Proceedings 6th National Conference of the Australian Forest History Society Inc, Michael Calver et al. (eds)

A historical forest management conundrum: Do social and biophysical science mix?

Heidi Bigler-Cole
United States Department of Agriculture Forest Service

Peer reviewed contribution

Keywords: integration, philosophy, E.O. Wilson, Wendell Berry, Thomas Gieryn

ABSTRACT: Forest managers face an array of prickly, seemingly intractable environmental problems. They have traditionally turned to the biophysical sciences to help gauge potential management effects, weigh alternatives, and set priorities. Over the past several decades, forest managers have watched management plans disintegrate in the face of grassroots-level protests, quarrels between regional-level regulatory organisations, and even national-level policy disputes. At whatever level, the controversies have a common denominator: they involve conflicting human values, attitudes and behaviors. With this realisation, several forest management efforts have attempted to incorporate social analyses into their scientific base, with limited success. This paper explores three models of social and biophysical scientific integration from Australia and the United States. It then turns to three philosophers who considered the benefits and barriers to integration: E.O. Wilson (an entomologist who advocates consilience, a convergence of all types of knowing); Wendell Berry (a historian who believes knowledge is context-dependent); and Thomas Gieryn (a sociologist of science who identifies cultural barriers to integration). The paper concludes with a summary of the experiential lessons and the philosophers' wisdom.

1 INTRODUCTION

In many ways, forest history has followed the same track in Australia and the United States. Early forest management predominantly focused on conquering the wilderness and, where possible, making a profit in the process. Not everyone subscribed to these values. In fact, the vocal dissenters, such as Australia's C.E. Lane Poole and the United States' Gifford Pinchot and Aldo Leopold, shaped early forest policy by introducing ideas about conservation, sustainability, and ecosystem function (Pinchot 1946; Meine 1988; Borschmann 1999).

These big ideas were, and are subject to myriad definitions and interpretations and, over the last century, have spawned both public and scientific debate. For example, does conservation mean suppressing wildfires so that merchantable timber will not be burned? Does conservation mean keeping humans and their impacts away from selected natural areas? In terms of sustainability, should land management emphasise forest-dependent communities, animal habitats and/or only resources with commercial value? Which resources should receive sustainability priority? When considering ecosystem function, where do humans fit? Are human needs and impacts factored into analyses, or are 'natural' ecosystem functions and processes analysed independent of human influences?

These questions have a common thread running through them: all are based on human values. Land managers, who have traditionally based their management plans on professional and scientific expertise, are finding that their conclusions often lack credibility and/or acceptability amongst their public constituents (e.g., Baird 2005, Blackwood 2005). In the United States, public protests and lawsuits repeatedly halt timber sales. Similarly campaigns launched by conservation organisations and individuals in Australia have caused forest planning efforts to implode (Schultz 2005).

In both countries, scientists and land managers have come to realise that social factors need to be integrated into their analyses and planning efforts. A greater understanding of natural resource issues can be achieved through melding knowledge between social and biophysical science. This integration has been attempted in many contexts. A single, widely accepted model has yet to emerge, although the need is great (Brennan 2004).

This paper seeks historical and philosophical insights that can inform and improve current integration efforts. The paper begins with an overview of three working situations in which integration was attempted, but not fully achieved. I then turn toward three philosophers who have pondered the need for and the feasibility of integration. The paper concludes with a synthesis of practical and philosophical ideas for fostering social and biophysical integration.

For the purposes of this paper, integration means melding knowledge from social and biophysical science to achieve a greater understanding of a problem or phenomenon.

2 THREE ERSTWHILE MODELS OF INTEGRATION

This section presents three integration attempts that fell short of some participants' expectations. I participated in all three projects. The examples are presented with two caveats:

1) although informed by discussions and interviews with participants, my perspectives may not reflect the views of all participants; and
2) these examples are drawn from experiences that occurred between five and 14 years ago. As a result, they may not reflect current practices.

2.1 *Deep Creek Timber Salvage Environmental Impact Statement*

In the United States, the 1969 National Environmental Policy Act (NEPA) guides all public land activities that could affect the environment (e.g., timber sales). The act requires land managers to do a four-part analysis. First, they define the project's purpose and need. Second, they assess and describe current environmental conditions from multiple disciplinary perspectives (e.g., social, economic, wildlife, soils, and timber). Third, they develop a range of prescriptive actions that would meet the purpose and need (e.g., cutting different amounts of timber using alternative timber felling schemes). Finally, they predict the consequences of adopting each of the prescriptive actions. Using these analyses, public input, and personal perspectives, decision-makers choose a course of action.

NEPA prompted at least two major changes in American forest planning: decision-makers now must consider analyses from specialists other than foresters, and they are required to factor human dimensions into their decisions.

