

20 Unique Cases of Herbicide Resistance in Wisconsin

- 20 unique cases (weed species by herbicide site of action) of herbicide resistance have been confirmed in Wisconsin, including 13 weed species with evolved resistance to one or more herbicide sites of action (Figure 1, Table 1).

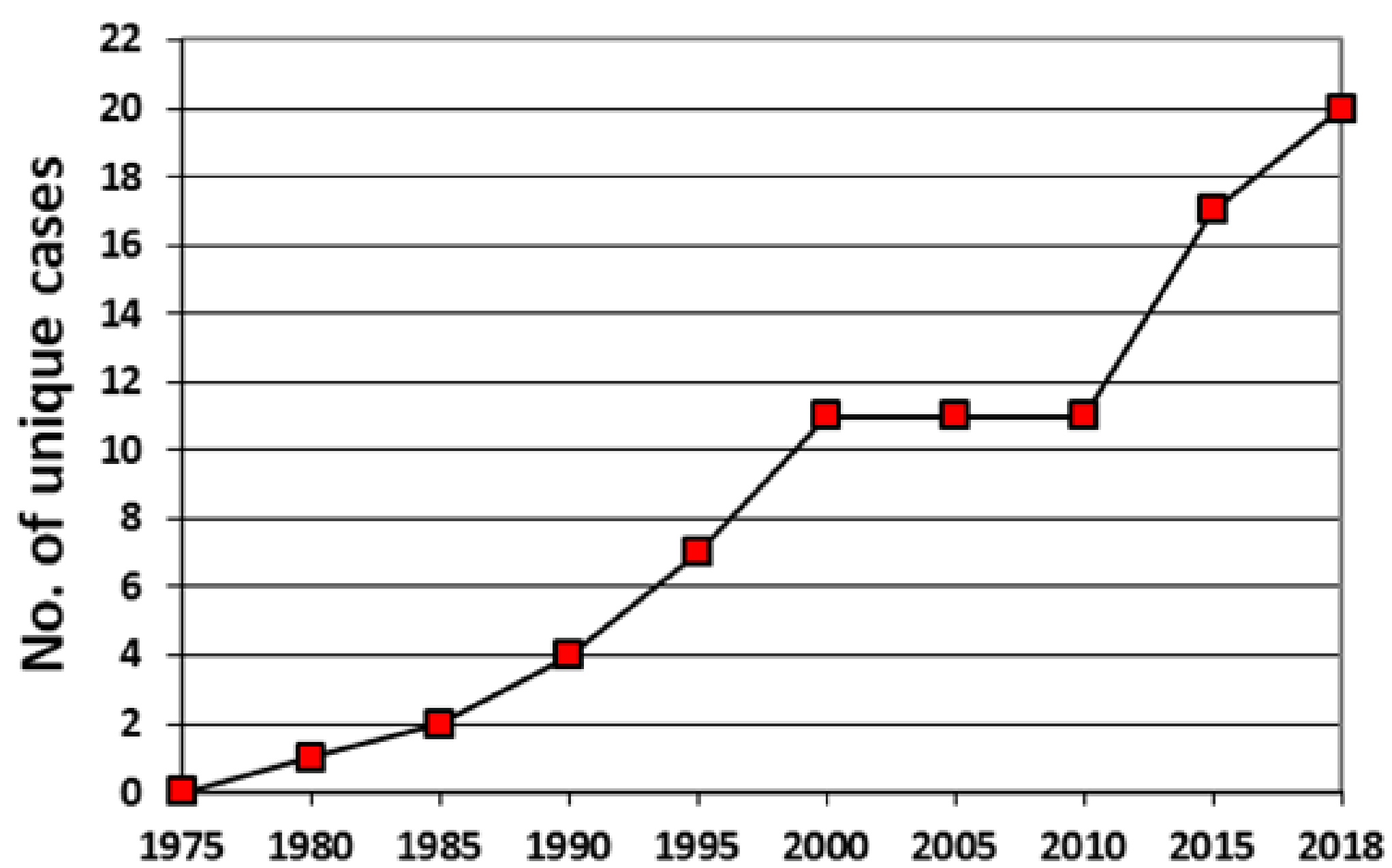


Figure 1. Unique cases of herbicide resistance in Wisconsin.

