Exploration of harvest strategies for the Bluenose East caribou herd:
Plain Language Summary (J. Adamczewski & J. Boulanger, based on Boulanger 2013)

Background:
The Bluenose-East caribou herd was surveyed in 2010 by GNWT ENR and found to have at least 100,000 caribou at least one year old (Adamczewski et al. 2012), with an increasing trend and generally good calf recruitment. Given severe harvest restrictions on the Bathurst herd, there was considerable interest from hunters in the south-central NWT in hunting this herd. ENR asked statistician John Boulanger to carry out initial modeling of harvest for this herd, to help define a range of harvest options – numbers and sex ratio – that might be acceptable for this herd, depending on management objectives. This modeling is meant to complement a draft management plan for the Cape Bathurst, Bluenose-West and Bluenose-East herds from the ACCWM (2011) by providing additional guidance on how various levels and sex ratio of harvest might affect the herd, depending on its size and trend.

The modeling builds on previous harvest modeling for the Bathurst herd (Boulanger and Adamczewski 2010) and preliminary Bluenose-East modeling in fall 2012 (Boulanger 2012). A larger set of model runs was carried out by J. Boulanger in March 2013 (Boulanger 2013), based on the July 2010 post-calving population estimate of 122,000. This summary describes the main results of the more recent modeling.

Modeling of likely trend in a caribou herd with various levels of harvest should not be thought of predicting the future. Many factors affect caribou herds, including weather in all seasons, which cannot be predicted. The modeling is meant to address this type of question: *Under a certain set of conditions, including harvest of a certain size and sex ratio, what is the likeliest trend for the caribou herd?*

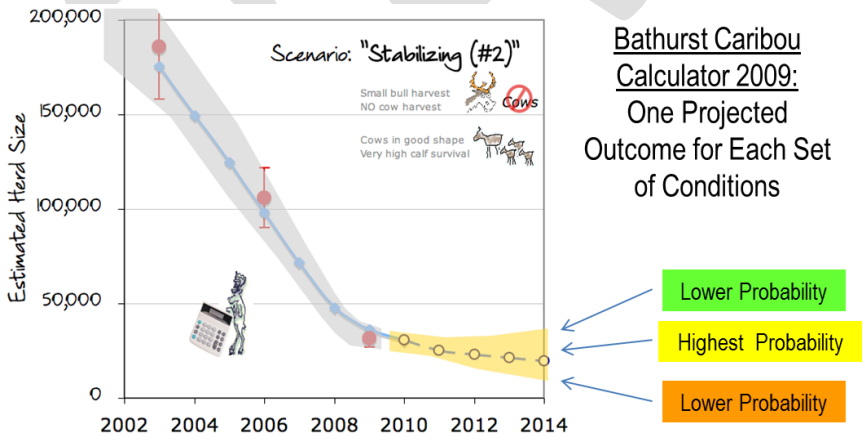

Fig. 1. An example of a deterministic population model for the Bathurst herd in 2009. The triangular shape was added to show that a herd's future is always variable, with the modeled outcome (line) as potentially the highest probability but with higher or lower outcomes possible.

Harvest modeling for the Bathurst Caribou Herd:
In workshops and reports on the decline of the Bathurst caribou herd in late 2009 and early 2010, Environment and Natural Resources (ENR) used population projections from the Bathurst Caribou Calculator, a spreadsheet model first built for the Porcupine caribou herd, to look ahead and assess likely trend for the Bathurst herd under various sets of conditions. In particular, the modeling allowed us to

consider how various levels of hunter harvest would likely affect the herd. This model is "deterministic", which means that it projects the herd's population trend as a single "determined" line with a single population estimate at any point (dotted line from 2009 to 2014; Fig. 1).

In the real world, weather, calf survival, and other variables change from year to year, and there is uncertainty. ENR asked modeller/statistician John Boulanger to look at the Bathurst herd's possible futures using a "stochastic" model. Instead of a single projection for the herd, the model was run hundreds of times for each set of conditions, with each model run having a different set of calf survival, cow survival, and other numbers changing from year to year, within known ranges for these variables. "Stochastic" essentially means that some random variation year to year is allowed for, and the outcome is a range of possibilities. For any set of conditions, the outcome is a projected population size, but there are in effect many lines and possible herd sizes over time. These can then be grouped and the percentage of lines in each category can be added up.

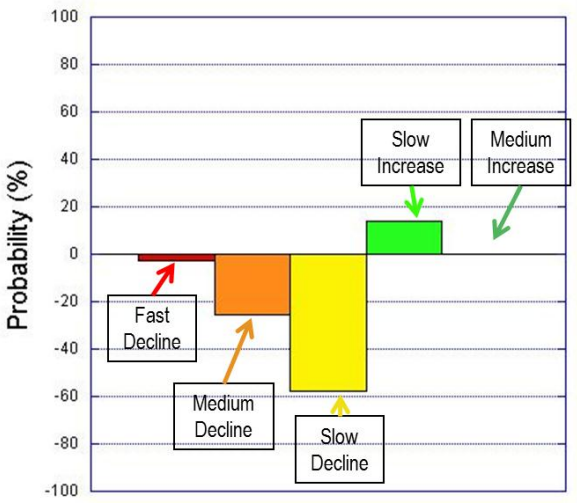

Fig. 2. An example of a stochastic set of population runs for the Bathurst herd in 2010. The likeliest outcome in this case, for these conditions, was a slow decline, but there was a low probability of slow increase and a chance of more rapid decline.

For each set of conditions, one or two of these categories were the most likely outcomes, with fewer outcomes in the other categories. These can then be interpreted as the probability of the herd following each of these trends. In the example above (Fig. 2), the most likely outcome is a slow decline, and little chance of a medium increase or rapid decline. For clarity, probabilities of decline are shown projecting down (even though probabilities cannot actually be negative) and probabilities of increase are shown projecting up. If the probability of a slow increase and a slow decrease is about equal, then the herd will most likely be stable. In simplest terms, a graph with much red and orange suggests a strong chance of rapid decline, and a graph showing mostly green suggests a strong chance of increase. Results of this modeling were reported by Boulanger et al. (2011) and Boulanger and Adamczewski (2010) and used to assess what limited harvest might be taken from the herd while providing it with a strong chance to recover.

