Notes that accompany the PowerPoint slides "The False Promise of SPLATs."

SLIDE 1. Title: The False Promises.
With two exceptions, all fuel reduction now proposed for National Forest land in the Sierra Nevada will be done in Strategically Placed Area Treatments (SPLATs). The exceptions are "defense zones" in Wildland Urban Intermix areas, and "Defensible Fuel Profile Zones" (DFPZs) around communities and across the forest in the Quincy Library Group Pilot Project.
SPLATs are disconnected area treatments of various sizes and shapes, supposedly in some kind of regular pattern on the landscape, whereas defense zones and DFPZs are continuous quarter-mile-wide strips of treatment. Defense zones are only around urban areas, whereas DFPZs are around communities and in a network across the forest.
My purpose here is to explain the SPLAT strategy in terms of its underlying theory and its proposed implementation, then compare the protection that can be expected with SPLATs against the protection to be expected with the DFPZ strategy.

Disclaimer:
I am a member of the Quincy Library Group, and I believe what I say in this paper is fully consistent with the QLG Community Stability Proposal, the HFQLG Forest Recovery Act, and correct implementation of the HFQLG Pilot Project. However, I am speaking for myself, not representing QLG.
Your comments, complaints, or corrections are always welcome at
939 Bucks Lake Road, Quincy, CA 95971   530-283-0899   gterhune@sbcglobal.net.

SLIDE 2. The SPLAT Strategy.
The SPLAT strategy is based directly on a paper by Mark A. Finney, which is reproduced in Appendix G of the SNFPA Final EIS. His paper explains and quantifies the "Finney Effect," which is created by a well defined geometry of fuel reduction treatments, and is measured by how much a fire is slowed as it moves through the landscape containing those treatments.
A second paper, also reproduced in Appendix G of the FEIS, was co-authored by Finney, and makes additional claims for the effectiveness of disconnected SPLAT-like treatments.
The Forest Service says that these "…were two key scientific papers … that were used to develop and support the fire strategies outlined in the Preferred Alternative." Since the only fire strategy in the Preferred Alternative is SPLATs, and that was the Alternative actually adopted, these are the papers referred to.

SLIDE 3. The "Finney Effect."
The "Finney Effect" is the slowing of a fire and a moderating of its effects as it moves through a pattern of disconnected area treatments. The pattern of treatment slows and moderates the fire in two ways:
(1) Changing fire behavior within the treated units, due to the treatments themselves.
(2) Causing the fire in the untreated matrix to zig-zag around treatment units, so it has to follow a longer path, which slows its forward progress, and to move at an angle to the wind, which also slows and moderates the fire.
Finney's paper is largely a mathematical analysis of how to optimize the pattern of treatment, so as to achieve the maximum reduction of a fire's overall forward spread rate, assuming a particular combination of the original fuel load, fraction of the landscape treated, treatment pattern, treatment effectiveness, and the effects of wind and terrain.
The maximum slowing of the fire is said to occur when all these factors come together in a way that causes the fire to burn through treatments just as fast as it zig-zags around them.

In the next few slides, I will examine Finney's concept in detail, to see how it is supposed to work, and whether it would actually work as advertised.

SLIDE 4. Finney's Examples.
In his paper Finney shows four examples:
(a) If there were no treatment, a fire burning through consistent fuel on level ground in a moderate wind (in this case blowing from bottom to top of the page) will tend to burn in an expanding ellipse, with the ignition point at the upwind focus of the ellipse. Finney shows two ignition points, resulting in two overlapping ellipses. In these examples, each ellipse is twice as long as it is wide. A stronger wind would make the ellipse longer for the same width, and zero wind in this example would result in concentric circles of uniform intensity, instead of ellipses.
(b) Fuel reduction treatments are shown in dark continuous lines across the path of the fire. For examples (b), (c), and (d), 19 percent of the landscape is treated, and within treatments the fire's Rate Of Spread (ROS) in treated units (Rt) is 1 / 10 of what it would be in the untreated matrix (Rm). That is, Rt / Rm = 1 / 10, or 0.1, or 10%.
(c) This "lattice" pattern of disconnected overlapping treatment units is used by Finney to illustrate the simplest form of his theory.
(d) The "herringbone" pattern is a variation that allows the fire to become somewhat larger with this wind direction, but keeps wind of a different direction from completely destroying the effectiveness of the pattern.
The "Spread Rate Fraction" is a fire's Rate of Spread with treatments in place, divided by the ROS with no treatments in place. Since all four of the example fires burned for the same time period, the SRF for fires (b), (c), and (d) is also the length of that fire from ignition point to the far end, divided by the length of fire (a) from its ignition point to the far end.
A smaller SRF is better. The SRF of fire (b) is 43%, fire (c) 45%, and fire (d) 60%. That is, the continuous strips of treatment slow the fire better than either of the Finney patterns.

