Southern Cross University
ePublications@SCU

School of Environment, Science and Engineering Papers

School of Environment, Science and Engineering

2007

Educating Australian foresters for the 21st century

Jerome K. Vanclay
Southern Cross University

Publication details

Vanclay, JK 2007, 'Educating Australian foresters for the 21st century', *International Forestry Review*, vol. 9, no. 4, pp. 884-891.
The abstract and pdf of the published article reproduced in ePublications@SCU with the permission of International Forestry Review

ePublications@SCU is an electronic repository administered by Southern Cross University Library. Its goal is to capture and preserve the intellectual output of Southern Cross University authors and researchers, and to increase visibility and impact through open access to researchers around the world. For further information please contact epubs@scu.edu.au.

COMMENTS

Educating Australian foresters for the 21st century

J.K. VANCLAY

Southern Cross University, PO Box 157 Lismore NSW 2480, Australia

Email: jvanclay@scu.edu.au

SUMMARY

A review of forestry education based on literature and a survey of 186 foresters reveals the diversity of interests within the Australian forestry profession. The survey reflects the utility of subjects such as silviculture, mensuration and forest management, and highlights the need to include subjects such as human resource management, business studies and communication skills in forestry programmes. Results also suggest that there is the need for more innovation in the teaching of foundation subjects such as chemistry. Important but unexpected findings from the survey were the high proportion of respondents who stated that their bachelor studies provided their formative career preparation, and the acknowledgement of the role of vacation work experience in reinforcing formal academic study.

Keywords: syllabus, curriculum, problem-based leraning, graduate attributes, professional forestry

Eduquer les forestiers australiens pour le 21ème siècle

J. K. VANCLAY

Un rapport sur l'éducation en foresterie basée sur la littérature et un sondage de 186 forestiers révèle la diversité des intérêts dans la profession de foresterie australienne. L'étude reflète l'utilité de sujets comme la sylviculture, la mensuration et la gestion forestière, et souligne le besoin d'inclure des sujets comme la gestion des ressources humaines, les études commerciales et la formation en communication dans les programmes de foresterie. Les résultats suggèrent également une nécessité d'innover l'enseignement des sujets de base comme la chimie. Des trouvailles importantes quoique inattendues dans l'étude montraient que la forte proportion des interviewés qui déclaraient que leurs premières études avaient fourni la préparation de leur carrières de formation, et une affirmation du rôle de l'expérience du travail de vacances pour renforcer les études académiques formelles.

Educación de silvicultores australianos para el siglo XXI

J.K. VANCLAY

Un análisis de la educación forestal basado en el material publicado y en una encuesta de 186 manejadores de bosque revela la diversidad de intereses dentro de la profesión silvicultural australiana. La encuesta refleja la utilidad de temas como la silvicultura, la mensuración y la gestión forestal, y pone de relieve la necesidad de incluir temas como la gestión de recursos humanos, los estudios empresariales y las ciencias de la comunicación en los programas de estudos silviculturales. Los resultados sugieren también que hace falta una mayor innovación en la enseñanza de temas fundamentales tales como la química. La encuesta reveló además algunos descubrimientos importantes pero inesperados, como la alta proporción de encuestados que afirmaron que su licenciatura proporcionaba la preparación formativa para su carrera, y que reconocieron el papel significativo de la experiencia laboral vacacional en el reforzamiento de los estudios académicos formales.

INTRODUCTION

There are big changes afoot in forestry practice and education in Australia, with changes evident in forestry courses, employment prospects, society's expectations and in the environment (FAO 2001, Vanclay 2005). Yet many forestry courses worldwide have not changed greatly in decades (cf. Sisam 1964), and some still resemble an Oxford syllabus almost a century old: "*the course is as follows:- the formation and properties of soil; elements of physics, chemistry and biology; systematic botany with special reference to trees and shrubs; the economics of forestry and forest policy; silviculture; forest protection; utilization; mensuration; forest management; forest valuation and finance*" (The Oxford Course, 1920, cited in Howe 2004).

