Appendix E

EXAMPLES & REFERENCE MATERIALS

- E-1: Cost Reference Materials
- E-2: Complete Streets Reference Materials
- E-3: Ebike Reference Materials
- E-4: Whitefish Planning Reference Materials

Appendix E - 1

COST REFERENCE MATERIALS

Unit Cost Data

Item		Cost	Unit	Contingency		Total
Bike Route Signing/Sharrows (epoxy)						
1 sign @ $300 + 1 sharrow @ $25 per 300 LF	$	1.08	LF			
UNC Highway Safety Research Center * ($25K/mile)	$	4.75	LF			
Average Cost	**$**	**2.92**	**LF**	**10%**	**$**	**3.21**
Bicycle Boulevard						
UNC Highway Safety Research Center * ($200-650K EA)						
Bike Lane Signing/Pavement Markings (epoxy)						
2 - 6" lines @ $0.82/LF + 1 sign/300' @ $300/sign	$	1.82	LF			
UNC Highway Safety Research Center * (painted curb/sidewalk cost)	$	3.06	LF			
Average Cost	**$**	**2.44**	**LF**	**10%**	**$**	**2.68**
Cycle Track Signing/Pavement Markings (epoxy)						
North Reserve Master Plan (estimate)	$	25.00	LF			
UNC Highway Safety Research Center * ($240K/mile)	$	45.00	LF			
Average Cost	**$**	**35.00**	**LF**	**10%**	**$**	**39**
Shared Use Path (Asphalt Surface)						
Lolo Trail (8 miles @ $4.5M)	$	107	LF			
Grant Creek Trail (2 miles @ $1.4M including r/w and a bridge)	$	134	LF			
Milwaukee Trail (1 mile @$850K including r/w)	$	161	LF			
UNC Highway Safety Research Center * ($481K/mile @ 8' width)	$	91	LF			
Average Cost	**$**	**123**	**LF**	**10%**	**$**	**136**
Urban Trail (Gravel Surface)						
4" Crushed Base Course @ $10/SY x 4' width	$	4.44	LF			
UNC Highway Safety Research Center * ($121K/mile @ 8' width)	$	23.00	LF			
Average Cost	**$**	**14**	**LF**	**10%**	**$**	**15**
Sidewalks (Concrete Surface not including curb)						
Mary Avenue Extension ($5/SF @ 5' width)	$	25	LF			
UNC Highway Safety Research Center * (5' width)	$	32	LF			
Average Cost	**$**	**29**	**LF**	**10%**	**$**	**31**
Curb, Gutter and Sidewalk (Concrete)						
Mary Avenue Extension	$	50	LF			
UNC Highway Safety Research Center *	$	50	LF			
Average Cost	**$**	**50**	**LF**	**10%**	**$**	**55**
Crosswalk Signing/Pavement Markings						
Mary Avenue Extension (2 lines @ $5.51/LF + yield symbols @ $12.35/4 LF + signs @ $30	$	16.10	LF			
UNC Highway Safety Research Center *	$	8.51	LF			
Average Cost	**$**	**12**	**LF**	**10%**	**$**	**14**
Crosswalk RRFB						
Whitefish 5th/Spokane			LF			
UNC Highway Safety Research Center *	$	22,250	LF			
Average Cost	**$**	**22,250**	**LF**	**10%**	**$**	**24,475**
Bicycle Racks						
Mary Avenue Extension	$	525	EA			
UNC Highway Safety Research Center *	$	660	EA			
Average Cost	**$**	**593**	**EA**	**10%**	**$**	**652**
Bus Shelter						
UNC Highway Safety Research Center *	$	11,560	EA			
Overpass/Underpass						
Russell St. Milwaukee Trail Underpass	$	5,000	LF			
UNC Highway Safety Research Center * (Overpass $150-250/SF @ 14' width)	$	2,800	LF			
UNC Highway Safety Research Center * (Underpass $120/SF @ 14' width)	$	1,680	LF			
Average Cost	**$**	**3,160**	**LF**	**10%**	**$**	**3,476**

* *Costs for Pedestrian and Bicyclist Infrastructure Improvements* ; Authors: Max A. Bushell, Bryan W. Poole, Charles V. Zegeer, Daniel A. Rodriguez; UNC Highway Safety Research Center; Prepared for the Federal Highway Administration and supported by the Robert Wood Johnson Foundation through its Active Living Research program; October, 2013

Maintenance Practices and Costs of Rail-Trails

rails-to-trails conservancy

CONTENTS

Wallkill Valley Rail Trail, NY.

Rails-to-Trails Conservancy serves as the national voice for more than 160,000 members and supporters, 30,000 miles of rail-trails and multiuse trails, and more than 8,000 miles of potential trails waiting to be built, with a goal of creating more walkable, bikeable communities in America. Since 1986, we have worked from coast to coast, supporting the development of thousands of miles of rail-trails for millions to explore and enjoy.

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ACKNOWLEDGMENTS

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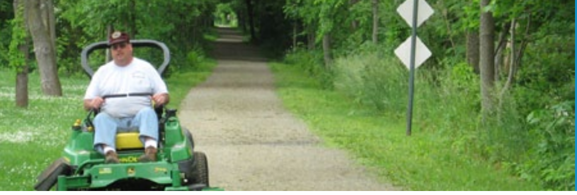
June 2015

The team wishes to recognize and thank RTC staff and others who contributed to the accuracy and utility of this report. Thanks to the trail managers and RTC staff who contributed photos for this report.

This study was made possible by the generous support of the Pennsylvania Department of Conservation and Natural Resources, Bureau of Recreation, Community and Conservation Partnership Program.

Allegheny River Trail, PA.



EXECUTIVE SUMMARY

For the past three decades of rail-trail development, maintenance costs have generally been seen as being expensive. These expenses, however, have remained largely untracked on a state or national basis. Further, a comprehensive breakdown and ranking of maintenance priorities did not exist.

To better understand this issue, RTC conducted a comprehensive survey of trail maintenance costs. Results of this study show that, contrary to popular belief, maintenance costs are not as high as many perceive them to be. In fact, when taking into account for volunteers, this study found that maintenance costs on average range from $500 to $1,000 per trail mile per year depending on surface.

St. John Valley Heritage Trail, ME.

In the 10 years that RTC's Northeast Regional Office has tracked technical inquiries, there has been a steady decline in the number of maintenance-related request. There are likely several reasons for this decline. Rail-trail managers and others share maintenance methods through a variety of networks, in addition to providing direct assistance to one another. Earlier documents on maintenance best management practices have also likely been helpful. In addition, many individual trails have been combined into larger systems, thus creating economies of scale. Volunteer programs also have grown in size and dependability and have taken on more responsibility.

Finally, it is evident that maintenance also has been deferred.

Therefore, it is possible that although maintenance costs have declined over time, perception of those costs has remained the same.

Trail managers and local stakeholders often cite the need for dedicated state or federal funding to help pay for trail maintenance. Up to this point, RTC has lacked sufficient data to make that case effectively to decision-makers at the state or federal level. This study was initiated to bring some clarity to this issue. Whether in a town hall meeting or a discussion with a member of Congress about the reauthorization of federal funding, more accuracy regarding rail-trail maintenance costs is required.

Because funding for rail-trails is difficult to secure, over-estimating maintenance costs can inadvertently give opponents easy leverage to speak against rail-trail development. In addition, funders often question if all aspects of any community development project should be funded by state and federal grants, particularly maintenance-related costs, which are often perceived as a "local issue."

This study presents a more comprehensive understanding of rail-trail maintenance, as has been done for other rail-trail issues such as construction costs, economic impact and rails-with-trails. Such an approach enables the rail-trail community to focus its limited resources more effectively on addressing the most critical issues.

This publication is the third in a series of similar works prepared by the RTC Northeast Regional Office. The first was released in 1996 in collaboration with a U.S. Department of Agriculture AmeriCorps staff member based in Fayette County, Pennsylvania. The second was released in 2005 and, as with this document, was made possible through a Growing Greener grant from the Commonwealth of Pennsylvania, Department of Conservation and Natural Resources, Bureau of Recreation and Conservation.

Each successive study has grown in size and scope and, ideally, usefulness. The 1996 study contained 40 questions and received responses from 60 rail-trail managers. The 2005 study expanded to 70 questions and 100 respondents. This latest version asked 117 questions and drew answers from 200 respondents.

Of all the 2014 participants, 37 percent represented rural rail-trails, 14 percent urban, 13 percent suburban and 36 percent mixed. The mixed category contained primarily a rural/suburban combination.

In addition to identifying the types and frequency of maintenance tasks, this study sought for the first time to secure data on the cost of rail-trail maintenance. Almost 50 percent of the 200 trail managers provided a total maintenance cost, though far fewer had an actual budget. With the help of several veteran trail managers, RTC went a step further and prepared an additional 44-question survey that broke down the cost of each task. Only 25 managers completed this survey, and many of these required repeated follow-up by e-mail and phone.

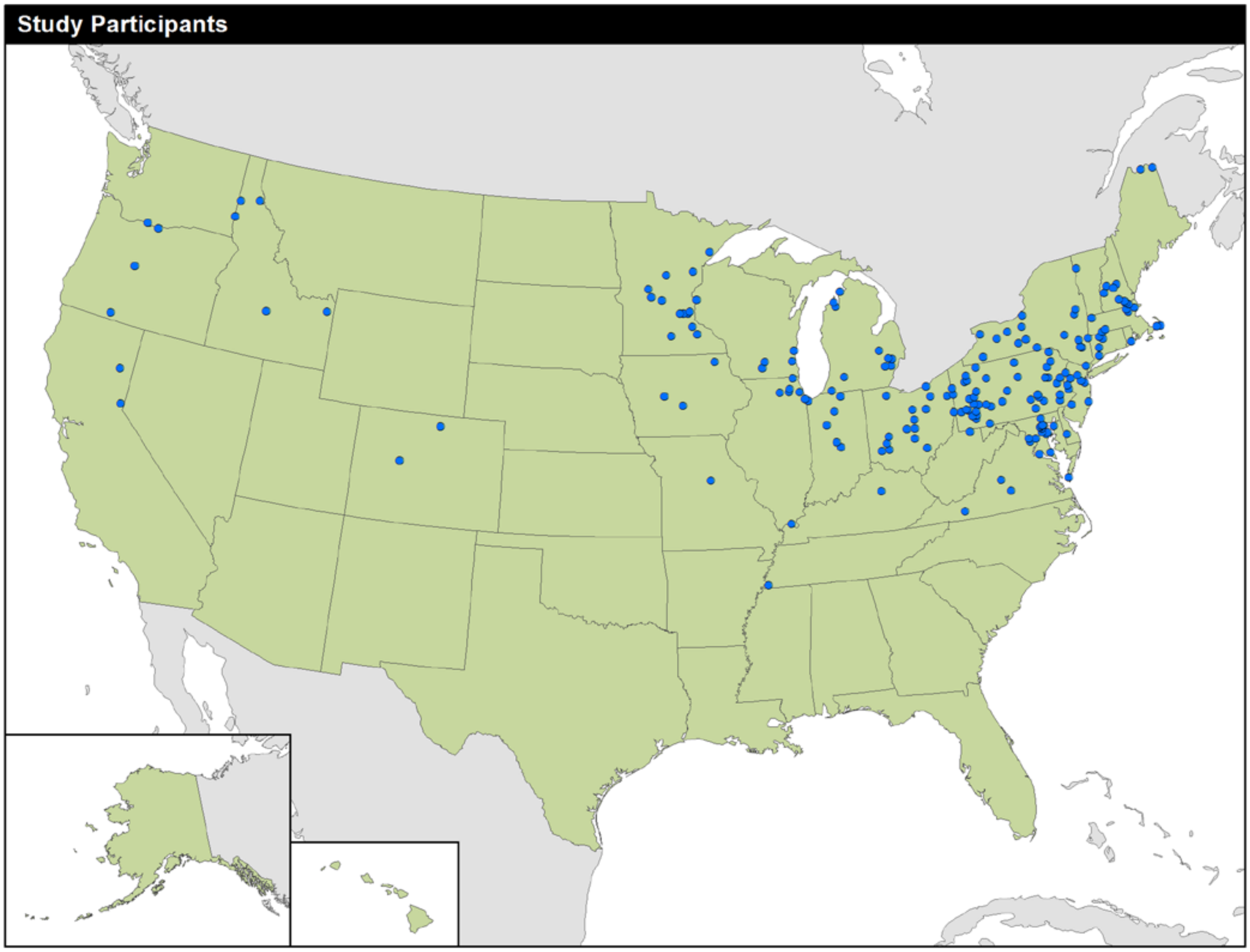


Figure 1. Map of Trail Groups Participating in Study

State and county managers said that it was too difficult to separate these costs from larger existing budgets. Small entities and private nonprofits said they simply did not have the capacity to track these figures.

If the need for maintenance funding is so critical, however, it would stand to reason that this data would be more available or that completion of the questionnaire would have greater value. This research indicates that the more likely explanation for why these costs are not tracked more rigorously is that rail-trails do not require as much maintenance as some fear or promote. This finding is critical in the ongoing case for funding support for rail-trails.

Snow covered bridge on the Piscataquog Trail in NH.

METHODOLOGY

The comparisons illustrated in this study are mostly between the 2005 and 2014 findings. The 1996 study contained too many "check all that apply" questions, which resulted in multiple answers and thus participation greater than 100 percent; comparison of the latter two studies was more reliable, as the answers in each added up to 100 percent. Further, not all the same trails were surveyed in the three studies. Unfortunately, only including those trails that participated in all three studies would have yielded too low a number to be significant.

The 2014 study began with a review of the earlier studies to determine which topics required updating. Our technical assistance team provided additional insights of the questions they typically are asked. We then did a review to determine what, if any, recent literature addressed the topics of trail maintenance activities and associated cost.

We then developed a survey instrument that would collect as much information as possible regarding the most important topics. During this process, we realized that there were different sets of questions for different trail surface types. This increased the number of questions in the survey to an overwhelming 195, which could prove prohibitive to trail managers.

This potential problem was solved by the decision to create the cost survey in Survey Monkey. Using this vehicle, we could provide trail managers with a link to the online survey, and they could take the survey at their convenience. This also enabled us reduce the number of questions by utilizing the skip logic in Survey Monkey, the manager of an asphalt-surfaced trail, for example, could "skip" all of the questions not applicable to their surface type.

To make comparisons across the trails, we limited our query to states with four seasons. We did not send invitations to trail managers in the southern tier of states.

Links to the online survey were sent to approximately 300 trail management organizations contained in RTC's national trails database as of January 6, 2014. Reminders to participate were sent to those organizations that did not immediately respond.

Of the responding trail management organizations, 95 indicated that they had a trail maintenance budget. A follow-up survey to gather more detailed maintenance cost information was sent to these 95 organizations. This was not an online survey but a Microsoft Excel spreadsheet, with 48 maintenance tasks as rows. Columns captured labor hours, hourly labor cost, volunteer hours, equipment costs, material costs, contracted services and total cost.

Many follow-up emails, phone calls and personal pleas were made over several months to encourage participation in this phase of the study.

Trail side mowing along the Perkiomen Tail in PA.

MAJOR MAINTENANCE TASKS

The 2005 study indicated that trail group volunteers performed maintenance tasks on 46 percent of the survey trails. In the 2014 study, this percentage increased to 58 percent. Municipal government was the second most cited entity for performing maintenance tasks after trail-group volunteers, at 32 percent in 2005 and jumping to 43 percent in 2014. The percent of municipal governments owning trails remained nearly the same in the two studies, at 30 percent and 34 percent in 2005 and 2014, respectively.

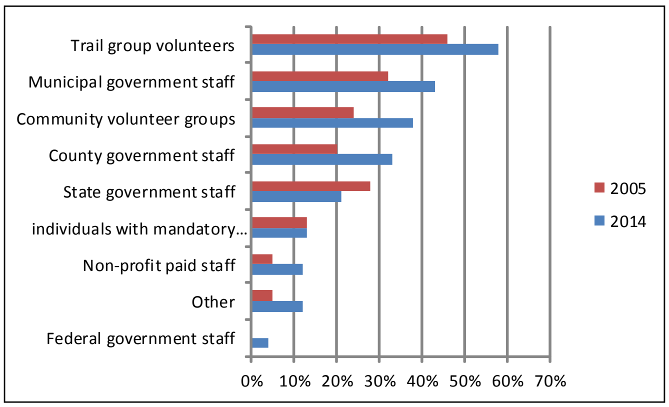


Figure 2. Who Performs Maintenance (2014 Survey)

Administration

Written trail maintenance plan

We were surprised that 60 percent of the responding trail managers indicated they do not have a written trail maintenance plan. A written maintenance plan will save time and money and contribute to a better experience for trail users.

Funding trail maintenance

In the 2014 survey, municipal government was the leading funder of trail maintenance, mentioned by 42 percent of respondents. This is a significant increase from the 2005 maintenance study, when 26 percent mentioned municipal government funding. Funding by a nonprofit fell slightly from 34 percent in 2005 to 32 percent in 2014.

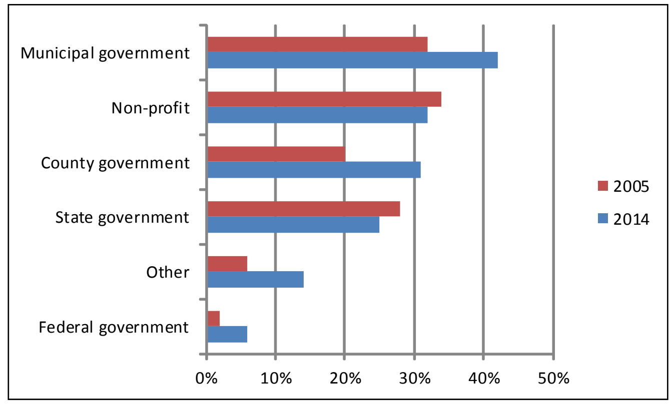


Figure 3. Trail Maintenance Funders (2014 Survey)

Of the trail managers who indicated that they had a budget specifically for trail maintenance, the figures for that budget ranged from less than $500 to more than $700,000. This range is nearly identical to that reported in the 2005 study.

Tracking annual users

Although not strictly a maintenance issue, the number of annual users of a trail does affect maintenance needs. Fifty four percent of our respondents indicated that they do not currently track the number of trail users; another 23 percent indicated that they guess or estimate. Of those trail managers who do conduct user counts, 16 percent do a manual count, and 23 percent conduct the count using an automated counter of some type. The reported annul usage ranged from 2,000 to more than 2 million.

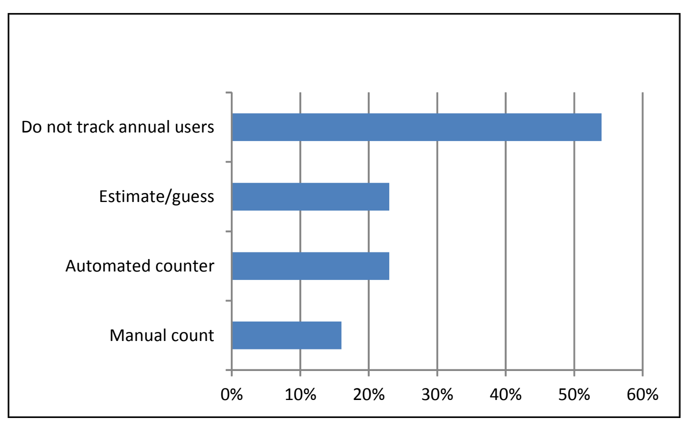


Figure 4. Tracking by Trail Managers (2014 Survey)

Hours of operation

Consistent with the 2005 trail maintenance and operations study, two-thirds of the trails surveyed in 2014 are open on a dawn-to-dusk schedule.

Vegetation – Grass, Trees, Herbicides and Invasives!

Mowing

Sixty percent of detailed cost survey respondents reported that mowing was a labor-intensive maintenance activity and a significant component of the annual maintenance budget. We conducted a correlation analysis to determine if there was a relationship between labor hours and the length of trails. The graph below reveals that such a relationship does not exist.

Based on the data provided in the detailed cost analysis, it is apparent that the amount of time and expense associated with mowing is really a function of how the trail was designed. Some trails have a lot of grassy areas on the shoulders of the trail tread, while others have crushed stone or other shoulder materials that don't require periodic mowing.

Perkiomen Rail Trail, PA.

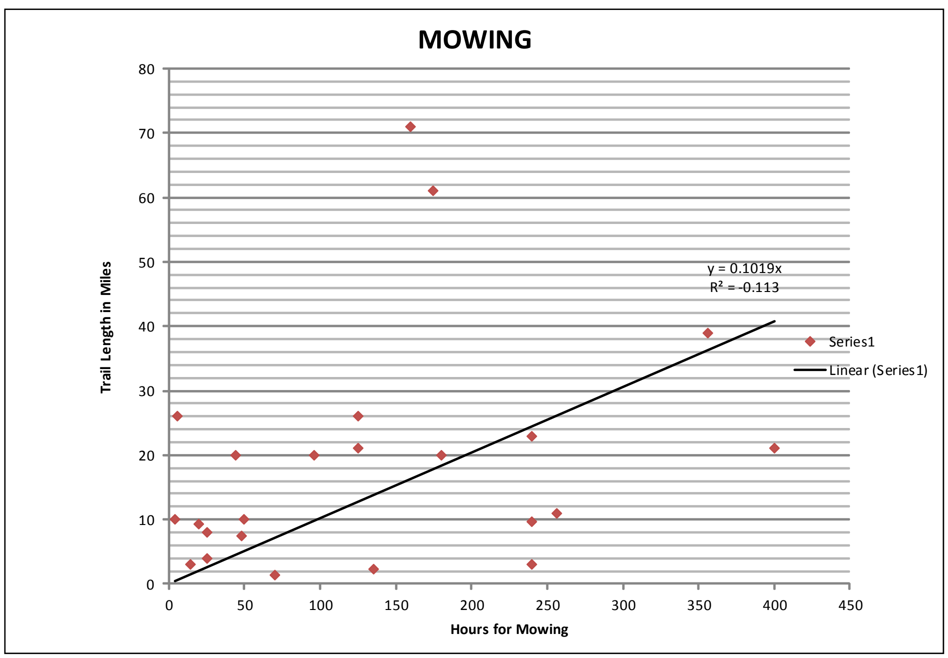
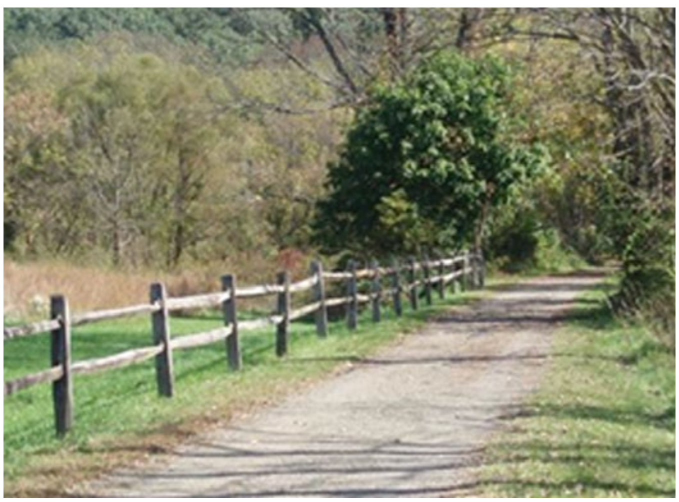


Figure 5. Correlation analysis shows no relationship between labor hours and length of trails.

MAJOR MAINTENANCE TASKS



Perkiomen Rail Trail, PA
20 miles
Annual mowing costs $12,542

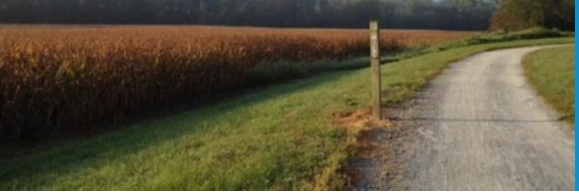
Rio Grande Rail Trail, CO
20 miles
Annual mowing costs $2,112

The Perkiomen Trail has a significant amount of grass along the shoulders of the trail and fencing that needs to be cut around manually. On the other hand, the Rio Grande Trail has more native vegetation or stone shoulders that do not require frequent mowing.

Heritage Rail Trail County Park, PA
21.1 miles
Annual mowing costs $6,000

Lackawanna River Heritage Trail, PA
19.9 miles
Annual mowing costs $7,367

The mowing cost for these two trails is fairly close on a per mile basis. The Heritage Rail Trail has a parallel rail bed along most of its length that requires herbicide treatment but no mowing. The Lackawanna Trail allows natural vegetation to grow along the shoulders or has placed stone shoulders.



MAJOR MAINTENANCE TASKS

Lititz-Warwick Trailway, PA
3 miles
Annual Hours mowing 240
Annual mowing costs $3,553

Oil Creek State Park Trail, PA
9.7 miles
Annual hours mowing 240
Annual mowing costs $3,739

The Lititz-Warwick Trailway has significant amounts of grassy areas that require mowing along trail edges in a primarily suburban setting. Oil Creek State Park Trail is more rural and relies on natural vegetation along the trail edges that does not require much maintenance. Surprisingly, however, both reported 240 hours was required for mowing each year. This example appears to indicate that there is no correlation between labor hours and costs.

Vegetation Management

We asked trail managers how much time they dedicate to vegetation management along the trail because this work is the second most labor-intensive, costly maintenance item reported by respondents to the detailed cost analysis survey. Of these respondents, 62 percent reported on this maintenance activity. The amount of time reported on a per-mile basis varied from as little as 0.25 hours per mile to 106 hours per mile (most of this work is carried out by volunteers).

We provided a list of 12 tasks to 2014 maintenance survey respondents when asking about their management of trail-side vegetation. More than 90 percent of our respondents reported that they do litter cleanup, tree pruning, fallen tree removal, tree removal as a safety issue, and mowing.

Removal of invasive tree species is becoming an increasingly necessary maintenance task. In the 2005 report, 36 percent of respondents reported invasive species removal as an important task; in 2014, almost 93 percent reported it as a major activity.

In the 2005 survey, about a third of the respondents indicated that they used a chemical herbicide to control vegetation. That percentage increased to 55 percent in the 2014 survey. Seventy-five percent of 2014 respondents reported that trail maintenance staff has responsibility for application of the herbicide. This activity was contracted out by only 14 percent of the respondents.

Tree down on Heritage Rail Trail County Park, PA.

Volunteers trimming brush, Three Rivers Heritage Trail, PA.

On average, respondents said they spent 13.5 hours per mile on vegetation management. The cost of vegetation management varied widely, from less than $100 for a four-mile trail to more than $55,000 for a 24-mile trail. Much of this work is carried out by trail management staff or volunteers, although some trail organizations do contract out this type of work. Volunteers should have some degree of training and supervision, especially when working with an herbicide.

Tree Removal

Tree removal was a significant maintenance task reported in our detailed maintenance cost analysis survey. Most of the reported costs were in excess of $1,000. Forty percent of the reporting trails indicated that they contracted out this activity. There are a number of reasons stated for removing trees. In some cases storms cause tress to block the trail. In others, a dead tree presents a potential hazard to trail users and is removed before limbs come crashing down on the trail.

MAJOR MAINTENANCE TASKS

Surface – Repair, Clearing, Snow

In the 2014 study we asked respondents to identify the predominant trail surface material based on six choices: asphalt, concrete, crushed stone, original railroad cinders, dirt/soil and boardwalk. The number of responses for concrete, railroad cinders, dirt and boardwalk were so small (seven or fewer) that analysis was not possible. Therefore, we concentrated our analysis on asphalt and crushed stone.

In the 2005 study, 45 percent of respondents indicated that their trails were composed of asphalt, and 41 percent said crushed stone. In 2014, asphalt increased to 52 percent, and crushed stone decreased to 34 percent. This increase in asphalt could either be because of increased use of asphalt surfaced trails or the samples included in the survey. In some cases, state policy dictates that trails must have an asphalt surface.

Beaver caused erosion damage, Ashuelot Rail-Trail, NH.

Maintenance of Non-asphalt Trails

The labor hours and resulting cost of repairs to non-asphalt trails varied widely among survey respondents. Labor hours reported for repairs ranged from 0.2 hours per mile for an 11-mile trail in Pennsylvania to 9.3 hours per mile for a three-mile trail in Massachusetts. The total cost of making repairs varied from a low of $31 to a high of nearly $13,000.

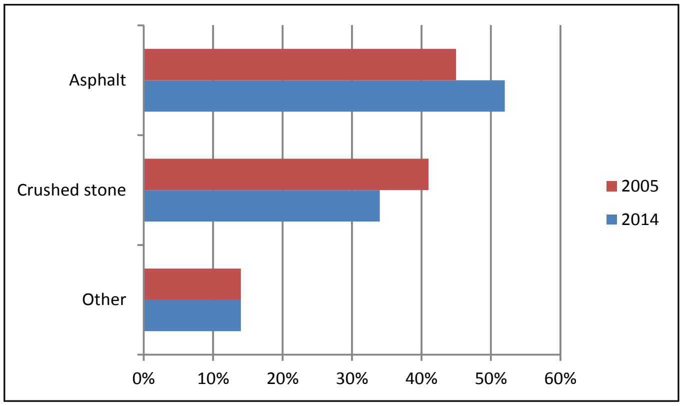


Figure 6. Predominant Trail Surfaces (2014 Survey)

Not only did these costs vary widely across our sample, but they also varied widely from year to year. The major cause of damage to non-asphalt trails was because of water erosion, as reported by 55 percent of survey respondents.

The second biggest cause for repairs is because of vegetation, as reported by 25 percent of survey respondents. This can be caused by grass growing through non-asphalt trail surface, vegetation encroaching on trail edges or proliferation of invasive species. Controlling damage caused by vegetation encroachment is manageable with a program of regular, scheduled inspection and preventative maintenance.

Uncontrolled weed growth through trail surface.

Regrading of some or the entire surface is another requirement in non-asphalt trail maintenance. The amount of labor hours involved to perform this task varied widely, from 14 hours to regrade a three-mile trail to two hours to regrade a 10-mile trail. The nature of the re-grading process and the type of equipment used contribute to this variability. A good estimate of the average, based on those reporting this activity, is two hours per mile for re-grading a non-asphalt surface trail.

Tree root damage Manhan Rail Trail, MA.

Maintenance of Asphalt Surfaced Trails

New to the 2014 were questions regarding causes of damage to asphalt trails. Survey respondents could list multiple causes of damage. As shown in Figure 7, tree roots are by far the leading cause of damage to an asphalt trail surface at 63 percent. The frost/freeze cycle and water erosion rank second and third, at 44 and 43 percent, respectively.

Respondents to the detailed maintenance cost survey submitted significant costs for repair of asphalt-surfaced trails. Examples include $9,600 for a 71-mile trail; $7,350 for a three-mile trail; and $7,200 for 39-mile trail. Only 30 percent of trail managers reported any asphalt repair. Only eight percent of managers of asphalt-surface trails reported that they seal-coated their trail. On a three-mile trail, the cost of the sealant material was $4,000 and the labor to apply it took 24 hours, or three work days.

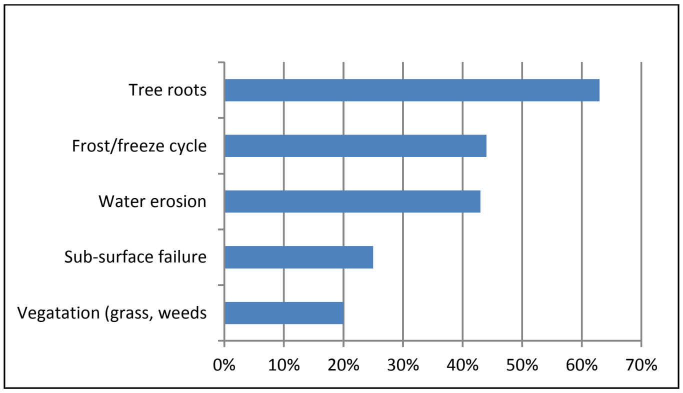


Figure 7. Sources of Surface Damage (2014 Survey)

Another task required for maintenance of asphalt trails is crack sealing. The Willard Munger State Trail in Minnesota reported spending 240 hours sealing cracks on the 71-mile trail. That's $5,760 in labor costs and $2,500 in material costs. Similarly, the Oil Creek State Park Trail in Pennsylvania had labor costs of $935 and material costs of $1,500 to seal cracks along the 9.7-mile asphalt trail. Lack of a crack-sealing program can lead to vegetation growing up through the cracks, and this will contribute to deterioration of the asphalt surface.

MAJOR MAINTENANCE TASKS

Maintenance of crushed stone

More than one-half, or 56 percent, of 2014 respondents with a predominantly crushed stone surfaced trail reported that their trail had been resurfaced since original construction. This is a decrease from two-thirds in the 2005 study. In 2014, the most mentioned interval for resurfacing was 10 years or longer, compared with nine years in the 2005 study.

Consistent with the 2005 study, 71 percent of respondents indicated that crushed surface trails are primarily repaired manually, with a rakes, shovels and other hand tools. Light duty power equipment such as a Bobcat was used to repair damage by 42 percent of the respondents, and 32 percent responded that they utilized heavy equipment such as a grader. The type of equipment used is dictated by the severity of the damage to the crushed stone surfaced trail.

Forty-four percent of our survey respondents indicated that their crushed stone trail had been regraded since its original construction. This maintenance activity is carried out on an as-needed basis by 70 percent of the trail managers.

Water erosion is the most frequently mentioned cause of damage to a crushed stone surfaced trail, with 77 percent of respondents reporting it the 2014 study.

Water erosion is the most frequently mentioned cause of damage to a crushed stone surfaced trail.

Vegetation encroaching through the trail surface was the second most common cause of damage to a crushed stone trail, with one-third of respondents citing this cause. Less than 2 percent of respondents indicated tree roots as a cause of damage to a crushed stone surface trail.

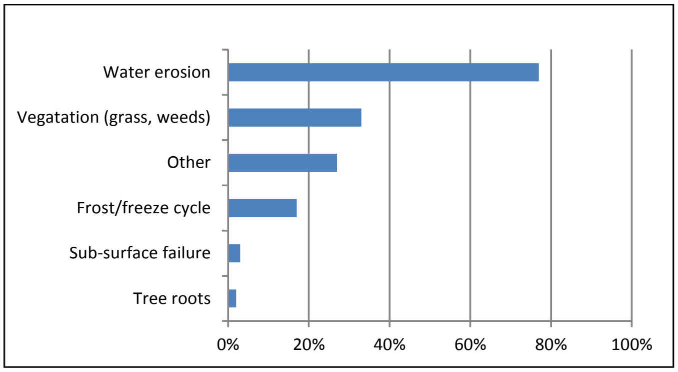


Figure 8. Sources of Damage to Crushed Stone Surface (2014 Survey)

Surface Clearing of Trail

For the purpose of the survey, trail clearing was defined as the removal of material such as leaves, sticks and stones from the trail surface. A third of the respondents to our detailed cost survey indicated that time was spent clearing the surface of the trail. This activity was mostly confined to asphalt surfaced trails. On average, surface clearing took 3.5 hours per mile, at an average cost of $22.25 per hour.

Erosion damage to stone dust trail.

Maintenance of Pavement Markings

Pavement markings are generally associated with asphalt-surfaced trails. This study found that a painted center line was the most common type of pavement marking. Other pavement markings are safety or instructional in nature. Some markings are painted on the trail surface, while others are applied thermally. The detailed cost analysis revealed that this activity, while not reported by many respondents, varied in cost from $19 per mile to $140 per mile.

Pavement markings, Hanover Trolley Trail, PA.

Snow Removal

Winter use of the Torrey C. Brown Trail, MD.

In the general maintenance study, 33 percent of respondents reported that they removed snow from portions of the trail, and 9 percent reported that they remove snow from the entire length of the trail. Generally, full or partial snow removal was more common on trails in urban or suburban areas.

According to respondents to the detailed cost study who reported snow removal (25 percent), the time and cost of snow removal varied widely. Time spent ranged from 500 hours on the 71-mile Traverse Area Recreation Trail in Michigan to 15 hours on the 24-mile Three Rivers Heritage Trail in Pittsburgh, Pennsylvania. This activity varied widely from year to year based on the frequency and amount of snowfall.

Some trail managers who did not report clearing snow from the trail surface did report that they cleared snow from trailhead parking lots. Trails can get a great deal of winter use if potential trail users have a place to park. Cross country skiing is a popular activity on many rail-trails in snow country. The Heritage Rail Trail County Park in Pennsylvania spent $600 clearing trailhead parking lots for skiers but does not clear the trail surface. In 2014, 63 percent of respondents reported doing trailhead snow removal, compared with half that number in 2005.

MAJOR MAINTENANCE TASKS

Drainage

Maintenance of drainage areas is critical to helping minimize the damage to both asphalt and crushed stone surfaced trails caused by water erosion. As we found in the 2005 survey, this activity is primarily carried out manually with the use of rakes and shovels. In both surveys, this manual activity was reported by 70 percent or more of the respondents.

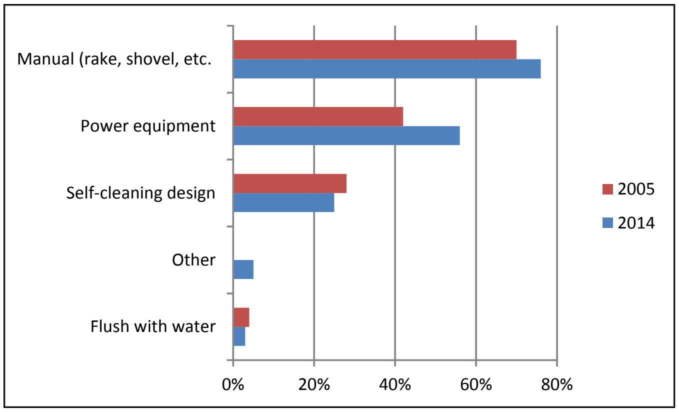


Figure 9. Drainage Activities (2014 Survey)

Culvert failure, Allegheny River Trail, PA.

Clearing of drainage swales and culverts

Periodically investing several hundred or even several thousand dollars in maintaining trail drainage systems and culverts can prevent catastrophic damage to a trail when a major water event occurs.

Culvert failure, Manhan Rail Trails, MA.

Forty-one percent of respondents to the detailed cost analysis survey reported spending staff and volunteer hours on this task. A quarter of those reporting indicated that this activity was carried out entirely by volunteers.

Volunteers on the four-mile Greater Hazelton Rails to Trails in Pennsylvania spent 60 hours on this task.

Of those trail management organizations that reported carrying out this this activity, the cost varied from $85 per mile to $350 per mile. Cost depended on the type of drainage system used along the trail, the number of culverts that required cleaning and the method used to clean drainage swales and culverts.

The Montgomery County Pennsylvania Regional Trail maintenance schedule requires that drains, pipes, culverts and inlets are cleared out three times per year and must be checked after all heavy rainfalls. All leaf litter, branches and other debris are required to be removed at inlets and along drainage swales.

The West Penn trail maintenance plan calls for clearing drainage swales twice a year or as needed. Most of this work is done with rakes and shovels. Some larger ditches may require the use of a backhoe.

Drainage swale in need of cleaning.

Trailhead Amenities

Between 2005 and 2014, dramatic changes were made in the types of facilities that trail managers provide at trailheads.

In 2005, only 58 percent of the survey respondents indicated that they provided an information kiosk at the trailheads. In the 2014 survey, however, 83 percent of respondents indicated that an information kiosk was part of the trailhead facility.

Availability of a permanent restroom facility increased from 25 percent in 2005 to 43 percent in 2014. Availability of portable toilet facilities at trailheads increased from 33 percent in 2005 to 45 percent in 2014, and the availability of trash receptacles increased from 42 percent to 61 percent over the decade between surveys.

Down East Sunrise Trail, ME.

