International—Other Than Canada

543) Abernethy, B., and I.D. Rutherfurd. 1998. Where along a river's length will vegetation most effectively stabilize stream banks? Geomorphology. 23: 55-75. (F)

Author abstract: Riparian vegetation has different impacts on stream processes depending upon its position in a catchment. Native riparian vegetation is increasingly becoming the favoured stream management tool but managers need to locate revegetation schemes where they will most effectively achieve ecological, geomorphological, or other, project goals. Using the Latrobe River in SE Australia as an example, this paper illustrates a structured decision-making approach for assessing the role of vegetation in stream bank erosion at different points throughout a catchment. Three bank-erosions process groups are identified: subaerial preparation, fluvial entrainment, and mass failure. Although these processes act on banks throughout the catchment there exists spatial zoning in the dominance of each process group over the others. Bank erosion in upper reaches is dominated by subaerial preparation, in mid-basin reaches by fluvial entrainment, and in the lower reaches by mass failure. We find that in upper reaches, windthrown trees are responsible for most bank sediment transfer to the flow. Where direct fluvial entrainment of bank material is the dominant erosion process, flow resistance due to vegetation becomes crucial. In reaches where bank slumping is the dominant erosion process, increased bank shear strength due to root reinforcement is the major role of vegetation is stabilizing banks. Other effects, such as tree surcharge, and altered bank hydrology appear to exert only minor influences on the slumping process. Considering the above variable we are able to define a critical zone in which revegetation will be most effective in reducing bank erosion. On the Latrobe River, this zone occurs in that portion of the river where it first leaves the mountain front and meanders across a broad floodplain. This research occupies the second quarter of the river's length. This information, combined with other scale analyses (e.g. ecological, hydrological), will assist river manager to plan physically based riparian revegetation strategies.

544) Abernethy, B., and I.D. Rutherfurd. 2000. Does the weight of riparian trees destabilize riverbanks? Regulated Rivers: Research & Management. 16: 565-576. (F)

Author abstract: In contrast to the generally accepted stabilizing effects of riparian vegetation, the surcharge of trees on riverbanks has been widely implicated as a source of bank instability. Fieldwork conducted along the Latrobe River in Victoria, Australia shows that the bank-destabilizing effects of surcharge, due to silver wattle (Acacia dealbata), are minimal. Field observations indicate that it is unlikely that the weight of silver wattles growing on an otherwise stable bank section will directly cause mass failure. Observations of deep-seated failures and silver wattle stands on the Latrobe River indicate that where average-sized slump-blocks support an average number of average-sized silver wattles, the trees represent only 4.1% of the total saturated slump mass. Infinite slope stability analysis indicates a threshold of around 48° where banks become prone to shallow-planar slide failures as they steepen. Where bank sections are inherently unstable and prone to shallow-planar slide failure, the additional weight of the trees may contribute to overall instability. However, manipulation of other stability parameters within reasonable constraints negates the effect of surcharge so it is not possible to demonstrate conclusively a destabilizing influence of silver wattles.

545) Abernethy, B., and I.D. Rutherfurd. 2000. The effect of riparian tree roots on the mass-stability of riverbanks. Earth Surface Processes and Landforms. 25: 921-937. (F)

Author abstract: Plants interact with and modify the processes of riverbank erosion by altering bank hydrology, flow hydraulics and bank geotechnical properties. The physically based slope stability model GWEDGEM was used to assess how changes in bank geotechnical properties due to the roots of native Australian riparian trees affected the stability of bank sections surveyed along the Latrobe River. Modelling bank stability against mass failure with and without the reinforcing effects of River Red Gum (*Eucalyptus camaldulensis*) or Swamp Paperbark (*Melaleuca ericifolia*) indicates that root reinforcement of the bank substrate provides high levels of bank protection. The model indicates that the addition of root reinforcement to an otherwise unstable bank section can raise the factor of safety (F_s) from F_s = 1·0 up to about F_s = 1·6. The addition of roots to riverbanks improves stability even under worst-case hydrological conditions and is apparent over a range of bank geometries, varying with tree position. Trees growing close to potential failure plane locations, either low on the bank or on the floodplain, realize the greatest bank reinforcement.

546) Anderson, D.M., and L.H. Macdonald. 1998. Modelling road surface sediment production using a vector geographic information system. Earth Surface Processes and Landforms. 23: 95-107. (K)

Author abstract: Field investigations indicate that unpaved roads are the largest sediment source on St John, US Virgin Islands. Cross-sectional measurements of eroded road surfaces were used to establish an empirical relationship to predict annual road surface erosion as a function of road gradient and contributing drainage area. A model (ROADMOD) for estimating and mapping average annual sediment production from a road network was developed by combining this empirical relationship with a series of network algorithms to analyse road data stored in a vector geographic information system.

ROADMOD was used to estimate road surface erosion in two St John catchments with very different road densities but similar land cover, topography and soils. Unpaved roads were found to increase sediment production in the more densely roaded catchment by a factor of three to eight, and in the less-roaded catchment by a factor of 1·3-2·0. Turbidity measurements in the receiving bays of these two catchments are consistent with model predictions and observed sediment delivery processes.

Although this model was developed specifically for St John, it can easily be adapted to other locations by substituting a locally derived predictive equation for road erosion. Model assumptions, limitations and potential improvements are discussed.

547) Arscott, D.B., K. Tockner, and J.V. Ward. 2001. Thermal heterogeneity along a braided floodplain river (Tagliamento River, northeastern Italy). Canadian Journal of Fisheries and Aquatic Sciences. 58: 2359-2373. (J)

Author abstract: Daily and seasonal water temperature patterns were investigated at 22 habitats in five geomorphic reaches along an Alpine-Mediterranean river. Study reaches spanned 2nd- to 7th-order river segments. Habitats included headwater streams, main and secondary channels,

backwaters, and isolated pools. Multiple linear regression analyses extracted elevation and azimuth (aspect) out of eight geographical and environmental variables to explain average daily temperature patterns among habitats. Azimuth and, to a lesser degree, slope, depth, velocity, and canopy were primary determinants of diel temperature amplitude and maximum rates of diel heating and cooling. Within lowland floodplain reaches, the relative influence of groundwater and surface water varied substantially among habitats. Thermal variation among habitats was greatest in lowland floodplain reaches (nearly 15°C difference). In summer and autumn, variation between lowland floodplain aquatic habitats exceeded thermal variation observed in the main channel along the entire river corridor (120 km; 5–1100 m above sea level). Spatiotemporal variation in temperature was greatest in lower reaches owing to the interaction of water level and connectivity of isolated water bodies. Influence of groundwater and cool-water tributaries exemplified the importance of local factors (geomorphology and hydrology) superimposed on regional factors (climate and altitude) in determining large-scale thermal patterns.

