The Role of the Nursery in Developing a Sustainable Forest Regeneration Program for the Rio Condor Project in Tierra del Fuego, Chile[1]

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One of the cornerstones of a sustainable forestry program is a solid regeneration plan. Bayside Ltd. took the steps to ensure that forest regeneration is a high priority by establishing the Rio Condor Forest Nursery and Regeneration Program prior to any harvesting activities. In 1995, Bayside contracted with New Mexico State University's Centro de Forestación de las Américas (CEFORA) to develop a nursery and reforestation research, training, and production program. CEFORA, an inter-disciplinary group of forest nursery and regeneration specialists, has been actively involved with training, technology transfer, technical services, and forest nursery and regeneration research in Latin America since 1991.

The six-member specialist team assigned to the Rio Condor Project included researchers, seedling production specialists, and technology transfer specialists in the areas of tree improvement, seed management, seedling production, and regeneration. Their career backgrounds include forest industry operations; university, U.S. Forest Service, and industry research programs; university and extension teaching experience; technology transfer and nursery product development; operation of private nurseries; and consulting experiences (Figure1).

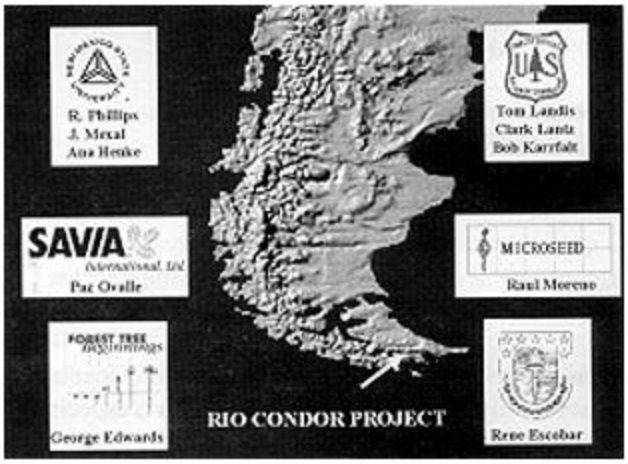

Figure 1. CEFORA's Rio Condor Project nursery and regeneration evaluation and support team.

The overall objective of the Rio Condor Forest Nursery and Regeneration Program is to successfully regenerate the company's *Nothofagus* forests on Tierra del Fuego (Figure 2). Artificial regeneration is the only viable option for the lands that have been degraded by fire, over-grazing, inundation due to beaver damage, and other poor land use practices in the past. The nursery program will also provide seedlings to meet the silvicultural requirements for optimum stocking on "Protection Cut" harvested lands where natural regeneration is inadequate.

Figure 2. *Nothofagus* forests on Tierra del Fuego.

In addition, a research program is being developed to study the biological and economic benefits of artificial vs. natural regeneration. The potential benefits of artificial regeneration include decreased rotation time; increased volume production; and potentially improved timber quality. A successful artificial regeneration program will require careful selection of adapted genotypes; production of quality seedlings; planting appropriate stocking levels; conducting quality plantings; and controlling guanaco and livestock grazing. The company is already taking steps to produce high quality seedlings and to conduct appropriate applied research. Forestal Trillium Ltda. and CEFORA are jointly developing the Rio Condor Nursery and Regeneration Program. The following steps have already been accomplished in the program: 1) assessed current native forest nursery technology in Chile; 2) assessed current natural forest regeneration; 3) determined the extent and condition of degraded lands; 4) developed seed collection strategy; 5) developed and conducted training program; 6) selected appropriate nursery technology; 7) developed a research/production nursery facility at University of Magallanes (UMAG); 8) produced 30,000 *Nothofagus pumilio* seedlings; 9) developed crop tracking system for *N. pumilio*; 10) established regeneration field plots on Tierra del Fuego; 11) identified research priorities.

In October 1995, CEFORA specialists and company project staff visited native forest nurseries in southern Chile and Argentina to evaluate seedling quality and current nursery technology. It was clear that the level of native forest nursery development lagged far behind the Chilean industry's exotic species nurseries. The company program managers and a six-member CEFORA specialist team conducted a second, more extensive evaluation of forest regeneration on Tierra del Fuego in January 1996. Subsequently, a plan was developed for staff training, seed collection, nursery development, seedling production, and forest regeneration.

A seed management program was developed for the 1996 and 1997 *Nothofagus* spp. seed crops for the company's forest on Tierra del Fuego. The objectives of this program included the following: 1) to select seed zones; 2) to develop seed tree selection criteria; 3) to select collection method options; 4) to determine a seed collection time-table; 5) to define storage conditions; 6) to select cleaning methods; 7) to develop seed testing procedures; 8) to select seed cleaning and testing equipment; and 9) to train in-country manager and field staff. In both 1996 and 1997 the company employed UMAG students and Porvenir residents to assist with harvesting, cleaning and testing of the seed.

A seedling production and seed testing training program was developed for the nursery management staff. A two-week intensive training program was conducted at one of CEFORA's associated nurseries, MICROSEED, in Ridgefield, Washington, USA. The company nursery and regeneration program manager and the director of the horticulture center at UMAG attended this training. The training facility, an operational nursery, utilizes the same technology selected for the Rio Condor Nursery. The training provided the staff with practical experience in equipment calibration, seedling production, seed testing, and crop tracking systems. Both CEFORA and Forestal Trillium Ltda. conducted follow-up training in Chile for the nursery staff.

