

The lessons of history are evident in this article adapted from an upcoming book that will trace 100 years of research history at the Wind River Experimental Forest. The authors demonstrate the value of long-term research as the Wind River story shows that outcomes are not always predictable and research results can change over time. The article is offered in recognition of the 75th anniversary of the USDA Forest Service Pacific NW Research Station.

FOREST OF TIME:

RESEARCH AT THE WIND RIVER EXPERIMENTAL FOREST 1908–1919

The Forest Service was three years old in 1908, and forestry was a new field of science, when a handful of freshly minted foresters came west to study the giant trees of the Pacific Northwest. Their first laboratory was nestled in the Cascade Mountains of Washington, between Mt. St. Helens and the

Columbia River, in the Wind River valley.

Studying forests is slow business. A tree can easily outlive a human, and the forests of the Pacific Northwest had outlived civilizations. The young researchers faced trees that were larger and older than any they had studied back east, in forests that were more ancient than anything described in their European texts. Yet the same scourges that had ravished forests across the American continent were making their mark in this last forested frontier. An industry of cut-and-run logging and an increasing number of massive fires left bare scars across the shoulders of the Cascades.

The forest laboratory would eventually be known as the Wind River Experimental Forest. It would be the site of ground-breaking research as Douglas fir became the preeminent commercial tree species, and the Pacific Northwest became ground zero for changes in forest policy. But in 1908, the foresters' attention was on how trees grow and how to reforest the burn-scarred land.

YACOLT BURN

Here, in a land so famously wet, it is not easy to understand the role of fire. Along the length of the Cascade Range, mountains block the flow of moist air blowing in from the ocean, and the wet western valleys and slopes grow some of the largest trees in the world. But the Columbia River has carved a narrow slot in the mountains, where the wind funnels with particular strength. And sometimes, when air pressure differences are especially strong east to west, the wind reverses to pull hot, dry air from the arid eastern plateau toward the coast and into the forests. The power of these desiccating winds can fan a small fire into a holocaust.

At the turn of century, small fires were common throughout the summer and fall. During the brief dry season, fires were started by Native Americans clearing meadows, or by lightning strikes, or by settlers trying to grub out a farm from the towering forest. On September 11, 1902, sudden east winds fanned a series of

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small fires throughout Washington and Oregon. These fires merged with fires blowing in from the east, and exploded into mammoth proportions. Eyewitnesses described a wall of fire burning across southern Washington, roaring and rolling in waves of flame that leapt hundreds of feet into the air. Survivors described the deafening roar of the firestorm with its fierce, pulsing wind. The fire burned for three days, and for weeks afterward the sound of falling trees cannonaded across the scorched landscape. The fire was named for the small town of Yacolt that had miraculously escaped incineration. In much of the Wind River valley, the fire left a ghost forest of dead, blackened snags.¹

SETTLEMENT AND THE LOGGING INDUSTRY

Before the Yacolt fire, some homesteaders had settled in the Wind River valley. But the hopes and investments of most of them had been doused by chilling frosts that tumbled out of the mountains at almost any time of year. The best way for some settlers to make it on this land was to sell out, and the Wind River Lumber Company was there to help with the transition.

Similar transitions between homesteaders and timber companies were occurring throughout the west, which raised concern for the fate of the nation's forests and eventually helped to prompt the creation of several forest reserves. By the time of the Yacolt fire, much of the western Cascades in Washington was part of the Mount Rainier Forest Reserve. In the Wind River valley, most of the land that was not part of the reserve was claimed by the Wind River Lumber Company.

The laws that had established the forest reserves provided their managers with the authority to sell mature or dead trees as a supplement to local timber supply. In 1905, when responsibility for the reserves was transferred to Gifford Pinchot's fledgling Forest Service, the young chief forester hoped the sale of timber would help pay for his programs to manage the nation's forests. Fire-killed

timber sold to the Wind River Lumber Company was one of the first large commercial timber sales on forest reserve lands in the Pacific Northwest. The 1906 sale covered 280 acres and 14.6 million board feet of timber, sold for \$12,921. Much more of the valley was harvested in the next eighteen years.²

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To supplement his meager farm income, one hardy Wind River homesteader, Elias Wigal, had hired on as a ranger in the Mt. Rainier Forest Reserve. It fell to Wigal to manage the Wind River timber sales. His job required close contact with the lumber operations, so he built a small cabin on the south side of Trout Creek, directly across the creek from Wind River Lumber Company's Logging Camp #3. By 1908, Camp 3 was a large operation with several bunkhouses, an office, a cookhouse, a filing shed, and a barn. In contrast, Wigal's new headquarters consisted of a one-room, cedar shake cabin. It was the first station built on the vast Mount Rainier Forest Reserve, and it was called the Hemlock Ranger Station, because of the western hemlocks surrounding the site.

