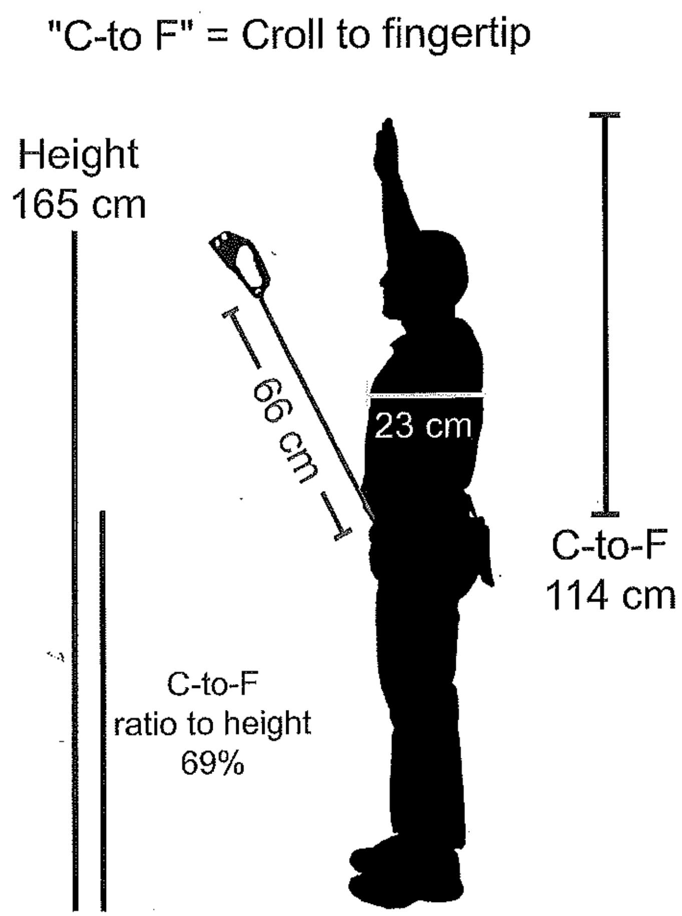


Fig #1: My actual body measurements. Overall height: 170 cm, Croll to Fingertip distance 114 cm (percentage to height - 69%), chest depth 23 cm, actual cowtail length 66 cm (without ascender). With a 35 cm stoke, my body type limits me to the low end of average for Frog System effectiveness.

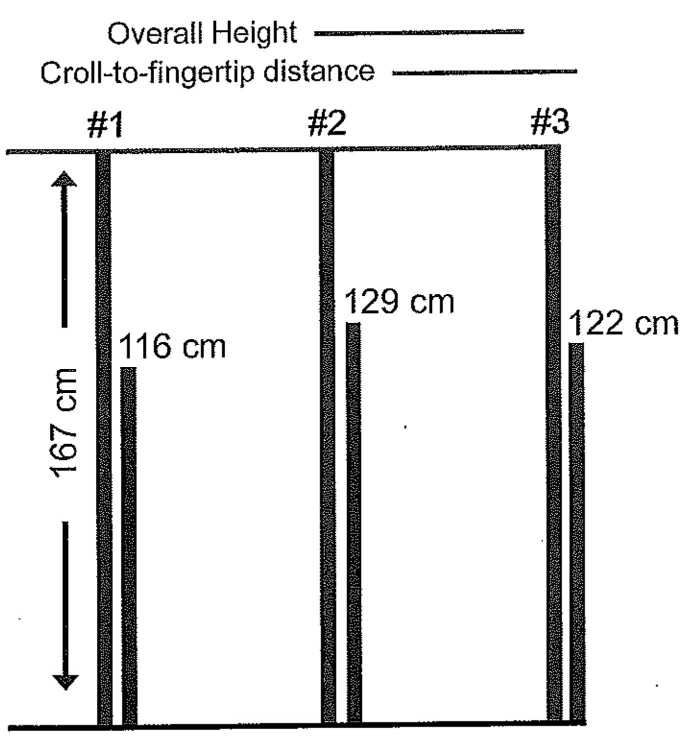
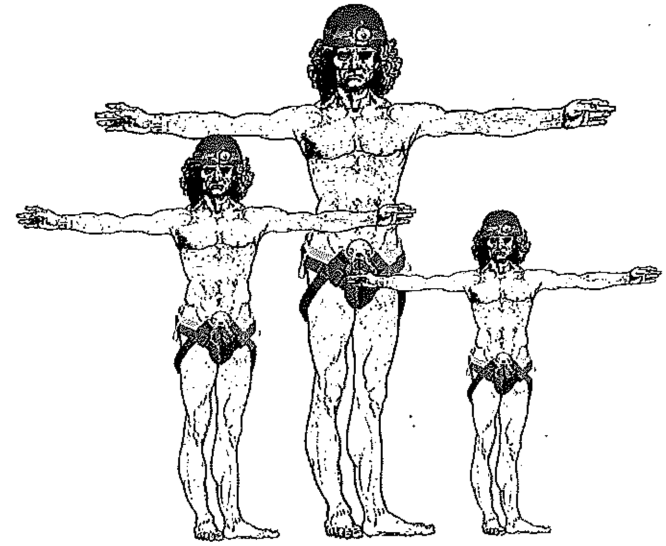


