King County's SciFYI

King County
Department of Natural Resources and Parks
Water and Land Resources Division

A digest of current natural science issues in King County

October 2012

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It takes a forest to save a fish: Monitoring changes in forest cover to help save salmon in King County

by Scott Stolnack

WHY DO YOU NEED TREES TO SAVE SALMON?

Forests filter rainwater, help keep streams cool and clear, and help provide complex habitat for salmon to spawn, rear and grow. Without forests, salmon probably wouldn't survive in King County. This is one reason that the County's salmon recovery plans and other guidelines include recommendations to protect forests wherever possible. And where it's not realistic to conserve whole forests, local "critical areas" rules still protect trees and shrubs along our most sensitive streamside areas.

With this in mind, Water Resource Inventory Area 8 (WRIA 8)[1], the Lake Washington/ Cedar/ Sammamish Watershed (see **Map 1**), received a grant from the Puget Sound Partnership to see if forest cover was being appropriately maintained in the watershed as recommended in its salmon recovery plan. Using satellite images, aerial photographs, and Geographic Information Systems (GIS) computer technology, we measured land cover change at two scales: over the whole watershed in general (inside and outside the Urban Growth Area boundaries), and at a much finer scale along a small sample of important stream reaches.

To make the work more manageable we divided the watershed into 47 separate mini-watersheds or "subbasins," and looked at overall forest cover in 1991, 1996, 2001 and 2006. During that 15-year period, overall forest cover inside urbanized areas declined more than 20 percent (**Figure 1**). This decline is not surprising, considering the changes that have taken place in King County since 1991. Areas in rural King County showed no overall loss of forest cover between 1991 and 2006.

Map 1.

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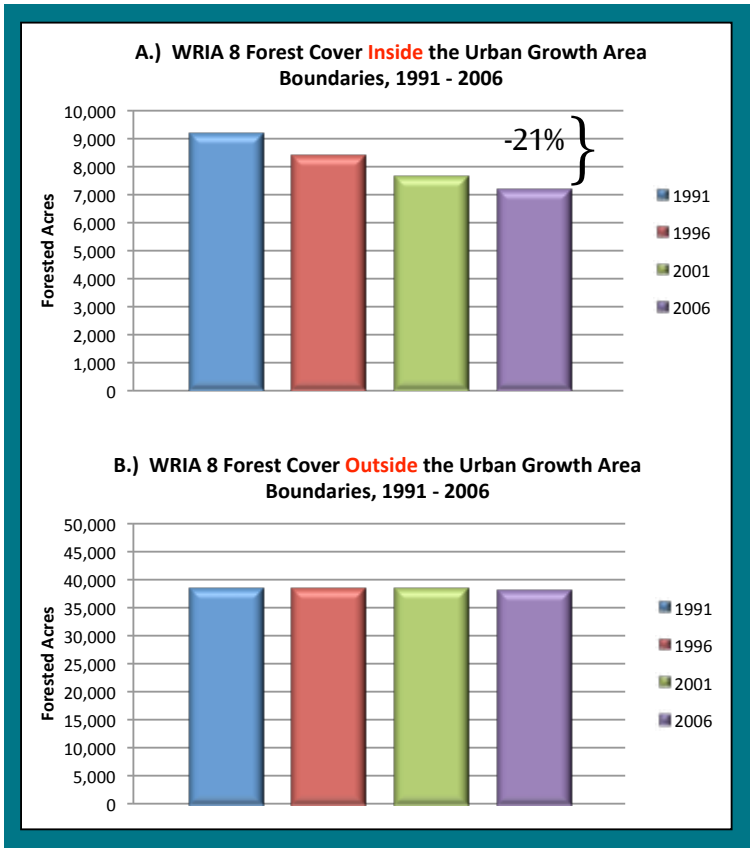


***Figure 1.** Forest cover change in WRIA 8, 1991-2006. Total area represented in B) does not include the Cedar River Municipal Watershed.*

[1] A Water Resource Inventory Area (WRIA), is a geographic watershed area defined by the Washington Department of Ecology for watershed planning purposes. The WRIA boundaries are also used to delineate watersheds for salmon recovery planning. The WRIA 8 watershed is mostly within King County, though about 15 percent of the watershed lies in Snohomish County.

