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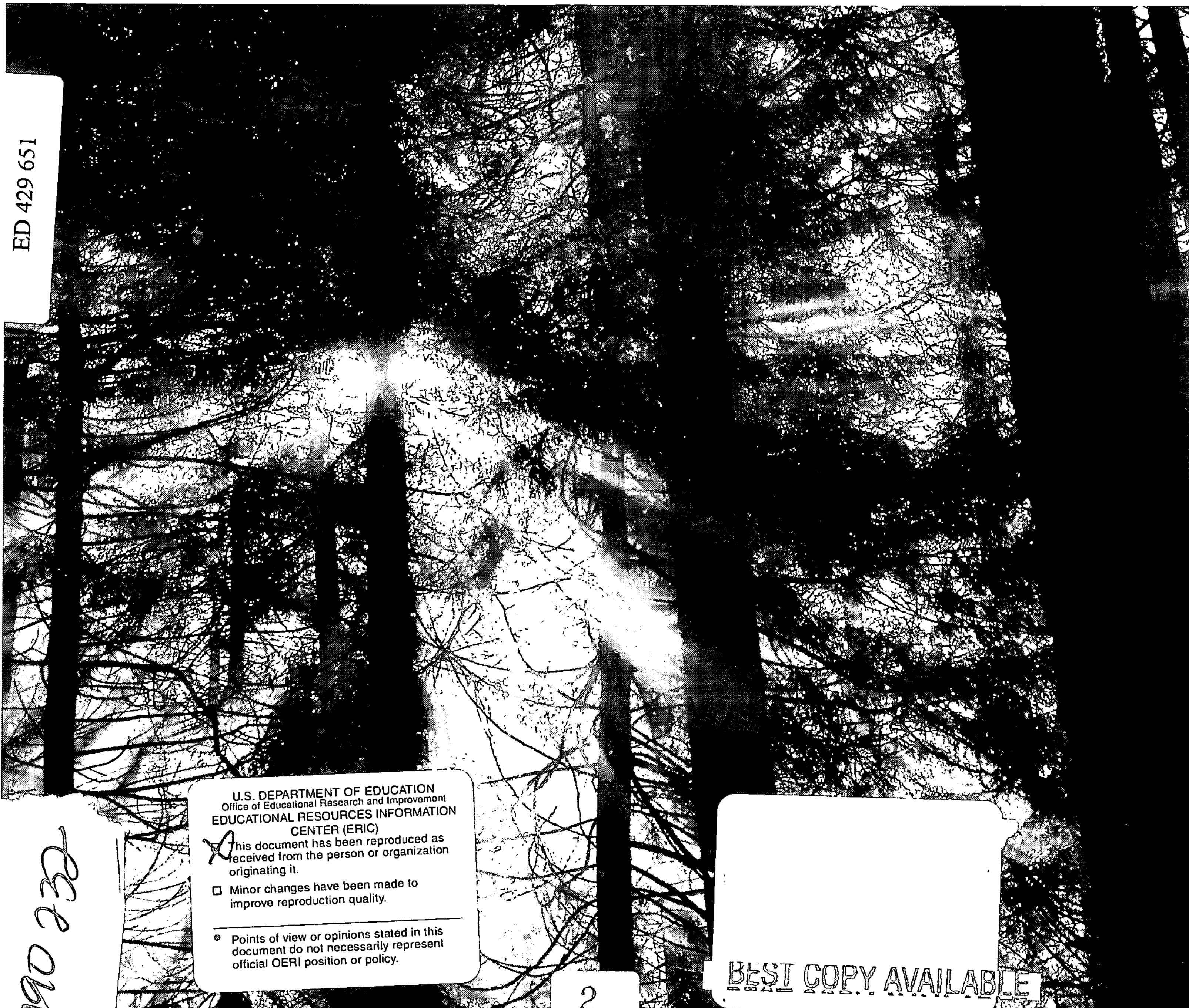
ABSTRACT

The Northwest Center for Sustainable Resources (NCSR) is a partnership of educators and numerous agencies dealing with natural resource management. NCSR emphasizes the ecosystem as a central theme in natural resource technical education. This booklet explains NCSR's relationship to secondary and higher education, describes NCSR programs and curriculum, and introduces NCSR partners, employers, and researchers. Curriculum discussions focus on core courses in environmental science and mathematics, standard and advanced mathematics in technological education, and technical mathematics for a state-of-the-art workforce. NCSR partners include employers, community colleges (Northwest Indian College, WA; Hawaii Community College, and Blackfeet Community College, MT), Native American organizations, professional associations, and universities. Five model community college programs supported by NCSR are: (1) Shasta College - agricultural technology; (2) Grays Harbor College - natural resources/fisheries technology; (3) Central Oregon Community College - forest resources/eastside and GIS technology; (4) Chemeketa Community College, Oregon - forest resources/westside; (5) Feather River College, California - wildlife technology; (6) Itasca Community College; and (7) Haywood Community College. Appended are a list of NCSR project partners, ecosystem management resources and examples, and charts related to program developments at Grays Harbor College, Central Oregon Community College, Chemeketa Community College, and Feather River College. (AS)



Visions for Natural Resource Education and Ecosystem Science for the 21st Century

An Interim Report of the **Northwest Center for Sustainable Resources** (NSF/ATE/DUE #9553760)

CHEMEKETA COMMUNITY COLLEGE

Visions for Natural Resource Education and Ecosystem Science for the 21st Century

An Interim Report of the

Northwest Center for Sustainable Resources

(NSF/ATE/DUE #9553760)

This project was supported in part by the
National Science Foundation
Opinions expressed are those of the authors and not necessarily those of the foundation

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CHEMEKETA COMMUNITY COLLEGE SALEM, OREGON

The following report

serves to describe and document

the activities of the

Northwest Center for Sustainable Resources.

The Center welcomes your comments

and invites your participation.

March 1998

Wynn Cudmore and Susie Kelly

Editors

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National Science Foundation

Vision, Leadership, and Guidance in Natural Resource Education and Ecosystem Science

This report reflects the vision and national leadership being provided by the Northwest Center for Sustainable Resources (NCSR), one of the National Science Foundation (NSF) Centers of Excellence supported through the Advanced Technological Education (ATE) program.

NCSR exemplifies the changes that must occur for our nation to remain globally competitive while remaining environmentally sound. First, there must be a community which values excellence in teaching and scholarship and is committed to reform of technological education at both the secondary school and undergraduate levels. NCSR supports numerous activities which ensure that faculty and teachers have the content and pedagogical skills to prepare the next generation of workers and enhance the skills of the current workforce. Second, only with a blend of core mathematics and science competencies which complement technical skills can we hope to have a technological workforce prepared to deal with not only today's challenges, but also those of tomorrow. NCSR is committed to improving core skills through varying and creative approaches and to enhancing technical skills through a combination of classroom and field experiences. Third, there must be a community ready to commit to changes that constitute systemic reform in natural resource education. Many walls exist that are ill-suited to educating the many individuals needed to make our country a better, safer, and more competitive place to live. Through NCSR, diverse groups working together represent segments of the academic community, business and industry, government, and the public that must cooperate to ensure that the United States has a workforce prepared in ecosystem science management as well as a public ready to support such a system.

The task for the community is a daunting one. We must have leaders who are ready to suggest, explore, and implement new approaches to the tasks at hand and to do this immediately so that we can achieve reform of the system that serves regional, national, and global needs. NSF is committed to supporting both experimentation and systemic changes. With leadership from institutions and individuals such as those in the Northwest Center for Sustainable Resources, this dream is becoming a reality.

Elizabeth J. Teles

Elizabeth J. Teles, Ph.D.
Lead Program Director for Advanced Technological Education
Division of Undergraduate Education

Opening Comments about the NORTHWEST CENTER FOR SUSTAINABLE RESOURCES

Mike Morgan, Ph.D.
Dean, Campus-Based Instruction
Chemeketa Community College

The Northwest Center for Sustainable Resources (NCSR) is in its third year of existence. It is funded by the National Science Foundation as part of its Advanced Technological Education Program. Chemeketa Community College plays the coordinating role for NCSR activities.

The NCSR is a partnership of dedicated educators and numerous agencies and others dealing with natural resource management. Lead colleges have engaged in significant curriculum revision and development in accordance with a central theme of an ecosystem approach to natural resource technical education. The NCSR has sponsored numerous workshops to provide up-to-date training for both high school and college instructors in the development of natural resource programs.

Chemeketa Community College's Forest Resources Technology (FRT) program is designated as one of the NCSR's lead programs. Some detail about the modification it has undergone is illustrative of the effect participation in the NCSR has had. Utilizing a DACUM process, which included the participation of representatives of business, industry and governmental agencies, the program assessed the technical skill level required of its graduates by employers. As a result, the program has collaborated with other discipline areas to establish entrance competencies. Students wishing to enter the program are assessed, and those not meeting the entrance competencies are advised to take "bridging" courses which will allow them to improve their skills. Also, the program now includes higher levels of mathematics and science than in past years. For example, students are now required to take a three-term, laboratory-based sequence in Environmental Science. Forestry Technology instructors take advantage of students' increased abilities in mathematics and science by presenting material at a higher technical level. The program has also established new partnerships with potential employers and with four-year schools. Contacts with four-year schools have lead to new and improved transfer agreements which facilitate students moving from an associate degree to a baccalaureate degree program. In summary, Chemeketa's FRT Program has been positively affected by its participation as an NCSR lead college.

Chemeketa has benefitted in other ways from its participation in NCSR. With the help of the Center, the college has established its *Aquatic Ecology Lab* which allows students to do hands-on, experimental science. Because of the notoriety brought by the NCSR, we have been contacted by several governmental agencies who have offered their help. This has led to establishment of several new field sites for use by science students. An example of these is the *Aumsville Site for Environmental Studies*, which is a result of a new partnership with Marion County governmental agencies.

Chemeketa's experience indicates that the NCSR has had a positive effect. The reports of the project's independent evaluator support this conclusion. Without a doubt, this is due to the efforts of all involved in NCSR activities, especially all of the dedicated professionals at lead colleges, all of the workshop planners and presenters, our advisory committees — as well as NCSR consultants and center personnel. The overall goal of the NCSR is to promote the sustainable use of natural resources through appropriate technician training and education leading to science-based management of natural resources. Progress in this endeavor is being made by the NCSR and its partners.

Northwest Center for Sustainable Resources: EDUCATION FOR A SUSTAINABLE FUTURE

Wynn W. Cudmore, Ph.D.
NCSR Principal Investigator
Susie Kelly
NCSR Director
Chemeketa Community College

Wynn Cudmore is Principal Investigator for the Center, and an instructor in Life Sciences at Chemeketa. Susie Kelly is Director for the Center. Cudmore and Kelly work as a team to provide leadership for NCSR activities.

The Center

The Northwest Center for Sustainable Resources (NCSR) (www.chemek.cc.or.us/ncsr/) is a partnership whose mission is to improve natural resources-based education programs at the high school and community college level. The NCSR is essentially without boundaries yet functionally includes northern California, Oregon, Washington and Maryland. It is a collaborative effort of partners from high schools, community colleges, four-year colleges and universities, private industries, government agencies, research groups, and Native American tribes. Partnering provides input by all principal stakeholders, assuring that students receive the best education possible to meet demands of the Twenty-First Century work place.

This six-year project, established September 1, 1995, creates a national Center of Excellence for the National Science Foundation's (NSF) Advanced Technological Education (ATE) program (http://www.nsf.gov/).

The Center is coordinated from Chemeketa Community College in Salem, Oregon (pronounced Shä-mĕ'-kĕ-tä). Featuring a "seamless" approach to natural resources education from middle and high schools to community colleges and 4-year colleges and universities, grant funds are committed to serving the dual roles of enhancing natural resources curricula and providing an information network for the region and nation. By the Year 2000, curriculum produced by the Center will be widely disseminated.

Seamless Education Defined:

1) a structured educational continuum that connects levels of education so students receive credit for past work and have the skills to succeed at higher levels
2) a flow from one level of education to another with minimal obstacles
3) an ease of transfer from one level of education to another (even across state lines)
4) education where transferability of course-work is maximized

Key Points/Features:

- A process that adds value to the anticipated exit point of a student's education
- Common threads/themes (e.g., Ecosystem Management, Environmental Education) that run through all grade levels

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Five community colleges from Oregon, Washington and California are taking the lead in program development in major natural resource areas — agriculture, fisheries, forestry, and wildlife. Other colleges in the region will test and modify lead programs. Core programs in Geographical Information Systems (GIS) and Environmental Science are being developed to be incorporated into each program. In addition to a partnering approach, NCSR programs feature faculty development opportunities and student internships, and ultimately, the production and dissemination of multimedia materials. Program graduates will be employed as technicians with advanced skills, or they may go on to earn baccalaureate or advanced degrees.

Curriculum Overview: Common Elements

Common guidelines which tie individual efforts of the Center together are that programs:

- show increased levels of mathematics and science
- are ecosystem-based
- apply advanced technologies
- increase field opportunities for students

Industry Input

NCSR's approach to curriculum improvement begins with identifying specific program objectives. These objectives are based on experiences of instructors as well as input from potential employers of program graduates. Employer input is achieved in numerous ways, including

Advanced Technological Education (ATE) of the National Science Foundation

[Managed jointly by the NSF's Division of Undergraduate Education (DUE) and the Division of Elementary, Secondary, and Informal Education (ESIE)]

The ATE program promotes exemplary improvement in advanced technological education at the national and regional level through support of curriculum development and program improvement at the undergraduate and secondary school levels, especially for technicians being educated for the high performance workplace of advanced technologies. ATE projects and Centers result in major improvements in advanced technological education, serve as models for other institutions, assure that students acquire strong backgrounds in mathematics and science, and yield nationally-applicable educational products.

ATE started as part of the 1992 *Scientific and Advanced Technology Act.* Congress was concerned that U.S. industry would lose its competitive edge without highly trained technicians; thus, NSF was charged with creating an education program. NSF/ATE program leader Elizabeth Teles, Ph.D., says, "Industries are asking for a work force that has strong background knowledge in math, science, and technology. While ATE projects take different approaches, all of the graduates need more than rote skills if they are going to keep pace with changes in the workforce."

The major focus for ATE is on two-year college students, but most ATE projects go beyond that. They create teacher development programs, support curriculum development and program improvement for high school students who will seek technical careers, and cooperate with four-year colleges and universities in program development.

ATE Program 1995 Awards and Activities Guide (NSF 95-64), page 1 -and- Frontiers Newsletter of the National Science Foundation, October 1995, "NSF Helps Two-Year Colleges Train Tomorrow's Technicians", page 2

Excerpts from a Statement for the *Hearing on the FY1998 Budget Request of the NSF for Math, Science & Engineering Education Programs*

Statement of
Alfredo G. de los Santos, Jr.
Vice Chancellor for Student and Educational Development
Maricopa County Community College District
Washington, D.C., March 13, 1997:

[Dr. de los Santos, Jr., is commenting on the ATE program]

...Education in science, mathematics, engineering and technology is essential for every American, regardless of his or her ultimate occupation...it is plain that as America prepares to enter the 21st Century, our ability to maintain our world leadership — and to ensure that every American has a real opportunity to share in our great wealth and fortune — will depend in very large measure on how well we educate our people in these critical skills...

...The student who attends college part-time at night because she has to work and care for a family deserves the same quality of math and science education as the "conventional" full-time student. And the student attending a community college has as much right to the best math and science education as does the student attending a university with an enormous investment in scientific research.

An undergraduate education is now key to success in the workforce, just as a high school diploma once was. It is that way for the young man or woman who progresses steadily from kindergarten on, and it is so for the adult learner who increasingly must return to school to obtain new skills and upgrade old ones. It is our nation's undergraduate institutions, and most particularly our community colleges, to which this task falls.

...ATE-funded Centers are proving that collaboration between community colleges, employers, and the rest of the education continuum can produce graduates with the right skills, the right education and indeed the right stuff to enable them — and the companies for which they work — to succeed.

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What is a DACUM?

It is an abbreviation for Developing A CurriculUM, an occupational analysis performed by expert workers in the occupation. The DACUM produces an occupational skill profile which can be used for instructional program planning, curriculum development, training materials development, and other employment-related activities.

In the case of community college curriculum development, the DACUM process would be as follows: program designers would identify a panel of about 8-12 "expert workers" from their program's field, including technicians and managers. The DACUM Panel would be convened for a day (or more), and a trained DACUM Facilitator would ask the "DACUM panel of experts" — *What skills and competencies do workers in your field need to be successful when entering the work force?* The basic assumption of the DACUM process is that expert workers are better able than anyone else to describe their occupation. The product of the DACUM panel is a chart which succinctly illustrates skills and competencies technicians need to enter the workforce. The chart is used by curriculum developers to design curriculum which includes those necessary elements defined by the expert workers.

NCSR has produced DACUM charts for each Lead program (for NCSR DACUM charts, see pp. 101-125). Also, to help other community colleges interested in learning about the process and becoming facilitators at their home sites, the Center has offered *DACUM Facilitator Training Institutes* in collaboration with Oregon State University's Western Center for Community College Development.

Center for Education and Training for Employment,
College for Education, Ohio State University

program advisory committees, DACUMs, and focus group interviews. The DACUM, for example, is a focal point for curriculum development and revisions. The DACUM process brings together current employees to generate skills and competencies graduates need for the working environment. Curriculum developed for the Center will incorporate skills and competencies identified by the DACUMs, advising committees, and focus group interviews, assuring that course content is relevant to the modern workplace. Through these avenues, the NCSR promotes an educational model where employers are actively involved in identifying objectives and outcomes for education programs.

Research — Education Connectivity

Although advisory committees and the DACUM process are effective mechanisms for defining necessary skills and knowledge for current technicians, they may not be as effective in defining the technician of the future. Faculty must therefore rely upon their own experiences, knowledge of current research, and economic and social trends to augment information gained from advisory committees and DACUMs. To aid faculty in gaining current information, the NCSR offers numerous opportunities for faculty development through institutes and field workshops. These Institutes bring faculty in contact with world-renowned scientists and agency and industry experts (see pp. 10-11 for more information).

The transfer of pertinent information from current research efforts into technical curricula is seen as an essential responsibility of NCSR program designers. This requires regular review of relevant literature and attention to current topics. Partnerships with university research faculty, agencies, research facilities, industry and professional societies are established to serve as sources for information. For example, the H.J. Andrews Experimental Forest, located in the Willamette National Forest, Blue River, Oregon, provides field experiences as well as cutting-edge scientific information for the Center. *For further information on the role of the Andrews, see page 78.*

NCSR Curriculum

Once program objectives are established, content is identified based on meeting those objectives. General education courses in writing, speech, mathematics and science provide a foundation for the technical curriculum. Technical courses give students ample opportunity to apply skills and knowledge acquired in general education classes.

A brief discussion of each of the goals for NCSR curriculum development follows:

I. Increased Mathematics and Science

Modern natural resource management is a science-based endeavor that demands a more broadly-educated technician.

Now and in the future, inventorying of natural resource components and monitoring of impacts of management will be conducted routinely by natural resource technicians. These tasks require a greater degree of responsibility, creativity and understanding on the part of the technician. Math and science are seen as essential foundation skills to achieve this level of competence. As a result, mathematics and science levels are being increased in NCSR technical programs.

II. Ecosystem-Based Curriculum and Ecosystem Management

It may be argued that to maintain ecosystem integrity, the "best management is no management". However, given that human disturbance and exploitation of ecosystems will continue in the future, it is in societies' best long-term interest to do so in a manner that assures, or at least improves the likelihood of, the integrity of that system in perpetuity. Ecosystem Management (EM) has been proposed as a mechanism that strives to achieve this goal.

"Does the Average Community College Student Fit the Mold of 'Seamless' Education?"
Joanne Truesdell

from *Abstracts, Western Center for Community College Development, Oregon State University,* April 1997 (Vol. 1 No. 2)

Conducting a retrospective study, Truesdell examined 60 students who had earned nontransfer (Associate of Science and Associate of Applied Science) degrees from Oregon community colleges, and who went on to complete baccalaureate degrees from Portland State University between June 1990 and June 1995.

When first entering community college, only 15 percent of the study participants identified "transfer to a baccalaureate program" as an objective — yet all participants went on to transfer and complete a baccalaureate degree. In addition, each student was required to complete additional course work (as much as 15 to 45 credits beyond their nontransfer degree) before beginning their upper division course work.

Along with other findings and recommendations, the author states that: "No education program is terminal ... While 57 percent of all associate degrees are earned by students in so-called 'terminal' tracks, one third of these students go on to complete baccalaureate courses — about the same percentage as those tracked as 'transfer'. However, these terminal students pay a price, in terms of greater difficulty transferring and completing their baccalaureate degrees."

The concept of EM is currently under development and has acquired labels ranging from an "oxymoron" to a guiding principle that will "protect the environment, maintain healthy ecosystems, preserve biological diversity, and ensure sustainable development" (Lackey, 1995). The concept has led to antagonism from pro-development interests who see it as a smoke screen by environmentalists to preserve more acreage in its natural state. Nevertheless, the USDA Forest Service and USDI Bureau of Land Management adopted EM as a guiding philosophy in 1992 and 16 additional federal agencies and departments in 1993 did the same. Attempts to apply EM on a large scale include the President's Forest Plan in the Pacific Northwest (FEMAT, 1993) and the Everglades Ecosystem Project in Florida. The concept has achieved a great degree of acceptance in scientific, socioeconomic and political circles and it appears, at least for now, that "ecosystem management represents our best opportunity to describe, understand and fit in with the natural world" (Grumbine 1994).

Similar to changes agencies are making, NCSR has adopted EM as a guiding principle in curriculum development, using Grumbine's 1994 definition that EM "...... integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term". The scientific basis for EM has been reviewed by Christensen, et al. (1996).

In general, ecosystem management strives to:
- maintain existing biodiversity at genetic, species and ecosystems levels
- maintain evolutionary and ecological processes within ecosystems
- manage over temporal and spatial scales that are appropriate for the ecosystem
- maintain long-term site productivity
- accommodate human uses within these constraints

Ecosystem management has ecosystem science at its core. An understanding of ecosystem structure and function is fundamental to intelligent management of natural resources. "As natural resource policies are more based on a good understanding of ecosystem dynamics, the smarter our decisions are going to be" (Lubchenco, 1997). Students will leave NCSR programs with a fundamental understanding of basic ecological concepts; these include, but are not limited to: interconnectedness of ecosystem components, biodiversity, nutrient cycling, energy flow, population growth, limiting

Primary Goals for the Northwest Center for Sustainable Resources (1995-2001):

— Develop curriculum that meets the ideals of the grant and the ATE program; update programs and institute changes at 5 "lead colleges"; test curriculum at 6 "test site colleges"

— Establish model partnerships among educators, employers, Native American tribes, research groups, and professional societies

— Develop and offer faculty development institutes

— Nationally disseminate curriculum and other products through a clearinghouse for information

Mission

The *Northwest Center for Sustainable Resources* (NCSR) is a collaborative effort of educators, employers, and others to enhance natural resources programs at community colleges and high schools and to provide a clearinghouse for sustainable natural resources information. One of ten Centers of Excellence funded by the National Science Foundation's (NSF) Advanced Technological Education (ATE) program, the NCSR will incorporate innovative teaching methods, state-of-the-art technology, cutting edge research, and field experience into natural resources technology programs. Major goals for the project include integrating community college programs into a "seamless education" from K-12 through university, working closely with employers in curriculum development, emphasizing hands-on experience for students through internships, and developing core programs that prepare students to work as technicians for organizations dealing with regional aquatic and terrestrial ecosystems. Programs will feature environmental monitoring, mapping, instrumentation, and other related skills woven within the context of managing complex ecosystems. Program graduates will receive technician degrees, and have advanced skills, or they will receive degrees which transfer to 4-year colleges and universities. Combining improved curricula with an information clearinghouse for natural resources education, the NCSR will provide an effective model for education/employer alliances for the nation.

factors, species interactions, competition, and symbiosis. As an example, these components are the basis for a sequence of courses in Environmental Science at Chemeketa Community College, and they will be recurring themes in Chemeketa's Forest Resources Technology program.

Ecosystem management requires a thorough understanding of ecosystems being managed. New practices, such as "adaptive management", recognize that current knowledge of ecosystems is incomplete and view management as an ongoing process which can be adapted or changed as further understanding is gained of impacts on complex systems. Management activities are viewed as experiments whose results are periodically monitored, providing a feedback loop to managers. Management practices can, therefore, be adjusted as inadequacies are learned or mistakes are made.

Ecosystem management goals are socially defined. People must be recognized as an integral component of ecosystems. Human values play an important role in defining the goals of ecosystem management. This may be the most problematic component of EM, for even if scientific knowledge is gained to manage ecosystems sustainably, conflicting societal goals and human values may prevent this from happening. There is ample evidence to suggest that some interests are using this aspect of EM to justify "business as usual" — short-term, single-commodity based management with minimal regard for ecosystem integrity.

Ecosystem management will require unprecedented cooperation between various parties, both public and private, that are responsible for stewardship of various land holdings since management will be based on *ecological* rather than *political* boundaries.

III. Application of Advanced Technologies
The implementation of ecosystem management requires the application of advanced technologies. Computers, for example, are required to store and analyze large databases that allow for managing landscapes rather than individual stands and that manage land on time scales measured in centuries rather than years. Data recording in the field has become more sophisticated with the widespread use of Global Positioning Systems (GPS), and Geographic Information Systems (GIS), which combine to create powerful databased mapping systems with capabilities of analysis, manipulation and visualization of data. Future technicians must be familiar with the use of these new tools and systems.

IV. Increased Field Experiences for Students
Laboratories and investigative field experiences are essential elements in the education of future technicians. Since modern natural resource management is science-based, these experiences should require a scientific, problem-solving approach. Towards these goals, students in NCSR programs are "doing science" — e.g., posing questions, hypothesis testing, designing experiments, and collecting, interpreting, and presenting data. Additionally, students are learning and working in field settings to become familiar with physical and biological components of managed ecosystems.

GIS & GPS

Geographic **I**nformation **S**ystems (GIS) is a new, computer-based technology used in many fields; in natural resources, a GIS "layers" spatial data into highly complex "maps" which can greatly improve analytical capability for natural sites. **G**lobal **P**ositioning **S**ystems (GPS) is a computer-based technology which uses satellite data to locate points accurately, and can be used to create GIS data bases. Overall, in mapping sites, *whereas GPS records locations, GIS integrates locations and attribute data.*

Faculty Development — NCSR Institutes

New approaches, pedagogies, field techniques, and technologies of NCSR curriculum are being disseminated through faculty development institutes. Already, educators from all around the U.S. have attended, and the Institutes continue to be offered annually during the summer. Dates for upcoming institutes and other details are provided in brochures and on our Web site.

Ecosystem Institute

The Ecosystem Institute, led by NCSR's Principal Investigator, Wynn Cudmore, Ph.D., is offered at the H.J. Andrews Experimental Forest, a world-class forest research site located on the west side of the Oregon Cascades Mountains. The Institute introduces participants to concepts and field applications of Ecosystem Management, and leading scientists from Oregon State University present their current research. Emphases are to provide mechanisms for instructors to incorporate information learned at the Institute into natural resource- and environmental science-based education programs, particularly in community college technical programs.

Topics covered in the **Ecosystem Institute** include:
- Nutrient Cycling
- Stream Ecology/Landscape Ecology
- Forest Fragmentation
- Geographic Information Systems (GIS)

Natural Resource Institute

The Natural Resource Institute, led by Jon Yoder and Neal Maine, NCSR Secondary Education Specialists, is offered at the naturally-beautiful campus of the Western Mennonite High School in West Salem, Oregon. Participants in the one-week Institute are led through numerous classroom/field lab activities, with leadership from natural resource agencies and employers and other specialists. Goals for the Institute, which includes a second-year follow-up session and third-year site visit, are for teachers to have the necessary expertise to develop natural resource-based programs at their home sites — programs emphasize the use of current technologies, such as Geographic Information Systems (GIS), and cutting-edge sciences including those embodied in Ecosystem Management.

Topics covered in the **Natural Resource Institute** include:
- Program Development — emphasizing linking of community and schools
- Field Experiences — offering models for connecting ecological with social and economic aspects of resource management and use
- Sustainability and Ecosystem-based Management
- GIS — using ArcView as a tool for monitoring and research

GIS Institute

The GIS Institute, offered at Central Oregon Community College (COCC), in scenic Bend, Oregon, offers instructors a course entitled "Introduction to Geographic Information Systems (GIS)", which includes lecture and lab activities. COCC is a leader in GIS and offers technical degrees in GIS and Forestry. Instructors Art Benefiel and John Schaeffer provide instruction about GIS using ESRI/ArcView software.

Topics covered in the **GIS Institute** include:
- GIS Basics (Geography, Hardware & Software)
- Models of Reality
- Thinking Spatially/Spatial Data
- GIS Implementation in Curricula (with forestry-based applications)

Adaptive Management

Adaptive Management is "the process of implementing policy decisions as scientifically-driven management experiments that test predictions and assumptions in management plans, and use the resulting information to improve the plans".

FEMAT 1993.
Forest ecosystem management: An ecological, economic, and social assessment.
Report of the Forest Ecosystem Management Assessment Team (FEMAT). 1993-793-071. Washington, DC:GPO

NCSR Clearinghouse

Through the Center's Website (**http://www.chemek.cc.or.us/ncsr/**) and other materials, a "clearinghouse for information" is being developed. The clearinghouse will feature information about 2-year community college programs, ecosystem management, high school activities and programs, and other partner inputs into the Center.

A Need For Change

The need for changes in natural resource management is evident in a region where the decline of Pacific salmon runs and old-growth forest debates have received national attention. Prevailing laws and past mismanagement of natural resources are forcing natural resource-based economies in the Pacific Northwest to make changes towards more sustainable methods for the management of fisheries, wildlife, forests and agricultural crops. The strengths of NCSR lie in a unique and unprecedented partnership which is cooperating to transfer new information about sustainable management of resources to classrooms of the twenty-first century.

