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RECREATIONAL IMPACTS ON NATURAL RESOURCES

SOILS ASPECT

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To most people, outdoor recreation is a positive word bringing to mind enjoyable times doing a variety of activities that we all enjoy. Unfortunately, however, there area number of negative aspects of outdoor recreation that, if not appropriately considered and addressed, can have a negative impact not only upon those recreational activities themselves but to the environment as a whole as well. Some of these impacts are subtle and only discovered after quite some time, often in combination with other impacts. Others are much more noticeable and can have an immediate and very noticeable impact. An example of a subtle impact on soils might be foot traffic that compacts the soil in a significant portion of a stream watershed. Compacted soil is less porous than uncompacted soil so rainfall tends to runoff from it rather than infiltrate into the soil. Over time, as the runoff quantity increases and infiltration decreases, down gradient streams becomes impacted. Streams, which used to receive a constant and controlled amount of cool and clear groundwater over the course of a year, including the summer months receive large volumes of warm and polluted runoff during storm events. The volume of runoff may exceed the capacity of the stream to hold it within its banks so flooding and erosion begin. The muddy water makes it difficult for native fish and other aquatic organisms to survive in and sediment may smother their eggs. Then, in the summer, the stream may dry up because there is no groundwater to feed it. This can result in the loss of a nursery for cold-water fish species, which supply the pond into which the stream flows so that it no longer supports a native fishery. In time, the pond may become eutrophic and no longer a suitable habitat for even stocked fish. A much more noticeable impact might be an ATV trail that crosses a streambed or wetland tearing up the soil and causing significant erosion and sedimentation. It can even cause the wetland to be drained or the stream channel to be redirected.

Negative impacts upon natural resources, including soils, need to be taken into consideration when planning outdoor recreational activities and guarded against as a maintenance measure for recreational sites. Following is a list of impacts upon soils that may be encountered at recreational sites:

- Alteration of soil drainage class
- Contamination of the soil
- Alteration of soil depth

- Alteration of soil infiltrative capacity
- Alteration of soil structure
- Alteration of soil consistency
- Alteration of soil cation exchange capacity (and filtering ability)
- Alteration of soil organic matter content
- Alteration of soil temperature
- Alteration of soil micro flora and fauna
- Alteration of soil macro flora and fauna
- Alteration of the erosion and sedimentation potential of the soil
- Alteration of the hydrologic of a watershed

Alteration of soil drainage class – The drainage class of a soil (depth to seasonal groundwater table and droughtiness) can be affected in one of two ways. The groundwater table of downslope soils may be lowered or eliminated on purpose by the installation of ditching for the construction of trails, parking lots or access roads or inadvertently by ATV trails that gouge into the native soil, intercepting the groundwater table and diverting it down the trail bed (runoff tends to take the easiest path of resistance). Or, the groundwater table may be increased by the discharge of runoff water to an area that was not wet (from culverts, ditches, parking lots). The soil drainage class may also be altered by altering the structure of a soil. Compacting a friable topsoil can make it less permeable and therefore have a shallower perched groundwater table. The groundwater table may also be effectively lowered by the addition of fill to build trails, roads, parking areas or lawn areas.

Contamination of the soil – There are several sources of contamination that may be introduced into the soil as a direct result of outdoor recreational activities. Snowmobiles, ATV's and other recreational vehicles can leak oil, gas and other such fluids directly into the soil. It is not unheard of for less scrupulous people to change the oil in a vehicle by draining the fluid directly onto the ground. Trash is another unfortunate by-product of recreational use, particularly if people can access a site by car or truck. Trash can be as simple as common litter but may also include unauthorized "dumps" where such things as unused paint, oil, gas, household chemicals, old tires, batteries, computers, insecticides etc that are costly to dispose of are discarded. Another contaminant is human waste. If enough people use an outdoor recreational site and there are no rest room facilities, they often use the "bushes" as a bathroom. Due to privacy issues and convenience, it is common to find an area that is used on a regular basis as a bathroom. Such repeated use can overwhelm a site if it exceeds the capacity of the soils to absorb and treat the waste. Fertilizers can also be a source of contamination that may be inadvertent, if over used or used at the wrong time (during rain events or on frozen or snow covered ground). Finally, there are air emissions where contaminants such as dioxins, MTBE, acid and phosphorous can be introduced into the soil by rainfall events.

