

Annotated Bibliography:  
Effects of Flow Alteration on Aquatic Ecosystems  
Normative Flow Studies Project  
King County and Parametrix, Inc.  
July 1, 2003



King County

Department of Natural Resources and Parks  
Water and Land Resources Division

**Reference Type:** Journal Article

**Record Number:** 342

**Author:** Andersson, E.; Nilsson, C.; Johansson, M. E.

**Year:** 2000

**Title:** Effects of river fragmentation on plant dispersal and riparian flora

**Journal:** Regulated Rivers: Research and Management

**Volume:** 16

**Issue:** 1

**Pages:** 83-89

**Call Number:** in house; NFP files

**Keywords:** corridor fragmentation; hydrochory; plant dispersal; riparian vegetation; rivers; vascular plants

**Abstract:** We evaluated the effects of river fragmentation by dams on hydrochory (i.e., plant dispersal by water) and on plant distribution by comparing two adjacent rivers in northern Sweden, one free-flowing and the other regulated. We collected stranded drift material from both rivers in order to quantify the drift material and its species content. We also estimated the floristic continuity along the two rivers by comparing the drift flora with the riparian flora further upstream. The drift amount deposited on the riverbank, its species richness, and its contribution to the species pool were higher in the free-flowing than in the regulated river. The floristic continuity was also higher in the free-flowing than in the regulated river.

**Reference Type:** Journal Article

**Record Number:** 71

**Author:** Arthington, A. H.; King, J. M.; O'Keefe, J. H.; Bunn, S. E.; Day, J. A.; Pusey, B. J.; Bluhdorn, D. R.; Tharme, R.

**Year:** 1991

**Title:** Development of a holistic approach for assessing environmental flow requirements of riverine ecosystems

**Journal:** Pigram JJ, Hooper BA, eds.

**Pages:** 69-76

**Reference Type:** Journal Article

**Record Number:** 72

**Author:** Auble, G.T.; Friedman, J. M.; Scott, M. L.

**Year:** 1994

**Title:** Relating riparian vegetation to present and future streamflows

**Journal:** Ecological Applications

**Volume:** 4

**Pages:** 544-554

**Reference Type:** Journal Article

**Record Number:** 49

**Author:** Baker, J. A.; Kilgore, K. J.; Kasul, R. L.

**Year:** 1991

**Title:** Aquatic habitats and fish communities in the lower Mississippi River.

**Journal:** Reviews in Aquatic Sciences

**Volume:** 3

**Pages:** 313-356

**Call Number:** Pringle et al. 2000

**Reference Type:** Journal Article

**Record Number:** 74

**Author:** Baker, William

**Year:** 1990

**Title:** Climatic and hydrologic effects on the regeneration of *Populus angustifolia* James along the Animas, River, Colorado

**Journal:** Journal of Biogeography

**Volume:** 17

**Pages:** 59-73

**Keywords:** Riparian forests, *Populus angustifolia*, population dynamics, floods, disturbance, Colorado

**Abstract:** I investigated the dates of origin of riparian forests dominated by *Populus angustifolia* James, and recent interannual fluctuation in *P. angustifolia* seedling abundance on a relatively undisturbed 6 mile reach of the Animas River in southwestern CO. The goal was to develop plausible hypotheses about the roles of floods and interannual climatic fluctuation in structuring these forests. I

determined the year of origin of 242 recently established seedlings and 57 forest stands, and then developed empirical models relating seedling abundance and stand origin events to climatic and hydrologic fluctuations.

**Reference Type:** Journal Article

**Record Number:** 343

**Author:** Baranyi, C.; Hein, T.; Holarek, C.; Keckeis, S.; Schiemer, F.

**Year:** 2002

**Title:** Zooplankton biomass and community structure in a Danube River floodplain system: effects of hydrology

**Journal:** Freshwater Biology

**Volume:** 47

**Pages:** 473-482

**Call Number:** in house; NFP files

**Keywords:** hydrology, large river, restoration, water age, connectivity, floodplain, zooplankton succession

**Abstract:** Zooplankton density and biomass was examined in a Danube River floodplain section with highly variable hydrological dynamics. Temporal patterns were analyzed to assess the effects of hydrological conditions on zooplankton community structure and the differential response of the two major zooplankton taxa, rotifers and crustaceans.

Calculated floodplain water age was used as an integrated parameter describing hydrological conditions and connectivity.

Total zooplankton biomass, crustacean biomass and crustacean species number were significantly positively related to water age. Rotifer biomass followed a hump-shaped relationship with water age, and rotifer species number decreased with increasing water age.

Rotifers dominated the community in periods of low to medium water ages. In periods of higher water ages the community was dominated by crustaceans.

We propose that the hydrological regime of floodplains is crucial for zooplankton biomass patterns and succession, through the alternation of washing-out effects, taxon-specific potential of reproduction and biological interactions. Flood events and high water levels reset the community to an early successional phase.

**Reference Type:** Journal Article

**Record Number:** 50

**Author:** Barthem, R. B.; Lambert, B.; Ribeiro, M. C.

**Year:** 1991

**Title:** Life strategies of some long-distance migratory catfish in relation to hydroelectric dams in the Amazon Basin.

**Journal:** Biological Conservation

**Volume:** 55

**Pages:** 339-345

**Call Number:** Pringle et al. 2000

**Reference Type:** Journal Article

**Record Number:** 394

**Author:** Beamish, R. J.; Neville, C.M.; Thomson, B. L.

**Year:** 1994

**Title:** A relationship between Fraser River discharge and interannual production of Pacific salmon (*Onchorhynchus* spp.) and Pacific herring (*Clupea pallasii*) in the Strait of Georgia

**Journal:** Can L. Fish. Aquat. Sci.

**Volume:** 51

**Pages:** 2843-2855

**Call Number:** in house; NFP files

**Keywords:** discharge, high flows, salmonids, herring, stratification, interannual production, annual catch

**Abstract:** We identified years of anomalously high and low discharge from the Fraser River and compared these years with indices of anomalously high and low production of Pacific salmon (*Onchorhynchus* spp.) and Pacific herring (*Clupea pallasii*). For chinook (*O. tsawytscha*) and coho salmon (*O. kisutch*), we found that brood years that went to sea in a year when the Fraser River discharge was very high compared with the previous year virtually never had an index of production that was higher than the previous year. Similarly, brood years that went to sea in a year when the Fraser River discharge was very low compared with the previous year almost never had a n index of productivity that was lower than the previous year. The analysis identified a weaker association between extreme discharge anomalies and chum salmon (*O. keta*) production. A close association was not found between extreme discharge anomalies and pink salmon (*O. gorbuscha*), sockeye salmon (*O. nerka*), or herring production. The relationships identify a connection between annual fluctuations in river flow and production of some marine fishes and may be of use in forecasting abundance changes.

**Reference Type:** Journal Article

**Record Number:** 434

**Author:** Beechie, T.; Beamer, E.; Wasserman, L.

**Year:** 1994

**Title:** Estimating coho salmon rearing habitat and smolt production losses in a large river basin, and implications for habitat restoration

**Journal:** North American Journal of Fisheries Management

**Volume:** 14

**Pages:** 797-811

**Call Number:** in house; NFP files

**Abstract:** To develop a habitat restoration strategy for the 8,270 km<sup>2</sup> Skagit River basin, we estimated changes in smolt production of coho salmon *Onchorhynchus kisutch* since European settlement began in the basin, based on changes in summer and winter rearing habitat areas. We assessed changes in coho salmon smolt production by habitat type and by cause of habitat alteration. We estimated that coho salmon smolt production capacity of summer habitats in the Skagit River basin has been reduced from 1.28 million smolts to 0.98 million smolts (-24%) and that the production capacity of winter habitats has been reduced from 1.77 million smolts to 1.17 million smolts (-34%). The largest proportion of summer non-main-stem habitat losses has occurred in side-channel sloughs (41%) followed by losses in small tributaries (31%) and distributary sloughs (29%). The largest loss of winter habitats has occurred in side-channel sloughs (52%), followed by losses in distributary sloughs (37%) and small tributaries (11%). By type of impact, hydromodification (diking, ditching, dredging) associated with agricultural and urban lands accounts for 73% of summer habitat losses and 91% of winter habitat losses. Blocking culverts on small tributaries account for 13% of the decrease in summer habitat and 6% of the decrease in winter habitat. Forestry activities account for 9% of summer habitat losses and 3% of winter habitat losses. Limitations of the analysis and implications for developing a habitat restoration strategy are discussed.

**Notes:** Not an explicit test of flow; due to importance of off-channel habitats for smolt production; effects of flow changes that limit access to and/or maintenance of these habitats could be important to salmonid recovery.

**Reference Type:** Book Section

**Record Number:** 221

**Author:** Beechie, T.; E. Beamer, B. Collins; Benda, L.

**Year:** 1996

**Title:** Restoration of habitat-forming processes in Pacific Northwest watersheds: a locally adaptable approach to salmonid habitat restoration

**Editor:** Klimas, D. L. Peterson and C. V.

**Book Title:** The Role of Restoration in Ecosystem Management

**City:** Madison, WI

**Publisher:** Society for Ecological Restoration

**Pages:** 48-67

**Reference Type:** Journal Article

**Record Number:** 78

**Author:** Beechie, T. J.; Sibley, T. H.

**Year:** 1997

**Title:** Relationships between channel characteristics, wood debris, and fish

habitat in northwestern Washington streams

**Journal:** Trans. Am. Fish. Soc.

**Volume:** 126

**Pages:** 217-229

**Reference Type:** Journal Article

**Record Number:** 45

**Author:** Benstead, J. P.; March, J. G.; Pringle, C. M.; Scatena, F. N.

**Year:** 1999

**Title:** Effects of a low head dam and water abstraction on migratory tropical stream biota.

**Journal:** Ecological Applications

**Volume:** 9

**Pages:** 656-668

**Call Number:** in house; NFP files

**Notes:** freshwater, amphidromous shrimp in Caribbean have been eliminated from upstream reaches above dams lacking spillways (migration barrier, fragmentation?); shrimp abundance and species richness reduced above dams with spillways; high mortality of larval shrimp migrating downstream to estuaries due to water intakes at dams

**Reference Type:** Journal Article

**Record Number:** 341

**Author:** Blanch, S. J.; Ganf, G. G.; Walker, K. F.

**Year:** 1999

**Title:** Tolerance of riverine plants to flooding and exposure indicated by water regime

**Journal:** Regulated Rivers: Research and Management

**Volume:** 15

**Pages:** 43-62

**Call Number:** in house; NFP files

**Keywords:** macrophytes, riverine vegetation; weirs; littoral zone; wetlands; hydrology; River Murray; hydrologic regime; flooding

**Abstract:** Selected water regime indices are used to describe the tolerances to flooding and exposure of littoral and floodplain plants of the River Murray, South Australia. The cover and abundance of 26 perennial species were surveyed at 12 sites along a reach where water levels were influenced by weir operations. Six indices were measured: days when water depths were  $\geq 0$ , 0-20, 20-60 and  $\geq 200$  cm; days when plants were exposed to  $\geq 100$  cm of water; and days of longest exposure to water. Ordinations of plant abundances were correlated with the frequency of flooding to 0-20 and 20-60 cm, and exposure to  $\geq 100$  cm. Five species clusters were apparent, these being common floodplain species

(*Muehlenbeckia florulenta*), uncommon floodplain species (e.g., *Eleocharis acuta*), species from infrequently flooded littoral (e.g., *Bolboschoenus caldwelii*), species from the permanently flooded littoral (e.g., *Vallisneria americana*) and widespread, common species tolerant to flooding and exposure (11 species, including *Phragmites australis*, *Cyperus gymnocaulos*, and *Bolboschoenus medianus*). Half of the 26 species occurred in at least four of seven regimes suggested by cluster analysis of water regime indices, thus indicating a broad tolerance to flooding and exposure. Preferred water regimes are summarized using minimum and maximum values and quartiles for the six indices, and similarities between preferences are illustrated by a model based on minimum spanning tree techniques.

**Notes:** growth of aquatic macrophytes and survival of seedlings affected by rates of water level fluctuation; reversals

**Reference Type:** Journal Article

**Record Number:** 410

**Author:** Blanch, S. J.; Walker, K. F.; Ganf, G. G.

**Year:** 2000

**Title:** Water regimes and littoral plants in four weir pools of the River Murray, Australia

**Journal:** Regulated Rivers: Research and Management

**Volume:** 16

**Pages:** 445-456

**Call Number:** in house; NFP files

**Keywords:** floodplain; littoral; macrophyte; Murray; regulation; river regulation; weir; vegetation; aquatic macrophytes; water regime; flow regime

**Abstract:** The composition and distribution of littoral vegetation in four weir pools of the lower Murray were surveyed in summer 1994. Between-weir gradients in the amplitude of water level fluctuations were reflected in the typical distributions of plants, with a 4-6 m elevational range in upper-pool sites, where levels fluctuate most, and a 1-1.5 m band in the lower-pool sites, where levels were more stable. Forty-one of 48 species occurred across much of the longitudinal X elevational site matrix within this cone-shaped distribution, indicating considerable tolerance to flooding and exposure; this was especially apparent for *Phragmites australis*, *Cyperus* spp. and *Centipeda* spp. The 41 species were represented in seven of nine water-regime groups identified by cluster analysis. The remainder, found within +/- 1 m of the water surface in lower-pool reaches, were aquatic macrophytes such as *Vallisneria americana* and *Typha* spp. and amphibious 'mudmats' such as *Glossostigma elatinoides*. Water regimes at given sites were measured by the number of days in 2 years flooded to any depth (>0 cm), or to 0-30 cm, and by days exposed by > 100 cm. Inter-pool differences in the median number of days flooded to >0 cm and 0-30 cm were 3-30% and < 8% respectively, for all species except *Typha* spp., but an order of

magnitude for the number of days exposed by >100 cm. However, eight of 14 common or representative species analyzed showed significant inter-pool differences in the number of days flooded to >0 cm, indicating that sufficient variation exists to necessitate considerable intra-pool replication to allow for the detection of statistical differences in a multi-pool experiment. **The practice of maintaining stable weir pool levels limits vegetation processes, e.g., germination, recruitment, decomposition. An increase in the amplitude of river level fluctuations during low flows, from the current 10-20 cm range to 20-50 cm, would reinstate water regimes suitable to the majority of species surveyed.**

**Notes:** growth and germination was reduced under increased water level fluctuations

**Reference Type:** Journal Article

**Record Number:** 386

**Author:** Bond, N. R.; Downes, B. J.

**Year:** 2003

**Title:** The independent and interactive effects of fine sediment and flow on benthic invertebrate communities characteristic of small upland stream

**Journal:** Freshwater Biology

**Volume:** 48

**Pages:** 455-465

**Call Number:** in house; NFP files

**Keywords:** disturbance, floods, refugia, sediment, stream mesocosms

**Abstract:** Floods are an important mechanism of disturbance operating in streams that can markedly influence the abundance and diversity of benthic fauna. In upland streams many studies cite the scouring effects of fine transported sediments as a potential source of disturbance to the biota during spates, but few studies have sought to test this hypothesis critically. Here we used a series of eight artificial streams to test whether high suspended-sediment concentrations influenced the short-term response of benthic invertebrate fauna to increases in flow. In an experiment designed to simulate a small spate, flow and sediment loads were each manipulated to examine their independent and interactive effects. Benthic invertebrates were sampled before and after the manipulation, and drift samples were taken at regular intervals during the experiment. The experiment was repeated twice, once at the end of winter (June 1998), and once in summer (February 1999). Flow increases caused large increases in the number and diversity of drifting animals, and significant declines in the numbers and diversity of organisms found in benthic samples, but these declines were apparently not affected by the addition of fine sediment. The addition of sediment alone had little effect on the fauna. These results were consistent across both experiments. The results suggest that flow increases alone can disturb benthic fauna, and that



neither substrate movement nor suspended sediment increases are necessary for floods and spates to disturb the benthic assemblage. However, as argued elsewhere, the effects of flow increases are likely to be contingent upon the presence or absence of local flow refugia, which can allow animals to escape the shear forces that would otherwise remove them from the surface or interstitial areas of the streambed.

**Reference Type:** Journal Article

**Record Number:** 193

**Author:** Bonn, A.; Hagen, K.; Reiche, D. Wohlgemuth-Von

**Year:** 2002

**Title:** The significance of flood regimes for carabid beetle and spider communities in riparian habitats - a comparison of three major rivers in Germany

**Journal:** River Research and Applications

**Volume:** 18

**Pages:** 43-64

**Call Number:** in house; NFP files

**Keywords:** alluvial forest, ground beetles, flood regime, flow regime, polder management, river margin, river regulation

**Abstract:** River regulation and water management practices have led to alteration of the flood regimes of all large rivers in Germany. To investigate its influence on the terrestrial arthropod fauna, a comparative study was carried out on the distribution of ground beetles (Carabidae) and spiders (Araneae) at the potamal sections of three large rivers in northern Germany, the Rivers Weser, Elbe and Oder. The three rivers differ markedly in their flood dynamics, mainly owing to weirs and polder management practices, but also owing to natural conditions in their headwaters. In total 45 sites were examined with a total capture of 46,727 carabid beetles and 38,066 adult spiders representing 178 and 209 species, respectively. Using multivariate TWINSpan analyses we found that the ground beetle species assemblages clearly varied according to the different flood regimes. By contrast, spiders differentiate well between sites of different habitat structure.

In particular, river margins hosted a specialized carabid fauna, and the alluvial Quercus-Ulmus forests were habitat for some rare and endangered carabid and spider species. Whereas the fauna of the strongly regulated River Weser was impoverished regarding stenotopic hygrophilous species, the fauna of the more natural rivers Elbe and Oder depended very much on the duration and timing of the flooding, as well as on the local micro-topographical situation. It is concluded that low lying areas behind dikes of the Elbe, or in polders of the Oder, which become frequently inundated by river or ground water, are extremely valuable for invertebrate conservation. The data suggest that careful polder management may support suitable habitat creation for riparian species, as long as the inundation scheme corresponds to natural flood dynamics conditions.

**Notes:** Natural flooding of large river floodplains associated with un-regulated flow regimes and un-leveed floodplains had greater species richness, more specialized fauna and contained more rare and endangered species than highly regulated rivers; low-lying floodplain habitats that are frequently inundated by river floods are important habitats for conservation of carabid beetles and spiders.

**Reference Type:** Journal Article

**Record Number:** 41

**Author:** Booth, D. B.

**Year:** 1990

**Title:** Stream channel incision following drainage basin urbanization.

**Journal:** Water Resources Bulletin

**Volume:** 26

**Pages:** 407-417

**Call Number:** in house; NFP files

**Reference Type:** Report

**Record Number:** 204

**Author:** Booth, D. B.; Karr, J. R.; Schauman, S.; Konrad, C. P.; Morley, S. A.; Larson, M. G.; Burges, S. J.

**Year:** 2001

**Title:** Urban stream rehabilitation in the Pacific Northwest

**City:** Seattle, Washington

**Institution:** Environmental Protection Agency

**Pages:** 84

**Date:** March 30, 2001

**Type:** Final Report of EPA Grant No. R82-5284-010

**Call Number:** in house; NFP files

**Keywords:** urbanization; hydrologic alteration; road density; TIA; impervious surface; hydrologic indices; restoration

**Reference Type:** Report

**Record Number:** 397

**Author:** Bottom, D.L.; Simenstad, C.A.; Baptista, A.M.; Jay, D.A.; Burke, J.; Jones, K.K.; Casillas, E.; Schiewe, M.H.

**Year:** 2001

**Title:** Salmon at the River's End: The Role of the Estuary in the Decline and Recovery of Columbia River Salmon

**City:** Seattle

**Institution:** National Marine Fisheries Service

**Pages:** 271

**Date:** 2001

**Type:** Draft Report

**Call Number:** in house; NFP files

**Keywords:** estuary, flow reduction, Columbia River, salmonids, sediment supply, sediment transport

**Abstract:** To evaluate the capacity of the estuary to support salmon, including the effects of flow regulation on this capacity, this study reviewed historical development relative to changes in salmon populations,, analyzed alternative conceptual frameworks for evaluating estuarine habitat conditions for Columbia River salmon; assessed effects of climate and hydropower on river flow and sediment transport within context of regional climate variability and change; tested ability of a hydrodynamic model to simulate effects of flow regulation and bathymetric change on opportunity of subyearling chinook to access preferred estuarine habitat; evaluated biological and bioenergetic factors that may affect capacity of available estuarine habitats to support salmon; evaluated population structure, life-history diversity, and performance of juvenile chinook over time. ..."a sound historical and evolutionary context for interpreting modern estuarine habitat conditions and for developing salmon recovery strategies is needed. In the absence of such a context, recovery actions may inappropriately target those few salmon life-history types and habitats that are abundant today, further reinforcing the symptoms of salmon decline rather than expanding the productive capacity of the basin....Recovery efforts should expand diversity of both salmon life-history and habitat opportunities to allow for the widest possible range of successful rearing behaviors."

**Notes:** magnitude and timing of river flow (everywhere but also at mouth), climate effects on flow magnitude and timing, timing and magnitude of maximum spring freshet; number and timing of overbank flows; low frequency variations suppressed, high frequency accentuated. reduction in overbank flow and/or isolation of river from floodplain blocks access to rearing habitats during flood events, reduces input of macrodetritus, changes sediment movements and topography reduced productive capacity of estuary (total area), shifts from macrodetritus- to microdetritus-based food web, changes in fish community, reduced salmon life-history diversity and estuarine residence time, reduced salmon growth in estuary, reduced salmon production

**Reference Type:** Journal Article

**Record Number:** 366

**Author:** Boulton, Andrew J.

**Year:** 1999

**Title:** An overview of river health assessment: philosophies, practice, problems and prognosis

**Journal:** Freshwater Biol

**Volume:** 41

**Issue:** 2

**Pages:** 469-479

**Date:** March 01, 1999

**Alternate Journal:** Freshwater Biology

**URL:** <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2427.1999.00443.x/abs>

**Reference Type:** Journal Article

**Record Number:** 335

**Author:** Bovee, K. D.; Scott, M. L.

**Year:** 2002

**Title:** Implications of flood pulse restoration for *Populus* regeneration on the upper Missouri River

**Journal:** River Research and Applications

**Volume:** 18

**Pages:** 287-298

**Call Number:** in house; NFP files

**Keywords:** flood routing; flow mass balance; flood pulse; flow restoration; *Populus*; riparian forests; Missouri River

**Abstract:** We developed a mass balance flow model to reconstruct unregulated daily peak flows in the National Wild and Scenic reach of the Missouri River, Montana. Results indicated that although **the observed frequency of large peak flows has not changed in the post-dam period, their magnitude has been reduced from 40 to 50%** as a consequence of flow regulation. Reductions in the magnitude of these flows **should reduce the expected frequency of large flood-pulses over a longer time-scale.** Results of a two-dimensional hydraulic model indicated that **limited cottonwood (*Populus deltoides* ssp. *monilifera*) recruitment occurs at relatively small peak discharges, but to maximize establishment of cottonwoods in the Wild and Scenic reach, a threshold of 1850 m<sup>3</sup>/s would be necessary at the Virgelle gauge. Floods of this magnitude or greater lead to establishment of cottonwood seedlings above the zone of frequent ice-drive disturbance.** Restoring the frequency, magnitude, duration and timing of these flood pulses would benefit important natural resource values including riparian cottonwood forests and native fish species in the upper Missouri River basin. However, **efforts to naturalize flow must be made in the context of a water management system that was authorized and constructed for the primary purposes of flood control, power generation and irrigation.** Using the synthesized flow model and flood damage curves, **we examined six scenarios for delivering flows => 1850 m<sup>3</sup>/s to the Wild and Scenic reach.** Whereas some scenarios appeared to be politically and economically infeasible, our analysis suggested that there is enough operational flexibility in the system to restore more natural flood pulses

without greatly compromising other values.

**Notes:** Used simulation models to synthesize unregulated flows during the post-dam period; found that regulation led to reductions in (largest) peak flow by 40% to 50%. Combining hydraulic models and aerial photographs, the extent of floodplain inundation under varying discharges (flood events) was compared to the canopy cover of cottonwood forests. Floodplain inundation matched most of area of cottonwood canopy at 1850 m<sup>3</sup>/s discharge (at Virgelle), so a peak flow of 1850 m<sup>3</sup>/s was considered to be the minimum flow necessary to allow cottonwood establishment (allows cottonwoods to establish above the line of ice-scour). This flow does not happen under regulated conditions but could be restored by changing dam operations. Used USACE flood damage estimates to evaluate the cost of restoring flood flows under a variety of scenarios (i.e. release from a single dam to releases from a combination of dams). Concluded that flood flows large enough to allow cottonwood regeneration could be implemented, but all would have some economic cost. Cost was very low for some flow restoration scenarios however. Concluded that buyout of floodplain landowners, compensation to landowners experiencing flood damage and increased flexibility in both BREC and COE dam operations would be necessary to implement flow restoration in the upper Missouri. Good additional references.

**Reference Type:** Journal Article

**Record Number:** 217

**Author:** Bowen, Z. H.; Freeman, M. C.; Bovee, K. D.

**Year:** 1998

**Title:** Evaluation of generalized habitat criteria for assessing impacts of altered flow regimes on warmwater fishes

**Journal:** Transaction of the American Fisheries Society

**Volume:** 127

**Pages:** 455-468

**Call Number:** in house; NFP files

**Abstract:** Assessing potential effects of flow regulation on southeastern warmwater fish assemblages is problematic because of high species richness and poor knowledge of habitat requirements for most species. Our study investigated relationships between availability and temporal persistence of key habitats and fish assemblage structure at regulated and unregulated sites in the Tallapoosa River system. Fish assemblage characteristics at seven sites were quantified based on 1,400 electrofishing samples collected during 1994 and 1995. Physical Habitat Simulation (PHABSIM) programs were used to model availability and persistence of key habitats at regulated and unregulated sites. Associations between fish assemblages and availability or persistence of key habitats were identified via regression and analysis of variance. We found hydropeaking dam operation reduced the average length of time that shallow-

water habitats persisted and also reduced year to year variation in the persistence of shallow-water habitats compared with unregulated sites. Across sites and years, proportional representation of catostomids was positively correlated with persistence of shallow-water and slow-water habitats during spring. Proportion of individuals as cyprinids was positively correlated with median availability of deep-fast habitat whereas proportion of percids was inversely related to median availability of deep-fast habitat. Mean fish density was positively correlated with the persistence of shallow and slow-water habitats. Comparisons of key-habitat measures and fish abundances between 1994 and 1995 at each site indicated that higher abundances of catostomids, percids, and cyprinids were associated with increased availability and persistence of shallow and slow-water habitats in 1995. These findings demonstrate that the temporal and spatial availability of key habitats could serve as useful measures of the potential effects of flow alteration on lotic fish assemblages and suggest both short-term persistence of key habitats as well as annual variation in key-habitat availability are important for maintaining diverse fish assemblages.

