

Whatcom Creek:

Ten-Years After Summary Report



Prepared for:

City of Bellingham
Department of Public Works
Environmental Resources



Prepared by:



R2 Resource Consultants, Inc.
15250 NE 95th Street
Redmond, Washington 98052



Acknowledgements

This report represents the efforts of numerous individuals and organizations over the past ten years. The Natural Resource Trustees including the United States Department of Commerce as represented by the National Oceanic and Atmospheric Administration; the United States Department of the Interior as represented by the United States Fish and Wildlife Service; the State of Washington as represented by the Department of Ecology; the City of Bellingham; the Lummi Nation of Washington; and the Nooksack Tribe of Washington provided immediate and invaluable oversight during the emergency response, and have since coordinated long-term restoration efforts. Nooksack Salmon Enhancement Association (NSEA), the City of Bellingham Parks and Recreation Department, and the Environmental Resources Division of the City of Bellingham Department of Public Works have spent many hours planting, planning, monitoring and improving the area affected by the fire. In 2007, the Lummi Nation installed a Memorial Pole honoring the three young boys who lost their lives in the fire, as well as community members who drew together to provide support and help restore the area. We thank them all, and others too numerous to mention here for their efforts on behalf of the City and this community.



Overview of the Event

On June 10, 1999 an underground pipeline ruptured in Bellingham, Washington, releasing approximately 237,000 gallons of unleaded gasoline into Hannah Creek. Spilled gasoline flowed down Hannah Creek, entering Whatcom Creek through the soil and surface water. The unleaded gasoline flowed downstream in Whatcom Creek as surface flow. At approximately 4:55 pm the gasoline was ignited, resulting in an explosion. The incident killed three people, and burned approximately 26 acres of trees and vegetation, including 16 acres of mature second-growth forest within Whatcom Falls Park and 10 acres of third- or fourth-generation floodplain forest and meadow west of the park (Map 1). Fish and wildlife impacts were impossible to fully quantify. Field staff collected or observed more than 100,000 dead salmon, trout, lamprey, and crayfish in the days following the fire. Scientists concluded that all aquatic life in three miles of Whatcom Creek was killed through direct contact with the fuel or fumes, or when the fuel ignited.

Under the Oil Pollution Act (OPA) of 1990, the parties responsible for the release of petroleum products are liable for the costs to restore natural resources. An oversight board, called the Natural Resource Trustees was established; its members include: the United States Department of Commerce as represented by the National Oceanic and Atmospheric Administration; the United States Department of the Interior as represented by the United States Fish and Wildlife Service; the State of Washington as

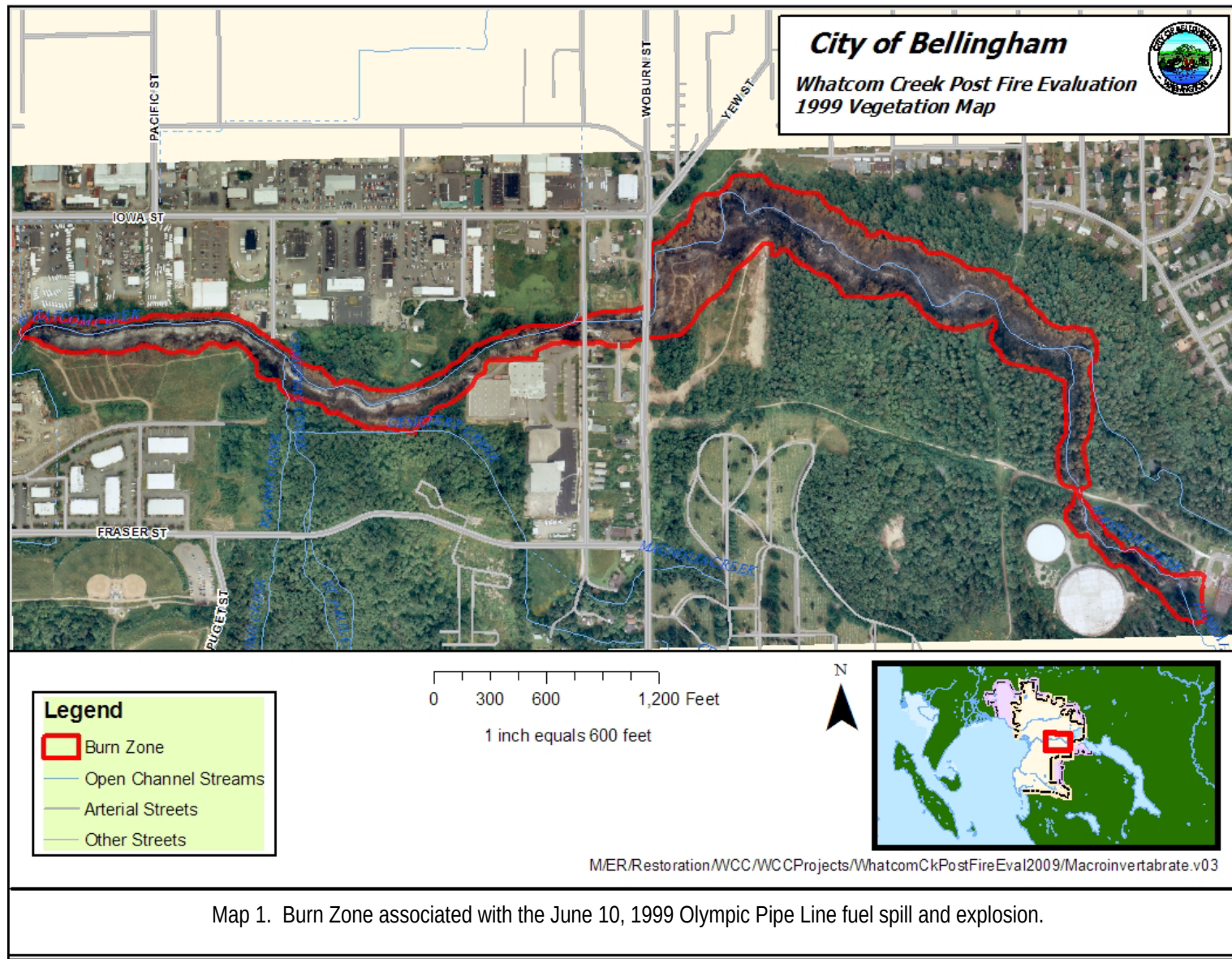


Source: Polaris Applied Sciences

Fire Along Whatcom Creek June 1999

represented by the Department of Ecology; the Lummi Nation of Washington; the Nooksack Tribe of Washington; and the City of Bellingham, appointed by the Governor. The Trustees oversaw the initial Emergency Response actions and development of a long-term restoration plan designed to determine the impacts of the spill on natural resources and identify measures that would be implemented to restore those injured resources. The plan included three primary components: 1) restoration actions, including emergency response and long-term restoration plan actions; 2) monitoring to track recovery of injured resources within the burn zone; and 3) monitoring and maintenance of sites where specific restoration actions were implemented.





