Draft Annotated Bibliography: Articles on salmon habitat and agriculture
Rob Walton March 16, 2015

Important note to readers of this bibliography: I have provided abstracts where available and excerpts from articles that have been brought to my attention in order to give an idea of the subjects covered, but I do not claim that these excerpts provide an accurate summary of the articles. For accurate and complete quotations and content, please read the articles.

Allan 2004. Landscapes and Riverscapes: The Influence of Land Use on Stream EcosystemsAuthor(s): J. David AllanSource: Annual Review of Ecology, Evolution, and Systematics, Vol. 35 (2004), pp. 257-284

Abstract Local habitat and biological diversity of streams and rivers are strongly influenced by landform and land use within the surrounding valley at multiple scales. However, empiricalassociations between land use and stream response only varyingly succeed in implicating pathways of influence. This is the case for a number of reasons, including (a) covariation of anthropogenic and natural gradients in the landscape; (b) the existence of multiple, scale-dependent mechanisms; (c) nonlinear responses; and (d) the difficulties of separating present-day from historical influences. Further research is needed that examines responses to land use under different management strategies and that employs response variables that have greater diagnostic value than many of the aggregated measures in current use.

Agricultural land use degrades streams by increasing nonpoint inputs of pol-lutants, impacting riparian and stream channel habitat, and altering flows (Ta-ble 1). Higher inputs of sediments, nutrients, and pesticides accompany increased agricultural land use (Cooper 1993, Johnson et al. 1997, Lenat 1984, Osborne & Wiley 1988). Streams in highly agricultural landscapes tend to have poor habitat quality, reflected in declines in habitat indexes and bank stability (Richards et al. 1996, Roth et al. 1996, Wang et al. 1997), as well as greater deposition of sediments on and within the streambed…

The rapidly expanding investigation of streams in the context of their catchments and landscapes clearly indicates that stream ecosystems are strongly affected by human actions across spatial scales. The impacts are numerous, both direct and in-direct, and complex, owing to the various pathways by which land use influences streams and the interaction between anthropogenic gradients and the hierarchi-cally structuredi nfluence of landformo n local streamc onditions. Not only does the valley rule the stream, as Hynes (1975) so aptly put it, but increasingly, human activities rule the valley. The extent of change in river health in response to future population growth and development can be anticipated from knowledge of the relationships between land use and stream condition and plausible alternative futures (Baker et al. 2004).

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Anlauf et al 2011. Explaining spatial variability in stream habitats using both natural and management-influenced landscape predictors. AQUATIC CONSERVATION: MARINE AND FRESHWATER ECOSYSTEMS Aquatic Conserv: Mar. Freshw. Ecosyst. 21: 704–714 (2011) Published online 22 September 2011 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/aqc.1221

ABSTRACT: The distribution and composition of in-stream habitats are reflections of landscape scale geomorphic and climatic controls. Correspondingly, Pacific salmon (Oncorhynchus spp.) are largely adapted to and constrained by the quality and complexity of those in-stream habitat conditions. The degree to which lands have been fragmented and managed can disrupt these patterns and affect overall habitat availability and quality **…** By using a sequential linear regression analysis, management-influenced factors could be segregated from natural gradients to identify those stream habitat features that may be more sensitive to land-use pressures. These results contribute to the progressing notion that the conservation of freshwater resources is best accomplished by investigating and managing stream systems from a landscape perspective.

Anlauf-Dunn et al 2014. Habitat connectivity, complexity, and quality: predicting adult coho salmon occupancy and abundance Can. J. Fish. Aquat. Sci. 71: 1–13 (2014) dx.doi.org/10.1139/cjfas-2014-0162 Published at www.nrcresearchpress.com/cjfas on 27 August 2014.

