

Basic Snow Grooming

From: https://wiki.fis-ski.com/index.php/Basic_Snow_Grooming

Equipment

Tillers A tiller is mounted on the rear of a grooming tractor and is driven hydrostatically. A tiller typically requires deep snow conditions and is used to break up compacted snow surface, to reduce snow and ice chunks, and to mix old and new snow.

The tiller itself is similar to a garden roto-tiller and consists of a rotating shaft (cutter bar), which has multiple tines that are typically three to five inches (7.6 to 12.7 cm) in length that condition the snow when operated at a high RPM, and a plastic comb or “snow finisher” (see The tractor’s horsepower must be sufficiently large to operate the tiller.

Benefits of a tractor equipped with a tiller include the extreme portability, ease of backing, ease of turning around, and ease of plowing drifts. Additionally, the unit can be easily stored and easily hauled on a truck or trailer. A tiller can work well in moist snow, but if there is dry powder snow, it can sometimes be hard to get a good trail since the snow/trail doesn’t stay together. Therefore, it can be important for there to be good moisture in the snow to get good results and “snow pavement” that lasts.

If the trail is heavily moguled, multiple passes may be required since a tiller can only process to a maximum depth that is equal to the length of its tines (if it has 3 inch {7.6 cm} tines, then that is the maximum processing depth; if it has 5 inch {12.7 cm} tines, it can process to a maximum depth of 5 inches {12.7 cm}, etc.). In such cases, a good front blade on the tractor, and an operator who can cut moguls with the front blade, is required to feed enough snow to the tiller for processing and ultimately creating a smooth trail. It is easy to build a smooth trail with a tiller, but not necessarily a level trail since the unit will bob up and down mirroring what the tracks of the tractor do. It can sometimes also weave side to side. For this reason, they produce better results on an undulating trail with frequent turns and ups and downs versus on a trail with long straightaway sections.

It is recommended that areas also have a drag to supplement trail grooming with a tiller, since it is rare that season-long grooming conditions (weather, snowfall, moisture, and traffic) are consistently favorable for grooming solely with a tiller.

Flex tillers pivot (or flex) in the center and are typically used on downhill ski hills to create terrain features. Some manufacturers provide a lockout device whereby a flex tiller can be locked in a rigid/straight position which is required to groom a flat trail surface.

Basic Grooming

Although the discussion of Snow Physics indicates that snow grooming has a science base, it would be far too simple to describe it as a purely scientific activity. One could argue that there is as much art as there is science in the practice. It is certainly true that much can be learned by studying snow crystals and their change processes under a magnifying glass, but for most experienced groomers a few boot kicks in the trail snow and the weather report will often give them all the information they need for a good grooming job. So much of the work relies on the groomer's practical experience with their area, their knowledge of the local climate, and the site's microclimates. With this comes a sense of intuition that can't be described in any formal manual. This makes it very difficult for any individual to be a true grooming guru, or for any manual to be considered as The Bible. The following discussion is intended as a brief overview of basic grooming processes for race officials and others who are new to the field.

Grooming can be relatively simple or very complex depending on conditions, the desired end product and the time and equipment available. For simplicity, the whole grooming program can be broken down into several basic processes.

Packing

This is a season long process. Ideally, packing should be done with at least every six inches of new snow (with the understanding that this is not always possible when big dumps come). In low snow areas groomers will carefully pack every time more than 2 cm of snow accumulates to gradually build up a base. Early season packing usually involves running over trail surfaces with light equipment meaning snowmobiles alone initially, followed by snowmobiles towing rollers or other compaction devices. Even high snow regions which normally groom trails with snowcats will find that snowmobile packing is essential until the initial base is set (this can range from 15 to 30 cm or 6 to 12 inches of packed snow depending on the smoothness of the ground surface).