548) **Baeza, C., and J. Corominas. 2001. Assessment of shallow landslide susceptibility by means of multivariate statistical techniques. Earth Surface Processes and Landforms. 26: 1251-1263. (K)**

Author abstract: Several multivariate statistical analyses have been performed to identify the most influential geological and geomorphological parameters on shallow landsliding and to quantify their relative contribution. A data set was first prepared including more than 30 attributes of 230 failed and unfailed slopes. The performance of principal component analysis, t-test and one-way test, allowed a preliminary selection of the most significant variables, which were used as input variables for the discriminant analysis. The function obtained has classified successfully 88.5 percent of the overall slope population and 95.6 percent of the failed slopes. Slope gradient, watershed area and land-use appeared as the most powerful discriminant factors. A landslide susceptibility map, based on the scores of the discriminant function, has been prepared for Ensija Range in the Eastern Pyrenees. An index of relative landslide density shows that the results of the map are consistent.

549) **Boothroyd, I.K.G., J.M. Quinn, E.R. Langer, K.J. Costley, and G. Steward. 2004. Riparian buffers mitigate effects of pine plantation logging on New Zealand streams. 1. Riparian vegetation structure, stream geomorphology and periphyton. Forest Ecology and Management. 194: 199-213. (A, C, F, H)**

Author abstract: Influences of the riparian zone vegetation characteristics on bank erosion, stream geomorphology, irradiance and periphyton were examined at 28 sites in the Whangapoua area of the Coromandel Peninsula, North Island, New Zealand. Riparian buffers were defined as areas alongside streams that were not managed for production forestry, and which contained native indigenous vegetation or mixed indigenous and introduced flora. Five forest and riparian zone types were selected: (i) harvested pine plantation with a clearcut to stream edge, (ii) harvested pine plantation with a vegetated riparian buffer, (iii) mature pre-harvest pine plantation with a riparian buffer dominated by native vegetation, (iv) mature pre-harvest pine plantation with a riparian zone of plantation pines and a native vegetation understory, and (v) mature native forest reference sites. Up to eight replicates were selected for each management regime. Species composition and canopy cover were measured from bounded plots, and stream bank vegetation

was recorded separately. Bank erosion was measured along the full length of each study reach, and stream water width and bankfull width were measured at ten transects within each study reach. Stream and bank lighting were measured using a canopy analyzer. Periphyton standing crop was measured as Chlorophyll *a* and ash-free dry weight.

Although channel width increased with catchment area for all of the study reaches, bank erosion and channel widths were greater at harvested sites where plantation pines occurred at the stream edge (i.e. within the riparian zone), than other forest and riparian treatments. Stream lighting was heavily influenced by the presence of riparian vegetation as well as stream size for these small to moderate size streams. Mature radiata pine in riparian areas of pre-harvest sites provided shading which was similar but less variable than that recorded in the native reference sites. Mature pine forest may be shading out the taller growing native broadleaved canopy, and thus creating a denser 5–11.9 m height class, reducing light penetration. The lack of native species >12 m in height is likely to be due to the length of time which native conifers and hardwoods take to develop as these are the species which normally dominate the greater than 12 m height class. Periphyton biomass was lowest at pre-harvest sites with native riparian buffers present and greatest at clearcut harvested sites with clearcut riparian zones. This work shows that riparian vegetation composition and maturity can influence the physical characteristics of afforested and harvested New Zealand streams

550) Casagli, N., M. Rinaldi, A. Gargini, and A. Curini. 1999. Pore water pressure and streambank stability: Results from a monitoring site on the Sieve River, Italy. Earth Surface Processes and Landforms. 24: 1095-1114. (F, G)

Author abstract: To investigate the role of pore water pressures in the stability of a streambank, a series of tensiometers and piezometers was installed in a bank of the Sieve River, Tuscany, Italy. Fluvial entrainment at the bank toe was monitored by repeated cross-profiling, erosion pins and marked pebbles. Fluctuations in matric suction measured at the tensiometers reflected the overall response of pore water pressures to rainfall, evapotranspiration, rising and drawdown of the river stage, and variations in water table. An expression was derived for the safety factor with respect to mass movement of the upper bank, incorporating the failure criterion for unsaturated soils and the normal Mohr-Coulomb criterion for saturated conditions. Variations in matric suction have important effects on the stability of the streambank. During low-flow periods, the shear strength term due to the matric suction allows the bank to remain stable at a steep angle. However, during rainfall and flow events, reduction in matric suction and increase in unit weight of the material from vertical and lateral infiltration may be sufficient to trigger a mass failure, without development of significant positive pore water pressures. During the rising limb of high-flow events, the factor of safety increases as a consequence of the stabilizing confining pressure of the water in the river, despite a reduction in matric suction. During drawdown in the river, when the suction values are still low and the confining pressure in the river decreases to zero, the factor of safety falls to lower values than those experienced prior to the runoff event. Measurements of fluvial entrainment reveal that, although the processes, mechanisms and the frequency of retreat of basal and upper bank zones differ significantly, the amount of retreat at the bank toe due to fluvial erosion is comparable to that of the upper portion of the bank due to mass failure.

