Evaluation of Neonicotinoid Seed Treatments in the Environment

VERMONT
AGENCY OF AGRICULTURE, FOOD & MARKETS

Neonicotinoids

- **Modeled after Nicotine**
- **Low mammalian toxicity**
- **Systemic insecticides**
  - Neonicotinoid taken up by plant or crop
  - Insect feeds on plant
  - Causes insect paralysis which leads to death
- **Much concern over the impact of these pesticides on pollinators**

- **Agency research = evaluate potential impacts of seed treatments in the environment**
  - Pollen
  - Surface waters
  - Tile drains
  - Soil
  - Vegetation

Neonicotinoids in Vermont

- One way neonicotinoids enter the state is as seed treatments on corn and soybeans
- Neonicotinoids used as seed treatments
  - Corn = thiamethoxam and clothianidin
  - Soybean = imidacloprid
- Purpose = protect seeds and seedlings from insect pests; wireworms & grubs
- Pollen and nectar could contain neonicotinoids from treated crop

Estimated annual acreage of treated seed planted in Vermont (2018)

- 100,000 – 120,000 acres of corn
- 2,500 – 3,000 acres of soybeans

- Treatments may not be completely taken up by plant and may enter the environment; soil, water, & non-target plants

Environmental Benchmarks

- Aquatic invertebrate values = Most conservative (restrictive)
  - Used as comparison in water results
- Aquatic invertebrate values = Most closely related to terrestrial insects
- Note: Thiamethoxam degrades into Clothianidin

Environmental benchmarks in parts per billion (ppb)

Pesticide	Year Updated	Fish		Aquatic Invertebrates		Nonvascular Plants	Vascular Plants
		Acute	*Chronic*	*Acute*	*Chronic*	*Acute*	*Acute*
Imidacloprid	2017	114500	9000	0.385	0.01	> 10000	-
Thiamethoxam	2017	> 50000	20000	17.5	-	> 97000	> 90000
Clothianidin	2016	> 50750	9700	11.0	1.1	64000	121000

*All units ug/L or parts per billion (ppb); data extracted 1/2018 and 11/2018

Vermont Pollen Studies

Samples collected 2012 - 2013

- Honey Bee Pollen - 2 Hives
  - Hay fields (Hive 1)
  - Conventional corn fields* (Hive 2)

Results:

- 2012-2013 Hive 1
  - No neonicotinoids
- 2012-Hive 2
  - Imidacloprid (0.70 ppb), week of 11-Jun 2012.
- 2013-Hive 2
  - 3 detections; thiamethoxam and clothianidin (0.80-6.20 ppb)
  - During planting

Vermont Surface Water

❖ **2014 – 2018: 252 surface waters tested**

- Areas of high agricultural use
- 3 positive for imidacloprid
  - All below acute benchmark
- More detections thiamethoxam and clothianidin
  - Usually at time of planting

A surface water sampling site.

Summary of neonicotinoid results from the surface water samples.

Neonicotinoid	Positive detection	Detection range	Acute benchmark*	Chronic benchmark*	Results ≥ Acute benchmark*
	#	ppb	ppb	ppb	#
Thiamethoxam	26	0.05 - 1.73	17.50	-	0
Clothianidin	25	0.05 - 1.37	11.00	1.10	0
Imidacloprid	3	0.05 - 0.20	0.385	0.01	0

*aquatic invertebrates

NO ACUTE

Vermont Tile Drain Water

Tile drain sampling location.

Tile drain = water from edge of field

- **2015-2018: 78 samples**
  - Imidacloprid = 4 samples ≥ acute benchmark
    -Soybean fields
  - Highest levels = during planting

Summary of neonicotinoid results from the tile drain water samples.

