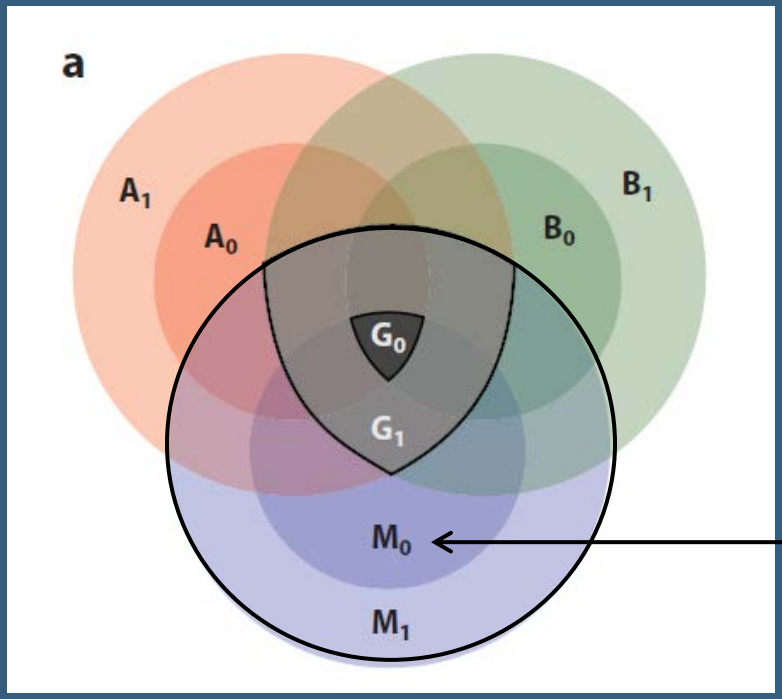
Novel Anthropogenic Activity Datasets and Predicting Long Range Introductions of Invasive Pests

Gericke Cook, USDA APHIS PPQ CPHST
Applied Geospatial Technology Program

August 25, 2015

Human Activity and Pest Spread

BAM Framework: Migration



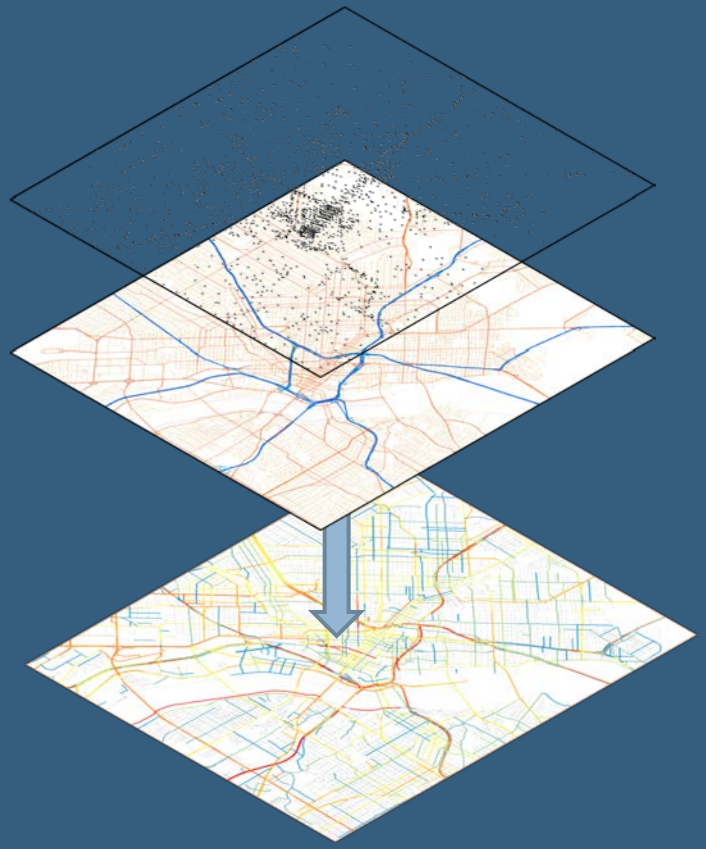
SDM

M0: Region a species is capable of reaching by dispersal

Human Activity Datasets

- Traffic Pattern
- U.S. Postal Service Address Forwarding
- National Household Travel Survey *New!*

