enforcement, legislative, and program evaluation needs, is essential to most effectively reduce speeding-related crashes and injuries.

Other resources and links:

- National Highway Traffic Safety Administration
  - Aggressive Driving - www.nhtsa.gov/Aggressive
  - Enforcement and Justice Services - www.nhtsa.gov/Driving+Safety/Enforcement+&+Justice+Services
  - Research and Evaluation - www.nhtsa.gov/Driving+Safety/Research+&+Evaluation
  - Behavioral Safety Research Reports - ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- FHWA Safety Office, Speed Management Safety page and links: safety.fhwa.dot.gov/speedmgt/
  - Speed Concepts: Informational Guide - http://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa10001/
  - Methods and Practices for Setting Speed Limits- http://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa12004/
- AASHTO Highway Safety Manual: www.highwaysafetymanual.org/
  - AASHTO Strategic Highway Safety Plan, including the NCHRP Report 500 series guides on reducing crashes: www.trb.org/Main/Blurbs/152868.aspx
- Centers for Disease Control, Community Speed Reduction and Public Health. Health Resources In Action resources: www.cdc.gov/healthyplaces/healthtopics/transportation/practice.htm
- Crash Modification Factors Clearinghouse: www.cmfclearinghouse.org/
- NCHRP Report 504, Design Speed, Operating Speed, and Posted Speed Practices: onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_504.pdf
- NCHRP Report 622, *Effectiveness of Behavioral Highway Safety Countermeasures*: www.nap.edu/openbook.php?record_id=14195
- Transportation Research Board Special Report 254, *Managing Speed: Review of Current Practice for Setting and Enforcing Speed Limits*: http://onlinepubs.trb.org/onlinepubs/sr/sr254.pdf Global Road Safety Partnership, *Speed Management: Road Safety Manual for Decision-makers and Practitioners*: www.who.int/roadsafety/projects/manuals/speed_manual/en/
- Transportation Research Information Services (TRIS) database – bibliographic database of transportation-related research: tris.trb.org

Countermeasures That Work

Countermeasures to reduce aggressive driving and speeding are listed below and discussed individually in this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The terms used are described below. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate. See each countermeasure discussion for more information.

1. Laws

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Speed limits	★★★★★†	$	High	Short
1.2 Aggressive driving laws	★	$	Low	Short

† When enforced and obeyed

2. Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Automated enforcement	★★★★★	$$$†	Medium	Medium
2.2 High visibility enforcement	★★	$$$	Low††	Medium
2.3 Other enforcement methods	★★	Varies	Unknown	Varies

† Can be covered by income from citations
†† For aggressive driving, but use of short-term, high visibility enforcement campaigns for speeding is more widespread

3. Penalties and Adjudication

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Penalty types and levels	★★	Varies	High	Low
3.2 Diversion and plea agreements	★	Varies	Unknown	Varies

4. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Public Information supporting enforcement	★★★	Varies	Medium	Medium

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources

★★- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

★- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, or equipment, or makes heavy demands on current resources

$$: requires some additional staff time, equipment, and/or facilities

$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities

Medium: between one-third and two-thirds of States or communities

Low: fewer than one-third of the States or communities

Unknown: data not available

Time to implement:

Long: more than one year

Medium: more than three months but less than one year

Short: three months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Laws

1.1 Speed Limits

Effectiveness: ★★★★★†	Cost: $	Use: High	Time: Short

† When enforced and obeyed

Speed limits are only one part of the system that attempts to control driving speeds. Well-established speed limits based on the use of appropriate engineering practices form the basis for roadway design and operations. Active enforcement and supportive adjudication are also essential to support established limits (NHTSA, FHWA, & FMCSA, 2014).

Speed limits are set both by legislation and by administrative action. General speed limits apply to all roads in a class, such as rural interstates or local streets. They are set by State, municipal, or even at times by Federal law based on tradeoffs between safety, travel efficiency, and community concerns, taking into account the design characteristics of each road class. Speed zones apply to road segments where the general speed limit is thought to be inappropriate. Speed limits in these zones usually are set by administrative action based on the road segment's free-flowing travel speeds, crash experience, road and land use conditions, and other factors (TRB, 1998).

The effects of maximum speed limits on speeds, crashes, and casualties have been studied extensively over the past 40 years. However, recent actions by States raising maximum limits, as well as changes in road design, hardware, vehicles, and drivers suggest that new studies may be needed. In 1974, the 55 mph National Maximum Speed Limit (NMSL) was enacted to conserve fuel. Travel decreased, speeds decreased on roads where the speed limit was lowered to 55 mph, and total traffic fatalities decreased by 9,100 from 1973. The slower and more uniform speeds due to the 55 mph limit are judged to have saved between 3,000 and 5,000 lives in 1974 (TRB, 1984). As fuel became plentiful again, travel increased and compliance with the 55 mph limit decreased markedly (TRB, 1984). In 1987, Congress allowed States to raise speed limits to 65 mph on rural interstate highways. States that raised their limits generally saw increases of about 4 mph in average speeds and 85th percentile speeds and statistically significant increases in traffic fatalities on these roads (TRB, 1998). In 1995, Congress repealed the NMSL and returned full authority to set speed limits back to the States. Again, increased speed limits produced modest increases in both average and 85th percentile speeds as well as increases in traffic fatalities (TRB, 1998; for the most recent analysis, see TRB, 2006). Speed limit increases from 75 to 80 mph on rural Texas interstates in 2006 also resulted in increased speeds relative to a comparison highway where the limit wasn't changed (Retting & Cheung, 2008).

Relatively few studies have examined the safety effects of speed limit changes on lower-speed roads. Earlier studies found little effect on driving speeds or crash rates when speed limits were raised to near the 85th percentile travel speed or lowered to near the 35th percentile speed, either on rural roads or on urban and suburban arterials (TRB, 1998, p. 6). However, a recent study from the City of Edmonton (Alberta province, Canada) found that speeds on residential streets decreased significantly when limits were lowered and supported with enforcement or other measures. Specifically, this study found significant speed reductions (3.9 to 4.9 km/h [2.4 to 3.0

mph], three and six months after treatment, respectively) when posted speed limits in residential areas were reduced from 50 km/h (31 mph) to 40 km/h (25 mph). Changes in posted limits were accompanied by education and enforcement measures, but no changes were made to the roadway. Speeds were reduced on both collector and local road types, in all types of communities, for light and heavy vehicles, for different times of day and on weekends and weekdays. Compliance improved over time up to six months post-implementation (Islam, El-Basyouny, & Ibrahim, 2013). Following the lowering of urban default maximum speed limits from 60 km/hr (37.3 mph) to 50 km/h (31.1 mph) in 2003 in Adelaide (South Australia), low speed roads showed a significant reduction in mean speed from 46.9 km/h (29.1 mph) to 44.8 km/h (27.8 mph) (Kloeden & Woolley, 2010). Between 2003 and 2010, yearly mean speeds have remained lower than before the limits were changed, fluctuating between a high of 44.8 km/h (27.8 mph) and a low of 43.3 km/h (26.9 mph).

When urban speed limits were increased from 50 to 70 km/h (from 31 to 43 mph) or from 70 to 80 km/h (from 43 to 50 mph) on 19 urban road segments in Hong Kong, crashes increased by 20 to 30% (Wong, Sze, Lo, Hung, & Loo, 2005).

A systematic evaluation of changed speed limits on rural roads and motorways in Sweden also found fairly consistent increases in travel speeds on all types of rural roads when limits were raised and decreases on roads where limits were lowered. Increases of the posted speed limit by 10 km/hr (6.2 mph) led to increases in speeds on the order of about 3 to 3.6 km/h (1.9 to 2.2 mph) in mean speeds (weighted for segments length and volume, and including all vehicles on a section for a given time period, not just free flow speeds). Decreases of the posted speed limit of 10 km/hr (6.2 mph) led to decreases of about 2 to 3.3 km/hr (1.2 to 2 mph) for most road types (Vadeby & Forsman, 2014). These findings are generally in line with those of earlier studies of the effects of changing limits by 5 or more mph (TRB, 1998).

