**A Friction Fire Inquiry: Bow Drill**
**By Storm**

During the winter of 1999 I was fortunate enough to teach at an outdoor school in southern California with Jeff Stauffer, now the Ethnobotanist of that school and an adjunct primitive skills instructor for Raven's Way Traditional School in Arizona. It was then that I first became aware that fire lay dormant within sticks, ready to expose itself with a little coaxing from humans. Jeff would reverently bring out his bow drill set, knead together a tinder nest, and with about fifteen seconds of bow-draw, an ember would magically appear. A spark was planted inside me at that very moment.

I moved to northern California in 2000 and mostly lost that valuable, one-to-one mentoring that has served to bring into each successive generation the exact duplication of skills necessary to promote us into the future. So I began to rely on the wisdom of elders in print: books, journals, newsletters, correspondence and Internet. I was inspired by the work of Dick Baugh, who offered encouragement and guidance. I was amazed at the variety of theories and techniques that surrounded friction fire. My amazement turned to confusion, however, when some applications consistently worked for me while others did not. Questions revolving around the nature of friction fire began to burn within me, questions that only I can answer for myself: Thus began an experiment. Here are the queries I wished to address:

1. Which local woods worked best?
2. Do woods used on themselves (e.g. buckeye on buckeye) generally perform better than woods used on other species (buckeye on redwood)?
3. Can non-wood hearthboards be employed successfully?

For the past eighteen months I gathered bow drill spindles and hearthboards from every single species of tree, shrub, liana and forb within a half-day walk of my home within the redwood forests of Loma Mar, California. As I collected such diverse materials as madrone, pear, and blackberry, I labeled and then dried the pieces for at least a week (in the house) before using them. I ended up with three or four spindles and a few hearthboards from each of the forty-four native and non-native species I was able to identify.

After cutting a piece of hairy honeysuckle for the bow, purchasing 500 feet of parachute cord, and finding a stone handhold in the tidepools, I began to attempt ember-making with all 1,936 possible combinations of the woods. Incredibly, the bow and rock handhold (which never heated up!) survived the entire experiment, while I ended up using around 400 feet of the cordage. Knowing from the onset that one of my goals was to add to the current amount of available information, I determined that the best way to relate what I *felt* was going on was to quantify the amount of effort I was putting into each attempt at an ember with a particular combination of woods. Effort ratings ranged from 1 (easiest) to 4 (very difficult), with a 5 representing the failure to get an ember. A summary is represented in **Table 1**.

While amassing the data I became concerned with the subjective nature of this endeavor. Interpreting effort expenditure can be highly variable, depending on such volatile factors as daily health, time of day, mindframe, energy level, and so on. One statistical procedure that can help gauge the coherency of the data is based on the overall average of the effort ratings. Since this is a comparative study, I had to quantify an average effort and assign it a number (in this case, 3). One could also argue that as I became increasingly proficient with the bow drill, my estimations would become skewed. So I looked at how close the average effort rating was (over all 1,936 data points the average was 3.22) to my initial average effort estimation (3.00). That's a 7% difference...is that significant?

It is interesting that while the overall average effort of all wood combinations is 3.22, using woods on themselves is just slightly lower, 3.18, It would seem that the supposed benefit of restricting oneself to making bow drill sets from only one species is rather insignificant.

