MODERN GROWTH TRENDS OF EARTH'S FORESTS

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How well have earth's forests been faring during the modern era? This question was asked a few years ago by five researchers (Lapenis *et al*., 2005[1]), who sought the answer by analyzing trends in forest biomass in all 28 ecoregions covering the Russian territory, based on data collected from 1953 to 2002 within 3196 sample plots comprised of about 50,000 entries, which database, in their words, "contains all available archived and published data." And in doing so, they discovered that over the period 1961-1998, "aboveground wood, roots, and green parts increased by 4%, 21%, and 33%, respectively," such that "the total carbon density of the living biomass stock of the Russian forests increased by ~9% from 4.08 to 4.44 kg C m^{-2}." In addition, they report there was an "increase in the area of the Russian forests (from 695.5 x 10^{10} m^2 in 1961 to 774.2 x 10^{10} m^2 in 1998)," which equates to an increase of about 11%.

As for the significance of these findings, Lapenis *et al*. suggested that where trees are not cut down but are allowed to grow, and where new trees are either planted or allowed to naturally regenerate, what some have called the *greening of planet earth* continues, in spite of all of the doom-and-gloom prognostications of the planet's radical environmentalists. In addition, the team of US, Austrian and Russian scientists reported that "within the range of 50-65° of latitude (the range of 90% of Russian and Scandinavian forests), the relationship between [forest] biomass density and the area-averaged NDVI [Normalized Difference Vegetation Index] is very close to a linear function, with a slope of ~1," citing the work of Myneni *et al*. (2001). Therefore, as they continued, "changes in the carbon density of live biomass in Russian forests occur at about the same rate as the increase in the satellite-based estimate in the seasonally accumulated NDVI," which observation strengthens the findings of all other satellite-based NDVI studies.

> *Globally, based on both satellite and ground-based data, climatic changes seemed to have a generally positive impact on forest productivity.*

One year later, Boisvenue and Running (2006)[2] - in an effort "to review documented evidence of the impacts of climate change trends on forest productivity since the middle of the 20th century" - conducted an analysis that cited 186 scientific journal articles. And as a result of this effort, they determined that "globally, based on both satellite and ground-based data, climatic changes seemed to have a generally positive impact on forest productivity when water was not limiting," which was the situation in most cases, because they reported that "less than 7% of forests are in strongly water-limited systems." So of the 49 scientific papers they reviewed that contained relevant

[1] http://www.co2science.org/articles/V9/N15/B2.php.
[2] http://www.co2science.org/articles/V9/N37/B2.php.

data, they found that "37 showed a positive growth trend, five a negative trend, three reported both a positive and a negative trend for different time periods, one reported a positive and no trend for different geographic areas, and two reported no trend."

Therefore, and in spite of what climate alarmists have routinely described as *unprecedented increases* in the "twin evils" of the radical environmentalist movement, i.e., atmospheric CO_2 concentration and air temperature (a situation that some of them have described as being a greater threat to the world than either global terrorism or nuclear warfare), there has *in fact* been what Boisvenue and Running called a significant "greening of the biosphere."

Working concurrently, Banfai and Bowman (2006)[3] reported that "a number of processes are thought to be threatening the ecological integrity of monsoon rainforests in Northern Australia," including "the combined effects of an increase in late dry season fires, feral animal damage and weed invasion." In addition, climate alarmists everywhere contend that rainforests the world over are in danger of succumbing to the supposedly deleterious effects of the continuation of what they call the *unprecedented global warming of the late 20th century*, which they claim was driven by concomitant *unprecedented increases in the air's CO_2 content*, which together comprise the "twin evils" of what some call the radical environmentalist movement.

Against this backdrop of despair, the two Australian researchers from Charles Darwin University's School for Environmental Research decided to test this *retracting rainforest claim* with a comprehensive repeat aerial photography study of the Northern Territory's Kakadu National Park, where monsoon rainforest exists as an archipelago of hundreds of small patches scattered within a larger eucalypt savanna matrix. In this undertaking, in the words of the two scientists, "changes to the boundaries of 50 monsoon rainforest patches were assessed using temporal sequences of digitized aerial photography [taken in 1964, 1984, 1991 and 2004], with a view to understanding the relative importance of the drivers of change." And what did they find?

