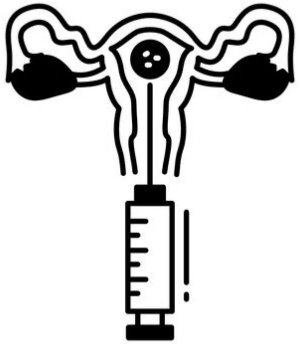
THE INCREASING POPULARITY OF EMBRYO TRANSFER HAS IMPLICATIONS FOR U.S. DAIRY CATTLE FERTILITY EVALUATIONS



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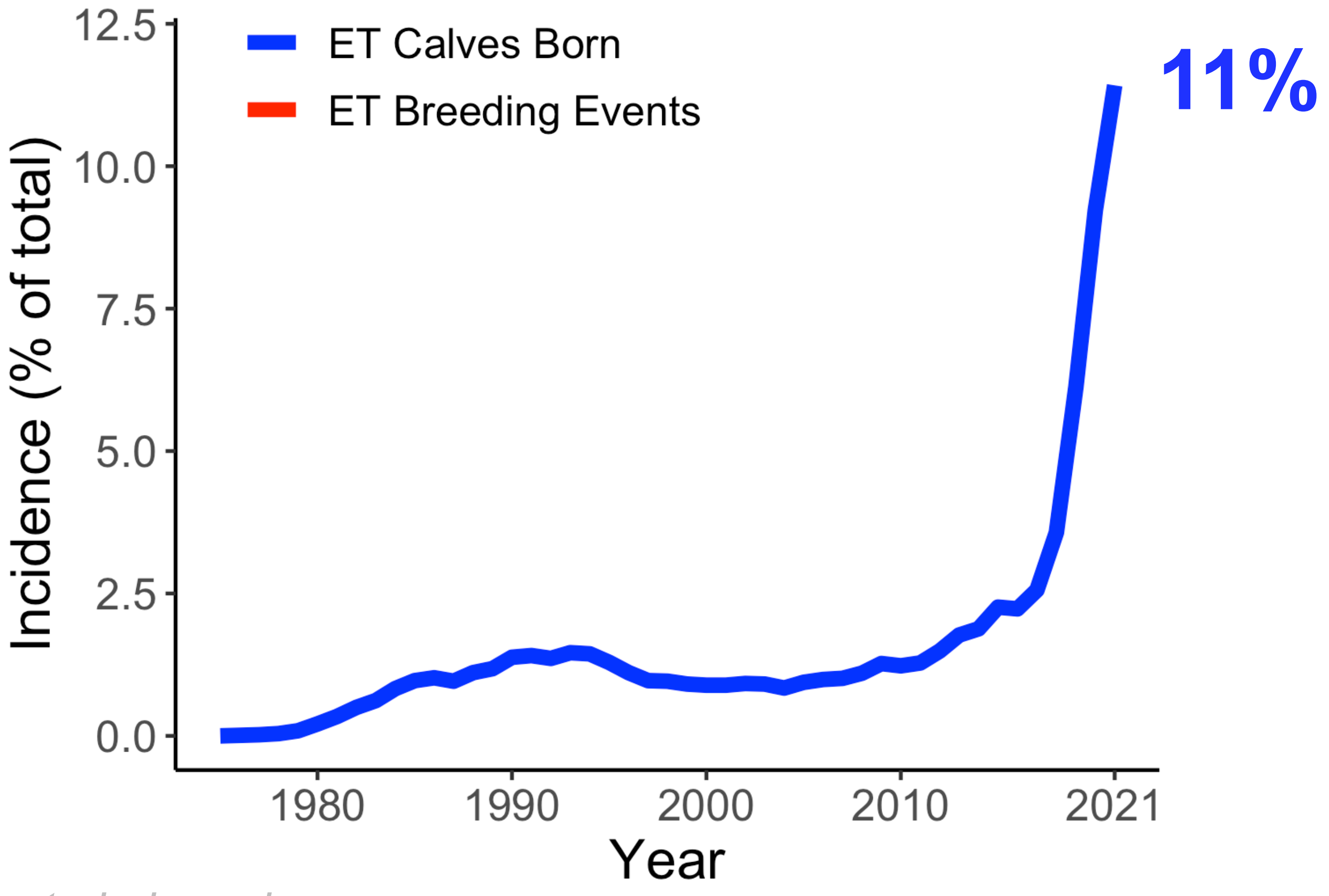
REASONS COWS EXIT THE HERD