Traffic Pattern Analysis Project

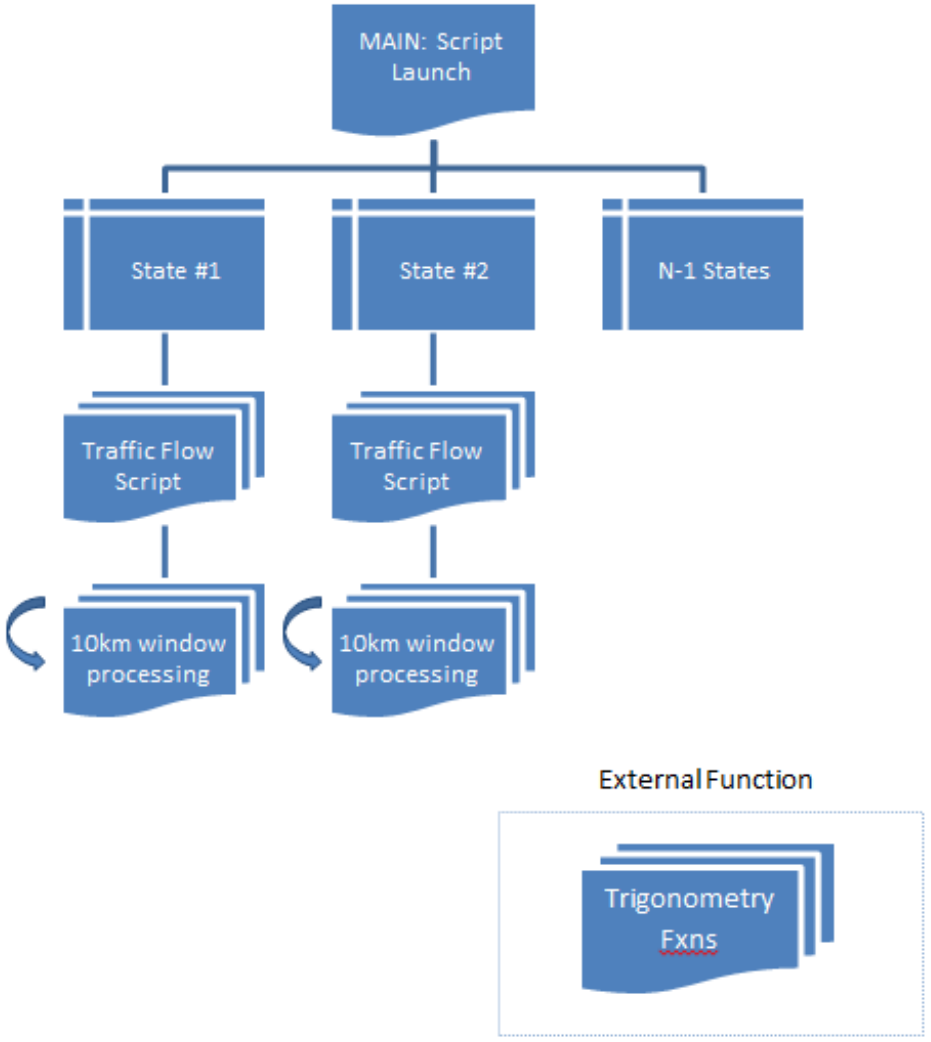


To create a high-resolution, spatially continuous traffic flow dataset for North America that can be used in the analysis of pest spread via vehicle traffic patterns.

"Create once, use many" dataset usable by all cooperating agencies.

Script Workflow

- Source: TrafficMetrix
- Most recent year of 10-year data sample.
- Destination Network: ESRI Streetmap 10.0
- 15-m snap tolerance
- Calculate road directionality for matching traffic volume
- Road name matching when interpolating
- Post-processing: Average volume of tile overlaps (1-km region)
- Volume metric: AADT



Final Product

- Stand-alone table of traffic volumes for both directions with unique road segment identifier.
- Join the table to the ESRI Streetmap dataset using DynaMap_ID.