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Banfai and Bowman reported that "rainforest patches increased in size between 1964 and 2004 by an average of 28.8%," and after lengthy analyses of several phenomena that might possibly have been responsible for the range increases, they concluded that "the expansion is likely to have been primarily driven by increases in variables such as rainfall and atmospheric CO_2." In this regard, for example, they noted that "the average [area] change for dry rainforests from 1964 to 2004 was an increase of 42.1%, whereas for wet

[3] http://www.co2science.org/articles/V9/N49/EDIT.php.

rainforests [the increase] was one-third of this at 13.1%." In addition, in the case of dry rainforests, they reported there was "an almost linear increase in rainforest area over the study period," in harmony with the concomitant upward trends of both atmospheric CO_2 and rainfall.

In further support of the validity of their findings, and "contrary to the view that monsoon rainforests are contracting," which is one of the chief pessimistic mantras of the world's climate alarmists, the two researchers went on to inform us that other repeat aerial photography studies conducted in Northern Australia *also* revealed rainforest "expansion at the expense of more open vegetation." These studies included those of monsoon rainforests in Litchfield National Park near Darwin (Bowman *et al*., 2001) - where forest patches nearly *doubled* in size between 1941 and 1994 - and in the Gulf of Carpentaria (Bowman *et al*., 2006). In addition, they wrote that "these changes parallel the observed expansion of tropical rainforest on the east coast of Australia (Harrington and Sanderson, 1994; Russell-Smith *et al*., 2004)."

Added to these Australian findings, Lewis (2006)[4] reported that most other tropical forests around the world also experienced significant increases in productivity over the last several decades; and he too concluded that the ongoing rise in the atmosphere's CO_2 concentration was likely the key factor responsible for their increased robustness. Hence, it would appear that wherever one looks around this amazing planet of ours, *the greening of the earth continues*.

Also publishing a pertinent paper in the same year were Midgley and Seydack (2006)[5], who noted that "present and predicted future impacts of global environmental change on intact forests are both alarming and contentious," and that "some local models have predicted the demise of South Africa's only significant extent of indigenous forest, the Knysna forest, by 2050," as earlier reported by Midgley *et al*. (2001). Thus, in a study designed to see how bad things had become by the end of the 20th century, the two researchers measured and analyzed the growth of all trees greater than 10 cm in diameter at breast height in 108 0.04-ha plots distributed throughout a nature reserve within the Knysna forest over the period 1991-2001.

Following a protocol that provided what they said was "probably an under-estimate," Midgley and Seydack determined that "net basal area and aboveground biomass increased over the 10-year study period by 2% and there was a 1.2% increase in stem numbers, distributed almost equally amongst all size-classes." And because of the particular nature of the Knysna forest, they noted that "over relatively short periods such as our decade, the aboveground biomass of this forest is more sensitive to negative/stressful conditions that would increase mortality, than to factors which may increase growth." *Despite this*, however, and as reported above, they found that "biomass increased." And because "precipitation over the period 1991-2001 was some 5% less than the long-term average," they concluded that the observed increase in growth rate "may have been the effect of the increase in global atmospheric carbon dioxide."

Contemporaneously, Kharuk *et al*. (2006)[6] - in an area of approximately 36,000 ha that extends from 72°02'N to 72°40'N and from 101°15'E to 102°06'E that includes the Ary-Mas forest (the northernmost forest on the planet) plus larch forests on southeastern slopes descending to the

[4] http://www.co2science.org/articles/V9/N30/EDIT.php.
[5] http://www.co2science.org/articles/V10/N4/B1.php.
[6] http://www.co2science.org/articles/V10/N4/B2.php.

Khatanga River - analyzed remote-sensing images made by Landsat satellites in 1973 and 2000. And in doing so, they found that "the most significant changes were observed in the class of normal larch stands (canopy density > 0.3): their area increased by 66%," while "the areas of open and sparse forests (0.1 < canopy density < 0.3, and canopy density < 0.1) increased by 16 and 8%, respectively, whereas the background area became 19% smaller." In addition, they reported that the rates of expansion of larch onto tundra "for sparse, open, and normal stands were estimated at 3, 9, and 11 m per year, respectively." However, they remarked that "since sparse stands are at the forefront of advancement to the tundra, the rate for this class (approximately 3 m per year) should be regarded as the rate of larch expansion in general," and that "the above rates reflect not only the expansion of trees to the tundra, but also an increase in the density of sparse and open stands."