Center Evaluation

The Center is independently evaluated by Lester Reed, Ph.D., *Western Center for Community College Development*, Oregon State University.

"I do believe, based on the sheer economic realities and the need for greater understanding of our interdependence in the world in which we're living, that we have to make the first two years of college as universal as a high school education is today."

President Clinton,
at the annual meeting of the American Council on Education

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NCSR & Secondary Education

Jon Yoder and Neal Maine
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Overview

NCSR's Secondary Education Program is helping to develop natural resource education programs at high schools throughout the Northwest and nation. Through summer institutes and an electronic clearinghouse of teacher resources, trained teacher leaders establish individual school programs in natural resources. These programs foster partnerships between secondary schools, agencies, industries, higher education, and communities. NCSR provides teachers with experiences to develop a new model for education where science is used as a tool by students as active, participating citizens.

Natural resource programs are based on ecosystem management, where interactions of social, economic, and ecological components of natural resources are addressed to attain "true sustainability". By developing partnerships with the community, public agencies, and the private sector, and highlighting essential technologies, this program will serve as both a national model and a catalyst for change.

Issues in Natural Resource Education

The need for national educational reform is on the agenda of nearly every group that is in any way connected to public education in America. Although education historically has been called upon to lead the way in dealing with change in our society, clearly the pressures of international competition, current economic issues, lack of skilled workers, need for highly-skilled and technology-literate citizens, and incidence of serious environmental issues cannot be denied. Increasing day-to-day needs for citizens to be scientifically, technologically, and ecologically literate underscores that there is an educational crisis in the U.S.

This background clearly illustrates that the task for reformers is more than simply rearranging what is currently being offered as science education. Changes called for cannot be achieved by attempts to simply revise, restructure, reorganize, or update the current science curricula. These courses and how they are currently taught are the very reasons for the demands for educational reform. The task, instead, is one of separating ourselves from the past and developing new ways of thinking about a citizen's education in science. As science educators, our responsibility is to provide leadership in creating programs that represent a system for citizens to engage in change that protects and enhances our natural and social worlds. Programs need to be more than single courses offered at the end of a student's high school experience, and instead should be comprehensive series of experiences — Grades 9 through 12. In natural resource education, students need to have a coordinated sequence of experiences with ecosystems, ecology, ecosystem management, and specific natural resource emphasis areas, including agriculture, fisheries, forestry, and wildlife.

NCSR's program is dedicated to helping provide leadership for this "new way of doing business" for secondary schools. This "new way" revolves about educators gaining field experience; developing interpersonal skills; acquiring special knowledge at the ecosystem level; exploring the relationship between research, management and resource use; and connecting to natural resource specialists in their communities. From these changes will emerge proactive students who are prepared in science literacy for local activities in the natural resource arena.

To reach these goals, NCSR Summer Institutes for secondary teachers provide a framework and experiences necessary for this type of program development. Offered on a three-year cycle, including an introductory institute with two follow-up meetings, the *Natural Resources Institute* provides teachers with needed support and training. Further support is provided by an electronic clearinghouse of natural resource information that any teacher can access to assist them in establishing a natural resource program.

To successfully deal with the future, students must have opportunities for extensive participation as citizens at developmentally appropriate levels. At appropriate levels, students must participate in social, political, historical, economic, and natural resource "agendas" that are meaningful to them in their community. To ensure this opportunity, educators must provide the necessary leadership in formal education programs that give students science and technology experiences that are linked to the learning process. This leadership should demonstrate that experience is not just a luxury for education — *but is fundamental to it.* These programs must be developed in such a way that students can use their science literacy in the public forum, not just in the science lab.

Science and technology are rapidly becoming critical elements for our economic and environmental survival. Communities throughout the U.S. depend on natural resources for their economic, social, and cultural frameworks. Too often, scientific and technological information regarding natural resources is lacking. NCSR hopes to assist schools in establishing programs that help address these issues.

Focus on *Oregon's Educational Act for the 21st Century* — the Certificate of Advanced Mastery/Natural Resources Endorsement Credential

Oregon's Educational Act for the 21st Century was signed into law July 1991 and amended July 1995. Education reform includes these concepts:

- Students will be more involved with their own learning
- The community is a classroom
- Knowledge and skills are taught in context
- Learning is integrated
- Learning is done cooperatively
- School to Work concepts are integrated in curriculum

Under the Act, Oregon's Department of Education is establishing policies and developing standards required for the Certificate of Advanced Mastery (CAM). Six "endorsement areas" included in the CAM are: *arts and communications, business and management, health services, human resources, industrial and engineering, and natural resources systems.*

The CAM will be awarded to students who:

- Achieve grade 12 academic standards in English, mathematics, science, social sciences, the arts and a second language
- Achieve grade 12 career-related standards in personal management, problem solving, teamwork, communication, workplace systems, career development and employment foundations
- Participate in an endorsement area and career-related learning experiences

While some components exist today, the concept of an Endorsement Credential is new to Oregon's educational system. The Department of Education is collaborating with partners including business, labor, the educational community, state agencies, parents, and others to provide operational definitions, establish policies, and develop the standards required for the Credential.

Susie Kelly
NCSR Director
Chemeketa Community College

Natural Resource 2-year programs & Where They Might Take You

Starting a career in natural resources with an education from a 2-year college can be uniquely satisfying. Using my background as an example, I had some exceptional experiences as a student in the forestry program at Paul Smith's College in Upstate New York. At Paul Smith's, I was a member of the women's "Woodsmen Team", where we competed in events including crosscut sawing, tree felling, canoe portaging and racing, ax throwing, and tree climbing. I was also active in the Forestry Club, and we did things on weekends like building a cabin, operating a cable logging system, and cutting and skidding balsam bows for shipments to New York City during the holidays. I also had the extraordinary opportunity to take care of, and work with, a team of Belgian draft horses —doing things like skidding beech, birch, and fir logs through snow-covered trails in the deep woods. Also, in very early spring, we used huge ice saws to cut channels through feet of ice on rivers, which served dual purposes: we could get out into the channel earlier to start practicing canoe racing techniques, and the blocks of ice we cut were used in ice sculpture contests in nearby Lake Placid. All of these activities were a part of a very hands-on oriented and rich curriculum where we studied and learned about the *practice* of forestry — along with math, English, and other core curricula, courses included dendrology, silviculture, mensuration, surveying, and others.

After graduating from Paul Smith's (Class of '78), I immediately gained employment in a Forest Service Work Camp located only 2 miles out of Glacier Park, Montana, in the Flathead National Forest. It was a "dream first job", and during that summer I learned that forestry is not for the weak at heart, and that working in the outdoors is an incredibly rewarding, yet physically demanding, field. I worked hard in highly remote areas, and it was exciting working in areas where grizzly, wolves, and moose roamed. Overall, I had an unforgettable experience!

I went on to other technician jobs and then to school at 2 universities before completing my Master's Degree in Forest Science at Oregon State University, Corvallis, Oregon. However, I still look back on my 2-year college experience as my base, my ballast, and the place where I *learned to love forestry.* I would never trade that experience for another.

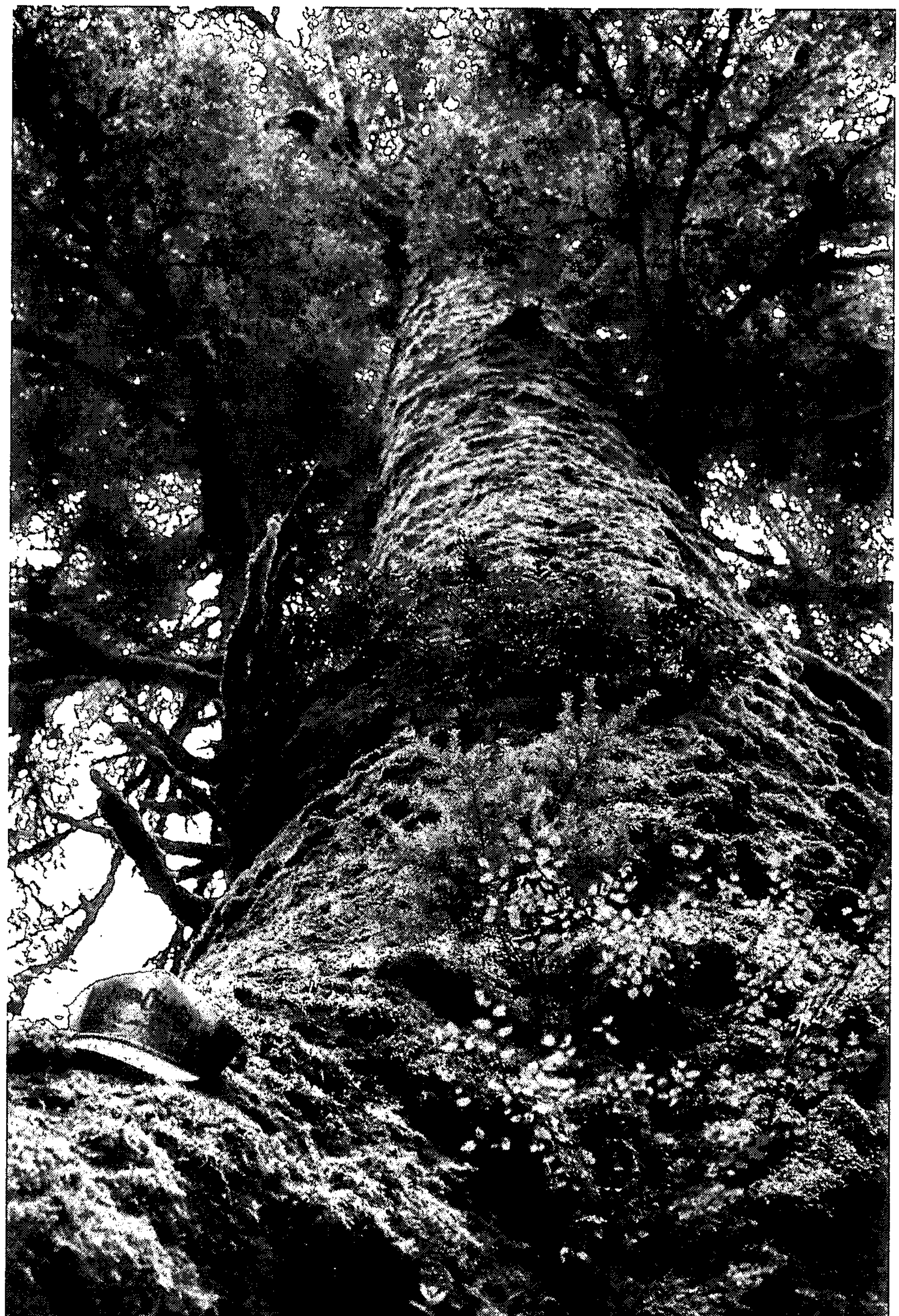
If you (or a student of yours) are considering an education in natural resources, these are some recommendations I would make, based on my experience (including some "mistakes" I made — and others undoubtedly have — along the way):

1. *Really consider* starting your education at a community college or a 2-year college — benefits include smaller classes and more interaction among both friends and faculty; if it's a community college, tuition is usually less; and field experiences can be *outstanding.*

2. *Don't sell yourself short on transfer classes* — if you choose a 2-year college to start your education, and you plan to go on, take as many transfer level courses as you possibly can (and keep in mind that even if you don't plan to go on, all indications are if you're a serious student, you will eventually go on!). Otherwise, you will lose valuable credit, and more importantly — valuable time. *Especially when it comes to math courses*, complete as high a level as possible at the 2-year college prior to transferring so you are well prepared to continue your education.

3. Be aware that forestry and related natural resources-based professions *require a substantial basis in science and mathematics* (the work is not just meandering through the woods and counting butterflies!!). If you are still in high school, start preparing by taking as many math/science courses as you can to better position yourself for future college courses; in a 2-year program, make sure you emphasize taking math and science core courses.

4. Know that if you are a person who loves the outdoors, is physically fit, and is diligent, that this profession can *definitely be the one for you!!*



NCSR Programs and Curriculum

The American Association of Community Colleges (AACC) currently lists 1,086 community colleges in the U.S. Among these colleges, 1997 Peterson's Educational Mailing Lists Services *registers approximately 222 technical degree programs in Agriculture, 101 in Forestry, and 58 in Natural Resources/Wildlife; additionally, approximately 20 programs exist in Geographic Information Systems.*

Partnering and collaborative efforts have greatly increased among community colleges in the last decade, and the NSF/ATE program deserves a great deal of credit towards promoting these new ways of community colleges doing business. Furthermore, the AACC, Phi Theta Kappa, and others, including the Partnership for Environmental Technology Education (PETE), are adding to this effort. The resulting intercampus interaction, even across the United States, is truly benefitting community college programs, which otherwise may operate in almost complete isolation. The NCSR is a prime example of how a consortium of community colleges is sharing ideas and innovations in a collaborative effort to improve natural resource programs. Students are the ultimate beneficiaries of this collaboration.

Core Curricula in Environmental Science and Mathematics

Environmental Science as a Model for NCSR Curriculum

Wynn W. Cudmore, Ph.D.
NCSR Principal Investigator

Environmental Science as "Core Curriculum"

NCSR curriculum represents a significant change from traditional natural resource education at many institutions. Among those curriculum characteristics is an increase in the mathematics and science required for these programs. Among NCSR lead colleges, although programs were free to incorporate these topics into courses as they saw fit, one course sequence – *Environmental Science* – was proposed as a model that included those concepts and experiences that were considered important enough to include in all curricula. Lead program developers at each lead college were provided with an "enhanced syllabus" (see p. 29) for this course and encouraged to incorporate main elements of the course into the revised curriculum.

Environmental Science (Bi 131, 132, 133) was developed in 1995-96 at Chemeketa Community College as a sequence of three courses that addresses environmental topics. Each 4-credit course requires a 3-hour lab that meets once per week and 3 hours of lecture.

SCANS —
The Secretary's Commission on Achieving Necessary Skills

The Secretary's Commission on Achieving Necessary Skills (SCANS) was appointed by the Secretary of Labor to determine the skills our young people need to succeed in the world of work. The Commission's fundamental purpose is to encourage a high-performance economy characterized by high-skill, high-wage employment ... [the] primary message to schools is this: look beyond the schoolhouse to the roles students will play when they leave to become workers, parents, and citizens.

The approach is based on the premise that a high-performance workplace requires workers who have a solid foundation in basic literacy and computational skills, in thinking skills necessary to put knowledge to work, and in the personal qualities that make workers dedicated and trustworthy. High-performance workplaces also require competencies: the ability to manage resources, to work amicably and productively with others, to acquire and use information, to master complex systems, and to work with a variety of technologies. This combination of foundation skills and workplace competencies is called "workplace know-how", which is described as follows:

Learning a Living: A Blueprint for High Performance — A SCANS Report for America 2000

[Executive Summary], U.S. Dept. of Labor, April 1992

Workplace Competencies

Effective workers can productively use:

Resources — they know how to allocate time, money, materials, space, and staff.

Interpersonal Skills — they can work in teams, teach others, serve customers, lead, negotiate, and work well with people from culturally diverse backgrounds.

Information — they can acquire and evaluate data, organize and maintain files, interpret and communicate, and use computers to process information.

Systems — they understand social, organizational, and technological systems; they can monitor and correct performance; and they can design or improve systems.

Technology — they can select equipment and tools, apply technology to specific tasks, and maintain and troubleshoot equipment.

Foundation Skills

Competent workers in the high-performance workplace need:

Basic Skills — reading, writing, arithmetic and mathematics, speaking, and listening.

Thinking Skills — the ability to learn, to reason, to think creatively, to make decisions, and to solve problems.

Personal Qualities — individual responsibility, self-esteem and self-management, sociability, and integrity.

The courses may be considered "Environmental Science for the Citizen", with emphasis on those concepts and issues that in my judgement should be understood by all citizens. The approach is science-based, and a distinct effort is made to present opposing viewpoints in contentious environmental issues. The sequence has been added as a new requirement for students in the Forest Resources Technology Program at Chemeketa where it serves primarily to introduce students to basic ecological concepts and environmental issues that relate to natural resource management.

The courses are targeted towards several audiences including:

- students in natural resource areas (e.g. Forestry, Fish and Wildlife, Agriculture)
- transfer students in areas other than biology who need a lab science course or sequence
- biology majors who wish to broaden their background in environmental biology
- anyone interested in learning more about environmental issues

Standards for Curriculum Development

The courses were developed to address the Secretary's Commission on Achieving Necessary Skills (SCANS) competencies (U.S. Dept. of Labor, 1993). These competencies were developed at the request of the Secretary of Labor in an effort to identify those skills required to be successful as a worker in a high performance workplace. Today's workplace requires workers who have a solid foundation in basic literacy and computational skills, in the thinking skills necessary to put knowledge to work, and in the personal qualities that make workers dedicated and trustworthy. High performance workplaces also require other competencies, such as the ability to work amicably and productively with others, to acquire and use information, to master complex systems and to work with a variety of technologies.

In addition to SCANS competencies, the courses attempt to improve basic science literacy by building on the National Science Education Standards established for grades 9-12 (National Research Council, 1996). Course content and laboratory activities are designed to provide students with additional opportunities to gain an understanding of the natural world as scientists see it. *Environmental Science* addresses many of the content areas for both life and physical science identified in these standards. Among these, the following topic areas are emphasized:

- the interdependence of organisms
- matter, energy and organization in living systems
- energy in the earth system
- geochemical cycles
- population growth
- natural resources
- environmental quality
- science and technology in local, national and global challenges
- science as a human endeavor
- nature of scientific knowledge
- historical perspectives

General Goals for Environmental Science

1. Introduce students to science as a way of knowing things
2. Introduce students to basic ecological concepts
3. Introduce students to environmental problems at three scales — local, national and global
4. Work cooperatively in small groups
5. Communicate effectively in written and oral formats
6. Apply appropriate technology to scientific exploration
7. Access and use supplemental information relevant to course topics
8. Increase hands-on experiences that require critical thinking
9. Emphasize field experiences

National Science Education Standards

> *"Students should develop an understanding of what science is, what science is not, what science can and cannot do, and how science contributes to culture."*

The *National Science Education Standards* present a vision of a scientifically literate populace. They outline what students need to know, understand, and be able to do to be scientifically literate at different grade levels. They describe an educational system in which all students demonstrate high levels of performance, in which teachers are empowered to make the decisions essential for effective learning, in which interlocking communities of teachers and students are focused on learning science, and in which supportive educational programs and systems nurture achievement. The *Standards* point toward a future that is challenging — yet attainable.

> *"Learning science is something students do, not something that is done to them."*

The underlying goals for the *National Science Education Standards* are to educate students who are able to:

- experience the richness and excitement of knowing about and understanding the natural world
- use appropriate scientific processes and principles in making personal decisions
- engage intelligently in public discourse and debate about matters of scientific and technological concern
- increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically-literate person in their careers

National Science Education Standards, National Research Council, National Academy Press, Washington, DC, 1996

10. Use ecosystem management as a major theme in natural resource management
11. Introduce students to societal aspects (political, economic, philosophical, etc.) of environmental issues
12. Apply mathematical concepts to investigations in environmental science

Each of these goals is discussed in detail below:

1. Science as a way of knowing things

Students are introduced to science as a process in lecture where it is contrasted with non-scientific approaches including pseudoscience. Several laboratories are open-ended and investigative in nature (see table – page 28) and require students to design experiments or make observations, record and present information in graphs and draw conclusions from this information. Students are encouraged to recognize the difference between "what we want to believe" and "what we have evidence to believe".

2. Introduce students to basic ecological concepts

Environmental Science I sets the foundation for the study of environmental problems by examining ecological principles such as ecosystem structure and function, community composition and interactions, population characteristics and population growth. Knowledge of these principles is required for understanding of environmental problems in later courses.

3. Introduce students to environmental problems at local, national and global scales

Global environmental issues such as deforestation, global warming, ozone depletion, loss of biodiversity and national issues such as the Endangered Species Act, air and water pollution, water supply and management, and agriculture represent the majority of environmental issues examined in the sequence. Although students should be aware

The National Science Foundation reports that 75% of Americans cannot pass a basic science quiz that asks questions like whether the center of the earth is hot (it is) or if humans and dinosaurs lived at the same time (dinosaurs were extinct for 60 million years before humans arrived).

90% of corporate executives say science literacy is becoming critical for even entry-level jobs.

"Science Illiteracy", Hope Healthletter of the Hope Heart Institute, June 1997, Vol. XVII, No. 6

Cited sources: National Science Foundation and Bayer Foundation of environmental issues at broad scales, they may find it easier to relate to those in their local communities. I have found weekly reading of selected articles in a regional agricultural newspaper *(Capital Press)* to be an effective method of exposing students to the complexity of local and regional environmental issues. Information on local issues is brought out in discussions in lecture and laboratories. Field trips to various local sites familiarize students with local flora and fauna and different perspectives on local environmental problems. In addition to characterizing environmental problems, students are made aware of those steps that are being taken to address these problems and are challenged to propose their own solutions.

4. Work cooperatively in small groups

Most laboratories require students to work cooperatively in groups of 3 or 4 to produce a "lab product". Additionally, students often meet outside of class time to prepare lab products, oral or written presentations or prepare for exams.

5. Communicate effectively in written and oral formats

The ability to communicate effectively varies considerably from student to student. A number of course activities allow students the opportunity to practice writing skills. Some examples include answers to essay and short answer type questions on exams, a technical report that conforms to the format in scientific journals (introduction, methods and materials, results, discussion), weekly reviews of journal articles and weekly lab products. Each term, students are responsible for at least one oral presentation to be presented to the class. These take the form of debates (human population issue), and short presentations on an aspect of the Northwest Salmon and Land Use issues. Laboratory time is generally used for these activities. In addition to formal presentations, students in *Environmental Science III* are responsible for leading a discussion on a relevant article. This is done in a seminar-like format. Spontaneous, informal discussions occur throughout the sequence of courses.

6. Apply appropriate technology to scientific exploration

The appropriate use of technology is an essential element of modern science education. Students in *Environmental Science* use technology in the laboratory, in the field and to access information outside of class. Examples include:

Laboratory Technology:

Soil testing kits	Limnology test kits
Spectrophotometers	Digital calipers
Electronic balance	Calculators
Compound microscope	Computers
Dissecting microscope	Muffle furnace
Aerial photographs	Topographic maps

Field Technology:

Light meters	Ceptometer
Digital anemometers	Compass
Field thermometers	pH meters
Stream invertebrate samplers	Dissolved oxygen meters
Digital thermohygrometers	

At Chemeketa's *Aquatic Ecology Laboratory*, we have installed an environmental monitoring system from Davis Instruments of Hayward, California that will be used to measure physical variables such as air temperature, rainfall, relative humidity and solar radiation. These data will be correlated with biological changes in outdoor tanks during student experiments. The data can be recorded at preset intervals, stored and displayed graphically. Using available software and a modem, students and faculty are able to access this information remotely from computers on campus.

'Advanced Technicians' in Natural Resource Fields

Defined: literate associate degree graduates with the ability to think analytically, work cooperatively with others, and who possess skills in communication, mathematics, science, and technology that can be applied to complex job-based technical tasks and solving problems in their specific discipline.

"Advanced Technicians" are technicians with higher-level skills to meet the requirements for a world class Twenty-First Century workforce.

Students in "Advanced Technological Education" should:

- Expand their "sphere of understanding" by considering the "why" of what they are doing
- Understand "systems" as well as elements of them
- Be exposed to "Real Time" problems of business through modeling; (e.g., Applied Forest Economics)
- Possess greater understanding of mathematics & science
- Be able to adapt to changing technologies
- Be competent with computers and various software programs

"Advanced Technological Education Programs" should:

- Integrate technical skills with SCANS competencies
- Incorporate core course sequences in Ecosystem or Environmental Sciences, and Geographic Information Systems technology, with an underlying philosophy of Ecosystem Management
- Include mathematics through basic statistics
- Focus on creating "generalists" rather than "specialists" for the workplace
- Recognize the need for continuous improvement & change
- Include better communication/analytical program elements
- Incorporate outcomes based on greater understanding of technologies available and needs of employers
- Incorporate budgeting and time management skills

Definitions & Key Features developed by the Northwest Center for Sustainable Resources staff and advisory committees, May 1997.

7. Access and use supplemental information relevant to course topics

Environmental science is a dynamic field of study that requires continual updating of curriculum. The transfer of pertinent information from current research into the technical curriculum is seen as an essential responsibility of curriculum developers. This requires regular review of pertinent literature and attention to current topics. Partnerships with university research faculty, agencies, research facilities, industry, professional societies, etc., are established to serve as sources of information.

A number of activities are designed with the secondary goal of getting students to access current information beyond their textbook and handouts. Students are required to access written materials in libraries (review articles in scientific literature, primary articles in popular literature, and books), information available through the Internet (e.g. Oregon Climate Service, San Diego Zoo), and conduct interviews with knowledgeable persons. In preparation for oral presentations on Pacific Salmon issues, for example, students are required to access at least five current and substantial sources. These included recent articles published in popular and scientific journals and interviews with biologists with the U.S. Fish and Wildlife Service, Oregon Department of Fish and Wildlife, Bonneville Power Administration, U.S. Forest Service, Bureau of Land Management, and Native American tribes. Also, students access County Soil Surveys prepared by the Natural Resources Conservation Service.

8. Increase hands-on experiences for students that require critical thinking

Laboratories and investigative field experiences are viewed as essential elements in the education of the advanced technician. Since modern natural resource management is a science-based endeavor, these experiences should require a scientific problem solving approach on the part of students. Students are *implementing the process of science* — posing questions, hypothesis testing, experimental design, data collection, data summary and presentation, analysis and interpretation.

In a Soils Laboratory, for example, students measure a number of physical and biological parameters of soils at various sites and draw comparisons between them. Soil nutrient levels, pH, organic content, and soil invertebrates — all are evaluated. County Soil Surveys are used in conjunction with this student-collected information to determine an appropriate land use for a site based on soils. Students describe their rationale for this land use in a written report.

9. Increase field experiences for students

In 1996-97, *Environmental Science* students attended six field trips at various locations in western Oregon. This number is expected to increase somewhat in 1997-98. Field trips are of two types — "investigative/analytical" and "observational" (see table – page 28). Investigative field trips require students to carry out experiments and observations in natural settings. *The Evaluation of the Edge Effect* is an example described in the enhanced syllabus. Observational field trips do not involve student measurements; rather, the natural setting is used as a visual aid in the discussion of relevant topics. For example, in a field trip to Baskett Slough National Wildlife Refuge, discussions are about environmental restoration, the national wildlife refuge system and the role of small reserves in the preservation of biodiversity. Students also identify native species of birds that use the refuge. Similarly, in a field trip to the Confederated Tribes of Grand Ronde Reservation, a Tribal Fish and Wildlife Biologist leads the discussion about natural resource management on tribal lands and stream restoration efforts.

Where is "Ecosystem Management" Being Implemented?

Wynn W. Cudmore, Ph.D.

Ecosystem Management (EM) has been a topic of interest in:

- National and international conferences including the 1996 *Seventh American Forest Congress* and the *Canadian Institute of Forestry* 1996 Annual Meeting
- The *Journal of Forestry*, which has published a number of major articles on EM and adaptive management in recent issues. Articles in the February and June 1996 issues address EM in non-industrial, private forests
- *BioScience: 45(3)* — which featured a series of articles about implementing ecosystem management in large rivers and floodplains

Some examples of large-scale projects that are serving as models in implementing ecosystem management:

- *Clayoquot Sound* — Vancouver, British Columbia
- *Eastside Ecosystem Management Project* — Eastern Washington
- *Columbia Basin Ecosystem Management Project*
- *Northwest Forest Plan* (Option 9)
- *Greater Yellowstone Ecosystem*
- *Everglades Restoration Project* — Florida
- *Wildlands Project* — North America

Industry/Agency implementation of EM:

(from personal communication, June 1997, with Steve Eubanks, Chippewa National Forest, MN, Forest Supervisor and NCSR National Visiting Committee Chair)

- The U.S. Forest Service adopted EM as a major emphasis in 1993. Concepts of EM are being implemented on National Forests across the United States
- Boise Cascade Corporation is developing a plan for managing a 300,000-acre area in Minnesota which will serve as a demonstration site for EM; another demonstration project is planned on the company's Idaho lands

10. Use ecosystem management as a major theme in natural resource management

Ecosystem management has been proposed as a guiding management philosophy for natural resource use. The concept has achieved a great degree of acceptance in scientific, socioeconomic and political circles. Ecosystem management is a recurrent theme in *Environmental Science II* which addresses major natural resource management issues. More detail on ecosystem management will be posted on the NCSR web site.

11. Introduce students to societal aspects of environmental issues

The social aspects of science are rarely addressed in science courses. Science is often portrayed as a stand alone discipline. For students to fully appreciate the implications of scientific findings and to understand why scientifically-valid solutions are not necessarily socially-valid solutions, social aspects must be addressed. *Environmental Science* students are exposed to societal aspects of environmental issues in all courses of the sequence. Examples include:

Bi 131 - Students discuss the results of an national opinion poll on environmental values and attitudes after they have responded to the poll questions themselves.

Bi 132 - Ecosystem management is a major theme and contains a strong social component. Students experience efforts to meet human needs in natural resource management through case studies and field trips. Economic realities of natural resource management are addressed as well as ecological aspects.

Bi 133 - Environmental policy, environmental economics, environmental values, environmental planning, and environmental ethics are major topics in this course.

12. Application of mathematical concepts

The mathematical background of *Environmental Science* students varies tremendously. As mathematics standards are raised for natural resource programs, it is essential that these new skills be applied in other courses in the program. There has been an effort in the development of *Environmental Science* to provide students with opportunities to apply appropriate quantitative skills. These include:

- Generation and interpretation of various types of graphs
- Descriptive statistics — calculation of mean, standard deviation, standard error
- Interpolation
- Estimation
- Calculation of surface areas, volumes and densities of regular and irregular objects
- Measurement — metric and English units on a wide variety of devices
- An understanding of accuracy and precision
- Spreadsheets as tools for summarizing and presenting data

Table.
Environmental Science Laboratories Summary

Laboratory Type	Number
Investigative/Analytical Field experiences	2
Observational Field experiences	4
Investigative/Analytical Laboratory	9
Observational Laboratory	1
Case Study Laboratory	7
Oral presentations/debates	4

For additional reading on Ecosystem Management — Resources and Examples, see page 89.