MAJOR MAINTENANCE TASKS

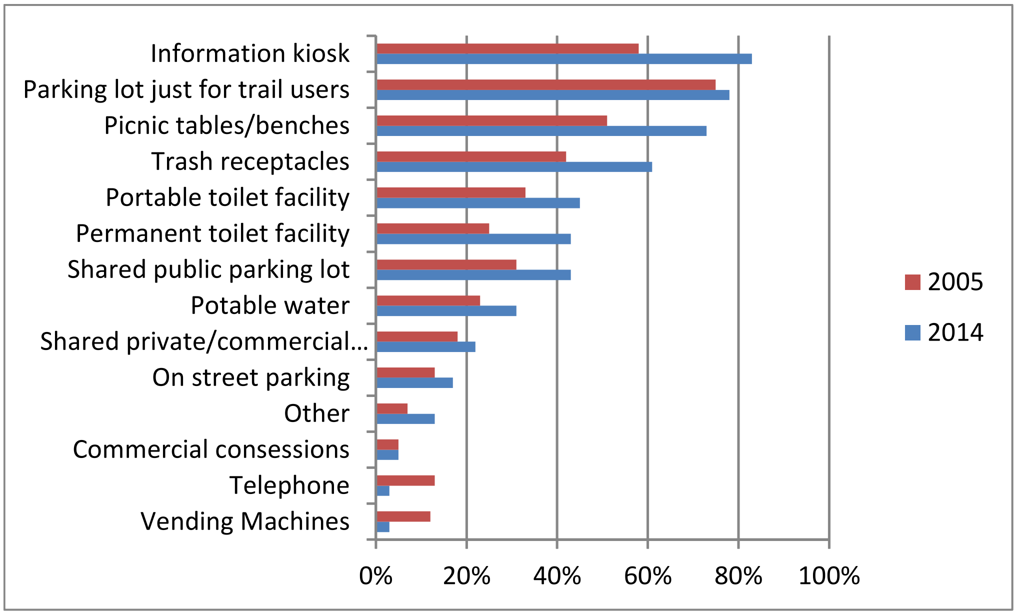


Figure 10. Trailhead Features (2014 Survey)

Between 2005 and 2014, dramatic changes were made in the types of facilities that trail managers provide at trailheads.

In 2005, 51 percent of the respondents reported trailheads featuring picnic tables and benches; that number increased to 73 percent in 2014. Telephones at trailheads fell from 13 percent in 2005 to 3 percent in 2014, consistent with an overall decline in public phones in the United States.

In 2005 only 43 percent of survey respondents reported the availability of picnic tables and benches along the trail. Today, 76 percent of trail managers' report that picnic tables or benches are provided along their trails.

Trailheads

Respondents were asked to provide a detailed cost for several aspects of trailhead maintenance, including landscaping, toilet facilities and kiosks. For the majority of those reporting, landscaping at trailheads was carried out by volunteers. Volunteer hours annually ranged from as few as eight to as many as 500. The largest cost item at trailheads was maintenance of restroom facilities. The lowest cost item was maintenance of informational kiosks at the trailhead.

Amenities

The cost of maintaining amenities such as picnic tables and benches varied among trail managers reporting detailed cost information. It was most strongly correlated to the length of the trails, as longer trails required more benches and picnic tables to maintain. For example, the 71-mile Willard Munger State Trail in Minnesota spent $1,260 on maintenance of amenities, while the eight-mile section of the Ghost Town Trail in Pennsylvania spent only $25. This type of maintenance spending likely also varies on a year to year basis.

Trailhead signage, Youghiogheny Rive Trail, Great Allegheny Passage, PA.

Sanitation

Litter Clean-Up

More than half of the trail managers who responded to the detailed trail maintenance cost survey reported on the number of hours spent cleaning up litter. Although the amount of time spent on litter removal is greater along urban trails, rural trails also require this task. Friends of the Riverfront, which manages the 24-mile Three Rivers Heritage Trail system in Pittsburgh, spends 2,000 hours annually on litter control. The 56-mile Trail of the Coeur d' Alenes in Idaho spends 300 hours on litter cleanup.

Cub Scouts help with litter clean-up on the Heritage Rail Trail County Park, PA.

Restroom Maintenance

Maintenance of restroom facilities, whether at trailheads or along the trail, can be an ongoing annual expense. Respondents to the detailed cost analysis survey provided information about maintenance of both permanent facilities and portable toilets. Costs varied widely. The Heritage Rail Trail County Park in Pennsylvania has both permanent and portable toilets at trailheads along the 21- mile trail. Maintenance costs for these facilities were reported at more than $14,000 a year.

Earth Day trash pick up along the Capital Greenbelt, Harrisburg, PA.

Permanent toilet facility along the Pine Creek Rail Trail, PA.

Signage

The 2014 survey revealed that trail managers are increasing the number and types of signs along trails, which adds to the need for maintenance. Posted trail identification signs increased from 75 percent in 2005 to 91 percent in 2014. More trails have mileage markers as well, an increase from 55 percent in 2005 to 74 percent in 2014. The placement of interpretive signs has also grown substantially, from 31 percent in 2005 to 57 percent in 2014. All of this additional signage helps to provide a better trail experience. However, 76 percent of trail managers reported that their signs were subject to vandalism.

Welcome sign, Ashuelot Rail Trail, NH.

Repair and Maintenance of Signage

Another major maintenance task is the repair and maintenance of trail signage. More than 40 percent of respondents reported this as a significant maintenance activity. In this case, trail length is correlated with cost: typically, the longer the trail the more signs that need to be maintained and the more time and cost is involved.

The four-mile Path of the Flood Trail in Pennsylvania reported spending two hours on signage repair and maintenance, and the 26-mile Catskill Scenic Trail in New York reported spending 135 hours on this work.

More than 75 percent of the respondents to the general maintenance survey reported that vandalism was the major cause of damage requiring signage repair and maintenance.

Greenline Trail sign used for target practice.

Access Control

Maintenance of Gates and Bollards

Gates and bollards are used to keep automobiles and other motorized vehicles off of trails that are intended only for non-motorized use. While maintenance costs associated with gates and bollards were reported by only 15 percent of detailed cost analysis respondents, most indicated costs of between $2,300 and $5,000.

Bollard at intersection, Bruce Freeman Rail Trail, MA.

Fencing

A majority of the respondents to our survey, 51 percent, indicated that they had some type of fencing along their trail. Most common was split rail wooden fencing, which was mentioned by 45 percent of the respondents. Over time this becomes a maintenance issue, as posts and rails rot or become damaged in some way.

Fencing generally is deployed along trails to protect trail users from a potential danger, such as a steep slope, or to prevent them from entering adjacent properties. In the detailed cost analysis, we looked at three types of typical trail side fencing: wooden, chain link and vinyl.

Of these three types, wooden fencing was reported to require the most maintenance. Thirty percent of the detailed cost survey respondents reported time repairing wooden fencing. This maintenance can take the form of replacing fencing that had rotted or fencing that had been damaged by accident or acts of vandalism. Only 8 percent of respondents reported repairs to chain link fence. No respondents reported repairs to vinyl fencing.

Damaged split rail fence along the Pine Creek Rail Trail, PA.

Split rail fencing, Pine Creek Rail Trail, PA.

Trail Features

Bridges

A full 88 percent of the trail managers indicated that they have at least one bridge along their trail. The most common — 61 percent — are original railroad bridges. The second most common type of bridge is new bike/pedestrian bridges with vehicle capacity. Surprisingly, 43 percent of respondents indicated that their bridges are not inspected on a regular basis by a certified inspectors or professional engineers. Fortunately, the number of trail managers reporting that their bridges are inspected increased from 33 percent in 2005 to 57 percent in 2014. The most frequent interval for bridge inspections reported in 2014 was two to three years, which is a shorter interval than that reported in 2005.

Scott Glen Bridge, Ghost Town Trail, PA.

Tunnels or Culverts

Tunnels are one of the most distinctive features of many rail-trails. In our 2014 survey, 41 percent of the surveyed trails reported that they had a tunnel on the trail, an increase of 14 percent from those reporting in 2005. Forty percent of the tunnels are illuminated, mostly on a dusk-to-dawn basis, with lighting triggered by a light sensor and powered by a municipal utility.

Average Labor Rate

Fifty nine percent of the respondents to the detailed maintenance cost survey reported labor rates for various trail maintenance activities. The rates ranged from a low of $10 per hour to a high of $75 per hour. Most labor rates were clustered around $25 per hour plus or minus $5. The average labor rate for all activities was $22.25.

Contracted Services

Many trail maintenance activities were carried out by trail management organizations and volunteers. Some, however, are better performed by outside contractors. In the survey, activities most commonly reported as being completed by contractors included tree removal, restroom maintenance, herbicide application, bridge inspections and clearing of drainage culverts and mowing.

Other

Vandalism and Illegal Dumping

A third of the respondents to our detailed cost analysis survey reported that they spent time repairing trails due to acts of vandalism or dumping along the corridor. Managers of four trails between 21 and 26 miles long in predominantly suburban/rural environments spent between 40 and 150 hours repairing trails after acts of vandalism or illegal dumping.

Cleaning-up illegal dumping along the Hanover Trolley Trail, PA.

Volunteers painting over graffiti.

Howard Tunnel, Heritage Rail Trail County Park, PA.

CONCLUSIONS

To better understand this issue, RTC conducted a comprehensive survey of trail maintenance costs. Results of this study show that, contrary to popular belief, maintenance costs are not as high as expected. Per mile yearly average costs for rail-trail maintenance assessed in this study ranged from $1,000 to $2,000, depending on whether the trail was asphalt or stone dust. This assessment supports the findings of the more detailed budgets that a few dozen trail managers provided, which averaged $2,026 per mile per year. This figure includes the value of volunteer service, which was assigned an equivalent hourly rate. When compared against the finding that 58 percent of trails reported using volunteers, both of the annual cost figures may decrease significantly.

Several additional significant findings from this study are summarized below.

Tree pruning even occurs in the dead of winter, Three Rivers Heritage Trail, PA.

Damage to asphalt trails from tree roots is significant and growing.

More than 60 percent of asphalt trail managers reported tree roots as the major source of trail damage. Clearly, as more asphalt trails are being built rather than stone dust trails (as required by some departments of transportation and metropolitan planning organizations); the true costs of these facilities needs to be better understood and shared. Replacing asphalt after several years is costly and frequently becomes a rebuild that is often funded by Transportation Enhancement (TE) programs or Transportation Alternatives Programs (TAP). This costly maintenance requirement might be prevented with better construction standards and possible use of root barriers in certain segments of a trail or periodic trenching to cut root growth. The removal of healthy trees several years after the trail is built is not the only option.

As an additional way to save money, several trail groups could work together to purchase materials or share equipment. State Departments of Natural Resources might use Recreation Trails Program funding to purchase equipment that can be used by any trail.

Invasive species concerns nearly tripled in importance from 2005 to 2014.

Some invasive species can be disproportionally destructive compared with native vegetation because natural control mechanisms do not exist in their new environment. This study found an increase in herbicide use, which is needed to control some invasive species. As a secondary issue, because trail groups rely heavily on volunteers and only contract out a small percent of herbicide application to professionals, it is logical to question if volunteers are adequately trained. Municipal workers, who would have adequate training, may be doing most of the herbicide application; however, this potential safety issue may warrant further examination.

CONCLUSIONS

Surprisingly, the survey found that 60 percent of rail-trails do not have maintenance plans.

This is surprising not only from a management perspective, but from a liability standpoint. All trail managers should have proof that they exercise a reasonable amount of due diligence to ensure that the trails are safe. Many government-owned and maintained rail-trails are included under larger park or civil works maintenance schedules. As a result, managers may believe that specific safety assurance for trails is not required. However, any trail that is owned, maintained or operated by a private, nonprofit organization should have a detailed safety management and maintenance plan with a schedule of tasks and inspections of related structures and facilities.

Estimating per-mile costs.

A total of 95 survey respondents provided an annual budget amount required to maintain their trail representing 40 percent of the trails included in the survey. Using the interquartile range (IQR) of those 95 trails gave us a total annual budget amount for maintenance. We determined that, of the sample group, annual maintenance cost per mile in 2013–2014 averaged $1,006 for a crushed stone trail and $1,971 for a paved asphalt trail. These figures do not include any extensive or exceptional repairs and are assumed to include only the most basic maintenance tasks needed to keep the trail usable.

Table 1. Estimated Costs Per Mile

Source	Asphalt Surface	Non-Asphalt Surface
RTC Maintenance & Operations Report - 2014	$1,971/mile	$1,006/mile
RTC Maintenance & Operations 2004 Report	$1,458/mile	$1,478/mile

Cost per activity.

Based upon the detailed cost analysis survey, we were able to determine the percentage that each activity represents in a typical trail maintenance budget. Data on asphalt and non-asphalt surfaces have been combined.

Table 2 Typical Maintenance Budget

Maintenance Activity	Percent of Budget
Surface clearing of trail	10.8%
Mowing	12.0%
Vegetation management (leaf clearing, pruning, etc.)	11.2%
Keep trail-side land clear of trash and debris	11.5%
Whole tree removal	5.4%
Application of herbicides or pesticides	2.3%
Clearing of drainage channels and culverts	5.4%
Surface maintenance of parking areas	2.7%
Litter clean up, trash cans	2.7%
Maintenance of toilets at trailheads	13.0%
Maintenance of toilets along the trail	1.2%
Trailhead parking snow removal	1.1%
Repair/maintenance of signs	6.3%
Recovery from illegal acts of vandalism/dumping	5.3%
Other trail maintenance activities	9.1%

Summary

Trail managers and local stakeholders often cite the need for dedicated state or federal funding to help pay for trail maintenance. Up to this point, RTC has lacked sufficient data to make that case effectively to decision-makers at the state or federal level. This study was initiated to bring some clarity to this issue. Because funding for rail-trails is difficult to secure, over-estimating maintenance costs can inadvertently give opponents easy leverage to speak against rail-trail development. In addition, funders often question if all aspects of any community development project should be funded by state and federal grants, particularly maintenance-related costs, which are often perceived as a "local issue."

This study presents a more comprehensive understanding of rail-trail maintenance, as has been done for other rail-trail issues such as construction costs, economic impact and rails-with-trails. Such an approach enables the rail-trail community to focus its limited resources more effectively on addressing the most critical issues.

Volunteers clear storm damage along trail in Heritage Rail Trail County Park, PA.

APPENDIX A

2014 SURVEY RESULTS

Please answer the following questions as completely and accurately as possible. If it is necessary to have more than one person in your organization answer different questions based on their personal areas of experience and expertise, please do so.

Please provide accurate information about the person to be contacted if any follow-up information is needed.

1. Please provide you name and contact information

Name
Title/Agency
Email
Phone

2. What is your Trail Name and state:

Trail name
State
Mileage

ADMINISTRATIVE

3. What is the trail surrounding Environment (check all that apply):

37%	Rural
12%	Urban
13%	Suburban
38%	Mixed

4. What are the permitted uses on your trail? (check all that apply)

3%	ATV
99%	Bike
79%	Cross Country Skiing
	Fishing
40%	Horseback Riding
56%	Inline skating
66%	Mountain Biking
16%	Snowmobile
100%	Walking
86%	Wheelchair Access

5. Who owns the land under the trail? If more than one, please indicate an approximate percentage.

23%	Federal government
43%	State government
34%	Municipal government
42%	County government
31%	Railroad
9.9%	Single private owner
46%	Non-profit entity
21%	Utility
12%	Multiple private owners

6. On a general basis, who PERFORMS maintenance of the trail? If more than one, please indicate an approximate percentage.

58%	Trail Group Volunteers
39%	Other volunteer community groups (please specify)
13%	Individuals with mandatory community service
4%	Federal government
21%	State government
33%	County government
43%	Municipal government
12%	Non-profit entity (paid staff)
12%	Other (specify)

7. Do you have a written Trail Maintenance Plan?

40%	Yes
60%	No

8. Who FUNDS maintenance of the trail? If more than one, please indicate an approximate percentage.

6%	Federal government
31%	County government
32%	Non-profit entity
25%	State government
42%	Municipal government
14%	Other (specify)

9. What is the annual maintenance budget for this trail? (Average for all respondents that provided a budget.)

$66,430

9.a. If known, please provide the dollar amounts for the following within your maintenance program. (Insufficient data)

Labor
Equipment
Supplies

10. How is the maintenance funded?

7%	Federally legislated (REC Trails funding)
24%	State Budget
49%	Municipal Budget
9%	Unique funding streams or fees collected through the community (e.g. hotel tax)?
39%	Local Fundraising activities (please describe)
29%	In-kind Donations

11. Is the trail covered by liability insurance?

77% Yes (If yes go to 12)
23% No (If no go to 15)

12. What is your coverage amount ?

Most indicated $1 - 2 Million

13. Who is your carrier?

Various

14. What is your annual cost?

Various

15. In what year was the trail first opened for public use?

Various

16. How do you track annual users:

54%	Do not currently track the number of annual users (Skip to 18)
23%	Estimate / guess
16%	Manual count
23%	Automated counter

17. How many users does your trail have on an annual basis?

Varied

18. What are the hours of operation of your trail?

63%	Dawn until dusk
30%	Open 24/7
7%	Other

SURFACE - GENERAL

19. What is the average width of your trail?

6%	6ft.
16%	8ft.
60%	10ft.
15%	12ft.
3%	Other (specify)

20. What surface material exists on any sections of your trail? (check all that apply)

76%	Asphalt
7%	Concrete
55%	Crushed Stone
9%	Cinders
21%	Dirt/ Soil
8%	Other (specify)

21. Please indicate any reused or recycled materials used in the surface of your trail?

69%	None
1%	Tires or other rubber
0%	Glassphalt
19%	Asphalt / pavement milling
2%	Coal ash (cinders)
8%	Quarry waste from stone/rock processing (tailings, etc.)
5%	Other (specify)

22. What is the predominant surface material on your trail?

52%	Asphalt	(Go to 23)
2%	Concrete	(Go to 35)
40%	Crushed Stone	(Go to 43)
4%	Original railroad cinders	(Go to 53)
4%	Dirt / Soil	(Go to 59)
0%	Boardwalk	(Go to 65)
5%	Other (specify)	(Go to 72)

SURFACE - ASPHALT

23. Has your trail been repaved or resurfaced since the original paving construction?

35%	Yes	(If yes go to 24)
65%	No	(If no go to 29)

24. At what frequency (in years)?

45%	Recurring
3%	3 to 5
7%	6 to 10
45%	10 plus

25. Has your trail been seal-coated since the original paving?

25% Yes	(If yes go to 26)
75% No	(If no go to 27)

26. At what frequency (in years)?

41%	Recurring
27%	3 to 5
23%	6 to 10
9%	10 plus

27. Do you have a crack sealing programing?

35% Yes	(If yes go to 28)
65% No	(If no go to 29)

28. At what frequency (in years)?

78%	Recurring
13%	3 to 5
9%	6 to 10
0%	10 plus

29. What are the major causes of damage to your asphalt surfaced trail?

43%	Water/erosion
63%	Tree roots
20%	Vegetation (grass, weeds)
25%	Sub surface failure
44%	Frost/freeze cycle

30. Is snow removed from your trail?

9%	Yes, fully
33%	Yes, partially
58%	No

31. How is the surface of your trail kept clear of trash and debris? (Check all that apply)

9%	Street sweeper
18%	Rotary brush
65%	Blower
58%	Manual (broom, rake, etc.)
7%	Other (specify)

32. Does your trail employ pavement markings? (Check all that apply.)

51%	No (if no skip to 72)
49%	Yes

33. Do you indicate a Center Line of the trail?

44%	Yes
24%	Painted
4%	Thermal transfer
51%	No

34. Do you employ other safety markings?

61%	Yes:	
	35%	Painted
	14%	Thermal transfer
35%	No	

SURFACE – CONCRETE

35. Have sections of your trail been re-poured or resurfaced since the original paving construction?

25%	Yes	(If yes go to 36)
75%	No	(If no go to 37)

36. At what frequency (in years)?

Recurring
3 to 5
6 to 10
10 plus

37. What are the major causes of damage to your concrete surfaced trail?

67%	Water/erosion
33%	Tree roots
0%	Vegetation (grass, weeds)
0%	Sub surface failure
33%	Frost/freeze cycle
33%	Other

38. Is snow removed from your trail?

33%	Yes fully
0%	Yes partially
67%	No

39. How is the surface of your trail kept clear of trash and debris? (Check all that apply)

33%	Street sweeper
33%	Rotary brush
100%	Blower
0%	Manual (broom, rake, chainsaw, etc)
Other (specify)	

40. Does your trail employ pavement markings? (Check all that apply.)

67%	Yes (if yes go to 41)
33%	No (If no go to 72)

41. Do you indicate a center line of the trail?

100%	Yes	
	0%	Painted
	0%	Thermal transfer
0%	No	

42. Do you employ other safety markings?

100%	Yes:	
	0%	Painted
	0%	Thermal transfer
0%	No	

SURFACE – CRUSHED/GRANULAR STONE

43. How was trail surface applied?

60%	Paving machine
21%	Box spreader
23%	Tailgate from dump truck
11%	Bucket spread from loader
0%	Wheelbarrow or other manual
8%	Other (specify)

44. Has your trail been re-surfaced since the original construction?

56%	Yes	(If yes go to 45)
48%	No	(If no go to 46)

45. At what frequency (in years)?

32%	Recurring
3%	3 to 5 years
21%	6 to 10 years
44%	10 years or longer

46. How is the surface material compacted?

14%	Not
38%	Steel drum roller (static)
47%	Steel drum roller (vibratory)
5%	Rubber tired roller
0%	Rammer
7%	Vibratory plates
10%	Other (specify)

47. If applicable, please indicate the size of aggregate used for your trail surface.

40%	Unknown
10%	1A
0%	1B 3% 2A
0%	2B 2% 2RC
30%	AASHTO #10
2%	DSA
18%	Other (specify)

48. Do you use any type of soil or aggregate binder?

97%	No
3%	Yes

49. What are the major causes of damage to your crushed stone surfaced trail:

77%	Water/erosion
2%	Tree roots
2%	Vegetation (grass, weeds)
3%	Sub surface failure
17%	Frost/freeze cycle
27%	Other (specify)

50. How are damages to your trail surface repaired:

32%	Grader or other heavy equipment
42%	Light duty power equipment
40%	Dragging
71%	Manual (rake, shovel, etc.)
13%	Other (specify)

51. Has your trail been re-graded since the original construction?

44%	Yes	(If yes go to 34a)
54%	No	(If no go to 36)

52. At what frequency (in years)?

74%	Recurring
4%	2 to 3 years
4%	4 to 5 years
19%	6 to 10 years

SURFACE – ORIGINAL RAILROAD CINDERS

53. How was the surface prepared after removal of the rails and ties

56%	Grader or other heavy equipment
11%	Light duty power equipment
33%	Dragging
11%	Manual (rake, shovel, etc.)
22%	Other (specify)

54. How was the surface material compacted ?

20%	Steel drum roller (static)
80%	Steel drum roller (vibratory)
0%	Rubber tired roller
0%	Rammer
0%	Vibratory plates
0%	Other (specify)

55. What are the major causes of damage to your cinder surfaced trail?

87%	Water/erosion
0%	Tree roots
25%	Vegetation (grass, weeds)
13%	Sub surface failure
50%	Frost/freeze cycle

56. How are damages to your trail surface repaired?

63%	Grader or other heavy equipment
63%	Light duty power equipment
25%	Dragging
50%	Manual (rake, shovel, etc)

Other (specify)

57. Has your trail been re-graded since the original construction?

71%	Yes	(If yes go to 58)
29%	No	(If no go to 65)

58. At what frequency (in years)?

100%	Recurring
0%	2 to 3 years
0%	4 to 5 years
0%	6 to 10 years

SURFACE – DIRT/SOIL

59. How was the surface prepared?

43%	Grader or other heavy equipment
43%	Light duty power equipment
15%	Dragging
29%	Manual (rake, shovel, etc)

Other (specify)

60. How was the surface material compacted?

20%	Steel drum roller (static)
20%	Steel drum roller (vibratory)
20%	Rubber tired roller
20%	Rammer
20%	Vibratory plates
40%	Other (specify)

61. What are the major causes of damage to your dirt/soil surfaced trail?

71%	Water/erosion
14%	Tree roots
14%	Vegetation (grass, weeds)
14%	Sub surface failure
29%	Frost/freeze cycle
43%	Other (specify)

62. How are damages to your trail surface repaired?

29%	Grader or other heavy equipment
71%	Light duty power equipment
0%	Dragging
71%	Manual (rake, shovel, etc)
0%	Other (specify)

63. Has your trail been re-graded since the original construction?

50%	Yes	(If yes go to 64)
50%	No	(If no go to 65)

64. At what age / frequency (in years)?

33%	Recurring
0%	2 to 3 years
33%	4 to 5 years
33%	6 to 10 years

SURFACE – BOARDWALK

65. Does you trail contain any segments of boardwalk?

18%	Yes	(If yes go to 66)
82%	No	(If no go to 53)

66. How long is the boardwalk segment of your trail?

0 %	10 feet or less
23%	10 to 50 feet
19%	51 to 100 feet
29%	101 to 500 feet
8%	501 to 1,000 feet
19%	1,001 feet or more

67. How wide is the boardwalk segment of your trail?

28%	5 to 7 feet
37%	8 to 10 feet
28%	11 to 12 feet
6%	Greater than 12 feet

68. What is the decking material of the boardwalk?

6%	Wood (pine, oak, et.) not pressure treated
0%	Wood (teak, red wood, etc.)
84%	Wood – pressure treated
3%	Synthetic wood (Trex, NewTechWood, ArmorGuard etc.)
0%	Concrete
7%	Other

69. How old is the boardwalk segment of your trail?

23%	1 to 3 years
42%	4 to 9 years
26%	10 to 20 years
10%	More than 20 years

70. Has your boardwalk been re-decked since its original construction?

33%	Yes	(If yes go to 71)
67%	No	(If no go to 72)

71. At what frequency has re-decking occurred?

11%	2 to 3 years
0%	4 to 5 years
22%	6 to 10 years
67%	More than 10 years

ADJACENT LAND AND VEGETATION

72. Does annual or perennial vegetation grow along your trail?

97%	Yes	(if yes go to 73)
3%	No	(if no go to 75)

73. Do you use any herbicides or pesticides in your trail maintenance?

45%	Yes	(If yes go to 73a)
54%	No	(If no go to 75)

If yes, please list:

74. Who is responsible for herbicide/pesticide application (check all that apply)

77%	Trail maintenance staff
20%	Volunteers
14%	Contractor

75. Do trees grow along your trail?

100%	Yes
0%	No

76. If planting new trees, what is the distance between the trees and the edge of the trail?

15%	8
7%	10
6%	12
5%	20
7%	other?

77. Please indicate any activities that are performed relative to trail side vegetation. (Check all that apply.)

93%	Litter clean-up
91%	Tree pruning
30%	Tree and shrub planting
90%	Tree removal - Safety
44%	Tree removal - Health
93%	Tree removal - Fallen
26%	Tree removal - Aesthetics (improve view shed)
92%	Mowing
40%	Leaf removal
62%	Invasive species removal
27%	Flower and ground cover planting
3%	Other (specify)

78. How is drainage accommodated? (Check all that apply.)

80%	Trail surface is crowned or sloped
76%	Trail-side drainage channels (ditches, gullies)
72%	Culverts
5%	Other (specify)

79. How are drainage areas kept clear? (Check all that apply.)

56%	Power equipment (backhoe, etc.)
76%	Manual (rake, shovel, etc.)
3%	Flush with water
25%	Self-cleaning design
5%	Other (specify)

PARKING, TRAILHEADS, and SANITATION

80. How many trailheads are there along your trail?

5%	None
26%	1-3
28%	3-5
26%	5-10
12%	10-15
4%	Other (please specify)

81. Please indicate the features of your trailheads. (Check all that apply.)

78%	Parking lot just for trail users
22%	Shared private/commercial parking lot
43%	Permanent toilet facility
83%	Information kiosk
31%	Potable water
5%	Any other commercial concession
3%	Telephone
43%	Shared public parking lot
45%	Portable toilet facility
17%	On-street parking
61%	Trash receptacles
3%	Vending machines
73%	Picnic tables/benches
13%	Other (specify)

82. What is the primary surface material for your trailhead parking area(s)?

53%	Asphalt
38%	Crushed Stone
0%	Cinders
6%	Dirt / Soil
3%	Other (specify)

83. Is snow removed from your trailhead parking lots?

63%	Yes
37%	No

84. Aside from trailheads, are any of these amenities provided along your trail. (Check all that apply.)

22%	Permanent toilet facility
52%	Informational kiosk
24%	Potable water
7%	Any other commercial concession
62%	Interpretive signage
22%	Portable toilet facility
43%	Trash receptacles
1%	Vending machines
76%	Picnic tables/benches
8%	Other (specify)

SIGNS, ACCESS CONTROL AND PUBLIC SAFETY

85. What types of signs do you use? (Check all that apply.)

91%	Trail identification sign ("welcome to ABC Trail")
74%	Mile marker
6%	Quarter miles
7%	1/10 mile
77%	Traffic control for trail users (stop, yield)
60%	Traffic control for cars at crossings
75%	Trail rules and regulations
25%	Property boundary sign (no trespassing)
57%	Interpretive signs
28%	Wayfinding on trail
20%	Wayfinding (off trail)
2%	No trail specific signage
12%	Other (specify)

86. Do you experience vandalism of your signs?

76%	Yes
24%	No

87. Please indicate any techniques you use to separate users by direction of travel or use? (e.g. pedestrian vs. bicycle) Check all that apply.

68%	None
13%	Pavement markings
23%	Signs
3%	Physical separation
3%	Different surface type
4%	Separate tread (Bridle or carriage path)
3%	Other (specify)

88. Is your trail patrolled by any professional policing authority?

65%	Yes	(If yes go to 89)
35%	No	(If no go to 90)

89. Police agency type:

5%	State police or state sheriff
42%	Municipal police
33%	Park or trail rangers
20%	Other (specify)

Rail-Trail Maintenance and Operations

90. Is your trail patrolled by a volunteer or a non-police group (e.g. crime watch)?

30%	Yes
70%	No

91. Do you have an on-going problem with any of the following activities on the trail? (Check all that apply.)

49%	Dumping
12%	Crimes against persons
28%	After hours use
17%	Trespass
71%	Vandalism
21%	Crimes against property
22%	Other (specify)

92. Are your trailheads lighted?

16%	Yes	(If yes go to 93)
84%	No	(If no go to 96)

93. During what times?

75%	Dusk until dawn
25%	Other

94. How are the lights controlled? (Check all that apply.)

13%	Always on
4%	Manual switch
25%	Clock / timer
75%	Light / dark sensor
4%	Motion sensor
18%	Other (specify)

95. How are the lights powered?

96%	Municipal power supply
4%	Solar panel
0%	Battery

96. Do you have emergency call boxes on along your trail or trailhead?

3%	Yes
97%	No

97. How is vehicular access to your trail controlled? (Check all that apply.)

22%	Vehicular access is not controlled
45%	Gates
26%	Fixed bollards
54%	Removable bollards
11%	Other (specify)

98. Do you use fencing along your trail?

64%	Yes	(if yes go to 99)
36%	No	(if no go to 101)

99. What types of fencing do you use?

18%	Chain link
45%	Split rail
7%	Woven Wire
3%	Stockade
27%	Other (specify)

100. What is the average height of the fence (in INCHES)?

48 “	most common

101. In what areas have you made accommodation for ADA standards or handicapped accessibility?

78%	Parking
50%	Restrooms
35%	Picnic tables
12%	Visitor's Center
15%	Interpretive areas
75%	Grade of trail
61%	Grade of access to trail
67%	Trail Surface
3%	Our trail has specific features for individuals with sight, hearing, or other impairments.
5%	Other (specify)

BRIDGES, TUNNELS and ROAD CROSSINGS

102. Do you have any bridges on your trail?

88%	Yes	(If yes go to 103)
12%	No	(If no go to 109)

103. What types of bridges do you have?

61%	Existing railroad bridge
33%	Pre-Fabricated
9%	New Bike/Ped (no vehicular capacity)
40%	New bike/ped (with vehicle capacity)
16%	Small foot bridge(less than 5' wide)
8%	Other (specify)

104. What is the deck material on your bridges? (Check all that apply.)

74%	Wood
9%	Synthetic lumber
1%	Rubber
11%	Metal
16%	Asphalt
36%	Concrete
11%	Stone/dirt/cinders
Other (specify)	

105. Do you have railings on your bridges?

97%	Yes	(If yes go to 106)
3%	No	(If no go to 109)

106. What is the height of the fence/railing (in INCHES)?

48"	most common

107. Are your bridges inspected on a regular basis by a certified inspector or professional engineer?

57%	Yes
43%	No

108. At what frequency (in years)?

0%	Recurring
66%	2 to 3 years
23%	4 to 5 years
11%	6 to 10 years

109. Do you have any tunnels or culverts for user passage under roads etc.

41%	Yes	(If yes go to 110)
59%	No	(If no go to 114)

110. Are your tunnels lighted?

40%	Yes
60%	No

111. During what times?

31%	24/7
61%	Dusk to dawn
8%	Other (please specify time of day/ night)

112. How are lights controlled?

23%	Always on
0%	Manual switch
31%	Clock / timer
46%	Light / dark sensor
0%	Motion sensor
Other (specify)	

113. How are the lights powered?

92%	Municipal power supply
8%	Solar
0%	Battery
0%	Generator

114 Do you paint/stain/treat bridge structures or decks, tunnel/underpass walls, etc?

45%	Yes	(If yes go to 115)
54%	No	(If no go to 116)

115. At what frequency (in years)?

68%	Recurring
0 %	2 to 3 years
10%	4 to 5 years
23%	6 to 10 years

116. How are at-grade crossings of roads controlled? (Check all that apply.)

89%	Stop sign for trail users
17%	Yield sign for trail users
17%	Traffic signal (red, yellow, green)
69%	Ped /bike crossing sign
17%	Stop sign for road users
20%	Yield sign for road users
30%	Pedestrian crossing signal (walk)
51%	Road striping
Other (specify)	

APPENDIX B LIST OF PARTICIPANTS

Trail Name	State	Opened	Mileage	Surface
Tahoe City Public Utility District Multi-use trails	CA	1991	20	Asphalt
Bizz Johnson National Recreation Trail	CA	1983	25.4	Ballast, Gravel
Fort Collins City Trails	CO	1998	36	Concrete
Rio Grande Trail	CO	1987	42	Asphalt
Middlebury Greenway	CT	2008	5	Asphalt
Sue Grossman Still River Greenway	CT	1995	3	Asphalt
Trumbull Rails to Trails	CT	2006	7	Crushed Stone
Farmington Canal Heritage Trail	CT	2010	56	Asphalt
Metropolitan Branch Trail	DC	2000	3.5	Asphalt
Prairie Farmer Recreational Trail	IA	1999	22	Asphalt
Raccoon River Valley Trail	IA	1990	89	Asphalt, Concrete
Gay Lea Wilson Trail	IA	2000	17	Asphalt, Concrete
Ashton-Tetonia Rail Trail	ID	1913	30	Crushed Stone
Latah Trail	ID	1984	16	Asphalt
Trail of the Coeur d'Alenes Recreational Trailway	ID	2006	73	Asphalt
Wood River Trail	ID	1990	22	Asphalt
Route of the Hiawatha	ID &MT	1986	15	Ballast, Dirt, Gravel
George Rogers Clark Discovery Trail	IL	2010	9.2	Concrete
Forest Preserves of Cook County	IL	2009	100	Crushed Stone
Burnham Greenway	IL	2004	2.5	Asphalt
Millennium Trail and Greenway	IL	2003	8	Crushed Stone
Great Western Trail	IL	1990	12	Crushed Stone
Illinois Prairie Path	IL	1966	62	Crushed Stone
DeKalb Nature Trail	IL	1985	1.2	Asphalt
Oak Savannah Trail	IN	2010	8	Asphalt
Nickel Plate Trail	IN	2012	35	Crushed Stone
Pumpkinvine Nature Trails	IN	1996	20	Asphalt
Delphi Historic Trails	IN	2008	10	Crushed Stone
Zionsville Rail Trail	IN	1997	3.75	Asphalt
Monon Trail	IN	1997	9	Asphalt, Crushed Stone
Brighton East Rail Trail	KY	1998	2	Asphalt, Crushed Stone
Narrow Gauge Rail Trail	MA	2010	3	Crushed Stone
Bruce Freeman Rail Trail	MA	1992	6.8	Asphalt
Cape Cod Rail Trail	MA	2011	22	Asphalt
Methuen Rail Trail	MA	1995	2.4	Crushed Stone
Danvers Rail Trail	MA	1994	4.3	Crushed Stone
Old Colony Rail Trail	MA	1992	3	Asphalt
Southwick Rail Trail	MA	1994	6	Asphalt
Springfield Riverfront Bikeway/Walkway	MA	1994	3.7	Asphalt
Ashuwillticook Rail Trail	MA	2003	11	Asphalt
Gwynns Falls Trail	MD	2005	15	Asphalt

Trail Name	State	Opened	Mileage	Surface
Jones Falls Trail	MD	2006	9.1	Asphalt
Herring Run Trail	MD	1978	2.5	Asphalt
Stony Run Trail	MD	2013	2.9	Asphalt
Three Notch Trail	MD	2013	7	Asphalt
Gilchrest Trail	MD	2011	1.2	Asphalt
Broadneck Trail	MD	2000	6.6	Asphalt
Washington, Baltimore & Annapolis Trail	MD	1983	10.25	Asphalt
Baltimore Washington International Airport Trail	MD	2013	12.5	Asphalt
Torrey C. Brown/Northern Central Railroad Trail	MD	1984	20	Crushed Stone
Baltimore & Annapolis Trail	MD	1991	14	Asphalt
Catonsville Short Line Trail	MD	2013	3.5	Dirt, Gravel
St. John Valley Heritage Trail	ME	1998	29	Crushed Stone
Bangor Aroostook Trail & Aroostook Valley Trail	ME	1999	61	Gravel, Dirt, Soil
Aroostook Valley Trail	ME	1991	28	Crushed Stone, Dirt
Polly Ann Trail	MI	1998	30	Asphalt, Crushed Stone
Riverfront Trail	MI	2005	2.25	Asphalt
Kalamazoo River Valley Trail	MI	1999	17	Asphalt
Clinton River Trail	MI	2004	1	Crushed Stone
Flint River Trail	MI	2009	20	Asphalt
Leelanau Trail	MI	1987	20	Asphalt
I-275 Metro Trail	MI	mid-1970's	30	Asphalt
Conner Creek Greenway	MI	2009	9.5	Asphalt
Traverse Area Recreation Trail	MI	1831	10.5	Asphalt
Little Traverse Wheelway	MI	1996	26	Asphalt
Dakota Rail Regional Trail	MN	2002	12.4	Asphalt
Rocori Trail	MN	2005	12.9	Asphalt
Paul Bunyan and Cuyuna State Trails	MN	2004	128	Asphalt
Kenilworth Regional Trail	MN	2005	0.15	Asphalt
Central Lakes State Trail	MN	1986	55	Asphalt
Willard Munger State Trail (Gateway Segment)	MN	1993	18	Asphalt, Crushed Stone
Bruce Vento Trail	MN	2010	23	Asphalt
Willard Munger State Trail (Matthew Lourey State Trail)	MN	1980	80	Asphalt, Crushed Stone
Cannon Valley Trail	MN	1986	20	Asphalt
Dairyland Trail	MN	1995	6.2	Crushed Stone
Lake Wobegon Trail	MN	1999	54	Asphalt
Sakatah Singing Hills State Trail	MN	1980	38	Asphalt
Duluth Winnipeg and Pacific Trail	MN	1985	8	Gravel
Douglas State Trail	MN	1974	26	Asphalt
MKT Nature and Fitness Trail	MO	1982	8.9	Concrete, Crushed Stone
Northern Rail Trail	NH	1995	23	Crushed Stone
Sugar River Trail	NH	1997	9	Dirt, Soil

