October 2008

LAWNS OF GRASS

AN ASSESSMENT

Kitsap County's charm flows partly from its lawns. Grassed lawns have played an admirable environmental role. Readers are reminded that, for other reasons too, lawns are and have ever been immensely important places.

These pages report research showing that replacing lawns with non-grass vegetation will not likely reduce alleged potential problems with excess nutrients nor 'pollutants'. Certain heavy-duty chemicals, released steadily and copiously, are likely to sluice through vegetation, regardless of its kind. This because of our stormwater's habits. However no kind of vegetation surpasses lawn grass in absorbing pollutants of all kinds.

Vistas, meadows, and lawns are hallmarks of pleasant lifestyles in every developed region of the world. They are celebrated in centuries of art, poetry and prose. Provincially they are implicit in the state's Growth Management Act and the Smart Growth agenda.

Locally questions have been raised about the laudability of lawns and the goodness of grass. Some have proposed that the City endorse and commit resources to replacement of lawns.[1]

It appears that issues about lawns devolve largely into concerns about what comes from, goes across or flows under lawns. Here are some of those issues with findings from the technical literature. Overall, as with other Island natural systems, lawns are complex places to which simple assumptions may not apply.

Yards, Lawns, and A Children's Place

Why is all this important? Because families coming here look forward to an outdoor place for children.

However, in land-use planning, a children's place is becoming an afterthought. Sad that, with buffering and the condo flood, yards are fading. Without yards and grassy home places what refuge is there for kids? Where will be the places to romp? Where will be the backyard swing sets, sandboxes, Radio Flyer wagons, croquet layouts, tent pitches, and private places to run and dream?

Presumably they'll be wedged among the requisite shrubs, 'native' groundcovers and Astroturf-like surfaces. Because all chemicals are very bad and lawns are surfeited with them.[2] However these underlying declarations of danger are largely false.

Hardpan, Climate, Vegetation, and the Stormwater Story

Across northern states the continental glaciers left a rich legacy of lakes and wetlands, and a belt of farm-poverty-producing soils: bedrock, gravels, and compressed hardpan. Bainbridge got some of all three: 350-plus wetlands, areas of hard rock and gravels, and a heavy harvest of hardpan. Which says much about *where* our stormwater goes.[3]

Our peculiar climate says it all about *when* surface water flows. In contrast to most other U.S. regions we have scant summer rainfall. We lack the brief but intense local "convectional" storms that provide summer runoff.[4] And our prolonged winter rain events add other unusual regional dimensions, not the least of which are leaky buffers and saturated soils.

Our vegetation is special too. It's irrepressible, providing a useful rain softener in almost all places and seasons, in some combination of surface veg, shrubs, and trees. Bare ground is an oddity. However a key fact is that most vegetation goes dormant in winter. For hardwoods and softwoods alike, winter transpiration is as little as one percent of that in summer.[5]

Together these three factors - soils, climate and vegetation profile - make us different relative to stormwater.

Why tell this stormwater story? Because stormwater is the prime mover of nutrients and pollutants, for better or worse, across the landscape including lawns and all other vegetation.

Prolonged (winter) rains soak into upper soil horizons as far as the hardpan, which can be a matter of only inches. The glacier-compacted subsoil accepts water very slowly, perhaps an equivalent of .06 rainfall inches per hour.[6] At that rate, after a week the hardpan is wetted downward only 1-2 feet. Meanwhile rainwater (and other fluids) drain downhill on the hardpan's surface, toward surface seeps at wetlands, ponds, and creeks. This subsurface flow diverts water from aquifers but it is critical to streams.

Vegetation matters. Roots have trouble invading the hardpan, but they impede water sliding along through the surface soil. The root-soil combination can be an effective dam, saturating the soil on the uphill side.

Vegetation aboveground helps in three ways. One is physical obstruction of moving water, typical of grass. Another is absorption, by the settled leaf litter under vegetation, including grass clippings. The third is uptake of water in the course of photosynthesis, a growing-season-only factor.