**HEARTHS**

| **BOWDRILL - Effort Ratings** | | aca | map | box | buc | ald | mad | sag | coy | lil | cle | hor | dog | haz | cyp | s.b. | euc | bur | ivy | toy | o.s. | tan | hon | lup | app | wax | pin | plu | che | fir | pea | oak | cof | rho | goo | ros | bla | thi | wil | eld | rw | ced | bay | huc | gra |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Acacia sp. | Acacia | 3 | 2 | 3 | 1 | 4 | 5 | 3 | 2 | 5 | 2 | 2 | 4 | 3 | 1 | 3 | 4 | 5 | 3 | 5 | 5 | 2 | 2 | 1 | 3 | 3 | 2 | 4 | 3 | 2 | 3 | 3 | 4 | 2 | 2 | 3 | 4 | 2 | 5 | 1 | 3 | 4 | 4 | 3 | 3 |
| Acer macrophyllum | Big-leaf Maple | 3 | 2 | 3 | 2 | 3 | 3 | 1 | 3 | 4 | 2 | 4 | 3 | 4 | 2 | 3 | 2 | 3 | 4 | 5 | 2 | 4 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 4 | 5 | 1 | 2 | 2 | 2 | 4 | 3 |
| Acer negundo | Box Elder | 4 | 2 | 3 | 3 | 4 | 5 | 2 | 3 | 5 | 2 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 2 | 5 | 5 | 5 | 1 | 4 | 1 | 3 | 4 | 3 | 2 | 2 | 1 | 3 | 4 | 4 | 2 | 1 | 3 | 2 | 4 | 1 | 2 | 2 | 2 | 4 | 2 |
| Aesculus californica | CA Buckeye | 2 | 1 | 2 | 1 | 3 | 3 | 2 | 4 | 2 | 1 | 1 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 3 | 2 | 4 | 1 | 3 | 1 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 4 | 1 |
| Alnus rhombifolia | White Alder | 3 | 3 | 3 | 4 | 4 | 5 | 2 | 4 | 5 | 2 | 5 | 3 | 2 | 3 | 4 | 4 | 3 | 4 | 5 | 5 | 5 | 2 | 4 | 3 | 4 | 4 | 4 | 2 | 2 | 4 | 3 | 4 | 5 | 4 | 2 | 4 | 3 | 3 | 2 | 1 | 3 | 3 | 4 | 3 |
| Arbutus menziesii | Madrone | 4 | 5 | 5 | 4 | 4 | 5 | 5 | 3 | 3 | 3 | 3 | 4 | 4 | 3 | 5 | 5 | 5 | 4 | 5 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 2 | 4 | 3 | 5 | 3 | 2 | 4 | 5 | 4 | 4 | 4 | 3 | 4 | 5 | 4 | 3 | 4 |
| Artemisia californica | CA Sagebrush | 3 | 4 | 2 | 3 | 3 | 5 | 3 | 4 | 3 | 2 | 3 | 4 | 5 | 3 | 4 | 2 | 2 | 4 | 5 | 5 | 4 | 4 | 5 | 4 | 5 | 3 | 2 | 4 | 3 | 2 | 5 | 4 | 5 | 3 | 2 | 5 | 3 | 4 | 2 | 3 | 2 | 2 | 4 | 1 |
| Baccharis pilularis | Coyote Brush | 4 | 2 | 5 | 3 | 5 | 4 | 3 | 3 | 3 | 4 | 2 | 3 | 3 | 2 | 2 | 3 | 4 | 3 | 5 | 5 | 5 | 4 | 3 | 3 | 4 | 3 | 4 | 3 | 1 | 3 | 5 | 5 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 3 | 2 | 3 | 4 | 3 |
| Ceanothus thyrsiflorus | CA Wild Lilac | 2 | 3 | 2 | 3 | 4 | 5 | 3 | 4 | 4 | 3 | 5 | 3 | 5 | 4 | 2 | 2 | 3 | 3 | 5 | 5 | 5 | 4 | 4 | 4 | 5 | 3 | 2 | 4 | 2 | 3 | 4 | 5 | 3 | 2 | 3 | 4 | 4 | 4 | 2 | 3 | 4 | 4 | 5 | 4 |
| Clematis ligusticifolia | Clematis | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 4 | 3 | 3 | 1 | 4 | 4 | 3 | 5 | 4 | 3 | 2 | 2 | 4 | 3 | 1 | 2 | 2 | 2 | 2 | 4 | 4 | 2 | 1 | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 4 | 4 |
