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Spatial Distribution of Small Water Body Types in Indiana Ecoregions

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Importance of Water Bodies

Over 3.5 million open water bodies in the US, covering 130,800 km^2 (McDonald et al. 2012)

- Over 99% are smaller than 100 ha, 29% of total area
- 84% are smaller than 1 ha

Vegetated water bodies in the US are estimated to add another 417,000 km^2 (Dahl 2011)

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Importance of Water Bodies

Particular attention to Small Water Bodies (SWBs)

Defined as: *Open water or vegetated lentic water bodies with an area <100 ha*

Cumulative numbers

- Hydrology
- Retention of nutrients, sediments, and pesticides
- Carbon cycling & generation of greenhouse gases
- Biological importance

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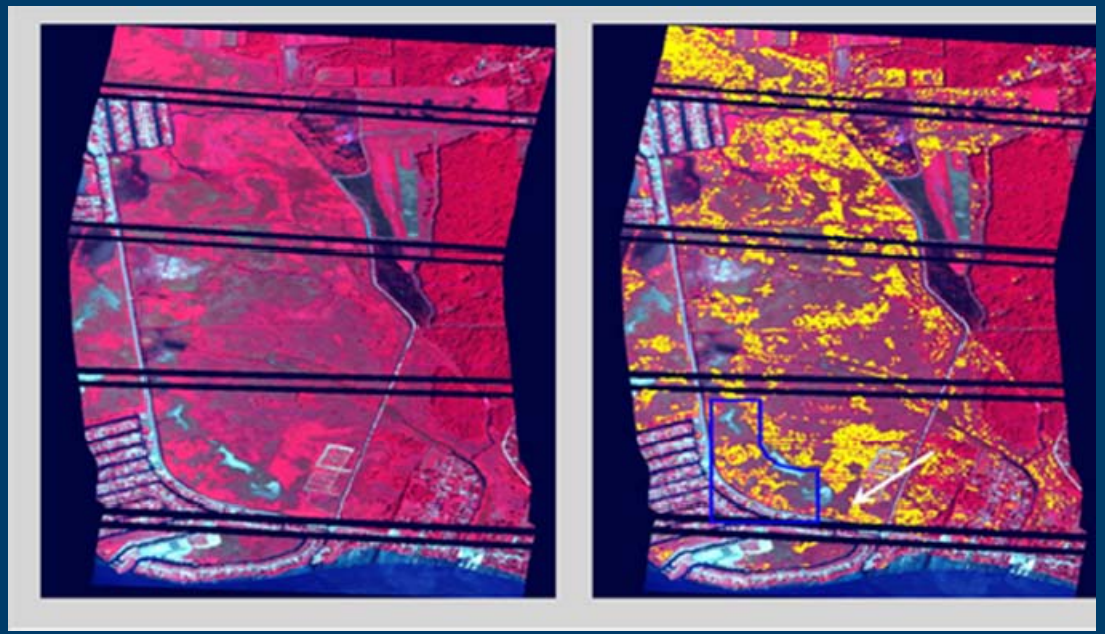
Importance of Small Water Bodies

Spatial distribution of SWBs limited or dated

Limitations of Remote Sensing technologies

For broader analysis pixel size >=30m

0.1 ha resolution



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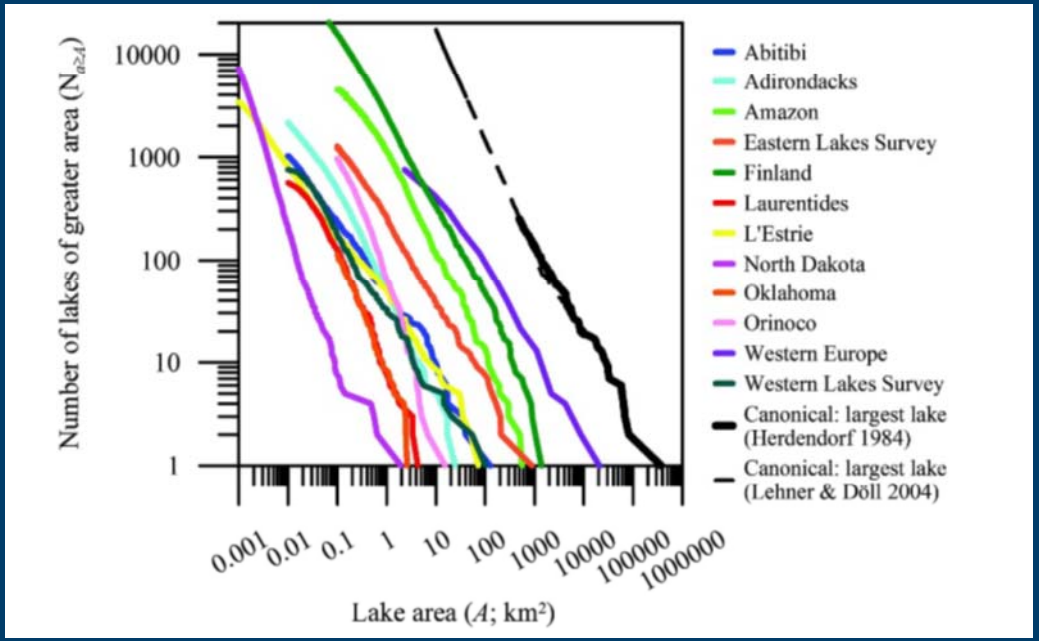
Importance of Small Water Bodies

- Spatial distribution of SWBs limited or dated
  - Reliance on datasets of larger water bodies to estimate SWB distributions



Downing et al. 2006

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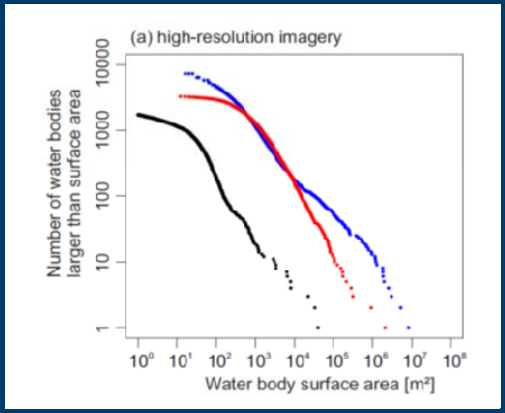
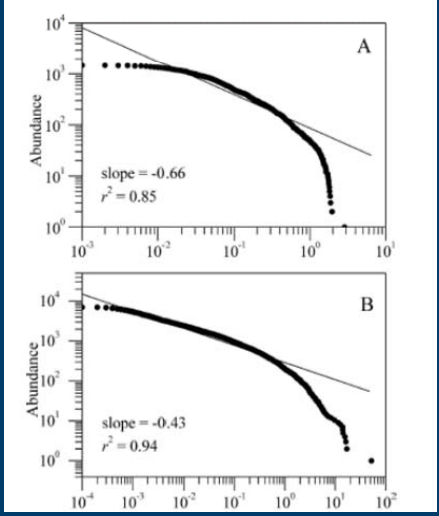
Importance of Small Water Bodies

- Spatial distribution of SWBs limited or dated
- Reliance on datasets of larger water bodies to estimate SWB distributions
  - May overestimate SWBs



SWBs in the Arctic

Muster et al. 2013



SWBs in the Adirondacks and Wisconsin's Northern Highland Lakes

Seekell and Pace 2011

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Importance of Small Water Bodies

- Spatial distribution of SWBs limited or dated
- Studies often focused on less disturbed regions
- Less data in disturbed areas
  - Urban areas dominated by open water
    - Loss of smallest WB and connection
    - (Steele and Hefernan 2014)

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Importance of Small Water Bodies

- Spatial distribution of SWBs limited or dated
- Studies often focused on less disturbed regions
- Less data in disturbed areas
  - Agricultural areas: large loss of wetlands, especially of smaller seasonal wetlands
  - Creation of farm ponds, livestock ponds

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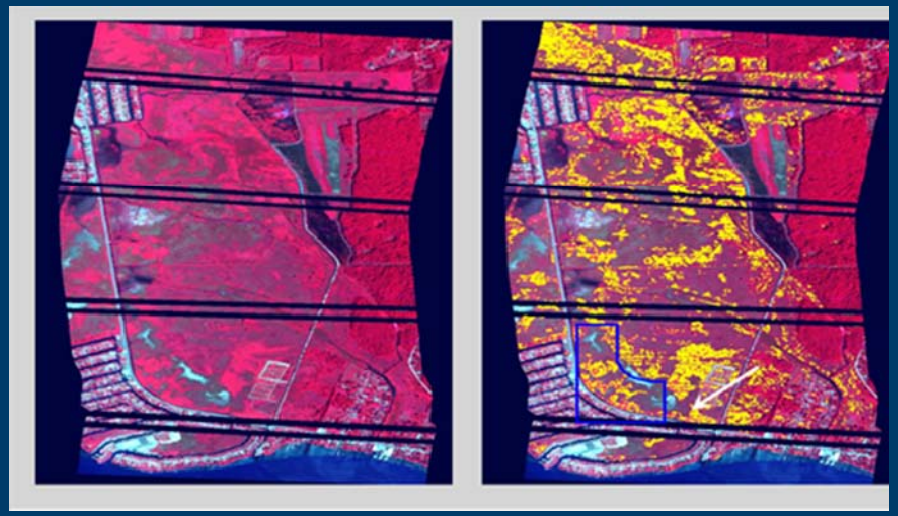
Importance of Small Water Bodies

- Spatial distribution of SWBs limited or dated
- Vegetated SWBs often not included
  - Spectral similarities with forests and grasslands