Neonicotinoid	Positive detection	Detection range	Acute benchmark*	Chronic benchmark*	Results ≥ Acute benchmark*
	#	ppb	ppb	ppb	#
Thiamethoxam	29	0.05 - 1.31	17.50	-	0
Clothianidin	61	0.05 - 4.17	11.00	1.10	0
Imidacloprid	12	0.09 - 1.12	0.385	0.01	4

NO ACUTE

*aquatic invertebrates

Vermont Soil

2016 Sampling

- High agricultural use; corn, soy/corn, soy/soy, & alfalfa/grass
- Three dates; June, September, & December
- Three depths; 0-12, 12-24, & 24-36 inches
- Next to tile drains.

Results

- Corn fields = several positive detections of thiamethoxam & clothianidin (2.08 -14.13 ppb)
  - Most during planting (June)
  - 0 – 12 inches
- Soy field = positive detection of imidacloprid (6.43 ppb)
  - 0 - 12 inches

Vermont Vegetation

Question: Are neonicotinoids being taken up by non-crop plants?

A vegetation sample taken from water sampling areas

❖ **Sampling:**

- September 2015 & 2016
- Vegetation collected from surface and tile drain water sampling areas in Franklin county
- Goldenrod = forage source for pollinators-later season
- Positive control = corn leaves from treated seed
- Corn leaves **only** positive detection
  - Clothianidin (2.91 ppb)

New York Subsurface and Surface Water, (2017-2018)

- Collaboration with Miner Institute, Chazy, NY
- Samples from edge-of-field research project
  - Comparing subsurface tile and surface water
  - Fields - continuous corn
  - Seed treated with neonicotinoids

