Habitat Characterization and Population Abundance of American Ginseng

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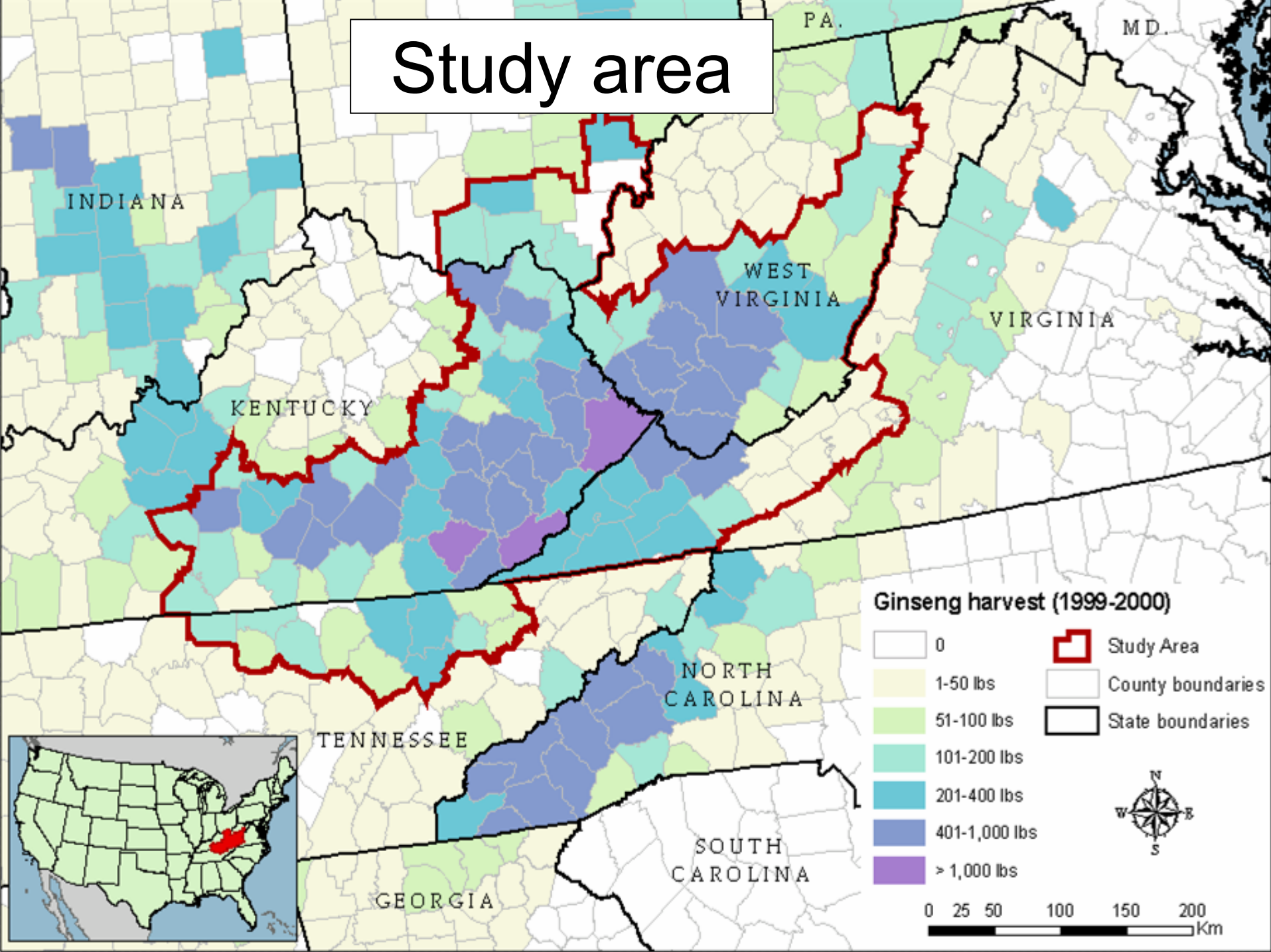
Management issue

- CITES Appendix II species

- Is harvest of wild populations sustainable?

- Need reliable information on distribution and abundance at landscape scale

Project objectives

Within core ginseng range:

- Predict occurrence based on habitat characteristics

- Estimate population abundance

- Examine relationships between abundance and harvest data

Study area

Ginseng harvest (1999-2000)

- 0
- 1-50 lbs
- 51-100 lbs
- 101-200 lbs
- 201-400 lbs
- 401-1,000 lbs
- > 1,000 lbs

Study Area
County boundaries
State boundaries
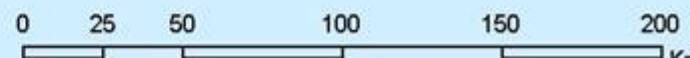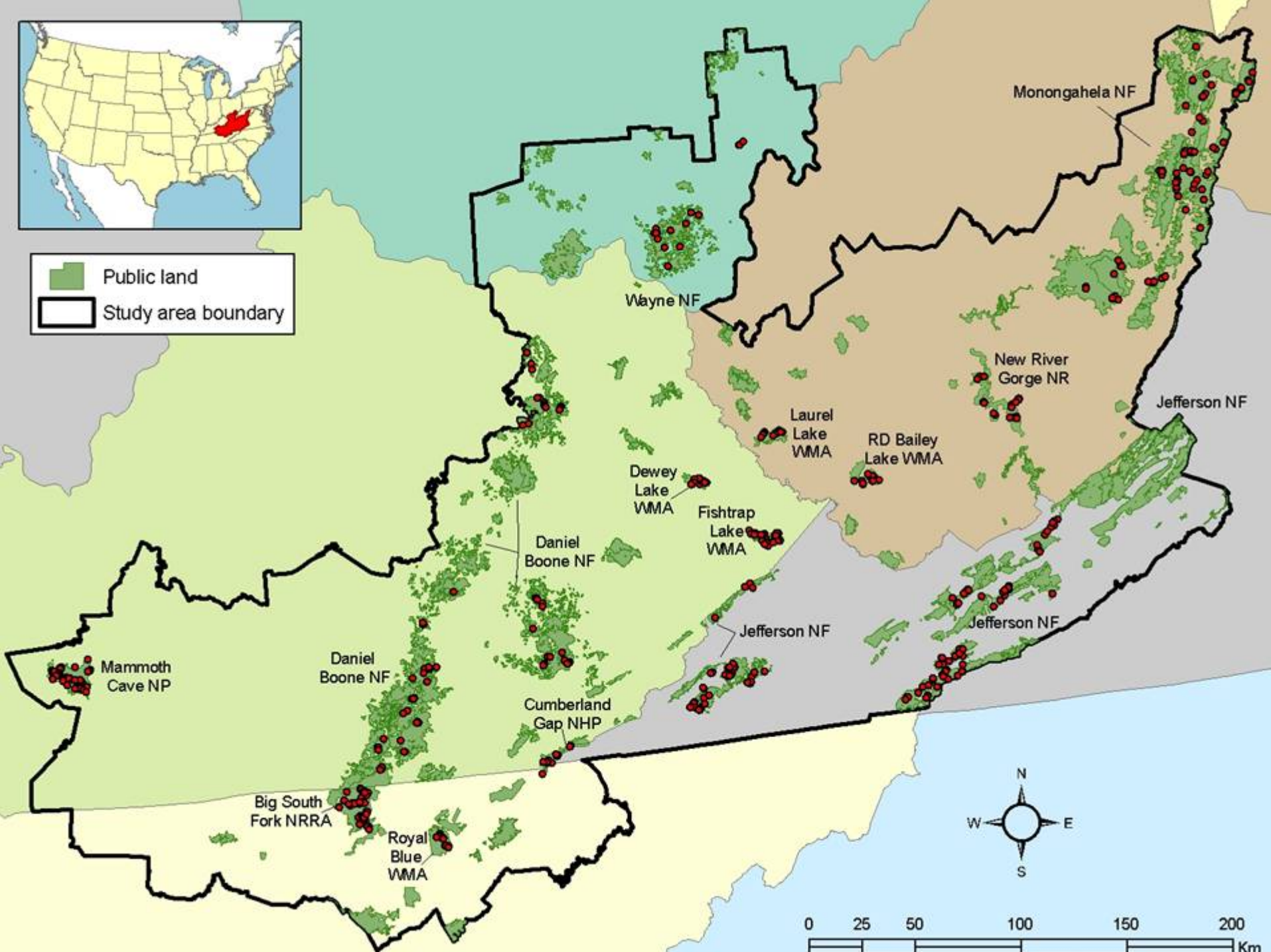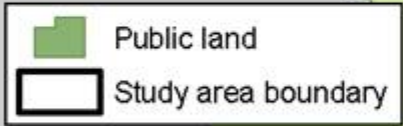
0 25 50 100 150 200
Km