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Importance of Small Water Bodies

Uncertainty in distributions makes it difficult to estimate effects on hydrologic, biogeochemical, or biological processes

EPA has interest in these cumulative effects and processes

Pesticide modeling for EPA

- Hypothetical 1 ha open water pond
- Exposure levels

Focus of Study

- Agricultural Regions
  - There are higher loadings of pollutants
  - 1) Need to know distribution of WB size across regions
  - 2) Need to know distributions of all SWB types
    - Determining distributions of different water body types 1st step to understanding the cumulative fate, exposure and risk

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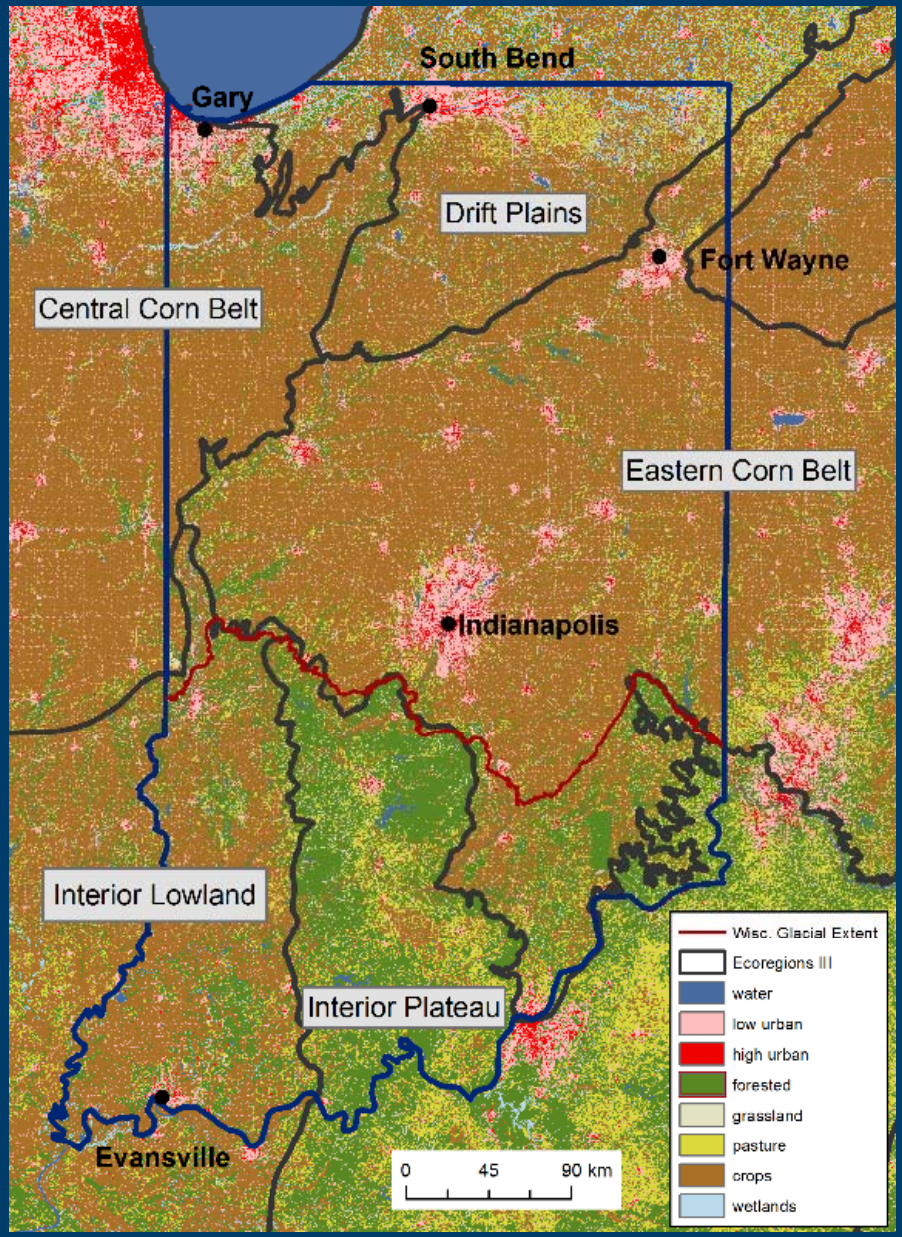
Indiana

- Northern 2/3 of state located in the Corn Belt
  - Varied geology within ag areas
  - Historical loss of wetlands due to agricultural drainage – 87%
  - Some Urban areas, (Indianapolis, Gary)



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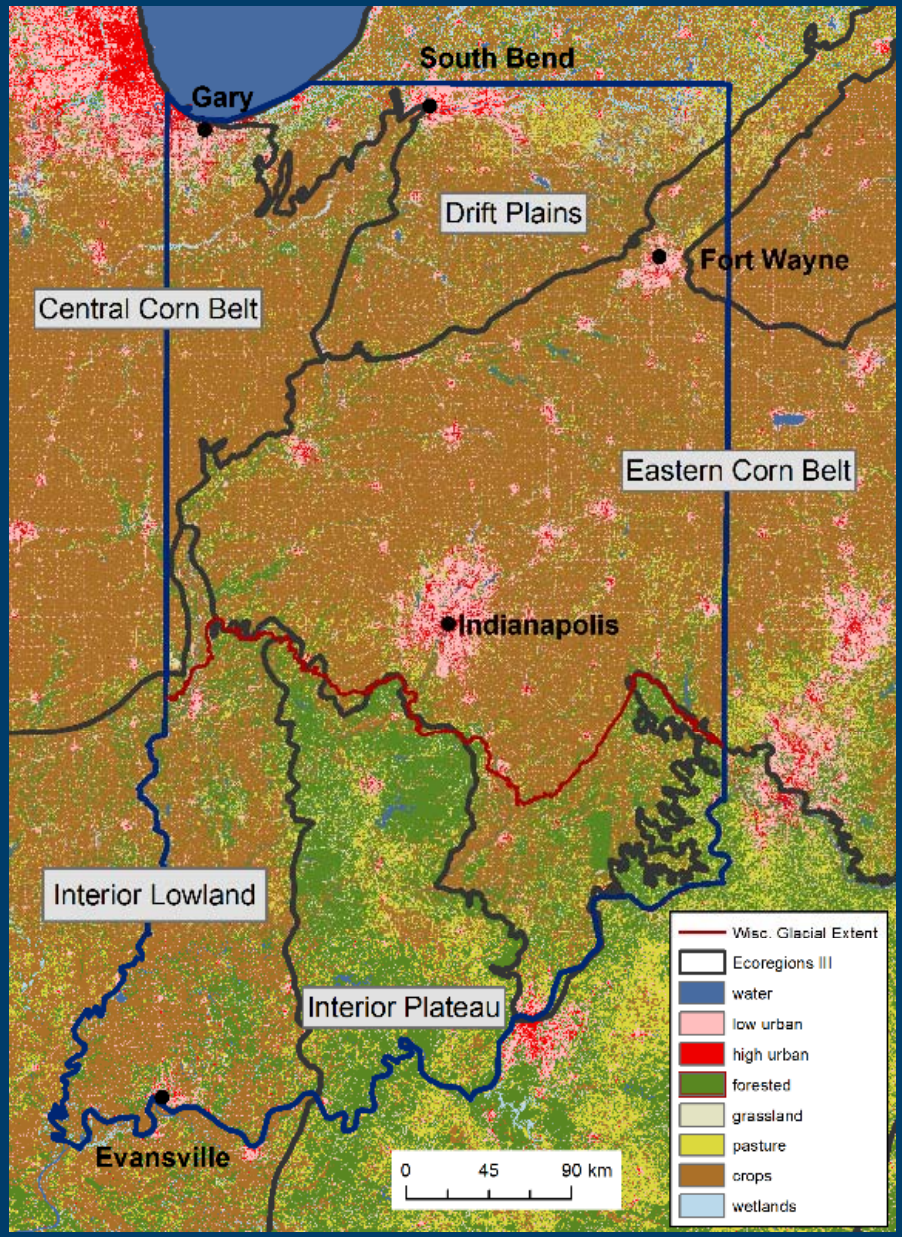
Indiana

- Southern 1/3 of state unglaciated Interior
  - Predominantly forested region
    - Varied geology as well
    - Karst topography
    - Higher levels of precipitation



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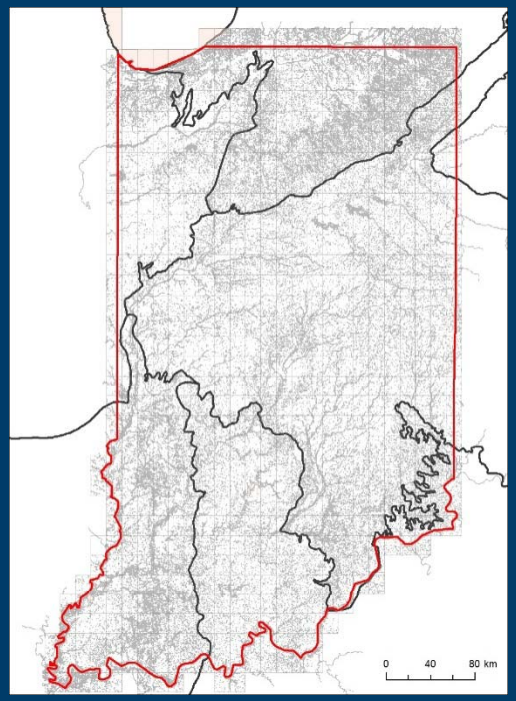
Indiana Dataset



