Threemile Creek Restoration Opportunities

Klawock Lake Watershed

October 2019

For:

Klawock Sockeye Salmon Stakeholder Group

By:

Southeast Alaska Watershed Coalition: John Hudson, Rob Cadmus, and Rebecca Bellmore
and
The Nature Conservancy: Conor Reynolds.

Summary of Recommendations:

- Replace the Klawock-Hollis Highway culverts with a bridge, as these culverts are a fish passage barrier. This action should be coupled with actions to reduce flooding risk for nearby homeowners.
- Reactivate as much of the historic alluvial fan as possible by breaching Road 5028000 in numerous locations and removing the small manmade dike on the southernmost stream channel within the currently active portion of the alluvial fan. Reactivating this southernmost channel (located just north of the Klawock Lake Subdivision, 150m downstream of the Klawock-Hollis Highway, river left) should be coupled with replacing the Klawock-Hollis Highway culverts and actions to reduce flooding risk for nearby homeowners.
- We do not suggest in-stream restoration of Threemile Creek via large wood placement upstream of the Klawock-Hollis Highway at this time. Access to the area is logistically challenging, there are existing large trees in the riparian zone that could eventually fall into the stream, and a sediment slug may be moving downstream potentially affecting vertical and horizontal channel stability. Moreover, fish habitat in Threemile Creek, both above and below the Klawock-Hollis Highway crossing, generally appears to be in good condition.
- Immediately downstream of the Klawock-Hollis Highway, illegal removal of instream large woody debris has caused channel incision, resulting in downstream sediment aggradation, tree death, and channel evulsion. This issue should be addressed. Any instream restoration work in this reach should be coupled with addressing the undersized Klawock-Hollis Highway culverts, reactivating the floodplain where possible, and addressing flooding risk for nearby landowners.
- In channels lower in the alluvial fan, because the density of key pieces of wood generally appears to be adequate (although variable from reach to reach), and because the channels are likely actively responding to sediment deposition and lateral confinement following construction of the highway and neighborhood, we do not suggest in-stream wood placement. However, because many of the key pieces of wood appear to be old and are decaying, and the rate of

large wood recruitment from the riparian zone is not expected to balance decay, we recommend assessing whether actions can be taken to promote accelerated growth of conifers in the riparian zone and monitoring the density and condition of key pieces of wood periodically through the coming decades.

- We do not suggest any riparian silvicultural treatments in the near-term upstream of the Klawock-Hollis Highway, as an unharvested buffer that could serve as a source of future large woody debris is relatively intact along the stream. The new-growth forest adjacent to the buffer was thinned in 2010. However, downstream of the crossing, a small-scale riparian treatment is advised in a 23.6-acre stand adjacent to the alluvial fan, with the goal of maintaining or increasing growth rates of young growth in the riparian zone, improving riparian and upland wildlife habitat by increasing understory forage abundance, and providing wood to build instream structures to improve aquatic habitat. The latter goals will be achieved by thinning to increase light available to understory forage plant species.
- Conduct hand-tool scale instream restoration on a small tributary to lower Threemile Creek. The goal of the project is to restore natural channel functions and fish habitat altered by past logging activity. The stream provides habitat for coastal cutthroat trout, Dolly Varden char, coho and sockeye salmon.
- Beaver management is a low priority for restoration of sockeye salmon, and we do not recommend active management of beaver populations (*See Appendix 1*).

Introduction:

Sockeye salmon from Klawock Lake have been important to the livelihood and culture of the people of Klawock, Craig, and Prince of Wales Island for millennia. It is evident that abundance over the last two decades is significantly less than historical values, and this has been a concern of local residents for some time. Because of these declines, there have been numerous actions in the last two decades to attempt to address declines. In 2016, The Nature Conservancy (TNC) released the Klawock Lake Retrospective Analysis (*linked here*), a compilation of the information regarding the many research, management, assessment, and watershed restoration projects that concern Klawock Lake sockeye salmon. In 2017, TNC partnered with the Klawock Cooperative Association (KCA), the Southeast Alaska Fish Habitat Partnership, and many others to host the Klawock Lake Sockeye Salmon Stakeholders Meeting, a forum that allowed resource professionals and community members to interact and exchange information and concerns about the current status of sockeye salmon in this watershed.

At the November 2017 Klawock Lake Sockeye Salmon Stakeholder's meeting, a Habitat Sub-committee was created. This subcommittee made recommendations to determine if restoration of instream spawning and rearing habitat for sockeye salmon is necessary in the Klawock Lake watershed, with a focus on the Threemile Creek drainage. Recommendations from the sub-committee included:

- Review past restoration projects conducted in the Threemile Creek sub-watershed and determine effectiveness.
- Determine if the Klawock-Hollis Highway culverts should be replaced.
- Determine if instream habitat restoration or other restoration opportunities would be beneficial to sockeye salmon.

As part of the Habitat Subcommittee, the Southeast Alaska Watershed Coalition (SAWC) and TNC, along with assistance from the KCA, US Forest Service, and others, conducted a desktop and field review of the Threemile Creek sub-watershed. The Threemile Creek sub-watershed is focused on here because this stream has been heavily impacted and was historically one of the most important spawning streams in the Klawock Lake Watershed. Our findings and recommendations are included here.

Review of Past Restoration Projects in the Threemile Creek Watershed

The US Forest Service and Central Council Tlingit and Haida Indian Tribes of Alaska conducted a watershed assessment in 2002 and The Klawock Watershed Council commissioned a Klawock Watershed Restoration Master Plan (Keta Engineering 2003), which was subsequently updated (Williams 2008). These documents made recommendations for restoration in the Threemile Creek Watershed. An exhaustive report documenting when and how these restoration projects were implemented was not produced, but the 2008 document noted that all proposed road closures had been carried out in the Threemile watershed and that landslides were seeded in 2005 and 2008. To review the success of these restoration projects SAWC and TNC conducted a partial assessment of the effectiveness of road closures, road erosion control, culvert removal projects, and landslide control measures.