Activities aimed at restoring the habitat associated with Whatcom Creek and monitoring the effects of the fire and subsequent restoration projects have been led by the City of Bellingham. To mark the ten-year anniversary of the event, the city has prepared a series of reports documenting those activities. Two supplemental technical reports provide



Source: Gunter Wilder, Bellingham Fire Department

Governor Locke Views Fire Damage

additional information on monitoring of the burn zone, “*Whatcom Creek Post-Fire Evaluation Report*” (Madsen and Nightengale 2009); and monitoring of restoration projects implemented since the fire, “*Whatcom Creek Restoration Project Report 2007-2008*” (Forester 2009). This Summary Report: 1) describes restoration projects that have been implemented since the burn, 2) summarizes the results of monitoring the recovery of the burned area (burn zone), and 3) summarizes the effectiveness of the restoration projects.



Source: R2 Resource Consultants

Burned Area in Whatcom Creek



Restoration Projects

Restoration of the burned area was undertaken in two phases. Emergency response activities commenced immediately following the fire. Long-term restoration actions were identified by the Board of Trustees following the fire, and have been implemented over the ensuing decade. Restoration activities have been complemented by acquisition of property and development of trails.

Emergency Response

Emergency response activities within the burn zone consisted of removing petroleum product from the water and streambed of Whatcom and Hannah creeks, restoring or enhancing aquatic habitat, protecting and stabilizing stream banks, and planting vegetation.

Hannah and Whatcom creeks were heavily impacted by the incident. After skimming as much gasoline as possible from the water, the stream channel was cleaned by excavating and removing contaminated soil and logs, and taking the material to a hazardous waste depository. Where excavation was impossible, stream bed gravel was manually washed and flushed.



Source: U.S. Environmental Protection Agency
Absorbent Boom in Whatcom Creek



Source: City of Bellingham
Planting in Burn Zone

Gravel from a local glacial deposit was imported as contaminated streambed materials were removed and used to replace streambed materials. Cobbles from the Nooksack River were added to help stabilize the smaller material. Pools, wood structures, and banks were reconstructed. Banks were sloped back behind the trees and wood. Exposed slopes were treated with coir fabric and hydroseeded. Burned logs that were soaked with gasoline were removed and more than 100 pieces of imported wood were placed in the channel to create pools and cover for fish.

Adjacent cedar trees and fern plants were transplanted in appropriate locations. Over 30,000 native tree seedlings were planted within the burned zone.



Long-Term Restoration

Of 34 potential restoration alternatives and/or restoration locations, the Long-Term Restoration Plan identified seven preferred alternatives (Table 1). Six of those projects had been completed by April 2009. In combination, these activities addressed injuries related to vegetation, wildlife, water quality, and recreation. Two undeveloped properties were acquired within or adjacent to the burn zone. Three major habitat restoration projects have been implemented as part of the Long-Term Restoration Plan, at Salmon Park, Cemetery Creek, and Red Tail Reach. Monitoring of those projects commenced in 2006, and maintenance activities are ongoing. Recreational improvements at Boulder Bend are still within the planning stage.

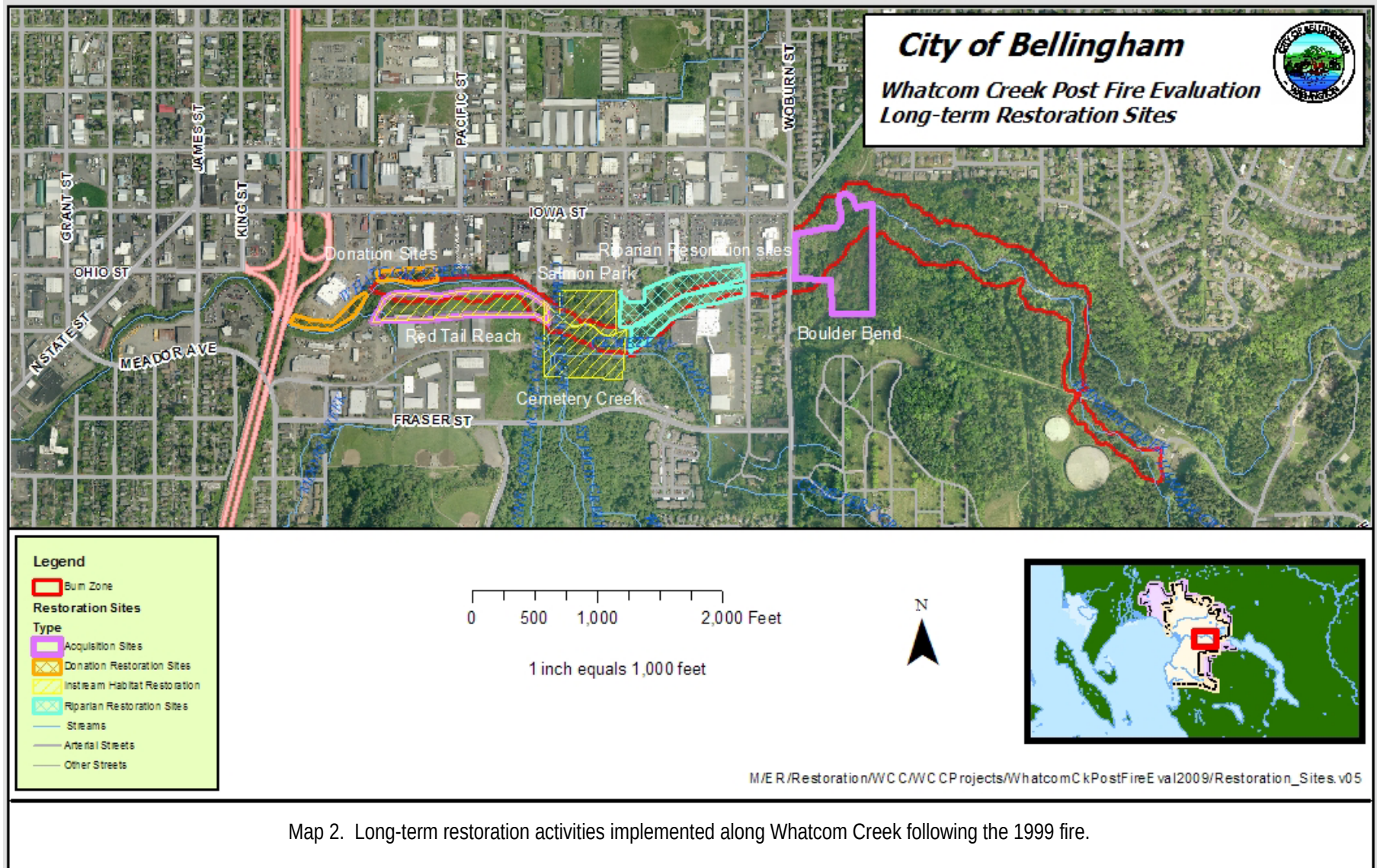
Table 1. Preferred Restoration Alternatives for the Whatcom Creek Long-Term Restoration Plan.