APPENDIX B LIST OF PARTICIPANTS

Trail Name	State	Opened	Mileage	Surface
Goffstown Rail Trail	NH	2005	5.5	Crushed Stone
Windham Rail Trail	NH	2000	4	Asphalt
Winnipesaukee River Trail	NH	2005	7.9	Crushed Stone
WOW Trail	NH	1990	1.3	Asphalt
Derry Rail Trail	NH	2004	4.5	Asphalt
Gloucester Township Health & Fitness Trail	NJ	2001	2	Asphalt
Henry Hudson Trail	NJ	1995	24.5	Asphalt
Delaware and Raritan Canal State Park	NJ	1980	80	Crushed Stone
Barnegat Branch Trail	NJ	1971	15.6	rushed Stone
Middlesex Greenway	NJ	2006	3.1	Asphalt
Columbia Trail	NJ	1990	7.5	Crushed Stone
Paulinskill Valley Rail Trail	NJ	1992	27	Cinders, Dirt, Grass, Ballast
Traction Line Recreation Trail	NJ	1986	3	Asphalt
Dutchess Rail Trail	NY	1991	13.5	Asphalt
Oswego County Recreation Trail	NY	1979	24.35	Original railroad cinders
Joseph B. Clarke Rail Trail	NY	1998	2.5	Asphalt
Ontario Pathway	NY	1992	23.5	Cinders, Grass, Gravel
Town of Ballston Veterans Bike Path.	NY	1960	3.6	Asphalt
Auburn Trail	NY	1993	10	Crushed Stone
Clarence Bike Paths	NY	2004	10.2	Asphalt
Hudson Valley Rail Trail	NY	1824	3.6	Asphalt
Pat McGee Trail	NY	1987	13	Crushed Stone
South Hill Recreation Way	NY	1988	3.4	Crushed Stone
Wallkill Valley Rail Trail	NY	2000	24	Asphalt, Cinders, Gravel
Harlem Valley Rail Trail	NY	1978	17	Asphalt
Genesee Valley Greenway	NY	1992	90	Original railroad cinders
Catskill Scenic Trail	NY	1990	26	Original railroad cinders
Catharine Valley Trail State Park	NY	2002	10	Crushed Stone
Ballston Veterans Bike Path	NY	1994	20	Asphalt
Vestal Rail Trail	NY	2002	5	Asphalt
Heritage Trail	NY	1996	11	Asphalt, Crushed Stone
Hockhocking Adena Bikeway	OH	1990	21	Asphalt
Kokosing Gap Trail	OH	1982	13.5	Asphalt
4-C Bicentennial Trail and Peace Path	OH	1972	2.5	Asphalt
Fairfield Heritage Trail	OH	1999	9.3	Asphalt
Infirmary Mound Park trails	OH	1991	7	Asphalt, Dirt
Taft Reserve Trails	OH	1992	8	Asphalt, Dirt
Lobdell Reserve Trails	OH	1992	8	Asphalt, Dirt
Holmes County Trail	OH	1995	15	Asphalt
Richland B&O Trail	OH	1999	18.4	Asphalt
Lebanon - Countryside YMCA Trail	OH	2011	8	Asphalt

Trail Name	State	Opened	Mileage	Surface
Cleveland Metro Parks	OH	1990	250	Asphalt, Crushed Stone, Dirt
Heart of Ohio Trail	OH	1989	16	Asphalt
MetroParks Bikeway	OH	1990	11	Asphalt
Bike & Hike / Towpath / Freedom	OH	1966	60.4	Asphalt
Simon Kenton Trail	OH	2003	18	Asphalt
Alum Creek Trail	OH	2010	20	Asphalt
Hock-Hocking Adena Bikeway	OH	1992	22	Asphalt
Slippery Elm Trail	OH	1995	13.5	Asphalt
Creekside trail and others	OH	2005	62	Asphalt. Concrete
Deschutes River Railbed Trail	OR	2008	16	Dirt, Soil
Deschutes River Trail (some surfacing cut off)	OR	1989	24	Crushed Stone. Asphalt, Ballast, Cinders
OC&E and Woodsline State Trail	OR	1994	108	Woodchips
Panhandle Trail in Allegheny County	PA	1999	7.5	Crushed Stone
Chester Valley Trail	PA	2007	11.5	Asphalt
Capital Area Greenbelt	PA	1978	22	Asphalt
Five Star Trail	PA	1990	7.75	Crushed Stone
McClintock Trail	PA	1996	3.5	Asphalt
Trout Island Trail	PA	1980	2.5	Asphalt
Greater Hazleton Rails to Trails	PA	2011	6	Crushed Stone
Steel Valley Trail	PA	1988	19	Asphalt
Warren/North Warren Bike/Hike Trail	PA	2011	3	Asphalt
Allegheny River Trail	PA	1983	34.2	Asphalt
Sandy Creek Trail	PA	1998	12	Asphalt
Great Allegheny Passage (Yough River Trail)	PA	2000	185	Crushed Stone
Path of the Flood Trail	PA	2012	9	Asphalt, Ballast
Luzerne County National Recreation Trail	PA	1989	1.8	Crushed Stone
Ghost Town Trail	PA	1992	18	Crushed Stone
Stavich Bike Trail	PA	1983	7	Asphalt
Swatara Rail Trail	PA	1994	10	Crushed Stone
Roaring Run Trail	PA	2005	5	Crushed Stone
Clarion-Little Toby Trail	PA	1994	18	Crushed Stone
Lebanon Valley Rail-Trail	PA	1987	15.5	Crushed Stone
Lehigh Gorge Trail	PA	1994	26	Original railroad cinders
Queen City Trail	PA	2008	1	Asphalt
Montour Trail	PA	1985	47	Crushed Stone
Pine Creek Rail Trail - Tioga County	PA	2001	27	Crushed Stone
Great Allegheny Passage - Somerset County Segment	PA	2001	42	Crushed Stone
Butler Freeport Community Trail Council	PA	1997	20.4	Crushed Stone
Warwick Trial system	PA	1992	6	Asphalt
Perkiomen Trail	PA	2010	20	Crushed Stone

APPENDIX B LIST OF PARTICIPANTS

Trail Name	State	Opened	Mileage	Surface
Lackawanna River Heritage Trail	PA	1986	35	Crushed Stone
Oil Creek State Park Bike Trail	PA	1998	9.7	Asphalt
Great Allegheny Passage	PA	1996	150	Crushed Stone
Delaware Canal State Park	PA	2003	60	Crushed Stone
West Penn Trail	PA	1991	15	Crushed Stone
Three Rivers Heritage Trail	PA	1986	24	Asphalt
D&H Rail-Trail	PA	1997	38	Original railroad cinders
York County Heritage Rail Trail	PA	1999	23.5	Crushed Stone
The Lower Trail	PA	1998	17	Crushed Stone
Redbank Valley Trail	PA	1999	51	Crushed Stone
Armstrong Trail	PA	1992	36	Crushed Stone
Plainfield Township Trail	PA	1991	6.7	Crushed Stone
Pine Creek Rail Trail - Lycoming County	PA	1992	38	Crushed Stone
Blue and White Trails	PA	2002	2	Asphalt
Delaware Canal State Park Towpath	PA	1940	60	Crushed Stone, Dirt
Coal and Coke Trail	PA	2007	5	Asphalt, Crushed Stone
Five Star Trail	PA	1997	7.5	Crushed Stone
Ironton Rail Trail	PA	1995	9.2	Asphalt
West Penn Trail	PA	2002	15	Crushed Stone
Panhandle Trail - Washington County	PA & WV	1999	17	Crushed Stone
William O'Neill/South County Bike Path	RI	2013	8	Asphalt
Shelby Farms Greenline Trail	TN	1966	6	Asphalt
High Bridge Trail State Park	VA	2007	30.9	Crushed Stone
Virginia Capital Trail	VA	2005	16	Asphalt, Boardwalk
Southern Tip Bike & Hike Trail	VA	2008	2.6	Asphalt
New River Trail State Park	VA	2007	57	Asphalt
Virginia Blue Ridge Railway Trail	VA	1987	7	Crushed Stone
Dahlgren Railroad Heritage Trail	VA	1998	15.7	Dirt, Soil
Washington & Old Dominion Trail	VA	2001	45	Asphalt
Burlington Bike Path	VT	1987	25	Asphalt
Klickitat Trail	WA	2002	31	Gravel, Dirt
Ozaukee Interurban Trail	WI	1963	29.5	Asphalt
Hank Aaron State Trail	WI	2006	14	Asphalt
Gandy Dancer Trail	WI	2001	20.3	Crushed Stone
Badger and Glacial Drumlin State Trails	WI	1984	60	Crushed Stone
Southwest Path	WI	2010	4.5	Asphalt
Mon River	WV	2008	6	Crushed Stone
Caperton Trail	WV	1999	6	Asphalt
Deckers Creek Trail	WV	1999	19	Asphalt, Crushed Stone

Pine Creek Trail, PA.

rails·to·trails conservancy

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railtrail@railstotrails.org

railstotrails.org

www.TrailLink.com

Hi Michelle~
So these quotes were for HUNGRY HORSE TO WEST GLACIER IS WHY PECCIA SAYS 9.4 MILES. THEY BOTH CAME UP WITH ABOUT $3500-$3700 PER MILE OF PAVED TRAIL PER YEAR.

Val

Sent: Wednesday, October 21, 2015 11:49 AM
Subject: Gateway to Glacier - Pavement Preservation Costs

Val:

I have reviewed the Flathead County 2-Year Road Network Maintenance Plan (February 2010) and the Flathead County 2025 Road Network Maintenance Plan (May 2015), both of which we completed.

Using estimated maintenance cost values and maintenance applications from these two documents, modified slightly because the wear-and-tear on a bicycle/pedestrian path would be less than a typical roadway, I have estimated the following asphalt maintenance costs:

Preservation	Age (Years)	Description	Cost per Mile	Miles	Total Costs			
1	7	Crack Seal & Fog Seal	$8,000.00	9.4	$75,200.00			
2	12	Crack Seal & Fog Seal	$8,000.00	9.4	$75,200.00			
3	17	Crack Seal & Fog Seal	$8,000.00	9.4	$75,200.00			
4	20	Non-Structural Overlay (2")	$50,000.00	9.4	$470,000.00			
		Total =			$695,600.00	Over a 20 Year Period		
		Amount Required for 20 Year Cycle =			$34,780.00	per Year		

Therefore, the maintenance district should plan on raising approximate $34,780/year for just asphalt maintenance. Other maintenance costs, such as mowing, sweeping, etc. will need to be included. Please note that all of these costs are in 2015 dollars.

Thanks and let me know if you have any questions.

Ryan E. Mitchell, PE, PLS | Kalispell Operations Manager
Robert Peccia & Associates Inc. **|** PO Box 5100 **|** Kalispell, MT 59903
406.752.5025 **|** 406.752.5024 (fax) **|** **ryan@rpa-kal.com**
Robert Peccia & Associates Home- Robert Peccia & Associates

RE: Gateway to Glacier - Pavement Preservation Costs

People

- Stack, Shane <sstack@mt.gov>
-
- 11/23/15 at 1:58 PM

To

- valerie parsons

Message body

Val
Here is what our maintenance team calculated for costs for pavement preservation:

Costs: There is a Future Surface Maintenance Plan that should be performed on a routine schedule and budgeted based on that schedule.

- Minor Crack Sealing - $1,600 per mile, to be scheduled every four years
- Major Crack Sealing - $4,800 per mile, to be scheduled as needed
- Hand Patching - $300 per mile, to be scheduled as needed
- Machine Patching - $3,075 per mile, to be scheduled as needed
- Fog Sealing - $1,100 per mile, to be scheduled every eight years
- Plant Mix Surfacing Overlay - $ 29,500 per mile, to be scheduled every 25 years

I looks pretty close to what I had calculated last year. In fact I think I had an estimated annual cost for the state at $690,000, and this maintenance team calculated $660,000 per year for the existing mileage. So we are pretty close.

Shane Stack
(406) 523-5830
sstack@mt.gov

Robert Peccia & Associates Home - Robert Peccia & Associa...

Robert Peccia & Associates is an award-winning full service Montana/Colorado civil engineering, surveying and landscape architecture firm.

View on **www.rpa-hln.com** Preview by Yaho

Appendix E - 2

COMPLETE STREETS REFERENCE MATERIALS

RESOLUTIONS OF THE CITY OF HELENA, MONTANA

RESOLUTION NO. 19799

A RESOLUTION STATING THE POLICY AND INTENT TO PROVIDE "COMPLETE STREETS" FOR ALL USERS OF PUBLIC STREETS IN THE CITY OF HELENA, MONTANA, AND PROVIDING AN IMPLEMENTATION STRATEGY

WHEREAS, U.S. Department of Transportation policy is to incorporate safe and convenient walking and bicycling facilities into transportation projects; and

WHEREAS, every transportation agency, including the U. S. Department of Transportation, has the responsibility to improve conditions and opportunities for walking and bicycling and to integrate walking and bicycling into their transportation systems; and

WHEREAS, because of the numerous individual and community benefits that walking and bicycling provide, including health, safety, environmental, transportation, and quality of life, transportation agencies are encouraged to go beyond minimum standards to provide safe and convenient facilities for these modes of travel; and

WHEREAS, complete streets are essential for providing safe routes to schools for children; and

WHEREAS, §61-8-501, MCA, states pedestrians are accorded privileges and are subject to restrictions on roads as set forth in the law; and

WHEREAS, §61-8-602, MCA, gives bicycle riders all the rights of and makes them subject to all the duties applicable to drivers of vehicles; and

WHEREAS, City policy, as stated in the Greater Helena Area Transportation Plan, approved by the City Commission on December 19, 2005, is to develop a living plan for the greater Helena area to create and maintain corridors for bicyclists and other modes of travel and recreation that are safe and effective for their transportation and enjoyment, and encourage walking, bicycling, and transit use as safe, convenient, and widely available modes of transportation for all people; and

WHEREAS, the proposed Helena Growth Policy recognizes the need to include facilities for safe travel by pedestrians and bicyclists in street improvement projects and developing areas, to minimize vehicle miles traveled in the Helena area, and to implement policies and decisions to ensure that bicyclists and pedestrians can use and cross major roadways and highways leading to surrounding areas; and

WHEREAS, the Helena City Commission accepted the Helena Climate Change Task Force Action Plan 2009 that included a recommendation to Improve Non-Motorized Transportation Policy and Infrastructure, and specifically recommended adoption of a "Complete Streets" transportation design ordinance by January of 2010; and

WHEREAS, a stated goal of the City-County Health Department is to prevent obesity and reduce the risk of chronic disease through promotion of physical activity, nutrition, and a better built environment; and

WHEREAS, the City-County Board of Health adopted a Resolution of Support for Local, Statewide, and Federal Initiatives That Promote Transportation and Land-Use Policies and Practices That Promote Good Health; and

RESOLUTIONS OF THE CITY OF HELENA, MONTANA

Resol. No. 19799

WHEREAS, other governmental agencies and jurisdictions nationwide have adopted Complete Streets policies, including the U.S. Department of Transportation, numerous state transportation agencies, Seattle, San Francisco, Sacramento, San Diego, Boulder, Chicago, Portland, Lansing, Bozeman, and Missoula; and

WHEREAS, the Helena Citizens' Council has determined that the implementation of Complete Streets concepts is in the best interests of Helena; and

WHEREAS, the Helena City Commission, in its resolution establishing the Non-Motorized Travel Advisory Council, has recognized that traffic congestion, community growth, limited parking facilities, environmental issues, climate change, increasing fuel costs, energy shortages, and concern for personal and public health have combined to make non-motorized transportation an increasingly needed alternative to use of automobiles.

NOW, THEREFOR, BE IT RESOLVED BY THE COMMISSION OF THE CITY OF HELENA, MONTANA:

Section 1. **Policy**: The City of Helena hereby establishes a policy to require the planning, design, construction, and maintenance of streets to work toward the goal of making streets in Helena complete streets.

Section 2. **Definitions**: The following definitions apply to the terms used in this resolution:

a. “Complete Street” is a street that has appropriate street features to accommodate and coordinate all modes of transportation, both motorized and non-motorized, and people of all ages and abilities, with special consideration to optimize safety, interconnectivity, compatibility, and convenience.

b. “Complete Street Features” are sidewalks, bicycle lanes, motor vehicle lanes, shared-use lanes and paths, paved shoulders, street trees and landscaping, vegetative planting strips, curbs and gutters, accessible curb ramps, crosswalks, refuge islands, pedestrian and traffic signals, directional signs, street furniture, bicycle parking facilities, public transportation stops and facilities, transit priority signalizations, traffic calming devices such as rotary circles and curb bulb-outs, and surface treatments such as paving blocks, textured asphalt, and concrete, narrow vehicle lanes, raised medians, and dedicated transit lanes.

Section 3. The City Manager shall direct appropriate staff to make a recommendation to the Commission of changes to City Code and engineering and design standards that are necessary to implement this policy into the design and construction of new streets as complete streets. This recommendation shall include a proposed timeline for suggested changes. No later than the end of June of 2011, the City Manager shall present a scoping document for the process of making this recommendation, which identifies sections of the Helena City Code and engineering and design standards likely to need changes.

Section 4. By the end of June 2011, the City Manager shall make a recommendation to the Commission for a process of reviewing, inventorying, and establishing a hierarchy of complete street needs for selected existing streets and proposed streets for which construction plans have been approved, all of which are either identified or are indispensably integral with the goals in the 2005 Greater Helena Area Transportation Plan. This recommendation shall also include a proposal for prioritizing selected streets for the addition of complete streets features. Additionally the recommendation shall make suggestions, consistent with the annual budget process, for triggering points as to when complete street features would be applicable to existing streets.

Section 5. Partnerships with private developers, Lewis and Clark County, Jefferson County, the Montana Department of Transportation, and other governmental agencies and organizations are encouraged so transportation and development projects that extend beyond the City's corporate limits meet the goals of this policy.

Section 6. The City will document progress when implementing complete streets features by reporting:

a. descriptive statistics such as miles of on-street bicycle and multi-use routes created, new linear feet of pedestrian accommodations, and number of ADA sidewalk ramps installed or improved;

b. qualitative measures and comparison with benchmarks or other appropriate metrics; and

c. other information the City Commission may require.

PASSED AND EFFECTIVE BY THE COMMISSION OF THE CITY OF HELENA, MONTANA, THIS 20th DAY OF DECEMBER, 2010.

/S/ James E. Smith
MAYOR

ATTEST:

/S/ Debbie Havens
CLERK OF THE COMMISSION

COMMISSION RESOLUTION NO. 4244

A RESOLUTION OF THE CITY COMMISSION PROVIDING FOR A COMPLETE STREETS POLICY AND DIRECTING STAFF TO DEVELOP PERFORMANCE MEASURES AND IMPLEMENTATION STRATEGIES TO ENABLE SAFE AND CONVENIENT ACCESS TO OUR TRANSPORTATION SYSTEM FOR ALL USERS, OF ALL AGES AND ABILITIES, INCLUDING PEDESTRIANS, BICYCLISTS, PEOPLE WITH DISABILITIES, TRANSIT RIDERS, AND MOTOR VEHICLE DRIVERS.

WHEREAS, the Bozeman Community Plan and the Greater Bozeman Area Transportation Plan have established as a goal and future policy a commitment to providing alternatives to the individual passenger vehicle to ensure that a variety of travel options exist which allow safe, logical, and balanced transportation choices; and

WHEREAS, the Bozeman Community Plan and the Greater Bozeman Area Transportation Plan recommend the adoption of a Complete Streets policy; and

WHEREAS, a Complete Street is one that is designed and operated to safely accommodate all users, including but not limited to: motorists, pedestrians, bicyclists, transit riders, and people of all ages and abilities; and

WHEREAS, a Complete Streets philosophy causes transportation agencies to design and operate the entire right of way, both along and across the corridor, to encompass users of all types and to promote safe access and travel for the users; and

WHEREAS, increasing active transportation (e.g., walking, bicycling and using public transportation) offers the potential for improved public health, economic development, a cleaner environment, reduced transportation costs, enhanced community connections, social equity, and more livable communities; and

WHEREAS, Complete Streets create safe routes for children to walk and bicycle to school; and

WHEREAS, a Complete Street is comprised of many different elements; these elements may include, but are not limited to: sidewalks, bike lanes, crosswalks, wide shoulders, medians, bus pullouts, special bus lanes, raised crosswalks, audible pedestrian signals, sidewalk bulb-outs, and more; and

WHEREAS, Complete Streets elements that are used can vary from project to project, but the end result is still to achieve a connected network that is safe and effective for all modes of travel; and

WHEREAS, a Complete Streets policy contributes to a comprehensive, integrated, and connected network for all transportation modes; and

WHEREAS, a Complete Streets concept also recognizes the need for flexibility: that all streets are different and user needs should be balanced; and

WHEREAS, any exceptions to Complete Streets implementation must be clearly and specifically stated within the policy and require high-level approvals so that there is no confusion what type of design is required; and

WHEREAS, the roadway design must fit in with the context of the community while using the latest and best standards; and

WHEREAS, all streets are unique and require different levels of attention, so an effective policy must be flexible enough to accommodate all types of roads and be adopted by every agency;

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COMMISSION OF THE CITY OF BOZEMAN, MONTANA, that the City of Bozeman adopts the following Complete Streets Policy; and

AND BE IT FURTHER RESOLVED, that effective implementation of this Complete Streets Policy will require the City of Bozeman to review their procedures and, if necessary, restructure them, to consider the needs of pedestrians, motorized and non-motorized vehicle users on every project; and

AND BE IT FURTHER RESOLVED, that applicable changes to design manuals or public works standards may need to be made to fully encompass the safety and needs of all users by employing the latest in design standards and innovation; and

AND BE IT FURTHER RESOLVED, that periodic education and training of planners and engineers is also recommended to ensure the latest techniques in balancing the needs of roadway users are being applied; and

AND BE IT FURTHER RESOLVED, that the City of Bozeman will work with other jurisdictions and transportation agencies within its planning area to incorporate a Complete Streets philosophy and encourage the Montana Department of Transportation, Gallatin County and other municipalities to adopt similar policies; and

AND BE IT FURTHER RESOLVED, that existing data sources and projects should be used to track how well the streets are serving all users.

Section 1

Complete Street Policy

The City of Bozeman will plan for, design, construct, operate, and maintain appropriate facilities for pedestrians, bicyclists, transit vehicles and riders, children, the elderly, and people with disabilities in all new constructionand retrofit or reconstruction projects subject to the exceptions contained herein.

The City of Bozeman understands that major street improvements are not a requirement through maintenance activities and should not be expected. However, maintenance activities do present some opportunities that can improve the environment for other roadway users. For example, while the construction of a sidewalk may not be appropriate as part of maintenance activities, facilities such as improved crosswalks, or bike lanes, or a shoulder stripe could be included in a routine re-stripe of a roadway if adequate space exists and the facility is designated to have such facilities in the Bozeman Area Transportation Plan. (See Section 6.6 of the Greater Bozeman Area Transportation Plan 2007 Update for additional examples of improvements that could be associated with various roadway maintenance activities).

The City of Bozeman has and will continue to incorporate Complete Streets principles into: The Greater Bozeman Area Transportation Plan, the Bozeman Community Plan, the Parks Recreation Open Space Trails (PROST) Plan, the Bozeman Unified Development Ordinance (UDO), and other plans, manuals, rules, regulations and programs as appropriate.

Complete Streets principles will be applied on new City projects, privately funded development, and incrementally through a series of smaller improvements and activities over time. All sources of transportation funding, public and private, should be drawn upon to implement Complete Streets within the City of Bozeman. The City of Bozeman believes that maximum financial flexibility is important to implement Complete Streets principles.

Complete Streets principles will be applied in street construction, retrofit, and reconstruction projects except in unusual or extraordinary circumstances contained herein:

1. Bicyclists and pedestrians are prohibited by law from using the facility. In this case, alternative facilities and accommodations shall be provided within the same transportation corridor.

2. Where the existing right-of-way does not allow for the accommodation of all users. In this case alternatives shall be explored such as the use of revised travel lane configurations, paved shoulders, signage, traffic calming, education or enforcement to accommodate pedestrians, cyclists, transit, and persons with disabilities.

3. The cost of establishing bikeways or walkways or other accommodations would be disproportionate to the need, particularly if alternative facilities are available within a reasonable walking and/or bicycling distance. Cost shall be considered disproportionate if the cost of additional complete street facilities is 20% or more of the cost of the work without the additional complete street facilities.

4. Where there is no need, including future need.

5. Where application of Complete Streets principles is unnecessary or inappropriate because it would be contrary to public safety and increase risk of injury or death.

6. The construction is not practically feasible or cost effective because of significant or adverse environmental impacts; or impact on neighboring land uses, including impact from right of way acquisition.

7. Ordinary maintenance activities designed to keep street and other transportation assets in serviceable condition or when interim measures are implemented on temporary detour or haul routes.

8. Ordinary public works or utility maintenance activities, including, but not limited to: water, sewer and storm sewer main repairs; installation of new or removal of existing water or sewer service lines; installation or repair of fire hydrants; installation or repair of private utility fixtures.

Exclusive of Exception 7 and 8, any project that does not meet the Complete Streets principles based on the above exceptions should have said determination confirmed and filed with the City Commission for review.

Section 2

Severability.

If any provision of this policy or the application thereof to any person or circumstances is held invalid, such invalidity shall not affect the other provisions of this policy which may be given effect without the invalid provision or application and, to this end, the provisions of this policy are declared to be severable.

Section 3

Effective Date.

This complete street policy shall be in full force and effect upon passage.

DATED this 22nd day of February, 2010.

JEFFREY K. KRAUSS
Mayor

ATTEST:

STACY ULMEN, CMC
City Clerk

APPROVED AS TO FORM:

GREG SULLIVAN
Bozeman City Attorney

RESOLUTION NO. 11-19097

A RESOLUTION OF THE CITY OF BILLINGS
TO ADOPT A COMPLETE STREETS POLICY

WHEREAS, in enacting this resolution, it is the intent of the City Council to encourage healthy, active living; reduce traffic congestion; and improve the safety and quality of life of Billings residents by providing safe, convenient, and comfortable routes for walking, bicycling, and public transportation; and

WHEREAS, the promotion of transportation improvements that are planned, designed and constructed to encourage walking, bicycling, and transit use increase the general safety, health and overall welfare of the citizens of and visitors to the City of Billings; and

WHEREAS, the Billings Urban Area Long-Range Transportation Plan 2009 Update states, as one of its Guiding Principles, "the City will develop a complete streets policy which will design and operate to enable safe access for all users including pedestrians, bicyclists, motorists, and transit riders of all ages and abilities to safely move along and across a complete street"; and

WHEREAS, the 2010 Community Investment Plan: City of Billings City Council and Staff Strategic Priorities identifies one of its goals to be the "development of a comprehensive, multi-modal transportation system" and includes "complete streets" as a priority; and

WHEREAS, 72.9% of residents are overweight or obese according to the 2010 Yellowstone County Community Health Assessment; and

WHEREAS, only 47.2% of residents meet nationally recognized physical activity recommendations according to the 2010 Yellowstone County Community Health Assessment; and

WHEREAS, Section 61-8-602 of the Montana Code Annotated (MCA) makes bicycle riders rightful road users, and Section 61-8-501, MCA, recognizes pedestrians as rightful road users; and

WHEREAS, the health, safety and welfare of the citizens of and visitors to the City of Billings will be enhanced by the adoption of a policy that promotes a complete transportation system that meets the needs and expectations of all transportation users; and

WHEREAS, the City Council of the City of Billings desires to establish a clear policy ensuring the needs of adjacent land users and all transportation users, including but not limited to pedestrians, bicyclists, transit users, people with disabilities, the elderly, emergency responders, motorists, and freight providers are considered.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL that the City of Billings adopt the following Complete Streets Policy.

COMPLETE STREETS POLICY

A complete street is comprised of many different elements that are tailored to fit the needs of Users. A complete street can vary considerably in context from rural to urban applications and the needs of Users.

1. DEFINITIONS. The following words and phrases, whenever used in this Policy shall have the meanings defined in this section unless the context clearly requires otherwise:

(a) "Complete Streets Infrastructure" means design features that contribute to a safe, convenient, or comfortable travel experience for users, including but not limited to features such as: sidewalks; shared-use paths; bicycle lanes; shared roadways; bicycle boulevards; automobile lanes; paved shoulders; street trees and landscaping; planting strips; curbs; accessible curb ramps; bulb outs; crosswalks; refuge islands; traffic signals, including pedestrian countdown signals, accessible pedestrian signals and pedestrian hybrid beacons; signage; street furniture; bicycle parking facilities; public transportation stops and facilities; transit priority signalization; traffic calming devices such as roundabouts/rotary circles, speed humps, and surface treatments such as paving blocks, textured or colored asphalt, and concrete; narrow vehicle lanes; raised medians; dedicated transit lanes; and those features identified in the Billings Area Bikeway and Trail Master Plan, and the Manual on Uniform Traffic Control Devices.

(b) "Street" means any road, public or private, open to the use of the public for vehicular travel, as well as bridges, tunnels, underpasses, overpasses and any other similar portions of the roadway network.

(c) "Street Project" means the construction, reconstruction, retrofit, maintenance, alteration, or repair of any Street, and includes the planning, design, approval, and implementation processes. "Street Project" does not include minor routine upkeep such as cleaning, sweeping, mowing, spot repair, or interim measures on detour routes.

(d) "Multi-modal Transportation Network" means all facilities, vehicles and devices designed to facilitate the mobility of people.

(e) "Users" are individuals who use the Multi-modal Transportation Network. Categories of Users include pedestrians; bicyclists; motor vehicle drivers; public transportation riders and people of all ages and abilities.

2. IMPLEMENTATION

(a) The City of Billings shall consider every Street Project an opportunity to incorporate the principles of Complete Streets.

(b) The City of Billings shall work in coordination with other organizations, agencies, and jurisdictions to achieve a safe, convenient and connected Complete Streets Infrastructure within the Multi-modal Transportation Network.

(c) This policy shall guide the City in the development of plans, design standards, procedures, rules, regulations, guidelines, programs, templates, and design manuals. As practicable, these documents and tools will be updated to reflect this Complete Streets Policy.

(d) The City will provide periodic training on how to integrate, accommodate, and balance the needs of each category of User. Training will be available to City staff, private industry, other jurisdictions, and community members.

3. DATA COLLECTION AND PROGRESS REPORTING

(a) The City will periodically collect, review and report performance data and benchmark measurements to demonstrate the effectiveness of the policy. This information could include: number of projects completed, number of projects incorporating complete streets infrastructure, actual infrastructure added, number of transit and non-motorized users, community attitudes and perceptions, and safety and health indicators.

(b) Existing advisory boards and committees such as the Technical Advisory Committee, the Traffic Control Board, the Bicycle and Pedestrian Advisory Committee, the Aviation and Transit Board, Public Works Board, Yellowstone County Board of Health and the Yellowstone County Board of Planning are encouraged to provide ongoing feedback and act as conduit for public participation on the implementation of Complete Streets practices.

4. EXCEPTIONS. Exceptions to implementation of this policy may be considered.

(a) In considering all exceptions, alternatives shall be explored such as the use of the revised travel lane configurations, paved shoulders, signage, traffic calming, education or enforcement to accommodate pedestrians, cyclists, transit and persons with disabilities.

(b) In considering all exceptions, future project phasing and improvements should address how complete streets principles will be accommodated.

(c) Exceptions shall consider the multi-modal transportation network in the immediate vicinity.

(d) When exceptions occur, alternatives and accommodations shall be documented.

PASSED by the City Council and APPROVED this 22nd day of August, 2011.

CITY OF BILLINGS
SEAL
YELLOWSTONE COUNTY, MONTANA

THE CITY OF BILLINGS:

BY: Thomas W. Hanel
Thomas W. Hanel, Mayor

ATTEST:

BY: Cari Martin
Cari Martin, City Clerk

RESOLUTION NUMBER 7473

A RESOLUTION OF THE CITY COUNCIL PROVIDING FOR A COMPLETE STREETS POLICY AND DIRECTING STAFF TO DEVELOP IMPLEMENTATION STRATEGIES TO INCREASE THE USABILITY OF ALL STREETS FOR ALL MODES OF TRAVEL FOR CITIZENS OF ALL AGES AND ABILITIES IN MISSOULA.

WHEREAS, The City of Missoula wishes to ensure that all users of our transportation system are able to travel safely and conveniently on all streets and roadways within the public right-of-way in Missoula; and

WHEREAS, a complete street is defined as one which provides a safe, convenient, and context-sensitive facility for all modes of travel, for users of all ages and all abilities; and

WHEREAS, complete streets better serve the needs of those who use transit by providing access to transit systems; and

WHEREAS, complete streets have public health benefits, such as encouraging physical activity and improving air quality, by providing the opportunity for more people to bike and walk safely; and

WHEREAS, complete streets improve access and safety for those who cannot or choose not to drive motor vehicles; and

WHEREAS, complete streets are essential in providing safe routes to school for children; and

WHEREAS, complete streets policies have been adopted legislatively by at least five states, and by at least 36 localities – of which 13 are by local law (resolutions or ordinances); and

WHEREAS, the City of Missoula currently has a limited complete streets policy applying particularly to streets developed in new subdivisions; and

WHEREAS, the City of Missoula Public Works Department has a Master Sidewalk Plan and other programs to improve the ability of Missoula's streets to meet the travel needs of all users; and

WHEREAS, the concept and principles of complete streets are entirely compatible with the direction and plans embodied in the 2008 Missoula Urban Area Transportation Plan update; and

WHEREAS, it is the desire of the City of Missoula to formalize a commitment to the principles of complete streets for all of our streets;

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF MISSOULA, MONTANA, that the City of Missoula commits to a Complete Streets Policy which has the following elements:

1. Any roadway in the city of Missoula which is to be newly constructed or completely reconstructed must be designed and constructed to
    - A. provide for the safety and convenience of all users of all ages and of all abilities: pedestrians, bicyclists, transit users, and motorists; and
    - B. address the needs of all users both along roadway corridors and crossing the corridors.

2. Any project in which an existing roadway surface is to be restored or rehabilitated, and any remediation of deficient or non-existent sidewalks, shall be reviewed for the potential of making the roadway a complete street. Consideration shall particularly include proportionality: is the scope of work needed to make a complete street reasonable in relation to the scope of the proposed roadway maintenance or improvement?

3. Any exception to applying this Complete Streets Policy to a specific roadway project must be approved by the City Council, with documentation of the reason for the exception.

4. An annual report will be made to the City Council by the City Administration showing progress made in implementing this policy.

AND BE IT FURTHER RESOLVED BY THE CITY COUNCIL OF THE SAID CITY OF MISSOULA, MONTANA, that this Complete Streets Policy will apply to the scoping, design, and construction of projects.

AND BE IT FURTHER RESOLVED BY THE CITY COUNCIL OF THE SAID CITY OF MISSOULA, MONTANA, that the Public Works Department will review current design standards, including the design standards embodied in the most recent version of the subdivision regulations (currently Article 3-2 and 3-3) which apply to new roadway construction, to assure that they reflect the best available design standards and guidelines, and effectively implement the Complete Streets Policy above stated.

AND BE IT FURTHER RESOLVED BY THE CITY COUNCIL OF THE SAID CITY OF MISSOULA, MONTANA, that these design standards also serve as guidance for all existing roadway rehabilitation, reconstruction, or resurfacing, to the extent that the work required is reasonably proportional to the scale of the proposed rehabilitation, reconstruction, or resurfacing.

AND BE IT FURTHER RESOLVED BY THE CITY COUNCIL OF THE SAID CITY OF MISSOULA, MONTANA, that application of design standards will be flexible to permit context-sensitive design, fitting the roadway design within the context of the neighborhood, recognizing that all streets are different and user needs will be balanced.

AND BE IT FURTHER RESOLVED BY THE CITY COUNCIL OF THE SAID CITY OF MISSOULA, MONTANA, that exceptions may be made when

- The project involves a roadway on which non-motorized use is prohibited by law. In this case, an effort shall be made to accommodate pedestrians and bicyclists elsewhere.
- There is documentation that there is an absence of use by all except motorized users now and would be in the future even if the street were a complete street.

AND BE IT FURTHER RESOLVED BY THE CITY COUNCIL OF THE SAID CITY OF MISSOULA, MONTANA, that staff in the Public Works Department be directed to develop ordinances, resolutions, programs, and recommendations for funding to implement the Complete Streets Policy, for consideration by the City Council; and that these shall identify the complete streets needs and recommend a plan to meet those needs, including for sidewalks, throughout the city.

AND BE IT FURTHER RESOLVED BY THE CITY COUNCIL OF THE SAID CITY OF MISSOULA, MONTANA, that the City Council commits to including Complete Streets Policy and principles in all future City plans.

PASSED AND ADOPTED this 24th day of August, 2009.

ATTEST:	**APPROVED:**
/s/ Martha L. Rehbein	/s/ John Engen
Martha L. Rehbein,	John Engen,
City Clerk	Mayor

(SEAL)

Appendix E - 3

EBIKE REFERENCE MATERIALS

E-Bikes in North America: Results from an online survey

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ABSTRACT
This research aims in part to understand if different bicycling technology, in this case electric assist bicycles or e-bikes, can reduce barriers to bicycling, including trip distance, topography, time, and rider effort. Doing so may result in more bike trips and longer bike trips, and increase the diversity of people bicycling, including people with a disability or chronic injury. E-bikes typically resemble a standard pedal bicycle with the addition of a rechargeable battery and electric motor to assist the rider with propulsion. To address these aims, we conducted an online survey of existing e-bike users on their purchase and use decisions. Responses from 553 e-bike users across North America are analyzed here. Results suggest that e-bikes are enabling users to bike more often, to more distant locations, and to carry more cargo with them. Additionally, e-bikes allow people who would otherwise not be able to bike because of physical limitations or proximity to locations, the ability to bike with electric assist.

INTRODUCTION

As the U.S. continues to urbanize and transportation funding becomes scarce, municipalities are increasingly looking to reduce reliance on single occupant motor vehicles in favor of bicycling, walking, and public transportation. These active transportation modes are attractive due to their reduced greenhouse gas (GHG) emissions, reduced road and parking space, and associated health benefits. To date, most efforts have been to increase these modes through changes in infrastructure, land use, and awareness programs. While these are critical elements in mode choice decisions, less research exists on improving the technology and usability of the mode itself to encourage more trips to be made by bike and for more people to take bike trips. This research focuses on electric assist bicycles or "e-bikes" and whether this technology can encourage more bike trips and longer bike trips, and increase the number of people biking by attracting people who typically do not or cannot ride a regular bicycle. By increasing the amount of biking, positive benefits could be realized in terms of reduced vehicle emissions and an increase in physical activity and mental well-being.

This paper includes a literature review focused on common barriers to bicycling and existing e-bike research. The literature review is followed by findings from an online survey of existing e-bike users. The purpose of the survey is to better understand the factors that influence purchase decisions and how current users in North America use their e-bikes. Survey responses were analyzed to determine if some of the barriers to biking can be addressed by e-bikes.

BACKGROUND

U.S. cities are faced with many transportation challenges such as traffic congestion, injury and loss of life from road crashes, local air quality, climate change, obesity and physical inactivity, economic burdens, and international supplies of oil. Shifting people out of cars to other modes of transportation, such as bicycling, can help address these challenges. With an increased focus on reducing the effects of motor vehicles in metro regions, planners and policy makers are looking to increase the attractiveness of walking and bicycling.

There are many factors (i.e., adequate infrastructure and supportive policies) that affect the extent to which bicycling will be a viable transportation mode in urban and suburban communities (1). According to the 2009 Nationwide Household Travel Survey (NHTS), 57% percent of daily vehicle trips are under five miles in length – a reasonable distance to ride a bike (2). Even with extensive bike infrastructure, riders must be willing and physically able to operate bikes for a full range of trips. Because of this, bicycle trips tend to be shorter than motor vehicle trips and cyclists tend to avoid hilly locations (3). If urban and suburban areas want to increase the numbers participating in biking, barriers for some individuals must be addressed.

One possible solution to increase biking in urban areas is through wider adoption of e-bikes. By providing electric power assistance to a rider, the potential role of the bicycle, especially for commuting and errands, can be expanded by addressing the limits of trip distance and terrain. In addition to distance and terrain, e-bikes have the potential to overcome other barriers to biking that have been identified in previous studies (4, 5).

Barriers to Biking

In the U.S., research has found that men bike at a significantly higher rate than women. Pucher, Buehler, and Seinen found the 2009 NHTS showed that women made 24% of all bike trips with men making up the remaining 76% (6). This is consistent with a study that found men's total bike trips surpass women's by a ratio of at least 2:1 (7). In contrast, industrialized European countries such as the Netherlands, Denmark, and Germany tend to have equal or higher rates of female cyclists compared to male cyclists (8). Past research has shown that factors that keep women from biking more include: increased concern for safety, the need to make multiple stops while hauling items such as groceries, and transporting passengers (9). Baby boomers came of age during the automobile era and yet as a whole, this group is more physically active than any previous generation. A report by the AARP Public Policy Institute states that there is renewed interest from older adults in alternatives to the automobile, such as bicycles (10). Past research has shown that older bike riders can have difficulty navigating intersections, left hand turns, and maneuvering the bicycle (11). As the baby boom generation ages, their continued mobility and accessibility needs will increase as their numbers increase.

In a survey of the bike commute literature, Heinen and colleagues found that barriers to biking include: safety, weather, inconvenience, lack of fitness, lack of time, being tired, too much effort, and difficulties with trip chaining (9). These barriers can be more or less significant based on an individual's age, fitness, or physical ability. Infrastructure improvements, destinations and destination amenities can address some of these concerns related to safety and distance but fail to address other barriers related to the individual rider such as fitness, topography, and effort. Distance and topography can be tied to many of the barriers to biking that include lack of fitness, lack of time, being too tired, too much effort and difficulties with trip chaining. E-bikes could allow people with physical limitations, older adults, and people in geographically challenging areas to participate in bicycling (5, 12).