Use: A speed limit is in effect on all road segments in all States. For summaries of each State's maximum speed limits see the Governors Highway Safety Association (GHSA, 2015c) and the Insurance Institute for Highway Safety (IIHS, 2015b) websites. NHTSA (2011) provides a publication with each State's complete speed limit laws.

Effectiveness: Lower maximum speed limits definitely reduce crashes and casualties when lower limits result in reduced speeds. In general, speeds tend to decrease, but to a lower degree than the reduction in limits. Similarly, when limits are raised, speeds tend to increase by a smaller amount than the change in limits. The same holds true on any road: if a lower speed limit yields reduced operating speeds, crashes and injuries are expected to decrease (AASHTO, 2010). A more comprehensive effort that includes changes to the roadway and/or enhanced enforcement may be required to reduce travel speeds by the desired amount, especially if the road design does not reflect the desired speed limit and operating speeds (TRB, 1998). The State of Victoria, Australia implemented a comprehensive effort to reduce speeds that combined review and adjustment of speed limits, covert and overt forms of enforcement, a media campaign, penalty restructuring, and other efforts. An evaluation found these combined elements reduced injury crashes by 10% and fatal crashes by 27% (D'Elia, Newstead, & Cameron, 2007).

Costs: The immediate costs of changing speed limits are for new signage and for publicizing the new limit. Enforcing the new limit may involve substantial costs.

Time to implement: Speed limit changes can be implemented quickly, as soon as signage is in place and the new limits are publicized.

Other issues:

- **Public acceptance, roadway characteristics, enforcement, and publicity:** Lowering speed limits can reduce average driving speeds, but it is generally difficult to enforce and obtain broad compliance with a lower speed limit on a roadway designed for much higher speeds (TRB, 1998). Thus, speed limits must be considered as part of a system including roadway design and other characteristics, active enforcement, and publicity (TRB, 1998).
- **Rational speed limits:** Speed limits on many road segments are frequently not obeyed, and average travel speeds on these segments substantially exceed the speed limit. One strategy that has been proposed to increase overall safety is to carefully set and enforce credible speed limits for homogeneous road segments. Once credible, also called rational, speed limits are established, aggressive enforcement is used to enforce close to the actual limit. The goal of this strategy is to increase the public's overall acceptance of speed limits while reducing the number of people driving at speeds considerably higher than the limit. Evidence suggests that drivers' perceptions of safe speed are in fact influenced by their expectation of what speed above the limit would trigger a ticket (Mannering, 2009). Therefore, lower tolerances would help to increase the perception of the risk of exceeding limits by even small amounts. Although consistency in speed limit setting practices should provide better information about appropriate speeds to drivers, the safety effects of combining rational speed limit setting (with limits raised to between the 50th and 85th percentile free flow operating speed) with enhanced enforcement close to the new limit are uncertain. Reviews of the evidence suggest that it can be difficult to implement or sustain enhanced levels of enforcement. In general, higher speed limits are very likely to lead to higher average speeds if nothing is done to the road or enhanced enforcement is not maintained (Hauer, 2009). Higher average speeds are predicted to lead to an increase in fatal and injury crashes (ASHTO, 2010).When testing the effects of raising speed limits, followed by enhanced enforcement in Mississippi and Virginia, average speeds increased in both locations. In Virginia, average speeds tended to increase about 2 mph at locations where the limit was raised by 5 mph and by 3 to 4 mph where it was raised by 15 mph (Freedman, De Leonardis, Polson, Levi, & Burkhardt, 2007). In Virginia, average speed increased by a statistically significant 3 to 4 mph when the limit was raised from 55 to 65 mph on two rural Virginia highways (Fontain, Park, & Son, 2007). Speed variance did not increase and compliance overall was improved in Virginia, which supplemented stricter enforcement with enhanced roadside signs, media publicity, and brochures (Fontain et al., 2007). Average speeds as well as speed variance increased in Mississippi, where limits were increased on different sections of one route by 5 to 15 mph and the number of extreme speeders were not reduced, except on sections where limits were increased by 15 mph (Freedman et al., 2007). Mississippi chose to enforce only flagrant violators (at least 5 mph above the limit). Crash effects were inconclusive over both of these fairly short term evaluations (1 to 1.5 years), although crashes were higher during the Mississippi trial compared to a prior three year period. A test in Minnesota yielded

more promising, though inconclusive crash trends (Harder & Bloomfield, 2007). The Minnesota campaign, which used speeding and crash histories to help target enforcement, effectively reduced mean speeds and especially excessive speeding (speeds of 70 mph and more), but the study period was insufficient to assess crash trends. Extensive radio publicity supplemented by earned media was used in the Minnesota campaign, but it was unclear if these efforts were successful at reaching the target audience.

- **Variable speed limits**: Speed limits that may adjust to adverse or changing environmental conditions are considered by FHWA to have promise in restoring credibility of speed limits on some highways. Variable speed limits (VSLs) have long been used on European freeways to manage speed and traffic flows. As of 2007, six metropolitan areas in the United States were employing enforceable, variable speed limits on freeways (posted on changeable message signs) (RITA, 2007). Variable speed limits have also been tested in Michigan work zones (FHWA, 2004). A high quality study of safety effects of variable limits deployed on freeways in the St. Louis area reported crash reductions of 8%. The congestion relief benefits were not as high as the public and agencies had hoped, however, leading to somewhat equivocal support for the measure (Bham et al., 2010). No other quality evaluations are available at present. Preliminary investigation of a Wyoming freeway VSL system showed speed reductions from 0.47 to 0.75 mph for every mph reduction in speed limit (Buddemeyer, Young, & Dorsey-Spitz, 2010). Other States that have used VSL systems to alter speed limits for weather conditions include Alabama, Delaware, and Washington (Katz et al., 2012). Automated speed enforcement could potentially be linked to variable limits to increase compliance.
- **Work Zone speed limits:** If drivers perceive that limits are too low, workers are not present, and other changes to the roadway do not seem to justify the lower limits, they may not comply, and extensive enforcement may be needed to enforce the limit (NCHRP, 2013).

1.2 Aggressive Driving and Other Laws

Effectiveness: ★	Cost: $	Use: Low	Time: Short

Aggressive driving actions are covered by specific traffic laws, such as the laws regarding speeding, improper lane changes, and following too closely, or by general laws, such as those that target reckless driving. Most existing reckless driving statues carry relatively minor penalties and may be difficult to prosecute according to NHTSA (NHTSA, 2001a). Aggressive drivers, as distinct from aggressive driving, often can be identified as those who violate traffic laws repeatedly or whose violations lead to crashes producing serious injury or death. Therefore, the primary traffic law strategy to address aggressive driving is to assure that more severe penalties are available for repeat offenders and for violations causing death or serious injuries. Existing statutes, including reckless driving laws, may be strengthened or aggressive driving laws may be enacted.

NHTSA's 1999 Symposium on Aggressive Driving and the Law recommended that States implement laws targeting aggressive drivers by providing for:

- enhanced penalties for repeat offenders, including increased driver's license points, license suspension or revocation, higher fines, and jail or probation; and
- felony charges for violations resulting in serious injury or death (NHTSA, 2001a).

NHTSA also developed a model statute that defines aggressive driving as three moving violations in a single driving incident and a number of States have adopted similar laws; however, aggressive driving violations may be difficult to enforce and prosecute (Flango & Keith, 2004). The NCHRP Aggressive Driving Guide also suggests a strategy of applying increased sanctions and treatment for repeat offenders and serious offenses (NCHRP, 2003a, Strategy A3).

Use: In general, States provide for increased penalties for repeat offenders and for violations with serious consequences. Eleven States have aggressive driving laws (GHSA, 2015a).

