Miller Creek

FISH/HABITAT RELATIONSHIPS

MEASURES, ANALYSIS and REPORT

Using the

U. S. FOREST SERVICE

SCIENTIFIC METHOD of STREAM SURVEY

by

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January 2009

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Executive Summary

This report examines the effects of 15 years of stream restoration work on 2,000 feet of Miller Creek on the Normandy Park Community Club (NPCC) property in Normandy Park, WA. The work included in-stream structure installations, invasive weed removal, native plant re-vegetation and trail improvements.

The U.S. Forest Service Scientific Method of Stream Survey was used for the original survey in 1993. The same survey was done again in 2008. Trout Unlimited performed both surveys.

The data collected by the two surveys were compared and analyzed to identify changes to the stream caused by the restoration work and to guide future restoration projects.

The results of the analysis show the following:

- **Some new pools were created using large wood; most existing pools were maintained or improved, some existing pools were lost due to flooding.**
- **There was a significant improvement in the quality of existing pools.**
- **The substrate composition has not changed much, but the distribution of silt and gravel has changed to the positive.**
- **The stream canopy and streamside habitat has improved significantly.**
- **Large wood in the stream has increased by a factor of 37 times.**

Much has been learned in the past 15 years about stream restoration practices. Many subject-matter-experts from Washington State WDFW, King County, Port of Seattle, University of Washington, Trout Unlimited, consulting firms and private individuals have contributed their knowledge to this restoration effort over the years. The findings of this study will form the basis of future restoration work and will be used to assist other communities and groups in their stream restoration efforts.

Additionally, citizen, community and local government involvement in local stream restoration and “ownership” has improved dramatically.

2008 Survey Team Members

The 2008 Survey Team members:

- **Al Miller – Trout Unlimited (leader of the 1993 survey)**
- **Dr. John Muramatsu – Trout Unlimited (1993 survey team member)**
- **John Richardson – Trout Unlimited (1993 survey team member)**
- **Andy Batcho – Trout Unlimited and Stewards of the Cove (1993 survey team member)**
- **Art Kawaguchi- Stewards of the Cove member**
- **Pat Pressentine – Stewards of the Cove member**
- **Gary Gaebler – Stewards of the Cove member**
- **Ron Ebbers – Stewards of the Cove member**
- **Ron Johanson – Stewards of the Cove member**
- **Dave Evans – Stewards of the Cove member**
- **Dan Rue – Stewards of the Cove member**

Purpose

The purpose of this U.S. Forest Service Scientific Method of Stream Survey - Habitat/Fish Relationships, data collection, and analysis is to scientifically measure the fish/habitat characteristics of ~2,000 feet of Miller Creek on the Normandy Park Community Club (NPCC) property in 2008.

This data collection process was previously preformed in 1993 by volunteers from Trout Unlimited. The data from the 2008 survey were analyzed and compared to the 1993 data to determine what changes the stream had experienced due to restoration work and other factors at work in the stream basin. Then we determined which areas of the stream needed further restoration attention and specifically which habitat factors needed assistance.

The survey and analysis was only done on the ~2,000 feet of Miller Creek from saltwater upstream to S.W. 175th Place. Most of this stretch is on NPCC property but the uppermost reach is on property owned by Helen Kludt.

The survey and analysis did not include any portion of Walker Creek, the man-made salmon rearing pond, or the restored salt-marsh area that have been a major part of TU and Stewards of the Cove restoration work. The survey conclusions and recommendations are most suited for small urban streams, although they may apply to larger river systems in many ways, large rivers were not the focus of this study.

U.S. Forest Service Scientific Method of Stream Survey

Fish/Habitat Measurements and Salmon Relationships

The U.S. Forest Service Scientific Method of Stream Survey - Fish/Habitat relationships requires the measurement of many physical stream habitat elements. These elements are important to both spawning adult salmon and juvenile salmon that rear in the freshwater environment for up to 18 months.

This survey method examines physical habitat elements such as stream and overall channel width and depth, substrate make-up, riffle-to-pool ratios, pool quality, large woody debris (logs), and riparian habitat with 100 feet of each bank. Each of these analysis elements is graded, using a numerical and/or alpha system.

This survey does not examine other required elements of a healthy salmon environment such as water quality, insect populations, pollutants, and nutrients. Some of these and other factors have been measured with other methods and surveys. As of late 2008, a separate process was underway to prioritize and coordinate desirable monitoring of water quantity, water volumes, and biological factors/habitat elements in the Miller/Walker Creeks basin.

Elements of this survey, the grading systems, and importance to salmon habitat consist of:

- ***HT = Habitat Type:*** **The stream is broken into habitat types as part of the survey. There are 24 separate types. For the sake of brevity, only the 4 major categories are explained below.**
  - ***Riffle (RF)*** **= shallow water flowing over rocks, showing waves or white water.**
  - ***Run (RU)*** **= fast-moving water without evidence of waves or white water; deeper than a riffle.**
  - ***Glide(GL)*** **= similar to a pool but with faster-moving water; deeper than a run, shallower than a pool.**
  - ***Pool (PL)*** **= slower moving water than a glide; deeper than a glide.**

- **Just an example of the other sub-types of these habitat types for pools. There are secondary channel pools, backwater pools, corner pools, lateral scour pools, trench/chute pools, dam pools, plunge pools, obstruction pools, confluence pools & step pools. Riffles can be edge water, low gradient, high gradient, cascade and bedrock sheet.**

Importance to salmon**: Riffles and runs are essentially shallower, faster flowing areas of clean gravel. These are areas where adult salmon tend to spawn and were aquatic insects live in large populations, under clean gravel; thereby providing food for juvenile salmon. Pools and glides are slower and deeper sections of water; the preferred rearing habitat for juvenile salmon.**

