

# Clothing Materials

## A totally (or near-totally) subjective analysis of newer clothing materials for outdoor clothing

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## Putting my Money Where my Mouth Is

People sometimes ask me what I *really* wear in cold weather, and to name manufacturers and models. For the winters of 2014-17, my go-to clothing for aerobic cold weather activities around the freezing point – hiking, climbing, search and rescue tasks, or disaster team tasks – is mostly wool instead of synthetics, at least above the waist. Why? Stretchier so I can move better, doesn't smell as bad after a week or so of wear, and ventilates better. From inside to out:

- **Ibex Pulse bike jersey:** this short-sleeve stretch wool garment fits well, wicks, is warm when wet, and doesn't smell bad for 3-4 days of continuous use. I like to have a short sleeve baselayer so I can strip down if I go into a warm building. Quite comfortable against the skin.
- **Ibex Shak** full-zip non-hoody long sleeve wool top. I find the full-zip version better than the pullover. I can ventilate better by pulling the zipper way down, and it's easier to get on and off. The zipper causes no problems when I tuck the Shak into my pants. Very stretchy.
- **Ibex Scout** full-zip wool sweater. It's cut well enough and stretchy enough that I can do twist in any direction without it binding, whether reaching for a handhold or putting up a Disaster Medical Assistance Team Western Shelter tent.
- **Ibex Guide** wool sweater. This is thick but very, very stretchy, and easily fits over the other tops without any difficulty. For really cold weather, I add a second Guide sweater; I have a small and a medium for layering like this.
- A **North Face Nimble softshell** made of Apex Aerobic. It's only mildly to moderately wind- and rain-resistant but very breathable, and the stretchiest softshell I've found.
- Only if needed for wind or cold, an **Arcteryx Squamish** ultralight hooded windshirt. It stuffs into its own pocket and easily and completely fits into a side pocket of my buttpack. The only drawback is that it's hard to fit gloves, hat and facemask into the one chest pocket available on the Squamish hoody.

- And for when I stop for lunch, or to take care of an emergency, and I need extra warmth, I throw a hooded **Feathered Friends Helios Down Jacket** over it all. If you want a high-quality down jacket, Feathered Friends in Seattle has long been my go-to place. Europeans call such a garment as a "duvet" and it's standard practice to always have a duvet in your pack for emergencies. For less-cold weather, a Feathered Friends down vest goes in my pack.

I always keep the same things in the same packets in my softshell:

- **Right zip "handwarmer" pocket:** Gloves, and when it's cold enough, mitten shells for over them, and for when it's really cold, mittens to go between the gloves and the mitten shells.
- **Left zip "handwarmer" pocket:** hat. I've played with many different hats over the years, and my current favorite is the Outdoor Research Rando Cap. Its Gore-Tex, so it's waterproof. It has a small brim that keeps the sun out of your eyes, and it's stiff enough to work as a brim yet foldable enough that you can easily fold up the hat and stick it in your pocket. It's lined with comfy wicking fuzzy fairly thin fleece. There are ear flaps that actually stay over your ears. If you're warm enough you don't need the ear flaps you can fold them up inside the cap and still wear it to keep the sun out of your eyes or the rain off your head
- **Chest zip pocket:** a thin neoprene facemask, or for when it's colder, one that's wider, with fleece on the sides and back, and if you pull it down off your face, serves as a fleece neck gaiter. This is needed on windy cold frostbite-prone days. But It also adds a fair bit of warmth by insulating your nose and acting as a little bit of a "rebreath flap" to use your exhaled warmth and moisture to warm and humidify air even before it gets to your nose. For such a light item, it adds an amazing amount of warmth on a cold day.

Below the waist, I wear Capilene Daily briefs, and two layers of Capilene 4 = Expedition Weight = Thermal Weight, size medium over size small. Over this I wear a pair of REI Mistral or Acme or similar stretchy softshell pants. Why not wool below the waist? It would certainly smell better after a week.

I've yet to find wool long underpants that provide the warmth-without-weight of Capilene. The die-cut fuzz on the inside of Capilene provides a level of warmth with sturdiness that none of the wool long underwear can match. Unfortunately, Ibex doesn't make an equivalent of the Shak, Scout or Guide sweater for your legs. If they did, I'd buy one. And I've yet to

find a pair of wool-lined softshell pants that actually fit me properly; and, the wool lining is very thin.

I expect that at some point I will switch to wool below the waist, but not yet. And I just love all those funny bumps on my legs after taking off Capilene 4 underwear.

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## Names and Fabrics: A Rose is a Rose, but Polyester isn't just Polyester!

There are zillions of fabric materials out there. For example, Malden Mills, which is the Polartec people, has only about 12-15 brand names. But each of these comes in slightly different flavors – they actually make more than 150 different fabrics! Only some are suitable for the outdoors, and I've tried to limit the table to outdoor or travel clothing materials.

Here's just one example. Eastern Mountain Sports (EMS) sells a lot of outdoor clothing in the northeast. They had a brand name called *Bergelene* (though I haven't seen it in recent years). I'd seen mention that *Bergelene* was nylon, that *Bergelene* was polyester, that *Bergelene* was *Malden Power Dry*, and then I bought a pair of men's *Bergelene* briefs at the local EMS store, and the label says "*CoolMax*." What gives? Well, I talked with Patricia at EMS, and she told an interesting story. Back when Patagonia came out with *Capilene* treated polyester underwear (which has evolved over the years, but always continues to be a favorite), EMS came out with their own trade name for similar clothing, *Bergelene*. I'd heard it was bought from a Norwegian company that makes clothing with a somewhat similar name, but Patricia pooh-pooed this, saying it was named after a guy who worked for EMS named Berge. And, she told me, the fabric used in "*Bergelene*" products did indeed change over the years. The lightweight *Bergelene* I bought back about 2006 was indeed *CoolMax*. But of interest, the *CoolMax* that they used was knit in a way that makes it very, very stretchy, much more so than most *CoolMax* items. But the mid- and heavy-weight *Bergelene* was actually Malden's *Power Dry*. And, to make things more complicated still, EMS switched to the *TechWick* brand name (which it has used for the past decade or two), which includes something similar to silkweight *Capilene*: very silky, feeling somewhat like the *Intera DryForce* mentioned below.

Another problem is that the same material may appear under different brand names. For example, Malden Mills' *Power Stretch* line of stretch fleece appears in a number of guises and brand names. The original *Power Stretch* is still one of my favorite fabrics – I have a vest and sweater made of it that I wear all the time – but Malden Mills has continued to develop the fabric in new directions. Over the years, they've made it more stretchy. They've also experimented with cutting away bits of the fleece on the inside, making the fabric lighter but still preserving the insulating and wicking properties. The early versions, some of which were called "high void grid" by Malden Mills, weren't as stretchy as the original, and a bit more itchy against the skin. Gradually they got more stretchy and less itchy. It seems as though Malden Mills and Patagonia cut a deal, because in about 2001, Patagonia started offering this stuff, not with Malden Mills' *Power Stretch* brand name on it, but Patagonia's own *Regulator* brand name ("R 0.5" was the initial

name). Even though the material hadn't changed in any major way, in 2006 Patagonia decided to rebrand it as *Capilene 4*. *Capilene 1* is very thin, for summer wear, and *Capilene 4* is the thickest marketed as "underwear" (expedition weight). *Capilene 2* and *3* are intermediate thicknesses. Both *Capilene 3* and *4* for many years had the bumpy, grid-cut fleece inside (the successor-variant of Malden Polartec *Power Stretch*). *Capilene 1* and *2* were the successors to the original Polartec *Power Dry*, but not quite as stretchy and not quite as fuzzy on the inside. Even if it's marketed as underwear I think a *Capilene 4* zip-turtleneck top makes a great shirt, it's my default cold-weather top.

The "original" (non-grid) *Power Stretch* has gradually become softer and stretchier. When I got a new (2012) hooded full-zip *Cloudveil Run Don't Walk* top of *Power Stretch*, it was so soft and stretchy that my 12-year daughter grabbed it and ran away with it. I only got it back after getting her one of her own. It now stretches 1.75x, making it very easy to push the sleeves above the elbow.

The 2006/7 version of the *Capilene 4* zip mock turtleneck was much better than previous years' versions. Not only was the material softer, less itchy and more stretchy, Patagonia also added a "draft flap" behind the zipper; it doesn't really protect from drafts, but it *does* protect the thin skin over your sternal notch (at the base of the neck) from being abraded by the edge of the zipper pull, which was a bit of a problem with the previous versions. As I type this in 2011, I'm wearing one right now. Still great stuff, and my four zip mock turtlenecks of it are my favorite winter shirts. In 2011, there was no more Patagonia R 0.5, and Patagonia R1 was also branded as Polartec *Power Dry*, though it's got a grid inside of it; R2 and R3 are also branded as Polartec *Thermal Pro* in two different weights, which seem a lot like the original *Power Stretch*; and R4 is also branded as Polartec *WindBloc*. But with the 2011 year, Patagonia started replacing the grid in the *Capilene 3* and *4* with something that is smooth inside like the original *Powerstretch*.

A further example: *CoolMax*. Originally made by Dupont Textiles, Dupont spun off and sold its textile business in 2003, so now *CoolMax* is made by the company [Invista](#). Dupont said in 2002 that there were three different types of "*CoolMax*": "*CoolMax Everyday*" and "*CoolMax Active*" and "*CoolMax Extreme*." It seemed to me that the *CoolMax* variants "*CoolMax Everyday*" and "*CoolMax Active*" had less wicking, but better and longer-lasting appearance. I got a "*CoolMax*" polo shirt from [Tilley](#) (the maker of the famous hats), and, though relatively quick-drying, it certainly doesn't absorb sweat from my skin the way other *CoolMax* garments do. It's got a

relatively hard finish, and is a bit stiff compared to other CoolMax garments I've got. So, don't depend on simple "CoolMax" labeling to ensure you are getting something suitable for the outdoors. When I revisited the [CoolMax website](#) in 2011, Invisita listed a grand total of NINE fabrics that bear the CoolMax moniker:

- COOLMAX EVERYDAY fabric
- COOLMAX EXTREME performance fabric
- COOLMAX EcoMade fiber and fabric
- COOLMAX freshFX fabric
- COOLMAX All Season fabric
- COOLMAX ACTIVE fabric
- COOLMAX UPF fabric
- COOLMAX XtraLife fabric for legwear
- COOLMAX fabric for wool

And in fall 2015, Patagonia renamed all of their Capilene weights. I was very happy with their 1 2 3 4 weights as it made perfect sense. But I guess the marketing people won the arm-wrestling match, and so here are the new names:

Capilene 1 > Capilene Silkweight > Capilene Daily

Capilene 2 > Capilene Lightweight

Capilene 3 > Capilene Midweight

Capilene 4 > Expedition Weight > Thermal Weight

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## A Pile of Fleece

Karl Ziegler and Giulio Natta were awarded the Nobel Prize for Chemistry in 1963 for the polymer process, resulting in textiles such as polypropylene and polyester. In the 1970s, [Helly-Hansen](#) invented (and still sells) pile: a knitted base with fibers sticking up, sort of an artificial fur, known by the trade name Lifa. The early versions matted down after a while, but this wasn't as much a problem with the later versions. I still have an early HH pile jacket in the basement that was one of my first artificial-fiber garments. Fuzzy jackets such as Patagonia sells ("Retro-X Fleece") are basically the same as that early Helly-Hansen Lifa pile, though with finer and denser fibers. Pile transports moisture quite well, but pile has basically no wind resistance at all. Helly-Hansen pile is still used widely in the maritime environment.

Fleece is like pile, but with two fuzzy faces, and has mostly replaced older styles of pile. Malden Mills makes most of this although it is marketed under a variety of names. Malden called their earliest efforts (~1981) Polarfleece, and Patagonia also sold it as Synchronilla. In 1991, Malden Mills introduced the original Polartec 100 and 200 and 300, which were three increasing thicknesses of fleece, slightly stretchy, very soft and comfortable, and like pile, virtually no wind resistance. They are now known as "Polartec Classic." There was an early version with a wind-resistant layer between the two faces of

I was about to order new Capilene underpants, and was even more confused by their new terminology. This is what they said:

*We will have one type of Brief available in the Spring, which will be the Capilene Daily Brief, which is also available currently. We will have 3 types of Boxer Briefs available: the Capilene Daily, the Everyday, and the Merino Daily. The construction is all similar, but the difference will be in the make-up of fabric.*

*The Capilene Daily will be the closest to our old Silkweight material, it's 94% Polyester, and 6% Spandex. The Everyday will be a 59% Organic Cotton, 35% Polyester and 6% Spandex blend. So it will not feel quite as light or silky as the Capilene Daily or the former Silkweight. The Merino Daily will be 52% Merino Wool, and 48% Capilene, these will be the lightest weight, and great for temperature regulating, but they won't have the stretch, or the silky feel.*

I guess the bottom line is to not take clothing material trademarks too seriously after they've been around a while. Just like cold medicines, (think Advil or Aleve) once a name becomes popular they get applied to all sorts of things that have only a sketchy relationship with the original.

One more note about words: the term "technical," as used by many manufacturers to describe their clothing, is meaningless noise: ignore it. Most marketing-speak is meaningless, but "technical" actually gets into the negative numbers. Originally it meant something that had good abrasion resistance for rock climbing, but marketing types used it for jackets with lots of pockets, embroidery, patches and epaulettes and killed its original meaning.

the pile, called Polartec 1000, but I never even heard of it being made into a commercial garment; later versions became known as *WindBloc*. I was initially skeptical of the idea: putting a wind-resistant layer in the middle, so that the outer layer of fleece is useless when the wind blows? And, the earlier versions didn't breathe that well. There is even a variant known as *Survivor Windbloc Fleece* that uses a waterproof-breathable membrane. Again, seems to me that your shell should be on top of your fleece, not in the middle of it.

And then they came out with *Wind Pro*, which is "4x more wind-resistant than standard fleece" (that is to say, not all that wind-resistant, but better than none at all). The *Wind Pro* has a woven layer that resists wind, rather than a laminate. Both fabrics are available, for example, from retailers such as [rockywoods.com](#). My REI *Wind Pro* fleece has just the right balance of breathability (as good as regular fleece, perhaps due to the panels of Power Stretch incorporated into the jacket) and wind resistance (mild, but notably better than plain fleece). See also [Windproofness](#), below.

In 1994, Malden came out with Power Stretch and Power Dry, two of my most favorite fabrics, which are discussed elsewhere.

In 1999, Malden started selling Polartec Thermal Pro, and then in 2000 die-cut versions marketed as Regulator (“R”) by Patagonia. These were in a way a step back to pile: the material had a woven outer layer and a fuzzy inner layer. But the inner fuzz was shaved into a grid of little squares to lessen weight but still allow wicking and warmth. The early versions didn’t work all that well and weren’t very stretchy, but later versions improved quite a bit: softer, stretchier, closer grids so less itchy. In 2015, they came up with a new name for their latest die-cut fabric: Power Grid. Despite the silly name, the material’s impressive: still very light, comfortable against the skin, and the stretch is up to about 20%, which is amazingly more than the earlier versions of their similar thin fleece (though still much less than my Ibex Guide Sweater). Along about this time, Malden also started using hollow fibers to lessen weight.

Helly Hansen of Norway, long-famous for making high-tech clothing for Norwegian weather, is now making clothing of a material from labtex.com.tw that, like Power Grid is textured to trap air, though not so deeply 3-D as Power Grid, and not as stretchy, but apparently cheaper.

Polartec is Malden Mill’s trademark, and almost every fabric they make is preceded with “Polartec” so it’s not a very useful name, is it? Their website even says *Polartec manufactures over*

*300 different fabrics under the brand Polartec.* There are many, many types of Polartec; they do have a variety other trade names added to the Polartec moniker, but even within each of the sub-tradenames (e.g., Malden Polartec Thermal Pro) there are many different fabrics.

In 2010 or thereabouts, Patagonia started marketing their “Better Sweaters”: things that, on the outside, looked like a knit sweater, but were knit out of polyester, and had an inside of brushed fleece. As far as I can tell, the main attraction is appearance: you can wear this with nice clothing and it looks like a sweater. It has some advantages of fleece over wool: it doesn’t smell like a sheep, it isn’t at all scratchy, it’s a bit lighter, and it dries more quickly. However, it has one big disadvantage compared with an equivalent wool sweater: it pills more easily. And, unlike newer wind-resistant fleece, it doesn’t break the wind as well. I don’t own one of these, but I’ve tried them on. But I decided to stick with my merino wool Ibex Scout Vest and Guide Sweater. I wear the Scout Vest at work over a nice shirt and often a tie, and the Guide Sweater goes to dinner at nice restaurants as well as being worn on winter day-hikes all the time. No, it’s not as wind-resistant as my old REI wind-resistant fleece, but when I want to open up my shell and ventilate as I’m going uphill and overheating, that wind permeability is a definite plus.

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## Batting

No, not baseball or cricket. Batting is fluffy stuff that you cram into pillows, mattresses, and... clothing. It can be as crude as a pile of leaves stuffed into your plastic leaf bag that you carry for shelter. (You *do* carry a couple of plastic leaf bags for a survival shelter, right? It’s a good enough idea that the [Appalachian Search and Rescue Conference](#) requires it of all members.) Duck and goose down (the short, soft, fluffiest of their winter feathers) have been used as batting for millennia, and still in some ways are the best batting. Goose down is better – lighter per unit warmth – than duck down. In fact it’s fluffier than any artificial batting to date – though artificial batting is working hard on catching up.

Down is rated in terms of its *fill power*. Higher fill powers mean fluffier down. Fill power ranges from about 300 in<sup>3</sup>/oz (175 cm<sup>3</sup>/g “300 fill”) for feathers to around 1500 in<sup>3</sup>/oz (900 cm<sup>3</sup>/g) for the highest quality down. Medium-range down clothing has a fill power of about 500. High-end down-clothing suppliers such as [Feathered Friends](#) and [Western Mountaineering](#) offer clothing with 850+ fill down. Such clothing is not only lighter but due to the higher-quality down, but lasts longer. High-quality down sleeping bags are generally half the weight and packed bulk of their artificial-insulation competitors. Down clothing is the same, and this means that it’s easy to compress a down jacket or down vest and keep it in the bottom of your pack. When it’s lunchtime, or if someone gets injured and needs insulation right away, you pull it out, shake it out and fluff it, and voilà: instant warmth.

Down makes the lightest, warmest clothing, but unfortunately, down mats down and loses most of its insulation value when

wet. Most down sleeping bags these days have a water-resistant outer layer that helps somewhat. To preserve loft (fluffiness) and prolong the life of down bags and clothing, store only slightly if at all compressed. So store all your fluffy clothing and sleeping bags uncompressed. Once it’s time to throw them in your pack, and only then, you can make them tiny with a compression stuffsack. Interestingly, down bags and clothing last longer with intermittent compression than artificial-fiber bags and clothing, maybe three times longer; up to 30-40 years with careful care.

Many outdoorspeople own down sleeping bags and clothing, and treasure them, but they also pamper them. My 3-season and winter sleeping bags are down, and I have a down vest, a down jacket, and for standing around at search and rescue operations in really cold weather, down pants and parka.

Here is a table of clo/ounce (a measure of warmth/weight) provided by Richard Nisely, who posts a lot of very detailed information about clothing for the outdoors at <http://backpackinglight.com>:

Cotton	0.04
Merino wool	0.08
Polartec 100,200, 300	0.16
Polarguard 3D	0.63
Exceloft	0.68
Polarguard Delta	0.68
Climashield HL	0.68

Down (550 fill)	0.7
Primaloft Sport	0.74
Climashield Combat	0.79
Climashield XP	0.82
Primaloft One	0.84
Down (850+ fill)	2.53

Which means if you buy an expensive down garment or sleeping bag from Feathered Friends or Western Mountaineering, you will be getting your money's worth.

The big news in 2011-12 was "waterproof down." A couple of manufacturers have come out with garments stuffed with this putative waterproof down. The ones I've seen have are thin jackets and vests, with only a little down in them, which is a poor way to maximize the benefits of down's lightweight loft. Despite the claims, I worry about how this stuff will last after stuffing and re-fluffing; I suspect that the treated down won't be as durable. It reminds me of what Dr. William Osler said in 1901: "One should treat as many patients as possible with a new drug while it still has the power to heal." Or the computer aphorism of "never buy release 1.0 of any software." Actually, neither *DownTek* nor *DriDown*, two water-resistant downs, are touted as being waterproof. They are just water-resistant, and keep lofting more when they get damp compared with standard down. Apparently the down has a hydrophobic coating applied to it during processing. I talked with the people at Feathered Friends in Seattle last time I was there, who opine that (1) this stuff may not last nearly as long as standard down, (2) it doesn't loft as well as "real" down, and thus the garment manufacturers are creating garments with lots of little pockets for the down, as opposed to the large pockets in Feathered Friends' and other high-end down clothing. Thus, the warmth-to-weight ratio for these garments, regardless of the fill power of the down, is poor. I will hang onto my Feathered Friends Helios Vest and Helios Jacket, which even after many years of use, still loft fully, are toasty warm, only weigh a few ounces, and compress into a small stuffsack.

So, for "waterproof down: caveat emptor." Keep tuned.

Artificial-fiber sleeping bags and clothing have one great advantage over down: they don't mat down as much when they get wet. Well, maybe they have a second advantage: they're cheaper. Used to be that artificial-fiber batting was really quite a bit heavier than down, and not nearly as compressible. In the beginning, the term *Fiberfill* was used for the first such artificial-fiber bags and clothing, but that seems to have become generic over the years.

Later, Dacron *Hollofil* was a significant advance in that the fibers were hollow, which decreased weight. Even later, its successor [Quallofil](#) was even better; if you looked at a cross-section of the fiber, had four separate holes in it – lighter, but better insulation. Quallofil has mutated over the years; now it has **seven** holes in the fiber! But Quallofil is a bit bulkier and heavier than newer batting, so is used mostly in low-end sleeping bags and comforters. *Climashield* and *Primaloft* are now common fills

for sleeping bags, as is *SL90*. Even more common, even in high-end garments, is generic noname "polyester fiber."

*Thinsulate* boasted that it insulated even with thin layers, as it insulated better than an equivalent layer of down. It did, but it also was pretty stiff and didn't drape well; the vest of Thinsulate I got back when it first came out got used very little compared with my trusty old down vest, back from when the only place to get down clothing was from LL Bean. Over the years, Thinsulate has become specialized primarily for hat, glove and shoe applications.

The name probably doesn't matter very much, they're just tradenames from the various manufacturers and indeed, today's Quallofil, to pick an example, is nothing like the original Holllofil or even first-generation Quallofil. Manufacturers do things like crimp fibers, mix fibers of different diameters, and use continuous-fiber batting instead of cut bits of fiber, all in an attempt to make a lighter, more compressible, warmer when wet and longer-lasting insulation. And, to a degree, all of these things have worked. All brands of fiber batting are far better than they were a decade or two ago. In 2013, the makers of Primaloft entered an exclusive deal to market their latest fluff insulation, Thermoball. As with other artificial fibers, compared to down, it retains more of its warmth when wet – but is still not nearly as warm when wet! As far as I can tell from the marketese available, it lofts as well as 600-fill down (though good down gets up to the 800-900-fill range), but apparently has to be sewn in an overlapping-V-tube construction for some reason, which increases the weight of the garments. All of the Thermoball garments I've seen are fairly thin compared with my down vest, jacket and parka. It's also not clear how long it will last compared to well-cared-for down.

There are many manufacturers and brands: *Polarguard*, *Thermolite*, *LiteLoft*, *Thermaloft*, and many others. Each one of the brand names may have sub-brands as well (e.g., *Thermolite Extreme*, *Thermolite Extra*, *Thermolite Micro*, *Thermolite Plus*, and *Thermolite Active*.) Each brand claims it's better than the others, because of blah, blah, blah. Please disbelieve all the marketing hype.

There are standards for a bag's temperature rating, for example, [EN 13537](#) used throughout Europe and beyond since 2005. Most reputable manufacturers use this test method, and you may therefore use the comfort temperature. Mark Verber also has a page that provides [a table](#) of loft (thickness) vs. sleeping temperature, as well as much more detailed information about sleeping bags.

Even though a bag is only rated to, say, 20°F, you can sometimes extend this a bit. Being inside your tent allows your bag to work down an additional 10°F below its rated temperature. American-style bivouac sacks can add about 10°. (American style bivouac sacks are basically sleeping bag covers, sometimes with a mini-tent at the head. European-style bivvy sacs are tiny, poleless and stakeless tents, that when out on the mountain and hit by sudden bad weather, that you pull out of your pack and throw over the whole party so you can huddle for warmth. Very handy, and indeed I carry and use them, but quite different from something for a single individual's sleeping

bag.) Sleeping bag liners can add about 5° (and keep your sleeping bag cleaner, and keep you from screaming when your skin encounters the cold nylon of the sleeping bag). Wearing clothing – or sleeping on your clothing if your sleeping pad is a bit skimpy, or even spreading it on top of your sleeping bag – can add a lot.

