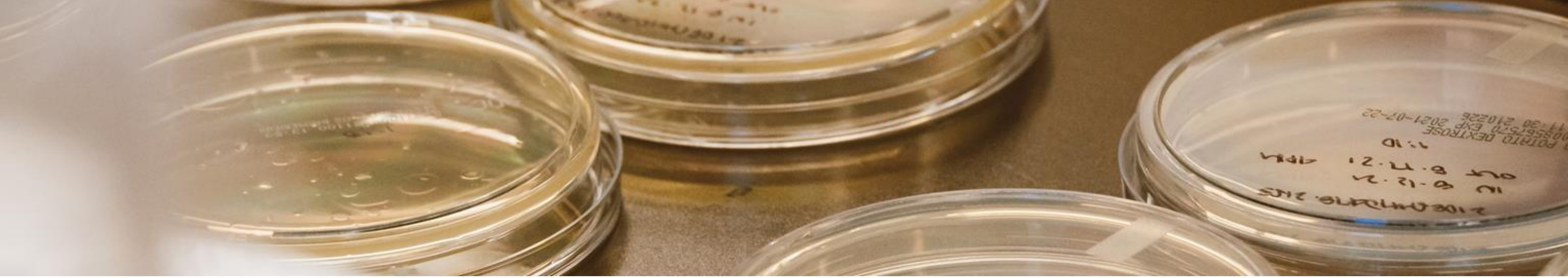
While we meet on a virtual platform, we acknowledge the Indigenous Peoples, who traditionally resided on all the lands that we are on today. From coast to coast to coast, we acknowledge the ancestral territories of all the First Nations, Inuit, and Métis, Peoples across the country. We do this as a reminder as public servants our commitments and responsibility in addressing the lasting impacts of colonization in Indigenous communities, especially the public health inequities experienced by Indigenous Populations. I ask that you take a moment to reflect on the traditional territory where you reside, and your responsibilities as non-partisan public servants to Indigenous Peoples in Canada.



The Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS)

2022 Integrated Findings

Annual Stakeholder Webinar
November 22nd, 2023

Canada

Agence de la santé publique du Canada
Public Health Agency of Canada

Dr. Michael R. Mulvey

September 17th, 1963 – August 29th, 2023

We dedicate this work in memory of our colleague, mentor and friend, Dr. Michael (Mike) R. Mulvey. This "Super-Bug Fighter" was passionate and committed to the battle against AMR. He was a pillar of the CIPARS program from its inception over 20 years ago and his contributions (knowledge, experience, and resourcefulness) were instrumental to the conception, design and expansion of the program. Mike's legacy will echo in CIPARS for countless years to come as we work to support measures to contain the emergence and spread of AMR.

"People who are crazy enough to think they can change the world, are the ones who do."

- Steve Jobs

Housekeeping

Presentation link

This presentation (FR/EN) can be found at:

[Document library - CIPARS Annual Stakeholder Meeting Integrated Findings Presentation 2023 (cahss.ca)]

- The Canadian Animal Health Surveillance System AMU/AMR Network has also developed several guidance documents on antimicrobial use reporting that can be found at https://cahss.ca/cahss-networks/amuamr

Comments and Questions

- Comments/questions (FR/EN) will be taken at the end of the presentation
- Please mute until the question period begins

Survey/Poll using Menti.com

- Please use either your mobile phone or a web browser to access www.menti.com
- An 8-digit code will be provided to you and must be entered to access the survey questions

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What organization do you represent?/ À quelle organisation êtes-vous affiliée?

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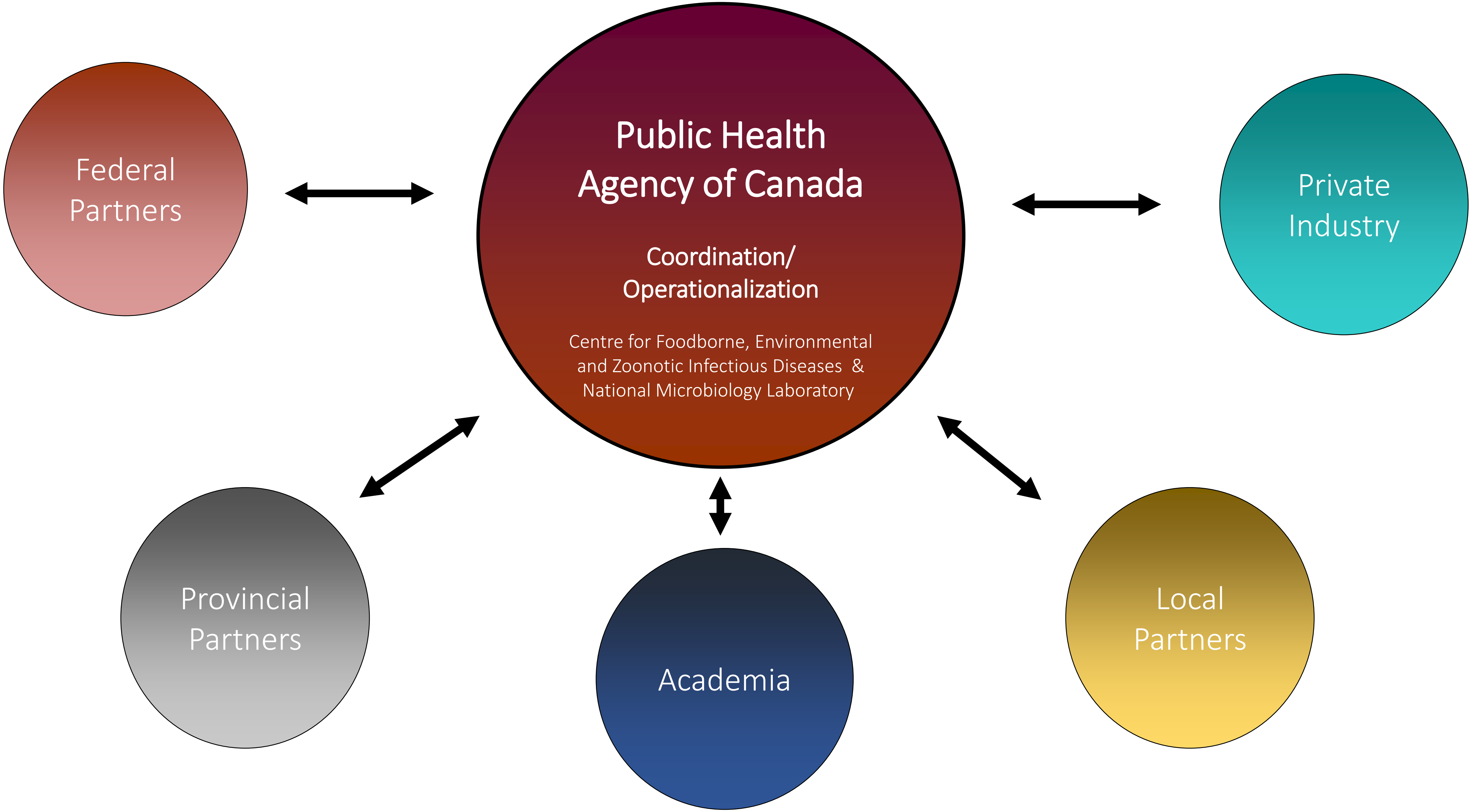
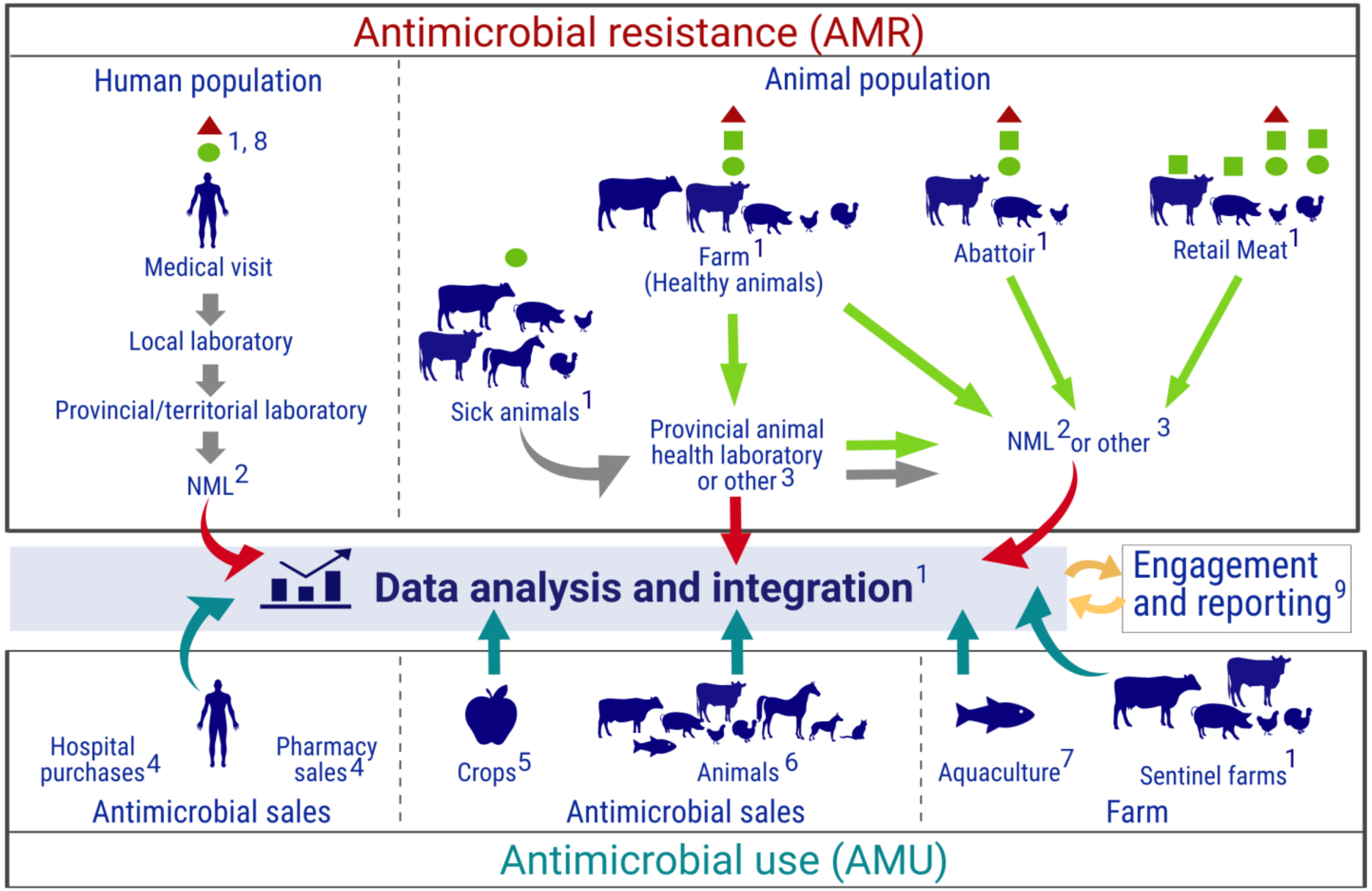

Federal Partners
Public Health Agency of Canada
Coordination/ Operationalization
Centre for Foodborne, Environmental and Zoonotic Infectious Diseases & National Microbiology Laboratory
Private Industry
Provincial Partners
Academia
Local Partners

Agenda

- CIPARS Activities
- 2022 Integrated Findings
- Interactive Data Visualizations
- Summary
- Comments, questions, and answers

Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS)



1 Centre for Foodborne and Environmental and Zoonotic Infectious Diseases (CFEZID), Infectious Diseases and Vaccination Programs Branch (IDVPB), Public Health Agency of Canada (PHAC)
2 One Health Division, and Division of Enteric Diseases, National Microbiology Laboratory (NML) Branch, PHAC
3 University laboratory or private laboratory
4 Canadian Antimicrobial Resistance Surveillance System (CARSS), PHAC. Data source: IQVIA
5 Pest Management Regulatory Agency, Health Canada
6 Veterinary Antimicrobial Sales Reporting (VASR), Veterinary Drugs Directorate, Health Canada and CFEZID, PHAC
7 Fisheries and Oceans Canada
8 FoodNet Canada, CFEZID, IDVPB, PHAC
9 CIPARS engagement and reporting including: Annual Stakeholder Webinars, Integrated Findings Reports, Data Visualizations, Farm Surveillance Technical Reports (including health and biosecurity data), Fact sheets, Infographics, Journal publications, VASR Highlights Reports, and CARSS Reports

- Active surveillance
- Passive surveillance
- *Campylobacter*
- *Escherichia coli*
- *Salmonella*
- AMR data
- AMU data
- Communication

Since its inception in 2002, CIPARS has expanded to a large multidisciplinary team with multiple antimicrobial resistance (AMR) and antimicrobial use (AMU) surveillance components

Led by the Public Health Agency of Canada in conjunction with multiple federal departments and external stakeholders

Antimicrobial Categorization

Antimicrobials are grouped into categories based on their importance to human medicine

Medically important antimicrobials

Category I: Very high importance

Examples: 3rd generation cephalosporins, fluoroquinolones

Category II: High importance

Example: macrolides

Category III: Medium importance

Examples: tetracyclines, sulfonamides

Category IV: Low importance

Example: ionophores

*Categorization system developed by Health Canada's Veterinary Drugs Directorate

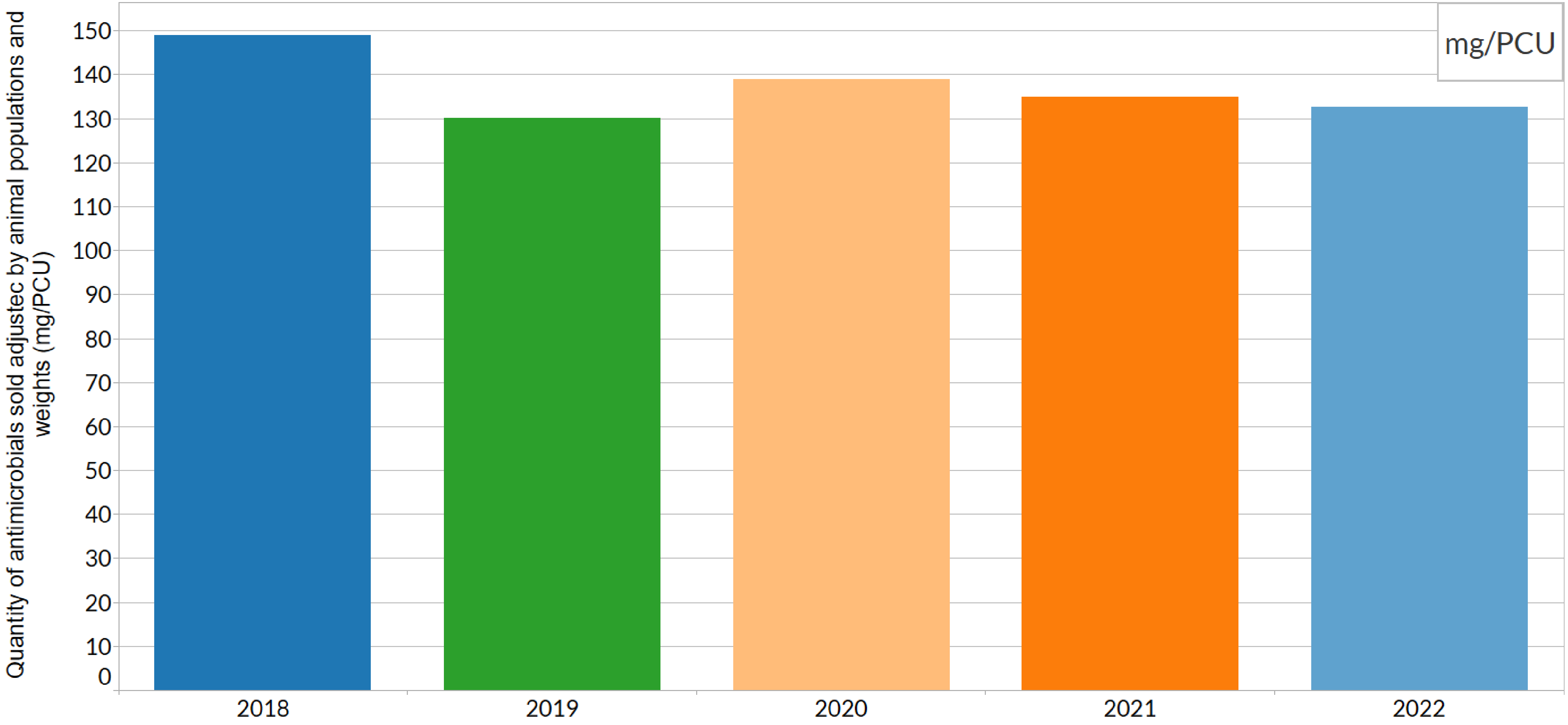
Chemical coccidiostats are considered out of scope of medically important antimicrobials. Uncategorized medically important antimicrobials include pleuromutilins, orthosomycins, coumarins and pseudomonic acids

Categorization of antimicrobials: https://www.canada.ca/en/health-canada/services/drugs-health-products/veterinary-drugs/antimicrobial-resistance/categorization-antimicrobial-drugs-based-importance-human-medicine.html

List of certain antimicrobial active pharmaceutical ingredients: https://www.canada.ca/en/public-health/services/antibiotic-antimicrobial-resistance/animals/veterinary-antimicrobial-sales-reporting/list-a.html

Integrated Antimicrobial Sales

After accounting for the number of animals and their weights using an average weight at treatment (mg/population correction unit or mg/PCU_{CA}), there was an **11% decrease** in the quantity of antimicrobials sold for use in all animals **since 2018**

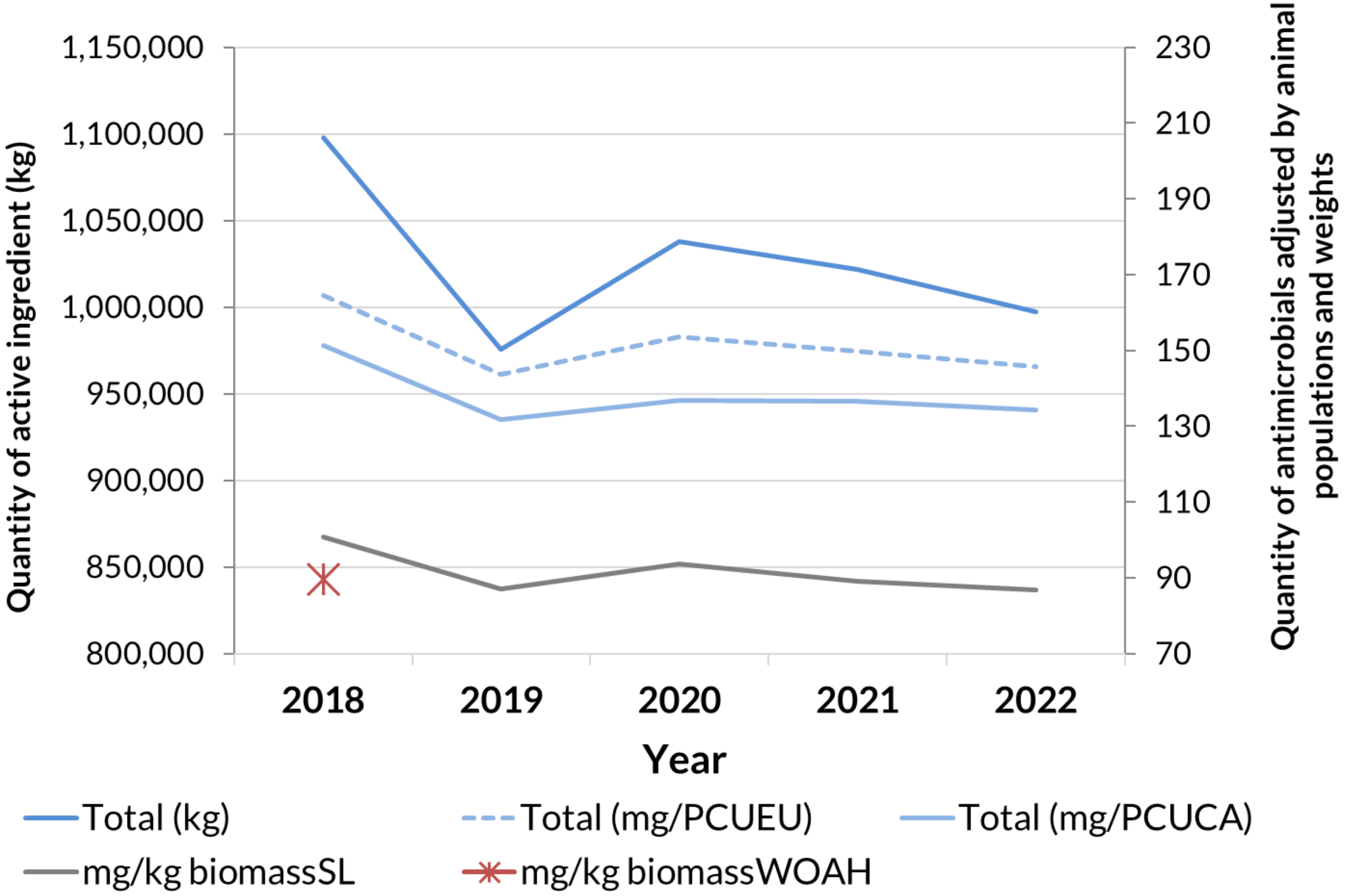


The total quantities of antimicrobials sold by manufacturers and importers for use in **production animals** decreased by **2.4%** (in kg) between 2021 and 2022

When the total quantities were adjusted for biomass, the decrease was **1.7%** when using Canadian average weights at treatment (mg/PCU_{CA}) and **2.6%** when using an average live weight at slaughter (mg/kg $biomass_{SL}$)

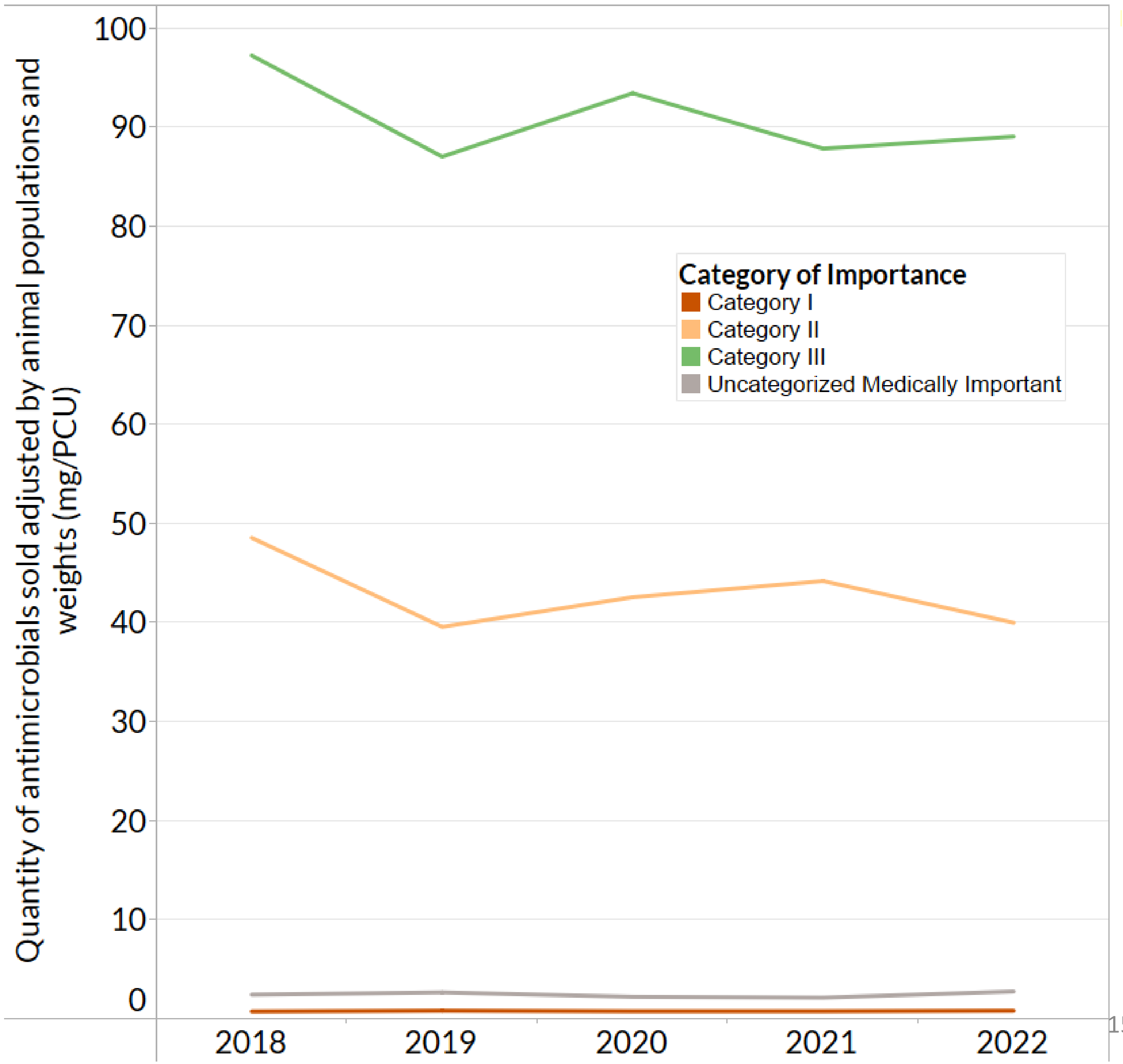
The quantity of antimicrobials sold for use in animals has decreased since 2018, however, sales (adjusted for animal biomass) have remained fairly stable since 2019

Regardless of the metric used, the trends in the quantity of sales are similar



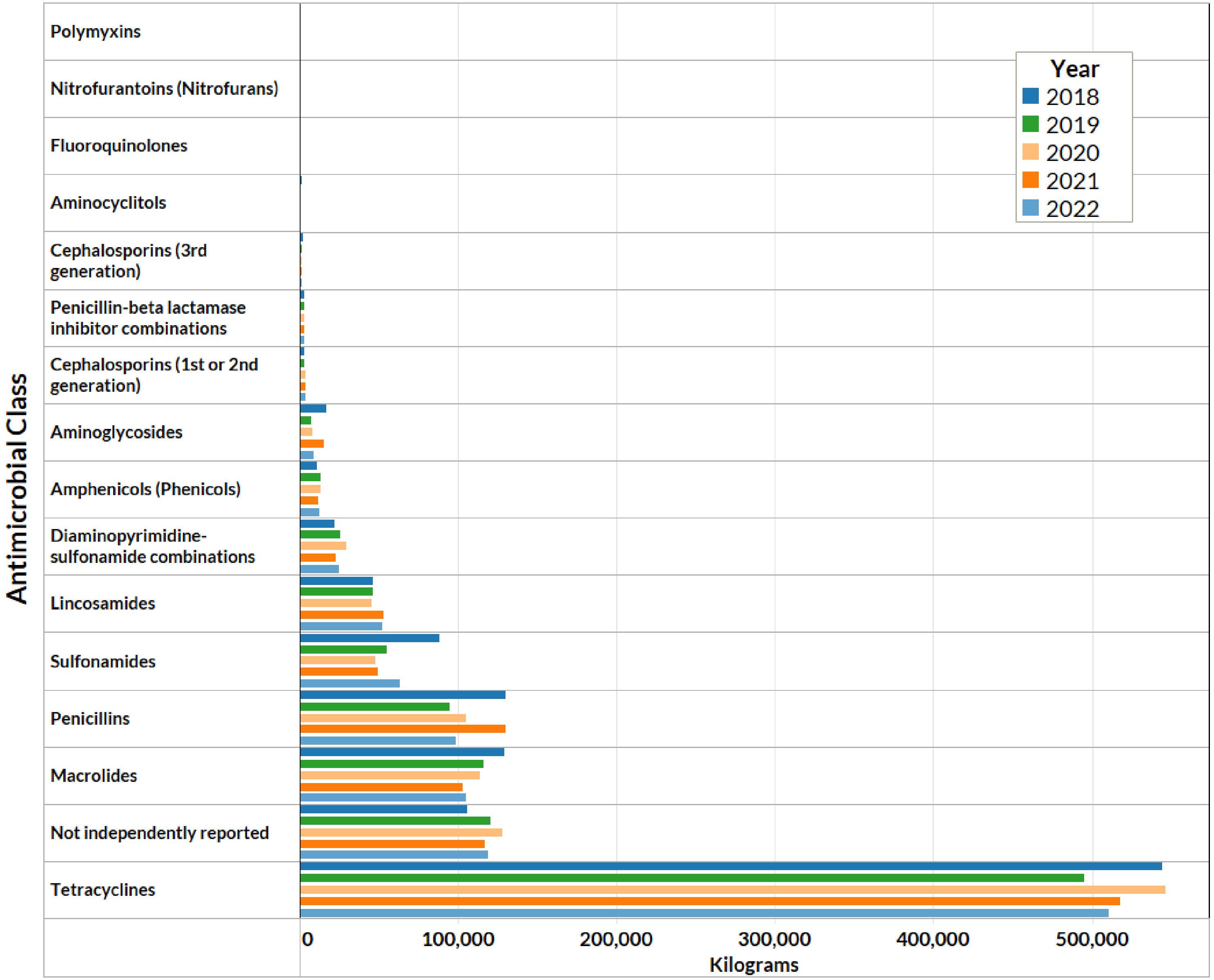
The majority of antimicrobials sold since data collection began in 2018 were Category II and III antimicrobials

- **Less than 1%** of antimicrobials sold annually are **Category I** antimicrobials
- Between 2021 and 2022, sales of Category I antimicrobials (adjusted by animal biomass) increased by 6%



https://www.canada.ca/en/health-canada/services/drugs-health-products/veterinary-drugs/antimicrobial-resistance/categorization-antimicrobial-drugs-based-importance-human-medicine.html

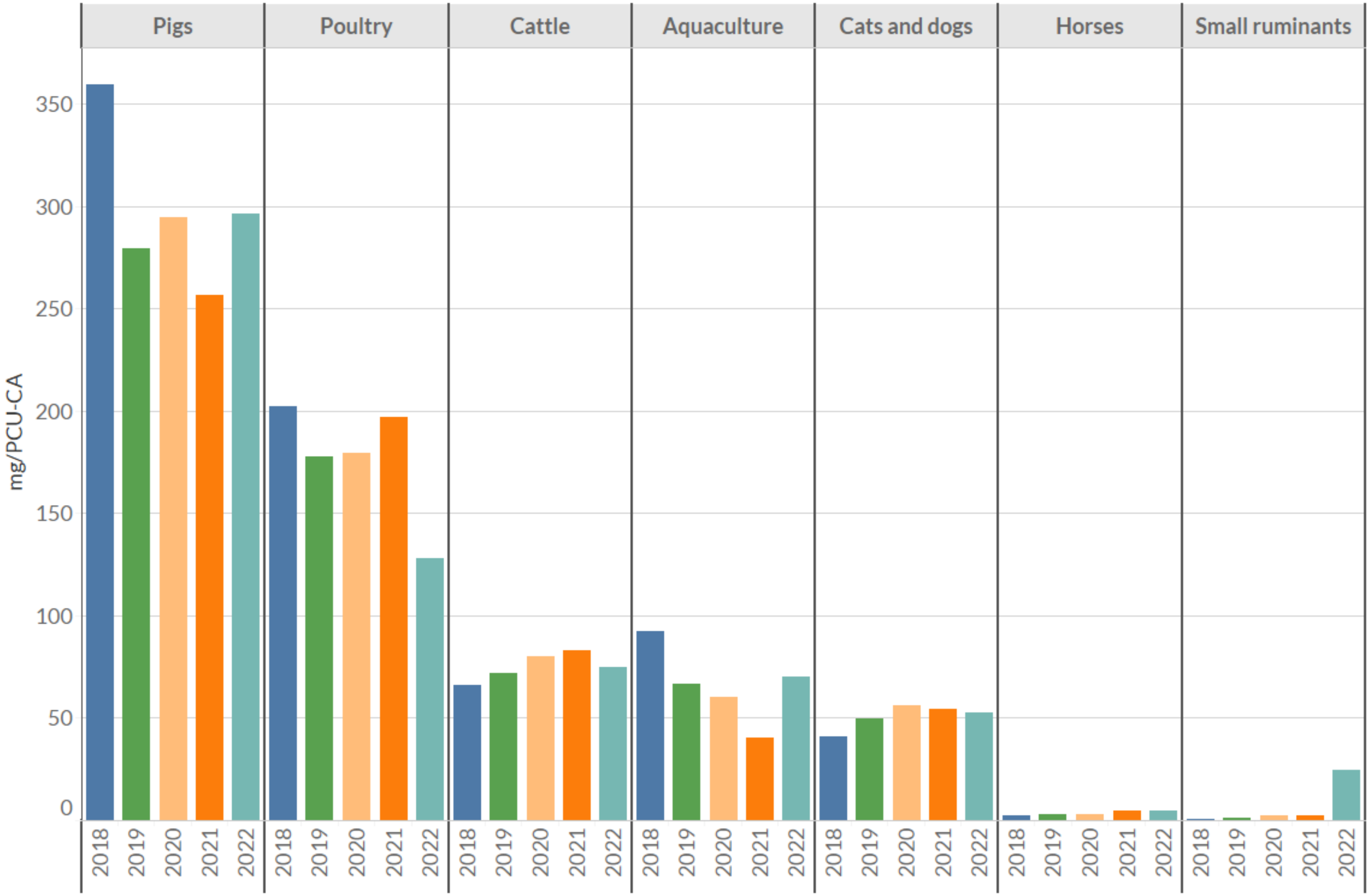
Kilograms of antimicrobials sold for use in all animals (manufacturers and importers) (unadjusted)



- In **2022, tetracyclines had the highest quantity of sales**, followed by macrolides, penicillins, and bacitracins
- Between 2020 and 2022, tetracycline sales decreased by ~35,000 kg
- Between 2021 and 2022, the classes with the largest decreases in sales were penicillins, tetracyclines, aminoglycosides and bacitracins

***Not independently reported (NIR)** antimicrobials include aminocoumarins, bacitracins, diaminopyrimidines, fusidic acid, glycopeptides, nitroimidazoles, orthosomycins, phosphonic acid derivatives, pleuromutilins, pseudomonic acids, streptogramins, and therapeutic agents for tuberculosis

After adjusting for the number of animals and their weights at treatment, the majority of sales in 2022 were intended for use in **pigs**, **poultry**, **cattle, and aquaculture**



Notable species findings:

Sales for pigs have been more variable, however, there was a less than 1% change between 2020 and 2022

