



Using three different thermal approaches to characterize the physical limnology and surface – groundwater relations in a shallow pond (Doñana National Park, Spain)

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The aim of our study has been a multi-approach characterization of the physical limnology of shallow pond using hourly data from temperature sensors. We have carried out an energy balance, classified the water column stability and determined the groundwater discharge rate, by a thermal model (1D Temp Pro-V2). This has been done in Santa Olalla pond, the only permanent water body of Doñana Biological Reserve (Andalusia, Southern Spain) from February to December 2017. Although thermal studies have been carried out in Doñana marshes, none have been done in dune ponds such as Santa Olalla within the boundaries of Doñana National Park. One the one hand, the results from the energy balance has improved the current knowledge about the thermal structure and the heat flux exchange in Santa Olalla pond. One the other hand, results obtained about the water inputs highlight that groundwater discharge is being produced heterogeneously through the pond's bed. The comparison of these outcomes with previous studies made in the pond (hydrological water balances, hydrogeological methods) is coherent and strengthens the existing hydrological and limnological knowledge of this water body located in a flagship protected area.