Abstract: The distribution, quality, and connectivity of instream habitat can influence adult salmon occupancy and abundance patterns and alter population dynamics. In this study, we evaluated the relationships between adult coho salmon (*Oncorhynchus kisutch*) occupancy and abundance with instream habitat conditions, including measures of spawning gravel, habitat complexity, and juvenile rearing habitat. We used corresponding adult salmon spawning and instream habitat data collected within coastal Oregon watersheds as part of a long-term monitoring program… Densities of coho salmon tend to be higher in areas dominated by forest cover, with less agricultural land use, and where sedimentary (versus volcanic) geologies prevail (Firman et al. 2011; Steel et al. 2012). The habitat conditions that influence adult salmonid occupancy and abundance are hierarchical; landscape scale features such as climate, geology, geomorphology, or land use account for only a portion of the variability in adult
salmonid spawning location, timing, and (or) abundance (Steel et al. 2012). Controls operating at landscape scales bound the distribution of conditions at smaller scales (Beechie et al. 2008).
Therefore, landscape features may help explain patterns in maximum fish abundance, but finer-scale habitat features, measured within a stream reach or specific types of habitat, are necessary to further illuminate differences in site occupancy and abundance. (Montgomery et al. 1999).

Beechie et al 1994. Estimating Coho Salmon Rearing Habitat and Smolt Production Losses in a Large River Basin, and Implications for Habitat Restoration. North American Journal of Fisheries Management 14:797-811, 1994

This is the NWFRSC coho paper from 1994 that shows agriculture having a large impact on the physical capacity of coho salmon habitat.
"The largest loss of winter habitats has occurred in side-channel sloughs (31%) and distributary sloughs (29%). By type of impact, hydromodification (diking, ditching, dredging) associated with agricultural and urban lands accounts for 73% of summer habitat losses and 91% of winter habitat losses. …

… staff resources would more efficiently be expended on developing a methodology for addressing impacts on slough habitat types rather than impacts on main-stem areas."

Beechie, Tim and Pollock, Michael: NWFSC Memo: September 25, 2008: Riparian Buffer Zones in the Interior Columbia River Basin: A Review of Best Available Science

"We contracted the Battelle Institute to perform a literature review on functions of riparian buffers in agricultural areas of the interior Columbia River Basin … . In general, the contracted review found that the current literature provides a reasonably thorough coverage of the effectiveness of riparian buffers for sediment filtration, nitrogen filtration, wood supply, and shade. Studies of pesticide and phosphorous filtration are less common, and therefore are less well represented in the review. The available literature indicates that buffer width and vegetation type are primary factors influencing buffer effectiveness for most functions. …

In general, buffers 50 feet wide should provide moderate to high function in both hardwood and brush vegetation types. Fifteen foot buffers provide low to moderate function in both vegetation types with wood and shade functions being low (<50%) in hardwoods and moderate in brush vegetation. Buffer widths of 15 feet likely provide moderate (50-75%) function for sediment filtration, nutrient filtration, wood, and shade functions in brush areas where most runoff is sub-surface zone. By contrast, buffer widths of 15 feet only provide low (<50%) levels of nitrogen filtration when most runoff is on the surface and natural vegetation is tall hardwoods…

<u>CREP buffers</u>
The Columbia River Basin Conservation Reserve Enhancement Program, which provides support for landowners to convert stream-adjacent farm lands into riparian buffers, requires a minimum 35 foot buffer set aside to enroll in the program. This program has been used throughout the interior Columbia River Basin, and questions as to whether a 35 foot buffer is sufficient to adequately protect streams has arisen. The attached Riparian Buffer Zones review suggests that a 35 foot buffer may not be effective in supporting all streamside ecosystem functions. We concur with this general conclusion, but we also

interpret the conclusion differently depending on natural vegetation potential. We conclude that > 75% of most functions are likely achieved with a 35 foot buffer where natural vegetation is willow or brush, but that < 50% of the critical wood and shade functions are likely achieved where natural vegetation is cottonwood or other tall hardwoods.

Data needs

Regardless of the program through which riparian buffers are established, we strongly recommend a robust monitoring component to assess both the initial success of the program in establishing riparian vegetation, and the long-term success at improving stream habitat by comparing treatments (buffers) to controls (no buffer or riparian enhancement) or reference streams. We also recommend that NOAA establish an interior Columbia River Basin riparian functional assessment program to determine 1) what functions such riparian forests provide to stream habitat 2) how those functions vary with riparian buffer width, stream size, and stream condition, 3) what techniques are required for successful establishment of riparian forests and 4) how riparian functionality and establishment techniques may vary under climate change. Answering such questions is essential to the successful restoration and enhancement of stream habitat in the interior Columbia River Basin.