Sales for poultry decreased in 2022 by 35% since 2021

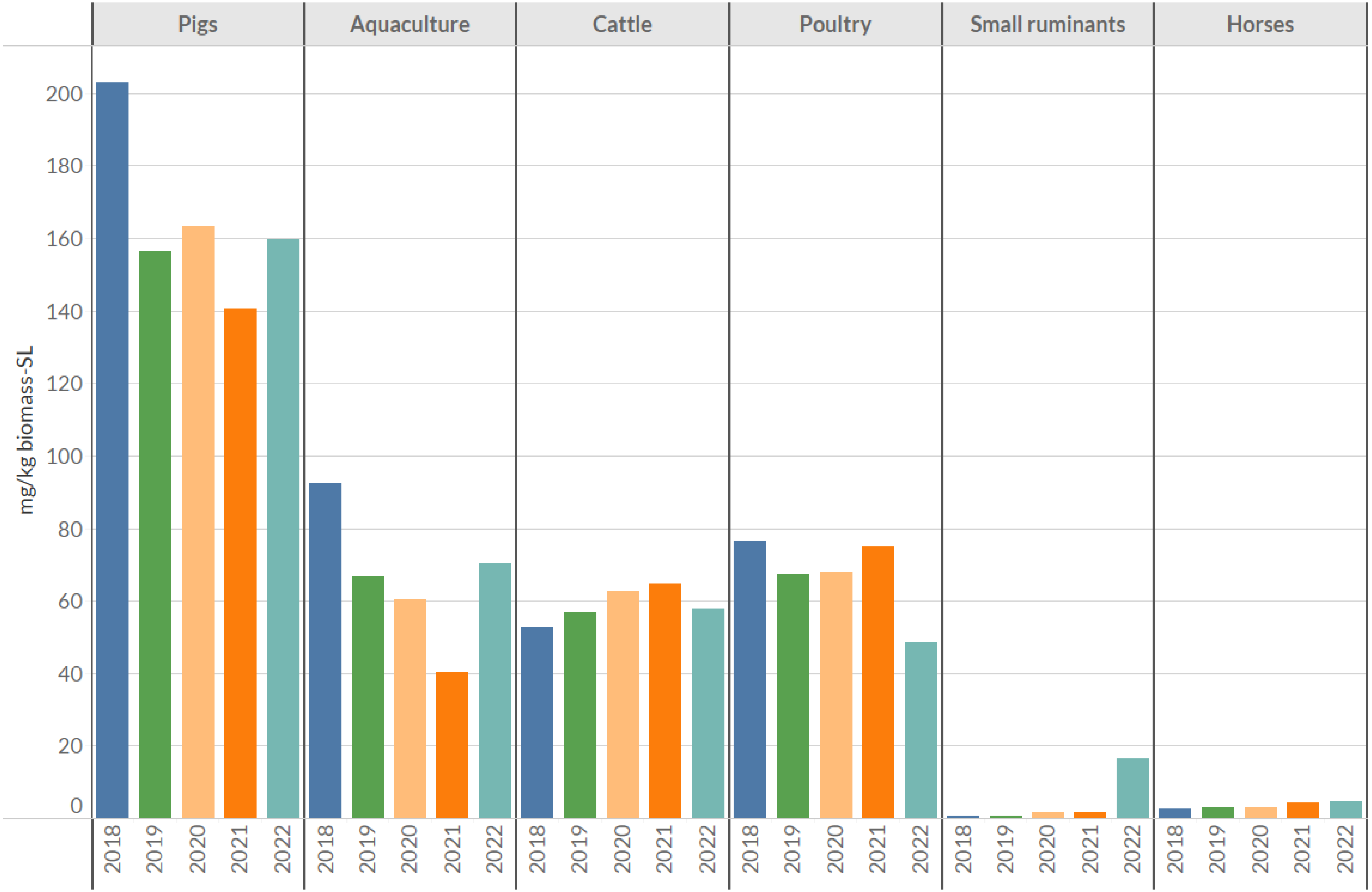
Sales for cattle decreased in 2022 for the first time since 2018

Sales for aquaculture increased in 2022 by 74% since 2021
For aquaculture mg/PCU = mg/kg $biomass_{SL}$

In 2022, there were reported sales for use in honey bees (tetracyclines)

1 population correction unit (PCU) =1 kg animal

After adjusting for biomass using an average weight at slaughter, the majority of sales in 2022 were intended for use in **pigs, aquaculture, cattle, and poultry**



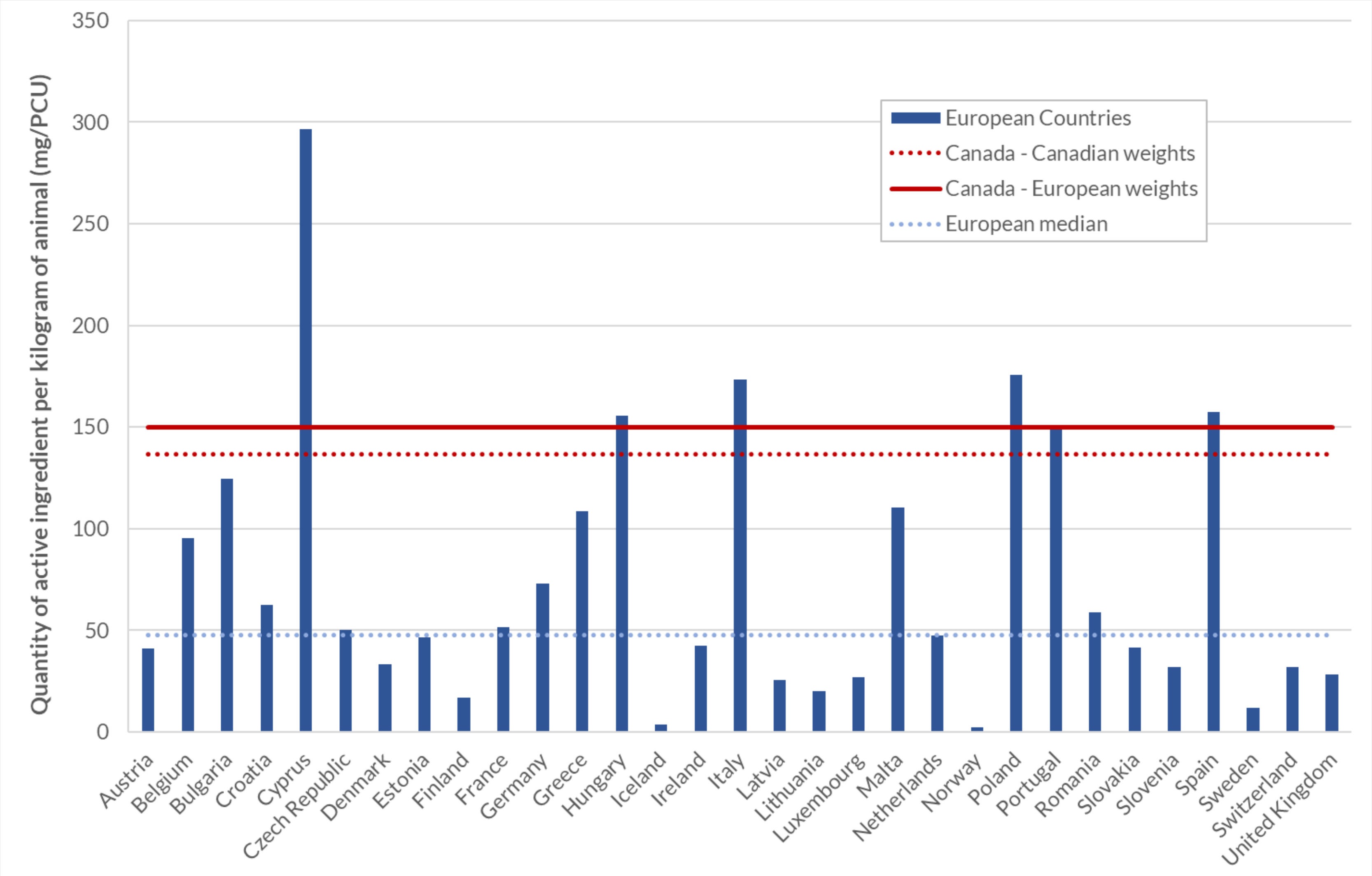
The ranking of species by quantity of sales varies depending on the measure used.

We are currently working on developing biomass denominators for beef cattle, dairy cattle, and veal calves.

*Average weight at slaughter for horses = average live adult weight

In 2021, when compared with European countries participating in the ESVAC network, Canada ranked **7th highest for** quantities of antimicrobials sold

Quantities of antimicrobials sold (mg/PCU_{EU}) for production animals by Canada and countries participating in the European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) network, 2021



Assuming data are comparable

Canadian sales are ~ 3 times the median of 31 European network countries

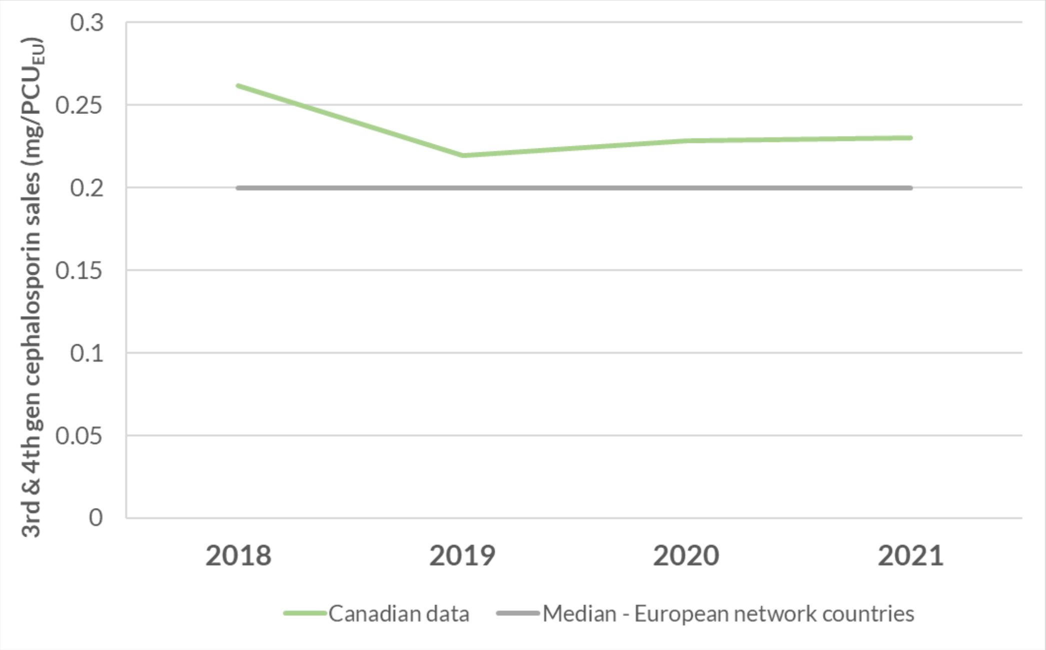
Numerator data sources: VASR, European Medicines Agency

*The European median may include the sale of a small quantity of injectable products intended for use in companion animals. Also, the ESVAC (European) denominator does not include beef cows, whereas in Canada beef cows are a significant population and are included

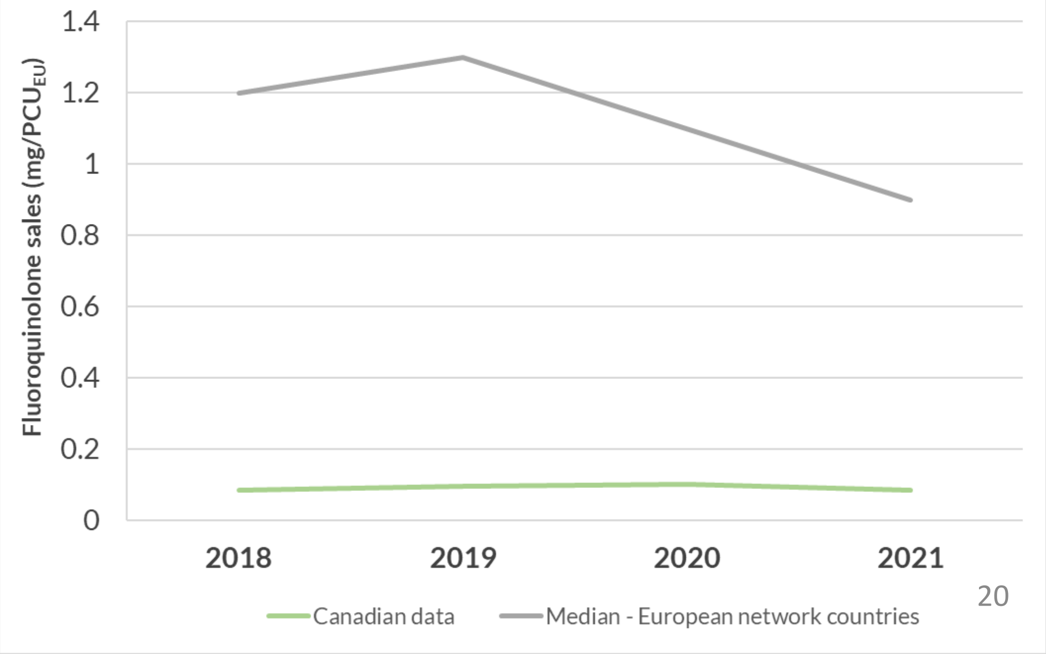
[a]European median includes data from 31 European countries as reported by the European Medicines Agency.

However…

- From 2018 to 2021, the quantity of 3rd generation (and higher) cephalosporins sold for production animals was similar to Europe (**~1.1 – 1.3 times higher** in Canada than European median)
  - Note: 4th generation cephalosporins are not labelled for use in animals in Canada



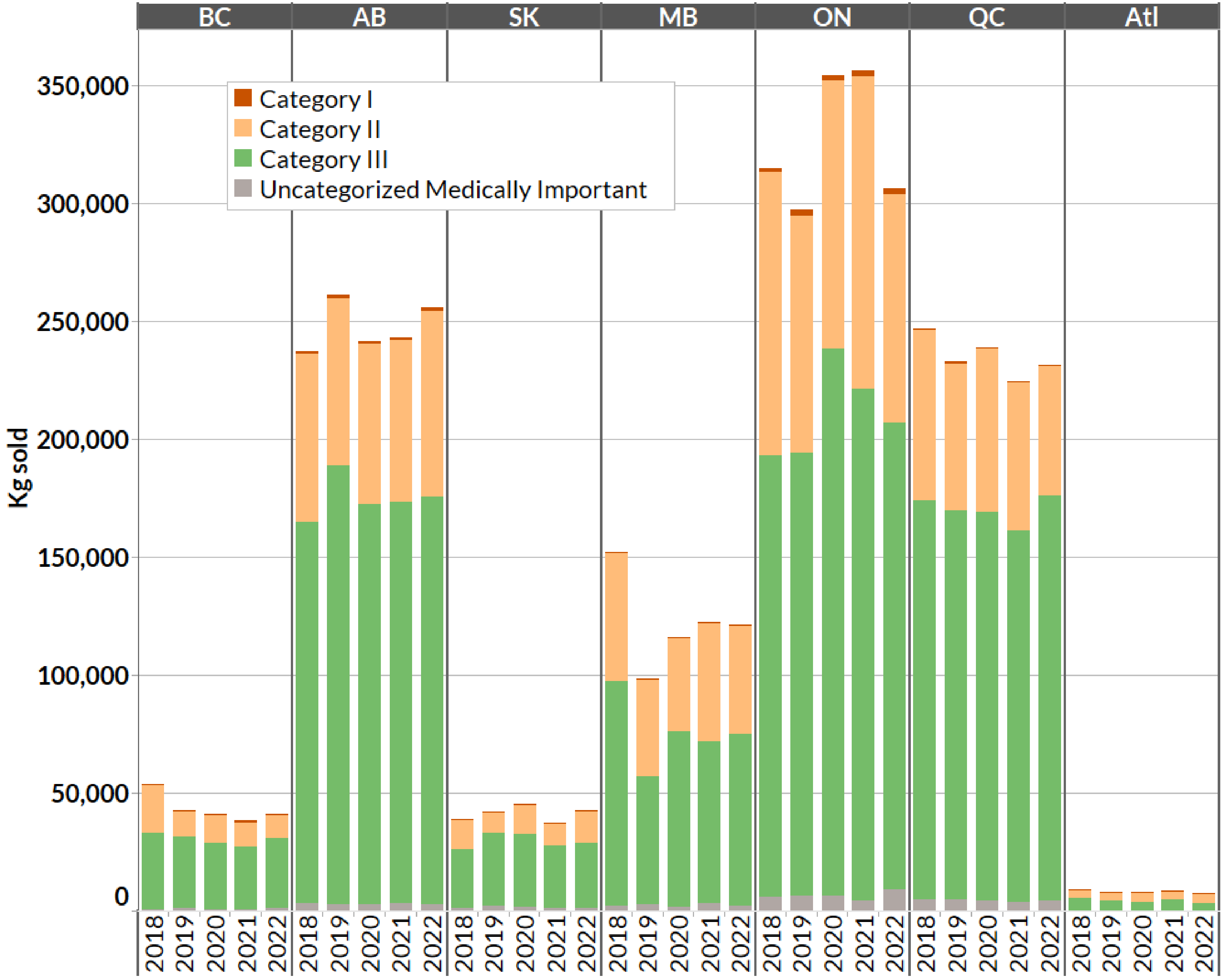
- From 2018 to 2021, the quantity of fluoroquinolones sold for production animals was **~11-15 times lower** in Canada than the European median



*The European median may include the sale of a small quantity of injectable products intended for use in companion animals. Also, the ESVAC (European) denominator does not include beef cattle, whereas in Canada beef cows are a significant population and are included.

[a]European median includes data from 31 European countries as reported by the European Medicines Agency

Veterinary Antimicrobial Sales Reporting (VASR)



We see the most antimicrobial sales where there are the most animals

While quantities of antimicrobials compounded are not included in this figure, the majority of what was reported as compounded continued to be intended for use in **pigs**

Québec, Ontario, and Manitoba continued to be the provinces with the largest quantity of reported compounding

*Provincial biomass estimates will soon be available to contextualize sales




In 2022:

Unadjusted (kg only):

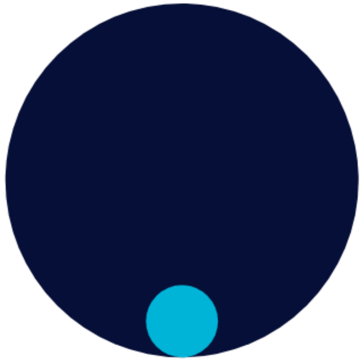
80%
Production animals

19%
Humans

< 1%
Cats and Dogs

< 1%
Crops

~22x **more animals** than people in Canada



~1.5x

More medically important antimicrobials were sold for use in **production animals** than humans **after adjusting for underlying biomass** in 2022

Data sources:
Human hospital purchases and community pharmacy dispensations: CARSS (IQVIA); Crops: Health Canada's Pest Management Regulatory Agency (HC-PMRA); Human population: Statistics Canada

There is a different spectrum of antimicrobials sold for use in animals compared to people

Antimicrobial Class	Human 2018	Human 2019	Human 2020	Human 2021	Human 2022	Animal 2018	Animal 2019	Animal 2020	Animal 2021	Animal 2022
1-2 gen cephalosporins	17.8	17.5	15.4	14.6	14.5	0.4	0.4	0.5	0.5	0.5
3-4 gen cephalosporins	2.4	2.3	2.3	2.2	2.3	0.3	0.2	0.2	0.2	0.2
aminoglycosides	0.1	0.1	0.1	0.1	0.1	2.3	1.0	1.1	2.0	1.1
carbapenems	0.7	0.5	0.5	0.5	0.5	0.0	0.0	0.0	0.0	0.0
fluoroquinolones	6.8	5.8	4.8	4.6	4.9	0.1	0.1	0.1	0.1	0.1
lincosamides	2.5	2.3	2.1	2.0	1.8	6.3	6.1	6.0	7.0	6.8
macrolides	5.5	4.9	3.0	2.2	3.1	17.5	15.2	15.0	13.6	13.8
other	5.8	6.9	6.8	6.8	6.9	15.5	17.6	18.7	17.2	17.3
penicillins	54.4	52.4	39.9	35.4	46.2	17.9	12.8	14.3	17.7	13.3
sulfonamides	8.7	7.7	7.3	7.2	6.9	15.4	10.5	10.2	9.6	11.6
tetracyclines	3.5	3.3	2.9	3.1	3.2	73.4	64.8	72.3	68.8	66.9

Milligrams adjusted for biomass
0.0 – 75.0

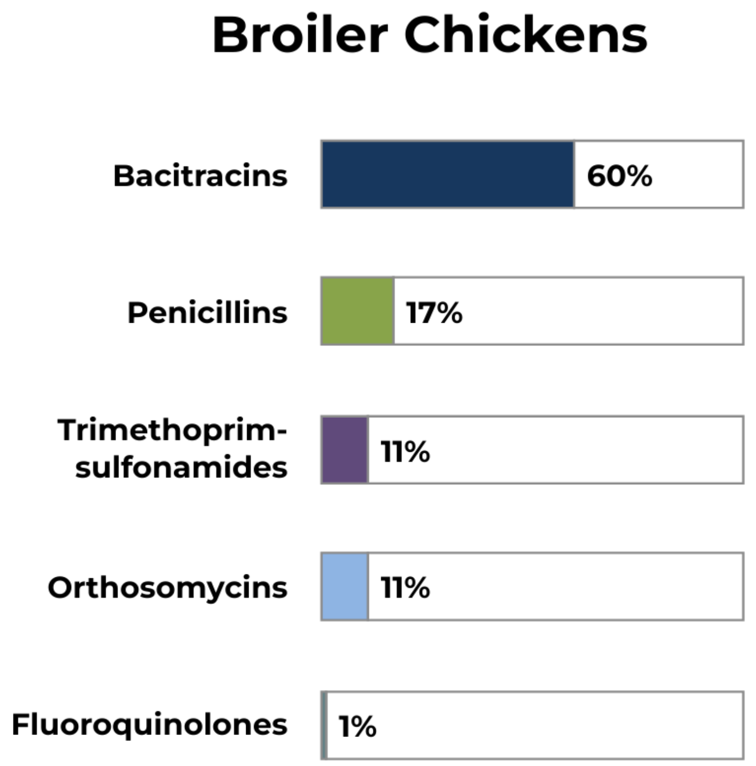
Note: The only medically important antimicrobial class sold for use on crops are aminoglycosides (Source: HC-PMRA).
Animal = food animals, horses, and cats and dogs
Data sources: CARSS (IQVIA) and CIPARS-VASR

Others for **humans** includes: bacitracins, 5th generation cephalosporins, fosfomycins, fusidic acid, glycopeptides, lipopeptides, monobactams, nitrofurans, nitroimidazoles, oxazolidinones, phenicols, and polymyxins.
Others for **animals** includes: aminocoumarins, aminocyclitols, amphenicols, β-lactamase inhibitors, cyclic polypeptides, fusidic acid, glycopeptides, nitrofurantoins, nitroimidazoles, orthosomycins, phosphonic acid derivatives, pleuromutilins, polymyxins, pseudomonic acids, streptogramins, and therapeutic agents for tuberculosis

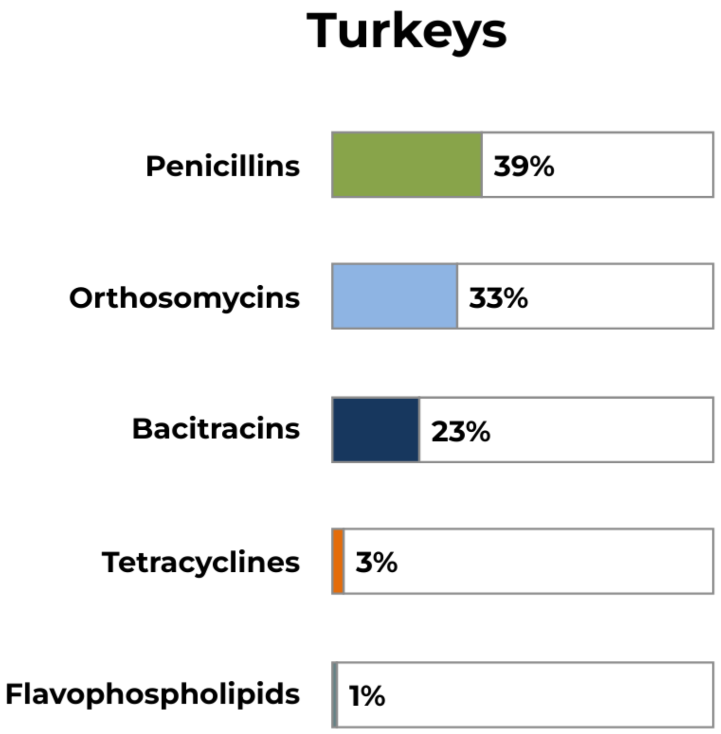
Integrated Farm AMU, and AMR at Farm and Retail*

*Due to low sample numbers at retail, we will be presenting aggregated data from CIPARS and FoodNet Canada (FNC)
For more information visit: https://www.canada.ca/en/public-health/services/surveillance/foodnet-canada.html

Important to recognize the different spectrum of antimicrobials used across host species*



Not shown: flavophospholipids (<1%)

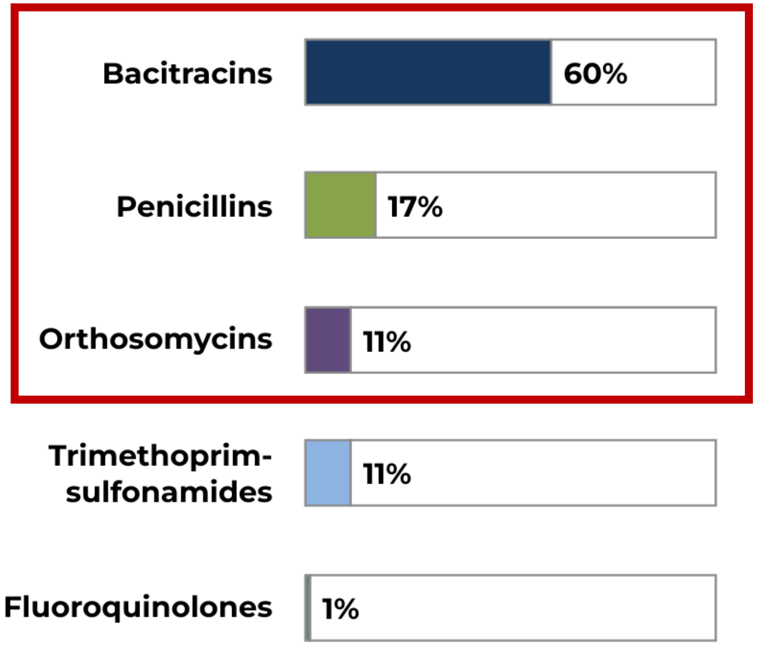


Not shown: fluroquinolones (<1%)

*The percentages are based on reported total kilograms of active ingredients

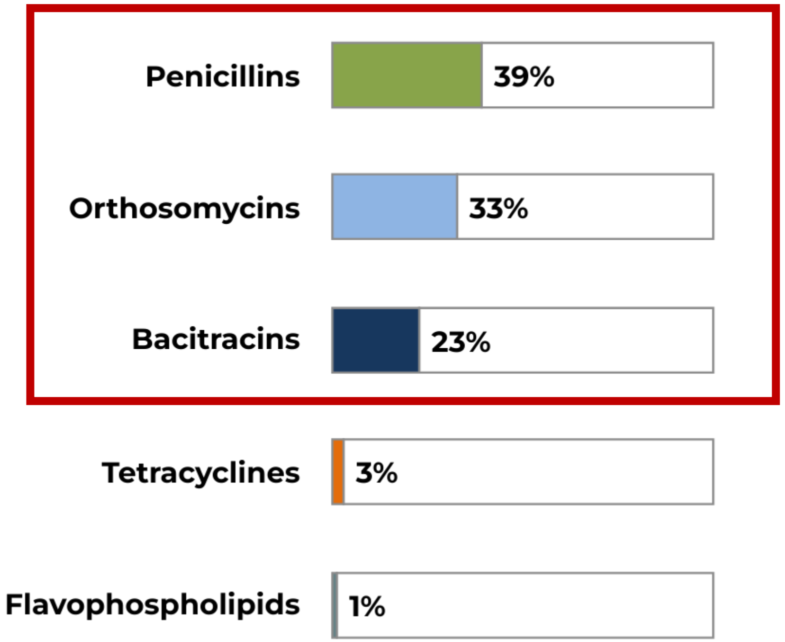
*VASR: Top classes sold for use in poultry in 2022

Broiler Chickens



Not shown: flavophospholipids (<1%)

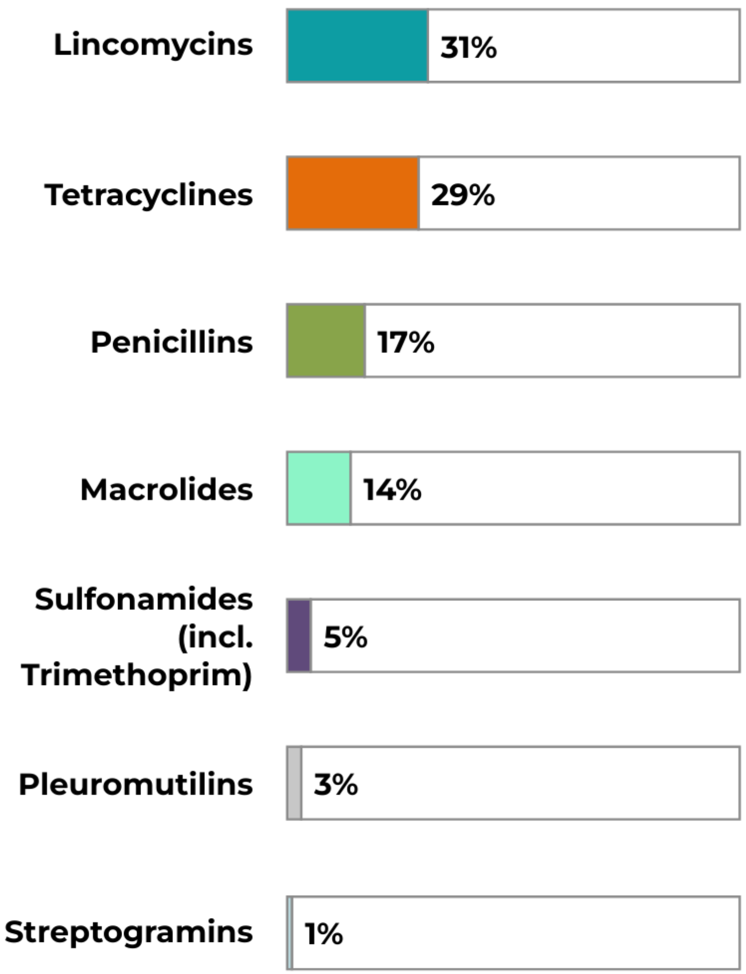
Turkeys



Not shown: fluroquinolones (<1%)

*Data highlighted by the addition of a red box around the respective AMU data

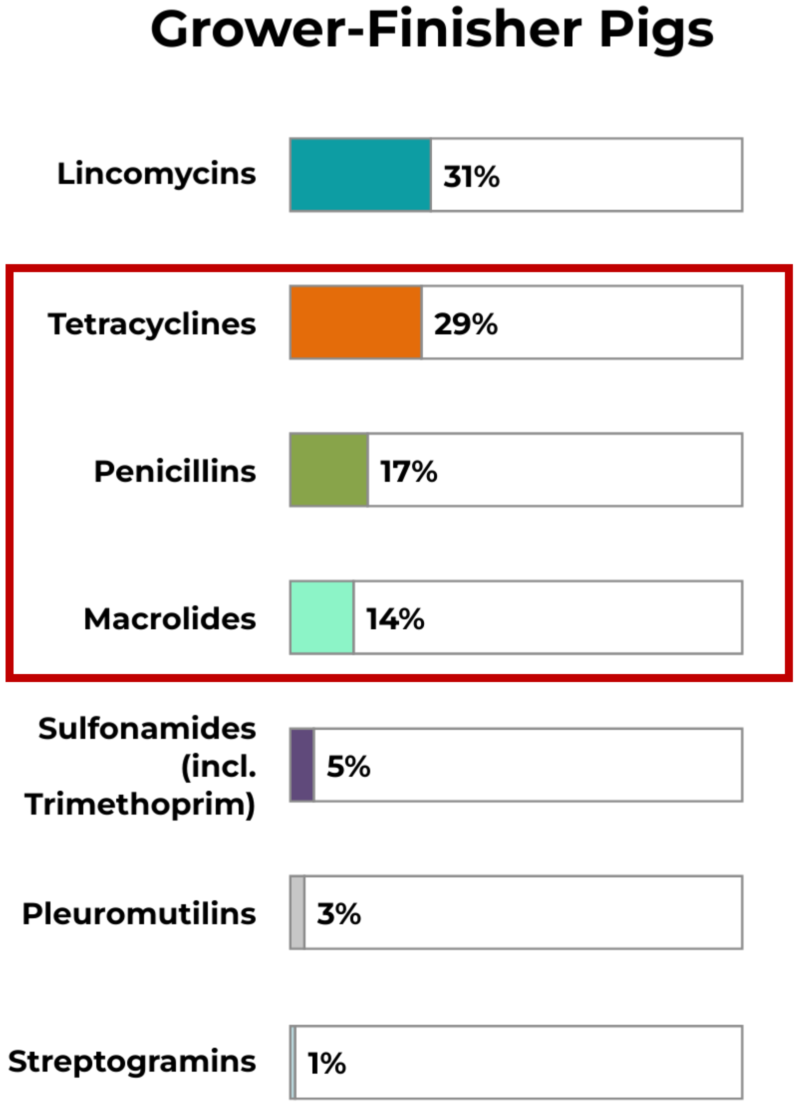
Grower-Finisher Pigs



Not shown: phenicols (< 1%), third generation cephalosporins (< 1%), and fluoroquinolones (< 1%)

*The percentages are based on reported total kilograms of active ingredients

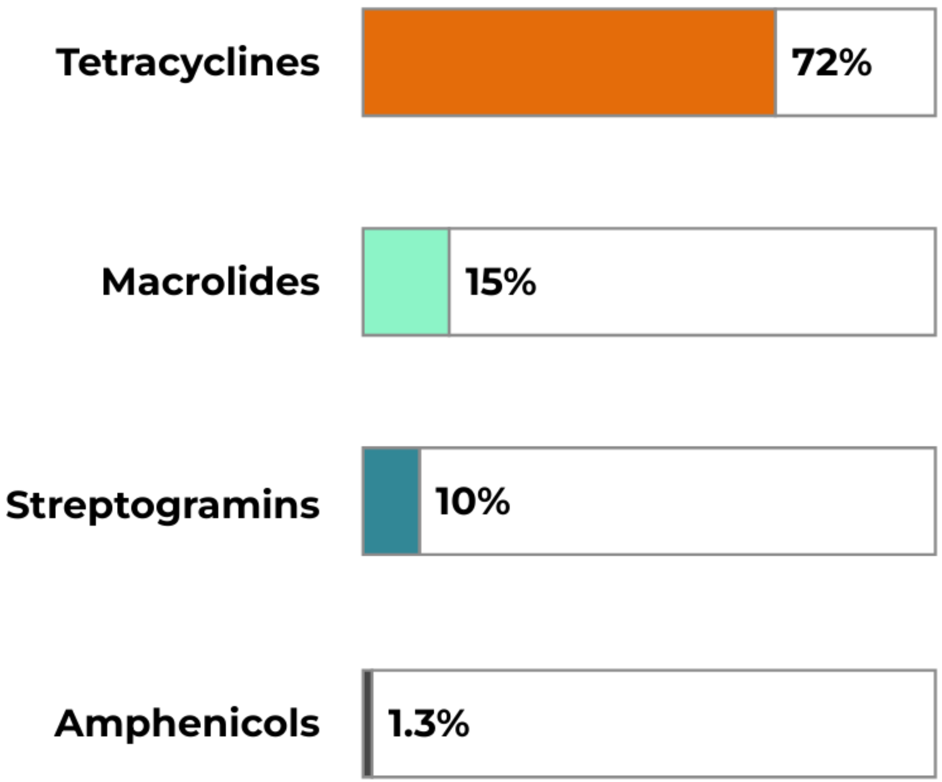
*VASR: Top classes sold for use in swine in 2022