NCSR's "Enhanced Syllabi"

Wynn W. Cudmore, *NCSR Principal Investigator*

NCSR personnel and curriculum developers agreed that one of the products produced by NCSR would be "Enhanced Syllabi" of courses that were developed or modified as a result of NCSR funds. An "Enhanced Syllabus" is a document that provides a detailed account of content and resources for a course that could be passed on to a colleague at another institution who wishes to develop and teach the same or similar course. NCSR Test Sites will be among the first recipients of these enhanced syllabi and they will evaluate their suitability prior to national dissemination. "Enhanced Syllabi" are developed for *Environmental Science* courses at Chemeketa Community College, and these are proposed as the model for curriculum developers.

Although the format of "Enhanced Syllabi" is standardized, flexibility will be built in to accommodate different types of courses. Thus, a list of required and optional elements was prepared, and follows:

The "Enhanced Syllabus" *must* include:

1. General course information (title, credits, prerequisites, lecture/laboratory hours, etc.)
2. Recommended text(s)
3. Course description
4. Course objectives
5. Course topics - detailed in standard outline form
6. Laboratories, field experiences or other activities (including actual protocols and student handouts)
7. Sample exams

The "Enhanced Syllabus" may include, when appropriate:

1. Student study guides
2. Supplemental reading lists (required reading by students beyond texts)
3. Audiovisual materials (e.g. titles and sources for videotapes)
4. Software (titles and sources for computer software used in course)

Mathematics: in Community Colleges and NCSR Curriculum

Mathematics forms the core for many community college programs, and it plays a central role in natural resource technology programs. The following articles describe that role for mathematics in Advanced Technology curricula. Susan Forman, Bronx Community College, serves as an advisor to NCSR on the Center's National Visiting Committee. Franz Helffenstein, Central Oregon Community College, is a math instructor and current committee chair for AMATYC. Chemeketa's Ara Andrea is a forestry instructor, with extensive background in mathematics.

Susan L. Forman, Ph.D.
Professor of Mathematics
Bronx Community College
City University of New York

Mathematics Standards and Advanced Technological Education

Mathematics education at the community college serves multiple purposes, including preparation for work, for citizenship, and for further study. Of these, preparation for productive work takes priority in the minds of many students and the public. Two-year colleges, like all educational institutions, now face the daunting challenge of preparing all their students for a rapidly changing world economy. In particular, in this era of advanced technology, global competitiveness, and an increasing reliance on telecommunications, more students than ever need to learn more mathematics than anyone has ever tried to teach on so massive a scale.

This challenge is reflected to some extent in the various sets of standards that have emerged from the mathematics community in recent years. In 1989 the National Council of Teachers of Mathematics (NCTM) issued their *Curriculum and Evaluation Standards for School Mathematics.* This document offers teachers, administrators, parents, and students a vision of mathematics designed to enhance the teaching and learning of mathematics by all students. It addresses three important aspects of mathematics for grades K-12 — problem solving, communication, and reasoning — and provides a general framework for curriculum development. Although not without its critics, the NCTM standards have helped to focus national discussion on what every student should know and be able to do in mathematics upon leaving high school.

Six years later, the American Mathematical Association of Two-Year Colleges (AMATYC) published its standards. *Crossroads in Mathematics: Standards for Introductory College Mathematics Before Calculus* builds on the NCTM standards by describing how the first two years of collegiate mathematics should enhance what students learned in high school. *Crossroads* also includes recommendations for what mathematics students should study in college if they did not complete an 11-year school mathematics program as recommended by NCTM, or if they have been out of school for some period of time before entering postsecondary education.

Mathematics education for a technologically advanced society is addressed in both sets of standards. The NCTM *Standards* (page 4) cites 1987 testimony to the National Science Board by Henry Pollack, formerly of Bell Labs, and currently affiliated with Teachers College, Columbia University, who summarized the mathematical expectations for new employees in industry:

I. The ability to set up problems with the appropriate operations.

II. Knowledge of a variety of techniques to approach and work on problems.

III. Understanding of the underlying mathematical features of a problem.

IV. The ability to work with others on problems.

V. The ability to see the applicability of mathematical ideas to common and complex problems.

VI. Preparation for open problem situations, since most real problems are not well formulated.

VII. Belief in the utility and value of mathematics.

In its section on Technical Mathematics, AMATYC's *Crossroads* states that the courses that provide technical students with their required mathematics must provide a broad base of mathematical knowledge. Such courses also must contain the appropriate rigor and depth to allow students to study any additional mathematics that their careers may require and to ease the transition from one technical area to another or from an associate degree program to a baccalaureate program.

The messages are clear. Every mathematics curriculum should provide extensive experience solving authentic workplace-based problems based on real data while exposing students to those abstract mathematical concepts essential to the habits of mind all problem solvers need. Watering down curricula or teaching mathematical concepts on an "as needed" basis will not accomplish these goals and will not prepare students to meet the challenges they will face in the job market. Instead they will limit students to entry-level, low-paying jobs with few prospects for advancement.

It follows that community college mathematics programs must maintain high standards for all students in all courses, including developmental courses designed to prepare students to study college-level mathematics. As leaders of one important part of our nation's postsecondary educational system, community college faculty must set high expectations for students and provide them with the kinds of experience they need to succeed in the workplace and in life.

Ara Andrea, Ph.D.

Forest Resources Technology Instructor
Chemeketa Community College

Northwest Center for Sustainable Resources — Integrating Mathematics into Natural Resources Technical Curriculum

To meet the increasingly complex, multifaceted needs of the field of Natural Resources (NR) management, and to better prepare NR technicians for the workplace, community college curricula must focus on conveying a better understanding of algebraic, trigonometric, geometric, and statistical principles. With advanced technological tools, such as Geographic Information Systems, remote sensing, and Global Positioning Systems being used to record and manipulate data in many realms of land management, the ability to apply mathematical principles is essential in understanding how these inventory tools are used. A cognitive grasp of trigonometry and geometry is critical in understanding applications in land surveying, mensuration, and silviculture. Even the "traditional" tools of forest data acquisition, e.g., clinometers, relaskops, and diameter tapes cannot be comprehended without a firm understanding of trigonometric functions, Pythagorean theorem, and circle geometry. Statistical concepts behind sampling, inventorying, estimating volumes, and estimating populations are additional educational needs of technicians in NR management. Students, historically, have come to Northwest colleges with math skills that do not prepare them to move forward in this arena of advancing technology. As a result, as technology in the NR field increases, it becomes increasingly difficult for educators to keep students prepared. Ideally, applications from the NR field will be integrated into the technical math curricula so that NR instructors move from a focus of, "How do you get the numbers?" to "What do the numbers mean?"

Franz Helffenstein, Ph.D.

Associate Professor, Mathematics Department
Central Oregon Community College, Bend, OR and *Chair*, AMATYC, Technical Mathematics/AAS Committee

A Technical Mathematics Curriculum for a State-of-the-Art Workforce

To better prepare students to meet the challenges of today's society, the Mathematics Department at Central Oregon Community College (COCC), in conjunction with the Professional-Technical Department, has been implementing a new curriculum which fosters the skills so crucial to success in professional technical occupations. Teamwork, technology, creative and critical thinking, and communication skills are crucial to success in today's professional world and are cornerstones of this reform effort.

Unlike most mathematics curricula, the driving force behind this curriculum is the direct needs of employers in the region. Our Forestry, GIS, CADD, EMT, Fire Science and Manufacturing programs are closely tied to local employers. As employers demand more of their employees and applicants, professional technical programs demand more from their supporting mathematics curricula. Clearly, modernizing the technical mathematics curriculum is essential to these programs.

At COCC, the Mathematics Department meets regularly with the faculty from professional technical programs. In addition, we meet with the Advisory Committee for Forestry programs — who include various employers, graduates, state foresters and university faculty. This has led to a one year sequence (8 quarter credits) at the Algebra and College Algebra level.

The sequence begins with real arithmetic, measurement, linear equations, algebraic manipulation, and graphing — as you would find in many Algebra I courses. In addition, there is a strong 2 and 3-dimensional geometry component. The second term consists of a two-credit trigonometry course which includes an introduction to vectors. The third term is an introduction to functions with an emphasis on creating technical reports which involve substantial mathematics.

Wherever possible, material is presented using applications from the students' program areas. In addition, programmable/graphing calculators, spreadsheets, technical writing, group work, and interdisciplinary projects are emphasized.

This has led to a curriculum that has received praise from students, professional technical faculty, and employers. However, there are some concerns, and they follow:

Problem: Few (if any) Technical Mathematics texts work well for this curriculum.

Solution: We are developing course materials in line with the NCTM reform standards.

Problem: There are increasing demands for more technology and higher level mathematics in the limited credits available.

Solution: Increase the number of credits in the sequence. To keep the total number of credits from increasing, make the first course a prerequisite course but not a program requirement. Students graduating from high school should meet this prerequisite, but often they do not.

Problem: Though the introductory course (4 quarter credits) is developmental, the second (2 credits) and third (2 credits) terms are still numbered as non-transfer though they are clearly at the college level. This can cause a significant hardship for students receiving financial aid, for students in retraining programs and for students transferring to another school.

Solution: Develop a national standard for college level A.A.S. mathematics courses. We would still expect to run the majority of our students through our introductory course but at least the later courses would be accepted as college level.

We believe that technical mathematics nationwide, statewide and specifically at COCC must continue to implement curriculum reform to prepare students for their professions. As industry calls for more technology, more teamwork and more mathematics (specifically statistics), we must evolve while continuing to follow the national reform movement standards. The result will be a continued state-of-the-art mathematics curriculum at COCC.

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Model Community College Programs

Northwest Center for Sustainable Resources

Lead Colleges

NCSR sets precedents in both forming a unique consortium of community colleges, and in instituting changes in partners' programs. These improvements will endure long after grant activities are finished. Programs have been restructured to provide ideal sequencing, and core courses have been developed or added; additionally, course content has been updated. The hope of the Center is that its efforts will be used as a model by others who seek to improve their programs. The next section describes NCSR programs.

Shasta College

Located in Redding, CA
Total Students: 10,500 Full Time: 6,700
Contact Person: Francis Duchi, 916-225-4684
E-mail: duchi@dlj.shasta.cc.ca.us
Center for Science, Industry and Natural Resources
NCSR Test Site: Blue Mountain Community College, Pendleton, OR

Agriculture Technology

Shasta College (http://www.shasta.cc.ca.us) is a lead college specializing in Agriculture Technology for the Northwest Center for Sustainable Resources (NCSR).

Natural resource management is undergoing significant changes as new philosophical approaches which emphasize resource management from an ecosystem perspective are being developed. Shasta College's Environmental Resources and Technologies Department (formerly Agriculture and Natural Resources) offers Agriculture, Equine, Horticulture, and Natural Resources Associate of Arts degree programs. Current theories and methods of ecosystem management, watershed analysis, and holistic resource management are being taught and courses have been added and upgraded based on the goals and objectives of NCSR.

The Agriculture program is emphasizing the Holistic Management (HM) model as a teaching tool. The essence of HM is that decisions relating to the quality of life, future landscape prescriptions, and economic production are derived from a goal statement in which a thorough understanding of ecosystem relationships is essential.

The 90-acre Holistic Management Lab at Shasta College provides student-directed learning, combined with hands-on opportunities in applying the HM model and ecosystem management concepts, to work toward sustainable agricultural practices.

Overall, the structuring of the Agriculture program strives to improve traditional methods of education by teaching a broader approach to environmental resource management. *Holistic Management* (AGRI 50) is a capstone course required during a student's last semester of the Associate of Arts degree program in Agriculture. This course serves to measure the effectiveness of the program's enhanced curriculum through the NSF/ATE grant. The course has been strengthened in a number of ways, including adding a semester-length project. This course as well as others will be widely available as a result of the NCSR partnership.

For Shasta's DACUM chart, turn to page 102.

Agriculture Technology
Associate of Arts Degree
Shasta College

First Semester, (Fall) Units

AGRI 51	Agriculture Records & Analysis	3
AGRI 52	Computers in Environmental Resources	3
AGRI 54	Resource Economics	3
ENVR 1	Career Planning for Environmental Resources	2
	(Learning Community with SPCH 54)	
ENVR 9	Environmental Resources Leadership	1
SPCH 54	Small Group Communication - (Learning Community with ENVR 1)	3

Second Semester, (Spring) Units

AGRI 19	Principles of Animal Science	3
AGRI 20	Plant Science	4
ENGL 1A	Reading and Composition	4
ENVR 44	Mechanical Technology for Environmental Resources	3
MATH 14	Introduction to Statistics	3

Third Semester, (Fall) Units

AGRI 56	Agriculture Practices	1-4
or		
ENVR 90	Environmental Resources Field Training	2-5
or		
ENVR 94	Worksite Learning	1-4
CHEM 6	Introductory Chemistry - Applied to the Environment	4
ENVR 24	Soils	3
	Social Science Course	3
	Multicultural/Living Skills Course	3

Fourth Semester (Spring) Units

AGRI 6	Career Placement - Agriculture	1
AGRI 50	Holistic Management	3
	Humanities Course	3

A.A. Degree Requirements

Major	50
Additional General Education	9
Electives	1
TOTAL	**60**

... as we approach the millennium, a new system of crop management called precision farming is bringing agriculture into the Information Age ... "modern" agriculture of the last 50 years has tended to treat whole tracts of land ... as great, homogenous plots of potting soil ... [as such,] some areas end up overfertilized; others don't get enough herbicide. Still others get the wrong seed variety — so costs soar and crop yields suffer.

Precision farming delivers more personalized attention ... Danny Keppel of the National Alliance of Independent Crop Consultants says, ... "If you spoon-feed each plant based on what it needs, it'll probably do better." ... You won't find bottle-fed rutabagas at the corner marker yet, but the first generation of precision farming systems is already in the field. Employing such innovations as Global Positioning Systems (GPS), computer mapping systems and a Star Trek-like crop monitoring system that uses beams of light to get a reading of "plant health", the technology is allowing farmers to collect and absorb unprecedented amounts of data about their fields and crops, and to tailor their husbandry to the findings. Lasers measure field topography ... and multiple soil samples are analyzed for fertility, salinity, pH, [etc.] ... Satellite images are used to pinpoint problem areas in the fields. Every [weedy area, sandy area, etc.] is recorded with GPS locators and is plotted out on maps so that the same area can be monitored year after year ... At harvest, electronic yield monitors built into combines automatically log the weight and quality of the crop.

... Field tractors are now equipped with on-board computers, and ["they" are] informed by field-specific databases, [to] control exactly where fertilizer is applied, and how much. Similar systems are under development for spraying pesticides and planting seed ... "It's like a kid in the candy store in terms of what we can do in the field now," says Bernie Poore, manager of Future Product Development at John Deere ...

2000, The Millennium Notebook, O Brave New Farm, Tilled by Satellite and Robot,
Newsweek, November 24, 1997, p. 14

Located in Aberdeen, WA
Total Students: 3,000 Full Time: 2,000
Contact Person: Don Samuelson, 360-538-4177
Science and Math Division
E-mail: dsamuels@ghc.ctc.edu
NCSR Test Site: Mount Hood Community College
Gresham, OR

Natural Resources/Fisheries Technology

Grays Harbor College [http://ghc.library.ctc.edu – click on "Academia", then - "Academic Divisions", then – "Natural Resources Technology Program"] is the lead college in Fisheries Technology for the Northwest Center for Sustainable Resources (NCSR). Grays Harbor College's Natural Resources Department includes a long-standing Fisheries Technology Program (formerly Fisheries and Wildlife), and more recently-implemented programs in Natural Resources Technology (started in 1995-96), and Geographic Information System (GIS) Technology (launched February 1997).

Through the NSF/ATE grant, major objectives have included curriculum development for new programs and revision of existing curricula. All

Natural Resources Technology

Associate of Applied Science Degree
Grays Harbor College

First Year, Fall Term Courses

CIS102	Introduction to Personal Computers	3
HIST264	PNW History	5
MATH103	Intermediate Algebra	5
NR120	Introduction to Natural Resources	5

First Year, Winter Term Courses

CHEM101 or	Introduction to Chemistry	5
CHEM111	General Chemistry 1	6
CIS150	Spreadsheet Applications	3
ENGL101	Expository/Argumentative Writing	5
FISH121	Introduction to Fisheries Management	3

First Year, Spring Term Courses

ENGL250	Technical Writing	5
PSYCH100 or	General Psychology	5
PSYCH106	Applied Psychology	3
SOC110	Introduction to Sociology	5
SPCH101	Fundamentals of Speech	3
	ELECTIVES	Variable

Second Year, Fall Term Courses

FISH215	Fisheries Biology	6
GEOL101	Physical Geology	5
NR130	Wildlife Management	5
	ELECTIVES	Variable

Second Year, Winter Term Courses

FISH220	Chemical Field & Lab Methods	6
NR140	Watershed Ecosystems (Systems and Functions)	5
*FISH 258/259	Cooperative Work Experience	1-5
	ELECTIVES	Variable

Second Year, Spring Term Courses

FISH221	Biological Field & Lab Methods	6
*NR240	Watershed Ecosystems (Analysis and Monitoring)	5
*FISH 258/259	Cooperative Work Experience	1-5
	ELECTIVES	Variable

*FISH 258/259 - Cooperative Work Experience, six (6) total credits required for AAS degree.

*NR240 - Watershed Ecosystems (Analysis and Monitoring) (5 cr.); and FISH 258/259 - Cooperative Work Experience (6-10 cr.) may be taught during summer quarter (some years) as a coordinated studies offering.

new and revised curricula include concepts and practices of ecosystem and adaptive management philosophies as they apply to sustainability of Pacific Northwest natural resources, including timber, fish and wildlife. Watershed analysis and ambient monitoring relating to riparian and stream ecosystems are primary areas of focus, and the GIS Technology program provides students "state-of-the-art" analytical tools for examining the complexities of aquatic, marine and terrestrial ecosystems. At least one GIS course will be integrated into both the Fisheries and Natural Resource degree programs. Graduates of these programs are being encouraged to also attain the GIS degree to maximize job opportunities. Four "capstone" field and laboratory courses are included among sophomore level offerings. These courses will emphasize physical, chemical and biological monitoring, and data collection and analysis. And importantly, industry-derived DACUM results and SCANS foundation skills are being integrated into all natural resources degree and certificate program offerings.

Grays Harbor College offered an NCSR-sponsored, one-week faculty institute (August 1997) titled *Collaborative Teaching and Learning In Natural Resources* for twelve high school and 2- and 4-year Natural Resources faculty. Participants were immersed in a team-taught, integrated "learning community" to learn an alternative pedagogy for teaching and learning. It was an especially challenging and highly rewarding experience for both students and faculty.

For Grays Harbor's DACUM charts, turn to pages 106 and 110.

Fisheries Technology
Associate of Applied Science Degree
Grays Harbor College

First Year, Fall Term Courses

CIS 102	Introduction to Microcomputers	3
HIST 264	PNW History	5
MATH103	Intermediate Algebra	5
NR 120	Introduction to Natural Resources	5

First Year, Winter Term Courses

CHEM 101	Introduction to Chemistry	5
CHEM 111	General Chemistry I	5
or		
ENGL 101	Expository/Argumentative Writing	5
FISH 122	Introduction to Aquaculture	3
FISH 121	Introduction to Fisheries Management	3

First Year, Spring Term Courses

CIS 111	Electronic Spreadsheet Applications	3
ENGL250	Technical Writing	5
POLS 205	State/Local Government	5
or		
PSYCH100	General Psychology	5
or		
PSYCH106	Applied Psychology	3
SPCH 101	Fundamentals of Speech	3

Second Year, Fall Term Courses

BIOL 130	Wildlife Management	5
FISH 215	Fisheries Biology	6
GEOL 101	Physical Geology	5
or		
OCEAN101	Intro to Oceanography (Spring Quarter)	5
*FISH 258/259	Cooperative Work Experience	1-5

Second Year, Winter Term Courses

FISH 220	Chemical Field & Lab Methods	6
FISH 222	Advanced Aquaculture	3
*FISH 258/259	Cooperative Work Experience	1-5
	ELECTIVES	Variable

Second Year, Spring Term Courses

FISH 221	Biological Field & Lab Methods	6
BIOL 114	Marine Biology	5
OCEAN101	Introduction to Oceanography	5
or		
GEOL101	Physical Geology (Fall & Winter Quarter)	5
*FISH 258/259	Cooperative Work Experience	1-5
	ELECTIVES	Variable

*FISH 258/259 - Cooperative Work Experience, six (6) total credits required for AAS degree.

*NR240 - Watershed Ecosystems (Analysis and Monitoring) (5 cr.); and FISH 258/259 - Cooperative Work Experience (6-10 cr.) may be taught during summer quarter (some years) as a coordinated studies offering.

CENTRAL OREGON COMMUNITY COLLEGE

Located in Bend, OR
Total Students: 3,200 Full Time: 1,200
Contact Person: Art Benefiel, 541-383-7703
Forestry and GIS
E-mail: art_benefiel@cocc.edu
NCSR Test Site:
Forestry: Allegany College of Maryland, Cumberland, MD
GIS: Grays Harbor College, Aberdeen, WA

Forest Resources/Eastside and GIS

Central Oregon Community College (COCC), (http://www.cocc.edu/) located on the eastern edge of the Cascade Mountains in Bend, Oregon, is serving as the lead college in Forest Resources/Eastside and GIS Technology programs for the Northwest Center for Sustainable Resources (NCSR).

About 1,200 full-time students attend credit classes at COCC and about 2,000 take credit classes on a part-time basis. One-third of the students enroll in one- and two-year training programs for employment in business, industry, the trades, or government service. The remaining two-thirds enroll in courses which form the freshman and sophomore years of a four-year college program.

GIS—A Note of Caution

Some concerns should be raised regarding Geographic Information Systems ... GIS is not an easy tool to manipulate and use. In our enthusiasm about the possibilities for implementing GIS in the curriculum, we must be cautious not to mislead those teachers eager to provide additional tools for students. Teachers must be offered appropriate inservice situations to learn the powerful opportunities that GIS, as well as other technologies, can bring to their classroom.

"Defining GIS — A Note of Caution", Kay Weller, Univ. of Colorado Dept. of Geography, from the First National Conference on the Educational Application of Geographic Information Systems (EdGIS) Conference Report, Jan. 27-29, 1994, Washington, D.C. page 117.

Geographic Information Systems Technology

Associate of Applied Science (AAS) Degree
Central Oregon Community College

First Year, Fall Term Courses		Lecture	Lab	Credits
MET 275A	AutoCAD I	2	4	3
WR 121	English Composition	3	0	3
MTH 85	Technical Math	4	0	4
BA 131	Business Data Processing	3	2	4
*FE 210A	Intro. Forestry Survey	2	4	3

First Year, Winter Term Courses		Lecture	Lab	Credits
LIB 127	Library Skills	2	0	2
*FOR 220B	Resource Measurement	2	4	3
*BA 205	Database Management	3	2	4
MTH 86	Tech. Math II	2	0	2
*GEOG 211	Computer Cartography	2	3	3
*FE 210B	Intro. Forestry Survey II	1.5	6	3

First Year, Spring Term Courses		Lecture	Lab	Credits
*GEOG 265	Geographic Info. Systems	2	3	3
WR 227	Technical Report Writing	3	0	3
*FOR 220A	Aerial Photo Interpretation	1.5	6	3
BA 114	Intro. to Operating Systems	2	2	3
MTH 87	Tech. Math III	2	0	2
MET 275B	AutoCAD II	2	4	3

First Year, Summer Term Courses				
CWE	Coop Work Experience	0	99	3

Second Year, Fall Term Courses		Lecture	Lab	Credits
6.530	AutoCAD Tool Dev.	1	3	2
*6.505	Civil Drafting/Survey	2	4	4
HHP 252A	Fitness/First Aid	3	1	3
*GEOG 280	GIS Dataset Creation	2	4	3
GEOG 288	Remote Sensing	3	3	4

Second Year, Winter Term Courses		Lecture	Lab	Credits
*GEOG 106	Economic Geography	3	0	3
—	General Ed. Elective	3	0	3
—	General Ed. Elective	3	0	3
GEOG 282	Arc/Info.	2	3	3
GEOG 285	Data Sources/Concerns	2	3	3

Second Year, Spring Term Courses		Lecture	Lab	Credits
6.585	GIS Practicum	2	6	3
*6.535	Advanced CADD	1	3	2
—	General Ed. Elective	3	0	3
GEOG 287	Analysis of Spatial Data	2	3	3
*PSY 207	Applied Psychology	3	0	3

Courses with a single * are offered in that term only.

The two-year Associate of Applied Science degree program at COCC in Forest Resources Technology (FRT) provides students with the education and practical skills needed to succeed as technicians in forestry and related natural resource fields throughout the western United States. Course work includes biological sciences, natural resources, surveying, mathematics and statistics, computer skills and other subjects. COCC's forestry program is recognized by the Society of American Foresters (see Greg Smith's article, page 74).

The Geographic Information Systems (GIS) program at COCC prepares students for employment as GIS technicians as well as providing a basis for understanding the place of GIS in problem analysis and decision making. The curriculum includes course work based on GIS computer software, and course work in surveying, natural resources, mathematics and other topics.

Through the NSF/ATE grant, COCC has made important curriculum improvements in ecosystem science, mathematics and statistics in the FRT and GIS programs. As a result, technicians entering the workforce from these programs will be better prepared to address complex contemporary natural resource management issues.

For Central Oregon's DACUM chart, turn to page 115.

Forest Resource Technology

Associate of Applied Science (AAS) Degree
Central Oregon Community College

First Year, Fall Term Courses		Lecture	Lab	Credits
FOR241A	Dendrology I	1.5	6	3
FE 210A	Intro. to Forest Survey I	2	4	3
FOR 240A	Forest Ecology	2	4	3
MTH 85	Tech. Math I	4	0	4
WR 121	English Comp.	3	0	3

First Year, Winter Term Courses		Lecture	Lab	Credits
FOR 220B	Resource Measurements	3	4	4
FE 210B	Intro. to Forest Survey II	1.5	6	3
GEOG 211	Computer Cartography	2	3	3
FOR 112	Computer Application	2	3	3
MTH 86	Tech. Math II	2	0	2
WR 227 or WR 214	Tech. Report Writing or Bus. Communications	3	0	3

First Year, Spring Term Courses		Lecture	Lab	Credits
8.132	Forest Entomology and Pathology	2	4	3
FOR 220A	Aerial Photo	1.5	6	3
8.130	Wildland Fire Science I	1	4	2
FOR 241B	Dendrology II	1.5	6	3
8.134	Forest Stand Dynamics	2	4	3
MTH 87	Tech. Math III	2	0	2

Second Year, Fall Term Courses		Lecture	Lab	Credits
FOR 220C	Resource Sampling	3	4	4
FOR 240B	Wildlife Ecology	2	4	3
8.214	Timber Harvesting Systems	2	7	4
8.212	Silvicultural Methods	2	4	3
8.210	Wildland Fire Science II	1	4	2

Second Year, Winter Term Courses		Lecture	Lab	Credits
8.224	Forest Cost Analysis	2	3	3
8.222	Forest Contracts and Business	3	0	3
GEOG 265	Geographic Info. Systems	2	3	3
8.220	First-Line Supervision	3	0	3
—	General Ed. Course	3	0	3

Second Year, Spring Term Courses		Lecture	Lab	Credits
8.230	Forest Resource Planning	2	4	3
—	Gen. Ed Courses (2)	6	0	6
—	Required Option Course	3 credits		
FOR 260	Conservation of Natural Resources	2	4	3
HHP 252A	Fitness/First Aid	3	1	3

Recommended Option Courses		Lecture	Lab	Credits
FP 210	Wood Tech. and Utilization	3	4	4
FOR 195 WC	Wilderness Concepts	1	0	1
FOR 195 WI	Wilderness Internship	0	9	2
FOR 251	Recreation Resources Management	2	4	3
FOR 111	Intro. to Forestry	3	4	4
8.191	Cooperative Work Experience	3	0	3
FW 251	Principles of Wildlife Conservation	3	0	3
FE 210C	Intro. Forest Survey III	2	4	3
FOR 199	Spec. Studies/Forestry	Variable		
MFG 103	Intro. to Welding	2	6	4
FW 199	Spec. Studies/Fish/Wildlife	Variable		
9.889	Fire Ecology & Effects	2	3	3
9.887	BEHAVE - Users	2	3	3
HHP 295	Health & Fitness	1	2	2
—	Approved Business Course	3	0	3
—	Approved Speech Course	3	0	3
8.213	Chainsaw Use & Maintenance	2 credits		
8.216	Directional Timber Falling	1 credit		

CHEMEKETA
COMMUNITY COLLEGE

Located in Salem, OR
Total Students: 41,000 Full Time: 11,000
Contact Person: Tim Dunn, 503-399-5253
Forest Resources Technology
E-mail: dunt@chemek.cc.or.us
NCSR Test Site: Southwestern Oregon Community College, Coos Bay, OR

Forest Resources/Westside

Chemeketa Community College (CCC) (http://www.chemek.cc.or.us) is the lead college in Westside Forest Resources for the Northwest Center for Sustainable Resources (NCSR). CCC's Forest Resources Technology (FRT) program, through the NSF/ATE grant, is undergoing curriculum updating to ensure that students are well prepared to work in today's complex field of forestry.

Chemeketa is located on the west side of the Cascade mountain range along the Willamette River, and it is ideally located for students to study Douglas-fir-dominated forests of the Coast and Cascade mountain ranges. As forest resource management undergoes significant changes, new philosophical approaches which emphasize resource management from an ecosystem perspective are being developed. CCC's FRT program is undergoing major changes and in effect, the program is providing a more broadly-focused, ecosystem-based curriculum which incorporates environmental science, watershed analysis, wetland restoration, forest policy, sociology, more relevant mathematics and state-of-the-art technologies (e.g., GIS, GPS), along with basic forestry courses.