Fig #2: Combined torso and arm length varies between cavers of the same height. Red line = overall height, blue line = Croll to fingertip distance. Percentages are C to F distance to overall height. This affects the Frog "stoke" because it affects the length of the safety tether.



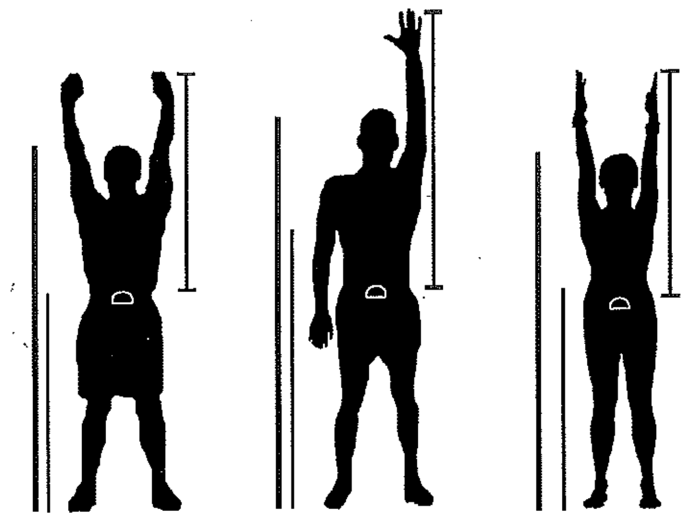


Fig #3: These silhouettes are made from photos and are proportionally accurate. The Maillon was added for clarity, but is located correctly for each person when standing. Measuring the Croll-to-fingertip distance on different cavers reveals the ratio of a caver's torso and arms to their height. The man in the center is not only 8 cm taller than the man on the left; his Croll-to-fingertip distance is also a larger proportion of his height. Given equal body conditioning and skill levels, the Frog System is inherently most effective for the man in the center. The woman (right) is not only the shortest individual; she also has the lowest Croll-to-fingertip ratio. Her body type is the least effective of the three for the Frog System.