SLIDE 5. Disconnected vs. Continuous.
The intensity of the fire at each point is indicated by the darkness of the shading, and the fire boundary at the end of each burn period is shown by fine lines within the fires.
On Finney's diagram, the "continuous treatment" fire on the right is about 5% shorter than the "disconnected treatment" fire on the left, measuring from the ignition points to the upper ends. And the total area burned with the continuous treatments is about 15% less than the area burned with the disconnected treatments.
However, if the exercise had been terminated at 17 burn periods instead of 18, the length difference would have been greater – about 16% instead of 5%. This is because, during the 18th period, the forward fire front on the left happens to be moving slowly through a treated area, while the fire front on the right is burning at full speed through an untreated area.

SLIDE 6. Effectiveness of a "Lattice Pattern."
One major problem with the Finney theory is that the claimed effectiveness of the lattice or herringbone treatment pattern would be very difficult if not impossible to achieve in practice, because it depends on fairly precise interactions among several variable factors.

- The thickness of each treatment unit.
- The spacing between one line of treatment and the next.
- The overlap of the ends of units in succeeding lines, which determines the angle a fire must take to get around each treatment unit, and therefore largely controls the slowing effect along that path.
- The treatment fraction, which is the percentage of the whole landscape that is treated.

- The effectiveness of the treatment, which Finney defines as the forward rate of spread through a treatment (Rt) divided by the forward rate of spread in the untreated matrix (Rm). A smaller Rt/Rm is better. For example, an Rt/Rm of 0.1 (10%) would be a 90% slowing of the fire in a treated area, whereas an Rt/Rm of 0.5 (50%) would slow the fire only by half in the treated area.

The pattern's geometry and the effectiveness of the treatment are all determined at the time of treatment. But the actual effectiveness of the pattern in slowing any particular fire – the overall Spread Rate Fraction – also depends on the speed and direction of the wind at the time of the fire. A pattern that is optimized for one particular wind will not be optimal for another. If the wind is stronger than planned, the fire will tend to burn through a treatment quicker than it burns around. On the other hand, if there is less wind speed than planned, the fire will burn around before it burns through.

And if the wind direction is diagonal to what was planned, then the lattice pattern might not slow a fire at all.

SLIDE 7. Graph: Spread Rate Fraction -- Treatment Fraction.

This graph from the Finney paper relates Spread Rate Fraction to Treatment Fraction for three different Rt/Rm ratios, 0.05 (1/20), 0.1 (1/10), and 0.2 (1/5). The Finney examples assumed the middle line, an Rt/Rm of 0.1. The performance of a treatment pattern is better as you move downward on the graph, i.e. as you get the best (lowest) possible SRF for a given amount of treatment.

Finney explains that the three heavy lines represent only the continuous strips of treatment – fire (b) in his example – while the area of lighter lines associated with each heavy line represent the performance of disconnected area treatments – fires (c) and (d) in his example. The arrows labeled "O" and "S" are said to indicate the effect on performance if you vary the Overlap "O" and Spacing "S" of treatment areas in the lattice pattern. Unfortunately, the actual performance of neither fire (c) in Finney's example nor any other Finney pattern of treatment can actually be quantified and plotted on this graph.

The best you can say – and it turns out to be fully sufficient – is that in ALL cases, a pattern of disconnected treatments will ALWAYS come out higher on the graph (i.e. worse SRF, worse performance) than the point representing continuous treatments for that same Treatment Fraction and Rt/Rm ratio. No amount of fiddling with overlap and spacing will change that fundamental fact.