| Conyza canadensis | Horseweed | 4 | 4 | 1 | 2 | 3 | 3 | 2 | 1 | 4 | 3 | 1 | 3 | 4 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 1 | 3 | 4 | 4 | 3 | 1 | 3 | 3 | 1 | 5 | 5 | 4 | 3 | 3 | 5 | 4 | 3 | 3 | 2 | 1 | 3 | 4 | 2 |
| Cornus sericea | Amer. Dogwood | 2 | 1 | 4 | 2 | 3 | 3 | 2 | 5 | 4 | 3 | 2 | 4 | 4 | 2 | 4 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 5 | 3 | 3 | 3 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 4 | 3 | 5 | 4 | 3 | 2 | 3 | 3 | 4 | 5 | 4 |
| Corylus cornuta var. californica | CA Hazelnut | 3 | 2 | 2 | 3 | 5 | 5 | 4 | 5 | 4 | 2 | 3 | 4 | 3 | 4 | 3 | 3 | 4 | 1 | 5 | 4 | 5 | 3 | 3 | 4 | 4 | 3 | 5 | 5 | 3 | 3 | 4 | 4 | 5 | 3 | 3 | 5 | 3 | 4 | 2 | 3 | 2 | 4 | 5 | 4 |
| Cupressus abramsiana | SC Cypress | 2 | 4 | 4 | 4 | 4 | 3 | 3 | 5 | 3 | 2 | 2 | 4 | 5 | 2 | 3 | 4 | 3 | 3 | 4 | 4 | 5 | 3 | 4 | 2 | 5 | 5 | 2 | 2 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 4 | 4 |
| Cytisus scoparius | Scotch Broom | 1 | 3 | 5 | 1 | 5 | 5 | 3 | 4 | 4 | 3 | 4 | 3 | 4 | 2 | 3 | 2 | 3 | 2 | 5 | 4 | 2 | 3 | 3 | 2 | 5 | 5 | 5 | 4 | 3 | 3 | 4 | 3 | 4 | 3 | 2 | 4 | 4 | 3 | 1 | 1 | 2 | 2 | 4 | 4 |
| S Eucalyptus globulus | Eucalyptus | 4 | 3 | 2 | 2 | 2 | 5 | 1 | 5 | 3 | 3 | 1 | 3 | 3 | 2 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 5 | 2 | 2 | 4 | 3 | 4 | 3 | 4 | 4 | 5 | 4 | 1 | 3 | 2 | 5 | 3 | 2 | 1 | 2 | 2 | 3 | 4 | 5 |
| P Euonymus occidentalis | Burning Bush | 5 | 3 | 2 | 2 | 4 | 5 | 4 | 5 | 4 | 2 | 4 | 4 | 5 | 3 | 4 | 4 | 3 | 5 | 4 | 4 | 5 | 3 | 2 | 4 | 5 | 2 | 2 | 5 | 2 | 4 | 5 | 4 | 4 | 2 | 2 | 5 | 4 | 4 | 4 | 4 | 3 | 3 | 5 | 3 |
| I Hedera helix | English Ivy | 4 | 2 | 4 | 1 | 3 | 4 | 2 | 3 | 4 | 3 | 4 | 4 | 3 | 1 | 4 | 2 | 4 | 4 | 5 | 4 | 3 | 3 | 3 | 5 | 4 | 1 | 2 | 4 | 3 | 4 | 4 | 5 | 5 | 3 | 3 | 5 | 3 | 2 | 1 | 2 | 3 | 2 | 4 | 4 |
| N Heteromeles arbutifolia | Toyon | 3 | 5 | 3 | 2 | 4 | 4 | 5 | 5 | 5 | 3 | 5 | 5 | 3 | 5 | 4 | 4 | 3 | 4 | 5 | 2 | 4 | 3 | 4 | 4 | 5 | 5 | 3 | 2 | 2 | 4 | 4 | 5 | 3 | 5 | 5 | 5 | 3 | 4 | 3 | 3 | 3 | 4 | 5 | 3 |
| D Holodiscus discolor | Ocean Spray | 2 | 4 | 4 | 3 | 4 | 5 | 3 | 5 | 3 | 2 | 3 | 5 | 4 | 4 | 3 | 4 | 4 | 3 | 2 | 3 | 5 | 3 | 4 | 4 | 4 | 4 | 5 | 4 | 1 | 2 | 4 | 4 | 3 | 3 | 5 | 3 | 5 | 4 | 1 | 3 | 2 | 2 | 3 | 2 |
| L Lithocarpus densiflorus | Tan Oak | 1 | 3 | 5 | 2 | 5 | 4 | 4 | 3 | 3 | 4 | 5 | 4 | 5 | 4 | 4 | 2 | 4 | 4 | 4 | 3 | 5 | 5 | 4 | 3 | 5 | 5 | 2 | 4 | 3 | 4 | 4 | 4 | 2 | 3 | 5 | 4 | 4 | 5 | 2 | 2 | 3 | 3 | 4 | 3 |
