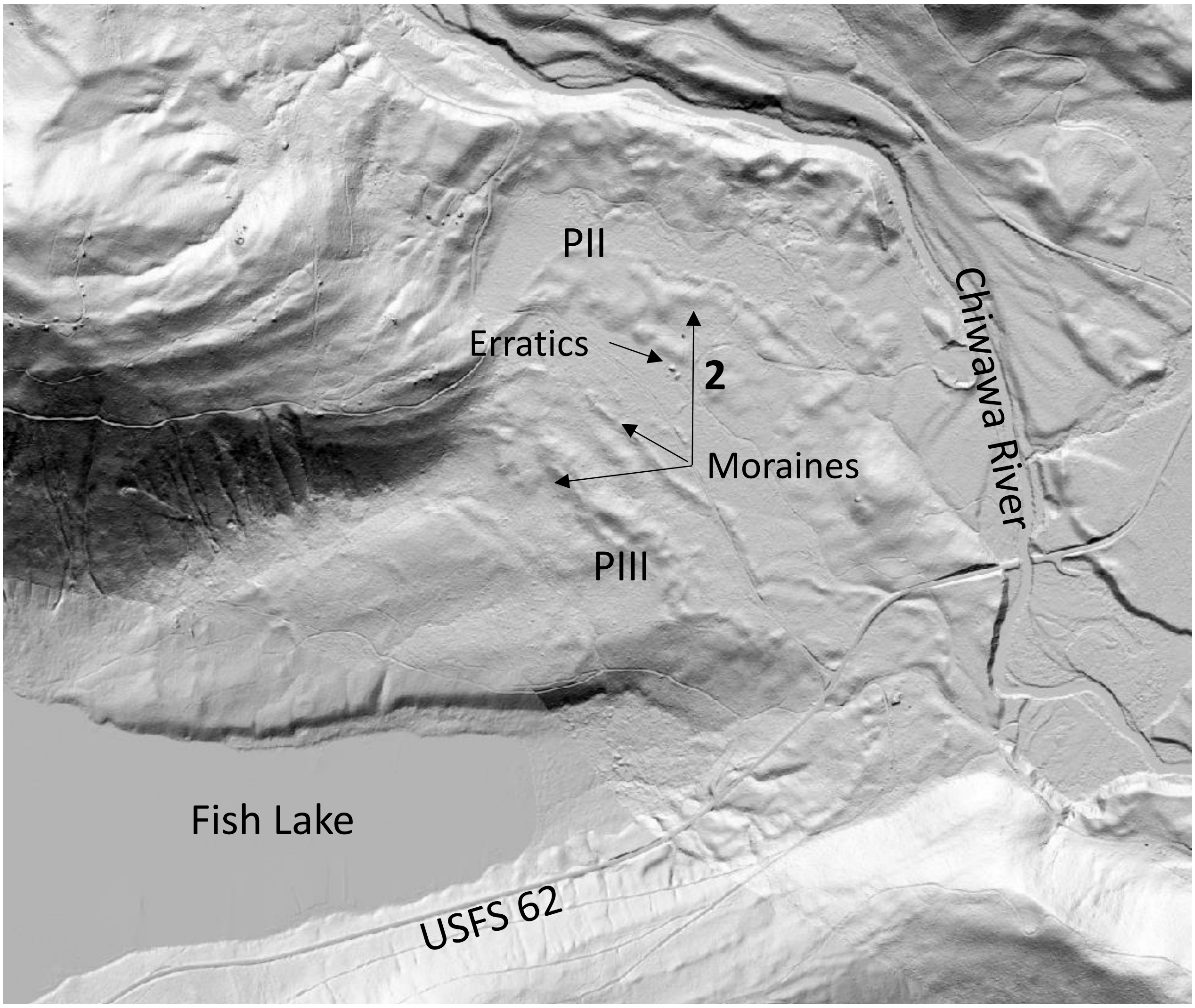

Figure 12. Lidar image of Stop 2 and vicinity showing arcuate end moraines and erratics deposited by a lobe of Plain II ice from the Wenatchee River Valley. Source: Washington Lidar Portal.

Stop 2—Northeast of Fish Lake

Figure 13. Subtle crest (note line) of late Pleistocene Plain II end moraine at Stop 1. Source: author photo, 15 July 2025.

Figure 14. Late Pleistocene Plain II erratics unearthed by road construction near junction of USFS 6300 and 111. Source: author photo, 15 July 2025.

Stop 2—Northeast of Fish Lake

Age of Glacial Deposits. I have noted above that the glaciation here is "late Pleistocene" yet I have offered no firm dates. That's because I don't know of any dates determined on these glacial deposits! Because of the presence of crystalline erratics, these deposits are ripe for isotopic dating… such as has been done in the Leavenworth area by Porter and Swanson (2008). However, by using the presence of "tephra" (i.e., volcanic deposits) we can refine the age limits here a bit. Four tephra layers were deposited in the area by Glacier Peak, Mt. Mazama, and Mt. St. Helens (Nimick, 1977; Waitt in Tabor & others, 1987) (Table 1). All are useful time markers on the landscape. This is especially true of nearby Glacier Peak tephras which were deposited about 13,710–13,410 calibrated years before present (cal yr BP) (Kuehn & others, 2009). These large eruptive episodes sent tephra across much of Eastern Washington including today's field trip area (Figure 15). Given the presence of Glacier Peak "lapilli" (i.e., pebble-size tephra) atop the moraine here (Figure 16) we know the moraine is more than 13,410 years old.

Table 1. Tephras present in the lower lake Wenatchee area. Source: Nimick (1977) and Waitt in Tabor & others (1987).

Tephra	Age
Mt. St. Helens W	1,480-1,482 AD
Mt. St. Helens Y	3,000-4,000 yr BP
Mt. Mazama	7,640 cal yr BP
Glacier Peak	13.710-13,410 cal yr BP

Glacier Peak Pumice. Pumice is a porous, low density volcanic rock. It forms when gas-rich "magma" (i.e., molten rock) is ejected into the air from an explosive volcanic eruption. The resulting drop in confining pressure causes the sudden release of trapped gases through numerous holes called "vesicles". An analogy would be the appearance of CO_2 bubbles at the surface of a just-opened soda pop can. The rapidly cooling tephra preserves these vesicles giving the rock its porous, low density nature. This pumice has an orange tinge that reflects weathering since deposition here ~ 13,410 cal yr BP. Imagine the force of an eruption that would send pumice "lapilli" (i.e., 2-64 mm diameter pieces of tephra) ~25 miles to here!

Stop 2—Northeast of Fish Lake

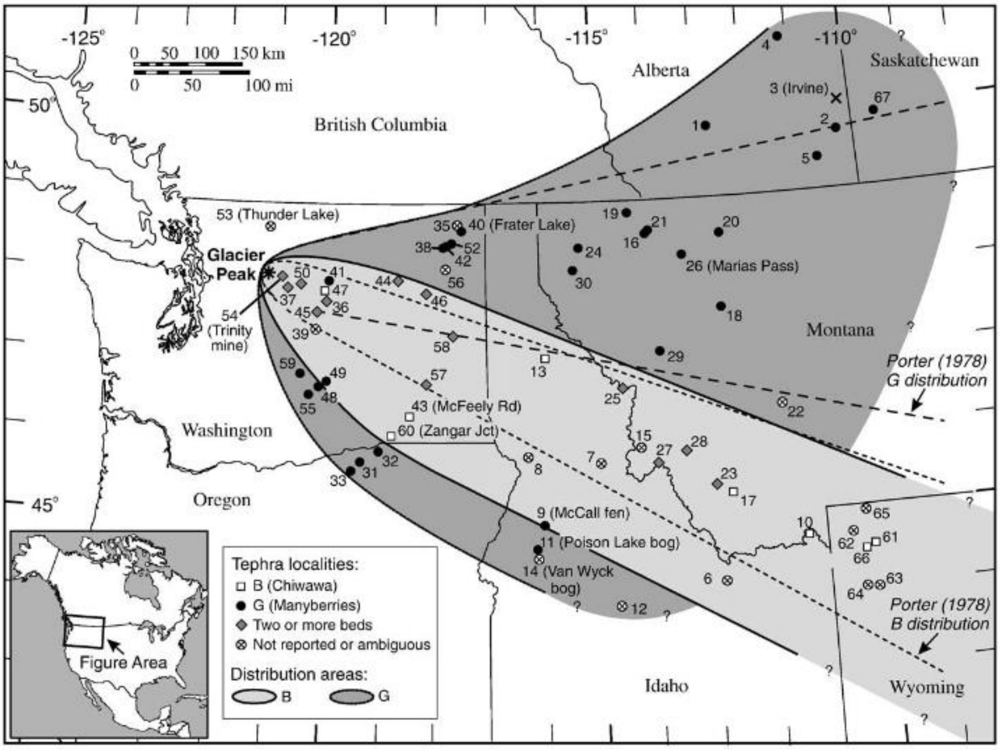

Figure 15. Distribution of the late Pleistocene Glacier Peak G (dark gray) and B (light gray) tephras across the Pacific Northwest. Note the location of Trinity mine on the map. Trinity mine is located about 13 miles upvalley of here. Numbers refer to particular sites. Source: Kuehn & others (2009).