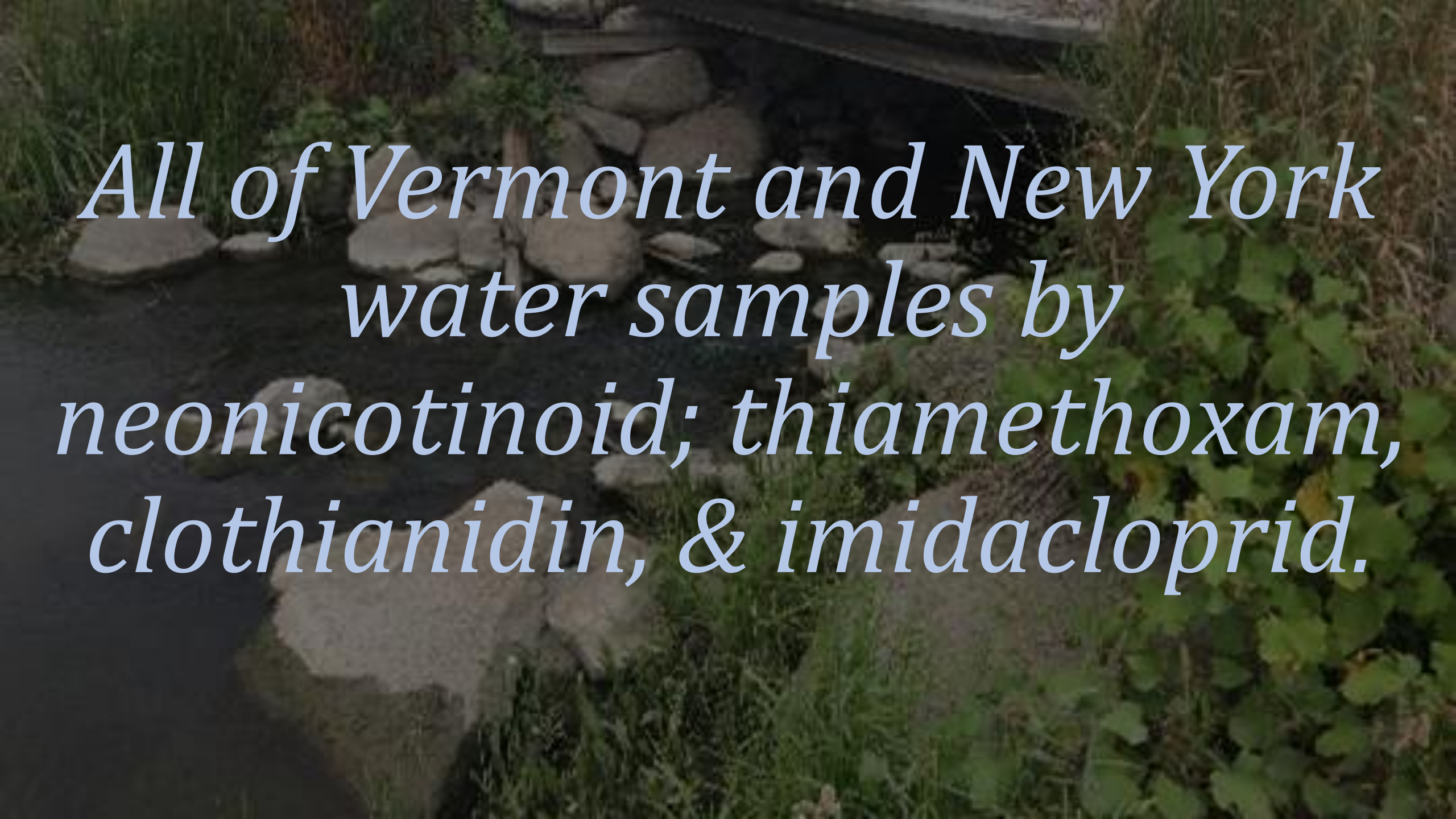
Results

- 128 samples analyzed
- 27 positive detections total
  - Thiamethoxam (0.06-6.48)
  - Clothianidin (0.08-0.40)
  - No imidacloprid
- Highest detections;
  - Surface water
  - All below acute benchmark
  - During and right after planting

Summary results from the subsurface and surface water samples analyzed for neonicotinoids, Chazy, NY, 2017-2018. (n=128)

