PAT CREEK WATERSHED RECONNAISANCE

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Introduction

The community of Wrangell is located on Wrangell Island in the south-central portion of Southeast Alaska (Figure 1). Home to roughly 2,500 people, the maritime community relies heavily upon the surrounding ocean and forest for food, jobs, and recreation. Most of the land on Wrangell Island is managed by the US Forest Service (USFS) as part of the Tongass National Forest.

Located 9 miles south of Wrangell, the Pat Creek watershed (Figure 2) is a highly valued and easily accessible area that residents and visitors use for sport fishing, hunting, berry picking, and other subsistence and recreational activities. Pat Creek is an anadromous fish stream supporting coho, pink, chum, and sockeye salmon, as well as Dolly Varden char, coastal cutthroat trout, and steelhead trout. Fish populations in the watershed are valued by the Wrangell community for supporting recreational fishing opportunities[1].

The Pat Creek watershed spans 13,900 acres, one third of which is managed by the State of Alaska while the remaining area is managed by the USFS (Figure 3). The main stem of the stream is formed by the confluence of the east and west forks of Pat Creek approximately 0.5 miles upstream of 17-acre Pat Lake (Figure 2). From Pat Lake the stream flows 0.35 miles into saltwater at Zimovia Strait.

Figure 1. Location of the Pat Creek watershed and community of Wrangell on Wrangell Island.

[1] US Forest Service, Wrangell Ranger District (1998). *Wrangell Island Analysis Report.*

Much of the valley bottom in the Pat Creek watershed was logged in the 1960s, 70s, and 90s[2] (Figure 2); about 2,000 acres of timber on federal lands was harvested during that time. These lands were transferred to the state of Alaska in 1991 and are presently managed by the Alaska Department of Natural Resources (ADNR) Division of Forestry and the Alaska Mental Health Trust Authority.

The USFS has identified Pat Creek as a sensitive watershed due to the high proportion of inherently unstable terrain. Relative to other watersheds on the island, Pat Creek has a disproportionately high numbers of landslides, road-stream crossings, and miles of road in poor condition. Road density in the watershed is 1.23 miles/square mile. The density of roads and harvest units on unstable soils and in riparian habitat is higher in the watershed compared to other watersheds on the island[2].

Because Pat Creek is a highly valued and utilized watershed for the community of Wrangell, it is important to ensure that the watershed resources are restored and maintained. The Southeast Alaska Watershed Coalition (SAWC), with support from the U.S. Fish and Wildlife Service (FWS) Habitat Restoration Program, conducted a reconnaissance level assessment of the Pat Creek watershed in August 2014 and March 2015. The purpose of the assessment was to improve our understanding of existing conditions in the watershed, including stream habitat conditions, and to identify opportunities for improving water quality and riparian and instream habitat. Information from the assessment will be used to develop a detailed restoration plan if conditions in the watershed warrant habitat enhancement and restoration activities.

Project Objectives

The objectives of the watershed reconnaissance were to:

- Gather existing watershed information (e.g., maps, reports, etc.)
- Inventory and map watershed features (e.g., stream channels, roads)
- Identify opportunities to restore or enhance habitat, improve aquatic connectivity
- Quantify instream habitat conditions for stream reaches within harvest units

[2] US Forest Service, Wrangell Ranger District (1998). *Wrangell Island Analysis Report.*