Benefits and drawbacks to the law's interpretation can be examined in the 1990 Deep Creek salvage timber sale. The project was planned in the wake of a forest fire that burned approximately 10,000 hectares in Idaho. Land managers moved quickly, as burned timber decays rapidly and loses its merchantability.

As was the custom, public consultation occurred before and after the analysis. However, human dimensions were not factored into the analysis. Instead, members of the public were asked to comment on the rationale behind wildlife habitat management or timber felling techniques. In general, emotion-based comments (e.g., "The timber sale will ruin one of my special places") were dismissed. Instead, project leaders sought out specific, technically based questions (e.g., "The soils analysis on page 45 does not adequately consider soil compaction caused by logging equipment, because…"). Although public comments were duly included in the planning document, their direct impacts on the analysis, if there were any, were not tacitly clear. For this and most other timber sales, the primary mechanism for integrating social and biophysical perspectives was a stapler.

The technique prompted negative consequences under NEPA, which allows members of the public to legally appeal land management decisions. Over the years, individuals and conservation organisations have chosen to raise their concerns in court, rather than during the public comment process. Consequently, natural resource management decisions have been made by judges rather than land managers.

The inability to integrate social and biophysical analyses has been a detriment to natural resources, land managers and the public. Time and budgets have been spent in the courtroom rather than on the ground. As a result, public trust in natural resource management agencies, particularly the United States Forest Service, has eroded over time (Schindler 1996). Although some land managers have developed more inclusive public consultation processes and they have begun to hire social science specialists to do analysis, social and biophysical integration remains a struggle (Elaine Kohrman, pers. comm.).

2.2 *Interior Columbia Basin Ecosystem Management Project*

Providing a landscape-level analysis of social and biophysical conditions was the focus of this ambitious, 8-year project (1994-2001). Approximately 300 scientists and specialists assembled existing data in a project area approximately the size of France. Their analyses would guide restoration priorities in the Pacific Northwest.

Integrating scientific findings, especially social and biophysical findings, proved difficult for several reasons. Most of the scientists were experts with a narrow focus in their fields of expertise (e.g., bryologists, or botanists whose work focuses on mosses). In general, neither the scientists' educations nor their professional experience prepared them to think with other biophysical scientists (e.g., bryologists and landscape ecologists), let alone with social scientists.

Professional language barriers abounded. Commonly used terms had vastly different interpretations across disciplines. For example, empirical findings might mean 'experimental conclusions' to one scientist and 'transcribed interviews' to another. Differing interpretations of words and concepts increased levels of frustration and hampered integration efforts.

Questions of scale provided further challenges. While the biophysical scientists generally had locally collected, fine scale data that had been collected over the course of decades, the social scientists, who were relative newcomers to forest plan analysis, had little to no fine-scale data. Available data were limited to tax records and census data, both at the regional scale. As this was a regional-scale analysis, the biophysical scientists could aggregate existing data and conduct regional analyses more readily than their social science counterparts. As a result, analyses occurred over disparate timelines, which further hampered integrative discussions.

Additionally, social and biophysical scientists generally used different methods and data analysis processes. As a result, it was difficult for scientists to assess the quality of each other's work or to integrate their results. Social scientists were encouraged to use scientific methods and analyses similar to their biophysical counterparts. The suggestion proved frustrating, because the proffered integrative tools (e.g., regional scale maps) were not suitable for characterising some of the pressing social conditions.

On the whole, little social and biophysical integration occurred on this project. Near the project's conclusion, some social scientists attempted to map social trends and conditions using broader scale data obtained from an 8-year-old census and tax records. Scientists from other disciplines produced similar maps. In many cases, the spatially displayed data helped scientists identify how one discipline's trends and conditions influenced those of other disciplines. However, problems came with public scrutiny. While most members of the public weren't particularly knowledgeable about fire regimes or fish habitat, the majority had solid ideas about the social dynamics of their communities and regions. However, when they looked at the broad scale maps, they often saw inaccuracies: they couldn't see their stories in the data. Mistrust of the social data led many constituents to question the validity and reliability of data from other disciplines.

This project offered many lessons for future integrative projects. Chief among them is that integration requires participants who are willing to think beyond their specialties' boundaries. While natural resource questions require analyses from people with in-depth expertise, they also require generalists who can see disciplinary linkages and explore the resulting research questions. As post-graduate studies tend to emphasise depth over breadth, there are fewer scientists who think across disciplines. However, a few of the project's scientists and specialists were expansive thinkers who worked to combine social and biophysical information, despite language barriers, methodological conventions scale-related issues, and data availability. They tended to have generalist backgrounds, interdisciplinary curiosities and patience. For example, there is Wendell Hann, an avid horsepacker whose ties to wilderness areas are both personal and professional. Hann trained as a wildland fire-fighter, a fire ecologist, and a landscape ecologist. He examined data across disciplines and scales and saw patterns in wildfire regimes that had not previously been discovered. His observations were shared with other scientists and members of the public in a way that they meshed with others' professional training and experience. Hann's success is not isolated; others made integrative in-roads. Several participants are using their hard-won integration skills and lessons in current integrative endeavours.