DYNAMAP_ID	FT_COUNT	FT_DIR	FT_CNTYEAR	FT_METHOD	TF_COUNT	TF_DIR	TF_CNTYEAR	TF_METHOD
387082116	-9999	SE	N/A	0: One-way street. No value this direction.	27422	NW	2010	3: Interpolated counts.
387082121	31900	SE	2010	3: Same as nearest spatial join.	-9999	NW	N/A	0: One-way street. No value this direction.
387100057	43119	SE	2010	3: Interpolated counts.	-9999	NW	N/A	0: One-way street. No value this direction.
387082132	9020	NW	2010	3: Same as nearest spatial join.	5350	SE	2010	3: Same as nearest spatial join.
387082134	32300	NW	2010	4: Assigned from opposite direction.	32300	SE	2010	3: Same as nearest spatial join.
387147673	27910	N	2010	3: Interpolated counts.	-9999	S	N/A	0: One-way street. No value this direction.
387147678	-9999	N	N/A	0: One-way street. No value this direction.	39568	S	2010	3: Interpolated counts.
387147681	26975	N	2010	3: Interpolated counts.	-9999	S	N/A	0: One-way street. No value this direction.
387147685	-9999	N	N/A	0: One-way street. No value this direction.	38836	S	2010	3: Interpolated counts.
387147689	24170	N	2010	3: Interpolated counts.	-9999	S	N/A	0: One-way street. No value this direction.
417802622	-9999	S	N/A	0: One-way street. No value this direction.	25535	N	2010	3: Interpolated counts.
387082160	32300	NW	2010	4: Assigned from opposite direction.	32300	SE	2010	3: Same as nearest spatial join.
387147706	39667	E	2010	3: Interpolated counts.	42910	W	2010	3: Interpolated counts.
387082190	10474	NE	2010	3: Same as nearest spatial join.	14041	SW	2010	3: Interpolated counts.
387147729	40768	E	2010	3: Interpolated counts.	44623	W	2010	3: Interpolated counts.
387082209	10474	E	2010	3: Same as nearest spatial join.	14024	W	2010	3: Interpolated counts.
387082223	10474	NE	2010	3: Same as nearest spatial join.	14007	SW	2010	3: Interpolated counts.
387082233	12592	NE	2010	3: Interpolated counts.	6770	SW	2010	3: Same as nearest spatial join.

