Interannual-to-decadal variations in the subtropical countercurrent (STCC) and low-potential vorticity (PV) water and their relations in the North Pacific Ocean are investigated based on a 60-year-long hindcast integration of an eddy-resolving ocean general circulation model. The interdecadal intensification of STCC is associated with negative PV anomalies to the north on isopycnals beneath, by contrast, on interannual time scales, vertically coherent variations are dominant for STCC variability. This study focuses on the vertical shear of STCC in the near surface layer in relation to low-PV water in interannual variations. A correlation analysis shows that an intensified STCC vertical shear accompanies lower PV than usual to the north on 25.5 to 26.1 σθ isopycnal surfaces, and intensified meridional density gradient in subsurface layers. The low PV signals appear at least two years before peaks of STCC, propagating southwestward from the subduction region. These results strongly suggest that interannual to decadal variations in STCC vertical shear are associated with variations in low-PV water ventilation. Although interannual variations in STCC have been considered to relate to local wind variations, the relationship between STCC and low-PV water originally suggested by Kubokawa (1999) and found in observed climatology holds in interannual to interdecadal variations at least in this particular model.