551) Collier, K.J., and J.N. Halliday. 2000. Macroinvertebrate-wood associations during decay of plantation pine in New Zealand pumice-bed streams: Stable habitat or trophic subsidy? Journal of the North American Benthological Society. 19: 94-111. (C, D, E)

Author abstract: Extensive areas of production pine forest in New Zealand have been planted in the North American native *Pinus radiata.* We investigated the use of pine large woody debris (LWD) by aquatic invertebrates in central North Island spring-fed streams with pumice beds to provide an improved basis for managing LWD inputs following logging. Invertebrate faunas in early summer were dominated by Ephemeroptera and Diptera on inorganic substrates, and by these groups and Trichoptera (predominantly *Pycnocentria funerea*; Conoesucidae) on wood. Densities of total invertebrates and *P. funerea, Eukiefferiella* sp. (Diptera), and the Ephemeropterans *Coloburiscus humeralis* (Coloburiscidae), *Zephlebia dentata*, and *Austroclima sepia* (both Leptophlebiidae) were significantly higher on wood than on inorganic substrates in summer. These dominant species showed varying preferences for wood at different stages of decay. *Austroclima sepia* appeared to prefer wood at early to intermediate stages of decay, *P. funerea* and *Z. dentata* preferred wood at intermediate to advanced stages of decay, and *C. humeralis* and *Eukiefferiella* preferred severely decayed wood. *Pycnocentria funerea* larvae excavated feeding grooves 1–2 mm deep along LWD, and gut analyses of larvae collected in summer confirmed ingestion of pine wood. This material dominated the gut contents of large larvae collected from wood at intermediate to advanced stages of decay. Stable isotope analyses of potential C sources and selected wood-dwelling invertebrates discriminated between pine wood and other types of allochthonous organic matter, and indicated that some larvae could derive substantial proportions of their nutrition from pine wood at certain times of year. In a laboratory experiment, *P. funerea* larvae produced significantly more fine particulate organic matter from wood at advanced stages of decay than from less-decayed wood or controls (PVC tubes) over 8 and 26 d. However, growth rates did not differ significantly between wood-decay treatments. Our findings 1) indicate that wood in pumice-bed streams enhances habitat for lotic invertebrates, and 2) suggest invertebrate community succession as wood passes through different stages of decay. Some predominantly xylophagous species, such as *P. funerea*, appear to be responding partly to enhanced food resources, indicating that inputs of pine woody debris can provide a trophic subsidy to pumice-bed streams in production forest environments.

552) Costard, F., L. Dupeyrat, E. Gautier, and E. Carey-Gailhardis. 2003. Fluvial thermal erosion investigations along a rapidly eroding river bank: Application to the Lena River (central Siberia). Earth Surface Processes and Landforms. 28: 1349-1359. (F)

Author abstract: In Central Yakutia, frozen river banks are affected by a combination of thermal and mechanical erosion. Exceptional bank retreat of up to 40 m per year is observed. This results from ground thawing produced by heat transfer from the flow of water through the frozen ground, followed by mechanical transport of the thawed sediments. A one-dimensional model is proposed to estimate the thermal erosion efficiency. A test of this model is a comparison of results obtained from experiments carried out in a cold room. A hydraulic channel allows measurements of the thaw front propagation, as well as the thermal erosion rate, in simulated ground ice that is subjected to warm water flow. Various laboratory simulations

demonstrate the validity of the mathematical model for the range of laboratory conditions. A hierarchy of parameters (Reynolds number, water and ground ice temperatures) is proposed to explain the present efficiency of thermal erosion along the Siberian rivers. From the characteristics of the Lena River (geometry, temperature and discharge) during the flood season, the erosion of banks with different ice content predicted by the model is in agreement with field observations.

553) Couper, P.R., and I.P. Maddock. 2001. Subaerial river bank erosion processes and their interaction with other bank erosion mechanisms on the River Arrow, Warwickshire, UK. Earth Surface Processes and Landforms. 26: 631-646. (F)

Author abstract: River bank erosion occurs primarily through a combination of three mechanisms: mass failure, fluvial entrainment, and subaerial weakening and weathering. Subaerial processes are often viewed as 'preparatory' processes, weakening the bank face prior to fluvial erosion. Within a river basin downstream process 'domains' occur, with subaerial processes dominating the upper reaches, fluvial erosion the middle, and mass failure the lower reaches of a river. The aim of this paper is to demonstrate that (a) subaerial processes may be underestimated as an erosive agent, and (b) process dominance has a temporal, as well as spatial, aspect. Bank erosion on the River Arrow, Warwickshire, UK, was monitored for 16 months (December 1996 to March 1998) using erosion pins. Variations in the rate and aerial extent of erosion are considered with reference to meteorological data. Throughout the first 15 months all erosion recorded was subaerial, resulting in up to 181 mm a^{-1} of bank retreat, compared with 13 to 27 mm a^{-1} reported by previous researchers. While the role of subaerial processes as 'preparatory' is not contended, it is suggested that such processes can also be erosive. The three bank erosion mechanisms operate at different levels of magnitude and frequency, and the River Arrow data demonstrate this. Thus the concept of process dominance has a temporal, as well as spatial aspect, particularly over the short time-periods often used for studying processes in the field. Perception of the relative efficacy of each erosive mechanism will therefore be influenced by the temporal scale at which the bank is considered. With the advent of global climate change, both these magnitude-frequency characteristics and the consequent interaction of bank erosion mechanisms may alter. It is therefore likely that recognition of this temporal aspect of process dominance will become increasingly important to studies of bank erosion processes.

554) Dahlström, N., and C. Nilsson. 2004. Influence of woody debris on channel structure in old growth and managed forest streams in central Sweden. Environmental Management. 33: 376-384. (A, D)

Author abstract: Anecdotal information suggests that woody debris have had an important channel-forming role in Swedish streams and rivers, but there are few data to support this view. We identified 10 streams within near-natural and 10 streams within managed forest landscapes in central Sweden, and quantified their channel characteristics and content of woody debris. All pieces of woody debris greater than 0.5 m in length and greater than 0.05 m in base diameter were included. The near-natural forests were situated in reserves protected from forest cutting, whereas the managed forests had previously faced intensive logging in the area adjacent to the stream. The two sets of streams width, slope, or boulder cover, but the number of wood pieces was twice as high and the wood volume almost four times as high in the near-natural streams.

