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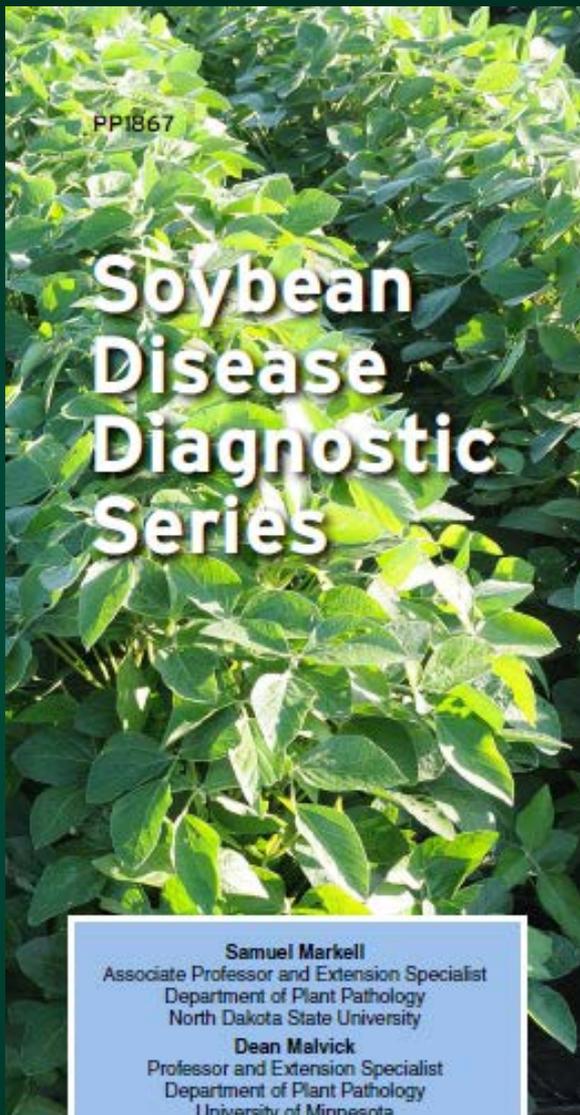
Getting it Right: Soybean Diseases

Sam Markell, Ph.D.
Extension Plant Pathologist

Diseases of Soybean

- Roots
 - Root Rots
 - Soybean Cyst Nematode
- Stems
 - White Mold
 - Some other diseases, especially over time
- Leaves
 - Usually minor issues (bacteria, brown spot, downy mildew)

Diagnosis

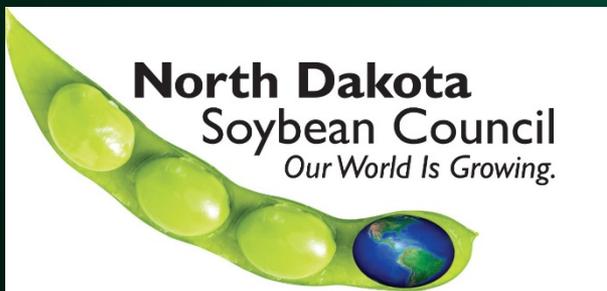


PP1867

Soybean Disease Diagnostic Series

Samuel Markell
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Department of Plant Pathology
University of Minnesota



NDSU NORTH DAKOTA STATE UNIVERSITY



NDSU EXTENSION SERVICE

Root Diseases

Fusarium root rot.....	PP1867-1
Phytophthora root and stem rot.....	PP1867-2
Pythium root rot.....	PP1867-3
Rhizoctonia root rot.....	PP1867-4
Seed and seedling rot complex.....	PP1867-5
Soybean cyst nematode.....	PP1867-6
Sudden death syndrome.....	PP1867-7

Stem Diseases

Anthracnose.....	PP1867-8
Brown stem rot.....	PP1867-9
Charcoal rot.....	PP1867-10
Pod and stem blight.....	PP1867-11
Stem canker.....	PP1867-12
White mold.....	PP1867-13

Leaf Diseases

Bacterial blight.....	PP1867-14
Bacterial pustule.....	PP1867-15
Bean pod mottle virus.....	PP1867-16
Cercospora leaf blight.....	PP1867-17
Downy mildew.....	PP1867-18
Frogeye leaf spot.....	PP1867-19
Powdery mildew.....	PP1867-20
Septoria brown spot.....	PP1867-21
Soybean mosaic virus.....	PP1867-22

Additional Diseases (not known to occur in ND/MN)

Soybean rust.....	PP1867-23
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Cover photo: Sam Markell, NDSU

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For more information on this and other topics, see www.ag.ndsu.edu

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PP1867-13
Soybean Disease Diagnostic Series



White mold (Sclerotinia stem rot)

Sclerotinia sclerotiorum (fungus)

Figure 1



Figure 2



Photo: S. Markell, NDSU

Figure 3



Figure 4



PP1867-13
Soybean Disease Diagnostic Series



White mold (Sclerotinia stem rot)

Sclerotinia sclerotiorum (fungus)

AUTHORS: Sam Markell and Dean Malvick

SYMPTOMS

- Stem lesions begin as water-soaked spots near nodes
- Lesions enlarge, fluffy white fungal growth develops on moist stems
- Infected stems become bleached white and may shred
- Hard black structures (sclerotia) form on infected tissue

FIGURE 1 - Lesions with white mold and sclerotia

FIGURE 2 - Severe white mold infection

FIGURE 3 - Black sclerotia among shriveled seeds

FIGURE 4 - Apothecia

FACTORS FAVORING DEVELOPMENT

- Wet soils prior to and during soybean flowering
- Frequent wetness (rain, fog, heavy dew) and cool temperatures during bloom
- Dense plant canopy, high fertility, high plant populations
- Disease history in field

IMPORTANT FACTS

- Severe yield losses can occur when July and early August are cool and wet
- Many broadleaf crops and weeds are hosts
- Pathogen survives in soil for many years as sclerotia
- Sclerotia produce apothecia (about 1/4-inch mushrooms), which produce ascospores that initiate infection
- Apothecia commonly confused with bird's nest fungi
- Management options: partially resistant varieties and fungicides

Card 13 of 23



Brown stem (BSF)

Cadophora gregal



Photo: D. Malvick, Univ. of Minnesota



Figure 3



Photo: D. Malvick, Univ. of Minnesota



Photo: B. Nelson, NDSU



Photo: B. Nelson, NDSU



Photo: B. Nelson, NDSU

Charcoa

Macrophomina phase

Pod and stem Phomopsis

Diaporthe sojae and *Di*



Photo: D. Malvick, Univ. of Minnesota



Photo: D. Malvick, Univ. of Minnesota

Stem c

Diaporthe caulivora (northern)
D. aspalathi (southern)



D. Malvick, Univ. of Minnesota



Photo: S. Markell, NDSU



Photo: S. Markell, NDSU

White mold (Sclerotinia stem rot)

Sclerotinia sclerotiorum (fungus)



Photo: D. Malvick, Univ. of Minnesota

Figure 1



Figure 2



Photo: S. Markell, NDSU

Figure 3

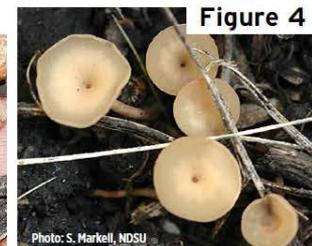


Photo: S. Markell, NDSU

Figure 4



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AUTHORS: Sam Markell and Dean Malvick

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Charcoal rot

Macrophomina phaseolina (fungus)

AUTHORS: Sam Markell and Dean Malvick

SYMPTOMS

- Symptoms usually not apparent until flowering or later
- Taproot and lower stem may appear gray/silver
- Numerous black fungal specks (microsclerotia) under epidermis give a "charcoal" appearance
- Premature death with wilted leaves attached
- Frequently occurs in patches in fields

FIGURE 1 - Large patches of soybean with charcoal rot

FIGURE 2 - Patch of wilting soybeans

FIGURE 3 - Infected (L and C) and healthy soybean (R)

FIGURE 4 - External gray lesion peeling away, revealing profuse "charcoal" sclerotia

FACTORS FAVORING DEVELOPMENT

- Hot temperatures
- Drought stress
- May be more severe when soybean cyst nematode is present

IMPORTANT FACTS

- Yield loss may occur in hot, dry growing seasons
- Disease typically most severe in drought-prone areas of fields
- Very wide host range, which includes corn, sunflower, other legume crops and weeds
- Commonly confused with anthracnose, Phytophthora stem rot, pod and stem blight, stem canker



Root Rots

Lots of pathogens

	Soil moisture	Soil temperature
Pythium	Flooded	Cool (50-60 F)
Phytophthora	Flooded	Warm (70s F)
Fusarium	Wet to dry	Cool to warm
Rhizoctonia	Damp to wet	Warm (70-80s)

Fusarium

Rhizoctonia



- True Fungi
- Fusarium
 - ‘Dry Rot’
 - General Browning
- Rhizoctonia
 - ‘Dry Rot’
 - Red Cankers

Photos Carl Bradley

Pythium



Photo: U of Wisc

Phytophthora



Photo: Berlin Nelson

- Not 'true' Fungi
- Black/wet lesions
- Need Wet Soil!

Zoospore Discharge in Phytophthora sojiae



Root Rot Management

- Rotation

Root Rot Management

Rotation

- *Pythium* and *Fusarium* are 'broad'
- *Rhizoctonia* is semi-specific to crop
- *Phytophthora* is specific to crop

Consider similarity of crops

Root Rot Management

- Rotation
- Resistance genes to *Phytophthora*

Root Rot Management

- Rotation
- Resistance genes to *Phytophthora*
- Field tolerance / resistance

Root Rot Management

- Rotation
- Resistance genes to *Phytophthora*
- Field tolerance / resistance
- Seed Treatments
 - Broad Spectrum
 - Effective for several weeks
 - Help germination and stand establishment

https://cropprotectionnetwork.org

The screenshot shows the website's navigation menu with 'RESOURCES' selected. The main content area is titled 'Resources and Tools' and contains a paragraph about the network's resources. Below this are two columns of article categories: 'Diseases' (with a star icon) and 'Insects [coming soon]' (with a bug icon). At the bottom, there are three more categories: 'Publications' (with a document icon), 'Features' (with a star icon), and 'Webinars' (with a monitor icon). A yellow arrow points to the 'Features' category.