One of the institutional obstacles to reform is an understandable tendency to offer programmes attuned to the capability and interests of existing staff, rather than to the

future needs of the forestry profession. Thus an important way to inform the discussion about forestry education is to revisit the role of a forester. These issues have often been canvassed in the American *Journal of Forestry* (e.g., Winkenwerder 1918, Dana and Johnson 1964, Spurr and Arnold 1971, Zabel 1984, Sample *et al.* 1999, Helms 2002) and elsewhere (e.g., Kanowski 1995, Turner 1996, and Vanclay 1996, Leslie *et al.* 2006). Some current issues have been with the profession for a long time: in his analysis of 'Some fundamental problems in forestry education', Winkenwerder (1918), then the Professor of Forestry at the University of Washington, concluded that there was "*no danger of overcrowding the profession for many years to come. In fact, there is a crying need for specialists … which will take many years to fill*".

THE FORESTER'S ROLE

Definitions of a forester often rely on their training rather than their function. For instance, "*a forester is a person who has had special education, training, and experience in forestry…*" (Helmes 2002), and "*A forester is a person who by reason of his knowledge of the natural sciences, mathematics, economics and the principles of forestry and by his demonstrated skills acquired through professional forestry education … is qualified to engage in the practice of forestry …*" (Mississippi Board of Registration for Foresters, 1977).

Davis (1960) offered a more informative description, suggesting that the distinguishing mark of a forester was "*a central core of sober concern with the ownership and management of forest lands*" with three closely related parts:

1. the biological and physical sciences bearing on methods of perpetuating and taking goods and services from the forest,
2. the social sciences dealing with the interrelations of people and the impact of their many needs on the forest, and finally,
3. the integrative managerial combination of all skills into effective use of forest areas.

Despite the passage of 36 years, the view of Spurr and Arnold (1971) remains current and is reproduced verbatim: "*… we do not know exactly what the forester of tomorrow will be doing. We do know, however, that it is our responsibility to educate the foresters of the future so that they will be able to cope with future change in the practice of forestry … Foresters are applied ecologists … aware of the whole balance of nature and the total environment of man. … concerned with long-range as well as regional planning. Their time frames are long; their criteria focus on social and/or economic goals; their production and marketing areas are large … As a profession, foresters must seek ways to optimize land use, increase the sustained productivity of forests … Foresters are also scientists. They discover the knowledge required to understand the ecologic, economic, and social systems of which forestry is a part. … foresters are 'managers' in the sense of working in organizations and directing or supervising others. Common management skills must become part of their tools and used effectively. … The forester's job is to manage this [tree-based] environment to maximize its benefits to mankind. … The forester should better recognize man's critical and complex interface with his forest environment, and be prepared to cope with this interface – not to teach man how to minimize his impact on the forest, but to maximize the forest's impact on man. … the forester should surround the cities with forests … He [sic] should develop and protect natural areas, take responsibility for endangered species of plants and animals, and … interpret man's forest environment so that people can understand the costs and benefits in reaching necessary management decisions. … Tomorrow's forester, if not today's, will have to reverse the trend from the more efficient man-simplified ecosystems to more complex ecosystems … Tomorrow's forester must have an holistic approach. … He will understand that he is principal change-agent … To create tomorrow's forester, changes in forestry education must take place … There will be a less obvious connection between professional forestry training and professional activity in the future. The forester will continue to be a generalist, but he must have opportunity for changing and elaborating his training as his education proceeds. Students must be given the opportunity to work as they learn and workers must be given the opportunity to learn as they work. Forestry faculties must be reorganized to be more flexible and more capable of change in themselves. This is the challenge that is before us*."

More recently, Sangster (2002) argued that "*Our job as foresters is to manage place, often on a grand scale. Therefore we are immediately located in the sphere of social action, as well as scientific action. This means … growing emphasis on consultation and participation in forestry*."

My own view of the role of a forester builds on all these views, especially those of Davis (1960) and Spurr and Arnold (1971). I feel that the hallmark of a forester is that s/he

- manages ecosystems characterized by trees, and
- manages these systems at the landscape scale, for the long term, and for many services and several products,
- manages services that are regarded as common property by many interested stakeholders, and
- manages interconnected ecological, economic and social aspects of these systems.