For a sleeping bag, figure out what temperature rating you want in a bag – most people will go for a three-season bag, something rated to perhaps 10 to 20°F (-12°C to -7°C). Then find the lightest, most compressible bag that meets your budget.

When selecting clothing (or a sleeping bag) filled with artificial fiber, it's probably better to go with a reputable brand, and the latest year's model, rather than worrying too much about what precise brand of fiberfill is in the garment. If I had to pick the most reputable brands, I would include *Feathered Friends* and *Western Mountaineering* for down, *Arc'Teryx*, *Cloudveil*, *Patagonia*, *Outdoor Research*, and *The North Face* for artificial-fiber bags and clothing.

One thing about garments made with batting, such as down jackets, is that they just don't stretch. The more reputable manufacturers, such as *Feathered Friends*, design their garments so that you can easily reach above yourself, important when climbing, but you still need to make sure that you get one sized large enough so that you can move.

But Patagonia is trying to change this, at least a little bit. In fall 2014, they introduced the Nano-Air line, insulated with their FullRange batting. There are two new features of these garments. First, despite being filled with batting, they have four-way stretch. Second, the shell material is also breathable (pretty much required if you're going to have significant stretch).

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## Sleeping Pads

This is a new section for 2012. This table and essay is about clothing materials, but sleeping bags are just clothing for nighttime. But experienced outdoorspeople will tell you to put your extra money into a better sleeping pad than a better sleeping bag. And you can now spend a *lot* of money on your sleeping pad.

When I first started backpacking, when I was just a small kid in the 1950s and 1960s, I was taught how to make a pine-bough bed. You would find a pine – preferably a white pine, as the needles were nice and soft – and hack off some of the lower live branches. The larger parts of the branches you would form into a grid, to support you a couple of inches above the ground. You would then cover this with the thinner ends of the branches, which, along with their attached needles, would provide some padding and insulation. You then throw your sleeping bag on top of this. A bit lumpy, but it kept you warm. Of course, this was back when only a few people enjoyed backpacking; you could do a prolonged hike along the Appalachian Trail and always be able to find a place to sleep in a three-sided Adirondack-style shelter hut. With the number

Matthew Timothy Bradley emailed me about his experience with the Nano-Air Hoody last winter, running and snowshoeing:

*I wore a baselayer + Patagonia Nano-Air Hoody for most of my outside time this winter. For this season's conditions in western Massachusetts (frequent fresh snow with temperatures between the lower teens and lower 20s with moderate to minimal wind) it's been very good. Caveat emptor: I run warm, and with all the powder this season and the hilly terrain I've found I have to pair it with a minimal baselayer to keep from overheating. The jacket doesn't incorporate any mesh — perhaps mesh pairs poorly with the FullRange insulation, maybe hampering the stretchiness and/or the seams would be likely to fail? — and truth be told I wouldn't mind some venting at the armpits like with the Marmot DriClime Windshirt. The back of the Nano-Air that is against my pack has ended up noticeably wet on all but the coldest days. It's an awfully nifty product, though, the kind of thing I wouldn't have imagined five years ago. <https://db.tt/FSL19vow>*

I too have a Marmot DriClime windshirt that I've worn in the winter, and the open mesh inserts in the armpits are nice for aerobic winter activities. However, this windshirt doesn't stretch at all. And I found the mesh simply not enough ventilation, so I added pit zips to really open up the underarms for when I'm moving uphill.

I asked Matthew how stretchy the NanoAir really is, and in particular, my rough-and-ready way to assess this: can you comfortably push it up above your elbow? The answer was no. But he noted he got a size to fit pretty tightly over a baselayer, and the cuff is tapered and has elastic to keep snow out, so maybe someone else could push it above his or her elbow. Email me if you have one and can (or can't) get it above your elbow.

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of backpackers today, though, pine-bough beds would deforest entire mountain ranges.

The trouble with this is that you needed pine trees. No good above timberline.

There were air mattresses designed for camping that you could use... but they were made of early vinyl, were quite fragile, didn't work in the cold (you couldn't unfold them until you warmed them up) and weighed many pounds. Though they were fairly comfortable, they also didn't insulate well. The big tubes developed convection that sucked heat right out of your butt. A pine bough bed was both more comfortable and warmer.

The first high-tech solution to this problem was Ensolite. The original Ensolite was (and in my basement box labeled "old sleeping pads" still is) a closed-cell foam. "Closed-cell" is important: it doesn't absorb water. Much. That is, as opposed to open-cell foam pads, which are basically large, soft sponges, only appropriate for deserts where it never rains. The original Ensolite had some open cells on the surface, which absorbed a bit of water. Subsequent designs got rid of these open cells on

the surface, leaving a flat surface that doesn't absorb much water. The original Ensolite also got stiff in the cold, making it a challenge to flatten out your pad to sleep on it. Newer Ensolite is much more flexible in the cold.

Ensolite was originally developed by NASA as shielding for pressure vessels, first manufactured by Uniroyal in about 1967. It's made of PVC (polyvinyl chloride) and NBR (nitrile butadiene rubber).

It's still made, in 20-odd different types, and used as padding in head-strike zones in aircraft, on roll bars in off-road vehicles, and as soundproofing in cars, as well as sleeping pads. There are many other brands of closed-cell padding, some of which are usable as sleeping pads.

Ensolite was a big advance in sleeping technology. It had (and still has) the great advantage that it is *warm*. Ensolite isn't all that comfortable... it's pretty heavy, and if you took a pad thick enough to be comfy, it would weigh and bulk as much as the rest of your pack. Sleeping on a concrete floor on Ensolite, as in some Appalachian Trail shelters, requires some ingenuity, with some padding under the lumbar area and the neck. But it keeps your butt from freezing in the cold, which other pads and air mattresses didn't. Some still swear by Ensolite as a sleeping pad in the winter, or use a thin Ensolite pad under a more comfortable but less-insulating mattress. And if you're sleeping on soft snow, and you can hollow out little dips for your butt and hips and shoulder, resulting in a little lumbar support, it's not too uncomfortable. There are many similar pads available now, with the corrugated ThermaRest RidgeRest pads currently the most popular, and inexpensive, in the \$30 range, and weighing about 14 ounces and with an R value (insulation rating) of ~2.8.

Some people started using blue foam pads because they were so cheap (currently \$10-25). These generic closed-cell ethylene-vinyl acetate (EVA) foam pads are very light (10 ounces), yet bulky, and have an R value of only 1.4. Given a RidgeRest is only slightly more expensive, and slightly heavier, but much more comfortable and warmer, I can't see why anyone uses blue EVA foam pads any more.

In the late 1960s and into the 70s, backpacking exploded in popularity. New and innovative designs abounded. Probably the most famous is Cascade Designs' ThermaRest line, starting in 1971, designed by aerospace engineers. It used open-cell foam, which is much lighter than closed-cell foam such as Ensolite. To avoid the problem of the foam getting wet, which was a problem with prior open-cell pads, it was enclosed in a waterproof cover. Some prior open-cell pads were covered in waterproof covers, but the difference with the ThermaRest pad cover was that it was totally sealed. Not only that, but the cover was air-proof as well, with an inflation valve on one corner. So, you could deflate it and roll it up like an air mattress. But, when you unrolled it and opened the valve, the foam expanded and it sucked in air and reinflated. Well, most

of the way. You could think of it as an air mattress filled with open-cell foam; this meant that there was no convection, so, unlike air mattresses, it actually kept you warm. Well, somewhat warm. Your butt and shoulders sunk in a bit, which decreased the insulation there.

By 1977, Backpacker Magazine was able to compare 38 different brands of sleeping pads, including air mattresses with down-filled tubes (warm, but couldn't blow them up with your mouth as the moisture would make the down rot). By now, there have been hundreds of different models of sleeping pads. Closed-cell pads evolved by developing small egg-crate wiggles in them, and then by developing hinges so they folded up in a Z pattern to make packing easier (ThermaRest Z-rest is an example). ThermaRest foam pads have continued evolving, with innovations to make them lighter (mummy shapes instead of rectangles, die-cut holes in the open-cell foam), warmer, and more comfortable. They have an R value of about 2, which is suitable for all but deep winter or high altitude.

Through a process of Darwinian selection, certain subspecies of ThermaRest and other whole brands went extinct. For example, I once had a mummy-shaped ThermaRest with a zipper around the edge, so you could zip a bottomless sleeping bag to it. Nice in theory, failure in practice. Despite a draft flap on the sleeping bag, cold air crept in, and the sleeping bag wouldn't conform to my body because it was stretched out to the size of the ThermaRest, so I froze. After a couple of uses, I cut off the zipper to make the pad lighter, continued using it, and donated the bottomless sleeping bag to my mountain rescue group to use in the Stokes litter as a fancy blanket. More recently, Klymit makes lightweight air mattresses with major bits missing. They look like a moth-eaten sweater, or perhaps an air mattress designed by Klingons. Supposedly you can use them inside your sleeping bag. Some of the reviews at REI are positive. I'm not impressed.

Over the years roughly 2005-2012, there has been intensive competition and innovation in sleeping pad design, with new and truly better designs coming out at a rapid pace. I'm concentrating on ThermaRest as they are the market leader, but many other manufacturers also make high-quality pads. There was the ThermaRest NeoAir, which was basically a better and lighter air mattress, without foam, and not self-inflating, but very light, with multiple overlapping V shaped tubes, providing much improved insulation (R ~2) compared to prior air mattresses, while still remaining quite light. Then there were mummy-shaped NeoAir pads with more tiny overlapping tubes (R=3.2). Most recently is the ThermaRest NeoAir XTherm, which has even more overlapping tubes, aluminized, with an R value of 5.7, which is very impressive. I have one; it's very comfortable, while still small and light (15 ounces). The only problem is the price (\$190).

But, as they say, put money into your pad, not your bag.

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## Baselayer

Wicking baselayer and fleece polyester material have improved in recent years. If you read the manufacturer's fluff, there are hundreds of different kinds of treated polyester, each better than the others. But cutting through the marketese, you can see several major changes, which seem to apply regardless of brand name.

1. **Smell:** most fabrics now have a coating or treatment that discourages the bacterial growth that makes clothing smell bad. (Too bad we can't spray this on ourselves before we go out for a week in the mountains.) While not as good as wool for resisting bacterial growth and smell, they are really quite good. There are different treatments; one repels body oils, another prevents bacterial growth by embedding silver (which is a strong antibacterial) in the fibers, and – I just (11/23/14) discovered this – Capilene, at least some of it, has iodine in it. I pulled out a pile of Capilene 4 now that it's time to wear it again, and when I pulled out one of the pieces in the middle and opened it up and got a very strong whiff of iodine. Hard to mistake this smell. Interestingly, a colloidal silver solution (Silver Zone) is marketed for you to use on your own clothing. Probably effective, but you'll have to keep treating your clothing on a regular basis.
2. **Wicking Persistence:** Used to be that polyester lost its wicking after a certain number of washings. The number of washings is now very much higher than it used to be. There are proprietary names for the different treatments (e.g., *NanoTex*, *Acclimate*) but they all basically do the same thing. Some are better than others, but there's very little hard data, so you're better off going with brand-name wicking material, specifically from major mountaineering clothing companies.
3. **Stretch:** Most polyester now is knit in a manner to allow it to be relatively stretchy, and sometimes *Lycra* or other stretch fibers are added to make the material even more stretchy. What is stretchy "enough"? Stretchy enough that you can push the sleeves of a long-sleeve top above your elbow, and it (a) won't compress your arm so much as to hurt after a long day of climbing, and (b) when you pull it back down, it'll recover enough to fit properly at your wrist. Malden Power Stretch meets this requirement, as does the thin 2004 Malden Power Dry used in the Patagonia R.5 fabric. (Doing a quick stretch-test, I found that Power Stretch stretches 1.5x its original length; by comparison, Malden WindPro only stretches 1.25x, and doesn't quite meet this test.) The 2001-2002 thicker Malden Power Dry isn't quite stretchy enough to meet this criteria, though the thinner Power Dry of this vintage does. With a skin-tight Power Stretch union suit (used under coveralls for caving) I can contort into any position and it doesn't bind. Knit wool stretches even better than the polyester microfiber materials used for most artificial-fiber baselayers. Some of the stretchiness in my "above-the-elbow" test relates to the sewing used in the cuffs. Neither I nor my tailor have the fancy sewing machine that will do a 2x stretch of the cuff, but some manufacturers do this. Which means if the sleeves are too long and you tailor them, you might not be able to push them above your elbow.
4. **Bumps and Holes:** Many companies now offer fabrics of fleece, or sometimes very thin fleece that works as a thin baselayer, which allows the material to preserve much of its warmth but make it a lot lighter. Early examples of this include revisions of *Aleutian* fleece from *Lowe*, *Polartec 100 Lattice*, and the *Patagonia R1* and (now-extinct) *R.5*. R stands for "Regulator," though the R .5 is was later known as *Capilene 4* (see above). Originally I thought this was a mixed blessing – the original lumpy-bumpy fabrics didn't feel quite as nice against the skin as something smoother, and since there is less contact with your skin, I'd expected the material to be not quite as good at sucking sweat off your skin. Patagonia came out with *R.5/Capilene 4* with smaller bumps (2003), and made it stretchier (2004), and so I got two Patagonia R .5 men's zipneck tops (2005 vintage) which are stretchy enough that I can wear a size small (usually I wear a medium) and they fit pretty well – stretchy enough that they don't bind. This material is very, very light, wicks very well, better than I expected, and slightly itchy compared with, say, the original thin Malden Power Dry, which is as comfortable as a well-used cotton T-shirt (my Cloudveil Teewinot short-sleeve T-shirts of the original Power Dry circa 2000 are my favorite everyday three-season shirts). The original Malden Mills Polartec Patagonia Capilene 4 (follow that?) wicks about as well or maybe a little bit better than the original Malden Power Dry, despite the lumps. And at the tail-end of 2006, I got two more of these – a bit stretchier, not at all itchy, a bit softer on the inside, a bit better wicking, and now each has a tiny breast pocket. And stretchy enough to pass the "push up over your elbow" test. REI offers garments made of the same type of material, though it's called Polartec Power Dry; soft and stretchy, relatively cheap, though the tailoring isn't quite up to Patagonia standards. October 2011: do you want that same material in a zip turtleneck? Well, first off, you can never actually get the same material twice in a row because it changes so often. But if you want something quite similar, get an REI expedition-weight underwear top in zip turtleneck; the material is now called Polartec Power Dry (though it's not really like the original Power Dry), or a Patagonia Capilene 4

(now also branded as Polartec Power Dry) top. Unfortunately, neither has a small chest pocket like my originals. The tailoring's a bit different, too. I also got zip T-necks of Capilene 3 and the equivalent midweight REI underwear. The REI is Polartec Power Dry with a thin square grid on the inside, the Patagonia one is their own proprietary material, with a more complicated meshy-type pattern. The Patagonia one is more comfortable, and stretches enough to push the sleeve up over my elbow, which I can't quite do with the REI midweight. The 2012 version of Patagonia Capilene 4 (branded Polartec Powerdry) – I just got some bottoms of it (early 2013) – is interestingly different than its predecessors. There is a line of square fuzzy bumps, and then a line with nothing but the stretchy very thin base material, alternating up and down the legs. And within each line, there are two square fuzzy bumps, a space, and then two more square bumps, and so on. This seems to have several effects. First, it's not as quite as warm as the original Patagonia Capilene 4/R2. But it's much, much lighter, and less bulky, and stretchier, and more flexible, with less binding behind the knees. Overall, a big win, and now looking and working in some ways similar to the wool fishnet underwear I used to wear in the 1960s and 70s. Gor really cold weather (near zero F), I'm going to try a pair of a medium Capilene 4 pants over a pair of small Capilene 4 pants, all covered by my REI/Schoeller Dryskin stretchy shell pants. This will approximate the warmth of a pair of winter bibs, but much less bulky and awkward. I'll let you know how it goes.

The old original PolyPro baselayer had disadvantages: it melted in the dryer or in front of a fire, smelled bad, and after a while was nothing but a mass of pills (those little wads of fuzz that form on the surface of some fabrics). Things have improved a lot since then, but there are still some companies marketing substandard baselayer materials. A few years ago, Cheng Hu emailed me that he tried Medalist *Skinetics* and didn't find it wicked very well. You're generally better off with a well-known brand name – you're more likely to get better pill-resistance, odor-resistance, and wicking.

Back in the days before modern high-tech fabrics, we used fishnet T-shirts. Originally, these were actual bits of old fishnets sewn into T-shirts, and they were worn under other clothing to provide some airspace for ventilation, to keep you less sweaty. In the summer you wore cotton fishnets, and in the winter, wool. I used to use these all the time. For a while you could get very thin fishnet CoolMax T-shirts (I got mine from [Brigade Quartermasters](#)), but they don't carry them anymore. Too bad – they were great when I responded with a disaster team to the Gulfcoast during and right after Hurricane Katrina in fall 2005. We were supposed to wear cotton T-shirts as part of our uniforms, and it was very, very hot and humid. Wearing a CoolMax fishnet under the T-shirt didn't make me significantly hotter, and wicked even better than the T-shirt, particularly as it had "DMAT PA-1" in big, waterproof and

vapor impermeable letters on the back. I could then wash the CoolMax fishnet, wring it out, and put it back on under the same T-shirt, making me feel a lot cleaner. And, when I travel long distances, I always put on one of these CoolMax fishnets on under a nylon shirt. Even when stuck in an airplane for 12 hours, you can go to the head, wash the fishnet, wring it out, dry it a bit with a few paper towels, and put it back on – you feel a *lot* less greasy this way. Searching the Web for "CoolMax mesh tshirt" I did find <http://www.pinnaclearmor.com/body-armor/accessories.php> which offers mesh (or fishnet to us oldtimers) CoolMax T-shirts. I also found some sales on Calvin Klein Lycra-CoolMax mesh T-shirts. Caveat emptor.

A similar concept is CoolMax RVU (ribbed, ventilated underwear) designed for use under armor – you can get this for example at <http://www.rvuultracool.com/rvu.html>. But I've tried it, and it's a lot like wearing a flak vest in itself – the ribs don't really bend at all. I would only consider this as an alternative if you spend a lot of time in a bulletproof vest. However, that same website also lists what looks like my old CoolMax mesh t-shirts – only you can't buy them online, and there are only a few retailers across the country. When I searched the Web to try to find them online, I found a lot of technical (there's that word again) baby suits but no shirts.

There is one more thing to say about baselayers, and it is really more a design feature than specifically to do with materials. And that is *zip turtlenecks*. You can get baselayer tops with crew necks, turtlenecks, or zip turtlenecks. Zip turtlenecks certainly offer the most flexibility, and I'm a big fan of flexibility. When you get warm, you can push up the sleeves and unzip – and most zip turtlenecks have zippers that unzip halfway to your navel, allowing some significant ventilation.

The only problem with zip turtlenecks is that the zipper can be irritating. I still have faint scars over my sternum (breastbone) and under my chin from the zipper on one of the early zip turtlenecks that I wore on a long trip. No lie, I had significant bleeding abrasions in both places.

However, there are a variety of changes over the years that have made me rethink my rejection of zip t-necks. Zippers are much more flexible and less abrasive now, which helps. Some manufacturers offset their zip t-neck zippers so they don't link up with jacket and parka zippers, which decreases the force pressing on your skin. Patagonia's baselayer zip t-necks first offered a "storm flap" at the top that (somewhat) prevented abrasion under the chin, and later added a storm flap along the entire zipper that also protected the sternum (which certainly helps) and also cleverly looped over the top of the zipper to protect your chin. Current versions offer tiny flap on either side of the zipper that meet precisely over the middle of the zipper, which works quite well.

There is a draft flap behind the zipper on the current REI zip turtleneck but it doesn't come over the top like the old Patagonia zip turtlenecks. The Patagonia tops have better tailoring than the REI ones. The REI top is \$50 and the Patagonia one is \$100.

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## Wicking vs. Bipolar Construction

There is no argument that, in cold/wet conditions, one wants something against the skin that is warm when wet. And one wants something that doesn't hold water against the skin. The traditional material was fine [wool](#) – reasonably warm when wet, doesn't hold much water against the skin, lasts a long time, and if made from high-quality wool (cashmere, or north coast Australian wool like the old Sears wool underwear), not all *that* itchy. (Actually, I used to go caving in the Sears underwear all the time.)

But wool, unless you got the really good stuff, was itchy. And when wet you smelled like a wet sheep. And though it was much, much better than cotton, it still held a significant amount of water against the skin – wet wool is still heavy and cold when you put it on. But compared to cotton, the water would drain out the bottom of the wool underwear a lot quicker.

Well, next was [PolyPro](#) underwear. Polypropylene was used because it was very hydrophobic (“water-hating”) — compared to wool, it wouldn't hold hardly any water at all, and by staying drier it was warmer (and lighter) when wet. And, since it was made into a loose weave, it was pretty porous, so sweat could pass through fairly easily. But polypro absorbed body odor, “pilled” (developed lots of little fuzzy balls on its surface), and melted in the drier or near a fire, resulting in an ugly, smelly lump of melted plastic. So [polyester](#), with less pilling, and better heat resistance, replaced polypro.

But even polyester didn't really feel all that comfortable against the skin in warm weather compared to dry cotton. Why? Well, cotton fibers, unlike polyester fibers, are made up of many, many smaller microfibers, which makes it softer against the skin, and allows it to drape a bit better. Cotton's microfiber construction, along with its hydrophilic nature (“water-loving”), means that it *wicks* water away from the skin — that is, until the cotton is soaked through and through. When soaked, cotton holds water near the skin, and allows it to circulate from the skin to the surface of the cotton and back again, making a pretty good heat pump. Good in warm weather, bad in cold weather.

So people thought “Can't we find something that is as comfortable as cotton in warm weather AND in cold weather? And is comfortable even when soaked?” One way is to make polyester fibers made up of tiny microfibers, just like cotton — this should make it more comfortable against the skin, drape better, and look better, but with polyester's hydrophilic nature, it shouldn't hold as much water or act like a heat pump. Indeed, as I type this, I was wearing a pair of [polyester microfiber](#) dress pants at work, and they're extremely comfortable against the skin. Nice stuff. You can also “brush” materials made out of microfibers so that they are all fuzzy on one side, and wear that against your skin. The older (pre 2004?) Malden Power Dry is a great example of this kind of construction (and the most comfortable stuff against the skin I've ever worn, it's even better than cotton).

But there was still the problem of sweat. Even though polyester knits could pass sweat, they still weren't as good as dry cotton at sucking up sweat. So what can we do? If we make material as hydrophilic as cotton, and with as small of a microfiber size, it'll end up acting just like cotton. It turns out that you can coat polyester fibers with a variety of materials, you can make the surface hydrophilic enough to wick water — but since the fibers aren't as small or as hydrophilic as cotton, it still won't hold much water. You can also roughen the surface of the fibers, or make them with cross-sections not like a circle, but like a cross or asterisk or other shapes, which improves wicking.

But, compared with cotton, this wicking effect isn't great, so what else can we do? Well, some clever people realized that if you combine two different types of fibers, in just the right yarn and with just the right construction, you can put a hydrophilic material on the outside and hydrophobic on the inside. The first such fabric I saw was called *DriClime*, and I was impressed. The outdoor store had a swatch, and the owner wadded it up, put it in a cup of water, and then wrung it out. He handed it to me, and I could feel that one side was wet and cold, and the other side felt warm and dry. I've had a Marmot Shelled DriClime windshirt since then and been very happy with it. Some prominent versions are Malden [Power Dry](#) and [Power Stretch](#), Paramo [Parameta-S](#) and Intera [DryForce](#).

Some companies insist that artificial fibers don't wick at all, moisture just passes through them via vapor diffusion and bipolar fabrics are the only things that seem to move moisture away from your skin. Well, we know that cotton wicks — you can demonstrate this by taking a cotton towel, and hanging it up so that one end is in a bucket of water. Half an hour later a lot of the water will be drawn up into the towel, and it will be soggy. You can do the same thing with artificial “wicking” fibers, too — there is little moisture in them after the bucket experiment, but enough to show that there is indeed wicking. Certainly polyester microfiber seems to do this more than other artificial fibers with which I've tried this, perhaps due to the enhanced wicking of the microfibers, and the best I've seen so far for wicking is Malden [Power Dry](#), although [Power Stretch](#) comes close, mostly because you can buy it small and wear it so it's tight against your skin (improves wicking a lot). Power Dry seems best as a summer T-shirt or as a base layer in colder weather.