Harvest modeling for the Bluenose-East Caribou Herd: Preliminary Bluenose-East harvest modeling in fall 2012 was reported by Boulanger (2012). A larger set of model runs was carried out by J. Boulanger in March 2013 (Boulanger 2013), based on the July 2010 post-calving population estimate of

122,000 (Adamczewski et al. 2012). The modeling was carried out to assess likely effects of harvest of 1000, 2000, 3000, 4000, 5000 and 6000 caribou on this herd, while considering variation in harvest sex ratio and herd productivity. In this summary, 6-year projections are considered but longer and shorter projections are reported by Boulanger (2013). The categories of possible herd trend were[1]:

- rapid decline (herd less than 60,000);
- medium decline (herd 60,000-89,500);
- slow decline (herd 89,500-123,000);
- slow increase (herd 123,000-167,000); and
- medium increase (herd over 167,000).

The simulation model used in this study assumes similar cow survival rates between the Bluenose-East and Bathurst herds (with harvest removed) (Boulanger and Adamczewski 2010).

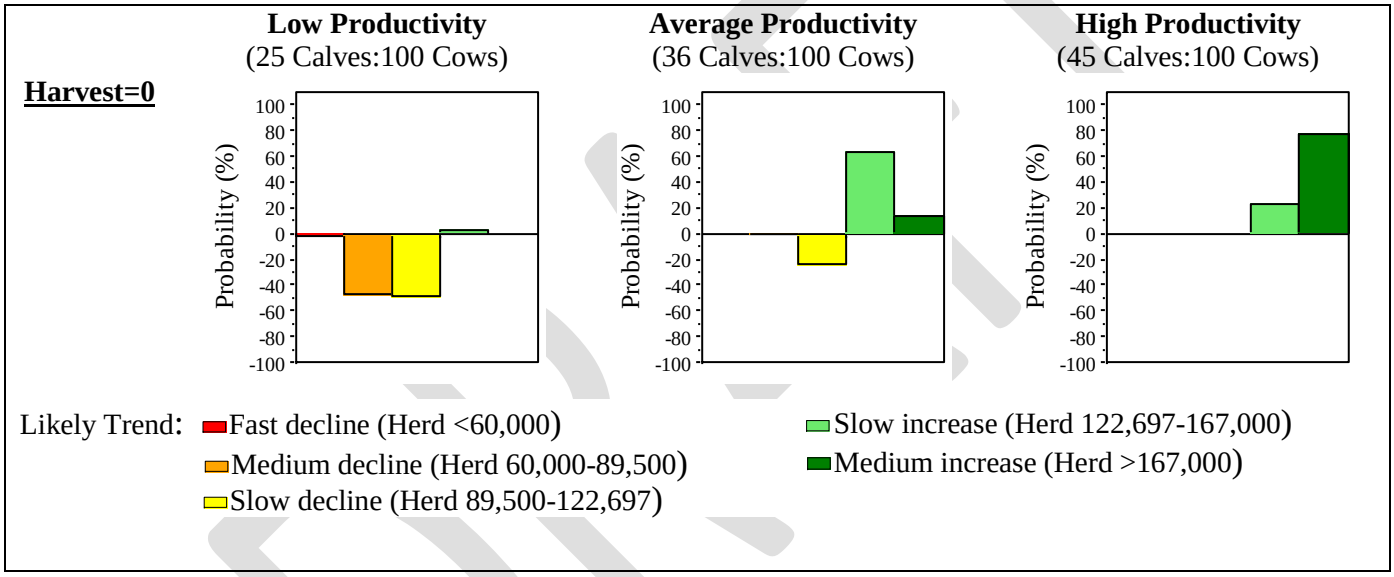

Fig. 3. Likely trend in the Bluenose-East herd with no harvest and varying calf productivity (6 years, 2010-2016)

Fig. 3 above shows likely trend for the Bluenose-East herd with no harvest and calf productivity (1) assuming a low value recorded for this herd in April 2012 would continue (25 calves:100 cows), (2) assuming calf productivity averaged for 2010-2012 would continue (36 calves:100 cows), and (3) assuming sustained high calf productivity (45 calves: 100 cows). This kind of sustained high productivity in NWT herds was last seen in the early 1980s when the herds were increasing rapidly. Even with no harvest, there is considerable variation in possible future trend for the herd. The sensitivity of herd trend to sustained low calf recruitment is apparent. As the herd has in recent years shown an increasing trend, the middle graph which shows a strong likelihood of continuing slow increase is the most realistic projection. Fig. 4 (next page) shows how harvest levels of 2000, 4000 and 6000 caribou, in each case with a sex ratio of 50:50 are likely to affect herd trend.

[1] The slow increase and slow decline outcomes would not be statistically detectable from successive post-calving herd size estimates, whereas faster increases or declines would be detectable.