(Continued from page 1)

When we focused on streamside areas, where rules about retaining trees are the most protective, we found that forest cover still declined in some subbasins despite these rules. In our finer scale analysis of important stream reaches, we found a surprising 3.8 percent decline in forest cover in those streamside areas.

When we dug a little further, much of the forest cover loss in the streamside areas appeared to be the result of "vested" development in just a few areas, that is, construction legally permitted under older, less-protective rules (**Figure 2**). However, not all of the forest cover loss could be linked to vested development. Some may have been from local property owners cutting down trees or building closer to streams than regulations allowed.

Conclusions

Although the continued loss of forest cover inside urban areas was predictable because development is directed into those areas, we were surprised to find that forest cover declined in some sensitive urban streamside areas. Much of this unanticipated forest cover loss appeared to have occurred legally, because they were permitted under prior sensitive areas rules.

Jurisdictions in WRIA 8 are planning to use this information to improve protection of streamside areas in two ways: (1) connect with private landowners to help them be good stewards of the streams in their backyards, and (2) identify important riparian areas subject to vested development rights, and work with those property owners to find acceptable means of protecting and improving forest cover in those areas.

Figure 2. *Example of forest cover change between 2006 (left) and 2009 (right). This development was legally permitted under prior sensitive areas rules.*

Report Citations and Sources

Vanderhoof, J., S. Stolnack, K. Rauscher, and K. Higgins. *Lake Washington/ Cedar/ Sammamish Watershed (WRIA 8) Land Cover Change Analysis.* Prepared for WRIA8 Technical Committee by King County Water and Land Resources Division, Department of Natural Resources and Parks. Seattle, Washington, 2011.

This project was partially funded by the Puget Sound Partnership through an EPA National Estuary Program grant, administered by the Washington State Recreation and Conservation Office (RCO Grant #09-1546).

For the full report, go to www.govlink.org/watersheds/8/reports/W8LandcoverChangeReport7-19-2011.pdf

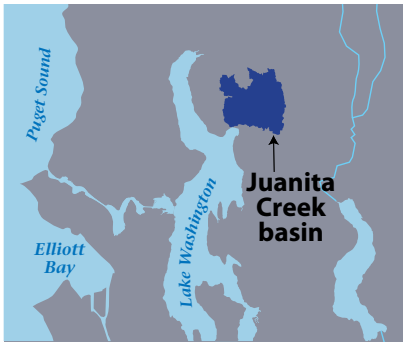
For more on salmon recovery in King County, go to www.govlink.org/watersheds/default.aspx

Juanita Creek Basin Stormwater Retrofit Cost Study

by Mark Wilgus, Jeff Burkey, and Hans Berge

Untreated stormwater runoff is an identified threat to water quality and watershed health in the Puget Sound region. In the in the urbanized Juanita Creek basin, runoff patterns and water quality have changed dramatically as a result of development that occurred over many decades with ineffective or no stormwater controls. Consequently, Juanita Creek's water and habitat quality is degraded with issues that include pervasive bank instability, low habitat complexity, excessive sediment deposition that limit salmon spawning areas, and low frequency of large wood and generally poor biological conditions as evidenced by a low BIBI (Benthic Index of Biotic integrity) score of 17 (see **Table 1**, page 4).

This study evaluated the cost and effectiveness of seven potential basin-wide stormwater retrofit strategies at achieving improved water quality and flow conditions that would be supportive of native fish and insects in the stream. There is strong regional interest in understanding the effectiveness of stormwater retrofit strategies because these problems are pervasive in many other parts of the Puget Sound basin.



***Map 2.** Juanita Creek basin.*

Study Area

Located northeast of Juanita Bay in the City of Kirkland, the Juanita Creek basin covers about 6.8 square miles that includes 15.7 miles of stream channel (see **Map 2**). Roofs, streets, and other paved surfaces cover nearly 68 percent of the basin. The primary land use is residential with some commercial development.

The vast majority of development in the basin was constructed with no or highly ineffective stormwater control facilities, a consequence of the mid- and late 20th Century development standards in effect when most development was occurring. As a result, rainwater has less opportunity to infiltrate into the ground, and travels directly to the stream system without being slowed or filtered – causing impacts that reduce the creek's capacity to support salmon and the insects that they feed on.