Overall, the restructuring of the Forest Resources Technology program is striving to improve traditional methods of education with collaborative learning approaches to produce a more comprehensive program. For example, *Forest Management Problem Solving* (FRT095) is a capstone course developed under the NSF/ATE grant which is required during a student's last quarter. This course serves to measure the effectiveness of the program's enhanced curriculum. This course, as well as others, will be available as a result of the NCSR partnership.

For Chemeketa's DACUM chart, turn to page 119.

Forest Resources Technology
Associate of Applied Science Degree
Chemeketa Community College

		Credits
Term 1 (Fall)		
BI131	Environmental Science 1	4
FT051	Introduction to Forest Resources	4
FT061	Tree and Shrub Identification I	3
MTH081	Technical Mathematics	4
Term 2 (Winter)		
BI132	Environmental Science 2	4
CS101	Intro. Microcomputer Applications	3
FT055	Forest Surveying I	3
FT063	Forest Photo Interpretation	3
MTH082	Technical Mathematics II	4
Term 3 (Spring)		
BI133	Environmental Science 3	4
FT062	Tree and Shrub Identification II	3
FT071	Forest Inventory	5
FT280F	Cooperative Work Experience	6
WR121	English Composition	3
Term 4 (Fall)		
DRF220	GIS ArcView	2
FT056	Forest Surveying II	5
FT072	Timber Cruising/Log Scaling	5
FT081	Introduction to Silviculture	3
WR227	Technical Writing	3
Term 5 (Winter)		
FE205a,b,c	Job Search Techniques	3
FT052	Forest Seminar	1
FT065	Forest Insect and Disease Management	3
FT086	Principles of Supervision	3
SOC235	Society and Forestry	3
SP111	Fundamentals of Speech	3
Term 6 (Spring)		
BI251	Wildlife Conservation	3
ES071	Work Place Safety Skills	1
FT075	Forest Contracts	3
FT088	Forest Policy	4
FT095	Forest Mgmt. Problem Solving	4

Feather River College

Located in Quincy, CA
Total Students: 2,400 Full Time: 1,042
Contact Person: Voc. Ed. Division Chairperson or Jay Wright, 530-283-0202 x239
E-mail: jayw@frcc.cc.ca.us
NCSR Test Site: Shasta College, Redding, CA

Wildlife Technology

Feather River College (FRC) (http://www.frcc.cc.ca.us) is the lead college in Wildlife for the Northwest Center for Sustainable Resources (NCSR). A primary objective under the NSF/ATE grant is to produce a model for incorporating ecosystem management into Wildlife curricula for community colleges.

FRC's Natural Resources/Wildlife Technician curriculum has been revised to encompass the goals and objectives of NCSR. Using one definition of ecosystem — "a spatially explicit unit of the earth that includes all of the organisms, along with all the components of the abiotic environment, within its boundaries"— FRC is incorporating into its revised curriculum biodiversity study and protection, a major element of ecosystem management. To this end, curriculum developers believe in minimum management to maintain biological and habitat diversity which allows for the integrity of natural ecosystems.

New course offerings for Fall 1997 are emphasizing these new approaches in courses such as *Wildlife & Fisheries Management*, *Wildlife Ecology*, and *Geographic Information Systems* (GIS). A new field research site in Sierra Valley, California, is also emphasizing biodiversity studies. This hands-on facility will offer these studies in Spring 1998.

Thirteen courses make up the newly-revised program for the NSF/ATE grant. All courses emphasize ecosystem management principles and concepts. The new program will offer two degrees: Associate of Arts (A.A.) and Associate of Science (A.S.). Additionally, math and natural science courses have been upgraded for transfer to four-year state colleges and universities. Notably, many of the new requirements were a direct result of input from past graduates now employed in wildlife positions, through the DACUM process. Another very positive outcome of the NCSR grant has been the program's recent success in becoming recognized by the North American Wildlife Technology Association.

For Feather River's DACUM chart, turn to page 123.

Wildlife and Fisheries
Associate of Applied Science Degree
Feather River College

Fall Semester (Year 1)		**Units**
WILD 100	Intro. to Wildlife & Fisheries	3
BIOL 102	General Biology	4
WILD 055	Hatchery Operation 1	2
WILD 025	Fish and Game Laws	2
Spring Semester (Year 1)		
BIOL 106	Botany	4
WILD 056	Hatchery Operation 2	2
BIOL 162	Intro. to Fish, Amphibians, & Reptiles	3
Fall Semester (Year 2)		
BIOL 163	Intro. to Mammals	3
WILD 101	G.I.S. Wildlife	2
BIOL 140	Ecology	3
Spring Semester (Year 2)		
BIOL 104	Zoology	4
BIOL 160	Intro. to Ornithology	3
ITEC 018	Wildlife Equipment: Care & Maintenance	2

Math and General Education courses are not listed but are required for a degree.

Other Model Natural Resource Technical Programs

In the next section, other program models from 2-year colleges are presented. To identify other models from around the nation, NCSR used recommendations provided by its National Visiting Committee. Two models suggested were Haywood Community College and Itasca Community College. "Observations" are included from site visits conducted at these colleges.

Itasca Community College

Grand Rapids, MN
Harry Hutchins, NR/Forestry Instructor
Natural Resources/Forestry (NR/Forestry) Program

Itasca (http: //www.it.cc.mn.us) offers a beautifully landscaped campus associated with the U.S. Forest Service North Central Experiment Station and the University of Minnesota Agricultural Experiment Station. This allows the college to "borrow" expertise from some of the leading natural resource professionals in the state. Adjoining the campus is an extensive experimental forest which is used for class study, hiking and skiing. Itasca prides itself in having an "up-to-date" program.

Although traditional natural resource core classes and outdoor labs are still an important part of the program, a strong emphasis is placed on students having current skills in computer applications. Additionally, high priority is placed on students gaining job-related experience as they pursue their education. Itasca is already offering a course in Ecosystem Management.

Three degree options are offered — a two-year Associate in Applied Science (A.A.S.) degree in Natural Resources/Forestry, or the Associate in Science (A.S.) Transfer degree. Also, a three-year Natural Resource Law Enforcement Program is offered, where students are provided with a strong resource background combined with over a year of law enforcement skills.

Site Visit Observations:

Distance Education

In Minnesota, distance education networks are highly evolved, particularly at community colleges. All high schools, community colleges, and the state system of education is on Interactive TV. Post-secondary institutions, including technical schools, community colleges, and state 4-year colleges have access to live Interactive TV.

Transfer Agreements with 4-year Colleges and Universities

A total of 16 NR/Forestry courses transfer to University of Wisconsin/Stevens Point (one course even transfers as a 400-level course). UW/Stevens Point has the largest school in natural resources in the country.

GIS

A 2-credit course in GIS is currently taught at Itasca with plans to expand the program in fall 1998. Employers are especially interested in students with GIS knowledge for student intern positions. When arranging student internships, often employers ask faculty — *"Do you have any students who know anything about GIS?"*

Field Sites and Natural Resources/Forestry

Itasca uses many different sites for field experience for students, and holds this experience in high esteem. Along with a 600-acre Research Experiment Station located on campus, there is also a 20-acre wetland which has been restored on college property. These field sites, and others in the vicinity of Grand Rapids, including the Chippewa National Forest, are used by students in courses including logging, dendrology, cruising, surveying, wildlife, and biological sciences.

Getting High School Students Interested in Coming to Itasca's NR/Forestry Program

Recruiting students personally is the key for success. Although it can be difficult to "cut loose" busy faculty, Itasca has been successful in having a part-time instructor go out to high schools with emphases on natural resource programs. One-on-one connections with high school students can be very successful for a community college program, but a commitment must be made to have faculty members involved in this activity.

Science, Ecosystem Management

Itasca's program prides itself on being "very science-oriented", where the "scientific method is really adhered to." A number of laboratory science courses are offered in Itasca's program, including a soil science course, "Forest Soils"; interestingly, this course is emphasized in Minnesota, because "soils in this part of the world are extremely important", due to their high spatial variability. In fact, ecological

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Natural Resources/Forestry
Associate in Applied Science Degree
Itasca Community College

First Year - Fall Term

ForT 100	Natural Resources Careers I	1
ForT 111	Computers in Forestry I	3
Biol 131	Plant Taxonomy	4
ForT 118	Forest Nursery	2
Engr 105	Introduction to Survey Methods	5
ForT 120	General Forestry	1

First Year - Winter Term

ForT 114	Forestry Math	3
Engl 101	English Comp. I	4
Nsci 128	Wildlife Management	4
Spch 101	Fundamentals of Public Speaking	4
or		
Spch 100	Speech Communications	4
ForT 211	Computers in Forestry II	4

First Year - Spring Term

ForT 124	Silviculture	4
ForT 127	Forest Products	4
Engl 114	Technical Writing	4
Biol 211	Ecology and Field Biology	5

Second Year - Fall Term

ForT 109	Soils	1
ForT 137	Forest Inventory	5
ForT 150	Wildland Recreation	1
Econ 101	Introduction to Economics	4
PE 148	Wellness	3
Hlth 101	First Aid	3
General Education Elective from MN Transfer Curriculum		3

Second Year - Winter Term

ForT 101	Natural Resource Careers II	1
ForT 112	Forest Mgmt. Computer Simulation	2
ForT 115	Forest Protection	4
Psych 201	General Psychology	3
	Humanities Elective	3
	Natural Science Elective	3

Second Year - Spring Term

ForT 126	Scaling	1
ForT 128	Logging	5
ForT 251	Ecosystem Management	3

classifications in this region are a product of both habitat type and soils classification, and soils have a central role in natural resource management.

Uniquely, Itasca has offered (since 1989) and continues to offer a 3-credit course entitled *Ecosystem Management.* The text used for the course is Malcolm Hunter's "Wildlife, Forests, and Forestry" (Prentice Hall, 1990). Prerequisites for the course are *Silviculture* and *Forest Ecology.*

Two-Year Versus Three-Year Community College Programs

At Itasca, the Associate of Applied Science (A.A.S.) program in NR/Forestry is basically a 2-year program; however, it is "math weak" compared to the Associate of Science (A.S.) degree program. The A.S. program generally takes 3 years for students to complete. The differences between programs can pose real problems for articulation to 4-year institutions.

Continuing on this note, a three-year program may be a necessary reality for students transferring to major universities. Notably, many Canadian forestry technology programs are transitioning to three years — a current model in Thunder Bay, Canada, is for students to successfully complete a 2-year education program and also a 1-year internship for a technical degree.

In the fall of 1992, two-year institutions accounted for 44% of enrolled undergraduates, and 34% of all undergraduate Science, Mathematics, Engineering, and Technology enrollment.

Shaping the Future — New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology,

A Report on its review of undergraduate Education by the Advisory Committee to the National Science Foundation Directorate for Education and Human Resources

(NSF 96-139), 1996; p33

Haywood Community College

Clyde, NC
Natural Resources Division
Douglas Staiger, Forest Management Technology
David Dudek, Fish and Wildlife Management Technology

Haywood Community College is located on an 83-acre campus which features an arboretum, a 320-acre teaching forest, and a working sawmill. The arboretum includes a large number of plant collections and various gardens. Within the campus woodlands are over 1,000 trees, including white oaks, dogwoods, and native sourwoods. The arboretum and teaching forest provide an outdoor laboratory for study of the southern Appalachian region.

Students enrolled in forestry and wildlife programs use the campus's unique "outdoor classrooms" for wildlife observation stations, forest stand mapping and measurement projects, wildlife enhancement projects, and field trips.

Associate of Applied Science degrees are offered in Fish and Wildlife Management Technology, Forest Management Technology, and Wood Products Technology.

Site Visit Observations:

From Quarters to Semesters & Increased Levels of Math and English

Haywood's technical programs are transitioning from quarter to semester systems this year ('97-'98); concomitantly, core courses in mathematics and English are being upgraded in technical programs across campus. The transition to semesters, interestingly, causes a "perceived drop out" of specific subjects taught (e.g., *Ecology* will not be offered as a separate course anymore — instead, it will be integrated among other courses, such as *Silvics*, *Wildlife Management* and *Botany*). Overall, changes are part of North Carolina's effort called "re-engineering statewide" — and a major goal cited in this process is to increase interest from universities in linking to community college programs. In mandating these changes, the State is attempting to bridge common gaps between 2- and 4-year education institutions. At the community college level, these changes are expected to increase needs for remediation and bridging courses for students, particularly in mathematics.

Science and Field Sites In Forestry and Wildlife Programs

Sciences in Haywood's Forestry and Wildlife programs are particularly emphasized — they serve as "core-builders", and include *Botany* in Forestry and *Zoology* in Wildlife. Also, field sites are emphasized for hands-on study — Haywood's Division of Natural Resources owns lands which encompass a complete watershed of 320 acres. Among other sites used for "outdoor classrooms" are nearby National Forests including the Pisgah, the Nantahala, and Cherokee National Forest; Great Smokies National Park, sites along the Appalachian Trail, which cuts through the area; and Coweeta Hydrologic Lab, a world class research site.

Articulating Natural Resources Programs with High Schools

Similar to efforts made in Tech/Prep programs around the nation, Haywood provides its own unique model for 2-year programs to connect with local high schools — part-time instructors in the Forestry/Wildlife programs go into two local high school classrooms and teach courses in Forestry and Wildlife Management. The model is successful, and high school students are tremendously excited about the classes. Through this model for collaboration, high school students may earn college credit, and come better prepared to Haywood's program.

Recognition By Professional Societies

Haywood's Forestry and Wildlife Programs are not only certified by their respective professional societies, but program developers have been among pioneers in developing standards for recognition from those societies. Faculty participated in writing the standards for the Society of American Forester's (SAF) *Recognition for Two-Year Programs* (excerpts in appendix, page 95), and the Forestry Program is currently recognized under those Standards. Similarly, the Wildlife Program is recognized by the North American Wildlife Technology Association (excerpts in appendix, page 93). The Wildlife Program is the first 2-year school in the nation to receive student chapter status from the Wildlife Society. Currently, about fourteen 2-year programs are now recognized through the Wildlife Technology Association, and about twenty-nine 2-year forestry schools are now certified through SAF. Positive outcomes of SAF recognition cited by Haywood faculty include:

- hiring of program graduates increases
- providing unique opportunities for connecting with employers — e.g., students can become members through student chapters of the Society, and student chapter links with professionals can give them inroads to future opportunities
- gaining a certain 'seal of approval' that it is, indeed, a high quality program; and increasing visibility of the program for both students seeking to enter the program *and* employers hiring graduates
- mentoring activities, conferencing, and having opportunities to work with professionals

Allegany College of Maryland reports that 95% of graduates of their forest technology program are employed in their field within 3 months of graduation, with a starting salary of $20,000.

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Forest Management Technology

Associate of Applied Science Degree
Haywood Community College

General Ed. Courses Required		Lecture	Lab	Credit
ENG 111	Expository Writing	3	0	3
ENG 114	Professional Research and Reporting	3	0	3
MAT 115	Mathematical Models	2	2	3
MAT 120	Geometry and Trigonometry	2	2	3
	Humanities - Elective	3	0	3
	Social Science - Elective	3	0	3

Major Hours Required		Lecture	Lab	Credit
BIO 111	General Biology I	3	3	4
BIO 120	Introduction to Botany	3	4	4
CIS 111	Basic PC Literacy	1	2	2
FOR 121	Dendrology	2	6	4
FOR 131	Forest Measurements	2	3	3
FOR 171	Intro to Forest Resources	3	0	3
FOR 173	Soils and Hydrology	2	3	3
FOR 211	Aerial Photo Interpretation	2	3	3
FOR 215	Introduction GIS/GPS	1	4	3
FOR 225	Silvics and Silviculture	3	3	4
FOR 232	Forest Mensuration	2	6	4
FOR 234	Forest Surveying	2	6	4
FOR 240	Forest Protection	2	3	3
FOR 271	Forest Management	2	3	3
FOR 282	Forest Recreation	2	3	3
FOR 296	Seminar in Environmental Chemicals	0	3	1
FWL 142	Wildlife Management	2	3	3
WPP220	Forest Products Marketing	1	3	2
or				
WPP 221	Timber Procurement	1	3	2
WPP 230	Forest Equipment Operations	1	3	2

Fish and Wildlife Management Technology

Associate of Applied Science Degree
Haywood Community College

General Ed. Courses Required		Lecture	Lab	Credit
ENG 111	Expository Writing	3	0	3
ENG 114	Professional Research and Reporting	3	0	3
MAT 115	Mathematical Models	2	2	3
MAT 120	Geometry and Trigonometry	2	2	3
	Humanities - Elective	3	0	3
	Social Science - Elective	3	0	3

Major Hours Required		Lecture	Lab	Credit
BIO 111	General Biology I	3	3	4
BIO 130	Introductory Zoology	3	3	4
CIS 111	Basic PC Literacy	1	2	2
FOR 121	Dendrology	2	6	4
FOR 131	Forest Measurements	2	3	3
FOR 173	Soils and Hydrology	2	3	3
FOR 211	Aerial Photo Interpretation	2	3	3
FOR 223	Silviculture	2	3	3
FOR 234	Forest Surveying	2	6	4
FWL 126	Wildlife Ornithology	2	3	3
FWL 142	Wildlife Management	2	3	3
FWL 212	Wildlife Policy and Law	2	0	2
FWL 222	Wildlife Mammology	2	2	3
FWL 232	Terrestrial Ecology	2	3	3
FWL 234	Aquatic Ecology	2	3	3
FWL 242	Fishery Management	2	3	3
FWL 252	Wildlife Maintenance Techniques	2	3	3
FWL 254	Habitat Manipulation	2	3	3
FWL 256	Animal Immobilization	1	3	2

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Community Colleges

Northwest Indian College (NWIC)
Lummi Nation, Bellingham, WA
Dan Burns
Coordinator – Biology/Environmental Studies

The Northwest Indian College (NWIC), in collaboration with three other post-secondary institutions within the Pacific Northwest region, will be developing and implementing an advanced technical education program in environmental and natural resource management which will emphasize Tribal issues *(Associate of Science in Environmental Technology)*. The National Science Foundation, through its Advanced Technology Education Program, has provided the funding for this new program. The pedagogy will be based on collaborative learning and multi-disciplinary teaching and the intent is to meet a critical need for Native American technicians and professionals in Tribal natural resource and environmental management programs. Northwest Indian College has brought together for this project those post-secondary institutes within the region that have a track record and commitment of working to meet the educational needs of Native American students and tribal communities. These institutions include the Evergreen State College, Huxley College and Fairhaven College both at Western Washington University (WWU). In addition, Mesa State College, Dine' Community College, Partnership for Environmental Technology Education, Northwest Natural Resource Technology Education Consortium and the Pacific Northwest Tribes will provide assistance. Specialized assistance in the areas of collaborative learning and learning communities will be given by the Washington Center for Undergraduate Education at the Evergreen State University. Program methods will be developed specifically to support Native American learning styles and will be designed with the following objectives:

- Teach students important concepts in the areas of biology, communications, chemistry, mathematics, political science and economics in large block multi-disciplinary classes

- Emphasize Tribal issues such as cultural needs, treaty rights, and Tribal fishery, forestry and water management

- Give students the ability to integrate knowledge from the above fields into a more realistic, interdependent concept of environmental and natural resource management

- Provide students with technical skills required in the areas of environmental protection and natural resource management

– Provide students with essential knowledge and skills in writing and mathematics

– Give students the knowledge necessary to transfer to a 4-year university program

NWIC will serve as the lead institution where all classes will be taught. These courses will be given by both NWIC and WWU faculty along with environmental experts brought in to provide "real world" perspectives. The basis for curriculum development will come from the needs of Pacific Northwest Tribes. As the program curriculum develops, Tribal managers will be asked for feedback.

During the first year (1997/98) of the three-year project, program content will be finalized, articulation agreements between the partners will be settled, and curriculum will be developed for Year One courses. In the second year (1998/99), Year One courses will be taught and Year Two curriculum developed. In the third year, Year Two courses will be taught and a workshop will be given on multi-disciplinary science pedagogy for educators.

Hawai`i Community College
Hilo, HI
Fred D. Stone, Ph.D. and
Laura Brezinsky, Ph.D
Math & Natural Sciences Division

Development of a Native Ecosystem Management Curriculum at Hawai`i Community College

Hawai`i has been described as an evolutionary laboratory, with over 950 species of native plants, 30 forest birds and 5500 arthropods (Wagner, Herbst & Sohmer, 1990; Pratt, 1993; Howarth & Mull, 1992). It also has more endangered species than the rest of the U.S. (423 native plant taxa are extinct or threatened), and native forests are declining due to introduction of alien species, increasing human population and development pressures. Currently, the State of Hawaii has an initiative to develop forestry resources, and the effort is primarily oriented to commercial forestry based on a few eucalyptus species, but also with a focus on native trees. Native hardwoods, such as koa (*Acacia koa*), and sandalwood (*Santalum* spp.) are in demand for furniture and carving, but extant stands of the native hardwoods are declining along with the native forests. A clear need exists for people trained in management of Hawai`i's forest ecosystems to maintain habitats for endangered native species while allowing managed growth of commercially-valuable hardwoods. This need was recognized in the State School-to-Work Environmental and Natural Resource Skills Committee (Draft report of Environmental and Natural Resource Industry Skills, 1997).

Hawai`i Community College (HCC) is located in Hilo on the Island of Hawai`i, which has a larger area of native forest than the other 7 main Islands combined (Dept. of Geography, 1983). Large areas of rain forest exist within a half-hour drive from campus, and these forests are a valuable living laboratory for field classes taught at the College. Over the past several years, the College has developed the basis on which a program in native ecosystem management and regeneration can be built. Besides basic *Biology, Botany* and *Zoology* courses, current courses include lecture and laboratory sections in *Plants of Hawai`i, Natural History of the Hawaiian Islands* and *Environmental Science* — all which have a strong field component. Additionally, a native ecosystem regeneration area has been developed on campus, where students learn to propagate and grow native forest species. Activities include faculty members participating in a joint program with the College of Tropical Agriculture and Human Resources on propagation and establishment of native trees, providing State support for native plant propagation by students in the Environmental Science Laboratory (Miyasaka, 1993, *et al*). Students grew about 40 species of native plants, established the native ecosystem regeneration area on campus, and distributed more than 2000 native trees to the public on Earth Day over the past 3 years. HCC's programs also participated in over 15 public workshops, poster sessions and field trips for the Big Island community. Recently we have completed a new shade house, allowing more classes to participate in propagation of native plant species.

With this foundation in place, Hawai`i Community College is in a unique position to further develop a specialization leading to a certificate in native ecosystem management. This will necessitate adding new courses focusing on field survey methods and on specific management skills to meet the needs of Hawai`i's unique ecosystems. We are currently in the process of developing a proposal, in conjunction with other campuses of the U.H. Community College system, to the NSF Advanced Technological Education program, which will be submitted in Spring, 1998.

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Blackfeet Community College
Browning, MT
Terry Tatsey
Instructor, Natural Resource Management (NRM)

The following comes from a presentation by Terry Tatsey at the Partnership for Environmental Technology Education (PETE) Annual Meeting in Jackson Hole, WY, May 22, 1997. During the presentation, Tatsey describes aspects of Blackfeet Community College's Natural Resource Management program.

Blackfeet Community College (BCC) is a Tribally-controlled community college chartered by the Blackfeet Tribal Business Council in 1974.

The Blackfeet Reservation encompasses 1.5 million acres divided by 20% tribal trust, 46% allotted tribal trust, and 34% fee land. The majority of the land-base is rangeland, forest, cropland, and urban and rural development.

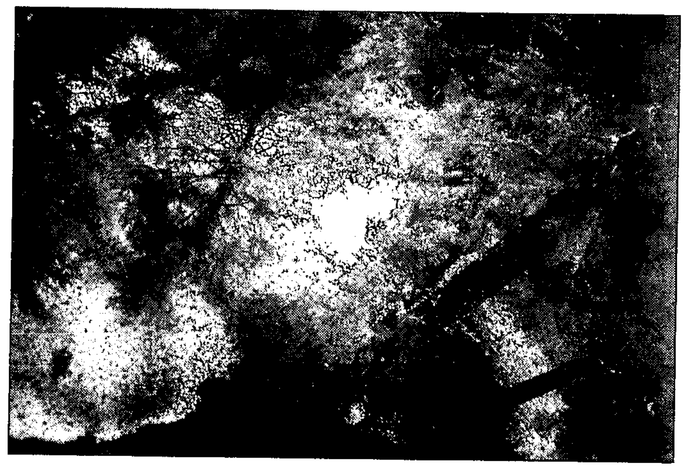
The Blackfeet Reservation's unique setting includes Alberta, Canada to the north; Glacier National Park to the northwest; and Lewis and Clark National Forest on the southwest boundary. The Blackfeet people have retained Rights within Glacier National Park and Lewis and Clark National Forest from the Agreement of 1896. Additionally, the Triple Divide is a unique feature at the historical Blackfeet lands. Our land base is rich in Blackfeet culture and natural resources.

The college has 400-500 students full-time and up to 600 including those who take classes part-time. There are two departments on campus: 1) Vocational Education (which includes NRM, offering both one-year certificates and Associate of Applied Sciences degrees); and 2) Academic Affairs, which is responsible for transfer programs, and includes a Blackfeet Studies program, where classes are taught in Blackfeet Culture, Language, Policy, and Politics. In some ways, "politics" takes on new meaning with issues of Tribal Sovereignty, treaty rights, and other political issues. The bottom line, however, is that BCC continues to stay focused on the community's needs.

Courses for the NRM program fall under both the Academic Affairs and the Vocational Education Departments. Students majoring in the A.A.S. degree program are required to take courses offered under the general core of the Academic Affairs program. Students take Life Science, Computer Sciences, Chemistry, and Communication courses as part of the core requirements.

A brief history of the NRM follows: A Vocational Education 2-year A.A.S. degree program was designed in 1993 to cover a broad spectrum of natural resources. The focus was not on Forestry, Rangeland, Wildlife Biology, or Agriculture, but was focused on the interrelationship of all Natural Resources. In the Natural Resources Management program, courses in Animal Science include: *Horsemanship*, because horses are a big part of the Blackfeet culture; *Beef production*, which is a main source of income, and was one of the objectives of the U.S. Government; *Wildlife Management*, because this is how the Native American people survived with bison as the staple food. Our Blackfeet Ancestors were some of the best wildlife biologists, but due to various reasons, this knowledge was not passed on. The one thing we try to focus on in *Agriculture Education* is the historical agriculture of the Blackfeet as well as contemporary agriculture issues. We also feature classes dealing with endangered species. The Blackfeet Reservation has an Endangered Species Program, where BCC students are placed as interns to get hands-on learning. Endangered species on our lands include the Grizzly Bear, Grey Wolf, Peregrine Falcon, Bald Eagles, and plants — people forget that endangered species include plants as well as animals.

We have a Blackfeet Geographic Information Systems (GIS) program. *Introduction to GIS* is taught winter quarter by the Blackfeet Tribal GIS department. Students learn the important role that GIS plays in mapping and monitoring our natural resources, highways, and home-sites. We have numerous populations of Grizzly Bears in our ecosystems on the East Slopes of the Rocky Mountain Front, and GIS is used by Wildlife Technicians to monitor the annual cycles of the Grizzly Bear in its habitat.



BCC also offers a course in *Blackfeet Environmental Studies* during Winter Quarter. The Blackfeet Tribal Environmental Department teaches the course based on the studies they do on the Blackfeet Reservation. A new course offered at BCC is *Wind Energy*, which studies converting wind to electricity by using a wind turbine. We have winds that can reach speeds of 121 mph in late fall to early spring!

These are some of the courses offered at BCC in the NRM program. The program could not offer as many interesting courses without the help of the Blackfeet Tribal Departments, Bureau of Indian Affairs, and Natural Resources Conservation Service.

Employers

Gene Davis, Ph.D.
President
International Resources Unlimited, Inc.
Eugene, OR.

Gene Davis serves on the NCSR's Advisory Committee, where he brings expertise in environmental business at national and international levels. Davis enthusiastically supports goals for the Center and contributes to NCSR as a representative of potential employers of our students. Davis illustrates, through his article, the key role advisory board members can play for a Center by "talking it up" with others, even with those from other countries.

I have enjoyed being a partner of the Northwest Center for Sustainable Resources (NCSR). As President/CEO of International Resources Unlimited, Inc. (IRU), (http://www.rio.com/~gdavis/index.html) I have had many opportunities to talk with others about this unique program. Those I have spoken with have expressed great interest and admiration for the efforts of NCSR.

IRU is a consulting and engineering firm specializing in natural resources industries, environmental reclamation services, and business management and retention services. Our extensive background in these industries, coupled with our global involvement, allows us to provide our clients with up-to-date information and specialized solutions for their needs. IRU Project Teams consist of professional engineers, researchers, marketing specialists, financial planners, and other experts. Our range of services assist clients in a variety of industries from both the public and private sectors around the globe. This international experience gives us the necessary knowledge to provide our clients with vital information on the total outlook for their industry, from the small business owner to the global corporation.

While visiting my office in Bangkok last month, I had an opportunity to mention the NCSR program to the President of Kasetsart University. I promised to bring Dr. Thira Sutabutra a 50 hertz video developed for the project on my return trip this month. Kasetsart University offers agricultural, engineering, and now environmental science programs at two different campuses in Thailand.

Although Thailand is experiencing some hard times at the moment, the University continues to move ahead in looking for curriculum relationships with schools abroad. The Princess of Thailand is very active with Kasetsart University and recently received an Honorary

Doctorate of Botany for her extensive work in that area. I will provide the video NCSR recently sent me to the school and request that they get in touch with NCSR to explore any commonalties they may have with the program and to see if NCSR is something they would like to be involved in.

I had another chance to talk about this fine program at a recent dinner with the senior executive vice president of timberlands and manufacturing for one of North America's largest integrated forest products companies. When I went to the Eugene Airport to pick him up, he had also brought along two company scientists who were busy developing the life cycle analysis for some of their company's timberlands in our area. The scientists and I had a very lively discussion prior to my friend and I departing for dinner later that evening. I shared with the two scientists a bit about your program. Both were pleased to hear of NCSR's activities and applauded its efforts.