End Result – An Increase in Snow Density

Snowmobile groomers may have to fall back on track packing with snowmobile only at later times in the season for big dumps of snow which would make towing any implements impossible, and even cat groomers will occasionally find track packing useful with unusually heavy snowfalls. But, normally packing will be done with implements. Snowmobile groomers can pack with two basic types of equipment – rollers, or compaction pans/bars. Rollers offer the advantage of packing snow without dragging or displacement. They can, however, ice up in warm conditions, and working speed needs to be kept low to keep them from bouncing (creating washboard surfaces). Homebuilt rollers can be produced quite easily using various types of pipe, steel culvert, etc, but some of the most efficient units are produced by grooming suppliers

such as YELLOWSTONE TRACKSETTING SYSTEMS, and TIDD TECH. There are several compaction bar/pan devices available from equipment suppliers. The TIDD TECH Trail Tenderizer which has been around for more than a decade is a good example of a useful compaction pan when run with the front cutter teeth cranked up. Many groomers prefer compaction bars and pans to rollers for season long packing because they level and smooth the surfaces as they compact and they don't tend to ice up as readily in warm wet conditions. Working speeds still have to be kept low enough to prevent washboarding. Compactor bars ("C-Bars") are available for larger snow vehicles. These bladelike bars mount at the rear of snowcats. Down pressure and blade trim (vertical angle) are all hydraulically controlled. "C-Bars" are particularly useful for early season packing (assuming a sub-base packed by smaller vehicles) where rocks, stumps, and other obstructions might still be hazards to power tillers, and they may be handy for later season mega -dumps which would clog tillers. Generally though, most cat groomers will routinely pack recurring snowfalls with tiller passes. If compactor bars aren't available particularly heavy snow dumps may have to be track packed before tilling. Course Preparation & Tracksetting 6-5 Groomers often have little choice about timing for packing. Normally snow will pack and groom best in a relatively narrow temperature range between -10 and 0 degrees Celsius. Extremely cold dry snow (below -20 C) does not pack well, and as a general rule, all grooming of extremely warm snow (above 0 C) should be avoided. Warm wet snow can be a sticky frustrating mess and if followed by a cold spell the resulting icy surface can be dangerous. But, the pressures applied by an impatient skiing public or an upcoming race may force groomers to pack and groom in less than ideal conditions.

Surface Shaping

Most of the time, careful packing will leave trail surfaces smooth enough for tracksetting and skiing, but this isn't always the case. Packing can leave bumps and dips which should be flattened out. Skier traffic and repeated grooming passes can also gradually push snow to trail sides leaving a concave or dished surface. Periodically all of these irregularities should be flattened out, and snow may have to be moved back from trail sides to the middle. In the past, there has been a grooming theory that the ideal trail surface should be crowned (a convex surface higher in the middle than the sides). This would provide better snow depth in the middle where traffic would be highest. It would also make for more efficient ski skating (every skating thrust from the top of the crown results in a downhill glide) and it would make herringboning steep uphill easier for classical skiers since ski tips would not dig into higher side surfaces. A nice theory on paper - but in practice it has proven to be impractical. The excavation required to shave snow from trail sides to move it to the centre is very difficult to do with snowmobile equipment and in low snow regions the risk of digging up dirt and debris is much too high even if snowcats with skilled blade operators are available. The most practical aim for the majority of groomers is to maintain surfaces as flat and as smooth as possible. For snowmobile groomers drag graders are the basic tool for surface shaping. These can range from home built devices like the old bed-spring drag to commercial units such as YELLOWSTONE TRACKSETTING SYSTEMS Compaction Drag or ADVANCE TRACKSETTING SYSTEMS Renovating Leveller. They can be

used throughout the season to plane and flatten trails. Both the YELLOWSTONE Compaction drag and the ADVANCE Leveller are approx seven feet long (excluding the hitch). This seems to be a reasonable length for most snowmobile drag grader work. A number of ski and snowmobile clubs have been using longer bed graders (10-12 ft) originally built by BOMBARDIER and other makers for maintaining snowmobile trails. The extra length makes these very effective surface planers, but they can be brutes to tow in steep terrain and they will scrape high spots bare very quickly. In low snow country they have to be used with caution.

The most efficient tools for surface shaping are snowcat multidirectional front U-blades. U-blades can move massive amounts of snow and skilled operators can shape trails with near surgical precision. Again – as with long bed graders – the limiting factor is snow quantity. In most nordic trail systems outside of the heavy snow belts, operators will have relatively little chance to use the blades during regular grooming. Unless there is more than a foot of compacted snow on the trail surface, anything but the most conservative blade use will scrape snow down to the dirt, and dirt in trail snow packs is a nasty problem. Dirt and debris worked into a trail snowpack early in the winter can turn into a season long headache. Unless it is completely buried by a large dump (50 cm or more) regular grooming will continually work dirt up into the trail surface. Gravel and rock chips can foul expensive race waxes, or damage ski bases. More important to the groomer, the discoloration of the snow will cause rapid melt out patches in warm periods. In spite of this cautionary note, the front U-blade is an indispensable tool. It can flatten out and redistribute drifted snow; it can wing in snow from beside trails to fatten up thin spots (assuming that trail sides are relatively smooth and free from stumps, rocks, etc.). Unfortunately, as noted above, many groomers in low snow areas never have the opportunity to become skilful blade operators. For those who may wish to learn more about the art of blading, the best approach would be to arrange to ride along with an alpine groomer on a few shifts. Alpine groomers are the true masters of blade work.