Project Partners

King County collaborated with the Washington State Department of Ecology (DOE), the City of Kirkland and the Washington State Department of Transportation (WSDOT) to recommend a plan of action to improve water quality and flow conditions in Juanita Creek. Project funding was provided by DOE with matching funds and labor provided by the King County Water and Land Resources Division, the City of Kirkland and WSDOT. The total estimated project cost was $922,389.

Project Approach and Methods

The project included extensive stormwater infrastructure mapping, flow gauging, habitat assessment, and water quality testing, as well as the development of a Hydrological Simulation Program-Fortran model characterizing hydrology and water quality.

Seven potential future stormwater mitigation scenarios were evaluated to assess their effectiveness in improving stream insect community health based on the BIBI score meeting Washington state water quality standards, and reducing the yearly number of gravel disturbances in Juanita Creek. The scenarios included various combinations of low-impact development techniques (e.g., rain gardens) and conventional stormwater ponds. For comparison purposes, fully forested, 1977 land use, existing land

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Findings

- The strategies varied greatly in terms of costs improvements and BIBI scores.
- The best performing stormwater mitigation scenario, **Alternative 4** resulted in a potential BIBI score of 35 – just above an identified critical level and at the high end of "Fair" on the narrative BIBI scale and produced significant improvements in stream water quality. This scenario routed 80 percent of impervious surfaces in the basin to both rain gardens and detention ponds.
- The second best performing stormwater mitigation scenario, **Alternative 3** resulted in a potential BIBI score of 28 (low end of "Fair") and had water quality improvements similar to the best scenario by routing 80 percent of impervious surfaces in the basin to rain gardens only.
- The remaining five scenarios produced potential BIBI scores ranging from 17 to 24 ("Poor") and resulted in variable improvements in water quality.
- Benchmark scenarios for fully forested and existing conditions resulted in potential BIBI scores of 38 ("Good") and 17 ("Poor"), respectively.
- All seven scenarios were generally effective in reducing the number of gravel disturbances in the stream.

It should be noted that the best performing mitigation scenario, **Alternative 4** was designed to achieve flow control performance standards proposed in the draft Phase 1 Municipal National Pollutant Discharge Elimination System permit with an effective date of Aug. 1, 2013.

The estimated costs (present value, 2011 dollars) to achieve the seven mitigation scenarios ranged from $200 million to $1.4 billion ($30 million to $200 million per square mile) with increased costs generally equating to increased effectiveness:

- The most effective scenario **Alternative 4** was also the most expensive at $1.4 billion;
- The second most effective scenario **Alternative 3** was estimated at $1.2 billion;
- The other five mitigation scenarios had lower cost estimates and lower overall levels of effectiveness.

(Continued from page 3)
use, and hypothetical build-out land use conditions were also evaluated. (See **Tables 1** and **2** respectively.)

Present value cost estimates for the mitigation scenarios were calculated in 2011 dollars with an assumed 4 percent discount rate over a 40-year design life. Estimates include capital costs (land acquisition, design, and construction) and operation and maintenance costs.

For the full report, go to http://green.kingcounty.gov/WLR/Waterres/StreamsData/reports/JuanitaCreek2012

Key Results and Recommendations

1. Based upon the study results, retrofitting urbanized Puget Sound basins to achieve the highest performance standard will require a significant public and private sector resource investment. Along with the cost, the time factor to achieve the water quality standard is measured in decades.
2. For the Juanita Creek basin, implementing and measuring the best performing mitigation strategy in a pilot study area prior to building capital retrofit projects basin-wide is strongly encouraged to field test the efficacy of the strategy.
3. To achieve the Alternative #4 performance standard, both conventional end-of-pipe facilities (e.g. ponds) and low impact development techniques (e.g. rain gardens) that infiltrate stormwater into the ground were required for most impervious surfaces.
4. To achieve the targets a detailed plan is recommended that includes performance measures and targets; monitoring and adaptive management; and, a cost benefit effectiveness evaluation. The study did not evaluate the cost-benefit of meeting different targets.