Colvin et al 2009 Fish Use of Intermittent Watercourses Draining Agricultural Lands in the Upper Willamette River Valley, Oregon Transactions of the American Fisheries Society 138:1302–1313, 2009 _ Copyright by the American Fisheries Society 2009 DOI: 10.1577/T08-150.1

Abstract.—Historically, the upper Willamette River valley in western Oregon was characterized by seasonal floods and large expansions of its stream network. During the past century, human activities have altered or eliminated many intermittent stream and floodplain habitats in the valley. As a result, the remaining intermittent streams and ditches, referred to as watercourses, may still provide habitat that is critical for native fish. Our objectives were to determine (1) fish presence, (2) the spatial gradients of fish distribution (including species identity, native versus nonnative status, and numbers), (3) fish use of the intermittent streams as spawning and nursery habitats, and (4) the main factors that influence the numbers of fish and fish species. In the winter and spring of 2002–2003, we examined the distributions of fish species in five subbasins within the Willamette River valley. The sampling sites were in intermittent watercourses that drained grass seed– producing fields. We collected water samples and sampled fish from December to May with minnow traps and an electrofishing unit and collected data on the standard fish habitat variables at all sites in spring. Thirteen fish species were found and only three of them were exotic. The presence of recently hatched and juvenile fish shows that intermittent watercourses offer conditions suitable for spawning and juvenile rearing. The two watershed-scale variables with the most influence on fish species richness were the percentage of the watershed covered by forest and the distance to perennial water, the first of which had a direct relationship to species diversity and the second an inverse

relationship. In turn, fish abundance had a negative, albeit modest, relationship with the distance to perennial water. Among local-scale variables, water velocity and conductivity were inversely related to species richness and fish numbers. Our results highlight the relevance of intermittent agricultural watercourses for native fish species in the Willamette River valley and call for the promotion of agricultural conservation practices that benefit farmers while maintaining aquatic biodiversity in floodplain habitats.

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Flitcroft et al 2014. Riverscape Patterns among Years of Juvenile Coho Salmon in Midcoastal Oregon: Implications for Conservation
To cite this article: R. Flitcroft , K. Burnett , J. Snyder , G. Reeves & L. Ganio (2014), Transactions of the American Fisheries Society, 143:1, 26-38
To link to this article: http://dx.doi.org/10.1080/00028487.2013.824923

Abstract
Patterns of salmon distribution throughout a riverscape may be expected to change over time in response to environmental conditions and population sizes. Changing patterns of use, including identification of consistently occupied locations, are informative for conservation and recovery planning. We explored interannual patterns of distribution by juvenile Coho Salmon *Oncorhynchus kisutch* in 11 subbasins on the midcoast of Oregon. We found that juvenile Coho Salmon distribution expanded and contracted around stream sections that were continuously occupied (core areas). Timing of expansion or contraction was synchronous among subbasins and appeared to be related to the size of the parental spawning run. Juvenile distribution expanded from core areas when adults were abundant and contracted into core areas at lower adult abundances. The "intrinsic potential" of stream sections to support high quality habitat for Coho Salmon also appeared to inform distribution patterns. In most subbasins, when populations expanded, they moved into areas of high intrinsic potential. We identified areas that were consistently used by juvenile Coho Salmon which may be important target locations for conservation and restoration. Our study contributes to the body of work that seeks to explain the processes behind spatial and temporal patterns of freshwater habitat use by salmonids in the Pacific Northwest, thereby enhancing understanding of the complexity of biological and environmental interactions over broad scales.

Hubler 2007. Wadeable Stream Conditions in Oregon Shannon Hubler. ODEQ Laboratory Division—Watershed Assessment Section DEQ07-LAB-0081-TR November 2007

"This report describes the ecological conditions of wadeable, perennial streams throughout Oregon, and relates indicators of chemical and physical conditions to the conditions of the biological communities. The results of this 5-year study are part of the Western States Environmental Monitoring and Assessment Program (W-EMAP), which was designed to summarize stream conditions for 12 western states and across the entire western United States…

A*gricultural Disturbances*--This metric is calculated in the same way as All Human Disturbances (above), but is limited to only those disturbances associated with agricultural practices observed by the field survey crew. The isolation of different types of stressors by landuse type, especially this metric, has shown significant correlations with biological condition in previous studies.

