

Clubroot Update 2018

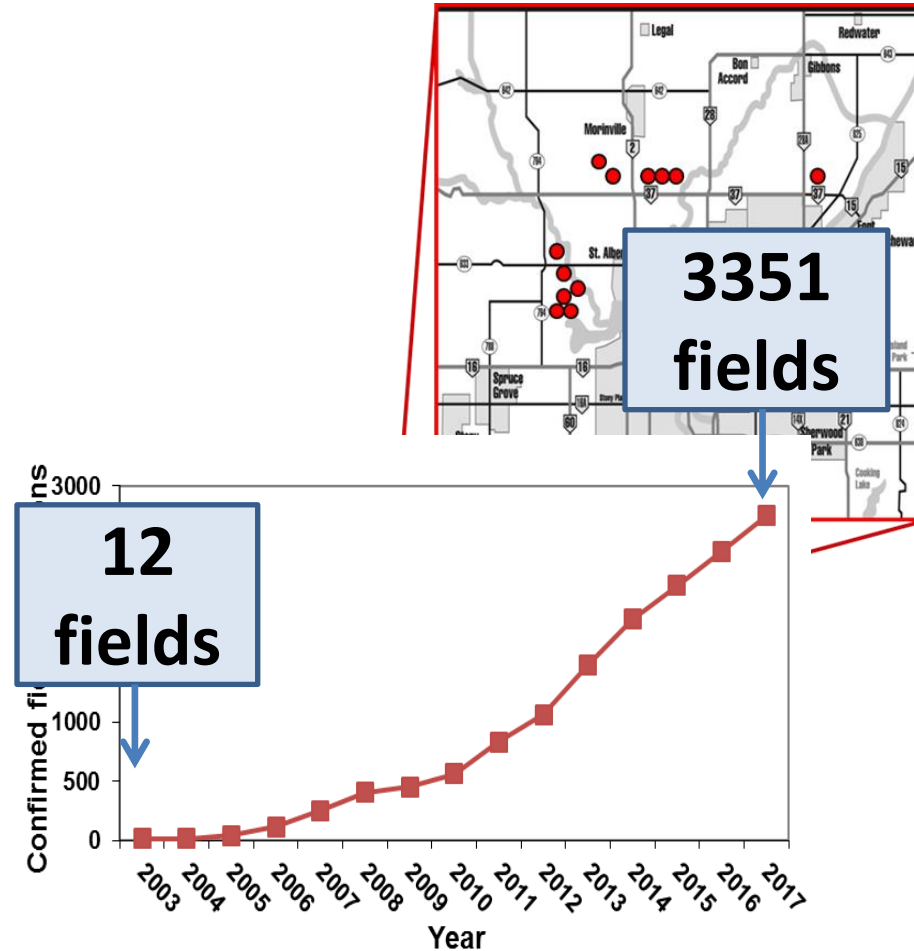
Presenter: Keisha Hollman, M.Sc. Student
S.E. Strelkov, S.F. Hwang, V.P. Manolii, M.W.
Harding

Canola Discovery Forum
November 2019
Winnipeg, MB



History of Clubroot in AB

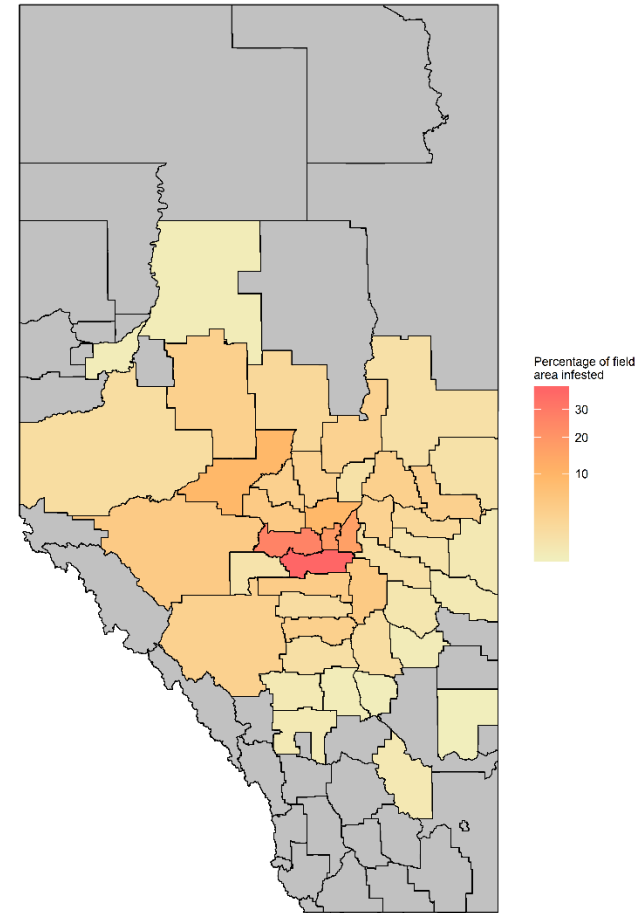
- Isolated cases reported in home and market gardens (1970s – 2001)
- First cases on canola identified in 2003 (12 fields near Edmonton, AB)
- Rapid increase in confirmed infestations in subsequent years (2005-2019)



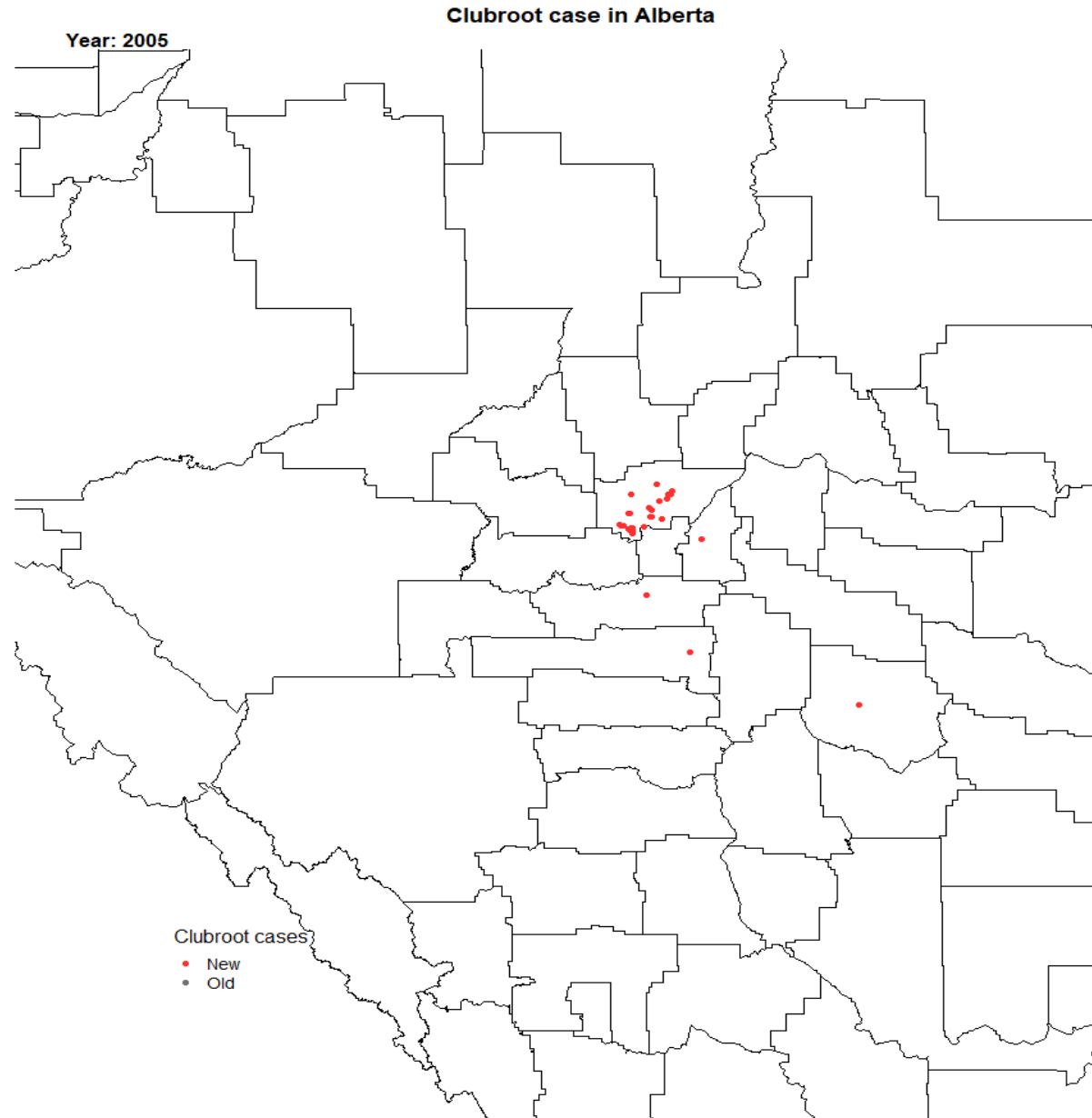
Clubroot Situation

- Clubroot continues to spread
 - First cases in Kneehill & Starland (2019)
 - Total of 307 new confirmed infestations in 2019
- Some of most severely infested fields were planted to CR canola

