What are herd bulls accomplishing in multiple sire breeding pastures?

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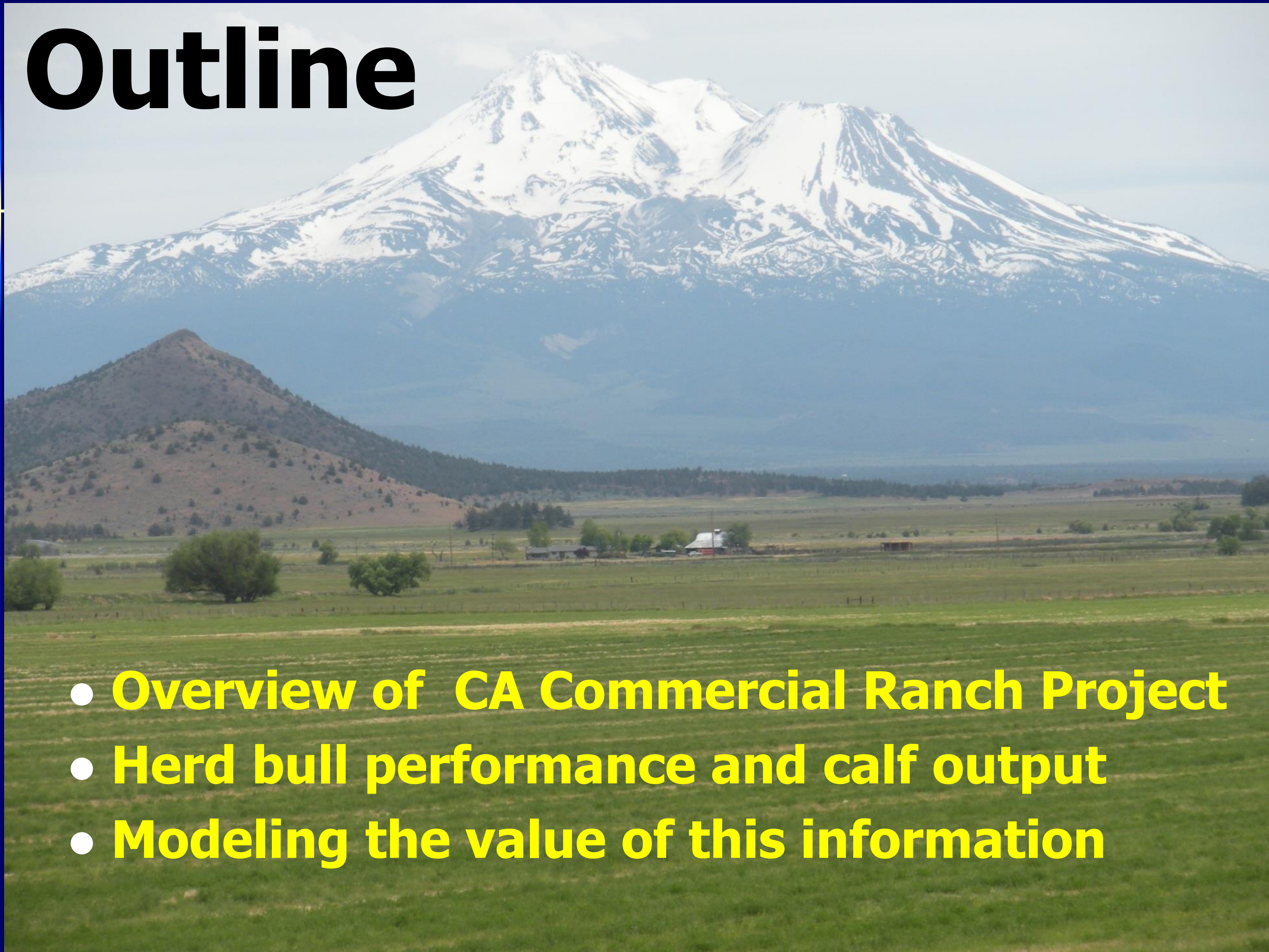
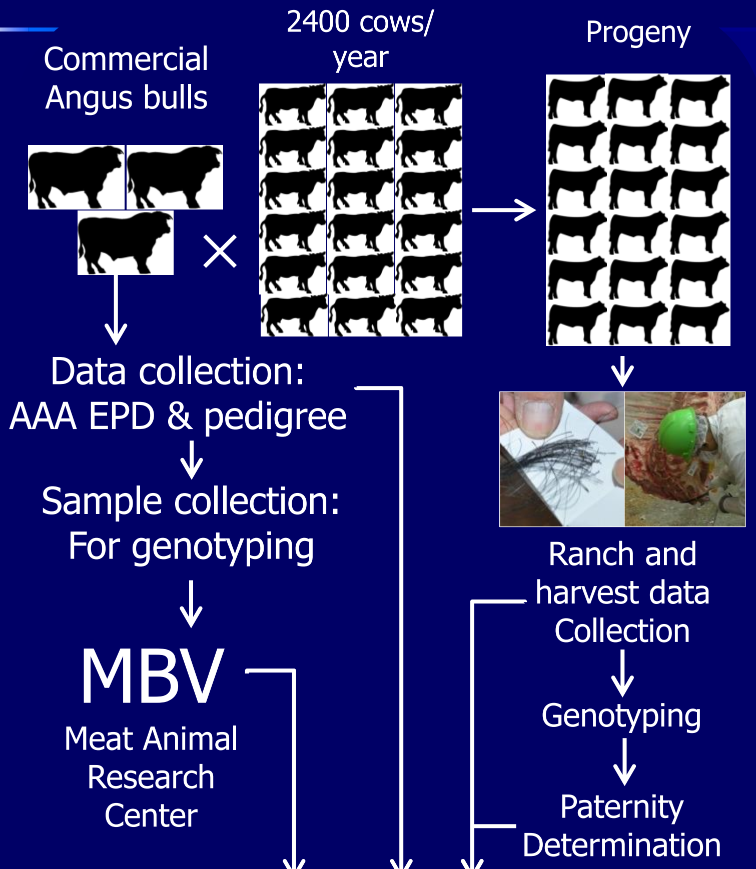
Outline



- Overview of CA Commercial Ranch Project
- Herd bull performance and calf output
- Modeling the value of this information

California Commercial Ranch Project



Assessment of DNA-enabled approaches for predicting the genetic merit of herd sires on commercial beef ranches

Four ranches:

- Cowley (900 cows)
- Kuck (500 cows)
- Mole-Richardson (700 cows)
- UC Davis (300 cows)

Approximately 100 Angus bulls, and 2,400 cows per year on project

United States Department of Agriculture
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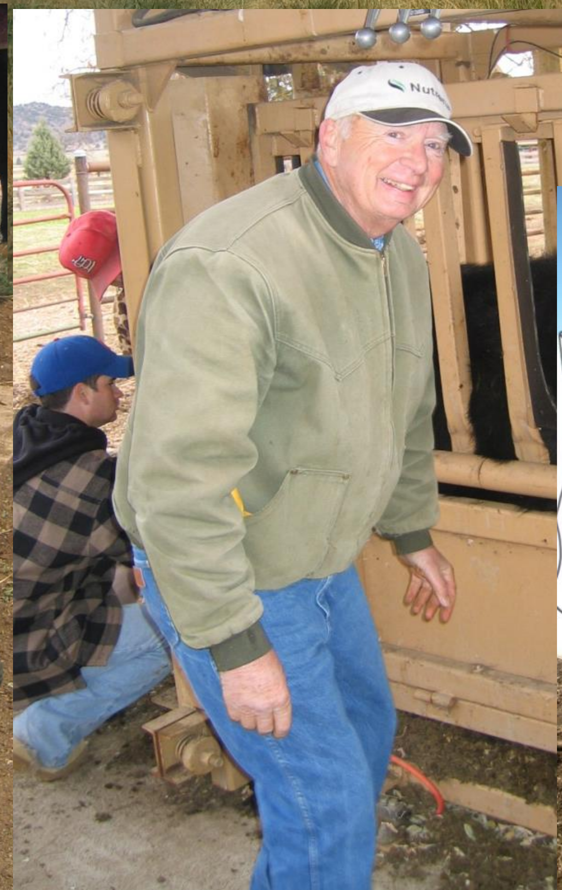
What does a California Commercial Ranch collaborator look like?

