Canadian Feedlot Antimicrobial Use and Antimicrobial Resistance Surveillance Program

World Antimicrobial Resistance Awareness Week
November 19, 2024

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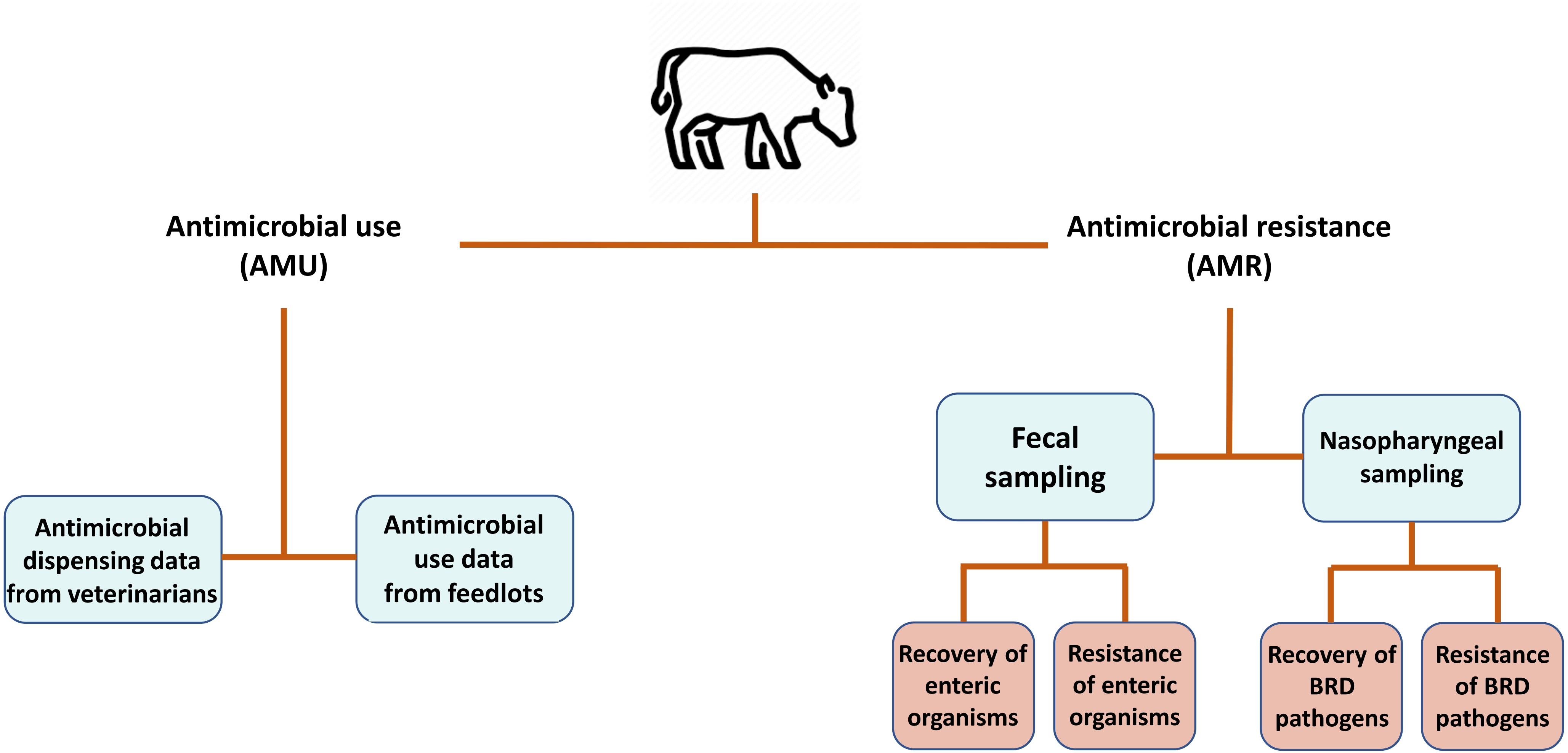
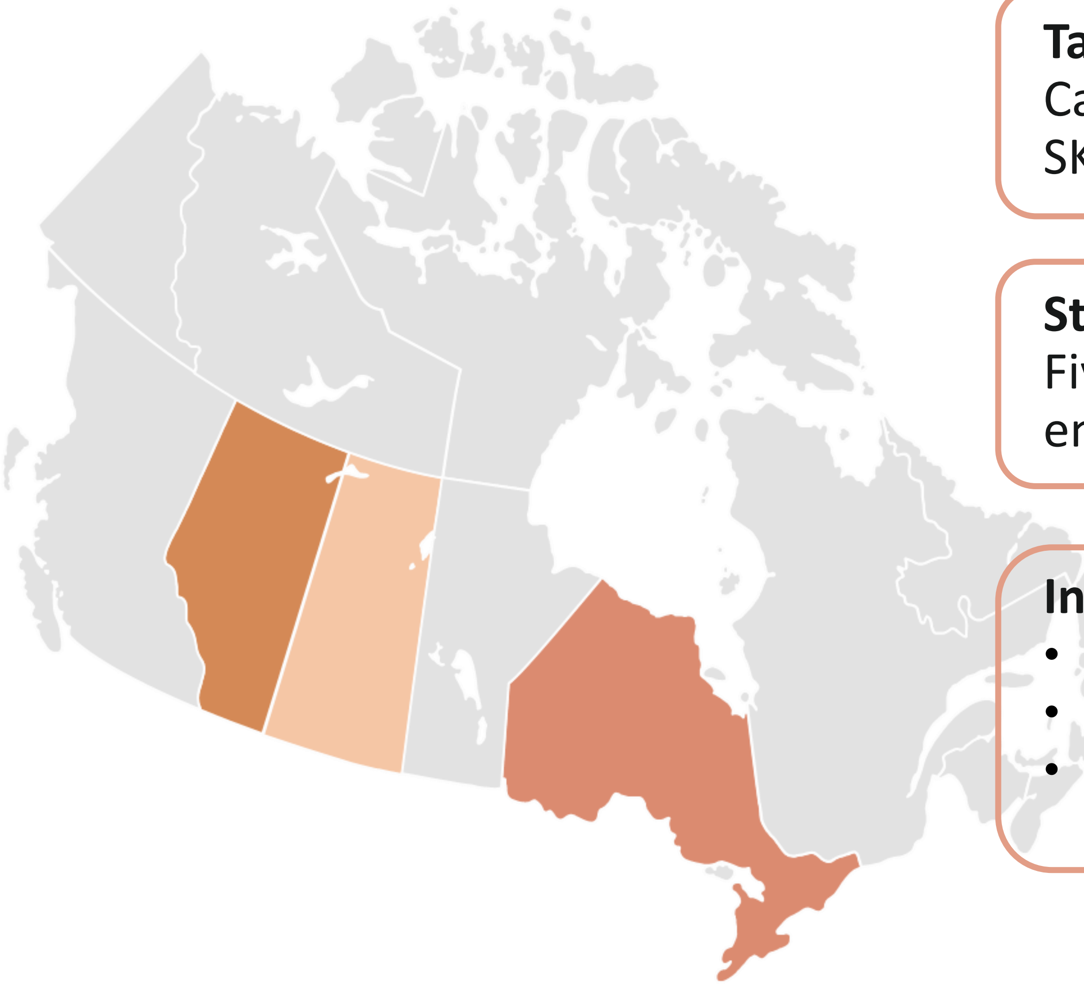
Objectives

- Provide representative national estimates of AMU and AMR in Canadian finishing feedlots
- Monitor trends in AMU and AMR in feedlots over time and in the context of changes to veterinary practice
- Assess the potential risk arising from AMU in feedlots on the effectiveness of antimicrobials in animals and humans

Data collection framework



Target population and sampling frame



Target:
Cattle destined for slaughter in finishing feedlots in AB, SK, ON

Strategy:
Five large feedlot veterinary consulting groups were engaged to recruit participating feedlots

Inclusion criteria:
- Engaged in finishing phase of production
- One-time capacity >1000 animals
- Valid veterinary-client-patient relationship with the enrolling veterinarian

AMR: FECAL ORGANISMS

2023 HIGHLIGHTS AND 5-YEAR TEMPORAL TRENDS

Sample collection: fecal organisms (2023)

329 fecal samples

<u>Isolation and susceptibility testing</u>: *E. coli, Campylobacter* spp., and *Salmonella spp.*

EC

S

C

One isolate of each recovered organism per sample was tested for susceptibility to a panel of antimicrobials

14 antimicrobials (8 classes) for *E. coli* and *Salmonella* spp.
9 antimicrobials (7 classes) for *Campylobacter* spp.

NML in Saint-Hyacinthe, QC

PDS in Saskatoon, SK

<u>Isolation</u>: *Enterococcus* spp.
<u>Susceptibility testing</u>: *E. faecalis, E. faecium* and *E. hirae* **(n = 305)**

329 fecal samples

EF

EH

EF

O

Only one *Enterococcus* spp. isolate per sample was tested for susceptibility to a panel of 16 antimicrobials (13 classes)

**E. faecalis* was selected over *E. faecium* and *E. hirae*

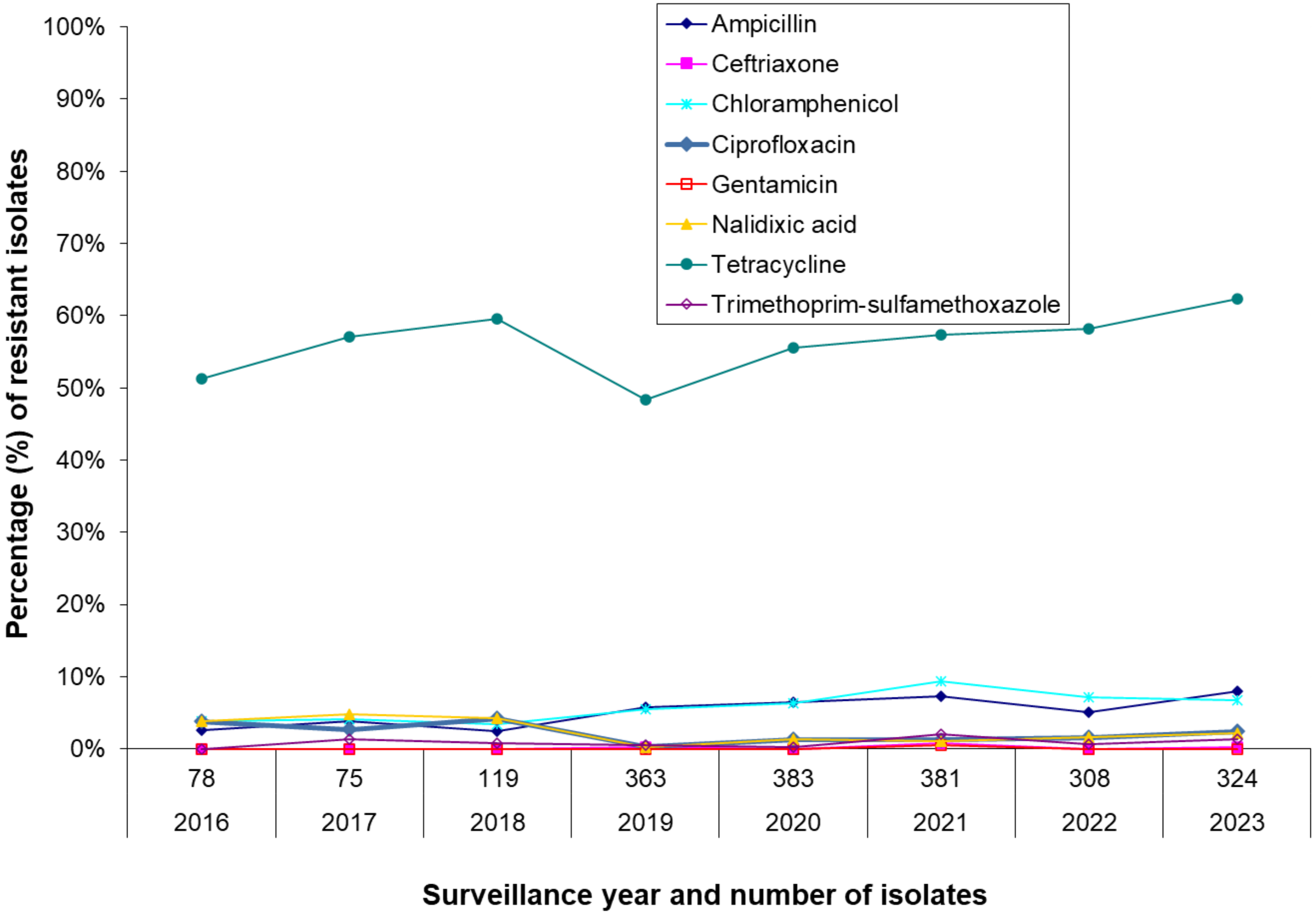
**E. faecalis* and *E. faecium* were selected due to their importance in human illness. *E. hirae was* selected because it is the most common species in fed cattle.

Recovery of fecal organisms, 2019-2023

- Stable recovery for *E. coli* and *Enterococcus* spp.
- Variable recovery for *Salmonella* and *Campylobacter*
  - ↑ in *Salmonella* spp. recovery in 2023 vs. 2022
  - ↓ in *Campylobacter* spp. recovery in 2023 vs. 2022

Province/ region	Year	Percentage (%) of isolates recovered (number of isolates recovered/number of samples submitted)							
		Escherichia coli		*Salmonella* spp.		*Campylobacter* spp.		*Enterococcus* spp.	
National	2019	**99.2%**	363/366	**7.1%**	26/366	**44.3%**	162/366	**100.0%**	355/355
	2020	**97.5%**	384/394	**3.8%**	15/394	**23.4%**	92/394	**97.5%**	384/394
	2021	**99.0%**	381/385	**4.4%**	17/385	**64.2%**	247/385	**99.0%**	386/390
	2022	**99.0%**	308/311	**2.9%**	9/311	**59.2%**	184/311	**99.4%**	309/311
	2023	**98.8%**	324/328	**4.9%**	16/328	**45.4%**	149/328	**100.0%**	329/329

E. coli resistance is low/stable except for tetracycline, 2019-2023



- ↑ in TET resistance since 2019 (48% to 62%)
- ↑ in CIP and NAL resistance since 2019 (<1% to 2%)
- 1 isolate resistant to 6 classes, including CIP + CRO
  - AMP-AZM-CHL-CIP-CRO-SSS-SXT-TET

Six multidrug resistant (*MDR) *Salmonella* spp. isolates detected in 2023

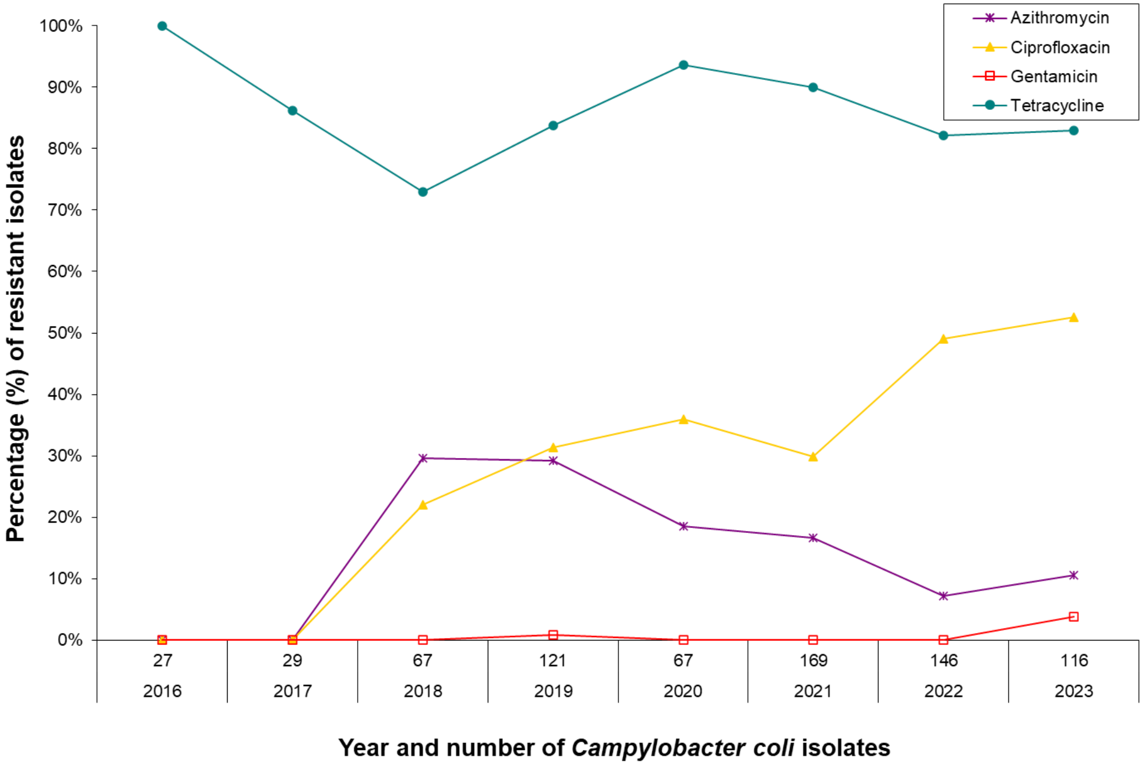
Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern				
		0	1	2–3	4–5	6–7
Give	6 (37.5)	4			1	1
Muenchen	4 (25.0)		1	3		
Typhimurium	4 (25.0)				4	
Agona	1 (6.3)	1				
Uganda	1 (6.3)			1		
Total	**16 (100)**	**5**	**1**	**4**	**5**	**1**