- ***W = Mean WIDTH*** **of Habitat Type. Width of habitat type at current water levels.**
- ***D = Mean DEPTH*** **of Habitat Type. Taking three measurements across the width of a habitat type, D is the average depth of the habitat type.**

- ***L = Length of Habitat Type.*** **This measure is a bit more important. If the habitat type is a pool, L is the measure of the length of the pool? If the habitat type is riffle, L is the length of the riffle?**
- ***CW = Channel Width*** **A measure the channel width from bank full mark to bank full mark.**
- ***CD = Channel Depth*** **Channel depth consists of three averaged depth measurements across the width of the habitat type down from an imaginary line drawn from the full bank mark on each shoreline.**

***Importance to salmon*:** **The above measures determine the size of the habitat type compared to the total width of the stream. Larger (more square feet) of prime habitat rears more juvenile salmon, just as larger pastures raise more cattle.**

Riparian Zone measures:

- ***LB –RB*** **LB = left bank RB = right bank. Left and right are determined by facing down stream.**
- ***SS = Streamside Structure*** **0= no riparian zone (lawn, road, building). 1 = mature complex forest. 2 = immature/even–aged/disturbed forest. 3 = shrub-dominated. 4 = grassland/meadow/pasture. 5 = wetland.**
- ***Width = Width of Habitat Type*** **on the left bank and right bank (up to 100 foot maximum on either side)**
- ***TY = Type of vegetation*** **C = coniferous. D = deciduous. M = mixed; if lawn, write in lawn.**

Importance to salmon: **The vegetation of the riparian zone is very important to juvenile salmon. The vegetation provides several important features to the salmon including bio-filtration of pollution and excess nutrients and shade to keep waters cool. Roots bind the soil to prevent erosion and siltation of gravel. Trees eventually fall into the river and create structure. Leaves and logs provide nutrients (nitrogen) for aquatic plant growth and food for aquatic leaf-chewing insects. In natural streams; other than salmon carcasses, leaves and logs are the main nutrient supply to the stream; although in highly urbanized streams, fertilizers and failed septic systems add to the nutrient load significantly. Terrestrial insects are attracted by the leaves, flowers, and fruits. The terrestrial insects are blown or fall into the stream, providing additional food source for juvenile salmon. Native plants provide the advantage of growing in these habitats with little human assistance. In contrast, shallow rooted grass/lawn provides little to none of these advantages to the salmon and mono-cultures of invasive weeds such as Himalayan blackberry provide only a fraction of the values of mature native vegetation.**

- ***SBST = Dominate SUBSTRATE TYPE*** **throughout habitat type. 1 = bedrock 2 = silt/organic (mud) 3 = sand 4 = gravel (1” diameter or less) 5 = gravel (1” to 4” diameter) 6 = cobble (4” to 9” diameter) 7 = boulder (10” or greater diameter)**

***Importance to salmon*:** **Proper-sized, clean (not impacted by silt) gravel is extremely important to the salmon life cycle. The adults use the clean gravel to form redds (egg nests). Insects, that feed the fry, live in clean gravel, cling to the surface and algae graze on the surface of cobble. Boulders create pools due to hydraulics and provide resting areas for adults and juveniles. Some natural organic silt areas provide habitat for other types of aquatic insect food sources (e.g., worms).**

- ***PQI = Pool Quality Index*** **On a scale of 1 to 5, a rating of the pool. (this is simplified from the USFS 10 point scale)**
- **1 = pool is 1' or less deep, is 25% or less of overall stream width, has little to no cover (cover = overhanging brush, logs, wood, underwater complexity of sticks, tree roots, brush, etc.).**
- **2 = pool is 1' to 2' deep, is 50% or less of overall stream width, has some cover.**
- **3 = pool is 2' to 3' deep, is 50% of stream width, has some cover.**
- **4 = pool is 3' deep, is 75% of stream width, has good cover.**
- **5 = pool is 3 or more feet deep, is 100% of stream width, has excellent cover.**

Importance to salmon**: Juvenile salmon tend to prefer pools for rearing habitat. The PQI measure attempts to measure the quality of a pool from a juvenile salmon's perspective. Larger, deeper pools that are more complex and have cover are the highest quality pools. Improvement in these factors allows more salmon to live in a pool, use less energy to obtain food and protect personal space, and avoid predators.**

- ***LWD = Large Woody Debris***
- **LE = Length, length of log**
- **DI = Diameter, average diameter of log**
- **ST = Stability of Log, A = anchored U = unanchored ? = unknown**
- **V = Variety of log, C = coniferous D = deciduous ? = uncertain**
- **CN = Condition of Log, S = solid R = rotted**
- **TY = Type of LWD Jam, J = jam F = floating S = secured**

Importance to salmon**: Logs in a stream, in conjunction with high flow hydraulics, create the pools that juvenile salmon prefer. Logs promote insect propagation and slowly shed nutrients to fertilize aquatic plants. These plants feed aquatic insects that feed the salmon fry. Logs also provide hiding places for adult and juvenile salmon. The variety, condition, and stability of the LWD are important to determine how long the wood will provide benefits to the salmon. Deciduous trees rot more quickly than coniferous trees. Coniferous trees can contribute to pool formation for more than 100 years, as in the case of cedar. Anchored (by man or nature) logs remain in the stream longer than free-floating logs. Larger logs tend to create deeper pools. Properly placed large wood can prevent bank erosion, the use of rock rip-rap fails nearly every time due to incision. Large wood can be used to trap migrating materials to repair eroded stream banks and prevent slides.**

1993 vs. 2008 Data Analysis

Conclusions and Recommendations

Several changes were noted in the analysis of the 1993 and 2008 stream data. Some were positive and some were neutral. No negative effects were noted, but there were a few lessons learned over 15-years of restoration processes.