Human disturbances were grouped according to all types of disturbances, and only those pertaining to agricultural practices (Figure 10). We examined agricultural activity separately because this metric has shown a strong linkage to biological integrity in past studies. Throughout Oregon, 56% of assessed stream kilometers were in "least disturbed" condition for agricultural disturbances, while only 30% of stream kilometers were "least disturbed" condition for all disturbances. A high percentage of assessed stream kilometers were in "most disturbed" condition for all types of disturbances (46%) and agricultural disturbances (42%). Since reference sites are selected in watersheds that are relatively undisturbed by human activity, it is not unexpected that the random population would have more extensive disturbances than the reference population. For both parameters 36% of stream kilometers were not assessed."

See excerpt on next page.

Excerpt from Huber:

Physical Habitat Indicators of Stress

Physical habitat indicators were grouped into five categories: human disturbances, stream morphology, riparian condition, habitat structure, and substrate. No water quality standard exists for any of these indicators, so regional reference sites were used to determine condition classes (Appendix A).

Human disturbances

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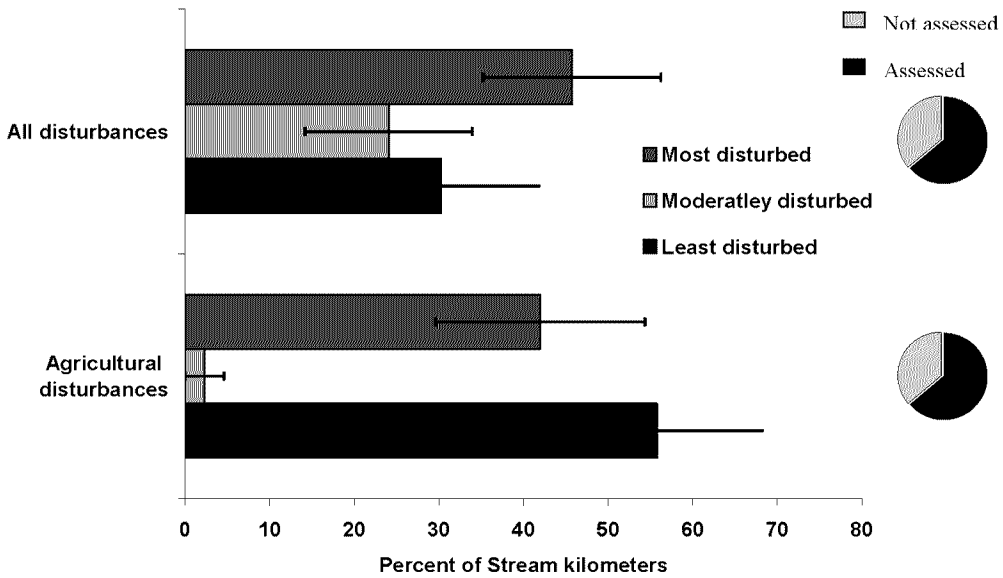

Figure 10. Extent of human disturbance indicators in each condition class. (Error bars are 95% confidence intervals.) The pie chart to the right shows the percentage of all perennial, wadeable stream kilometers actually assessed (dark blue) and the percent of kilometers not assessed (grey).

Micheli et al 2004 QUANTIFYING THE EFFECT OF RIPARIAN FOREST VERSUS AGRICULTURAL VEGETATION ON RIVER MEANDER MIGRATION RATES, CENTRAL SACRAMENTO RIVER, CALIFORNIA, USA E. R. MICHELI,[a]* J. W. KIRCHNER[b] and E. W. LARSEN[c] RIVER RESEARCH AND APPLICATIONS
River Res. Applic. 20: 537–548 (2004) Published online 29 April 2004 in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/rra.756

