How to link environment with physical activity? How GIS can facilitate this?

Wearable GPS Units

- Accuracy and Efficiency
- Location, Speed and Time
- Wearability
- User Intervention Needs
- Battery Capacity
- Memory Capacity

Accelerometers/Pedometers

- Need to be combined with GPS (& survey/diary)

7-Day Activity Diary:

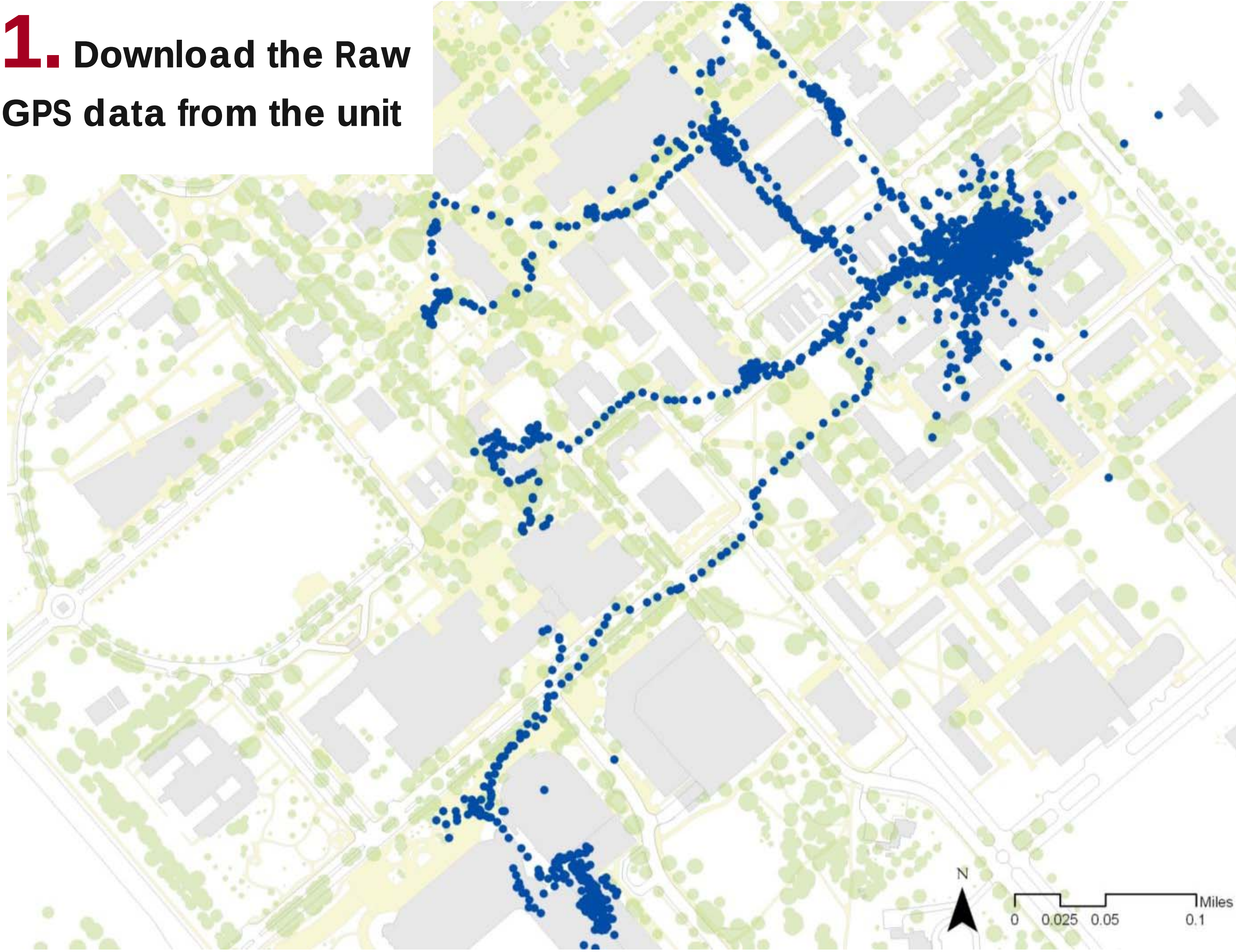
Date: ______________________ ID: ______________

	From where did your child start this trip?	Where was your child going to?	What time did your child leave?	What time did your child arrive?	How did your child get there?	Why did your child go there?	While your child was there, did he/she do any physical activities, such as walking, bicycling, and playing sports? If YES, how long did it last?
Examples Put "?" if you are not sure or don't know	Example: Home, School, Store, Church, Park (add park name), Friend's House, etc.	Example: School, Home, Store, Church, Park (Add park name), Friend's House, Other (Specify)	Example: 8:15AM	Example: 8:25AM	I or someone drove my child Took the school bus Biked Walked ? I do not remember/know	Example: To study To meet friends To eat To exercise (list activity) To play sports (list sport) To go to church	Yes | No _15_ minutes
Trip #1					?		Yes | No ___minutes
Trip #2					?		Yes | No ___minutes
Trip #3					?		Yes | No ___minutes
Trip #4					?		Yes | No minutes

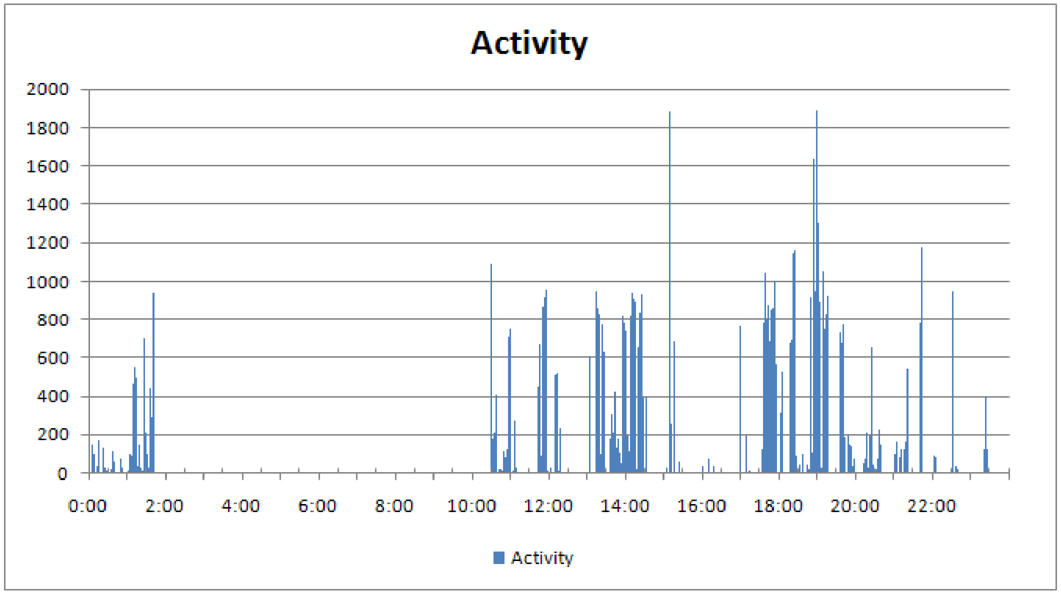
Other Tools Available (examples):

- GPS-camera → 3D
- Video Recorder → 3D
- Photovoice → 3D, perceptions
- Infrared Motion Sensor → indoor
- PDA (Ecological Momentary Assessment) →Perceptions

1. Download the Raw GPS data from the unit



2. Download the Raw Accelerometer data



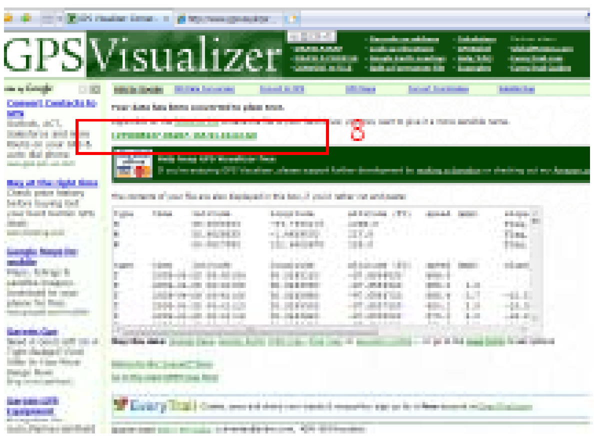
Date	Time	Activity	Activity (Horizontal)	3rd Axis	Steps
6/30/2009	8:13:00	0	0	4	0
6/30/2009	8:13:30	33	103	47	3
6/30/2009	8:14:00	225	228	149	7
6/30/2009	8:14:30	91	114	56	3
6/30/2009	8:15:00	378	165	198	13
6/30/2009	8:15:30	21	118	437	0
6/30/2009	8:16:00	887	1108	1535	33
6/30/2009	8:16:30	753	1008	1248	29
6/30/2009	8:17:00	942	1110	1414	37
6/30/2009	8:17:30	194	509	548	6
6/30/2009	8:18:00	209	239	540	2
6/30/2009	8:18:30	14	78	66	1
6/30/2009	8:19:00	227	260	541	2
6/30/2009	8:19:30	98	156	312	2
6/30/2009	8:20:00	36	126	127	1
6/30/2009	8:20:30	0	23	109	0
6/30/2009	8:21:00	0	18	24	0
6/30/2009	8:21:30	0	3	0	0
6/30/2009	8:22:00	0	21	2	0

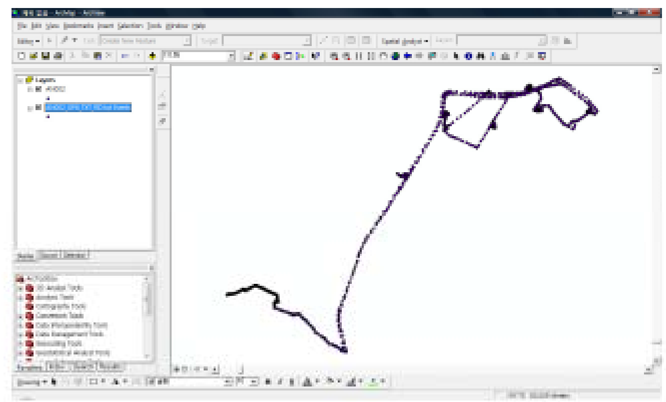
3. Link GPS with Accelerometer data

- Use "time" as the common link
- Issues/challenges:
  - Missing or erroneous GPS data while indoors or under heavy canopy (buildings/trees)
  - Lack of clear (valid) thresholds/guidelines for data processing
  - Labor-intensive (need to develop special program to handle large samples)

  If interested in getting a copy of a sample program and protocol, indicate in the sign-up sheet

REF: Rodriguez DA, Brown AL, and Troped PJ (2005). Portable global positioning units to complement accelerometry-based physical activity monitors. Medicine & Science in Sports & Exercise, S572-581.





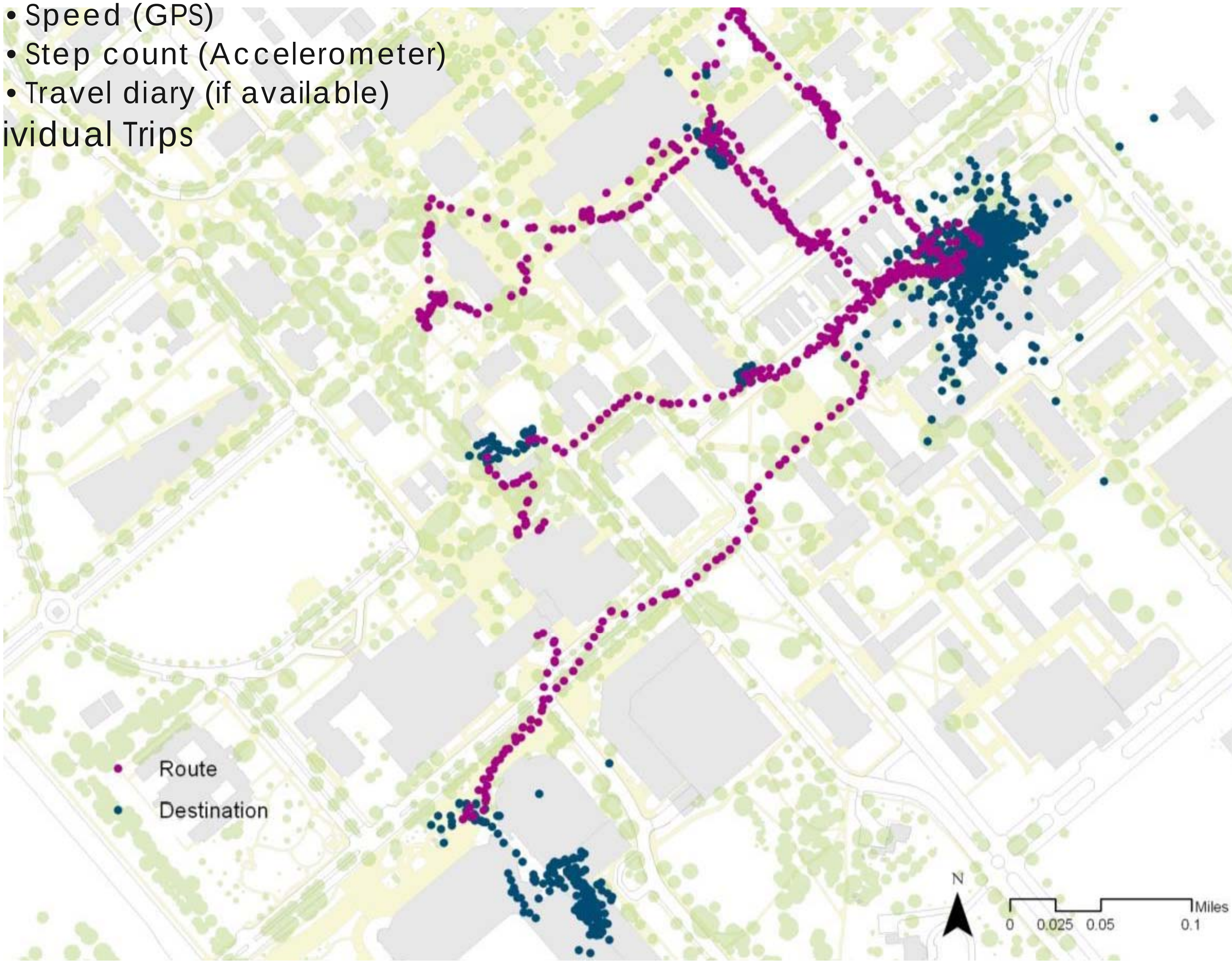
Software needed:
GPS Visualizer (to convert GPS raw data to GIS-compatible file)
A web-based program available from: http://www.gpsvisualizer.com/convert_input
Matlap (to merge GPS and Accelerometer data)
ArcGIS (to map the data and conduct spatial analysis)
Training Center and Way Point Manager (to download GPS data)
ActiGraph (to download Accelerometer data)