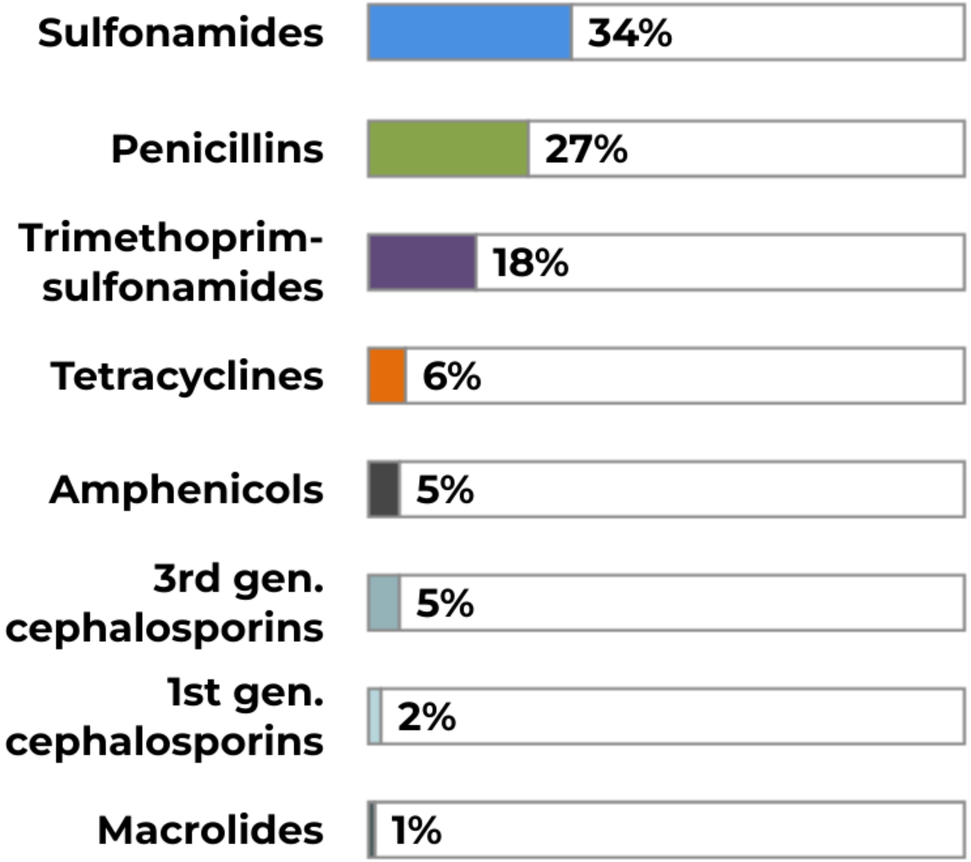
Not shown: phenicols (< 1%), third generation cephalosporins (< 1%), and fluoroquinolones (< 1%)

*Data highlighted by the addition of a red box around the respective AMU data

Feedlot Cattle



Dairy Cattle (2019)

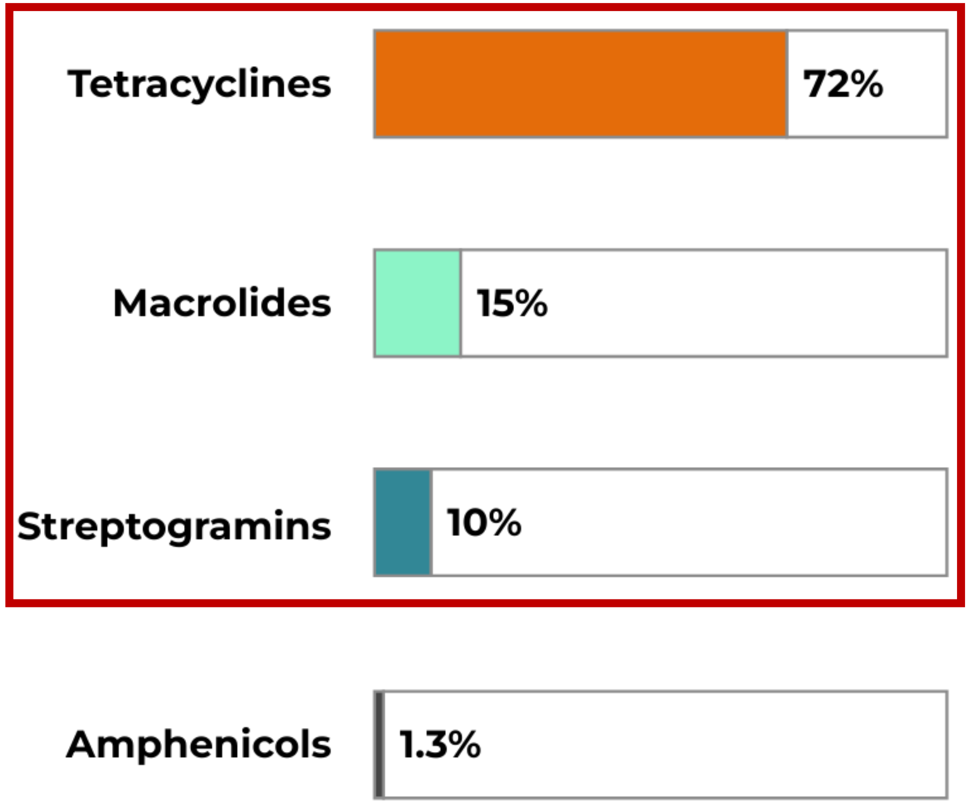


Not shown: aminocoumarins (< 1%), aminoglycosides (< 1%), fluroquinolones (< 1%), lincosamides (< 1%), polymyxins (< 1%)

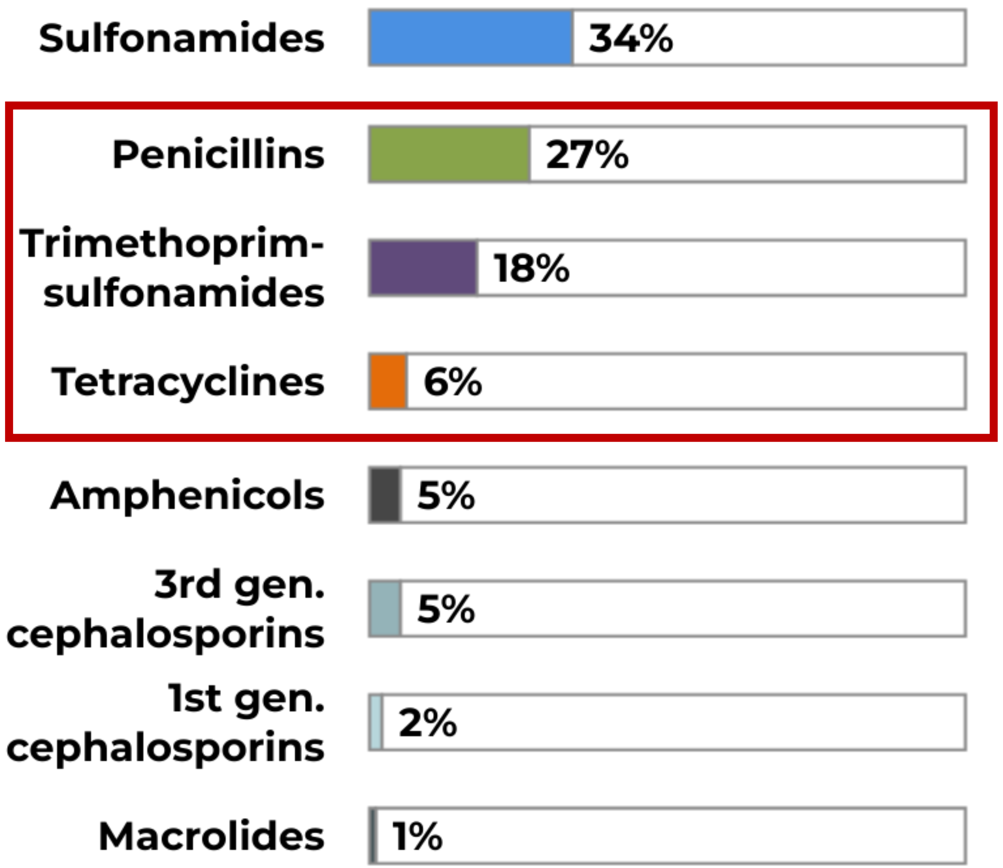
***The percentages are based on reported total kilograms of active ingredients**

*VASR: Top classes sold for use in feedlot and dairy cattle in 2022

Feedlot Cattle



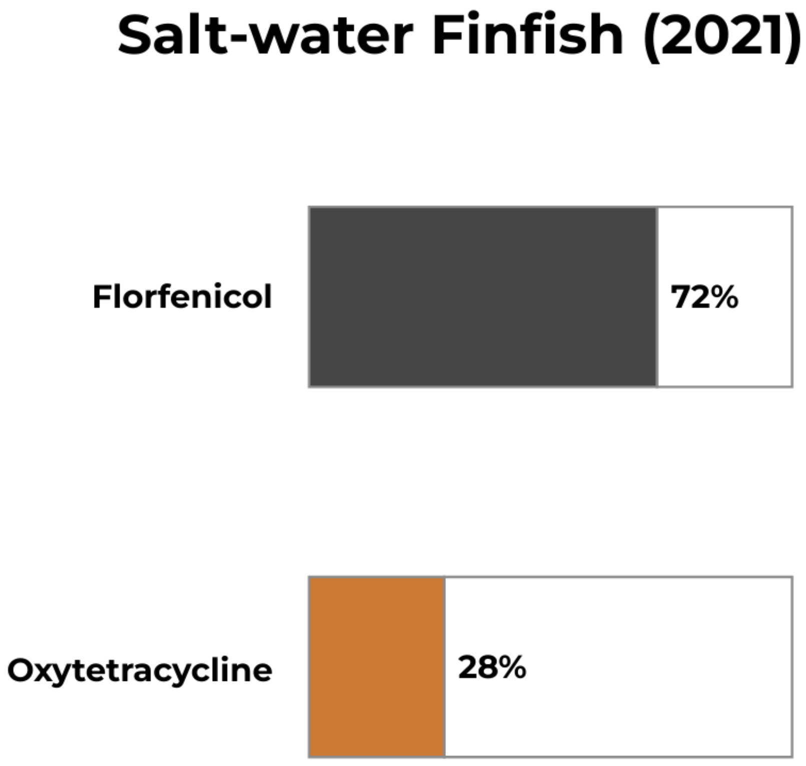
Dairy Cattle (2019)

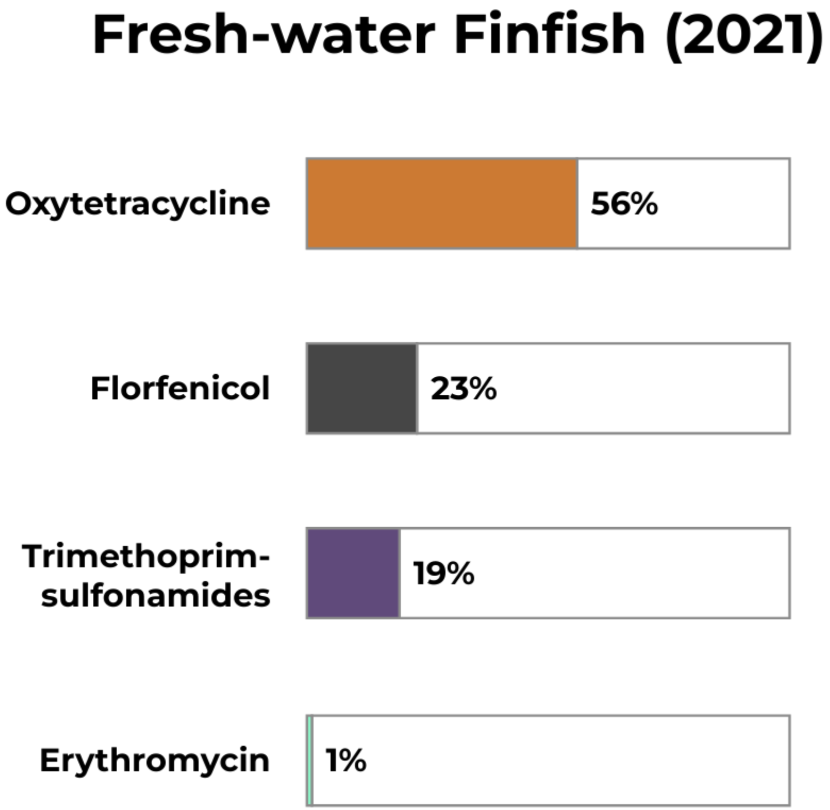


Not shown: aminocoumarins (< 1%), aminoglycosides (< 1%), fluroquinolones (< 1%), lincosamides (< 1%), polymyxins (< 1%)

*Data highlighted by the addition of a red box around the respective AMU data

Fisheries and Oceans Canada – Aquaculture Data





*The percentages are based on reported total kilograms antimicrobials (active ingredients), not including anti-parasitic drugs

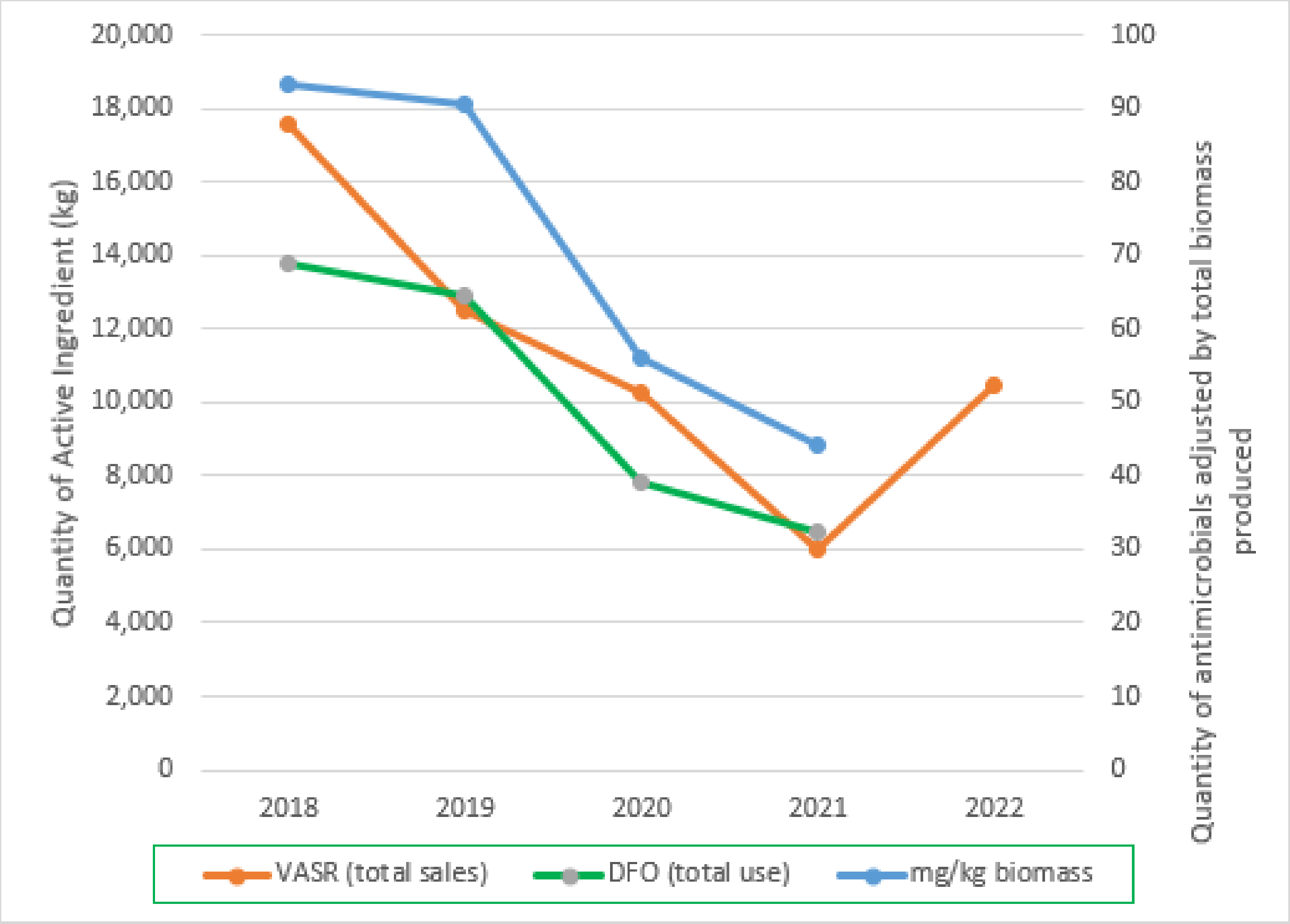
DFO: https://open.canada.ca/data/en/dataset/288b6dc4-16dc-43cc-80a4-2a45b1f93383

The quantity of antimicrobials sold and used nationally in aquaculture in kg and adjusted for population biomass*

- First comparison of sales data with the aquaculture prescription data – they are very similar

- Sales and use have decreased substantially between 2018 and 2021(noting the recent increase in sales in 2022)
    - VASR: 66% decrease between 2018 and 2021 (kg)

*Antimicrobial totals in kg do not include anti-parasitic drugs



Broiler Chickens – AMU increased, AMR stable or increased, flock mortality generally stable

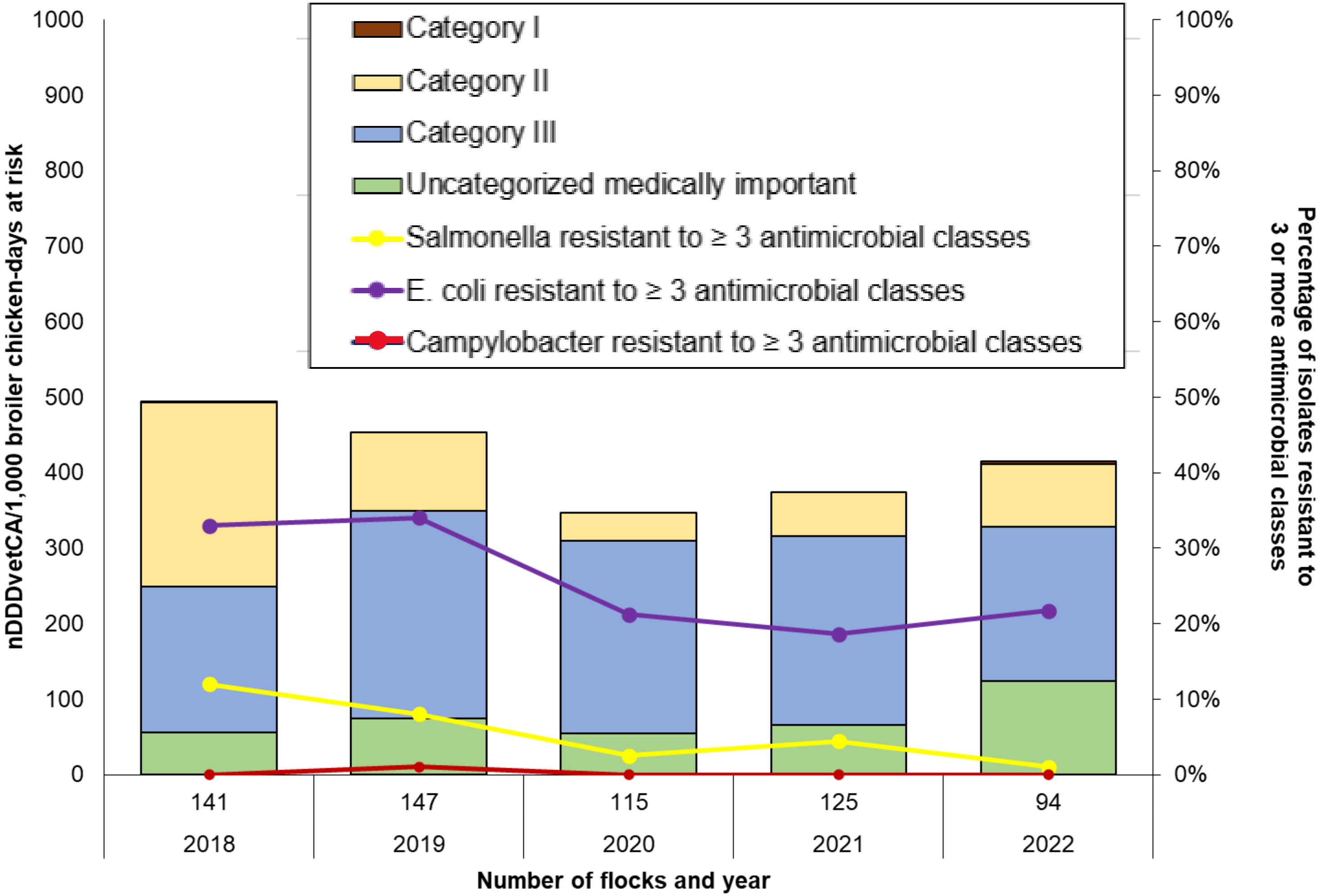
- 2022 marked the 4th year of the Poultry Industry's Step 2, of their **AMU reduction strategy**

- AMU increased by 11% in 2022 (measured by nDDDvetCA/1,000 broiler chicken-days at risk) compared to 2021
  - Most antimicrobials were used for the prevention of enteric diseases (~86%)
  - Treatment of localized or systemic infections accounted for the remaining use

- Flock mortality remained stable (4%)
- Except for *Enterococcus cecorum/Staphylococcus* spp. infections that increased from 5%-13% (2021-2022), the diagnosis of most diseases decreased or remained stable in 2022
  - 1 flock was treated with fluoroquinolones due to early chick mortality
  - Vaccination against certain pathogens added to routine broiler vaccination schemes: bacteria - necrotic enteritis vaccination, viral diseases – infectious laryngotracheitis

AMU and AMR in broiler chickens

- AMU has increased in 2022 compared to 2020 and 2021 but lower compared to 2018/2019
- Resistance to ≥3 antimicrobial classes: *Salmonella*-decreased by 3%; *E. coli* - increased by 3%; *Campylobacter:* no notable change
- Ceftriaxone resistance: Decreased for both *Salmonella* (by 1%) and *E. coli* (by 4%) compared to 2021
- Nalidixic acid-resistance: Increased for *Salmonella* (by 4%) compared to 2021
- Ciprofloxacin resistance: Substantial increase in *Campylobacter* since 2018 (22% increase)



Raw chicken: Increased nalidixic-acid resistance observed in *Salmonella* isolates

Ceftriaxone resistance:

- Between 2018 and 2022, the trend in the frequency of resistance has decreased for both *E. coli* (6% to 2%) and *Salmonella* (11% to 7%)

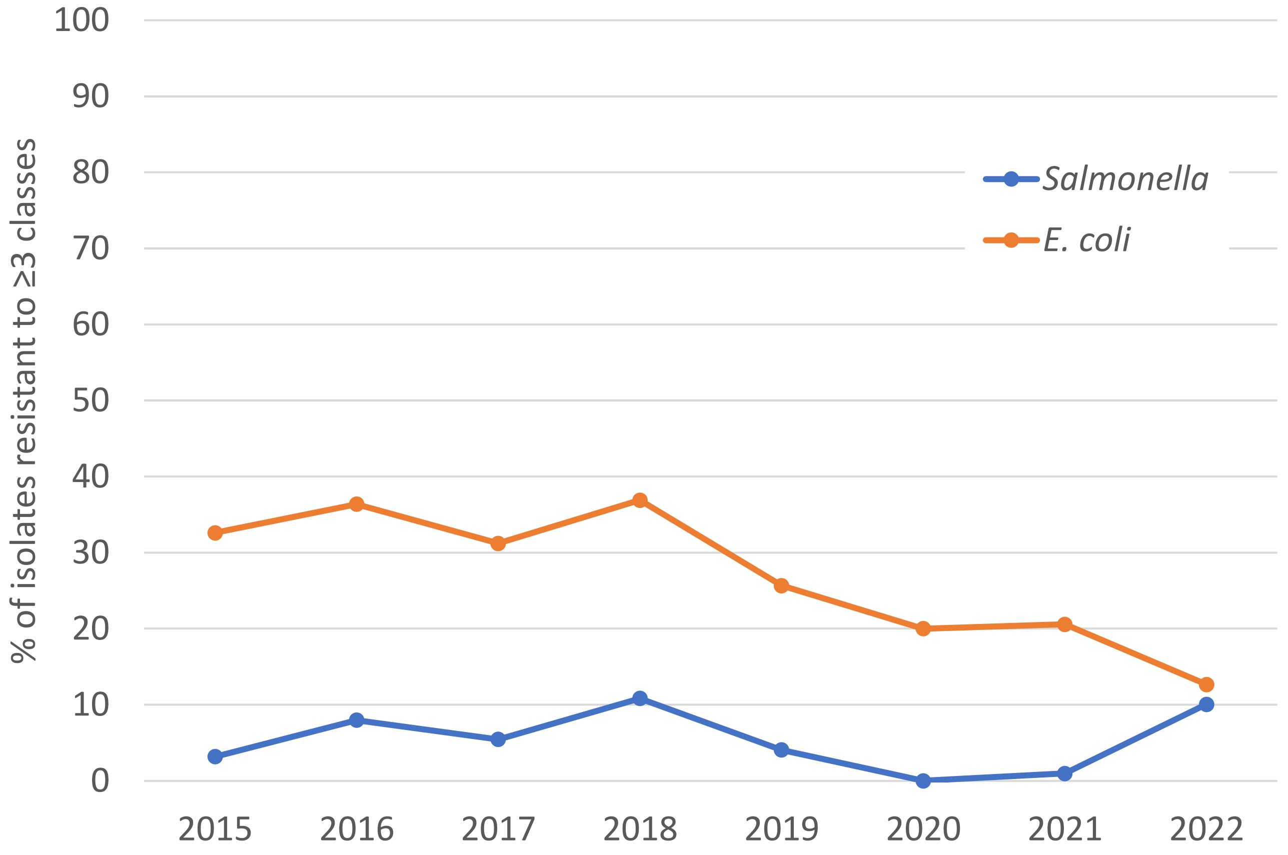
Nalidixic acid resistance:

- For *E. coli* the frequency of resistance ranged from 4%-6% with an increase to 11% in 2020
- For *Salmonella,* the frequency of resistance increased to 18% in 2022 from 1%-4% in previous years (resistance to ciprofloxacin was not observed)

Gentamicin resistance:

- For *E. coli*, resistance has decreased from 25% to 11%
- For *Salmonella* resistance was very low ranging between 0% to 3%

Resistance to ≥3 antimicrobial classes



n		2015	2016	2017	2018	2019	2020	2021	2022
n	*Salmonella*	347	276	239	203	222	92	104	159
	E. coli	414	503	570	496	495	225	350	442

Note: The proportion of isolates resistant towards ceftriaxone, nalidixic acid, and gentamicin was similar to what was seen among abattoir isolates.

Turkeys –AMU decreased, AMR stable, flock mortality stable

- Decrease in AMU (measured by nDDDvetCA/1,000 turkey-days at risk) driven by the reduced use of category II and III antimicrobials
  - A limited quantity of Category I (fluoroquinolones) continued to be reported

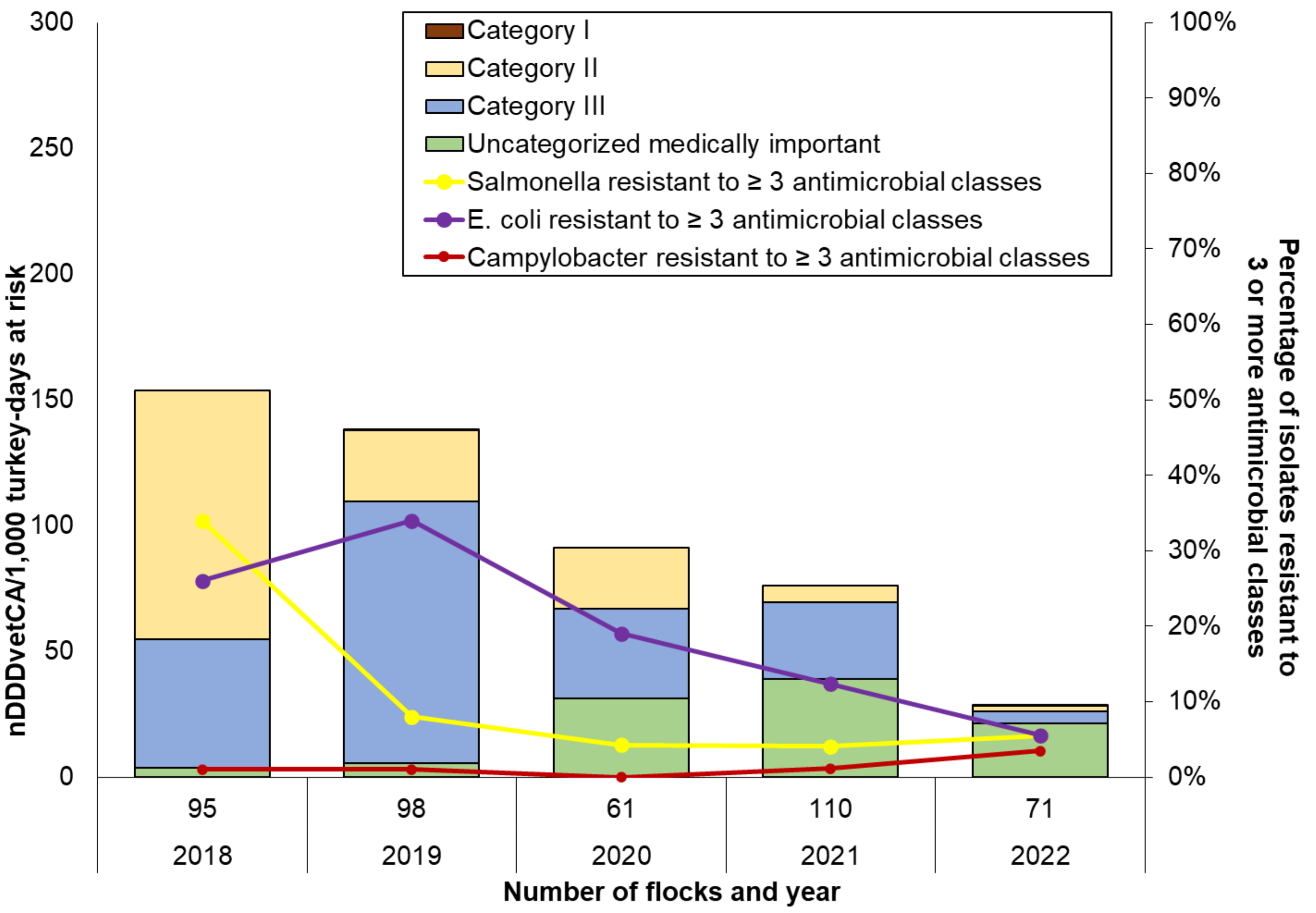
- Most antimicrobials were used for the prevention (56%) and treatment of localized and systemic infections (36%). Treatment of enteric (8%) diseases accounted for the remaining use
  - One flock that experienced early mortality was treated with a fluoroquinolone

- Average flock mortality increased by 0.7% in 2022 (5.9% to 6.6%) with occasional occurrences of yolk sac infection and respiratory diseases. In 2021, 3 flocks were diagnosed with histomoniasis (blackhead, a protozoal disease)

**fewer flocks sampled in some provinces due to the prolonged HPAI outbreak situation*

AMU and AMR in turkeys

- AMU in turkeys decreased by 63% since 2022 compared to 2021
- The diversity of antimicrobial classes reported to be used has decreased from 8 classes in 2021 to 5 classes in 2022
- Resistance to ≥ 3 antimicrobial classes increased by 1% in *Salmonella,* and 2% in *Campylobacter* and decreased by 7% in *E. coli*
- Ceftriaxone and nalidixic acid resistance remained stable in *Salmonella* and *E. coli*
- Since 2018 ciprofloxacin-resistant *Campylobacter* has decreased by 27%



Turkey: Resistance to ceftriaxone and nalidixic acid remain low

Ceftriaxone resistance:

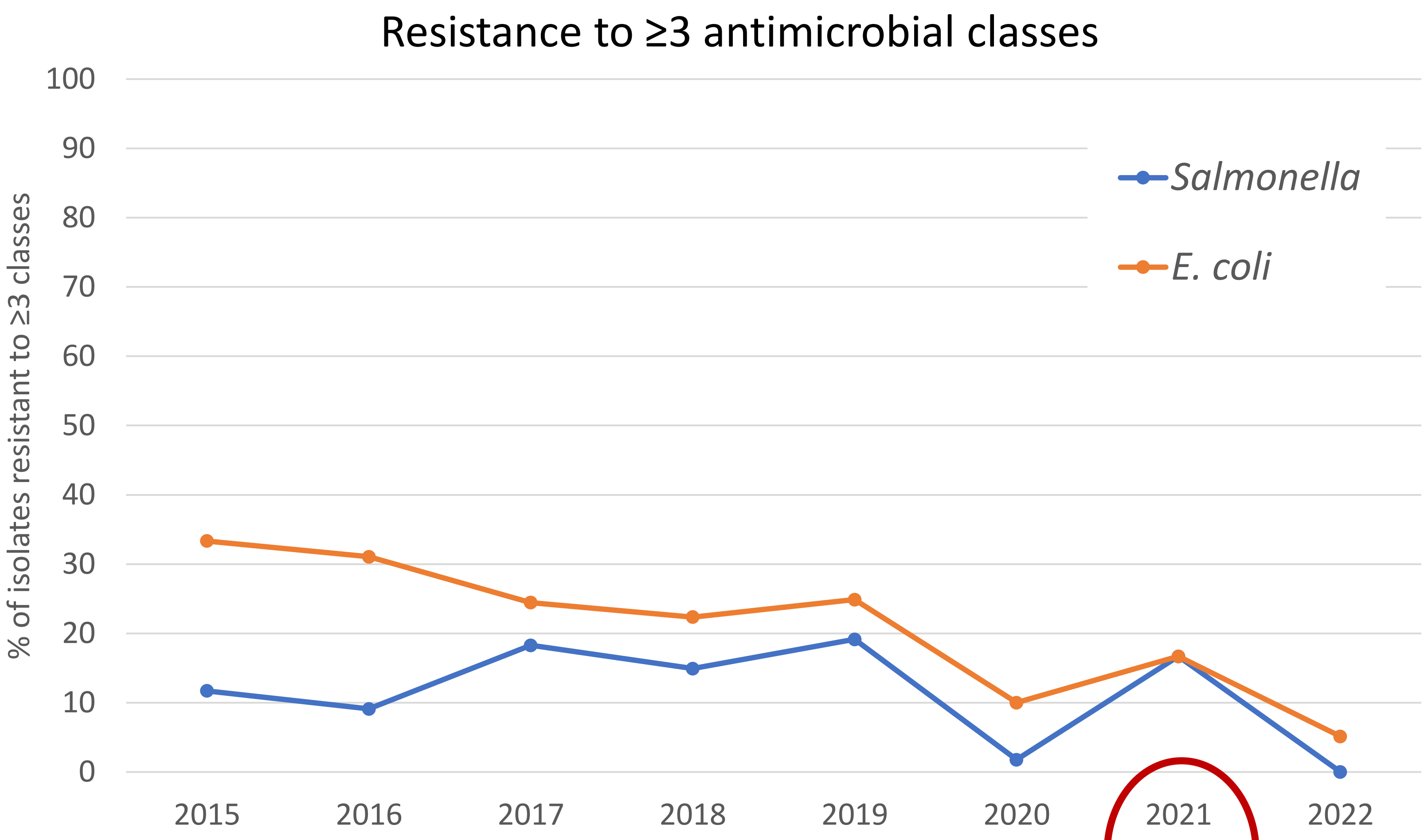
- Resistance ranges between 1% and 6% for *E. coli* and 0% to 2% for *Salmonella*

Nalidixic acid resistance:

- Resistance in *E. coli* was 1% or 2% for most years except 2021 where it increased to 17% (n=30 isolates)
- Resistance was not observed for *Salmonella*

Gentamicin resistance:

- Resistance in *E. coli* decreased from 12% to 4%
- Resistance in *Salmonella* ranged from 0% to 7%



n		2015	2016	2017	2018	2019	2020	2021	2022
	Salmonella	171	88	93	114	115	57	12	48
	E. coli	318	264	266	179	181	90	30	78

AMU

- Bacitracin use was reported in 2020/21 (9% of flocks; n=72) and 2022 (20% of flocks; n=50)
- Amprolium (2% of flocks) and monensin (8% of flocks), both non-medically important were also reportedly used in 2020/21, and amprolium (1 flock) in 2022
- These findings suggest that layers are also susceptible to enteric diseases and occasionally exposed to antimicrobials

AMR in *E. coli*

- 280 (2021) and 198 (2022) isolates were tested
- Low-level(< 3%) of the isolates were resistant to 3 or more classes
- ≥ 70% susceptible to all antimicrobials tested in all surveillance years
- No isolates resistant to Category I antimicrobials