These four points distinguish foresters from agricultural scientists (who tend to manage resources at the paddock scale for an annual production cycle) and environmental scientists (who tend not to have a production focus).

EDUCATING FORESTERS

Preparing a forester to manage such situations involving

landscape-scale, long-term, multiple-use, common-property issues with multiple stakeholders is no easy task, and many writers have offered suggestions, a few of which I review. Westoby (1971) suggested that forestry education should:

- help the student to discern what knowledge is relevant, where to find it, and how to use it;
- bring the student to an understanding of the interrelatedness of phenomena, and the interpenetration of the various disciplines;
- cultivate in the student a sense of responsibility - for his own actions, and for the welfare of others;
- inoculate the student against received doctrine; and to
- help the student overcome the problems, and taste the joys, of cooperating unselfishly with others.

Zabel (1984) drew upon survey results to observe that, in addition to a familiarity of the art and science of forestry, there is a need to develop inter-personal skills, as communication is a part of almost any forestry activity. Wagner (1999) observed that many US forestry graduates lack fluency in both written and oral communication, and that there is a need to develop better critical thinking, synthesizing, and problem solving skills. He argued that interdisciplinary teaching, and the fostering of critical thinking and problem solving skills needs to occur throughout an undergraduate course, not just during the final year, and that the development of these skills required classes in research methods. Wagner (1999) observed five necessary conditions for meeting near-future needs of the forestry profession in the USA:

1. to develop better written and oral communication skills by graduates;
2. to develop better critical thinking, synthesizing, and problem solving skills;
3. to better understand the concepts and interactions, not just the facts, of the analytical, biological, physical, and social sciences as applied to forestry and natural resources;
4. to better balance intra-disciplinary and inter-disciplinary research and teaching;
5. to have the students more actively involved in their learning process, changing from a passive learning model to an active learning model.

The Pinchot Institute for Conservation (2000) argued that silviculture, biometrics, ecology, forest management, and base sciences continue to be critical in forestry, but that expertise in these areas does not provide the skill-set needed to become a successful forester. Ethics and collaborative planning principles were seen as important features omitted from many US curricula. The Pinchot Institute for Conservation (2000) proposed a partnership among US forestry schools to offer a graduate-level curriculum for forestry schools, including:

- Forest auditing, assessment, and certification systems
- Natural resources public relations
- Ecosystem management and biodiversity conservation
- Conflict resolution
- Collaborative planning
- Forest products marketing
- Industrial management systems
- Community-based stewardship
- Forest engineering
- State and federal forest policy

Bourgeois (2001), representing corporate employers, argued that forestry schools should provide graduates with:

- an understanding of strategic landscape-level planning for specified objectives;
- training in silviculture, management and harvesting;
- knowledge of non-timber values and their integration in forest management at the strategic, tactical and operational levels;
- understanding of the social implications of sustainable forest management;
- the ability to appraise sustainability in a scientifically rigorous manner and accounting for both production and conservation objectives;
- communication skills for public presentations and technology transfer; and an
- ability to work as a team member capable of building relationships.

Bourgeois (2001) emphasised the importance of creating an environment and a challenge to attract non-foresters to forestry classes, to provide the cross-fertilization necessary to produce the rounded student required to meet the objectives of sustainable forest management.

An international Expert Consultation on Forestry Education (FAO 2001) noted that rural development should be an explicit part of forestry curricula to foster an understanding of the role of forestry in poverty reduction, food security and sustainable livelihoods, and that forestry education should address the interests and concerns of communities that use and/or live in forests, including issues of equity and forest users' responsibilities and rights in sustainable resource use and management.

Howe (2004) reported that UK employers had noted a decline in the quantity and quality of applicants over the preceding 5 years, and that employers sought candidates with business acumen, marketing knowledge (understanding the market and able to maximize the value of timber), and an ability to work well with people. Howe (2004) concluded that forestry courses should ensure silvicultural competence, reinforced by practical experience and contact with industry, coupled with generic skills such as working with people, consultation, and business skills.