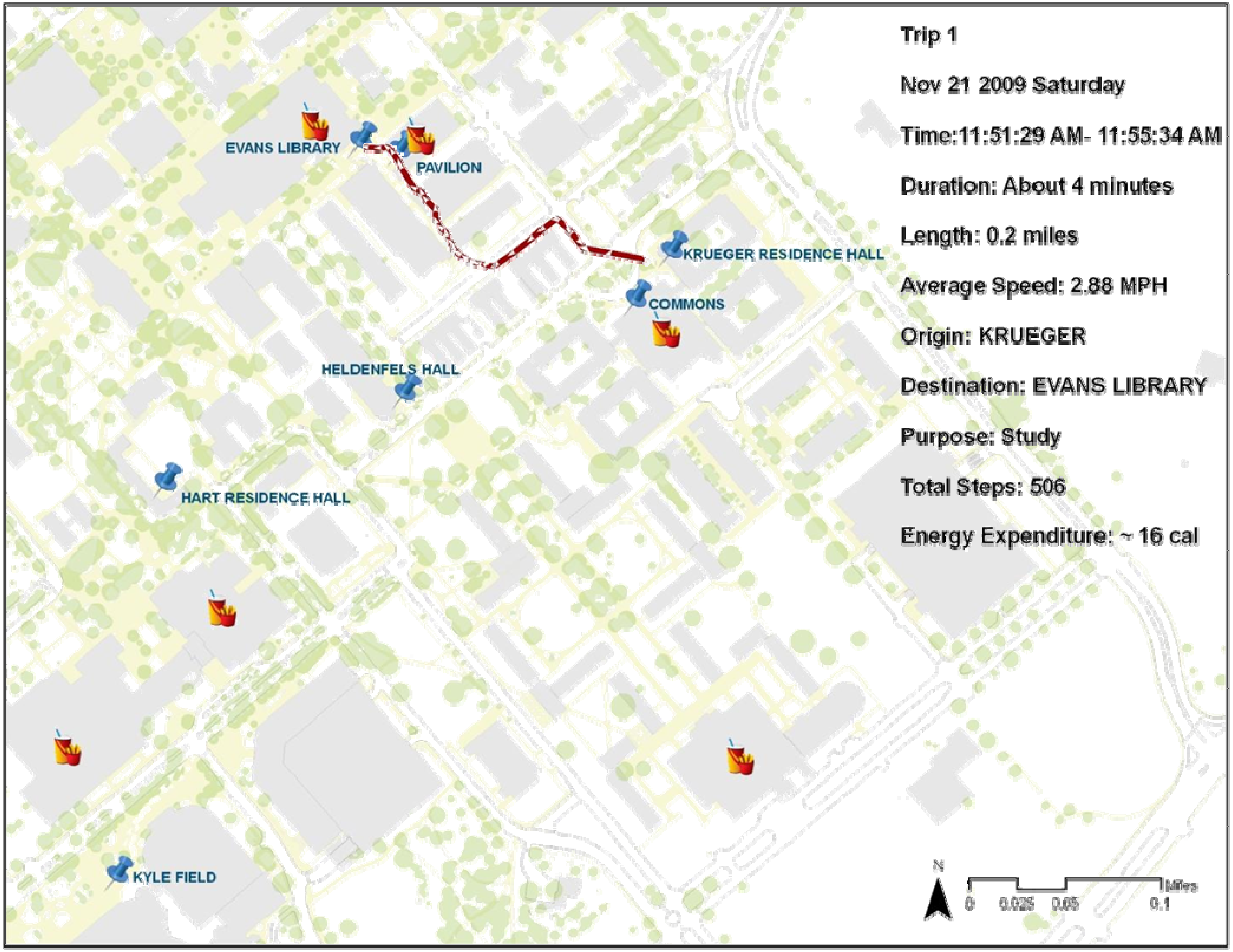
Files needed:
.GPX file (downloaded from the GPS unit)
.CSV file (downloaded from the Accelerometer unit)

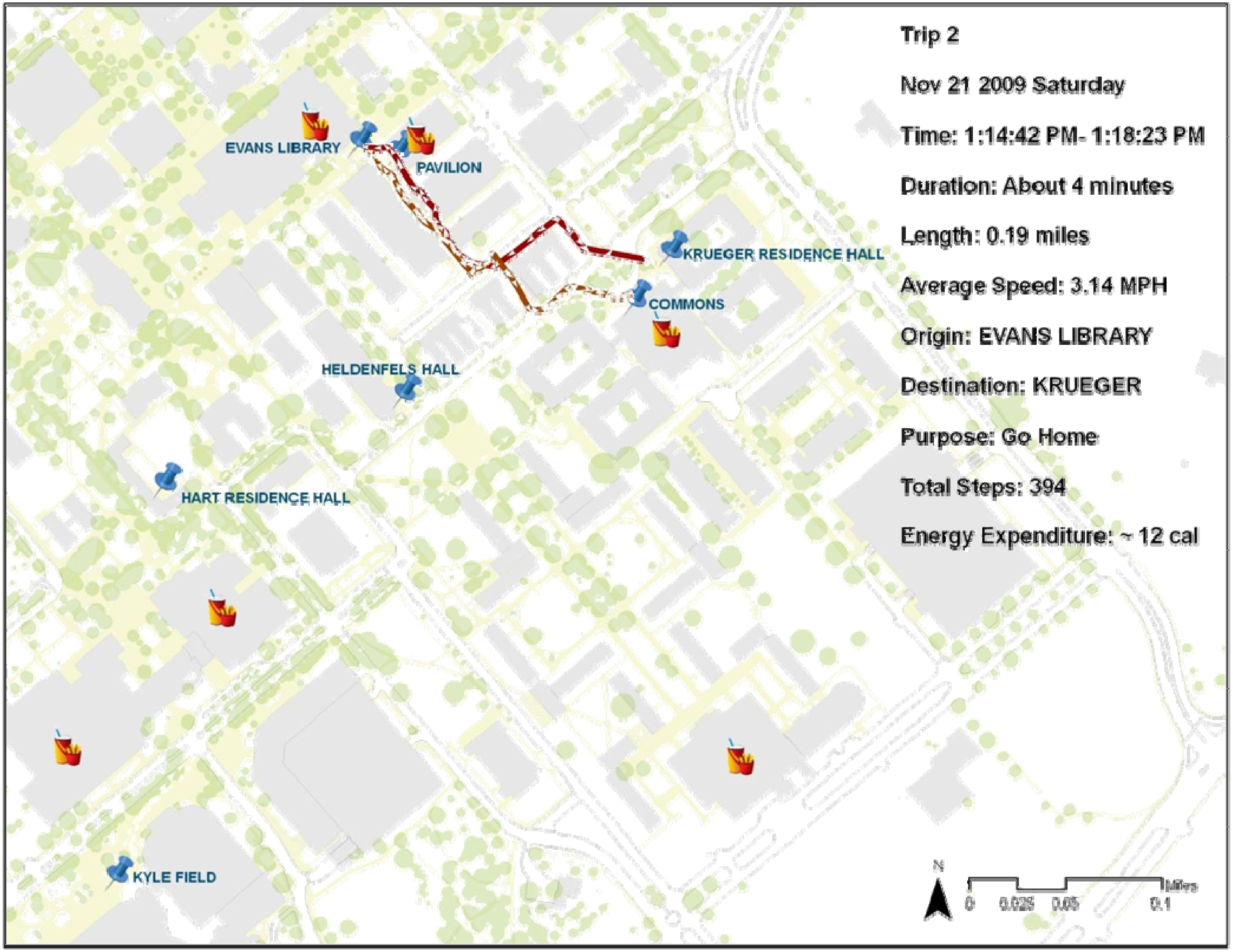
4. Classify the Synchronized data

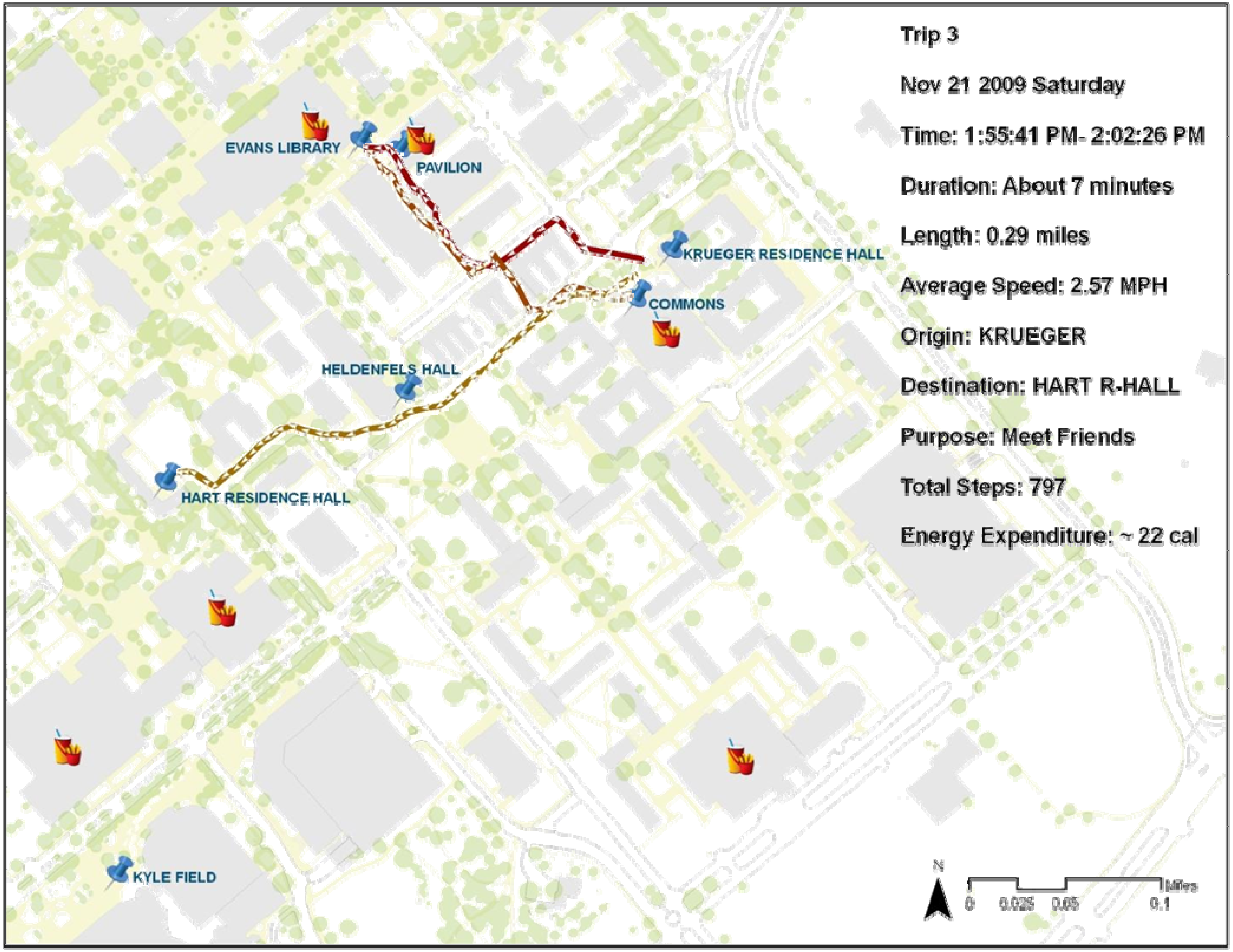
REF: *Troped et al. (2008). Prediction of activity mode with global positioning system and accelerometer data. Medicine & Science in Sports & Exercise, 40(5) 972-978.*

- Route vs. destinations
- Modes (e.g. walking, driving) based on:
  - Speed (GPS)
  - Step count (Accelerometer)
  - Travel diary (if available)
- Individual Trips