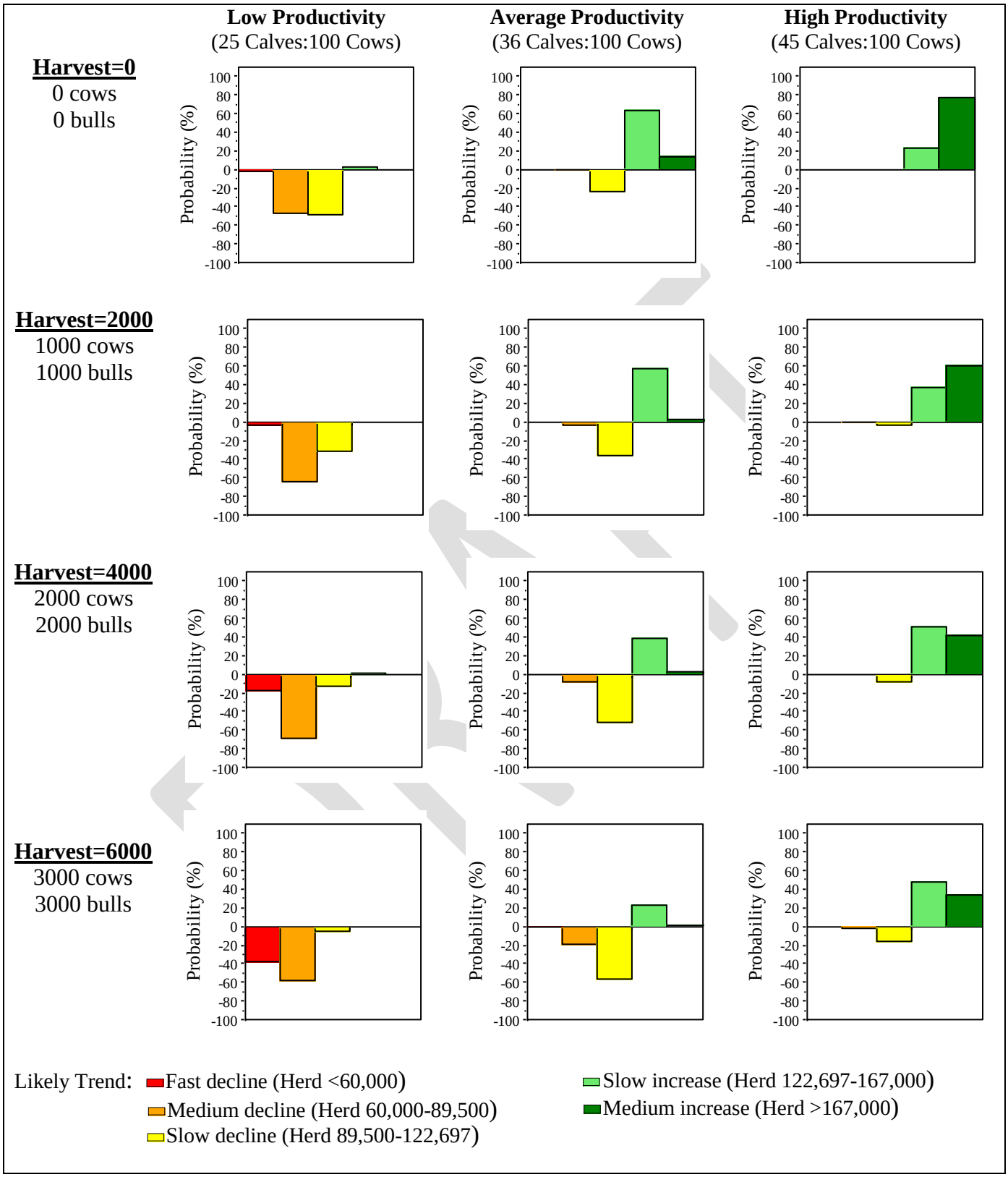

Fig. 4. Likely trend in the Bluenose-East herd with varying calf productivity and harvest of 2000, 4000, and 6000 caribou, each with sex ratio of 50% bulls.

A useful way to consider the results is to treat the No Harvest result as the "Base Case" and assess how the outcomes change compared to the base case. Comparing within columns shows how varying harvest alters the outcome while calf productivity is held constant; comparing within rows shows how changing calf productivity alters the outcome while harvest is held constant.

A harvest of 2000 caribou in a herd with average productivity changes the herd's likely trend little and a stable or slowly increasing herd is still likely. Harvest increasing to 4000 and 6000 increasingly shifts the probability toward a declining trend. Harvest of 6000 caribou is associated with about 80% probability of decline with average calf productivity. At sustained high calf productivity, the herd could sustain harvest of up to 6000 and continue to grow. The effects of harvest on herd trend are most pronounced if the herd has continued low productivity, with increased likelihood of rapid decline at harvest of 4000-6000.

Estimates of actual harvest from the Bluenose-East herd from all aboriginal harvester groups were approximately 3,500, 2,900 and 1,750 caribou in 2009-2010, 2010-2011 and 2011-2012, respectively. Sex ratio of the harvest was not always recorded but the harvest has likely been at least 2/3 cows as most of it occurs on the winter range, where cows are generally more available and preferred by hunters.

The effects of changing sex ratio in the harvest are demonstrated in Fig. 5 (below). At a harvest of 2000 caribou, a change in the sex ratio between 33% cows and 66% cows has little effect on likely herd trend. At harvest of 6000, however, and particularly at low calf productivity, increasing the cow harvest from 33% to 66% has a more pronounced effect: the probability of rapid decline increases to 50%.

Composite graphs showing harvest modeling results for harvest of 1000, 2000, 3000, 4000, 5000 and 6000 caribou from the Bluenose-East herd, with varying calf productivity and varying harvest sex ratio, are in the appendix (all from Boulanger 2013).