Termination Code	Holstein	Jersey	Other Breeds[1]
Unspecified	29.8 %	30.3 %	28.7 %
Low production	22.0 %	27.4 %	18.7 %
Reproduction problems	14.9 %	11.7 %	18.4 %
Mastitis or high SCC	12.6 %	11.8 %	12.4 %
Locomotion problems	4.7 %	1.2 %	5.0 %
Udder problems	0.1 %	0.1 %	0.2 %
Undesirable conformation	0.0 %	0.0 %	0.0 %
Bad behavior	0.0 %	0.0 %	0.1 %

[1]Ayrshire, Brown Swiss, Guernsey, Milking Shorthorn, Red & White

From: Norman et al (2021)

EMBRYO TRANSFER IS ON THE RISE



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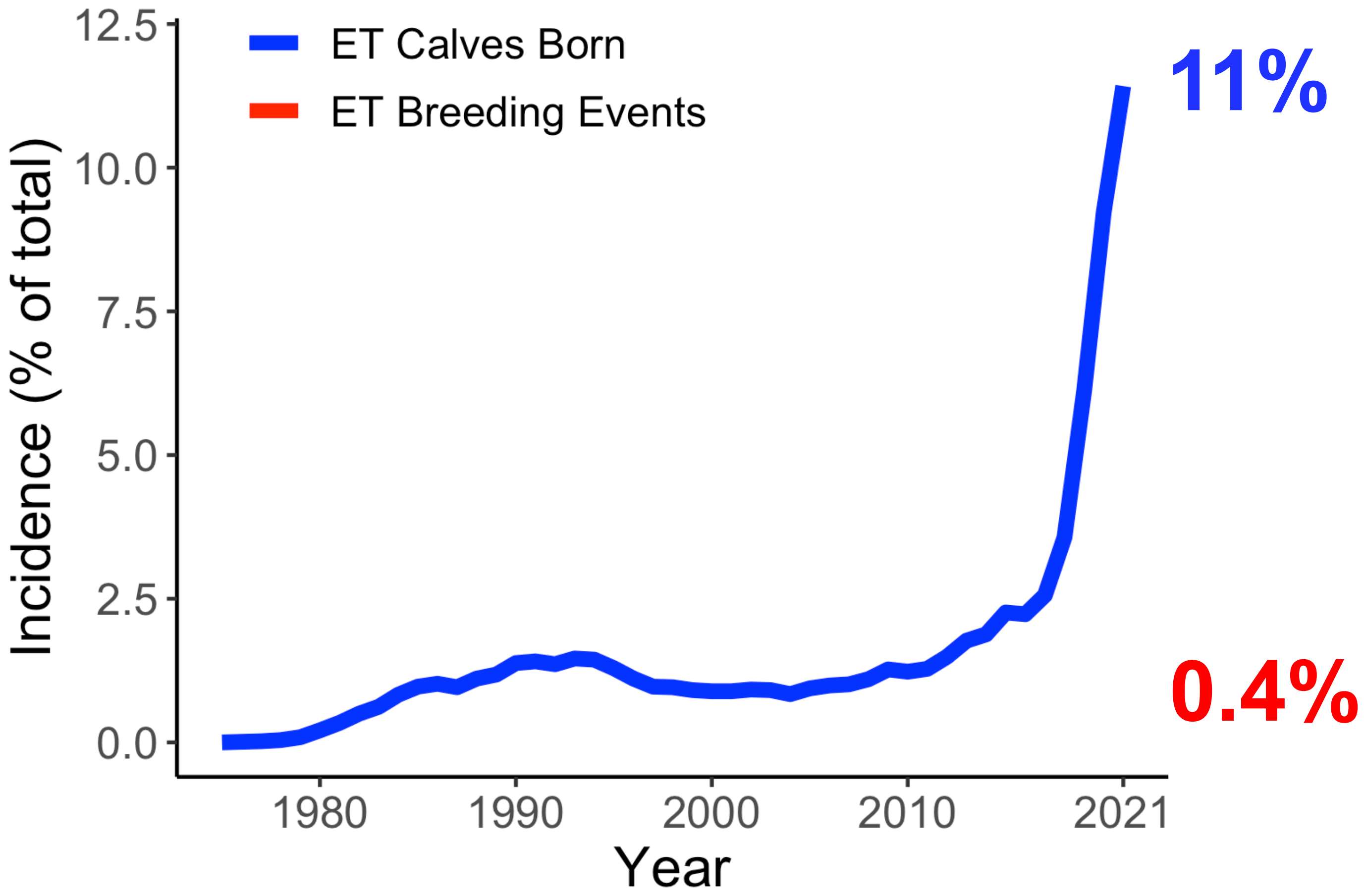
EMBRYO TRANSFER IS ON THE RISE