Alternative Number	Name
1	Planting and invasive species control on all city-owned property affected by the fire
2	Acquisition of 6.3-acre Red Tail Reach parcel near confluence with Cemetery Creek and instream habitat improvements
3	Acquisition of 9.5-acre Boulder Bend parcel at Woburn Street
4	Recreational improvements at Boulder Bend
5	Salmon Park Instream Habitat Restoration Project
6	Cemetery Creek Instream Habitat Restoration Project
7	Long-term monitoring and maintenance of burn zone and associated restoration projects

Property Acquisition

To ensure the long-term recovery of the burned area, the city acquired lands along the creek and restored or enhanced habitat in areas affected by the fire. Properties purchased by the city included a 9.5 acre parcel upstream of Woburn Street (Boulder Bend) and a 6.3 acre parcel at the west end of the burned area (Red Tail Reach; Map 2). Acquisition of these properties complements the purchase of lands along Whatcom Creek northeast of Woburn Street, between Woburn and Racine Streets and along lower Cemetery Creek that were acquired using funds generated by the 1990 Greenways levy. Additional lands have been donated to the city or dedicated as conservation easements. To date, more than 26 acres of riparian habitat have been protected within the burn zone.





Salmon Park and Cemetery Creek

The Salmon Park and Cemetery Creek projects were completed in 2006. These projects are located near the confluence of Cemetery Creek and Whatcom Creek. The Salmon Park Project covers over 350 feet of the Whatcom Creek stream bank to the north, while the Cemetery Creek Project encompasses approximately 250 feet along the south bank of Whatcom Creek and over 1,300 feet along Cemetery and West Cemetery creeks. Project elements included construction of backwater habitats along Whatcom Creek, creation of three small



Source: City of Bellingham

Pond Created at Cemetery Creek



Source: City of Bellingham

Salmon Park Wetland and Backwater Habitat



Source: City of Bellingham

Cemetery Creek Channel Reconstruction

ponds, and reconfiguration of the Cemetery Creek channel to include large woody debris, meanders, pools, backwaters and complex habitats in the formerly channelized stream. Ponds and backwaters provide refuge for salmon during high flows and wetland habitat for amphibians and other wildlife throughout the summer months. These projects enhanced habitat conditions throughout the area, while minimizing impacts to surrounding vegetation and ground surfaces. In addition, portions of an anthropogenic gravel berm were removed from the Salmon Park area, restoring geomorphic function by allowing Whatcom Creek to access and migrate within its associated floodplain.



Red Tail Reach

The Red Tail Reach Project was completed in April 2009. The project improved 1,550 linear feet of the Whatcom Creek stream bank and floodplain. The project area is located on the south side of Whatcom Creek between I-5 and Racine Street. The project removed 30,000 cubic yards of man-made fill from the floodplain, re-contoured sections of the existing stream bank, created three new backwater areas that emulate the appearance and function of historic channel oxbows, and placed large wood in the stream to enhance pools and provide cover for salmon. Following construction, 14,600 native plants were planted throughout the site, replacing a vegetation community that had previously consisted almost entirely of invasive weeds.

The site was planted in 2008 through the cooperative efforts of the City of Bellingham Public Works and Parks Departments, city-sponsored Washington Conservation Corps crews, and the Nooksack Salmon Enhancement Association (NSEA). Willows, sedges, ferns, and other plants were added in April 2009. The Red Tail Reach Project increases rearing habitat for juvenile salmonids and holding habitat for adults by improving pools. In addition, the project provides winter rearing habitat and refuge from high flows in backwater areas. The increased habitat complexity and future native forest will benefit all salmon lifestages as well as other wildlife species.



Source: City of Bellingham

Fish removal during Red Tail Reach construction



Source: City of Bellingham

Volunteer Planting Party at Red Tail Reach Site



Source: City of Bellingham

Red Tail Reach Site in the Spring After Planting



Trail System and Memorial

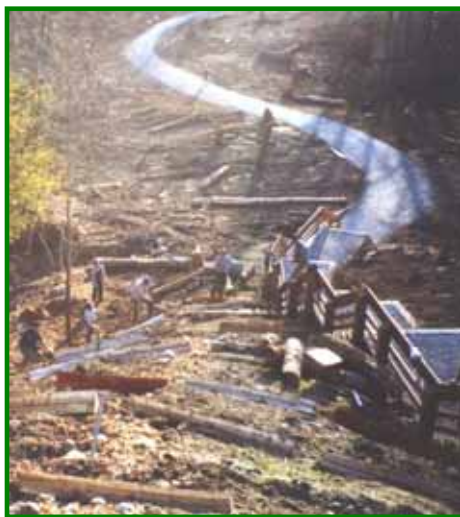
Prior to the fire, the City of Bellingham Parks Department had identified land acquisition and trail development along Whatcom Creek as high priorities. Since the fire, many of those goals have been achieved. The trail system provides an invaluable resource for the community, and provides an opportunity for all city residents to observe the area as it recovers following the fire.