It is important to note that in the 15 years between the two surveys, the subject stretch of Miller Creek experienced a variety of influences. Some of these influences were deliberate and positive, the effect of stream restoration by Trout Unlimited and Stewards of the Cove volunteers. The recent installation of additional water detention facilities high in the watershed can also be viewed as a positive. Other influences were less positive and unintentional, the effect of past and on-going development higher in the basin that increased impervious surfaces and presumably the "flashiness" of stream flow. The flow regime in the subject reach, being at the bottom of the basin, has likely affected many of the surveyed elements in a negative way. In other words, the positive benefits of the restoration work may have been undermined by high storm flows coming downstream. Thus the benefit of this comparison of 1993 and 2008 data is to show the incremental, aggregate changes in the reach and identify further needed changes.

The easiest way to see the changes is by examining each element of the survey process.

The 1993 and 2008 detailed survey data and the details of my analysis are on separate Excel spreadsheets. These data are available upon request. Contact: Andy Batcho at: earthday1@mindspring.com if you are interested in the details.

The findings and conclusions in this report are strictly the opinions of the author. Further scientific input and opinions by subject-matter-experts are desirable. Upon receiving "better science", this report will be updated.

Data Findings, Analysis, Conclusions and Recommendations:

Riffle-to-Pool Ratio – Data Findings and Analysis:

Riffle-to-pool ratio is important to understand in a stream since pools are the preferred rearing areas for juvenile salmon. Lack of pools in urban streams is mainly due to the lack of large woody debris (LWD). In nature, trees fall in the water and stream hydraulics cause pools to be scoured around them. In urban streams, trees that fall into the water are normally removed as part of a clean-up effort to avoid blocking culverts. In nature, this material moves downstream over time in conveyer belt fashion, floating, lodging, and dislodging continuously throughout the length of the stream.

Ideally, in a natural stream, the makeup is a combination of riffles (~50%) and pools (~50%) with connecting glides and runs. Glides and runs are waters classified half way between riffles and pools. Glides and runs are deeper and slower than a riffle and shallower and faster than a pool.

Observing natural streams usually reveals a riffle – pool – riffle - pool pattern. Obviously, many factors affect the extent of this ratio with topography (steep or flat) being one of the most influential. That said, the desirability of the relative ratio still holds; it's just a matter of degree.

The 1993 survey revealed the riffle-to-pool ratio of the entire 5-miles of Miller Creek to be 87% riffle to 13% pool. In other words, 37% of the potential pool rearing habitat of Miller Creek was missing. The 1993 survey found the riffle to pool ratio of the lower 2,000' of Miller creek to be 75% riffle and 25% pool. The 2008 survey also found the riffle-to-pool ratio of the lower 2,000 feet of Miller Creek to be 75% riffle to 25% pool.

Side-note: It should be noted that a large upper section of Miller Creek was restored/renovated in 2006/07 during the Sea-Tac airport third-runway installation. This renovation removed many homes, septic tanks, repaired stream banks and installed LWD, gravel and thousands of native plants. All habitat elements of this ~1-mile long stream section have improved since the 1993 survey. Coho salmon have been seen spawning in this reach since downstream migration barriers have been removed. The first time in some 50-years!

The fact that the riffle to pool ratios of the lower 2000 feet has remained the same does not totally reflect the actions that have taken place in the stream. Some pools that existed in 1993 have been lost due to flooding that moved logs and transported masses of sand and gravel. New pools have been formed by installations of LWD and naturally fallen trees (which had been normally removed in the past). Without these natural and mad-made interventions, I am certain that the riffle to pool ratios of this section of stream would have degraded substantially.

The riffle-to-pool ratios were also broken into 400 foot-sections of the overall 2,000 feet of the stream length. Each 400 foot-section was analyzed separately. Some sections performed much better than others. Some sections had LWD added, some did not. Some sections had LWD added early in the restoration project (15-years ago), some sections have had LWD added recently. Some sections had natural tree falls and log jams form, others didn't.

LWD installed in the early years of restoration were place mainly along the stream edges, or pointed downstream with the current. These installations were not as effective at creating pools as LWD installed in later years when the Rosgen method of "J's" and "W" installations was discovered and employed. The Rosgen method essentially advocates installing LWD in an angled upstream direction. This method causes high stream flows to impact the log, turn at 90-degrees and deposit the current energy back into the center of the streambed, causing a scour pool. This method is also much more effective at preventing bank erosion. It is actually very effective at building up eroded bank areas.

Early LWD installations consisted of single or two log installations. Later installations consist of multiple-log, more complex installations with the addition of smaller wood and brush, in an effort to more closely mimic naturally created log jams. These installations performed better at forming pools than the early, less complex structures.

In urban streams, the chronic unusually high flows cause the stream to widen to handle the excessive volumes of water. When the stream drops back to normal low flows the widened streambed produces very shallow, braided channels that are of little use to juvenile or adult salmon. The introduction of properly installed LWD in these "artificially widened" areas, use the high flow velocities to scour pools and channels into the center of the streambed. When the flows drop back to normal levels, the water is concentrated into deeper, more "fish-friendly" pools and channels.

In sections where early LWD was added, but not installed in a manner that used stream hydraulics to create pools and channels, the pool creating results were poor. More recent LWD installations, using advanced methods, have produced much better results. Areas where naturally-fallen trees were allowed to remain and collect floating debris resulted in the production of the most dramatic new pools. It's hard to beat Mother Nature's work!