*MDR indicates resistance to 3 or more antimicrobial classes

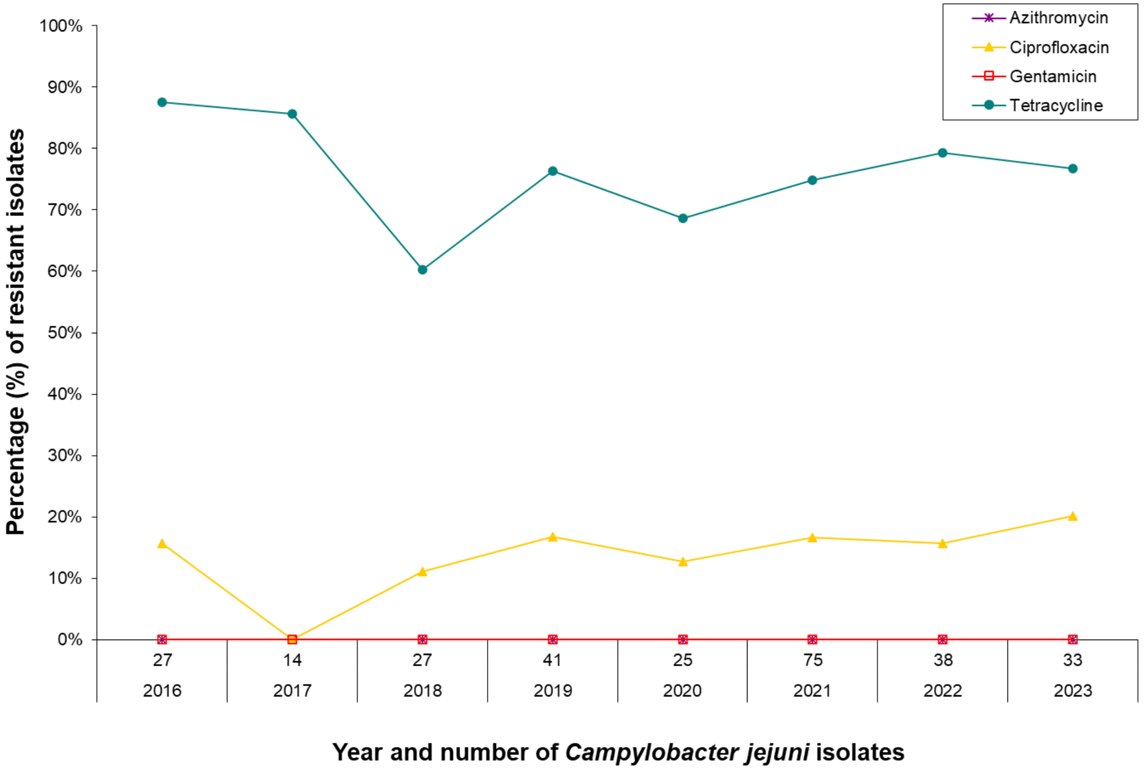
- **4** *S.* Typhimurium isolates from 2 feedlots
  - AMC-AMP-CHL-CRO-FOX-SSS-TET-
- **6** *S.* Give isolates from 4 feedlots
  - 4 susceptible
  - 2 MDR isolates (same feedlot)
  - AMC-AMP-CHL-CIP-CRO-FOX-(GEN)-NAL-SSS-TET

Ciprofloxacin-resistant *Campylobacter* spp. continues to increase; gentamicin resistance detected

C. coli (n = 116 in 2023)



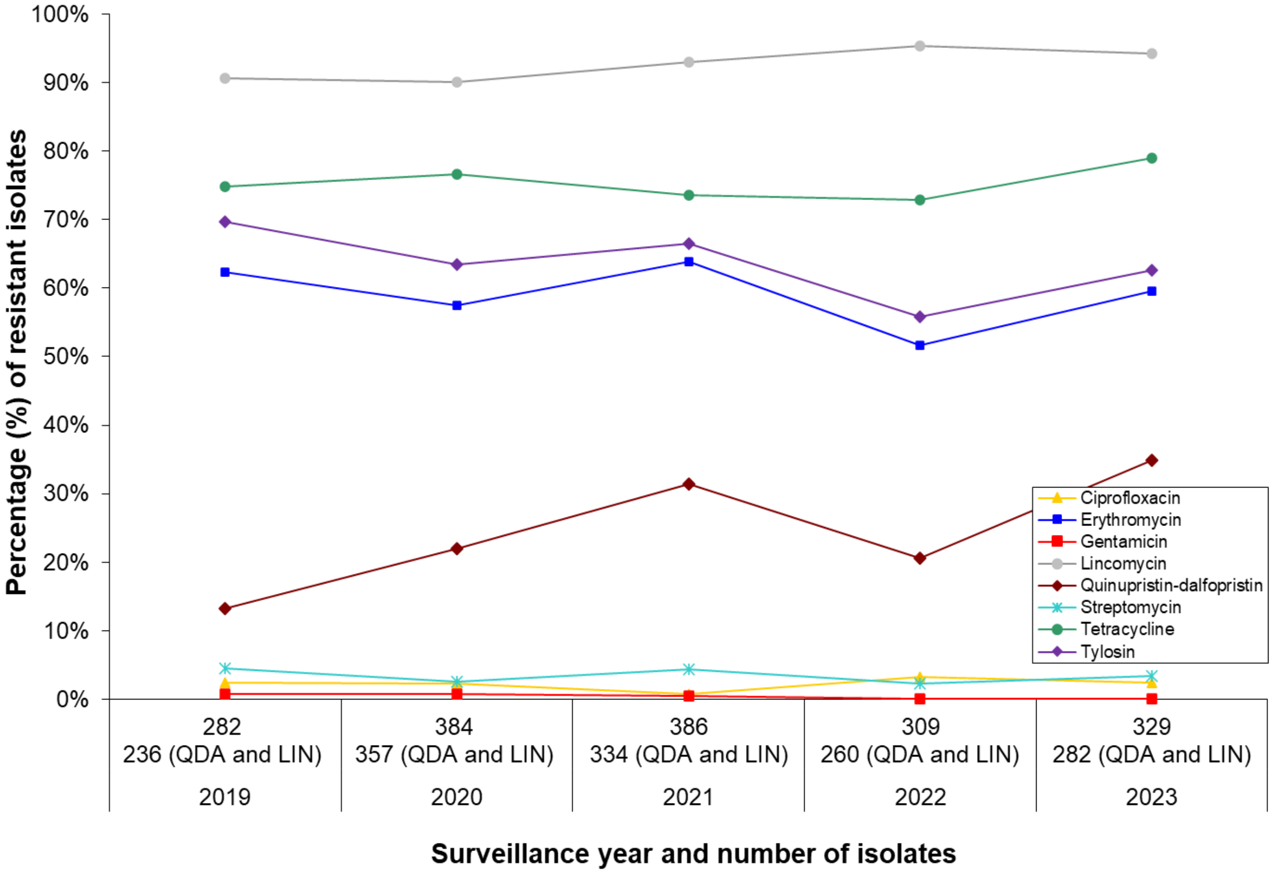
C. jejuni (n = 33 in 2023)



***C. coli*:** ↑ in CIP resistance since 2019 (31% to 53%); ↓ in AZM resistance since 2019 (29% to 11%)

High levels of resistance to select classes in *Enterococcus* spp., increase in quinupristin-dalfopristin resistance since 2019

- ⬆ in QDA resistance since 2019 (13% to 35%)
- Category I resistance
  - CIP
    - 23% of *E. faecium* isolates
    - 2% of total isolates
  - LNZ
    - 1 resistant *E. faecalis* isolate
  - No vancomycin resistance

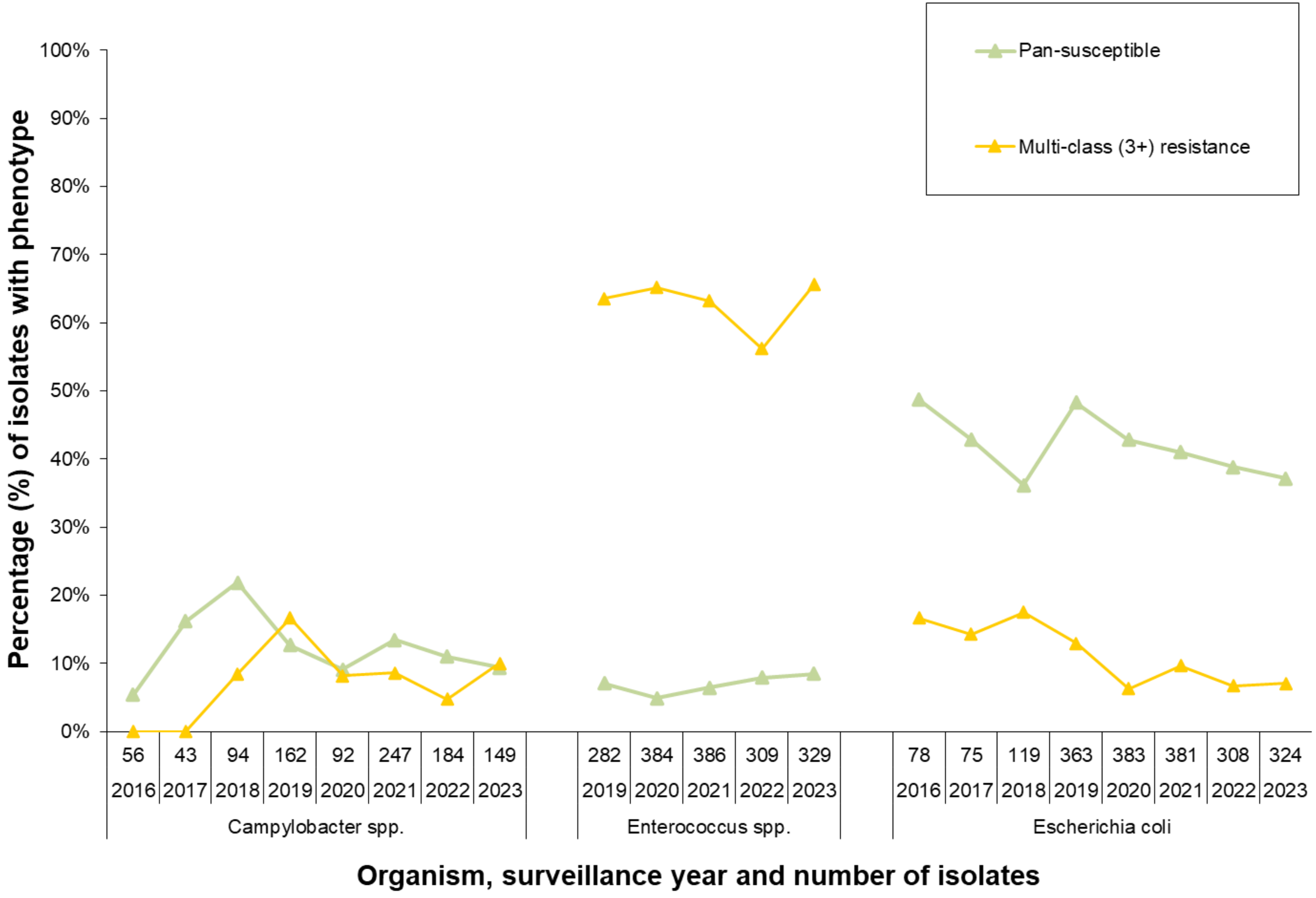


Multidrug resistance is common in *Enterococcus* spp. (<10% of isolates are pan-susceptible in 2023)

- **9** isolates resistant to 6 classes of antimicrobials
  - 7 *E. hirae* isolates from 6 feedlots
    - DAP-ERY-LIN-QDA-STR-TET-TYL (n = 5)
  - 2 *E. faecium* isolates from 2 feedlots
    - CHL-CIP-ERY-LIN-QDA-TET-TYL
    - ERY-LIN-NIT-QDA-TET-TIG-TYL

Species	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern				
		0	1	2–5	6–9	10–13[a]
Enterococcus hirae	227 (69.0)		6	214	7	
Enterococcus faecalis	47 (14.3)	26	8	13		
Enterococcus faecium	31 (9.4)	2	5	22	2	
Enterococcus durans	8 (2.4)			8		
Enterococcus casseliflavus	6 (1.8)		2	4		
Enterococcus avium	4 (1.2)		2	2		
Enterococcus malodoratus	2 (0.6)		1	1		
Enterococcus thailandicus	2 (0.6)			2		
Unspecified Enterococcus spp.	2 (0.6)		1	1		
Total	**329 (100)**	**28**	**25**	**267**	**9**	

Trends in key phenotypes, fecal organisms (2016-2023)



- ***Campylobacter* spp.**
  - Equal percentages of MDR and pan-susceptible isolates in 2023
- ***Enterococcus* spp.**
  - High percentage of MDR isolates, low percentage of pan-susceptible isolates
- ***E. coli***
  - Percentage of both MDR and pan-susceptible isolates trending downward

Key take-home messages, AMR in fecal organisms

- **AMR in *E. coli* is relatively stable over time**
- **MDR *Salmonella* spp.**
  - 6/16 isolates (37.5%) were resistant to 4 or more classes in 2023
- **Ciprofloxacin-resistant *Campylobacter coli***
  - Significant increase in **CIP** resistance since 2019 (31% to 53%)
  - 4 **GEN**-resistant isolates from 3 feedlots in 2023
- **Streptogramin resistance in *Enterococcus* spp.**
  - Significant increase in **QDA** resistance since 2019 (13% to 35%) coincides with increasing use of virginiamycin in feed

AMR: RESPIRATORY PATHOGENS

2023 HIGHLIGHTS AND 5-YEAR TEMPORAL TRENDS

Sample collection: respiratory pathogens (2023)

Prairie Diagnostic Services in Saskatoon, SK

<u>Isolation and susceptibility testing</u>: *Mannheimia haemolytica, Pasteurella multocida* and *Histophilus somni*

Time point 1: on **arrival**

<u>368</u> *NP samples

MH

PM

HS

One isolate of each recovered organism per sample was tested for susceptibility to a panel of 19 antimicrobials (10 classes)

Time point 2: at **re-handling**

<u>366</u> NP samples

MH

PM

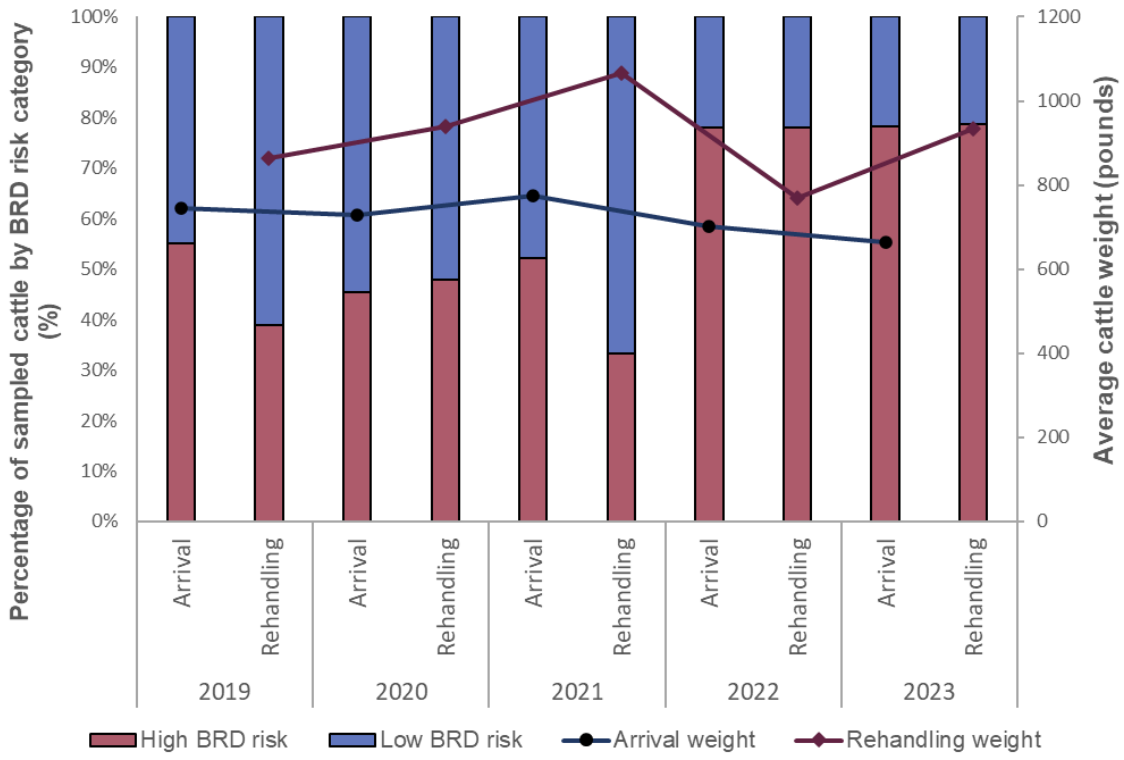
HS

One isolate of each recovered organism per sample was tested for susceptibility to a panel of 19 antimicrobials (10 classes)