Privately-owned forests at this time were often abandoned after harvest, left to the whims of natural revegetation and reoccurring fire. Even the cutover lands of the federal forests were ignored. Few records were kept on federal lands following timber sales, and nothing was known about the rate of regeneration. Reforestation was not in the minds of those who cut the trees, but it was uppermost in the minds of the young foresters when they arrived at the new Forest Service District office in Portland in 1908.

Earlier that year, Gifford Pinchot had divided the national forests into six inspection districts, each with four branches of investigation: Operations, Grazing, Products, and Silviculture.



J. V. Hofmann overlooks Yacolt Burn at Wind River Experimental Station (1919).

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District Six, including the states of Washington and Oregon and the territory of Alaska, established headquarters in Portland, Oregon, where E. T. Allen was named District Forest Inspector.

E. T. Allen, a largely self-taught forester, had made a study of Douglas fir in 1903. In it he had recognized that few other trees “promise to exert such influence on the lumber supply of the future.”

“Since the ultimate exhaustion of virgin timber in the United States is certain, it follows that the forest regions that can be relied on to furnish the first and largest supply of second growth are National resources of great value and knowledge of their capacity to furnish this supply is of the utmost importance.”³

This work continued through the District Branch of Silviculture, in its section of Silvics, headed by a young forester fresh out of Yale School of Forestry named Thornton T. Munger.

T. T. MUNGER

T. T. Munger was the son of a New England minister, and his manner reflected a disciplined, no-nonsense approach to life and study. Munger had come west to study pines in the dry country east of the Cascades. When reassigned to Portland, he turned his attention to the tree that dominates the moist western forests, the Douglas fir.

Munger reviewed the few studies available to him at the time, including E. T. Allen’s early report of the so-called red fir. Munger’s assignment in Portland was “to make an authoritative, useful report on the silvicultural requirements, rate of growth, and volume and stand tables for this tree.”

This was a tall order. What was known at the time about Douglas fir had been learned primarily from observation. Munger set about to quantify that knowledge, to put measurements on those observations.

DOUGLAS FIR

Although cedar had been more important to the Indians of the Pacific Northwest, Douglas fir captured the attention of the earliest European travelers. In the early 1800s, the Hudson Bay Company developed a vigorous trade in ship timbers from the tall, straight firs. Douglas fir was recorded from the Rocky Mountains to the Pacific, and from the Mexican border to Canada, but its most dominant presence was in the western forests of Oregon, Washington, and British Columbia. There, explorers marveled at the massive old-growth stands of Douglas fir. The



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T. T. Munger (1883–1975) pioneer scientist at Wind River.

tree grew straight toward the sun, shading out side branches to form tall trunks of clear strong wood. The young wood was red; the older wood was yellow. Early names were varied, including red fir, yellow fir, and false hemlock. David Douglas, the British botanist whose name the tree now bears, called it Oregon pine.

Munger found a natural laboratory of Douglas fir in the vast burned-over hillsides of the western Cascades, including the Wind River valley. The Yacolt fire had burned the southern half of the valley, and left untouched a patchwork of ancient forest and older burns to the north. The older burns particularly caught Munger’s attention. Where fires had burned through 40 years earlier, Munger found a solid stand of 40-year-old Douglas fir growing. Similarly throughout the Cascades and Coast Range, he found pure stands of Douglas fir clustered by age from 30 years old up to 125, “and they weren’t very hard to find because there was a great deal of second growth Douglas fir on old burns.”⁴ The natural tendency for Douglas fir to revegetate burned land had