- Updated NWI for the state
  - Imagery from 2003 and 2005
  - Created and verified by Ducks Unlimited
    - resolution of 0.04 ha
  - Included Seasonal and Permanent SWBs
  - NWI types considered:
    - Forested, Emergent, Open Water (OW), OW-diked, OW excavated
  - Adjacent NWI polygons combined to form one SWB
    - Predominant type assigned to polygon
    - Sizes recalculated and summarized by ecoregion

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Results

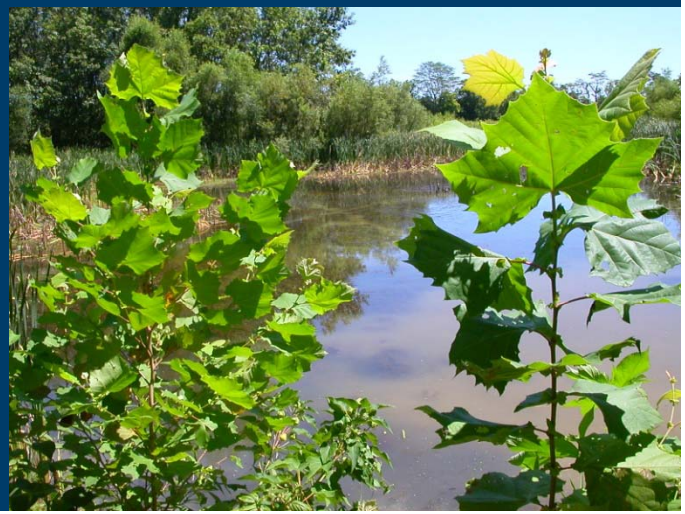
203,942 total SWBs or 1.9 SWBs/km^2

Covering 192,600 ha or 1.8% of state

SWBs account for 99% of WBs, and 74% of WB area

75% of SWBs had permanent water

- 80% of permanent water was excavated or diked ponds



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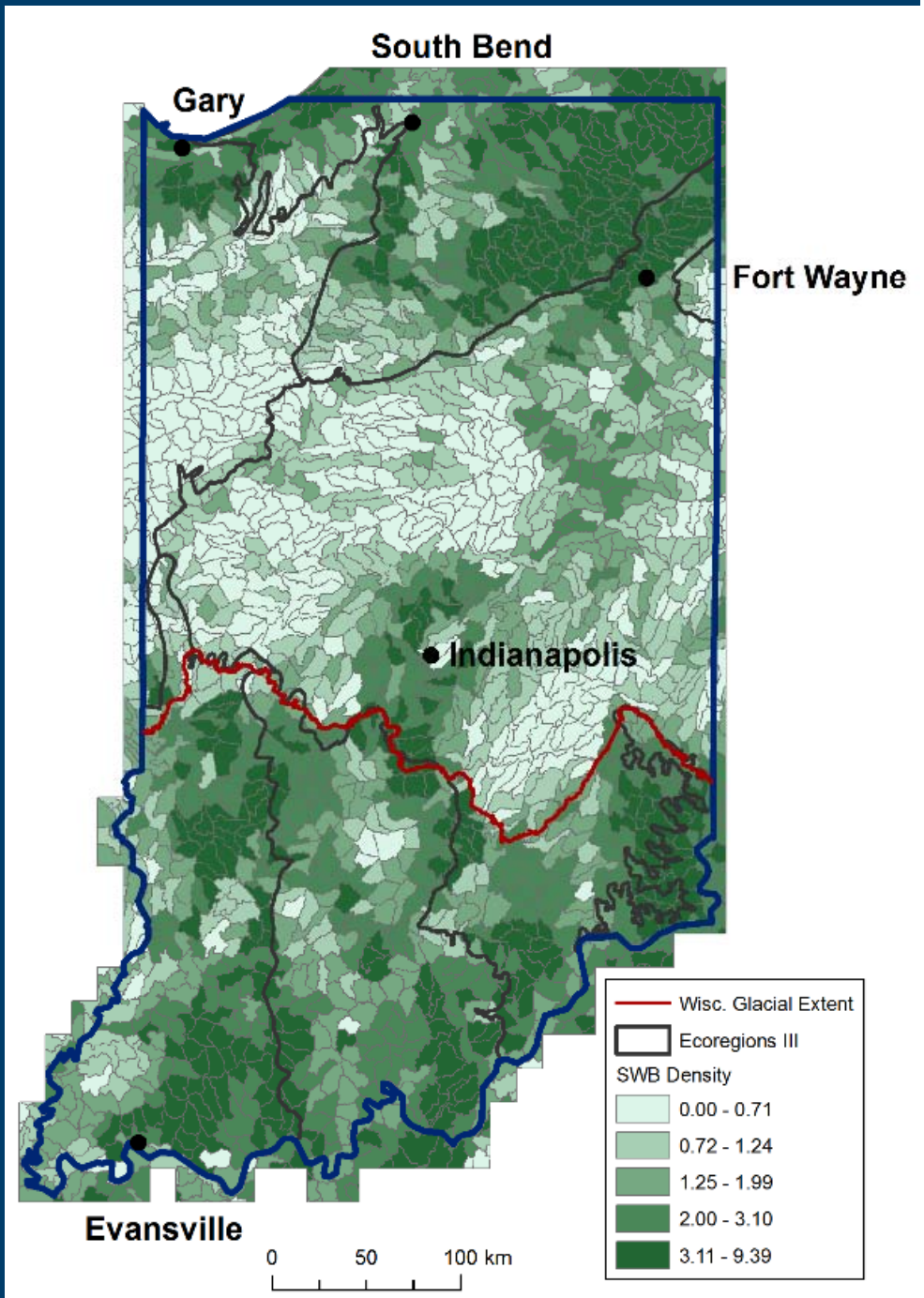
Results

71% of SWBs in Ag

25% of SWBs in forest

4% of SWBs in Urban

12-23% located within 30m of NHD high resolution stream



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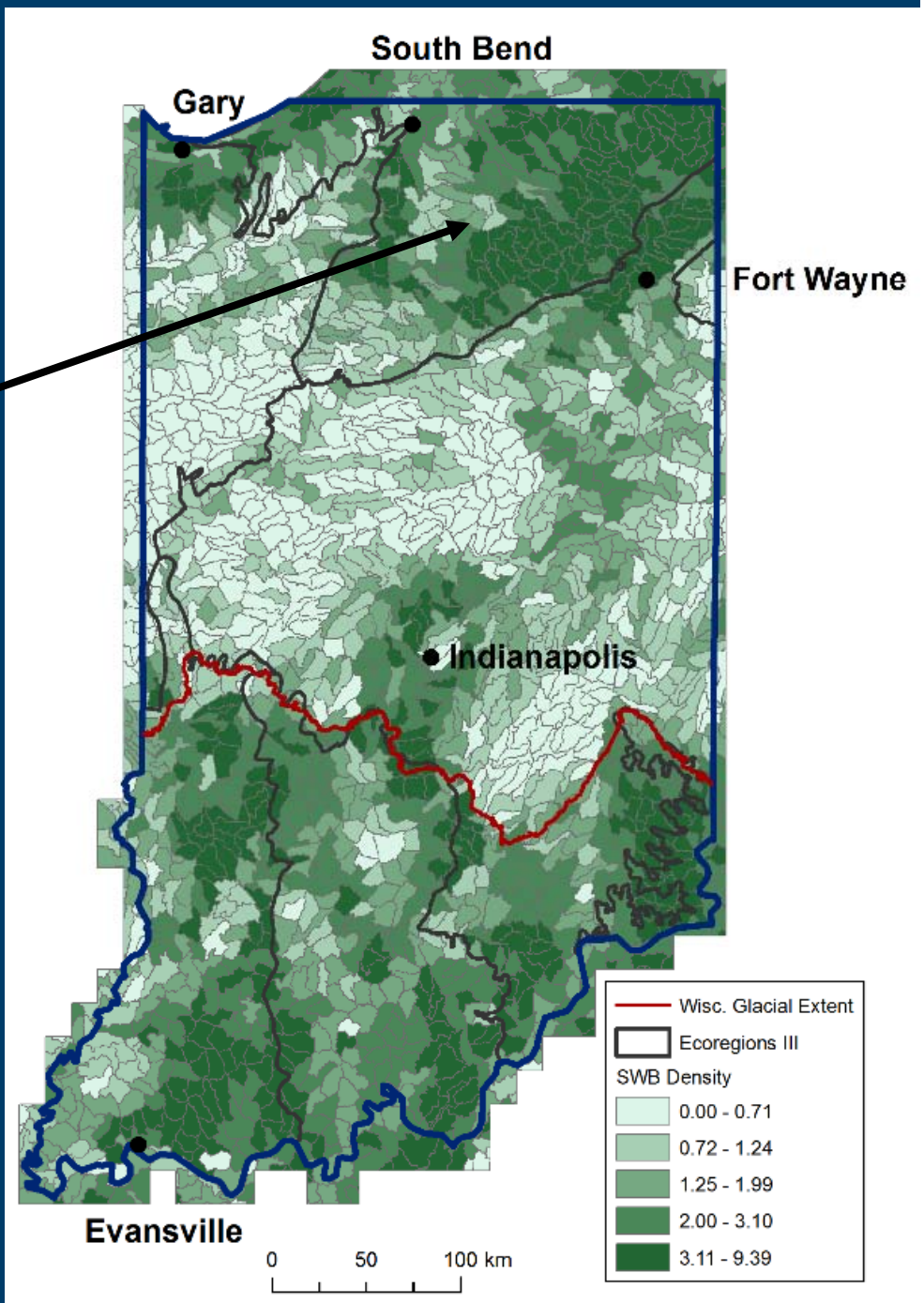
Results

