Fluvial Geomorphology Annotated BibliographyFluvial Geomorphology Annotated Bibliography

Geology/Geography 621, Fall 2004
http://www.geo.wvu.edu/~kite/Geol621Bibliography.html

Link to Eric Hopkins's 2004 Geology/Geography 621 Class Page

Rosgen Stream Classification, Channel Units, Habitats

Rosgen, D. L., 1994, A classification of natural rivers: Catena, v. 22, p. 169-199.

Online linkage:
http://www.wildlandhydrology.com/assets/CLASS_OF_NATURAL_RIVERS_300.pdf
or http://www.geo.wvu.edu/~kite/RosgenLoadAlternatvive.html

Rosgen describes a stream classification scheme that is based on geomorphological characteristics. He notes the classification evolved from data collected from 450 rivers in a great diversity of hydro-physiographic provinces of various scales within Canada, the U.S. and New Zealand. Based on entrenchment, gradient, the width/depth ratio and sinuosity, streams are first classified into seven major types (A, B, C, D, E, F and G types). For example, an A-type stream is characterized by a steep gradient, a small width/depth ratio and low sinuosity and is deeply entrenched. Subsequent to this initial classification each major type is further divided based on dominant channel materials (mud, sand, gravel , cobble, boulder or bedrock). For example, a bouldery, type-A stream is classified as an A-2. Because channel geomorphology is complex and parameter values vary along a continuum, application of the scheme is not straightforward. Consequently, the system can be manipulated in that classification of streams with parameter values in more than one category is subjective. The Rosgen scheme is beneficial as a communication tool or a way of creating order out of channel description chaos.

Kite, J. S., 2003, Fluvial geomorphology train is leaving the station; shouldn't we be on board?: Stream Notes, October 2003, p. 6-7.

Natural stream design is a rapidly growing field that has been ignored by many fluvial geomorphologists. Practitioners of natural stream design are often required only to take a set of short courses to learn basic methods of stream classification and stream function and lack the overall understanding of fluvial processes obtained by students of geomorphology. The author calls on fluvial geomorphologists to step forward and introduce students to the field of natural stream design in order to ensure its inclusion of geomorphic knowledge. Introducing students to the terms and concepts used in natural stream design will allow them to better communicate with others already working in the field and be more marketable to potential employers. Recognition of this field by fluvial geomorphologists will ensure the applied principles used remain rooted in the science of fluvial geomorphology.

Stream Classification II - Alternatives to Rosgen

Montgomery, D. R., and Buffington, J. M., 1998, Channel processes, classification, and response, in Naiman, R. and Bilby, R., eds., River Ecology and Management: Lessons from the Pacific Coastal Ecoregion: New York, Springer-Verlag, p. 13-42.

From a relatively limited set of processes, many different stream channel types emerge. By using a hierarchical classification scheme, difference in processes and responses can be identified on many scales, from geomorphic provinces, down to individual reaches. This research focuses on mountain streams and stresses the important relationship between transport capacity and sediment supply. Taking under consideration bed morphology, confinement, spatial location, and external influences such as vegetation and large woody debris, channel condition and response potential can be assessed.

Montgomery, D. R. and J. M. Buffington. 1997. Channel-reach morphology in mountain drainage basins. Geological Society of America Bulletin, v. 109, p.596-611.

The authors provide a mountain stream channel classification system that relies on aspects of channel form that reflect channel processes. Seven distinct channel reach types are identified and important characteristics are listed for each. These types include colluvial, bedrock, cascade, step pool, plane bed, pool riffle, and dune ripple reaches. The authors identify the typical bed material, bedform pattern, dominant roughness elements, dominant sediment sources, sediment storage elements, level of confinement, and typical pool spacing for each reach-type. In addition to these descriptions, photographs, plan view illustrations of channel morphology, and longitudinal profile illustrations of channel bed morphology are provided for each reach-type. The second section of this paper provides a field test of this classification on four drainage basins in Oregon and Washington. Reaches (10-20 channel widths in length) throughout each basin were surveyed and each was classified as one of the above reach-types. At each reach the investigators surveyed gradient, collected a Wolman pebble count, and identified the basin area. There is a general downstream progression of reach-types in each basin which proceeds as colluvial, cascade, step pool, plane bed or forced pool riffle, and pool riffle. Along with this trend, there is also a decrease in reach gradient and sediment grain size heading downstream.

Reactions to Rosgen Classification

Miller, J. R., and Ritter, J. B., 1996, An examination of the Rosgen classification of natural rivers: Catena, v. 27, p. 295-299.

Miller and Ritter evaluate Rosgen's classification of natural rivers as proposed in his 1994 paper, concluding it is useful as a communication tool only and fails utterly as a predictor of fluvial processes. Also, it has minimal value as a methodology for stream restoration. They highlight Rosgen's diffuse presentation of the classification scheme, his lack of data, and his failure to explain how the analyses were conducted. In addition, they note Rosgen's frequent misapplication of previous works and subsequent erroneous (at least questionable) conclusions. Rosgen's scheme is openly criticized because the individual classifications are not linked to the current equilibrium state of the channel, nor do they account for climatic or hydrologic regime. Miller and Ritter complain that Rosgen does not define his hydraulic terminology and that he uses some terms interchangeably, thereby adding confusion. Ultimately, they discredit Rosgen's classification scheme because it is not process-based and the lack of geomorphic significance of his classification criteria precludes its ability to predict fluvial response to perturbations.

Doyle, M. W., Miller, D. E., and Harbor, J. M., 1999, Should river restoration be based on classification schemes or process models? Insights from the history of eomorphology: ASCE International Conference on Water Resources Engineering, Seattle, Washington.

While geomorphology has progressed into the study of physical processes, river restoration utilizes historical classification schemes, reminiscent of William Davis. Where Davis focused on landscape evolution of one form to another, Grove Karl Gilbert pushed modern studies, focusing on process and using the scientific method to test hypotheses. Classification systems are so prominent in restoration because they are an easily understood communication tool, allowing those with little or no geomorphology training to use them. The classification systems are also being taught to thousands, and are the standard for many agencies involved in restoration. The science of restoration can only develop with less dependence on classification and application of analog, empirical, and analytical research.

Kapitzke, R., 2003, Appendix C(4): Natural Channel Design at the University of Guelph: in Agencies, people and sites visited in Canada (Alberta & Ontario), Land and Water Australia Project JCU 15, Traveling Fellowship Report, p. 6-7.

Stream restoration in Ontario is overseen by different agencies at each level of government, while planning and research is done at institutions such as the University of Guelph. Ontario has had many successes in stream restoration using multidisciplinary approaches involving engineers, environmental planners, biologists, and other professionals. The Ministry of Natural Resources is currently producing a Natural Channel Design manual to aid others in multidisciplinary approaches. Despite successes, stream processes and dynamic behavior are often not incorporated in stream restoration. The Rosgen classification system is widely used by people often lacking sufficient geomorphic knowledge, leading to the misapplication of the system. Practitioners sometimes use Rosgen's system like a biological classification system.