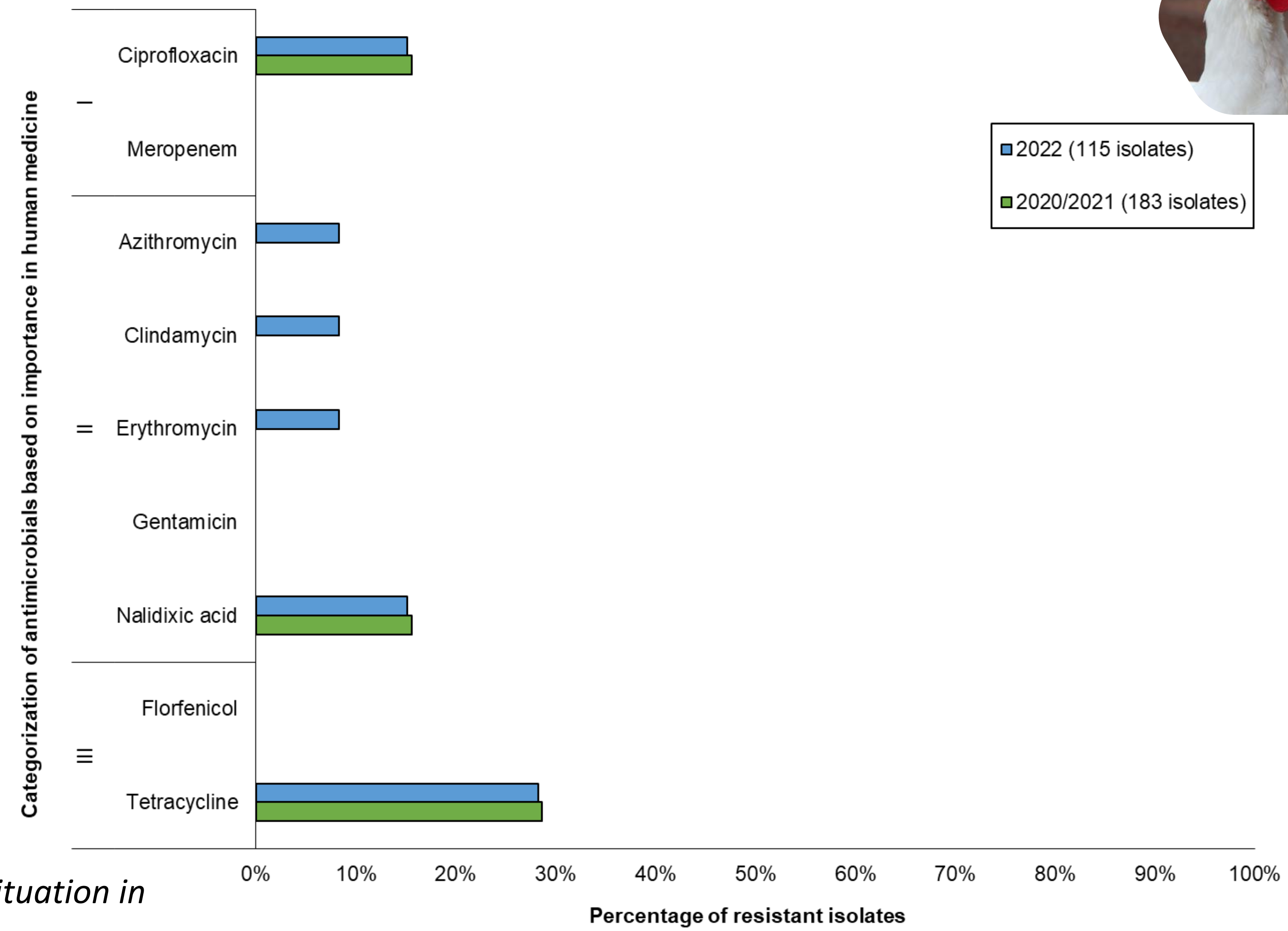
AMR in *Salmonella*

- 71 (2021) and 33 (2022) isolates were recovered
- *S.* Kentucky and *S.* Heidelberg were the 2 most frequently isolated serovars in 2021 and 2022
- Very low level (1%) resistance to 3 or more classes was detected (2022 only)
- 59% (2020/21) and 73% (2022) of the isolates were susceptible to all antimicrobials tested
- No isolates resistant to Category I antimicrobials detected in all surveillance years

**no samples from BC due to the prolonged HPAI situation in the province*

AMR in *Campylobacter*

- More than half of the isolates in 2020/21 and 2022 were *C. jejuni*
- 65% (2020/21) and 50% (2022) of all *Campylobacter* were susceptible to antimicrobials tested
- Ciprofloxacin-resistant *Campylobacter* were detected in all surveillance years (>10%)
- Ciprofloxacin-resistant isolates were detected in layers from 3 provinces (2020/21) and 2 provinces (2022)
- Low-level resistances (<10%) to macrolides (azithromycin/erythromycin) and lincosamides (clindamycin) were detected in 2022



**no samples from BC due to the prolonged HPAI situation in the province*

First look at avilamycin resistance in poultry – 7-9% of *Enterococcus* isolates were resistant in broilers and turkeys

Enterococcus Resistance	Broiler Chickens (n= 282)	Layers (n=86)	Turkeys (n=184)
Ciprofloxacin	9%	0%	9%
Avilamycin	9%	0%	7%
Erythromycin	45%	16%	34%
Tetracycline	74%	43%	64%
Quinupristin-dalfopristin (streptogramin)	89%	92%	81%
Resistance to ≥ 1 antimicrobial	96%	96%	84%

- Vancomycin resistance was not detected
- Intrinsically resistant species have been removed from the data presented

High proportions of resistance to ≥ 1 antimicrobial related to high frequencies of quinupristin-dalfopristin resistance

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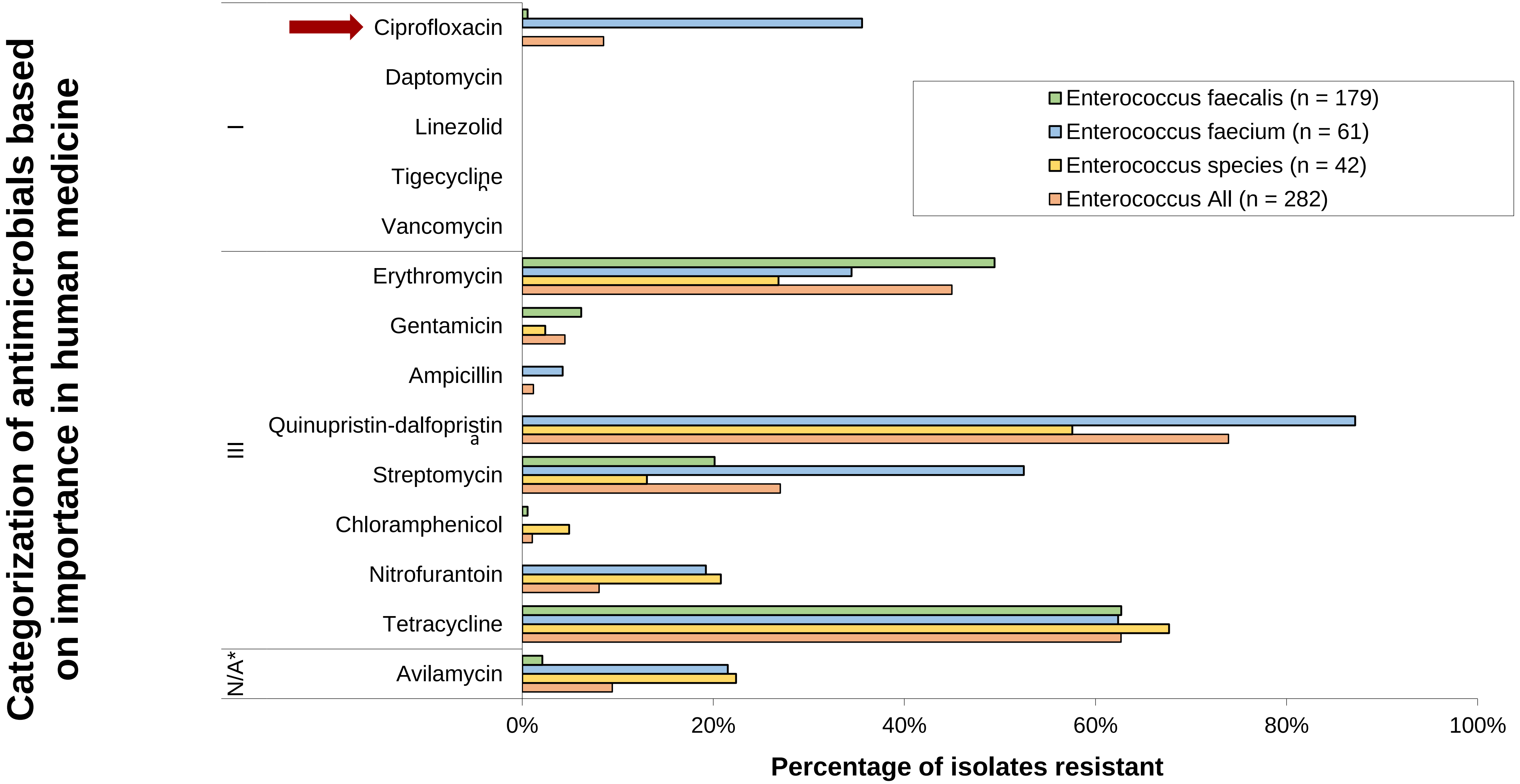
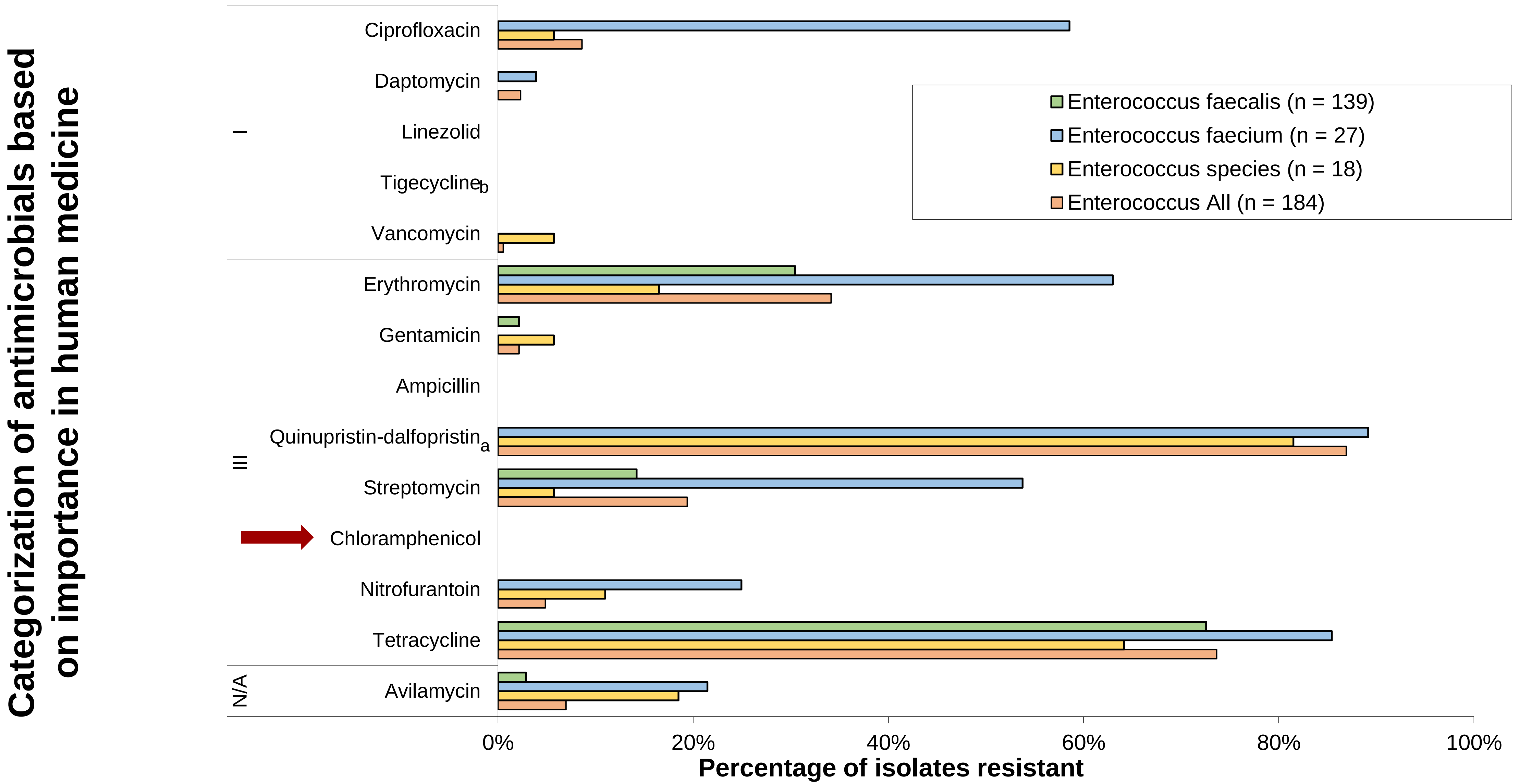
- Intrinsically-resistant *Enterococcus* species have been removed from the data presented

Broiler Chickens: High-level ciprofloxacin resistance (35%) in *E. faecium* isolates



Turkeys: Very high-level ciprofloxacin resistance (56%) in *E. faecium* isolates



Grower-Finisher Pigs – AMU decreased

Between 2021 and 2022:

AMU decreased by 27% (measured by nDDDvetCA/1,000 grower-finisher pig-days at risk) between 2021 and 2022

- Category III antimicrobial use (including tetracyclines) decreased by 49%
- Category II antimicrobial use (including macrolides and penicillins) decreased by 15%

Since 2018:

AMU decreased by 34% (measured by nDDDvetCA/1,000 grower-finisher pig-days at risk) since 2018

- Category III antimicrobial use decreased by 65%
- Category II antimicrobial use decreased by 18%

Small quantities of Category I antimicrobials are used by injection each year. In 2022, Category I antimicrobials used included 3rd generation cephalosporins and fluoroquinolones

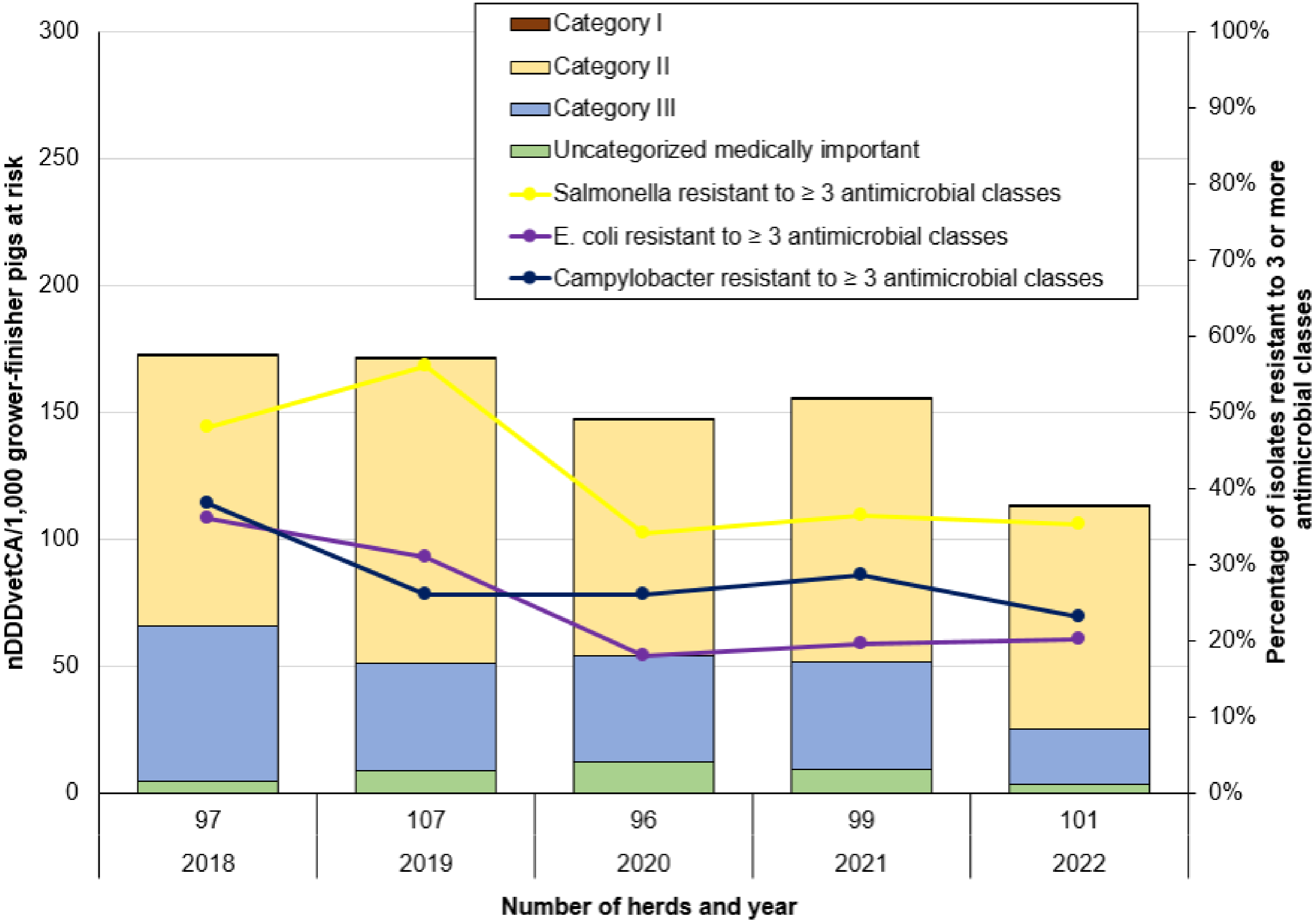
Reasons for use:

There was no reported use of medically important antimicrobials for growth promotion in 2022

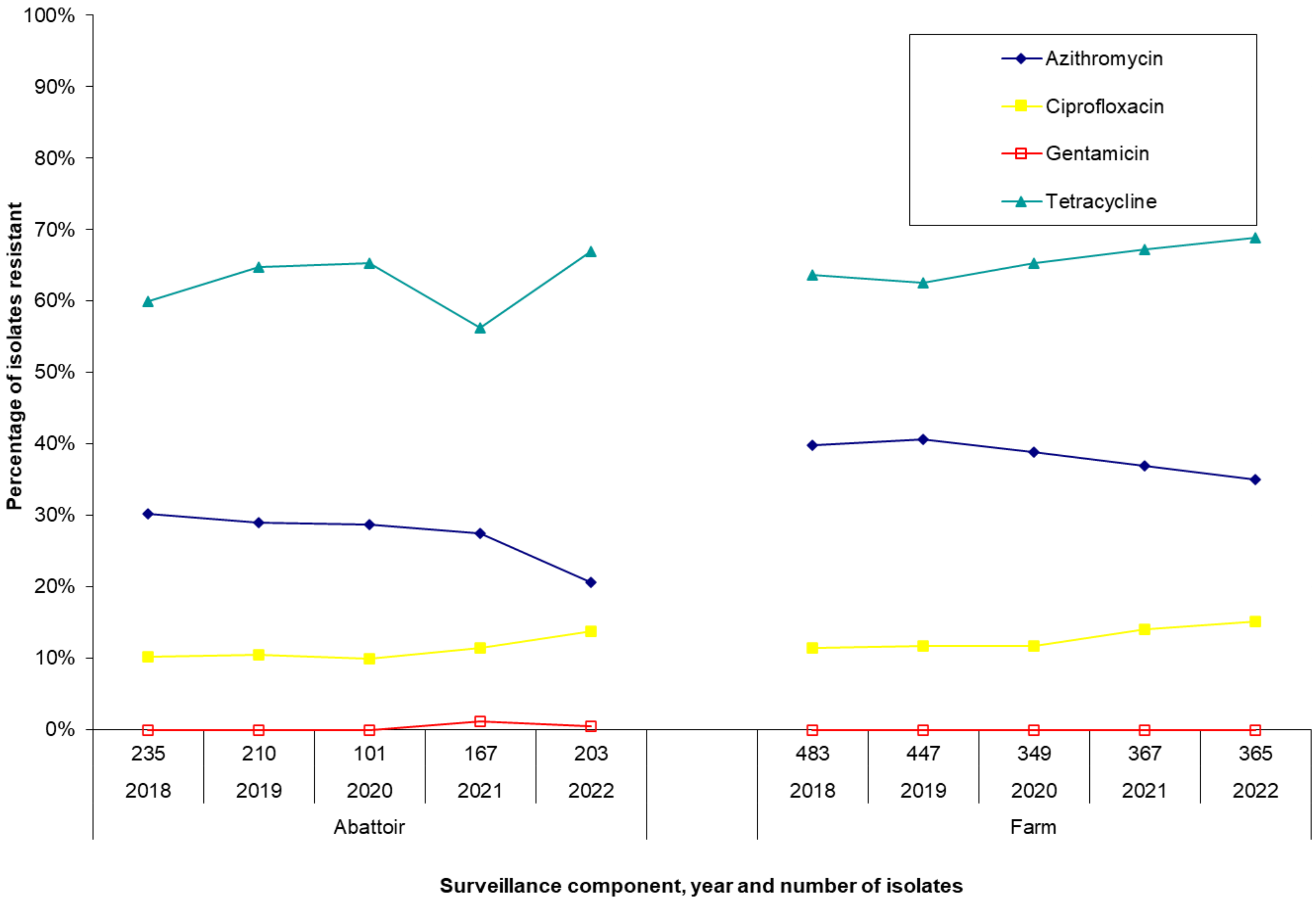
The use of medically important antimicrobials for disease prevention decreased by 31% (measured by nDDDvetCA/1,000 grower-finisher pig-days at risk) between 2021 and 2022

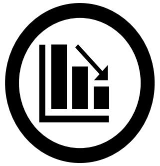
Grower-Finisher Pigs: AMU and AMR decreased

- **Since 2018**, both the quantity of antimicrobials used and resistance to ≥ 3 antimicrobial classes has **decreased** in *Salmonella*, *Campylobacter*, and *E. coli*
- **Since 2021**, resistance to ≥ 3 antimicrobial classes **decreased** for *Campylobacter* and **remained stable** for *Salmonella* and *E. coli*



AMR in *Campylobacter* from abattoir and grower-finisher pigs on farm





Azithromycin resistance appears to be decreasing in abattoir and farm isolates

Ciprofloxacin resistance appears to be increasing in abattoir and farm isolates

Pork: The observed frequency of resistance may be influenced by the number of samples collected

Ceftriaxone resistance:

- Resistance was only observed in 2018 and 2019 (1%)

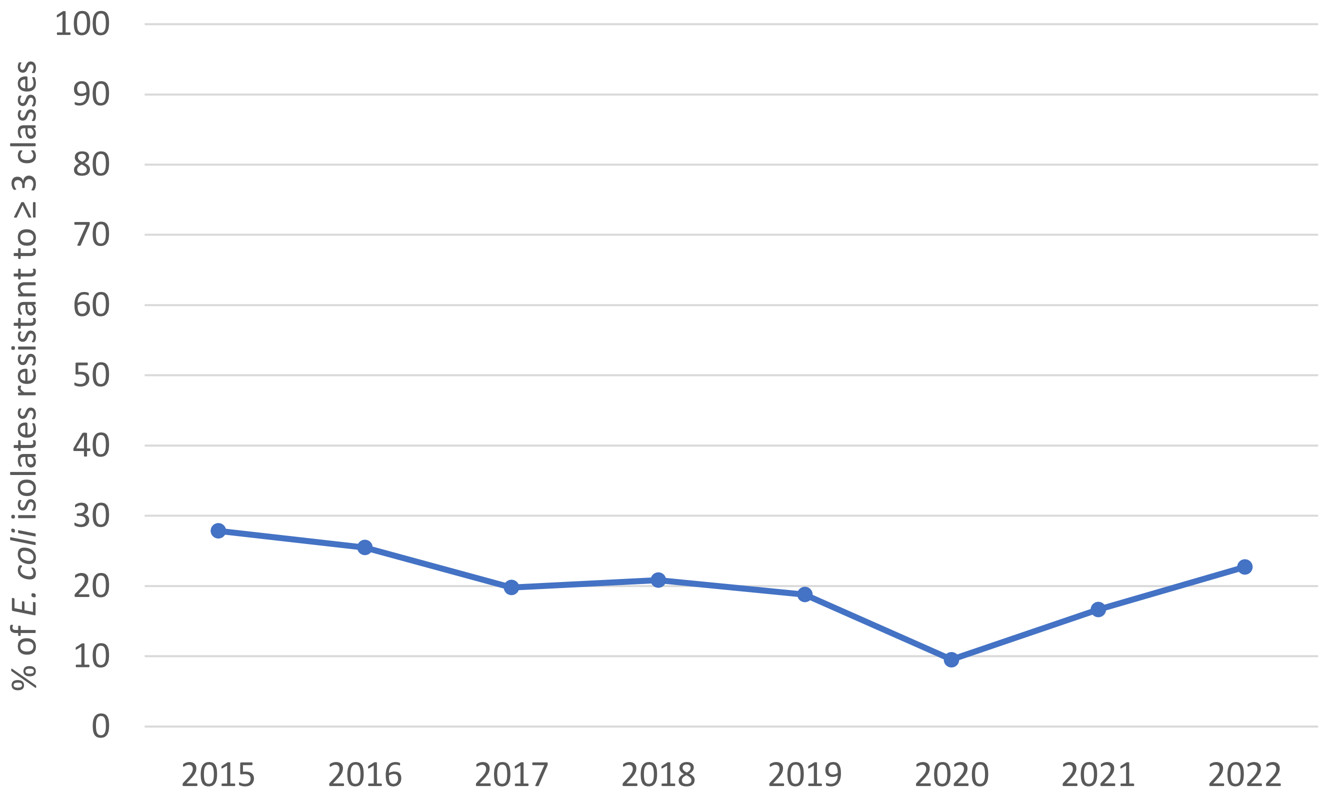
Nalidixic acid resistance:

- Resistance in *E. coli* was 1% between 2018 and 2019 (n=>300 isolates per year)
- However, it increased to 8% in 2021 (n=12 isolates) and 14% (n=22 isolates) in 2022

Gentamicin resistance:

- Resistance was only observed in 2018 (1%)

Resistance to ≥3 antimicrobial classes among *E. coli* isolates

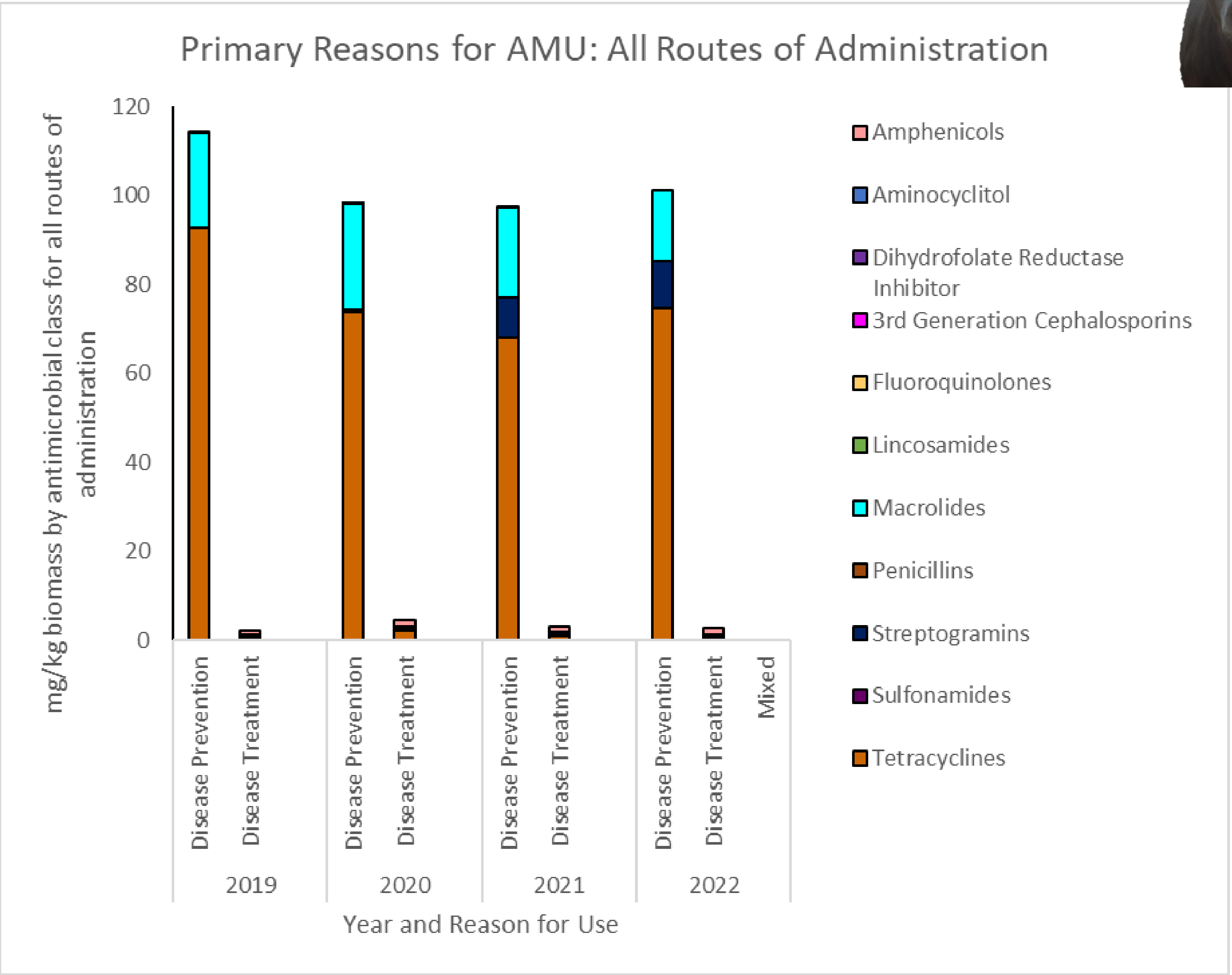


n	183	404	106	326	367	42	12	22

Note: The proportion of isolates resistant towards ceftriaxone and gentamicin was similar to what was seen among abattoir isolates. Nalidixic acid resistance at abattoir has consistently been 0-1% since 2013.

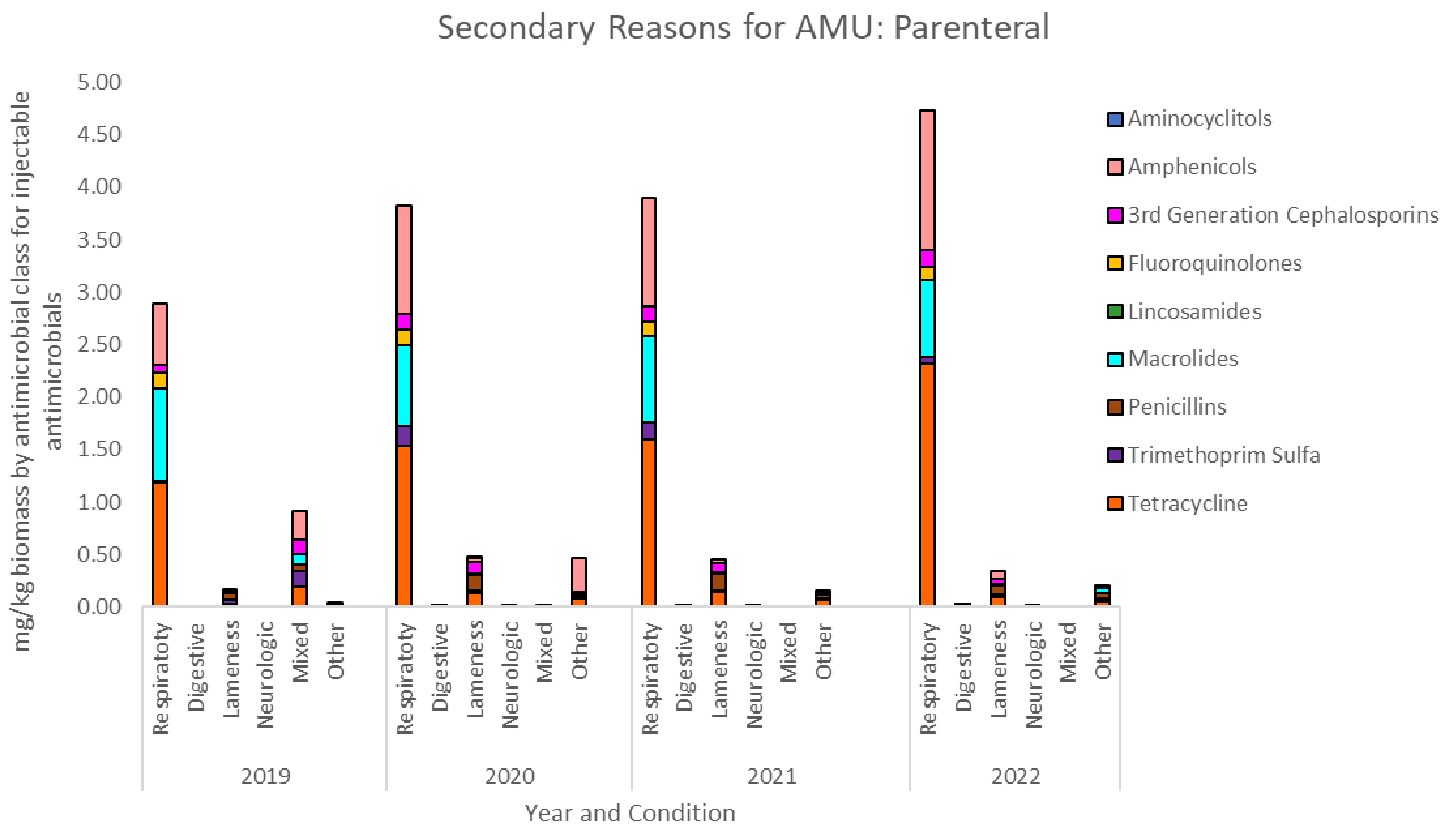
Feedlot Cattle: AMU (mg/kg biomass) decreased

- Since 2019, overall, AMU has decreased. AMU was stable between 2021-2022.
- Most used antimicrobial classes: tetracyclines (72%), macrolides (16%) and streptogramins (10%)
- Majority of antimicrobials were for disease prevention and were administered via feed (97%)



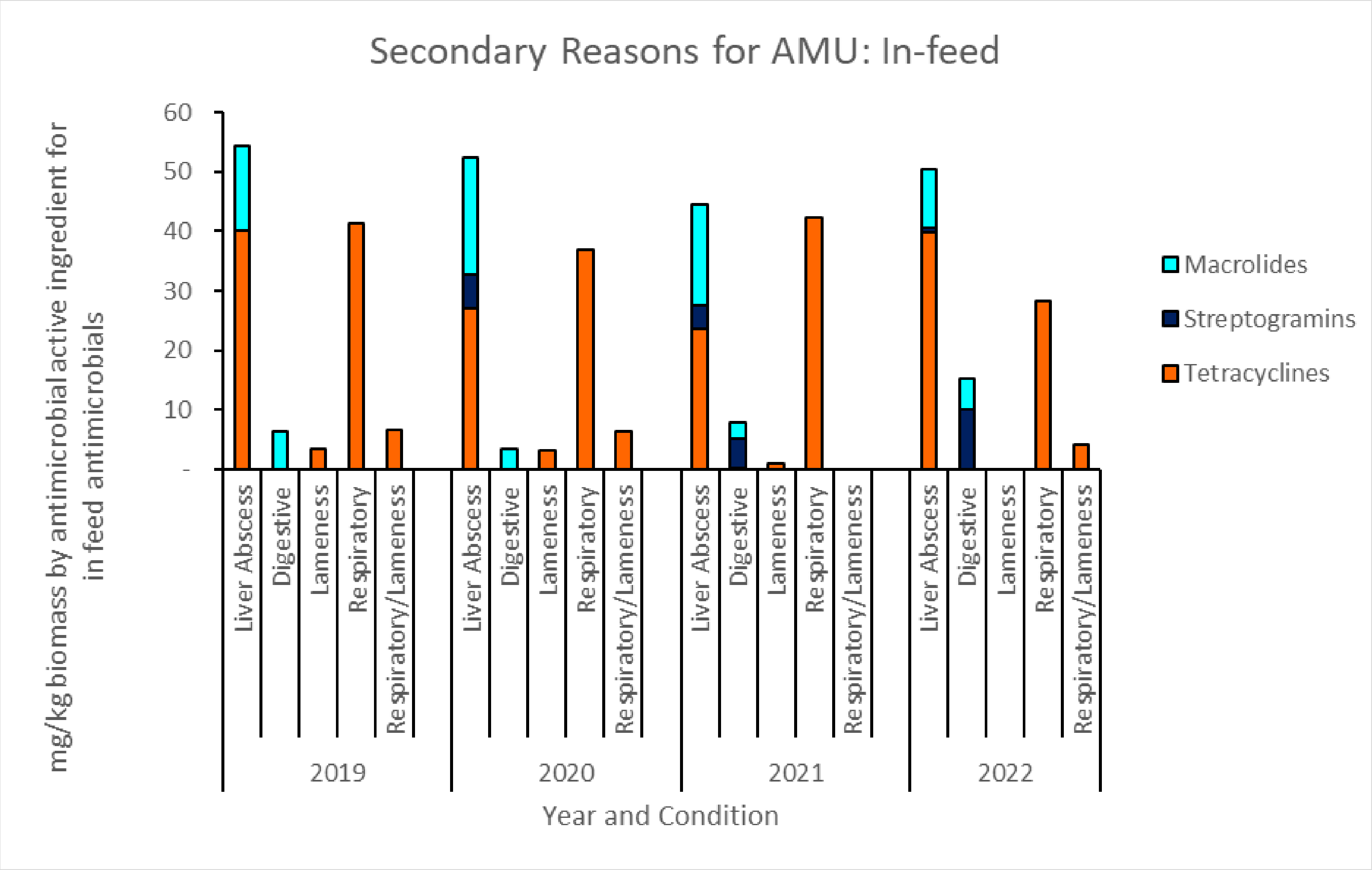
Feedlot Cattle: Respiratory disease driving parenteral AMU

- 89% of parenteral AMU in 2022 was for the prevention or treatment of respiratory disease
- Since 2019, macrolide use decreased by 21%, and tetracycline use increased by 31%



Feedlot Cattle: In-feed tetracycline and macrolide use decreased, streptogramin use increased

- Primarily for the prevention of liver abscesses (51%) and respiratory disease (28%)



Feedlot Cattle: AMU and AMR stable

- Category I contributes 0.4% of overall AMU.