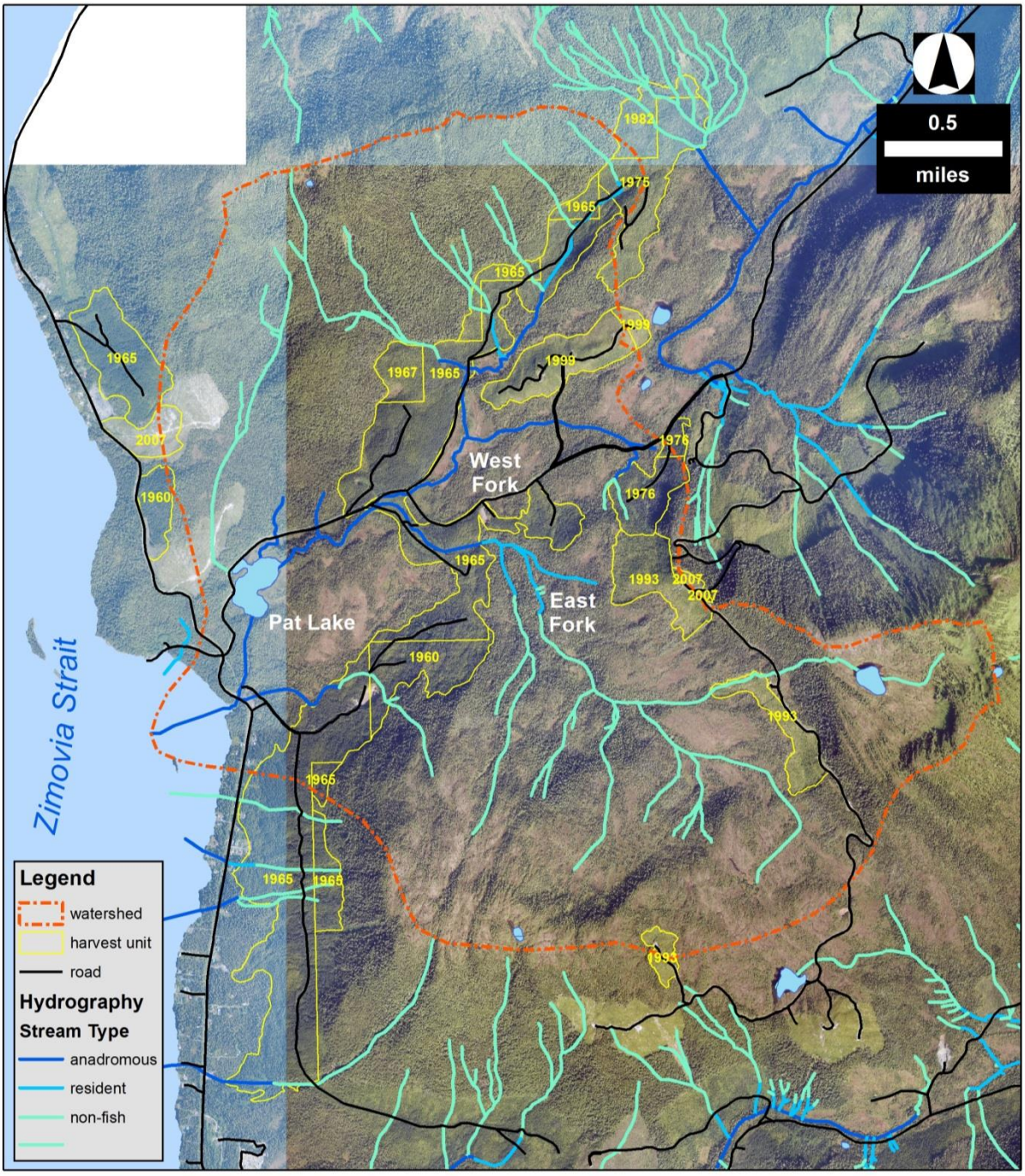


Figure 2. Pat Creek watershed hydrography and harvest units.

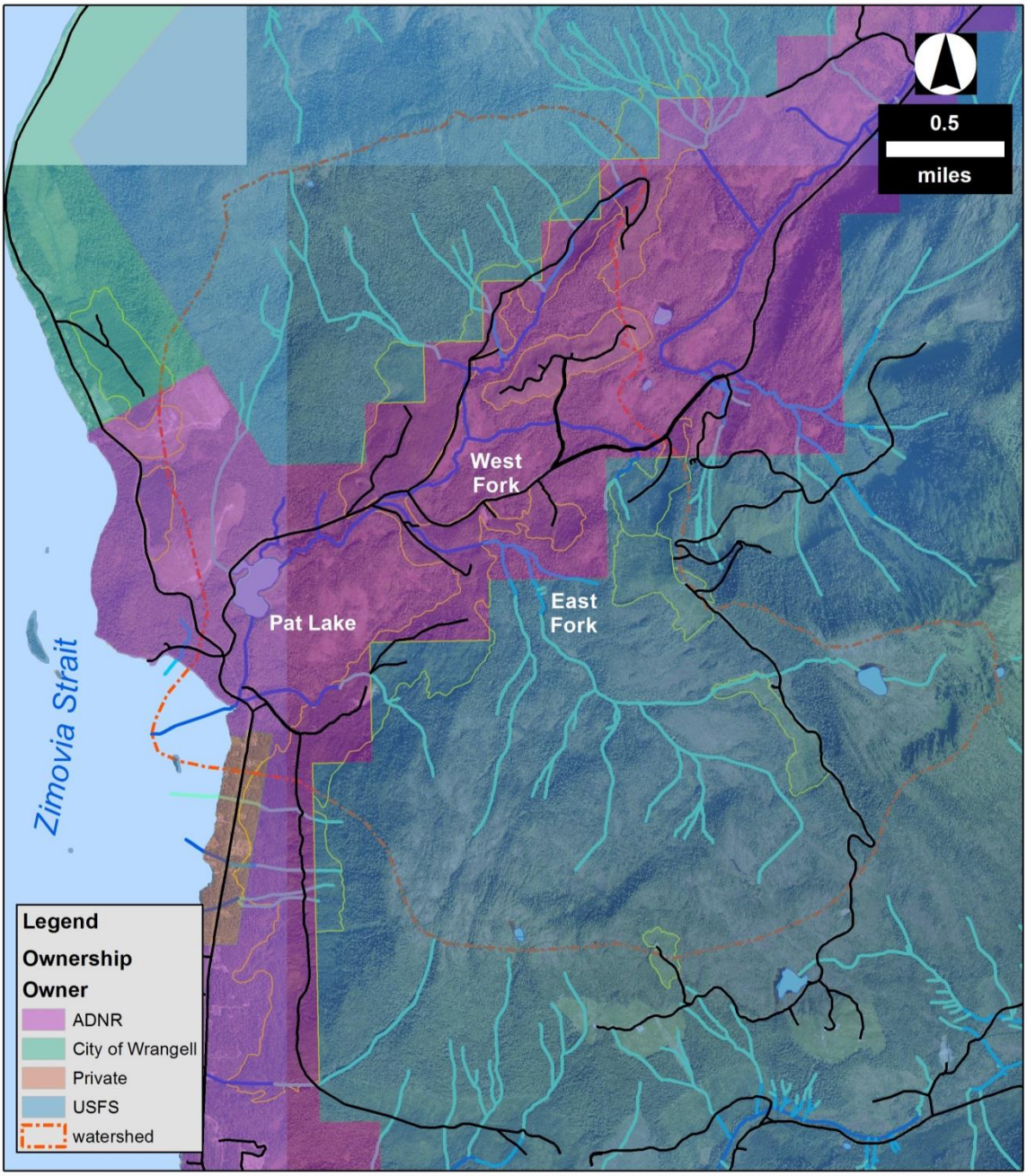


Figure 3: Land ownership status in the Pat Creek watershed.

Methods

Background information for the Pat Creek watershed was obtained from reports and consultations with staff from the Alaska Department of Natural Resources and the U.S. Forest Service. Site visits were conducted in August 2014 and March 2015 to familiarize ourselves with the watershed and to identify habitat condition and restoration opportunities. Aquatic stream habitat surveys were conducted on the

East and West Forks of Pat Creek to assess stream habitat conditions in areas that were harvested in the 1960s.