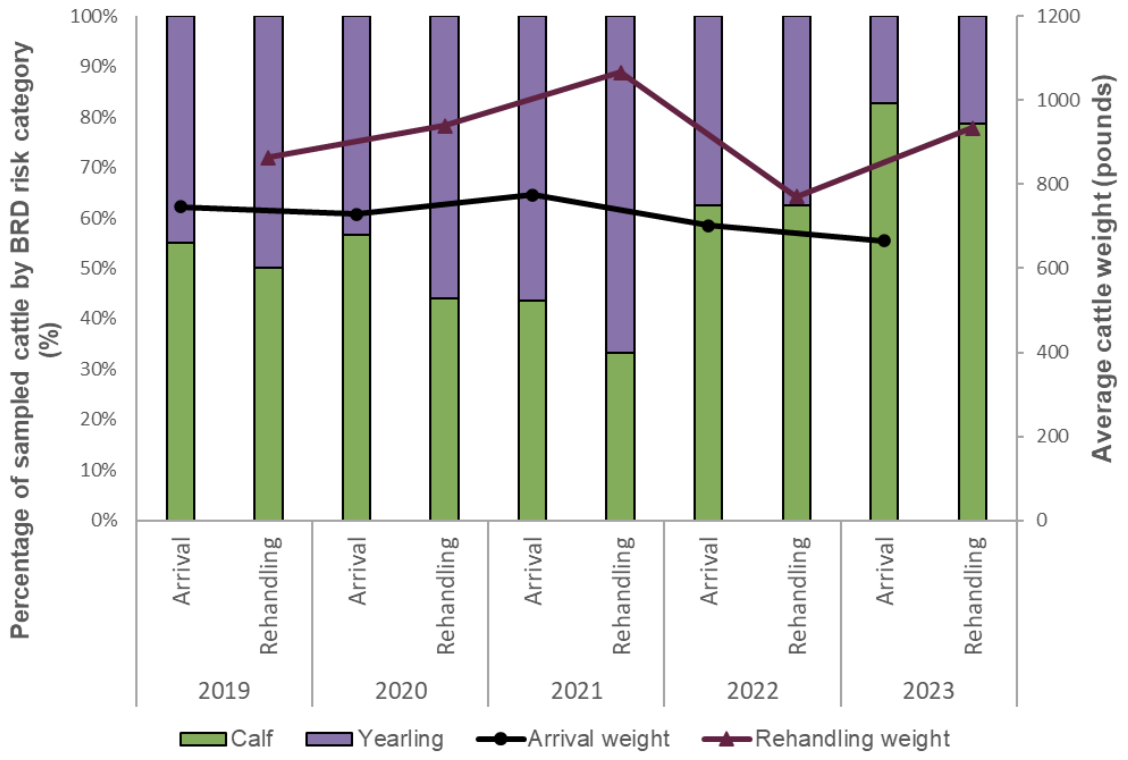
*NP-nasopharyngeal

Trend toward sampling younger and higher-risk cattle, 2019-2023

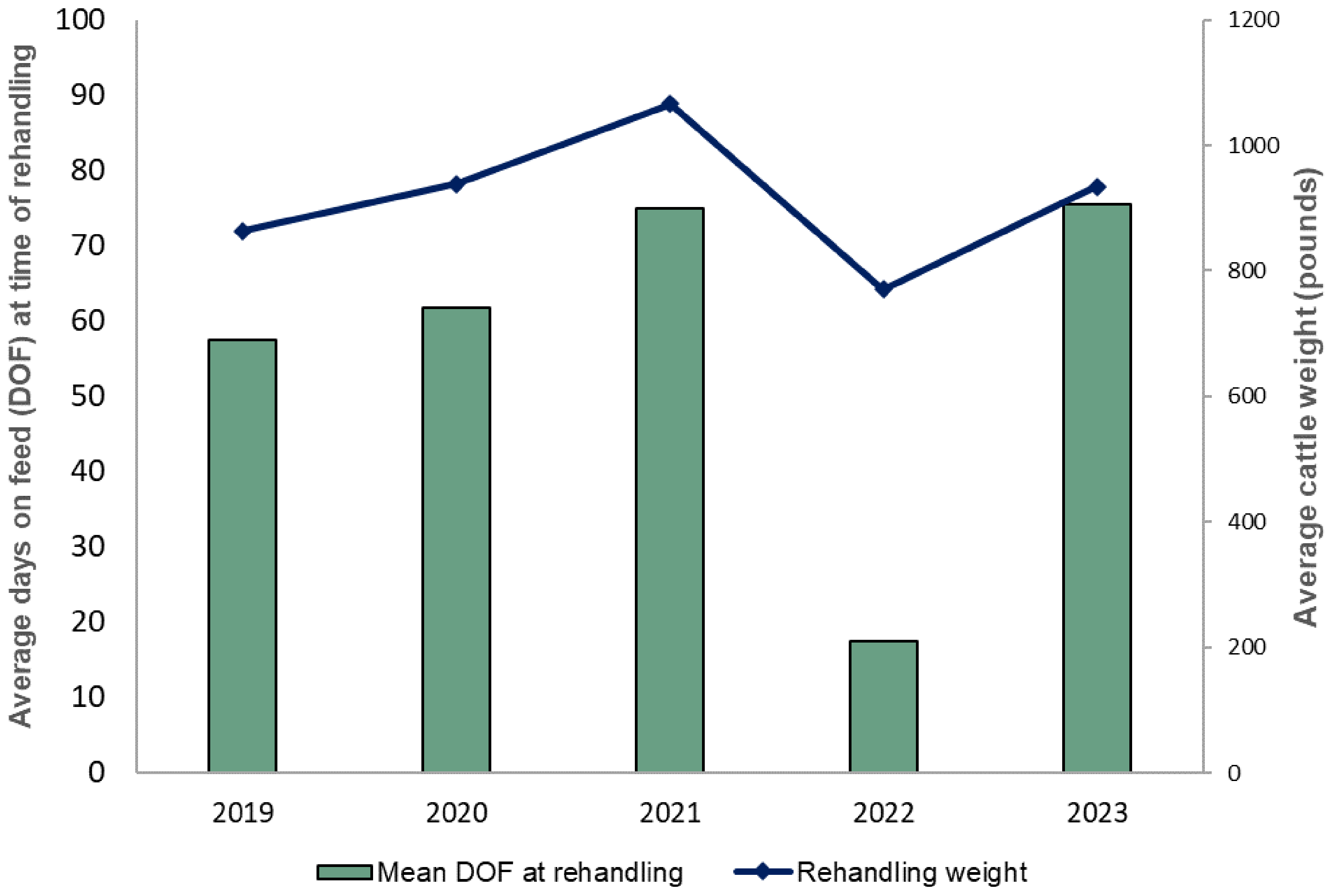
BRD risk



Age category

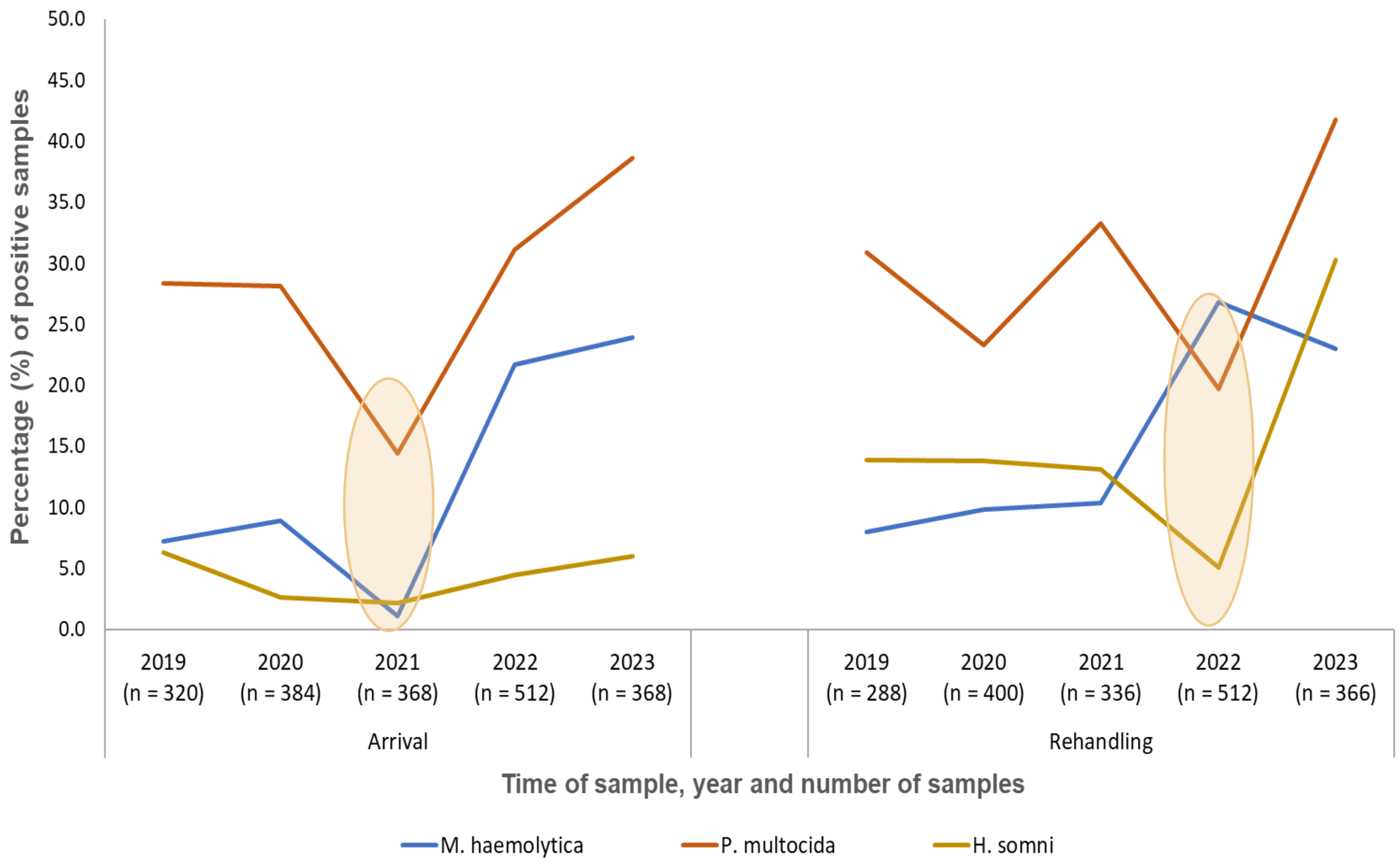


Collaboration with ASSETS in 2022 impacted second sampling time



- Mean DOF in 2022: **17.5**
  - Temporary protocol change to reflect sampling requirements of *ASSETS* program
  - Mean weight: 771 pounds
- Mean DOF in 2023: **75**
  - Mean weight: 934 pounds

Respiratory pathogen recovery impacted by sampling protocol, 2019-2023



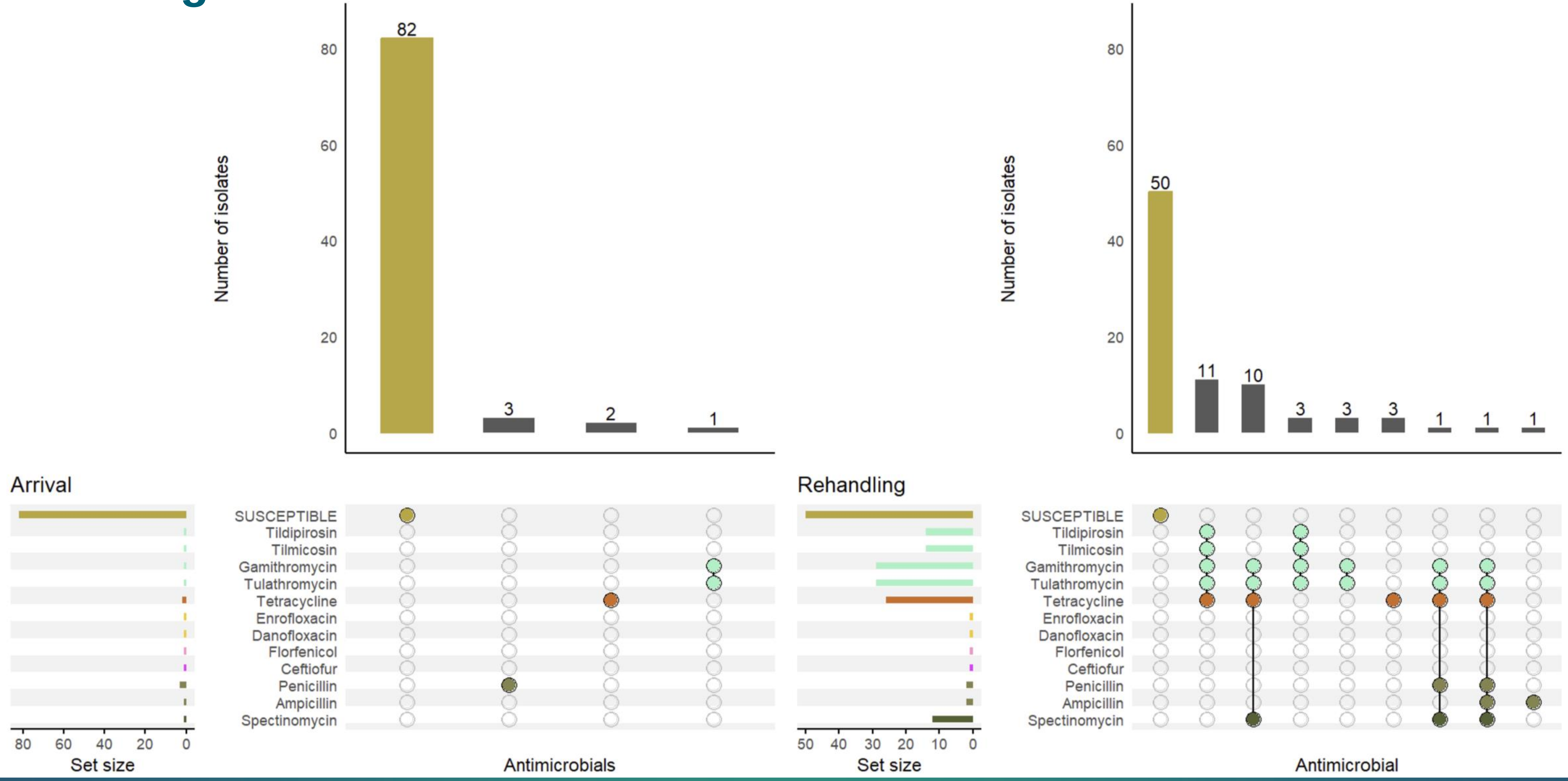
Arrival

- Low recovery in 2021
  - Investigation revealed poorer recovery with increasing time between sample collection and laboratory processing
- Improved recovery with reduced times between sampling and processing in 2022 and 2023