Effectiveness: There is as yet no evidence for whether aggressive driving laws in general, or increased penalties in particular, affect aggressive driving and related crashes. See Chapter 3, Section 3.1 for a discussion of the effects of driver improvement actions in general.

Costs: The only immediate costs of the recommended law changes are to publicize the new or altered laws. Additional costs may result as drivers are sentenced to more costly sanctions.

Time to implement: Law changes can be implemented quickly, once legislation is passed and publicized.

Other issues:

- **Public acceptance, enforcement, and publicity:** Law changes by themselves cannot reduce aggressive driving. Traffic laws in general and aggressive driving laws in particular are essential to, but only a part of, a system that includes broad public

acceptance, active enforcement, effective adjudication, and publicity (NHTSA, 2001a).

- **Record-keeping:** Information on prior convictions of offenders must be up-to-date and available to prosecutors and court officials so that repeat and flagrant violators may be prosecuted in keeping with the strategy to increase sanctions for these offenders. Providing the technology and ability for patrol officers to obtain up-to-date driver history information at the time of traffic stops is another strategy recommended to deal with drivers with suspended or revoked licenses who continue to violate traffic laws (NCHRP, 2003b).

2. Enforcement

2.1 Automated Enforcement

Effectiveness: ★★★★★	Cost: $$$[†]	Use: Medium	Time: Medium

[†] Can be covered by income from citations

Automated enforcement is used in some jurisdictions to reduce red-light running and speeding above limits. At intersections with traffic lights, automated cameras take photographs of vehicles entering the intersection on a red light. Citations are sent to the vehicle's registered owner. FHWA's Red- Light Camera Systems Operational Guidelines (FHWA, 2005) provides information on red-light camera program costs, effectiveness, implementation, and other issues. Speed cameras, also called photo radar or automated speed enforcement, operate similarly, recording a vehicle's speed using radar or other instrumentation and taking a photograph of the vehicle when it exceeds a threshold limit. NCHRP (2012), and NHTSA and FHWA (2008) have released automated enforcement program and operational guides with information on identifying problems and setting up and maintaining an effective and transparent, community-supported enforcement program using speed or red light cameras.

Use: Red-light cameras are used extensively in other industrialized countries and were first employed in the United Sates in 1993 (NCSRLR, 2002). As of June 2015, red-light cameras were being used in about 460 communities in 24 States, the District of Columbia, and the U.S. Virgin Islands. Speed cameras were being used in approximately 134 jurisdictions in 12 States, the District of Columbia, and the U.S. Virgin Islands, including four statewide work zone automated enforcement programs (in Illinois, Maryland, Oregon, and Washington) (GHSA, 2015b; IIHS, 2015a). Speed cameras also are used extensively in other countries (WHO, 2004).

Effectiveness: Red-light camera effectiveness has been studied fairly extensively. Summary reviews conclude that they increase rear-end crashes, reduce side-impact crashes (the target group), and reduce overall crash severity (Aeron-Thomas & Hess, 2006; Decina, Thomas, Srinivasan, & Staplin, 2007; Maccubbin, Staples, & Salwin, 2001; McGee & Eccles, 2003; Retting, Ferguson, & Hakkert, 2003; Washington & Shin, 2005; WHO, 2004). Because there tend to be increases in lower-severity rear end crashes that somewhat offset reductions in the target group of higher- severity angle crashes, cameras were found to be more beneficial at intersections with a higher ratio of angle crashes to rear-end crashes. The best-controlled studies have found that intersections with high total volumes, higher entering volumes on the main road, longer green (through) cycle lengths, protected left turn phases, and higher publicity may also increase the safety and cost benefits of red light camera enforcement (Council, Persaud, Eccles, Lyon, & Griffith, 2005; Washington & Shin, 2005). Other factors that may improve safety benefits included the posting of warning signs in advance of the intersection. Washington and Shin (2005) also caution that less expensive engineering solutions should be sought before implementing camera programs.

Speed cameras can also reduce crashes substantially. Decina et al. (2007) reviewed 13 safety impact studies of automated speed enforcement internationally, including one study from a U.S. jurisdiction. The best-controlled studies suggest injury crash reductions relating to the

introduction of speed cameras are likely to be in the range of 20 to 25% at conspicuous, fixed camera sites. Covert, mobile enforcement programs also result in significant crash reductions area-wide (Thomas, Srinivasan, Decina, & Staplin, 2008). Recent crash-based studies from the United States have reported positive safety benefits of crash and speed reductions from mobile camera enforcement on 14 urban arterials in Charlotte, North Carolina (Cunningham Hummer, & Moon, 2008), and from fixed camera enforcement on an urban Arizona freeway (Shin, Washington, & van Schalkwyk, 2009).

The Shin et al. (2009) study examined effects of a fixed camera enforcement program applied to a 6.5-mile urban freeway section through Scottsdale, Arizona. The speed limit on the enforced freeway was 65 mph; the enforcement trigger was set to 76 mph. Total *target* crashes were reduced by an estimated 44 to 54%, injury crashes by 28 to 48%, and property damage only crashes by 46 to 56% during the 9-month program period. Since analyses found low speeding detection rates during peak travel times, the target crashes (speeding-related crashes) were considered to be those that occurred during non-peak flow periods (weekends, holidays, and non-peak weekdays hours). In addition to the crash reductions, average speed was decreased by about 9 mph and speed variance also decreased around the enforced zones. Another positive finding from this study was that all types of crashes appeared to be reduced, with the possible exception of rear-end crashes, for which effects were non-significant. Thus, there were no obvious trade-offs of decreases in some crash types at the expense of increases in others. The program effects should be considered short-term. There was also very limited examination of spillover effects, including the possibility of traffic or crash diversion to other routes.

In 2009/2010, the freeway speed camera program in Arizona was discontinued as the result of a political decision based on a variety of factors. A mobile speed camera operator was shot and killed on a deployment, creating concerns for the safety of personnel in the field. Additionally, a change in administration in the State shifted the view of automated enforcement in general, and on the freeways around Phoenix, in particular.

Pilot project evaluations of speed camera use in the United States have also obtained promising speed reductions from fixed speed cameras in low-speed, school zones in Portland, Oregon (Freedman et al., 2006), and low-speed limit residential streets and school zones in Montgomery County, Maryland (Retting, Farmer, & McCartt, 2008). In the latter case, speed reductions attributed to spillover from the automated enforcement program were also observed on unenforced comparison streets (Retting et al., 2008). The percentage of speeders was also substantially reduced when police-operated photo radar enforcement vans were present in a work zone on a non-interstate highway in Portland, Oregon, but there was no carry-over when the enforcement was not present (Joerger, 2010). Given that there was no evidence of any accompanying signs or publicity, there was, however, no reason to expect carry-over outside of the enforced periods. Crash and injury outcomes were not evaluated in these studies.

Costs: Costs will be based on equipment choices, operational and administrative characteristics of the program, and specific negotiations with vendors. Cameras may be purchased, leased, or installed and maintained by contractors for a negotiated fee (NHTSA & Federal Highway Administration, 2008). In 2001, red-light film-based camera systems cost about $50,000 to

$60,000 and digital systems were around $100,000 to purchase and $25,000 to install. Monthly operating costs were about $5,000 (Maccubbin et al., 2001). Most jurisdictions contract with private vendors to install and maintain the cameras and, to process images and violations. A substantial portion of the fines from red-light citations is generally used to cover program costs (Washington & Shin, 2005).