Electric Bikes

E-bikes typically resemble a standard pedal bicycle with the addition of a rechargeable battery and electric motor to assist the rider with propulsion. E-bike makes and models vary widely in their technology. This paper will focus on e-bikes that are essentially standard bicycles that have a battery and small motor to assist the rider with propulsion. Electric scooters with or without pedals are not considered e-bikes for the purposes of this paper. The location of the batteries and motors on the e-bike vary from model to model. Many e-bikes place a motor either on the front or rear wheel hub of the bicycle. Alternatively, e-bike motors can be located near the middle of the bicycle around the crank area to provide assistance to the crank or chain. Batteries can be built into the frame of the e-bike, mounted externally or within a rear rack. Some researchers make a distinction between powered bicycles (PBs) and power-assisted bicycles (PABs), also referred to as "pedelecs". The critical difference between PBs and PABs is that on the former, the motor operates with a switch or throttle without any pedaling from the rider, on the latter, power assistance is only provided when the rider is pedaling (13). The e-bike as we know it today originated in Japan sometime during the early 1980s with the intent of making bicycling easier for the elderly (14).

Federally, the Consumer Product Safety Act defines a low-speed electric bicycle as a "two-or three-wheeled vehicle with fully operable pedals and an electric motor of less than 750 watts (1 horse power), whose maximum speed on a paved level surface, when powered solely by such a motor while ridden by an operator who weighs 170 pounds, is less than 20 mph" (15). Individual states may have their own definitions and requirements with respect to use and operation of e-bikes that are more stringent than the federal law. Many states do not have specific e-bike regulations at this time but that may change if this technology continues to expand. As of this paper, we found that 18 of 50 U.S. states had e-bike specific regulations. Some municipalities in the U.S. specifically prohibit e-bikes on multi-use paths or city streets (16, 17, 18).

The worldwide market for e-bikes is growing but varies geographically. According to Navigant Research, worldwide sales of e-bikes were expected to be 30 million units in 2012 and 47.6 million by 2018 with the majority of sales being in Asia. In China alone, 120 million e-bikes (includes scooter and mopeds) were operating in the country as of 2010 and a total of 200 million were expected to be on roads by 2012. In the U.S., e-bike sales in 2012 were approximately 53,000. Comparatively, approximately 252,000 e-bikes were sold in Germany, a country with less than one-third the population of the U.S. (19). Because of limited numbers in North America, e-bikes can still be considered in the "early adopter" phase though U.S. consumers are being presented with a broader range of e-bike options through specialty bicycle stores, online stores and electronic retail outlets. Mainstream use of e-bikes in the U.S. has been hampered by low retail availability, cost of units, lack of knowledge about the technology and issues effecting general bike use; such as, inadequate infrastructure investments and a lack of comprehensive, integrated policies and programs to promote bicycling and cycling safety (6).

The majority of the e-bike research has focused on use and adoption in China and Europe. In 2006, Weinhart et al. detailed results of intercept surveys on consumer travel behavior and attitudes of 460 e-bike user in Shijiazhuang, China (20). More recently, Johnson and Rose looked to understand the Australian e-bike market (21). These studies show that e-bikes are used by a variety of individuals to bike further distances and to overcome barriers to biking, such as trip length, cargo weight or physical limitations. One of the striking differences in the studies and with this study is that Shijiazhuang e-bike users where evenly split between male and female and 73% where between 24 and 40 years old (20). The Australian and North American users tend to be older and male.

METHODS

Existing e-bike owners and users, primarily in the U.S., were surveyed using an instrument adapted from the Institute of Transport Studies at Monash University in Melbourne, Australia (21). The e-bike survey was administered online starting March 7, 2013 and remained open until July 1, 2013. The survey link was distributed through e-bike blogs, online forums, Facebook pages, Twitter accounts, e-mails to manufacturers and retailers, and via postcards left in local bicycle shops in the Portland region. Closed-ended responses were analyzed using SPSS to identify trends and differences. The survey included a number of questions with the opportunity for the participant to include open-ended text responses. These responses were analyzed and grouped into major themes where possible.

Five hundred and fifty-three people who own or use an e-bike regularly in the U.S. or Canada took the survey, though not everyone answered all questions. Because the individuals were not a random sample and there is very limited knowledge of actual e-bike ownership in the North America, findings may not accurately represent the population of e-bike owners. FIGURE 1 shows the geographic distribution of survey respondents across the U.S. and Canada. Concentrations of respondents are observed in Southern California, the San Francisco Bay Area, the Pacific Northwest and along the northeastern corridor.

FINDINGS

Demographics/Purchase Decision

TABLE 1 presents the user characteristics of the e-bike survey respondents. Respondents were predominately male (85%) and 71 percent of them were 45 years of age or older. Ninety percent of survey respondents identified themselves as white with 71 percent reporting that they were a college graduate or had obtained a graduate degree. Respondents reported on their general state of health with 58 percent indicating that they were in very good or excellent condition. Nearly one-third (30%) of respondents stated that they had a physical condition that makes riding a standard bike difficult. Respondents listed knee problems, arthritis, asthma, and back pain as common ailments.

Respondents were nearly evenly split between e-bike conversions of a standard bike (52%) and purchases of new, fully assembled e-bikes (48%). Cargo bikes and increasing cargo capacity were cited by respondents for reasons to convert their standard bicycle to an e-bike. Respondents indicated that increasing the hauling capacity of their bicycle was one of the main reasons they bought or converted a standard bicycle at 14 percent of open ended responses. When asked the reasons for changing from a standard bike to an e-bike in an open ended question, 8 percent of respondents listed increased cargo capacity. Respondents that converted standard bikes to e-bikes did so using a mountain bike almost 40 percent of the time. The next most common conversion was hybrid bikes at 16 percent, cargo bikes/trikes at 13 percent and recumbent bikes at 11 percent followed by road bikes, women's bikes/commuters, other and folding bikes. Two-thirds of respondents (66%) had purchased their e-bike or conversion kit in the past two and a half years. This information is consistent with reports that e-bike sales have increased over the past few years (14). When asked how the electric power turns on for their e-bike, 46 percent of respondents said that their e-bike either had a grip or thumb throttle on the handlebar. Thirty percent of respondents indicated that their e-bike had an on/off button and 13 percent said that their e-bike only provides assistance when pedaling. The remaining 11 percent of respondents chose "other" with 65 percent indicating that their e-bike had a pedal assist option in addition to a throttle and the remaining 35 percent described an ignition or switch to activate the power assistance.

When asked how much their e-bike or conversion kit cost to purchase, the responses varied within categories from $500 or less to $2,501 or more. Twenty-two percent of respondents indicated that their e-bike or conversion kit cost was $1,000-$1,500. The least populated price category was the $2,001-2,500 range with only 10 percent of respondents. When price was compared to conversion type, differences in purchase price were more apparent with those who converted a standard bike in general spent less than respondents who purchased an e-bike.

Many, but not nearly all, of the e-bike users were standard bike riders prior to getting their e-bike. Ninety-four percent of respondents indicated that they rode a standard bike as an adult before owning an e-bike, but only 55 percent rode a standard bike either weekly or daily prior to e-bike purchase. When asked how often they ride a standard bike now, 31 percent indicated weekly or daily. Interestingly, 6 percent of respondents didn't ride a standard bike as an adult before they purchased an e-bike and 89 percent of them now ride daily or weekly.

The majority of e-bike survey respondents (90%) indicated that they have access to a motor vehicle at home and 91 percent have a license for a motor vehicle. Seven percent of respondents reported having zero motor vehicles in their household and 72 percent reported that they had one or two motor vehicles. Nearly one-third (33%) of respondents reported that 61 percent or more of their trips were by e-bike. Household size was predominately one or two persons (65%), reflecting the majority of older adult respondents.

Motivations for Purchasing an E-bike

Respondents were asked about the main reasons they bought or converted an e-bike, with the ability to indicate multiple reasons. Nearly 65 percent of respondents stated that one of the main reasons they bought or converted an e-bike was to replace some car trips. Twenty-one percent of respondents indicated that one of the main reasons for converting to an e-bike was a medical condition reduced their ability to ride a standard bike and 52 percent of respondents indicated that one of the main reasons was to increase fitness. Nearly 60 percent of respondents indicated that one of the main reasons was because they live or work in a hilly area and 55 percent said that they wanted to ride with less effort. The reason with the least percentage of respondents was to keep up with friends/family, 11 percent of respondents chose this as one of the main reasons they bought or converted an e-bike.

When these responses are disaggregated by gender, age and physical ability some differences emerge. Results are shown in TABLE 2. Fifty-six percent of females chose "because you live or work in a hilly area" compared to 40 percent of males. Females also chose to be able to keep up with friends/family as one of the main reasons 23% compared to males at nine percent. Sixty-five percent of respondents that identified as having a physical limitation that prevents them from riding a standard bike indicated that one of the main reasons they bought an e-bike was "to ride with less effort" compared to 53% of those without a physical limitation. Notable differences exist between older (55+) and younger (under 55) adults. Sixty-one percent of older respondents indicated that one of the main reasons was to replace some car trips compared to 72% of those under 55. Similar differences can be observed in the other main reasons listed in TABLE 2.

One-hundred and seventeen respondents chose "other" as a main reason for buying or converting an e-bike. Twenty-eight percent of these responses listed fun as the reason, 23 percent indicated that they wanted to travel farther or faster by bike, 14 percent listed increased hauling capacity with hobby, saving money, driving not being an option and to keep up with traffic/safety comprising the other answers.

Electric Bike Use

The survey responses indicate that e-bikes may be increasing overall levels of bicycling. When asked how often they rode a standard bike before owning an e-bike, 55 percent of respondents indicated that they rode weekly or daily. When asked how often they ride their e-bike, 93 percent of respondents replied that they ride weekly or daily. Some of this difference may be attributed to response bias (the most enthusiastic owners are more likely to take the survey), though that may not account for the large difference (55% versus 93%).

E-bikes appear to be used primarily for utilitarian travel. Respondents were asked to pick the main reason that they used their electric bike. In aggregate, 45 percent of respondents chose commute to work/school as the main reason that they used their e-bike with local trips accounting for 24 percent, recreation at 20 percent and 11 percent chose other. The majority of respondents that chose other wanted an option for all of the above. When these responses were disaggregated by gender, physical ability and age, some differences emerged. Males were more likely to use their e-bikes for recreation compared to females with 20 percent of males choosing recreation as the main reason they use their e-bike versus 13 percent of females. Respondents with a physical limitation were less likely to use their e-bike to commute to work than those without a physical ability, 31 percent versus 51 percent respectively. Consequently, 28 percent of those with a physical limitation responded that they use their e-bike for recreation compared to 16 percent of respondents without a physical limitation. Thirty-one percent of respondents 55 and older use their e-bikes for recreation compared to nine percent of those under 55. Commute trips were much higher for respondents under 55 (58%) compared to those 55 and older (30%). This difference may be explained by the probability that fewer respondents 55 and older are in the workforce.

E-bikes do appear to be changing the way bicyclists ride. Forty-five percent of respondents indicated that they take a different route on their e-bike than they did on their standard bike. When segregated by gender, 51 percent of females responded that they take a different route compared to 44 percent of males. In an open-ended question, respondents that indicated that they take a different route listed the routes they take on their e-bike. Thirty-five percent of respondents indicated that they do not avoid hills on their e-bike as compared to a standard bike. Thirty-one percent of respondents indicated that they take a more direct or higher traffic route on their e-bike and interestingly, 30 percent indicated that they take a lower traffic or less direct route. The remaining responses listed avoiding off street or multi-use paths to limit confrontation with other users.

Some of the advantages of an e-bike include being able to travel further, accelerate more easily, travel faster, and ride up hills more easily. These advantages were evident among our respondents. Seventy-three percent of respondents indicated that they ride their e-bike to different destinations than they did on their standard bike. Again, there was a difference by gender with 79 percent of females indicating that they ride to different destinations compared to 71 percent of males. Respondents that ride to different destinations were asked what those destinations are in an open ended format. Nearly 34 percent indicated that they ride to places that are farther away. Another third listed errands or social events as a different destination that they ride to on their e-bike. Sixteen percent listed commute as a different destination, 10 percent indicated recreational trips and seven percent listed hillier destinations or origins.

When asked how often they stop and wait at all stop signs on their e-bike, 54 percent chose always. When asked the same question for riding their standard bike, 25 percent chose always but 10 percent chose not applicable presumably because they do not currently ride a standard bike. When asked a series of question on if their top speed and average speed was higher than when they rode a standard bike, the vast majority of respondents either agreed or strongly agreed. In the same set of questions participants were asked to agree or disagree with statements about not needing a shower at the end of their trip and if they were to make the same trip by a standard bike they would need a shower. Here again, respondents agreed or strongly agreed that they don't need a shower at the end of the trip (74%) and that they would need a shower if they had ridden a standard bike (67%).

When this data are disaggregated by gender, age and physical limitations some differences are more apparent as seen in TABLE 3. Seventy-one percent of respondents 55 and older agreed or strongly agreed that their top speed is higher on an e-bike than a standard bike compared to 65 percent of respondents under the age of 55. When asked to agree or disagree about their average speed being higher on an e-bike, 86 percent of males either agreed or strongly agreed compared to 77 percent of females. When asked to agree or disagree with the statement "I don't need to shower at the end of the trip", 80 percent of respondents under the age of 55 either agreed or strongly agreed compared to 68 percent of those 55 and older. This could be partly explained by how older adults use their e-bikes, a higher percentage of older adults use their e-bikes for recreation. When asked if they would need a shower to ride the same trip on a standard bike, 69 percent of males either agreed or strongly agreed compared to 55 percent of females.

Safety and Maintenance

Other research questions focused on the effect of e-bikes may have on safety and safety perceptions. When asked to agree or disagree with the statement, "I feel safer on the e-bike than on a standard bike", 60 percent of all respondents either agreed or strongly agreed. When asked if they ever had any crashes on the e-bike, 34 percent of respondents indicated that they had. Of the 34 percent that responded that they had experienced a crash, 10 percent stated that the e-bike contributed to the crash. Participants were asked to describe their crash in an open ended question, responses varied widely from problems with increased speed and weight, to rider error and conflicts with other road users. Alternatively, when asked if the e-bike helps them avoid crashes, 42 percent replied yes. When asked to describe how the e-bike helps them avoid crashes in an open ended question, responses included acceleration to get out of intersections more quickly, keeping up with car traffic, and better balance at higher speeds.

When asked to rank where they typically recharge their e-bike, 83 percent ranked home as the primary location. The workplace was ranked as the second most frequent recharge location at 52 percent. Destinations ranked as the third most frequent charging location with 37 percent of responses. Fifty-three percent of respondents indicated that the battery has run out when they were out riding. An open ended follow-up question asked what they did when the battery ran out. Ninety percent of respondents indicated that they pedaled when the battery ran out. Other answers included switching batteries, recharging somewhere, walking the bike home, calling for a ride or using transit. The respondents were asked where they get their bike serviced, 58 percent responded that they service it themselves and 31 percent had it serviced where they had purchased the bike. Another electric bike retailer (8%) and private service (3%) were less popular locations for service. When asked how often their e-bike needs to be serviced compared to a standard bike, 49 percent indicated that it was about the same and 27 replied more often than a standard bike.

User Perceptions

When respondents were asked if they ever had any reactions – positive or negative – from other road users, 36 percent of respondents indicated that they had positive reactions, followed closely by curiosity at 34 percent. Alternatively, 20 percent of respondents indicated that they had negative or angry reactions and 10 percent used the word cheating explicitly. The perceptions of existing users may be useful in developing marketing messages for non-users, some of whom who may have negative opinions of e-bikes. Participants provided the main advantages and disadvantages to riding an e-bike in an open ended question. Responses varied widely with no clear advantage dominating. Equal shares (18%) cited increased speed and range and to ride with less effort or help with hills. The third most frequent response included health advantages of riding an e-bike (16%). Cheaper transportation, fun and replacing car trips/ environmental reasons were cited by about equal shares of respondents (11-12%).

Weight was cited as the main disadvantage by 26 percent of respondents and perhaps surprisingly, cost and limited range each were mentioned by only eight percent of respondents. This could be due to the fact that participants taking the survey had already made the initial e-bike purchase. Fourteen percent of respondents cited inclement weather as the main disadvantage to riding an e-bike. It is unclear how many of these responses were specific to inclement weather negatively affecting the e-bike compared to those who did not want to be exposed to the elements themselves. Thirteen percent of respondents took the time to type that there are no disadvantages to riding an e-bike.

DISCUSSION OF RESULTS AND CONCLUSIONS

The objectives of this paper were to understand the factors that influence purchase decisions and use of e-bikes by existing users and to analyze participant responses and compare them to barriers to bicycling to determine if e-bikes can address these barriers and encourage more biking. The analysis presented here suggests that e-bikes are enabling users to bike more often and to increase the amount existing cyclists bike. Additionally, e-bikes allow people who would otherwise not be able to bike because of physical limitations or proximity to locations, the ability to overcome these challenges to bike with electric assist.

Results show e-bikes have the potential to get more people to bike. From previous research, some primary barriers to encourage new people to participate in biking include inconvenience, safety, and amount of effort to bike, including distance traveled and physical limitation (9). Results show demographics of e-bike users to include populations that tend to bike less – women, older adults, people with physical limitations, and people with longer distances to travel. Though only 15% of the respondents were women, this still represents a sizeable number since this is a new technology and many of earlier year e-bikes where owned by men and are conversions. The following comments from respondents illustrate these points:

> *I live in a hilly town and would never commute to work on a standard bike -- I wouldn't be able to make it up the hills. My electric assist bike makes commuting by bike possible.*
>
> *I am age 78, legally blind, live alone in a semi-rural area. 4 miles to the nearest scheduled bus route and town, 7 miles to my favorite shopping area, 12 miles to my church.*
>
> *I cannot drive due to epilepsy. I cannot bus due to severe motion sickness. Biking is my only way to work other than getting a ride. Bike commuting maintains my fitness level. I can ride even when I don't feel physically well or am overtired. I get to work faster than it takes when I get a car ride. I love the time outdoors, seeing the city and feeling like part of the bike community.*

On the goal of encouraging more people to bike more often and to bike to more distant locations, results show a positive relationship of having an e-bike and the increase in riding. Six percent of the respondents stated that they did not ride a bike as an adult until purchasing an e-bike and 89 percent of them now ride daily or weekly. Of the people owning a standard bike as an adult, 55 percent indicated that they rode their standard bike daily or weekly before purchasing an e-bike. That number rose to 93 percent after purchasing an e-bike. Respondents also indicated that they are biking farther distances less sweaty or tired than with a standard bicycle, they are not avoiding certain trips, destinations and hills and they enjoy the experience of bike riding.

One of the primary advantages stated was the ability of biking with less effort. This benefit plays out in different populations. For older adults and people with physical limitations, it means having an easier time biking and it is not as strenuous. For younger people, it means the ability to travel farther distances and not exerting too much effort to cause perspiration while riding. The following comments from respondents highlight these points:

> *I get more exercise with the e-bike because I ride more.*
>
> *E-bikes are a fantastic replacement for a car for short distances.*
>
> *I can ride to and from work without needing to shower at my destination.*
>
> *I use the e-bike primarily as a substitute for the car where I would have otherwise would have driven a car.*
>
> *I can carry my son and a week's worth of groceries.*

Assessing the net effects of these shifts – more biking but with less effort – on physical activity was not an objective of this research. However, the findings indicate that the net effect may be positive. About two-thirds of the users got their e-bike to replace car trips, and 30% have physical limitations that make riding a standard bike difficult. Our survey respondents also indicated that they are riding more often than they rode their standard bike (if they did at all). In addition, research indicates that even with the electric assist, e-bikes can enhance health. At least three separate studies testing adults in laboratory-type setting found that the even with the electric assist, an e-bike provided moderate to vigorous physical activity (22, 23, 24). These researchers concluded that the e-bikes could lead to health benefits because the reduced perception of effort could get people to bicycle more.

Overall this research offers insights about existing e-bike owners to help identify potential policy issues and areas for future research. To date, little research has been completed on how improvements in bicycling technology can encourage more trips to be made by bike and for more people to take bike trips. Any time a new technology is adopted, there are issues and challenges that arise in its use. Some of those issues explored in the survey where related to cost, battery life, safety and conflicts, and perceptions of other cyclists and motorists. All these topics should be explored in more detail, especially issues around safety and perceptions from others. In areas of the country, where e-bike usage is increasing there could be policy issues that influence the adoption of e-bikes, as seen in New York and Toronto. For example, there is concern on how e-bikes interact with standard bikes and pedestrians on shared facilities. Issues of speed, safety, and operator behavior should be explored. About 20 percent of the respondents noted negative feedback from other cyclists and motorists. Some negative feedback (10%) was related to perceptions that e-bike riders were seen as cheating. This perception may be a function of awareness and social acceptance as more people adopt the technology.

This study was the first known nationwide survey of e-bike users in North America but it still only reached an unknown fraction of the total North American e-bike owners. We acknowledge that these results are not based upon a random sample of e-bike owners and may not be necessarily representative of the population, but they are perhaps indicative of general decision factors and uses by individuals. Because of the low adoption rates in the U.S., a random sample survey is not economically feasible at this time. We received lower than expected representation from female riders. Because this is a crucial group to encourage to cycle more often, further research should look into women and e-bikes. Additionally, further research is needed to consider the implications of e-bikes on physical activity. Future studies could examine how, when, and to what extent users engage in power assistance in conjunction with pedaling. Finally, more insight is needed to understand how e-bikes might replace trips by standard bike, transit, or car.

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FIGURE 1 - Locations of Survey Respondents

TABLE 1 - Respondent Characteristics (*n = sample size*)

Gender		n=553
Male	85%	
Female	15%	
Age		n=451
18 to 24	1%	
25 to 34	10%	
35 to 44	18%	
45 to 54	26%	
55 to 64	32%	
65 and over	13%	
Ethnicity		n=428
White	90%	
Black or African American	0%	
Asian or Asian-American	5%	
American-Indian or Alaskan Native	0%	
Native Hawaiian or other Pacific Islander	0%	
Other	5%	
Education		n=448
High School	4%	
Some College	25%	
College Graduate	37%	
Graduate Degree	34%	
Health		n=449
Excellent	21%	
Very Good	37%	
Good	31%	
Fair	9%	
Poor	2%	
Do you have any physical limitations that make riding a standard bike difficult?		n=450
Yes	30%	
No	70%	

TABLE 2 – Motivations for Purchasing and Using an E-bike

	Male	Female	Respondents with physical limitation	Respondents without a physical limitation	Respondents Under 55	Respondents 55 and Older
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
What were the main reasons you bought an electric bike, or converted a standard bicycle?						
To replace some car trips	69%	61%	**56%**	**72%**	**72%**	**61%**
Health - medical condition reduced your ability to ride a standard bike	23%	20%	**59%**	**6%**	**13%**	**33%**
Health - to increase physical fitness	54%	57%	60%	52%	**49%**	**61%**
Because you live or work in a hilly area	**40%**	**56%**	41%	43%	41%	44%
To ride with less effort	57%	51%	**65%**	**53%**	**51%**	**63%**
To be able to keep up with friends/family when I go for rides	**9%**	**23%**	**20%**	**8%**	**9%**	**15%**
Sample size (n)	381	70	133	317	249	202
What is the main reason that you use your electric bike (purpose of trips)?						
Commute to work/school	45%	49%	**31%**	**51%**	**58%**	**30%**
Local trips (shopping and errands)	24%	27%	27%	23%	21%	29%
Recreation	20%	13%	**28%**	**16%**	**9%**	**31%**
Other	11%	12%	14%	10%	12%	10%
Sample size (n)	381	68	132	316	248	201

Note: **Bold** indicates a significance difference between values based a chi-square test, $p \leq 0.05$

TABLE 3 – Perceptions of Use

	Disagree or Strongly Disagree	Neither agree or disagree	Agree or Strongly Agree	Don't know	n
My top speed is higher than when I rode a standard bike					
All respondents	23%	9%	68%	0%	447
Male	23%	9%	68%	1%	372
Female	23%	9%	68%	0%	69
Under 55	25%	9%	65%	0%	244
55 and Older	20%	8%	71%	1%	197
Respondents with physical limitation	16%	11%	74%	0%	129
Respondents without physical limitation	26%	8%	65%	1%	311
My average speed is higher than when I rode a standard bike					
All respondents	10%	5%	84%	1%	447
Male	10%	4%	86%	1%	372
Female	12%	10%	77%	1%	69
Under 55	9%	5%	86%	0%	244
55 and Older	12%	5%	82%	1%	197
Respondents with physical limitation	8%	7%	85%	0%	128
Respondents without physical limitation	11%	4%	84%	1%	312
I don't need to shower at the end of the trip					
All respondents	10%	14%	74%	1%	450
Male	11%	14%	74%	1%	376
Female	6%	18%	77%	0%	68
Under 55	**8%**	**12%**	**80%**	**0%**	243
55 and Older	**13%**	**18%**	**68%**	**2%**	201
Respondents with physical limitation	11%	19%	69%	2%	131
Respondents without physical limitation	10%	12%	77%	1%	312
To ride the same trip by standard bike I would need a shower					
All respondents	12%	20%	67%	2%	436
Male	11%	19%	69%	2%	363
Female	19%	24%	55%	2%	67
Under 55	**17%**	**15%**	**67%**	**1%**	242
55 and Older	**6%**	**25%**	**66%**	**3%**	188
Respondents with physical limitation	8%	20%	70%	2%	124
Respondents without physical limitation	13%	19%	65%	2%	305
I feel safer on the e-bike than on a standard bike					
All respondents	15%	23%	60%	2%	447
Male	**16%**	**22%**	**61%**	**1%**	374
Female	**12%**	**28%**	**54%**	**6%**	67
Under 55	12%	25%	63%	1%	244
55 and Older	20%	21%	56%	2%	197
Respondents with physical limitation	15%	21%	61%	4%	130
Respondents without physical limitation	16%	24%	60%	1%	310

Note: **Bold** indicates a significance difference between values based a chi-square test, $p \leq 0.05$

CALIFORNIA ELECTRIC BICYCLE POLICY

VEHICLE TYPE	VEHICLE		USER				BIKEWAY ACCESS			
	PEDAL OPERATED	MAXIMUM MOTOR-ASSISTED SPEED (MPH)	MINIMUM AGE (YEARS)	DRIVER'S LICENSE	LICENSE PLATE	HELMET	CLASS I BIKE PATH	CLASS II BIKE LANE	CLASS III BIKE ROUTE	CLASS IV PROTECTED LANE
BICYCLE	YES	N/A	N/A	NO	NO	17 AND UNDER	YES	YES	YES	YES
TYPE 1 E-BIKE*	YES	20	N/A	NO	NO	17 AND UNDER	YES	YES	YES	YES
TYPE 2 E-BIKE*	NO	20	N/A	NO	NO	17 AND UNDER	YES	YES	YES	YES
TYPE 3 E-BIKE*	YES	28	16	NO	NO	YES	NO	YES	YES	YES
MOPED	NO	N/A	16	YES	YES	YES	NO	YES	YES	NO

*PENDING AB-1096

bpsa

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Assembly Bill No. 1096

CHAPTER 568

An act to amend Sections 406, 12804.9, 21113, 21207.5, and 24016 of, and to add Sections 312.5 and 21213 to, the Vehicle Code, relating to vehicles.

[Approved by Governor October 7, 2015. Filed with Secretary of State October 7, 2015.]

LEGISLATIVE COUNSEL'S DIGEST

AB 1096, Chiu. Vehicles: electric bicycles.

Existing law defines a "motorized bicycle" or a "moped" as a 2-wheeled or 3-wheeled device having fully operative pedals for propulsion by human power, or having no pedals if powered solely by electrical energy, and an automatic transmission and motor, as specified.

Existing law also defines a "motorized bicycle" as a device that has fully operative pedals for propulsion by human power and has an electric motor that meets specified requirements. Existing law requires a motorized bicycle, as described by this definition, to comply with specified equipment and manufacturing requirements. Existing law also imposes specified requirements relating to the operation of bicycles. A violation of the Vehicle Code is a crime.

This bill would delete the latter definition of a "motorized bicycle." The bill would define an "electric bicycle" as a bicycle with fully operable pedals and an electric motor of less than 750 watts, and would create 3 classes of electric bicycles, as specified. The bill would require manufacturers or distributors of electric bicycles to affix a label to each electric bicycle that describes its classification number, top assisted speed, and motor wattage. The bill would require every electric bicycle manufacturer to certify that it complies with specified equipment and manufacturing requirements. The bill would also require an electric bicycle to operate in a manner so that the electric motor disengages or stops functioning when brakes are applied, or in a manner so that the release or activation of a switch or other mechanism disengages or stops the electric motor from functioning.

The bill would require a person riding an electric bicycle to comply with the above-described requirements relating to the operation of bicycles. The bill would prohibit persons under 16 years of age from operating a class 3 electric bicycle. The bill would also require persons operating, or riding upon, a class 3 electric bicycle to wear a helmet, as specified. The bill would prohibit the operation of a class 3 electric bicycle on specified paths, lanes, or trails, unless that operation is authorized by a local ordinance. The bill would also authorize a local authority or governing body to prohibit, by ordinance, the operation of class 1 or class 2 electric bicycles on specified paths or trails. The bill would prohibit a person from tampering with or modifying an electric bicycle to change its speed capability, unless he or she appropriately replaces the classification label. The bill would specify that a person operating an electric bicycle is not subject to financial responsibility, driver's license, registration, or license plate requirements. The bill would also make conforming changes.

This bill would incorporate additional changes to Section 21113 of the Vehicle Code proposed by AB 604 that would become operative only if this bill and AB 604 are both chaptered, and this bill is chaptered last.

Because the bill would create new requirements regarding electric bicycles, the violation of which would be a crime, the bill would impose a state-mandated local program.

The California Constitution requires the state to reimburse local agencies and school districts for certain costs mandated by the state. Statutory provisions establish procedures for making that reimbursement.

This bill would provide that no reimbursement is required by this act for a specified reason.

The people of the State of California do enact as follows:

SECTION 1. Section 312.5 is added to the Vehicle Code, to read:

312.5. (a) An "electric bicycle" is a bicycle equipped with fully operable pedals and an electric motor of less than 750 watts.

(1) A "class 1 electric bicycle," or "low-speed pedal-assisted electric bicycle," is a bicycle equipped with a motor that provides assistance only when the rider is pedaling, and that ceases to provide assistance when the bicycle reaches the speed of 20 miles per hour.

(2) A "class 2 electric bicycle," or "low-speed throttle-assisted electric bicycle," is a bicycle equipped with a motor that may be used exclusively to propel the bicycle, and that is not capable of providing assistance when the bicycle reaches the speed of 20 miles per hour.

(3) A "class 3 electric bicycle," or "speed pedal-assisted electric bicycle," is a bicycle equipped with a motor that provides assistance only when the rider is pedaling, and that ceases to provide assistance when the bicycle reaches the speed of 28 miles per hour, and equipped with a speedometer.

(b) A person riding an electric bicycle, as defined in this section, is subject to Article 4 (commencing with Section 21200) of Chapter 1 of Division 11.

(c) On and after January 1, 2017, manufacturers and distributors of electric bicycles shall apply a label that is permanently affixed, in a prominent location, to each electric bicycle. The label shall contain the classification number, top assisted speed, and motor wattage of the electric bicycle, and shall be printed in Arial font in at least 9-point type.

SEC. 2. Section 406 of the Vehicle Code is amended to read:

406. (a) A "motorized bicycle" or "moped" is a two-wheeled or three-wheeled device having fully operative pedals for propulsion by human power, or having no pedals if powered solely by electrical energy, and an

automatic transmission and a motor that produces less than 4 gross brake horsepower and is capable of propelling the device at a maximum speed of not more than 30 miles per hour on level ground.

(b) Every manufacturer of a motorized bicycle or moped, as defined in this section, shall provide a disclosure to buyers that advises buyers that their existing insurance policies may not provide coverage for these bicycles and that they should contact their insurance company or insurance agent to determine if coverage is provided. The disclosure shall meet both of the following requirements:

(1) The disclosure shall be printed in not less than 14-point boldface type on a single sheet of paper that contains no information other than the disclosure.

(2) The disclosure shall include the following language in capital letters:

"YOUR INSURANCE POLICIES MAY NOT PROVIDE COVERAGE FOR ACCIDENTS INVOLVING THE USE OF THIS BICYCLE. TO DETERMINE IF COVERAGE IS PROVIDED YOU SHOULD CONTACT YOUR INSURANCE COMPANY OR AGENT."

SEC. 3. Section 12804.9 of the Vehicle Code is amended to read:

12804.9. (a) (1) The examination shall include all of the following:

(A) A test of the applicant's knowledge and understanding of the provisions of this code governing the operation of vehicles upon the highways.

(B) A test of the applicant's ability to read and understand simple English used in highway traffic and directional signs.

(C) A test of the applicant's understanding of traffic signs and signals, including the bikeway signs, markers, and traffic control devices established by the Department of Transportation.

(D) An actual demonstration of the applicant's ability to exercise ordinary and reasonable control in operating a motor vehicle by driving it under the supervision of an examining officer. The applicant shall submit to an examination appropriate to the type of motor vehicle or combination of vehicles he or she desires a license to drive, except that the department may waive the driving test part of the examination for any applicant who submits a license issued by another state, territory, or possession of the United States, the District of Columbia, or the Commonwealth of Puerto Rico if the department verifies through any acknowledged national driver record data source that there are no stops, holds, or other impediments to its issuance. The examining officer may request to see evidence of financial responsibility for the vehicle prior to supervising the demonstration of the applicant's ability to operate the vehicle. The examining officer may refuse to examine an applicant who is unable to provide proof of financial responsibility for the vehicle, unless proof of financial responsibility is not required by this code.

(E) A test of the hearing and eyesight of the applicant, and of other matters that may be necessary to determine the applicant's mental and physical fitness to operate a motor vehicle upon the highways, and whether any grounds exist for refusal of a license under this code.

(2) (A) Before a class A or class B driver's license, or class C driver's license with a commercial endorsement, may be issued or renewed, the applicant shall have in his or her driver record a valid report of a medical examination of the applicant given not more than two years prior to the date of the application by a health care professional. As used in this paragraph, "health care professional" means a person who is licensed, certified, or registered in accordance with applicable state laws and regulations to practice medicine and perform physical examinations in the United States. Health care professionals are doctors of medicine, doctors of osteopathy, physician assistants, and registered advanced practice nurses, or doctors of chiropractic who are clinically competent to perform the medical examination presently required of motor carrier drivers by the United States Department of Transportation. The report shall be on a form approved by the department. In establishing the requirements, consideration may be given to the standards presently required of motor carrier drivers by the Federal Motor Carrier Safety Administration.

(B) The department may accept a federal waiver of one or more physical qualification standards if the waiver is accompanied by a report of a nonqualifying medical examination for a class A or class B driver's license, or class C driver's license with a commercial endorsement, pursuant to Section 391.41(a)(3)(ii) of Subpart E of Part 391 of Title 49 of the Code of Federal Regulations.

(3) A physical defect of the applicant that, in the opinion of the department, is compensated for to ensure safe driving ability, shall not prevent the issuance of a license to the applicant.

(b) In accordance with the following classifications, an applicant for a driver's license shall be required to submit to an examination appropriate to the type of motor vehicle or combination of vehicles the applicant desires a license to drive:

(1) Class A includes the following:

(A) Except as provided in subparagraph (H) of paragraph (3), a combination of vehicles, if a vehicle being towed has a gross vehicle weight rating or gross vehicle weight of more than 10,000 pounds.

(B) A vehicle towing more than one vehicle.

(C) A trailer bus.

(D) The operation of all vehicles under class B and class C.

(2) Class B includes the following:

(A) Except as provided in subparagraph (H) of paragraph (3), a single vehicle with a gross vehicle weight rating or gross vehicle weight of more than 26,000 pounds.

(B) A single vehicle with three or more axles, except any three-axle vehicle weighing less than 6,000 pounds.

(C) A bus with a gross vehicle weight rating or gross vehicle weight of more than 26,000 pounds, except a trailer bus.

(D) A farm labor vehicle.

(E) A single vehicle with three or more axles or a gross vehicle weight rating or gross vehicle weight of more than 26,000 pounds towing another vehicle with a gross vehicle weight rating or gross vehicle weight of 10,000 pounds or less.

(F) A house car over 40 feet in length, excluding safety devices and safety bumpers.

(G) The operation of all vehicles covered under class C.

(3) Class C includes the following:

(A) A two-axle vehicle with a gross vehicle weight rating or gross vehicle weight of 26,000 pounds or less, including when the vehicle is towing a trailer or semitrailer with a gross vehicle weight rating or gross vehicle weight of 10,000 pounds or less.

(B) Notwithstanding subparagraph (A), a two-axle vehicle weighing 4,000 pounds or more unladen when towing a trailer coach not exceeding 9,000 pounds gross.

(C) A house car of 40 feet in length or less.

(D) A three-axle vehicle weighing 6,000 pounds gross or less.

(E) A house car of 40 feet in length or less or a vehicle towing another vehicle with a gross vehicle weight rating of 10,000 pounds or less, including when a tow dolly is used. A person driving a vehicle may not tow another vehicle in violation of Section 21715.

(F) (i) A two-axle vehicle weighing 4,000 pounds or more unladen when towing either a trailer coach or a fifth-wheel travel trailer not exceeding 10,000 pounds gross vehicle weight rating, when the towing of the trailer is not for compensation.

(ii) A two-axle vehicle weighing 4,000 pounds or more unladen when towing a fifth-wheel travel trailer exceeding 10,000 pounds, but not exceeding 15,000 pounds, gross vehicle weight rating, when the towing of the trailer is not for compensation, and if the person has passed a specialized written examination provided by the department relating to the knowledge of this code and other safety aspects governing the towing of recreational vehicles upon the highway.

The authority to operate combinations of vehicles under this subparagraph may be granted by endorsement on a class C license upon completion of that written examination.

(G) A vehicle or combination of vehicles with a gross combination weight rating or a gross vehicle weight rating, as those terms are defined in subdivisions (j) and (k), respectively, of Section 15210, of 26,000 pounds or less, if all of the following conditions are met:

(i) Is operated by a farmer, an employee of a farmer, or an instructor credentialed in agriculture as part of an instructional program in agriculture at the high school, community college, or university level.

(ii) Is used exclusively in the conduct of agricultural operations.

(iii) Is not used in the capacity of a for-hire carrier or for compensation.

(H) Firefighting equipment, provided that the equipment is operated by a person who holds a firefighter endorsement pursuant to Section 12804.11.

(I) A motorized scooter.

(J) A bus with a gross vehicle weight rating or gross vehicle weight of 26,000 pounds or less, except a trailer bus.

(K) Class C does not include a two-wheel motorcycle or a two-wheel motor-driven cycle.

(4) Class M1. A two-wheel motorcycle or a motor-driven cycle. Authority to operate a vehicle included in a class M1 license may be granted by endorsement on a class A, B, or C license upon completion of an appropriate examination.

(5) (A) Class M2 includes the following:

(i) A motorized bicycle or moped, or a bicycle with an attached motor, except an electric bicycle as described in subdivision (a) of Section 312.5.

(ii) A motorized scooter.

(B) Authority to operate vehicles included in class M2 may be granted by endorsement on a class A, B, or C license upon completion of an appropriate examination, except that no endorsement is required for a motorized scooter. Persons holding a class M1 license or endorsement may operate vehicles included in class M2 without further examination.

(c) A driver's license or driver certificate is not valid for operating a commercial motor vehicle, as defined in subdivision (b) of Section 15210, any other motor vehicle defined in paragraph (1) or (2) of subdivision (b), or any other vehicle requiring a driver to hold any driver certificate or any driver's license endorsement under Section 15275, unless a medical certificate approved by the department that has been issued within two years of the date of the operation of that vehicle and a copy of the medical examination report from which the certificate was issued is on file with the department. Otherwise, the license is valid only for operating class C vehicles that are not commercial vehicles, as defined in subdivision (b) of Section 15210, and for operating class M1 or M2 vehicles, if so endorsed, that are not commercial vehicles, as defined in subdivision (b) of Section 15210.

(d) A license or driver certificate issued prior to the enactment of Chapter 7 (commencing with Section 15200) is valid to operate the class or type of vehicles specified under the law in existence prior to that enactment until the license or certificate expires or is otherwise suspended, revoked, or canceled. Upon application for renewal or replacement of a driver's license, endorsement, or certificate required to operate a commercial motor vehicle, a valid medical certificate on a form approved by the department shall be submitted to the department.