Figure 16. Glacier Peak pumice lapilli atop Plain II moraine at Stop 2. Pumice pieces are the gravel size particles. Leatherman tool for scale. Source: Author photo, 15 July 2025.

Enroute to Stop 3

Return to USFS 6300 and follow this paved road northwest for about 2.5 miles to its junction with 6306 (Figure 17). Turn right onto gravel USFS 6306 and follow this road about 0.6 mi to its junction with USFS 6307. Turn left onto gravel USFS 6307 and follow it to ~1.8 mi to where a new logging road veers upslope to the right. This is Stop 3. Park alongside the road taking care to leave enough room for vehicles to pass. Approximate GPS coordinates: 47.885416°N & 120.719566°W. From our parking spot, we will walk up the new logging road to the crest of the ridge to the east.

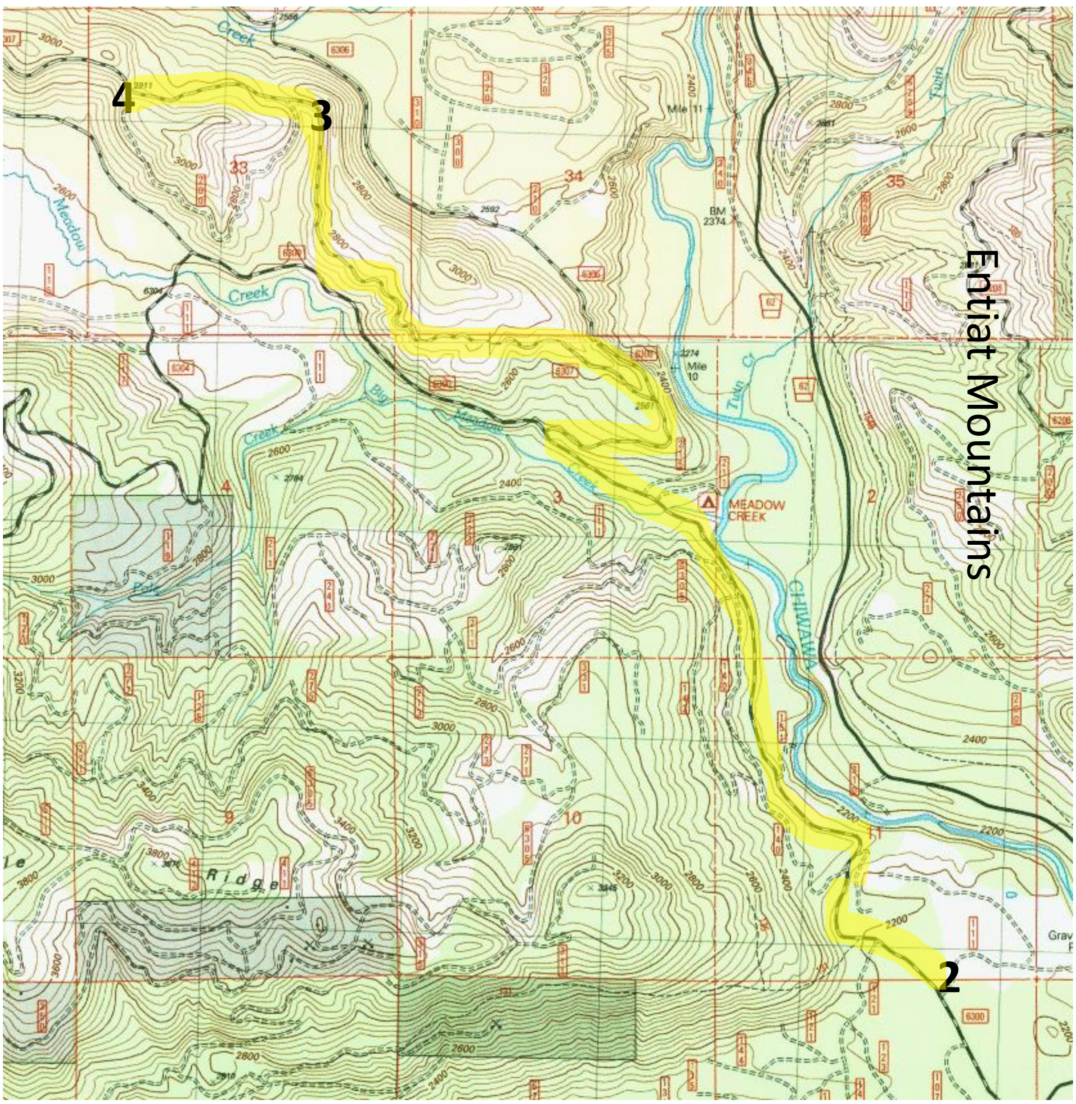

Figure 17. Topographic map showing Stops 2, 3 and 4 (bold numbers) and vicinity. Also, noted highlighted route from Stop 2 to Stops 3 & 4. Source: Caltopo.com.

Stop 3—Chiwawa River Valley Overlook

Location. We are standing atop a ridge with a view east and north of the Chiwawa River Valley and the Entiat Mountains (Figure 17). Landforms associated with two different glaciers are visible from here.

More Glacier Peak Tephra. Glacier peak tephra (especially lapilli) is evident in the roadcut as we hike up the logging road (Figure 18). Here, we get a better view of the "stratigraphy" (i.e., layering) of the tephra than we did at Stop 2. Note the coarse-textured upper portion lying atop finer sediments. I interpret the coarse and fine as tephras but from different Glacier Peak eruptions. Porter (1977) interpreted this stratigraphy as seen in Figure 19 showing five small, less explosive (hence finer textured) eruptions—T, M, F, C & N--below the coarse layer representing eruption B. Tephra size and thickness varied with the eruptions (Figure 20). For example, the two largest eruptions were B and G. Note how tephra size and thickness varies between those eruptions in the vicinity of Stop 3.

Layer G is present within about 1 mile of the headwaters of the Chiwawa River. This indicates that the Chiwawa Glacier had receded far upvalley from its maximum downvalley Late Pleistocene end moraine by ~13,410-13,710 cal yr BP (Porter, 1977; Kuehn & others, 2009). This evidence, combined with that from nearby Entiat and Chelan valleys suggests that deglaciation was "rapid and extensive" (Porter, 1977, p. 39).

Figure 18. Exposure of Glacier Peak tephra in roadcut of new logging road at Stop 3. Note textural differences representing different eruptions. Source: author photo, 15 July 2025.

Stop 3—Chiwawa River Valley Overlook

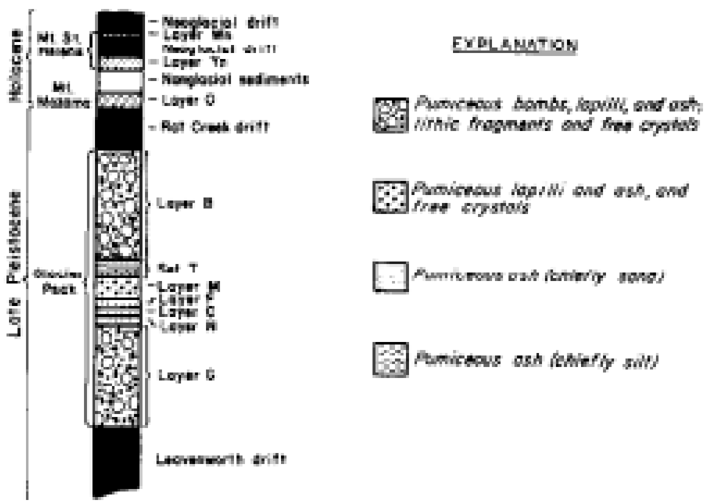

Figure 19. Composite stratigraphy of major tephra units in Eastern Cascades and their relationships to alpine glacial deposits. Source: Porter (1977).

Entiat Mountains and Chumstick Basin. Through the trees, we can see the Entiat Mountains. The edge of these mountains defines the edge of the Chumstick Basin. Crystalline rocks such as schist, amphibolite, gneiss, and tonalite characterize the terranes visible from here (Tabor & others, 1987). Here, in the Chumstick Basin, we are standing on sedimentary rocks (likely sandstones and shales here) of the Chumstick Formation.

Chiwawa River Glacier. At least several times during the Pleistocene, the Chiwawa River Glacier advanced into the valley between here and the Entiat Mountains. At its maximum late Pleistocene extent, this glacier was ~21 miles long extending from Fortress, Chiwawa, and Dumbell mountains to just downstream of here (Nimick, 1977; Long, 1989). The end moraine representing this maximum extent can be seen to the southeast of here (Figure 21) but it is very subtle due to the dense forest cover. The lidar image shows it well (Figure 22). The moraine, combined with the huge alluvial fan at the mouth of Chikamin Creek, resulted in a large postglacial lake that stretched for miles up the Chiwawa River Valley.