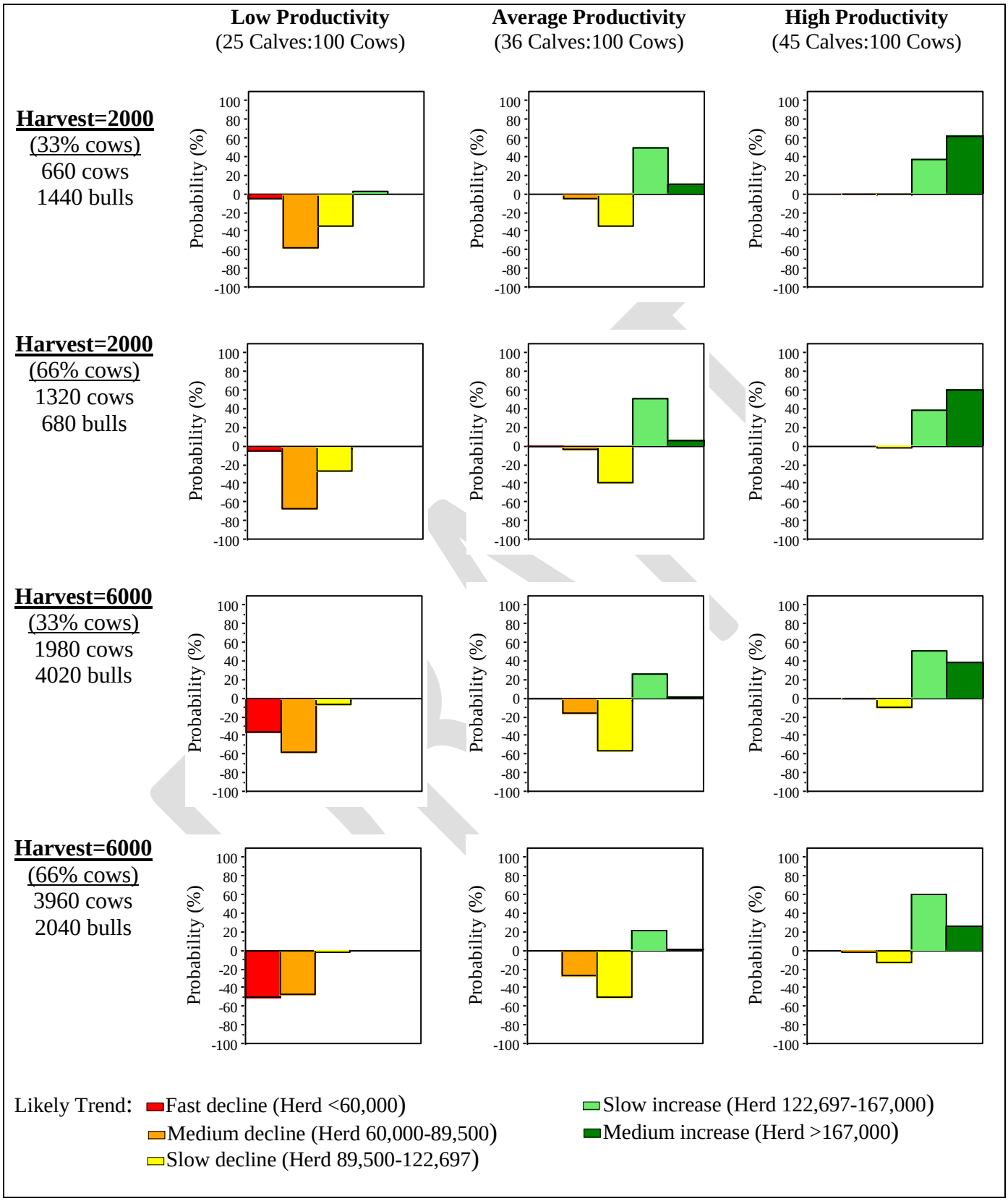

Fig. 5. Likely trend in the Bluenose-East herd with varying calf productivity and harvest of 2000 or 6000 caribou, with sex ratio varying between 33 and 66% cows.

Approaches to Management of Bluenose-East Caribou Harvest

Some general conclusions can be drawn about harvest of Bluenose-East caribou from the modeling; further details are in Boulanger (2013). These may assist in complementing the draft caribou management plan for the Bluenose-East, Bluenose-West and Cape Bathurst herds (ACCWM 2011).

1. The Bluenose-East herd numbered about 122,000 in 2010 and has had a positive trend since 2006, thus it can sustain some harvest without risk of rapid decline. However, calf recruitment from 2007 to 2012 showed a declining trend (Fig. 5). If this trend continues, the Bluenose-East herd may have a declining natural trend, which would be accelerated by any substantial harvest.

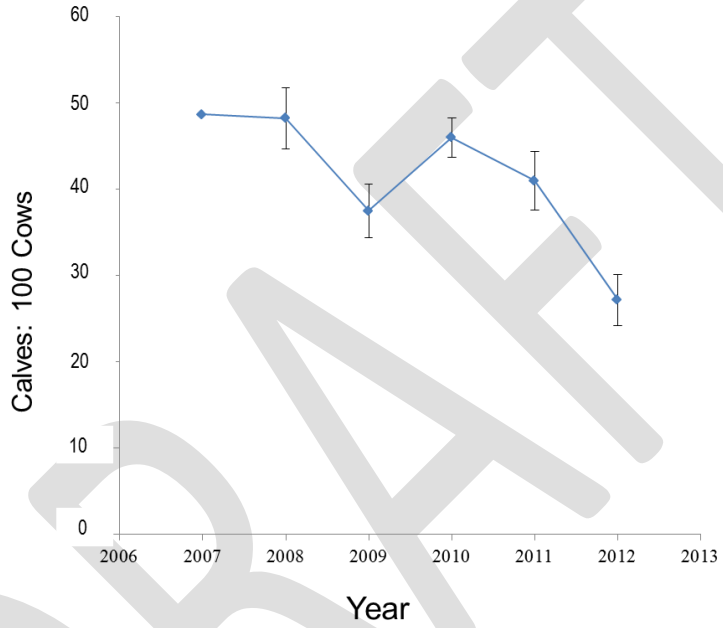

Fig. 6. Recent late-winter calf:cow ratios for the Bluenose-East herd 2007-2012. Sustained ratios below 30 calves:100 cows are a clear signal of a declining natural trend (as in Bathurst herd 2000-2007).

2. Close monitoring of the herd's calf recruitment, herd size and harvest is needed so that adaptive changes can be made in a timely manner. The effects of harvest, and particularly cow harvest, on the herd depend strongly on its natural trend. The effects of a substantial bull-dominated harvest could be monitored by frequent fall composition surveys.

3. A herd with sustained high calf productivity could sustain a substantial harvest (including the harvest of 6000 modeled here) and continue to grow. This level of sustained high calf productivity was last seen for NWT herds in the early 1980s.

4. A herd with sustained low calf productivity will have a declining natural trend; any additional harvest mortality will accelerate the decline, particularly if it includes a large cow harvest.

5. A harvest of 2000-3000 would likely be compatible with a stable Bluenose-East herd if average productivity 2010-2012 continues in the next few years.

6. Most model runs projected a high probability of decline as harvest approached 5000-6000 caribou, with average calf productivity. Most projected declines were at a slow rate, except if poor calf productivity in 2012 were to continue. At these higher harvest levels, a bull-dominated harvest would have less effect on herd trend.

7. Estimates of actual harvest from the Bluenose-East herd from all aboriginal harvester groups were approximately 3,500, 2,900 and 1,750 caribou in 2009-2010, 2010-2011 and 2011-2012, respectively. Sex ratio of the harvest was not always recorded but the harvest has likely been at least 2/3 cows as most of it occurs on the winter range, where cows are generally more available and preferred by hunters.

8. Modeling for the Bluenose-East herd confirms earlier modeling for the Bathurst herd that showed the sensitivity of herd trend to cow harvest, particularly if the herd has a naturally declining trend and the cow harvest is large compared to the number of cows in the herd (Boulanger et al. 2011).

9. Earlier modeling for the Bathurst herd showed that herd trend was much less sensitive to variation in bull harvest than variation in cow harvest, particularly over small ranges of bull harvest (a few hundred)[2]. At harvest levels of 3000 or less, variation in the size of the bull harvest had relatively little effect on likely herd trend (see Boulanger 2013 for details).

10. Although not explored in this modeling for the Bluenose-East herd, earlier modeling for the Bathurst herd showed that larger bull-focused harvests could reduce bull:cow ratios to very low levels (Boulanger and Adamczewski 2012) that may not be healthy for the herd. Monitoring of bull-cow ratios would allow for ongoing assessment of the proportion of bulls in the population.