Target plant species

- American ginseng (*Panax quinquefolius* L.)

- Goldenseal (*Hydrastis canadensis* L.)

- Bloodroot (*Sanguinaria canadensis* L.)

- Black cohosh (*Actaea racemosa* L. [syn. *Cimicifuga racemosa* (L.) Nutt.])

Stratified random sampling

- 2004 sampling based on Ecological Land Units (F. Biasi,The Nature Conservancy)
  - Topographic landform type (i.e., cove, sideslope, etc)
  - Geology
  - Elevation
- 2005 sampling based on 2004 habitat models
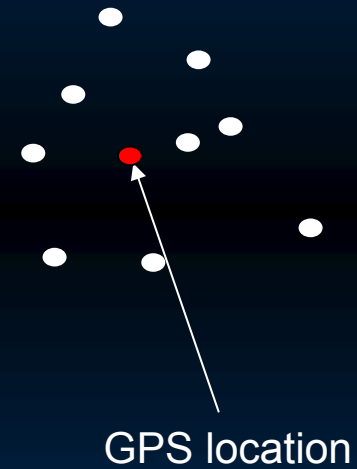- All surveys conducted on public lands

Legend:
- Public land
- Study area boundary

Map labels:
- Monongahela NF
- Wayne NF
- New River Gorge NR
- Jefferson NF
- Laurel Lake WMA
- RD Bailey Lake WMA
- Dewey Lake WMA
- Fishtrap Lake WMA
- Daniel Boone NF
- Jefferson NF
- Jefferson NF
- Mammoth Cave NP
- Daniel Boone NF
- Cumberland Gap NHP
- Big South Fork NRRA
- Royal Blue WMA

Scale bar: 0 25 50 100 150 200 Km

Compass: N, E, S, W

Field surveys

Plot locations

Incidental locations

GPS location
(plot center)

Plot size =   30 m

GPS location

Field survey data

- GPS coordinates of all sample plots and any incidental locations

- Size class of each ginseng plant

- Site description (slope, aspect, landform type, etc.)

- Presence/absence of ginseng indicator species

Summary of field data (2004-2005)

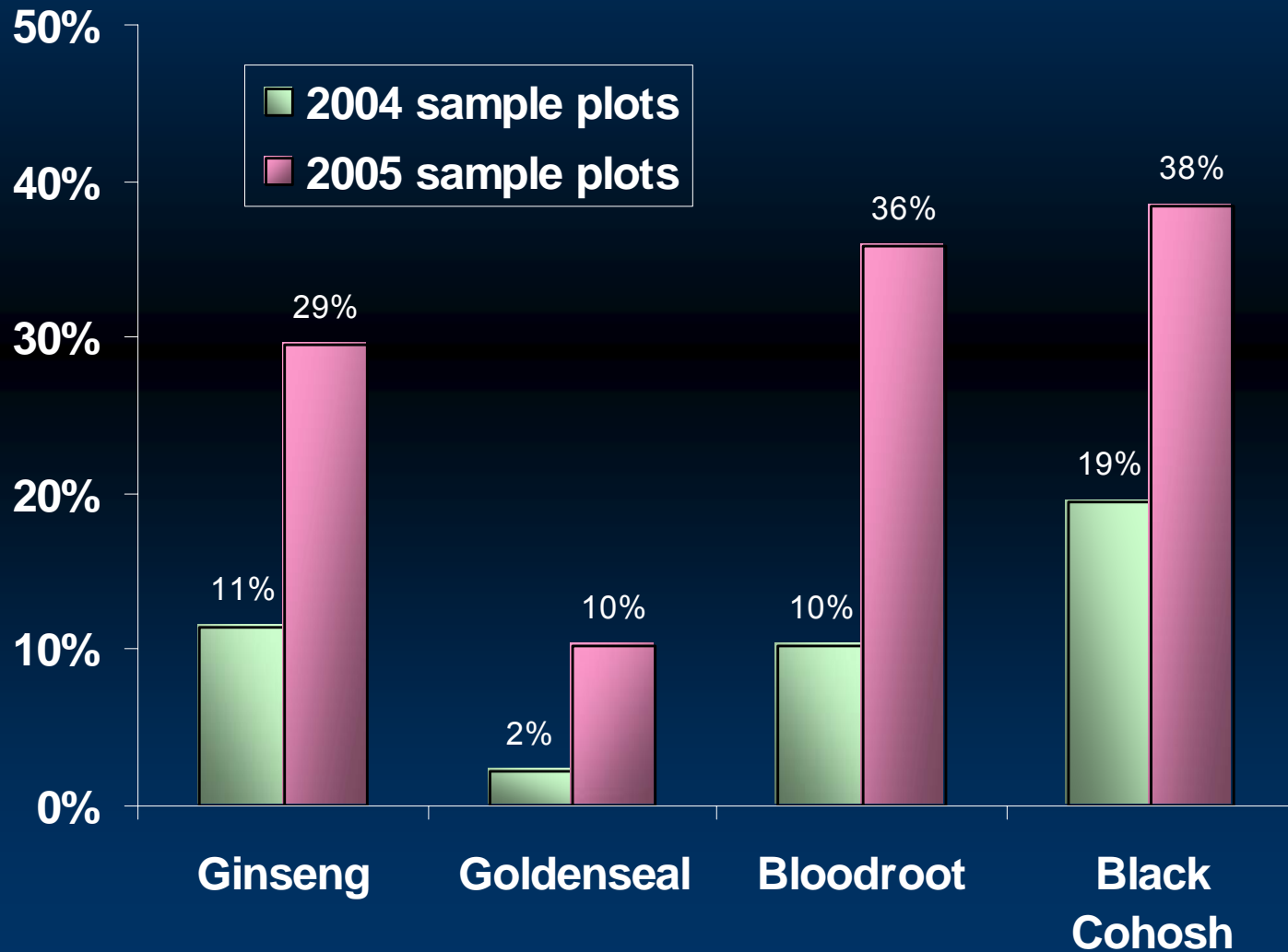Number of sample plots and incidental locations, 2004-2005.