2.3 *Western Australian Regional Forest Agreement*

In Australia, both State and Commonwealth laws address environmental protection; however, each State independently determines most environmental standards and practices. Driven primarily by local politics, each State has taken a different approach to environmental management. As a result, there are frequently State and Commonwealth (national) constitutional conflicts (Dargavel 1998). It was such a conflict that helped initiate the Regional Forest Agreement (RFA) process in 1992 (Commonwealth of Australia 1992). Under the Export Control Act 1982 (Commonwealth), States must meet Commonwealth criteria in order to be licensed to export wood chips. This license renewal process became an annual focal point for the forest debate. Resolving the debate, or at least removing it from the national political agenda, became a driving force behind the RFA process.

RFA projects were scheduled throughout Australia, and process organisers developed an over-arching set of goals and objectives. As a result, all RFAs were regionally-based, so they could address locally relevant management needs. Each was to establish a system of 'comprehensive, adequate and representative' habitat reserves. Representatives from State and Commonwealth governments, including all resource and environmental agencies, were to coordinate the process and, in the end, develop a series of binding land use agreements. These agreements would last 20 years allow States and industrial representatives to negotiate natural resource agreements without Commonwealth government intervention (Dargavel 1998).

In Western Australia (WA), the RFA process was orchestrated by a steering committee whose responsibilities included setting local goals and objectives, defining scientific needs and integrating research results into a Comprehensive Regional Agreement (Western Australian Regional Forest Agreement Steering Committee 1997). The eight-member committee consisted of Commonwealth and State representatives. Neither scientists nor members of the public were included on the WA steering committee; organisers feared an all-inclusive steering committee would prove unwieldy (Alan Walker, pers. comm.).

The steering committee identified research needs and commissioned a series of scientific studies and syntheses that covered environmental, indigenous heritage, economic, and social values. The lead land management agency, WA's Department of Conservation and Land Management (CALM), rarely used social analyses. At the time, they had no social scientists on their staff, so the work had to be contracted.

Integration in this instance was efficient, as Steering Committee members were responsible for sifting through the studies and developing the RFA's scientific framework. However, for many disenfranchised scientists, members of the public and other stakeholders, the process was suspect. They questioned the RFA's objectivity and completeness (Bigler-Cole 1999).

Integrating social science was particularly problematic in this RFA, because some participants distrusted the discipline's potential influence on the decision-making process. Neither the WA nor the Commonwealth governments offer opportunities to lodge legal complaints about forest management. Likewise, agencies are not legally required to use public input. Although WA RFA organisers strove for a transparent process and offered many opportunities for public consultation, many members of the public generally believed that there were no meaningful ways to influence the planning process. Some participants feared—or hoped—that the social science analyses became subjects of intense professional and personal scrutiny. Various members of the public investigated the social scientists' personal affiliations, publicly impugned their personal integrity, and questioned motives behind their research methods. Many members of the public perceived that the social analyses were being conducted by advocates, not scientists. The fact that their offices were not co-located with their biophysical science counterparts underscored their separateness.

Scientific and political boundaries are blurred in Western Australia. The scientists and managers are co-located and they are funded from the same source. Furthermore, in the case of the RFA, land managers determined research directions and which findings were incorporated into the planning effort's scientific framework. However, other scientists and members of the public also found this arrangement suspect. They theorised that RFA organisers were financing and integrating only the science that would justify continued woodchip exports. Therefore, in many eyes, the science backing the RFA was not objective and the scientists, especially the social scientists, were viewed as advocates (Bigler-Cole 1999). In this case, integration was efficient; however, they didn't have a lasting impact. Some scientists ((e.g., Horwitz and Calver 1998, Buchy and Hovermann 1999) but not all (Davey et al. 1997, 2002) and members of the public questioned the plan's quality and trustworthiness. Eventually, both the WA RFA and the organisation that produced it were discarded.

2.4 *In summary*

Common threads run through the three working models of social and biophysical integration. In all cases, project organisers wanted to incorporate a social layer into their analyses. Similarly, all projects had finite budgets and timelines. As a result, project organisers sought efficient integration mechanisms. In the Deep Creek Timber Salvage Sale, the mechanism was a stapler. ICBEMP organisers used interdisciplinary discussions and regional-scale maps as a means for integration—a process far more expensive and time consuming than anticipated. The WA RFA delegated the task to a steering committee populated by government-employed land managers. None of the models worked as hoped; many constituents either had reservations about accepting the planning outcomes or they rejected them outright. None of the integration models were considered unmitigated successes.