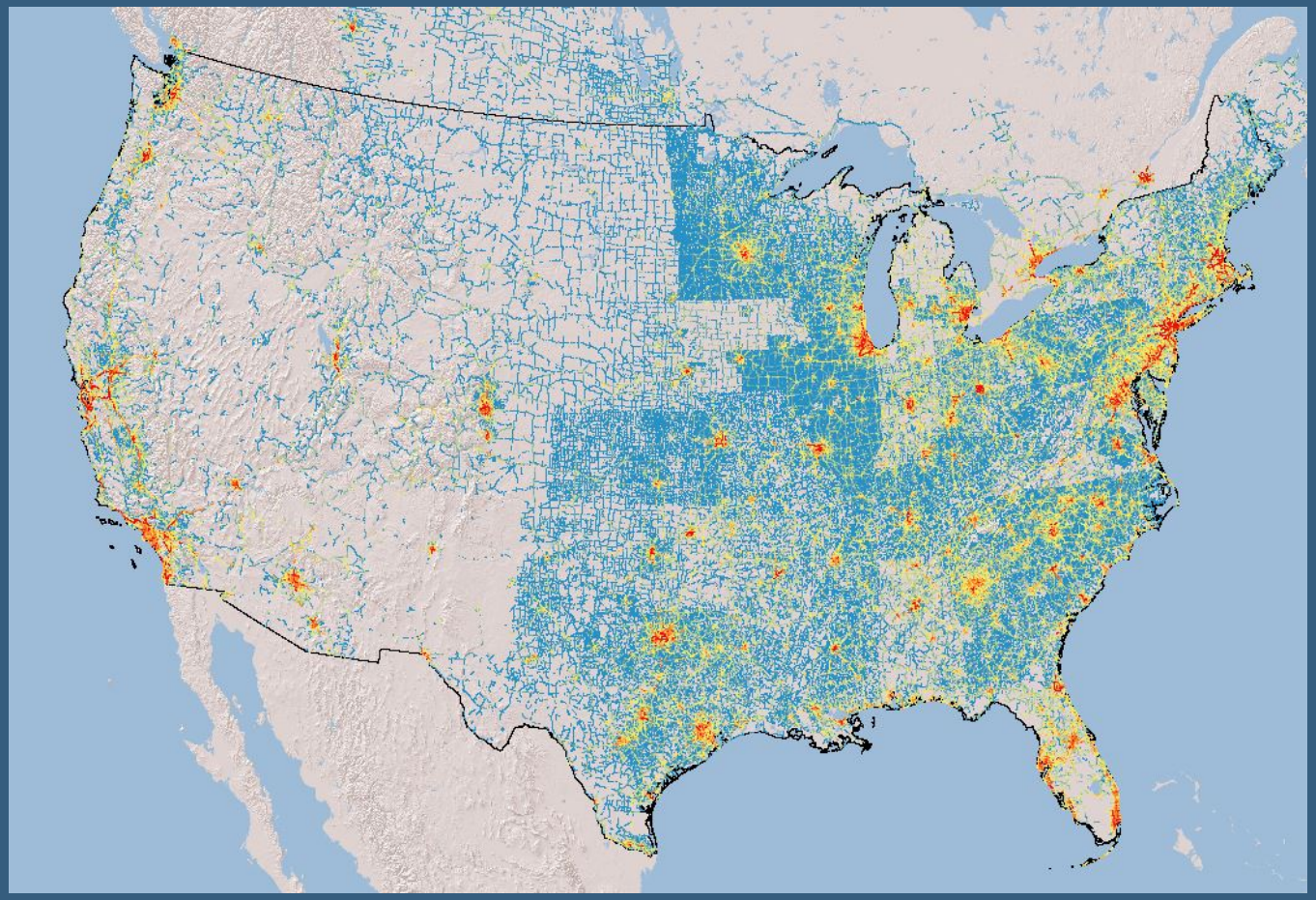
National Traffic Map

Private vs. Commercial?

Primary vs. Secondary Roads?

Continuity of volume on roads still an issue.

Volume is localized, has no origin-destination.



USPS Address Forwarding Data

Address Forward: Request to post office to forward mail to new change of address.