Stop 3—Chiwawa River Valley Overlook

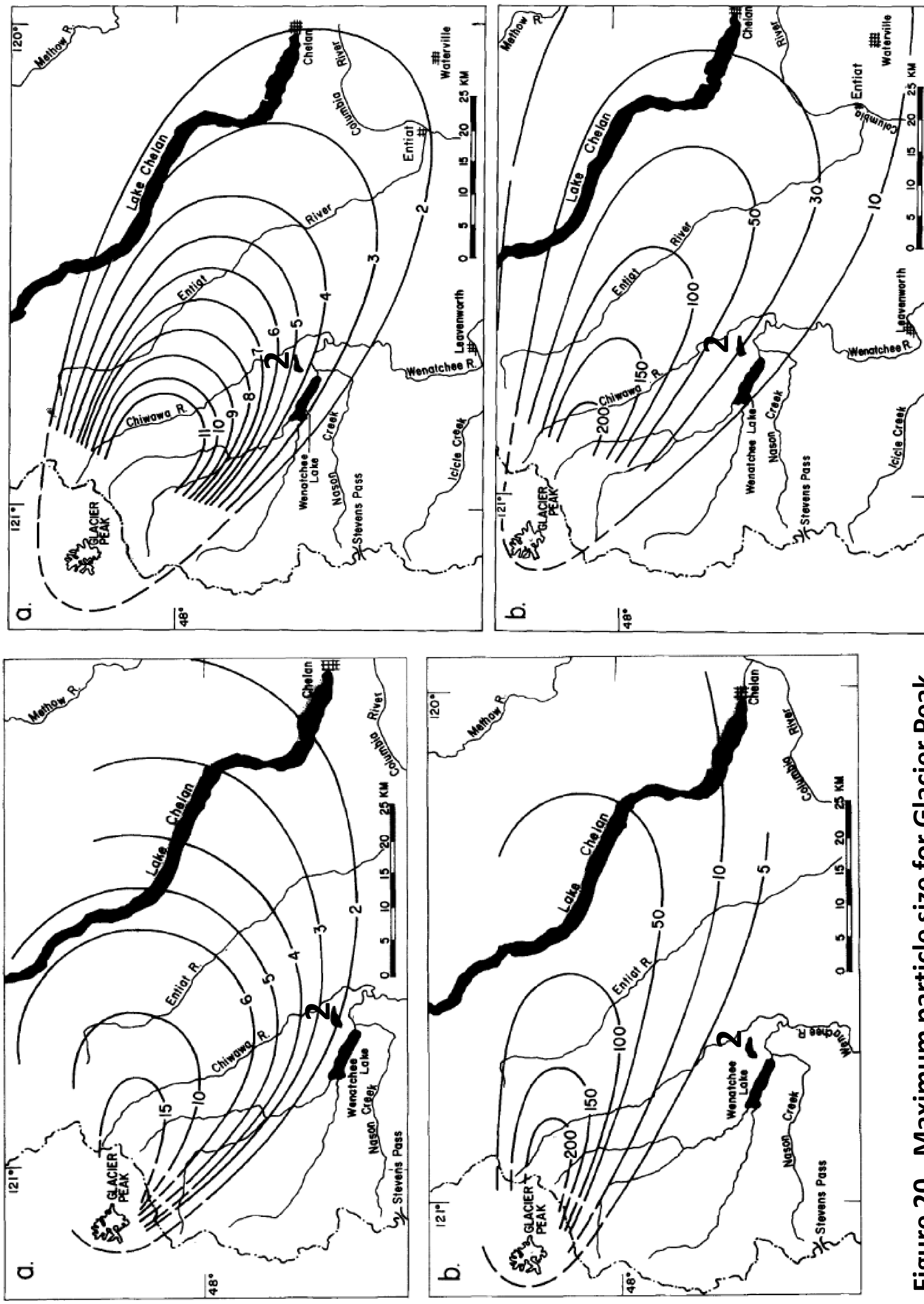

Figure 20. Maximum particle size for Glacier Peak tephra G (top left) and B (top right). Maximum thickness of Glacier Peak tephra G (lower left) and B (lower right). Source: Porter (1977). Approximate location of field stop shown with bold number.

Stop 3—Chiwawa River Valley Overlook

Figure 21. Indistinct end moraine (white line) of Plain glaciation. View southeast at Chiwawa River Valley and Entiat. Source: Author, 07/29 2025.

Chiwawa vs. Wenatchee River Glacier. Why didn't the late Pleistocene Plain Chiwawa River Glacier advance nearly as far downvalley as the same-aged Wenatchee River Glacier? It is likely due to drainage basin size and elevations. The drainage basin of the Wenatchee River is much larger than that of the Chiwawa River (268 mi^2 vs. 185 mi^2—Nimick, 1977). I also suspect more overall high elevations are present in the Wenatchee River drainage. Because of this, there should be more glaciers present in the larger, higher Little Wenatchee and White River drainages. Based on recent US Geological Survey topographic maps this is true. If we extrapolate this observation back in time, it makes sense that the Wenatchee River glacier was better fed by ice than was that in the Chiwawa River Valley. In the Chiwawa River valley, glaciers originated in cirques on Chiwawa Ridge, the high peaks at the head of the drainage, and Entiat Ridge.

Icefield Glaciation and Outlet Glaciers. Earlier I attributed most of the glaciation in the area to cirque and valley glaciers. An exception to this cirque origin is an "icefield" that formed in the headwaters of the Mad River in the Entiat Mountains to the northeast of here. A 25 mi^2 icefield above 5000 ft elevation spawned "outlet glaciers" that flowed down Chikamin, Marble, Alder, Elder, and Goose creeks as well as through Maverick Saddle (Figure 23). However, none of these reached and joined the Chiwawa River Glacier (Long, 1987, 1989).

Stop 3—Chiwawa River Valley Overlook

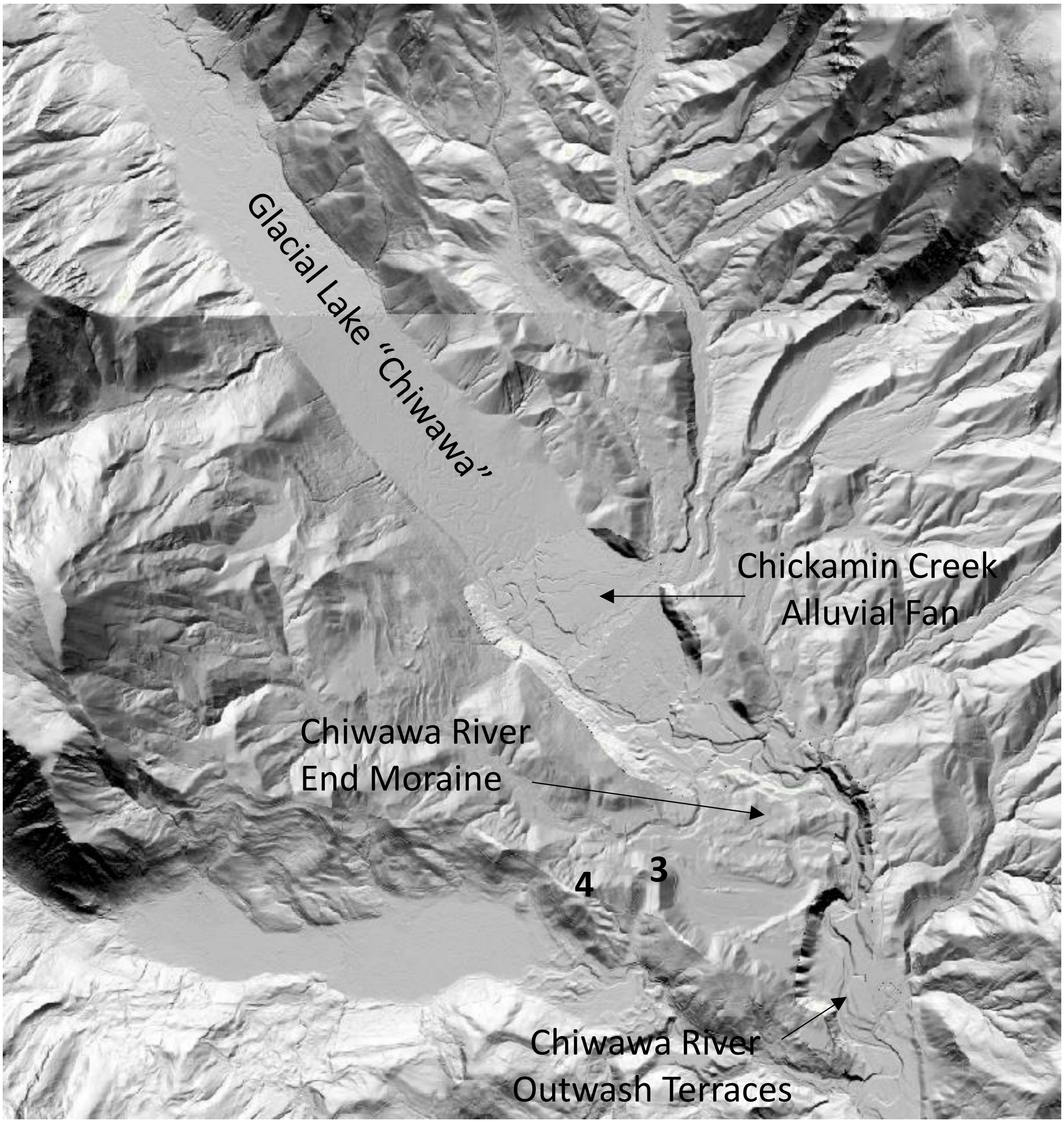

Figure 22. A portion the Chiwawa River floodplain and the Chikamin Creek alluvial fan. Note hummocky nature of the Chiwawa River glacier Plain II end moraine. Also note outwash terraces trailing off the end moraine. Bold numbers indicate approximate locations of stops 3 & 4. Source: Washington Lidar Portal.