References

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Adamczewski, J., J. Boulanger, B. Croft, T. Davison, H. Sayine-Crawford, and B. Tracz. 2012. A comparison of calving and post-calving photo-surveys for the Bluenose-East Herd of barren-ground caribou in the Northwest Territories, Canada in 2010. Environment and Natural Resources, GNWT, Yellowknife, NT. Manuscript Report (in prep.).

Boulanger, J. 2012. Exploration of harvest strategies for the Bluenose East caribou herd, draft contract report October 15, 2012. Environment and Natural Resources, GNWT, Yellowknife, NT (unpublished report).

[2] The main reason for the limited sensitivity to variation in bull harvest is that the model assumes no effect on herd productivity from low bull numbers; that is, pregnancy rate will not be affected as a function of bull abundance

Boulanger, J. 2013. Exploration of harvest strategies for the Bluenose East caribou herd using post-calving based estimates of herd size, draft contract report March 13, 2013. Environment and Natural Resources, GNWT, Yellowknife, NT (unpublished report).

Boulanger, J., A. Gunn, J. Adamczewski, and B. Croft. 2011. A data-driven demographic model to explore the decline of the Bathurst caribou herd. Journal of Wildlife Management 75: 883-896.

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Appendix 1. Harvest modeling outcomes for Bluenose-East herd and annual harvest of 1000-6000 caribou

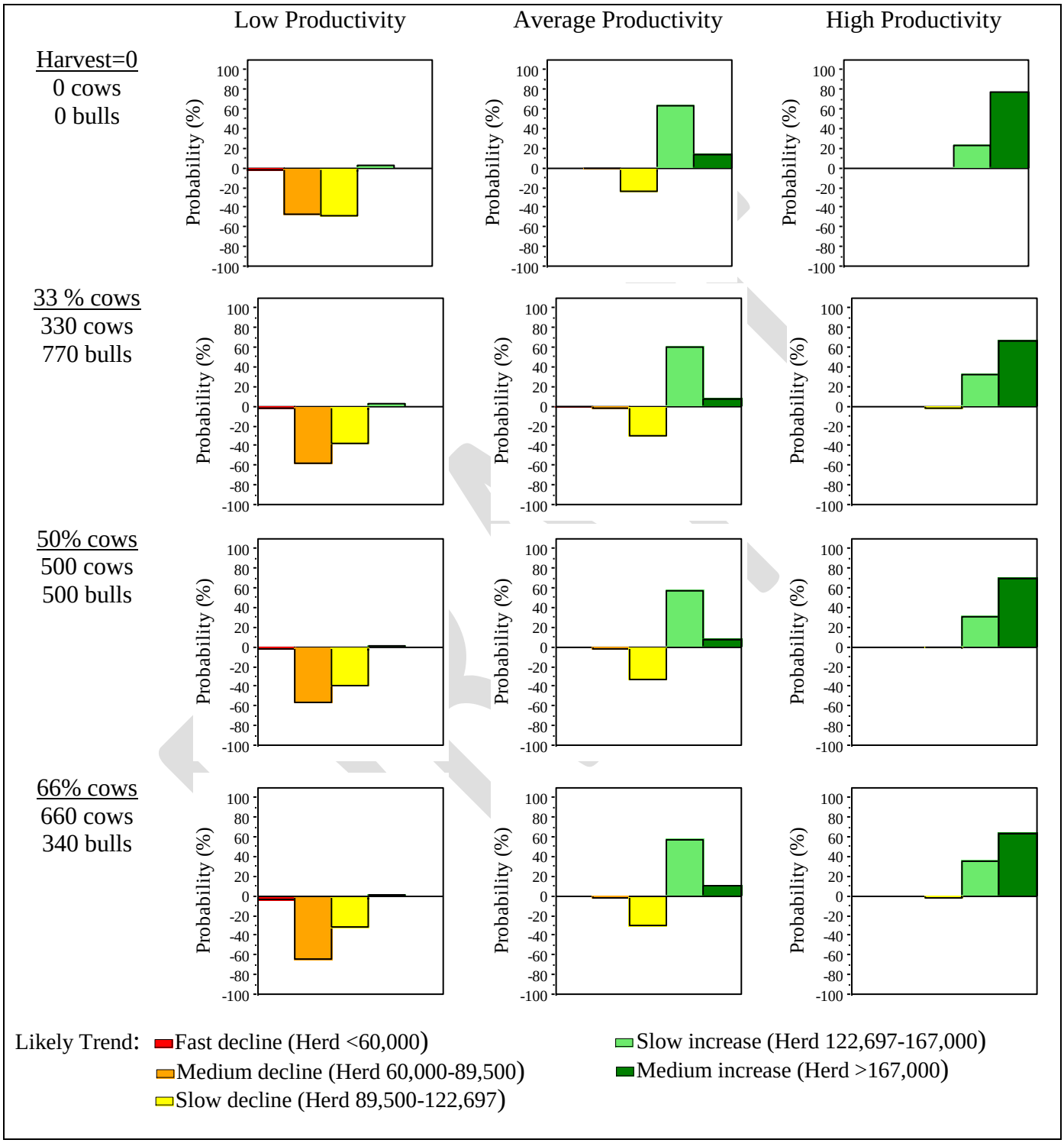

Figure 7: Simulation outcomes under a harvest level of 1000 and various harvest sex ratios evaluated at 6 years