Purpose

Quantify number of household movements originating from the gypsy moth quarantine area to other areas of the U.S.

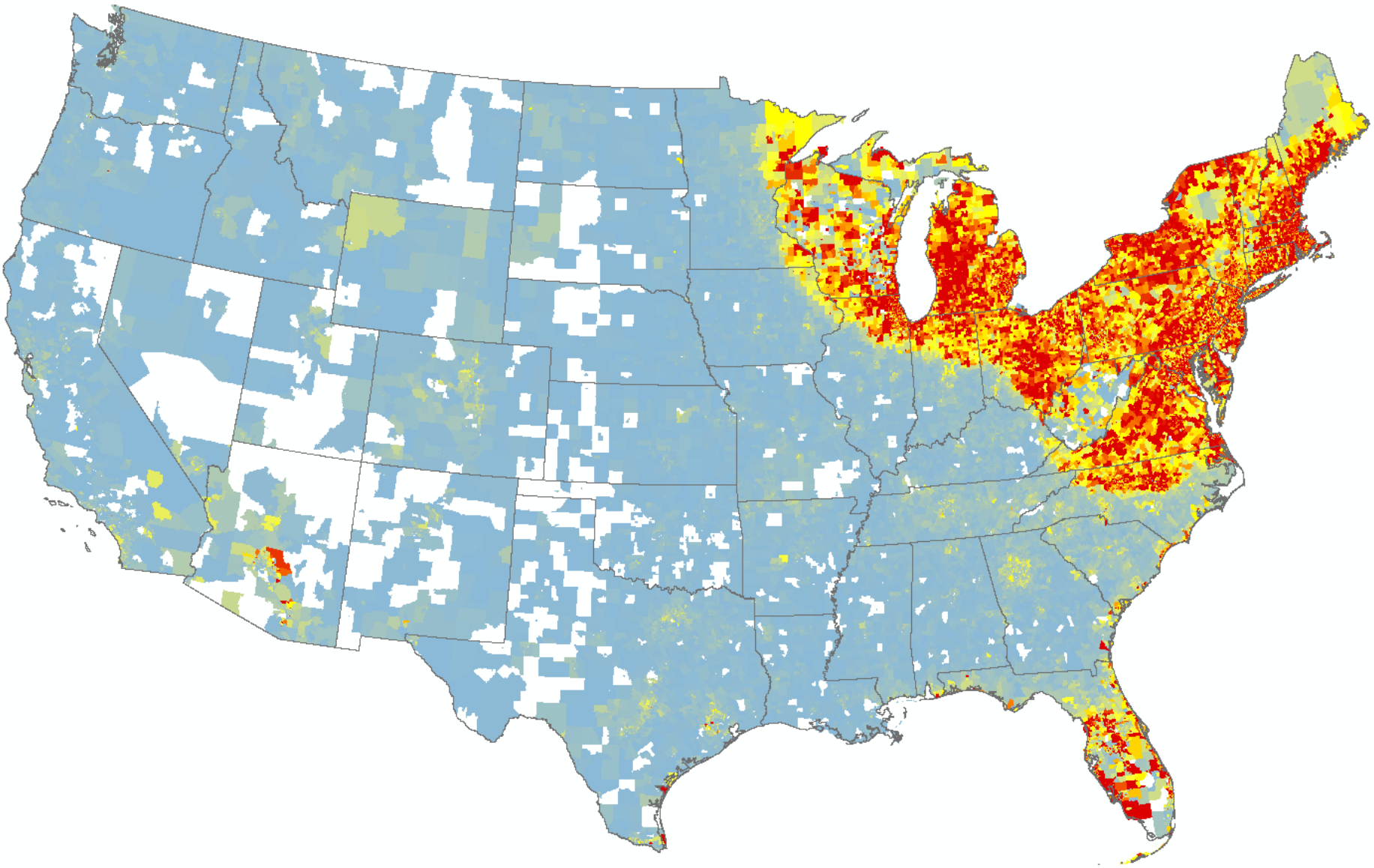
Targets pathway risk of egg mass hitchhikers on outdoor regulated articles (OHAs)

