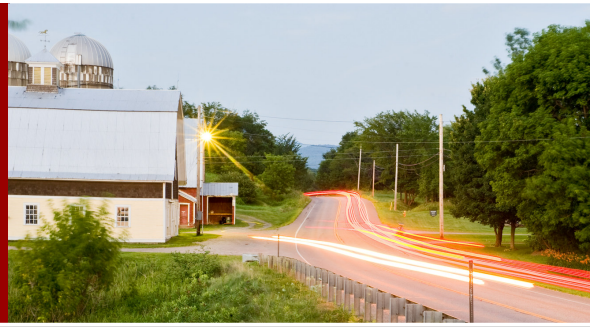
CRITICAL LINKS SUPPORTING VERMONT'S BULK MILK TRANSPORTATION: A NOVEL APPLICATION OF THE NETWORK ROBUSTNESS INDEX

AUTHORS: Julia M. Smith, James Sullivan, and Rebecca Grover

PAPER # 10-0593



ABSTRACT

The network robustness index (NRI) has been proposed as a more holistic approach to prioritizing road segments for maintenance, improvement, and protection. The utility of this index for identifying segments of importance for freight has not been tested. This project applied the index to a data set representing milk flows in northwestern Vermont. Data for bulk milk collection routes were collected using geo-loggers carried on each truck. A TransCAD street layer was used as the base network. An origin-destination matrix representing two days of milk flows was used to calculate the NRI with TransCAD. For assessing the costs of disruption to the network, the authors used units of pound-hours, which expressed the dual importance of milk transport volumes and their corresponding travel times. Links associated with a higher "cost" to the system when removed received a higher ranking in terms of criticality. Using the NRI to identify critical links in the movement of bulk milk may help state agencies or towns prioritize road investments to support the movement of this economically important freight. This information can also help milk handlers and regional cooperatives engage in emergency contingency planning.

DATA

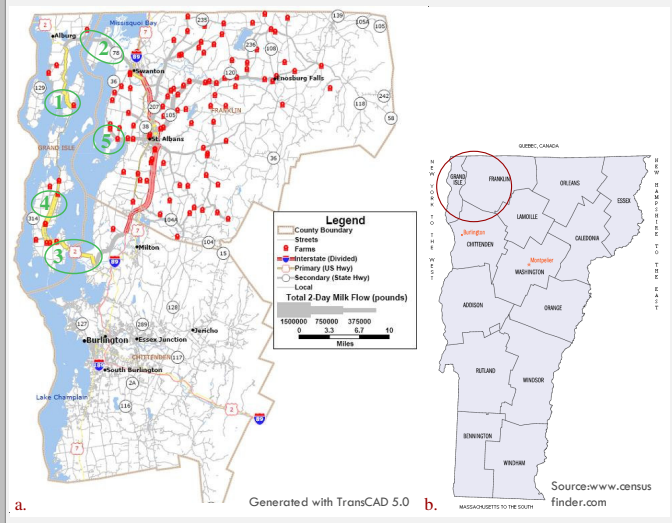


Figure 1. (a.) Total milk flows in northwest Vermont data set. Critical links identified by the network robustness index (NRI) have been circled. Numbers correspond to their NRI rankings. Note: 1 mile = 1.61 km. (b.) Geographic region of the network analyzed. This section of Vermont (circled) is bordered by Canada to the north and by New York to the west.

DATA AND ANALYSIS

Table 1. Links with Highest Network Robustness Index, in Descending Order

Ranking	Description	Hourly Capacity (vph)[a]	Free-Flow Speed (mph)[b]	Total Flow (pounds)	NRI (pound-hours)
1	Crossing of Lake Champlain between South Alburg and North Hero Island	1,200	40	430,428	330,000
2	Extended crossing of the Missisquoi River, Charcoal Creek, and Lake Champlain between Swanton and Alburg	1,000	40	266,000	113,400
3	Crossing of Lake Champlain between West Milton and South Hero Island	1,200	40	387,000	106,000
4	Several segments of Route 2 on South Hero Island	1,200	40	462,600 to 584,600	30,000 to 50,000
5	Lake Road, west of Cherry Street in St. Albans Bay	1,000	40	390,300	25,000

[a]vph = vehicles per hour

[b]mph = miles per hour

- Although most of the heavy flows are concentrated in downtown St. Albans, the NRI results show that, because alternate routes exist for these streets, they are not critical. Several streets carry over 1.5 million pounds (over 174,000 gallons) every 2 days.
- On the other hand, the links connecting the network of interest with the northern and southern ends of Grand Isle County (#2 and #3) have limited alternate routes (each other), and carry 266,000 and 387,000 lbs of milk every 2 days. Thus, these roadways are far more critical to the robustness of milk transportation in northwestern Vermont.

ACKNOWLEDGMENTS

This research was conducted with partial funding from the UVM Transportation Research Center under US DOT DTRT06-G-0018. The authors gratefully acknowledge the St. Albans Cooperative Creamery, McDermott's Inc., Agri-Mark Inc., and DMS for their assistance with this project. The authors also extend their gratitude to Lisa Aultman-Hall and David Novak for their support of this work.

CONCLUSIONS

- This study represents the first application of the NRI to freight transported in a real-world network, specifically the network of bulk milk collection in northwestern Vermont.
- Four of the 5 links with the highest NRI were associated with bridges, highlighting the importance of connectivity between portions of the network.
- The criticality of these links relative to total milk flows confirmed the utility of this index as an improved method of prioritizing links over simply looking at flow volume.