Kennebec County Road Bicycle Commuting Compatibility

Daniel Homeier ‘12
Environmental Studies Program, Colby College, Waterville, Maine, 04901

Abstract
As bicycles become an increasingly popular means of transportation it is vital to determine what roads are most suitable for bicycle commuting. I used GIS to analyze factors that influence bicycle compatibility to create a bicycle commuting compatibility model and map for roads in Kennebec County, Maine. I found that more roads in Kennebec County are suitable for bicycle commuting (37.8% with medium compatibility and 37.9% with high compatibility) than unsuitable (24.3% with low compatibility).The model I developed could be applied to any roads for which appropriate data are available.

Introduction
Bicycles are an inexpensive and effective form of transportation. They can play an important role in the United States’ transportation infrastructure, but not all roads within the United States are ideal for bicycling. In many areas there is a need to identify what roads are most suitable for bicycle transportation (Rybarczyk and Wu 2010).

The Maine Department of Transportation has made bicycle route maps, but these maps are not designed for bicycle commuters. The goal of my project was to evaluate different factors that may influence bicycle compatibility and compile the most important ones to create a bicycle compatibility model that identifies what roads are best for bicycle commuting.

Methods
I obtained GIS data from the Maine Office of GIS, Maine DOT and ESRI. Using ArcGIS I clipped all data to the extent of Kennebec County. I spatially joined the road centerline data from the Maine Office of GIS, ESRI and Maine DOT. I converted the resulting road centerline data to eight raster layers (speed, road class, pavement condition rating, international roughness index, factored average annual daily traffic, shoulder type, and shoulder width). I created a percent rise raster using the DEM. I reclassified the eight road raster layers to represent bicycle commuting compatibility (see Table 1 for reclassification scheme and Figure 2 for a visual example of road speed reclassification).

Table 1. Reclassification scheme

Bicycle Compatibility Factor	Reclass Value
Road Class	
Major Road	1
Minor Road or Vehicular Trail	2
Local Road	3
Pavement Condition Rating	
Fair	1
Good	2
Very Good	3
International Roughness Index	
Poor	1
Fair	2
Good	3
Average Annual Daily Traffic	
High	1
Medium	2
Low	3
Shoulder Type	
Gravel	1
Curb Present	2
Paved	3
Traffic Speed	
50 - 65 MPH	1
10 - 20 MPH	2
25 - 35 MPH	3
Percent Rise	
Steep	1
Moderately Steep	2
Flat	3

I created a weighted sum raster layer using the following formula:

Bicycle Compatibility Level = Percent Rise + Speed + Road Class + Pavement Condition Rating + International Roughness Index + Annual Average Daily Traffic + Shoulder Type + Shoulder Width

I applied an appropriate number scheme to the weighted sum raster (values 6-15 representing low bicycle compatibility, 15-18 medium bicycle compatibility and 18-24 high bicycle compatibility). I reclassified the weighted sum layer into three categories, 1 representing low bicycle compatibility, 2 representing medium bicycle compatibility, and 3 representing high bicycle compatibility.

Results
I found that of the 3,972 Km of roads in Kennebec County, 829 Km (24.3%) have low bicycle commuting compatibility, 1,521 Km (37.8%) have medium compatibility and 1,622 Km (37.9%) have high compatibility (Table 2).

Figure 1 depicts the bicycle compatibility of roads in the Belgrade Lakes region of Kennebec County. Figures 3 and 4 are visual representations of the distribution of bicycle compatibility levels 1, 2 and 3 for roads in Kennebec County.