WIND RIVER EXPERIMENTAL FOREST

In 1908, after the Forest Service established its first experiment station, in Arizona, the search was on for an appropriate site for an experiment station in the Pacific Northwest. The record is not clear if there were any other serious candidates, but Wind River seemed like the natural choice, with the Hemlock Station in place and growing, its nursery established, and increasing research in the valley and surrounding hills. In 1913, the Wind River Experiment Station was officially designated, and J. V. Hofmann hired to be its director. Each year, the station put out

publications, shared information, and established new research. Even during World War I, when manpower was short, the permanent plots were remeasured, maintaining a continuous record of growth in the experimental plots. The Wind River Experimental Station was replaced by the Pacific Northwest Forest and Range Experiment Station in 1924, with T. T. Munger as its director, and administrative offices were moved to Portland. Research continued at Wind River, and in 1932, it was designated as part of the Wind River Experimental Forest.

created a laboratory of single age stands just right for comparative study.

Munger examined single-age stands throughout the region, and noted different qualities of land within each stand. He measured 40-year-old trees and compared them to the size of 50-year-old trees, and to 60- and 70- and 80-year-old trees. He compared trees on similar sites, so that only the growth and not the favorability of the site would be measured.

Such fieldwork could be done for only a few months of the year. During the long wet winter, Munger employed “computers,” which in 1908 were men hired to compute the measures into tables for comparison. Munger poured through the computed growth tables and saw how the numbers increased rapidly across the age classes. Munger’s documentation confirmed what E. T. Allen’s observations had shown, that Douglas fir grew very fast.

The next year, Munger decided to test his findings. Again working in the even-aged second growth stands on old burns, Munger mapped acre-size plots, and tagged and recorded the size of each tree within each plot. He hoped to be able to demonstrate the rate of growth of the trees over time. Munger was only 26 years old at the time. His plan was to measure each of the trees in his permanent plots every few years from then on. Evidence would

accumulate slowly, but eventually he would have “the most convincing evidence that lumbermen needed to show that those stands do grow.”⁵ A sample of these original plots are still maintained and periodically measured.

REGENERATING THE FOREST

However, James Wilson, Secretary of Agriculture, did not have Munger’s patience. He did not think the Forest Service was acting fast enough to replant cutover and burned lands. Wilson was a farmer, and according to Munger, his idea of reforestation was to toss out seeds and hope they grew. It did not matter to Wilson that the Forest Service had no nursery, no seedlings, not even any seeds for tossing. “That doesn’t make any difference,” Munger quotes Wilson, “get some seed from Europe.” So they did.

Munger recalled a trip up to the flanks of Mt. Hood to carry out Secretary Wilson’s directive. Armed with five horses and several sacks of tree seed from Europe and the East Coast, Munger and two colleagues set out in November to reseed the most suitable sites for reforestation. Caught in a sudden snowstorm, men and horses had to get out quick. They jettisoned all the seed onto the snow, and beat a hasty retreat to lower altitudes. Munger later quipped, “People who have gone through that area since then are surprised to discover once in a while an eastern oak or a European pine of some kind, and wondered how in the world it got there.”⁶

WIND RIVER NURSERY

While Munger was establishing research plots at Wind River, another young forester from the Portland office, Julius Kummel, was planning a nursery. Multiple attempts to broadcast seed had failed, and it was becoming clear that in order to replant the cut and burned land of the western Cascades, the Forest Service needed seedlings. Lots of seedlings. Kummel estimated that it would require 2 million tree seedlings annually to replant the federal forests of the region, and keep them stocked after future harvests.

Of particular concern was the Bull Run watershed, within one of the first Forest Reserves and the source of drinking water for the city of Portland. A series of fires over the course of several decades had left 13,000 acres bare.

Kummel drew up a plan and chose the Hemlock Ranger Station in Wind River as a good site for the nursery operations. According to documents, the site was chosen for its good soil, mild climate, good growing season, and abundant rainfall. However, two other features not officially documented must have been considered strong advantages. First were the facilities at the Hemlock Ranger Station, and second, was the ranger stationed there, Elias Wigal.