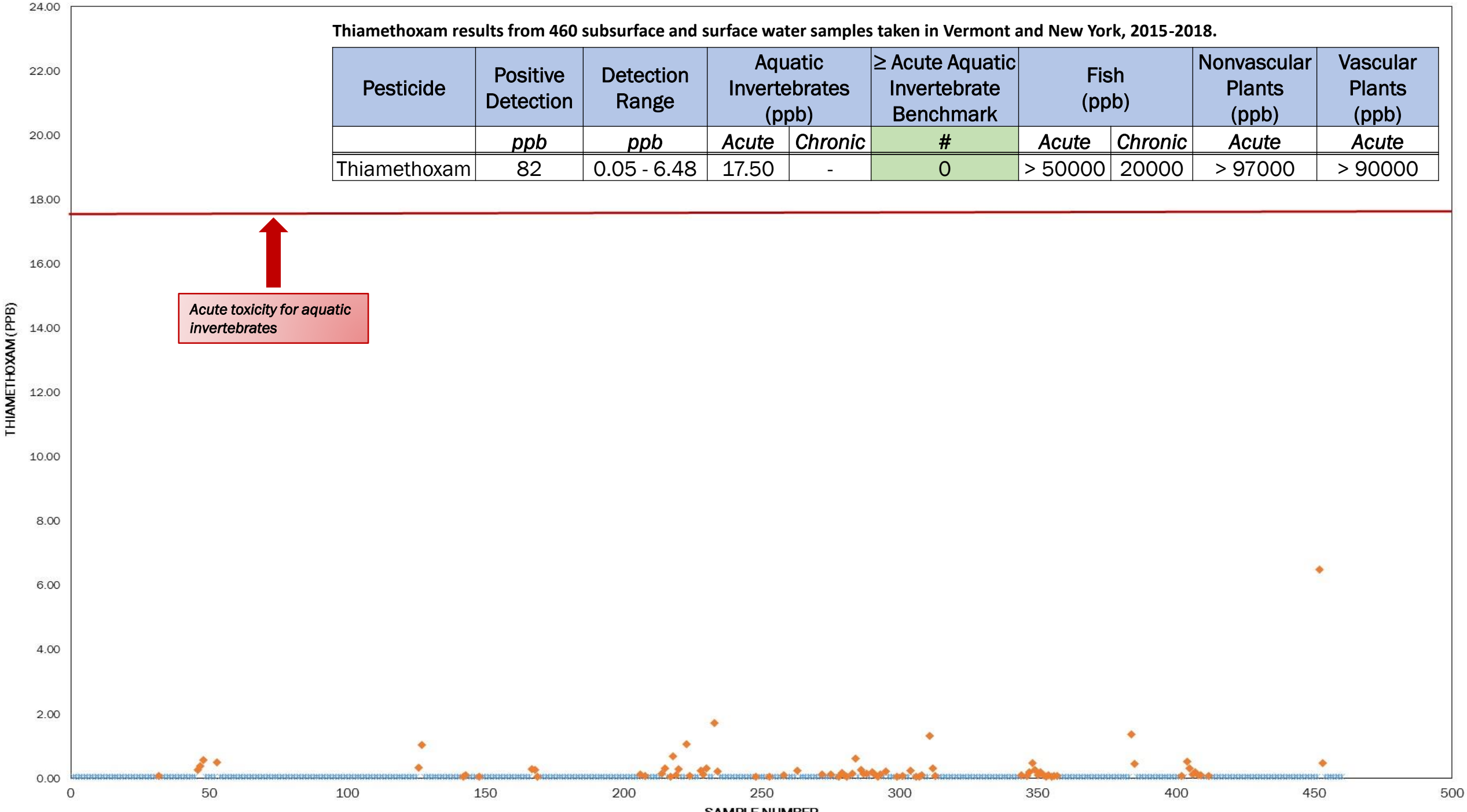
Neonicotinoid	Positive detection	Detection range	Acute benchmark*	Chronic benchmark*	Results ≥ Acute benchmark*
	#	ppb	ppb	ppb	#
Thiamethoxam	25	0.06 - 6.48	17.50	-	0
Clothianidin	13	0.08 – 0.40	11.00	1.10	0
Imidacloprid	0	<0.05	0.385	0.01	0