Conditioning

Further snow conditioning processes will be required during a ski season. The following process definitions are somewhat arbitrary, and - obviously - there is considerable crossover between them.

Aging

This is a term used for a complex set of processes touched on in this chapter's earlier section on Snow Physics. Most types of fresh fallen snow require mechanical aging to turn them into suitable building materials for a ski trail surface. Cold dry snow is light and fluffy; it flows easily and resists compaction. Snow aging is a natural process, but mechanical action can speed it up to produce a consistent snow mass which can be shaped into firm tracks and skating surfaces. The process is started by packing which reduces air spaces, forces snow crystals together, and promotes sintering. It is continued with the surface shaping which will further mill snow depending on the exact implements used. For most grooming operations packing and shaping will provide all of the aging necessary for good skiing. Groomers in low

snow areas will rarely want to go further, because skiing traffic and subsequent grooming passes will harden trail surfaces surprisingly fast when regular snowfalls are a rare commodity. And re-grooming hardened old snow becomes increasingly difficult with each successive grooming shift.

There will be situations requiring additional aging passes. High level ski races require firm surfaces, and in deep snow country where snow comes every week, extra work will be necessary to produce hard fast skating surfaces. In addition to shaping surfaces, simple drag graders such as the YELLOWSTONE Compaction Drag mill snow quite effectively as the cutting blades move it inwards and then back out, creating high-speed snow crystal collisions. The friction of these collisions produces heat which promotes sintering and speeds up natural aging. Additional drag passes will gradually harden trail surfaces. Cat groomers have the most efficient aging implement, the power tiller, with its cutting teeth mounted on a shaft spinning at 1000 rpm or more.

Mixing

This is another part of the conditioning process which can be considered separately, but which is obviously involved in several of the other conditioning stages (surface shaping, aging, renovation). New snow from surface layers can be mixed with older lower snow to produce an “aged” trail surface which will set up and withstand skier traffic much more readily than fresh snow alone. For an opposite effect - trail surfaces which have been turned to boiler plate or otherwise worn out by skier traffic, natural freeze-thaw cycles, or repeated grooming can be rejuvenated by being mixed with lower layers which have not been overused. Mixing is done with the same deep-cutting implements used in heavy renovation.

Renovation

This is a term for a series of processes whose objective is really the opposite to that of packing and aging. Snow which has been hardened excessively through a combination of skier traffic, grooming, and weather conditions must be loosened and converted back into a more powdery form before it can be reshaped into new tracks or a smoother more forgiving skate surface. Renovation may be required at different levels. End Result – A Reduction in Snow Density

Deep Renovation

Sooner or later deep renovation will be required. Old tracks which have become worn and icy, and trail surfaces turned hard and glazed by traffic and weather will need to be broken up and refined into snow soft enough to be moulded into new tracks and skate surfaces which allow ski edges to bite. This can be one of the most challenging processes for groomers –especially for snowmobile groomers in low snow areas.

Tools of agricultural origin (discers, harrows, rotary hoes) have been used to break up hard pack snow with mixed results. Most of these implement types tended to be too heavy and aggressive for dependable use behind snowmobiles. They were usually better suited for use behind heavier vehicles like the “Bombi”, or some of the older types of snowcat. None of the old “Farmer Jones” type implements for snow grooming are currently available in the regular market. Fortunately, the current market does offer a small range more efficient renovation implements for snowmobile groomers. Most groomers will be familiar with the old BAECHLER Pull Renovators which first appeared in the early 1970’s. Many are still in use and many more sit in “bone yards” around the country. The old PL with its two and a half foot horizontal cutting bar could rip up hard snow, but it came up in big chunks and the machine was a notoriously hard pull for snowmobiles in hard conditions on hilly trails. The BAECHLER renovator is still manufactured under license by YELLOWSTONE TRACKSETTING SYSTEMS. YTS has modified it by replacing the original horizontal teeth with a set of vertical cutting knives, which leave a finer textured product and make the pulling a little easier.