Fixed speed camera costs may not be similar to those for red-light camera programs, based on volume of activity and violations they generate. An economic analysis estimated the total cost savings of the Scottsdale freeway fixed speed enforcement were from $16.5 to $17.1 million per year, considering only camera installation and operational cost estimates and crash cost impacts (other potential economic impacts were not considered) (Shin, Washington, & van Schalkwyk, 2009). Chen (2005) provides an extensive analysis of the costs and benefits of the British Columbia, Canada, mobile speed camera program and estimated a societal savings of C$114 million and a savings of over C$38 million for the Insurance Corporation of British Columbia (ICBC) that funded the program. Gains, Heydecker, Shrewsbury, and Robertson (2004) reported a 4:1 overall societal cost to benefit ratio of operating the national (fixed) speed camera program in the U.K. based on 33% reductions in personal injury crashes at camera sites and a 40% reduction in the number of people killed and seriously injured.

Time to implement: Once any necessary legislation is enacted, automated enforcement programs generally require 4 to 6 months to plan, publicize, and implement.

Other issues:

- **Laws:** Many jurisdictions using automated enforcement are in States with laws authorizing its use. Some States permit automated enforcement without a specific State law. Others prohibit or restrict some forms of automated enforcement (GHSA, 2015b; IIHS, 2015a). In yet others, there is no specific statute, and it cannot be inferred from case law whether the State allows automated enforcement. As of February 2010, 9 States had statutes specifically authorizing the use of automated speed enforcement, three implicitly allowed automated speed enforcement (but had no specific authorizing statute), and 6 had statutes allowing specific or limited automated speed enforcement (NHTSA, 2011). See NCUTLO (2004) for a model automated enforcement law.
- **Public acceptance:** Public surveys typically show strong support for red-light cameras and somewhat weaker support for speed cameras (NHTSA, 2004). A 2011 nationally-representative survey of drivers found that 86% thought automated speed cameras would be acceptable to enforce speed limits in school zones. Significant majorities also thought they would be acceptable at high-crash locations (84%), in construction zones (74%), and in areas that would be hazardous for police officers to stop vehicles (70%) or would cause congestion (63%). Thirty-five percent thought automated camera enforcement of speeds is acceptable on all roads (Schroeder, Kostyniuk, & Mack, 2012). Support appears highest in jurisdictions that have implemented red-light or speed cameras. A survey of District of Columbia residents found 76% favored speed cameras, with even higher support among non-drivers (Cicchino, Wells, & McCartt, 2014). A larger majority of 87% favored the use of red light cameras. Interestingly, support was lower for measures not currently in use, including photo-enforcement of stop signs (50%) and yielding at crosswalks (47%). Again, support was higher among non-drivers for these measures

(Cicchino et al., 2014). However, efforts to institute automated enforcement often are opposed by people who believe that speed or red-light cameras intrude on individual privacy or are an inappropriate extension of law enforcement authority. They also may be opposed if they are viewed as revenue generators rather than methods for improving safety. Drivers responding to the NHTSA survey, although indicating support generally for automated enforcement in certain types of locations or conditions, were also more likely to somewhat agree or strongly agree with the statement that speed cameras are used to generate revenue (70%) than with the statement that speed cameras are used to prevent accidents (55%) (Schroeder et al., 2012). Such concerns should be carefully and openly addressed in any automated enforcement program. FHWA recommends, for example, that per citation payment arrangements to private contractors should be avoided to reduce the appearance of conflicts of interest (FHWA, 2005). A case study from Portland Oregon's RLC program indicates that the vendor payment structure is a blended contract. The vendor receives a fixed amount per intersection to install and operate the cameras (the city picks the sites) and a monthly amount based on the number of citations that are issued (NCHRP, 2012). The marginal amount decreases with more citations issued. The current payment structure is $27 per citation for the first 500 paid citations in a month, $20 for citations 501-700, and $18 for each paid citation over 700. A couple of research papers have discussed how Australia and the United Kingdom have dealt with the opponents of and controversies associated with speed cameras and expanded programs at the same time (Delaney, Diamantopoulou, & Cameron, 2003; Delaney, Ward, Cameron, & Williams, 2005). Also see NCHRP (2012) for more in-depth description of best practices for speed camera programs and case study examples of sustained programs.

- **Legality:** State courts have consistently supported the constitutionality of automated enforcement (Poole, 2012).
- **Covert versus overt enforcement:** Covert, mobile speed camera enforcement programs may provide a more generalized deterrent effect and may have the added benefit that drivers are less likely to know precisely when and where cameras are operating. Drivers may therefore be less likely to adapt to cameras by taking alternate routes or speeding up after passing cameras, but data are lacking to confirm this idea (Thomas et al., 2008). Public acceptance may be somewhat harder to gain with more covert forms of enforcement (NHTSA & FHWA, 2008). Fixed, or signed, conspicuous mobile enforcement may also be more noticeable and achieve more rapid site-specific speed and crash reductions at high crash locations. However, the use of general signs in jurisdictions with automated enforcement (not at specifically enforced zones), media, and other program publicity about the need for speed enforcement may help to overcome the idea that covert enforcement is unfair, and promote the perception that enforcement is widespread, enhancing deterrence effects. Based on lessons learned abroad, a mix of conspicuous and covert forms of enforcement may be most effective. See Belin, Tillgren, Vedung, Cameron, & Tingvall (2010) for a comparison of Australian covert and Swedish fixed, overt systems. NHTSA and FHWA's operational guidelines document outlines other considerations of overt and covert speed enforcement and signing strategies (NHTSA & FHWA, 2008).
- **Halo effects:** More research is needed to shed light on spillover effects (positive or negative) of automated speed enforcement programs of varying characteristics. While fixed cameras may yield more dramatic decreases in crashes at the treated sites (which,

however, are often sites with high crash frequencies that are likely to decrease in subsequent years) than mobile enforcement, there is little reason to expect that there would be a significant positive spillover effect. In fact some studies have detected crash migration related to conspicuous, fixed camera enforcement (Decina et al., 2007). There is also a possibility of negative spillover resulting from mobile camera enforcement, but signing and random deployment practices may reduce that possibility (Thomas, Srinivasan, et al., 2008).

- **Average speed (over distance) enforcement:** A review of the evidence to date suggests that enforcement (using multiple cameras and camera sites) of average motorist speed over distance is associated with reductions in average and 85th percentile speeds, and the proportion of speeding vehicles. Such systems have the potential to reduce speed variability and improve traffic flow characteristics, and may help to avoid negative halo effects such as crash migration to downstream sites that fixed or overt mobile enforcement sometimes experience (Soole, Watson, and Fleiter, 2013).
- **Enforcement threshold:** Victoria, Australia has had success with a program that tightened enforcement tolerances as part of an overall speed management package that included automated and other enforcement, publicity, and penalty restructuring (D'Elia, Newstead, & Cameron, 2007). A recent experiment in Finland also found that lowering the enforcement threshold of fixed, speed camera enforcement on a rural, two-lane road from 20 km/h (12.4 mph) above the limit to 4 km/h (2.5 mph) above the limit (advertised as zero tolerance) and publicity of the measure reduced mean speeds by 2.5 km/h (1.6 mph) and speed variance by 1.1 km/h (0.7 mph) in comparison with a similar, camera-enforced corridor where the threshold was not reduced (Luoma, Rajamäki, & Malvivuo, 2012). The percentage of vehicles exceeding the speed limit was reduced from 23% to 10%, so deterrence of speeding was increased without increasing the processed citations (police or administrative burden). The speed effect of the reduced threshold was within the range of effect of the initial implementation of the automated camera enforcement.

2.2 High Visibility Enforcement

Effectiveness: ★★	Cost: $$$	Use: Low-Medium†	Time: Medium

† Use is low for aggressive driving, but use of short-term, high visibility enforcement campaigns for speeding is more widespread

High visibility enforcement campaigns have been used to deter speeding and aggressive driving through both specific and general deterrence. In the high visibility enforcement model, law enforcement targets selected high-crash or high-violation geographical areas using either expanded regular patrols or designated aggressive driving patrols. This model is based on the same principles as high visibility seat belt and alcohol-impaired-driving enforcement: to convince the public that speeding and aggressive driving actions are likely to be detected and that offenders will be arrested and punished (see Chapter 1, Alcohol-Impaired Driving, Sections 2.1 and 2.2, and Chapter 2, Seat Belt Use, Section 2.1).