Photo taken in 1949 at Red Bluff Bull Sale, CA
Generously provided by Cathy Maas from Crowe Hereford Ranch, Millville, CA.

Cowley Ranch

~20 bulls/season



Kuck Ranch

~10 bulls/season

Mole-Richardson Farms

~30 bulls

You choose the bull for the following ranch environment

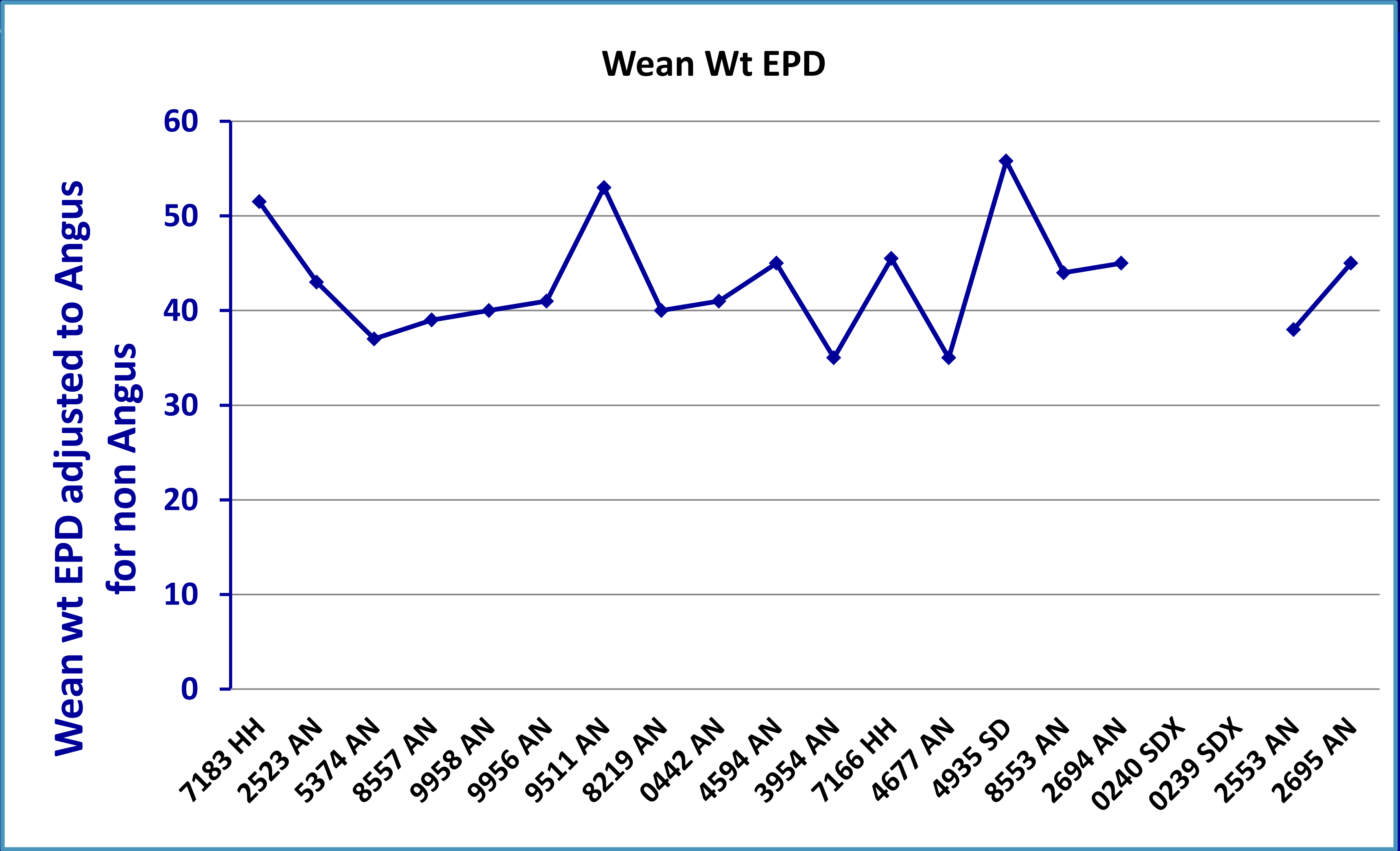
- Predominantly Angus cows
- Multi-bull breeding pasture
- All bulls appeared sound and passed BSE
- All bulls had acceptable semen quality
- Approximately 25:1 cow to bull ratio
- Fenced relatively flat breeding pastures
- Calves sold shortly after weaning