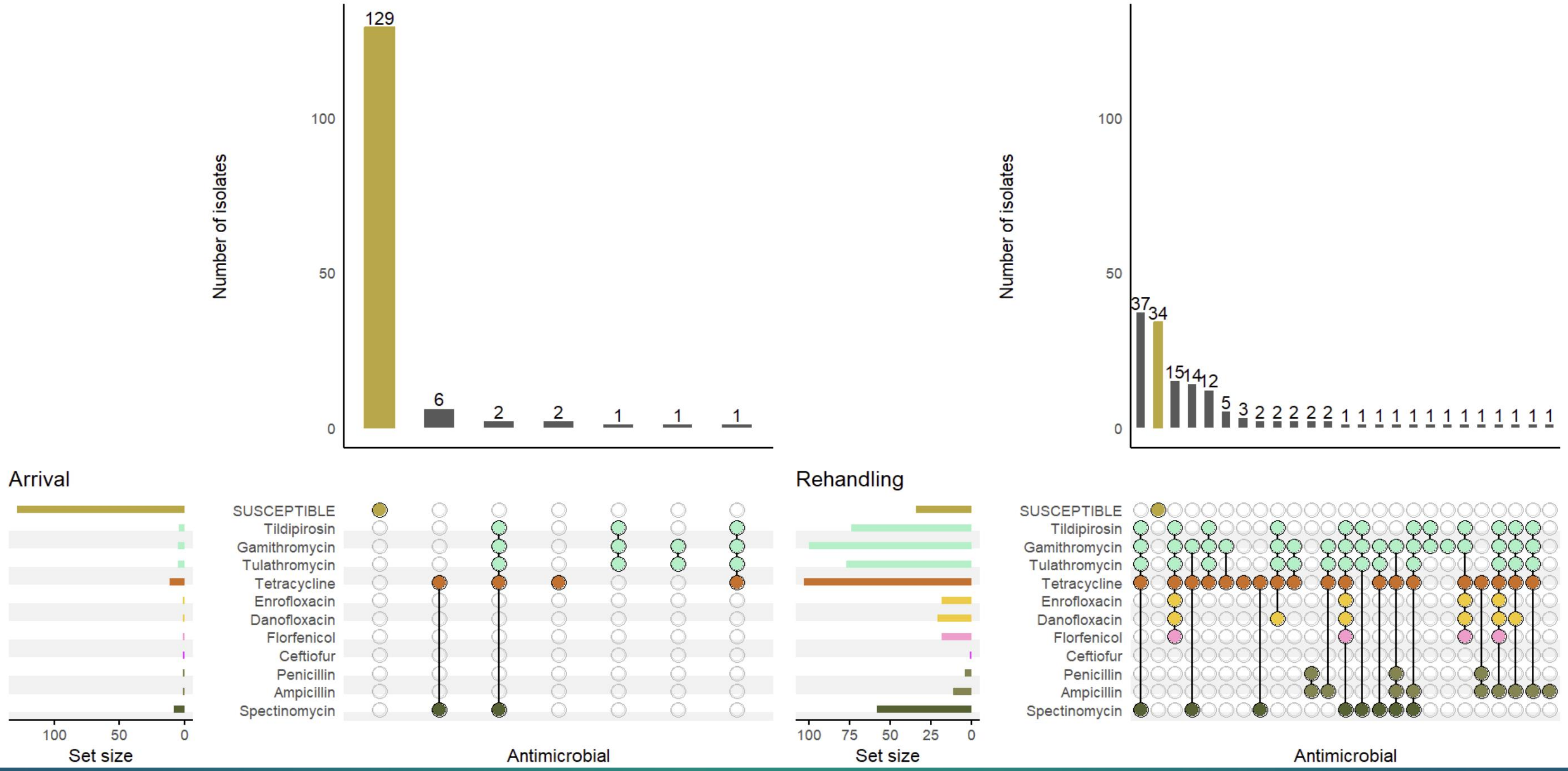
Rehandling

- Reduced recovery of *P. multocida* and *H. somni* in 2022 likely reflects second sampling within 3 weeks of arrival

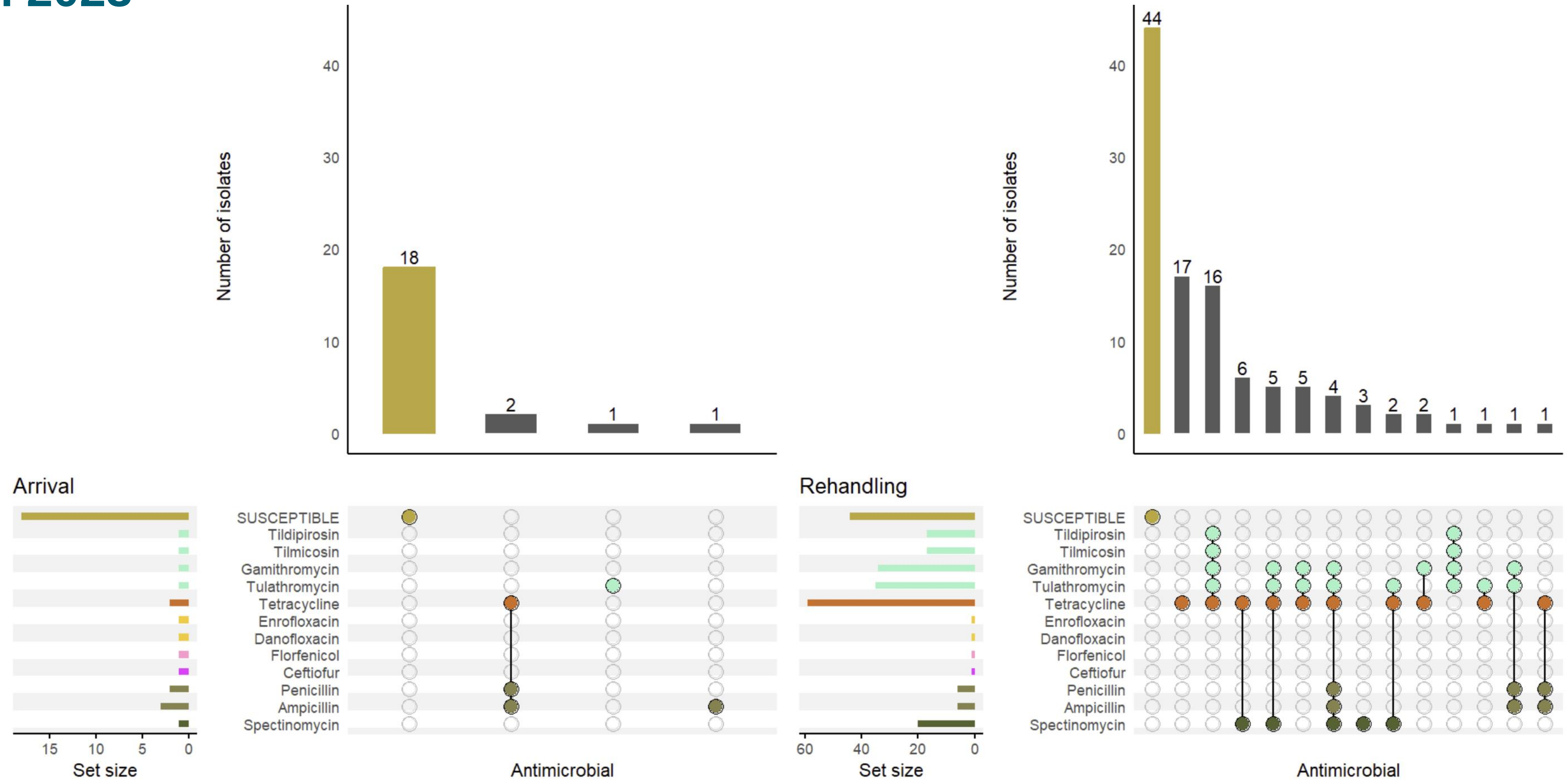
Increased resistance in *M. haemolytica* isolates between arrival and rehandling in 2023



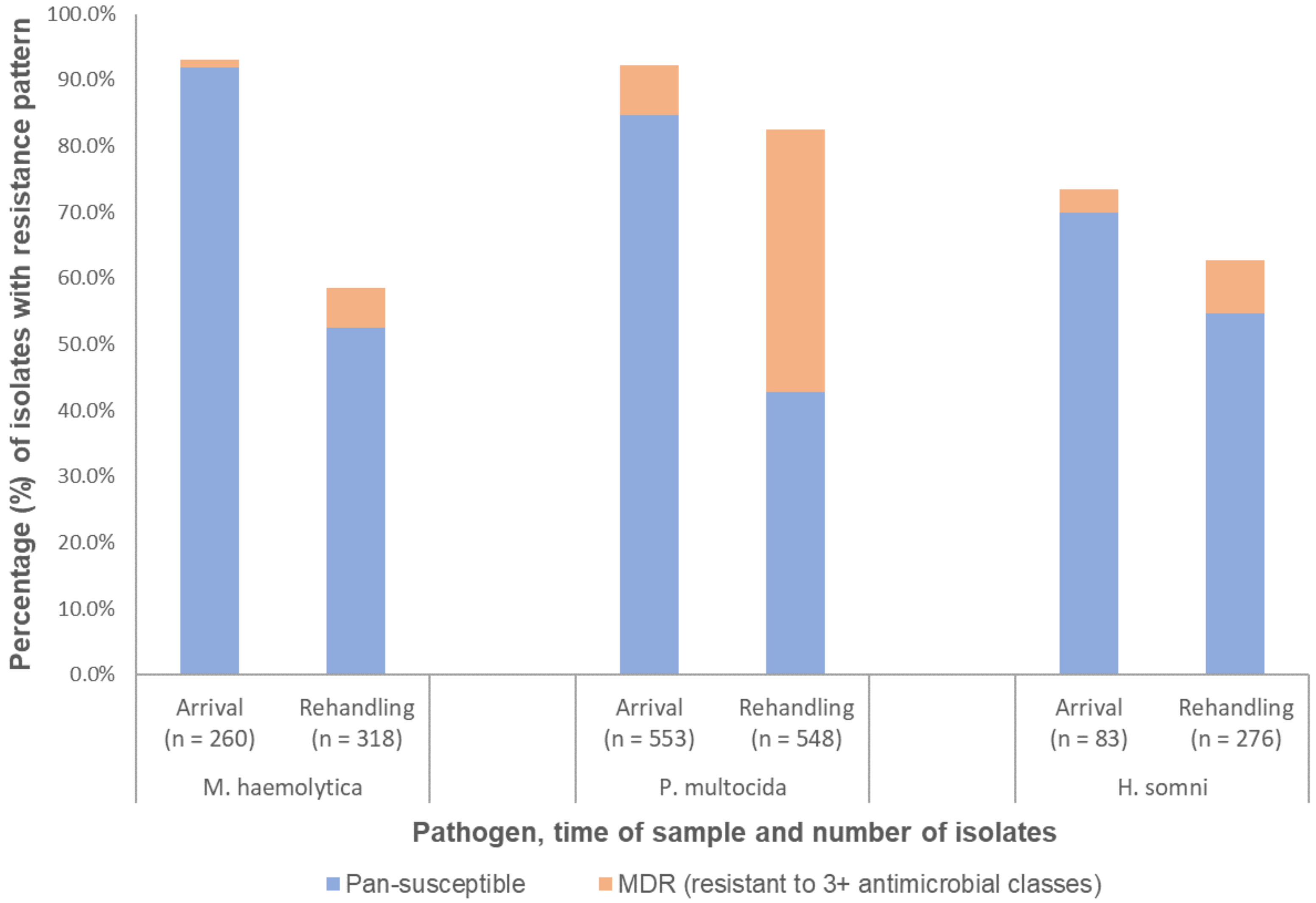
Multidrug resistance detected in 55% of *P. multocida* isolates at rehandling, 2023



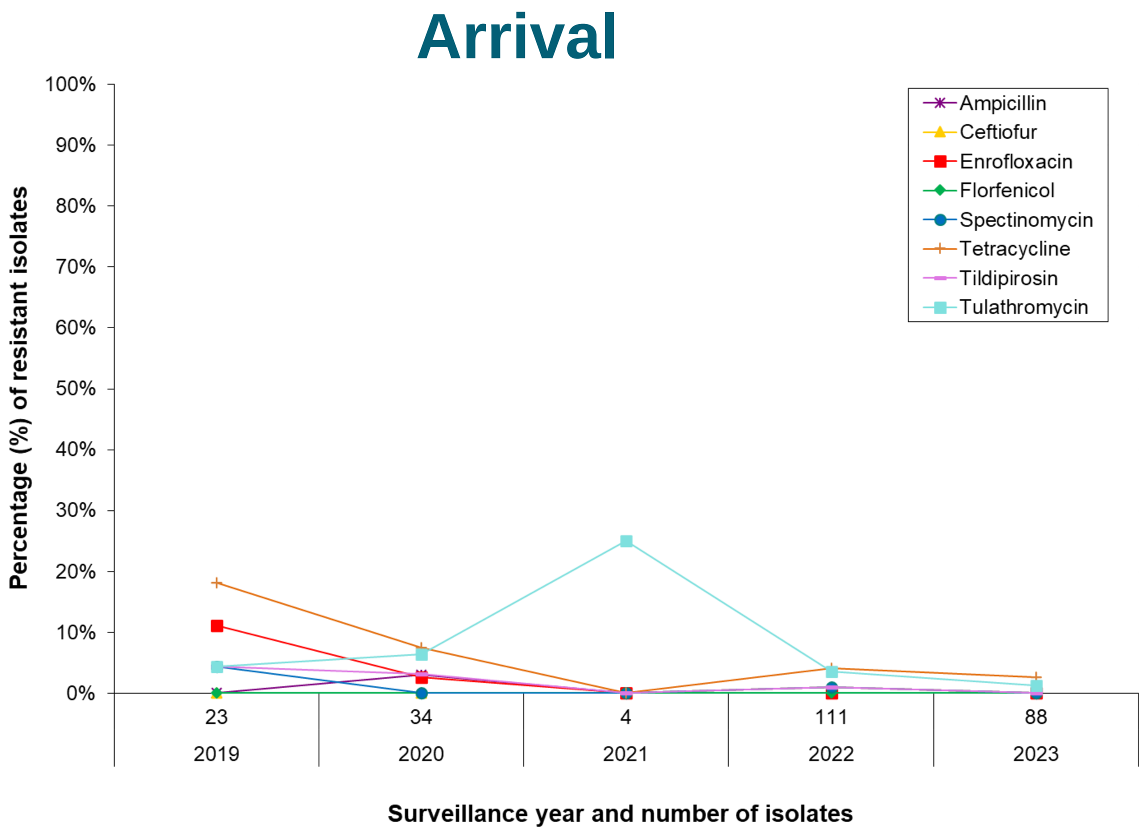
Increased resistance in *H. somni* isolates between arrival and rehandling in 2023

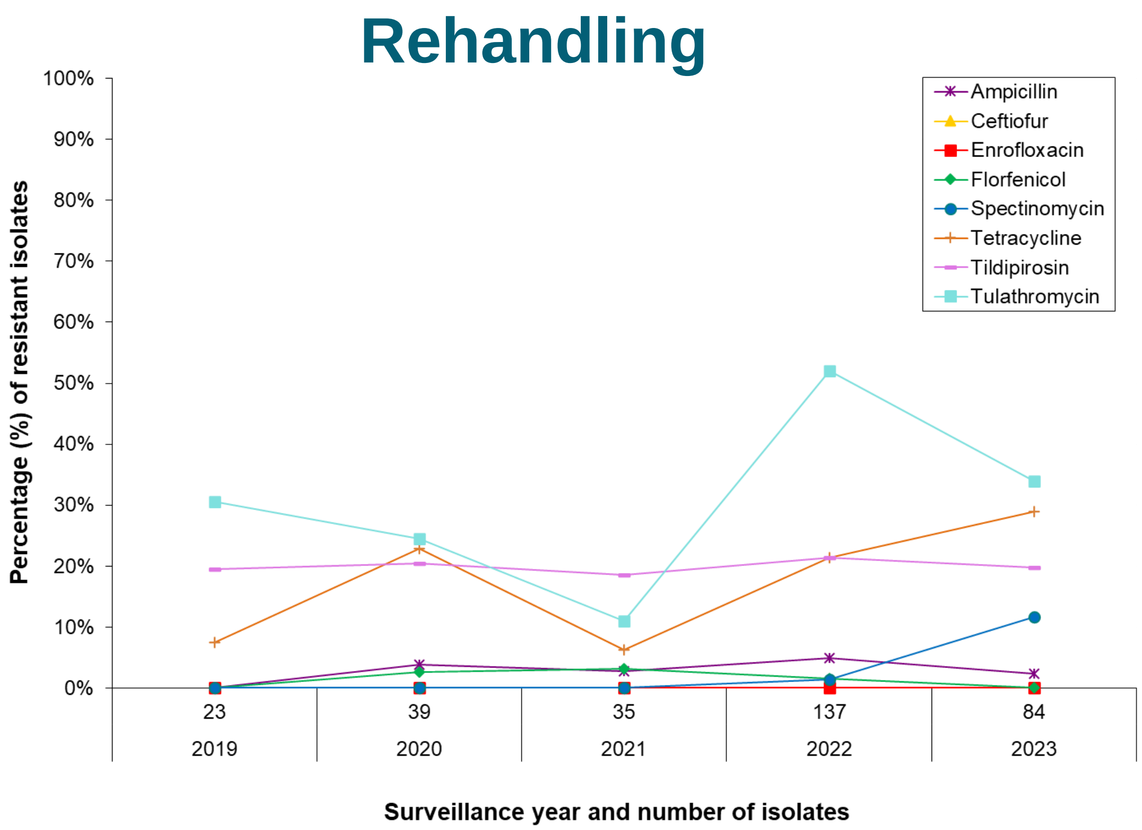


Increase in MDR at rehandling for all three BRD organisms (2019-2023 isolates combined)



Resistance at arrival trending down, resistance at rehandling trending up for *M. haemolytica*, 2019-2023