US Postal Service IAA

- Origin: Zipcode within gypsy moth quarantine area
- Destination: Census block
- Date: mm-yyyy
- Count: Number of forwards for origin-destination pair per month

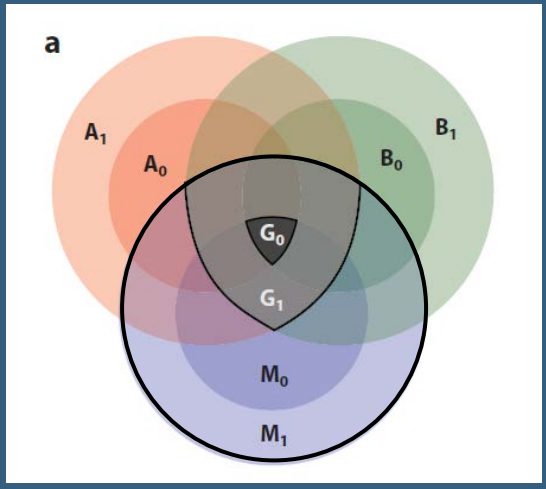
- Processing: Join to U.S. Census geography layer

Block Leveed IR Resolution



Application

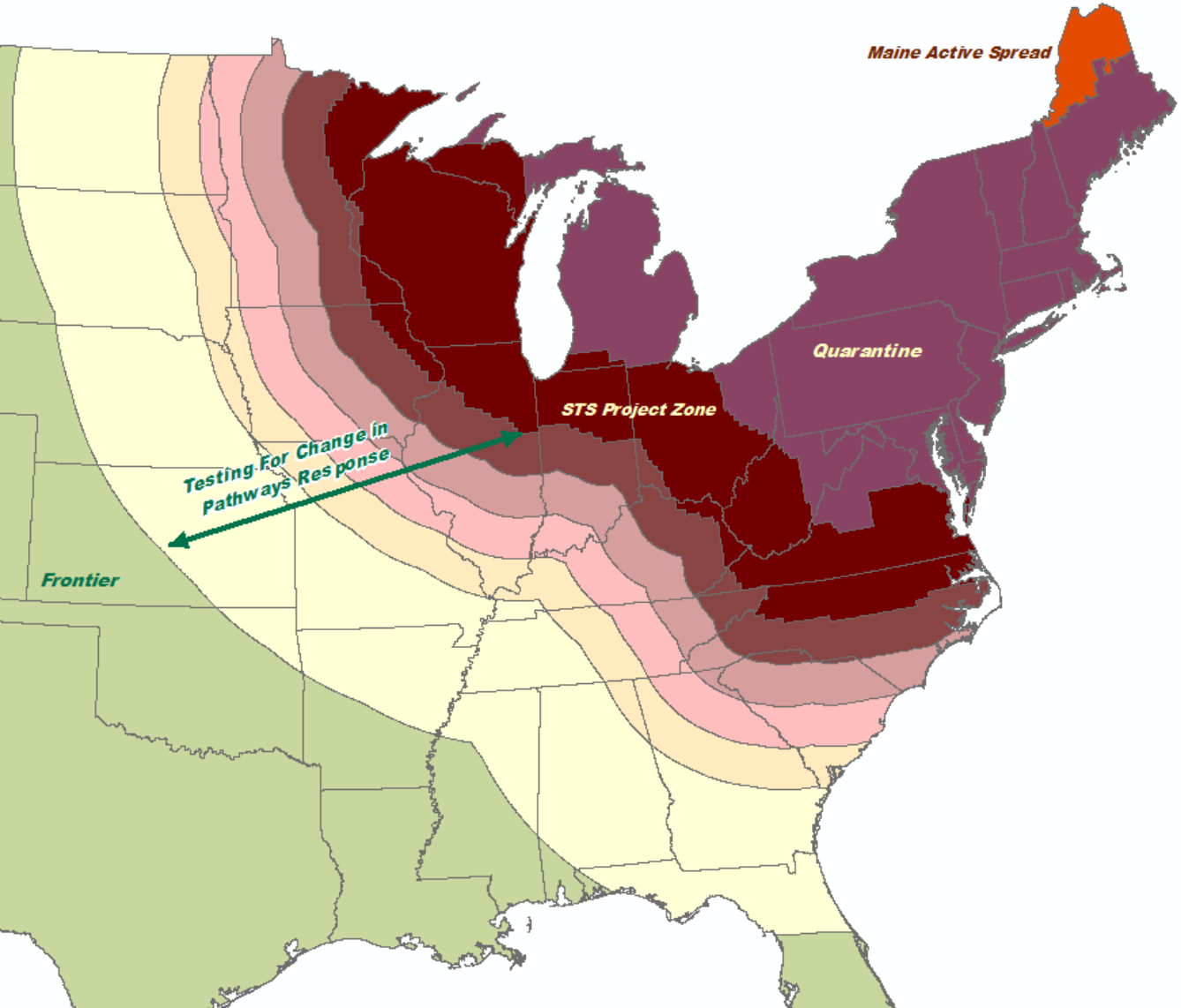
Putting the data into practice for gypsy moth