Indiana Drift Plain



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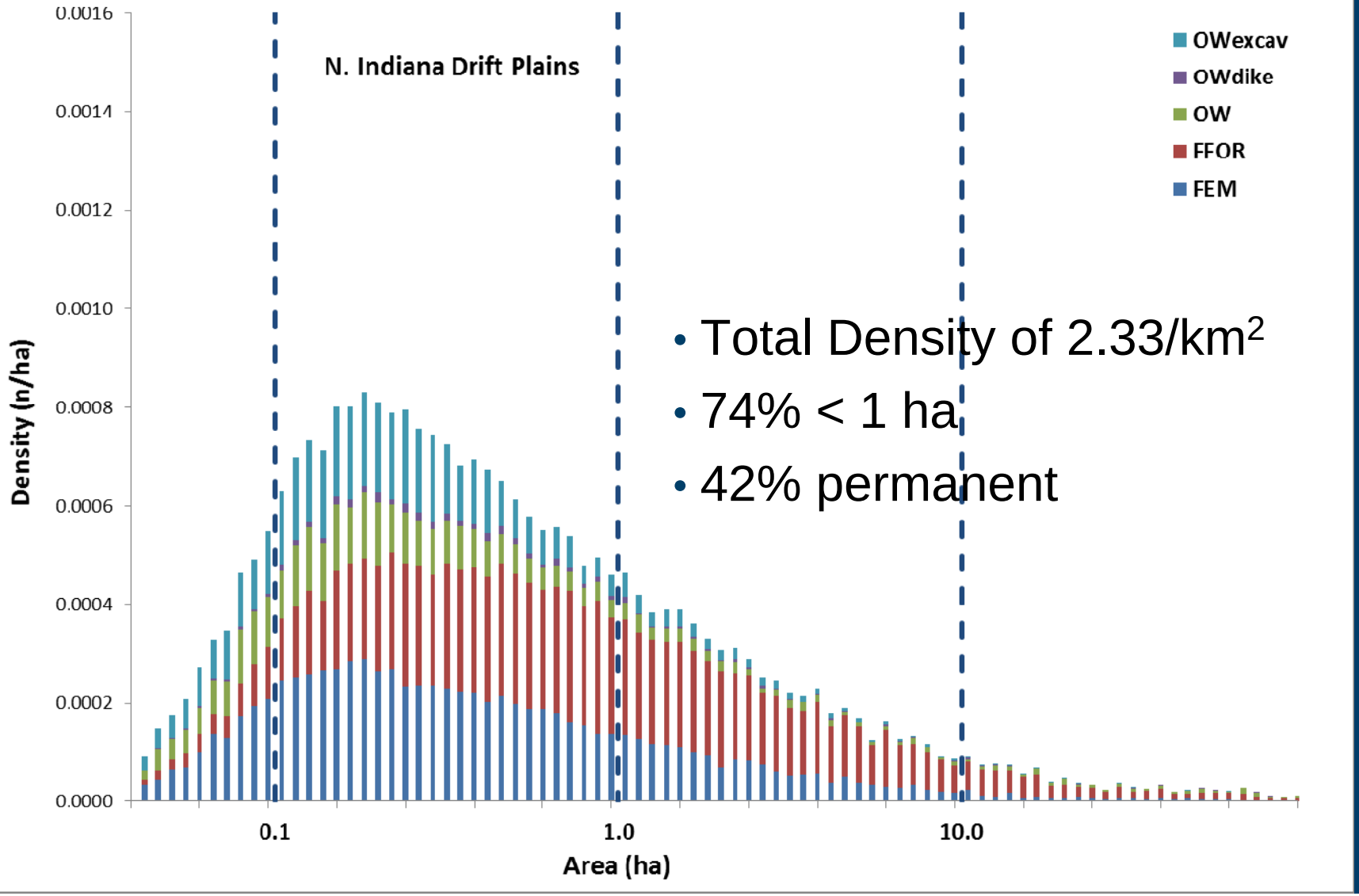

- Total Density of 2.33/km^2
- 74% < 1 ha
- 42% permanent

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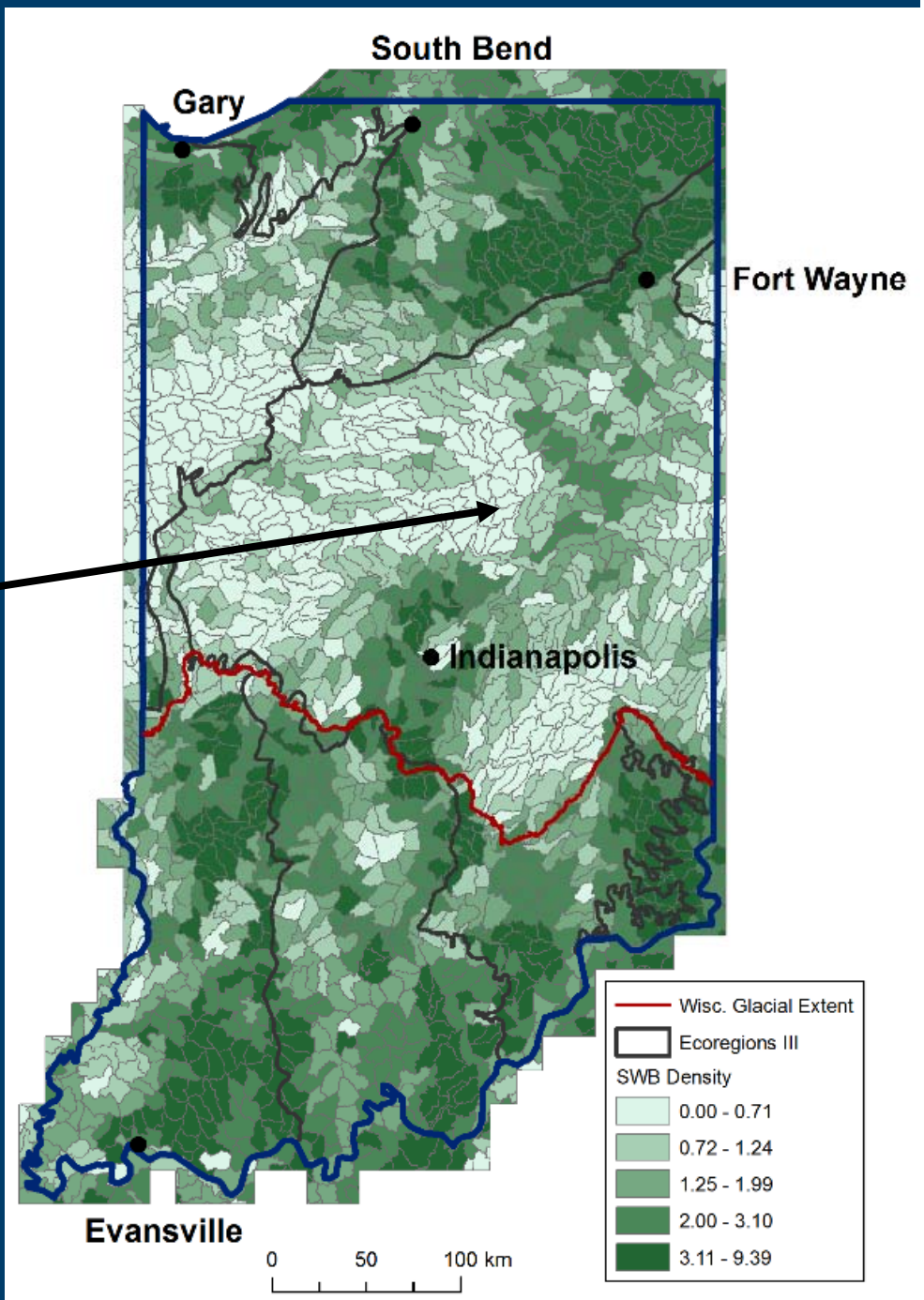
Results