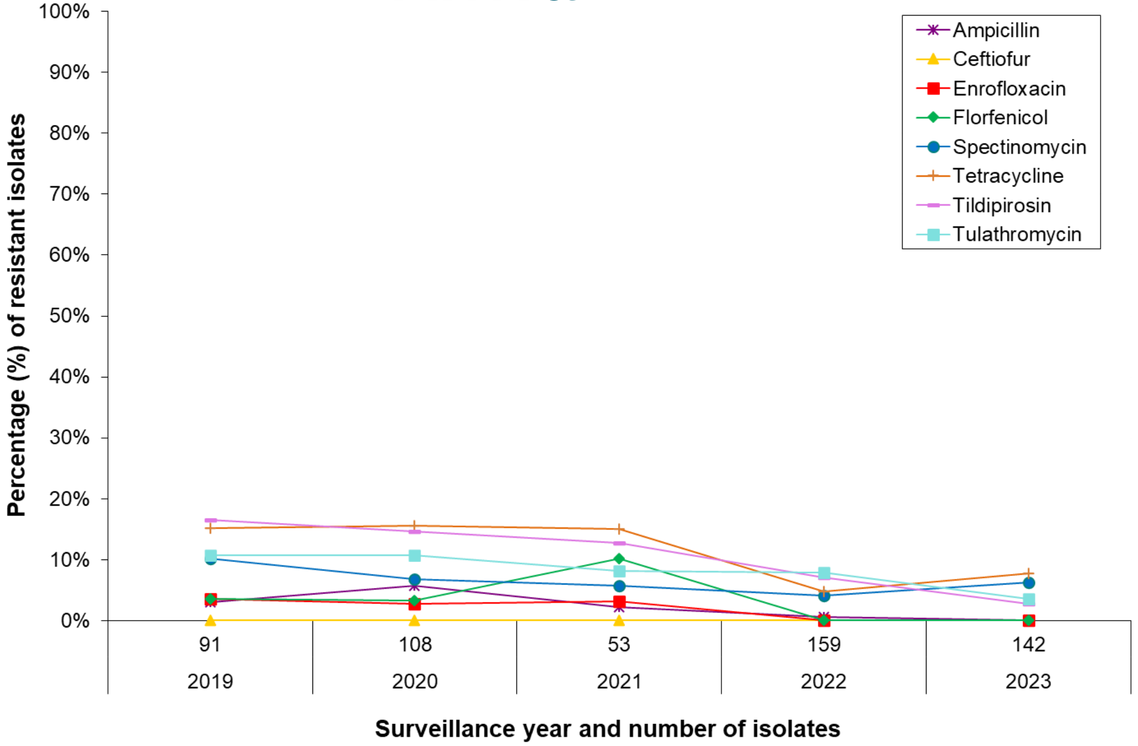


- ⬇ in TET resistance since 2019 (18% to 3%)
- ⬆ in SPT resistance since 2022 (1% to 12%)

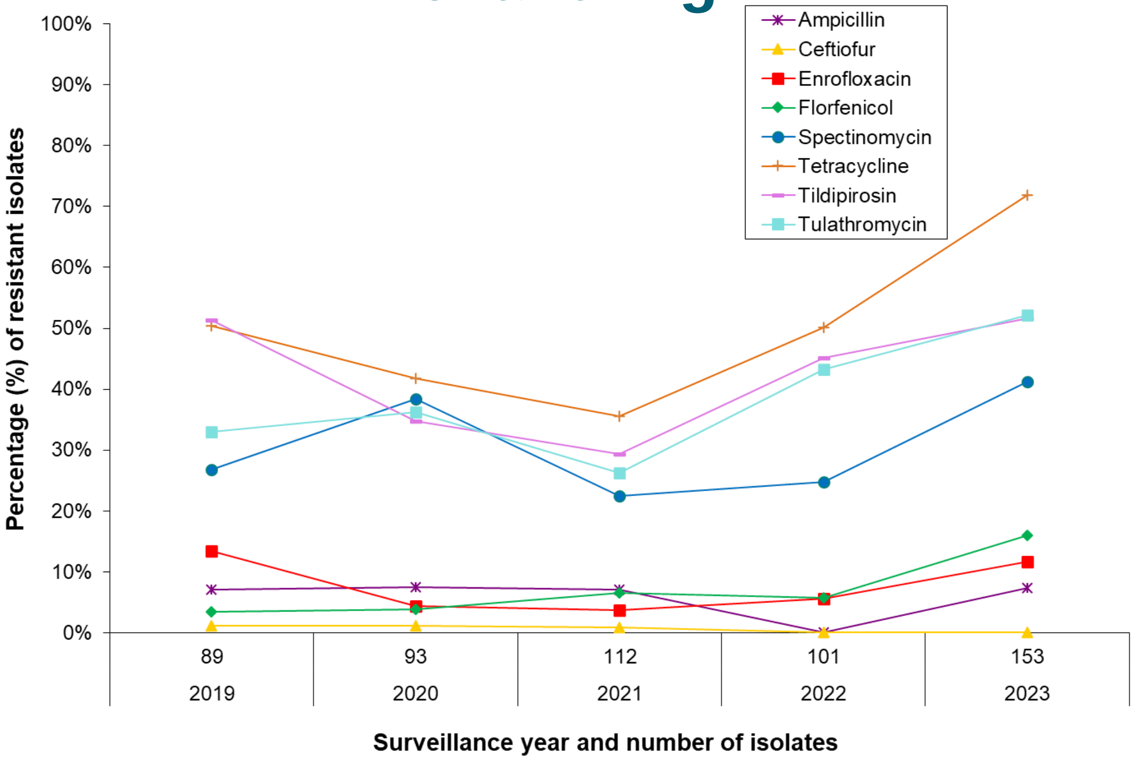
*Low isolate numbers increase variability, and trends prior to 2022 should be interpreted with caution

Decreasing resistance at arrival, increasing resistance at rehandling for *P. multocida*, 2019-2023

Arrival



Rehandling

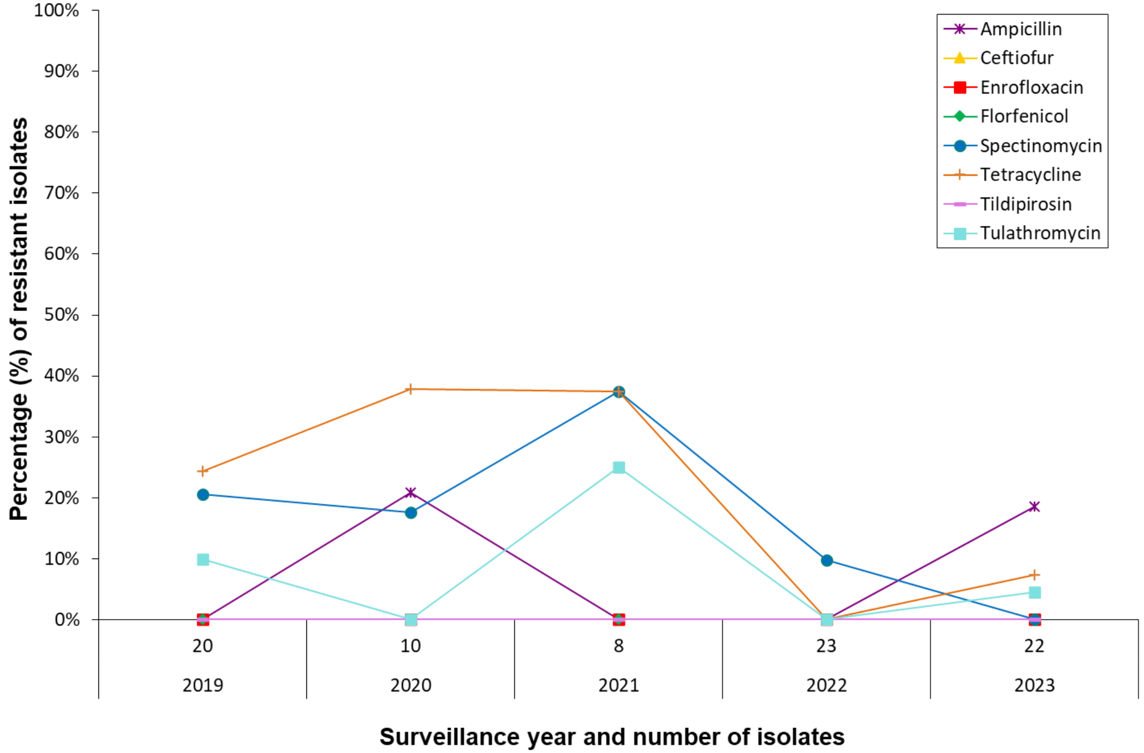


- ⬇ in TET, TILD + TUL resistance since 2019

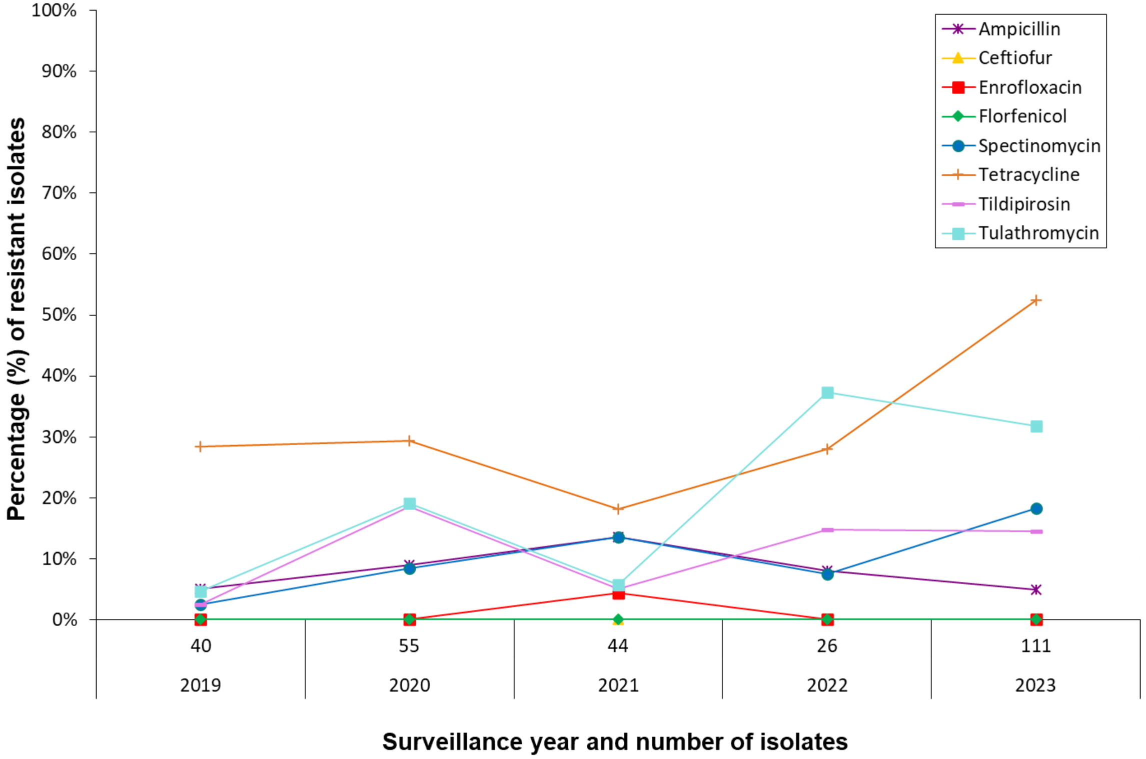
- ⬆ in FLR + TET resistance since 2019
- ⬆ in ENR resistance since 2022 (6% to 12%)

General trends toward decreased resistance at arrival, increasing resistance at rehandling for *H. somni*, 2019-2023

Arrival



Rehandling



- ↓ in SPT resistance since 2019 (21% to 0%)
- ↑ in TET + TUL resistance since 2019

*Low isolate numbers increase variability, and trends should be interpreted with caution

Key take-home messages, respiratory pathogens

- **Trend toward sampling younger and higher-risk animals since 2019**
- **Recovery substantially impacted by changes to sampling protocol**
- **Phenotypes at arrival vs. rehandling**
  - Decrease in pan-susceptibility by 32% (*MH*), 40% (*HS*) and 67% (*PM*)
  - Increase in MDR phenotype most significant for *PM* (1% *at arrival* → 55% *at rehandling* in 2023)
- **Temporal trends in AMR for BRD pathogens since 2019**
  - Decreased resistance *at arrival* over 5 years
  - Increased resistance *at rehandling* over 5 years

ANTIMICROBIAL USE (AMU)

2023 HIGHLIGHTS AND 5-YEAR TEMPORAL TRENDS

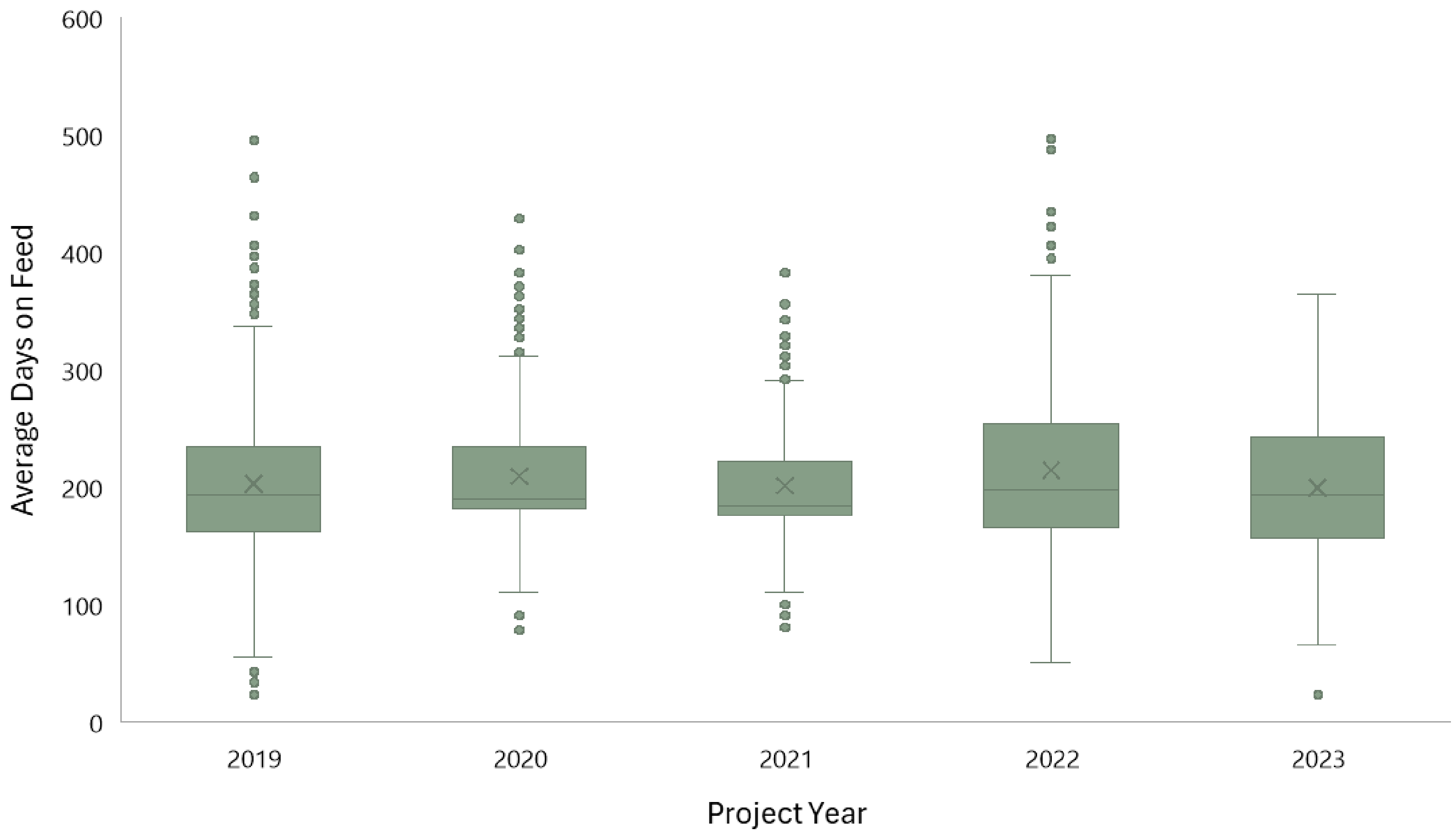
Sampling by Feedlot and Animals at Risk

Feedlot size impacts the number of cattle enrolled per feedlot

Year	Number of Feedlots	Number of Production Lots	Animals at Risk	Average Days on Feed (DOF)
2019	23	474	135,929	203
2020	26	624	160,458	210
2021	24	598	140,984	201
2022	25	395	134,649	215
2023	26	393	129,871	199

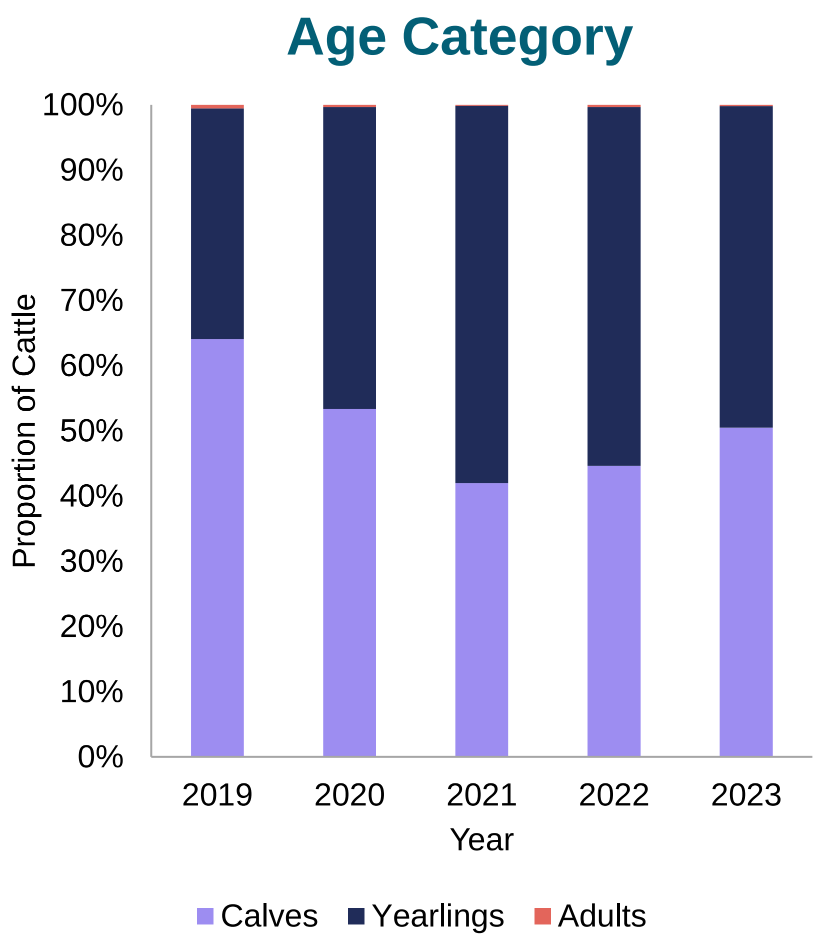
- Targeted number of animals for AMU data collection is 150,000
  - Based on sample size calculation
  - Proportionally distributed by province and feedlot size, based on the contribution to the Canadian fed cattle population
- Participating feedlots randomly sample closed production lots annually until the required number of cattle for each feedlot is met
- The average days on feed (DOF) varied only slightly over the past five years, ranging from 199 to 215 DOF.