As for the *cause* of these changes, Kharuk *et al*. felt that the late 20th-century increases in the densities of larch stands in the Ary Mas forest and the expansion of larch onto what previously was tundra were "induced by climatic trends," and that the continuation of this process "will result in the expansion of larch to the Arctic coast," which they described as a "phenomenon that took place in the Holocene." Hence, it would appear that whatever was driving the forest changes they chronicled (they mention temperature, to which could also be added the aerial-fertilization and transpiration-reducing effects of atmospheric CO_2 enrichment) is merely enabling forests such as the Ary Mas to *reclaim* that which had previously been *lost* by the progressive cooling of the planet after the Holocene Climatic Optimum, which cooling culminated in the record interglacial cold of the Little Ice Age, from which the earth and its biosphere are currently making an impressive comeback.

Dropping back a few years in time, the thought that the planting of trees could sequester a significant portion of the carbon emitted to the air via the burning of fossil fuels was labeled by Pearce (1999)[7] "a dangerous delusion." Citing as the basis for his statement a report of the Intergovernmental Panel on Climate Change (IPCC), wherein it was claimed that scientists said "planned new forests, called 'carbon sinks,' will swiftly become saturated with carbon and begin returning most of their carbon to the atmosphere," he went on to quote Peter Cox of the British Meteorological Office's Hadley Centre as stating "this is not something that may or may not happen," but something that is "more or less inevitable." Pearce then added that "the suggestion that planting trees means less atmospheric CO_2 ignores simple logic," and in derisive denigration of the concept of *biospheric carbon sequestration*, he mockingly asked: "How did researchers get it so wrong?"

In describing the evidence for his out-of-hand dismissal of the trees-as-carbon-sinks concept, Pearce cited South Africa's Bob Scholes, who he described as "a leading light in the International Geosphere-Biosphere Programme's Global Carbon Project," stating that because (1) increasing CO_2 concentrations have an ever-smaller effect on plant growth as they rise higher and higher, and because (2) plant respiration rates increase with rising temperatures (which Pearce assumed to be a consequence of increases in the air's CO_2 content), CO_2 fertilization rates "will flatten out while respiration rates soar," so that by 2050 "forests will

[7] http://www.co2science.org/articles/V10/N18/EDIT.php.

have released much of what they have absorbed." But is this truly the iron-clad case Pearce made it out to be, and which many climate alarmists quickly promulgated as fact?

In a subsequent review of this very question, an international team of distinguished forest researchers (Hyvonen *et al*., 2007) - which was comprised of 22 scientists from nine different countries (Belgium, Denmark, France, Finland, Iceland, Italy, Sweden, the United Kingdom and the United States) - came to some interesting conclusions. Noting that certain forest ecosystem models did indeed suggest that forest carbon sinks "may gradually diminish in the medium term" because "photosynthesis will increase less as the CO_2 concentration continues to rise, whereas respiration is expected to continue to increase with the rise in temperature," they gave as their considered expert opinion that "simplistic models forecasting that stand photosynthesis will be overtaken by stand respiration, purely on the basis of short-term responses of photosynthesis to CO_2 and respiration to temperature, should be treated with great caution," adding that "because of current limitations on our understanding with respect to acclimation of the physiological processes, the climatic constraints, and feedbacks among these processes - particularly those acting at the biome scale - projections of C-sink strengths beyond a few decades [which they acknowledged were likely to remain positive] are highly uncertain."

The *key question*, in their estimation, was "whether the mature forests that are C sinks today will continue to be sinks as the climate changes." One way of addressing this question is to look at what has happened to forests that were already mature several decades ago, and that have experienced the concurrent increases in air temperature and atmospheric CO_2 concentration of the past half-century or more, over which period climate alarmists claim that both factors rose at unprecedented rates and to unprecedented heights.

Real-world observations suggested that today's forest carbon sinks may well become even *stronger* carbon sinks as air temperatures and atmospheric CO_2 concentrations continue to rise.