As we are all aware, industry can respond rather slowly to programs being developed as curriculum within higher education, especially when those programs are intended to "benefit" the industry. Based on the feedback from this particular client, they felt NCSR and its sponsor, the National Science Foundation, were on the mark with your efforts.

I look forward to further involvement in my small way with NCSR's continued success. Congratulations on a well run program!

Steve Eubanks
Forest Supervisor
U.S. Forest Service
Chippewa National Forest
Cass Lake, MN

Steve Eubanks serves NCSR as Chair for the National Visiting Committee. The Committee meets annually to help the Center in its efforts and to advise NSF on progress of the Center. Eubanks is a leader in the U.S. Forest Service, and he is a strong advocate for ecosystem and adaptive management.

At present in the U.S., natural resources and natural resource management seem to have fallen off, or at least down, the public's list of priorities and interests as other major issues like crime, drugs, and education have received added attention. Yes, there is still heated debate about how the nation's natural resources should be managed, particularly on public lands, but in general, as the debate has intensified, proportionally fewer people have been involved as interest has shifted to other issues. However, that does not mean that the importance of natural resource management in the U.S. has dropped — *quite to the contrary.* Clearly, as the demand for natural resources and competing interests for every piece of land continue to rise, questions about future management of natural resources become more important, regardless of the level of overall public interest. The demand for natural resources is outstripping availability — and this trend will continue. As the level of debate about public land management continues to rise, there is increasing pressure and incentive for private landowners, particularly private non-industrial landowners, to increase the intensity of management on their lands.

Also at present, public land management agencies seem universally to be experiencing budget and workforce declines. This trend seems likely to continue given the level of debate about taxes resulting in less opportunities in the short-term for public agencies to hire new employees. Competition for the few jobs available will be intense.

These trends indicate that short-term employment opportunities seem to be strongest for small companies doing consulting work for private landowners, with a lesser number of jobs still available in the public sector. In the changing world of resource management, both situations will require a different kind of employee. No longer will it be acceptable to have an education based on "rote memory" of information. The employee of the future must be adaptable. Increasingly, this employee must have a basic understanding of how ecosystems function and a good grounding in tools like GIS. More important, because our knowledge of ecosystem functions is still changing and growing, the employee must have the ability to think and reason and must have the training, knowledge and background to find and use new resource management information.

The role of the Northwest Center for Sustainable Resources is to develop a natural resources education curriculum that will allow students to be successful in a challenging work environment. From what I have seen as a member of the National Visiting Committee, the member institutions are working well together in a collaborative mode to develop valuable pieces of that needed curriculum package. The programs I have personally viewed are impressive — not only in the quality of information learned by students, but also in the learning *process.* Students *are required to think* as they learn; to understand concepts, not just facts; and the curriculum is being closely tied with current natural resource research information so students know how to evolve their knowledge. Adaptive management, which advocates *implementing, learning, modifying; and repeating the process of implementing, learning,...* this is the paradigm of future resource management. The Northwest Center for Sustainable Resources is preparing a curriculum which will prepare students to meet that paradigm.

"All of this (new silvicultural practices/ecosystem management) will require resource managers to be schooled in a growing body of ecological and social research ... Indeed, carrying out customized harvest prescriptions means that woods workers of the 21st century often will be called upon to understand as much about forest ecology as professional resource managers have in the 20th century..."

Kohm & Franklin,
"Creating A Forestry for the 21st Century", 1997, pg.4

Jim Kiser
Senior Operations Specialist
Weyerhaeuser Company, Federal Way, WA

Mark Lawrence
Associate Manager
Salem District Bureau of Land Management
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Defining Environmental Technology Workshop
March 13-15, 1996, St. Louis, MO

Jim Kiser, who is currently employed as an Instructor, Forest Engineering, Oregon State University, and Mark Lawrence participated in the "Defining Environmental Technology" Workshop coordinated by the Advanced Technology Environmental Education Center (ATEEC), an ATE Center of Excellence like NCSR. The Workshop's aim was to define and clarify, for the nation, what is meant by the "environmental technology field", and to identify specialty areas for environmental technicians. The report for the workshop, "Defining Environmental Technology" contains the following section (somewhat modified by Kiser) that identifies natural resource management job titles and functions for technicians. It should be noted that Kiser and Lawrence described even more technician job titles, but in the interest of brevity, some were left out. Thus, the titles listed should serve as a broad sampling, yet not a comprehensive listing, for existing positions in the profession.

Technicians in Natural Resources Management
Job Titles and Tasks

Tasks Applicable To All Titles Listed

- Assess environmental impact of proposed development projects
- Assist in habitat restoration
- Assist in preparing environmental documents
- Assist in recommendations to federal, state, local, and private organizations
- Calibrate, operate, troubleshoot, repair, and maintain equipment
- Conduct environmental education programs
- Develop public information programs
- Develop reports on findings
- Follow and apply local, state, and federal environmental regulations
- Follow established quality control procedures
- Follow standard operating procedures
- Inventory, evaluate, and assist in development of resource management strategies for sites and areas with unique scenic, recreational, historical, cultural, paleontological, and other resource values

Tasks Applicable To All Titles Listed

- Inventory the resource (e.g., wildlife species and populations for the fisheries/wildlife technician; plant species and vegetative communities for the botany/forestry/range technician)
- Maintain accurate records
- Monitor compliance of plans/projects
- Organize and analyze data
- Oversee project maintenance
- Perform literature searches
- Prepare maps
- Read topographical maps
- Select and use proper personal protective equipment
- Use aerial photography
- Utilize computers and software
- Work with the public

Aquatic Ecologist *and* Aquatic/Terrestrial Habitat Restoration Technician

- Conduct surface and groundwater inventories and studies (i.e., watershed analysis)
- Identify and delineate wetlands based on plant/animal species and hydrology
- Implement plans to improve aquatic habitats
- Implement wetland restoration and construction activities
- Interpret water quality information
- Introduce rare/endangered species into ecosystems
- Propagate and plant woody and non-woody species

Botany Technician

- Assist in operational forestry
- Assist in species breeding/propagation programs
- Identify and delineate wetlands based on plant/animal species and hydrology
- Implement plans to improve aquatic habitats
- Implement wetland restoration and construction activities
- Inventory forest stands
- Propagate and plant woody and non-woody species

Ecologist Technician

- Assist in operational forestry
- Assist in species breeding/propagation programs
- Identify and control noxious weeds
- Implement plans to improve aquatic habitats
- Introduce rare/endangered species into ecosystem
- Inventory forest stands
- Propagate and plant woody and non-woody species
- Sample and identify aquatic organisms

Fire Management Technician

- Assist in development of fire management plans
- Assist in preparation of fire suppression and prescribed burning plans
- Implement prescribed burning
- Inventory forest stands

Fisheries Technician

- Assist with fish hatchery management
- Conduct surface and groundwater inventories and studies (i.e., watershed analysis)
- Implement farm pond management techniques
- Implement plans to improve aquatic habitats
- Operate boats and utilize seining, trawling, and electroshock equipment
- Practice techniques of aquaculture
- Sample and identify aquatic organisms
- Stock lakes and streams with fish

Forestry Technician

- Assist in development of designs for the protection, maintenance, rehabilitation, or enhancement of visual resources
- Assist in development of fire management plans
- Assist in forest nursery programs
- Assist in laying out timber sales
- Assist in operational forestry
- Assist in preparation of fire suppression and prescribed burning plans
- Assist in species breeding/propagation programs
- Compile, verify, and analyze appraisals
- Conduct surface and groundwater inventories and studies (i.e., watershed analysis)
- Cruise timber (i.e. measure height and circumference of trees)
- Identify and control noxious weeds
- Identify and delineate wetlands based on plant/animal species and hydrology
- Implement prescribed burning
- Implement wetland restoration and construction activities
- Introduce rare/endangered species into ecosystem
- Inventory forest stands
- Manage and use pesticides and herbicides
- Prepare appraisal documents
- Propagate and plant woody and non-woody species
- Recommend silvicultural practices
- Scale (i.e., measure) cut logs
- Assist in road layout, surveying, timber harvest operations

Forest Engineering Technician

- Be aware of land measurement systems; identify property lines and corners
- Lay out harvesting systems
- Understand yarding and loading timber processes
- Work with various transportation systems and road layout
- Work with various logging, road building, and other equipment
- Understand surveying processes and methodology

Geographic Information Systems (GIS) Technician

- Manage spatial data
- Integrate data from various sources
- Understand cartographic conventions
- Geo-reference imagery; determine appropriate projections
- Perform spatial data queries

Geological Technician

- Assess farmland for eligibility in federal programs
- Assist in checking geologic maps and reports
- Calculate rates of sediment production
- Collect and analyze geological data
- Collect data for use in identifying geologic structures and determine extent of formations
- Determine soil types and physical soil characteristics
- Identify fossils and rock samples
- Implement erosion control strategies
- Inventory soil conservation practices (e.g., terracing, grassed waterways, zero-till, crop rotation)
- Conduct surface and groundwater inventories and studies (i.e., watershed analysis)

Hydrology Technician

- Collect and analyze water samples
- Comply with local, state, and federal water pollution control acts
- Conduct surface and groundwater inventories and studies (i.e., watershed analysis)
- Decontaminate sampling equipment
- Examine water quality and quantity from streams and aquifers
- Implement plans to improve aquatic habitats
- Interpret surface and groundwater inventory and study data
- Interpret water quality information
- Label, preserve, and store samples

Range Technician

- Assess farm land for eligibility in federal programs
- Assist in development of fire management plans
- Assist in species breeding/propagation programs
- Determine soil types and physical soil characteristics
- Identify and control noxious weeds
- Identify and delineate wetlands based on plant/animal species and hydrology
- Implement erosion control strategies
- Implement wetland restoration and construction activities
- Introduce rare/endangered species into ecosystem
- Inventory soil conservation practices (e.g., terracing, grassed waterways, zero-till, crop rotation)
- Propagate and plant woody and non-woody species

Rare/Endangered Species Specialist

- Identify and delineate wetlands based on plant/animal species and hydrology
- Introduce rare/endangered species into ecosystem
- Propagate and plant woody and non-woody species

Recreation Technician

- Assist in development of designs for the protection, maintenance, rehabilitation, or enhancement of visual resources
- Assist in operational forestry
- Comply with local, state, and federal water pollution control acts
- Perform park maintenance

Soil Conservation Technician

- Assess farm land for eligibility in federal programs
- Calculate rates of sediment production
- Determine soil types and physical soil characteristics
- Examine water quality and quantity from streams and aquifers
- Identify and control noxious weeds
- Identify and delineate wetlands based on plant/animal species and hydrology
- Implement erosion control strategies
- Implement wetland restoration and construction activities
- Interpret surface and groundwater inventory and study data
- Inventory soil conservation practices (e.g., terracing, grassed waterways, zero-till, crop rotation)

Terrestrial Ecologist

- Implement wetland restoration and construction activities
- Introduce rare/endangered species into ecosystem
- Propagate and plant woody and non-woody species

Wetlands Technician

- Assist in habitat restoration
- Identify and delineate wetlands based on plant/animal species and hydrology
- Implement plans to improve aquatic habitats
- Implement wetland restoration and construction activities
- Introduce rare/endangered species into ecosystem
- Sample and identify aquatic organisms

Wildlife Technician

- Implement urban wildlife management strategies
- Participate in tag/release and tracking studies
- Rehabilitate injured wildlife for release
- Trap and relocate wildlife

Tony Melchiors
Wildlife Research Biologist
Weyerhaeuser Company
Arkansas

Tony Melchiors serves on the Center's National Visiting Committee. Representing Weyerhaeuser Company, a leading forest products firm in the U.S., Melchiors brings an industry perspective to NCSR curriculum.

Weyerhaeuser Forestry: A Process That Relies Upon Resource Information

"We have pledged to actively protect and enhance the environment through forestry excellence, pollution reduction and prevention, and increased conservation and recycling. Our ultimate goal is to operate sustainably, without harm to the environment," says John W. Creighton, Jr., president and CEO of Weyerhaeuser Company. The company has a long history of environmental stewardship and science-based forest management. It also has a vision for the next century to achieve a sustainable supply of wood from healthy forests that serve a variety of ecological, social, and economic needs.

Weyerhaeuser manages its forests primarily for the production of wood, guided by principles established through its own Weyerhaeuser Forestry Resource Strategies and the American Forest & Paper Association's Sustainable Forestry Initiative™ (SFI). The SFI is a comprehensive program of forestry and conservation guidelines designed to ensure the integration of growing and harvesting of trees for useful products with the conservation of soil, air, and water quality; wildlife and fish habitat; aesthetics; special sites; and biological diversity. Together, these approaches enable Weyerhaeuser to produce a sustainable supply of high-quality wood products while meeting — and often exceeding — state forest practice rules and Best Management Practices.

Weyerhaeuser is recognized as a leader in private forestry research. Teams of scientists, foresters, and technicians research many aspects of forests and forestry, including non-timber resources such as water quality, fish and wildlife habitat, and soil productivity. Many of the studies are done in cooperation with universities, resource agencies, conservation organizations, and others. Weyerhaeuser's environmental forestry research program has contributed to its forest management decisions for several decades and includes disciplines in forest health, wildlife, hydrology, geology, and fish biology. Currently, this research program is focused on acquiring science-based information for developing landscape-scale forest management planning processes. Recent examples are watershed analysis, wildlife habitat planning, and habitat conservation plans for threatened and endangered species protection.

Water quality and fish habitat are important environmental concerns, particularly in the Pacific Northwest where salmon and trout populations have been declining. The company uses a process called watershed analysis (assessment, prescription, implementation, monitoring) to care for aquatic resources while managing its land for the sustainable production of wood. It recognizes that every watershed has unique characteristics and uses a science-based process to address the effects of forestry. Weyerhaeuser piloted the first watershed analysis in Washington in 1993 in the 63,000-acre Tolt River watershed, and has extended this process to its forests across Washington and Oregon. Through 1997, the company has completed 38 analyses in Oregon and Washington, covering 862,000 acres of its private forestland. As a result of these scientific assessments, Weyerhaeuser is actively repairing and maintaining forest roads, protecting and managing streamside zones, identifying and replacing faulty culverts, and making in-stream enhancements as appropriate.

Weyerhaeuser is committed to maintaining or enhancing wildlife habitat and plant and animal species diversity by implementing landscape planning using wildlife-habitat data gathered on its lands. Company biologists and cooperators are conducting inventories of habitat types and conditions to understand habitat/wildlife relationships and identify current and future gaps in habitat availability across the forest landscape. For example, a pilot project on 107,000 acres of forestland in southwestern Washington is developing Geographic Information System (GIS) habitat models for 21 groups of vertebrates, including 121 species of birds. These studies are prompting foresters and contractors to increase the number of snags and down logs and open forest canopies to increase understory shrubs.

Threatened and endangered species occurring on or near Weyerhaeuser forestlands are protected through several approaches. In the Northwest, Weyerhaeuser has carefully planned forestry activities around eagle nests for 26 years. Up to 48 bald eagle and 5 golden eagle nest areas have been protected in a single year and annual nesting success has averaged a little over 1 eaglet fledged per occupied site. In 1995, Weyerhaeuser obtained approval for Oregon's first Habitat Conservation Plan (HCP), to protect the northern spotted owl on 209,000 acres of company forestland near Coos Bay. In 1996, Weyerhaeuser submitted a multi-species HCP for 400,000 acres in Oregon's southern Willamette Valley. Multi-species plans address the requirements of many different species — including threatened, endangered, and candidate species — at a landscape scale and reduce the need for a species-by-species approach to habitat protection. Another multi- species HCP is being developed for company lands in southwestern Washington. In the Southeast, the company has a Memorandum of Understanding with the Croatan National Forest to protect red-cockaded woodpeckers in North Carolina and it has an approved HCP for American burying beetles that occur in Oklahoma and Arkansas.

As the above examples illustrate, it is nearly impossible to overstate the importance of accurate and reliable data in Weyerhaeuser's sustainable forest management strategy. Generating this data requires a deep and talented pool of natural resource technicians proficient in forestry, hydrology, wildlife, fisheries, and geology, as well as the use of GIS, Global Positioning Systems, remote sensing, and other leading-edge technologies. Weyerhaeuser and other forest products companies will continue to employ natural resource technicians in research programs and land management businesses. The Northwest Center for Sustainable Resources (NCSR) serves a valuable role educating advanced technicians in natural resource fields and preparing students for other degrees. NCSR is making significant contributions to the development of advanced technicians and scientists that can be employed by private industry and others.

In Weyerhaeuser's view, a sustainable supply of renewable forest products is dependent upon healthy forest ecosystems. Likewise, a future workforce of highly skilled scientific technicians is dependent upon healthy educational programs, such as those promoted by NCSR and supported by private industry. In both cases, the results we can expect are directly proportional to our level of commitment. Weyerhaeuser is proudly committed to NCSR and encourages businesses to invest in sustainable technical expertise by supporting the Center's worthwhile educational objectives.

Profile of a GIS/Natural Resource-based company — Pacific Meridian Resources, Inc., Emeryville, CA.

Pacific Meridian Resources is an integrated GIS, remote sensing, and forestry consulting firm. It uses aerial photography, satellite imagery, and air-borne scanning to classify and monitor forests, range, wetlands, and other vegetation. The firm employs a variety of GIS software to update maps and to analyze timber supply, wildlife habitat, watershed impact, and land-use alternatives.

Other services include system design, onsite assistance, training, and imagery procurement. Pacific Meridian also develops applications software, including LUCCAS for land change detection, FIRE! for simulating wildfire spread, and SFT for testing the spatial feasibility of harvest scheduling solutions.

The firm's forestry practice includes inventory design and implementation, appraisal, forest planning and management, and timber sale administration.

Pacific Meridian's clients include forest products companies, Native American tribes, financial institutions, landowners, utility companies, trusts, and government agencies. Its multidisciplinary staff are also located in Salt Lake City; Atlanta; Juneau; Portland, Oregon; Lansing, Michigan; and Texas.

Remote Sensing, 1997 Journal of Forestry Buyer's Guide, Journal of Forestry, June 1997, Volume 95, Number 6, page 52

Jim Schriever
Regional Vice President, Northwest Office
Pacific Meridian Resources, Inc.
Portland, Oregon

Schriever serves as the Center's *Industry Advisor*. In this role, Schriever and Pacific Meridian provide needed input from industry into the Center's curriculum products and other activities. Schriever writes about the promise of GIS technology in natural resource fields.

Over the past decade, Geographic Information Systems (GIS) have emerged as promising tools for analyzing natural resource management and policy alternatives. Implementation of these tools has been prevalent in the western United States where GIS has been used for a variety of purposes including analysis of endangered species habitat, timber harvest scheduling, watershed assessment, monitoring of cumulative effects, fire management, ecological modeling, and growth management. Most western states and federal agencies use GIS to assess, manage, and regulate natural resources and natural resource management practices. In addition, many major western private landowners utilize GIS for resource management and planning. Some of these landowners include: Weyerhaeuser, Willamette Industries, Sierra Pacific Industries, Boise Cascade, Crown Pacific Corporation, Potlatch Hancock Timberlands, Potlatch, Plum Creek, Louisiana Pacific, and Roseburg Resources.

GIS and remote sensing provide resource managers with the ability to: 1) inventory and monitor resources; 2) plan both site specific and regional management; and 3) analyze policy alternatives.

Numerous applications have shown the usefulness of GIS and remote sensing in inventory and monitoring of natural resources. The Forest Service in Oregon and Washington was one of the first agencies to fully implement GIS remote sensing for ecosystem mapping when the technology was implemented to support inventory of spotted owl habitat. GIS is also a powerful management and policy analysis tool because it allows natural resource managers to simulate multiple future conditions and their resulting impacts across space. By linking possible future conditions to values, natural resource managers can use GIS to narrow options to a spatially feasible set.

GIS also facilitates sensitivity analysis of critical assumptions allowing managers to focus on critical areas of uncertainty. For example, Washington State's Department of Natural Resources developed a GIS model to help prioritize watersheds as to their probability of experiencing cumulative effects from forest management activities. The strength of these types of modeling efforts lies in the fact that they can be run multiple times with varying assumptions. This allows analysts and managers to identify variables that significantly affect resources of concern and prioritize implementation of enhancement efforts aimed at protecting these resources.

GIS and remote sensing hold tremendous potential as tools for facilitating natural resource management. Use of currently available satellite imagery is rapidly expanding. Because increasing demands on the land are increasing land values, the need to use GIS and remote sensing technology will continue to grow.

Future satellite launches and advancements in GIS software will provide new opportunities for increasing our understanding of the status of natural resources, their interactions, and change over time. However, the technologies can be both a panacea and a Pandora's box. The panacea exists in the promise of the technologies to meet the challenges of natural

Natural Resource Management Goes Hi-Tech

There is little doubt that natural resource professions are now "hi-tech", and these trends will continue in the future. To illustrate this point, in a recent advertisement in the *Journal of Forestry* from D.R. Systems, Inc., entitled, "Trying to develop and prove a Sustainable Forest Management Plan?" — the company went on to advertise it's services, and every option it listed for "developing and proving a sustainable management plan" was software/ electronic-based, including hi-tech systems such as PC GIS, Database and Hand-held Data Collection software.

resource inventory, monitoring, planning, and policy analysis. The Pandora's box contains the pitfalls of choosing the wrong imagery, using the technology incorrectly, capturing data poorly, miscommunication of information, conveying incorrect results, and overselling the capabilities. This underscores the need for skilled and trained technicians, like those graduating from Central Oregon Community College's and other NCSR-related GIS programs. We need people who are trained in these technologies to make sure that the technology is not used incorrectly, and that data is not captured poorly so that communication of information is appropriate and logical.

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Bob Tom

Confederated Tribes of Siletz Indians and NCSR Native American Advisor

Establishing Connections with Native American Tribes — Tips for Community Colleges

Bob Tom has served NCSR as Native American Consultant over the past two years. In this role, he has strived to develop or enhance connections among NCSR community colleges and their neighboring Tribes. The following is the result of a discussion between Susie Kelly and Tom — during the discussion, Tom pointed out numerous ways community colleges can make mutually beneficial and lasting connections with local Tribes. Tom's primary suggestion is for colleges to offer classes "On Line" for Native American students who live on reservations.

1. Given that Native American students, for many reasons, will often desire to stay near their reservation, success may be measured by distance delivery of community college classes.

   Thus, major efforts should be made to establish electronic networks between community college classrooms and those on reservations. Community colleges should provide technical support as well as collaborate with tribal technical support personnel to establish connections.

   Check early with your technical systems experts, finding out whether they will provide connections with the tribes through the Internet, and other means.

2. Collaboration should include interaction from the administrative to the department level of community colleges. Likewise, tribal councils (their governing bodies) and other appropriate representatives should be brought the table.

   "One-on-one" relationships will not provide for significant and lasting cooperation among schools and tribes.

   Collaboration should be mutually beneficial and long term.

   Find common ground — get to know each other — establish personal meetings with the "right people" to provide the best potential for success.

3. Schools need to respect tribal governments and sovereignty rules, and understand tribal protocol — *e.g., Tribes are self-governing.*

4. Community colleges really need to reach out to tribes and inform them about what they can offer students. For example, it may be unclear that transfer as well as technical programs are available. This is of particular significance to tribal students, given that they are supported by tribal funds that are available for both technical and transfer curriculum, yet are separated into "higher education credit" and "adult vocational training credit" funds. Tribal counselors need to understand what community colleges can offer students.

5. Community colleges, through counseling and admissions personnel, should target needs for Native American students in competency building and bridging skills — *these services should be emphasized.*

6. Examples of ways both community colleges and tribes can mutually collaborate (in natural resource programs): the tribe and the community college can develop electronic connections "going both ways"; tribes can offer students in natural resource programs internship opportunities on tribal lands. Similarly, tribal lands can be used for field sites for class study (i.e., Chemeketa's *Environmental Science* classes visit the Grand Ronde Tribe and interact with the Tribe's biologist).

7. Community college education programs should make efforts to incorporate Native American social and cultural attitudes and beliefs. For example, in the NCSR consortium, Shasta College recently offered for the first time a course called *Ecosystem Management from a Native American Perspective.* And at Chemeketa Community College, Salem, Oregon, classes are offered through distance delivery to the Grand Ronde Tribe, Willamina, Oregon, located about 30 miles from the campus. Another model within the NCSR consortium is Grays Harbor College (GHC). During the 1996-97 college year, GHC shared the cost of a full-time GIS instructor with the neighboring Quinault Indian Nations' Department of Natural Resources, providing instruction on both the reservation and the campus; this specialized form of distance education is not only very cost effective for the college, but provides "customized" teaching and learning for the Tribe that match their cultural, social, and educational needs.

8. Those seeking outreach to tribes should first find the organizational framework of the tribes they're working with so the right people can be brought to the table. Further meetings can bring others together. The ultimate group from the community college should include the president or vice president, department heads and instructors, and technical support personnel.

   When convened at the table, group interactions should include mutual courteousness, and openness to understand each other's differences (i.e., if past experiences for the community college has been that tribes "pass you along" to others, it should not be interpreted as negative — protocol urges that the appropriate people be contacted). A model for interaction may be — you (a community college representative) invite yourself to meet personally with tribal representatives at the first meeting, and at that meeting, let tribal members have a chance to become familiarized with you and your program — and let them respond. Be ready to follow up and ask if there are others who would be appropriate to meet the "next time".

9. Personal visits versus phone calls and E-mail can increase overall success — *better*

relationships can result when you "put a 'face to the voice'". Especially for remote tribes, a personal visit states: "you know who we are and where we live — we must be important for you to come and see us".

In further contacts, invite Tribal members to your school and provide a well planned tour. Try to introduce your Native American visitors "to everybody", especially multi-cultural or Indian coordinators at your site.

10. Keep in mind that Tribes are open to doing good things.

Recently, Oregon State University received a grant from the GTE Foundation to create and augment electronic links to the Warm Springs Reservation in central Oregon. Through these efforts, for the first time, Native American students will be able to earn a Bachelor's degree in Natural Resources/Environmental Sciences without ever leaving the reservation.

Judith R. Vergun, Ph.D.
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Judith Vergun has been a Center partner from its first gathering to announce that the grant had been awarded. Among other endeavors, Vergun has taught a unique and innovative course at Oregon State University entitled, "Ecosystem Science of Pacific Northwest Indians". Vergun provides an overview of the class for this report, which serves as a model others may emulate.

Ecosystem Science of Pacific Northwest Indians (AG 301/507)

Course Overview

This 3-credit course is designed and presented by Dr. Vergun and Pacific Northwest Indian and Alaska Native tribal members. Interdisciplinary and comparative in approach, its summary area of focus is natural ecosystems, the different views of European Americans, Pacific Northwest Indians, and Alaska Natives toward those systems, and the impact of these different views on power relationships, public policy making, and gender role status. Oral presentations by Pacific Northwest tribal members constitute a central component of this course. Presentations include pre-contact, Traditional Indian ecosystem management, a discussion of treaty rights on ceded and "usual and customary use lands", termination and restoration, trust responsibilities, and prognosis for the future. The course explores the contemporary impact of treaty agreements on natural resource use and current land-use controversies.

Course Goals

The course is designed to help the individual recognize, understand, examine, and even question her/his own biases. Students are encouraged to explore the relationship between their world view and their individual and collective life histories. Course goals, numbers one and two, are based on the Oregon Indian/Alaska Native Education State Plan. Goals numbered three and four reflect OSU's Difference, Power, and Discrimination course criteria guidelines:

1. To promote more effective education for American Indian students, and all students, by assuring meaningful participation of American Indian people in planning, implementation, and administration of education.

2. To recognize the dignity and worth of all individuals and their participatory roles in society.

3. To recognize the origins, operation and consequences of different types of discrimination, including both structural power differences and our individual, personal biases.

4. To understand how positions of power and differing values of natural systems by Euro-Americans have influenced changes in Pacific Northwest ecosystems and lifestyles since the time American Indians managed the lands.

Course Format

The format of the course is lecture and discussion. A critical discussion of the key issues and themes follows each oral presentation (by a tribal member). Students are encouraged to complete required readings before assigned dates – this facilitates both their listening and discussion skills.

There is one field trip to the Museum at Warm Springs, on the Warm Springs Indian Reservation, in north central Oregon. The one-day trip provides an opportunity for students to function as participant-observers. The purpose of this trip is to learn about the past, understand the present, and share hopes for the future, with members of the three tribes that make up the Confederated Tribes of Warm Springs: the Wasco, Paiute, and Warm Springs. Students will experience the history and traditions of the Tribes and gain some understanding of current reservation life.

General Information

Community members from outside the university often sit-in on this class. We often have retired people join us and contribute to our discussions. Whenever we sponsor special events — traditional dancing, drumming and singing, we encourage all to join us, especially K-12 children. During the four years this class has been offered (Spring Term), we have had continuing commitment and support from the nine Federally-recognized tribes in Oregon, Alaska Natives, the Oregon Indian Coalition for Post-Secondary Education, and the American Indian Science and Engineering Society (AISES).

Professional Societies

NCSR and Professional Societies

On October 29-30, 1992, the National Science Foundation hosted a workshop entitled "The Role of Professional Societies in Science, Technology, Engineering, and Mathematics Education in 2- Year Colleges". Luther Williams, Ph.D., Assistant Director, NSF/EHR, reported in a letter dated April 1, 1993 written to then–NSF Director Walter Massy, Ph.D., that at the workshop, 74 professionals representing 24 professional societies met to: 1) discuss how best to partner with 2- year colleges; 2) support initiatives to improve education in the first two years of college, and 3) help develop and promote 2-year college leaders and spokespeople.

The NSF report following the workshop, "Matching Actions with Challenges" asserted that discipline-based professional organizations should be recognized as being in the unique position from which to support innovation and disseminate information. Also, it recommended that professional societies assume a leadership role in the initiation and development of a new vision of the lower division undergraduate curriculum that capitalizes on the critical role of 2-year colleges. Overall, NSF reported that by partnering with professional societies, 2-year programs can improve the quality of education for an important segment of our population.