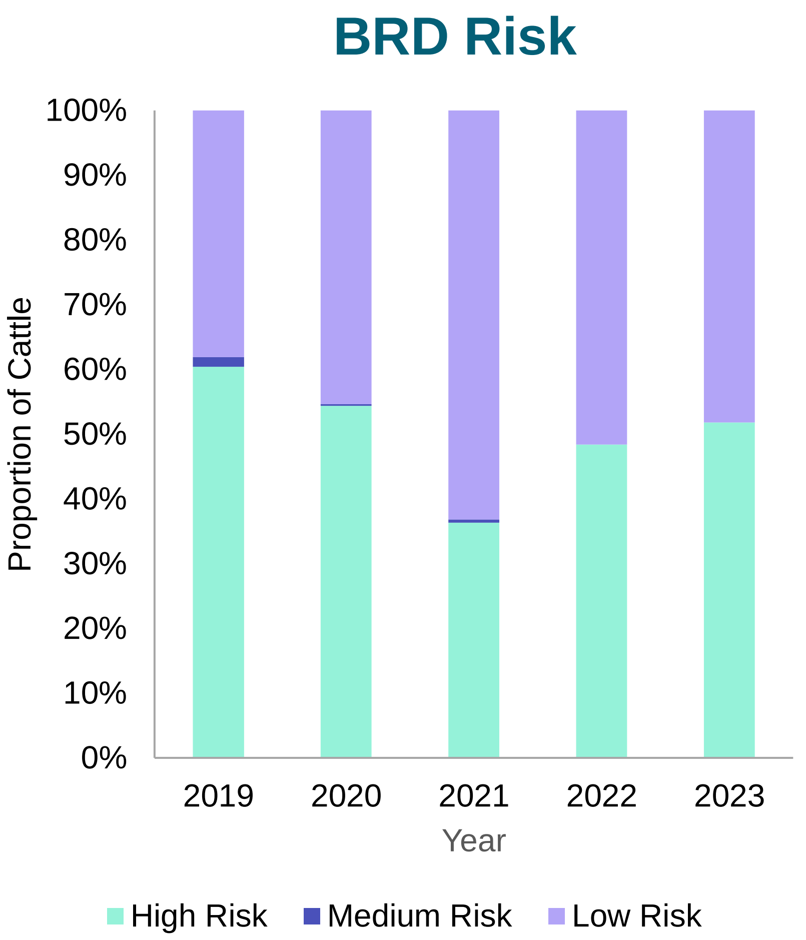
Decreasing variability in DOF since 2019



- The average number of DOF has remained relatively stable since 2019.
  - Often clustered around 200 DOF.

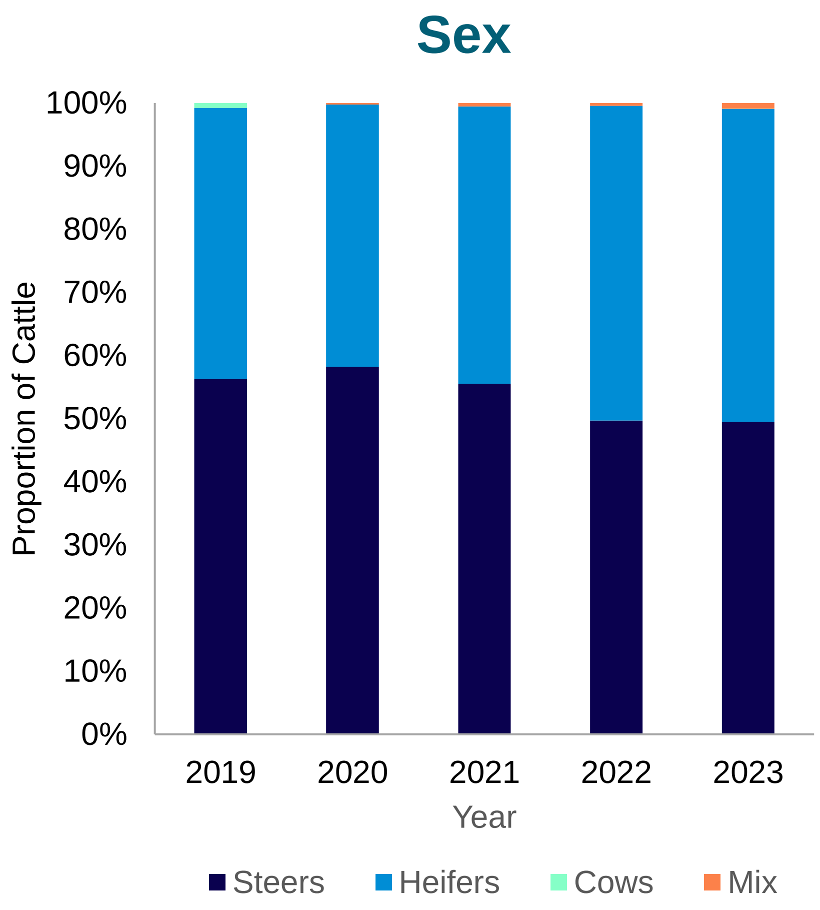
Cattle age and BRD risk categories mirrored each other, 2019-2023

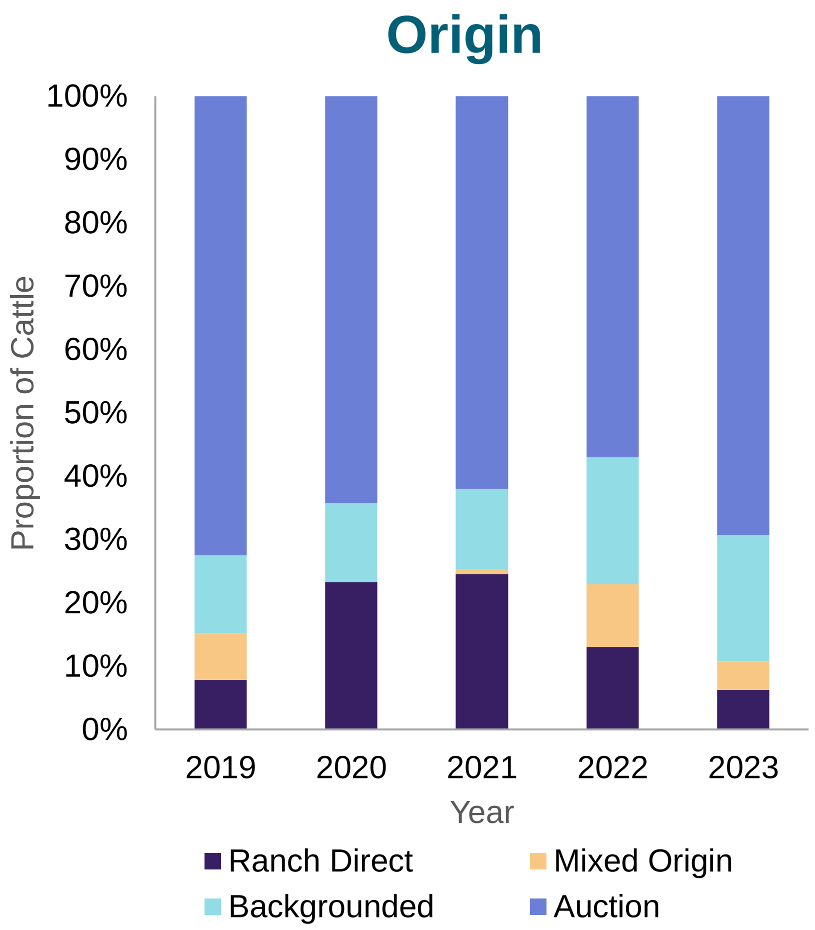




- Distribution of calves and yearlings varied annually but was relatively equal in 2023.
- Adult cattle are uncommon in feedlots.
- The proportion of high-risk and low-risk cattle was nearly equal in 2022 and 2023.

Roughly equal distribution of steers and heifers. Most cattle were sourced from auction market.

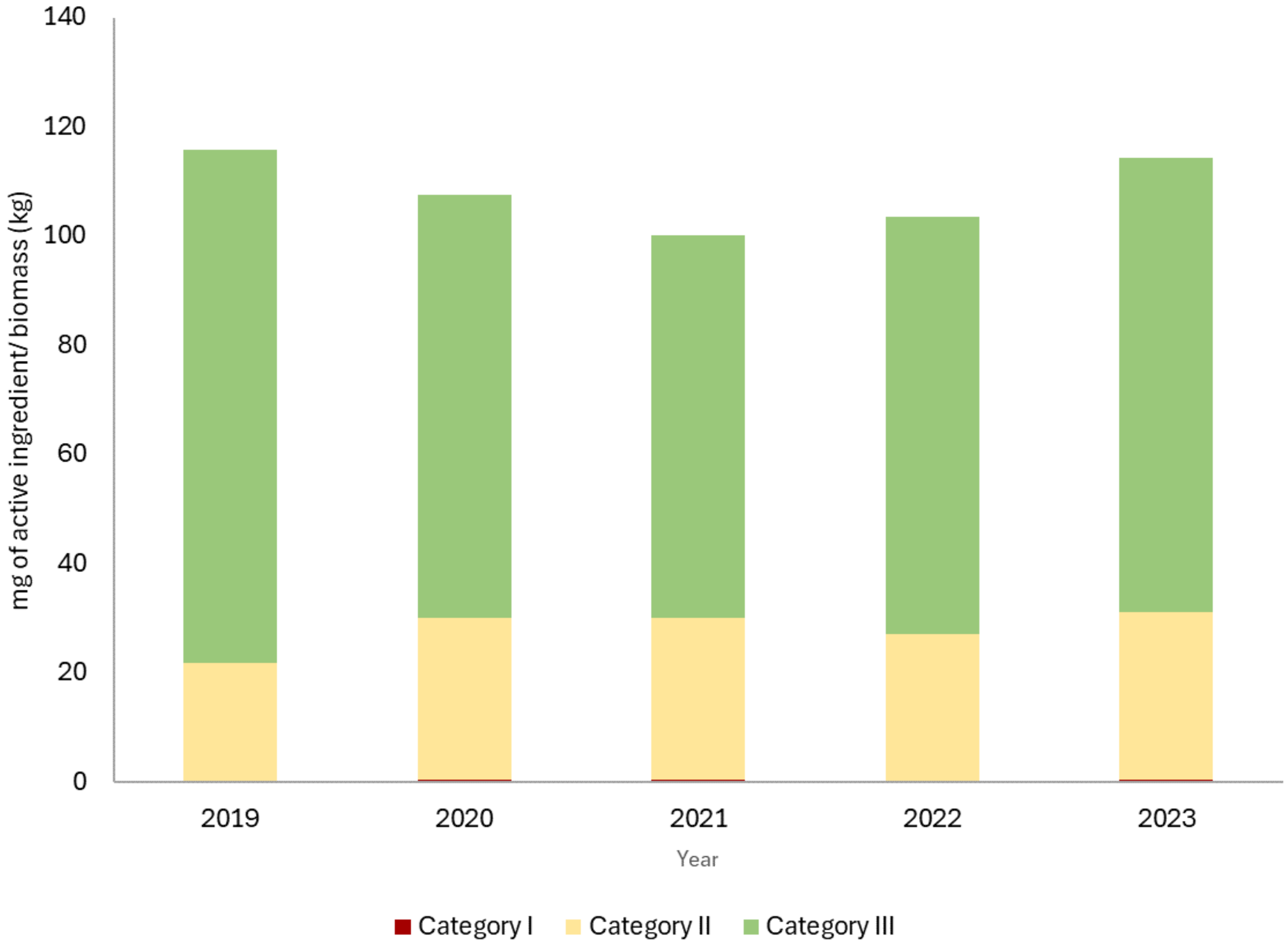




- **Steers and heifers** made up the majority of cattle in feedlots each year.
- The proportion of steers and heifers remained relatively constant across all five years.
- Most cattle originated from **auction markets**; however, the distribution of cattle origins varied annually.

Health Canada's Categorization for AMU by all routes of administration

Category I antimicrobials contribute <1% of all AMU, 2019-2023



Category I:

- Contributes <1 mg/kg biomass
- Increased 31% since 2022 and 35% since 2019, primarily due to increased use of fluoroquinolones and third-generation cephalosporins

Category II:

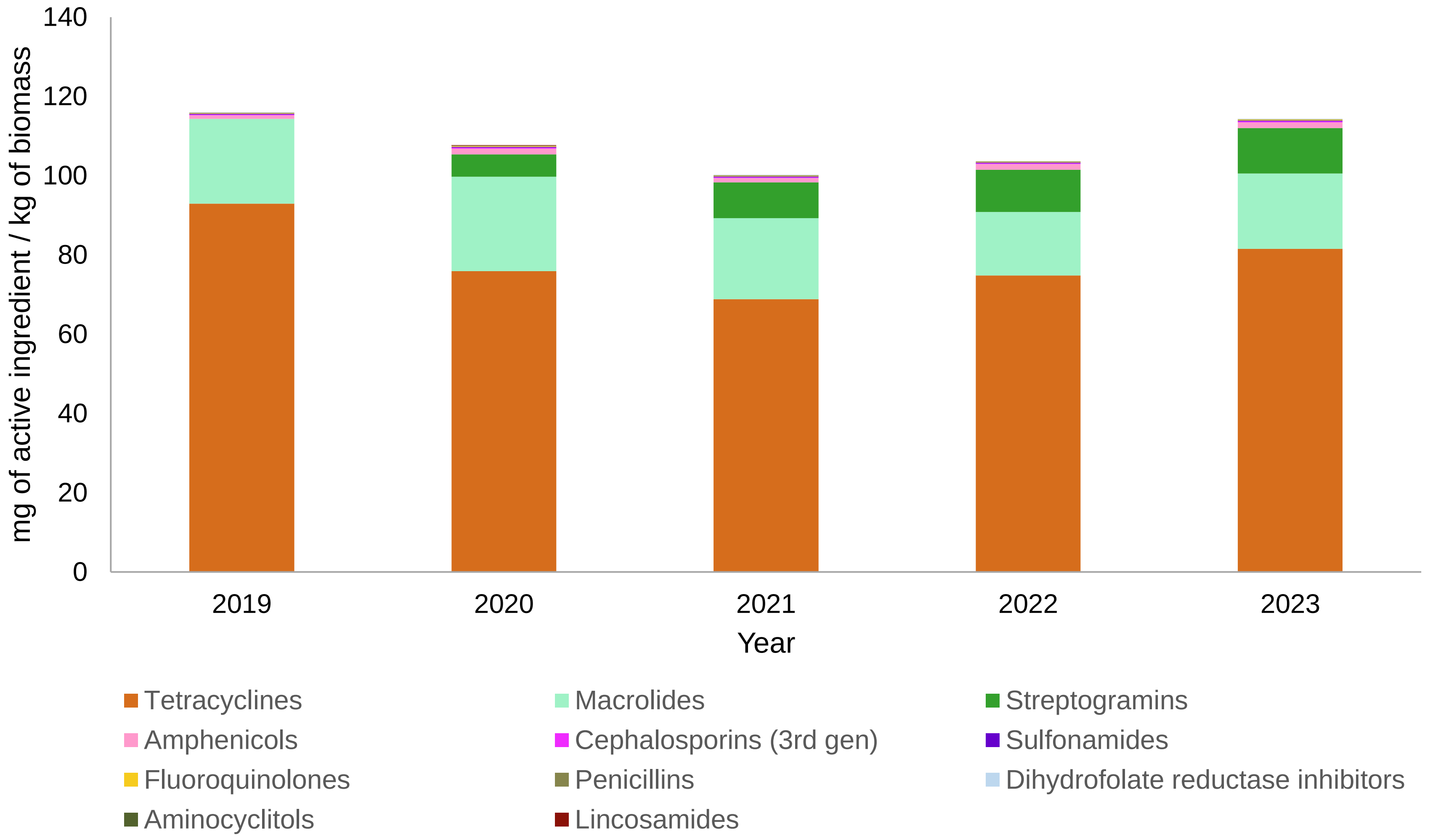
- Increased 29% since 2019, due to the introduction of streptogramins in feed.