Here are your choices

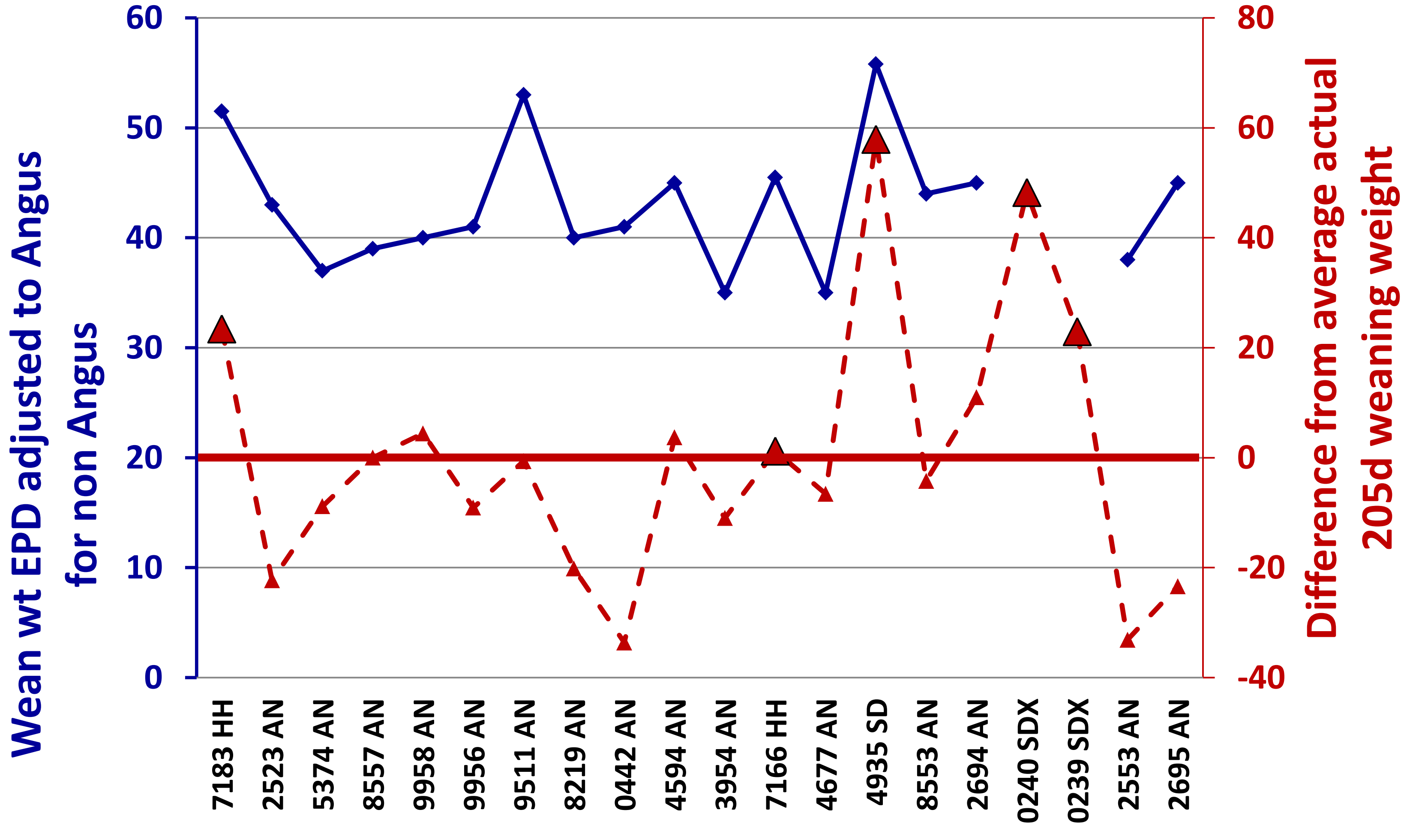
No.	Bull Id & Breed	Age	CED EPD	CED ACC	WN WT EPD	WN WT ACC	Sire
1	7183 HH	3.4	0.9	0.12	51.5	0.29	Go Excel
2	2523 AN	4.4	11	0.3	43.0	0.27	New Frontier
3	5374 AN	4.3	8	0.05	37.0	0.05	Integrity
4	8557 AN	4.3	1	0.29	39.0	0.26	Bushwacker
5	9958 AN	2.4	12	0.31	40.0	0.26	Premium Beef
6	9956 AN	2.4	12	0.31	41.0	0.27	Premium Beef
7	9511 AN	3.4	6	0.29	53.0	0.26	Mytty In Focus
8	8219 AN	2.8	5	0.3	40.0	0.27	Premium Beef
9	0442 AN	1.9	6	0.29	41.0	0.27	New Design
10	4594 AN	2.4	7	0.29	45.0	0.28	Mytty In Focus
11	3954 AN	3.3	9	0.24	35.0	0.26	Broadcast
12	7166 HH	3.4	-1.5	0.11	45.5	0.32	Go Excel
13	4677 AN	2.4	8	0.29	35.0	0.27	Total
14	4935 SD	4.3			55.8	0.51	Rider's Dream
15	8553 AN	4.3	0	0.3	44.0	0.27	Bushwacker
16	2694 AN	4.3	6	0.05	45.0	0.05	Destination
17	0240 SDX	4.3					
18	0239 SDX	4.3					
19	2553 AN	4.4	11	0.3	38.0	0.27	New Frontier
20	2695 AN	4.3	6	0.05	45.0	0.05	Destination

*** EPDs adjusted to Angus for non-Angus bulls**

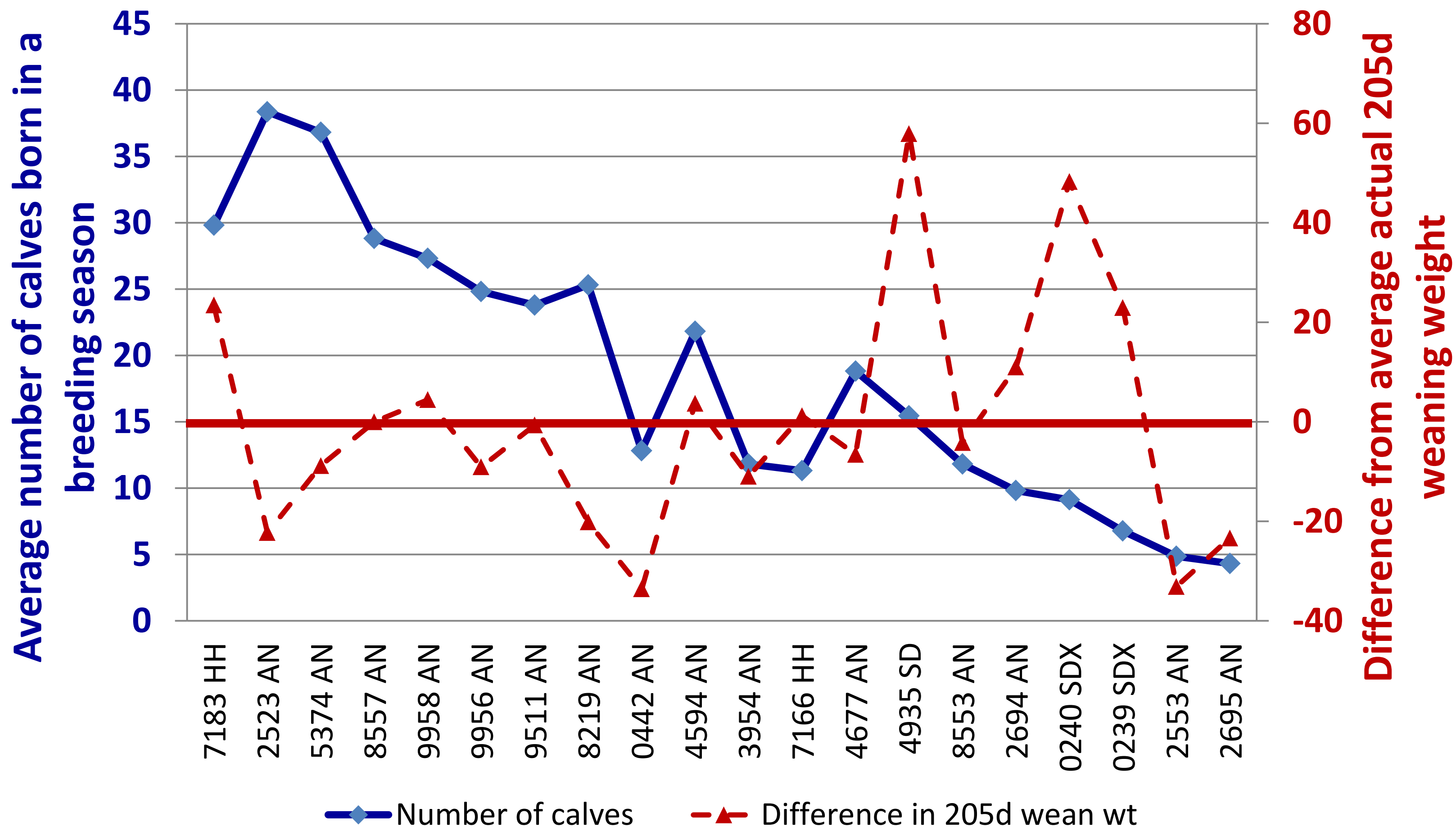
Weaning weight EPDs (---)