Good examples are old-growth forests, such as those of Amazonia, which for most of the past century were believed to be close to dynamic equilibrium. In one of the first studies to dispel this long-held notion, Phillips and Gentry (1994) analyzed the turnover rates - which are close correlates of net productivity (Weaver and Murphy, 1990) - of forty tropical forests from all around the world. In doing so, they found that the growth rates of these forests had been *rising ever higher* since at least 1960, and that they had experienced an apparent *acceleration* in growth rate sometime after 1980. A few years after that, Phillips *et al*. (1998) analyzed forest growth rate data for the period 1958 to 1996 for several hundred plots of mature tropical trees scattered throughout the world, finding that tropical forest biomass, as a whole, increased substantially over the period of record. In fact, the increase in the Neotropics was equivalent to approximately 40% of the missing terrestrial carbon sink of the entire globe. And a few years later still, Laurance *et al*. (2004a, 2004b) reported *accelerated* growth in the 1990s relative to the 1980s for the large majority (87%) of tree genera in 18 one-hectare plots spanning an area of about 300 km^2 in central Amazonia. And it thus became clear that there was strong reason to *reject* the doom-and-gloom scenarios of forest carbon sinks turning into forest carbon sources in the decades ahead. If anything, real-world observations suggested that today's forest carbon sinks may well become even *stronger* carbon sinks as air temperatures and atmospheric CO_2 concentrations continue to rise.

Moving on, Jandl *et al*. (2007)[8] evaluated the growth rates of two Norway spruce (Picea abies) stands in the Bohemian Massif of Northern Austria over the prior four decades by analyzing the stem characteristics (height and diameter) of several trees they felled at two different sites, and by comparing their results with data obtained from control plots of other experiments that had been conducted there over an even longer period of time. This work suggested, in the words of the three researchers, that "forest productivity is currently about two yield classes higher than it is in the regionally valid yield tables," which were derived from data collected at the end of the 19th century, and that "the height and diameter of dominant stems exceed expectations." And, therefore, Jandl *et al*. concluded that "the sites are in a steady process of aggradation and that site productivity is rising."

In spite of all of the negative phenomena attributed to increasing fossil fuel combustion over the past several decades, earth's trees and their roots are generally doing better than ever, thanks, it would appear, to increasing atmospheric CO_2 concentrations and nitrogen depositions that come from the very same source.

As for the *cause* of this phenomenon, the Austrian researchers contended that climate was unlikely to be the main driver of the elevated growth rates of the forest stands they studied, because neither air temperature nor precipitation were strong predictors of the increment rates at their experimental sites. In addition, they stated that the "ongoing improvement" was "not the mere consequence of a nitrogen-enriching effect." Hence, they were left with what they called "the enriching effect of increasing CO_2 concentrations" and possible changes in management practices (such as the abandonment of forest litter raking) as the only viable alternative explanations for the steady historical increase in Norway spruce productivity at the sites they studied.

Publishing concurrently were Brunner and Godbold (2007)[9], who wrote that among terrestrial ecosystems, "forests are considered as the most important terrestrial reservoirs of biological

8 http://www.co2science.org/articles/V10/N37/B2.php.

9 http://www.co2science.org/articles/V10/N39/B1.php.

diversity, containing as much as two thirds of all plant and animal species," while noting that they cover four billion hectares or 30% of the earth's land surface, and that 20-40% of forest biomass is made up of roots. Hence, in a *Special Feature Invited Review*, they briefly discussed the status of our knowledge of trees and their roots in our globally-changing environment.

Starting with the *bad*, Brunner and Godbold reported that soils of forest ecosystems "have been affected by high atmospheric inputs of acidifying pollutants (S and N compounds) originating from the combustion of fossil fuels in power generation, industry, and transportation," and they remarked that "these inputs have led to an acceleration of soil acidification, loss of basic cations, and release of Al ions into soil solution," noting that "besides its effect on soil acidification, excessive inputs of atmospheric N result in nitrate leaching and relative shortage of other nutritional elements for plants." *Nevertheless*, they reported "a trend of increasing aboveground growth of trees in European forests over a long term can be observed (Spiecker, 1999)," and they added that "these positive trends are attributed mainly to the increased contents of CO_2 in the atmosphere and to enhanced N depositions," noting that "both elevated CO_2 concentrations and N depositions lead to increased plant biomass, including that of roots." More specifically, they indicated that recent experiments with elevated CO_2 concentrations had "shown increases of the forest net primary productivity by about 23% (Norby *et al*., 2005), and, in the case of poplars, an increase of the standing root biomass between 47%-76% (Lukac *et al*., 2003) and 113% (King *et al*., 2002)." In addition, they stated that "the turnover of fine roots is also positively influenced by elevated CO_2 concentrations and can be increased in poplars by 25%-45% (Lukac *et al*., 2003)."