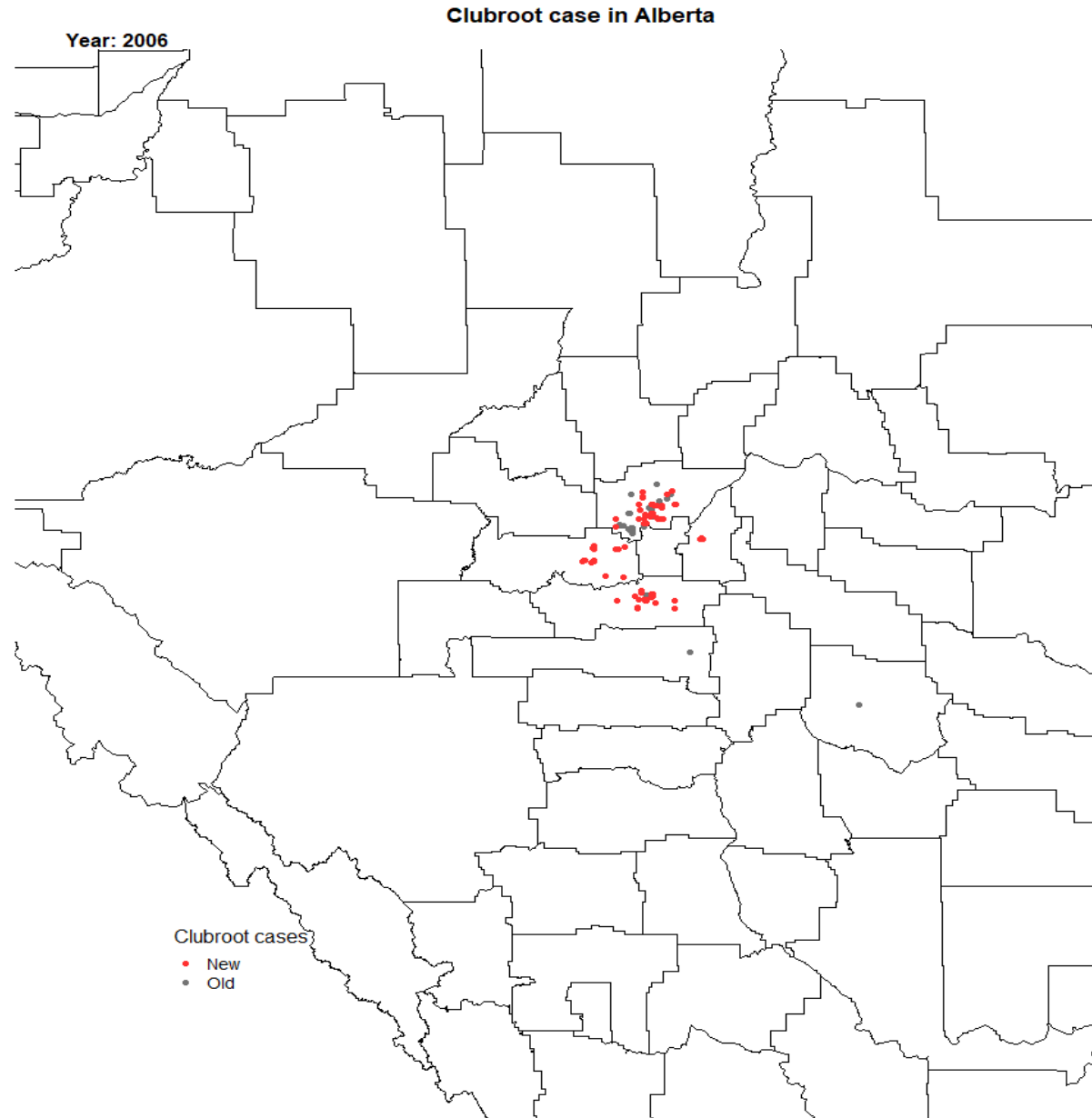
Percentage of field area infested by clubroot in Alberta by county in 2019