Stream Habitat Survey

The Tongass National Forest developed a standard technique for conducting aquatic stream habitat surveys in coastal Alaska[3]. The hierarchical survey protocol obtains quantitative measures of stream habitat parameters for several habitat attributes (Table 1). These attributes are considered sensitive to forest management activities (i.e., tree harvest) near stream channels[4]. Tier Two surveys were conducted in the lower reaches of the East and West Forks of Pat Creek in August 2014.

Survey reaches were located near the confluence of the two forks (Figure 4). Both survey reaches were within a 1965 clear-cut harvest unit. The East Fork survey was conducted in a 112 m long reach classified as a small floodplain channel (FPS) on a stable portion of an alluvial fan. The West Fork survey was conducted in a 160 m long reach classified as a small floodplain channel (FPS). The East Fork survey reach was located in the only channel that was active on the alluvial fan at the time of the survey. Forest Service staff led the habitat survey effort in the field and summarized the data.

The survey team included:

- Angie Eldred – Project Coordinator, SAWC
- John Hudson – Fish and Wildlife Biologist, FWS
- Emil Tucker – Hydrologist, USFS
- Olivia Guthrie – Hydrologic Technician, USFS
- Dennis Reed – Fisheries Biologist, USFS Wrangell Ranger District
- Martin Hutten – Supervisory Biologist, USFS Wrangell Ranger Distric

Stream habitat attributes measured in a Tier Two habitat survey:

- **Width-to-depth ratio** (WD): An indicator of stream channel stability. An increase from the mean WD can indicate a widening and/or shallowing of the channel, while a decrease in WD may indicate that the channel is becoming entrenched.
- **Large woody debris**: Pieces of large wood play an important role in stabilizing banks, moderating the transport of sediments, providing overhead cover, and forming pools for fish habitat. The functional role of wood in a stream depends on its size relative to the size of the stream, and key pieces are measured and qualified per the average channel bed width of the stream.
- **Pool measures**: Various pool metrics are used to evaluate the quantity and quality of fish habitat, as well as the complexity and stability of the channel. Generally speaking, reaches that

[3]2001. U.S. Forest Service. Tongass National Forest Aquatic Habitat Management Handbook, Chapter 20 - Fish and Aquatic Stream Habitat Survey. FSH 2090.21, pp. 1-55.
[4] Tucker, E. and J. Caouette. 2008. Statistical Analyses of Aquatic Habitat Variables in the Tongass National Forest. Unpublished report.

balance cover (pools) with spawning gravels (riffles) are thought to be the most productive. Pool metrics assessed in the Tier Two survey include:

- Pool frequency
- Pool spacing
- Pool length per meter of channel
- Pool size
- Average residual pool depth

- **Substrate**: Streambed substrate is sampled to assess median particle size. The size of substrate material on stream bottoms can impact the incubation and emergence of newly hatched salmonids.

Values for the stream habitat attributes from each survey reach were compared to channel type specific regional parameters to gage the relative condition of stream habitat and channel functionality in the survey reaches.

Table 1. Tier Two habitat survey attributes and equations.

Habitat attribute	Equation
Width-to-depth ratio (WD)	Bankfull width / mean bankfull depth
Total Large Wood pieces / meter (TLWD/M)	Total Pieces / meters surveyed
Total Key pieces Large Wood/meter (TKWD/M)	Total Key pieces / meters surveyed
Pool frequency (POOL/KM)	Total number of pools / meters surveyed * 1000
Pool Spacing (POOL SPACE)	(Length of stream surveyed / channel bed width) / total number of pools
Residual pool depth/channel bed width (RPD/CBW)	Average of all pool residual depth / average channel bed width
Substrate size, median particle size (mm)	Median particle size (D50)
Pool Length/meter of channel (PLNGTH/M)	Total pool length / total length of stream surveyed
Pool size	Average residual pool depth / average bankfull depth

