



The results are in: A first look at the real-world effect of the IIHS headlight ratings

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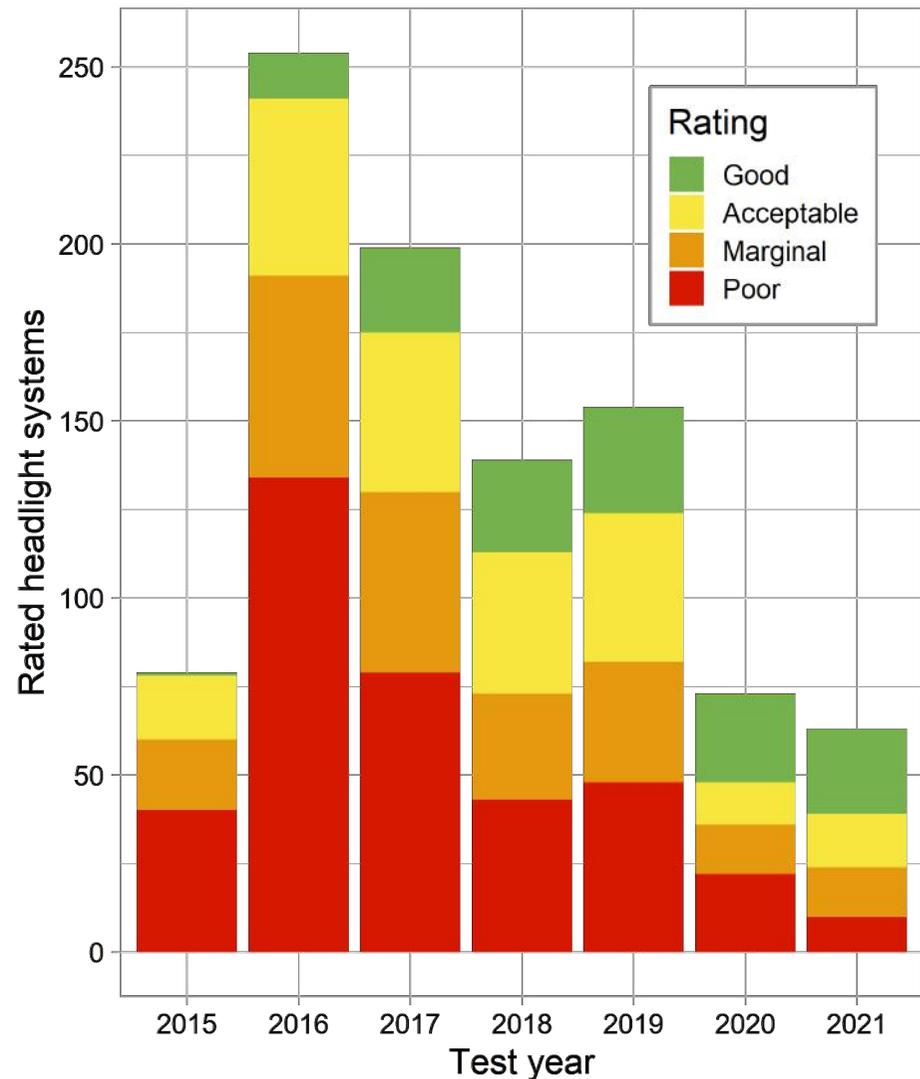
[iihs.org](https://www.iihs.org)

Increased crash risk at night

- ▶ 22% of vehicle miles traveled occur at night (EPA, 2020)
- ▶ 46% of passenger vehicle occupant fatalities at night (IIHS)
- ▶ Implies crash fatality rate per mile traveled at night is around 3 times the rate during the day
- ▶ Many reasons for this, including:
 - Higher intoxication rates
 - Higher speeding incidence
 - Lower restraint use
 - Reduced ambient illumination

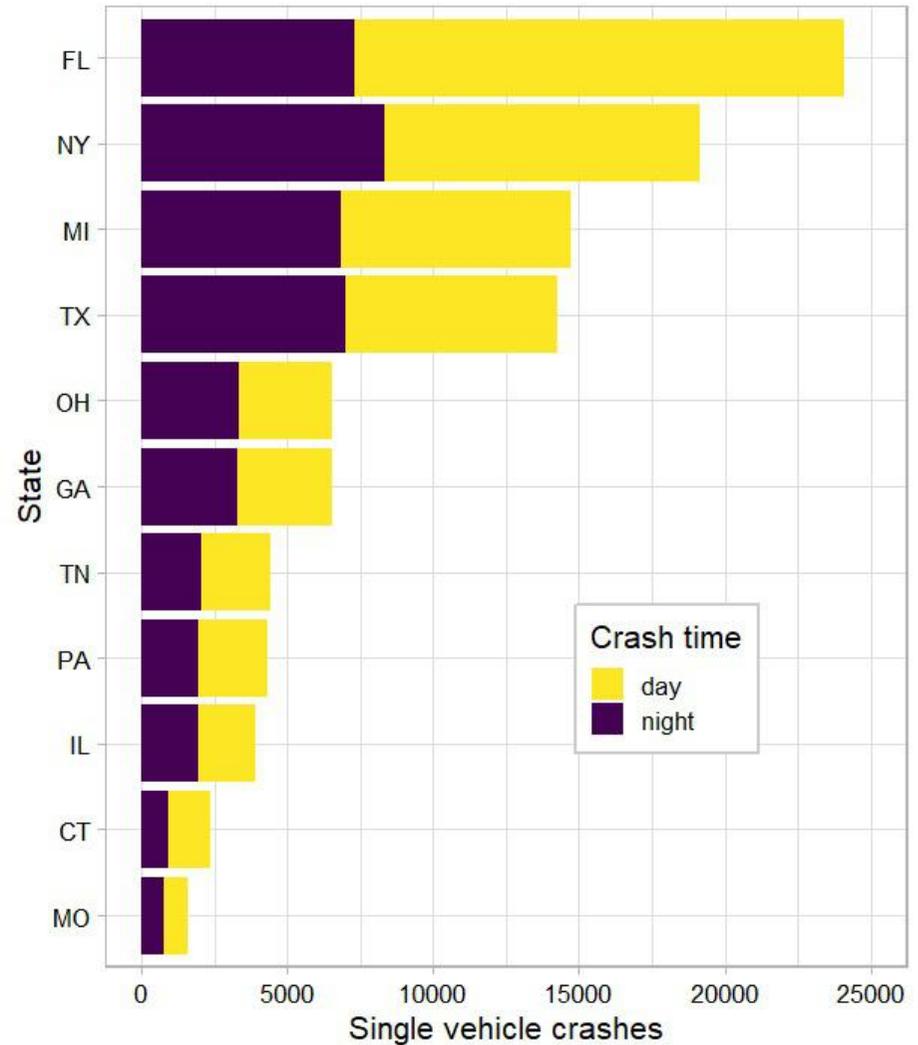
IIHS headlight rating program

- ▶ IIHS headlight rating is combination of:
 - Low & high beam visibility on curves and straightaway
 - Low beam glare on curves and straightaway
- ▶ Rating program began in 2015
- ▶ As of September 2021, over 970 headlight systems rated
- ▶ ~350 rated systems can be uniquely determined using VIN