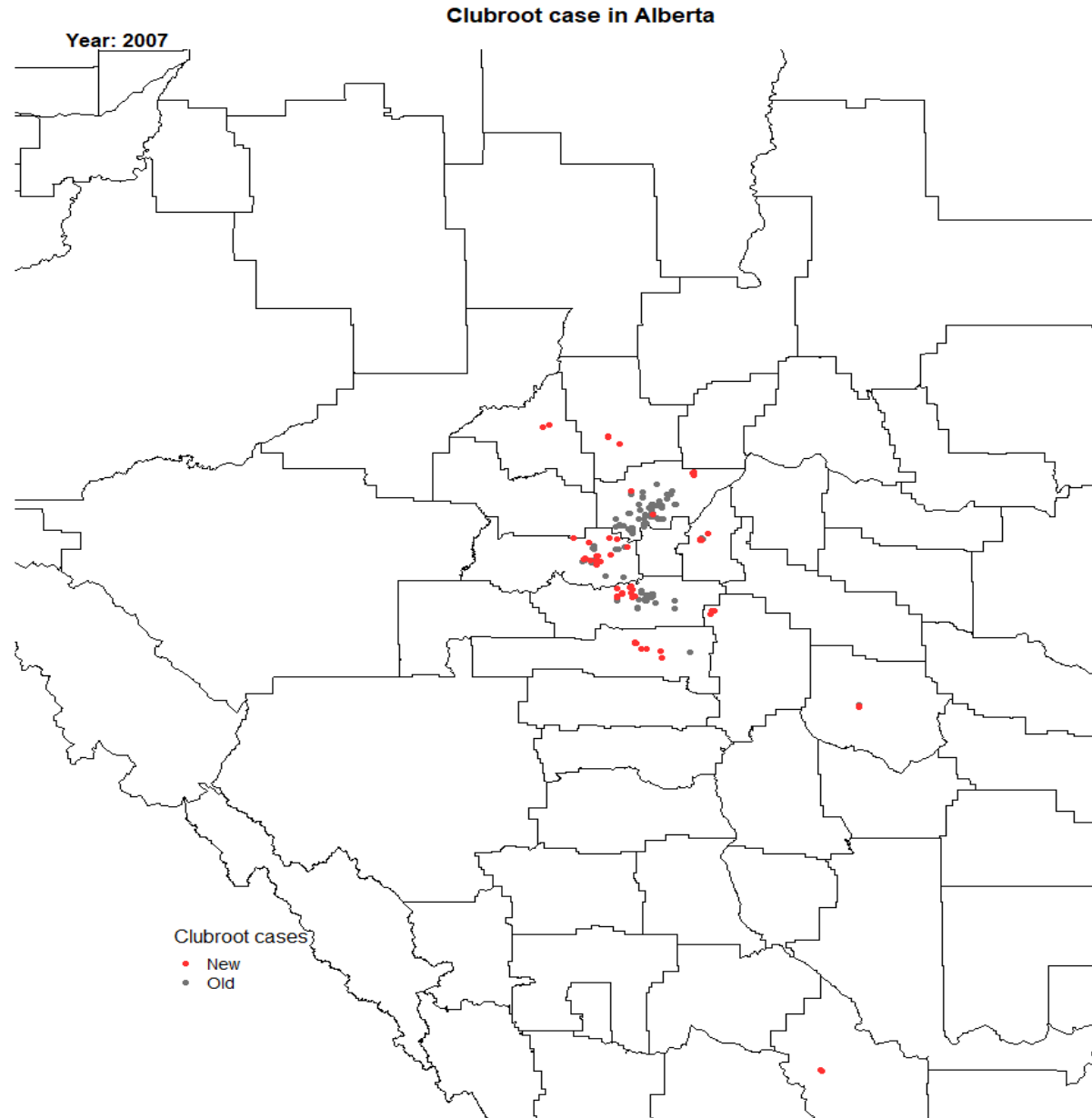
Strelkov et al. unpublished



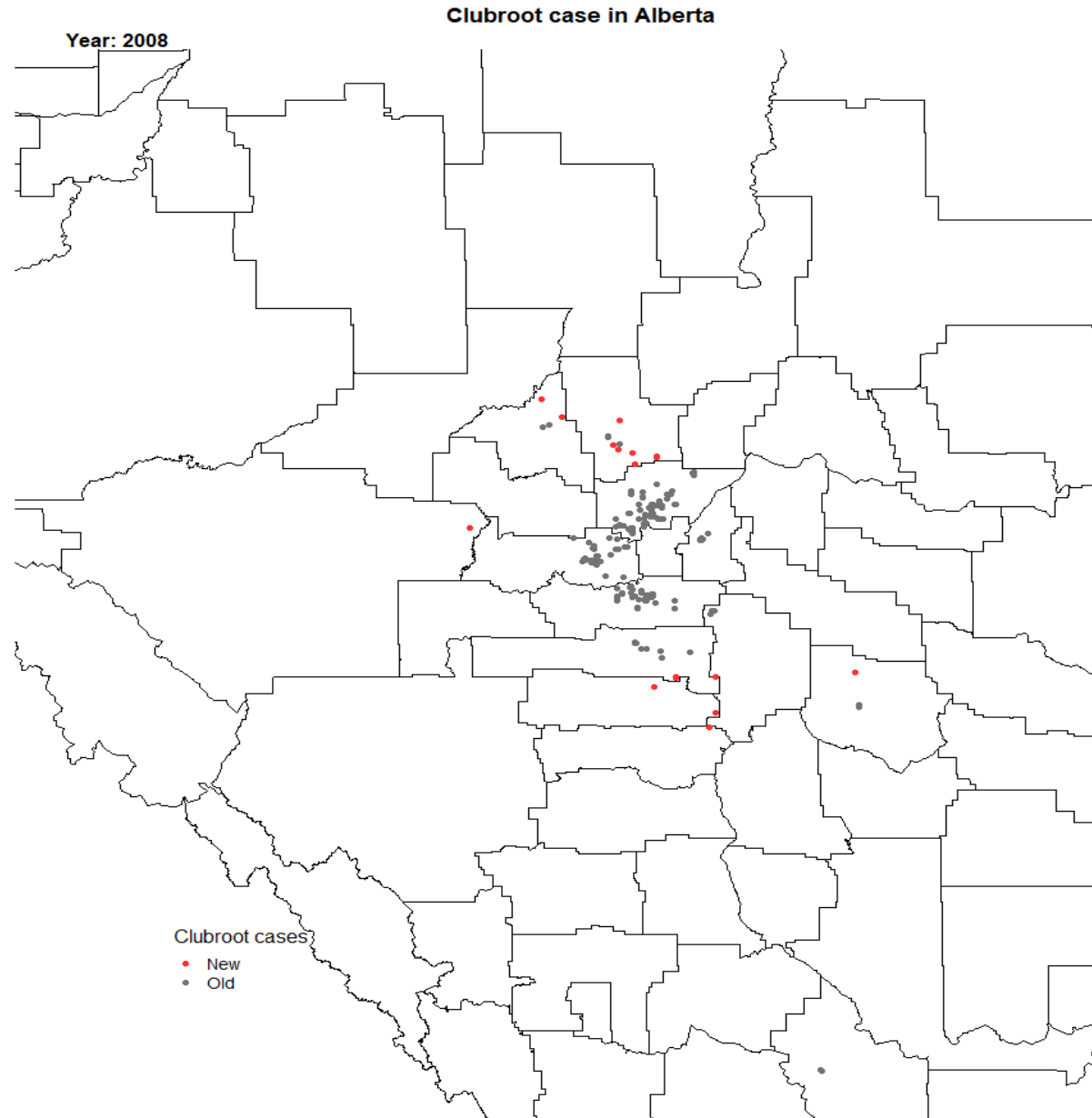
Strelkov et al. unpublished



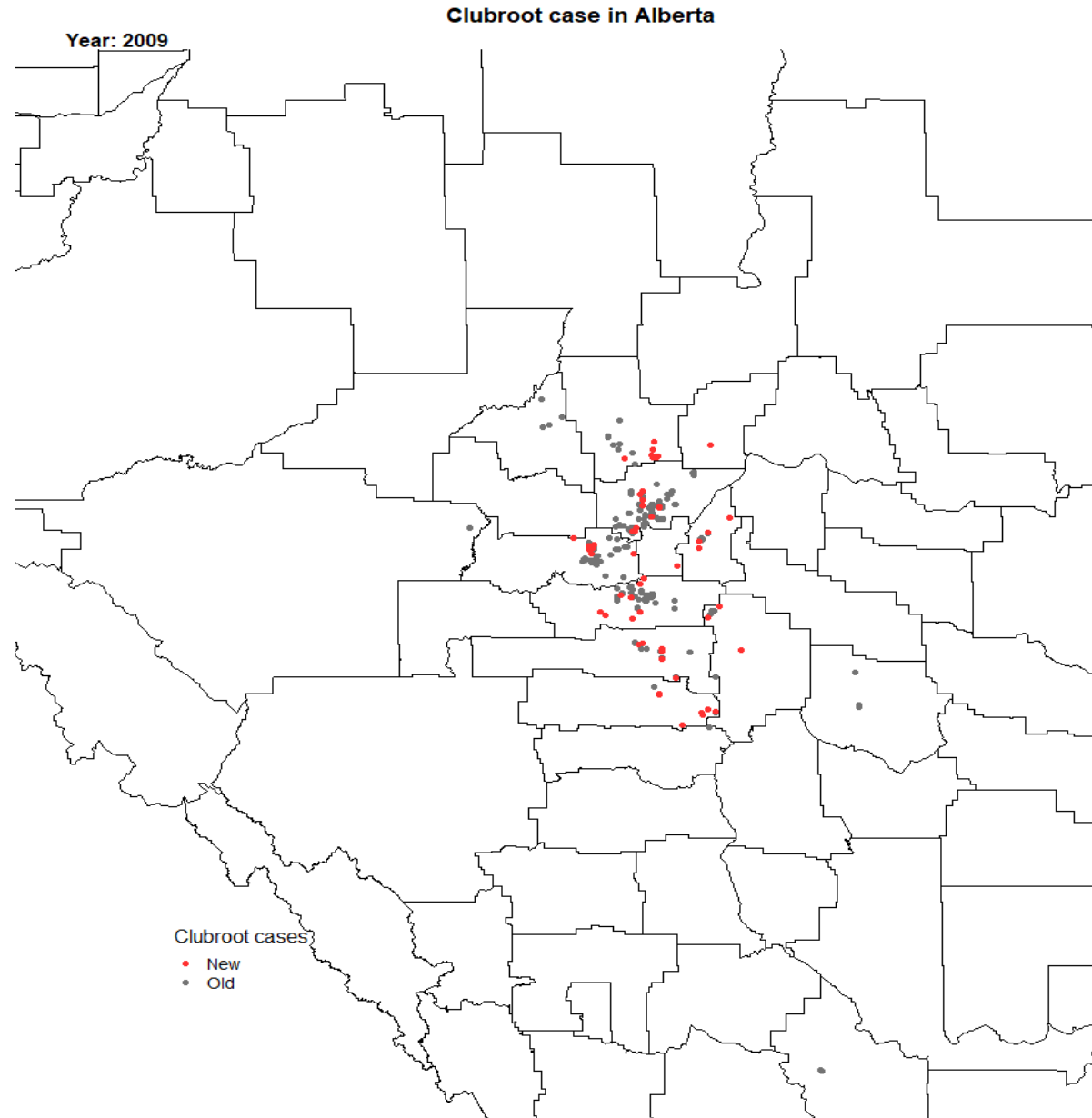
Strelkov et al. unpublished



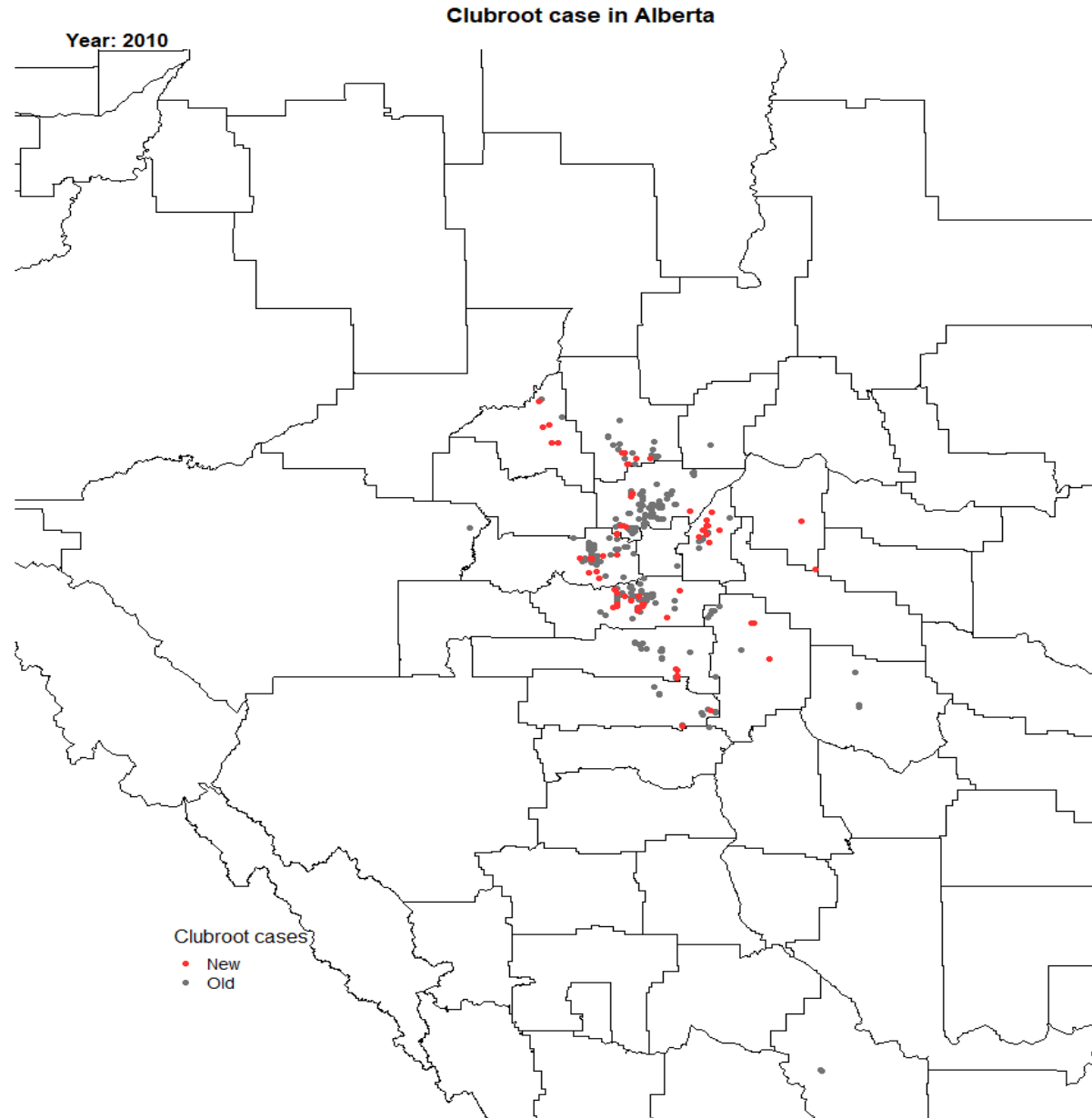
Strelkov et al. unpublished



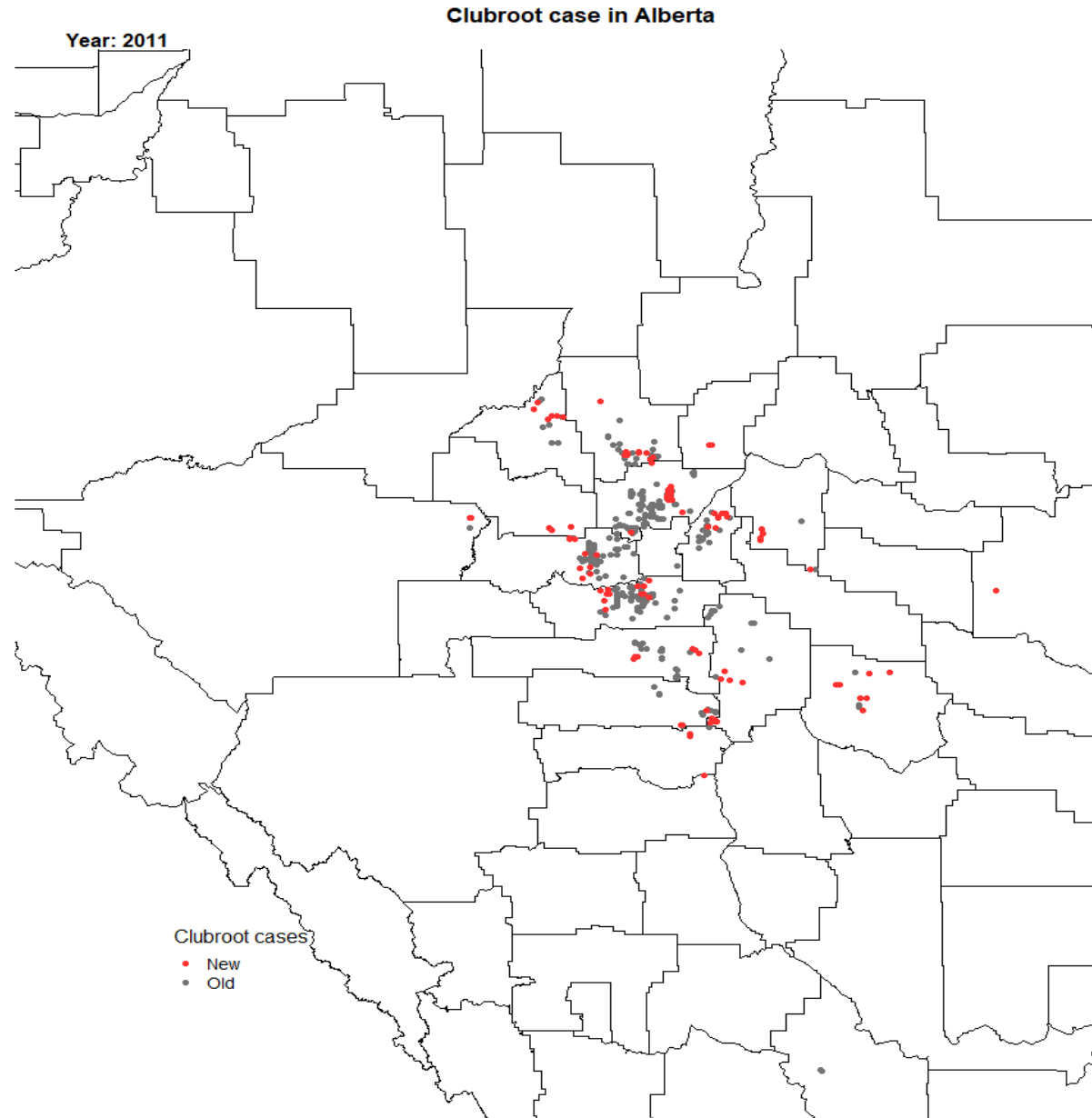
Strelkov et al. unpublished



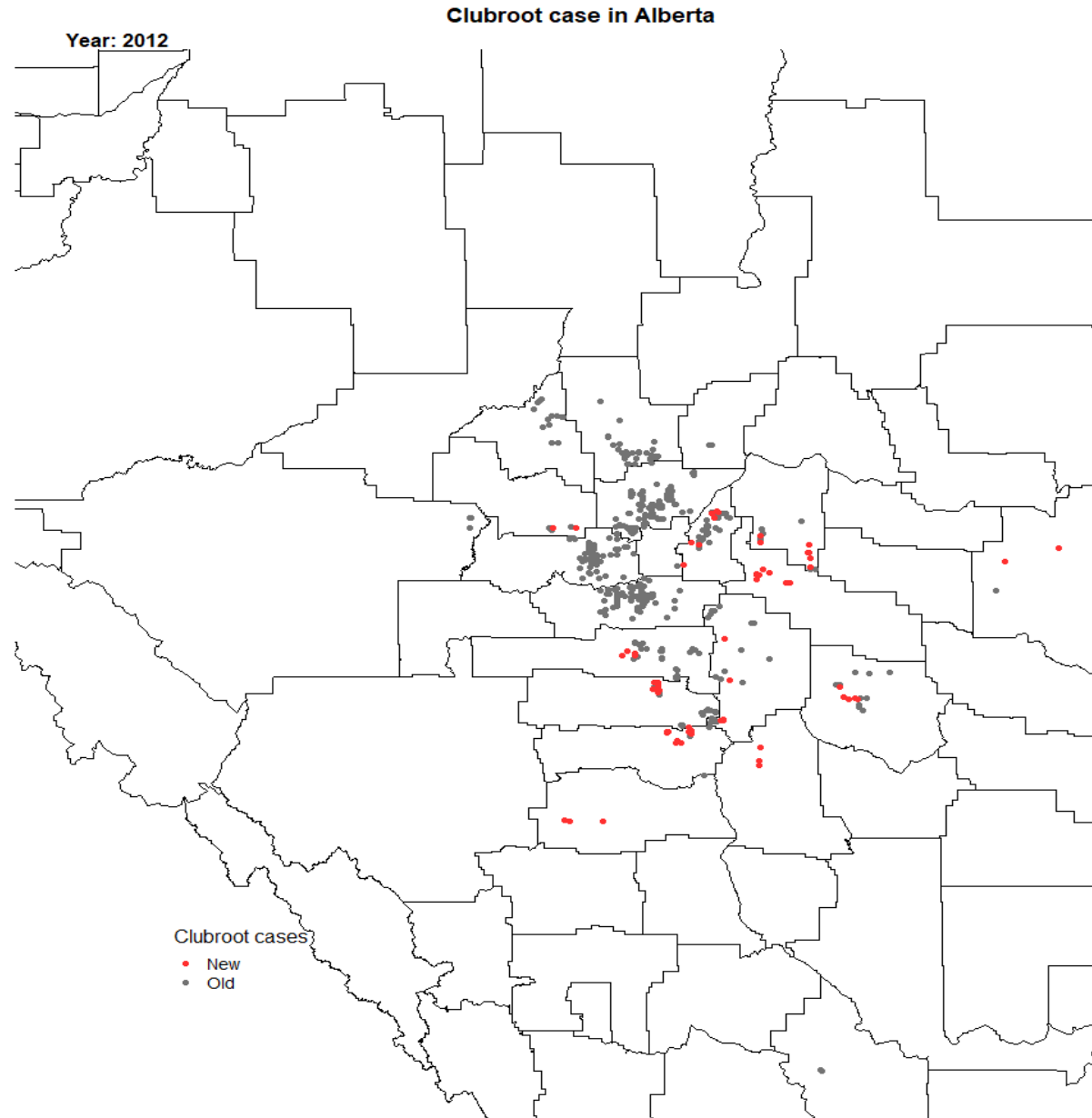
Strelkov et al. unpublished



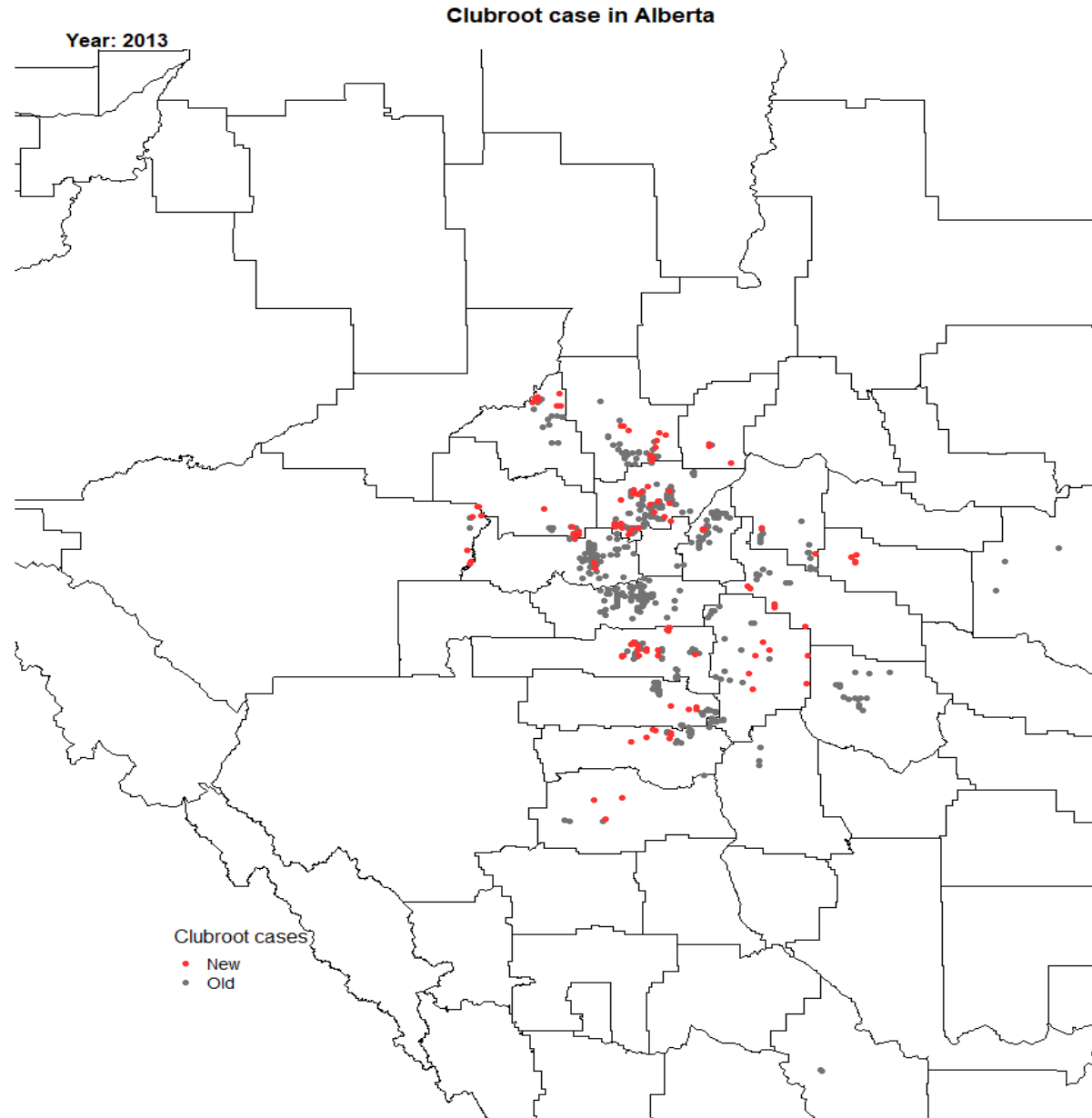
Strelkov et al. unpublished



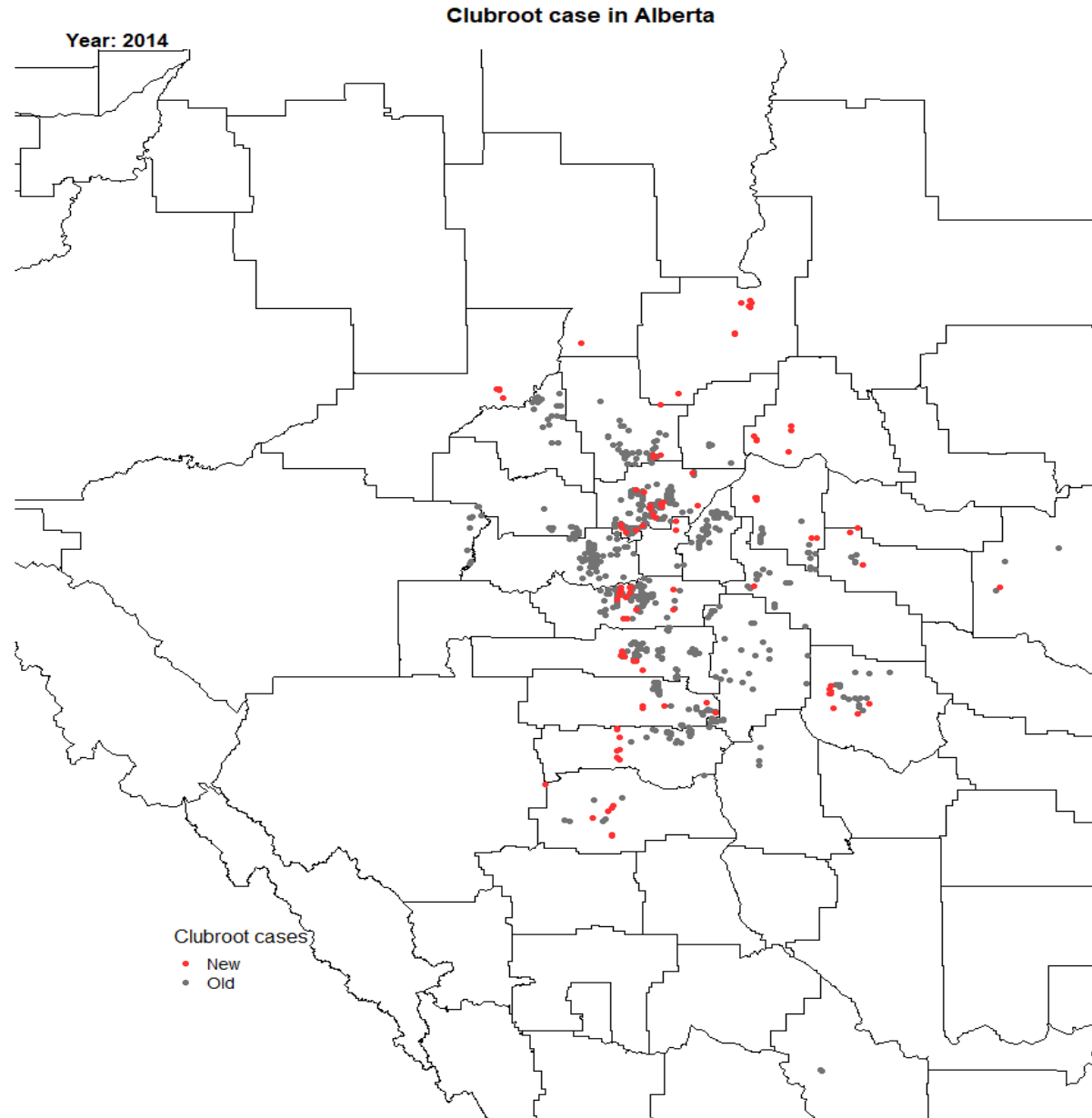