**Reference Type:** Journal Article

**Record Number:** 21

**Author:** Bren, L. J.

**Year:** 1992

**Title:** Tree invasion of an intermittent wetland in relation to changes in the flooding frequency of the River Murray, Australia.

**Journal:** Australian Journal of Ecology

**Volume:** 17

**Pages:** 395-408

**Call Number:** in house; NFP files

**Keywords:** flood regime; hydrological alteration; floods; river regulation; vegetation; wetland

**Reference Type:** Journal Article

**Record Number:** 189

**Author:** Briggs, S. V.; Thornton, S. A.; Lawler, W. G.

**Year:** 1997

**Title:** Relationships between hydrological control of river red gum wetlands and waterbird breeding

**Journal:** EMU

**Volume:** 97

**Pages:** 31-42

**Call Number:** in house; NFP files

**Keywords:** waterbirds; wetland; floodplain; river regulation; flood regime

**Abstract:** Fourteen wetlands on the floodplain of the Murrumbidgee River

(Murray-Darling Basin, Australia) were surveyed for breeding waterbirds during three annual flood periods. Degree of water control in the wetlands ranged from none to slight to medium to heavy. The wetlands comprised open areas with River Red gums (*Eucalyptus camaldulensis*). Most, but not all of the red gums were alive. Precocial waterbirds (those that do not feed their young; mostly Anatidae in this study) did not breed at wetlands with highly controlled water regimens. In altricial waterbirds (those that feed their young at the nest; Pelecaniformes and Ciconiiformes in this study) breeding was not directly related to water level control, but depended on areas of river red gums that flooded for at least four months. Within the altricial group, Darter *Anhinga melanogaster*, Great Cormorant *Phalacrocorax carbo* and Pacific Heron *Ardea pacifica* preferred sites with large areas of river red gum that flooded for at least four months and large areas of dead river red gum (which stayed flooded permanently). Little black cormorant *Phalacrocorax sulcirostris*, little pied cormorant *P. melanoleucos*, white faced heron *Ardea novaehollandiae* and Yellow-billed spoonbill *Ptalalea flavipes* favoured wetlands with large areas of live river red gum that flooded for at least four months. River red gum wetlands in which water levels are controlled can be managed for nesting Pelecaniformes and Ciconiiformes. Treeless parts of wetlands can be permanently flooded, but nest trees should not be killed by permanent inundation.

**Notes:** Breeding waterbirds were more abundant and there were more species at wetlands with no or slight hydrological control than in heavily controlled wetlands. Precocial waterbirds in particular did not breed in wetlands with controlled water regimes (i.e., permanently flooded and rapidly fluctuating); hypothesis is that macrophyte abundance and invertebrate production is lower when shallow, temporarily flooded wetlands are replaced by permanently flooded or widely fluctuating water levels. Altricial birds bred in controlled wetlands, but breeding will probably not continue in these areas if permanent inundation kills trees.

**Reference Type:** Journal Article

**Record Number:** 387

**Author:** Brown, L. R; Ford, T.

**Year:** 2002

**Title:** Effects of flow in the fish communities of a regulated California river: implications for managing native fishes

**Journal:** River Research and Applications

**Volume:** 18

**Pages:** 331-342

**Call Number:** in house; NFP files

**Keywords:** non-native fishes; native fishes; flow regime; fish communities; invasion; Tuolumne River; California

**Abstract:** We assessed the importance of flow regime to the success of native and non-native fish species by analysing winter/spring seining data collected

from 1987 to 1997 on the resident fish communities of the lower Tuolumne River, California. The data were analysed using regression models to predict the percentage of non-native fish at a site. The regression models included various combinations of the variables longitudinal location of the site, mean April/May stream discharge in the year of sampling, and mean April/May stream discharge in the previous year. Comparison of the models indicated that the best model included longitudinal location and stream discharge in the previous year. This model is consistent with the hypothesis that flow in the previous year differentially affects reproductive success of native and non-native species and thus the resulting community sampled in the following winter/spring. A detrended correspondence analysis of percentage abundance species data identified a co-occurring group of native species and a co-occurring group of non-native species with the non-native red shiner (*Cyprinella lutrensis*) grouping separately. The differing reproductive strategies of the species were consistent with the hypothesis concerning spawning success. Our results indicate that flow regime is an important determinant of the reproductive success of native and non-native fish species in regulated rivers. Manipulations of flow regime are a potentially powerful tool for managing native fish species, but should be considered in combination with other restoration efforts and in the context of ecosystem restoration.

**Reference Type:** Journal Article

**Record Number:** 427

**Author:** Bunn, S. E.; Arthington, A. H.

**Year:** 2002

**Title:** Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity

**Journal:** Environmental Management

**Volume:** 30

**Pages:** 492-507

**Call Number:** in house; NFP files

**Abstract:** The flow regime is regarded by many aquatic ecologists to be the key driver of river and floodplain wetland ecosystems. We have focused this literature review around four key principles to highlight the important mechanisms that link hydrology and aquatic biodiversity and to illustrate the consequent impacts of altered flow regimes: firstly, flow is a major determinant of physical habitat in streams, which in turn is a major determinant of biotic composition; secondly, aquatic species have evolved life history strategies primarily in direct response to the natural flow regimes; thirdly, maintenance of natural patterns of longitudinal and lateral connectivity is essential to the viability of populations of many riverine species; finally, the invasion and success of exotic and introduced species in rivers is facilitated by the alteration of flow regimes. The impacts of flow change are manifest across broad taxonomic groups including riverine



plants, invertebrates, and fish. Despite growing recognition of these relationships, ecologists still struggle to predict and quantify biotic responses to altered flow regimes. One obvious difficulty is the ability to distinguish the direct effects of modified flow regimes from impacts associated with land-use changes that often accompanies water resource development. Currently, evidence about how rivers function in relation to flow regime and the flows that aquatic organisms need exists largely as a series of untested hypotheses. To overcome these problems, aquatic science needs to move quickly into a manipulative or experimental phase, preferable with the aims of restoration and measuring ecosystem response.

**Reference Type:** Journal Article

**Record Number:** 357

**Author:** Bunn, S. E.; Davies, P. M.; Mosisch, T. D.

**Year:** 1999

**Title:** Ecosystem measures of river health and their response to riparian and catchment degradation

**Journal:** Freshwater Biol

**Volume:** 41

**Issue:** 2

**Pages:** 333-345

**Date:** March 01, 1999

**Alternate Journal:** Freshwater Biology

**URL:** <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2427.1999.00434.x/abs>

**Reference Type:** Journal Article

**Record Number:** 203

**Author:** Burns, A. ; Walker, K. F.

**Year:** 2000

**Title:** Effects of water level regulation on algal biofilms in the River Murray, South Australia

**Journal:** Regulated Rivers Research and Management

**Volume:** 16

**Pages:** 433-444

**Call Number:** in house; NFP files

**Keywords:** algae, biofilm, littoral, river regulation, flow regime, nutrients, water level, weir, turbidity

**Abstract:** The composition and growth of algal biofilms were monitored over 90 days at two littoral sites on the River Murray at Lock 1 (Blanchetown). Sites included the pool impounded by a 3 m weir, where water levels are relatively stable, and the tailwater, where levels fluctuate daily. Depth profiles of organic

biomass above the sediment and biofilm composition were similar between sites. Algal biomass peaked in the zones of maximum light and sustained inundation. Biofilm composition was affected more by temporal environmental changes common to both sites than by differences between sites. Filamentous Cyanobacteria (*Lyngbya*) were prevalent early in succession, but by day 90 were replaced by filamentous Chlorophyta (*Spirogyra*). If river levels are managed to maintain diverse successional stages as resources for grazing invertebrates, the magnitude and duration of inundation in the littoral zone should exceed dessication tolerances of biofilm organisms.

**Notes:** Compared algal biofilms in areas with stable water levels with daily fluctuations in water levels. Found no difference in communities between pool (stable) and tailwater (fluctuating); however, only one site used and river is highly regulated - biofilms may have already responded to river changes and are made up of communities that can tolerate existing flow conditions (?)

**Reference Type:** Journal Article

**Record Number:** 32

**Author:** Busch, D. E.; Ingraham, N. L.; Smith, S. D.

**Year:** 1992

**Title:** Water uptake in woody riparian phreatophytes of the Southwestern United States: a stable isotope study.

**Journal:** Ecological Applications

**Volume:** 2

**Pages:** 450-459

**Call Number:** in house, NFP files

**Reference Type:** Journal Article

**Record Number:** 3

**Author:** Cattaneo, F.; Carrel, G.; N. Lamouroux; Breil., P.

**Year:** 2001

**Title:** Relationship between hydrology and cyprinid reproductive success in the Lower Rhone at Montelimar, France.

**Journal:** Arch. Hydrobiol.

**Volume:** 151

**Pages:** 427-450

**Call Number:** in house; NFP files

**Keywords:** fish recruitment, flow regime, discharge, habitat template, substrate scouring

**Abstract:** Young-of-the-year (YOY) cyprinid recruitment success was investigated annually over a 16-year period (from 1983 to 1998) in relation with the annual hydrological regime in a large regulated river (the Rhone River, France). The annual discharge regime was divided among 3 seasons based on

the biological life cycle of fishes (wintering, reproduction, and growth periods), and characterized by descriptors of average, high and low flow conditions, and overall variability. Co-inertia analysis revealed two distinct effects of hydrology on YOY recruitment success. The first resulted in a sudden shift in the YOY community organization, and was the consequence of two unpredictable (of extremely high magnitude in regard with the long-term mean valued in a given time period) consecutive floods, in October 1993 (110-year return flood) and January 1994 (50-year flood). The resulting scouring of the substratum seems to have had a favourable effect on recruitment. The second, weaker effect was only observed in the 5 years after the 1993 and 1994 floods. It revealed the role of seasonality in hydrological conditions, because it separated high and variable discharge during the spawning period (favourable for barbel and bleak) from low discharge during this season (favourable for roach, rudd and nase). The results were consistent with previous knowledge concerning these species, and functional interpretations confirmed general expectations. Our findings support habitat template theories that attribute a major role to environmental variability (including disturbance history) in determining community characteristics. Finally, these results provide the first steps for a rational management of seasonal discharge in large regulated streams.

**Reference Type:** Journal Article

**Record Number:** 237

**Author:** Cattaneo, F.; Lamouroux, N.; Breil, P.; Capra, H.

**Year:** 2002

**Title:** The influence of hydrological and biotic processes on brown trout (*Salmo trutta*) population dynamics

**Journal:** Can.J. Fish. Aquat. Sci.

**Volume:** 59

**Pages:** 12-22

**Call Number:** in house; NFP files

**Keywords:** flow regime; hydrology; trout; population dynamics; density-dependence; emergence; biotic interactions

**Abstract:** Hydrological and biotic forces constrain brown trout (*Salmo trutta*) population dynamics, but tests of their role across numerous streams are uncommon. In 30 French stream reaches, using 5-8 samples (1 per year) each, we investigated whether the year-to-year seasonal hydrology influenced annual trout densities within reaches, and whether the relationships were shared by all reaches. We also searched for intraspecific interactions between and within cohorts. Trout data were age class (0+, 1+ and adults) densities. For each year, hydrology was described using 13 variables, each computed for a reproduction, emergence, and growth period related to the biological cycle of trout. We used analyses of covariance (ANCOVA) to test how trout densities at year n-1 and hydrology at year n influence trout densities at year n. High flows during

emergence significantly reduced the 0+ densities, consistently across the 30 reaches. The, 1+ and adult densities were linked, respectively, to 0+ and 1+ densities from the previous year. Analyses also revealed density-dependent survival mechanisms for the 0+ cohort, suggesting intracohort competition. Therefore, hydrology constrains trout dynamics only during the critical emergence period, after which intracohort interactions regulate 0+ density. Such mechanisms, validate across 30 environmentally different reaches, seem to be fundamental to trout population dynamics.

**Reference Type:** Journal Article

**Record Number:** 433

**Author:** Chovanec, A.; Waringer, J.

**Year:** 2001

**Title:** Ecological integrity of river-floodplain systems - assessment by dragonfly surveys (Insecta: Odonata)

**Journal:** Regulated Rivers: Research and Management

**Volume:** 17

**Issue:** 4-5

**Pages:** 493-507

**Call Number:** in house; NFP files

**Keywords:** assessment; connectivity; dragonflies; ecological integrity; Odonata; river-floodplain; Water Framework Directive

**Abstract:** Dragonflies are reliable indicators of ecological quality of land-water ecotones, habitat heterogeneity and the hydrological dynamics of water bodies. In recent years, surveys of dragonfly communities have become a powerful tool for the ecological assessment of floodplain areas. The goal of this paper is to present a new approach towards assessing the ecological integrity of river-floodplain systems by analyzing resident breeding dragonfly species. The methodology is based on experiences with existing approaches using macroinvertebrates as bioindicators, in particular, calculations of saprobic indices, longitudinal zonation and functional feeding group patterns. In addition to the total number of species and the number of sensitive species, the 'Odonate Habitat Index' (OHI) is a key element of the assessment method. It indicates characteristic features of a river-floodplain system, such as connectivity aspects, flow dynamics and terrestrialization processes. The OHI is calculated from the species-specific habitat values (expressing habitat preferences), abundances and the species-specific indication weight, which distinguishes eurytopic from stenotopic species. The comparison of the status quo with a reference condition allows an assessment of individual water bodies and/or of a whole area in a five-tiered classification scheme. The approach presented may also be used for the evaluation of restoration measures (e.g., reconnection of side arms) and for the definition of management objectives. Apart from the methodological framework, the results of a first application of this approach are presented in the paper as

well. The study areas were selected floodplain systems of the Austrian section of the Danube and man-made inshore structures of the impounded Danube section in Vienna.

**Reference Type:** Journal Article

**Record Number:** 2

**Author:** Clark, R. A.

**Year:** 1992

**Title:** Influence of stream flows and stock size on recruitment of arctic grayling (*Thymallus arcticus*) in the Chena River, Alaska.

**Journal:** Can. J. Fish. Aquat. Sci.

**Volume:** 49

**Pages:** 1027-1033

**Call Number:** not in house

**Reference Type:** Journal Article

**Record Number:** 390

**Author:** Clausen, B.; Biggs, B. J. F.

**Year:** 1997

**Title:** Relationships between benthic biota and hydrological indices in New Zealand streams

**Journal:** Freshwater Biology

**Volume:** 38

**Pages:** 327-342

**Call Number:** in house; NFP files

**Keywords:** flow regime; hydrological indices; benthic macroinvertebrates, New Zealand,

**Abstract:** The objective of this study was to identify the most ecologically relevant hydrological indices for characterizing hydrological regimes in New Zealand streams. To do this we related measures of periphyton chlorophyll a, ash-free dry mass (AFDM), species richness, and diversity and invertebrate density, species richness and diversity to thirty-four hydrological variables derived from daily flow records at eighty-three sites. The hydrological variables included some describing average flow conditions, flow variability, floods, and low-flow characteristics.

A principal components analysis showed that the interrelationship between many of the hydrological variables was high, and most variables correlated significantly with Principal Component 1 (PC1). The flood frequency variables formed a distinct component of the flow regime and were the main contributor to PC2. We found that both the average flow conditions and some measure of variability were significantly related to most of the biological variables, and these individual hydrological variables were more strongly correlated to the biological measures

than the composite principal components. Only four of the thirty-four flow variables were significantly correlated ( $p < 0.05$ ) with measures of periphyton biomass (chlorophyll a, and AFDM), whereas twenty-four variables were correlated with periphyton diversity. Conversely, thirty-one of the thirty-four variables were correlated with total invertebrate density, whereas only four variables correlated with diversity.

We selected a flood frequency (FRE3), where a flood is defined as flows higher than 3 times the median flow, as the most ecologically useful *overall* flow variable in New Zealand streams because it explained a significant amount of the variance in four out of the six main benthic community measures, and it had a clear mechanism of control of the biota which was commensurate with current stream ecosystem theory. Periphyton biomass decreased with increasing FRE3, whereas invertebrate density had an increasing/curvilinear relationship with FRE3. Periphyton species richness and diversity decreased with increasing FRE3.

**Reference Type:** Journal Article

**Record Number:** 23

**Author:** Conner, W. H.; Gosselink, J. G.; Parrondo, R. T.

**Year:** 1981

**Title:** Comparison of the vegetation of three Louisiana swamp sites with different flood regimes.

**Journal:** American Journal of Botany

**Volume:** 63

**Pages:** 320-331

**Call Number:** not in house

**Reference Type:** Journal Article

**Record Number:** 48

**Author:** Contreras, S.; Lozano, M. L.

**Year:** 1994

**Title:** Water, endangered fishes, and development perspectives in the arid lands of Mexico.

**Journal:** Conservation Biology

**Volume:** 8

**Pages:** 379-387

**Call Number:** not in house

**Notes:** water diversion from Rio Bravo del Norte in Mexico has resulted in: salinization of lower river; replacement of 32 native fishes adapted to freshwater with 54 marine, or highly salt-tolerant species; change in species composition; range expansion of marine fishes (as much as 40 km upstream)

**Reference Type:** Journal Article

**Record Number:** 419

**Author:** Converse, Y. K.; Hawkins, C. P.; Valdez, R. A

**Year:** 1998

**Title:** Habitat relationships of subadult humpback chub in the Colorado River through the Grand Canyon: spatial variability and implications for flow regulation

**Journal:** Regulated Rivers: Research and Management

**Volume:** 14

**Pages:** 267-284

**Call Number:** in house; NFP files

**Keywords:** humpback chub; habitat; geomorphology; shoreline; cover; flow; regulation; Colorado River; Grand Canyon

**Abstract:** We examined humpback chub densities along 24 km of the Colorado River in the Grand Canyon to: (1) identify geomorphic conditions in the study area; (2) determine associations between subadult humpback chub (<200 mm TL) habitat use and geomorphic differences; and (3) determine how discharge, during base flow conditions, was related to subadult humpback chub habitat conditions.

Habitat was categorized at two nested spatial scales: geomorphic reach and shoreline type. Within reaches, shoreline types were categorized according to geomorphology. We measured water depth, velocity and cover attributes along all shoreline types over a range of discharges to determine if habitat quality of reaches and shoreline types varied with discharge.

Reaches 1 and 3 had narrow, deep corridors, whereas Reach 2 was a wide, shallow reach. Among shoreline types, depth, velocity and cover varied; however, differences were not consistent between reaches. Fish densities also varied among shoreline types and reaches. Vegetation, talus and debris fan shorelines had the highest densities of subadult humpback chub in a pattern similar to that of cover. In addition, subadult humpback chub presence was associated with a high frequency of cover regardless of shoreline designation. However, these relationships explained little of the overall variation in subadult densities.

Lack of a strong association between fish density and geomorphology may be partially due to effects of discharge on habitat quality. The overall trend among shorelines (without regard to type) showed that cover decreased with increasing discharge, whereas depth and velocity increased. However, no consistent pattern between discharge and depth, velocity and cover among individual shoreline types was evident.

Vegetated shorelines, consisting mainly of non-native tamarisk (*Tamarix chilensis*), had nearly twice the fish densities of talus and debris fan. Reasons are discussed as to why subadult humpback chub occupy naturalized habitat like vegetated shorelines in greater densities than natural habitats. The relationships observed in this study have important implications for humpback chub recovery

and management of the Colorado River through Grand Canyon.

**Reference Type:** Journal Article

**Record Number:** 416

**Author:** Copp, G. H.

**Year:** 1989

**Title:** The habitat diversity and fish reproductive function of floodplain ecosystems

**Journal:** Environmental Biology of Fishes

**Volume:** 26

**Pages:** 1-28

**Call Number:** not in house; cited in Puckridge et al. 1998

**Keywords:** floodplains; flood pulse; fish recruitment; large rivers; connectivity; spawning

**Notes:** changes in variability of flood magnitudes changed patterns of floodplain inundation, availability of habitat and reproductive success of fish that spawn in floodplain habitats

**Reference Type:** Journal Article

**Record Number:** 420

**Author:** Cortes, R. M. V.; Ferrerira, M. T.; S. V. Oliveira; Oliveira, D.

**Year:** 2002

**Title:** Macroinvertebrate community structure in a regulated river segment with different flow conditions

**Journal:** River Research and Applications

**Volume:** 18

**Pages:** 367-382

**Call Number:** in house; NFP files

**Keywords:** regulation; impacts; hydropower; regulated river; river regulation; flow regime; hypolimnetic water; eutrophication; macroinvertebrates; diversity

**Abstract:** Two types of modification of the hydrological system are present in the same regulated segment of the Lima River (NW Portugal): (a) a reduced and constant flow from hypolimnetic release; (b) an intense irregular flow (daily and seasonal). Using multivariate techniques it was possible to compare the effects of these two kinds of disturbance on the macroinvertebrate communities. The communities colonizing both sites exhibited a higher variation in composition and diversity when compared to undisturbed sites. **However, such variability was even more evident in the first case, in spite of the stability of the environmental conditions. Such temporal replacement of species is linked to the dominance of tolerant taxa with short life cycles. In the regulated segment the poor water quality and the lack of litter input impacted mainly on the shredders group. This work shows the failure of the practice of**



**releasing constant flows as an attempt to mitigation regulation impacts.**

**Reference Type:** Book Section

**Record Number:** 51

**Author:** Cross, F. B; Moss, R. E.

**Year:** 1987

**Title:** Historic changes in fish communities and aquatic habitats in plains streams in Kansas

**Editor:** Heins, W. J. Matthews and D. C.

**Book Title:** Community and Evolutionary Ecology of North American Stream Fishes

**City:** Norman, OK

**Publisher:** University of Oklahoma Press

**Pages:** 155-165

**Call Number:** not in house, Pringle et al. 2000

**Reference Type:** Journal Article

**Record Number:** 52

**Author:** Cushman, R. M

**Year:** 1985

**Title:** Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities.

**Journal:** North American Journal of Fisheries Management

**Volume:** 5

**Pages:** 330-339

**Call Number:** not in house, Pringle et al. 2000

**Reference Type:** Journal Article

**Record Number:** 344

**Author:** Deiller, A-F.; Walter, J-M. N.; Tremolieres, M.

**Year:** 2001

**Title:** Effects of flood interruption on species richness, diversity, and floristic composition of woody regeneration in the upper Rhine alluvial hardwood forest

**Journal:** Regulated Rivers: Research and Management

**Volume:** 17

**Pages:** 393-405

**Call Number:** in house; NFP files

**Keywords:** floodplain; flood suppression; forest regeneration; jackknife estimator; Rhine; species richness, species diversity

**Reference Type:** Journal Article

**Record Number:** 4

**Author:** DeVries, P.

**Year:** 1997

**Title:** Riverine salmonid egg burial depths: review of published data and implications for scour studies.

**Journal:** Can. J. Fish. Aquat. Sci.

**Volume:** 54

**Pages:** 1685-1698

**Call Number:** in house; NFP files

**Abstract:** Published data on salmon, trout, and char egg burial depths are highly variable and inconsistent. Primary sources of variation include elevation datum and portion of the egg pocket referenced to; differences in spawning behavior and the number, thickness, and location of egg pockets; relationships between egg depth, fish species, and corresponding size of female and spawning substrate and velocity characteristics; sampling method; presence of excavation barriers; redd superimposition; and scour and fill by hydraulic and other mechanical processes. Such sources of variability in the reported data have important implications for studies of scouring processes in salmonid spawning areas that require accurate identification of egg burial depths for predicting and preventing potential scour impacts. Cumulative measurement error and unexplained variation may amount to 5 - 20 cm or more in published values. The most relevant data for scour impact assessments are depths from the original stream bed elevation down to the top of the main egg pocket. Frequency distribution data are needed for determining probabilities and cumulative levels of scour impacts and for managing genetic diversity as well as population size. Preliminary depth threshold criteria are proposed for use now, pending further research.

**Reference Type:** Journal Article

**Record Number:** 191

**Author:** Doupe, R. G.; Pettit, N. E.

**Year:** 2002

**Title:** Ecological perspectives on regulation and river allocation for the Ord River, western Australia

**Journal:** River Research and Applications

**Volume:** 18

**Pages:** 307-320

**Call Number:** in house; NFP files

**Keywords:** river regulation; flow variability; flow regimes; environmental water provisions; irrigation

**Abstract:** Water management agencies throughout Australia area attempting to find a balance between the water requirements of ecological and socio-economic

environments as part of a holistic approach to managing flow-dependent river ecosystems. Environmental water provisions are under consideration for the Ord River in far northern Western Australia. This river has been regulated for irrigation and there are plans for substantial expansion. Like other semi-arid and tropical rivers, however, the hydrology of the Ord River is highly variable and unpredictable, and therefore, proportionate water release strategies for the environment that are based on average monthly flows are unsuitable. Regulation continues to produce pronounced ecological changes throughout the river system as the impacts of flow regime are negated. There is a dichotomy in optimal flow regimes for the contrasting management aspirations of ecological restoration based on low seasonal flows, and the dilution flows required for the drainage of agricultural effluent. Whilst current agricultural land and water management practices continue, the two cannot coincide, and consequently, a decision should be made regarding which environmental water allocation holds the primary value. Such a decision would guide the appropriate dry season flow regime on the lower Ord River.

**Notes:** natural hydrology in northern, semi-arid rivers is highly variable; management based on average monthly flows do not adequately represent ecological flow requirements; there are conflicts between optimal flow regimes for providing seasonal low flows vs. providing dilution flows for mitigating agricultural runoff; approach for resolving these conflicts and making decisions re: which types of flow take precedence is discussed

**Reference Type:** Journal Article

**Record Number:** 201

**Author:** Dynesius, M.; Nilsson, C.

**Year:** 1994

**Title:** Fragmentation and flow regulation of river systems in the northern third of the world

**Journal:** Science

**Volume:** 266

**Pages:** 753-762

**Call Number:** in house; NFP files

**Keywords:** dams, fragmentation, river regulation, flow regime, irrigation, water diversion, river conservation, biodiversity

**Reference Type:** Journal Article

**Record Number:** 5

**Author:** Elliott, J. M.

**Year:** 1989

**Title:** The natural regulation of numbers and growth in contrasting populations of brown trout, *Salmo trutta*, in two Lake District streams.