The work to clear five acres for the nursery would be back-breaking. The site contained huge stumps and snags that had withstood fires and logging. Wigal’s journal entry for November 26, 1909 reads: “Snowing; left home; went to Carson to get men to look over ground and take contract to grub five acres on hemlock Station that Mr. Kummel wanted to use for nursery...”⁷ Over the winter, Wigal hired three men and began breaking new ground for the nursery.

Wigal and his crew blasted the big stumps with dynamite. They hacked out large blocks from what remained, split and piled



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Old growth Douglas fir forest at Wind River (1944).



Plowing nursery field, Wind River Nursery (1910).

them around the massive roots for burning. The process left massive holes that had to be filled. They plowed and replowed the land to dislodge smaller roots, and finally leveled the land with shovels and a harrow, and readied it for planting.

From the beginning, much of the nursery work was experimental. As Kummel directed, Douglas fir and western white pine were the primary species grown that first year. But Kummel also planted eastern hardwoods, such as shagbark hickory (a valuable wood for building wheels) and black walnut (much desired for furniture making), and several European conifers including Scotch pine, Norway spruce, and European larch.

NURSERY PRACTICES

When the Wind River Nursery began, its primary purpose was to provide seedlings to replant the massive burns that scarred the region. Although a crop of Douglas fir usually reseeded naturally following fires, the young trees and their seed sources were often destroyed by subsequent fires, making regeneration even more difficult the second time. In 1908, some of the larger burns, such as the Yacolt and the Bull Run fires, were not reestablishing forests. Early attempts at direct seeding left many well-fed mice, but few seedlings. Some of the most creative solutions to deterring rodents—coating seed with red lead, tar, or mink urine—led to even more loss of seed. The direction to hand plant the burns with nursery-raised seedlings was monumental, and

launched research that would last until 1997, when the nursery was finally closed.

Much of the nursery work was trial and error. The crew built contraptions to drill a million seeds into seedbeds. They struggled against the whims of the climate, to keep seeds from desiccating in summer, and drowning in winter, and protected from the cold that tumbled down into the valley on clear nights. Production came with a host of new practical questions, such as how to control germination, how to thin, how to irrigate, and how to prevent damping off.

To understand the scale of the planting that was needed, the Wind River Nursery would produce over a million seedlings in its first year alone. A million seedlings would cover two to three thousand acres of bare, burned ground. The Yacolt fire alone had burned over 238,000 acres of forest. The need for immediate results meant that Kummel and his crew had to learn quickly what was required to germinate seeds and protect the young seedlings from rot, rodents, and disease. They invented the tools and techniques they needed to extract and store seed, to lift and transport delicate seedlings, and to plant in the steep, unforgiving moonscapes of the burns. Their early experiments refined techniques for successful planting that are the cornerstone of much of the reforestation that occurs in northwest forests today.

The nursery's practical questions were focused on growing seeds into seedlings. But Munger's interests went further. The

nursery created a need for better information about growing trees, the best trees, for the Pacific Northwest.

Research in planting methods led to rapid improvement, and allowed two important studies at Wind River. One was the planting of the arboretum, the other was the Douglas fir Heredity Study.

WIND RIVER ARBORETUM

At the turn of the century, the search was on all over the world for fast-growing trees. Larches from northern Europe, pines from the Himalayas, and chestnuts from the Appalachians were turning up in unlikely places around the world, where native forests had been diminished and wood-hungry populations were looking for quick alternatives. Douglas fir had caught the eye of early travelers to the Pacific Northwest, and experimental plantings of that species were appearing from Europe to Australia.

In the Pacific Northwest, foresters trained in the hardwood forests of the eastern United States wondered how their familiar hickories and oaks would fare in the west. They also wondered about the fast-growing trees from other parts of the world. In the nursery, Kummel included small sowings of pignut, mulberry, black locust, and red oak, among others, in order to test the viability of exotic seed.

Munger's questions were bigger. He wanted to test the suitability of exotic trees to the specific climate and conditions of this part of the Pacific Northwest. He established an arboretum with experimental planting of 10 trees each of 16 exotic species from the nursery's first trials. When Munger designed an experiment, he had a very long timeframe in mind. He knew that when



U.S. FOREST SERVICE PHOTO

Wind River arboretum established in 1912 to test suitability of exotic tree species in the Pacific Northwest.



