The Alfacs Bay (Ebre Delta) is a microtidal semi-enclosed estuary in the NW Mediterranean, with extensive aquacultural activity and exposed to recurrent harmful algal blooms (HABs) events. The mechanisms underlying the population dynamics of species causing HABs are complex because they result from the interplay of a spectrum of physical, chemical and biological factors, to which the organisms respond with a variety of strategies. Still, it is not clear whether the responses of the harmful species are different of other phytoplankton species. With this in mind, we developed a field work program in with the objective of investigating the relationships between the small-scale hydrodynamic properties in the bay and the population dynamics of noxious phytoplankton species. A series of meteorology and hydrographic data combined with modelling exercises try to understand how the circulation in the bay affects the retention, dispersion and thus, the net development of (harmful) phytoplankton populations. Small-scale characterisation of the water column properties is performed using a high-resolution acoustic Doppler current profiler deployed on a fixed station (6 m depth) and SCAMP microstructure probe. With such approach, we aim to ascertain preferential distribution of the target organisms (harmful or not) and the possible scenarios are tested using Individual Based Models. In this presentation, we will show some of our advances on those aspects and highlight our future goals on real-time and automated control of the physical measurements and a deeper knowledge of the in situ biological dynamics of (harmful) phytoplankton.