The screenshot shows a dropdown menu for the 'RESOURCES' navigation item. The menu lists the following categories: Diseases, Insects, Weeds, Publications, Features, Webinars, Estimated Disease Losses, Foliar Disease Severity Training, and CCA CEU Quizzes. Below these is a section for 'Popular Downloads' with links to 'Crop Protection Network: 2017 Impact', 'Charcoal Rot', 'Southern Rust', and 'Grain and Silage Sampling and Mycotoxin Testing'. A yellow arrow points to the 'Publications' category in the dropdown menu.

to be harvested across the U.S. and Canada. Ear rots are some of the most important diseases to look for because they decrease yield and grain quality and several produce mycotoxins. [Read More](#)

Erget: Six things to be mindful of with erget in small grains and grasses

Charcoal Rot

CPN-1004 | doi.org/10.31274/cpn-20190620-010 | [PDF](#) | [CCA CEU Quiz](#)

Considerations for Selecting Soybean Varieties

CPN-4004 | doi.org/10.31274/cpn-20190620-011 | [PDF](#) | [CCA CEU Quiz](#)

Factors to Consider Before Using a Soybean Seed Treatment

CPN-4003 | doi.org/10.31274/cpn-20190620-012 | [PDF](#) | [CCA CEU Quiz](#)

Frogeye Leaf Spot

CPN-1017 | doi.org/10.31274/cpn-20190620-013 | [PDF](#) | [CCA CEU Quiz](#)

Fungicide Efficacy for Control of Soybean Foliar Diseases

CPN-1019 | doi.org/10.31274/cpn-20190620-014 | [PDF](#)

Fungicide Efficacy for Control of Soybean Seedling Diseases

CPN-1020 | doi.org/10.31274/cpn-20190620-015 | [PDF](#)

Pod and Stem Blight and Phomopsis Seed Decay

CPN-1007 | doi.org/10.31274/cpn-20190620-016 | [PDF](#) | [CCA CEU Quiz](#)

Scouting for Phytophthora Root and Stem Rot

CPN-1014 | doi.org/10.31274/cpn-20190620-017 | [PDF](#)

Scouting for Soybean Seed Diseases

CPN-1001 | doi.org/10.31274/cpn-20190620-018 | [PDF](#)

Scouting for Soybean Seedling Diseases

CPN-1009 | doi.org/10.31274/cpn-20190620-019 | [PDF](#)

Scouting for Soybean Stem Diseases

CPN-1002 | doi.org/10.31274/cpn-20190620-020 | [PDF](#)

Disease Loss Estimates



Disease Loss Estimates – 2012

CPN-2007-12 | doi.org/10.31274/cpn-20190620-035 | [PDF](#)

Disease Loss Estimates – 2013

CPN-2007-13 | doi.org/10.31274/cpn-20190620-036 | [PDF](#)

Disease Loss Estimates – 2014

CPN-2007-14 | doi.org/10.31274/cpn-20190620-037 | [PDF](#)



SOYBEAN DISEASE MANAGEMENT

CPN-1020-W



Fungicide Efficacy for Control of Soybean Seedling Diseases

The members of the **North Central Regional Committee on Soybean Diseases (NCERA-137)**, with the support of the United Soybean Board, have developed the following ratings for how well fungicide seed treatments control

fungicide-treated seed. This information is provided only as a guide. It is the applicator's and user's legal responsibility to read and follow all current label directions. Reference in this publication to any specific

Fungicide Efficacy for Control of Soybean Seedling Diseases

Fungicide Active Ingredient	<i>Pythium</i> sp. ¹	<i>Phytophthora</i>	<i>Rhizoctonia</i> sp.	<i>Fusarium</i> sp. ^{1,3}	Sudden death syndrome (SDS) (<i>Fusarium virguliforme</i>)	<i>Phomopsis</i> sp.
azoxystrobin	P-G	NS	VG	F-G	NR	P
carboxin	U	U	G	U	NR	U
ethaboxam	E	E	NR	NR	NR	NR
fludioxonil	NR	NR	G	F-VG	NR	G
fluopyram	NR	NR	NR	NR	VG	NR
fluxapyroxad	U	U	E	G	NR	G
ipconazole	P	NR	F-G	F-E	NR	G
mefenoxam	E ²	E	NR	NR	NR	NR

Treatment Type Legend

F	Fungicide
I	Insecticide
N	Nematicide
P	Plant Growth Regulator

Active Ingredient (s)	Product Trade Name	Crop
F azoxystrobin	Dynasty®	Corn, Soybean, Small Grains
F <i>Bacillus pumilus</i>	Sonata®	Corn, Soybean, Small Grains, Alfalfa
F <i>Bacillus subtilis</i>	HiStick® N/T	Soybean, Alfalfa
	Integral®	Soybean
F captan	Captan 4L ST	Corn, Soybean, Small Grains, Alfalfa
F copper hydroxide	Champ® Formula 2	Small Grains
F copper hydroxide + mancozeb	ManKocide®	Small Grains

F	F	I	metalaxyl, metconazole, clothianidin	NipsIt™ Suite Cereals	Small Grains	
F	F	I	mefenoxam, difenoconazole, thiamethoxam	Cruiser Maxx® Cereals	Small Grains	
F	F	F	F	azoxystrobin, fludioxonil, mefenoxam, thiabendazole	Maxim® Quattro	Corn
F	F	F	I	azoxystrobin, fludioxonil, mefenoxam, thiamethoxam	Seed Shield®	Soybean
F	F	F	I	mefenoxam, fludioxonil, sedaxane, thiamethoxam	CruiserMaxx® Vibrance	Soybean
				Warden® CX	Soybean	
F	F	F	I	mefenoxam, fludioxonil, sedaxane, thiamethoxam, <i>Pasteuria nishizawae</i> -Pn1	Clariva Elite Beans	Soybean

White Mold



White mold

- Fungal pathogen
 - *Sclerotinia sclerotiorum*
- Yield loss *possible*
- Manage with an Integrated Strategy
- Sunflower
- Dry Edible Beans
- Canola
- Soybean
- Pulse Crops
- Broadleaf weeds



White Mold

- Wet Soil
 - 1-2 inches of rain before bloom (minimum)
- Bloom
 - Infection begins with flower petals
- Cool
 - 60°'s and 70°'s
 - Over 85° F is unfavorable
- Wet
 - Humid canopy



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Managing White Mold

- Cultural Practices
 - Tillage.....?
 - Row spacing.....?
- Rotation
 - Cereals and corn are best rotation crops
 - Broadleaf crops susceptible
- Resistance
 - ‘Partial’ Resistance

Managing white mold... Cont..

- Fungicides –
 - Favorable for disease?
 - Economic return.....?
 - Product selection?
 - Timing (R1-R2)

Browser address bar: <https://www.ag.ndsu.edu/CarringtonREC/plant-pathology-1>

Navigation tabs: NDSU: Business Forms, Per Diem Rates, Faculty Senate (NDSU), PeopleSoft (NDSU), 7-Day Forecast for Lat..., NIFA - Peer Review Sy..., Microsoft Word - PHP...

Breadcrumbs: NDSU > Carrington Research Extension Center > Plant Pathology

Plant Pathology

The plant pathology program at the NDSU Carrington Research Extension Center conducts agronomy-focused crop disease management research, with a primary emphasis on improving the management of white mold (Sclerotinia stem rot) of soybeans and dry edible beans, Sclerotinia head rot of sunflowers, and root and foliar diseases of chickpeas, lentils, and field peas. The program also conducts work with diseases of safflower, flax, canola, faba beans, and root diseases of wheat.

PDFs of recent outreach talks

Improving the management of Sclerotinia head rot of sunflowers; slides accompanying on online meeting organized by SDSU, March 17, 2020:

- Part 1 – [Susceptibility to head rot relative to sunflower growth stage](#)
- Part 2 – [Prospects for managing head rot in sunflowers with partially resistant hybrids](#)
- Part 3 – [Prospects for managing head rot in sunflowers with fungicides](#)

Improving the management of white mold in soybeans: presentations given in Mankato, MN and Brookings, SD; Feb. 25-26, 2020:

- Part 1 – [Optimizing fungicide application timing](#)
- Part 2 – [Optimizing fungicide application frequency relative to soybean maturity](#)
- Part 3 – [Optimizing fungicide spray droplet size](#)
- Part 4 – [Fungicide efficacy and prospects for using drop nozzles](#)

Improving the management of white mold in dry edible beans – presentations given in Grand Forks, ND; Feb. 19, 2020:

- Part 1 – [Optimizing fungicide application timing](#)
- Part 2 – [Optimizing fungicide spray droplet size](#)

Left sidebar menu:

- Advanced Search
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 - Annual Reports
 - Center Points
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 - Foundation Seedstocks
 - Livestock
 - Livestock Environmental Nutrient Management
 - Map
 - News
 - North Dakota Agriculture Weather Network (NDAWN)
 - Northern Hardy Fruit Evaluation Project
 - Oakes Irrigation Research Site
 - Plant Pathology
 - Staff
 - Various Links
 - Videos

Differences in susceptibility to white mold across soybean varieties

White mold severity index and soybean yield averaged across fungicide-treated and non-treated soybeans.

**Carrington, ND
2018**

Completely randomized split-plot design

Main factor = Variety

Sub-factor = Fungicide treatment

1. No foliar fungicide
2. Endura 5.5 oz applied once at late R1 to early R2
3. Endura 5.5 oz applied twice R1/R2 + 10-12 days

Fungicides applied with XR110015 flat-fan nozzles at 40 psi (fine droplets); spray volume = 15 gal/ac

Soybean maturity rating

0.06
0.05
0.05
0.08
0.09
0.4
0.1
0.3
0.2
0.08
0.08
0.7
0.8
0.09

Company	Variety
Pioneer	P006A37X
Pioneer	P005A27X
Dairyland	DSR-C506/R2Y
Pioneer	P008T22R2
Dairyland	DSR-C905/R2Y
Pioneer	P04A77X
Peterson Farms	16R01
Pioneer	P03T68R2
Dairyland	DSR-0225/R2Y
Peterson Farms	18X008N
Peterson Farms	16R008N
Dairyland	DSR-0711/R2Y
Pioneer	P08A72X
Dairyland	DSR-C918/R2Y

Varieties

White mold (%)

average across all fungicide treatments

Percent of canopy; R8 growth stage



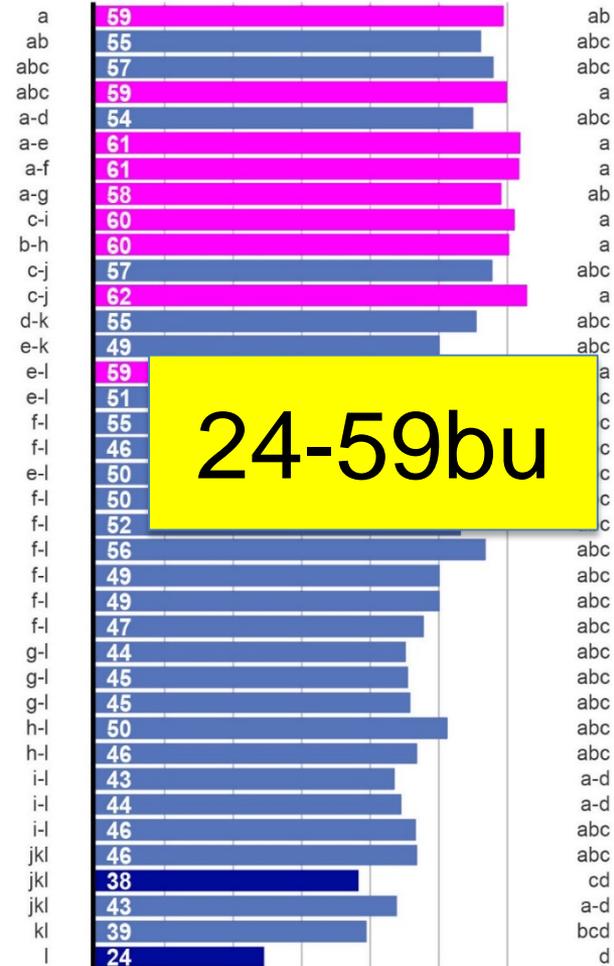
CV = 11.2

1-53%

Yield (bu/ac)

average across all fungicide treatments

13% moisture



CV = 9.8

24-59bu

Within-column means followed by different, non-overlapping ranges of letters are significantly different ($P < 0.05$; Tukey procedure)