Alteration of soil depth – Any grading or filling activity that is used to make a more uniform surface for recreational purposes and that is located over shallow to

bedrock or hardpan soils can effectively change the depth to that bedrock or hardpan. If the soil is made shallower to bedrock or hardpan by the grading activity, it will have less infiltrative capacity causing increased runoff, which can cause an increase in erosion and sedimentation. In extreme cases, the soil can be scrapped down to bedrock or hardpan in which case it will be very difficult if not impossible to revegetate. Conversely, if the depth to bedrock or hardpan is increased, it may result in an increase in infiltrative capacity and a reduction in runoff.

Alteration of soil infiltrative capacity – Infiltrative capacity is how easily water can move vertically into and laterally through a soil. It is a function of several soil properties including soil structure, consistency, texture and depth to bedrock or hardpan. Even vegetative cover affects infiltrative capacity as does the type and thickness of any surface organic horizons. If soil structure is degraded or destroyed, infiltrative capacity of the soil will decrease. This is true for all soils except for sands and gravels which do not generally have soil structural units. As mentioned above, if a soil depth to bedrock or hardpan is reduced, the infiltrative capacity will be reduced. If the soil is compacted (by foot traffic as well as vehicles) it will have a decreased infiltrative capacity. Infiltration in a forested area is greater than in a field and infiltration in a field is greater than on a bare soil area even if all are of the same soil type. That is partly due to varying degrees of compaction but also due to the organic duff layer in a forest, which acts like a sponge. Another reason for the forest having a superior infiltrative capacity is because a forest floor is uneven trapping water in depressions or behind forest debris forcing it to infiltrate into the soil rather than runoff over the surface. Runoff also reaches the ground slower and more gently in a forest due to its first being intercepted by trees. The rainfall reaches the ground surface by dripping from tree branches as compared to striking grass or bare ground directly from the clouds above. In a field, the grass absorbs some of the raindrop impact energy and runoff is slowed some by the vegetation, the degree of which is dependent upon the height and thickness of the vegetation. Unmowed fields are better than mowed lawns at slowing runoff rates. Bare soil areas have no protections whatsoever and therefore have the lowest infiltration rates of all. Any constructed areas, such as roads, trails, parking lots or driveways associated with recreational facilities generally have high runoff rates. Buildings have 100% runoff as compared to the native, vegetated ground. It is however, possible to install measures designed to minimize the impacts of decreased infiltration such as detention basins, to minimize those impacts. When water infiltrates into the soil, at least some removal of contaminants occurs. If the runoff water travels across the soil or other surface to a concentrated flow area (ditch, stream, drainage swale etc.) most of the contaminants will reach a surface waterbody or wetland with virtually no treatment. Therefore, infiltration is important for protecting surface water quality. Contaminant laden runoff water may however, negatively impact groundwater, particularly if the soils have a high water table and/or have little filtering ability (sands, gravels and soils shallow to bedrock).

Alteration of soil structure – About 50% of the volume of most upper soil horizons is pore space. Except for single grained soils such as sands and gravels, pores are created as a result of soil structural development. Sand, silt and clay particles clump together into various shapes, usually with the help of decomposing organic matter, to create soil structure. The cracks between these soil structural units are the primary pore spaces. If the soil structure is degraded or destroyed, pores will also disappear resulting in fewer pathways for water to travel into and through the soil and thereby greatly decreasing the soils infiltrative capacity. Good soil structure is vital for maintaining high infiltrative capacity. It is also very important for the roots of vegetation that depend on a well-aerated soil.

Alteration of soil consistency – Soil consistency is a measure of how firm or dense a soil or soil horizon is. A soil that is loose or friable is more permeable than a soil that is dense or firm. Therefore, any activity that compacts the soil making it denser will decrease its infiltrative capacity and increase runoff. Increased runoff increases pollutant loads to surface waterbodies and causes more soil erosion and sedimentation. The main sources of soil compaction in outdoor recreation areas are foot traffic and recreation vehicle traffic.

