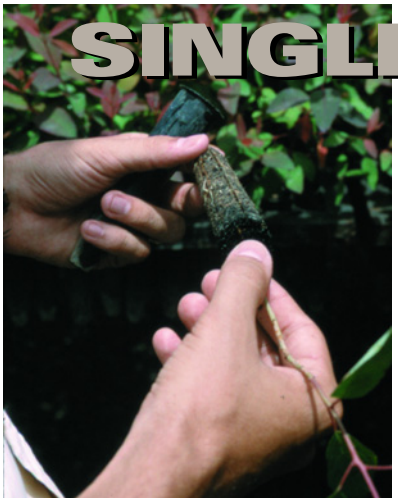

SINGLE-SPECIES PULPING: The world's preferred market pulps

'Outstanding attributes' are driving increased demand for single species pulps.

IN THIS ARTICLE, YOU WILL LEARN:

- How pulp markets have changed since the 1980s
- Advantages offered by single-species pulps
- The fiber attributes that give various pulps their distinct characteristics

ADDITIONAL RESOURCES:

- For information about TAPPI's pulping discussion boards, committees and events, go to www.tappi.org and click on the words "pulp/wood products" beneath the TAPPI logo.

Above: A nursery grown eucalypt seedling ready for transplant. Photo: Donald G. Meadows

Mixed hardwood and mixed softwood pulp producers continue to lose ground to companies promoting single-species pulps. Increasingly, mixed-grade U. S. pulps (excluding diaper fluff) are now thought by many specialty paper producers to be less desirable and bought only for their often discounted prices rather than for any special attributes.

Instead, more papermakers are demanding single species pulps that, unlike mixed species pulps, offer specific benefits and well-defined attributes. The movement toward single species pulps in the market pulp arena has been increasing in recent years as producers bring new "products" on to the market.

FEW ALTERNATIVES

Before the 1980s, global market pulp producers offered only two alternatives to traditional North American mixed hardwoods and softwoods: Scandinavian birch and Iberian eucalypts. Both were from naturally grown trees with widely varying harvest ages. Birch was a long (1.4 mm), slender, thin-walled fiber suitable for lightweight coated (LWC) and coated papers, but not for bulk sensitive grades, toothy finishes, or board grades. Iberian eucalyptus was over-aged and lacked any semblance of fiber-to-fiber uniformity.

North America was then producing two naturally grown, hardwood grades. Northeastern mixed hardwood was comprised of short, relatively thin-fiber maple, along with birch, beech, and poplar that exhibited a population of approximately 8 million fibers/g. Southern United States mills were producing a mixed hardwood consisting of oak, gum, ash, poplar, sycamore, maple, hickory, beech, magnolia, pecan, and perhaps six others. These fibers were relatively coarse with typical fiber diameters of 22-29 microns and fiber lengths varying from 1.0 mm to 1.7 mm for gum and sycamore.

These southern pulps had a relatively unimpressive population of 4 million fibers/g. This required papermakers to introduce at least 30% southern mixed hardwood pulp into an all softwood furnish for the sheet to begin to show any improvement in formation, opacity, surface smoothness, holdout, etc. The mixed northeastern hardwoods with their 8 million fibers/g had fibers whose diameters measured only 19-22 microns with lengths of 1.0 mm for maple and beech up to 1.4 mm for birch.

HARDWOOD ADVANTAGES

Consequently, northeastern mixed hardwoods were valuable for their ability to produce a tighter, better formed, smoother sheet with little of the onerous vessel-segment picking that characterized the white oak portion of southern mixed hardwoods. Papermakers found that northeastern mixed hardwoods significantly improved softwood pulps at an addition rate of only 20%. As a result, producers of lightweight opaque sheets, Bible and hymnal paper, directory stock, and financial bonds specified northern hardwoods from Georgia-Pacific, St. Anns, Thurso, and E.B. Eddy (now Domtar).

Throughout the 1970s and most of the 1980s, global customers accepted mixed hardwoods and softwoods because no major alternatives existed. Market pulp producers traditionally made "one size fits all" pulp grades. They did not engage in "target marketing" to search out and uncover unique pulp properties that might make their pulps particularly suitable to specific paper grades. They also did not divide their monthly production into customer-oriented "specialties" with properties such as high brightness, low dirt, high tensile, and low ash/extractables.