Stop 3—Chiwawa River Overlook

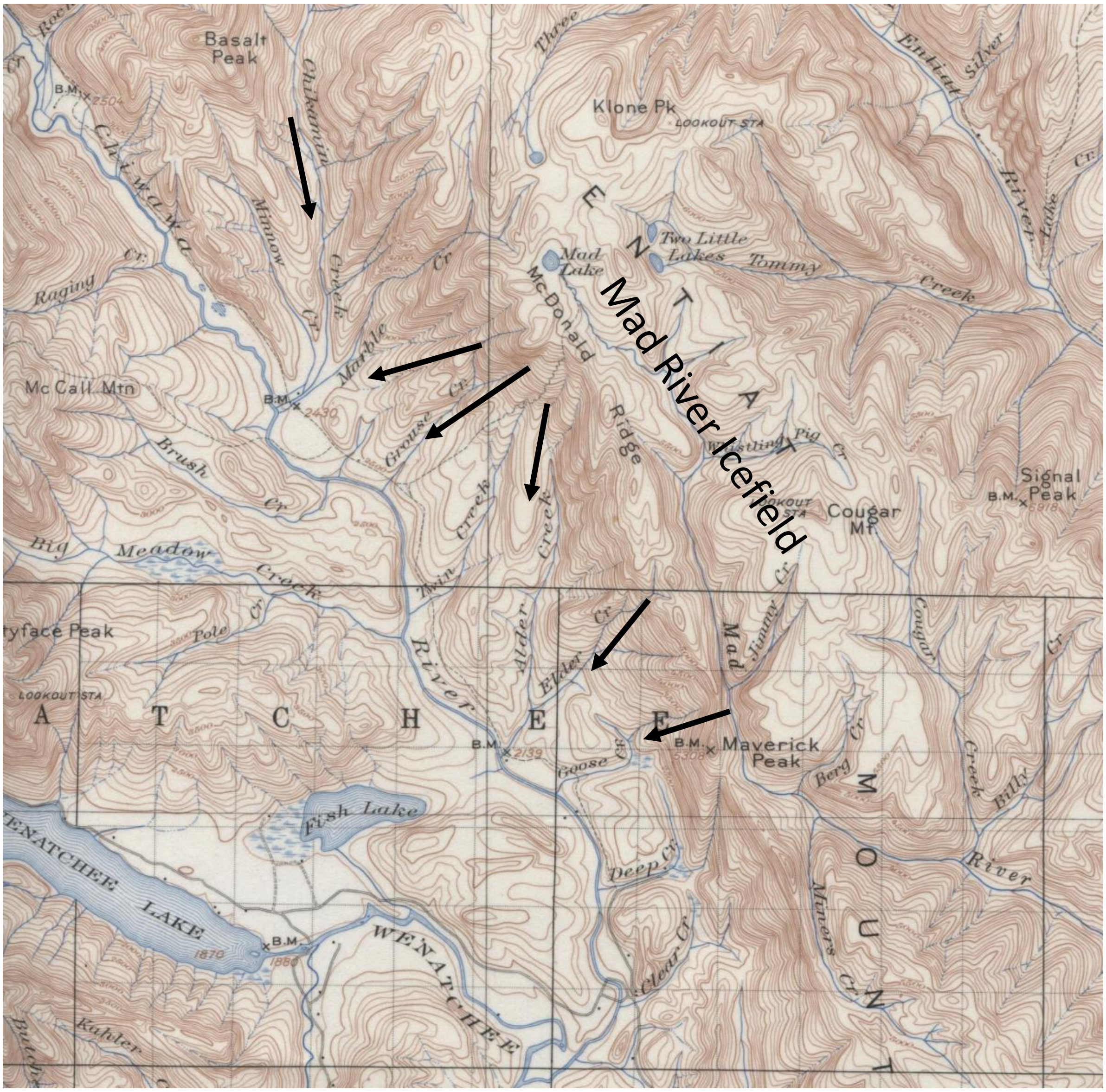

Figure 23. Mad River Icefield and outlet glaciers (heavy arrows). Source: US Geological Survey Chiwaukum, WA 1:125,000 quadrangle (1901).

Outwash Plains & Terraces. "Outwash plains" are deposited by glacial meltwater at the ends of end moraines. These plains consist of relatively clean sand and gravel. Therefore, in glaciated terrain, one can often see gravel quarries on outwash deposits. Outwash plains may extend for miles downvalley. Subsequent post-glacial runoff often incises the outwash forming "outwash terraces". Note the terraces immediately downstream of the Plain II end moraine in the Chiwawa River Valley (Figure 22). This outwash has been mapped as far downvalley as the town of Plain (Nimick, 1977).

Stop 3—Chiwawa River Valley Overlook

Historical and present-day glaciers. From here we can see the south faces of Buck Mountain (8573 ft) (left) and Fortress Mountain (8674 ft) (right) (Figure 24) in the upper Chiwawa River drainage. South faces are not ideal places for cirque glaciers to persist; therefore, what we are seeing are "snowfields". Several small glaciers were present on Buck Mountain in the upper Chiwawa River Basin as shown on 1901 (Stehekin) and 1949 (Holden) topographic maps. In a 1971 inventory of North Cascades glaciers, Post & others identified five very small glaciers in the upper Chiwawa River watershed (Figure 25). As of the 20 September 2023 Google Earth Pro image, only one of the remaining snow and ice patches came close but still did not meet the glacier criteria set out in Post and others (1971) (Figure 26). Given the rising temperatures in this area over the past half century, and the declining April 1st snowpack over the past 40 years (Figures 27 & 28), this should not be a surprise. And given predicted future temperatures, I suspect the small Buck Mountain snow and ice patches will be gone in the coming decades.

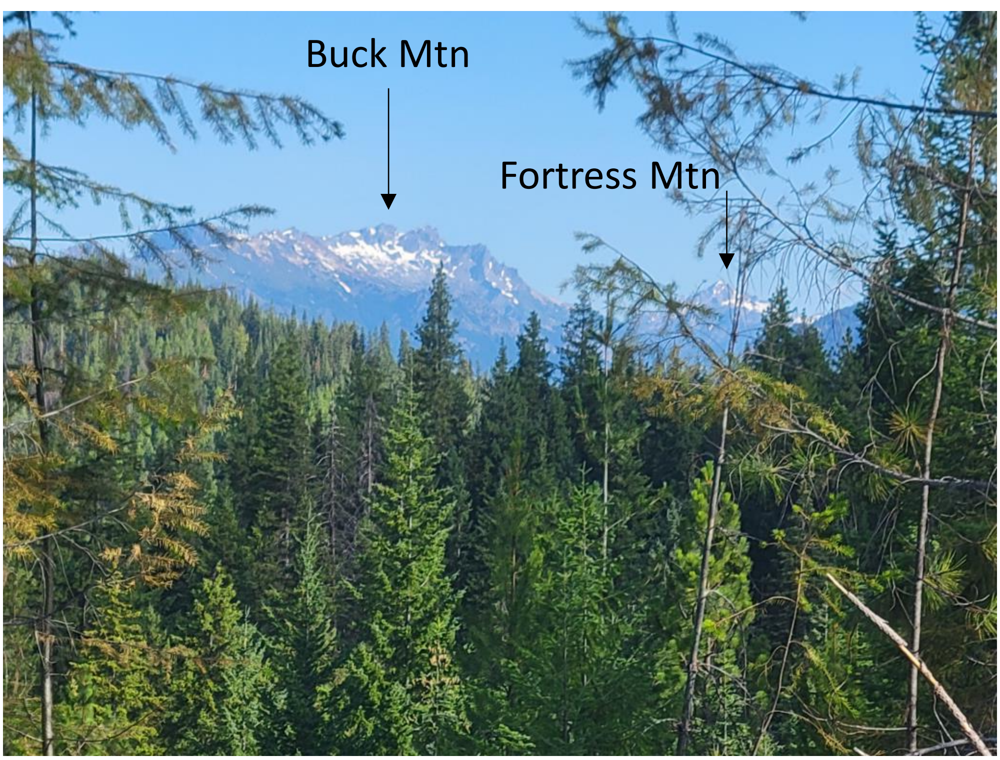

Figure 24. Snowfields on Buck Mountain (left) and Fortress Mountain (right) in the upper Chiwawa River watershed as July 2025. Photo taken from Stop 3. Source: author photo, 15 July 2025.