SLIDE 8. Stronger Wind.

These diagrams compare the progress of a fire as it moves through continuous strips of treatment versus its progress moving through Finney's example pattern, but with a wind strong enough to make the length of the fire ellipse three times as long as it is wide, instead of two. In a stronger wind, the relative advantage of continuous strips is even greater that in the Finney example.

Note:

My diagrams are of fires with only one ignition point instead of the two simultaneous ignition points assumed by Finney in his examples. I did this to simplify the diagrams and facilitate analysis by graphic approximations of Finney's computer program. It turns out that performance of the Finney pattern is slightly sensitive to the location of the ignition point. That is, if you optimize a pattern for an ignition point near the end of a treatment unit, but start the fire on the centerline of a unit, as I did, the pattern is no longer optimized – it will always burn through before it burns around. On the other hand, if you optimize for ignition on the centerline of a treatment unit, but let the fire start near one end, then the fire will always burn around before it burns through. So it isn't just that

an “optimized” Finney pattern becomes non-optimal if the overlap, spacing, Rt/Rm, and wind speed change, it also goes slightly off optimum if the ignition point is other than the one assumed.
No such problems exist with continuous strips of treatment.
It appears that Finney used two simultaneous ignition points because he had optimized his geometry for ignition at one end of a treatment unit, and he wanted to have a “balanced” looking pattern instead of one that looked like it wobbled back and forth as it zig-zagged around the treatments.
Just a guess.

SLIDE 9. Calm Wind.
If there is no wind, the performance of a Finney pattern really goes bad, compared to the performance of continuous strips of treatment. In this case the fire burns around every disconnected treatment unit well before it can burn through.
Continuous strips of treatment win again.

SLIDE 10. Summary of Finney Pattern Deficiencies.
To sum it up so far:
If SPLATs were actually to achieve the Finney Effect, they are still inherently deficient because:

- The Finney geometry cannot really be optimized, since a pattern optimized for one wind speed will not be optimal for any other wind speed, and not all fires have the same winds.
- Similarly, a pattern that is optimized for one treatment effectiveness (Rt / Rm ratio) will not be optimal for a different Rt / Rm, and that ratio can change significantly over time, as treated areas and the untreated matrix fill in and re-grow at various rates.

Furthermore, as noted earlier, continuous lines of treatment will always perform better than an equivalent amount of treatment in a Finney pattern, even an optimized Finney pattern. And the margin of superior performance by continuous lines of treatment only increases as changes in wind speed or treatment effectiveness degrade the Finney performance.
Finally, as Finney clearly says in his paper, it would be completely impractical to impose an optimized Finney pattern on the landscape. The Forest Service itself has published a SPLAT diagram in the SNFPA EIS, and another in the study of a major watershed on the El Dorado National Forest, both of which show that any SPLAT pattern they could actually put on the landscape would not have sufficiently precise geometry to achieve a significant Finney Effect.

SLIDE 11. Performance of Treatment Patterns.
How well could SPLATs actually be expected to perform? I’ll deal with that question in the next several slides.
As a starting point, let’s take another look at the graph which shows the best possible performance of a treatment pattern. I’ve simplified it to show only the heavy line for continuous strips of treatment with an Rt/Rm ratio of 0.1, as in Finney’s example fire (b). I’ve added an arrow at the Treatment Fraction of 0.3, which the Forest Service originally stated as its target, to treat 30% of the landscape within 25 years. It shows that continuous strips of treatment would slow a fire to about 27% of its untreated Rate of Spread, provided you reduced the fire’s ROS in treated areas to 1/10 of its ROS in the remaining matrix of untreated areas. (You can also think of 27% SRF as a 73% slowing of the fire.)
The Forest Service has used this graph to imply that a similar performance would be achieved by SPLATs. Not true.
Even if the SPLATs were shaped and spaced exactly as Finney specifies for optimal performance of the lattice pattern, that performance would still be worse – sometimes much worse – than is indicated by the heavy line on the graph. But in fact the SPLATs proposed in the Sierra Nevada

Framework would not even come close to the Finney lattice pattern, much less to the performance of continuous strips of treatment, as shown on the following slide.

