

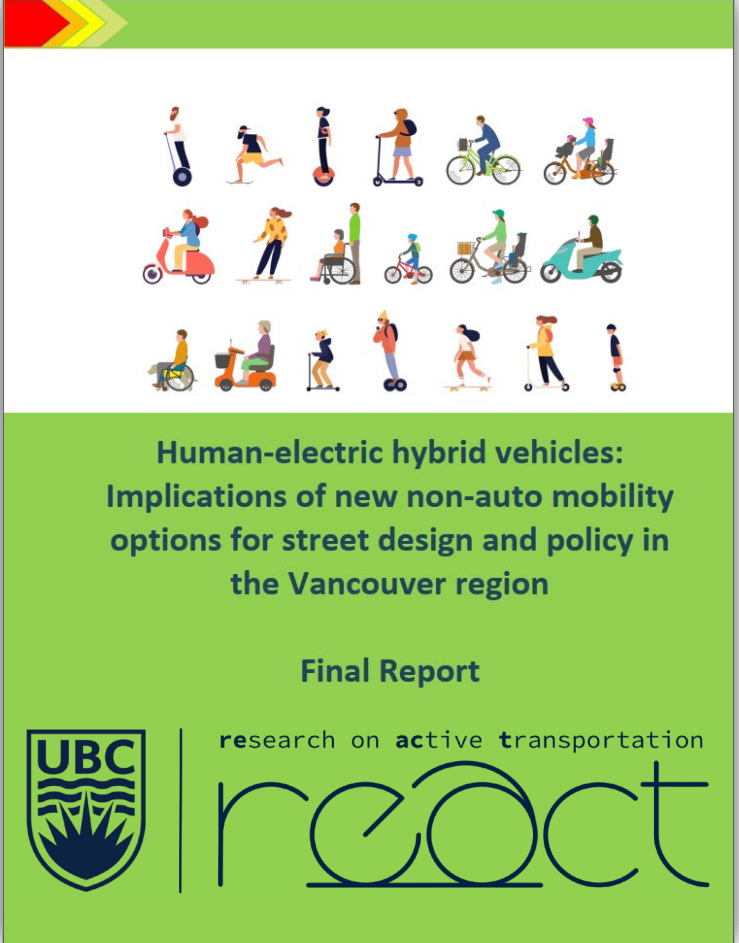
What is on the bicycle paths?

A detailed vehicle taxonomy with mode share data for off-street paths in metro Vancouver, Canada

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The cover features a green background with a white section at the top. A decorative header at the very top consists of a red arrow pointing right, followed by yellow and green arrows. Below this, a grid of 21 colorful icons illustrates various modes of transport: a person on a kick scooter, a person running, a person on a balance bike, a person on a motor scooter, a person on a bicycle, a person on a bicycle with a child seat, a person on a bicycle with a cargo box, a person on a bicycle with a child seat and cargo box, a person on a bicycle with a child seat and cargo box, a person on a bicycle with a child seat and cargo box, a person on a bicycle with a child seat and cargo box, a person on a bicycle with a child seat and cargo box, a person on a bicycle with a child seat and cargo box, a person on a bicycle with a child seat and cargo box, a person on a bicycle with a child seat and cargo box, a person on a bicycle with a child seat and cargo box, a person on a bicycle with a child seat and cargo box, a person on a bicycle with a child seat and cargo box, a person on a bicycle with a child seat and cargo box, a person on a bicycle with a child seat and cargo box, a person on a bicycle with a child seat and cargo box.

**Human-electric hybrid vehicles:
Implications of new non-auto mobility
options for street design and policy in
the Vancouver region**

Final Report

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OPPORTUNITY & CHALLENGES

- Increasing availability of low-power vehicles such as e-bikes, e-scooters, and e-skateboards
-New Mobility Devices (NMD)
- NMD can help address challenges related to congestion, emissions, public health, etc.
- NMD sharing space with peds & bikes raises comfort and safety concerns





AIMS



Broader (3-year) project: Street design & policy to mitigate conflicts on ped/bike facilities with NMD