(e) The department may accept a certificate of driving skill that is issued by an employer, authorized by the department to issue a certificate under Section 15250, of the applicant, in lieu of a driving test, on class A or B applications, if the applicant has first qualified for a class C license and has met the other examination requirements for the license for which he or she is applying. The certificate may be submitted as evidence of the applicant's skill in the operation of the types of equipment covered by the license for which he or she is applying.

(f) The department may accept a certificate of competence in lieu of a driving test on class M1 or M2 applications, when the certificate is issued by a law enforcement agency for its officers who operate class M1 or M2 vehicles in their duties, if the applicant has met the other examination requirements for the license for which he or she is applying.

(g) The department may accept a certificate of satisfactory completion of a novice motorcyclist training program approved by the commissioner pursuant to Section 2932 in lieu of a driving test on class M1 or M2 applications, if the applicant has met the other examination requirements for the license for which he or she is applying. The department shall review and approve the written and driving test used by a program to determine whether the program may issue a certificate of completion.

(h) Notwithstanding subdivision (b), a person holding a valid California driver's license of any class may operate a short-term rental motorized bicycle without taking any special examination for the operation of a motorized bicycle, and without having a class M2 endorsement on that license. As used in this subdivision, "short-term" means 48 hours or less.

(i) A person under the age of 21 years shall not be issued a class M1 or M2 license or endorsement unless he or she provides evidence satisfactory to the department of completion of a motorcycle safety training program that is operated pursuant to Article 2 (commencing with Section 2930) of Chapter 5 of Division 2.

(j) A driver of a vanpool vehicle may operate with a class C license but shall possess evidence of a medical examination required for a class B license when operating vanpool vehicles. In order to be eligible to drive the vanpool vehicle, the driver shall keep in the vanpool vehicle a statement, signed under penalty of perjury, that he or she has not been convicted of reckless driving, drunk driving, or a hit-and-run offense in the last five years.

SEC. 4. Section 21113 of the Vehicle Code is amended to read:

21113. (a) A person shall not drive a vehicle or animal, or stop, park, or leave standing a vehicle or animal, whether attended or unattended, upon the driveways, paths, parking facilities, or the grounds of any public school, state university, state college, unit of the state park system, county park, municipal airport, rapid transit district, transit development board, transit district, public transportation agency, county transportation commission created pursuant to Section 130050 of the Public Utilities Code, joint powers agency operating or managing a commuter rail system, or any property under the direct control of the legislative body of a municipality, or a state, county, or hospital district institution or building, or an educational institution exempted, in whole or in part, from taxation, or any harbor improvement district or harbor district formed pursuant to Part 2 (commencing with Section 5800) or Part 3 (commencing with Section 6000) of Division 8 of the Harbors and Navigation Code, a district organized pursuant to Part 3 (commencing with Section 27000) of Division 16 of the Streets and Highways Code, or state grounds served by the Department of the California Highway Patrol, or any property under the possession or control of a housing authority formed pursuant to Article 2 (commencing with Section 34240) of Chapter 1 of Part 2 of Division 24 of the Health and Safety Code, except with the permission of, and upon and subject to any condition or regulation that may be imposed by, the legislative body of the municipality, or the governing board or officer of the public school, state university, state college, county park, municipal airport, rapid transit district, transit development board, transit district, public transportation agency, county transportation commission, joint powers agency operating or managing a commuter rail system, or state, county, or hospital district institution or building, or educational institution, or harbor district, or a district organized pursuant to Part 3 (commencing with Section 27000) of Division 16 of the Streets and Highways Code, or housing authority, or the Director of Parks and Recreation regarding units of the state park system or the state agency with jurisdiction over the grounds served by the Department of the California Highway Patrol.

(b) A governing board, legislative body, or officer shall erect or place appropriate signs giving notice of any special conditions or regulations that are imposed under this section and the governing board, legislative body, or officer shall also prepare and keep available at the principal administrative office of the governing board, legislative body, or officer, for examination by all interested persons, a written statement of all those special conditions and regulations adopted pursuant to this section.

(c) When a governing board, legislative body, or officer permits public traffic upon the driveways, paths, parking facilities, or grounds under their control then, except for those conditions imposed or regulations enacted by the governing board, legislative body, or officer applicable to the traffic, all the provisions of this code relating to traffic upon the highways shall be applicable to the traffic upon the driveways, paths, parking facilities, or grounds.

(d) A public transportation agency that imposes any condition or regulation upon a person who parks or leaves standing a vehicle, pursuant to subdivision (a), is authorized to do either of the following:

(1) Enforce that condition or regulation in the manner provided in Article 3 (commencing with Section 40200) of Chapter 1 of Division 17 of this code. The public transportation agency shall be considered the issuing agency for that purpose.

(2) Designate regularly employed and salaried employees, who are engaged in directing traffic or enforcing parking laws and regulations, for the purpose of removing any vehicle in the same manner as a city, county, or jurisdiction of a state agency pursuant to Chapter 10 (commencing with Section 22650) of Division 11 of this code.

(e) With respect to the permitted use of vehicles or animals on property under the direct control of the legislative body of a municipality, no change in the use of vehicles or animals on the property, that had been permitted on January 1, 1976, shall be effective unless and until the legislative body, at a meeting open to the general public, determines that the use of vehicles or animals on the property should be prohibited or regulated.

(f) A transit development board may adopt ordinances, rules, or regulations to restrict, or specify the conditions for, the use of bicycles, motorized bicycles, electric bicycles, skateboards, and roller skates on property under the control of, or any portion of property used by, the board.

(g) A public agency, including, but not limited to, the Regents of the University of California and the Trustees of the California State University, may adopt rules or regulations to restrict, or specify the conditions for, the use of bicycles, motorized bicycles, electric bicycles, skateboards, and roller skates on public property under the jurisdiction of that agency.

(h) "Housing authority," for the purposes of this section, means a housing authority located within a county with a population of over 6,000,000 people, and any other housing authority that complies with the requirements of this section.

(i) "Public transportation agency," for purposes of this section, means a public agency that provides public transportation as defined in paragraph (1) of subdivision (f) of Section 1 of Article XIX A of the California Constitution.

SEC. 4.5. Section 21113 of the Vehicle Code is amended to read:

21113. (a) A person shall not drive a vehicle or animal, or stop, park, or leave standing a vehicle or animal, whether attended or unattended, upon the driveways, paths, parking facilities, or the grounds of any public school, state university, state college, unit of the state park system, county park, municipal airport, rapid transit district, transit development board, transit district, public transportation agency, county transportation commission created pursuant to Section 130050 of the Public Utilities Code, joint powers agency operating or managing a commuter rail system, or any property under the direct control of the legislative body of a municipality, or a state, county, or hospital district institution or building, or an educational institution exempted, in whole or in part, from taxation, or any harbor improvement district or harbor district formed pursuant to Part 2 (commencing with Section 5800) or Part 3 (commencing with Section 6000) of Division 8 of the Harbors and Navigation Code, a district organized pursuant to Part 3 (commencing with Section 27000) of Division 16 of the Streets and Highways Code, or state grounds served by the Department of the California Highway Patrol, or any property under the possession or control of a housing authority formed pursuant to Article 2 (commencing with Section 34240) of Chapter 1 of Part 2 of Division 24 of the Health and Safety Code, except with the permission of, and upon and subject to any condition or regulation that may be imposed by, the legislative body of the municipality, or the governing board or officer of the public school, state university, state college, county park, municipal airport, rapid transit district, transit development board, transit district, public transportation agency, county transportation commission, joint powers agency operating or managing a commuter rail system, or state, county, or hospital district institution or building, or educational institution, or harbor district, or a district organized pursuant to Part 3 (commencing with Section 27000) of Division 16 of the Streets and Highways Code, or housing authority, or the Director of Parks and Recreation regarding units of the state park system or the state agency with jurisdiction over the grounds served by the Department of the California Highway Patrol.

(b) A governing board, legislative body, or officer shall erect or place appropriate signs giving notice of any special conditions or regulations that are imposed under this section and the governing board, legislative body, or officer shall also prepare and keep available at the principal administrative office of the governing board, legislative body, or officer, for examination by all interested persons, a written statement of all those special conditions and regulations adopted pursuant to this section.

(c) When a governing board, legislative body, or officer permits public traffic upon the driveways, paths, parking facilities, or grounds under their control then, except for those conditions imposed or regulations enacted by the governing board, legislative body, or officer applicable to the traffic, all the provisions of this code relating to traffic upon the highways shall be applicable to the traffic upon the driveways, paths, parking facilities, or grounds.

(d) A public transportation agency that imposes any condition or regulation upon a person who parks or leaves standing a vehicle, pursuant to subdivision (a), is authorized to do either of the following:

(1) Enforce that condition or regulation in the manner provided in Article 3 (commencing with Section 40200) of Chapter 1 of Division 17 of this code. The public transportation agency shall be considered the issuing agency for that purpose.

(2) Designate regularly employed and salaried employees, who are engaged in directing traffic or enforcing parking laws and regulations, for the purpose of removing any vehicle in the same manner as a city, county, or jurisdiction of a state agency pursuant to Chapter 10 (commencing with Section 22650) of Division 11 of this code.

(e) With respect to the permitted use of vehicles or animals on property under the direct control of the legislative body of a municipality, no change in the use of vehicles or animals on the property, that had been permitted on January 1, 1976, shall be effective unless and until the legislative body, at a meeting open to the general public, determines that the use of vehicles or animals on the property should be prohibited or regulated.

(f) A transit development board may adopt ordinances, rules, or regulations to restrict, or specify the conditions for, the use of bicycles, motorized bicycles, electric bicycles, skateboards, electrically motorized boards, and roller skates on property under the control of, or any portion of property used by, the board.

(g) A public agency, including, but not limited to, the Regents of the University of California and the Trustees of the California State University, may adopt rules or regulations to restrict, or specify the conditions for, the use of bicycles, motorized bicycles, electric bicycles, skateboards, electrically motorized boards, and roller skates on public property under the jurisdiction of that agency.

(h) "Housing authority," for the purposes of this section, means a housing authority located within a county with a population of over 6,000,000 people, and any other housing authority that complies with the requirements of this section.

(i) "Public transportation agency," for purposes of this section, means a public agency that provides public transportation as defined in paragraph (1) of subdivision (f) of Section 1 of Article XIX A of the California Constitution.

SEC. 5. Section 21207.5 of the Vehicle Code is amended to read:

21207.5. (a) Notwithstanding Sections 21207 and 23127 of this code, or any other law, a motorized bicycle or class 3 electric bicycle shall not be operated on a bicycle path or trail, bikeway, bicycle lane established pursuant to Section 21207, equestrian trail, or hiking or recreational trail, unless it is within or adjacent to a roadway or unless the local authority or the governing body of a public agency having jurisdiction over the path or trail permits, by ordinance, that operation.

(b) The local authority or governing body of a public agency having jurisdiction over a bicycle path or trail, equestrian trail, or hiking or recreational trail, may prohibit, by ordinance, the operation of a class 1 or class 2 electric bicycle on that path or trail.

SEC. 6. Section 21213 is added to the Vehicle Code, to read:

21213. (a) A person under 16 years of age shall not operate a class 3 electric bicycle.

(b) A person shall not operate a class 3 electric bicycle, or ride upon a class 3 electric bicycle as a passenger, upon a street, bikeway, as defined in Section 890.4 of the Streets and Highways Code, or any other public bicycle path or trail, unless that person is wearing a properly fitted and fastened bicycle helmet that meets the standards of either the American Society for Testing and Materials (ASTM) or the United States Consumer Product Safety Commission (CPSC), or standards subsequently established by those entities. This helmet requirement also applies to a person who rides upon a class 3 electric bicycle while in a restraining seat that is attached to the bicycle or in a trailer towed by the bicycle.

SEC. 7. Section 24016 of the Vehicle Code is amended to read:

24016. (a) An electric bicycle described in subdivision (a) of Section 312.5 shall meet the following criteria:

(1) Comply with the equipment and manufacturing requirements for bicycles adopted by the United States Consumer Product Safety Commission (16 C.F.R. 1512.1, et seq.).

(2) Operate in a manner so that the electric motor is disengaged or ceases to function when the brakes are applied, or operate in a manner such that the motor is engaged through a switch or mechanism that, when released or activated, will cause the electric motor to disengage or cease to function.

(b) A person operating an electric bicycle is not subject to the provisions of this code relating to financial responsibility, driver's licenses, registration, and license plate requirements, and an electric bicycle is not a motor vehicle.

(c) Every manufacturer of an electric bicycle shall certify that it complies with the equipment and manufacturing requirements for bicycles adopted by the United States Consumer Product Safety Commission (16 C.F.R. 1512.1, et seq.).

(d) A person shall not tamper with or modify an electric bicycle described in subdivision (a) of Section 312.5 so as to change the speed capability of the bicycle, unless he or she appropriately replaces the label indicating the classification required in subdivision (c) of Section 312.5.

SEC. 8. Section 4.5 of this bill incorporates amendments to Section 21113 of the Vehicle Code proposed by both this bill and Assembly Bill 604. It shall only become operative if (1) both bills are enacted and become effective on or before January 1, 2016, (2) each bill amends Section 21113 of the Vehicle Code, and (3) this bill is enacted after Assembly Bill 604, in which case Section 4 of this bill shall not become operative.

SEC. 9. No reimbursement is required by this act pursuant to Section 6 of Article XIII B of the California Constitution because the only costs that may be incurred by a local agency or school district will be incurred because this act creates a new crime or infraction, eliminates a crime or infraction, or changes the penalty for a crime or infraction, within the meaning of Section 17556 of the Government Code, or changes the definition of a crime within the meaning of Section 6 of Article XIII B of the California Constitution.

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Electric Bikes and Transportation Policy

Insights from Early Adopters

Jennifer Dill and Geoffrey Rose

Electric bikes (e-bikes) are increasingly common in China but are relatively rare in the United States. The findings from interviews with 28 e-bike owners in the Portland, Oregon, region provide insight into the potential market for and use of e-bikes in the United States. The interviews revealed several possible demographic markets for e-bikes that could expand the bicycling population: women, older adults, and people with physical limitations. Owners of e-bikes noted their ability to travel longer distances and over hills with relative ease and to arrive at a destination, such as work, less sweaty and less tired than a regular bicycle would allow. These features may overcome some of the common barriers to bicycling for all demographics. Most of the interviewed e-bike owners used their e-bikes to substitute for travel by either human-powered bicycles or traditional motor vehicles. Therefore, the e-bike can address concerns about health problems related to inactivity, pollution, and other public policy problems to which private vehicles contribute. Further research is needed to determine whether specific policies are needed to increase adoption of e-bikes. The potential for conflict between riders of e-bikes and of regular bikes because of speed differentials is a concern. Whether speed differentials will pose a significant problem will depend not only on the extent of adoption of e-bikes but the characteristics of the riders.

The bicycle has a valuable role to play in addressing such urban challenges as traffic congestion, injury and loss of life from road crashes, local air quality, climate change, obesity and physical inactivity, energy availability, and security. Many factors affect the extent to which bicycling can be a viable urban transportation mode, although research consistently highlights adequate infrastructure and supportive policies (*1–4*). The performance of the bicycle, in contrast to most other modes, is dependent on the physical ability of the rider and the rider's willingness to provide all the energy needed to reach a destination. Because of this, bicycle trips tend to be shorter than motor vehicle trips and cyclists tend to avoid hilly locations (*5*). Power assistance could expand the role of the bicycle in urban transport by addressing the limits of trip distance and terrain. In addition, power assistance could allow people with physical limitations, including older adults, to bicycle more (*6–8*).

Power-assisted bicycles are not new. At the beginning of the 20th century, the Singer Company in Britain began manufacturing motorized back wheels, powered by a small two-stroke engine, that could be fitted onto existing heavy-duty bicycle frames (*9*). Because of improvements in battery technology, which was commercialized in the 1990s (*10*), electric models now dominate the motorized bicycle market. Although electric bicycles, or e-bikes, are growing in popularity, they have received little attention from transportation researchers and policy makers. A recent review of e-bikes in the context of urban transportation highlighted that little research deals with demand, supply, and operational issues, particularly in western countries (*11*). E-bikes have received the most attention in China, where there is an estimated 120 million such bikes (*12, 13*). Two types of electric two-wheeled vehicles are available in China: bicycle style, for which pedaling is supplemented by battery power, and scooter style, for which electricity supplies nearly all the power. The latter often come with pedals to satisfy the legal definition that differentiates bicycles from motorcycles (*14*). Combined, these vehicles make up from less than 10% to more than 60% of two-wheel vehicle traffic in some Chinese cities (*13*).

The reasons for rapid adoption of e-bikes in China are numerous, including improvements in technology, rising incomes and falling prices, national standards and policies, and changing travel patterns (*14*), as well as bans or limits on gasoline-powered motorcycles in some cities (*12, 14*). National law in China classifies e-bikes as nonmotorized vehicles, giving owners the right to ride them in bike lanes and without a driver's license or helmet (*14*). Surveys in Shanghai and Kunming, China, found that e-bike riders are more educated and earn higher incomes than bicycle riders, but few lived in households with cars or motorcycles. For most riders the e-bike substitutes for taking the bus. Trips taken on e-bikes were longer than those made on bicycles. The primary motivation for choosing an e-bike was speed, and more than 70% of e-bike riders cited that factor; fewer than 30% of respondents cited reduced level of effort, lower cost than cars, and crowded public transit as motivations (*15*). Researchers in Kunming found that e-bikes averaged nearly 22 km/h, which is about 7 km/h faster than bicycles (*16*).

These findings from China, although enlightening, are not entirely transferable to the North American context. Some motivations for adoption, such as bans on motorcycles, are not on the near horizon, although speed and travel time are clear motivations in choice of travel mode nearly everywhere. China is not alone in its adoption of e-bikes. E-bikes are a growing share of the new bicycle market in the Netherlands (*6*), a country well known for supportive bicycle policies and infrastructure and whose model many U.S. cities are following. There is little research about e-bikes in North America and Europe. A qualitative examination of blogs that discuss e-bikes (*17*) identified topics for future research and found that e-bikes

- Are used for utilitarian travel, including commuting to work and shopping;
- Have replaced car trips on journeys of up to 24 km (15 mi);

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- Help to overcome constraints imposed by geography, such as long distances and hilly areas; and
- Could suit older riders or individuals who have a medical condition such as arthritis that makes riding a bicycle difficult.

However, not all comments were positive. Nonusers expressed concerns or negative opinions, such as the following:

- E-bikes are not "real" bikes.
- Costs and battery technology (specifically the battery's weight and its storage capacity, which limits the range for power assistance) may affect widespread adoption.
- Mixing of e-bikes and bicycles in bike lanes or paths is a concern because of differences in speed.
- Use of electricity to power bicycles raises questions about environmental impacts.

Technology diffusion is often characterized as following a somewhat predictable transition as the market grows from innovators, to early adopters, to the early majority, to the late majority, and finally to the laggards (*18*). Moore conceptualized that a chasm exists in the early-adopter market that can be difficult for some products to cross (*19*). Current North American users of e-bike can be considered early adopters because U.S. consumers can purchase e-bikes through a range of specialist bicycle stores and e-bike retail outlets (*11*).

An understanding of early adopters may help to identify issues of relevance to transportation planners, modelers, and policy makers. For example, a greater understanding is needed of the role that e-bikes could play in household mobility decisions, particularly their potential for substituting for bike, transit, or auto trips. E-bikes could moderate growth in the demand for motor scooters and motorcycles, which is a concern in many jurisdictions where strong growth in motorcycle and motorbike registrations is translating into more and more-severe crashes (*20, 21*). The growth of e-bikes in China has raised safety concerns (*22*), because lack of enforcement means that many vehicles in regular use in China are capable of much higher speeds than specified in regulations (*13*). Because of similar fears, some North American cities are considering limits on where e-bikes may operate (*6*).

There is considerable uncertainty about the potential of e-bike technology in the context of urban transportation. Will they cross Moore's chasm, remain a novelty, or carve out a niche market? Garrison and Levinson argued that technologies may rise to prominence where they fill a "transport gap" (*23,* p. 8), noting that the Segway personal transporter is marketed as filling a gap in the too-far-to-walk-and-too-close-to-drive market. Perhaps this is where the e-bike will find a niche, although there is no evidence that the Segway has crossed the chasm to win a larger share of the urban mobility market. Shaheen et al. suggested that e-bikes could be a feature of the next generation of city bike-sharing schemes (*24*). The launch of the first fully automated e-bike sharing system on a university campus in the United States will provide lessons in that context (*25*).

METHODS

Because e-bikes are still in the early adoption stage in the United States, their limited penetration into the urban transportation system presents a challenge to traditional quantitative research methods. There is growing recognition that qualitative research techniques can play an important role in transportation research in general and travel behavior research in particular (*26*). Qualitative research techniques, for example, have provided insight into understanding the factors motivating early adoption of hybrid motor vehicles in the United States (*27*). Qualitative techniques can be particularly insightful when little is known about a topic and can form the basis of future quantitative work. The analysis of discussions about e-bikes on popular blogs helped identify issues to explore further through in-depth interviews of e-bike owners (*17*).

To further the understanding of the potential market for and use of e-bikes in the United States, this paper presents findings from interviews with e-bike owners in the Portland, Oregon, region. The Oregon state code classifies electric assisted bikes as bicycles as long as they have fully operative pedals for human propulsion, have an electric motor with a power output no greater than 1,000 W, and are capable of operating at a speed no greater than 20 mph on level ground (*28*). Owners do not need to register or insure the vehicle (*28*). Riders must be 16 or older and be eligible for driving privileges (*28*). A person whose driving privileges have been suspended or revoked could be cited for operating any motorized vehicle on public roads (*28*). Because e-bikes are classified as bicycles, they may be ridden in travel lanes as well as in bike lanes or on paths. However, Oregon Statute Section 814.410 specifies that it is an offense to operate an electric assisted bicycle on a sidewalk.

A total of 28 people were interviewed. They were solicited through three primary methods: referrals by personnel of e-bike stores ($n = 3$), personal contacts ($n = 4$), and an invitation to participate in the study posted on a popular website, Bikeportland.org ($n = 21$). A structured interview script was used that covered information about the owner (demographics, housing characteristics, travel patterns, use of green energy), motivations for purchasing an e-bike, the purchase process (e.g., what options were considered), use of the e-bike, e-bike features, and policy issues. Each interview was conducted in person with one or two interviewers and lasted approximately 45 min. The interviews were taped and transcribed for analysis. The study was reviewed and approved by Portland State University's Human Subjects Research Review Committee. Because the subjects were not a random sample, findings from the interviews may not accurately represent the population of e-bike owners. All subjects lived in the Portland region; the sample was chosen for some gender balance and to focus on purchasers of bikes already equipped with electric assist units or installed by e-bike stores, rather than do-it-yourself owners. The latter may be considered innovators rather than early adopters.

RESULTS

Who Are E-Bike Owners?

The e-bike owners interviewed ranged in age from 24 to 64; the median age was 48. Twelve were women. The owners appeared to be concerned about the environment—about two-thirds purchased green or renewable energy from their electric utility for their homes. The owners lived in a range of terrains, five living in neighborhoods with steep hills. All but five of the owners indicated that there was at least one other motor vehicle (car, truck, SUV, etc.) in their household. Levels of bicycle ownership were high; 12 of the interviewees owned at least two other bicycles (non e-bikes), and all had at least one other bicycle (non e-bike) in their household.

Which E-Bikes Were Purchased and Why?

Only 10 of the e-bike owners converted an existing bike to an e-bike; the majority purchased e-bikes. Twelve of the e-bikes had a throttle, and most of these were conversions. Most bikes had detachable batteries, and of those owners who worked outside the home, more than half charged their batteries at work (as well as home). More than half the e-bike owners had little experience riding e-bikes, such as a single test ride, before their purchase. Knowledge of e-bikes varied before purchase with about one-quarter of interviewees having no or very little knowledge and one-third having extensive knowledge.

The top motivation for purchasing an e-bike was the capabilities it provided beyond a conventional bicycle ($n = 20$). This was consistent with the next most popular motivation—an alternative to a car ($n = 15$). Environmental concerns were mentioned by just under one-third of the owners. A handful of the owners had limited ability to ride a conventional bike, either because of age or because of health factors. One long-time bicyclist said, "I probably wouldn't have given these things a moment's thought 10 or 15 years ago." Another owner who had suffered serious injuries in a bike crash found that the e-bike was the only option for continuing to ride, given lasting health issues that also limited her ability to drive or use transit comfortably. She said, "I've been on my bike every day since I got it. I've been able to bike every day. . . . I felt like it, it kind of changed my life back. . . . I got back something I'd lost."

Several owners noted the potential for e-bikes to increase cycling among some populations:

- "I think for women especially there are benefits since there are less women on bikes than there are men."
- "I feel like the electric bike has the potential to reach people that wouldn't normally ride and to make cycling more attractive."
- "I think there's growing acceptance to augmented bicycle riding. I mean in particular people of my age that, you know, can't ride like they used to."

How Were E-Bikes Used?

The e-bikes were primarily used for utilitarian travel. Of the owners who worked outside the home, nearly all used their e-bike for commuting at least part of the time. About two-thirds rode their e-bikes for errands or shopping.

E-bikes appear to change owners' bicycling behavior and substitute for driving a motor vehicle to some extent. Most of the owners (23 of 28) indicated that they had increased their overall amount of cycling since purchasing their e-bikes. The increase in cycling was usually for commuting or other utilitarian purposes with only six owners saying that they increased their recreational cycling. In some cases, owning an e-bike was a reason to change from driving a car to bicycling to work. One owner said, "I was able to turn the worst part of the day, which is getting in the car and driving to work, into the best part of the day by bicycle commuting." Another was able to get rid of a car after the e-bike purchase. One owner had been an avid recreational cyclist before her e-bike purchase but lived in a very hilly area, which kept her from cycling from her home to any destination (or for recreation); the e-bike allowed her to commute by bike. A few owners said they ride their e-bikes in the rain more than they would a regular bicycle: "I'm more apt to ride in the rain. . . . Because I feel like it's safer. It's not as messy. Because I can go a little faster, I'm just not absorbing quite as many raindrops."

About half indicated that they ride to different destinations, and a similar share take different routes with the e-bike. In some cases, the e-bike allowed them to take more direct routes with more hills, compared with a regular bicycle, or to take a route with higher-speed traffic, where the e-bike helped them keep up and feel more confident.

What Are Positive and Negative Aspects of E-Bikes?

Positive Owner Experiences, Some Reservations

Owners noted several positive aspects of their e-bikes. The following characteristics were volunteered by a majority of the owners:

- Riders arrive at their destinations less sweaty or more energized: "I decided to use the electric bike because I didn't want to feel tired the rest of the day."
- Climbing hills is easier: "The e-bike just really helps flatten out the hills between my house and work."
- E-bikes can accelerate up to the speed of cars or go faster than conventional bikes: "I find I can actually ride the bike faster than the bus."
- E-bikes allow riders to carry more or heavier items.

Some owners tried to promote e-bike use by letting others test ride their e-bike:

- "Everyone that I've let try the bike has thought it was really fun. I don't know that I've ever actually sold anyone on getting their own."
- "I love letting people ride my e-bike, because whatever negative feeling they have about e-bikes is gone once they get on it."

Four of the owners said that allowing others to ride their e-bike lead to an e-bike purchase.

About half the owners said that the additional weight of an e-bike is a problem, making the bike difficult to lift generally, difficult to fit on a car rack, or difficult to lift or fit onto the bike racks on transit vehicles. Eight of the owners were concerned about an increased risk of theft. Five noted increased difficulty in fixing a flat tire or making other minor repairs. Several noted a need for a longer battery range.

Speed Benefits and Safety Implications

E-bike riders regarded increased speed as a positive factor for a variety of reasons. For example, one owner said that the e-bike made riding with her male partner a more positive experience: "What I love about it is he's a stronger biker than me, and it used to be with regular bikes that he'd periodically have to wait for me. . . . Now, you know, I let him get a little bit ahead, and then I just flip on the e-bike, and then I catch up with him." Another woman said, "As a woman, it just seems like that was the extra little oomph of power that put me at an advantage, or put me in line with some of the other zippier cyclists." One-third of the owners said that the e-bike allowed them to travel more like they travel with a motor vehicle ("vehicular cyclist").

In addition, about one-quarter of the owners said that the additional weight or size of the e-bike, compared with a conventional bike, made them feel safer or more stable. Only three of the owners were worried about going too fast, and only two of the owners said that they wanted more power.

Several owners raised concerns related to public policy and e-bikes. One owner feared that potential conflict caused by differences in speeds could lead to government bans on use of e-bikes in bike lanes, so she tried to "tone it down" while riding. The fear of more regulation came up in a few interviews. One owner said, "When e-bikes become mainstream, there will be lots of laws controlling them," and another advocated for regulations that would prevent e-bikes from "getting to be too much like motorcycles."

Physical Activity Implications

Despite the electric assistance, several owners said that the e-bike provided a satisfactory level of physical activity:

- "It doesn't do it for you. You still have to work."
- "I personally feel that even riding an e-bike is healthier than not riding a bike at all. People with e-bikes are obviously people that are not in cars."
- "I lost about 12 pounds, I think, during the summer when I was riding. You get the physical fitness benefit from it."

However, one owner with a throttle-style e-bike said he switched back to a regular bike when he felt out of shape.

Legitimacy

There is some conflict in opinions about the legitimacy of e-bikes and their value relative to human-powered bikes, particularly from other bicyclists. For example, in response to the request for interview subjects on a local website, one reader said, "E-bikes are for overweight and lazy people." Of the interviewees who mentioned reactions from peers about their e-bikes, a slight majority noted positive feedback, whereas the others said that their peers expressed negative feelings toward e-bikes. One owner said, "I do hear a lot of snarky comments about it, like, oh that's cheating," and another said that cyclists he passed on a street with a bike lane "got bent out of shape." Another noted more negative reactions from other cyclists than from car drivers. Some of the owners themselves were conflicted or self-conscious:

- "Now, I do worry a little bit about people relying on them a little bit too much instead of pedaling, but I think it's a lesser evil than cars."
- "I feel like I'm cheating when I'm on the road with other bikers; I feel very self-conscious."
- "I haven't told a whole lot of people, because I think they're gonna go, Oh my gosh, she got old, she got an electric bike."
- "You know, I guess there is a little bit of feeling apologetic about it since you're out biking and everyone else is working hard and you're having an easy time."

CONCLUSIONS AND RESEARCH NEEDS

In the United States, e-bike owners should be considered early adopters. In Rogers' theory of diffusion, an innovation might transition from the stage of early adopters to an early majority (*18*). Whether e-bikes will follow that pattern is open to debate. The research presented in this paper offers insights about early adopters to help identify potential policy issues and areas for future research.

The interviews revealed several possible demographic markets for e-bikes that could expand the population that uses bicycles for transportation: women, older adults, and people with physical limitations. Most of the interviewed owners used their e-bikes to substitute for travel by either human-powered bicycles or traditional motor vehicles (cars, pickup trucks, etc.). The e-bikes were not viewed as an alternative to or substitute for motorcycles or scooters. When the e-bike substituted for a regular bike, the owner often had experienced some change (e.g., aging, injury, or change in travel distances) that would have reduced their bicycle travel if not for the e-bike.

E-bike features may overcome some of the common barriers to bicycling for all types of riders. Owners noted the ability to travel with relative ease for longer distances and over hills and to arrive at a destination, such as work, less sweaty or tired than with a regular bicycle. Although none of the owners specifically noted so, an e-bike could allow parents to transport small children who cannot yet ride a bike.

Even with the electric assist, e-bike riders get some physical activity while riding. Therefore, the e-bike can address concerns about how the reliance on private motor vehicles contributes to health problems through inactivity. However, further research is needed to consider the implications of e-bikes for physical activity. Future studies could examine how, when, and to what extent power assistance provided by the e-bike is used in conjunction with pedaling. More insight is needed into the extent to which e-bikes replace trips by conventional bike, transit, or car, because these modes have different implications for changes in physical activity levels associated with choice of an e-bike.

Whether specific policies are needed to increase adoption of e-bikes is unclear. Just as electric cars are more expensive than gasoline-powered cars, e-bikes are generally more expensive than regular bikes. Whereas e-bike conversion kits start at around $500, purpose-built e-bikes range from about $1,500 for a base model to more than $5,000 for a premium brand fitted with extended-range batteries. Purchases of electric cars are promoted through federal and state tax incentives and feebate schemes (*29*), and some of the interviewed e-bike owners suggested something similar for e-bikes. This research could not address whether a subsidy would increase adoption or the magnitude of a resulting sales increase, because the people interviewed had made their purchases without subsidies. Further focus group or survey research of potential owners could answer that question.

Other policy responses could perhaps promote e-bike adoption. Range anxiety has long been considered a factor that negatively affects consumer interest in electric vehicles. However, there is evidence that such anxiety affects participants in field trials of electric vehicles substantially less, because their experience using the vehicles results in improved understanding of vehicle capabilities, appropriate driving techniques, and journey planning (*30*). Public charging or battery swap stations could help overcome range limitations of e-bike, although the interviews did not reveal a clear need for these. Battery swapping has been deployed in Switzerland to support bicycle touring by e-bike (*31*). Many e-bike owners charged their bike batteries at work without problem. The ability to take their bikes on transit, as in Portland, also eased fears of dead batteries among some of the owners interviewed. However, other e-bike owners noted that bike racks on transit vehicles did not accommodate the weight or design (longer wheelbase) of their e-bikes. Design changes could address this problem. Therefore, the issues of range limitations and range anxiety that drive the need to install public charging stations and battery swap facilities for electric cars (*32*) may not be analogous to e-bikes. However, these interview participants were early adopters who may be more willing to take risks by trying a new technology. Accessible charging stations for e-bikes could appeal to later adopters. Further research could address this question. Rather than adopting policies or facilities specific to e-bikes, several e-bike owners suggested policies that would promote all bicycle use, including bike infrastructure and disincentives for car use (e.g., higher gasoline taxes).

The potential for conflict between e-bike riders and riders of regular bike should be a concern for planners and policy makers. About half the interviewed e-bike owners noted negative feedback from other cyclists, sometimes because of the speed differential. However, some negative feedback was related to perceptions of level of effort, that is, e-bike riders were seen as not working as hard, as cheating. The latter perceptions may be addressed only as the technology is more widely adopted and social networks increase awareness and acceptance. From a sociological perspective, e-bikes can be considered in the context of a city's underlying cycling culture because of increased awareness of the e-bike's role in promoting and sustaining increased levels of cycling (*33, 34*). Many current e-bike owners have acted as goodwill ambassadors for e-bikes, letting people test ride their bikes and answering questions.

However, managing speed differentials may require other approaches. Oregon's (and other states') vehicle code limits the performance speed of e-bikes, which can help reduce the differential. Wider bike lanes would allow faster cyclists to pass slower cyclists. Speed limits on bicycle facilities are another option. The extent of the potential problem is unclear, and the need for or type of policy intervention requires more research. Several of the e-bike owners interviewed, particularly women, noted that the e-bike allowed them to travel at speeds comparable to, not necessarily faster than, other cyclists. Others noted that they avoided riding too fast out of courtesy or fear of conflict. As with any mode of transportation, some road users will operate in a manner that annoys other users and poses potential safety risks. The appropriate policy response may need to target the particular behavior, regardless of mode of technology. Moreover, whether the speed differential will be a significant problem in the future will depend on not only the extent of adoption of e-bikes but also the characteristics of the riders. E-bikes may appeal more to riders who do not necessarily want to go significantly faster than other cyclists. More extensive quantitative research could be used to further assess this issue.

This study focused on e-bike users in one U.S. city; it would be useful to consider geographically diverse locations in such research. As the number of e-bike users grows, a broader range of quantitative data will be needed. Future research could include measuring travel behavior before and after the purchase of an e-bike to gain understanding of the impact on the use of other modes and on physical activity levels. It would be possible to monitor An e-bike rider's travel activity could be monitored with the Global Positioning System so their speed profiles and use of bicycle facilities (off-road paths versus bicycle lanes versus travel lanes) could be studied. Also valuable would be information about e-bike user experiences when sharing facilities with conventional bicycles and pedestrians, including details of interactions and cases of near misses and collisions.

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The Bicycle Transportation Committee peer-reviewed this paper.

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REPORT

Regulations of E-Bikes in North America

NITC-RR-564

August 2014

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REGULATIONS OF E-BIKES IN NORTH AMERICA
A POLICY REVIEW

Report

NITC-RR-564

by

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16. Abstract

Throughout the world, the electric bicycle (e-bike) industry is growing very quickly. The North American market has been somewhat slow to adopt this technology, which is still considered to be in the "early adopter" phase (Rose & Dill, 2011; Rose, 2011), but in recent years, this has begun to change. But as e-bike numbers increase, so too will potential conflicts (actual or perceived) with other vehicles and non-motorized devices, bicycles and pedestrians, causing policy questions to arise. Indeed, conflicting user groups are petitioning state legislatures and local governments for permission to operate legally on roadways and paths or to ban these devices.

Although some states, such as Oregon, Minnesota, and Pennsylvania, have created specific e-bike legislation, other states' legislation surrounding e-bikes is best described as nebulous. The confusion stems from the wide variety of devices and technologies on the market; perceived overlap of legal entities' jurisdiction over the device, which under certain circumstances can be either a consumer product or a motor vehicle; outdated laws and regulations; and inconsistency of terms. The purpose of this paper is to outline the different classifications of e-bikes—what they are and what they are not—and to help shed light on aspects of federal and state legislation of e-bikes. In addition, this paper explores the potential conflicts these regulations may cause for the adoption of this technology.

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ERRATA

A correction was made to the first paragraph, second sentence on page 41. The sentence now reflects that e-bike speeds are slightly higher than standard bicycles. Maps were updated to reflect recent revisions in addition to correcting errors: Maryland introduced a law defining an *electric bicycle*, changing most maps; an error was corrected in Wisconsin—a driver's license is required (Figures 13 and 19); Hawaii was corrected to show both a driver's license and vehicle registration is required (Figure 19); Pennsylvania was corrected showing that *pedalcycles with electric assist* are not considered motor vehicles (Figure 18). Several numbers in the section *Analysis of E-Bike Laws* were updated based on the above changes (pages 17-21).

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REGULATIONS OF E-BIKES IN NORTH AMERICA: A POLICY REVIEW

John MacArthur[1] and Nicholas Kobel[2]
OTREC at Portland State University

Throughout the world, the electric bicycle (e-bike) industry is growing very quickly. China's e-bike market has grown to an estimated 150 million units, and sales in European countries continue to rise (Hurst & Gartner, 2013). As reported by Bike Europe, e-bikes now account for 11 percent of market share in Germany, with more than 400,000 units sold in 2013 (Beckendorff, 2014). The North American market has been somewhat slow to adopt this technology, which is still considered to be in the "early adopter" phase (Rose & Dill, 2011; Rose, 2011), but in recent years, this has begun to change. Many sales estimates and projections show steady increases, with 2013 estimates ranging from 75,000 units (Hurst & Gartner, 2013) to 159,000 units (Jamerson & Benjamin, 2013) sold in the U.S. This makes it increasingly difficult to deem this technology a novelty. And for good reason: E-bikes may play a key role in addressing cities' transportation and public health issues by getting more people out of cars and onto bicycles–to get more people biking and biking more often. But as e-bike numbers increase, so too will potential conflicts (actual or perceived) with other vehicles and non-motorized devices, bicycles and pedestrians, causing policy questions to arise. Indeed, conflicting user groups are petitioning state legislatures and local governments for permission to operate legally on roadways and paths or to ban these devices.

Although some states, such as Oregon, Minnesota, and Pennsylvania, have created specific e-bike legislation, other states' legislation surrounding e-bikes is best described as nebulous. The confusion stems from the wide variety of devices and technologies on the market; perceived overlap of legal entities' jurisdiction over the device, which under certain circumstances can be either a consumer product or a motor vehicle; outdated laws and regulations; and inconsistency of terms. Unlike the European Union, the U.S. does not have one standard governing e-bikes. The E.U. directive—EN15194 standard—both defines a "pedelec" e-bike and legally classifies it as a bicycle. At the U.S. federal level, the Consumer Product Safety Commission (CPSC) and the National Highway Transportation Safety Administration (NHTSA) are charged with the safety and manufacturing regulations of such devices. They have agreed on a term, *low-speed electric bicycle*, that we commonly call an *e-bike*. The federal definition does not necessarily translate to states and cities,

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which have vastly differing and vague state laws and municipal codes, some of which have prohibited the use of some types of e-bikes on all public ways, like in New York City. Even colloquial conceptions of e-bikes are not standardized, ranging from a scooter-like vehicle (*scooter-style electric bike* (SSEB)) to a standard bicycle with a small hub motor (*bicycle-style electric bike* (BSEB)). The term *e-bike* is used primarily as a generic term in the U.S. to refer to most electric-assist bicycles. This does create some confusion because people in the U.S. and in other countries use the term *e-bike* for electric scooter-type devices, which have different regulatory requirements than bicycles.