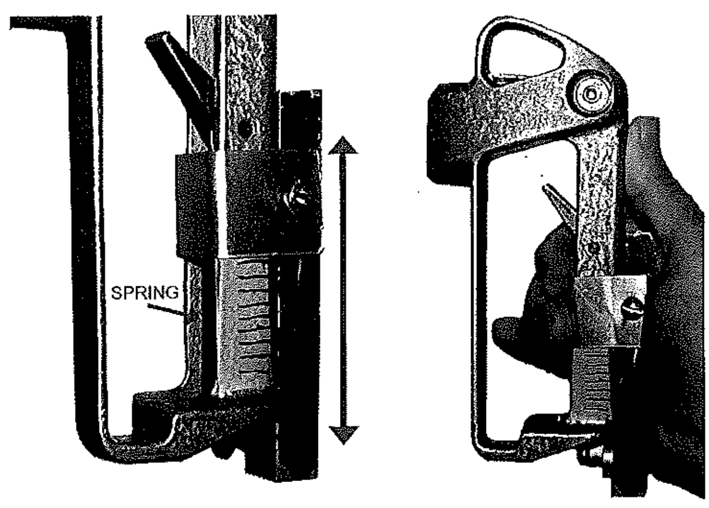


Fig #4: To measure arm load, I converted an old Jumar to a scale using a spring and a sliding hand grip. Loads were recorded while climbing with the Frog and calibrated using a fishing scale. The ascender on the right shows a 500 g load.

Typecasting The Vertical Caver

John Woods, NSS #10503

My curiosity about how body types affected the efficiency of rope climbing systems was sparked by watching students ascend. Some struggled with the Frog System while others had little or no trouble using it. The more I watched, the more it seemed that the efficiency of the Frog System was affected by a person's body type. I wondered if there was a point at which the system itself became detrimental to some cavers. It is important to remember that I am not writing about people who are out of shape or physically disadvantaged. These are people whose body type may not correspond with what is efficient for the Frog system. I felt that body characteristics should be seriously considered when assessing personal vertical efficiency with an ascending system.

Universal techniques are generally effective, but when a specific climbing system hinders individual efforts, it should be reconsidered in favor of a broader view of the effectiveness of the individual, and subsequently, of the caving group at large. The most common justification for the Frog System is: *Use a standard system and everyone will be happy forever after.* A noble goal, but it denies the aphorism: "Foolish consistency is the hobgoblin of small minds." The key word here is "foolish." A "consistency above all" doctrine fosters the impression that an ascending method other than the Frog somehow subverts all alpine SRT technique, causing fires, floods, and disasters of biblical proportions. Personally, I doubt the existence of panaceas and debate the competence of any caver who cannot master a second ascending system without forgetting the first.

Staunch proponents of specific systems cleverly address their favorite only within the context where it excels. Froggers cite crossing obstacles like rebelays or equipment simplicity as the highest priorities. They claim that other systems are "heavy," "slow to cross mid-rope obstacles," or "very slow on/off rope." *Climbing efficiency is never mentioned since it does not suit their arguments.* Of the 20 cavers that I polled from the U.S. and abroad who advocated that the Frog System was definitively superior, only 2 had ever actually *used* any other system. Eighteen had formed their opinions without either testing or personal experience.

Ropewalker and Mitchell advocates (all U.S. cavers) stress climbing efficiency as the highest priority. They suggest that the Frog is far less efficient and also claim that any time lost in crossing rope obstacles is compensated for by faster climbing times and energy saved. *They ignored versatility, weight and simplicity when it compromised their position.* Out of the 20 U.S. cavers who advocated systems other than the Frog, eighteen had previous experience with two or more systems including the Frog.

None of the advocates on either side paid more than cursory attention to the relationship of body characteristics to the effectiveness of a system and none had ever compared the effectiveness of different systems when ALL aspects of ascending were considered. This prompted me to conduct three sets of tests:

1. **The Frog System body type tests.** An investigation of the Frog System's relative effectiveness with different body types. These are the tests described in this article.
2. **Comparisons of the Frog and the Mitchell ascending systems for crossing common mid-rope obstacles and for overall vertical effectiveness.** I tested the overall vertical efficiency when using both the Frog and the Mitchell systems under common Alpine SRT rigging conditions.
3. **The Mitchell System body type tests.** An investigation of the Mitchell System's relative effectiveness in real-world situations with different body types.