This difference resulted in a higher frequency of debris dams in the nearnatural streams. Although the total pool area did not differ between the two sets of streams, the wood-formed pools were larger and deeper, and potentially ecologically more important than other pools. In contrast to what has been believed so far, woody debris can be a channel-forming agent also in steeper streams with boulder beds. In a stepwise multiple regression analysis, pool area was positively and most strongly related to the quantity of woody debris, whereas channel gradient and wood volume were negatively related. The frequency of debris dams increased with the number of pieces of woody debris, but was not affected by other variables. The management implications of this study are that the wood quantity in streams in managed forests would need to be increased if management of

555) Dapporto, S., M. Rinaldi, N. Casagli, and P. Vannocci. 2003. Mechanisms of riverbank failure along the Arno River, central Italy. Earth Surface Processes and Landforms. 28: 1303-1323. (F)

Author abstract: Riverbanks along the Arno River have been investigated with the aims of defining the main mechanisms of failure and retreat, their spatial distribution, and their causes. Geomorphological aspects were investigated by a reconnaissance of riverbank processes, for a number (26) of representative sites. Laboratory and *in situ* tests were then performed on a selected number of riverbanks (15). Based on the material characteristics, six main typologies of riverbanks have been defined, with homogeneous fine-grained and composite banks representing the most frequent types. Slab-type failures are the most frequent mechanism observed on fine-grained banks, while cantilever failures prevail on composite banks.

The role of river stage and related pore water pressure distributions in triggering the main observed mechanisms of failure has been investigated using two different types of stability analysis. The first was conducted for 15 riverbanks, using the limit equilibrium method and considering simplified hypotheses for pore water pressure distribution (annulment of negative pore pressures in the portion of the bank between low water stage and peak stage). Stability conditions and predicted mechanisms of failure are shown to be in reasonably good agreement with field observations. Three riverbanks, representative of the main alluvial reaches of the river, were then selected for a more detailed bank stability analysis, consisting of: (a) definition of characteristic hydrographs of the reach with different return periods; (b) modelling of saturated and unsaturated flow using finite element seepage analysis; and (c) stability analysis with the limit equilibrium method, by adopting pore water pressure values derived from the seepage analysis. The results are compared to those obtained from the previous simplified analysis, and are used to investigate the different responses, in terms of stability, to different hydrological and riverbank conditions.

556) Díez, J.R., S. Larrañaga, A. Elosegi, and J. Pozo. 2000. Effect of removal of wood on streambed stability and retention of organic matter. Journal of the North American Benthological Society. 19: 621-632. (A, C, D)

Author abstract: We tested the hypothesis that wood influences stream channel morphology, sediment composition, retention, and storage of organic matter by experimentally removing all wood from 2 first-order reaches (ca 90 m length) of 2 neighboring tributaries (Salderrey and Cuchillo streams) in the Agüera catchment (Basque Country, Spain). We established 2 *control*

reaches upstream from these *treatment* reaches. We completed maps of substrate, fill/scour transects, and wood surveys in 1997 (prior) and 1998 (after) wood removal. We measured monthly inputs of fine wood to the treatment reaches. In addition, we measured seston every 2 wk, benthic coarse organic particulate matter (CPOM) every 2 mo, and the retention capacity of reaches every 3 mo. All reaches were scoured during the study period, but the volume of sediment lost was higher in the treatment reaches (53 m^3) than in the controls (14.2 m^3 in Salderrey, 2.7 m^3 in Cuchillo). As a result, the area of coarse substrate increased in the treatments, but remained unaltered in the controls. The capacity of the reaches to retain CPOM decreased after the treatment, but affected neither seston concentration nor the benthic storage of CPOM. Wood is an important constituent of Basque streams, and removal of wood significantly impacts channel structure and organic matter storage.

557) Fransen, P.J.B., C.J. Phillips, and B.D. Fahey. 2000. Forest road erosion in New Zealand: Overview. Earth Surface Processes and Landforms. 26: 165-174. (K)

Author abstract: New Zealand research relating to erosion impacts of plantation forest roads, tracks and landings has been carried out since the mid-1970s. Methods include paired catchment studies, storm-induced mass movement surveys, and surface erosion plot experiments from both natural and simulated rainfall-runoff. Road surface erosion data exist only for indurated conglomerate, granitic, schist and pumice terrains, with annual sediment yields up to 15 kg m^{-2} for a range of treatments and source types including graded, ungraded and gravelled road surface-ditch, cutbank and sidecast. Sediment generated from infrequent storm-induced landslides over entire forest road networks range from *c*. 40 to 8000 t km^{-1} road, or one to three orders of magnitude greater than combined surface road erosion processes. Young roads tend to have greater landslide susceptibility. Despite predicted increases in sediment yields from road surfaces during forest establishment and harvesting activities, annual sediment yields from catchments appear to be within natural levels.

558) Graça, M.A.S., R.C.F. Ferreira, and C.N. Coimbra. 2001. Litter processing along a stream gradient: The role of invertebrates and decomposers. Journal of the North American Benthological Society. 20: 408-420. (A, C, E)

Author abstract: Dissolved nutrients and temperature tend to increase in a downstream direction, whereas shredder density tends to decrease. As a result, the relative importance of microbes (bacteria and fungi) and invertebrates in leaf litter processing may gradually shift along a stream gradient. Therefore, we hypothesized that differences in litter decay between fine-mesh (invertebrates excluded) and coarse-mesh (accessible to invertebrates) bags will be high in low-order streams (i.e., <4) and low in high-order streams (i.e., >4). To test this hypothesis, we investigated the processing of alder (*Alnus glutinosa*) litter in 12 sites ranging from 2nd to 6th order in central Portugal during autumn/winter and spring/summer seasons. Mass loss rates (measured as % ash-free dry mass [AFDM]) were higher in spring/summer than in autumn/winter and higher in coarse- than in fine-mesh bags. No clear relationship was observed between river order and litter processing (% AFDM loss). In spring/summer, the difference in remaining mass between fine- and coarse-mesh bags was higher in low-order than in high-order streams and decreased in a downstream direction, supporting our hypothesis. Other evidence for shifting in processing vectors includes the observations that 1) the biomass and % of shredders

were generally higher in low-order than in high-order streams and tended to decrease downstream, 2) high microbial biomass was reached earlier in high-order than in low-order rivers, and 3) the density of fungal conidia tended to increase with increasing stream order. No pattern of shifting in processing vectors was observed in autumn/winter, possibly because food was nonlimiting.