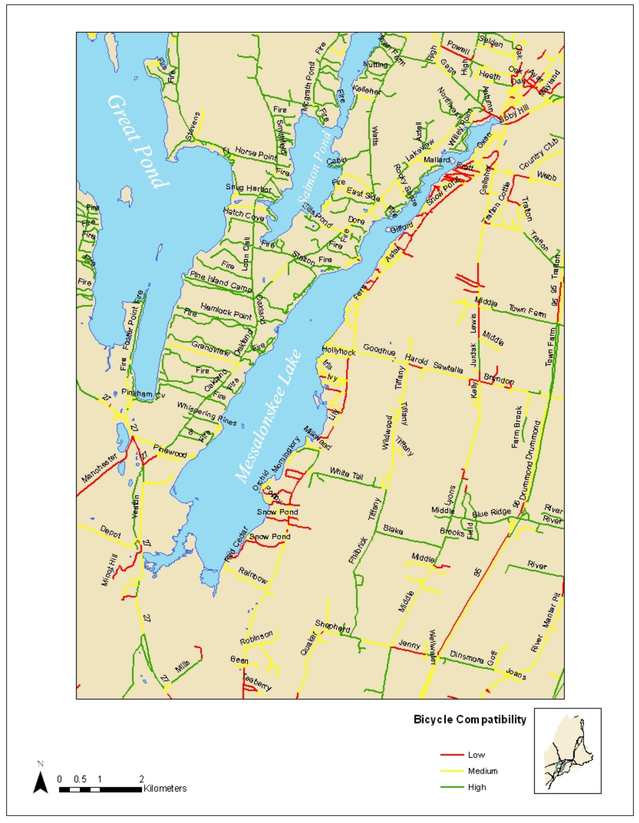

Figure 1. Belgrade Lakes bicycle commuting compatibility map

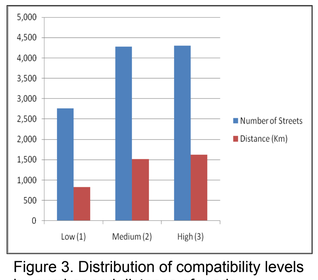

Figure 3. Distribution of compatibility levels by number and distance of roads

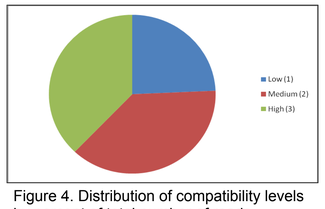

Figure 4. Distribution of compatibility levels by percent of total number of roads

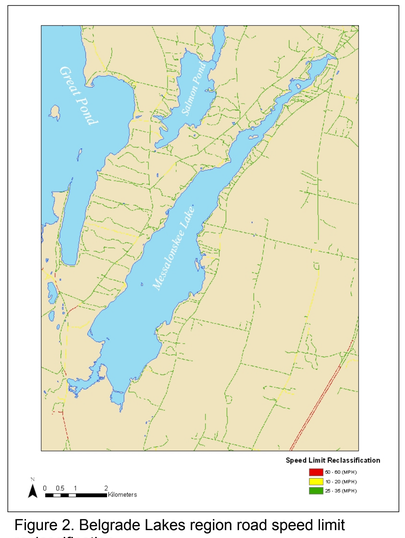

Figure 2. Belgrade Lakes region road speed limit reclassification

Table 2. Distribution of compatibility levels by number, distance and percent of total number of roads

Bicycle Compatibility	Number of roads	Distance (Km)	Percent
Low (1)	2,757	829	24.3
Medium (2)	4,284	1,521	37.8
High (3)	4,297	1,622	37.9
Total	11,338	3,972	100

Discussion
My analysis shows that the majority of roads in Kennebec County have a high level of bicycle commuting compatibility. However, 24.3% of all roads in Kennebec County have a low level of compatibility, meaning that a number of roads could benefit from bicycle compatibility improvements. Due to weaknesses in my model it is hard to tell what factors most influence compatibility. In this regard my model does not help those looking to improve bicycle commuting compatibility.

I ran into two issues while creating this model and map. The first issue stems from data inaccuracy. Some of the road condition and characteristics data were not up to date or available. Furthermore, some of the road condition and characteristics data seemed to be wrong due to inaccuracies in surveying or data entry (for example, some roads were classified incorrectly). This resulted in a weighted sum layer with some errors.

The second issue stems from the data reclassification process. I could find no published reclassification scheme based on bicycle commuting compatibility. For example, the Bicycle Compatibility Index published by the Federal Highway Association derives bicycle compatibility from a survey of cyclists and the factors that influence their comfort level while riding (Federal Highway Association 1998). I felt this method did not give adequate importance to factors that influence bicycle commuting, such as slope. Similarly, the Maine Department of Transportation maps highlight roads for recreational quality, not commuting compatibility, and did not provide an adequate model (Maine DOT 2010). As a result I had to create my own model that may not give certain factors enough importance, while giving some factors too much influence. The best way to address this issue would be to conduct a study analyzing the factors that influence bicycle commuting, deriving the extent to which certain factors influence compatibility.

Conclusions
I used ArcGIS to evaluate the bicycle compatibility of roads in Kennebec County, ME. The GIS model I developed shows that the majority of roads in Kennebec County have a medium or high level of bicycle commuting compatibility. This model can be used for other locations within the United States (provided the appropriate data are available) to determine bicycle commuting compatibility. Such information could be vital to the growth of bicycle commuting within the United States.

Acknowledgements
I would like to thank Philip Nyhus and Manny Gimond for their assistance. I’d also like to thank Dan Stewart and Michael Spaulding from the Maine DOT for the invaluable data they provided.

References
FHWA (USDOT). 1998. The Bicycle Compatibility Index: A Level of Service Concept, Implementation Manual. http://www.tfhrc.gov, accessed April 15, 2010.

Huang, R, Hawley, D. A Data Model and Internet GIS framework for Safe routes to School. URISA Journal. 2009 Jan 1.

Maine DOT. Explore Maine by Bike. http://www.exploremaine.org, accessed April 29, 2010.

Pucher, J., Komanoff, C. & Schimek, P. 1999. Bicycling renaissance in North America? Recent trends and alternative policies to promote bicycling. *Transportation Research Part a-Policy and Practice,* 33, 625-654.

Rybarczyk, G. & Wu, C. 2010. Bicycle facility planning using GIS and multi-criteria decision analysis. *Applied Geography,* 30, 282-293.