Nobel Peace Prize Laureate Norman Borlaug has attributed his achievements in part, to the broad-based education he received as a forester, because it informed

his capacity to be an innovative scientist, and helped him to translate that innovation into action around the world (Robison 2005). However, it is not the breadth of training itself that is important (many environmental sciences also offer a broad selection of subjects), but the integration of these units in capstone subjects such as forest management planning. However, Innes (2005) observed many forestry programmes lack sufficient integration of material, and advocated an inter-disciplinary approach to produce graduates better able to meet the challenges faced in forestry. Brown (2003) also argued for problem-based learning (PBL) as an effective way to facilitate integration. PBL has gained a large following during the last 50 years, but it is not a panacea: a meta-analysis by Dochy *et al.* (2003) suggest that it is ideal for imparting skills, but that students who experience PBL may gain less knowledge – although they tend to remember more of their acquired knowledge.

CONDUCT OF THE SURVEY

The literature reviewed above relates to the overseas situation, primarily in the USA. A survey of members of the Institute of Foresters of Australia (IFA) was conducted to see how local perceptions compare with these overseas studies. An 8-question survey (see Appendix) was distributed on the IFA email list and in the weekly IFA Bulletin of 20 April 2007, and precipitated 186 responses. Most respondents (93%) took forestry as their first degree; 52% were graduates from the Australian National University, 60% were employed in eastern Australia (ACT, NSW, Qld), and 60% had gained most of their forestry experience working for a government agency. Respondents reported completing their first degree between 1948 and 2007, and 48% of respondents had subsequently completed a second or higher degree.

This is a biased sample, which represents only those IFA members who receive Institute communications by email. No attempt was made to sample forestry graduates who are not IFA members, or who do not receive email correspondence. The study is not a statistical sample of all forestry graduates, but a survey of individuals who are active in shaping the future of the forestry profession in Australia.

One aspect of the survey was to canvass university subjects that respondents thought more or less useful, as well as subjects that in hindsight, they wished they had taken. These findings are summarized in Table 1.

Numbers indicate percent of respondents mentioning each subject. Omits subjects with <5% in all columns.

Table 1 includes only those subjects that were mentioned by at least 5% of respondents. Totals do not sum to 200%, because not all respondents confined their views to two subjects, and because many subjects mentioned infrequently (<5% of respondents, especially in response to the 'should have studied' question) are omitted from the table. The 'least useful' column also omits 12% of responses in which respondents indicated it was not the subject matter that lacked utility, but the delivery that made the content inaccessible (half of these relate to Economics). The score represents the aggregate of 'most useful' plus 'should have studied' minus 'least useful', and is the basis for ranking entries in this table. The score correlates well with comparable studies in the USA, including a study of employer ratings of curriculum needs (r=0.66, Brown and Lassoie 1998), and a survey of consulting foresters (r=0.66, Straka and Childers 2006), suggesting that this ranking is generic across the profession.

The scores reflected in Table 1 depend to some extent on the level of aggregation. Most of the subjects listed in Table are intuitive and are listed exactly as stated in survey responses. One entry labeled 'Community engagement' is a composite entry that also includes some responses entitled conflict resolution, rural development, and rural sociology. Responses regarding subjects that respondents 'should have studied' were many and varied, ranging from the practical (e.g., first aid, 4x4 training) to the more esoteric (e.g., ethics, systematics), and some aggregation of these responses was necessary to allow analyses. About 18% of the responses to 'should have studied' remain unrepresented in Table 1, but these represent diverse interests not easily amalgamated into homogeneous categories representing more than 2% of total responses.