**Journal:** Freshw. Biol.  
**Volume:** 21  
**Pages:** 7-19  
**Call Number:** not in house

**Reference Type:** Journal Article

**Record Number:** 249

**Author:** Elliott, J. M.; Hurley, M. A.; Elliott, J. A.

**Year:** 1997

**Title:** Variable effects of droughts on the density of a sea-trout, *Salmo trutta* population over 30 years.

**Journal:** J. Appl. Ecol.

**Volume:** 34

**Pages:** 1229-1238

**Call Number:** in house; NFP files

**Keywords:** density dependence; fisheries management; stock-recruitment models; low flows; flow regime

**Abstract:** This study shows how a stock-recruitment model can be used to assess the effects of drought on fish survival, using data from a long-term study of a sea-trout population. Droughts were severest in the summers of 1976, 1983, 1984 (also a severe spring drought) and 1995, and less severe in summer, but followed by autumn droughts in 1969, 1989, and 1993.

The Ricker curvilinear model significantly fit ( $p < 0.01$ ) the relationship between initial egg density and survivor density for parr aged 0+ years sampled in late May or early June, and late August or early September; parr aged 1+ years sampled in late May or early June and late August or early September; spawning females and their total egg production. These analyses provided strong evidence for density-dependent population regulation and also identified extreme outliers, all these being for year-classes affected by the summer droughts.

The variable effects of the seven summer droughts were quantified by expressing the difference between each pair of observed and expected values as a percentage (with 95% CL) of the expected value predicted from the Ricker model. The 1969 drought continued with an autumn drought and reduced the density of 1+ parr (1968 year-class) but had no long-term effects on female or egg densities. **The 1983, 1984 (plus spring drought) and 1989 droughts reduced 0+ (1983, 1984 and 1989 year-classes) and 1+ (1982, 1983 and 1988 year-classes) parr densities and led to low densities of returning females and their eggs from the 1982, 1983 and 1988 year-classes.** The 1976 summer drought and the 1993 summer and autumn droughts had little effect on parr densities, but in the long term produced low densities of returning females and their eggs from the 1975 and 1992 year-classes. The 1995 drought reduced 0+ (1995 year class) and 1+ (1994 year class) parr densities, but its long-term effects cannot be evaluated until more data are available.

**Reduced densities of returning females and their eggs were associated with 1+ parr being subjected to droughts; possible reasons for this are discussed, including growth retardation.**

**Notes:** low flows and fish populations

**Reference Type:** Journal Article

**Record Number:** 403

**Author:** Ellis, L. M.; Molles, M. C.; Crawford, C. S.

**Year:** 1999

**Title:** Influence of experimental flooding on litter dynamics in a Rio Grande riparian forest, New Mexico

**Journal:** Restoration Ecology

**Volume:** 7

**Pages:** 193-204

**Call Number:** in house; NFP files

**Keywords:** flow regime; flood regime; Rio Grande; litter dynamics; riparian vegetation; invertebrates

**Abstract:** Terrestrial arthropod communities remain poorly described for riparian ecosystems of the arid southwestern United States, and the effects of extensive river regulation and habitat alteration on these potentially important invertebrates are largely unknown. Beginning in 1991, surface-active arthropods were trapped at two riparian sites along the Rio Grande, in central New Mexico, for 2 years. One site was then experimentally flooded from mid-May to mid-June for each of the next 3 years to simulate historic, low intensity flooding, after which arthropod collections were continued. These primary sites, located outside the riverside levee, and isolated from flooding for about 50 years prior to the experiment, were compared with a naturally flooded site and a second non-flooded reference. Experimental flooding and observations of the naturally flooded site indicated that flooding did not affect total taxonomic richness, or richness of spiders, beetles or ants. However, flooding may have slightly increased the number of carabid beetle taxa present. Flooding altered the overall composition for all taxa, insects, beetles, and carabid beetles. Spider taxa composition may be insensitive to flooding, while ant responses were not clear. Abundance of terrestrial isopods and spiders decreased after flooding, while overall beetle abundance did not change. Abundance of crickets and carabid beetles increased, but the response was delayed until after the second flood. Changes in taxa composition and abundance after experimental flooding were generally consistent with arthropod community structure observed at a nearby naturally flooded site. This similarity suggests that reorganization of the terrestrial arthropod community may follow restoration of flooding to this riparian ecosystem.

**Notes:** Litter dynamics (turnover rates; standing stocks) were significantly different following experimental flooding along Rio Grande. Comparison of riparian forest that had not experienced natural regime of spring flooding for

several decades with riparian forest following initiation of experimental floods in 2 of 3 years.

**Reference Type:** Journal Article

**Record Number:** 7

**Author:** Elwood, J. W.; Walters, T. F.

**Year:** 1969

**Title:** Effects of floods on food consumption and production rates of a stream brook trout population.

**Journal:** Trans. Am. Fish. Soc.

**Volume:** 98

**Pages:** 253-262

**Call Number:** not in house

**Reference Type:** Journal Article

**Record Number:** 421

**Author:** Extence, C. A; Balbi, D. M.; Chadd, R. P.

**Year:** 1999

**Title:** River flow indexing using British benthic macroinvertebrates: a framework for setting hydroecological objectives

**Journal:** Regulated Rivers: Research and Management

**Volume:** 15

**Pages:** 543-574

**Call Number:** in house; NFP files

**Keywords:** drought; summer flows; low flows; flow; flow regime; hydroecology; macroinvertebrates

**Abstract:** A method linking qualitative and semi-quantitative change in riverine benthic macroinvertebrate communities to prevailing flow regimes is proposed. The Lotic-invertebrate Index for Flow Evaluation (LIFE) technique is based on data derived from established survey methods, that incorporate sampling strategies considered highly appropriate for assessing the impact of variable flows on benthic populations.

Hydroecological links have been investigated in a number of English rivers, after correlating LIFE scores obtained over a number of years with several hundred different flow variables. This process identifies the most significant relationships between flow and LIFE which, in turn, enables those features of flow that are of critical importance in influencing community structure in different rivers to be defined. Summer flow variables are thus highlighted as being most influential in predicting community structure in most chalk and limestone streams, whereas invertebrate communities colonizing rivers draining impermeable catchments are much more influenced by short-term hydrological events. Biota present in rivers with regulated or augmented flows tend to be most strongly affected by non-

seasonal, interannual flow variation.

These responses provide opportunities for analysing and elucidating hydroecological relationships in some detail, and it should ultimately be possible to use these data to set highly relevant, cost-effective hydroecological objectives. An example is presented to show how this might be accomplished.

Key areas of further work include the need to provide robust procedures for setting hydroecological objectives, investigation of habitat quality and LIFE score relationships in natural and degraded river reaches and evaluation of potential links with other biological modeling methods such as RIVPACS.

**Notes:** Evaluated macroinvertebrate data for a series of English streams (chalk, granite, sandstone) to determine if LIFE scores (Lotic-invertebrate Index for Flow Evaluation) could be correlated with any of a set of flow statistics describing stream hydrology. LIFE scores were derived from flow associations (literature/BPJ) and relative abundances. Flow statistics were mean, max, min, median, percentiles, etc. for different time periods (year, summer season, running summer mean - RSM) and flow statistics were used with measures of flow duration and flow period to assess relationships between LIFE scores and flow variables. Summer flows were most strongly correlated with LIFE scores, especially RSM of different durations for summer season, esp. for chalk streams. Decreased relative abundance of taxa associated with fast flowing water was associated with prolonged minimum flow periods. Single flow variables frequently accounted for most of ecological variation, but combinations of flow variables sometimes increased amount of variation explained and may suggest flow targets for specific rivers or river types. Examination of LIFE X flow variable plots may reveal thresholds below which change in community composition suggests irreversible or unacceptable levels of change.

Good source for statistical techniques for relating flow to invertebrate index.

Good additional references.

**Reference Type:** Journal Article

**Record Number:** 349

**Author:** Fairweather, Peter G.

**Year:** 1999

**Title:** State of environment indicators of 'river health': exploring the metaphor

**Journal:** Freshwater Biol

**Volume:** 41

**Issue:** 2

**Pages:** 211-220

**Date:** March 01, 1999

**Alternate Journal:** Freshwater Biology

**URL:** <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2427.1999.00426.x/abs>

**Reference Type:** Journal Article

**Record Number:** 408

**Author:** Fenner, P.; Brady, W. W.; Patten, D. R.

**Year:** 1985

**Title:** Effects of regulated water flows on regeneration of Fremont cottonwood

**Journal:** Journal of Range Management

**Volume:** 38

**Pages:** 135-138

**Call Number:** in house; NFP files

**Keywords:** riparian vegetation; cottonwood; *Populus*; Fremont cottonwood; flow regulation; river regulation; recruitment

**Abstract:** The reduction in extent of riparian forests in the southwestern United States has been a topic of recent concern. The effect of dams on downstream river flow and the consequent modification of the riparian habitat was studied along the lower Salt River in central Arizona. Dams were found to change the magnitude of river flows and change the seasonal timing of flows in such a way that the habitat appeared less adapted for regeneration of *Populus fremontii*. Modification of river flow patterns, therefore, appears likely to have been a significant factor causing change in vegetation along the Salt River.

**Reference Type:** Journal Article

**Record Number:** 53

**Author:** Freeman, M. C.; Bowen, Z. H.; Bovee, K. D.; Irwin, E. R.

**Year:** 2001

**Title:** Flow and habitat effects on juvenile fish abundance in natural and altered flow regimes.

**Journal:** Ecological Applications

**Volume:** 11

**Issue:** 1

**Pages:** 179-190

**Call Number:** in house; NFP files

**Keywords:** flow regulation; habitat stability; hydrologic alteration; instream habitat; juvenile fish; PHABSIM; riverine fishes; southeastern U.S. river; Tallapoosa River

**Abstract:** Conserving biological resources native to large river systems increasingly depends on how flow-regulated segments of these rivers are managed. Improving management will require a better understanding of linkages between river biota and temporal variability of flow and instream habitat. However, few studies have quantified responses of native fish populations to multiyear (>2 yr) patterns of hydrologic or habitat variability in flow-regulated systems. To provide these data, we quantified young-of-the-year (YOY) fish abundance during four years in relation to hydrologic and habitat variability in two



segments of the Tallapoosa River in the southeastern U.S. One segment had an unregulated flow regime, whereas the other was flow-regulated by a peak-load generating hydropower dam. We sampled fishes annually and explored how continuously recorded flow data and physical habitat simulation models (PHABSIM) for spring (April-June) and summer (July-August) preceding each sample explained fish abundances. Patterns of YOY abundance in relation to habitat availability (median area) and habitat persistence (longest period with habitat area continuously above the long-term median area) differed between unregulated and flow-regulated sites. At the unregulated site, YOY abundances were most frequently correlated with availability of shallow-slow habitat in summer (10 species) and persistence of shallow-slow and shallow-fast habitat in spring (9 species). Additionally, abundances were negatively correlated with 1-h maximum flow in summer (five species). At the flow-regulated site, YOY abundances were more frequently correlated with persistence of shallow-water habitats (four species in spring; six species in summer) than with habitat availability or magnitude of flow extremes. The associations of YOY with habitat persistence at the flow-regulated site corresponded to the effects of flow regulation on habitat patterns. Flow regulation reduced median flows during spring and summer, which resulted in median availability of shallow-water habitats comparable to the unregulated site (i.e., no difference between sites in availability). However, habitat persistence was severely reduced by flow fluctuations resulting from pulsed water releases for peak-load power generation. Habitat persistence, comparable to levels in the unregulated site, only occurred during summer when low rainfall or other factors occasionally curtailed power generation. As a consequence, summer-spawning species numerically dominated the fish assemblage at the flow-regulated site; five of six spring-spawning species occurring at both study sites were significantly less abundant at the flow-regulated site. Persistence of native fishes in flow-regulated systems depends, in part, on the seasonal occurrence of stable habitat conditions that facilitate reproduction and YOY survival.

**Reference Type:** Journal Article

**Record Number:** 54

**Author:** Galat, D. L.

**Year:** 1998

**Title:** Flooding to restore connectivity in regulated large-river wetlands.

**Journal:** BioScience

**Volume:** 48

**Pages:** 721-733

**Call Number:** Pringle et al. 2000

**Keywords:** restoration; flow regime; large rivers; river regulation; Missouri River; range of variation; RVA; indicators of hydrologic alteration; IHA

**Reference Type:** Report

**Record Number:** 412

**Author:** Galat, D. L.; Lipkin, R.

**Year:** 1999

**Title:** Characterizing the natural flow regime of the Missouri River using historical variability in hydrology

**City:** Columbia, Missouri

**Institution:** University of Missouri

**Pages:** 67

**Date:** January 1999

**Type:** Missouri Cooperative Fish and Wildlife Research Unit

**Call Number:** in house; NFP files

**Abstract:** Restoring ecological integrity of regulated large rivers necessitates characterizing the natural flow regime. We applied "Indicators of Hydrologic Alteration" to assess the natural range of variation of the Missouri Rivers' flow regime at 11 locations before (1929-1948) and after (1967-1996) mainstem impoundment. The 3768 km long Missouri River was divided into three sections: upper basin least-altered from flow regulation, including the lower Yellowstone River; middle basin inter-reservoir, and lower basin channelized. **Flow regulation was associated with a reduction in magnitude and duration of the annual flood pulse, an increase in the magnitude and duration of annual discharge minima, a reduction in frequency of annual low-flow pulses, earlier timing of March-October low-flow pulses, and a general increase in frequency of flow reversals with a reduction in the rate of change in river flows.** Hydrologic alterations were smallest at two least-altered upper basin sites and most frequent and severe in inter-reservoir and upper-channelized river sections. The influence of reservoir operations on depressing the annual flood pulse was partially offset by tributary inflow in the lower 600 km of river. Reservoir operations could be modified to more closely approximate the 1929-1948 flow regime to establish a simulated natural riverine ecosystem. For inter-reservoir and upper channelized river sections, we recommend periodic controlled flooding through managed reservoir releases during June and July; increased magnitude, frequency and duration of annual high-flow pulses; and increased annual rates of hydrograph rises and falls. All of the regulated Missouri River would benefit from reduced reservoir discharges during August-February, modified timing of reservoir releases and a reduced number of annual hydrograph reversals. Assessment of ecological responses to a regulation of Missouri River flows that more closely approximates the natural flow regime should then be used in an adaptive fashion to further adjust reservoir operations.

**Reference Type:** Journal Article

**Record Number:** 213

**Author:** Galat, D. L.; Lipkin, R.

**Year:** 2000

**Title:** Restoring ecological integrity of great rivers: historical hydrographs aid in defining reference conditions for the Missouri River

**Journal:** Hydrobiologia

**Volume:** 422/423

**Pages:** 29-48

**Call Number:** in house; NFP files

**Keywords:** ecological reference; flood pulse; flow regulation; river regulation; flow regime; hydrology; hydrologic alteration; RVA; range of variation approach

**Abstract:** Restoring ecological integrity of regulated large rivers necessitates characterizing the natural flow regime. We applied "Indicators of Hydrologic Alteration" to assess the natural range of variation of the Missouri Rivers' flow regime at 11 locations before (1929-1948) and after (1967-1996) mainstem impoundment. The 3768 km long Missouri River was divided into three sections: upper basin least-altered from flow regulation, including the lower Yellowstone River; middle basin inter-reservoir, and lower basin channelized. **Flow regulation was associated with a reduction in magnitude and duration of the annual flood pulse, an increase in the magnitude and duration of annual discharge minima, a reduction in frequency of annual low-flow pulses, earlier timing of March-October low-flow pulses, and a general increase in frequency of flow reversals with a reduction in the rate of change in river flows.** Hydrologic alterations were smallest at two least-altered upper basin sites and most frequent and severe in inter-reservoir and upper - channelized river sections. The influence of reservoir operations on depressing the annual flood pulse was partially offset by tributary inflow in the lower 600 km of river. Reservoir operations could be modified to more closely approximate the 1929-1948 flow regime to establish a simulated natural riverine ecosystem. For inter-reservoir and upper channelized river sections, we recommend periodic controlled flooding through managed reservoir releases during June and July; increased magnitude, frequency and duration of annual high-flow pulses; and increased annual rates of hydrograph rises and falls. All of the regulated Missouri River would benefit from reduced reservoir discharges during August-February, modified timing of reservoir releases and a reduced number of annual hydrograph reversals. Assessment of ecological responses to a regulation of Missouri River flows that more closely approximates the natural flow regime should then be used in an adaptive fashion to further adjust reservoir operations.

**Notes:** In this study one of the most critical flow variables was not the standard IHA variable, but a season-specific variable - new variable was the Julian date of the 'vegetation growing season' 1-day minimum flow (growing season was defined as March to October). Growing season is critical to reproduction of a number of fish, turtles, birds and riparian plants. Prior to regulation, the annual minimum generally occurred during August to early October and was most common in September; the timing of minimum flows was later the farther

downstream in the system. With regulation, summer flows have been increased in general and the timing of the minimum daily flow occurs later in the season at several river stations, earlier at some and was 'erratic' at others - but at all sites it change significantly. During the summer growing season, critical nesting periods occur on in channel islands for a number of birds and turtles and fish that use shallow water habitats around gravel bars and islands - after regulation there is more summer flooding and these above water or shallow water habitats are no longer available; the seasonal 1-day min flows no longer correspond to reproductive period of most species. In addition, germination of floodplain plants occurs on recently exposed soils following minimum flows - these no longer occur when plant seeds are available for germination, and elevated summer flows prevent germination of early-successional tree species.  
Good additional references.

**Reference Type:** Journal Article

**Record Number:** 399

**Author:** Gehrke, P. C.; Astles, K. L.; Harris, J. H.

**Year:** 1999

**Title:** Within-catchment effects of flow alteration on fish assemblages in the Hawkesbury-Nepean River system, Australia

**Journal:** Regulated Rivers: Research and Management

**Volume:** 15

**Issue:** 1-3

**Pages:** 181-198

**Call Number:** in house; NFP files

**Keywords:** fish communities; river regulation; disturbance; Australia

**Abstract:** Streamflow in the Hawkesbury-Nepean River system has been progressively regulated and diverted since 1888 by the construction of 29 dams 7 m or more in height and another 52 smaller structures to supply water for the populations of Sydney, Wollongong and the Blue Mountains. This study identifies differences in fish assemblages between reaches of the river system affected by dams, flow diversion and regulation, and rivers unmodified for water supply. Fish were sampled in the upper-reach tributaries above five major dams, in slopes reaches within 1 km downstream of the dams, and in the lowland reaches of the Nepean and Hawkesbury rivers. Corresponding upper, slopes and lowland reaches were sampled in two unregulated tributaries. Fish were also sampled within the impoundments. Seven fish assemblages were identified by multivariate analyses, which revealed a separation of assemblages in habitats affected by dams or flow alteration. Fish within the lowland reaches of all three rivers formed a single assemblage, which became progressively fragmented with increasing distance upstream, and with increasing differences between regulated and unregulated rivers. *Gambusia holbrooki* and *Anguilla reinhardtii* were more abundant in the upper reaches of unregulated rivers, whereas *Galaxias*

*brevipinnis* and *Retropinna semoni* were abundant in upper reaches above dams, but not recorded in upper reaches of unregulated rivers. In slopes reaches, *Gambusia holbrooki* and *Gobiomorphus coxii* were more abundant in unregulated reaches while *Retropinna semoni*, *Phylypnodon grandiceps* and *Anguilla reinhardtii* were more abundant in regulated reaches. Characteristic species in lowland reaches included *Macquaria novemaculeata*, *Mugil cephalus*, *Phylypnodon grandiceps*, *Cyprinus carpio* and *Potamalosa richmondia*. However, the true effects of flow alteration in the system are confounded by geomorphic and climatic variation and other disturbances within the catchment. Sustainable development of water resources in the catchment requires a more detailed analysis of biotic responses to river flows, accounting for confounding factors.

**Reference Type:** Journal Article

**Record Number:** 392

**Author:** Gehrke, P. C.; Harris, J. H.

**Year:** 2001

**Title:** Regional-scale effects of flow regulation on lowland riverine fish communities in New South Wales, Australia

**Journal:** Regulated Rivers Research and Management

**Volume:** 17

**Pages:** 369-391

**Call Number:** in house; NFP files

**Keywords:** fish communities, river regulation, Australia, invasive species, alien species, dams

**Abstract:** Lowland reaches of 40 rivers in New South Wales, Australia were designated as 'regulated' or 'unregulated', depending on the degree to which flows were modified by the operation of a dam upstream. Five replicate rivers of each type were selected from the North Coast, South Coast, Darling, and Murray regions in the State. Fish communities in each river were sampled in summer and winter in two consecutive years. Regulated and unregulated rivers contained significantly different fish communities, although communities in each region retained characteristic features. The proportion of native species in the total catch was greater in unregulated rivers in all regions, ranging from 27% in the Murray region to 100% in South Coast rivers. In regulated rivers, native species made up 20% of the catch in the Murray region compared to a maximum of 99% in the North Coast. Carp, *Cyprinus carpio*, were the main alien species contributing to changes in the proportion abundance of native fish. Native species most affected by river regulation were western carp gudgeons, *Hypseleotris* spp., bony herring *Nematalosa erebi*, and striped gudgeons, *Gobiomorphus australis*. Fifteen native species showed some effect of river regulation on their population structures. Individual species showed positive, negative, or mixed positive and negative effects of regulation, at population,

species or community levels. Three abundant alien species and seven native species showed only positive or mixed responses, whereas 13 native species exhibited only negative effects. Flow regulation has reduced the resilience of New South Wales rivers and native fish communities to invasion by alien species. New research has commenced to investigate whether recently introduced environmental flow rules are effective in reducing the effects of river flow alteration on fish communities in New South Wales rivers.

**Reference Type:** Journal Article

**Record Number:** 404

**Author:** Glazebrook, H. S.; Robertson, A. I.

**Year:** 1999

**Title:** The effect of flooding and flood timing on leaf litter breakdown rates and nutrient dynamics in a river red gum (*Eucalyptus camaldulensis*) forest

**Journal:** Australian Journal of Ecology

**Volume:** 24

**Pages:** 625-635

**Call Number:** in house; NFP files

**Keywords:** flood timing, flood regime; floodplain forest; leaf litter; nutrient cycling; organic matter; river regulation

**Abstract:** Comparisons of litter standing-stocks in low-lying and higher areas of the floodplain and the effects of controlled flooding events on leaf litter decomposition and leaf litter nutrients were examined during autumn and winter in a southeastern Australian river red gum (*Eucalyptus camaldulensis*) floodplain forest. The mean mass of total litter and some litter components was significantly greater in autumn than in winter but there were few differences in litter mass between low-lying flood runners and higher sites (1.5 m) on the floodplain, regardless of season. Leaf decomposition was more rapid in flooded areas than in non-flooded areas and was significantly faster in autumn than in winter. In flooded leaves, concentrations of phosphorus and nitrogen dropped rapidly during the first 3 days of each experiment, increased to near original after 7-10 weeks and then decreased again. After 112 days of decomposition the C:N:P ratios of leaf litter increased, but this effect was most marked for flooded leaves. Simple models of leaf litter dynamics indicated that leaf litter standing-stocks in low-lying flood runners would be reduced by flooding, particularly during autumn. In contrast, models predicted a net gain in standing stocks of leaf litter to be higher on the floodplain, particularly in autumn. Alteration to the seasonal timing of floods by river regulation has probably decreased litter standing-stocks and nutrients available in low-lying areas of the floodplain to support production of macrophytes and biofilms during winter and spring floods.

**Reference Type:** Journal Article

**Record Number:** 195

**Author:** Goes, B. J. M.

**Year:** 2002

**Title:** Effects of river regulation on aquatic macrophyte growth and floods in the Hadejia-Nguru wetlands and flow in the Yobe River, Northern Nigeria: implications for future water management

**Journal:** River Research and Applications

**Volume:** 18

**Pages:** 81-95

**Call Number:** in house: NFP files

**Keywords:** floods, flow regime, regulated river, aquatic macrophytes, wetlands, *Typha domingensis*

**Abstract:** The Hadejia River is a tributary of the Yobe River in semi-arid northern Nigeria and is regulated by two major dams. The other main tributary is uncontrolled. Comparison of the discharge data for the controlled and uncontrolled rivers shows **an average decrease of 33% in annual flow in the upstream part of the Hadejia River. The total annual flow and the peak flow in the Hadejia River further downstream, just above the Hadejia-Nguru Wetlands (HNW), however, did not show a significant reduction in discharge. This is related to a relatively small river flow reduction at lower flows in the upstream part of the Hadejia River and the fact that the formal large upstream water users are not (yet) working at full capacity.** The major impact of the dams on the downstream part of the river is the **change in regime from ephemeral to perennial.** The introduced dry season flows created favourable circumstances for the development of aquatic macrophyte blockages in the HNW. Owing to these blockages, **the Hadejia River stopped contributing to the flow in the Yobe River** for much of the year. Furthermore, after the completion of the dams, **the timing of the floods in the HNW became less predictable.**

Suggestions for improvement of water management are made. These comprise engineering structures, including a flow diversion structure to regulate flows in the HNW, implementation of environmentally acceptable river flow strategies and water allocation management.

**Notes:** Comparison of controlled and uncontrolled tributaries; flow regulation due to dams caused significant flow alteration in upper reaches (adjacent to dam) but less significant changes in lower reaches. Full water abstraction is not now occurring but will occur with current plans. Flow alterations have changed ephemeral reaches into perennial reaches (i.e., area is semi-arid and dry season typically did not have flows), resulting in enhanced aquatic macrophyte growth. This growth now blocks flows from tributary into main river upstream of wetlands with potential impacts to wetlands. Flooding in wetlands is now less predictable than it was before river regulation. Peak flows (i.e., wet season, wetland inundating flows) and annual flows have been reduced just downstream of dams; the proportion of dry season flows has increased from 4% of annual flows pre-

dam to 32% of annual flows post-dam. Ephemeral reaches have become perennial, which has resulted in invasion of the streams by *Typha* and an increase in siltation. The combination of aquatic macrophytes and siltation has completely blocked some reaches so that water no longer flows to downstream portions of the system. The effects of dams vs. drought were separated by comparison of regulated and unregulated rivers in same catchment. Ecological effects are not really discussed in the paper, but effects on local farming practices are significant (e.g., flood recession farmers and rice farmers in wetlands rely on extent and timing of floods in wetlands for successful farming).