Maternal line and genotyped embryo of dam HOCAN13913420

Maternal Generation	0	1	2	3	4	5	6	7
Birth Year	2022	2020	2019	2018	2016	2015	2013	2012
Birth Month	3	11	6	3	11	6	12	6
Age @ Embryo Donation[1]	--	7	8	6	7	8	9	9
Generation Interval[1]	16	17	15	16	17	18	18	--

[1]months

EMBRYO TRANSFER IS ON THE RISE



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CDCB
COUNCIL ON DAIRY CATTLE BREEDING

Format 5

E: embryo donation

I: embryo implantation (sire)

J: embryo implantation (dam)

ET REPORTING ERROR RATES

Code	Mating Type	ET Births	All Other Calvings	
A	AI	35,100	11,060,000	
G	AI (sexed semen)			
N	Natural Service			
E	Embryo Donation			
I/J	Embryo Implantation			

The rate at which ET is **incorrectly** reported

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ET REPORTING ERROR RATES

Code	Mating Type	ET Births	All Other Calvings	
A	AI	35,100	11,060,000	**0.3%**
G	AI (sexed semen)	14,833	1,175,795	**1.3%**
N	Natural Service	2,035	584,971	**0.4%**
E	Embryo Donation	0	13	**0.0%**
I/J	Embryo Implantation	372	29,416	**1.3%**

The rate at which ET is **incorrectly** reported (codes A, G, N)

The rate at which ET is **correctly** reported (codes E, I/J)

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THE PROBLEM

- With embryo transfer, conception is not actually occurring
- Unreported ET may bias fertility evaluations in the population
- Previously, the US excluded all ET donors & recipients in evaluations
- ET-associated records represent the most elite animals & herds so removing them is not necessarily the desired approach

APPROACH

1. Identified herds doing substantial amount of ET but with inconsistent reporting

Censor herdyears reporting

>10 % calves born by ET, but

< ½ the expected number of ET breeding events

APPROACH

2. Recalculated conception rate evaluations

BLUP Animal Model

(Wiggans and VanRaden 1989)

$$y_{ijkl} = m_{ij} + a_{kl} + p_{kl} + c_{ik} + e_{ijkl}$$

m_{ij} : management group

a_{kl} : animal effect

p_{kl} : permanent effect of environment

c_{ik} : herd-sire interaction

e_{ijkl} : residual variance

APPROACH

BLUP Animal Model
(Wiggans and VanRaden 1989)

$$y_{ijkl} = m_{ij} + a_{kl} + p_{kl} + c_{ik} + e_{ijkl}$$

2. Recalculated conception rate evaluations

Sire Conception Rate (SCR)

$$\frac{\text{\# confirmed successes}}{\text{\# inseminations}}$$

- Only data from most recent 4 years
- No genetic relationships (a_{kl})
- Additional environmental effects included

Interpretation

SCR 2%

Conception rate is predicted to be 2 percentage points higher than the average conception rate for the AI bulls in that breed