| E Lonicera hispidula var. vacillans | Hairy Honeysuckle | 2 | 2 | 4 | 1 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 2 | 2 | 3 | 4 | 4 | 3 | 4 | 2 | 3 | 5 | 1 | 2 | 3 | 3 | 2 | 1 | 3 | 1 | 2 | 4 | 5 | 5 | 3 | 4 | 2 | 2 | 3 | 1 | 1 | 2 | 4 | 3 | 3 |
| S Lupinus arboreus | Tree Lupine | 4 | 3 | 3 | 2 | 4 | 5 | 5 | 3 | 4 | 3 | 5 | 2 | 4 | 4 | 3 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 3 | 2 | 4 | 4 | 2 | 3 | 2 | 5 | 4 | 2 | 2 | 4 | 5 | 3 | 2 | 3 | 3 | 4 | 4 | 5 | 2 |
| Malus sp. | Apple | 2 | 3 | 2 | 1 | 3 | 5 | 3 | 3 | 3 | 1 | 3 | 4 | 4 | 2 | 5 | 2 | 4 | 2 | 5 | 5 | 3 | 1 | 2 | 4 | 4 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 5 | 2 | 4 | 4 | 2 | 3 | 2 | 3 | 4 | 5 | 3 |
| Myrica californica | Pac. Wax Myrtle | 3 | 3 | 4 | 2 | 3 | 4 | 4 | 3 | 4 | 2 | 2 | 4 | 5 | 5 | 4 | 2 | 2 | 2 | 4 | 5 | 4 | 4 | 4 | 4 | 4 | 3 | 2 | 3 | 3 | 1 | 3 | 4 | 2 | 4 | 4 | 5 | 3 | 4 | 3 | 3 | 4 | 4 | 5 | 5 |
| Pinus radiata | Monterey Pine | 4 | 2 | 3 | 2 | 4 | 4 | 3 | 5 | 3 | 2 | 2 | 4 | 3 | 3 | 3 | 3 | 2 | 2 | 4 | 3 | 4 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 4 | 3 | 2 | 3 | 3 | 3 | 1 | 1 | 2 | 1 | 3 | 2 |
| Prunus cerasifera | Cherry Plum | 3 | 3 | 1 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 5 | 3 | 5 | 3 | 4 | 3 | 4 | 4 | 2 | 5 | 4 | 3 | 3 | 3 | 5 | 3 | 5 | 3 | 3 | 2 | 4 | 4 | 4 | 5 | 3 | 3 | 3 | 5 | 3 | 2 | 3 | 5 | 5 | 3 |
| Prunus sp. | Wild Cherry | 4 | 1 | 2 | 2 | 5 | 4 | 3 | 4 | 4 | 3 | 3 | 1 | 5 | 2 | 3 | 2 | 2 | 5 | 3 | 4 | 3 | 2 | 5 | 4 | 4 | 3 | 4 | 3 | 2 | 4 | 5 | 3 | 5 | 4 | 5 | 3 | 3 | 5 | 2 | 1 | 5 | 4 | 3 | 1 |
| Pseudotsuga menziesii | Douglas Fir | 2 | 2 | 3 | 2 | 2 | 5 | 3 | 3 | 4 | 2 | 1 | 4 | 4 | 3 | 2 | 3 | 2 | 3 | 4 | 4 | 3 | 2 | 3 | 1 | 2 | 3 | 2 | 1 | 2 | 4 | 2 | 3 | 3 | 4 | 1 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | 3 | 3 |
| Pyrus sp. | Pear | 5 | 4 | 2 | 2 | 2 | 4 | 5 | 5 | 4 | 1 | 4 | 3 | 3 | 4 | 5 | 2 | 3 | 4 | 4 | 5 | 2 | 2 | 2 | 5 | 5 | 2 | 2 | 4 | 1 | 4 | 4 | 4 | 3 | 5 | 1 | 3 | 3 | 3 | 2 | 1 | 2 | 1 | 5 | 2 |
| Quercus wislizeni | Interior Live Oak | 5 | 4 | 5 | 4 | 5 | 5 | 4 | 5 | 5 | 4 | 4 | 4 | 4 | 5 | 4 | 4 | 5 | 4 | 3 | 5 | 3 | 5 | 4 | 3 | 4 | 3 | 3 | 2 | 2 | 5 | 5 | 5 | 2 | 2 | 3 | 4 | 5 | 5 | 3 | 2 | 4 | 3 | 5 | 5 |
| Rhamnus californica | Coffeeberry | 4 | 2 | 5 | 2 | 5 | 4 | 4 | 4 | 2 | 3 | 1 | 5 | 4 | 2 | 1 | 3 | 4 | 2 | 5 | 5 | 4 | 4 | 4 | 5 | 5 | 4 | 2 | 1 | 3 | 3 | 5 | 5 | 2 | 3 | 4 | 4 | 4 | 3 | 2 | 2 | 3 | 3 | 3 | 1 |
| Rhododendron macrophyllum | Rhododendron | 4 | 3 | 3 | 3 | 5 | 5 | 4 | 3 | 5 | 2 | 4 | 3 | 4 | 3 | 4 | 2 | 3 | 2 | 2 | 3 | 5 | 3 | 4 | 2 | 3 | 4 | 5 | 2 | 3 | 2 | 5 | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 4 | 1 | 1 | 5 | 4 | 2 |