Indiana Drift Plain

Eastern Corn Belt



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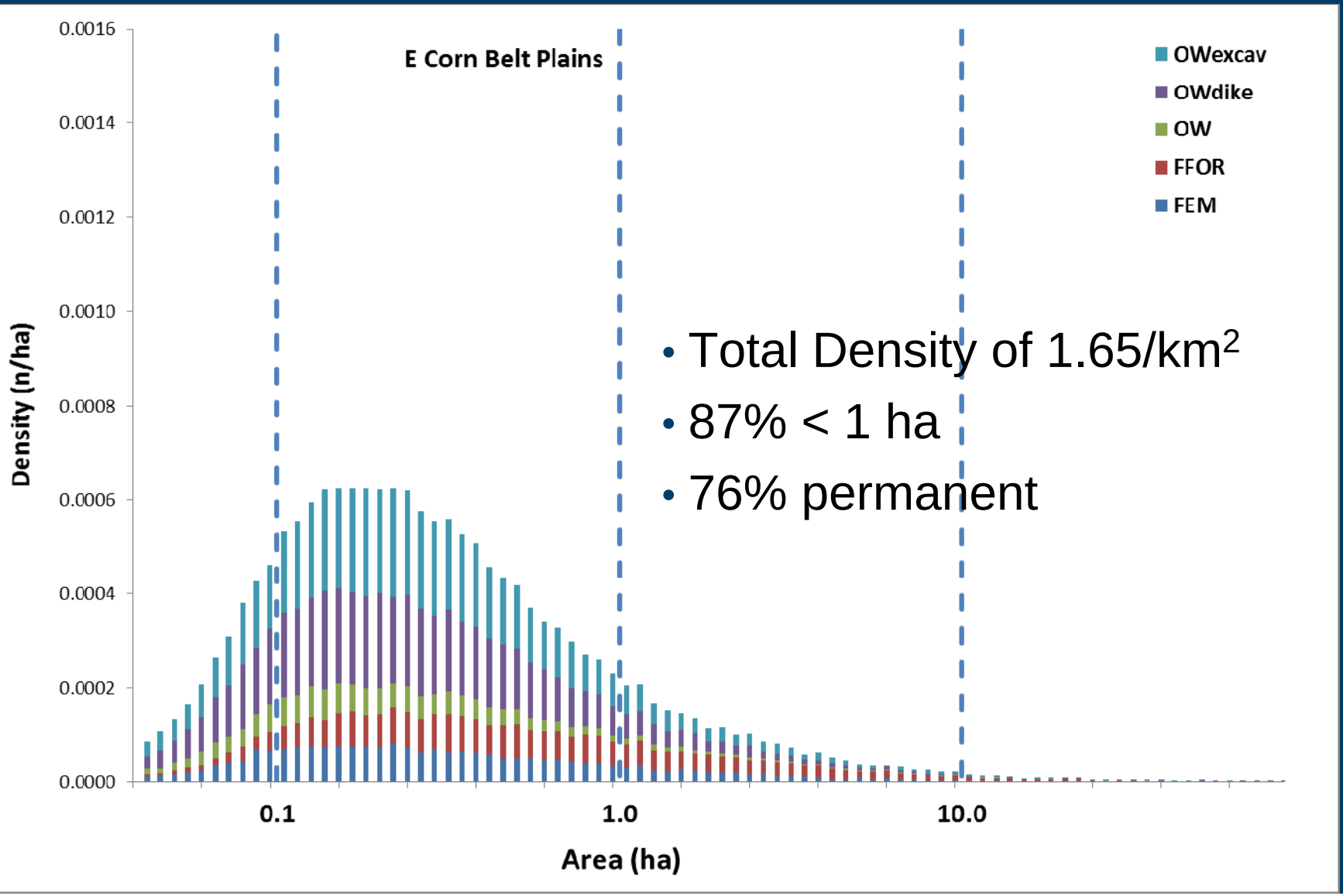

- Total Density of 1.65/km^2
- 87% < 1 ha
- 76% permanent

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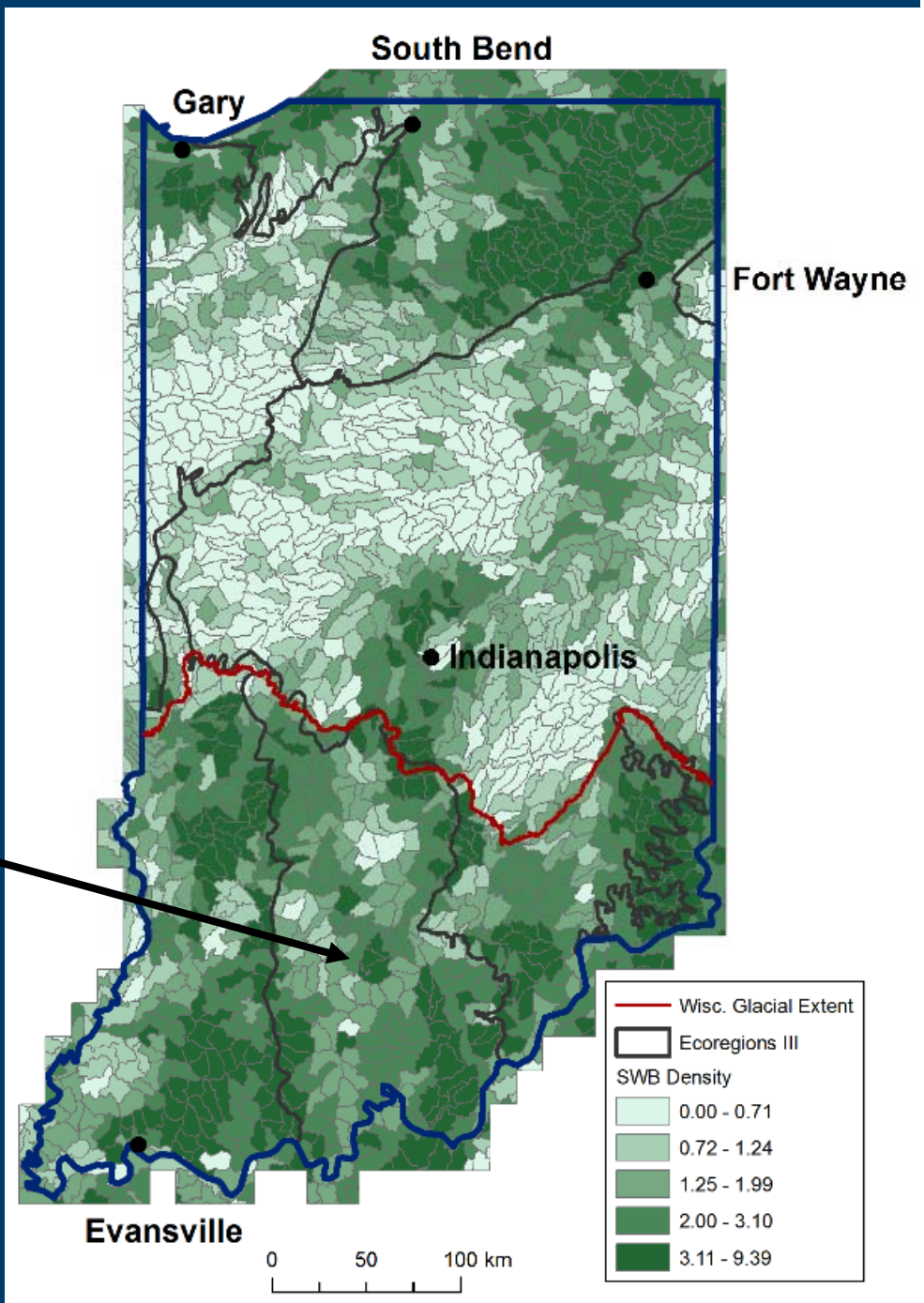
Results