In the high visibility enforcement model, officers focus on drivers who commit common aggressive driving actions such as speeding, following too closely, and running red lights. Enforcement is publicized widely. The strategy is very similar to saturation patrols directed at alcohol-impaired drivers (Chapter 1, Section 2.2). Because speeding and aggressive driving are moving violations, officers cannot use checkpoints. Rather, they must observe driving behavior on the road.

NHTSA's *Aggressive Driving Enforcement: Strategies for Implementing Best Practices* (NHTSA, 2000) provides brief descriptions of 12 aggressive driving enforcement programs from around the country. A few examples:

- The Albuquerque, New Mexico, Safe Streets program used saturation patrols in four high-crash and high-crime areas, writing tickets when infractions were observed. At about the midpoint of the program, traffic enforcement focus was shifted from the high crime neighborhoods to high crash corridors and intersections. On freeways they observed speeding and aggressive driving from a "cherry picker" platform and radioed to patrol officers. See www.nhtsa.gov/people/injury/enforce/safestreets/index.htm for more information including some measures of program effects.
- The greater Washington, DC, area multi-agency Smooth Operator program uses shared publicity and coordinated enforcement waves with marked and unmarked patrol vehicles as well as nontraditional vehicles. This program provides a website link where the public can report observed instances of aggressive driving: (www.smoothoperatorprogram.com/aggressive_reporting.html). Also see the District's web page about the program (http://mpdc.dc.gov/node/208412). The State of Maryland also participates in Smooth Operator (see Sprattler, 2012).
- The Washington State Patrol's Enforcement Target Zero Program involves State troopers, county sheriff's deputies and city and tribal police officers collaborating to focus on those violations proven to cause fatal or serious injury collisions. The program uses mapping to target resources and experienced officers and training on completing investigations and arrest reports to assist with prosecution. See www.wsp.wa.gov/targetzero/targetzero.htm for more information.

See a few other examples of high visibility speed and aggressive driving enforcement programs in GHSA's Survey of the States: Speeding and Aggressive Driving (2012), and NHTSA's *Aggressive Driving Programs* (NHTSA, 2001b).

Use: High visibility speed enforcement campaigns are common, with most States providing some funding for speed equipment (47 States and Guam), overtime enforcement (42 States and Guam), or speed public information campaigns (31 States and Guam) (Sprattler, 2012). Relatively few States fund aggressive driving-related equipment or enforcement (six States; Sprattler, 2012) and it is likely that high visibility aggressive driving enforcement campaigns are not common. NCHRP (2003a, Strategy A1) provides a few examples of aggressive driving enforcement programs.

Effectiveness: Moon and Hummer (2010) estimated that 8 to 9% of the total and injury crash reduction effects of around 25% associated with an automated mobile, speed enforcement program in Charlotte, NC, were attributable to media coverage of the program. In addition to results from automated camera enforcement programs (see Section 2.1), which typically incorporate a significant amount of publicity and media coverage (see section 4.1), some crash-based effectiveness evidence comes from NHTSA demonstrations in three communities. All three demonstrations lasted 6 months and included extensive publicity but differed in other respects. Milwaukee was the most successful. Red-light running decreased at targeted intersections. Crashes in the city dropped by 12% in targeted corridors and by 2% in comparison corridors (McCartt, Leaf, Witkowski, & Solomon, 2001). The Indianapolis demonstration was not a success. Average speeds dropped slightly. Total crashes *increased* 32% over the previous year. Crashes increased *more* in the demonstration area than in other areas, and the proportion of crashes involving aggressive driving behaviors also increased in the demonstration areas (Stuster, 2004). Tucson had mixed results. Average speeds dropped moderately. Total crashes *increased* 10% in the demonstration areas and *decreased* in comparison areas. However, the proportion of crashes involving aggressive driving behaviors decreased by 8% in the demonstration areas (Stuster, 2004).

Several studies have reported reductions in crashes or reductions in speeding or other violations attributed to both general and targeted high visibility speed enforcement campaigns. Although the evidence is not conclusive, the trends are promising. These efforts have included a substantial increase in general traffic enforcement in Fresno, California (Davis et al., 2006), and a community-based high visibility speed enforcement campaign, entitled *Heed the Speed*, in the Phoenix, Arizona-area that aimed to reduce pedestrian crashes and injuries (Blomberg & Cleven, 2006). No particular publicity measures were noted for the Fresno campaign, but it is likely that the increase from 20 to 84 traffic patrol officers, the addition of 20 new police motorcycles and radar guns, and more than 3-fold increase in citations in two years generated some publicity. Publicity measures for the *Heed the Speed* campaign included street and yard signs, educational material and active participation of neighborhood groups. Speed reductions were greatest in neighborhoods where new vertical traffic calming measures were also installed (Blomberg & Cleven, 2006; also see a *Traffic Tech* summary, NHTSA, 2006).

A recent effort to scale-up the Heed the Speed program to six (out of 25 total) police districts in Philadelphia, met with limited success and some challenges. There were both unique challenges,

including State legal restrictions on the use of radar for issuing citations, and other challenges, which the planned use of a new speed enforcement technology was unable to overcome. These other challenges such as competing law enforcement priorities, equipment loss, funding limitations, difficulty engaging public involvement, and gaining message penetration that were experienced in Philadelphia may also be challenges in other large cities. Even without an increase in speeding citations, however, there were decreasing trends in percentages of speeders on 17 of 24 streets over the three years of the program, especially on the streets that received a type of engineering treatment– three-dimensional painted markings that simulate traffic calming devices. Other treatments included ensuring appropriate posting of limits, message-oriented signs with and without speed limit reminders along the roadways, and flyers and other outreach. See also Section 4.1 Communications and Outreach in Support of Enforcement for more information.

A 2008 test of a 4-week, high visibility enforcement campaign along a 6-mile corridor with a significant crash history in London, U.K., found significant reductions in driver speeding in the enforced area. There was also a halo effect up to two weeks following the end of the campaign (Walter, Broughton, & Knowles, 2011). A crash-based analysis was not conducted. The campaign was covered by print media as well as by billboards and active messaging along the enforced corridor.

High visibility model programs to target specific aggressive driving actions around large trucks have also been undertaken in several States. The program, known as TACT (Ticketing Aggressive Cars and Trucks) is modeled on the *Click It or Ticket* belt use campaigns. An evaluation found promising results in reducing the number of targeted violations as the program was implemented in Washington State; effects on crashes or injuries were not determined (Nerup et al., 2006; Thomas, Blomberg, Peck, Cosgrove, & Salzberg, 2008).

In summary, the evaluation evidence suggests that high visibility, anti-speeding and aggressive driving enforcement campaigns have promise, but safety benefits are far from guaranteed. Given challenges in administering police enforcement resources, one approach to develop a sustainable and effective campaign may be to randomly target low levels of conspicuous enforcement on an unpredictable basis to a larger share of network roads that account for a significant majority of injury crashes on the entire network (Newstead, Cameron, & Leggett, 2001). Such a program may warrant expanding enforcement coverage to many more roads in a jurisdiction to increase network-wide deterrence. In Queensland, Australia, the Random Road Watch enforcement program aims explicitly to cover a large portion of the road network where serious crashes occur, not just crash black spots, by randomly targeting police enforcement for two hour periods from 6 a.m. to midnight using marked, parked police vehicles. Significant reductions in fatal and all crashes were estimated for the enforced zones that translated into statewide reductions of 12% in all severity of crashes and 15% of the State’s fatal road crashes (including non-metro areas). No additional publicity was undertaken; it is unknown how much free publicity the program generated.

Other methods making use of enforcement time halos such as enforcing a corridor or other area for up to 4 weeks as described earlier, and then rotating the enforcement to another zone could also be utilized to maximize enforcement’s deterrent effects.