The JACA skate surface renovator mentioned above also uses a horizontal cutter. It produces a beautiful fine-grained skate surface when set at shallow cutting depth, but since it is almost five feet wide it could be an extremely tough pull in hard conditions if set for deep cuts. Groomers would have to make repeated passes at increasing depth settings to renovate to track depth. The same would apply to the Tidd Tech Trail Tenderizer. The Tenderizer comes in four and six foot widths. Two rows of 2-inch long vertical cutter teeth are deployed by cranking the front of the implement pan up or down. This is normally done by hand with the attached trailer type jack, but an electrically operated depth control device which permits adjustments on the fly from the snowmobile is available as an option. A small Canadian supplier ADVANCE TRACK SETTING SYTEMS promotes its leveling drag (Renovating Leveller) as a renovation tool, and it also sells a Renovator for deep cutting in hard and icy snow. It is similar to the old BAECHLER PL in width (2-3ft). Again, it would probably require several passes to tear up extremely hard snow to any considerable depth, and depth adjustments are manual (although an electrical control was rumoured to be on the way as of the summer of 2004). YELLOWSTONE TRACK SYSTEMS’ Ginzugroomer - already noted for its shallow scarification abilities - also works for deeper renovation. The Ginzu’s vertical cutter teeth are mounted on a rotatable spring-tensioned pipe which permits the teeth to pivot out of the way when rocks, stumps or other obstacles are hit. This spring tensioning also produces a cutter action which leaves behind a relatively fine textured loose snow layer quite similar to that produced by power tilling. In very hard conditions – again- multiple passes would probably be needed to get down to depths of 5 cm or more. TIDD TECH’s “G-2” which appears to be close to the Ginzu in principle should produce similar results (at the time of writing the writer had not yet had a chance to test a G-2).

Power Tilling

To many skiers and for groomers in deep snow country the whole art and science of snow grooming relies on one tool – the hydraulic tiller. In the right conditions, power tillers mounted behind modern snowcats can

handle the whole series of grooming processes from initial packing to light or deep renovation. In areas where fresh snowfalls can be counted on every week, nothing more is needed. Grooming in the snow-rich Okanagan (i.e. Silver Star) is done throughout the winter by sending a big cat with tiller and tracksetters out on the trails every day. In drier parts of the BC interior, and other areas not so blessed tillers have to be used with much more caution. Repeated tilling passes in snow which is not being renewed by fresh snowfalls can do a lot of damage. Tilling is an extremely aggressive process. Snow crystals are rapidly reshaped into smaller more rounded forms, resulting in a more compact denser snow pack. If carried to extremes, tilling can actually reduce snow depth on trails. Snow particles repeatedly ground down to finer size leaving a denser and thinner snow pack. Carried on further, excessive tilling can leave “dead” snow. In this case rather than being too hard trail surfaces become sugary. Snow crystals have been altered so much that they will no longer compact. The only thing that will rejuvenate “dead snow” is an infusion of fresher snow which can come from snowfalls or snowmaking from above – or by bringing up and mixing in fresher snow from lower layers. The most efficient tool for breaking up old hard pack and mixing with sub layers is the front renovator. A wide (2.5 – 4+ m) horizontal cutting blade front mounted on a snowcat cuts and lifts hardpack, leaving a loose chunky layer which is then refined by tilling into a smooth finish surface. The original Front Renovator introduced by the Swiss firm, BAECHLER TOP TRACK, is still being manufactured and sold under license by YELLOWSTONE TRACK SYSTEMS. A front renovator variation (an attachment to the snowcat front U-blade) is available from the German Pisten Bully maker, KASSBOHRER.

When to Groom ?