3 PERSPECTIVES FROM THREE PHILOSOPHICAL SAGES

Hoping that professional thinkers might offer insights, I sought counsel in the literature. Wilson, Wendell Berry, and Thomas Gieryn offer divergent perspectives that could inform future integration efforts.

This section briefly introduces the men and the historical and social contexts which have shaped their thinking. The section concludes with a panel discussion guided by two questions. The sages' hypothetical answers are compiled from their writings.

3.1 *The panelists and their contexts*

3.1.1 *E.O. Wilson*

E.O. Wilson was trained as a myrmecologist who began his academic career studying ants' social behavior. His approach to his work is heavily influenced by a post-positivist perspective, which shapes most natural resource-related biophysical research (Wilson 1994).

In short, post-positivists believe only one true explanation exists for any given phenomenon. Scientists operating under this paradigm generally formulate narrow, testable research questions. They believe research results can be aggregated and used to understand more complex phenomena.

Historically, post-positivists have used conflicting theories to test hypotheses. However, it is understood that only the 'true' theory will stand; all others will be disproved (Guba and Lincoln 1998).

Throughout his career, Wilson has been both a synthesiser and a world-class aggravator. He gained the former title, in part, through his pioneering work in biodiversity, describing why ecosystem health is dependent upon maintaining organism diversity (Wilson 1988). His syntheses and generalisation have often been controversial, especially his published work on sociobiology. In this work, Wilson (1995) asserted that biology pre-determined human nature and behavior. Some historians and social scientists compared his work to Nazi science, because it inferred that some human races are genetically inferior (Bradley 2004).

In *Consilience*, Wilson (1998) developed an ambitious framework for unifying all forms of knowledge, including science, religion and history. For the most part, his work inflames rather than unifies people from other fields. With post-positivism as the basis for his framework, he dismissed disciplines that allowed for alternative perspectives (Ceccarelli 2001). Consequently, the social sciences, with the possible exception of psychology, were deemed inappropriate for his framework. He suggests religions would fit, because they can be explained and represented by astrophysics (Wilson 1998).

3.1.2 *Wendell Berry*

Wendell Berry was one of one of Wilson's most vocal critics. He channeled his vexation into a book denouncing Wilson's ideas of consilience (Berry 2000). A modern day renaissance man Berry is not easily categorised. He is by turns a theologian, a historian, a poet, a tobacco farmer, conservationist and a rural community advocate. His family has lived in a small agricultural community for generations. His affinity with that community and its landscape has shaped his values and given an experiential basis for his concerns. For example, the eastern part of his native Kentucky is rife with corporately-owned coal mines. Prior to environmental laws, the mines operated for decades with no regard for environmental consequences. He writes:

> The damage has no human scale. It is a geologic upheaval. In some eastern Kentucky counties, for mile after mile after mile, the land has been literally hacked to pieces. Whole mountain tops have been torn off and cast into the valleys. And the ruin of human life and possibility is commensurate with the ruin of the land. It is a scene from the Book of Revelation. It is a domestic Vietnam (Berry 1970, p. 174).

Two common themes run through Berry's work. First is the idea that conservation is community choice, and only community members who revere and love a specific landscape are capable of conserving it. The second theme concerns the unbridled and unthinking use of science-based technology. Berry is concerned that corporations do not consider the potential consequences of their newly-developed tools. As a result, both human and environmental communities are suffering great damage (Berry 2000). Given these themes, Berry believes that decisions about resource use are best left in the hands of community members. For example, he believes that forest community members would favor sustainable timber harvest, and thus they would choose forest management schemes that employ the most local people for the longest time with the least damage to forests and soil. In such a situation, there would be no need for labor-saving machinery, because forests would be managed for local jobs and local markets. He warns against giving non-residents responsibility for the land's bounty and health. Corporations use larger economies of scale and the needs of local communities rarely rank high on the priority list (Berry 1995).

3.1.3 *Thomas Gieryn*

Thomas Gieryn is affiliated with one of the most spurned and condemned branches of science: he is a sociologist of science. Rather than view scientists as objective truth seekers, Gieryn and his disciplinary colleagues examine science using an anthropological perspective. Latour and Woolgar (1979) compare scientists to members of primitive tribes. They suggest that members from both groups conduct their lives and judge each other based on culturally-based rules. To justify the sociological examination of science, Gieryn (1999) notes that scientists and their conclusions wield powerful influences on corporations, personal lives, and society. Understanding how scienctific practices, skills, texts and achievements attain power presents compelling sociological questions. Understandably, some scientists bristle at the idea that their work is culturally-based rather than truth-based. Also, many feel uncomfortable being scrutinised and analysed like objects under a microscope. They have been known to launch attacks in the peer-reviewed literature (Labinger 1995).