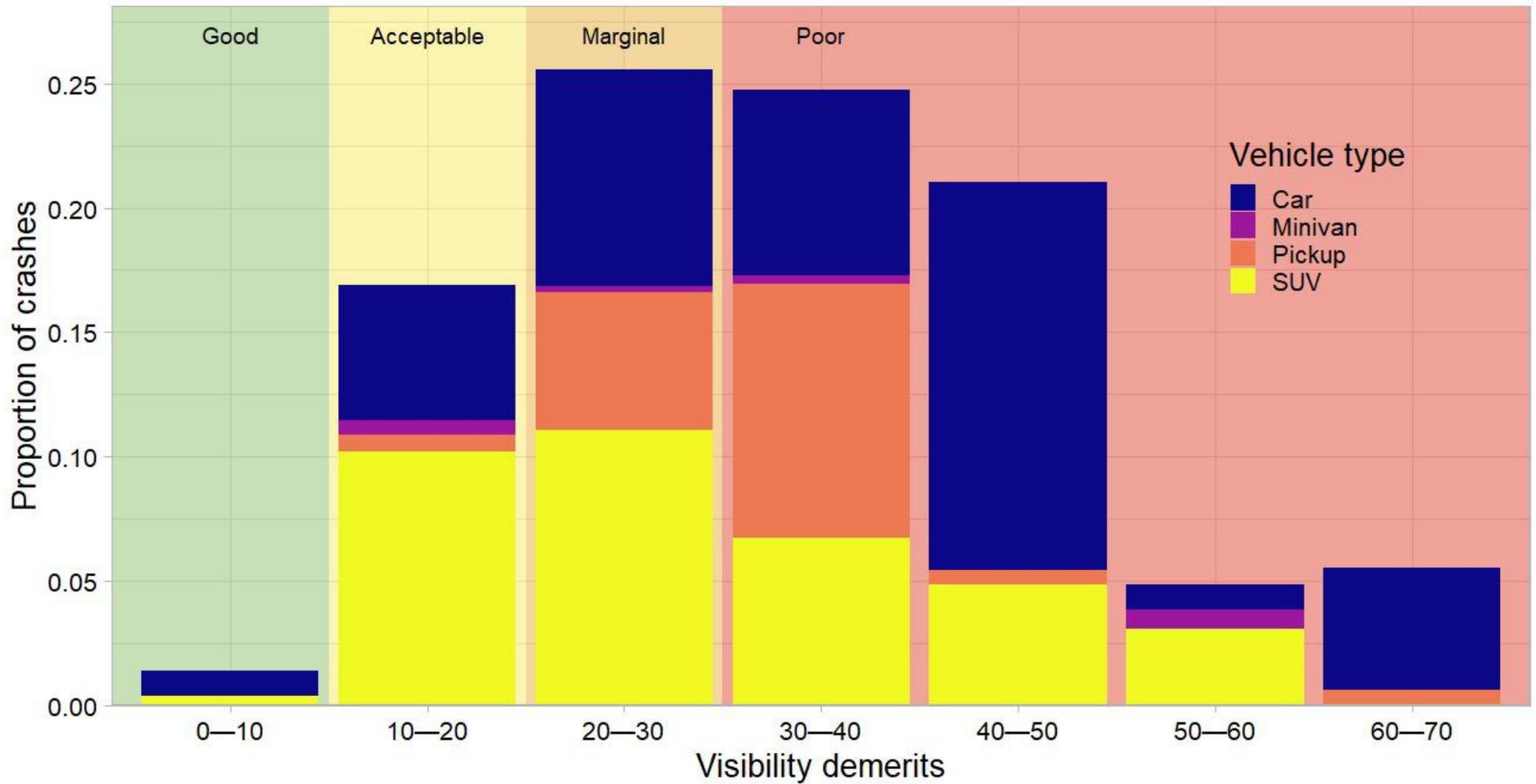


State data

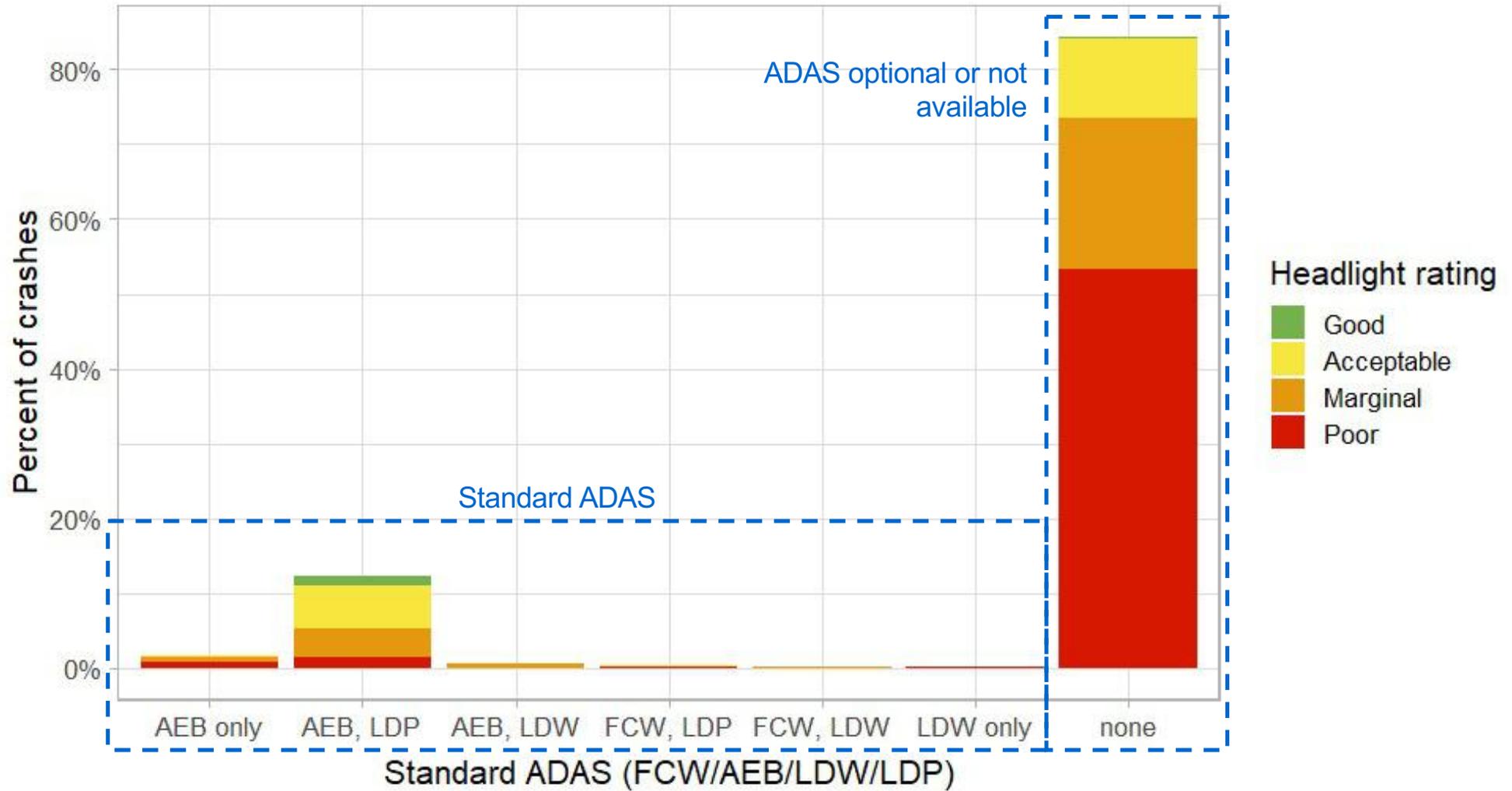
- ▶ Queried 11 state databases of police-reported crashes with full VINs
- ▶ 101,823 single-vehicle crashes with known headlight rating
- ▶ 43,659 (43%) at night
- ▶ Day/night status independently determined using crash time, day of year, latitude/longitude
- ▶ Dawn & dusk treated as daylight



