Overexploitation in mixed fisheries occurs when catches continue for available quota species while low quota species are discarded. As EU fisheries move to count all fish caught against quota (the ‘landings obligation’), the challenge is to catch available quota within new constraints. A mechanism for decoupling species caught together is spatial targeting, which is challenging due to complex spatiotemporal fishery and population dynamics. We develop a dimension-reduction framework to understand how spatial community and fishery dynamics determine species and size composition. Application to the highly mixed fisheries of the Celtic Sea shows clear common spatial patterns for three species-groups. We highlight the importance of dimension reduction techniques to focus on axes of maximal spatiotemporal separation to address pervasive and nuanced challenges of managing mixed fisheries.