Alteration of soil cation exchange capacity (CEC) – Cation Exchange capacity is a measure of the soils ability to adsorb cations (positively charged ions such as phosphorous, potassium and ammonia). It occurs mostly on the surfaces of very small particles such as silt, clay and highly decomposed organic matter (humus) and is an important mechanism by which soils treat liquid borne contaminants. Positively charged elements attach themselves to the negatively charged surfaces of very small soil and organic matter particles. Generally, sandy or gravelly soils have very low CEC while silty or clayey soils or soils high in organic matter content have high CEC. The CEC of a soil can be decreased by removing the organic duff layer of a forested soil (making a trail, road, camping spot, parking lot etc.) or by removing the topsoil from a field area. CEC can also be increased by adding bark mulch, compost or some other form of organic matter. The CEC of a soil is also influenced by its depth to bedrock or hardpan. Soil particles must be in contact with contaminants in order for those contaminants to be removed from the water carrying them. Bedrock has no soil particles and hardpans are too dense for liquid borne contaminants to effectively penetrate. Therefore, effective CEC is restricted to soils loose or friable enough for liquids to easily penetrate and that are high in silt, clay and/or organic matter.

Alteration of soil organic matter content – Soil organic matter is a small but very important component of a soil. It increases the CEC of a soil and may represent the primary source of CEC in coarse textured soils. It is responsible for the development of good soil structure in topsoil which in turn is a major component affecting the permeability of the soil, particularly in soils high in silt or clay content. It also serves as the major source of food for a number of soil microorganisms, which in turn release nutrients into the soil for plants. Without organic matter in a soil it is essentially “dead” instead of having a flourishing

microorganism community necessary for a healthy soil. Soil organic matter also has high water retention capacity, which is important for plant growth, particularly in soils, which tend to be droughty such as sands and gravels or shallow to bedrock soils. If a forest soil has the organic matter removed or if a field area is graded so that the topsoil is removed, it will have a profound effect on the soil and how it protects other natural resources. On the other hand, if organic matter is added to the soil, such as compost or bark mulch, it can be a positive effect on the soils ability to absorb and treat runoff water.

Alteration of soil temperature – The temperature of a soil is directly related to soil cover type. Forested soils are the coolest during the summer due to shading and evapo-transpiration, with coniferous forests being the coolest forest type. Conversely, in winter, forests protect the soil from deep frost penetration. Bare soil areas are the warmest in summer and have the deepest frost penetration in winter. Chemical and biological reactions are much faster in warm soils than soils that are cool, which affects micro and macro plants and animals growing on a site. If a forest is converted to a field or bare soil, the temperature of the soil will change. Warmer groundwater will be discharged too streams and wetlands in the summer while groundwater flows may stop in winter due to deep frost penetration. This may also affect precipitation patterns, particularly in the more arid regions of the country. Desert areas can increase in size by removing vegetation. It can also affect microbial populations and types, which can affect a host of other soil properties and how well it can treat contaminants in groundwater. Soil temperature can also impact the types of vegetation that can grow on a site. If the soil warms up too much after being deforested, it may not be able to support a forest again without human intervention. Ultimately, a significant change in soil temperature can have widespread impacts on whole eco-systems.

Alteration of soil micro flora and fauna – A healthy soil is one in which there is a robust community of microscopic plants and animals such as nematodes, bacteria, fungi, algae etc. These microorganisms are a very important component of soil for several reasons. They are a significant factor in a soils ability to treat contaminants and are critical to the survival of certain higher plants. Soils that are low in organic matter content tend to be low in microorganism populations as are soils that become anaerobic due to compaction. Microorganism communities can also be impacted by the introduction of contaminants or altering the soils pH. A low population of soil microbes will slow decomposition of organic matter and the resulting release of important nutrients larger plants need to grow. That in turn will affect animal types and populations that depend on plants for food and cover. Also, many plants depend on what is called a mycorrhizae, which is where certain fungus species grow on plant roots to the mutual benefit of both the plant and fungus. In many instances, plants can’t grow where their special mycorrhizae fungus is not present. If the macro plant community is altered by the lack of beneficial microorganisms, that in turn will change many characteristics of the natural area including soil properties.