Stop 3—Chiwawa River Valley Overlook

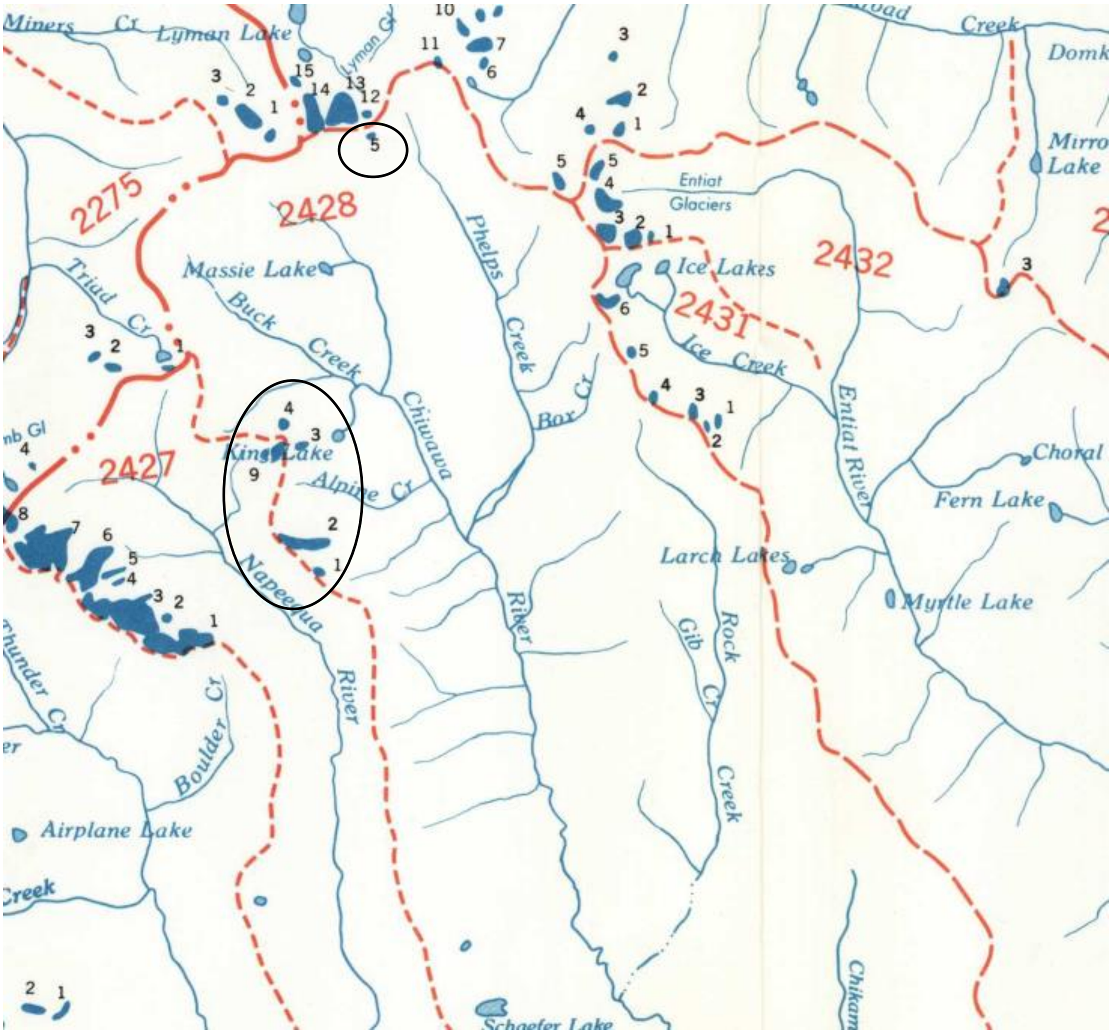

Figure 25. Five mapped, small glaciers (circled) in the upper Chiwawa River watershed as of 1971. Southern circle is centered on Buck Mountain and northern circle is centered on Phelps Ridge just east of Fortress Mountain. Source: a portion of Plate 2 in Post & others (1971).

Enroute to Stop 4

Return to USFS road 6307. Continue north then west on 6307 for approximately 0.7 miles to a wide spot in the road where a logging road joins 6307 on the left (south) (Figure 18). Park here taking care to leave room for vehicles to pass. GPS coordinates: 47.886426°N &120.732475°W. From our parking spot, we will walk up a skidder trail in the newly logged hill to the south. We will meet on the first bench of this hill.

Stop 3—Chiwawa River Valley Overlook

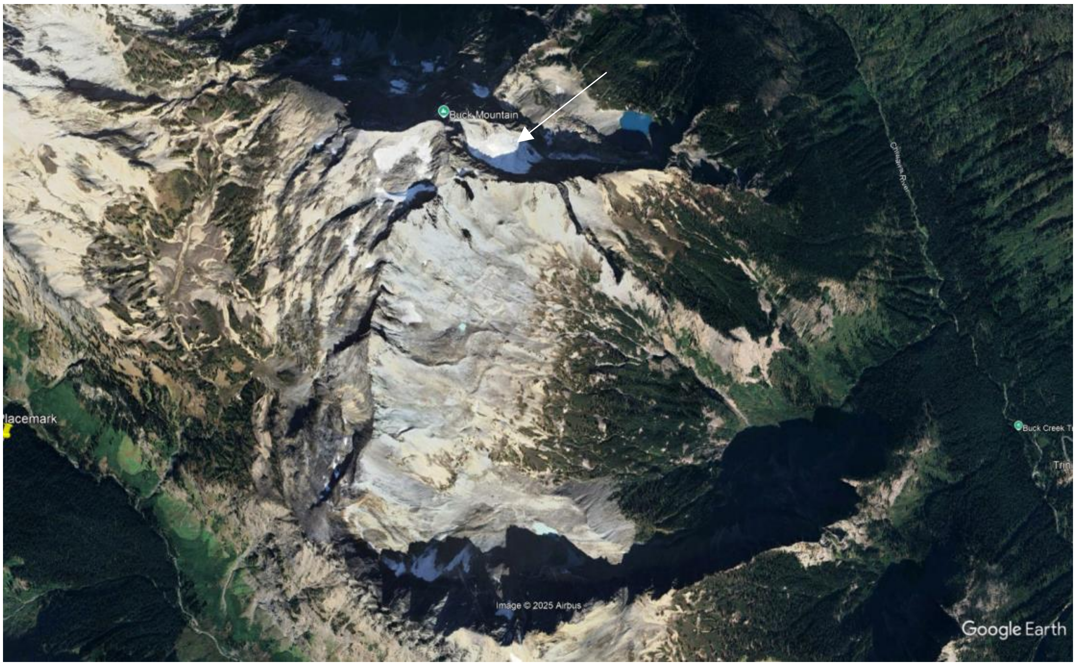

Figure 26. Vertical overhead view of small ice patch (but no longer a glacier) (white arrow) on northeast face of Buck Mountain. Source: Google Earth Pro, 9/20/2023.

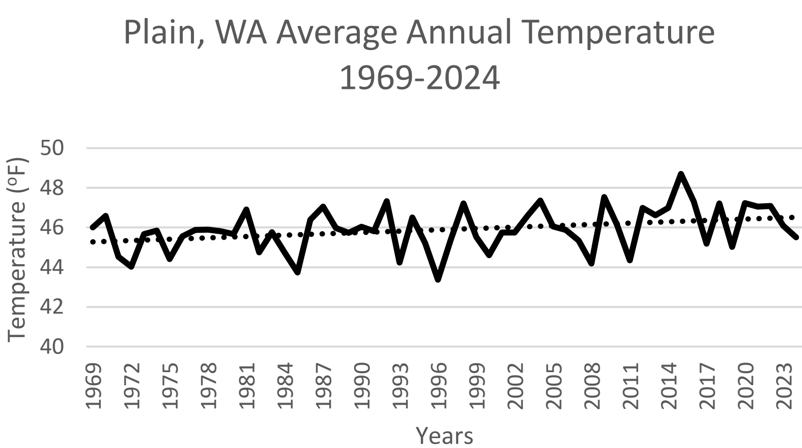

Figure 27. Annual average temperature at Plain, WA since 1969. Note the upward trend during this period (dashed line). Source: Western Regional Climate Center.

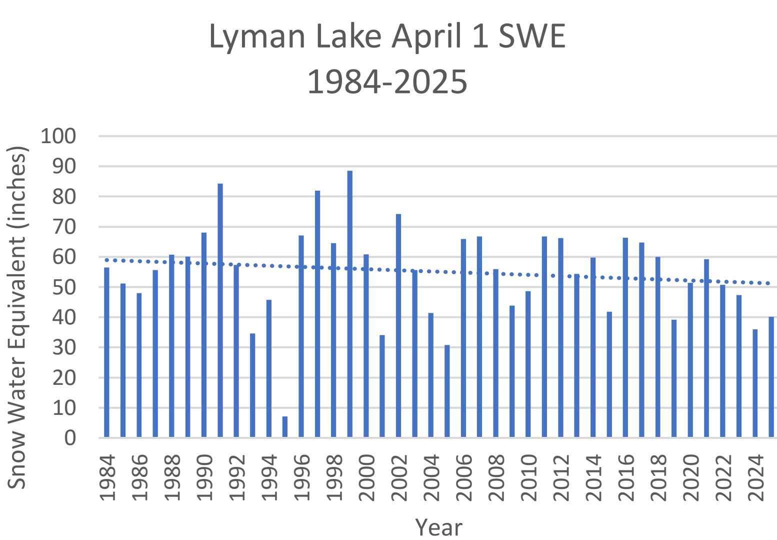

Figure 28. April 1st snow water equivalent at Lyman Lake in the upper Railroad Creek Basin about 23 miles to the north. Source: USDA-NRCS SNOTEL.