Culvert removal, erosion control, and road closures: The Klawock Watershed Restoration Master Plan made numerous recommendations to upgrade or remove culverts and bridges and close roads in the Threemile Creek Watershed (See Figs. 3 and 4 in the Klawock Watershed Restoration Master Plan). These projects were meant to allow fish passage, enhance hydrologic conductivity of the alluvial fan, and reduce erosion. We surveyed roads to assess if these projects were completed successfully, including:

- Road 5015000 (mile 0 to approximately 1.5); the road east of the Threemile mainstem, north of the Klawock-Hollis Highway that parallels the creek;
- Road 5032000 (mile 0 to approximately mile 2); the road west of the Threemile mainstem, north of the Klawock-Hollis Highway that parallels the creek;
- Road 5028000, 5030000, 5031000, 5031600, and 5026000; the roads in the alluvial fan south of the Klawock-Hollis Highway.

Aside from road 5026000 (Threemile Subdivision Road), we found that the roads had been successfully closed in-line with State Forest Practices Act standards. All culverts had been removed, and most roads are beginning to be overgrown with vegetation. At some sites where culverts had been removed, the grade from the old roadbed to the waterbody was steep, causing some limited erosion. We would generally recommend pulling the roadbed back further to produce a grade that is less erodible, but given the fact that roads are now closed, it is not practical or cost effective to intervene.

Road 5028000 parallels the north side of the Threemile mainstem south of the Klawock-Hollis highway crossing and has been breached in several locations, including one area where a side channel is passing through the roadbed (Fig. 1). FS Hydrologists Keegan Krantz and Helen Sladek and a SAWC Biologist visited this site during high flows in November of 2018, and this side channel was actively flowing. Despite the four existing breaches in this road, the roadbed is containing flow in several areas, including one location, marked on Figure 1 in yellow, which had ponded water. Additional breaches or full excavation of this road would allow the stream to access a larger portion of the alluvial fan in the future, partially compensating for the inaccessibility of the south portion of the fan due to the presence of the subdivision.

Full excavation of this road would require building temporary stream crossings and backhauling the material to a waste dump. For this reason, we suggest adding 6-8 breaches west of the active breach mentioned above. Waste material would be spread onto the remaining road bed, so backhauling would not be necessary. The excavator would lessen the grade of the existing road breaches and ford the breaches. Puncheon material could be used if the ground is soft, but the construction of temporary stream crossings would not be necessary. Figure 2 (A&B) shows a photo and the design plan of a typical road breach. This breach was placed along an abandoned logging road in the Pat Creek alluvial fan near Wrangell to reconnect floodplain and allow natural channel migrations. We suggest that breach locations be chosen at the time of construction based of wetland vegetation, the presence of water or historic channels, or at regular intervals. All roadbed material would be removed at breaches to an elevation equal to or slightly below the surrounding grade. We estimate that this would be about 16-24 hours of work for a mid-sized excavator (Estimated at $250 per hour plus mobilization costs). We estimate this action should cost around $10,000-$15,000. An ADF&G Fish Habitat Permit would be necessary. Aside from cost, the major negative consequence of this action is that all re-growth along the road would be removed (*See Figure 2 (c) for an example from Pat Creek*).