ABSTRACT
Riparian forest vegetation is widely believed to protect riverbanks from erosion, but few studies have quantified the effect of riparian vegetation removal on rates of river channel migration. Measured historical changes in a river channel centreline, combined with mapped changes in floodplain vegetation, provide an opportunity to test how riparian vegetation cover affects the erodibility of riverbanks. We analysed meander migration patterns from 1896 to 1997 for the central reach of the Sacramento River between Red Bluff and Colusa, using channel planform and vegetation cover data compiled from maps and aerial photography. We used a numerical model of meander migration to back-calculate local values for bank erodibility (i.e. the susceptibility of bank materials to erosion via lateral channel migration, normalized for variations in near-bank flow velocities due to channel curvature). A comparison of migration rates for approximately 50 years before and after the construction of Shasta dam suggests that bank migration rates and erodibility increased roughly 50%, despite significant flow regulation, as riparian floodplains were progressively converted to agriculture. A comparison of migration rates and bank erodibilities between 1949 and 1997, for reaches bordered by riparian forest versus agriculture, shows that agricultural floodplains are 80 to 150% more erodible than riparian forest floodplains. An improved understanding of the effect of floodplain vegetation on river channel migration will aid efforts to predict future patterns of meander migration for different river management and restoration scenarios. Copyright # 2004 John Wiley & Sons, Ltd.

"A comparison of migration rates and bank erodibilities between 1949 and 1997, for reaches bordered by riparian forest versus agriculture, shows that agricultural floodplains are 80 to 150% more erodible than riparian forest floodplains. An improved understanding of the effect of floodplain vegetation on river channel migration will aid efforts to predict future patterns of meander migration for different river management and restoration scenarios. Copyright # 2004 John Wiley & Sons, Ltd."

Nickelson, Thomas.E Futures Analysis for Wetlands Restoration in the Coquille River Basin: How many adult coho salmon might we expect to be produced? A Report to the Nature Conservancy. November 2012

This paper by Tom Nickelson provides a good basis for the limiting factors for coho and ties it to the alteration of much of the lowland habitat. It also has a large number of references related to the habitat types used by coho.

"Given the importance of off-channel wetlands to the over-winter rearing of coho salmon (*See* Introduction), restoring the wetlands of the lower Coquille River River should be the highest priority action to recover the coho salmon population of the basin, which is currently at about 6- 12% of historic levels…

Based on these analyses, each acre of restored wetland would be expected to produce on average 11-17 adult coho salmon; 18-27 in good ocean years. A 100 acre restored wetland would produce an estimated 1,100-1,700 adults and a harvest of 110-170 adults in the in-river sport fishery…"

Pollock et al 2004 The Importance of Beaver Ponds to Coho Salmon Production in the Stillaguamish River Basin, Washington, USA *North American Journal of Fisheries Management* 24:749–760, 2004 Copyright by the American Fisheries Society 2004

Abstract.—The use of beaver *Castor canadensis* ponds by juvenile coho salmon *Oncorhynchus kisutch* and other fishes has been well established. However, the population-level effects on coho salmon resulting from the widespread removal of millions of beaver and their dams from Pacific Coast watersheds have not been examined. We assessed the current and historic distributions of beaver ponds and other coho salmon rearing habitat in the Stillaguamish River, a 1,771-km2 drainage basin inWashington and found that the greatest reduction in coho salmon smolt production capacity originated from the extensive loss of beaver ponds. We estimated the current summer smolt production potential (SPP) to be 965,000 smolts, compared with a historic summer SPP of 2.5 million smolts. Overall, current summer habitat capacity was reduced by 61% compared with historic levels, most of the reduction resulting from the loss of beaver ponds. Current summer SPP from beaver ponds and sloughs was reduced by 89% and 68%, respectively, compared with historic SPP. A more dramatic reduction in winter habitat capacity was found; the current winter SPP was estimated at 971,000 smolts, compared with a historic winter SPP of 7.1 million smolts.
In terms of winter habitat capacity, we estimated a 94% reduction in beaver pond SPP, a 68% loss in SPP of sloughs, a 9% loss in SPP of tributary habitat, and an overall SPP reduction of 86%. Most of the overall reduction resulted from the loss of beaver ponds. Our analysis suggests that summer habitat historically limited smolt production capacity, whereas both summer and winter habitats currently exert equal limits on production. Watershed-scale restoration activities designed to increase coho salmon production should emphasize the creation of ponds and other slow-water environments; increasing beaver populations may be a simple and effective means of creating slow-water habitat.