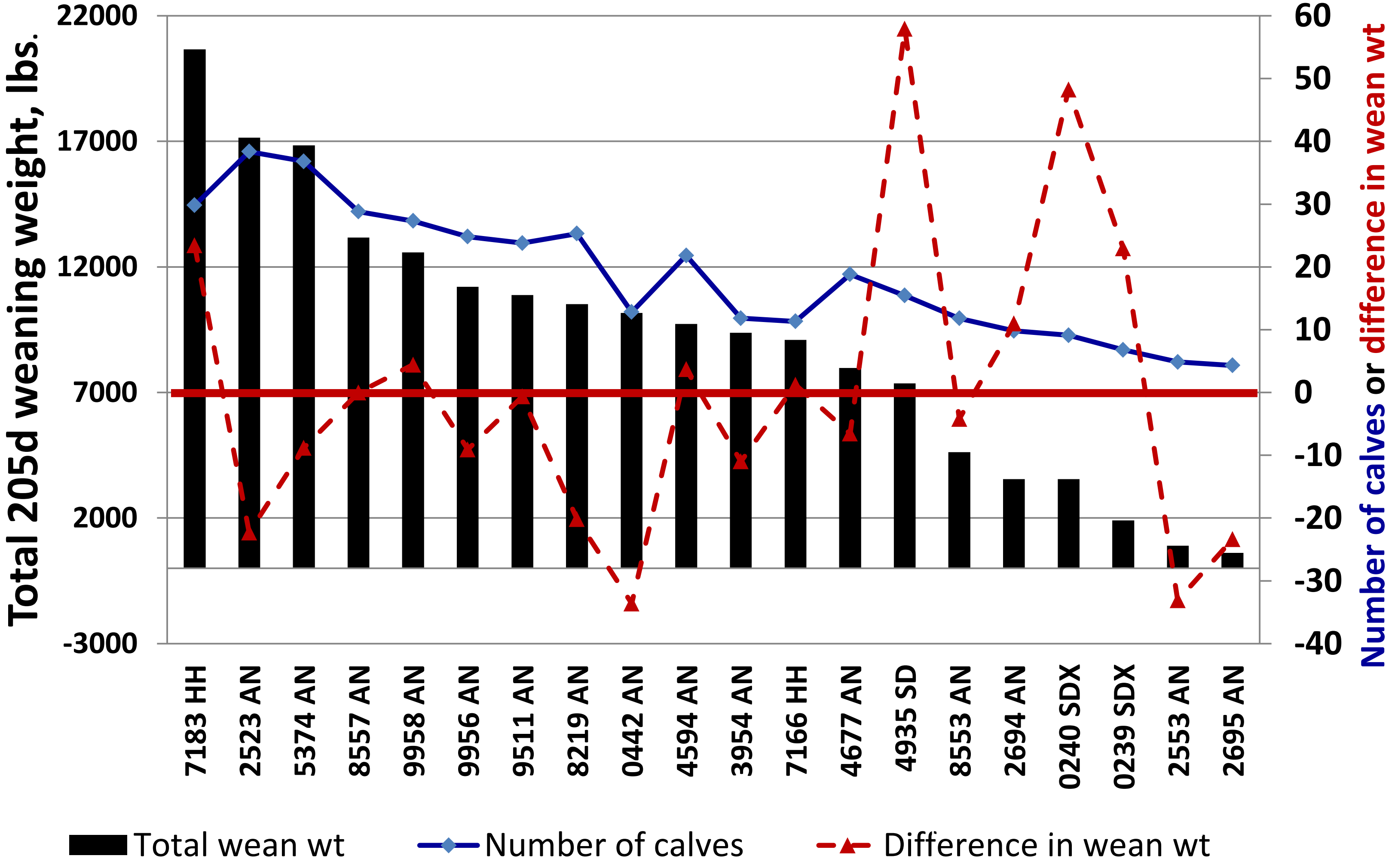
Actual 205 day weight performance of calves (---)



Average number of calves born per breeding season



Total 205d weaning weight, no. of calves, and difference from 205d weaning weight mean (Figure 2)



Total 205d weaning weight, number of calves, and difference from 205d weaning weight mean (Figure 3)

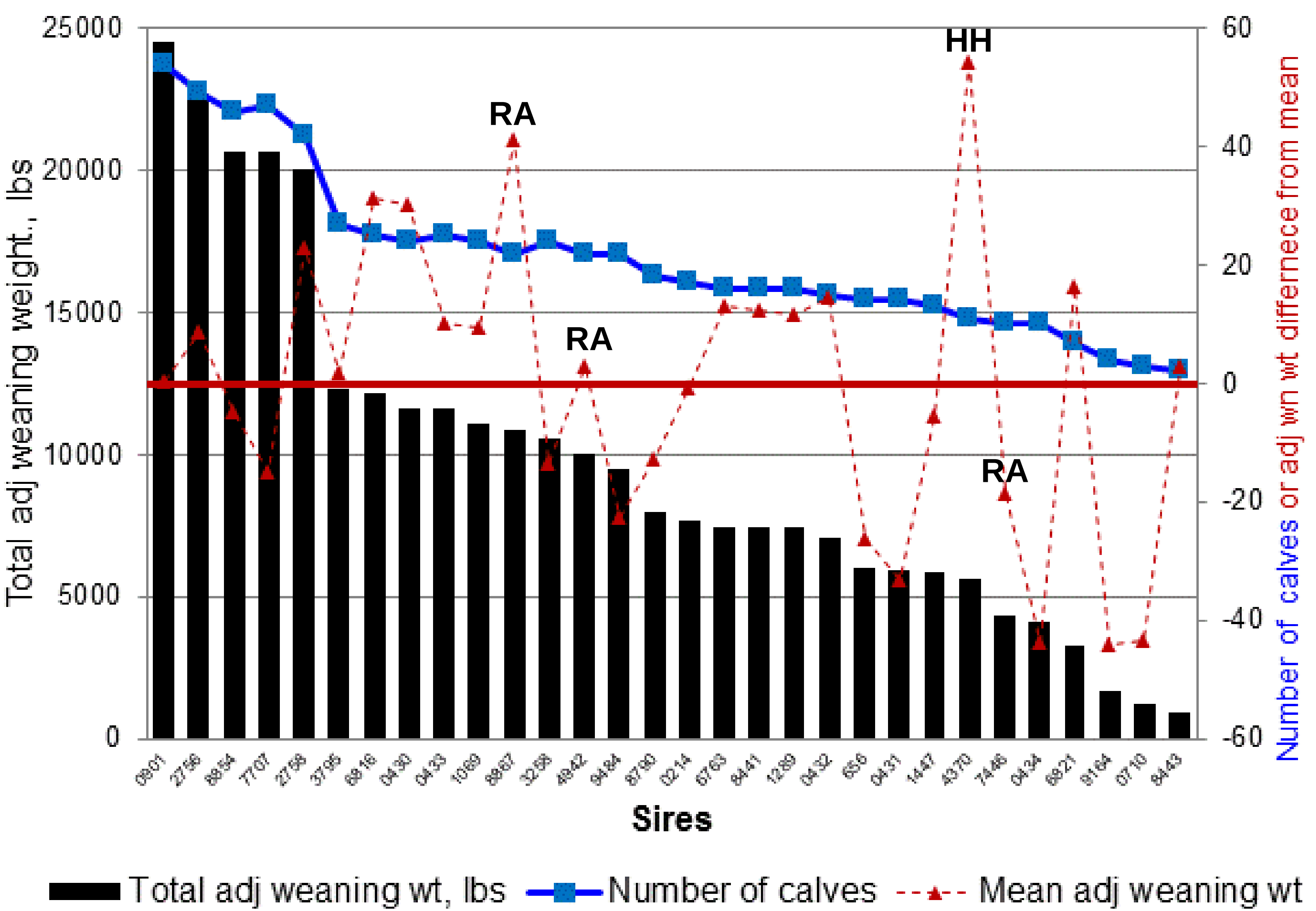


Table 1. Average bull age at the beginning of the breeding season, and number of calves produced per bull that sired at least one calf on 3 commercial ranches in Northern California in 2009 and 2010.