The results may be found at: www.johncharleswoods.net/pages/cavetech.htm

The Frog System body type tests

The basic body characteristics affecting the Frog system are:

1. Overall height
2. Torso length
3. Arm and leg length
4. Chest depth: *To clarify: This is NOT a circumference measurement. It is the distance as measured straight through the body from the sternum to the backbone (see Fig. 1). A wide chest (left to right) does not necessarily indicate a deep chest*
5. Weight distribution top-to-bottom (top heavy or bottom heavy people).

I could find no published evaluations of how each body characteristic affected the Frog system. My best option was to test each effect on a practical level. Ten (10) different cavers were selected for body type testing. They represented a variety of body types ranging from short and stout to tall and lean. They comprised a reasonable cross section of cavers in the U.S., both in body type and degree of vertical experience.

Overall height: I'm a short guy at 1.70 meters and my Frog vertical progress per stroke is only about 35 cm. I measured the stroke of a very tall, long-limbed, narrow-chested caver (aka: "the perfect Frog body") and his bite was almost 63 cm. This means that I must do 86 sit-stand cycles to ascend 30 meters while the taller caver does only 48 sit-stand cycles. When I mentioned this as a personal disadvantage to one Frog advocate, he rashly declared that the total amount of energy required to climb a rope was ALWAYS the same for everyone. This is technically, but not effectively true because the efficiency of the climbing system has not been considered. Publications suggest that a properly adjusted Frog System should provide a stroke of approximately 25% of the caver's height. This could only be literally true if everyone's body proportions were identical. By those calculations, my stroke should be approximately 40 cm. Due to my body type however; my practical stroke limit is 35 cm. A 5 cm per-stroke disadvantage may sound small, but I have heard many a vehement argument about an 80 gm difference in ascending system weight when it tipped the scales toward a favorite system.

Even if all body proportions were identical, this single assertion acknowledges that shorter cavers are inherently disadvantaged when using the Frog. I challenged the "perfect Frogger" to limit his stroke to equal mine and then tell me he used the same amount of energy to climb the rope as before. He refused. He then countered with "But you have less mass to move each time," (which is NOT always the case). The conversation ended when I replied "You have more muscle mass to move it!" It appears that even for advocates, the Frog is much less appealing with a 35 cm bite than a 63 cm bite. It would be equally inaccurate to state that long-limbed, broad-shouldered cavers can pass through small holes and tight "S" turns with the same amount of energy that I use. After all, it's the same horizontal distance isn't it? The lesson here is the imprudence of saying: "It works perfectly for me, so it must therefore be perfect for you!"

It is important to note that shorter stature or less effective body proportions do not necessarily indicate lower mass. In Figure #2, caver #1 and caver #2 were of equal weight, but had significantly different strokes. This means that caver #1 had to move equal mass through more sit-stand cycles than caver #2 to cover the same distance.

Note: Common U.S. practice is to connect the long cowstail to the upper ascender during ascents. Dedicated tethers are seldom used. The term "cowstail" will be used in this article when referring to this connection.

Torso length: A major consequence of torso length is that, when combined with arm length, it determines the maximum practical length of the cowstail attached to the upper ascender. This affects the maximum *Croll-to-upper ascender* distance and therefore the maximum potential bite. A cowstail longer than someone's reach is both pointless and problematic. Conversely, a cowstail that is too short limits the Frog stroke.

Torso length varied considerably between the people of similar heights who were tested. The worst case (shortest torso) lost about 4 cm on every stroke compared to a longer torso. This is an accumulating effect and is impossible to correct by altering the system in any safe way. Observations suggest that leg length is less important than torso/arm length to the amount of stroke because it does not affect the length of the cowstail that limits the stroke. Most Frog systems are initially adjusted to accommodate proper cowstail lengths and then the foot loops are adjusted in relation to the cowstail. The maximum stroke however, is still limited by the cowstail. More tests are needed to determine the precise effect of leg length on the Frog system.