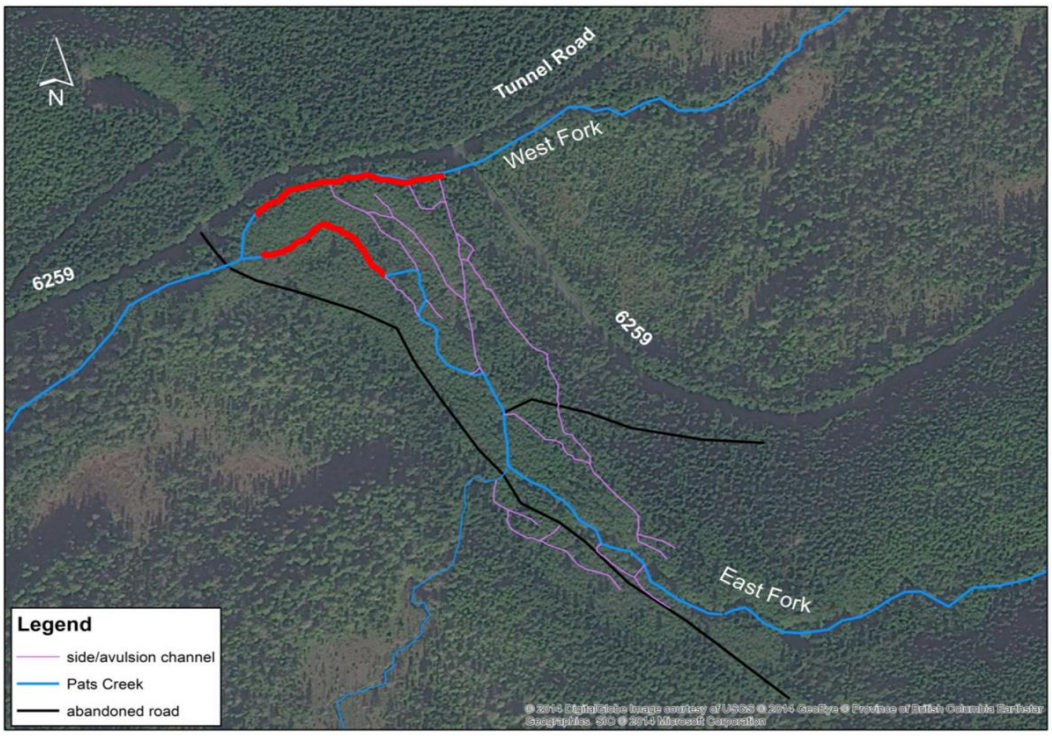


Figure 4. Tier Two habitat survey reaches shown in red on the East and West Forks of Pat Creek.

Habitat Survey and Reconnaissance Results

Pat Creek – East Fork

General Observations

The lower East Fork of Pat Creek flows over an alluvial fan that was clearcut harvested in 1965 (Figure 2). At the time of the assessment, the streamflow was confined to a single active channel interconnected to numerous inactive avulsion channels (i.e. side channels) (Figure 4). Avulsion channels were not receiving surface flow from the active channel during the time of the assessment; however, some channels showed evidence of recent (< 12 months prior) activation during high flow events. When active, avulsion channels convey flow either to the West Fork or return flow to the East Fork.

Avulsion channels were largely dry, although some of these channels contained standing water in isolated pools or small amounts of flowing water, the latter from groundwater connections to the active channel. Surface water presence in avulsion channels appeared to be influenced by channel slope and bed topography, bed coarseness, and groundwater connectivity. Juvenile fishes (coho salmon, coastal cutthroat trout) were observed at several locations in these channels (Figure 5).

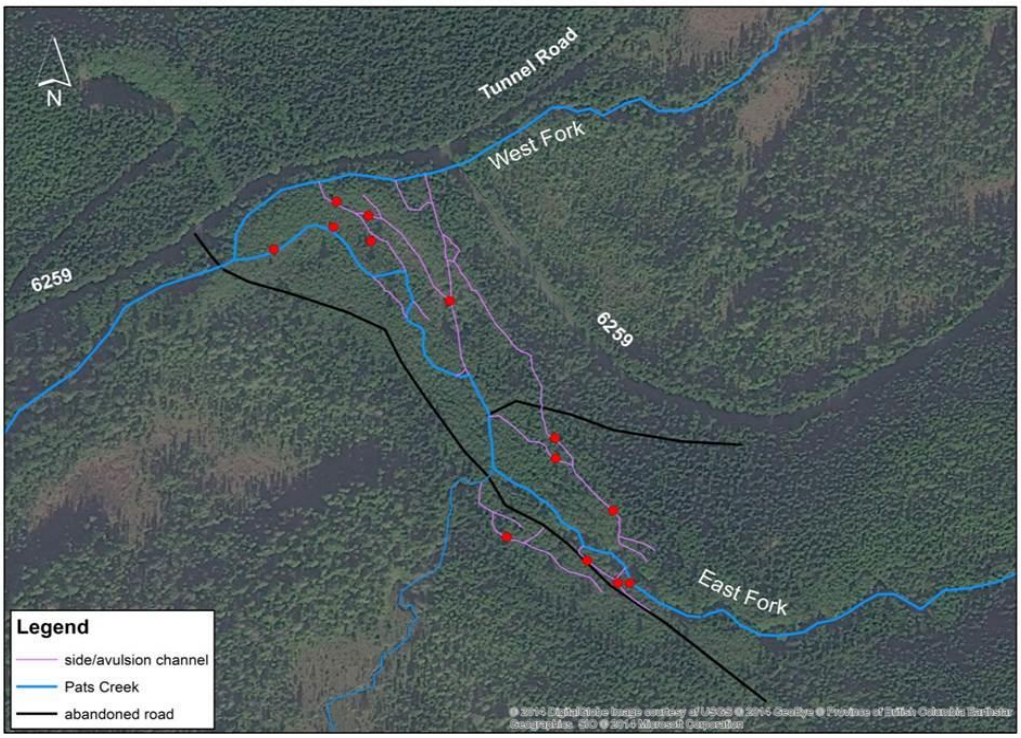


Figure 5. The lower East Fork of Pat Creek at its confluence with the West Fork. The low-flow channel that was active in August 2014 is indicated by a blue line; purple lines indicate avulsion channels. Red symbols indicate the location of fish observations.

Channel stability and morphology differed dramatically between the upper and lower reaches of the active alluvial channel (Figure 6). Sediment aggradation in the upper half of the alluvial fan was evidenced by large depositional bars of coarse sediment, relatively high width-to-depth ratios, and extreme bank erosion. At several locations within this reach numerous mature red alder had recently fallen or were in the process of falling into the channel (Figure 7). Most of the recently active avulsion channels originate from the upstream half of the fan.