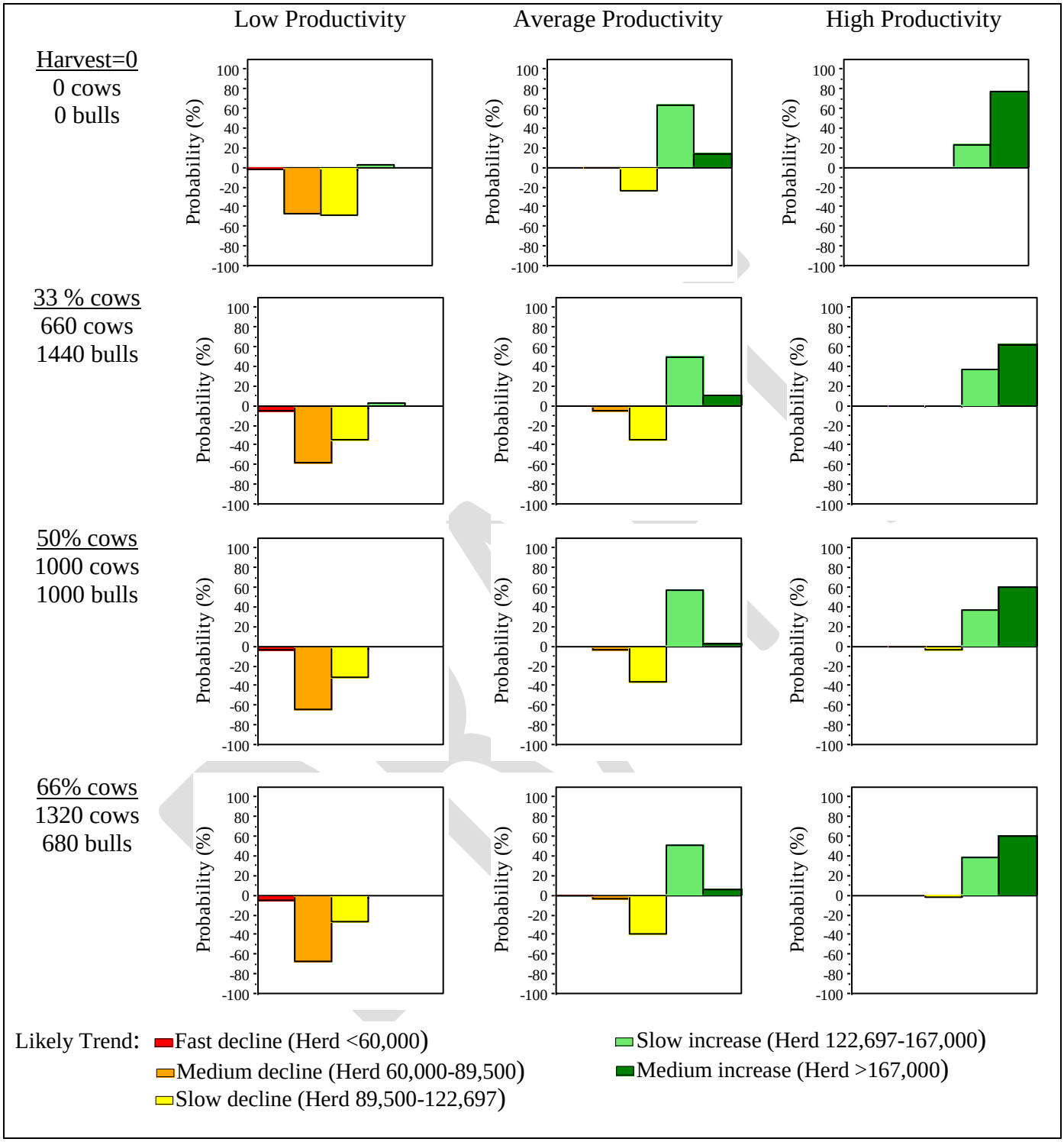

Figure 8: Simulation outcomes under a harvest level of 2000 and various harvest sex ratios evaluated at 6 years

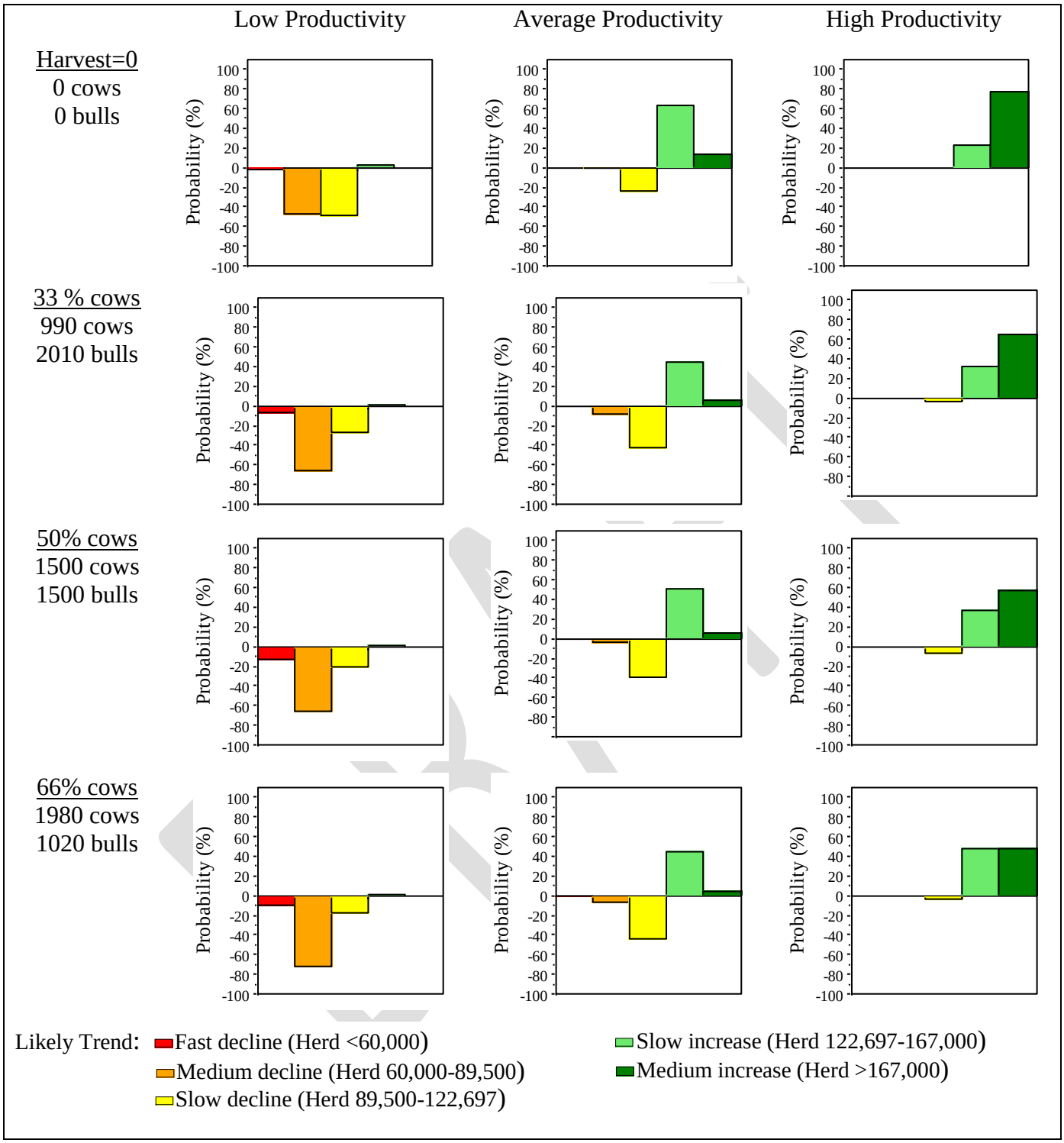

Figure 9: Simulation outcomes under a harvest level of 3000 and various harvest sex ratios evaluated at 6 years