Rosgen's classification does not take geomorphic processes or dynamic stream behavior into account. The authors provide an example where bankfull was miscalculated and Rosgen's system was applied and led to further degradation. The authors recommend the inclusion of stream geomorphology into all stream restoration activities.

Natural Stream Design

Shields, F. D., Copeland, R. R., Klingeman, P. C., Doyle, M. W., and Simon, A., 2003, Design for stream restoration: Journal of Hydraulic Engineering, v.129, p. 575-584.

Although there are many ways to rehabilitate streams, this paper describes methods for channel reconstruction. Sedimentation analysis is so important due too most failure is caused by sedimentation or erosion. Since interdisciplinary teams carry out most restoration projects, objectives must be clearly defined and the stream thoroughly assessed before work can begin. The balance between stability and stream dynamics must be established. Studies to find channel-forming discharge, bed material size, and channel type, such as alluvial or bedrock must be conducted. The design should be planned with as little change as possible to carry the sediment load. Computer models can be utilized to monitor stability.

Skidmore, P. B., Shields, F. D., Doyle, M. W., and Miller, D. E., 2001, A Categorization of Approaches to Natural Channel Design: ASCE River Restoration Conference, Reno, NV.

This paper categorizes common approaches used in natural channel design. Analog approaches make use of historic or adjacent channel characteristics. Analog approaches can only be used under equilibrium sediment and hydrologic conditions. Empirical approaches use large regional or universal data sets to derive channel characteristics. Empirical approaches also assume equilibrium sediment and hydrologic conditions. Analytical approaches use the continuity equation, roughness equations, hydraulic models, and sediment transport functions to develop design characteristics. The use of modeling and equations allow the analytical approach to be applied in conditions that are not in equilibrium. Analog and empirical approaches are simple to apply. Analytical approaches require more data, time, and training to apply, but is the only approach that can be used if the site is not in equilibrium.

Copeland, R. R., McComas, D. N., Thorne, C. R., Soar, P. J., Jonas, M. M., and Fripp, J. B., 2001, Hydraulic design of stream restoration projects (ERDC/CHL TR-01-28): US Army Corps of Engineers, Coastal and Hydraulics Laboratory, Vicksburg, MS. 109 p., appendices.

This comprehensive stream restoration manual is an introductory source for stream restoration and design. It covers a variety of topics and methods used in modern stream restoration. The manual places a strong emphasis on effective planning of restoration projects, hydraulic design, stability analyses, and methods for understanding given stream systems.

The River Continuum Concept

Allan, J. D., 1995, The river continuum concept, in Allan, J. D., ed., Stream Ecology Structure and Function of Running Waters: London, Chapman & Hall p. 276-281.

This paper concentrates on the river continuum concept, a set of correlations that attempt to describe ecologic settings along the length of a river or stream based upon stream order, morphology, organic matter, food webs, energy pathways, and other variables. Site-specific or regional conditions will sometimes prove the model ultimately incorrect. While the concept may be correct on a broad spectrum, many streams do not fit the model and therefore the river continuum concept has met resistance.

Power, M. E. and Dietrich, W. E., 2002, Food webs in river networks: Ecological Research, v. 17, p. 451-471.

The authors explore classical and recent ideas for controls on food chain length in river food webs. Classical hypotheses for controls on food chain length that are discussed include: productivity/efficiency - chains should lengthen as fluxes of limiting energy resources increase in frequency and magnitude or as consumers increase resource sequestering and/or conversion efficiency; disturbance/stability - chains should be shorter in more frequently disturbed environments; and design constraints - e.g., it would be impossible to subdue a pterodactyl predator because an organism large enough to capture it would be physically unable to fly. The one control discussed, shown to strongly influence food chain length in recent research is habitat size. Recent research in lakes and other environments has shown that larger habitats support larger taxa, and most food webs are strongly size structured with the largest organisms occupying the highest trophic levels. The authors then discuss how these controls vary across positions within drainage networks where energy sources, habitat structure, and disturbance regimes differ between channels and adjacent watersheds.

Sun, G., McNulty, S. G., Amatya, D. M., Skaggs, R. W., Swift, Jr., L. W., Shepard, J. P., and Riekerk, H., 2002, A comparison of watershed hydrology of coastal forested wetlands and the mountainous uplands in the Southern US: Journal of Hydrology, v. 263, p. 92-104.

This paper compares seasonal runoff patterns, water balances, and storm flow patterns in three different watersheds in the southern United States representing three different forest ecosystems. The ecosystems represented include a hilly upland watershed covered with native hardwoods located in western North Carolina, a costal wetland watershed with a mature loblolly pine plantation in eastern North Carolina, and another costal wetland with an unmanaged mature cypress-pine plantation in the Florida panhandle. The inland hilly watershed had a higher water yield than the costal wetlands. The hilly watershed also had continuous streamflow throughout the year while the costal wetlands did not. Stormflow peaks were normally higher in the hilly watershed except in extremely wet conditions when the storage capacity of the wetlands was full before the storm event. The authors conclude that climate is the most important factor affecting water balances, while topography plays an important role in streamflow and stormflow.

Fluvial Geomorphology & Adaptation to Streams & Bottomlands

Rabeni, C. F., and Jacobson, R. B., 1993, The importance of fluvial hydraulics to fish-habitat restoration in low-gradient alluvial streams: Freshwater Biology, v. 29, p. 211-220.

Rabeni and Jacobson describe management options to restoration of fish habitats. Rabeni and Jacobson's study focused on low-gradient streams in the Ozark Plateau of the central U.S. and the preferred habitats of the smallmouth bass and northern hog sucker. Aquatic habitats are first classified according to associated geomorphic qualities and fluvial dynamics. Important to the habitat classification are geomorphic characteristics such as point bars, cutbanks and bedrock bluffs, as well as fluvial characteristics like riffles, pools, obstruction pools, islands and chutes. The habitats are then ranked according to temporal stability and degree of economic manipulation (ie., cost-effective construction). Additionally, the habitat preferences of the fish in question are defined in terms of the classified habitats. Hydraulic parameters (e.g., velocity, depth, etc.) also figure into the classification. The application of the hydraulic habitat units to fish restoration requires knowledge of the longitudinal change in natural habitats (i.e., geomorphic and fluvial features) found in a stream and how the habitats are used by fish. Finally, the economics and ease of restoring the various habitats must be evaluated.

Hupp, C. R., 1988, Plant ecological aspects of flood geomorphology and paleoflood history, in Baker, V. R., Kochel, R. C., and Patton, P. C., eds., Flood Geomorphology: New York, John Wiley and Sons, p. 335-356.