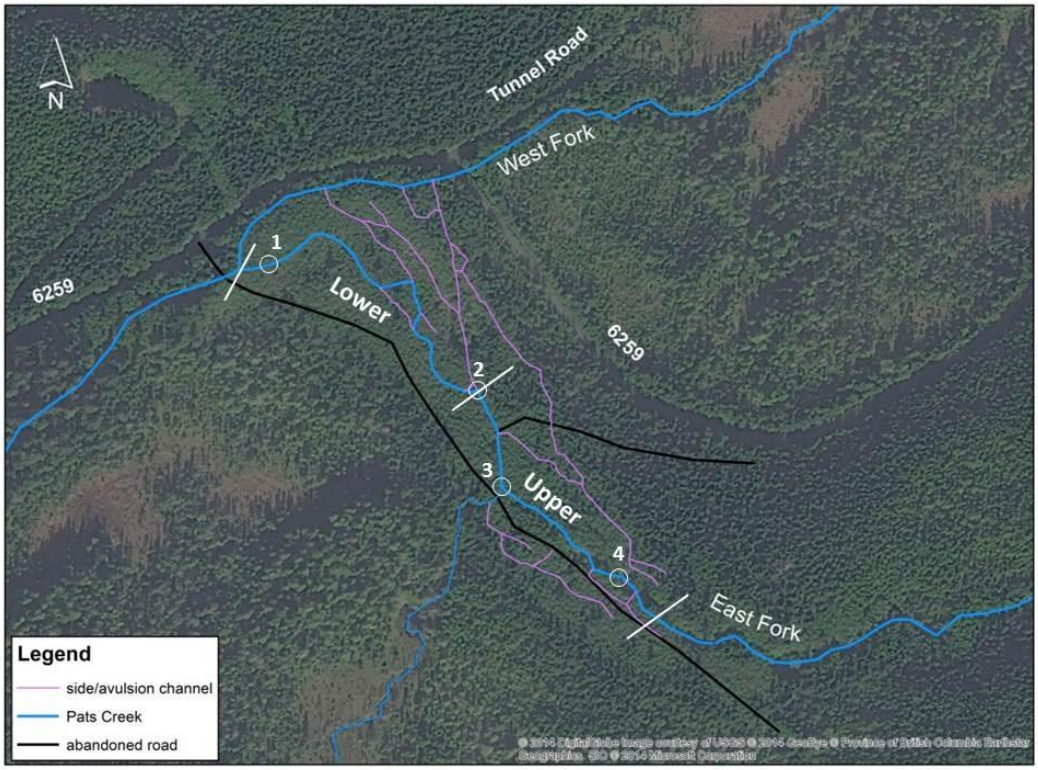


Figure 6. Upper and lower reaches of the East Fork alluvial channel and the location of photo points referenced below.

Figure 7. Panoramic view of the upper reaches of the East Fork alluvial channel (Photo point 4 in Figure 6). Large deposits of unvegetated substrate on the floodplain indicate recent sediment aggradation. Stream flow is from left to right.

In contrast to the upper reach, the lower half of the active alluvial channel appeared stable. There was no evidence of channel incision or bank erosion and the width-to-depth ratio appeared to be considerably lower than in the upper half of the channel (Figure 8). Evidence of recent bedload aggradation was limited to a 150 foot long reach directly downstream of the upper reach.

The upper-lower reach transition point is located at Photopoint 2 in Figure 6. At this location a 6-foot tall stable debris dam consisting of a large stump and other wood debris appears to have caused a channel avulsion to the west (Figures 6 & 9). Prior to the avulsion the active channel connected to the West Fork upstream of the current confluence of the two forks. Given the apparent stability of this channel, instream wood amendments may be possible. The lower reach channel should be monitored to determine the extent and impacts of recent sediment aggradation from upstream inputs.

An abandoned logging road parallels the lower reaches of the East Fork on its west side (Figure 6). A small portion of the road is eroding into the active alluvial channel at its confluence with a tributary entering from the west side of the channel (Figure 10). Existing and potential effects of this road on lateral channel migration should be investigated in the future.

Figure 8. Upstream view of the East Fork of Pat Creek near its confluence with the West Fork (Photopoint 1 in Figure 6).

Figure 9. A 6-foot tall debris dam on the East Fork has resulted in significant upstream sediment aggradation resulting in a westward avulsion of the active channel (Photopoint 2 in Figure 6). View looking upstream.

Figure 10. At its confluence with the East Fork, a tributary flows over an abandoned logging road (Photopoint 3 in Figure 6). View looking downstream.

Tier Two Habitat Survey Results

Four of the ten habitat attributes measured in the East Fork survey reach had values consistent with conditions present in unmanaged stream reaches of the same size and channel type (Table 2). These attributes included pool size, percent pool habitat, substrate size, and total large woody debris abundance. Key pieces of large woody debris, which provide cover and are frequently associated with pools, were less abundant in the survey reach than in unmanaged stands. Several pool attribute values in the survey reach differed from those of unmanaged reaches. In contrast to unmanaged reaches, East Fork pool habitats were less abundant, less deep, and more widely spaced. The channel width-to-depth ratio of the East Fork was greater than that found in unmanaged channels, a condition often associated with bank erosion and increased sediment supply following riparian tree harvest. Collectively, these results indicate a trend towards reduced habitat quantity and complexity that may be related to sediment dynamics and large wood deficiencies.

Table 2. Habitat attribute values for the East Fork survey reach. Each attribute is assigned to one of 3 quartile groups[1] according to its value. Quartile groups were derived from a distribution of attribute values obtained from unmanaged (i.e. unlogged) stream reaches[5]. Habitat conditions in unmanaged reaches are assumed to represent the ideal condition. East Fork attributes that fall within the quartile representing the ideal habitat condition are highlighted in grey.

Habitat Attribute	*Value*	*Assigned quartile group*	*Ideal habitat condition quartile*
Width-to-depth ratio	28.13	Upper	Inter
Total large woody debris/meter	0.62	Upper	Upper
Total key woody debris/meter	0.036	Lower	Upper
Pool frequency	44.56	Inter	Upper
Pool spacing	3.78	Inter	Lower
Residual pool depth/channel bed width	0.07	Inter	Upper
Substrate, median particle size (mm)	31.16	Inter	Inter
Pool length/meter of channel (% pools)	0.41	Inter	Inter
Pool size	1.7	Upper	Upper

[1]Lower quartile (<25%), Inter-quartile (>25% & <75%), Upper quartile (>75%)

Pat Creek – West Fork

General Observations

The West Fork of Pat Creek is approximately 175 m long between its confluence with the East Fork and Forest Service Road 6259 (Figure 6). This section of stream passes through a 1965 clear-cut and closely parallels Road 6259. Portions of the right bank are located immediately adjacent to the road embankment; the left bank is formed by the downstream edge of the East Fork alluvial fan. The West

[5] Tucker, E. and J. Caouette. 2008. Statistical Analyses of Aquatic Habitat Variables in the Tongass National Forest. Unpublished report.

