Matrix functions preserving sets of generalized nonnegative matrices are characterized. These sets include PFn, the set of \( n \times n \) real eventually positive matrices; and WPFn, the set of matrices \( A \in \mathbb{R}^{n \times n} \) such that \( A \) and its transpose have the Perron-Frobenius property. Necessary conditions and sufficient conditions for a matrix function to preserve the set of \( n \times n \) real eventually nonnegative matrices and the set of \( n \times n \) real exponentially nonnegative matrices are also presented. In particular, it is shown that if \( f(0) \neq 0 \) and \( f'(0) \neq 0 \) for some entire function \( f \), then such an entire function does not preserve the set of \( n \times n \) real eventually nonnegative matrices. It is also shown that the only complex polynomials that preserve the set of \( n \times n \) real exponentially nonnegative matrices are \( p(z) = az + b \), where \( a, b \in \mathbb{R} \) and \( a \geq 0 \).

Key words. Matrix functions, Generalization of nonnegative matrices, Eventually nonnegative matrices, Eventually positive matrices, Exponentially nonnegative matrices, Eventually exponentially nonnegative matrices, Perron-Frobenius property, Strong Perron-Frobenius property.

AMS subject classifications. 15A48.