Online linkage: http://ereserves.lib.wvu.edu/
Log in with account name "Kite" and password "321" Click on "GEOG 321" and click on "hupp-plant-0.pdf"
or http://www.geo.wvu.edu/~kite/hupp1988-plant-0.pdf

Hupp assesses the utility of bottomland vegetation distribution patterns and vegetation damage to flood reconstruction, flood prediction and paleoflood history studies. He focuses his study on the vegetation and fluvial features common to high-energy streams. Two significant effects of floods on bottomland vegetation are the establishment of new areas of growth (e.g., point bars) and the damage that is subsequently indicated by anomalous growth patterns or stem deformations. Hydro-geomorphic conditions that can be inferred from these two effects include flow duration, flood intensity and frequency. Hupp first identifies the fluvial landforms, their propensity to be affected by floods and the vegetation established on them as a result. He notes that the frequency and duration of inundation of the various landforms determine the vegetation types that subsequently become established on each. Higher stream gradients influence discharge variables and are positively related to increased flooding and vegetation species diversity. Paleofloods can be reconstructed through dendro-geomorphology, ie., damage to bottomland trees by floods is reflected their tree rings. In addition to ring anomalies, corrasion scars, adventitious sprouts and tree age are useful for interpretation of flood history.

Articles from Stream Notes
(Quarterly publication)
USDA Forest Service Stream Systems Technology Center,
Fort Collins, CO

McBain, S., and Trush, B., 2000, Attributes of bedrock sierra nevada ecosystems: Stream Notes, July 2000.

This paper makes an effort to highlight seven important attributes of Sierra Nevada bedrock streams. It also attempts to negate common misconceptions regarding bedrock channel morphology. For example, the author argues that bedrock streams are complex depositional environments instead of scoured channels that are insensitive to flow. Large flows are required to maintain bedrock streams and only through larger flows can native ecosystems maintain themselves.

Furniss, M. J., Flanagan, S. A., and McFadin, B., 2000, Hydrologically-connected roads: an indicator of the influence of roads on chronic sedimentation, surface water hydrology, and exposure to toxic chemicals: Stream Notes, July 2000.

Online linkage: http://www.stream.fs.fed.us/news/index.html.

Roads are hydrologically connected to the stream network when overland flows are continuous between roads and streams. The extent of hydrologic connectivity in a stream network then serves as an indicator of the potential adverse affects of roads to streams. Units of connectivity can be expressed in length or proportion of road connected. Hydrologic connectivity is associated with greater runoff, excess sediments, and chemical pollution. Several avenues exist for these consequences: ditches at stream crossings, ditches from cross drains, juxtaposition of road and stream, and landslides and landslide scars along streams. Several inexpensive treatments are possible to disconnect roads from streams: drain ditches into the forest floor to reduce sediment load, decrease cross-drain spacing, structures that retard flow and sediment, and road surface outsloping.

Merritt, D. M., and Wohl, E. E., 2003, The importance of hydrochory (water dispersal of seeds) in free-flowing and regulated rivers: Stream Notes, April 2003.

Online linkage: http://www.stream.fs.fed.us/news/index.html.

Dispersal of seeds by water is an important structuring agent for plant communities along rivers. Marked seeds were followed in a flume under natural and modified hydrologic regimes to determine the pattern and mechanisms of seed transport. Most all seeds were flushed from the flume in the ascending hydrologic regime. The stepped descending regime had more seeds deposited than the smooth descending regime. Natural flows do not necessarily deposit more seeds. Thus, a modified hydrologic regime as below reservoirs can be adjusted to deposit seeds at selected times and locations. More seeds were deposited in areas of slow flow in the flume. There are two plant strategies that synchronize dispersal timing and flow regime: early dispersers that may later desiccate and late dispersers that may later be scoured. Specialists are vulnerable to modifications to flow, but flow adjustments can be made in artificial settings to encourage native species. This approach would be more cost effective than large scale plantings without compromising the benefits of dams.

Goodwin, C. N., 1999, Improving future fluvial classification systems: Stream Notes, October 1999.

Goodwin notes that classification is important for creating order out of chaos or for ordering observations and descriptions. As such, it usually occurs early on in the process of a new scientific field. With progress, classification facilitates the development of empirically based laws and finally the development of theory. Goodwin applies this progression to the field of fluvial studies, noting several fluvial classification schemes and listing ten recommendations to improve future fluvial classifications. Goodwin concludes that classifications are important tools in fluvial studies, but that they are only a small part of a larger scientific process that includes hypotheses, theories, laws and models.

Potyondy, J., and Schmidt, L., 1999, Why do we exaggerate stream channel cross-section plots? The case for true scale plotting: Stream Notes, October 1999.

Potyondy and Schmidt discuss the effects of vertical exaggeration of stream channel cross-sections on perceptions by the reader. They illustrate how vertically exaggerated cross-sections can lead to misinterpretations of the pictorial data. Particularly troublesome is the incorrect conclusions that unaware viewers may make regarding river behavior. For example, vertically exaggerated channels may appear to have a narrow floodplain, whereas a true-scale plot would reveal a wide floodplain. The authors recommend using as close to true-scale as is feasible and even using panoramic pictures to better communicate the true geomorphic nature of the stream.

Trieste, D. J., 2000, Mannings equation and the internal combustion engine: Stream Notes, April 2000.

This short discussion was written to intrigue the reader to inquire about possible better solutions to flow problems than the Manning's equation. It does this by making a comparison between Manning's equation and the internal combustion engine, which were developed in the second half on the 19th century. The author suggests that advancements have been made with the internal combustion engine over time but the Manning's equation still takes the same form as it did when it was first created.

Anonymous, 2001, Mountain Rivers: Stream Notes, October 2001.

This is a review and summary of a book entitled "Mountain Rivers," by Dr. Ellen Wohl. The book provides a simple definition for the term "mountain river:" a river located in a mountainous region. In addition, the book provides an overview of typical physical and basic biological characteristics observed in mountain river systems: steep channel gradient; high channel roughness and resistance; highly turbulent flow; stochastic sediment movement; strong seasonal discharge regime; spatially variable channel morphology; potentially high sediment yields following disturbance; and a longitudinal zonation of aquatic and riparian biota. This book is ideal for those who need to catch up with the latest literature on mountain rivers or as a spot reference for those already familiar with river processes and forms.

Sylte, T. L., 2002, Providing for stream function and aquatic organism passage: An interdisciplinary design: Stream Notes, January 2002.

Historically culverts have not been designed for stream function or organism passage. They have been designed for hydraulic efficiency alone. Bedload and debris passage have been ignored, causing blockage within the culvert, along with ponding and deposition behind it. These blockages inhibit fish movement, and when culverts restrict stream width the velocity in the pipe can be too fast for smaller and younger fish to pass. In low flows depths may be inadequate for movement. When backwater conditions are created at the inlet, erosion occurs at the outlet, often with a perch height to great for organisms to pass. Properly designed culverts large enough to handle bankfull, and new technologies, such as bottomless culverts, can allow stream processes to continue normally.