SLIDE 12. SPLATs are not Finney.
The lower curve is the same as on the previous slide, an Rt/Rm ratio of 0.1.
But the Sierra Nevada Framework (SNFPA) decision does not require an Rt/Rm ratio anywhere near that good. It accepts a ratio as large as 0.5, represented by the upper curve on this graph. This gives very poor performance, compared to the Finney example.
If 30% of the landscape were covered in SPLATs that met the Forest Service standard of acceptable performance, the upper curve shows an SRF of 0.77, only a 23% slowing of the fire. But a Finney pattern would do worse than that, and SPLATs would do much worse.
In other words, you treat 30% of the landscape, take 25 years to do it, and you could end up with significantly less than a 23% slowing of the fire.

By basing their SPLAT strategy on faulty implementation of a corrupted version of a deficient theory, the Forest Service has managed to construct a lose-lose-lose situation.

SLIDE 13. Forest Service Example of SPLATs.
But don't take my word for it, just take a close look at some patterns of treatment that the Forest Service has published as examples of SPLAT implementation.
The SNFPA FEIS includes this diagram, copied from an earlier Finney paper.
The treated areas (white) occupy about 27 percent of the landscape that actually contains treatments (i.e. after removing the untreated areas around the edges).
The zig-zag arrows are said to represent two paths that a fire might take, one moving generally northward, driven by a wind from the south, and the other moving generally north-east, driven by a wind from the south-west.
In the next two slides I'll take a closer look at that northbound fire.

SLIDE 14. A fire burning around the treatments …
The slowing of a fire moving through this pattern of treatments is due to two effects:

(1) a "distance effect" because the zig-zag path is longer than the straight line distance; and
(2) a "wind angle effect" which causes a fire's speed to be slower when moving at an angle to the wind than it would be when moving straight down wind.

Both the distance effect and the wind angle effect were exaggerated to the point of misrepresentation in this FEIS diagram.
If Finney's assumptions of wind and treatment effectiveness are applied to the Forest Service diagram at the left, it amounts to a claim that the fire would be slowed by 77%, i.e. it would move only 23% as fast, compared to the same area without the SPLATs.
But the actual shortest path around the treatments, shown on the right, is shorter and on average less angled to the wind than the path on the left. On those same assumptions, the fire would be slowed only 27%. That is, it would burn through this pattern about 73% as fast as if the treatments weren't there at all.

SLIDE 15. Treatments that easily meet SNFPA Standards …
But in fact, if the treatment effectiveness specified in the Forest Service Standards and Guidelines were applied to this pattern of SPLATs, (that is, if the fire is slowed in the treated area by 50% instead of Finney's assumption of 90%), then this fire would actually burn through three of the treatments before it could burn around them. The slowing of the fire as it moves through the

treatments is not sufficient to make up for the shorter distance and less wind angle along the path on the right.
The bottom line is this: when you use the correct geometry and the Forest Service specs for treatment effectiveness, the fire would be slowed only 15% by this pattern of SPLATs, not the 77% implied by the original Forest Service diagram.
Actual performance would be only one fifth of what the Forest Service diagram implies.

SLIDE 16. SPLAT pattern from a study on the El Dorado.
OK, maybe the SPLAT diagram in the FEIS was not well-considered, so let's look at another example.
The Forest Service published a study which modeled several potential SPLAT patterns on a major watershed of the El Dorado National Forest. This is the SPLAT pattern they published, so presumably it is the best they could do on that landscape.
There are numerous unobstructed straight line fire paths, whatever the wind direction. I've shown a few lines representing fire paths with winds from the south and southwest, which are said to be the most likely fire wind directions. Some of these paths are completely unobstructed, and others are nearly straight lines that need to burn through only thin areas of treatment.
These SPLATs would perform even worse than the SPLATs in the FEIS diagram.