APPROACH

BLUP Animal Model
(Wiggans and VanRaden 1989)

$$y_{ijkl} = m_{ij} + a_{kl} + p_{kl} + c_{ik} + e_{ijkl}$$

2. Recalculated conception rate evaluations

Heifer Conception Rate (HCR)	Cow Conception Rate (CCR)
% inseminated heifers that become pregnant at each service	% inseminated cows that become pregnant at each service

- Multi-trait model along with AFC and DPR
- All available data from 2003+ used
- Breeds evaluated together including regressions on inbreeding and heterosis

Interpretation

HCR, CCR 2%

Daughters of this bull are 2% more likely to become pregnant at each service than the average

APPROACH

3. Assessed impact of edit

- Correlate new and old values
- Difference = new values – old values
- Examine differences for each breed in context of bull popularity, ET usage, and genetic merit

IMPACTS ON SCR

		Change in Evaluation (%)				
	Bulls Compared	Min	Median	IQR	Max	**Correlation**
Ayrshire	6	-0.3	-0.1	0.4	0.3	0.98*
Brown Swiss	44	-0.9	-0.1	0.3	0.6	0.99*
Guernsey	14	-0.6	0.1	0.6	0.6	0.96*
Holstein	1379	-1.9	0.0	0.2	1.3	0.99*
Jersey	132	-1.4	-0.1	0.3	0.9	0.99*
Milking Shorthorn	1	0.0	0.0	0.0	0.0	--

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Previously overestimated

Previously underestimated

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Milking Shorthorn	1	0.0	0.0	0.0	0.0	--

Edit removed 252 herdyears (1.2% reduction)

Miles et al., in review

IMPACTS ON HCR

		Change in Evaluation (%)				
	Bulls Compared	Min	Median	IQR	Max	**Correlation**
Ayrshire	22	-0.5	0.0	0.3	0.3	0.98*
Brown Swiss	156	-0.6	-0.2	0.2	0.5	0.99*
Guernsey	43	-0.8	-0.2	0.3	0.3	0.99*
Holstein	13807	-1.6	-0.1	0.3	3.7	0.99*
Jersey	1574	-1.6	-0.9	0.3	1.5	0.99*
Milking Shorthorn	14	-0.4	-0.1	0.3	0.3	0.99*

Edit removed 237,414 herdyears (2.2% reduction)

Miles et al., in review

IMPACTS ON CCR

		Change in Evaluation (%)				
	Bulls Compared	Min	Median	IQR	Max	**Correlation**
Ayrshire	370	-0.8	-0.3	0.1	0.4	0.99*
Brown Swiss	1058	-1.5	-0.3	0.2	0.5	0.99*
Guernsey	805	-0.8	-0.3	0.1	0.3	0.99*
Holstein	47262	-1.6	-0.3	0.2	1.4	0.99*
Jersey	5303	-1.8	-0.3	0.2	1.0	0.99*
Milking Shorthorn	158	-0.9	-0.3	0.3	0.3	0.99*

Edit removed 323,618 herdyears (1.0% reduction)