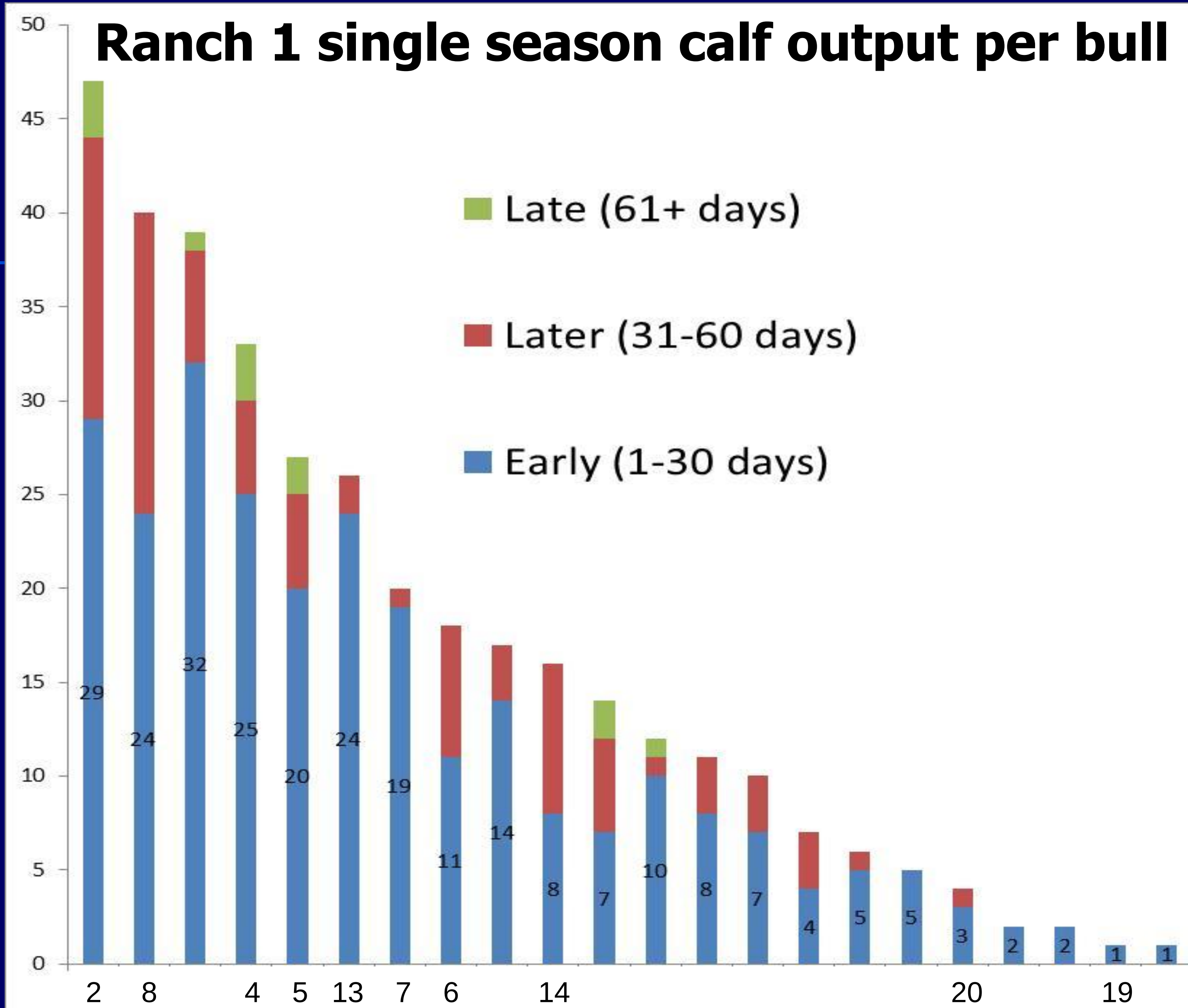
Ranch	Year	Season	# of sires	Bull Age		Mean bull age	Total # of calves	Number of calves per bull		Aver # of calves per bull/season
				Min	Max			Min	Max	
1	2009	Spring	13	1.5	3.1	2.5 ± 0.6	246	6	40	**18.9** ± 12.5
1	2009	Fall	19	1.6	3.8	2.9 ± 0.9	345	1	47	**18.2** ± 13.9
1	2010	Spring	19	2.1	5.2	3.4 ± 0.9	366	5	36	**19.3** ± 10.7
2	2009	Spring	8	0.7	9.2	3.5 ± 2.7	139	1	44	**17.4** ± 16.6
2	2009	Fall	9	1.4	8.8	4.4 ± 2.2	196	10	48	**21.8** ± 11.4
2	2010	Spring	8	1.7	5.3	2.9 ± 1.2	129	3	28	**16.1** ± 9.1
3	2009	Fall	30	1.6	5.6	3.3 ± 10	639	2	54	**21.3** ± 13.8
3	2010	Fall	27	1.6	5.2	3.7 ± 1.3	568	1	52	**21.0** ± 13.1
						3.3	**2628**			**19 ± 2**

Additionally, 7.3% sires failed completely (i.e. no calves sired) in any given breeding season.

No obvious phenotype associated with the bulls that sired no offspring

# of calves born/bull – Fall 2009 calving

Ranch 1 single season calf output per bull



Van Eenennaam Alturas 2/2012

Calf output was moderately repeatable, and correlated with Scrotal Circumference EPD

Using the 20 bulls that were in use for 2 or 3 breeding seasons (Figure 2), on Ranch 1 and 2 calculated the repeatability of 5 traits between their 1st and 2nd breeding season.

Repeatability

- total adjusted weaning weight r=0.50
- number of calves r=0.50
- mean adjusted weaning weight=0.675

Also analyzed calf output repeatability between the same bulls from the single Fall calving group on Ranch 3 in years 1 and 2 (Figure 3).

Repeatability

- number of calves r=0.33

Sire output as total adjusted weaning weight and number of calves were not well correlated to Angus Association growth EPDs but had moderate correlation to scrotal circumference EPDs (r=0.42 & 0.38; n=5), respectively.

BUT DOES IT PAY?