LWD installations provide several benefits to a stream including; bank stabilization, providing hiding places for adult and juvenile salmon, providing insect habitat, providing nitrogen due to decay, and causing pools to scour. LWD installed in the earlier years met four of these five desirable characteristics. Later installations, using Rosgen methods and information learned from observation added pool creation, therefore meeting five of the five desirable characteristics of large wood in streams.

Riffle-to-Pool -- Conclusions and Recommendations:

- **The results produced in later years with improved, more complex installations of LWD produced better results than earlier installations.**
- **Observe where the stream "wants" to create pools. Certain combinations of gradient, substrate, and channel sinuosity are more suitable for pool creation than others. Assist the stream in creating these "wanted" pools with log (and some log/rock combinations) installations that are designed to use high water hydraulics to create better quality pools.**
- **Use new knowledge and experience in LWD installations to nudge the riffle-to-pool ratio closer to normal. There's nothing wrong with re-positioning or re-designing past engineered log structures if the stream "tells" you they aren't working as you want them to.**
- **Use Mother Nature as a teacher in designing wood installations. New LWD installations should be more complex (multiple logs) than single log installations. Complexity should also be increased by the addition of smaller debris (brush) items as part of the log installation to catch additional materials moving down the stream. Logs should be installed in an up-stream angle fashioned to create the "J's" & "W's" recommended by Rosgen.**
- **The practice of leaving fallen trees in the stream should continue unless they present an immediate hazard.**

Pool Quality Index (PQI) – Data Findings and Analysis:

Pool Quality Index examines the quality of a pool from the perspective of a juvenile salmon that spends 12 – 18 months in the stream. Pool quality is improved by increased depth, increased size (compared to overall stream width), and increased cover and complexity (plants growing over and brush in the water).

This survey used a scale of 1 to 5 (a simplified version of the USFS 10-point scale) where 1 = poor and 5 = best.

The 1993 survey indicated that the PQI of the lower 2,000 feet of Miller Creek was 1.85 with a typical pool of 1 to 1.5 feet deep, 25% to 50% stream width and little/no vegetative cover. The average pool depth in 1993 was slightly more than 1 foot. The 2008 survey indicated a PQI of 2.67 with a typical pool 2 to 2.5 feet

deep, 50% of stream width and good/excellent vegetative cover. The average pool depth in 2008 was 2.167 feet.

This change in PQI is a dramatic improvement! The average pools are now 1 foot deeper than in the past and are caused mainly by LWD (both man-made and natural) in the stream. Pools have also become larger compared to overall stream width. The addition of hundreds of native plants, especially in previous lawn areas, has improved stream cover dramatically.

PQI -- Conclusions & Recommendations:

- **Continue to plant areas where stream cover is needed.**
- **Observe new quality pools; maintain gains and improve where justified.**
- **Observe marginal pools; use learned and observed "best practices" to improve them.**
- **Help the stream create new pools where it's already trying to do so. Don't force it, assist it.**
- **In the long run, wood that creates pools should be recruited naturally from the riparian area. Consequently, native tree growth should be encouraged in riparian areas.**

Large Woody Debris (LWD) -- Data Findings and Analysis:

As mentioned previously, large woody debris contributes in several ways to stream health from a salmon's perspective (bank stabilization, nutrient contribution by rotting, insect habitat, cover from predators, and pool formation).

Detailed observations of the stream produced another interesting contribution provided by large wood in a stream. Chewing aquatic insects need leaves and pine needles as a food source. These food source materials need to decompose in the stream for several months before they become of value to the insects. The "flashiness" of the flooding in urban streams seems to remove many of these materials before insects can use them. Large wood appears to be one of the mechanisms that trap and hold these materials so they can decompose and be consumed. The more complex and brushy the installation, the better it holds leaves. Large complex wood also tends to help hold salmon carcasses until their nutrients can be absorbed, rather than quickly flushed to saltwater.

The change in large woody debris from 1993 to 2008 was the most dramatic of all changes observed.

In 1993, the 2,000 feet section of Miller Creek contained 20 feet of wood that could be classified as LWD. The definition of LWD in this study includes wood that is a minimum of 10 feet in length and 10 inches in diameter or greater.

In 2008, the amount of natural and added LWD was 737.5 feet made up of 51 logs, 70.6% of which were anchored. That's a LWD increase of 36 times!

If the studies that I've read are correct, a natural NW stream of this size should contain about one log for every 30' of stream length, 68 logs for the 2,000 feet of Miller Creek. Miller Creek now has 51 logs. Other studies indicate that streams should contain up to two pieces of LWD (6 feet long x 4 inches in diameter (note: smaller than the logs used in our study)) per bank full stream width. This method of calculating

stream LWD needs would indicate that this 2000' section of Miller Creek should contain as many as 400, although smaller, logs. Using smaller wood pieces and brush in conjunction with larger multi-log installations is ideal. This survey did not measure the smaller pieces of wood (6' x 4") in the stream, if it had, the numbers would have been even higher.

In any case, the amount of LWD in lower Miller Creek has improved dramatically since the 1993 survey.

LWD -- Conclusions & Recommendations:

- **Some of the wood in the stream is performing well to all five desired criteria. Some aren't. Examine the wood in the stream looking for opportunities to further enhance pools and remove silt.**
- **Add new wood to high potential areas and adjust existing wood to perform better.**
- **In an urbanized stream with high storm flows, wood must be anchored if it is desirable or necessary to keep it in place (for example, to avoid jams blocking culverts downstream).**

Substrate – Data Findings and Analysis:

Substrate is important to salmon in at least three significant ways. Most important is clean gravel for adult salmon looking to create a redd (nest). Juvenile salmon rely on clean gravel for insects as an aquatic food source. Properly sized, clean gravel that is not impacted by silt is required for both of these functions. Silt can "cement" gravel stones together, preventing water from freely flowing through the gravel and thereby smothering salmon eggs and keeping insects from living under the stones. A third way in which substrate matters to salmon is boulders that create scour pools for juvenile salmon habitat and create shelter for adults and juveniles.

