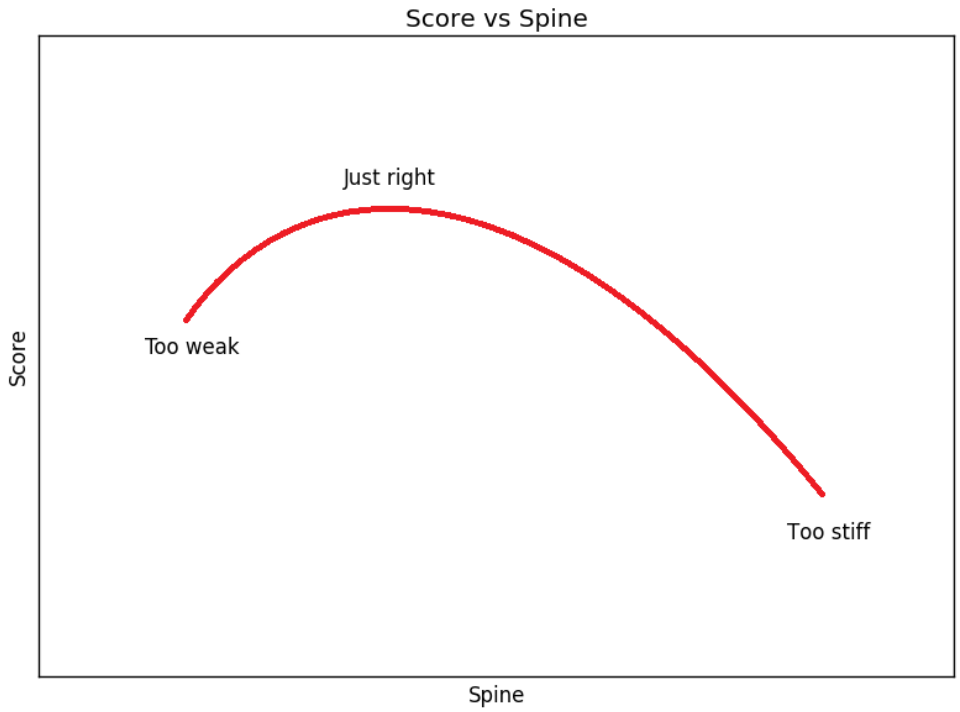
The Arrow Mystery - Part 2

Finding the Right Dynamic Spine - Tip Weight

Ben Axelrod
February 2021

One of the lingering questions from my last investigation was that I still wanted to find the best dynamic spine for my bow. It was clear that a weaker spine was better, but *how* weak? And could the spine be *too* weak? I'm sure the phenomenon is something like this:



The way I think about it is like an under-damped system. Clearly, the arrow needs to be a little "floppy" to allow the arrow and fletching to bend around the bow riser. But allowing the arrow to continue to flop around for a long time while in flight is probably bad. I think you should try to achieve a critically damped system. One that allows the arrow to flex around the riser, but then stops oscillating as soon as possible.

So far, I haven't been able to find that "just right" sweet spot yet. Unfortunately, using arrow length and static spine alone wasn't enough to get over the hump and make the arrows too flexible. Time for another experiment!

I bought the full range of field tip weights and outfitted all my arrows with the new tips. The larger diameter arrows (11/32") have tip weights 125, 145, 160, and 190 grains. The smaller diameter (5/16") only has 100 and 125 grain tips.

I have come to view arrow spine as a combination of static spine and a dynamic adjustment on top of that. Where a 28 inch long arrow with a 125 grain tip is considered baseline (zero dynamic adjustment). If the arrow is longer than 28 inches, then it gets a dynamic spine adjustment of -5 lbs / in. If the arrow has a heavier tip than 125 grains, then it gets a dynamic spine adjustment of - 5 lbs / 25 grains. In other words:

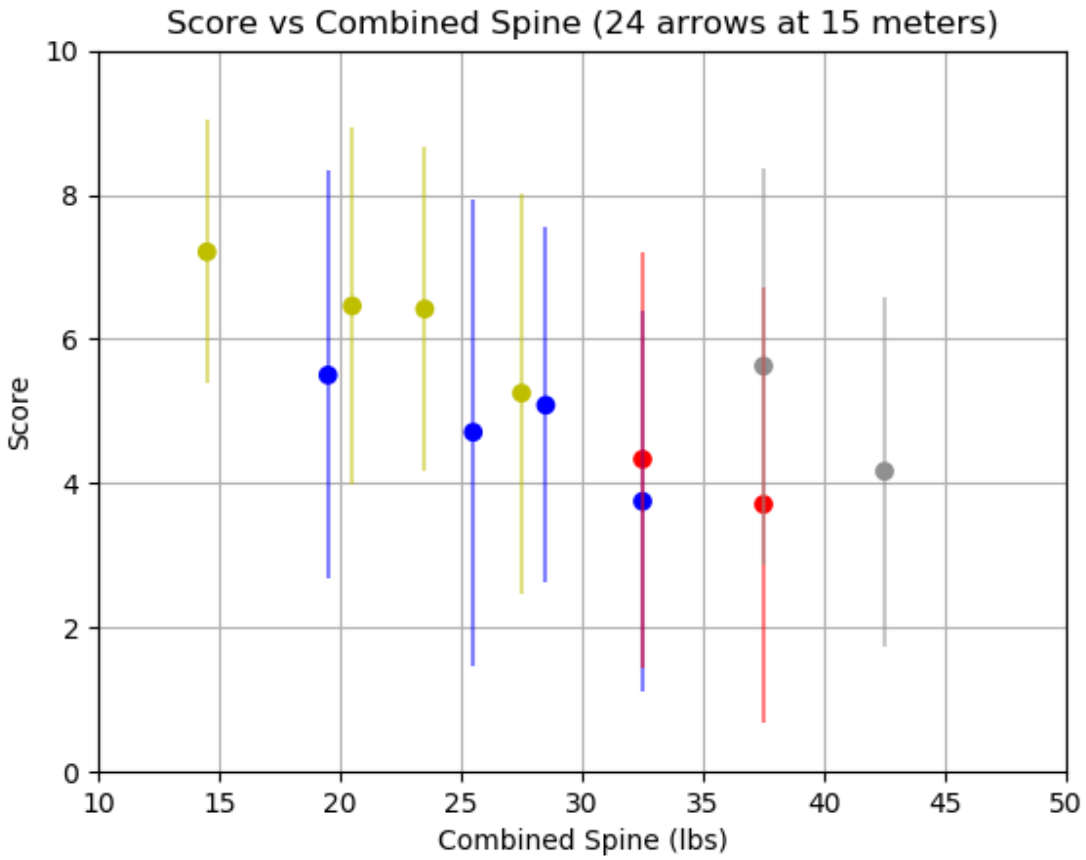
Static Spine	+	*Dynamic Spine Length Adjustment*	+	*Dynamic Spine Tip Adjustment*	=	*Combined Spine*

So here is the table of all my arrows and their combined spine.

Arrow Type	**Static Spine (lbs)**	**Length (in)**	**Dynamic Spine Length Adjustment (Δ lbs)**	**Tip Weight (grains)**	**Dynamic Spine Tip Adjustment (Δ lbs)**	**Combined Spine (lbs)**
Yellow	40-45	31	-15	125	0	25-30
				145	-4	21-26
				160	-7	18-23
				190	-13	12-17
Blue	30-35	28	0	125	0	30-35
				145	-4	26-31
				160	-7	23-28
				190	-13	17-22
Red	30-35	28	0	100	5	35-40
				125	0	30-35
White	35-40	28	0	100	5	40-45
				125	0	35-40

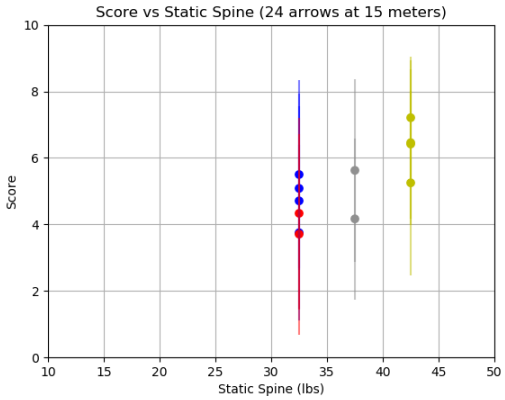
Now for the data! Unfortunately, I only had enough arrows for 1 in each category. I shot each arrow 24 times at 15 meters. Initially, I shot them in random order. But I started to notice a significant difference between the heavier tips and the lighter tips. So after a few rounds, I grouped them into heavier and lighter groups, then shot those together.