SCLEROTINIA MANAGEMENT IN SOYBEANS

Fungicide efficacy

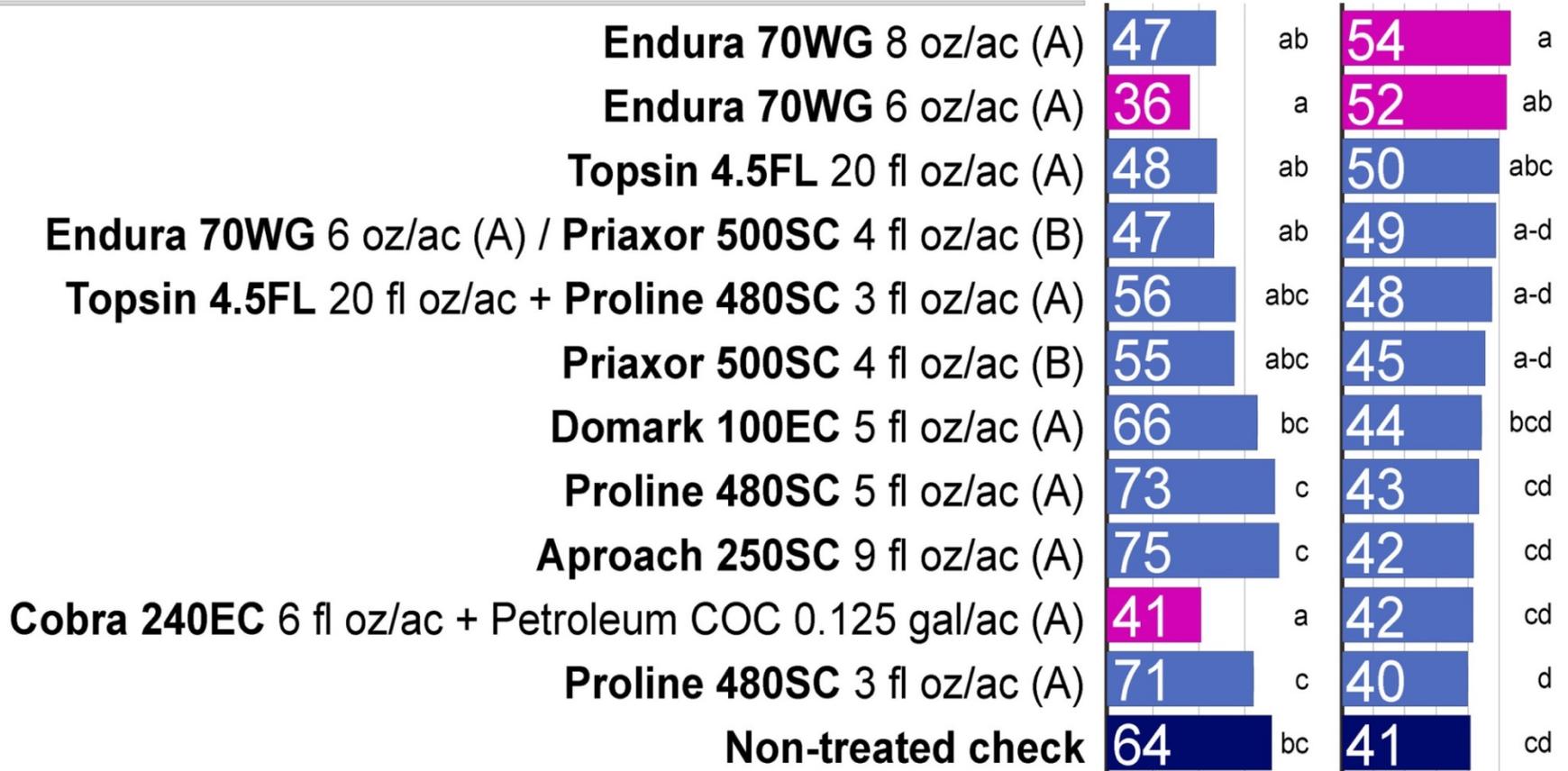
CARRINGTON, ND (2013)

Treatment (application timing)

All products except Cobra were applied with a non-ionic surfactant at 0.25% (v/v)

**Sclerotinia
Incidence**
percent

**Soybean
Yield**
bushels/acre



P>F: 0.0057
CV: 33.4

P>F: 0.0423
CV: 16.7

Variety: Dairyland 'DSR 0404 R2Y' | **Row spacing:** 14 inches

Application A: July 27; shortly before canopy closure at R2 growth stage

Application B: August 8; early R4 growth stage

Application methods: 15 gal water/A; 35 psi; 8001VS flat-fan nozzles

Courtesy: Dr. Michael Wunsch

When conditions favored white mold as soybeans entered bloom:

Applying fungicides at the mid/late R1 growth stage (60-85% R1)

optimized white mold management
when the canopy was closed at mid/late R1.
(100% of the ground covered by the canopy)

Applying fungicides at early R2 growth stage (80-99% R2)

optimized white mold management
when the canopy was at or near closure at early R2.
(97-100% of the ground covered by the canopy)

Applying fungicides at full R2 growth stage (100% R2)

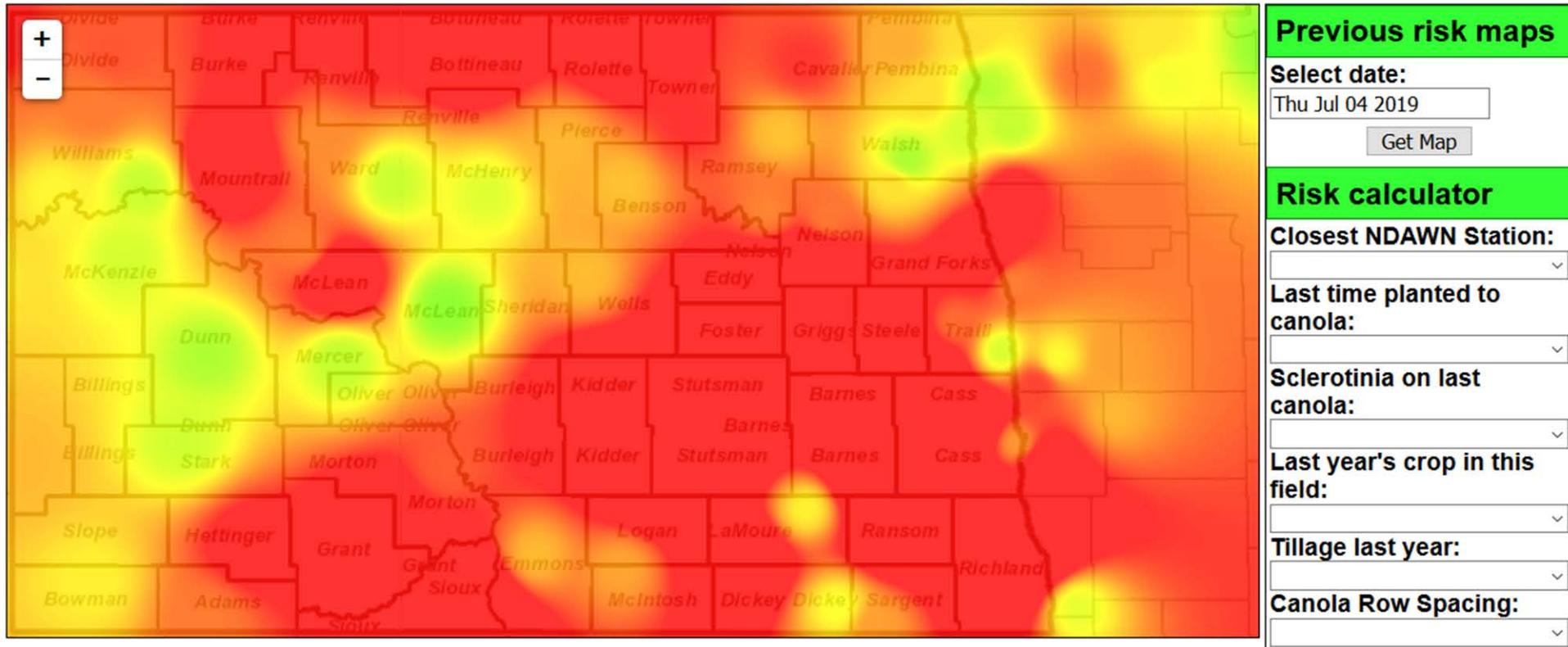
optimized white mold management
when the canopy was open at early R2.
(<95% of the ground covered by the canopy)

R1: at least one open blossom on the plant.

R2: at least one open blossom at one of the top two nodes of the plant.

<https://www.ag.ndsu.edu/sclerotinia/riskmap.html>

Estimated risk of Sclerotinia stem rot development for canola 07/04/2020



Soybean Cyst Nematode

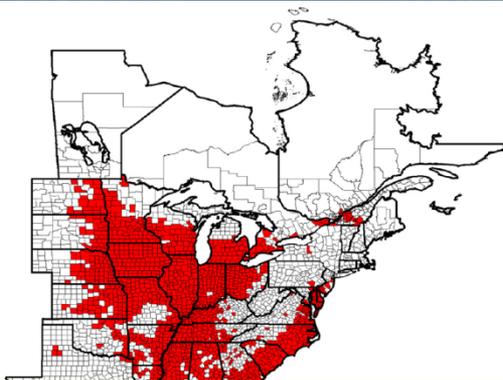
What's your number?

Take the test.  Beat the pest.

