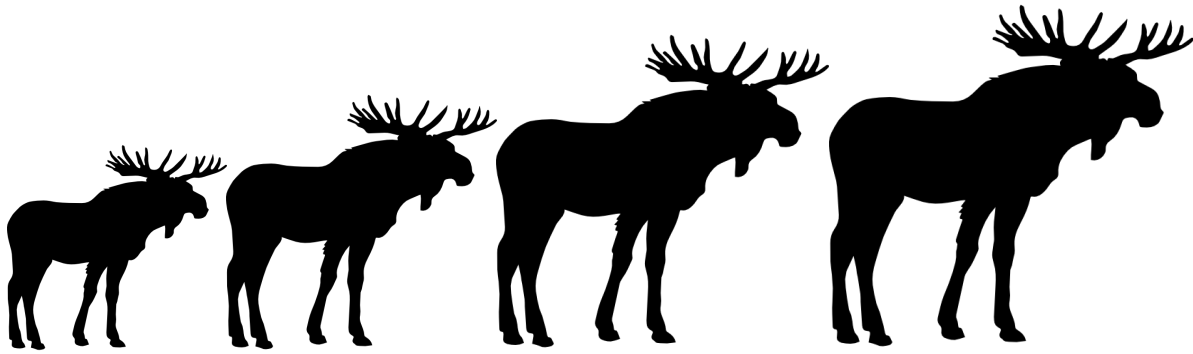


The perfect moose



How large should a moose be? Like some of the other animals we have seen one plausible goal is to maximize the net energy intake. We've seen earlier that the size of the rumen limits how much food a moose can ingest, and that the energy required is a nonlinear function of the moose weight.

We begin with the sodium intake requirement = unit sodium requirement × moose weight

The energy from the aquatics is = (unit sodium requirement × moose weight) × **cropping time coefficient** × ((aquatic caloric content × digestibility – cropping cost)/aquatic bulk coefficient)

This will require space in the rumen = aquatic bulk coefficient × unit sodium requirement × moose weight

The space left for terrestrial food is = total rumen capacity – (aquatic bulk coefficient × unit sodium requirement × moose weight)

The resulting energy supplied by the terrestrials is = (total rumen capacity – (aquatic bulk coefficient × unit sodium requirement × moose weight)) × (terrestrial caloric content × digestibility – cropping cost)/terrestrial bulk coefficient

Putting it all together, the energy intake is then = (unit sodium requirement × moose weight) × cropping time coefficient × ((aquatic caloric content × digestibility – cropping cost)/aquatic bulk coefficient) + (total rumen capacity – (aquatic bulk coefficient × unit sodium requirement × moose weight)) × (terrestrial caloric content × digestibility – cropping cost)/terrestrial bulk coefficient

Substituting the numerical values for the constants in this expression and simplifying gives:

$$E_{in} = 26,806 \log_{10} W - 44,356 - 20.4W$$

The energy requirement for a bull is $140W^{0.75} = E_{out}$

Combining these two expressions gives us the net energy intake for a bull¹:

= Energy intake - Energy expenditure

$$E = (26,806 \log_{10} W - 44,356 - 20.4W) - 140W^{0.75}$$

So what moose weight will maximize the net energy intake?

$$\frac{dE}{dW} = 26,806 \frac{1}{W \ln 10} - 0 - 20.4 - 140 \cdot 0.75 W^{-0.25}$$

$$= \frac{26,806}{\ln 10} \cdot \frac{1}{W} - 20.4 - \frac{140(0.75)}{W^{1/4}} \stackrel{!}{=} 0$$

$$= \frac{26,806}{\ln 10} - 20.4 W^{4/4} - 140(0.75) W^{3/4} \stackrel{!}{=} 0$$

$$= -20.4 (W^{1/4})^4 - 140(0.75) (W^{1/4})^3 + \frac{26,806}{\ln 10} \stackrel{!}{=} 0$$