Lawns and Erosion

Sediment is widely cited as a threat to wetlands and streams[7], going back decades to times of rampant logging, land clearing and farming across America. An active construction area is said to produce about 2000 times as much sediment as a fully vegetated area.[8]

However the erosion concern may be beating a dead horse. I suspect there were three periods in Kitsap history when erosion was prevalent. One was the 1870s and 80s, when logging and burning reached almost everywhere. Another was the era of stump ranching when everybody had livestock and overgrazed pastures were the norm. The third was the time of strawberry farms when much of the island was kept clear for berry culture, with long rows of bare soil exposed to winter rains.

Our present era of abundant vegetation and a cultural aversion to bare dirt mitigate against surface erosion. A few pastures are still with us, but given sensible animal management the Island's risk of rill erosion, the main source of sediment outside construction sites, is probably nil. Certainly woods and subdivision lawns don't carry that risk.

Stormwater in Flood Mode

However, overland flow of the waters not retained by vegetation or floodwater restrainers can wash away the accumulated dead leaves and twigs that make up forest duff, stripping the ground back to the underlying hardpan. Grass bends its head and lets the water flow over[9], but the woodland detritus has almost no capacity to cling.

These sluices through the bushes are junior versions of the woodland debris flows that Northwest scientists have been studying for decades.[10] Such flows are narrow, sudden, and sodden. They surge through wooded buffers into streams. Scoured out along the way are surface vegetative litter and duff and their algae, fungi, and fauna. A legacy is the woody debris that shelters fish and kills kayakers. Small versions of these flows are common in ravines all around Puget Sound.

Aside from trenching against the torrent or routing water into closed conduits, the best protection against erosion is stormwater capture at the top of the slope. No matter what the groundcover, water moving across the ground tends to concentrate, carving out tiny rills that merge into bigger channels. This can be seen in gardens in which shrubs are open-spaced. "...naturally occurring vegetated buffers are generally incapable of inducing sheet flow from storm water runoff ..." and "The natural tendency of water to move in discrete channels may be one of the greatest impediments to successful buffer implementation for nonpoint source pollution control..."[11] Up-slope capture leads to ways to encourage infiltration, mentioned next.

Aquifer Recharge and Yard Vegetation

How best to enhance infiltration of (presumably clean) stormwater? In a land of extremely dense glacial tills, adjusting vegetation would seem to have little merit, unless the till sill is narrow enough that tree roots can break through. Unless the roots block the breakthrough. I know of no Puget Basin research on this matter.

One objective is to delay stormwater long enough to allow it to infiltrate downward. Our winter storms are long enough that stormwater tends to roll over grass, run across bare ground around shrubs, and right on through woodland duff. Especially on steep ground. An option that works, although site-specific and generally expensive, is 'low impact development' (LID), which embraces water gardens, permeable pavements, small structural and roadway footprints, rain barrels – a landscape reminiscent of the 1930s.[12]

A King County analysis concluded that "...if a forested area is replaced with a paved surface for which runoff is collected in a recharge pond, net recharge may be greater than under the original condition in which much of the precipitation is lost to interception and evapotranspiration."[13]

This says little about lawns, except that infiltration (retention) ponds are typically lined with grass and other vegetation is excluded.

Given that our residential open space is invariably covered by some kind of vegetation, and all veg draws water from below, choosing least-thirsty plants has appeal. A woodsy setting transpires perhaps 2,000 to 4,000 tons of water per acre per summer.[14] During that time, a watered lawn might use 1800 tons over four months.[15]

A further advantage of a managed lawn is that water use can be controlled by the turn of a spigot. Trees, those great water conduits to the sky, keep right on doing their thing.

Septic Output and Lawns

Septic systems discharge whatever goes into them, of course, if one includes periodic pumping. Around Puget Sound two septic products, both involving drainfields, generate special concerns. These are coliform bacteria and nitrogen.

Fecal Coliform is a goner in a standard, maintained septic system (tank plus field). EPA reports that 99-99.99 percent removal is common.[16] Recently the Kitsap County Health District surveyed some 50 miles of shoreline along Hood Canal, finding only 13 septic systems needing attention.