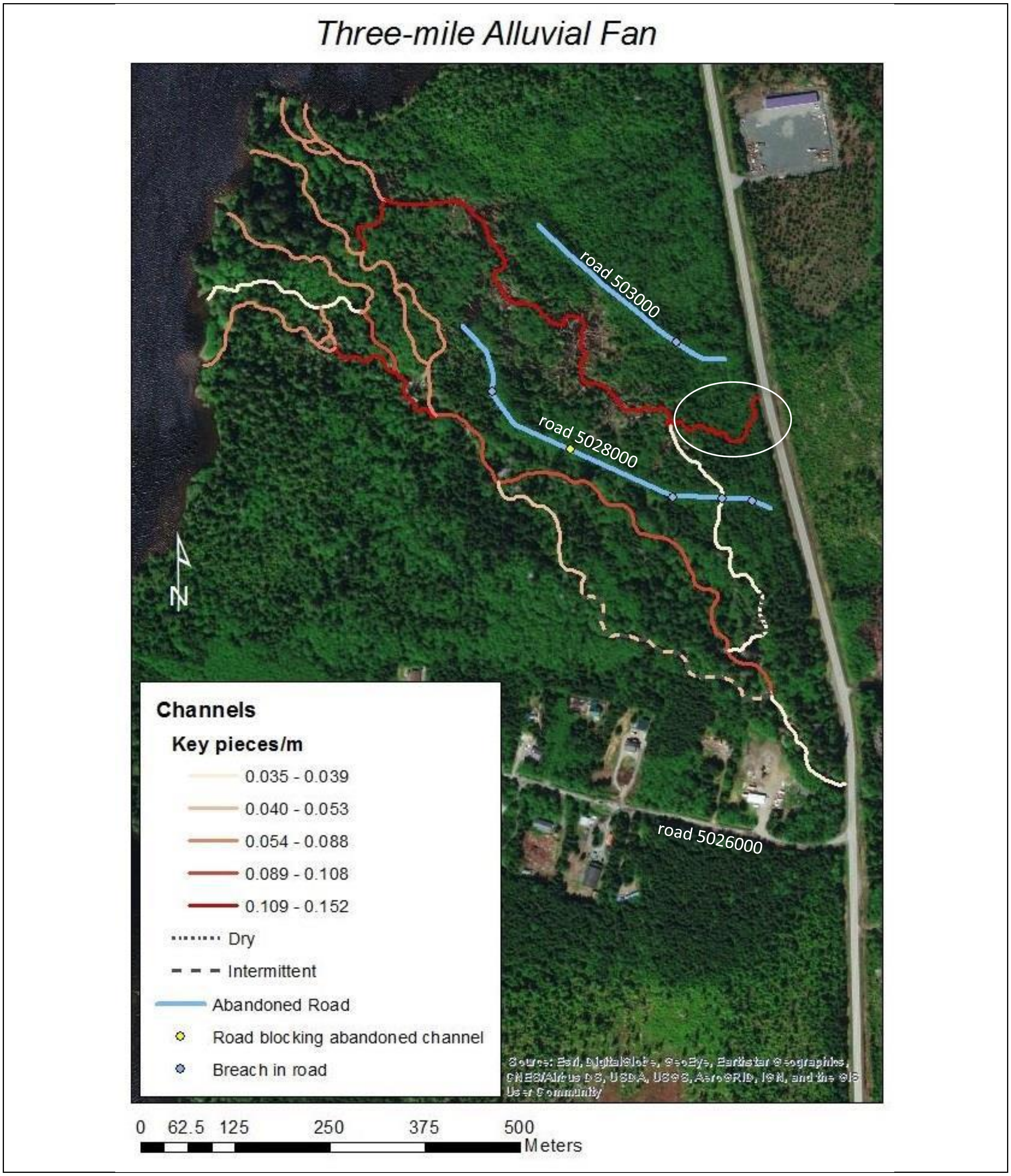
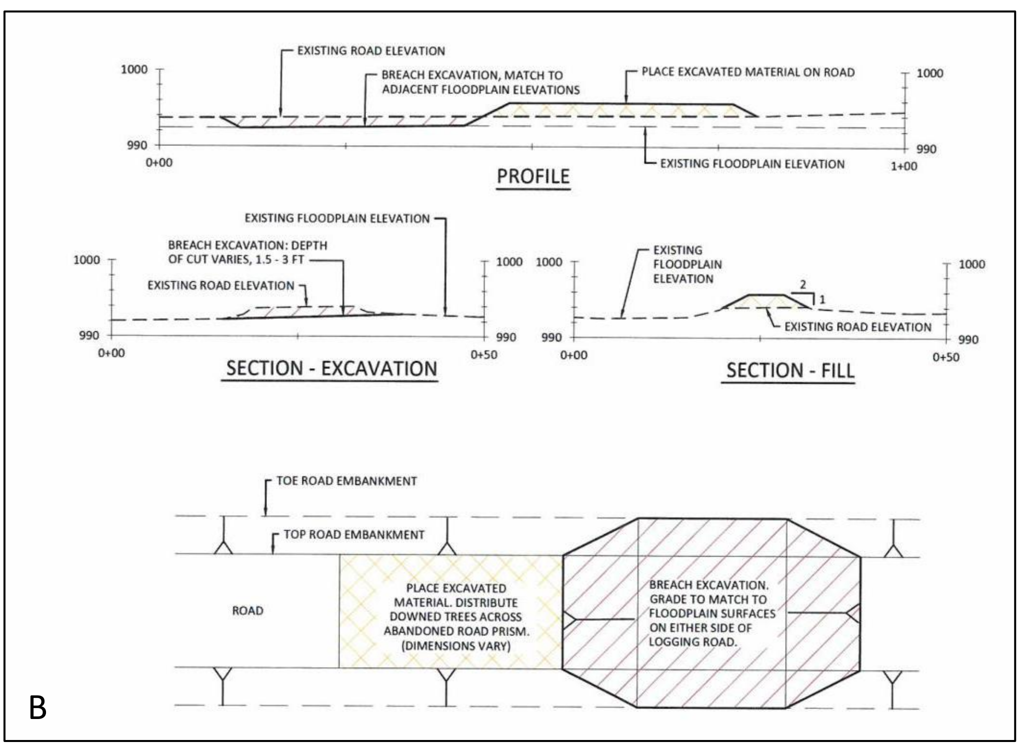


Figure 1. Active channels in the alluvial fan, density of key pieces of wood in different reaches, and abandoned (blue lines) and open roads. Note that the small northern tributary (in circle) flows through a culvert under the highway, but was only mapped downstream of the highway.

Figure 2. From the Pat Creek Fish Habitat Enhancement Project. (A) Example of a road breach excavated to the elevation of the surrounding grade on an alluvial fan. (B) Schematic of a typical road breach. (C) A logging road on an alluvial fan after removing alder trees to access breach sites.



Landslide and Erosion Control- Numerous landslides occurred in the Threemile basin post-logging and road construction. A notable storm in 1993 caused several landslides, and debris torrents scoured four small fish bearing streams to bedrock and subsequently deposited large quantities of sediment and debris into Threemile Creek (Figure 3, A). To reduce the risk of landslides, culverts were removed and waterbars were installed along roads subject to landslides. Broadcast seeding was done in at least three slide areas in 2005 and 2008 to attempt to stabilize slides.

During field surveys in August of 2018 and September 2019, several old and active landslides were visible from the Klawock-Hollis Highway and other vantage points in the watershed. Landslides associated with the 5032510 and 5032500 roads were visited. We found that all culverts had been removed from these roads, waterbars had been installed, and we saw no evidence of water flowing parallel to the road bed. There were some areas that had a small amount of ponded water on the roadbed. The road appears to have been built on a steep slope on top of highly erodible sand and small gravel (Figure 3, B). Several exposed sections of clay were also visible (Figure 3, C). Satellite imagery from 2003 and 2019 show that slides initiated directly adjacent to and on the 5035210 and 5032500 roads (Figure 3 D & E). While most older slides have regrown in alder, active debris gullies are still likely contributing some material into tributaries of Threemile Creek (Figures 3, F & G). We also inspected an older slide that crossed road 5025000, and noted that it likely contributed a limited amount of material into the stream. While walking Threemile Creek above the Klawock-Hollis Highway, a large sediment slug was noted approximately 920 meters upstream that may have been from a landslide (Fig. 4).