Arm length: Combined with torso length, the shortest torso and shortest arm combination that was tested showed a loss of about 10 cm per cycle compared to people of similar overall height: 5 cm for the arms plus about 5 cm for the torso. The shortest torso and shortest arm proportion also happened to be on the shortest person tested: 160 cm. With the long cowstail length keeping the upper ascender within reach, their total stroke was about 33 cm per cycle. This translates to a required 70 sit-stand cycles to climb 30 meters versus 92 for two climbers of equal height, but different proportions.

Chest depth (front to back): I modified a Jumar ascender (See Figure #4) to measure how much relative load (pull) was being placed on it. Admittedly, the tests were not very precise, but I was after general load *differences*, not literal measurements. Climbing speed was not an issue and climbing times were not measured in this test. I instructed the climbers to use the best Frog technique possible and the climbing distance was kept short at 20 meters, so fatigue would be a small factor. In reality, Frog climbing technique gets worse with longer ascents. Because literal arm loads varied with the climber, the distance and the individual climbing style, the results are expressed in percentages compared to the normal arm load of each subject.

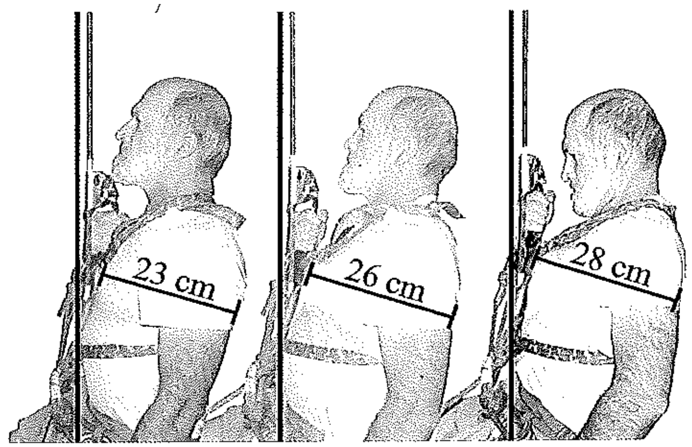


Fig #5: Relative body positions while on rope with increased chest depth. The vertical red lines are a true vertical reference, the blue line a true horizontal reference. Numbers indicate effective chest depth. The climber is grayed out to show measurements more clearly. The padded chest harness is worn underneath the shirt and is slightly visible. The left photo is without chest harness (normal). The center photo shows a 2 cm increase. The right photo shows a 4 cm increase. In each case, an effort was made to remain as vertical as possible. Note the changing head positions in each photo as the climber involuntarily adjusts to being thrown off the vertical. The 4cm increase forced climbers into uncomfortable head positions to maintain proper equilibrium and verticality.

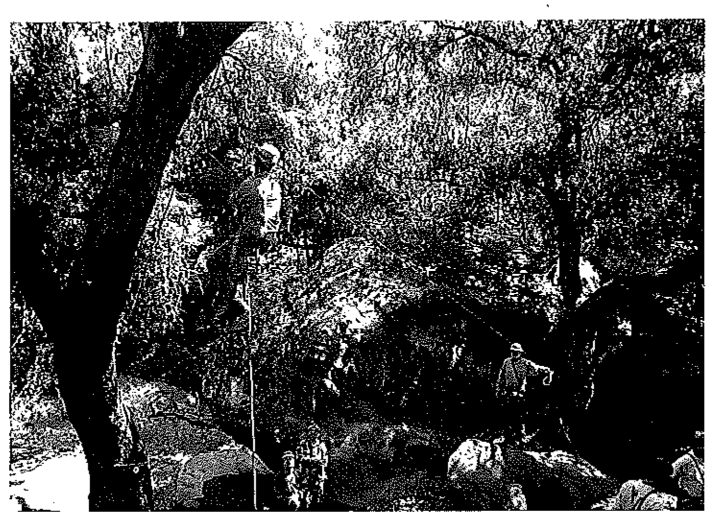
The front-to-back chest depth was increased 4 cm using a padded chest harness (See Fig. #5). The harness simulated the consistency and flexibility of the human body as closely as possible within my budgetary limitations. I then measured the arm load *difference* from each subject's norm without the vest. A 4 cm increase in chest depth resulted in a *minimum* of 25% more load on the arms even with the best possible Frog technique. This 25% increase in load is not to be confused with 25% of the total body weight – it means that the climber placed 25 % more weight on the upper ascender than without the padded harness. Although the literal amount of load varied with each person's technique, the percentage changes were fairly consistent in each individual as the chest depth increased.

