Symposium abstracts from
Society of Wetland Scientists Annual Meeting
Providence, Rhode Island, May 31- June 4 2015
"Plant Guild and Functional Group Frameworks in Riparian and Wetland Management and Restoration: Models and Applications"
Moderators Daniel Sarr and David Merritt

Functional Groups in Wetland and Riparian Plants: A Strategic Perspective

Presented During: Plant Guild and Functional Group Frameworks in Riparian and Wetland Management and Restoration: Models and Applications, Part 1 of 2
06/04/2015: 10:00 AM - 11:30 AM
Room: 553

Presenting Author:

Paul Keddy

Reviewer:

Jennifer Karberg PhD

Abstract Body:

Wetland and riparian plants, like all living organisms, can be classified in two entirely different ways. I have written elsewhere (in Plants and Vegetation) about this paradox: although there is one Earth, we apparently need two systems to describe the evolution of life forms. The first system is phylogenetic, beginning with Linnaeus (and flower morphology) and ending with the Angiosperm Phylogeny Group (and DNA sequences). This is a powerful way to retrace the origins and evolution of plants, but is rather useless for ecological prediction. The second system is functional. In the broad sense, it is almost the opposite of the phylogenetic approach, because we are seeking patterns in evolutionary convergence. Plants from different origins have converged to become 'mud flat annuals' or 'clonal dominants' or 'sclerophyllous shrubs'. For predictive ecology, we need to identify these convergent groups, come up with consistent names for them, identify their key life history traits, and incorporate them into predictive models. I describe this process at some length in Wetland Ecology. It is not a new idea: foundations include Humboldt (19 groups), Raunkiaer (12 groups), Hutchinson (26 groups, just for aquatics), van der Valk (12 groups) and Grime (3 groups). All of these influenced my own team's approach to this problem (with Shipley, Boutin, and others), and our body of work included mass screening for ecological traits such as relative growth rate and relative competitive ability. The path ahead remains clear. We need to compile a matrix of ecological traits that transcends morphology, adding in innovative functional traits for which we must screen systematically: relative growth rate, nutrient conservation, relative competitive ability, juvenile (establishment) traits, and no doubt others. We are nearly there.

Keywords: functional plant groups, innovative plant traits, predictive ecology, strategic perspective

Effects of Flow Regulation on Numbers and Functions of Riparian Plants

Presented During: Plant Guild and Functional Group Frameworks in Riparian and Wetland Management and Restoration: Models and Applications, Part 1 of 2
06/04/2015: 10:00 AM - 11:30 AM
Room: 553

Presenting Author:

Maria Dolores Bejarano

Additional Author(s):

Christer Nilsson
Francisca C. Aguiar

Reviewer:

Deborah Picking

Abstract Body:

Effects of regulated stream-flows on riparian vegetation were addressed through species-based and process-based approaches. In the former case, we stressed the effects on plant species richness and composition, and in the latter we focused on diversity of plant traits and guilds. The study was conducted along ten rivers in northern Sweden where more than 200 reaches (75% free-flowing and 25% spanning a range of altered flow regimes) were characterized in terms of hydrology and plant species numbers and traits in riparian areas. The degree of regulation and biologically relevant attributes of flow alteration were later used to explain between-reach variation in riparian species and functional diversities. We expected losses or gains of particular guilds depending on the sensitivity of specific traits to regulation and within guild species richness variations, which ultimately may result in changes on riparian ecosystem functioning and resilience. Given the relative youth of the process-based compared to the species-based approach, our final goal was to test whether the former is useful in interpreting the effect of regulation on plant communities, and to identify its strengths and limitations.