Logging and roadbuilding appears to have initiated landslides and elevated landslide risk. It is likely that landslide risk has been reduced since logging occurred, but it is unknown if landslide risk is still elevated above pre-logging conditions. Previous and future landslides may contribute additional sediment to the system. While this sediment certainly has an impact on the streams, we suggest naturally allowing the streams to process and work through this material. As the roads are already decommissioned, it is impractical to do any additional larger scale road stabilization work. Also, we are hesitant to suggest additional earthworks that could cause temporary increases in landslide risk, as natural re-vegetation is likely stabilizing some of the old slides. We do suggest continued monitoring of landslides through satellite or aerial imagery, and we suggest that any instream restoration work consider the fact that some landslide deposited material is still likely working its way through the system.

Figure 3. A) Debris torrent in Threemile Creek Watershed from 1993 landslides (*taken from USFS 2002*). B) Sand and gravel underneath the 5032510 and 5032500 roads. C) Clay layer exposed in a slide along the 5032500 Road. E) 2003 satellite imagery showing slides initiating on or near 5032510 and 5032500 Roads. F) 2019 satellite imagery showing active debris gullies with some alder regrowth.

A.


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Figure 4. (A) A large sediment slug in Threemile Creek approximately 920 meters upstream of the Klawock-Hollis highway. It was unclear if the sediment was the result of a landslide. (B) The channel is shifting laterally as it processes the sediment. Here, it has moved into a previously dry area where alders grew.

Klawock-Hollis Highway Crossing of Threemile Creek

We recommend replacing the two culverts at the Klawock-Hollis Highway crossing of Threemile Creek to allow for fish passage (Fig. 5, A). Needham *et al.* (2018) surveyed this double culvert crossing and classified it as "red," because it provides inadequate passage for juvenile fish based on criteria set by Eisenmen and O'Doherty (2014). Further, this crossing is listed as "red" by the Alaska Department of Fish and Game for outfall height and culvert gradient (ADF&G 2017).

A Tier I habitat survey was conducted for approximately 2,000 m upstream of the Klawock-Hollis Highway crossing (Needham *et al.,* 2018). Based on comparisons of established metrics set by Tucker and Caouette (2008), there is at least 2.5 km of habitat for anadromous and resident fish upstream of this culvert (Needham *et al.,* 2018), and our observations during August 2018 confirm this finding and the presence of suitable fish habitat upstream of the culvert.

Immediately downstream of the Klawock-Hollis Highway crossing, bank armoring on river-left and removal of large woody debris has mobilized stored sediment, causing channel incision and decreased habitat complexity (Fig. 5, B). A sediment slug immediately downstream of these operations is likely linked to upstream wood removal and channel incision, resulting in sediment aggradation and associated tree death, as well as channel avulsion on river-right. Further, a side channel on the south side of the mainstem has been blocked by a constructed dike. These activities appear tied to homeowner-initiated flood control efforts in response to the effects of the undersized culverts at the Klawock-Hollis Highway and poor site selection for the Threemile subdivision. The undersized culverts are pointed directly at a homeowner's property, and during high water the flow in these culverts is very high and contributes to flooding risk (Fig. 5). Prior to the construction of the Klawock-Hollis Highway, the main channel of Threemile apparently flowed through this property and the Threemile Subdivision (See historic channel in Fig. 6.)

We recommend that the design for a new stream crossing be coupled with hydrologic and geotechnical analyses to determine if flooding risk for the adjacent landowner can be reduced sufficiently to allow for in-stream habitat restoration of the stream reach immediately downstream of the culvert, including reactivation of the side channel currently diked off.

Past efforts to replace this crossing were stalled because of high costs. The Klawock Cooperative Association has begun it investigate if tribal transportation dollars could help address this issue. We recommend that the Klawock Sockeye Stakeholders' Habitat Subcommittee support this effort as necessary.

Figure 5. (A) Low flow through the double culvert at the Klawock-Hollis Highway crossing August, 2018. (B) Illegal cutting of large woody debris in the channel immediately downstream of the highway. (C) Downstream end of the sediment slug where sediment aggradation has caused channel avulsion and raised the water resulting in tree death.


C

Figure 5. E) Culvert outlets at the Klawock-Hollis Highway during a flood in 2005. F) Flood waters on the property just downstream and to the south of the culverts. Photos courtesy of Mark Minnillo.

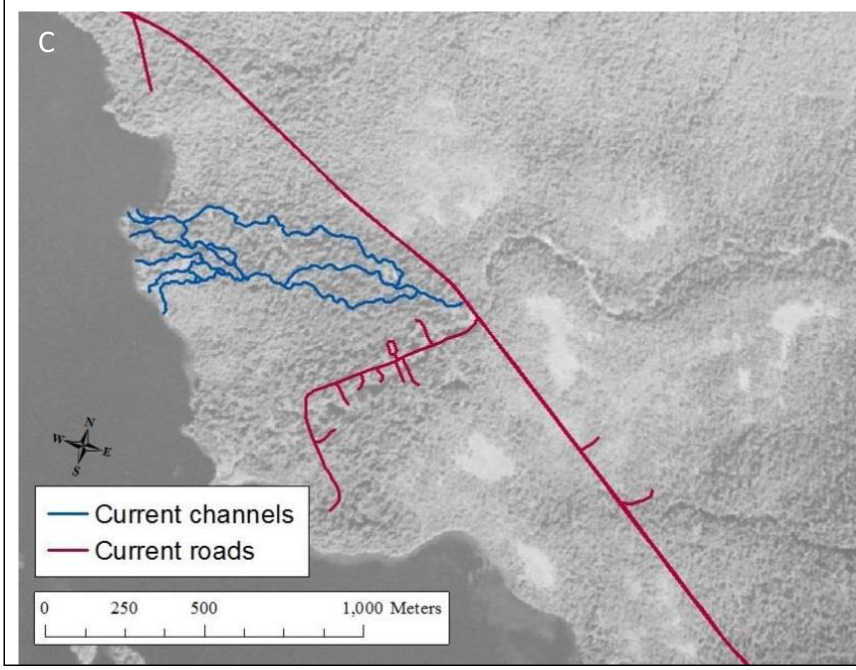

Figure 6. (A) Historic (1940's) and (B) current (2014) imagery of the Threemile alluvial fan. (C) Historical imagery with current channels and roads mapped in blue. Imagery provided by The Nature Conservancy.

