# Risk-based Viable Population Monitoring[AFS]

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We describe risk-based viable population monitoring in which the monitoring indicator is a yearly prediction of the probability that, within a given timeframe, the population abundance will decline below a pre-specified level. Common abundance-based monitoring strategies usually have low power to detect declines in threatened and endangered species and are largely reactive to declines. Comparisons of the population's estimated risk of decline over time will help determine status in a more defensible manner than current monitoring methods. Monitoring risk is a more proactive approach; critical changes in the population's status are more likely to be demonstrated before a devastating decline than with abundance-based monitoring methods. In this framework, recovery is defined not as a single evaluation of long-term viability, but as maintaining low risk of decline for the next several generations. Effects of errors in risk prediction techniques are mitigated through shorter prediction intervals, setting threshold abundances near current abundance, and explicitly incorporating uncertainty in risk estimates. Viable population monitoring also intrinsically adjusts monitoring effort relative to the population's true status and exhibits considerable robustness to model misspecification. We present simulations showing risk predictions made with a simple exponential growth model can be effective monitoring indicators for population dynamics ranging from random walk to density dependence with stable, decreasing, or increasing equilibrium. In analyses of time-series data for five species, risk-based monitoring warned of future declines and demonstrated secure status more effectively than statistical tests for trend. We presented more detailed risk-analyses for Flathead bull trout populations.