Strelkov et al. unpublished



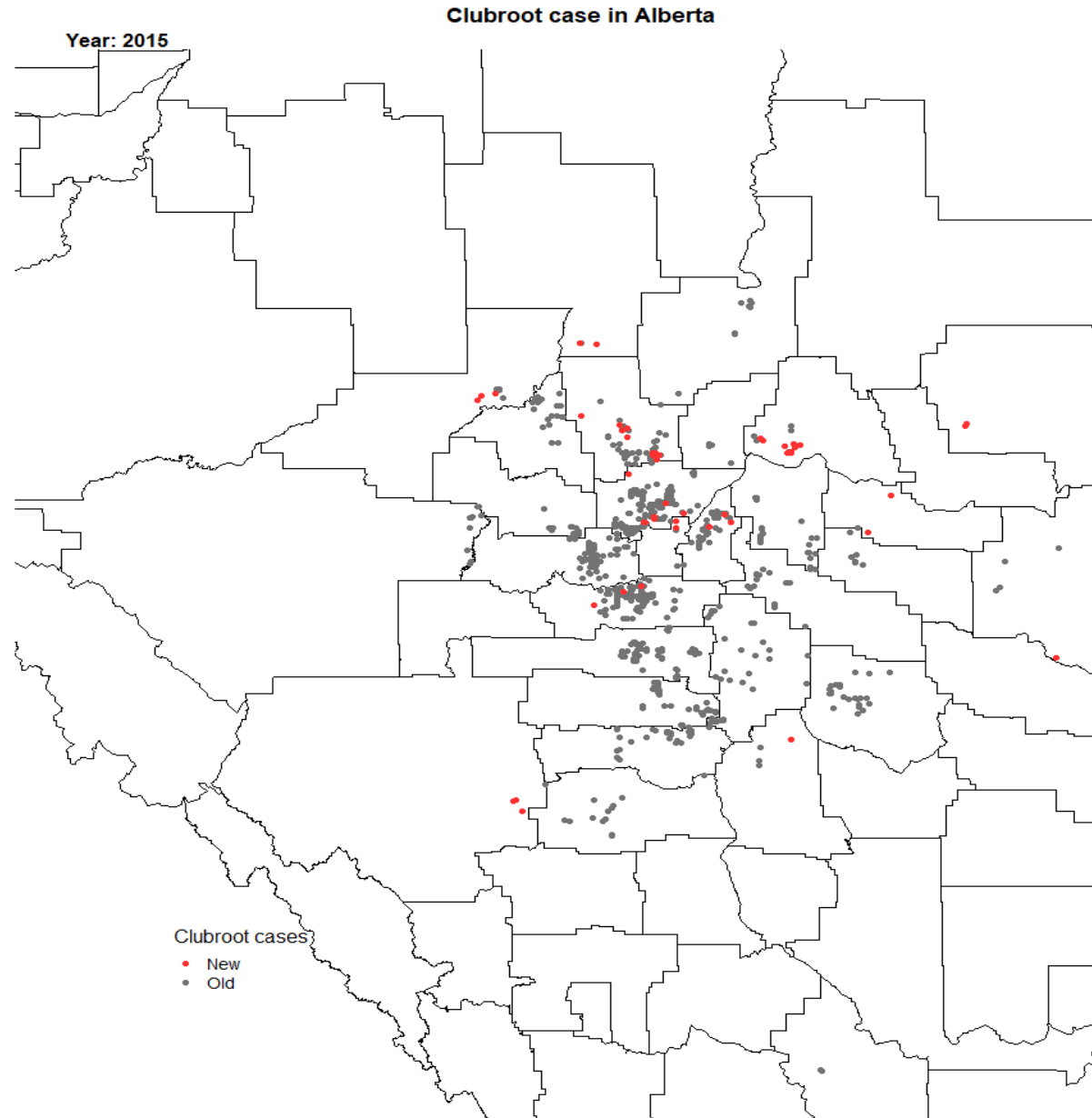
Strelkov et al. unpublished



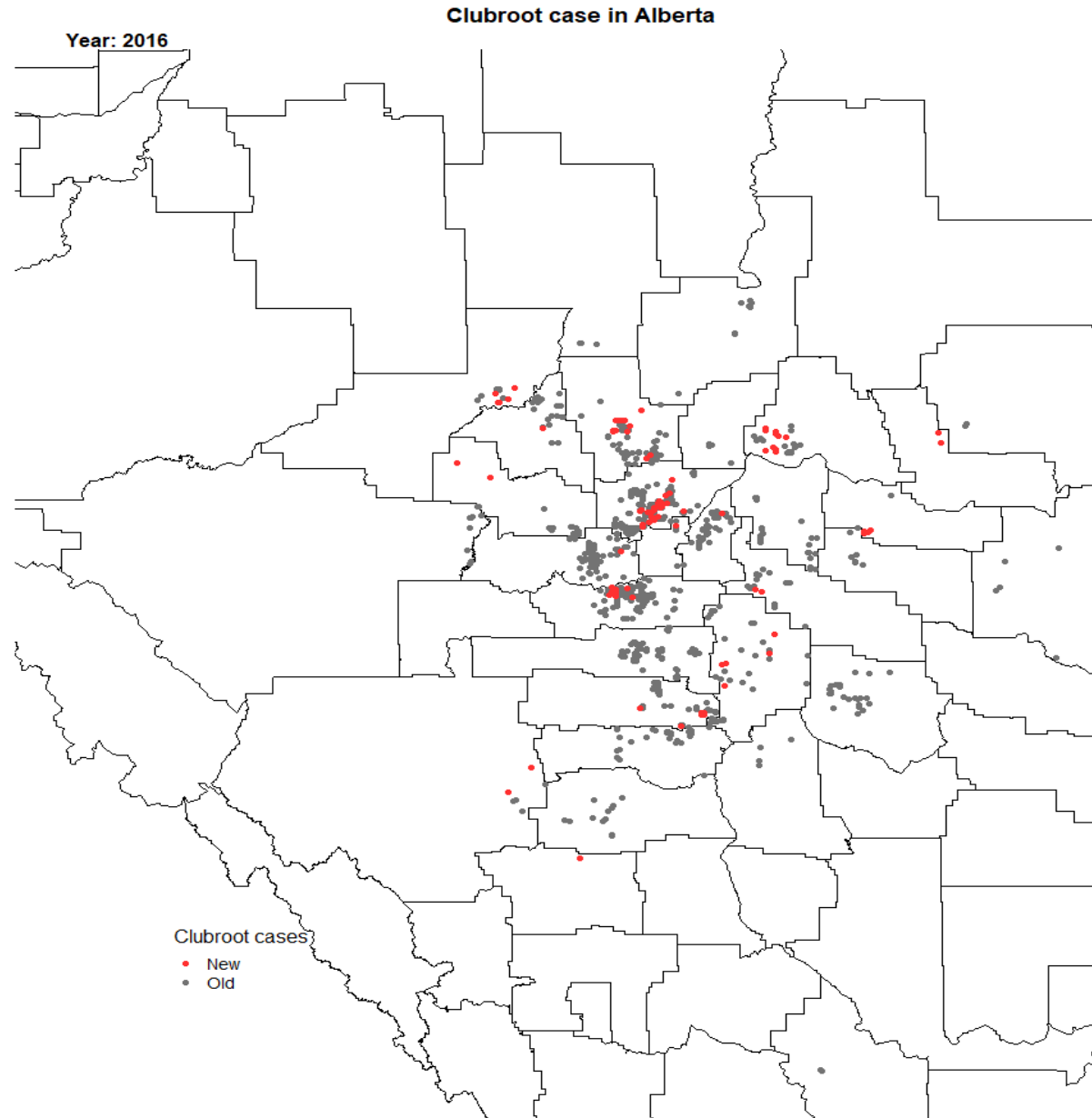
Strelkov et al. unpublished



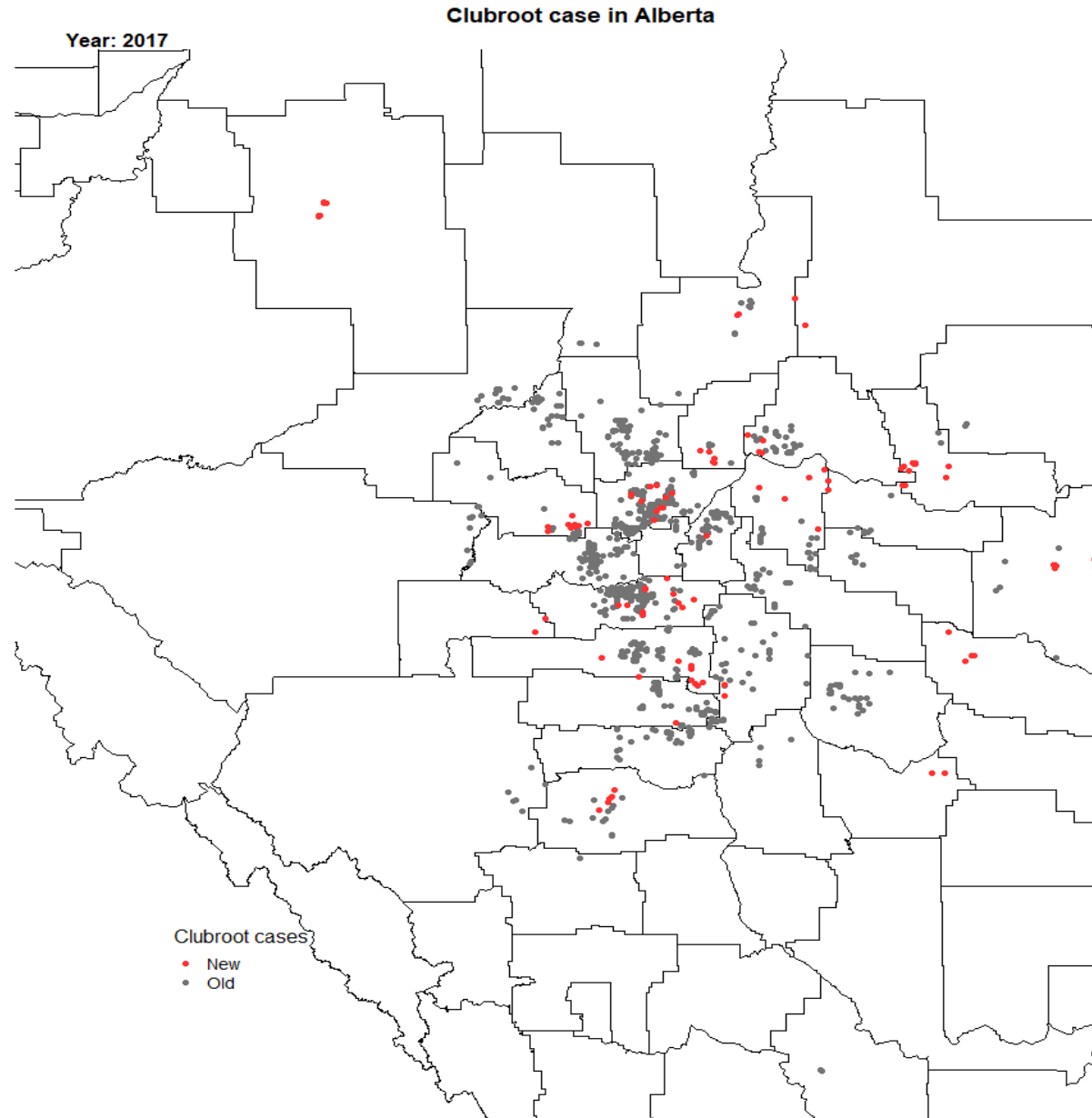
Strelkov et al. unpublished



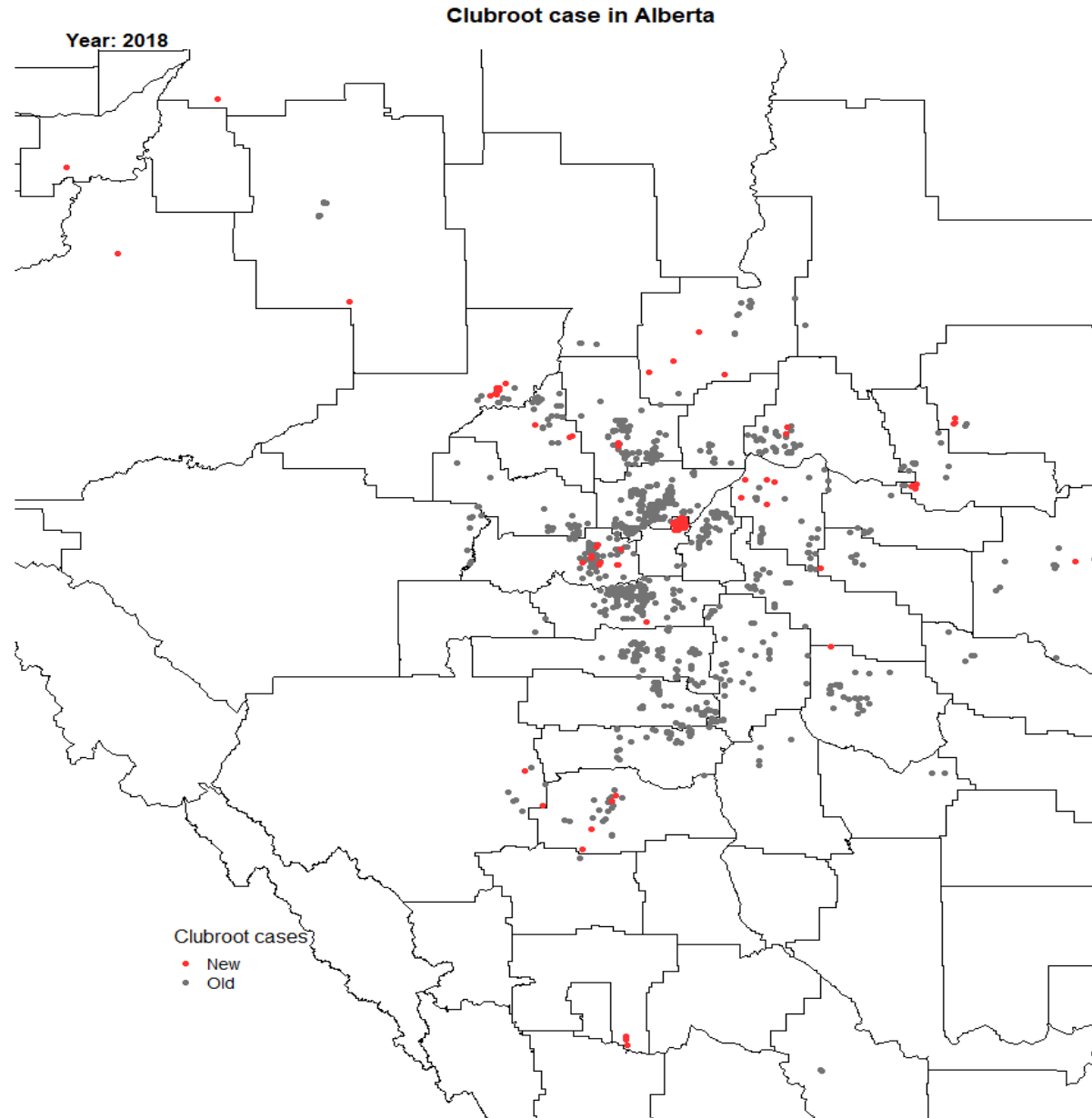
Strelkov et al. unpublished



Strelkov et al. unpublished



Strelkov et al. unpublished



Strelkov et al. unpublished

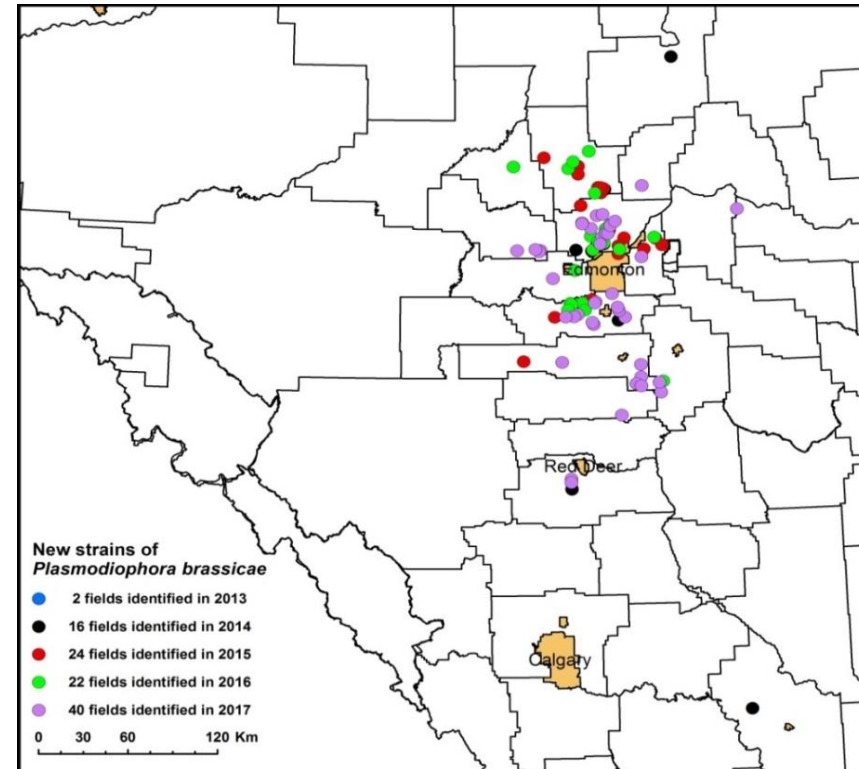
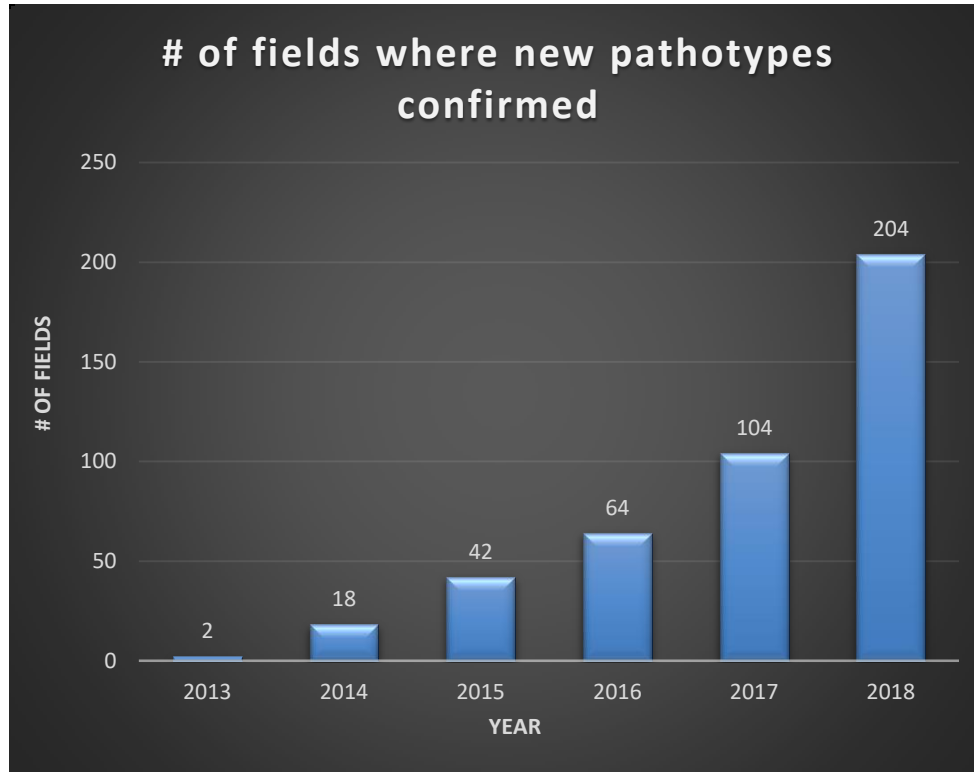
Clubroot in CR Canola

