

# IDENTIFICATION AND MANAGEMENT OF ALLELES IMPAIRING HEIFER FERTILITY WHILE OPTIMIZING GENETIC GAIN IN CATTLE

USDA-NIFA Award #2013-68004-20364

JF Taylor, DS Brown, MF Smith, RD Schnabel,  
SE Pooock, JE Decker, FD Dailey, and DJ  
Patterson  
**University of Missouri**



AL Van Eenennaam  
**University of California, Davis**

MM Rolf  
**Oklahoma State University**

BP Kinghorn  
**University of New England, NSW, Australia**

MD MacNeil  
**Miles City, MT**



# Broken Genes...



- ~100 genes where one copy is functional and the other is broken
- ~20 genes where the broken copy is a lethal mutation
- Called Loss of Function mutations



# Broken Genes...





# Broken Genes...

What happens when a broken gene is inherited from the father and the mother?

- Genetic abnormality
- Spontaneous abortion



# Broken Genes...

## Inconvenient Genetic Truth

- Everybody has genetic defects!!!



Even the  
most  
beautiful  
people in the  
world





# Broken Genes...



23andMe



# Broken Genes...

What happens when a broken gene is inherited from the *sire* and the *dam*?

- Genetic abnormality
- Spontaneous abortion



# Broken Genes...

- Some we know about
- Some we don't

## KNOWN

100% genetic defect free PRODUCTION oriented CALVING EASE bulls, that won't leave you short handed in terms of PHENOTYPE and MUSCLE



Even the most beautiful *cattle* in the world





# Genetic Defects

- There are more than 35 genetic defects in cattle with a DNA test



# Silver Lining





# Silver Lining

- DNA tests can now be developed in a few months
- With DNA tests available, frequency of the known genetic defect rapidly decreases
- Now we can *manage* genetic defects



# The Truth

## **BEEF**<sup>®</sup>

**The Truth: Every Living Thing Is A  
Genetic Defect Carrier**



# What to do before breeding

- Test at-risk breeding stock for genetic defects
  - Do we know the pedigree of the animals?
  - Are there carriers in the pedigree?



# What to Do with an Abnormal Calf

- Take a picture or video of affected calves
- Freeze the entire animal if possible, otherwise preserve the abnormal body part
- Obtain 40 hair bulbs from the calf, dam, and sire



# What to Do with an Abnormal Calf

- Create a documented record of what happened
- Breeders should contact their breed association and local veterinarian
- Need intensive description of phenotype
- The majority of abnormalities are caused by the environment, not genetics



