Phthalate esters (PAEs) are widely used as plasticizers and have become one of the emerging contaminants with an increasing public concern. The residues of PAEs frequently co-exist with heavy metals such as cadmium (Cd) in waters; however, their joint ecotoxicity remains largely unknown. We herein investigated the single and joint toxicity of commonly used PAEs and Cd using freshwater luminescent bacteria Vibrio qinghaiensis sp.-Q67. The median effective concentration (EC_{50}) of benzyl butyl phthalate (BBP), dibutyl phthalate (DBP), diethyl phthalate (DEP), dimethyl phthalate (DMP), diisooctyl phthalate (DIOP) and di-n-octyl phthalate (DOP) were determined to be in the range from 134.4mg/L to as high as 1000mg/L, indicating very weak toxicity to Vibrio qinghaiensis sp.-Q67. The toxicity of single PAEs showed a significant linear relationship with Log K_{ow}, indicating the dependence of the elevated toxicity on the increasing hydrophilicity. The toxicity of binary mixture of PAEs was further evaluated in silico using the independent action (IA) model and concentration addition (CA) model. DMP-DEP, DEP-DBP or DMP-DBP exhibited antagonistic effects with the toxic unit value higher than 1.2. The CA and IA models poorly predicted the joint toxicity of DMP-DEP, DEP-DBP or DMP-DBP. The joint toxicity of the binary mixtures of DMP, DEP or DBP with Cd was simple additive as predicted by the CA and IA models. Our results indicated the potentially higher risk of PAEs in the presence of Cd, emphasizing the importance of determining the impact of their joint effects on aquatic organisms. The integrated in vitro and in silico methods employed in this study will be beneficial to study the joint toxicity and better assess the aquatic ecological risk of PAEs.