Crash distribution by headlight visibility demerits



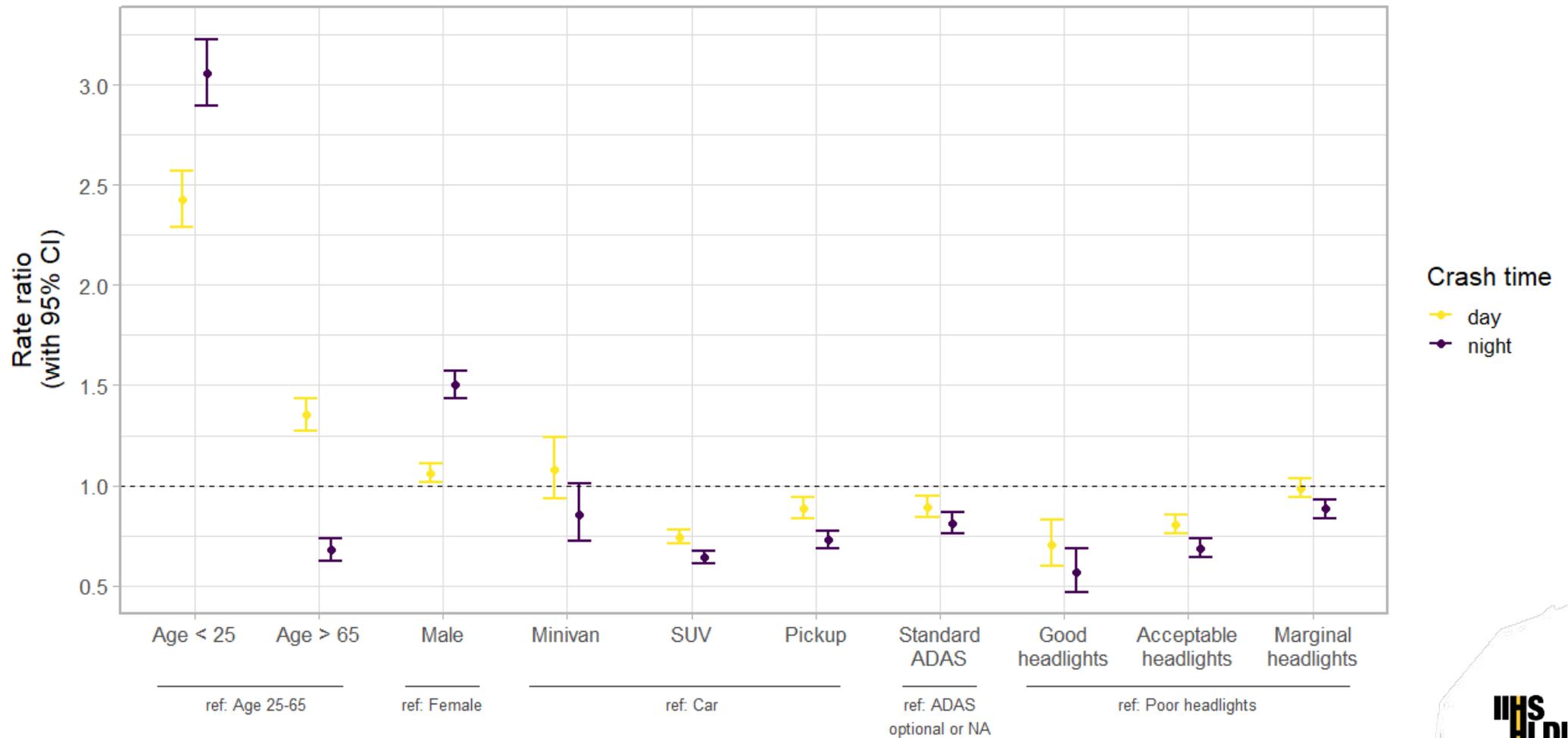
Standard ADAS features for study vehicles



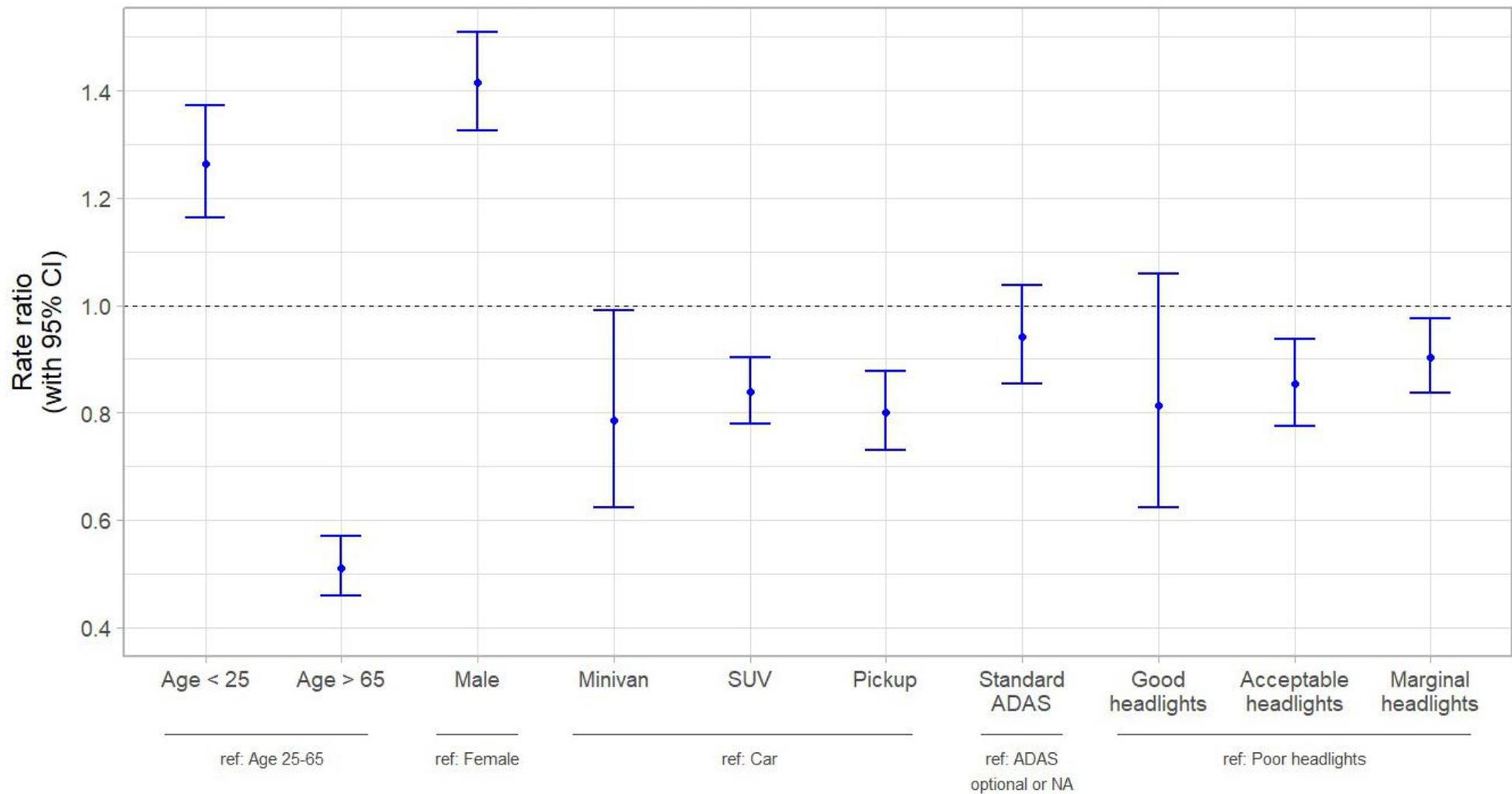
Modeling approach for studying headlight effect