Rains, M. C., 2003, Hydrogeological principles useful in predicting the effects of streamflow alsterations on shallow groundwater and associated riparian vegetation: Stream Notes, July 2003.

Interactions between stream flow and groundwater can be complex, but can be broken down into four major categories -Shallow groundwater recharged by stream with no lateral spreading -Shallow groundwater recharged by stream with extensive lateral spreading -Shallow groundwater recharged by regional groundwater -Mixing of conditions If stream flow is recharging the shallow groundwater, alterations in flow can have a profound impact on the groundwater and riparian vegetation, if there is lateral spreading. In cases where the shallow groundwater is recharged by the regional groundwater there is very little effect. In a mixed situation, the effects are not always consistent or clear.

Anonymous, 1993, Would the Real Bankfull Please Stand Up!: Stream Notes, April 1993.

The concept of bankful stage is simple, but field interpretation for a given stream or reach can be difficult and potentially ambiguous. This article addresses the differing views of engineers and geomorphologists in the context of a Federal court case, the subject of the subsequent article in the same issue of Stream Notes. The US Forest Service was denied water rights it had claimed, and this article appears to be a response to that legal decision. Engineers view bankfull as equivalent in elevation to the "valley flat", which often contains properties subject to economic damage during floods. Geomorphologists view bankfull stage as a phenomenon of the "active floodplain", the product of current climatic conditions and subject to annual flooding, in contrast to the 50-year or 100-year events of concern to the built-up valley flat. The active floodplain, or simply floodplain, may coincide with the valley flat in some mountain streams. Entrenched channels are a clear case where they are not equivalent. The short format of Stream Notes is well suited to this discussion of a particular concept and its application in a specific case. More complex articles may only be able to touch on the main points. The reader should gain from this article insite into the potential ambiguities involved in the practical determination of bankful stage.

Fitzgerald, J., and Clifton, C., 1998, Flooding Land Use, and Watershed Response in the Blue Mountains of Oregon and Washington: Stream Notes, January 1998.

This article presents a summary of the analysis of flooding and mass wasting events that occurred in response to heavy rain and rapid snow melt on the Umatilla, Walla Walla, Tucannon and Wenaha Rivers during November 1995 and February 1996. Many debris flows and slides were associated with roads or logging activity. Discharge was estimated using the indirect slope-area method. USGS regional flood equations were used to estimate frequency. Fluvial channel responses, which varied with elevation and land use, included scouring, aggradation, lateral channel migration and a build-up of large woody debris. Culverts in the study area were generally designed to accommodate the experienced flows but often became clogged with coarse sediment or large woody debris. Most fish habitat structures survived the flooding. The results suggest, however, that such structures should "work with fluvial processes" and avoid "rigid" construction. Other recommendations included improvements to culvert design, assessment of mass wasting potential, sediment catchment basins and cost-benefit analysis for decomissioning versus repairing damaged sites. This study is difficult to present in the brief Stream Notes format, though the authors do provide information that will lead the reader to the full text version. Valuable information is presented but full assessment will be possible only with the full text. Land use issues in particular are not well documented within the article.

Reference Reaches and Hydraulic Geometry Data

Messinger, T., and Wiley, J. B., 2004, Regional relations in bankfull channel characteristics determined from flow measurements at selected stream-gaging stations in West Virginia, 1911-2002: U.S. Geological Survey Investigations Report 03-4276, p. 1-43.

The authors of this publication used available stream gage data from 74 gages in West Virginia with data recorded from 1911-2002 to create regional models for calculating bankfull discharge and dimensions. They divided the state in to eastern (Appalachian Plateaus) and western (Valley and Ridge) regions and developed models that relate bankfull cross-sectional area to drainage area. The authors also found that channel characteristics were highly variable for streams by examining multiple cross-sections for gaging stations. There are several problems with the data used by the authors. Many cross-sections were at bridges, which can affect channel shape. Also lack of gages exists for steams with drainage areas less than 100 sq. mi. While the streams used to develop models may not be representative of all streams, the authors believe the equations derived can provide useful insights for identifying bankfull in the field.

Miller, K. F., 2003, Assessment of channel geometry data through May 2003 in the Mid-Atlantic Highlands of Maryland, Pennsylvania, Virginia, and West Virginia: U.S. Geological Survey Investigations Report 03-388, 22 p.

The purpose of this paper was to compile stream gage data from small streams (less than 250 sq. mi. drainage basin) in the Mid-Atlantic Highlands. Criteria for data selection included streams without regulation, less than 20% urbanization in the watershed, and minimum of 10 years of gage data. Data was compiled from USGS data and several other entities in the area to create regional curves. Regional curves are useful in estimating bankfull discharge and dimensions, which is important for stream restoration activities. The author reported a lack of stream gages for basins less than 1 sq mi. This poses a problem since most restoration activities require regional curve data for small streams.

Wiley, J. B., Atkins, J. T., Jr., and Newell, D. A., 2002, Estimating the magnitude of annual peak discharges with recurrence intervals between 1.1 and 3.0 years for rural, unregulated streams in West Virginia, U. S. Geological Survey Water Resources Investigations Report 02-4164, 73 p., 1 plate

Stream restoration requires knowledge of 1.1-3.0 year peak discharges (bankfull). Stream gages are used to monitor stream flow and collect flow data that can be used to create models that estimate discharges for different sized drainage basins. This publication is a compilation of stream gage data from 236 gages with a minimum of 10 years of data. Gages were located along rural and unregulated streams in West Virginia. Least regression was used to create regional equations for 1.1, 1,2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2.0, 2.5, 3.0-year recurrence intervals for peak discharges. The equations given should be useful for calculating bankfull discharges in rural and unregulated streams.

Wiley, J. B., Atkins, J. T., Jr., and Tasker, G. D., 2000, Estimating magnitude and frequency of peak discharges for rural, unregulated, streams in West Virginia: U.S. Geological Survey Water Resources Investigations Report 00-4080, 90 p.

The US Geological Survey and the West Virginia Department of Transportation revised equations to estimate the magnitude and frequency of peak discharges for the 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year recurrence interval. These equations are applicable to rural, unregulated streams in West Virginia only. They were found by gathering annual peak stream flows and basin characteristic, determining the 100-year recurrence interval, and applying multiple and simple least-squares regression models to the data. The report contains description of the study area, flood history, and the development of equations, along with many maps and charts of stream data.

Paleohydraulics, Paleohydrology: Bedload Competence

Jarrett, R. D., and Tomlinson, E. M., 2000, Regional interdisciplinary paleoflood approach to assess extreme flood potential: Water Resources Research, v. 36, no. 10, p. 2957-2984.