Stop 4—Big Meadow Creek Valley Overlook

Location. We are located on a Chumstick Formation hill overlooking lower Big Meadow Creek Valley (Figure 17). Dirtyface Ridge is to the west, Chiwawa Ridge is northwest, and Chiwawa River and the Entiat Mountains are east.

Big Meadow Creek Glacier. As noted above, alpine glaciers often form and occupy cirques. In the northern hemisphere mid-latitudes, cirques are most commonly oriented to the north where they receive the least amount of snow-melting sunlight. A glacier that forms in a cirque may grow beyond the cirque to spill downslope to form a valley glacier. In places, these side valley glaciers may join main valley glaciers.

As we look west, Big Meadow Creek has the broad U-shaped valley characteristic of alpine glaciated terrain (Figures 29 & 30). If we look upslope on Dirtyface Mountain, we can see several of the six large, amphitheater-shaped cirques that formed the cirque glaciers that fed a valley glacier (Figure 29). These cirques all face northeast. When measured from the headwaters of Big Meadow Creek, the valley glacier was less than five miles long ending in the lower end of the Big Meadow Creek Valley where one can see hummocky topography (Figure 30) characteristic of end moraine. Based on the very level topography upvalley of the hummocky terrain, I suspect that a lake formed behind this moraine as the glacier receded. An examination of Web Soil Survey soils data reveals that the basin floor is composed of loamy fine sand and very fine sandy loam to a depth of at least 60”. Such uniformly fine sediments characterize old lake floors.

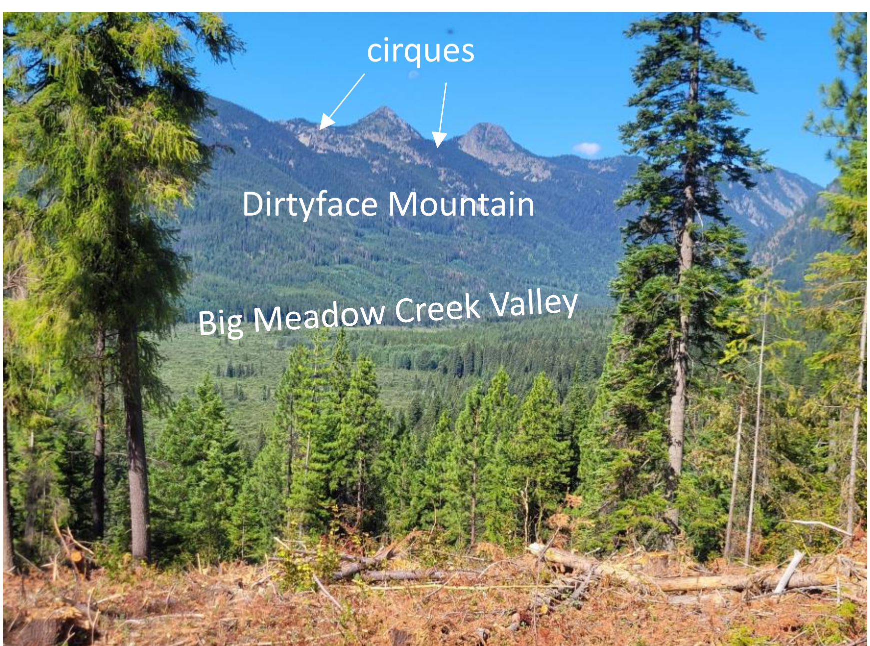

Figure 29. Lower Big Meadow Creek Valley and northeast face of Dirtyface Mountain. Note the cirques that formed cirque glaciers that joined the valley glacier. Also note the broad, level floor of the Big Meadow Creek Valley that likely once held a large, moraine-dammed lake. Source: author photo, 15 July 2025.

Stop 4—Big Meadow Creek Valley Overlook

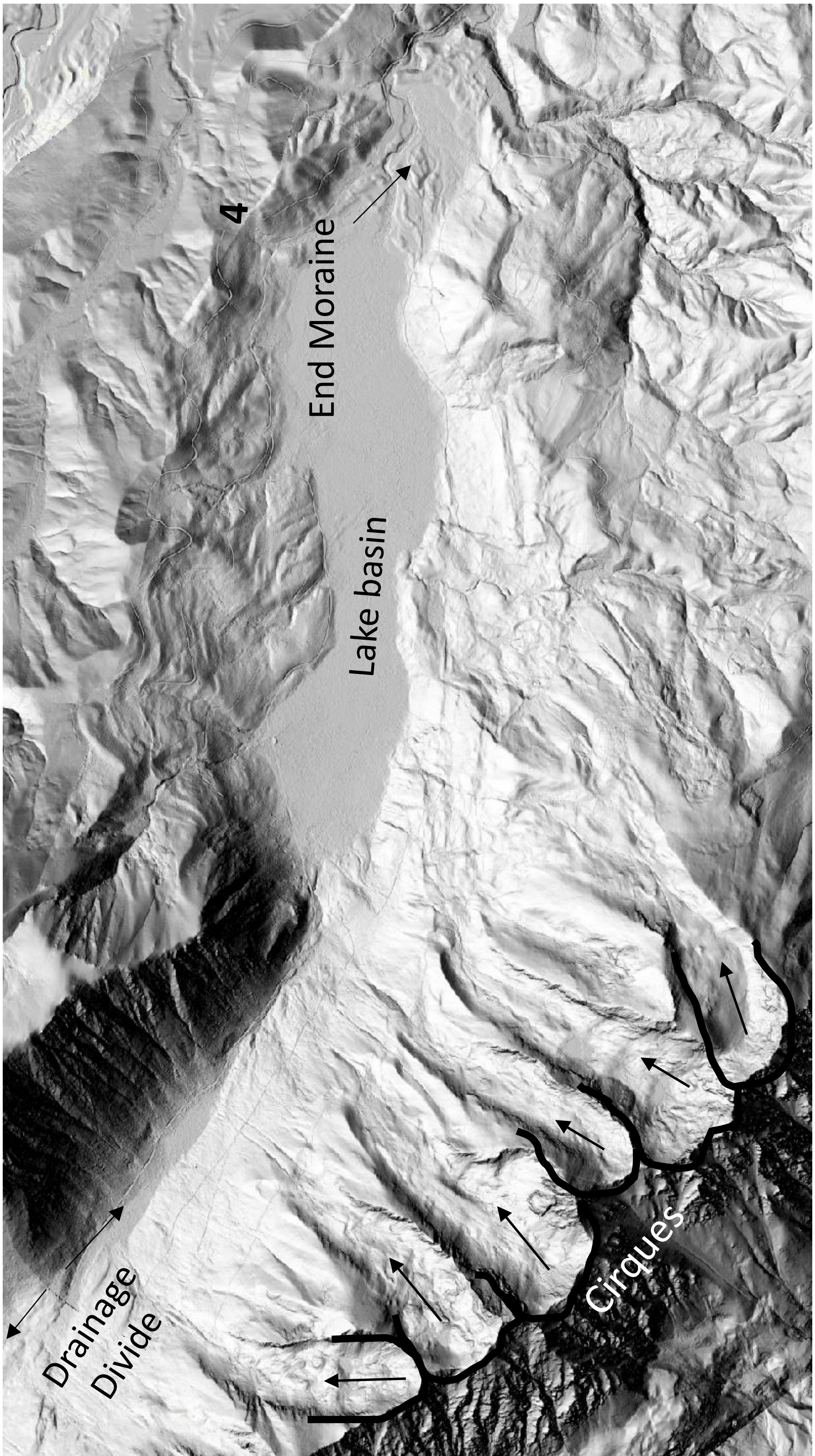

Figure 30. Northeast-facing cirques (arrows) on Dirtyface Mountain that fed the Big Meadow Creek glacier. Note hummocky end moraine topography and level topography characteristic of a former lake. Also note the mid-valley drainage divide. Bold number indicates approximate location of Stop 4. Source: Washington Lidar Portal.

Stop 4—Big Meadow Creek Valley Overlook

Big Meadow Creek Valley Oddities. Big Meadow Creek Valley has several odd topographic characteristics. First, it has a drainage divide in the middle of the valley (Figure 30). The streams coming from the Dirtyface Mountain cirques drain into Big Meadow Creek. However, the streams just north of that drain into the Twin Lakes drainage (Figure 31). The pass between the two drainages if very subtle with less than 40 feet of relief separating them. Lots of streams feed into the Twin Lakes basin from the northern portion of Dirtyface Mountain and Chiwawa Ridge. However, only one possible cirque fed into this basin during the late Pleistocene. So…perhaps the presence of cirques in the Big Meadow Creek basin helped create the low drainage divide here by increasing erosion in the southeastern portion of this valley. Second, the continuous nature of the Big Meadow Creek Valley with the Napeequa Valley (Figure 31) suggests that the Napeequa Glacier once flowed down what is now Big Meadow Creek Valley (Long, 1987). The Napeequa Valley was extensively glaciated as indicated by the numerous cirques (I count ~15 northeast-facing features). This ample Pleistocene glaciation is supported by existing glaciers in the surrounding mountains. The resulting valley glacier flowed to the southeast. However, just northwest of Twin Lakes, the Napeequa River has eroded through the ridge separating the Napeequa from the White River. We call this a “stream capture”—i.e., the White River has captured the Napeequa River. This capture led to the mountains north of this channel being called the White Mountains and the mountains to the south being Dirtyface Mountain. Why did the Napeequa erode through this ridge? Was it due to pre-existing weakness in the rocks? Did the channel occur due to headward erosion by a White River tributary? Did a landslide cause the capture? Stay tuned!