	Ginseng	Goldenseal	Bloodroot	Black cohosh	None present
Study plots n = 351	54	14	56	83	226
Incidental locations	78	29	130	168	n/a
Total	132	43	186	251	226

Total no. of ginseng plants encountered: 919

Percentage of sample plots containing study species

Ginseng — 2004: 11%, 2005: 29%
Goldenseal — 2004: 2%, 2005: 10%
Bloodroot — 2004: 10%, 2005: 36%
Black Cohosh — 2004: 19%, 2005: 38%

Legend:
- 2004 sample plots
- 2005 sample plots

Predicting
species occurrence
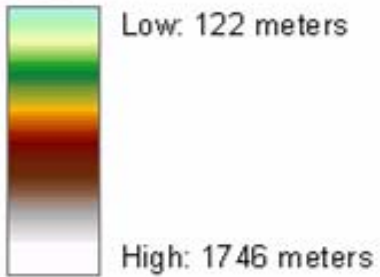
Habitat model development

1. Plant presence and absence locations

2. Logistic regression models

3. Calculate predicted probability of occurrence based on habitat characteristics

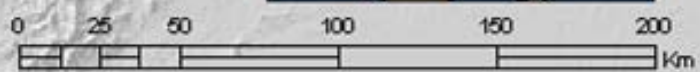4. Applied to entire study area with geographic information system (GIS)
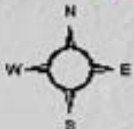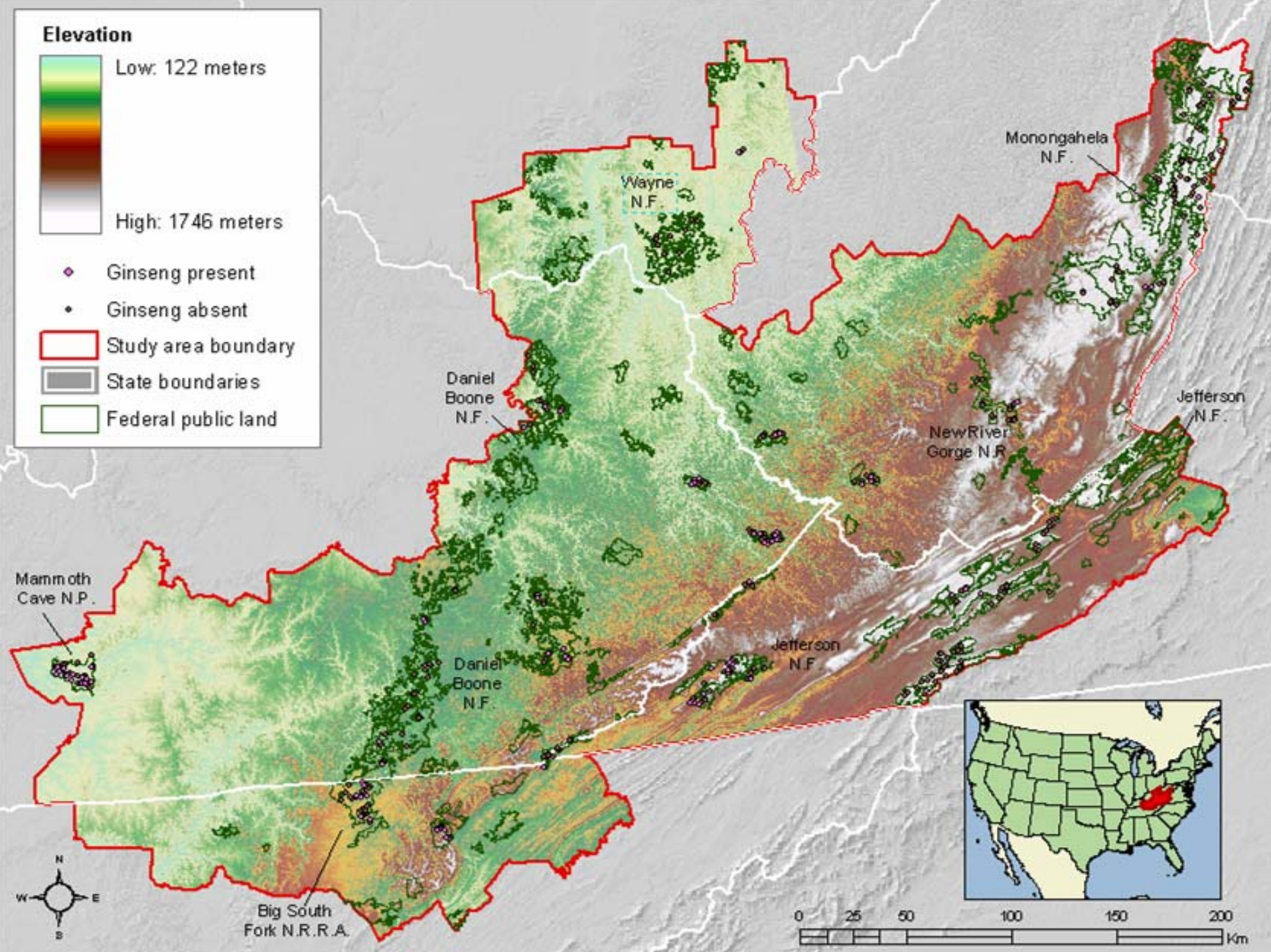
Variables

- Elevation
- Slope
- Aspect (Beers transformation)
- Terrain shape index
- Topographic relative moisture index
- Solar insolation

- Topographic convergence index
- Relative slope position
- Mean annual precipitation
- % deciduous forest
- % evergreen forest

Akaike's Information Criterion (AIC) to select best set of habitat variables

Elevation

Low: 122 meters

High: 1746 meters

◇ Ginseng present

◆ Ginseng absent

Study area boundary

State boundaries

Federal public land

Monongahela N.F.

Wayne N.F.

Daniel Boone N.F.

New River Gorge N.R

Jefferson N.F.

Mammoth Cave N.P.

Daniel Boone N.F.

Jefferson N.F.

Big South Fork N.R.R.A.

0 25 50 100 150 200 Km

	Barren
	Open water
	Deciduous forest
	Mixed forest
	Evergreen forest
	Forest loss
	Grasslands
	High intensity urban
	Low intensity residential
	Pasture
	Row crops
	Woody wetlands