The purpose of this paper is to outline the different classifications of e-bikes—what they are and what they are not—and to help shed light on aspects of federal and state legislation of e-bikes. In addition, this paper explores the potential conflicts these regulations may cause for the adoption of this technology.

METHODOLOGY

In the first part of the paper, terminology, we started from what we know about e-bikes. Having conducted e-bike literature reviews in recent months, we looked through several academic and online sources to determine how people use the term e-bike. From there, we developed a normative framework for addressing the standardization of e-bike terminology. We purposefully append broadly the term *e-bike* to the class of bicycles that have a small electric motor attached and simultaneously distinguish the term from similarly operating devices.

In the second part of our paper, legislation, we researched federal, state/provincial, and municipal codes. Many questions were answered through searching credible web sources and legal databases, such as LexisNexis. In addition, we contacted state departments of transportation (DOT), departments of motor vehicles (DMV), and state police. We corresponded with representatives from several state agencies as well as NHTSA, CPSC, and FHWA to ensure we have accurately interpreted the laws and definitions.

WHAT ARE E-BIKES?

Electric bicycles (e-bikes) are similar in geometry to human-powered bicycles but have a small electric motor that provides pedal assistance and allows riders to accelerate, climb hills, and overcome wind resistance more easily than manually powered bikes. They are part of a broader classification of *motorized bicycles*, which includes a range of bicycles with motors, from gasoline- and diesel-powered internal combustion engines, to even steam-powered engines. The modern electric variety of motorized bicycles emerged in the early 1980s in Japan as a way to make cycling easier for the elderly. By 2001, Japan had sold over 900,000 units (Rose & Cock, 2003). E-bikes can be generally divided into two categories: *bicycle-style electric bikes* (BSEB) and *scooter-style electric bikes* (SSEB).

The authors have chosen to use these two categories in order to group different e-bike styles and to facilitate the discussion in the report around federal, state, and local definitions. Because the e-bike market is quickly changing and evolving, there is more of a spectrum of low-speed electric bicycles that range from more traditional bicycles to scooters than there are distinct classifications, all of which could be officially classified as an e-bike by the federal CPSC definition. As discussed in this report, the variety of e-bikes on the market have caused confusion for policymakers, the general public, retailers, law enforcement, media and other groups in understanding what an electric bicycle is and how it may differ from other devices, such as scooters, mopeds, motorcycles, bicycles, and Segways. We are hoping that by using *BSEB* and *SSEB*, it will help the reader understand the different broader categories of e-bikes on the market. In general, we use characteristics such as geometry, functional pedals, speed, additional safety components (e.g., headlights, mirrors, and turn signals) and motor type to describe BSEBs and SSEBs.

Bicycle-style electric bikes (BSEB)

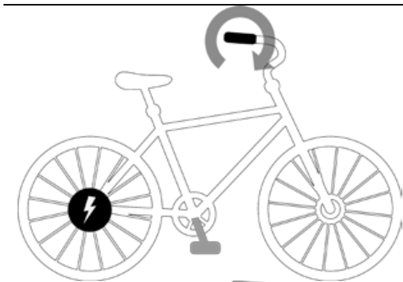
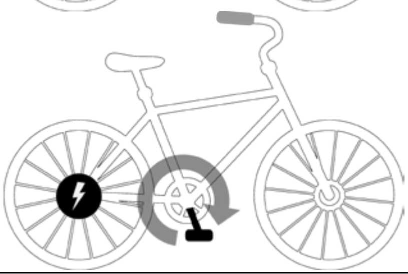
In North America, many terms are associated with the general classification of *bicycle-style electric bicycles* (BSEB), sometimes called *low-powered electric bicycles* or *low-speed electric bicycles*. In general, BSEBs have an electric motor powered up to 750 watts that goes slower than 20 miles per hour. These bikes have working pedals that are meant to propel the bicycle with or without the help of the electric motor.

BSEBs can be further divided into two broad categories: *powered bicycles* (PB) and *power-assisted bicycles* (PAB), or *pedelecs* (Table 1). The term *pedelec* is mostly used in Europe[3] and sometimes used in the U.S., but it is more of an insider's term and does not appear in the legal definitions. *S-pedelecs*, another common classification in Europe,[4] are bikes with motor power greater than 250 watts and can attain speeds up to 27.9 mph (European Parliament & European Council, 2003). In the U.S. this term is rarely used, and there are not many S-pedelec electric bikes on the market. In most cases, these types of bikes would potentially be classified as a *moped* or *motorized bicycle* in local jurisdictions.

[3] In 2009, the European Committee for Standardization (CEN) created a new standard for *electronically power assisted cycles* (EPAC), which are excluded from type approval by Directive 2002/24/EC. The new standard (EN 15194) specifies safety requirements and test methods for the assessment of the design and assembly of electrically power assisted bicycles and sub-assemblies (AFNOR, 2009).

[4] S-pedelecs ('S' for *schnell*, or "fast") usually require a license plate and insurance in Europe. In the U.S. the term refers to *speed pedelec*.

Table 1: Common alternative terms for two main categories of bicycle-style e-bikes.

	E-bike type	Alternative terms [a]
	Powered bicycle (PB, E-PB)	**Throttle-assisted bicycle**; electrically propelled bicycle (EPB); electric bike power-on-demand (POD); on-demand bikes; motorized bicycle
	Power-assisted bicycle (PAB, E-PAB)	**Pedal-assisted bicycle**; electrically assisted bicycle (EAB); pedal electric cycle (**pedelec**); electric pedal assist cycle (EPAC); human-powered hybrids

[a] Bold indicates more commonly used terms in North America.

Powered bicycles have a throttle on the handlebar that is often twisted with the wrist or thumb to engage the motor, similar to how a motorcycle or moped engages (Figure 11). Pedelecs do not have a throttle that propels the bike without pedaling; rather, the motor engages only when the operator pedals the wheels (Figure 2). Pedelecs include an electronic controller that stops the motor from producing power when the rider is not pedaling or when a certain speed—usually 20 mph—has been reached.[5] An electronic sensor, typically torque or cadence, detects changes in resistance or in the cranks and then engages the motor. This provides an extra boost when the bike accelerates or attempts to climb a hill. Some e-bikes can operate as both PB and PAB, such as Currie-Tech IZIP E3 Compact (Figure 3). In some regions, like the E.U., Japan, and some cities in China, powered bicycles are forbidden but power-assisted bicycles are permitted (Table 2).

Figure 1: A common throttle mechanism for powered bicycles. *Image source*: E-Republic.co.uk

[5] There are pedelecs that go faster than 20 mph, such as the Specialized Turbo and the Stromer Mountain 33 and Power 45.

Figure 2: Kalkhoff Sahel I8—a modern power-assisted bicycle (PAB) or pedelec. *Image source*: Kalkhoff-Bikes.com

Figure 3: Currie iZip E3—a hybrid PB/PAB folding electric bicycle. *Image source*: CurrieTech.com

Table 2: Comparison of e-bikes across regions globally, national level.

Region	Power limit	Top speed	PB	PAB	Other conditions
U.S.	750 W	20 mph	Yes	Yes	Operable pedals required
Canada	500 W	20 mph	Yes	Yes	Power assistance only above 2 mph
Australia	250 W [a]	No limit	Yes	Yes	Operable pedals required. Power (electric or IC) must be auxiliary, not the main source of power
E.U.	250 W	16 mph	No	Yes	Power assistance only when pedaling
China	No limit	12 mph	Yes	Yes	Inconsistent enforcement by region and/or city
Japan	250 W	15 mph	No	Yes	Max assistance at 9 mph declining to zero above 15 mph

[a] In Australia, PABs and PBs have different power outputs. PBs (*power-assisted pedal cycle*) are limited to 200W, while PABs (*pedalec*) are set at 250W.
Source: Rose, 2011, modified by authors.

Some of the latest developments in BSEBs are the motor-battery hub and encapsulated recumbent electric bikes. The Copenhagen Wheel from MIT SENSEable City Lab and the Smart Wheel from Flykly are two models of the hub technology, which is essentially a bicycle wheel with a self-contained motor and battery (Figure 4). No torque or cadence sensor is needed; instead, the device communicates with the operator's smart phone. The wheels' streamlined installation and ability to interface with smart phones brings great promise for this technology, especially for those who want to convert their own bikes.

Figure 4: Superpedestrian's Copenhagen Wheel—a wheel that converts a standard bicycle into a pedelec using a motor and battery in a self-contained hub. *Image source*: Superpedestrian.com

Encapsulated recumbent electric bicycles also challenge our conception of what an electric bicycle could be. The ELF from Organic Transit outfits a recumbent bicycle with an electric motor and places a lightweight material around the bike to shield the operator from the elements (Figure 5). Although bulky, it is only slightly wider than the handlebars of a standard bicycle.

Figure 5: Organic Transit's ELF, which is a *low-speed electric bicycle* as defined by CPSC, despite its bulk. *Image source*: OrganicTransit.com

Scooter-style electric bikes (SSEB)

While in the purest sense, e-bikes are bicycles with a small electric motor attached, the term has also been applied to scooters, mopeds and even motorcycles. These are called *scooter-style electric bikes* (SSEB). The distinction between BSEB and SSEB is of growing importance as more people start using e-bikes and as other emerging low-speed vehicles come to market. Because the term *e-bike* has been broadly used to refer to a varied class of vehicles, the general public is not clear of the differences, and policymakers are forced to make decisions on regulations that might not serve the overall needs of the public. It is important to note that we differentiate BSEBs from other vehicles based on the potential to be considered a bicycle—in geometry, weight, speed, and the ability to be pedaled. Furthermore, our report focuses on electric bicycles in the United States and Canada that meet the federal definitions described in our review of the legislation below.

Many people confuse electric scooters,[6] mopeds, and other SSEBs with BSEBs (usually powered bicycles).[7] Although electric mopeds may have pedals, they are more of an appendage than a functional necessity. In fact, these scooter-like vehicles often feature a platform on which the operator can rest his/her feet. The profile of these bikes ranges between a bulky bicycle and an Italian Vespa (Figure 6 and 7). Such bikes are quite common

[6] There is some confusion with the term *scooter*. We do not refer to *kick scooters*, devices typically ridden for recreation, consisting of a footboard mounted on two wheels and a long steering handle, propelled by resting one foot on the footboard and pushing the other against the ground (Figure 8).

[7] NHTSA defines the term *motor-driven cycle* as a motorcycle with a motor that produces five-brake horsepower or less. A motor-driven cycle is exempted from certain requirements of the FMVSS that apply to motorcycles (49 C.F.R. 571.3). NHTSA does not define the terms *motor scooter* and *moped*. These terms, therefore, have no relevance to the classification of a vehicle for the purpose of determining which FMVSS would apply to it.

in China (Weinert, Burke, & Wei, 2007). In some jurisdictions around the world and in the U.S., there is no legal difference between SSEBs and BSEBs.

Electric mopeds straddle the line of being classified as *e-bikes* because of the semi-functional pedals (Figure 6). Several states in the U.S. do not distinguish between a moped and an electric bicycle/motorized bicycle, which is one cause for the confusion. Another cause may be that the term *bike* can mean both a *bicycle* and informally a *motorized cycle* (moped, motorcycle, etc.). Many states do not differentiate between fuel sources of these motorized cycles. The power of electric mopeds range from about 350 watts to 3,000 watts or more, and they can reach speeds of 20 to 35 mph. There are some moped-type e-bikes on the market that meet the federal definition of an e-bike set by the Consumer Product Safety Commission (CPSC) and by Transport Canada (Figure 6). These have caused confusion and frustration with both law enforcement officials and users of bike facilities because they look like a moped but have minimal restrictions.

Lastly, the term *e-bike* is sometimes confused with electric motorcycles. These vehicles can reach speeds of 50 or 60 mph. In North America, this category of electric bikes is not generally considered an e-bike because they are not primarily human powered.

Figure 6: Scooter-style electric bike (SSEB) with operable pedals. *Image source*: OkOkChina.com

Figure 7: Electric scooter has no pedals, which is not considered an "e-bike." *Image source*: Made-in-China.com

Figure 8: Razor E300 stand-up electric kick-style scooter. This style of kick scooter is <u>not</u> a *scooter-style electric bicycle* (SSEB). *Image source*: Razor.com

Review of North American legislation

When it comes to e-bike legislation in the United States and Canada, it is important to ground the reader in three focus areas: systems of governance; relevant regulatory bodies; and specific e-bike legislation. This section gives an overview of the federal systems in North America, noting that the federal government is generally responsible for setting standards and doesn't specify usage and licensing of vehicles. It is also important to recognize that municipalities are often "creatures of the state/province," which may not have the powers granted to them to enact ordinances governing e-bikes. This section also looks at the specific roles of federal bodies—what they do and do not have jurisdiction over. Lastly, we look at how each country defines e-bikes at the federal level and what that means for state/provincial governments.

United States

The 10th Amendment of the Constitution establishes the American system of federalism by reserving for the states those powers not delegated to the federal government. States are able to enact and enforce police powers—the inherent authority of the state to impose restrictions on individual rights for the betterment of health, safety, morality, and general welfare—to achieve their goals. This means they can levy property taxes, require driver's licenses and enact vehicle codes, in addition to numerous other powers.

The powers and roles of the federal and state governments are made clear by the U.S. Constitution; however, it is silent about the roles and powers of municipalities. This has resulted in 50 unique political and legal situations by which states delegate powers to municipalities and local charters. In some states, constitutional amendments give local jurisdictions the right to self-govern by enacting local laws that are consistent with both the state and federal constitutions. These are called Home Rule states. In other states, the authority of local jurisdictions is limited to only those powers expressly permitted under state legislation. These are called Dillon's Rule states. Home Rule and Dillon's Rule are not mutually exclusive.[8] Some states, like Michigan, can be a Dillon's Rule state but also have Home Rule. These states have typically loosened their constructionist stance on local government autonomy.

This framework is important when considering e-bike laws in the United States. First, it makes clear the ability for the federal government to establish agencies, such as the Consumer Product Safety Administration (CPSC), the National Highway Transportation Safety Administration (NHTSA), and the Federal Highway Administration (FHWA), and to remind the reader of the limitation of power. Secondly, as discussed later, the absence of a state law about e-bikes could tie the hands of municipalities in Dillon's Rule states when attempting to legislate the device.

Federal agencies: CPSC, NHTSA, and FHWA

Certain federal agencies are charged with ensuring the standardization and proper safety of products in the United States. CPSC handles consumer products, and its purview is limited only to the ***manufacture and first sale of consumer products***. Products that do not fall under the jurisdiction of CPSC include those specifically named by law to be under the jurisdiction of other federal agencies, such as firearms, motor vehicles, and food and drugs. When CPSC defines a device as a *consumer product*, it means the device must comply with all manufacture and product sales regulations set by CPSC that pertain to the device. This does not affect how states may decide to govern the ***licensing and use of*** consumer products, such as bicycles or all-terrain vehicles.

Similarly, NHTSA handles motor vehicles, and its purview is limited primarily to ***safety requirements of motor vehicles***. Through administering the Federal Motor Vehicle Safety Standards (FMVSS), NHTSA is able to impose requirements on the design, construction, performance, and durability of motor vehicles. In addition, NHTSA administers the vehicle

[8] States without Home Rule: Alabama, Delaware, Mississippi, Nebraska, Nevada, New Mexico, Oklahoma, Vermont, West Virginia and Wyoming.

identification number (VIN) system and standards for motor vehicle theft, fuel economy, manufacturer and importer licensing, and safety testing of motor vehicles and motorcycle helmets. When NHTSA defines a device as a *motor vehicle*, it means the device must comply with all regulations set by NHTSA that pertain to the device. This does not affect how states may decide to govern the ***licensing and use of*** motor vehicles, such as mopeds or passenger vehicles.

The key points to understand are that CPSC handles only the manufacture and first sale of consumer products, such as bicycles; NHTSA handles vehicle and safety standards of motor vehicles. When CPSC or NHTSA define a product or vehicle, the extent of the definition is limited only to the purview of their regulations. Thus, **states are free to govern the licensing and use of consumer products and motor vehicles as they wish**, insofar as states do not enact laws that reduce the manufacture/safety standards set by the federal agencies.

Finally, the Federal Highway Administration (FHWA) is a division of the U.S. Department of Transportation, and its primary role in the federal-aid highway program is to oversee federal funds used for design, constructing and maintaining the National Highway System (primarily interstate highways, U.S. routes, and most state routes). In addition, FHWA provides oversight and guidance for non-motorized trails and pedestrian walkways using federal transportation funds (23 U.S. Code § 217).

U.S. e-bike federal regulations

Having explained the extent to which the federal government can legislate both motor vehicles and consumer products, we now examine specific regulations of e-bikes at the federal level. In 2002, the U.S. Congress enacted Public Law 107-319, which amended the Consumer Product Safety Act by updating 15 U.S.C. Chapter 47 Section 2085 that establishes the requirements for low-speed electric bicycles, defined as:

> a two- or three-wheeled vehicle with **fully operable pedals**[9] and an electric motor of less than **750 watts** (1 h.p.), whose maximum speed on a paved level surface, when powered solely by such a motor while ridden by an operator who weighs 170 pounds, is less than **20 mph**.

CPSC considers e-bikes that meet this definition to be standard bicycles for the purposes of manufacture and first sale at the federal level, and they must adhere to the requirements (for bicycles) set forth in 16 C.F.R. § 1512 (2014).

Public Law 107-319 also differentiates low-speed electric bicycles from *motor vehicles*:

> For the purposes of motor vehicle safety standards […], a low-speed electric bicycle [as defined above] **shall not be** considered a motor vehicle [per 49 U.S.C. § 30102(a)(6)].

[9] There is no guidance to describe what "fully operable" means. There are scooters and mopeds on the market that have pedals that can move the wheels but would prove very difficult to propel the device for any substantial distance or any distance at all.

A 2005 docket from NHTSA addressed the apparent incongruence between a motor vehicle and a low-speed electric bicycle by stating that NHTSA's interpretation is in coordination with that of CPSC: Low-speed electric bicycles are not motor vehicles (Federal Register, 2009). Thus, NHTSA defers to CPSC to regulate these products (Table 3) (Hansen, 2013).

Table 3: Matrix summary of regulatory bodies with jurisdiction over described e-bikes.

	Meets definition	**Does not meet definition**
Off-road	CPSC	Uncertainty of agency jurisdiction
Street-use	NHTSA defers to CPSC	NHTSA

However, we are left with a gray area for e-bikes that do not meet CPSC's definition of *low-speed electric bicycle* (i.e., e-bikes that go faster than 20 mph and/or are powered above 750 W). The bikes would then fall into the arena of NHTSA and would be defined as a *motor vehicle*. It is uncertain how NHTSA would classify these types of bikes, especially S-pedelecs, and what additional safety requirements would be added.[10] There is also lack of clarity in the regulatory definition for pedelecs that reach speeds greater than 20 mph. The Specialized Turbo has a top speed of 28 mph and is currently on sale in the U.S. Specialized interprets the federal regulations to mean that the 20 mph speed limit only pertains to a bike that is powered solely by the motor and can be ridden without any human power (Roberts, 2013). This interpretation potentially creates a second classification for low-speed electric bicycles and could cause additional policy-related questions for state and local municipalities.[11] For example, would a bike that could reach speeds of 28 mph be allowed on a separated bike path in the Boulder, CO or Toronto, Canada where the use of e-bikes in these areas is already in question?

As for the operation and licensing of e-bikes, states and local municipalities are responsible for regulating these products. As we will see, how states incorporate e-bikes into their vehicle codes varies greatly. Although states are delegated this task, one clause that often leads to confusion is part (d) of Public Law 107-319:

> d) This section shall supersede any State law or requirement with respect to low-speed electric bicycles to the extent that such State law or requirement is more stringent than the Federal law or requirements referred to in subsection (a).

When taken out of context, this clause might suggest that the "federal definition" of an e-bike takes precedent over any and all state laws pertaining to e-bikes. Since the "federal definition" considers *low-speed electric bicycles* to be standard bicycles, the assumption follows that states cannot impose more stringent restrictions on e-bikes and that CPSC's

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[10] An e-bike powered in excess of 750 watts and capable of speeds above 20 mph may be considered a motor-driven cycle, as defined by NHTSA (49 U.S.C. § 30101, et seq.).

[11] The authors were not able to obtain any official interpretation from CPSC.

definition is *the definition* for all states. ***This common interpretation is wrong***.[12] Because Public Law 107-319 amends the Consumer Product Safety Act, the provision is limited to only the manufacturing and first sale of the product.

There is one area the federal government has established jurisdiction on the use of electric bicycles. In 23 USC Section 217, electric bicycles are permitted to be used on trails and pedestrian walkways that are built using federal funds where state or local regulations permit. Though this legislation still gives state and local regulations the final say, it does provide an opportunity for e-bikes to be considered for use in these areas with federally funded trails and walkways. In a particular sense, knowing where an e-bike is allowable becomes difficult to determine for the user and regulatory authorities, since a roadway, path or trail might be comprised of different funds throughout. To help clear up how this legislation can be applied, FHWA has created a framework for considering motorized use on non-motorized trails and pedestrian walkways (Federal Highway Administration, Office of Planning, Environment, and Realty, 2014).

An interesting aspect of the legislation is how it defines an electric bicycle as "any bicycle or tricycle with a low-powered electric motor weighing under 100 pounds, with a top motor-powered speed not in excess of 20 miles per hour," which was added to 23 USC 217 in Pub. L. 105–178, title I, § 1202(a), on June 9, 1998. Though this legislation predates Pub. L. 107-317, the federal agencies are faced with two different definitions, which is confusing and unnecessary.

Finally, as for use in the National Park System, e-bikes are not explicitly banned from use in national parks, but they would not be considered a bicycle. The National Park Service regulates the use of bicycles on park roads, in parking areas, and on routes designated for bicycle use (Federal Register, 2012). E-bikes would fall under the designation of *motorcycle* or *motor vehicle* and would be banned from use in areas for non-motorized use, such as paths and trails (36 C.F.R. § 4). The International Mountain Bicycle Association (IMBA) has called for different classifications of electric-assist/motorized mountain bicycles and mountain bikes (IMBA, 2010). Much of the mountain bike community would like to see e-bikes only used on legal off-highway vehicle (OHV) trails and roads. The belief is that e-bikes would lead to the deterioration of single-track trails and nature areas (Lockwood, 2014).

Canada

The federal system of Canada differs from that of the U.S. in that it recognizes two jurisdictions with political authority: the federal and provincial governments.[13] The federal and the provincial governments are both autonomous and interdependent; cooperation at the provincial-federal level is an essential feature of their interconnected relationship, and their roles cannot be neatly separated. To help rationalize both jurisdictions' authority,

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[12] Michigan State Police issued the Field Update #26 stating this misconception that some retailers and operators have of the federal regulation.
http://www.michigan.gov/documents/msp/TSS_Field_Update_26_180953_7.pdf

[13] The territories are delegated powers to be exercised by Parliament.

Canada has several doctrines in place. While the federal government is delegated responsibilities to connect provinces and regulate commerce and transportation in the national interest, exclusive powers of provincial legislature are those that are inherently local. Such powers include municipalities, property rights, and taxation/spending.

The provincial-municipal relationship is quite different from the federal-provincial relationship. Provinces not only determine the specific powers delegated to municipalities, but they are also responsible for the very existence of municipalities. For example, the Local Government Act of British Columbia spells out what local governments are responsible for and what they can enact; the exception is the Vancouver Charter that established the City of Vancouver. Each province, however, has a unique relationship with its municipalities (for example, Vancouver Charter, SBC 1953, c 55).

Transport Canada and MVSR

Transport Canada is the federal department charged with developing transportation policies, regulations, and services in Canada. In 1971, Transport Canada established the Motor Vehicle Safety Act for creating safety standards for motorized transport, which enabled the legislation of Motor Vehicle Safety Regulations (MVSR). MVSR establish the Canada Motor Vehicle Safety Standards (CMVSS), which aim to set standards for safer vehicles. Provinces also have their own transportation departments to handle vehicle licensing, infrastructure planning and maintenance, and vehicle regulation. MVSR ensure proper standards for human safety are met, while province regulations address use, definitions and licensing, among others.

Canadian e-bike federal regulations

With a general understanding of the Canadian federal system and the powers of the provinces and federal government, let's look at exactly how Canada addresses e-bikes at the federal level. Transport Canada defines a *power-assisted bicycle* (PAB) in the MVSR (CRC, c 1038 (2)):

> "power-assisted bicycle" means a vehicle that:
>
> (a) has steering handlebars and is equipped with **pedals**,
> (b) is designed to travel on not more than three wheels in contact with the ground,
> (c) is capable of being propelled by muscular power,
> (d) has one or more electric motors that have, singly or in combination, the following characteristics:
>
> (i) it has a total continuous power output rating, measured at the shaft of each motor, of **500 watts** [0.67 horsepower] or less,
> (ii) if it is engaged by the use of muscular power, power assistance immediately ceases when the muscular power ceases,
> (iii) if it is engaged by the use of an accelerator controller, power assistance immediately ceases when the brakes are applied, and
> (iv) it is incapable of providing further assistance when the bicycle attains a speed of 32 km/h [**19.9 mph**] on level ground [...].

Transport Canada has the power to define *power-assisted bicycles* for the purposes of setting safety standards. Although different from federal preemption, Transport Canada does not require licensing and registration for power-assisted bicycles. However, similar to the United States, the provinces reserve the authority to require licensing, define the vehicle, and add restrictions like age and helmet requirements. PABs in Canada are similarly defined to how low-speed electric bicycles are in the United States, the exception being that the maximum power output in Canada is 250 watts fewer than in the U.S. The federal definition in Canada includes both powered bicycles (throttle-assist) and pedelecs (pedal-assist).

STATE AND LOCAL REGULATIONS

As it relates to motor vehicles (including bicycles), states and municipalities are given the powers to authorize vehicular registration and licensing, as well as operator licensing. States also have the power to define vehicles under their corresponding vehicle codes. Although NHTSA, CPSC and FHWA have set definitions of e-bikes for their own provisions, these agencies' definitions do not weigh in directly to states' decisions. In the case of e-bikes, states can define what an e-bike is, whether the device requires operator licensing, where the device can be operated, and several other factors (e.g., need of helmet and age restrictions).

The National Committee on Uniform Traffic Laws and Ordinances (NCUTLO) is a private, non-profit membership organization made up of mostly state government and related transportation organizations, focused on providing uniformity of traffic laws and regulations through the creation of the Uniform Vehicle Code (UVC) (NCUTLO, 2000). The UVC acts as model regulatory framework on traffic safety issues that can be adopted by states. The intent is to create uniformity and consistency in state vehicle regulations. In the latest version of the UVC, there is no mention of electric bicycles, but it would probably classify them as mopeds.[14]

In 2012, the National Committee on Uniform Traffic Control Devices (NCUTCD)[15] appointed a task force to review the Rules of the Road as found in Chapter 11 of the millennial edition of the UVC, and to generate proposed amendments to these traffic laws as necessary to reflect the new engineering principles and applications as they appear in the current version of the Manual on Uniform Traffic Control (NCUTCD, 2012). The NCUTCD suggests

[14] S 1-154 Moped - A motor-driven cycle with a motor which produces not to exceed two-brake horsepower and which is not capable of propelling the vehicle at a speed in excess of 30 mph on level ground. If an, internal combustion engine is used, the displacement shall not exceed 50 cubic centimeters, and the moped shall have a power drive system that functions directly or automatically without clutching or shifting by the operator after the drive system is engaged.

[15] The NCUTCD is an organization whose purpose is to assist in the development of standards, guides and warrants for traffic control devices and practices used to regulate, warn and guide traffic on streets and highways. The NCUTCD recommends to the FHWA and to other appropriate agencies proposed revisions and interpretations to the Manual on Uniform Traffic Control Devices (MUTCD) and other accepted national standards.

new language for a definition of *electrically-assisted bicycle* and defining them as bicycles, with the same privileges:

> Every vehicle upon which any person may ride, and propelled by the operator, having two tandem wheels and an electric motor, whose maximum speed on a paved level surface, when powered solely by such a motor while ridden by an operator who weighs 170 pounds, is less than 20 mph.

The NCUTCD justified the changes to the UVC, because low-powered bicycles were becoming more common due to improvements in battery and motor technology. E-bikes are low-speed, quiet and non-polluting, which make the bicycles acceptable on paths. Though this definition is similar to the CPSC definition, it doesn't specify motor size, the requirement of working pedals, and doesn't seem to allow for three-wheeled bicycles.

Local municipalities have also started to look into regulating the use of e-bikes. Some notable cities include Boulder, CO; Eugene, OR; New York City, NY; Park City, UT and Toronto, ON. In these cases, the city has established, or is currently establishing, local regulations determining what is considered an e-bike and where e-bikes can and cannot be ridden. For Boulder and Eugene, the definition of an electric-assisted bicycle is consistent with state definitions. Toronto, on the other hand, has a definition more stringent than provincial law. Park City Council staff are proposing a more stringent set of restrictions and definition than Utah State Code.[16] These cities and others are highlighted in our analysis below.

Additionally, confusion occurs in the states and provinces that don't have specific e-bike regulation. Many of the U.S. states and Canadian provinces that are silent on the issue have regulations in place governing *moped*, *motorcycle*, *motorized bicycle*, *motorscooter*, *scooter*, and/or *motor-driven cycle*. By default, an e-bike would fall into these categories for areas that are silent on e-bike regulation.[17] This creates two types of problems for e-bike owners. First, they will have licensing and registration requirements that are stricter than necessary, including helmet and safety light requirements. These restrictions can be barriers to participating in cycling. In some cases, like in New York and New Jersey, the lack of a proper definition has created a problem whereby e-bikes are not able to be registered by state DMVs, even as mopeds, thus making them illegal. Secondly, if e-bikes are not considered *bicycles*, they can then be barred from use on bicycle infrastructure such as paths, bike lanes or sidewalks.

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[16] On May 29, 2014, Park City Council staff proposed recommendation for the use of electric assisted personal assistive mobility devices on city pathways and trails. The recommendations include edits to the municipal code to establish definitions, restrictions on use and a proposed pilot program to collect data on use on public pathways and trails (Park City Council, 2014)

[17] Some states have seemingly incompatible definitions for e-bikes, particularly when specifications for engine displacement (CCs—cubic centimeters) are used. However, a reference to engine displacement does not intrinsically take e-bikes out of such a definition. For example, a moped could be defined as a "device equipped with a motor with an engine displacement of less than 50 CC." Because e-bikes do not have any engine displacement, the displacement is indeed less than 50 CC.

Analysis of e-bike laws

For this section, the term "e-bike" is limited to those equipped with fully operable pedals and a motor of no more than 750 W (U.S.) or 500 W (Canada) that propels the bike at a maximum speed of 20 mph (U.S.) or 32 km/h (Canada).

The analysis below summarizes Appendix A, which attempts to catalogue the legal status of electric bicycles in all 50 states, Washington, D.C., and Canada's 13 provinces and territories. It is our first attempt at digesting 64 different regulatory situations for electric bicycles. While we took pains to identify the correct legislation for this table, we cannot guarantee its accuracy. For example, it is difficult to determine whether an area explicitly permits or prohibits operation of e-bikes on paths/sidewalks; some states also have multiple definitions for e-bikes. We invite readers to provide feedback with local knowledge they may have. Appendix A addresses the following regarding e-bikes:

1. State/provincial vehicle code definition that contains e-bikes
2. If it is essentially classified and treated as a bicycle
3. If the operator is required to have a license
4. If the e-bike is required to be registered
5. Minimum age of operation
6. Maximum power output
7. Maximum speed of operation
8. If pedals are required
9. If the state/provincial definition meets the federal definition
10. If a helmet is required
11. If e-bikes are allowed on paths
12. If e-bikes are allowed on sidewalks
13. References to code

Of the 50 states plus D.C., 30 do not have definitions that recognize e-bikes as a unique vehicle separate from mopeds or similar devices (Appendix A). Only 10 states have definitions that correspond to CPSC's definition of a *low-speed electric bicycle*. The terms used to identify e-bikes also vary, but the most common are *motorized bicycle* (12 states); *moped* (11 states); *electric-assisted bicycle* (seven states); *motor-driven cycle* (four states); and *bicycle* (four states). Several others are variations of these. Surprisingly, only three states, Maryland, Nevada and Texas, dodge the convoluted naming structure and identify e-bikes as simply *electric bicycles*, and five other states have some derivation of electric bicycle not mentioned above.

Based on various states' definitions and requirements, we determined whether electric bicycles as defined by CPSC were *rendered* bicycles—those regulatory situations that make the use of an e-bike analogous to a bicycle (Figure 13). We define this by whether a driver's license is required and whether the e-bike is required to be registered with a DMV. We found that in 24 states, e-bikes are treated essentially as bicycles; 27 states have more onerous requirements, such as vehicle registration, rider licensing, or require special equipment. At least 10 states consider e-bikes to be motor vehicles (Figure 18). Of the 24 states that treat e-bikes as standard bicycles, five include e-bikes in the very definition of *bicycle*.[18] Only 10 states have adopted a definition that is in line with the federal definition.

The following states are those without Home Rule: **Alabama**, Delaware, **Mississippi**, **Nebraska**, Nevada, **New Mexico**, Oklahoma, **Vermont**, **West Virginia**, and **Wyoming**. Out of these 10 states, the seven in bold do not have a definition that recognizes e-bikes as a unique vehicle (Figure 14). This overlap is surprising and has several implications for policy and responsive governance. For example, if a municipal corporation in Alabama wished to add its own definition of *electric-assisted bicycle* to its city ordinances, the city would encounter the issue of whether it has the authority to do so. Unless the authority to amend parts of vehicle code is expressly granted to the city, it cannot make rules about e-bikes that do not comply with state law. Although all Canadian provinces and territories do not have Home Rule, their delegations of power to local authorities often include those matters pertaining to bicycling.

Most states (44) impose a speed limit on e-bikes; 22 states limit e-bikes to 20 mph, 6 states to 25 mph, and 16 states to 30 mph (Figure 17). All but three of the 22 states that recognize e-bikes as a special vehicle set the maximum speed at 20 mph. As for engine output, only 33 states specify a maximum power output in a unit relevant to e-bikes—either horsepower or watts (Figure 9 and 16). However, 18 states do not accommodate electric motors in the vehicle's definitions and instead designate an internal combustion engine's maximum piston displacement (Figure 10). There is not a direct unit conversion between engine displacement (cc) and horsepower or watts, thus making the determination of classifying these bikes difficult to impossible.[19]

Considering the 22 states that recognize e-bikes as a unique vehicle, the particular definitions they set create a gap between what is allowed in the state and what CPSC requires in order to be considered a *low-speed electric bicycle* (Table 4). These states either have a higher allowable maximum speed (20 mph) or power output of the motor (750 W).

About half of all states (27) require an operator's license to ride an e-bike, but nearly three-quarters (38) do not require registration (Figure 12 and 19). This is consistent with the minimum age of operation; most states (36) have a minimum age, with 18 states requiring the operator be 16 years of age (Figure 11 and 15). In some states, like Alabama, Connecticut, and North Dakota, motor-driven cycles, motorized bicycles, or mopeds require an additional endorsement in order to be legally operated. The extent of this requirement varies. Some states, like Arkansas, require only an easily obtained certificate. Other states, such as Alaska, riders are required to obtain a motorcycle class license through a DMV-administered exam. In most other states, such as Tennessee, Hawaii, and Michigan, no additional endorsement beyond a standard operator’s license is required; the caveat is that these types of vehicles stay within some specified power range, typically less than 50 cc.

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[18] These states include Delaware, Florida, Idaho, Montana and Pennsylvania.

[19] Conversion used in Appendix A: watts expressed in horsepower equivalent: 1 H.P. = 745 watts.

Table 4: States whose permitted speed or power for electric bicycles exceeds the CPSC definition of *low-speed electric bicycle*.

State [a]	Identity	Power	Speed
California	Motorized Bicycle	*1,000 watts*	20 mph
Georgia	Electric-assisted Bicycle	*1,000 watts*	20 mph
Indiana	Motorized Bicycle	50 cc	*25 mph*
Kansas	Electric-assisted Bicycle	*1,000 watts*	20 mph
Minnesota	Electric-assisted Bicycle	*1,000 watts*	20 mph
Mississippi	Bicycle with a Motor Attached	*no limit*	*no limit*
Montana	Bicycle	*2 HP*	*30 mph*
Nebraska	Moped	*2 HP*	*30 mph*
North Carolina	Moped	50 cc	*30 mph*
Oregon	Electric-assisted Bicycle	*1,000 watts*	20 mph
Texas	Electric Bicycle	*no limit*	20 mph
Virginia	Electric Power-assisted Bicycle	*1,000 watts*	*25 mph*
Washington	Electric-assisted Bicycle	*1,000 watts*	20 mph

[a] Only states that have a definition recognizing e-bikes as unique vehicles were considered

For adults, most states (41) do not require the rider to wear a helmet; however, for riders under a specified age limit, helmets may be required. This figure is consistent with state laws for bicycle helmets. As of April 2014, 22 states have codified into state law requirements for bicycle helmets—typically geared toward children—and 13 states have no helmet laws, even in any of their municipalities (Bicycle Helmet Safety Institute, 2014). Because some states view e-bikes as mopeds or motor-driven cycles, a motorcycle helmet meeting safety standards laid out by NHTSA may be required for adults.[20] In Louisiana, the operator may have an insurance policy of at least $10,000 in place of a motorcycle helmet. In other states, like California and Georgia, a bicycle helmet will suffice in place of a motorcycle crash helmet.

Of the 13 provinces/territories in Canada, only four do not have vehicle definitions that are relevant to e-bikes: New Brunswick, Newfoundland and Labrador, Northwest Territories, and Nova Scotia.[21] Only pedal-assist bicycles are permitted in Alberta and British Columbia, which is similar to how Europe and Japan structure their laws. Only Prince Edward Island, which calls e-bikes *motor-assisted pedal bicycles*, requires a driver's license to operate an e-bike. We could not confirm whether any province prohibited e-bikes on bike paths.

The question of where electric bicycles are permitted is complex. States can explicitly permit or prohibit operation of standard bicycles on sidewalks, paths, trails, etc. However, many states stay silent on where cyclists can ride. In vehicle code, vehicles are often prohibited from operation on sidewalks, and in many states, e-bikes are defined as vehicles. For standard bicycles, eight states ban their use upon sidewalks, and 21 states

[20] States with motorcycle-style helmet requirements include Alabama, Massachusetts, New Jersey, Nebraska, North Carolina, Tennessee, and West Virginia.
[21] The four provinces accounted for 6.7% of the population in 2011 (Statistics Canada, n.d.).

explicitly permit use on sidewalks. While four states have conditions when a cyclist can use a sidewalk, 18 states have either no law whatsoever or it is unclear (League of American Bicyclists, n.d.). But we have seen that e-bikes are not defined as bicycles under many states. Some states, like Oregon, have provisions that make e-bikes essentially bicycles but have additional restrictions on using electric-assist bicycles on sidewalks.

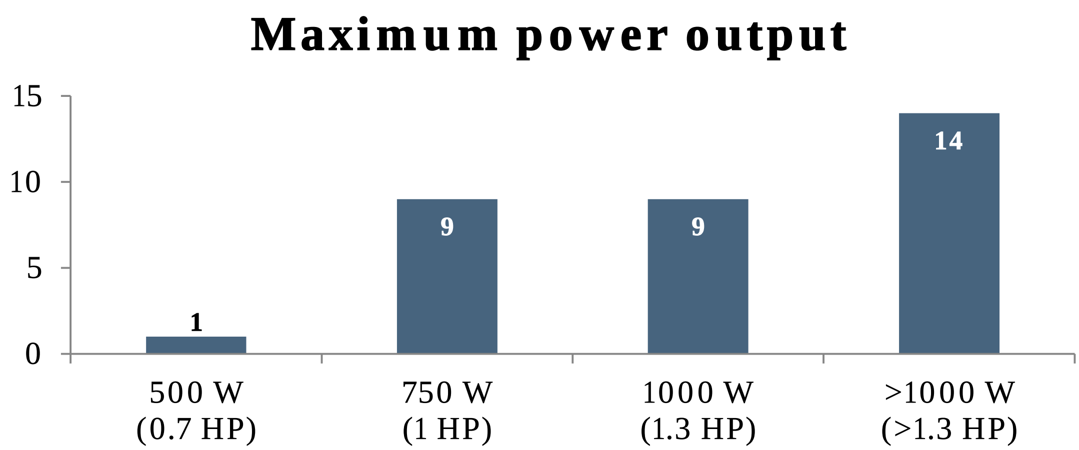

Figure 9: Number of U.S. states with specified allowable maximum output of an electric-bicycle motor. Horsepower was converted to watts. 1 horsepower = 745.7 watts. *N* = 33.