Knowledge of extreme flood events is important to the design and engineering of dams for risk assessment. A cost effective, interdisciplinary approach was applied to the Elkhead Reservoir in northwestern Colorado. A site-specific paleoflood study was conducted for the Elkhead Creek Basin, as well as a probable maximum precipitation (PMP) study for the area. Regional paleoflood and precipitation studies were also carried out, and relative dating techniques defined record length. Envelope curves were made for both modern and prehistoric data, and flood frequency data was combined from both regional and basinal data using expected moments algorithm. This type of study can be effective in many other hydrometeorologic setting to assess flood potential.

Costa, J. E., 1983, Paleohydraulic reconstruction of flash flood peaks from boulder deposits in the Colorado Front Range: Geological Society of America Bulletin, v. 94, p. 986-1004.

Using the size of large boulders moved during floods in steep, bedrock channels, large paleofloods could be reconstructed. This method is described for nine watersheds in the Colorado Front Range. The middle axes of the five largest boulders are averaged to determine velocity. Discharge is calculated from width, determined from cross sections, and depth, found using the Manning's equations.
This method was generally found to underestimate slope-area calculations,

possibly because larger boulders could be moved, roughness coefficients could be underestimated, or macroturbulence may affect velocity. This method can be used on streams with no other direct discharge estimates.

Paleohydrology:Slackwater-Deposits Step-Backwater Methods

Springer, G. S., 2002, Caves and their potential use in paleoflood studies, in House, P. K., Webb, R.H., Baker, V.R., and Levish, D.R., eds., Ancient Floods, Modern Hazards: Principles and Applications of Paleoflood Hydrology: American Geophysical Union Water Science and Application Series, v. 5, p. 329-343.

Springer addresses the usefulness of subterranean paleoflood deposits in paleoflood studies. He reviews previous works in this area, reasons why karst and fluvial studies are estranged, and how this estrangement has hindered the use of caves in paleo-geomorphic research. Most notably, he notes that paleoflood studies using slackwater deposits have traditionally focused on arid or semi-arid regions, where preservation potential is higher, and are lacking in humid regions (e.g., the eastern U.S.). Springer discusses the preservation potential and usefulness of slackwater sediments in true caves, which he distinguishes from cave-like shelters or alcoves and defines as voids with lengths exceeding entrance widths. If caves or cave systems are aligned with surface streams, it is likely that they were established by flow from streams, rather than by groundwater. Therefore, when stream systems flood, the cave systems may act to transport floodwaters and accumulate deposits that record the flood event. Springer notes that water-borne sediments in caves range from clay to boulders and can form allostratigraphic packages. Individual events are bound by scour surfaces, mud-cracked planes, organic horizons and even soils. Sediments are coarsest at cave mouths and fine with depth into the cave. In general, slackwater sediments are found at a level below silt lines that mark the height of the flood. The humid and relatively warm temperatures of caves in the eastern U.S. promote decay and bioturbation of slackwater deposits, limiting its usefulness in paleoflood studies.

Kite, J. S., Gebhardt T. W., and Springer, G. S., 2002, Slackwater deposits as paleostage indicators in canyon reaches of the Central Appalachians: reevaluation after the 1996 Cheat River flood: in House, P. K., Webb, R.H., Baker, V.R., and Levish, D.R., eds., Ancient Floods, Modern Hazards: Principles and Applications of Paleoflood Hydrology: American Geophysical Union Water Science and Application Series, v. 5, p. 257-266.

Kite, et al., discuss the usefulness of slackwater deposits as paleostage indicators by comparing slackwater evidence from two large floods on the Cheat River in West Virginia. They found that the accuracy of stage, as determined by slackwater sediments, varied based on the landscape on which they repose. For example, they found that deposits in caves or on sheltered terraces were closer to high-water marks than those at tributary mouths. Also, the availability of good deposit sites affects the usefulness of slackwater sediments in paleoflood studies. This became evident when comparing the slackwater sediments of the 1985 and 1996 floods on the Cheat River. The 1985 floodwaters completely inundated the floodplain and terraces before being confined by the steep bedrock canyon walls. Steep slopes are not conducive to accumulating or preserving slackwater deposits, so useful slackwater evidence of the 1985 flood stage was scarce. Kite, et al., concluded that slackwater deposits from moderate events have a higher preservation potential than those from extreme events. Finally, the authors note the susceptibility of slackwater deposits to decay, reworking and bioturbation. Consequently, the usefulness of slackwater sediments as paleostage indicators varies from setting to setting.

Debris Flows & Hyperconcentrated Flows I

Campbell, R. H., Varnes, D. J., Fleming, R. W., Hampton, M. A., Prior, D. B., Sangrey, D. A., Nichols, D. R., and Brabb, E. E., 1985, Landslide classification for identification of mud flows and other landslides, in Campbell, R.H., ed., Feasibility of a nationwide program for the identification and delineation of hazards from mud flows and other landslides: U.S. Geological Survey Open-File Report 85-276, p. A1-A24.

This paper was the first of four chapters of work undertaken for the U.S. Geological Survey and the Federal Emergency Management Agency to identify areas susceptible to mudflows and other landslides. It describes a classification and nomenclature system for different kinds of landslides making up a continuum of types according to mechanism of transport and moisture content. Characteristics, triggering events, and damage were related to the types of landslides. The report adopts Varnes (1978) (Slope movement types and processes, in Schuster, R. L., and Krizek, R. J., eds., Landslides-analysis and control: transportation research Board Special Report 176, National Academy of Sciences, p. 11-33) classification system.

Hungr, O., Evans, S. G., Bovis, M. J., and Hutchinson, J. N., 2001, A review of the classification of landslides of the flow type: Environmental and Engineering Geoscience, v. 7, p. 221-238.

Hungr, et al., present a topological classification of flow type slope failures using genetic and morphological aspects of materials rather than material size limits. Ten classes of landslides are recognized, defined, and compared to the previously defined classes of other workers. Classes are discriminated based on material, water content, flow velocity and attributes unique to the flow called special conditions. This topological system is important for landslide hazard assessment. A translation is provided to aid the comparison to existing classification schemes.

Morgan, B. A., Eaton, L. S., and Wieczorek, G. F., 2004, Pleistocene and holocene colluvial fans and terraces in the Blue Ridge Region of Shenandoah National Park, Virginia: U.S. Geological Survey Open-File Report 03-410 (online), 10/28/2004, http://pubs.usgs.gov/of/2003/of03-410/, 25p.

This paper covers the history, geology, and stratigraphy defining quaternary Colluvial Fans and Terraces in and around Shenandoah National Park. The purpose of the report is to illustrate the relationships between geology and those specific landforms. The authors effectively illustrate these relationships for terraces and Colluvial fans on both eastern and western fronts of the Blue Ridge. They also offer a variety of ages relating to landforms studied.