| Ribes menziesii | Gooseberry | 3 | 4 | 5 | 4 | 2 | 5 | 2 | 4 | 5 | 2 | 3 | 2 | 4 | 3 | 1 | 4 | 2 | 3 | 4 | 4 | 2 | 4 | 5 | 3 | 5 | 3 | 1 | 3 | 2 | 1 | 3 | 4 | 4 | 3 | 3 | 3 | 2 | 5 | 1 | 3 | 3 | 3 | 3 | 2 |
| Rosa gymnocarpa | Wood Rose | 4 | 2 | 2 | 1 | 2 | 5 | 3 | 3 | 3 | 1 | 4 | 3 | 3 | 4 | 2 | 4 | 3 | 5 | 4 | 5 | 4 | 4 | 3 | 3 | 4 | 2 | 2 | 4 | 1 | 3 | 5 | 3 | 3 | 2 | 2 | 4 | 4 | 4 | 1 | 1 | 3 | 3 | 4 | 3 |
| Rubus discolor | Hm. Blackberry | 4 | 4 | 5 | 5 | 4 | 5 | 2 | 5 | 5 | 2 | 3 | 5 | 5 | 4 | 5 | 5 | 4 | 3 | 4 | 5 | 4 | 1 | 4 | 5 | 5 | 4 | 5 | 4 | 2 | 5 | 4 | 5 | 3 | 5 | 4 | 4 | 5 | 3 | 2 | 3 | 5 | 4 | 5 | 5 |
| Rubus parviflorus | Thimbleberry | 2 | 3 | 1 | 1 | 2 | 3 | 4 | 4 | 3 | 2 | 4 | 3 | 4 | 5 | 3 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 3 | 2 | 4 | 4 | 2 | 2 | 4 | 5 | 3 | 5 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3 | 5 | 3 |
| Salix sp. | Willow sp. | 2 | 1 | 3 | 2 | 3 | 3 | 3 | 4 | 3 | 4 | 1 | 4 | 5 | 5 | 4 | 3 | 3 | 2 | 2 | 4 | 3 | 2 | 2 | 4 | 5 | 4 | 2 | 2 | 1 | 3 | 3 | 3 | 3 | 4 | 4 | 5 | 3 | 2 | 1 | 1 | 3 | 4 | 5 | 5 |
| Sambucus mexicana | Blue Elderberry | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 4 | 2 | 2 | 3 | 4 | 1 | 1 | 3 | 5 | 3 | 2 | 2 | 3 | 2 | 4 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 4 | 2 | 1 |
| Sequoia sempervirens | Coast Redwood | 1 | 3 | 4 | 1 | 4 | 4 | 3 | 1 | 3 | 2 | 2 | 2 | 4 | 3 | 2 | 4 | 2 | 1 | 3 | 3 | 1 | 1 | 4 | 3 | 3 | 3 | 1 | 2 | 4 | 2 | 3 | 3 | 5 | 2 | 3 | 3 | 3 | 1 | 2 | 2 | 2 | 3 | 2 | 4 |
| Thuja plicata | W. Red Cedar | 4 | 2 | 3 | 2 | 2 | 4 | 3 | 2 | 3 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 3 | 2 | 4 | 4 | 3 | 2 | 5 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 4 | 4 | 3 | 4 | 3 | 5 | 3 | 3 | 2 | 1 | 3 | 4 | 4 | 2 |
| Umbellularia californica | CA Bay Laurel | 3 | 3 | 3 | 1 | 4 | 4 | 4 | 4 | 3 | 1 | 4 | 2 | 2 | 3 | 2 | 4 | 4 | 4 | 4 | 5 | 5 | 2 | 3 | 2 | 4 | 5 | 3 | 3 | 3 | 4 | 5 | 4 | 3 | 4 | 4 | 5 | 3 | 5 | 3 | 2 | 1 | 3 | 4 | 3 |
| Vaccinium ovatum | Huckleberry | 1 | 1 | 2 | 3 | 5 | 5 | 4 | 4 | 5 | 2 | 3 | 4 | 4 | 2 | 5 | 3 | 5 | 3 | 5 | 5 | 3 | 3 | 3 | 1 | 4 | 4 | 2 | 3 | 4 | 2 | 2 | 5 | 2 | 4 | 3 | 5 | 5 | 4 | 3 | 2 | 3 | 3 | 4 | 3 |
| Vitus californica | Wild Grape | 2 | 4 | 5 | 1 | 3 | 5 | 3 | 5 | 4 | 2 | 1 | 2 | 3 | 3 | 4 | 2 | 4 | 1 | 4 | 3 | 2 | 5 | 5 | 2 | 2 | 3 | 3 | 2 | 2 | 4 | 4 | 5 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 2 | 4 | 3 | 2 | 2 |