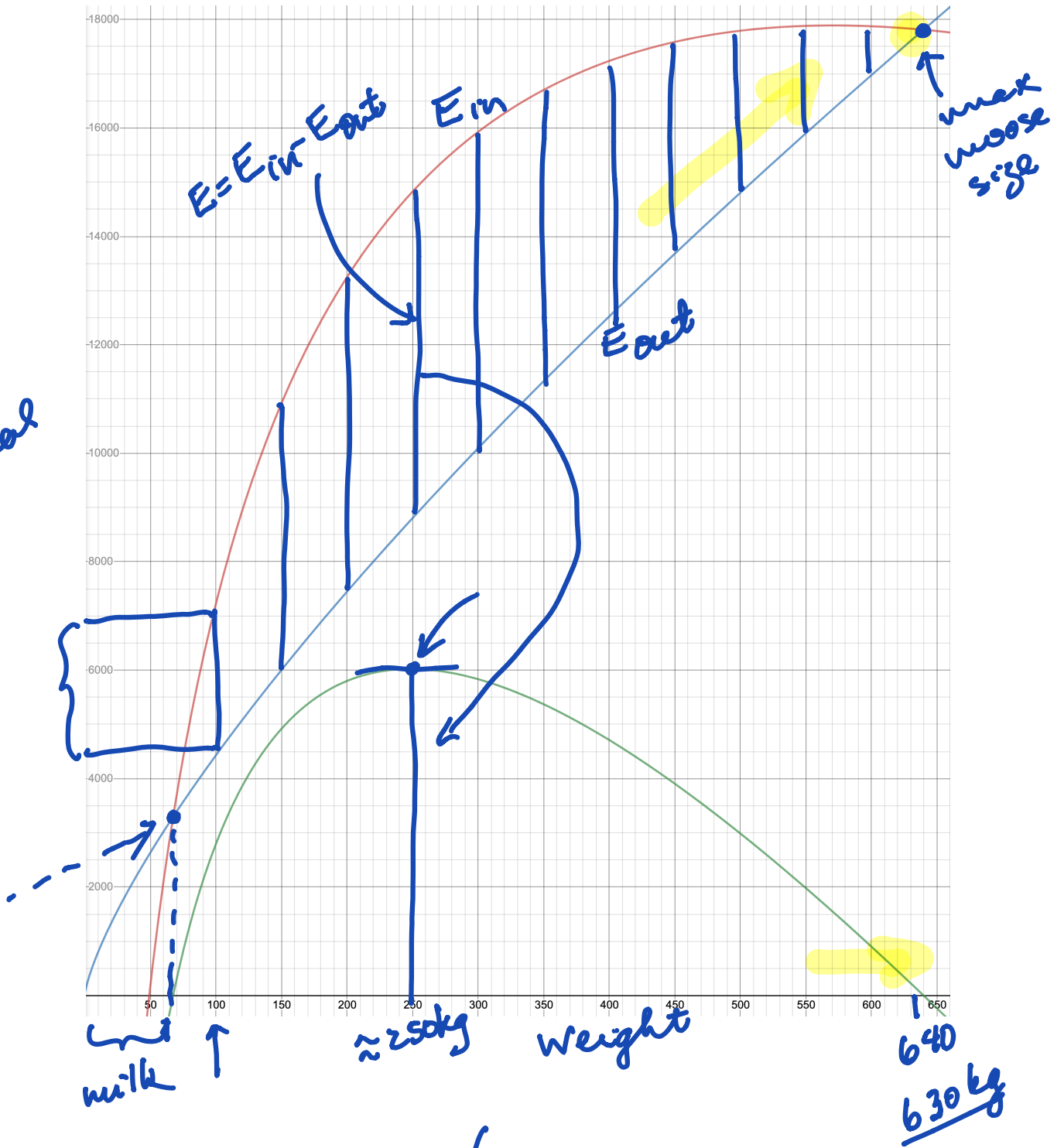
$a \cdot x^4 - b \cdot x^3 + c = 0$

quartic equation.

¹ Substituting the values for a cow gives the similar formula,

$$\text{Net energy intake} = (32,167 \log_{10} W - 59,361 - 20.4W) - 189W^{0.75}$$

kCal



Cow Moose ✓
 young " ✓
 mat " ✓
 Bull Moose x