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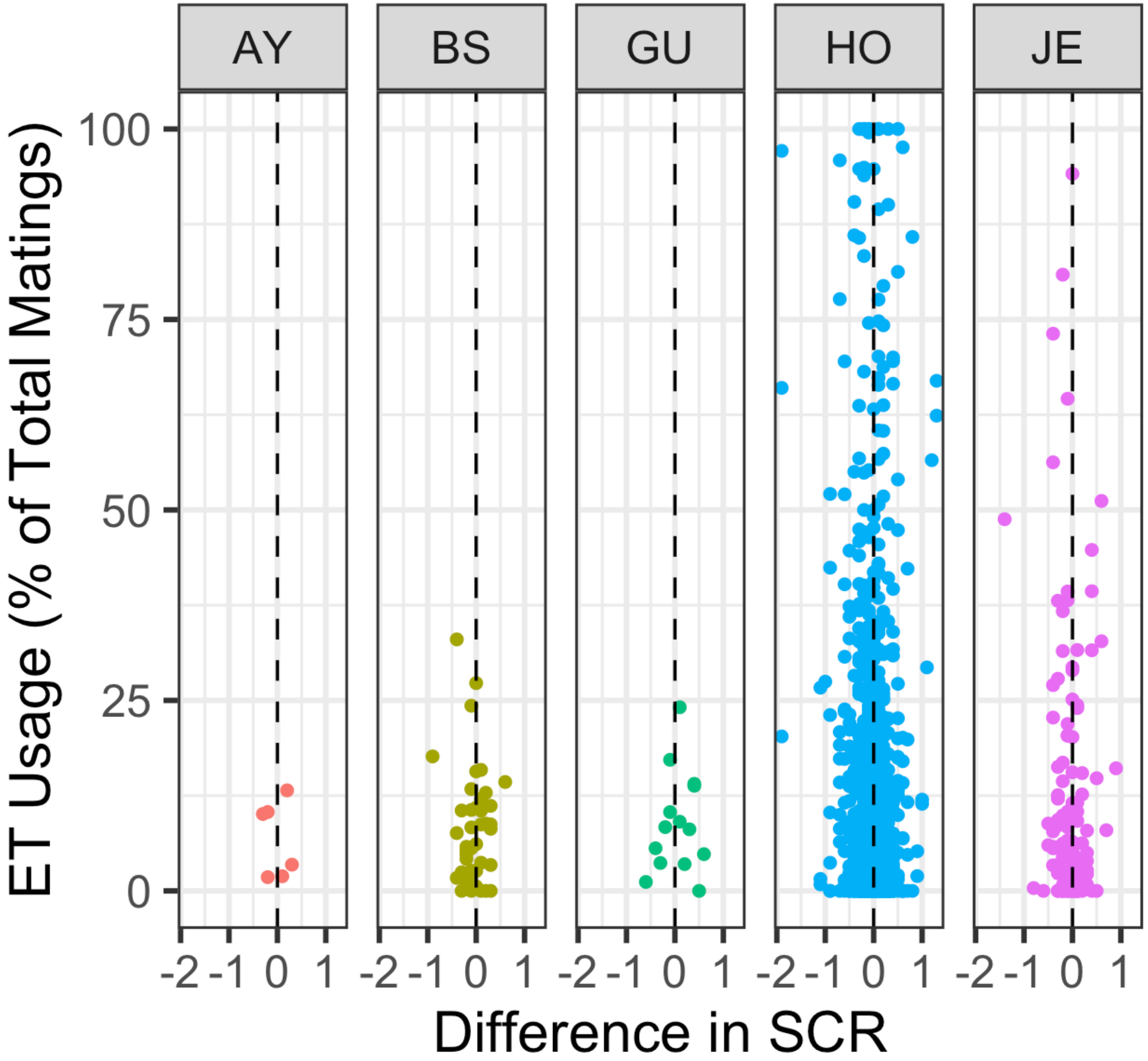
CLOSER LOOK: SCR