Table 1. *Comparative BIBI Score Scenarios*

SCENARIOS	DESCRIPTION	BIBI
Forested	Basin is assumed fully forested, pristine conditions.	**38**
Land Use / Cover 1977	Land use derived from 1977 aerial imagery.	**19**
65/10	Basin is assumed to have evolved under early watershed planning threshold of stream stability with forest retention and limited impervious surfaces.	**29**
Land Use / Cover 2002	Existing conditions as defined with 2002 satellite imagery.	**17**
FUTURE	Full build-out of potential land use based on current zoning, no mitigation.	**16**

Table 2. *Stormwater Mitigation Alternatives Total Cost*

ALTERNATIVES	DESCRIPTION	BIBI	TOTAL COSTS
1	King County Future land use with Level 2 stormwater ponds applied basin-wide.	**23**	$210 million
2	Future land use with 40 percent Total Impervious Area (TIA) captured by rain gardens	**20**	$590 million
3	Future land use with 80 percent Total Impervious Area (TIA) captured by rain gardens	**28**	$1.2 billion
4	New Washington State DOE Proposed Standard: Matching durations from 8 percent of the 2-year forested to the 50-year forested, using a combination of Alternative 3 and stormwater detention ponds stacked on basic wetponds applied basin-wide.	**35**	$1.4 billion
5	Combination of alternative 2 throughout the basin with King County Level 2 stormwater detention ponds stacked on basic wetponds in three catchments.	**20**	$591 million
6	Future land use with King County Level 2 stormwater detention ponds stacked on basic wetponds applied basin-wide.	**24**	$215 million
7	Future land use where roof area runoff from a mild wet season of rainfall is captured, then released July-September each calendar year at a constant rate.	**17**	$257 million

King County Marine Phytoplankton and Nutrient Monitoring

by Gabriela Hannach and Kimberle Stark

Why are phytoplankton and nutrients important?

Phytoplankton are microscopic plant-like organisms that contain chlorophyll, which is necessary for photosynthesis. They live in the upper layers of oceans, lakes and rivers. An estimated 4,000 species exist worldwide, exhibiting a great variety of size, shape, and pigmentation. Phytoplankton produce a quarter of the world's oxygen and are also a key element in the carbon cycle - their utilization of carbon dioxide is critical in the control of climate change.

Phytoplankton require sunlight and nutrients for growth and are a critical part of the Puget Sound ecosystem as they form the bottom of the food chain. Frequent or persistent phytoplankton "blooms" (a significant increase in organism abundance), however, can be an indicator of eutrophication, which is a process caused by an over-abundance of nutrients - most often nitrogen compounds from manmade sources - that can lead to oxygen depletion when the cells decay and can, in extreme cases, result in dead zones that cannot support aquatic life.

What is King County doing?

The King County Environmental Laboratory and the Marine and Sediment Assessment Group have been collecting and analyzing phytoplankton samples from three central Puget Sound locations since 2008: Point Jefferson, East Passage, and Quartermaster Harbor (see **Map 3**). The phytoplankton sampling component is part of a larger marine monitoring program managed by the Marine and Sediment Assessment Group.

At present, sampling is performed twice a month during the March-through-October phytoplankton bloom season. Nutrients are analyzed concurrent with the phytoplankton samples to provide information on the nutrient chemistry of the water, which is directly relevant to phytoplankton species composition and abundance.

Map 3. *Three Central Puget Sound sampling locations.*

There are several reasons King County monitors phytoplankton in Puget Sound. King County's wastewater treatment plants discharge treated wastewater into the Central Puget Sound Basin. As a clean water utility, the Wastewater Treatment Division (WTD) has a history of continuous improvements to its effluent quality, and has a long history of water quality monitoring to ensure its activities work to protect public health and the environment. WTD therefore has a strong interest in factors that affect water quality, such as nutrients and phytoplankton levels.

Main objectives of the phytoplankton monitoring program are to:

- assess relative abundance and community composition of the major phytoplankton taxonomic groups at three locations;
- identify dominant phytoplankton species;
- document timing of seasonal shifts in major taxonomic groups; and
- detect long-term changes in taxonomic composition.

Moreover, climate change and population growth are generally recognized as significant stress factors for the health of Puget Sound. Obtaining long-term information on phytoplankton species composition is essential to properly evaluate Puget Sound's ecosystem response and resilience to environmental change.