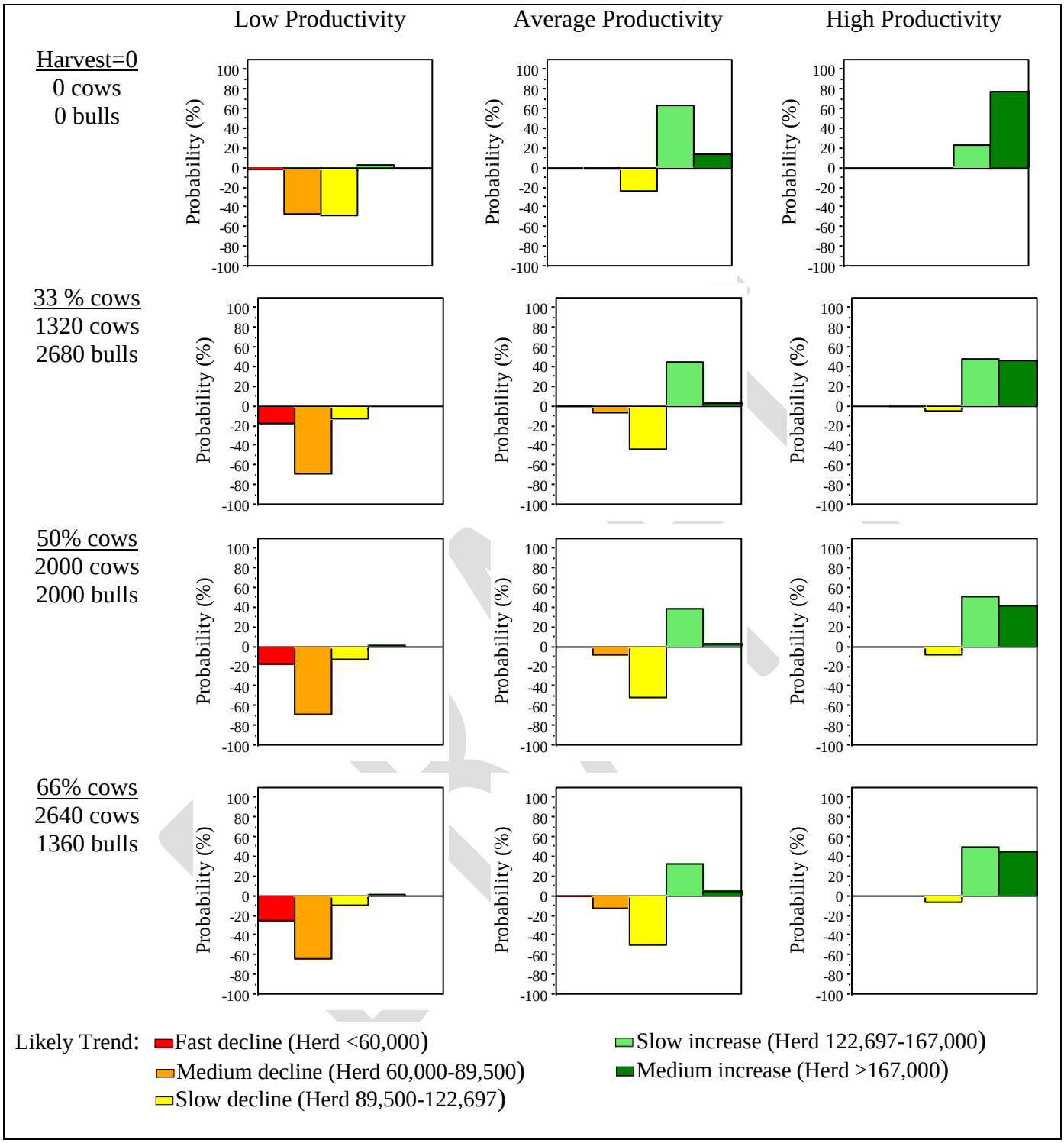

Figure 10: Simulation outcomes under a harvest level of 4000 and various harvest sex ratios evaluated at 6 years

