WATER RESEARCH COMMISSION

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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

Water and the environment

Exploring the links between aquatic and terrestrial ecosystems

A new Water Research Commission (WRC) study has explored the reciprocal links between adjacent aquatic and terrestrial ecosystems in South Africa.

Background

An important aspect of the dynamics of nutrients and pollutants in natural systems is captured in the concept of allochthony, founded on the observation that nutrients and energy in a variety of forms are transferred between adjacent habitats, communities and ecosystems that are not routinely considered as connected.

Different forms of nutrients and energy move across the conceptual boundaries of habitats via organisms' activities or physical processes, such as wind or water currents, and these transfers can represent important food subsidies.

Such cross-partition ecological subsidies can augment the nutritional condition, biomass and biodiversity of communities, particularly where local production (or autochthony) alone may be inadequate to support local food webs.

Furthermore, organic subsidies can influence population dynamics, community interactions and ecosystem processes, and can represent dominant flux inputs in ecosystem budgets.

The intention of this WRC study was to explore organic nutrient fluxes in relation to a primarily lotic (i.e. flowing) aquatic system at the scale of a hydrological catchment.

The overarching aim of the study was to identify and quantify invertebrate- and vertebrate-mediated reciprocal transfers of organic nutrients among aquatic (freshwater, estuarine, near-shore marine) and terrestrial habitats (including the buffer zone between aquatic and terrestrial habitats) in a South African hydrological catchment.

Methodology

The project team assessed the flux or organic nutrients in a freshwater/estuary/terrestrial region represented by a hydrological catchment, primarily using stable isotope ratios, augmented with stomach contents and/or fatty acid analysis in certain cases.

Wherever possible, the isotope and lipid tracer techniques have been used concurrently to cross-validate diet composition of consumers in the habitats of interest (river, riparian one, land, estuary).

Three estuarine and six freshwater sites were selected in the Kowie River, Eastern Cape. Sampling at each site was aimed at assessing as many elements of the food web as possible.

Main results

Basal resources

Carbon and nitrogen stable isotope values in basal sources (benthic algae, aquatic macrophytes and terrestrial leaves) and the mixed organic groups (suspended particulate matter and detritus) indicated that there were shifts in the contributions of the sources to the mixed pools across time and space.

Contributions of allochthonous materials were more substantial in bulk detritus, whereas autochthonous materials were generally more substantial in the particulates. However, the detritus was dominated by aquatic macrophytes and benthic algae in the upper reaches in all sampling periods, with detritus in the lower reaches dominated by terrestrial sources.

Invertebrates

The diets of freshwater invertebrates did not always match the availability of sources identified in the mixed organic pools. The isotope models identified autochthonous (mainly aquatic macrophytes and attached algae) matter as the main food fueling consumers in most freshwater parts of the river, although allochthonous organic matter was important at the headwaters and at the mouth of the estuary.

Among all the functional feeding groups analysed in the river, there was a gradual shift from the assimilation of allochthonous to autochthonous material from headwaters to the downstream freshwater regions.

The benthic food webs were measurably different along the length of the estuary, and trophic interactions within each site varied with season.

Vertebrates

The tracer and gut content results illustrated that several species and life-stages of amphibians had well-differentiated diets, with some relying mainly on aquatic-derived food sources, others relying on terrestrial-derived food sources, and yet others feeding on a mixture of the two.

Clear spatial differences in the diet characteristics of the anurans were detected, with limited dietary ranges in the upstream community, and much greater variety in species occurring downstream.

Flux model

A multi-phase model was developed during the study, whereby complexity is added in a stepwise manner to produce a spatially explicit model of the Kowie River system with terrestrial/aquatic interactions, multiple trophic levels, and the integration of disparate food webs.

This ambitious platform can serve as an invaluable management tool, and a theory-building initiative, whereby the fate of biologically conserved molecules can be traced through multiple food webs and locations.

It is clear from the flux model results that further model refinements are necessary so that the empirical dietary data of some consumers more closely match what the model is calculating at each site. Small adjustments to the model parameters can have large influences on the general outcome.

Conclusions

Trophic connectivity between freshwater and terrestrial systems, or freshwater and estuarine systems, is ecosystem- and area-specific, and a variety of environmental factors contribute to the variability among locations and through tie.

The size of the riparian buffer zone along a river varies depending on the organisms considered, the morphology of the river, and a variety of environmental factors.

Spatial and temporal patterns that occur in the organic composition of the basal food sources do not necessarily transmit to the consumers in a system, so it is important to examine each trophic level.

Primary consumers in the Kowie River system more closely matched the variability in organic matter composition (i.e. allochthonous vs. autochtonous contributions) than did higher consumers, particularly owing to the greater mobility and selectivity among higher consumers.

Pollutants entering a freshwater system can readily influence the community composition and hence the food web structure, leading to shifts in connectivity between adjacent communities.

The application of ecosystem modelling to questions of connectivity and organic matter inputs may help managers to view a river basin in a holistic way that may in turn enhance the preservation of natural and ecologically important connections among habitats.

Further reading:
To obtain the report, *Connectivity through allochthony: Reciprocal links between adjacent aquatic and terrestrial ecosystems in South Africa*
(**WRC Report No. 2186/1/15**), contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.