Costa, J. E., and Williams, G. P., 1984, Debris-flow dynamics: U.S. Geological Survey Open File Report 84-606, 1 VHS videotape.

This video, narrated by John E. Costa, was the first VHS publication ever issued by the US Geological Survey. It provided information on the anatomy of debris flows from head to tail as well as how they start and what conditions typically favor them. All of the footage in this tape was of natural flows. The video was published after the Mt. St. Helens eruption but before the Campbell et al. (1985) classification paper. Therefore, several of the debris flows that they provide footage for would probably be classified as hyperconsentrated flows. Debris flows can be very fast and violent or slow and creeping, but either way can cause extensive damage to anything in their path. It was interesting to note that the largest boulders always occur at the head of the debris flow and the tail consists of the most liquid material. Additionally, sometimes fairly viscous debris flows will occur in waves and each wave of energy pushes the flow further. The video footage was informative and fascinating to watch and the soundtrack was inspirational!

Iverson, R. M., 2002, Highlights from USGS Debris Flow Flume Studies, 1 VHS videotape.

This videotape shows clips of simulated debris flows proceeding down flumes. The simulations are limited in scale. Extent and size of debris are relatively small, but nevertheless provide insight into the action and processes that occur during, and relative to, natural events. There is no audio on the videotape, which would provide additional sensory stimulation of the impressive nature of debris flows.

Paleoflood Hydrology I

Baker, V. R., 2002, The study of superfloods: Science, v. 295, p. 2379-2380.

Baker acknowledges flaws in the scientific approach to studying superfloods. This premise is supported by Baker's statement that there has never been a testable or confirmed theory of superfloods. Methodological problems and misapplied scientific logic has contributed to the lack of advancement in knowledge of superfloods. For over one hundred fifty years the concept of uniformitarianism has confined interpretation of superflood evidence to the slow-acting, low-magnitude processes observed today. However, over the last forty years evidence has accumulated all over the world, and most recently on Mars, pointing to numerous events of catastrophic superflooding. It is Baker's view that the scientific method has not been adequately applied to studies of superfloods, and improvement in this area is needed.

Baker, V. R., and Kochel, R. C., 1988, Flood sedimentation in bedrock fluvial systems, in Baker, V. R., Kochel, R. C., and Patton, P. C., eds., Flood Geomorphology: New York, John Wiley and Sons, p. 123-137.

Baker and Kochel argue in this paper that sedimentation in cataclysmic flood events is highly different in narrow bedrock channels than in alluvial channels.
Narrow bedrock channels have extremely high stream power and flow velocities due to their confined shape and lack of resistance. These systems also develop large-scale bedforms during very high flood events such as enormous bars and ripples comprised of coarse- grained sediment. Existing slackwater deposits are rare, but sometimes recognizable flood stage indicators for these events and are found most often in tributary mouths.

North Fork Mountain Debris Flow Field Trip

Teets, B., and Young, S., 1985, Killing Waters: The great West Virginia Flood of 1985: Terra Alta, WV, Cheat River Publishing, 112 p.

This is a collection of newspaper articles, personal accounts, photos, and facts surrounding the 1985 flood that swept through many areas of West Virginia. The flood was triggered by hurricanes Juan and Isabel and affected many West Virginia homes and communities, some of which were declared national disaster areas. Millions of dollars in property were destroyed and many lives were lost.
The book also covers the restoration efforts of affected towns and communities.
Vivid photos and shocking accounts illustrate the power behind this enormous flood.

Jacobson, R. B., ed., 1993, Geomorphic studies of the storm and flood of November 3-5, 1985, in the upper Potomac River basin: U.S. Geological Survey Bulletin 1981.

Cenderelli, D. A., and Kite, J. S., 1998, Geomorphic effect of large debris flows on channel morphology at North Fork Mountain, eastern West Virginia, USA: Earth Surface Processes and Landforms, v. 23, p. 1-19.

Online linkage:
http://www.geo.wvu.edu/~kite/www.geo.wvu.edu/~kite/cenderelli98-0.pdf

Cenderelli and Kite conclude from extensive field research and mapping of four debris flows at North Fork Mountain that the geomorphic effects of these flows are spatially variable and four zones can be delineated. The failure zone is characterized by a distinct scarp and extensive erosion. However, the subsequently developed transport/erosion zone is deeply scoured and the volume of erosion exceeds that of the failure zone. Further downstream, the deposition zone occurs in third-order channels and is typified by an abundance of boulders that form lobes, terraces and levees. Beyond the deposition zone, the hyperconcentrated flow or sediment-laden floodwaters cause intense erosion of channels followed by deposition of thin, clast-supported sheet deposits. Debris flows are effective erosion agents and deposits are often reworked by floodwaters of adjoining tributaries.

Paleoflood Hydrology II
Dating Methods for Alluvial Deposits and Landforms

Blais-Stevens, A., Clague, J. J., Mathewes, R. W., Hebda, R. J., and Bornhold, B. D., 2003, Record of large, Late Pleistocene outburst floods preserved in Saanich Inlet sediments, Vancouver Island, Canada Quaternary Science Reviews v. 22 p. 2327-2334.

Two anomalous beds of silty clay occur within the highly diatomaceous sediments in Ocean Drilling Program cores collected from Saanich Inlet, Vancouver Island, British Columbia, Canada. These beds contain tertiary pollen exotic to eastern Vancouver Island and abundant illite-muscovite, which are common minerals in the Fraser River sediments. These silty clay beds are dated at approximately 11,000 calendar years based on radiocarbon dating on shells and wood from just above and below the beds. The authors hypothesize that these beds were deposited during large floods which are attributed to the sudden draining of ice-dammed glacial lakes during glacial retreat (possibly Glacial Lake Deadman and/or Glacial Lake Fraser). During this draining, the floods eroded Pleistocene sediments and Tertiary rocks in the Fraser Valley and some of the sediment was carried in overflow plumes into Saanich Inlet.

Bierman, P. R., Lini, A., Zehfuss, P., Church, A., Davis, P. T., Southon, J., and Baldwin, L., 1997, Postglacial ponds and alluvial fans: recorders of Holocene landscape history: GSA Today, v. 7, p. 1-8.

The authors examined alluvial fan cross-sections and sediment cores from ponds in Vermont to describe postglacial (Holocene) hillslope history. They found that the early and late Holocene hillslopes were more active with high rates of sediment erosion from slopes and high rates of sediment deposition in alluvial fans and ponds. Middle Holocene landscapes were comparatively stable. The active hillslopes of the late Holocene coincide with deforestation and agricultural practices associated with the settlement of Europeans. Postglacial ponds and alluvial fans provide a geologic record of Holocene landscape history and can provide insight for future landscape activities.