This paper: Address knowledge gaps for tracking & managing the emergence of NMD

1. Mode share data on ped/bike facilities
2. Classification system for non-auto vehicles/devices

OBJECTIVES



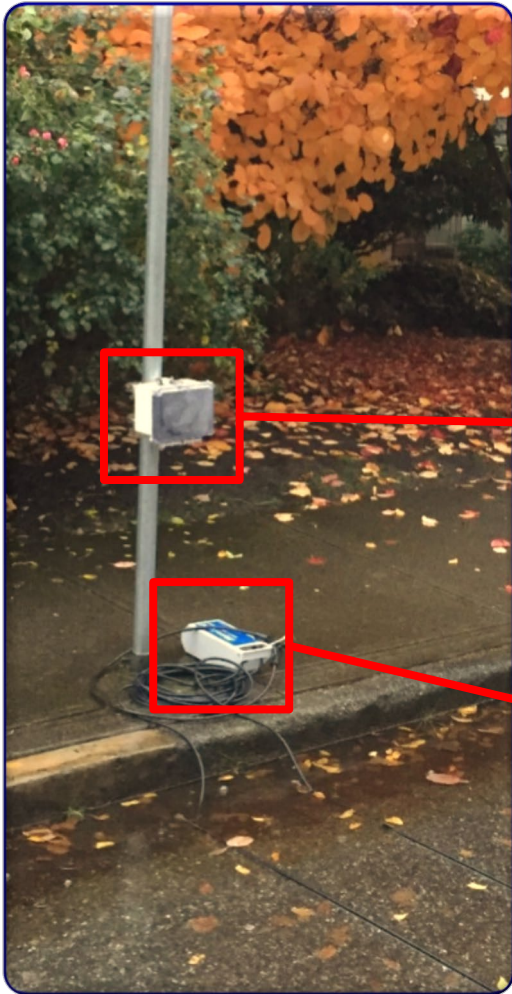
This paper:

1. Catalogue all motorized and non-motorized vehicles in use on cycling facilities in metropolitan Vancouver, Canada
2. Create a reliable taxonomy of all vehicles using visually identifiable features
3. Determine volumes and mode shares for each vehicle type



DATA COLLECTION

(after examining 12 different technologies...)



SAMPLING LOCATIONS



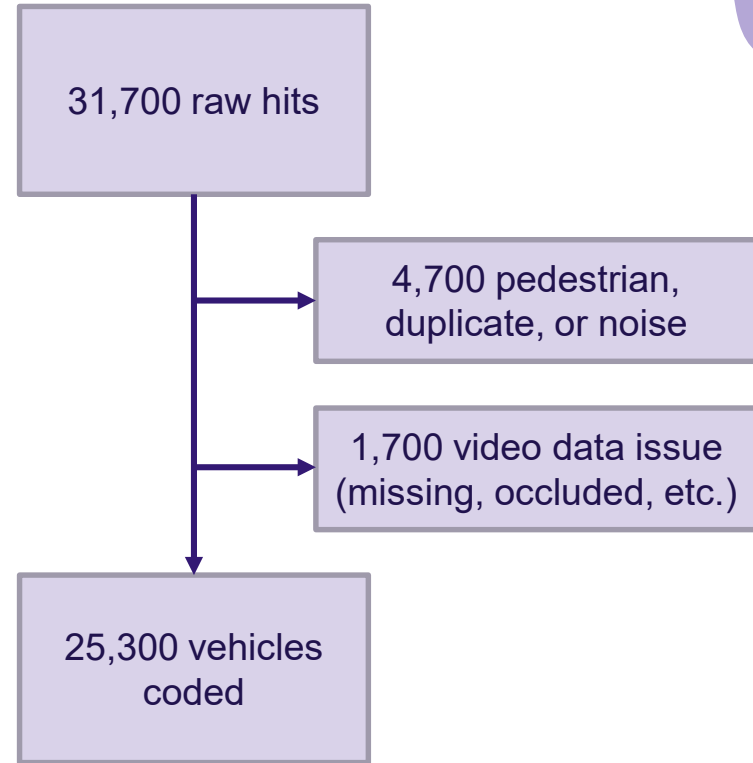
- 4 seasons (Summer 2019–Spring 2020)
- Weekday & weekend; ~8a–6p

- Off-street facilities (multi-use and cycling)
- $\leq 3\%$ grades
- $> 30\text{m}$ from intersection
- Straight, homogenous section
- Sufficient volumes
- Regional coverage & land use
- Bike/ped counting guidance
- ...