In 2007, the Lummi Nation created and installed a Memorial Pole honoring the three young men who lost their lives in the fire, as well as community members who drew together to provide support and help restore the area. The pole was installed during a healing event attended by tribal leaders, city, state and federal officials, and community members whose lives were deeply affected by the event.



Source: City of Bellingham

Lummi Nation Memorial Pole Ceremony, April 2007



Source: City of Bellingham

Heart Attack Hill before Construction



Source: City of Bellingham

Heart Attack Hill Trail after Construction



Post-Fire Monitoring

Data utilized to complete the post-fire evaluation of Whatcom Creek were generated primarily through ongoing monitoring activities conducted by the City of Bellingham. The 2009 Post-Fire Evaluation Report (Madsen and Nightengale 2009) provides a point-in-time re-evaluation of environmental conditions in the burn zone in 2009 as compared to 1999 post-burn conditions and the original restoration plan goals. The evaluation focused on biological communities and physical habitat attributes.



Source: City of Bellingham
Planting at Salmon Park

Biological Monitoring

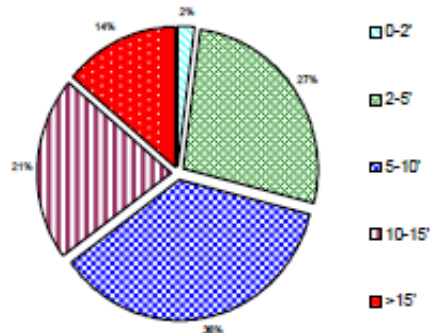
Vegetation

Ten years after the fire, aquatic and terrestrial ecosystems associated with Whatcom Creek are well on their way to recovery. Vegetation monitoring was conducted in 2000, and again in 2006-2007 (Cantrell and Associates 2007). Trees planted following the Whatcom Creek fire have been largely successful in survival and growth. While the number of young trees per acre has decreased slightly and the spacing between trees has increased slightly since 2000, this is to be expected as trees mature and naturally thin due to competition for resources. The number of trees per acre decreased by only 12 percent, while 95 percent of trees have at least doubled in height, and 71 percent of young trees are 5-feet tall or taller. Average canopy cover in the Whatcom Creek study area increased from near zero in many areas to 47 percent and will likely continue to rise as planted trees continue to grow. Control of invasive species remains an ongoing challenge, but periodic monitoring facilitates the early identification and treatment of problem sites. Immediate treatment of exposed soils appears to have successfully prevented ongoing erosion problems related to the fire.

Table 15. Young tree density (trees per acre) and tree spacing (feet) for the 2000 monitoring effort and the current study (from Cantrell and Associates 2007).

Polygon Name	Trees Per Acre		Tree Spacing (FT)	
	2006/2007	2000	2006/2007	2000
1 Hannah Creek and Whatcom Canyon South Slope	1191	1178	6	6.1
2 Whatcom Canyon North Slope	1136	870	6.2	7.1
4 Heart Attack Hill and Riparian Fringe	619	971	8.4	6.2
6 Grizzly	773	N/A	7.9	N/A
6B Grizzly (Third Party Planting)	694	N/A	7.9	N/A
7 Whatcom Creek Salmon Park	1034	1295	6.5	5.8
7C Whatcom Creek Salmon Park (Not Planted Zone)	0	N/A	N/A	N/A
8 Haskell Site (Red Tail Reach)	0	N/A	N/A	N/A
Average for Planted Burn Zone	951	1079	7	6





The percent of planted trees within the different height categories in the burn zone in 2007 (from Cantrell and Associates 2007).

Fish Community

The City of Bellingham has conducted surveys of spawning salmon in the burn zone since 1999. City staff walk the stream every seven to ten days from September through March, counting live adult fish, salmon carcasses and redds (where salmon lay their eggs). In 2000 and 2001, nearly 100 Chinook per year were observed spawning in the burn zone. In 2002, few Chinook were observed, but 92 chum were counted within the burn zone. Since that time, fewer than ten Chinook or chum have been observed in any year during spawning surveys. Chinook salmon, coho salmon, and steelhead trout that return to Whatcom Creek are also counted at the Whatcom Falls Hatchery before being released upstream. The number of anadromous fish returning to the Whatcom Creek Hatchery since the fire has also been substantially lower.

Several factors confound determination of a cause and effect relationship between the fire and the decline in fish returns to Whatcom Creek. Concurrent with the 1999 fire, several salmon species in Puget Sound



Source: City of Bellingham
Chinook Spawning in Whatcom Creek

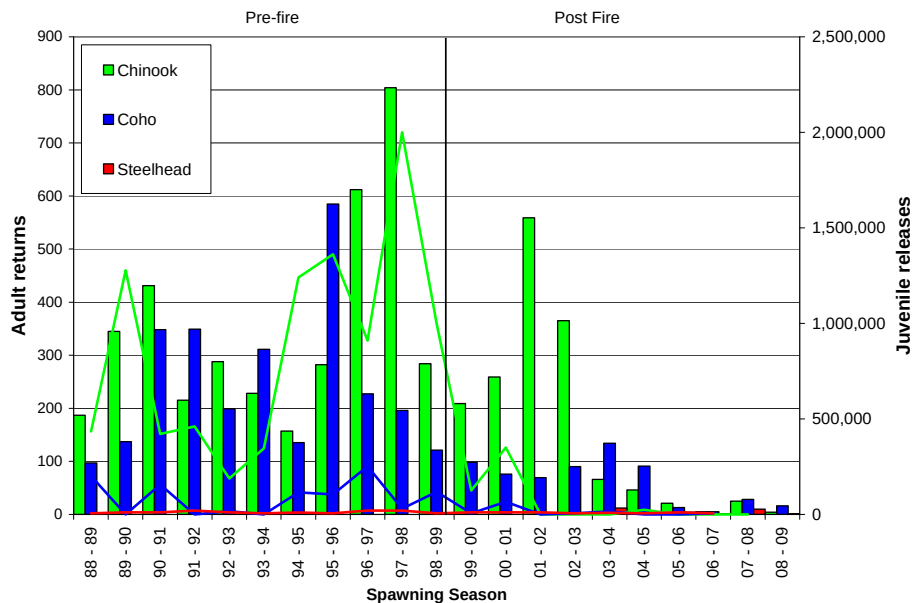


Source: City of Bellingham
Spawning Survey in Whatcom Creek



were listed as threatened under the Endangered Species Act (ESA). At the time of the burn, the Washington Department of Fish and Wildlife Hatchery Management policies were evolving in response to ESA listings of anadromous fish throughout the Pacific Northwest. Operations at the Maritime Heritage facility were altered to bring them in line with the Washington Wild Salmonid Policy and emphasize production of local stocks. Prior to the fire, large numbers of juvenile fish from stocks originating outside of the Nooksack basin were released in Whatcom Creek. Planting of Chinook salmon was halted in 1999. At the same time, numbers of planted coho salmon and steelhead trout were reduced to around 5,000 fish of each species each year.

