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Science FINDINGS

INSIDE

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"Science affects the way we think together."
Lewis Thomas

SOGGY SOILS AND SUSTAINABILITY: FORESTED WETLANDS IN SOUTHEAST ALASKA

Credit: USDA Forest Service

Regenerating forested wetland stands have variable tree growth depending on microsite conditions. Trees in these stands grow slowly because of limited nutrient availability caused by soil saturation. Raised sites provide more favorable growing conditions owing to the aeration of the soil and the increased turnover of nutrients.

"The soil is the source of life, creativity, culture, and real independence."

David Ben Gurion (1886-1973)

Soil maps tend to show relatively large areas classified together, with small-scale variability left out. In southeast Alaska, it is the small-scale variability that tells the story.

The Tongass National Forest occupies 80 percent of southeast Alaska. During revision of the Tongass Land Management Plan (TLMP) from 1994 to 1997, there was debate over whether forested wetlands were suited for timber production.

The debate resulted in a study to determine the wood-volume productivity of young-growth stands on wet organic soils after clear-cutting. The study also assessed whether forest productivity meets the minimum threshold for lands classified as suitable for timber production on national forest lands.

IN SUMMARY

The question has risen over whether forested wetlands in southeast Alaska are suitable for sustainable timber production. A significant factor limiting forest productivity in this region is excess soil moisture. Very little is known about the soil conditions that influence tree growth on forested wetlands. A research study was completed to provide information on the growth of trees on these lands, resulting in an administrative decision to leave 100,000 acres of forested wetland in the timber base on the Tongass National Forest.

The forested wetland research provided information about soil types and the distribution of forested wetland soils in southeast Alaska. A related study is determining how soil hydrology influences the flow and retention of water, nutrient cycling, and the formation of hydric soils in forested wetlands.

"When we began our study to examine this issue more closely, we couldn't actually find the soils we were supposed to be finding in these forested wetland areas," says Dave D'Amore, a soil scientist at the Forest Sciences Laboratory of the Pacific Northwest Research Station in Juneau, Alaska. "The soil mapping relied heavily on aboveground vegetation as an indicator of belowground conditions. We found that, at least for wetland soils in southeast Alaska, vegetation is not necessarily a good indicator of soil type." The other lead scientist in the study was Kent Julin, County of Marin, California.

In continuing investigations, that's not all they've found. On closer investigation, some distinct characteristics of southeast Alaskan wetlands began to emerge as a result of southeast Alaska soil research.

KEY FINDINGS

- The rate of wood production on forested wetlands in southeast Alaska is greater than the minimum USDA Forest Service standard for commercial timberland. New tree growth information has allowed managers to evaluate the suitability of forested wetland soils for timber harvest.
- An analysis of fiber contents in forested organic soils discovered a much broader range of decomposition than the established classification presently used on the Tongass.
- Flow of water through upland wetlands may be considerably faster than usually associated with lowland wetlands, thereby resulting in differences in decomposition rates of organic matter, and in nutrient cycling.

THE FORMATION OF SOIL IN SOUTHEAST ALASKA

Soils in southeast Alaska defy most classifications. "They are made complex by the factors of their formation—climate, landscape, plants, parent materials, and time—along with the tendency for southeast Alaska to produce extremes of all these," says D'Amore. Specifically, the area is very wet year round; suffers some low temperatures; and is a geologically young, steep, landscape.

"Not only do rapid changes in landform factors lead to variation in the landscape, but the influence of the landform on soil-forming factors means new soil is always being formed. Landslides, soil-slumping, uprooting of trees, and flooding are among the forces constantly setting things back to zero," he explains. Furthermore, intense and regular rainfall causes rapid weathering, and in turn highly differentiated soils.

"The result is a very complex soil situation; often one hillslope will contain many different soil types, and there can be two totally different soil types right next to each other, such as an organic (peaty) soil beside a mineral (rocky) soil," D'Amore says. The latter condition usually occurs in a pattern of raised mounds and pits commonly called pitt-mound typography.

The existing soil survey, begun in 1961, tackled a huge task, mapping soils over roughly 8 million acres and trying to isolate soil types based on field visits and aerial photos. It was a good job done under difficult circumstances, D'Amore emphasizes, but has its limitations at the finer scale.

