Stochastic Calculus for Finance: Continuous-time models By Steven E. Shreve

PROOF: Let $0 \leq s < t$ be given. Because $N(t) - N(s)$ is independent of $\mathcal{F}(s)$ and has expected value $\lambda(t-s)$, we have

$$\begin{aligned}
\mathbb{E}\big[M(t)\big|\mathcal{F}(s)\big] &= \mathbb{E}\big[M(t) - M(s)\big|\mathcal{F}(s)\big] + \mathbb{E}\big[M(s)\big|\mathcal{F}(s)\big] \\
&= \mathbb{E}\big[N(t) - N(s) - \lambda(t-s)\big|\mathcal{F}(s)\big] + M(s) \\
&= \mathbb{E}\big[N(t) - N(s)\big] - \lambda(t-s) + M(s) \\
&= M(s).
\end{aligned}$$

□