Explanation of Flowchart Modules for Herd Categories with Known M. ovi. Status

The flowchart starts with metrics of more immediate visibility to managers: 1) is the herd at acceptable abundance? (I've used abundance in preference to density, as I believe density is poorly defined concept when applied to group living animals that have geographically discrete and limited habitat preferences), and 2) Is lamb recruitment acceptable? (given the abundance, noting implicitly that a herd that's about as big as it will likely get long-term is unlikely to have (and doesn't need) as high lamb recruitment as one that is under-populated, regardless of disease status).

Below is the older version of herd categories with our original numbering system intact, and the new 'flow-chart code' indicated in ***red, bold italics.***

Herd categories are identified based on the following criteria: 1) risk of exposure to *M. ovi*, 2) herd response following *M. ovi* introduction, and 3) long term herd performance.

1. ***B.2.a*** Infected with *M. ovi*, with an initial population decline, followed by continued evidence of *M. ovi* and persistent or variable annual lamb mortality, resulting in below expected lamb recruitment and a stagnant/declining population.
2. ***A.1.a*** or ***A.2 a***. Infected with *M. ovi,* with little, or no initial population decline, continued evidence of *M. ovi*, and herd recovery to pre-disease event levels or higher (Mike's "Rock Stars" (I think)).
3. ***C.2***. Infected with *M. ovi*, with little or no initial population decline, followed by lack of evidence of *M. ovi* and herd recovery to pre-disease event levels or higher.
4. **B.2.b.** Unknown M. ovi status, with little or no initial population decline, followed by poor herd performance.
5. ***C.3***. Unknown M. ovi status, with initial population decline, persistent or variable annual lamb mortality, followed by herd recovery to pre-disease event levels or higher.
6. ***A.1.b.*** *M. ovi* negative with low risk of disease transmission
7. ***A.2.b.*** *M. ovi* negative with high risk of disease transmission
8. ***B.1.b****. M. ovi* negative but stagnant/declining population.

A few points worth noting:

1) I didn't further categorize herds by additional risk/virulence factors beyond *M. ovi* (e.g. Pasteurellaceae suite, sinus tumors, population 'density' at time of outbreak). Others might wish to do so, and they'd be free to add boxes to the right. My read of the state of the science at this point is that while it's quite possible other factors matter, we currently lack enough replicates or clarity on them to justify creating categories based on them that all would recognize. At the risk continuing to highlight the role of *M. ovi* to the discomfort of some, I think what I've done here is consistent with the state of the science, while not elevating *M. ovi* status to the role of "first and foremost thing you think about…".

2) I didn't recognize a B.2.c category, that would have designated herds with documented pneumonia but known to be free of *M. ovi*. Correct me if I'm wrong, but my understanding is that while we know of *M.ovi*-positive herds that evidently are doing OK, we have yet to find a pneumonic herd in which *M. ovi* was absent AND in which we had the sampling and tools to look for it.

3) I also didn't recognize a B.1.a herd: doing poorly, pneumonia suspected, but *M.ovi* known to be absent. Same rationale as above; pneumonic herds have *M. ovi* when we've the opportunity to look for it.

Here's my interpretation of the learning opportunities from these newly categorized herds:

A.1.a. Mike's "Rock Star" herd, e.g. a wilderness herd in Wyoming doing its thing and seemingly forming the exception to the general rule of "if you've got *M.ovi*, you're going to be in trouble". High priority for researching why these herds can pull this off. What makes them special?

A.1.b. Safe and secure, "control" herds, that don't so much require research and protection.

A.2.a. Another kind of Rock Star herd, except here, we'd wonder if the herd is really doing as well as we think. High priority for finding out more.

A.2.b. "At risk" herd – one we might want to monitor for "before" information, with the notion that it's fairly likely that in a few years, the status of this herd might change.

B.1.b. Unhappy herd due to poor habitat, lots of predation, *Psoroptes ovis*, or other non-pneumonia-related cause. Moderate priority for enhanced monitoring because it may have nothing to do with pneumonia, but it may if these other aspects predispose the herd to future infection.

B.1.c. – Probably should test, because maybe the assumption of not having pneumonia is wrong.

B.2.a. The "classic" long-term pneumonia affected herd (e.g., Hells Canyon).

B.2.b. Candidate for "pneumonia is actually here but we haven't yet confirmed it"

C.1. Another variant of one of Mike's "Rock Stars". High priority for research, because we'd like to know how this herd managed to pull it off.

C.2. Probably a herd that has managed to purge itself of necessary pathogens.

C.3. Should test, since we'd like to know which of the other kinds of "C" herds it actually is.

This may not match exactly what the group had developed earlier, but I think it more closely matches how a manager might approach it, is more transparent, meet's Dr. Craig Stephen's criterion of allowing one to categorize more coarsely (by stopping before the final box), or more finely (by adding more boxes, according to taste), and reduces the sense that *M. ovi* is the first thing one thinks about.

Below is an example of categorizing Washington state bighorn herds by Rich Harris in May 2017

1. Hall Mtn – B.1.b.
2. Vulcan – B.1.b.
3. Black Butte – B.2.a.
4. Mtn View/Wenaha- B.2.a.
5. Asotin – C.2.
6. Tucannon - B.1.b.
7. Lincoln Cliffs A.2.b.
8. Mt. Hull – A.1.b.
9. Sinlahekin – B.1.b.
10. Manson – A.1.b.
11. Chelan Butte A.2.b.
12. Swakane – A.2.b.
13. Quilomene – A.1.b.
14. Yakima Canyon B. 2.a.
15. Cleman – A.2.b.
16. Tieton – B. 2.a.