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Covered seed beds, Wind River Nursery (1910).

he planted those 160 seedlings the experiment would outlive him. Trees have a way of doing that.

Relatively few of the hardwoods survived the first year, and fewer still made it through their first decade. Increasingly, research at the arboretum focused on testing conifers from around the world, and more were planted. Although the exotic hardwoods had failed early, some of the northern European conifers showed great promise. Larches put on rapid growth for the first 25 years, outperforming the native Douglas fir. Norway spruce and Scotch pine were also strong producers for the first quarter century. Had the experiment stopped there, our forests might look very different than they do today.

But the experiment continued. Records were kept on each individual tree for another half century. In the slow march of time, larches slowed their growth rate, and proved to be brittle in heavy snowstorms. Native sapsuckers developed a special preference for Scotch pine and Norway spruce. Pines that had sprinted at the beginning were eventually checked by blister rust, drought, or frost. Even the native species from farther inland gradually lost vigor to needle diseases and damage from heavy, wet snow. After more than 75 years' of record, Wind River scientists concluded that the search for superior trees had been a one-way street. Douglas fir has been successfully transplanted around the world, but in the Douglas fir region, there is no substitute for the native.

This outcome was not suspected when the experiments began in 1912, and it did not become obvious in all cases for 60 or 70 years. After reviewing 75 years of record, Wind River scientists concluded, "one grows to appreciate the genetic precision that is showing through the statistical chatter of the measurement data. Even though most of these data were not anticipated when Munger [and others] carried on their work, they are now important enough that all practicing foresters and biologists know of them as part of their educational background"⁸

FOREST GENETICS

The suitability of trees to sites was the problem posed by another study that grew from the needs and the advances of the nursery, the Douglas fir Heredity Study. The nursery required a huge volume of seeds. But, from what kind of trees and from what kind of sites should seeds be collected? Wind River scientists needed information about how seeds grow, what seeds grow best at specific sites, and ultimately, which seeds make the best trees in the long run. Such questions would take a lifetime to answer, but Munger understood their importance. In 1912, he launched what he assumed would be a 40-year study of Douglas fir seed from known sources throughout the region.

The study is remarkable for many reasons, not least for the details of heredity and genetics it demonstrates, general principles that had been described only a decade earlier when Gregor Mendel's experiments had been rediscovered by European scientists. Munger's study was meticulous.

In the fall of 1912, Munger sent out a crew to collect cones from thirteen locations in the western Cascades of Washington and Oregon. He had selected sites that would provide a range of altitudes from 100 to 3,850 feet, and instructed his crew to select both young and old trees, large and small, with and without infection, from both good and poor sites, from both dense and open stands within each location. That way, Munger obtained seeds from known

individual trees with observable, comparable traits. Munger's crew selected several individual trees to represent specific combinations of traits, sketched each tree in each group to record its form and placement of cones, and recorded the traits represented in each collection of cones. To eliminate "the personal element and the chance of bias toward this or that conclusion,"⁹ the recorded traits were coded and each lot of cones assigned a number.

Upon return to the nursery, the cones were subjected to a battery of tests to determine differences in seed quality. The tests bore fruit immediately. In 1915, Wind River scientists published preliminary findings, including observations that large cones from open growing trees, young or old, large or small, bear larger, more viable seed. And seedlings from different altitudes display different times of bud opening.

The experiment was just beginning. Thousands of seedlings with known heritage were ready to plant. Munger directed the crew to locate six planting locations throughout District Six, including Wind River, and to plant representatives of each family in each location to compare results over time. Each tree in each plantation was marked with the code of its individual inheritance.

It was innovative that Munger had designed his study with six replications and two seasons of planting. The design was specifically aimed at in-plot variation, and so lacks randomness necessary for most modern statistical analyses. However, the long-term value of these plots cannot be overstated.

Wind River scientists achieved 90 percent survival rate of first year plantings in the heredity study. Within a few years differences among the races became apparent. Saplings from the Darrington source of seed, for example, outpaced most of the other trials in all locations. Racial differences, long assumed in such a wide-ranging species as Douglas fir, now could be demonstrated.