As long as few alternatives existed, North American mixed hardwoods and softwoods were widely accepted and able to hold their own with normal market prices. A price differential between northern including Scandinavian birch and southern mixed hardwoods usually amounted to no more than US$ 10/a.d. metric ton. Some producers—Rayonier, Buckeye and Weyerhaeuser-Cosmopolis—made sophisticated pulp grades that had all the necessary benefits.

SINGULAR SENSATIONS

In the 1980s, the pulp market began to change. North American mixed hardwood and softwood producers found themselves at a distinct disadvantage. Traditional customers began to favor newer single-species pulps. Brazilian eucalyptus is the best example of a "new" pulp that offered papermakers outstanding advantages. This uniform, single-species pulp comes from plantation-grown trees. Superior seedlings and "cloned" trees produce harvestable fiber in 6-7 years.

Facial tissue producers such as Proctor & Gamble and Kimberly-Clark soon learned that Brazilian eucalypts had the unusual ability to produce tactile softness when layered on the surface. This quickly became the "outstanding attribute" of Brazilian eucalypts, and it found a niche market with facial tissue producers. Today, facial tissue is this pulp's major end-use application.

NEW IDEA FROM THE NORTH

The late 1980s and early 1990s saw the emergence of another single-species hardwood—aspen from mills in Alberta, Canada. Though naturally grown with considerable fiber-to-fiber variation, this single-species pulp quickly became popular among producers of coated paper seeking smoothness and coating holdout.

Because aspen fiber has a very low specific gravity with thin walls enclosing a large lumen, the fiber has little strength and is prone to collapse into a ribbon. This kept it from use in bulk-sensitive grades, but made it ideal for coated papers designed for gravure printing where smoothness is the most important quality. Coated paper producers (C1S label producers, for example) whose customers desired high degrees of printed gloss were quick to recognize that aspen was an ideal hardwood for those paper grades.

These Alberta mills have expanded their single-species pulp offerings by adding a bleached softwood kraft made entirely from white spruce, which is a thin-walled northern conifer pulp that refines easily and develops high tensile, fold, and burst strength. By contrast, southern U. S. softwood mills continue to use varying mixtures of loblolly, shortleaf, slash, longleaf, and sometimes Virginia pine with chips coming from both roundwood—a combination of juvenile and mature wood—and sawmill slabs that are 100% mature wood.

Exceptions include specialty mills and fluff pulp producers. These mills-predominately located in the southeastern U.S.-have learned to cultivate and cut only slash pine for their market pulps. Slash pine has an unusually high specific gravity and thick cell walls. This allows it to maintain its structural integrity and makes it ideal for filter media papers, latex saturated products, mercerization, and diaper fluff. United States mills using slash pine hold a dominant position in the global diaper fluff market producing more than 3 million metric tons annually with half exported to more than three dozen countries.

INDONESIAN ACACIA, CANADIAN MAPLE

The latest entry in the single-species hardwood pulp arena is Indonesian acacia. An earlier Indonesian market pulp from PT Riau Andalan was a mixed tropical hardwood containing 65-80 different hardwood species. It was unpopular and required heavy discounting. Later, PT Kiani Kertas introduced an 80% *Acacia mangium*/20% *Gmelina arborea* Roxb. pulp with good

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Table 1: Single species pulp producers, species, attributes, and most appropriate applications

Country	Major producers	Species	Attributes	Major applications
Indonesia	PT Tel, PT Riau Andulan PT Kiani Kertas	acacia	high opacity, low bulk very high population	Bible/hymnal paper, textbook Int'l directory, financial prospectus
Brazil	Aracruz, Klabin-Riocell Cenibra, Bahia Sul, Jari	*Eucalyptus grandisflora*	bulk, opacity, high population, tactile smoothness	facial tissue, printing papers filters, specialty products
Canada	AlPac, DMI, Domtar	aspen	high smoothess, holdout	coated papers, especially gravure
Canada	Domtar, Irving	maple	high population, thick walls	printing/writing grades resists abuse of refining
Spain, Portugal, Chile,Thailand	ENCE, Portucel, Phoenix CMPC, Santa Fe	*Eucalyptus globulus*	endures abuse of joint re-refining. papermaking	towelling, tissue, coated and uncoated printing papers
Sweden, Finland, Canada	major pulp producers	birch	long/slender fibers, refines easily, strength, entanglement	LWC, coated/uncoated printing papers
Chile	CMPC/Arauco	radiata pine	thick-walled fibers, good blend of tear, fold, burst, tensile	cement reinforcing, packaging papers
Canada	DMI, AlPac	white spruce	thin-walled, easy refining low coarseness	printing, converting papers smooth surfaced grades
Canada	Domtar, Abitibi-Cons.	black spruce	thin-walled, easy refining low coarseness	facial tissue, towelling printing/writing grades