Since the fire, physical conditions in Whatcom Creek have been improving. Flows in Whatcom Creek have increased during the spawning season of Chinook, chum, and coho as compared to before the burn. The increase is due to changes in flow management as well as an increase in the amount of water available when delivery of 51 cfs to the Georgia Pacific Paper Mill ceased in 2001. Increased flows provide better fish access and more habitat at some times of the year. In addition, habitat surveys show that habitat and water quality have been maintained or improved by the emergency response and long-term restoration actions. As a result, while the fire may have contributed to reduced adult returns of salmon, it seems unlikely that it is the major factor responsible for the observed decline.



Anadromous fish returns and juvenile releases to the Whatcom Creek hatchery since 1989. Bars represent adult fish returns and lines represent juvenile fish releases (from R2 2009).



Aquatic Macroinvertebrates

Aquatic insects (macroinvertebrates) in Whatcom Creek were sampled at three sites for five years following the fire (1999-2003), and again in 2007. These data were compared to samples collected by the Washington Department of Ecology in



Source: Tim Nightengale
Rhithrogena mayfly

1998 to assess recolonization and recovery. Sampling seven days after the fire showed an almost complete loss of the macroinvertebrate community (LaCroix 2001). Estimates of the mean density (individuals/ m²) in October 1999 indicate that aquatic insects rapidly repopulated sampling sites on Whatcom Creek following the fire. However, data indicate that the type of aquatic insects inhabiting the stream has changed. Three months after the fire, both the Racine and James Street sites showed an increase in minnow-tailed mayflies (Baetidae), which are known to be more tolerant of poor water quality conditions. By the fall of 2000, both sites showed a return of flat-headed mayflies (Heptageniidae), a less-tolerant family of mayflies that were common before the burn. While this suggested recovery was at hand, their numbers have since continued to be significantly less than that seen in pre-burn samples.



Source: Tim Nightengale
Perlid stonefly like those found at Middle Fall

Results of the comparative analysis indicate a shift away from aquatic insect species that graze on algae and other materials on streambed gravels (scrapers), towards a community of species that gather fine particulate matter (collector-gatherers). The reduction of percent scrapers in 1999 suggests that Whatcom Creek is not as productive as it was before the fire, at least in terms of algal growth. Two indices that are commonly applied in macroinvertebrate studies are the Community Tolerance Index (CTI) and Benthic Index of Biological Integrity (B-IBI). Results using CTI give scores ranging from 6.1 to 7.2, with an overall average CTI score of 6.6. On a biotic index scale of 0 to 10, this average score indicates “fair” conditions, often a result of “fairly significant organic pollution.” Scores for the B-IBI ranged from 12 to 28, out of a possible total of 50, indicating that the sites on Whatcom Creek are in “poor” to “fair” condition. It is



Source: City of Bellingham
Macroinvertebrate Sampling



unclear whether this effect is related to the fire or other urban impacts within the Whatcom Creek watershed.

Birds and Terrestrial Wildlife

Riparian restoration along the Whatcom Creek corridor has benefited all wildlife that use riparian forest areas. Using settlement funds, the City of Bellingham has acquired and restored native vegetation on two large parcels of land, increasing the amount of protected riparian habitat by 13.5 acres. In addition, planting of riparian areas occurred throughout the 26-acre burn zone. Although few quantitative data are available on wildlife use of the area prior to the 1999 fire, it appears that wildlife communities currently inhabiting the burn zone are similar to those that would be expected to inhabit the area in an urban ecosystem. Deer, mink, and beaver are commonly observed along Whatcom Creek, as are tracks and scat of otter, coyote, raccoons, and other small to mid-size mammals. The numerous snags created by the fire may have increased habitat for some species such as cavity-nesting birds and mammals. However, non-native bird species appear to dominate cavities in more open areas (Dolan 2008).



Source: City of Bellingham

Downy Woodpecker
on Snag along Whatcom Creek

Physical Monitoring

Instream Habitat



Source: R2 Resource Consultants

Crew Conducting Habitat Surveys after Burn

Stream habitat was surveyed immediately following the burn in 1999, and again following the emergency response restoration actions in 1999 and 2000. Additional surveys were conducted in 2007 and 2009 to track changes over time. Prior to the emergency response actions, aquatic habitat conditions in Whatcom Creek were considered poor according to all available criterion. Wood placement and pool excavation as part of the



emergency response resulted in short-term improvements of habitat. Subsequent instream habitat restoration projects have maintained improved habitat conditions, particularly downstream of Woburn Street. Throughout the stream, the amount of wood and the number of pools is similar to, or better than in 1999. Off-channel habitats and the meandering channel configuration established by restoration projects at Salmon Park, Cemetery Creek, and Red Tail Reach have improved habitat complexity, and substantially increased backwater habitat that serves as refuge for juvenile salmon during floods.

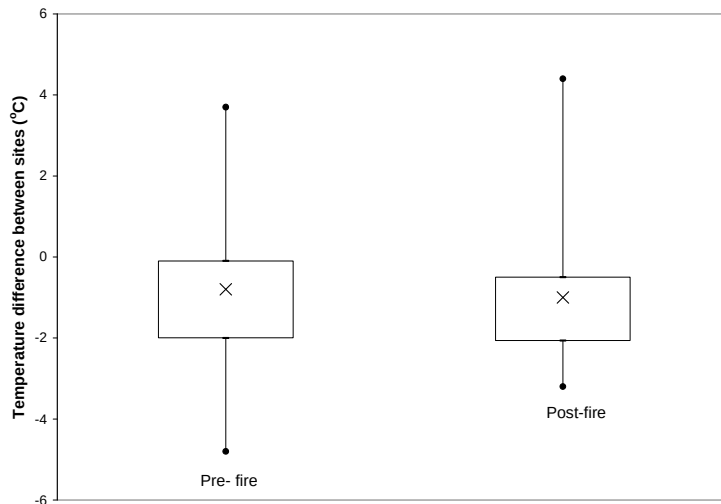


Source: City of Bellingham

Conducting Survey of Large Woody Debris

Water Quality

Monthly water quality measurements upstream and downstream of the burn zone indicate that the fire does not appear to have had substantial, long-term negative effects of water quality parameters that are closely linked to biotic health. The most direct effect of the fire and subsequent loss of vegetation within the burn zone would have been to reduce the cooling properties of streamside vegetation. However, the data indicate that the relatively warm water flowing out of Lake Whatcom continues to cool slightly as it flows through the Whatcom Creek gorge, despite the loss of streamside vegetation. Subsequent property acquisition and revegetation projects completed as part of the Long-Term Restoration Plan will eventually improve riparian shading levels throughout the stream corridor as compared to the pre-fire conditions.