Some sociologists of science approach their work from a variety of perspectives. Some take a post-positivist approach and search for traits that universally apply to powerful scientists (e.g., professional moral codes, how scientists evaluate peers, characteristics of frequently published scientists) (Gieryn, 1995; Sonnert, 1995; and Shadish, 1995).

Gieryn, however, belongs to a different philosophical camp: constructivism. Constructivists believe, in part, that truth is contextual, not universal (Guba and Lincoln 1998). Thus, Gieryn believes scientific power can only be understood episodically. While researching European and American science power plays, he discovered that elements influencing power shifts include historical context, cultural norms, the personalities involved, and participants' relative skills in using rhetorical devices (Gieryn 1999).

A self-described cultural cartographer, Gieryn describes his findings using a map metaphor. Boundary lines on the map determine which disciplines or individuals fall within the realm of science and which do not (and, as a result, lose the power of a scientific endorsement.) The map's boundary lines are not static; they shift with contextual changes.

With the introductions complete, I will now convene the panel. In an attempt to understand whether social and biophysical integration possibilities, I will ask two questions:

1) What is science?;
2) How can social and biophysical science be integrated?

3.2 *What is science?*

3.2.1 *E.O. Wilson*

E.O. Wilson's definition is simple and straightforward: "Science...is the organised, systematic enterprise that gathers knowledge into testable laws and principles" (Wilson 1998, p. 58).

He further suggests that five qualities distinguish science from 'pseudoscience':

1) *Repeatability*—Attempts to replicate experiments are made, preferably by independent investigators, and novel experiments and analyses are used to confirm or discard original findings;
2) *Economy*—Scientists are to strive for elegance, by presenting information in its simplest, most aesthetically pleasing form. The goal is to present the most information with the least effort;
3) *Mensuration*—Universally accepted measurement scales must be used, so that resulting generalisations are unambiguous.
4) *Heuristics*—Stimulating new research questions and new discoveries is a by-product of the best science. New knowledge can also be used to test the original principles that led to its discovery; and
5) *Consilience*—scientific explanations that connect or are consistent with other explanations are the most likely to survive (Wilson 1998).

In Wilson's eyes, science strives to explain complexity. Reductionism, or dividing nature into its natural components, allows scientists to progressively understand pieces of complex systems. Wilson suggests that consilience is achieved as laws and principles are aggregated or 'folded into' those at higher, or more fundamental levels. Total consilience occurs when links to the simple laws of physics are established (Wilson 1998).

As a post-positivist, Wilson does not believe that scientific truth is contextual. As a result, he would reject the idea that Gieryn's work is science.

3.2.2 *Wendell Berry*

Wendell Berry is not a scientist and readily admits that he cannot evaluate scientific methods or truth claims. He has experienced the costs and benefits of science and he focuses his concerns on science's often unwitting impacts on society. Science, he says, has become a form of religion so powerful that, once established, it cannot be easily challenged (Berry 2000).

Because science is so powerful, Berry believes that practioners should approach their work with humility and caution. Scientists often fail to consider potential ramifications of their work; the search for greater understanding can lead to technology powerful enough to destroy the world. As an example, he cites federally financed research conducted at the United States National Aeronautics and Space Administration (NASA). Work touted as space exploration also supports the military-industrial complex (Berry 2000).

Berry acknowledges that science provides unique and important insights, but he argues that science's reductionist nature often misses the big picture:

> For quite a while, it has been possible to a free and thoughtful person to see that to treat life as mechanical or predictable or understandable is to reduce it…Cloning—to use the most obvious example—is not a way to improve sheep…Cloning, besides being a new method of sheep-stealing, is only a pathetic attempt to make sheep predictable. But this is an affront to reality. As any shepherd would know, the scientist who thinks he has made sheep predictable has only made himself eligible to be outsmarted (Wilson 2000, p. 7).

In short, Berry questions the authority that society has given science, given its limitations. "To know some things is to know other things not so well, or not at all. Knowledge is always surrounded by ignorance" (Berry 2000, p. 60).

3.2.3 *Thomas Gieryn*

Gieryn asserts that science does not have a static definition; that the boundary between science and non-science is continuously shifting (Gieryn 1983). Thomas Kuhn, another scientist who has examined science's inner workings, suggests that scientific boundaries change with new knowledge; they advance and recede as new ideas are tested further or disproved (Kuhn 1970). In contrast, Gieryn suggests that boundary shifts are motivated by scientists' quests for authority, jobs, fame and influence. For instance, social scientists are not considered to be full members of the scientific community unless their presence furthers the quest (Gieryn 1999).