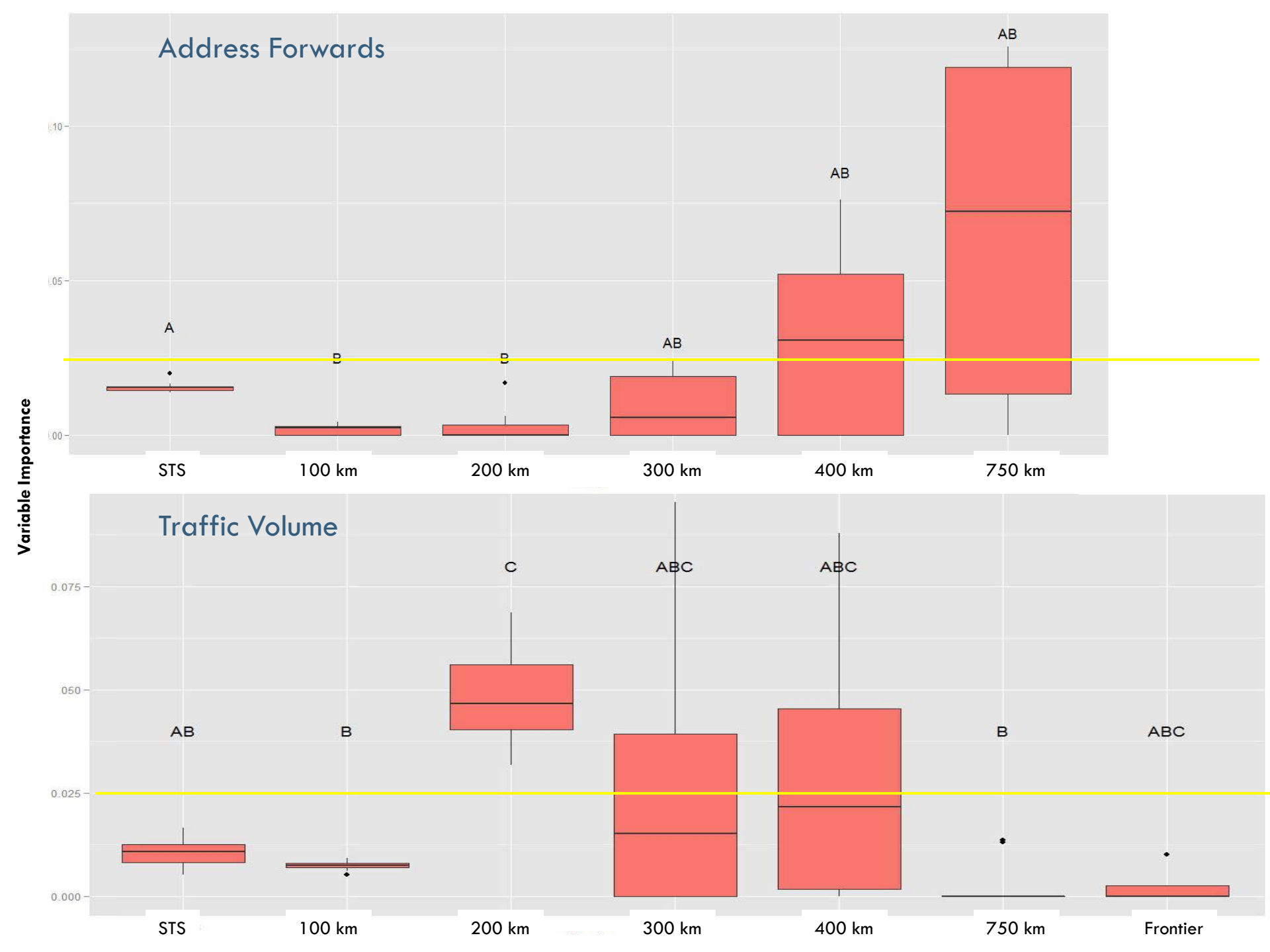
Species Distribution Model

- Response: Presence/Absence gypsy moth detection
- Covariates:
  - Traffic Volume (rasterized)
  - Household income
  - Address forwarding
  - Population Density
  - Distance from campgrounds, universities, sawmills, etc.
  - Distance from spread front (proxy for propagule pressure)
  - Distance from prior year detection