- Annual surveys have found increasing numbers of fields where resistance has been overcome
- Resistance has been overcome in Alberta and Manitoba, but so far not in Saskatchewan
- Samples from each potential case are evaluated in the greenhouse, and tested against suite of canola varieties on the CCD set and based on unique virulence pattern are assigned a pathotype designation



Clubroot Resistance Erosion

Increase in fields with resistance issues



Strelkov et al. unpublished

Clubroot resistance breakdown in Alberta

2013



2014



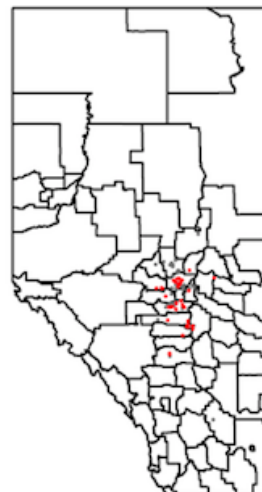
2015



2016



2017



Resistance breakdown

• New

• Old

Challenge: Pathotype Identification

- “New” *P. brassicae* strains that overcome resistance cannot be distinguished from “old” strains based on commonly used pathotype classification systems
- Example: First of the new strains were classified as pathotype 5 on Williams’ differential set
 - But this classification did not reflect their virulence on CR canola

Pathotyping

- Long process typically taking several months to complete
- High demand for pathotyping from Agriculture Fieldman, Agronomists, and Counties
- Important to determine spread of new pathotypes, as well as pathotype diversity
- Helps agronomists and land owners determine the best on farm management plan, as well as smart genetic deployment schedules

Canadian Clubroot Differential Set

- Populations from fields with resistance issues are tested for pathotype designation on the Canadian Clubroot Differential (CCD) Set
- Results from 2018 collections have been completed