"The soil types were lumped into groups rather than split into subgroups, which is where the scale becomes a problem," he explains. "In many cases, the survey would have remained more accurate if it had left the organic soil classifications at a coarser level of detail."

The point here is not to criticize existing soil maps, D'Amore says, but to recognize the limitations of what we have, so that when we use resource inventories such as this, we make the correct interpretations from them.

Purpose of PNW Science Findings

To provide scientific information to people who make and influence decisions about managing land.

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WETLANDS IN THE UPLANDS?

The high rainfall and low temperatures of southeast Alaska help create soils that are often highly organic. This is because decomposition does not keep up with organic matter accumulation. The water flows at considerably higher rates on steep slopes than on the lowlands. It is common to see wetlands at the base of the slopes, but they also can form in the uplands in flatter areas that slow water movement.

"The low decomposition rate in forested wetlands leads to nutrient limitations for the above ground vegetation," D'Amore explains. "But because of the water flow through the wetlands, we are starting to believe that there may be wetlands acting as sources, as well as sinks, for nutrients and carbon. The wetlands may play a more dynamic role in the nutrient cycles of the southeast Alaska landscape than previously believed."

This perception comes easier in southeast Alaska, where steep terrain can release water from wetlands in a steady flow toward the rivers. Release in the lower 48 states is weaker and so less obvious.

LAND MANAGEMENT IMPLICATIONS

- Forested wetlands may remain in the commercial timber base according to the minimum standard for commercial timberland in southeast Alaska.
- Research in southeast Alaska on the relations among soil hydrology, water, and fiber content in steep, humid, mountainous conditions can now serve as a model for such landscapes.
- Recognition of broader levels of decomposition in organic soils will lead to more accurate estimates of carbon storage in organic soils in southeast Alaska.
- Soil research can provide information on wetland functions to assist in wetland protection.

COMMERCIAL TIMBER ON WETLAND SOILS?

"Different drainage characteristics of the glacial features forming the southeast Alaska landscape have created a mosaic of well-drained soils, particularly on hills and till-plains with coniferous forest, and poorly drained peatlands with moss and scrub forest vegetation," D'Amore says.

About 15 percent of the Tongass National Forest's 10 million forested acres is wetland. For the study, stands growing in saturated, organic soils were chosen because of evidence suggesting that trees did not grow well on these soil types.

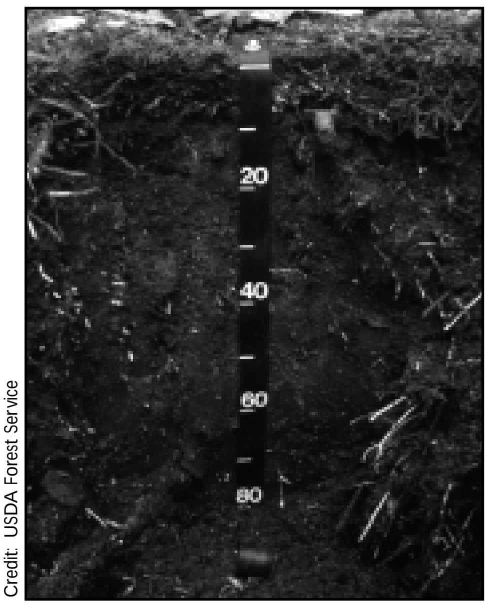
"But after clearcutting, the forested wetland stands we observed successfully regenerated and grew into densely stocked, differentiating stands dominated by western hemlock and Sitka spruce. Volume growth proceeded regularly, albeit slowly," he says. "We believe that growth in these stands will closely follow the curves predicted by the SEAPROG model." SEAPROG is a regional growth and yield model with an extensive database, developed from stand information in southeast Alaska and British Columbia over a wide range of stand and growth conditions, including forested wetlands.

"If the rates of productivity observed during the first 50 years are sustained for the next 60 years, these stands will exceed the minimum USDA Forest Service volume production standard for commercial timberland," D'Amore says. "We don't have any data to confirm that the stands will resemble the structure of older wetland stands, but the arrangement of the trees and the growth patterns are similar.