0   25   50   100   150   200
Km
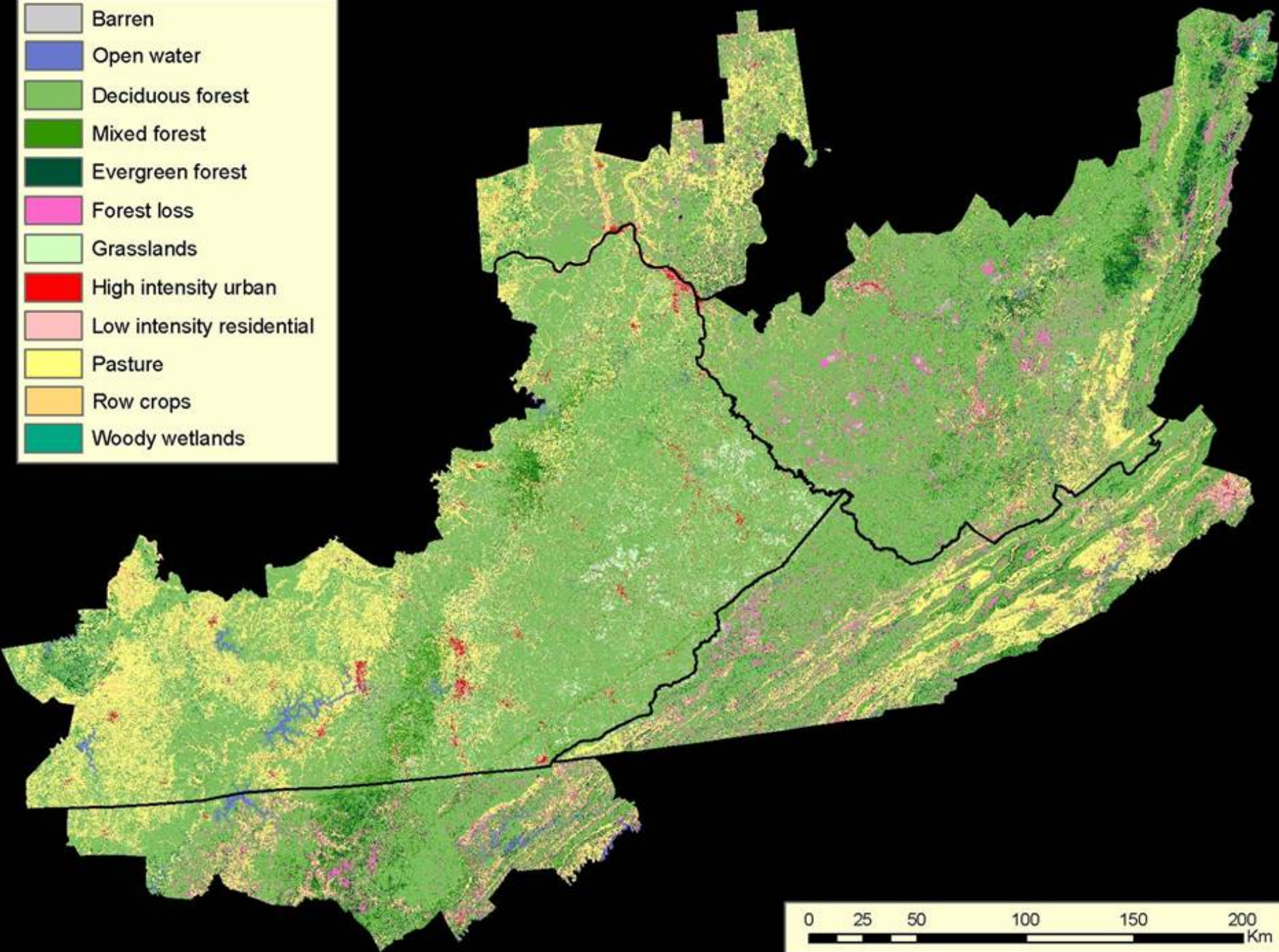
Ginseng habitat model

Variable	Parameter estimate	*P*-value
Intercept	-1.5016	0.0942
Elevation	-0.0012	0.0046
Slope	0.0558	0.0011
Solar insolation	-0.0112	0.0026
% deciduous forest	0.0193	0.0002

GIS overlay

Plant locations

Grid Cell

Elevation
Slope
Solar insolation
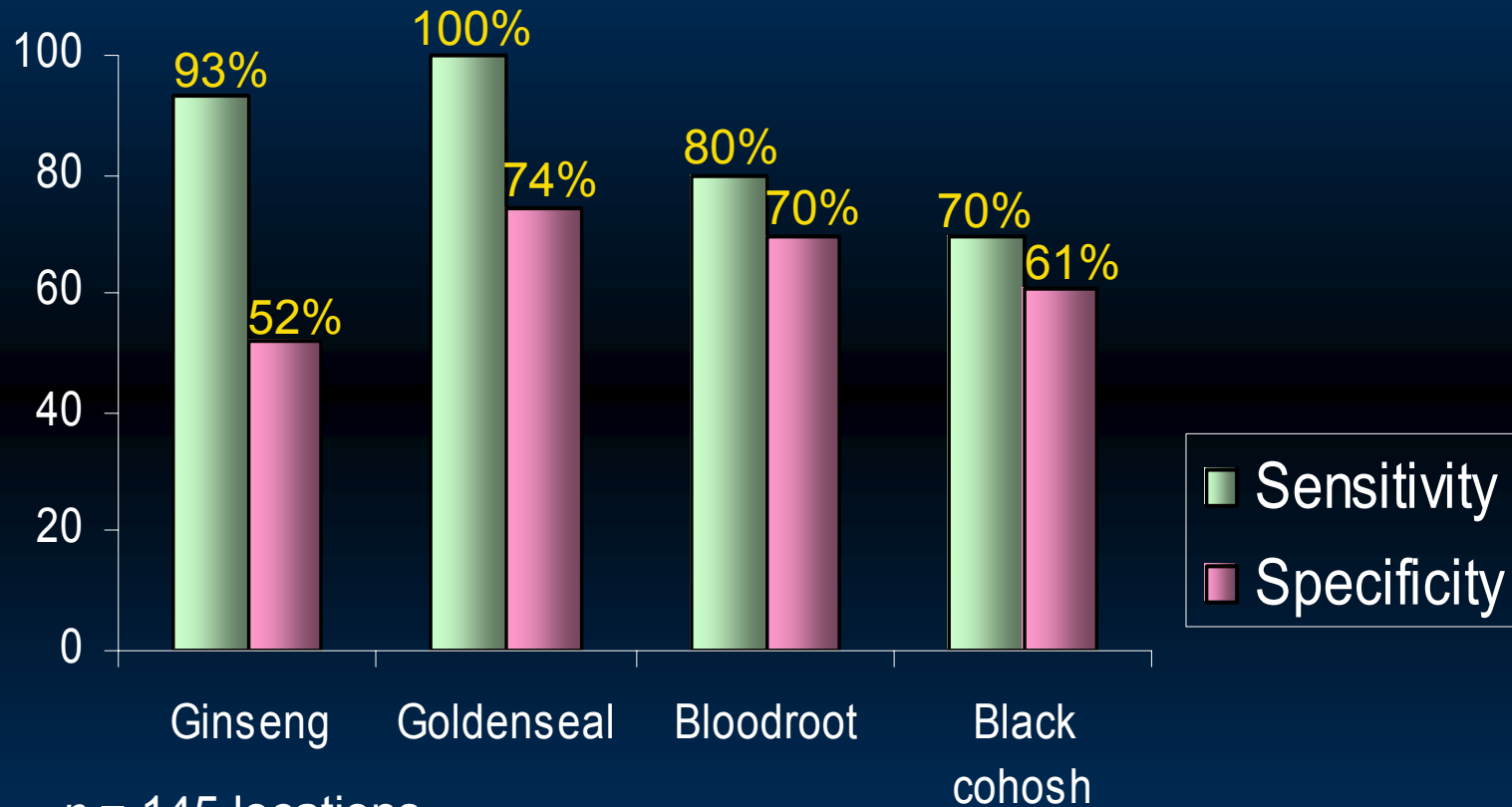% Deciduous forest