**Reference Type:** Journal Article

**Record Number:** 100

**Author:** Gorman, Owen; Karr, James

**Year:** 1978

**Title:** Habitat Structure and stream fish communities

**Journal:** Ecology

**Volume:** 59

**Issue:** 3

**Pages:** 507-515

**Keywords:** channelization, community structure, fish communities, habitat structure, Indiana, Panama, seasonality, species diversity, streams

**Abstract:** Stream habitat complexity is correlated with fish species diversity in selected Indiana and Panama streams. Habitat diversity was measured along 3 dimensions judged important to a wide range of fish groups and applicable to many stream conditions: stream depth, bottom type, and current.

**Reference Type:** Journal Article

**Record Number:** 101

**Author:** Gregory, S. V.; Swanson, F. J.; McKee, W. Arthur; Cummins, K. W.

**Year:** 1991

**Title:** An ecosystem perspective of riparian zones

**Journal:** BioScience

**Volume:** 41

**Issue:** 8

**Pages:** 540-551

**Reference Type:** Journal Article

**Record Number:** 55

**Author:** Guillory, V.

**Year:** 1979

**Title:** Utilization of an inundated floodplain by Mississippi River fishes.



**Journal:** Biological Sciences  
**Volume:** 42  
**Pages:** 222-228  
**Call Number:** not in house; Pringle et al. 2000

**Reference Type:** Journal Article  
**Record Number:** 351  
**Author:** Harris, J. H.; Silveira, R.  
**Year:** 1999  
**Title:** Large-scale assessments of river health using an Index of Biotic Integrity with low-diversity fish communities  
**Journal:** Freshwater Biol  
**Volume:** 41  
**Issue:** 2  
**Pages:** 235-252  
**Date:** March 01, 1999  
**Alternate Journal:** Freshwater Biology  
**URL:** <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2427.1999.00428.x/abs>

**Reference Type:** Conference Proceedings  
**Record Number:** 338  
**Author:** Harris, R. R.; Risser, R. J.; Fox, C. A.  
**Year of Conference:** 1985  
**Title:** A method for evaluating streamflow discharge - plant species occurrence patterns on headwater streams  
**Editor:** Harris, R. R.  
**Conference Name:** North American Riparian Conference  
**Conference Location:** Tucson, Arizona  
**Publisher:** North American Riparian Conference  
**Pages:** 87-90  
**Date:** April 16-18, 1985  
**Keywords:** discharge, annual floods, flow regime, riparian vegetation, IFIM, instream flow  
**Notes:** proposes method for relating cross sectional distribution of vegetation, flood tolerance of vegetation, flood frequency, inundation duration, etc. to developing an instream flow requirement for maintaining riparian vegetation and evaluating effects of hydroelectric regulation on distribution of vegetation

**Reference Type:** Journal Article  
**Record Number:** 347

**Author:** Hart, D. D.; Finelli, C. M.

**Year:** 1999

**Title:** Physical-biological coupling in streams: the pervasive effects of flow on benthic organisms

**Journal:** Annual Review of Ecology and Systematics

**Volume:** 30

**Pages:** 363-95

**Keywords:** algae, boundary layer, hydrodynamics, hydraulics, invertebrates

**Abstract:** Flowing water has profound effects on a diverse array of ecological processes and patterns in streams and rivers. We propose a conceptual framework for investigating the multiple causal pathways by which flow influences benthic biota and focus particular attention on the local scales at which these organisms respond to flow. Flow (esp. characteristics linked to the velocity field) can strongly affect habitat characteristics, dispersal, resource acquisition, competition, and predation; creative experiments will be needed to disentangle these complex interactions. Benthic organisms usually reside within the roughness layer, where the unique arrangement of sediment particles produces strongly sheared and highly three-dimensional flow patterns. Thus, accurate characterization of the local flow environments experienced by benthic organisms often requires the use of flow measurement technology with high spatial and temporal resolution. Because flow exhibits variation across a broad range of scales, it is also necessary to examine how organism-flow relationships at one scale are linked to those at others. Interdisciplinary approaches are needed in the study of physical-biological coupling; increased collaboration between ecologists and experts in fluid mechanics and hydraulic engineering is particularly desirable. A greater understanding of physical-biological coupling will not only yield deeper insights into the ecological organization of streams and rivers, it will also improve our ability to predict how flow alterations caused by various human activities affect these vital ecosystems.

**Notes:** Good summary of types of flow effects likely to be important to benthic invertebrates; flow affects habitat suitability, dispersal, resource acquisition, competition and predation. Summary of issues related to accurate local flow characterization at temporal and spatial scales important to benthic invertebrates; recommendations regarding methods for characterizing ecologically important aspects of flow for benthic invertebrates.

**Reference Type:** Journal Article

**Record Number:** 8

**Author:** Hayes, J. W.

**Year:** 1995

**Title:** Spatial and temporal variation in the relative density and size of juvenile brown trout in the Kakanui River, North Otago, New Zealand.

**Journal:** New Zealand Journal of Marine and Freshwater Research

**Volume:** 29  
**Pages:** 393-407  
**Call Number:** not in house

**Reference Type:** Journal Article

**Record Number:** 422

**Author:** Healey, M.; Thompson, D.; Robertson, A.

**Year:** 1997

**Title:** Amphibian communities associated with billabong habitats on the Murrumbidgee floodplain, Australia

**Journal:** Australian Journal of Ecology

**Volume:** 22

**Pages:** 270-278

**Call Number:** in house; NFP files

**Keywords:** cattle, fish; predation; frogs; microhabitat; river regulation; flood regime; wetlands; riparian vegetation; water quality

**Abstract:** A study of frog species richness and abundance at four permanent billabongs located in and around the city of Wagga Wagga, southern New South Wales, was carried out from the spring of 1991 to the autumn of 1992. During the sampling period a total of 4040 individual adult frogs from six species were recorded. No egg masses or tadpoles were detected during a total of 32 survey hours. Four species of the family Myobatrachidae represented 81% of the total number of adult individuals sampled, the remaining species belonging to the family Hylidae. There were significant differences in mean species richness and mean total number of adult individuals among billabongs. Significant positive correlations were recorded between total adult individuals, total frog species richness and the number of riparian plant species recorded at all billabongs. There were no significant correlations between adult frog numbers and meteorological and water quality parameters. The adults of the four most abundant frog species exhibited significant association with particular microhabitats surrounding billabongs; *Crinia parinsignifera* was associated with the creeping grass *Paspalum distichum*, *Limnodynastes fletcheri* with the rush *Eleocharis sphacelata*, *L. tasmaniensis* with sedges *Cyperus* spp. and the grass *P. distichum* and *Litoria peronii* with red gum *Eucalyptus camaldulensis* and introduced tree species. Differences in adult frog abundance between billabongs appears to be related to disturbance of riparian vegetation by domestic stock, **while the absence of eggs and tadpoles from these permanent billabongs may be explained by the presence of abundant exotic fish species in the billabongs.**

**Notes:** Not a direct test of flow effects on floodplain amphibians, but river regulation has resulted in floodplain wetlands changing from ephemeral, seasonally flooded, largely fishless wetlands to permanently inundated billabongs with abundant exotic fish species. Includes discussion of predation effects of

exotic fish on native frog species and influence of changes in flood timing and frequency associated with the change from fishless to with fish billabongs.

**Reference Type:** Journal Article

**Record Number:** 9

**Author:** Heggenes, J.; Traaen, T.

**Year:** 1988

**Title:** Downstream migration and critical water velocities in stream channels for fry of four salmonid species.

**Journal:** Journal of Fish. Biology

**Volume:** 32

**Pages:** 717-727

**Call Number:** in house; NFP files

**Keywords:** flow velocities; salmonids; fry; trout; migration

**Abstract:** Fry of brown trout, Atlantic salmon, brook trout and lake trout were tested for downstream migration and critical velocities with a method of stepwise increasing water velocities. Each velocity was tested for 15 minutes before increase to the next step. Critical velocities for fry entering the free-feeding stage, defined as the stage when the fry has resorbed its yolk sac and will have to ascend from the bottom gravel to catch food, were between 0.10 and 0.25 m/sec, varying among individuals and depending on the species and water temperature. Downstream displacement started at lower velocities. Lake trout had the lowest critical velocity. Temperature influenced swimming performance considerably. On average, a 7 deg. C increase in temperature resulted in a 0.05 m/sec increase in critical velocity. The fry actively searched out the low velocity niches in the channels. Flow sensitivity gradually decreases with fry development; when the fry had reached a length of 40-50 mm, they were able to tolerate water velocities higher than 0.50 m/sec.

**Reference Type:** Journal Article

**Record Number:** 405

**Author:** Hein, T.; Baranyi, C.; Herndl, G. J.; W. Wanek; Schiemer, F.

**Year:** 2003

**Title:** Allochthonous and autochthonous particulate organic matter in floodplains of the River Danube: the importance of hydrological connectivity

**Journal:** Freshwater Biology

**Volume:** 48

**Pages:** 220-232

**Call Number:** in house; NFP files

**Keywords:** detritus; plankton; POM; restoration; stable isotope; hydrological connectivity; floodplain; flood regime

**Abstract:** The elemental composition, the proportion of living organic carbon and

the carbon stable isotope signatures of particulate organic matter (POM) were determined in a large river floodplain system in order to elucidate the major carbon sources in relation to the hydrological conditions over a 13-month period. Two floodplain segments and the main channel of the River Danube downstream of Vienna (Austria), were compared on the basis of discharge and water age estimates. The more dynamic floodplain was connected to the main channel for 46% of the study period and drained up to 12% of total discharge at high water. The mean C:N ratio and C13 signature of the POM increased from the floodplain site that was more isolated from the river (6.6; -33parts per thousand) to the main channel (8.4; -25 ppt). At the dynamic floodplain site, the C:N ratio and the C13 signature of the POM increased with hydrological connectivity (expressed as water age).

Only during flood events (4% frequency of occurrence), a considerable input of riverine POM was observed. The input was indicated by a C:N ratio of the POM pool of more than 10, the amount of detrital carbon (>80% of the total POM) and a C13 signatures of POM of more than -25 ppt in the dynamic floodplain. Plankton derived carbon, indicated by a C:N ratio of less than 8 and C13 values lower than -25 ppt, dominated the particulate organic carbon (POC) pool at both floodplain sites, emphasizing the importance of local (autochthonous) production. Phytoplankton was the major plankton compartment at the dynamic site, with highest biomasses at medium water ages.

At the dynamic floodplain site, the Danube Restoration Project has enhanced the duration of upstream surface connection with the main channel from 4 to 46% frequency of occurrence. Therefore, the export of living POC to the main channel is now established during phases of maximum phytoplankton production and doubled the estimated total export of non-refractory POM compared to pre-restoration conditions.

**Reference Type:** Book Section

**Record Number:** 56

**Author:** Hesse, L. W.; Mestl, G. E.; Robinson, J. W.

**Year:** 1993

**Title:** Status of selected fishes in the Missouri River in Nebraska with recommendations for their recovery.

**Editor:** Hesse, L. W., C. B. Stalnaker, N. G. Benson, and J. R. Zuboy

**Book Title:** Restoration Planning for the Rivers of the Mississippi River Ecosystem.

**City:** Washington D.C.

**Publisher:** U. S. Department of the Interior, National Biological Survey

**Volume:** Biological Report 19

**Pages:** 327-340

**Call Number:** not in house, Pringle et al. 2000

**Reference Type:** Journal Article

**Record Number:** 263

**Author:** Hillman, T. J.; Quinn, G. P.

**Year:** 2002

**Title:** Temporal changes in macroinvertebrate assemblages following experimental flooding in permanent and temporary wetlands in an Australian floodplain forest

**Journal:** River Research and Applications

**Volume:** 18

**Pages:** 137-154

**Call Number:** in house; NFP files

**Keywords:** billabong, floodplain, floods, flow regulation, flow management, flow regime, macroinvertebrates, wetlands, temporary wetlands

**Abstract:** River management (80% reduction in flow) on Murray-Darling system has resulted in changed in pattern of wetting and drying of floodplain wetlands. Experimental flooding and multivariate (ordination) analysis used to determine if flooding regime and permanent vs. temporary status of wetlands resulted in changes in invertebrate community assemblages. Assemblages in temporary and permanent wetlands were different and assemblages in temporary wetlands changed in a predictable way over time (but not towards more similarity with permanent wetland fauna). River management should focus on maintaining a mosaic of different wetland types and habitat heterogeneity to maintain floodplain biodiversity.

**Reference Type:** Journal Article

**Record Number:** 190

**Author:** Holmquist, J. G.; Schmidt-Gengenbach, J. M.; Yoshioka, B. B.

**Year:** 1998

**Title:** High dams and marine-freshwater linkages: effects on native and introduced fauna in the Caribbean

**Journal:** Conservation Biology

**Volume:** 12

**Issue:** 3

**Pages:** 621-630

**Call Number:** in house; NFP files

**Keywords:** freshwater shrimp; dams; amphidromy; river regulation; migration

**Abstract:** Caribbean streams are dominated by a shrimp and fish assemblage for which amphidromy (eggs or larvae carried to the ocean followed by migration of juvenile upriver) is suspected. Effects of dams on this assemblage are likely to demonstrate complex interactions as a function of reproductive strategy and type of dam structure. Our goals were to determine (1) whether high dams reduce or eliminate stream corridor permeability with respect to migration, (2) the extent to

which permeability is a function of spillway discharge, (3) the relative roles of native fauna and disturbance suppression (in this case river regulation) as predictors of success by exotic fishes, and (4) the uniformity and extent of obligate amphidromy in this assemblage. We sampled adults and juveniles of shrimps and fishes in Puerto Rican streams via electrofishing and sampled shrimp larvae with drift nets. Replicate stream reaches were assigned to the following five categories: undammed, above or below dams, and with or without water released over spillways. Dams without such discharge were impermeable barriers that eliminated all native fish and shrimp fauna from upstream reaches. Though more permeable, dams with spillway discharge had smaller populations of native species above these structures than below the dams or on undammed streams. Our data on adult and larval distributions, combined with the absence of first-stage shrimp larvae, indicate that amphidromy is obligate for most of the native fauna. Disturbance regime appeared to be a poor predictor of successful invasion by exotics in this system, whereas exotic abundance was consistently inversely related to abundance and species richness of native fauna across all sampling categories. The prevalent amphidromy in these streams provides a tight marine-upland linkage that is disrupted by dams in several ways. We recommend adding shrimp and fishways to dams on these tropical streams.

**Notes:** Tropical streams with amphidromous shrimp (eggs/larvae carried to ocean and juveniles migrate upstream from ocean); dams form migration barriers resulting in changes in species abundances, composition above and below dams; native fauna has disappeared from reaches upstream of dams. No native species were found above dams without spillways. Spillways were partial barriers - fewer native species were found above dams with spillways. Exotic species were not correlated with river regulation but were negatively correlated with native faunal abundance and distribution.

**Reference Type:** Journal Article  
**Record Number:** 402  
**Author:** Humphries, P. ; Lake, P. S.  
**Year:** 2000  
**Title:** Fish larvae and the management of regulated rivers  
**Journal:** Regulated Rivers: Research and Management  
**Volume:** 16  
**Pages:** 421-432

**Reference Type:** Journal Article  
**Record Number:** 215  
**Author:** Humphries, P.; Serafini, L. G.; King, A. J.  
**Year:** 2002  
**Title:** River regulation and fish larvae: variation through space and time

**Journal:** Freshwater Biology

**Volume:** 47

**Pages:** 1307-1331

**Call Number:** in house; NFP files

**Keywords:** fish spawning, Australia, flow alteration, flow regime, river regulation, Murray-Darling Basin, river ecology

**Abstract:** Patterns in abundance and distribution of larval fish in a heavily regulated and a mildly regulated Australian lowland river were compared over four breeding seasons to gain some insight into how river regulation affects fish populations.

Larvae from a total of 13 species from nine families were recorded from the two rivers. The mildly regulated Broken River supported twice as many species as the heavily regulated Campaspe River. The two rivers shared three introduced species but only two native species. The dominant species in the Campaspe was not found in the Broken River.

The two most abundant species in the Campaspe were classified as 'opportunists'. They are small, short-lived species, which spawn for up to 9 months, encompassing extremes in temperature and flow. The extended spawning period may place a subset of larvae in optimal conditions for recruitment and is hypothesized as being the key to the success of these species.

Most species spawned each year, despite large interannual variation in flow and temperature conditions. Poor recruitment over several decades, rather than a failure to spawn, is considered the most likely explanation for differences in the larval fish faunas between the two rivers.

The highly regulated section of the Campaspe River downstream of the regulating impoundment is thought to provide suboptimal habitat conditions for larvae relative to the less regulated downstream sections.

The timing of occurrence of larvae of the dominant species varied by breeding season and may be the result of flexibility in the timing of spawning.

**Reference Type:** Journal Article

**Record Number:** 105

**Author:** Irvine, J.R.; Henriques, P.R.

**Year:** 1984

**Title:** A preliminary investigation on effects of fluctuating flows on invertebrates

**Journal:** New Zealand Journal of Marine and Freshwater Research

**Volume:** 18

**Pages:** 283-290

**Call Number:** in house; NFP files

**Keywords:** Hawea River; fluctuating flows; benthic invertebrates; invertebrate drift; aquatic invertebrates; periphyton; freshwater ecology; regulated river; instream flow needs; benthos



**Abstract:** An experiment with flow changing at 3, 9, and 18 m<sup>3</sup>/sec/hr on consecutive days failed to produce any measurable effect on benthic invertebrates in the regulated Hawea River, New Zealand, but did result in increased numbers of drifting chironomid larvae, trichopteran larvae, and oligochaetes compared to days when flow was stable. Drift densities were at least as high on the day flow changed at 3 m<sup>3</sup>/s/hr (minimum flow 15 m<sup>3</sup>/s; max flow 30 m<sup>3</sup>/s) as on subsequent days when flow changed at 9 and 18 m<sup>3</sup>/s/hr, indicating that rapid rates of change of flow may not necessarily cause more benthic invertebrates to enter the drift than slow rates of change. Fluctuating flows resulted in more animals entering the drift at a site 5 km below a control dam than at a site 0.8 km below the dam. Drift of non-invertebrate organic matter (mainly periphyton) showed similar patterns to invertebrate drift. It is suggested that most of the invertebrates displaced by the flow fluctuations were associated with periphyton in the river, and as such, these taxa may have been more prone to being swept away during flow increases than other invertebrate taxa.

**Reference Type:** Journal Article

**Record Number:** 210

**Author:** Irwin, E. R.; Freeman, M. C.

**Year:** 2002

**Title:** Proposal for adaptive management to conserve biotic integrity in a regulated segment of the Tallapoosa River, Alabama, U.S.A.

**Journal:** Conservation Biology

**Volume:** 16

**Issue:** 5

**Pages:** 1212-1222

**Notes:** Excellent example of developing hypotheses regarding flow-ecology relationships and using these in an adaptive management context to develop data to test the hypotheses as well as refine river management.

**Reference Type:** Journal Article

**Record Number:** 43

**Author:** Ittekkot, V.; Humborg, C.; Schafer, P.

**Year:** 2000

**Title:** Hydrological alterations and marine biogeochemistry: a silicate issue?

**Journal:** BioScience

**Volume:** 50

**Issue:** 9

**Pages:** 776-782

**Call Number:** in house NFP files

**Notes:** reductions in river discharges from dams/water diversion has reduced

amount of silica reaching nearshore waters; rivers supply more than 80% of the input of silicate to oceans; reductions in silicate levels have changed nutrient ratios (Si:N:P) and shifted species composition of phytoplankton - away from diatoms and towards other groups, including toxic bloom species; silicate concentrations affect working of ocean carbon pump because much of the CO<sub>2</sub> that is removed from oceans is due to diatoms locking up C and sinking into sediments; river inputs of silicate are probably very important to phytoplankton dynamics where major rivers enter ocean (Amazon - western Atlantic; Ganges-Brahmaputra - Bay of Bengal; Danube - Black Sea). Includes additional good citations (FAO 1995)

**Reference Type:** Journal Article

**Record Number:** 396

**Author:** Jay, D. A.; Simenstad, C. A.

**Year:** 1996

**Title:** Downstream Effects of Water Withdrawal in a Small, High-Gradient Basin: Erosion and Deposition on the Skokomish River Delta

**Journal:** Estuaries

**Volume:** 19

**Pages:** 501-517

**Keywords:** flow (reduction) sediment transport capacity, bathymetry, erosion, deposition

**Abstract:** Change in slope of estuary and loss of intertidal habitats at elevations most often used by juvenile fish and colonized by eelgrass. Change in locations of benthic and epibenthic invertebrates. The purpose of this paper is to analyze downstream effects of freshwater flow diversion from a small, active-continental-margin river basin. The Skokomish River delta is a tributary estuary to Hood Canal in Washington State that receives drainage from the southeastern side of the Olympic Mountains. Its drainage basin is steep, and rainfall is high. Approximately 40% of the annual average runoff of the entire system has been diverted from the North Fork Skokomish River for power production since completion of two dams in 1930; this water does not pass through the lower river or over the delta. Extensive logging has occurred in the remainder of the basin. Comparison of pre-diversion (1885) and post-diversion (1972) bathymetric surveys shows that deposition (about 0.03 to 0.022 m yr<sup>-1</sup>) has occurred on the inner delta and erosion (up to 0.033 m yr<sup>-1</sup>) on the outer delta. This steepening of the delta surface has apparently been caused by a loss of sediment transport capacity in the lower river and estuary combined with an increased sediment supply due to logging. Although the total area of unvegetated tidal flats has decreased by only about 6%, there has been a more than 40% loss of highly productive low intertidal surface area. A conservative estimate of loss of eelgrass (*Zostera marina*) beds is 18%; a reduction in the size of mesohaline mixing zone has also occurred. These habitat losses are similar to those observed elsewhere

in the world in larger river basins that have suffered water withdrawals of the same magnitude, but their impacts cannot either be evaluated or understood casually through consideration of simple measures like changes in total estuarine deltaic area. Evaluation of estuarine effects of anthropogenic modification must, therefore, include consideration of both changes in habitat function and in the physical processes. These must be evaluated within the totality of the riverbasin-estuary system that causes these changes. In this case, sediment transport constitutes the critical link between fluvial alterations and the remote downstream, estuarine consequences thereof. Similar to effects in North San Francisco Bay, Black Sea deltas (Ukraine), and Sea of Azon (Ukraine, Russia).

**Reference Type:** Journal Article

**Record Number:** 10

**Author:** Jensen, A. J.; Johnsen, B. O.

**Year:** 1999

**Title:** The functional relationship between peak spring floods and survival and growth of juvenile Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta*).

**Journal:** Funct. Ecol.

**Volume:** 13

**Pages:** 778-785

**Call Number:** in house; NFP files

**Keywords:** alevin, density estimates, egg, emergence, mortality, peak flows, floods, flow regime

**Abstract:** The effects of high spring floods on survival, growth of juvenile Atlantic salmon, *Salmo salar*, and Brown Trout *Salmo trutta*, are explored, using data from a long-term study in the River Saltdalselv, northern Norway. The flow regime in this river is typical for northern rivers.

There was considerable variation in year class strength of both species.

Mortality of Atlantic salmon increased significantly in years with high discharge during the alevin stage as well as the first week after emergence. High discharge during the egg stage and more than 1 week after emergence seemed to be of minor importance. Water temperature at emergence was rather high (average 10.5 deg C) and did not significantly affect year class strength.

Brown trout emerged earlier than Atlantic salmon at an average water temperature of 8.2 deg C. Highest mortality was observed in years with low water temperatures at emergence as well as high discharge during the alevin stage. For 1-year old fish or older, the size of the spring peak flood did not influence mortality significantly.

Growth of Atlantic salmon parr was diminished in years with a high peak spring flood. A similar effect on Brown trout was not detected.