As an example, Gieryn documented how United States politics influenced definitions of science through research funding. An abbreviated summary follows: In the 1930s, politicians were faced with social problems that accompanied the Great Depression. The New Deal, a federal program designed to reverse the impacts of the Depression, funded social scientists to inform policy on unemployment, poverty and stagnation. During this time, biophysical research products were considered luxuries and received comparatively little funding. Political needs for science shifted during World War II—developing technology that would boost the war effort (e.g., the atom bomb) was the pressing priority. At the war's conclusion, Congress established the National Science Foundation (NSF), which would administer federal scientific research funds. At this time, the definition of science was hotly debated. On the heels of their technological successes, biophysical scientists argued that social scientists could not do basic science and that their methods weren't truly scientific. One Senator in particular, Harley Kilgore, disagreed with their logic. A sponsor of the social science funded by the New Deal, he argued science was a public resource that supported public betterment. Thus defined, he said social scientists should have access to NSF funding. The biophysical scientists won the debate, and were the exclusive recipients of NSF funding until their monopoly was again questioned in the 1960s. Once again, the greatest political pressures belonged to the social arena, where dealing with racism, poverty, crime, and health became a priority. Because there was no federal outlet for social research monies, Senator Fred Harris introduced legislation that would create the National Foundation for Social Science. Fearing that available funding resources would be split, the NSF argued that social science really belonged in their realm. The biophysical argued that the two branches of science should be unified, since current research priorities would benefit from an integrative perspective. The biophysical scientists' arguments again held sway, and NSF remained the main federal funding source. However, the NSF's current definition of science does not include all social scientists. Proposals with a post-positivist foundation are more likely to be funded (Gieryn 1999).

3.3 *How can social and biophysical science be integrated?*

3.3.1 *E.O. Wilson*

According to Wilson integration can occur if all scientists, humanists and religion practitioners base their knowledge on one common assumption: culture and other unique human qualities only make sense when they are causally linked to the natural sciences, especially biology. He believes that once all forms of knowing are grounded in this assumption, it will be possible to reduce them to their most basic forms. The disparate parts can then be synthesised into a holistic understanding. The holism is necessary to understand complex systems— cause and effect explanations can be developed across all disciplines and all levels of organisation, from the cell to the ecosystem.

3.3.2 *Wendell Berry*

Barry bristles at the thought that reductive, biology-based thought is the common denominator for understanding the world's complexity. He bases his refutation on science's limitations. First, he suggests that Wilson's description of holism is "neither whole nor holy" (Berry 2000, p. 34). He suggests Wilson's holism is based only on parts we are able to isolate, and we can only have a limited understanding of those parts. Second, Berry questions whether our system can support the interdisciplinary conversations required to achieve consilience. Professional thinkers are often caught in the rigours and demands of what he calls "academic Darwinism." Faced with the publish or perish mentality, academicians often focus single-mindedly on their work and, as a result, they don't have the grounding that comes with belonging to a land-based community. As a result, they are generally incapable of gaining holistic insights on a personal level. Furthermore, the culture in many academic/research institutions is competitive, rather than complementary. Barry's experience tells him that there is little institutional support for integration. Finally, he questions the purpose of integration. If protecting the environment is the goal, science makes an important contribution—it provides important knowledge, such as the existence of a species or the value of species diversity. However, "…it cannot replace and cannot become the language of familiarity, reverence and affection by which things of value are ultimately protected" (Berry 2000, p. 41).

3.3.3 *Thomas Gieryn*

For Gieryn, social and biophysical science integration is a pragmatic matter: it is only possible if it benefits the scientists in power. In Gieryn's estimation, this type of integration is guided by post-positivist assumptions. Social scientists whose work has humanistic, qualitative leanings are less likely to be included (Gieryn 1999). Having the full spectrum of social science paradigms can be critical, especially with natural resource issues. Social scientists in the post-positivist camp tend to ask questions beginning with 'what', 'who', 'where', and 'when'. These questions are more readily captured with quantitative approaches. Conversely, 'how' and 'why' questions lend themselves to qualitative, humanistic approaches (Yin 1994). A social science analyses that avoid 'how' and 'why' questions can be a handicap to an integrative project—these are the questions that can enable people to find themselves in the data.

After examining integrative attempts across time and space, Gieryn concludes that there are few natural linkages between social and biophysical research. In terms of practical applications, the two branches of science tend to inform each other sequentially rather than simultaneously. Consequently, he sees no reason why science should be integrated institutionally. He concludes that biophysical and social science should be funded separately, so that social scientists are able to use the full spectrum of tools to answer socially compelling research questions (Gieryn 1999).