Indiana Drift Plain

Eastern Corn Belt

Interior Plateau



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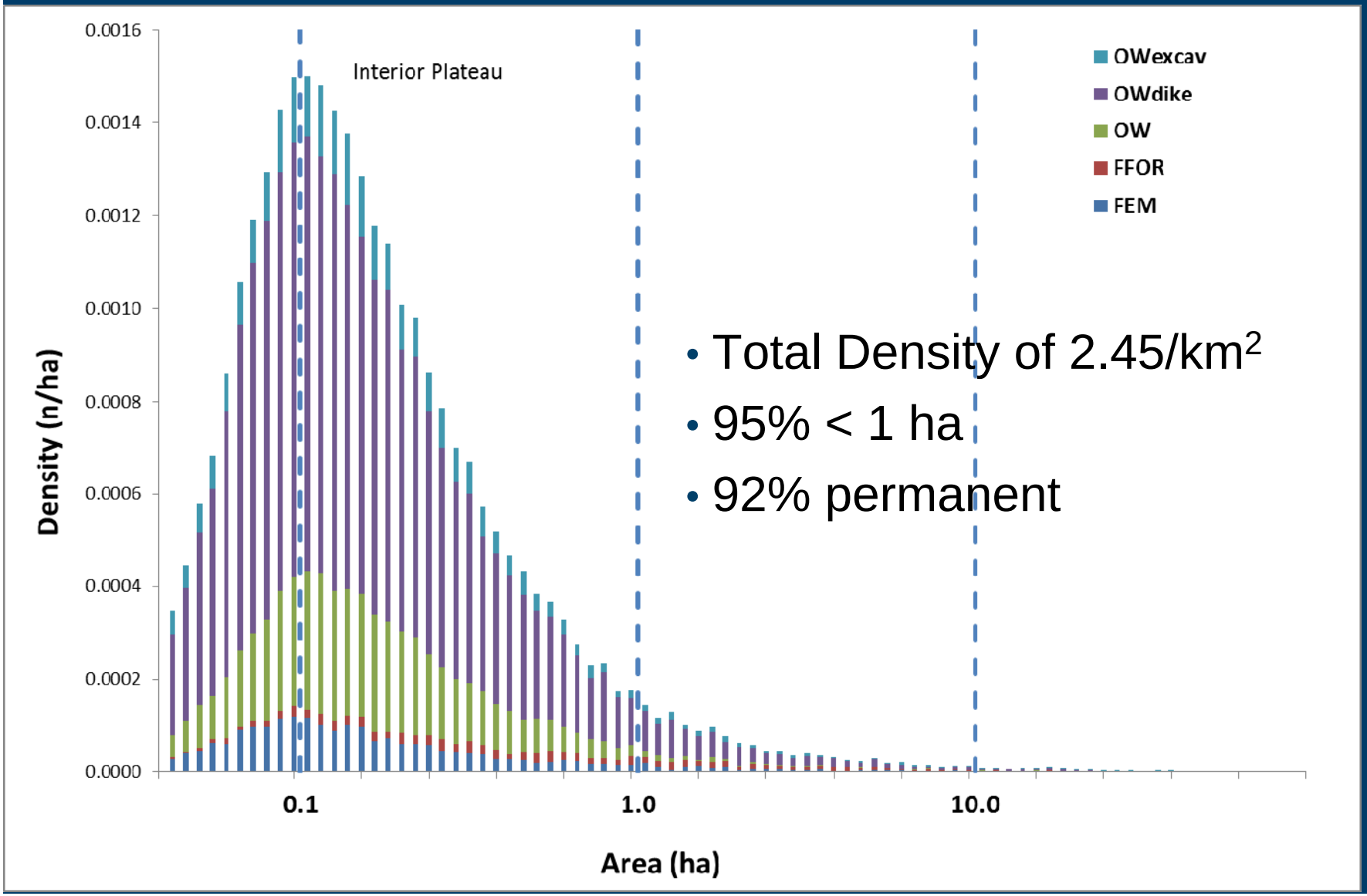
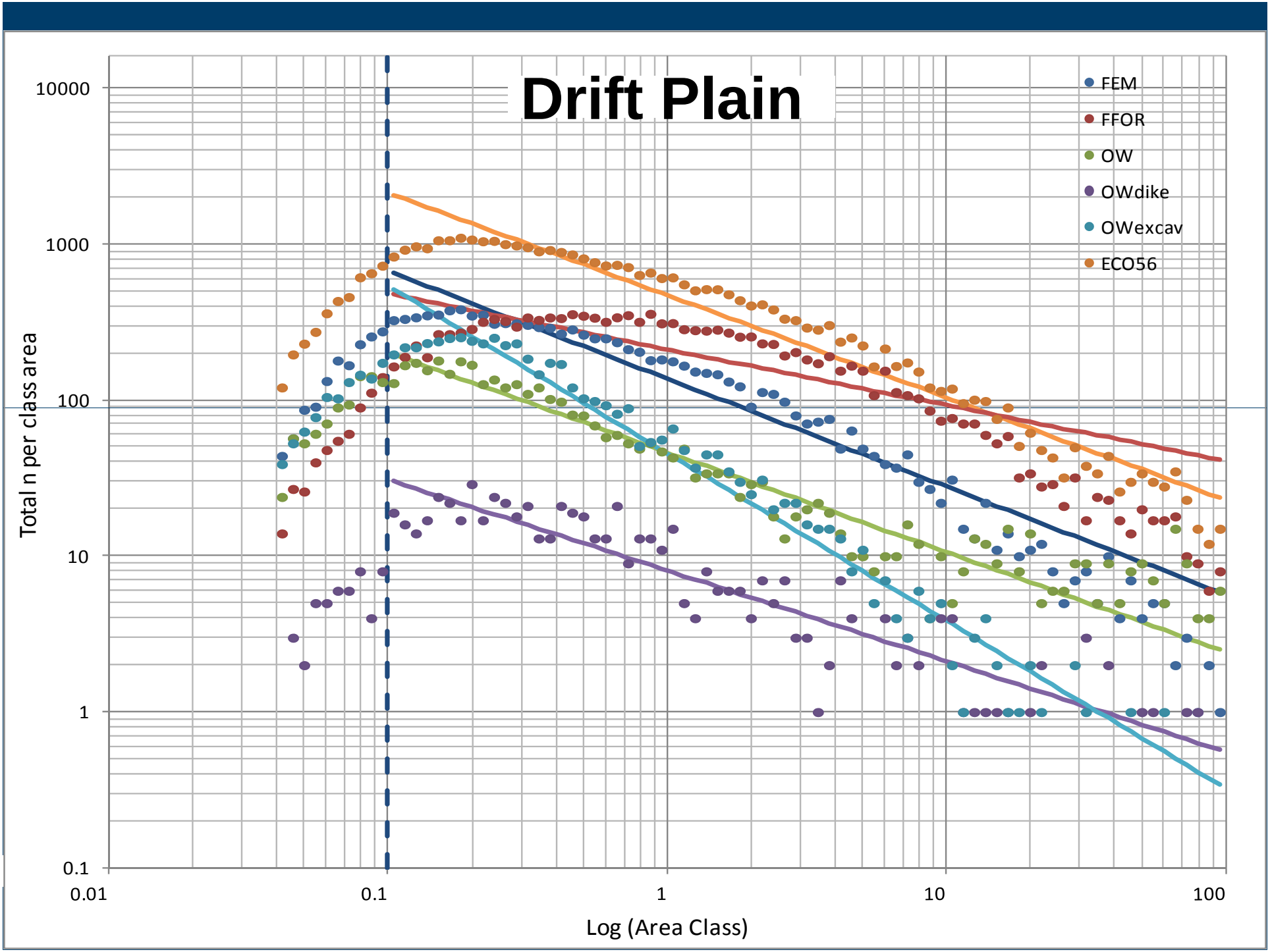
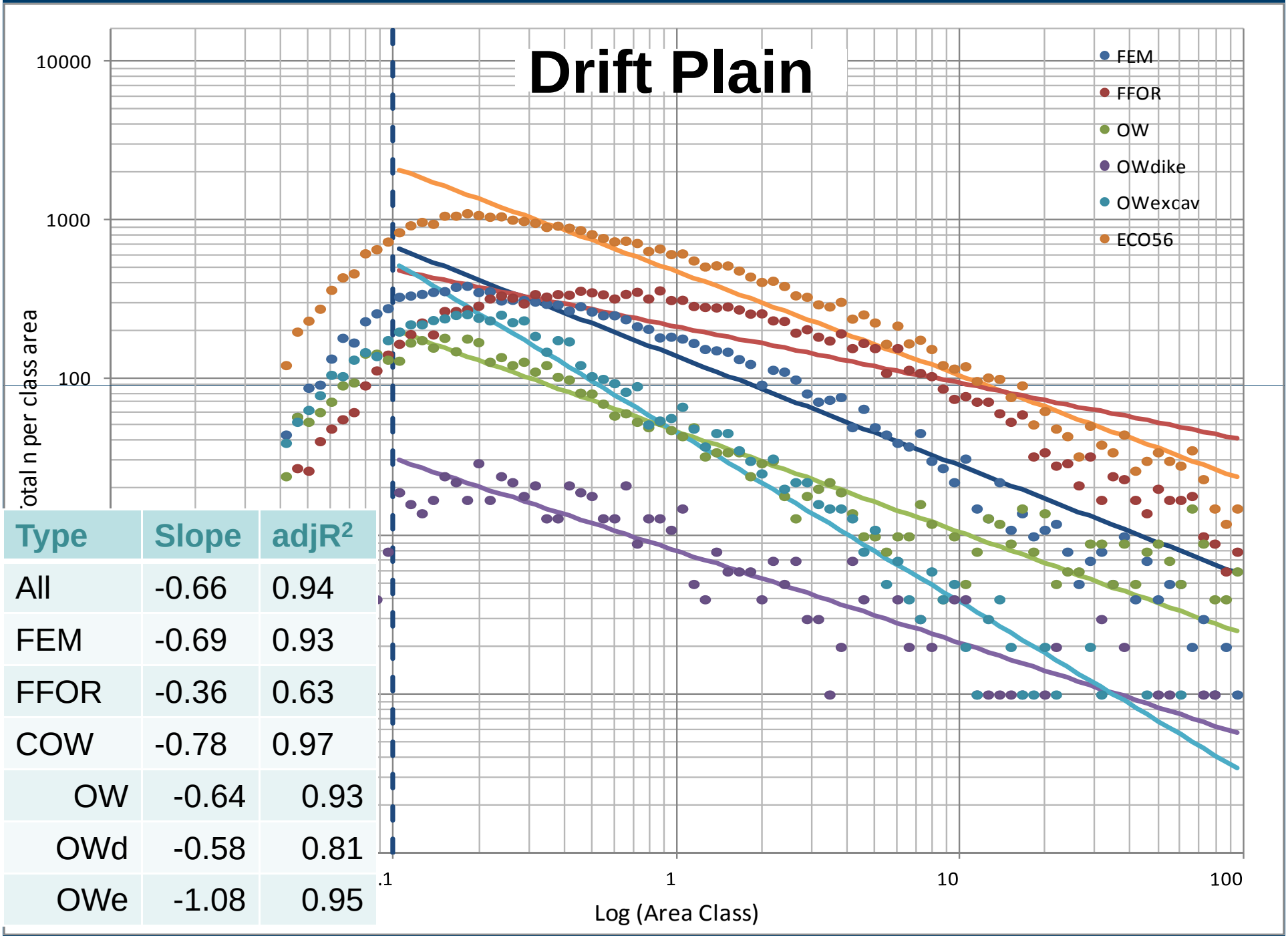