**Reference Type:** Journal Article

**Record Number:** 424  
**Author:** Johnson, W. C.  
**Year:** 1992  
**Title:** Dams and riparian forests: case study from the upper Missouri River  
**Journal:** Rivers  
**Volume:** 3  
**Pages:** 229-242  
**Call Number:** cited in Galat and Lipkin 2000

**Reference Type:** Journal Article  
**Record Number:** 425  
**Author:** Johnson, W. C.  
**Year:** 1994  
**Title:** Woodland expansion in the Platte River, Nebraska: Patterns and causes  
**Journal:** Ecological Monographs  
**Volume:** 64  
**Pages:** 45-84  
**Call Number:** in house; NFP files  
**Keywords:** riparian vegetation; flow regime; river regulation; irrigation; gravel bars; recruitment  
**Notes:** cited in Nilsson and Svedmark

**Reference Type:** Journal Article  
**Record Number:** 417  
**Author:** Jowett, I. G.; Duncan, M. J.  
**Year:** 1990  
**Title:** Flow variability in New Zealand rivers and its relationship to in-stream habitat and biota  
**Journal:** New Zealand Journal of Marine and Freshwater Research  
**Volume:** 24  
**Pages:** 305-317  
**Call Number:** in house; NFP files  
**Keywords:** flow variability; hydrologic indices; hydrology; discriminant analysis; classification; in-stream habitat; community structure; benthic invertebrates; periphyton; trout; morphology  
**Abstract:** Flow variability indices were determined for 130 sites on New Zealand rivers and the sites were divided into groups based on these indices. Univariate and discriminant analyses were used to identify the catchment characteristics that contributed to flow variability. Climate, as determined by topography, geographic location, and the composition of the regolith (especially water storage capacity and transmissivity characteristics), accounted for a broad regional distribution of groups. Flow variability decreased with catchment size and area of

lake and to a lesser degree, with catchment slope. Relationships were found between flow variability, and morphological and hydraulic characteristics. The longitudinal variability of water depth and velocity increased with flow variability, indicating a more pronounced pool/riffle structure in rivers with high flow variability. **Mean water velocity at mean annual low, median, and mean flow was higher in rivers of low flow variability. There were strong associations with periphyton communities and trout distribution and abundance and a weak association with benthic invertebrate communities. Water velocity was the most important hydraulic variable; it could be linked to changes in water temperature, benthic invertebrate and periphyton community structure, and trout distribution and abundance.**

**Reference Type:** Journal Article

**Record Number:** 369

**Author:** Karr, James R.

**Year:** 1999

**Title:** Defining and measuring river health

**Journal:** Freshwater Biol

**Volume:** 41

**Issue:** 2

**Pages:** 221-234

**Date:** March 01, 1999

**Alternate Journal:** Freshwater Biology

**URL:** <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2427.1999.00427.x/abs>

**Reference Type:** Journal Article

**Record Number:** 208

**Author:** Karr, J. R.; Chu, E. W.

**Year:** 2000

**Title:** Sustaining living rivers

**Journal:** Hydrobiologia

**Volume:** 422/423

**Pages:** 1-14

**Call Number:** in house; NFP files

**Keywords:** biological integrity, IBI, rivers, RIVPACS, urban rivers, water cycle

**Reference Type:** Report

**Record Number:** 107

**Author:** Kerwin, John

**Year:** 2001

**Title:** Salmon and Steelhead Habitat Limiting Factors Report for the Cedar-Sammamish Basin (Water Resource Inventory Area 8)

**City:** Olympia

**Institution:** Washington Conservation Commission

**Date:** 2001

**Keywords:** limiting factors, habitat, salmon decline, salmon recovery, Cedar River, Sammamish River, WRIA 8, hydrologic alteration

**Reference Type:** Journal Article

**Record Number:** 429

**Author:** King, J. M.; Cambray, J. A.; Impson, D. N.

**Year:** 1998

**Title:** Linked effects of dam-released floods and water temperature on spawning of the Clanwilliam yellowfish, *Barbus capensis*

**Journal:** Hydrobiologia

**Volume:** 384

**Pages:** 245-265

**Call Number:** cited in Bunn and Arthington 2002

**Notes:** loss of spawning cues due to aseasonal flood spates associated with dam releases

**Reference Type:** Journal Article

**Record Number:** 418

**Author:** Kingsford, R. T.; Thomas, R. F.

**Year:** 1995

**Title:** The Macquarie Marshes in arid Australia and their waterbirds: a 50-year history of decline

**Journal:** Environmental Management

**Volume:** 19

**Pages:** 867-878

**Keywords:** flow regimes; waterfowl; Australia; flow regulation; water abstraction

**Reference Type:** Journal Article

**Record Number:** 58

**Author:** Kinsolving, A., D.; Bain, M. B.

**Year:** 1993

**Title:** Fish assemblage recovery along a riverine disturbance gradient.

**Journal:** Ecological Applications

**Volume:** 3

**Pages:** 531-544

**Call Number:** in house; NFP files

**Keywords:** disturbance; fish communities; gradients; habitat use; hydroelectric dams; recovery; riverine biodiversity; rivers; streamflow regulation

**Abstract:** Artificial fluctuations in streamflow have been documented to alter the composition and structure of stream communities. This study tests the hypothesis that a spatial recovery gradient in fish assemblage structure exists downstream of a hydroelectric dam, and that recovery can be identified by the presence and abundance of species largely restricted to flowing-water habitats (fluvial specialists). A longitudinal gradient of change in a shoreline fish assemblage was quantified in a 66-km reach of a mid-sized, species rich river (Tallapoosa River, Alabama) with daily flow fluctuations from hydropower generation. The shoreline fish assemblage in a nearby and similar river (Cahaba River, Alabama) was quantified as a regional reference for the occurrence of fish assemblage gradients. Fish were collected with prepositioned area electrofishers in 240 randomly located sampling sites, and physical habitat was quantified. Using distributional and habitat use information, fish species were categorized as fluvial specialists or macrohabitat generalists (species that occur in a wide variety of aquatic systems). Sampled habitats were similar between rivers and along each study reach. The longitudinal pattern of species occurrence and fish abundance was consistent in the free-flowing river. A longitudinal gradient of increasing abundance and richness of only fluvial specialists existed downstream of the hydroelectric dam. No similar spatial gradient existed for macrohabitat generalists in either river. Although a fish community recovery gradient was identified, a recovery endpoint was not evident because assemblage change was gradual and possibly incomplete. The preservation and management of riverine fish faunas will partly depend on incorporating spatial recovery into decisions about permitting and siting of anthropogenic changes like hydroelectric dams.

**Reference Type:** Journal Article

**Record Number:** 209

**Author:** Koel, T. M. ; Sparks, R. E.

**Year:** 2002

**Title:** Historical patterns of river stage and fish communities as criteria for operations of dams on the Illinois River

**Journal:** River Research and Applications

**Volume:** 18

**Pages:** 3-19

**Call Number:** Cassin; NFP files

**Keywords:** connectivity, floodplain, ecosystem management, river regulation, flow regime, hydrologic alteration, hydrology, large river, water level variability

**Abstract:** The hydrologic regime of the Illinois River has been altered over the past 100 years. Locks and cams regulate water surface elevations and flow, enabling commercial navigation to continue year round. This study relates

changes in water surface elevation to fish abundance in the river, and establishes target criteria for operating locks and dams. Using long-term records of daily river stage, we identified ecologically meaningful hydrological parameters for eight gage locations along the Illinois River. Inter-annual variability of a long-term fisheries dataset beginning in 1957 was related to variability in stage, flood and recession duration, frequency, timing, and rate of change of water levels. **Reversals in water surface elevation, maximum stage levels and length of the spring flood were the most important parameters** influencing abundance of age-zero fishes in annual collections. Smallmouth buffalo (*Ictiobus bubalus*), black crappie (*Pomoxis nigromaculatus*), freshwater drum (*Aplodinotus grunneins*), and white bass (*Morone chrysops*) were most abundant in samples during years that approximated the natural water level regime. Of the 33 hydrologic parameters evaluated for the entire water year from an Illinois River gage site on La Grange Reach, all except average stage in January and Julian date (JD) of maximum stage had moderate or high hydrologic alteration based on the historical range of variation (RVA). The highest degree of hydrologic alteration was for minimum stage levels (1-day, 3-day, and 7-day), rate of rise, and rate of fall. Other parameters that have been severely altered were 30-day minimum stage, 90-day maximum stage, and the annual number of water level reversals. Operations of the La Grange and Peoria locks and dams could be modified so water level variability would approximate that of the late 1800s, when fish and wildlife resources were abundant. The water regime could be regulated to maintain navigation and improve conditions for native plants and animals without increasing flood damages.

**Reference Type:** Journal Article

**Record Number:** 275

**Author:** Kondolf, G. Mathias

**Year:** 1998

**Title:** Lessons learned from river restoration projects in California

**Journal:** Aquatic Conserv. Mar. Freshw. Ecosyst.

**Volume:** 8

**Pages:** 39-52

**Keywords:** flow management, flushing flows, river restoration, natural flow regime, riparian restoration

**Reference Type:** Journal Article

**Record Number:** 384

**Author:** Ladson, Anthony R.; White, Lindsay J.; Doolan, Jane A.; Finlayson, Brian L.; Hart, Barry T.; Lake, P. Sam; Tilleard, John W.

**Year:** 1999

**Title:** Development and testing of an Index of Stream Condition for waterway



management in Australia

**Journal:** Freshwater Biol

**Volume:** 41

**Issue:** 2

**Pages:** 453-468

**Date:** March 01, 1999

**Alternate Journal:** Freshwater Biology

**Keywords:** methods; environmental flows

**URL:** <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2427.1999.00442.x/abs>

**Reference Type:** Journal Article

**Record Number:** 279

**Author:** Lapointe, M. ; Eaton, B.; Driscoll, S.; Latulippe, C.

**Year:** 2000

**Title:** Modeling the probability of salmonid egg pocket scour due to floods.

**Journal:** Canadian Journal of Fisheries and Aquatic Science

**Volume:** 57

**Pages:** 1120-1130

**Call Number:** in house; NFP files

**Keywords:** peak flows; high flows; scour; bed mobility; egg pocket; redd; salmonid

**Reference Type:** Journal Article

**Record Number:** 115

**Author:** Larkin, Randall; Sharp, John

**Year:** 1992

**Title:** On the relationship between river-basin geomorphology, aquifer hydraulics, and ground-water flow direction in alluvial aquifers

**Journal:** Geological Society of America Bulletin

**Volume:** 104

**Pages:** 1608-1620

**Keywords:** The delineation of ground-water flow in alluvial valley stream-aquifer systems is important in studies of water availability, environmental impact, and aquifer remediation and is required by some states water laws. Published potentiometric surfaces and head data, however, are not always available. When data are absent, it is commonly assumed that ground water and dissolved solutes flow toward the river. Analysis of published geomorphologic and hydraulic data in 24 alluvial systems and the results of digital simulation indicate that in some cases this assumption is only valid immediately adjacent to an effluent river. Ground water flow in the remaining portions of an alluvial valley aquifer may be dominated by downstream or underflow components.

**Reference Type:** Journal Article

**Record Number:** 281

**Author:** Latterell, J. J.; Fausch, K. D.; Gowan, C.; Riley, S. C.

**Year:** 1998

**Title:** Relationship of trout recruitment to snowmelt runoff flows and adult trout abundance in six Colorado mountain streams.

**Journal:** Rivers

**Volume:** 6

**Pages:** 240-250

**Call Number:** in house; NFP files

**Keywords:** density dependence; density independence; salmonids; flow regime; streamflow; recruitment; *Salvelinus trutta*, *Salvelinus fontinalis*

**Abstract:** High snowmelt runoff flows are reported to reduce trout recruitment in Rocky Mountain streams, but biotic interactions from older trout may also limit fry abundance. We tested these relationships for fall-spawning brook trout (*Salvelinus fontinalis*) and brown trout (*Salvelinus trutta*) in six small Colorado streams by relating magnitude, duration, and frequency of peak flows, and abundances of juvenile and adult trout, to recruitment over an 8- year period. Abundance of age-1 trout declined with increases in mean 30-day maximum streamflow and adult trout abundance the previous year when the recruits were age-0. Similar but weaker relationships were found using annual maximum streamflow or frequency of high flows. These results indicated that displacement of fry during high snowmelt runoff is a general mechanism limiting trout recruitment in western U.S. mountain streams, but that density-dependent reductions by adult trout combine with high flows to regulate these trout populations.

**Reference Type:** Journal Article

**Record Number:** 438

**Author:** Lesica, P.; Miles, S.

**Year:** 1999

**Title:** Russian olive invasion into cottonwood forests along a regulated river in north-central Montana

**Journal:** Canadian Journal of Botany

**Volume:** 77

**Pages:** 1077-1083

**Keywords:** riparian vegetation; cottonwoods; dams; flood regime; Russian olive; river regulation

**Reference Type:** Report

**Record Number:** 59

**Author:** Light, H. M.; Darst, M. R.; Grubbs, J. W.

**Year:** 1995

**Title:** Hydrologic conditions, habitat characteristics, and occurrence of fishes in the Apalachicola River floodplain, Florida.

**City:** Washington D.C.

**Institution:** U.S. Geological Survey Open File Report 95-167

**Date:** 1995

**Type:** U.S. Geological Survey. Second Annual Report of Progress, Oct. 1993 - Sept. 1994.

**Call Number:** Pringle et al. 2000

**Reference Type:** Journal Article

**Record Number:** 282

**Author:** Ligon, F. K.; Dietrich, W. E.; Trush, W. J.

**Year:** 1995

**Title:** Downstream ecological effects of dams, a geomorphic perspective

**Journal:** BioScience

**Volume:** 45

**Pages:** 183-192

**Call Number:** in house; NFP files

**Reference Type:** Journal Article

**Record Number:** 440

**Author:** Livingston, R. J.

**Year:** 1997

**Title:** Trophic response of estuarine fishes to long-term changes in river runoff

**Journal:** Bulletin of Marine Science

**Volume:** 60

**Pages:** 984-1004

**Reference Type:** Journal Article

**Record Number:** 441

**Author:** Livingston, R. J.; Lewis, F. G.; Woodsum, G. C.; Niu, X. F.; Galperin, B.; Christensen, W. H.; Monaco, M. E.; Batista, T. A.; Klein, C. J.; Howell, R. L.; Ray, G. L.

**Year:** 2000

**Title:** Modeling oyster population response to variation in freshwater input

**Journal:** Estuarine and Coastal Shelf Science

**Volume:** 50

**Pages:** 655-675

**Keywords:** estuary; flow regime; freshwater input; oysters; productivity

**Notes:** spatial and temporal variation in freshwater inputs, which vary in response to flow regime and river regulation, to Gulf estuary affect salinity balance, productivity and oyster growth rates, predation, and population dynamics

**Reference Type:** Journal Article

**Record Number:** 439

**Author:** Livingston, R. J.; Niu, X.; Lewis, F. G.; Woodsum, G. C.

**Year:** 1997

**Title:** Freshwater input to a Gulf estuary: long-term control of trophic organization

**Journal:** Ecological Applications

**Volume:** 7

**Pages:** 277-299

**Keywords:** trophic organization; estuary; freshwater inputs; discharge

**Notes:** changes in relative magnitude of freshwater flows affect productivity and trophic organization of estuary

**Reference Type:** Book

**Record Number:** 406

**Author:** Lowe-McConnell, R. H.

**Year:** 1987

**Title:** Ecological Studies in Tropical Fish Communities

**City:** Cambridge

**Publisher:** Cambridge University Press

**Call Number:** not in house; cited in Puckridge et al. 1998

**Keywords:** fish; tropical fish; community; low flows; duration; zero flows; predation

**Notes:** Relationship between protracted low flow periods (zero flows) and increased mortality from predation in tropical fish.

**Reference Type:** Journal Article

**Record Number:** 352

**Author:** Marchant, R.; Hirst, A.; Norris, R.; Metzeling, L.

**Year:** 1999

**Title:** Classification of macroinvertebrate communities across drainage basins in Victoria, Australia: consequences of sampling on a broad spatial scale for predictive modeling

**Journal:** Freshwater Biol

**Volume:** 41

**Issue:** 2

**Pages:** 253-268

**Date:** March 01, 1999

**Alternate Journal:** Freshwater Biol

**URL:** <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2427.1999.00429.x/abs>

**Reference Type:** Journal Article

**Record Number:** 388

**Author:** Marchetti, M. P.; Moyle, P. B.

**Year:** 2001

**Title:** Keeping alien fishes at bay: effects of flow regime and habitat structure on fish assemblages in a regulated California stream

**Journal:** Ecological Applications

**Volume:** 11

**Pages:** 75-87

**Call Number:** not in house

**Reference Type:** Journal Article

**Record Number:** 339

**Author:** Merritt, D. M.; Cooper, D. J.

**Year:** 2000

**Title:** Riparian vegetation and channel change in response to river regulation: a comparative study of regulated and unregulated streams in the Green River basin, USA

**Journal:** Regulated Rivers: Research and Management

**Volume:** 16

**Pages:** 543-564

**Call Number:** in house, NFP files

**Keywords:** channel change; channel geometry; fluvial marsh; Green River; metamorphosis; regulated river; riparian vegetation; Yampa River; flow regime

**Abstract:** The effects of river damming on geomorphic processes and riparian vegetation were evaluated through field studies along the regulated Green River and the free-flowing Yampa River in northwestern Colorado, USA. GIS analysis of historical photographs, hydrologic and sediment records, and measurements of channel planform indicate that fluvial processes and riparian vegetation of the two meandering stream reaches examined were similar prior to regulation which began in 1962. Riparian plant species composition and canopy coverage were measured during 1994 in 36, 0.01 ha plots along each the Green River in Browns Park and the Yampa River in Deerlodge Park. Detrended correspondence analysis (DCA) of the vegetation data indicates distinctive vegetation differences between Browns Park and Deerlodge Park. Canonical correspondence analysis (CCA) indicates that plant community composition is controlled largely by fluvial

processes at Deerlodge Park, but that soil chemical rather than flow related factors play a more important role in structuring plant communities in Browns Park.

Vegetation patterns reflect a dichotomy in moisture conditions across the floodplain on the Green River in Browns Park: marshes with anaerobic soils supporting wetland species (*Salix exigua*, *Eleocharis palustris*, *Schoenoplectus pungens*, and *Juncus nodosus*) and terraces having xeric soil conditions and supporting communities dominated by desert species (*Seriphidium tridentatum*, *Sarcobatus vermiculatus*, and *Sporobolus airoides*). In contrast, vegetation along the Yampa River is characterized by a continuum of species distributed along a gradual environmental gradient from the active channel (ruderal species such as *Xanthium strumarium* and early successional species such as *S. exigua*, *Populus deltoides* ssp. *wislizenii* and *Tamarix ramossissima*) to high floodplain surfaces characterized by *Populus* forests and meadow communities. GIS analyses indicate that the channel form at Browns Park has undergone a complex series of morphologic changes since regulation began, while the channel at Deerlodge Park has remained in a state of relative quasi-equilibrium with discharge and sediment regimes. The Green River has undergone three stages of channel change which have involved the transformation of the historically deep, meandering Green River to a shallow, braided channel over the 37 years since construction of Flaming Gorge dam. The probably long-term effects of channel and hydrologic changes at Browns Park include the eventual replacement of *Populus*-dominated riparian forest by drought tolerant desert shrublands, and the enlargement of the in-channel fluvial marshes.

**Notes:** The unregulated Yampa had riparian plant species representing a continuum from wet (flood/inundation tolerant) to dry, while regulated Green only had very wet (inundation but not scour-tolerant) and dry species (inundation intolerant); cottonwood forests were being replaced by xeric upland vegetation. Diversity of vegetation types was greater along Yampa than along Green. Following damming on the Green, the channel changed in a complex sequence of geomorphic changes, with initial channel narrowing and then bank erosion, channel widening and formation of a braided channel where before damming the channel was a classic meandering channel.

**Reference Type:** Journal Article

**Record Number:** 14

**Author:** Mesick, C. F.

**Year:** 1995

**Title:** Response of brown trout to streamflow, temperature, and habitat restoration in a degraded stream.

**Journal:** Rivers

**Volume:** 5

**Pages:** 75-95

**Call Number:** not in house

**Reference Type:** Book Section

**Record Number:** 60

**Author:** Mestl, G.E.; Hesse, L. W.

**Year:** 1993

**Title:** Secondary productivity of aquatic insects in the unchannelized Missouri River, Nebraska

**Editor:** Hesse, L. W., C. B. Stalnaker, N. G. Benson, and J. R. Zuboy

**Book Title:** Restoration Planning for the Rivers of the Mississippi River Ecosystem.

**City:** Washington D.C.

**Publisher:** U.S. Department of the Interior, National Biological Survey

**Volume:** Biological Report 19

**Pages:** 341-349

**Call Number:** not in house, Pringle et al. 2000

**Reference Type:** Journal Article

**Record Number:** 287

**Author:** Mitsch, William; Rust, William

**Year:** 1984

**Title:** Tree Growth responses to flooding in a bottomland forest in northeastern Illinois

**Journal:** Forest Sci.

**Volume:** 30

**Issue:** 2

**Pages:** 499-510

**Reference Type:** Journal Article

**Record Number:** 24

**Author:** Mitsch, W. J.; Dorge, C. C.; Wiemhoff, J. R.

**Year:** 1979

**Title:** Ecosystem dynamics and a phosphorous budget of an alluvial cypress swamp in southern Illinois.

**Journal:** Ecology

**Volume:** 60

**Pages:** 116-1124

**Call Number:** in house

**Reference Type:** Journal Article

**Record Number:** 288

**Author:** Molles, M. C.; Crawford, C. C.; Ellis, L. M.

**Year:** 1995

**Title:** Effects of an experimental flood on litter dynamics in the Middle Rio Grande riparian ecosystem

**Journal:** Regulated Rivers: Research & management

**Volume:** 11

**Pages:** 275-281

**Reference Type:** Journal Article

**Record Number:** 122

**Author:** Montgomery, David; Buffington, John

**Year:** 1993

**Title:** Channel classification, prediction of channel response, and assessment of channel condition

**Journal:** Washington State Timber/Fish/Wildlife Agreement

**Volume:** Report TFW-SH10-93-002

**Abstract:** A process based landscape and channel classification is proposed as a framework for assessing watershed response to natural and anthropogenic environmental change. Our proposed classification is based on a hierarchy of process-regimes at several spatial scales: geomorphic province, watershed, valley segment, channel reach, and channel unit. The geomorphic province level identifies watersheds developed in similar materials, topography, and climates, reflecting comparable hydrologic, erosional, and tectonic processes. The watershed level distinguishes hillslopes from valleys, defining fundamental differences in transport processes within a contiguous drainage basin.

**Reference Type:** Journal Article

**Record Number:** 123

**Author:** Montgomery, D. R.; Beamer, E. M.; Pess, G. R.; Quinn, T. P.

**Year:** 1999

**Title:** Channel type and salmonid spawning distribution and abundance

**Journal:** Can. J. Fish. Aquat. Sci.

**Volume:** 56

**Pages:** 377-387

**Call Number:** in house; NFP files

**Keywords:** bed scour, bed mobility, flow regime, salmonid, spawning success, spawning patterns

**Abstract:** Consideration of fundamental channel processes, together with map-based and field investigations, indicates that stream channel type influences salmonid spawning distributions across entire channel networks and salmonid abundance within channel reaches. Our analysis suggests that salmonid



spawning patterns in mountain drainage basins of the Pacific Northwest are adapted to, among other things, the timing and depth of channel-bed mobility. We hypothesize that because the bed of pool-riffle and plane-bed reaches scours to a variable fraction of the thickness of alluvium, survival to emergence is favored by either burying eggs below the annual scour depth or avoiding egg burial during times of likely bed mobility. Conversely, annual mobility of all available spawning gravel in steeper step-pool and cascade channels favors either adaptations that avoid egg burial during times of likely bed mobility or selection of protected microhabitats. Consistent with these expectations, we find that salmonid spawning distributions track channel slope distributions in several west-slope Pacific Northwest watersheds, implying that spatial differences in channel processes influence community structure in these rainfall-dominated drainage basins. More detailed field surveys confirm that different channel types host differential use by spawning salmonids and reveal finer scale influences of pool spacing on salmonid abundance.

**Reference Type:** Book Section

**Record Number:** 290

**Author:** Montgomery, D. R.; Buffington, J. M.

**Year:** 1998

**Title:** Channel processes, classification, and response.

**Editor:** Naiman, R. J. and R. E. Bilby

**Book Title:** River Ecology and Management: Lessons from the Pacific Coastal Ecoregion

**City:** New York

**Publisher:** Springer-Verlag

**Call Number:** Cassin Library

**Keywords:** stream classification, channel morphology, hierarchical classification, flow regime, discharge, sediment transport, channel forming processes

**Notes:** good discussion of relationship between spatio-temporal scales of processes, channel features and responses to changes in discharge and sediment supply

**Reference Type:** Journal Article

**Record Number:** 395

**Author:** Montgomery, D. R.; Buffington, J. M.; Peterson, N. P.; Sheutt-Hames, D.; Quinn, T. P.

**Year:** 1996

**Title:** Streambed scour, egg burial depths, and the influence of salmonid spawning on bed surface mobility and embryo survival

**Journal:** Can. J. Fish. Aquat. Sci.

**Volume:** 53

**Pages:** 1061-1070  
**Call Number:** not in house

**Reference Type:** Thesis  
**Record Number:** 124  
**Author:** Morley, Sarah Ann  
**Year:** 2000  
**Title:** Effects of urbanization on the biological integrity of Puget Sound lowland streams: restoration with a biological focus  
**Academic Department:** Fisheries  
**City:** Seattle  
**University:** University of Washington  
**Number of Pages:** 61  
**Thesis Type:** Master of Science

**Reference Type:** Journal Article  
**Record Number:** 292  
**Author:** Morley, S. A.; Karr, J. R.  
**Year:** 2002  
**Title:** Assessing and restoring the health of urban streams in the Puget Sound basin  
**Journal:** Conservation Biology  
**Volume:** 16  
**Call Number:** in house; NFP files

**Reference Type:** Journal Article  
**Record Number:** 125  
**Author:** Moscrip, A. L.; Montgomery, D. R.  
**Year:** 1997  
**Title:** Urbanization, flood frequency, and salmon abundance in Puget Lowland streams  
**Journal:** J. of the American Water Resources Association  
**Volume:** 33  
**Issue:** 6  
**Pages:** 1289-1297  
**Call Number:** in house; NFP files  
**Keywords:** urban hydrology; watershed management; hydrobiology; salmonids  
**Abstract:** Urbanization history and flood frequencies were determined in six low-order streams in the Puget Lowlands, Washington, for the period between the 1940/50s and the 1980/90s. Using discharge records from USGS gauging stations, each basin was separated into periods prior to and after urban

expansion. Four of the study basins exhibited significant changes in urbanized area, whereas two of the study basins exhibited only limited change in urbanized area and effectively serve as control basins. Each of the basins that experienced a significant increase in urbanized area exhibited increased flood frequency; pre-urbanization 10-year recurrence interval discharges correspond to 1 to 4-year recurrence interval events in post-urbanization records. In contrast, no discernible shift in flood frequency was observed in either of the control basins. Spawner survey data available for three of the study basins reveal systematic declines in salmon abundance in two urbanizing basins and no evidence for decreases in a control basin. These data imply a link between ongoing salmon population declines and either increased flood frequency or associated changes in habitat structure.

**Reference Type:** Book

**Record Number:** 38

**Author:** Naiman, R. J.; Bilby, R. E.

**Year:** 1998

**Title:** River Ecology and Management: Lessons from the Pacific Coastal Ecoregion

**City:** New York

**Publisher:** Springer-Verlag

**Number of Pages:** 705

**Call Number:** Cassin Library

**Reference Type:** Journal Article

**Record Number:** 127

**Author:** Naiman, R. J.; Bilby, R. E.; Bisson, P. A.

**Year:** 2000

**Title:** Riparian ecology and management in the Pacific Coastal rainforest

**Journal:** BioScience

**Volume:** 50

**Issue:** 11

**Pages:** 996-1011

**Keywords:** riparian ecology, flow regime, hydrologic alteration, channel geomorphology, disturbance regime, sediment transport, LWD, floodplain forests, floodplain vegetation, hyporheic

**Notes:** good source of references; basic summary of state of science regarding natural disturbance regime, and dynamic geomorphologic/hydrologic factors that affect stream and riparian habitats; possibly good source of matrix of effects of flow on habitat

**Reference Type:** Journal Article

**Record Number:** 194

**Author:** Nakamura, F.; Jitsu, M.; Kameyama, S.; Mizugaki, S.

**Year:** 2002

**Title:** Changes in riparian forests in Kushiro Mire, Japan, associated with stream channelization

**Journal:** River Research and Applications

**Volume:** 18

**Pages:** 65-79

**Call Number:** in house; NFP files

**Keywords:** alder, channelization, riparian vegetation, suspended sediment, wetland

**Notes:** channelization shortens channels resulting in streambed aggradation, reduced channel capacity, and increased overbank flooding (greater water level fluctuations and more frequent flooding) of sediment laden water; increased flooding and sediment alters the composition of riparian vegetation

**Reference Type:** Journal Article

**Record Number:** 15

**Author:** Nehring, R. B.; Anderson, M. A.

**Year:** 1993

**Title:** Determination of population-limiting critical salmonid habitats in Colorado streams using the physical habitat simulation system.