Category III:

- Highest use overall, driven by use of tetracyclines in feed

Antimicrobial Use by All Routes, 2019-2023

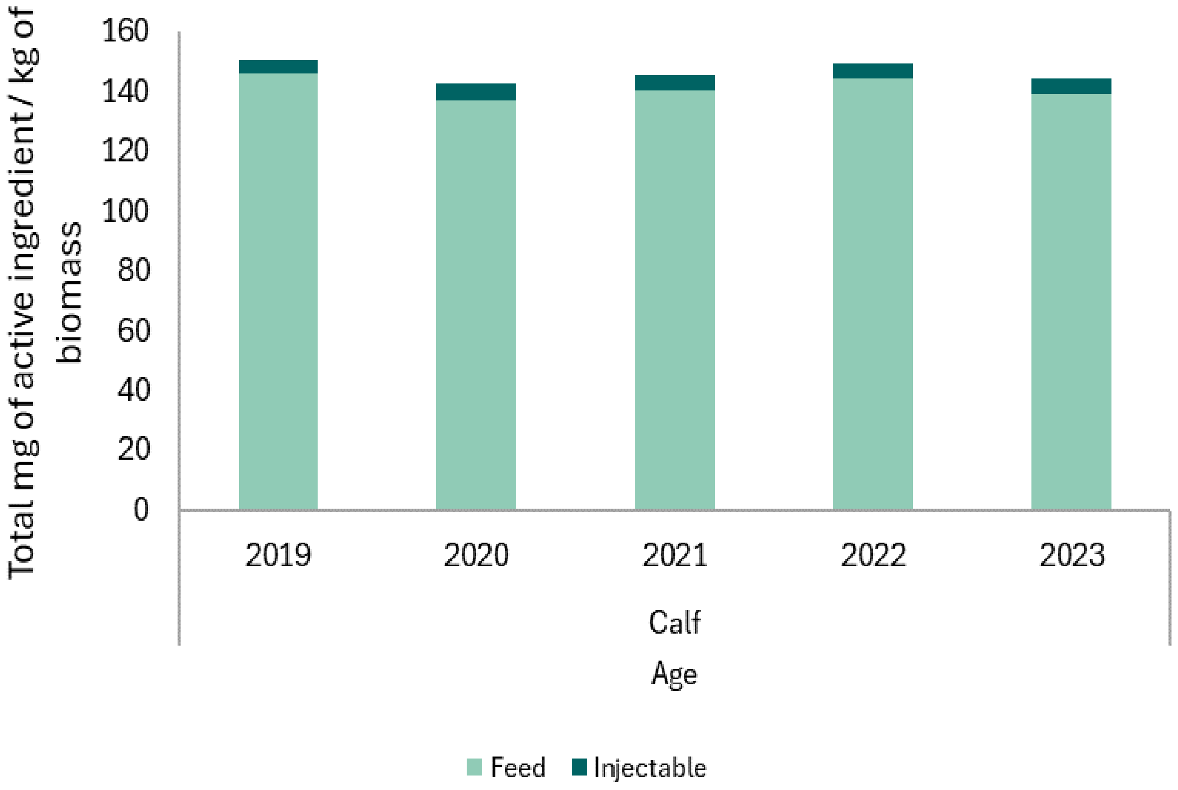
Tetracyclines are the major contributor to antimicrobial use



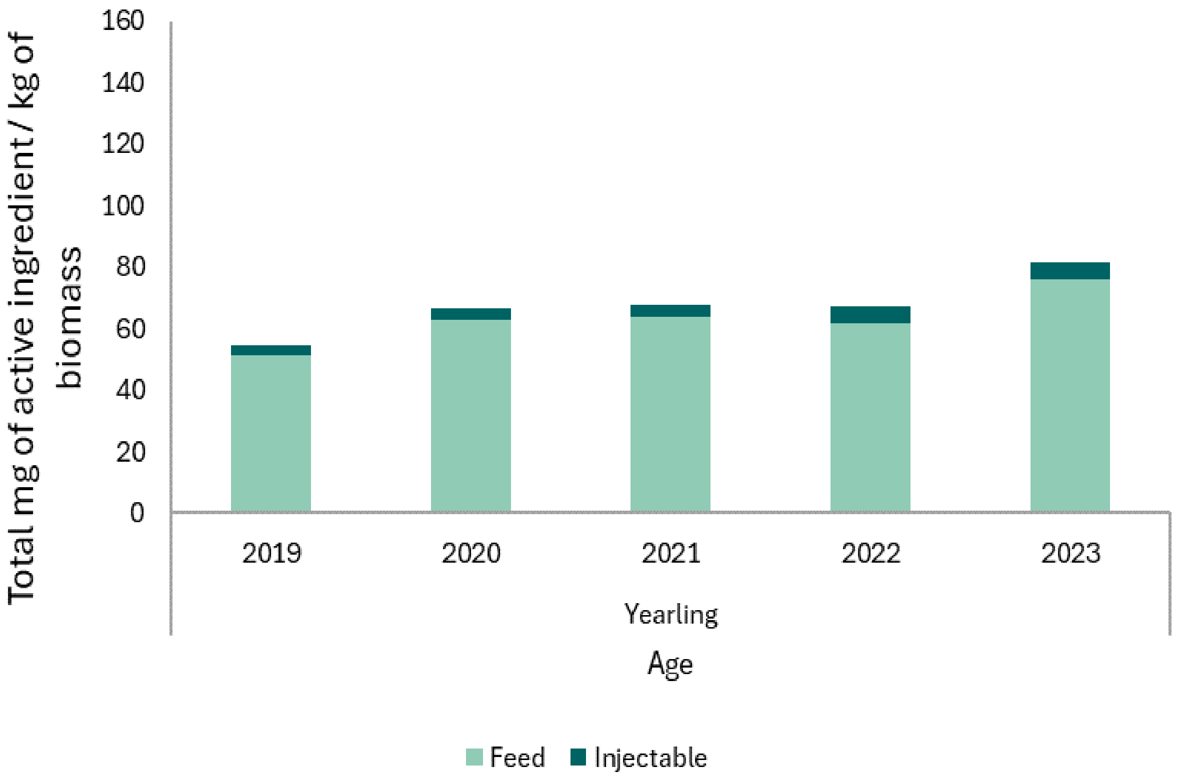
- **Macrolides** are the second most used class of antimicrobials
- **Streptogramin** use increased annually
- Use of other antimicrobial classes remained relatively low and stable.
- The majority of AMU (95% in 2023) was driven by the administration of **in-feed antimicrobials**.

AMU in calves often more than doubled that of yearlings
Animal age is an important factor that can impact AMU, 2019-2023

CALF

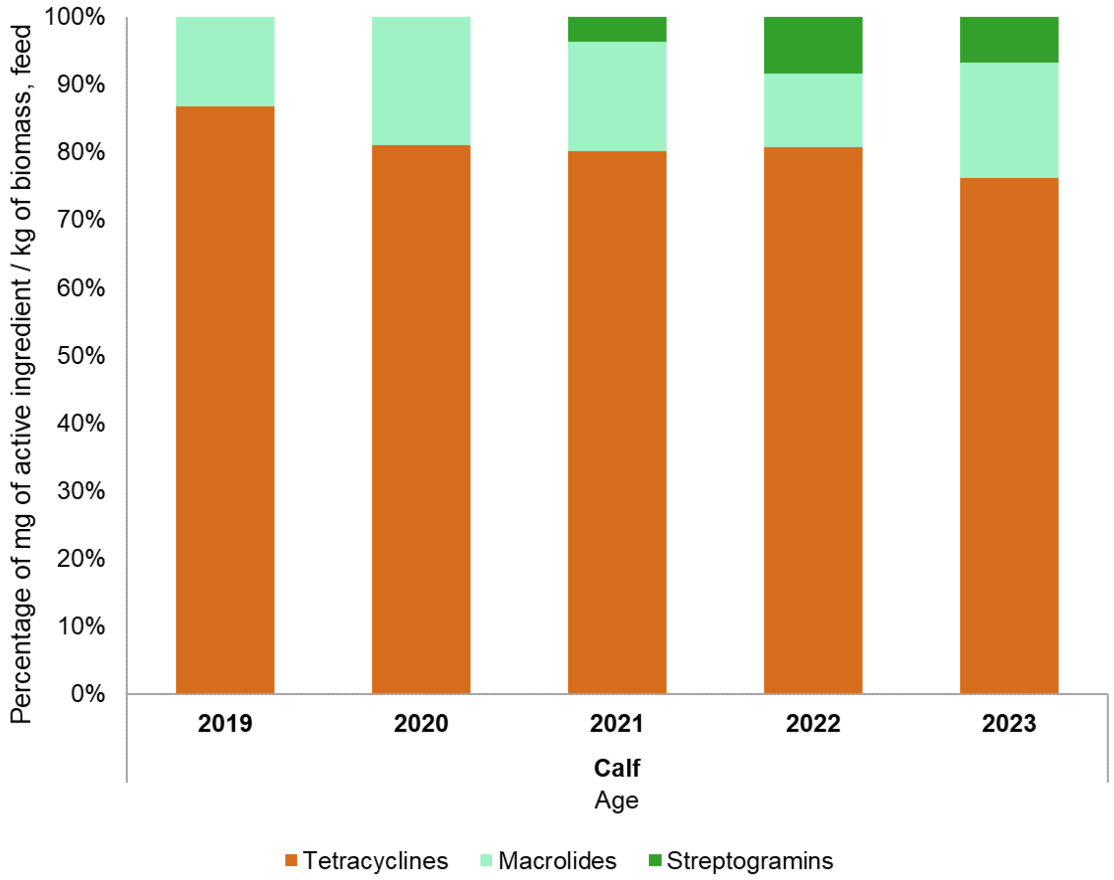


YEARLING

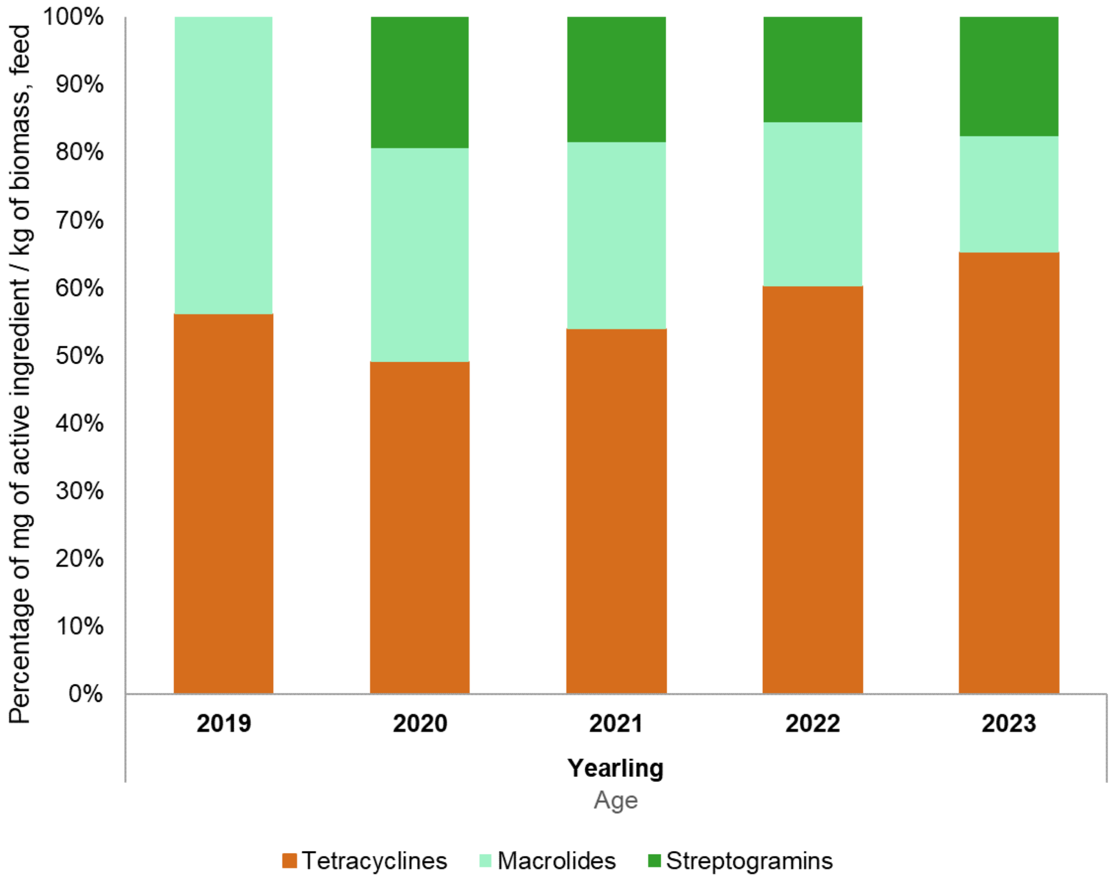


In-feed tetracycline AMU was more common in calves than yearlings
Macrolide and streptogramin use in feed predominated in yearlings over calves