VIDEO CODING

- 10 observable features
 1. Visible battery or motor
 2. Pedals
 3. Seats
 4. Handles
 5. Seatback
 6. Attached to feet
 7. Axles
 8. Wheels
 9. Built-in cargo space
 10. Shared vehicle
- Coders trained on photobank
- Inter-rater reliability tests (150 obs.)
 - Kappa: 0.98 for motor, 1.00 others

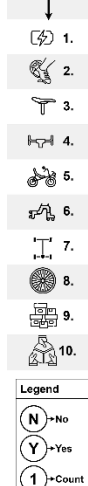


(requiring ~40 min per video-hr)

DEVELOPING THE TAXONOMY

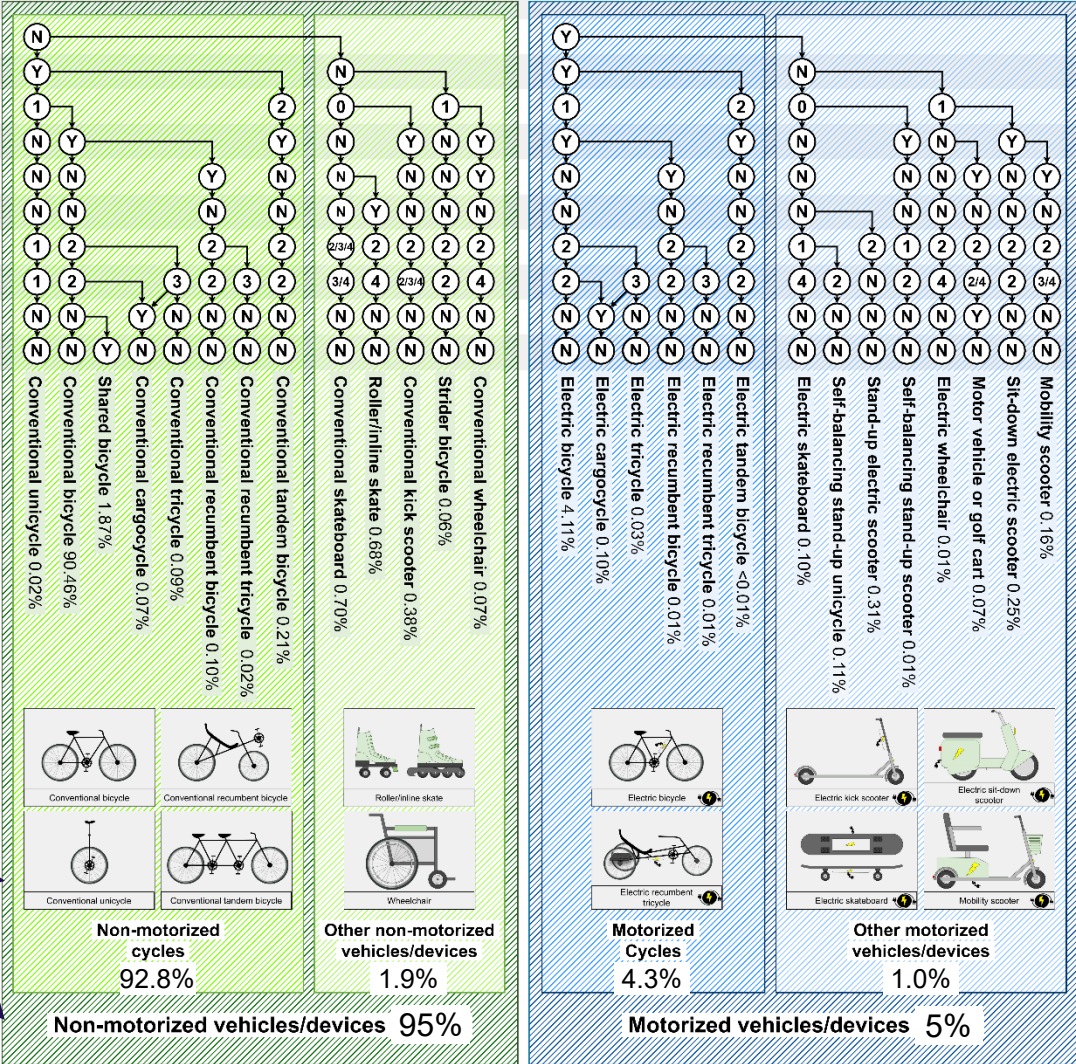
- Taxonomy:
 - Mutually exclusive and collectively exhaustive categories
 - Classify on *empirical diagnostic characteristics*
 - Distinctions should be functional/useful
- Exhaustive: all observed combinations of 10 coded attributes
- Hierarchical: sub-sets of attributes in tree structure
- Guiding principles
 - 1) relevant to decision-making (policy, regulation, design)
 - 2) practically useful (produces non-trivial mode shares)