559) Gurnell, A.M., G.E. Petts, N. Harris, J.V. Ward, K. Tockner, P.J. Edwards, and J. Kollmann. 2000. Large wood retention in river channels: The case of the Fiume Tagliamento, Italy. Earth Surface Processes and Landforms. 25: 255-275. (A, D)

Author abstract: After more than 300 years of widespread and intensive river management, few examples of complex, unmanaged river systems remain within Europe. An exception is the Fiume Tagliamento, Italy, which retains a riparian woodland margin and unconfined river channel system throughout almost the entire 170 km length of its river corridor. A research programme is underway focusing on a range of related aspects of the hydrology, fluvial geomorphology and ecology of the Tagliamento. This paper contributes to that programme by focusing on large wood retention. The paper adopts a simple force:resistance approach at the scale of the entire river corridor in order to identify reaches of the river with a high wood retention potential. Information on the character of the river corridor is derived from 1:10 000 scale topographic maps. A range of indices measured at 330 transects across the river corridor supports a classification of the geomorphological style of the river which reflects the presence and abundance of properties previously identified in the literature as large wood retention sites. This classification provides a qualitative representation of the 'resistance' of the corridor to wood movement and thus its overall wood-retention potential. The map-derived indices are also used to extrapolate estimates of the ten year return period flood to each of the 330 transects so that the downstream pattern of unit stream power can be quantified as an index representing 'force' in the analysis. Although input of wood is an important factor in many river systems, it is assumed not to be a limiting factor along the Tagliamento, where riparian woodland is abundant.

Field observations of large wood storage illustrate that wood retention at eight sites along the river reflects the presence and abundance of the features incorporated in the classification of geomorphological style, including the complexity of the channel network, the availability of exposed gravel areas, and the presence of islands. In general at the time of survey in August 1998, open gravel areas were estimated to store approximately 1 t ha^{-1} of wood in single-thread reaches and 6 t ha^{-1} in multiple-thread reaches. Established islands were estimated to store an average of 80 t ha^{-1} of wood. Nevertheless, there was considerable variability between sites, and pioneer islands, which are not represented on maps or readily identified from air photographs because of their small size, were estimated to store an order of magnitude more wood than established islands. Furthermore, the wood storage from this sample of eight sites did not reflect variability in estimated unit stream power.

A series of areas for further research are identified, which can be explored using field data, and which will throw more light on the processes of wood retention in this extremely dynamic fluvial environment.

560) Harwood, K., and A.G. Brown. 1993. Fluvial processes in a forested anastomosing river: Flood partitioning and changing flow patterns. Earth Surface Processes and Landforms. 18: 741-748. (A, D, G, F)

Author abstract: In an effort to further our understanding of multiple channel systems, this paper presents data on the flood response of channels in one of the last wooded, semi-natural anastomosing systems in Europe. The Gearagh, Ireland, is characterized by hundreds of small islands separated by interconnected channels of low slope. These include channels that cross islands at right angles to the main flow and blind anabranching channels. Islands are relatively stable and wooded, with evidence of division by channel erosion and growth by in-channel sedimentation. Four active zone cross-profiles were surveyed, each containing between seven and 13 channels. Velocities were measured in several channels before and during two separate floods. From these observations channels have been categorized into three types: fast (shallow and trapezoidal); slow (deep and more irregular); and flood channels. During the floods, interchannel flows were caused by variations in water surface elevations due to backing-up behind debris dams, and it is suggested that this is the origin of the anomalous cross-island channels and one cause of island division. Another potential cause of island division, blind anabranching channels, is the result of concentrated bank scour between root masses. Biotic components such as debris dams, tree root masses and tree-throw pits play a key role in the partitioning of flow, and cause variations in channel velocities and the overbank velocity distribution. The implications of these observations for channel pattern maintenance are briefly discussed.

561) Huisink, M., J.J.W. de Moor, C. Kasse, and T. Virtanen. 2002. Factors influencing periglacial fluvial morphology in the northern European Russian tundra and taiga. Earth Surface Processes and Landforms. 27: 1223-1235. (A, F, G)

Author abstract: The influence of geology, discharge regime, slope, vegetation type, vegetation density and permafrost conditions on periglacial channel morphology has been investigated in the USA catchment (northern European Russia). Rivers are dominated by meandering or anabranching plan forms and rarely show braiding characteristics, despite a nival discharge regime, the presence of discontinuous permafrost and locally steep slopes.

The dense vegetation cover is an important factor in determining the meandering morphology as it inhibits the sediment supply and hence braided conditions. Differences in vegetation types (taiga in the south, tundra in the north) have no effect on channel plan form

562) Jeffries, R., S.E. Darby, and D.A. Sear. 2003. The influence of vegetation and organic debris on flood-plain sediment dynamics: Case study of a low-order stream in the New Forest, England. Geomorphology. 51: 61-80. (D)

Author abstract: The presence of large woody debris (LWD) has important implications for the physical and ecological behaviour of rivers, and these aspects have been researched extensively in recent years. However, this research has so far focused primarily on interactions between LWD and in-channel processes, and the role of LWD in flood-plain genesis is still poorly understood. Established conceptual models of flood-plain evolution are, therefore, lacking because they neglect the complex interaction between water, sediment, and vegetation in systems with accumulations of LWD. This study examines the effect of LWD on patterns of sediment deposition within a small area of forest flood plain along the Highland Water, S. England. In-channel debris dams locally increase the frequency and extent of overbank flows, and the impact

of such dam on flood-plain sedimentation was observed. Nine separate flood events were monitored through the exceptionally wet winter of 2000–2001. During each of these, water and sediment fluxes were quantified and correlated with general rates of overbank sedimentation. Flood-plain topography, vegetation, and LWD were surveyed and related to micro- and mesoscale patterns of sediment accretion. The amount of overbank sediment deposition was correlated most closely with flood hydrology and sediment input. The amounts (0–28 kg m^{-2}) and patterns of sediment deposition were both greater and more variable than have been observed on nonforest flood plains. The highly variable pattern of accretion can be explained by the combined effects of topography and organic material present on the surface of the flood plain.