The perceived utility of some subjects is evident at the top (useful) and bottom of Table 1 (not seen as useful), but it is also interesting to note the strong polarization of views towards subjects such as statistics, economics and wood science, all of which have advocates (who nominated these amongst their 'top two' subjects they have studied, or 'should have studied', and who did not report finding these subjects of little utility) and detractors (respondents who found the subject of little utility). Where the temporal (i.e., year of graduation) or spatial trend is significant, the advocate group has been included in Table 1. Thus for instance, mature graduates (those who completed their first degree many years ago) tended to recognize the utility of chemistry, whereas recent graduates found it irrelevant. A temporal trend could be that experience in the workplace changes the perception of utility, or that that there has been a change in the delivery or content of a subject. This reflects a more general trend for older respondents to reflect that "all their studies had been useful at some point in their career", and that "irrelevancies of the past have been forgotten long ago".

An examination of the ranking of subjects in Table 1 suggests that 'integrative' and 'applied' subjects are better received than 'foundation' subjects. For instance, Mensuration contains a great deal of computing, statistics and mathematics, but the former is near the top of Table 1 and is seen as useful, while the latter are near the bottom of the table and are seen as less useful. A challenge for educators is to find ways to make foundation subjects such as chemistry and mathematics more relevant and interesting, perhaps through integration with other subjects and through innovative teaching (such as problem-based learning).

The survey also revealed other notable aspects of forestry training. Half the respondents (48%) volunteered that their bachelor degree programme provided their formative career preparation. A third of these specifically mentioned their

TABLE 1 *Perceived utility of university subjects to career foresters*

Subject	Most useful (%)	Should have studied (%)	Least useful (%)	Score	Advocates
Silviculture	54	3	3	54	Government employees
Human resource management		36	1	36	
Mensuration and inventory	32		2	31	Company employees
Business skills	1	27		28	
Forest management planning	26	1	3	24	Recent graduates
Forest policy	8	15	3	19	Recent graduates
Fire management	14	2	1	15	Southern states
Community engagement	1	13	1	13	
Communication and media skills		14	1	13	
Geographic information systems	1	11	1	11	
Forest ecology	11	1	2	10	
Soil science	8	4	3	10	Mature higher graduates
Computing skills	2	6	2	7	
Forest operations & engineering	12	5	12	5	
Dendrology & botany	10	3	8	5	Mature graduates
Statistics	7	8	10	4	Government & higher grads
Economics	8	6	13	1	Company & higher graduates
Wood science	8	4	16	-4	Recent graduates
Physics & pure mathematics	2		8	-5	Mature & higher graduates
Recreation management			5	-5	
Biology	1		12	-12	Mature graduates
Chemistry	1	1	27	-25	Mature graduates
Total	207	159	132		

Numbers indicate percent of respondents mentioning each subject. Omits subjects with <5% in all columns

vacation work experience and several respondents mentioned the importance of their cadetships (traineeships, or bonded scholarship) in their career development. A further 19% of respondents nominated their mentors as the source of their formative career preparation. Many respondents declined this question or indicated that many factors contributed, so the high attribution to bachelor degree programmes indicates the importance of tertiary training for the profession. These data suggest that the profession and prospective employers are well advised to invest in quality bachelor-level training of foresters, including vacation work experience and support schemes such as cadetships.

Half of the respondents reported experience with more than one form of course delivery, and of these, 44% favoured intensive short courses. A further 18% emphasized that practical fieldwork was an essential element of forestry training. Twelve percent of respondents also mentioned the benefits of close links to industry. Graduates who reported having a cadetship all expressed a conviction that this was the best possible form of career preparation. One graduate from 1999 reflected that "my education wasn't as thorough as those before me", but this is balanced by a 2002 graduate from the same institution who expressed the view that their forestry degree conferred a "significant edge over colleagues with environmental science degrees" (a view expressed by several recent graduates from three institutions). There were also other responses contrasting forestry with other courses: "… I did a double degree … was generally disappointed with the quality of teaching in [the other degree] and did not get much out of the degree. Forestry was a much better degree …". About 5% of respondents volunteered that they saw an on-going role for universities to provide to professional development courses.