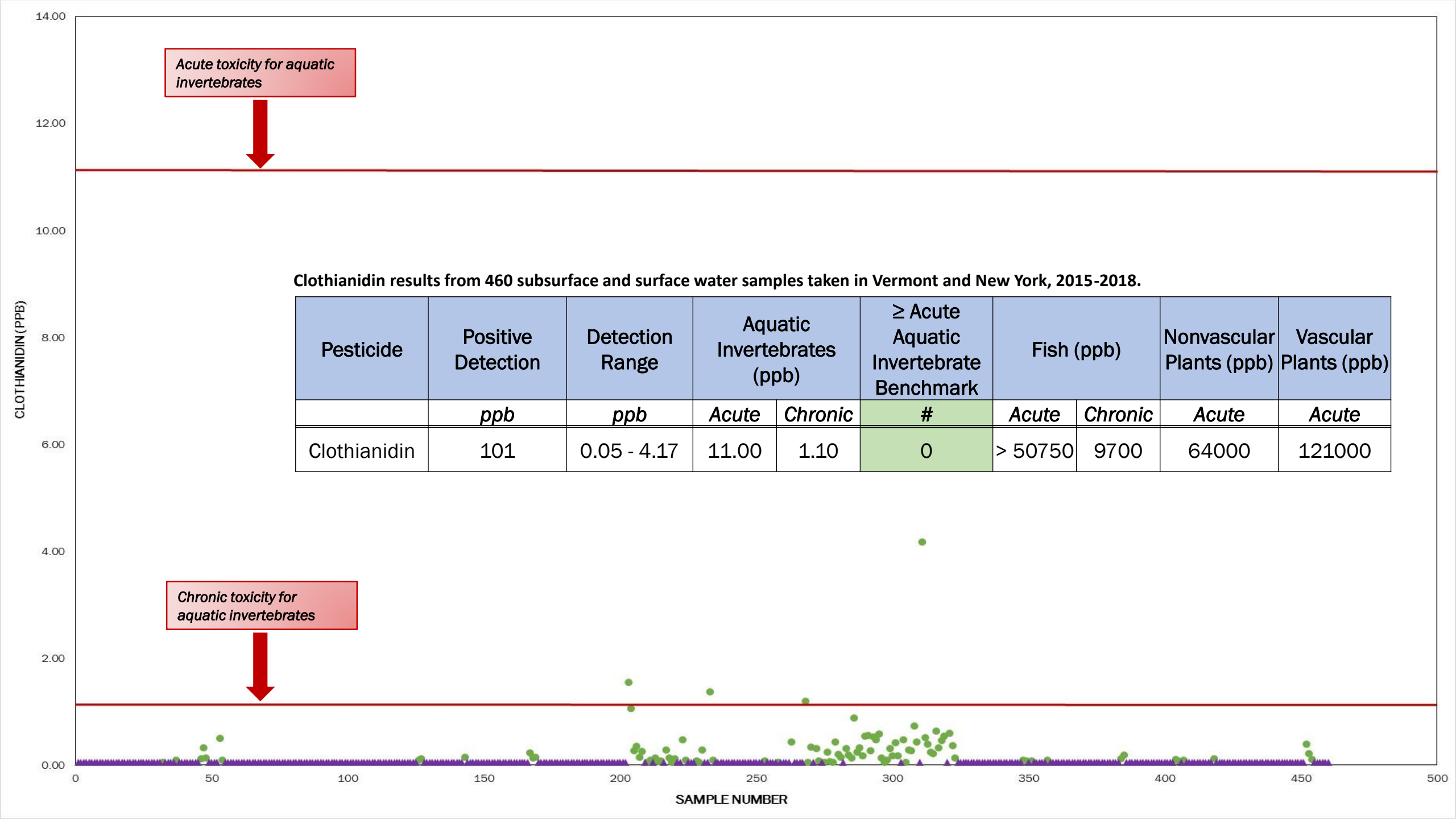
*aquatic invertebrates


All of Vermont and New York water samples by neonicotinoid; thiamethoxam, clothianidin, & imidacloprid.

Thiamethoxam results from 460 subsurface and surface water samples taken in Vermont and New York, 2015-2018.

Pesticide	Positive Detection	Detection Range	Aquatic Invertebrates (ppb)		≥ Acute Aquatic Invertebrate Benchmark	Fish (ppb)		Nonvascular Plants (ppb)	Vascular Plants (ppb)
	ppb	*ppb*	*Acute*	*Chronic*	#	*Acute*	*Chronic*	*Acute*	*Acute*
Thiamethoxam	82	0.05 - 6.48	17.50	-	0	> 50000	20000	> 97000	> 90000