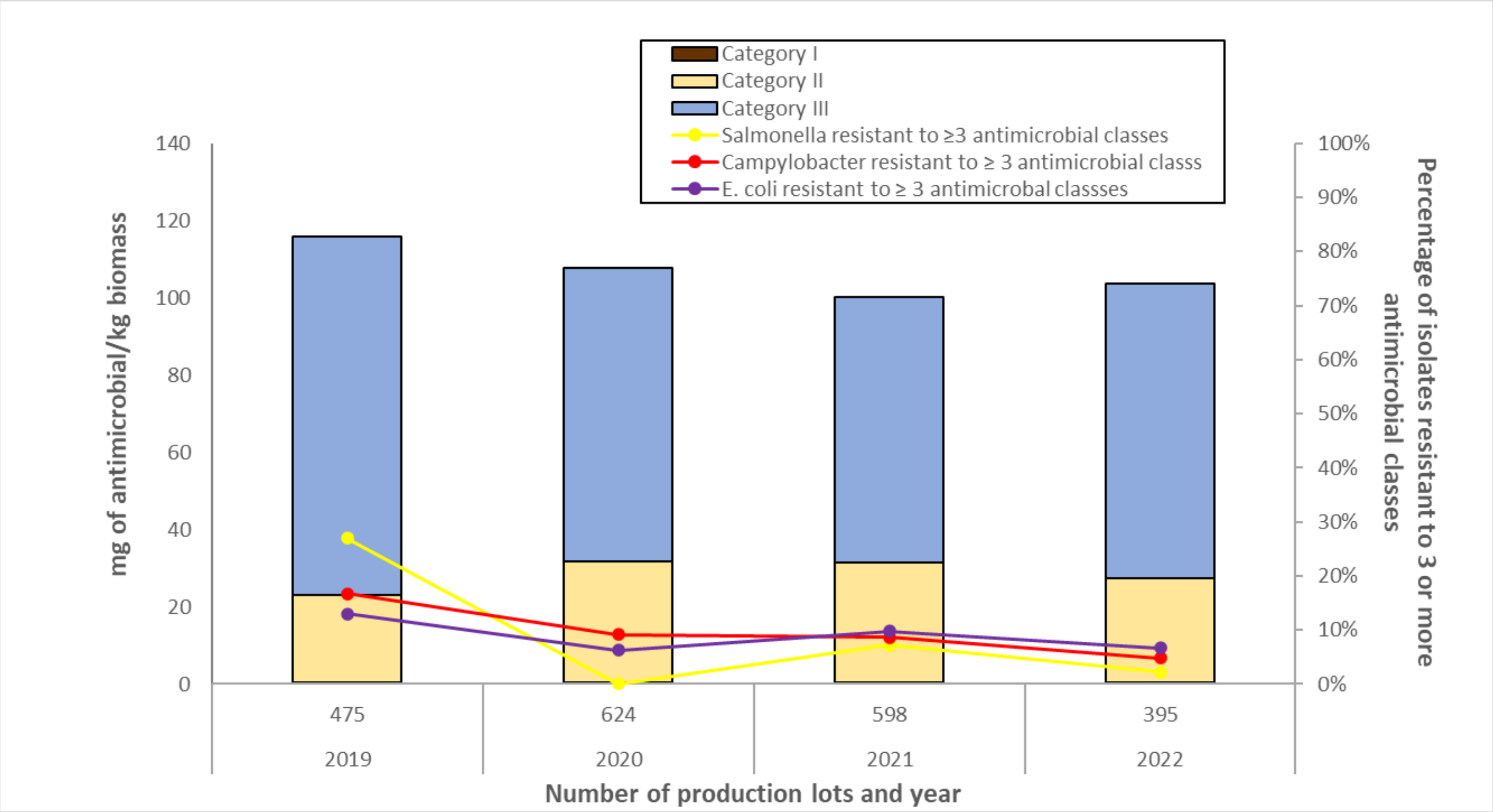
- Resistance ≥ 3 antimicrobial classes is relatively stable for *E. coli* and *Campylobacter* spp.

***Salmonella* spp.**

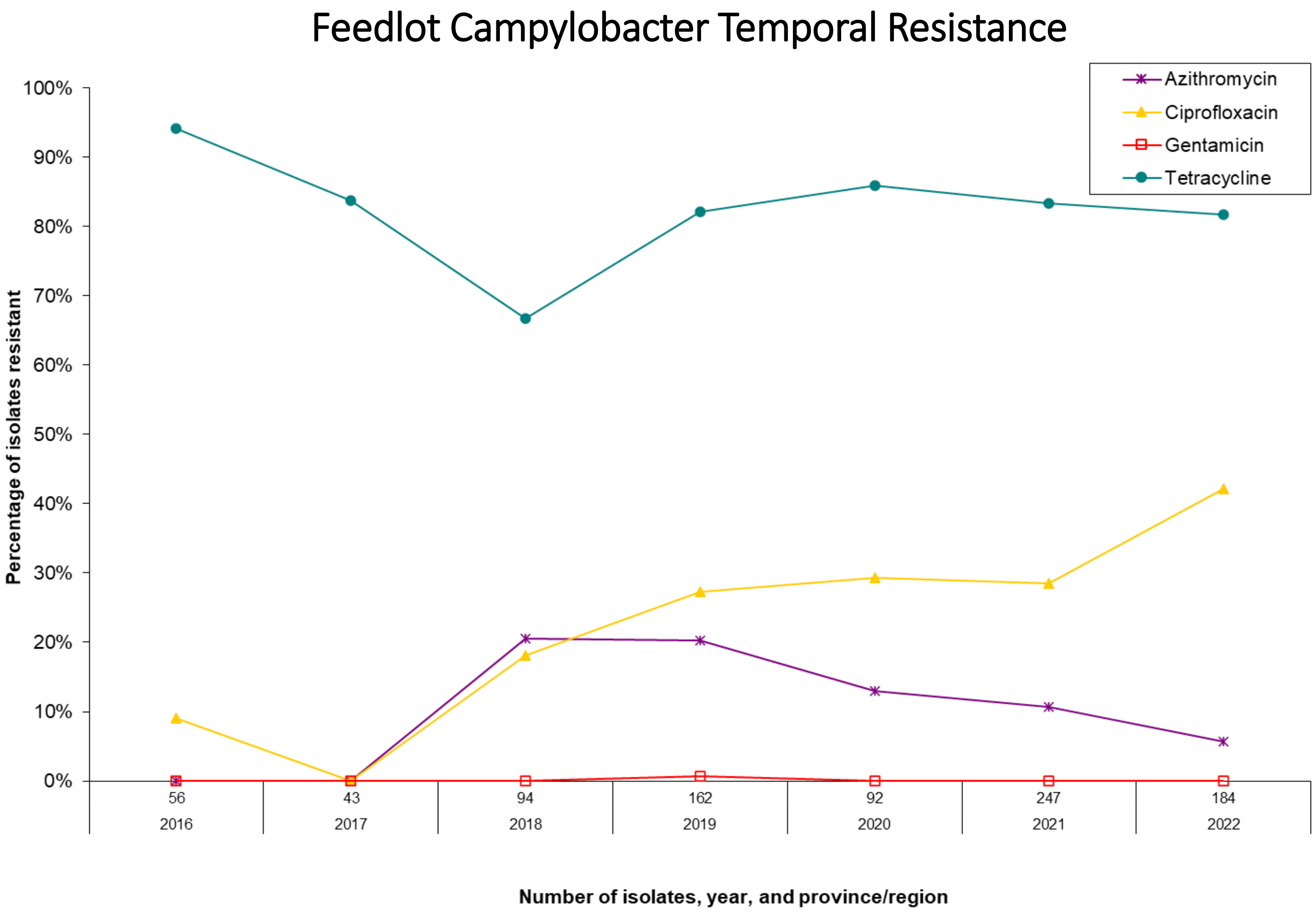
- Only 9 isolates were recovered.
  - 3 were susceptible to the panel of antimicrobials tested
  - 2 *S.* Typhimurium isolates were resistant to 4 classes, and 2 *S.* Uganda and 2 *S.* Muenchen, all resistant to sulfisoxazole and tetracycline

E. coli

- No Category I antimicrobial resistance
- Resistance was not detected in 40% of isolates



Feedlot Cattle AMR 2022: Significant rise in ciprofloxacin-resistant *Campylobacter*

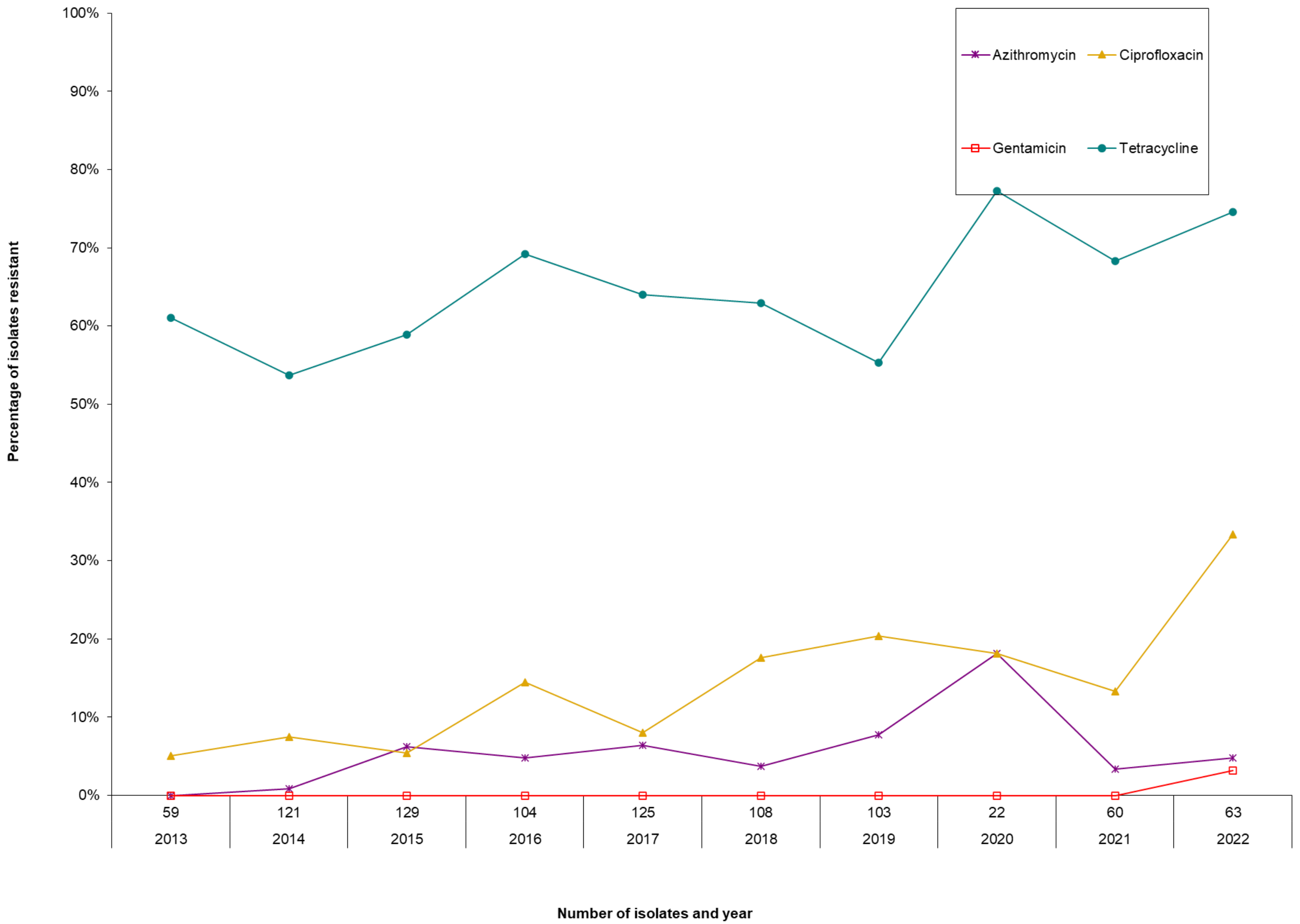


- Significant rise in ciprofloxacin resistance in 2022 (29% in 2020 to 42% in 2022) - most were *C. coli* (92%)
- 89% of isolates were resistant to at least one antimicrobial
- Very low fluoroquinolone AMU (0.20%)

Cattle (at slaughter) AMR 2022: Significant rise in ciprofloxacin resistance in *Campylobacter*

Significant rise in ciprofloxacin resistance in 2022 (13% 2021 to 33% 2022) *Campylobacter* isolates from healthy cattle at slaughter

Campylobacter Temporal Resistance in Cattle from Slaughter



Beef: Antimicrobial resistance among *E. coli* from beef remains consistently low

Ceftriaxone resistance:

- Resistance was only observed in 2018 (1%)

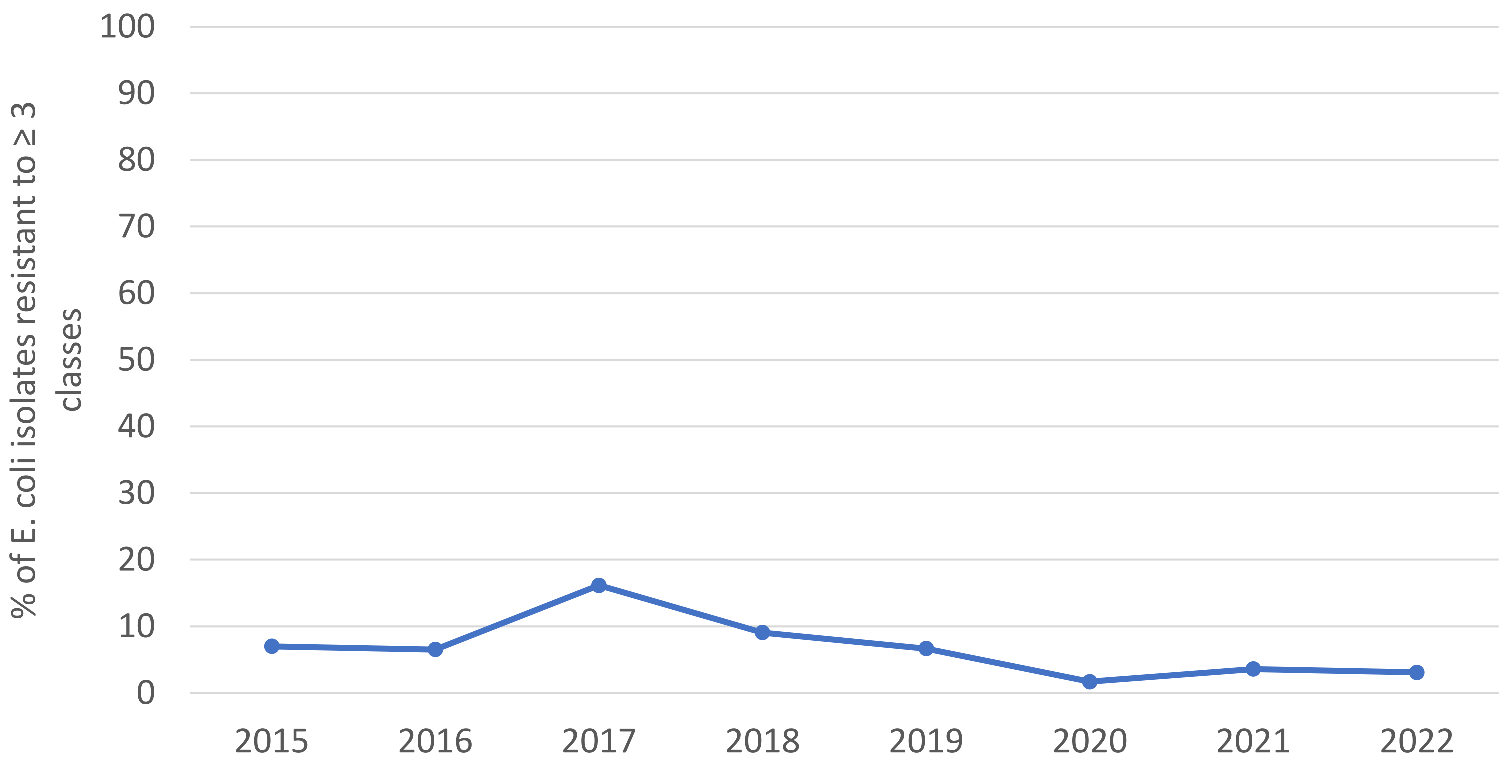
Nalidixic acid resistance:

- Resistance in *E. coli* was 1% or 2% between 2018 and 2020 and not observed in 2021 or 2022

Gentamicin resistance:

- Resistance was only observed in 2018 (2%)

Resistance to ≥3 antimicrobial classes among *E. coli* isolates



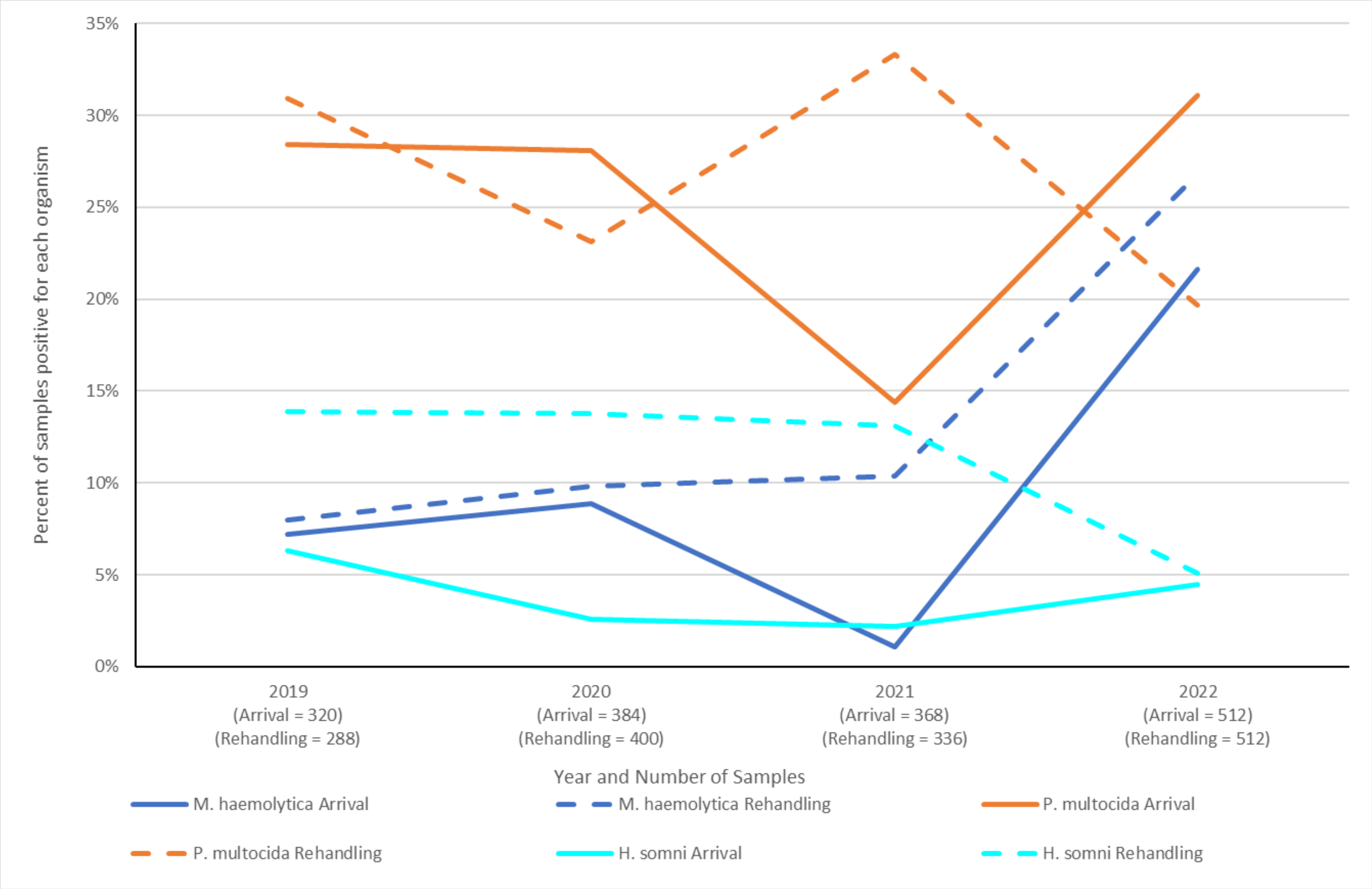
n	515	506	700	420	451	177	279	356

Note: The proportion of isolates resistant towards ceftriaxone, nalidixic acid, and gentamicin was similar to what was seen among abattoir isolates.

CIPARS - Bovine Respiratory Disease Pathogens

- *Pasteurella multocida* was the most common pathogen recovered at arrival since 2019
- In 2022, *M. haemolytica* replaced *P. multocida* as the most common pathogen recovered at re-handling
- Recovery of *M. haemolytica* and *P. multocida* at arrival and *M. haemolytica* at rehandling increased in 2022
  - *H. somni* was recovered at lower levels at rehandling in 2022

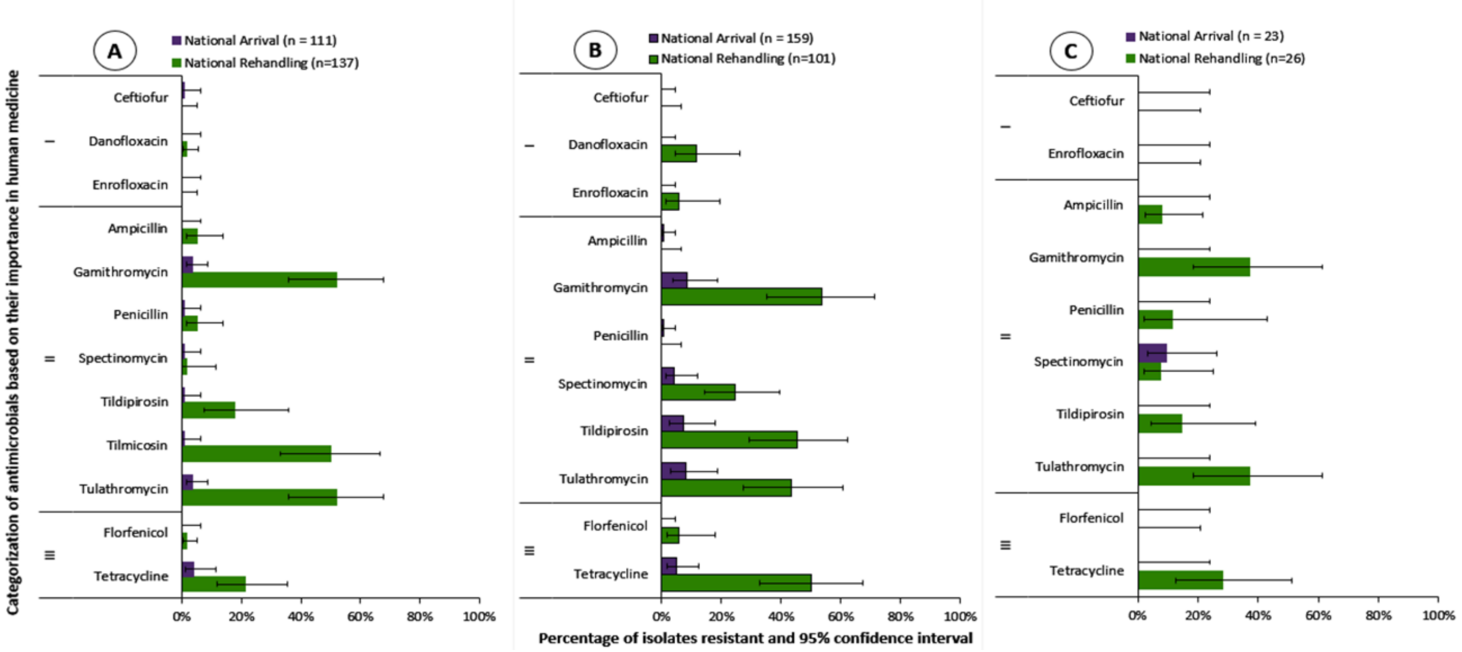
Percentage recovery of *Mannheimia haemolytica*, *Pasteurella multocida*, and *Histophilus somni* by surveillance year and time of sample



CIPARS - AMR in Bovine Respiratory Disease Pathogens

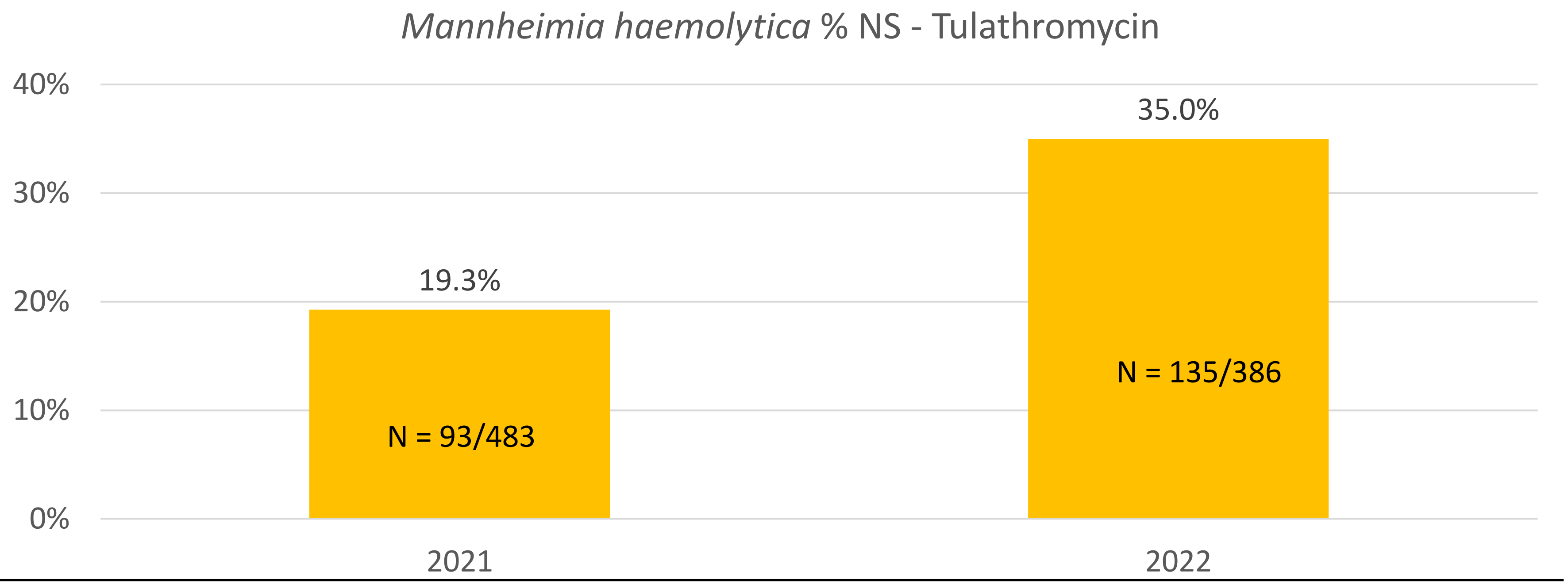
- 90% of the recovered BRD isolates were susceptible to the tested antibiotics with established breakpoints at arrival
- 39% of the recovered BRD isolates were susceptible to the tested antimicrobials with established breakpoints at rehandling
- Resistance to Category 1 antimicrobials was low in BRD pathogens (<5%)

Resistance of A) *M. haemolytica*, B) *P. multocida,* and C) *H. somni* isolates to antimicrobials with Clinical & Laboratory Standards Institute breakpoints at feedlot arrival and at rehandling over in 2022, adjusted for clustering by feedlot.



Bovine/Cattle (Livestock) – Preliminary

(proof of concept)



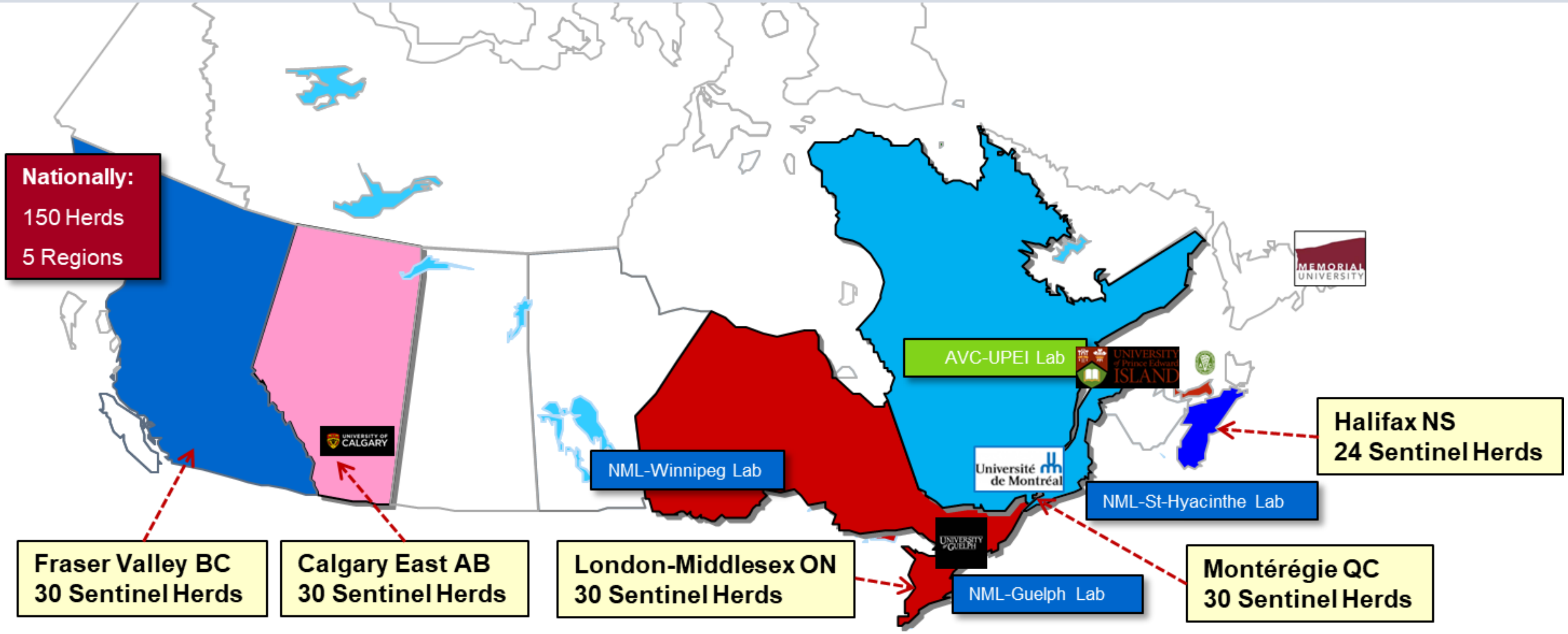
# Provinces	3	2

***Note** – data include isolates from research, surveillance and clinical laboratories

Year	Organism	Abx	Susceptible	Non-Susceptible
2021	*Pasteurella multocida*	Tulathromycin	302 (91%)	30 (9%)
2022	*Pasteurella multocida*	Tulathromycin	266 (81%)	62 (19%)
2021	*Histophilus somni*	Tulathromycin	442 (89%)	52 (11%)
2022	*Histophilus somni*	Tulathromycin	77 (84%)	15 (16%)

Dairy Cattle

- Methodology
  - ~150 farms sampled annually from 2019-2022, with farms in 5 regions nationally (NS, QC, ON, AB, BC)
  - Sample types include:
    - Composite manure samples taken from pre-weaned calves, post-weaned heifers, and lactating cows.
    - Manure pit.
    - Bulk tank milk sample.



Component design: https://doi.org/10.3389/fvets.2021.799622

Dairy Cattle: low levels of multi-class resistance.

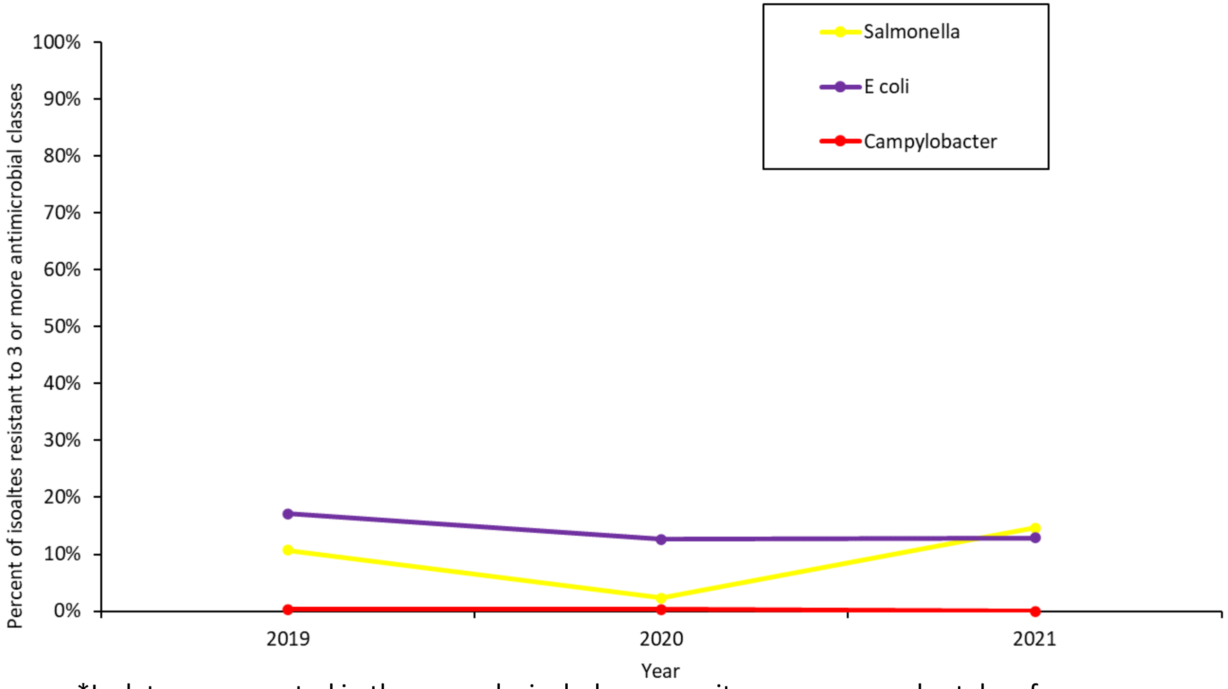
AMR:

- Resistance to ≥3 antimicrobial classes decreased for *E. coli* and *Campylobacter*.
- Resistance to Category I antimicrobials in *E. coli* was less than 5% in all years and decreased between 2019 and 2021.
- No resistance to Category I antimicrobials in *Salmonella* from any year.
- Ciprofloxacin resistance in *Campylobacter* decreased from 20% in 2019 to 16% in 2021.
- No *Salmonella* isolates were resistant to >6 antimicrobial classes.