Pollock et al 2013 Using reference conditions in ecosystem restoration: an example for riparian conifer forests in the Pacific Northwest. ECOSPHERE. www.esajournals.org 1 November 2012 v Volume 3(11) v Article 98

Abstract. Quantifying the attributes of reference sites is a crucial problem in the restoration of ecosystems, driving both the evaluation of current conditions and the setting of management targets for specific points in the future. Restoration of riparian ecosystems, particularly those dominated by conifers, has become a priority because of

the numerous ecosystem services they provide, including a high number of vertebrate species in population decline that utilize these structurally complex forests. By way of example, we illustrate a three-step process to assess the effects of proposed riparian ecosystem restoration efforts: (1) identify reference sites (2) quantify metrics that describe the reference sites, and (3) use models to predict the likely effects of restoration actions relative to reference conditions. To this end, we identified 117 natural, late-successional conifer dominated stands from existing forest inventories in the Pacific Northwest for the purpose of establishing reference conditions. We did this to establish quantitative metrics for structural attributes essential to the maintenance of biodiversity in these forests, and to assess whether there were any important quantitative differences between upland and riparian forests or whether upland and riparian forest reference sites could be used interchangeably. Both forest types were generally similar, but riparian stands had higher average live tree wood volumes and basal areas, suggesting they may be growing on sites that are more productive. Both riparian and upland forests had abundant large diameter (.50 cm) live trees and snags. Collectively, our data suggest that mature, late-successional conifer dominated forests have well developed structural characteristics in terms of abundant large trees in the overstory, abundant large snags, and a well-developed understory of shade-tolerant trees. We modeled the growth of young conifer stands to assess whether a common restoration treatment would accelerate development of structural characteristics typical of reference conditions. We found that left untreated, the stands followed a trajectory towards developing forest structure similar to the average reference condition.
In contrast, the restoration treatment followed a developmental trajectory along the outside range of
reference conditions.

Sather, N.K. and May, C.W. Marine Sciences Laboratory Sequim, Washington 98382 March 2008. Riparian Buffer Zones in the Interior Columbia River Basin: A Review of Best Available Science Riparian Buffer Zones in the Interior Columbia River Basin: A Review of Best Available Science. Prepared for NMFS Northwest Fisheries Science Center Seattle, Washington. Battelle Memorial Institute Pacific Northwest Division Richland, Washington 99352

"This report summarizes the findings of applicable studies that qualify as best available science. Based on the body of research, it is evident that riparian buffers, when properly designed and maintained, can significantly reduce the impacts of agricultural land-use activities on streams, lakes, and wetlands.

Stein, John E. (with Roni and Beechie): Initial Review of AFW Riparian Buffer Table. Memo to Will Stelle. September 27, 2012

"This is a NWFSC initial review of the AFW agricultural riparian buffer table … only to assess if the proposed buffers provided improvement in some functions and if it had any fatal flaws. We did this in part based on two literature reviews; one we did in 2002 (see Memo dated March 20, 2003) and another we did for agricultural lands in the Columbia Basin in 2008 (see Memo dated September 28, 2008)…

Based on a quick look at the table and our previous literature reviews summarizing buffer widths and functions, it appears that both options 2 and 3 would provide at least moderate function for most streams in classes 2 and 3 (fish bearing)…

In summary, in reviewing the brief information provided in the AFW Riparian Buffer Table, it appears that the proposed buffer widths on agricultural lands under Option 2 and Option 3 are a substantial improvement over the current baseline on agricultural lands (little to no buffers)."