Given the concerns about water quality and climate, the phytoplankton monitoring program seeks to address relevant questions about the health of the ecosystem and efforts to manage it, such as "Are environmental or anthropogenic changes having an adverse effect on phytoplankton populations, and consequently impacting the Puget Sound food web?"

This monitoring is particularly important because relatively little is known about the overall structure of the Puget Sound phytoplankton community, particularly the annual variability and how variations in nutrient availability affect phytoplankton populations. Most phytoplankton analysis conducted in Puget Sound focuses on those species that cause harmful algal blooms (for example, phytoplankton species that produce toxins) because of their potential impact on recreational and commercial shellfish harvests.

In addition to our ongoing program, we have requested funding to measure phytoplankton abundance more precisely, or quantitatively, in the 2013 sampling season. Having more precise abundance data will be helpful for determining the magnitude of phytoplankton blooms when they occur, such as the recent *Noctiluca scintillans* bloom that was observed Puget Sound-wide, as well as the relationship of these levels and nutrients.

There is an online image library of Puget Sound marine phytoplankton. We hope that this will be a useful resource for researchers and managers in the Puget Sound area as they seek to understand the health of the marine ecosystem. The image library will be available at: http://green.kingcounty.gov/marine/Photos.aspx.

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If you would like additional information on King County's marine phytoplankton program, please contact: Gabriela Hannach (Gabriela.Hannach@kingcounty.gov), or Kimberle Stark (Kimberle.Stark@kingcounty.gov). For the full report go to: http://green.kingcounty.gov/marine/Reports.aspx

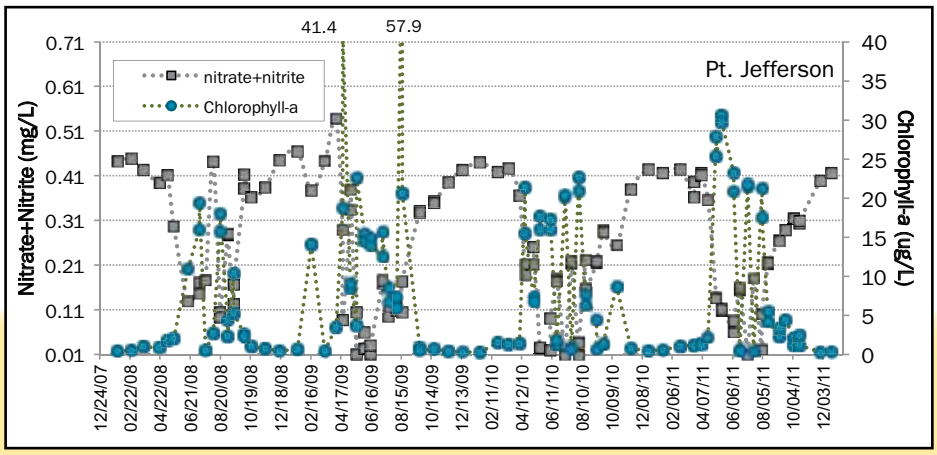

Figure 3. This figure shows the relationship between nitrate+nitrite and chlorophyll-a for monthly surface water samples collected between 2007 and 2011 at Point Jefferson. As phytoplankton abundance increases (indicated by chlorophyll-a levels) nitrate goes down because of uptake and conversely, when phytoplankton abundance is low, nitrate levels are higher.

Findings and Discoveries

To date, a few interesting patterns have emerged:

- A seasonal relationship exists between phytoplankton abundance and nutrient levels, nitrate +nitrite and silica in particular. As phytoplankton abundance increases in the spring and summer, nutrient levels decrease (see **Figure 3**);
- The cold, wet spring in 2011 caused the spring phytoplankton bloom to be delayed until May at the two open water sites. Overall, blooms in 2011 did not follow the typical pattern seen in previous years;
- The delayed 2011 spring phytoplankton bloom affected nutrient levels which resulted in higher than normal nutrients in April due to a lack of uptake by the phytoplankton;
- The bloom season in Quartermaster Harbor starts earlier (February) and lasts longer (through October) than in the main part of the central Puget Sound basin;
- Diatoms (a broad class of phytoplankton that have a rigid silica shell) have dominated throughout much of the sampling season, particularly during the spring bloom (April-June);
- Species composition differs between the northern (Point Jefferson) and the southern (East Passage) sampling sites;
- *Alexandrium catenella*, the species responsible for causing paralytic shellfish poisoning , was the dominant organism in the fall of 2008 in Quartermaster Harbor. However, to date there have been no shellfish closures in Quartermaster Harbor because of the toxin levels produced by this organism; and
- *Akashiwo sanguinea*, the species responsible for thousands of seabird deaths off the Washington coast in 2009, was generally present from late August to early October (except in 2011) but was found earlier in the year and at higher abundances in 2009.