CALF

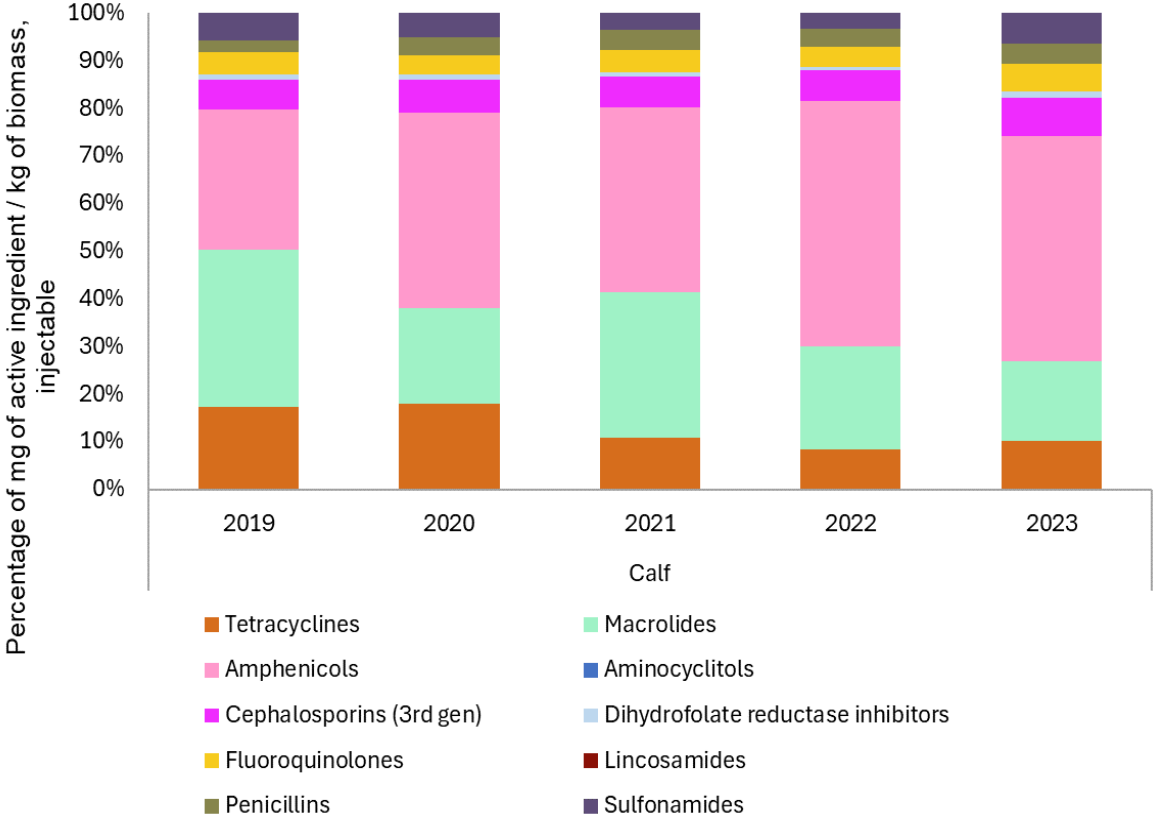


YEARLING

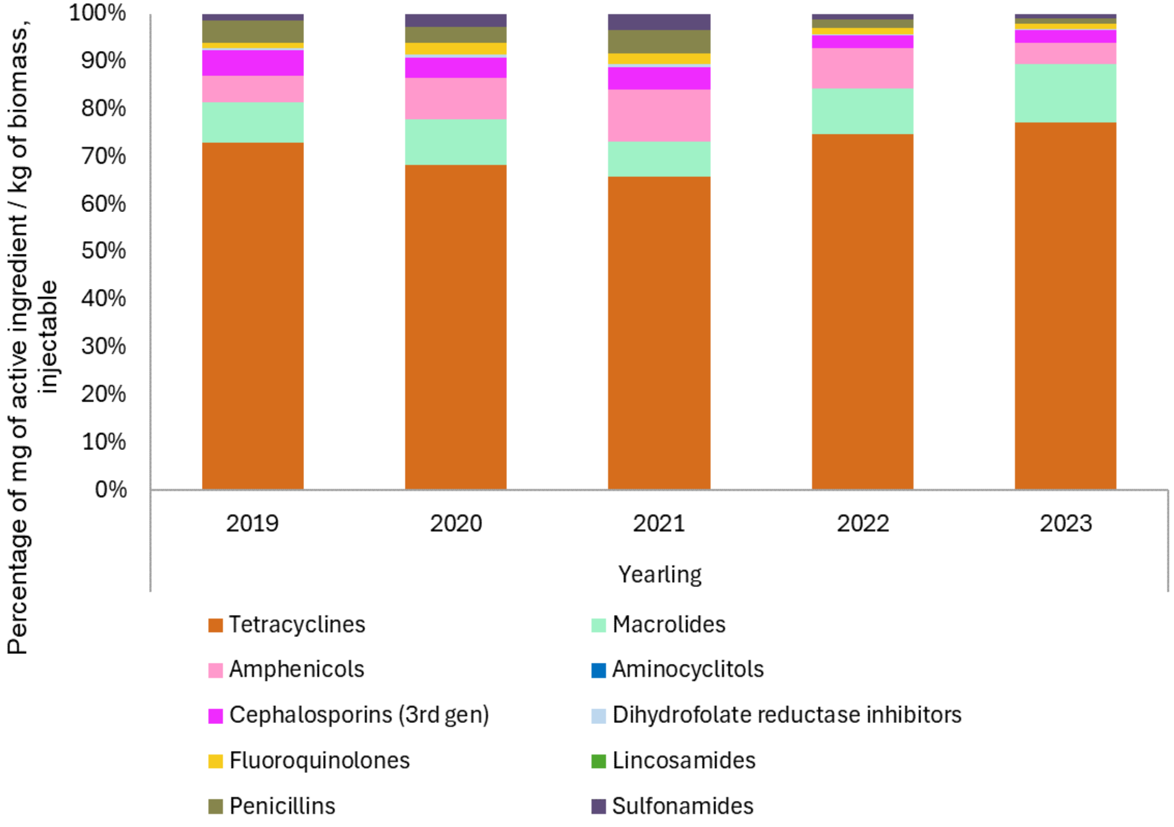


Amphenicols and macrolides were the main antimicrobials used by injection for calves, while tetracyclines were more commonly administered to yearlings.

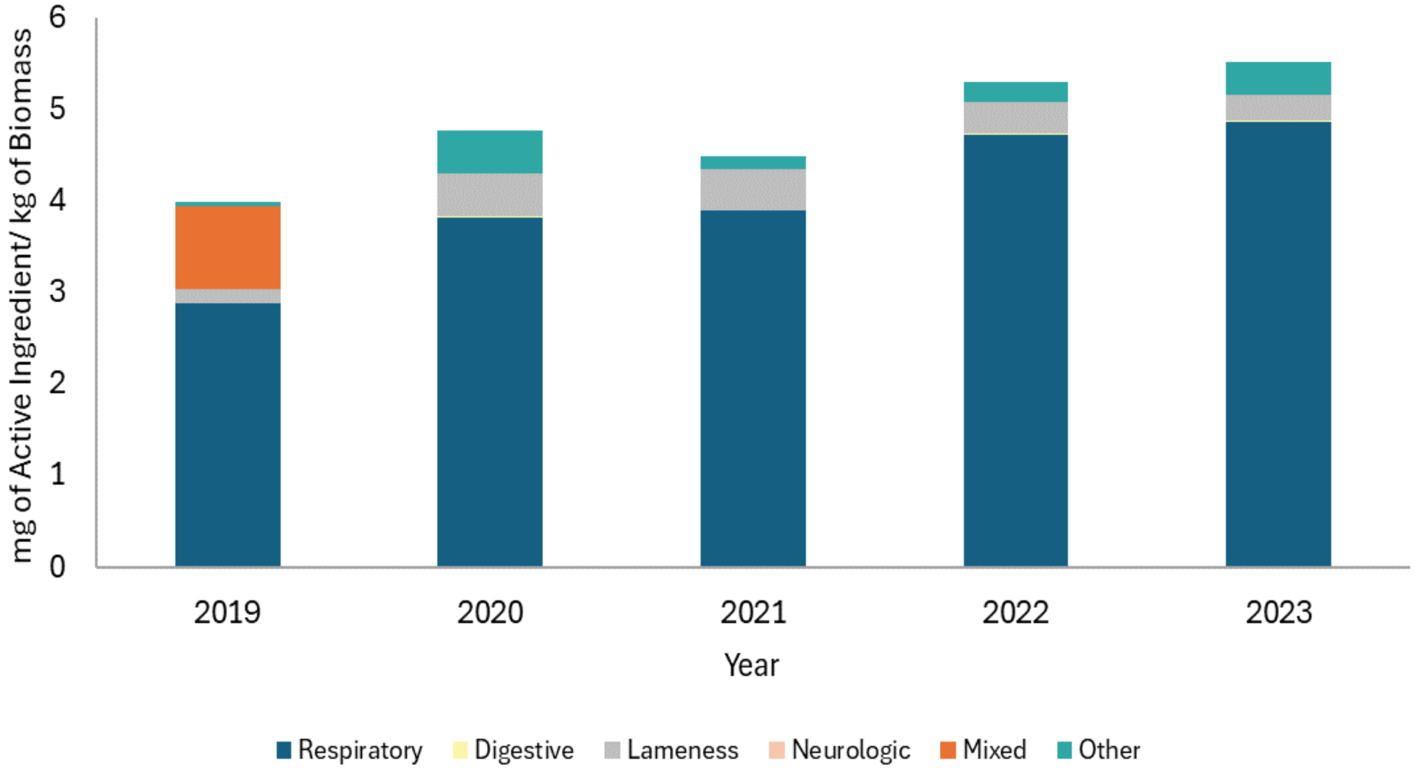
CALF



YEARLING

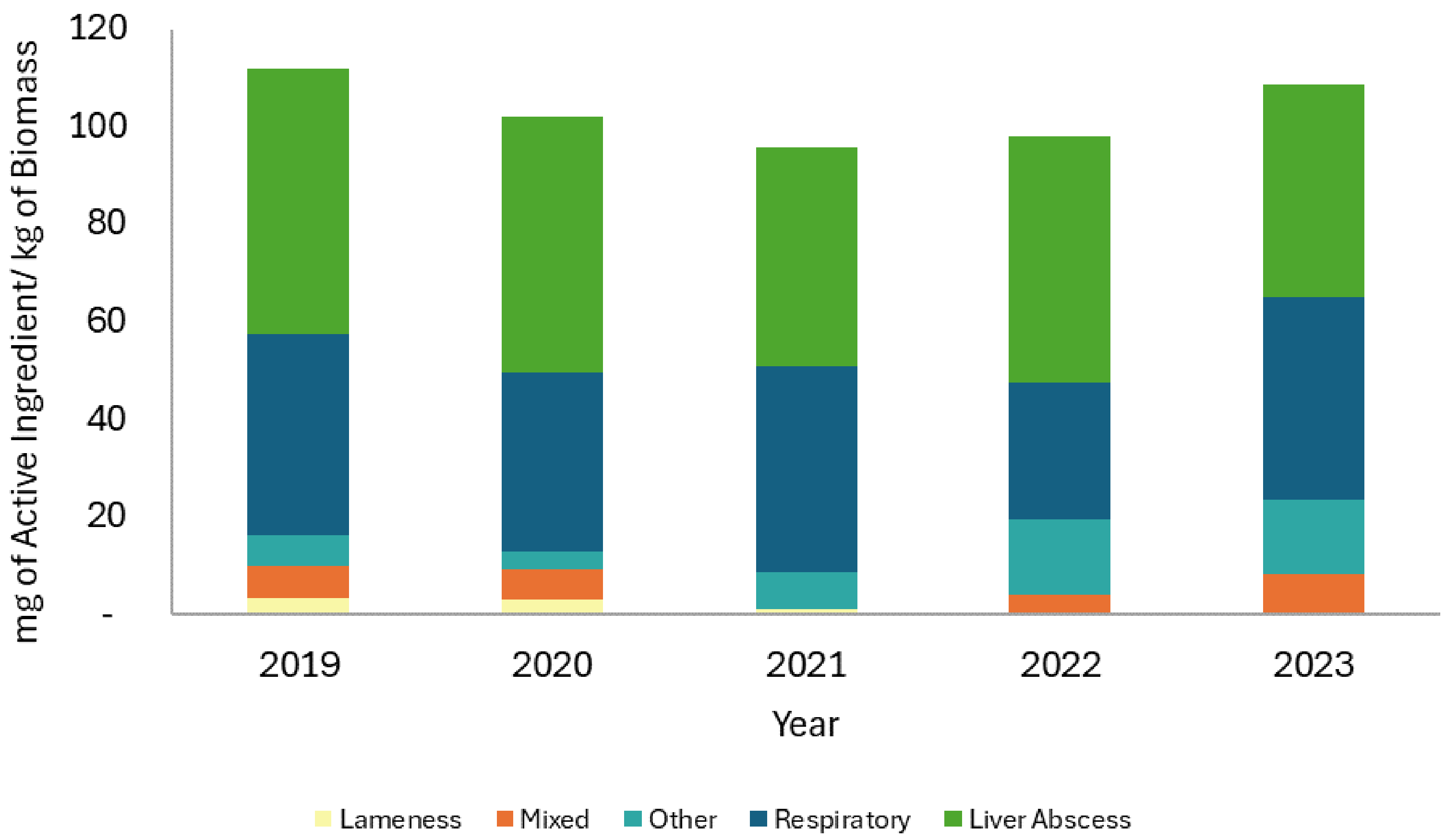


Respiratory disease was the main reason for AMU by injection, 2019-2023



- **Lameness**-related AMU peaked in 2020 and 2021 but has declined since 2022.
- **Digestive and neurologic** conditions have remained rare reasons for AMU via injection.

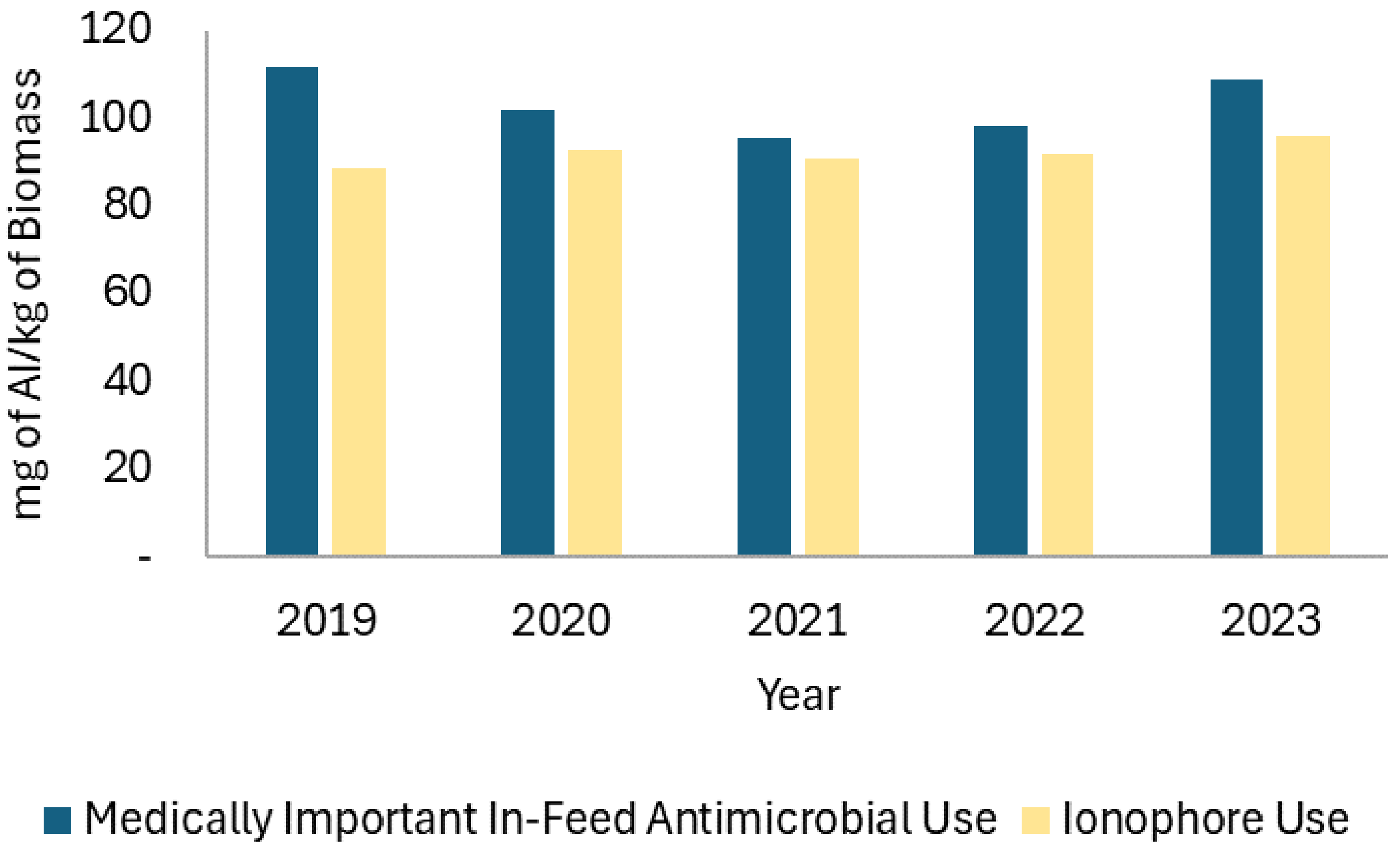
Liver abscesses and respiratory disease were the major reasons for AMU in feed, 2019-2023



- **Liver abscesses** and **respiratory disease (including histophilosis)** were the primary reasons for antimicrobial use in feed and are the principal drivers of AMU in beef cattle.

Use of Medically Important Antimicrobials Versus Ionophores in Feed

Ionophore use has remained relatively stable, 2019-2023



- The gap between the use of ionophores and the remaining medically important antimicrobials for feedlot cattle decreased each year until 2021, but increased again in 2022 and 2023.

Key Takeaways - AMU Comparisons

- AMU in calves (>140 mg/kg biomass) often **more than doubled** that of yearlings (<82 mg/kg biomass).
- Consistent with the **feedlot production cycle**, calves are often fed for **longer periods and have different risk factors for disease.**
- While the use of injectable antimicrobials in mg of active ingredient per kg of animal biomass was relatively stable for calves, it has increased each year for yearlings.

Key Takeaways - AMU Comparisons

- **Tetracyclines dominated in-feed AMU**, especially in **calves** (>75%).
- Higher proportions of **macrolides** and **streptogramins** were administered in feed to **yearling cattle**.
- **Tetracyclines** made up more than 58% of the **injectable AMU** for **yearlings**, followed by macrolides and/or amphenicols, whose proportions varied year over year.
- In contrast, **amphenicols** comprised the majority of **injectable AMU** in **calves**, and predominated over the use of macrolides and tetracyclines.

Fed Cattle Industry different than many other livestock commodities

Key Takeaways

- Cattle entering feedlots are not uniform in terms of:
  - Age
  - Gender
  - Disease risk
  - Breed type
- Type of cattle placed in feedlots can impact:
  - Risk of disease
  - Days on feed
  - Type and quantity of AMU

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Ontario

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