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Using Nanobiotechnology to circumvent the "Nonpoint" problem in nonpoint source pollution: Possibilities, challenges, and progress to date

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Applying the power of nanoscale technology to answer landscape-scale questions constitutes an exciting new frontier in science and engineering. In this project, we are exploring a possible method of reducing the "nonpoint" problem associated with nonpoint source (NPS) pollution, a problem that has hampered agricultural sustainability and water quality protection for decades. We are developing superparamagnetic polylactic acid (PLA) microspheres incorporating DNA “nanobarcodes” as potential tracers. The eventual goal of this project is to develop technologies for identifying and characterizing different flowpaths at field and watershed scales by using multiple sets of polymer microspheres, each coded with unique DNA sequences, of which there are essentially limitless combinations, i.e., many flowpaths can be uniquely coded. Our ultimate vision is to have the capacity of introducing microsphere-encapsulated DNA at different points in a watershed and collecting these microspheres elsewhere in the watershed; using quantitative, real-time polymerase chain reaction targeted at the specific DNA, we would be able to determine the hydrological linkages and transport times between the collection point(s) and the points of DNA introduction. The potential advantages of this nanotechnology strategy compared to conventional tracers are the elimination of background interferences, the ability to segregate superimposed flowpaths through the design of strictly unique DNA tracers and the biodegradability of the tracers. This presentation highlights recent advances, new challenges, and potential applications for this tracer technology.