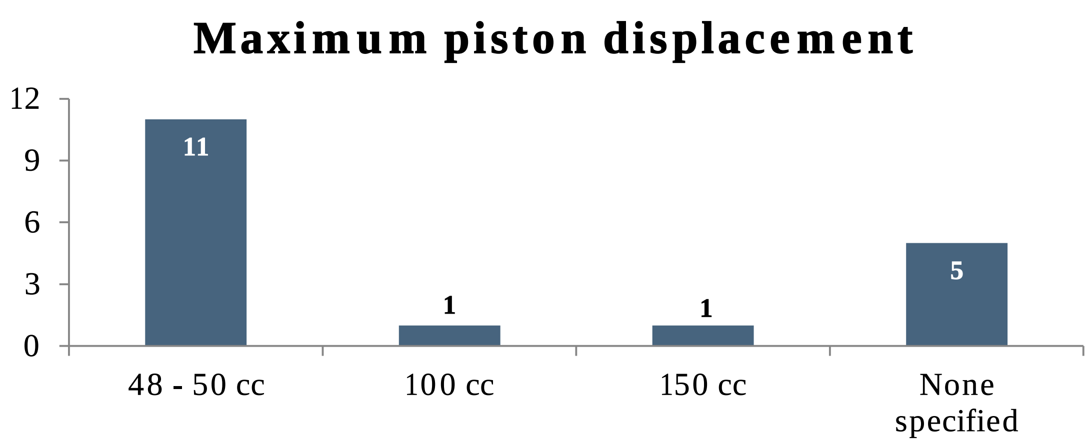

Figure 10: Number of U.S. states with specified maximum piston displacement by the identification under law. *N* = 17.

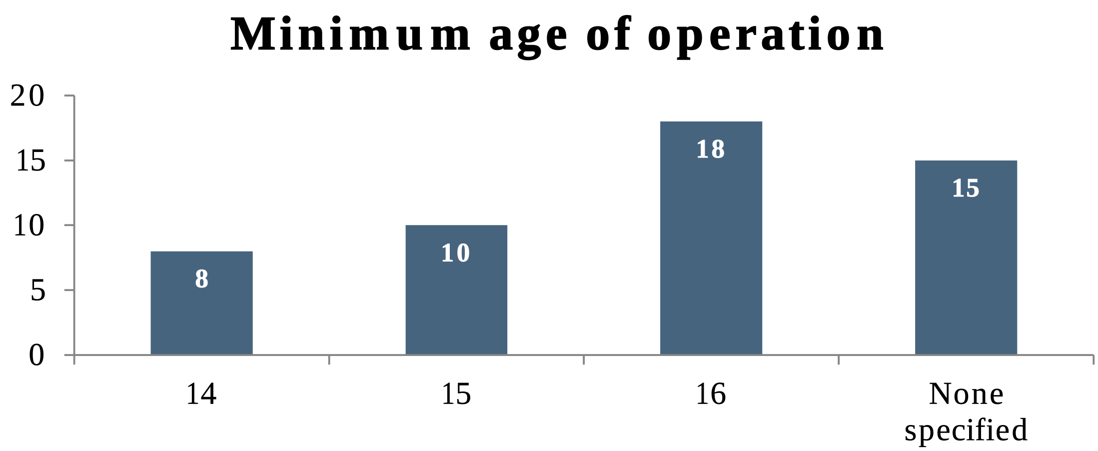

Figure 11: Number of U.S. states with specified minimum age of operator. *N* = 51.

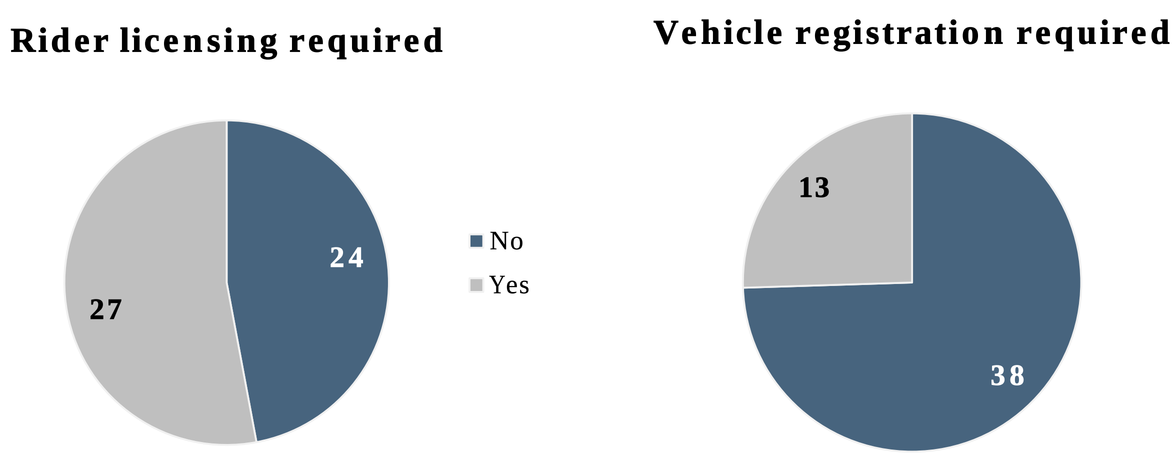

Figure 12: Number of U.S. states requiring rider licensing and vehicle registration for operation of electric bicycles. *N* = 51.

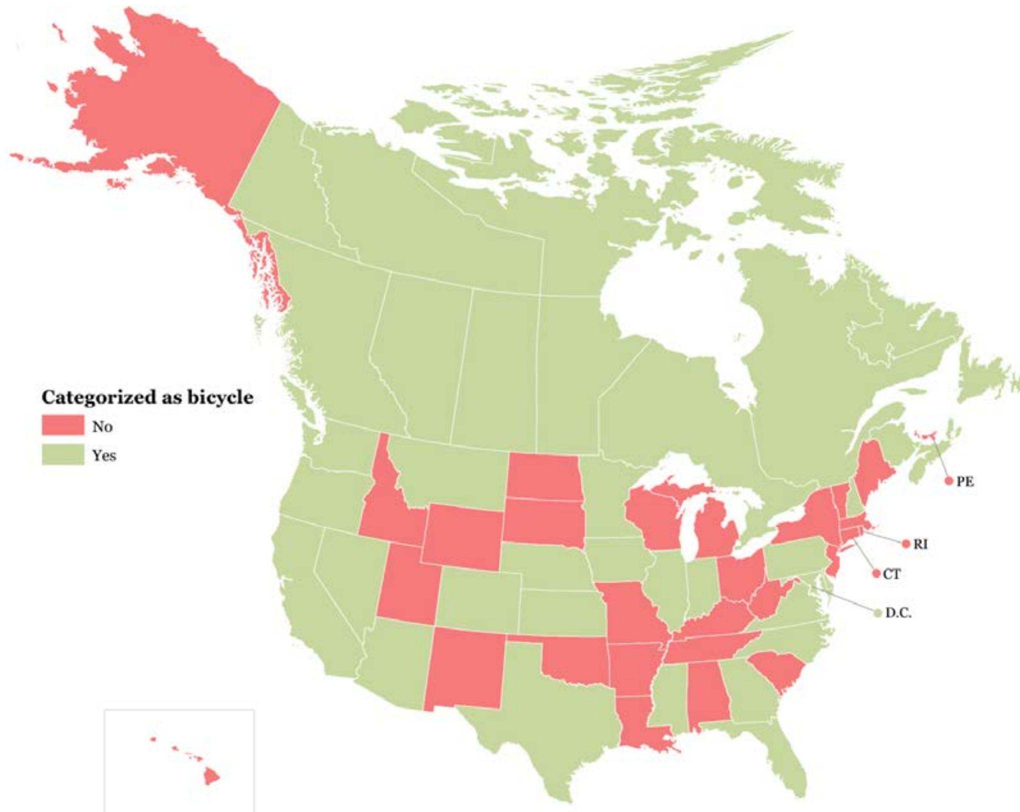

Figure 13: Areas where electric bicycles are classified essentially as standard bicycles, Canada and U.S., Nov 2014.

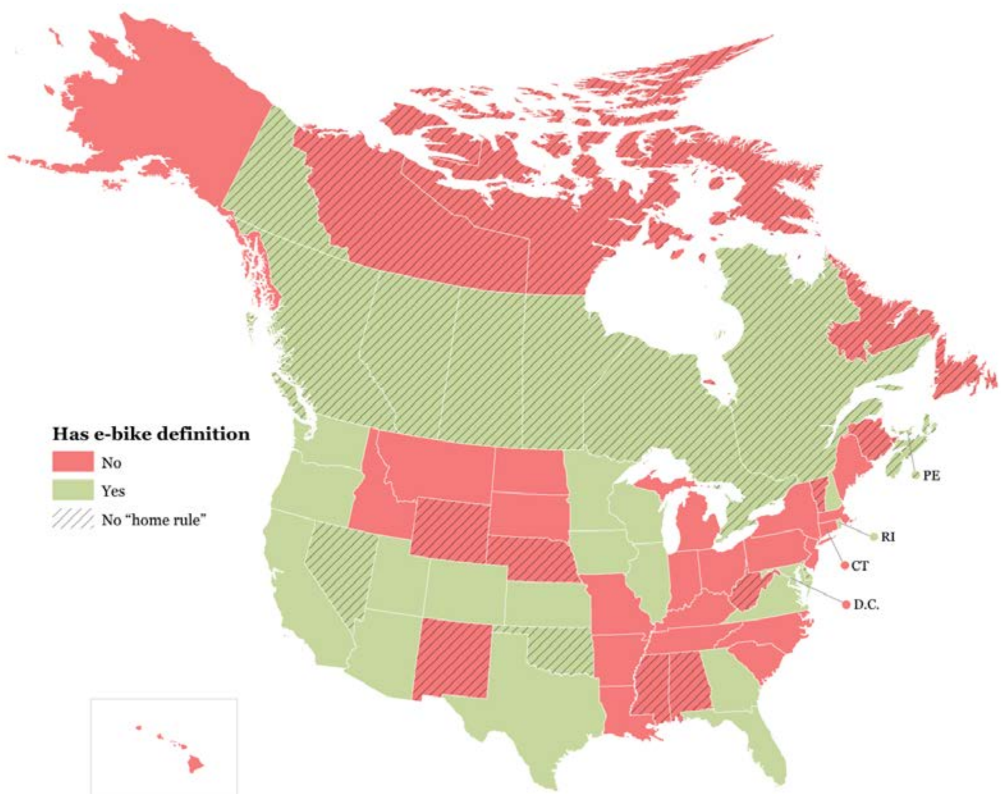

Figure 14: Codified definition that encompasses e-bikes by province/state with "home rule" areas un-hatched, Canada and U.S., Nov 2014.

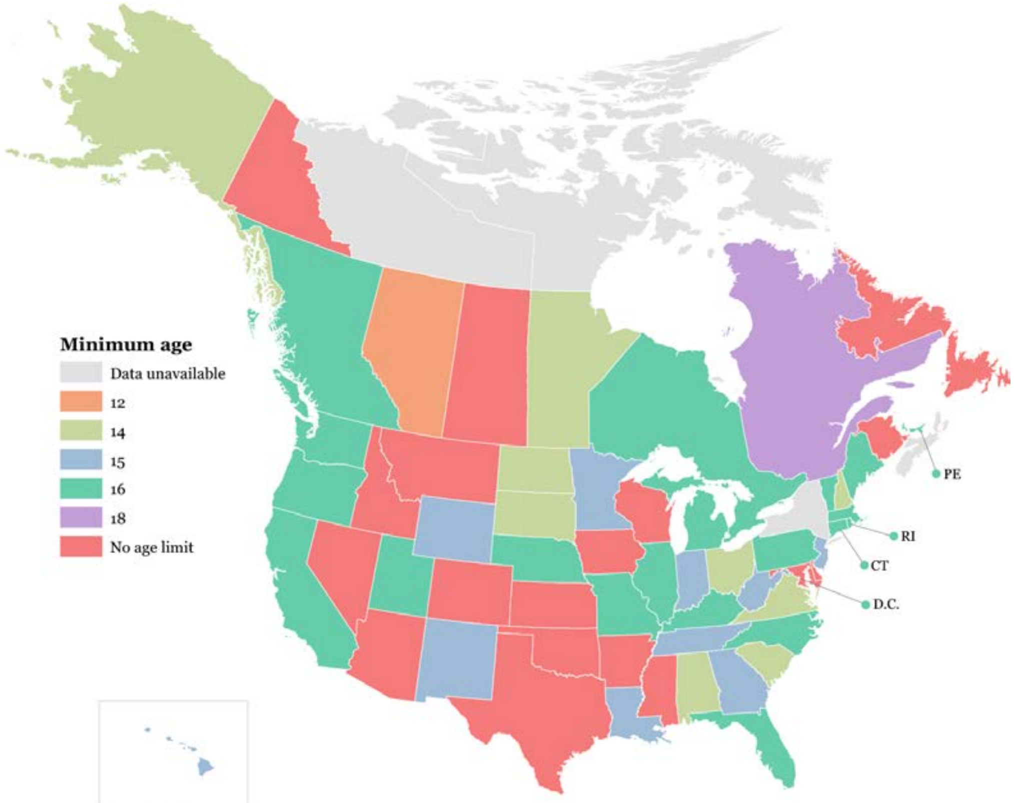

Figure 15: Minimum age of e-bike operation by province/state, Canada and U.S., Nov 2014.

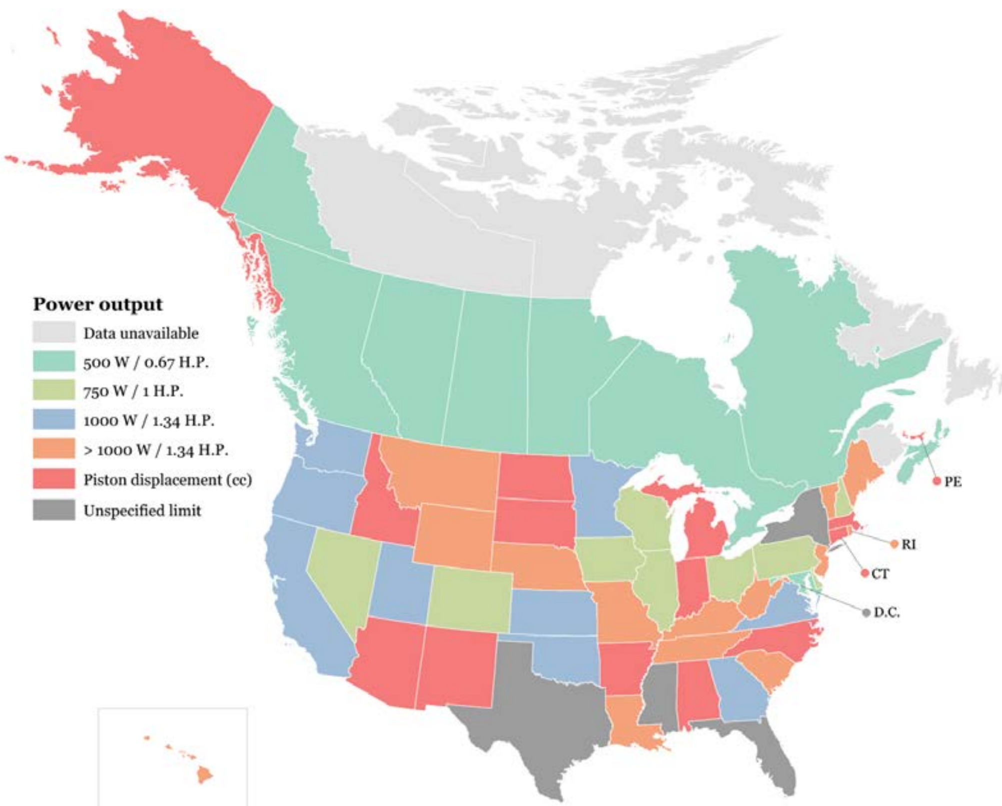

Figure 16: Maximum power output of e-bike motor by province/state, Canada and U.S., Nov 2014.

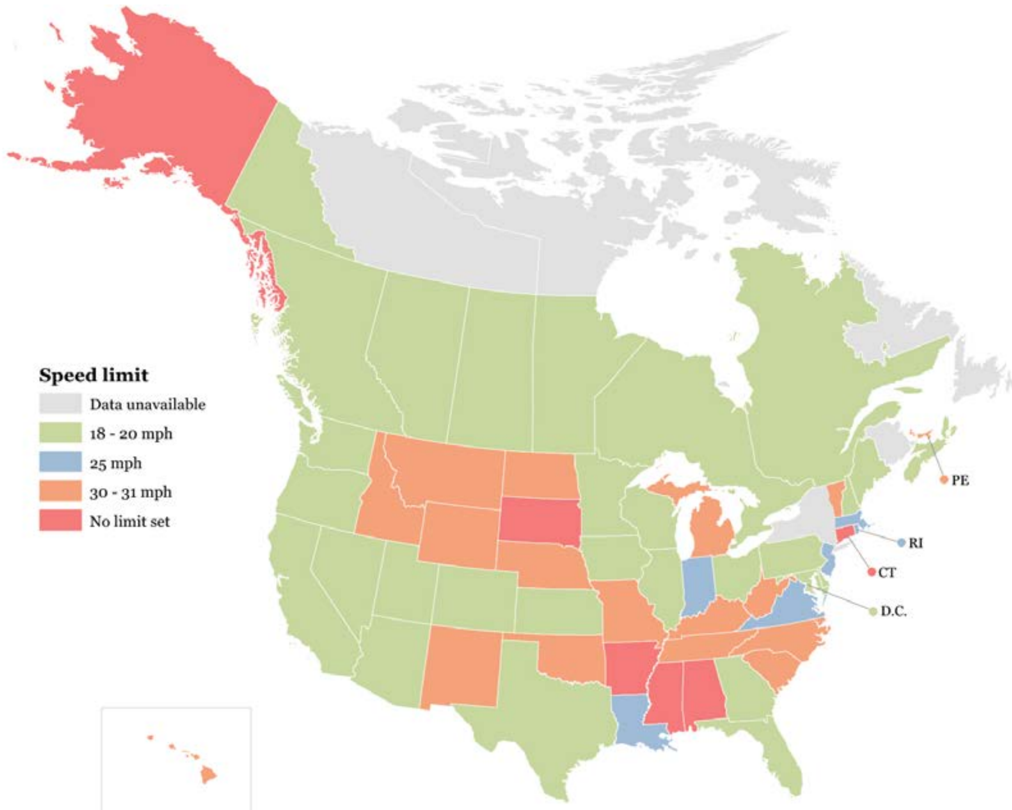

Figure 17: Maximum speed of e-bike operation by province/state, Canada and U.S., Nov 2014.

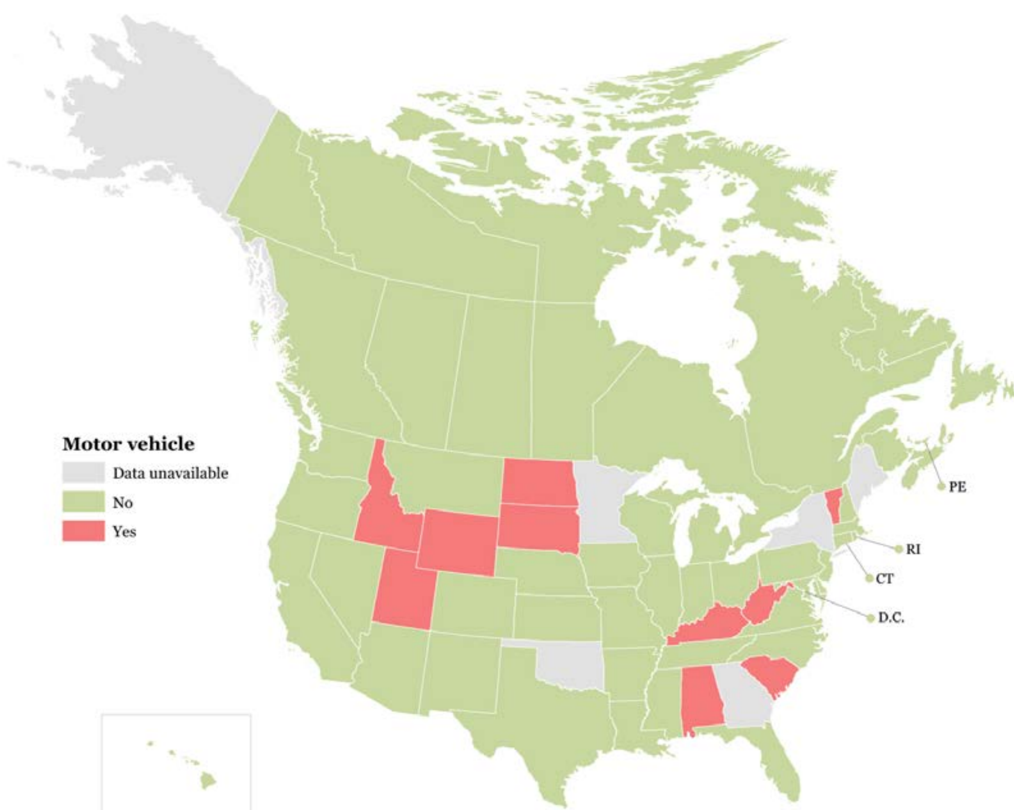

Figure 18: E-bikes considered "motor vehicles" by province/state, Canada and U.S., Nov 2014.

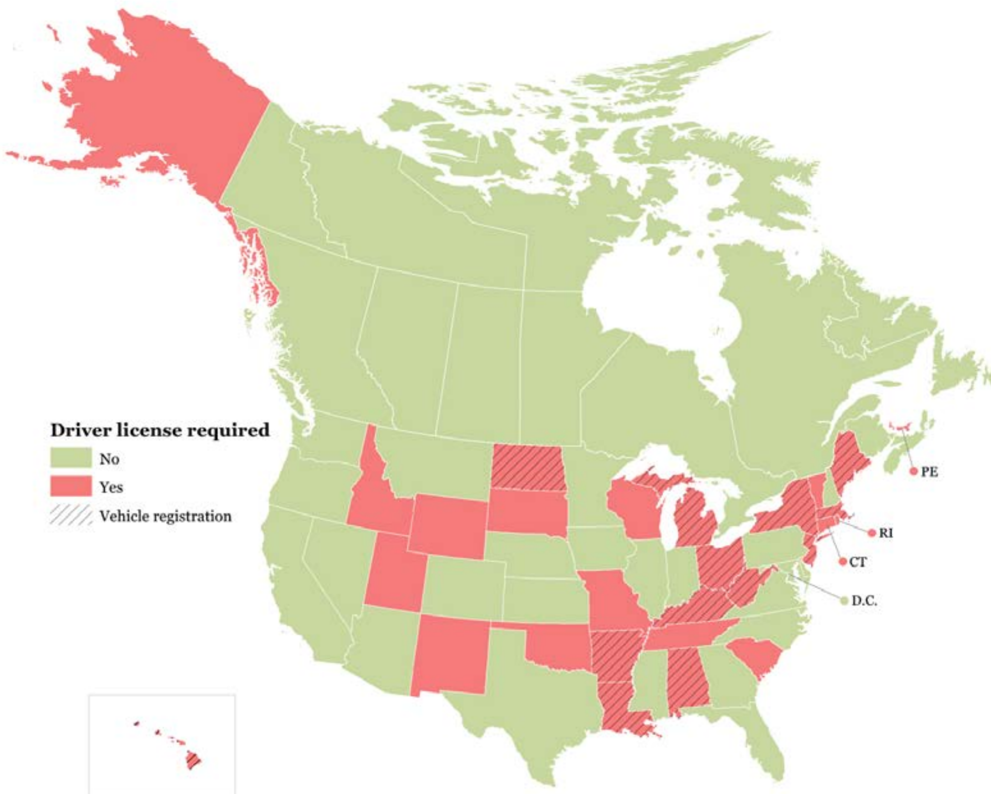

Figure 19: Provinces/states requiring operator license and vehicle registration for e-bikes, Canada and U.S., Nov 2014.

Specific examples in North America

In the text below, we look at how some cities and states classify e-bikes under the law. It should be noted that in some locations, current laws are being proposed to amend vehicle code or local traffic ordinances, including Park City, Utah, Chicago, Nebraska and New York State.

Province of Ontario

Federal agency Transport Canada defined *power-assisted bicycles* (PABs) in 2000. In 2009, Ontario passed Bill 126, which amended the definition of bicycle to include PABs. It also adopted *power-assisted bicycles* into its Highway Traffic Act (HTA). This legislation came after a pilot project was launched in October 2006 that sought to evaluate the use of PABs on public roads, highways and in places where standard bicycles were allowed. The definition of PAB is under the current HTA (Highway Traffic Act, RSO 1990, c H.8):

> "power-assisted bicycle" means a bicycle that:
> (a) is a power-assisted bicycle as defined in subsection 2 (1) of the Motor Vehicle Safety Regulations made under the Motor Vehicle Safety Act (Canada),
> (b) bears a label affixed by the manufacturer in compliance with the definition referred to in clause (a),
> (c) has affixed to it pedals that are operable, and
> (d) is capable of being propelled solely by muscular power.

The same law also requires the operator to be 16 years of age or older and to wear a bicycle or motorcycle helmet, but no insurance, registration or operator's license is required. The pilot project in 2006 provided feedback from stakeholders on a range of issues, and one of the primary concerns was safety. Ontario responded by providing additional specifications for e-bikes, found in O Reg 369/09. One requirement is that the PAB's maximum weight is 120 kg (265 lbs) or less (Power-Assisted Bicycles, O Reg 369/09).

City of Toronto

Although Ontario has permitted the use of PABs on public thoroughfares since 2009, the province does not have jurisdiction over bicycle lanes and multiuse paths of municipalities. In Toronto, municipal code prohibits motor-powered vehicles from operation in bike lanes and shared paths. As e-bikes have become more popular, the need to address the incongruence between the spirit of the law and the ban itself has become more pressing. Following a staff report on PABs, City Council adopted the policy proposed therein with amendments in February 2014 (Toronto Transportation Services, 2013). The policy amended three municipal by-laws—parks, bike paths, and traffic and parking—by replacing the definition of *bicycle* with the following (Toronto City Council, 2014):

> **BICYCLE** – Includes a bicycle, tricycle, unicycle, and a **power-assisted bicycle** which **weighs less than 40 kg** [88 lbs.] and **requires pedalling for propulsion ("pedelec")**, or other similar vehicle, but does not include any vehicle or bicycle capable of being propelled or driven solely by any power other than muscular power.

Pedelecs will be permitted wherever bicycles are permitted, except on sidewalks. Transportation Services, in consultation with power-assisted bicycle riders and retailers, cycling groups, and the Toronto Police Service will monitor for the next two years the operation of power-assisted bicycles in conventional bicycle lanes in order to identify any safety concerns. Toronto regulation clearly defines pedelecs and e-scooters, but e-bikes that have throttle-only motors or throttle modes are not allowed. The MVSA defines a *power-assisted bicycle* as "***capable*** of being propelled by muscular power," but Toronto's definition "does ***not*** include any vehicle or bicycle ***capable*** of being propelled or driven ***solely*** by any power ***other than*** muscular power." So an e-bike similar to the Currie iZip E3 (Figure 3) may be illegal because it is capable of being propelled or driven by motor power only.

State of Colorado

Colorado is one of nine states that have incorporated aspects of CPSC's definition of low-speed electric bicycles into its vehicle code. The definition of *electrical-assisted bicycle* is found in Colo. Rev. Stat. § 42-1-102 (2013):

> "Electrical assisted bicycle" means a vehicle having two tandem wheels or two parallel wheels and one forward wheel, **fully operable pedals**, an electric motor not exceeding **seven hundred fifty watts** of power, and a top motor-powered speed of **twenty miles per hour**.

Colorado requires neither an operator's license nor vehicle registration. There is no minimum age of operation, and helmets are not mandated by state law. Colo. Rev. Stat. § 42-4-1412 (2013) lays out the proper operation of bicycles and other human-powered vehicles, including electrical-assisted bicycles. From left turns to operation on sidewalks, this clause contains a fair amount of language to make cyclists feel informed. One other noteworthy fact is that e-cyclists are forbidden from engaging the engine on bike and pedestrian paths under the same clause:

> 14. Except as authorized by section 42-4-111 [powers of local authorities], the rider of an electrical assisted bicycle shall not use the electrical motor on a bike or pedestrian path.

Another clause implies the power of local jurisdictions to impose further restrictions on e-bikes, such as the use upon sidewalks:

> 10. […] (b) A person shall not ride a bicycle or electrical assisted bicycle upon and along a sidewalk or pathway or across a roadway upon and along a crosswalk where such use […] is prohibited by official traffic control devices or local ordinances. […]

In general, Colorado has been responsive and proactive to e-bikes by enacting these laws and establishing clearly the rules and responsibilities of riders.

City of Boulder, CO

Even though the state of Colorado has been responsive to developments in bicycle technology and their potential to reduce auto-dependency, the state still forbids road users from engaging the engine of *electrical-assist bicycles* on shared-use paths. In an effort to further the "complete streets" focus of the city's Transportation Master Plan (TMP), the City of Boulder announced a pilot program in August 2013 to allow e-bikes on multiuse paths, but not open-space trails (Boulder, CO, 2013). After a City Council unanimously approved the pilot in late October 2013, and from Feb. 7-Dec. 31, 2014, e-cyclists will be permitted to turn on the throttle of their e-bikes on designated multiuse paths.

State of New York

New York State has an outright ban on the use of e-bikes on any public thoroughfare. Dissenters are subject to arrest. Posted to their webpage on recreational vehicles, NYS DMV states (New York DMV, n.d.):

> **Motorized devices that cannot be registered in New York**
> You cannot register any of the motorized devices from the list below in NYS. You cannot operate these devices on sidewalks, public streets or highways in NYS. These devices are motor vehicles, but they do not have the correct equipment or design for operation on roadways. [...]
>
> **Motor-assisted Bicycle** - a bicycle to which a small motor is attached. A motor-assisted bicycle does not qualify for a registration as a motorcycle, moped or ATV and does not have the same equipment.

These devices are not allowed on any street, highway, parking lot, sidewalk or other area that allows public motor vehicle traffic. You are subject to arrest if you operate one of these motorized vehicles and do not have a registration, driver's license, inspection, insurance or correct equipment. The DMV cannot provide any information about operation of these devices on private property. Contact the local authorities and property owners.

It appears that New York State insists on having e-bikes registered using the VIN system. However, NHTSA, the federal agency responsible for issuing VINs, acknowledges the CPSC definition of low-speed electric bicycle, which is not a motor vehicle pursuant to 49 U.S.C. § 30102(a)(6). After all, bicycles are not provided a VIN by NHTSA. Many states assign VIN numbers to homemade vehicles and in other scenarios, but New York DMV refuses to assign a VIN to *motor-assisted bicycles*.

New York State Assembly and Senate have had various bills proposed over the years seeking to define *electric-assisted bicycles*.[22] The most recent bill is active in the 2014

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[22] In the Assembly, Bills A00091-2001, A00588-2003, A00071-2005, A00189-2007, A02393-2009, A01350-2011, and A01618-2013 all sought to define *electric-assisted bicycle*. In each session, the Assembly voted nearly unanimously in favor of amendment, but the bills all died in the Senate through inaction.

session (A1618A-2013 and S390A-2013)[23] to amend the vehicle and traffic code in relation to the definition of electric-assisted bicycle and to bring New York in line with the CPSC definition. The bill's text does have one unique clause about use, where "no person less than sixteen years of age shall operate or ride as a passenger upon an *electric assisted bicycle*." This brings into question the use of electric cargo bikes that are used to carry small children.

New York City

New York City has an entirely different experience with e-bikes. The city's problem is that too many speeding messengers and food-delivery persons on e-bikes and e-scooters zoom down the crowded sidewalks, which poses a threat to pedestrians' safety (New York Office of Communications, 2013; Singer & Kilgannon, 2011). However, the city decided to make a sweeping ban on electric bicycles through Local Laws 2013/40 and 2013/41 (New York City, 2013a, 2013b).

Local Law 2013/40 defines *motorized scooter* to include powered bicycles (PB e-bikes):

> (a) […] The term "motorized scooter" shall mean any wheeled device that has handlebars that is designed to be stood or sat upon by the operator, is powered by an electric motor or by a gasoline motor that is capable of propelling the device without human power and is not capable of being registered with the New York State Department of Motor Vehicles.

Local Law 2013/41 turns the focus toward *commercial* enterprises, stating:

> (k) A business using a bicycle for commercial purposes shall not possess any motorized scooter and shall not permit any employee of such business to operate such a motorized scooter on behalf of such business. A business using a bicycle for commercial purposes shall be liable for any violation of section 19-176.2(b) of this code committed by an employee of such business while such employee is operating a motorized scooter on behalf of such business.

Although New York City has recently doubled the fine for using motorized scooters on public thoroughfares. Power-assisted bicycles, which are not capable of propelling the bicycle *without* human power, seem to be exempt from this definition. But PABs are subject to state laws, and New York State still has a ban on any bicycle with a motor.

State of Michigan

While New York City has a clear stance on e-bikes, Michigan's law is ambiguous toward electric bicycles. The problem here is that Michigan vehicle code definitions are completely irrelevant to electric bicycles, but those definitions still govern the use and requirements for e-bikes.

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[23] Progress on the bill can be viewed at http://open.nysenate.gov/legislation/bill/S390A-2013 and at http://assembly.state.ny.us/leg/?bn=A01618&term=2013.

The Traffic Services Section of the Michigan State Police released Field Update 26 in 2006, which claimed that electric bicycles meet the state's definition of both *motor vehicle* and *moped* (Michigan State Police, 2006). Michigan Department of Transportation (MDOT) defines a *motor vehicle* at Mich. Comp. Laws § 257.33 (2013):

> "Motor vehicle" means every vehicle that is **self-propelled** [with exceptions].

And *vehicle* is defined under Mich. Comp. Laws § 257.79 (2013):

> "Vehicle" means every device in, upon, or by which any person or property is or may be transported or drawn upon a highway, **except devices exclusively moved by human power** [and other exceptions].

MDOT defines a *moped* at Mich. Comp. Laws § 257.32b (2013):

> "Moped" means a 2- or 3-wheeled vehicle to which **both** of the following apply:
> (a) It is equipped with a motor that **does not exceed 100 cubic centimeters piston displacement** and cannot propel the vehicle at a speed greater than 30 miles per hour on a level surface.
> (b) Its power drive system does not require the operator to shift gears.

Furthermore, mopeds must be registered with the Michigan Secretary of State and outfitted with headlights, turn signals, a horn, and brake lights, among other specifications. Applicants seeking to register their e-bike as a moped must provide a VIN number or allow the Secretary of State to assign a VIN.

Field Update 26 has two problems. First, because some e-bikes, specifically PABs, are not *self-propelled*, MDOT's definition of *motor vehicle* doesn't adequately include this hybrid, *assistive* technology. It is unclear whether there is any distinction between PBs and PABs under Michigan Comprehensive Laws. Second, the scope of MDOT's definition of *moped* would appear to be limited in scope to vehicles with internal combustion engines because it specifies a maximum cubic centimeter piston displacement (cc). E-bikes do not have an internal combustion engine specifically because they are electric, which makes irrelevant the specification for piston displacement. This ambiguity makes it seem as though e-bikes *cannot* be mopeds because they do not meet both of the specifications (a and b) of *moped*. However, e-bikes are in fact equipped with a motor that does not exceed 100 cc because there is *no* piston displacement.

State of Oregon

Oregon is one of several states that have specifically codified e-bikes into law. Oregon Department of Transportation (ODOT) defines an electric-assisted bicycle at Or. Rev. Stat. § 801.258 (2013):

> Electric-assisted bicycle means a vehicle that:
> 1. Is designed to be operated on the ground on wheels
> 2. Has a seat or saddle for use of the rider

3. Is designed to travel with not more than three wheels in contact with the ground
4. Has both **fully operative pedals** for human propulsion and an electric motor
5. Is equipped with an electric motor that
    a. Has a power output of not more than **1,000 watts**
    b. Is incapable of propelling the vehicle at a speed of greater than **20 miles per hour** on level ground

ODOT has even elucidated any potential ambiguity in its definition of a moped, at Or. Rev. Stat. § 801.345 (2013):

> Moped means a vehicle, including any bicycle equipped with a power source, other than an electric assisted bicycle as defined in ORS 801.258 (Electric assisted bicycle) or a motor assisted scooter as defined in ORS 801.348 (Motor assisted scooter) [...]

Furthermore, Or. Rev. Stat. § 814.405 (2013) establishes electric assisted bicycle as a bicycle under law:

> **Status of electric assisted bicycle.**
> An electric assisted bicycle shall be considered a bicycle, rather than a motor vehicle, for purposes of the Oregon Vehicle Code, except when otherwise specifically provided by statute.

The state does have some exceptions on the operation of e-bikes. Or. Rev. Stat. § 814.410 (2013) forbids using e-bikes on sidewalks. Or. Rev. Stat. § 807.020 (2013) sets the requirement of age at 16.

City of Eugene, OR

Home to the University of Oregon, the city of Eugene has a slightly different stance on e-bikes than ODOT. In 2005, Ordinance No. 20340 (2005) made several amendments to Eugene Code (E.C.) regarding motorized transportation devices. The city lumps all vehicles with any motor into one definition at E.C. 5.010:

> **Motorized transportation device.**
> Any vehicle that is not propelled exclusively by human power, including but not limited to, an **electric assisted bicycle** (when not being operated by human propulsion), an electric personal assistive mobility device, a moped, a motor assisted scooter, a motor vehicle, a motorcycle, a motorized skateboard, any similar vehicle that operates without human propulsion.

Ordinance No. 20340 (2005) also made it illegal to operate an e-bike on an off-street bike path at EC 5.160:

> **Unlawful Use of Motorized Transportation Device.**
> 1. No motorized transportation device may be operated on any city owned off-street bicycle or pedestrian path or trail, unless exempt. A motorized transportation device

> is exempt from this provision if it is used as a mobility aid by a person with a mobility impairment, used by a person with express permission from the City, or used by a City employee or agent in the course of City business.

The ordinance emerged at a time when the city saw an increase in several newer forms of motorized transportation, from gas-powered scooters to electric bicycles. The problem was that many residents who enjoyed walking along off-street nature trails felt that these new motorized devices detracted from the experience and beauty of the natural scenes along the trails. Among the worst were motorized scooters, which emitted noxious fumes and were a noisy nuisance. Residents reported their concerns to the city, and the conversation followed local police. The police department felt it would be too difficult to discern one type of motor from another for the purposes of enforcement. The city thus re-classified all vehicles with a motor as a *motorized transportation device* and forbid their operation on trails. Although cyclists can still pedal their e-bike down bike and pedestrian paths, they are forbidden to engage the motor.

There are efforts in the making to change this law, which are being spearheaded by Lee Shoemaker, Eugene's Bicycle and Pedestrian Coordinator. In November 2013, Shoemaker helped host an open house to hear public comments on a proposal to allow electric-assisted bicycles to be operated on off-street, shared-use paths. Although there were 15 yeas and five nays, some of the comments reflected a lack of understanding about what an e-bike is and how it is used (Personal correspondence, 2013). One commenter even voiced concern over fumes and noise, which suggests she/he anticipated a gas-powered engine. In July 2014, City Council voted to allow e-bikes on off-street bicycle and pedestrian paths/trails.

Discussion

A scan of the regulations and definitions used for e-bikes shows the vastly differing terms and requirements for electric bikes. It is clear how easily confusion can arise. First, there is a perceived contradiction between the federal "definition" and how state bodies classify and govern the use of e-bikes. Second is the general lack of e-bike-specific definitions at the state level for most states, which tend to lump e-bikes into classifications such as *moped* or *motorized cycle*. When definitions do exist, they are often inappropriate, convoluted or inconsistent with information available on DOT and DMV websites. Lastly, there is sometimes contention between how states define and govern e-bikes and how municipal governments do so within their jurisdictions.