Two days before version 1.7 of this document, I was hiking fast on a warm day, relatively level trail, with a heavy pack (20 lbs. gear + 30 lbs. of 2-year-old) and was wearing a [Power Dry](#) shirt. Admittedly it was a fairly dry day for the Appalachians, but even though my entire shirt would get soaked in sweat going uphill — showing it spread out the sweat quite well — a 15' rest stop would find it almost entirely dry at the end.

So don't believe that artificial fibers don't wick. As far as the relative contribution of wicking vs. bipolar construction for moving water away from your body, though, the jury is still

out. One thing I've found is that wicking layers only work if they're right up against your skin. So stretch materials are important, another reason to like Malden [Power Dry](#) or [Power Stretch](#). (No, I don't own stock in Malden Mills or work for them.)

Malden WindPro is stretchy, too – but unlike Power Stretch, which stretches 1.5x, WindPro only stretches 1.25x. The difference is enough that REI, when making my favorite fleece jacket out of WindPro, used small inserts of Power Stretch under the armpits and on the shoulders to improve stretch.

I have a top of Intera [DryForce](#) from Cloudveil (April 2003). Think “thin bicycle jersey” and you get an idea of what this material is like. It's constructed like Power Stretch, in that it is fuzzy on the inside and less fuzzy on the outside. But DryForce is **very** slick on the outside, so clothing will go over it easily. However, it really doesn't stretch as well as Power Stretch, so it's not as comfortable. And the outside, while slick, doesn't seem all that tough, certainly not shell-like. DryForce seems a bit like Schoeller *Dynamic*, and is about the same thickness, and is considerably more stretchy, but not nearly as tough on the outside. It wicks very well, about as well as I've ever experienced, similar to Marmot's DryClimate. But overall, I think I like T-shirts of the original Malden Power Dry better as a base layer. Power Dry is more stretchy, more porous, and overall more comfortable.

One development along this line is the idea espoused by the European company [Paramo](#) in the Parameta-S fiber garments that they market. These are reversible bipolar garments, wear one way for hot weather and inside out for cold weather. Interesting idea! However, this material isn't really stretchy, so it loses out to Malden Mills' otherwise-similar [Power Stretch](#) fabric in my book.

In 2003, the big news was adding special coatings to fabrics to improve wicking and water resistance; for example, [Schoeller](#) added a 3xdry coating to its *Dryskin Extreme*, found for example in the classic softshell [Cloudveil](#) Serendipity jacket, the first true softshell jacket; and in 2012 when I got some new Dryskin pants (not “Extreme,” meaning the nylon in the weave is not the thicker Cordura; this means the pants might not be quite as tough, and is a bit thinner, so not quite as warm) I found they were now using something called *NanoSphere* which as far as I can tell does the same thing as 3xdry.

Wicking fabrics have been getting thinner and more stretchy. In spring 2015, I got some Park Tee shirts from Salomon, made from Advancedskin Extradry (companies seem to be running out of trademarks for this stuff). The t-shirts are very thin and

light, but still provide excellent sun protection (UPF 50). They are very, very, stretchy. They wick very, very well. They are not warm when wet, but I used them for a week of summer hiking in Shenandoah National Park next week. Given that even thin wool is still warm when wet from sweat, these are my go-to tops for variable but mostly hot weather. Results of this, and my daughter's similar North Face Reactor T-shirts: rather than sweat dripping off, these materials spread out the sweat over a large area. Even when quite humid, the slightest breeze gives a cooling effect over a wide area. Significantly better than cotton T-shirts. I got the shorts that paired with these T-shirts, and also wore them all week. They also claim to be made out of Advancedskin Extradry [sic] but the material is a bit thicker, harder, sturdier, and not as stretchy. This is appropriate in a pair of shorts rather than a T-shirt, but just goes to show that you can't trust material names to represent the same material either over time or even at the same time; see the next section for more on this topic. I also got an AdvancedSkin Extradry Salomon T-shirt that is fuzzy rather than slick, even though the material is about the same weight and slickness. The slick material feels cool against the skin, and in warm, sweaty conditions I found that the slick material did a much better job of sucking up and spreading out and evaporating my sweat than the fuzzy material. I also felt that the slick material did a much better job of cooling me off than the fuzzy material; I guess that's why we have the phrase “warm and fuzzy.”

One question that sometimes arises: if cotton wicks, and artificial fibers wick, what's the difference? Why is cotton so bad? Why are [Mountain Rescue Association](#) teams famous for teaching that “cotton kills”?

Seems to me there are two parts to this. First, though cotton **wicks**, it's also **absorbent**. That means it sucks up lots of water and holds onto it. In a towel, at home where it will have plenty of time to dry, that's good. But if you're out in cold weather, and not interested in having a lot of cold water held right against your skin, then it's bad. Artificial fibers wick but don't hold much water. That's why those “pack towels” of polyester microfiber, no matter how good they are, will never beat a good cotton towel for sucking up water.

There is also another effect that makes cotton bad in cold, wet weather: loss of insulating value. Wet cotton allows water to circulate, and it's just like a little heat pump sucking the heat from your skin and sending it to the outside of the cotton garment to radiate away. Good in summer, bad in cold-wet conditions.

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## Fabric by the Yard, Fabric by the Number

Although you won't find it on the informational pages at [www.polartec.com](#) (Malden Mills' site), they have started numbering their fabrics. A phrase from their website (copied and pasted here) says *Polartec Thermal Pro is our most diverse family of fabrics*. So don't think that “Polartec Thermal Pro” means a specific fabric!

[Lowe Alpine](#) made clothing of a variety of Malden Mills (and other) fabrics, sold through retailers but not through their website. Some of the fleece jointly designed by Malden Mills and Lowe was called *Aleutian* (some may be from other suppliers, Aleutian was just Lowe's trade name) and there were several varieties, mostly lumpy-bumpy type things similar to the R1 and R .5 fabrics used by Patagonia. Lowe's

webmaster was nice enough, at one point, to include the numbers of the fabrics on the [glossary page](#) of their website, which, if others did the same thing, would be a great way to make sure the fabric you're buying is (more or less) what you've bought in the past.

- **Polartec Special Edition with Power Dry Technology (7347)**  
Technical inner layer insulation. Innovative 'pillar' interior traps warm air, improves breathability, reduces weight and increases packability. Power Dry wicking performance allows next-to-skin use or as an intermediate layer.
- **Polartec Special Edition with Thermal Pro Technology (4060)**  
Versatile mid-layer insulation. The deep pile face is open-stitched to the interior velour, giving a high-loft fabric with low density. Maximum warmth with

excellent airflow, low weight and packability. Top warmth-to-weight ratio.

- **Polartec Special Edition with Thermal Pro Technology (40810)**  
The fleece that thinks it's down insulation. The deep pile face is open-stitched to the interior velour, giving a high-loft fabric with low density. Maximum warmth with excellent airflow, low weight and packability. Standard and marled versions.

There was also a "Special Edition" version of Power Stretch: **Special Edition Power Stretch (9400)**, see below. If you find this all very confusing, don't worry, the fact that you're confused is clear evidence that you know more than most people, who don't yet know enough to be confused!

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## Windproofness

One of the trends over the past few years is for new materials that have the warmth of fleece but with improved resistance to wind (traditional fleece has basically no wind resistance). Here are some figures that Katherine at Malden Mills emailed to me in February 2002 as far as wind resistance of newer Malden Mills Polartec fabrics. Wind resistance is cubic feet per square foot per minute (ft<sup>3</sup>/ft<sup>2</sup>/min)

Polartec Windbloc	0
Polartec Power Shield	6.42
Polartec Windbloc ACT	15
Polartec Wind Pro	65
Polartec 200	325

I find this very useful information, because the marketing information really doesn't give you much quantitative information about wind resistance. The way I read the figures:

- **Windbloc** (and the Gore equivalent, *WindStopper*) basically stop all wind but don't ventilate moisture all that well; Windbloc isn't very stretchy.
- **Wind Pro** is about as stretchy as old-style fleece – i.e., it doesn't quite meet the "push above the elbow" test mentioned above. So Wind Pro is just fleece that's a bit better against wind, without losing too much vapor permeability or softness.
- **Power Shield** makes a pretty good (though heavy) wind shell. BTW, both North Face and [Mountain Equipment Coop](#) offer garments made of PowerShield.

I have a 2005-era [REI](#) jacket that's mostly WindPro, and with panels of Power Stretch here and there for better stretch. Although I always have reservations about garments made from two different materials, this jacket has become my favorite fleece – I wear it all the time.

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## Waterproof-Breathable: Gore-Tex et al.

The original Gore-Tex fabric was a true revolution in outdoor fabrics. By allowing water vapor to pass (at least when dry), yet preventing liquid water from penetrating, this fabric was a wonderful replacement for the other fabrics us outdoor people used prior to Gore-Tex. Before Gore-Tex, we had *Ventile*, which was a special, long-staple Egyptian cotton, the fibers all being very tightly wound. When wet, the fibers swelled, becoming (mostly) waterproof, although when wet and frozen, it was like cast iron (not great for climbing). I started mountaineering using a Ventile cotton parka. 60/40 cloth, which mixed polyester fibers with the long-fiber cotton for better durability and flexibility when frozen, was "the thing" for a while – my wife and I still have our original "sixty-forties" – I use mine as a durable jacket for working on my truck. I think I threw my ventile anorak away years ago (it had big holes in it, ventile wasn't that durable).

Gore-Tex is a trade name for something known generically as "expanded polytetrafluoroethylene" or PTFE for short – basically Teflon plastic that had been "expanded" in a proprietary manner to make zillions of tiny pores, small enough to prevent liquid water from penetrating, yet small enough for water vapor to get through. How so? Well, when water is liquid, it's not just individual molecules of H<sub>2</sub>O, it's actually a clump of H<sub>2</sub>O molecules bound together with hydrogen bonds, so the clumps are pretty big. But as water vapor, H<sub>2</sub>O exists as individual molecules, i.e., much smaller.

Gore-Tex I ("one") worked, mostly, but broke down quickly. I was lucky enough to have an early North Face pullover made from Gore-Tex I, which was nice, but the waterproofness only lasted about a year. However, Gore had a money-back lifetime guarantee, so I ended up with a free brand new pullover

(which still hangs in my closet) made of Gore-Tex II, which was much sturdier. Gore-Tex I and II, however, really didn't breathe all that well, and none of these fabrics breathe at all when they're wet on the outside (a layer of water doesn't "breathe") which is why they also have a DWR (durable water-repellent) coating that makes the water on the surface bead up, covering less surface area. And so, especially for those like me who sweat a lot, pit zips (underarm zippers) are essential. I've even added pit zips to some of my old Gore-Tex jackets. The current basic Gore-Tex is now (2013) called *Performance Shell*.

Today there are dozens of waterproof and breathable fabrics, including *Pertex*, *Cloudveil Dermizax*, *Bibler ToddTex*, *Marmot MemBrain* and *PreCip*, *Patagonia H<sub>2</sub>No*, *Mountain Hardwear Conduit*, *Sympatex*, *eVENT*, *Hydroflex*, *Ultrax*, *Omni-Tech*, *H<sub>2</sub>No Storm HB*, *Nikwax Analogy*, *Cloudburst*, *HyVent*, *Triple Point Ceramic*, *Aquafoil*, *Hydro/dry P2* and *Hydro/dry P3*, *Aqua Dry* and *Aqua Dry Pro*, and *Aqua Foil*. Just to mention a few. All of these (including current Gore-Tex Performance Shell) are better than Gore-Tex I, and as far as which is best, I doubt that anyone, anywhere, can give you a good answer. Some are more breathable than the original Gore-Tex, some both more breathable and more waterproof, and all pretty much more durable. Sympatex is pretty much just for shoes, as it's very durable but not very flexible. *Gore-Tex XCR* ("extended comfort range"), now renamed as *ProShell*, is about as waterproof as Gore-Tex Performance Shell but much more breathable – but I still say that Gore-Tex XCR jackets need pit zips. Round about 2011 or so Gore-Tex XCR was renamed *Proshell*, though the XCR name was retained for a version of Gore-Tex used in footwear. There is also a Gore-Tex *PaCLite* (debuted about 1995) that is very thin, and used in ultralight equipment, but I have a Patagonia Specter Pullover (ultralight at 6.5 ounces) of their H<sub>2</sub>No PTFE laminate which seems similar to PaCLite; the 2006 version of this ultralight waterproof jacket had an innovation, which was welded rather than sewn seams, decreasing weight even further and eliminating the ridges of sewn seams that are targets for rips and abrasion. After destroying this, I later got a NorthFace Triumph jacket that was similar, even to the welded seams, but even lighter – since Patagonia didn't make a similar jacket when I wanted a bigger one.

Pertex seems to be singled out as being very light and breathable. I have a couple of European style bivouac sacs made of Pertex. These sacs are basically a tiny tent without any provision for stakes or poles – you pull it over yourself and others when hit by a storm; handy to have a dry lunch in a downpour (which I've done several times). I have one for two people, and one that fits four. The four-person is big enough for two people and packs eating lunch comfortably, or three with packs eating lunch but quite crowded. The two-person was big enough for me and my daughter (she was five years old at the time) and our packs while eating lunch, but she was in my lap most of the time. I recently got new ones made out of sil-nylon (silicone-coated nylon) from Integral designs which are about half the weight and half the bulk.

But to give Pertex its due, in about 2014 they started marketing a very-light waterproof-breathable variant called *Pertex Shield+*. It reportedly has specs of Waterproof 20,000 g/m<sup>2</sup>/24 hours and 25,000 MVTR which is pretty good. It's slick on the inside, no fuzzy wicking layer to make it comfortable on the skin. But the Outdoor Research Helium II HD jacket only weighs 9.1 ounces and folds up to fit in a pocket. I bought one from rei.com and thus far very impressed, it's now my everyday rain jacket, though I will probably wear something thicker and more durable if I'm worried about abrasion on rocks. I sweat a lot, so I insist on pit zips on all raingear. It's not as breathable as my Arcteryx Squamish Hoodie ultralight windshirt, which will still travel with me pretty much all the time. The non-HD jacket is lighter at 6.4 ounces but lacks a hood wire, handwarmer pockets, and pit zips.

[Gore-Tex](#) (W.L. Gore) has Gore-Tex *Windstopper N2S* ("next to skin") which is a wicking layer directly bonded to Gore-Tex XCR. This makes a nice pair of thin gloves, and I like the pair I have. However, I *hate* the feel of the original Windstopper (it is the feel-equivalent of the fingernails-on-a-blackboard sound).

Waterproofness can be measured precisely. The European standard for "waterproof" is that the material will not pass water if you pile 1,500 mm of water on top of it – a column of water 1.5 meters high. But this isn't quite waterproof enough if you figure you don't want water to seep through under your packstraps, where the pressure may easily exceed this. It's generally accepted that outdoor clothing needs to have a rating of 10,000 mm (10 meters). Classic Gore-Tex II has a rating of 28,000, though this decreases with age and with contamination with body oils (which, however, can be counteracted with proper washing agents, such as those offered by [NikWax](#)). Gore-Tex XCR was rated at 45,000 mm.

Breathability is hard to assess, as it varies so much with the temperature, humidity, amount you sweat, and perhaps the phase of the moon. Breathability however may be measured. A standard rating is grams of water vapor passed by a square metre of fabric in 24 hours (gm/m<sup>2</sup>/24h); a standard minimum for outdoor clothing is 10,000gm/m<sup>2</sup>/24h, but this is clearly not enough for me, which is why I put pit zips in most of my parkas. W.L. Gore rates their fabrics in RET units (Resistance to Evaporative Transfer, AKA the sweating hot plate test), smaller being better. You can see how Gore-Tex has improved over the years:

- Classic Gore-Tex II: Waterproof 28,000 mm (>40 PSI), RET <90
- Gore-Tex XCR 2-layer: Waterproof 28,000 mm (>40 PSI), RET <45
- Gore-Tex XCR 3-layer: Waterproof 45,000 mm (>40 PSI), RET <60
- Gore-Tex PaCLite: Waterproof ? mm (>40 PSI), RET <60 (<40 for most garments)
- Gore-Tex Active Shell: Waterproof: nobody knows, they won't publish the figures, but RET reportedly ~3

Unfortunately, it's hard if not impossible to get these numbers for competing fabrics. I do have some for Mountain Hardwear's Conduit line, and Marmot's MemBrain and PreCip:

- Conduit 3-layer: Waterproof 15,000 mm, RET <90
- Conduit 2-layer: Waterproof 12,000 mm, RET <95
- Conduit Silk: Waterproof 15,000 mm, RET <120
- MemBrain 2-layer: Waterproof ? mm (25,000 g/m/24 hours), RET <50
- MemBrain 3-layer: Waterproof ? mm (20,000 g/m/24 hours), RET <60
- PreCip: Waterproof 15,000 mm (~25 PSI), RET <70
- PreCip Plus: Waterproof 25,000 mm (~40 PSI), RET <60

You will likely see more and more of these figures as manufacturers start to compete on their numbers. The RET is performed by soaking the fabric in water, then placing it over a porous hot plate, and the volume of evaporated water is measured. A related test, the MVT (moisture vapor transfer) test, is performed by stretching the material over a cup full of water, and the volume of evaporated water is measured. But the MVT is not yet standardized, some test with the cup upright, others with it upside down with the water actually on the material, so you can't really compare MVT results yet. There is also a DMPC (dynamic moisture permeation cell test) that measures water vapor transmission at different humidity levels. The fabric is placed as a barrier between two cells, one with humid air and one with dry air, and the moisture transmission is measured at different levels of humidity.

The problem with such testing is that it's hard to relate to real-world conditions. The DMPC is probably the closest to real-world conditions, but the RET is a more common test. It's also true that there are many factors other than the membrane that affect real-world breathability: the fabric itself,

Of interest, the membrane used in Marmot *Membrain* is the same as that used in Cloudveil and others' *Dermizax* clothing. This material is claimed to become more vapor-permeable as it gets warmer. However, after testing, the US Army concluded that *Shape Memory Polymer films show no special increase in permeability as compared to other waterproof breathable materials. The SMP [Shape Memory Polymers] laminates are comparable to standard Gore-Tex, so they are fairly functional in terms of being "breathable", but they don't have any unique behavior with regard to permeability at different temperatures.*

Phil Gibson, of the Materials Science Team at the U.S. Army Soldier Systems Center in Natick, MA has performed a number of tests on commercially available fabrics. A PDF with some of the results has been posted by Mark Verber at [www.verber.com/mark/outdoors/gear/breathability.pdf](http://www.verber.com/mark/outdoors/gear/breathability.pdf).

Though the Army does a lot of testing of clothing materials, they often have to promise the companies not release the test results – so if you hear something unofficially from someone

who knows someone in the Army test labs, what they say is probably true.

Some scholarly papers on the science of Gore-Tex and similar materials may be found at:

[www.emeraldinsight.com/Insight/ViewContentServlet?FileName=Published/EmeraldFullTextArticle/Pdf/0580150306.pdf](http://www.emeraldinsight.com/Insight/ViewContentServlet?FileName=Published/EmeraldFullTextArticle/Pdf/0580150306.pdf)

[jit.sagepub.com/cgi/content/abstract/32/3/165](http://jit.sagepub.com/cgi/content/abstract/32/3/165)

[jit.sagepub.com/cgi/content/abstract/34/4/223](http://jit.sagepub.com/cgi/content/abstract/34/4/223)

In 2011, Gore introduced Gore-Tex *Active Shell*, which is much more breathable than prior versions; an RET of around 3, which is much more breathable than prior Gore-Tex editions and comparable to a woven softshell. Waterproofness? Don't know. Gore doesn't post it on their site and I haven't seen it anywhere else.

Anything Polartec comes out with sounds interesting, although the marketese on their new [NeoShell website](#) makes me nauseated; not a figure of speech, literally. I guess I have a low tolerance for marketing hype.

There seem to be at least three different fabrics that share the *NeoShell* name. Some are thin, some are thick, so they are quite different. But unlike most of Malden Mills' Polartec textiles, NeoShell is a direct competitor to Gore-Tex: highly waterproof. It's also mildly stretchy, but don't expect stretch like Polartec Power Stretch or its new successor, the fuzzy Power Dry (as opposed to the slick Power Dry which is quite different).

Malden Mills seems to be pushing the idea that NeoShell is more breathable than competitors. There is some support; Popular Science in their May 2011 edition [compared NeoShell with Gore-Tex Active Shell](#), and found NeoShell to breathe better, even though a bit lighter. Four testers used the shell jackets skiing for a month. However, this was a test skiing; is NeoShell as waterproof as Gore-Tex Active Shell? I just don't know, but I suspect it is not as waterproof.

Since I have parkas of Gossamera and Cyclone (see [below](#)), I feel no urge to go out and buy a NeoShell or Gore-Tex Active Shell parka.

Back in 2004, Gore-Tex came out with *Gore-Tex Soft Shell*. It's a shell, and it's soft, so I guess the name is apt. But it's **very different** than all other soft shells. Other soft shells are stretchy, as they are woven materials. Gore-Tex Soft Shell is not stretchy. It's a Gore-Tex membrane, with fuzzy but tough fabric laminated to the outside, and fleece laminated to the inside. There are versions with thin fleece ("lo-loft") and thicker fleece ("high loft"). So it's soft against the skin. And warmer than a straight Gore-Tex shell. That may be good in the winter but worse in the summer: Gore-Tex Soft Shell is clearly cold-weather rather than all-weather gear. They say "greater freedom of movement" as less layers are needed, but it seems to me the freedom of movement in a real, stretchy soft-shell is a lot better, especially if it's something quite stretchy like Schoeller Dryskin. Gore-Tex Soft Shell seems to

be used primarily for fly-fishing and snow skiing/snowboarding clothing.

Waterproof-breathable membranes for boots are very important but get no respect. My feet sweat much more in boots with waterproof-breathable laminates in them. I've had such boots ever since the first boot with a Gore-Tex lining, by Danner. I hiked a couple hundred miles of the Appalachian Trail in them, and then they started leaking. Since then, manufacturers of waterproof linings for boots have engineered them to be much longer-lasting, and more recently a bit more breathable, but they're really not breathable by the usual definition of breathable. And the materials used in boots, despite similar names such as Gore-Tex, are very different from those used in clothing, and to my mind, doesn't get enough attention in the outdoor press. I've had generally good luck with some 10-15 pairs of Gore-Tex boots since that first pair of Danners. However, my most recent lightweight boots, which I love dearly, are the Salomon XA Pro Mid GTX "Hiking Shoe." It's sort of strange to call this a "hiking shoe" as it provides a modicum of ankle support, and a fairly solid sole. It's

very light and comfortable, and with the cordlock and Spectra laces they're on and off in a second or so. I had the predecessor to this boot, and loved it. I was sad when the sole wore out and that model wasn't available. But this newer model is even better. Except that after a year and a half of just moderate use, the Gore-Tex broke down and started leaking like a sieve. I discovered this on a search task occasionally wading through three (3) inches of water whereupon my feet were totally soaked.

Once home, just to check, I loaded the boots with heavy objects (water bottles) and had them "stand" in about 3" of water for about 5 minutes. When I pulled out the heavy objects and then used my hand to hold the boots under water, I could feel the Gore-Tex lining moving inwards from the outside of the boot, and then start leaking. Delamination is the problem, probably thence stretching and ripping the inner Gore-Tex liner. I contacted W.L. Gore, and they accepted the boots for their testing, and agreed that the Gore-Tex had failed. They then sent me a new pair of the same boots. Hope the new pair's Gore-Tex liner lasts longer.

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## Emergency Shelter

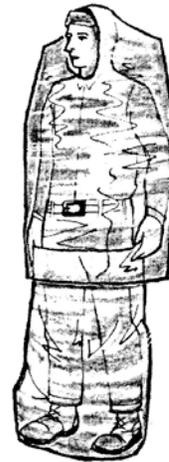
It's not strictly "clothing" but it definitely involves "materials." This won't be a discussion of tents, which is a whole 'nuther discipline. But I do think a brief discussion of shell material for an emergency bivouac fits in nicely here.

In the very old days (think: ancient Greece and since), there was waxed canvas. It was quite heavy, and you had to re-wax it from time to time, but it resisted wind and rain pretty well. Back in the 1960s, though, came the tube tent. A tube tent about three-foot diameter by eight-foot long cylinder of very thin (2.5-3.5 mm) plastic. You ran a length of parachute cord (or Type 3 paracord, or shroud line, if you prefer one of those names for 550-pound test 3-4 mm kernmantel nylon cord) through the tube, tied each end to a tree, and you had a tent. Sort of. The ends don't close, which is bad when it rains in either end. Or the wind blows through one end. But since there is no ventilation, and you can get lots of condensation inside, having the ends open helps prevent this. A bit.