Author's Note: Our apologies to those companies omitted due to space limitations

SINGLE-SPECIES PULPING: Simply superior?

Several clear advantages show why more mills are adopting this 'singular sensation.'

IN THIS ARTICLE, YOU WILL LEARN:

- Process advantages and disadvantages of producing single-species pulps as opposed to mixed-species
- How single-species pulping affects pulp uniformity

ADDITIONAL RESOURCES:

- The University of Helsinki's Laboratory of Pulping Technology's home page: www.hut.fi/Units/Pulp/
- Home page for the Swedish Pulp and Paper Research Institute is: www.stfi.se

Above: Eucalypts at Mondi Forests KwaMbonambi tree improvement nursery in South Africa. Photo: Donald G. Meadows

In the global pulp market, traditional mixed hardwood and softwood pulps are now competing with single-species pulps such as eucalyptus and acacia. magazine asked several pulping experts for their thoughts on the advantages and disadvantages of single-species pulps compared with traditional mixed pulps.

Some wood species have fiber properties that provide particular values in finished products, and contamination with other species reduces their value. "Producing pulps from these wood species without mixing with other fibers makes sense," says Steven W. McDonald, senior process manager for Metso Paper USA, Atlanta, Georgia. "A mill that has these species in its wood supply with the capability to keep the fibers separated from other species all the way to the pulp dryer or paper machine has an advantage over other mills."

BATCH COOKING

McDonald noted that few mills can produce more than one single-species pulp without also producing large amounts of transition pulp. This process requires separate chip storage and pulp storage. Batch cooking is particularly suitable for single-species operations.

"Some integrated mills cook hardwood and softwood together to supply the desired mixture to the paper machine," said McDonald. "This strategy also avoids the production of low value transition pulp. It requires good control of the chip supply system to deliver the desired mixture to the digester, and optimized process cooking and bleaching conditions for each species mixture."

McDonald added that some wood species do not provide any particular advantage if cooked separately, but they are less expensive and therefore useful as fillers to lower total wood cost. "A disadvantage of single-species pulp production may sometimes be the limitation on using available fiber sources to lower the total raw material cost."

According to McDonald, it is easier to optimize single-species pulping process operations mixed-species pulping. This is an important advantage. "A frequent problem with mixed pulp production is mixture variation," he said. "The pulping rate and bleaching response have very clear differences, especially among hardwoods. Mills that buy mixed-species chips have specifications for chip size distribution and limits on bark and decay, but they have less control over the species mixture and the associated properties of cellulose content, lignin structure, and specific gravity."

DELIGNIFICATION

When mills change the chip furnish mixture, delignification conditions are typically adjusted after kappa control has deteriorated—rather than before the furnish change—because the mixture is difficult to measure or not closely monitored. "This produces more variation throughout the process, less capability to optimize chemical application rates, and variation in final pulp properties," said McDonald. "In this respect, a single-species operation has an advantage

over mixed-species pulp production."

Martin MacLeod, senior scientist for Paprican, Pointe Claire, Quebec, Canada, agrees that single-species pulping offers several advantages for most mills. "Single-species pulp will always be the way to go, at least until we can control tree genetics to achieve the exact chemical content and fiber morphology we want," he said. "Many single-species examples exist around the world: eucalyptus species in South America and in Japan with imported wood, various pines (*Pinus taeda* in the United States, *P. sylvestris* in Scandinavia, *P. radiata* in New Zealand and Chile), and aspen in Canada. Let the papermakers set the fiber recipes but give them very predictable, consistent pulps.