Cosmogenic Dating Methods

Rittenour, T. M., Goble, R. J., and Blum, M. D., 2003, Luminescence geochronology of late Pleistocene braid channel belts of the Mississippi River: Quaternary Science Reviews, v. 22, p. 1105-1110.

The authors used optically-stimulated luminescence (OSL) to estimate the ages of three channel belts preserved in the northern lower Mississippi Valley (LMV) west of the Holocene floodplain. The objective of the research was to use OSL to link the timing of channel-belt formation to formative agents. The author also compared optical ages to those proposed from radiocarbon dating by earlier researchers and used these optical ages to test previous models of channel-belt formation in the area. They determined that optical ages were in agreement with radiocarbon dates and that optical dates suggested the belts were formed during Pleistocene deglaciation and high meltwater discharge. The OSL technique is valuable because the dating material used (quartz-rich sand) is ubiquitous in the LMV whereas organic material sufficient for radiocarbon dating is lacking.

Bierman, P. R., 1994, Using in situ produced cosmogenic isotopes to estimate rates of landscape evolution: A review from the geomorphic perspective: Journal of Geophysical Research, v. 99, p. 13,885-13,896.

Cosmogenic isotopes are frequently used to study landscape age and evolution. The author reviews the method and critiques its use by the geomorphologic community. Cosmogenic isotopes provide information on erosion rates and ages of geologic surfaces. The author discusses the interpretation of the data and the assumptions of the methods employed. The author found all studies using cosmogenic isotopes to date surface exposure have very high age variability. Generally, rates of erosion as determined from cosmogenic isotopes are similar in most climates. Currently, the cosmogenic isotopes method is only useful on relatively short geologic time scales-shorter than required for investigations of plate tectonics. The method has its limitation, but the author notes its future promise as uncertainties are corrected.

Stream Piracy I - Salem Outlet Map Exercise

Goldthwait, R. P., 1991, The Teays Valley problem: a historical perspective, in Melhorn, W. N., and Kempton, J. P., eds., Geology and hydrogeology of the Teays-Mahomet Bedrock Valley System: Boulder, CO, Geological Society of America Special Paper 258, p. 3-8.

Goldthwait recounts a century's worth of geologic research into the origin, demise and burial of an ancient fluvial system called the Teays River. Evidence of the northwestward-draining system has been documented from the apparent source in Blowing Rock, North Carolina through Virginia, West Virginia, Kentucky, Ohio, Indiana and Illinois. It is certain that both the Illinoian and Wisconsin stages of the Pleistocence ice age post-date the system. The extent to which glaciation interrupted Teays River flow is still being examined. Extensive lacustrine clays (Minford) testify to the existence of Lake Tight, believed to have originated consequent to damming of the Teays River by pre-Illinoian ice. Many intriguing questions remain to be addressed in the ongoing study of this ancient system including: What was the primary cause of the complete rearrangement of stream courses (from NW to SW) in the unglaciated region of southern Ohio? Why are Teays Valley tributary straths in Indiana much shorter than those in Ohio, Kentucky and West Virginia? A hundred years of research has revealed much, but much remains unresolved.

Hansen, M. C., 1995, The Teays River: Ohio Division of Geological Survey GeoFacts No. 10 (online), 12/08/2004, http://www.dnr.state.oh.us/geosurvey/geo_fact/geo_f10.htm, 2 p.

Teays River was formed in the Tertiary Period and drained most of the modern day east-central United States. The Teays originated in western North Carolina and flowed across Virginia, West Virginia, Ohio, Indiana, and Illinois where it emptied into the then much larger Gulf of Mexico. Some question exists as to whether the river actually flowed north through Ohio into the ancient Erigan River. Bedrock-topography maps may help determine the actual course of the Teays. Glaciers in the Pleistocene created a large lake named Lake Tight in southern Ohio, which caused the destruction of the Teays. The lake existed for an estimated 6,500 years and filled to an elevation over 900 feet before it spilled over drainage divides creating a new drainage system including part of the present day Ohio River. In Ohio, evidence of the Teays includes flat-bottomed valleys in unglaciated southern Ohio and deep, sediment filled valleys in glaciated parts of Ohio. In West Virginia evidence includes the valleys of the modern New River and Kanawha River.

Stream Piracy II - The response

Kinziger, A. P., and Raesly, R. L., 2001, A Narrow Hybrid Zone Between Two Cottus Species in Wills Creek, Potomac Drainage: The Journal of Heredity v. 92, no. 4, p. 309-314.

The authors describe a hybrid zone between two sculpin species (Cottus bairdi bairdi and C. caeruleomentum) as a result of stream capture that transferred C. b. bairdi to C. caeruleomentum's geographic range. Allozymes, morphological characters, and spawning coloration distinguish the species where stream capture intermixed the species. Allozyme differences distinguish the hybrids from parental species. Genotypes that distinguished the species were mixed in the hybrids. Hybrids were more heterozygous and polymorphic for 20 loci examined.

Morphological variables that distinguished the species were different in the hybrids suggesting secondary contact for the origin of hybrids. The authors calculated that the hybrid zone was narrow compared to the dispersal rate of the fishes and that gene flow was intermediate. That the parental species are distinct from hybrids suggests that the hybrids are on a unique evolutionary trajectory.

Howard, J.H., and Morgan, R.P., 1993, Allozyme variation in the mottled sculpin (Cottus bairdi): a test of stream capture hypotheses: Copeia, 1993, p. 870-875.

Evidence for stream capture has typically involved inference from drainage history and faunal composition and distribution. This study examined the genetic composition of sedentary sculpin (Cottus bairdi) populations on opposite sides of the Eastern Continental Divide in western Maryland and southwestern Pennsylvania to test specific hypotheses of stream capture events. Populations on opposite sides of the divide that have similar allelic frequencies would support claims of stream capture. Streams pairs where capture was proposed had sculpin populations with shared alleles. The stream pair without evidence of drainage diversions had sculpin populations that did not share alleles. In all stream pairs where stream capture occurred heterozygosity between sculpin populations was lower. This study showed that genetic analysis of populations is a useful alternate tool to investigate stream capture events.

Human-Impacts on Streams:
PSA (Post-Settlement Alluvium), PSS (Post-Settlement Surfaces) and other Legacies of Euro-American Land Use

Trimble, S. W., 1983, A sediment budget for Coon Creek Basin in the Driftless Area, Wisconsin, 1853-1977: American Journal of Science, v. 283, p. 454-474.