Substrate is measured by a series of numbers indicating the type of materials making up the stream bottom.

1 = Bedrock
2 = Silt / Organic
3 = Sand
4 = Gravel (< 25mm)(< 1")
5 = Gravel (25mm - 100mm)(1"- 4")
6 = Cobble (100mm - 256mm)(4" - 10")
7 = Boulder

The 1993 study averaged the substrate in the 2,000 foot section of Miller Creek at 3.634, meaning that generally the stream bottom is made up of 1" gravel and sand.

The 2008 survey found similar results with a score of 3.5 for the entire 2,000 foot stretch. When examined in 400 foot increments, the increments scored somewhat differently from each other with a low average score of 3.19 (sand) and a high average score of 4.0 (1" gravel), representing a range from concentrated sand to mainly good, clean gravel.

An alternative perspective came from looking at the 2008 grab-samples in each of the 400 foot-sections to see how many samples were sand and how many were gravel. In some cases, the sand and gravel were in equal proportions. Other samples were 1/3 sand and 2/3 gravel. Most of the gravel in the survey section is

not impacted by silt and is loose enough to be dug by adult salmon. This compared favorably with the 1993 survey, when much of the gravel was "cemented" with silt. Localized current acceleration and agitation by LWD is the likely cause of this substrate improvement. Essentially, the sand and gravel mix have been separated in many areas, leaving good stretches of desirable clean spawning gravel.

The stream contains some boulders, mostly from old rip-rap. Cobble, the preferred substrate of aquatic insects, is scarce due to the lack of cobble-sized rocks in the stream's gravel supply or to the lack of water velocity to move larger rocks in this shallow gradient stretch of the stream. Bedrock is non-existent in the sample area. Natural organic silt (from rotting leaves) is present in several backwater areas and provides good aquatic insect habitat. Sand and silt are natural to this type of stream given the soils that the stream flows through. It is possible that that slit levels are higher now than in the past due to sand/dirt contributions from impervious surfaces upstream.

Substrate -- Conclusions & Recommendations:

- **The substrate in the survey section has not changed substantially, but has changed its mix and distribution. Previously, most gravel areas were highly impacted with sand. Now the gravel and sand seems to have separated a bit with areas of pretty good, clean gravel and other areas of sand concentrations. This is somewhat more normal and improvement can likely be attributed to the localized stirring and current-accelerating effects of LWD.**

- **Work to place LWD to clean silt from premiere gravel spawning areas, realizing that some silt areas are normal. Be cautious not to disturb known, quality spawning areas with the addition of LWD.**

- **Add some boulders to the stream to create pools, complexity, and resting habitat. Even though not natural to this stream given the substrate, they do create efficient, cost effective habitat structures in a stream that has a very un-natural flow regime. Well placed boulder installation can tend to "draw" a stream back to center channel due to the "digging" action of current around the boulders. Boulders can be a very efficient and effective way to re-focus shallow, braided summer flows in a wide, "blown-out" urban stream into a deeper, more useable channel habitat.**

- **Add some cobble-sized rocks to the stream in riffle and run areas as part of insect population enhancement studies/experiments. Observations have shown that aquatic insects prefer larger stones (4" to 8" diameter) over smaller rocks as habitat. Apparently the larger rocks provide more security from being dislodged and larger grazing surfaces for algae eaters. The rocks should not be placed where they are impacted (buried) by silt or they will be useless to insects.**

Riparian Zone -- Streamside Habitat:

The benefits of streamside habitat (plants) have been listed in other parts of this report. Streamside plants are one of the most beneficial elements to a healthy stream.

In 1993, much of the streamside area was lawn down to the stream. Invasive plants were extensive. Upper and lower stream canopy was marginal. Deciduous trees (alder) were beginning to reach the end of their life without evidence of succession by conifers. Extensive informal trails along the streamside excluded plants from growing and hanging over the stream.

In 2008, the stream has little or no lawn area next to the stream bank, especially in the middle 800 feet where the problem was concentrated in the past. Hundreds of native plants have replaced the lawn areas back 20 to 40 feet from the stream. Many coniferous trees have been planted to replace dying alder. Upper and lower stream canopy has improved dramatically. Informal trails have been moved away from the streamside and replaced with raised trails in most areas, improving streamside plant populations. Invasive plants have been reduced considerably.

While removal of invasive plants is desirable, problems can be experienced with an improper approach. Extensive removal in a short period of time can produce soil destabilization due to loss of roots, loss of pool habitat and loss of canopy and cover.

When large stands of Himalayan Blackberry (an invasive plant) near a stream are removed en-mass without immediate actions to reduce impacts several negative situations can occur. The mass of blackberry hanging into the stream often causes scour pools (fry habitat), soils become destabilized (silt moves into the stream) and canopy/cover are removed. Stream temperatures rise without shade canopy and a salmon fry trying to hide from a predator no longer have a place to hide. Fish don't care if a hiding place is produced by a native or non-native plant.

To mitigate these impacts; LWD might have to be planned to substitute for the scouring provided by the invasive plants hanging in the water, brush many need to be substituted for some of the shade and cover removed. Immediate planting of native plants &/or use of coir cloth/heavy mulch might be necessary to prevent soil erosion. Removing large, important invasive plant groupings might also be best done in stages to reduce stream impact. To prevent excessive soil disruption when planting near the stream bank; select smaller plants that can be planted by "punching" holes in the bank rather than "digging" holes near the bank. Plant the larger plants back for the stream edge where the soils are more stable. Also note that plants tend to survive better when planted in the early spring & fall when rains keep them watered. Coordinate large scale invasive removal times with ideal native planting seasons.