Modeled the savings from using DNA information to cull non-prolific bulls

Assumptions

- Bulls used for 4 years (bought at 18 months of age, used until culled for age at 5 ½ years old)
- Average prolificacy of bulls which do produce calves: 20 ± 2 calves/bull (i.e. average prolificacy across the battery is 18.6 calves/bull)
- Percent of bulls which produced no calves: 7%
- 1 breeding season per year
- Bull premature death rate: 1%
- Bull injury rate: 3%
- Average age at injury: 4 years
- Annual vet costs: $75/year, $25 if bull died prematurely mid-year
- Salvage value
  - Non-injured $2000
  - Injured $1000
- Cost of trucking bull to sale: $50
- Selling commission: $20

What was modeled?

- Paterity test
  - Performed once on the entire bull battery (all bulls and calves tested)
  - Paternity test price (/head): $10, $15, or $20
  - Bulls are not replaced if they are culled for poor prolificacy
- Bull Purchase price: $3500, $4500, or $5500
- Annual feed costs per bull: $425, $525, or $625
- Bulls sired an average of 20 calves per year

Bull costs

In a herd with 7% of bulls consistently producing no calves and the rest of the bulls producing 20 calves/calf crop on average:

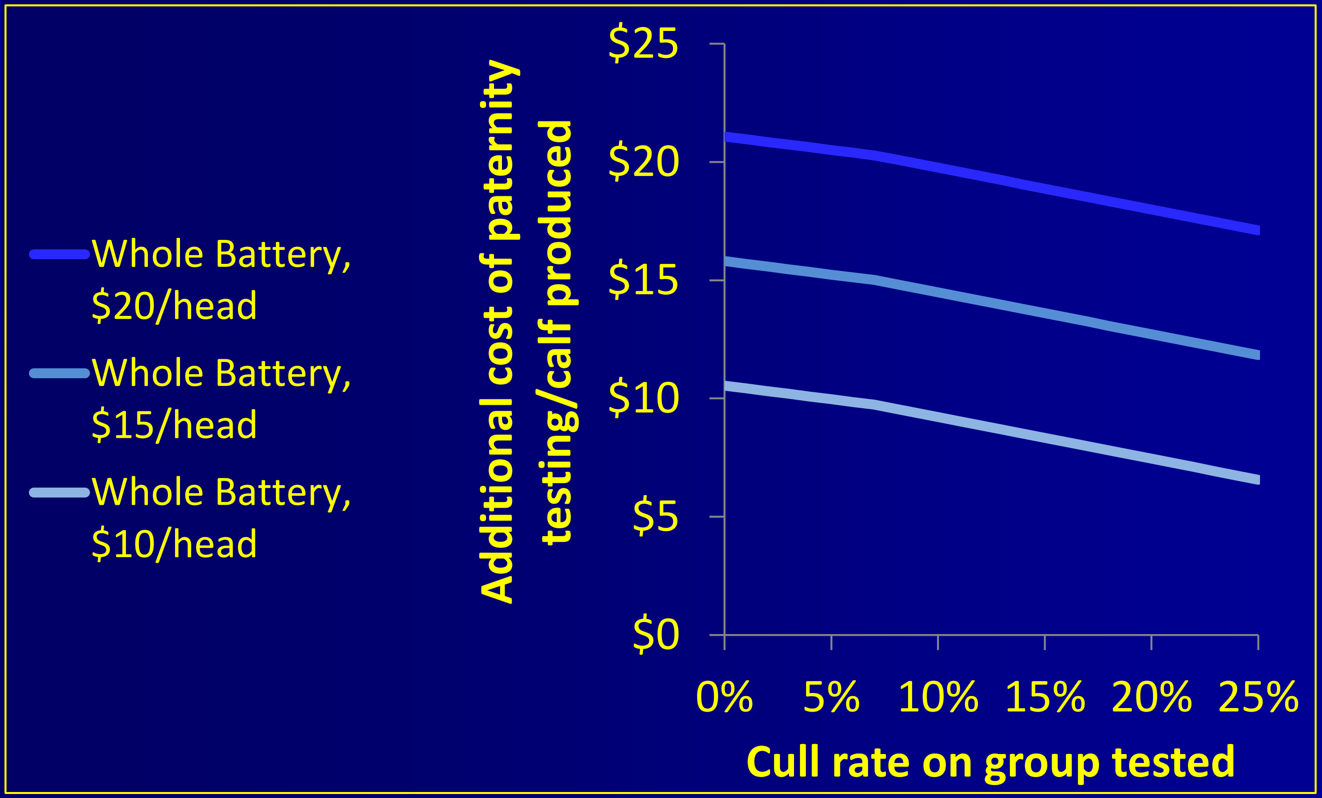
The average bull will be used 3.94 years (3 years, 11 months) and produce a total of 73 calves over his productive life.

Bull Purchase Price	Annual Feed Costs/ Bull	Average Lifetime Bull Costs (Total)	Average Lifetime Bull Costs/ Calf Produced
$3500	$425	$3,583.18	$48.96
$3500	$525	$3,976.71	$54.33
$3500	$625	$4,370.25	$59.71
$4500	$425	$4,583.18	$62.62
$4500	$525	$4,976.71	$68.00
$4500	$625	$5,370.25	$73.37
$5500	$425	$5,583.18	$76.28
$5500	$525	$5,976.71	$81.66
$5500	$625	$6,370.25	$87.04

Additional cost of paternity testing

In a herd with

- **7% of bulls consistently producing no calves**
- **The rest of the bulls producing 20 calves/calf crop on average**
- **Purchase price $3500 - Average annual feed costs $425**



For cull rates up to 25% (1 in 4 bulls tested) and paternity tests costing $10-$20/head, the cost of testing is always greater than the $ saved by culling low prolificacy bulls

What does it take to make paternity testing pay?

Assumptions:

- 7% of zero prolificacy bulls
- Other bulls producing 20 calves/calf crop on average
- Purchase price $4500
- Paternity test price $15/head
- Testing the whole battery and all calves once

Annual Feed Costs/Bull	Cull rate to reach break-even
$425	87.5%
$525	77.0%
$625	68.8%
$825	55.6%

What paternity test price would it take to reach break-even at 7% and 25% cull rates?

Cull Rate	Annual Feed Costs/Bull	Paternity Test Cost/head
7%	$425	$0.76
	$525	$0.89
	$625	$1.01
	$825	$1.28
25%	$425	$4.05
	$525	$4.62
	$625	$5.18
	$825	$6.32

There are other advantages of DNA-based paternity testing

The use of multi-sire breeding pasture is desirable because:

- Higher fertility
- Elimination of sire failure
- Tighter calving season

- Reduces the need for different breeding pastures
  - Allows for better pasture management
  - Less sorting and working of animals into different groups

DNA testing enables

- Can use it determine which bull is causing calving problems
- Enables the development of commercial-ranch genetic evaluations

Summary and some learnings along the way

1. **Bulls produced average of 19 calves (large variation)**
   - **Calf output was moderately repeatable (~0.33-0.5)**
   - **Prolific bulls tended to remain prolific, low tended to stay low**
2. **7% of bulls had no calves – 1 in 14**
3. **Do not use yearling bulls in with older bulls - older bulls will be dominant and chance of injury goes up**
4. **Heifer bulls (low CED) often ended up as mature cow bulls despite having been selected on CED!!**
5. **There are few EPDs for selection on reproduction**
6. **Crossbreeding still works! And would be expected to improve reproduction traits also**
7. **Paternity testing on commercial ranches for sire failure needs to be inexpensive to be cost-effective**

USDA Integrated Grant Collaborators "Integrating DNA information into Beef Cattle Production Systems"

Producer Collaborators:

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- Dale, Greg, and Richard Kuck, Kuck Ranch, Siskiyou County, CA
- Matt Parker, Mole-Richardson Ranch, Siskiyou County, CA

Processor Collaborators:

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- Los Banos Abattoir, Los Banos, CA

Graduate Students

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Other Contributors/Collaborators

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- Dr. Mike Goddard, University of Melbourne and Victorian DPI, Australia
- Dr. Darrh Bullock, Extension Professor, University of Kentucky, KY
- Dr. Leslie "Bees" Butler, Extension Marketing Specialist, UC Davis, CA
- Dr. Daniel Drake, University of California Cooperative Extension Livestock Advisor, CA
- Dr. Dorian Garrick, Professor, Iowa State University, IA
- Dr. John Pollak, US Meat Animal Research Center, Clay Center, NE
- Dr. Mark Thallman, US Meat Animal Research Center, Clay Center, NE

Software Collaborators:

- Jim Lowe, Cow Sense Herd Management Software, NE

Questions?