AMU:

- Primary route of administration - injection.
- Primary reason for use - disease treatment, rather than disease prevention.

Percentage of *E. coli*, *Salmonella*, and *Campylobacter* isolates from dairy cattle resistant to ≥ 3 antimicrobial classes (2019-2021)*



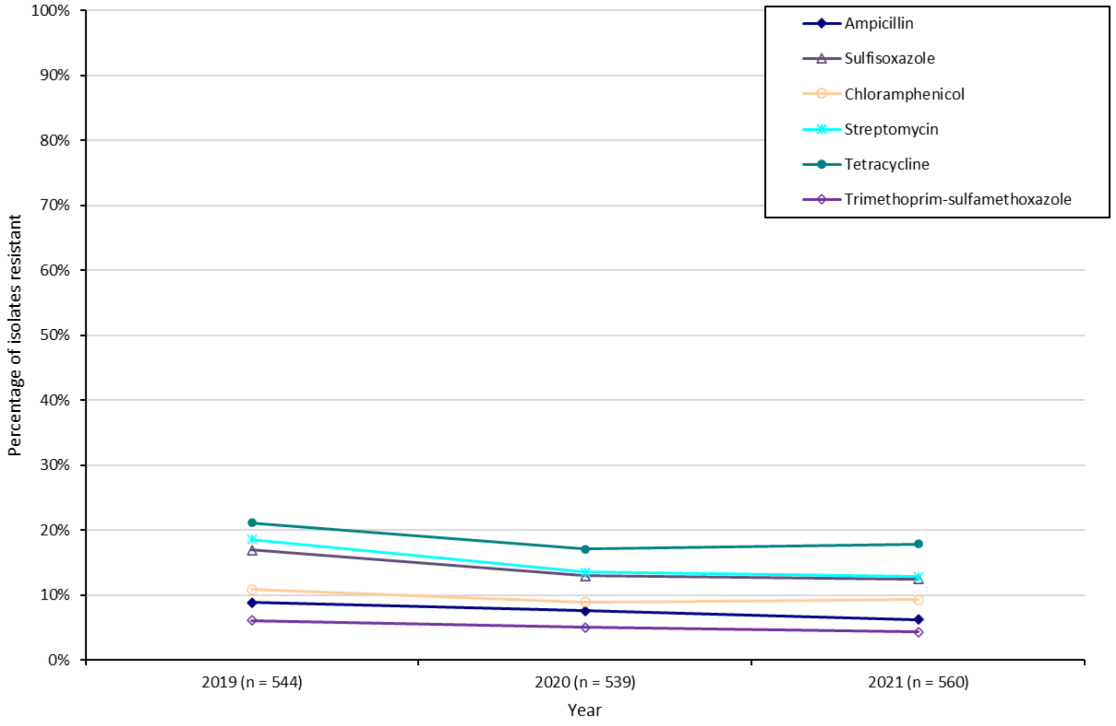
*Isolates represented in these graphs include composite manure samples taken from pre-weaned calves, post-weaned heifers, lactating dairy cattle, and the manure pit.

***Due to low isolate numbers (n=41), trends in AMR for *Salmonella* need to be interpreted with caution.**

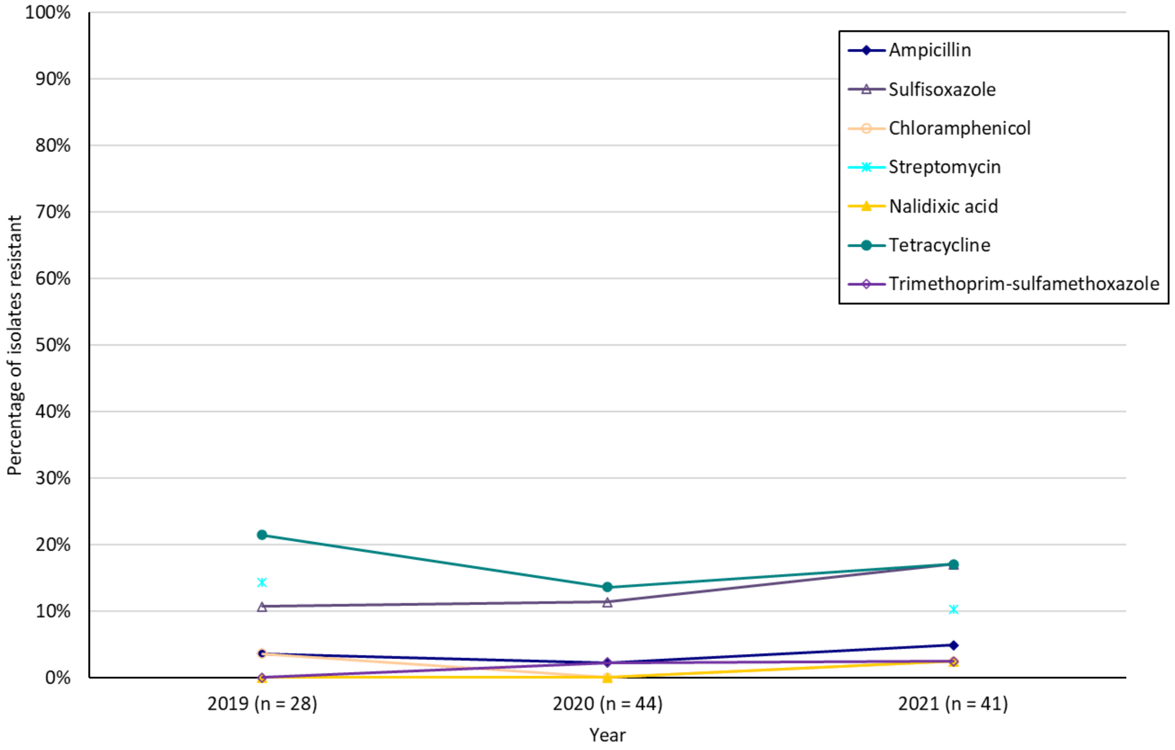
Three Year Trend Data for AMR in *E. Coli* and *Salmonella:* low levels of resistance.

- *E. coli* isolated from calf manure samples had significantly higher levels of resistance to Category II and III compared to other production phases.

AMR in *E. coli* *



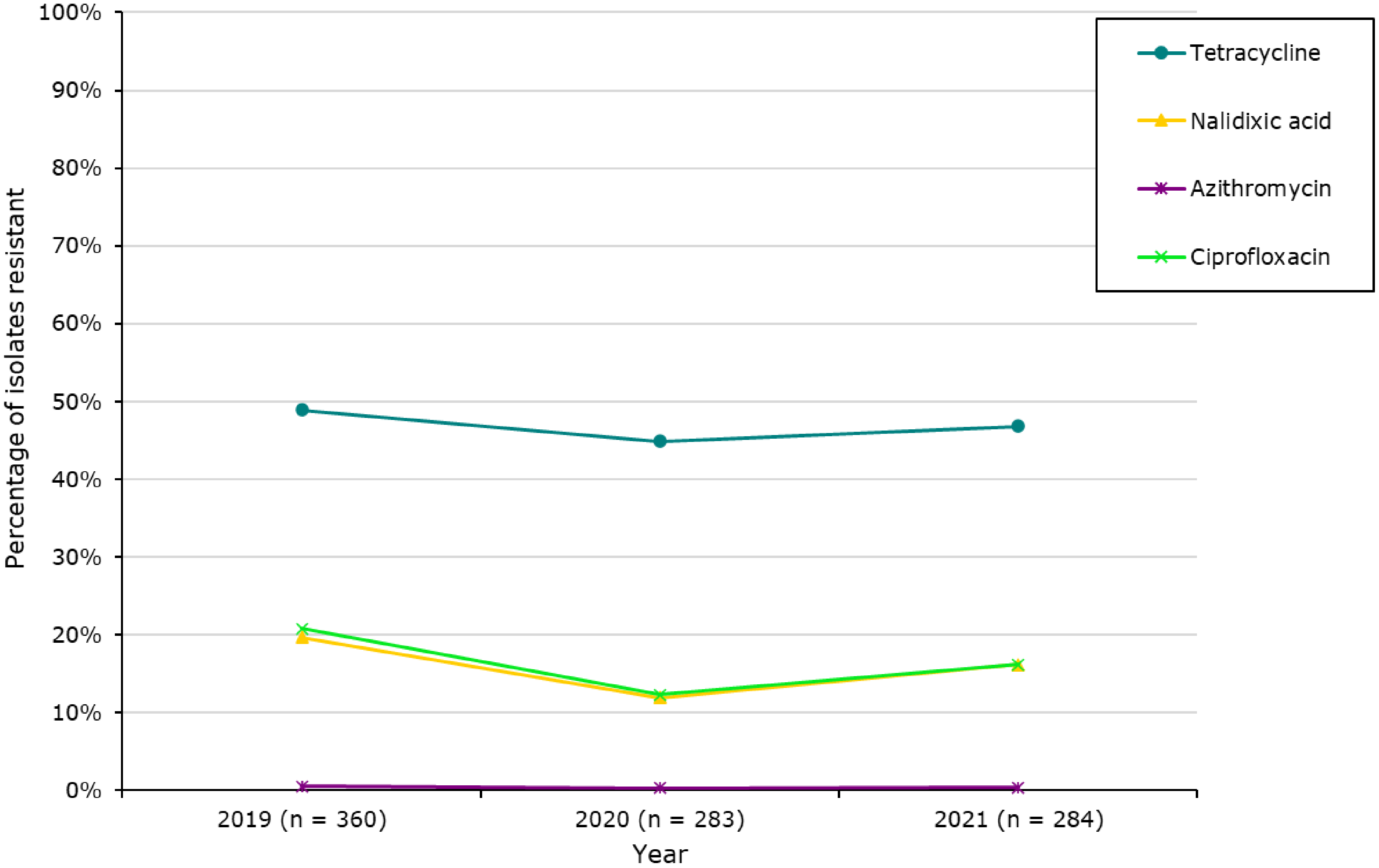
AMR in *Salmonella* *



**Isolates represented in these graphs include composite manure samples taken from pre-weaned calves, post-weaned heifers, lactating dairy cattle, and the manure pit.*

NEW Data - AMR in *Campylobacter* from Dairy Cattle

Campylobacter isolated in 2021 from calf (n=26), heifer (n=97) and cow (n=101) manure samples, and manure pit samples (n=60) showed no significant difference in AMR across production phases or sample type.



*Isolates represented in these graphs come from composite manure samples taken from pre-weaned calves, post-weaned heifers, lactating dairy cattle, and the manure pit

Preview from Dairy Cattle 2022 – AMU Questionnaire Data

Category I antimicrobials are used by **injection** and **intramammary routes** of administration.

Category II antimicrobials are most commonly used across **all production types** and **all routes of administration.**

Main Reasons for AMU

13%
Calf Respiratory Disease

17%
Clinical Mastitis

10%
Dry Cow Treatment & Reproductive Tract Diseases

There is evidence of selective AMU practices in both clinical mastitis and dry cow treatment, positive stewardship indicators.

Stable Reasons for AMU 2019-2022

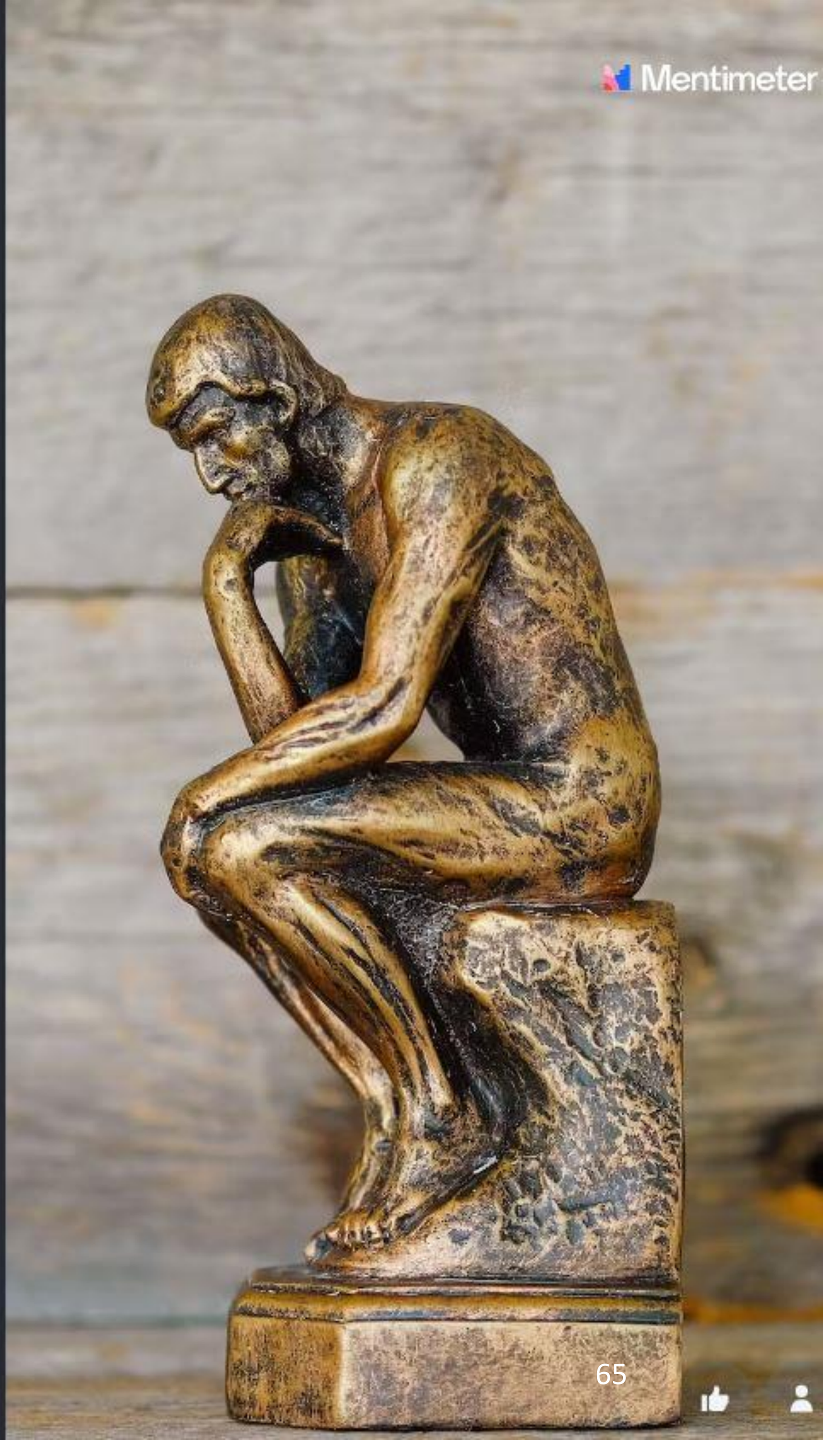
Reported herd-level disease prevalence (by calendar year) by reasons for use and proportion of animals treated:

- Reasons for AMU differed by production stage and remained consistent over 4 years of reporting.
- Respiratory tract infections, diarrhea, and navel infections are strong reasons for use in calves.
- Fewer farms report disease in heifers than in the other evaluated stages of production.
- For most of the disease categories asked about, the majority of farms reported treating 75-100% of animals with antimicrobials.

Join at menti.com use code 7352 4620

Antimicrobial use: tell us what you think. /Dites nous ce que vous pensez à propos de l'utilisation des antimicrobiens (UAM).

GO TO
menti.com
ENTER THE CODE
7352 4620
0



Join at menti.com use code 7352 4620

Mentimeter

Foodborne AMR: tell us what you think. / Dites-nous ce que vous pensez à propos de la résistance aux antimicrobiens (RAM) d'origine alimentaire.

Waiting for responses

GO TO
menti.com

ENTER THE CODE
7352 4620

0

Human *Salmonella* and *Campylobacter* Antimicrobial Resistance

Important changes are here!

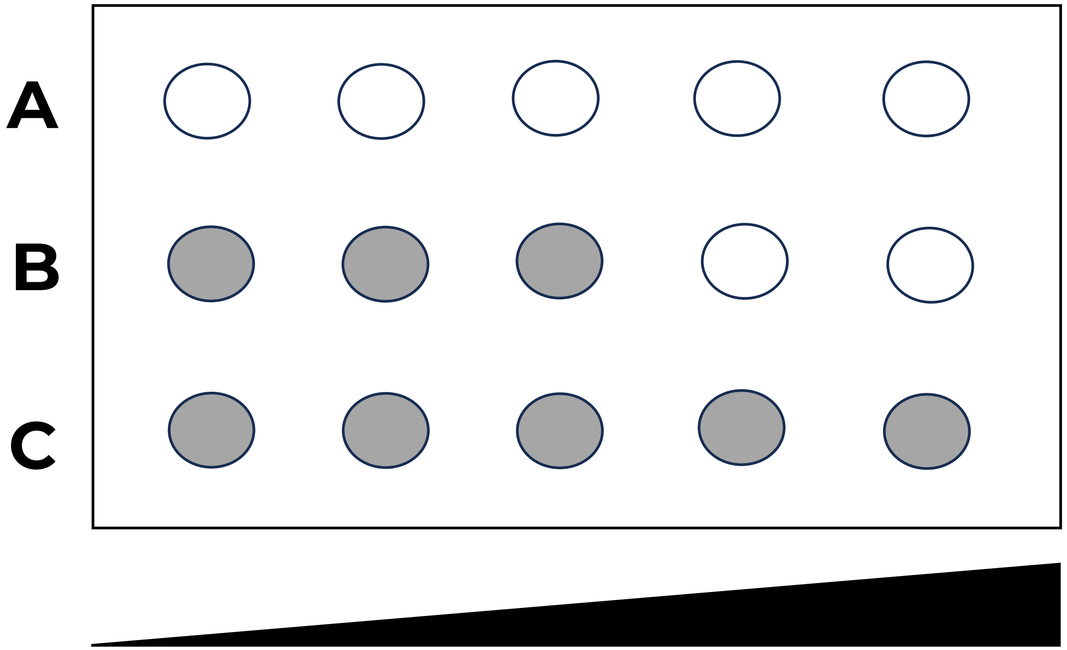
CIPARS is including

AMR data from WHOLE GENOME SEQUENCES.

Today, genomically acquired data from ***Salmonella*** will be presented from **human isolates, ONLY.**

The presence of the DNA symbol on the slide, indicates that the data presented was collected from whole genome sequences.

Broth Microdilution



Increasing concentrations of antimicrobial

S I R

Whole Genome Sequencing (WGS)

Predicted phenotypes based on the resistance genes and/or mutations detected

What does this mean for our stakeholders?

1

Over time, you will see more genomic derived data, in interactive data, reports or publications.

2

We will now be reporting **PREDICTED PHENOTYPES** based on **genes and/or mutations.**

***10% of isolates continue to undergo quality control using broth microdilution.**

3

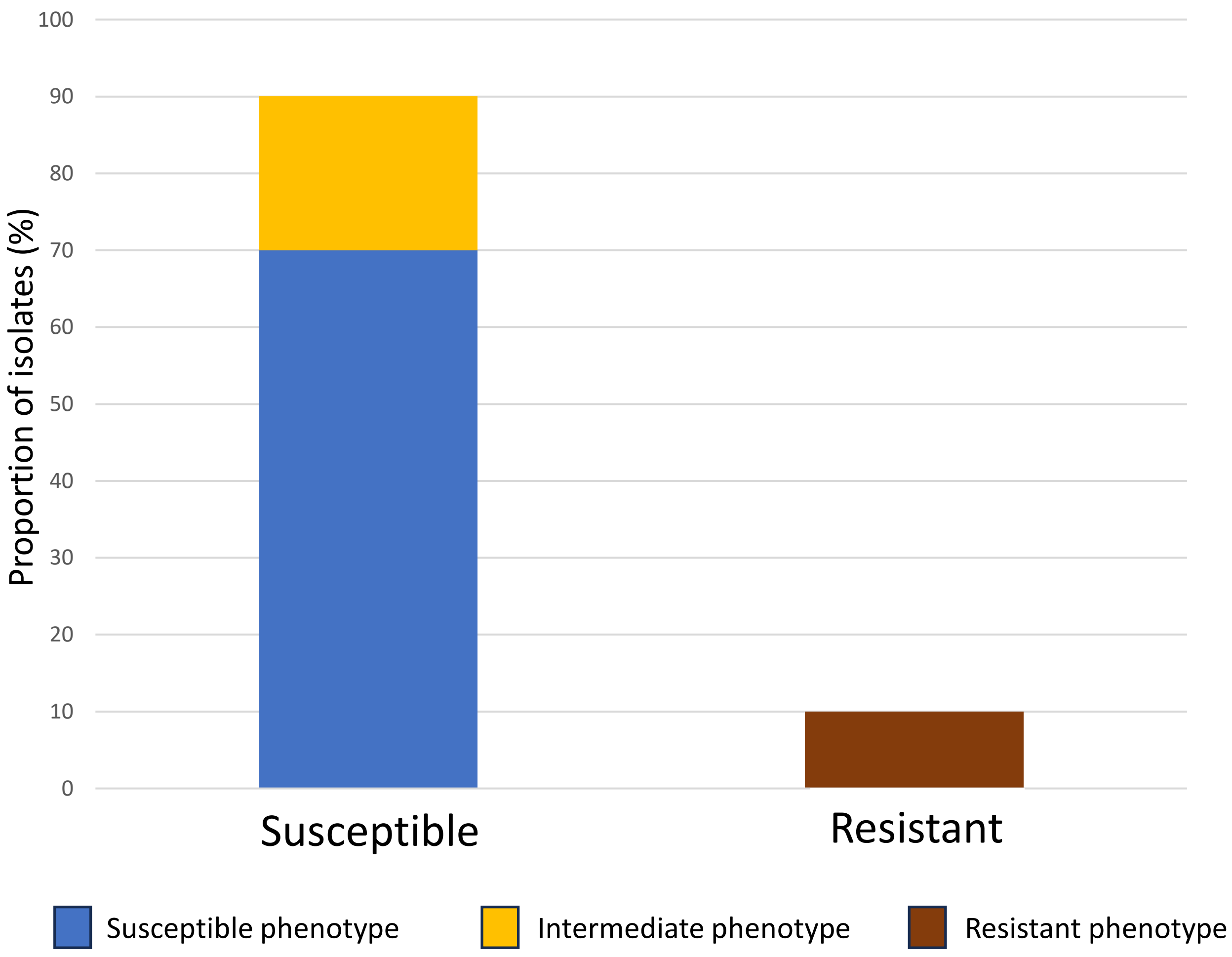
S/I

For **CIPROFLOXACIN**, isolates with predicted **INTERMEDIATE or RESISTANT MICs** will be categorized together as **NON-SUSCEPTIBLE.**

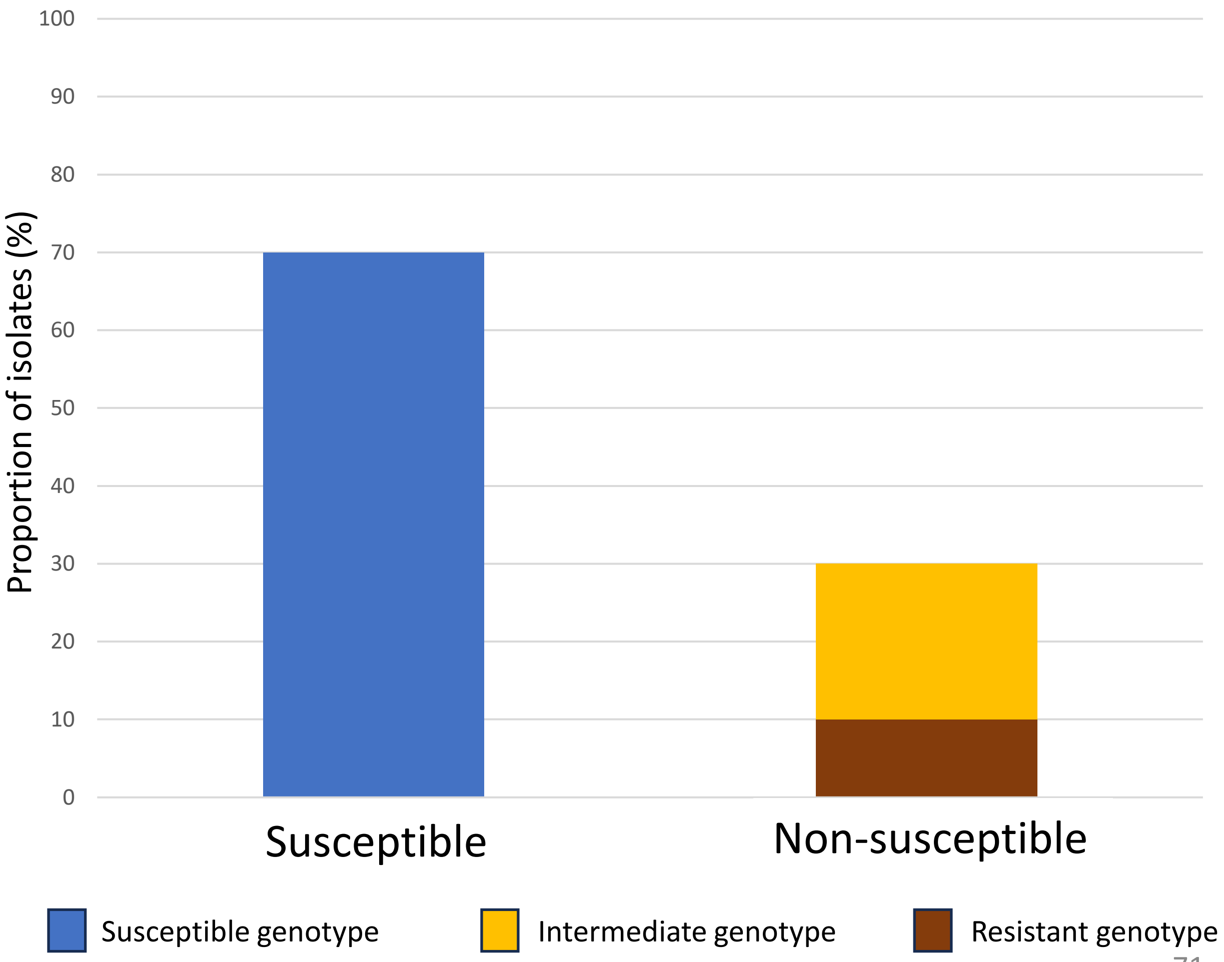
I/R

The proportion of ciprofloxacin-resistant *E. coli* recovered from North American House Hippos in 2022.

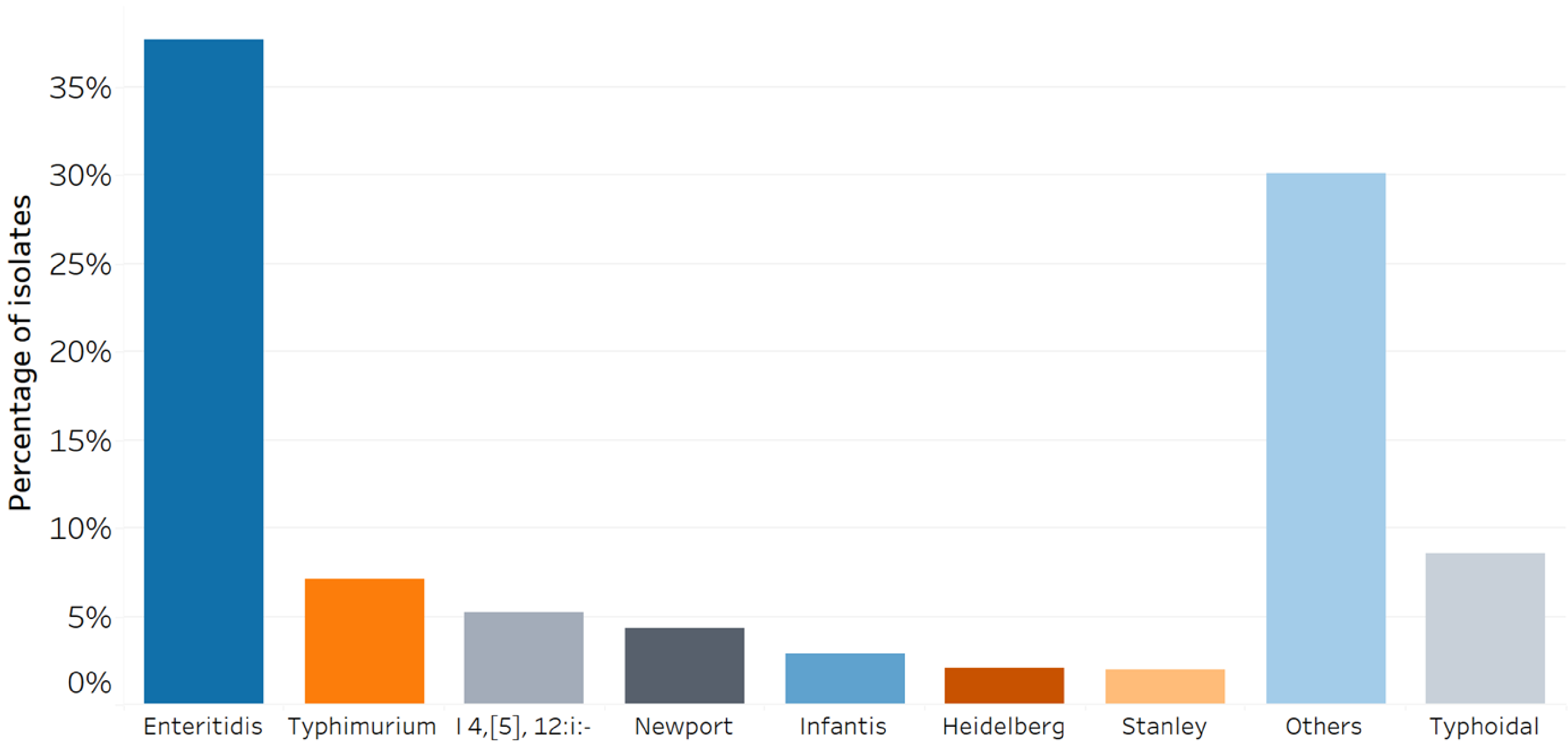
Interpretation using CIPARS broth microdilution testing



Interpretation using CIPARS WGS methodology



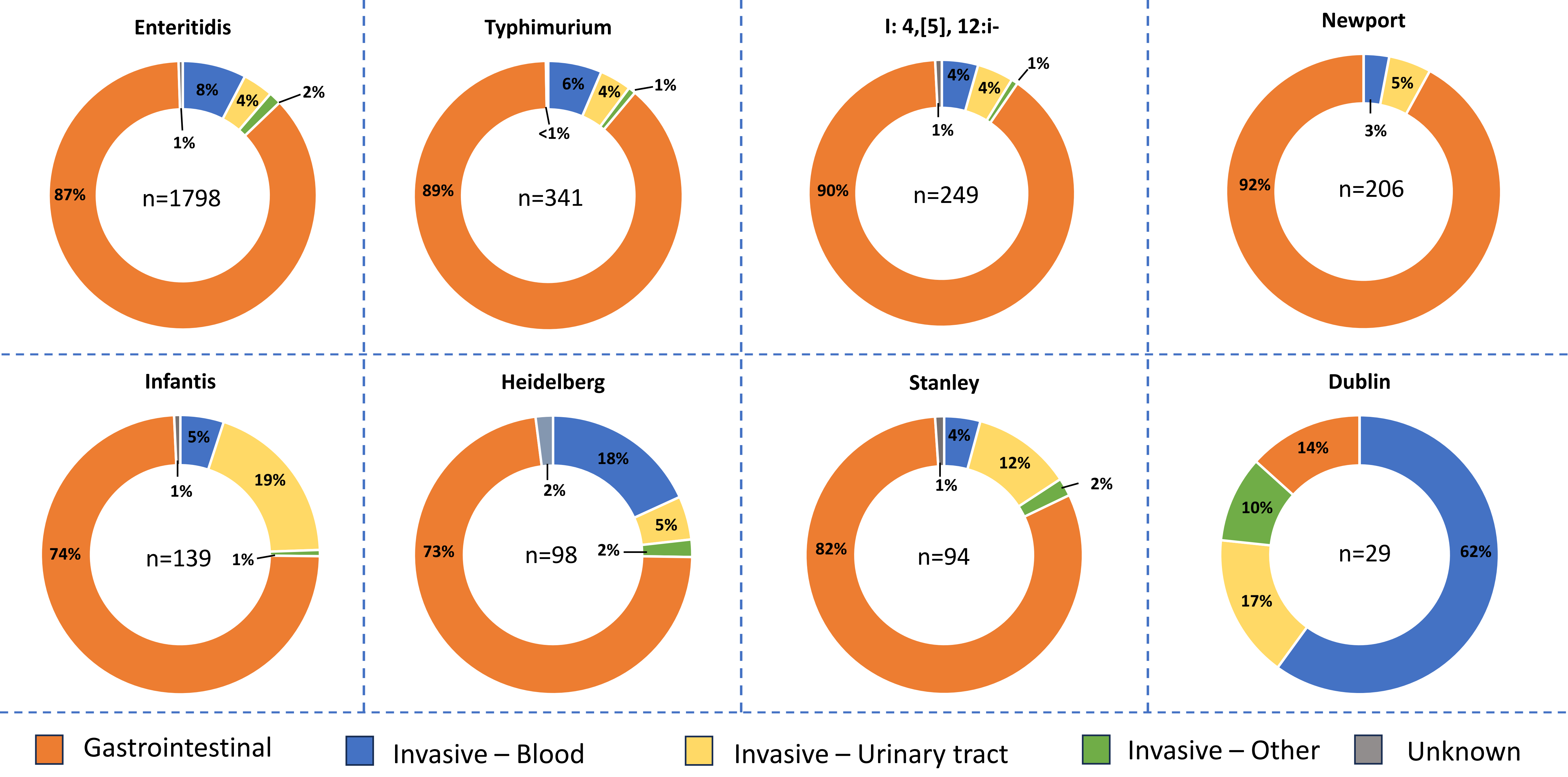
Distribution of human *Salmonella* serovars, 2022



Enteritidis	Typhimurium	I 4,[5], 12:i:-	Newport	Infantis	Heidelberg	Stanley	Others	Typhoidal	Grand Total
1,798	341	249	206	139	98	94	1,437	409	**4,771**
38%	7%	5%	4%	3%	2%	2%	30%	9%	**100%**

- *Salmonella* Enteritidis continues to be a predominant serovar causing human illness.
- The relative proportion of *S.* Heidelberg has decreased over time.

CIPARS Human (2022) – *Salmonella* Serovar by Sample Type



Salmonella Dublin manuscript doi: 10.1128/AAC.00108-19

Human *Salmonella*: Top 7 serovars remain stable, AMR dependent on serovar.