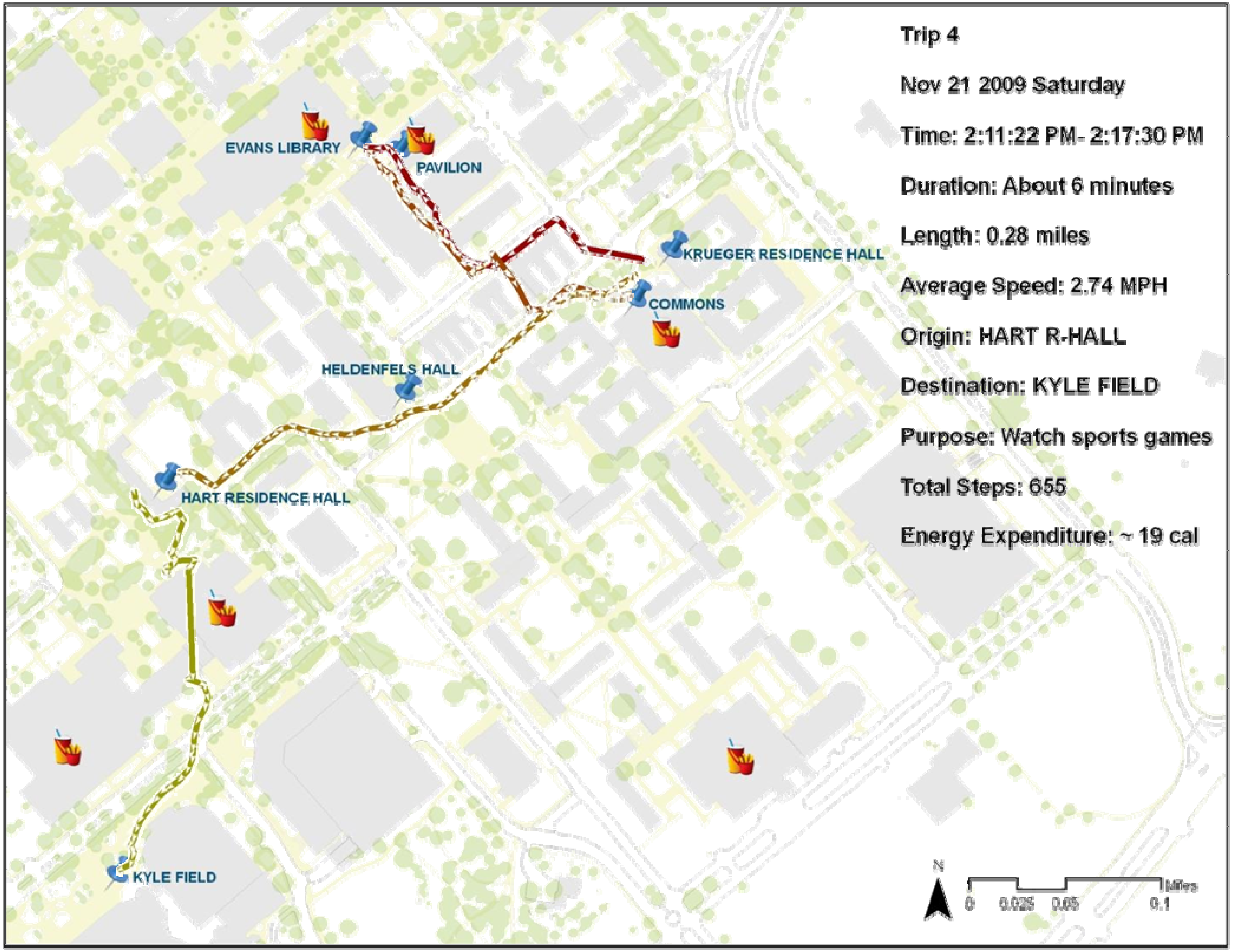


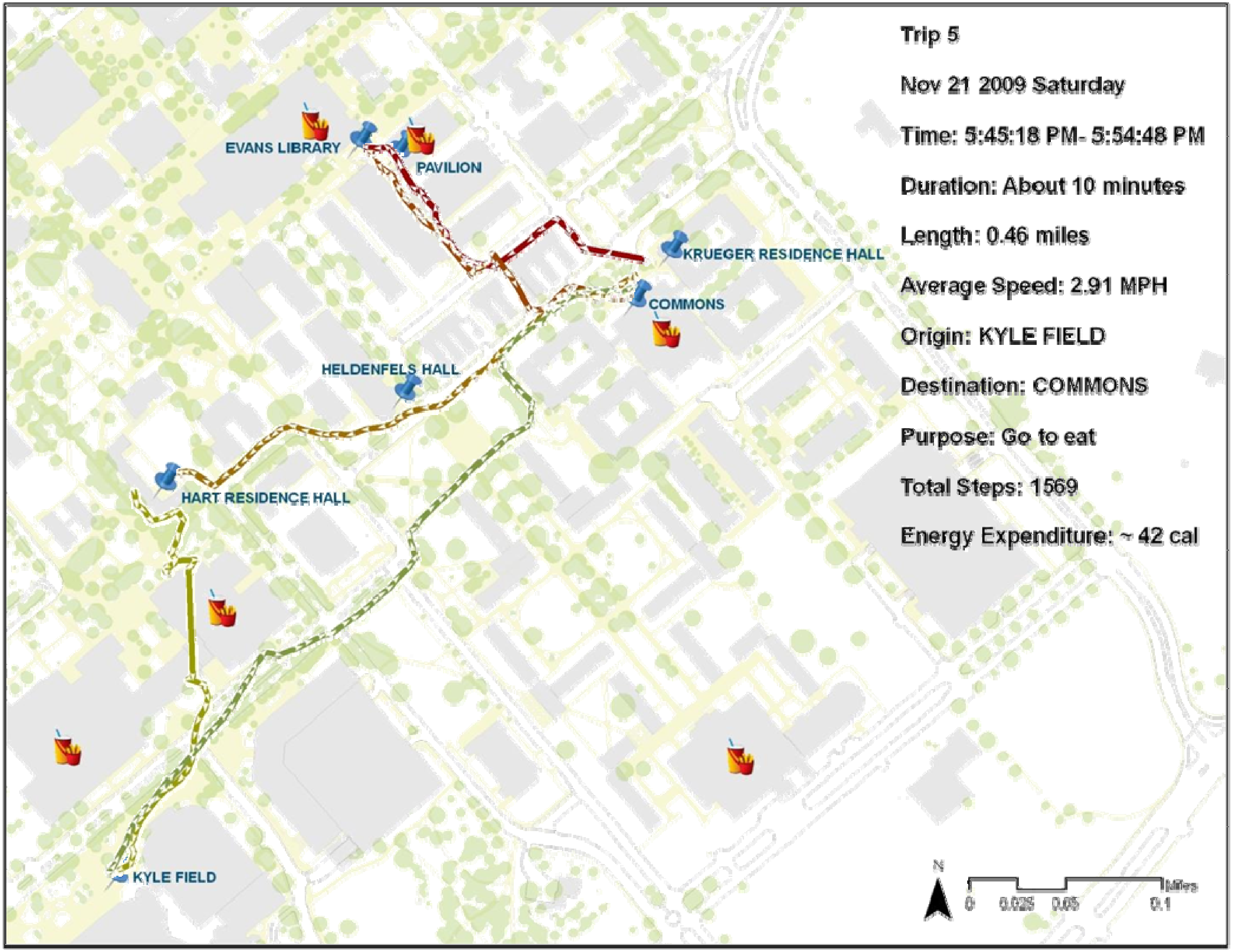

EVANS LIBRARY
PAVILION
KRUEGER RESIDENCE HALL
COMMONS
HELDENFELS HALL
HART RESIDENCE HALL
KYLE FIELD
Trip 1
Nov 21 2009 Saturday
Time:11:51:29 AM- 11:55:34 AM
Duration: About 4 minutes
Length: 0.2 miles
Average Speed: 2.88 MPH
Origin: KRUEGER
Destination: EVANS LIBRARY
Purpose: Study
Total Steps: 506
Energy Expenditure: ~ 16 cal
N
0 0.025 0.05 0.1
Miles

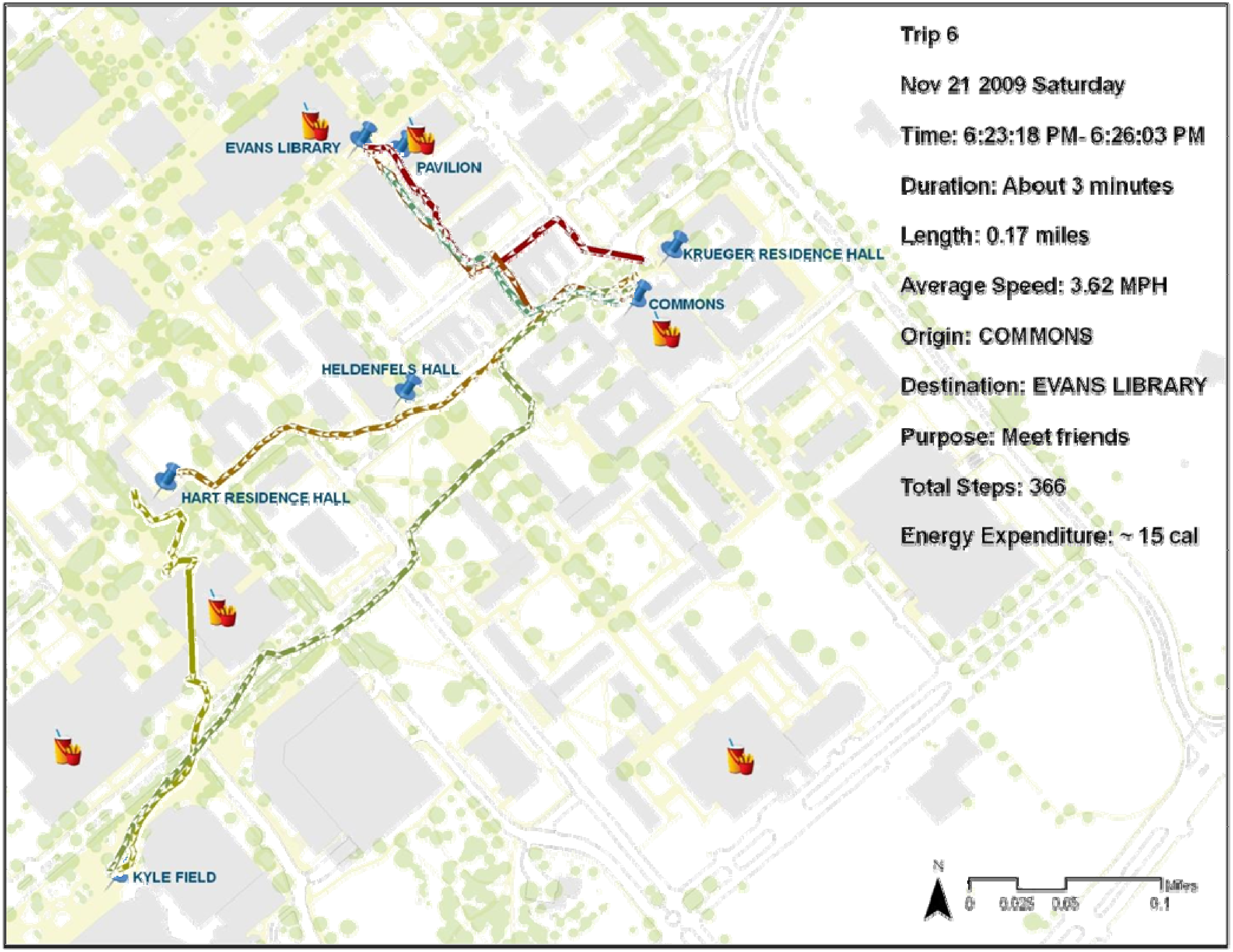

Trip 2
Nov 21 2009 Saturday
Time: 1:14:42 PM- 1:18:23 PM
Duration: About 4 minutes
Length: 0.19 miles
Average Speed: 3.14 MPH
Origin: EVANS LIBRARY
Destination: KRUEGER
Purpose: Go Home
Total Steps: 394
Energy Expenditure: ~ 12 cal
EVANS LIBRARY
PAVILION
KRUEGER RESIDENCE HALL
COMMONS
HELDENFELS HALL
HART RESIDENCE HALL
KYLE FIELD
N
0
0.025
0.05
0.1
Miles