Keywords: boreal, flow regulation, process-based approach, riparian plants, species-based approach

Advances and Limitations on Modelling the Effects of Flow Disturbance in Riparian Forests of Mediterranean Europe

Presented During: Plant Guild and Functional Group Frameworks in Riparian and Wetland Management and Restoration: Models and Applications, Part 1 of 2
06/04/2015: 10:00 AM - 11:30 AM
Room: 553

Presenting Author:

Francisca Aguiar

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Pedro Segurado
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Reviewer:

Jennifer Karberg PhD

Abstract Body:

Major problems in Mediterranean Europe are the loss of habitats, biodiversity and water resources. We focused our research in understanding the effects of key human stressors in river systems and riparian forests in this region. Nowadays, these systems are mainly affected by two interacting stressor axes: stream flow alteration by dams and land-use. Approaches based on functional traits are being successfully used in ecological research and in decision sciences. However, for some regions or flora types, such as Mediterranean riparian flora, the existing databases on trait data are limited to specific taxa. In addition, there are generally few attributes that can be related with responses to flow disturbances. Thus, we first developed a riparian on-line trait database–the FLOWBASE (www.isa.ulisboa.pt/proj/flowbase)– which links information on functional traits, riparian woody species, sites of occurrence and sources of information.
Then, we selected 16 hydropower rivers and collected biological data (riparian species cover), environmental data (local, geographic, climatic), and stressor data (land-use, hydrology) from free-flowing referential rivers and from hydropower rivers in Portugal. We derived riparian guilds using data from 66 riparian woody species and 26 traits as expressions of responses to stream flows. We calculated Indicators of Hydrological Alteration for overall sites (n=52), as well as cover of each riparian guild. We used a reduced set of principal components for environment, land-use and hydrology, and adjusted Generalized Linear Models and mixed models (GLMM) to explore the effect of environment, stream flow and land-use (separate and joint effects) on riparian guilds, and to select influential hydrological variables. This approach holds great potential to understand and predict the effects of key-drivers of change in regulated rivers. Our findings also indicate that related research must incorporate the resilience of communities and the complexity of multilevel landscape factors and stressors. Acknowledgements: To FCT through OASIS PTDC/AAC-AMB/1201972010, APA and EDP.

Keywords: regulated rivers, riparian guilds, land-use, functional plant traits, Iberian Peninsula

Riparian Functional Guild Responses to Hydroclimatic Change in the Columbia River Basin

Presented During: Plant Guild and Functional Group Frameworks in Riparian and Wetland Management and Restoration: Models and Applications, Part 1 of 2
06/04/2015: 10:00 AM - 11:30 AM
Room: 553

Presenting Author:

Nate Hough-Snee

Additional Author:

Joe Wheaton

Reviewer:

Deborah Picking

Abstract Body:

Riparian flow guilds have been proposed as a method of measuring riparian ecosystem integrity in large alluvial rivers, especially rivers with regulated flows or strong potential for flows to be reduced by climate change. The riparian flow guild concept identifies groups of species with similar life-history strategies that result from similar physiological requirements and morphological attributes. These trait-based riparian guilds respond to common environmental stressors within the riparian environment such as flooding, drying, and soil moisture availability. In smaller streams however, where hillslopes often directly connect to stream corridors, fluvial and hydrologic processes may work in tandem with riparian and watershed management to influence guild abundance. Here, we build on the concept of riparian flow guilds by identifying riparian disturbance guilds - riparian guilds whose functional and morphological attributes correspond to multiple disturbance or resource axes. We used 26 environmental tolerance and morphological attributes in 30 species to identify five riparian disturbance guilds: a tall, deeply-rooted coniferous tree guild, a rapidly-growing, drought-plastic shrub guild, a low-stature hydrophytic shrub guild, vegetative reproduction guild, and a short-statured, shade-tolerant, understory shrub guild. We modeled these guilds' presence and abundance, finding that each guild responded to a variety of climatic, disturbance, and watershed management attributes. Each guild corresponded to climatic and watershed disturbance attributes that were related to the traits most characteristic of that guild. Most notably, we found that complimentary coexisting guilds or mutually exclusive guilds were strong predictors of guild presence and abundance. From these observations, we conclude that riparian disturbance guilds respond not only to environmental variability that corresponds to each guild's attributes, but also niche partitioning in which different life history strategies can coexist under comparable disturbance regimes. By modeling each guild against future climate and hydrologic scenarios, we make predictions about where each guild is most vulnerable to changes in climate, hydrology, and land-use.

