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Critical source times for nutrient loss in agricultural catchment streams

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Identifying periods of the year when there is a high risk of incidental nutrient loss from farms via runoff to streams underpins current nutrient management legislation in Europe. This research explored high-temporal resolution nutrient transfer patterns relative to the time that manure and fertiliser are prohibited from being spread (the mandatory spreading 'closed' period) in five Irish agricultural catchments. Catchment nutrient losses during the 12 week closed periods in 2009-10, 2010-11 and 2011-12 were compared with losses during the remainder of the year, and with losses in the two week 'shoulder' periods immediately before and after the closed period. The closed period losses were assumed to be residual from soil nutrient stores and the 'shoulder' periods were considered to also include incidental losses. Nutrient loss was measured at sub-hourly frequency as total phosphorus (P) and total oxidised nitrogen (mostly nitrate-N) fluxes in streamflow. The streamflow fluxes showed that the proportion of the annual nitrate-N loss occurring during the closed periods (33-61%) was high compared with the remainder of the year. Six to ten times more nitrate-N loss occurred in the two weeks after, compared with the two weeks before, the closed period. These two week 'shoulder' period losses were, on average, less than or equal to 2.5 kg nitrate-N/ha and 9% of total annual nitrate-N loss in streamflow. On average, 40-53% of the annual P loss occurred during the closed periods but in a runoff-prone catchment in a year with a wet summer, the closed period was the less risky period. Similar to nitrate-N, two to twenty times more P loss occurred in the two weeks after, compared with the two weeks before, the closed period. These shoulder period losses were, on average, less than or equal to 0.027 kg/ha and 4.2% of total annual P loss in streamflow. The proportion of the shoulder period loss that could be attributed to recently spread nutrients was not known but can be informed by farm practice and nutrient flow pathways analysis. Losses after the closed period, especially P, could include a significant contribution from eroded soil, which would not be prevented by extending the spreading closed period. Policy proposals to extend the mandatory closed period should consider the long term potential for nutrient runoff and plant growth conditions during the 'shoulder' periods, infrastructure costs of further storage requirements, production costs of restricting critical farm operations during the shoulders and unintended environmental costs such as shifting farm activities towards periods when water bodies are more susceptible to eutrophication.