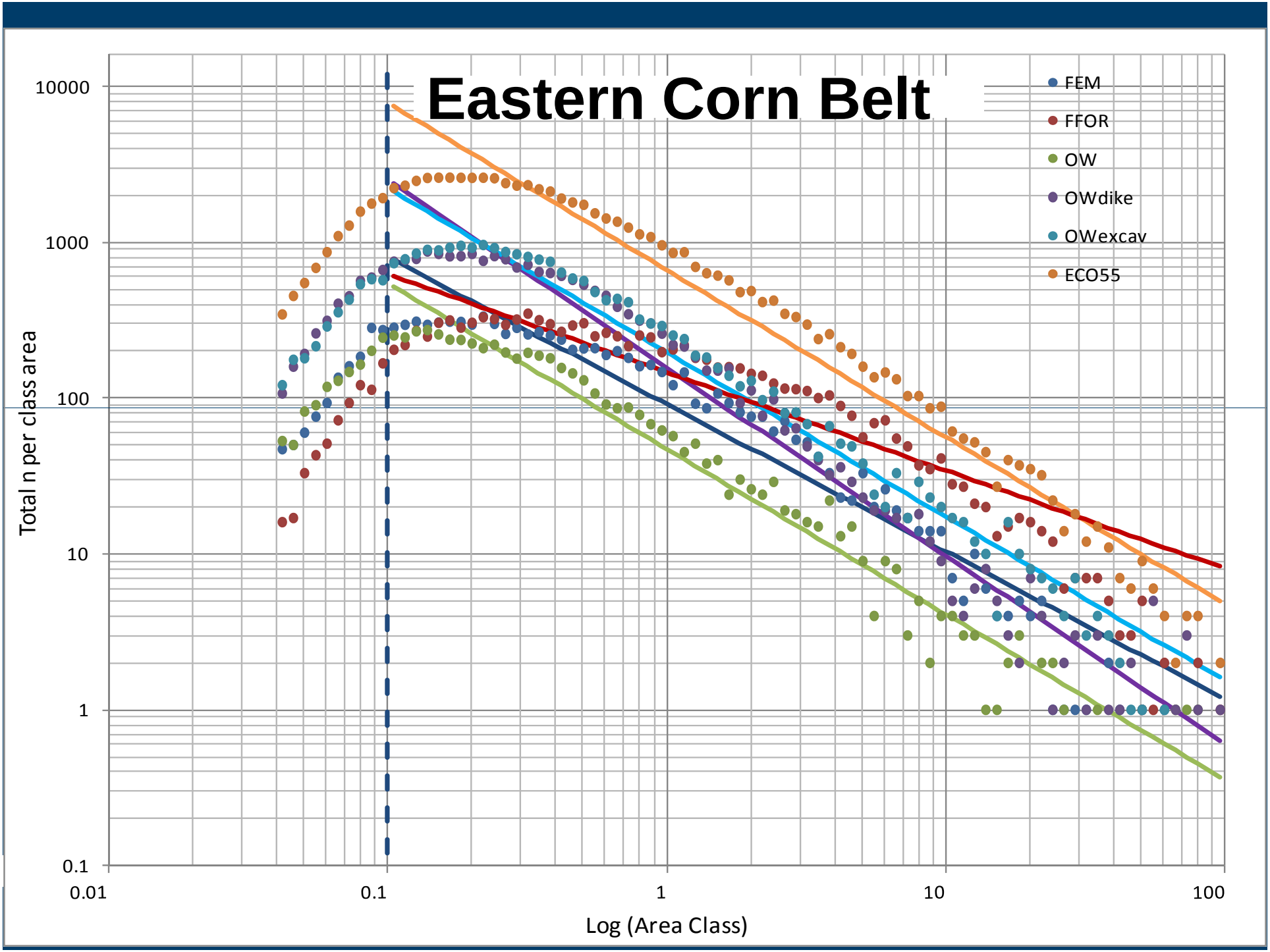
- Total Density of 2.45/km^2
- 95% < 1 ha
- 92% permanent


Drift Plain
FEM
FFOR
OW
OWdike
OWexcav
ECO56
10000
1000
100
10
1
0.1
Total n per class area
0.01
0.1
1
10
100
Log (Area Class)

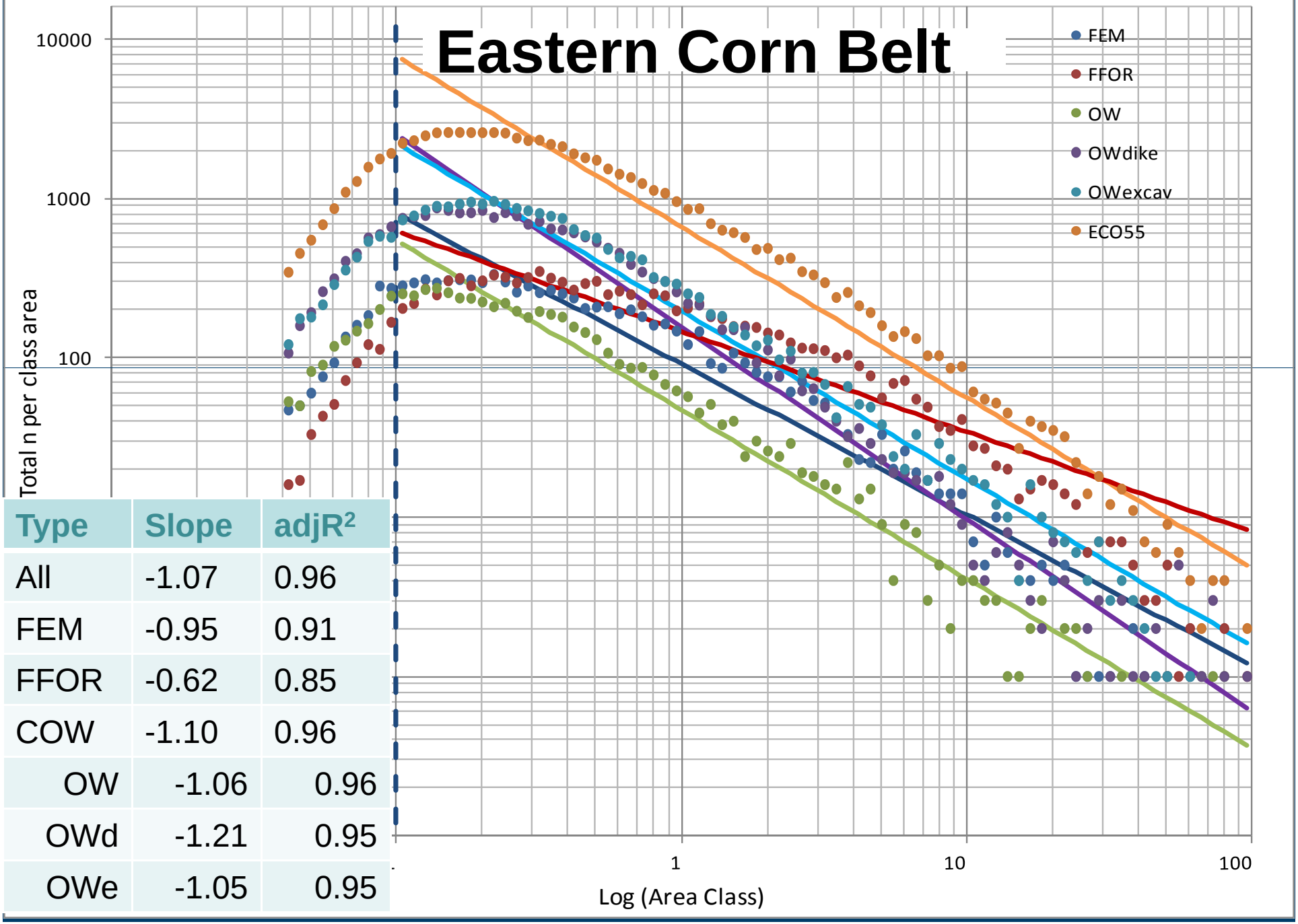
Drift Plain



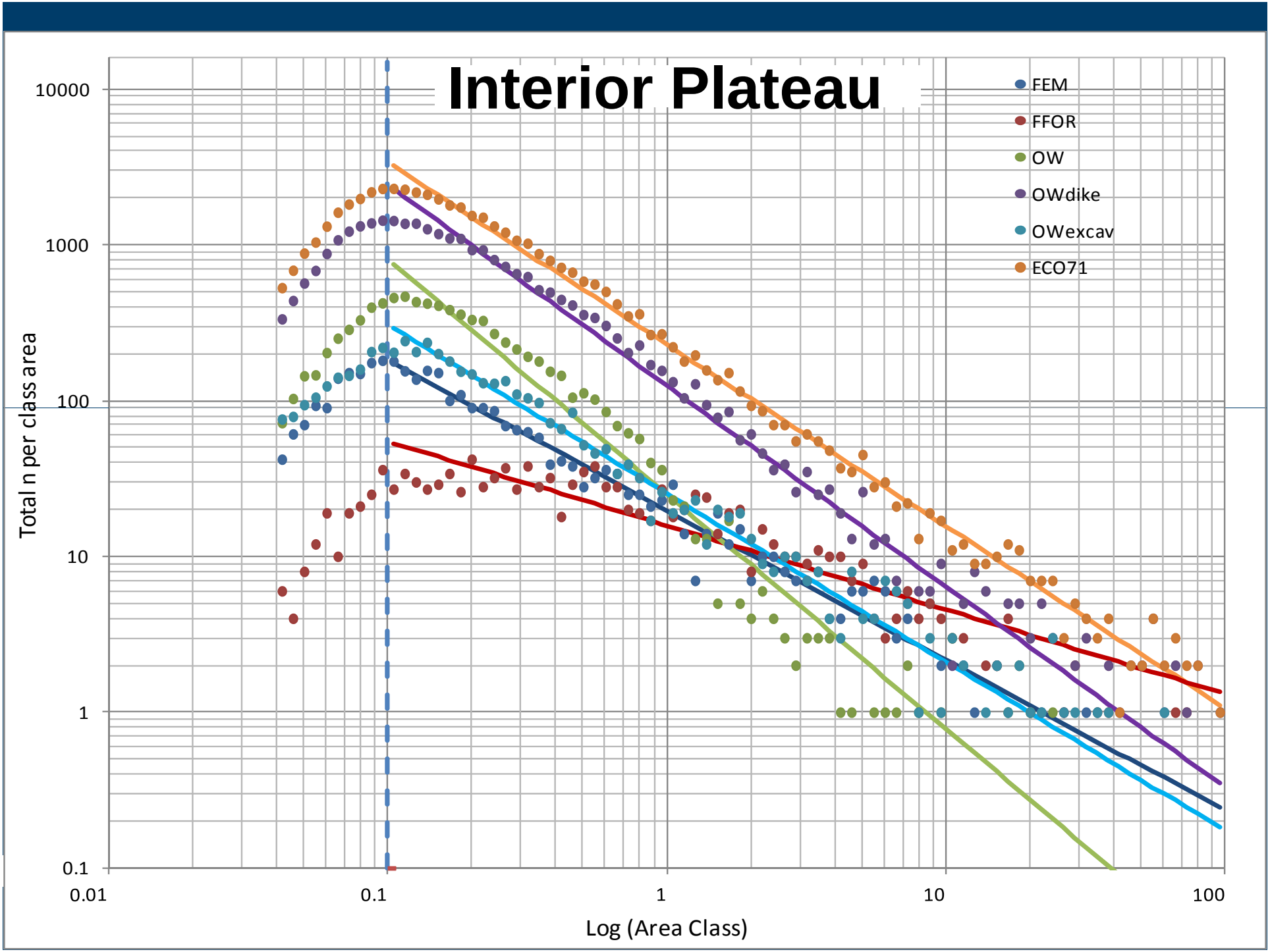
Type	Slope	adjR²
All	-0.66	0.94
FEM	-0.69	0.93
FFOR	-0.36	0.63
COW	-0.78	0.97
OW	-0.64	0.93
OWd	-0.58	0.81
OWe	-1.08	0.95