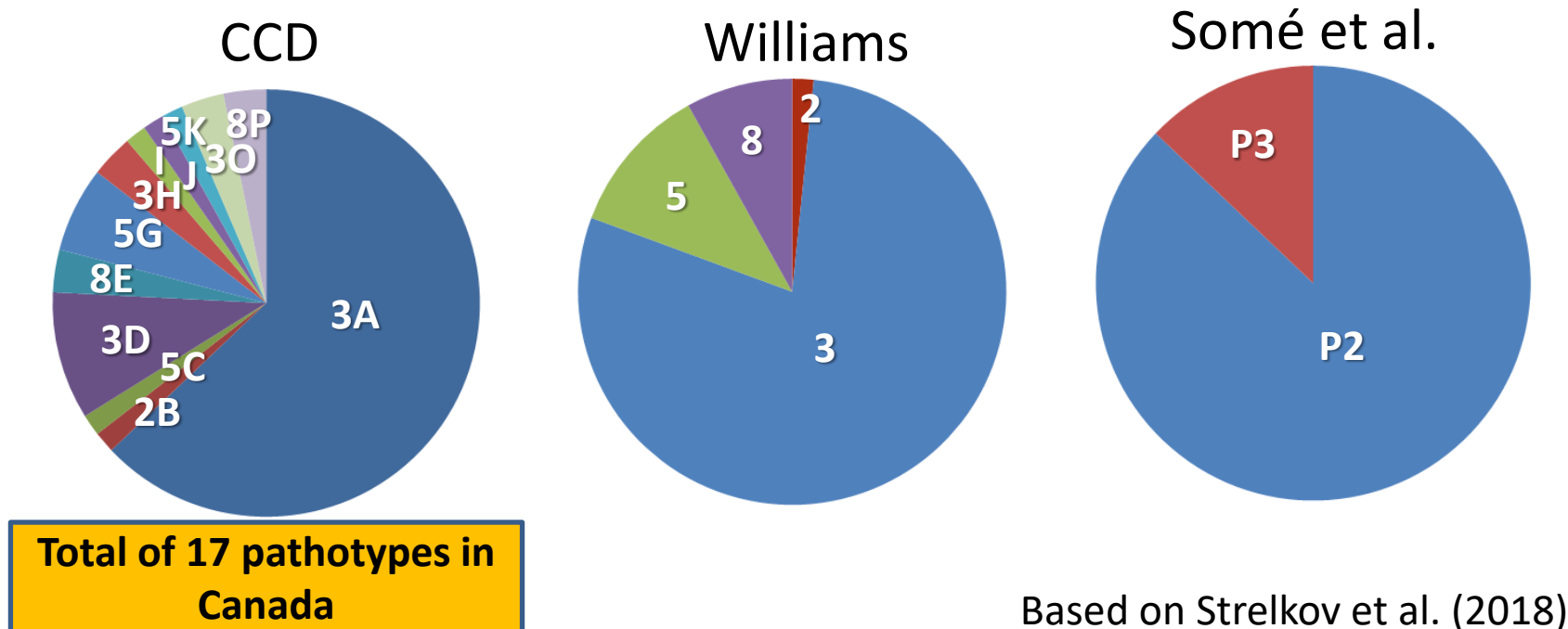
CCD Pathotype Classifications

Differential Host	Reaction																	
ECD 02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ECD 05	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
ECD 06	+	+	+	+	+	+	-	+	+	-	-	-	+	+	-	+	-	-
ECD 08	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+
ECD 09	+	+	+	+	+	+	-	+	+	-	-	-	+	+	+	+	+	-
ECD 10 W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ECD 11 BS	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
ECD 13 JQ	+	+	-	+	-	+	-	+	-	-	-	-	+	-	+	-	-	-
Brutor	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Laurentian	+	+	-	+	+	+	-	+	-	+	-	-	-	+	+	+	+	-
Mendel	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Westar	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
45H29	+	+	+	+	+	-	+	-	-	+	+	-	-	-	+	+	+	+
Pathotype designations																		
CCD	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	X	
Williams	3	2	5	3	8	2	5	3	5	8	5	5	6	8	3	8	5	
Somé et al.	P2	P2	P2	P2	P2	P2	P3	P2	P2	P3	P3	P3	P2	P2	P3	P2	P3	

- Unique virulence patterns assigned different letters to designate each pathotype (Strelkov et al. 2018)
- Also allows for pathotype designations to be obtained as per Williams (1966) & Somé et al. (1996)

Pathotypes Identified 2014-2016

- CCD Set has a good differentiating capacity
- Enabled identification of multiple distinct virulence phenotypes among pathogen populations able to overcome resistance



Current Pathotypes

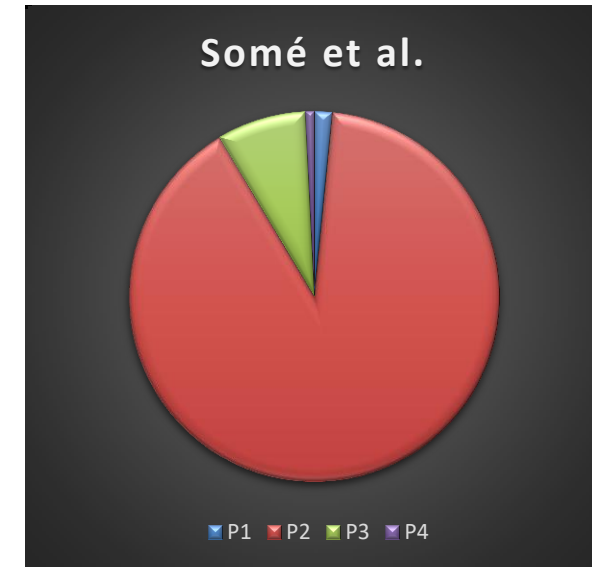
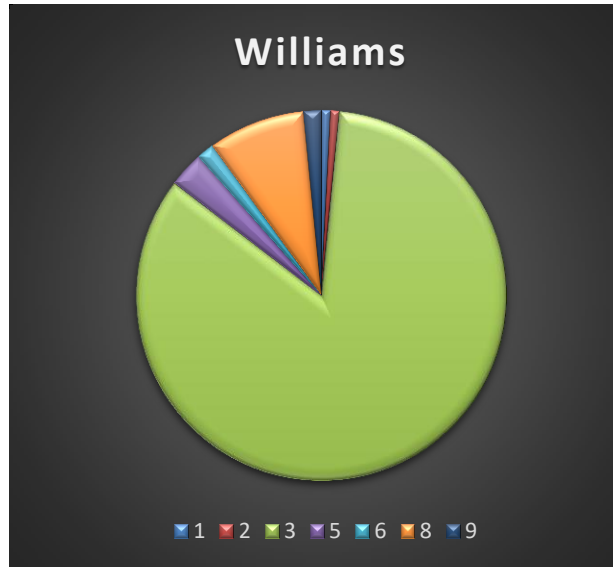
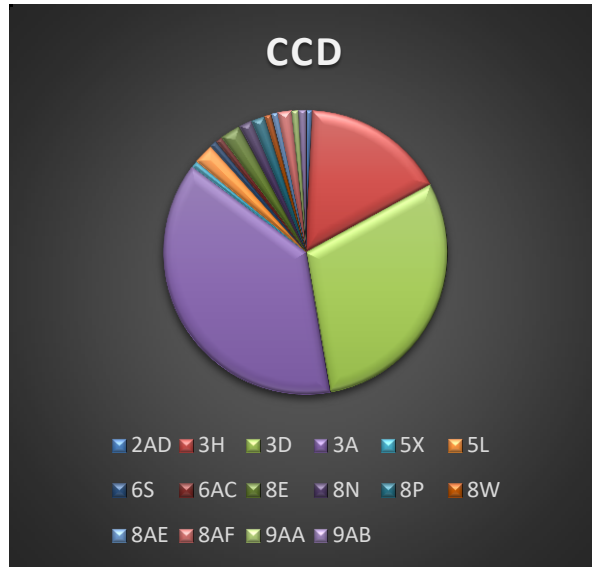
Pathotype designation ^a																																						
CCD	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	X	Q	R	S	T	U	V	W	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ		
Williams	3	2	5	3	8	2	5	3	5	8	5	5	6	8	3	8	5	6	6	6	2	4	7	6	8	8	9	9	6	2	8	8	1	9	1	1	2	
Differential Host	Reaction																																					
ECD 02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
ECD 05	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
ECD 06/N	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
ECD 08	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
ECD 09	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
ECD 10 W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
ECD 11 IQ	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
ECD 13 85	+	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Brutor	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Laurentian	+	+	-	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Mendel	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Westar	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
4SH29	+	+	+	+	+	-	+	-	-	+	+	-	-	-	+	+	+	+	+	-	+	+	-	+	+	-	-	+	+	-	-	+	+	+	-	-	-	

- Number of new pathotypes has continued to increase
- Several novel virulence patterns identified in ‘new’ clubroot regions and from single-spore isolates
- 36 unique pathotypes characterized to date

New Pathotypes

- Total of 9 new pathotypes identified from pathogen collections in 2017 and 2018
 - 6S, 8W, 9AA, 9AB, 6AC, 2AD, 8AE, 8AF, 1AG
 - Demonstrated the diversity in pathogen virulence
 - Most of the ‘new’ pathotypes confined to a specific area/county
- Predominant pathotypes continue to be 3A, 3D (and the ‘old’ pathotype 3H)

Pathotypes Identified 2017 & 2018



**Total of 36 pathotypes in
Canada as of 2018**

- More diversity in pathotypes discovered
- Continued increase in new pathotypes
- CCD designations help further identify a pathotypes unique virulence pattern in order to more accurately focus breeding efforts

Some Things a Pathotype Designation Will Tell You

- Virulence pattern of the isolate on the hosts tested
- How this virulence pattern compares with other isolates (Different or the same? New? Common? Rare?)
- Can the isolate overcome important sources of resistance? Does it break first generation resistance?
- Are there potential resistance sources among the differentials?

More generally, pathotyping helps guide resistance breeding activities and can be used to decide on deployment of resistance sources

Pathotyping

- With so many new pathotypes, breeders may have difficulty keeping up
 - Focus on predominant pathotypes
 - Genetics may not be an option for some farms with unique/rare pathotypes
- Integrated approaches to management will become more important (i.e., more diligent sanitization, working infested fields last, longer rotations out of host crops), as well as alternative strategies such as liming

Conclusions

- Clubroot continues to spread
- Biggest issue (in established clubroot areas) is the emergence of new pathotypes
- Pathotyping is important in order to focus breeding efforts, tailor management plans, and map clubroot areas to locate high risk zones and trends in pathotype spread and establishment

Acknowledgements

- Collaborators, students and staff
- Yoann Aigu for preparing maps
- Funders:
 - Alberta Canola
 - SaskCanola
 - Manitoba Canola Growers
 - Agriculture and Agri-Food Canada
 - Canola Council of Canada (CARP, Growing Forward Programs)
 - Industry partners
- In-kind support from Alberta Agriculture and Forestry, University of Alberta