4 CONCLUSIONS: AN EVOLVING MODEL OF INTEGRATION

American and West Australian scientists are ethically and legally bound to integrate their work into the social context. The question remains: how can social and biophysical integration be improved? The historical and contemporary perspectives presented in this paper may provide insights for future social/biophysical integration attempts.

In summary, the Deep Creek Timber Salvage sale demonstrated both the need for integration and that using a stapler falls short of the mark. The Interior Columbia Basin Ecosystem Management Project illustrated that collaborative, discursive forms of integration are time-consuming and expensive. The project also highlighted cultural barriers to integration: disciplinary specialisation; differences in language, methods and analysis; and inequities in data availability. Experience indicated that not all scientists have the interest and/or skills to integrate. Generalist backgrounds, interdisciplinary curiosities, and patience characterised those who embraced the challenge. The WA RFA offered several lessons for future integrative efforts. First, project participants learned that integrative efficiency comes at the expense of inclusiveness. The organisers' attempts to streamline the process backfired. Second, the project demonstrated difficulties that can emerge when science/management boundaries are blurred and social science is perceived to be a more powerful form of public consultation.

On the philosophers' side, several points warrant further consideration. Berry's notion that all land management and resource extraction should be done at the community level is not realistic given our current natural resource management organisations and fiscal limitations. However, his belief that integration means combining the 'dispassionate and objective' voice of science with the local voices of those who have emotional and spiritual ties to the land merits future thought. Although Wilson's post-positivist prescription for integration irritated some and inflamed others, some of his suggestions may be helpful to future efforts. Wilson followed the formula taught to post-graduate students: he articulated a suite of integrative questions and then chose the analytic framework he believed to be appropriate. The "first the questions, then the tools" mantra might be useful for future integration process development. Gieryn concludes that complex social questions are best addressed by the full range of social science tools and paradigms. Following his reasoning, it would be interesting to see how a social/biophysical integrative project would operate if the organising framework were social, rather than biophysical.

Integration is an evolutionary process. In all of the working examples, participants used the knowledge and skills at their disposal. While none of the described projects serves as a stellar example for integration, there were incremental successes. In 1990, when the Deep Creek Salvage Timber Sale occurred, nobody realised that it was possible to do a social analysis comparable to those of the biophysical analyses. Now research and management are gingerly asking for social science input. Universities have recognised the importance of interdisciplinary thinking, and scholarships, departments, and courses of a cross-disciplinary nature are being developed. The broad scope and integrative nature of current land management and research indicates how perspectives and priorities have shifted. Exciting things are happening.

This analysis offers several salient lessons including: "Avoid the stapler"; "Seek the broad thinkers"; "Expect inefficiency"; "Meaningfully involve the community", "Choose the question and then the tools", and "Enjoy the challenge". Social and biophysical integration is necessary, and therefore it is possible.

ACKNOWLEDGEMENTS

This research benefited from anonymous and identified interviews with participants in the Deep Creek Salvage Timber Sale, the Interior Columbia Basin Ecosystem Management Project, and the Western Australian Regional Forest Agreement. The author specifically thanks the integrative thinkers who helped hone the ideas in this paper: Marti Aitken, Ian Barns, Mike Calver, Wendell Hann, Jane L. Hayes, Bridgett J. Naylor, Thomas M. Quigley, and Andrew Youngblood.

REFERENCES

Baird, D. 2005. A tale of two processes: the resource advisory commission (USA) and the Regional Forest Agreement (Australia). In: Calver, M.C., Bigler-Cole, H., Bolton, G. Dargavel, J., Gaynor, A., Horwitz, P., Mills, J. and Wardell-Johnson, G. *A forest conscienceness*. Rotterdam, Netherlands: Millpress Science Publishers.

Berry, W. 1970b. *A continuous harmony; Essays Cultural and Agricultural*: San Diego: Harcourt Brace & Company.

Berry, W. 1995. *Another turn of the crank*. Washington D.C: Counterpoint.

Berry, W. 2000. *Life is a miracle; an essay against modern superstition*. Washington, D.C.: Counterpoint.

Bigler-Cole, H. 1999. *Perceptions of science in the Western Australian Regional Forest Agreement process*. Master's thesis. Perth: Murdoch University.

Blackwood, J.D.. 2005. People, their values and forest management – an American experience. In: Calver, M.C., Bigler-Cole, H., Bolton, G. Dargavel, J., Gaynor, A., Horwitz, P., Mills, J. and Wardell-Johnson, G. *A forest conscienceness*. Rotterdam, Netherlands: Millpress Science Publishers.