**Journal:** Rivers

**Volume:** 4

**Pages:** 1-19

**Call Number:** not in house; Puckridge et al. 1998

**Reference Type:** Journal Article

**Record Number:** 16

**Author:** Nelson, F. A.

**Year:** 1986

**Title:** Effect of flow fluctuations on brown trout in the Beaverhead River, Montana.

**Journal:** N. Am. J. Fish. Manag.

**Volume:** 6

**Pages:** 551-559

**Call Number:** in house

**Reference Type:** Journal Article

**Record Number:** 128

**Author:** Nesler, T. P.; Muth, R. T.; Wasowicz, A. F.

**Year:** 1988

**Title:** Evidence for baseline flow spikes as spawning cues for Colorado Squawfish in the Yampa River, CO

**Journal:** American Fisheries Society symposium

**Volume:** 5

**Pages:** 68-79

**Call Number:** in house; NFP files

**Keywords:** peak flows; flow spikes; Yampa River; Colorado squawfish; *Ptychocheilus lucius*; spawning; spawning cues

**Abstract:** The Colorado squawfish, *Pytochocheilus lucius* is an endangered species in the Colorado River basin. Understanding the spawning ecology of this cyprinid has been an important focus of research directed at recovery of the species. Comparison of yearly river flow regimes to estimated Colorado squawfish spawning periods in the Yampa River, Colorado, suggested that the first major flow spike in early summer, as river flows decline to near baseline, may act as an environmental cue that stimulates substantial spawning. In five cases during 1983-1986, estimated spawning peaks were associated with flow spikes of 27.5-71.4 m<sup>3</sup>/sec that occurred over a 203 day period sometime during late June to late July. These flow spikes represented 25-139% increased in river flows. Rainstorms representing 23-89% of total monthly precipitation appeared to cause the observed flow spikes. Spawning activity appeared to become negligible when flows decreased below 57-66 m<sup>3</sup>/sec. Flow spikes similar to those in 1983-1986 represented 34% of the 68 spikes documented for the Yampa River during the June-August period from 1934 to 1986. These flow spikes occurred in 19 of 53 years with a mean interval of 1.7 years. Seventy-four percent of the flow spikes of a magnitude similar to those in 1983-1986 peaked in 4 days or less. Because of their recurrent nature, these flow spikes qualify as potential environmental cues serving to stimulate spawning by Colorado squawfish. These results may bear on recommended flow windows and water project operations criteria for the protection and management of this species in regulated river environments.

**Reference Type:** Journal Article

**Record Number:** 298

**Author:** Nielsen, D. L.; Hillman, T. J.; Smith, F. J.; Shiel, R. J.

**Year:** 2002

**Title:** The influence of seasonality and duration of flooding on zooplankton in experimental billabongs

**Journal:** River Research and Applications

**Volume:** 18

**Pages:** 227-237

**Call Number:** in house; NFP files

**Keywords:** microcrustaceans, zooplankton, cut-off meanders, billabong, floodplain, flooding, flow regime

**Abstract:** The **regulation of Australian lowland rivers such as the River Murray has resulted in changes to the flooding characteristics of many associated wetlands.** It has been suggested that these changes in flooding have changed the pattern of response of many wetland biota. The substantial variability in the size and shape of these wetlands makes limited field observations difficult to interpret. To overcome this variability 16 experimental billabongs were constructed in which factors that may cause changes to populations within billabongs could be manipulated. In this paper we report on experiments that **test the hypothesis that changing the pattern of flooding alters the density and diversity of rotifers and microcrustaceans in billabongs.** The experimental billabongs were sampled fortnightly for two years. During this time **four flood events were imposed.** Flooding of the experimental billabongs resulted in increased microcrustacean abundance. Rotifer abundance rarely increased following flooding. Changing the timing of flooding did not modify this response. Observed **changes in community structure** following flooding **result from changes in the relative densities of taxa already present rather than changes in community composition.**

**Notes:** Tests hypothesis that changes in **duration and timing (seasonality)** of flooding of billabongs influences the **density and diversity** of rotifer and microcrustacean populations. Billabongs typically are ephemeral and fill with winter floods and/or rainfall and dry during summer/fall. Experimental manipulation of billabongs on River Murray floodplain to test hypothesis that changes in the pattern of flooding will alter the density and diversity of rotifers and microcrustaceans in floodplain wetlands. Invertebrates were sampled every two weeks for two years. Changes in flooding patterns altered the relative abundances of species already present in billabongs (microcrustaceans increased in abundance following flooding but rotifers did not) but did not change overall composition of billabong invert communities. Ostracods (*Newnhamia*) were less abundant in permanently inundated billabongs; in spring flooded treatment, there were sharp seasonal spikes in the density of ostracods, but these peaks were absent in summer or permanently flooded treatments. Many ostracods are adapted to colonize temporary waterbodies during early stages of inundation - may require variability in hydrology or particular timing of signals to trigger emergence of resting eggs. Authors concluded that because no invertebrates showed a consistent increase in abundance following flooding at different seasons (i.e., no effect of season), seasonality of flooding may not be important to these inverts (or right set of cues in addition to flooding may not have been present in experimental billabongs). Changes in the invert communities were related to changes in population densities rather than changes in community composition. These billabongs did not dry out completely prior to the flooding experiments though; permanently flooded sites may show much less response to flooding than sites that are ephemeral and dry

out between flooding events (i.e., egg bank may be much more important).  
Species that are adapted to a regime of wetting and drying may be lost from the system under conditions of permanent inundation because cues for emergence are missing.

Good additional references.

**Reference Type:** Journal Article  
**Record Number:** 130  
**Author:** Nilsson, C  
**Year:** 1982  
**Title:** Effects of stream regulation on riparian vegetation  
**Journal:** Regulated Rivers  
**Volume:** New York: Columbia University  
**Pages:** 93-106

**Reference Type:** Journal Article  
**Record Number:** 69  
**Author:** Nilsson, C. ; Berggren, K.  
**Year:** 2000  
**Title:** Alterations of riparian ecosystems caused by river regulation  
**Journal:** BioScience  
**Volume:** 50  
**Issue:** 9  
**Pages:** 783-792  
**Call Number:** in house; NFP files  
**Keywords:** flow regime, hydrological alteration, river regulation, riparian vegetation

**Reference Type:** Journal Article  
**Record Number:** 336  
**Author:** Nilsson, C.; Svedmark, M.  
**Year:** 2002  
**Title:** Basic principles and ecological consequences of changing water regimes: riparian plant communities  
**Journal:** Environmental Management  
**Volume:** 30  
**Issue:** 4  
**Pages:** 468-480  
**Call Number:** in house; NFP files  
**Keywords:** flow regime, land-water interactions, management, plant communities, riparian corridor, river, flow restoration

**Abstract:** Recent research has emphasized the importance of riparian ecosystems as centers of biodiversity and links between terrestrial and aquatic systems. Riparian ecosystems also belong among the environments that are most disturbed by humans and are in need of restoration to maintain biodiversity and ecological integrity. To facilitate the completion of this task, researchers have an important function to communicate their knowledge to policy-makers and managers. This article presents some fundamental qualities of riparian systems, articulated as three basic principles. The basic principles proposed are (1) The flow regime determines the successional evolution of riparian plant communities and ecological processes. (2) The riparian corridor serves as a pathway for redistribution of organic and inorganic material that influences plant communities along rivers. (3) The riparian system is a transition zone between land and water ecosystems and is disproportionately plant species-rich when compared to surrounding ecosystems. Translating these principles into management directives requires more information about how much water a river needs and when and how, i.e., flow variables described by magnitude, frequency, timing, duration and rate of change. It also requires information about how various groups of organisms are affected by habitat fragmentation, especially in terms of their dispersal. Finally, it requires information about how effects of hydrologic alterations vary between different types of riparian systems and with the location within the watershed.

**Notes:** Excellent current review of effects of flow regulation and river fragmentation by dams on riparian vegetation and floodplain processes. Three basic principles proposed for effects of flow on riparian vegetation: (1) The flow regime determines the ecological processes and the successional evolution of riparian plant communities and ecological processes; (2) The riparian zone serves as a pathway for redistribution of organic and inorganic material that influences plant communities along rivers; (3) The riparian system is a transition zone between land and water ecosystems and is disproportionately plant species-rich when compared to surrounding ecosystems. Good additional references.

**Reference Type:** Journal Article

**Record Number:** 348

**Author:** Norris, Richard H.; Thoms, Martin C.

**Year:** 1999

**Title:** What is river health?

**Journal:** Freshwater Biol

**Volume:** 41

**Issue:** 2

**Pages:** 197-209

**Date:** March 01, 1999

**Alternate Journal:** Freshwater Biol



**URL:** <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2427.1999.00425.x/abs>

**Reference Type:** Journal Article

**Record Number:** 17

**Author:** Nuhfer, A. J.; R. D. Clark, Jr.; Alexander, G. R.

**Year:** 1994

**Title:** Recruitment of brown trout in the south branch of the Au Sable river, Michigan in relation to streamflow and winter severity.

**Journal:** Fisheries Research Report 2006

**Volume:** Michigan Department of Natural Resources Fisheries Division, Lansing, MI

**Call Number:** not in house; Puckridge et al. 1998

**Reference Type:** Journal Article

**Record Number:** 423

**Author:** Olden, J. D.; Poff, N. L.

**Year:** 2003

**Title:** Redundancy and the choice of hydrologic indices for characterizing streamflow regimes

**Journal:** River Research and Applications

**Call Number:** in house; NFP files

**Keywords:** hydrology; dams; alteration; hydrologic indices; variability; indicators

**Abstract:** The utility of hydrologic indices for describing various aspects of streamflow regimes has resulted in their increased application in riverine research. Consequently, researchers are now confronted with the task of having to choose among a large number of competing hydrologic indices to reduce computational effort and variable redundancy prior to statistical analyses, while still adequately representing the major facets of the flow regime. The present study addresses this concern by providing a comprehensive review of 171 currently available hydrologic indices (including the commonly used Indicators of Hydrologic Alteration) using long-term flow records from 420 sites from across the continental USA. We highlight patterns of redundancy among these hydrologic indices and provide a number of statistically and ecologically based recommendations for the selection of a reduced set of indices that can simultaneously (1) explain a dominant proportion of statistical variation in the complete set of hydrologic indices and (2) minimize multicollinearity while still adequately representing recognized, critical attributes of the flow regime. In addition, we examine the transferability of hydrologic indices across 'stream types' by identifying indices that consistently explain dominant patterns of variance across streams of varying climatic and geologic environments. Together, our results provide a framework from which researchers can identify

hydrologic indices that adequately characterize flow regimes in a non-redundant manner. In combination with ecological knowledge, this framework can guide researchers in the parsimonious selection of hydrologic indices for future hydroecological studies.

**Notes:** For snow and rain stream climatic regimes, authors list the hydrologic indices that exhibited the largest loadings on each statistically significant principal component (i.e., explained most of the variation); they also stress importance not only of choosing non-redundant indices that explain dominant patterns of variation, but also selecting additional indices that are likely to be ecologically important. For example, timing variables were not prominent in the list of variables with high loading on statistically significant principal components axes, but the timing of flows has been shown to be significant to fish reproductive cycles, riparian plants.....

**Reference Type:** Journal Article

**Record Number:** 389

**Author:** Osmundson, D. B.; Ryel, R. J.; Lamarra, V. L.; Pitlick, J.

**Year:** 2002

**Title:** Flow-sediment-biota relations: implications for river regulation effects on native fish abundance

**Journal:** Ecological Applications

**Volume:** 12

**Issue:** 6

**Pages:** 1719-1739

**Call Number:** in house; NFP files

**Keywords:** benthic macroinvertebrates; Colorado pikeminnow; Colorado River; fish distribution; flow regime; foodweb; interdisciplinary research; natural flow regime paradigm; *Ptychocheilus lucius*; river regulation; river restoration; sediment

**Abstract:** Alteration of natural flow regimes by river regulation affects fish distribution and assemblage structure, but causative pathways are not always direct and may go unrecognized. The Colorado River population of the endangered Colorado pikeminnow, *Ptychocheilus lucius*, suffers from low rates of recruitment and reduced carrying capacity. We hypothesized that availability of prey fish for this large-bodied native piscivore may, in part, be limited by reduced standing crops of periphyton and macroinvertebrates resulting from accumulation of fine sediment in the riverbed. We stratified the 373-km long study area into 11 strata and sampled various physical and biological parameters in runs and riffles of three randomly selected 1- to 3-km long study reaches in each stratum during base flows in spring and fall 1994-1995. Significant correlations were found between biomass of both chlorophyll a and macroinvertebrates and various physical metrics that described the degree of fine sediment accumulation in gravel-cobble substrates. Riffles were relatively

free of fine sediment throughout the study area, but substrates of runs contained progressively more fine sediments with distance downstream. There was a corresponding longitudinal change in biota along the river continuum with greatest biomass of fish, invertebrates, and periphyton upstream. Adult pikeminnow were concentrated in upstream strata where potential prey fishes were most abundant. We suggest that fine sediment effects on biota have increased in recent years as a result of river regulation. Historically, spring snowmelt frequently produced flows with magnitudes sufficient to mobilize the bed and winnow silt and sand from coarse substrates. Following regulation, the mean recurrence interval of such flows lengthened from 1.3 - 2.7 yr (depending on the stratum) to 2.7 - 13/5 yr, extending the duration of fine sediment accumulation and potentially depressing biotic production. Our results describe and help explain the spatial distribution of the Colorado River fish community and establish a link between flow, sediment, and the riverine food web supporting the community's top predator. To maintain intact native fish communities in this and other river basins, managers need to identify functional aspects of the natural hydrograph and incorporate these findings into river restoration efforts.

**Reference Type:** Journal Article

**Record Number:** 337

**Author:** Palmer, M. A.; Moglen, G. E.; Bockstael, N. E.; Brooks, S.; Pizzuto, J. E.; Wiegand, C.; VanNess, K.

**Year:** 2002

**Title:** The ecological consequences of changing land use for running waters, with a case study of urbanizing watersheds in Maryland

**Journal:** Yale Forestry and ES Bulletin

**Volume:** 107

**Pages:** 85-113

**Call Number:** in house; NRP files

**Reference Type:** Journal Article

**Record Number:** 301

**Author:** Parkinson, A.; Nally, R. Mac; Quinn, G. P.

**Year:** 2002

**Title:** Differential macrohabitat use by birds on the unregulated Ovens River floodplain of southeastern Australia

**Journal:** River Research and Applications

**Volume:** 18

**Pages:** 495-506

**Call Number:** in house; NFP files

**Keywords:** billabong; floodplain; birds; river red gum; wetlands; river regulation; flow regime; flooding; waterbirds; Australia; Ovens River; Murray-Darling

**Abstract:** In many lowland floodplains around the world, upriver interferences to flows (weirs, dams, off-takes) have led to much reduced frequency and duration of flooding. As a result, many floodplain wetlands are now inundated relatively rarely if at all. Given regulation of most lowland rivers in southeastern Australia, we assessed use of wetlands by birds in the essentially unregulated Ovens River in northeastern Victoria. Twelve sites (0.4-1.2 ha) were studied after flooding. Four sites were 'permanent billabongs', four were temporary wetlands and the other four were randomly selected woodland sites > 60m from the nearest water body (including the river) acting as 'control' or 'reference' sites. Aquatic birds were not recorded using woodland sites, but many species were differentially associated with either billabongs or temporary wetlands. A surprising number of non-aquatic birds either exclusively or differentially were associated with wetland sites compared with woodland sites. We concluded that heterogeneous macrohabitat will increase local avian biodiversity on lowland floodplains. Moreover, densities and diversity of non-aquatic, woodland species also increased with the presence of wetlands. Temporary wetlands were used differently from permanent billabongs by birds, especially in foraging methods. This suggests that the reinstatement of major flooding on heavily regulated floodplains would be ecologically advantageous for birds by providing foraging and breeding opportunities.

**Notes:** On the unregulated Ovens River, floodplain wetlands range from permanently inundated billabongs (oxbow lakes) to temporarily inundated, ephemeral wetlands. The presence of the full range of wetland types likely contributes to species richness and abundance of floodplain birds (macrohabitat heterogeneity increases species richness). Temporary wetlands were utilized more by aquatic birds than billabongs were in this study. Shallow waters of temporary wetlands had greater cover of macrophytes, direct and indirect (macroinvertebrates) source of food for aquatic birds. Cycle of alternate wetting and drying of temporary wetlands may also result in greater litter decomposition and greater availability of nutrients - greater productivity of aquatic invertebrates. River regulation that reduces floodplain inundation and/or increases water level stability (changes ephemeral wetlands to permanent wetlands) may result in reduced floodplain and riparian bird abundance and species richness.

**Reference Type:** Journal Article

**Record Number:** 211

**Author:** Parsons, H.; Gilvear, D.

**Year:** 2002

**Title:** Valley floor landscape change following almost 100 years of flood embankment abandonment on a wandering gravel-bed river

**Journal:** River Research and Applications

**Volume:** 18

**Pages:** 461-479

**Call Number:** in house; NFP files

**Keywords:** fluvial landforms, embankments, channelization, floodplain vegetation, channel change, landscape patches, gravel bars, impounded rivers, gravel-bed rivers

**Notes:** Using aerial photographs, historical maps and field work, reconstructed changes in channel form and floodplain habitat mosaic following abandonment of agricultural embankments in the early 20th century. Removing channel constrictions restoring the natural flood regime to the floodplain and allowed the channel to move, resulting in increased habitat complexity and vegetation complexity on floodplain over past 50 years. Includes methods for measuring floodplain and channel dynamics and morphology for assessing impacts of flow or floodplain/channel modifications.

**Reference Type:** Journal Article

**Record Number:** 435

**Author:** Paul, M. J.; Meyer, J. L.

**Year:** 2001

**Title:** Streams in the urban landscape

**Journal:** Annual Review of Ecology and Systematics

**Volume:** 32

**Pages:** 333-365

**Call Number:** in house; NFP files

**Keywords:** impervious surface cover; hydrology; fluvial geomorphology; contaminants; biological assessment

**Abstract:** The world's population is concentrated in urban areas. This change in demography has brought landscape transformations that have a number of documented effects on stream ecosystems. The most consistent and pervasive effect is an increase in impervious surface cover within urban catchments, which alters the hydrology and geomorphology of streams. This results in predictable changes in stream habitat. In addition to imperviousness, runoff from urbanized surfaces as well as municipal and industrial discharges result in increased loading of nutrients, metals, pesticides, and other contaminants to streams. These changes result in consistent declines in the richness of algal, invertebrate, and fish communities in urban streams. Although understudied in urban streams, ecosystem processes are also affected by urbanization. Urban streams represent opportunities for ecologists interested in studying disturbance and contributing to more effective landscape management.

**Notes:** Good additional references. Reviews current understanding of the types of hydrological and geomorphic changes associated with urbanization, as well as reviewing what is known about effects of urbanization on macroinvertebrate, riparian vegetation and fish communities.

**Reference Type:** Journal Article  
**Record Number:** 303  
**Author:** Pegg, M. A.; Pierce, C. L.  
**Year:** 2002  
**Title:** Classification of reaches in the Missouri and lower Yellowstone Rivers based on flow characteristics  
**Journal:** River Research and Applications  
**Volume:** 18  
**Pages:** 31-42  
**Call Number:** in house; NFP files  
**Keywords:** human alteration, hydrology, hydrologic alteration, multivariate analyses, river ecology, flow regime

**Reference Type:** Journal Article  
**Record Number:** 132  
**Author:** Pejchar, Liba, and Keith Warner  
**Year:** 2001  
**Title:** A river might run through it again: criteria for consideration of dam removal and interim lessons from CA  
**Journal:** Environmental Management  
**Volume:** 28  
**Issue:** 5  
**Pages:** 561-575  
**Call Number:** in house; NFP files  
**Keywords:** salmon; anadromous fish; watershed management; dam management; dam removal; endangered species act; dam hazard  
**Abstract:** Resource managers are increasingly being challenged by stakeholder groups to consider dam removal as a policy option and as a tool for watershed management. As more dam owners face high maintenance costs, and rivers as spawning grounds for anadromous fish become increasingly valuable, dam removal may provide the greatest net benefit to society. This article reviews the impact of Endangered Species Act listing for anadromous fish and recent shifts in the Federal Energy Regulatory Commission's hydropower benefit-costs analysis and discusses their implications for dam removal in California. We propose evaluative criteria for consideration of dam removal and apply them to two case studies: the Daguerre and Englebright Dams on the Yuba River and the Scott and Van Horne Dams on the South Eel River, California.

**Reference Type:** Report  
**Record Number:** 133  
**Author:** Pess, G. R.; Collins, B. D.; Pollock, M.; Beechie, T. J.; Haas, A.; Grigsby, S.

**Year:** 1999

**Title:** Historic and current factors that limit coho salmon (*Onchorhynchus kisutch*) production in the Stillaguamish River basin, Washington State: implications for salmonid habitat protection and restoration

**City:** Arlington, WA

**Institution:** Snohomish County Department of Public Works and the Stillaguamish Tribe of Indians

**Pages:** 57

**Type:** Unpublished, Final Report

**Reference Type:** Conference Proceedings

**Record Number:** 407

**Author:** Peterson, N. P. ; Reid, L. M.

**Year of Conference:** 1984

**Title:** Wall-base channels: their evolution, distribution, and use by juvenile coho salmon in the Clearwater River, Washington

**Editor:** Houston, J. M. Walton and D. B.

**Conference Name:** Olympic Wild Fish Conference

**Conference Location:** Port Angeles, Washington

**Pages:** 215-226

**Edition:** Proceedings of the Olympic Wild Fish Conference

**Date:** March 23-25, 1983

**Call Number:** in house; NFP files

**Keywords:** juvenile salmonids; overwinter survival; wass-base channels; fry; Clearwater Basin;

**Abstract:** Wall-base channels are a type of channel formed on floodplain or terrace surfaces by the channeling of runoff through swales created by the migration of the mainstem stream. Channels appear to develop either along abandoned meander scars or in swales between scroll bars, but in most cases follow the foot of the valley or upper terrace wall quite closely. Such channels are heavily colonized by coho salmon fry in late spring and again in autumn. Where the channels are associated with ponds or swamps they form highly productive habitat for the overwintering fish. Productivity varies between sites and is related to the physical characteristics and stage of geomorphological development of these channels and ponds. Under present conditions a significant proportion of smolts produced by the Clearwater basin comes from wall-base channels, and the importance of this habitat is expected to be even greater for higher levels of escapement.

**Reference Type:** Thesis

**Record Number:** 431

**Author:** Pettit, N.E.

**Year:** 2000

**Title:** Factors affecting the recruitment of riparian vegetation on the Ord and Blackwood Rivers in Western Australia

**City:** Perth

**University:** Edith Cowan University

**Thesis Type:** Ph.D.

**Notes:** cited in Pettit et al. 2002

**Reference Type:** Journal Article

**Record Number:** 432

**Author:** Pettit, N.E.; Froend, R. H.

**Year:** 2001

**Title:** Variability in flood disturbance and the impact on riparian tree recruitment in two contrasting river systems.

**Journal:** Wetland Ecology and Management

**Volume:** 9

**Pages:** 13-25

**Notes:** cited in Pettit et al. 2002

**Reference Type:** Journal Article

**Record Number:** 340

**Author:** Pettit, N. E.; Froend, R. H.; Davies, P. M.

**Year:** 2001

**Title:** Identifying the natural flow regime and the relationship with riparian vegetation for two contrasting western Australian rivers

**Journal:** Regulated Rivers: Research and Management

**Volume:** 17

**Pages:** 201-215

**Call Number:** in house; NFP files

**Keywords:** environmental flows; flooding; flow regime; recruitment; regeneration; riparian vegetation; river hydrology; vegetation dynamics

**Abstract:** The natural flow regime and the relationship between flows and riparian vegetation are described for sites on both the Blackwood River in southwestern Australia and the Ord River in northwestern Australia. Analysis of long-term flow data showed the historic mean monthly river discharge for the Blackwood River is strongly seasonal and highly predictable with generally low variability each month. The Ord River showed a strong seasonality of flows with about 92% of the (total) yearly flow occurring between December and March. Flow variability was very high (e.g., coefficient of variation >100% for all months) but highly predictable, with this mostly attributed to low but constant dry-season flows. **Water depth, duration of flood events and the number of flood events per year show a significant correlation with aspects of the riparian**



**vegetation** within experimental vegetation plots. Results highlight the strong relationship between floristics, life form structure, and population dynamics with stream hydrology. On the Blackwood River, species richness and cover of shrubs reduced with increased duration and frequency of flooding, while cover of exotic species and annual herbs increased with increased flooding. Germination of tree seedlings was not influenced by flood regime, but size class of tree species increased with flooding frequency. On the Ord River, species richness was not influenced by flooding regime. However, cover of perennial grasses increased with flooding frequency whilst cover of shrubs decreased. There was no relationship between flooding and seedling establishment whilst tree size class decreased with increased flooding. **The methods described here can be used to compare the response of different components of riparian vegetation to different fluvial regimes (e.g., because of impoundment and abstraction).** This technique can be expanded for the management of riparian zones and planning rehabilitation programmes. It may also be useful for improving the ecological knowledge base for setting environmental flows in regulated systems.