Summary statistics for dry season difference in temperature up and downstream of the burn zone before and after the fire. Median is represented by x, and the boxed area encompasses the 25th to 75th percentiles. Tails represent maximum and minimum values for the period of record (1999-2008) (from R2 2009).



Dissolved oxygen (DO) levels appear to have increased in the burn zone since the fire. Dissolved oxygen is strongly related to temperature, flow, and turbulence. While data show that water temperatures do not appear to have increased as a result of the fire, habitat restoration projects completed as part of the emergency response and subsequent Long-Term Restoration Plan have increased the hydraulic complexity and turbulence, and this is likely contributing to the increased DO levels observed in the burn zone. Conductivity, pH, and turbidity do not appear to have been affected by the fire.

Erosion and Slope Stability

One of the greatest fears immediately following the fire was that slopes would undergo severe erosion during heavy fall rains following the fire. Immediate treatment and riparian plantings, in combination with recovery of plants whose roots survived underground prevented this from happening. No major areas of erosion that could be directly related to the 1999 fire were observed in 2009. In general, slopes in these areas are well vegetated and appear stable.



Source: Polaris Applied Sciences
Hydroseeding Exposed Slopes Following the Fire



Restoration Site Monitoring

Long-term restoration projects resulted in the creation of three ponds along Cemetery Creek, two backwaters along Whatcom Creek, reconfiguration of the Cemetery Creek channel, and installation of large wood throughout the sites (Map 3).

In 2006, the City of Bellingham initiated monitoring of long-term restoration sites funded through the Olympic Pipe Line Settlement. The Restoration Monitoring and Maintenance Program will track the condition and effectiveness of the Cemetery Creek and Salmon Park Projects over a ten-year period. Results from the first two years of monitoring have been summarized in the Restoration Project Monitoring Report (Forester 2009).

Vegetation

Vegetation monitoring indicates that more than 75 percent of the plants installed in the restoration project areas have survived and are in fair to good condition. In many areas, there has also been a dramatic increase in native trees and shrubs due to natural recolonization by red alder, cottonwood, salmonberry, snowberry, and Indian plum seedlings. Willows, red alders, and black cottonwood planted at the site are growing rapidly, and many are more than 5-feet tall just two years following planting. Ground cover has increased at most sample transects as a result of plant growth and natural recruitment. Aquatic vegetation has also been observed colonizing the shallow pond margins and backwater habitats. Native aquatic vegetation provides hiding cover for fish and substrate for amphibians to lay eggs on.