Enroute to Stop 5

Retrace our route to USFS 6300. Follow this back to USFS 62. From USFS road 6300, turn left onto paved USFS road 62 and drive east over the Chiwawa River. Just after crossing the Chiwawa, you will come to the junction of USFS road 62 and USFS 6100. Turn right onto gravel USFS 6100 and head east, then south for about 2.5 mi. Turn left onto gravel USFS 6101 and drive about 0.7 miles to Morrow Meadow in the Deep Creek Valley. Park alongside the roads at the junction of USFS 6101 and USFS 6102 taking care to leave room for automobiles to pass. GPS coordinates: 47.824071°N & 120.622685°W (Figure 32). We will walk a short distance to the middle of the valley on USFS 6101.

Stop 4—Big Meadow Creek Valley Overlook

Figure 31. Drainage oddities in the Napeequa/Twin Lakes/Big Meadow Creek valleys. Note drainage divide separating Twin Lakes and Big Meadow Creek basins (white arrows). Also note possible pathway of former Napeequa River (dotted arrow) into Twin Lakes basin vs. current path (solid arrow) into White River basin. Source: Washington Lidar Portal.

Stop 5—Deep Creek Valley

Location. We are located in Deep Creek Valley about a mile east of the Chiwawa River Valley (Figures 32 & 33).

Geology. The geology of the area consists of metamorphic rocks of the Mad River Terrane. This unit includes schists, quartzite, amphibolite, marble, and gneiss. The amount of sand here suggests that we are also on the edge of the younger sedimentary Chumstick Formation. The northwest-trending Entiat Fault zone parallels and includes this valley (Tabor & others, 1987) (Figure 34).

Chiwawa River Paralleling Valleys. As seen at Stop 4, odd valley patterns are seen in the topographic maps, Google Earth, and lidar imagery of the area. At this site, we see another example of such odd valley patterns. The lower eastern portion of the Chiwawa River Valley is paralleled by a linear valley that is interrupted by series of small perpendicular streams (i.e., Clear, Deep, Goose, Alder, and Minnow creeks) that are tributaries to the Chiwawa (Figures 32 & 35). Upriver, Raging and Brush creek valleys lie west of, and parallel to, the Chiwawa River Valley. Each of these valley segments has a low gradient, Chiwawa River-parallel portion that ranges from 1.2 to 1.8 miles long and up to 0.25 mi wide then eventually bends sharply to flow downslope into the Chiwawa River.

Possible Causes of Parallel Valleys. The inferred path of the Entiat Fault passes through the Chiwawa River-parallel Deep-Clear-Alder creek valley (Laravie, 1976; Tabor & others, 1987) (Figure 34). Fractured rock associated with the Entiat Fault zone could have facilitated removal by glaciation (Laravie, 1976).

Could glacial meltwater have also played a role? The proximity of the valleys to the glaciated Chiwawa River Valley leads to a “lateral channel” interpretation. Such channels may form at the margins, beneath, or within the glacial ice. Such channels form from glacial meltwater or streams draining adjacent uplands (Sugden & John, 1976; Benn & Evans, 1998). Glacial ice may form one of the valley walls therefore preventing the water from immediately reaching the valley floor. Such valleys may form because of conditions that favor rapid erosion including sudden releases of floodwaters from a glacier as a result of high precipitation events on low permeability glacier surfaces or sudden release of meltwater from ice dammed lakes as “jokulhlaups”. Combined with the scant vegetation of ice marginal environments and steep slopes, this is a recipe for rapid erosion (Sugden & John, 1976).

Stop 5—Deep Creek Valley

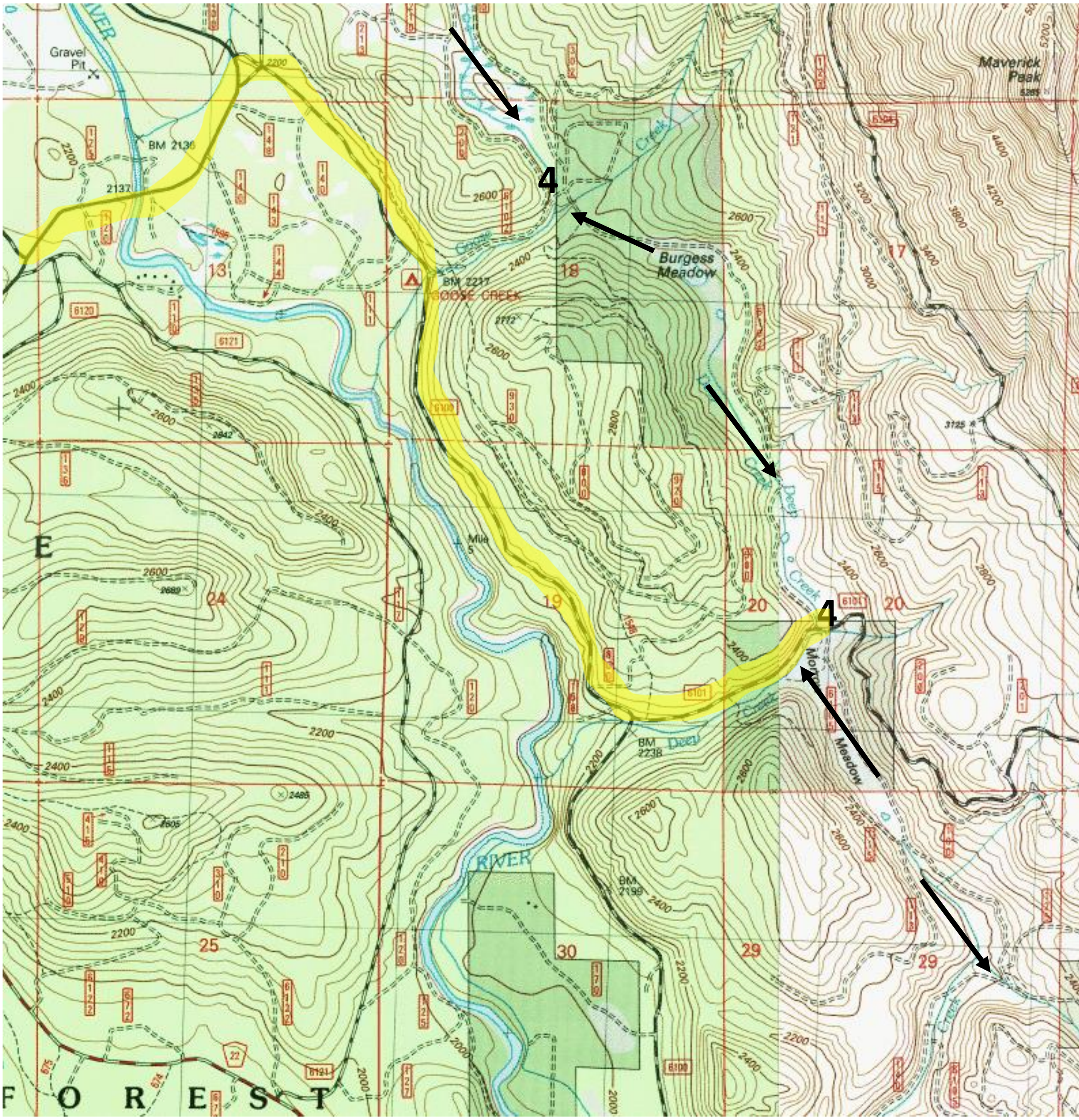

Figure 32. "Lateral channels" (arrows) paralleling the lower Chiwawa River Valley. Approximate location of Stop 4 shown with bold number. Note highlighted portion of route from junction of USFS 6300 and USFS 62. Source: Caltopo.com.

Stop 5—Deep Creek Valley

Figure 33. Deep Creek Valley, a possible lateral channel for Chiwawa River Glacier meltwater. View upvalley (to the north). Source: author photo, 14 July 2025.

Possible Causes of Parallel Valleys (cont)…While they are typically associated with retreating or stagnating ice, lateral channels may also be associated with advancing ice when a glacier diverts a large river or stream (Benn & Evans, 1998). Long (1987) speculates that the lateral channels in this area transported Chiwawa Glacier and Mad River icefield meltwater (Figure 23) when the valley floor was blocked by the Chiwawa Glacier.