563) Jones, A. 1971. Soil piping and stream channel initiation. Water Resources Research. 7: 602-610. (K)

Author abstract: The hydrologic significance of soil piping has been generally ignored. Piping has been associated primarily with drylands, yet evidence of piping is available from a large range of climatic regions. In particular, soil piping is found to be widespread in the United Kingdom. Preferred locations for piping are either just above or within a horizon of low relative permeability and low aggregate stability. Chemical environment may range from acidic moorland soils to saline marshes. There are significant trends to lower aggregate stability and coarser grain size (particularly in the range above 250 μm) in the bed of a pipe than in the roof. Many pipes in the areas studied appear to be dormant or relatively inactive and may well be in approximate equilibrium with the soil pore and channel subsystems. However, when equilibrium is destroyed (e.g., by stream incision) pipes can form loci for channel extension. Studies of the spatial distribution of outlets show that to create normal channel networks, pipe clusters within the ensemble and, similarly, individual pipes within those clusters must be selected on an unequal basis. A low density random selection from piped located on percolines would fulfill the requirements. The presence of piping may have a significant effect on the form of the hydrograph.

564) Kail, J. 2003. Influence of large woody debris on the morphology of six central European streams. Geomorphology. 51: 207-223. (A, D)

Author abstract: The impact of large fallen trees on channel form is described for six short stream sections in central Europe influenced by large woody debris (LWD sections), five of which are compared to nearby reference sections free of LWD (reference sections). Three-dimensional models of streambed topography were generated by surveying cross-sections with a spacing of 1 per 1/15 channel width. Parameters derived from digital terrain models and cross-sections compared between LWD sections and reference sections include the extent of pools, bars, and cutbanks, streambed and bank complexity, cross-sectional area, width, depth, and cross-section complexity as described by Andrle's [Math. Geol. 26 (1994) 83] `angle-measurement-technique' (AMT analysis), a measure of the deviation of a cross-section line from a straight line. Structural diversity is greater in LWD sections at almost all spatial scales, particularly in terms of pool volume (Mann–Whitney *U*-test, $p<0.01$) and cross-section complexity described by median angle of AMT analysis (Mann–Whitney *U*-test, $p<0.05$). Large pools are clearly associated with large fallen trees and attain volumes up to 36 m^3. With the

exception of the ratio of one LWD section where the fallen tree is oriented parallel to flow, the ratio of pool volume to bed planimetric area ranges from 424 to 693 m^3/ha, which is in the upper range reported for small, high-gradient streams in Oregon, NW America (229–755 m^3 /ha) [Can. J. Fish. Aquat. Sci. 47 (1990) 1103]. Pool volume of LWD sections is strongly correlated to the blockage ratio (Spearman rank order correlation, r_s=0.93, p<0.01). Differences in channel morphology between the LWD sections and reference sections indicate a strong morphologic control of large woody debris in these central European stream sections.

565) Kobayashi, S., and T. Kagaya. 2004. Litter patch types determine macroinvertebrate assemblages in pools of a Japanese headwater stream. Journal of the North American Benthological Society. 23: 78-89. (C)

Author abstract: In forested streams, litter patches are important microhabitats for macroinvertebrates, and the nature of litter patches can affect structure and function of macroinvertebrate assemblages. We examined whether litter patch types with different characteristics could be predicted by their location within stream pools (pool middle, alcove, edge) and, if so, whether patch types had different macroinvertebrate assemblages. Mean mass of leaves per unit area of streambed was 2 to 3x higher in edge patches than in other patches, whereas mean mass of wood and small litter particles was 2 to 6x higher in middle patches. Densities of nemourid stonefly taxa were higher in edge patches than other patches, with density of *Nemoura* being highly correlated with leaf mass, whereas densities of lepidostomatid caddisfly taxa were higher in middle patches, with density of *Goerodes complicatus* being highly correlated with mass of small litter particles. Mean biomass and annual secondary production of shredders, collectors, and predators were 1.6 to 4x higher in middle patches than in other patches. Our results indicate that macroinvertebrate community structure and production may differ within and among forested streams according to relative composition of litter patch types, even if overall litter abundance is similar.

566) Quinn, J.M., I.K.G. Boothroyd, and B.J. Smith. 2004. Riparian buffers mitigate effects of pine plantation logging on New Zealand streams. 2. Invertebrate communities. Forest Ecology and Management. 191: 129-146. (C, F, G, H, I, J)

Author abstract: The influences on forest stream invertebrate communities of riparian forest type (native/exotic *Pinus radiata*) and logging, with or without native forest riparian buffers, were investigated at 28 stream sites on Coromandel Peninsula, New Zealand. Stream reaches were surveyed under summer, baseflow conditions in six riparian/forest vegetation types: native forest, mature pine plantations with pines planted to the stream edge, mature pine plantations with native forest in the riparian area, clearcut pine plantations, and logged pine plantations with patch buffers of native forest vegetation (upstream areas clearcut) or continuous buffers along the perennially flowing stream length. Multivariate analyses showed that clearcut reaches differed in invertebrate community structure from pine and native forested reaches, and from logged reaches with continuous riparian buffers. Communities at patch buffer sites were intermediate between these groups. Amongst the common taxa, mayflies were the most sensitive to clearcut logging, with three species less abundant at clear-cut and/or patch buffer sites; only the algal-piercing caddis *Oxyethira albiceps* (Hydroptilidae) responded positively to logging. Clearcut reaches had lowest diversity, taxon richness, relative abundance and numbers of the

sensitive mayfly, stonefly and caddisfly taxa, and index of biotic integrity. In contrast, sites that had been logged leaving continuous buffers did not differ in these biometrics from those in intact native or mature plantation forest, indicating that buffers greatly reduced disturbance associated with logging. Logged sites with patch buffers had biometric values intermediate between clearcut and forested/continuous buffered reaches, indicating less protection from logging impact. Correlation and multiple regression analyses showed that logging impacts are strongly related to increases in periphyton biomass and water temperature, associated with changes in stream lighting, and increased channel instability/fine sediment. The findings indicate that late-rotation exotic pine plantations can support very similar stream invertebrate communities to native forests, and highlight the benefit of retaining forested buffers along stream riparian areas to avoid harvesting impacts on stream habitat and invertebrate communities.