Motorized →
 Pedaled →



RESULTS

Full taxonomy →
 • 27 vehicle types using 10 features



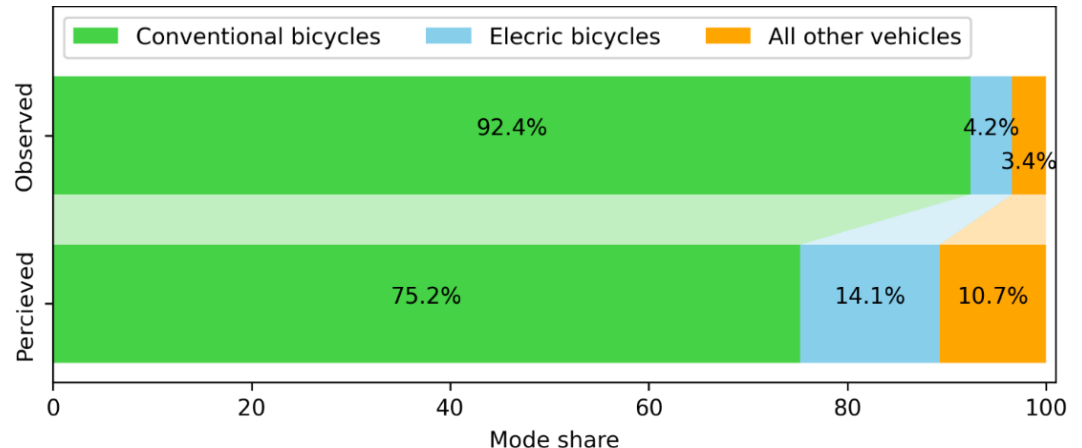
Aggregate categories →
 • Motorized + Pedaled
 • Other diagnostics yield mode shares <0.1%

VARIATION IN MODE SHARES

- Substantial variation in mode shares by location-day
 - E-bikes ranged 0% to 20%
- No significant ($p < 0.05$) differences in e-bike or e-assist mode *shares*:
 - Over 4 seasons
 - Before/after COVID
 - Cycleways vs. multi-use paths
 - In/outside bikeshare coverage area
 - Proximity to CBD
 - Precip, temperature

CONTEXT & COMPARISONS

- 11 of the 27 of the observed types not legal to operate (<3% by volume)
- BC Motor Vehicle Act only allowed* e-bikes (pedals & ≤ 32 km/hr)
- New Zealand study: e-bikes 4% -> 15% over 2017-2020, & huge variation by location
- Lower than expected e-bike mode share



LIMITATIONS

- Missed detections from tubes
- Representativeness of sampling times & locations
- Costly manual coding
- Unable to distinguish ambulatory disability
- “Other” categories

FUTURE WORK

- Applied the taxonomy to investigate speeds, comfort, & interactions on off-street paths
- Will return in summer 2023 to measure long-term changes
- Compare similar data across geographies
- A.I. coding?



SUMMARY

On cycleways & paths in Vancouver...

- Conventional bicycles still the dominant vehicle
 - Wide variety of NMD observed, but very small mode shares
 - E-bikes far outnumber all other e-assist combined
 - Large but un-systematic variability in non-bicycle mode shares
- Proposed taxonomy for reliable, comparable classified volume data
 - Exhaustive & avoids ambiguities of MVA, SAE, etc.
 - We recommend coding *motorization & pedals*

THANK YOU!

Questions?

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Final Report

Prepared for TransLink
April 2022

reactlab.civil.ubc.ca



PREVIEW OF FINDINGS FROM FULL REPORT

- Can accommodate NMD with minor effects on speeds & comfort
- Exclude sit-down electric scooters from ped/bike facilities
- Reduce thresholds for separating peds on multi-use paths with NMD
- E-bikes under 32 km/h limit, but e-scooters not under 24 km/h limit
- Public perception biased high for e-bike volumes and speeds
- Update design guidelines with real-world speeds

FURTHER ANALYSIS IN REPORT

Speed- and comfort-aligned vehicle clusters for design and policy