Borschmann 1999. *The people's forest; a living history of the Australian bush.* Blackheath, NSW: The People's Forest Press.

Bradley, C. 2004. Stephen Jay Gould: An appreciation. *New Politics*, 36, www.wpunj.edu/newpol/ issue36/Bradley36.htm, accessed November 15, 2004.

Brennan, A., 2004. Biodiversity and agricultural landscapes: can the wicked problems be solved? *Pacific Conservation Biology* 10: 124-142.

Buchy, M. and Hoverman, S. 1999. *Understanding public participation in forest planning in Australia: How can we learn from each other?* Canberra, Australia: Australian National University Forestry Occasional Paper 99.2.

Ceccarelli, Leah 2001. Shaping Science with Rhetoric; The cases of Dobzhansky, Schroedinger, and Wilson. Chicago: University of Chicago Press.

Commonwealth of Australia 1992. *National forest policy statement; A new focus for Australia's forests*. Canberra.

Dargavel, J. 1998. Politics, policy and process in the forests. *Australian Journal of Environmental Management* 5(1): 25-30.

Davey, S.M., Hoare, J.R.L. Rumba, K.E. 2002. Science and its role in Australian Regional Forest Agreements. *International Forestry Review* 4: 39-55.

Davey, S. M., Hoare, J.R.L., Binning, C. Bright, C. 1997. Assessment of ecologically sustainable forest management for Regional Forest Agreements. In Preparing for the 21st century, ed. E. Bachelard A.G. Brown, Pp. 235-246 Canberra, Australia: Institute of Foresters of Australia.

Gieryn, T.F. 1983. *Boundary-work and the demarcation of science from non-science: strains and interests in professional interests of scientists*. American Sociological Review. 48:791-95.

Gieryn, T.F. 1995. Boundaries of Science. *Handbook of science and technology studies*. Thousand Oaks, California: Sage Publications.

Gieryn, T.F. 1999. *Cultural boundaries of science; Credibility on the line.* Chicago: University of Chicago Press.

Guba, E.G. and Lincoln, Y.S. 1998. Competing paradigms in qualitative research. *The landscape of qualitative research; theories and issues.* Thousand Oaks, California: Sage Publications.

Horwitz, P. and Calver, M. C. 1998. Credible science? Evaluating the Regional Forest Agreement process in Western Australia. *Australian Journal of Environmental Management* 5: 213-225.

Kuhn, T.S. 1970. The structure of scientific revolutions. Chicago: University of Chicago Press.

Labinger, J.A. 1995. Science as culture: A view from the petri dish. *Social Studies of Science*. 25:285-306.

Latour, B. and Woolgar, S. 1979. Laboratory life: The social construction of scientific facts. Beverly Hills, California: Sage Publications.

Meine, C 1988. *Aldo Leopold: His life and work*. Madison, Wisconsin: University of Wisconsin Press.

Pinchot, G. 1947. *Breaking new ground*. Washington, D.C.: Island Press.

Schultz, B. 2005. Getting involved: a persional account of involvement in the forests debate in Western Australia. In: Calver, M.C., Bigler-Cole, H., Bolton, G. Dargavel, J., Gaynor, A., Horwitz, P., Mills, J. and Wardell-Johnson, G. *A forest conscienceness*. Rotterdam, Netherlands: Millpress Science Publishers.

Shadish, W.R. *et al*. 1995. Author judgments about works they cite: three studies from psychology journals. *Social Studies of Science*. 25:477-498.

Shindler, B. 1996. *Forest management in the Blue Mountains: public perspectives on prescribed fine and mechanical thinning.* Corvallis, Oregon: Oregon State University.
Sonnert, G. 1995. What makes a good scientist?: Determinants of peer evaluation among biologists. Social *Studies of Science*. 25:35-55.
Western Australian Regional Forest Agreement Steering Committee 1997. *Information kit: A regional forest agreement for Western Australia.* Perth: Commonwealth of Australia.
Western Australian Regional Forest Agreement Steering Committee 1998. *Comprehensive regional assessment: A regional forest agreement for Western Australia.* Perth: Commonwealth of Australia.
Wilson, E.O. 1975. *Sociobiology; The new synthesis.* Cambridge, Massachusetts: Harvard University Press.
Wilson, E.O. 1994. The Naturalist. Washington, D.C.: Island Press.
Wilson, E.O. 1988.The current state of biological diversity. Biodiversity. Washington, D.C.: National Academy Press.
Wilson, E.O. 1998. *Consilience;* The Unity of Knowledge. New York: Vintage Books.
Yin, R.K. 1994. Case study research: design and methods. Thousand Oaks, California: Sage Publications.