Evaluation of In-stream Restoration Opportunity and Need

Large, stable pieces of wood in streams create important habitat diversity by promoting pool formation, channel migration and sediment storage/sorting and providing cover for fish. Various logging practices can alter the amount of wood in streams immediately and for decades to centuries in the future. For example, stream cleaning (removing logs from streams) results in an immediate decline in in-stream wood, while the practice of leaving narrow buffers of trees along stream banks can increase rates of wood recruitment in streams in the decades following logging by making those trees more susceptible to windthrow. Logging large trees in the riparian area that would have eventually fallen into the stream, replacing decaying wood, can result in a decline in key pieces of in-stream wood decades or centuries after logging until new tress have matured and begin falling into the stream.

Previous surveys of Threemile Creek indicated that in-stream restoration in the form of large woody debris placement might be appropriate in a few reaches (Needham *et al.,* 2018). These included a 300 m stream reach just downstream of the highway crossing, 400 m just upstream of the highway, and another 250 m reach about 1500 m upstream of the highway (reaches 1, 2, and 7 in Needham *et al.*, 2018), which all had stream conditions scores of 1.5 or lower due to low large wood and/or pool spacing scores. Stream Condition Scores are based on comparison to metrics in similar reaches in unmanaged watersheds in Southeast Alaska: Fair=1, Good=2, and Excellent=3.

Results upstream of the highway: Along with Forest Service hydrologists, Keegan Krantz and Helen Sladek, and fish biologist, Neal Schoenfelder, SAWC biologists walked Threemile Creek upstream of the highway through the areas that had previously been surveyed, focusing on in-stream wood abundance, distribution and condition, riparian condition, and any factors that might affect the appropriateness or feasibility of in-stream restoration. Except for a few short reaches, habitat in Threemile Creek upstream of the highway appears to be in fairly good condition. The upper reaches that could possibly benefit from large wood placement would be extremely difficult to access because the logging roads along both sides of the stream have been decommissioned and are impassible by vehicles, and because the slope from the road to the channel is very steep. Additionally, the riparian zone does not appear to have been heavily logged and many large standing trees remain, so wood recruitment should continue in the coming decades. The reach just upstream of the highway could possibly benefit from large wood placement, but a large debris dam just upstream of this reach and a sediment slug is located approximately 920 meters upstream of the highway crossing that appears to be working its way downstream (Fig. 2.), and it is possible that any in-stream work may be undermined as the sediment moves downstream and the channel adjusts.

Results downstream of the highway: To better understand existing stream habitat quality and quantity, the SAWC field crew mapped the active channels in the alluvial fan and marked the locations of key pieces of wood (>0.3 m diameter, >7.6 m length) that were within the bankful width (zones 1 and 2 in Tier II) (Fig. 1). The number of key pieces of wood per meter averaged 0.09, and ranged from 0.04 to 0.15 across reaches, with the lowest value observed just downstream of the culvert where large wood is being removed from the stream, and the highest in the northern-most channel, which flowed through very dense young-growth riparian forest (Fig. 1). Because of the variability within and among alluvial fans, no habitat condition scores related to wood have been developed for alluvial fans in southeast Alaska (E. Tucker, personal communication), so there are no “reference” conditions to compare with the data. Of channel types with reference condition statistics, the mainstem in the alluvial fan is most similar to small floodplains, based on channel width and slope. The observed values for key pieces per meter are on the low end of those reported for unmanaged small floodplains (25th percentile is 0.1, median is 0.25 key pieces per meter) (Kelliher 2010). Additionally, most of the key pieces are old and degrading, suggesting that the habitat, with respect to large wood, may be on a downward trajectory. Channel instability in alluvial fans represents an additional risk to any in-stream restoration work. Based on historical aerial imagery, a main channel crossed what is now the highway at a different location than the current culvert and flowed through the area with the housing development (Fig. 5), so the current channels may be carrying more water and sediment than historically and may still be responding to these changes.

We suggest that large woody debris introductions should be considered for the section of the mainstem of Threemile Creek immediately downstream of the Klawock-Hollis Highway culverts to replace the wood that has been removed. This instream restoration is only feasible if the design for a new stream crossing for the Klawock-Hollis Highway is coupled with hydrologic and geotechnical analyses to determine if flooding risk for the adjacent landowner can be reduced sufficiently to allow for in-stream habitat restoration. Further, we recommend assessing the riparian areas to determine whether or not actions can be taken to promote the growth of large conifers (e.g. thinning). Because most of the existing large wood in Threemile Creek is old and degrading, we suggest periodically assessing in-stream wood over the coming decades and revisiting the option of adding wood in the future. Table 1. outlines a basic monitoring protocol to help determine when and if introduction of large wood would be beneficial.

Table 1. Outline of Monitoring Protocol for Large Woody Debris in Threemile Creek Alluvial Fan.

Purpose: To determine when and if introduction of large wood would be beneficial for sockeye salmon habitat in the Threemile Creek alluvial fan.

Timeframe: Initial survey was conducted in 2018. Next survey should occur 2025 or earlier and every 5-10 years thereafter.

Scope of Work: Map active and inactive channels in the Threemile aulluvial fan downstream of the Klawock-Hollis Highway Culvert and compare to channels mapped in Figure 1. This can be done by simply walking all channels with a GPS on "Track."