Costs: As with alcohol-impaired driving and seat belt use enforcement campaigns, the main costs are for law enforcement time and for publicity. The Minnesota Speed Management Program cost approximately $3 million, with $2.5 million for increased enforcement, $350 thousand for paid media (primarily radio), and $150 thousand for data collection and evaluation. The Minnesota DOT and State Patrol also made significant in-kind contributions toward project management, sign installation, speed detection equipment, engineering reviews, and fuel and vehicle costs (Harder & Bloomfield, 2007). The Milwaukee demonstration received a $650,000 grant and the other two demonstrations each received a $200,000 grant. Public-private partners (such as those in interests in injury prevention and public health) may be able to assist with publicity.

Time to implement: High visibility enforcement campaigns may require 4 to 6 months to plan, publicize, and implement.

2.3 Other Enforcement Methods

Effectiveness: ★★	Cost: Varies	Use: Unknown	Time: Varies

Many traffic enforcement operations help to deter speeding and aggressive driving as well as other traffic offenses. In addition to high visibility enforcement campaigns (Chapter 3, Section 2.2) and automated enforcement (Section 2.1), a number of new technologies have been recommended to address speeding and aggressive driving (NHTSA, 2001). Law enforcement agencies around the country have also conducted innovative and effective aggressive driving enforcement programs (NHTSA, 2000).

Technology: Both external and in-vehicle technologies may help in several ways.

- In-car video equipment in patrol cars allows law enforcement to record aggressive driving actions and can enhance the ability to prosecute and convict offenders (NHTSA, 2001).
- Laser speed measuring equipment can provide more accurate and reliable evidence of speeding (NHTSA, 2001a).
- Unstaffed speed display devices, also known as speed trailers, can show drivers that they are speeding and may encourage some drivers to slow down, but effects may last only as long as the devices are in place (Donnell & Cruzado, 2008). They may also suggest to drivers that speeds are being monitored or enforcement is nearby. Signs that provided either an implication that speeds were being monitored or a social norms message (average speed at the site; your speed) were effective at reducing speeds in a 50 km/h zone although not as much as in earlier studies (Wrapson, Harre, & Murrell, 2006). Other studies have shown that speed trailers or portable changeable message signs, which may include speed feedback plus other messages such as “Slow Down Now” can be effective in reducing speeds in work zones (Brewer, Pesti, & Schneider, 2006; Mattox, Sarasua, Ogle, Eckenrode, & Dunning, 2007) and school zones (Lee, Lee, Choi, & Oh, 2006). Automated speed display monitors also provide a method to collect location-specific travel speed data. Speed feedback devices are likely to be more effective on two-lane highways than multi-lane ones. In addition, they may not provide accurate speed indications if traffic volumes are too high (NCHRP, 2013). Speeds seem to rebound quickly downstream and as soon as the devices are removed (Walter & Broughton, 2011; Hajbabaie, Medina, Wang, Rahim, & Chitturi, 2011).
- In work zones, a combination of a parked police vehicle and speed feedback trailer reduced average and 85th percentile traffic stream speeds and free flow speeds to a similar degree as automated camera enforcement, whereas the effect of speed trailers alone was the same as no treatment. Parked police alone was also effective, but to a lesser extent than the combination of police + trailer or the camera system. The number of speeders above 10 mph over the limit was essentially reduced to zero by both the automated enforcement and police + trailer combination. However, the treatment effects on speeds in work zones disappeared within 40 – 50 minutes of removal (Hajbabaie et al., 2011). See the NCHRP (2013) Report 746 for in-depth discussion of advantages, disadvantages and deployment considerations for various methods of traffic enforcement in work zones. According to this report, which provides state of the knowledge for work zone enforcement, there have been insufficient controlled trials to identify the optimal

mix of enforcement types and other treatments for different highway types, geometries, and work zone situations. The report reiterates the importance of work zone speed limits that reflect the situation, including the presence of workers or alignment changes.

- Drone radar - A study of the use of this technology in work zones suggests that it may be effective at reducing overall speed of the traffic stream, with particularly large speed reductions among vehicles equipped with radar detectors (Eckenrode, Sarasua, Mattox, Ogle, & Chowdhury, 2007). Both in-vehicle driver warning systems, as well as traditional cruise control, are widely available technologies that may be well-accepted by drivers to help govern their own speeds (Sivak et al., 2007; Young & Regan, 2007).
- Intelligent Speed Adaptation (ISA) involves in-vehicle devices that "know" the speed limit through accurate digital maps of speed limits and global positioning system (GPS) data of the vehicle location. ISA systems can either warn when the speed limit is being exceeded or apply active controls to slow the vehicle. A recent pilot study was conducted in the United States among a group of repeat violators. (See section 3.1 for information about this study.) The devices have been widely studied in European countries for acceptability and effects on driver behavior with more widespread on-road trials currently underway. (See http://ec.europa.eu/transport/wcm/road_safety/erso/knowledge/Content/20_speed/intelligent_speed_adaptation_isa_.htm for more information.) In Europe, the effects on speeding have been fairly dramatic for both warning and control type ISA systems, decreasing the amount of speeding and narrowing the speed distributions (Carsten, 2012; Lai & Carsten, 2012; van der Pas, Kessels, Veroude, & van Wee, 2014). These are very promising results for potential crash and injury reductions. However, a widespread implementation and trial have yet to be documented. While there remain issues to be resolved, including the extent to which behaviors in international trials are generalizable to the United States, the main roadblock to implementation may be political (Carsten, 2012) rather than safety or technological reasons. Some issues uncovered in recent trials include that serious offenders were more likely to disable or over-ride the devices than other drivers (van der Pas et al., 2014), and may be less likely to adopt ISA use, even with incentives (Chorlton, Hess, Jamson, & Wardman, 2012; De Leonardis, Huey, & Robinson, 2014). It is not clear if drivers' behavior may change after the devices are inactivated, or when they are disabled. Drivers' intentions to speed and actual behaviors were assessed following driving with an Intelligent Speed Adaptation in-vehicle system that provided direct resistance to speeding (Chorlton & Connor, 2012). While measured intentions to speed and impressions of time-savings that could be gained by speeding were decreased among the participants, actual speeding behavior after the system was inactivated returned to pre-exposure levels within 4 weeks.
- According to researchers from the U.K., the devices may potentially be over-ridden where they may be most needed (Lai & Carsten, 2012). Other uncertainties also still exist about driver behaviors or adaptations, and even external forces that may potentially affect the costs and benefits of ISA (van der Pas et al., 2012). Finally, there is a need to provide current and accurate maps of speed limits (Carsten, 2012).
- A study of the effects of in-vehicle warning and monitoring systems was disappointing with respect to speed control by young teens (Farmer, Kirley, & McCartt, 2010). Even with parental notification (immediate or delayed) and with or without in-vehicle alerts, there was either no reduction in instances of teens exceeding the limit by more than 10

mph or initial declining trends reversed after a few weeks.

- Alerts or speed monitoring combined with rewards may work better than alerts and monitoring alone. Several field tests from Europe have found that drivers exceeded limits less when offered economic incentives such as reduced insurance premiums or discounts (for lease vehicles). Results were positive for lease car drivers in the Netherlands (Mazureck & van Hattem, 2006), young drivers in the Netherlands (Bolderdijk, Knockaert, Steg, & Verhoef, 2011), and members of a large motor club in Sweden (Stigson, Hagborg, Kullgre, & Krafft, 2014).

Many jurisdictions use some of the above technologies. Each has costs for new equipment, maintenance, and training, and perhaps other costs. In the case of ISA, accurate digital maps of speed limits are needed.