Fork is backwatered by the East Fork for a distance of approximately 70 m upstream of the confluence of the two channels.

Tier Two Habitat Survey Results

The relative condition of habitat attributes in the West Fork survey reach was mixed (Table 3). The width-to-depth ratio of the channel, substrate size, and large woody debris abundance were consistent with values for these attributes in unmanaged stream reaches of the same channel type and size. The abundance of key pieces of woody debris was lower in the survey reach than in unmanaged stream reaches. Many of the key pieces of woody debris appeared stable and were associated with well-developed scour pools; however, the physical integrity of the wood was low as evidenced by splintering, abrasion, and advanced decomposition (Figure 11). There are only a few standing trees in the riparian area along this reach that could provide large wood recruitment to the stream channel in the future.

All pool attribute values fell outside of the quartile representing the ideal habitat condition (Table 3). Pools in the survey reach were less common, smaller in size, and shallower than pools within unmanaged stream reaches. In contrast to pools in unmanaged reaches, pools in the survey reach were longer and more widely spaced.

Table 3. Habitat attribute values for the West Fork survey reach. Each attribute is assigned to one of 3 quartile groups[1] according to its value. Quartile groups were derived from a distribution of attribute values obtained from unmanaged (i.e. unlogged) stream reaches[6]. Habitat conditions in the unmanaged reaches are assumed to represent the ideal condition. West Fork attributes that fall within the quartile representing the ideal habitat condition are highlighted in grey.

Habitat Attribute	***Value***	***Assigned quartile group***	***Ideal habitat condition quartile***
Width to depth ratio	12.45	Inter	Inter
Total large woody debris/meter	0.92	Upper	Upper
Total key woody debris/meter	0.06	Lower	Upper
Pool frequency	31.25	Inter	Upper
Pool spacing	3.61	Inter	Lower
Average residual pool depth/channel bed width	0.08	Inter	Upper
Substrate, median particle size (mm)	37.85	Inter	Inter
Pool length per meter of channel (% pools)	0.79	Upper	Inter
Pool size	0.43	Lower	Upper

[1]Lower quartile (<25%), Inter-quartile (>25% & <75%), Upper quartile (>75%)

[6] Tucker, E. and J. Caouette. 2008. Statistical Analyses of Aquatic Habitat Variables in the Tongass National Forest. Unpublished report.

Figure 11. A scour pool in the West Fork created by a key piece of legacy wood.

Tunnel Road Reconnaissance

The locally named Tunnel Road is an unmaintained former logging road constructed off of Forest Service road 6259 to provide access to timber that was harvested in the 1960s and 1970s (Figure 12). The road is located on the west side of the West Fork and runs generally parallel to the stream channel for most of its length. The road is used by ATV riders and for illegal dumping of household garbage and yard waste. Our reconnaissance efforts along Tunnel Road identified several opportunities for improving road conditions and aquatic connectivity (Figure 12).