**Notes:** relationships of flow with floristics, life-form structure and population dynamics of riparian vegetation; responses differed between two river systems - one characterized by Mediterranean climate with high and predictable winter flows vs. summer-monsoon system with low winter base flows and highly variable, episodic extreme flows associated with summer monsoons

**Reference Type:** Journal Article

**Record Number:** 134

**Author:** Petts, GE

**Year:** 1984

**Title:** Impounded rivers: perspectives for ecological management

**Journal:** New York: John Wiley & Sons

**Reference Type:** Journal Article

**Record Number:** 135

**Author:** Petts, Geoffrey

**Year:** 1985

**Title:** Time-Scales for Ecological Change in Regulated Rivers

**Reference Type:** Journal Article

**Record Number:** 136

**Author:** Petts, Geoffrey

**Year:** 1996

**Title:** Water allocation to protect river ecosystems

**Journal:** Regulated Rivers; research and management  
**Volume:** 12  
**Pages:** 353-365

**Reference Type:** Book Section  
**Record Number:** 61  
**Author:** Pfeleger, W. L. ; Grace, T. B.  
**Year:** 1987  
**Title:** Changes in the fish fauna of the lower Missouri River, 1940-1983.  
**Editor:** Heins, W. J. Matthews and D. C.  
**Book Title:** Community and Evolutionary Ecology of North American Stream Fishes  
**City:** Norman, Oklahoma  
**Publisher:** University of Oklahoma Press  
**Pages:** 166-177  
**Call Number:** not in house, Pringle et al. 2000

**Reference Type:** Journal Article  
**Record Number:** 428  
**Author:** Pizzuto, J.  
**Year:** 2002  
**Title:** Effects of dam removal on river form and process  
**Journal:** BioScience  
**Volume:** 52  
**Issue:** 8  
**Pages:** 683-691  
**Call Number:** in house; NFP files  
**Keywords:** geomorphology; river regulation; dams; fluvial processes; sediment transport;  
**Abstract:** Review article. Good additional references.  
**Notes:** Discussion of general geomorphic processes (almost all sediment transport based) following dam removal and current lack of data and models for predicting responses for specific site. Good references; most of discussion is based on documented geomorphic effects of dam operations and river regulation and conceptual models of sediment transport and deposition; assumption is that dam removal will reverse these effects.

**Reference Type:** Journal Article  
**Record Number:** 140  
**Author:** Poff, N. L.  
**Year:** 1996

**Title:** A hydrogeography of unregulated streams in the United States and an examination of scale-dependence in some hydrological descriptors

**Journal:** Freshwater Biology

**Volume:** 36

**Pages:** 101-121

**Reference Type:** Journal Article

**Record Number:** 304

**Author:** Poff, N. L.

**Year:** 1997

**Title:** Landscape filters and species traits: towards mechanistic understanding and prediction in stream ecology.

**Journal:** J. North. Am. Benthol. Soc.

**Volume:** 16

**Pages:** 391-409

**Call Number:** not in house

**Reference Type:** Journal Article

**Record Number:** 139

**Author:** Poff, N. L.; Allan, J. D.

**Year:** 1995

**Title:** Functional organization of stream fish assemblages in relation to hydrological variability

**Journal:** Ecology

**Volume:** 76

**Pages:** 606-627

**Reference Type:** Journal Article

**Record Number:** 436

**Author:** Polzin, M. L.; Rood, S. B.

**Year:** 2000

**Title:** Effects of damming and flow stabilization on riparian processes and black cottonwoods a long the Kootenay River

**Journal:** Rivers

**Volume:** 7

**Issue:** 3

**Pages:** 221-232

**Call Number:** in house; NFP files

**Keywords:** cottonwood seedlings; floodplain ecology; fluvial geomorphology; instream flow needs

**Abstract:** The Kootenay (Kootenai) River of British Columbia and Montana was

dammed in 1972 by the Libby dam that is operated for hydroelectric power and flood control. Subsequently, downstream flows have been stabilized below the prior 1-in-2 year peak discharge. Historical changes in the river valley were assessed using air photos from 1930, 1962/1963, and 1992/1994. Prior to damming the upstream and downstream reaches involved dynamic channels with changing positions and an abundance of barren sand bars. Following damming, the lower Kootenay channel has become fixed in position and barren bars are deficient. Field surveys in 1996 and 1997 involved three sites along each of the upstream and downstream reaches of the Kootenay and two sites along the free-flowing tributary, the Fisher River. Cross-sectional transects were established up the stream banks, and elevation, vegetation, and substrate were surveyed. These confirmed the abundance of barren sand bars along the upper Kootenay versus cobble substrate and a lack of barren bars along the downstream reach. The free-flowing upper Kootenay and Fisher reaches experience extensive sediment deposition in the riparian zones after the 1996 and 1997 high water (mean changes of 26 and 52 cm for 1997) whereas the lower Kootenay experienced minimal change (<7 cm). Abundant black cottonwood (*Populus trichocarpa*) recruitment occurred in 1996 and 1997 along the upper Kootenay and Fisher rivers (1997 densities of 536 and 142 seedlings/m<sup>2</sup>) but no seedlings were successfully established along the lower Kootenay. Grasses have encroached to the river's edge along the lower Kootenay, further preventing cottonwood recruitment. Flow stabilization has thus resulted in channel stabilization, minimal cottonwood recruitment, and diminished deciduous shrubs along the lower Kootenay. The conservation of the riparian woodlands along the lower Kootenay would benefit from the reestablishment of more naturally dynamic flow patterns that would include occasional high spring flows.

**Reference Type:** Journal Article

**Record Number:** 207

**Author:** Poole, G. C.; Berman, C. H.

**Year:** 2001

**Title:** An ecological perspective on in-stream temperature: natural heat dynamics and mechanisms of human-caused thermal degradation

**Journal:** Environmental Management

**Volume:** 27

**Issue:** 6

**Pages:** 787-802

**Call Number:** in house; NFP files

**Keywords:** stream temperature; shade; hyporheic zone; groundwater; channel morphology; riparian vegetation; anthropogenic influences; flow regime; in-stream flow

**Abstract:** While external factors (drivers) determine the net heat energy and

water delivered to a stream, the internal structure of a stream determines how heat and water will be distributed within and exchanged among a stream's components (channel, alluvial aquifer, and riparian zone/floodplain). Therefore, the interaction between external drivers of stream temperature and the internal structure of integrated stream systems ultimately determines channel water temperature. This paper presents a synoptic, ecologically based discussion of the external drivers of stream temperature, the internal structures and processes that insulate and buffer stream temperatures, and the mechanisms of human influence on stream temperature. It provides a holistic perspective on the diversity of natural dynamics and human activities that influence stream temperature, including discussions of the role of the hyporheic zone. Key management implications include (1) Protecting or reestablishing in-stream flow is critical for restoring desirable thermal regimes in streams. (2) Modified riparian vegetation, groundwater dynamics, and channel morphology are all important pathways of human influence on channel-water temperature and each pathway should be addressed in management plans. (3) Stream temperature research and monitoring programs will be jeopardized by an inaccurate or incomplete conceptual understanding of complex temporal and spatial stream temperature response patterns to anthropogenic influences. (4) Analyses of land-use history and the historical vs. contemporary structure of the stream channel, riparian vegetation, and alluvial aquifer are important prerequisites for applying mechanistic temperature models to develop management prescriptions to meet in-channel temperature goals.

**Reference Type:** Journal Article

**Record Number:** 308

**Author:** Power, M.; Sun, A.; Parker, G.; Dietrich, W.; Wooton, T.

**Year:** 1995

**Title:** Hydraulic food-chain models

**Journal:** BioScience

**Volume:** 45

**Issue:** 3

**Pages:** 159-167

**Call Number:** in house

**Keywords:** floodplain; trophic dynamics; food web; hydrology; flow regime; flood regime

**Reference Type:** Book Section

**Record Number:** 35

**Author:** Prax, A.

**Year:** 1991

**Title:** The hydrophysical properties of the soil and changes in them.

**Editor:** Penka, M., M. Vyskot, E. Klimo, and F. Vasicek  
**Book Title:** Floodplain Forest Ecosystem. II. After Water Management Measures  
**City:** Amsterdam  
**Publisher:** Elsevier  
**Pages:** 145-168  
**Call Number:** not in house

**Reference Type:** Journal Article  
**Record Number:** 310  
**Author:** Pringle, C. M.; Freeman, M. C.; Freeman, B. J.  
**Year:** 2000  
**Title:** Regional effects of hydrologic alterations on riverine macrobiota in the New World: tropical-temperate comparisons.  
**Journal:** BioScience  
**Volume:** 50  
**Issue:** 9  
**Pages:** 807-823  
**Call Number:** in house; NFP files  
**Notes:** Summary of regional effects of hydrologic alterations on riverine macrobiota (fish, mussels, crustaceans, a few mammals - dolphins) in North America and then comparison with more recently documented alterations and effects in the American tropics. Summary of effects in terms of population declines, changes in regional biodiversity, effects on metapopulation dynamics and increases in exotic taxa. Good set of references; strong focus on southeastern US.

**Reference Type:** Book Section  
**Record Number:** 47  
**Author:** Pringle, C. M.; Scatena, F. N.  
**Year:** 1999  
**Title:** Aquatic ecosystem deterioration in Latin America and the Caribbean  
**Editor:** Hatch, U. and M. E. Swisher  
**Book Title:** Managed Ecosystems: the MesoAmerican Experience  
**City:** New York  
**Publisher:** Oxford University Press  
**Pages:** 104-113  
**Call Number:** not in house  
**Keywords:** Pringle and Scatena 1999b is in same volume

**Reference Type:** Journal Article

**Record Number:** 200

**Author:** Puckridge, J. T.; Sheldon, F.; Walker, K. F.; Bouton, A. J.

**Year:** 1998

**Title:** Flow variability and the ecology of large rivers

**Journal:** Marine and Freshwater Research

**Volume:** 49

**Pages:** 55-72

**Call Number:** in house; NFP files

**Keywords:** flow variability, hydrographs, river conservation, river management, flood pulse, flow regime; flow-fish relationships; fish; ecologically functional flow variables; indicators of hydrologic alteration; IHA

**Abstract:** Ecological processes in large rivers are controlled by their flow variability. However, it is difficult to find measures of hydrological variability that characterize groups of rivers and can also be used to generate hypotheses about their ecology. Multivariate analyses of the hydrographs of 52 rivers worldwide revealed distinctive patterns of flow variability that were often correlated with climate. For example, there were groups of rivers that corresponded broadly with 'tropical' and 'dryland' climates. However, some rivers from continental climates occupy both extremes of this range, illustrating the limitations of simple classification. **Individual rivers and groups of rivers may also have different hydrographic 'signatures' and attempts to combine measures of hydrological variability into indices mask biologically significant variation. This paper identifies 11 relatively independent measures of hydrological variability that help categorize river types and are each associated with aspects of fish biology.** Ways are suggested by which the flood pulse concept can be expanded to encompass hydrological variability and accommodate differences among groups of rivers from different climatic regions. Such recognition of the complex role of hydrological variability enhances the value of the concept for river conservation, management, and restoration.

**Notes:** Used multivariate analyses to determine if there are measures of hydrologic variability that characterize groups of rivers and could be used to generate hypotheses about river ecology. Found distinctive patterns of flow variability related to climate - i.e., groups of tropical and dryland type rivers. However, a simple classification or use of indices may mask significant differences that are biologically important. Authors identify 11 'relatively' independent measures of hydrological variability that are associated with aspects of fish biology and could be used to categorize river types according to flow variability. Applies this system to flood pulse concept to show how it can be expanded to incorporate variability among rivers in different climatic regions.

**Reference Type:** Journal Article

**Record Number:** 411

**Author:** Rea, N.; Ganf, G. G.

**Year:** 1994

**Title:** Water depth changes and biomass allocation in two contrasting macrophytes

**Journal:** Australian Journal of Marine and Freshwater Research

**Volume:** 45

**Pages:** 1459-1468

**Call Number:** in house; NFP files

**Keywords:** aquatic macrophytes; flow regime; biomass allocation

**Abstract:** The response of *Baumea arthrophylla* and *Triglochin procerum* in pot experiments to depth and depth changes provided insight into how plants survive fluctuating water levels. At 0 cm depth, most biomass was placed below ground, which can be interpreted as the placement of resource-acquiring tissues (roots, rhizomes) in resource (nutrients, space)-supplying environments. At 50 and 100 cm, the placement of biomass into shoots recognized the need for a higher supply of above-ground resources (light, inorganic carbon, oxygen). However, the responses of the two species to flooding or exposure differed. Rhizome storage supported an increase in the number and height of *B. arthrophylla* stems when flooded by 50 cm but this species was unable to counteract submergence to 100 cm without the critical loss of root mass. The slow turnover rate of the cuticularized *B. arthrophylla* stems indicates that biomass needs to be allocated above water as well as above ground. Other responses indicated that this species may be better suited to seasonally fluctuating rather than permanent water levels. *T. procerum* dealt with water level changes via morphological plasticity. Along with the rapid growth and turnover of the spongy leaves, its shoot and total mass were maintained primarily from resources in the tubers.

**Notes:** growth rates of *B. arthrophylla* were reduced with fluctuating water levels; good example of differing tolerances of aquatic macrophytes to inundation and exposure; tolerances used to predict flow regimes and water level fluctuations that each species requires to persist

**Reference Type:** Journal Article

**Record Number:** 409

**Author:** Reily, P. W.; Johnson, P. W.

**Year:** 1982

**Title:** The effects of altered hydrologic regime on tree growth along the Missouri River in North Dakota

**Journal:** Canadian Journal of Botany

**Volume:** 60

**Pages:** 2410-2423

**Call Number:** in house; NFP files

**Keywords:** flow regime; river regulation; riparian vegetation; cottonwood; recruitment



**Reference Type:** Conference Proceedings

**Record Number:** 426

**Author:** Relyea, C. D.; Minshall, G. W.; Danehy, R. J.

**Year of Conference:** 2000

**Title:** Stream insects as bioindicators of fine sediment

**Conference Name:** Watershed Management 2000 Conference

**Publisher:** Water Environment Federation

**Keywords:** flow regime; sediment; bioindicator

**Abstract:** Fine inorganic sediment ( $\leq 2\text{mm}$ ) is a major non-point source pollutant in streams. While some fine sediment in streams is natural, loads in human-impacted streams often exceed their capacity to flush these sediments during high flows. Regardless of the source, the negative effects of increased levels of fine sediment in streams are realized in all biotic components of stream ecosystems from microbes to fish and in functional components such as primary and secondary production and nutrient cycling. Bioindicators sensitive to these negative impacts would be a valuable tool for resource managers. We focus on aquatic insects and their usefulness as bioindicators of increased fine sediment in stream ecosystems. Aquatic biomonitoring typically is used in most stream monitoring protocols. One disadvantage of current applications of aquatic biomonitoring is that it does not allow one to discriminate among pollutants. To address this disadvantage we targeted a specific pollutant, fine inorganic sediment, and examined the relationship between fine inorganic sediment and aquatic insects.

**Notes:** Fine sediment index may be used together with flow variables to evaluate relative effects of flow changes and changes in sediment regime on aquatic macroinvertebrates. Paper contains a list of sediment tolerances for macroinvertebrates in Idaho streams.

**Reference Type:** Journal Article

**Record Number:** 62

**Author:** Ribeiro, M. C.; Petrere, M.; Juras, A. A.

**Year:** 1995

**Title:** Ecological integrity and fisheries ecology of the Araguaia-Tocantins river basin, Brazil.

**Journal:** Regulated Rivers: Research and Management

**Volume:** 11

**Pages:** 325-350

**Call Number:** not in house, Pringle et al. 2000

**Reference Type:** Journal Article

**Record Number:** 346

**Author:** Richter, B. D.; Mathews, R.; Harrison, D. L.; Wigington, R.

**Year:** 2003

**Title:** Ecologically sustainable water management: managing river flows for ecological integrity

**Journal:** Ecological Applications

**Volume:** 13

**Issue:** 1

**Pages:** 206-224

**Call Number:** in house; NFP files

**Keywords:** sustainable water development; water resources management; ecosystem management; river management; adaptive management; hydrologic alteration; freshwater biodiversity; freshwater ecosystems; instream flow; dam operations; ecosystem monitoring; ecological flow assessment

**Abstract:** Human demands on the world's available freshwater supplies continue to grow as the global population increases. In the endeavor to manage water to meet human needs, the needs of freshwater species and ecosystems have largely been neglected, and the ecological consequences have been tragic. Healthy freshwater ecosystems provide a wealth of goods and services for society, but our appropriation of freshwater flows must be better managed if we hope to sustain these benefits and freshwater biodiversity. We offer a framework for developing an ecologically sustainable water management program, in which human needs for water are met by storing and diverting water in a manner that can sustain or restore the ecological integrity of affected river ecosystems. Our six-step process includes: (1) developing initial numerical estimates of key aspects of river flow necessary to sustain native species and natural ecosystem functions; (2) accounting for human uses of water, both current and future, through development of a computerized hydrologic simulation model that facilitates examination of human-induced alterations to river flow regimes; (3) assessing incompatibilities between human and ecosystem needs with particular attention to their spatial and temporal character; (4) collaboratively searching for solutions to resolve incompatibilities; (5) conducting water management experiments to resolve critical uncertainties that frustrate efforts to integrate human and ecosystem needs; and (6) designing and implementing an adaptive management program to facilitate ecologically sustainable water management for the long term. Drawing from case studies around the work to illustrate our framework, we suggest that ecologically sustainable water management is attainable in the vast majority of the world's river basins. However this quest will become far less feasible if we wait until water supplies are further over-appropriated.

**Reference Type:** Journal Article

**Record Number:** 430

**Author:** Richter, B. D.; Richter, H. E.

**Year:** 2000

**Title:** Prescribing flood regimes to sustain riparian ecosystems along meandering rivers

**Journal:** Conservation Biology

**Volume:** 14

**Issue:** 5

**Pages:** 1467-1478

**Call Number:** in house; NFP files

**Keywords:** riparian vegetation; flow regime; river regulation; recruitment; flood regime

**Abstract:** The composition and structure of native riverine ecosystems are tightly linked to natural hydrologic variability. By managing river flows for water supplies and power generation, water management agencies have inadvertently caused considerable degradation of riverine ecosystems and associated biodiversity. New approaches for meeting human needs for water while conserving the ecological integrity of riverine ecosystems are greatly needed. We describe an approach for identifying the natural flooding characteristics that must be protected or restored to maintain riparian (floodplain) ecosystems along meandering rivers. **We developed a computer model to simulate flood-driven changes in the relative abundance of riparian patch types along the Yampa River in Colorado (U.S.A.).** The model is based on research suggesting that the duration of flooding at or above 209 m<sup>3</sup>/s (125% of bankfull discharge) is particularly important in driving lateral channel migration, which is responsible for initiating ecological succession in the Yampa's riparian forest. Other hydrologic variables, such as the magnitude of annual peak flows, were not as strongly correlated with lateral channel migration rates. Model simulations enabled us to tentatively identify a threshold of alteration of flood duration that could lead to substantial changes in the abundance of forest patch types over time should river flows be regulated by future water projects. Based on this analysis, we suggest an ecologically compatible water management approach that avoids crossing flood alteration thresholds and provides the opportunity to use a portion of floodwaters for human purposes. Recommended improvements to the Yampa model include obtaining additional low-elevation aerial photographs of the river corridor to enable better estimation of channel migration rates and vegetation changes. These additional data should greatly improve the model's accuracy and predictive capabilities and therefore its management value.

**Notes:** Good example of correlations revealing potential 'ecologically relevant flow variables' and of target setting for management flows to sustain riparian forests.

**Reference Type:** Journal Article

**Record Number:** 149

**Author:** Robertson, A.I.; Bacon, P.; Heagney, G.

**Year:** 2001

**Title:** The responses of floodplain primary production to flood frequency and timing

**Journal:** Journal of Applied Ecology

**Volume:** 38

**Pages:** 126-136

**Call Number:** in house, NFP files

**Keywords:** conservation; floodplain; flood regime; wetland primary production; wood production

**Abstract:** River regulation and abstraction have dramatically altered the natural flow regime of many rivers world-wide, but experimental investigations of the biological effects are infrequent. In the mid-region of the Murray River, Australia, river regulation has reduced the frequency and duration of spring floods and increased the frequency of summer floods. We used controlled floods (treatments; no floods, spring floods, summer floods, and spring+summer floods) to determine how the growth of river red gum *Eucalyptus camaldulensis* trees, aquatic macrophytes and biofilms varied with the seasonal timing and frequency of flooding.

After 6 years of controlled flooding, above-ground net production of wood by river red gum trees was equal and greatest in plots receiving spring+summer floods and summer floods (mean 496 g/m<sup>2</sup>/yr). Production was significantly lower in plots receiving spring floods or no controlled floods, which had similar rates of production (mean 330 g/m<sup>2</sup>/yr).

During 2 yrs of measurement in wetlands created by flooding, production and species richness of aquatic macrophytes were both greater in spring than in summer floods. The history of flood frequency at any experimental site did not affect macrophyte production or species richness. The aquatic macrophyte community in shallow regions of wetlands differed significantly with the seasonal timing of floods but not flood frequency.

The accumulation of chlorophyll-a and total mass of biofilm on wood surfaces in wetlands created by flooding were greater in spring (mean chlorophyll-a 0.88 ug/cm<sup>2</sup>, mean mass 0.066 mg/cm<sup>2</sup>) than in summer floods (mean chlorophyll a 0.09 ug/cm<sup>2</sup>; mean mass 0.034 mg/cm<sup>2</sup>). The history of flood frequency at any experimental site did not affect accumulation of either the autotrophic or heterotrophic components of biofilms.

Spring flooding, while not as beneficial for tree growth, is critical for the growth of wetland macrophytes, the maintenance of macrophyte species richness, and favours better development of autotrophic biofilms. Maintenance of both the timber harvest and wetland conservation values of these floodplains will require the return of more natural flood flows in the spring period. Restoration of floodplain rivers requires a thorough understanding of the relationships between ecological functions and the natural flow regime.

**Notes:** good additional citations

**Reference Type:** Journal Article  
**Record Number:** 364  
**Author:** Rogers, Kevin; Biggs, Harry  
**Year:** 1999  
**Title:** Integrating indicators, endpoints and value systems in strategic management of the rivers of the Kruger National Park  
**Journal:** Freshwater Biol  
**Volume:** 41  
**Issue:** 2  
**Pages:** 439-451  
**Date:** March 01, 1999  
**Alternate Journal:** Freshwater Biology  
**Keywords:** environmental flows; river management; river regulation; indicators  
**URL:** <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2427.1999.00441.x/abs>

**Reference Type:** Journal Article  
**Record Number:** 151  
**Author:** Rood, Stewart; Mahoney, John  
**Year:** 1990  
**Title:** Collapse of Riparian Poplar Forests Downstream from Dams in Western Prairies: Probable causes and prospects for mitigation  
**Journal:** Environmental Management  
**Volume:** 14  
**Issue:** 4  
**Pages:** 451-464  
**Keywords:** Poplars, river damming, riparian vegetation, environmental mitigation  
**Abstract:** Although historically abundant, the riparian poplar forests of the western prairies are now endangered as a result of the damming and diversion of rivers in this region. Recent reports have described substantial declines of riparian poplar forests downstream from dams in Alberta, Canada, Montana, Wyoming, Colorado, and Arizona. The present report analyzes the forest and hydrological conditions reported previously in order to clarify the causes of the downstream forest decline.

**Reference Type:** Journal Article  
**Record Number:** 316  
**Author:** Rood, Stewart; Mahoney, John  
**Year:** 1995  
**Title:** River Damming and Riparian Cottonwoods along the Marias River,

Montana

**Journal:** Rivers

**Volume:** 5

**Issue:** 3

**Pages:** 195-207

**Keywords:** Instream flow, populus, riparian vegetation, river damming, seedlings

**Abstract:** The Tiber Dam on the Marias River, Montana, moderates downstream flows by trapping spring flood flows and augmenting flows at other times.

Cottonwoods, and their interspecific hybrids occur along the river and similar in health upstream and downstream from the dam. However, there is a severe deficiency of cottonwood seedlings downstream from the Tiber Dam that probably results from the stabilized river flows. Descriptive analyses of riparian cottonwoods and quantitative analyses of streamflow patterns were conducted to investigate the factors that influence the regeneration of riparian cottonwoods.

**Reference Type:** Journal Article

**Record Number:** 153

**Author:** Rood, Stewart; Mahoney, John; Reid, David; Zilm, Leslie

**Year:** 1995

**Title:** Instream flows and the decline of riparian cottonwoods along the St. Mary River, Alberta

**Journal:** Canadian Journal of Botany

**Volume:** 73

**Pages:** 1250-1260

**Keywords:** cottonwood; recruitment; Populus; dams; river regulation; instream flows

**Reference Type:** Journal Article

**Record Number:** 437

**Author:** Rood, S. B.; Taboulchanas, K.; Bradley, C. E.; Kalischuk, A. R.

**Year:** 1999

**Title:** Influence of flow regulation on channel dynamics and riparian cottonwoods along the Bow River, Alberta

**Journal:** Rivers

**Volume:** 7

**Issue:** 1

**Pages:** 33-48

**Call Number:** in house; NFP files

**Keywords:** damming, floods, flow stabilization; hydrograph; recruitment; riparian vegetation; channel morphology

**Abstract:** Following extensive damming, flood flows along Alberta's Bow River have been attenuated. To determine consequences of flow regulation, we

compared historical river channel characteristics from 1918 land survey maps and 1950 air photos with those of 1991 and 1992. Comparisons revealed reduced channel movement, braiding, and island occurrences by 1991. These changes decreased the extent of barren streamside zones that provide recruitment sites for balsam poplar (*Populus balsamifera*) and sandbar willow (*Salix exigua*). Cottonwoods were aged after increment coring, and an irregular age distribution suggests that cottonwood establishment was episodic, partially occurring in pulses following flood events. A deficiency of recruitment after 1955 may be due to flood attenuation combined with impacts from cattle. Analyses of annual hydrographs for apparent recruitment years support the 'recruitment box' model. Cottonwood establishment was probably dependent on (1) high flows that preceded seed release, (2) flow recession that permitted establishment at appropriate stream-bank elevations, (3) gradual flow decline for seedling survival, and (4) absence of floods in the following year(s). Air photo analysis revealed minor changes in the extent of riparian woodlands between 1962 and 1992, indicating that the deficiency of cottonwood recruitment had not yet impacted woodland abundance. Inflows from the non-dammed Highwood River led to partial recovery of Bow River flow and channel dynamics, increasing areas of barren bars and cottonwood recruitment. This study demonstrates that flow stabilization led to channel stabilization and reduced cottonwood recruitment and suggests that conservation of Bow River woodlands will rely on the dynamic inflows from the Highwood River.