In any case, the removal of large groupings of invasive plants near streams should be accompanied by a well designed plan that quickly mitigates any impacts from the removal. Use subject-matter-experts to help develop a quality plan.

Wide riparian zones are most desirable, but where impractical, narrower riparian zones are better than lawn. Even a few native plantings near the stream provide benefits.

Miller creek has been straightened throughout much of its length, mainly by sewer pipe installations. Sinuosity and many natural off-channel rearing areas have been lost due to the straightening. Natural streams have "side-pools" that allow salmon fry to escape high flow situations, then naturally drain back into the stream as water levels drop. Consideration should be given to recreating off-channel – side pools to protect salmon from flooding.

Sinuosity of a stream also lessens the impact of high flood flows. Each bend in a stream absorbs stream flow energy. Likely there isn't much opportunity to improve Miller creek sinuosity.

In some areas, the stream leaves its banks during flooding. Mainly this situation is ok since the large volumes of water "have to go somewhere". But in some locations, the flooding is digging channels, scouring land and depositing silt into the stream. These situations need to be corrected.

Riparian Zone -- Conclusions and Recommendations:

- **Fifteen years of native plant re-vegetation and invasive plant removal have had dramatic positive impact on the stream side habitat.**

- **Working on the trails along the stream has increased citizen use of the streamside areas while improving the streamside vegetation benefits.**

- **Work should continue on invasive plant removal and native plant re-vegetation.**

- **Consider creating "off channel – side pool rearing habitat" habitat were possible. Look for places to improve sinuosity.**

- **Take actions where the stream leaves its bank during flooding causing silt to be scoured and dumped into the stream.**

- **The raised trail should be completed on the upper section of Miller Creek on the Club property.**

Additional Information:

- **Benthic Index of Biotic Integrity (BIBI) studies on aquatic insect abundance and diversity are being done on the stream. Results show that the stream insect population and diversity are poor to moderate, with scores such as 12 and 14 (Miller and Walker Creeks Basin Plan, Executive Proposed, February 2006). Study and experiments are being pursued to improve bug population and diversity although it is understood that high stream flows driven by stormwater inflows combined with non-point source pollution are likely to limit BIBI scores.**

  Fish counts of Coho and Chum, vary from 100 to 200 adults per year by an informal counting process that we use. The highest number observed has been 400. This is an informal approach that relies on interested visitors to the Cove taking the time to report what they see to the staff of the Club. There is probably some double-counting and not all fish are observed. However, the practice of reporting fish in this manner has occurred for a number of years and it provides one indication of relative abundance.

- **Biologist calculations I've read indicate that 700 to 1100 adult salmon used Miller creek when it was pristine. Other technical experts estimate pristine run sizes to be as high as 2000 spawning salmon and Cutthroat Trout. Likely the stream also supported some number of spawning steelhead in the past, although in the past 15-years only a handful of steelhead trout have been observed in Miller creek. The heavy development in the basin over many years had dropped adult salmon populations to near zero. With the stream work and stewardship the past 15-years spawning populations have return to numbers estimated to be 100 to 400 per year.**

- **According to records kept since 2000 of informal observations at the Cove (described above), adult Coho begin returning to the streams during the first two weeks of October with the mid-point of the Coho run being mid-November. Chum salmon usually appear in mid-November. Spawning Coho have been observed as late as early January.**

- **In some years, the early returning Coho Salmon of Miller Creek show signs of pre-spawn mortality.**
- **Based on personal observations of feeding activities, net samples and reading Washington Trout electro-shock surveys, the Sea-run Cutthroat Trout populations in the stream and in the man-made beaver pond appear healthy and numerous. Although this is good news for the Cutthroat in the system, Cutthroat trout are the salmonid species most tolerant to stream degradation and their increased presence in a stream system isn't an indication of pristine conditions.**
- **Large numbers of juvenile salmon have been observed feeding in the man-made beaver pond on the Cove property. Some numbers of Coho & Chum fry have been observed in Miller Creek. A few Coho fry have been captured and examined while moving fish from proposed stream restoration areas as directed by WDFW. The fish examined appear to be very healthy and well fed.**
- **Excessive and frequent flooding of this urban stream is likely the No. 1 impact that the stream and its inhabitants face. The impacts of excessive and frequent flooding include;**
  - **Washing salmon eggs from the gravel where they are damaged and become vulnerable to predators.**
  - **Flushing recently born salmon fry, yet unable to resist high flood forces, from the stream into saltwater, where they perish.**
  - **Washing adult and juvenile fish from the streambed into surrounding areas, leaving them stranded when the flood subsides.**
  - **Dislodge and washing stream insects from the stream into saltwater, reducing the aquatic food sources in the stream.**
  - **Washing insect food sources (leaves, needles, etc.) from the stream, reducing stream viability.**
  - **Prematurely flushing adult salmon carcasses from the stream, reducing the nutrients they supply to the system.**
  - **Injecting large amounts of silt and pollutants to the stream.**

  - **Northwest streams have experienced the effects of flooding for millions of years, but Salmonids have prevailed. What's different in urbanized streams? The answer is the frequency of severe events. What use to be a 100-year flood event, is now realized every three to five years, sometimes more often. The species has been able to survive through the occasional disaster, but the species and its environment doesn't seem to be able to adapt to the constant crisis of excessive & frequent flooding. The Salmon are much like a human family who might be able to survive a home fire every 100 years; but if the home fire occurred every three to five years, one might imagine the family would move or go extinct! The extent of impervious surface (roofs, roads, parking lots, etc.) in a basin appears to be directly proportional to the health of the streams in the basin. The negative effects of**

impervious surface have been cumulative over many years; one would suspect that the solution would include many small improvements whose cumulative effects would create a positive environment. The mighty Mississippi River is made up of millions of tiny rivulets of water that come together to form a giant. In the same way, tiny contributions of water from thousands of impervious surface areas, plus piping that directs them quickly into streams causes the extreme and frequent flooding we now experience. We have good crisis response, it's not clear that we have good preventative regulation in place. Many cumulative small steps will correct the problem. Taking steps to improve frequent and excessive flooding not only improves salmon habitat, but lessens severe impacts on people living near the waterways.