Final model
(predicted probability
of occurrence)
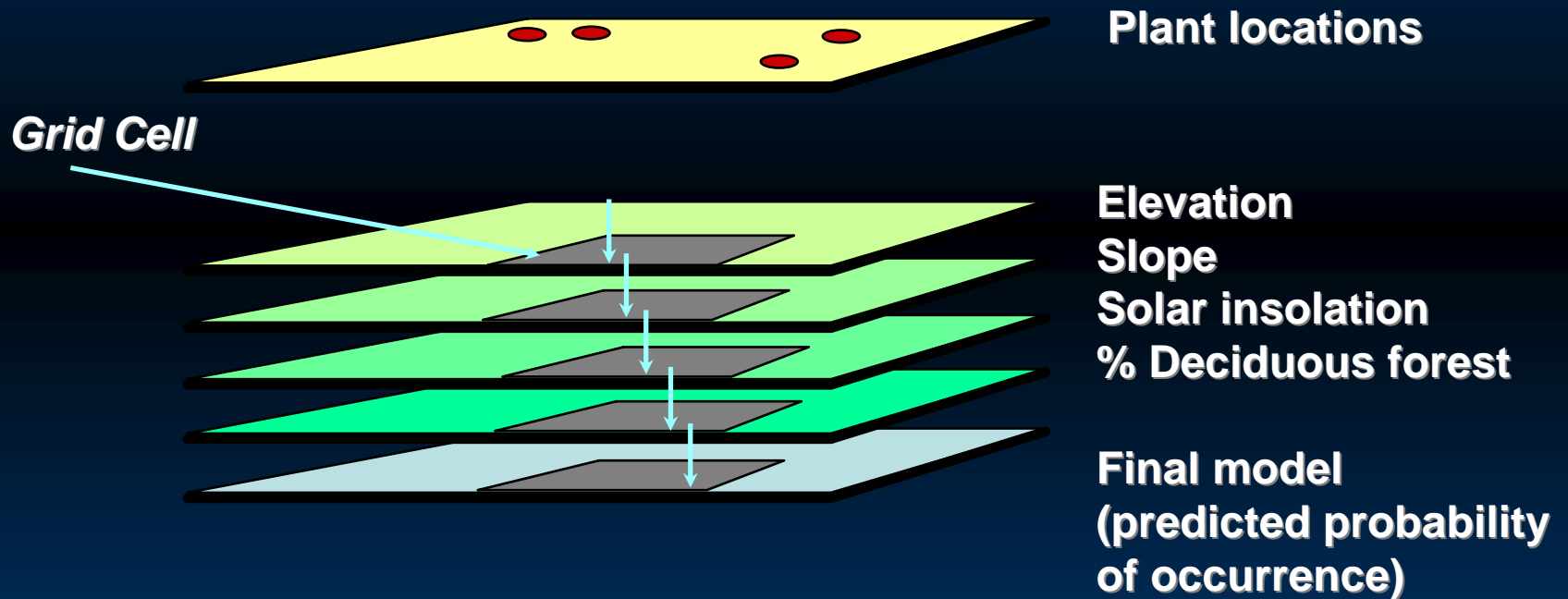
Model testing:
Increased sampling efficiency
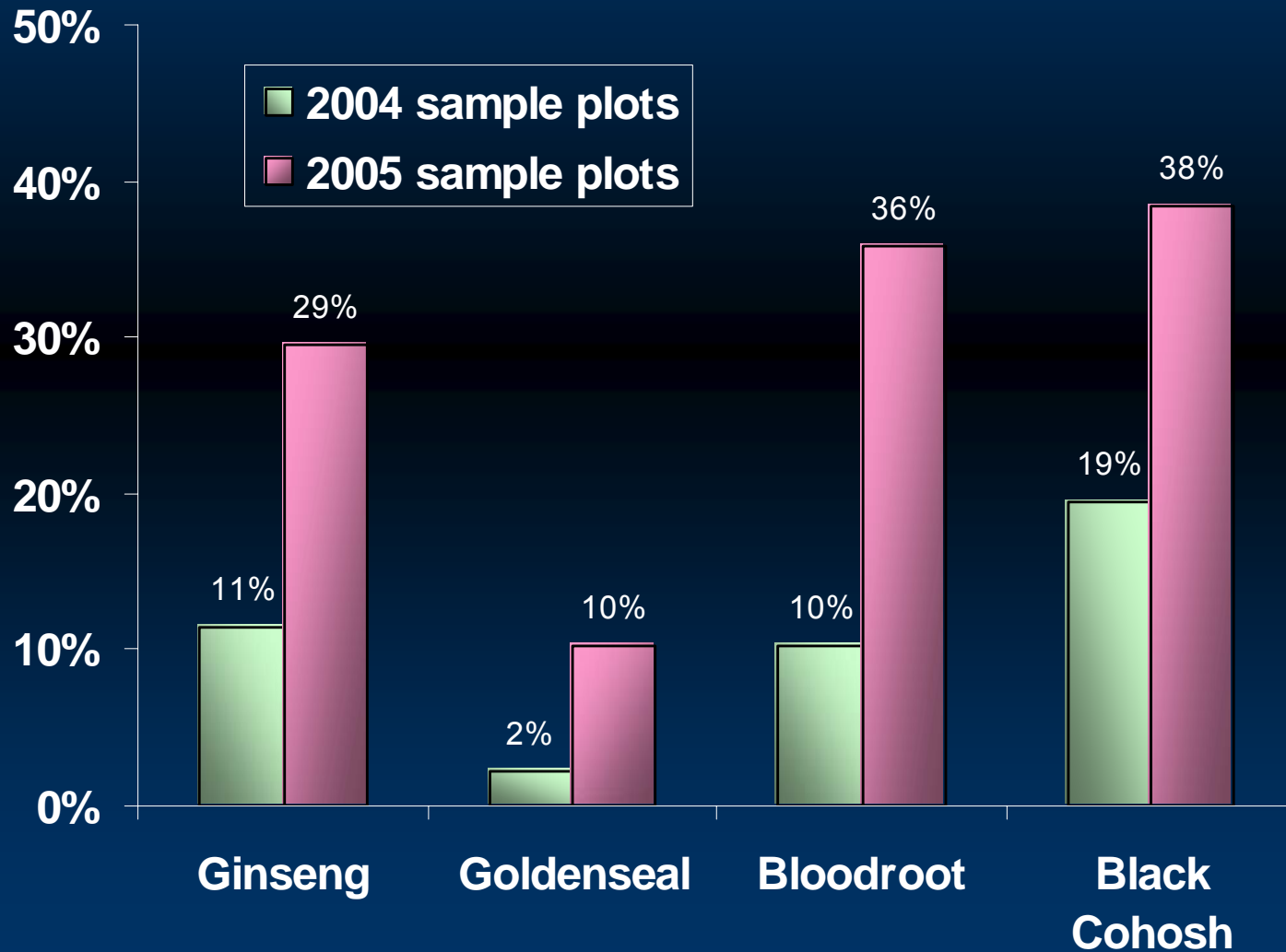
Model testing:
test dataset (25% of locations)

n = 145 locations
Sensitivity = presence locations correctly predicted
Specificity = absence locations correctly predicted

Estimating
Population Abundance

Population abundance: approach

- Habitat model: predicted probability of ginseng presence

- Use predicted probability to scale population abundance to habitat

- Multiply by average ginseng density (±SE) at sample plots

- Yields spatially explicit population estimate

Population abundance

$$N = \sum_i D \times A(x_i)$$

N = ginseng population

D = ginseng density (30- x 30-m plot)

A(x_i) = No. of grid cells estimated to contain ginseng in each habitat class (Boyce and Waller 2003)

