We present a rate equation model for quantum-dot light-emitting devices that take into account Purcell enhancement of both spontaneous emission and stimulated emission as well as the spectral profile of the optical and electronic density-of-states. We find that below threshold the $b$-factor in a quantum-dot nanolaser depends strongly on the pump. For quantum dots with linewidth comparable to that of the cavity, we then show that an otherwise non-lasing device can lase due to Purcell enhancement of the stimulated emission. Finally, we compare the rate equation model to a microscopic model and obtain good agreement.