**Notes:** importance of inter-annual variability of flows as well as timing, frequency and magnitude of high flows for dynamic channel/floodplain and riparian vegetation recruitment

**Reference Type:** Journal Article

**Record Number:** 19

**Author:** Schlosser, I. J.; Angermeier, P. J.

**Year:** 1990

**Title:** The influence of environmental variability, resource abundance, and predation on juvenile cyprinid and centrarchid fishes.

**Journal:** Pol. Arch. Hydrobiol.

**Volume:** 37

**Pages:** 265-284

**Call Number:** not in house

**Reference Type:** Journal Article

**Record Number:** 63

**Author:** Schmidt, J. C.; Webb, R. H.; Vadez, R. A.; Marzolf, G. R.; Stevens, L. E.

**Year:** 1998

**Title:** Science and values in river restoration in the Grand Canyon.

**Journal:** BioScience  
**Volume:** 48  
**Pages:** 735-747  
**Call Number:** Pringle et al. 2000

**Reference Type:** Book  
**Record Number:** 64  
**Author:** Scopettone, G. C; Vinyard, G.  
**Year:** 1991  
**Title:** Life history and management of four endangered lacustrine suckers.  
**Series Title:** Battle Against Extinction: Native Fish Management in the American West  
**City:** Tucson, AZ  
**Publisher:** University of Arizona Press  
**Number of Pages:** 359-377  
**Call Number:** Pringle et al. 2000

**Reference Type:** Journal Article  
**Record Number:** 159  
**Author:** Scott, Michael; Friedman, Jonathan; Auble, Gregor  
**Year:** 1996  
**Title:** Fluvial process and the establishment of bottomland trees  
**Journal:** Geomorphology  
**Volume:** 14  
**Pages:** 327-339  
**Abstract:** The effects of river regulation on bottomland tree communities in western North America have generated substantial concern because of the important habitat and aesthetic values of these communities. Consideration of such effects in water management decisions has been hampered by the apparent variability of responses of bottomland tree communities to flow alteration. When the relation between streamflow and tree establishments is placed in a geomorphic context, however, much of that variability is explained, and prediction of changes in the tree community is improved.

**Reference Type:** Journal Article  
**Record Number:** 20  
**Author:** Sear, D. A.  
**Year:** 1993  
**Title:** Fine sediment infiltration into gravel spawning beds within a regulated river experiencing floods: ecological implications for salmonids.  
**Journal:** Regul. Rivers



**Volume:** 8  
**Pages:** 373-390  
**Call Number:** Puckridge et al. 1998

**Reference Type:** Journal Article  
**Record Number:** 323  
**Author:** Sear, D.A.  
**Year:** 1995  
**Title:** Morphological and sedimentological changes in a gravel-bed river following 12 years of flow regulation for hydropower  
**Journal:** Regulated Rivers: Research and Management  
**Volume:** 10  
**Pages:** 247-264

**Reference Type:** Journal Article  
**Record Number:** 413  
**Author:** Segelquist, C. A.; Scott, M. L.; Auble, G. T.  
**Year:** 1993  
**Title:** Establishment of *Populus deltoides* under simulated alluvial groundwater declines  
**Journal:** American Midland Naturalist  
**Volume:** 130  
**Pages:** 274-285  
**Call Number:** in house; NFP files  
**Keywords:** cottonwood; *Populus deltoides*; groundwater tables; flow regime; river regulation  
**Abstract:** Establishment, growth and survival of seedlings of *Populus deltoides* subsp. *monilifera* (plains cottonwood) were examined in an experimental facility simulating five rates of declining alluvial groundwater. The treatments were permanent saturation, draw-down rates of 0.4, 0.7, 2.9 cm/d and immediate drainage. The experiment was conducted outdoors in planters near Fort Collins, Colorado. Seedling survival was highest under the two slowest drawdown rates and declined significantly with faster drawdown rates. The highest growth rate was associated with a drawdown rate of 0.4 cm/d, in which mean shoot height was 2.4 cm and mean root length was 39 cm 98 days after planting. Growth of shoots and roots was reduced both by saturated conditions and by the more rapid drawdown rates of 0.7 and 2.9 cm/d. No establishment was observed in the immediate drawdown treatment. Whereas maximum biomass accumulation is associated with the most gradual drawdown or saturated conditions, seedlings establishing naturally under such conditions are also most likely to be removed by ice or subsequent flooding. Seedlings establishing in higher topographic positions, in contrast, are subject to increased mortality and reduced shoot

growth, resulting from reduced soil moisture. Rapid root extension following establishment allows *P. deltoides* seedlings to grow across a wide range of groundwater drawdown rates, and thus a variety of positions across a gradient of riparian soil moisture. Our results indicate that in coarse alluvial sands of low fertility, 47% of germinating *P. deltoides* seeds were able to survive in association with a drawdown rate of 2.9 cm/d and a final water table depth of 80 cm.

**Notes:** experimental test of seedling survival and growth under varying soil moisture drawdown rates simulating variations in conditions found on regulated vs. unregulated rivers; establishes conditions required for successful recruitment of cottonwood seedlings

**Reference Type:** Journal Article

**Record Number:** 325

**Author:** Smith, S.; Wellington, B. A.; Nachlinger, J.; Fox, C.

**Year:** 1991

**Title:** Functional Responses of Riparian Vegetation to streamflow diversion in the eastern Sierra Nevada

**Journal:** Ecological Applications

**Volume:** 1

**Issue:** 1

**Pages:** 89-97

**Keywords:** Betula, deuterium, Populus, riparian, Salix, Sierra Nevada, stable isotopes, stomatal conductance, streamflow diversion, water potential

**Abstract:** Partial streamflow diversion due to the siting of hydroelectric generating plants may increase the incidence and degree of water stress in riparian vegetation. This study, conducted on Bishop Creek in the eastern Sierra Nevada, CA, compared the water relations of riparian vegetation on paired undiverted and diverted reaches.

**Reference Type:** Journal Article

**Record Number:** 170

**Author:** Stanford, Jack; Ward, jJ. V.; Liss, W.; Frissell, C.; Williams, R.; Lichatowich, J.; Coutant, C.

**Year:** 1996

**Title:** A General protocol for restoration of regulated rivers

**Journal:** Regulated Rivers: Research and Management

**Volume:** 12

**Pages:** 391-413

**Reference Type:** Journal Article

**Record Number:** 199

**Author:** Strange, E. M.; Fausch, K. D.; Covich, A. P.

**Year:** 1999

**Title:** Sustaining ecosystem services in human-dominated watersheds: biohydrology and ecosystem processes in the South Platte River Basin

**Journal:** Environmental Management

**Volume:** 24

**Issue:** 1

**Pages:** 39-54

**Call Number:** Cassin; NFP files

**Keywords:** biohydrology, aquatic ecosystems, watershed restoration, ecosystem services, flow regime, flow management, river regulation, community assemblages

**Notes:** Case study illustration of an approach to link hydrology and population, community and ecosystem processes; focus on species functional traits in relation to composition of biotic communities and ecosystem function in a particular system; illustrates importance of case study approach (site- or system-specific) in setting flow restoration goals and targets.

**Reference Type:** Journal Article

**Record Number:** 176

**Author:** Stromberg, Juliet; Chew, Matthew

**Year:** 1997

**Title:** Herbaceous Exotics in Arizona's riparian ecosystems

**Journal:** Desert Plants

**Pages:** 11-17

**Keywords:** Riparian ecosystems of the desert Southwest support a surprising variety of plant species. The native trees include the (by now) familiar Fremont cottonwood, Goodding willow, and mesquites, and a less celebrated supporting cast of shrubs such as seep-willow, burro brush, and rabbit brush. But the true indicators of diversity are the non woody herbs of the riparian understory. During a three year collection period at the Arizona Nature Conservancy's Hassayampa River Preserve, Wolden et al 1994, documented over 340 plant species along 8 km of the stream and associated riparian corridor.

**Reference Type:** Journal Article

**Record Number:** 174

**Author:** Stromberg, Julie; Patten, Duncan

**Year:** 1990

**Title:** Riparian Vegetation Instream Flow Requirements: A case study from a diverted stream in the eastern Sierra Nevada, CA, USA

**Journal:** Environmental Management

**Volume:** 14

**Issue:** 2

**Pages:** 185-194

**Keywords:** Instream flow, riparian vegetation, stream diversion, computer model, rush creek

**Abstract:** A methodology is described that allows determination of instream flow requirements for maintenance of riparian trees. Tree-ring data revealed strong relationships between tree growth and stream flow volume for riparian species at Rush Creek, an alluvial stream within an arid setting. These relationships allowed development of models that predict growth rates from hydrologic variables. The models can be used to assess instream flow requirements under the assumption that certain levels of growth are necessary to maintain the population. There is a critical need for development and use of instream flow methodologies for riparian vegetation, since present methodologies focus on needs of aquatic animals and may underestimate needs of the entire riparian ecosystem.

**Reference Type:** Journal Article

**Record Number:** 414

**Author:** Stromberg, J. C

**Year:** 1993

**Title:** Instream flow models for mixed deciduous riparian vegetation within a semiarid region

**Journal:** Regulated Rivers: Research and Management

**Volume:** 8

**Pages:** 225-235

**Call Number:** in house; NFP files

**Keywords:** riparian vegetation; instream flow; flow reduction; semiarid region; Arizona

**Abstract:** Empirical evidence from a semiarid watershed of the southwestern United States (Verde River basin, Arizona) indicated that abundance and species richness of mixed deciduous riparian forests varied in a curvilinear and quantifiable fashion as a function of stream flow parameters. **Three indicators of riparian abundance - foliage area, stem basal area, and stand width - increased most significantly with growing season flow volumes, a surrogate indicator of riparian water availability.** Tree species richness varied in a bell curve fashion with flood size, with the greatest richness occurring at streams with intermediate flood magnitudes. These instream flow models have management implications for riparian habitats. They suggest that flow volume (and the related attributes of water-table recharge and floodplain soil wetting) is the primary factor regulating riparian vegetation abundance in the Verde River watershed, and provide a first approximation of the extent of riparian loss expected from flow diversion or other types of flow reduction.

**Reference Type:** Journal Article

**Record Number:** 173

**Author:** Stromberg, J. C.; Patten, D.

**Year:** 1992

**Title:** Mortality and age of black cottonwood stands along diverted and undiverted streams in the eastern Nevada, CA

**Journal:** Madrono

**Volume:** 39

**Issue:** 3

**Pages:** 20-223

**Abstract:** Effects of stream flow diversion on riparian vegetation can range from extreme to subtle. Extreme effects include extensive loss of riparian vegetation such as has occurred along portions of Bishop Creek, Rush Creek, and other eastern Sierra Nevada streams diverted for hydropower production and municipal water use. Some diverted reaches of these and other streams, however, have relatively dense vegetation. This study revealed the presence of subtle diversion effects within such reaches of Bishop Creek, as indicated by younger age and size, higher mortality, and lower canopy foliage density of black cottonwood stands in comparison to black cottonwood stands along a nearby free-flowing river.

**Reference Type:** Journal Article

**Record Number:** 175

**Author:** Stromberg, J.C. ; Patten, D. T.

**Year:** 1996

**Title:** Instream flow and cottonwood growth in the eastern Sierra Nevada of CA, USA.

**Journal:** Regulated Rivers: Research and Management

**Volume:** 12

**Pages:** 1-12

**Call Number:** in house, NFP files

**Keywords:** instream flow, riparian vegetation, populus trichocarpa, dendro-ecology, geomorphology

**Abstract:** Dendro-ecological studies indicated that radial growth of *Populus trichocarpa* was significantly related to annual stream flow at 20 riparian sites in the eastern Sierra Nevada of CA. The strength of the relationship varied among sites, depending on geomorphology and tree cover. The strongest correlation between streamflow and tree growth occurred at sites in wide, unconfined valleys, where alluvial groundwater typically fluctuates directly with surface water. In such areas, trees on streambanks and in the floodplain showed equally strong relationships between flow and growth.

**Notes:** matrix

**Reference Type:** Journal Article

**Record Number:** 415

**Author:** Stromberg, J. C.; Richter, B. D.; Patten, D. T.; Wolden, L. G.

**Year:** 1993

**Title:** Response of a Sonoran riparian forest to a 10-year return flood

**Journal:** Great Basin Naturalist

**Volume:** 53

**Issue:** 2

**Pages:** 118-130

**Call Number:** in house; NFP files

**Keywords:** riparian vegetation; flood flow; disturbance; *Populus fremontii*; *Salix goodingii*; floodplain aggradation; resilience

**Abstract:** In March 1991, a 10-year return flood (368 m<sup>3</sup>/sec) occurred in the Hassayampa River, a perennial stream (0.1 m<sup>3</sup>/sec base flow) within the Sonoran Desert. Depth of the floodwater ranged from 2.64 +/- 0.2 m (mean +/- SD) near the stream to 0.47 +/- 0.31 m in the highest floodplain zone (*Prosopis* forest). Flow velocity was 1.7 +/- 0.6 m/sec and 0.9 +/- 0.4 m/sec in these same zones. An average of 8 cm of sediment was deposited on the floodplain, with maximum deposition (to 0.5 m) on densely vegetated surfaces 1-2 m above the water table. Native riparian vegetation showed resistance and resilience to the flood disturbance. Plants on high floodplains (e.g. *Prosopis velutina* trees and saplings, and *Populus fremontii* and *Salix goodingii* trees) had low mortality. *Populus fremontii* and *S. goodingii* 'pole' trees and saplings were on less aggraded floodplains and sustained varying mortality depending on floodplain elevation and depth of flood waters. For example, *P. fremontii* pole trees on 1-2 m high floodplains averaged 6% mortality, compared to 40% for those on low floodplains (< 1m above the water table) where standing water was > 2m. Seedlings of *P. fremontii* and *S. goodingii* established abundantly after the flood along overflow channels and main channel sediment bars, contributing to age-class diversity for these episodically recruiting species. The exotic species, *Tamarix pentandra*, had greater mortality of pole trees (62%) and low post flood recruitment compared to *P. fremontii* and *S. goodingii*. Survivorship of shrub species also corresponded to floodplain elevation. *Zizyphus obtusifolia* grew on high elevation floodplains and had no mortality. Shrub species of lower elevation floodplains underwent mortality but revegetated after the flood via asexual reproduction. For example, stem density of the dominant shrub (*Baccharis salicifolia*) declined by half but recovered to pre-flood levels by late summer primarily by stem sprouting. Dominant herbaceous plants on stream banks and low floodplains (i.e., the rhizomatous perennial grasses *Paspalum distichum* and *Cynodon dactylon*) similarly compensated for a 50% decline in cover by vegetative spread. The post flood herbaceous understory vegetation in high

elevation floodplain zones (i.e., *Prosopis velutina* forests) remained sparse throughout the summer and shifted in composition from nearly monotypic stands of exotic annual species to more diverse mixtures of native and exotic annual grasses and forbs.

**Reference Type:** Journal Article

**Record Number:** 362

**Author:** Thoms, M. C.; Ogden, R. W.; Reid, M. A.

**Year:** 1999

**Title:** Establishing the condition of lowland floodplain rivers: a paleo-ecological approach

**Journal:** Freshwater Biol

**Volume:** 41

**Issue:** 2

**Pages:** 407-423

**Date:** March 01, 1999

**Alternate Journal:** Freshwater Biology

**URL:** <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2427.1999.00439.x/abs>

**Reference Type:** Journal Article

**Record Number:** 391

**Author:** Thomson, J. R.

**Year:** 2002

**Title:** The effects of hydrological disturbance on the densities of macroinvertebrate predators and their prey in a coastal stream

**Journal:** Freshwater Biology

**Volume:** 47

**Pages:** 1333-1351

**Call Number:** in house; NFP files

**Keywords:** disturbance, environmental stress models, floods, harsh-benign, predation, hydrological disturbance

**Abstract:** Environmental Stress Models (ESMs) predict that abiotic disturbance or harshness will differentially affect predators and prey. Consumer Stress Models (CSMs) predict that consumers will be relatively more inhibited by disturbance than prey, and therefore predator impacts will be reduced. Conversely, Prey Stress Models (PSMs) predict that prey will be more adversely affected and consequently predator impacts will increase in disturbed habitats. This study compared the relative tolerances of lotic invertebrate predators and their prey to hydrological disturbance in an Australian coastal stream to test the initial predictions of ESMs.

Macroinvertebrates were sampled with a suction sampler at monthly intervals

and immediately following four high flow events at five sites on the Cumberland River, in south-west Victoria, Australia. Various statistical procedures were used to compare the relative resistances of predator and prey taxa to each high flow event.

The relative resistances of seven predator and nine prey taxa to four floods over a 12-month period were highly variable between floods and between runs within the same flood. Prey taxa appeared to be more resilient than predators to the largest flood event, but there were no differences in the resilience of predators and prey following smaller floods. If disturbance tolerance is determined by resistance and resilience, then there was no consistent pattern of differential tolerance to floods among invertebrate predators and prey in this system. The variability in the relative tolerances of taxa to different disturbance events makes general predictions about the effects of disturbance on the community-wide impact of predation extremely difficult.

**Reference Type:** Journal Article

**Record Number:** 216

**Author:** Tockner, K.; Pennetzdorfer, D.; Reiner, N.; Schiemer, F.; Ward, J. V.

**Year:** 1999

**Title:** Hydrological connectivity and the exchange of organic matter and nutrients in a dynamic river-floodplain system (Danube, Austria)

**Journal:** Freshwater Biology

**Volume:** 41

**Pages:** 521-535

**Call Number:** in house; NFP files

**Keywords:** connectivity, ecosystem processes, large river, organic matter, retention, flow regime, floods

**Abstract:** The relationship between hydrological connectivity, and the exchange processes of suspended sediments, organic matter and nutrients (NO<sub>3</sub>-N) was investigated in a dynamically connected river-floodplain segment of the Danube over a 15-month period in 1995 and 1996 in the Alluvial Zone National Park, Austria.

Based on water level dynamics and water retention times, three phases of river-floodplain connectivity were identified: disconnection (phase I), seepage inflow (phase II) and upstream surface connection (phase III). The frequency of occurrence of these phases was 67.5%, 29.3%, and 3.2%, respectively, during the study period.

A conceptual model is presented linking hydrological connectivity with ecological processes. Generally, the floodplain shifts from a closed and mainly biologically controlled ecosystem during phase I to an increasingly open and more hydrologically controlled system during phases II and III. Phase I, with internal processes dominating, is designated the 'biotic interaction phase'.

Phase II, with massive nutrient inputs to the floodplain yet relatively high



residence times, and therefore, high algal biomass, is classified as the 'primary production phase'. This demonstrates that **water level fluctuations well below bankfull may considerably enhance floodplain productivity.**

Finally, since transport of particulate matter is mainly restricted to short flood pulses above bankfull level, phase III has been defined as the 'transport phase'. The floodplain served as a major sink for suspended sediments (250 mt/ha/yr), FPOM (96 mt/ha/yr), particulate organic carbon (POC; 2.9 mt/ha/yr) and nitrate-nitrogen (0.96 mt/ha/yr), but was a source for dissolved organic carbon (DOC; 240 kg/ha/yr), algal biomass (chlorophyll-a; 0.5 kg/ha/yr) and CPOM (21 kg/ha/yr). Considerable quantities of DOC and algal biomass were exported to the river channel during phase II, whereas particulate matter transport was largely restricted to the short floods of phase III.

The Danube Restoration Project will create a more gradual change between the individual phases by increasing hydrological connectivity between the river channel and the floodplain, and is predicted to enhance productivity by maintaining a balance between retention and export of nutrients and organic matter.

**Reference Type:** Journal Article

**Record Number:** 361

**Author:** Townsend, Colin R.; Riley, Ralph H.

**Year:** 1999

**Title:** Assessment of river health: accounting for perturbation pathways in physical and ecological space

**Journal:** Freshwater Biol

**Volume:** 41

**Issue:** 2

**Pages:** 393-405

**Date:** March 01, 1999

**Alternate Journal:** Freshwater Biol

**URL:** <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2427.1999.00438.x/abs>

**Reference Type:** Journal Article

**Record Number:** 180

**Author:** Travnichek, V.; Bain, M.; Maceina, M.

**Year:** 1995

**Title:** Recovery of a warmwater fish assemblage after the initiation of a minimum flow release downstream from a hydroelectric dam

**Journal:** Transactions of the American Fisheries Society

**Volume:** 124

**Pages:** 836-844

**Call Number:** in house; NFP files

**Keywords:** dams; flow regime; regulated rivers; fish abundance; diversity; riverine fish

**Abstract:** Artificial fluctuations in streamflow caused by hydroelectric power dams can degrade fish habitat and reduce the abundance and diversity of riverine fish faunas. Increased minimum water releases and reduced fluctuations in discharge may mitigate these effects. In this study, we compared shoreline fish abundance and diversity before and after an enhanced flow regime was implemented on the Tallapoosa River (Alabama) downstream of a hydroelectric dam. Before the minimum-flow regime, only eight species of fish were collected 3 km downstream from the dam and all were classified as macrohabitat generalists. After the minimum flow was initiated, species richness 3 km below the dam more than doubled, and over half of the species collected were classified as fluvial specialists. Fish community response to the enhanced flow was not as great at a site 37 km downstream from the dam, where species richness was similar between the two periods. However, more species classified as fluvial specialists were collected after the minimum flow regime than before enhanced flows at this site. Additionally, relative abundance of species classified as fluvial specialists increased from less than 40% of fish collected before enhanced flows to over 80% after minimum flows began. Our results suggest that the enhanced flow regime provided conditions supporting a relatively abundant and diverse fish assemblage more reflective of a riverine system.

**Reference Type:** Journal Article

**Record Number:** 400

**Author:** Travnichek, V. H.; Maceina, M. J.

**Year:** 1994

**Title:** Comparison of flow regulation effects on fish assemblages in shallow and deep water habitats in the Tallapoosa River, Alabama

**Journal:** Journal of Freshwater Ecology

**Volume:** 9

**Issue:** 3

**Pages:** 207-216

**Call Number:** in house; NFP files

**Keywords:** flow regulation; riverine fish; Tallapoosa River;

**Abstract:** We measured species richness, diversity, and abundance of fish in both shallow and deep water areas in regulated and unregulated sections of the Tallapoosa River in Alabama from July 1990 through September 1992 to compare the effects of flow regulation on fish assemblages in shallow and deep water habitats. Flow regulation had a greater effect on shallow water fish assemblages than on deep water fish assemblages. Species richness and diversity of shallow water fishes were reduced below two hydroelectric dams compared with unmodified river segments, and we attribute this to a reduction in

species adapted to fluvial environments below the two dams. Additionally, the density of fish in shallow water areas of unregulated portions of the river was significantly ( $p < 0.05$ ) higher than the density at most of the regulated sites. No reductions in species richness or diversity below the two dams were observed for species inhabiting deep water areas. However, we collected a significantly ( $p < 0.05$ ) higher number of catostomid species in the unmodified river sections compared to the flow-regulated streams.

**Reference Type:** Journal Article

**Record Number:** 354

**Author:** Turak, E.; Flack, L. K.; Norris, R. H.; Simpson, J.; Waddell, N.

**Year:** 1999

**Title:** Assessment of river condition at a large spatial scale using predictive models

**Journal:** Freshwater Biology

**Volume:** 41

**Issue:** 2

**Pages:** 283-298

**Date:** March 01, 1999

**Alternate Journal:** Freshwater Biol

**URL:** <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2427.1999.00431.x/abs>

**Reference Type:** Journal Article

**Record Number:** 36

**Author:** Ward, J. V.

**Year:** 1989

**Title:** The four-dimensional nature of lotic ecosystems.

**Journal:** J. N. Amer. Benthol. Soc.

**Volume:** 8

**Issue:** 1

**Pages:** 2-8

**Call Number:** NFP files

**Keywords:** lotic ecosystems, flow regime, upstream-downstream linkages, floodplain, groundwater, time scales, spatio-temporal hierarchy, lateral connectivity, longitudinal connectivity, vertical connectivity, hyporheic

**Notes:** general references on mostly indirect relationships between flow and habitat/biota

**Reference Type:** Journal Article

**Record Number:** 333

**Author:** Ward, J. V.; Stanford, J. A.

**Year:** 1995

**Title:** Ecological connectivity in alluvial river ecosystems and its disruption by flow regulation

**Journal:** Regulated Rivers: Research & Management

**Volume:** 11

**Pages:** 105-119

**Keywords:** dams; river regulation; connectivity; fragmentation; alluvial rivers; flow regime; flow regulation

**Reference Type:** Journal Article

**Record Number:** 65

**Author:** Watters, G. T.

**Year:** 1996

**Title:** Small dams as barriers to freshwater mussels (*Bivalvia*, *Unionida*) and their hosts.

**Journal:** Biological Conservation

**Volume:** 75:

**Pages:** 79-85

**Call Number:** Pringle et al. 2000

**Reference Type:** Journal Article

**Record Number:** 401

**Author:** Welcomme, R. L.

**Year:** 1989

**Title:** Review of the present state of knowledge of fish stocks and fisheries of African rivers

**Journal:** Canadian Special Publication of Fisheries and Aquatic Sciences

**Volume:** 106

**Pages:** 515-532

**Call Number:** Pringle et al. 2000

**Keywords:** channel spawners; floodplain spawners; river regulation; African rivers

**Reference Type:** Journal Article

**Record Number:** 66

**Author:** Welcomme, R. L.; Hagborg, D.

**Year:** 1977

**Title:** Towards a model of a floodplain fish population and its fishery.

**Journal:** Environmental Biology of Fishes

**Volume:** 2

**Pages:** 7-24

**Call Number:** Pringle et al. 2000

**Reference Type:** Journal Article

**Record Number:** 67

**Author:** Williams, J. D. ; M. L. Warren, Jr.; Cummings, K. S.; Harris, J. L.; Neves, R. J.

**Year:** 1993

**Title:** Conservation status of freshwater mussels of the United States and Canada

**Journal:** Fisheries

**Volume:** 18

**Issue:** 9

**Pages:** 6-22

**Call Number:** Pringle et al. 2000

**Reference Type:** Journal Article

**Record Number:** 68

**Author:** Winston, M. R.; Taylor, C. M.; Pigg, J.

**Year:** 1991

**Title:** Upstream extirpation of four minnow species due to damming of a prairie stream.

**Journal:** Transactions of the American Fisheries Society

**Volume:** 120

**Pages:** 98-105