Scaling population abundance

Class	Predicted occurrence	Grid cell count	Percent containing ginseng	Estimated no. of grid cells with ginseng presence
1	0 - 0.01	52,410,212	3	1,455,839
2	0.01 - 0.20	30,101,166	16	4,841,446
3	0.20 - 0.29	21,151,714	22	4,607,304
4	0.29 - 0.39	11,617,992	29	3,382,453
5	0.39 - 0.49	6,841,622	48	3,283,979
6	0.49 - 0.58	4,106,342	50	2,053,171
7	0.59 - 0.97	2,904,800	64	1,848,509

Population abundance

- $\bar{x}$ = 7.6 ± 2.3 (SE) ginseng plants per plot

- Population estimate:
  - 1,000–1,900 plants/km^2
  - 2,600-4,800 plants/mile^2

  (95% confidence interval)

7/18/2001 2:10pm

Ginseng population estimate

509,000 - 783,000	⬛	State boundaries
784,000 - 1,160,000	🟦	Study Area
1,170,000 - 1,640,000	⬜	County boundaries
1,650,000 - 2,240,000		
2,250,000 - 2,940,000		
2,950,000 - 5,350,000		

INDIANA
OHIO
WEST VIRGINIA
KENTUCKY
VIRGINIA
TENNESSEE
N. C.

0 15 30 60 90 120
Km
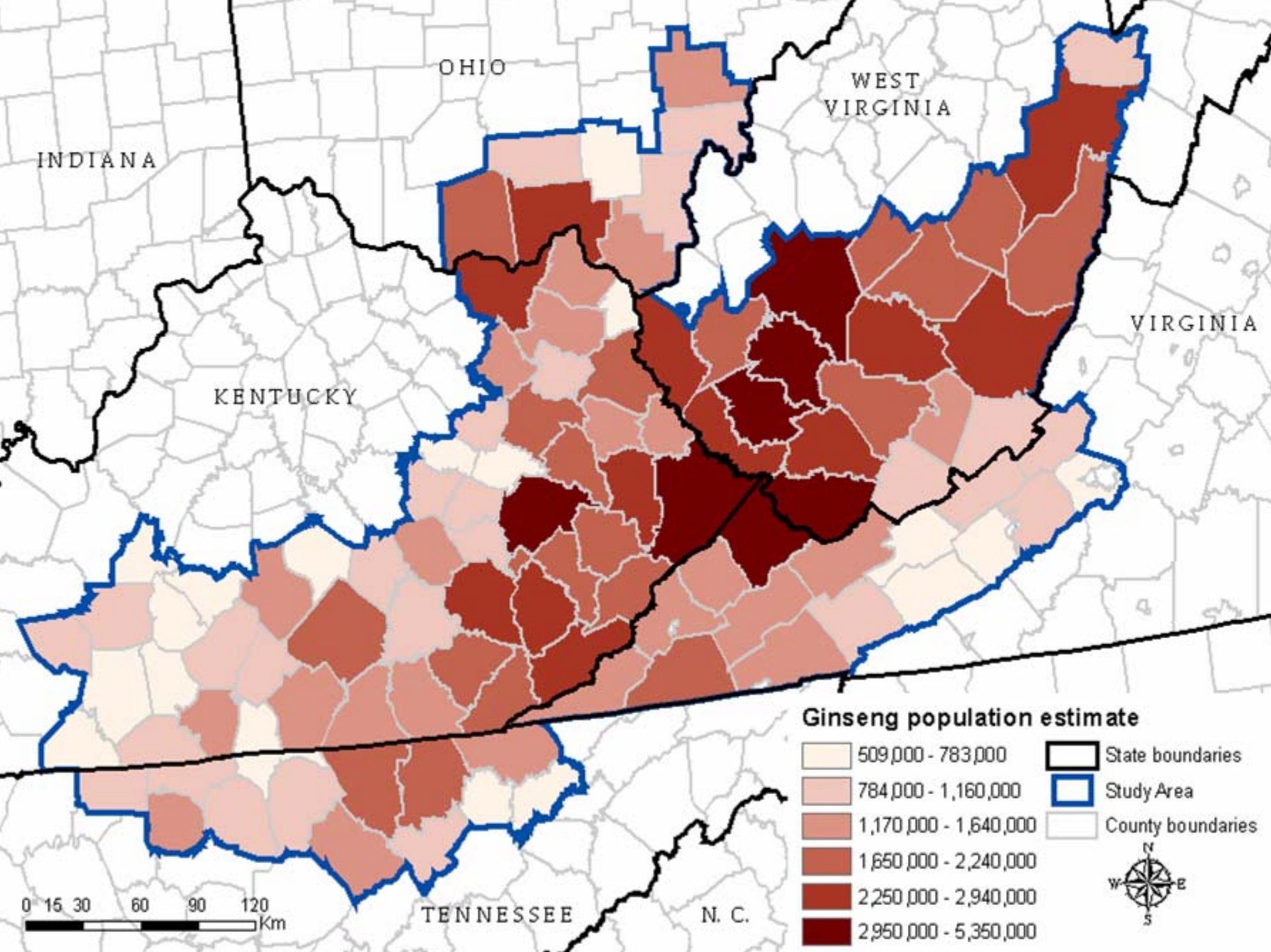
Relationships between Population Abundance and Harvest

Annual ginseng harvest

INDIANA

OHIO

WEST VIRGINIA

VIRGINIA

KENTUCKY

TENNESSEE

N. C.

Average ginseng harvest (lbs)