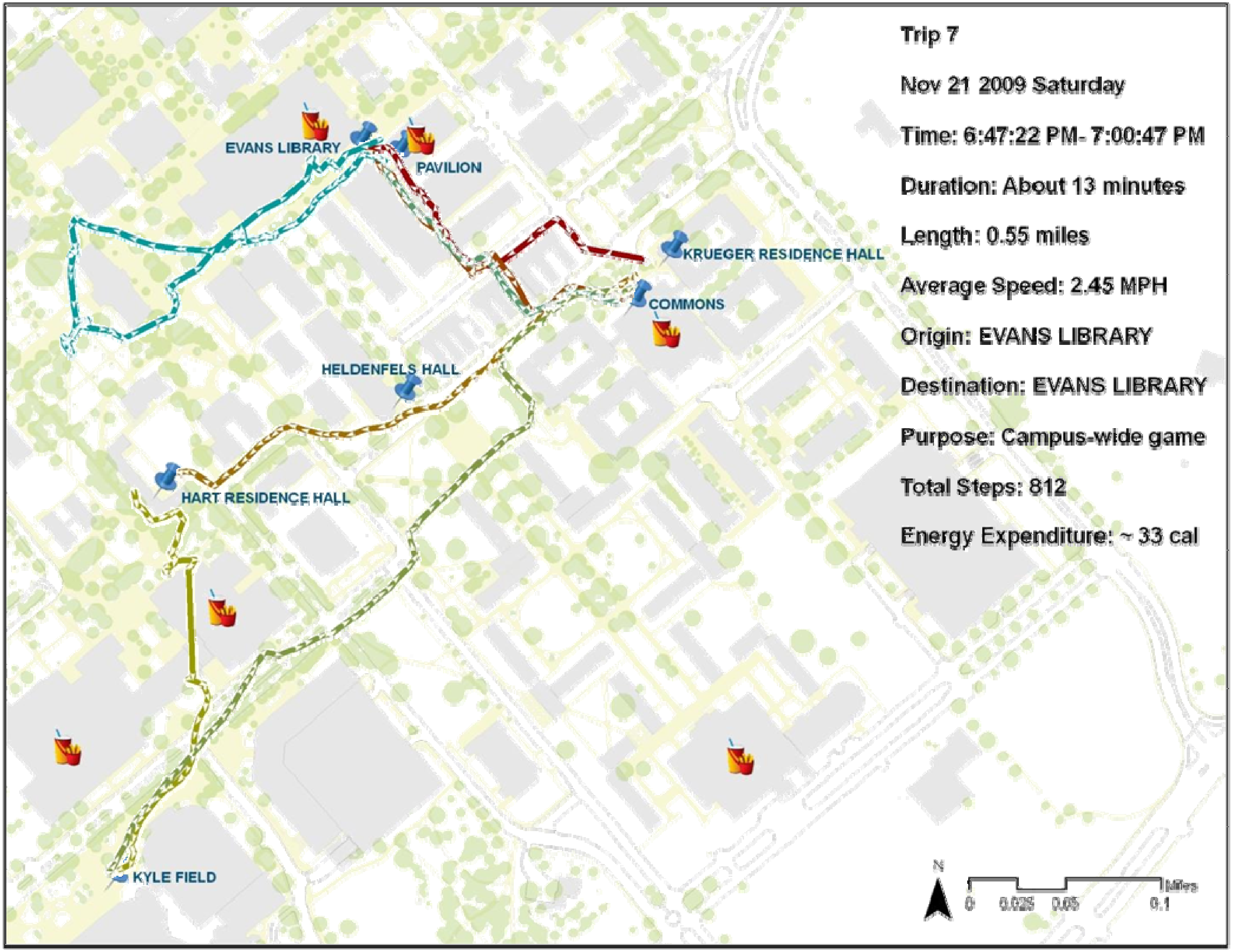


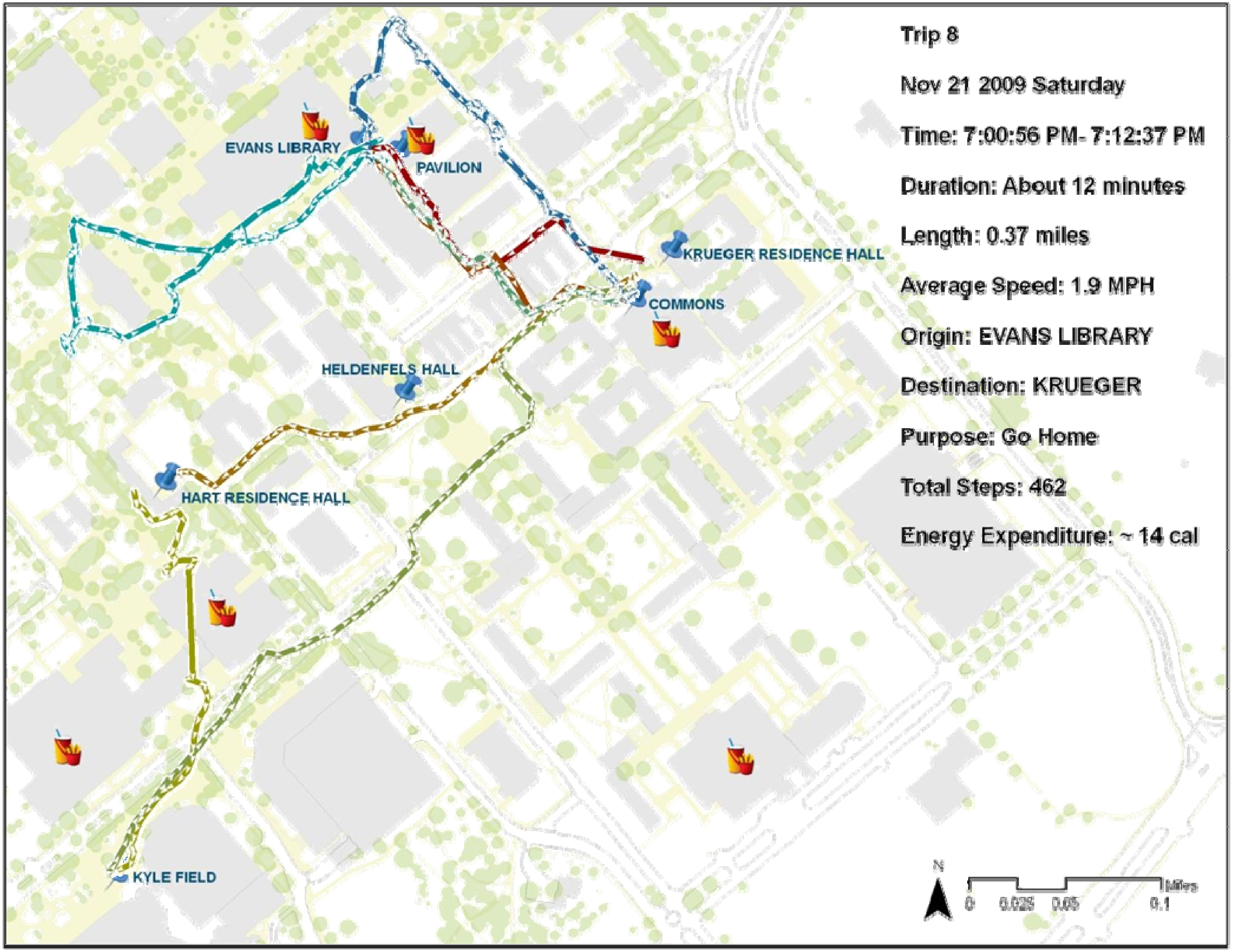
Trip 3
Nov 21 2009 Saturday
Time: 1:55:41 PM- 2:02:26 PM
Duration: About 7 minutes
Length: 0.29 miles
Average Speed: 2.57 MPH
Origin: KRUEGER
Destination: HART R-HALL
Purpose: Meet Friends
Total Steps: 797
Energy Expenditure: ~ 22 cal
EVANS LIBRARY
PAVILION
KRUEGER RESIDENCE HALL
COMMONS
HELDENFELS HALL
HART RESIDENCE HALL
KYLE FIELD
N
0
0.025
0.05
0.1
Miles

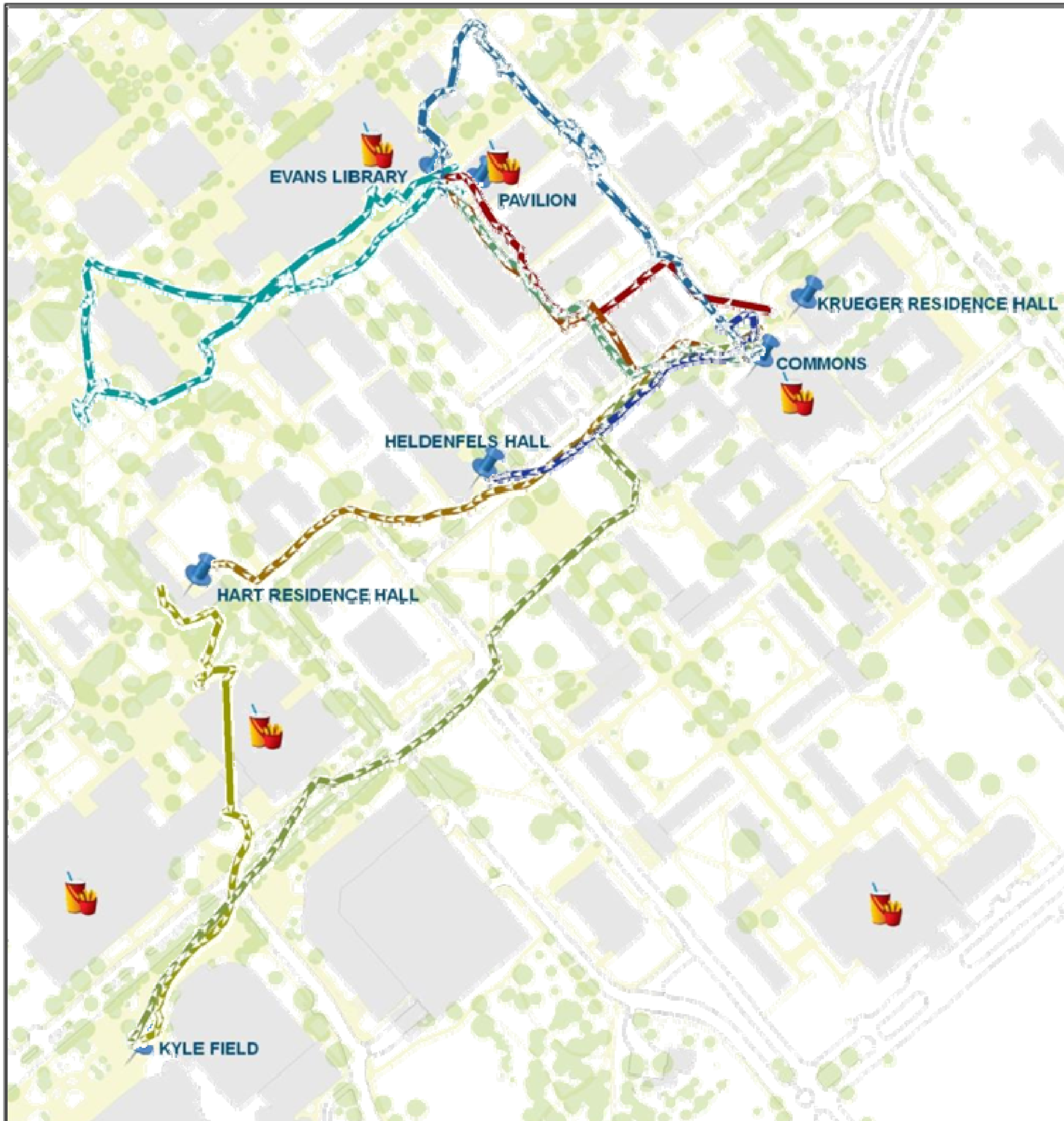

Trip 4
Nov 21 2009 Saturday
Time: 2:11:22 PM- 2:17:30 PM
Duration: About 6 minutes
Length: 0.28 miles
Average Speed: 2.74 MPH
Origin: HART R-HALL
Destination: KYLE FIELD
Purpose: Watch sports games
Total Steps: 655
Energy Expenditure: ~ 19 cal
EVANS LIBRARY
PAVILION
KRUEGER RESIDENCE HALL
COMMONS
HELDENFELS HALL
HART RESIDENCE HALL
KYLE FIELD
N
0
0.025
0.05
0.1
Miles


Trip 5
Nov 21 2009 Saturday
Time: 5:45:18 PM- 5:54:48 PM
Duration: About 10 minutes
Length: 0.46 miles
Average Speed: 2.91 MPH
Origin: KYLE FIELD
Destination: COMMONS
Purpose: Go to eat
Total Steps: 1569
Energy Expenditure: ~ 42 cal
EVANS LIBRARY
PAVILION
KRUEGER RESIDENCE HALL
COMMONS
HELDENFELS HALL
HART RESIDENCE HALL
KYLE FIELD
N
0
0.025
0.05
0.1
Miles


Trip 6
Nov 21 2009 Saturday
Time: 6:23:18 PM- 6:26:03 PM
Duration: About 3 minutes
Length: 0.17 miles
Average Speed: 3.62 MPH
Origin: COMMONS
Destination: EVANS LIBRARY
Purpose: Meet friends
Total Steps: 366
Energy Expenditure: ~ 15 cal
EVANS LIBRARY
PAVILION
KRUEGER RESIDENCE HALL
COMMONS
HELDENFELS HALL
HART RESIDENCE HALL
KYLE FIELD
N
0
0.025
0.05
0.1
Miles


Trip 7
Nov 21 2009 Saturday
Time: 6:47:22 PM- 7:00:47 PM
Duration: About 13 minutes
Length: 0.55 miles
Average Speed: 2.45 MPH
Origin: EVANS LIBRARY
Destination: EVANS LIBRARY
Purpose: Campus-wide game
Total Steps: 812
Energy Expenditure: ~ 33 cal
EVANS LIBRARY
PAVILION
KRUEGER RESIDENCE HALL
COMMONS
HELDENFELS HALL
HART RESIDENCE HALL
KYLE FIELD
N
0
0.025
0.05
0.1
Miles


Trip 8
Nov 21 2009 Saturday
Time: 7:00:56 PM- 7:12:37 PM
Duration: About 12 minutes
Length: 0.37 miles
Average Speed: 1.9 MPH
Origin: EVANS LIBRARY
Destination: KRUEGER
Purpose: Go Home
Total Steps: 462
Energy Expenditure: ~ 14 cal
EVANS LIBRARY
PAVILION
KRUEGER RESIDENCE HALL
COMMONS
HELDENFELS HALL
HART RESIDENCE HALL
KYLE FIELD
N
0
0.025
0.05
0.1
Miles