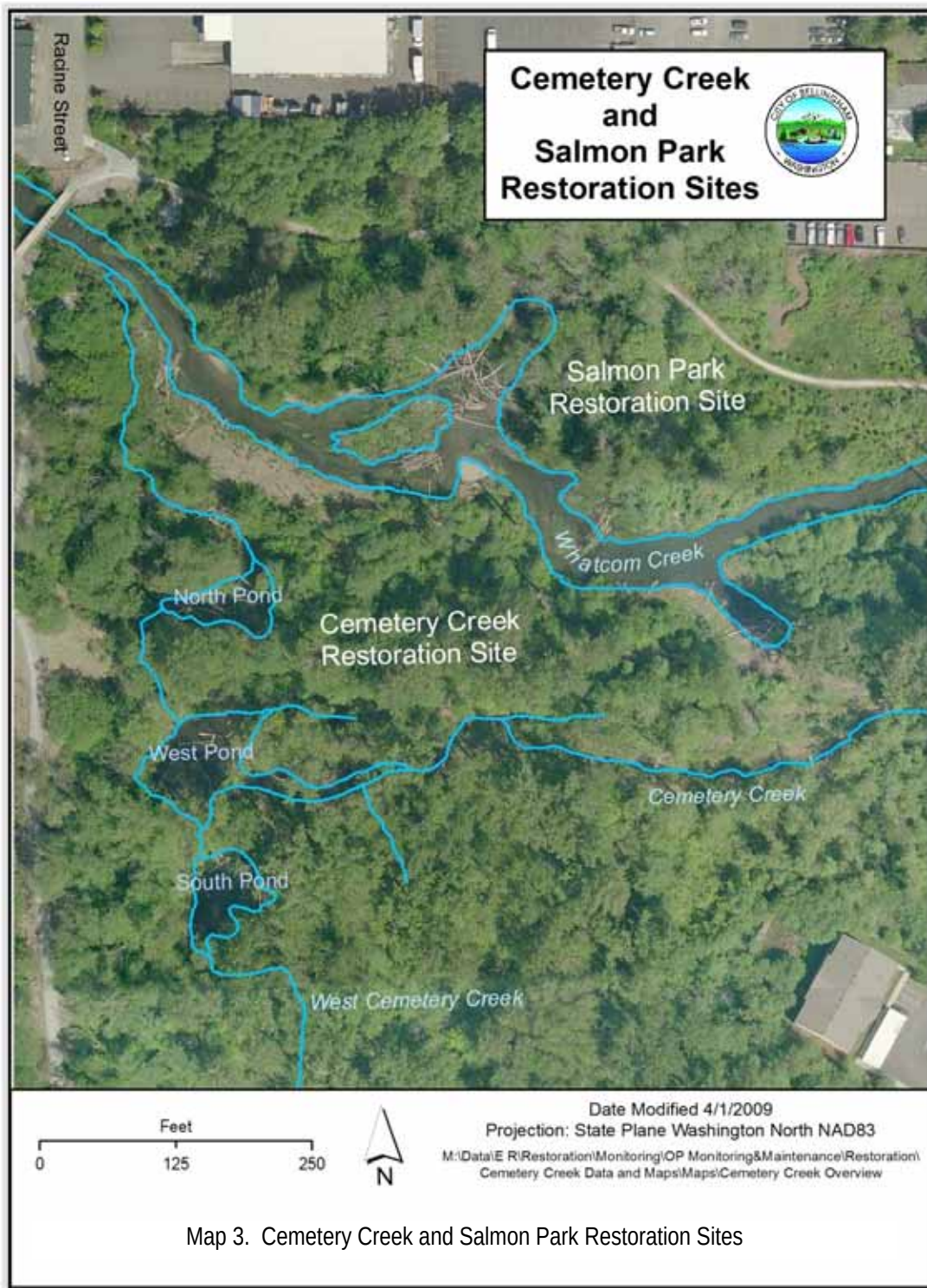
Source: City of Bellingham



Cemetery Creek Immediately after Restoration

Invasive species are tracked as part of the overall monitoring program. Small invasive plants such as creeping buttercup, reed canary grass, and seedling blackberry are common, but will ultimately be shaded out. Larger invasive species are regularly removed from the site. To date, there has been no indication of the presence of two highly problematic invasive aquatic plants: Brazilian elodea (*Egeria densa*) and hydrilla (*Hydrilla verticillata*).





Fish Community

Fish use of the Cemetery Creek restoration site is being monitored by conducting annual spawning surveys and periodic smolt trapping. Spawning surveys occur from September through March, and are repeated at 7- to 10-day intervals. To date, coho are the only species documented as spawning in the restoration project area. Two coho redds were identified in 2007-2008 and also in 2008-2009. The location of redds indicate that salmon are using spawning gravel patches placed as part of the restoration project. One or two coho or carcasses per year have been observed in the survey reach. In 2007, a male Chinook carcass was found within the project site; however, examination revealed it had died before successfully spawning.



Source: City of Bellingham
Coho Carcass in Cemetery Creek

The smolt trap is constructed on Cemetery Creek just downstream of the West Pond. Juvenile fish moving downstream in Cemetery Creek are intercepted in a screened box; the box is checked at least twice a day, and more often during high flows. Fish are identified to species and recorded by size class. Trapping occurred in 2007, and is underway in the spring of 2009. In 2007, a total of 1,984 fish were collected from the trap between March 28 and June 7. Coho salmon and cutthroat trout dominated out-migration. Non-native species such as smallmouth bass, and goldfish were also occasionally encountered. As of May 15, 2009, almost 1000 salmonids had been counted at the trap, predominantly coho salmon and cutthroat trout.

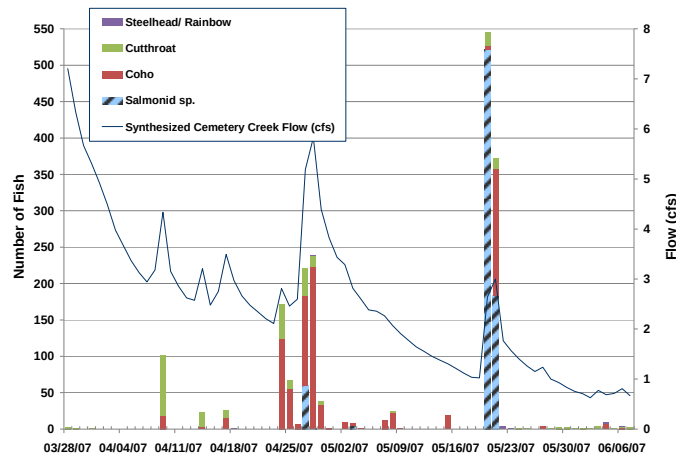


Source: City of Bellingham
Smolt Trap Data Collection



Source: City of Bellingham
Checking Smolt Trap in Cemetery Creek





Cemetery Creek Smolt Trap Results from 2007 (from Forester 2009).

Aquatic Macroinvertebrates

Macroinvertebrate samples have been collected from three sites within the reconstructed Cemetery Creek channel. Sample processing is currently underway, and results will be presented in the Restoration Project Monitoring 2009 data report.

Riparian and Terrestrial Wildlife

Under the long-term monitoring program, bird and amphibian surveys are conducted each spring within the Salmon Park and Cemetery Creek sites. Amphibian surveys have confirmed the presence of two native frog species (red-legged frog and Pacific tree frog) and one native salamander species (long-toed salamander). Non-native bullfrogs have also been observed in the restoration sites, and may represent a threat to native fish and amphibian species.



Source: City of Bellingham (2009)

Red-Legged Frog and Long Toed Salamander Found at the Cemetery Creek Restoration Site



Breeding bird surveys are conducted at three locations each spring. Incidental sightings are also reported by staff working in the area. Overall, the restoration sites show high species richness, with 63 species positively identified. The species list does not include nocturnal birds that likely use the restoration site; these may include barn, great horned, barred, and western screech owls. Seven of the birds observed at the site are listed as Priority Species by the State of Washington. The restoration sites appear to support breeding populations of two Priority Species (Wood duck and Pileated woodpecker), and their presence has been reported to the Washington Department of Fish and Wildlife. One non-native species, the European starling, is frequently seen at the restoration sites. European starlings have been observed ejecting native bird species from cavities in snags originating from large trees burned in the 1999 fire (Dolan 2008).



Source: City of Bellingham

Amphibian Surveys at Cemetery Creek Site



Source: City of Bellingham

Raccoon Tracks in Cemetery Creek



Source: City of Bellingham

Blacktail Deer Fawn at Cemetery Creek Site

Six native mammal species have been identified within the restoration sites, and it is likely that several others are present. Black-tailed deer, beaver, muskrat, voles, rabbits, and mink have been observed. Raccoon (tracks), otter (scat), and coyote (tracks and scat) are also believed to be present. Non-native eastern cottontail rabbits and grey squirrels are abundant.