The **SCN** Coalition™

Funded by the soybean checkoff

The New SCN Coalition



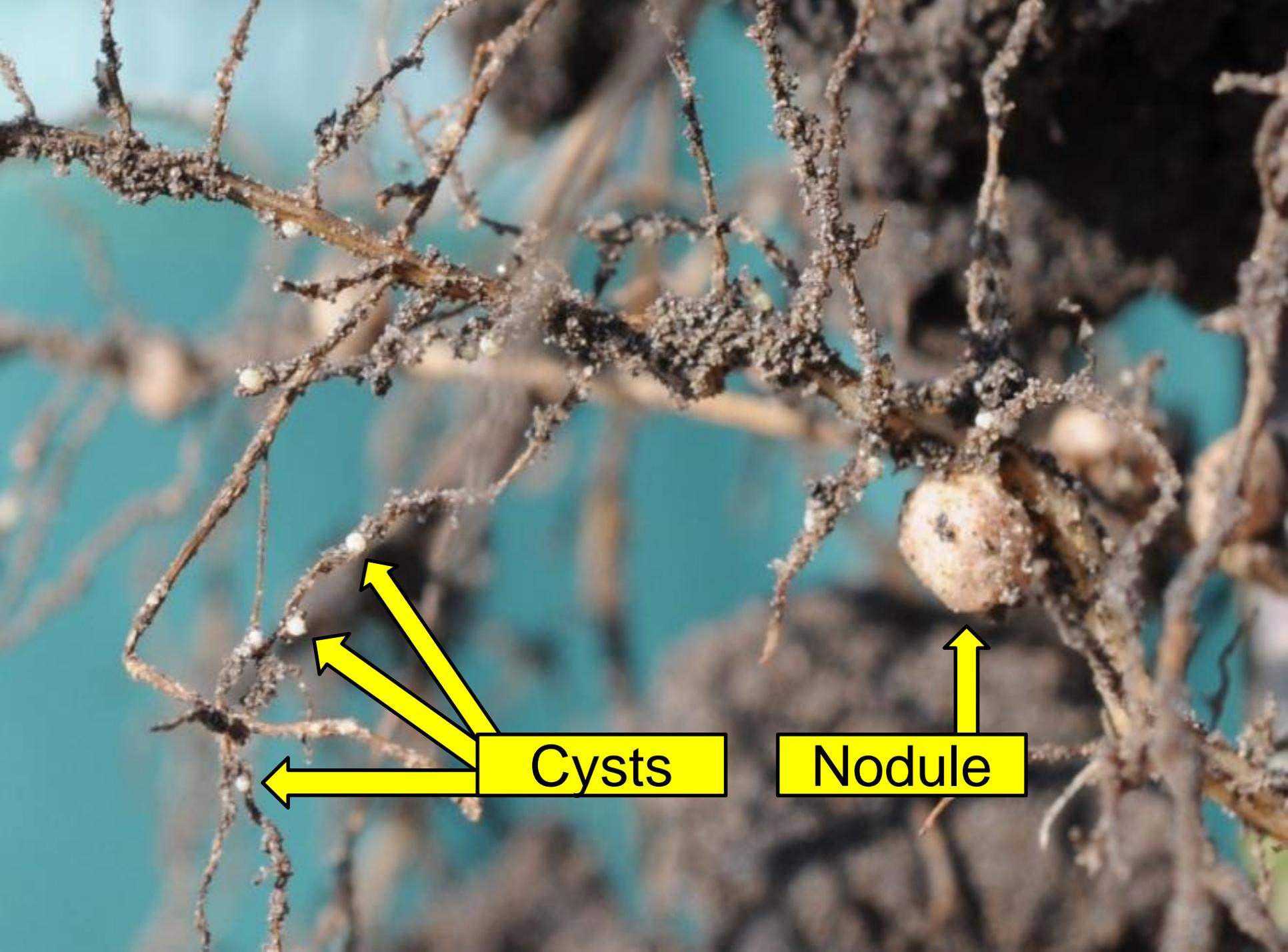
www.thescncoalition.com

Soybean Cyst Nematode (SCN)

- A future concern
- Yield reductions (15-30%) before above ground symptoms are present
- Once in soil... you will have it forever
- Spreading
- Few above ground symptoms
- Can manage SCN if you find it

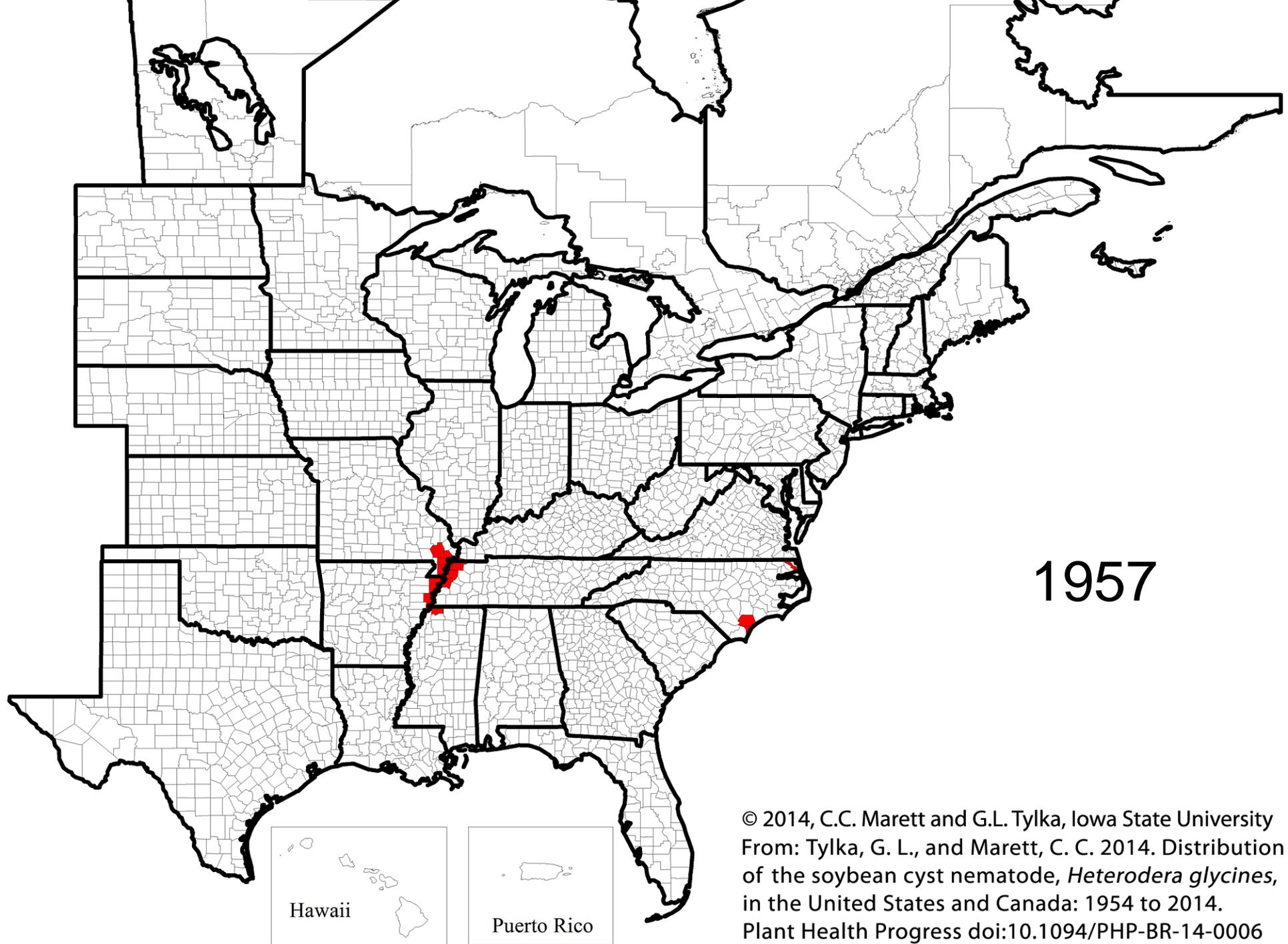


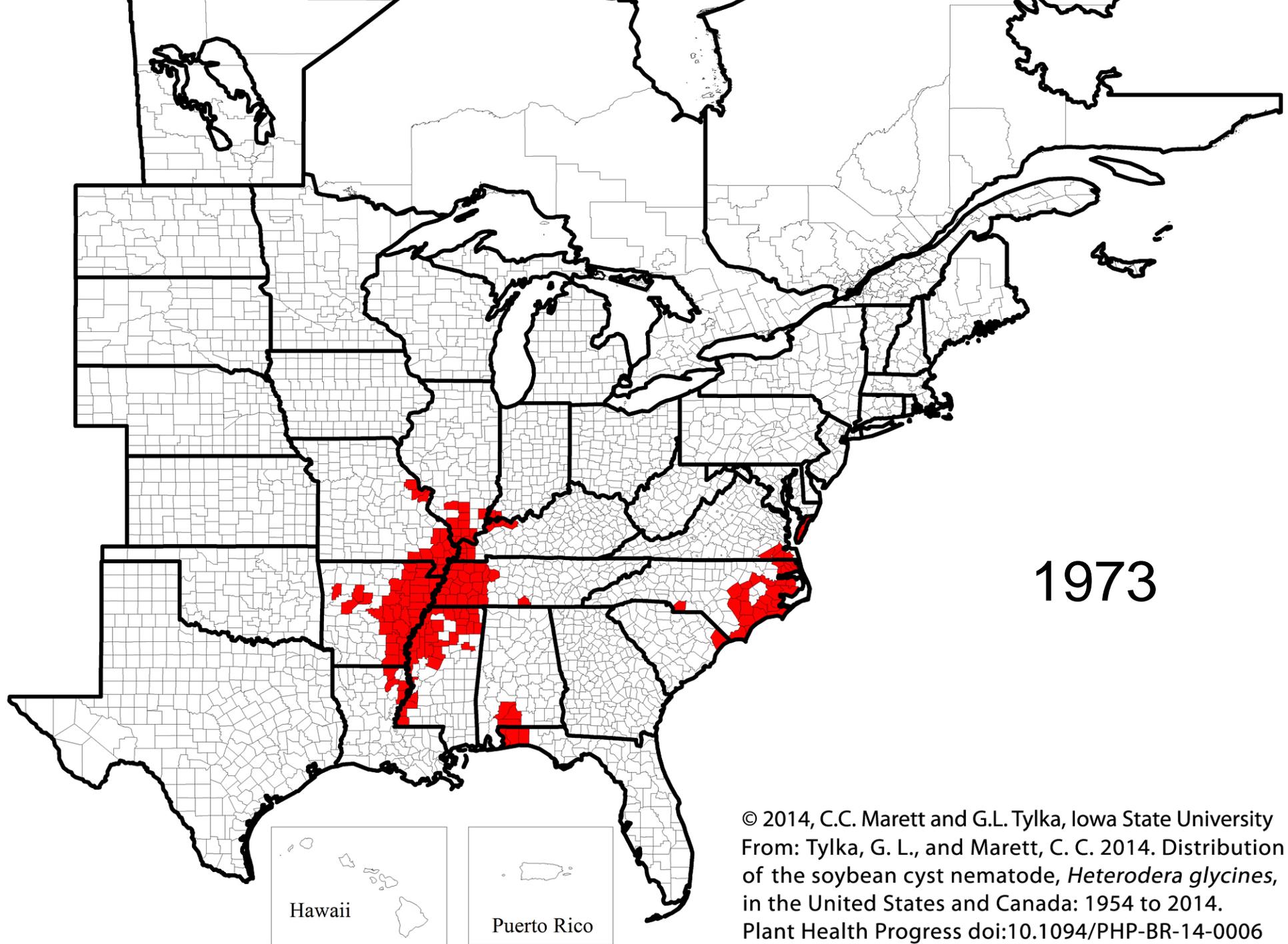
https://en.wikipedia.org/wiki/Soybean_cyst_nematode