Trip 9

Nov 21 2009 Saturday

Time: 7:14:10 PM- 7:17:39 PM

Duration: About 4 minutes

Length: 0.16 miles

Average Speed: 2.81 MPH

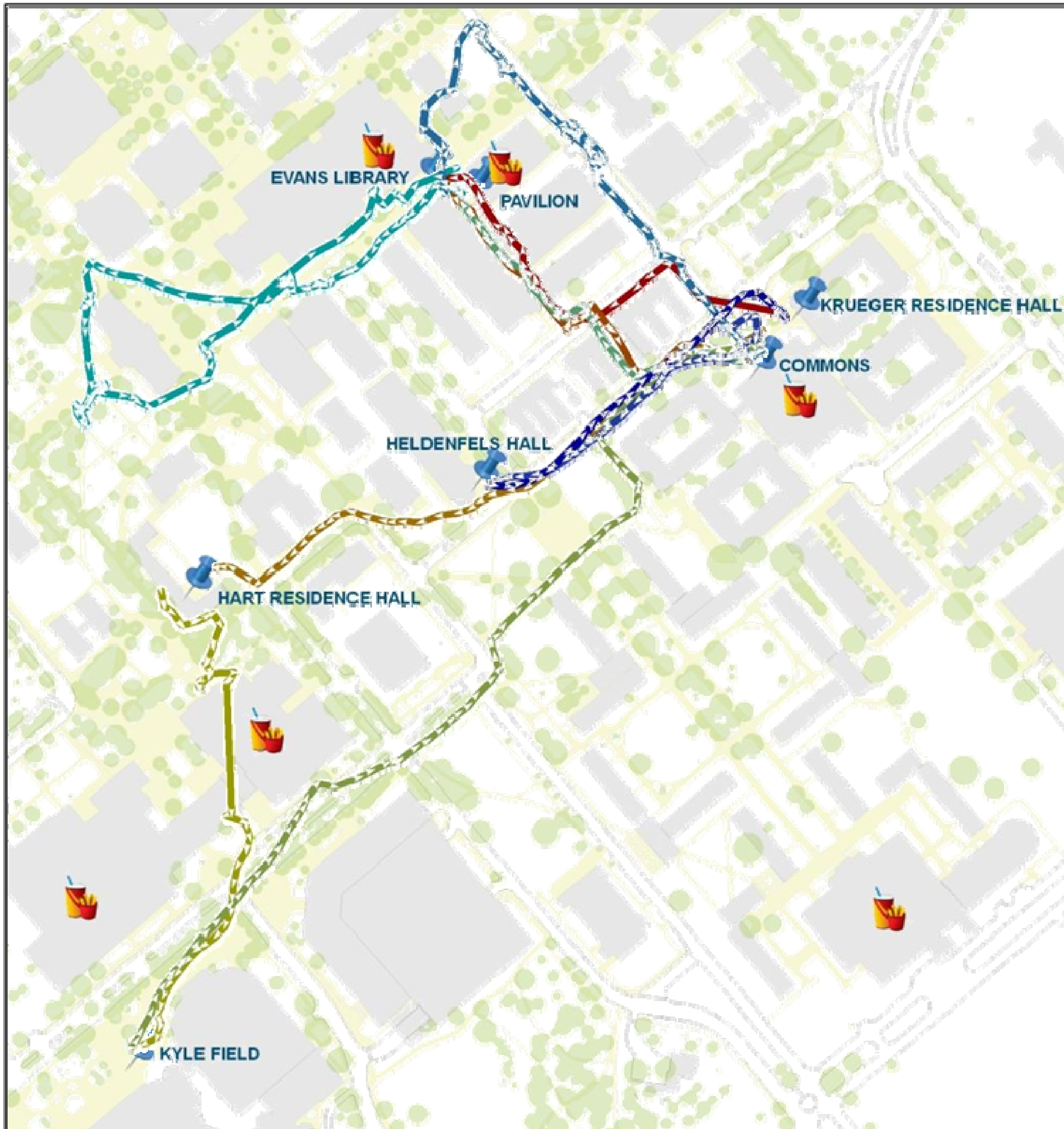
Origin: KRUEGER

Destination: HELDENFELS

Purpose: Study

Total Steps: 298

Energy Expenditure: ~ 10 cal



Trip 10

Nov 21 2009 Saturday

Time: 7:36:31 PM- 7:40:35 PM

Duration: About 4 minutes

Length: 0.17 miles

Average Speed: 2.41 MPH

Origin: HELDENFELS

Destination: KRUEGER

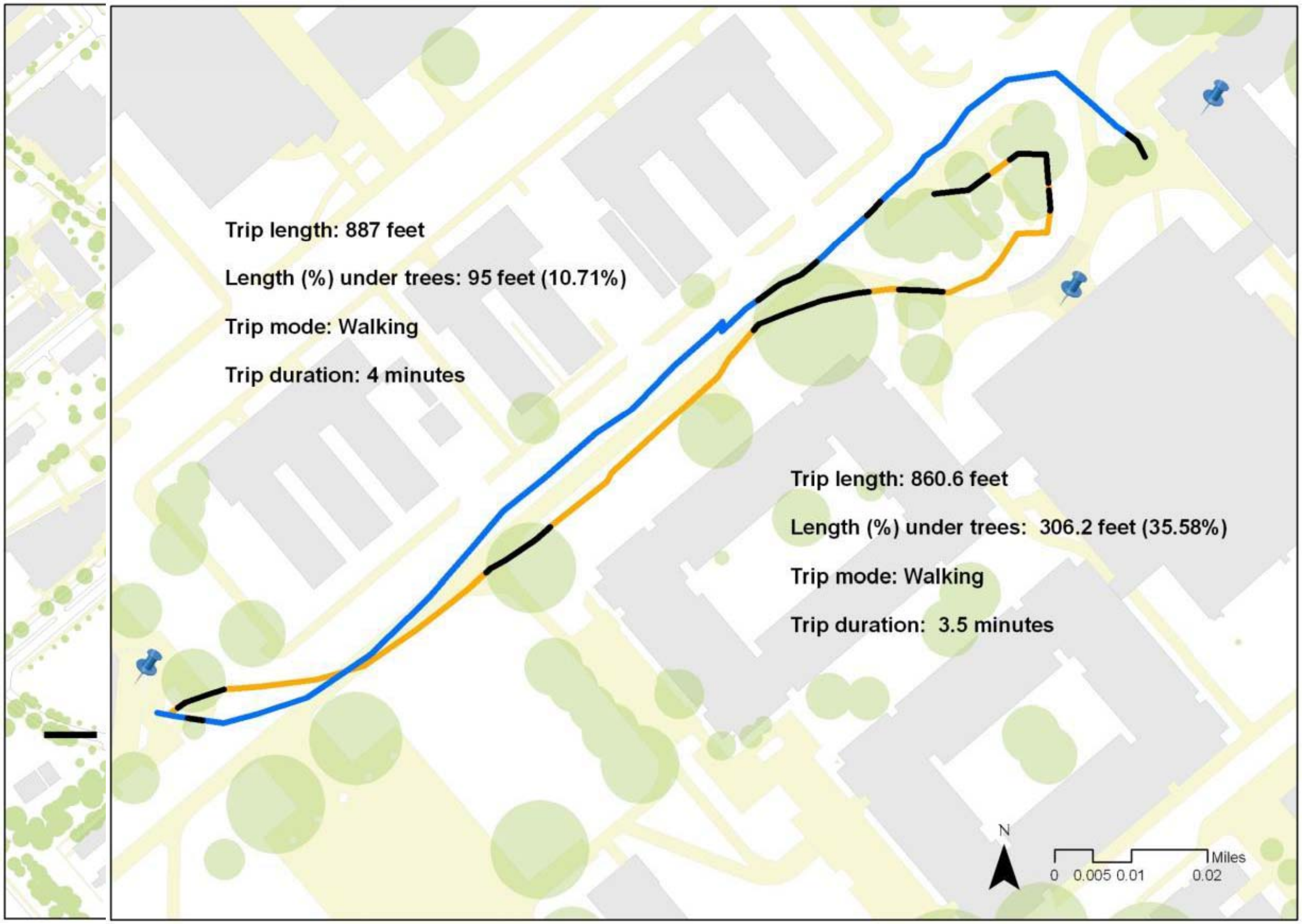
Purpose: Go Home

Total Steps: 400

Energy Expenditure: ~ 11 cal

5. Conduct Spatial Analysis (examples)

- Types of destinations by mode
- Route qualities (e.g. % of walking routes under tree canopy, along sidewalks, etc.)



Objective 3

Learn about a spatial sampling approach that considers environmental characteristics during the sampling process

Spatial Sampling Method

1. Define Conceptual Study Population
2. Define Spatial Extent of Population and Establish Spatial Sample Frame
3. Examine the Spatial Sample Frame
4. Determine Sample Design & Size, and Draw Samples

Lee C, Moudon AV, and Courbois JY (2006). Spatial sampling and the built environment. *Annals of Epidemiology*, 16 (5), 387-394.

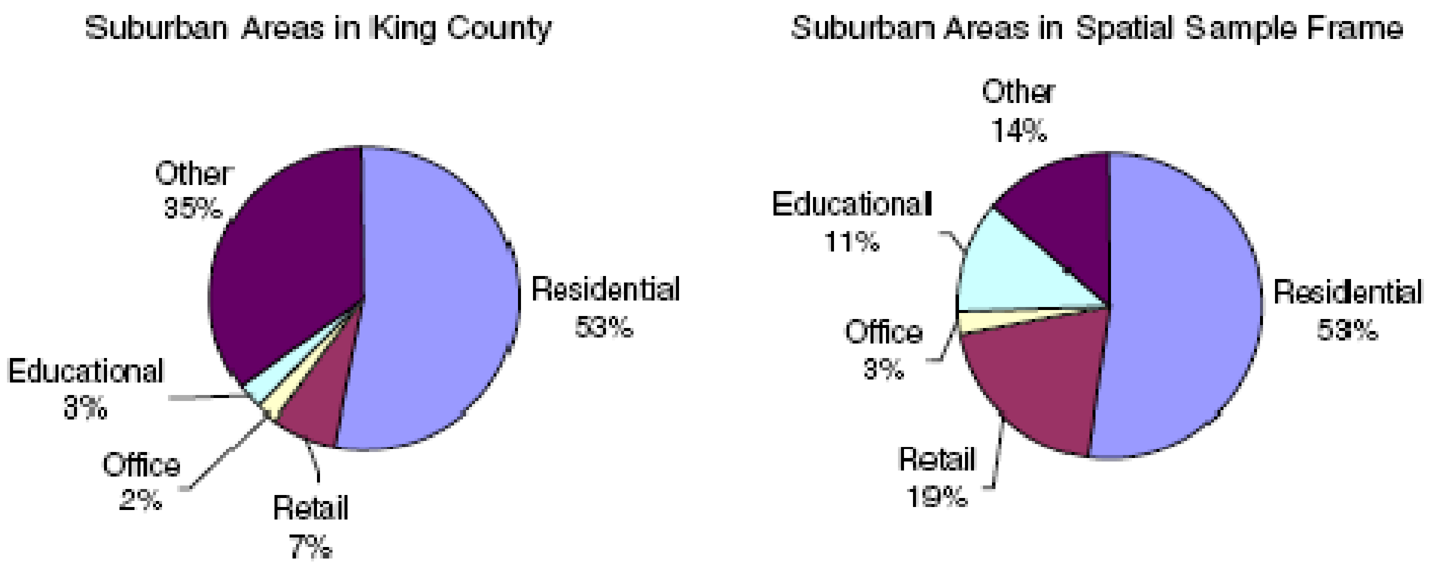
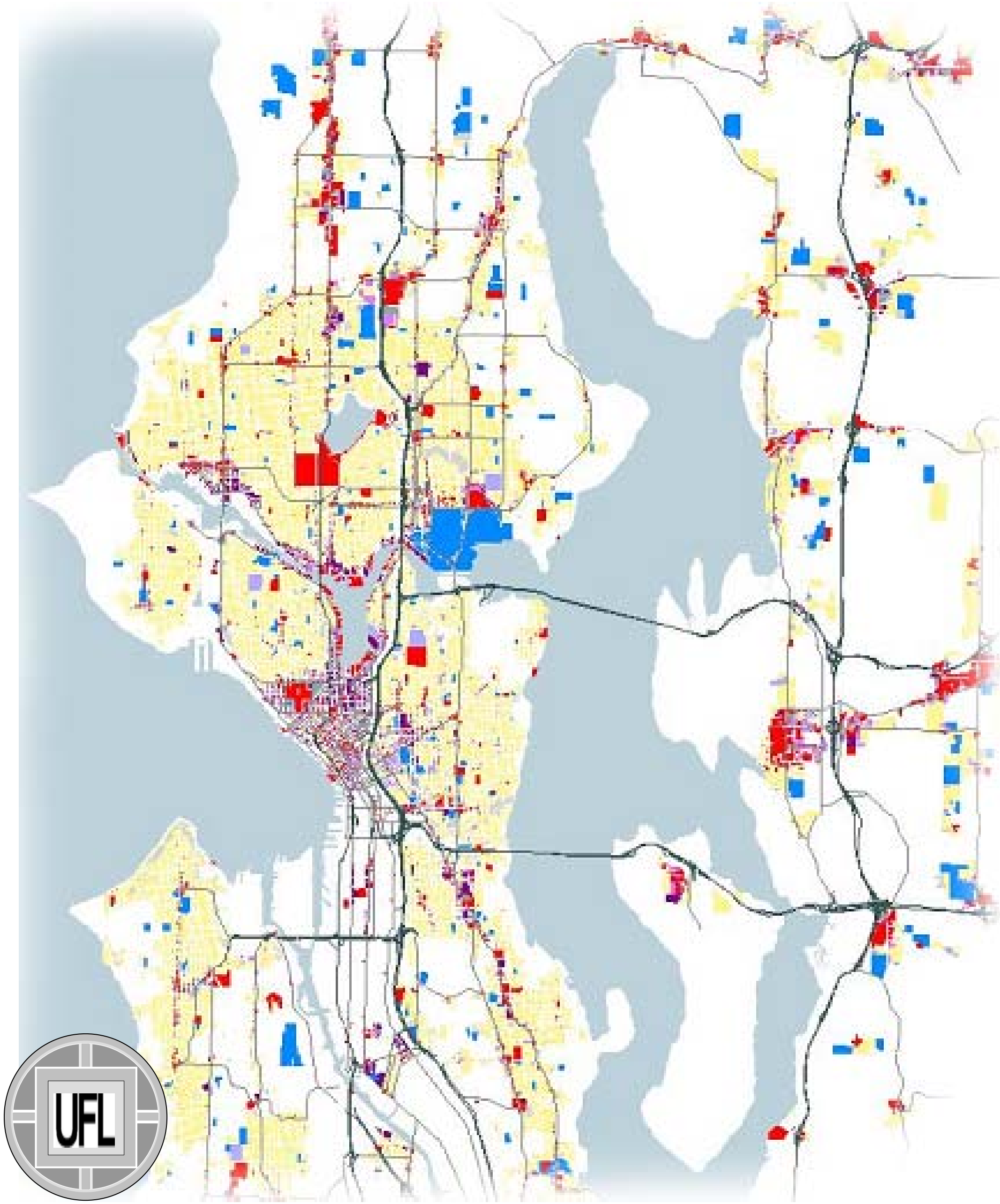