Sweeney, Bernard W. and J. Denis Newbold, 2014. Streamside Forest Buffer Width Needed to Protect Stream Water Quality, Habitat, and Organisms: A Literature Review. Journal of the American Water Resources Association (JAWRA) 50(3): 560-584. DOI: 10.1111/jawr.12203

ABSTRACT: This literature review addresses how wide a streamside forest buffer needs to be to protect water quality, habitat, and biota for small streams (≤~100 km2 or ~5th order watershed) with a focus on eight functions: (1) subsurface nitrate removal varied inversely with subsurface water flux and for sites with water flux >50 l/m/day (~40% avg base flow to Chesapeake Bay) median removal efficiency was 55% (26-64%) for buffers <40 m wide and 89% (27-99%) for buffers >40 m wide; (2) sediment trapping was ~65 and ~85% for a 10- and 30-m buffer, respectively, based on streamside field or experimentally loaded sites; (3) stream channel width was significantly wider when bordered by ~25-m buffer (relative to no forest) with no additional widening for buffers ≥25 m; (4) channel meandering and bank erosion were lower in forest but more studies are needed to determine the effect of buffer width; (5) temperature remained within 2°C of levels in a fully forested watershed with a buffer ≥20 m but full protection against thermal change requires buffers ≥30 m; (6) large woody debris (LWD) has been poorly studied but we infer a buffer width equal to the height of mature streamside trees (~30 m) can provide natural input levels; (7, 8) macroinvertebrate and fish communities, and their instream habitat, remain near a natural or semi-natural state when buffered by ≥30 m of forest. Overall, buffers ≥30 m wide are needed to protect the physical, chemical, and biological integrity of small streams.

"Nitrogen
The potential for streamside forests to improve water quality by removing nitrogen from upland sources such as agriculture has long been recognized (Asmussen et al., 1979), and because excessive nitrogen concentrations contribute to such problems as anoxia in the Chesapeake Bay (Officer et al., 1984) and the Gulf of Mexico (Diaz and Rosenberg, 2008), this function of streamside buffers has received a great deal of attention. Asmussen et al. (1979) …

In his review of early literature on grass buffers in agricultural settings, Dosskey (2001) concluded that they removed 40-100% of the sediments that entered them from cultivated fields. Buffer widths ranged from 0.5 to 20 m, and while Dosskey made no inferences about the relative merits of wider buffers, he did discuss several factors that influence buffer effectiveness and contribute to their highly variable performance. These included soil type, vegetation, slope, sediment load, rainfall intensity, and microtopography.

Varanasi, Usha. Memo to Robert D. Lohn. Review of "Efficacy and Economics of Riparian Buffers on Agricultural Lands." March 17, 2003

The Washington Hops Association, Agricultural Caucus, and the Agriculture Fish Water Process hired GEl consultants to review the functions and design dimensions for riparian buffers, their use and efficacy, their applicability to agricultural lands, and potential alternatives to fixedwidth buffers. The question they address is whether it is nece~sary to "broadly prescribe buffers of a specific width on agricultural lands to protect listed salmon", and the Report has two primary objectives: (1) to determine what scientific and technical data and analyses have been applied to the issue of agricultural buffers, and whether the data and analyses are being appropriately matched to buffer zone applications, and (2) to evaluate the economic costs associated with the proposed set asides. We do not have the expertise to comment on the economic analysis in the report; therefore, our analysis focuses on evaluating the first objective.

It is the major conclusion of the Report that narrow buffers (about 10 m or less) are sufficient for protecting low-elevation streams in agricultural lands from impacts specific to farming (sediment, pollutants, nutrients). This conclusion is supported primarily by citation of non peer-reviewed gray literature, which is in contrast to the statement that the report relies "primarily on reviews of peer-reviewed scientific literature". This approach is not consistent with the criteria presented in the report of using all the best available science (Appendix B of the Report).

Providing adequate riparian protection along lowland streams and associated riparian habitats is especially important for salmon populations, as these areas were historically the most productive in many watersheds (Beechie et ale 1994). Habitat functions do not vary by land-use type (e.g., fish still need instream LWD, regardless of whether land use activities in the uplands is agriculture or logging). Because the majority of the ecological literature demonstrates that buffers that are 30-60 m or greater provide more protection than narrow buffers for the full suite of habitat functions, we suggest there i~ more certainty that a wider buffer is more protective of aquatic habitat and fish populations than a buffer that is less then 30 m. Moreover, unconstrained (floodplain) stream channels may migrate from less then tenths to tens of meters during the course of a winter or even one high flow event (Nanson and Beech 1977; Abbe and Montgomery 1996). Thus, narrow fixed buffers may be particularly inappropriate for dynamic floodplain channels 'as narrow buffers could easily be eliminated during a high flow event on an active channel.