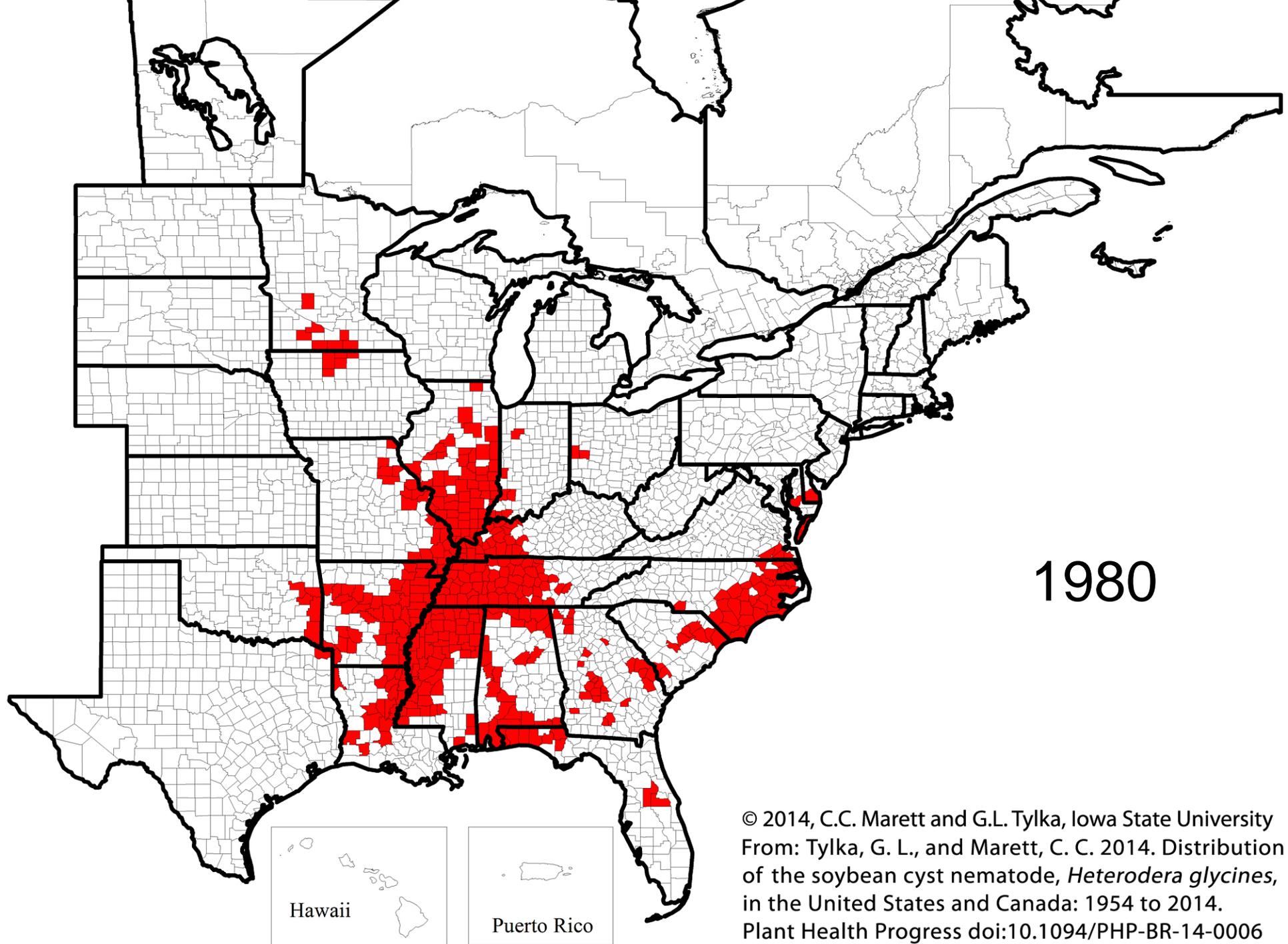


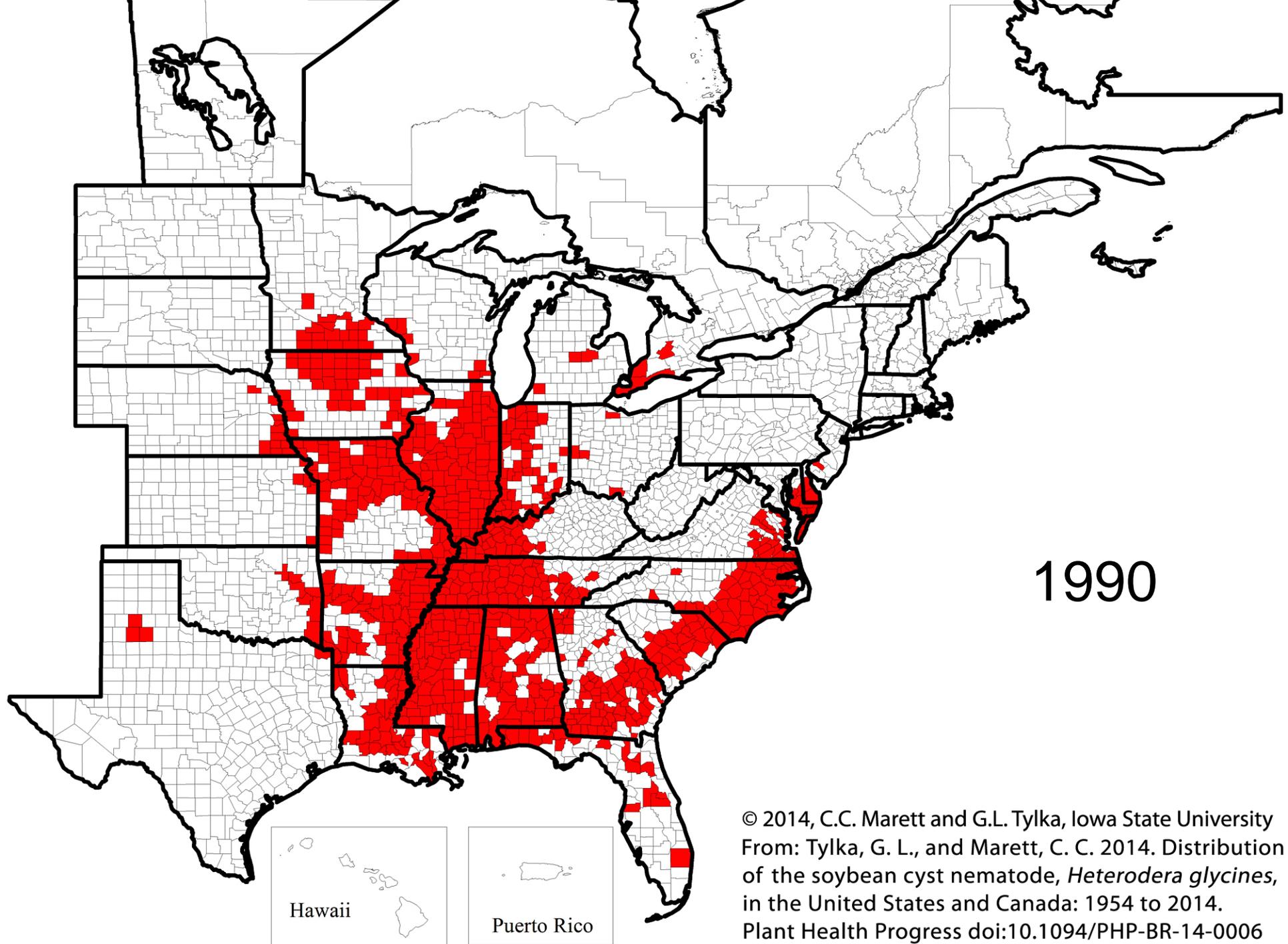
Cysts

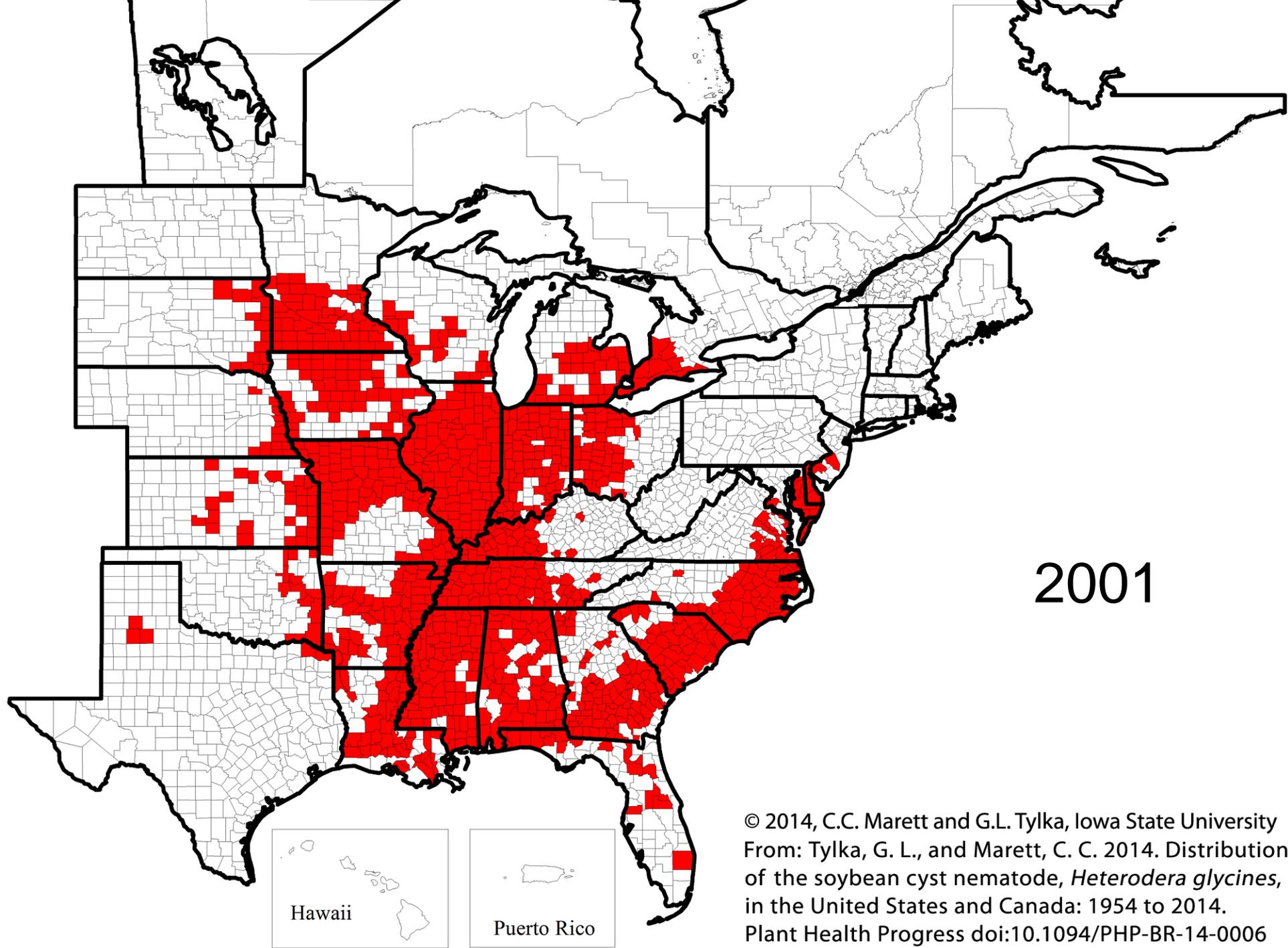
Nodule



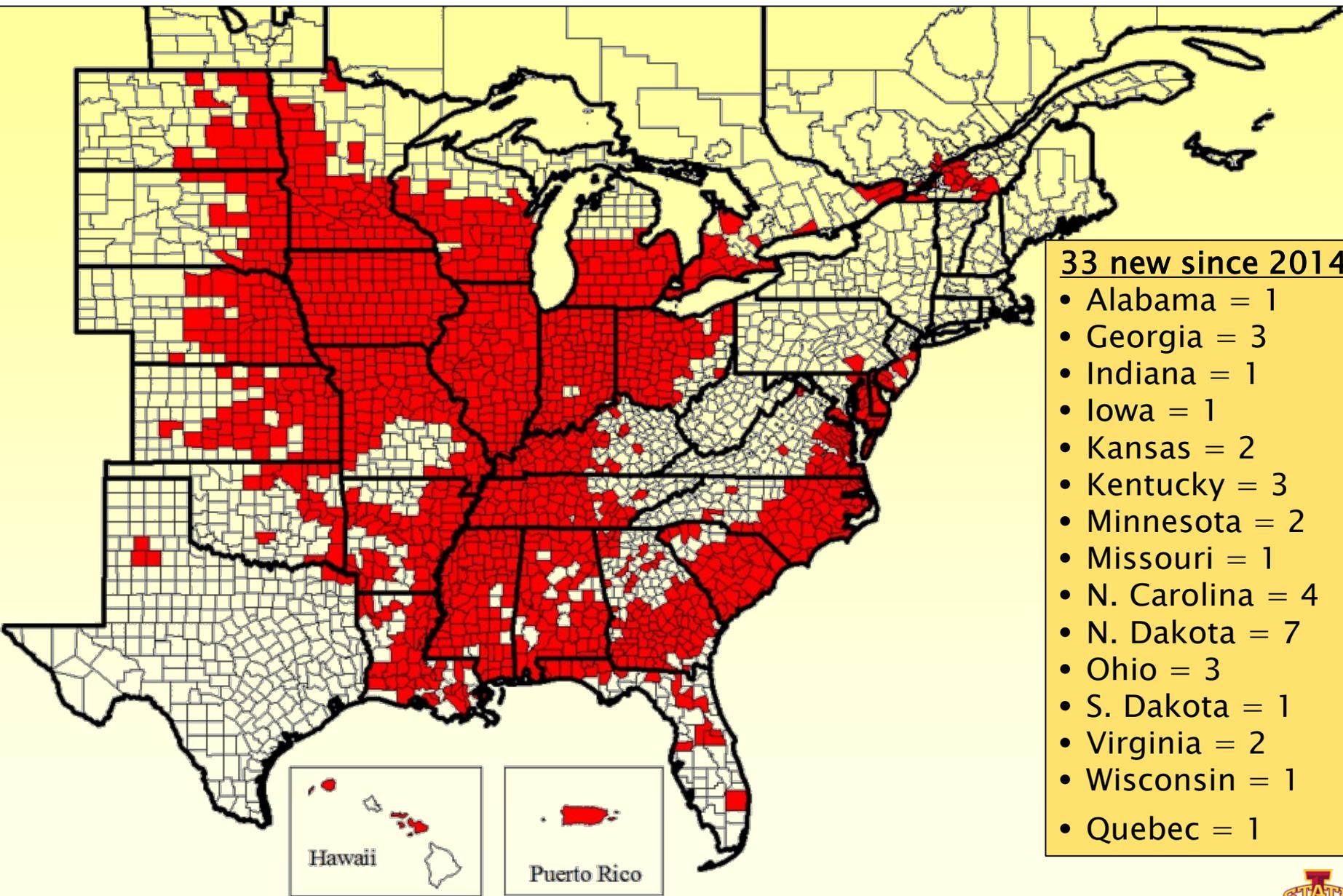








Known SCN-Infested Counties – Feb. 2017