FIGURE 3. Distribution of land uses in suburban areas in King County and in spatial sample frame.

Respondents' Spatial Sampling Frame



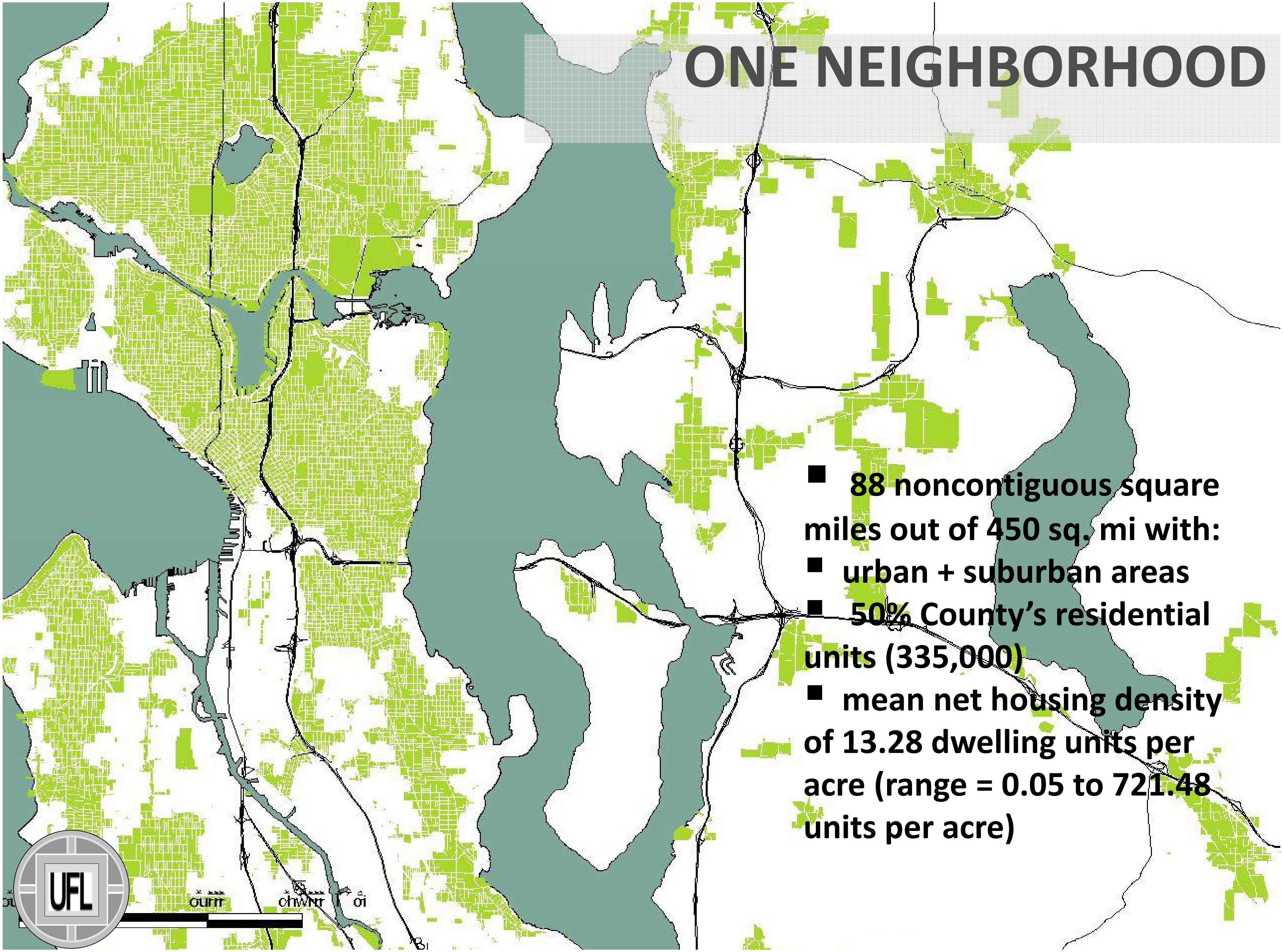
Sample frame:

Able-bodied residents of households with telephones living in "Cluster"

Built Environment defined by:

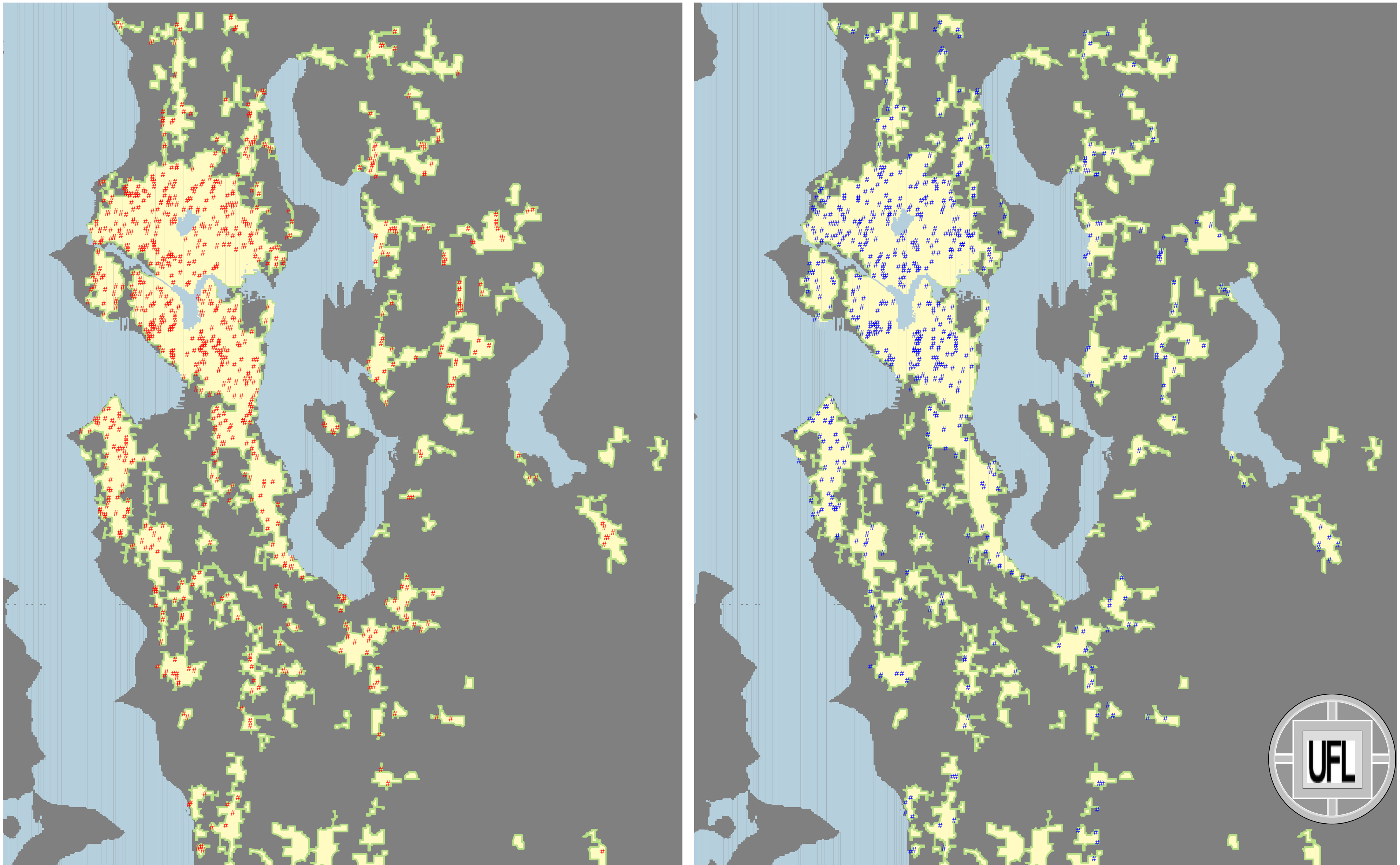
- Net housing density of more than 10 dwellings units per acre
- Neighborhood retail and/or residences are within 240 meters or less of each other

ONE NEIGHBORHOOD



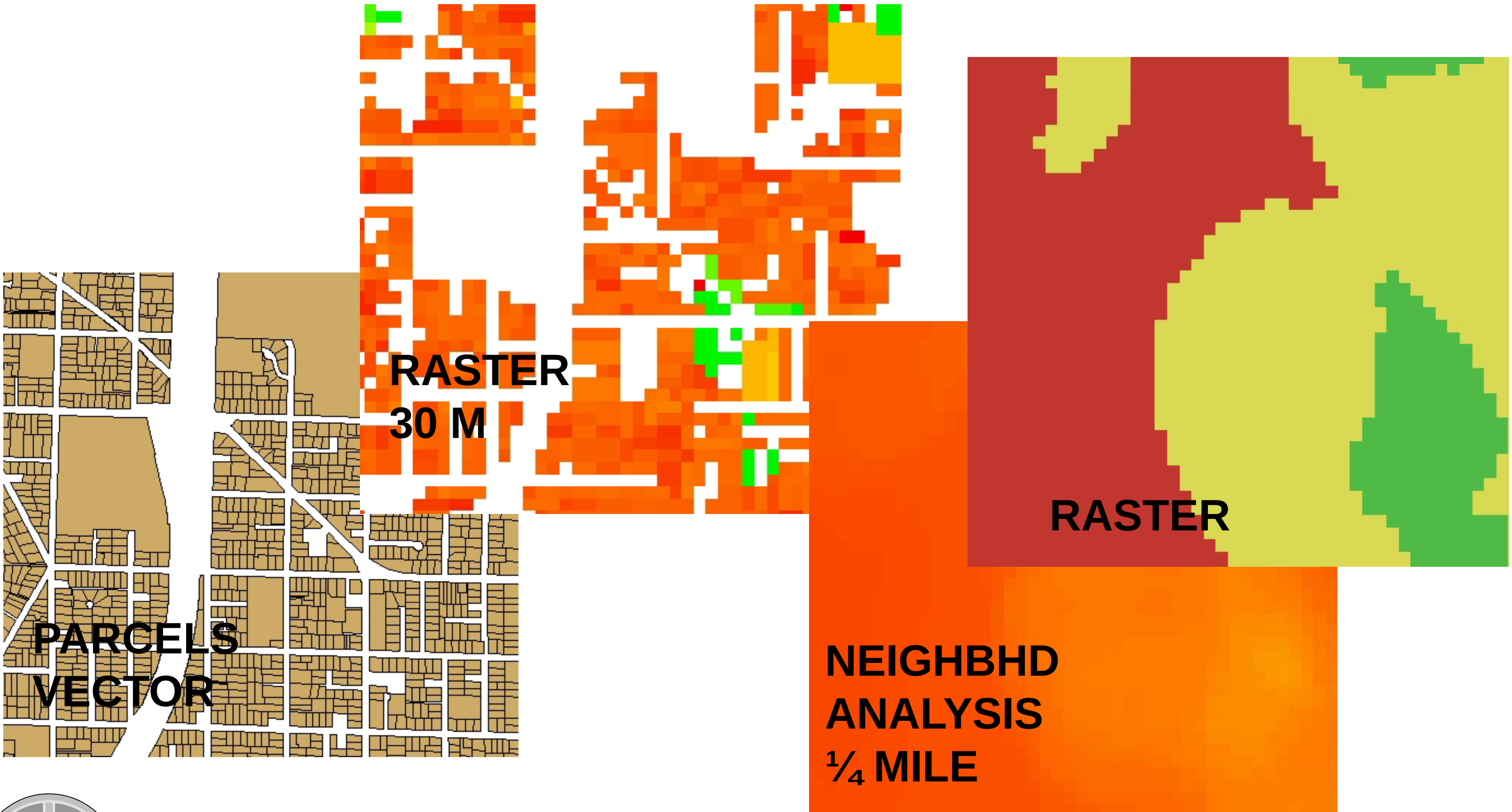
- 88 noncontiguous square miles out of 450 sq. mi with:
- urban + suburban areas
- 50% County's residential units (335,000)
- mean net housing density of 13.28 dwelling units per acre (range = 0.05 to 721.48 units per acre)