567) Rinaldi, M., and N. Casagli. 1999. Stability of streambanks formed in partially saturated soils and effects of negative pore water pressures: The Sieve River (Italy). Geomorphology. 26: 253-277. (F)

Author abstract: Streambanks of alluvial channels are usually composed of loose materials, which are unsaturated in ambient conditions. Unsaturated soils are subject to negative pore water pressures, which cause an apparent cohesion. The latter is the main factor in allowing the stability of near-vertical banks. Even during moderate in-bank flow events, the apparent cohesion can be strongly reduced as the material approaches full saturation; therefore, during the drawdown phase, as the confining pressure of the water in the channel disappears, a bank failure is likely to occur. Channel bed-level lowering along the Sieve River, Central Italy, has caused widespread bank instability. A geomorphological reconnaissance of forms and processes was followed by in situ tests to determine the shear strength of the banks. Interpretation of the tests and a streambank stability analysis were based on the concepts of soil mechanics for unsaturated soils, in order to obtain relations between bank angle and height in limit equilibrium conditions. A stability chart was obtained with curves for different apparent cohesion values, and a stability analysis was performed taking in account the effects of flow events. In order to investigate the pore pressure effects, a series of piezo-tensiometers were installed in a streambank of the Sieve River. Data from a 1 year monitoring period show variations in pore water pressure and matric suction as a consequence of rainfall, evapotranspiration, and water stage variations. A planar failure with a tension crack occurred in the upper cohesive part of the bank during December 1996. The safety factor has been expressed as a function of the geometry of the bank and of the shear strength of the material. Safety factor variations through time are therefore shown as a function of seasonal variations in matric suction.

568) Rinaldi, M., N. Casagli, S. Dapporto, and A. Gargini. 2004. Monitoring and modelling of pore water pressure changes and riverbank stability during flow events. Earth Surface Processes and Landforms. 29: 237-254. (F, G)

Author abstract: Pore water pressures (positive and negative) were monitored for four years (1996-1999) using a series of tensiometer-piezometers at increasing depths in a riverbank of the Sieve River, Tuscany (central Italy), with the overall objective of investigating pore pressure changes in response to flow events and their effects on bank stability.

The saturated/unsaturated flow was modelled using a finite element seepage analysis, for the main flow events occurring during the four-year monitoring period. Modelling results were validated by comparing measured with computed pore water pressure values for a series of representative events. Riverbank stability analysis was conducted by applying the limit equilibrium method (Morgenstern-Price), using pore water pressure distributions obtained by the seepage analysis.

The simulation of the 14 December 1996 event, during which a bank failure occurred, is reported in detail to illustrate the relations between the water table and river stage during the various phases of the hydrograph and their effects on bank stability. The simulation, according to monitored data, shows that the failure occurred three hours after the peak stage, during the inversion of flow (from the bank towards the river). A relatively limited development of positive pore pressures, reducing the effective stress and annulling the shear strength term due to the matric suction, and the sudden loss of the confining pressure of the river during the initial drawdown were responsible for triggering the mass failure.

Results deriving from the seepage and stability analysis of nine selected flow events were then used to investigate the role of the flow event characteristics (in terms of peak stages and hydrograph characteristics) and of changes in bank geometry. Besides the peak river stage, which mainly controls the occurrence of conditions of instability, an important role is played by the hydrograph characteristics, in particular by the presence of one or more minor peaks in the river stage preceding the main one.

569) Rowntree, K.M., and E.S.J. Dollar. 1999. Vegetation controls on channel stability in the Bell River, Eastern Cape, South Africa. Earth Surface Processes and Landforms. 24: 127-134. (A, F)

Author abstract: Channel instability has occurred in the Bell River in the form of meander cutoffs, a number of which have occurred since 1952. Increased sediment loading from widespread gully erosion in the catchment has been proposed as the trigger for this instability. Willow species of the *Salix* family, in particular *S. caprea*, have been planted along the banks in an effort to prevent further channel shifting. This study reports the results of an investigation into the effect of vegetation on channel form and stability over a 17 km stretch of channel. Results indicate that riparian vegetation has significant effects on channel form which have implications for channel stability. Riparian vegetation increases bank stability and reduces channel cross-sectional area, thereby inducing stability at flows less than bankfull. Evidence indicates that narrow stable stretches are associated with relatively high levels of riparian vegetation. Wider, unstable channels are associated with relatively less riparian vegetation. The effectiveness of riparian vegetation relative to bank sediments was investigated. A dense growth of willows was found to have an equivalent effect to banks with a silt-clay ratio of about 70 per cent. The channel narrowing induced by vegetation may contribute to channel shifting at high flows. The reduced channel capacity is thought to result in more frequent overbank flooding which may ultimately lead to channel avulsion. Thus where increased sediment loading is pushing the channel towards instability, vegetation may be effective in imparting local stability, but it is unable to prevent long-term channel shifts, and may rather help to push the system towards more frequent avulsions.

570) Sabater, F., A. Butturini, I. Muñoz, A. Romaní, S. Sabater, E. Martí, and J. Wray. 2000. Effects of riparian vegetation removal on nutrient retention in a Mediterranean stream. Journal of the North American Benthological Society. 19: 609-620. (C, E, H, I)

Author abstract: We examined the effects of riparian vegetation removal on algal dynamics and stream nutrient retention efficiency by comparing NH_4-N and PO_4-P uptake lengths from a logged and an unlogged reach in Riera Major, a forested Mediterranean stream in northeastern Spain. From June to September 1995, we executed 6 short-term additions of N (as NH_4Cl) and P (as Na_2HPO_4) in a 200-m section to measure nutrient uptake lengths. The study site included 2 clearly differentiated reaches in terms of canopy cover by riparian trees: the first 100 m were completely logged (i.e., the logged reach) and the remaining 100 m were left intact (i.e., the shaded reach). Trees were removed from the banks of the logged reach in the winter previous to our sampling. In the shaded reach, riparian vegetation was dominated by alders (*Alnus glutinosa*). The study was conducted during summer and fall months when differences in light availability between the 2 reaches were greatest because of forest canopy conditions. Algal biomass and % of stream surface covered by algae were higher in the logged than in the shaded reach, indicating that logging had a stimulatory effect on algae in the stream. Overall, nutrient retention efficiency was higher (i.e., shorter uptake lengths) in the logged than in the shaded reach, especially for PO_4-P. Despite a greater increase in PO_4-P retention efficiency relative to that of NH_4-N following logging, retention efficiency for NH_4-N was higher than for PO_4-P in both study reaches. The PO_4-P mass-transfer coefficient was correlated with primary production in both study reaches, indicating that algal activity plays an important role in controlling PO_4-P dynamics in this stream. In contrast, the NH_4-N mass-transfer coefficient showed a positive relationship only with % of algal coverage in the logged reach, and was not correlated with any algal-related parameter in the shaded reach. The lack of correlation with algal production suggests that mechanisms other than algal activity (i.e., microbial heterotrophic processes or abiotic mechanisms) may also influence NH_4-N retention in this stream. Overall, this study shows that logging disturbances in small shaded streams may alter in-stream ecological features that lead to changes in stream nutrient retention efficiency. Moreover, it emphasizes that alteration of the tight linkage between the stream channel and the adjacent riparian zone may directly and indirectly impact biogeochemical processes with implications for stream ecosystem functioning.