A key factor in septic-system success is, of course, free flow of fluids through the drainfield's dispersal pipes. Which accounts for regulators' insistence on grass rather than deeper-rooted plant covers.

Nitrogen, essential to all proteins and thus to all animals and plants, is both nuisance and necessity in the Puget Sound country. Nuisance because in some wild waters nitrogen is a limiting factor to the reproduction of algae. Adding nitrogen can support explosive growth of these marine and freshwater plants that are at the bottoms of many food chains as well as adding oxygen. That's good, but excess algae die, decompose, and the decay organisms use up oxygen, a process to which fish deaths in Hood Canal have been attributed.[17] Some lakes, and probably some West Side wetlands, have been oversupplied with nitrogen, creating an excess of algae in a process called eutrophication.

The necessity side relates to dry-land plants all around, from lawns to forests, and famously to fish, in freshwater streams. So deficient that adding fertilizer to streams has markedly increased invertebrate populations and the numbers and sizes of juvenile salmon.[18] Volunteers have been carrying salmon carcasses from hatcheries to backcountry streams.[19]Wipfli, Mark S. et al. 2003. Marine subsidies in freshwater ecosystems: salmon carcasses increase the growth rates of stream-resident salmonids. Transactions of the American Fisheries Society 132:371-381. [Results in Southeast Alaska]

Elsewhere, nitrogen abounds. There is four times as much nitrogen as oxygen in air. Ocean upwelling brings huge amounts into Puget

Sound.[20] Animal doo and decaying vegetation may be the main sources of nuisance nitrogen on the Island. Alder trees are great nitrogen-fixers, using nodules on their roots.[21] Drainfields are probably trivial troublemakers given recent estimates along Hood Canal.[22]

Septic nitrogen is not well-processed inside a septic tank. Its return to the atmosphere involves a change from ammonia to nitrite, then nitrate, then (via bacterial action) to gas. This needs to happen in the "vadose" (porous, unsaturated) zone in and around the drainfield. So it's no surprise that grass outperforms woodlands by 2 to 1 in protecting aquifers and water places from nitrogen.[23]

Phosphorus Plus Some of the Really Bad Stuff

These are chemicals that cling to sediments. As goes surface erosion so go these things. Some, including phosphorus and many organic chemicals, move from the sediments to roots and up into plants. This assuming the plants are actively taking up water. We are fortunate here in having a long growing season and ground covers that stay green. The bad bit can be saturation. Saturation with the chemicals, harming the plants. Or saturation by stormwater that carries the soil particles on down the hill.

An asset of wetlands here is their abundance of clay-sized bottom sediments. By adsorption these gather phosphates, toxics and metals. Our wetlands' typical low (acid) pH helps too. This may seem a strange function for wetlands, but DOE has said that a function of wetlands is to trap and transform chemicals and improve water quality in the watershed.[24]

You may well disagree. Be of cheer. There's a consensus that, overall, grasses

> "...are generally able to respond rapidly to increased concentrations of nutrients, grow rapidly and densely, and typically grow well in nearly all climates. Thickly planted, clipped grasses provide a dense, obstructive barrier to horizontally flowing water. This increases the roughness of the terrain, which reduces flow velocity, promotes sheet flow, and increases sediment and adsorbed pollutant removal efficiency."[25]

Too, grasses have an advantage over other vegetation in their greater capacity (per square foot) to absorb otherwise unwanted chemicals. This because of their higher "primary productivity".[26]

Fertilizers and Yard Chemicals Generally

Farmers, foresters and landscapers are economically and biologically shrewd. They have a strong incentive to minimize the use of expensive chemical treatments, so most operators do soil testing as part of site- and time-specific fertilizing. Some homeowners resort to soil analyses, but most can readily judge when grass and shrubs have gotten greener and taller and trees are adding new growth.

As with fertilizers, the extent of use of herbicides and insecticides here is unknown. Insecticide use may increase as we see an influx of gypsy moths to decimate flower and vegetable gardens and deciduous trees, perhaps followed by the Asian gypsy moth that will take conifers. Not to mention rusts, wilts, mildews, galls, chewers, girdlers, and wasps. Native plants will presumably be especially susceptible as these (and most other harmful) insects come from abroad. Another challenge to creative chemistry will be mosquito-borne West Nile disease and, with regional warming, malaria.