Therefore, and in spite of all of the negative phenomena attributed to increasing fossil fuel combustion over the past several decades, earth's trees and their roots are generally doing better than ever, thanks, it would appear, to increasing atmospheric CO_2 concentrations and nitrogen depositions that come from the very same source.

Shortly thereafter, Kellomaki *et al*. (2008)[10] investigated the impact of projected climate change from then to somewhere in the range of AD 2050-2099 on the boreal forests of Finland, over 90% of which were under regular management, including clear cuts with regeneration by planting and regular thinnings, where management actions were intended to direct the successional process "to produce such ecosystem structures that facilitate the production of the targeted services (e.g. timber production)," which they represented in terms of *potential cutting drains* that they defined as "maximum sustainable removals under a given management." And in so doing, they determined that in response to the climate changes projected by the Arctic Climate Impact Assessment of 2005 (ACIA, 2005) - i.e., a temperature increase of 1-2°C in summer and 2-3°C in winter over the next 50 years (Carter *et al*., 2005) - potential cutting drains were projected to rise by approximately 56% in southern Finland, 168% in northern Finland, and 82% over the country as a whole. So instead of some type of *disaster*, the results of Kellomaki *et al*.'s analysis portended much-better-than-ever times for the country's forests, the people who benefit from their wood products, and the wildlife that benefits from the food and habitat they provide.

[10] http://www.co2science.org/articles/V11/N34/B3.php.

Moving forward another year, Koutavas (2008)[11] analyzed ring-width variations obtained from cores of eight Greek fir (*Abies cephalonica*) trees growing at elevations between 1300 and 1600 meters on the southern slopes of Mt. Ainos on the island of Cephalonia in the Ionian Sea west of mainland Greece, finding that there was a "strong acceleration of growth over the second half of the 20th century," about the only rational explanation for which was " a fertilization effect due to rising CO_2 in the global atmosphere." And with the passage of another year, Peng *et al*. (2009)[12] likewise concluded that - based on a model for which "validation results show that the simulated tree total volume, NPP, total biomass and soil carbon are consistent with observed data across the Northeast of China" - "future climate change and increasing atmospheric CO_2 would have a significant impact on the forest ecosystems of Northeastern China," and that that impact would be *beneficial*.

Contemporaneously, Pan *et al*. (2009)[13] examined "how changes in atmospheric composition (CO_2, O_3 and N deposition), climate and land-use affected carbon dynamics and sequestration in Mid-Atlantic temperate forests during the 20th century," by modifying and applying "a well-established process-based ecosystem model with a strong foundation of ecosystem knowledge from experimental studies," which they validated "using the U.S. Forest Inventory and Analysis (FIA) data." This work indicated that "the change in atmospheric composition, particularly elevated CO_2, will gradually account for more of the carbon sink of temperate forests in the Mid-Atlantic region," and they thus opined that "such a significant 'fertilization effect' on the forest carbon sequestration could eventually result in a 'greener world'."

And in another concurrent study, Johnson and Abrams (2009)[14] - using data obtained from the website of the International Tree-Ring Data Bank, as well as from cores that had been collected previously and stored in their laboratory at The Pennsylvania State University (USA) - explored growth rate (basal area increment, BAI) relationships across age classes (from young to old) for eight tree species commonly found throughout the eastern United States, namely, bigtooth aspen (*Populus grandidentata* Michx.), blackgum (*Nyssa sylvatica* Marsh.), black oak (*Quercus velutina* Lam.), chestnut oak (*Quercus Montana* L.), hemlock (*Tsuga canadensis* L. Carr.), pitch pine (*Pinus rigida* Mill.), red oak (*Quercus rubra*) and white oak (*Quercus alba* L.). This work revealed that "even the oldest trees of several species had slow but increasing BAI values, which continued throughout the life of most trees," and that "over the last 50-100 years, younger trees within a species grew faster than did the older trees when they were of the same respective age." And two years later, a study conducted by Knapp and Soule (2011)[15] in ponderosa pine forests of the USA's northern Rocky Mountains revealed that those forests also had increasing growth rates, even into their third, fourth, and fifth *centuries* of life, and that their intrinsic water use efficiencies during 1955-2004 were 11% greater than during 1905-1954.