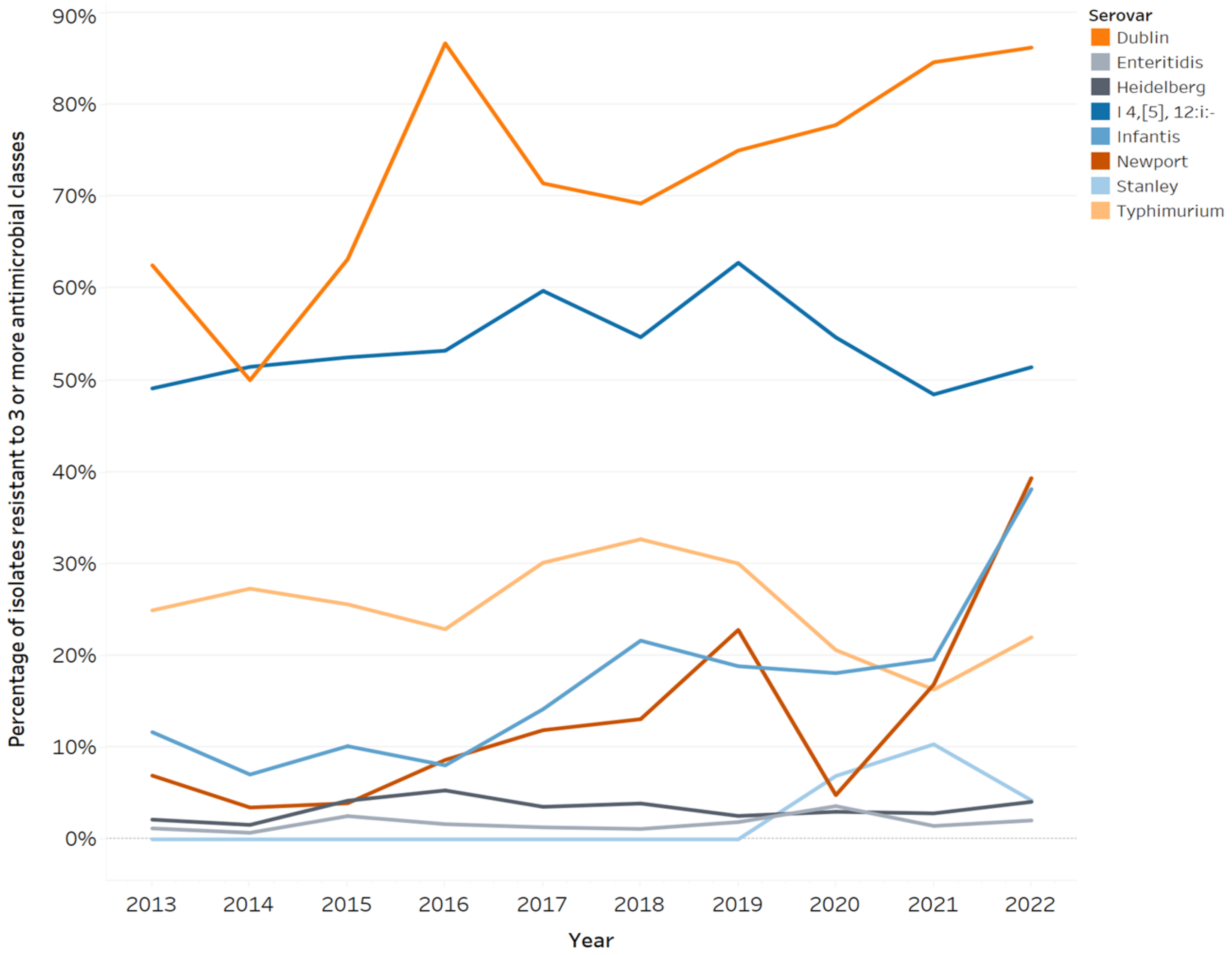
Number of *Salmonella* isolates resistant to 0, 1, 2, or 3 or more antimicrobial classes among the top 7 serovars.

Serovar	0	1	2	≥3	Total isolate count
Enteritidis	888	766	106	37	1,798
Typhimurium	191	39	35	75	341
I:4,[5], 12:i:-	89	22	10	128	249
Newport	25	22	0	81	206
Infantis	3	21	2	53	139
Heidelberg	0	19	4	4	98
Stanley	79	9	2	4	94

Number of *S.* Newport, and *S.* Dublin isolates resistant to 3 or more antimicrobial classes.

Serovar	3	4	5	6	≥7	Total isolate count
Newport	5	7	6	1	62	206
Dublin	0	1	13	11	0	29

Proportion of *Salmonella* isolates resistant to ≥ 3 antimicrobial classes among the top 7 serovars, Dublin and Newport



- Very high proportion (>80%) of *S*. Dublin resistant to ≥ 3 antimicrobial classes (noting the small number of isolates).
- *S*. Newport and *S*. Stanley showing sharp increases in frequency of isolates resistant to ≥ 3 antimicrobial classes.

NOTE: As of January 1st, 2020, whole genome sequencing began, and data is now reported for all serovars.

The proportion of isolates resistant to Category I, II, and III antimicrobials.

Serovar	Category I	Category II	Category III	n
Enteritidis	46%	47%	3%	1798
Typhimurium	8%	42%	32%	341
I: 4,[5],12:i:-	16%	59%	58%	249
Newport	35%	49%	39%	206
Infantis	50%	54%	39%	139
Heidelberg	8%	28%	5%	98
Stanley	10%	14%	6%	94

<u>Predicted resistances</u>

Category I: ciprofloxacin, ceftriaxone, amoxicillin/clavulanic acid, colistin.

Category II: ampicillin, cefoxitin, nalidixic acid, amikacin, gentamicin, tobramycin, streptomycin, kanamycin, erythromycin, azithromycin.

Category III: tetracycline, trimethoprim, sulfisoxazole, chloramphenicol.

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Ciprofloxacin resistance (n=831):
gyrA/gyrB (n=746)
gyrA/gyrB + qnr (n=6)
qnr (n=70)
qnr + aac(6')-Ib-cr (n=5)
aac(6')-Ib-cr (n=4)

Ceftriaxone resistance (n=2):
CMY-2 (n=2)

<u>Predicted resistances</u>

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Category III: tetracycline, trimethoprim, sulfisoxazole, chloramphenicol.

The proportion of isolates resistant to Category I, II, and III antimicrobials.

Serovar	Category I	Category II	Category III	n
Enteritidis	46%	**Ciprofloxacin resistance (n=33):** *gyrA/gyrB* (n=1) *qnr* (n=32) **Ceftriaxone resistance (n=19):** *CMY-2* (n=3) *CTX-M-15* (n=1) *CTX-M-55* (n=14) *TEM-93* (n=1)	3%	1798
Typhimurium	8%		32%	341
I: 4,[5],12:i:-	16%		58%	249
Newport	35%		39%	206
Infantis	50%		39%	139
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The proportion of isolates resistant to Category I, II, and III antimicrobials.

<table>
<tr><th>Serovar</th><th>Category I</th><th>Category II</th><th>Category III</th><th>n</th></tr>
<tr><td>Enteritidis</td><td>46%</td><td rowspan="7" colspan="2">Ciprofloxacin resistance (n=72):
parC (n=3)
gyrA/gyrB + parC (n=2)
qnr (n=3)
qnr + parC (n=64)

Ceftriaxone resistance (n=4):
CMY-2 (n=3)
CMY-2 + TEM-116 (n=1)</td><td>1798</td></tr>
<tr><td>Typhimurium</td><td>8%</td><td>341</td></tr>
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</table>

Predicted resistances

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Infantis	50%			139
Heidelberg	8%			98
Stanley	10%			94

Ciprofloxacin resistance (n=66):
gyrA/gyrB (n=3)
gyrA/gyrB + *parC* (n=62)
qnr + *parC* (n=1)

Ceftriaxone resistance (n=32):
CMY-2 (n=1)
CTX-M-55 (n=1)
CTX-M-65 (n=30)

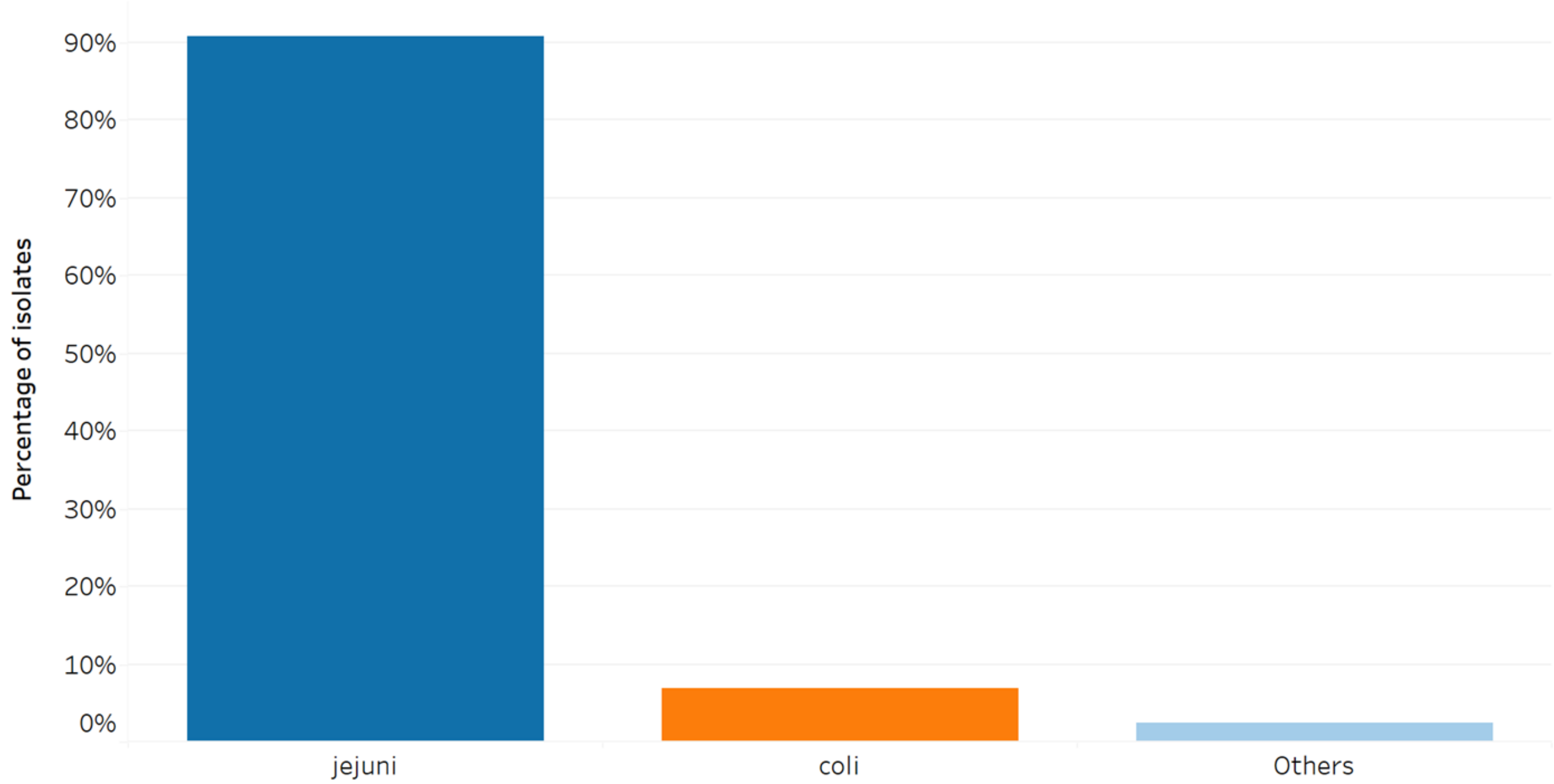
<u>Predicted resistances</u>

Category I: ciprofloxacin, ceftriaxone, amoxicillin/clavulanic acid, colistin.

Category II: ampicillin, cefoxitin, nalidixic acid, amikacin, gentamicin, tobramycin, streptomycin, kanamycin, erythromycin, azithromycin.

Category III: tetracycline, trimethoprim, sulfisoxazole, chloramphenicol.

Distribution of human *Campylobacter* species, 2021



jejuni	coli	Other species	Grand Total
551	42	15	**608**
90.6%	6.9%	2.5%	**100.0%**

Species grouped
- coli
- jejuni
- Other species

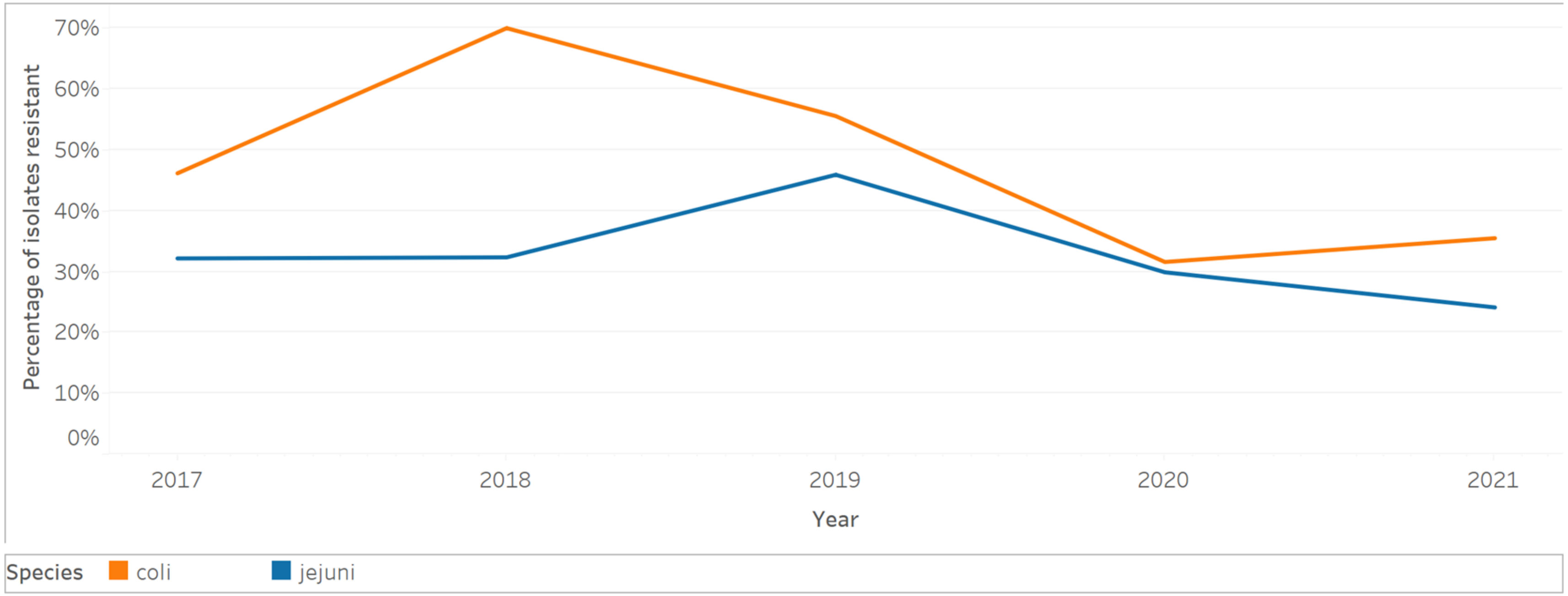
- In humans, the majority of isolates are *Campylobacter jejuni.*
- While "Other" species were identified, their individual proportions were not greater than 1% - these included *C. upsaliensis*, *C. lari*, *C. fetus*, and *C. ureolyticus.*

FoodNet Canada: https://www.canada.ca/en/public-health/services/surveillance/foodnet-canada

Number of *C. jejuni and C. coli* isolates resistant to 0, 1, 2, 3, 4, or 5 antimicrobial classes: 2021

Species	0	1	2	3	4	5	Total isolate count
jejuni	171	145	75	2	0	1	394
coli	12	10	8	1	0	0	31

Ciprofloxacin resistance among *Campylobacter* spp. isolated from human clinical samples.



- Resistance to multiple classes of antimicrobials was rarely detected among *C. jejuni and C. coli* isolates.
- Although ciprofloxacin resistance among *Campylobacter* isolates remains high - decreasing trend in resistance since 2017.

Emerging stories

Emerging Issue: XDR *Salmonella* I: 4,[5],12:i:-

- Extensively drug resistant (XDR) non-typhoidal *Salmonella* express resistance to **ampicillin, ceftriaxone, ciprofloxacin, azithromycin, trimethoprim, and sulfonamides.**

Year	# of XDR	Ages 0-2yr	Ages 3-9yr	Adult 20+
2020	0	N/A	N/A	N/A
2021	7	5	0	2
2022	14	5	1	8

- In 2021, **ONE** XDR isolate from children was invasive (blood)
- In 2022, **ALL** isolates from children were non-invasive (stool)
- CTX-M-55 I:4,[5],12:i:-: Closely related strains from a sick pig (diagnostic sample) and humans were detected
- An investigation of a cluster in 2022 linked human isolates of CTX-M-55, I:4,[5],12:i:- in several provinces, but primarily Ontario and Québec, to strains from beef cattle, pigs, dogs, and raw pet food

Extended-spectrum beta-lactamase (ESBL)-producing *Salmonella*.

- Detection of ESBLs is increasing in *Salmonella* isolates from humans, animals and food.

- Detection of ESBLs prior to 2017 (of total isolates tested): less than 0.5% for each of humans and animals.

- Detection of ESBLs in 2022 (of total isolates tested): 1.5% for each of human and animals.





Some common ESBL producing strains found across human and animal/meat sources, including outbreak strains.

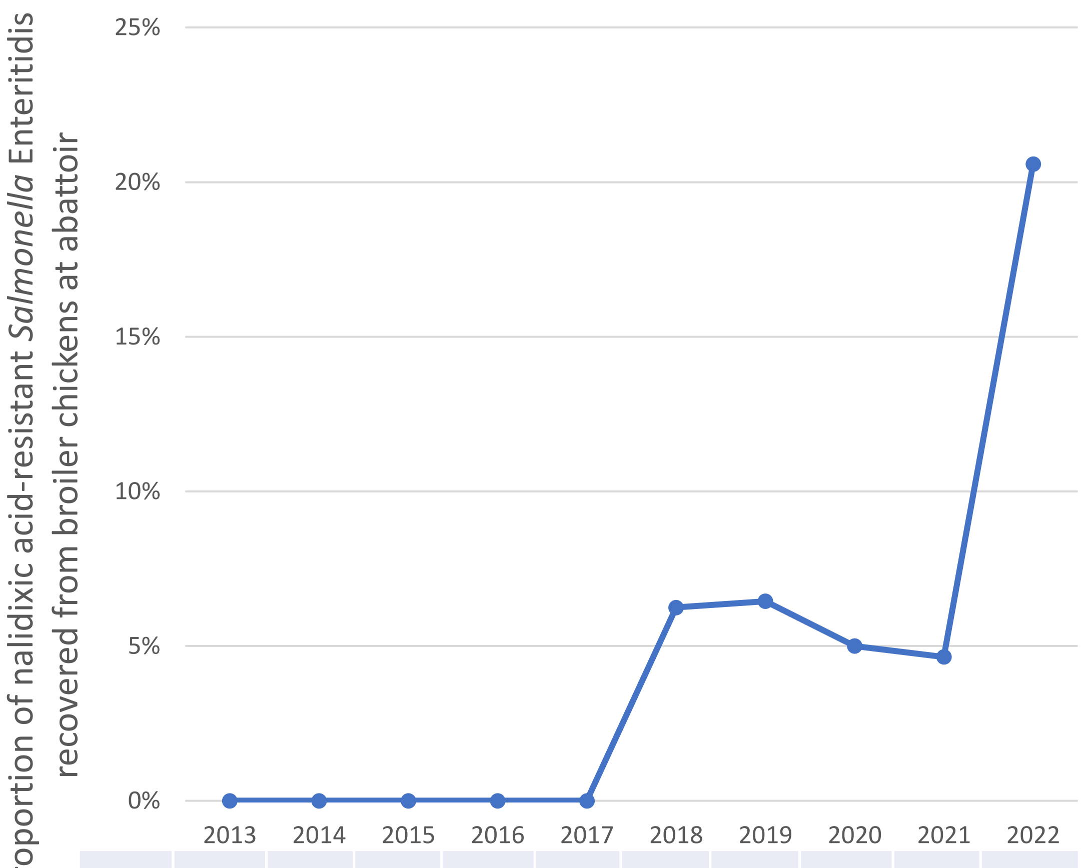
- CTX-M-65 *S*. Infantis: This is an emerging strain in poultry. Closely-related strains from humans (n=166), healthy chickens (n=3), healthy turkeys (n=12) and raw chicken from grocery stores (n=15) were detected.

- CTX-M-55 *S*. Typhimurium: Closely related strains from cattle (n=6) and humans (n=1) were detected.

- CTX-M-55 *S.* I:4,[5],12:i:-: Closely related strains from a sick pig (diagnostic sample) and humans were detected.

- An investigation of a cluster in 2022 to 2023 linked human isolates (n=40) of CTX-M-55 *S.* I:4,[5],12:i:- in several provinces, but primarily Ontario and Québec, to strains from beef cattle (n=17), pigs (n=3), dogs (n=3), mixed ground meat (n=1), and raw pet food (n=1).

Nalidixic acid-resistant *Salmonella* Enteritidis continues to be detected among broiler flocks.



n	14	29	31	29	29	32	31	20	43	34

**fewer flocks sampled in some provinces due to the prolonged HPAI outbreak situation*

In 2022,

- *Salmonella* Enteritidis was **NOT** detected in turkeys, layers, or beef cattle.
- Five Enteritidis isolates were recovered from swine, 3 isolates from farm surveillance and 2 isolates from abattoir surveillance , all were **SUSCEPTIBLE** to the antimicrobials tested.
- 38 Enteritidis isolates were recovered from broiler chickens (preharvest).
  - 15 isolates were resistant to nalidixic acid.
    - 7 from Québec and 8 from the Prairies.
- 34 Enteritidis isolates were recovered from broiler chickens at abattoir
  - 7 isolates were resistant to nalidixic acid.
    - 3 from Québec and 4 from Atlantic Canada.

Retail (FNC & CIPARS):

- 44 Enteritidis isolates were recovered from raw chicken.
  - 5 isolates were resistant to nalidixic acid.

Gentamicin resistance emerging in *Campylobacter* from cattle, swine, and poultry.

- Historically, gentamicin resistance has not been reported in *Campylobacter* isolates at the farm or abattoir level.
- All isolates were *C. coli* or *C.* spp. and were isolated from animals in the Prairies.

Cattle:

- 1 *Campylobacter* isolate from healthy feedlot cattle in 2019.
- 2 *Campylobacter* isolates from healthy cattle at slaughter in 2022.

Broiler Chickens:

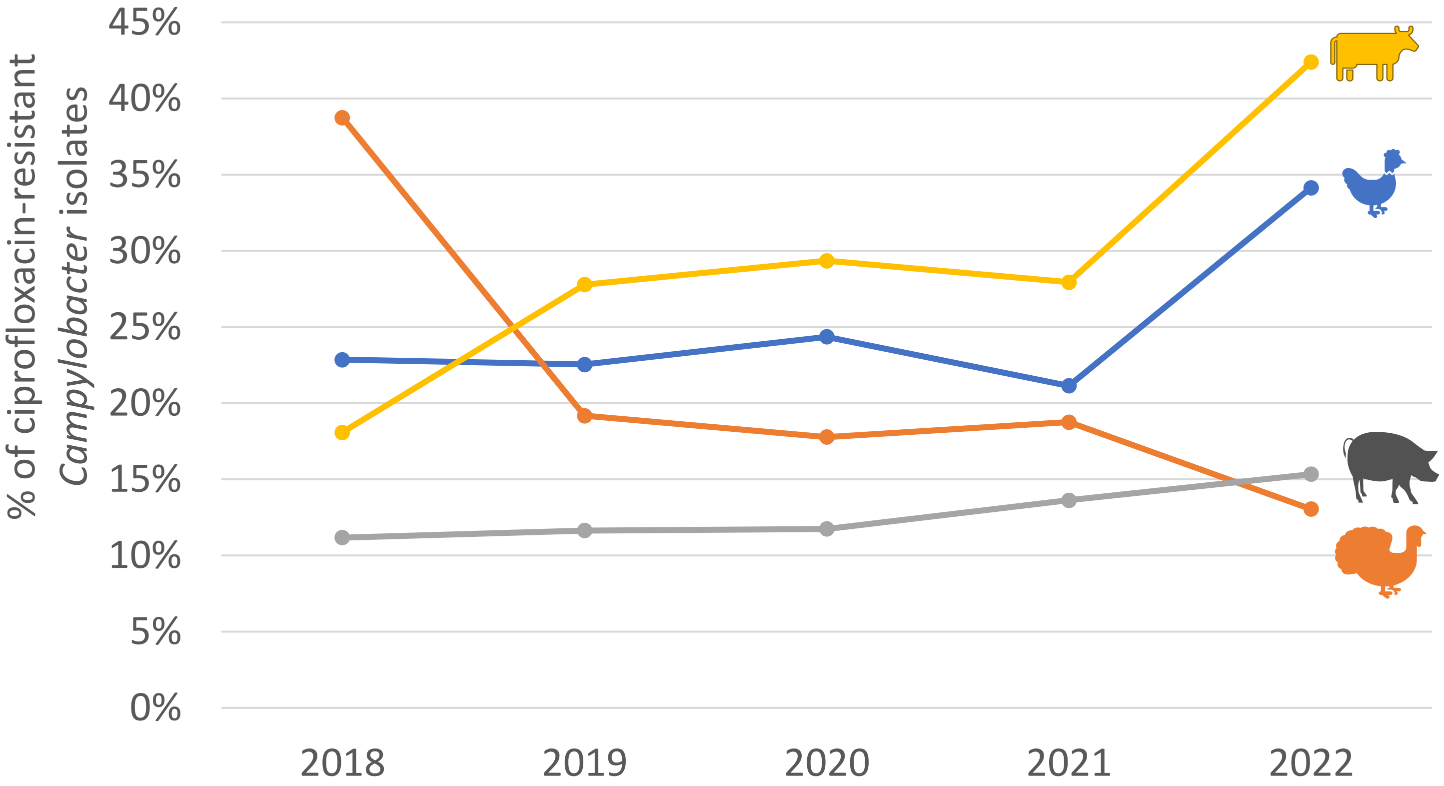
- 1 *Campylobacter* isolate from slaughter in 2021.

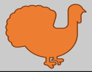
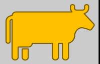
Pigs:

- 2 *Campylobacter* isolates from healthy swine at slaughter in 2021.
- 1 *Campylobacter* isolate from healthy swine at slaughter in 2022.

Substantial increase in ciprofloxacin-resistant *Campylobacter* from chickens, feedlot cattle and grower-finisher pigs at farm.

Despite reports of **LOW** fluroquinolone sales and use across all commodities, there is an increase in ciprofloxacin resistance among *Campylobacter* recovered from chickens, feedlot cattle, and grower-finisher pigs.



n		2018	2019	2020	2021	2022
		35	142	78	123	123
		191	73	90	240	115
		483	447	349	367	365
		94	162	92	247	184

Reported Category I antimicrobial use and Category I antimicrobial resistance in isolates from healthy animals or food.

- **Category I reported AMU on farm:** In 2022, the reported use of Category I antimicrobials from CIPARS volunteer sentinel farms (broiler chicken, turkey, grower-finisher pigs, and beef cattle feedlots), was very small fraction of the overall reported AMU (<0.2%)

- **Ceftriaxone-resistant *E. coli* and *Salmonella***: The trend (2018-2022) and detection of ceftriaxone resistance in *E. coli* and *Salmonella* from multiple surveillance components (samples from healthy animals at farm, abattoir and retail) show similar patterns. The general trend in resistance was either decreasing or stable.

    - For healthy broiler chickens, there was a decrease from 13% to 5% on farms, a decrease at abattoir from 8% to 5% and a decrease in raw chicken at retail from 11% to 7%

    - For grower-finisher pigs, there was a decrease from 8% to 6% from samples from farms with a low stable occurrence in samples from abattoirs (2 to 3%)

    - For ceftriaxone-resistant *E. coli*, the occurrence of resistance ranged from 0-3% for any samples collected from healthy animals on farms, at abattoir or retail

Mobile colistin resistance was rarely detected among human samples and not from animal or food samples.

- In 2020, **THREE** *Salmonella* isolates from humans
  - Serovars I: 4,5,12:i:- (n=1), and Cerro (n=2) were multiclass resistant and carried the ***mcr*** **gene**
- Human: No mobile colistin resistance was found in *Salmonella* in 2021 and 2022. There were 18 isolates with mobile colistin resistance detected between 2017 and 2020
- Animals and food: Mobile colistin resistance has not been detected in submitted isolates of *Salmonella* and *E. coli*

Carbapenem resistance

- *Salmonella*: isolates from a sick pig (2017) and one human sample (2018)

Interactive Data Visualizations

- Platform: Infobase
- Antimicrobial Sales (VASR)
  Antimicrobial Use (farm)
- Antimicrobial Resistance

Summary

	Antimicrobial Sales (mg/PCU) **(2018-2022)**	**AMU (farm) (2018-2022)**
Pigs	All pigs: ↓	Grower-finishers: (2018-2022) ↓
Cattle	↑	Feedlot (2019-2022): ↓ Dairy: NA – **new!**
Poultry	↓	Broilers: ↓ Turkeys: ↓ Layers; NA – **new!**
Cats and Dogs	↑	NA
Horses	↑	NA
Small Ruminants	↓	NA
Aquaculture	↓	↓

NA – not applicable

	AMR* (farm) (2018-2022)	AMR* (abattoir) (2018-2022)	AMR* (retail meat) (2018-2022)
Pigs/Pork	Grower finishers: ↓	Pigs: *Salmonella/E. coli* → *Campylobacter* ↓	Pork: →
Cattle/Beef	Feedlot (2019-22): Dairy (2019-21): ↓	Cattle: →	Beef: ↓
Chickens/Chicken	Broilers: ↓ Layers; NA – **new!**	Chickens: →	Chicken: *E. coli* ↓
Turkeys/Turkey	Turkeys: ↓ **	NA	Turkey: ↓

NA – not applicable

*AMR for this table is reflected primarily by the indicator "resistant to ≥ 3 antimicrobial classes". Noting that there are fluctuations in resistance to individual antimicrobials within bacterial species

**Resistance to ≥ 3 antimicrobial classes for *Salmonella* and *Escherichia coli* decreased while resistance to ≥ 3 antimicrobial classes for *Campylobacter* increased

Take away messages

- Expansion of surveillance and reporting.
  - Poultry *Enterococcus* data
  - Layer data
  - Human *Campylobacter* data

- Whole genome sequence – phenotypic prediction of resistance for human *Salmonella* isolates

- Interactive data expansion

- Since 2019, CIPARS has been collecting isolates for susceptibility testing for bovine respiratory disease pathogens. New to CIPARS is engagement with AMRNetVet to compare with clinical diagnostic isolates.

Take away messages

- The quantity of antimicrobials sold for use in animals has decreased since 2018, however, sales (adjusted for animal biomass) have remained fairly stable since 2019. It is important to note that the first two years of VASR data (2018, and 2019) reflect a time of regulatory and policy changes implemented by Health Canada to promote the responsible use of antimicrobials in animals.
    - Overall, across the animal commodities reported farm-level AMU has generally decreased since 2018 and **AMR has decreased**
        - Noting that there is a recent increasing trend in reported AMU in broiler chickens on-farm, and sales for aquaculture
    - **Colistin and carbapenem resistance is rarely found**. Transmissible colistin resistance has not been detected in any animal or food isolates.
- Despite reports of **LOW** fluroquinolone use and sales across all food animal commodities, there was a **notable increase in ciprofloxacin resistance** among *Campylobacter* recovered from chickens, feedlot cattle, and grower-finisher pigs. Ciprofloxacin resistance in *Campylobacter* from humans is decreasing.

Take away messages

- In 2022, **CIPARS continued to detect nalidixic acid-resistant *S.* Enteritidis** from healthy broiler chickens on farm, samples from healthy chickens at abattoir, samples of raw grocery store chicken, and samples from sick chickens (recognizing that sick animals do not enter the food chain).

- Historically, gentamicin resistance has not been detected in *Campylobacter* in animals and food from CIPARS components. However, **since 2019, detection of gentamicin resistance in *Campylobacter* has been found in multiple CIPARS components.**

- Emerging *Salmonella* XDR I: 4,[5],12:i:- in humans. Proportions of invasive infections in children ≤ 10 yrs remain low, but have increased since 2020.

- Increased detection of extended-spectrum beta-lactamase-producing *Salmonella* from humans, animals and food.

Acknowledgements

Human (AMR)

- NML Division of Enteric Diseases and PulseNet Canada
- Provincial Public Health Laboratories
- FoodNet Canada (*Campylobacter*)
- National Enteric Surveillance Program (NESP)

Farm (AMR and AMU):

- Veterinarians, producers and commodity groups who participate in the farm program, Saskatchewan Agriculture
- Feedlot Cattle Surveillance Funding: Canadian Agricultural Partnership in Alberta and Ontario, Alberta Cattle Feeders Association, Bayer Animal Health, Beef Farmers of Ontario, Beef Cattle Research Council, Alberta Beef Producers, McDonald's, Saskatchewan Cattle Feeders and Vetoquinol
- Dairy Cattle Surveillance: Funding provided by Dairy Farmers of Canada Dairy Research Cluster as part of the Canadian Agricultural Partnership
- Fisheries and Oceans Canada (DFO)

Abattoir:

- Canadian Food Inspection Agency, abattoir operators, samplers and personnel

Retail:

- Participating health units and institutions
- FoodNet Canada

Clinical Animal Isolates:

- Provincial Animal Health Laboratories

Antimicrobial sales for animals:

- VASR: Health Canada's Veterinary Drugs Directorate, PHAC

Antimicrobial Use - humans:

- AMR Task Force and IQVIA

Antimicrobials Sold as Pesticides for use in Crops:

- Health Canada's Pest Management Regulatory Agency

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Appendices

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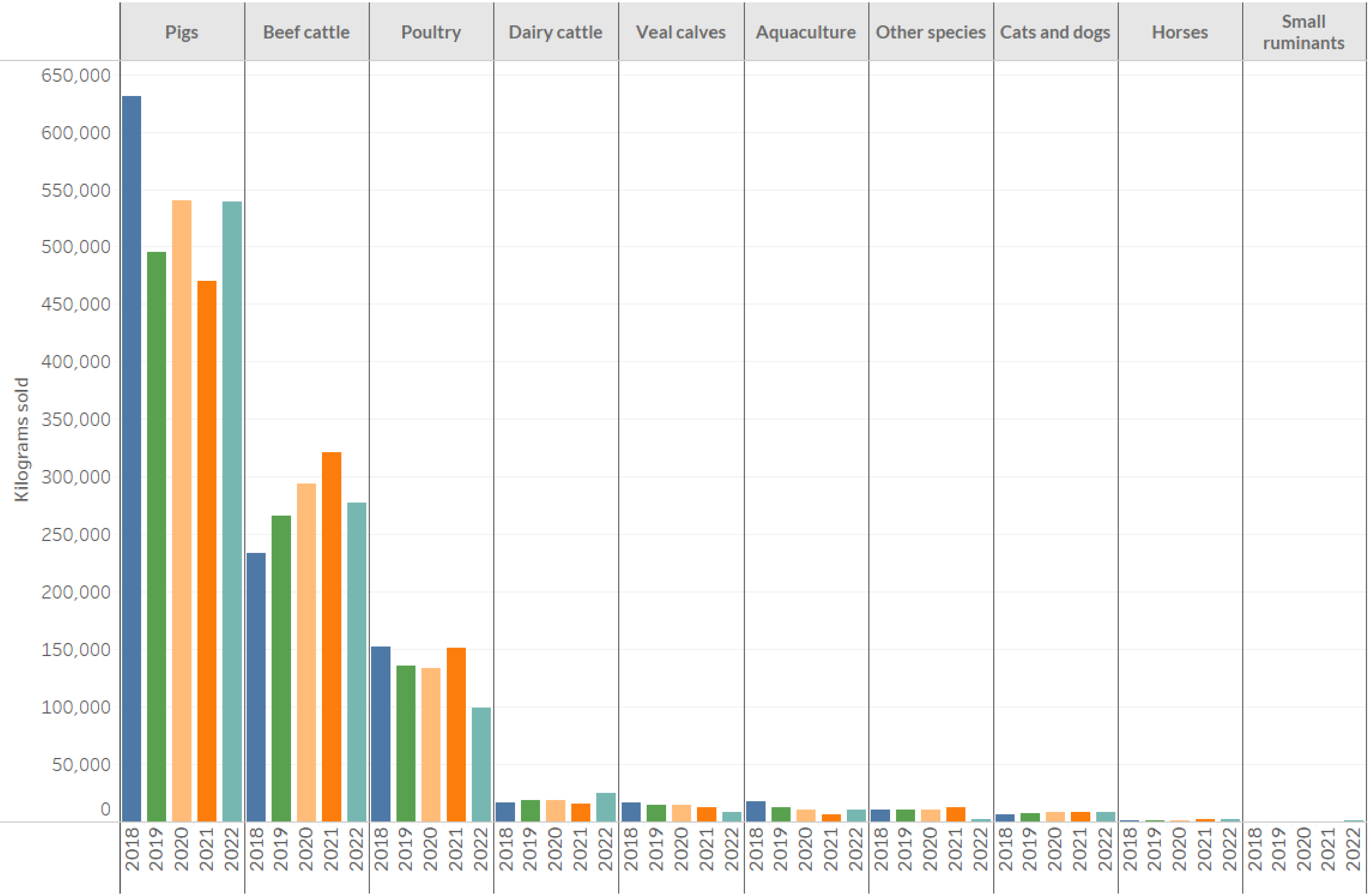
CIPARS publications: https://www.canada.ca/en/public-health/services/surveillance/canadian-integrated-program-antimicrobial-resistance-surveillance-cipars/publications.html

In kilograms, the majority of sales in 2022 were intended for use in **pigs, beef cattle, and poultry**.