- ▶ Estimated day and night single-vehicle crash rates per mile traveled using Poisson model
 - Vehicle mileage supplied from Carfax; does not account for day/night exposure
- ▶ Covariates included in crash rate estimates:
 - Crash state
 - Standard ADAS
 - Vehicle type
 - Insured rated driver age group (<25, 25-65, >65)
 - Insured rated driver gender
 - Headlight rating or headlight demerits (only rating results presented today)
- ▶ Daytime crash rates used to control for differences that may be unrelated to darkness; interaction between crash time (day/night) and each covariate indicates the effect at night relative to the effect during the day
- ▶ Repeated analysis for different types of single-vehicle crashes

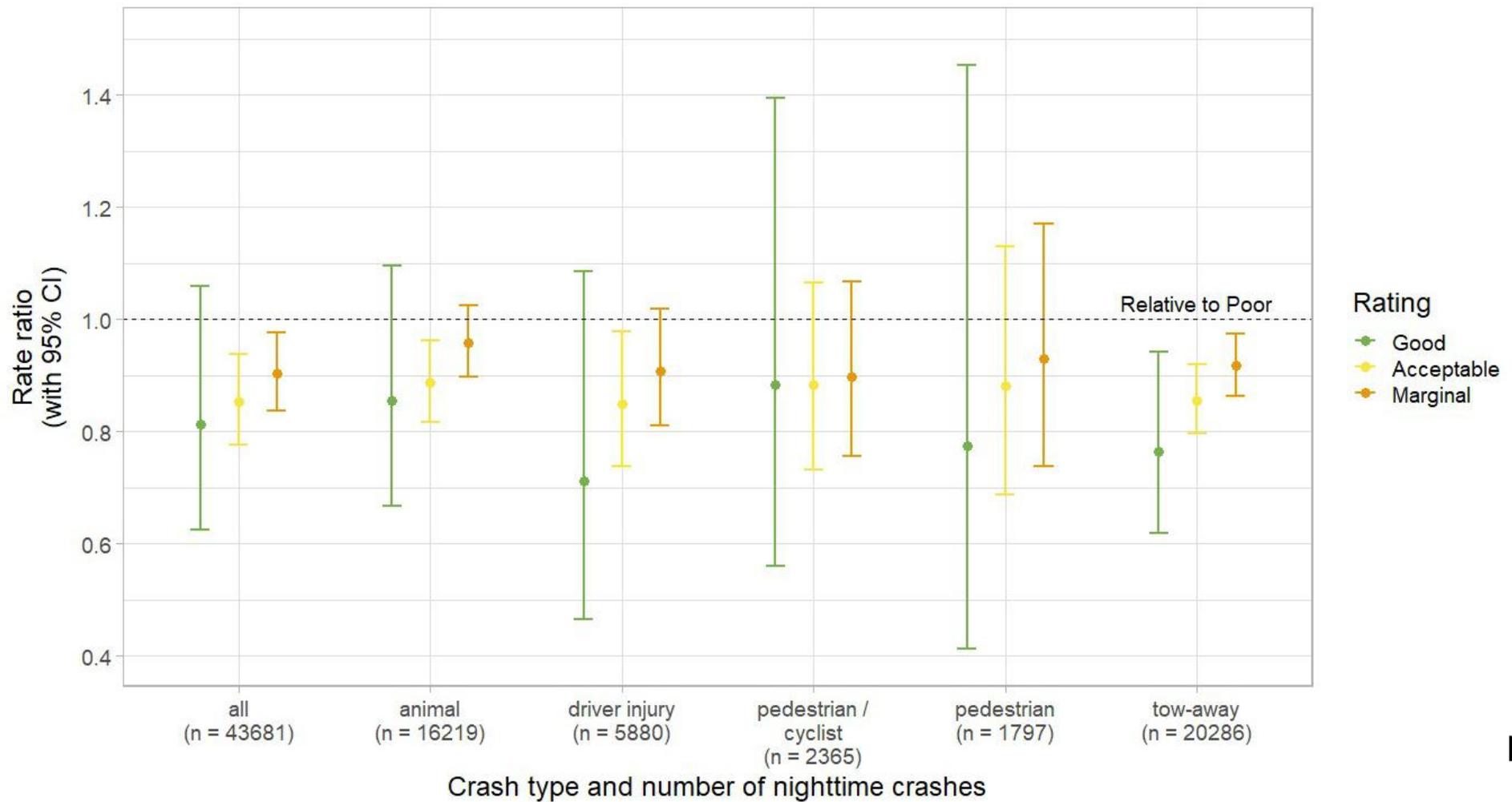
Estimated effects of model parameters on daytime and nighttime crash rates (state effects not shown)