- The first confirmed case of herbicide resistance in Wisconsin was PSII inhibitor resistance in common lambsquarters in 1979.
- Since then, ALS-inhibitor resistance has been confirmed in more weed species than other type of herbicide resistance, totaling eight weed species including common ragweed, giant ragweed, Palmer amaranth, and waterhemp.
- In comparison, PSII inhibitor resistance has been confirmed in four species, whereas ACCase inhibitor resistance has been confirmed in only two species (giant foxtail and large crabgrass).
- The first confirmed case of glyphosate (an EPSP synthase inhibitor) resistance in Wisconsin was a non-rapid response phenotype of giant ragweed in 2011 (Figure 2). Glyphosate resistance has subsequently been confirmed in horseweed, waterhemp, Palmer amaranth, and most recently, common ragweed in 2018.



Figure 2. Glyphosate resistance in giant ragweed.

Herbicide group	Herbicide site of action	Weed species	Year confirmed
1	ACCase inhibitors (acetyl CoA carboxylase)	Giant foxtail Large crabgrass	1991 1992
2	ALS inhibitors (acetolactate synthase)	Kochia Eastern black nightshade Giant foxtail Green foxtail Waterhemp Giant ragweed Common ragweed Palmer amaranth†	1995 1999 1999 1999 1999 2013 2013 2014
5	PS II inhibitors (photosystem II)	Common lambsquarters Smooth pigweed Kochia Velvetleaf	1979 1985 1987 1990
9	EPSP synthase inhibitors (enolpyruvyl-shikimate-phosphate)	Giant ragweed Horseweed Palmer amaranth Waterhemp‡ Common ragweed	2011 2013 2013 2013 2018
14	PPO inhibitors (protoporphyrinogen oxidase)	Waterhemp‡	2016
27	HPPD inhibitors (hydroxyphenyl-pyruvate dioxygenase)	Palmer amaranth†	2014

†Multiple resistance to ALS inhibitors and HPPD inhibitors.

‡Multiple resistance to EPSP synthase inhibitors and PPO inhibitors in some populations.

Waterhemp in Wisconsin

- Waterhemp presence has increased rapidly in Wisconsin to include over 400 locations in 61 of 72 counties in the state (Figure 3).
- In recent years, glyphosate resistance concerns have focused on waterhemp which has also increased rapidly to include confirmed cases in 28 counties (Figure 4). Among these, multiple resistance to glyphosate and PPO inhibitors has been confirmed in 10 counties.