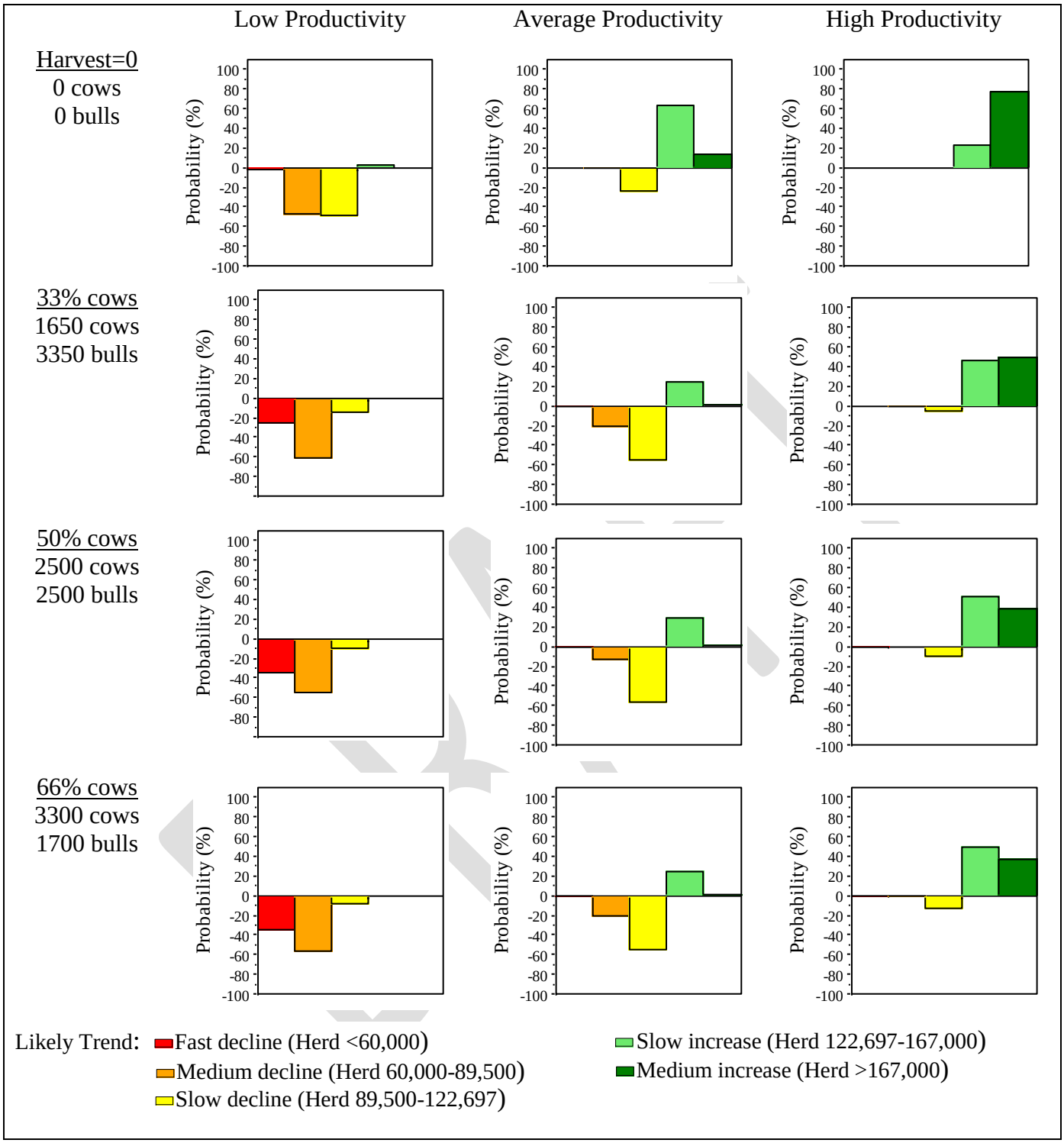

Figure 11: Simulation outcomes under a harvest level of 5000 and various harvest sex ratios evaluated at 6 years

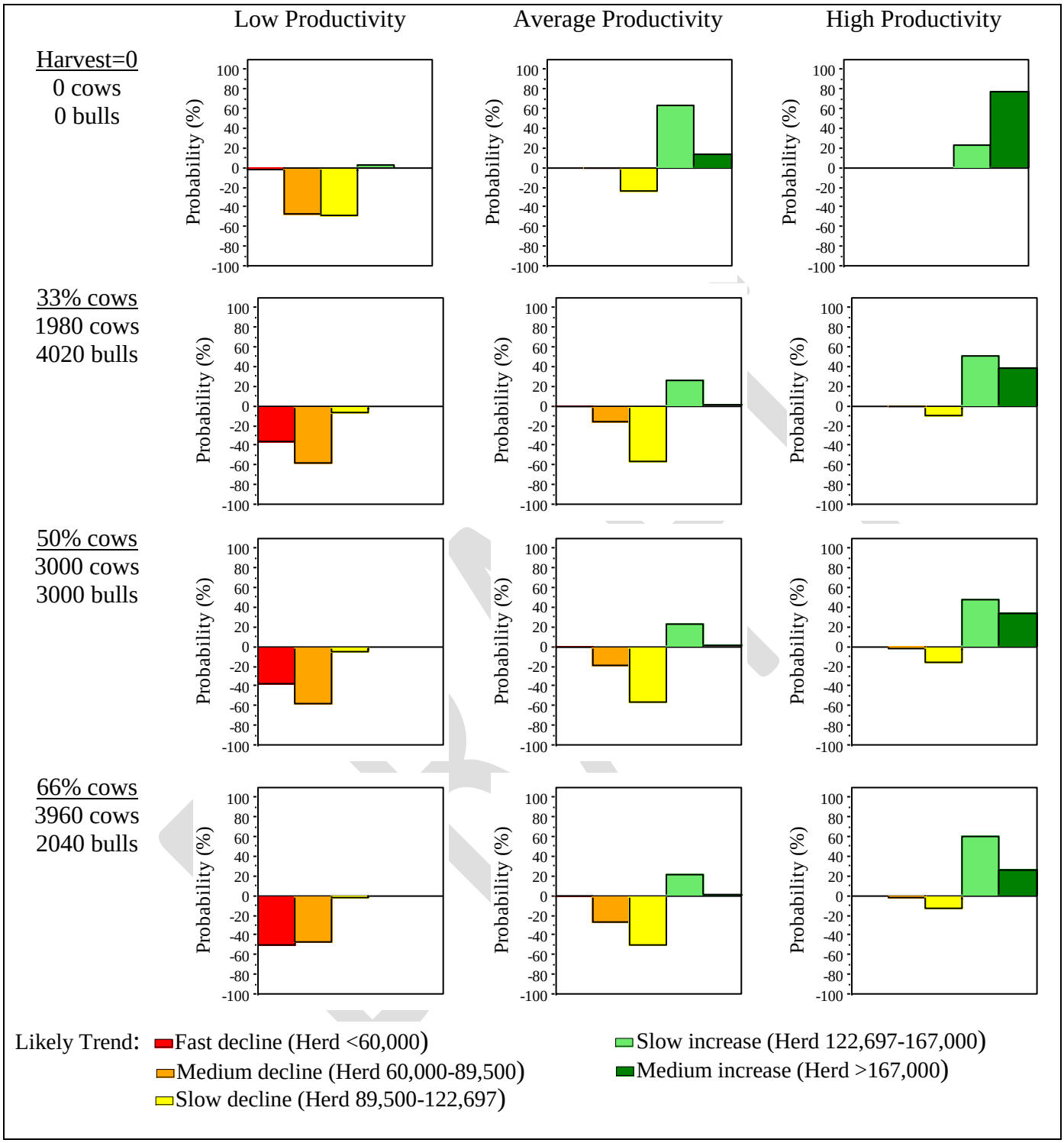

Figure 12: Simulation outcomes under a harvest level of 6000 and various harvest sex ratios evaluated at 6 years