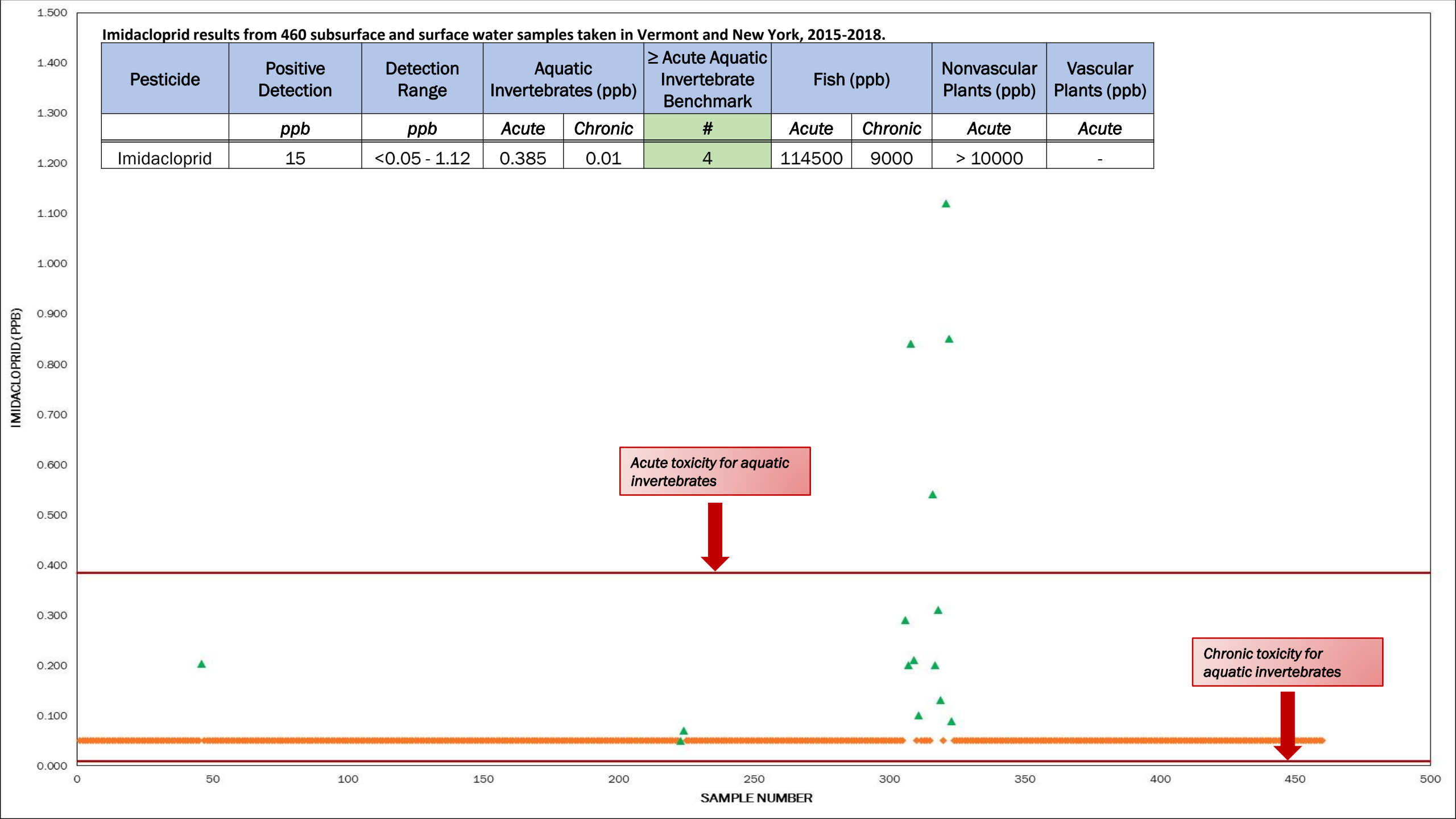


Clothianidin results from 460 subsurface and surface water samples taken in Vermont and New York, 2015-2018.

Pesticide	Positive Detection	Detection Range	Aquatic Invertebrates (ppb)		≥ Acute Aquatic Invertebrate Benchmark	Fish (ppb)		Nonvascular Plants (ppb)	Vascular Plants (ppb)
	ppb	*ppb*	*Acute*	*Chronic*	#	*Acute*	*Chronic*	*Acute*	*Acute*
Clothianidin	101	0.05 - 4.17	11.00	1.10	0	> 50750	9700	64000	121000

Imidacloprid results from 460 subsurface and surface water samples taken in Vermont and New York, 2015-2018.