Stop 5—Deep Creek Valley

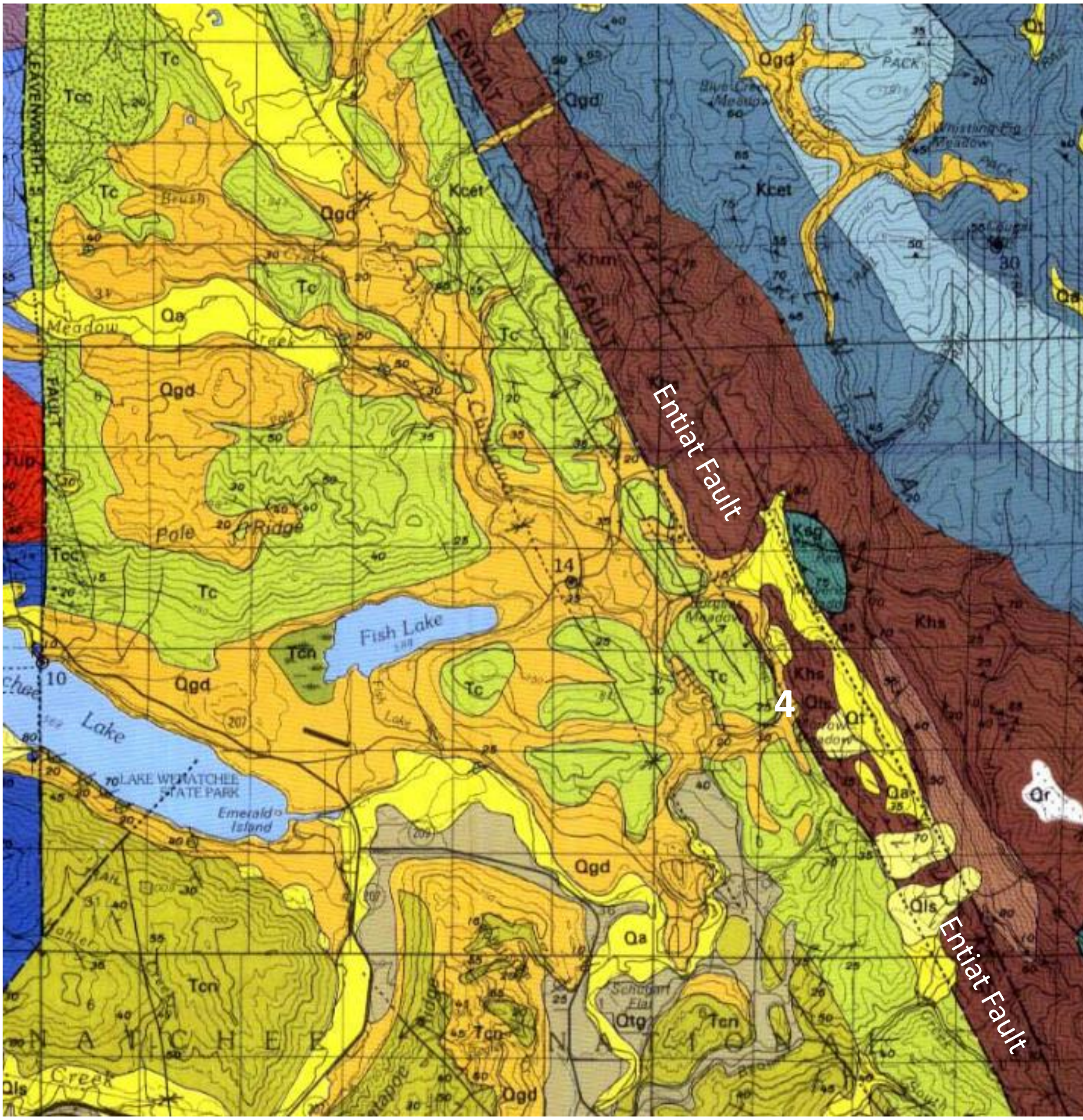

Figure 34. Deep Creek near Morrow Meadow as a Chiwawa River paralleling valley. Note the presence of part of the Entiat Fault running through the valley in which Morrow Meadow is located. Bold number indicates approximate location of Stop 4. Source: Tabor & others (1987).

Stop 5—Deep Creek Valley

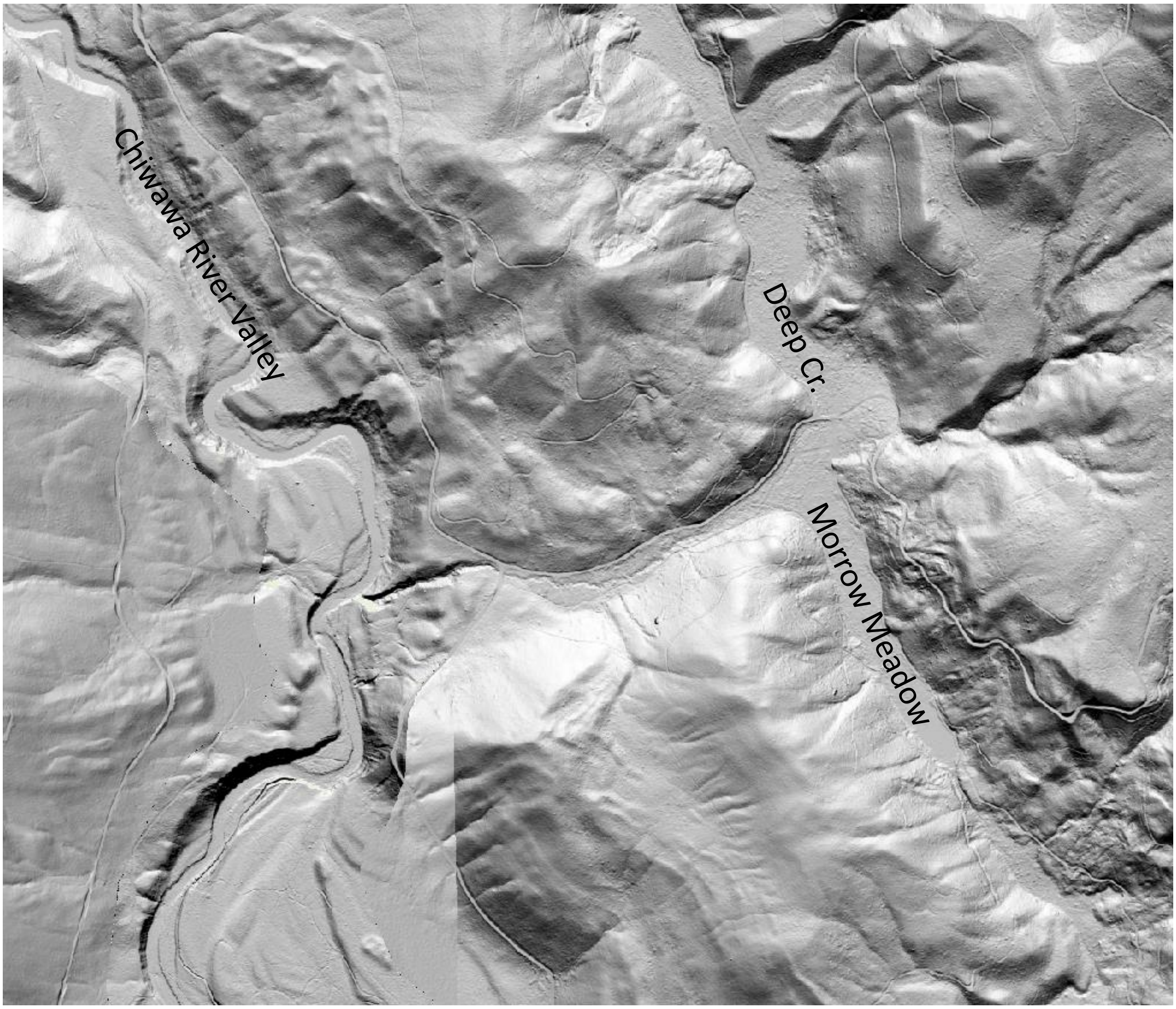

Figure 35. Chiwawa River-paralleling channel just south of USFS 62 bridge over Chiwawa River. Source: Washington Lidar Portal.

Possible Lakes in Lateral Valleys. The Chiwawa River glacier would have blocked the tributary valleys leading to the formation of small lakes in those valleys. Such lakes would result in sedimentation in the valleys therefore levelling the valley floors. Such sediments should have been fine textured. For example, Web Soil Survey shows silt loams, sandy loams, and sands on the valley floor of Deep Creek and adjacent Morrow Meadow. Further, the smooth appearance of topography on the floor of the parallel valley (Figure 36) suggests a former lake basin.

Wrapping Up

Today, we have explored the physical geography and geology of the lower Lake Wenatchee Lake area with an emphasis on the glacial history here. We have seen evidence of glaciation associated with two lobes of Wenatchee River ice, the Chiwawa River glacier, the Big Meadow Creek/Napeequa River glacier, and outlet glaciers from an icefield in the Entiat Mountains. All ultimately shaped the upper Wenatchee River watershed through the direct action of glacial ice and associated meltwater. Each had different impacts on the landscape depending on differences in underlying substrate. And now, we are seeing the real-time impacts of warming temperatures on snowpack and the few remaining glaciers in the watershed.

Thanks for participating today. And thank you for your support of the Ellensburg chapter of the Ice Age Floods Institute. These trips don't happen without your continued interest and support. Feel free to contact me at lillquis@cwu.edu or (509) 963 1184 if you have further questions/comments. I hope to see you on the next trip!

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