The effect of low visibility on both crash occurrence and severity is a major concern in the traffic safety field. Different approaches were utilized in this research to analyze the effects of fog on traffic safety and evaluate the effectiveness of different fog countermeasures. First, a “Crash Risk Increase Indicator (CRII)” was proposed to explore the differences of crash risk between fog and clear conditions. A binary logistic regression model was applied to link the increase of crash risk with traffic flow characteristics. Second, a new algorithm was proposed to evaluate the rear-end crash risk under fog conditions. Logistic and negative binomial models were estimated in order to explore the relationship between the potential of rear-end crashes and the reduced visibility together with other traffic parameters. Moreover, the effectiveness of real-time fog warning systems was assessed by quantifying and characterizing drivers’ speed adjustments through driving simulator experiments. A hierarchical assessment concept was suggested to explore the drivers’ speed adjustment maneuvers. Two linear regression models and one hurdle beta regression model were estimated for the indexes. Also, another driving simulator experiment was conducted to explore the effectiveness of Connected Vehicles (CV) crash warning systems on the drivers’ awareness of the imminent situation ahead to take timely crash avoidance action(s). Finally, a microsimulation experiment was also conducted to evaluate the safety benefits of a proposed Variable Speed limit (VSL) strategy and CV technologies. The proposed VSL strategy and CV technologies were implemented and tested for a freeway section through the microsimulation software VISSIM. The results of the above mentioned studies showed the impact of reduced visibility on traffic safety, and the effectiveness of different fog countermeasures.