Neutron total cross sections of elemental palladium are measured from $\approx 0.6 \rightarrow 4.5$ MeV. These results, combined with others previously reported from this laboratory, provide a detailed knowledge of the neutron total cross sections of palladium from $\approx 0.1 \rightarrow 20$ MeV. Differential neutron elastic-scattering cross sections are measured from $\approx 1.5 \rightarrow 10$ MeV in sufficient energy and angle detail to well define the energy-average behavior. Concurrently, neutron inelastic-scattering cross sections are measured from $\approx 1.5 \rightarrow 8$ MeV. Inelastically-scattered neutron groups are observed corresponding to excitations of: $306 \pm 14$, $411 \pm 47$, $494 \pm 20$, $924 \pm 20$, $1156 \pm 24$, $1358 \pm 35$, $1554 \pm 47$ and $1706 \pm 59$ keV, with additional tentative groups at 1938 and 2059 keV. Particular attention is given to the inelastic excitation of the $2^+$ yrast states of the even isotopes. This broad data base is examined in the context of optical-statistical and coupled-channels models. The resulting model parameters are consistent with systematic trends in this vibrational mass region previously noted at this laboratory, and provide a suitable vehicle for many applications.