Two-year programs in natural resources have enjoyed the benefits of partnering with professional societies for a number of years. Professional societies include the *American Fisheries Society, North American Wildlife Technology Association (NAWTA)*, and *Society of American Foresters (SAF)*.

For example, from its "Purpose Statement", the NAWTA."... will provide: 1) a description of the Wildlife Technician which will be beneficial to employers, students, educational institutions, and professional wildlife biologists; 2) accreditation standards for postsecondary education institutions training Wildlife Technicians and a means of reviewing and updating these standards; and 3) a forum for continued exchange of ideas, educational material, and recognition for two-year and three-year Wildlife Technology programs in North America."

Natural resource professional societies can assist education programs by developing and setting standards which meet the profession's needs. Meeting this need for technicians, both NAWTA and SAF have developed "standards for recognition" of 2-year programs; Canada also has its own "National Standards for Applied Science and Engineering Technologists", including education standards for Forest Resource Technologies. For excerpts of standards in each of these organizations, see

Appendix D pp. 93 and 95. There are currently about 14 Wildlife Technology programs recognized by NAWTA, and about 29 Forestry Technology programs recognized by the SAF (for more, see "Model Programs — Haywood Community College", page 46).

Greg Smith
Director, Science and Education
Society of American Foresters (SAF)
Bethesda, MD

The Society of American Foresters (Est. 1900) is involved in many aspects of the profession, including producing the "Journal of Forestry", a national monthly magazine. Representing the Society, Greg Smith writes about the SAF and its role in 2-year college programs.

Society of American Foresters (SAF) (http://www.safnet.org) is the national, professional, scientific organization representing the forestry profession in the United States. Through its membership base of over 18,000 foresters, including federal, state, private, and consulting foresters, as well as student and academician members, the Society has established programs to direct resource policy, publications, continuing education, certification, and education review. It remains the sole accreditation authority for professional forestry education in the U.S., and also maintains the only program to review and recognize forest technology education programs.

The Society's mission is to advance the science, education, technology, and practice of forestry; to enhance the competency of its members; to establish professional excellence; and to use the knowledge, skills, and conservation ethic of the profession to ensure the continued health and use of forest ecosystems and the present and future availability of forest resources to benefit society.

Society members subscribe to a code of ethics, the foundation for their professional behavior in relations with the public, their employers (including clients), and with each other. Stewardship of the land is the cornerstone of the forestry profession. As such, SAF members advocate and practice land management consistent with ecologically sound principles.

SAF has several mechanisms to address local education issues at postsecondary institutions. First, it maintains an educational review process guided by standards developed both by educators and employers of graduates. This process — recognition for associate-degree granting institutions — involves a comprehensive evaluation of programs by a panel of professional peers, following a self-evaluation report developed by the program that assesses compliance with national recognition standards. Recognition results are summarized in national publications and provided to employers of graduates and prospective students. The aim of recognition is to improve educational quality and resulting land management activities.

Second, SAF maintains student chapters throughout the country to encourage mentoring of students by faculty and active practitioners. SAF student chapters may elect representatives to the SAF National Student Assembly, where delegates contribute to the advancement of their profession by developing recommendations to national SAF leadership. Student members are also introduced to the professional code of ethics and contribute to local meetings of the SAF membership.

Third, SAF accepts graduates of forest technology programs as Technician Members, with voting and office-holding privileges at the local and regional level, as well as the opportunity to serve on national task forces and committees.

Specifically, SAF continues to be very interested in the Northwest Center for Sustainable Resources (NCSR) project since this effort represents a regional attempt to coordinate and encourage excellence in land resource management in a way that has national implications for developing model educational outreach programs.

SAF plans to closely monitor the curriculum development of NCSR as a way to review and, possibly, to modify its own standards for recognition of forest technology curricula throughout the country. These standards represent the guide for programs wishing to achieve recognition status from the Society. The curriculum standard addresses such topics as adequate college-level mathematics instruction, ecosystem management principles, and rigorous field training in all aspects of forest resources identification and management.

Excerpts of SAF Standards for 2-Year College Recognition can be found in the Appendix, page 95.

Jim Brown, Ph.D.
Chair, Department of Environmental Science
University of San Francisco
San Francisco, CA

The University of San Francisco, a partner of NCSR since its inception, has offered both undergraduate and graduate courses in Environmental Sciences, including Ecosystem Management, for a number of years. Jim Brown writes about 4-year programs for the future, emphasizing needs for newly-educated citizens for the 21st Century.

As we move toward the next millennium, programs like the Northwest Center for Sustainable Resources (NCSR) must continue to develop and serve as models for other community colleges and four-year universities. The University of San Francisco (http://www.usfca.edu/) is pleased to have served as one of the participating four-year universities in the development of the program.

After the 70's environmental legislation was passed, it became more and more apparent that education was the key to long-term environmental problem solving. Those of us who do research and teach in the environmental field have a two-part responsibility. We must continue to develop studies that define the problems associated with environmental degradation and develop techniques to better remediate the impacts. However, just as importantly, we must champion the development of environmental studies that permeate all the disciplines (arts and sciences). It is absolutely critical to have a citizenry educated to receive and understand technical information about a particular issue. One wonders what kind of job educators have done about informing the public about the questions of global warming, when greater than 90% of the public doesn't know that the bulk of green plants comes from the carbon obtained from carbon dioxide in the air we breathe.

Most of us who have grown up professionally over the past 25 years have come to learn that good environmental management comes about when public policy is set by an informed citizenry in which all the stakeholders can come together. Environmental issues have to be approached with a partnership of science with politics, psychology, sociology, ethics, economics, government, etc. Because these stakeholders are all products of our educational system, the challenge seems clear — give students the training and information they need to get more involved in shaping policy and directing decision making. But let's make sure we give students the tools to develop into a well-informed citizenry who are trained to think critically and responsibly.

The University of San Francisco's Department of Environmental Science offers a B.S. degree in Environmental Science and a M.S. degree in Environmental Management. The undergraduate program has a strong core curriculum in the physical and biological sciences as well as a balanced component of general education courses in the humanities and arts. Each undergraduate major must complete an internship program that includes actual work outside the confines of the university. The internship may be with local industry or various governmental agencies. Students gain practical experience about how the business and professional community uses technical information to solve environmental problems. Perhaps the most unique feature of the undergraduate program has been the incorporation of an environmental monitoring course. This course is an in-depth study of a watershed in northern California. Currently the class is working with the National Park Service to monitor Redwood Creek in the Golden Gate National Recreation Area.

The Environmental Management graduate program's curriculum provides the background knowledge necessary to understand the complexities of a wide range of environmental problems. Courses offered include ecoscience, law, engineering, management, public policy, ethics and philosophy. The curriculum also provides the scientific, technical, regulatory, and public policy knowledge related to problems of air and water quality, solid and liquid waste, energy, resource use and human and ecological health issues. Classes meet on Saturdays and evenings — allowing students to pursue their graduate degrees while maintaining their jobs. Students accepted to the program are expected to be working in the environmental field and use their workplace as the laboratory in which their thesis work is focused.

The NCSR is an outstanding program for other colleges and universities to model. The curriculum is rich in the mixture of science and the humanities, and the close working relationship fostered with private industry and local, state and federal governmental agencies is exactly the formula needed to produce well-trained individuals both ready to enter the work force as well as continue on for additional college degrees. The University of San Francisco looks forward to seeing graduates from the Center. Their training and work experience will enrich our student body.

Congratulations on a job very well done and I look forward to a long and continuing relationship with the Center.

Art McKee, Ph. D.
Director
H.J. Andrews Experimental Forest
Willamette National Forest
Department of Forest Science
Oregon State University
Corvallis, OR
and
NCSR Co-Principal Investigator (Co-PI)

Art McKee has actively served the NCSR in a number of ways, including as a member of its Advisory Committee and most recently, as the Center's Co-PI. Representing the H.J. Andrews Experimental Forest and Oregon State University, McKee has helped bring leading research scientists to the forefront of Center activities, especially in collaborating with Wynn Cudmore and the Ecosystem Institute. The Experimental Forest is part of the National Science Foundation's Long-Term Ecological Research (LTER) program, making it a world leader in forest ecosystem-based research. The Andrews/ NCSR partnership provides unique opportunities for faculty, and ultimately their students, to experience "science at the cutting edge."

The research community associated with the H.J. Andrews Experimental Forest (http://www.fsl.orst.edu/lterhome.html) continues to be a strong supporter of the Northwest Center for Sustainable Resources. We feel it exemplifies the kinds of productive interactions possible in a well-organized collaborative effort among educational institutions, state and federal agencies, and private firms when they are working in common cause. In this case, the common cause is improved management of natural resources by improving the education of those who will be working in natural resources.

To that end, scientists and educators working at the Andrews Forest have gladly joined with NCSR to improve science-based natural resource education at community colleges. Oregon State University as represented via the Andrews Forest program has several roles as a partner in NCSR: 1) be an informational resource (at many levels); 2) facilitate the transition of students from the participating community colleges to four-year schools in general and Oregon State University in particular; 3) offer employment guidance and advice for graduates of the NCSR colleges; and 4) participate in short courses for community college teachers.

Instructors and students at NCSR community colleges should be aware of the informational resources available from the Andrews Forest research program through publications and reports, personal contact, and the Internet. Because of the NCSR program, several faculty at OSU have added information pertinent to ecosystem management and sustainability of resources to the Andrews Forest home page, the OSU College of Forestry home page, or their own home pages. We will continue to emphasize the openness of the Andrews Forest program to providing information to those interested.

Oregon State University has already developed a cooperative program with Central Oregon Community College which assures a smooth transfer to the College of Forestry, OSU if the student chooses to pursue a four-year degree. The Dean of the College of Forestry at OSU, a member of the Advisory Committee for NCSR, is on record as supporting the development of similar transfer protocols from other NCSR colleges, including options with other colleges and majors at OSU. This is an area which will be pursued over the next 2 years.

The Andrews Forest program works in close collaboration with the US Forest Service, BLM, National Park Service, Biological Services Division of USGS, Fish and Wildlife Service,

The Wind River Canopy Crane Research Site — Another Premier Research Site Featured By NCSR

How much water does a forest return to the atmosphere as transpiration? How do climatic conditions, such as temperature, change as one moves 220 feet up through a [tree] canopy? ... *How do parasitic organisms, like dwarf mistletoe, and leaf-eating insects spread and [how do they] affect productivity?* What are the contributions of epiphytes, such as lichens and mosses, to productivity and other ecosystem processes? ... *What kind of structural "niches" are the flying squirrels using?* The bats? How important are tall snags and for whom are they important?

Wind River Canopy Crane, A Research Facility for Access to and Study of the Forest Canopy
1997 brochure

These questions, and many more, are being studied at the Wind River Canopy Crane Research Site (http://weber.u.washington.edu/~wrccrf/) in Wind River, WA, located in the Gifford Pinchot National Forest. The Crane, which towers 300 feet over an old-growth Douglas-fir/western hemlock forest, is one of only a few similar sites internationally. This model research site, like the H.J. Andrews Experimental Forest LTER site, is incorporated into NCSR's backbone activities in research.

Forest canopy research using cranes began in 1990 with the erection of a 38-meter crane in Panama City's Parque Natural Metropolitano, and now include sites in Venezuela — and Wind River.

The work at these sites has led the way in a blossoming of research in forest canopies. Canopy studies completed thus far include the following:

- the role of canopy mosses, fungi and lichens in forest nutrient cycling
- photosynthetic rates and nitrogen fixation in the forest canopy
- development of new forest management techniques
- the role of forest canopies in global carbon balance
- responses of trees to carbon dioxide concentration
- adaptations of trees to changing canopy climatic conditions
- diversity and ecological roles of invertebrates
- mapping of canopy structure — foliage, snags and canopy gaps

An international research group — The International Canopy Network — was formed in 1994 to facilitate communication among those involved in canopy research, education and conservation. The group organizes scientific symposia and meetings and has plans for a library of color slides and videotapes for educators. More information can be obtained from their World Wide Web Site (http://www.lternet.edu/ican/info.htm)

BEST COPY AVAILABLE

Andrews Forest Scientists Participating in the NCSR Ecosystem Institute for Community College Instructors:

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the Oregon Departments of Forestry, and Fish and Wildlife, and many other agencies charged with natural resource management. There are excellent opportunities for students to network through the Andrews Forest program when seeking employment, and they are encouraged to do so.

Finally, Andrews Forest scientists have worked with NCSR faculty to design and conduct a short course for community college instructors. The course has been offered twice, summers of 1996 and 1997, under the direction of Wynn Cudmore of Chemeketa Community College/ NCSR and Arthur McKee of the Dept. of Forest Science, Oregon State University. The intensive, week-long course examines the scientific basis for the current efforts toward ecosystem management which all federal and many state agencies have adopted as policy. (For more information, see Ecosystem Institute, page 10).

NCSR advertises the course nationally and selects about 15 community college instructors from the applicants. Participating community college instructors have come from all around the nation and represent many different disciplines. Collectively, these instructors teach dozens of classes and interact with several hundred students annually. Clearly, teaching these instructors about the latest advances in ecosystem science and management has a huge multiplier effect. With that in mind, it has been easy to engage some of the best scientists at Oregon State University and the Andrews Forest to participate as instructors in the short course (see sidebar).

The course begins with an overview of what ecosystem management is, includes a short history of the development of the concepts and the emergence of the philosophy of sustainability, and then goes into detailed background in topical areas which are especially germane to ecosystem management. The topical areas which are addressed include: landscape ecology (including disturbance and fragmentation effects); terrestrial-aquatic interactions (riparian zone ecology); aquatic ecology; carbon dynamics and decomposition; nutrient cycling/soil ecology; and terrestrial vertebrate ecology. In addition to providing basic information about the science behind ecosystem management, the teachers for the short course are also asked to present field and laboratory exercises which the participating community college instructors can adapt for their own classes.

By all measures, the short course has been well received by the community college instructors and is achieving its intended purposes. The students have had opportunities to critique each session, and an independent evaluation has been performed by the Western Center for Community College Development at Oregon State University. The evaluations have been used to modify and improve the short course.

Because this short course has proved so successful, it will be continued until it becomes clear the need has ended. In a recent discussion among the Andrews Forest community about the value of the short course, the consensus was overwhelming — continue involvement and development.

In summary, the Andrews Forest program is enthusiastically committed to remain an active partner with NCSR. We feel this to be a positive and productive collaboration, and will continue to play the roles described above.

Sergei A.Polozov, Ph.D.
Associate Director
Environmental Management Program
Concordia University
Portland, Oregon

Sergei Polozov has expressed enthusiastic interest in the Center. In continuing collaboration, Polozov has incorporated NCSR in his work with Concordia University regarding sustainable development initiatives in Smolensk, Russia.

Northwest Center for Sustainable Resources — A Model for the International Community

The Northwest Center for Sustainable Resources (NCSR), created in 1995 as a collaborative partnership of diverse institutions, has many functions. Among them are being a model for other regional American institutions, and developing approaches to sustainability in the field of education, industry, and policy. At the same time, NCSR can be considered an important model for implementation not only within other regions of the United States, but in other countries as well.

The partnership between NCSR and Concordia University (CU) was formed in 1995, and CU was among educational institutions involved in development of the Center from the very beginning. Representing education at the university level, CU is a part of the chain, educating specialists at the next level after high school and community college. The integrity of educational strategies at the different levels is therefore a critical point concerning efficiency of the preparation of graduates for practical work in general — and in the field of sustainable resources in particular.

Implementation of any model in another country always faces cultural, economic, political, and geographical differences. Identification of

"...The outlines of a global approach to the biodiversity crisis [are now becoming apparent]... Saving species will require a dense network of protected areas... and international equity [must be addressed]...Yet without some sort of overarching commitment that can guide and sustain individual efforts, they will fall short...This collective will to act must transcend politics and economics. It must engage our reasons for being on Earth and our most deeply cherished hopes for the future. Fostering this determination to act wisely is humanity's greatest challenge."

Peter H. Raven, Director,
Missouri Botanical Garden, St. Louis
Greatest Environmental Crisis: Mindless Destruction of Species
Science Watch, Corvallis Gazette-Times,
Sunday, January 4, 1998

similarities between countries considered is the critical issue, leading to selection of a particular model for components which can be introduced to another society. During the past three years, CU has worked closely with Russia in the field of Sustainable Development. In this effort, NCSR was among active participants of that work from the beginning of the first strategic discussions between government officials, industries, businesses, research, and educators from the American Northwest and the Smolensk region of Russia. At the second step of that work, oriented on creation of a *Regional Model of Sustainable Development*, information about NCSR was delivered to a broad audience of specialists from public and private Russian institutions representing the Smolensk district as a model area in Russia. NCSR's activities attracted the deep interest of different specialists, but first and foremost — of educators at different levels.

The economic situation in Russia makes it very difficult if not impossible to financially support any educational initiative, even at the regional level, by the government. At the same time, the infrastructure of private business has not yet been developed for its broad involvement in the facilitation of progressive social initiatives. As a result, the most critical innovations in education have been implemented by enthusiasts, who are not only without any financial support, but who are very often without coordination and strategic management. Under these conditions, examples like a regional center such as NCSR, which is a working consortium of interested and interrelated parties, with financial support via grants, is a very promising strategy, immediately attracting attention of educators and managers in education — it is true for representatives at the university level as well as for grade school teachers, including elementary schools. Also, the model is important for representatives of non-formal educational groups, who expressed the highest interest.

The Russian educational system, being traditionally one of the strongest in the field of academic standards, has always had a very diverse infrastructure in the field of extracurricular activities — mainly because of free public education, which was supported by the government. Even today, private educational institutions are not numerous, and the private system is still new for people, and does not form its niche within the field of education. At the same time, difficulties inherent to the transition period have destroyed many traditional components of public education. Among those components are many extracurricular activities and structures such as sport, art, science, etc., and clubs and groups. At the very beginning of the educational chain, that level is very important for the formation of the whole foundation for upper educational institutions. For specialists who are working hard for the development of strategies for organization of regional structures involving educational, financial, business, and governmental institutions for educational purposes, NCSR's example has been considered a potential model for that undertaking.

Curriculum development is another area attracting attention of representatives from different educational, social, economic, and government institutions. First of all, academic aspects of curriculum improvement in itself is very important. With new trends in Russian education today, educators have significant and new responsibilities in introducing into the teaching-learning process current materials which reflect specific local needs, problems, and phenomena. It was very difficult or even impossible to do that earlier, under the conditions of a unified curricula introduced from the top of governmental pyramid. At the same time, without flexible curricula which adequately reflected local specifics of different regions, it was impossible to speak not only about sustainable strategies, but even about proportional development of the job market, and preparation of professional workers for any field in the economy — and in society in general.

Environmental education, ecological education, and special professional education together represent yet another model of NCSR's strategy of collaboration between different regional institutions. Under conditions of economic transition, conservation and rational use of natural resources are not among first priorities. More than that, consumption of natural resources becomes the easiest way of generating profit, and for attracting the most aggressive and irresponsible businesses and industries to unlimited and inappropriate use of nature. When government, even with strong environmental laws, cannot control those processes, public involvement is more important than ever. Environmental education, in a broad understanding, includes ecological culture and information about environmental conditions which are important conditions for stimulating public activities and local control.

Democracy, in a traditional sense, means first of all — *active public opinion*. Without that, no one freedom, coming from the top of the political pyramid, will work. Russia today is offering all kinds of freedom for citizens, yet public opinion is not really active because of political stress over the last few years, coupled with difficulties of everyday life, pessimism concerning the government, etc. So traditional mechanisms of democracy, being available, are not working. The model of coordinating efforts of several institutions, oriented on sustainable approaches in different fields, may be a critical factor — and this model will result in positive outcomes in society-in-general, reaching far beyond the field of sustainability in itself.

Local communities are traditionally very important elements of the whole social infrastructure in the United States. It is very important to remember that in Russia, local communities historically were very strong as well, forming economic, social, and cultural processes within different geographical regions. The huge size of the country with dramatic differences in natural conditions is another factor making local communities a critical element of efficient activities. At the same time, totalitarian communist ideology did a lot to destroy all possible links within local communities across the whole former USSR. It was a special strategy, involving many different tactics, such as the destruction of Russian Orthodoxy, and the artificial economic interdependence of different regions. As a result, even the understanding of the phenomenon of local or regional community in many areas has been lost. Being totally pessimistic about government and official regulations, people had lost their own responsibility for their own neighborhood.

Today, very positive changes may be found everywhere. Local community as a cultural and economic phenomenon is coming back to Russian life. In that situation, building the union between diverse institutions from different professional fields around regional problems of sustainable development looks more and more as one of the most effective ways of resurrection of the common sense in economy and of democracy — in its original meaning. NCSR's model is a valuable resource with great potential for implementation under the specific conditions of today's Russia.

Bilateral communication and mutual interests between different parties involved are additional values that should be greatly appreciated when working with a project such as NCSR. In today's post-Soviet society, separated by political, national, and religious differences, any field capable of stimulating interactive trends is a critical thing to support. *Sustainability* is exactly that kind of thing. In any nation — or social, or religious group — there are people appreciating common sense and caring about the future for their children (unfortunately, they are not necessarily among decision-makers responsible for policy in the society, but that is another problem, and it is a much broader topic for discussion). Above all, *sustainable development* has a much better chance to facilitate productive communication between real or potential opponents than any other issue. That is one more reason that NCSR's model is a very attractive example for very different societies who are struggling today with diverse problems in all major spheres of social and economic life.

NCSR
Final Observations

Susie Kelly

Partnering *can* make a difference

From our partners' roles as advisors to the Center, to partner community colleges, to Center consultants, to presenters at faculty institutes — our experience has shown that many minds rather than just a few can combine to catalyze and accelerate change, increase overall impact, and expand and proliferate new programs. Partnering can be as simple as an invitation over the phone, at a meeting, or by other means. And though it's generally not difficult to forge a partnership, it takes sincere effort to make it work to its fullest extent. If you find meaningful and mutually beneficial ways for partners to interact, many people are willing, *and enthusiastic about,* working with community colleges.

Similar Issues Face Community Colleges Everywhere

Issues facing community colleges in say, California, can be similar, if not practically the same, as many of those faced in a community college in say, Alabama. Two-year technical programs experience many of the same problems and hurdles as all educational institutions, yet they can have some unique problems of their own — "unique challenges" may include:

– dealing with issues of under-prepared students, particularly in the "hard sciences" and mathematics

– difficulties in increasing program requirements (particularly in math and science) when issues exist of remediation, bridging, and limitations of two-year programs to be completed in two years

– challenges posed by non-traditional students, including students who are entering college later in life, and who have families and, perhaps, jobs

– problems of decreasing funding for programs, yet increasing standards and rates of reform in classrooms

– difficulties in "keeping up with new technology", for reasons of high cost for equipment, access to trained teaching personnel, and even simply finding ways to "fit new courses" into programs already burgeoning with course requirements

Emphasizing 4-Year College and University Transfer options for students

NCSR partners recommend that 2-year programs emphasize transferability of courses to 4-year institutions. The Center has responded to this recommendation in its curriculum revision efforts, and encourages others to follow this model. To accomplish this, it is largely up to individual instructors in technical programs to instill in their students that they take as many transfer courses as possible, and to upgrade their programs and professional development so they are able to offer transfer level courses; also, they must be successful in forging articulation/transfer agreements with universities and colleges. An Associate degree program which allows for maximum transfer of technical and core credits will be the most beneficial for students in the long run.

Assuring Programs are Work-Based

NCSR has strived to assure that community college technical programs are, indeed, work-based. Programs in our consortium already had local advisory committees and councils to provide guidance, and NCSR helped augment this activity by requiring each lead program to conduct a DACUM (see pp. 101 - 125 – DACUM charts).

Recommendations of the Center's advisory committees have included ideas about industry and agency contribution to programs. Also, program developers have been encouraged to seek recognition by their respective professional societies — those such as the *Society of American Foresters* and the *North American Wildlife Technology Association* (Appendix D); these organizations have done a great deal of the legwork in linking educational standards with work-based competencies, and by achieving recognition, community college programs can gain greater credibility in the workplace. Finally, NCSR partners agree that job-based student internships are imperative to an outstanding educational program.

Needs to Keep Programs "At the Cutting Edge"

Especially in our role as a National Science Foundation Center of Excellence, and from the urging of our partners, we feel the importance of keeping natural resource programs "at the cutting edge" cannot be understated. New scientific information must be incorporated in curriculum change. The 1990s has seen extraordinary change in environmental laws, employment opportunities for graduates, technology use, and management philosophies. These changes point towards continuing demands on educators to keep abreast of new ideas, and for them to actively participate in evolving with industries and agencies who hire their students.

Appendices

A. NCSR Project Partners

Advanced Technology Environmental Education Center
Allegany College of Maryland
American Fisheries Society
American Society of Range Management
Applied Geotechnology, Inc.
Battelle Pacific Northwest Laboratory
Blackfeet Community College
Blue Mountain Community College
Bonneville Power Administration, Fish and Wildlife Division
California Department of Fish and Game
California Polytechnic State University
California State University — Chico
CalTrans
Cascade Center for Ecosystem Management
Center for Holistic Resource Management
Central Oregon Community College
Central Cascades Adaptive Management Area
Chemeketa Community College
Clatsop Community College, Marine and Environmental Research/Training Station
Concordia University
Confederated Tribes of the Grand Ronde
Confederated Tribes of the Siletz
Confederated Tribes of Warm Springs
Council of Eastern Forest Technology Schools
Deschutes National Forest
E&S Environmental Chemistry, Inc.
Ecological Planning and Toxicology, Inc.
Ecosystem Workforce Project
Environmental Systems Research Institute (ESRI)
Everett Community College
Evergreen State College
Feather River College
Gadsden State Community College
Global Rivers' Environmental Education Network
Governor's Watershed Enhancement Board
Grays Harbor College
Hawai'i Community College
Hawai'i State Department of Labor and Industrial Relations
Haywood Community College
Heritage College
Humboldt State University, Zoology
Humboldt State University, Department of Natural Resources
International Resources Unlimited, Inc.
Itasca Community College
Jefferson High School
Linn-Benton Community College
Local Indians For Education
Maidu Tribal Council
Marion County Dept. of Public Works
Mt. Hood Community College
Natural Resources Conservation Service
North American Wildlife Technology Association

North Cascades Institute
Northwest Indian College
North Salem High School
Northwest Environmental Business Council
Olympic National Forest
Oregon Bureau of Labor's Apprenticeship and Training Division
Oregon Community College Association
Oregon Department of Education
Oregon Department of Environmental Quality
Oregon Department of Fish and Wildlife
Oregon Department of Parks and Recreation
Oregon Economic Development Department
Oregon Indian Coalition on Post Secondary Education
Oregon Institute of Technology
Oregon State University, Andrews Forest Ecosystem Group
OSU, College of Forestry
OSU, Extension Service
OSU, Forestry Education Program
OSU, Native Americans in Marine Sciences Program
OSU, Science and Math Investigative Learning Experience
OSU, Western Center for Community College Development
Oregon's Dislocated Workers Project
Pacific Educational Resources
Pacific Farms
Pacific Meridian Resources, Inc.
Partnership for Environmental Technology Education
Peninsula College
Plumas National Forest
Plumas Unified School District
Portland State University, Center for Science Education
PSU, Pacific Northwest Environmental Studies Project
Prince Albert Model Forest Association
REA Science and Testing, Inc.
Red Bluff Union High School
Rogue Community College
Rogue Institute for Ecology and Economy
Salem-Keizer School District
Salix Applied Earth Care
Scientific Ecology Group, Inc.
Shasta College
Shasta Union High School
Sierra Pacific Industries
Siuslaw National Forest
Society of American Foresters
Soil and Water Conservation Society
Southwestern Oregon Community College
The Makah Tribe
The Quinault Indian Nation
The Wildlife Society
U.S. Bureau of Land Management, Eugene District
U.S. Bureau of Land Management, Salem District
U.S. Bureau of Land Management, State Office
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Forest Service
Umatilla Education Service District
Umpqua Community College
University of California Cooperative Extension
University of Oregon, Labor Education Research Center
University of San Francisco, Environmental Sciences
University of Washington
Washington Department of Fisheries & Wildlife
Washington Office of Environmental Education
Washington State Board of Education Programs for Community and Technical Colleges
Watershed Research and Training Center
Western Agriculture Services
Western Forestry Technology Instructors Forum
Western Oregon University, School of Education
Western Washington University, Huxley College of Environmental Science
Weyerhaeuser Company
Willamette Industries
Willamette National Forest
World Resources Institute

B. Ecosystem Management — Resources and Examples

Wynn W. Cudmore
NCSR Principal Investigator

An "open letter" entitled "NCSR and Ecosystem Management" was prepared in 1996 that reviewed the literature on ecosystem management and summarized current thinking. Since that document was produced, a number of articles have been published that further define the concept and describe attempts to implement it. The following articles are representative of some of these refinements. Educators interested in incorporating ecosystem management into curricula should find these to be valuable resources.

1. Grumbine, R.E. 1994. *What is ecosystem management?* Conservation Biology 8(1):27-38.

   This is the original summary article on EM cited in the "NCSR and Ecosystem Management" open letter.

2. Nielsen, L.A. and D.J. Decker. 1995. *Educating natural resource professionals for ecosystem management.* Renewable Resources Journal. Spring 1995:12-17.

   This article addresses some of the issues concerning the preparation of natural resource workers in a world where ecosystem management is implemented. It confirms the need for the efforts of NCSR.

3. Seastedt, T. 1996. *Ecosystem science and society.* BioScience 46(5):370-372.

4. Several authors. 1996. Ecological Applications 6(3)

   This issue contains a series of articles from a number of authors who describe their insight on ecosystem management. Authors include representatives of the wood products industry, universities and federal agencies. One of these articles is co-authored by a member of our National Visiting Committee - Wayne Swank, of the Coweeta Hydrologic Laboratory in North Carolina.