Alteration of the macro flora and fauna – One of the 5 major soil-forming factors is vegetation. Any change in the vegetation, which grows on a site, will therefore have a significant impact on many soil properties. Soil pH, soil organic matter content, soil microorganism communities, soil moisture, soil nutrient content and availability, soil erosion, even soil consistency can be affected by the type of vegetation growing in an area. Plant communities can also be affected by the species and numbers of animals living in the area. If non-native animals are introduced into an area, they can alter what type of plants can grow on a site. Conversely, if vegetation on a site is changed, it can affect native animals ability to survive in an area. Soil moisture content is affected by the type of vegetation. Grasses can provide protection from the drying effects of a hot sun but do not loose much moisture through transpiration. Trees, on the other hand, transpire great quantities of moisture in the summer, which can lower the water table of a soil. That transpired water however, may contribute to the amount and frequency of precipitation in an area. Nutrient content of a soil is also affected by plant communities. Some plant species can actually add nutrients such as alders that have nitrogen-fixing bacteria on their roots. Other plants, such as Norway Maples (a commonly planted invasive species), make the soil very acid to create a hostile environment for other plant species thereby limiting competition.

Alteration of the erosion and sedimentation potential of a soil – The most common surface water pollutant in Maine (and the country) is fine soil particles referred to as sediment. Generally, sediment becomes a pollutant because soil particles were loosened up somewhere in a watershed by water, wind, gravity or ice, a process known as erosion. The deposition of those eroded soil particles in a waterbody is called sedimentation. Erosion and sedimentation is a natural process but human activity often accelerates the process to where it becomes a (or even the) major contributor to water quality degradation. Erosion potential depends on a number of factors but the most important factor is soil cover. The best soil cover is a forest, which has trees to slow down raindrop impact and a duff layer to absorb rainfall, Fields are fairly well protected but not to the extent of a forest. Other factors of importance include runoff water volume and velocity and soil type. The greater the volume and velocity of runoff, the greater the potential for significant erosion. Silt and fine sand are the most erodable soil particles (coarse sand is too heavy and clay is sticky so particles are hard to erode away). Therefore, a soil high in silt and fine sand content are the most likely to erode and suffer the highest amount of erosion. Any activity that changes the vegetation type growing on a site will change the erosion potential (sometimes it becomes greater and sometimes it becomes less). Also, if vegetation is changed or the soil becomes compacted so that rainfall runoff is increased, that runoff will likely accelerate erosion somewhere down gradient. Activities such as ATV use can be major contributors to erosion and sedimentation if they stray from properly designed and constructed trails, especially when the soil is saturated so that it is soft and unstable.

Alteration of the hydrology of a watershed – Watersheds are the land area surrounding (upslope of) surface waterbodies that contribute surface and/or subsurface water to that waterbody. There are many ways to alter the hydrology of a watershed. The hydrology of a forested watershed can be altered simply by cutting the trees and, in the process, compacting the organic duff layer so that less rainfall infiltrates into the soil. This is particularly true if the harvest is done on wet soils and/or at the wrong time of year when soil rutting is common. The resulting increased runoff reaches streams much quicker as overland flow than subsurface flow and it is warmer. This can have a major impact on the stream channel and life that lives in the stream. It also will affect the water quality of a pond or wetland, the degree to which is dependent upon the size of the pond or wetland. Another way to alter the hydrology within a watershed is to disturb the soil. Some types of disturbance will cause a greater modification to the hydrology than others. Skid trails for forest operations or trails used for recreation (especially ATV trails) can have significant impacts on the hydrology if they have ditches that extend into the groundwater table or if the trail itself is eroded down into the groundwater table. That intercepted groundwater is often redirected by the ditch or trail so that it goes in a different direction than the groundwater originally did. And, even if it isn't redirected, it gets to the waterbody in a faster time, in a greater volume and much warmer than the groundwater did. This can cause a stream to overflow its banks causing flooding and erosion of the stream banks. The resulting sediment can have a profound effect on aquatic life in the stream as can the warmer water. The nutrients in the sediment can cause algae blooms, particularly in ponds, degrading the water and making it undesirable for humans and animals. Then, during the driest summer months, streams may dry up do to the lack of groundwater making it impossible for cold water fish and other aquatic organisms to survive.

One important thing to always remember, in natural systems, is that it is virtually impossible to change one thing without inadvertently changing at least one other thing. That is because everything is interrelated and interconnected in a natural system, sometimes in ways we never would have thought about until later when it may be too late. Therefore, it is very important to think carefully before taking an action, particularly one that has not been well studied and documented.