Grass has advantage over less-dense plantings like shrubs because of its structural integrity. Invaders like Scotch broom, laurel, poison oak and blackberries are better repelled by lawns. And grass establishes that tight cover in weeks rather than the years required by even broadleafed-tree litter.

Concern about yard chemicals should be moderated by the fact that chemicals are applied mostly in seasons in which stormwater will not wash them away before they decompose.

There are yard and buffer chemicals that meet these environmental standards: [27]

> Persistence. A half-life of less than 30 days is a recommended objective.
>
> Adsorptivity. The tendency of a chemical to adhere to soil particles rather than passing through to groundwater or horizontally to streams. The coefficient is K, preferably above 300.[28]
>
> Solubility in water. Less than 30 mg/L is considered desirable, especially if persistence is high and adsorptivity is low.

Petroleum Products and Industrial Chemicals

There are heavy-duty chemicals, including organics and heavy metals, in Puget Sound. Familiar names are zinc, lead, mercury, copper, PAHs, PCBs, dioxins, and furans. Most of the Sound's contaminated sediments are associated with industrial areas, and the great majority lie in Elliott Bay.[29]

The weakness of buffers, including lawns, applies also to petroleum products and heavy metals. It is argued that vegetation, by capturing rainwater, also absorbs the chemicals. It does, but only in the growing season and only up to a point: plants have a limited capacity for the chemicals they don't need.

Even woodlands become overwhelmed, especially where soils are dense and slow to absorb water, as on much of the County. The hardpan helps keep chemicals out of aquifers but speeds the chemistry downhill to wetlands and creeks. So pervious are woods that a research compilation points out that 300-foot wooded buffers are no more effective than 6-foot buffers.[30]

Stormwater dilutes these chemicals but they don't dissolve; they just ride the wave of water to wherever they settle. As lawns and other buffers become saturated with water they can also be saturated with the bad stuff.

The primary enduring solution to chemical pollution is cutting off chemicals at the source. This is not an indictment of septic systems, lawns, nor suburban life. Snohomish County, in an assessment of their many lowland lakes, found that the quality of lake water is better where shores are lined with homes than where they are not.[31]

Lawns, Grass, and Native Vegetation

Lawns preserve a heritage of native grass. The key lawn grass species here are fescues, descendants of the grass that predated fir trees in the Puget Lowland. Remnants of the grass-oak savannas remain from Victoria south into California.[32] It is ironic that restoration of those grass-based environments is a key element of conservation these days, while some folks would have grasses diminished.

If Not Grass, What?

Presumably some other vegetative child-friendly groundcover. Ideally, one that provides all the functions and values of grassed lawns with less expense or hassle. A challenge indeed.

D. F. Flora

NOTES

---

1. CAO Non-Regulatory Citizens Working Group. 2004. Matrix of recommendations for Land Use Committee [of Bainbridge Island City Council] re: Critical Areas Ordinance non-regulatory options. April 27, 2004. On file at Bainbridge Island Department of Planning and Community Development.

2. For example, Cruickshank, Cara. 2002. "Get your lawn off drugs:" the natural landscapes project. Scotch Broom. Autumn.

3. There is a soil-type survey done by the U.S. Department of Agriculture covering all of Kitsap County.

4. Hornbeck, James W., et al. 1984. Forest hydrology and watershed management. In: Wenger, Karl F., ed. Forestry Handbook (Society of American Foresters). New York: Wiley.

Hewlett, J. D. 1982. Principles of forest hydrology. Athens, GA: University of Georgia Press.

5. Baker, Frederick S. 1950. Principles of Silviculture. New York: McGraw-Hill.

6. A calculation based on equations and data in: Washington Department of Ecology. 1992, 2000. Stormwater management manual for the Puget Sound basin [with amendments], Section III. Soil type D.