Respondents offered a wide range of other observations, a selection of which follows (chosen to illustrate the diverse range of views):

- get back to the basics of forestry … Forest Inventory; Forest Engineering and Harvesting; Wood Science and Technology; Forest Products; Forest Industries; Forest Economics and Accounting Practices; Marketing of Forest Products; Forest Health and Protection; and Working Safely and Productively;
- balance course content to deliver fundamental training in the elements of timber management within a broader context of forests in landscapes managed

for sustainable water, biodiversity, carbon, social and other values;
- content is less important than the delivery, which should be integrative, not reductionist;
- education is more about thinking than about knowledge, so promote investigative skills;
- greatly benefited from the action learning/action research approach …, allowing me to develop a systemic view of issues and to more rigorously approach challenges with an open mind;
- greater emphasis on general skills of problem solving, project management and teamwork;
- critical to be able to manage and communicate with a broad range of people with conflicting views, and my training did not prepare me well for this;
- encourage undergraduates to work in overseas positions prior to graduation;
- learning from the experience of other students (especially after their participation in vacation work) was particularly helpful, so giving students the opportunity to mix across the year levels is important;
- post-graduate courses accessible to professionals in the rapidly changing workplace of forestry and natural resource management.

Finally, an observation from a non-forestry graduate, now an IFA member working in forestry "… formal forestry qualifications are vital for the future of the profession but I think it is equally vital that forestry is offered within other environmental science degrees too. The forestry profession is too inaccessible and esoteric, and part of the reason for that is because formal study of forestry is confined to professional degrees".

DISCUSSION

Earlier it was proposed that the hallmark of a forester was an ability to manage ecosystems characterized by trees, at the landscape scale, for the long term, and for multiple services and products, where some services are regarded as common property and have many interested stakeholders, as well as interconnected ecological, economic and social aspects. Table 2 examines the subjects that could be offered to develop these skills.

Table 2 deals with aspects largely unique to forestry. In addition, there are many leadership skills needed by foresters, that are common to other professions and fields of endeavour (e.g., human resources management, financial management). There are many common elements between Table 2 and the 'Most useful' column of Table 1, indicating the emphasis that forestry schools have placed on the special needs of foresters. However, the 'Should have studied' column of Table 1 offers a rather comprehensive list of the generic skills needed by successful leaders, suggesting that forestry schools have tended to neglect the broader aspects of professional and leadership development.

Table 2 is not exhaustive or incontestable. Others may wish to include Dendrology, to substitute Multiple-use Forestry for Agroforestry, or to narrow the focus of 'Resource assessment' to 'Inventory and Mensuration'. Table 2 is not intended to be the final word, but rather to provoke more discussion on successful ways to create better foresters, and in turn, better forestry and land use outcomes.

The danger in categorizing existing subjects into Table 2 is that it overlooks the need for holistic integrative study. Just as the study of ecosystems is more than the study of its plants and animals (it is the study of the interactions between the plants and animals and the physical environment), so it is with the issues in Table 2. Listing existing subjects will not necessarily create the learning opportunities and outcomes that we seek, and we need to devise innovative ways to achieve these objectives.

The career of some foresters leads them into research or wood processing rather than land management, and they – and other specialists - have training needs not reflected in Table 2. Others, who develop careers in other areas of land management (e.g., national parks, catchment management, land councils, etc), may benefit from many of the subjects outlined in Table 2, but they also need the flexibility to gain expertise in other areas such as hydrology, wildlife management, agronomy, etc.

CONCLUSION

The findings of the present survey are consistent with those obtained elsewhere. They also reveal the diversity of interests within the Australian forestry profession, and illustrate how perceptions about the utility of a subject varies with experience. This indicates the need for caution in interpreting small surveys, and in interpreting surveys of recent graduates who may have limited experience in the

TABLE 2 *Training needs to develop skills in forestry students to deal with 'hallmark' issues*

Hallmark issue	Training to develop required skills
Ecosystems characterized by trees	Ecology, Silviculture, Forest Health
Landscape scale	GIS, Forest management planning
Long term	Economics, Forest policy
Multiple services and products	Resource assessment, Marketing, Agroforestry
Common property with many stakeholders	Participatory modeling, Conflict resolution
Interacting ecologic, economic, social aspects	Systems modelling, Adaptive Co-management

workplace.