- **Although levies are not used in the lower 2000' of Miller Creek, they are often considered a solution to flooding. Levies set close to streams actually increase stream damage by "focusing" flood currents into a torrent. This "fire-hose" effect damages downstream properties, causing downstream property owners to install their own levies. The cumulative effect of this solution is best represented by the Los Angles River. (a concrete ditch) To mitigate the damage caused by flooding, streams must be allowed to spread out and reduce their energy while large volumes of water are moving thru them. If levies are the only solution, they are best installed as far back from the stream bed as possible or practical, leaving as much room as possible for the stream to overflow it's banks throughout its length. Properties protected by levies learn to live under a false sense of security. Then when the levies fail, and they will fail, the damage is overwhelming.**

History

Habitat Restoration in Miller Creek

The Des Moines Salmon Chapter of Trout Unlimited was formed in 1981 by founding President Deryk Row, a long-time Normandy Park resident. Trout Unlimited (TU) is a national organization formed in Michigan 50 years ago by a group of anglers concerned with the loss of fish habitat and fish numbers in their local waters. With 150,000 members nationally, TU is headquartered today in Vienna, Virginia. The Trout Unlimited mission statement is, "To conserve, protect and restore North America's coldwater fisheries and their watersheds." Trout Unlimited chapters across the nation are challenged to "think globally and work locally".

When the Des Moines chapter was formed, we took that challenge to heart as we began to form the specific mission statement of our chapter. Our chapter's geography consists of the waters in and along Puget Sound from the cities of Des Moines on the south, Normandy Park in the middle, Burien on the north and Sea-Tac on the east. Since these waters are the habitat of Pacific Salmon and Sea-run Cutthroat Trout, we made those species and their habitat the focus of our mission.

In 1981-82, chapter President Deryk Row started a delayed-release Chinook and Coho salmon net pen project in the Des Moines Marina. The goal of this project was to provide sport-fishing opportunities to shore-bound anglers at the new Des Moines fishing pier. Swarms of adult salmon returned to the Marina with some choosing to spawn in local streams, namely Des Moines and Massy Creeks. The net pen is still operating today.

In 1983-84, chapter President, Andy Batcho started a 100,000+ Coho Salmon Hatchery on the grounds of the Southwest Suburban Sewer District plant in Normandy Park with the approval of District Commissioner Bert Larson. This was the first salmon raising operation in partnerships with a sewer district in the country! The goal of this project was the return of self-sustaining salmon runs in local streams. The hatchery is still operating today.

Seven subsequent chapter presidents and chapter members preserved and enhanced these operations, while adding involvement with kids, teaching fishing and ecology to the community, and inviting the community to participate in salmon restoration efforts through chapter events.

In 1993, then chapter Vice President Al Miller (chapter president in '95, '96) started the Chapter in a new direction of stream restoration with a goal of understanding and restoring urban stream habitat. Salmon live in our local streams for 12 to 18 months prior to smolting and heading to sea. The era of just putting more fish into the system to "fix the problem" was over and a focus on habitat restoration began.

Al Miller, along with chapter Vice President, John Richardson, Dr. John Muramatsu, Dale Cap, and Andy Batcho (Stream Restoration Director) headed the effort to explore what could be done to restore urban streams. Al called a planning meeting where we asked ourselves some basic questions.

- “Who’s responsible for restoring urban streams?” At first we thought it was the state agencies, but soon realized these agencies had “bigger fish to fry” and it would be a long time before they could focus attention on the small urban streams in our area.

- “Why doesn’t the community restore the streams?” That question lead to a discussion of barriers that prevented communities from restoring their streams. We identified three barriers: permits, money, and a plan. After much discussion we felt our Trout Unlimited chapter could best serve our community by helping to overcome these barriers and allow the community to restore and take ownership of their streams.

A Plan for Overcoming the Barriers to Community Stream Restoration:

- ***Permits:*** We assumed that permits would be a barrier for the community since permits tend to scare people especially when the terms, jargon, questions, and the science involved in the permitting process is foreign to the average citizen. We examined the permits and forms necessary for stream restoration projects. Basically, we found that the permits are designed to prevent well-intended development effort from destroying stream habitat. **Our** intentions were to repair the stream, not destroy it! Therefore, we found the permitting questions easy to answer given our intentions. Permits did not seem to be a problem, but before we could apply for permits, we needed a good plan to submit.

- ***Money:*** Obviously**, some** money is required to do stream restoration work even if volunteers do much of the labor. But without a plan, we had no idea *how much* money would be required. We were aware that there were many grants available for stream restoration work, including from our own organization, Trout Unlimited. The bottom-line was that without a plan, we couldn’t ask for money. As it turned out, after our plans were prepared and permitted, money was no issue: “it fell out of the sky”. We coined a term while going thru this process**: “**A good plan is like a ‘Money Magnet’**”!** Everyone wants to be a part of it.