[11] http://www.co2science.org/articles/V11/N49/EDIT.php.
[12] http://www.co2science.org/articles/V12/N33/B2.php.
[13] http://www.co2science.org/articles/V13/N37/B1.php.
[14] http://www.co2science.org/articles/V14/N8/C3.php.
[15] http://www.co2science.org/articles/V14/N8/EDIT.php.

Also in 2011, and noting that "responses to recent climate change start to become visible if observation periods become long enough," Pilegaard *et al.*[16] presented the results of continuous CO_2 flux measurements that they had made above a mature Danish beech stand in the "Lille Bogeskov" forest located near Soro on the island of Zealand (55°29'13"N, 11°38'45"E) over the period 1996-2009. This work revealed "significant linear trends of increasing gross ecosystem exchange (GEE: 29 g C/m^2/year) and increasing net ecosystem exchange (NEE: 23 g C/m^2/year), while the positive trend for ecosystem respiration (RE: 5 g C/m^2/year) was not significant." They also stated that "the length of the carbon uptake period increased by 1.9 day/year, whereas there was a non-significant increase of 0.3 day/year in the leafed period," which means, in their words, that "the leaves stay active longer." Nevertheless, they indicated that "the increase in the carbon uptake period explained only part of the increasing NEE (9 gC/m^2/year)." And noting that "the maximum rate of photosynthetic assimilation increased by 15% during the 14-year period," they speculated that the increase in canopy carbon uptake capacity "could be due to a combination of [the] increase in atmospheric CO_2, higher summer precipitation, and increased availability of nitrogen."

> *The overwhelmingly positive results obtained by Pilegaard et al. are most reassuring, especially in light of the fact that the world's climate alarmists claim that the warming experienced over the past quarter-century is the greatest threat ever to be faced by the planet.*

Within the context of today's illogical obsession with the ongoing rise in the atmosphere's CO_2 concentration, together with the many environmental catastrophes it has been predicted to produce as a result of CO_2-induced global warming, the overwhelmingly positive results that were obtained by Pilegaard *et al*. are most reassuring, especially in light of the fact that the world's climate alarmists claim that the warming experienced over the past quarter-century or so was *unprecedented* over the last one to two *millennia*, and their claim that this phenomenon is *the greatest threat ever to be faced by the planet*. Apparently, the beech trees that the Danish research team studied didn't understand the seriousness of the situation.

In a third study from 2011, Bellassen *et al.*[17] used ORCHIDEE-FM - a process-based vegetation model that differs from earlier versions of ORCHIDEE by "its explicit representation of stand growth and idealized forest management" - to "simulate changes in the net ecosystem productivity (NEP) of forests with and without changes in climate, CO_2 and age structure." This work revealed, first of all, that the model they used "simulates carbon stocks and volume increment that are comparable ... with inventory-derived estimates at country level for 20 European countries," providing "an upwards trend of forest NEP of 1 ± 0.5 g C/m^2/year between

[16] http://www.co2science.org/articles/V14/N29/B1.php.
[17] http://www.co2science.org/articles/V15/N5/B2.php.

1950 and 2000 across the EU 25," ending with "a mean European forest NEP of 175 ± 52 g C/m²/year in the 1990s." And they found that "61% of the change in NEP [over the last half of the 20th century] was attributed to changes in CO_2, 26% to changes in climate, and 13% to changes in forest age structure."