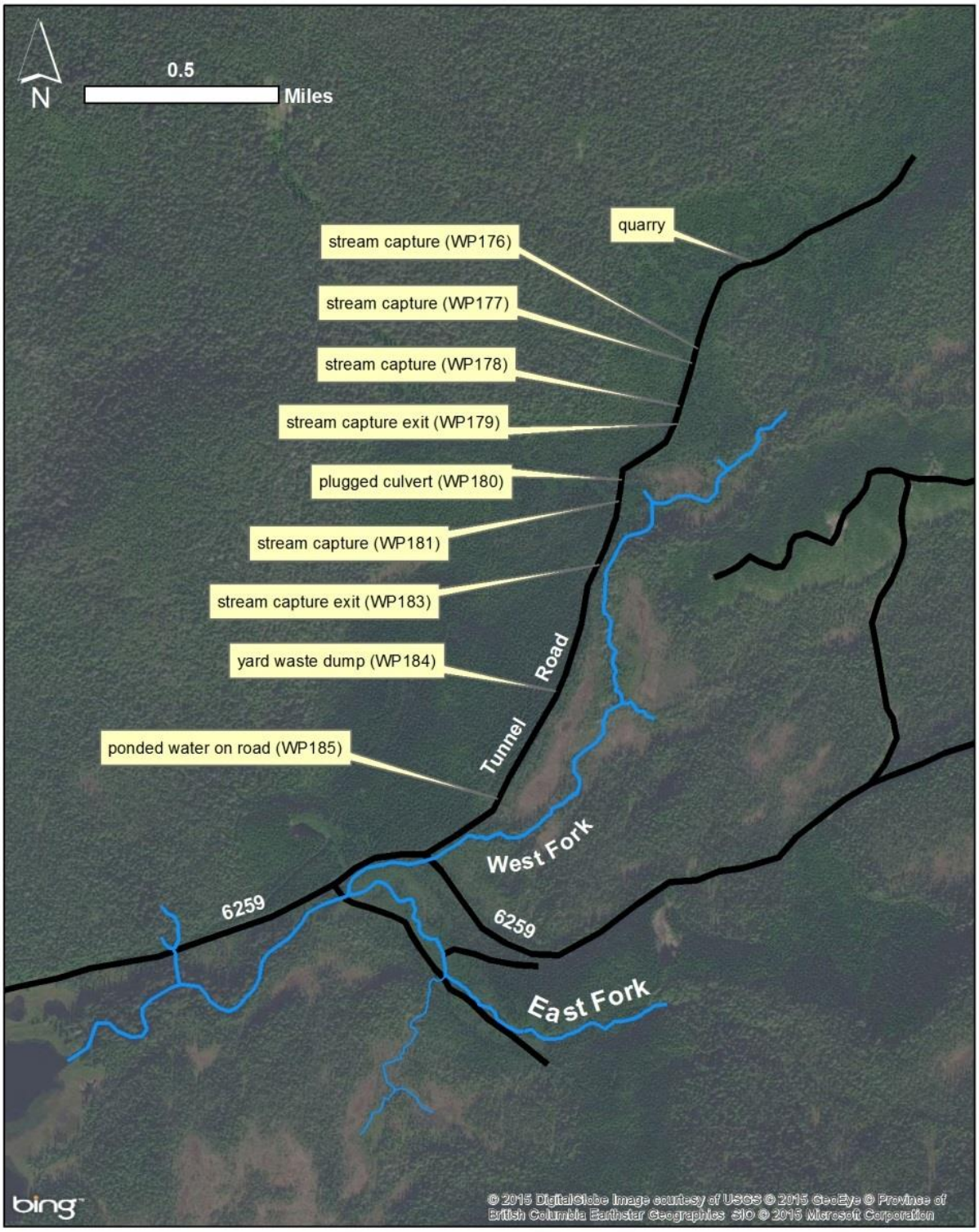


Figure 12. Observation waypoints along Tunnel Road in the West Fork subwatershed of Pat Creek

WP175 (56.3669, -132.3087): Quarry

WP176 (56.3652, -132.3109): Small stream captured by road. Half of stream volume flowing on road surface; captured flow joins another stream crossing the road at WP177.

WP176. Stream flow from right to left. View looking downslope.

WP177 (56.3649, -132.3110): Small stream crossing over road; receiving road-captured flow from stream crossing at WP 176.

WP177. Stream flow from left to right. View looking upslope.

WP178 (56.3640, -132.3115): Several small surface flows and seeps upslope of the road coalesce in this area to form a single stream which flows down center of road.

WP178. View looking downslope.

WP179 (56.3636, -132.3116): Streams captured at WP 178 exits road downslope at this waypoint.

WP179. Stream flow from upper left to lower right.

WP180 (56.3625,-132.3137): Sediment-plugged culvert. The entire volume of the stream is flowing over the road surface. A 6- foot deep sediment deposit has formed upstream of the road.

WP180. Stream flow cascading over road embankment. The outlet of a plugged culvert (not visible in photo) is located on the right side of the cascade.

WP181 (56.3621,-132.3135): Landslide deposit zone. At mile 0.6 of the Tunnel Road, a landslide originating in the headwaters of a West Fork tributary (hereafter referred to as Landslide Creek) crossed over Tunnel Road. Aerial photography suggests that the landslide occurred in 1994 (Dennis Reed, personal communication). Landslide Creek flows down the slide path and splits into two channels approximately 300 feet upstream of the road. The more northerly flow leaves the landslide and enters the original channel and crosses over Tunnel Road at WP180. The southerly flow continues down the landslide and is partially captured by Tunnel Road. The captured flow travels 450 feet down the road before entering the West Fork at WP183. The path of stream flow not captured by Tunnel Road was not investigated. In August 2014, we observed young-of-the-year juvenile salmonids (cutthroat trout or Dolly Varden char) where Landslide Creek flows onto the deposition zone. An encampment present at the site in August 2014 was gone in March 2015.

WP181. View looking downstream

WP181. View looking upstream.

Water from Landslide Creek flows south down Tunnel Road between WP181 and WP183.

WP183 (56.3608, -132.3144): Stream flow captured at WP 181 flows from the road into the West Fork of Pat Creek at this location. A 30-foot long, 1-foot deep pool has formed on the road at this location. The pool also receives water from a ditch that extends north to the slide zone on the west side of the road. There is a plugged cross-drain culvert between the ditch and the West Fork along this reach of road.

WP183. Road-captured stream flows from top of image to bottom; West Fork of Pat Creek to right of view.

WP184 (56.3580, -132.3158): Yard waste dump site (chicken manure, straw, etc.) on the east side of Tunnel Road. Invasive reed canarygrass, creeping buttercup, chickweed present. Portions of the Tunnel Road have been used for unauthorized dumping of garbage and yard waste. The Wrangell Cooperative Association removed waste from multiple sites in the Pat Creek watershed in the last year.

WP184. Yard waste pile on east side of Tunnel Road.

WP185 (56.3559, -132.3181): Ponded water on road surface in several places. Reed canarygrass growing on sides of road.

WP185. View looking north.

A reed canarygrass infestation on the West Fork of Pat Creek upstream of FS Road 6259 in March 2015 (56.3552, -132.3193).

Pat Creek – Zimovia Highway

Trees and other vegetation on the banks of Pat Creek were removed from an electric transmission corridor upstream of Zimovia Highway in 2013 (Figure 13). Recovery of the riparian plant community will be inhibited by slash discarded next to the stream.

Figure 13. Riparian forest cleared in a utility corridor upstream of Zimovia Highway.

Pat Creek watershed enhancement recommendations

East Fork Pat Creek

- Floodplain Roughening: Because of the dynamic nature of this fork of the stream, attempts at restoring habitat with placement of key pieces of large wood are risky and may prove to be a wasted effort if the stream continues to change course. A possible solution to consider is floodplain roughening as a method of stabilizing the stream's alluvial fan.

  Lacking historical data on the nature of the East Fork's channel prior to the harvest of large riparian spruce, it is difficult to know for certain the historic condition of this stream's alluvial fan. Further investigation and literature research on the applications of this method, as well as a site evaluation by a specialist would be required before pursuing this possible restoration approach.