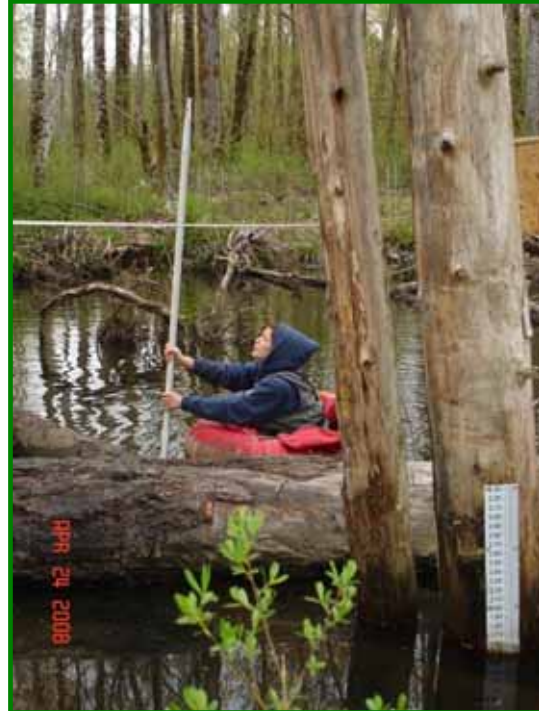


Ponds and Streams

Ponds and streams are monitored to ensure the project continues to provide high quality habitat for fish. Pond depths are measured to track the rate at which sediment accumulates in the ponds. Channel cross-sections are surveyed to confirm that bank erosion is minimal and that the reconfigured channel does not fill with sediment or downcut. Stream surveys are conducted to track the quality of salmon habitat within the Cemetery Creek restoration site.

The depth and volume increased for all ponds from 2007 to 2008. This result is somewhat surprising as the most likely response of the ponds over time was hypothesized to be filling. Changes in depth may be related to surveyor techniques (i.e., the amount of force used to set the rod on the pond bottom).

Future surveys will be conducted using a depth sounder with a standard weight to avoid surveyor bias.



Source: City of Bellingham

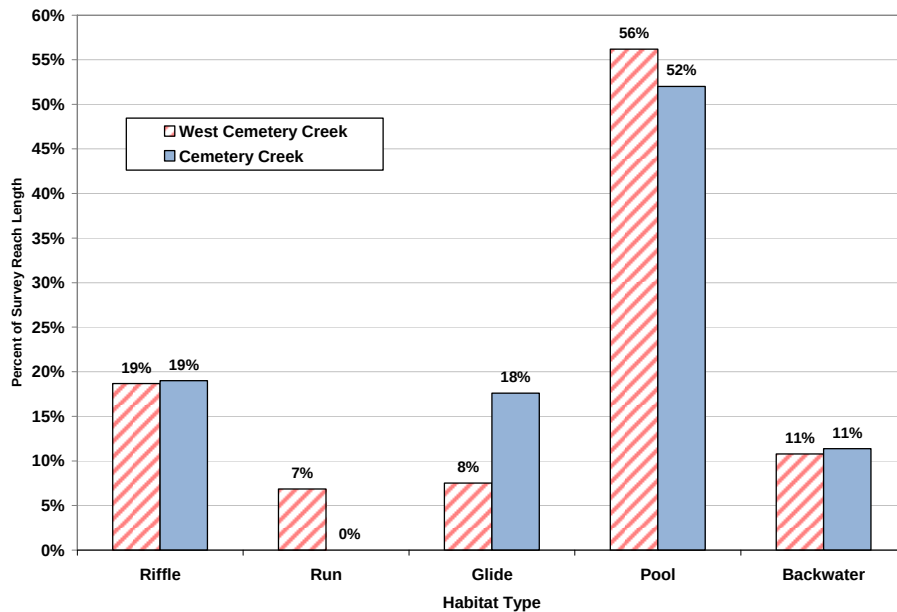
Pond Bathymetry Survey

Channel cross-sections remained stable from 2007 to 2008. A confirmed change in channel profile was observed at only one cross-section, where erosion has lowered the bed for six to eight inches across approximately 5 feet of bed. The scour has occurred behind a piece of large wood and around the roots of an adjacent tree, and has functionally increased habitat complexity and hiding cover for fish in that area.

Prior to restoration, Cemetery Creek consisted of a narrow, channelized stream with little habitat complexity. The restoration project increased pool and pond habitat; in 2007, more than 50 percent of the project reach consisted of those low velocity habitat types. Deep, low velocity areas provide refuges that allow small fish to avoid swift flows during floods. Riffle habitats were the second most common, representing about 20 percent of the habitat. Riffles provide substrate for macroinvertebrates, and the clean gravels needed for successful salmon spawning.



Habitat conditions currently are rated good in West Cemetery Creek, and fair to good in Mainstem Cemetery Creek according to NMFS standards for properly functioning conditions (NMFS 1996).



Habitat Unit Subtypes in Mainstem and West Cemetery Creek in 2008 (from Forester 2009).

Water Quality

Water quality is monitored monthly or more frequently in the ponds and streams at the Cemetery Creek sites. Water quality conditions are generally good during the wet season. Temperatures in the ponds and in Cemetery Creek exceed the state standard of 16°C during the summer, while the groundwater-fed West Cemetery Creek generally meets the state water quality requirements. In all cases, temperatures in the Cemetery Creek system are lower than in mainstem Whatcom Creek.

Dissolved oxygen (DO) levels also vary both seasonally and spatially. DO levels are generally high during the wet season. In the summer, flows in Cemetery Creek are very low (at times subsurface), and DO levels do not meet Washington State water quality standards. In contrast, flows in the groundwater-fed West Cemetery Creek are more consistent, and DO levels, while somewhat lower than state standards, are considerably higher than in the mainstem. DO levels drop in the ponds, and may reach levels considered to be potentially detrimental to salmonid fishes; however, higher DO levels have been identified near pond outlets. DO levels downstream of the ponds increase somewhat, and, except for the season immediately following construction, appear to be consistent with pre-project values.



Conductivity and pH in the Cemetery Creek restoration site meet state standards. Extremely high fecal coliform levels were occasionally identified in inflows to the project sites. Fecal coliform levels generally drop slightly through the restoration site. Very high values are reported to City's stormwater management division for follow-up surveys as part of the ongoing NPDES permit and TMDL compliance.



Source: City of Bellingham
Measuring Water Quality in Cemetery Creek North

Conclusions

Although complete recovery of the area may take decades, ten years after the incident, ecosystems associated with Whatcom Creek appear to be recovering. Successful implementation of Emergency Response and Long-Term Restoration Actions has maintained or improved aquatic, riparian, and terrestrial environments throughout the area affected by the fire. Monitoring of restoration projects provides invaluable scientific information about the effectiveness of the projects that can be applied to similar systems.

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