Also publishing in 2011 were Girard *et al.*[18], who - working within lichen woodlands of the forest zone of Eastern Canada between longitudes 70 and 72°W - acquired data that enabled them to calculate radial, height and volume growth rates at every 15 minutes of latitude from 47°30'N to 52°41'N for black spruce (*Picea mariana*) trees ranging in age from 34 to 188 years. Dividing the trees into a *young group* and an *old group*, with ages ranging between 34 and 93 years for the young group and between 109 and 188 years for the old group, the three Canadian researchers determined that same-age "radial, height and volume growth rates of trees in stands younger than 100 years were 46%, 51% and 38%, respectively, greater than those of trees in stands older than 100 years." And for the two youngest stands with mean ages of 34 and 43 years, they found that "black spruce showed radial, height and volume growth rates of 66%, 74% and 71%, respectively, greater than those in woodlands older than 100 years." And in further discussing their findings, Girared *et al*. cited several other studies that also demonstrated that "tree productivity in northern forests of eastern North America has increased significantly since the middle of the 19th century," namely, those of Payette *et al*. (1985), D'Arrigo *et al*. (1987), D'Arrigo *et al*. (1992) and Lavoie and Payette (1994). In addition, they also noted that "similar trends have been observed in the American West," citing Graumlich *et al*. (1989) and Peterson *et al*. (1990).

The change in shrubs and small trees they observed was consistent with anticipated changes due to climate change and reduced herbivory, which change in climate, in their words, "could be interpreted as an ongoing natural re-establishment of plants at higher altitudes due to a natural increase in the temperature since the 'Little Ice Age.'

Simultaneously, while working on an east-facing slope of the Slattatjakka/Njulla mountains (68°21'N, 18°49'W) in the Abisko Valley about 200 km north of the Arctic Circle, Rundqvist *et al.* (2011)[19] documented - in September of 2009 and August of 2010 - the presence of several shrub and tree species in three 50 x 50-m plots that had been similarly documented in 1976 and 1977, two of which were located at the tree-line (characterized by sparse occurrences of solitary trees or small groups of trees), while the other one was located just below the forest-line, parts of which consisted of a denser mountain birch forest. Under these conditions, the

[18] http://www.co2science.org/articles/V15/N15/B1.php.
[19] http://www.co2science.org/articles/V15/N19/B1.php.

seven scientists documented "rapid and substantial increases in the abundance of prominent tree and shrub species near tree-line and forest-line in sub-Arctic Sweden," and they "recorded an invasion by a thermophilic tree species not present in the plots 34 years ago."

In discussing their findings, Rundqvist *et al*. described how they meshed well with those of many other researchers, noting that "there is an indication that the shrub layer near the tree-line has expanded, since the 1930s, in the Abisko area (Enquist *et al*., 1933; Sandberg, 1963)," while "data from Canada, Fennoscandia, Alaska and Russia reveal that there is a Pan-Arctic expansion of shrubs and trees in progress (e.g. Kullman, 2002; Tommervik *et al*., 2004; ACIA, 2005; Tape *et al*., 2006; Karlsson *et al*., 2007; Olofsson *et al*., 2009; Hallinger *et al*., 2010; Hendenas *et al*., 2011)." And they stated that the change in shrubs and small trees they observed was "consistent with anticipated changes due to climate change and reduced herbivory," which change in climate, in their words, "could be interpreted as an ongoing natural re-establishment of plants at higher altitudes due to a natural increase in the temperature since the 'Little Ice Age' (Kammer *et al*., 2007)."

Rounding out the family of pertinent papers published in 2011, Hedenas *et al.*[20] wrote that "during the last 15 years, there has been an increasing focus on how climate change has and will affect the distribution and extent of ecosystems around the globe including alpine and Arctic areas (e.g., Callaghan *et al*., 2005)," and in this regard they report that "field studies and remote sensing have revealed a recent increase in altitude of the tree line (e.g., Kullman, 2002)," as well as "an extension and increased cover of mountain birch forest (Tommervik *et al*., 2009; Rundqvist *et al*., 2011)." More specifically, they say that Tommervik *et al*. have determined that "tree biomass has doubled over a 43-year period, within an area of Finnmarksvidda, and Rundqvist *et al*. have observed an increased density and cover of mountain birch in the treeline over the last three decades, within an area near Abisko village."