5. Kohm, K.A. and J.F. Franklin (eds.) 1997. *Creating a forestry for the 21st century: The science of ecosystem management.* Island Press, Washington, D.C. 475 pp.

   This newly-released publication addresses ecosystem management as it applies to forestry. It represents the first attempt to place ecosystem management in an "operational context" — i.e. from "theory" to "practice". NCSR provides a copy of this book to its partners and participants in the Ecosystem Institute.

6. Christensen, N.L. 1996. *The scientific basis for ecosystem management: an assessment by the Ecological Society of America.* Ecological Applications 6:665-691.

This document is available via e-mail. You can order a copy at esahq@esa.org.

7. LaRoe, E.T., et al. 1995. *Our living resources: A report to the nation on the distribution, abundance and health of U.S. plants, animals and ecosystems.* U.S.D.I. National Biological Service, Wash., D.C. 530 pp.

This report is the first comprehensive publication to come out of the biological science branch of the Department of the Interior — the National Biological Service. It is a large collection of short articles that addresses most biological resource issues in the United States. GIS– generated maps and data summaries are found throughout the document. I have found it to be a valuable resource and a good starting point for researching any biological resource issue. It is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Stock # 024-010-00708-7

8. Baker, J.P. et al. 1995. *Ecosystem management research in the Pacific Northwest — five year research strategy.* U.S. Environmental Protection Agency, Corvallis, OR.251 pp.

This report outlines EPA's view of ecosystem management and describes this agency's plan for implementation in the Pacific Northwest. The document number is EPA/600/R-95/069 and it is available from:

Western Ecology Division
National Health and Environmental Effects Research Laboratory
U.S. Environmental Protection Agency
200 SW 35th Street, Corvallis, OR 97333

9. Logan, R.S. and R.A. Fletcher. 1996. *Forest Ecosystem Stewardship.* Montana State University Extension Service #EB141. 49 pp.

This document describes current thinking on forest ecosystem management to a person without an extensive background in forestry or ecosystem science. Jargon is kept to a minimum, yet the most important ecosystem principles are introduced, defined and examples are given. The use of "ecosystem science" as a basis for natural resource management is a dominant theme. There is a good balance between principles/theory and practical, and "how to" information that could be applied by a timber owner. The document represents a good approximation of the level of understanding of EM for students in natural resources technician programs.

10. Oliver, C. 1996. *Forest Ecosystem Management: A Graphic Overview.* Boise Cascade Corporation, LaGrande, Oregon. 52 pp.

This document is a bit more technical than Logan and Fletcher (1996) and addresses ecosystem management on industrial forests. It contains a wealth of information and flashy graphics to illustrate major points. All main elements of ecosystem management are addressed in the document - maintaining biodiversity, ecological processes, and site productivity while managing on larger scales of time and space and meeting human needs. Expectedly, there is a clear emphasis on the latter and the message of meeting the social and economic needs of humans receives priority.

11. Yaffee, S.L., A.F. Phillips, I.C. Frentz, P.W. Hardy, S.M. Maleki and B.E. Thorpe. 1996. *Ecosystem management in the United States: An assessment of current experience.* Island Press, Washington, D.C. 352 pp.

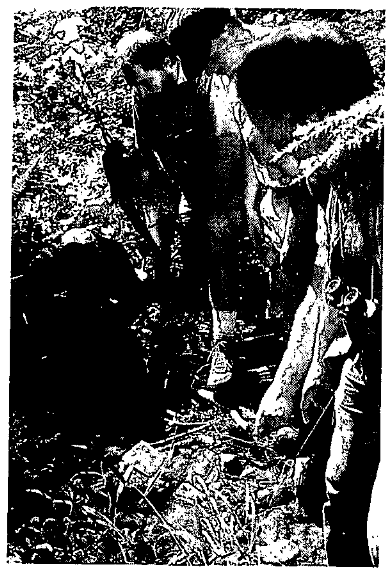
This publication is a collaborative effort of the University of Michigan and the Wilderness Society. Using the definition proposed by Grumbine (1994), the authors examine in detail 105 ecosystem management projects throughout the U.S. General characteristics, goals, challenges and expected outcomes are described for ecosystem management projects.

12. Bennett, M. 1996. *Ecosystem management — opportunities and implications for woodland owners.* EC 1469, Oregon state University Extension Service, 11 pp.

This short Extension Service bulletin is designed to explain ecosystem management to private woodland owners. Various definitions of ecosystem management are given and the characteristics and rationale for implementation of EM are succinctly explained.

13. Moote, M.A., Burke, S., Cortner, H.J. and M.J. Wallace. 1994. *Principles of Ecosystem Management.* Water Resources Research Center, Univ. of Arizona. 14 pp.

14. U.S. Department of Interior, Bureau of Land Management. 1993. *Grazing Administration Regulations, Proposed Rule.* Federal Register 58(155): 43208-43231. August 13, 1993



C. NCSR Center Framework

Northwest Center for Sustainable Resources

Wynn Cudmore
Principal Investigator

Art McKee
Co-Principal Investigator

Susie Kelly
Director

Jon Yoder
Secondary Education Coordinator

Lauren Elliano
Staff Assistant

Consultants

Jim Schriever
Industry

Neal Maine
Secondary Education

Bob Tom
Native American Tribes

Christina Berry
Marketing

Lead Community Colleges

Central Oregon Community College

Chemeketa Community College

Feather River College

Grays Harbor College

Shasta College

Partners

4-Year Colleges & Universities

Agencies/Industries

Secondary Education

Research Groups

Community Colleges

Native American Tribes

Professional Societies

Test Community Colleges

Allegany College

Blue Mountain Community College

Everett Community College

Mount Hood Community College

Shasta College

Southwest Oregon Community College

Advisory Committee and National Visiting Committee

Information Clearinghouse

Chemeketa's Information Technology Department

Evaluation

OSU's Western Center for Community College Development

D1. Professional Societies/North American Wildlife Technology Association (NAWTA)

Excerpts for NCSR Interim Report

Purpose:

The purpose of this organization is to promote, enhance, and advance the status of the Wildlife Technician by the following objectives:

1. Provide a description of the Wildlife Technician which will be beneficial to employers, students, educational institutions, and professional wildlife biologists.

2. Provide accreditation standards for postsecondary education institutions training Wildlife Technicians and a means of reviewing and updating these standards.

3. Provide a forum for continued exchange of ideas, educational material, and recognition for two-year and three-year wildlife technology programs in North America.

North American Wildlife Technology Association Program Recognition Standards (Revised 1993):

Standard I: Program Objectives

To be recognized by the NAWTA, educational programs in wildlife technology shall be offered as two-year or three-year, terminal, associate degrees or their equivalent. They shall consist of classroom, indoor laboratory, and field experiences necessary to develop field competence.

The program shall have clearly defined, publicly stated objectives expressed as terms of the educational results it is seeking to achieve. These objectives express (1) the specific knowledge, skills, and attitudes sought to be imparted to the student, (2) consistency with the objectives of The Wildlife Society, (3) responsiveness to the needs of the constituencies which the program seeks to serve, and (4) sensitivity to the role of wildlife technology in meeting the increasing diverse needs of society and the profession of wildlife science and management.

Standard II: Curriculum

1. Minimum requirements for recognition by the NAWTA are 1000 contact hours with at least 400 of the 1000 hours dedicated as laboratory instruction.

Recognizing that Canada's economic future depends on the skills and knowledge of Canadians and on the effectiveness with which these can be applied to new opportunities, effective training is key both to the economy and the quality of life for Canadian workers. To this end, standards for technologists have been developed for a range of occupations, including forestry.

*The following are a few highlights of the 1994 document, **National Standard/ Forest Resource Technologies**, National Standards for Applied Science and Engineering Technologists, British Columbia Institute of Technology.*

General competencies for Forest Resource Technologists include:

- Communicate effectively in public and working environments
- Prepare and present effective written and oral reports
- Apply scientific and mathematical principals to the analysis and solution of project-related problems
- Apply business management principles to the solution of project-related problems
- Use computer software
- Apply principles of sustainable development in the planning, design, and implementation of renewable resource projects
- Conduct resource surveys and inventories such as those related to soils, wildlife, hydrology, silviculture, pestology, and yields
- Apply statistical methods to the analysis and solution of resource management problems

2. Wildlife Technology curriculum should include instruction in subject areas including: *Wildlife Biology and Management; Biological and Ecological Science; Communications Skills; Forest Sciences or Range Science; Surveying, Mapping and Inventory Skills; Fisheries and Aquatic Science; Law Enforcement Administration and Policy.*

3. Broad content descriptions are included for each subject area listed. *Wildlife Biology and Management*, for example, includes the following topics: identification of vertebrate and plant species; collection of data on age, sex, and reproductive status; field note record techniques; population dynamics; design and implementation of management plans; animal damage control; preservation of biological specimens.

Excerpts for NCSR Interim Report

Standards and Procedures for Recognizing Educational Programs in Forest Technology

Part I: Standards

The Society of American Foresters (SAF) was founded in 1900. It is the national organization that represents all segments of the forestry profession including public and private practitioners, researchers, administrators, educators, forest technicians, and students. The Society's Mission is to advance the science, technology, education, and practice of professional forestry; to enhance the competency of its members; to establish professional excellence; and to use the knowledge, skills, and conservation ethic of the profession to ensure the continued health and use of forest ecosystems and the present and future availability of forest resources to benefit society.

The SAF first established guidelines for recognizing educational programs in forest technology in 1971. The objectives of the SAF recognition program are to:

1. Seek continued advancement in the quality of technical forestry education.
2. Give students, employers, SAF members, and the general public assurance that graduates of SAF- recognized programs have been instructed in the basic knowledge and skills, as well as environmental ethics and values.
3. Provide prospective students, employers, SAF members, and the general public assurance that a quality educational environment is available at SAF-recognized programs.
4. Establish, maintain and improve standards to guide and measure achievement for programs.

Although rigid adherence to the standards described here is not mandatory, programs are expected to meet the minimum criteria. Well-planned experimentation and development are encouraged. Innovative or non-traditional approaches and programs, when identified and documented, will be evaluated against the intent of the minimums established.

The word *shall* as used in these standards is defined to mean a required or mandatory criterion. The word *should* is defined to mean a recommended criterion.

Standard I: Program Objectives

To be recognized by SAF, educational programs in forest technology shall be offered as two-year, associate degrees or their equivalent in contact hours and content. They shall consist of classroom, indoor laboratory, and field laboratory experiences necessary to develop field competence. Correspondence and preforestry programs do not qualify.

The program shall have clearly defined, publicly stated objectives expressed in terms of the educational results it is seeking to achieve. These objectives should express (1) the specific knowledge, skills, and attitudes sought to be imparted to the student, (2) consistency with the objectives of the parent institution, (3) responsiveness to the needs of the constituencies which the program seeks to serve, and (4) sensitivity to the role of forest technology in meeting the increasingly diverse needs of society and the profession of forestry.

Standard II: Curriculum

1. The program shall provide for a minimum total of 800 contact hours of instruction in forestry and related technical development courses, of which a minimum of 530 hours is devoted to indoor and field laboratory instruction. (A contact hour is a clock or a classroom hour allocated for lectures and scheduled indoor and field laboratories.)

2. The forest technology curriculum shall include instruction in these technical subject areas:

   a. Dendrology
   b. Forest Ecology
   c. Silviculture
   d. Protection
   e. Measurements
   f. Land Surveying
   g. Aerial Photo Interpretation
   h. Woods Safety
   i. Harvesting Techniques
   j. Multiple Use of Forest Land
   k. Forest Management Practices
   l. Principles of Human Resource (Personnel) Management

Broad content descriptions of these subject matter areas follow (Depth of instruction should reflect regional priorities and practices):

Dendrology:
Field identification of regionally important species by leaves, twigs, bark and fruit characteristics; knowledge of family, genus, and species of each specimen; knowledge of species association and succession; knowledge of the major commercial species of trees in North America and their uses; understanding of the use of dichotomous keys

Forest Ecology:
Plant succession; site; soils; silvics; environmental protection; weather and climate influences; relations of trees to other organisms; biodiversity; ecosystems

Silviculture:
Methods of regeneration; site preparation; planting practices; intermediate treatments; nursery practice; seed orchards; pesticide use and application; prescribed burning; precommercial thinning, commercial thinning, and harvest cutting

Protection:
Fire management; regional problems and control of insects, diseases, and animal damage; threats to forest health

Measurements:
Forest measuring equipment; log scaling practices; forest product measurement; sampling statistics; cruising and inventory techniques; log rules and volume tables; log and tree grading; growth measurement; computer applications and usage

Land Surveying:

Hand compass; surveying equipment and procedures; pacing and chaining; map reading; deed and title search; land descriptions; computer mapping; global positioning systems (GPS); geographic information systems (GIS)

Aerial Photo Interpretation:

Set up for stereo viewing; scale; height measurement; type mapping; road location; bearings and distances; area determination; identification and interpretation

Woods Safety:

Basic first aid; identification of hazards; hand and power tool safety; pesticide herbicide safety

Harvesting Techniques:

Harvesting Systems; cost analysis; logging plans; wood identification; wood products; road layout and construction; best management practices (BMPs)

Multiple Use of Forest Land:

Wildlife; fish habitat; recreation; wilderness; watershed; timber; range; minerals; public conflicts and public participation

Forest Management Practices:

Timber appraisal; contracts; forest management principles; principles of ecosystem (landscape) based management; regional forest management regulations; sustainable forest management concepts/certification; record keeping and basic accounting

Principles of Human Resource (Personnel) Management:

Human behavior: groups, individuals; motivation; leadership; team building and dynamics; planning; decision-making; rating and evaluation; controlling the work force; conflict resolution

3. In order to advance the basic attainment of the students, the curriculum shall also include general education requirements. The curriculum shall provide instruction in oral and written communication, mathematics, natural and physical sciences, social sciences, and business and computer skills.

4. Course syllabi or outlines shall be maintained which clearly state instructional objectives, activities, and resources to be utilized during instruction. Such documents shall be reviewed at least every three years and revised when appropriate, and dated.

5. Technically accurate, up-to-date instructional materials, textbooks, and computer and electronic related resources shall be utilized by students to support instruction.

6. Instruction in safety shall be provided as needed in advance of indoor and field laboratories.

7. A forestry-related work experience of reasonable duration, such as on-the-job training or comprehensive field projects, shall be required prior to graduation. The experience should simulate working conditions of typical employing organizations, i.e., full-day schedules with appropriate assignments.

Standard III: Faculty

1. The forest technology faculty shall consist at minimum of two full-time (minimum 9-month contract per year) instructors. The forest technology faculty member deemed to be the head of the forest technology program — responsible for administrative and academic supervision and direction — shall hold a bachelor's or higher degree in forestry. All personnel teaching or assisting in forestry or forestry-related subject matter shall be qualified on the basis of formal training or extensive practical experience.

2. During the academic year, the teaching ratio between full-time-equivalent students taught by the forest technician faculty and full-time-equivalent teachers on the forest technician faculty should not exceed 20 to 1. A full-time-equivalent student is calculated as one whose schedule equals 30 semester- or 45 quarter-hours per academic year.

3. The number of students per faculty or qualified staff member should not exceed 25 in indoor and field laboratories, and should not exceed 12 in laboratories where hazardous equipment, such as logging or sawmilling equipment, is used.

4. Faculty members shall participate in continuing professional development through or participation in various professional, scientific, technical or scholarly endeavors such as professional or public service, research, consulting, continuing education, and publication.

Standard IV: Students

1. The program, within the guidelines of the institution, shall formulate student recruitment, admission, retention, and graduation policies which contribute to the realization of the program's objectives and which meet or exceed the minimum standards of the parent institution for equivalent programs.

2. The program or institution shall provide opportunity for academic and career guidance and counseling to the student.

3. The program or institution shall provide opportunity and encouragement for student participation in activities that will develop technical skills, leadership, and cultural awareness.

Standard V: Program

1. Where the forest technology program is offered at an institution having a baccalaureate program in forestry, the technology faculty shall be separate and distinct from that of the baccalaureate faculty. The purpose of this separation is to give the technology faculty visibility and control of the program's content.

2. A technical advisory body shall be in operation and function under written guidelines which specify the length of a member's term, responsibilities, and the operational procedures. The advisory body should meet at least once a year. Consideration should be given to including members from representative professional associations such as SAF or the Canadian Institute of Forestry, forestry baccalaureate programs, forest industries, public forestry agencies, and the interested public.

3. General cooperative working relations should exist and be maintained with regional industries, organizations, and agencies.

4. The program should have adequate technical, secretarial, clerical, and custodial support.

Standard VI: Parent Institution and Supporting Areas

1. Students shall have ready access to library facilities having current forestry literature, including: forestry journals; forestry-related journals, such as soils, recreation, range, wildlife, surveying; research publications; current forestry and related books. Students should have access to computerized library listings and retrievals, to the Internet, and to the World-Wide Web.

2. The instructional program shall have a separate, identifiable budget that considers the program's needs. Included are: staff

compensation; facility operation and maintenance; equipment and material purchase and replacement; consumable supplies; travel and per diem; transportation for field trips; in-service education; professional improvement. In cases where the forest technology program's budget is part of an overall division or department budget, the budget administrator shall provide documentation concerning how the budget/financial process operates; how the needs of the forest technology program are evaluated and accommodated; and budget figures. The forest technology program shall document recent equipment/supplies purchases, professional development, and any other expenditures that can be identified.

3. The institution or the program shall assist in placing students and conduct periodic follow-up surveys of graduates. A file should be maintained at the program level regarding student placement and subsequent employment and educational status.

Standard VII: Physical Resources and Facilities

1. An outdoor laboratory or school forest shall be available and utilized. It should be readily accessible and within reasonable commuting time. Such forests may be privately owned, or under public control, for which instructional use agreements have been contracted.

2. The classroom, shops and laboratory facilities shall be adequate for the number of students in each class section. The training equipment shall be consistent with that found in contemporary forestry organizations employing forest technology graduates.

3. Modern audio-visual aids, computer graphics, instructional materials, computers and training equipment shall be available and used in the instructional program.

4. Transportation shall be arranged by the program and available to students for scheduled, off-campus class activities.

5. Classroom, shop and laboratory facilities, and equipment should be arranged for effective teaching, class control, safety, and economy.

For further information contact the:
Department of Science and Education
5400 Grosvenor Lane, Bethesda, MD 20814
(301) 897-8720 ext. 119
e-mail: smithg@safnet.org
Fax: (301) 897 3690
www.safnet.org

Adopted: November 1982
Standards Revised: October 1997 (Replaces all past versions)
Procedures & Guidelines Revised: October 1997
(Replaces all past versions)

E. NCSR DACUM Charts

DACUM is an abbreviation for Developing A CurriculUM, an occupational analysis performed by expert workers in the occupation.

The DACUM produces an occupational skill profile which can be used for instructional program planning, curriculum development, training materials development, and other employment-related activities.

In the case of community college curriculum development, the DACUM process would be as follows: program designers would identify a panel of about 8-12 "expert workers" from their program's field, including technicians and managers. The DACUM Panel would be convened for a day (or more), and a trained DACUM Facilitator would ask the "DACUM panel of experts" — *What skills and competencies do workers in your field need to be successful when entering the work force?*

The basic assumption of the DACUM process is that expert workers are better able than anyone else to describe their occupation.

The product of the DACUM panel is a chart which succinctly illustrates skills and competencies technicians need to enter the workforce. The chart is used by curriculum developers to design curriculum which includes those necessary elements defined by the expert workers.

NCSR has produced DACUM charts for each Lead program.

Resource Ecologist Technician:

A scientifically trained, multi-disciplined individual who applies a variety of skills which facilitate sound management practices in Agriculture, Natural Resources and Ornamental Horticulture.

DACUM Results

A. Demonstrate Communication Processes					
A1 Apply interpersonal skills	A2 Be a creative problem solver	A3 Perform effective writing skills	A4 Be able to implement conflict resolution techniques	A5 Be able to teach or train coworkers	A6 Be able to address a group confidently and persuasively
A7 Participate in political processes	A8 Be able to perform and model leadership skills	A9 Be able to perform public speaking skills	A10 Be able to educate/enlighten public	A11 Cultivate partnerships; network	A12 Recognize steps/procedures to reach goals
A13 Be able to teach realistic, obtainable goals	A14 Be able to interpret	A15 Be able to demonstrate appropriate assertiveness	A16 Be able to share successful or unsuccessful treatments or processes	A17 Be able to present information	A18 Be able to contact resource agencies
A19 Be able to work with experts in special fields	A20 Be able to work with diverse populations	A21 Demonstrate effective interview skills	A22 Be able to follow directions	A23 Be able to market product knowledge	
B. Demonstrate Professional Demeanor					
B1 Understand customs/practices of different cultures	B2 Be willing to work with diversity	B3 Be able to interpret rules/regulations pertaining to personnel	B4 Be able to keep up with technology	B5 Be able to interpret and follow Environmental Laws/Regulations	B6 Be flexible
B7 Be able to market product knowledge	B8 Be able to develop a professional resume	B9 Be able to perform employee evaluations	B10 Be able to demonstrate effective interview skills	B11 Be able to do a self-evaluation	B12 Be able to model leadership skills

DACUM Project: Resource Ecologist Technician **Sponsored by:** Shasta College (NSF/NCSR) **Date:** January 12, 1996

Data Facilitator: Ron Wheadon **Data Recorder:** Francis Duchi

Panel Members:

Cathy Bartels, Farm Credit Services
Sandra Dupret, Trinity County Resource Conversation District
Bill Eiler, Eiler Ranches
Jeanean Falletti, Turtle Bay Park and Museum
Robert Frazier, USFS
Stan Gorden, Shasta College
Thomas Jordan, Shasta County Opportunity Ctr.
Cindi Juhasz, U.S. Bureau of Reclamation
Vanza Rising-Smith, California Dept. of Transportation
Shelly Stoltenberg, Fall River Feed Store
Roxanne Turkovich, Carter House Natural Science Museum
Linda Weaver, California Dept. of Fish and Game/Adopt-a-Watershed

B. Demonstrate Professional Demeanor					
B13 Be aware of career opportunities and limitations	B14 Be a self-starter; be productive	B15 Be able to recognize your limitations	B16 Be able to inspire others	B17 Be able to follow through on commitments	B18 Be able to follow directions
B19 Be able to work unassisted	B20 Demonstrate a good work ethic	B21 Be able to work with little or no supervision	B22 Be able to recognize the ability of disabled populations	B23 Read periodicals and professional journals	B24 Be involved in professional organizations and support groups
B25 Develop partnerships	B26 Perform effective writing skills	B27 Dress appropriately with safety and utility in mind	B28 Be able to recognize the limitations of others		

C. Demonstrate Effective Business and Financial Processes					
C1 Be able to do effective planning	C2 Demonstrate organizational skills	C3 Operate computers	C4 Operate office machines	C5 Be able to evaluate competitors	C6 Be able to identify prospective customers
C7 Be able to determine if you are able to meet customer needs	C8 Be able to qualify customers	C9 Be able to demonstrate time management	C10 Be able to develop and monitor budgets	C11 Be able to do forecasting	C12 Be able to develop a business plan
C13 Be able to read and interpret a financial plan	C14 Be able to interpret tax laws	C15 Be able to perform employee safety training	C16 Be able to perform effective personnel management	C17 Be able to apply for a loan	C18 Be able to collect data
C19 Be able to interpret data	C20 Be able to keep up with technology	C21 Be able to market product knowledge	C22 Be able to apply basic math skills	C23 Be able to do accounting and bookkeeping	

D. Evaluate, Monitor, Maintain and Improve the Ecosystem					
D1 Be able to collaborate; use, repair and maintain equipment	D2 Analyze weather patterns	D3 Be able to analyze soil	D4 Be able to analyze water cycle	D5 Be able to analyze plant characteristics	D6 Be able to recognize toxic situations

D. Evaluate, Monitor, Maintain and Improve the Ecosystem					
D7 Be able to perform ecological assessment	D8 Be able to collect field specimens	D9 Be able to prevent toxic buildup	D10 Be able to utilize the information from resource agencies	D11 Be able to work with experts in special fields	D12 Be able to collect data
D13 Be able to read and create maps	D14 Be able to use GIS	D15 Be able to operate/understand GPS/GIS	D16 Be able to do basic surveying	D17 Be able to analyze/balance life cycles and energy flows	D18 Be able to analyze air quality
D19 Be able to analyze the chemistry relationship in plants/soil/ environment	D20 Be able to operate CAD	D21 Be able to read Natural Resource Indicators	D22 Be able to analyze wildlife/livestock	D23 Be aware of geological impact	D24 Be able to use alternative methods of pest control
D25 Be aware of ecosystems	D26 Be able to utilize restoration techniques	D27 Be able to recognize pest/diseases	D28 Be able to prescribe treatments for pest/diseases	D29 Be able to use integrated pest management skills	D30 Be able to use evapotranspiration data

E. Perform Effective Research Processes					
E1 Be able to explain successful or unsuccessful treatments or processes	E2 Be able to work within a timeline	E3 Be able to survive in adverse outdoor environment	E4 Be able to do grant and technical report writing	E5 Be aware of resources	E6 Be able to collect data
E7 Be able to interpret data information	E8 Be able to use computers and software	E9 Be able to use a library	E10 Be able to prioritize	E11 Be able to present information	E12 Be able to contact resource agencies
E13 Be able to delegate	E14 Be able to do basic math, basic algebra, and statistics	E15 Be able to plan	E16 Be able to demonstrate organizational skills	E17 Be able to operate office machines	E18 Be able to calibrate, use, operate, and repair equipment
E19 Be able to collect data	E20 Be able to operate and understand GIS/GPS	E21 Be able to analyze and balance life cycles and energy flows	E22 Be able to analyze the chemistry relationship in plants/soil/ environment	E23 Be able to determine necessary equipment	E24 Be aware of ecosystems

E. Perform Effective Research Processes					
E25 Be able to read and create maps	E26 Be connected to periodicals, organizations, and support groups				
F. Additional Equipment Exposure Beyond Existing Equipment					
F1 Natural Resources *	F2 Agriculture *	F3 Horticulture *			

APPENDIX

F1-Natural Resources:
- relaskop
- water quality equipment
- densiometer
- altimeter
- packing equipment
- erosion control equipment
- chainsaw

F2-Agriculture:
- soil moisture equipment
- chipper/shredder
- no-till drill

F3-Horticulture:
- backhoe
- chipper/shredder
- erosion control equipment
- manual shift vehicle
- quad ATV
- multimeter
- soil testing equipment
- survey equipment

*** See Appendix**

Geographic Information System (GIS) Specialist:

A scientifically trained, multi-disciplined individual who applies sophisticated computer hardware and software to collect, store, retrieve, process and present geographic information.

DACUM Results

A. Data acquisition and development					
A1 Determine data needs/format	A2 Determine hardware/software requirements/ constraints	A3 Evaluate sources	A4 Contact data originator for acquisition	A5 Assess acquisition/costs	A6 Coordinate geodetic control prior to mapping
A7 Capture spatial and attribute data	A8 Conversion of digital formats-data abstraction (cut, simplify, stretch, and fit)	A9 Integrate data from various sources into consistent format	A10 Verify content and spatial accuracies	A11 Create metadata	A12 Let users know that data is available
B. Maintain and update data					
B1 Establish the data custodianships	B2 Assess maintenance and update cost	B3 Develop a data maintenance schedule	B4 Gather data for updates	B5 Perform spatial and content updates	B6 Verify that updates are error free
B7 Let users and data custodians know that updates are completed					
C. Paper mapping design and development					
C1 Define purpose and use of maps	C2 Design layout	C3 Determine appropriate scale	C4 Determine appropriate fonts and colors	C5 Recognize cartographic conventions	C6 Select proper media/output device
C7 Acknowledge contributors	C8 Maintain inventory of supplies				

DACUM Project: GIS Specialist **Sponsored by:** Grays Harbor College (NSF/NCSR) **Date:** April 22, 1997

Data Coordinator: Don Samuelson **Data Facilitator:** Krista Mahan **Data Recorder:** Fred Wood

Panel Members:

Kyle Bastrup, Grays Harbor Co. Central Services
Michael Bishopp, Pacific Co. Public Works Dept
David Caudill, WA Dept. of Fish and Wildlife
Robin Nelson, Pacific Co. Public Works Dept.
Joan Persinger, Weyerhaeuser Company
Don Saul, WA Dept. of Fish and Wildlife
Mark G. Scott, The Willapa Alliance
Mike Stamon, Quinault Dept. of Natural Resources
Kim Taylor, Northwest Indian Fisheries Commission
Tim Triesch, Grays Harbor Regional Planning Commission
Andy Wilson, Rayonier Inc.
Angie Wollen, Grays Harbor College Central Services

D. GIS and remote sensing analysis					
D1 Communicate with peers	D2 Determine appropriate projections	D3 Geo-reference imagery	D4 Classify remote sensing data	D5 Develop orthophotography	D6 Perform spatial database queries
D7 Perform vector/raster overlay analysis	D8 Perform statistical analysis	D9 Perform buffer analysis	D10 Perform network analysis (dynamic segmentation)	D11 Report results	

E. Application development					
E1 Assess client needs	E2 Develop applications to simplify and/or standardize procedures	E2a Determine programming tools required to develop applications	E2b Test application performance	E3 Design application	E4 Exercise quality control
E5 Support application	E6 Update and maintain application				

F. Document data					
F1 Assess client needs	F2 Produce in-house standardized data documentation	F3 Disseminate documentation where appropriate	F4 Document spatial and content changes		

G. Database design					
G1 Communicate with other database managers/users	G2 Determine coverages to be managed	G3 Select database software according to: performance, usability, cost, manageability, uses, output format,...	G4 Assist in defining deliverables (maps, reports,...)	G5 Determine data consistencies	G6 Define database tables
G7 Determine key fields	G8 Create data dictionary				

H. Information sharing data exchange					
H1 Develop policy for sharing data	H2 Adhere to policies for sharing and receiving data	H3 Export data in transferable format	H4 Import data into existing GIS	H5 Verify accuracy of imported data	
I. Training and education					
I1 Assess level of user's knowledge and needs and train accordingly	I2 Provide information presentations for users	I3 Develop user guides	I4 Establish and maintain remote training sites	I5 Develop training applications and course materials	I6 Provide post-training support
I7 Disseminate information through a WEB site	I8 Promote GIS uses				
J. Project management					
J1 Determine scope of project	J2 Define deliverables	J3 Determine resource needs (equipment, personnel, data)	J4 Conform to policy and standards	J5 Determine future uses for completed project data/processes	J6 Develop project timetables
J7 Assess project costs	J8 Budget project	J9 Allocate internal/ external resource needs (equipment, personnel, and data)	J10 Coordinate multiple projects and on-going activities	J11 Monitor project progress	J12 Verify that project goals were met
J13 Maintain project resources (equipment, personnel, data)					
K. System administration/hardware-software integration					
K1 Evaluate user needs	K2 Select system design	K3 Design/implement database back-up procedures	K4 Troubleshoot hardware/software problems	K5 Optimize system performance	K6 Schedule multi-tasking of equipment
K7 Maintain systems security	K8 Maintain peripheral compatability	K9 Maintain compatibility between system components	K10 Maintain network system	K11 Perform file management	K12 Ensure continuous software upgrades

K. System administration/hardware-software integration					
K13 Procure new technologies	K14 Comply with software licensing agreements	K15 Maintain hardware maintenance agreements			

APPENDIX

Knowledge
- Forestry Basics/Survey
- Fisheries
- Wildlife
- Geology
- Geography
  - Cartography
  - Urban planning
  - Census
  - Remote Sensing
  - Photogrammetry
  - Transportation
  - Competency in software navigation/trouble shooting
- Engineering
  - Surveying
  - Cogo
  - CAD
- Computer Science
  - Information Management
  - Database Design
- Statistics

Equipment
- CD-ROM unit
- Date recorders
- Digitizer
- GIS software
- GPS software
- Modem
- Operating systems/work stations
- Plotters
- Printers
- Scanners
- Storage device
- Surveying equipment
- Transferable media

Skills
- Operating systems
- Digital file management
- Networking systems
- Research technical support
- Jargon
- Platform shop talk
- Understand national documentation standards

Concerns and Future Trends
- Instantaneous remote sensing
- Data overload
- Interactive distribution of data via Internet
- Despecialization (making GIS too generalized)
- Integration between GPS and GIS
- Open systems

Work Behaviors
- Analytical
- Attitude
- Communication skills
- Detail orientated
- Diversified tasks - time management
- Divine - all knowing
- Independent worker
- Motivated
- Organized
- Positive attitude
- Problem solving skills
- Reliable - Punctual
- Self-starter
- Team player

Natural Resources Technician:

A scientifically trained, multi-disciplined individual who applies a variety of skills which facilitate sound natural resource management.