Mark locations of key pieces of wood (>0.3 m diameter and >7.6 m length) that are within the bankfull width of the stream channels. This can be done while mapping the stream channels by simply creating a GPS Waypoint for every key piece.

Compare tracks and key pieces of wood per meter to previous surveys and the values for unmanaged small floodplain channels outlined by Kelliher, 2010 (*25th percentile is 0.1, median is 0.25 key pieces per meter*).

When to take action? If the average values for key pieces per meter drops below .05, consult with experts on the potential to enhance habitat by adding large woody debris.

Three-mile Creek Tributary Restoration

In August 2018, SAWC staff visited and mapped the lower reach of a tributary to Threemile Creek to look for restoration opportunities (Fig. 1). SAWC staff returned to the site in April 2019 to gather additional information. The second-order stream begins on a hillside north of the Klawock-Hollis highway and passes under the highway through a culvert about 1,600 ft. northwest of the Threemile Creek culverts. Downstream of the culvert, the stream flows about 450 ft. through an old clearcut before entering a distributary channel on the north side of the Threemile Creek alluvial fan/delta. The anadromous stream is used by sockeye and coho salmon, Dolly Varden char, and coastal cutthroat trout. A portion of the channel upstream of the highway is also designated anadromous and arises in both old-growth and new-growth forest. This upstream reach, which was not visited by SAWC, does not appear to be accurately mapped on the ADFG Anadromous Waters Catalog mapper.

Figure 7. An abandoned and failing beaver dam on a tributary to Threemile Creek near the west side of the alluvial fan. Stream flow is from left to right.

Logging and beaver activity have altered the stream channel and riparian zone (Figs. 7 & 8). In the downstream reach, riparian forest is dominated by dense stands of young Sitka spruce; red alder is also present but limited to the streambanks (Fig. 8). With the exception of mosses, most understory plants have died following closure of the new-growth forest canopy.

Figure 8. A section of formerly ponded channel about 70 feet downstream of the highway. View looking upstream.

The beaver dam, which is located about 200 feet downstream of the highway, is abandoned and has partially failed. Before the dam failed, sediments trapped behind the dam had completely filled the channel and portions of the floodplain. Following dam failure, the stream has begun to process and route the sediment downstream. Stream flow is alternately incising through this bedload in some areas and depositing sediment in other areas. Aggrading areas have become over-widened and often contain mid-channel bars; frequent lateral channel shifts in aggrading reaches are eroding stream banks and exposing tree roots (Fig. 8). The abundance of large woody debris in the active channel appears to be low for a channel of this size. Downstream of the dam the channel generally has a normal appearance.

Instream and riparian restoration are recommended for this stream, both downstream and, if warranted, upstream of the highway. The goal of a restoration project would be to improve fish habitat quality and quantity and enhance plant species and structural diversity in the riparian zone, including promoting conifer growth. Large pieces of wood sourced from riparian spruce trees can be placed in the channel using hand tools (i.e. shovels, picks, winches). The large-wood structures will be located at specific sites to route excess sediment accumulations through the reach, restore natural channel dimensions, and create riffles and pools for fish habitat. Riparian trees could be thinned or pruned to

Figure 9. A large-wood structure constructed with hand tools in the Spaski Creek watershed on Hoonah Totem land on Chichagof Island. Photo by Ian Johnson.

improve understory light levels, enhance tree growth, and encourage greater plant species diversity. Appendix 2 provides the proposed prescriptions for thinning in the Threemile Creek alluvial Fan. Additional assessment work is necessary to better understand existing conditions so that specific restoration objectives and plans can be developed. A hand-tool instream restoration project in the lower reach of this channel would require a 4-person crew for 6 days. Total cost, including planning and permitting, is estimated at around $15,000.

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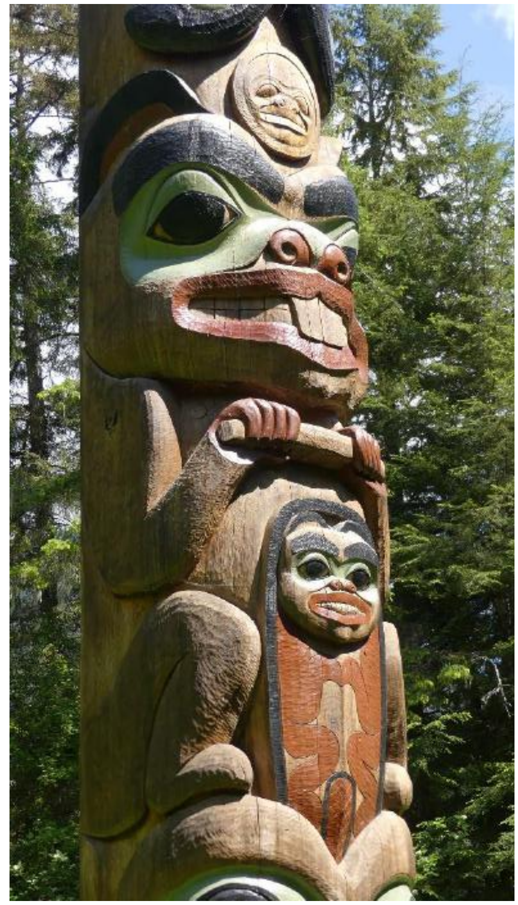
Appendix 1: Beavers and Salmon in the Klawock Lake Watershed

In the 19th Century, fur trading in North America drove beavers to near extinction. Since that time, populations have rebounded, experiencing exponential growth as beavers recolonize habitats throughout their historical distribution. As populations recover, beavers frequently come into conflict with humans, especially when their feeding and dam-building activities impact agriculture, transportation infrastructure, and residential areas. While many new techniques are available to reduce or prevent the adverse impacts of beavers, problem beavers are commonly trapped or relocated.