"It's important to understand that we are not recommending that these wetlands be regarded as timber producing areas, we have simply produced the growth data to assist managers in making a decision on the use of forest resources."

The study has been cited as a good example of science-management interaction, D'Amore says, a case where science provided data to managers, who needed it to better assess risk and be more assured of potential results of their actions. The study resulted in an administrative decision to leave 100,000 acres of forested wetland in the timber base on the Tongass National Forest.

But still the information on what limits productivity on these lands is sparse.



Credit: USDA Forest Service

Typical soil profile for wetland soils in southeast Alaska. Several varieties of peaty soil can be found close together in forested wetlands.

WRITER'S PROFILE

Sally Duncan is a science communications planner and writer specializing in forest resource issues. She lives in Corvallis, Oregon.

NUTRIENT CYCLING IN FORESTED WETLANDS

A related study is addressing part of the elusive productivity picture by assessing the movement of groundwater through the region's soils and how the flow of water influences soil development. What nutrients does all that moving water carry away? How does water actually move through wetlands? What does waterflow mean for vegetation?

"Fluxes of water down steep slopes may create highly-oxygenated water flow conditions, thus influencing both the physical and chemical changes of the soil, and the transport of materials and nutrients," he says. "The monitoring sites in this study have provided a valuable framework for the study of hillslope processes. This hillslope approach will help build water regime flow models and determine how key nutrient cycles interact."

Perhaps most importantly, the sequence of sampling sites near Juneau is being used to challenge the paradigm that peat-forming wetlands (peatlands) are net nutrient sinks. Contrary to what is currently believed, peatlands may actually have more water and nutrients moving through them than previously recognized. The research will develop a nutrient availability gradient, which likely can be applied throughout the forest's wetlands and help reveal how timber grows in wetlands.

"A point not to be lost, however, is that wetlands not only produce timber—they produce many other products and services important to forest and wildlife health and sustainability, and our studies will provide illumination on those areas as well," D'Amore says.

The protection of wetlands has been a somewhat neglected area in southeast Alaska until recently, he notes, with roads being built across them if the resource value of an adjoining nonwetland are more important to protect. In addition, the Clean Water Act section allows roads to be built because of the "silvicultural exemption." "Overlay roads" are the usual design, with timber, rocks, and gravel laid down across the surface to support wheel traffic. Recent identification and protection of biologically significant wetlands on the Tongass makes the decision to avoid wetland impacts easier and identifies locations to perform restoration of degraded wetland functions.

The types of soils found in forested wetlands also are taking center stage in the global carbon debate.

MOVING CARBON AROUND

"It is widely recognized that organic soils are important in cycling carbon between its terrestrial and atmospheric pools, and the boreal and temperate wetlands are coming under closer scrutiny in that context," D'Amore notes. "They are regarded as carbon stockpiles that will not be added to the atmosphere, and thus a potentially useful buffer against global warming."

But is this the case?

Global carbon research is attempting to discover the balance between production and consumption of carbon. D'Amore says it is difficult to estimate the huge fluxes of carbon gases from the world's sources and sinks: a balance between art and science. The nature of boreal soils affects how big their assumed carbon buffer is by the quality of their carbon content: microbes that help transform carbon cannot get at organic matter that is well decomposed; so the level of decomposition in these soils becomes a crucial factor in assessing carbon levels.

In general, forested uplands and wetlands sequester carbon dioxide and act as a sink for carbon, whereas stagnant wetlands produce carbon-containing methane and release it to the atmosphere.

"Determining the peatland areas that act as sinks or sources for carbon can aid in establishing carbon budgets for northern peatlands," D'Amore says. "Rapid water transmission on steep slopes in southeast Alaska may promote aeration and minimize methane production, leading to a relative increase in carbon sequestration."

"Understanding the carbon content of these soils is very important. What kind of carbon do we have here? How is the carbon supplied to streams and trees? How available are nutrients such as carbon to wetlands? We have to know these things to make our estimates of the carbon sink realistic, and the current soil maps don't give enough detail," he says.