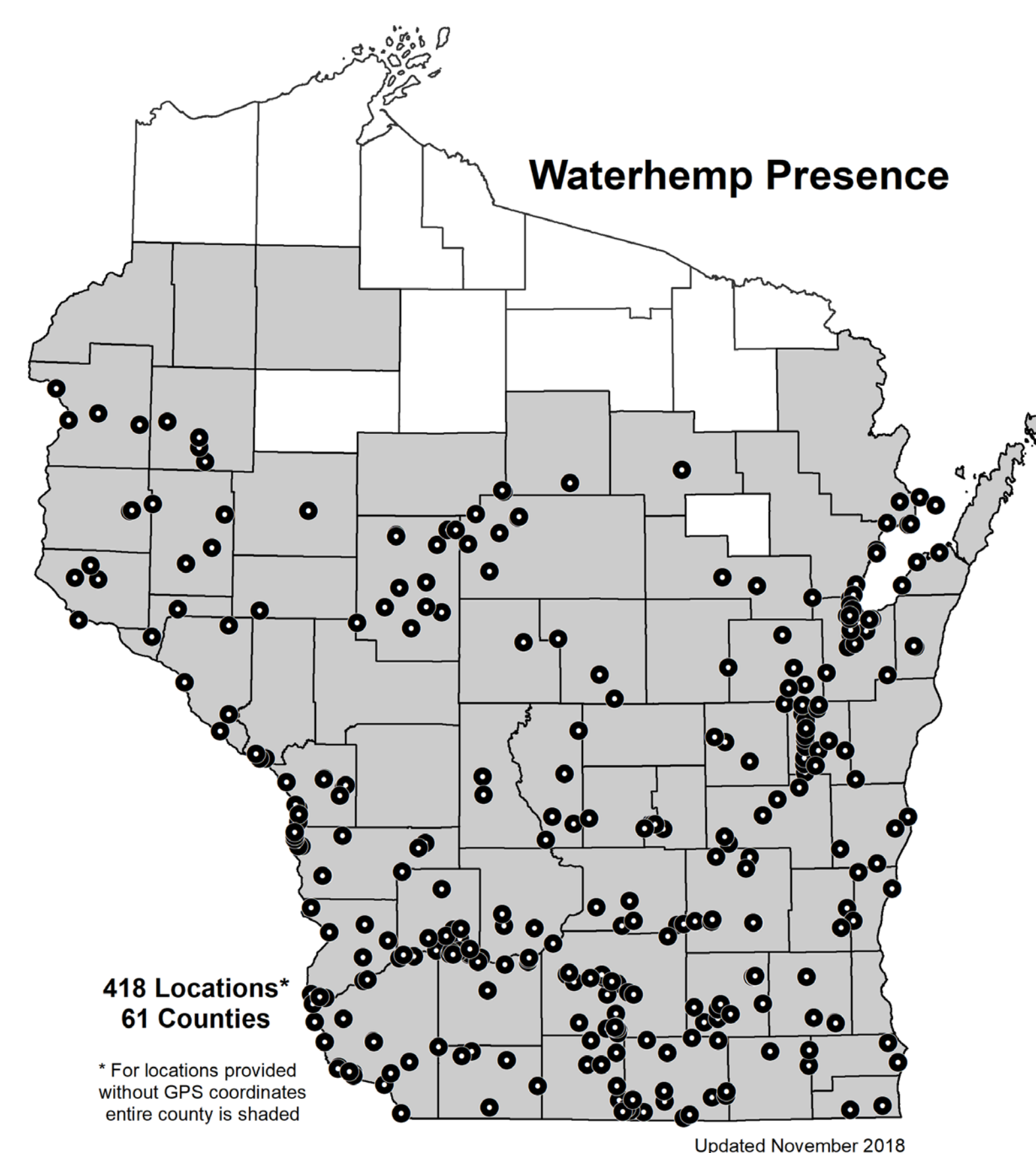


Figure 3. Waterhemp presence in Wisconsin.