The survey reflects the utility of subjects such as silviculture, mensuration and forest management, and highlights the need to include subjects such as human resource management, business studies and communication skills in forestry programmes. Results also suggest that there is the need for more innovation in the teaching of foundation subjects such as chemistry. Ultimately, each student must take the initiative themselves to acquire the skills and experience needed to be a successful forester, but they can be assisted through techniques such as problem-based learning (Lobry de Bruyn and Pryor 2001), action learning (McGill and Beaty 2001), systems thinking (Checkland 1981), and adaptive management (Colfer 2005, Vanclay *et al.* 2006).

Important but unexpected findings from the survey were the high proportion of respondents who stated that their bachelor studies provided their formative career preparation, the acknowledgement of the role of vacation work experience in reinforcing formal academic study, and the conviction expressed by several respondents that cadetships offer the best possible career preparation. The high proportion (44%) of respondents who offered favourable comment about intensive short courses is also noteworthy.

REFERENCES

BOURGEOIS, W., 2001. Requirements of a forestry education from an employer perspective. Meeting of International University Forest Education Leaders, 4 December 2001, University of British Columbia Faculty of Forestry, Vanc ouver BC, Canada. http://www.fao.org/DOCREP/MEETING/007/AD234E/AD234e05.htm 13 April 2007.

BROWN, N. 2003. A critical review of forestry education. *Bioscience Education E-Journal* 1(1):4. http://bio.ltsn.ac.uk/ jpurnal/vol1/beej-1-4.htm

BROWN, T.L. and J.P. LASSOIE. 1998. Entry-Level Competency and Skill Requirement of Foresters: What Do Employers Want? *Journal of Forestry* 96(2):8-10.

CHECKLAND, O., 1981. *Systems thinking, systems practice*. Wiley, NY.

COLFER, C.J.P., 2005. *The Complex Forest: Communities, Uncertainty, and Adaptive Collaborative Management*. Resources for the Future, Washington DC.

DANA, S.T. and E.W. JOHNSON 1964. Selected bibliography on education in forestry and related fields on natural resources management. *Journal of Forestry* 62:541-549

DAVIS, K.P., 1960. What is a Forester? *Journal of Forestry* 58:986-988.

DOCHY F., M. SEGERS, P. van den BOSSCHE and D. GIJBELS, 2003. Effects of problem-based learning: a meta-analysis. *Learning and Instruction* 13(5):533-568.

FAO 2001. Expert consultation on forestry education. Food and Agricu lture Organization, Rome. http://www.fao.org/DOCREP/MEETING/007/Y2993E/y2993e03.htm 13 April 2007.

HELMS, J.A. 2002. What do these terms mean: Forest, Forestry, Forester. *Journal of Forestry* 100:15-19.

HOWE, R., 2004. Review of Higher Education for Forestry. Forestry Commission, Edinburgh.

INNES, J.L. 2005. Multidisciplinarity, interdisciplinarity and training in forestry and forest research. *Forestry Chronicle* 81(3): 324-329.

KANOWSKI, P., 1995. The future of forestry education. *Institute of Foresters of Australia Newsletter* **36**(6):16-21.

LESLIE, A.D., E.R. WILSON and C.B. STARR, 2006. The current state of professional forestry education in the United Kingdom. *International Forestry Review* **8**(3):339-349.

LOBRY DE BRUYN, L. and PRIOR, J. (2001). Changing student learning focus in natural resource management education - problems (and some solutions) with using problem based learning. *In* L. Richardson and J. Lidstone (Eds), *Flexible Learning for a Flexible Society*, 441-451. Proceedings of ASET-HERDSA 2000 Conference, Toowoomba, Qld, 2-5 July 2000. http://www.aset.org.au/confs/aset-herdsa2000/procs/lobrydebruyn.html

McGILL, I. and L. BEATY, 2001. *Action Learning: A Guide for Professional, Management & Educational Development*. Kogan Page, London.