Moving the upper body weight further away from the rope forced a significantly larger reliance on the arms to carry the load regardless of all attempts to remain vertical. It also forced the climber to thrust their head uncomfortably forward to maintain equilibrium. This makes it impossible for people with deeper chests to stay as vertical as people with narrower (front to back) chests and significantly increases neck fatigue. Due to fatigue, the arm load inevitably increased as the length of the climb increased.

Weight distribution (top to bottom): Since increased chest depth virtually always indicated greater upper body weight, the subjects were loaded up with chest weights equaling approximately 5% of their total body weight. The extra upper body weight also forced the climber away from the vertical with every sit/stand cycle, subsequently forcing greater reliance on the arms to ascend. Increasing the chest depth 4 cm AND chest weight 5% resulted in an arm load increase of about 33% (average) per sit/stand cycle compared to their norm.

Compounding the chest depth/weight problem

It is important to note that the above chest depth and chest weight tests measure only the arm load difference between each individual's normal technique and the modified chest test. Comparing the relative effort between climbers of different body types is even more revealing. My sampling included two subjects of approximately the same chest *circumference*, 104 cm and 106 cm, and of approximately the same weight, 81 kg and 86 kg respectively. The first subject however, was barrel-chested and the other had a relatively broad (wide), but not a deep chest. Despite the similar chest circumference and relatively equal weight,



the barrel-chested subject routinely loaded the upper ascender with 10-12% more weight than the wide-chested subject. If equal strength and stamina are assumed for all subjects, the barrel-chested caver is at considerable disadvantage compared to the "average" caver.

Body Type Test Conclusions

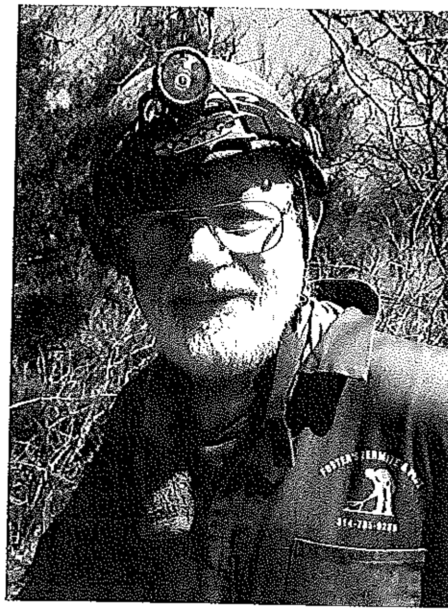
I do not consider these tests definitive, but they do provide insight into how body type affects the Frog system. The results suggest that with the Frog System, the amount of wasted energy significantly increases for some body types compared to others. The negative effects of greater chest depth, greater upper body weight, short stature, short arms and short torsos are cumulative and negative. They result in progressive inefficiency as the number of sit/stand cycles increases and fatigue sets in. Every time the climber is forced to compensate for being thrown off vertical or is required to use more sit stand cycles, energy is expended that the ideal Frog body type does not expend.

The degree of efficiency varies with each climber, but the negative effects cannot be denied. These factors indicate that for some climbers, there may be a point where the Frog system cannot be justified due to the body type. This suggests a need for an alternate ascending system that combines the versatility of the Frog under Alpine SRT rigging conditions, with greater climbing efficiency for those body types. Europeans have recognized this systemic problem and some address it through the addition of a low-placed foot ascender such as a Petzl Pantin for longer climbs. I have even found a couple of British websites illustrating a method of converting a Frog System to a bungee-assisted ropewalking system for very long ascents.