Despite these conflicts, beavers have long been considered a keystone species. A keystone species is a species that numerous other species depend on and whose presence in an ecosystem is necessary to maintain community structure. For example, beaver dams on small streams create ponds, an entirely different type of aquatic habitat used by waterfowl, fish, aquatic invertebrates, amphibians, and other mammals that would not otherwise inhabit the area (Collen and Gibson 2000, Pollock et al. 2004).



Beaver forms are common on Tlingit totem poles.

In recent years, a growing body of scientific evidence indicates that beavers often have positive impacts on salmon and trout populations. Compared to watersheds without beavers, beaver watersheds overall support a greater abundance of salmon (Pollock 2004) and fish experience higher survival rates and faster growth (Bouwes et al. 2016, Sigourney 2006). In contrast to the impounded stream reach, beaver ponds provide more food resources (McDowell and Naiman 1986), as well as more favorable temperatures for growth (Sigourney 2006) and a refuge from predators and high flows (Pollock et al. 2003). Beaver ponds also can improve habitat for salmon and trout by trapping sediment (Pollock et al. 2007) and increasing groundwater recharge (Westbrook et al. 2006). Not all fish species, life stages, or populations respond to the presence of beavers in the same way, and more research is necessary to better understand the full scope and scale of their impacts on fish. Nonetheless, beavers are being protected and reintroduced into their former habitats throughout their global distribution, not just to restore ecosystems, but also to reduce flood damage and water shortages related to climate change.

Beavers are common throughout the Klawock watershed, including in the Hatchery Creek and Threemile Creek watersheds, the two largest sockeye salmon streams entering Klawock Lake. Recent efforts to assess watershed health and identify habitat restoration opportunities have brought attention to beavers and their impacts on sockeye salmon habitat. There are concerns that beaver dams and ponds negatively impact sockeye salmon by blocking or impeding upstream migration and impounding stream reaches used for spawning. There is also concern that past logging has altered the forest composition to favor deciduous trees, primarily red alder, which beavers appear to prefer over conifers as a food source. The exceptionally high alder component in the Klawock watershed, particularly in floodplain riparian areas occupied by beaver and salmon, may be sustaining unnaturally high numbers of beavers, with unknown consequences for sockeye, other fish, and wildlife species.

The remains of an abandoned beaver dam on Hatchery Creek that was partially removed to expose potential spawning habitat. View looking upstream.

Within the Klawock watershed, beavers are legally trapped and one inactive beaver dam has been removed from Hatchery Creek. The intent of the dam removal project was to restore easier access to over a mile of high-quality sockeye spawning habitat above the dam. In this case, beavers had built a dam on a channel spanning log that had been felled by humans. This dam removal was predicated on concerns that sockeye spawning habitat throughout the watershed has been degraded by logging, roadbuilding, and housing development, and exposing potential spawning habitat through dam removal could compensate for some of that loss.

Considering the current scientific evidence that beavers often enhance salmon and trout populations, watershed stakeholders and managers should use caution when considering beaver control and dam removal as a means of restoring sockeye populations. Keystone species like beaves exert a disproportionately large influence on natural processes and community structure within the ecosystems they inhabit, and spawning salmon are known to be adept at navigating beaver dams to access spawning areas. Without a full understanding of the distribution and ecological role of beavers in the Klawock watershed, beaver control measures could have unintended negative consequences for sockeye salmon, other species, and the hydrologic and physical environment. Further, beaver population control is time consuming and costly, and results are often only temporary. Managers should have clear long-term and short-term goals, targets, and endpoints before investing in beaver population control measures.

Before any targeted beaver population control measures or dam removals are attempted in the watershed to restore or maintain historical sockeye spawning habitat, it is recommended that the following steps are taken:

1. Document the location and size of beaver dams and ponds in the watershed
2. Determine the amount of known or potential salmon spawning habitat impacted by beaver ponds
3. Document fish species and life stages living in beaver ponds
4. Measure the influence of beaver ponds on water temperature and sediment transport/storage
5. Assess the potential for beaver dams to block or impede fish passage.