"Making mixed-species pulps is inevitably a compromise, and softwood/hardwood pulps are the biggest compromises," MacLeod continued. "Why make wildly 'bimodal' pulps for bad reasons in a digester instead of making uniform ones for good reasons to deliver to a stock preparation department?"

Peter W. Hart, senior research engineer for MeadWestvaco Corp., Chillicothe, Ohio, USA, noted that a mill can gain several advantages by pulping single-species trees instead of mixed species. In a single-species cook, the average density variation within the wood chips is substantially lower. Cooking liquor penetrates more uniformly, producing lower kappa number variability within the cook.

"A more uniform cook translates to reduced bleaching costs and better strength properties in the final bleached pulp," said Hart. "Improved uniformity also means better process control capabilities for reduced cooking and bleaching chemicals. This reduces total costs. Pulp yields improve as portions of the resulting pulp are not overcooked. Single-species cooking and bleaching provide mills with many advantages—reduced chemical costs, improved pulp yield, and improved pulp strength."

Panu Tikka, professor at the Helsinki University of Technology, Laboratory of Pulping Technology, Helsinki, Finland, agreed that single-species hardwood pulps are superior to mixed-species hardwood pulps due to the constant and suitable fiber morphology and fiber physics. These characteristics enable fast, mass production of high quality papers. He noted that mixed softwoods should never be cooked together since fiber physics vary a great deal and fiber properties cannot be fully used.

Peter Axegård, program director for STFI, Stockholm, Sweden, noted that the main advantage of single-species pulp is that the resulting fiber properties can be more diverse and fit different end uses. The main disadvantage is the complicated logistics a vast supply of one species provides.

SINGLE FUTURE?

Single-species pulps have gained acceptance and customers throughout the world. (See related article on page 27.) With single-species pulping offering producers and customers significant advantages, this concept will continue to gain acceptance and market share in the future. **S!**

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uniformity. In 2000 PT Tel introduced a 100% *A. mangium* pulp. *A. mangium* quickly gained wide acceptance among producers of lightweight textbook papers, lightweight opaque printing grades, Bible paper, and other papers requiring low bulk and high opacity. This is an unusual blend of properties, but it has great value to certain mills.

These acacia pulps have unusually high populations of 18-23 million fibers/g. This reflects a wide variation in fiber lengths and diameters. Brazilian eucalypts, for example, exhibits strong uniformity in fiber dimensions with the vast majority of fibers measuring 0.95 mm by 16 microns in diameter. Natural growth aspen by contrast has fibers that vary from 0.7 mm all the way to 1.2 mm and diameters that vary from 14 microns to almost 20 microns.

Not to be outdone, eastern Canadian mills, along with Domtar's mill in Woodland, Maine, USA, and International Paper's Quinnesec, Michigan, mill began to move toward the selective harvesting of only maple trees so they could promote "high maple hardwoods." In the middle 1980s, these pulps were only 50%-60% maple. Mills then ratcheted up to 80% and later to 90% maple. Today, five northern hardwood mills can boast that their hardwood pulp is "predominantly maple." Domtar's Espanola mill has three hardwood grades that are 100% maple, 100% birch, and 100% aspen, respectively.

FIBER OF THE FUTURE

Single species pulps clearly are the fiber of the future. As the choice and quality of these pulps continues to grow, they are fast becoming the preferred fiber source for papermakers around the world. However, mills and their pulp suppliers must clearly define the target pulp's outstanding attributes, unusual properties and (if any) unique or distinctive characteristics. Knowing this will help determine what category of paper grades in which to use a single species pulp.

Finally, paper mills must work closely with their customers to identify each grade's "prime requisite" or most essential property. Paper mills can then strategically target the best mix of pulp and papermaking technology needed to deliver superior products. **S!**

About the author: David C. Hillman is market pulp consultant based in Erie, Pennsylvania, USA. A graduate of Georgia Tech, Hillman, worked for 17 years at Westvaco's Luke, Maryland, mill; Wickliffe, Kentucky, mill; and in the New York corporate office. From 1981 to 1982, Hillman was vice president/specialty sales for Woodpulp International and from 1982 to 1987 was manager of pulp sales for Hammermill. In 1987, he became a market pulp consultant and has worked with more than 100 pulp and paper companies. Contact him by email at dhillman87@juno.com or by phone at +1 814 452-1136.