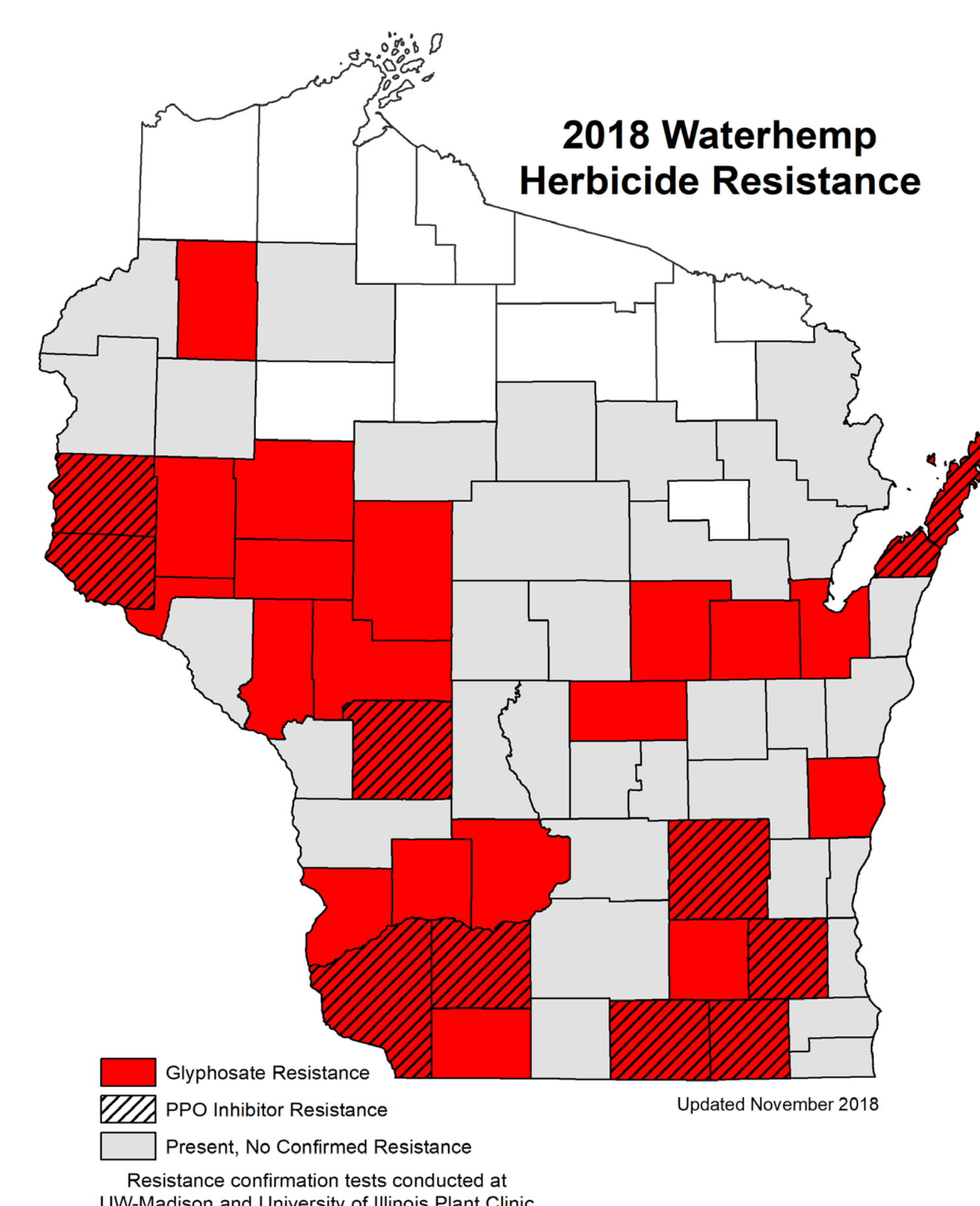


Figure 4. Waterhemp herbicide resistance in Wisconsin

Palmer Amaranth in Wisconsin

- Palmer amaranth was first identified in Wisconsin in 2011. Since then, 12 populations have been found among nine counties (Figure 5).
- Herbicide resistance in Palmer amaranth has been limited to two cases of confirmed glyphosate resistance and one case of confirmed multiple resistance to ALS inhibitors and the HPPD inhibitor tembotrione (Figure 5).