Nighttime crash rate effects relative to daytime effects



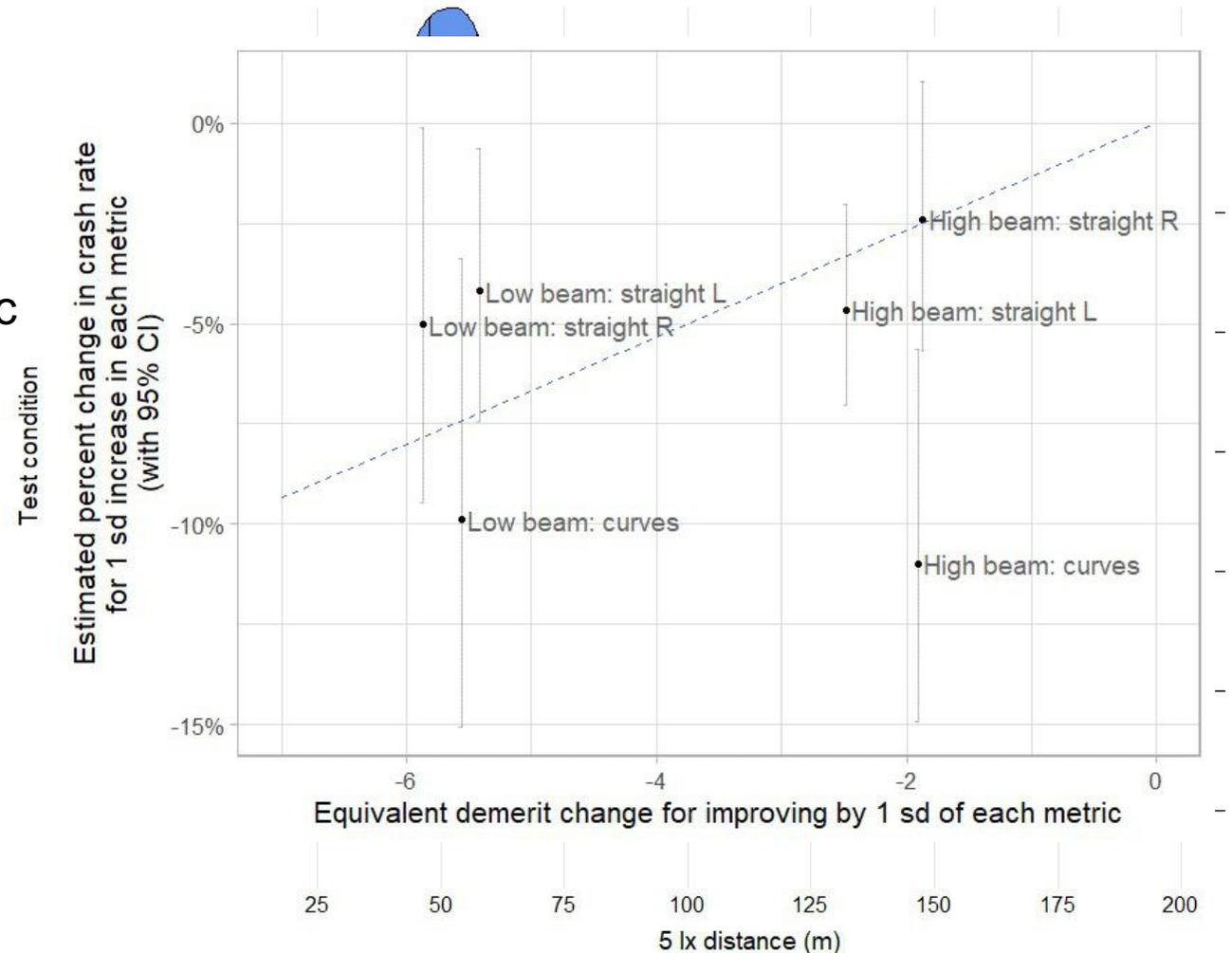
Adjusted effect of headlight rating on nighttime crash rate for different SV crash types



Additional models looked at effects of different demerit types

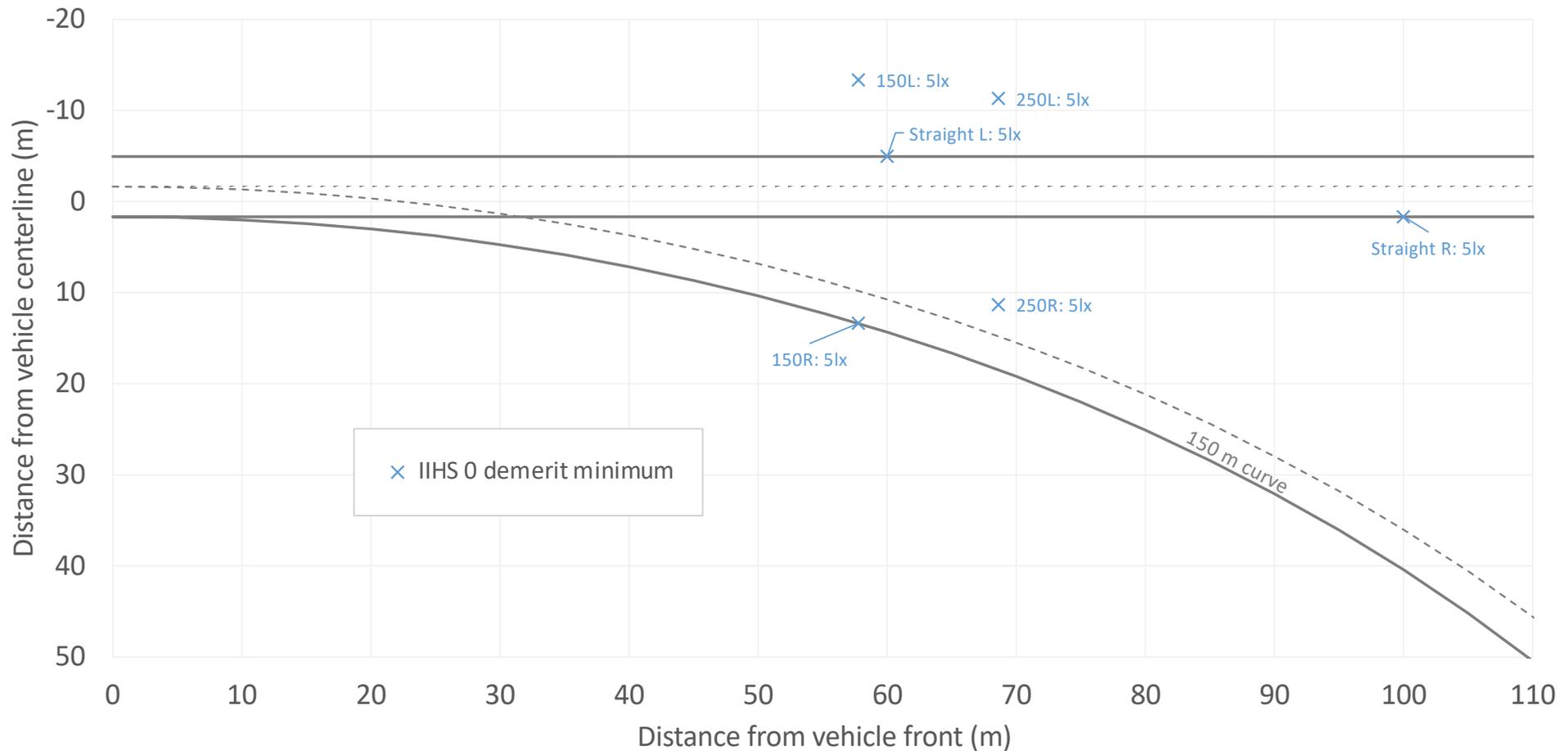
Does the IIHS procedure weight the different test conditions appropriately?

