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The application of the intermediate disturbance hypothesis to physical systems: a case study on floodplain soils

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Disturbances, defined as discrete events that disrupt physical and/or biological systems, are a component of every natural system. Disturbance ecology has been dominated, for the last 30 years or so, by the intermediate disturbance hypothesis that states that biological diversity will be maximised where disturbance occurs at an intermediate level. A wide range of disturbances and organisms have been examined with respect to the intermediate disturbance hypothesis and in many cases (especially with respect to sessile organisms) the theory has proven valid. In rivers, lakes, wetlands and floodplains, the predominant agent of disturbance is flooding. In flood disturbed environments, the intermediate disturbance hypothesis has been shown to apply to terrestrial and aquatic vegetation, but conflicting results have been observed when dealing with mobile organisms like macroinvertebrates, fish or amphibians. The argument for the validity of the intermediate disturbance hypothesis (irrespective of disturbance type) stems from the notion that an intermediate frequency of disturbance promotes diversity by: 1) preventing the competitive exclusion by the dominant species that can arise in infrequently disturbed sites; and 2) facilitating greater diversity than that observed in highly-disturbed sites where only species tolerant of the disturbance can thrive. A singular omission in this logic, and indeed in research into the intermediate disturbance hypothesis more generally, has been the lack of focus on its application or relation to physical systems.

This study addresses this lack by investigating whether an intermediate level of flood disturbance leads to a greater diversity of soil character (assessed using a wide range of physical and geochemical soil properties). Four flood frequency (or disturbance frequency) categories are included in this study spanning the range from frequent through to infrequent flood disturbance. These are: a high-inundation-frequency flood zone that floods, on average, once per year; an intermediate-inundation-frequency zone that floods once in five years; a low-inundation-frequency zone that floods, on average, once in ten years; and a never flooded zone which is above the active floodplain and hence does not flood even during extreme events. Thirty samples were collected from each flood frequency zone and the resulting physical and geochemical soil data were subjected to a range of univariate and multivariate statistical tests to determine whether the intermediately disturbed sites were more diverse (in terms of their soil properties) than the frequently and infrequently disturbed sites. The results of this study show that sites subject to an intermediate level of flood disturbance have a greater level of diversity in soil properties than those sites subject to frequent flood disturbances. Thus, the results of this study suggest that the intermediate disturbance hypothesis does apply to physical systems, at least where the disturbance mechanism is consistent between sites. Our understanding of what generates biodiversity in intermediately disturbed sites, therefore, may need to be expanded to include a more diverse physical template being present in intermediately disturbed sites creating a wider range of habitat types than those available in frequently or infrequently disturbed sites.