One advantage of a tube tent is that it's cheap. Under \$10, even including a length of shroud line or twine. Another advantage is that it's light and compact. It weighs less than a pound. And even if you

I would say the great advantage of spending a night in a tube tent, however, is persuading you to think more about proper shelter in the backcountry. First, it starts you thinking about saving up for a real tent. But if you're using it as an emergency bivouac shelter, it also make you start thinking about alternative ultralight bivouac shelters.

Back in the 1960s or maybe late 1950s, Tacoma Mountain Rescue Unit, as a fundraiser, started selling survival kits, which they still do to this day. One of the components is an ultralight disposable tube tent, not really intended for use as a tent so much as an emergency bivouac shelter; sit on one end to keep



it closed, pull the other end over your head, and you're sheltered from wind and rain, ready for an uncomfortable but more likely survivable night out.

Ev Lasher and Gene Fear (who helped design the TMRU survival kit) also popularized the idea of *leaf bags* as a survival/bivouac shelter. They also popularized this standard survival teaching:

- Without food you can survive for *3 weeks*.
- Without water you can survive for *3 days*.
- Without shelter in a cold environment you can survive for *3 hours*.
- Without air you can survive for *3 minutes*.

In the North American backcountry, it's uncommon for someone to die of starvation or lack of water. But it's quite common for people to die of hypothermia, or from the injuries caused by hypothermia's effects on the body and mind. So, survival teachers have been enamored of the idea of teaching about leaf bags as the #1 component of a survival kit. We're talking about the large plastic bags you can get in the grocery store, usually called "lawn and leaf bags."

I'm the faculty advisor for the Wilderness Medical Society Student Interest Section at the University of Pittsburgh Medical School, and once they asked me to give a talk about survival kits. I gave them the standard lecture about how the contents of your survival kit depends on where you are going: you might want different gear for the Kalahari Desert, or the Amazon jungle, or Mars... I then wrote the above "Without ... you can

survive” on the blackboard and talked about shelter from cold being the most important part of a survival kit. I then suggested that we think about what would be a good survival kit to bring if you’re going to lead a bunch of neophytes on a spring or fall day hike, in the nearby Laurel Highlands.

And then I reached into the bag of goodies I brought and threw (hard enough to make a loud bang; nothing wrong with a bit of showmanship) a box of leaf bags on the table. “This is it.” Enough leaf bags to give at least one to each of the hikers.

But things change. First let’s talk about the two major subdivisions of bivouac shelters: bothy bags vs. bivvy bags (sleeping bag style shelters).



Lairig Leacach Bothy, Lochaber, Scotland

Chris Eilbeck [CC BY-SA 2.0 (<http://creativecommons.org/licenses/by-sa/2.0>)], via Wikimedia Commons

“Bothy” is the Scottish term for a small unlocked hut in the mountains, used as a temporary foul-weather shelter by shepherds and hill-walkers. “Bothy bag” refers to something you can carry with you that provides the same temporary shelter. If the weather closes in, with wind and rain (“hypothermia weather”), your group can huddle together and throw the shelter over the entire group. There are bits that you sit on to take the place of tent stakes, and your heads serve as the tent poles. Most bothy bags also have a small tube vent with some mesh on the end, which also serves as an attached stuffsack. They can also be homemade, often from parachute material. While not entirely waterproof, parachute material is very light and cuts the wind and helps contain people’s body warmth. It’s amazing how quickly the warmth will build up inside even in deep winter.

Commercial bothy bags have traditionally been made from waterproof coated nylon, or nylon with a DWR (durable water repellent) finish. I’ve used one of these on day hikes, not only as shelter from cold-wet conditions, but also as a snug place to wait out a brief summer thunderstorm. I’ve also used larger ones to throw over the patient and a few rescuers during real and simulated wilderness search and rescue situations.

I have recently gotten 2- and 4-person “SilBothy” bags, made by Terra Nova, made out of silicone-treated (silnylon). They are half the size and weight of the regular waterproof “regular” waterproof nylon bothy bags, also made by Terra Nova. That makes me much more likely to carry them, which can have happy consequences.

A week ago as I write this in May 2015, we had the annual general membership meeting of the Appalachian Search and Rescue Conference (the ASRC), in Pennsylvania’s Ohiopyle State Park. Part of the festivities was a “Search and Rescue Games” where teams made of members of the ASRC’s 10 component Groups, mixed and matched, had to navigate to various backcountry locations to accomplish various secret SAR-related tasks. One of the stations was on bivouac skills. We were to be graded on how quickly and how well we could set up a bivouac shelter for one person, using only what we had with us or could find in the surrounding open (but quite rainy) woodland. The five of us put down our packs, with the padded sides up, which became a place for our bivouacker to lay herself down, then I pulled a SilBothy 2 out of my pack (just happened to be in there, we had no idea there was a bivouac station), shook it out, and placed it over our bivouacker, and said “done!” in less than two minutes. It actually would be a pretty comfy bivouac for the night. We did go on after that to set up a hammock with a tarp rainfly to use up the rest of the allotted time for the station, but just goes to show how handy one of these bothy bags can be. It only takes a few seconds to pull it out and deploy it, and only a bit longer to pack up again.

Bothy bags are all the rage in Europe, and after spending some time there teaching wilderness EMS I’ve picked up the habit. But most North Americans think of a “bivouac sac” as basically a sleeping bag cover, albeit sometimes usable without a sleeping bag inside it. As with bothy bags, you can get both coated nylon and silnylon sleeping bag covers/bivouac sacs. But you can get more expensive ones that have a thicker, coated waterproof bottom and a Gore-Tex top that breathes a bit, preventing moisture buildup. Unless it’s raining, in which case the wet Gore-Tex top doesn’t let the water vapor out, and you get condensation inside. Of course, you pay extra for this. You can even get bivouac sacs with a Gore-Tex top and little poles that keep the top off of your face at night, and have mosquito netting. I have one of these, an Outdoor Research Advanced Bivy Bag. It’s good for when you just have to throw it out on the ground, throw in your sleeping bag and pad, and crawl in to get a few hours’ sleep. Of interest, it and quite a few other similar bivy bags have a special kind of waterproof/breathable membrane on top, different from that found in most waterproof/breathable membranes. Mine has Gore Respiration Positive, which omits the inner lining used in clothing. That inner lining prevents the wet raingear from sticking to your skin, and allows some wicking, at the expense of some breathability. But Gore Respiration Positive membrane has no inner lining – doesn’t need it as it should never be right against your skin – so, as long as it’s not wet, it’s more breathable than Gore-Tex clothing.

When she was in her teens, my daughter went to some nearby Quaker summer camps, which were delightful... except that

they had backpacking trips and my daughter found herself teaching the other kids and occasionally the staff things about the outdoors. They would sleep just under a tarp, and after her first wet experience with that, she took my OR Advanced Bivy Sac with her not as a tent but just as a “sleeping bag cover” and had much drier nights as a result. Laurel says “One one rainy night, I was the only dry person in the camp, including the staff! And you can quote me on that.”

The OR Advanced Bivy works pretty well overall, but it's not all that light or small (2 lbs 6 ounces = 1 kg, 4x16" = 10x40 cm), so it's really more of a very small tent than an emergency bivy sac. We won't go further along this “sleeping bag cover morphing into a small tent” direction. Except to say something about the Hennessey Hammock, which weighs the same and bulks the same as the OR Advanced Bivy. I think of myself as a backpacker and not as any sort of “car-camper.” However, I often have to set up a quick place to sleep during an extended search or disaster operation. If I have the time and can find a couple of trees the right distance apart, I will simply set up my Hennessey Hammock (ultralight silnylon version) and use that instead, even in the winter, as it's a lot more comfortable. Even when I responded to the Gulfcoast during the Hurricane Katrina disaster, I used my Hennessey Hammock. I strung it between two columns of an abandoned hospital where we set up a Disaster Medical Assistance Team tent field hospital in the parking lot.

Going in the other direction, from tent back towards ultralight emergency shelter, it's worth looking at some newer materials than the plastic used in tube tents or leaf bags.

First was the Space Blanket. Developed in 1964 to prevent radiative heat gain in spacecraft, a civilian version soon emerged and was sold for emergency insulation. The Mylar backing, just like a plastic garbage bag, cut heat loss from convection and evaporation, and the aluminized mirror coating cut radiative heat loss. It only weighed a few ounces, and folded up would fit into a pocket.

However, there were a few downsides to using a space blanket.

First, they were blankets and not bags, so you couldn't really seal yourself up in it, so if there was any significant wind, it didn't really protect you as it blew open. This was fixed by the Space Bag, basically a space blanket taped together into a bag. I tried to spend a night in one once.

I quickly discovered a second disadvantage. As it was not at all breathable, I had to keep flapping the opening a bit to ventilate, all night long, and I still got quite wet, even though it was a dry night.

And I discovered a third big disadvantage. Every time I moved even a tiny bit, the CRINKLE CRINKLE CRINKLE was so loud that it woke me up. Much louder than a plastic tube tent or leaf bag. I quickly gave up on it as a really cool but useless item.

My next attempt was a variant called a Space Sportsman's Blanket. This was a similar sized blanket, but about twice the weight, twice the bulk, and many times the durability. That's

because there were fibers laminated within the material that gave it significant strength. I made up a bivy sac out of my Space Sportsman's Blanket by folding it over once, and running sticky Velcro along two edges, stapling in place with a heavy-duty stapler. I left a little space open along the bottom for ventilation. I spent a few nights in this, once in rain and a couple of times on a dry night, and it was a lot better than the space bag. Not *nearly* as crinkly, and whether it was because of the little vent at the bottom, or the fact that it was stiffer and that allowed more ventilation, my nights were much drier. These still seem pretty popular. When I was out on those SAR games mentioned above, of our five-member team, no less than three members hauled out these blankets to use for the bivy construction.

The search for the ultimate lightweight bivy continues. There is a company called the Tender Corporation that consists of Adventure Medical Kits and SOL (Survive Outdoor Longer). They sell a lot of useful outdoor stuff, and seem to be cornering the market on new, cool ultralight bivvys. The first to attract my attention was the SOL Thermo-Lite 2 Bivy Blankets, or actually the original Thermo-Lite Bivy; version 2 was a bit lighter at 8.9 oz (252 g) and tougher; fairly small at 7x6.5" (18x17 cm). It's a better version of my homebrew folded-and-Velcroed-and-stapled Space Sportsman's Blanket. The Velcro is not continuous like my homebrew, which certainly makes it lighter, and the one night I spent in it in a light rain I didn't notice any rain coming in, but I was careful to line up the bivy so the Velcro side was slightly downhill.

But SOL has gone on to make lighter and better bivvys. One is the Thermal Bivy, which is just a slightly improved version of the Thermo-Lite 2 Bivy.

An interesting variant is the [SOL Emergency Bivy](#), which weighs only 3.8 ounces (108 g), made of a material called Heatsheets which is an improved version of the original Space Blanket; tougher, not as crinkly, and in a bag form. I wouldn't expect it to last more than a few uses, and there is no side ventilation or side opening. A good alternative to a pair of leaf bags, though a bit more expensive at ~\$15 each.

But the *most* interesting is the [SOL Escape Bivy](#). It's a bit more expensive at \$50 (though with some searching you can find it online for less than \$40). It's in mummy sleeping bag shape, with a hood drawstring and a partial side zip. That adds a bit of weight but cutting it down to mummy shape saves some weight, so it's actually slightly lighter than the Thermal Bivy at 8.5 oz = 235 g). For the purists, there is the SOL Escape Lite, which gets rid of the zipper which means it's \$10 cheaper and a bit lighter at 5.5 oz = 156 g.

It's made of a new, proprietary Escape fabric. (This is the real reason I have to discuss bivvys in an article on clothing materials.) It's reflective silver on the inside, bright orange on the outside, very thin, relatively soft compared with the Thermal Bivy, and not particularly crinkly. It seems to have many tiny holes punched in it, but if you hold it up against your mouth and try to blow through it, no air comes through.

It's made of spun-bonded olefin. A [detailed analysis](#) posted on the [Backpacking Light](#) website (thanks to Richard Nisley for posting his test results) provides information including microscopic views of the material showing that the holes go through the orange layer but not the silver inner layer. Here are some of the details:

- .0087 inches (.220 mm) thick
- basis weight of 83 g/m<sup>2</sup> (2.45 oz per square yard)
- hydrostatic head analysis: withstood 1,336 mm of water
- air permeability of .67 CFM
- reflective coating is coated and both more durable and more reflective than most alternatives

What does this mean? Well, "waterproof" is usually defined as withstanding 1,500 mm of water, so this is basically waterproof. In fact it's better than some "waterproof-breathable" shell clothing materials. And the air permeability of .67 CFM is excellent, in fact, better than the most breathable version of eVent at .5 CFM.

As far as durability, there are multiple reports online of people using this over extended periods for lightweight backpacking, either instead of a sleeping bag for summer, or over a sleeping bag for spring and fall.

It doesn't have the mosquito netting and the poles to keep the top off of my face like the OR Advanced Bivvy. But it weighs about 2 pounds less, and costs about \$200 less. Due to their innovative fabric design, I think that SOL has a winner here.

When spending a week hiking in Shenandoah National Park early summer 2015, my daughter and I ran into 25 of the 2000 Appalachian Trail through-hikers heading to Maine. Dan Kayser and his brother agreed to accept a gift of one of the SOL Lite and one of the SOL regular bivvy bags for the last part of their trek, in New England in the fall. They liked the "regular" one considerably better; with the Lite version, you tend to pull your head inside it to stay warm, then you get condensation. It's worth the extra weight and cost to get the full version. Dan says it truly does add another 5-10° of warmth, is good in the rain, and as long as your face isn't inside, doesn't get much condensation.

OK, I give up. (2015.) People have been bugging me to add something about [Blizzard Bags](#). I have heard people refer to a Blizzard Bag as a freeze-dried compressed sleeping bag, and that's not a bad metaphor.

Blizzard Bags are made of a "material" (using the term loosely) called [ReflexCell](#). It's made up of three layers of mylar-like material which are welded together so they form cells like

those of an overlapping-V tube down sleeping bag. But instead of down to hold the cells open, little elastic strings "crinkle" the material so as to hold the cells open. A blizzard bag comes compressed, and you can never get it back to the same original size, so in one sense, it's a single-use item. You can fold it up, but it ends up being about three times the original size. The early one I had was compressed, and in a small stuffsack that expanded to three times the size to accommodate the uncompressed size. Clever.

The company has inflated claims about how warm the bag is, but I've tried to sleep out in my backyard with it in winter (gave up after a few hours), and don't think it meets its claims. It provides about a bit less than an inch of loft all around you, so it is considerably warmer than a non-insulated bivouac bag. But the cells are filled just with air, which allows convection currents, and doesn't add any insulation value above air, as down or artificial-fiber batting does.

As a bit of survival gear, it might mean the difference between life or death. But as a regular sleeping bag? No way.

First, it crinkles. Loudly. A lot. It's worse than a first generation space bag as it has three layers crinkling all at once.

Secondly, it's waterproof and not at all breathable. So you (and any insulation inside) gets wet. Now there are those who don't mind such "vapor barrier" bags, and even wear leaf bags inside their sleeping bags to keep moisture out of the sleeping bag. There is good evidence that it will keep you warmer, at the risk of making you sweaty inside. Those who do this all the time tend to wear their leaf bags or a formal vapor barrier liner over a thin wicking baselayer to keep spread out their sweat and improve comfort. This tiny fanatic minority were likely encouraged by [Stephenson's Warmlite](#), who has been manufacturing vapor barrier sleeping bags since 1955, and still does. I will also note that in the 1950s and 60s many young male outdoor enthusiasts were encouraged to try his gear by the pictures of Jack Stephenson's scantily-clad daughters in his gear.

I sweat a lot, and have never been able to sleep comfortably in a vapor barrier bag. That's also maybe why I love parka pit zips so much. I reserve the vapor barrier idea as a survival technique for forced bivouacs. Your mileage may vary.

Blizzard has improved ReflexCell over the years by making tiny perforations in the two inner layers of foil so it's a bit breathable. Sort of. I was so unimpressed with my initial experiences that I have not tried the newer version. I relegated my Blizzard Bag to the back of my truck, rather than considering adding it to my SAR or backpacking packs. I figure I can give it to someone else who is really cold and can feel good about that without having to actually use it again myself.

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## Softshell vs. Hardshell

No, I'm not talking about crabs.

For the past decade or more, people have been talking (cf the Mountain Gear 2003 catalog) about the "old" method of

outdoor dressing, i.e., wearing a “hardshell” Gore-Tex parka (or, in earlier years, a completely waterproof parka or anorak or cagoule) over middle and inner layers that really don’t resist wind or rain. They contrast this with the new “softshell” where the middle layers not only provide stretchy insulation but also shed wind and rain to a degree (as well as providing significant protection against abrasion, mud and dirt, which the older fleece didn’t). Having worn some of these “softshell” garments, I have to admit I’m impressed with the idea. With “softshell” dressing, you rarely take out your Gore-Tex parka, and can therefore have a relatively thinner and lighter shell which stays in your pack most of the time.

These relatively new fabrics, pioneered by Schoeller of Switzerland, are woven so that they have a tough nylon on the outside and a warm, fuzzy, wicking CoolMax on the inside. Of interest is the great breathability of Schoeller *Dryskin*, which is probably why I like my Cloudveil Serendipity jacket and Symmetry pants so much (I basically live in the Symmetry pants all winter). I would add that you should use the NikWax *SoftShellProof* DWR treatment on a regular basis on Dryskin to keep it as water-resistant as possible. While Dryskin is not waterproof enough to be your sole rain jacket, you can carry a lightweight Gore-Tex or similar shell to put on over it in really rainy weather – you’ll find that you don’t need this outer shell that much, so even if it’s not that abrasion resistant, it doesn’t get used that much anyway.

Malden Mill claims to have started the softshell movement in 1998 with their PowerShield, but I think the prize goes to Schoeller of Switzerland for their Dryskin, which was featured in the original CloudVeil Serendipity Jacket. I have one of those that I have used for many years primarily as an outer shell in the winter, so much so that it’s pretty worn out. More recently I’ve started using a windshell of Gossamera (see [below](#)) in the winter, but not sure how durable it’ll be compared with that basically indestructible Schoeller material. On the other hand, my Gossamera windshell weighs and bulks a tenth as much...

Malden Mills’ Polartec PowerShield has been used in the well-known Arc’teryx Gamma jackets and pants, but in 2011, Arc’teryx switched to a fabric known as *Fortius*. Fortius comes in several versions; Fortius 1.0 is a thin woven stretch fabric, similar to Schoeller Dynamic (though it’s reputed to soak up more water, for example, in the Arc’teryx Gamma LT pants); Fortius 2.0 is a laminate of a thin fleece inside a nylon shell, with the “glue” (laminate) being a membrane that is wind-resistant but vapor-permeable; Fortius 3.0 is similar to 2.0 but with a thicker lining.

Malden Mills (“Polartec”) tried a kind of fleece called *BiPolar* that was similar in intent, but the outside was really just shaved pile, not a heavy-duty shell like the Schoeller fabrics. Malden Polartec Power Stretch has a bit more of a “shell” on the outside, though nothing compared to Schoeller Dryskin Extreme. There was also a new (2011) *Polartec O2 High Loft* that was a grid-cut fleece similar to the old Patagonia R1: thicker than Polartec Power Dry. Reputedly the laminate is similar to that in PowerShield but more breathable (Polartec Power Shield O2). The newer Malden fabrics like PowerShield,

as they mature, have given Schoeller a run for its money. Most of these softshell garments, especially the Schoeller, have moderate wind resistance but are extremely breathable. Even for heavy-sweating people like me, they may do OK without pit zips (unlike any kind of Gore-Tex equivalent).

Cloudveil also, in 2005, came out with Inertia Plus, which was a very thin, mildly stretchy, shell fabric like a thinner version of Dryskin. In my informal tests, it stretches about 1.15%, so not nearly as much as Power Stretch, but more than some other fabrics that claim to be stretchy. It has a soft outer finish, unlike Schoeller’s Dynamic or Cloudveil’s DryForce. As far as I can tell, it was more breathable than DrySkin, just as durable, significantly less windproof and waterproof, about as stretchy if not a bit more, about as wicking, a nice “hand” (feel to the touch) but less than half the thickness and half the weight. That means it’s not as warm, I supposed, but it seemed like great softshell material. Some people wear garments of this Inertia as a shirt. I’ve got a medium-size Cloudveil hooded Prospector jacket that makes a very nice softshell jacket (the only problem is that they designed it without a hood drawstring – I ended up adding one myself – it now lives in my bike panniers.) I also have a size small non-hooded jacket that works as a 3-season shirt/jacket – very nice – and a pair of shorts and pants in the same material which are now my favorite summertime pants and shorts. I did find that my Cloudveil Prospector jackets of the pre-2007 Inertia Plus were pretty good for wind, but in a thunderstorm with big droplets, the droplets just forced themselves through the weave – not very rain-resistant at all. The 2007 Inertia Plus fares a bit better in a storm.

But when I ordered some more pants and shorts in the spring of 2007, I found that Cloudveil had changed the cloth – the new Inertia Plus was twice the thickness and twice the weight. It’s now more than half the weight and thickness of Schoeller’s Dryskin. In fact, I found that the old Inertia Plus shorts weighed 6 ounces, and the new Inertia Plus shorts weighed 10 ounces. The finish on the newer Inertia Plus was quite a bit harder; the old Inertia Plus was very light and supple, and the new Inertia Plus was quite a bit harder and less supple. The outside of the material is like a hard-finished cotton twill; a bit like new, tight cotton denim. Initially, I wasn’t too pleased with it. But after a bit, it grew on me. It softened with use, and indeed it provides significantly better protection for elbows and knees. But I still miss the original Inertia Plus; for super-lightweight summer wear that provides wicking, and just a bit of protection, it was great. I’ve been wearing these shorts and pants of the thicker Inertia Plus all the time since they first came out, and except for a few minor thorn-pulls, they look like new. Indeed, the Cloudveil Inertia Plus pants are my favorite pants for three-season use, just like the Cloudveil Schoeller Dryskin pants are my favorite winter pants.

I will admit that I’m moving back towards the hard-shell idea – due to the advent of very, very thin and light windshells like the Gossamera described [below](#). Or, more accurately, moving back in time even before Gore-Tex. Back in the day, we used to hike and climb always with two parkas. One was a light windshell – at first cotton, later nylon as soon as it came out, that was quite breathable. Then there was your “waterproof”

– a non-breathable parka for bad rain. Well, I'm back at the same place, only now I'm carrying my ultralight Gossamera for daily use, and an ultralight Gore-Tex with pit zips for my "hard shell", which almost never gets used. Same basic idea, but a tenth of the weight. And now I'm wearing softshell garments for pants and shirt, so I guess the softshell has moved inwards.

There were some bits of softshell innovation in soft shells in 2011. (If you believe the marketing hype, they're big innovations; they're really not.)

There was a new soft shell material, Cyclone, that, unlike prior soft shells, had a thicker inner fleece lining (about the same as 100-weight Polartec), and a less-porous outer layer. Cloudveil and [Vaude](#) offer jackets made of Cyclone. (BTW, Vaude offers some very, very nice ultralight top-loading daypacks/climbing packs. My wife and daughter and I each have one and we use them all the time.) I got a Cloudveil First Turn jacket made out of Cyclone. It's thicker and heavier than my old Cloudveil Serendipity jacket made out of Schoeller Dryskin, but seems pretty bombproof in terms of wind and water resistance, and even likely abrasion resistance, much more so than Dryskin. Will have to see how it lasts. The only thing I don't like about it is the hood design; there is no drawstring around the entire face opening of the hood, only something that pulls from the back and tightens the top half of the opening. While this allows flexibility for active travel, it's not as good when you're hunkered down in a bivouac and want to cinch the hood tight to shut out the wind. Cyclone seems similar in some ways to Polartec Weather Shield (see below), but my experiences suggest that Cyclone absorbs much less water and stays drier than Weather Shield.

Arc'teryx (which seems to have supplanted Cloudveil as the leading vendor of very-nice but very-expensive outdoor clothing) has two new materials, Burly Double Weave (thinner softshell fabrics are pretty much all [double weave](#), thicker ones are sometimes a laminate of two fabrics), which they have used to replace Schoeller Dynamic (thin softshell, good wicking); and Fortius (three variations, see above), both of which are similar to Schoeller Dryskin Extreme, and Arc'teryx makes both jackets and pants of these materials. Since Cloudveil no longer makes the Symmetry pants, if you want durable, warm, fast-drying, wicking, well-fitting pants that you will use for many years, you might look at what Arc'teryx has.