West Fork Pat Creek

- Large wood placement: Large wood structures could be placed in the West Fork of Pat Creek downstream of FS Road 6259 to maintain or enhance fish habitat as existing legacy wood degrades. The design and placement of structures should take into consideration protection of the adjacent road and enhancement of existing fish habitat created by decaying legacy wood. Channel aggradation at the confluence of the two forks (a terminus of the East Fork alluvial fan) has backwatered an 80 m reach of the West Fork upstream of the confluence. Wood placement in this reach may not be warranted due to the backwatered condition of the channel. Low channel slope and low width-to-depth ratio in this reach may limit the hydraulic capacity of the channel to scour the streambed and affect sediment transport.

- Assess habitat conditions in the mainstem of Pat Creek from the confluence of the East and West Forks to the downstream edge of the 1965 clearcut. Assess mainstem habitat conditions downstream of the clearcut to provide reference information for improving habitat in the managed reach.

Zimovia Highway

- Riparian vegetation recovery: All remaining slash within 100 feet of the stream should be removed to accelerate recovery of the riparian forest in this area. Encourage utility crews to remove only vegetation that threatens the integrity of overhead utilities.

Tunnel Road

- Install culverts or bridges at the Landslide Creek crossings of Tunnel Road to stop road degradation, restore fish passage and natural sediment transport, improve water quality, and protect fish habitat.

- Consider establishing Tunnel Road as a designated ATV/snow machine trail (i.e. closed to highway vehicles when not in use for State Forest timber harvest) to provide recreational opportunities for residents of the Wrangell community and to reduce garbage and yard waste dumping along sensitive riparian areas.

- Install culverts or construct hardened fords where non-fish bearing stream flow has been captured by the road to restore hydrology and sediment transport.

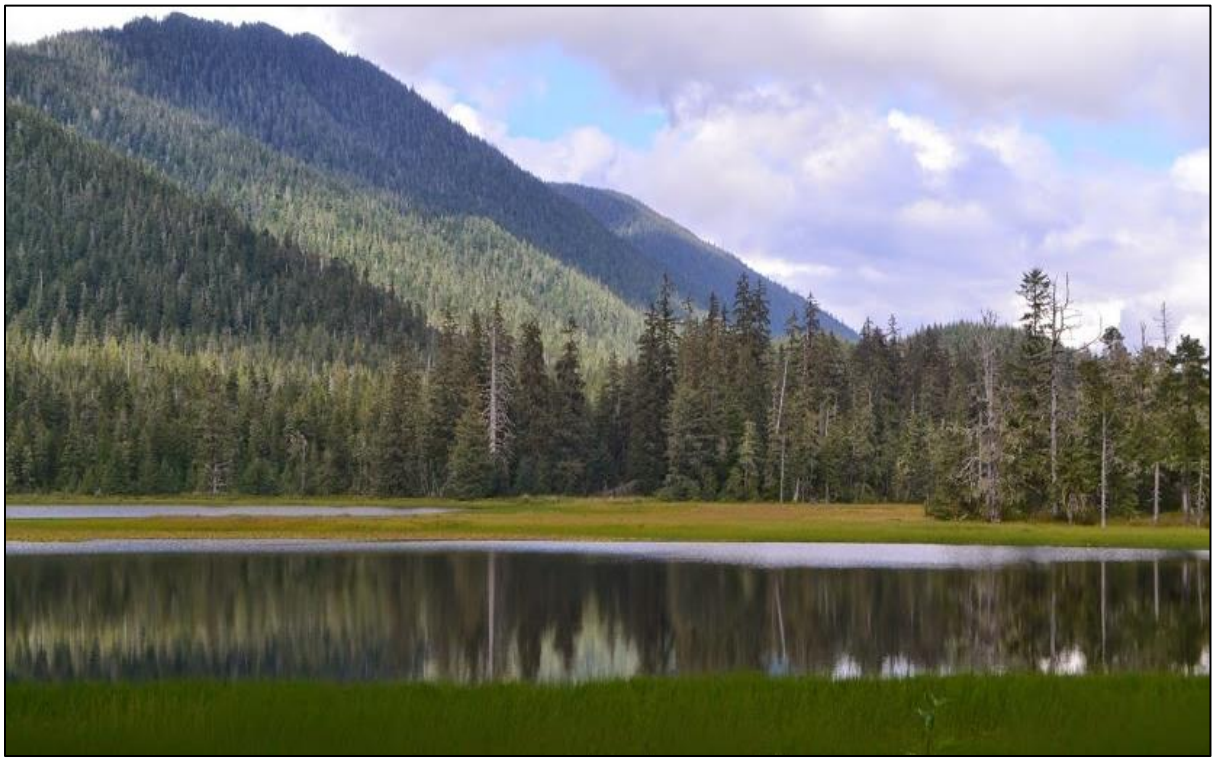
Next Steps:

- Acquire hydrologic, topographic, and other information necessary for developing stream habitat improvement concepts for managed reaches near the East and West Forks confluence

- Brief existing and potential partners on the findings of this reconnaissance effort and recommendations

- Formalize relationships with partners, including Alaska Division of Forestry, U.S. Forest Service, SAWC, FWS, and other identified stakeholders.

The Pat Creek restoration and enhancement opportunities discussed above are only possible with careful planning and collaboration among a diverse group of stakeholders including state and federal agencies, as well as Wrangell community stakeholders. SAWC's previous and current partnerships and collaborative efforts in Wrangell and throughout the region put us in an apt position to engage this stakeholder group and facilitate development of this effort to restore and enhance the aquatic resources of the Pat Creek watershed.



Pat Lake

Acknowledgements

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