Random Sample of Respondents in Spatial Sample Frame



Refusals **Respondents**

DATA TRANSFORMATION



Objective 4

Learn and discuss about geospatial analyses to measure and model the environment or behaviors

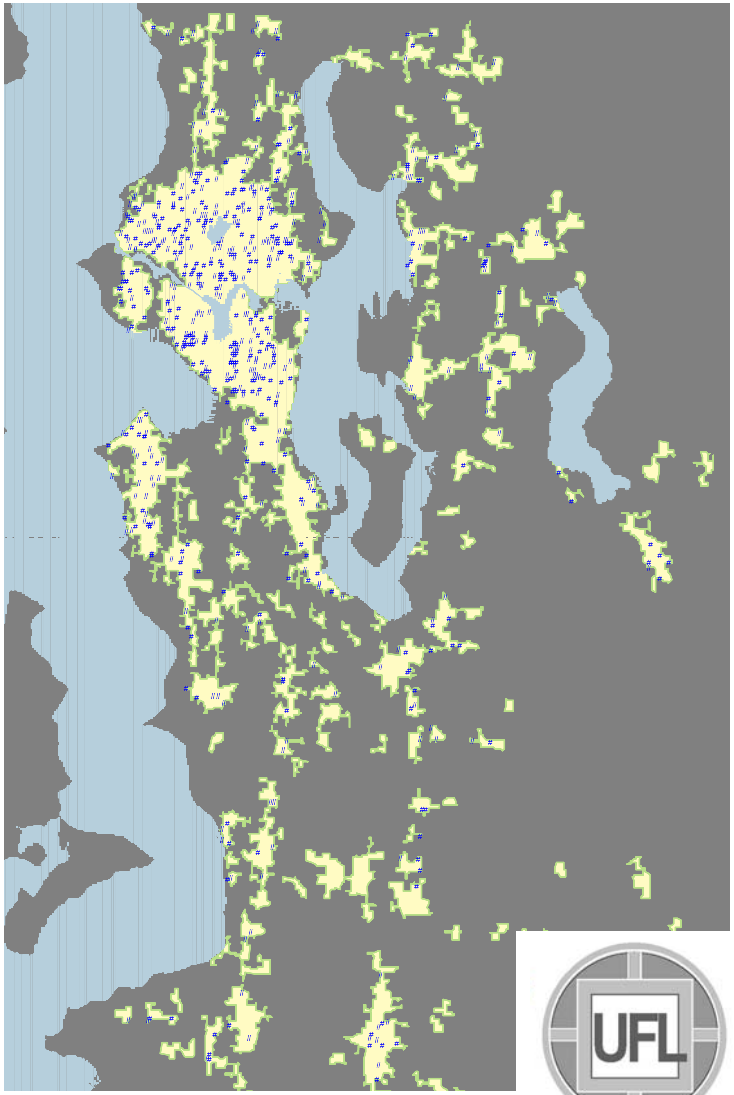
4.1. Predicting behavior based on environmental exposure and access/use

Surface Models

- LOCATIONS: 608 random sample of survey respondents in the sample frame

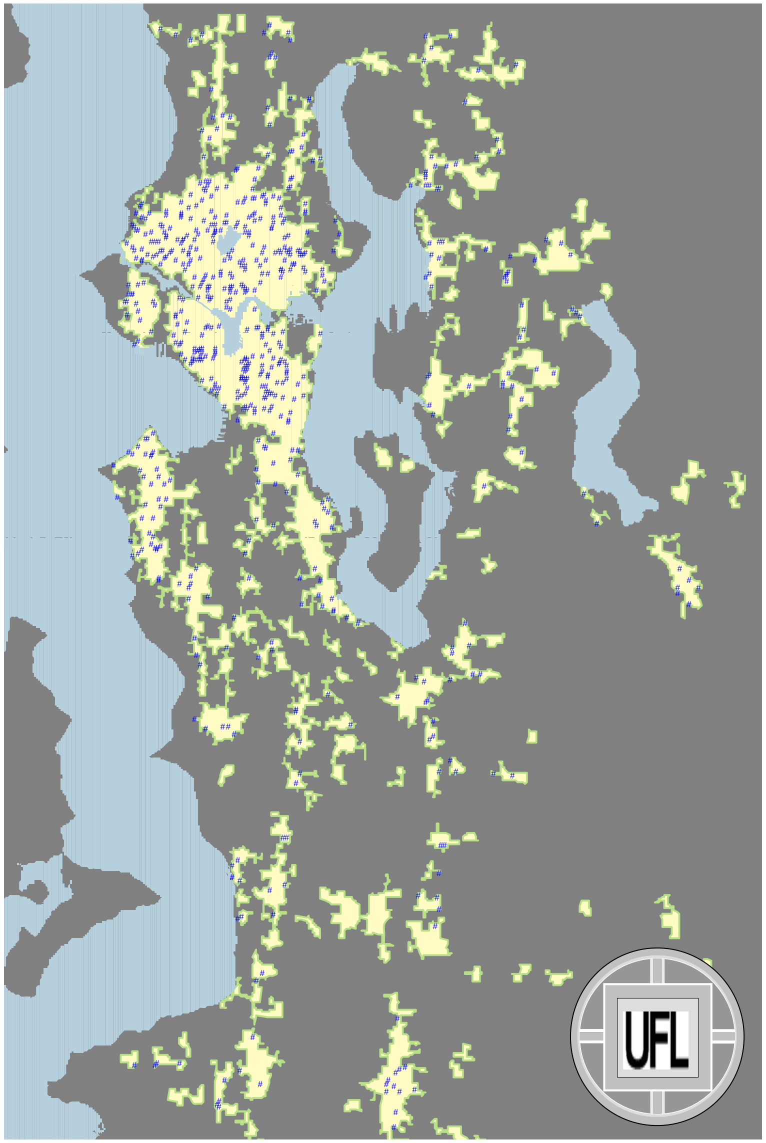
- ESTIMATING PROBABILITY OF WALKING: Multinomial logistic regression models were developed to estimate the probability of a “Moderate Walker” (1-149 min per week) or “Sufficient Walker” (>=150 min per week), relative to not walking (0 min walking per week).

- VALUES of LOCATIONS: values (probability of walking) are calculated using the regression



Methods

- Multinomial logit models estimating
  - odds of walking sufficiently (150+minutes per week, meeting the recommendation for health)
  - moderately (1-149 minutes per week),
  - relative to not walking
- Objective environmental variables that showed statistical significance in the models were translated into audit items.



Top predictors of walkability

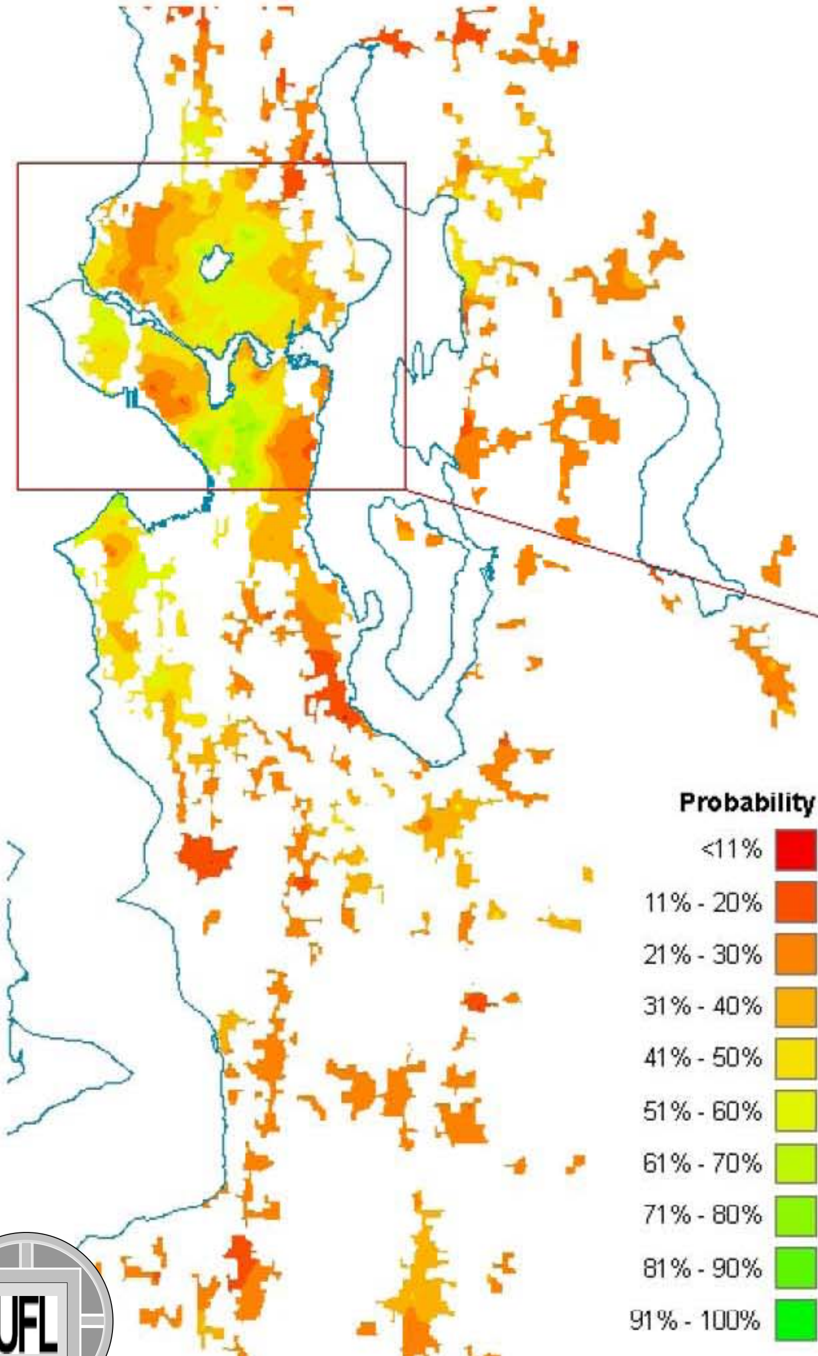
Environmental Characteristic (Threshold Value)	**Odds ratio of walking >150 min/week vs. not walking** (airline measurement)
•Shorter distance to closest grocery store (<440 m)	**2.257****
•Fewer grocery stores or markets within buffer (less than 3.7)	**1.50***
•More grocery store/restaurant/retail clusters in 1km buffer (more than 1.8)	**1.697****
•More dwelling units per acre of the parcel where the residence is located (more than 21.7 units/net acre)	**1.959****
•Fewer educational parcels in 1km buffer (less than 5.1)	**1.553***
•Smaller size of closest office complex (less than 36,659 m2 or 9 acres)	**1.28***
•Longer distance to closest office/mixed use complex (more than 544 m)	**1.27*§**
•Smaller block size where residence is located (less than 23,876 m2 or 5.9 acres)	**1.19***

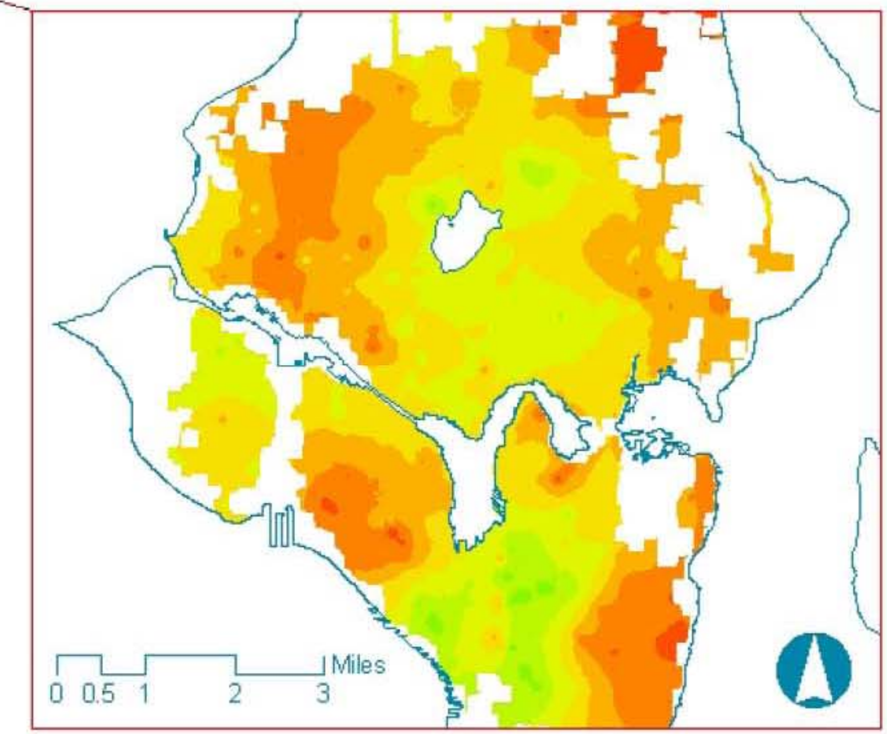
* $p < 0.1$; ** $p < 0.05$

Adapted from Moudon AV, Lee C, Cheadle A, et al. Attributes of Environments Supporting Walking. Am J Health Promot. 2007;21(5):448-459. *: significant at 0.1 level; **: significant at 0.05 level