DACUM Results

A. Scientific Training					
A1 Develop basic math skills, i.e., divide, multiply, add and subtract	A2 Understand basic statistics	A3 Develop a background in natural and physical sciences	A4 Ability to use scientific methods and terminology	A5 Identify flora and fauna species	A6 Identify fish and wildlife, history relevance
A7 Knowledge of historic relevance of past practices	A8 Ability to research information	A9 Utilize and understand scientific and mathematical modeling	A10 Integrate principles of natural resource management	A11 Knowledge of principles of natural resource economics	A12 Identify diseases
B. Skills Training					
B1 Ability to use first aid and C.P.R.	B2 Practice safe operation and survival skills	B3 Perform calibration procedures	B4 Receive equipment training	B5 Use of basic trade skills	B6 Possess boat handling and seamanship skills
B7 Receive sensitivity training	B8 Use of material safety data sheets	B9 Maintain special licenses (pesticides, CDL)	B10 Gain an understanding of fire behavior	B11 Receive facilitation training	B12 Ability to write grants, be aware of propriety
B13 Possess basic media skills	B14 Operate electronic hand-held data recorders	B15 Use equipment manuals	B16 Ability to speak on two-way radio	B17 Operate a computer (computer literacy)	B18 Writing skills (reports, articles)
B19 Operate standard office equipment	B20 Develop public speaking skills				

DACUM Project: Natural Resources Technician **Sponsored by:** Grays Harbor College (NSF/NCSR) **Date:** January 10 & 11, 1996
Data Coordinator: Don Samuelson **Data Facilitator:** Robert S. Clark **Data Recorder:** Sheila Pebles

Panel Members:
- **Randy Aho,** WA Dept. of Fish and Wildlife
- **Greg Edwards,** Eco Systems
- **Dan Guy,** WA Dept. of Fish and Wildlife
- **Holly Jacobson,** Weyerhauser Co.
- **Dan Longmire,** WA Dept. of Fish and Wildlife
- **Norby MacMillan,** Columbia Pacific Resource Conservation and Development
- **Randy McIntosh,** WA Dept. of Fish and Wildlife
- **Mark Mobbs,** Quinault Dept. of Natural Resources – Timber Fish and Wildlife
- **Allen Pleus,** NW Indian Fish Commission
- **Tom Ross,** Columbia Pacific Resource Conservation and Development
- **John Todd,** Weyerhauser Co.
- **Jim Walls,** Columbia Pacific Resource Conservation and Development
- **Lorna Wargo,** WA Dept. of Fish and Wildlife
- **Mike Womer,** Scan-Am Fish Farms
- **Doug Zimmer,** U.S. Fish and Wildlife Service

C. Data Collection Analysis

C1 Use common sense	C2 Write good field notes	C3 Consult with statistician	C4 Design and conduct pilot studies	C5 Create sample design	C6 Establish baseline conditions
C7 Prepare for data collection	C8 Collect accurate/ legible data	C9 Monitor quality of data collection	C10 Maintain sampling protocol	C11 Conduct quality control (replicate surveys, etc.)	C12 Create a data tracking check list
C13 Create a data base	C14 Create a data management system	C15 Enter data into computer accurately	C16 Create a backup file	C17 Check for errors	C18 Correct errors
C19 Organize data for accessibility	C20 Check analysis against hypothesis	C21 Interpret and apply results	C22 Determine relevance of data	C23 Write a report	C24 Report findings
C25 Provide suggestions for improvement	C26 Observe/safeguard confidentiality and proprietary information	C27 Integrate principles of timber, fish and water management	C28 Archive data		

D. Field Work

D1 Work independently	D2 Identify fish and plant, wildlife species	D3 Read and interpret maps and photos	D4 Perform surveys (environmental, stream, upslope, in stream)	D5 Acquire trespass authorization	D6 Accurately locate sample site
D7 Operate a computer	D8 Check precision of instruments	D9 Know equipment (logistics)	D10 Operate equipment	D11 Maintain equipment	D12 Understanding of permit process
D13 Possess regulatory process familiarity	D14 Participate in multi-interest review of projects	D15 Investigate permit applications	D16 Practice public relations with land owners	D17 Develop a quality assurance plan	D18 Conduct water quality sampling

D. Field Work					
D19 Conduct biological sampling	D20 Sample fish and wildlife harvests	D21 Interpret and apply information to field work	D22 Implement habitat restoration projects (fish, wildlife, plants)	D23 Apply bio-engineering techniques	D24 Delineate ecologically sensitive areas (RM2)
D25 Observe need for forest road maintenance	D26 Maintenance of forest roads	D27 Calculate tree density	D28 Perform timber cruise	D29 Mark boundaries	D30 Perform post-logging utilization survey
D31 Propagate plants	D32 Grow and manage fish stocks	D33 Perform remote site spawning	D34 Work with and understand hatchery practices	D35 Maintain water supply	D36 Perform facility maintenance
D37 Use test equipment	D38 Make decisions in the field	D39 Know when to call a professional/specialist	D40 Apply prescriptions		
E. Teamwork					
E1 Together Everyone Accomplishes More (TEAM)	E2 Respect others	E3 Communicate	E4 Support objectives of job, project, etc.	E5 Contribute to team effectiveness	E6 Work as a team member
E7 Accomplish fair share of project	E8 Work as a team member	E9 Develop leadership skills	E10 Encourage input/involvement	E11 Have fun!	
F. Communication					
F1 Basic understanding of English language	F2 Ability to use English language	F3 Apply listening skills	F4 Practice basic manners	F5 Practice telephone protocol	F6 Practice interpersonal skills
F7 Create a safe environment for discussion	F8 Acknowledge limits of responsibility	F9 Understand and use chain of command	F10 Use appropriate channels (methods) of communication	F11 Develop clear goals/objectives	F12 Clarify set goals

F. Communication

F13 Apply positive reinforcement when applicable	F14 Practice constructive criticism	F15 Define problems and offer solutions	F16 Practice critical thinking	F17 Possess a sense of humor	F18 Use two-way communication
F19 Convey mistakes and problems	F20 Maintain documentation	F21 Ask questions	F22 Maintain a positive attitude	F23 Possess job appreciation	F24 Interpret scientific data into lay terms
F25 Ability to speak in front of a group	F26 Ability to be a salesperson	F27 Provide training to others			

G. Office Management

G1 Follow agency or company policy/procedure	G2 Be aware of and use organizational resources	G3 Possess time management/ organizational skills	G4 Possess conflict resolution and negotiation skills	G5 Practice empathy	G6 Display keyboarding skills
G7 Create and maintain a file system (paper and computer)	G8 Ability to use/learn word processing, spread sheet, and data base software	G9 Ability to use/learn specialized software	G10 Develop and track budgets		

H. Career Planning

H1 Possess awareness of job market	H2 Examine market opportunities	H3 Possess political awareness	H4 Appreciate structure of funding source	H5 Overview of existing agencies	H6 Develop entrepreneurial skills
H7 Develop job search skills	H8 Continue education				

I. Professionalism

I1 Maintain professionalism (dress, appearance, language, hygiene)	I2 Exhibit common courtesy/positive work ethic	I3 Interpersonal skills	I4 Maintain team spirit	I5 Observe/safeguard confidentiality and proprietary information	I6 Practice positive sensitivity in regards to cultural awareness (ethic, gender, racial)

I. Professionalism					
I7 Possess a knowledge and understanding of tribal history and issues	I8 Respect other agencies	I9 Respect social and political position of others	I10 Possess and develop leadership skills	I11 Continue personal growth	
J. Public Relations					
J1 Be honest	J2 Avoid jargon	J3 Be aware of own/agency limitations	J4 Be aware of applicable laws/rules that govern agencies	J5 Communicate policies and/or procedures to the public	J6 Be aware of the impact of actions
J7 Recognize $$$ consequence of actions	J8 Be aware of people represented	J9 Report back to supervisor contacts	J10 Recognize a developing problem to a supervisor	J11 Know when to call a professional/specialist	J12 Be an ambassador
J13 Use conflict management	J14 Involve public	J15 Make public presentations			

Forest Resources Technology

DACUM Results

A. Demonstrate Professionalism					
A1 Keep accurate records – data recording – data and info management	A2 Pay attention to details	A3 Complete paperwork accurately	A4 Follow directions; perform assigned tasks satisfactorily and on time	A5 Meet deadlines	A6 Speak and listen effectively
A7 Work effectively with client	A8 Achieve and maintain high level of physical fitness	A9 Be objective; avoid interjecting personal bias	A10 Work independently	A11 Maintain professional skills and knowledge	A12 Participate in continuing education – workshops – short courses
A13 Stay current with advancing technology	A14 Maintain assigned equipment	A15 Practice/master stress management	A16 Make decisions	A17 Respect management	A18 Demonstrate personal responsibility
A19 Be personally accountable	A20 Practice good work ethic	A21 Be self motivated; a self starter	A22 Be flexible; accept change	A23 Practice good time management	A24 Practice work planning
A25 Prioritize tasks	A26 Be an effective trainer/instructor	A27 Recognize and consider conflicting issues	A28 Work effectively with other organizations and agencies	A29 Exercise initiative within organizational structure	A30 Promote and support organization's mission/goals
A31 Participate in professional associations	A32 Develop goals	A33 Implement goals	A34 Evaluate goals	A35 Apply organizational skills	A36 Anticipate organization's needs and problems

DACUM Project: Forest Resources Technology **Sponsored by:** Central Oregon Community College (NSF/NCSR) **Date:** April 8, 1996 **Data Facilitator:** Ron Wheadon

Panel Members:
Shiela Holman, Wallowa-Whitman National Forest
JoAnne Hanney, Bureau of Land Management
Andy Coray, Deschutes National Forest
Dave Pitts, Forestry Consultant/Logging Contractor
Mark White, Mason, Bruce & Girard
Jerry Orr, Confederated Tribes of Warm Springs
Brian Wilkinson, Logging Engineering International
Lyle Klenski, Malheur National Forest
Janice Madden, Deschutes National Forest
Bob Parker, Crown Pacific Corporation
Jill Williams, Bureau of Land Management
Lisa Rynearson, Malheur National Forest
John Jackson, Oregon Dept. of Forestry

A. Demonstrate Professionalism					
A37 Visualize final product during planning	A38 Assume responsibility for administrative duties *	A39 Market self to public, administrators	A40 Understand and explain scope of services offered by organization	A41 Understand and explain scope of services offered by sister agencies	A42 Find relevant information - references, literature, documents
A43 Analyze and interpret data	A44 Practice communication skills *	A45 Apply supervisory skills *			

B. Apply Technical Skills of the Profession					
B1 Measure (cruise/scale) timber	B2 Conduct natural resource surveys *	B3 Conduct physical land surveys *	B4 Employ orienteering skills using topographic maps and aerial photos	B5 Utilize/interpret aerial photos and topographic maps	B6 Process multispectral satellite imagery
B7 Utilize "tools" *	B8 Use field data recorder *	B9 Utilize Global Positioning System technology *	B10 Utilize Geographical Information System technology *	B11 Utilize keys and other references to identify *	B12 Employ computer skills in...*
B13 Convert data among various measurement systems (English, metric, etc.)	B14 Safely operate machinery *	B15 Apply sampling statistics to data	B16 Design cruise/sampling projects	B17 Apply math skills *	B18 Evaluate conditions that affect fire behavior and occurrence
B19 Perform basic fire fighting skills	B20 Plan/layout timber marking unit	B21 Perform harvest system analysis	B22 Design unit-level harvest plan	B23 Design biomass handling plan	B24 Plant trees
B25 Write long-term harvest schedule	B26 Work with contracts – prepare – administer	B27 Run and interpret growth and yield models	B28 Perform quality assurance checks	B29 Apply timber theft prevention measures	B30 Manage special products—mushrooms, firewood, etc.
B31 Collect and handle seeds of non-tree species (revegetation projects)	B32 Implement multiple resource management system	B33 Practice safety			

*** See Appendix**

C. Practice Effective Interpersonal Skills					
C1 Be a team player	C2 Respect diverse viewpoints	C3 Respect cultural differences	C4 Defuse hostile/dangerous situations	C5 Work effectively with distraught persons	C6 Communicate effectively with colleagues
D. Apply Business Management Principles to Natural Resource Management					
D1 Practice business aspects of the profession	D2 Recognize and integrate economic considerations	D3 Support economic decisions	D4 Conduct cost analysis *	D5 Manage budget	D6 Market/advertise services
D7 Provide customer services	D8 Write bids/proposals	D9 Be financially responsible with purchases, etc.	D10 Relate to path of raw materials through manufacturing to product(s)	D11 Administer financial aspects of contracts (e.g. payments)	
E. Abide by Policies and Rules					
E1 Comply with regulations	E2 Explain state and federal regulations	E3 Be aware of authority and limitations	E4 Be aware of conflicting policies and rules		

* See Appendix

APPENDIX

A38-Administrative duties:
- travel
- time
- costs, etc.

A44-Communication skills:
- use telephone and radio correctly
- communicate effectively with the public
- report on field work
- write technical reports
- utilize natural resource vocabulary/glossary
- utilize taxonomic nomenclature for all classes of plants
- write an effective resume

A45-Supervisory skills:
- apply personnel management principles
- explain hiring policy and procedures
- promote safe working practices
- supervise and manage people
- conduct performance evaluations
- communicate effectively with subordinates
  - give clear instructions
  - assign tasks
- conduct employment interview
- resolve grievances

B2-Conduct natural resource surveys:
- stand exam
- reproduction (seedling) stocking
- fuel loading
- range condition/forage
- botanical
- plant communities and associations
- archeological
- threatened & endangered (T&E) spp.
- stream/fish
- insects/disease

B3-Conduct physical land surveys:
- unit traverse
- road location and layout
- property lines
- skyline profile
- hand compass
- staff compass
- pacing
- string box

B7-Utilize tools:
- clinometer
- relaskop
- range finder
- tape recorder
- camera
  - video
  - still

B8-Use field data recorder:
- program recorder
- enter data
- download data to computer

B9-Utilize Global Positioning System technology:
- operate equipment
- download data to computer
- differentially correct readings
- upload to graphics/mapping software

B10-Utilize Geographical Information System technology:
- create data layers
- apply models
- produce maps

B11-Utilize keys and other references to identify:
- plants
- grasses
- plant associations and communities
- wildlife
- insects

B12-Employ computer skills in:
- word processing
- data bases
- spreadsheets
- drafting (CADD)
- Geographical Information Systems (GIS)
- Global Positioning Systems (GPS)

B14-Safely operate machinery:
- chain saw
- hand tools
- pumps
- all terrain vehicle
- snow mobile
- fork lift
- bulldozer
- 4-wheel drive vehicle
- manual shift vehicle
- mountain bike

B17-Apply math skills:
- geometry
- right triangle trigonomic functions
- unit circle
- algebra
- formulae

D4-Conduct cost analysis:
- benefit/cost ratio
- present net value
- future net value
- time value of money
- sinking fund
- depreciation
- capitalization

Forest Resources Technology

DACUM Results

A. Be Competent in Scaling and Cruising					
A1 Be able to take basic measurements	A2 Identify plants, trees and wood types	A3 Use and care of tools of the trade *	A4 Ability to read a map	A5 Be aware of the different methods of cruising	A6 Interpret aerial photos
A7 Identify grades of logs	A8 Identify forest diseases and forest insects	A9 Identify high and low value timber	A10 Compute timber volumes and economic values	A11 Write technical reports	A12 Administer a basic contract
A13 Comply with regulations					

B. Competency in Surveying and Mapping					
B1 Be aware of land measurement systems	B2 Operate equipment, use and care for tools of the trade *	B3 Identify property lines and corners	B4 Access county land records	B5 Read topographical maps	B6 Be aware of land measurement systems *
B7 Identify land ownership	B8 Draft maps (including computer generated maps)	B9 Knowledge of GIS (Geographic Information System)	B10 Be competent in computer skills	B11 Identify correct property locations	B12 Write technical reports
B13 Comply with safe practices	B14 Administer a basic contract	B15 Comply with regulations			

DACUM Project: Forest Resources Technology **Sponsored by:** Chemeketa Community College (NSF/NCSR) **Date:** October 31, 1996
Data Facilitator: Ron Wheadon **Data Coordinator:** Ara Andrea

Panel Members:
- **Dennis Creel,** Hampton Tree Farms
- **Terry Fennell,** Bureau of Land Management
- **Tom Vanderhoof,** Bureau of Land Management
- **Darrel Foster,** Bureau of Land Management
- **Mo Jeffries,** USDA Forest Service
- **Dan Johnson,** Siuslaw National Forest
- **Al Tocchini,** Oregon Dept. of Parks & Recreation
- **Dean Berg,** Silvicultural Engineering

* See Appendix

C. Take Inventory of Resources					
C1 Recognize plant communities	C2 Be aware of ecosystem structure and function	C3 Be aware of the principles of ecology	C4 Use computers and data recorders	C5 Design effective measurement systems	C6 Interpret contracts
C7 Recognize soil/physical qualities of landscape	C8 Recognize noxious weeds	C9 Collect data for watershed analysis	C10 Be aware of basic science principles *	C11 Write technical reports	C12 Administer a basic contract
C13 Comply with regulations	C14 Read topographical maps	C15 Use and care for tools of the trade *			

D. Be Competent in Road Engineering and Logging					
D1 Be able to read maps	D2 Comprehend array of harvesting systems	D3 Comprehend transportation systems	D4 Be aware of the various uses of equipment and costs	D5 Calculate payload limits	D6 Design and lay out harvest systems
D7 Design a road	D8 Understand basic hydrology	D9 Be aware of yarding and loading timber processes	D10 Be aware of felling and bucking principles	D11 Be aware of the uses of rocks and other road building materials	D12 Write a basic contract
D13 Administer a basic contract	D14 Comply with regulations	D15 Read soil conservation maps	D16 Distinguish between how regulations relate and don't relate	D17 Monitor the impact on the environment	D18 Convert from metric to standard measurement
D19 Stay within legal limits of contract law	D20 Recognize unstable soil conditions (roads)	D21 Obliterate roads	D22 Maintain roads	D23 Comprehend basic principles of forest economics	D24 Write technical reports
D25 Use and care for tools of the trade *	D26 Administer a basic contract	D27 Comply with regulations			

*** See Appendix**

E. Be Competent in Computer Skills					
E1 Perform adequate keyboard skills	E2 Perform data entry	E3 Use word processing and spread sheets	E4 Use data tables	E5 Manage files	E6 Be aware of computer terminology
E7 Use data recorders	E8 Use GIS software				

F. Demonstrate Professionalism					
F1 Exhibit good attitudes	F2 Be aware of basic supervisory skills	F3 Be able to work as a team member	F4 Get along with other people	F5 Demonstrate good judgement	F6 Demonstrate good public relations and customer service skills
F7 Comply with professional and work ethics	F8 Listen for instructions and information	F9 Write technical reports			

G. Be Competent in Silviculture					
G1 Manage the landscape	G2 Be aware of silviculture systems	G3 Be able to develop goals	G4 Take inventory (stand exam)	G5 Recognize diseases of trees	G6 Take precise measurements on the stand plot
G7 Analyze data related to goals	G8 Present information	G9 Implement the decision	G10 Be aware of techniques of silviculture *	G11 Be aware of nursery options	G12 Perform tree planting
G13 Be aware of young stand manipulations	G14 Recognize importance of soils	G15 Write technical reports	G16 Administer a basic contract	G17 Comply with regulations	G18 Read topographical maps
G19 Use and care for tools of the trade *					

* See Appendix

H. Comply with Safe Practices					
H1 Recognize and evaluate hazardous situations	H2 Put chains on a vehicle	H3 Perform CPR/Survival training	H4 Perform basic outdoors survival skills	H5 Comply with OSHA regulations	H6 Be aware of dangerous situations
I. Perform Basic Firefighting Skills					
I1 Run, maintain, and repair firefighting equipment	I2 Obtain a CDL	I3 Be competent in ICS			

APPENDIX

A3-Use and care of tools:
- compass
- map
- rangefinder
- laser tools (criterion)
- diameter tape
- scale stick
- biltmore stick
- increment borer
- data recorder
- tape measure
- relaskop
- logger's tape
- prisms
- clinometer

B2-Use and care of tools:
- data recorder
- pocket compass
- staff compass
- transit
- theodolite
- clinometer
- tape (cloth and steel)
- EDMI (Electronic Distance-Measuring Instruments)

B6-Land measurement systems:
- latitudes and departures
- metes and bounds
- rectangular grid system
- township
- range and sections

C10-Basic science principles:
- Biology (wildlife and fish)
- Hydrology
- Environmental Science
- Soils
- Geology

C15-Use and care of tools:
- compass
- map
- rangefinder
- laser tools (criterion)
- diameter tape
- scale stick
- biltmore stick
- increment borer
- data recorder
- tape measure
- relaskop
- logger's tape
- prisms
- clinometer

D25-Use and care of tools:
- data recorder
- pocket compass
- staff compass
- transit
- theodelite
- clinometer
- tape (cloth and steel)
- EDMI (Electronic Distance-Measuring Instruments)

G10-Techniques of silviculture:
- tree planting
- site prep
- mechanics
- chemistry
- safety
- slash burning
- awareness of Forest Practices Act
- thinning
- spacing
- animal contact
- state and federal regulations
- wildlife considerations
- woody debris
- stream needs
- planting methods

G19-Use and care of tools:
- compass
- map
- rangefinder
- laser tools (criterion)
- diameter tape
- scale stick
- biltmore stick
- increment borer
- data recorder
- tape measure
- relaskop
- logger's tape
- prisms
- clinometer

*** See Appendix**

Fish and Wildlife Technician

DACUM Results

A. Understand Fish and Wildlife and Their Ecosystems					
A1 Perform habitat improvement	A2 Possess knowledge of plants *	A3 Possess knowledge of wildlife *	A4 Possess knowledge of current environmental issues	A5 Access research	A6 Use and implement scientific method
A7 Understand marine resources	A8 Know organizational goals				
B. Skills Training					
B1 Restrain wildlife	B2 Understand and apply fish and wildlife laws/regulations	B3 Rehabilitate wildlife	B4 Inventory, monitor, and survey wildlife, fish and habitat	B5 Use/implement scientific method	B6 Perform habitat improvement
B7 Practice wildlife safety	B8 Assist in basic veterinary and drug techniques	B9 Access research	B10 Practice fish culture	B11 Use radio telemetry	
C. Perform Fish and Wildlife Resource Assessment					
C1 Use/implement scientific method	C2 Perform project interpretation and follow-through	C3 Perform map and compass work	C4 Interpret and gather data	C5 Access research	C6 Interpret maps
C7 Use GIS and GPS	C8 Read aerial photos				

DACUM Project: Fish & Wildlife Technician **Sponsored by:** Feather River College (NSF/NCSR) **Date:** November 6, 1996
Data Coordinator: Jay Wright **Data Facilitator:** Michael Welser

Panel Members:
Dennis Chester, U.S. Forest Service
Clay Clifton, U.S. Forest Service
Charlotte Coultier, U.S. Forest Service
Jan Dawson, California Dept. of Fish and Game
Ron Decoto, California Dept. of Fish and Game
Syd Kahre, California Dept. of Fish and Game
Pamela McKinnon, U.S. Forest Service
Bill Peters, California Dept. of Fish and Game
Gary Rotta, U.S. Forest Service
Tricia York, U.S. Forest Service

* See Appendix

D. Utilize Communication Skills

D1 Possess basic understanding of sociology	D2 Write literate technical reports	D3 Practice people skills	D4 Understand and cope with supervisors	D5 Perform project interpretation and follow-through	D6 Conduct tours
D7 Demonstrate public contact skills	D8 Use basic supervisory skills	D9 Conduct public presentations	D10 Perform interagency communication	D11 Conduct meetings	D12 Possess interpretive skills

E. Maintain Job Safety

E1 Perform first aid and CPR	E2 Possess survival skills	E3 Practice 2-way radio skills	E4 Practice safety techniques with all equipment	E5 Practice wildlife safety	E6 Maintain physical fitness
E7 Assess dangerous situations	E8 Practice fire safety				

F. Demonstrate Professionalism

F1 Use common sense	F2 Accept and give criticism (feedback)	F3 Possess time management skills	F4 Practice self-motivation	F5 Perform project interpretation and follow-through	F6 Use basic supervisory skills
F7 Practice teamwork	F8 Conduct meetings	F9 Know organizational goals	F10 Perform individual tasks	F11 Maintain positive attitude	

G. Operate a Computer

G1 Possess basic computer skills	G2 Perform word processing	G3 Operate a relational database	G4 Operate GIS program	G5 Access/send e-mail	G6 Access Internet
G7 Perform statistical analysis	G8 Gather/interpret data	G9 Enter data			

H. Maintain and Operate Equipment					
H1 Operate vehicles *	H2 Assess dangerous situations	H3 Practice 2-way radio skills	H4 Operate watercraft *	H5 Demonstrate firearm use	H6 Use pack stock
H7 Maintain vehicles	H8 Operate equipment *				

I. Perform Non-Fish/ Wildlife Skills					
I1 Possess basic accounting skills	I2 Possess basic farming skills	I3 Possess job interview and application skills	I4 Practice 2-way radio skills	I5 Apply basic construction skills *	I6 Maintain physical fitness
I7 Perform basic math skills *	I8 Possess business/contract skills	I9 Possess basic science skills *			

APPENDIX

A2-Knowledge of plants:
- Taxonomy
- Physiology
- Species
- Dendrology
- Botany
- Aquatic
- Habitat

A3-Knowledge of wildlife:
- Habitat
- Behavior
- Birds
- Mammals
- Amphibians/reptiles
- Insects
- Invertebrates
- Fish

H1-Operate vehicles:
- 4-wheel drive pickup
- Snowmobile
- ATV
- Heavy equipment

H4-Operate watercraft:
- Kayak
- Jet ski
- Canoe
- Raft
- Electrofishing boat
- Motorboat

H8-Operate equipment:
- Field compass, binoculars, staff compass and rod, clinometer, densiometer, relaskop, auger, posthole digger, comealong

Hand tools:
- McCloud, Polaski, shovel, axe, hammer, extension ladder

Fencing materials:
- barbed wire, camera equipment, tape recorders, power horn, solar pathfinder, spotting scope, microscope (dissecting)

H8-Operate equipment:
- Chainsaw
- Pigmy meter
- Hatch kit
- Pack horse gear
- Transit
- Carpentry tools
- Electroshocker
- Fish nets
- Aerator
- Various measuring devices
- Electric/manual flow meters
- Soil percolation testing (compaction)
- Hip chain
- Radio Telemetry equipment
- Stereoscope for aerial photos
- DBH tape
- Water sampling equipment
- Transmitter/receiver
- Data collector
- Trailmaster 110m and 35mm

I5-Apply basic construction skills:
- Plumbing
- Electrical
- Fencing
- Concrete
- Carpentry

I7-Perform basic math skills:
- Addition, subtraction, multiplication, division
- Algebra
- Geometry
- Trigonometry
- Statistics

I9-Possess basic science skills:
- Chemistry
- Biology
- Zoology
- Ecology
- Geology
- Hydrology

*** See Appendix**

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The outstanding discovery of the 20th Century is not television, or radio, but rather the complexity of the land organism. The last word in ignorance is the man who says of an animal or plant: 'What good is it?' If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering.

Round River

From the Journals of Aldo Leopold, 1952
published posthumously
by Luna B. Leopold, pp. 146-147

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