There is no single answer to the question of “When to groom?” Generally grooming should be done at times when skiers aren’t around. Aside from the obvious safety issues raised by the possibility of skiers running into grooming machinery on trails, fresh groomed snow normally needs time to set up before it is ready to take skier traffic (usually 2 hours minimum - as little as 1 hour in areas with high snow humidity). This normally means grooming at night or very early in the morning. There are also other considerations such as current weather and temperature conditions, and the general condition of the snow pack. As noted previously in the section on packing, grooming is most effective in a relatively narrow temperature range just below the freezing point (0 to -10 C.). Cold dry snow doesn’t pack well, so grooming in extreme cold won’t be completely productive, but it also won’t do any real damage if it must be done. Warm, wet snow is another matter. Whenever possible the best course of action in extremely sloppy conditions is to leave it alone. This is especially true if cold weather is predicted for the immediate future. The extra compaction produced by grooming melting snow can turn trails into armour plate if temperatures drop suddenly. Still, there will be times when grooming in the slop has to be done, and in some areas (coastal zones, for example) where warm and wet are the norm, there will be no choice. Even in warm periods there may be times when temperatures and surface moisture levels drop enough for productive grooming (usually late

night or very early morning). Snowmobile groomers with their limited horsepower will often have to time their work for a small window when snow has cooled and dried enough, but not yet frozen solid.

For ski races grooming should usually be done in the evening before the event, allowing maximum time for set up. Obviously, final grooming and tracksetting may have to be delayed until early morning with completion planned for just before the race if heavy snowfall is predicted

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Tracksetting 6-8

Manual Grooming

Although machines do most of the work there will often be a need for some manual labour in competition and recreational grooming. In thin snow conditions shovellers may have to fatten up thin spots, especially in high wear areas such as tight downhill corners. Cat growser marks and other rough spots left by machines should be raked smooth. During competitions manual groomers with rakes and shovels should be stationed at high speed corners and downhills where hazards (rocks, bare patches, icing) can be expected to turn up under racer traffic. Extra lookouts may be needed on blind corners.

Grooming Glossary

Compactor Bar: A rear mounted bar with a plastic comb used to compress (Packer Bar) deep new snowfall (over 18 in. / 46 cm) prior to grooming the trail with a drag or for early season trail set-up.

Dead-Head Miles: Return trip over the same trail because of a dead end trail.

Front Blade: A front mounted blade used to doze snow drifts, to help pull new snow in from the sides of the trail, and to provide rear grooming implements a properly prepared surface to process the snow.

Groom: To get into a state of readiness for a specific objective; to take care of the appearance of; to make neat and tidy = trail maintenance; the mechanical alteration of the snow to provide a safe, smooth surface for travel.

Groomed Miles: Total miles put on the groomer during the process of grooming the entire trail system.

Groomer: A grooming tractor equipped with grooming implements (drag, tiller, or compactor bar).

Groomer Operator: An employee or volunteer that is in physical control of and operates the grooming tractor.

Grooming Drag: An implement pulled behind the grooming tractor which does the actual grooming

Grooming Manager: A local official or club member charged with coordinating grooming activities, including establishing schedules and priorities. Some areas call this person the Trail Master or the Grooming Coordinator.

Grooming Speed: The speed the groomer travels over the trail while performing the grooming operation (typically recommended to be 5 to 7 mph / 8 to 11 kph).

Grooming Tractor: A heavy-duty, two or four-tracked vehicle for which the (Tractor) primary purpose is to provide the pulling power for grooming implements. Also called a Prime Mover.

90Hours of Operation: The time that the grooming tractor actually spends grooming the trails, not necessarily as recorded by the hour meter.

IASA: The International Association of Snowmobile Administrators, which consists of state, provincial, territorial and federal government officials with responsibility for administering snowmobile trail, safety, and/or enforcement programs.

Miles of Trail: One-way miles of trail in the system, including loops and dead-ends.

Moguls: A pattern of mounds, dips, and ruts in a trail.

Operation Log: Used to record the date, the hours of operation, miles of trail groomed as recorded by the vehicle odometer, time in and out, parts of the trail system groomed, and general comments regarding repairs and maintenance records.

Scarifier: A blade used to scar icy surfaces to rough them up, usually mounted in the front row of multi-blade drags or on the bottom of the front tractor blade.

Snowmobile Trail: A compacted snow road for use by snowmobiles and other authorized over-snow vehicles.

Tiller: A hydraulically driven, rear mounted implement similar to a roto-tiller that mechanically processes and mixes snow.

Trail Bed: The compacted snow surface or trail.

Trail Grooming: The activity of producing a smooth, uniformly compacted snow surface with a uniform high density through the use of mechanical equipment.

Track Packing: Using the tracks of the grooming tractor to pack the snow without the use of any grooming implements.