# Broken Genes...

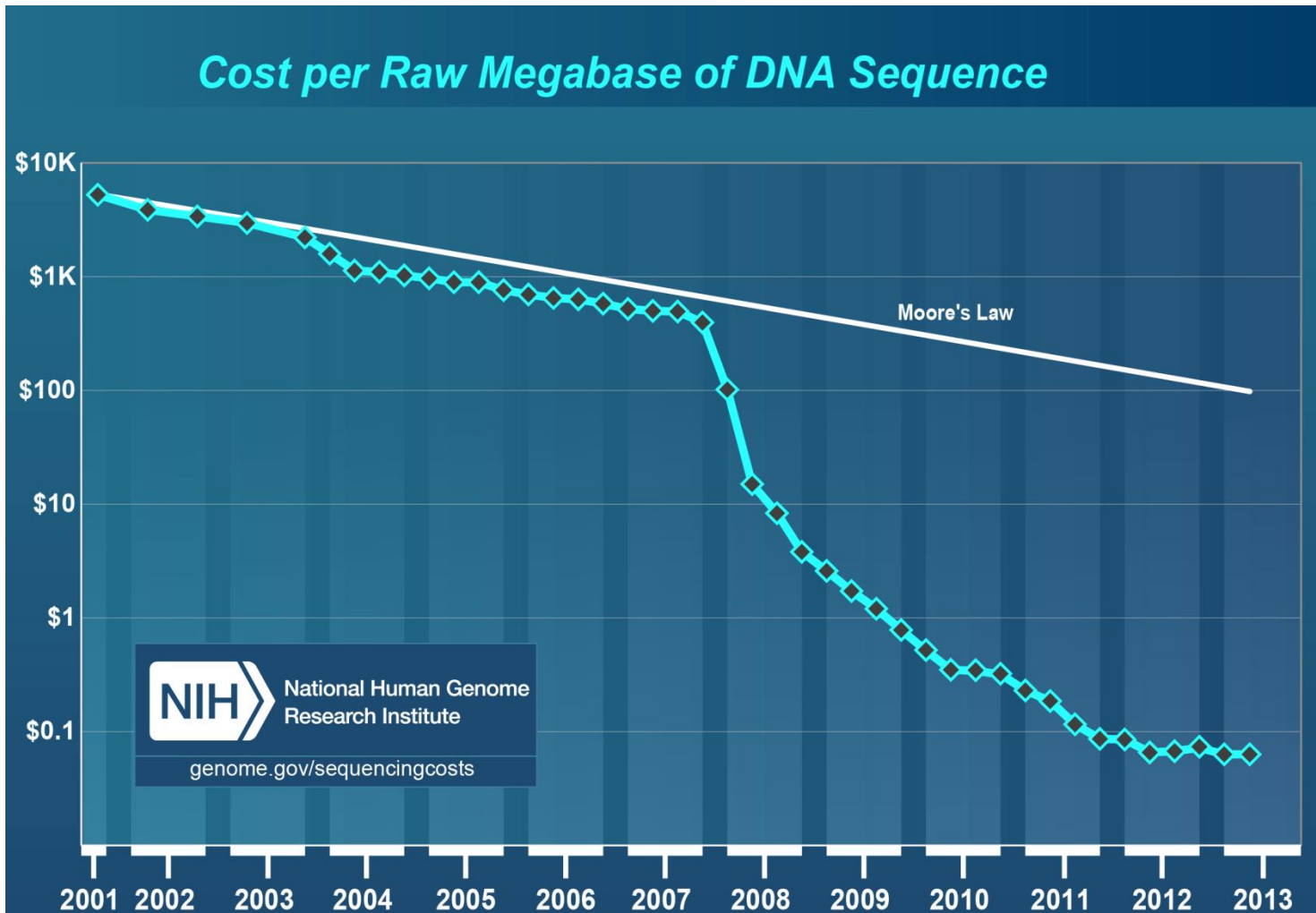
What happens when a broken gene is inherited from the *sire* and the *dam*?

- Genetic abnormality
- ***Spontaneous abortion***





# DNA Sequencing





# Variants Reducing Fertility

- We will be sequencing 150 sires from 9 different breeds
- We will discover hundreds of broken genes
- Most embryonic lethals



# Variants Reducing Fertility

- Sequencing completed to date:

Angus	45
Hereford	9
Limousin	10
Beefmaster	9



# Variants reducing Fertility

- We have already analyzed the genomes of 11 bulls



# Variants reducing Fertility

- We have already analyzed the genomes of 11 bulls
- Identified 176 possibly lethal alleles



# Validation





# Validation





# Genomic Prediction

- Predictions are sums of marker effects
- For lethal mutations
  - Homozygous normal: effect is 0
  - Heterozygous lethal: effect is  $-q_i f$
- Allows publication of a fertility EPD





# Mate Selection Software

- Avoid mating carriers of the same lethal mutation
- Will also manage
  - Genetic merit
  - Genetic diversity
- Built upon economic selection indexes





# The Old Paradigm

- See abnormal calf
- Bury calf



# The Current Paradigm

- Report abnormal calves
- Collect data
- Create a test
- Manage the defect



# The Genomics Paradigm?

- Sequence influential AI sires
- Create tests for LOF mutations
- Manage the mutations while accounting for overall genetic merit



# Optimal practices





**Thank  
You!**

**Questions?**

<http://steakgenomics.blogspot.com>