United States Department of Agriculture

National Institute of Food and Agriculture

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Integrated Program for Reducing Bovine Respiratory Disease in Beef and Dairy Cattle

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Bovine Respiratory Disease Complex
Coordinated Agriculture Project

USDA United States Department of Agriculture National Institute of Food and Agriculture

The "Integrated Program for Reducing Bovine Respiratory Disease Complex (BRDC) in Beef and Dairy Cattle" Coordinated Agricultural Project is supported by Agriculture and Food Research Initiative Competitive Grant no. 2011-68004-30367 from the USDA National Institute of Food and Agriculture.

Bovine Respiratory Disease Complex
Coordinated Agriculture Project

Background and Rationale

"Year in and year out, diseases of the respiratory system are a major cause of illness and death in cattle from 6 weeks to two years of age. Sadly, this is as true today as it was 30 years ago despite development of new and improved vaccines, new broad spectrum antibiotics, and increased fundamental knowledge as to the cause of disease"

- Bovine Respiratory Disease (BRD) has been extensively studied since the 1800s, and yet it remains prevalent
- More effective vaccines have not decreased the morbidity or mortality of BRD
- Mortality has increased as vaccine efficiency has increased
- 1.4% of all US feedlot cattle perish before reaching harvest weight
- **Need to develop new approaches to tackle BRD**

Montgomery, D. 2009. Bovine Respiratory Disease & Diagnostic Veterinary Medicine. Proceedings, The Range Beef Cow Symposium XXI. December 1, 2 and 3 2009, Casper, WY. Pages 1-6.

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BRD Coordinated Agricultural Project

Long-term goal is to reduce the incidence of BRD in beef and dairy cattle by capitalizing on recent advances in genomics to enable novel genetic approaches to select for cattle that are less susceptible to disease

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Coordinated Agriculture Project

Potential benefits of genomics are greatest for economically-important traits that:

- Are difficult or expensive to measure
- Cannot be measured until late in life or after the animal is dead
- Are not currently selected for because they are not routinely measured
- Have low heritability

Yep, looks like all of 'em were susceptible

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Disease resistance is a very attractive target trait for genetic improvement

- The presence of genetic variation in resistance to disease, coupled with the increased consumer pressure against the use of drugs, is making genetic solutions to animal health problems increasingly attractive.
- The non-permanent effectiveness of chemical agent (due to development of resistance by the pathogen) further contributes to this interest.

Newman, S. and Ponzoni, R.W. 1994. Experience with economic weights. Proc. 5th World Congress on Genetics Applied to Livestock Production. 18:217-223.

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Other animal industries have successfully targeted selection for disease resistance

- In dairy cattle, selection programs have been developed to take advantage of genetic variability in mastitis resistance, despite the fact that the heritability of clinical mastitis is low and mastitis resistance has an adverse correlation with production traits
- Likewise chicken breeders have long used breeding to improve resistance to avian lymphoid leucosis complex and Marek’s disease

Stear, M. J., S. C. Bishop, B. A. Mallard, and H. Raadsma. 2001. The sustainability, feasibility and desirability of breeding livestock for disease resistance. Res Vet Sci 71: 1-7

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Need for large discovery populations

- The ready availability of dense single nucleotide polymorphism arrays (i.e. 700 K SNP chips) has given rise to hitherto unforeseen opportunities to dissect host variation and identify possible genes contributing to this variation using genome wide association studies
- To have the power to meaningfully quantify genetic variation or perform a genome scan using a dense SNP chip it is necessary to have datasets comprising observations **on several thousands of individuals**.

Bishop, S. C., and J. A. Woolliams. 2010. On the genetic interpretation of disease data. Plos One 5: e8940.

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What is needed to develop DNA-tests for BRD susceptibility?

Large training/discovery populations with BRD observations and SNP genotypes = used to estimate the value of every chromosome fragment contributing variation BRD susceptibility. This allows for prediction of which chromosome segments regions are important for the trait.

Prediction equation = the results of training can then be used to predict the genetic merit of new animals, not contained in the training data set

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Need for careful "case" definition

- For studies of infectious diseases this usually necessitates utilizing field data because challenge experiments of a sufficient scale will not be possible.
- However, such field data is very 'noisy'
  - diagnosis of infection or disease may be imprecise; it can be difficult to determine when infection of an individual occurred
  - it is often unclear whether or not apparently healthy individuals have been exposed to the infection
- These factors add environmental noise to the epidemiological data.

Bishop, S. C., and J. A. Woolliams. 2010. On the genetic interpretation of disease data. Plos One 5: e8940.

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Accurate diagnosis (i.e. case definition) of BRD is critical for success of studies

- Traditional methods for detecting morbid cattle include visual appraisal once or twice daily.
- Animals displaying nose or eye discharge, depression, lethargy, emaciated body condition, labored breathing or a combination of these, should be further examined
- Symptomatic animals with a rectal temperature ≥ 103°F are usually considered morbid and given treatment.
- All of these diagnostic systems are **subjective in nature**.
- Confounding factors include the diligence and astuteness of those checking the animals, the variability and severity of the symptoms the animals experience with chronic and acute BRD, and the disposition of the animals

BRD CAP: BRD field datasets

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Case:control field datasets are being developed for bovine respiratory disease

- 6000 animals – case:control design
  - 2000 dairy calves diagnosed on a collaborating dairy calf rearing ranch (CA)
  - 2000 feedlot cattle diagnosed on a collaborating feedlot (TX)
  - 1000 dairy (NM) and 1000 beef (NV) case:control animals will be used to validate loci associated with BRD in the discovery populations
- All will be genotyped on 700K high density SNP chip

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Year 1: CA Dairy Calf Ranch: 70,000 head capacity

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California Animal Health and Food Safety Laboratory System

Photo credit: Jessica Davis

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Standardization of BRD Diagnosis

- 1000 case and 1000 control 30-60 day old calves
- Use Dr. Sheila McGuirk's calf respiratory scoring chart
  - Temperature, eyes, ears, nose, +/- cough
  - Additional clinical signs: tachypnea, dyspnea, position of head, appetite
  - Give score and either enroll or not (5 or greater to enroll as case)
- Sample collection
  - Blood for DNA extraction and high density SNP genotyping
  - Nasal swab and deep pharyngeal swab to identify viruses (PCR: IBR, BVD, BRSV, and Corona) and bacteria (*Manheimia haemolytica, Pasteurella multocida*, and *Histophilus somni*, and Mycoplasma spp.) present in the nasopharyngeal and pharyngeal recesses

http://www.vetmed.wisc.edu/dms/fapm/fapmtools/8calf/calf_health_scoring_chart.pdf