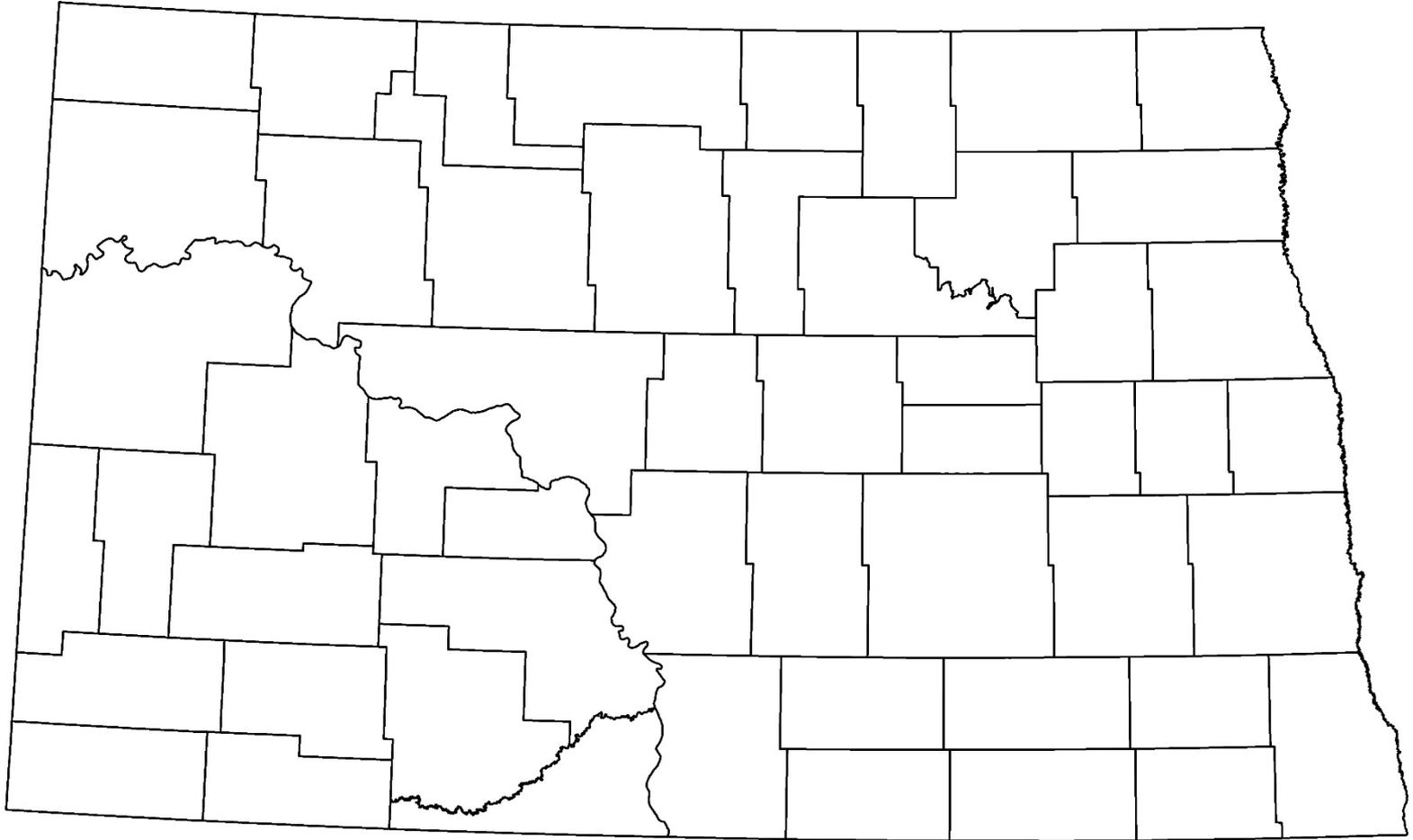
ND Sampling Program (2013-2020)

- Funding = North Dakota Soybean Council
- Pick up sample bags at County Extension Office (Mid-August or later)
- Soil Sample – Send in sample
- Data mailed to you
- Reported in eggs/100cc