Trimble uses Coon Creek Basin in the Driftless Area of Wisconsin to determine how sediment moves through a system over time. As sediment erodes it can either be stored on the toes of slopes as colluvium or on floodplains as alluvium, or be carried by the stream out of the system. Trimble uses three graphical methods to determine the sediment yield. The first method provides a mean over a long time, which shows that storage is the largest part of the budget. The second method compares deposition at different parts of the basin using flood plain cross-sections. It shows variability though time, but not through space. The third technique compares sediment movement both spatially and temporally, showing the complexity of the budget. His results show that after European settlement, sediment storage increased greatly, although the yield did not alter much. This is because sediment yield is limited by the transport capacity of the stream, and the storage to yield ratio can vary throughout time and space.

Jacobson, R. B., and Coleman, D. J., 1986, Stratigraphy and recent floodplain evolution of Maryland Piedmont flood plains: American Journal of Science, v. 286, p. 617-637.

This paper deals with determining three distinct recent time periods responsible for piedmont Maryland’s upper floodplain stratigraphy. The author used multiple cutbanks, cross-valley stratigraphic sections, and cores to determine these three periods. The periods are as follows: pre-1730 or pre-European settlement, 1730-1930, and post 1930. These three periods were found to be significant because of the types of floodplain deposits representing each period and have been historically linked with agricultural practices.

Jacobson, R. B., Femmer, S.F., and McKenney, R., 2001, Land-Use Changes and the Physical Habitat of Streams: U.S. Geological Survey Circular 1175, 63 p.

The landscape has undergone significant change since European settlement. Resource managers need to understand the effects of land-use changes on the physical habitat in streams for better management and restoration activities. Land-use and stream interactions are complex typically involving altered runoff and sediment yields, while channel scale disturbances such as mining, livestock grazing, and channelization often increase stream energy. Land-use changes and channel disturbances affect the depth, velocity, substrate, cover, and temperature of streams. These features make the physical habitat for stream biota. The authors review research done on land-use/stream interactions and provide information to aid resource managers in predicting changes to physical habitat from channel and watershed disturbances.

Flood-Flow Modelling II

HEC-RAS (Hydrologic Engineering Centers River Analysis System): U.S. Army Corps of Engineers (online), 12/08/2004, http://www.hec.usace.army.mil/software/hec-ras/hecras-hecras.html.

Student Topics / Presentation Background Readings

Kendra Hatcher

Sims, P., 2003, Previous actors and current influences: Trends and fashions in physical geography, in Trudgill, S., and Roy, A., eds., Contemporary meanings in physical geography: London, Arnold, p. 3-23.

This essay provides a summary of the development of physical geography, mainly through geomorphology. Sims reviews the beginnings of the discipline, starting with James Hutton and then discussing the importance of William Morris Davis’s work. He notes the change from theorization to quantitative research, mainly through work on fluvial processes. Process studies dominated in the 1960s, and numerical models were popular research tools as technology allowed advanced modeling capabilities. With the discovery of widespread glaciation, Quaternary research advanced knowledge of glacial and periglacial environments, as well as information on the affects of climate change on landscapes. This has great implications for humans today and in the future, and research is ongoing about how landscapes react to change, either from climate or man. The author believes that an understanding of the history of physical geography is imperative to the future research.

George Merovich

Rice, S. P., Greenwood, M. T., and Joyce, C. B., 2001, Tributaries, sediment sources, and the longitudinal organisation of macroinvertebrate fauna along river systems: Canadian Journal of Fisheries and Aquatic Sciences, v. 58, p. 824-840.

At moderate spatial scales, the physico-chemical conditions in main channels can change abruptly at tributary mouths due to addition of water and sediment. Therefore, the longitudinal gradient in conditions along rivers is rarely continuous, but rather is punctuated by shifts in bed character, water quality, and water volume, which have consequences for the longitudinal organization of riverine biota. The authors discuss these shifts in character and discuss how tributaries reconfigure the river system into a series of successive links as a result. They proposed the 'link discontinuity concept' that emphasizes the changes in geomorphological and hydrological variables at tributary mouths to affect spatial organization of macroinvertebrates along rivers. In a test of their model the authors found that macroinvertebrate samples from sites that straddled lateral sources of sediment (LSS) at tributary mouths and at landslides were very different in composition. Between LSS's, macroinvertebrate sample characteristics gradually changed downstream within the sedimentary links. Thus, abrupt changes in macroinvertebrates that were associated with the abrupt step-changes in sediment characteristics would have been considered noise had larger spatial scale models (i.e., the river continuum concept) been utilized that do not incorporate the impact of tributaries.

Reed Johnson

Donovan, J. D., and Rose, A. W., 1992, The chemical jump: Hydrologic control of brine reaction path within calcareous glacial aquifers and alkaline lakes, semi-arid northern Great Plains, USA: in Kharaka, Y.K., and Maest, A.S., eds., Proceedings - International symposium on water-rock interactions: v. 7, p. 639-642.

This short paper examines the chemical jump between groundwater and lake water chemistry in saline lakes in northwestern North Dakota and northeastern Montana. Lake chemistry in this region is strongly correlated to aquifer characteristics due to the high occurrence of groundwater fed lakes. Carbonate, glacially derived aquifers cause high amounts of dissolved solids in groundwater. Rapid calcite and aragonite precipitation is common as groundwater enters the lake environment.

Ira Poplar-Jeffers

Warren, Jr., M. L. and Pardew, M. G., Road crossings as barriers to small-stream fish movement: Transactions of the American Fisheries Society, v. 127, p. 637-644.

In this experiment, the researchers used mark-recapture techniques to compare fish movement effects of four different types of road crossings: culvert, slab, open-box, and ford crossings. They assessed movement for 21 fish species. Movement was an order of magnitude lower through culverts than through other crossings or natural reaches. The number of species that successfully traversed crossings and movement within three of four fish families at culverts were reduced at culverts relative to other types of crossings. The researchers also observed that stream segments above crossings retained more species than the segments below crossings. They attribute this to excessive scouring and sedimentation downstream due to spring spates and excess velocity through the culvert barrel due to flow constriction. Additionally, water velocity through crossings was inversely related to fish movement.

Ryan Ward

Jones, J.A., Swanson, F.J., Wemple, B.C., and Snyder, K.U., 2000, Effects of roads on hydrology, geomorphology, and disturbance patches in stream networks: Conservation Biology, v. 14, p.76-85.

Roads have many effects on watersheds, and the authors create a framework for how road and stream interactions may affect geomorphology and stream ecosystems. On a landscape scale, peak flows and debris flows are geomorphic forces that are influenced by roads and affect aquatic and stream ecosystem patch dynamics. Roads often increase the magnitude and frequency of peak flows and debris flows within watersheds. Increased disturbances to ecosystems may reduce the amount of refuge areas that serve as sources for organisms to later recolonize disturbed areas. Detecting the influence of roads is difficult due to the complex nature of geomorphic processes and their effects on biological communities. Future studies in stream ecology should incorporate the density of the road network within the watershed, road crossings on the stream, and any predisposition for debris flows or large peak flows within the area.