7. Desbonnet, Alan, et al. 1994. Vegetated buffers in the coastal zone, a summary review and bibliography. Coastal Resources Center Technical Report No. 2064. Narragansett, RI: University of Rhode Island Sea Grant.

8. U.S. Environmental Protection Agency. 1976. Erosion and sediment control in surface mining in the eastern U.S., Volume 1, Planning. EPA Technology Transfer Seminar Publication EPA 625/3-76-006. Cited in: Barfield, B. J., et al. 1977. Prediction of sediment transport in a grassed media. Paper No. 77-2023. St. Joseph, MI: American Society of Agricultural Engineers.

9. Ree, W. O. 1949. Hydraulic characteristic of vegetation for vegetated waterways. Agricultural Engineering 30(4):184-9. Cited in: Barfield, et al, above.

10. For example (there are scores of relevant pubs):

Swanson, F. J. Et al. 1982. Material transfer in a western Oregon forested watershed. In: R. L. Edmonds. Analysis of Coniferous Forest Ecosystems in the Western United States. Stroudsberg, PA: Hutchinson Ross Publishing Co.

Swanson, F. J. et al. 1987. Mass failures and other processes of sediment production in Pacific Northwest forest landscapes. In: Salo, E. O. And T. W. Cundy, eds. Streamside management: Forestry-fishery interactions. Seattle: University of Washington.

Swanson, F. J. et al 1998. Flood disturbance in a forested landscape. BioScience 48(9):681-9.

Skaugset, A. E. Et al. 2002. Landslides, surface erosion, and forest operations in the Oregon Coast Range. In: Hobbs, S. D., et al, eds. Forest and Stream Management in the Oregon Coast Range. Corvallis: Oregon State University Press.

11. Desbonnet et al, above, p. 10.

12. An array of such treatments is in:

Hinman, Curtis. 2005. Low impact development – Technical guidance manual for Puget Sound. Olympia and Tacoma respectively: Puget Sound Action Team and Washington State University’s Pierce County Extension.

13. King County Department of Natural Resources and Parks et al. 2004. Best available science, Volume 1. P. 6-20, citing:

Bidlake, W. R. And K. L. Payne. 2001. Estimating recharge to ground water from precipitation at Naval Submarine Base Bangor and vicinity, Kitsap County, Washington. Water-Resources Investigation Report 01-4110. U.S. Geological Survey. [Place of publication unk.]

King County also says (same report, p. 6-17), “The routing of storm water into infiltration systems is the preferred method for storm water management in Washington...”

14. 2,000 tons is based on research by Prof. Leo Fritschen at the University of Washington. He measured transpiration for a second-growth Douglas-fir by putting an adult forest tree into a very large pot, called a lysimeter, which measured how much water the tree took up. It corresponded to about 20 inches of rain per year. This in the Cedar River watershed.

4,000 comes from Buell, Jesse H. 1949. The community of trees. In: Trees, the Yearbook of Agriculture.

15. This is based on the common Puget Sound prescription of one inch of water per week. I doubt that most people use that much.

16. U.S. Environmental Protection Agency. 2002. Onsite wastewater treatment systems manual. EPA/625/R-00/008. Cincinnati: National Risk Management Research Laboratory.

17. Fagergren, Duane, et al. 2004. Hood Canal low dissolved oxygen - Preliminary assessment and corrective action plan. Puget Sound Action Team and Hood Canal Coordinating Council. [Processed. Place of publication unknown.]

Paulson, Anthony J., G. L. Turney, et al. 2004. An analysis of nitrogen loading to Hood Canal. Preliminary results, subject to revision. Tacoma: U.S. Geological Survey. Two papers at HTTP://wa.water.usgs/projects/hoodcanal.

18. Ward, Bruce R., Donald J. F. McCubbing, and Patrick A. Slaney. 2003. Evaluation of the addition of inorganic nutrients and stream habitat structures in the Keogh River watershed for steelhead trout and coho salmon. In: Stocker, John G., ed. Nutrients in salmonid ecosystems: Sustaining production and biodiversity. Proceedings of the 2001 Nutrient Conference, Eugene. Bethesda: American Fisheries Society.