I got a new North Face Elixir top in May 2012. It's made of two versions of Apex, which is The North Face's name for any softshell material that they sell, and in particular, "Apex Aerobic" which I guess means relatively thin and breathable. ("Apex Aerobic" appears to apply to both materials.) Both of the softshell materials are quite thin. One is moderately wind-resistant and somewhat water resistant (although being out in mild rain for a 15 minute walk had my shoulders getting damp), and has impressive one-direction stretch, oriented around the circumference of the arms. The other is less wind- and water-resistant, but stretchier and more vapor-permeable, and used in the armpits and sides (and, by November 2013, this material is now all pilled and fuzzy, with wisps sticking out 14", simply from abrasion from my pack hipbelt). This means that, despite

this being marketed as a soft-shell, I can push the sleeves above the elbow without constriction. This reminds me of the REI fleece that I have, that's WindBloc throughout most of the jacket, but Powerstretch along the sides and in the underarms, quite similar two-material construction.

The Elixir top is designed as a softshellish jacket – it has a full zip and a drawcord around the bottom – and it makes a nice stretchy shell over my Ibex wool sweater to block mild wind, though I would put my Arc'teryx Squamish Hoodie or Gossamera over it if there was either rain or strong wind.

North Face in November 2013 only sold clothing with Apex ClimateBlock fabric, which is highly wind-resistant (0 CFM they claim), and Apex Universal, which is less wind-resistant (5-15 CFM) but more breathable and more stretchy. But I lost my Elixir jacket on a flight to Zion National Park, and was able to get (March 2015) the North Face Nimble Jacket, which is made out of Apex Aerobic, but without the contrasting side-panel material. It seems to be just as stretchy, and a bit more wind-resistant. Like the Elixir, it also has three zip pockets: a right handwarmer pocket for my Outdoor Research (OR) Sensor gloves that allow me to use my cellphone as a GPS, and OR Revel mitten shells; a left handwarmer pocket for my OR Rando Cap; and a small chest pocket for a Seirus Comfort facemask. That's my standard outerwear for cold weather hikes, climbs, SAR tasks, or just walking the dog.

I got (2012) a pair of REI Endeavor pants. These come in two models, plain pants and ones that have zip-off legs, the kind that you can zip off and remove by unzipping the entire side seam, without taking off your boots or even your pack. I got the zip-off kind, as these are the first completely-removable zipoff softshell pants I've seen. They are made of a thin softshell that seems quite sturdy on the outside, and the inside is a comfortable wicking layer. The material is just a bit stretchy, and fairly stiff. It is about the thickness of Schoeller Dynamic.

I contacted my local REI store to ask what they were made of. They didn't know. I called REI HQ in Seattle. Turns out that the material, which is a proprietary material that REI contracted with an unnamed company to provide, doesn't have a name. The suggested I come up with one, so I did: "Endeavour-cloth." I truly like these pants; I think they're ideal for hiking when the mornings are cool, the days are warm, and there may be rain. Where the pants legs zip off, wind comes through a bit, so not ideal for windy conditions.

Does this mean the end is nigh for named clothing materials? Not that names actually corresponded with any one particular material, but if a big retailer like REI doesn't even bother to name the materials, then I guess people are finally catching on that names don't have much correlation with actual materials.

In December 2012, my wife got three softshell jackets from [Woot](#) for \$20 each. They're made out of the same Endeavour cloth. The tailoring's not great, as there's no drawstring on the bottom, and the wrists just have some elastic. And, the jacket is heavy (twice the weight of my stretchy North Face Apex softshell jacket), and not very stretchy. But it's nice and fuzzy on the inside, and the outside seems quite bombproof. Highly

wind-resistant, more so than the North Face Apex Aerobic jacket, and I suspect highly water- and abrasion-resistant. REI still sells the Endeavour pants.

In 2012, REI also started selling a line of Acme softshell pants, made of the latest version of Schoeller DrySkin. It's quite interesting to compare these with my Cloudveil Symmetry pants, made of one of the first generations of DrySkin. The new pants' DrySkin is thinner... about half the thickness of the original. It is made of thread about twice as small, which is why it's thinner. It seems to be more water- and wind-resistant, and much stretchier. The early DrySkin stretches about 10-15%; this new stuff stretches about 30-40%. The tailoring is great, and the pants have nice features such as an gusseted ankle zip, and when you unzip this, it's easy (and reasonably comfortable) to fold them up above your knees to make shorts. They also have grommets at the cuff for gaiter-type straps for under your foot. They aren't as warm as my original Cloudveil Symmetry pants of Dryskin, simply because the material is thinner. I got another pair of the Acme with a 2" larger waist than my normal to wear over thick fleece tights in deep winter. I finally decided that these are the best 3-season outdoor pants ever made. The Dryskin performs better than any other softshell pants I've ever worn: wide comfort range, great wicking, impressive wind and water resistance, quite stretchy. Schoeller continues to improve Dryskin and I regard it as the acme (pun intended) of softshell materials. The REI Acme pants also work well in the heat. There is a wide gusset behind the zipper at the bottom, and the Velcro closure tab will hold the gusset open when you unzip the gusset. You can then fold the pants above your knees easily, turning them into shorts. Far superior to zip-off legs. REI, start making these again! I want another pair! I have only one complaint: this newer DrySkin is not as durable as the original. After a couple of years of frequent use, there are areas at the knee and around the ankles where the inside fuzz has worn off.

In 2013, REI came out with Mistral pants, again made from an unnamed softshell from an unnamed source. I did contact REI and they said "The softshell material used in the Mistral pant is non-branded and is from a textile mill called Everest and is a blend of nylon/polyester/spandex."

Compared to the Acme, the Mistral pants:

- are made of a generic softshell material, much rougher on the inside; not as bad as Spandura, that after a day of climbing left the back of my knees bleeding from the abrasions, but halfway between Spandura and Schoeller Dryskin and Endeavor cloth;
- are less stretchy, as the axis of the major stretch of the material goes along the legs rather than around the legs like in the Acme pants, however, they are more stretchy than the Endeavour pants;
- do not have a patch cargo pocket on the thigh (which is a handy place to keep a folded map);
- do not have a gusset behind the lower-leg zipper, which means the Mistral allows some wind through

and it's harder to roll them up above the knee to make into shorts;

- are more water- and wind-resistant. (REI makes no claims for water resistance, that's just my observation, but they do note that the Mistral pants will resist wind up to 25 MPH.)

I would rate the Mistral as a superior shell pant over Capilene 4 bottoms for very cold weather (this would eliminate chafing, and it stretches fairly well), but much inferior to the late and lamented Acme pants for 3-season wear. REI says they stopped selling the Acme pant as sales dropped off; this is likely because the Acme pants cost \$170, and the Mistral pants cost only \$100. That's because the Mistral design isn't as good, and the material isn't as good, as the Acme pants. I guess you get what you pay for.

In 2015, I got another pair of REI Mistral Pants. The material has changed a bit. It is thinner and lighter, still a very fine weave. It now has 4-way stretch equal to the Schoeller Dryskin Acme pants. But compared to Dryskin, the material doesn't drape as well, feels more slick and hard on the outside and not as fuzzy on the inside. Still, probably the best deal in a pair of general-purpose softshell pants as they cost less than \$100.

Mountain Hardware has a midweight very-stretchy softshell called Chockstone Doubleweave Softshell. I have a pair of these pants. They aren't quite as good as the late, lamented REI Acme pants in construction, but they are stretchy enough that you can roll up the pants above your knee, but unlike the Acme pants with their gusset, it's pretty tight and tends to cut off your circulation a bit. Still, a respectable pair of softshell pants, and a close runner-up to the REI Acme pants.

As far as softshell materials, it seems to me that Scholler's Dryskin is always a couple of years ahead of the competition. It has a great "hand" (feel), is quite stretchy, and is water- and wind-resistant enough. Competitors may tout their material as better in terms of water- and wind-proof qualities. But that's always at the cost of being less stretchy or less breathable.

Finally I should mention Ibex (the current leading manufacturer of pricey wool outdoor clothing) and their line of softshell materials. The Ibex softshell materials have an abrasion/wind/water resistant outer shell and an inner layer, not of polyester microfiber, but of soft wool. I have two pairs of pants of Ibex softshell. The Tuck Pants are comfortable midweight pants with an elastic drawstring at the cuff. Quite comfortable, wicking, and durable; suited best for spring and fall. The Equipo pants are designed for winter, with medial-ankle abrasion patches, and snow cuffs (internal gaiters). However, they really aren't that thick for winter use, so I use them over a pair of long underwear. Are these pants better than, say, my Cloudveil Symmetry pants or REI Acme pants made of Schoeller Dryskin? Hard to tell.

January 2016: I should make a note about abuse of the term "softshell." ORC Industries makes special forces style military clothing. I was looking for softshell uniform pants, and found their [MCU Level 5 Softshell Trouser - Alpha Green](#) for less

than \$100 a pair. They are made out of a softshell material called Agility by the Brookwood Companies. It's 98% nylon and 2% Spandex. It reputedly has 2-way stretch.

I am now holding these pants in my hands, and wearing my 20-year old Cloudveil Symmetry softshell pants, the bottom partner to Cloudveil's first-of-a-kind Serendipity Jacket, the first softshell garments sold. They're made out of the original Schoeller Dryskin. There is almost no comparison.

The Cloudveil pants have a soft "hand": the material is supple, bending easily and draping across my legs well. They are stretchy enough – about 10-15% – that they feel comfortable even when I'm sitting on a Balans chair with my feet right under my butt. They are also soft on the inside... a brushed wicking

layer that sucks the sweat off my skin and is very comfy against the skin.

The Agility pants are hard to the touch, are crinkly and noisy, and there is no fuzzy, wicking lining. When I first got them, I was convinced they didn't stretch at all. After reading more about the material, I tried really hard, and with difficulty, was able to get it to stretch about 2%.

There is a lot of variation in what's considered softshell. I hereby stipulate that to be considered a softshell, a garment must (a) have a soft hand and drape well, (b) stretch at least 10% in at least one dimension, and (c) have a fuzzy, wicking inside.

That said, these MCY Level 5 pants are pretty good *hardshell* pants.

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## Gloves

There is a material called Polartec Weather Shield that is waterproof and breathable and stretchable; my wife, 12-year-old daughter and I used Seirus All Weather gloves made out of it on an 8-hour hike in rain with temperatures just above freezing in Shenandoah National Park in October 2011. The gloves are not seam-sealed – seam-sealing would make the gloves much more bulky and stiff. The material got and stayed pretty wet, and was slow to dry. And, our daughter's fingers were red and numb the entire time. I think her gloves were a little tight, and the compression effect of the stretch material was enough to keep her fingers numb the entire day, though no actual immersion foot (hand) or frostnip. Seems like nice material for wind – the gloves are OK in the wind when it's not raining – but not ideal for wet-cold condition.

I have some Outdoor Research Windy Ridge gloves of Polartec WindBloc that, like natural materials, end up "breaking in" like a pair of shoes and now fit my fingers perfectly. Even if not as waterproof, nor quite as thick, I suspect they would have done slightly better on this wet-cold hike.

My favorite gloves for somewhat wet-cold conditions are now the REI Minimalist gloves. They are relatively cheap, and consist of a (non-seamsealed) waterproof-breathable shell, and a thin fleece lining. Unlike attempts to combine both shell and lining in one material, these are made of two distinct layers. And the

outer shell is cut generously, so at first the gloves seem a bit clumsy. However, I soon realized that there is a great advantage to this: *no constriction of your fingers*. Those Seirus gloves I mentioned above really constrict the fingers, decrease bloodflow, and make your fingers cold, whereas the Minimalist gloves don't constrict at all.

Sometimes older construction techniques outperform newer high-tech materials. The REI minimalist gloves are highly recommended.

However, my go-to hand covering for most winter conditions has changed. Many companies make midweight gloves that will also work with your cellphone's touchscreen. My favorite brand is the Outdoor Research Sensor gloves. These are fine by themselves in temperatures above freezing as long as they're not wet. For colder or wet conditions, I put a pair of Outdoor Research Revel Shell Mitts over them. These waterproof-breathable shells fold up small and are light, but make the gloves about twice as warm. They have cords you can loop around your wrists, so that you can easily pull them off and let them dangle from your wrists while you use your gloved hands for your cellphone or other tasks. They aren't quite as supple as thin liner gloves, but the OR Sensor gloves are very supple and allow you to accomplish most tasks you could do with thin liner gloves.

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## NikWax

Many of my European mountain rescue friends swear by [NikWax](#). Now NikWax is a company that makes lots of different things, including a big line of detergents and treatments for clothing. If you go to any REI store, you'll find a whole display of NikWax products, including stuff for washing down, for replacing the DWR treatment (durable water-resistant) for softshell garments (which works quite well – I've used it on my older softshell garments), etc.

But what the Europeans swear by (and I've told myself over and over I'm going to try) are garments specifically made of

materials that are waterproofed by a special NikWax wax treatment. Those who hang out in the wet cold of northern England, Wales, Ireland and Scotland ("where we have a wee problem with horizontal precipitation" as my Scottish climbing guide friend Eric Pirie puts it) swear by the stuff. Some are very much into good Gore-Tex, and indeed my Marmot Cairngorm hardshell Gore-Tex parka, designed by Marmot in coordination with the climbing guides at Glenmore Lodge, is one of my prize possessions. (It was my big Christmas present from my wife a few years ago.) But a sizable fraction use the NikWax garments and swear by them. William Lumb, a mountain rescue doctor

from the north of England, puts it thusly: after a wet, cold day-trip in the mountains, you can take off your NikWax top, leave on the NikWax bibs, and drive hours back home while still wearing them, in perfect comfort – something seldom done with Gore-Tex bibs. But they nonetheless keep you dry in wet, cold conditions.

Though NikWax is similar to other DWR treatments, the actual wax product, used on specific softshell materials, seems to provide a level of waterproofness and breathability similar to Gore-Tex. [Paramo](#) has a big line of softshell NikWax-treated “waterproofs” that are very popular in the UK and Ireland. They are available [online](#). They do require retreatment with the NikWax wax waterproofing solution every couple of years (with average use) but this can be reapplied indefinitely.

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## Higher-Tech Flash-in-the-Pan: PCMs et al

People are always trying something new, from battery-operated sock heaters (forget them) to Phase-Change Materials (PCMs) such as [Outlast](#) and ComforTemp. PCMs are basically materials that absorb lots of heat when warm (like when you’re struggling up the side of the mountain) and then release it when you get cold (like coming back down). Once when coming down off a snowy peak in the Cairngorms (Scotland) I had a mitten with Outlast in it on one hand and one without on the other hand. It didn’t make a big difference, but it did seem a bit warmer than the other mitten. In 2011, this idea to have gone out of vogue.

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## Old is New: Wool and ThinShell

For the first major update in several years (version 2.7, August 2011), I highlighted two new materials that are really old materials: wool and nylon.

Wool is in. As far as I’m concerned, wool has always been in – at least for socks. Socks that are at least partly made from wool are superior to any synthetics. True, they’re smelly when wet, and take a long time to dry compared to synthetics. But unlike synthetics, they keep their spring, and avoid matting down under your foot. And the padding provided by wool under your foot is nothing to sneeze at. A good wool sock can extend by hours the time when the bottom of your feet say “no more”! But wool socks were so scratchy that people hated them. Used to be, everyone wore Ragg wool socks made of hard, scratchy wool, and thin liner socks to protect us from the scratchy Ragg socks. (Don’t believe those who said it was to prevent blisters.) You can buy things called Ragg socks but they’re pale, soft and wimpy imitations of the he-man Ragg socks that were available back in the 1950s and 60s.

Ah, but if your socks are made of a fine merino wool – like expensive dress socks only thicker – they aren’t scratchy! It used to be that only Rohner of Switzerland made merino-wool socks. Merino wool is soft, tough, and expensive. Their socks are great – I seldom wear anything else. But the only place I can get them is remaindered at [sierratradingpost.com](#). Nobody thought that customers in the U.S. would pay the extra for merino wool outdoor socks.

I often wonder if the marine climate of the British Isles has something to do with the clothing preferences of British and Irish outdoorspeople – it’s wet and cold, but the change in temperature throughout the day is seldom much, and it’s very rare to have sudden changes in temperature, unlike the more continental climates in the Alps and in many parts of the USA. British and Irish climbers also tend to do lots of day trips and not many multi-day climbs, at least proportional to what happens in the USA, and I wonder if this affects choice of clothing materials. I’d be interested in hearing anyone who uses NikWax-specific “waterproofs” in place of Gore-Tex in the USA.

In 2005, W.L. Gore also came out with Airvantage: breathable clothing you blow up to make it thicker and warmer when needed. Marmot made an *Echo Airvantage Vest* out of the stuff for \$150, and Victorinox a \$350 jacket made of the stuff. Supposedly it fluffs up to the same insulation as 200-weight fleece. But I don’t know what kind of insulation it offered before you blew it up, or how much it weighed, or how durable it was, and I suspect it didn’t ventilate at all. By 2011, it seems to have died a natural death.

But then in 1994, SmartWool started selling expensive merino wool socks, and they sold like hotcakes. And soon everyone was selling merino-blend socks. The [footnote to Cotton](#) mentions Hamlet Socks, which Murray Hamlet developed for the military to prevent blisters.

I think I need to expand a bit on Hamlet Socks.

Murray Hamlet, DVM, was Research Director at the Army Research Institute of Environmental Medicine in Natick, MA in the early 1990s. He was very interested in foot blisters: a big problem in basic training. He researched the available sock systems, including coarse Ragg wool socks with thin, slippery liners (what he and I learned to hike and climb in), and a variety of commercially-available socks. He and his colleagues developed a new military sock that reduced blisters significantly, based in large part on the trekking-sock design of Rohner of Switzerland. This new design featured terrycloth-type loops, like the padding inside many commercial boot socks, but unlike those socks and like the Rohner socks, on the *outside* of the sock. This allowed most of the movement between foot and boot to occur between this “nap” and the boot, rather than against the foot where the movement and friction heating and damage might cause blistering. Although the socks were made from a fairly fine, soft wool, the terrycloth-like loops on the outside were twisted quite tightly.

In 1992, they tested this prototype using Marine recruits at Parris Island. The new design, with an added thin, slick polyester inner liner sock, was tested against standard Marine socks (a blend of wool, cotton, nylon and Spandex), and against a standard Marine sock with the same thin liner. Recruits with the prototype and liner had a lower blister incidence than recruits with the standard sock (risk ratio=1.8,  $p<0.01$ ) and recruits with the standard sock with a liner sock (risk ratio=2.0,  $p<0.01$ ).<sup>\*</sup> Subsequent unpublished testing showed that, with the new design, a liner sock was not needed.<sup>†</sup>

You can get military-style socks from military suppliers like TechSpun. You can also buy socks like SmartWools, with a terry-loop nap inside, and wear the socks inside out. However, the loops in most such socks are not twisted as tightly as those in the military “Hamlet Socks” nor in the Rohner socks (which I wear all the time) that provided inspiration for the new military sock design, so it’s not a perfect substitute, but enough to prevent blisters.

Other than Rohner trekking socks, the only socks I’ve found to rival those civilian Hamlet socks are Patagonia’s Ultra Heavyweight Mountaineering Socks, again worn inside-out. The weave is much denser than SmartWool socks, which provides better cushioning under your feet. However, they’re so thick your boots may not fit.

Back in the old days (1950s and 1960s) all outdoorsmen (there were very few outdoorswomen then, and the men were mostly very sexist, so I use the then-contemporary term) in cold-wet conditions wore wool. I did a lot of climbing and backpacking and caving in wool with a ventile cotton parka or coveralls over it.

More recently, several outdoor clothing companies – SmartWool being one – have started selling merino wool clothing, from summer T-shirts to thick winter sweaters. [Ibex](#) is the best-known manufacturer of wool outdoor gear. I have one of their vests, but to be truthful, it’s so nice that I wear it with my work clothes all the time (and get compliments on it) and use my Power Stretch vest for true outdoor use.

Aficionados of wool point out that it ventilates better than fleece. And it’s true. This past winter (writing this in 2010), whenever I would go out for a half-day walk or a dayhike, I would wear a wicking baselayer (often one of those Patagonia R 0.5 tops I mentioned above), a thick loose-knit wool sweater, and a wind shell, with hat, mittens or gloves, and a facemask. By unzipping the wind shell, I could let some wind into the sweater and easily ventilate going uphill, and then zip up when on a windy ridge or heading downhill. For fall 2011, Ibex introduced a full-zip version of their thick Guide sweater (I want a full zip for better ventilation and ease in donning and removing), and I got one, as it’s a lot lighter than the “street”

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<sup>\*</sup> [Thompson KJ, Hamlet MP, Jones BH, Knapik JJ. Impact of Sock Systems on Frequency and Severity of Blister Injury in a Marine Recruit Population. Natick, MA: US Army: 1993.](#)

<sup>†</sup> Murray Hamlet, DVM, personal communication.

wool sweater I wore a lot last winter. From my experience: if unsure which of two sizes to order, order the smaller one, as it’s quite stretchy. Indeed, the Ibex sweaters are extremely stretchy, so they fit you like a glove.

Makers of synthetic baselayer fabric have struggled for years trying to find the ideal additive or coating to prevent bacterial growth, which causes smell. They’ve tried many things, including silver (which works fair but not great). But wool has its own natural antibacterial effect, which works much better. In 2014, a microbiology research report<sup>1</sup> explained why it’s so hard to keep polyester clothing smelling nice; bacteria called micrococci love to live in polyester, and they stink (nothing personal). From my own personal experimentation, wool T-shirts stay unstinky for 3-4 times as long as synthetic ones. YMMV (your mileage may vary). I don’t have a very strong body odor, but when in the backcountry, I can wear a wool T-shirt for almost a week before it gets smelly.

Backpackinglight.com has a nice [review of their testing](#), using hybrid garments, half wool and half synthetic, as well as lab testing, with background information and lots of graphs. Their bottom line is that wool baselayer takes about twice as long to dry as synthetics, for a given thickness=warmth, but that wool felt warmer as it was drying. Wool is also heavier when wet, as it holds more water. Mark Veber did some [testing on water retention](#), providing detailed figures on cotton, wool, and polyester, showing that you can get polyester fleece soaking wet, then wring it out, and it only retains 10% of its weight in water. After wringing out, cotton retains **150%** of its weight in water. Wool is in-between. Let me offer an observation on drying wool, though: spinning. If you wash your wool socks, you can get most of the water out of them by holding them by the ends and spinning them around your head for a couple of minutes. Centrifugal force drains out most of the water. (Don’t do this in a crowded room.)

Addendum, May 2105: Ibex and Smartwool (at least) are promoting thin wool garments for summer use. I have a few thin wool T-shirts and bicycle-jersey type tops that I have used extensively in mixed cool-warm conditions, and I’ve been very happy with their performance, indeed, they’re my favorite tops for these kind of conditions. More recently, I’ve tried them in hot, humid conditions, comparing them with thin synthetic-wicking tops. The synthetic tops win, hands-down. Why? Because “wool is warm when wet” whether the wet is from rain or sweat. The synthetic tops cool me off quite a bit better, they not only feel cooler, but you can tell that the sweat is spreading better than with the wool tops.

Full disclosure: there are a few disadvantages to wool. First, though it’s warmer than fleece, it’s heavier. For a given thickness of material, I’d guess that wool is about 2.5 times as heavy and 1.5 times as warm. So, for a given warmth, fleece is lighter. Fleece also retains less water than wool, and dries quicker. Wool smells like sheep, especially the better wool like that used by Ibex, and more so when it’s wet. Wool can be scratchy, though the high-quality merino wool used by Ibex and Smartwool is only very minimally scratchy. And, wool isn’t as strong as polyester or cotton. Thin pure wool baselayer lasts

about a tenth as long as cotton or polyester. I have had to trash a number of Ibex wool T-shirts as they just fell apart. Ibex has now (2013-14), though, made up a new thread (officially, “yarn” but it’s thin enough your or I would call it thread) with a nylon core. I have a couple of T-shirts made from this yarn, and they do seem a lot more durable. The only downside I see is that they don’t stretch quite as much as thin pure wool baselayer, but they still stretch plenty.