Confusion at federal level

Some of the clauses used regarding e-bikes by CPSC and NHTSA have led individuals to think that the federal rules "supersede" state laws. As discussed above, these rules are limited only to safety standards of manufacture because the regulatory bodies' jurisdictions do not extend beyond the purview of their roles as standard-enacting federal agencies.

Despite this separation of powers, it is common to find e-bike dealers and distributors encouraging their customers to print what they see as the "federal definition" and carry it with them when they ride in case of any run-ins with police officers.[24] Although a copy of P.L. 107-319 might be convincing to a less-informed police officer, this interpretation demonstrates a lack of understanding of federal law, the role of certain federal agencies, and the interaction of federal law with state law. This also places a burden on dealers and distributors, who may not have the (legal) resources to parse through convoluted clauses. More importantly, however, it highlights the defensive and proactive approach riders must engender in order to establish themselves and their vehicle as a legitimate and properly regulated mode choice.

There is also the question of e-bikes not meeting the definition set by CPSC and NHTSA. Not all possible forms of e-bikes are encompassed by the federal definition, and new forms of transportation continually emerge. Firstly, what if an e-bike isn't manufactured and first sold as a *low-speed electric bicycle*, as defined by CPSC? Research recently completed by Portland State University surveying existing e-bike users in North America shows that 52 percent of e-bike owners converted their standard bicycle to an electric-assist bicycle (MacArthur, Dill & Person, 2014). These e-bikes were first purchased as a bicycle and later outfitted with an electric motor. Thus, CPSC is limited in its capacity to regulate the technology.

Secondly, there is a potential that e-bike manufacturers claim their products are not primarily for use on public thoroughfares. We did not find any legislative framework that would cover such e-bikes, as NHTSA does not regulate off-road vehicles such as ATVs or low-powered scooters/skateboards. The result is that manufacturers can produce non-standard e-bikes that may or may not be street legal, depending on the locality. Our analysis of how states define e-bikes discovered that 23 states set a maximum power output of 1,000 watts or greater (1.34 horsepower), which is above the 750-watt (1-horsepower) limit set by CPSC. Is this a safety standard that CPSC shall supersede, or does it qualify the device as something that's no longer a *low-speed electric bicycle*?

These scenarios present a problem because the law does not articulate clearly the various types of e-bikes and the way people currently use them. This creates uncertainty for manufacturers and distributors, as well as potential costly lawsuits for operators using non-standard bicycles on public thoroughfares.

Confusion at state level

As we have seen, the classification and identification of e-bikes varies widely by state (and, to a lesser extent, the Canadian provinces). An e-bike could be a bicycle, a moped, a motorized bicycle, a motor-driven cycle, a motorcycle, a motor vehicle, have its own definition, or none of these. But what about those states that have no definition of an e-bike? Certain states such as New Jersey, Michigan and New York (and others) do not allow for any middle ground between bicycles and motorcycles. The capability of motorized propulsion is enough for any two-wheeled vehicle to fall under motorcycle/moped

[24] Examples of dealers, distributors and manufacturers who advise patrons incorrectly about P.L. 107-319 are numerous, and include PAElectrics.com, High5Scooters.com, ShockingRides.com, and ScooterCatalogue.com, among others.

classification. The issue in such states is the lack of deference given to low-powered vehicles that do not require strict regulation.

Other states have more focused legislation that complies with the main premise of the federal definition, yet differs in several aspects (Table 4 above). Virginia, for example, requires pedals, an electric motor, and has legislation specifically designed to meet the requirements of the electric pedal assisted bicycle; however, the maximum speed and power exceed federal limits. Other states, like Texas, may meet the power and speed requirements, but do not require functional pedals or an electric motor. The issue in these states is whether that state recognizes the e-bike or simply uses existing moped laws, which are not tailored to the needs of cyclists.

There is also the question of the subtle distinction between "human powered" and "*solely* human powered" when defining bicycles and vehicles. The way Colorado amended its definition of bicycles in 2009 following House Bill 1026—the same bill that provided the definition of *electrical-assisted bicycle*—has implications for how other states' definitions of *bicycle* might actually encompass e-bikes. H.B. 1026 amended the definition of *bicycle* by striking the word "solely" from before "human powered" (Colorado Legislature, 2009):

> 10. "Bicycle" means ~~every~~ a vehicle propelled **~~solely~~** by human power applied to pedals upon which ~~any~~ a person may ride having two tandem wheels or two parallel wheels and one forward wheel, all of which are more than fourteen inches in diameter.

Because legislators intentionally deleted the requirement that the bicycle be exclusively human powered in the same bill they added the definition of e-bike to, this implies that bicycle-like devices which might have a motor or other assistive device to propel the bike, including electrically assisted bicycles, are indeed bicycles. Unless otherwise stated, wherever a law applies to a bicycle, it would apply to an e-bike, too.

Does that mean, then, that in states that omit the phrase "solely/exclusively [human powered]" when defining the term *bicycle*, e-bikes are considered to be bicycles? Finding the answer is something that may baffle even the most adept vehicle code attorneys. It partly depends on how other terms, like *motor vehicle* and *vehicle*, are defined, as well as the type of e-bike in question (i.e., throttle- vs. pedal-assist), as in the city of Toronto. If the motor disengages when the cyclist stops pedaling, then the device could arguably be "human powered." Whether this would stand in court is beyond the scope of this paper.

For the 20 states that do have definitions that are relevant to e-bikes, several have conflicting information. Taking the Colorado example further, when H.B. 1026 amended several codes, the definition of motor vehicle was amended as follows:

> 58. "Motor vehicle" means any self-propelled vehicle ~~which~~ that is designed primarily for travel on the public highways and ~~which~~ that is generally and commonly used to transport persons and property over the public highways; ~~but~~ except that the term does not include [...] **vehicles moved solely by human power** [...]

The legislature took time to amend bicycle to include *electrical-assisted bicycle* through striking the word "solely," but did not do the same for *motor vehicle*. So are e-bikes motor vehicles in Colorado? The city of Broomfield, CO, has a different take on the definition. Their website claims that *electrical-assisted bicycles* are not defined as motor vehicles and thus do not require a driver's license (Broomfield official website, n.d.):

> **Are riders of electrical assisted bicycles required to have a driver's license?** NO. Colorado Revised Statute 42-2-103 requires that the operator of a motor vehicle, including motorcycle and low-power scooter, obtain a driver's license. **Electrical assisted bicycles are not considered or defined as a motor vehicle and no license is required.**

The city of Broomfield may very well be providing the correct interpretation, but this highlights the contradictory nature of e-bike laws.

The significance of "solely [human powered]" hinges on the states of Utah and Oklahoma, which have an identity for electric bicycles but do not classify the device consistently relative to other states. In Utah, the classification is cyclical: an *electric-assisted bicycle* is defined as a *moped*, which is defined as a *motor vehicle*. However, the definition of *bicycle* includes *electric-assisted bicycle*, and Utah Code § 41-6a-102 (34)(b) (2013) states that a *motor vehicle* "does not include vehicles moved solely by human power." As a *bicycle*, is an *electric-assisted bicycle* allowed in bicycle lanes or sidewalks? As a *motor vehicle*, is the operator required to be licensed? The law is contradictory and creates considerable confusion for the cyclist who seeks to be compliant.

Oklahoma is similarly unclear. *Electric-assisted bicycles* are defined as bicycles, and they are allowed on multi-use paths, bicycle lanes and sidewalks. They do not require registration, and there is no minimum age. However, e-cyclists are required to have a driver's license to operate an *electric-assisted bicycle*. Again, a *motor vehicle* is any self-propelled vehicle except those moved solely by human power in Oklahoma (Okla. Stat. tit. 47 § 1-134, 2013), so does that include *electric-assisted bicycles*? If so, how are these motor vehicles permitted to operate on sidewalks, especially considering they are allowed to reach speeds of up to 30 mph?

The need for uniformity of state e-bike regulation is clear. Several states seem to have laws that are appropriate and proportional yet fall short by requiring helmets, age restrictions, and licensing and registration of the vehicle and rider. For many e-bike advocates, the ideal situation would apply legislation to bicycles and low-speed electric bicycles equally, providing riders of low-speed electric bicycles the same rights and restrictions as the standard cyclist. But this equivalence is something still in question by the general public, policymakers, some bike and pedestrian advocates, and public safety officials.

What constitutes an e-bike?

The confusion at the state and federal levels can be attributed partially to the ambiguity of the laws. The definition laid out by CPSC covers three requirements: speed, power and pedals, though there is no consensus or details on the meaning of "functional pedals." States and provinces often include these same requirements. What are not specified is size, weight, geometry and assistance ratios, leaving an incredible amount of flexibility in the law. Manufacturers have taken advantage of that flexibility by supplying the market with vehicles that—though technically *low-speed electric bicycles* (U.S.) or *power-assisted bicycles* (Canada)—look nothing like a bicycle. Indeed scooter-style electric bicycles (SSEBs) that meet the federal and state/provincial definitions often don't require a driver's license and vehicle registration, which makes them a popular alternative to higher-powered mopeds, scooters and motorcycles,[25] particularly for those people who have never been licensed or who have lost their license because of DUIs or other reasons. This raises several questions. What makes an e-bike an *e-bike*? Can we reasonably expect law enforcement to become aware of all forms of e-bikes in order to carry out the law? Can the existing framework enable policymakers to write the most appropriate legislation for the use of e-bikes?

The concerns raised here are not hypothetical, and one case in Oregon helps to illustrate the tension caused by SSEBs and law enforcement. In 2011, Springfield Police stopped and cited rider Paul McClain six times for operating a motor vehicle without a driver's license (McCowan, 2011b). McClain's license was revoked several years earlier for operating a motor vehicle without insurance. The last citation, issued by Officer Michael Massey on March 24, 2011, caused McClain to argue in court *pro se* that his vehicle was no motor vehicle at all, rather a fully compliant *electric-assisted bicycle*. Indeed, the vehicle met ***most*** of the requirements fitting the definition of electric-assisted bicycle under Or. Rev. Stat. § 801.258 (2013). The outward appearance struck the officers as more of a moped than an electric bicycle. One officer felt that if you're not pedaling the bicycle, it becomes a motor vehicle under law (McCowan, 2011a). The "e-bike" was, after all, a scooter-style electric bicycle (Figure 20). The case made its way to District Court, where Senior Judge Raymond White ruled that, due to a missing pedal, the vehicle was rendered a *motor vehicle* under Or. Rev. Stat. § 825.005 (9) (2013). McClain was found guilty of operating a motor vehicle on a suspended license.

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[25] Though this paper tries to show the differences between electric bicycles and other devices, such as scooters, mopeds, etc., and the need for specific recognition for e-bikes in state regulations, the authors recognize that these other devices are important transportation vehicles and should be promoted where appropriate.

Figure 20: Photograph of McClain's scooter-style electric bicycle with a broken pedal. The imprint reads *XL500W*, which corresponds to an EW-600 model of manufacturer Electric Wheels.
Image source: Officer Michael Massey, Springfield Police, edited by authors.

This case is more complex than initial observation and lends itself well to other cases in which an individual was operating an e-bike without a grant of driving privileges. It had potential to set a precedent as to what constitutes an e-bike and whether operating an e-bike on a suspended license was forbidden. But what would have happened if the pedals had been fully operable? Or what if the pedals were removed and stored under the seat, as one Ontario man did in 2012 (R. v. Pizzacalla, 2013 ONCJ 31). In this case, which landed in provincial court, the judge ruled in favor of the defendant, wherein a "defective or incomplete" *power-assisted bicycle* did not inherently elevate to the status of a motor vehicle. Some kinds of e-bikes may push the intent of the law. But the question of whether it is still appropriate on bicycle infrastructure is still open to debate. As more vehicles emerge that push the extent of the law, the need to draw a line between motor vehicles and electric bicycles will grow.

The question of whether riders with suspended driver licenses are allowed to operate e-bikes is another area of uncertainty. In Oregon, Or. Rev. Stat. § 807.020 (2013) specifies that although no driver's license is required, the operator must be *eligible for* a license:

> **Exemptions from requirement to have Oregon license or permit.**
> A person who is granted a driving privilege by this section may exercise the driving privilege described without violation [...] A grant of driving privileges to operate a motor vehicle under this section is subject to suspension and revocation the same as other driving privileges granted under the vehicle code. [...] The following persons are granted the described driving privileges:
>
> 1. [...] A person is **not granted driving privileges** under this subsection:
>   a. If the person is under the minimum age required to be eligible for driving privileges under ORS 807.060 (Eligibility); [or]
>   b. **During a period of suspension or revocation** by this state or any other jurisdiction of driving privileges or of the right to apply for a license or driver permit issued by this state or any other jurisdiction; [...]

14. A person may operate a bicycle **that is not an electric assisted bicycle** without any grant of driving privileges.
15. A person may operate an electric assisted bicycle **without a driver license or driver permit** if the person is 16 years of age or older.

In extended correspondence with the Oregon Department of Motor Vehicles, they stated that the legality of riding an e-bike with a suspended license is left up to law enforcement and the courts, and that the DMV does not provide information on whether law enforcement or courts can cite/convict people. Essentially, some law enforcement agencies will cite and convict while others will not. This does not lend confidence to riders who have been convicted of DUIs.

While some may argue the revocation of a license is both punitive and remedial, others might argue the fines and other sanctions associated with DUI convictions are the punitive portion; the revocation is remedial for the sake of public safety. Following the latter argument, if e-bikes are similar to standard bicycles in terms of potential for inflicting harm, does the remedial function of license revocation have any relevance for e-bikes?

IMPLICATIONS

More people participating in cycling can help alleviate environmental, traffic and public health concerns. More manufacturers producing electric bicycles can help increase and diversify the economic base of cities across the nation and provide family-wage jobs. If we want the benefits of cycling and of an emerging industry, it is important to have a standardized definition and uniform regulation of e-bikes at state and federal levels. E-cyclists should be able to cross borders without fearing harassment, confusion or penalties. Manufacturer's should feel confident about expanding their markets and not have to worry about the legal status of their product. The need for standardization is pressing, and policymakers must determine the appropriate requirements for e-bikes.

Unclear legislation and a lack of agreement about what exactly constitutes an e-bike is cause for uncertainty over the proper and legal use of e-bikes. What, then, are the ramifications of that uncertainty?

E-bikes are not mopeds and should have their own regulations

E-bikes are neither mopeds nor scooters. Although e-bikes are typically heavier than the average bicycle due to the battery and motor, these components are becoming lighter and lighter, which brings them more in line with standard bicycles than devices that weigh several times more. Moreover, the maximum possible speed of electric bicycles pales in comparison to that of mopeds, scooters and motorcycles. We learn early in school that kinetic energy varies directly with mass and velocity squared and that force is the product of an object's mass and acceleration. The mass and maximum velocity (and hence acceleration) of an e-bike are significantly lower than a moped or motorcycle. Assuming the risks of bodily harm are a major component in the formation of vehicle legislation, why do 24 states lump electric bicycles in the same category as mopeds or scooters? What kinds of issues does this create?

Recall the distinction between bicycle-style electric bikes (BSEB) and scooter-style electric bikes (SSEB). These broad categories provide us with conceptual frameworks for considering e-bikes, which exist on a spectrum rather than a rigid classification. But this is imprecise for policy making and legislation, particularly when dealing with bicycle infrastructure. Do the definitions of e-bikes need to be made clearer to either broaden or narrow the interpretation? Or does a multi-criteria analysis of e-bikes need to be implemented, which accounts for the differences in speed, functional pedals, weight, geometry, function, power, etc.? The Volkswagen concept e-bike, *Bik.e,*[26] is an electric velocipede—that is, it has no pedals but is similar in geometry and weight to a standard bicycle. Another example is the SOLARped,[27] which has four wheels and a top cover. Many of the definitions of e-bikes limit bikes to two or three-wheeled devices. It is arguable that such devices are suitable for bicycle infrastructure, but the lack of operable pedals or the geometry raises questions about how to classify them.

One issue is a clear gap between the prescribed safety requirements for electric bicycles and the actual risk posed to the safety of e-bike riders and others. Additional requirements discourage the (legal) use of electric bicycles, which is one way to allow a broader participation in cycling. In states like Michigan, the additional requirements are particularly onerous: a headlight that illuminates objects at least 100 feet ahead; a horn audible from at least 200 feet away; a tail light; a brake light; a rear-view mirror; a permanently mounted seat; and handlebar geometry. Some states may require DOT FMVSS 218 approved helmet which would make bicycling difficult and excessive for bicycling speeds. Without even considering the cost imposed on the consumer for bringing an e-bike into compliance, how does the state of Michigan view these requirements as necessary for safe operation? Indeed, if the requirements *are* considered necessary for safe operation, why aren't they required for standard bicycles, which are more similar to e-bikes than e-bikes are to mopeds? The point is that definitions and requirements of vehicles should be based on factual safety considerations that take into account the vehicle's weight and speed.[28]

Incidental to the safety gap is another issue: liability. Draconian rules may seem incredulous to e-bike cyclists, who react by thinking the law doesn't apply to their bicycle. A Michigan resident might read the definition and requirements of a moped and believe it impossible for brake lights and a fixed seat to be required of their electric bicycle. This belief is consistent with reports of e-bike distributors claiming that CPSC's definition of *low-speed electric bicycle* "supersedes" states' definitions (see footnote 24). But in reality, the consequences for disobeying these requirements can be severe. It leaves the operator exposed to the risk of expensive lawsuits in the event of an accident, particularly if it involves a pedestrian. It also leaves the cyclist with little recourse for accidents where the

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26 Electric Bike by Volkswagen Auto China 2010: https://www.youtube.com/watch?v=sXhhWXw9V7A
27 http://store.rhoadescar.com/SOLARped_c_16.html
28 Regulating the power output of electric motors is an indirect way to control safety, usually measured in (brake) horsepower or watts. As the vehicle weight (or weight of rider) increases and the power output remains constant, the maximum achievable speed decreases, which in turn affects kinetic energy.

cyclist was not at fault, for their case may be more easily dismissed if they were operating non-compliant equipment.

It's not just inconvenience and financial risk that result from conflating e-bikes with scooters and mopeds under law. Another issue is that the true parameters for safe operation are not communicated to e-bike users. Although e-bikes can be more similar to bicycles than they are to scooters, they are indeed not bicycles. Relative to bicycles, specific locations may need to impose more stringent regulations on e-bikes. For example, in a city that has frequent interaction between cyclists and pedestrians, a valid concern is that pedestrians might see a bicycle not being pedaled and think it is slowing down. In reality, it could be an e-bike being accelerated via the throttle. Such a city might dutifully permit only pedal-assist bicycles (PABs) and prohibit throttle-assist e-bikes (PBs), as Toronto and European countries have done. However, implicit in lumping e-bikes with scooters and mopeds is the assumption that there are no divergent safety considerations beyond what is stated in the law. These nuances can only be appreciated when e-bikes are fully recognized as a vehicle separate from mopeds and scooters.

E-bikes should be given (most of) the same rights as bicycles

In addition to the issues caused by the lack of standardization of electric bicycle definitions and requirements, the manner in which e-bikes ought to be used brings up other concerns. Where should they be permitted or prohibited from operating, and how fast should they be set at? What kind of burden do electric bicycles place on bicycle infrastructure? Is there a difference between PBs and PABs that should be acknowledged by policies? Does it matter if an e-bike has pedals? As more people start to participate in biking, situations will arise that will require the answers to these questions.

Devices that go faster than 20 mph probably do not belong in bicycle lanes and shared-use paths. But it's an open debate about where e-bikes belong if they travel slower than 20 mph, and it is especially debatable and contentious if they don't look like a standard bicycle (i.e., they are SSEBs). However, in general, the design of shared-use paths[29] accommodates electric bicycles. The American Association of State Highway and Transportation Officials (AASHTO) specifies a 14-mph minimum and a 30-mph maximum design speed for shared-use paths in their bicycle facilities guide, with a generally sufficient design speed of 18 mph (AASHTO, 2010). The mean speed of cyclists in one study was 11 mph, with a standard deviation of 3.7 mph—the 85th percentile was 14 mph (Landis, Petritsch & Huang, 2004). Only 1 percent of bicyclists observed exceeded 20 mph (ibid). This is mostly consistent with AASHTO's performance criteria for upright adult cyclists on paved level terrain, which ranges from 8-15 mph; physically fit cyclists can reach speeds of 30 mph or higher (AASHTO, 2010). If low-speed electric bicycles are not allowed to be on bicycle infrastructure because of their speeds, it does create additional safety issues if they are forced into vehicle traffic lanes.

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[29] A shared-use path is defined as, "a bikeway physically separated from motor vehicle traffic by an open space or barrier and either within the highway right-of-way or within an independent right-of-way. Shared-use paths may also be used by pedestrians, skaters, wheelchairs users, joggers, and other non-motorized users. Most shared-use paths are designed for two-way travel," (AASHTO, 2010).

These standards and statistics show that shared-use paths meeting AASHTO standards can easily accommodate e-bikes. Although reports of actual e-bike speeds are sparse in the literature, one study documenting an electric-bike sharing system showed that both the average speed and maximum speed of e-bikes were slightly higher (approximately 3 mph) than standard bicycles (Langford, 2013). This is consistent with anecdotal evidence of e-bike speeds. There is a design-cost tradeoff between the quality and efficiency of the pedal chain drive and the inclusion of electrical components, such as the motor, battery and sensors. The weight and inferior chain-drive components of e-bikes requires more physical exertion to attain speeds higher than the maximum motor output relative to standard bicycles. This means that the variance of e-bikes' speed is likely lower than standard bicycles. One study in Sweden showed a much lower variance of e-bike speeds compared to standard bicycles, though reported average speeds were higher (Dozza, Werneke & Mackenzie, 2013). Transportation planners and policymakers must evaluate their bicycle facilities to determine if electric bicycles ought to be permitted. However, in order for planners and policymakers to rationally evaluate the potential impact of e-bikes on their facilities, more robust data on e-bikes must be available. Manufacturers must test the speed, weight and other characteristics of their e-bikes and publish their results. Simultaneously, transportation researchers ought to collect on-the-ground data for e-bikes to help determine the true differences between e-bikes and standard bicycles.

Another concern planners must face is whether there is a meaningful difference between PBs (pedaling not required) and PABs (pedaling required), and whether the presence of pedals has any impact on where the device can and cannot be used. In British Columbia and Toronto, PABs are permitted while PBs are classified as a higher order vehicle (BC Reg 151/2002; Toronto, Ontario, City Council, 2014). Although the European Union also extends leniency to PABs while imposing more restrictions on PBs, most other places in North America do not distinguish between the two types. SSEBs are often PBs, but the degree to which a rider can effectively propel the bicycle using the pedals is questionable.

There is no legislation in place that imposes requirements on how effective the pedals must be. There are philosophical arguments about "cheating" by operating SSEBs and PBs in bicycle lanes without pedaling. There are also arguments about whether operators of SSEBs and PBs would be safe in traffic if they were prohibited from bike lanes, paths and trails. Policymakers and planners must consider the safety of PBs and SSEBs mixing with cyclists, pedestrians and other path users. But they must also think about climate change goals and how privileging PBs and SSEBs to use bicycle infrastructure would still encourage more people to get out of their car and onto a more efficient vehicle.

The federal governments of the United States and Canada have provided a framework for states and provinces with regard to e-bikes. Policymakers must now work to incorporate the federal law into local statutes. More populous provinces have been successful at adopting the federal law, but only nine of 51 U.S. states have amended their vehicle code to accept CPSC's definition. The question of what kinds of bicycles we wish to see in our transportation facilities, such as protected lanes, shared used paths, sidewalks and trails, remains open to debate.

CONCLUSION

Electric bikes are here to stay. The federal government did its part in providing a framework definition of the low-powered electric bicycle. However, the widely disparate statutes and codes, some of which were discussed in this paper, leaves the public all but confused about their legal rights and duties when using electric bicycles. While some states like Oregon readily accept the burgeoning technology, other states such as Michigan are behind in developing regulations. If we are to meet our goals of reduced emissions and VMTs for the next 30 years, policymakers must readily provide a place for e-bikes in codified law. Alas, until we have a common understanding of "e-bike," this will be a difficult road to travel down.

There is much confusion in North America as it relates to the definition of e-bikes but also in how they are governed. Part of the problem has been due to the fact that this is a new industry with low market penetration, so the general public is not aware of the differences in technology. This directly translates into how policy is written and developed. The other issue has been the industry's inability to differentiate their products from other devices, such as mopeds, scooters and motorcycles. Part of the issue in New York City and the recent ban of e-bikes is due to poorly written state and local regulations, but it is also an issue of clearly defining the difference between scooters and e-bikes. It is now the responsibility of the consumers, the industry and interested parties to educate policymakers in each state to change definitions and regulations related to e-bikes.

There is currently no known published research or market data showing how the general public perceives electric bikes in the U.S. This includes both how people define an electric bike and the differences between electric bikes and scooters, mopeds, motorcycles and traditional bicycles, and how and where these bikes should be used. To develop national statewide policy, this type of information is extremely important in crafting both appropriate policies but creating buy-in by the public in how these bikes should be used. In recent reviews of blogs, many people believe that a typical e-bike will go faster than a bicycle. This might be the case of average speed and under certain conditions, but many road bicycles can reach speeds far greater than 20 mph. Understanding how e-bikes fit into the transportation system and interact with other vehicles, bikes and pedestrians can add to the discussion.

This can be accomplished through groups like the Light Electric Vehicle Association (LEVA). The LEVA represents the strategic interests of light electric vehicle retailers, dealers, distributors, manufacturers and suppliers to promote the development, sale and use of LEVs worldwide. The LEVA has developed a legal regulation policy document, which includes definitions for e-bikes and suggested use regulations for states to adopt (LEVA, 2011). The LEVA and other e-bike advocates should work with organizations that have interest in how e-bikes are defined and legislated, such as the National Bicycle Dealers Association, the League of American Bicyclists, the Association of Pedestrian and Bicycle Professionals, International Mountain Bicycling Association, AAA, and the American Association of Motor Vehicle Administrators.

Finally, it is important to reach out to the general public to ensure a common understanding what e-bikes are and how they differ from mopeds. This can be done through media outreach and events that help reach a better understanding. How print and online media discuss e-bikes can greatly shape perception of the devices. For example, on May 14-15, 2014, in Crystal Springs Resort, NJ, there was an e-bike and outdoor technology media event called Charged Up (http://www.interbike.com/events/electric-bike.htm). The event was aimed at non-endemic consumer and technology print, broadcast and online media. Invited journalists were exposed to the advancements and functionality of e-bikes, portable power, safety and fitness gear, along with innovations in wearable technology.

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Appendix A: Electric bicycle laws by state/province.

Area	Identity	Bicycle?	License?	Registration?	Age	Power	Speed	Pedals?	Federal?	Helmet?	Paths?	Sidewalks?	Law references
Alabama	Motor-Driven Cycle	N	Y	Y	14	150 cc	--	N	N	Y	N	N	Ala. Code § 32-1-1.1 (2013); § 885-1-1-.05; 32-5A-245; 32-12-41
Alaska	Motor-Driven Cycle	N	Y	N	14	50 cc	--	N	N	N	N	N	Alaska Stat. § 28.90.990
Arizona	Motorized Electric Bicycle	Y	N	N	--	48 cc	20	N	N	N	Y	Y	Ariz. Rev. Stat. § 28-2516
Arkansas	Motorized Bicycle	N	Y	Y	--	50 cc	--	N	N	N‡	N	N	Ark. Code § 27-20-101; § 27-20-106
California	Motorized Bicycle	Y	N	N	16	1000 W	20	Y	N	Y	N	Y	Cal. Veh. Code. § 100-680-406; 21207.5 & 21209; 24016; 21212
Colorado	Electrical Assisted Bicycle	Y	N	N	--	750 W	20	Y	Y	N	N*	Y	Colo. Rev. Stat. § 42-1-102 (28.5); § 42-4-1412; § 42-4-111
Connecticut	Motor-Driven Cycle	N	Y	N	16	50 cc	--	N	N	N‡	N	N	Conn. Gen. Stat. § 248-14-1 (52); § 248-14-286
D. C.	Motorized Bicycle	Y	N	N	16	--	20	Y	N	N	N	N	D.C. Code § 18:99-01; § 50:1501.01-03; D.C. Act 19-658
Delaware	Bicycle	Y	N	N	--	750 W	20	Y	Y	N‡	Y	Y	Del. Code tit. 21 § 1-101 (2); tit. 21 § 41
Florida	Bicycle	Y	N	N	16	--	20	Y	N	N	Y	Y	Fla. Stat. § 322.01; § 316.003
Georgia	Electric Assisted Bicycle	Y	N	N	15	1000 W	20	Y	N	Y	Y	N	Ga. Code § 40-1-1 (15.5); § 40-6-294; § 40-6-351; § 40-6-352
Hawaii	Moped	N	Y	Y	15	1491 W†	30	N	N	N‡	N	N	Haw. Rev. Stat. § 14:249-1; § 17:286-81; § 17:291C-194
Idaho	Moped	N	Y	N	--	50 cc	30	N	N	N		Y	Idaho Code § 49-114; § 49-721; § 49-1428
Illinois	Low-Speed Electric Bicycle	Y	N	N	16	750 W	20	Y	Y	N‡		N	625 Ill. Comp. Stat. 5/1-140.10; 625 ILCS 5/11-1516
Indiana	Motorized Bicycle	Y	N	N	15	50 cc	25	N	N	N‡		N	Ind. Code § 9-13-2-109; § 9-21-11-12
Iowa	Bicycle	Y	N	N	--	750 W	20	Y	Y	N	Y	Y	Iowa Code § 321.1
Kansas	Electric Assisted Bicycle	Y	N	N	--	1000 W	20	Y	N	N	Y	Y	Kan. Stat. § 8-1489
Kentucky	Moped	N	Y	Y	16	1491 W†	30	N	N	N‡		N	Ky. Rev. Stat. § 187.290 (5); § 189.285
Louisana	Motorized Bicycle	N	Y	Y	15	1119 W†	25	N	N	Y		N	La. Rev. Stat. § 32:401 (19); § 32:198; § 32:190
Maine	Motorized Bicycle	N	Y	Y	16	1119 W†	20	N	N	N‡		Y	Me. Rev. Stat. tit. 29-A § 101-1 (41); tit. 29-A § 11; tit. 29-A § 19; tit. 29-A § 2063
Maryland	Electric Bicycle	Y	N	N	--	500 W	20	Y	Y	N	Y	N	Md. Code, Com. Law § 11-117.1; § 21-1200
Massachusetts	Motorized Bicycle	N	Y	Y	16	50 cc	25	N	N	Y	Y*	Y*	Mass. Gen. Laws ch. 14, §§ 90-1B~E; ch. 14 § 90-1
Michigan	Moped	N	Y	Y	16	100 cc	30	N	N	N‡	N	N	Mich. Comp. Laws § 257.32b; § 257.79; § 257.33; § 257.4
Minnesota	Electric-Assisted Bicycle	Y	N	N	15	1000 W	20	Y	N	N	Y	Y	Minn. Stat. § 169.011 (27); § 168A.03; § 160.263
Mississippi	Bicycle with a Motor Attached	Y	N	N	--	--	--	N	N	N	Y*	Y*	Op. Atty. Gen. No. 2007-00602; Op. Atty. Gen. No. 2011-00095; Miss. Code § 63-3-103
Missouri	Motorized Bicycle	N	Y	N	16	2238 W†	30	N	N	N		N	Mo. Rev. Stat. § 301.010 (36); § 300.347; § 307.180; § 307.195
Montana	Bicycle	Y	N	N	--	1491 W†	30	Y	N	N	Y	Y	Mont. Code § 61-8-102; § 61-1-102; § 61-8-608
Nebraska	Moped	Y	N	N	16	1491 W†	30	Y	N	Y	Y	Y	Neb. Rev. Stat. § 60-122; § 60-638; § 60-6,279
Nevada	Electric Bicycle	Y	N	N	--	750 W	20	Y	Y	N	Y	N	Nev. Rev. Stat. § 484B.017; § 484B.777; § 484B.117; § 483.090
New Hampshire	Electrically Powered Bicycle	Y	N	N	14	750 W	20	Y	Y	N‡		N	N.H. Rev. Stat. § 259:65
New Jersey	Motorized Bicycle	N	Y	Y	15	1119 W†	25	N	N	Y	N	N	N.J. Rev. Stat. § 39:1-1; § 39:3-10
New Mexico	Moped	N	Y	N	15	50 cc	30	N	N	N‡		N	N.M. Stat. § 66-1-4.11; § 66-1-4.2; § 66-5-2
New York	Motor-Assisted Bicycle	N	Y	Y	--	--	--	N	N	N	N	N	N.Y. Veh. & Traf. Law § 102; § 123
North Carolina	Moped	Y	N	N	16	50 cc	30	N	N	Y		N	N.C. Gen. Stat. § 105-164.3; § 20-4.01 (27) d1; § 20-140.4
North Dakota	Motorized Bicycle	N	Y	Y	14	50 cc	30	Y	N	N		N	N.D. Cent. Code § 39-01-01 (48); 39-06-14.1
Ohio	Motorized Bicycle	N	Y	Y	14	745 W†	20	Y	Y	N‡		N	Ohio Rev. Code § 4501.01(L); § 4511.521; § 4511.711
Oklahoma	Electric-Assisted Bicycle	N	Y	N	--	1000 W	30	Y	N	N	Y	Y	Okla. Stat. tit. 47 § 1-104; tit. 47 § 11-805.2; tit. 47 § 11-1103
Oregon	Electric Assisted Bicycle	Y	N	N	16	1000 W	20	Y	N	N	Y	N	Or. Rev. Stat. § 801.258; § 814.405; § 814.410; § 807.020
Pennsylvania	Pedalcycle with Electric Assist	Y	N	N	16	750 W	20	Y	Y	N		Y*	Senate Bill 997; 75 Pa. Cons. Stat. § 102; 75 Pa.C.S. § 3525; 75 Pa.C.S. §3703
Rhode Island	Electric Motorized Bicycle	N	Y	N	16	1491 W†	25	Y	N	N‡	Y	Y	R.I. Gen. Laws § 31-1-3; § 31-3-2.2; § 31-19.1.1

Appendix A: Electric bicycle laws by state/province.

Area	Identity	Bicycle?	License?	Registration?	Age	Power	Speed	Pedals?	Federal?	Helmet?	Paths?	Sidewalks?	Law references
South Carolina	Moped	N	Y	N	14	1491 W†	30	N	N	N‡		N	S.C. Code § 56-5-165; § 56-1-1720
South Dakota	Moped	N	Y	N	14	50 cc	--	N	N	N‡		N	S.D. Codified Laws § 32-3-1; § 32-20-1; § 32-5-1.2; § 32-26-21.1
Tennessee	Motorized Bicycle	N	Y	N	15	1491 W†	30	N	N	Y		N	Tenn. Code § 55-8-101; § 55-9-302
Texas	Electric Bicycle	Y	N	N	--	--	20	N	N	N	Y	Y	Tex. Trans. Code §541.201 (24); §541.202 (4); §551.106
Utah	Electric Assisted Bicycle	N	Y	N	16	1000 W	20	N	N	N	Y		Utah Code § 41-6a-102
Vermont	Motor-Driven Cycle	N	Y	N	16	1491 W†	30	N	N	N		N	Vt. Stat. Ann. tit. 23 § 4 (45)
Virginia	Electric Power Assisted Bicycle	Y	N	N	14	1000 W	25	Y	N	N	Y	Y	Va. Code § 46.2-100; § 46.2-903; § 46.2-908.1; § 46.2-906.1
Washington	Electric Assisted Bicycle	Y	N	N	16	1000 W	20	Y	N	N	Y	N	Wash. Rev. Code § 46 4-169; § 46 61-710; § 46 4-320; § 46 37-530; § 46 16A-080; § 46 20-500
West Virginia	Moped	N	Y	Y	15	1491 W†	30	Y	N	Y		N	W. Va. Code § 17C-1-5a; § 17C-15-44
Wisconsin	Motor Bicycle	N	Y	N	--	750 W	20	Y	Y	N	Y*	Y*	Wis. Stat. § 340.01 (30); § 346.02 (4); § 346.79 (5); § 343.05(3)(c)
Wyoming	Moped	N	Y	N	15	1491 W†	30	Y	N	N‡	N	N	Wyo. Stat. § 31-5-102(xxi); § 10.32.160; § 31-5-115 (o); § 31-1-101
Alberta	Power Bicycle	Y	N	N	12	500 W	20	Y	Y	Y			Alta Reg 304/2002; Alta Reg 122/2009; RSA 2000, c T-6; Alta Reg 320/2002
British Columbia	Motor Assisted Cycle	Y	N	N	16	500 W	20	Y	Y	Y	Y	N*	BC Reg 151/2002; RSBC 1996, c 318, Part 1 & Part 3
Manitoba	Power-Assisted Bicycle	Y	N	N	14	500 W	20	Y	Y	Y		N	CCSM c H60
New Brunswick	Bicycle	Y	N	N	--					Y		Y	RSNB 1973, c M-17
Newfoundland	Bicycle	Y	N	N	--					N		N	RSNL 1990, c H-3
Northwest Territories	Bicycle	Y	N	N	--					N		N	RSNWT 1988, c M-16
Nova Scotia	Bicycle	Y	N	N	--	500 W	19	Y	Y	Y	Y	N	RSNS 1989, c 293
Nunavut	Bicycle	Y	N	N	--					N		N	RSNWT (Nu) 1988, c M-16
Ontario	Power-Assisted Bicycle	Y	N	N	16	500 W	20	Y	Y	Y	Y*	Y*	RSO 1990, c H.8; O Reg 369/09
Prince Edward Island	Motor Assisted Pedal Bicycle	N	Y	Y	16	50 cc	31	N	N	Y	Y	N	RSPEI 1988, c H-5; PEI Reg EC642/75
Quebec	Power-Assisted Bicycle	Y	N	N	18	500 W	20	Y	Y	Y	Y*	N	CQLR c C-24.2; CQLR c V-1.2, r 4.1; CQLR c P-9, r 25
Saskatchewan	Electric Assist Bicycle; Power Cycle	Y	N	N	--	500 W	20	Y	Y	Y	Y*	Y*	SS 2004, c T-18.1; Motorcycle handbook
Yukon	Electric Power-Assisted Bicycle	Y	N	N	--	500 W	20	Y	Y	N		N*	RSY 2002, c 153

Area: Which state or province in the United States or Canada?
Identity: Under which definition in vehicle code does an electric bicycle fall?
Bicycle: Is it essentially classified and treated as a bicycle?
License: Is a driver's license required to operate an e-bike?
Registration: Is the e-bike required to be registered with the state/province?
Age: What is the minimum age of operation of an e-bike?
Power: What is the maximum power output permitted?
Speed: What is the maximum speed of operation permitted?
Pedals: Are fully functional pedals required for operation?
Federal: Is the state/provincial definition in line with the federal definition?
Helmet: Is a helmet required for operating an e-bike?
Paths: Are e-bikes permitted on shared-use paths and trails?
Sidewalks: Are e-bikes permitted on sidewalks?
Law reference: What is source of this information?

--	= Limit not specified under law
(grey)	= Information unclear/inconsistent

"Bicycle" = allowed on bicycle paths and no license/registration required

† Horsepower expressed in watts equivalent; 1 hp = 745 watts
Different than maximum speed capability, though most areas see this as the same

‡ Age requirement; those under a certain age are required to wear a helmet
* Restrictions apply (engine cannot be engaged, local ordinances prohibit use, etc.)
* Restrictions apply (engine cannot be engaged, local ordinances prohibit use, etc.)

November 2014

Appendix E - 4

WHITEFISH PLANNING REFERENCE MATERIALS

CONNECT WHITEFISH

BICYCLE & PEDESTRIAN MASTER PLAN

RPA

ROBERT PECCIA & ASSOCIATES
Helena and Kalispell, Montana
CIVIL
TRANSPORTATION
ENVIRONMENTAL
ENGINEERS

40 0 40 80
(SCALE IN FEET)

ADVANTAGES
- INCREASED SAFETY
- SLOWER VEHICLE SPEEDS
- BETTER DEFINED PARKING
- DESIGNATED BIKE ROUTE
- DECREASED TRAFFIC LEVELS

DISADVANTAGES
- LIMITED ACCESS
- ONE-WAY TRAFFIC
- EMERGENCY VEHICLE ACCESS MAY BE INHIBITED
- MAY CAUSE HIGHER TRAFFIC ON ADJACENT ROUTES

City of Whitefish

WHITEFISH BEACH CONCEPTUAL PLAN
TSM-4

SITE PLAN

Figure 6-1