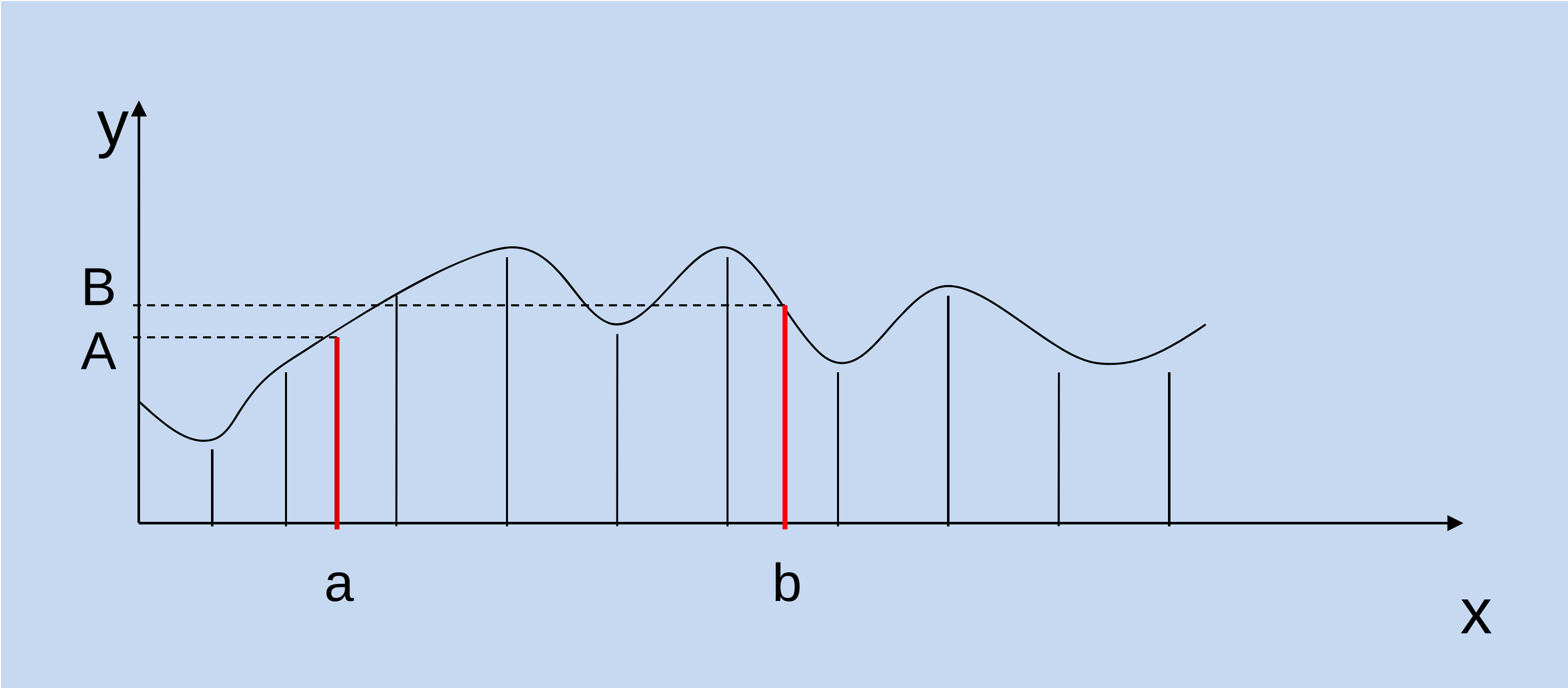
WBC Surface modeling

Likelihood of Sufficient Walking for Average Person





Surface Modeling Algorithm

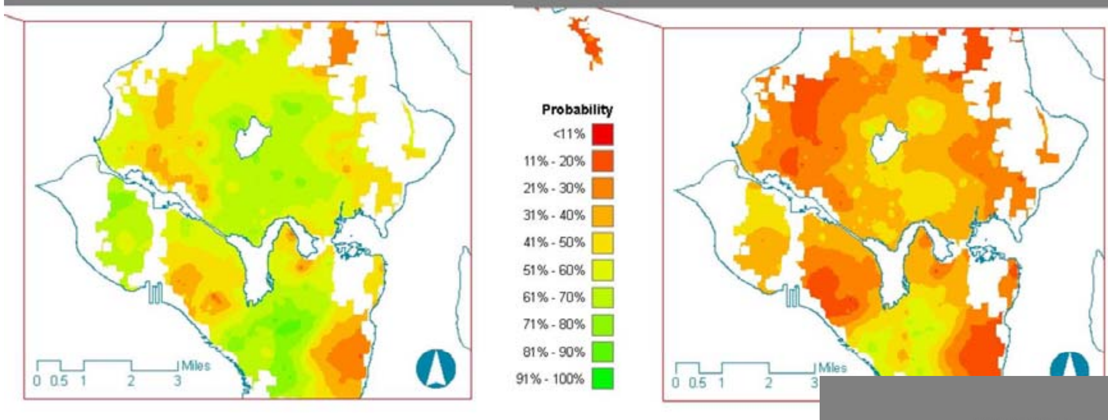


WBC Surface modeling

Likelihood of Sufficient Walking

(>150 minute a week)

Older Adult >65 **Younger Adults <35**

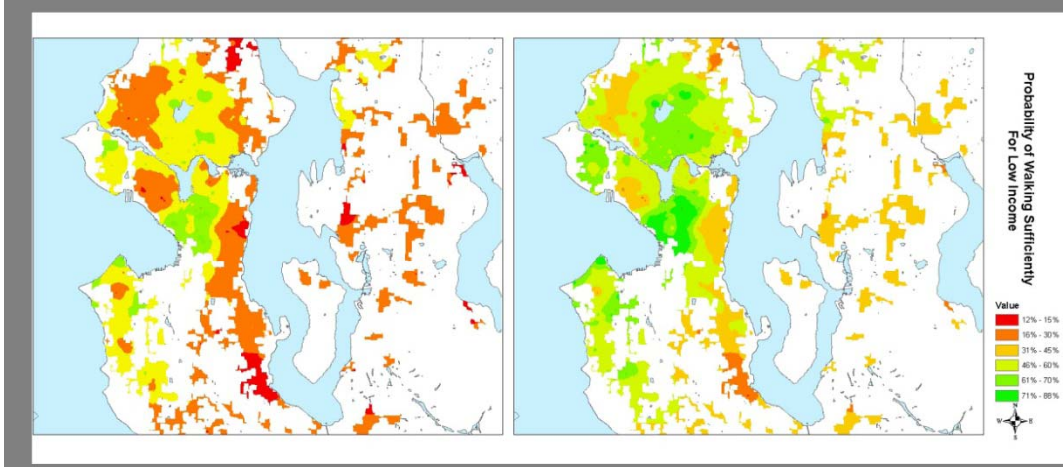


UW Urban Form Lab Walk and Bike Communities project

Probability of Walking Sufficiently

(>150 minute a week)

High / Low Reported Income
(>$75,000 vs. <$25,000)



4.2. Maps in GIS can serve as data layers

E. Berke

Berke E, Koepsell T, Moudon A, Hoskins R. Physical activity and obesity in older persons: association with the built environment. American Journal of Public Health 97, 3:1-7

Berke EM, Gottlieb LM, Moudon AV, Larson EB. Protective Association of Neighborhood Walkability with Depression in Older Males. J Am Geriatr Soc. In Press.

Research Goal

–Evaluate the association of individual-level neighborhood walkability with depression and physical activity in older adults.

E. Berke

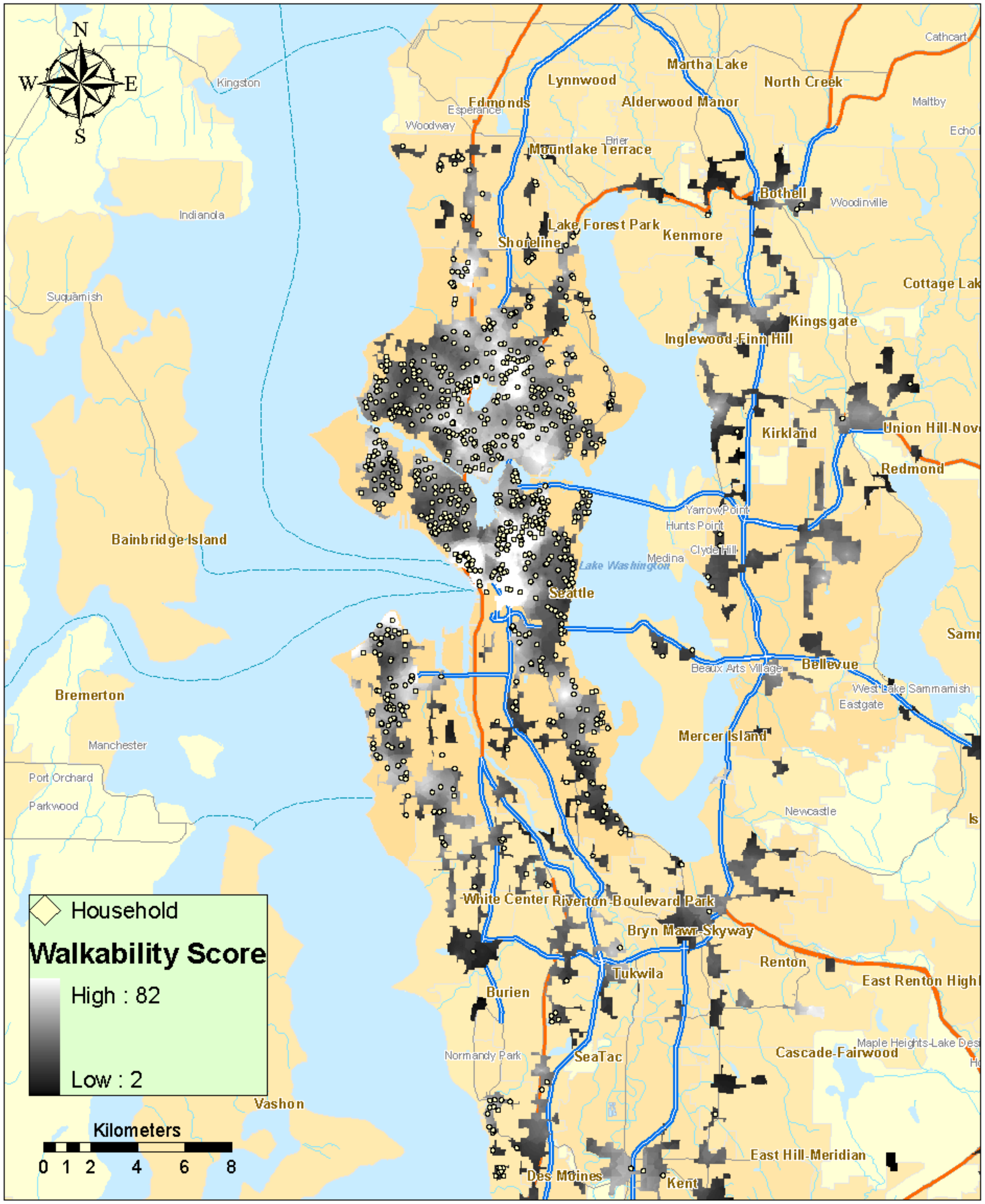
Subject Population

- Adult Changes in Thought (ACT) study
  - Group Health Cooperative study - 1994 - present
  - Prospective longitudinal design
  - ≥ 65 y/o
  - ~2500 subjects
  - Surveyed biennially
  - Information on BMI, self-reported walking, depression
  - Chronic dz burden, demographics, health conditions

Neighborhood

- Subjects geocoded at parcel level
  - 100m, 500m, 1000m, buffers
- Walkability score computed for each person at each buffer size

E. Berke
Individual-Level Advantages



- Precise description of habitat immediately around subject’s home
- Not census or other aggregate measure
- Reduced risk of ecologic fallacy

Results Walkability Score and Walking

Older adults (65-97; n = 936)

Berke E, Koepsell T, Moudon A, Hoskins R. Physical activity and obesity in older persons: association with the built environment. American Journal of Public Health 97, 3:1-7

- ✓ Higher walkability scores significantly associated with more walking for exercise across buffers of varying radii

  (for men, odds ratio [OR]=5.86; CI=1.01, 34.17 to OR=9.14; CI=1.23, 68.11; for women, OR=1.63; CI=0.94, 2.83 to OR=1.77; CI=1.03, 3.04).

- ✓ A trend toward lower body mass index in men living in more walkable neighborhoods did not reach statistical significance.

Results

Walkability Score and Depression

(n = 740; >65y)

Berke EM, Gottlieb LM, Moudon AV, Larson EB. Protective Association of Neighborhood Walkability with Depression in Older Males. J Am Geriatr Soc. In Press.

- ✓ Physical activity known to be inversely related to depression in older persons

- ✓ Neighborhood Walkability Scores negatively associated with depression in older males [adjusted for individual-level risk factors of income, physical activity, education, smoking status, living alone, age, and chronic disease burden]

- ✓ OR (interquartile range of walkability score, 25th-75th percentile) = 0.32 to 0.34 for buffer radii of 100, 500, and 1000 m (p = 0.01 to 0.02)