Supermassive black holes, and the active galactic nuclei (AGN) that they power, are thought to play an integral role in the evolution of galaxies by acting to regulate, and eventually suppress, the star formation activity of their host galaxies. I will discuss recent efforts to test this proposed connection by studying the demographics of galaxies undergoing active black hole growth. In particular, I will highlight recent results from the CANDELS survey, whose panchromatic Hubble ACS and WFC3 imaging is now allowing us to characterize the morphologies and stellar populations of thousands of AGN hosts out to z=2, the era when star formation activity and black hole growth in the Universe are at their peak. I will discuss what CANDELS is currently revealing about the mechanisms that fuel AGN activity at this epoch and the connection between black hole growth and the emergence of the first generation of passive galaxies in the Universe.