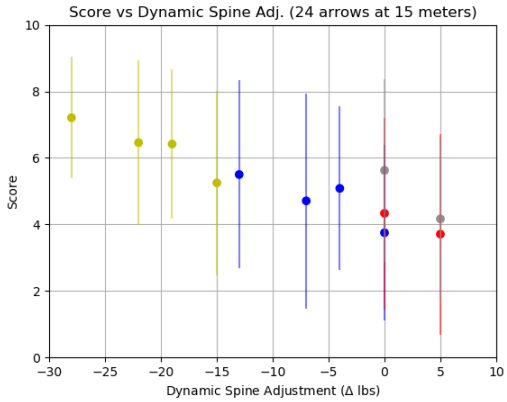
Here is the score versus the calculated combined spine. As you can see, even with the longest arrows, and heaviest tips, I am still not able to make the spine “too weak”.



Here, the color of the dots indicates arrow type (with grey for the white arrows). On the X axis, dots are placed in the center of the spine range. (For example at 42.5 if the range is 40-45). On the Y axis, the dots indicate average score, and the error bars extend one standard deviation. It is interesting that the highest score also has the lowest standard deviation.

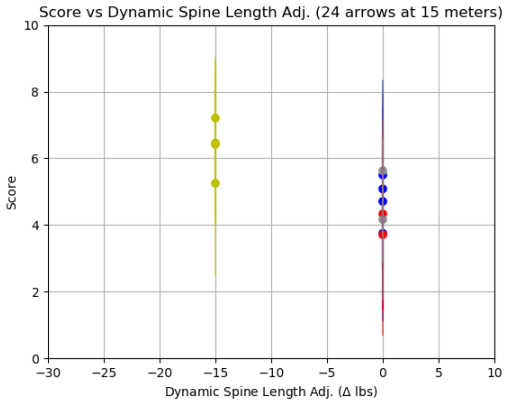
Digging into the numbers a little more, what is the static spine vs dynamic spine trade off? There isn’t much data on static spine. But it appears that a high static spine, and low dynamic spine is best. In other words, a long, stiff arrow with a heavy tip.

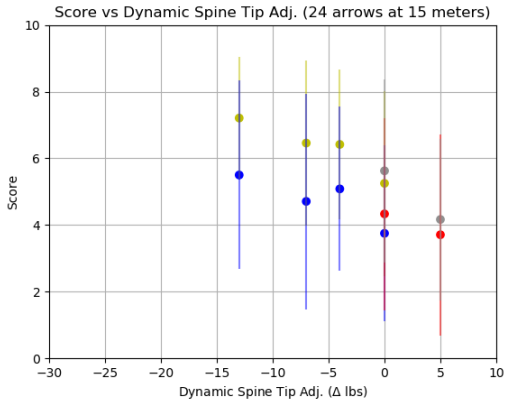




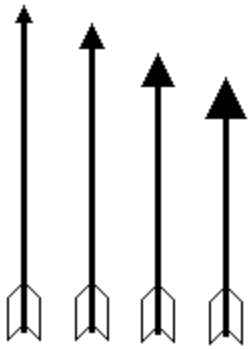
The plot on the left shows score vs. just static spine. (All dynamic spine adjustments are ignored). The plot on the right shows score vs. just the dynamic adjustment. (Static spine ignored). While it looks like a long, stiff arrow with a heavy tip is best, you will notice that there are blue and grey points above the lowest yellow point. That seems to indicate that even a short, weak arrow with a heavy tip may be better than a long, stiff arrow with a light tip.

And what about the tradeoff between length and tip weight? There isn't much data here either. So it is a little hard to draw any conclusions.





I think the next experiment should be to compare the two different dynamic spine adjustments: length vs. tip weight holding static spine constant. For this, I'll need a much finer grain resolution on arrow length. Then put light tips on longer arrows, and heavy tips on short arrows. For example:



I should also get some long arrows with a weaker spine. Perhaps then I'll be able to "get over the hump" and make them "too weak". But it's possible that with a 30 lb bow, it just can't be done. It would be interesting to try these experiments again with a higher draw weight bow.

Lastly, I wonder if there are some other drawbacks to having such a weak spined arrow that is not captured in these tests. Less range, or accuracy at a longer range for example. It is also entirely possible that if my shooting precision was better (i.e. tighter groupings), then the data might show something different.