N



SCN Survey 2013-2019

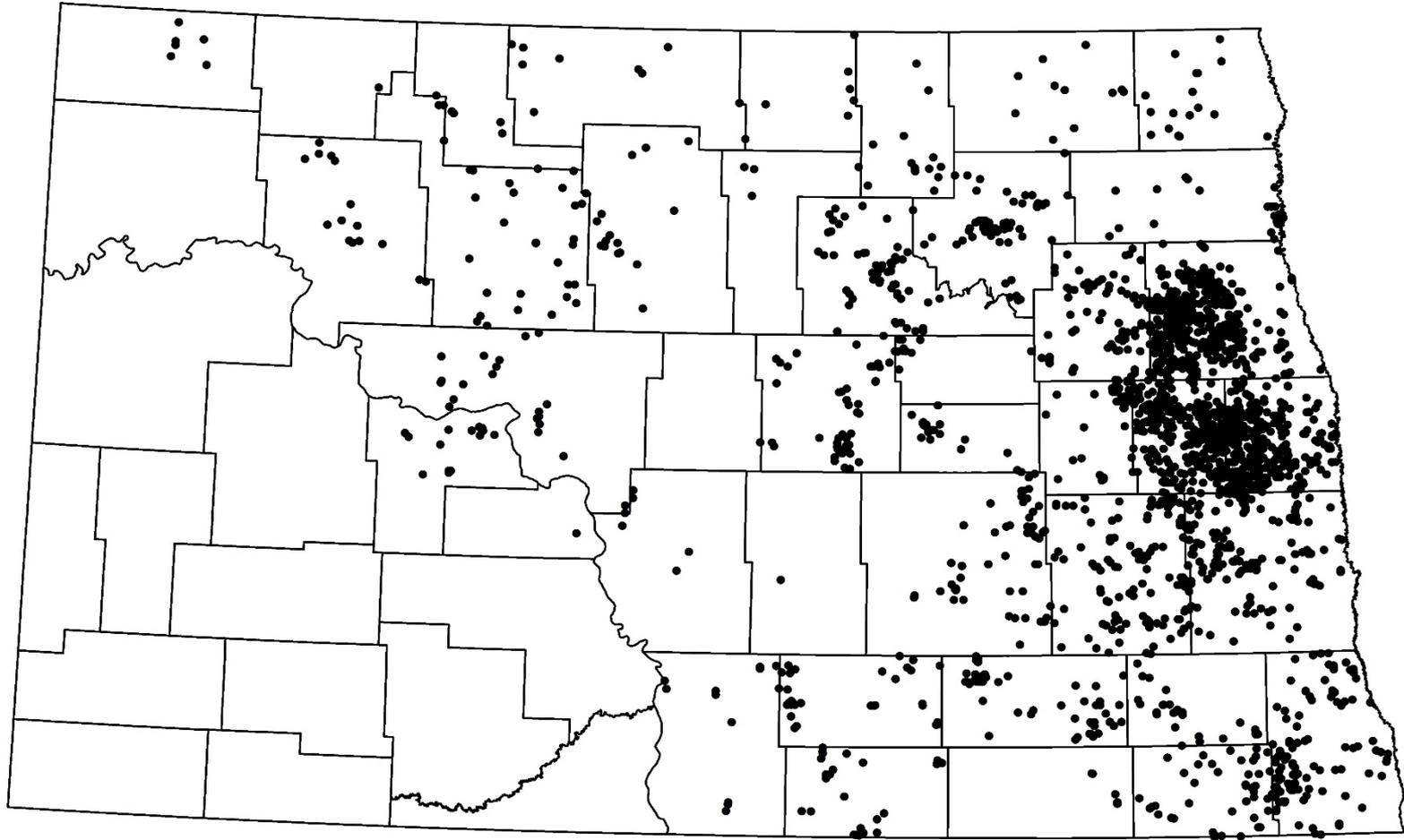


0 12.5 25 50 Miles





SCN Survey 2013-2019



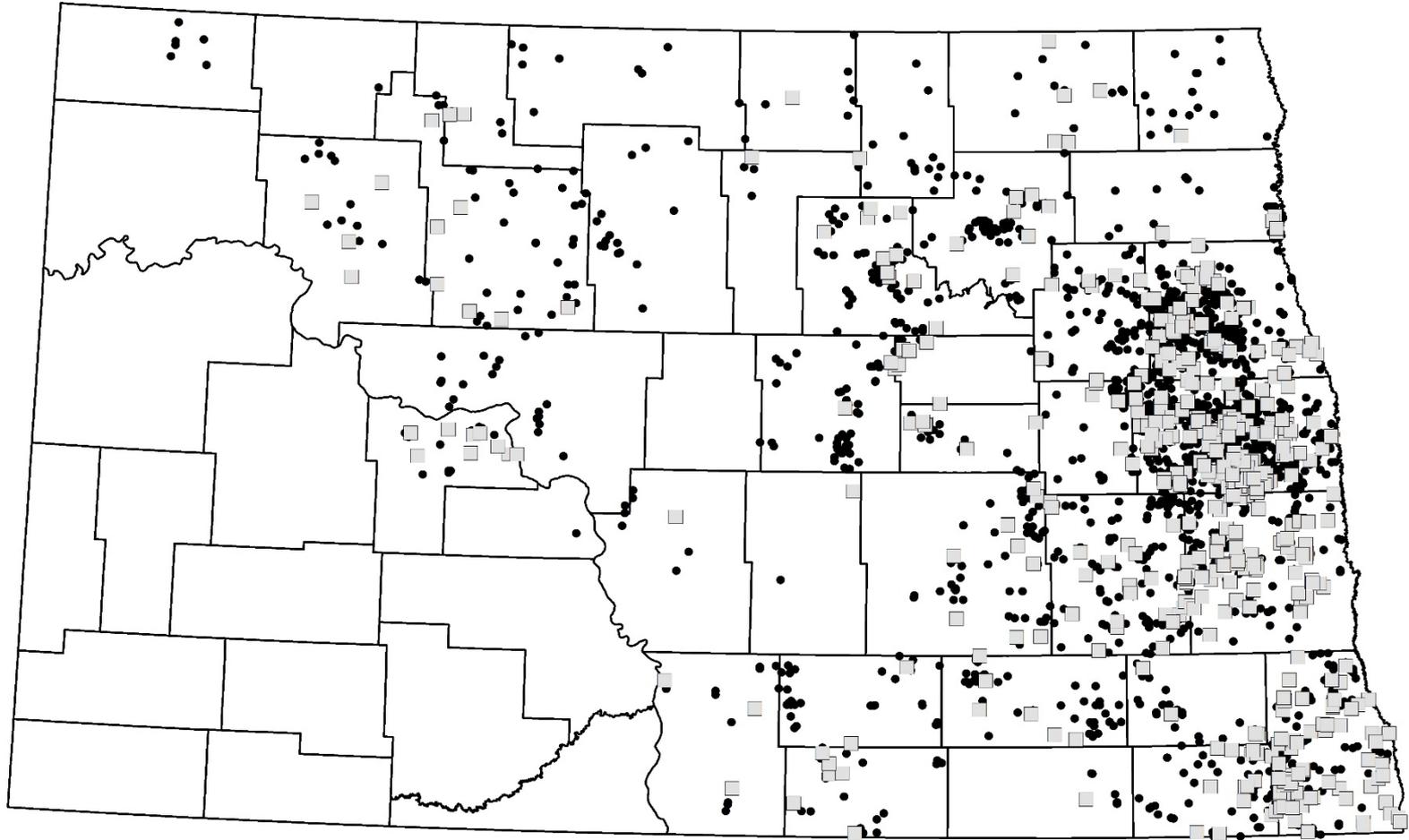
Eggs/100cc

• 0-49

0 12.5 25 50 Miles



SCN Survey 2013-2019



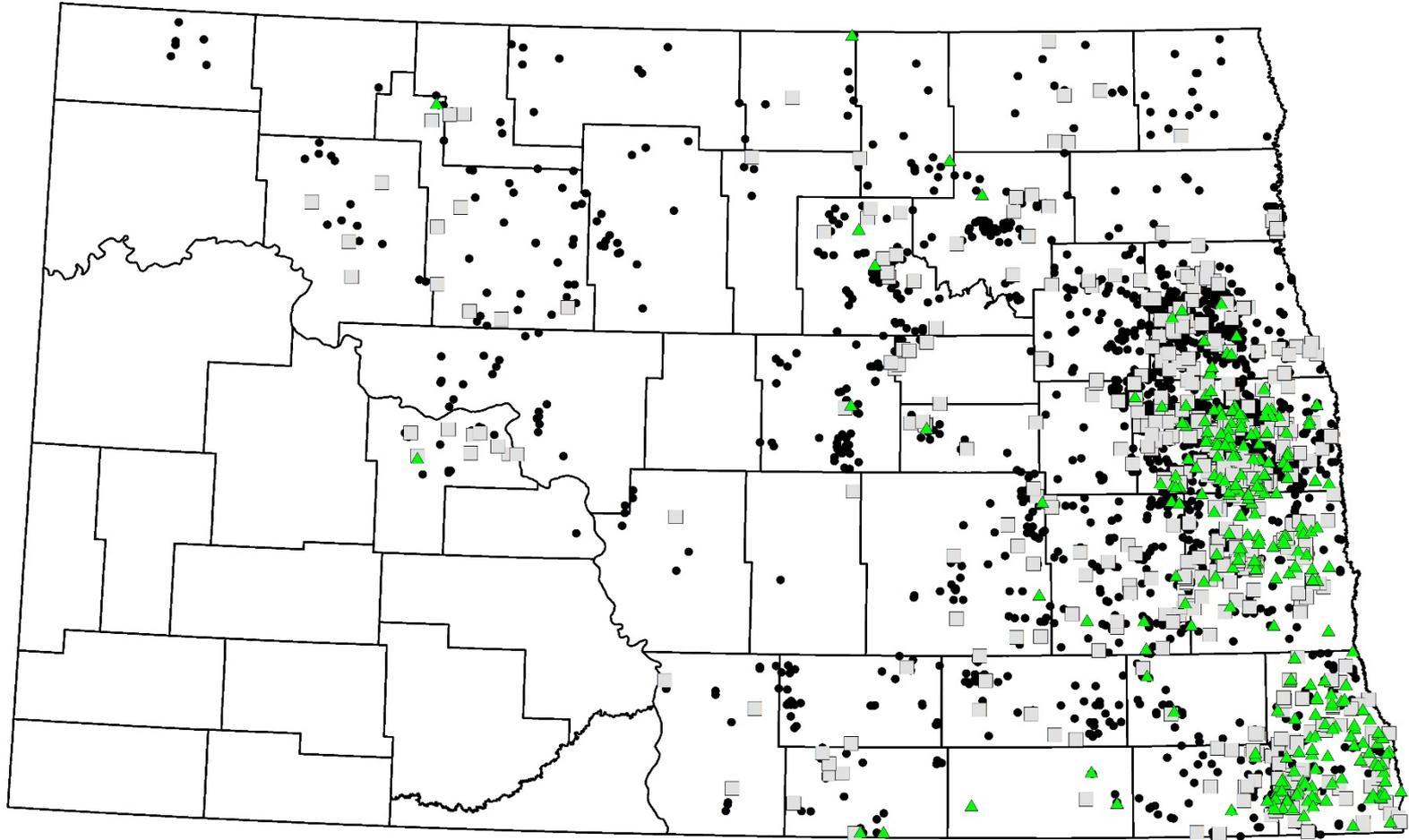
0 12.5 25 50 Miles

Eggs/100cc

• 0-49 ◻ 50-200



SCN Survey 2013-2019



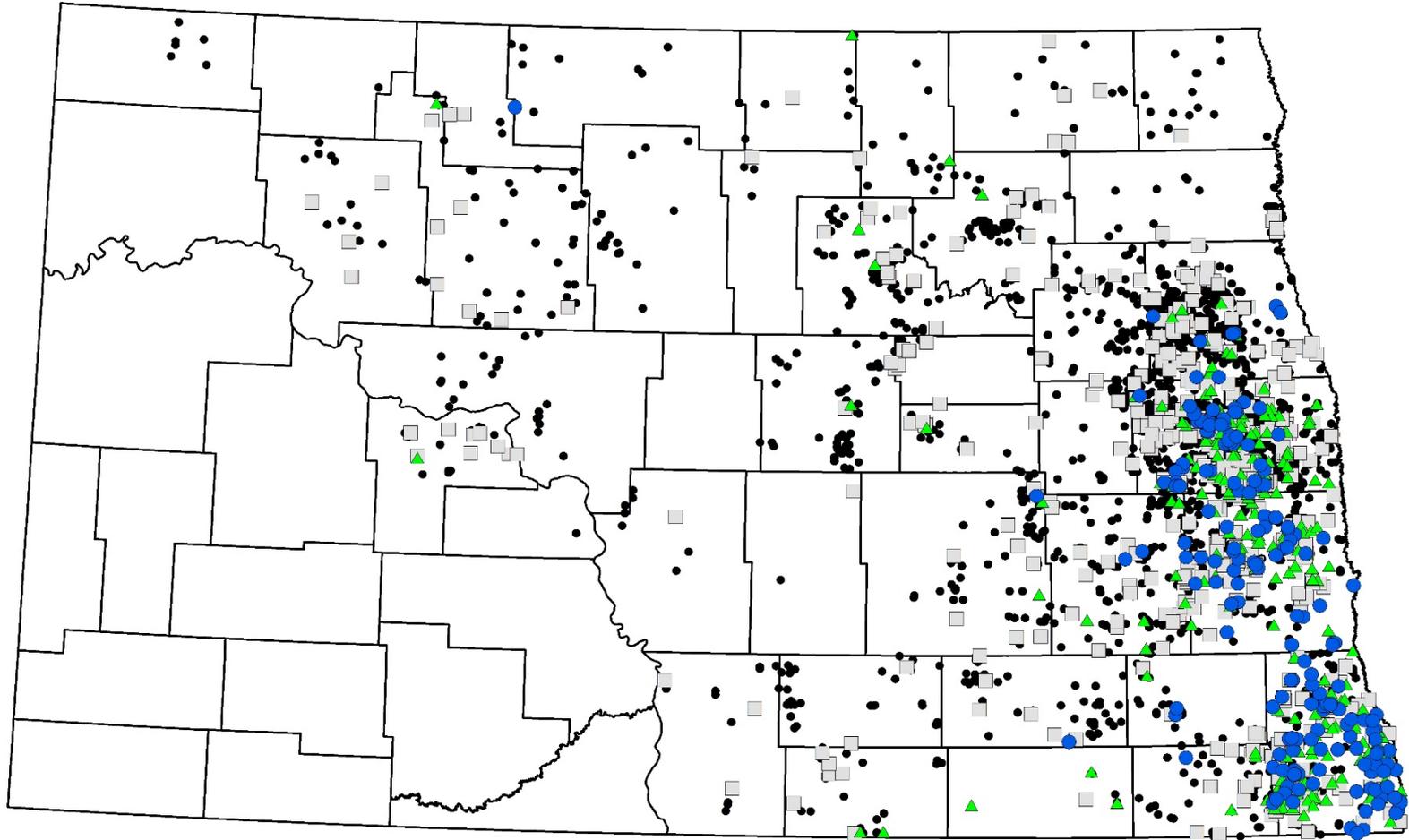
Eggs/100cc

0 12.5 25 50 Miles

• 0-49 ◻ 50-200 ▲ 201-2000



SCN Survey 2013-2019



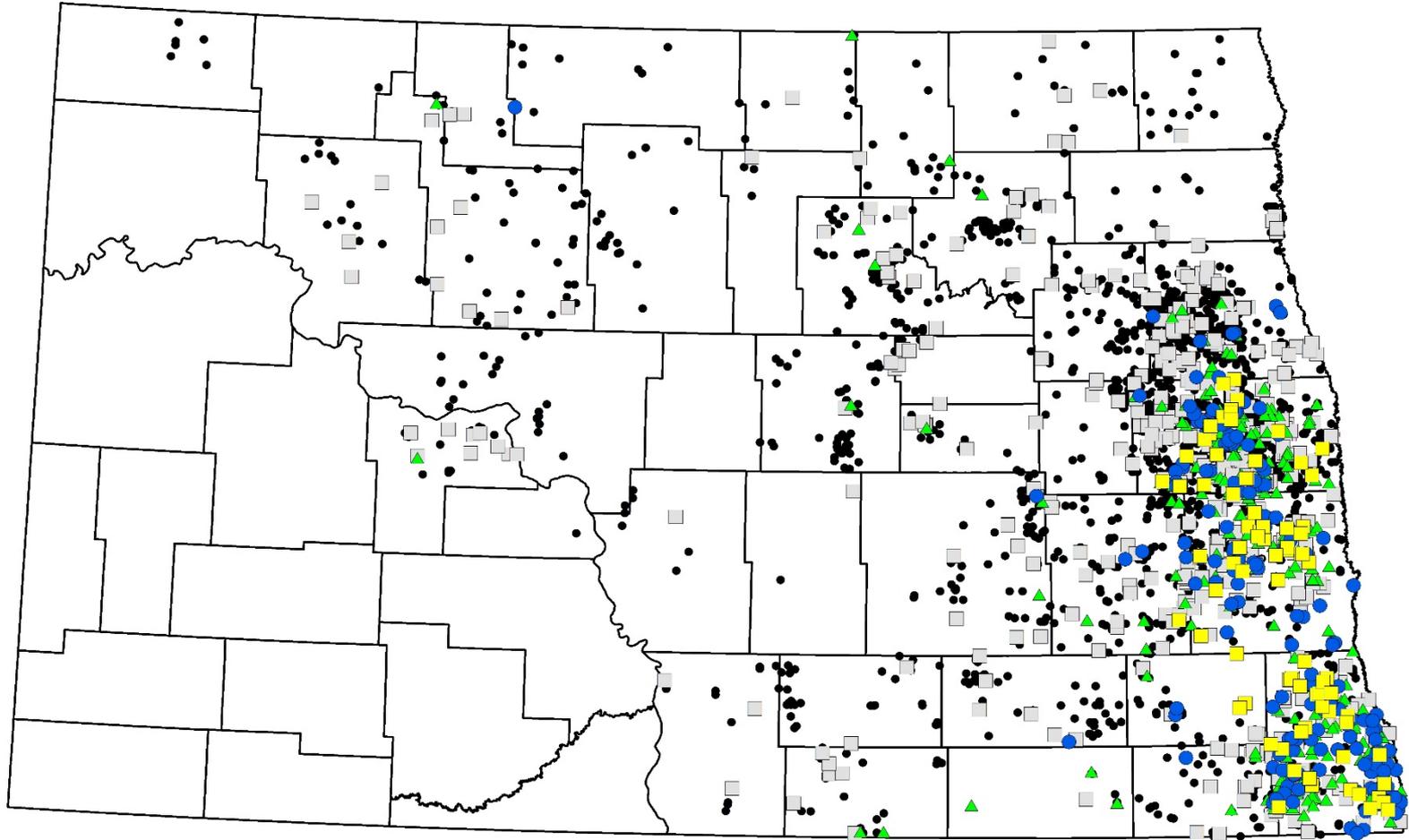