Between 2021 and 2022: Sales for beef cattle and veal calves decreased, while sales for dairy cattle increased.

We are currently working on developing biomass denominators for beef, dairy and veal.

Between 2020 and 2022, sales (in mg/PCU) decreased for poultry & remained stable for pigs

Poultry

- **Top classes sold in 2022**: bacitracins, orthosomycins, and penicillins
- **mg/PCU sold:** Increased by 10% between 2020 and 2021 and decreased by 35% between 2021 and 2022 (in mg/PCU)
- **Category I:** None manufactured or imported for use in poultry since 2019. Small quantities of fluoroquinolones (less than 1 kg) were compounded for use in chickens

Pigs

- **Top classes sold in 2022**: tetracyclines, penicillins, and macrolides
- **mg/PCU sold:** Decreased by 13% between 2020 and 2021 and increased by 15% between 2021 and 2022
- **Category I**: increased by 15% (0.02 mg/PCU, 42 kg) between 2021 and 2022

Between 2020 and 2022, sales (in kg) decreased for beef and increased for dairy

Beef Cattle

- **Top classes sold in 2022:** tetracyclines (75% of sales), macrolides, and streptogramins.
- **kg sold:** increased by 9% between 2020 and 2021 and decreased by 13% between 2021 and 2022.

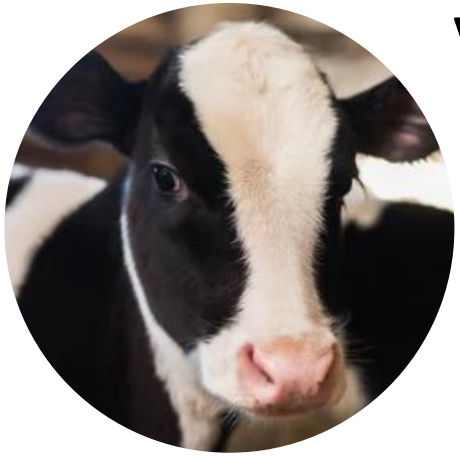
- **Category I**: increased by 18% (209 kg) since 2021.
  - 3rd generation cephalosporin sales increased by 6% (45 kg)
    fluoroquinolone sales increased by 39% (164 kg)

Dairy Cattle

- **Top classes sold in 2022**: tetracyclines, diaminopyrimidine-sulfonamide combinations, and penicillins.
- **kg sold:** decreased by 20% between 2020 and 2021 and increased by 65% between 2021 and 2022.

- **Category I:** increased by 12% (65 kg) since 2021, due to increased sales of fluoroquinolones.
  - 3rd generation cephalosporin sales decreased by 17% (89 kg) between 2021 and 2022.

Between 2020 and 2022, sales decreased (in kg) for veal and increased for aquaculture (in mg/PCU)



Veal Calves

- **Top classes sold in 2022**: tetracyclines, sulfonamides, and penicillins.
- **kg sold:** increased by 6% in between 2020 and 2021 and decreased by 41% between 2021 and 2022.
- **Category I**: None reported to be sold by manufacturers or importers since 2018.

Aquaculture

- Only tetracyclines, amphenicols, macrolides and diaminopyridine-sulfonamide combinations were sold in 2022.
- **mg/PCU sold:** decreased by 33% between 2020 and 2021 and increased by 74% between 2021 and 2022.
- **Category I:** None manufactured or imported since 2018.

Between 2020 and 2022, sales (in mg/PCU) increased for horses and decreased for cats and dogs

Horses

- **Top classes sold in 2022**: diaminopyrimidine-sulfonamide combinations, penicillins and sulfonamides
- **mg/PCU sold**: increased by 42% between 2020 and 2021 and increased by 7% between 2021 and 2022
- **Category I**: None reported in 2022. In 2021 a small quantity of therapeutic agents for tuberculosis (rifampin) were sold
- More antimicrobials were compounded for use in horses, than were sold by manufacturers and importers

Cats and Dogs

- **Top classes sold in 2022**: 1st generation cephalosporins, penicillin beta-lactamase inhibitor combinations and penicillins
- **mg/PCU sold:** decreased by 3% between 2020 and 2021 and decreased by 4% between 2021 and 2022
- **Category I:** decreased by 1% between 2021 and 2022

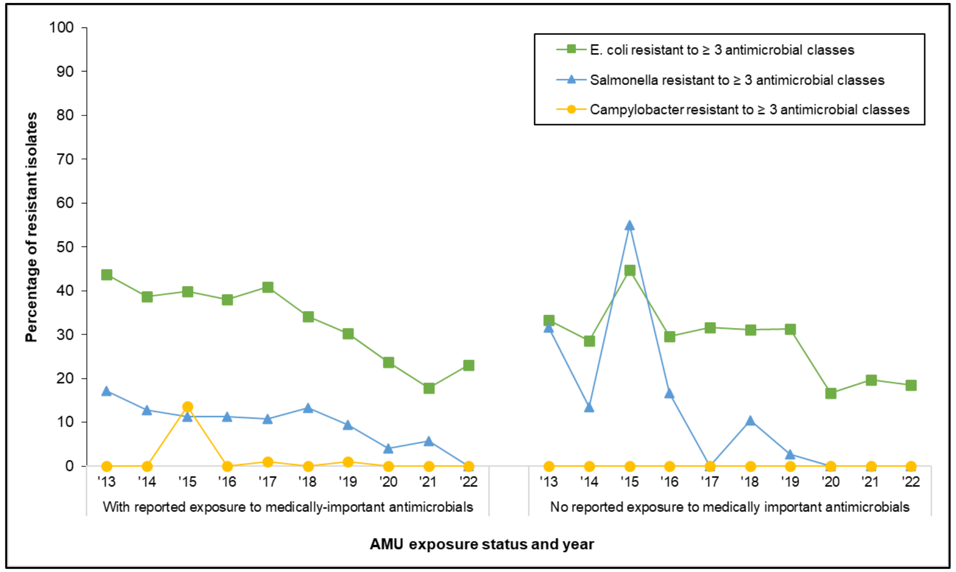
Between 2020 and 2022, sales (in mg/PCU) increased for small ruminants

Small Ruminants

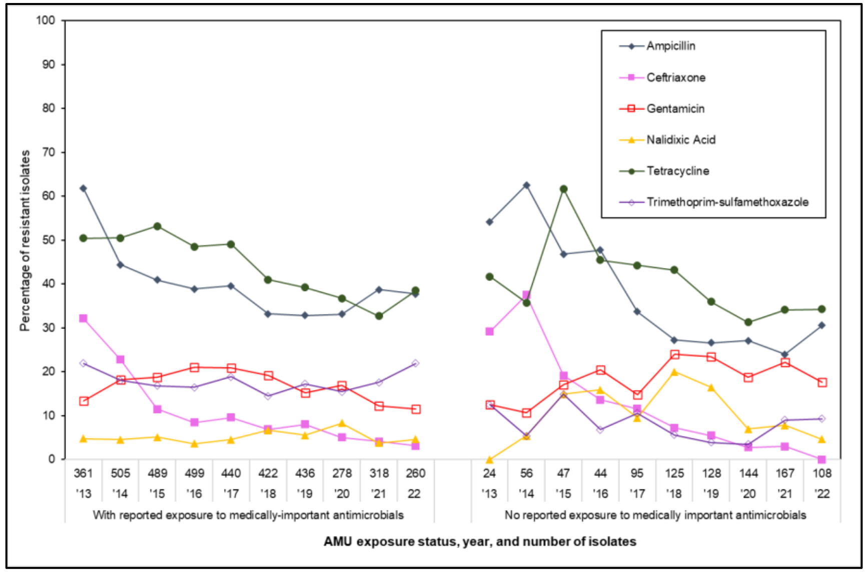
- **Top classes sold in 2022**: sulfonamides, aminoglycosides, amphenicols, and penicillins
- **mg/PCU sold**: increased by 4% between 2020 and 2021 and increased by 920% between 2021 and 2022 (due to improved species-level reporting for small ruminants).
- **Category I**: small quantity of 3rd generation cephalosporins reported in 2022.

AMR in broiler chickens based on their AMU* exposure status

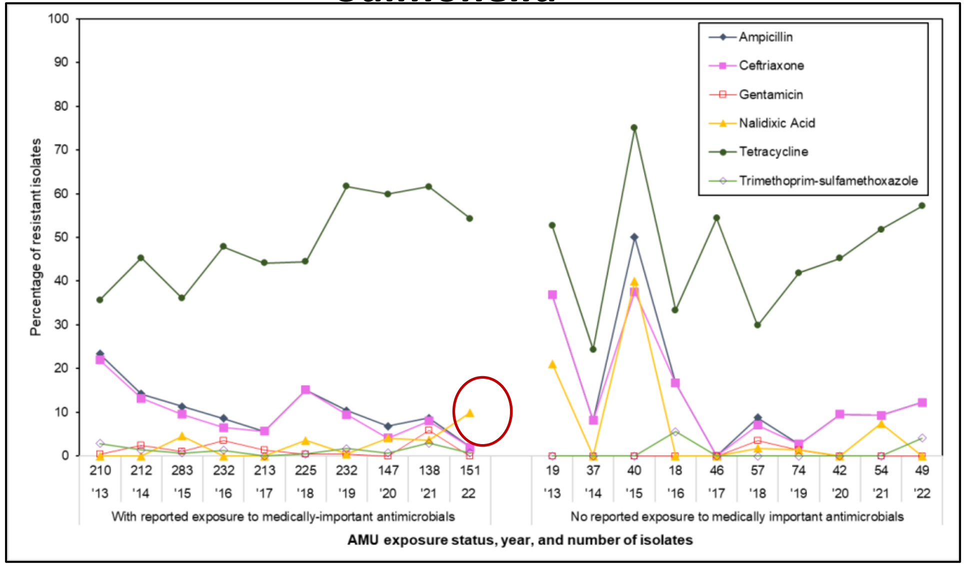
Resistance to ≥ 3 antimicrobial classes



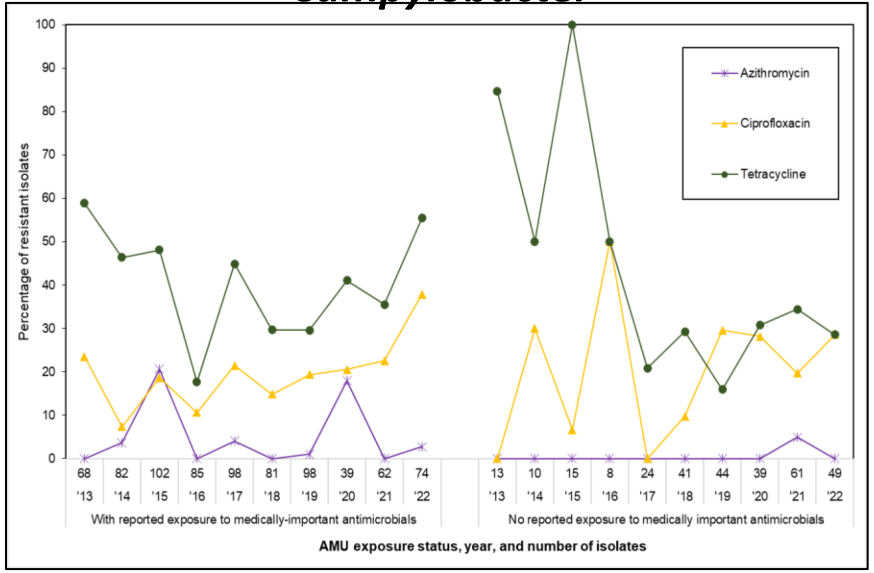
E. coli



Salmonella



Campylobacter

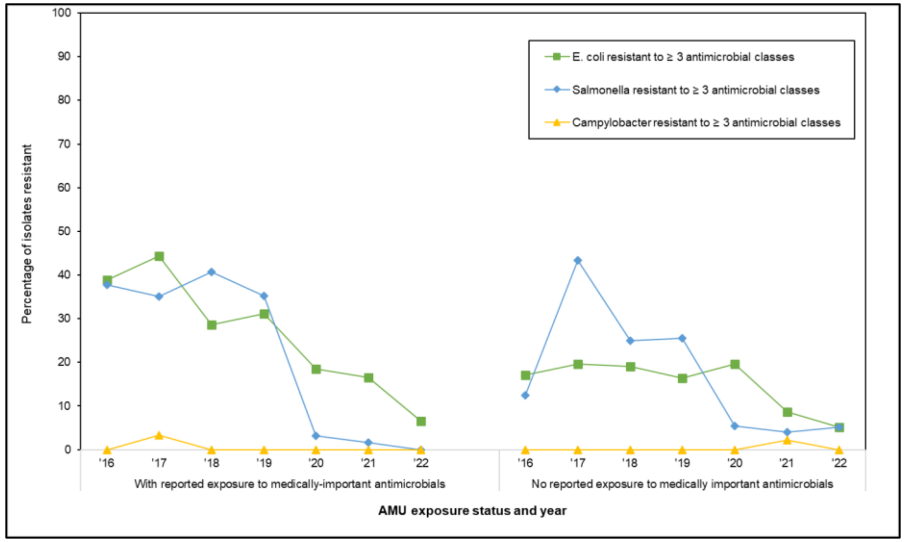


- Trends in most AMR measurements in flocks exposed and unexposed to medically important antimicrobials were essentially the same.
- Rise in nalidixic acid resistant *Salmonella* was noted only in flocks exposed to medically-important antimicrobials (presented earlier; mainly *S.* Enteritidis).

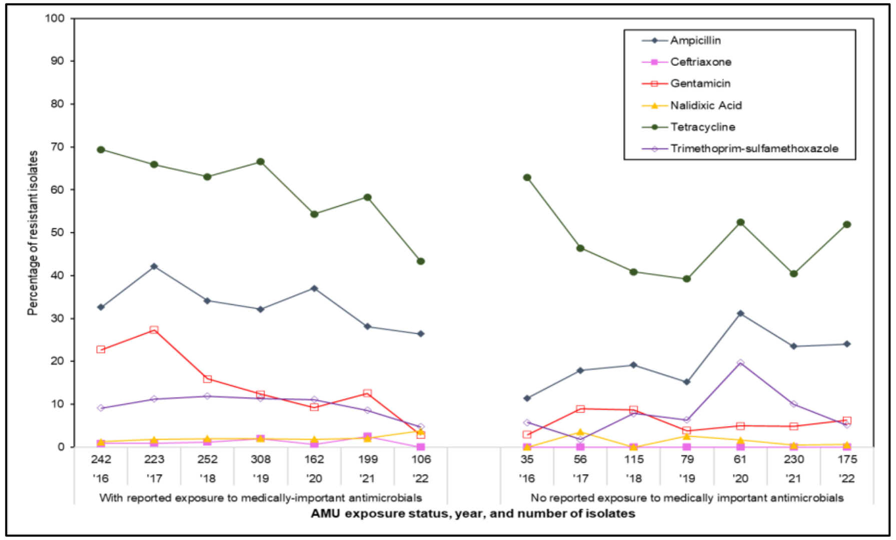
*https://www.canada.ca/en/public-health/services/antibiotic-antimicrobial-resistance/animals/veterinary-antimicrobial-sales-reporting/list-a.html

AMR in turkeys based on their AMU* exposure status

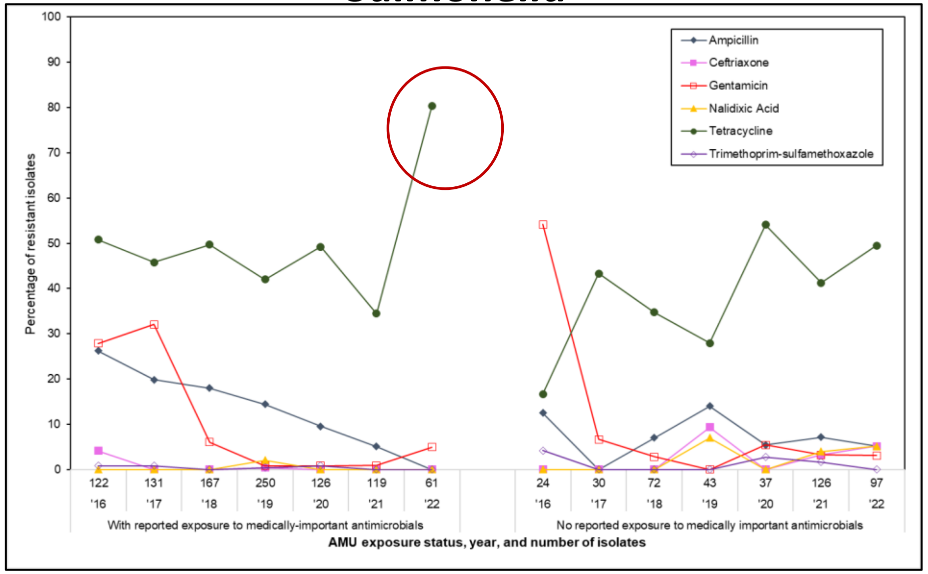
Resistance to ≥ 3 antimicrobial classes



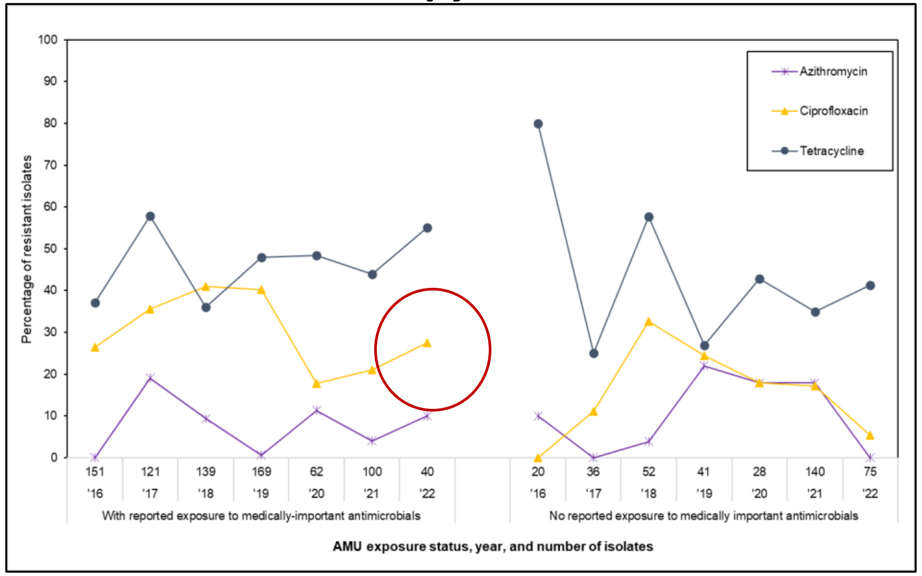
E. coli



Salmonella



Campylobacter



- Trends in most AMR measurements in flocks exposed and unexposed to medically important antimicrobials were essentially the same except in highlighted antimicrobials.
- Rise in tetracycline resistance in *Salmonella* and ciprofloxacin resistance in *Campylobacter* were noted in flocks exposed to medically important antimicrobials.

*https://www.canada.ca/en/public-health/services/antibiotic-antimicrobial-resistance/animals/veterinary-antimicrobial-sales-reporting/list-a.html

Highlights from Dairy Cattle 2021/2022

- Category I resistance in *E.coli* was less than 5% in all years and decreased between 2019 and 2021.
- There was no resistance to Category I antimicrobials in *Salmonella* from any year.
- For all antimicrobials tested, there was less than 25% resistance in *E. coli* isolates in 2021.

Distribution of reported antimicrobial use, by route of administration and category of importance to human medicine, within each disease category listed, 2022.

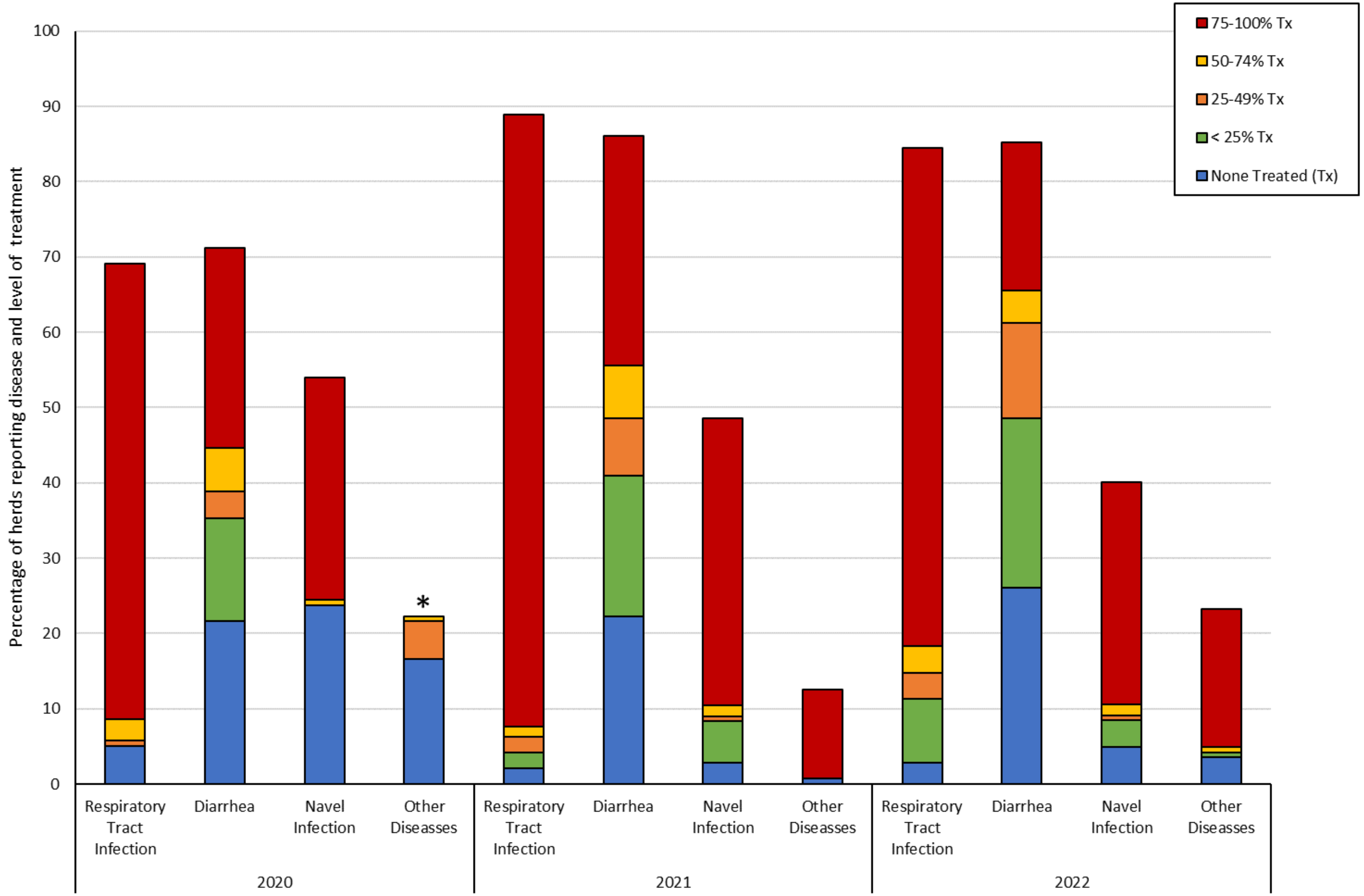
Disease Category	Route of Administration	Reported Disease Herd Prevalence	Category of Importance to Human Medicine		
			I	II	III
Calf Respiratory Inf.	Injection	90%	7%	92%	1%
Calf Diarrhea	Injection	90%	10%	61%	2%
	Oral		0%	22%	5%
Calf Navel Inf.	Injection	43%	5%	93%	2%
Heifer Respiratory Inf.	Injection	60%	5%	86%	9%
Heifer Lameness	Injection	46%	7%	67%	11%
	Topical		0%	0%	16%
Heifer Diarrhea	Injection	16%	20%	50%	0%
	Oral		0%	10%	20%
Cow Respiratory Inf.	Injection	52%	41%	56%	3%
Cow Lameness	Injection	93%	28%	41%	7%
	Topical		0%	0%	25%
Cow Diarrhea	Injection	48%	27%	64%	0%
	Oral		0%	0%	9%
Cow Wound Mgmt	Injection	79%	7%	93%	0%
Cow Mastitis	Intramammary	96%	38%	38%	0%
	Injection		2%	22%	0%
Cow Reprod. Tract Inf.	Injection	86%	25%	42%	1%
	Intra-uterine		0%	31%	2%
Dry Cow Therapy	Intramammary	93%	21%	79%	0%

- Category I antimicrobials were used by injection and intramammary routes of administration.
- Category II antimicrobials were most commonly used across all production types and all routes of administration.
- Overall antimicrobial products reported, 20% were Cat. I, 74% Cat. II and 6% Cat. III.
- Main drivers of use were calf respiratory infections (13%), clinical mastitis (17%), dry cow therapy (10%), and reproductive tract infections (10%), accounting for 50% of overall reported AMU.

Dairy calves

Respiratory and intestinal infections in calves were reported by a majority of farms

Respiratory disease is a major driver of AMU in dairy calves

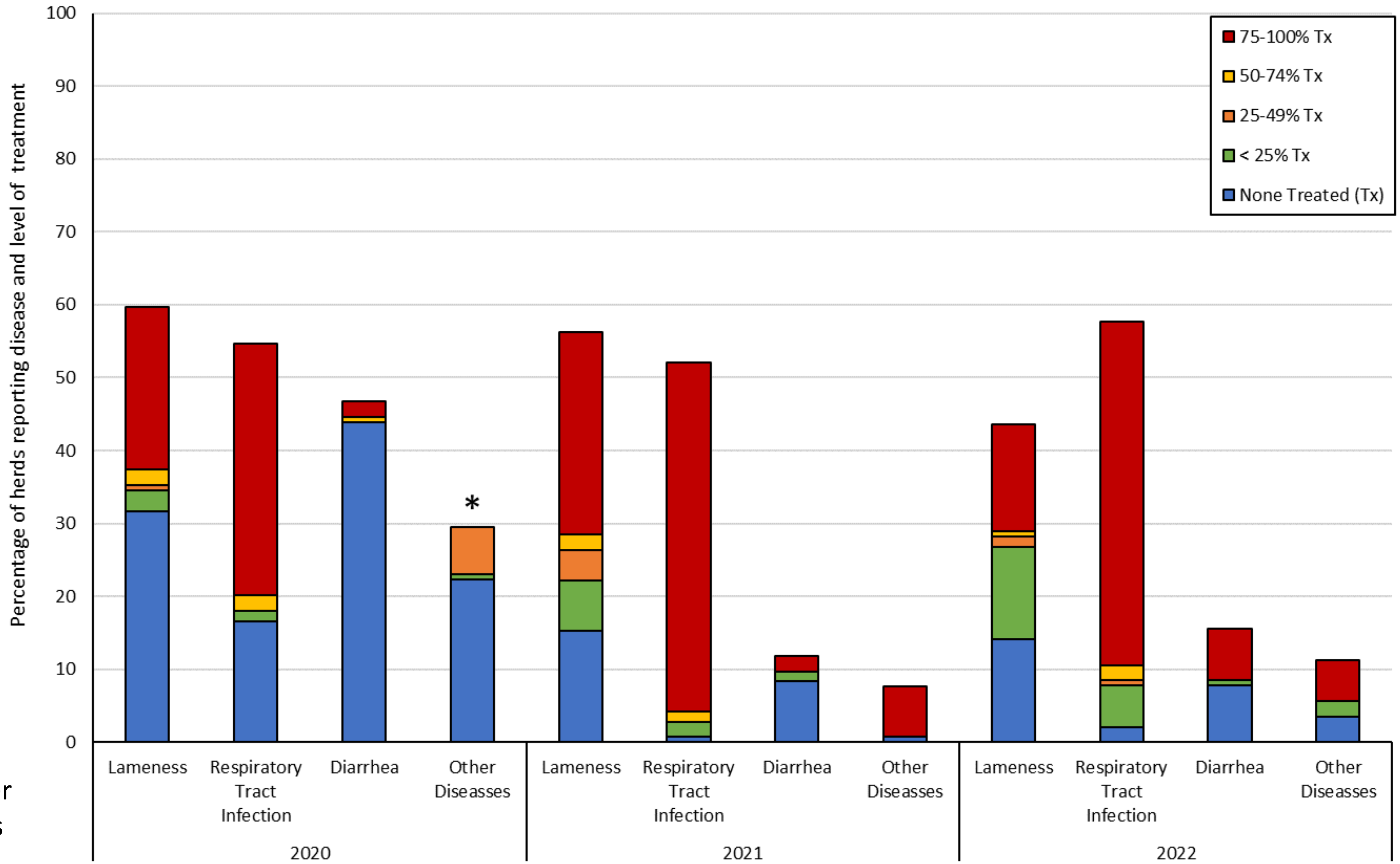


*The 2020 questionnaire asked about extra ailments compared to 2021, these were grouped together under "Other" in the 2020 analysis to match 2021 questionnaire data.

Tx : treatment

Dairy heifers

Lameness and respiratory tract infection in heifers were reported by just over half of participating farms; the majority of heifers with respiratory tract infection are treated with antimicrobials.

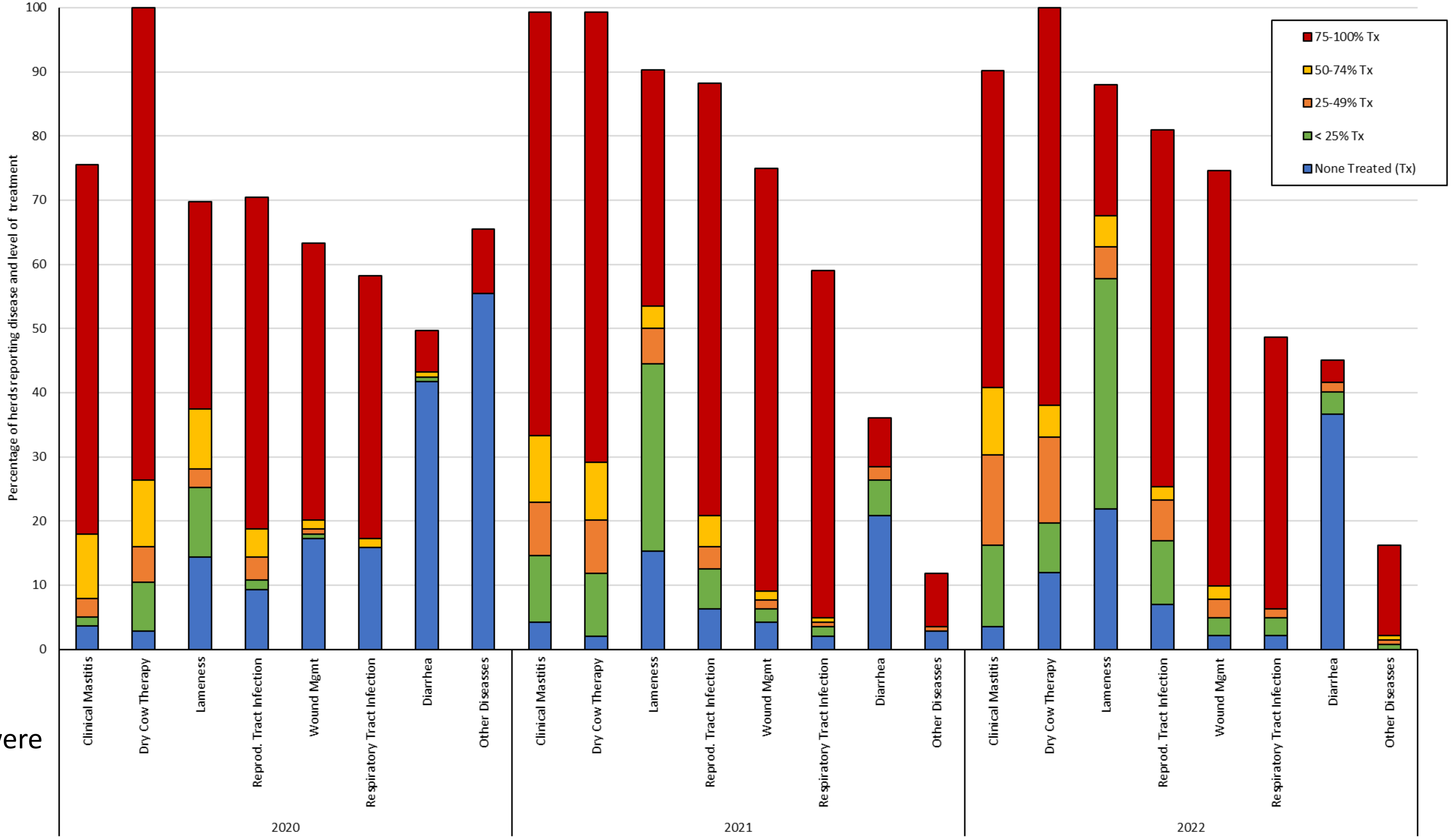


*The 2020 questionnaire asked about extra ailments compared to 2021, these were grouped together under "Other" in the 2020 analysis to match 2021 questionnaire data.

Tx : treatment

Dairy cows

Clinical mastitis, DCT, lameness and reproductive tract infection were reported by a majority of farms and are apparent drivers of AMU in cows.



*Dry cow therapy data in 2020 were collected using a separate questionnaire developed for research purposes.

Tx : treatment

Summary of temporal changes in resistance in *Salmonella*, *E. coli* and *Campylobacter* fecal isolates from dairy calves, heifers, lactating cows, and the manure pit (2019-2021)

		2019	2020	2021	Comparing 2021 to 2020
Salmonella	Number of isolates	28	44	41	
	Ceftriaxone	0%	0%	0%	0%
	Nalidixic acid/ciprofloxacin	0%/0%	0%/0%	2%/0%	2%/0%
	Resistant to ≥1 classes	25%	16%	20%	4%
E. coli	Number of isolates	544	539	560	
	Ceftriaxone	3%	1.7%	1.2%	-0.5%
	Nalidixic acid/ciprofloxacin	1%/0.2%	1%/0.2%	1%/0.4%	0%/0.2%
	Resistant to ≥1 classes	24%	19%	19%	0%
Campylobacter	Number of isolates	360	286	288	
	Nalidixic acid/ciprofloxacin	20%/21%	12%/12%	16%/16%	4%/4%
	Resistant to ≥1 classes	55%	48%	50%	2%

Notes: Dairy program data began being collected in 2019, so earlier information is unavailable.