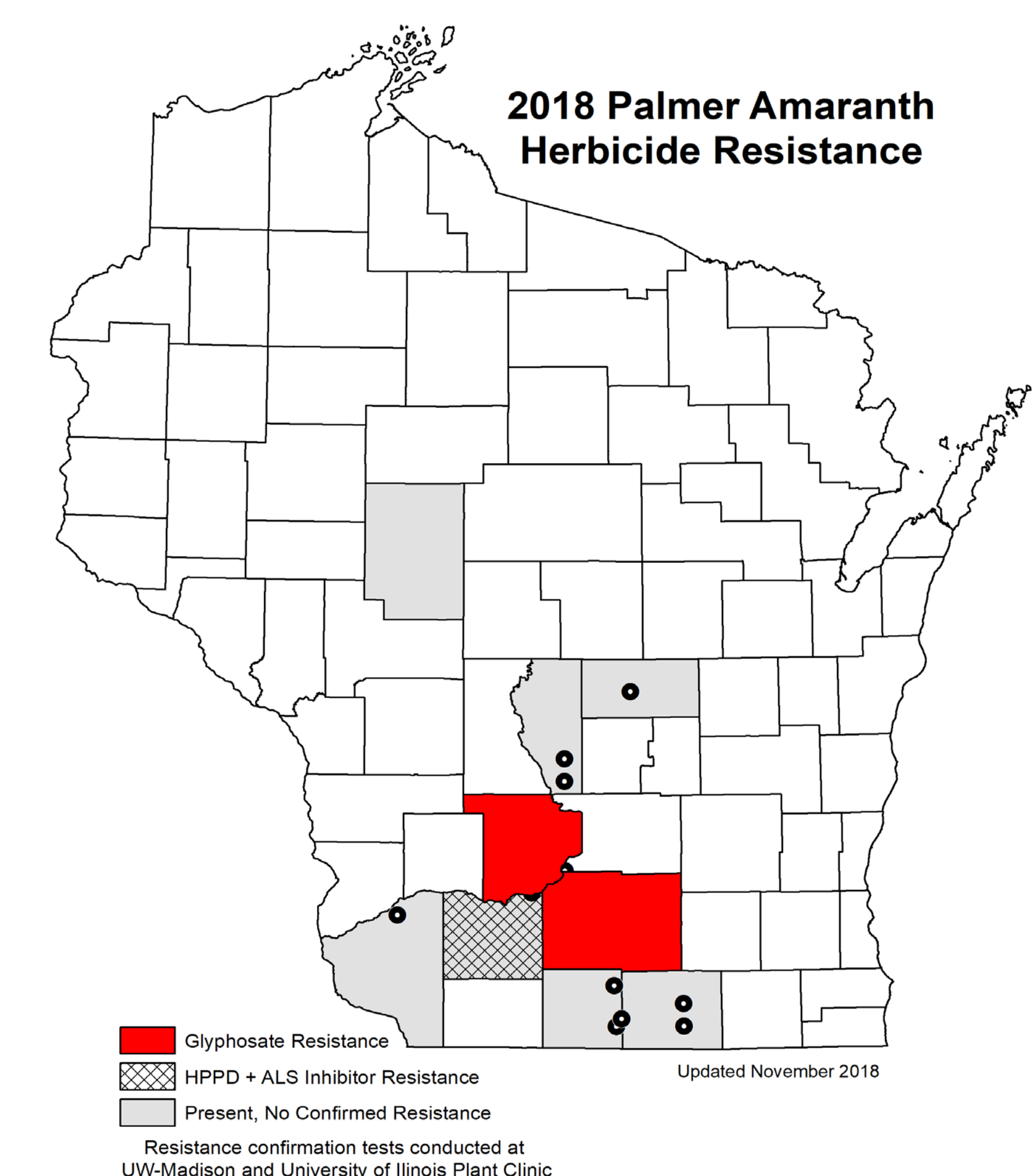


Figure 5. Palmer amaranth presence and herbicide resistance in Wisconsin

Grower Concerns

- Glyphosate resistance in waterhemp, and multiple resistance to glyphosate and PPO inhibitors, have increased rapidly in Wisconsin indicating that effective waterhemp management will continue to be a top concern of Wisconsin growers.
- Herbicide resistance in Palmer amaranth is currently limited to three counties in southern Wisconsin, but glyphosate resistance in two populations, and multiple resistance to ALS and HPPD inhibitors in another population, also have serious management implications for Wisconsin growers.
- It is critical that diversified management tactics be implemented to reduce the spread, persistence, and impact of these and other herbicide-resistant species.