- ▶ Calculated distribution of 5 lx distances for all tested vehicles without any glare demerits
- ▶ Converted an improvement of 1 standard deviation in each metric to the equivalent demerits for that condition
- ▶ Modeled the effect of each reduced demerit score on the change in night crash rate
- ▶ Results indicate that on a demerit basis, the curves are underweighted relative to the straightaway conditions



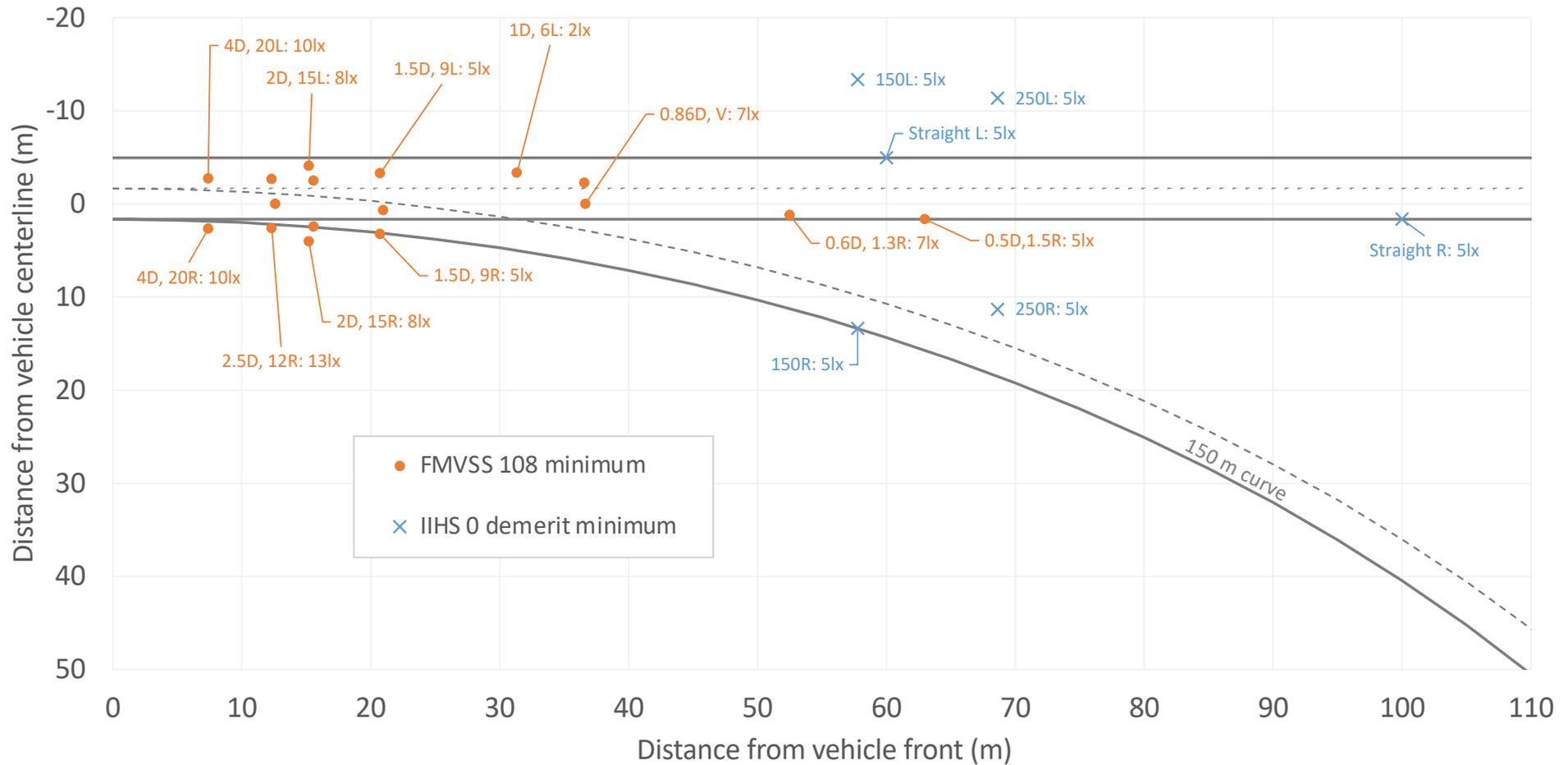
Curve tests encourage wider beam patterns which likely help on straightaways too

IIHS low beam requirements for 0 demerits (25 cm sensor height)

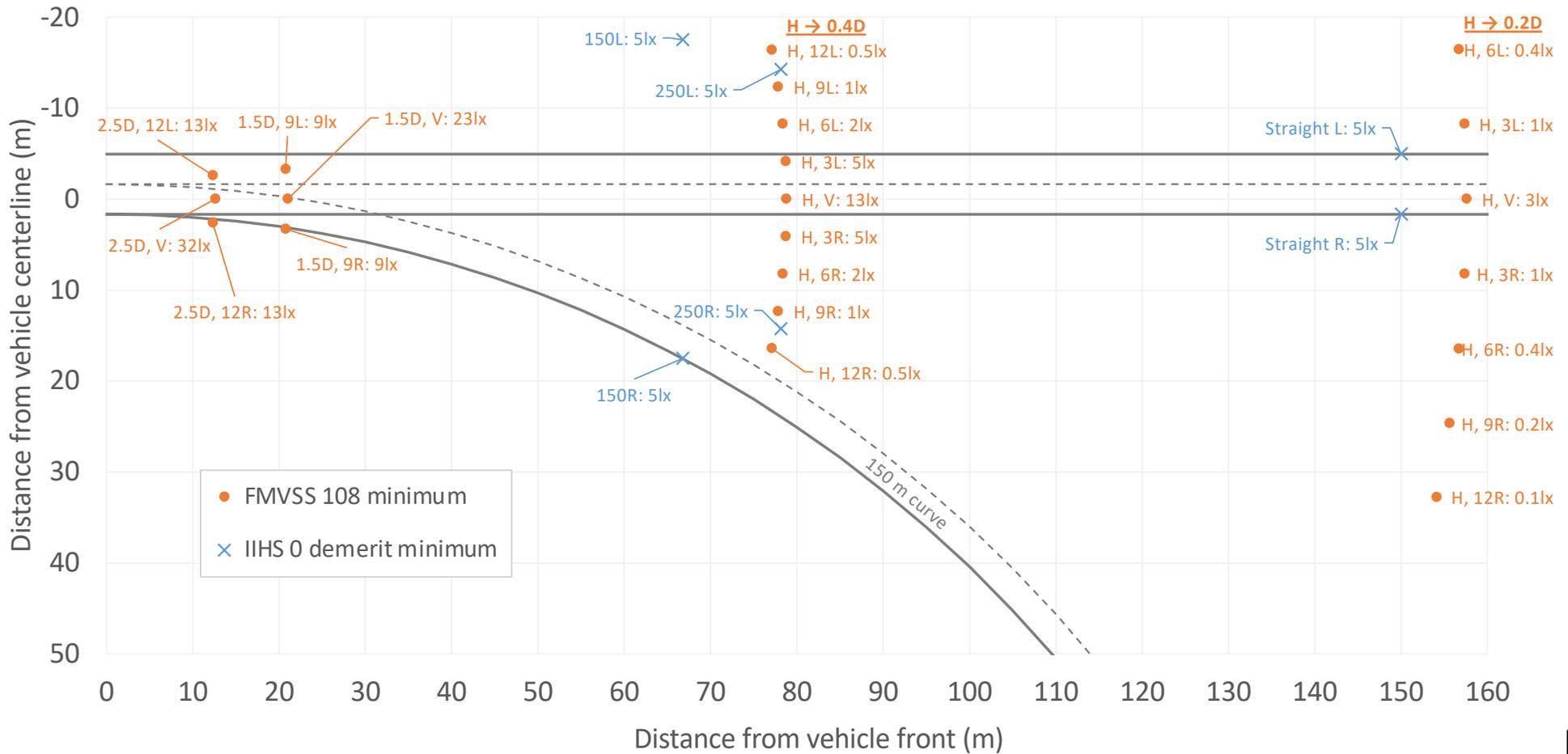


IIHS low beam requirements vs. FMVSS 108

FMVSS test points converted to illuminance at 25 cm above road (80 cm height, 150 cm spread)



