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# 14C as a tool to trace terrestrial carbon in a complex lake system: implications for food-web structure and carbon cycling

Evelyn Keaveney (1), Christopher Barry (2), Paula Reimer (1), and Robert Foy (2)

(1) 14CHRONO Centre, School of Geography, Archaeology and Palaeoecology, Queen's University, Belfast, United Kingdom, (2) Agri-Food and Biosciences Institute, Newforge Lane, Belfast, Unitd Kingdom

Globally lakes bury and remineralise significant quantities of terrestrial C, and the associated flux of terrestrial C strongly influences their functioning. Changing deposition chemistry, land use and climate induced impacts on hydrology will affect soil biogeochemistry and terrestrial C export[1] and hence lake ecology with potential feedbacks for regional and global C cycling.

C and nitrogen stable isotope analysis (SIA) has identified the terrestrial subsidy of freshwater food webs. The approach relies on different $^{13}C$ fractionation in aquatic and terrestrial primary producers, but also that inorganic C demands of aquatic primary producers are partly met by $^{13}C$ depleted C from respiration of terrestrial C, and 'old' C derived from weathering of catchment geology. SIA thus fails to differentiate between the contributions of old and recently fixed terrestrial C. Natural abundance $^{14}C$ can be used as an additional biomarker to untangle riverine food webs[2] where aquatic and terrestrial $\delta^{13}C$ overlap, but may also be valuable for examining the age and origin of C in the lake.

Primary production in lakes is based on dissolved inorganic C (DIC). DIC in alkaline lakes is partially derived from weathering of carbonaceous bedrock, a proportion of which is $^{14}C$-free. The low $^{14}C$ activity yields an artificial age offset leading samples to appear hundreds to thousands of years older than their actual age. As such, $^{14}C$ can be used to identify the proportion of autochthonous C in the food-web. With terrestrial C inputs likely to increase, the origin and utilisation of 'fossil' or 'recent' allochthonous C in the food-web can also be determined.

Stable isotopes and $^{14}C$ were measured for biota, particulate organic matter (POM), DIC and dissolved organic carbon (DOC) from Lough Erne, Northern Ireland, a humic alkaline lake. Temporal and spatial variation was evident in DIC, DOC and POM C isotopes with implications for the fluctuation in terrestrial export processes. Ramped pyrolysis of lake surface sediment indicates the burial of two C components. $^{14}C$ activity (507 $\pm$ 30 BP) of sediment combusted at 400˚C was consistent with algal values and younger than bulk sediment values (1097 $\pm$ 30 BP). The sample was subsequently combusted at 850˚C, yielding $^{14}C$ values (1471 $\pm$ 30 BP) older than the bulk sediment age, suggesting that fossil terrestrial carbon is also buried in the sediment.

Stable isotopes in the food web indicate that terrestrial organic C is also utilised by lake organisms. High winter $\delta^{15}N$ values in calanoid zooplankton ($\delta^{15}N$ = 24%¸) relative to phytoplankton and POM ($\delta^{15}N$ = 6‰ and 12‰ respectively) may reflect several microbial trophic levels between terrestrial C and calanoids. Furthermore winter calanoid $^{14}C$ ages are consistent with DOC from an inflowing river (75 $\pm$ 24 BP), not phytoplankton (367 $\pm$ 70 BP). Summer calanoid $\delta^{13}N$, $\delta^{15}N$ and $^{14}C$ (345 $\pm$ 80 BP) indicate greater reliance on phytoplankton.

1 Monteith, D.T *et al.*, (2007) Dissolved organic carbon trends resulting from changes in atmospheric deposition chemistry. *Nature,* **450:**537-535

2 Caraco, N., et al.,(2010) *Millennial-aged organic carbon subsidies to a modern river food web.* Ecology,**91:** 2385-2393.