Impacts by bull popularity for ET



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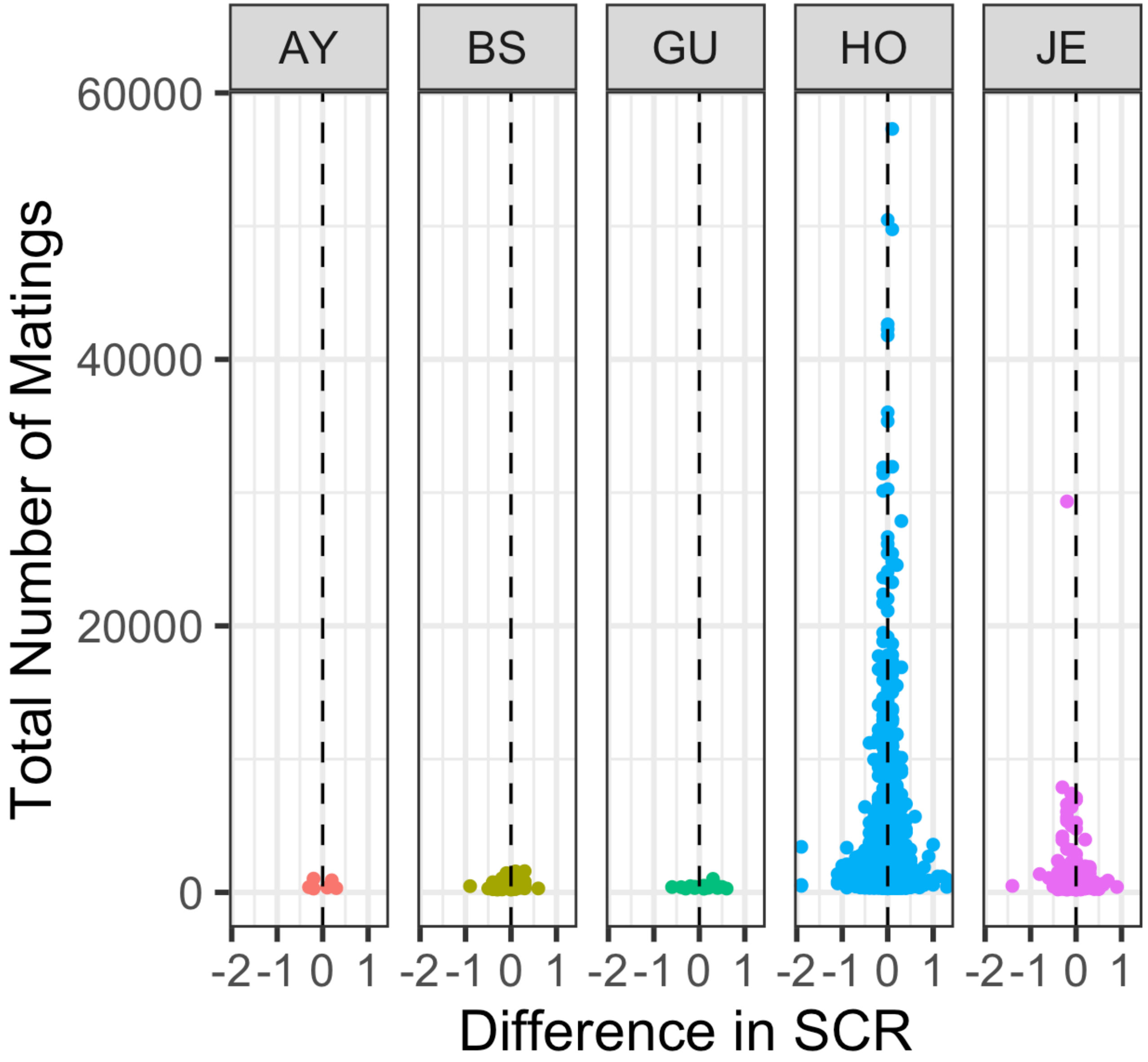
CLOSER LOOK: SCR

Impacts by overall bull popularity



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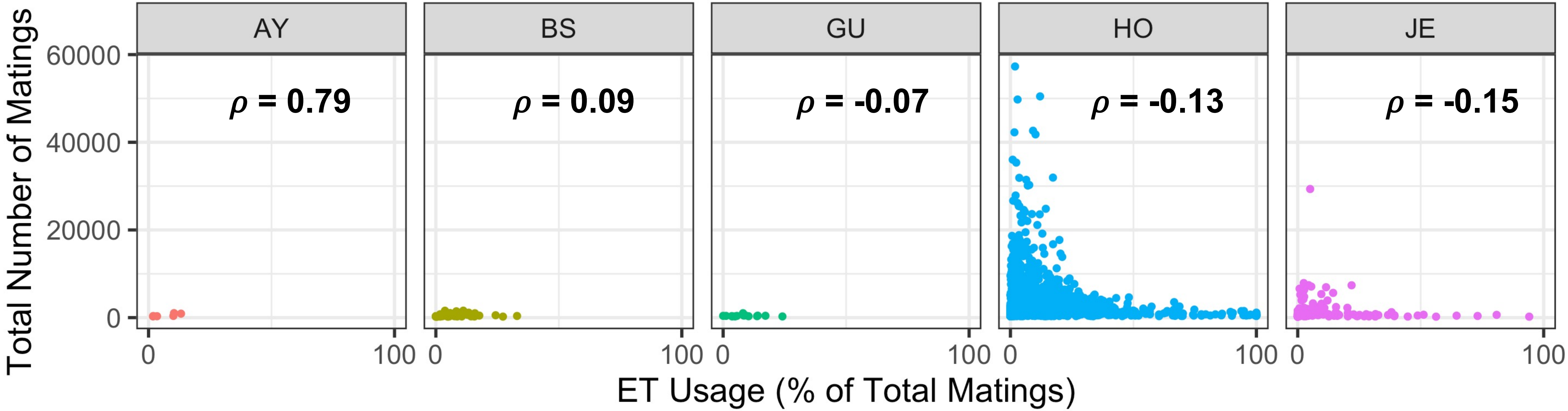
CLOSER LOOK: SCR