MISSISSIPPI BOARD OF REGISTRATION FOR FORESTERS, 1977. *Mississippi Foresters Registration Law of 1977. http://www.cfr.msstate.edu/borf/faq.asp 13 April 2007.*

PINCHOT INSTITUTE FOR CONSERVATION, 2000. Mainstreaming sustainable forestry graduate education in forestry schools of the United States: a proposal of the sustainable forestry partnership in cooperation with the Pinchot Institute for Conservation, Washington DC.

ROBISON, D.J., 2005. Teaching Borlaug – or valuing the "expertise of breadth". *Journal of Forestry* 103(8):423-424.

SAMPLE, V.A, P.C. RINGGOLD, N.E. BLOCK and J.W. GILTMIER, 1999. Forestry education: adapting to the changing demands on professionals. *Journal of Forestry* 97(9):4-10.

SANGSTER, M., 2002. Forests, places and identities. *Le Perception de la Foret*, Paris, 25-27 November 2002.

SISAM, J.W.B., 1964. Teaching forestry and utilization. *Unasylva 18(4). http://www.fao.org/docrep/18587e/18587e04.htm 13April 2007.*

STRAKE, T.J. and C.J. CHILDERS, 2006. Consulting foresters' view of professional forestry education. *Journal of Natural Resources and Life Sciences Education* 35:48-52.

SPURR, S.H. and R.K. ARNOLD, 1971. The Forester's role in today's social and economic changes. *Journal of Forestry* 69:795-799.

TURNER, B.J., 1996. The future of forestry education. *Institute of Foresters of Australia Newsletter* **37**(1):11-16.

VANCLAY, J.K., 1996. The future of forestry education. *Institute of Foresters of Australia Newsletter* **37**(2):2-6.

VANCLAY, J.K., 2005. Achieving a quiet revolution in forestry education. *Australian Forest Grower* **28**(3):25-26.

VANCLAY, J.K., R. PRABHU and F.L. SINCLAIR, 2006. *Realizing Community Futures: A practical guide to harnessing natural resources*. Earthscan, London.

WAGNER, J.E., 1999. Focus on teaching and learning. State University of New York, http://www.esf.edu/iq/focus/wagner.htm 13 Ap ril 2007.

WESTOBY, J. 1971. Forestry education: to whom and for what? Chapter 7 in: Westoby, J. (1987). *The purpose of forests*. Basil Blackwell, Oxford. 193-205.

WINKENWERDER, H., 1918. Some fundamental problems in forestry education. *Journal of Forestry* 16(6):641-652.

ZABEL, R.A. 1984. Building a better forester. *Journal of Forestry* 82(12):724-729.

APPENDIX

This is the questionnaire that was included in the IFA Bulletin of 19 April 2 007 (http://www.forestry.org.au/news/templates/ifa-bulletins.asp?articleid=733&zoneid=8):

I'm interested in your views on forestry education. This is to inform both an upcoming review of the forestry program at Southern Cross University, and the design of the new National Forestry Masters Program. I'd be very pleased if you could offer a one-line answer to each of the eight questions below, and forward them to me at jvanclay@scu.edu.au. The rationale for the first few questions is fairly obvious. I ask questions 6 & 7 because I suspect that your reflections on the utility of your studies will depend on the stage of your career. All responses will remain anonymous.

1) Of all the subjects you studied at university, which two have been most useful in your forestry career?

2) Of all the subjects included in your university forestry training, which two have been the least useful in your career?

3) Can you suggest any subjects that were not, but should have been included in your forestry training: topics amenable to university teaching, that were not offered in your training, but that you have subsequently found important?

4) Where do you think you gained your formative career preparation: at school, as part of your B.Sc., as part of your higher degree, from a mentor or peer, as on-the-job training, in- service courses, or elsewhere?

5) If you experienced more than one mode of delivery (e.g., external study, intensive short courses) please comment briefly on strengths and weaknesses of each, with respect to your experience and learning:

6) At what institution did you study, what qualification did you gain, and when did you complete your formal forestry education?

7) Briefly describe the role, played by you during your career, that most informs the views you expressed above (eg, district forester for government forest service, sawmill manager, extension officer, etc):

8) Any other observations on your experience of forestry education that may be relevant in reviewing existing courses or designing new courses?