PHYTOPLANKTON PHOTOS

Chain forming diatoms, especially in the genus Chaetoceros (A-D), typically dominate the spring bloom in Puget Sound. Other common chain-forming genera are Thalassiosira (E).

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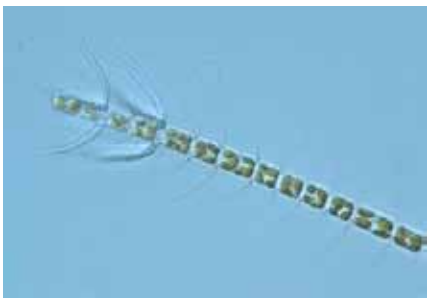

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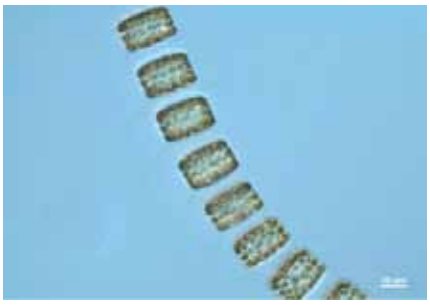

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Science Staff Bios

Hans Berge

(BS, MS) Hans is a Senior Ecologist in the Science and Technical Support Section within King County's Water and Land Resources Division. He is a certified Fisheries Biologist and has worked on salmon recovery projects across all watersheds in King County since 1999. Much of his work has focused on research related to habitat preferences and productivity of native fishes, but he also contributes to a wide range of projects across many aspects of aquatic ecology. His work often includes collaboration with partners from federal, state, and local jurisdictions.

Jeff Burkey

Jeff Is a Hydrologist in the Science and Technical Support section. During his 20 years at King County, he has developed hydraulic and hydrologic models; model designs; and, manages water quality sampling and analysis plans. Jeff served as the primary architect for designing King County's Brightwater treatment plant's stormwater and base flow sampling and analysis plan for its NPDES construction permit. Most recently, he co-authored with the Washington State Department of Ecology staff, the Temperature TMDL and Implementation Plan for Newaukum Creek. He also co-designed the water quality sampling and analysis plan for supporting development of King County's water quantity/quality models for the Green River and greater Lake Washington watersheds.

Gabriela Hannach

Gabriela is a Senior Scientist at the King County Environmental Lab where she has been part of the Aquatic Toxicology team for the last nine years. Gabriela holds a B.S. in Biology and a Ph.D. in Botany and has 20 years of experience researching marine and freshwater algae. Gabriela is currently involved with the analysis of cyanobacterial toxins and is the lead in the identification of marine phytoplankton.

Kollin Higgins

Kollin is a Senior Ecologist in the Science and Technical Support Section of King County Water and Land Resources Division. Kollin has primarily worked on salmon recovery and shoreline management issues over the past 12 years throughout the County's various watersheds. His time is currently focused on salmon recovery planning and restoration projects in the Green Duwamish and the Snoqualmie watersheds.

Ken Rauscher

Ken is a Senior GIS Analyst for the King County Water and Land Resources Division. He has over 13 years of experience working on a wide variety of projects with most sections within WLRD. His most recent geographical analysis skills are primarily focused on habitat restoration and floodplain management projects. Ken also works with LiDAR and other raster and aerial photography data.

Kimberle Stark

Kimberle is a Marine Biologist and Senior Water Quality Planner in the Science and Technical Support Section. During her almost 17 years with King County, Kimberle has worked on a variety of projects including siting of the Brightwater treatment system marine outfall; Elliott Bay habitat enhancement; eelgrass restoration; and a nitrogen management study in Quartermaster Harbor. Kimberle is the project manager for King County's marine water quality-monitoring program.