- 0
- 1 - 33
- 34 - 111
- 112 - 232
- 233 - 427
- 428 - 745
- 746 - 1307

State boundaries
County boundaries
Study Area

0 15 30   60   90   120
Km

N
W   E
S
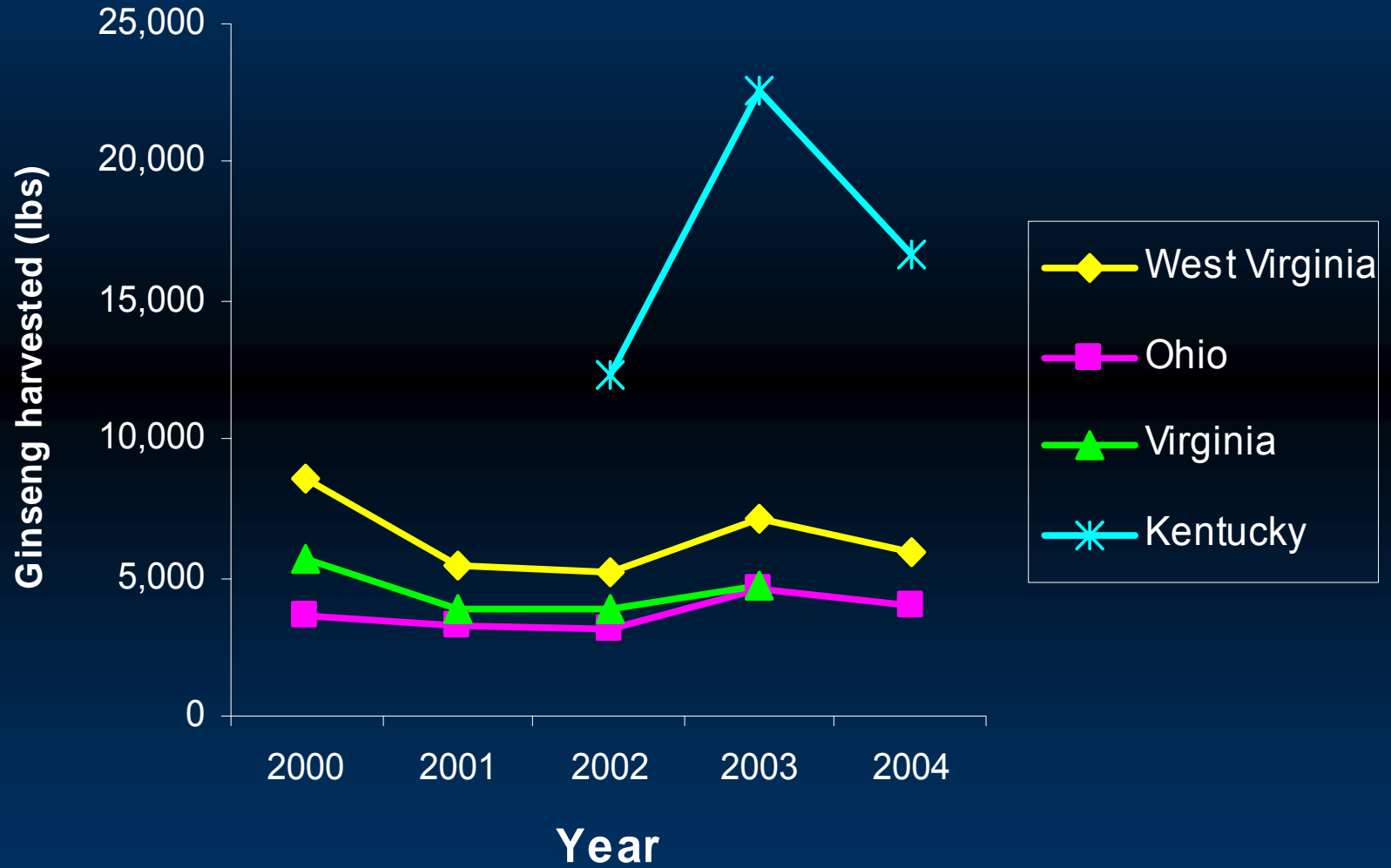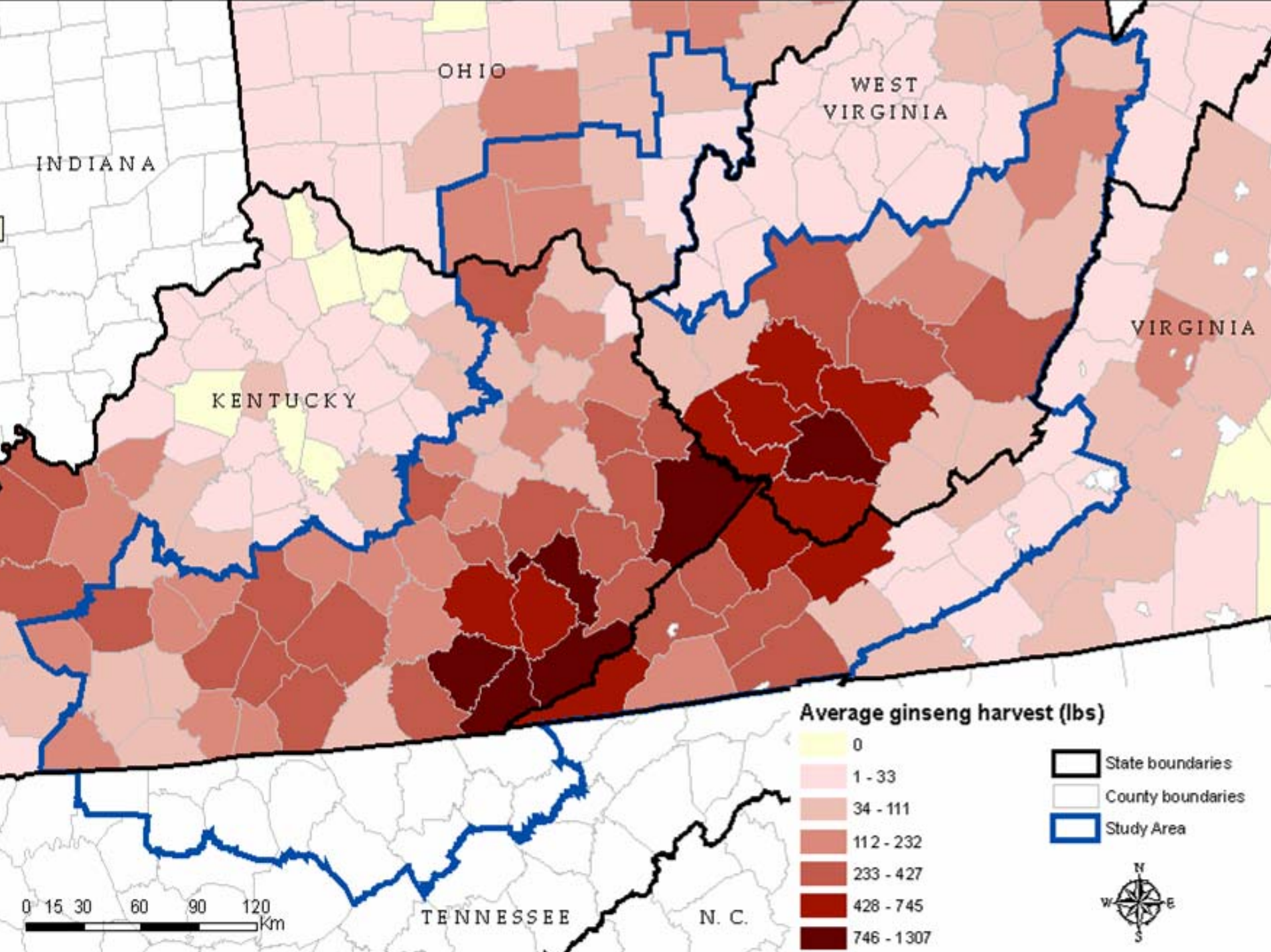
Ginseng harvest

- Linear regression: county ginseng harvest vs. population abundance:

Variable	Parameter estimate	P-value
Intercept	-21.742	0.504
Ginseng population abundance	0.000184	<0.001