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0 12.5 25 50 Miles

• 0-49 ◻ 50-200 ▲ 201-2000 ● 2001-10000



SCN Survey 2013-2019



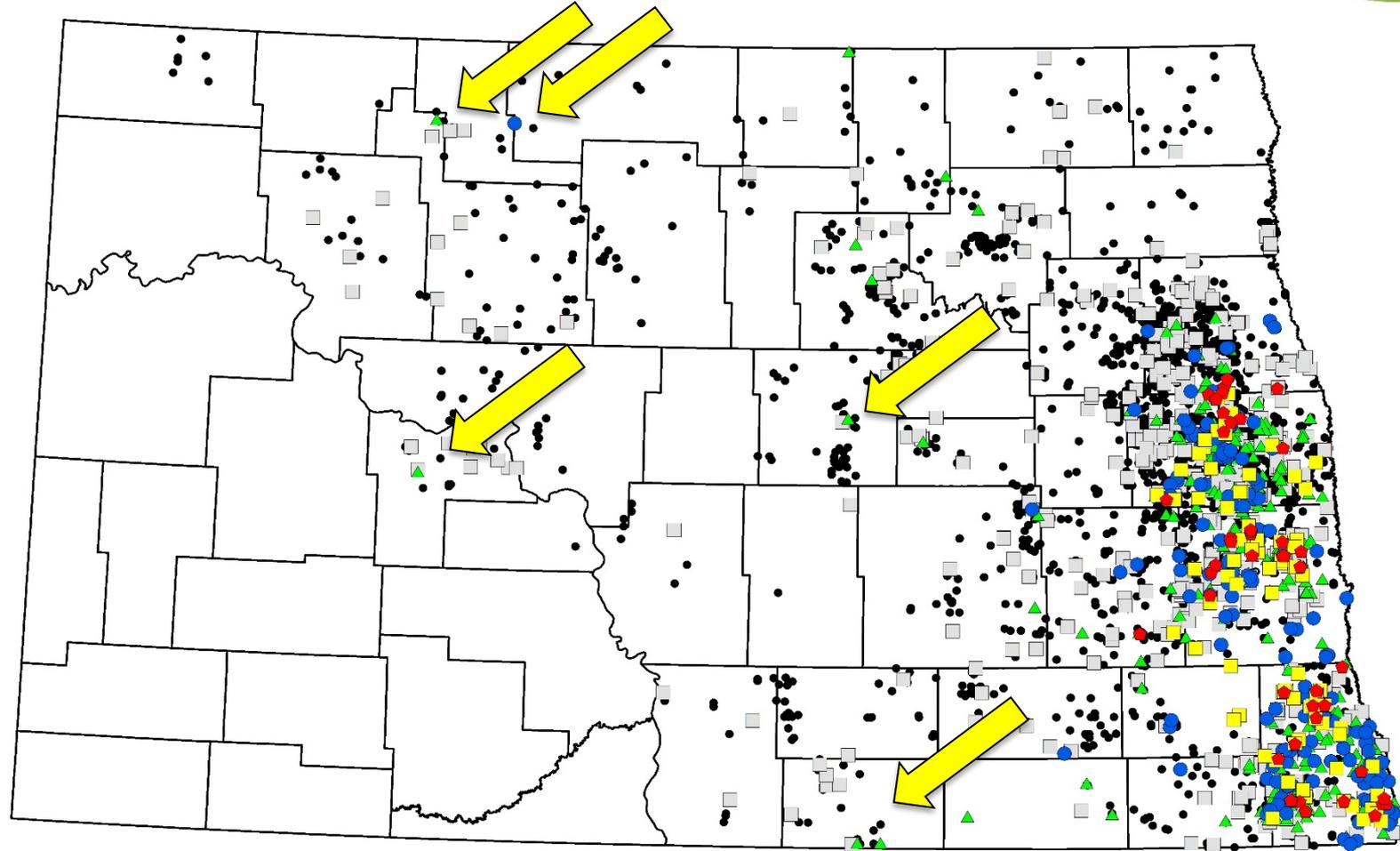
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0 12.5 25 50 Miles

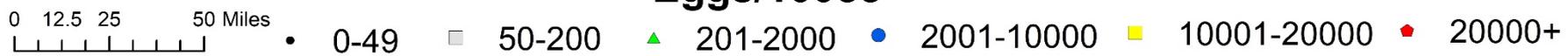
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- ◻ 50-200
- ▲ 201-2000
- 2001-10000
- 10001-20000



SCN Survey 2013-2019



Eggs/100cc



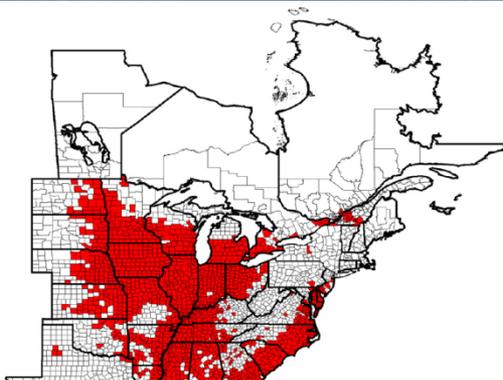
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www.thescncoalition.com