Scott Stolnack

Scott is a Senior Ecologist (BA, BS, MS) in the Science and Technical Support Section. Before becoming an ecologist, he was a science fiction author, technical writer and freelance journalist. His current work involves restoration and watershed ecology, endangered species recovery, monitoring, and environmental policy. He is Technical Coordinator for the scientific components of Chinook salmon recovery for the Lake Washington/ Cedar/ Sammamish Watershed (WRIA 8).

Jen Vanderhoof

Jen is a Senior Ecologist in the Science and Technical Support Section. Her work often focuses on issues related to wildlife, biodiversity, and climate change. Jen frequently contributes to interdisciplinary projects involving the Parks Division, Roads Services Division, the Director's Office, and the Floodplain Management Section. Jen's hobbies include photography, and she brings this talent to bear at work whenever possible.

Mark Wilgus

(BSCE, P.E.) Mark is a Senior Engineer in King County's Stormwater Services Section. He has served as a stormwater system designer and project manager for 15-years. He provided regulatory review for the King County Roads Division's South Park Bridge project. He also served as stormwater designer for the Novelty Hill Road improvement project that included both traditional facilities and Low Impact Development stormwater techniques.

King County's Science and Technical Support Section: Who We Are and What We Do

By Dave White, Science and Data Management Section Manager

King County's Science and Technical Support Section has a long tradition of providing accurate and useful scientific information. Located within the Water and Lands Resources Division, we are a group of scientists and engineers who supply information supporting the County's Strategic Planning goal of environmental sustainability. To safeguard and enhance King County's natural resources and environment, we gather, analyze, and synthesize information so that it can be used to measure program effectiveness, so they can be adjusted and improved. Our work supports a variety of programs such as stormwater management, wastewater treatment, river and flood management, ecosystem restoration, habitat protection, solid waste, water quality, and the cleanup of Puget Sound. The County also uses our expertise to assist in broader efforts addressing climate change, land use, and countywide comprehensive planning and policy. We also work in collaboration with—and often for—regional partners including cities, state agencies, tribes, Water Resource Inventory Area committees and others.

WHO WE ARE:

A team of water quality scientists, ecologists, hydrologists, biologists, limnologists, toxicologists, hydrogeologists, chemists and oceanographers that assess environmental conditions in King County.

Dave White

Dave Is the Science and Technical Support section Manager within King County's Water and Land Resources Division. Dave has held several positions in King County over the past 12 years within the Department of Natural Resources and Parks. Dave previously worked as an environmental consultant, as a university researcher, and as a Fisheries Officer for the Peace Corps in West Africa. He has an undergraduate degree in Environmental Science, and master's degrees in Natural Resource Management and Public Policy.

WHAT WE DO:

- Track long-term status and trends to assess if conditions are getting better or worse.
- Implement studies to assess project effectiveness, find sources of pollution, characterize important environmental features, and support capital projects.
- Provide scientific information to assist in planning efforts, policy decisions, and program design and implementation.
- Make information available to the public—who enjoy and care about our environment.

This newsletter touches on only a small part of the work we do. I encourage you to visit our website www.kingcounty.gov/environment/wlr/sections-programs/science-section.aspx to get a better picture of the breadth of our work. As scientists, our products are information – data sets, analyses, technical advice and reports. Those using the information we generate range from environmental program managers, to other scientists or research organizations, to the general public. We do applied work that must be clearly relevant to users needs, so we value customer service as well as accuracy. For us to be effective, good communication is key: to understand what information users need, as well as to be sure the information we provide is understood and meets those needs.

We are very proud of our role and our accomplishments, and continually look to improve our services to meet increasing and changing needs. Scientific questions and information priorities change over time, and we expect that the provision of timely, accurate and objective scientific information will become more important in the future. Environmental program managers face increasing budget pressures, and need information to help them ensure limited resources are spent where they are most effective. Increasingly, members of the public will demand more information, as our information-savvy culture recognizes the importance of environmental sustainability to their quality of life. We are accountable to our customers and data users to help meet their information needs, and will look to continue to improve in the services we provide. We welcome your suggestions.

About King County's SciFYI

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Send questions, comments and future story ideas to: Kate O'Laughlin - kate.olaughlin@kingcounty.gov, 206-296-8363 or Jim Simmonds - jim.simmonds@kingcounty.gov, 206-296-1986

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