For many body types, the Frog System offers adequate climbing efficiency combined with minimal equipment and high versatility. Due primarily to its universality, most cavers should consider another ascending system ONLY if the caving situation warrants it, such as for extremely deep pits. However, with body types where the Frog System is significantly less effective, switching to an alternate system could improve overall vertical efficiency in nearly every situation. This would also improve group efficiency whenever that caver is present. The amount of individual improvement would depend upon the alternate system, the number of mid-rope obstacles (rebelays. knots etc.) and the length and spacing of the pitches.

[Ed. note: This article was previously published in the British caving magazine *Descent*]

OBITUARIES



James V. Wilson

NSS 27405 FE
1937 – 2012

Jim Wilson died unexpectedly at his home on June 6, 2012 at the age of 74. I and many other Colorado cavers had the privilege of caving with him over two decades. Jim was born October 13, 1937. He grew up in Kansas City and then went to college at Arizona State University. After serving in the Navy, he moved to Colorado in the early 70s where he worked as a comptroller for the University of Colorado. Upon retiring, he worked part time at a supplier for National Public Radio. Jim and his wife Jane had just celebrated their 52nd anniversary.

You never forgot caving with Jim. He was absolutely tenacious. Although he caved all over the Southwest and Midwest, his first love was Wind Cave NP in South Dakota. He carefully studied maps of the passages and pushed leads in areas that nearly every other caver bypassed on their way to the outer edges of the map. He never took what he saw on faith. If a map showed a blank wall, it triggered an almost irresistible urge to see if the area was truly devoid of leads. In this way, he made one of his most significant discoveries—the Kneebone area of Wind Cave with over three miles of passage. It was right in the middle of known cave and had probably been bypassed hundreds of times. Jim knew there had to be a way into the void and he pushed every crack until he found it. Although Jim was 74, he always kept in great physical shape, mostly through swimming. He could easily exhaust cavers in their 20s and 30s.

When Jim was in his 60s, a reporter from the Denver Post was invited on one of Jim's trips to Wind Cave. He called it "brutal." Jim was just doing what he normally did. In all, he made 139 trips there, surveying almost nine miles of passage.

There were certain rules to caving at Wind Cave with Jim. He always insisted on spending at least as much time in the cave as driving to and from it. This made for some very long trips. When it came time to leave the next morning, it was always at 5:00 a.m. sharp. It didn't matter how tired you were. Jim was as meticulous with his surveying as with exploration. It was a pleasure to cave with him.

Around fifteen years ago, Jim met Leo Thompson from Missouri. Leo had been caving at Wind Cave NP and Jewel Cave, NM in South Dakota. They got together and organized an annual Spring trip to southern Missouri and northern Arkansas with Jon Beard and other fellow cavers from the Ozarks region. We typically drove down to the Springfield, Missouri area on a Thursday, caved our brains out Friday and Saturday, and drove back on Sunday. He was on the most recent trip this March although he couldn't crawl into the caves due to a broken collarbone.

Jim was a Fellow of the NSS and longtime Colorado Grotto member, serving as Secretary, Treasurer, and Grotto Greeter. He put in a lot of work as treasurer of the 1996 NSS Convention. He took his job very seriously. Jim was also an excellent writer, specializing in cave-related fiction. He was an early member of the Arts and Letters section of the NSS.

Jim loved to backpack. Some of these trips were combined with caving. He organized an annual Marble Mountain trip to Spanish, White Marble Halls, and other high alpine caves in the Westcliffe, Colorado area. He organized annual weeklong backpacking trips with Colorado cavers to remote areas of Colorado, New Mexico, and Utah. He truly enjoyed the wilderness. Later he continued backpacking with his daughter Susan. After every trip, Jim produced a wonderful photo book for every participant with stories about the trip.

He is survived by his wife Jane, a brother, Richard; sons Peter, Jeff and Jon and a daughter Susan along with seven grandchildren.

He will be truly missed by the caving community.

Greg Glazner
NSS 31856