IIHS high beam requirements vs. FMVSS 108

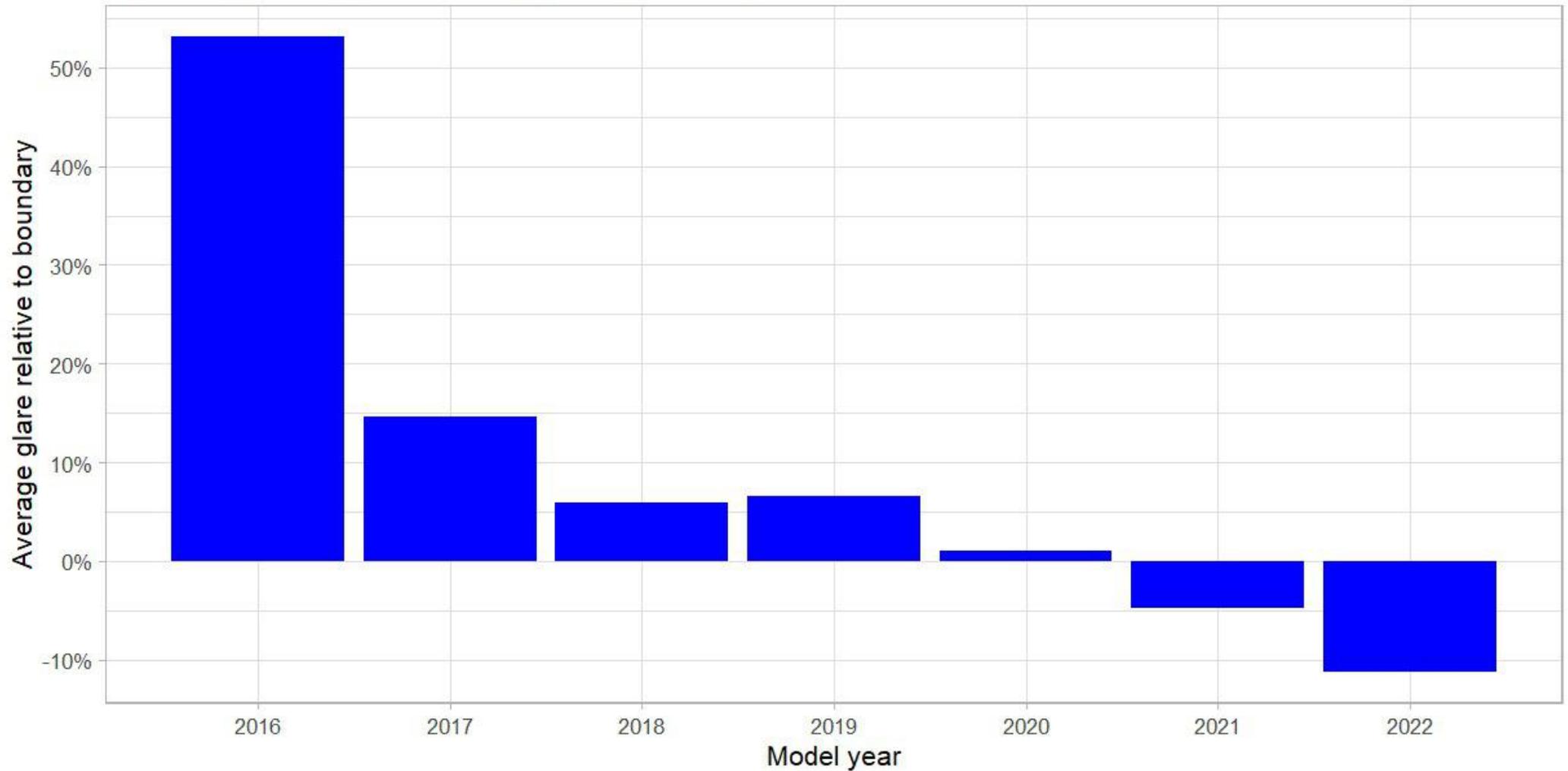


But what about glare?