In a continuation of these types of studies, Hedenas *et al*. went on to say that in 2010 they re-surveyed shrub, tree and vegetation data at 549 plots grouped into 61 clusters that were originally surveyed in 1997 in two areas close to the Abisko village, which is located approximately 200 km north of the Arctic Circle at 68°20'N, 18°50'E. There, the six Swedish scientists found that "tree basal area and biomass increased by 19% between 1997 and 2010 with the main increase occurring in established birch forest," noting that this result "concurs with the results of other studies which suggest that there has been a general increase in cover and biomass of trees and shrubs in sub-Arctic and Arctic areas," additionally citing in this regard, the studies of Sturm *et al*. (2001), Tape *et al*. (2006), Danby and Hik (2007), Forbes *et al*. (2010), Hallinger *et al*. (2010) and Van Bogaert *et al*. (2011).

Hedenas *et al*. additionally went on to write that in spite of the increased browsing pressure provided by an increasing reindeer population over the period of their study, as well as periodic outbursts of geometrid moths - which severely defoliated the birch trees in their study area in 2004 (Babst *et al*., 2010) - "there has been a net increase in biomass and carbon drawdown of 19%." As for the *cause* of this welcome phenomenon, they indicated "it has been suggested that increased nutrient availability associated with higher soil temperatures, and a longer

[20] http://www.co2science.org/articles/V15/N19/B2.php.

growing season could underpin increased tree and shrub abundance and biomass in the Arctic (e.g., Chapin, 1983; Weih and Karlsson, 1997; Hartley *et al*., 1999)," as a result of "a delayed re-expansion of shrubs and trees following the 'Little Ice Age'," as suggested by Grubb (2008). And, of course, there is the ongoing and ever-increasing *aerial fertilization* and *transpiration-reducing* effects of the concomitant rise in the atmosphere's CO_2 concentration, which must be playing significant roles as well, as the remarkable *greening of the earth* continues.

Moving forward one final year, Parn (2012)[21] wrote that "the potential productivity of a forest site has been regarded as natural and stable in a long-term perspective (Elfving *et al*., 1996)," but he indicated that "environmental changes such as increase of CO_2 in the atmosphere, deposition of pollutants and climate changes since the 1950s have had various effects on forest ecosystems," and that "the increasing human impact on the environment makes the stability of the site conditions questionable."

Thus determined to learn if these environmental changes may have impacted the growth of Scots pine trees, Parn studied the growth history of trees of identical *cambial* age but of two different *calendar* ages at two different sites: Koiguste on Saaremaa island, the largest of the Estonian islands in the Baltic Sea, and Pirita in North Estonia near the Estonian capital. The age of the old stand at the Koiguste site was 160 years and that of the young stand 55 years; while the ages of the old and young stands at the Pirita site were 155 and 55 years, respectively. At both of these locations, in the words of Parn, "the differences in the radial growth of successive stand generations were assessed using the average tree ring widths of the same cambial age of stands at age of 30, 40 and 50 years."

> What climate alarmists claim to be *bad for the biosphere* – rising atmospheric CO_2 concentrations and temperatures – appear to actually have been having a significant *positive* effect on the planet's trees and, by inference, much of the rest of earth's plants as well.

This work revealed that "the radial growth of young generations exceeded that of old stands at the same cambial age," and Parn stated that "approximately similar results were obtained when latewood widths were used instead of the tree-ring widths in the analysis." In addition, he reported that "a fairly strong positive effect of the mean temperatures of the spring months on the latewood width can be observed." And he noted that a similar "strong link between the latewood width and spring temperatures was described by Miina (2000) for Scots pines in eastern Finland, by Savva *et al*. (2003) for pines from different provenances in Russia, and by Drobyshev *et al*. (2004) for pines in the Komi Republic."

[21] http://www.co2science.org/articles/V16/N18/B3.php.

As for what was responsible for these findings, Parn suggested "it may be assumed that long-term climate change may have caused, at least partly, the increasing growth of young generations of pine," while also noting that "the increased nitrogen deposition and elevated CO_2 level during the second half of the 20th century may have had some positive influence."

And so we see that what climate alarmists claim to be *bad for the biosphere* - rising atmospheric CO_2 concentrations and temperatures - appear to actually have been having a significant *positive* effect on the planet's trees and, by inference, much of the rest of earth's plants as well.

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