Although organic soils are abundant in southeast Alaska, little information is available on the state of decomposition or variability within organic soil mapping units.

The decomposition state of organic soils influences a large range of factors: the flow and retention of water, organic carbon accumulation, and nitrogen content, among others. Soil classification tables generally assume that physical and chemical states of decomposition coincide, but such does not appear to be the case in the sloping terrain of southeast Alaska.

"It is likely that rapidly moving water on steep slopes in the Tongass is aerated, decomposition is relatively high, and the products are transported down slope," D'Amore explains. "Strong soil-vegetation relationships were assumed when the Tongass soil survey was initiated in 1961, but we now see that peat accumulates over time from several vegetation communities, and each contributor brings a distinct decomposition pattern."

The result is that more descriptive information from the field is crucial to both the soil mapping of southeast Alaska and the related estimates of global carbon deposits.

REFINING SOILS AS INDICATORS

The forested wetland growth study based on soil types assisted the Regional Leadership Team in its recommendation to leave the forested wetlands in the Tongass timber base, and the soil hydrology and fiber study provided clearer information on nutrient cycling in upland and wetland soils.

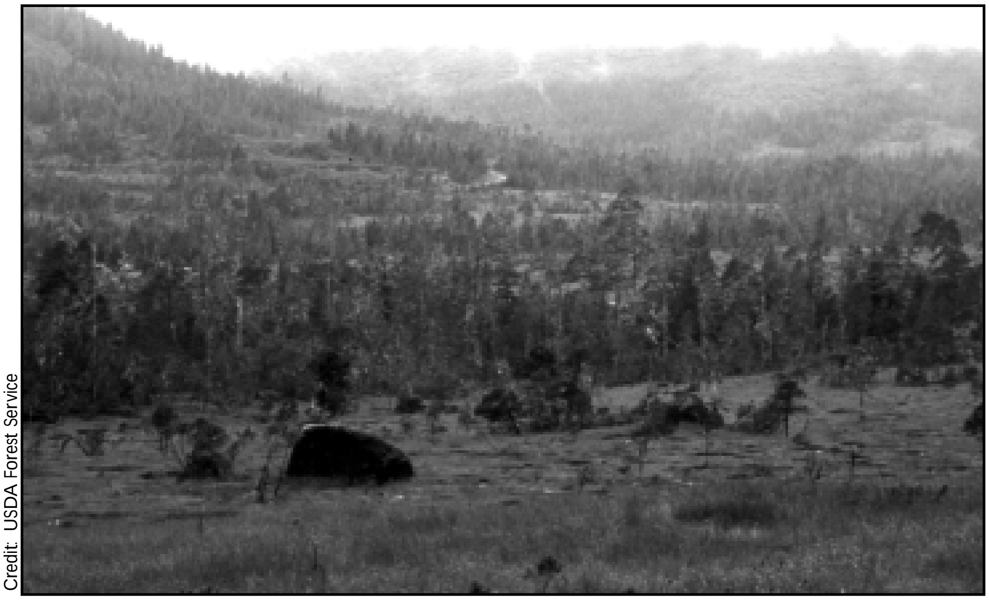
"Locating the boundary between wetlands and uplands is more accurate due to research on wetland soil indicators," D'Amore notes. "Soil scientists, hydrologists, botanists, and other resource specialists can apply the information from the long-term soil saturation studies to accurately identify wetlands in potential project areas."

Further, the wetland soil research has provided information on wetland functions to improve the evaluation of wetland protection measures, he says. The TLMP requires that managers evaluate the effectiveness of Best Management Practices and their impacts on wetland function and values.

The soil conditions in southeast Alaska are very complicated, D'Amore acknowledges, and the work yet to be done for better understanding is considerable. The emerging knowledge of soils in this region is changing the understanding of wetland functions and their role in carbon cycling.

"What would the world be, once bereft of wet and wildness?"

Gerard Manley Hopkins (1844-1889)



Credit: USDA Forest Service

Open bogs known as "muskeg" are common in southeast Alaska. These types of vegetation communities and soils are found in a mosaic with uplands and forested wetlands throughout the landscape.

FOR FURTHER READING

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