19. Bilby, Robert E., et al. 1998. Response of juvenile coho salmon (*Oncorhynchus kisutch)* and steelhead (*Oncorhynchus mykiss*) to the addition of salmon carcasses to two streams in southwestern Washington, U.S.A. Canadian Journal of Fisheries and Aquatic Science 55:1909-1918.

20. Harrison, P. J., D. L. Mackas, B. W. Frost, et al. 1994. An assessment of nutrients, plankton, and some pollutants in the water column of Juan de Fuca Strait, Strait of Georgia and Puget Sound, and their transboundary transport. In: Proceedings of the BC/Washington Symposium on the Marine Environment, January 13 & 14, 1994. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1948. Ottawa[?]: Fisheries and Oceans Canada.

21. Bollen, W. B. And K. C. Lu. 1968. Nitrogen transformation in soils beneath red alder and conifers. In: Trappe, J. M., et al., eds. Biology of alder. Portland: USDA Forest Service, Pacific Northwest Research Station.

Edmonds, R. L. 1980. Litter decomposition and nutrient release in Douglas-fir, red alder, western hemlock, and Pacific silver fir ecosystems in western Washington. Canadian Journal of Forestry Research 10:327-337.

22. Flora, D. F. 2005. An ocean view from the foot of Hood Canal: A different perspective on the dead zone. Bainbridge Is.[processed].

23. Desbonnet et al, above.

24. Paraphrased from : Sheldon, Dyanne et al. 2003. Freshwater Wetlands in Washington State, Vol. 1: A Synthesis of the Science (Draft, August 2003). Olympia: Department of Ecology. P. 2-5.

25. Desbonnet et al, above.

26. Falk, John H. 1980. The primary productivity of lawns in a temperate environment. Journal of Applied Ecology 17:689-696.

27. Mulla, David J. Et al. 1996. Clean water for Washington - Pesticide movement in soils - Groundwater protection. Extension Bulletin 1543. Pullman: Washington State University Cooperative Extension.

28. K is the ‘partition coefficient’, the ratio of adsorbed to dissolved pesticide concentrations per 1% of soil organic carbon content. Knew you’d wonder.

29. Map in Puget Sound’s Health 2002, published by Puget Sound Action Team [formerly Puget Sound Water Quality Action Team].

30. Desbonnet et al, above.

31. Williams, Gene and Heidi Reynolds. 2003. State of the lakes report. Everett: Snohomish County Public Works, Surface Water Management.

32. Brubaker, Linda B. 1991. Climate change and the origin of old-growth Douglas-fir forests in the Puget Sound Lowland. In: Ruggiero, L. F., et al. Wildlife and vegetation of unmanaged Douglas-fir forests. General Technical Report PNW-GTR-285. Portland: USDA Forest Service, Pacific Northwest Research Station.

Chappell, Christopher B. and Rex C. Crawford. 1997. Native vegetation of the South Puget Sound prairie landscape. In: Dunn, Patrick and Ewing Kern, eds. Ecology and conservation of the South Puget Sound prairie landscape. Seattle: The Nature Conservancy of Washington.

Chappell, Christopher and Jimmy Kagan. 2001. Westside grasslands. In: Johnson, David H. And Thomas A. O’Neil, manag. Dir., Wildlife-habitat relationships in Oregon and Washington. Corvallis: Oregon State University Press.

Hitchcock, C. Leo and Arthur Cronquist. 1973. Flora of the Pacific Northwest. Seattle and London: University of Washington Press. See sections on *Festuca* (fescues) and *Elymus* (ryegrasses).

Mathews, Daniel. n.d. Cascade-Olympic Natural History. Portland: Raven Editions in conjunction with the Portland Audubon Society.

Thysell, David R. and Andrew B. Carey. 2001. *Quercus garryana* communities in the Puget Trough, Washington. Northwest Science 75(3):219-235.

Tveten, R. K. and R. W. Fonda. 1999. Fire effects on prairies and oak woodlands on Fort Lewis, Washington. Northwest Science 73(3):145-158.