3. Penalties and Adjudication

3.1 Penalty Types and Levels

Effectiveness: ★★†	Cost: Varies	Use: High	Time: Low

† For general traffic offenses

Penalty types and levels for speeding and the various traffic offenses included under aggressive driving are part of each State's overall driver control system. Penalties typically are low for first offenses that do not produce serious crashes and casualties and include small fines and perhaps a few demerit points assessed against the driver's license. When violations cause a crash producing serious injury or death, the offense may carry criminal charges and sanctions may be more severe. As discussed in Chapter 3, Section 1.2, NHTSA's Aggressive Driving Symposium and NCHRP's Aggressive Driving Guide recommend enhanced penalties for repeat aggressive driving offenders and felony charges for offenses resulting in serious injury or death (NCHRP, 2003a, Strategy A3; NHTSA, 2001a).

States use the demerit point system in an attempt to prevent drivers from committing repeated traffic offenses. As drivers accumulate demerit points, States use various actions and penalties such as warning letters, educational brochures, group counseling meetings, individual counseling, administrative hearings, and driver's license suspension or revocation (Masten & Peck, 2004). Penalty levels and types for speeding and aggressive driving offenses should be considered within the context of a State's overall driver control and problem driver remediation system.

Use: Each State has a system of penalties for traffic offenses. Each system includes more severe penalties for significant individual offenses, such as those producing serious injury or death, and for repeated offenses, often determined through accumulated driver's license demerit points.

Effectiveness: Generally, for penalties to be effective, perceived risk of getting caught must be high. Evidence is mixed about effectiveness of varying severity of penalties. Masten and Peck (2004) reviewed the effectiveness evidence for different driver improvement and driver control actions, including penalty levels and types, from 35 high-quality studies of 106 individual actions and penalties. They found that, taken together, all actions and penalties reduced subsequent crashes by 6% and violations by 8%. Even simple warning letters had some effect on both violations and crashes. The effect increased as the "obtrusiveness" of the action increased, with license suspension or revocation the most effective by far. The authors noted that the threat of license suspension probably is responsible for the effectiveness of the weaker actions such as warning letters. Educational brochures by themselves had no effect. However, administrative penalties imposed by the driver licensing agency were more effective than penalties imposed by the courts.

In Norway, Elvik and Christensen (2007) reported there was a weak tendency for speeding violations to decrease near camera-enforced sites in response to increasing fixed penalties over

time. However, there was no general effect of increasing fixed penalties over the road system at large. The researchers thought this was likely due to the overall low risk of detection.

Recent evaluations of the introduction of penalty point systems in European and middle-eastern countries, including Kuwait in 2006, suggest that the introduction of penalty points, including for speeding, have significantly reduced road traffic injuries (Akhtar & Ziyab, 2014). Although the time series analysis may not have been able to control for all confounders, including driver education weeks and the volume of citations, the results of this and other studies suggest that introduction of a penalty system can be an effective safety measure, in conjunction with enforcement and education. However, the long-term effects of penalty systems are somewhat uncertain and likely depend on how they continue to be implemented.

For example, research in Maryland found that various legal consequences for speeding had little impact on future citations for individual drivers (Lawpoolsri, Li, & Braver, 2007). Drivers who received legal consequences had the same likelihood of receiving another speeding citation as drivers who escaped legal consequences. Only fines coupled with probation before judgment (PBJ) was associated with a reduced risk of receiving a subsequent speeding ticket (Lawpoolsri et al., 2007). A follow-on longitudinal study found that the 54% of cited drivers who opted for court appearance to contest their speeding citations were more likely to be involved in future crashes and receive future speeding citations than drivers who accepted a guilty verdict and paid fines by mail (Li et al., 2011). In addition, whether drivers who opted for court appearance received guilty or not-guilty verdicts, or had charges dismissed had little effect on deterrence of future speeding *or* prevention of crashes, even controlling for prior driver histories and other potential confounders. Only suspended types of prosecutions (e.g. probation before judgment or other suspension) were associated with somewhat decreased risk of speeding recidivism and future crashes, but a still higher risk compared to those who paid fines by mail. The two types of suspended prosecutions associated with somewhat reduced future speeding and crash risk both provide some incentive to avoid additional citations that would result in a reinstatement of charges and potential loss of license. Also, many of the drivers receiving suspended judgments may have had reduced exposure owing to having prior alcohol traffic violations and license restriction/suspension.

Similar to the results from Maryland, a U.K. study that examined survey and conviction data found that the immediate threat of being disqualified from driving deterred those with points on their license from further speeding. However, for a subset of drivers, the threat of this sanction did not appear to affect their choice to speed (Corbett, Delmonte, Quimby, & Grayson, 2008).

Most evidence suggests there is at least a subset of drivers for whom sanctions and increasing penalties do not seem to have the desired deterrent effect. Many studies and NHTSA statistics verify the prevalence of young, male driver involvement in speeding crashes. A review of the literature by Fuller et al. (2008a) suggests that young males may simply be immature, with incomplete development of self-knowledge, self-control, social responsibility and independence of judgment. Drivers with attention deficit hyperactivity disorder (ADHD) may be particularly at risk because of self-control challenges. In addition, there is evidence of socially deviant speeders for whom speeding is associated with other forms of risk taking. These groups are distinguished from those who speed unintentionally due to failure to perceive risks and adjust accordingly (Fuller et al., 2008a).

Repeat offenders: Repeat speeding and aggressive driving offenders may be especially difficult to deter. Recommended methods to reach them include:

- Enhanced penalties, including increased driver's license points, immediate license suspension or revocation, higher fines, and jail or probation, but research described in this section makes clear that the availability of such penalties alone is unlikely to lead to individual deterrence of speeding. See Chapter 3, Sections 1.2 and 3.1, for more information. The certainty of punishment may be more important than the level of penalty (Li et al., 2011; Shinar, 2007). Furthermore, courts may be reluctant to impose the most serious penalties, such as license suspension, for speeding violations, or simply unable to effectively prosecute speeders as charged.
- Improved traffic record systems, to better identify repeat offenders and to allow patrol officers to immediately access a driver's complete driving record (NCHRP, 2003b; NHTSA, 2001a). There are no studies of the effects of improved record systems on repeat offenders. Costs and implementation time will vary.
- Providing alternate modes of transportation, electronic monitoring, enforced restrictions or limits on mobility through license plate "striping" or vehicle impoundment are other recommendations to address unlicensed drivers, including those who have already received the maximum penalties but continue to drive (NCHRP, 2003b).

In the future, there may be potential to utilize ISA (vehicle-based speed monitoring and warning or control of speed) systems for repeat offenders. A Maryland pilot study assessed the effects of an ISA warning type system on speeding behavior among 78 volunteer drivers who had at least three speeding violations in the prior three years (De Leonardis, Huey, & Robinson, 2014). Both verbal and red LED light alerts were provided in real time to the drivers any time their speed exceeded the speed limit on a given road by more than 8 miles per hour. Subjects' speeding behavior was monitored for two weeks prior to the systems being activated, for four weeks with the warning systems activated, and for a two-week follow-up period with the alert systems deactivated. Results were promising. Drivers sped more than 8 mph over the limit a small, but significantly lower proportion of the distance driven during the alerting phase (0.43) compared to the baseline phase (0.45). Proportion of speeding also remained somewhat lower (0.44) during the two-week follow-up period when the systems were turned off except among the more habitual speeders, who immediately resumed their normal speeds. However, participants were very concerned about providing driving speed data to insurance or licensing agencies. They anticipated negative consequences, including the potential for revocation of their driver licenses and increased insurance premiums. Such concerns would need to be addressed to encourage drivers to voluntarily use such a system to help control their speed (De Leonardis et al., 2014). In general, the systems seemed to be well accepted by a majority of the drivers, except for the concerns mentioned. Two types of ISA – speed alerting and speed-controlling – were also evaluated among a group of serious speeders in the Netherlands (van der Pas, Kessels, Veroude, & van Wee, 2014). While the devices were active, there was much less speeding, but once inactivated, levels of speeding quickly rebounded to normal levels.