Keywords: biodiversity, functional ecology, global change, riparian ecology, riparian guilds

Riparian Vegetation-Flow Response Guilds for the Colorado River Ecosystem in Grand Canyon, Arizona: A Novel Approach to Riparian Vegetation Analysis

Presented During: Plant Guild and Functional Group Frameworks in Riparian and Wetland Management and Restoration: Models and Applications, Part 2 of 2
06/04/2015: 1:00 PM - 2:30 PM
Room: 553

Presenting Author:

Daniel Sarr, Research Ecologist

Additional Author(s):

David Merritt, Riparian Ecologist
Julian Scott, Hydrologist
Patrick Shaftroth, Research Ecologist
Emily Palmquist, Ecologist
Barbara Ralston, Deputy Director

Reviewer:

Terri Albanese

Abstract Body:

The Colorado River in Grand Canyon has undergone major changes in riparian habitat since the closure of Glen Canyon Dam. Adaptive management of the current regulated river ecosystem requires a means to link flow with riparian vegetation response. Riparian vegetation-flow response guilds provide a potential tool to mechanistically link flow attributes to the distribution and abundance of specific riparian vegetation species, communities, and traits. We compiled physiological and morphological trait information for 114 vascular plant species that were present in sample plots located along the Colorado River in Grand Canyon in 2012 and 2013. For these species, we conducted two guild classifications using hierarchical cluster and analysis and Principal Coordinates Analysis ordination using eight trait variables. The first guild classification was an unsupervised classification that used a Gowers distance metric to classify the pool of 114 species into 7 guilds. The second guild classification was supervised, and intentionally upweighted three traits (Anaerobic Tolerance, Drought Tolerance, and Height at Maturity) to ensure guilds were strongly linked to flow. The supervised guild classification identified 7 guilds. For each guild classification, we fit logistic regression models to link guild probability of presence with flow exceedance (the proportion of time that a site was inundated during the period of detailed flow records from 1985-2013). Logistic regression models were then used to map guild probability of occurrence on a large, heterogeneous sandbar in Grand Canyon. We discuss the process and key findings for riparian flow guild development for the Colorado River in Grand Canyon, and compare to other work being conducted in the Colorado River basin. We explore the merits and challenges associated with guild development as a novel form of riparian vegetation analysis with application to other arid, regulated river systems.

Keywords: riparian flow guilds, Grand Canyon, classification, functional group, regulated river

Identification of Plant Functional Groups Along Gradients of Anthropogenic Disturbance: Implications for Restoration and Conservation

Presented During: Plant Guild and Functional Group Frameworks in Riparian and Wetland Management and Restoration: Models and Applications, Part 2 of 2.
06/04/2015: 1:00 PM - 2:30 PM
Room: 553

Presenting Author:

Siobhan Fennessy

Additional Author:

Nicole Kirchner

Reviewer:

Deborah Picking

Abstract Body:

Plant traits can form the basis for ecosystem assessment using indicator species analysis, which allows the environmental preferences of target species to be identified and related to habitat types, site characteristics, environmental change, and gradients of human disturbance. We applied this approach to identify disturbance-based functional groups using vegetation data from 315 riparian and wetland ecosystems in Ohio, with associated data on anthropogenic disturbance gradients (vectors). Ecological vectors were selected based on the data availability and the strength of the relationship to human activities. Disturbance gradients were quantified using vectors based on nutrient enrichment (N and P), soil metal concentrations (Cu, Pb, Zn), soil organic carbon (TOC), land use change (Landscape Development Index, LDI) and stressors as measured by the Ohio Rapid Assessment Method (ORAM). The functional groups identified for the high and low range of each vector varied in species composition and numbers, ranging from three to forty-two species. There was considerable overlap between species in the high disturbance functional groups, perhaps due to the autecological plasticity of these species. To test our hypothesis that the indicator species analysis identified functional groups associated with plant traits linked to specific human disturbance gradients, we calculated mean coefficients of conservatism for each. Mean C values ranged from 6.5 to less than 1, differing significantly for the functional groups at the low and high ends of gradients related to TOC, ammonium, Cu, ORAM, and LDI. We show this approach is valuable for evaluating sites that are candidates for restoration as well as monitoring sites to determine their conservation status. It also demonstrates the importance of considering species traits when predicting vegetation response to disturbance and identifying functional groups.