Ginseng harvest vs. population by county

Scatter plot with x-axis "Estimated ginseng population by county" (ranging from 500,000 to 5,500,000) and y-axis "Pounds harvested by county" (ranging from 0 to 1,400). Labeled data points:
- Pike Co, KY
- Knox Co, KY
- Harlan Co, KY
- Wyoming Co, WV
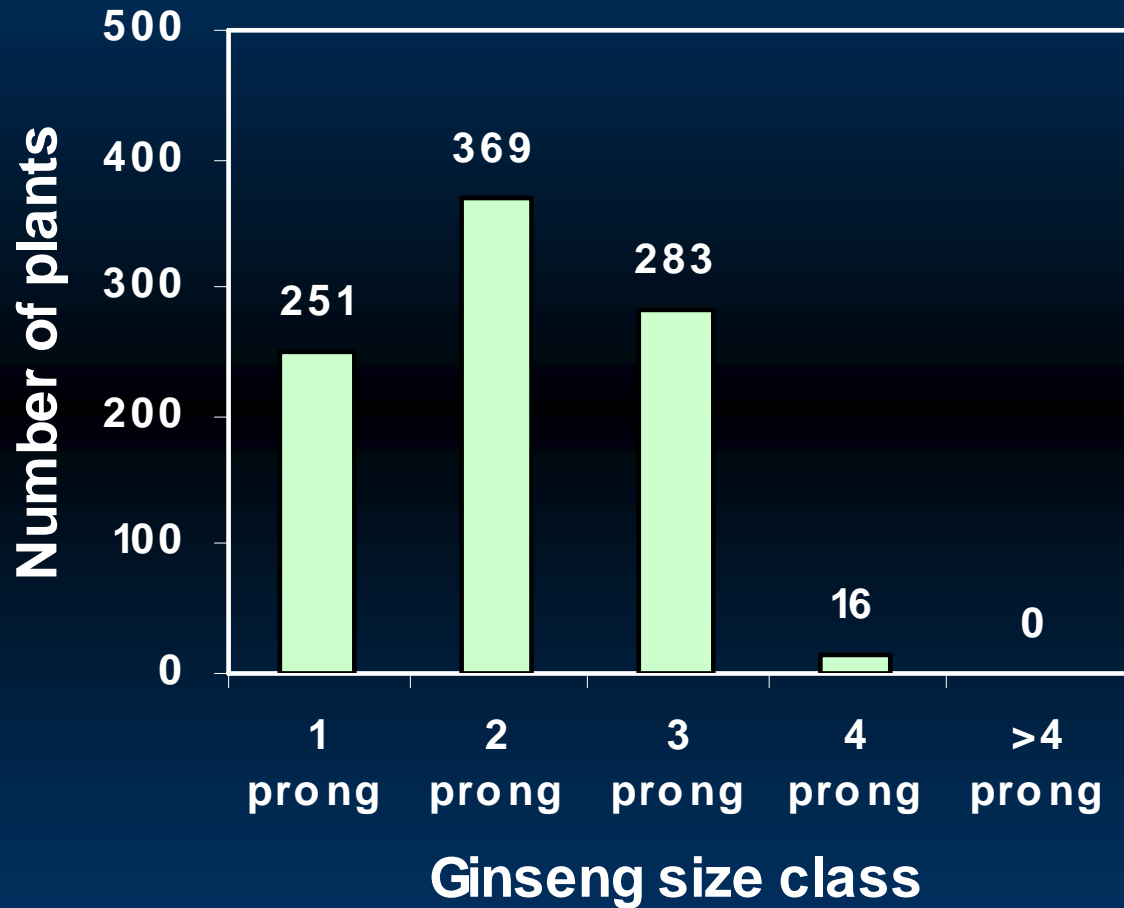- Buchanan Co, WV
- Kanawha Co, WV
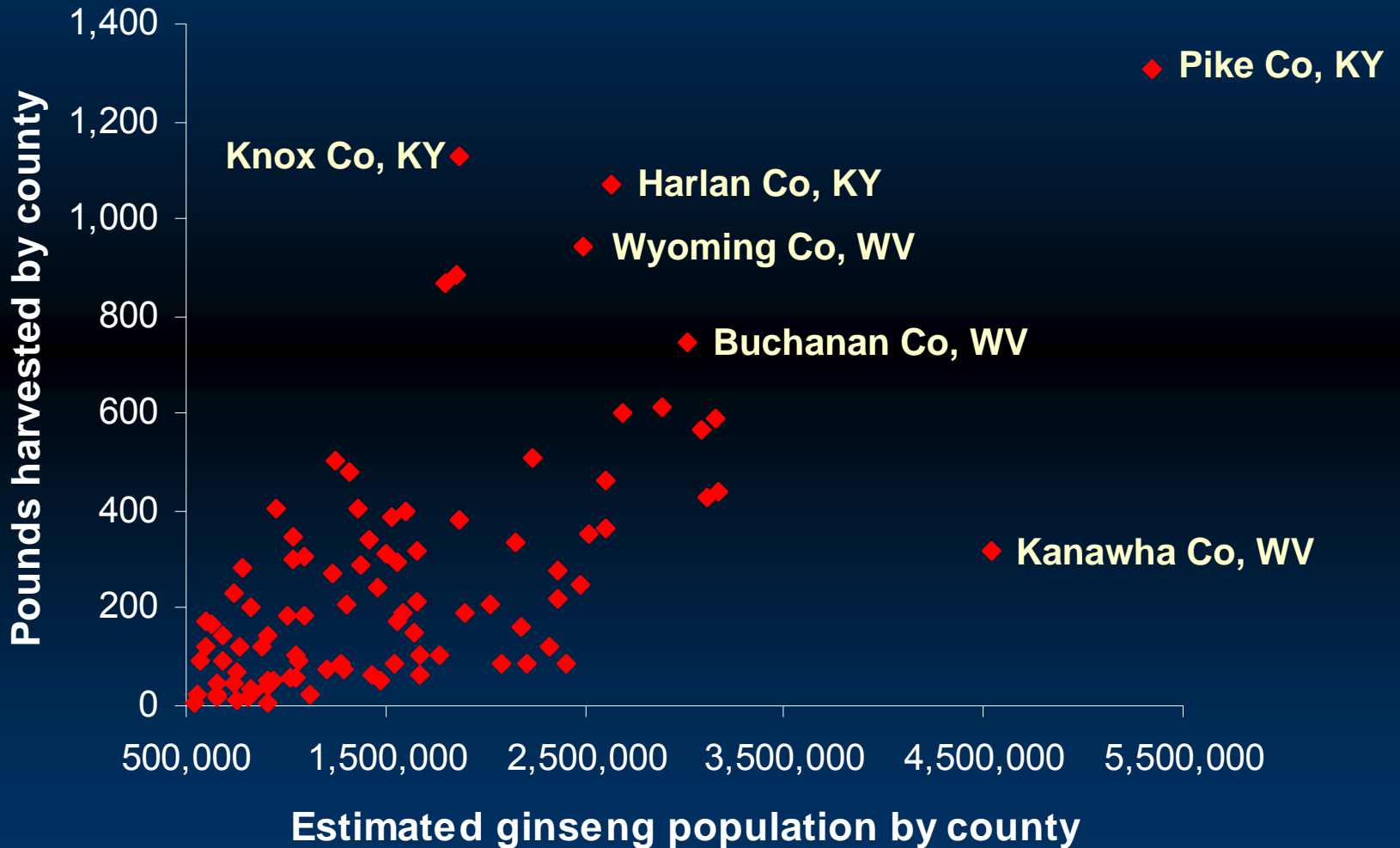
Indicators of ginseng harvest

- Largest population = 70, mean = 7.6

- Size class distribution
  - Only 11% of populations had 4-prong plants
  - 30% of populations had 3-prong plants as most abundant size class
  - 80% of survey plots had $\leq$10 plants

Ginseng size class distribution

Number of plants

500
400 — 369
300 — 251, 283
200
100 — 16
0 — 0

Ginseng size class: 1 prong, 2 prong, 3 prong, 4 prong, >4 prong

n = 132 ginseng locations

Conclusions and recommendations

- Ginseng distribution model was effective
- Spatially-explicit estimates of abundance
- Abundance and county harvest relationship
- Evidence of harvest pressure: monitor ginseng size-class distribution
- Importance of ginseng harvest data by county
- Routinely collect GPS coordinates of rare plant species during field work

Information sharing

- Transferred location data to NPS & USFS botanists, state natural heritage commissions

- Provide model results to NPS & USFS staff
  - Improve knowledge of local plant communities
  - Monitoring programs
  - Law enforcement activities
  - Baseline data for future habitat/population studies

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