- ***A Plan:*** To overcome the “we don’t have a plan” barrier, we generated a list of subject-matter-experts to help train us in doing stream analysis and restoration. King County, the Washington Department of Fisheries, and the University of Washington School of Fisheries provided the experts we needed. From them, we learned the U.S. Forest Service Scientific Method of Stream Survey, in-stream structure designs, native plant re-vegetation, invasive weed identification, and fish scale sample analysis. King County senior biologist Bob Furstenberg was our mentor.

  In 1993, with our new skills and under the leadership of Al Miller, we took on the project of performing the U.S. Forest Service Scientific Method of Stream Survey on the approximately five (5) miles of Miller Creek from saltwater to headwater. On Saturday mornings over the course of six months, TU chapter volunteers surveyed the entire stream, collecting thousands of data points consisting of substrate type, stream-width, stream-depth, riffle-to-pool ratios, pool quality index, large-woody-debris and habitat 100’ on either side of the stream. During those six months, we became *the* subject-matter-experts on Miller Creek since no one had seen the stream in the detail we had.

Armed with all this data, the next step needed was a place to practice our new skills. We approached the Normandy Park Community Club (NPCC) and President Shawn McEvoy with a request to prepare a set of plans for a stream restoration project of Miller and Walker Creeks on their property. The Normandy Park Community Club, popularly known as "the Cove" owns the lowest portions of both Miller and Walker Creeks including the confluence with Puget Sound.

Andy Batcho, the engineer in the group, took on the effort of preparing a detailed set of stream restoration drawings including invasive weed removal, native plant restoration, in-stream structures on the ~2,000 feet of Miller Creek and ~500 feet of Walker Creek on the Club property. After reviewing the plans with the NPCC Board of Trustees, the plans were submitted for permitting. The Club committed funds as did the Des Moines Trout Unlimited Chapter.

On-the-ground restoration began in 1994. Chapter members, Club volunteers, Boy Scouts, Girl Scouts, and Brownies all participated in the initial restoration efforts guided by the plans. The work went on for several years. The then NPCC President, Tony Cassarino, started the Stewards of the Cove program where community members participated in monthly stream restoration and maintenance projects. Tony Cassarino, Shawn McEvoy, John Patha, Doug Osterman, Andy Batcho and Tom McCann were instrumental in taking the stream, wetlands and salmon-rearing pond projects to the next level of restoration.

As we continued to learn more about the ecological environments that support the salmon life-cycle, we realized that "fixing" a couple small streams west of Sea-Tac Airport wasn't going to fix all the salmon problems in Puget Sound or Washington State. But we did discover that all the small streams along Puget Sound work as a system like the "rungs of a ladder". As salmon migrate out of Puget Sound along the marine near-shore, they use each of the small streams as a feeding stop along the way out of the Sound and to Alaska. The importance of these so-called "pocket estuaries" has since been demonstrated through scientific research. Working on each of these small streams throughout Puget Sound is analogous to fixing the rungs of a ladder. The Puget Sound aquatic ecosystem works better with all the rungs!

While working on future stream restoration plans, Tony Cassarino and Andy Batcho decided that another scientific survey of Miller Creek was needed. The purpose of the new survey was to provide insight into the habitat changes and provide direction for future restoration projects. In fact, the funding and science communities were asking that volunteer efforts use more science in directing their projects. We took on that challenge. Contacting professional survey consultants indicated that a survey alone might cost some $5,000. The cost of comparing collected data to the 1993 survey, analyzing the data, and providing recommendations would have required an additional expense.

In August 2008, Andy arranged for the original 1993 Trout Unlimited survey team leaders to volunteer to re-survey Miller Creek on the Cove property. Tony arranged for members of Stewards of the Cove to assist. The survey team met at the Cove on Saturday, August 9, 2008, broke into three groups, and completed the survey of approximately 2,000 linear feet of Miller Creek in four hours.

Andy Batcho took the data collected, put it in an Excel spreadsheet format, analyzed the data, provided conclusions and recommendations, and produced this report in January 2009.

The stream restoration efforts at the NPCC property included stream restoration, control of invasive non-native plants, native plant re-vegetation, creation of a salt-marsh, and building of an artificial "beaver pond" to rear young salmon and provide cutthroat trout habitat. Most rewarding is the acceptance by the community to take ownership and restore their streams! Mentoring many Boy Scouts to their Eagle Rank, providing Brownies with native plant raising projects, and offering a Girl Scout the highest honor in scouting through these projects is heartwarming. Bringing school children to the stream to release their classroom-raised salmon also is gratifying. Seeing the surrounding cities take active roles in salmon recovery is outstanding. And recently, having the cities jointly fund a King County Basin Steward, Dennis Clark, to lead efforts elsewhere in the basin and guide us in the future achieves the goal of Trout Unlimited to have the community take long-term ownership of their streams. The efforts by all have received national recognition.

Trout Unlimited (TU) also has helped neighbors living on the stream with restoration designs, permits, and implementation. It assisted the Port of Seattle with reviews of stream restoration proposals. TU supported a collation of cities to develop restoration plans for Des Moines Creek, reviewed stream restoration plans for Saltwater Park in Redondo, and did preliminary surveys of Salmon Creek in Burien. All of this was accomplished under the leadership of the current TU Chapter President, Dr. John Muramatsu. John also introduced the Salmon in the Classroom project to bring children and education into the process.

Stream restoration and salmon recovery in the Puget Sound area has become as much about the people as it is about the salmon. After all, if the people don't care about their waters and their salmon, the fish don't have a chance!

Excel Spreadsheets

The Excel spreadsheets containing the data from the 2008 and 1993 U.S. Forest Service Scientific Method of Stream Survey – Habitat / Fish relationships is available by contacting Andy Batcho (earthday1@mindspring.com) or Dennis Clark, King County (dennis.clark@kingcounty.gov).