Keywords: functional groups, human disturbance, indicator species

Traits for Restoration: A Meta-Analysis of the Relationship Between Plant Community Functional Composition and Ecosystem Function in Restored Wetlands

Presented During: Plant Guild and Functional Group Frameworks in Riparian and Wetland Management and Restoration: Models and Applications, Part 2 of 2
06/04/2015: 1:00 PM - 2:30 PM
Room: 553

Presenting Author:

Saras Windecker

Additional Author(s):

Peter Vesk, Assoc Prof
Jane Catford, Dr

Reviewer:

Deborah Picking

Abstract Body:

Wetlands are some of the most productive ecosystems on the planet and provide valuable ecosystem services such as water filtration, flood mitigation, and carbon sequestration. Despite their global importance, Ramsar estimates that 64% of the world's wetlands have been lost or degraded in the last century, and recent research suggests that restoration of plant biodiversity and ecosystem function has, for the most part, been unsuccessful. Despite theoretical developments about the utility of traits in understanding ecosystem function, few, if any, assessments of restoration have considered trait-based responses. In this project, we use plant functional traits to ask: 1) How does the functional composition of plant communities in restored wetlands compare with those of reference ("natural") sites? 2) How does the functional composition of restored wetlands change over time? And 3) What factors influence the rate of functional recovery? Based on a systematic review of wetland restoration literature, we have compiled temporal data about plant community composition and ecosystem biogeochemistry from restored and reference wetlands throughout the world. Augmenting this dataset with key plant functional traits, we use a meta-analysis to examine relationships between plant community functional composition and ecosystem function. Identifying these links in the context of restoration may highlight the most effective way to restore degraded wetlands for multifunctionality.

Keywords: ecosystem function, functional traits, meta-analysis, restoration

Vegetation State Changes in Inland and Coastal Riparian and Wetland Ecosystems: Implications for Ecosystem Carbon Retention

Presented During: Plant Guild and Functional Group Frameworks in Riparian and Wetland Management and Restoration: Models and Applications, Part 2 of 2
06/04/2015: 1:00 PM - 2:30 PM
Room: 553

Presenting Author:

Sean Charles

Additional Author:

John Kominoski

Reviewer:

Deborah Picking

Abstract Body:

Inland and coastal riparian and wetland ecosystems support mosaics of terrestrial and aquatic plant species that influence biogeochemical processes. Plant species compositions and distributions are rapidly changing in these ecosystems in response to various global change drivers, and the implications of these widespread changes on net ecosystem carbon (C) retention are uncertain. Widespread vegetation state changes that influence ecosystem C retention include increases in: 1) drought-tolerant and N-fixing plants, 2) woody encroachment into herbaceous communities, 3) replacement of mature wetlands by developmental wetlands. We use a conceptual framework and data from experimental studies to illustrate how changes in ecosystem C retention can be predicted for a given vegetation state change by examining gains and losses in functional traits that influence production and breakdown rates of leaf and root litter. We use predicted activation energies from metabolic theory of ecology expected if metabolism is limited by 1) autotrophic production (0.30 eV), or 2) temperature dependence of microbial and metazoan organic matter breakdown (0.65 eV) to predict vegetation-induced changes in C retention. Establishment of drought-tolerant, N-fixing species like non-native Elaeagnus angustifolia increases nutrient availability but reduces leaf litter production. Production of lower quantity, higher quality litter potentially increases C breakdown and decreases C retention in riparian floodplains. Poleward expansion of subtropical mangrove species Avicennia germinans into graminoid- and succulent-dominated salt marshes alters the microclimate, the production and breakdown of organic matter and the capture of allochthonous materials in ways that may increase C storage. Wetland mitigation is often successful in reestablishing plant species composition, but developmental wetlands often store less C than mature wetlands. Effective conservation and management efforts in inland and coastal riparian and wetland ecosystems requires matching of plant functional traits associated with C gains and losses with changing environmental conditions to optimize C retention in ecosystems.

Keywords: carbon storage, vegetation state change, ecosystem function