But, as with fleece, quality and construction matter. Interestingly, Ibex wool gear may not be the best in terms of usefulness-to-weight ratios. I’ve got some sort of fluffy-ish wool sweaters that are as thick as my Ibex wool sweater but less than half the weight, much likely due to their loose weave, and loose yarn. The Ibex sweater that I have is, however, much, much tougher and likely to last for a long time. One other thing: you can tailor fleece and other artificial fiber materials easily; for instance I have shortened the sleeves and tightened the wrists on my Capilene 4 zip turtlenecks that I wear all the time. (I have shorter arms and smaller wrists than Patagonia designed into them.) You can’t tailor a knit sweater. However, the cuffs are designed to turn back to shorten the sleeves if needed, and it is so stretchy that you really don’t need to tighten the wrists even if, like me, you have smaller wrists.

Ibex has started offering softshell gear. Their gear is basically like other softshells, except that it’s a mixture of artificial fibers (for the outer, wind/water/abrasion resistant layer) and wool, instead of wicking polyester, for the inner layer. They have an Equipo jacket and pants made of material jointly labeled as Schoeller Naturetec and PeakIbex Climawool. I got a pair of the pants, and they’re very, very similar to my Schoeller DrySkin Cloudveil Symmetry pants, except they have a softer hand and better drape. The material has limited four-way stretch. The outer layer has a fairly hard, plastic-y feel, so I suspect it will be quite abrasion-resistant. The pants have an abrasion patch on the medial ankle, and an integrated snow cuff with a gaiter hook. However, the material is pretty thin, so when I use the for deep winter/snow, I’ll be putting on some long underwear first. I also got a pair of the Tuck pants, which are of a slightly different material; it’s about the same thickness as the material used for the Equipo pants, but the outside is quite a bit softer and finer to the hand than the Equipo pants or my original Schoeller Dryskin pants. The material, however, has only 2-way stretch, oriented along the long axis of the legs, and they are cut slim, which might be an issue if you bike a lot and have big thighs. They are a bit snug on my thighs but not uncomfortably so. Overall, the Tuck pants are quite light: just a bit over a pound. There is no snow cuff, and no abrasion patches. There is stretch-cord around each of the cuffs, allowing you to snug them tight around your boots. Given how wool is superior to artificial fibers for preventing bacterial growth = smell, I could see wearing these pants on a trek, every day for a couple of weeks.

I and other cavers used to wear Sears wool underwear under our coveralls (caving coveralls, either military-surplus flight suits or Sears work coveralls, often with the seats and knees treated with a rubber-cement-like stuff called Canvas-Grip, alas no longer available). The Sears wool underwear was superior to

other brands, as it was made from a long-staple north-coast Australian wool that was actually not very scratchy. (I do remember one trip where I was sunburnt and then my wife accidentally spilled sweetened tea on me in the tent, and the combination of sunburn, stickiness from the sugar in the tea and the wool underwear was particularly itchy, but I’m sure you’ll agree that was an exceptional case... ) But the wool in Ragg socks, Dachstein mitts, and particularly some very-hard wool knickers (still in my closet) are quite itchy.

The Swiss company Rohner has made high-quality wool trekking socks since 1933, and I wear them all the time, even as my dress socks, and don’t find them itchy at all. And my daughter (12 years old as I write this) who instantly rejects anything with a trace of itchiness, used to wear inside-out SmartWool socks (I couldn’t find Rohner trekking socks in her size) without complaint, and now that she’s 14, wears Rohner socks and is quite happy with them.

This brings up another “old is new” – nylon wind shells. Nylon wind shells have been around for years; I had an REI nylon windshell back in the 1960s. It was OK. But things are now changing.

I am going to coin a new phrase (September 2011), and we’ll see if it catches on: **ThinShell** (or perhaps **LightShell**). A decade or two ago, SoftShell was all the rage: water-resistant but highly-breathable shells with a wicking construction on the inside. Now, new tough, very thin-and-light, water-resistant and highly-breathable nylon fabrics such as Gossamera make a new kind of shell possible.

Most of the winter of 2010-11, I used an old CloudVeil Cirque jacket. This is a thin nylon shell jacket, DWR (Durable Water-Resistant = mildly water resistant, but very breathable), with a generous hood to accommodate a helmet or hat, a half-zipper in the front, and two big pockets on the front to hold hat, gloves and facemask when going uphill. I found this was fine even in wet snow around freezing; it was water-resistant enough for me to never have resorted to my Gore-Tex shell jacket.

The only thing I really didn’t like about it was that half zip in front. I really wanted a wind shell that would allow me to ventilate better. And I figured that I would be able to get something in a lighter, thinner nylon.

First, I got one of the new, lighter nylon [Pertex](#) 685 shells – made by [Integral Designs](#) (“Pertex Wind Jacket” – a true, descriptive name for a change). It’s designed to be ultralight. It weighs only 4.6 ounces and will fit into your pocket with room left over. It seems quite breathable and water-resistant enough to keep me dry during some light freezing rain showers. The material, Pertex 685, is impressive stuff. I found this online: *Pertex 685 is a 40 denier microfibre ripstop nylon weighing 1.85 oz per square yard. The purpose of this fabric is to use fine filament, closely woven calendered materials to create a low bulk product that is windproof, water repellent and breathable. Pertex 685 is constructed using the same DWR + technology as Pertex Microlight (see above). However, the 40 denier base fabric is more robust and abrasion resistant than Microlight, making it the fabric*

of choice as a shell fabric for Primaloft insulated clothing. It's about twice the weight of Pertex Quantum, which is used for down gear linings.

However, it has no pockets for my gloves and hat. And, the hood's front closure is bizarre – to save weight, it merely has some elastic around it, no actual drawcord. That means that when the wind comes up – and remember, this is supposed to be a windshell – that the wind comes in around your head and chills your head and neck, and there's just no way to prevent this. I was unhappy enough with it – bad hood design, no pockets for my gloves and hat – that I relegated it to emergency use as a loaner and it went into the back of my car. I also later found it had basically zero resistance to real rain.

Next, I got an [Arc'teryx](#) Squamish Hoodie, which I think is more designed for warm-weather use than my intended use as an outer shell for the winter. I got a large so it would fit over my heavy sweater or a couple of layers of fleece. It has a great hood design with a drawstring closure with hidden ends to avoid them slapping you in the face when windy, Velcro wrist closures with just enough stretch to get on without undoing the Velcro, excellent tailoring and design overall, and a full front zip for ventilation. It only has one pocket in front, and it's a tight squeeze to get a facemask, hat and gloves in there, but I can make it work. If they would only add a second breast pocket, it would be a perfect winter shell.

Most interestingly, the Squamish is made of Gossamera, a very light micro-ripstop nylon with a very thin urethane coating on the inside and DWR (durable water-resistant) coating on the outside. It has an air permeability of 7 cubic feet/minute, similar to Pertex Quantum's 5 cfm. It has a harder finish than Pertex Quantum, which is quite soft, but it's not noisy like some hard-finish nylon. Despite being as light as gossamer, it really seems quite tough, though I'm not sure I'd do a long climb on rough rock wearing it. In practice, it seems quite breathable, much more so than my current HyVent North Face ultralight Gore-Tex-equivalent pullover (to which I added pit zips).

Like the Pertex wind jacket, the Squamish has a DWR finish, but the Squamish's seems much more effective. I once put on the Squamish and went for an hour-long walk in a mild to moderate cold rain. At the end, when I took off the jacket and looked at the inside, there was a little water coming in the seams, and just a bit of water coming through the shoulders, but really only a tad more than I would expect from condensation inside a Gore-Tex jacket. I liked it so much I also got one in size small to carry in the summer, and it certainly sheds water a lot better than the Pertex shell. I even seam-sealed the shoulder and hood seams on my small one.

This Gossamera wind shells are about half the weight of my old nylon CloudVeil Cirque windshirt, more water-resistant, more wind-resistant, seem to be tougher and just as breathable, and are full-zip. I'm very pleased with them. As with anything made by Arc'teryx, they are relatively expensive (~\$150), but the design and tailoring are impeccable.

This combination: a wicking layer, covered by a highly-breathable merino wool layer, covered by a ThinShell of Gossamera, is in my opinion a better solution than a softshell jacket in many ways. The most important is weight; using wool rather than fleece adds some weight but using a Gossamera shell instead of a "wicking" softshell saves a lot more weight.

Eventually, we will have fabrics that have a permanent DWR finish as part of the yarn from which the fabric is made, as shown by [a report](#) in the New Scientist. At that point, semipermeable membranes like Gore-Tex may become a thing of the past, like my Ventile cotton anorak and 60/40 parka.

So. ThinShell is in. Wool and nylon are dead. Long live wool and nylon!

Addendum, October 2011: My wife and daughter and dog and I were on a hike in Shenandoah National Park. It snowed 2 inches the first morning, and then a fairly hard and quite cold rain ensued for most of the day. I think the high was a bit less than 40° F. In addition to this being good hypothermia training for my 12-year old daughter, I should note that I wore my Squamish windshirt rather than my Gore-Tex parka. My wife wore a Lowe Triple Point Ceramic (Lowe Gore-Tex clone) parka. However, my non-seam-sealed Squamish windshirt kept me drier than her waterproof-breathable parka. Not sure if this was from condensation (though she had her front zipper open quite a bit to ventilate) or simply from water coming through. Under the Squamish I had a Patagonia R 0.5 top, two Power Stretch pullovers, and a Cloudveil FirsTurn softshell jacket made of their Cyclone material.

After the days' hiking, the Cloudveil FirsTurn jacket – the first layer under the Gossamera windshirt – was barely damp in a few places, but only on the outside. The Arc'teryx Squamish won the contest handily, and its weight is a fraction of her parka's.

I got my wife and daughter each a Squamish hoodie. We used them on a similar week of hiking in Shenandoah National Park in October 2012. However, it was sunny all week with highs in the 60's so it wasn't much of a test!

One other thought about keeping dry in cold-wet conditions: heat. When you're active, you generate a lot of heat. This generates an outward pressure to move water away from you, unless blocked by an impermeable layer. And Gore-Tex and its clones, even when dry, are relatively impermeable layers, whereas the Gossamera windshirt is relatively permeable to water vapor. So, my rave reviews about this windshirt should be taken with a grain of salt. If you're not active – just sitting there, for instance in a bivouac – then likely Gore-Tex would keep you warmer and drier in the rain. And, I haven't tried the Gossamera windshirt in a real downpour, only in a moderate rain. Once I have a chance to try it out, I'll post the results here.

Well, here are (some) results. I've used the Gossamera jacket in a downpour, and it kept me pretty dry, except for the slight leakage at the seams and a small bit on the shoulders. I also just (February 2012) used my small Gossamera jacket on a trip to Disney World with my preteen daughter and wife, and wore it

on a trip on the Kali River Rapids. On this, you get hit with high-velocity water, including that sprayed by the people on the bridge above who can press a little button to make the decorative elephants on either side squirt you with water. I found that the high-velocity water defeated the DWR coating, in that the material wetted, rather than the water beading up. This meant it took longer to dry. However, I really didn't get wet inside the jacket. I like this material, and the excellent Arc'teryx tailoring, the more I used it. BTW, I was able to get pants made out of Gossamera, but only from a tactical rather than an outdoor supplier. Like the jacket, the pants will fit into a pants pocket, and weighs about 4 ounces (120g). Means that

for a weight of half a pound you have a solid nontechnical wind suit/rain suit.

May 2013: North Face has a Verto Jacket made out of Pertex Quantum GL, which is even lighter than Gossamera; it's about 2/3 the thickness and 2/3 the weight, but I'm not sure how water-resistant it is compared to the Gossamera. I did note that my Gossamera jacket, after a couple of years of quite frequent use, is getting wetted more easily in the rain, so I sprayed some ScotchGard on the hood and shoulders. No tears, pulls or signs of abrasion.

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## Combination Yarns

Ibex manufactures some thin wool baselayer garments, and touts them for wear even in the summer. I have several different models of their thin/baselayer T-shirts, and I have to say that I'm sold on them for three-season use. The only problem is that wool that is so thin is really quite fragile. Three of my shirts have gotten holes or runs in just a couple years of use. But Ibex now (2014) has a new material, made from a yarn (thread) that has a nylon core with wool around it. As I write this, I'm wearing a zip T-shirt/bicycle jersey of it. Not quite as stretchy as the pure wool, but still quite stretchy. I suspect this will be much longer-lasting than my other Ibex wool T-shirts, one of which had to be trashed and another of which will likely be there soon. Ibex is also starting to make a version with wool around a Lycra core... haven't tried that particular variant yet. Ibex calls it "W2" (for "weightless wool") and I love this stuff for summer wear.

A company called Optimer patented a new type of yarn called Dri-Release (aka *drirelease*). Like Ibex, they use two different fiber types in the same yarn. Ibex wraps wool around a core of nylon or spandex to make the yarn stronger. But Optimer twists different fibers together in the same yarn, fibers that have different wicking and water retention properties. Roughly 80-90% of the yarn is polyester fibers, and about 10-20% of the fibers are "natural" fibers.

To make it wick better, other companies have applied coatings to polyester yarn. This wasn't very satisfactory, as the coating wore off after a certain number of washings. More recently, companies are applying permanent wicking coatings to polyester yarn. Akwatek is the most prominent brand of such permanent wicking treatments.

However, Optimer is treating their yarns, not to make them more wicking, but to make them *less* wicking. (This is the same as "making them less hydrophilic and more hydrophobic"). However, they only treat with enough of this material – Teflon and related compounds<sup>‡</sup> – to partially coat the polyester and "natural" fibers. Indeed, that partial treatment of the fibers is part of their patent.

Optimer seems to be combining polyester with 10-20% of any other "natural" fiber they can get hold of, up to and including bamboo; I suspect the main advantage of bamboo is that you can tell people your underwear is made out of bamboo. As discussed in the Wikipedia [article on bamboo textiles](#), there are many questionable claims for bamboo fabric. The most common "natural" fiber they use, judging by what retailers sell, is cotton. But note that the cotton as well as the polyester are partially waterproofed.

The central advantage, as expressed in their patent application,<sup>§</sup> is that this decreases the amount of water the material will hold. Less water = quicker drying; they point out that their fabric dries more quickly than CoolMax Extreme and some other wicking fabrics (though they don't compare to DrySkin, my favorite wicking softshell). Indeed, drying time is important for comfort... when I stop at the top of a climb, I want my sweaty garments to dry quickly, as I cool off quickly and want to be dry sitting on top and on the way down.

But does it get the water away from your skin? Does it "wick?" Or does your skin stay all sweaty inside a *drirelease* garment? There are a few individual evaluations of *drirelease* garments that note that they do, indeed, wick – or perhaps pass through – moisture quite well.

The patent application goes on and on about "water release" instead of "wicking." I have am not sure this is anything more than patent-lawyer obfuscation. The patent application also goes on and on about how much money we will all save by having clothes that dry faster in the dryer. Does quick-drying also mean wicking? A plastic leaf bag dries quickly but certainly doesn't wick.

Well, in the patent application, Optimer cites some research they did, where one (1) person exercised, both mildly and strenuously. In both cases, the test subject wore a pair of liner socks under thicker outer cotton socks. One of the liners was treated with dilute Teflon, the other was not. After exercise, the outer cotton socks were weighed to determine the moisture content. With both mild and strenuous exercise, there was more water in the outer cotton sock, showing that

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<sup>‡</sup> They coat fibers with a polytetrafluoroethylene, polyvinyl acetate, and polyvinyl acetate/acrylic copolymer.

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<sup>§</sup> <http://www.google.com/patents/US20040185728>

the Teflon treatment improved wicking. The subject also noted that the foot with the Teflon-treated liner sock felt drier.

There some independent single-person test reports on the web that tend to confirm that the fabric does indeed wick quite well. It's not clear to me that any one combination is superior to the other; I would love to see some testing of the different variants. I would suspect that the polyester/cotton or polyester/wool would be best. The wool would help prevent it from smelling. The cotton would wick better. However, note that the hydrophobic treatment is applied to the cotton as well as the polyester.

Optimer says that their fabrics have the trademarked-but-not-patented FreshGuard to prevent the fabric from getting smelly. On investigation, this seems likely to be a function of the Teflon-and-related stuff with which they treat the yarn. Teflon is hydrophobic – water doesn't stick to it – but it's also lipophobic – grease and oil don't stick to it. Which is why you may have a nonstick frying pan coated with the stuff. The hydrophobic quality of this Teflon treatment is what keeps *drirelease* from retaining water (but the remaining wicking of the small amount of non-coated cotton probably provides enough wicking). The lipophobic quality of this Teflon treatment is what likely helps keep down odors. Smelly clothing comes mostly from oils from our skin getting into the

material and then being decomposed by bacterial. The Teflon keeps the oils from sticking to the material. [One independent tested noted](#) his *drirelease*/wool pants getting a bit smelly after three days. Another independent tester [reported online](#) that he rated a *drirelease*/wool shirt as a 7/10 for odor-resistance, with 10 being pure wool, and one being the original untreated polypro underwear (very smelly after just one day). So, not too bad.

Another question still to be answered: does this yarn retain its warmth when wet, like wool or other all-polyester materials? One would suspect so, given their numbers on how little water the yarn absorbs.

Allegheny Mountain Rescue Group just (2015) got new summer uniform T-shirts of *dri-release* which are 85% poly and 15% cotton. The material feels much more like a good quality cotton than polyester. After it finally gets warm enough to test these out I will report back. Update, April 2015: we had an evening canine training in the rain, with temperature about 55°F (13°C) and wore the uniform Tshirt under a Malden Powerstretch sweater and a Gore-Tex parka. The Tshirt seemed to wick quite well, and felt quite dry the entire time, except slightly damp in the underarms. I'm very impressed.

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## Insects

Ticks. Mosquitoes. Biting black flies. None of us like feeding insects with our blood. (OK, ticks are arachnids and not insects. Doesn't matter for what we're discussing here)

The traditional way to protect yourself is to slather your exposed skin with DEET or another insect repellent. (I prefer picardin = Natrapel. See <http://www.conovers.org/ftp/Ticks.pdf> for more on insect repellents.)

However, a reasonable alternative, or perhaps we should say a reasonable complement to putting picardin on your skin, is to have clothing that is treated with the insect repellent permethrin.

But first, a bit of pedantic terminology modification: permethrin is often talked about as an insect repellent, but it's not, it's actually an insecticide. But it's quite a safe insecticide to put on clothing, unless you have a pet tarantula, or if you dump it in the aquarium with your pet fish. It kills insects and arachnids but has minimal effects on humans, and is not well-absorbed from human skin. (It can be toxic to cats in large commercial-insecticide concentrations, so keep them away from it.)

You probably don't want to put it on your skin on a regular basis to prevent insect bites, as you'd eventually develop some toxicity. It is OK to put it on your skin for a short time; putting 5% permethrin on your skin from the neck down at night, then

washing it off in the morning, is the standard treatment for scabies. An over-the-counter permethrin shampoo is also available for treating head lice. Permethrin also works for chiggers = sand fleas, a common ankle mite infestation from walking barefoot on certain beaches.

For preventing tick bites (and probably black fly and mosquito bites through thin clothing) you can treat your clothing with permethrin. Stores such as Dick's Sporting Goods and REI carry spray-on permethrin. Turns out that you can prevent 75% of tick bites by simply treating your socks with permethrin. Treating your pants gets you even better protection. Since ticks climb up you from the ground, treating just your socks and pants will get you quite good protection.

When you apply permethrin to your clothing at home, it lasts for 6 washings or 6 weeks. But you can get clothing treated commercially using a specific formulation of permethrin that binds to the fibers of clothing; it's called *Insect Shield*. It reportedly will last through 70 washings, which they state is the typical life of an outdoor garment. (I don't know about that, as I'm writing this I'm wearing a pair of Cloudveil Symmetry pants, which were the first softshell pants marketed in the US. I've had them since maybe 1995 (20 years) and they're still going strong, a testament to the durability of Schoeller's first Dryskin fabric. I wear them a lot. I suspect they have been washed *many* more than 70 times.

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## Where to Learn More

Mark Verber has a fairly long page with detailed discussion and specific recommendations for different types of outdoor clothing at

[www.verber.com/mark/outdoors/gear/clothing.html](http://www.verber.com/mark/outdoors/gear/clothing.html).

Backpacking Light has a page with the [names and lineages of breathable fabrics](#), but without detailed information on most fabrics. There are websites at [www.gearreview.com](http://www.gearreview.com) and [www.backpackgeartest.org](http://www.backpackgeartest.org) that feature detailed reviews of many pieces of outdoor clothing, some with comments about their materials. The current Polartec website has a [page](#) devoted to a history of their fabrics. Crestone Designs has [a page](#) about the fabrics they use.

There are zillions of different brand names listed here, and so in this document – no matter how overwhelming it might seem – I just try to hit the high points. There are many, many outdoor garment manufacturers. The ones I know well and/or like are listed as links in the footnotes. Because there are so many good outdoor clothing materials, each garment manufacturer has to choose just a few fabrics. Thus, if you shop around, you can find many similar garments in different materials. The fabric and garment manufacturers use the same name for many different fabrics, and sometimes a single fabric has more than one name, *and* sometimes they keep the same name but change the fabric. Sigh.

Keith's Picks in <b>Bold</b>	comfort against skin	warmth (not per weight)	warmth when wet?	water resistance	wind resistance	abrasion resistance	stretch	wicking and sweaty comfort	resistance to pilling	thorn-pull resistance	Speed of Drying	Wrinkle- resistance	Resistance to matting	
<i>Against the Skin Everyday Clothing</i>														
<b>Schoeller Dynamic<sup>ii</sup></b>	++	+	++	+	++	++	++	++	NA	xxx	+++	+	+	
North Face Apex Aerobic	++++	+	+	+	++	+	++++	+++	++	+	+++	+++	++	
North Face Apex Climateblock	+++	++	+	++	++++	++	+	+	++	++	++	+	++	
North Face Apex	+++	+	+	+	++	++	++	++	++	++	++	+	++	
REI Endeavor- Cloth	+++	++	++	++	+++	+++	+	++	NA	++	+	++++	++	
REI Mistral Cloth	x	++	++	+++	++++	+++	++	++	NA	++	++	++++	++	
<b>Schoeller Dryskin<sup>iii</sup></b>	++++	+++	+++	++	+++	+++	++++	++++	NA	+	+++	+++	++	
Schoeller WB-400 and F-Shell <sup>iv</sup>	?	?	?	?	?	?	?	?	?	?	?	?	?	
Schoeller NatureTec/ Peakbex ClimaWool	++++	++	++++	+	+++	++++	++	++++	++	?	++	++++	++++	
Polartec Power- stretch Cordura <sup>v</sup>	?	?	?	?	?	?	?	?	?	?	?	?	?	
Polartec Power- Shield, Fortius 2.0/3.0 <sup>vi</sup>	+++	++	+++	+++	++++	+++	++	++	+++	?	++	++	++++	
Gore Wind- stopper <sup>vii</sup>	+	+	+	++	++++	?	+	x	?	?	?	++	++	
Polartec Windbloc	+	++	+	++	++++	?	+++	+	?	?	?	++	++	
Polartec Aqua Shell <sup>viii</sup>	?	?	?	?	?	?	?	?	?	?	?	?	?	