Calf Health Scoring Criteria

0	1	2	3
Rectal temperature			
100-100.9	101-101.9	102-102.9	≥103
Cough			
None	Induce single cough	Induced repeated coughs or occasional spontaneous cough	Repeated spontaneous coughs
Nasal discharge			
Normal serous discharge	Small amount of unilateral cloudy discharge	Bilateral, cloudy or excessive mucus discharge	Copious bilateral mucopurulent discharge

0	1	2	3
Eye scores			
Normal	Small amount of ocular discharge	Moderate amount of bilateral discharge	Heavy ocular discharge

0	1	2	3
Ear scores			
Normal	Ear flick or head shake	Slight unilateral droop	Head tilt or bilateral droop

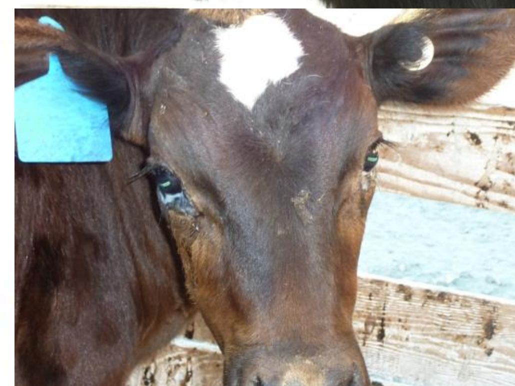
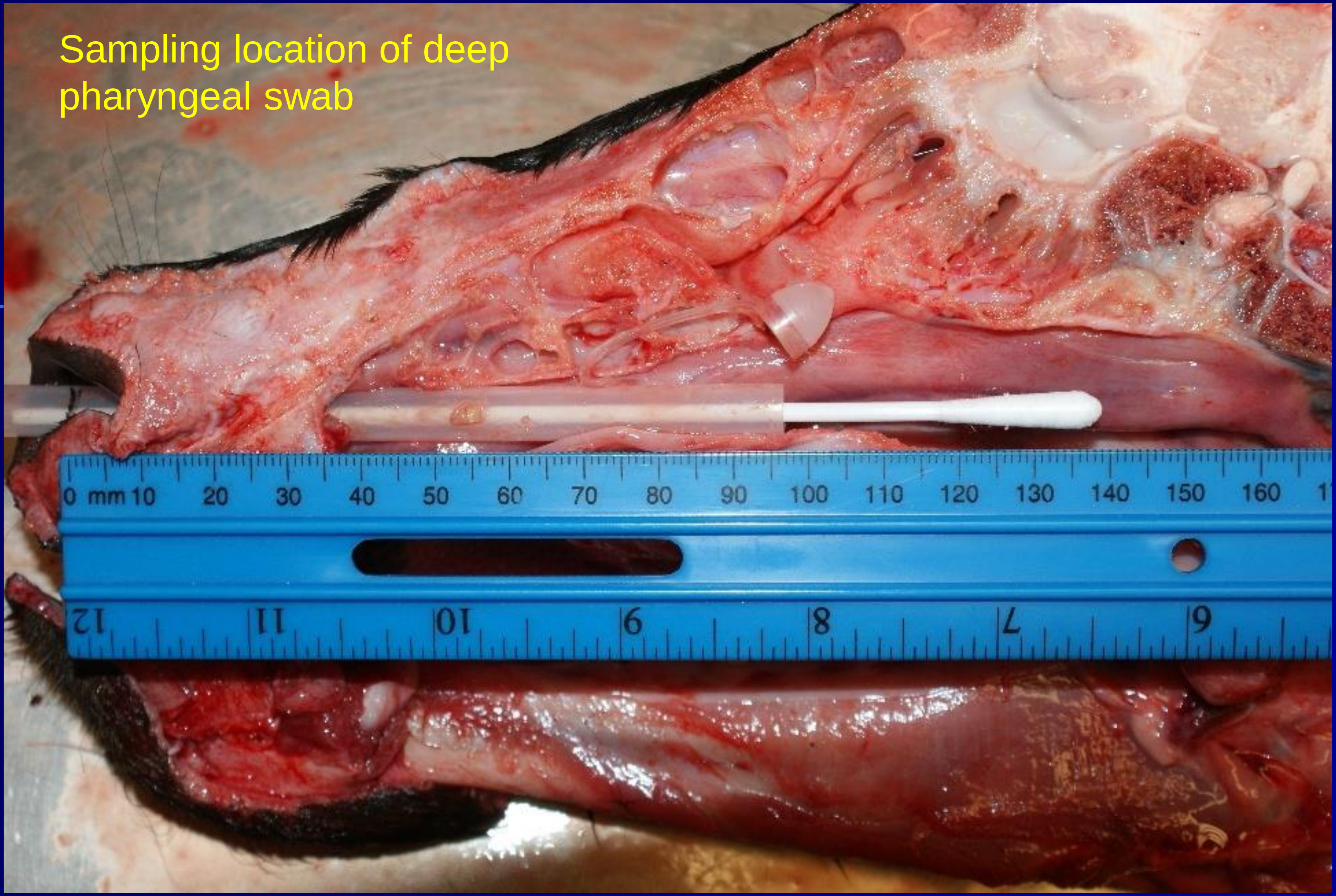


Photo credit: Jessica Davis



To culture organisms associated with BRD, pharyngeal swabs offer a less invasive, less stressful and more rapid alternative to broncheoalveolor lavage.

Photo credit: Jessica Davis

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Controls

- Score control in same way as cases (score of 4 or less)
- Try to select animals in the adjacent hutch, same dairy of origin, and same sex
- Collect samples for control animals in same was as case

Objective: Try to identify cases and controls in a relatively constant environment, subjected to the same exposure and stresses, to decrease the environmental "noise" of these field BRD datasets

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Year 2: TX Feedlot Gonzalez, Texas

Sample collection (1000 case and 1000 controls) scheduled to be completed by 3/2013 and analysis of genotype data completed by 12/31/2014

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BRD Coordinated Agricultural Project

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BRD Coordinated Agricultural Project

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www.brdcomplex.org

http://www.brdcomplex.org/

About

Bovine Respiratory Disease Complex

Coordinated Agricultural Project

BRD Complex — Facts | Prevention — What you can do | Education — Teaching Materials | Links — Resources | About — Our Research

We are a collaborative group of researchers whose goal is to reduce the prevalence of bovine respiratory disease complex in beef and dairy cattle for the improvement of animal welfare and profitability. The "Integrated Program for Reducing Bovine Respiratory Disease Complex (BRDC) in Beef and Dairy Cattle" Coordinated Agricultural Project is supported by Agriculture and Food Research Initiative Competitive Grant no. 2011-68004-30367 from the USDA National Institute of Food and Agriculture. Our project is led by Dr. James Womack of Texas A&M University and includes scientists and educators from the University of California-Davis, Colorado State University, the University of Missouri, New Mexico State University, Washington State University and USDA's Agricultural Research Service.

USDA NIFA

United States Department of Agriculture
National Institute of Food and Agriculture

Research Plan (PDF 6MB)

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Calendar of Events (PST)

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