The company committed to developing a state-of-the-art nursery facility utilizing the latest nursery technology available to create optimum seedling growing conditions. A 400 m2 greenhouse was leased from UMAG. Appropriate media, containers, automated irrigation system, fertilizer injector, rolling benches, and bio-therm vegetative propagation system were purchased and installed (Figure 3). In addition, seed cleaning equipment, a seed testing laboratory and seed storage facility were developed.

Figure 3. ITS Grower® uniformly irrigating lenga seedlings at the Rio Condor Nursery, 1996.

n October 1996, a pilot crop of 30,000 Nothofagus pumilio seedlings was grown at the company's UMAG research/production facility (Figure 4). A seedling production schedule was developed by CEFORA along with a crop tracking system to monitor the development of these seedlings. Figure 5 illustrates the mean height growth for three-seedling container volumes (336 ml, 172 ml, 80 ml styroblocks) for 20-week-old seedlings grown at the company's greenhouse at UMAG. In addition, these seedlings had excellent stem caliper (mean diameter of 4.5 mm for 20-week old seedlings grown in 336ml styroblocks), and a well-developed root system. Irrigation and fertilization response demonstrations and seedling pruning and conditioning trials were also conducted with this experimental seedling crop.

Figure 4. 1996 Nothofagus pumilio seedling crop at the company's research nursery greenhouse at the University of Magallanes.

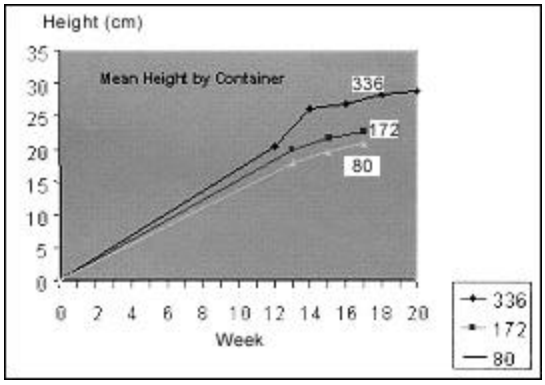

Figure 5. Nothofagus pumilio growth response to three different styroblock cavity volumes (336ml, 172 ml and 80 ml) at Rio Condor Nursery.

Nine different seedling container types were selected that represented a critical range of growing density and cavity volumes. These seedlings will be outplanted in spring 1998 to evaluate the impact of key morphological characteristics on subsequent survival and growth.

Forest regeneration activities have already been initiated. In January 1997, demonstration plantings were established within the company's experimental "Protection Cut" plot in Tierra del Fuego (fig. 6). Additional experimental areas have been selected for planting in spring 1998 on fire damaged areas. The objective of the first planting was to evaluate seedling conditioning, guanaco control, and time of planting trials. The first evaluation of these plantings, conducted one month after planting, demonstrated excellent survival (99%), good vigor, and 100% guanaco browsing damage on non-protected seedlings. Follow-up evaluations for survival, growth, and development will be conducted throughout the early years of establishment of these and subsequent regeneration studies.

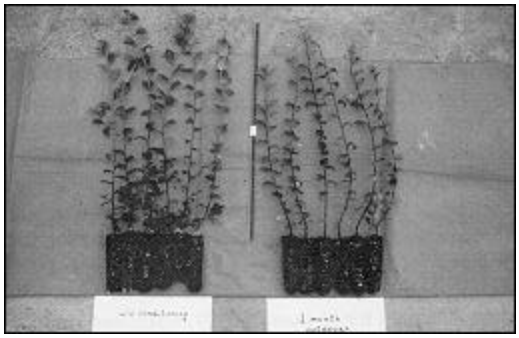

Figure 6. Five month old Nothofagus pumilio seedlings grown at the Rio Condor Nursery and used for the initial seedling conditioning trials on Tierra del Fuego.

During the initial phases of the seed management, seedling production, and regeneration operations, the program has been continuously evaluated and applied research opportunities have been identified. Research is being conducted on seed storage, seed stratification and seed testing. In addition, direct sowing and seedling transplant trials are being conducted in the nursery to improve seed use efficiency prior to sowing a second larger, operational seedling crop in September 1997. Additional regeneration trials are planned including: site preparation; guanaco control; time of planting trial; seedling container type comparison trials; and progeny tests for a wide range of outplanting site conditions.

A successful vegetative propagation trial has been conducted and a second study is currently being designed on the basis of preliminary results. This propagation technique maybe useful in production of seedlings in the event of seed scarcity. Vegetative propagation is a technique that also could be useful in the future development of a tree improvement program.

Forestal Trillium Ltd., CEFORA, and scientists from the Instituto Forestal, are currently pursuing collaborative research opportunities on artificial regeneration and seedling production. The results of these proposed research activities will be available to regional nursery managers and regeneration specialists in order to help improve the level of native forest management.

The Rio Condor Forest Nursery and Regeneration Program has made significant progress by demonstrating the application of forest science to nursery and regeneration opportunities. The growth and quality of Rio Condor Nursery-produced seedlings have greatly exceeded the expectations of regional foresters, nursery managers and forest researchers (Figure 7). Future gains from the company's nursery and regeneration research and development program will continue to benefit all those interested in the professional forest management of the Nothofagus forests on Tierra del Fuego.

Figure 7. N. pumilo seedling plant at the company's regeneration trials on Tierra del Fuego, 1997.