Bull popularity correlation with ET usage



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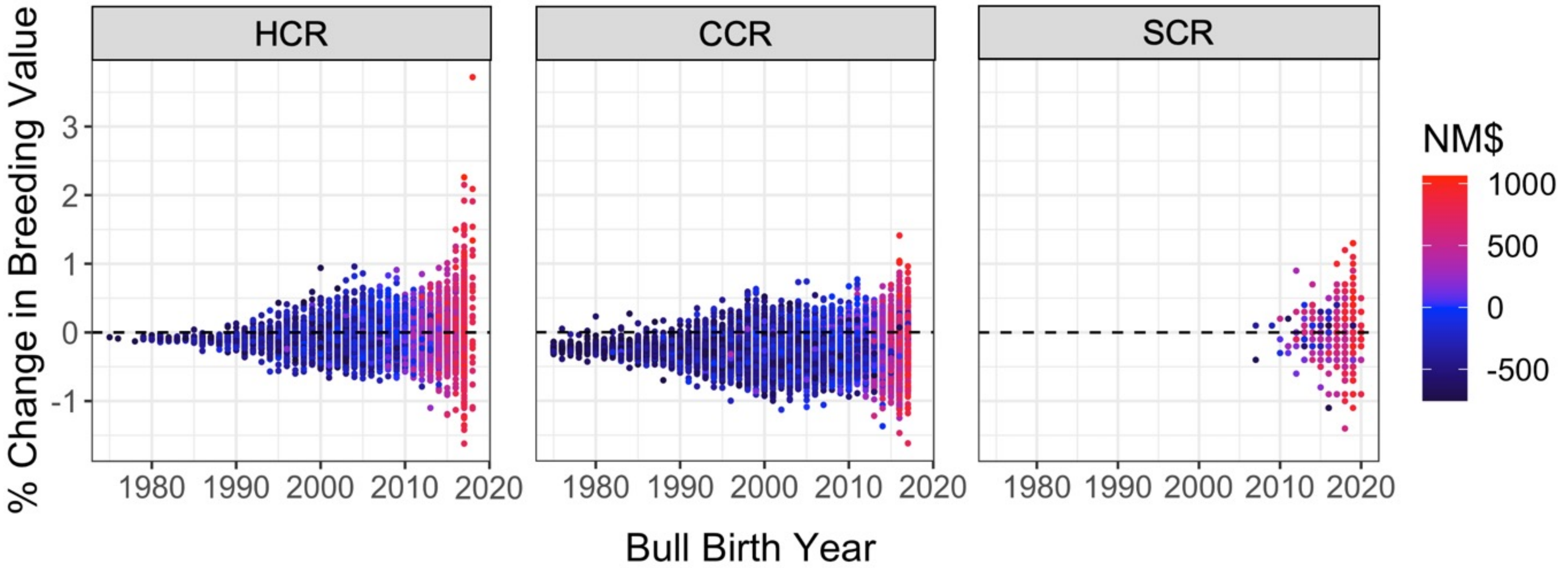
ELITE YOUNG BULLS MOST AFFECTED