Spatial Stratification to Evaluate Model Response over Space



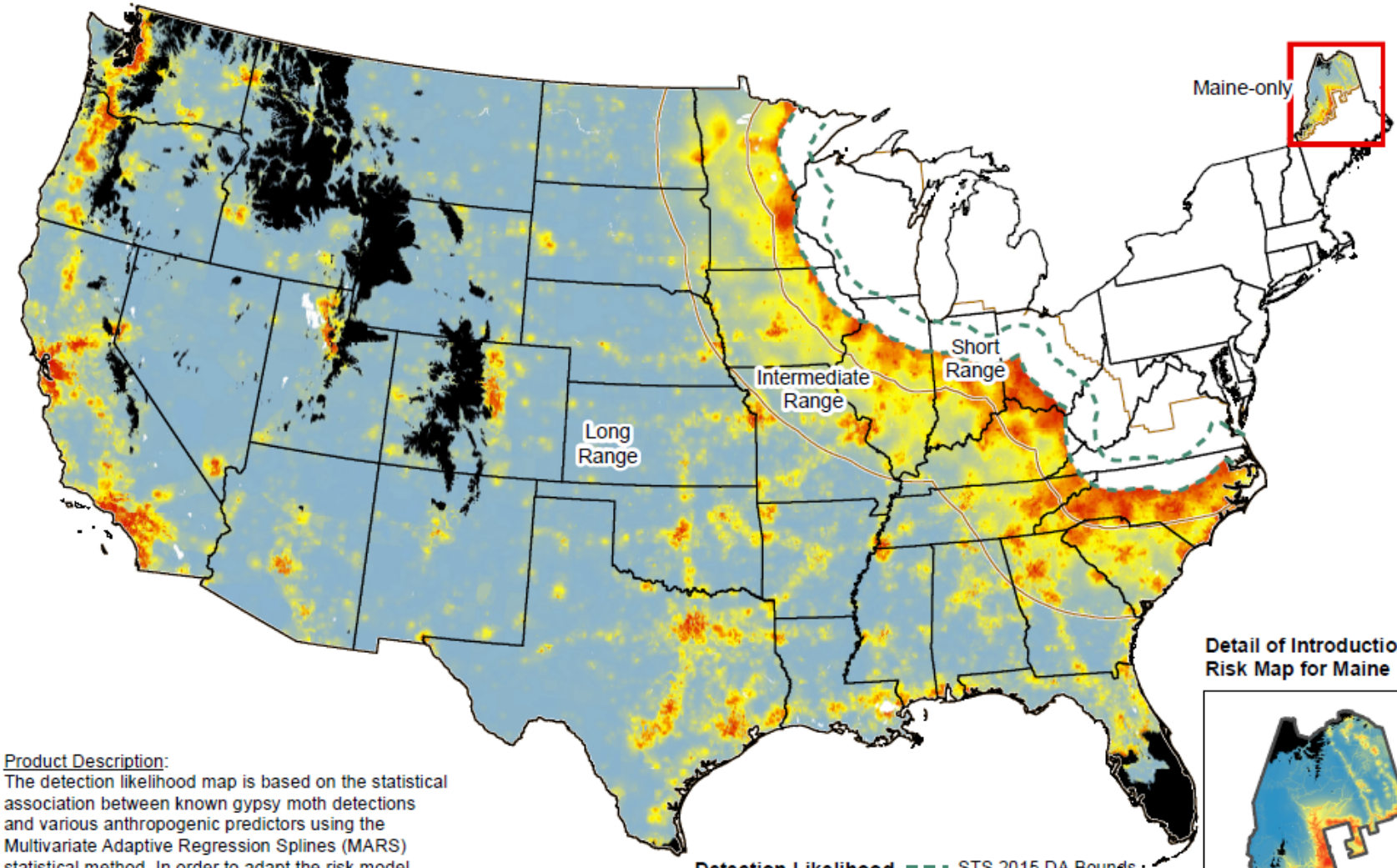
With a given set of covariates, how does predictor importance change over space?


Address Forwards
Variable Importance
.10
.05
.00
A
B
B
AB
AB
AB
STS
100 km
200 km
300 km
400 km
750 km
Traffic Volume
0.075
0.050
0.025
0.000
AB
B
C
ABC
ABC
B
ABC
STS
100 km
200 km
300 km
400 km
750 km
Frontier

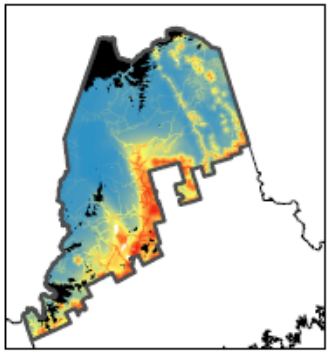
European Gypsy Moth *Lymantria dispar dispar*
2015 Detection Likelihood

USDA United States Department of Agriculture

APHIS Animal and Plant Health Inspection Service



Detail of Introduction Risk Map for Maine



Product Description:
The detection likelihood map is based on the statistical association between known gypsy moth detections and various anthropogenic predictors using the Multivariate Adaptive Regression Splines (MARS) statistical method. In order to adapt the risk model to changing pathways leading away from the generally infested area, four distint model regions were developed, and a separate model fitted to each. The maximum probability among the short, intermediate, and long range models produced the final introduction risk surface when combined with the Maine-only model.

Detection Likelihood

Relative Probability

High : 1

Low : 0

STS 2015 DA Bounds

Model Regions

Exclusion Area

Climate Mask

USDA-APHIS-PPQ-CPHST
2301 Research Blvd, Suite 108
Fort Collins, Co 80526

Date Printed: February 18, 2015
Time Printed: 2:55 PM MST

Data Sources:
STS Program, USDA APHIS PPQ
Individual State Cooperators

Coordinate System:
U.S. Contiguous Albers Equal Area

National Household Travel Survey

- Produced by Federal Highway Administration
- Resolution: Census Group Block/ Census Tract
- Multitude of travel modes/activity
- Most interested in recreation
- Relate activity to secondary household characteristics

Collaborators:

Traffic Pattern Project:
Marla Downing, Frank Koch, Denys Yemshanov

Gypsy Moth Modeling Group:
Andrew Liebhold, Marla Downing, John Withrow,
Ian Leinwand, Catherine Jarnevich