Costs: Costs vary by penalty type. For example, warning letters are very cheap once a record system has been established to identify drivers who should receive letters. Individual counseling

and administrative hearings may require substantial staff time. Some costs may be recovered through offender fees.

Time to implement: Most changes in penalty levels can be implemented quickly within a State's overall driver improvement system.

Other issues:

- **Public acceptance, enforcement, and publicity:** Changes in speeding and aggressive driving sanctions by themselves cannot reduce speeding and aggressive driving. To be effective, sanctions must be well known to violators and they must have a high probability of being imposed (Preusser, Williams, Nichols, Tison, & Chaudhary, 2008). Traffic laws, penalty types, and penalty levels are essential to, but only a part of, a system that includes broad public acceptance, active enforcement, effective administration of penalties, and publicity (NHTSA, 2001a).

3.2 Diversion and Plea Agreement Restrictions; Traffic Violator School

Effectiveness: ★	Cost: Varies	Use: Unknown	Time: Varies

In many jurisdictions, drivers who have accumulated a specific number of demerit points on their driver's licenses are given the option of attending Traffic Violator School in order to reduce their punishment. In most instances, if they complete Traffic Violator School, their traffic offenses are dismissed or removed from their driving record (Masten & Peck, 2004).

Negotiated plea agreements are a necessary part of an effective and efficient court system. However, plea agreements may allow offenders to have their penalties reduced or eliminated, for example if a driver is allowed to avoid a driver's license suspension by attending Traffic Violator School.

Use: No data are available on the number of jurisdictions in which Traffic Violator School is available or the number of offenders who use Traffic Violator School to reduce their penalties. Similarly, no data are available on the use of other plea agreements for speeding or aggressive driving violations.

Effectiveness: Masten and Peck's review (2004) included high-quality studies of over 30 group meeting programs, including Traffic Violator School. Taken together, these group-meeting programs reduced subsequent crashes by 5% and violations by 8%. Masten and Peck point out that Traffic Violator School programs in California increased, rather than decreased, crashes because they allowed offenders to escape more severe penalties and start again with a clean driving record. Their review was not able to determine whether other Traffic Violator School programs that dismissed an offender's violation had similar negative effects. These reductions or eliminations of penalties also make it difficult to use driver histories to track and provide serious sanctions to repeat violators.

Costs: Costs for establishing diversion or Traffic Violator School programs will depend on the nature of the program. Costs include developing and maintaining a tracking system, notifying offenders, and administering the Traffic Violator School. Costs for limiting or eliminating diversion programs, plea agreements, and Traffic Violator School can be determined by comparing the per-offender costs of these programs with the costs of the penalties that would otherwise be applied.

Time to implement: Diversion or Traffic Violator School programs will require at least 6 months to establish and implement. They can be modified within a few months.

Other issues:

- **Diversion and plea agreement issues in alcohol-impaired driving:** Diversion and plea agreements have been discussed and evaluated more extensively for alcohol-impaired driving offenses than for speeding and aggressive driving offenses. See Chapter 1, Section 3.2 for additional discussion.
- **Public acceptance, enforcement, and publicity:** Changes in the adjudication of speeding and aggressive driving infractions, such as limiting or eliminating diversion and

plea agreements, by themselves cannot reduce speeding and aggressive driving. Traffic laws and adjudication are essential to, but only a part of, a system that includes broad public acceptance, active enforcement, and publicity (NHTSA, 200la).

4. Communications and Outreach

4.1 Communications and Outreach Supporting Enforcement

Effectiveness: ★★★	Cost: Varies	Use: Medium	Time: Medium

Effective, high visibility communications and outreach are an essential part of successful speed and aggressive-driving enforcement programs (NCHRP, 2003a; NHTSA, 2000). All of the examples discussed in Chapter 3, Sections 2.2, High visibility Enforcement, and 2.3, Other Enforcement Methods, used extensive communications campaigns to support their enforcement efforts. Most campaigns to date have not used paid advertising. The success of paid advertising in seat belt use campaigns (Chapter 2, Section 3.1) suggests that it is worth considering for speed and aggressive driving enforcement campaigns.

The objective should be to provide information about the program, including expected safety benefits, and to persuade motorists that detection and punishment for violations is likely. See also NCHRP (2003a, Strategy A2). Communications and outreach programs urging drivers to behave courteously or not to speed are unlikely to have any effect unless they are tied to vigorous enforcement (NCHRP, 2003a, Strategy A2). Campaign messages that are pre-tested to ensure they are relevant to the target audience and that reach the audience with sufficient intensity and duration to be perceived and noticed are most likely to be effective (Preusser et al., 2008). Other State and community partners may also help leverage resources and achieve a wider reach if they have common goals and concerns (GHSA, 2004).

A recent assessment report prepared for the Governor's Highway Safety Association also recommends raising the priority of speed enforcement as a traffic safety priority among law enforcement agencies, the general public and the courts (Sprattler, 2012). Such an effort may require careful framing of the message that speed enforcement is a public injury prevention strategy. Health Resources in Action developed community resources for the Centers for Disease Control and Prevention highlighting injury-reduction and public health and community livability issues in relation to speed and speed management (Health Resources in Action, 2013; and other resources available at www.cdc.gov/healthyplaces/healthtopics/transportation/practice.htm.)

Use: Most aggressive driving and speed enforcement programs have a communications and outreach component. At least half the States have a named public awareness campaign (Sprattler, 2012).

Effectiveness: A recent meta-analysis of 67 worldwide studies of the effect of road safety campaigns on crashes suggests a general campaign effect of 9%; however, anti-drunk-driving campaigns were considerably more effective than anti-speeding campaigns (Phillips, Ulleberg, & Vaa, 2011). Other evidence comes from publicity associated with automated enforcement programs. Reductions in crashes in Victoria, Australia, have been attributed to a television advertising campaign that supported, but did not relate directly, to automated speed enforcement initiatives (Bobevski, Hosking, Oxley, & Cameron, 2007). A study from Charlotte, NC also found that publicity from an aggressive media outreach campaign and on-going publicity related to automated enforcement was responsible for an 8 to 9% reduction in crashes. Effects carried

over for several months after the program ended before gradually returning to pre-intervention levels (Moon & Hummer, 2010). Earlier evidence from Australia also suggested that paid media advertising could enhance the effectiveness of automated speed enforcement (Cameron, Cavallo, & Gilbert, 1992). The evidence from seat belt (Chapter 2, Sections 2.1, 2.2, and 3.1) and alcohol-impaired driving (Chapter 1, Sections 2.1 and 2.2) enforcement programs also strongly suggests that good communications and outreach are essential to a successful enforcement program.

Costs: Good media campaigns can be expensive. See Chapter 2, Section 3.1.

Time to implement: An effective media campaign requires 4 to 6 months to plan and implement.

Other issues:

- **Effective campaign characteristics:** The Phillips et al. (2011) meta-analysis of publicity campaigns attempted to identify factors associated with successful campaigns. The researchers caution that they could not assess factors that were not reported on frequently, or had little variation, and also could not assess important program aspects such as the degree of publicity achieved, whether a campaign addressed the social norm, or whether behavioral change was achieved. As mentioned above, they found that speed-based campaigns were generally less effective than alcohol-themed ones. In addition, results suggested that the type of message delivery had an effect. Messages delivered through personal communications or at the roadside (such as variable and mixed message signs, etc.) were independently associated with greater effectiveness than campaigns that used mass media. Roadside delivery may provide the message in a context-relevant way that is more proximal to the potentially negative behaviors (such as speeding), while personal communications may improve processing of the message and message uptake compared with mass media delivery (Phillips et al., 2011). However, the authors emphasized that the potential target reach of mass media suggests it still be considered a viable method of delivery.
- As found in Philadelphia's *Heed the Speed* campaign, getting message penetration through signs, flyers and other community outreach is a challenge in a large urban setting (Blomberg, Thomas, & Marziani, 2012).

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