The notion of superior seed sources for general use dominated nursery practices for decades to come. But the experiment was not over. By the 1940s, different patterns began to emerge in the experimental plantations. High elevation races survived the rigors of high elevation sites better than those from lower elevations. The coastal race eventually died in every plantation except the coastal site. Cascade seed did best at Cascade sites. The notion of specific seed source for specific use emerged just as large-scale tree plantations began to appear in the Northwest following World War II.

The heredity study demonstrated genetic differences in Douglas fir races, and provided a mechanism for improving the genetic stock of trees for planting in particular locations. This has proven to be much more effective than the old system of grafting from selected trees that was the practice in Europe and the eastern United States.

DOUGLAS FIR NATURAL REVEGETATION

Other early experiments at Wind River also have had important consequences. Because the task of reforesting the burns was so vast, both planting and natural regeneration of forests had to be undertaken. Wind River scientists wanted to know what limited the natural reforestation of harvested and burned land, and what forest practices could be developed to better ensure a second crop of trees after harvest.

In 1913, J. V. Hofmann was hired to direct forest experiments at Wind River, and he took up the questions of natural revegetation.

Hofmann established a transect of small plots across the Wind River Valley where he recorded establishment and growth of every natural seedling within the transect plots. Because the Wind River valley had been logged from a railroad, cutover land extended across the valley and up each slope to the limit of skyline yarding. The transect of plots across the valley allowed researchers to compare seedling success on northeast and southwest facing slopes at various distances from the edge of standing timber. Establishment and growth of every natural seedling was measured 5, 10, 15 and 22 years after logging. The first 22 years of observations showed that the northeast slope was fully replanted within a quarter mile from the forest edge, whereas the corresponding southwest slope had sparse, irregular restocking within only a couple of hundred feet of the forest edge. This was one of a number of regional studies that concluded that harvested openings should be between 200 feet and a half-mile, depending on the suitability of the site.¹⁰

Once again, time would reverse the earlier conclusion. Generations of Wind River scientists continued to observe gradual changes along the transect. Over time, growth on the heavily stocked northeast slope slowed and included many openings from snow damage. The southwest facing slope has maintained a density of about 100 trees per acre, and is now of commercial size and more valuable per acre than the overstocked northeast slope.

DOUGLAS FIR MANAGEMENT

Many of the early studies at Wind River were designed to help generate the fastest crop from a second growth stand.

In 1919, J. V. Hofmann instituted one of the first precommercial thinning studies. He established three plots in a dense stand of Douglas fir that had established after logging nine years earlier. He thinned two plots to an 8 by 8 foot spacing, one at exact spacing, the other to favor the dominant trees, and he left a third plot unthinned as a control.

For the first thirty years, the plot thinned for dominance had the most growth. By mid-century, however, the results took a surprising turn when the exact spacing plot began to show better growth. In this plot, a number of poorer trees had been retained because they grew on the exact spacing. Eventually, these poorer trees died out, leaving wider spacing for the remaining trees. This was the first study to document a correlation between early thinning and increased stem growth in Douglas fir, and showed that thinning to exact spacing was a more reliable technique. This study, along with a spacing study initiated a few years later, was used to promote the widespread practice of commercial thinning in the region.

Experiments such as these within the natural forest prompted questions of how to manage young, planted stands. As early as 1903, E. T. Allen had seen that the future of forestry research in the Northwest would be in the management of second growth. Much of the early work at Wind River was meant to urge private timber owners to retain and replant their land after cutting, to grow forests as a crop, not to mine them and move on.

RETROSPECTIVE

Forest research that began at Wind River in 1908 continued to evolve throughout the twentieth century. Through that time,



U.S. FOREST SERVICE PHOTO

Wind River Experimental Station 1914. Wind River arboretum is in lower right, nursery fields in center, Yacolt Burn to the right and unburned forest to the left in the background.

forestry research has been designed to help make forests more predictable. Yet, long-term research at Wind River has often shown that outcomes are not predictable and results can change over time. It takes a lifetime to grow a tree, and longer to make a forest. Throughout that time, the tree and the forest change. Both forests and research can be rearranged by events that cannot be predicted. It is only over very long periods of time that we can begin to perceive the pulse of change in the forest and the general trajectory of research trials and errors. And only by having an experimental forest in which to conduct long-term studies have scientists at Wind River been able to ask questions that take a lifetime to answer. □

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