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FUTURE RESEARCH NEEDS

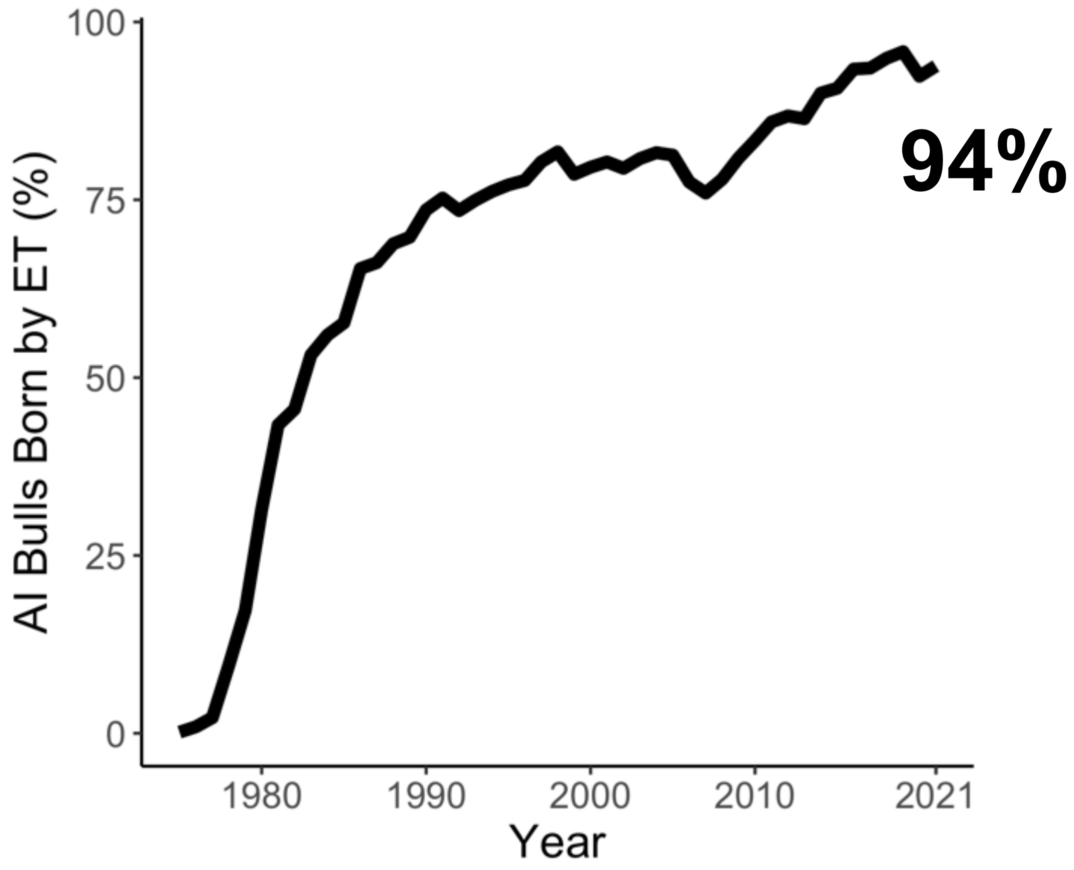
- Other reproductive traits
  - Daughter Pregnancy Rate, Age at First Calving, Gestation Length
- Data needs
  - Accurate reporting of breeding events
  - Multiple ovulation v. IVF
  - Fresh v. frozen embryos
  - Embryo grade and stage
  - Recipient synchrony
  - FSH protocol

BIF

ET: Data Collection & Utilization

http://guidelines.beefimprovement.org/index.php/Embryo_Transfer_(ET):_Data_Collection_And_Utilization

USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE



ET for cows may continue to increase, as it has for AI bulls

Key Messages

- These edits were implemented in CDCB April 2022 Evaluations
- Effects for SCR, CCR, and HCR were overall small, except for elite new bulls popular for ET usage
- Acquiring high quality ET records will be essential to providing accurate fertility evaluations in the future

THANK YOU

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