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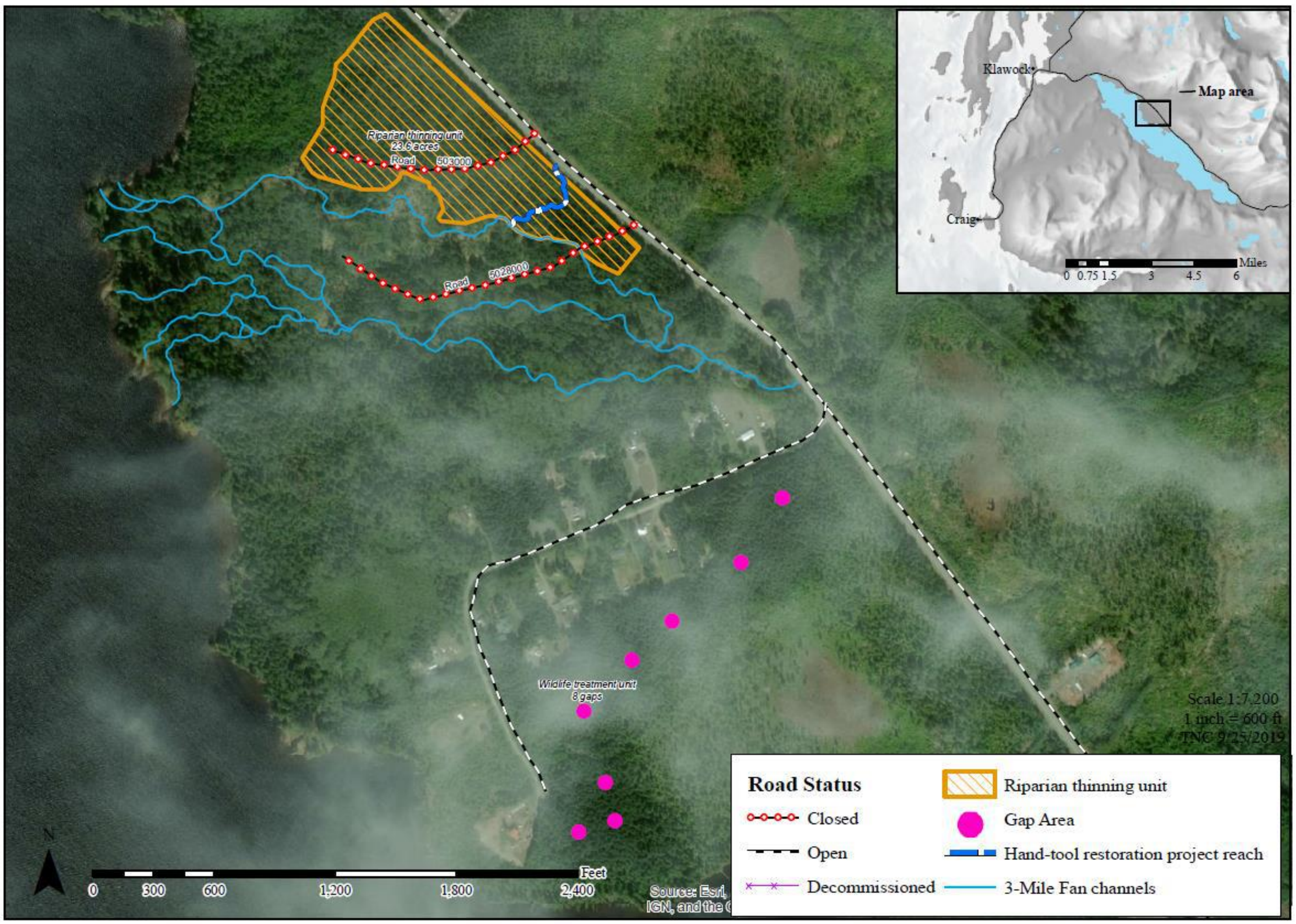
Appendix 2. Threemile Creek Fan Riparian Thinning

Summary

This proposed project is to thin a ~23-acre, stem-excluded second growth stand between the road and Threemile Creek fan to concentrate resources on residual tree diameter growth, improve wildlife habitat, increase the rate of recruitment of future large woody debris into the fan, and provide wood for the handcrew restoration project. This proposed project would also create eight "radial tree release" gaps to improve wildlife habitat and forest structure.

Threemile fan riparian and wildlife thinning units



Due to the density of the stand and the desire for intensive slash treatment, this project is projected to take a 4-man saw crew 25-30 days, at a cost of approximately $28,000. The per-acre rate paid to contract crews from the lower-48 for thinning and slash treatment is frequently $800-$1,000/acre; we expect this treatment to cost at least this much.

Stand condition (*derived from LiDAR remote sensing inventory*)

Quadratic Mean Diameter: 8 inches
Trees per acre >=2" dbh: 724
Trees per acre >=6" dbh: 172
Crown Competition Factor: 277.48%
Species composition: Spruce, western hemlock, red alder

Prescription

Thinning: The treatment prescribed for this stand is a 12X12' spaced thinning to reduce tree stocking to approximately 300 trees per acre, with slash treatment to maintain access to the stand for wildlife, and also featuring girdling wherever safe and feasible. Specifically, the treatment should feature:

- 12-ft spacing, with 50% variance encouraged to favor larger trees and create variability in the stand.
- Retention of dominant, largest trees with good form
- Girdling of any thinned trees >7" DBH
- Upper diameter limit of 10"; **any trees >10" dbh are to be left alive**
- Bucking and limbing any trees felled while thinning (maximum acceptable slash depth 2 ft.)
- Red alder will not be cut. It will not be counted when determining spacing.

The riparian stand in question, not having undergone any intermediate treatment since harvest in ~1987, is in a state of stem exclusion ("dog-hair") due to being overstocked with conifers. There is currently very little understory forage except in places where red alder is growing (generally old skid trails and accumulations of logging debris).

This treatment is focused on maximizing diameter growth in selected residual trees for timber value; selecting for dominant crop trees; increasing long-term stand stability; placing the stand on a trajectory that provides opportunities for future stand treatments that benefit multiple resources; increasing short-term forage biomass for wildlife; maintaining low-elevation winter wildlife cover; and avoiding creating a large, persistent slash load that restricts human and wildlife access.

A stand of this size and age has already passed the optimal window for precommercial treatment and is rapidly approaching a point beyond which any treatment would risk undermining stand stability. It is important for stand health to implement a treatment that decreases height/diameter ratios. The thinning prescribed above is designed to address this in the short term while avoiding wider spacing that might lead to the stand unraveling, and is expected to provide temporary benefits to wildlife. A second entry (potentially commercial) thinning should be considered in 20 years to maintain a high growth rate and benefit bear and deer that use this stand.

Radial Tree Release Gaps: Between one individual tree up to five clumped trees of above-average diameter and form will be selected and flagged at each of the eight locations on the map to be the live centers of radial tree release openings. A “gap” (shaped like a donut) of radius 37 ft. will then be created surrounding the flagged tree(s) to create persistent wildlife forage, while also maximizing the growth rate of the center tree(s) and the trees on the edge of the opening. The flagged center trees will be left alive (residuals), while all trees >2 ft. tall within 37 ft. of the center trees will be killed by felling or girdling, depending on diameter.

This creates an opening of roughly 0.1 acre in area, intended to mimic the small windthrow events that are the predominant natural disturbance regime of Southeast Alaska forests. Various studies have shown this opening size to be a sweet spot between maintaining or encouraging understory forage growth, while avoiding a “conifer flush” of hemlock seedlings that would result from a larger opening. Leaving center trees will further benefit wildlife by encouraging the rapid growth of large, wolfy trees that, over time, will grow large boughs capable of capturing snow.

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