SLIDE 17. Finney pattern considered in the El Dorado study.
OK, maybe a "real" Finney pattern would do a better job. Presumably this example from the El Dorado study is also the best they could come up with.
Besides the fact that it would be virtually impossible to put this pattern on the ground, it also has numerous unobstructed or only slightly obstructed paths for a fire to burn right through.

Unavoidable conclusion: Neither SPLATs nor a Finney pattern can be made to work.

SLIDE 18. Alternative Strategy.
Well, if SPLATs won't do the job, what other strategy is there? Actually, Finney's study itself gives us a good answer: Example (b), the continuous strips of treatment.
If you adjust these strips to fit the terrain, follow existing roads wherever possible, and cross-connect the strips now and then at road intersections, you have a DFPZ network like that being implemented in the HFQLG Pilot Project.
Finney shows, if you read his paper carefully, that continuous strips of treatment *always* perform better than any pattern of the same amount of equivalent disconnected treatments
Furthermore, the relative effectiveness of a DFPZ network is the same with different wind speeds, whereas the effectiveness of a Finney or SPLAT pattern is reduced if the wind is *either* faster or slower than the wind the pattern was designed for.
(Of course, both strategies will be compromised to some extent if the wind is strong enough to cause spotting from fire brands blown over the treated area. But even in that case DFPZs give better protection than SPLATs, because, if all else fails, the DFPZ network will provide safe redeployment of suppression forces to another ready-made fire line within a few miles downwind.)

SLIDE 19. A direct comparison…
SPLATs and DFPZs, each covering about 30% of their landscape.

SLIDE 20. Add the same fire to both…
These are the kinds of spread rates and fire sizes you would get with the same fire moving through the SPLATs and the DFPZs for the same amount of time. DFPZs are even more advantageous,

relative to SPLATs, if you compare the two patterns with only 15 or 20 percent of the landscape treated.

(Any resemblance of the SPLAT pattern to Edvard Munch's painting "The Scream" is purely coincidental – but kinda nice.)

SLIDE 21. Potential uses for SPLATs.
Is there any good use at all for SPLATs?
Yes, there are two good uses.

(1) Area treatments could be used to reinforce DFPZs wherever complete continuity is not possible. For example, in the diagram at the left a wildlife corridor (or some other land allocation or circumstance) restricts or prohibits adequate fuel reduction and causes gaps across the DFPZ network. The corridor could probably be adjusted slightly, and SPLATs added to reinforce the gaps, as shown at the right. (And even without such reinforcement, the roads already existing in most DFPZ gaps would give a very good start on fireline construction. In contrast, the SPLAT strategy requires the construction of a lot more fire line in much less favorable circumstances.)
(2) After a DFPZ network is sufficiently complete to provide adequate protection from large high intensity fires, (which would probably occur when about 15% of the landscape has been treated) , the emphasis could shift to treating individual stands of particular interest within the larger areas protected by DFPZs. The diagram at the right also shows a few of these added area treatments.

SLIDE 22. SPLATs vs DFPZs with roads considered.
A very big advantage of DFPZs over SPLATs – aside from the advantage of continuity, already discussed – is that DFPZs are intended to include roads, but the SPLAT strategy says nothing about how roads should relate to the treatments. The SPLAT standard says only that fireline construction within treated areas should be at twice the rate that was possible before treatment. The DFPZ strategy doesn't need to specify fireline construction rates, because the included roads would already be better firelines than any hand or dozer line that could be constructed in or between SPLATs during a fire.
A major objective of a DFPZ is to bring crown fires to ground and reduce the intensity of all fires within the strip of treatment, in order to make fire suppression safer and more effective. The included roads would give rapid access and be very efficient ready-made firelines, so fire fighters and their best equipment could be deployed quickly and used most effectively. And the protected roads would be safe lines of retreat or redeployment if that became necessary.
Furthermore, if a fire did go through or over the defense mounted on one segment of the DFPZ network, a new defense line would be readily available a few miles downwind.
SPLATs offer none of those advantages for suppression effectiveness, defense in depth, or fire fighter safety.

SPLATs could be very useful follow-up treatments after an adequate DFPZ network is already in place, but SPLATs are fatally deficient as the initial treatment strategy.

-- end --