571) Stott, T. 1997. A comparison of stream bank erosion processes on forested and moorland streams in the Balquhidder Catchments, central Scotland. Earth Surface Processes and Landforms. 22: 383-399. (F)

Author abstract: Stream bank erosion rates measured over a two-year period on a moorland and a forested stream in the Institute of Hydrology's Balquhidder Paired Catchments in central Scotland were compared. Bank erosion rates are generally higher on the mainstream of the moorland catchment and highest in winter on both streams. Bank erosion is correlated with the incidence of frost: minimum temperatures measured on stream banks of the forested stream were an average of 3.7°C higher than on stream banks both outside the forest and on the moorland stream. This makes the incidence of frost on forested stream banks half as frequent. Volumes of material eroded from the mainstreams were combined with bulk density measurements and it is

estimated that erosion of the mainstream banks is contributing 1.5 and 7.3 per cent of the sediment yield of the forested and moorland catchments, respectively. Analysis of the vertical distribution of erosion on the banks of both streams suggests an undercutting mechanism which is more pronounced in the moorland stream. The influence of trees on bank erosion and possible implications for the management of forest streams are discussed.

572) van der Nat, D., K. Tockner, P.J. Edwards, and J.V. Ward. 2003. Large wood dynamics of complex alpine river floodplains. Journal of the North American Benthological Society. 22: 35-50. (A, D)

Author abstract: Despite a considerable amount of literature on large wood (LW) in freshwater ecosystems, its dynamic nature in large rivers has hardly been investigated. Our study focused on the mass and turnover of LW in braided floodplains of the Tagliamento River (northeastern Italy), the last morphologically intact large river flowing out of the Alps. LW masses and turnover were quantified by establishing 165 permanent plots (100 m^2 each) and then revisiting them after 4 floods of differing magnitude. The following hypotheses were tested: 1) presence of vegetated islands increases LW densities; 2) masses of LW remain constant through time; 3) species composition of LW matches the species composition of woody plants on vegetated islands; 4) lateral erosion is the most significant source of LW; and 5) the probability that a LW deposit survives a flood increases with the presence of islands, the size of the deposit, and its location within vegetation, but decreases with flood magnitude. During the study, LW mass was high and constant in the island-braided reach, reaching values (100–150 t/ha) comparable to those reported for pristine mountain streams. In the bar-braided reach, LW mass was significantly lower (15–70 t/ha) and more variable. Although the total quantities of LW on the floodplain remained relatively constant, turnover rates of LW were very high (up to 95% during one major flood). An analysis of the species composition of LW showed that, although it was similar to that of woody plants on vegetated islands, at least 30% of the wood originated from upstream. Analysis of deviance from stepwise forward logistic regression models showed that the probability that a LW deposit survives a flood depends on flood magnitude, deposit volume, and position of the LW within the channel.

573) Webb, A.A., and W.D. Erskine. 2003. Distribution, recruitment, and geomorphic significance of large woody debris in an alluvial forest stream: Tonghi Creek, southeastern Australia. Geomorphology. 51: 109-126. (D, F)

Author abstract: The complex yet poorly understood interactions between riparian vegetation, large woody debris and fluvial geomorphology in an anthropogenically undisturbed reach of an alluvial, sand-bed forest stream in SE Australia have been determined. Riparian vegetation exhibits lateral and vertical zonation of understorey and overstorey species. The dominant riparian tree species, *Tristaniopsis laurina* (water gum), grows within the channel and on the floodplain within one channel width of the stream. Larger *Eucalyptus* species only grow on the highest parts of the floodplain and on a low Pleistocene river terrace. A complete large woody debris (LWD) census conducted in the 715-m-long study reach revealed that water gum comprises 17.6% of the total LWD loading, which, at 576 m^3 ha^{-1}, is high for a stream with a catchment area of 187 km^2. Although most LWD has a small diameter (0.1–0.3 m), the greatest contribution to the total volume of LWD is by pieces with a diameter between 0.3 and 0.7 m. A

high proportion of LWD (10.4%) has a blockage ratio greater than 10%. The spatial distribution of LWD is random both longitudinally and within individual meander bends. Dominant recruitment processes of LWD vary by species. *T. laurina* trees are recruited to the channel by minor bank erosion and senescence, while the *Eucalyptus* species are predominantly recruited from the highest parts of the floodplain/low-river terrace by episodic windthrow during large storms. Multiple radiocarbon dates of outer wood of immobile LWD indicate a maximum residence time of 240±40 years BP for *T. laurina* timber. The high loading of LWD combined with the extensive root systems of riparian vegetation stabilize Tonghi Creek. Log steps form natural wooden drop-structures with a mean height of 29 mm that were responsible for 20.5% of the total head loss under base flow conditions (Q=0.08 $m^3 s^{-1}$). Large woody debris is buried in the bed at depths of up to 2.3 m and is responsible for an estimated 49% of the 11, 600 m^3 of sand stored in the study reach. Pools are spaced at 0.8 channel widths and 82% of pools are formed by scour over, under, around, or beside LWD or by the impoundment of water upstream of debris dams. Due to the high density of hardwood timber species, debris dams, however, do not readily form in Tonghi Creek as the timber is difficult to transport and LWD usually sinks to the bed of the stream. Despite the high degree of channel stability provided by LWD, high blockage ratios in the channel result in relatively frequent overbank flows. These flows are often concentrated in chutes across the neck of meanders or multiple loops, which can develop into cutoffs and channel avulsions, respectively.