Keith's Picks in <b>Bold</b>		comfort against skin	warmth (not per weight)	warmth when wet?	water resistance	wind resistance	abrasion resistance	stretch	wicking and sweaty comfort	resistance to pilling	thorn-pull resistance	Speed of Drying	Wrinkle- resistance	Resistance to matting
	Polartec Weather Shield <sup>ix</sup>	++++	++	+	++	++++	+++	++	++	++++	?	+	++++	++++
	<b>Cloudveil Inertia</b> , Schoeller Dynamic Extreme, Fortius 1.0 <sup>x</sup>	+++	++	++	+++	+++	++++	++	++++	++	+	++++	+++	na
	<b>Cloudveil Cyclone Plus</b> <sup>xi</sup>	+++	++	++	+++	+++	++++	+++	++++	+++	++	++++	+++	na
	Patagonia Tactile Aspira (extinct) <sup>xii</sup>	?	?	?	?	?	?	?	?	?	?	?	?	?
	Gore-Tex Soft Shell II Masai, now just Gore- Tex Soft Shell <sup>xiii</sup>	+++	+	+++	++++	++++	+++	x	+	+	++	+	++	+++
	Brookwood Agility	--	+	+	++	+++	+++	---	----	++++	++	+	---	na
<b>Pile and Fleece</b>	Helly- Hansen Pile <sup>xiv</sup>	+++	+++	+++	x	x	x	+	++	+	x	++	++	x
	Non-Helly- Hansen Pile <sup>xv</sup>	+++	+++	+++	x	x	x	+	++	xxx	x	++	++	x
	Malden <sup>xvi</sup> Polartec 100/200	+++	+++	+++	x	x	+	++	++++	++	x	++++ +	++++ +	+
	Marmot Outlast (extinct) <sup>xvii</sup>	++	+++	+++	x	x	x	+	++	+	x	+	+	?
	<b>Polartec Power- stretch 100/200</b> <sup>xviii</sup>	++++	+++	++++	x	x	+	++++	++++ +	++	x	++++ +	++++ +	+
	Therma Fleece <sup>xix</sup>	++++	+++	++++	x	x	x	++	++++	++	x	++++	++++	+
	<b>Paramo Parameta-S</b> <sup>xx</sup>	++	++	++	x	x	x	+	++	?	x	++	++	++
	<b>Patagonia RI and R0.5/ Capilene 4</b>	++++	+++	+++	x	x	x	++/ ++++	++++	++++	+++	x	++++	+++

Keith's Picks in Bold		comfort against skin	warmth (not per weight)	warmth when wet?	water resistance	wind resistance	abrasion resistance	stretch	wicking and sweaty comfort	resistance to pilling	thorn-pull resistance	Speed of Drying	Wrinkle-resistance	Resistance to matting
Shellish Clothing	<b>Water-proof Zippers<sup>xxd</sup></b>	xx	xx	xx	++	++	+	x	x	na	na	na	na	na
	Nylon <sup>xxii</sup>	x	x	x	++	++++	+	xxxx	x	++++	+	++++	+	na
	<b>Coated Nylon (SilNylon, Nextec Epic, Gossamera)<sup>xxiii</sup></b>	xxx	++	x	++- ++++	++- ++++	+--+				++			
	Supplex <sup>xxiv</sup> Nylon	+	x	x	++	++++	++	xxxx	x	na	++	++++	++	na
	Spandura <sup>xxv</sup>	x	+	+	+	++	++++	+++	x	++++ +	x	++	++	na
	Supplex Ripstop Nylon <sup>xxvi</sup>	++	x	x	++	++++	+++	xxxxx	++	na	++++	++++	+++	na
	<b>Gore-Tex<sup>xxvii</sup></b>	x	+	+	++++	++++ +	varies <sup>xxviii</sup>	x <sup>xxix</sup>	xxxx	na	+++	++	varies	na
	<b>Pertex<sup>xxx</sup></b>	x	+	+	++	++++ +	varies	x	xxx	na	+++	++	varies	na
Escape cloth <sup>xxxi</sup>	x	+++	+++	++	+++	+	x	x	na	x	+++	+++	na	
Everyday Materials/Base Layer	Wool <sup>xxxii</sup>	x	++	++	x	x	++	+	x	x	+++	x	+++	++++ +
	Silk	++	+	++	+	++	++	+	xxx	na	x	+	xx	na
	Cotton <sup>xxxiii</sup>	++- <sup>xxxiv</sup>	+++	xxxxx	xxx	++	+	x	x <sup>xxxv</sup>	++++ +	++++	xxxxx	xx	xx
	<b>Malden Power Dry<sup>xxxvi</sup></b>	++++	++	+++	x	x	x	++++	++++ +	++	x	+++	++++	++
	<b>Intera<sup>xxxvii</sup></b>	+++	+	+	x	+++	++	x	++++	na	+	+++	++++ +	na
	<b>Intera DryForce<sup>xxxviii</sup></b>	+++	+	++	+	+	x	++	++++	+++	x	++++	++++	na
	Tencel <sup>xxxix</sup>	+++	x	+	x	++	x	x	x	na	x	+	+++	na
	<b>Polyester Microfiber<sup>xl</sup></b>	++	+	++	x	+++	x	+	++	na	x	+++	+++	na
	<b>CoolMax (as everyday clothing)<sup>xli</sup></b>	++	++	+	x	x	x	+++	+++	xx	xx	+++	+	na
<b>Polarmax<sup>xlii</sup></b>														

Keith's Picks in <b>Bold</b>	comfort against skin	warmth (not per weight)	warmth when wet?	water resistance	wind resistance	abrasion resistance	stretch	wicking and sweaty	resistance to pilling	thorn-pull resistance	Speed of Drying	Wrinkle- resistance	Resistance to matting
	comfort against skin	warmth (not per weight)	warmth when wet?	water resistance	wind resistance	abrasion resistance	stretch	wicking and sweaty	resistance to pilling	thorn-pull resistance	Speed of Drying	Wrinkle- resistance	Resistance to matting

<i>Layering and Sleeping Bag Materials</i>													
Down/shell	na	++++	xxxx	na	na	na	na	xxxx	na	na	xxxxx	na	xxxxx
Dacron-88	na	++	++	na	na	na	na	+	na	na	xxxx	na	xx
Hollofill	na	+++	++	na	na	na	na	++	na	na	xxx	na	xx
Qualofill	na	+++	++	na	na	na	na	++	na	na	xxx	na	xx
Primaloft/ Liteloft <sup>xliii</sup>	na	++++	++	na	na	na	na	+++	na	na	xx	na	xx
3M Thinsulate matting <sup>xliv</sup>	na	++++	++	na	na	na	na	+++	na	na	xx	na	xxxx
	comfort against skin	warmth (not per weight)	warmth when wet?	water resistance	wind resistance	abrasion resistance	stretch	wicking and sweaty comfort	resistance to pilling	thorn-pull resistance	Speed of Drying	Wrinkle- resistance	Resistance to matting
<i>Underwear Materials</i>													
Polypropylene <sup>xlv</sup>	++	+	++	na	na	xxx	+++	<sup>xlvi</sup>	xxx	xxx	++	x	x
CoolMax polyester <sup>xlvii</sup>	++++	++	+++	na	na	xxx	+++	++++ +	xxx	xxx	+++	x	x
Thermax polyester <sup>xlviii</sup>	+++	++	+++	na	na	xxx	+++	+++	xxx	xxx	+++	x	x
Other polyester <sup>xlx</sup>	++++	++	+++	na	na	xxx	+++	++++	xxx	xxx	+++	x	x
<i>Unique Clothing Materials</i>													
crystalline alkanes <sup>i</sup>													
gel-bead bandannas <sup>ii</sup>													
treated leather <sup>lii</sup>													

## NOTES:

<sup>i</sup> Callewaert, C., et al. (2014). "Microbial Odor Profile of Polyester and Cotton Clothes after a Fitness Session." *Appl Environ Microbiol.* Aug 15.

Clothing textiles protect our human body against external factors. These textiles are not sterile and can harbor high bacterial counts as sweat and bacteria are transmitted from the skin. We investigated the microbial growth and odor development in cotton and synthetic clothing fabrics. T-shirts were collected from 26 healthy individuals after an intensive bicycle spinning session and incubated for 28h before analysis. A trained odor panel determined significant differences between polyester versus cotton fabrics for the hedonic value, the intensity and five qualitative odor characteristics. The polyester T-shirts smelled significantly less pleasant and more intense, as compared to the cotton T-shirts. A dissimilar bacterial growth was found in cotton versus synthetic clothing textiles. Micrococci were isolated in almost all synthetic shirts and were detected almost solely on synthetic shirts by means of DGGE fingerprinting. A selective enrichment of micrococci in an in vitro growth experiment confirmed the presence of these species on polyester. Staphylococci were abundant on both cotton and synthetic fabrics. Corynebacteria were not enriched on any textile type. This research found that the composition of clothing fibers promotes differential growth of textile microbes and, as such, determines possible malodor generation.

<sup>ii</sup>**Schoeller Dynamic:** My pick for pants and thin jacket for mild conditions. Cloudveil used to make nice pants ("Maverick") and a pullover.

<sup>iii</sup>**Schoeller Dryskin** Somewhat thicker than Dynamic, and ideal for cool conditions. The Cloudveil Symmetry pants made out of Schoeller Dryskin Extreme used to be the best pants I've ever had, perfect for inside, outside, wherever, a very wide comfort range; they have only been superseded by the REI Acme pants, made of a 15-year-newer generation of Schoeller Dryskin. The Cloudveil

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Serendipity jacket is a great all-around jacket. Dry skin is stretchy enough to be quite comfortable – I’ve found that I wear a size smaller than normal (small instead of medium) and the pants don’t bind at all. There used to be Dryskin, then Dryskin Extreme, then Dryskin Extreme with 3XDry – all just marketese for minor improvements in the fabric. The ratings here reflect the 2013 version, such as in the REI Acme pants, which is thinner and stretchier and more wind- and water-resistant and thorn-pull resistant than the original.

<sup>iv</sup>**Schoeller WB-400** is a bit like their Dryskin but with a layer of rubbery foam covered by fleece inside. [Mountain Gear](#) used to offer a Cloudwalker vest/bib and a top of this material. It is reputedly rated 1-3 CFM (cubic feet per minute) air permeability so very windproof. Compared with Dryskin it’s warmer, heavier, not as stretchy, not as breathable, but more snag-resistant. It looks as though now it’s relegated to knuckle patches on gloves, and an occasional pair of pants ([Outdoor Research](#) made some) and jacket ([Cloudveil](#) makes one). **Schoeller F-Shell** seems to be similar. There seems to be a trend (e.g., the Cloudveil Rayzar jacket) to use WB-400 in the shoulders of jackets for better rain resistance.

<sup>v</sup>**Polartec Power Stretch Cordura:** [Crestone Designs](#) offers tops and bottoms of this material, which I haven’t tried. They also will make custom-fitted clothing of many Polartec fabrics. Anyone who’s tried this material please let me know how you like it.

<sup>vi</sup>**Polartec Powershield** This is a combination of 100-weight Polartec fleece combined with a breathable barrier (Gore-Tex equivalent) and stretch nylon/Lycra outside. The garments made of it seemed way too heavy to me, but I’m sure they’re bombproof in bad weather.

<sup>vii</sup>**Gore Windstopper and Malden WindBloc:** Both the Gore and Malden wind-blocking fleece seem a bit silly – the nice thing about fleece is that it is stretchy and porous, and works nicely under a shell garment. They seem especially silly, since the fleece is on the outside where it does virtually no good. Theories for this include (1) fashion, and (2) protection of the wind-blocking layer from abrasion. The Malden Windbloc, in my opinion, has it all over the Gore Windstopper. Windbloc is stretchier by far. And Windstopper feels, well, yucky against the skin, though it has gradually improved to where it is only mildly yucky against the skin. Malden now has WindBloc ACT, which only blocks 98% of the wind, to allow better ventilation. They also have WindPro which is a somewhat wind-resistant fleece. Gore came out with “WindStopper N2S” (next to skin), thereby admitting the yuckiness of WindStopper, but it’s quite thin. Except for gloves, stick with Malden or Schoeller for wind-resistant fleecy stuff.

<sup>viii</sup>**Malden Aqua Shell (AKA Thermal Stretch)** This material was made for whitewater sports and sailing and perhaps diving – it’s touted as a replacement for 2.5/3 mm neoprene wetsuit materials. Gotten some good reviews for diving in warmer water. By 2011 it seems to have disappeared.

<sup>ix</sup>**Malden Thermal Shield** I suspect this is the new name for a stretchier Aqua Shell. Used by Serious in non-seam-sealed gloves. Holds water against the skin and slow-drying, but excellent in gloves for windy days.

<sup>x</sup>**Inertia:** is a proprietary softshell fabric from Cloudveil. Think of the drape and “hand” of a pullover made of fine, tightly-woven but very soft long-staple cotton. Inertia is soft, flexible, feels very nice to the hand but is highly wind-resistant, quiet, very tough, very thin, wicking – everything you wanted your nylon windshell to be but it wasn’t. Very nice stuff. Any downsides? Not very stretchy (about 1.15%) compared to, say, Power Stretch. Not quite as windproof as Dryskin. North Face has their thin softshell (Apex) that feels similar, and Schoeller has (2006) a Dynamic Extreme, which seems to have a much softer hand than the original Dynamic, and is stretchier; I got a pair of REI short gaiters made of Schoeller Dynamic Extreme, but I haven’t tried any large garments of it. However, I have a small Prospector jacket from Cloudveil that’s made out of Intertia Plus fabric of 2005-6 vintage, and it’s rapidly becoming one of my favorite jackets. Seems significantly better than the larger Prospector hooded jacket I got two years previously as the Inertia got thicker but also much more wind- and water-resistant. The Prospector hood didn’t have a drawstring around the hood opening (bizarre) and so I added one myself. But the newer Inertia cloth has the hand of a fine, well-worn cotton with a soft, wicking internal layer, enough stretch to make a difference (though again still not like Power Stretch) and a very durable outer shell. Moderately wind-resistant, moderately waterproof, and very breathable.

<sup>xi</sup>For many of its softshell jackets, Cloudveil switched from Schoeller fabric to Cyclone Plus, a softshell fabric proprietary to Cloudveil (I wonder if Schoeller makes it for them?) Their Cyclone Plus FirstTurn jacket won a Gear of the Year award from Outside Magazine in 2009. Cyclone Plus started as a mix of spandex and polyester with fleece on the inside, very similar to Schoeller DrySkin, but not as stretchy. The 2011 version of Cyclone now incorporated some wool as well.

<sup>xii</sup>**Patagonia Tactile Aspira:** a fabric from Dupont very similar to Schoeller [WB-400](#).

<sup>xiii</sup>**GORE-TEX Soft Shell II Masai** is a waterproof shell outer with a laminated 100-weight fleece liner, introduced in the winter 2004-2005. [Berghaus](#) was the first to make a parka made of the material. See the text. It’s not really a soft-shell like the other materials, as it’s not stretchy at all. It’s just fuzzy.

<sup>xiv</sup>**Helly-Hansen Pile:** the original pile (see text above table)

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<sup>xv</sup>**Non-Helly-Hansen Pile** copies of Helly-Hansen pile by other companies used different, non-knit base (basically, glued); they pilled a lot, matted down after a while. Not as good as the patented original Helly-Hansen stuff.

<sup>xvi</sup>**Malden Polartec 100-micro, 100, 200, 300, Bipolar, DWR, High Void Grid, Regulator, Thermal Pro, Thermal-FR (flame-resistant), Aircore-200, Lattice, Monkey Phur, etc.**

<sup>xvii</sup>**Marmot Outlast** is a type of thick pile for gloves, but with tiny beads of wax embedded in the material – the idea is that the beads absorb heat when your hands are warm and then reradiate it to your hands when they are cold. I would have said that this was a bizarre and unworkable idea but it really does seem to work. A friend who's an instructor at the Scottish National Outdoor Center at Glenmore Lodge has tried alternating them with similar gloves during winter climbs – and the hand with the Outlast glove always stayed warmer. I tried one of his Outlast gloves on a winter trip near Cairngorm and indeed, it really seemed to work, at least a bit.

<sup>xviii</sup>**Malden Power Stretch (and Power Stretch RX, and Special Edition Power Stretch 9400)**

Very, very stretchy, bipolar construction for wicking. I loaned my Power Stretch pullover to a colleague during a wet-cold Wilderness EMT exercise where he was a victim. He liked it so much I had a very hard time getting it back! This stuff is as stretchy as Spandex – or maybe more so. As with Schoeller Dryskin, I've found I wear a small instead of a medium as I usually do. It is so stretchy that getting pullovers on and off is very easy. Used for layering usually right over a fishnet (mesh) CoolMax shirt, or a Patagonia R .5 top, and with a shell over it when needed, this stuff is great. Indeed, Malden Mills markets it as an against-the-skin fabric, and it's indeed comfortable that way, though it doesn't wick as well as a true baselayer like Capilene.

[Cloudveil](#) makes a very nice Run Don't Walk pullover and vest (I have both and wear them all the time); and [Crestone Designs](#) makes a variety of garments out of Power Stretch 100 – I particularly like Crestone's designs as they all include lots of long zippers for ventilation, which I think is very important. For women, Crestone even makes bra tops of Power Stretch 100.

[Toesteessocks](#) makes custom whole-body suits that are great under a caving suit; mine is quite comfortable even when wet; BTW, for a shell over this, the best custom caving suits are from [B&C Wunderwear](#).

Although Malden's website used to show Polartec 100/200/300 having mild-moderate wind resistance and Power Stretch having moderate wind resistance, really this stuff isn't very wind resistant, even the Power Stretch. Nonetheless it make a great layering material – *very* stretchy, very comfortable.

The original Power Stretch has been gradually improved, first a version with a durable water-repellent treatment, then treated with silver to prevent bacterial growth that causes bad odors. In the summer of 2002, I got some garments from [Lowe Alpine Systems](#) (their MultiPro line) made of **Special Edition Power Stretch 9400** which is different from "standard" Power Stretch in that the fuzzy inner layer is only about 1/4 there: it's a series of "dots" that hold the garment away from the skin. This makes a bit smaller-packing and lighter garment with a bit less insulation but a better warmth/weight ratio than standard Power Stretch. I'm tried this stuff under a variety of conditions and it seems to work pretty well, but I like the Patagonia R1 and R .5 a bit better, perhaps because I bought it a couple of years later and Malden's technology improved.

All in all, Power Stretch is recommended highly.

<sup>xix</sup>From DashAmerica, Inc.: a cheaper and not as stretchy clone of Malden Power Stretch. Pearl Izumi uses it in bicycle clothing.

<sup>xx</sup>**Parameta-S** from [Paramo](#) is an interesting material, or at least interesting marketing. This is a bipolar material, hydrophilic on one side and hydrophobic on the other. The interesting twist is that it's reversible clothing -- wear the fleecy side, which is like a fine plush velour, against your skin for warmth. The plush velour fleece is hydrophobic, but the hydrophilic outer layer attracts moisture away from the skin (sort of like DriClime – if you dip the material in water then feel it, the plush side feels dry). If you find it too warm, you take it off and put it back on inside out. Nice idea, but you can tell that, because they ship them with the plush on the inside and the pockets on the outside only, that you're expected to wear it mostly with the plush side inside. But I must admit, wearing it inside out when you're sweating a bit makes it a bit cooler and more comfortable. They make a Mountain Shirt that's a pullover with a snap mock turtleneck and sleeves designed for reaching above your neck (I have one I got in the UK; I wear it for walking the dog and the the odd half-day hike, but it's not stretchy like Power Stretch, so I don't use it for true outdoor pursuits), and a Trail Shirt that's cut on a standard shirt design with a collar and a full set of front snaps. Interesting and different, but not on a par with Power Stretch (and it's about the same as Power Stretch without the stretch), Power Dry or Scholler Dryskin Extreme.

<sup>xxi</sup>**Waterproof Zippers** I first saw these on Arc'Teryx packs, but now they're appearing everywhere. Arc'Teryx calls them WaterTight zips, and Mountain Hardwear calls the Simplex zips, and YKK (who makes them) calls them Reverso zippers. Regardless of the name, they allow manufacturers to eliminate flaps over zippers. Though the waterproof zippers are stiff compared with non-waterproof zippers, they're flexible enough, at least on rainpants, that they do cut down on bulk and weight without impeding movement. In 2004 or so, I was finally able to get some of these zippers from [Quest Outfitters](#), and sew them into some of my existing parkas as pit zips. Very nice.

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<sup>xxiii</sup>**Nylon** Retains a feeling of warmth next to skin, while still allowing lots of heat through; bad against the skin (cold in winter, uncomfortable in summer). [Tactel](#) is DuPont/Invista's tradename for its nylons, and Tactel Aquator is their tradename for a special construction of nylon with a bipolar construction – the only thing I could find that was made out of this stuff was a dress riding shirt, no outdoor garments, and the Dupont site had little information other than that it's a bipolar sweat-moving fabric. It seems to have disappeared somewhen about 2005. However, there has been a gradual change in nylon over the years – the fibers of the thread are getting smaller, providing a better “hand” and less of a rustle when walking, and making it more comfortable against the skin. For instance, I have a couple pair of very nice Mountain Hardwear nylon pants, made from a very soft but quick-drying nylon. Some of these are zip-off pants that turn into shorts, and some are extremely light yet still quite comfortable and durable.

Ex-Officio is now using a material called DryFlyLite (no kidding) that is 80% Nylon / 20% Polyester

Also, see the Supplex Nylon below, and the section “Old is New” above the table about Gossamera.

<sup>xxiii</sup>**Silnylon** is nylon coated with silicone. The older K-Cote treated nylon was waterproof, but the coating was heavy, it flaked off after a few years of use, and if packed wet, or after a few years in the basement even if not wet, started smelling like an overripe herring. But modern silicone-coated nylon is very light, very tough, doesn't delaminate, and smells only like whatever you spill on it. **Nextec Epic** ([Nextec](#) is the company, Epic is the treatment/material), AKA **EncapSIL**, works a bit similarly to Gore-Tex, but instead of a laminated membrane, Epic consists of a coating applied to the fibers of the fabric itself—the silicone coats the fibers themselves, leaving holes the right size to pass water vapor but small enough to not pass liquid water. Seems similar to Pertex in that it's not as waterproof as Gore-Tex (Gore-Tex is >40 PSI waterproof, but Epic is reportedly only ~1 PSI waterproof), but very windproof and very breathable, and reputedly it will last longer than Gore-Tex or DWR coatings. Does not stretch, but very light. [Wild Things](#) used to use Epic in many of its garments, as [Mountain Hardwear](#) still does. Gossamera (see text above table) is most interesting recent evolution of nylon: very light, reasonably tough, water-resistant, windproof, breathable.

<sup>xxiv</sup>**Supplex** is DuPont/Invista's trade name for microfiber nylon. I've had good experiences in cool, rainy weather in Ireland and Scotland with wearing Supplex nylon clothing from [Ex-Officio](#) over some thin wicking layer of underwear – many of Ex-Officio's shirts are ventilated with mesh inserts. [RailRiders](#) offers Supplex nylon shirts and pants that have even more ventilation in the form of CoolMax mesh inserts. Their EcoMesh pants have zippers that close over the CoolMax inserts, allowing a degree of control over warmth/ventilation – however, even though I am not all that fat around the middle, I found that the EcoMesh pants that fit my waist were way too long, and with the zippers the way they are they're a pain to tailor.

<sup>xxv</sup>**Spandura** A combination of Lycra and Cordura nylon. [Outdoor Research](#) used to make a variety of garments, especially pants, out of Spandura. Not very comfortable against the skin, and my Spandura pants caused bleeding abrasions on the back of the knees after a day of climbing or hiking, but stretchy and tough. Mine lie unused in the bottom of one of my dresser drawers, which is likely why all the outdoor clothing manufacturers seemed to have stopped using it.

<sup>xxvi</sup>**Supplex Ripstop Nylon** As with Intera shirts, the combination of a ripstop-style weave with a wicking coating on the fibers makes this stuff a lot more comfortable against the skin than non-ripstop nylon and Supplex nylon materials. A Supplex ripstop-texture shirt from LL Bean (that they don't offer any more) is my favorite for really wet weather; tough, and unlike plain supplex, the ripstop texture means it doesn't stick to my skin when wet.

<sup>xxvii</sup>**Gore-Tex et al** I include here Gore-Tex and all the various similar fabrics, now that the original patent has expired. Please email with similar fabrics you've seen and I'll add them here. Of particular interest is the Gore-Tex XCR fabric which is just as waterproof as classic Gore-Tex but 25% more breathable, or at least so they say; also their Paclite which is a very thin but durable lighter-weight Gore-Tex. Cloudveil (Dermizax) and Marmot (MemBrain) have stretchy-versions of Gore-Tex, but they're really not that stretchy compared to some of the other fabrics available now. Also note Gore-Tex Windstopper which competes directly with the Malden Mills WindBloc fleece fabric. I personally find the idea of a windproof layer **INSIDE** of a wool or pile or fleece layer one of the stupidest things I've ever seen of. (Every heard of [Bloody Stupid Johnson](#) in Terry Pratchett's Discworld novels? He must have designed these fabrics.)

<sup>xxviii</sup>**Gore-Tex et al Abrasion Resistance** The abrasion resistance of Gore-Tex and Pertex and similar waterproof/breathable materials (generally some form of expanded polytetrafluoroethylene = PTFE = Teflon) is nil. The abrasion resistance is entirely dependent on whatever it's laminated to. Some of the materials are simply thin nylon (I have an LL Bean nylon-Gore-Tex parka like this that folds up into almost nothing) but are not suitable for abrasion on rocks – others, such as parkas made by Patagonia, Marmot, Cloudveil, Arcteryx and other top-end suppliers, are much more abrasion resistant. One of the most interesting variants is something called ToddTex – developed by Todd Bibler for [Bibler tents](#). It has a fuzzy internal laminate that works like a built-in frost liner. Nice stuff, but fragile – I've had to repair some abraded holes in my Bibler Torre tent where something rubbed against the ToddTex. Pertex and similar materials sacrifice some waterproofness for breathability. I have a British-style bivouac shelter (a [Terra Nova Bothy 4](#), from [Cotswold Outdoor Equipment](#), who will sell these by email) of Pertex, which is very light but provides a sort of floorless tent to throw over four people (four very friendly people, or two if you want room to eat lunch in the rain). The Pertex is waterproof enough that

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you won't notice any rain coming through compared to the condensation, even with two vents. Terra Nova now also offers lighter but more expensive SilNylon versions. These shelters are great for day-hikes in marginal weather and high terrain, or for wilderness first aid to quickly shelter an injured person.