Eastern Corn Belt
FEM
FFOR
OW
OWdike
OWexcav
ECO55
Total n per class area
10000
1000
100
10
1
0.1
0.01
0.1
1
10
100
Log (Area Class)

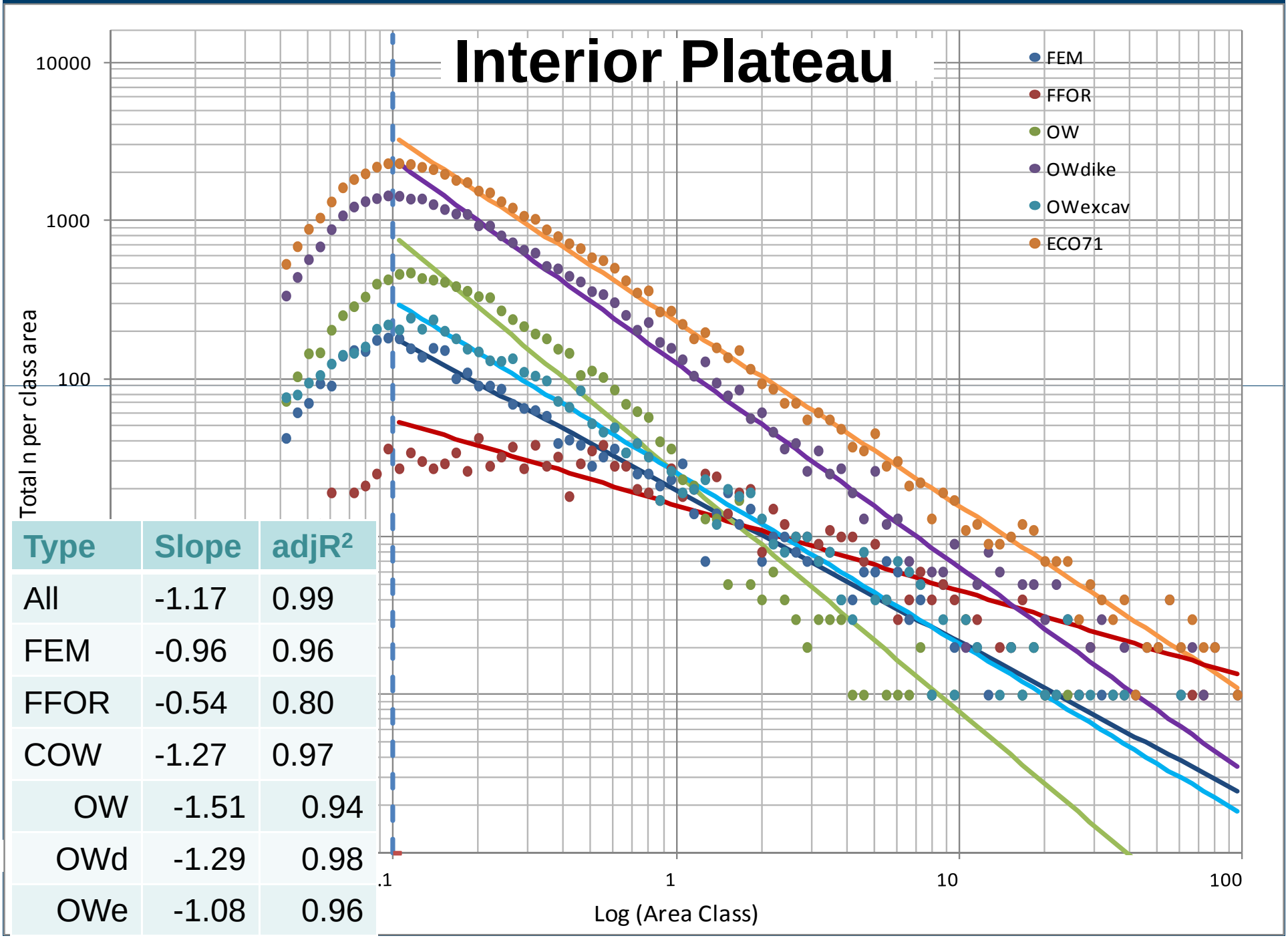
Eastern Corn Belt



Type	Slope	adjR²
All	-1.07	0.96
FEM	-0.95	0.91
FFOR	-0.62	0.85
COW	-1.10	0.96
OW	-1.06	0.96
OWd	-1.21	0.95
OWe	-1.05	0.95


Interior Plateau
FEM
FFOR
OW
OWdike
OWexcav
ECO71
Total n per class area
10000
1000
100
10
1
0.1
0.01
0.1
1
10
100
Log (Area Class)

Interior Plateau



Type	Slope	adjR²
All	-1.17	0.99
FEM	-0.96	0.96
FFOR	-0.54	0.80
COW	-1.27	0.97
OW	-1.51	0.94
OWd	-1.29	0.98
OWe	-1.08	0.96

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Implications

- Increased resolution size
  - Increased densities
    - Added 1% of area, 18% of SWBs
  - Inclusion of small OW in Interior Plateau
    - Influence of connection, biological processes
  - Log-log plots show decline, especially below 0.1ha
    - Supports studies that suggests power law not appropriate for very small water bodies

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Implications

All SWB types

- Inclusion of vegetated SWBs
  - Increased densities
  - Large increase of area in Drift Plain
    - Impacts on biogeochemical processes
  - Increased connection
    - Nearest neighbor 257 m when including wetlands, 440 m without wetlands in Drift Plain

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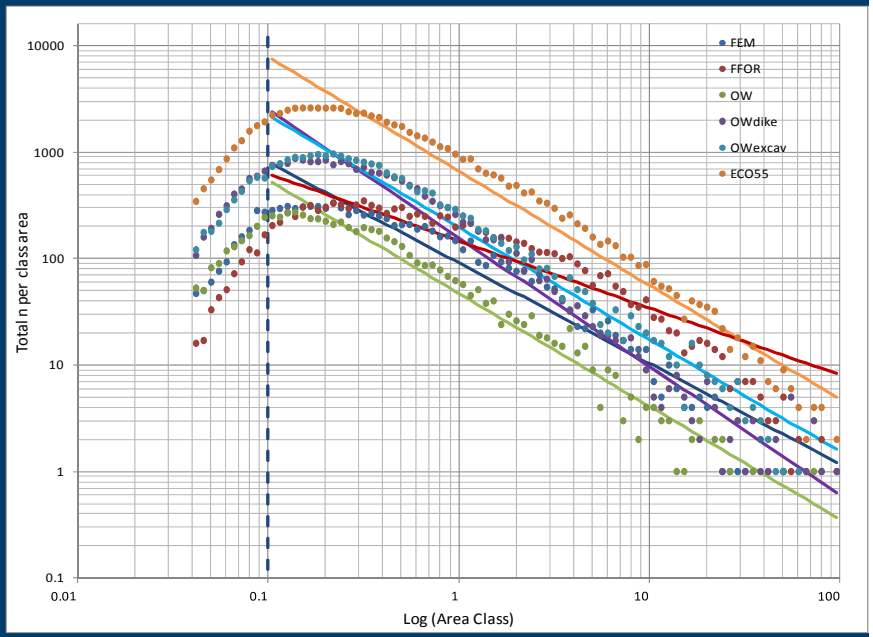
Implications

All SWB types

- Inclusion of vegetated SWBs
  - Log-log plots – fewer smaller wetlands
  - Only larger, more permanent wetlands remain – legacy of removal practices (Miller et al. 2009)



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Implications

- Importance of ponds
  - Diked ponds in Interior Plateau
  - Excavated ponds in Corn Belt
    - Most of a particular size class (0.1-1 ha)
    - Increasing number of ponds (Downing et al. 2006, Dahl 2011) yet largely uninventoried
    - Research needed on cumulative impacts from ponds on hydrology and biogeochemistry

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Implications - focus

In Agricultural Regions

EPA pesticide models

1) Need to know distribution of size across regions

Closer to 0.1 ha than 1 ha

2) Need to know distributions of all SWB types

Very small diked open water dominates some regions

Larger vegetated SWBs can dominate others

Small vegetated SWBs have been lost

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Questions?