Pesticide	Positive Detection	Detection Range	Aquatic Invertebrates (ppb)		≥ Acute Aquatic Invertebrate Benchmark	Fish (ppb)		Nonvascular Plants (ppb)	Vascular Plants (ppb)
	ppb	*ppb*	*Acute*	*Chronic*	#	*Acute*	*Chronic*	*Acute*	*Acute*
Imidacloprid	15	<0.05 - 1.12	0.385	0.01	4	114500	9000	> 10000	-



Best Management Practices (BMP's) for using neonicotinoid treated seed

Use integrated pest management (IPM) Practices:

- Know which of your crop production practices (tillage, rotations, weed and nutrient management) increase or reduce the likelihood for stand-reducing insect pests(wire worms, grubs, etc.).
- Use alternate crop production practices (i.e. cultural, mechanical, biological) where possible, to reduce risk of insect pests.
- Scout fields to determine whether an insect pest is present and poses an economic risk to warrant using neonicotinoid seed treatments.
- Keep records of crop practices and insect infestations to inform your decisions for seed treatment usage in similar situations.

Pest Scouting Method

Soil Pest Assessment:

The objective is to determine whether there are grubs or wireworms present on a given farm that meets or exceeds a pest threshold for use of neonicotinoid treated seed.

1. Calculate how many acres proposed for use of neonicotinoid treated seed
2. The total area will be divided into areas no greater than 100-acre parcels
3. In each area, select five locations to scout for wireworms and grubs
4. Choose one of the two following soil scouting techniques:

Digging Technique:

- In each of the 5 locations within an area (no greater than 100 acres), dig a 12- inch by 12-inch ($1ft^2$) hole that is 4 inches deep
- Shift through the soil removed from the hole and count wireworms and grubs
- Record the number of grubs and wireworms in each of the locations

Bait Trap Technique:

- In each of the 5 locations dig a 6-inch by 6-inch hole that is 6-inches deep
- Place 1 cup bait into the hole and cover hole with soil.
- Mound the soil to prevent standing water
- Mark site to able to find again (exp. flag or stake)
- Seven to 10 days after setting up the bait traps, dig out the bait to count the number of wireworms
- Record the number of wireworms found in each of the locations.

5. Count the number of grubs found in each the five locations and divide by five, this gives you the average for the area.
6. Do the same for the number of wireworms.

Pest thresholds:

Grubs = 2 grubs averaged over the 5 scouting locations

Wireworm = 1 wireworm averaged over the 5 scouting locations

❖ If the area meets or exceeds the pest thresholds, neonicotinoid treated seed may be used in that area.

Using Treated Seeds

- Use only where necessary
- At the lowest effective treatment rate.
- When the use of neonicotinoids is not warranted, purchase seed not treated with neonicotinoids.
- Before planting neonicotinoid treated seed, read and follow the directions for proper handling during transport, storage, and use.

Communication and Cooperation

In order to help reduce the risk to pollinators, it is important for farmers and beekeepers to talk to each other.

- ❖ Before planting with neonicotinoid treated seed, farmers should notify any nearby beekeepers.
- ❖ Nearby beekeepers should let farmers know the locations of any hives near farm fields.
- ❖ Farmers should control flowering weeds in the field and around field edges before planting by mowing or tillage so that pollinators are not attracted to in-field foraging.

Handling and Planting

- Help keep the treatment on the seed during storage and handling by not storing seed under extreme temperatures and excessive humidity.
- The use of vacuum planters poses a higher risk of pollinator exposure of neonicotinoid dust from drift. Farmers should take measures to reduce insecticide containing dust exhausted from planters.
- Pay special attention while adding treated seed to your planter to reduce dust generated from abrasion.
- Avoid loading treated seed into planter near pollinator foraging areas.
- Plant neonicotinoid treated seed at recommended seeding rate and depth.
- Avoid planting on windy days when any dust will blow into the environment.

Clean-up and Disposal

- Spilled or exposed treated seeds and/or dust must be buried in the soil or removed from the soil surface.
- Keep treated seed and dust away from surface waters.
- Dispose of any leftover treated seed properly, following directions on the seed tag.
- Dispose of any dust left over in seed bags and filters properly
- Clean and maintain planting equipment regularly, including hoppers.