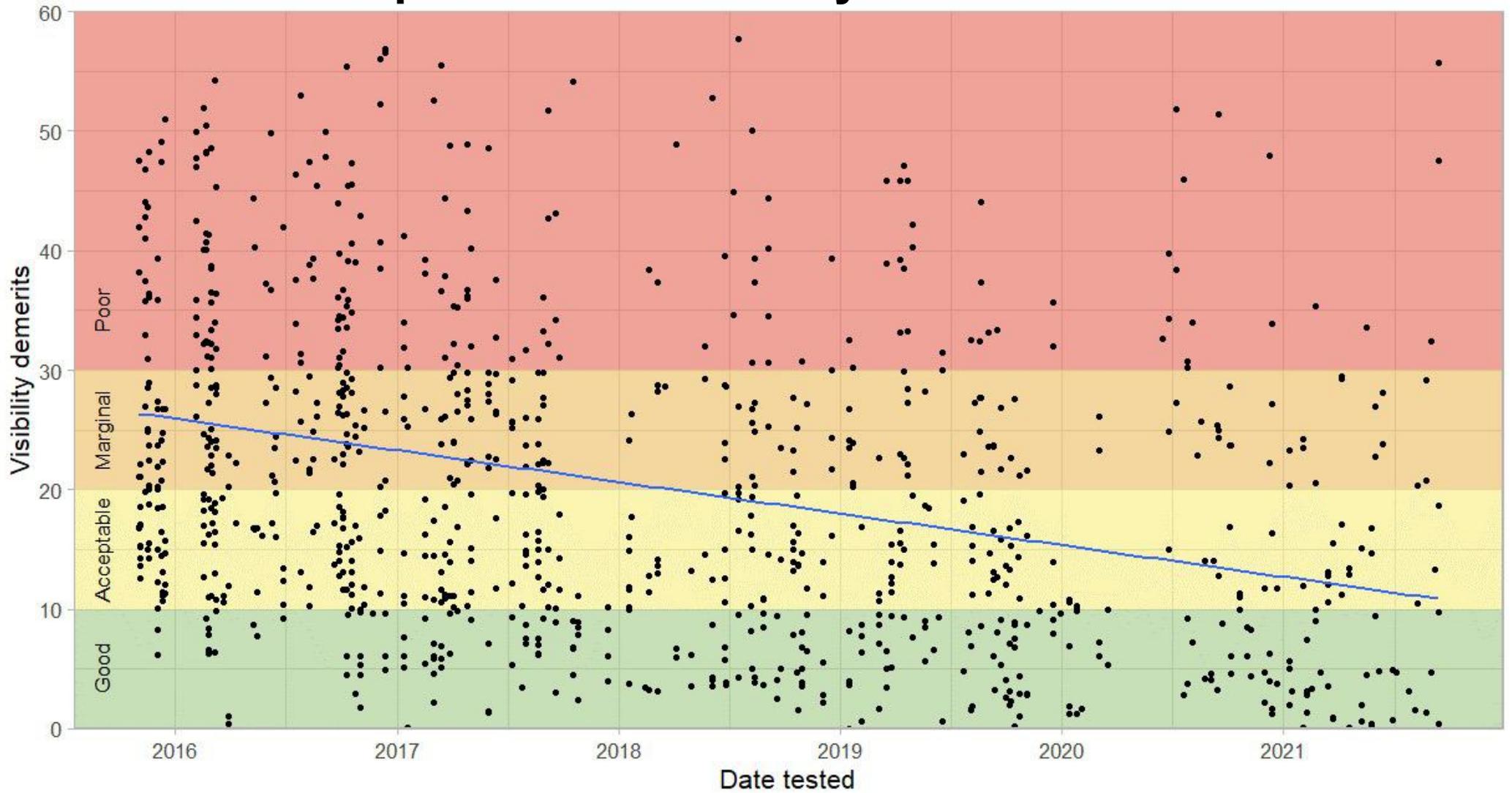
- ▶ Excluded glare from current study of single vehicle crashes
- ▶ Any glare effect will be difficult to study
 - Single vehicle crashes may have glare sources but will always be unknown
 - Multiple vehicle crashes (36% of nighttime crashes) may have glare sources but will only be known if all vehicles have IIHS-tested headlights and all involved vehicles end up crashing
 - Retrospective crash data analysis will never be able to discern whether disabling glare increases risk of crashing into vehicles or objects other than glare-producing vehicles
- ▶ Separate question: would the single vehicle crash results be different without glare contribution to visibility?
 - Answer: no major differences when limiting analyses to vehicles without any glare demerits (63% of crashes) other than wider confidence intervals

Overall fleet improvement: glare

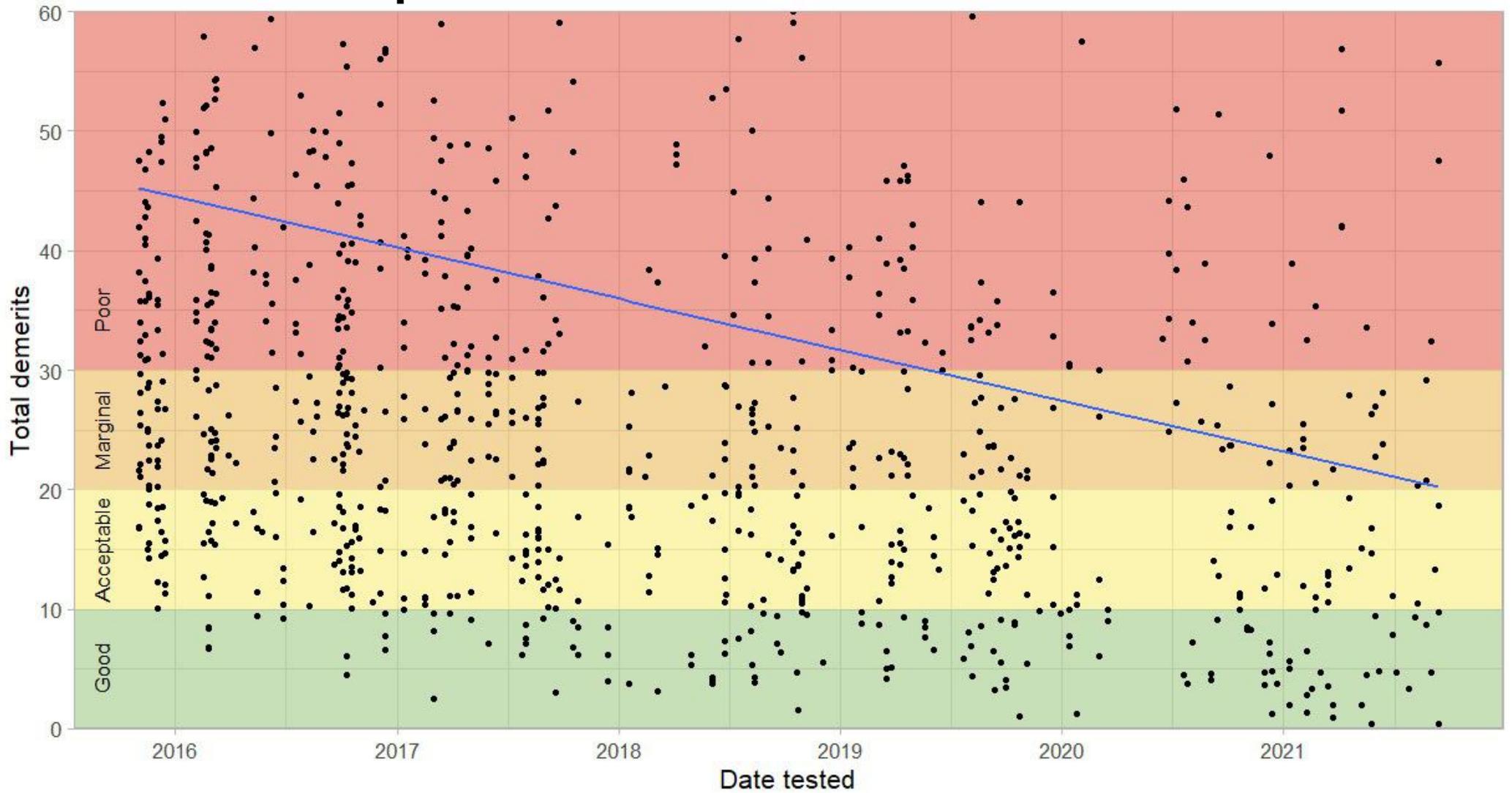
Average straightaway low beam glare by model year for IIHS tested vehicles



Overall fleet improvement: visibility demerits



Overall fleet improvement: total demerits



Conclusions

- ▶ IIHS headlight rating has strong effect on the rate of SV nighttime crashes relative to the rate of SV daytime crashes per mile traveled
- ▶ Effect estimates are well-aligned with the rating scale
- ▶ Relative to Poor-rated headlights, Good-rated headlights associated with:
 - Overall SV nighttime crash rate reduction of 20%
 - Pedestrian, tow-away and driver injury crash rate reductions of 23-29%
- ▶ Precision of estimates should increase over time, especially on good end of rating scale
- ▶ Current rating system may underweight curve conditions relative to straightaways
 - May indicate that for a typical beam pattern, increasing width will produce greater crash reductions than increasing reach



More information at [iihs.org](https://www.iihs.org) and on our social channels:



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