<sup>xxxix</sup>**Gore-Tex et al Stretch** There are a few stretchy Gore-Tex-like materials on the market. None of them stretch much compared to, say, Malden Mills' Polartec Power Stretch, or Spandura. Cloudveil, for instance, made a pair of pants that look like regular pants but were stretchy (slightly), waterproof yet breathable. The material is called Dermizax Stretch Light (where DO they get these names?) and it's called the Snaz line, they also make a parka. I've tried the pants in the rain a couple of times, they're OK, but you still sweat in them, a lot. Remember that Gore-Tex covered with water doesn't breathe. But with intermittent wind and rain, these pants are pretty nice. And they stretch enough to be better than most rainpants (although my Arcteryx rainpants that have waterproof zips up the side are very, very nice, and roll up quite small for good sturdy rainpants). I use my Snaz pants when I'm going out for a hike in cool weather and I know it's going to rain all day.

<sup>xxxix</sup>**Pertex et al** This includes a variety of similar fabrics – a fairly open PTFE layer bonded to some other fabric, which is water-resistant (not waterproof like the original Gore-Tex and clones) but very windproof and somewhat breathable (not as breathable as they'd like you to believe, though!) Examples other than Pertex include Activent for shell clothing and Dryloft for sleeping bags from W.L. Gore; interestingly, at least one of the companies that makes expedition-style down parkas went from Dryloft back to regular Gore-Tex as the Dryloft wasn't durable enough, same with some sleeping bag manufacturers. Pertex Quantum is very thin and light, used in sleeping bags; Quantum GL is similarly very light and thin, but used in windshell jackets.

<sup>xxxix</sup> Used in the SOL Escape Bivvy. See detailed analysis in the preceding text in the [Emergency Shelter](#) section.

<sup>xxxix</sup>**Wool** The scales on the outside of wool fibers break up surface tension, and resist wetting. The lanolin (oil) on wool also helps resist water, and it olden days, oiled wool sweaters (with extra lanolin added back after the material was made) were the standard for cold, wet conditions. But when wool gets very wet, the hydrophilic core soaks up water, is heavy, and requires lot of body warmth to dry out; wool is kinky, no parallel surfaces to hold water (such as in cotton). Wool is still king for socks. Some comments on socks may be found in the emails below the chart but above these footnotes. In particular, Jacob Rohner of Switzerland makes what are probably the best everyday socks in the world—all of the socks I wear every day are Rohner trekking socks. Expensive but worth it. Sometimes you can get closeouts on Rohner socks from Sierra Trading Post.

<sup>xxxix</sup>**Cotton** Has a reputation for killing people in cold, wet conditions, and deservedly so. I had originally planned to leave it off the table entirely. However, in hot, dry conditions, wet cotton's ability to absorb and hold lots of water, and to act like a heat pump, and to wick and rapidly spread water from one place to another, is a positive benefit. In hot, dry environments, it's common to wear a cotton T-shirt with a loose, long-sleeve cotton shirt over it. And I've heard that at Outward Bound in Texas, not only the women but some of the men hike in ankle-length loose cotton skirts to protect against the sun while allowing ventilation. (Thanks to Suzanne Atkinson of [Allegheny Mountain Rescue Group](#) for this tip.)

**Subject:** RE: Clothing Materials Table/no cotton?  
**To:** NCRC Discussion List <NCRC@ontosystems.com>  
**Copies to:** sar-l@listserv.islandnet.com, mra@altadena.net  
**Send reply to:** kconover@pitt.edu  
**Priority:** normal

On 16 Aug 2000, at 15:54, Steve Knutson wrote:

> Regarding cotton, I think it is absolutely necessary if you want to have "perfect" clothing. On the feet,  
> it should be either cotton or wool (some people are allergic to wool) next to the skin--the coefficient of  
> friction of synthetics is much higher than natural fabrics and you will be more prone to blisters and skin  
> irritation in tropical conditions with synthetic socks.

Interesting point. I don't like cotton for liner socks because they tend to hold water against your skin, causing maceration ("prunification") and thus predispose to blisters.

Nevertheless, this at least is something on which we have some scientific evidence. Murray Hamlet of the U.S. Army looked at various types and combinations of socks in various materials, because the Army has a BIG interest in preventing blisters. He finally decided that there were no socks out there that were ideal, and so ended up contracting for what are now known as "Hamlet Socks" -- a combination of an outer very thick sock, made mostly of Merino (=expensive) wool, with the plush layer on the outside and the flat, smooth surface on the inside. The fibers are very highly twisted during material construction, both to resist matting and for durability, and despite the military's desire for multiple suppliers, they've only got one supplier at present. I got a pair of the original Hamlet socks and they are the best socks I've ever had. However, then I ordered some more and they, to put it bluntly, sucked. I found out from Murray that the original company basically went bankrupt and their quality was terrible -- later they got bought out and the socks are now back up to Murray's exacting standards.

Interestingly, he specifies a Coolmax liner sock. And with this combination, compared to normal wool Army socks, he found a lot less blisters. Specifically, he went to the US Marine Corps base at Parris Island, South

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Carolina and outfitted recruits and their drill sergeants with Hamlet socks, Coolmax liners, and then let them get on with their 14 hours/day of basic training. Blisters dropped by a factor of 3! This is the best scientific evidence for any particular sock actually making blisters less likely.

A poor second best, he says, is to get SmartWool socks with CoolMax liners, but wear the SmartWool socks inside-out.

To buy Hamlet socks, call 800-392-8500 and speak with Joe Gallagher.

I have no affiliation nor do I receive any kind of remuneration for endorsing these socks.

Addendum 2006: The quality of the TechSpun socks has been variable. The first pair I got were outstanding; a subsequent box from about 2001 showed poor construction, with there being "dog-ears" at the to seams that made big lumps that pressed on your toes. Some subsequent socks I got from them a year or two ago were much better, but not up to the quality of their first socks. Others including Cheng Hu emailed me with similar experiences from 2002-2003. If you got some then and were disappointed, try again.

- > Remember that synthetics DO NOT wick moisture--the myth that they do is an advertising ploy and has no reality.
- > Synthetics are almost always hydrophobic and thus CANNOT wick moisture. What happens is that your body heat
- > drives the moisture in vapor form through the fabric, but this doesn't happen when you are very cold. Drylete
- > and other dual fiber fabrics (with a hydrophilic yarn on one side and hydrophobic on the other) are the only
- > synthetics that wick moisture. Cotton underwear shorts are also much kinder to your skin. This is
- > especially important in the tropics.

You know, I've heard this before, but certainly there are a lot of people, Murray Hamlet included, who disagree, and indeed have done some studies to show that these wicking treatments do work. For instance, remember the British ship hit by an Exocet missile during the Falklands war? They were wearing polypro, and during the explosion, there were a lot of burns, and there was melted polypro all over them. But the British docs found the polypro actually helped the debridement of the burns slightly, rather than causing much additional burning as rumored. So, the British still wear polypro -- but have a silverized outer layer that helps protect against flash burns. (Information from the British via Murray Hamlet of the U.S. Army, again.) Maybe this should make us reconsider the polypro vs. cotton/fireproof fabrics for domestic mountain rescue helicopter use?

[Massif (<http://www.massif.com>) has a line of Nomex fleece—fire-resistant, but insulating/wicking qualities not well known. – KC.]

Indeed, there is an easy way to test this yourself. Take a bowl of water and hang some of the material in it. Wait an hour and see how high the moisture has climbed up the material. Cotton is clearly the champ, but the fact that it also acts like a heat pump when wet, along with the large amount of water that it retains.

However, this is a poor test of wicking related to what we really want it to do, as in wicking sweat off the skin. I suspect that the Army has done some more detailed tests, and I'll ask Murray what he's found in his lab at Natick, MA and let everyone know.

And John Gookin wrote:

- > Thanks for posting this great information. Good stuff. I completely agree with the confusion created by
- > manufacturers' claims.

Not sure it's "great," in fact I'm sure, especially after looking at all the typos and stupidity in version 0.1 (0.2 is up now) that it's pretty cr\*\*py information. But I just couldn't find anything quite like it, and whenever I do something for my own use, I like to share it. A few others might find it interesting, and many others like you with more knowledge than me may give me some pointers.

- > I wrote the clothing chapter for Paul Auerbach's upcoming edition of his big Wilderness Med book. My point
- > isn't that I'm smart; it is that I recently researched these topics pret I included cotton in the fabrics (in
- > PA's book) for a few reasons. 1) "Cotton kills", so people who do serious stuff need to see how far off
- > scale it is in temperate or cold environs. People often want to do micro-analyses of various fabrics when 2)
- > In hot weather, "cotton's cool" because it wicks moisture so well. 3) Firefighters, welders, helo crews and
- > others exposed to flames like the slow burn/melt rate of cotton. 4) When we are going in and out of heated
- > spaces the absorbancy of cotton socks CAN BE healthier for athlete's foot or even immersion foot. I think
- > cotton socks cause more immersi Don't get me wrong. I don't WANT all those firefighters & EMT's to
- > keep wearing jeans when they come "lend a hand" in the deep snow. But I think cotton has its little niche as a
- > t
- > John Gookin
- > Curriculum Manager The National Outdoor Leadership School (NOLS)
- > 288 W Main St. Lander, WY 82520-3140 307.335.2264 / fax
- > 307.332.8811

OK, OK, I'll add cotton. And the things that make cotton bad in cold- wet conditions makes it good in the heat -- retaining lots of water and acting like a heat-pump. Speaking of which, I've tried those "cool bandannas" with beads of some sort of polymer in them that hold water -- and though they do indeed hold a lot of water for a long time, they give it up pretty sparingly. In the humidity of the East they're useless. So last week I tried one of them at 10,000 feet in Utah. The outer cotton dried out pretty quickly, cutting down on the coolness and evaporative cooling, even though the polymer beads had lots of water still left in them. So I think a nice cotton headband, wetted every hour or so, is probably a lot better brow-cooler.

And Rebecca Jones wrote:

- > Just a note, this is the way these fibers perform under "ideal" conditions. Add dirt, and all bets are off.
- > Mud encrusted clothing can't wick, no matter what it's made of. "Resistance to Compression Matting" is
- > probably the best indication that, after thorough washing, a garment will regain its

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> characteristics.

True. When your clothing is covered with cave mud, you're basically wearing cave-mud laminate, and it doesn't really matter what the inner layer is. Which is one of the reasons why my caving suits have pitzips for ventilation. Surprisingly, I've had no failures or problems with them over the past 10 years.

And Anmar Mirza wrote:

> Further, I really like jeans for caving in the conditions in which I normally cave for a number of reasons.  
> (some of my trips extend 15-20 hours. Mostly non immersed but many slimy and wet)  
> 1. Jeans are very cheap. \$10 a pair from wally world, I can wear them for a few months then retire them for  
> caving.

Point. Most of these new materials are expensive.

> 2. Jeans are fairly durable. I cave a \*lot\* (1-2 trips a week) and some of the places I go are very hard on  
> clothing. I can't afford to buy a new cave suit every couple of months which is what I would have to  
> do given the type and quantity of caving I do. (this is based on experience)  
> 3. Jeans are flexible (unless you buy them too tight).  
> I also like surplus light jackets which are also made of cotton. I can get these for \$5-10 and they last a  
> long time (except for having to sew the buttons back on).  
> I cave \*hot\* so normally being cold is not a problem for me. For others this is not the case. Cotton is  
> pretty good when it comes to hot weather stuff, combine this with it being cheap and you have a resource  
> that should not be ignored.

I suspect that you are in excellent aerobic condition, too -- so you don't tire out where others might. And the problem with cotton comes when one's energy runs down -- and there's still all that cold water held against your skin. I'd suggest that your wearing cotton is a lot like rock-climbing without a helmet or belaying without gloves -- some people can get away with it but it's certainly not something to suggest to a newbie, or to even allow them to know about.

> When I am going into a wet cave, or a cold cave, or cold weather conditions, of course my clothing fabric  
> choices will change (34f caving, expedition weight polypros, a 3mm shorty wetsuit, and a full  
> nylon caving suit. 72f caving, shorts, tshirt and knee and elbow pads...) But for 90% of the caving I do and  
> a third of the outdoor stuff, the cotton shell I use suits my needs pretty well.  
> While it is fine to say "cotton kills," what really kills is ignorance and lack of experience/training.  
> Just like I said in another thread on this list, I think that using equipment and resources when and where  
> appropriate is much better than trying to make a rule of thumb fit every occasion.  
> Other than that think the table is a neat idea. Even though it is subjective, it gives folks a good starting  
> point. I've got it bookmarked, thanks Keith!  
> Anmar Mirza - Central Region National Cave Rescue Commission  
> Coordinator EMT-A: Amateur Radio N9ISY: Cave Rescue Coordinator for  
> LCSAR IKC Rescue Coordinator

Well, please let me know about all of the errors and omissions. I've added Gore-Tex and Pertex and will need to add Activent, Bipolar, and some others. As well as some links to some good sites with more information about clothing materials. There are so many different materials that I'm going to have to, I think, keep it a selective list, with the best/most popular only (with the ones I like best featured, of course).

Thanks for all the comments!

--Keith Conover, M.D., FACEP  
http://www.pitt.edu/~kconover  
sent with Pegasus high-security email  
download free from www.pmail.com

=====  
SAR-L Search and Rescue discussion list. For unsubscribe information-email  
to [sar-l-request@listserv.islandnet.com](mailto:sar-l-request@listserv.islandnet.com) with the word 'help' in the  
subject field.

=====  
From: Keith Conover, M.D., FACEP <kconover@pitt.edu>  
To: sar-l@listserv.islandnet.com, Allegheny Mtn. Rescue Maillist <amrg@list.pitt.edu>  
Subject: more on Hamlet socks  
Copies to: mra@altadena.net, NCRC@ontosystems.com (NCRC Discussion List)  
Send reply to: kconover+@pitt.edu  
Date sent: Fri, 25 Aug 2000 08:13:13 -0400

Some more information on the military-designed Hamlet socks I have been raving about recently. The company is Double Lay-R doing business as TechSpun, and is reachable via the email <tecspun@aol.com> (Joe said that AOL wouldn't let him put in the "h". Go figure.). Or 1-800-392-8500. They offer several different socks.

**1. Double Lay-R Blister Free.**

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These double-layer socks have outer and inner faces that are designed to be high-friction, and the matching faces are designed to slip against one another. I used to use some of these socks as liner socks, and they worked pretty well to prevent blisters. However, you have to be careful in putting them on so as not to get wrinkles, and your foot does slide a bit, which can be a bit of a problem going downhill.

## 2. Seamfree seamless socks.

These are designed for people with diabetes and ischemic feet.

## 3. All-Weather Lightweight Sock System.

These are a somewhat lighter version of the "true" Hamlet socks, below. Includes a lightweight Coolmax liner sock and a thicker outer sock, about the same weight as a usual boot or Ragg sock. If your boots fit snugly, you won't be able to wear the "real" Hamlet sock without your boot fitting too tightly, so order these. Retail price is \$13.75/set as of August 2000 (? if that includes the liners). High-density reverse nap, same as the "real" Hamlet socks. Liners are 80% Coolmax, 20% nylon. Socks proper are 40% long-staple wool, 40% polypro, 10% nylon in the toe and leg, and 50% long-staple wool, 50% polypro in the foot.

## 4. All Weather "Extreme Weather" Heavyweight

This is the "real" Hamlet sock, the one with the 3-fold decrease in blisters in Marine boot camp recruits and DIs at Paris Island. Work well in very hot or very cold, but may require a boot one size larger than usual. As of August 2000, retail price was \$14.75/set. (Actually, I think it's \$5 extra for the liners -- although maybe that's for extra liners.)

Bulk pricing is available if you order in lots of 12, especially for SAR teams -- available in whole sizes 7-15. Cost varies with sock size and number of socks and shipping, but less than \$10/pr for the outer socks, and \$3/pair plus shipping for the liners.

Again, I have no affiliation with this company at all, I just really, really like the socks and respect the guy from the Army who designed them (who also makes no money at all from their sales).

<sup>xxxiv</sup>**Cotton Comfort** For cotton, comfort against skin is really +++++ when dry and XXXXX when wet. Take your pick.

<sup>xxxv</sup>**Cotton Wicking** For cotton, when sweaty, it starts off great, but after it gets soaked it's miserable.

<sup>xxxvi</sup>**Polartec Power Dry** Against your skin, the original stuff is as comfortable as a well-worn cotton sweatshirt -- and soaks up your sweat as well (must be the way that they make the inner portion). However, it's warm when wet and dries quickly. Great stuff. Cloudveil's TeeWinot line used to use this material. I think the fuzziness of the inner face of this fabric is what allows it to soak up the sweat so well. Just like the original polypro spread out the sweat better than wool, and wicking treatments for polypro and now polyester allow underwear to wick sweat better than the original polypro, this stuff beats other treated polyester -- the best wicking layer I've experienced. The Cloudveil TeeWinot line also looks good, good enough to replace a polo shirt for when you need to be dressed up just slightly. Unfortunately, Cloudveil quit making the TeeWinot line, and Malden had also changed Power Dry. There is one version of Power Dry used in the Patagonia R 0.5 line and REI midweight and expedition-weight underwear (with fuzzy bumps inside). It is really a die-cut successor to Polartec Power Stretch. There is another Power Dry variant that is thin and somewhat silky, but not as comfortable against the skin as the original. OK, but I have to admit I liked the earlier thin Power Dry -- it looked and felt like a well-worn cotton T-shirt, only stretchier, and wicking. If anyone has any used TeeWinot shortsleeve shirts, size small, let me know and I'll pay you top dollar for them. Sigh.

<sup>xxxvii</sup>**Intera** Intera is a coating for either nylon or polyester, a permanent wicking coating (at least they say it's permanent, and have some test data on their website that, if accurate, supports this, and nothing on the other companies' websites contradicts it). But as I know it from two shirts I have, it is type of almost ripstop-like nylon, and the Intera shirts I own have alternating thicker and thinner threads in the weave. Although a relatively hard fabric, it's nonetheless relatively comfortable against the skin when you're sweating. I got a couple of shirts from LL Bean out of this fabric, and they are indestructible, almost totally impervious to wrinkles, and look good. Ideal for travel clothing. They still have something called a Journey shirt that is made of ripstop with a wicking treatment, but may not be the Intera trademark. They point out on their [website](#), though, that using fabric softeners can ruin the coating.

<sup>xxxviii</sup>**Intera DryForce** is listed as separate from plain Intera as it's a very different material. No coating, this is a bipolar material similar to Parameta-S or Power Stretch. It has a smooth, silky outside that feels like fine nylon tricot, and a fuzzy inside that feels like the inside of Power Stretch, but the shirt I got from Cloudveil is only about half the thickness of Power Stretch; not quite as stretchy as Power Stretch but a nice "hand" to it, drapes well.

<sup>xxxix</sup>**Tencel [Tencel](#)** is a fabric made from reprocessed cotton. The main marketing feature is that it feels like silk. It does, and drapes nicely -- I have a couple of [mock-denim shirts](#) out of the stuff and they're quite nice. Seem to wick a bit less than cotton, hold a great deal less water than cotton, and wrinkle quite a bit less (though not so wrinkle-resistant as Intera).

<sup>xl</sup>**Polyester microfiber** Despite the reputation of polyester from the 1960's, this is a great material. It's really not an "outdoor" fabric, but as I'm a fan of wearing "outdoor" clothing everyday (I don't see why *everyone* doesn't switch from cotton to CoolMax underpants) I

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have several pair of dress pants in polyester microfiber from [Travelsmith](#), which are virtually indistinguishable from fine worsted wool trousers – but resist stains better, dries more quickly, doesn't wrinkle as much (though worsted wool is quite good for resisting wrinkles) and can be washed in a hotel sink and hung up, and they will be dry the next morning. Travelsmith has shirts and pants, and LL Bean also makes a nice pair of pants in microfiber. I also have a blazer from Travelsmith in “tropical” microfiber – relatively light, looks nice, doesn't wrinkle, stains come out easily. Indeed, one of the nursing supervisors at my hospital spilled some coffee on my blazer, and she was horrified and was afraid she'd ruined it. I threw the arm of the jacket in the sink, rinsed a bit of hand soap through it, rinsed it out, and hung it up on the back of a chair for an hour. After that it was dry and looked good as new.

<sup>xli</sup>**CoolMax everyday wear** I got a pair of pants from Travelsmith in sort of a stretchy CoolMax canvas back about 1999. They pill a lot, get a lot of pulls, and are sort of ugly. Totally unlike their polyester microfiber.

<sup>xlii</sup>**PolarMax** is a brand of wicking polyester. I like it because their mock turtlenecks look quite dressy, and you can wear them with a (polyester microfiber) sport coat and look like you're semi dressed up, yet still be dressed in wicking warm-when-wet clothing.

<sup>xliii</sup>**Primaloft/Liteloft** Three different diameters together, crimped, larger fibers on the outside layers,

<sup>xliv</sup>**Thinsulate** Once washed, the insulation value goes down; made by blowing fibers onto a surface; good for high-compression areas, too stiff for most handwear, OK for boots and similar.

<sup>xlv</sup>**Polypropylene** There are many various coatings for polypro and polyester underwear, with various brand names and various claims. However, polyesters have generally replaced polypro for against-the-skin wear—does better in hot dryers and near campfires without melting, doesn't hold odors as much, doesn't “pill” as much.

<sup>xlvi</sup>**Polypro Wicking** Depends on coating.

<sup>xlvii</sup>**CoolMax Polyester** CoolMax is an extruded material with dips in it, better than Thermax; very good against-the-skin material. There is also now a CoolMax Alta fabric, which reputedly is better in all sorts of ways -- as far as I can tell from one T-shirt I got (from [Campmor](#), by Duofold: Hybrid Lightweight T-shirt), it's a bit thinner yarn, which can make a thinner layer against your skin (although I'm sure they can make it thicker), and it's a bit more durable (doesn't pill as much). So it's probably just the next generation CoolMax. Look for it to replace CoolMax. However, it seems a bit fragile—my T-shirt developed several holes after only having it for a few months.

<sup>xlviii</sup>**Thermax Polyester** Extruded hollow polyester; doesn't pass moisture well compared with CoolMax; seems to be extinct.

<sup>xlix</sup>**Other Polyester** certain types of Capilene, others – no independent confirmation of various wicking claims. Some of the materials/coatings include: Terramar's Body Sensors EC2 Qwik-Dri fabric (I hope they didn't pay much to the agency that came up with these names), which claims it moves perspiration by electrostatics and not by wicking. They say that this makes it work better because it sucks water vapor away even where it's not in contact with the skin. Of interest, Terramar has trademarked the phrase “There is no such thing as bad weather, only bad clothing.” The way I'd heard it was “There's no such thing as bad weather, just the wrong clothes. –anon Norwegian” Whatever.

I gotta admit all these materials/coatings seem to wick pretty well, and except for Malden Power Dry, none seems to be much better than the other. See also the notes on [Intera](#), above.

<sup>l</sup>**Crystalline Alkanes** [Talion Corporation](#) makes vests, for both humans and dogs, of this special material that cools as it melts. Objective testing by the U.S. Air Force, [quoted on their website](#), confirms its efficacy. Certainly for hot, humid conditions, like inside a HazMat suit, or in Florida or Louisiana or the tropics, evaporation is of limited use. Amir Findling of [Western New York SearchDogs](#) says the vests are somewhat heavy, pricey, and maybe not durable enough for a dog in a backcountry search task, but did a great job of cooling for about 4 hours.

<sup>li</sup>**Gel-Bead Bandannas** These are marketed under a variety of names. The gel inside the “bandanna” soaks up water and lets it evaporate slowly. These are, by my testing, totally useless anywhere in the East or the Appalachians in the summer. I've used them in dry conditions in Utah and they help, a little bit, but the beads evaporate so slowly they don't cool enough. Despite some good testimonials from some people, my recommendation is to get a stretchy cotton terry cloth sweatband and keep soaking it with water instead. The Sharper Image used to market an active cooling device for the back of the neck. It had a metal plate for good heat transfer to the neck, a reservoir for water, and a little fan powered by a single AA cell. It had a number of significant design flaws and some signs of frantic last-minute modifications. I got one to play with and wasn't impressed. A nice water-soaked terry-cloth sweatband and a small bottle of water will work better and weigh less.

<sup>lii</sup> Pittards of England is the best known, and some Lake winter bike boots I recently bought (very, very nice) had a card for Pittards WR100, which is I guess their current leather treatment. I know almost nothing else about it.